Technical Report and Recommendations for Mission-Critical Voice Communication Systems in King, Pierce and Snohomish Counties

February 22, 2012

Prepared for the Radio Executive Policy Committee
by the Project Steering Committee

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1. Executive Summary

The radio systems used by emergency workers in our three-county Region face significant service degradation unless we begin upgrading or replacing these systems soon. The degradation will result from a combination of factors including age of the equipment, increased service demands, and the withdrawal of vendor support. This degradation could take the form of degraded sound quality, service outages and interruptions leading to delays in response times, greater difficulty in incident coordination, and increased danger to our police officers, fire fighters, paramedics, and the public.

Some systems within the Region require significant upgrades or replacement to meet federal regulatory requirements and changing operational requirements, to accommodate population shifts, and to compensate for increased metropolitan building density. Current systems have demonstrated a lack of capacity for large scale events involving natural disasters or critical incident responses.

It takes many years to replace radio systems of this size and complexity. For example, when the King County Emergency Radio Communication System was built, it took five years from the time funding was approved until the system was fully operational. While there will always be some risk of system failure when operating a public safety radio system, the current elevated risk will not return to acceptable levels until all outdated components have been replaced. Thus, we must begin work now to avoid this otherwise inevitable increase in risk to the public and our first responders.

Work to address the need by public safety agencies for wireless Broadband data is being done through a separate planning effort and is not discussed in this report.

Background

There are eight primary public safety Land Mobile Radio (LMR) systems operating in the Region. Most are interconnected in some manner to allow end users to communicate with one another across systems.

Several issues affect these radio systems:

- The oldest systems include components that are almost 18 years old. The electronics themselves are reaching a point of increasing unreliability.
- Some critical SmartZone system components are no longer sold or supported, and the vendor has said that it will discontinue sale of

other components in phases over the next few years (2011-2013). Original components are still available on the secondary market; however, there is significant risk in relying upon secondary market equipment because the condition and service history of the components is unknown and the needed version of any particular component may not be available.

- Improved coverage is needed in some areas, but cannot be implemented because the vendor no longer ships the version of Radio Site equipment needed for our systems.

- Existing VHF and UHF radio systems must comply with the Federal Communications Commission (FCC) Narrowbanding mandate. They must act immediately to upgrade or replace Mobile and Portable radios and other radio system equipment before the January 1, 2013 deadline.

- Various factors influence the degree of urgency with which radio system owners must respond to these issues:

    - King County's radio system contains electronic components that are almost 18 years old, and some critical parts are no longer sold or supported. Because the system is very complex and has over 16,000 users, it will take several years to upgrade or replace it.

    - Vendor support for Port of Seattle's system will end in July 2016, and the Port must act by 2013 to avoid potential system degradation or failure. Already, if a Dispatch Console fails, it cannot be replaced because the Port's system does not support the vendor's current version of Dispatch Consoles.

    - Pierce County operates a VHF radio system that is subject to the FCC Narrowbanding mandate and must act immediately. In November 2011, Pierce County voters approved a tax measure to improve public safety communications throughout the county. Pierce County plans to purchase 4,000 new radios and upgrade the Pierce Transit 700 MHz system to P25 Phase 2 to serve agencies that currently use the Pierce County Government VHF system. Tacoma and Puyallup plan to upgrade the Tacoma-Puyallup 800 MHz system to P25 Phase 2 to provide a consistent technology platform throughout the county.

- Washington State Patrol (WSP) plans to Narrowband statewide VHF Interoperability channels and to move its main dispatching operations from the existing VHF radio system over to the Department of Justice VHF P25 narrowband radio system prior to the Narrowbanding deadline, January 1, 2013.
- SERS has the newest radio system equipment. Because of the newness of its system and due to contractual vendor obligations, support for the SERS radio system may extend beyond other systems in this report. Bonds that funded portions of the SERS radio system do not mature until 2020. Snohomish County does not plan to seek additional funding to replace its current radio system until those bonds mature.

Options Considered

The Project Steering Committee (PSC) evaluated four options:

1. Keep existing Land Mobile Radio (LMR) systems in place.
2. Follow Motorola's recommendations to migrate existing SmartZone LMR systems to P25 Phase 2 LMR system(s).
3. Build new P25 Phase 2 LMR system(s) to replace existing LMR systems.
4. Build a regional Long Term Evolution (LTE) cellular system for mission-critical voice.

Within these options, alternatives were evaluated. For example, Option 2 and Option 3 both considered technical and operational questions relating to whether we should continue to have multiple independent radio systems linked together or a single, regional radio system.

The options were evaluated according to the following criteria:

- Coverage
- Spectrum
- Mobility and Interoperability
- Reliability
- Implementation and Transition
- Scalability
- Local Service Delivery and Control
- Encryption Key Management

- Over-the-Air-Programming (OTAP) and End User Template Management
- GPS-Enabled End User Devices
- Broadband-Enabled End User Devices

Options were evaluated with a planning horizon of 2015-2030. Viable options must offer capabilities and performance that are equal to or better than current systems. Transitioning 30,000 radios to new or upgraded system(s) must be simple from the end user perspective to the maximum extent possible. End user uncertainty during transition could put the safety of first responders and the general public at risk.

PSC Assessment of the Options

Option 1

There are two potential benefits to Option 1, keeping existing systems in place. First, doing so may enable us to minimize or defer costs in the short term. Whether we choose to upgrade or replace our systems, the costs could potentially run in the hundreds of millions of dollars. Second, some observers hope that keeping existing systems in place may enable us to avoid building another generation of LMR systems, giving time for future public safety wireless communication technology to develop and mature.

However, Option 1 will not allow radio system owners to improve coverage, add capacity, or make it easier for agencies across the Region to communicate with others on an everyday basis and during large incidents. Option 1 is also time-limited by vendor end of support dates. End of support means that the vendor no longer maintains systems, repairs failed components, or provides technical "help desk" support.

The risk for SmartZone radio systems is that a key part will break and can't be replaced, causing reduced coverage, capacity or voice quality, or complete system failure. The degree of risk for any particular system is a combination of the equipment in the system, the age of that equipment, the date the vendor stops repairing and replacing components, and the individual radio system owner's vendor support agreement. Until remedial action is complete, risk will increase over time.

VHF and UHF systems that are not compliant with the FCC Narrowbanding mandate by January 1, 2013 will not be allowed to operate. Doing nothing is not viable for VHF and UHF radio systems: system owners must upgrade or replace systems to make them compliant.

Option 2 and Option 3

From a technical perspective, Option 2, migrating existing systems to P25 Phase 2 LMR systems, and Option 3, building new P25 Phase 2 LMR systems, have many similarities. Both would enable significant improvements in service relative to existing radio systems and alleviate risks discussed above. Option 2 is a phased approach that would allow radio system owners to replace the oldest, highest risk components first to begin decreasing risk sooner. Option 3 requires that new systems be complete before system users could begin migrating off old equipment, taking somewhat longer to alleviate risks.

The Region's population has grown since the current systems were built, and some areas that were not then heavily populated have grown significantly. System users also need dependable in-building coverage where no such requirement existed previously. Both Option 2 and Option 3 would allow system owners to modify the design of their radio systems to address this issue.

Option 2 and Option 3 could both be implemented as multiple independent radio systems linked together or as a single, regional radio system. The equipment available to link systems together is sophisticated enough that, from an end user perspective, multiple systems linked together could perform the same as a single system provided a single vendor is selected for all systems. Technology is only one factor in this decision: cost, governance, operations, and funding strategies also need to be considered to determine the best approach.

Virtually all currently deployed Mobile and Portable radios need to be upgraded or replaced in both options. All radios likely need to operate as SmartZone and P25 Phase 2 radios until transition is substantially complete to maintain communication within and between agencies while groups of users are split between old and new radio systems. The project should anticipate providing new P25 Phase 2 radios to all users in the Region.

Without engaging potential vendors in a bid process, the PSC could only estimate order of magnitude costs for Option 2 based upon component-level pricing available through existing contracts. Costs solicited through a competitive bid process could be substantially different than the PSC's estimate because vendors typically offer system-level discounts for large projects and because vendor strategies in a competitive bid process often affect cost.

Option 4

Long Term Evolution (LTE) is perceived as the next generation of public safety wireless communication technology. An LTE system could potentially enable the Region to consolidate networks into a single, integrated wireless network for voice and Broadband data and allow end user agencies to purchase smaller, less expensive end user devices.

However LTE, whether private or commercially-owned, does not currently meet requirements for mission-critical voice, as defined by the National Public Safety Telecommunications Council, the U.S. Department of Homeland Security Office of Emergency Communications, and others, and we do not know when it will. Technical standards and end user devices have not yet been developed by manufacturers nor have they been evaluated and endorsed by public safety. Until this occurs, Option 4, a regional LTE system, will not be a viable replacement for existing public safety LMR systems.

Because technology changes quickly, the PSC should review the status of LTE again, and confirm whether or not it supports public safety mission-critical voice requirements, prior to spending money to upgrade or replace existing LMR systems.

PSC Recommendations

1. Technical recommendation

   On a technical level the PSC recommends Option 2A, migrating existing LMR systems to P25 Phase 2 LMR systems and having multiple independent systems linked together.

Why LMR (and not LTE)?

LMR meets public safety requirements for mission-critical voice today. LTE does not currently support mission-critical voice and there is no certainty about when it will. Even when it does, the PSC would not recommend using the first generation of a new technology for public safety. The Region should wait until other field deployments prove that LTE meets public safety requirements for mission-critical voice before it is deployed here as a replacement for LMR systems.

Why multiple systems rather than one regional system?

Current technology will meet end user requirements whether we have multiple systems or a single system. The multiple systems approach would give system owners greater flexibility to implement P25 Phase 2

systems and transition end users over to those systems within their own time frames to meet their individual timing constraints. If the Region moves ahead with multiple systems, it will still have the option to merge multiple, independent systems into a single, regional system in the future, if desired.

Why not defer action (Sub-option 1A)?

Doing nothing is not practical because these are public safety radio systems. Some electronic components are almost 18 years old and certain critical components are no longer sold by the manufacturer. Risks for many systems will increase significantly starting in 2013 when support for additional hardware and software is discontinued. The PSC believes that not taking action is too risky.

Sub-option 1A is not valid for VHF and UHF radio systems. System owners must comply with the FCC Narrowbanding mandate by January 1, 2013 or they will be forced to shut down their radio systems.

Why not just make minimum investments (Sub-option 1B)?

Making minimum investments will extend the useful life of existing SmartZone LMR systems, but only for a few years. Support for all components of those systems is being phased out, and the PSC believes that risk will become unacceptable in the 2018-2020 time frame (depending upon the age of existing equipment and other factors). Replacing equipment piecemeal as it fails will cost radio system owners more money over the long term.

2. Procurement recommendation

   Procurement has three major components: technical/functional, management/schedule, and pricing. The differences among the Option 2 and Option 3 alternatives are small and the outcome of procurement can be greatly influenced by the other two major components. The PSC recommends an open RFP process that invites the current vendor and other possible vendors to bid their best strategies to move from existing LMR systems to P25 Phase 2 LMR systems.

3. Timing recommendation

   The PSC estimates that it will take 4 to 6 years to upgrade each radio system once funding is available. We need to begin work now.

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2. Scope of the Report

The following items are included within the scope of this report:

- Mission-critical voice for public safety agencies and other authorized users in King, Pierce, and Snohomish counties;
- Existing Motorola 800 MHz Land Mobile Radio (LMR) systems operated by the King County Regional Communications Board, Port of Seattle, Snohomish County Emergency Radio System (SERS), and the cities of Tacoma and Puyallup;
- Narrowbanding of existing VHF LMR systems operated by Pierce County Government, Pierce County FireCom, and the Washington State Patrol (WSP) only to the extent that their end users could be served by the systems considered in this report to improve capabilities;
- The Motorola 700 MHz LMR system operated by Pierce Transit only to the extent that it could be upgraded to serve end users that currently use the Pierce County Government VHF system;
- Limited assessments of other communication system assets such as radio Spectrum, Backhaul systems, Radio Sites, and towers that directly affect cost, performance, transition, and risk;
- Identification and discussion of key issues;
- Analysis of four options and corresponding sub-options for future system(s) to serve end users in the three counties, including strengths, weaknesses, opportunities, and threats for each option;
- Evaluation of how well each option meets requirements, including the extent to which the option enables improvements in coverage, capacity, Reliability, and Interoperability; and
- High-level discussion about costs not intended to support specific funding strategies.

Excluded from this report are:

- Systems to support Broadband data applications for public safety (beyond an indication whether or not each option would support Broadband-enabled end users devices). While public safety agencies are relying increasingly upon Broadband data, there is a separate planning effort underway to address the need for wireless Broadband data;

- Radio systems other than those listed above;
- Narrowbanding of VHF and UHF radio systems (beyond a description of the impact of Narrowbanding upon radio system owners). Efforts by agencies that must comply with VHF and UHF Narrowbanding are occurring in parallel;
- Rebanding of 800 MHz radio systems (beyond a description of the impact of Rebanding upon radio system owners). Efforts by agencies that must comply with 800 MHz Rebanding are occurring in parallel;
- Technology evaluations (because the REPC already adopted P25 and Long Term Evolution (LTE) as the technology standards for the Region); and
- Detailed system specifications, designs, and costs (because those items required engineered solutions and would be products of a future detailed design phase).

3. Background

This section provides background information about public safety Land Mobile Radio (LMR) systems operating in Snohomish, King, and Pierce Counties (the Region). Included are brief descriptions of the individual radio systems, governance models, and historical funding mechanisms, as well as key issues and challenges faced by radio system owners.

a. Overview of current radio systems

There are eight primary public safety LMR systems operating in the Region. They are:

- Snohomish County Emergency Radio System;
- King County Regional Emergency Radio Communication System;
- Port of Seattle Public Safety Radio System;
- Tacoma-Puyallup Public Safety Radio System;
- Pierce County Government Radio Communications System;
- Pierce Transit Radio System;
- Pierce County FireCom Radio System; and
- Washington State Patrol Radio System.

In some cases, these radio systems are interconnected via Gateways and Dispatch Console Patches[1] to allow end users to communicate with one another across systems. The Subscriber radios on these systems are also cross programmed with state and national Interoperability channels and regional Interoperability Talkgroups from each system to allow end users to communicate with one another across systems.

There are also separate transit, government, and business radio systems in the Region. Transit agencies and businesses (such as Boeing and Puget Sound Energy) and other government agencies can be essential participants in responding to emergencies; however, planning for their radio systems is beyond the scope of this report.

Additional information about each LMR system is provided below. Table 3-1, near the end of this section, provides a comparison of key attributes of these systems.

[1]This capability is called the Tri-County Regional Interoperability System (TRIS).

Key issues affecting multiple radio systems:

1. Most radio system owners do not own all of the Mobile radios, Portable radios, and Dispatch Consoles that operate on their systems. Replacing these devices will require close coordination with a large number of end user agencies. Replacing Mobile radios is particularly time-consuming.

2. Some critical system components are no longer sold or supported, and Motorola has said that it will discontinue sale of other components in phases over the next few years (2011-2013). Original components are still available on the secondary market; however, there is significant risk in relying upon secondary market equipment because the condition and service history of the components is unknown and the needed version of any particular component may not be available.

Snohomish County Emergency Radio System (SERS)

The Snohomish County Emergency Radio System (SERS) is a Motorola SmartZone 800 MHz Trunked radio system that provides coverage throughout Snohomish County. At the time that the SERS system was built, there were very few radio frequencies available within Snohomish County. As a result, the system was designed exclusively for use by police, fire, and emergency medical services ("public safety"). It does not support general government users.

The system supports approximately 4,300 Mobile and Portable radios and 40 Dispatch Consoles.

SERS is a non-profit government corporation that was created by an Interlocal agreement between ten founding members: Snohomish County and nine cities within the county. SERS is governed by a ten-member board composed of elected officials or their designees that represent the founding members.

The SERS radio system was funded and built in two phases. Phase I was completed in 2003 at a cost of $21.4M, and was funded by the founding members based upon a cost-sharing formula that considers population, geographic area, and call volumes. Phase II was completed in 2006 at a cost of $10.7M and was funded solely by Snohomish County. Ongoing costs are funded by the founding members using the same cost-sharing formula used for Phase I construction.

Key issue for SERS: The bonds that funded portions of the SERS radio system do not mature until 2020. Snohomish County has stated that it will not seek additional funding to upgrade or replace its current radio system until those bonds mature.

King County Emergency Radio Communication System

The King County Emergency Radio Communication System is a Motorola SmartZone 800 MHz Trunked radio system which provides coverage throughout King County by serving all major urban and community areas. It is used by public safety and general government and supports approximately 16,200 Mobile and Portable radios and 108 Dispatch Consoles.

The King County system consists of four sub-regions: City of Seattle, the Eastside Public Safety Communications Agency (EPSCA), King County, and Valley Communications Center (ValleyCom). Each sub-region operates and maintains radio system Infrastructure (radio transmitter sites) within its designated geographic area. The central Switch equipment that connects the four sub-regions into one integrated, countywide radio system is owned equally (25% shares) by the four sub-regional owners and is operated by the King County Regional Communications Board (KCRCB). The KCRCB was created by an Interlocal agreement and is composed of five members: one representative from each owner agency and one at-large member to represent non-owner interests.

The existing King County radio system was funded by a property tax levy approved by King County voters in 1992. The county collected $0.016 per $1,000 of assessed property value during 1993-1995 for a total of more than $57M by the end of the three-year period. Construction of the current 800 MHz radio system began in 1993 and was substantially complete in 1997.

Ongoing system costs are funded by the four system owners – either directly, in the case of radio system Infrastructure located within their geographic operating areas, or indirectly through the KCRCB, as is the case for the common Switch equipment.

Key issues for the King County radio system:

1. The existing radio system contains electronic components that are almost 18 years old. Some critical components (such as 6809 simulcast controllers) are no longer sold or supported. Because the system is very complex and has over 16,000 users, it will take several years to upgrade or replace it. System owners must act soon to avoid system degradation.

2. Improved coverage is needed in some areas but cannot be implemented because Motorola no longer ships SmartZone 4.1 Radio Site equipment.

Port of Seattle Radio System

The Port of Seattle Radio System is a Motorola SmartZone 800 MHz Trunked radio system that serves SeaTac airport, the seaport, and surrounding areas. It supports approximately 2,000 Mobile and Portable radios used by Port of Seattle Police, Port of Seattle Fire, emergency management, aviation operations and security, seaport security, and others. There are 23 Dispatch Consoles.

The current system was originally installed as a Motorola SmartNet system in 1993, and was upgraded to a SmartZone 4.1 system in 2004. The Port of Seattle's Aviation Division manages the radio system and funds ongoing operation and maintenance.

Key issues for the Port of Seattle: Motorola will not support SmartZone 4.1 Master Site equipment after July 2016. To avoid system degradation, the Port must act to upgrade its Master Site or join another radio system by 2013 for the following reasons:

1. Motorola offers transition devices that allow upgraded Switch equipment to work with legacy SmartZone 4.1 Radio Site equipment. This means that system owners do not have to upgrade Radio Sites, Mobile radios, and Portable radios all at the same time that they upgrade their Switch. However, Motorola has said that the converters will only be available until September 2013. If the Port does not act before September 2013, it will lose the option to upgrade its system using a phased approach.

2. If a Dispatch Console fails, it cannot be repaired or replaced. The Port's existing SmartZone 4.1 Master Site will not support Motorola's current Dispatch Console (MCC7500). Legacy Gold Elite Dispatch Consoles are no longer sold by Motorola and do not operate on current or future computer operating system software. (Gold Elite is only certified for Windows XP.)

Tacoma-Puyallup Public Safety Radio System

The Tacoma-Puyallup Public Safety Radio System is a Motorola SmartZone 800 MHz Trunked radio system. It covers approximately 60% of the population of Pierce County serving public safety and general government agencies throughout Pierce County metropolitan areas. The system supports approximately 3,600 Mobile and Portable radios and 61 Dispatch Consoles.

The Tacoma-Puyallup System was constructed in two parts. Tacoma completed construction of its portion of the system in 2004. The cities of Tacoma and Puyallup later formed a partnership, formalized by an Interlocal agreement in 2007, to develop a regional communication network serving the metropolitan areas of Pierce County as a single system linked at the Tacoma Switch.

Governance of this radio system is covered under terms of the Interlocal agreement between the two parties. Each party is responsible for the costs of building, operating, and maintaining its own portion of the system and shares the cost of the Switch.

Each party funded the majority of its own initial capital costs. Expansion projects were funded in part by approximately $5M of grants including a COPS grant in 2005, a State grant in 2007, and a PSIC grant in 2009.

Key issues for the Tacoma-Puyallup radio system:

1. Improved coverage is needed in some areas, but cannot be implemented because Motorola no longer ships SmartZone 4.1 Radio Site equipment.
2. In November 2011, Pierce County voters approved a tax measure to improve public safety communications throughout Pierce County that could fund investments in a new Pierce County radio system and a new or upgraded Tacoma-Puyallup radio system.

Pierce County Government Radio System

The Pierce County Government Radio System supports approximately 2,200 Mobile and Portable radios used by the Pierce County Sheriff and other agencies in the county.

The Pierce County Government Radio System is a "wide-band" VHF Conventional system and is subject to the Narrowbanding mandate (see "Key Issue," below). Rather than Narrowbanding its existing VHF radio system, Pierce County plans to migrate many users over to an upgraded Pierce Transit 700 MHz radio system. To support those users that will not move to the 700 MHz system and to preserve regional VHF Interoperability, Pierce County will also a new narrowband VHF system with minimal capacity.

Key issue for VHF and UHF system owners (including Pierce County and Washington State Patrol): Existing VHF and UHF radio systems must comply with the Federal Communications Commission (FCC) Narrowbanding mandate. Effective January 1, 2013, LMR systems operating in the VHF and UHF bands may no longer use "wide-band" 25 kHz radio channels and must use 12.5 kHz radio channels (or narrower). Portions of the present fleet of Mobile radios, Portable radios, and Radio Site equipment cannot be reprogrammed to support Narrowbanding and must be replaced with newer equipment. Narrowbanding can also reduce the coverage area of VHF and UHF radio systems.

Pierce Transit Radio System

Pierce Transit is the public transit authority for Pierce County and is governed by a board composed of elected officials from throughout the county. Pierce Transit owns and operates a six site, 700 MHz, Motorola P25 Phase 1 radio system to support its transit operations. Pierce County radio technicians currently support the Pierce Transit Radio System. Pierce County and Pierce Transit established an Interlocal agreement to work jointly on developing a future P25 Phase 1 and Phase 2 radio system to meet the needs of Pierce Transit and agencies now served by the Pierce County Government VHF system.

Pierce County FireCom Radio System

The Pierce County FireCom Radio System is a VHF Conventional radio system used by most fire and emergency medical service (EMS) agencies throughout the county. (Tacoma Fire and Central Pierce Fire and Rescue use the Tacoma-Puyallup System, and are the notable exceptions to this.) The FireCom dispatch system is directly connected to the Tacoma-Puyallup Radio System Switch to allow FireCom system users to communicate with other agencies.

Washington State Patrol (WSP) Radio System

The WSP Radio System is designed to cover state routes and Interstate highways throughout Washington. The WSP system consists of radio base stations and repeaters on dedicated "area" frequencies aligned with WSP autonomous patrol areas. The system also hosts WSP's "State Common" frequency and Interoperability channels supporting the Law Enforcement Radio Network (LERN), the National Law Enforcement Channel (NLEC), and the On Scene Command and Coordination Radio (OSCCR) system.

The current radio system is a "wide-band" VHF Conventional system and is subject to the Narrowbanding mandate (see "Key Issue," above).

WSP operates and maintains a fleet of approximately 1,200 Mobile and Portable radios statewide. Dispatching operations are done through eight regional communications centers located in WSP district headquarters facilities.

The WSP Electronic Services Division manages the radio system and funds ongoing operation and maintenance. Equipment replacement is funded through one-time allocations, typically grants or Legislative budget packages.

Table 3-1
Summary of Current Public Safety Land Mobile Radio Systems in the Region[2, 3]

Radio System	SERS	King County				Port of Seattle	Tacoma-Puyallup	Pierce County Government	Pierce Transit	WSP (within the Region)
		City of Seattle	EPSCA	King County	ValleyCom					
Type of system	800 MHz SmartZone 4.1 Trunked	800 MHz SmartZone 4.1 Trunked				800 MHz SmartZone 4.1 Trunked	800 MHz SmartZone 4.1 Trunked	VHF Conventional	700 MHz P25 Phase 1	VHF Conventional
Year completed	2003-2006	1993-1997				1993	2004-2008	1999	2007	2001 (major upgrade to base stations and repeaters)
Significant recent changes	Switch upgrade to Astro 25 version 7.8 in 2012	Switch upgraded to Astro 25 version 7.8 in 2010				Upgraded to SmartZone 4.1 in 2004	Added Puyallup in 2008. Expansions 2009-2010. Switch upgrade in 2012	Must Narrowband before 1/1/2013	Switch upgraded to Astro 25 version 7.7 in 2011	Must Narrowband before 1/1/2013
Number of Mobiles and Portables	4,300	5,000	2,700	5,000	3,500	2,000	3,600	2,200	668	350

[2] These are the major public safety Radio Systems in the Region. There are other, smaller systems that need to be addressed by some future planning and replacement effort.

[3] This table is a summary of current systems. It does not include information about future changes, including those planned for the Pierce County Government, Pierce Transit, and WSP Radio Systems.

Radio System	SERS	King County				Port of Seattle	Tacoma-Puyallup	Pierce County Government	Pierce Transit	WSP (within the Region)
		City of Seattle	EPSCA	King County	ValleyCom					
% of radios that are P-25 Phase 1 capable[4]	30%	95%	0%	0%	0%	60%	95%	0%	98%	0%
% of radios that are P-25 Phase 2 capable	0%	0%	0%	0%	0%	Less than 1%	Less than 1%	0%	2%	75%[5]
Number of Radio Sites	21	6	7	10	3	5	12	11	6	11
Number of dispatch centers	2	2	3	3	1	1	7	1	1	3
Number of dispatch positions	40	40	20	28	20	23	61	15	10	15

[4] The radios are P25-capable; however, many would require software upgrades to enable P25 operation.

[5] These are multi-band radios capable of operating on VHF, 700 MHz, and 800 MHz Radio Systems.

b. Planned short-term investments in existing systems

Agencies in the Region plan to make various short-term investments in existing LMR systems to respond to regulatory changes and address immediate operational issues. Generally, these projects fall into the 2012-2014 timeframe. Plans that have been identified are summarized below.

Projects that involve and affect multiple radio system owners in the Region include:

- 800 MHz Rebanding: All 800 MHz Trunked radio system owners need to reprogram or replace existing Mobile radios, Portable radios, and radio transmitter equipment, as necessary, to comply with a Federal Communications Commission (FCC) mandate to reconfigure the 800 MHz band. This project is funded by Sprint as a result of regulatory changes; however, some agencies have decided to provide funding to upgrade the basic radios provided through Rebanding to radios with greater capabilities. Radio system owners in the Region expect to finish Rebanding in the 2014 timeframe (dates vary by agency).

- Narrowbanding: All agencies in the Region that have VHF or UHF equipment need to reprogram or replace their Mobile radios, Portable radios, and radio transmitter equipment before January 1, 2013 to comply with the FCC Narrowbanding mandate. Government agencies that rely primarily upon 800 MHz Trunked radio systems still operate some VHF and/or UHF radio equipment to support public safety Interoperability channels and/or for general government, non-public safety communication. Narrowbanding is an unfunded mandate, and individual agencies must fund (or find funding to offset) the costs associated with Narrowbanding their systems.

- PSIC Next Generation Switch Project: The regional partners will continue their work on the 2008-2012 project to upgrade and interconnect the King County, SERS, and Tacoma-Puyallup Switches to provide Fingertip Roaming throughout the geographic area served by those radio systems. This project is funded primarily by the Public Safety Interoperable Communications (PSIC) grant program.

Plans specific to individual agencies are listed below:

- City of Seattle plans to upgrade Dispatch Consoles at its two dispatch centers during 2012 to mitigate risks related to the age of the existing Gold Elite dispatch equipment. Motorola no longer sells Gold Elite components and any Console hardware that fails has to be replaced with

third-party equipment. Gold Elite software only operates on Windows XP, and Windows XP lacks drivers necessary to operate on some new computer hardware, making it increasingly difficult to replace hardware. To alleviate this complexity and risk, Seattle plans to replace its Gold Elite Consoles with new MCC7500 Consoles.

- King County is performing needed maintenance repairs and upgrades on radio towers and associated Infrastructure at Radio Sites to extend the life of the systems installed there. This work will be complete in 2012.

- In November 2011, Pierce County voters approved Proposition 1 to fund radio system upgrades and consolidate 911 dispatch operations. The Tacoma-Puyallup 800 MHz system and the Pierce Transit 700 MHz system will be upgraded to Project 25 Phase 2 systems and connected. Some SmartZone capability will remain in place through approximately 2016 to provide Interoperability with agencies from King County and Snohomish County. Dispatch Consoles will also be upgraded. Completion is expected in 2013. Many existing VHF users will migrate from old VHF systems to the 700/800 MHz systems. Instead of Narrowbanding the existing separate systems for those VHF users that remain, the VHF licensees have submitted an FCC waiver request to obtain additional time to implement a single Narrowband VHF system for Interoperability purposes.

- Port of Seattle may consider a capital improvement project to upgrade its Switch during budget year 2013. To mitigate risks associated with Motorola's pending end of support for SmartZone 4.1 Master Site equipment, the Port would potentially upgrade to the same P25-compliant Switch installed in the King County, SERS, and Tacoma-Puyallup radio systems.

- SERS plans to upgrade its "East Loop" Microwave system to increase capacity in response to increasing demand for circuits on that system. This Microwave system provides Backhaul connections between radio transmitter sites and SERS' Switch. It also provides circuits for the TRIS system that interconnects regional radio systems and a Backhaul connection for the King County Radio System. This project has been partially funded by the Urban Area Security Initiative (UASI) grant program.

- WSP will narrowband its existing VHF Interoperability channels during September 2012 to comply with the FCC Narrowbanding mandate. WSP also plans to make significant, long-term investments in radio system Infrastructure and Mobile and Portable radios. WSP will move its main dispatching operations from the existing "wide-band" VHF radio system

over to the Department of Justice (DOJ) Integrated Wireless Network VHF P25 radio system. WSP will add 700 MHz P25 Phase 2 Radio Sites in the Puget Sound Region to reduce impact to the DOJ system from WSP users. WSP will also need to upgrade or replace Dispatch Consoles and to replace existing Mobile and Portable radios with multi-band, P25 Phase 2-capable units. WSP expects to complete this process by June 2013, with the majority of the changes completed prior to January 1, 2013.

WSP also plans to upgrade its Microwave system to support the P25 radio system and connect additional Radio Sites.

c. Problem statement

The problem statement developed at the onset of the project is included in the Appendices.

d. Local requirements

The Project Steering Committee compiled a list of requirements for public safety voice communication systems based upon stakeholder feedback and practical experience managing existing radio systems. The capabilities and features on this list are essential for public safety operation and need to be delivered by any viable option.

Coverage

- General Requirements:
  - 97% coverage in the bounded area[6] of each county
  - 97% coverage in each city (all cities should be included within the identified bounded areas)
  - 97% coverage along all major roadways (bounded areas should include the following major roads, at a minimum: Interstate 90, State Highway 410, and U.S. Highway 2)
  - Coverage that meets the business requirements of agencies that respond to incidents in mountainous areas east of the bounded area of each county. (This could be VHF coverage.)
- In-building coverage:[7]

[6] The bounded area includes the entire geography of each county west of the Cascade Mountain foothill boundary, all cities, and all major roadways. The foothill boundary is defined here as the first topographic contour that exceeds 750 feet of elevation as you travel eastward from Puget Sound.

[7] Engineers cannot fully predict in-building coverage within a given area. Instead, they design the Radio System to provide enough extra signal level at the outside of a building of a given assumed density that there is a strong statistical probability of coverage within

- Low Density Buildings: 97%
- Medium Density Buildings: 97%
- High Density Buildings: Yes
- SeaTac Airport: 97% throughout the entire airport, including buildings and tunnels

Coverage assumptions	Portable radios	Mobile radios
Antenna	1/2 wave antenna on belt	Unity gain antenna
Antenna height	1 m = 3.3 ft (hip level)	1.5 m = 5 ft
ERP (before loss)	3 W = 34.8 dBm	35 W = 45.4 dBm
Antenna/body/bldg loss	-14.3 dB	-1.5 dB
ERP (after loss)	20.5 dBm (-9.5dBW)	43.9 dBm (13.9 dBW)

Capacity

		Snohomish Co	King County	Pierce County
# channels	5 years	31	82	
	10 years	62	102	
# Talkgroups	5 years	150	500	
	10 years	250	580	
# radios	5 years	5,000	20,500	
	10 years	7,000	26,500	

Scalability

- The system must be able to accommodate growth of Radio Sites, Dispatch Consoles, and Mobile and Portable radios to support the capacity estimates noted above.
- Must be able to add features and functions
- Must be able to scale to add other counties
- Must be able to add or scale Backhaul capacity

Reliability

- Backhaul: 99.999
- Radio Site: 99.999
- Mobile and Portable Radios: 99.999
- Power: 99.999
- There can be no single point of system failure

---

buildings of a certain type. Coverage can also be enhanced within a structure through other means such as internal signal amplification systems (such as used at SeaTac Airport).

Connectivity

- All dispatch, PSAP, and EOC locations need to be connected

Implementation

- Minimal decrease in functionality or Interoperability during implementation
- Minimal loss of service during implementation

Encryption

- Ability to encrypt voice region-wide
- Supports multi-key Encryption

Mobility

- System users should be able to traverse the Region while maintaining mandatory P25 functionality.
- Any P25 discretionary features put into use must work throughout the Region.
- System users should be able to traverse the Region and maintain contact with their primary dispatch centers.

Interoperability

- Supports multiband radios
- System enables the right emergency response officials to share information on demand, in real time, when needed, and as authorized.

Vendor support program

- Support must be available on a 24/7/365 basis

Control

- Dispatcher or an organizational official must have the ability to control which specific radios are allowed on the system, or which specific radios are allowed to participate in a Talkgroup, from a Dispatch Console (without requiring specialized hardware or tools).
- Dispatcher must be able to bring disparate groups into a single talk path
- Dispatcher must be able to identify the source of a radio call when the Subscriber radio initiates a radio call. The unit ID should display on the Dispatch Console position and be available for use by a properly equipped CAD system for further use in alias processing, reporting, etc.
- Support over-the-air programming (OTAP)

- Support over-the-air rekeying (OTAR)
- Must be able to prioritize Talkgroups and Subscriber radios
- Availability of an integrated radio inventory system database such that when radios are put in or taken out of service this information is captured in the inventory system.
- System should be able to record all transmissions in such a way that they would be usable in court, as required.

Mobile and Portable Radios

- Have ability to "scan" between Talkgroups
- Buttons and knobs are functional even when the user is wearing personal protective equipment (PPE)
- Durable
- Emergency alert capable
- Encryption capable
- Available for purchase as intrinsically safe
- Battery rating must be accurate for conditions found in public safety use, such as much longer receive times as well as somewhat reduced transmit times.
- Devices have a display on front or top of radio as well as the options of a front facing (or back facing) display and an abbreviated top-mounted display that contains the most relevant information
- Radios operate without harmful interference in all but the most unusual circumstances. Devices must reduce or eliminate area noise that interferes with a communication sequence (acoustic interference such as ambient noise), and RF interference from sources such as cellular telephone operations.
- Lapel speaker/microphones must have a retracting or coiled cord that provides a near-neutral stress between the radio and the shoulder unit and that is durable
- Devices include a programmable software volume limiter

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4. Description of the Options

This section describes the options for public safety voice communication systems that are evaluated within this report. There are four:

- Option 1: Keep existing Land Mobile Radio (LMR) systems in place;
- Option 2: Follow Motorola's recommendations to migrate existing SmartZone LMR systems to P25 Phase 2 LMR systems;
- Option 3: Build new P25 Phase 2 LMR system(s) to replace existing LMR systems; and
- Option 4: Build a regional Long Term Evolution (LTE) system for mission-critical voice.

Descriptions and drawings of the options and corresponding sub-options are on the following pages.

a. Option 1: Keep existing Land Mobile Radio systems in place

Option 1 is to keep existing LMR systems in place and operational for as long as possible. Some general characteristics of this option:

- Most radio system owners would operate existing systems beyond Motorola's announced end-of-support dates[8], with operational risk increasing over time.
- Motorola SmartZone radio system owners could not increase capacity or make improvements to coverage, where needed, because Motorola no longer sells SmartZone 4.1 Radio Site equipment and software licenses.
- Functionality would remain as it is today. SmartZone radio system components (Radio Sites, Mobile radios, and Portable radios) would continue to operate as proprietary Motorola SmartZone 4.1 systems with the current feature sets.
- Interoperability would remain as it is today. The radio systems would continue to use Gateway connections and Patches that allow end users to communicate with one another across systems. Mobile and Portable radios would still be cross programmed with Interoperability channels from most other systems to allow end users to communicate with one another across systems.

[8] End of support means Motorola will no longer maintain systems, repair failed components, or provide technical "help desk" support. Systems must be upgraded or replaced before support ends to avoid elevated risk of degraded performance or failure.

- There would be no transition, thus no transitional impact to end users.
- There would be no change to the level of autonomy between existing radio systems and no need to modify existing operational or governance models.

Within Option 1, there are two possible sub-options:

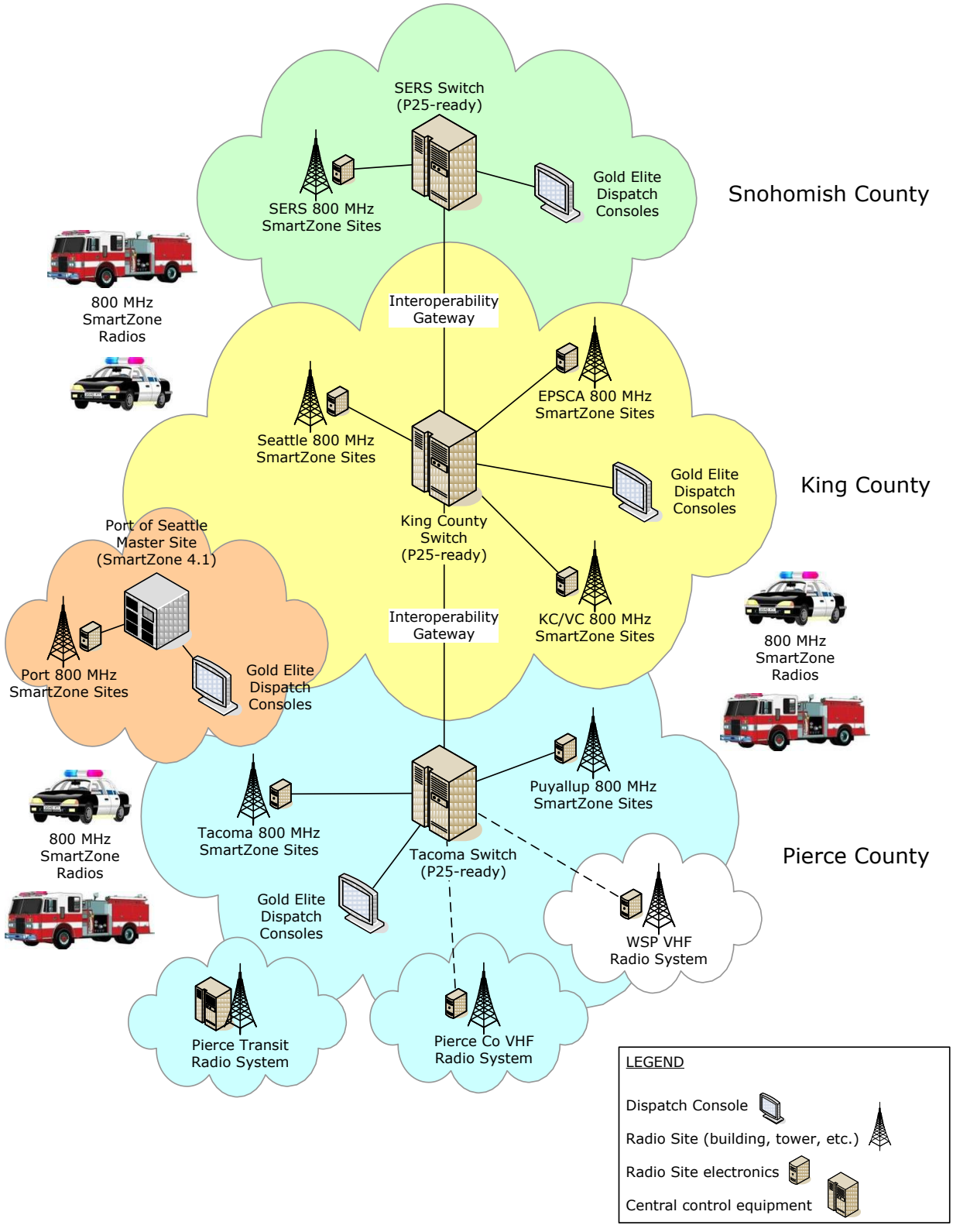
- Sub-option 1A is to do nothing.
- Sub-option 1B is to make minimum investments to preserve service levels and extend the useful life of the overall systems.

Some of the key differences between these two sub-options are listed in the table below.

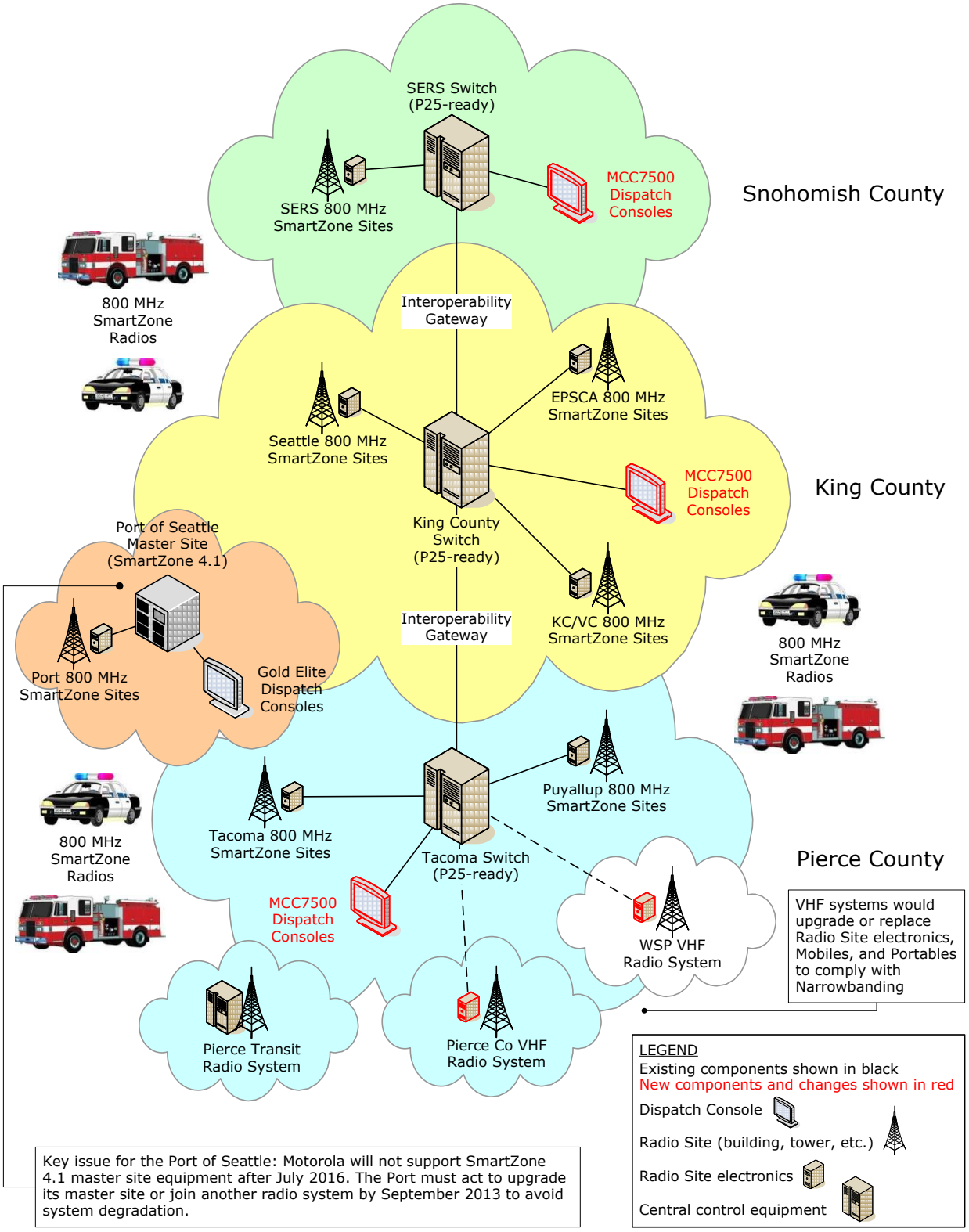
Sub-option 1A: Do nothing	Sub-option 1B: Make minimum investments
Radio system owners would do nothing more than continue to perform routine maintenance and make emergency repairs. They would make no planned capital investments.	In addition to performing maintenance and making repairs, radio system owners would upgrade or replace specific system components to mitigate risks associated with equipment that is not supported by the vendor and extend Motorola support dates for the overall systems. For example, planned capital investments could include replacing existing Gold Elite Dispatch Console equipment. VHF and UHF radio system owners would upgrade or replace Radio Site equipment and Mobile and Portable radios to comply with the FCC Narrowbanding mandate.

The two sub-options are illustrated on the following pages.

Option 1: Keep existing Land Mobile Radio systems in place
Sub-option 1A: Do nothing



Option 1: Keep existing Land Mobile Radio systems in place
Sub-option 1B: Make minimum investments to preserve service levels and extend the useful life of the overall systems



Key Consideration for Option 1: Motorola has announced end-of-support dates for all critical components of existing SmartZone radio systems that establish when there would be significant increases in operational risk. System owners will need to decide if, or how long, Option 1 is acceptable.

b. Option 2: Follow Motorola's recommendations to migrate existing SmartZone LMR systems to P25 Phase 2 LMR systems

Option 2 is to upgrade existing SmartZone radio systems to P25 Phase 2 following Motorola's upgrade road map. This would allow the Region to complete the upgrade in phases. All radio system components would not need to be replaced simultaneously, which may offer additional flexibility during implementation. Also, the radio system could support both old and new components (for example, SmartZone Radio Sites and P25 Phase 2 Radio Sites) at the same time, and for an extended period of time, if needed. This could give agencies additional flexibility as they migrate radio system users over to the new P25 Phase 2 and minimize the potential impact upon public safety operations.

Some general characteristics of Option 2:

- Radio system owners would upgrade existing SmartZone radio systems to P25 Phase 2 systems. Dispatch Consoles, Radio Site equipment, and Mobile and Portable radios would all need to be upgraded or replaced with P25 Phase 2-capable equipment;
- Radio system owners could make improvements to coverage or capacity, if desired;
- Reliability could be improved by equipping the system(s) with geographically-diverse, redundant Switches;
- Each radio system could upgrade to P25 Phase 2 independently, but would need to do so within a regional timeline;
- End user agencies would need to transition end users from Motorola SmartZone Mobile and Portable radios to P25 Phase 2 Mobile and Portable radios in a carefully coordinated manner to ensure that existing regional Interoperability is preserved. P25 Phase 2 Mobile and Portable radios could come from multiple vendors; and
- VHF systems would continue to link to 800 MHz systems as they do today. This functionality and Interoperability would not change.

Within Option 2, there are two possible sub-options:

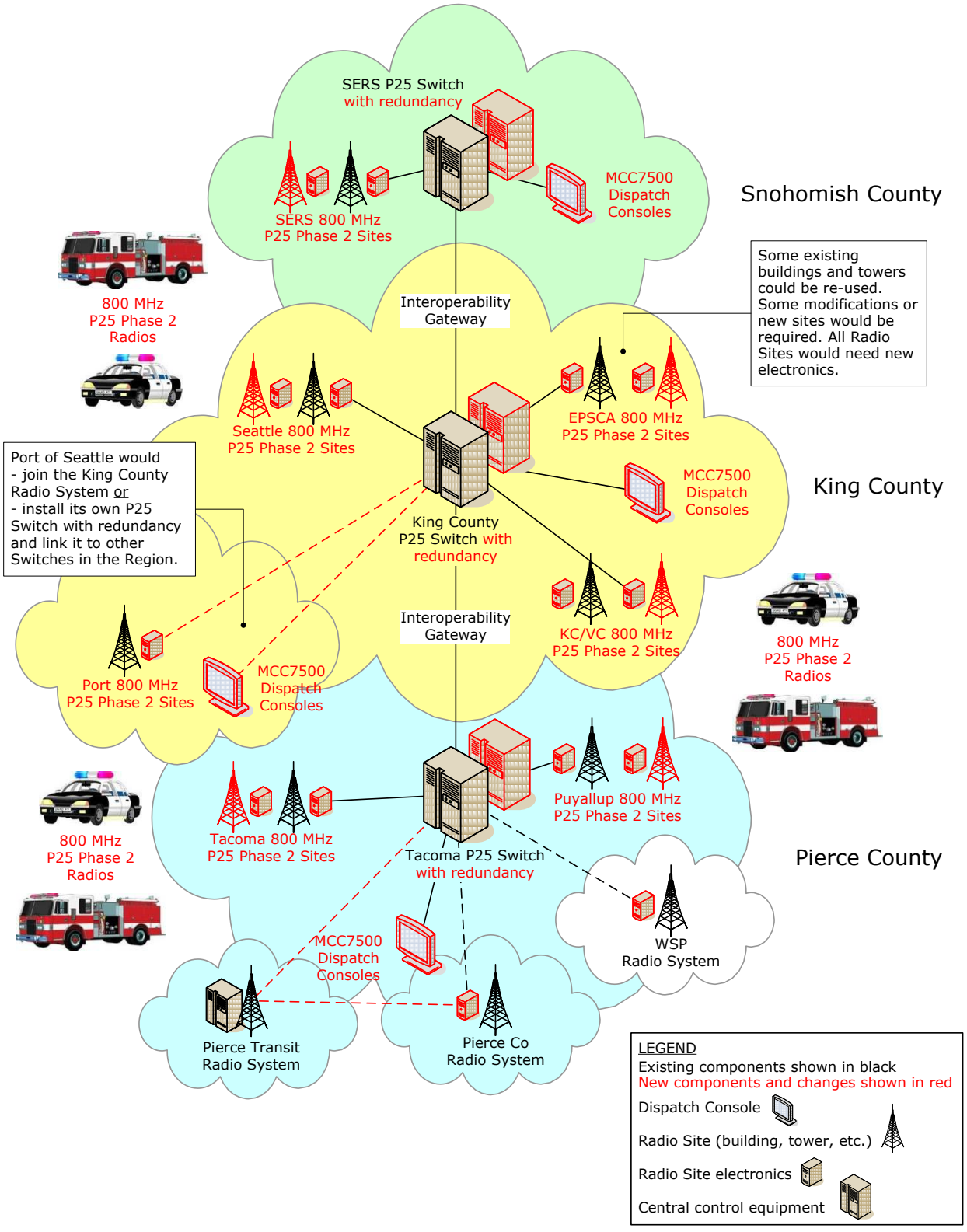
- Sub-option 2A would preserve the independent nature of existing SmartZone radio systems. The end result would be multiple P25 Phase 2 radio systems linked together.
- Sub-option 2B would merge existing radio systems into one regional P25 Phase 2 radio system.

Some of the key differences between these two sub-options are listed in the table below.

Sub-option 2A: Multiple upgraded systems linked together	Sub-option 2B: Merge existing systems into one regional system
• The end result would be multiple systems. Gateway equipment would be used to link individual systems together to enable Mobility and Interoperability. • This sub-option would preserve a fair amount of autonomy between radio systems and may not necessitate changes to existing operational or governance models. • Functionality and Interoperability would be equivalent to what exists today. At a minimum, end user radios would be able to Roam seamlessly between radio systems (available for a limited number of Talkgroups).	• The end result would be one system. Gateway equipment would not be required. • There would be changes to the level of autonomy between existing radio systems. This sub-option would require close coordination and collaboration, and could necessitate changes to operational and governance models. • This would provide the highest level of functionality, Mobility, and Interoperability. End user radios would automatically Roam throughout the Region, if authorized (available for a virtually unlimited number of talks groups).

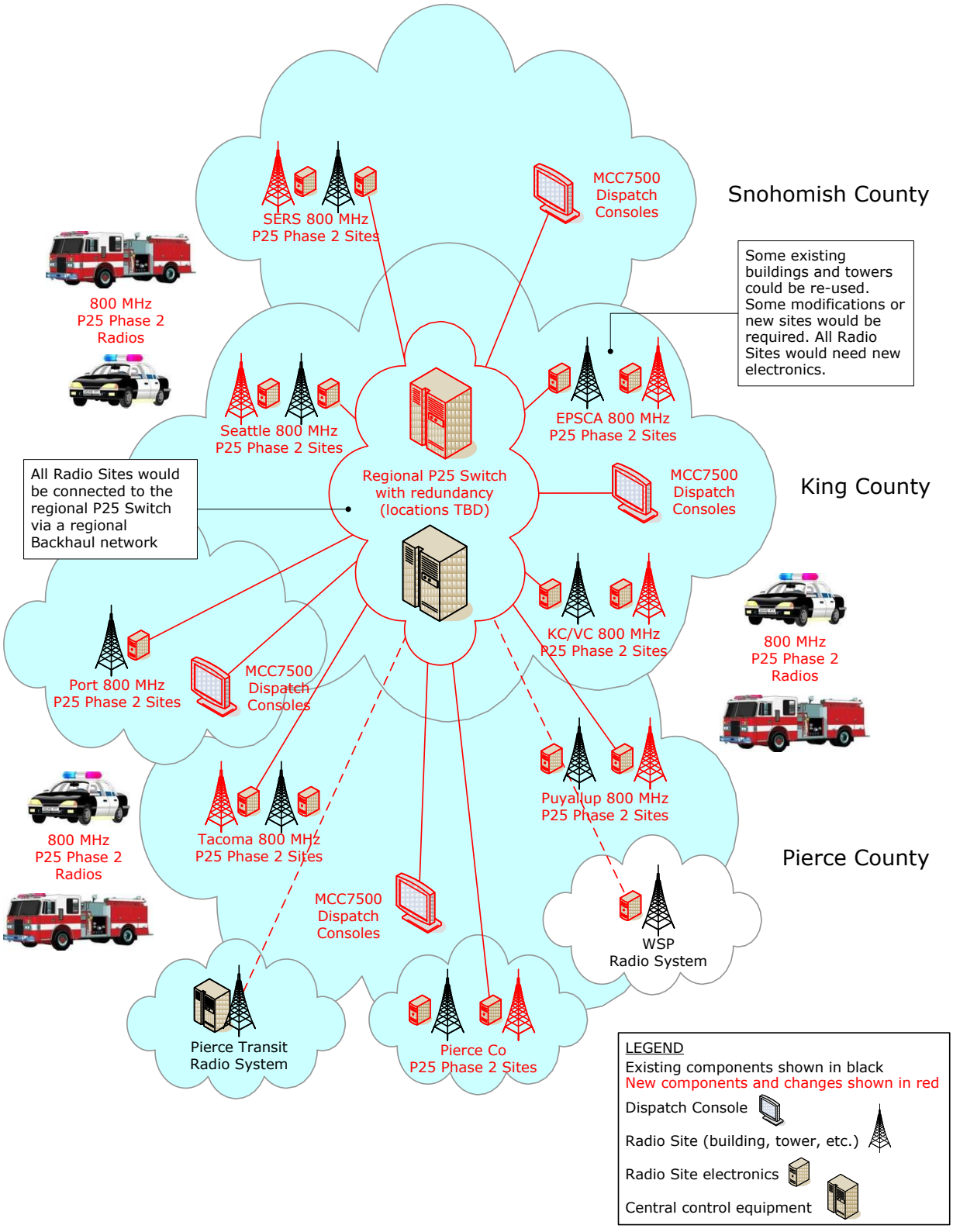
Option 2: Follow Motorola's recommendations to migrate existing SmartZone LMR systems to P25 Phase 2 LMR systems

Sub-option 2A: Multiple systems linked together



Option 2: Follow Motorola's recommendations to migrate existing SmartZone LMR systems to P25 Phase 2 LMR systems

Sub-option 2B: Merge existing systems into one Regional system



c. Option 3: Build new P25 Phase 2 LMR system(s) to replace existing LMR systems

Option 3 is that the Region would build complete, new P25 Phase 2 system(s). There is no assumption that existing radio system equipment would be reused. This option is intended to be vendor neutral.

Some general characteristics of Option 3:

- Radio system owners would procure and build new P25 Phase 2 radio system(s).
- Radio system owners could make improvements to coverage or capacity in their operating areas, if desired;
- Reliability could be improved by equipping the system(s) with geographically-diverse, redundant equipment; and
- End user agencies would need to transition system users from Motorola SmartZone systems to P25 Phase 2 systems in a carefully coordinated manner. End users could experience some loss of functionality and/or Interoperability during the transition period.

Within Option 3, there are two possible sub-options:

- Sub-option 3A would build multiple P25 Phase 2 systems that would be linked together.
- Sub-option 3B would build one new, regional P25 Phase 2 radio system.

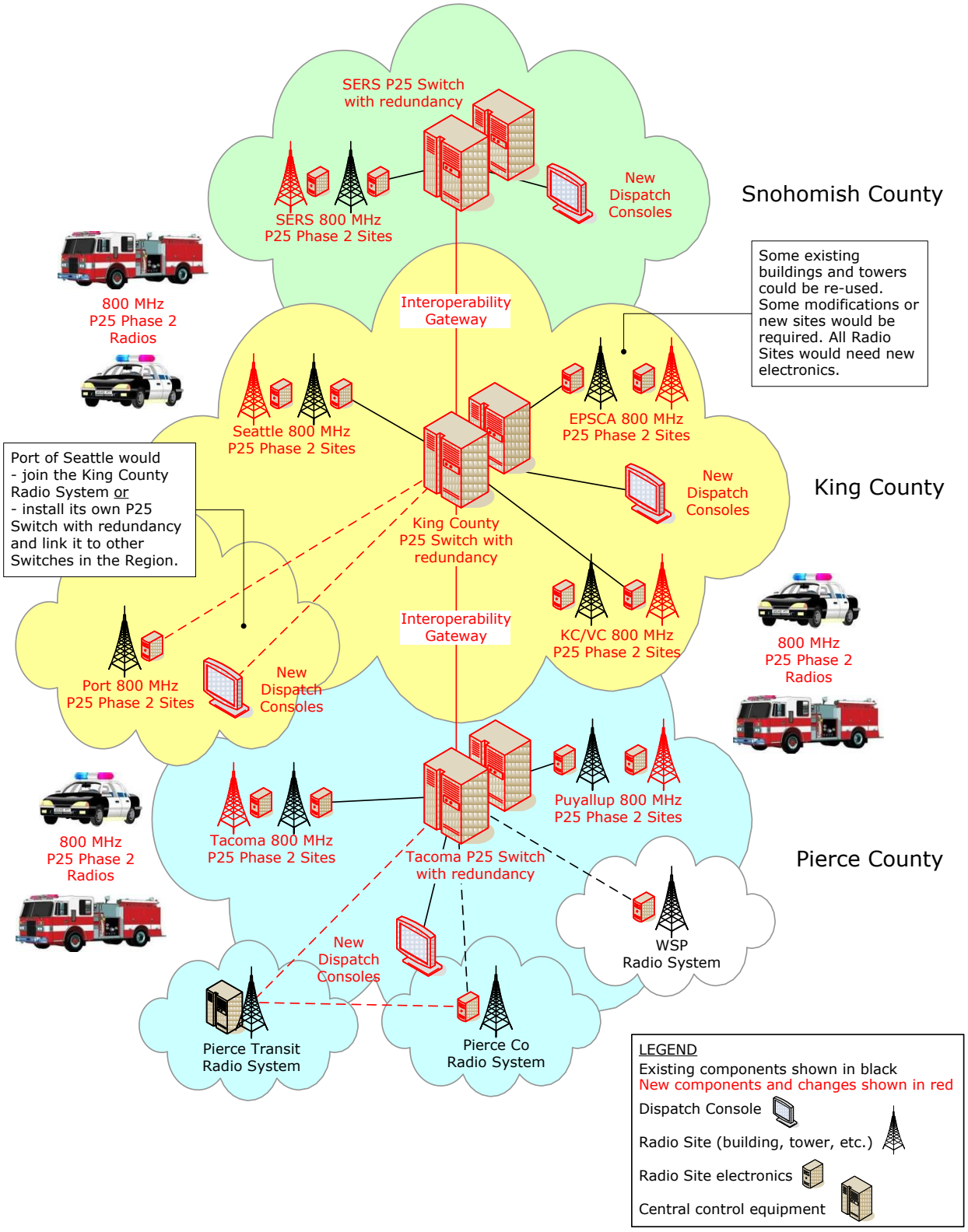
Some of the key differences between these two sub-options are listed in the table below.

Sub-option 3A: Multiple systems linked together	Sub-option 3B: One regional P25 system
• The end result would be multiple systems. Gateway equipment would be used to link individual systems together to enable Mobility and Interoperability. • This sub-option would allow a fair amount of autonomy between radio systems and may not necessitate changes to existing	• The end result would be one system. Gateway equipment would not be required. • There would be changes to the level of autonomy between existing radio systems. This sub-option would require close coordination and collaboration, and could necessitate changes to operational and governance

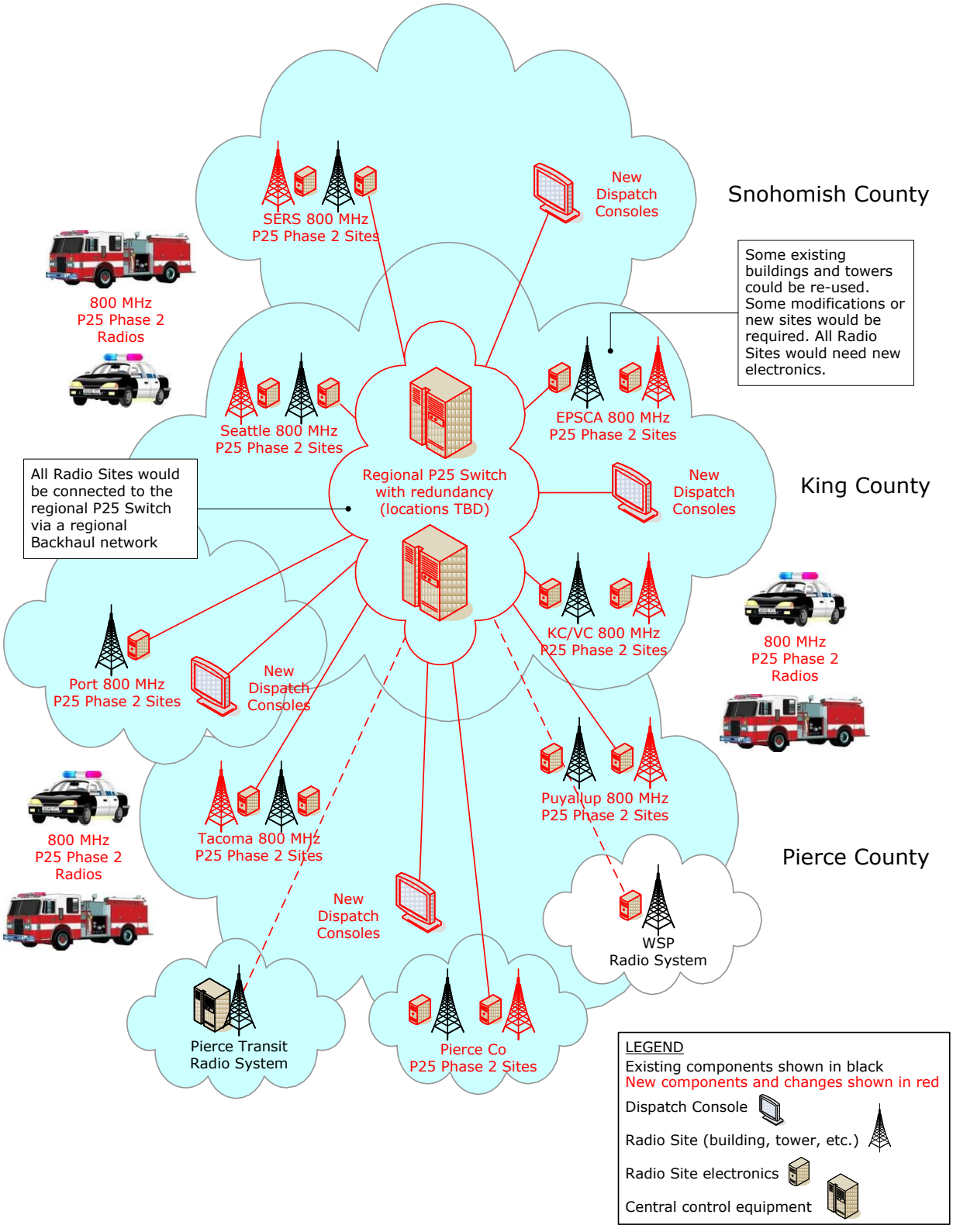
operational or governance models. • Functionality and Interoperability would be equivalent to what exists today. At a minimum, end user radios would be able to Roam seamlessly between radio systems (available for a limited number of Talkgroups).	models. • This would provide the highest level of functionality, Mobility, and Interoperability. End user radios would be able to seamlessly Roam throughout the Region, if authorized (available for a virtually unlimited number of talks groups).

Sub-options 3A and 3B are illustrated on the next two pages.

Option 3: Build new P25 Phase 2 LMR system(s) to replace existing systems
Sub-option 3A: Multiple systems linked together



Option 3: Build new P25 Phase 2 LMR system(s) to replace existing systems
Sub-option 3B: One regional system



d. Option 4: Build a regional Long Term Evolution (LTE) system for mission-critical voice

Option 4 is that the Region would build an LTE system that would serve both public safety and general government and that would provide mission-critical public safety voice. Initially, the LTE system would serve the geographies of King, Pierce, and Snohomish counties; however, it could be expanded to serve a larger area in the future.[9] It would be a purpose-built, government-owned system.

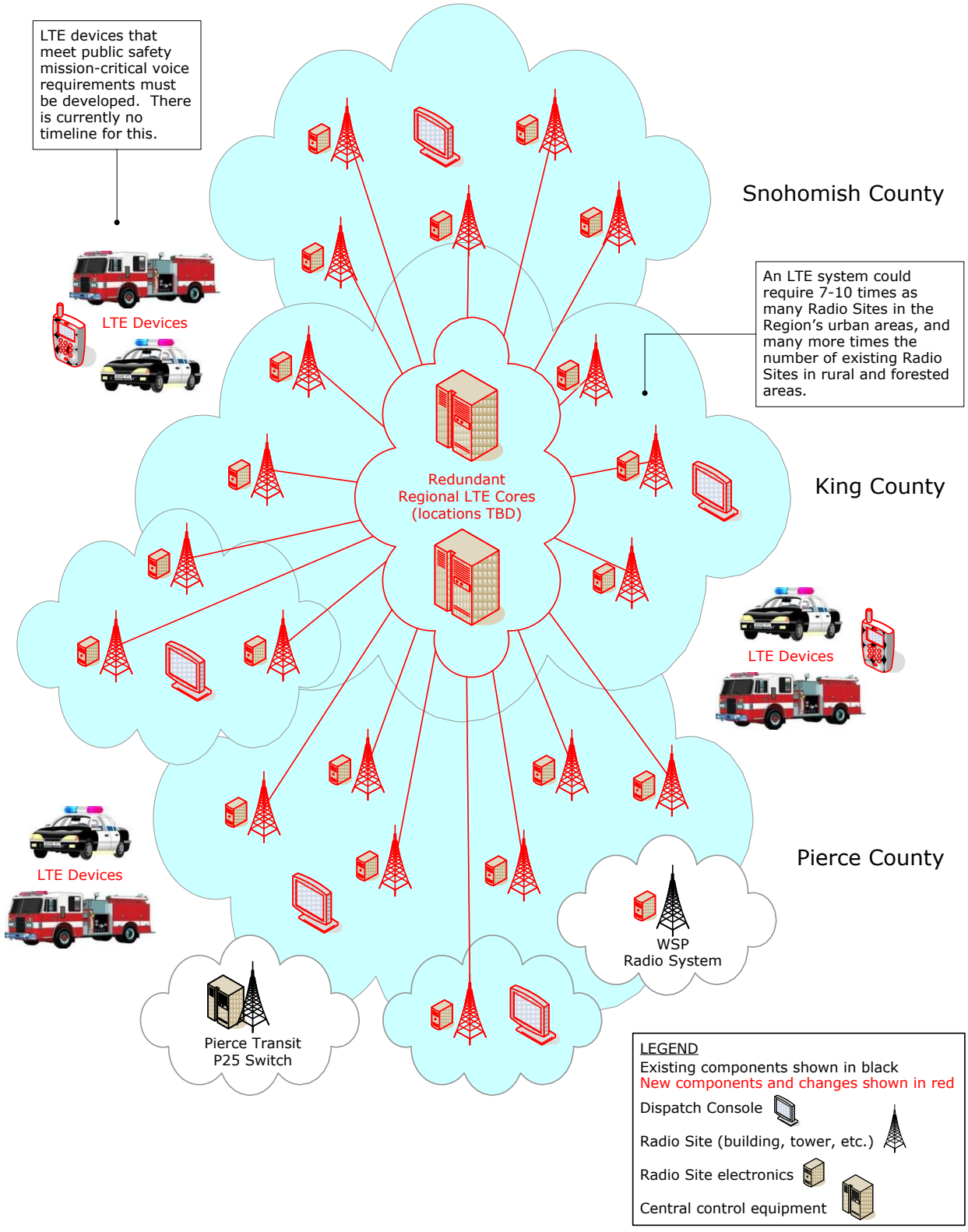
Some general notes about Option 4:

- LTE in general is capable of voice and data. However, mission-critical voice is not available and we do not know when it will be.
- The Region would procure and construct an LTE system including LTE Core equipment, LTE Radio Site equipment, a high-capacity Backhaul network, and LTE end user devices. It would require adding at least 7 to 10 times the number of existing LMR sites and a significant increase in Backhaul capacity and complexity at all sites.
- LTE is the technology required for the national wireless public safety Broadband data network by the FCC and public safety agencies. The LTE regional LTE system would need to meet or exceed requirements for the national Public Safety Wireless Broadband Network defined by the FCC, including requirements for coverage, reliability, throughput, and other technical parameters.
- Functionality and Interoperability could be less than, equal to, or better than what exists today, depending upon the state of the technology when it is deployed.
- This solution deploys a whole new technology and would necessitate new regional operational and governance models.

Option 4 is illustrated on the next page.

[9] The Region filed a request for waiver to deploy a regional 700 MHz wireless public safety broadband network in August 2010 that included Thurston County. See *Request by the Counties of King, Pierce, Snohomish and Thurston, the Cities of Seattle and Tacoma, the Eastside Public Safety Communications Association, Valley Communications and the State of Washington for Waiver of the Commission's Rules to Deploy a 700 MHz Public Safety Interoperable Broadband Network That Can Be Integrated into the Public-Private Partnership, PS Docket 06-229* available at http://fjallfoss.fcc.gov/ecfs/document/view?id=7020657809.The FCC has not yet acted on that request for waiver.

Option 4: Regional LTE system for mission-critical voice



Key Consideration for Option 4: The National Public Safety Telecommunications Council (NPSTC) Broadband Working Group identified the following key elements of mission critical voice:[10]

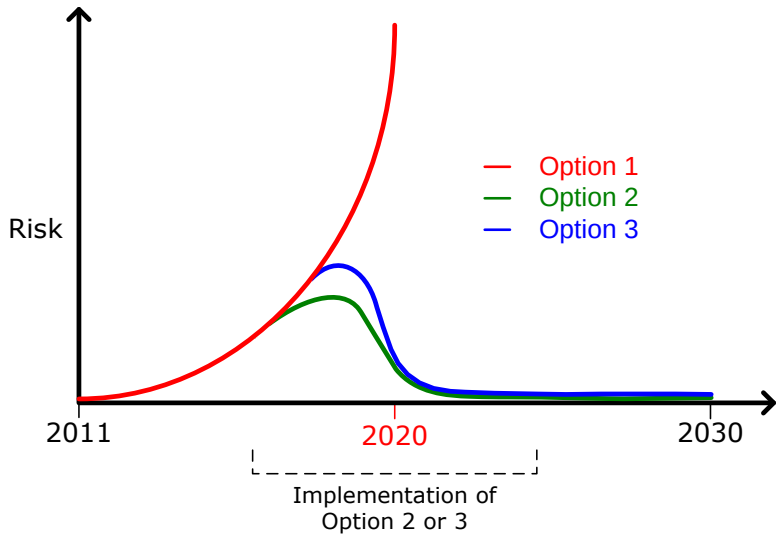
- Direct or Talk Around: This mode of communications provides public safety with the ability to communicate unit-to-unit when out of range of a wireless network OR when working in a confined area where direct unit-to-unit communications is required.
- Push-to-Talk (PTT): This is the standard form of public safety voice communications today – the speaker pushes a button on the radio and transmits the voice message to other units. When they are done speaking they release the Push-to-Talk switch and return to the listen mode of operation.
- Full Duplex Voice Systems: This form of voice communications mimics that in use today on cellular or commercial wireless networks where the networks are interconnected to the Public Switched Telephone Network (PSTN).
- Group Call: This method of voice communications provides communications from one-to-many members of a group and is of vital importance to the public safety community.
- Talker Identification: This provides the ability for a user to identify who is speaking at any given time and could be equated to caller ID available on most commercial cellular systems today.
- Emergency Alerting: This indicates that a user has encountered a life-threatening condition and requires access to the system immediately and is, therefore, given the highest level or priority.
- Audio Quality: This is a vital ingredient for mission critical voice. The listener MUST be able to understand without repetition, and can identify the speaker, can detect stress in a speaker's voice, and be able to hear background sounds as well without interfering with the prime voice communications.

LTE does not currently meet several of these requirements (talk around, push-to-talk, group call, emergency alerting, and audio quality) and we do not know when it will.

[10] See *NPSTC Functional Description MCV 083011 FINAL*, available by clicking here.

e. Timing and risk for the options

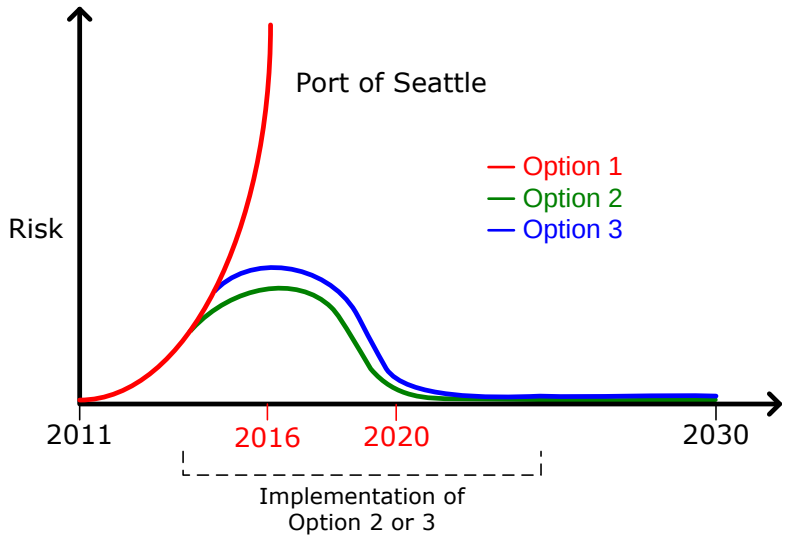
The graph bellow illustrates timing and relative risk for Options 1, 2, and 3.



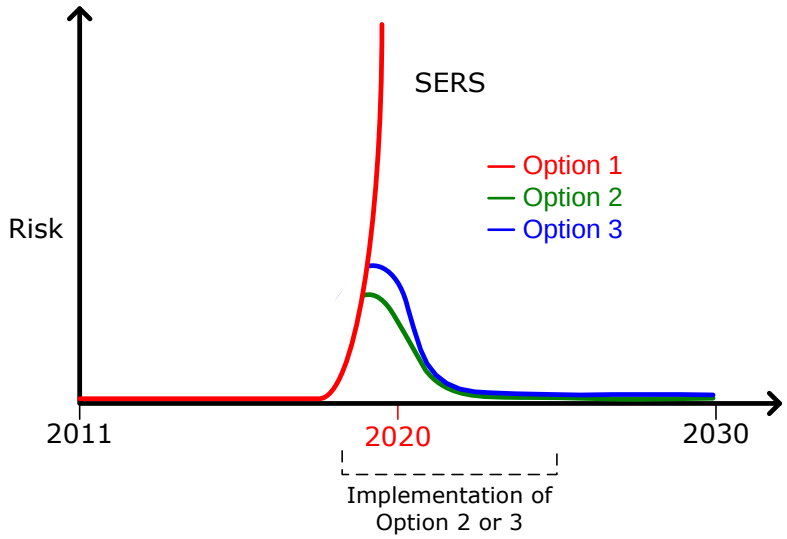
Option 1, keeping existing LMR systems in place, is time limited by vendor end of support dates. Until remedial action is complete, the risk of serious system degradation or failure will increase over time. Critical dates for existing LMR systems are listed in Section f. below.

Options 2 and 3 would procure and implement new LMR systems. Risk will taper off and decrease as implementation proceeds and as end users begin using the new systems. Option 2, the phased upgrade to P25 Phase 2, would allow system owners to replace the oldest or riskiest components first and begin decreasing risk sooner. Option 3, construction of completely new P25 Phase 2 system(s), would take longer to begin reducing risk but would eventually reduce risk to the same level as Option 2.

Radio systems in the Region are at different points in their equipment lifecycle. Risk for the Port of Seattle rises sooner than other SmartZone radio systems (for example, the King County and Tacoma-Puyallup radio systems) because the Port's SmartZone 4.1 Master Site equipment will not be supported after July 2016.

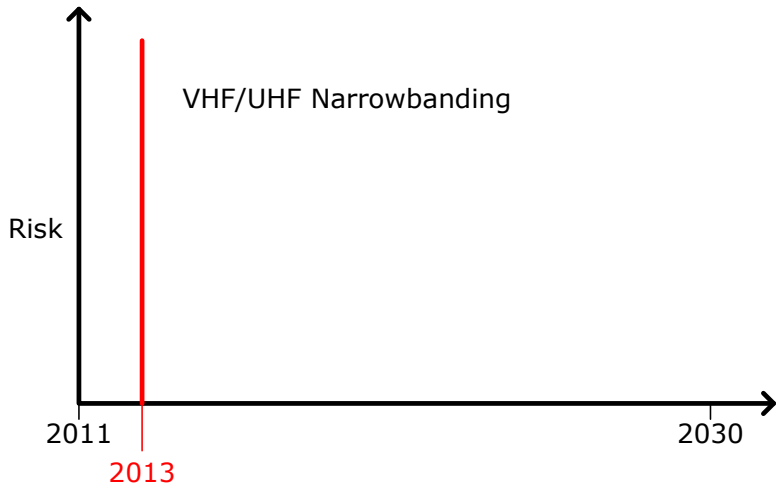


Risk for SERS rises later than other SmartZone systems because SERS has the newest equipment and an extended vendor service contract.



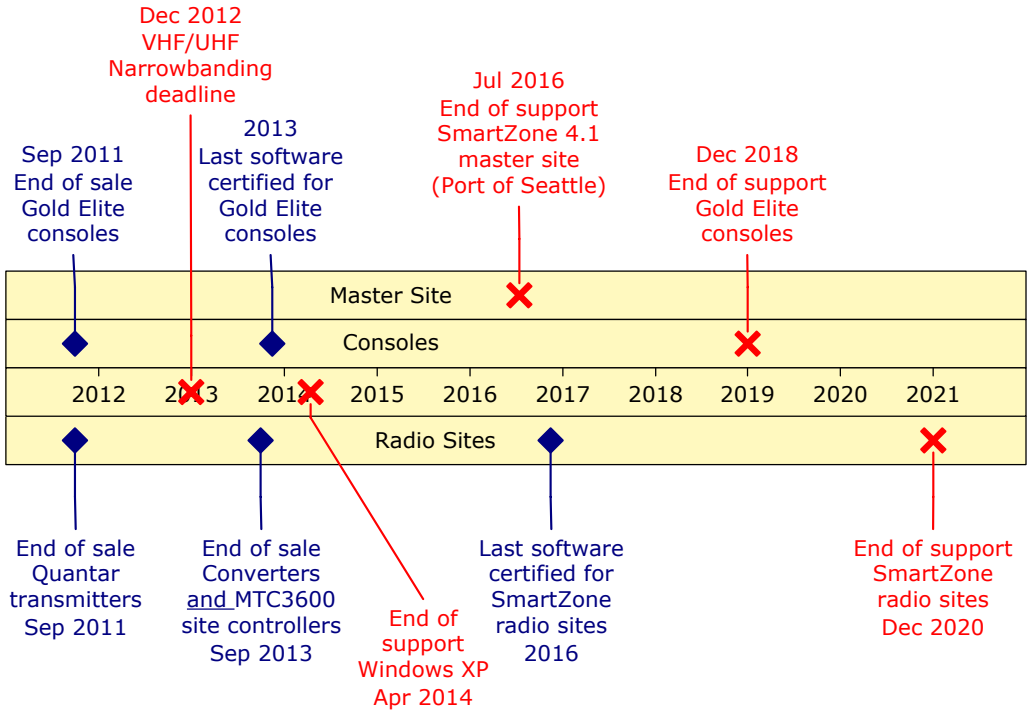
Option 4 would procure and implement an LTE system. LTE does not currently support mission-critical voice and we do not know when it will. The predominant risk for Option 4 is the unknown. Risk will eventually decrease after a standard is developed, devices become commercially available, and early deployments are complete.

VHF and UHF systems that have not complied with the FCC Narrowbanding mandate will not be allowed to operate after 12/31/2012. Systems that have not completed Narrowbanding have the following risk curve:



f. Critical dates for existing LMR systems

The following timeline shows milestones in the lifecycle of existing radio systems that determine when the risk of serious system degradation will increase unless remedial action is complete.



- September 2011: This was the end of sale for Gold Elite Dispatch Consoles. This is particularly important to Port of Seattle because, at this point, the Port can neither buy old (Gold Elite) Consoles nor new

(MCC7500) Consoles. Other Console manufacturer's equipment does not currently meet the business needs of the Port.

- September 2011: This was the end of sale for Quantar radio transmitter equipment. This is important to all SmartZone radio system owners because they can no longer add Radio Sites to increase coverage or channels to increase capacity.
- December 2012: This is the FCC deadline for Narrowbanding VHF and UHF radio systems. Any systems that have not completed Narrowbanding will not be allowed to operate.
- September 2013: This is end of sale for Motorola converter equipment that would allow Port of Seattle to do a phased migration from existing SmartZone systems to P25 Phase 2 systems, if desired.
- September 2013: This is the end of sale for MTC3600 simulcast controllers. (MTC3600 controllers are the technology replacement for the 6809 simulcast controllers used in the King County Radio System.) King County Radio System sub-regional owners will no longer be able to replace current 6809 simulcast controllers if they fail.
- 4Q2013: This is the vendor's planned release date for the last software that will be certified to support Gold Elite Consoles. Gold Elite Consoles may not operate properly on future releases of software.
- April 2014: This is the end of software support for Microsoft Windows XP which is used for Gold Elite Dispatch Consoles. This is a risk factor for all VHF, UHF, 700 MHz, and 800 MHz systems in the Region.
- July 2016: This is the end of hardware and technical support for Port of Seattle's SmartZone 4.1 Master Site. Radio communication at the Port will be at significant risk.
- 4Q2016: This is the vendor's planned release date for the last software that will be certified to support existing SmartZone Radio Site equipment. Existing Radio Site equipment may not operate properly on future releases of software.
- December 2018: This is the end of hardware and technical support for Gold Elite Dispatch Consoles.
- December 2020: This is the end of hardware and technical support for existing Radio Site equipment.

Special cases:

- The King County Radio System contains electronic components that are almost 18 years old, and some critical components (for example, 6809

site controllers) are no longer sold or supported by Motorola. Parts of this system are already at significant risk.

- Port of Seattle has SmartZone 4.1 Master Site equipment and must upgrade its Master Site or join another radio system before July 2016. However, the Port may need to act sooner than 2016 because it cannot currently replace, upgrade, or add Dispatch Consoles. Gold Elite Consoles are no longer sold by Motorola, and the Port's existing Master Site will not support Motorola's current MCC7500 Consoles.

5. Methodology

This section documents the approach that the Project Steering Committee (PSC) used to characterize and evaluate options and develop final recommendations. It includes descriptions of planning assumptions, constraints, evaluation criteria, and process.

a. Planning assumptions

The Project Steering Committee used the following assumption to guide the planning process:

i. Planning horizon. The planning horizon for the report is through the end of 2030.

ii. Current technology. Current technology is defined as technology that is available now or that will be commercially available, with reasonable certainty, by 2015.

iii. Radio system coverage areas. Some radio systems don't have adequate coverage today. With the conversion to P25 Phase 2, there will be less coverage than there is today. (Maps comparing current coverage for existing Motorola 800 MHZ radio systems to P25 Phase 2 coverage are included in the Appendices.) To get the coverage we need with P25 Phase 2, we will need to add and perhaps move some existing Radio Sites. In addition to this, requirements for in-building coverage would drive the need for additional sites.

iv. No loss of capabilities or performance. New or upgraded radio system(s) resulting from this project must provide voice communication capabilities and performance that are equal to or better than current LMR systems.

v. Critical capabilities must not be interrupted during transition. Loss of specific capabilities at any time would jeopardize public safety operations and/or the personal safety of first responders. Capabilities that must not be interrupted during transition include but are not limited to the ability to make wide area group calls and use the "emergency" button on first responder radios.

vi. Some capabilities may be limited during transition. Some features may be limited for a short period of time during transition with stakeholder concurrence. This could include certain Patching capabilities and the ability to pass radio unit ID's to different systems.

vii. System operation during transition must be simple from an end user perspective. Any end user uncertainty during transition could put public safety operations and the safety of first responders and the general public at risk.

viii. Mission-critical voice capabilities. The National Public Safety Telecommunications Council (NPSTC) Broadband Working Group identified essential capabilities of mission-critical voice communication systems.[11] New or upgraded system(s) resulting from this project must provide these capabilities.

b. Constraints

The following constraints apply to all options discussed in this report:

i. Motorola lifecycle dates. Motorola has announced end of support dates for existing Motorola SmartZone radio system hardware and software. End of support means Motorola will no longer maintain systems, repair failed components, or provide technical "help desk" support. Systems must be upgraded or replaced before support ends to avoid elevated risk of degraded performance or failure.

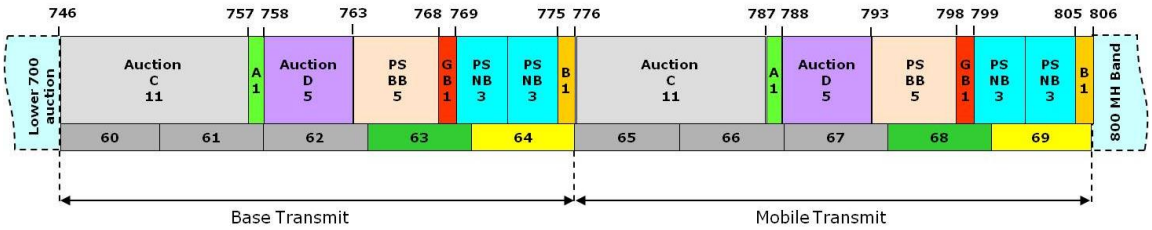
ii. Spectrum. Each option depends upon having sufficient radio Spectrum to meet end user requirements and facilitate transition from the current systems to new or upgraded system(s). Spectrum constraints are specific to each option:

- Option 1, continued use of existing systems, does not require any additional Spectrum.
- Options 2 and 3 depend upon having sufficient 800 MHz or 700 MHz narrowband public safety Spectrum to facilitate transition from existing systems to the new or upgraded P25 Phase 2 system(s) with limited negative impact upon public safety operations.
- Option 4 depends upon availability of 700 MHz public safety Broadband (PSBB) Spectrum (763-768 MHz/793-798 MHz). City of Seattle received a conditional Federal Communications Commission (FCC) waiver authorizing use of PSBB Spectrum within the geographic area of the city.[12] No other jurisdiction in the Region

[11] See *NPSTC Functional Description MCV 083011 FINAL,* available by clicking here.

[12] See *Requests for Waiver of Various Petitioners to Allow the Establishment of 700 MHz Interoperable Public Safety Wireless Broadband Networks, PS Docket 06-229, Order, 25 FCC Red 5145 (2010) (Waiver Order)* available at

currently has authorization to use that Spectrum. A regional waiver request is pending.



The performance of the Option 4 LTE network will improve if the 700 MHz D-block (758-763 MHz/788-793 MHz) also becomes available. The D-block is not considered in this report, however, because it is not certain if or when Congress will pass legislation to reallocate that Spectrum to public safety. (Current law dictates that the D-block be auctioned to a commercial carrier that would then construct and operate a network for public safety.)

iii. Backhaul. Backhaul refers to communications facilities, such as Microwave radio, Fiber, and telephone company circuits that connect central system control equipment to radio transmitter sites located in different geographic locations. There must be sufficient Backhaul to meet end user performance requirements and to facilitate transition from current systems to new or upgraded systems. Backhaul constraints are specific to each option:

- Option 1, continued use of existing systems, does not require additional Backhaul.
- Options 2 and 3 depend upon having sufficient additional Backhaul for the final, desired system and to facilitate transition from existing LMR systems to the new or upgraded P25 system(s).
- Option 4 would require many more Radio Sites, and each site would require 10-100 times the Backhaul capacity needed for traditional LMR sites. LTE systems typically need Fiber Backhaul.

iv. Narrowbanding. Effective January 1, 2013, public safety and business/industrial LMR systems operating in the VHF and UHF bands (below 512 MHz) may no longer use 25 kHz "wide-band" radio channels and must use technology supporting 12.5 kHz (or narrower) radio

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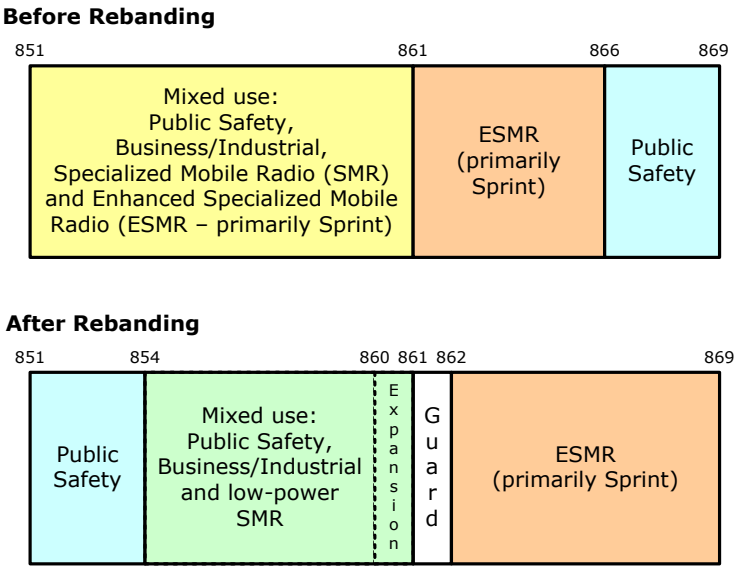
http://fjallfoss.fcc.gov/ecfs/document/view?id=7020505752 and http://fjallfoss.fcc.gov/ecfs/document/view?id=7020505753.

channels. The FCC established this requirement to drive more efficient use of radio Spectrum and increase channel capacity for public safety and non-public safety users. Licensees that do not comply could be subject to FCC enforcement action.

For purposes of this report, it is important to note that:

- Narrowbanding is driven by an FCC mandate.
- All radio system owners with VHF and UHF systems need to comply with the Narrowbanding mandate. That includes the following radio system owners in the Region:
    - SERS,
    - City of Seattle,
    - EPSCA member agencies,
    - King County,
    - ValleyCom,
    - Port of Seattle,
    - City of Tacoma,
    - City of Puyallup,
    - Pierce County,
    - Pierce Transit, and
    - WSP.
- The mandate most significantly affects Pierce County and Washington State Patrol (WSP) because their primary dispatch radio systems are VHF systems. Pierce County and WSP have to act very quickly to replace non-compliant VHF radio system Infrastructure and Mobile and Portable radios prior to the FCC deadline and could not wait for the final outcome of the Region's process to begin work on their systems; and
- Pierce County and WSP are, nonetheless, participating in the Region's process to identify opportunities to integrate systems to improve capabilities and performance.

v. 800 MHz Rebanding. Within the 800 MHz band, public safety radio frequencies are interspersed with radio frequencies used by Enhanced Specialized Mobile Radio (ESMR) service providers, particularly Sprint Nextel. ESMR systems transmit high-power signals from cellular radio towers that interfere with public safety 800 MHz radio systems. To reduce this interference, Sprint Nextel and the FCC developed a plan to reconfigure the 800 MHz band. The old and new plans are shown below.



After Rebanding is complete, all public safety radio channels will be located within a contiguous block of Spectrum. The use of contiguous Spectrum will allow radio vendors to use filters to protect public safety radio channels from ESMR interference, something that was not possible under the old plan.

To implement Rebanding, agencies need to "re-tune" existing Mobile and Portable radios and Radio Site transmitters to the new frequencies in a carefully coordinated manner. Some existing radios can be reprogrammed to support the new frequencies; those that cannot be reprogrammed must be replaced. Sprint Nextel is paying for much of the cost of this reconfiguration; however, some agencies have decided to provide funding to upgrade the basic radios provided through Rebanding to radios with greater capabilities.

For the purposes of this report, it is important to note that:

- Rebanding is driven by an FCC mandate.
- The following radio systems in the Region are currently in the midst of Rebanding 800 MHz systems:
  - SERS,
  - City of Seattle,
  - EPSCA,
  - King County,
  - ValleyCom,
  - Port of Seattle,
  - City of Tacoma, and

- City of Puyallup.

- Rebanding is a large and time-consuming effort for technical staff in the Region and could take 3-4 years to complete.

- Many agencies have received, or will receive, new Mobile and Portable radios. The new radios have varying capabilities depending upon when they were purchased, individual agency preferences, and agency funding available to support those preferences. Some new radios are P25 Phase 1-capable, others are or will be P25 Phase 2-capable, and others will not be P25 capable at all.

vi. New State Route 99 tunnel. Before the new State Route 99 tunnel under downtown Seattle opens (estimated to be late 2015), there must be radio communication in the tunnel to support public safety and transit operations.

c. Evaluation criteria

The Project Steering Committee (PSC) used the following criteria to characterize and evaluate the four options under consideration:

- Coverage
- Spectrum
- Mobility and Interoperability
- Reliability
- Implementation and Transition
- Scalability
- Local Service Delivery and Control
- Encryption Key Management
- Over-the-Air-Programming (OTAP) and End User Template Management
- GPS-Enabled End User Devices
- Broadband-Enabled End User Devices

Coverage. Local and regional general coverage goals were established and Sparling submitted coverage maps based on the general parameters. (Coverage maps are included in the Appendices.) Each Option was characterized in terms of how the Option would meet the coverage goals.

Spectrum. There must be sufficient radio Spectrum to manage transition from existing LMR systems to new or upgraded system(s) without negatively impacting end users. Each Option was characterized by whether or not there is enough Spectrum to meet the Region's needs throughout the planning horizon. Potential opportunities and risks related to Spectrum use and availability were characterized for each option.

Mobility and Interoperability. End users need to be able to use a limited number of Talkgroups (both unencrypted and encrypted) throughout the Region without having to make changes to their radios or Talkgroup selections. Each option was characterized by how well it would meet this need and by any limitations or enhanced capabilities it may have.

Reliability. End users need reliable service throughout the Region. At a minimum, central system control equipment needs to be redundant and preferably be capable of being installed in geographically-diverse locations. Each option was characterized by how well it could meet this need.

Implementation and Transition. Each option was characterized by the potential complexity of implementation and by the impact that transition would have on end users. Transition, the process of moving end users from existing LMR systems over to new or upgraded systems, was considered in three general frameworks:

- Communications capabilities: End users must maintain the ability to communicate on normal operational Talkgroups and designated Interoperability Talkgroups throughout transition. However, it may be acceptable to limit some other features during transition. Each option was characterized by how it would meet this requirement and by what general features or functionality would be limited during transition.
- Duration and certainty: The time required to complete transition needs to be limited and predictable to minimize impact on end user agencies and radio system owners.
- Timing flexibility: Each option was characterized by the degree to which it would allow radio system owners and end user agencies flexibility to plan their own migration timeframes (i.e. determine when they would upgrade or build radio system Infrastructure and transition end users) versus having to comply with a schedule determined by others.

Scalability. The system must allow for growth over time to account for population and other growth. Each option was characterized by its ability to accommodate growth of Radio Sites, capacity, Dispatch Consoles, and end-user radios over the planning horizon.

Local Service Delivery and Control. Each option was characterized by whether or not ownership and system management functions could be segmented so that system owners could continue to manage the service delivery process for their end user customers.

Encryption Key Management. Local agencies need the ability to control their own Encryption keys. Each option was characterized by whether or not it could allow local key management and system-level key management, if desired. Even if system-level key management is used, local jurisdictions would still need to be able to manage their own keys.

Over-the-Air-Programming (OTAP) and End User Template Management. Each option was characterized by whether or not it could support OTAP and the ability to centrally manage end user templates.

GPS-Enabled End User Devices. Each option was characterized by whether or not it could support GPS-enabled end user devices and how that GPS data could be made available for other uses.

Broadband-Enabled End User Devices. Each option was characterized by whether or not it could support Broadband-enabled end user devices in order to enhance situational awareness.

d. Analysis of options and development of this report

The Project Steering Committee (PSC) used the following process to evaluate the options and produce this report:

i. Development of evaluation criteria. The PSC collectively determined the criteria that would be used to evaluate each option. The evaluation criteria (listed above) are not a comprehensive list of requirements; rather, they are important capabilities and considerations that highlight conceptual differences and enable comparative analysis.

ii. Technical analysis of the options and sub-options. The PSC analyzed each of the options and sub-options using the evaluation criteria to characterize them from a technical perspective. The work of facilitating and documenting the technical analysis sessions was distributed among four agencies to share the work and to ensure that no one agency had too much influence during this process. Notes from the technical sessions are included in the Appendices.

iii. Analysis of strengths, weaknesses, opportunities, and threats (SWOT). After the technical analysis, the PSC completed a SWOT analysis. This process was intended to generate objective conclusions, free from preexisting personal or agency biases, about each option to guide and support the recommendations in this report. Another agency (different from the four agencies that facilitated the technical analysis sessions), facilitated SWOT analysis sessions for each option and sub-option. Seven

such meetings were held. Notes from the SWOT analysis sessions are included in the Appendices.

iv. Rating and comparative analysis. After the SWOT analysis sessions, the PSC rated each option against each of the evaluation criteria. Eight agencies participated in the process, with each agency having one equal vote. Representative(s) from each agency independently determined their agency's rating for each option and criteria. Agencies then shared their ratings, and the ratings were averaged to determine the PSC's collective assessment of each option. While a numerical scoring system was used to derive the group's collective assessment, the exact numerical score is not as important as the overall trends illustrated by the numbers (whether an option meets or exceeds requirements, fails to meet requirements, or has too many uncertainties to definitively rate).

v. Development of drafts. The work of writing this report was distributed among agencies. Each of the four agencies that facilitated technical analysis sessions also developed the first draft of the corresponding sections of the report (Sections 7, 8, 9, and 10). The agency that facilitated SWOT analysis sessions developed the first draft of the option comparison section of the report (Section 11). All other sections of the report were drafted by a designated technical writer working in close collaboration with the PSC.

vi. Draft review sessions. The PSC collaboratively reviewed and edited all sections of the report to ensure that the end result represented the consensus opinion of the group. Eight draft review sessions were held.

The timeline for development of this report listing all of the PSC working sessions is included in the Appendices.

e. Stakeholder review sessions

The Project Steering Committee presented it analysis and the recommendations in this report to approximately 55 public safety stakeholders during two meetings held in January 2012.

f. Independent review for quality assurance

The Project Steering Committee hired Sparling to review the draft and final versions of this report for completeness, consistency, and accuracy. Upon completion of its review, Sparling will prepare a written report that specifically addresses each of these areas.

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6. Key Questions

This section answers some key questions to illustrate key issues and support the recommendations in this report.

What defines risk?

Risk increases when electronic components become so old that they are more prone to fail, when key components cannot be repaired or replaced, when software is no longer supported by the vendor, or when software no longer supports the hardware. In the situation where software no longer supports the hardware, software must be kept at a specific version and cannot be upgraded unless the hardware is replaced. Keeping software at a specific version could result in security vulnerabilities and prevent implementation of new features or software patches to correct bugs.

Current radio systems have a heavy reliance on third-party components and software, and the radio system vendor does not have control over when those components and software become unsupported.

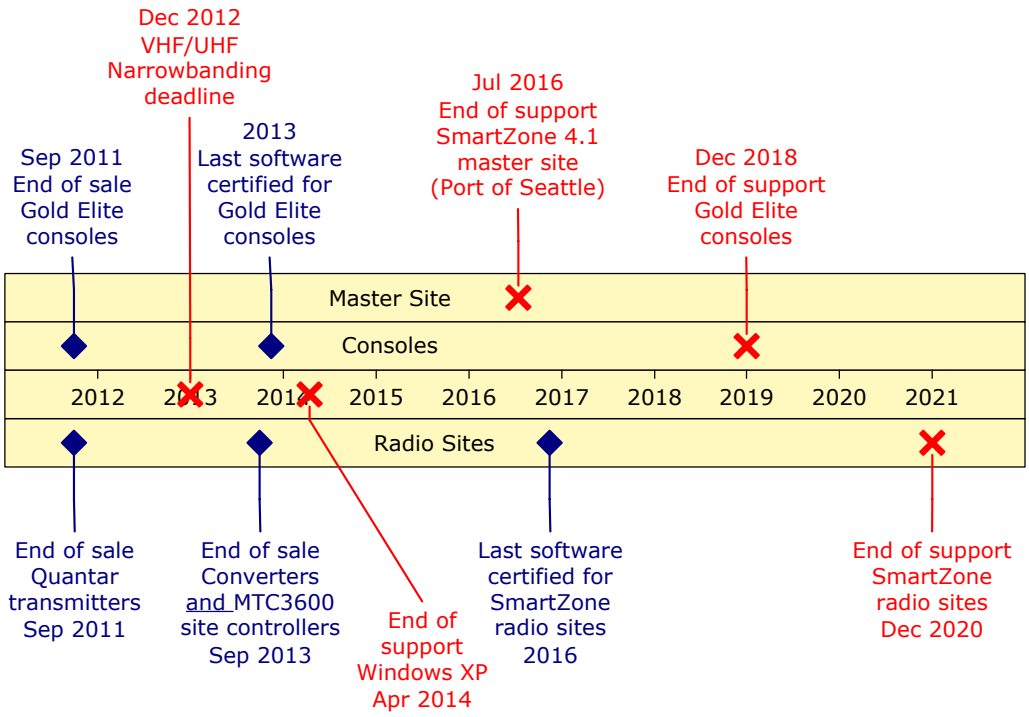
At what points does risk increase?

Risk increases when these milestones are reached:

- End of software support: The vendor is no longer developing the software to protect against security vulnerabilities or correct bugs. This applies to both radio system vendor software and third-party software;
- End of sale: The vendor is no longer shipping compatible, new equipment. This applies to both radio system vendor equipment and third-party equipment;
- End of hardware support: The vendor is no longer repairing equipment or providing parts to support in-house repair facilities; and
- End of vendor technical support: The vendor is no longer providing training and technical "help desk" services.

When do the risks of serious system degradation increase for current radio systems?

Unless remedial action is completed before the dates shown and noted below, the risk of serious system degradation or failure will increase.



- September 2011: This was the end of sale for Gold Elite Dispatch Consoles. This is particularly important to Port of Seattle because, at this point, the Port can neither buy old (Gold Elite) Consoles nor new (MCC7500) Consoles. Other Console manufacturer's equipment does not currently meet the business needs of the Port.
- September 2011: This was the end of sale for Quantar radio transmitter equipment. This is important to all SmartZone radio system owners because they can no longer add Radio Sites to increase coverage or channels to increase capacity.
- December 2012: This is the FCC deadline for Narrowbanding VHF and UHF radio systems. Any systems that have not completed Narrowbanding will not be allowed to operate.
- September 2013: This is end of sale for Motorola converter equipment that would allow Port of Seattle to do a phased migration from existing SmartZone systems to P25 Phase 2 systems, if desired.

- September 2013: This is the end of sale for MTC3600 simulcast controllers. (MTC3600 controllers are the technology replacement for the 6809 simulcast controllers used in the King County Radio System.) King County Radio System sub-regional owners will no longer be able to replace current 6809 simulcast controllers if they fail.

- 4Q2013: This is the vendor's planned release date for the last software that will be certified to support Gold Elite Consoles. Gold Elite Consoles may not operate properly on future releases of software.

- April 2014: This is the end of software support for Microsoft Windows XP which is used for Gold Elite Dispatch Consoles. This is a risk factor for all VHF, UHF, 700 MHz, and 800 MHz systems in the Region.

- July 2016: This is the end of hardware and technical support for Port of Seattle's SmartZone 4.1 Master Site. Unless the Port upgrades its Master Site or joins another radio system, radio communication at the Port will be at significant risk.

- 4Q2016: This is the vendor's planned release date for the last software that will be certified to support existing SmartZone Radio Site equipment. Existing Radio Site equipment may not operate properly on future releases of software.

- December 2018: This is the end of hardware and technical support for Gold Elite Dispatch Consoles.

- December 2020: This is the end of hardware and technical support for existing Radio Site equipment.

Special cases:

- The King County Radio System contains electronic components that are almost 18 years old, and some critical components (for example, 6809 site controllers) are no longer sold or supported by Motorola. Parts of this system are already at significant risk.

- Port of Seattle has SmartZone 4.1 Master Site equipment and must upgrade its Master Site or join another radio system before July 2016. However, the Port may need to act sooner than 2016 because it cannot currently replace, upgrade, or add Dispatch Consoles. Gold Elite Consoles are no longer sold by Motorola the Port's existing 4.1 Master Site will not support Motorola's current MCC7500 Consoles.

What, if anything, can we do to push out those dates?

Nothing. The dates noted above are outside our control.

When MUST a new system be in place?

This varies by system. Some radio systems have newer and different equipment than others, and certain actions can be taken to extend the life of existing systems. System owners are likely to consider the following factors in reaching a decision:

- Age of equipment
- Equipment/technology vintage
- Tolerance for risk by system owners
- Need for expanded coverage and increase capacity
- End user needs

What constraints prevent us from starting work to replace existing systems?

If this will be done as a regional effort, there are decisions to be made about governance, operations, technology, and scope. We lack funding, and we need system requirements and a final design.

Why can't we just buy spares on the secondary market?

Buying equipment on the secondary market presents significant risk to mission-critical operations. The existing radio systems require specific versions of electronic components, and the needed version of any particular component may not be available on the secondary market. Also, the condition and service history of equipment purchased on the secondary market is unknown, so the reliability of those parts is uncertain.

What is Interoperability?

Interoperability means the ability to exchange information on demand, in real time, as authorized. Interoperability is not a single defined state; rather, there are levels of Interoperability. For example, a user may be able to talk to another user outside the coverage area of his home system, but other features that would normally work on his home system (such as the emergency button) may not work.

Within the context of this report, Interoperability refers to having the technical capabilities necessary to enable the exchange of information. Additional factors necessary to achieve Interoperability in the field (governance agreements, operating procedures, end user training, etc.) are not considered in this report.

Should we have a single, regional radio system or multiple radio systems linked together?

The technology will meet end user requirements either way. Having all end users in the Region on a single regional system would ensure the highest level of Interoperability for system users; however, the equipment now available to link systems together is sophisticated enough that, from an end user perspective, multiple systems linked together could perform the same as a single system provided a single vendor is selected for all systems. The multiple systems approach could provide system owners with greater flexibility to implement new systems and transition end users over to the new systems within their own time frames.

Technology is only one factor in this decision; governance, operations, and funding also need to be considered to determine the best approach.

Is it possible to have one system from a technical viewpoint and still have some measure of local control and/or distributed operations?

Yes. The King County Radio System currently operates that way. Four agencies operate and maintain radio system Infrastructure within their designated geographic areas of King County and have equal ownership shares in the central Switch equipment that connects the four sub-regions into one integrated radio system. The four sub-regional owners support the end users (public safety agencies) within their geographic operating areas.

The exact extent to which a single system would allow local control and distributed operations will depend upon the capabilities of the manufacturer's equipment.

Will options 2, 3, and 4 all result in better coverage?

Options 2, 3, and 4 could all result in better coverage. Additional Radio Sites are needed to improve coverage, and Options 2, 3 and 4 could all scale to support additional Radio Sites. The extent to which coverage could be improved will depend upon the amount of funding available for additional Radio Sites. It could also depend upon having Spectrum available.

Once we have a contract in place, a detailed design, and a start date, how long should it take to implement option 1B (extend life)? Option 2? Option 3? Option 4?

Option 1B would not have a specific implementation plan. Work would be done in response to specific needs by individual system owners.

It is estimated that it will take 4 to 6 years to implement Option 2.

It is estimated that it will take 4 to 6 years to implement Option 3.

Implementation of Option 4 cannot proceed until there is a standard for mission-critical voice on LTE and equipment that complies with that standard. At present, there is no timeline for development of that standard.

What would transition be like for end users under option 1B? Option 2? Option 3? Option 4?

The transition plan for Option 1B would vary by agency and may not have a significant impact upon end users.

Option 2 would be done in phases. System owners and end user agencies would have some flexibility to establish their own timeframes for each phase, although the work would need to be done within a mutually-accepted, regional timeline. The major steps, not necessarily in order, are noted below.

- Port of Seattle would upgrade its Master Site to a P25 Switch or join another radio system.
- Dispatch centers would replace existing Gold Elite Dispatch Consoles with current Motorola MCC7500 Consoles. All dispatch centers would not need to replace their Consoles at the same time, nor would any single dispatch center need to replace all of its Consoles at the same time. (There are operational benefits to having all Consoles in a single dispatch center the same, however.)
- End user agencies would replace existing Mobile and Portable radios with radios that support both Motorola SmartZone and P25 Phase 2. A limited number of existing radios are capable of both technologies and could just need software upgrades. Mobile and Portable radios need to support both technologies to preserve communications during the transition. (There are over 16,000 users on the King County Radio System, for example, and it will take many months to move all of them to the upgraded P25 Phase 2 system(s). During that extended period of time, system users will need to be

able to communicate with others on SmartZone systems and P25 Phase 2 systems.)

- Radio system owners would install P25 Phase 2 equipment at existing Radio Sites. They could also add new Radio Sites to improve coverage, where needed.
- Migration of end users to the upgraded system(s) could begin when Mobile and Portable radios and P25 Radio Sites are ready. To the maximum extent possible, whole end user agencies (entire police departments or fire departments and their corresponding Talkgroups) would be moved over to the upgraded system(s) at the same time to minimize operational impact.
- As groups of users and Talkgroups are moved from SmartZone to P25 Phase 2, radio frequencies would also be moved, gradually decreasing capacity on SmartZone Radio Sites as it is no longer needed and increasing capacity on P25 Phase 2 Radio Sites.
- Upgrading Dispatch Consoles and migrating end user Mobile and Portable radios would be independent tasks and could be completed at different times.

Option 3 would construct whole new P25 Phase 2 system(s) from the ground up and move end user agencies and dispatch centers over to the new system(s) after construction is complete. A few notes about this transition:

- The complete new P25 Phase 2 system(s) would need to operate in parallel with existing systems for an extended period of time. Option 3 could require more space at Radio Sites and more radio frequencies to manage the transition than Option 2, adding complexity and possibly cost.
- Like Option 2, Option 3 would require that end user agencies replace existing Mobile and Portable radios with radios that support both Motorola SmartZone and P25 Phase 2 to preserve communication during the transition. A limited number of existing radios are capable of both technologies and could just need software upgrades.
- Migration of end users to the new P25 Phase 2 system(s) could begin when Mobile and Portable radios are ready and when the Infrastructure is complete, including Switch equipment, Radio Sites, and Dispatch Consoles. To the maximum extent possible, whole end user agencies (entire police departments or fire departments and their corresponding Talk Groups) would be moved over to the upgraded system(s) at the same time to minimize operational impact.

- Moving dispatch centers and end user agencies over onto the new system(s) would be interdependent tasks and would have to be carefully coordinated. This could give system owners and end user agencies less flexibility to establish their own timeframes for transition.

Option 4 would construct a whole new LTE system from the ground up. Migration of end users could begin when end user devices are ready and when the new Infrastructure is complete, including LTE Core equipment, Roaming infrastructure, Backhaul networks, Radio Sites, and Dispatch Consoles. There are still many unknowns about LTE, including what Dispatch Consoles and user devices will be available for public safety, so we cannot yet develop a specific transition plan.

What are the impacts of different systems pursuing the same target (P25 Phase 2 with the same equipment) at different points in time?

The Region needs to migrate to new system(s) in a carefully coordinated manner to preserve Interoperability and minimize impacts on radio system owners and end-user agencies.

Throughout transition, radio system owners will have to operate and maintain old SmartZone radio system Infrastructure to preserve Interoperability and enable mutual response throughout the Region. Until the last system user in the Region is moved over to a new system, system owners will have more equipment to support, and some of the Region's radio Spectrum will be tied up on SmartZone radio systems and unavailable for use on the new P25 Phase 2 system(s).

As soon as an end user agency (for example, a fire department) begins moving to the new radio system, it will be critically important to complete the process for that agency as quickly as possible to minimize confusion and risk. Radio system users need to know exactly which system (old or new) to use at every point during transition to ensure that communication is preserved. The longer the transition takes, the greater the risk to end users.

In border areas such as Federal Way and Bothell, where end users frequently cross over between radio system coverage areas, transition will require even greater coordination. If different radio systems move to P25 Phase 2 at very different points in time, the transition could be especially difficult for end users in these border areas. In this instance, Option 2 (following Motorola's recommendations to upgrade existing SmartZone systems) has a distinct advantage over Option 3 (building new systems). In Option 2, old SmartZone Radio Sites and new P25 Phase 2 Radio Sites could be connected to the same

Switch and operate as a single system. The Switch could bridge users on the old and new Radio Sites to lessen the impact of transition on end users.

What options enable us to procure equipment from more than one manufacturer, if desired?

Option 2 would allow end user agencies to purchase P25 Phase 2 Mobile and Portable radios from more than one manufacturer after the upgrade and transition to P25 Phase 2 is complete.

Option 3 could allow system owners to purchase P25 Phase 2 radio system Infrastructure (Switches, radio transmitters, and Dispatch Consoles) as well as P25 Phase 2 Mobile and Portable radios from more than one vendor. However, from a technical and operations support perspective, it is not recommended that Infrastructure from multiple different vendors be mixed within a single radio system.

Several equipment manufacturers are expected to offer LTE equipment for public safety, so Option 4 would likely enable procurement from multiple sources.

What are the benefits and risks of procuring equipment from multiple vendors?

Potential benefits of procuring equipment from multiple vendors are that it could put competitive pressure on price and provide supplier diversity. The greatest risk to procuring equipment from multiple vendors is that the responsibility for integrating system components, resolving technical incompatibilities, and troubleshooting complex technical issues involving multiple vendors' components could fall upon the Region, not any one vendor.

Can we just use cell phones?

No. Public safety has a number of requirements that are beyond what's currently available in commercial cell phone technology. For example, public safety needs:

- Instantaneous, push-to-talk, one-to-many communication;
- High quality audio that allows users to understand each other without repetition, detect stress in a speaker's voice, and hear background sounds without interfering with the prime voice communications;
- Guaranteed, priority access to the system at all times;
- Emergency alerting capability that gives a system user encountering a life-threatening condition immediate, high-priority access to the radio system;

- 99.999% reliability. For emergency responders to be able to rely on a system for mission-critical communications, it must be designed to prevent service degradation, including loss of coverage or capacity, regardless of conditions;

- Talk-around, or the ability to communicate device-to-device when outside of radio system coverage areas or if system Infrastructure has been damaged. This is a critical feature when firefighters respond to an incident in the basement of a building, for example, or when search and rescue responders operate in mountainous terrain outside reliable system coverage areas; and

- Ruggedized end user devices. While not all devices used by public safety need to be ruggedized, some must be. There can be serious consequences if a public safety device is rendered inoperable because it is dropped or submerged in water. For a policeman in a life-threatening situation or a fireman battling a fire, the consequences of mechanical failure can be deadly.

Additional information about the suitability of LTE and commercial cell phone technology for mission-critical public safety voice communication can be found here:

- The National Public Safety Telecommunications Council (NPSTC) Broadband Working Group developed a functional description of mission-critical voice. See *NPSTC Functional Description MCV 083011 FINAL* available by clicking here.

- Wireless industry consultant Andrew Seybold writes regularly about mission-critical voice and other topics relevant to public safety communications for his "Public Safety Advocate" newsletter: http://andrewseybold.com/publications/public-safety-advocate-e-newsletter. Recent articles include:

  - Mission-Critical Voice Over LTE: What, When, and How? – 12.08.2011

  - Mission-Critical Voice and LTE: Be Careful! – 08.26.2011

- The Department of Homeland Security's Office of Emergency Communications, in collaboration with SAFECOM and the National Council of Statewide Interoperability Coordinators, developed a brochure that describes the evolution of emergency communications and how traditional LMR communications used today may converge with wireless Broadband in the future if specific requirements are met. See *Public Safety Communications Evolution Brochure - November 2011* by clicking here.

7. Analysis of Option 1

Option 1 is to keep existing Land Mobile Radio (LMR) systems in place and operational for as long as possible. SmartZone 800 MHz radio system owners would continue to operate existing systems beyond Motorola's announced end-of-support dates[13], with operational risk increasing over time. VHF and UHF system owners would take the steps necessary to comply with the Federal Communications Commission's Narrowbanding mandate and continue to use those systems.

As long as there is no major component failure, end user functionality would remain as it is today. SmartZone radio system owners could not increase capacity or make improvements to coverage, where needed. Motorola no longer sells the Radio Site equipment and software licenses needed to make those improvements.

This option does nothing to protect against a failure of major components and the possibility that such components will not be able to be repaired or replaced with vendor-supplied and certified parts. Some electronic components in some systems have been in service for almost 18 years. As of September 2011, we can no longer purchase many new parts from Motorola to keep existing SmartZone systems operable. Over time, Motorola will stop supplying and repairing all of the parts in these systems. At that point, the only source for repair parts will be the secondary market – companies that sell used LMR equipment and auctions such as eBay. Depending upon the secondary market for parts is risky and unreliable because components have to be at specific hardware/software versions (not all parts are compatible with existing systems) and because the condition and service history of used components is unknown.

VHF and UHF radio systems may have similar product end of life issues, however, the scale and impact of these issues are presently undefined. Those same VHF and UHF systems are also under an additional constraint. Effective January 1, 2013, all systems operating in the VHF and UHF bands (below 512 MHz) may no longer use 25 kHz "wide-band" radio channels and must use technology supporting 12.5 kHz (or narrower) radio channels. Radio system owners cannot keep existing VHF and UHF systems in place without making some investments: affected agencies have to act to replace non-compliant radio system Infrastructure and Mobile and Portable radios prior to the FCC deadline.

[13] End of support means Motorola will no longer maintain systems, repair failed components, or provide technical "help desk" support. Systems must be upgraded or replaced before support ends to avoid elevated risk of degraded performance or failure.

The FCC Narrowbanding mandate most significantly affects Pierce County and Washington State Patrol because their primary dispatch operations use VHF systems. There are a number of other VHF and UHF systems in the Region, and the solutions developed as part of this project could be modified to accommodate smaller VHF and UHF systems.

There are two potential benefits to keeping existing systems in place. First, doing so may enable us to minimize or defer costs in the short term. Whether we choose to upgrade or rebuild our systems, the costs may run in the hundreds of millions of dollars. Second, some observers hope that, by keeping existing systems in place for a period of time, we may be able to avoid building another generation of LMR systems, giving time for the next generation of public safety wireless communication technology to develop and mature. The question for decision makers is whether and for how long these benefits outweigh the increasing risks of potential system degradation or failure of these systems.

Option 1 has two alternatives, described and illustrated on the pages that follow.

Sub-option 1A: Do nothing

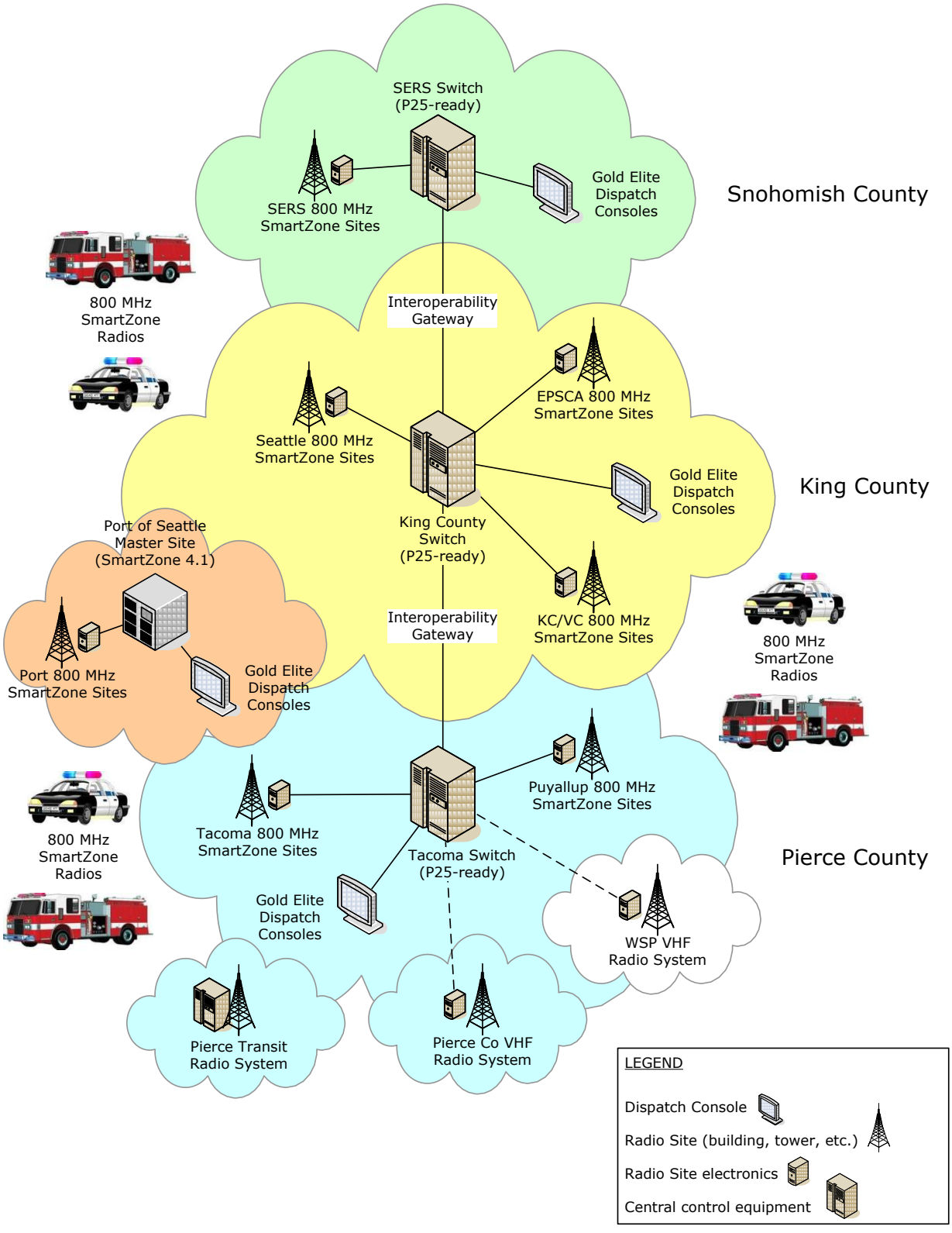
SmartZone 800 MHz radio system owners would perform routine maintenance and make emergency repairs, but would make no other investments in existing systems.

Sub-option 1A is not valid for VHF and UHF radio systems. VHF and UHF systems must narrowband their systems by January 1, 2013 or risk FCC citations and significant fines for each day of non-compliant operation.

SmartZone radio systems cannot be made to work properly forever, and current problems (such as the need to improve coverage and add capacity) cannot be fixed without major investments. The vendor has indicated that it will stop providing new parts and repairing broken parts for these systems over a period of years. In fact, it has already withdrawn support for some of the parts in some of the local systems. This sub-option does nothing to protect against the risks resulting from the unavailability of vendor-supplied and certified parts, firmware, and software.

There will be an aftermarket for parts; however, depending upon the aftermarket is risky and unreliable because components have to be at specific hardware/software versions (not all parts are compatible with existing systems) and because the condition and service history of used components is unknown.

Option 1: Keep existing Land Mobile Radio systems in place
Sub-option 1A: Do nothing



The risk for an individual SmartZone radio system is that a key part will break and can't be replaced, causing reduced coverage or capacity, reduced voice quality, or complete system failure. The degree of risk for any particular system depends upon a combination of factors: the equipment in the system, the age of that equipment, the date the vendor stops repairing and replacing those components, and each radio system's specific vendor support agreement.

Sub-option 1B: Make minimum investments to preserve service levels and extend the useful life of the systems

Under this sub-option, SmartZone system owners would make emergency repairs and replace end-of-life Dispatch Consoles and other system components to preserve vendor support and end user service levels. VHF and UHF system owners would Narrowband their systems, as required.

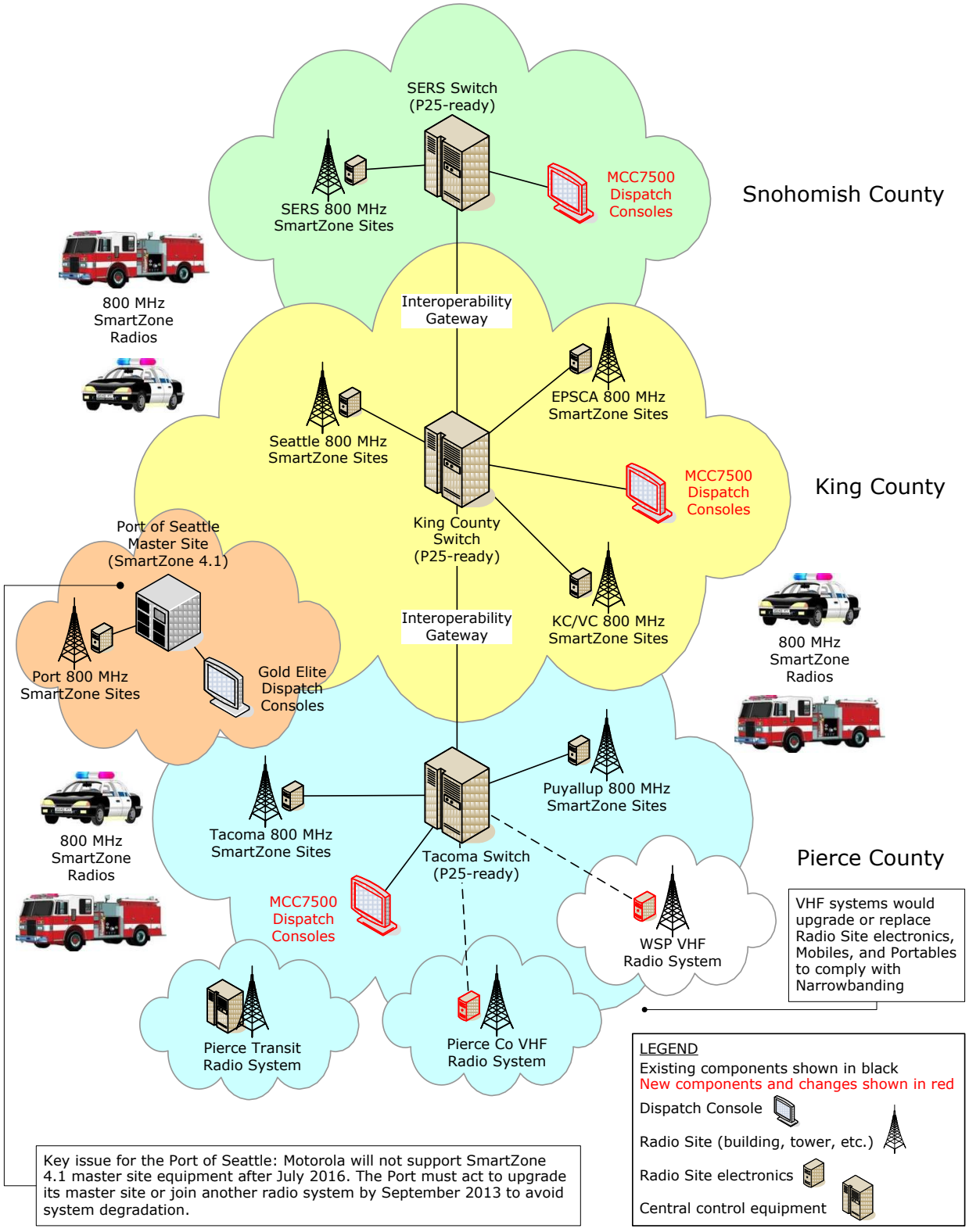
As noted above, the risk for SmartZone systems is that an original part will break and can't be replaced or repaired. In this circumstance, a system owner would attempt to replace the original part with a newer version of the part. It will sometimes be possible to substitute old parts for newer versions on a one-to-one basis. At other times, system owners will need to purchase and install multiple components to ensure compatibility. While this strategy may work in the short term, it does not make sense in the long term because the cost of rebuilding the system part-by-part will greatly exceed the cost of doing a planned upgrade or rebuild.

The unavailability of certain new SmartZone equipment prevents us from addressing current issues such as low service levels in some areas. For example, SmartZone radio system owners cannot increase capacity or make improvements to coverage, where needed, because Motorola no longer sells the Radio Site equipment and software licenses needed to make those improvements.

Again, the degree of risk for any particular system is a combination of the equipment in the system, the age of that equipment, the date the vendor stops repairing and replacing those components, and the system's vendor support agreement.

Option 1: Keep existing Land Mobile Radio systems in place

Sub-option 1B: Make minimum investments to preserve service levels and extend the useful life of the overall systems



Other expected characteristics of Option 1 are described below.

a. Regional Interoperability

Interoperability would remain as it is today. Mobiles and Portables are cross programmed with Interoperability channels from most other systems in the Region to allow end users to communicate with one another across systems. Gateways and Dispatch Console Patches are also used to allow end users to communicate with one another across systems.

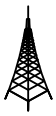
Existing Gateways between the King County, Tacoma-Puyallup, and SERS radio systems provide (or will provide) Fingertip Roaming on a limited number of pre-determined Talkgroups. The Gateways do not have the capacity to support large-scale incidents and require end users to manually change Talkgroups on their radios to operate across systems.

b. End user devices


SmartZone Radios

Option 1 delays the need to replace Subscriber radios. End users could continue to use their existing Mobiles and Portables. Radios would continue to operate using proprietary SmartZone 4.1 technology and have the same features.

c. Radio system Infrastructure

Central equipment | Radio Sites | Radio Site electronics | Dispatch Consoles

In general, there would be no major changes to central Switch equipment, Radio Sites, Radio Site electronics, or Backhaul systems.

In Sub-option 1B, system owners could replace end-of-life Gold Elite Dispatch Consoles or other system components to preserve vendor support and end user service levels. Replacing Gold Elite Dispatch Consoles with current Motorola MCC7500 Dispatch Consoles would

extend Motorola support for 800 MHz SmartZone radio systems for three years.[14]

This Option does not allow systems to scale to meet future needs. Radio system owners could not increase capacity or make improvements to coverage, where needed, because the necessary equipment is no longer sold by Motorola. It also does not allow system owners to modify systems to improve Radio Site and Spectrum efficiencies.

d. System performance

As long as there is no major component failure, coverage, capacity, and functionality would remain as they are today. This option would not fulfill needs for new capabilities such as Over-the-Air-Programming (OTAP), GPS-enabled end user devices, and Broadband-enabled end user devices.

e. Schedule

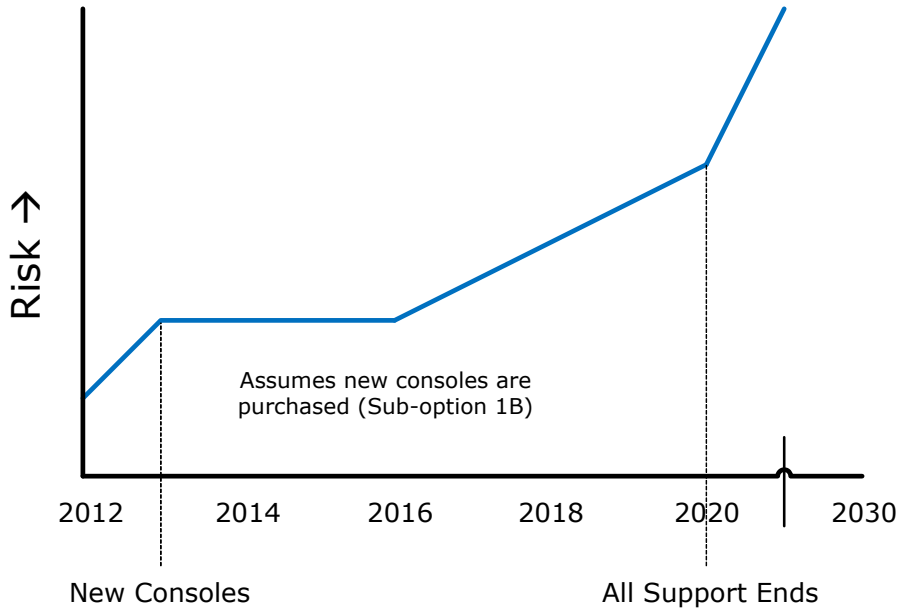
There is no implementation or transition schedule for Option 1. Instead, the schedule that impacts this option the most is the vendor's support timeline for existing equipment and the corresponding risk profiles for each radio system.

Radio system risk profiles

As noted above, the degree of risk for any particular system depends upon a combination of factors: the equipment in the system, the age of that equipment, the date the vendor stops repairing and replacing those components, and each radio system's specific vendor support agreement. Risk profiles for each of the systems studied are summarized below.

[14] The vendor's planned release date for the last central Switch system software that will be certified to support Gold Elite Consoles is 4Q2013. If Gold Elite Consoles are replaced with current Motorola MCC7500 Consoles, system software will be certified to support existing Radio System components until 4Q2016.

i. King County Radio System (EPSCA, King County, Seattle and ValleyCom) (800 MHz SmartZone system)



The King County Radio System contains electronic components that are almost 18 years old, and some critical components (for example, 6809 site controllers) are no longer sold or supported by Motorola. Parts of this system are already at significant risk. The system has also lost the ability to add Radio Sites to increase coverage or channels to increase capacity.

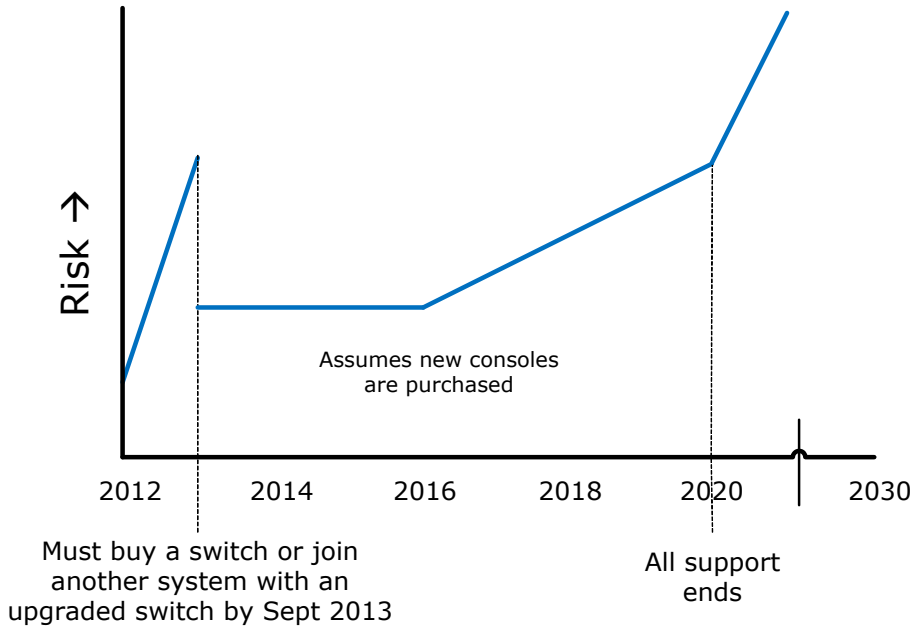
Key dates that impact the risk profile for the King County system are noted below.

- September 2011: This was the end of sale for Quantar radio transmitter equipment. This is important to all SmartZone radio system owners because they can no longer add Radio Sites to increase coverage or channels to increase capacity.
- September 2013: This is the end of sale for MTC3600 simulcast controllers. (MTC3600 controllers are the technology replacement for the 6809 simulcast controllers used in the King County Radio System.) King County Radio System sub-regional owners will no longer be able to replace current 6809 simulcast controllers if they fail.
- 4Q2013: This is the vendor's planned release date for the last software that will be certified to support Gold Elite Consoles.

Gold Elite Consoles may not operate properly on future releases of software.

- April 2014: This is the end of software support for Microsoft Windows XP which is used for Gold Elite Dispatch Consoles.
- 4Q2016: This is the vendor's planned release date for the last software that will be certified to support existing SmartZone Radio Site equipment. Existing Radio Site equipment may not operate properly on future releases of software.
- December 2018: This is the end of hardware and technical support for Gold Elite Dispatch Consoles.
- December 2020: This is the end of hardware and technical support for existing Radio Site equipment.

ii. Port of Seattle Radio System (800 MHz SmartZone system)

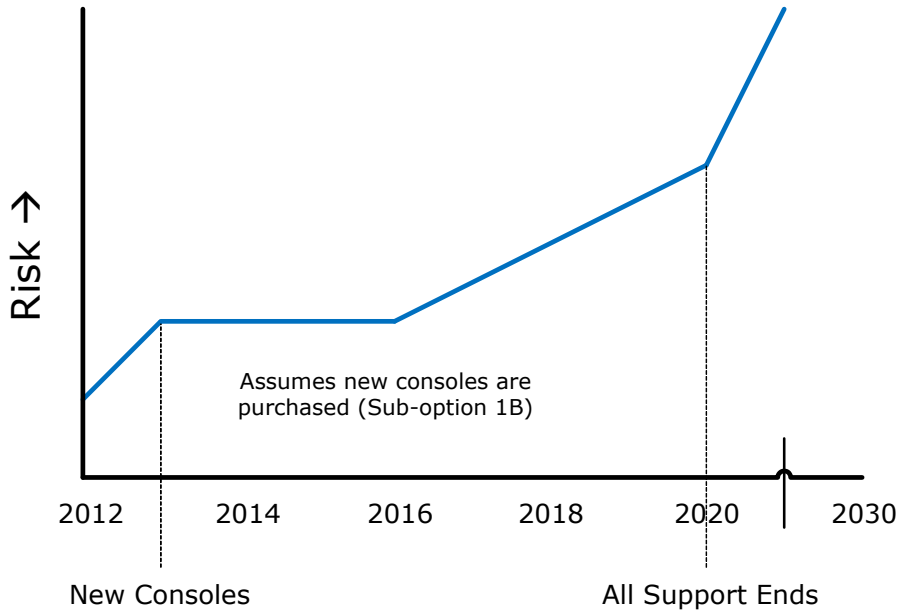


The Port of Seattle system does not have an upgraded Switch as do the King County, Tacoma-Puyallup, and SERS radio systems. The system has also lost the ability to add Dispatch Consoles and Radio Sites to increase coverage or channels to increase capacity.

Key dates that impact the risk profile for the Port of Seattle system are noted below.

- September 2011: This was the end of sale for Gold Elite Dispatch Consoles. This is particularly important to Port of Seattle system because, at this point, the Port cannot buy old (Gold Elite) Consoles or new (MCC7500) Consoles because they only work on upgraded Switches. Other Console manufacturers' equipment does not currently meet the business needs of the Port.
- September 2011: This was the end of sale for Quantar radio transmitter equipment. This is important to all SmartZone radio system owners because they can no longer add Radio Sites to increase coverage or channels to increase capacity.
- September 2013: This is end of sale for Motorola converter equipment that would allow Port of Seattle to do a phased migration from existing SmartZone systems to P25 Phase 2 systems or to join another system with an upgraded Switch, if desired.
- 4Q2013: This is the vendor's planned release date for the last software that will be certified to support Gold Elite Consoles. Gold Elite Consoles may not operate properly on future releases of software.
- April 2014: This is the end of software support for Microsoft Windows XP which is used for Gold Elite Dispatch Consoles.
- July 2016: This is the end of hardware and technical support for Port of Seattle's SmartZone 4.1 master site. If the Port has not acted to upgrade its system or join another radio system by this date, radio communication will be at significant risk. The Port needs to act much sooner than this – before September 2013 – if it intends to use Motorola converter equipment to do a phased upgrade or to join another upgraded Switch.
- 4Q2016: This is the vendor's planned release date for the last software that will be certified to support existing SmartZone Radio Site equipment. Existing Radio Site equipment may not operate properly on future releases of software.
- December 2018: This is the end of hardware and technical support for Gold Elite Dispatch Consoles.
- December 2020: This is the end of hardware and technical support for existing Radio Site equipment.

iii. Tacoma-Puyallup Radio System (800 MHz SmartZone system)



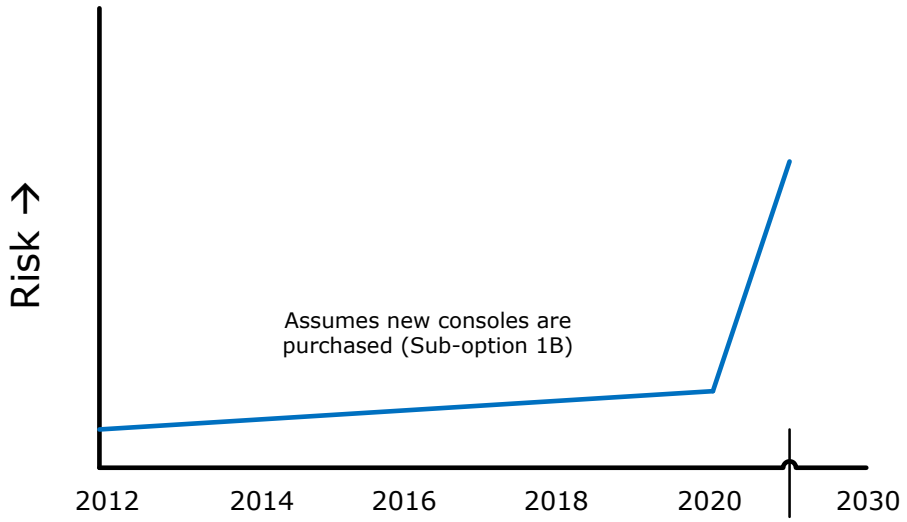
The Tacoma-Puyallup system is over 10 years old. Like other SmartZone systems, it has lost the ability to add Radio Sites to increase coverage or channels to increase capacity.

Key dates that impact the risk profile for the Tacoma-Puyallup system are noted below.

- September 2011: This was the end of sale for Quantar radio transmitter equipment. This is important to all SmartZone radio system owners because they can no longer add Radio Sites to increase coverage or channels to increase capacity.
- 4Q2013: This is the vendor's planned release date for the last software that will be certified to support Gold Elite Consoles. Gold Elite Consoles may not operate properly on future releases of software.
- April 2014: This is the end of software support for Microsoft Windows XP which is used for Gold Elite Dispatch Consoles.
- 4Q2016: This is the vendor's planned release date for the last software that will be certified to support existing SmartZone Radio Site equipment. Existing Radio Site equipment may not operate properly on future releases of software.

- December 2018: This is the end of hardware and technical support for Gold Elite Dispatch Consoles.
- December 2020: This is the end of hardware and technical support for existing Radio Site equipment.

iv. Snohomish County Emergency Radio System (SERS) (800 MHz SmartZone system)



The SERS system Infrastructure is over ten years old. SERS has a special support contract with the equipment vendor through 2020. In that contract, the vendor commits to repair or replace all parts in the SERS system (even beyond announced end of support dates).

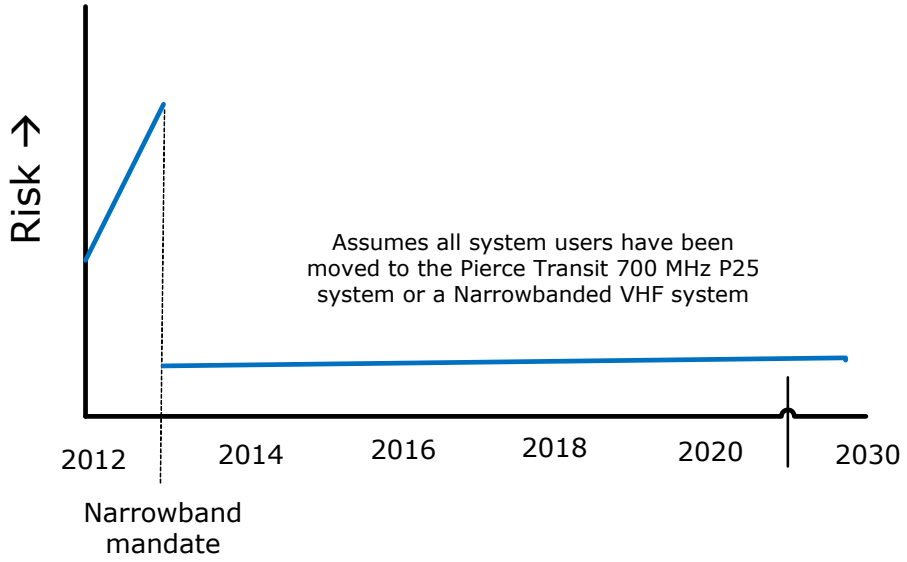
Like other SmartZone systems, SERS no longer has the ability to add Radio Sites to increase coverage or channels to increase capacity.

Key dates that impact the risk profile for the SERS system are noted below.

- September 2011: This was the end of sale for Quantar radio transmitter equipment. This is important to all SmartZone radio system owners because they can no longer add Radio Sites to increase coverage or channels to increase capacity.
- 4Q2013: This is the vendor's planned release date for the last software that will be certified to support Gold Elite Consoles. Gold Elite Consoles may not operate properly on future releases of software.

- April 2014: This is the end of software support for Microsoft Windows XP which is used for Gold Elite Dispatch Consoles.
- 4Q2016: This is the vendor's planned release date for the last software that will be certified to support existing SmartZone Radio Site equipment. Existing Radio Site equipment may not operate properly on future releases of software.
- December 2018: This is the end of hardware and technical support for Gold Elite Dispatch Consoles.
- December 2020: This is the end of hardware and technical support for existing Radio Site equipment.

v. Pierce County Government Radio System (VHF system)

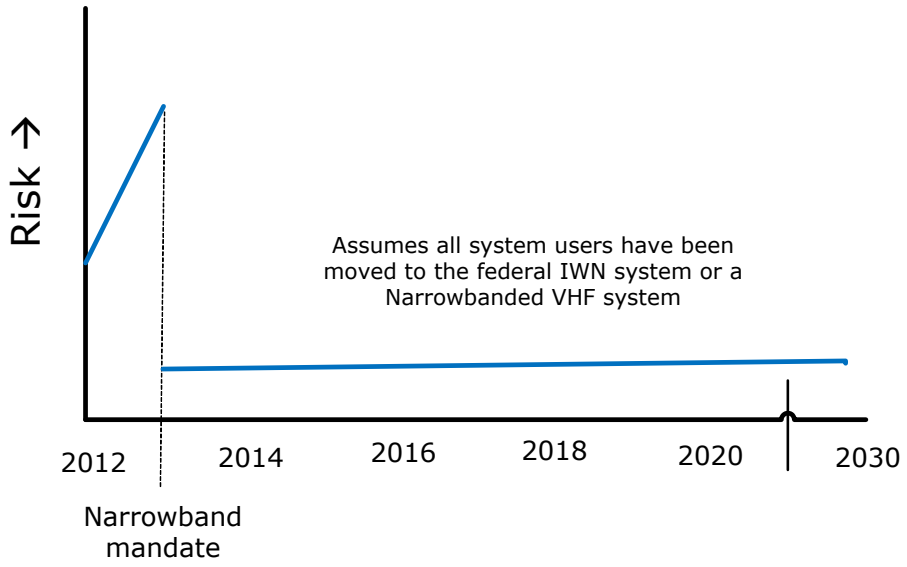


The Pierce County Government VHF system is subject to the FCC Narrowbanding mandate. It also has inadequate coverage and voice quality in places. Some components of this system may have reached the end of manufacturer support; however, this loss of support has less impact than that present for complex SmartZone radio systems.

In November 2011, Pierce County voters approved a tax measure to improve public safety communications throughout the county. Pierce County plans to use funding from that measure to upgrade the Pierce Transit 700 MHz P25 radio system to serve agencies that currently use the Pierce County VHF system. Some new equipment

will also be needed to comply with the FCC's Narrowbanding mandate (for users that remain on VHF).

vi. Washington State Patrol System (VHF)



The Washington State Patrol VHF system is subject to the FCC Narrowbanding mandate. The State Patrol is merging its system with the federal government's IWN System and is adding sites to improve coverage. Some new equipment will also be needed to comply with the FCC's Narrowbanding mandate. Some components of the existing system (notably Dispatch Consoles and Quantar radio transmitter equipment) may have reached the end of manufacturer support; however, this loss of support has less impact than that present for complex SmartZone radio systems.

f. Transition

Sub-option 1A does not make any changes, so there would be no transition.

In Sub-option 1B, transition would be limited to dispatch centers (assuming that they decide to replace Dispatch Consoles). System owners could work with the individual dispatch centers to replace Consoles as funding becomes available and in a manner that minimizes the impact upon dispatch center operations.

g. Key strengths, weaknesses, opportunities, and threats

The Project Steering Committee identified strengths, weaknesses, opportunities, and threats (SWOT) as part of its analysis of this option.

Keys points are summarized below. The complete result of the Steering Committee's SWOT analysis is included in the Appendices.

Strengths	Weaknesses
• No large, immediate capital investment required. • No immediate need to seek public funding. • Would allow continued use of existing equipment (Switches, Backhaul, Radio Sites, Mobile and Portable radios). • Would not require additional Spectrum for transition (unlike options 2 and 3). • No transitional impact on end users. • Would allow existing governance and business/operations models to remain intact, if desired.	• Does not preserve the current cost structure. Repair costs will increase in unpredictable ways over time. • Sub-option 1A does not preserve vendor support for existing systems. Sub-option 1B only temporarily extends it. • Does not extend the useful life of Port of Seattle's radio system. • Does not protect against a lack of vendor-supplied and certified parts. Depending upon the aftermarket for parts is risky and unreliable. • Does not allow radio system owners to add sites to improve coverage or add channels to improve capacity, if needed. • Does not allow system owners to scale systems up to meet future requirements because the necessary parts will be unavailable. • Do not fulfill needs for new capabilities such as Over-the-Air-Programming (OTAP), GPS-enabled end user devices, and Broadband-enabled end user devices. • Sub-option 1A does nothing to meet the FCC Narrowbanding mandate for VHF and UHF. • Does not allow Pierce County to share/join the Trunked radio technology used elsewhere in the Region.
Opportunities	Threats
• No significant opportunities noted.	• Potential for catastrophic system failure. • Potential future need to justify why failure was allowed to occur (why no preventative

	action was taken). • Some parts are not supported by the manufacturer today (6809 site controllers). • Some parts can no longer be purchase from the manufacturer (Gold Elite Dispatch Consoles, SmartZone Radio Site electronics) • Repair costs and repair times will increase in unpredictable ways. • We may lose capacity because of our inability to obtain replacement parts. • After September 2013, Port of Seattle will lose the option to do a phased migration. (Instead, the Port would need to do a complete system replacement.) • Vendor-supported agencies (as opposed to those that operate and maintain their own systems) are at greater risk. Existing vendor contracts have finite timelines, and costs for vendor service contracts will increase. This could ultimately affect end user rates. • Some existing Interoperability is dependent upon Dispatch Consoles. If end-of-life Gold Elite Consoles fail, we could lose Interoperability in the Region. Daily communications with local and federal partner agencies could be lost.

Summary

Option 1 is time limited by vendor end of support dates. Until remedial action is complete, the risk of serious system degradation or failure will increase over time. This risk will likely impact older systems with aging components (including King County and the Port of Seattle) sooner than those installed more recently.

Sub-option 1A does not address the need for existing VHF and UHF radio systems to comply with the FCC Narrowbanding mandate. Doing nothing is not a viable option for VHF and UHF systems.

Sub-option 1B would allow system owners to make a few investments to extend the useful life of their systems. (For example, replacing end-of-life Dispatch Consoles could add three years to the vendor-supported useful life of existing SmartZone systems.) In general, however, Option 1 would not allow system owners to meet future requirements (for example, increase capacity, improve coverage, improve Interoperability, and add new capabilities).

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8. Analysis of Option 2

With this option, the current multiple Motorola SmartZone radio systems would be upgraded to P25 Phase 2 and configured either as multiple connected systems (Option 2A) or a single regional system (Option 2B). In both options, existing or new links to Conventional systems in other frequency bands would maintain operational and Interoperability needs throughout the three-county Region.

Three of the systems (SERS, King County, and Tacoma) have taken an initial migration step by implementing and linking new P25 Switches which could be used as part of an upgraded system. The full implementation of Option 2 will consist of additional upgrades, replacements, and modifications that result in a fully operational P25 Phase 2 environment across the entire Region.

Sub-option 2A: Use multiple, upgraded radio systems linked together

With this alternative, the current architecture of multiple Trunked radio systems linked with one another and linked with Conventional radio systems would be continued. However, the final number of individual systems may change depending on choices made by the various system owners.

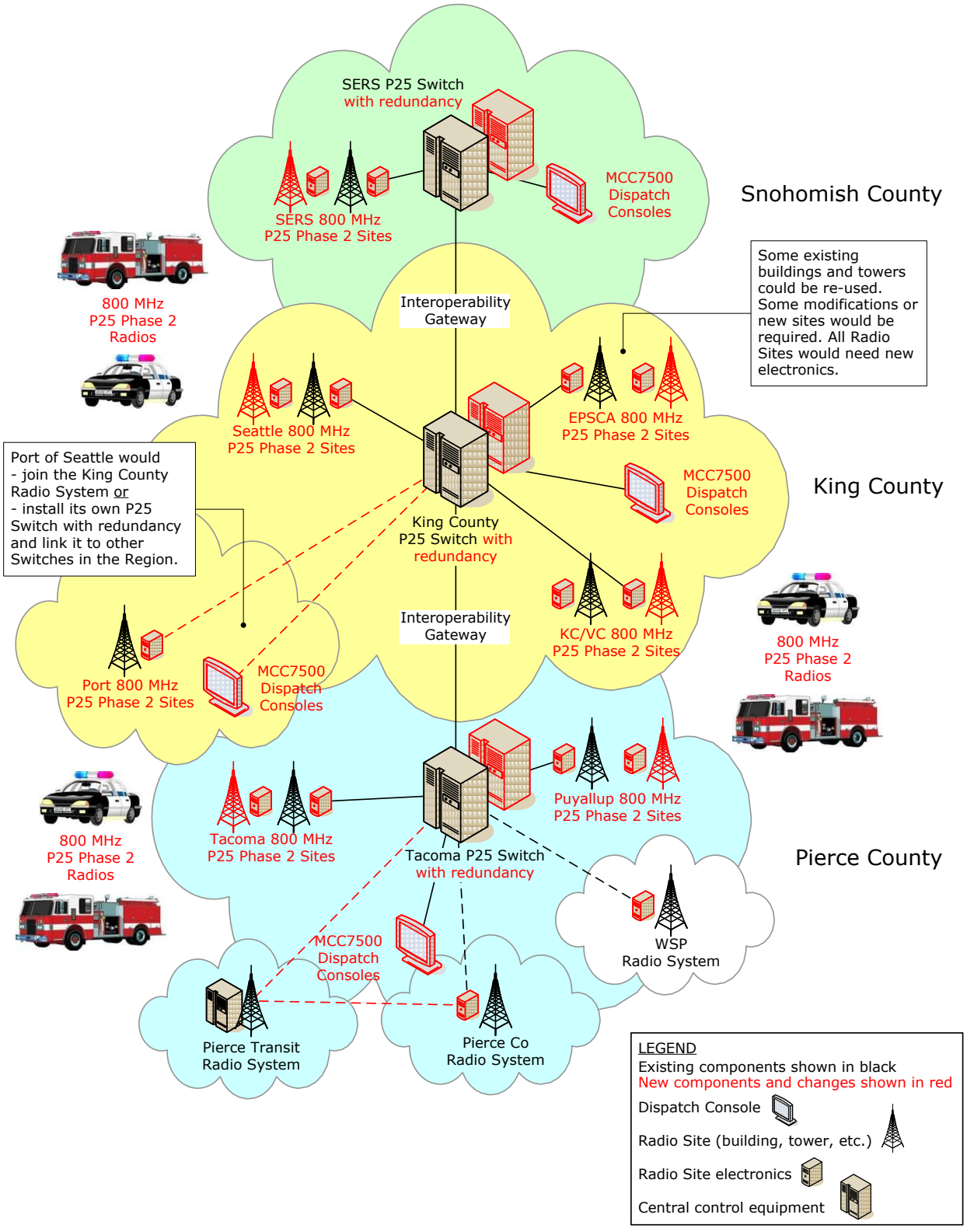
For example, the Port of Seattle could choose to merge its Infrastructure with one of the existing Switches (such as the King County system) instead of upgrading. Likewise, radio system owners in Pierce County could choose to merge their Infrastructures into one of the existing Switches (such as the Tacoma-Puyallup system). In this scenario, three connected P25 Phase 2 radio systems would form the foundation of the regional architecture.

As another example, Pierce County Government and Pierce Transit could choose to establish their own separate P25 Phase 2 system instead of joining the Tacoma–Puyallup system, and the Port of Seattle could chose to continue to operate as a separate system. In this scenario, five connected P25 Phase 2 radio systems would form the foundation of the regional architecture.

Regardless of the number of systems, the desired end-state will be that all systems migrate to P25 Phase 2 technology to ensure that the Region is using a common technology to maximize end user functionality. This would enable the systems to look the same to end users throughout the Region. The multiple systems approach is illustrated below.

Option 2: Follow Motorola's recommendations to migrate existing SmartZone LMR systems to P25 Phase 2 LMR systems

Sub-option 2A: Multiple systems linked together



In Sub-option 2A, the existing P25 Switches and Gateways shown for SERS, King County, and Tacoma would remain in place (indicated in black in the diagram) and receive upgrades and modifications to support the end-state P25 Phase 2 capability. All other equipment in the system (Radio Site equipment, dispatch center equipment and Subscriber Radio equipment) would be replaced (indicated in red in the diagram) with Phase 2 capable equipment.

The existing Conventional systems operated in Pierce County and by the Washington State Patrol could remain in place and be interfaced to the regionally connected P25 Switches, generically represented here as interfacing through the Tacoma Switch.

The following guidelines characterize implementation of this alternative.

- Each radio system would migrate within regionally-coordinated timeframes that are acceptable and manageable within its own governance, financial and operational models.
- Timing and careful coordination of individual system migrations by the individual systems will be necessary to ensure continued local and regional operability, Mobility and Interoperability both during and following the migration period.
- Each radio system would need to support both Motorola SmartZone and P25 phase 2 technologies in portions of its Infrastructure and Subscriber Radio inventory up to the completion of the Region-wide P25 phase 2 migration to ensure continued local and regional operability, Mobility and Interoperability.

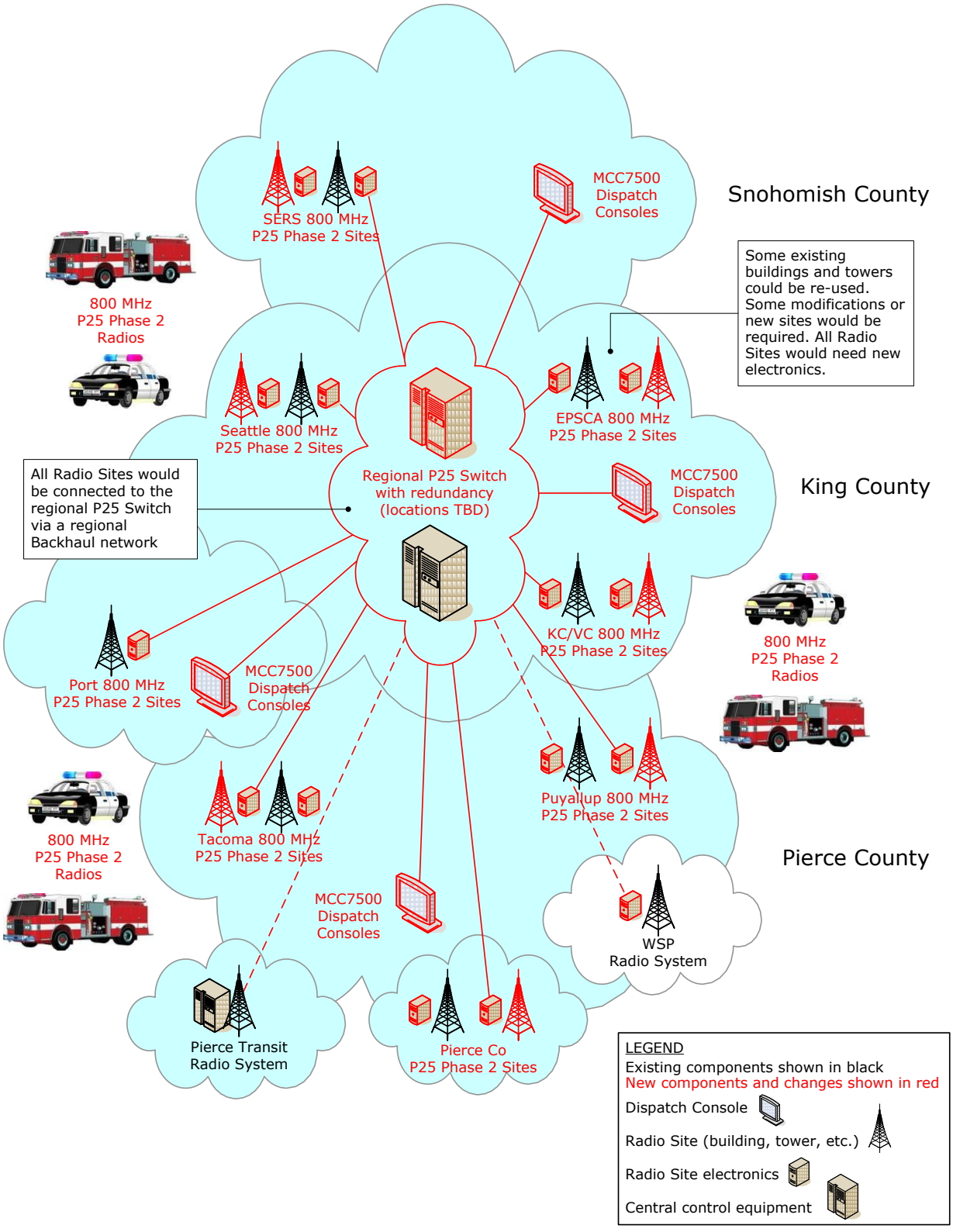
As an alternative to implementing redundant Switches for each individual radio system to meet Reliability needs, deployment of Motorola's recently announced advanced Interoperability Gateway technology may allow Switch backup between the multiple systems and provide additional inter-system networking capabilities.

Sub-option 2B: Move to one regional radio system

With this alternative, a single network of redundant master Switch control equipment would be implemented at separate physical locations. Radio equipment at each Radio Site and Dispatch Console systems at each dispatch center throughout the Region would be connected to and controlled by the master Switch network, all operating as a single system. This configuration is shown generically in the diagram below.

Option 2: Follow Motorola's recommendations to migrate existing SmartZone LMR systems to P25 Phase 2 LMR systems

Sub-option 2B: Merge existing systems into one Regional system



In addition to full replacement of Radio Site equipment, dispatch center equipment and Subscriber Radio equipment (as was the case in Sub-option 2A), Sub-option 2B would require either 1) acquisition of new master Switch equipment or 2) the reconfiguration and reuse of master Switch equipment now present in the SERS, King County and Tacoma systems. The master Switch network is represented by a single, centrally located cloud for simplicity. The final locations of non-collocated redundant master Switch equipment would be determined based on detailed design criteria including a variety of site availability, site capability, site security, and inter-site networking and Backhaul considerations.

The following guidelines characterize implementation of this alternative.

- Each system would migrate within regionally-coordinated timeframes but, in comparison to Sub-option 2A, there would be less flexibility for individual radio system owners to independently decide migration timing and duration.
- This decreased level of flexibility will also extend into the operational models for the radio system Infrastructure because close synchronization of upgrades and enhancements will be needed to ensure proper system functionality.
- In comparison to the multiple systems approach, the single system architecture is characterized by higher levels of system Infrastructure and Spectrum interdependence. This will require closer migration coordination between the system owners to ensure continued local and regional operability, Mobility and Interoperability, both during and following the migration period.
- Both Motorola SmartZone and P25 phase 2 technologies would need to be supported in portions of all Infrastructure and radio inventories up to the completion of the Region-wide migration to ensure continued local and regional operability, Mobility and Interoperability.

Other expected characteristics of Option 2 and changes relative to existing systems are described below.

a. Regional Interoperability

Both Option 2 alternatives will provide significant improvements in regional Interoperability and system backup.

Sub-option 2A closely resembles the current SmartZone system configurations that are connected by Gateways. Existing Gateways

provide Fingertip Roaming on a limited number of pre-determined Talkgroups. The Gateways do not have the capacity to support large-scale incidents and require end users to manually change Talkgroups on their radios to operate across systems. Motorola's recently announced advanced Interoperability Gateway technology could establish a larger number of Region-wide Talkgroups to support large-scale incidents and eliminate the need for end users to manually change Talkgroups.

Further, because of existing overlapping coverage in the Snohomish/King and King/Pierce county border areas, if a small number of Radio Sites on one system become inoperable due to emergency circumstances, the advanced Gateway may provide additional Reliability within these overlapping areas by allowing a user's radio to Roam to an adjacent radio system.

This additional cross-system Mobility and backup capability will require careful planning and coordination between the individual system owners to ensure that appropriate system capacities are available to process the Roaming traffic.

Sub-option 2B would manage regional Mobility and Interoperability through a common master Switch instead of through Gateways. A single system would provide the highest level of regional Interoperability: end users could control who they talk to anywhere in the Region in real-time, as the scenario dictates, if authorized.

Compared to existing LMR systems and the multiple systems approach (where coordination is required only to manage the operation of Gateway links), the single system option would require greater coordination between subsystem owners to ensure overall system performance.

b. End user devices

P25 Phase 2 Radios

In both alternatives, virtually all currently deployed Mobile and Portable radios will need to be upgraded to support P25 Phase 2 operation or replaced with P25 Phase 2 capable equipment (if they cannot be upgraded). All Mobile and Portable radios will need to be

capable of operating in the SmartZone environment and the P25 Phase 2 environment until regional transition is complete to maintain communication within and between agencies in the Region. An upside of this necessity is that it could provide individual end user agencies (for example, police and fire departments) with some increased timing flexibility when they transition their end users over to P25 Phase 2 operation.

Most end user devices are owned by the agency using the device, not the agency owning the radio system Infrastructure. A few agencies own radios that are capable of P25 Phase 1 with a software upgrade; however, if a Phase 1 radio is used on a Phase 2 Infrastructure, the entire Talkgroup call will fall back to the less efficient Phase 1 (the call will use twice as much channel capacity). Most user agencies will not be able to afford new devices; therefore, the project should anticipate providing new P25 Phase 2 radios to all users in the Region.

Programming radios, installing Mobile radios in vehicles, and training users to operate the new equipment will be significant work items.

After the transition is complete, there will be more flexibility to purchase radios from a number of different manufacturers; however, if radios are purchased from same manufacturer, it will simplify operation and maintenance and allow a shared inventory of spare parts. Because features vary from manufacturer to manufacturer, the availability of features across the Region will be enhanced if all radios are purchased from the same manufacturer.

Users performing differing job functions will need radios with differing features. First responders will likely need high tier radios with robust feature sets whereas many non-first-responders (for example, utility personnel) may have their needs met with lower tiered, less expensive radios.

c. Radio system Infrastructure

Central equipment | Radio Sites | Radio Site electronics | Dispatch Consoles

Both alternatives would require the complete replacement of Radio Site electronics and Dispatch Consoles.

Option 2A

Option 2A leverages the current P25 Switches currently installed and operational at SERS, King County, and Tacoma. Depending on the choices made, the net outcome could range from three to five P25 Switches being established. The Port of Seattle could either choose to replace its current SmartZone 4.1 Master Site with a P25 Switch or merge its system Infrastructure with the King County system. The jurisdictions in Pierce County could expand the service area of the Tacoma-Puyallup system to serve the whole county or implement a separate P25 Phase 2 system for Pierce County Government and Pierce Transit.

Option 2A Backhaul would be similar to the current combinations of Microwave and Fiber topologies used to provide highly reliable and redundant connectivity between Radio Sites, Switches, and Dispatch Consoles within the various systems. The complexity and cost of the Backhaul networks would increase if redundant, non-collocated Switches were implemented.

Option 2B

In Option 2B, a single set of Switches would serve the entire three-county area. Elements of the three existing P25 Switches could be used or new equipment could be acquired.

Option 2B would have a higher degree of geographical diversity between the redundant, non-collocated Switches and the Radio Sites and Consoles that need connection with them. This would create the need for more complex and costly Backhaul networking topologies than exists currently and that would be needed in the more localized Option 2A alternative.

d. System performance

From an end user perspective, coverage, capacity, and Reliability are the most important system performance criteria. Both of the Option 2 alternatives would meet these performance objectives.

Regardless of which Sub-option is selected, it is reasonable to expect that combinations of site selection and channel capacities will provide end user coverage and capacity experiences that are better than current systems. Most of today's systems were designed for the user to speak into a microphone the user holds in front of his or her mouth. That is not how most users currently work; they want their hands free

for other tasks and thus employ shoulder-mounted microphones which do not work as well as the original design.

In addition, the region's population has grown since the current systems were built, and some areas that were not then heavily populated have grown significantly. As systems are upgraded, radio system owners could modify the design to address these issues.

The system would also be designed to meet delivered audio quality of 3.4 (DAQ 3.4), the national standard for wireless public safety communication system quality.

During transition, the limited amount of Spectrum available may create short term capacity challenges. However, the limiting factor for coverage and capacity will most likely be the level of available funding rather than technology or Spectrum constraints.

Both configurations can be organized for highly reliable operations that are better than existing systems.

Both Option 2 alternatives offer system management and control features that would meet performance expectations. As noted previously, a single-system may provide somewhat more flexible administration capabilities at the cost of more localized flexibility. However the owners of the current systems have demonstrated an ability to successfully manage intra and inter-system performance in the SmartZone environment. They should be able to meet or exceed these capabilities in a P25 Phase 2 environment without requiring migration to a single-system architecture.

Both alternatives would provide P25 Phase 2 features like such as GPS-enabled end user devices, over-the-air changes of Encryption keys and over-the-air programming of end user devices. In Option 2B, system managers could perform these configurations regardless of where the end user device was located within the coverage area. In Option 2A, system managers could perform these same configurations within their individual system coverage areas.

e. Transition

Option 2A

From an end user perspective, the transition from the current radio systems to the multiple systems of Option 2A would be fairly straightforward. End user equipment could be acquired that was capable of both legacy SmartZone and P25 Phase 2 operation. End users would continue to use the legacy SmartZone system Infrastructure as the new P25 Phase 2 Infrastructures were built and then move to those Infrastructures when they were completed.

While some radio programming changes would be needed to affect this transition, it could be handled well enough in advance of the planned move to the new Infrastructure that the transition for end users could be fairly simple.

The more complex aspects of this transition process are related to ongoing operations. Careful coordination will be required between the individual systems as they each transition to P25 Phase 2 so that existing Mobility and Interoperability capabilities are maintained. This will likely require more complex Talkgroup strategies and radio template configurations so that during transition end users can operate in a predictable manner on both the legacy SmartZone technology and the new P25 Phase 2 technology. This will likely require multiple end user training cycles so they always have an up to date understanding of the available Mobility and Interoperability capabilities during transition.

Option 2B

The process of transitioning to Option 2B would be similar in many ways to the process of transitioning to Option 2A. End user devices with both legacy SmartZone and Phase 2 capability could be acquired in advance of the system Infrastructure cutover so that transition between the two system technologies could be accomplished so end users can begin using Phase 2 capabilities as soon as the Infrastructure is ready.

All systems would be merged to a common regional Switch instead of migrating to a local Switch within its own environment. This approach will require a much more tightly coordinated and simultaneous transition throughout the entire Region. There are several possible strategies for executing this complicated migration process, including

acquiring new Switch equipment instead of reconfiguring and reusing existing Switches. Regardless of the strategy selected, there should be acceptable levels of inter-system Mobility and Interoperability during transition.

As previously stated, the most complex transition aspect of either alternative will be the coordination needed between the system owners and their individual end user communities throughout the entire transition period. The longer the transition process takes, the more risk there will be that differing functional capabilities across the Region will result in confusion within the end user community. This can be mitigated with consistent and ongoing training processes that are well designed and well coordinated so the end users always have a clear understanding of what they can and can't expect from the systems during transition.

f. Schedule

It is estimated that it will take 4 to 6 years to upgrade system(s) Region-wide once funding is available.

Each of the existing SmartZone radio systems is under the same vendor support constraints for their existing system equipment as described in Section 4 of this report; however, individual risk profiles and equipment configurations will likely impact the timing of individual system migration and create an extended transition period before P25 Phase 2 technology will completely replace SmartZone technology throughout the Region.

Since the Port of Seattle does not currently own a P25 Switch, they will be the first to face vendor support thresholds. By September 2013, the Port needs to either upgrade to a P25 Switch or migrate its Radio Sites and Dispatch Consoles to one of the other existing P25 Switches. The King County and Tacoma systems will likely need to replace their Dispatch Consoles in the 2013/2014 timeframe and complete Radio Site migration by 2017 or sooner. The support agreement between SERS and Motorola allows SERS to extend the life of its current system until 2020.

g. Key strengths, weaknesses, opportunities, and threats

The Project Steering Committee identified strengths, weaknesses, opportunities, and threats (SWOT) as part of its analysis of this option.

Keys points are summarized below. The complete result of the Steering Committee's SWOT analysis is included in the Appendices.

Strengths	Weaknesses
• Preserves vendor support for existing systems. • Would meet or exceed coverage, capacity, Reliability, Mobility, Interoperability, and other performance requirements. • Would allow radio system owners to add sites to improve coverage and/or add channels to improve capacity, if needed. • Would allow continued use of some existing equipment (Switches, Backhaul, some Mobile and Portable radios). • Transition would be easier than moving to a different vendor (under Option 3) or a different technology (under Option 4). • Individual radio systems and end user agencies would have some flexibility to upgrade and migrate users on their own schedules (in consort with an overall regional plan). • Equipment could be replaced at the component level (versus at the system level) which could reduce building space requirements during transition. • Radio Sites could be transitioned from SmartZone to P25 Phase 2 on a channel-by-channel basis to preserve end user service levels during transition. • Would allow existing governance and business/operations models to remain intact, if desired. • Agencies could start directing current and future purchases towards the next-generation	• Increased flexibility (individual radio systems and end user agencies having some flexibility to upgrade on their own schedules) will also mean additional complexity. This could create an extended burden on end users and neighboring radio systems. It could also make it more difficult to preserve Interoperability throughout the Region.

system. For example, agencies could purchase new Dispatch Consoles now, use them on existing systems now, and continue to use them on the end-state system(s) into the future.	
Opportunities	Threats
• If Sub-option 2A (the multiple systems approach) is selected, there will still be the option to move to Option 2B (a single regional system) at any time. Sub-option 2A is a gradual migration path and we could alter our course later, with minimum abandoned investment, if that become more advantageous for the Region. • Other Switch configurations may be possible. We could improve upon the level of redundancy and Reliability. • Would require some changes to existing governance and business/operations models. While there could be some loss of local control and decision making (compared to existing radio systems), a new model could provide efficiencies, increase collaboration, and improve operations. • Would require changes to existing Backhaul networks and could result in a more flexible and increase overall Backhaul capacity (compared to the existing dedicated circuit approach).	• Unless there is unified funding, project timelines will be determined by the last partner to secure funding. • This option would require additional Spectrum for transition. Getting additional Spectrum would require re-management of existing 800 MHz channels (both within the current licensees and between licensees), use of Region 43 700 MHz channels, and/or use of State-controlled 700 MHz channels. We do not know for certain that the necessary additional Spectrum will be available. • The transition could extend over a significant period of time. Extended transition could necessitate multiple end-user training sessions for regional Interoperability.

Summary

Both of the Option 2 alternatives provide a reasonable path to achieving a P25 Phase 2 radio system environment for the Region. Both allow the migration to be planned and executed over a reasonable period of time and allow current systems to be operated for as long as practicable thus maximizing the value of current investments.

The multiple-system configuration of Sub-option 2A allows system owners to fully leverage their existing relationships and operational models with their end user communities while establishing migration timelines that best fit their governance and economic constraints. This is generally perceived as advantageous.

9. Analysis of Option 3

This option is to build new P25 phase 2 system(s) configured either as multiple systems (Option 3A) or as a single regional system (Option 3B). There is no assumption that existing radio system equipment would be reused. This option is intended to be vendor neutral.

In both alternatives, links to Conventional radio systems in other frequency bands would need to be established to meet operational and Interoperability needs throughout the Region.

Sub-option 3A: Multiple radio systems linked together

Sub-option 3A would continue the current architecture of multiple Trunked radio systems linked with one another and linked with Conventional radio systems. The final number of radio systems would depend on choices made by the various system owners. All Trunked radio systems would use P25 Phase 2 technology and, from an end user perspective, function very much like a single system.

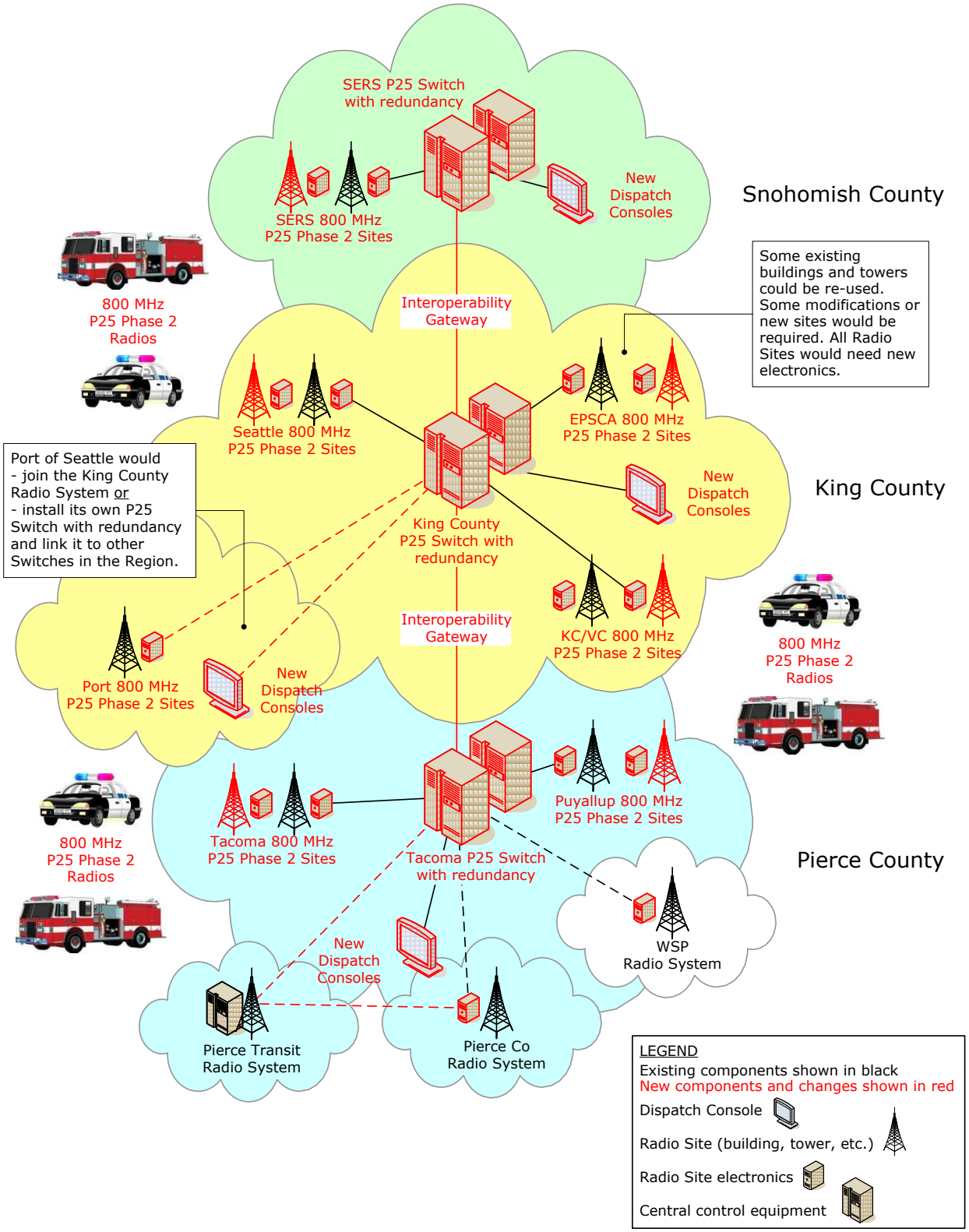
For the systems to work most effectively, the Switches, Radio Site equipment and Dispatch Consoles should all be purchased from the same vendor. If different vendors are used for radio system Infrastructure, there will be a significant risk of incompatibility between equipment.

Sub-option 3B: One regional radio system

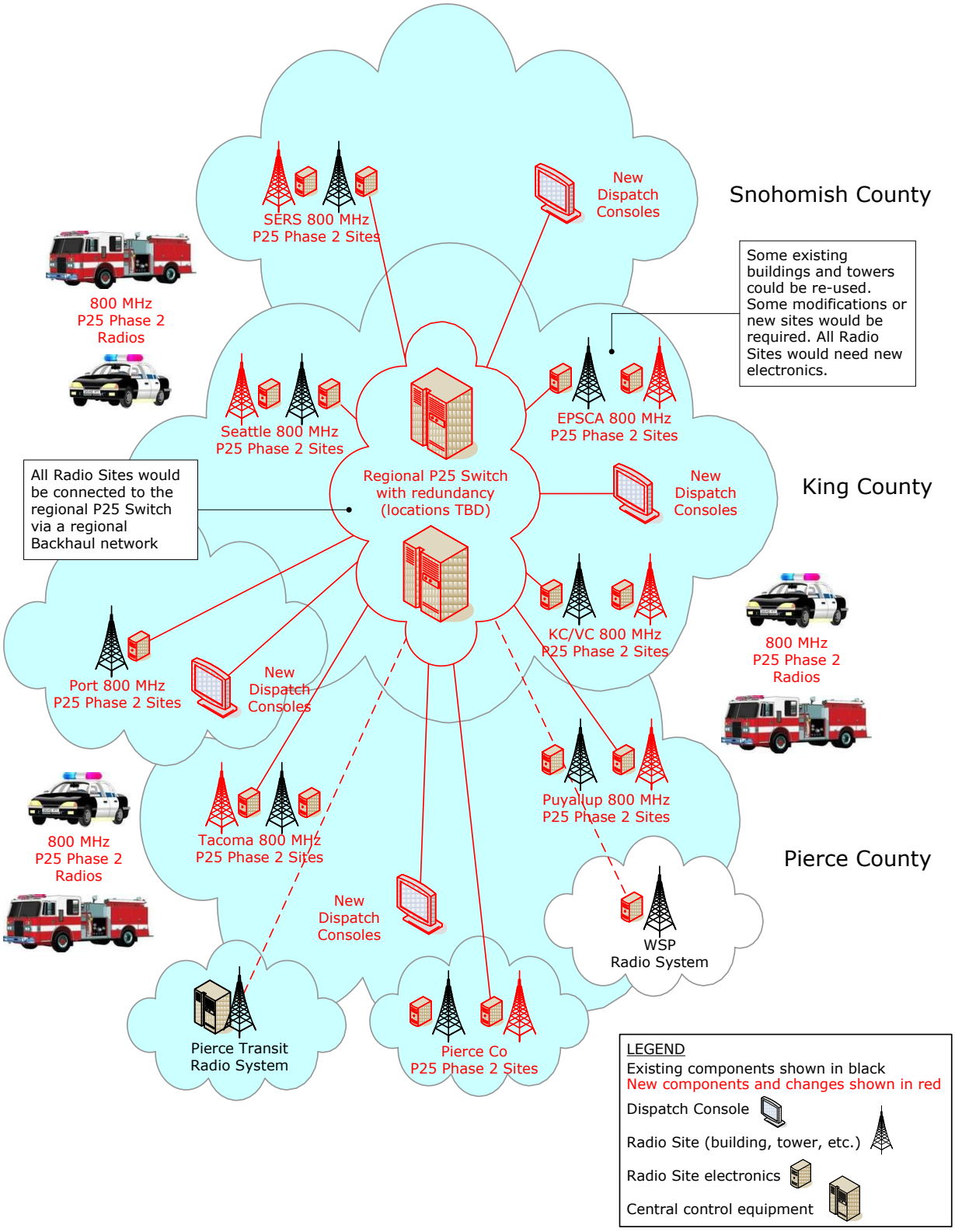
Sub-Option 3B is a single Switch with redundancy located in a strategic location to serve all agencies in the Region. It would provide Seamless Roaming across the three counties.

The two sub-options are displayed on the next two pages.

Option 3: Build new P25 Phase 2 LMR system(s) to replace existing systems
Sub-option 3A: Multiple systems linked together



Option 3: Build new P25 Phase 2 LMR system(s) to replace existing systems
Sub-option 3B: One regional system



Other expected characteristics of Option 3 and changes relative to existing systems are described below.

a. Regional Interoperability

Both Option 3 alternatives will provide significant improvements in regional Interoperability.

Sub-option 3A resembles the current SmartZone system configurations that are connected by Gateways. Existing Gateways provide Fingertip Roaming on a limited number of pre-determined Talkgroups. The Gateways do not have the capacity to support large-scale incidents and require end users to manually change Talkgroups on their radios to operate across systems. Newer Gateway technology could establish a larger number of Region-wide Talkgroups to support large-scale incidents and eliminate the need for end users to manually change Talkgroups.

This additional capability will require careful planning and coordination between the individual system owners to ensure that appropriate system capacities are available to process the Roaming traffic.

Sub-option 3B would manage regional Mobility and Interoperability through a common Switch instead of through Gateways. A single system would provide the highest level of regional Interoperability: end users could control who they talk to anywhere in the Region in real-time, as the scenario dictates, if authorized.

Compared to existing LMR systems and the multiple systems approach (where coordination is required only to manage the operation of Gateway links), the single system option would require greater coordination between subsystem owners to ensure overall system performance.

b. End user devices

P25 Phase 2 Radios

In both alternatives, virtually all currently deployed Mobile and Portable radios will need to be upgraded to support P25 Phase 2 operation or replaced with P25 Phase 2 capable equipment (if they cannot be upgraded). All Mobile and Portable radios will need to be

capable of operating in the SmartZone environment and the P25 Phase 2 environment until regional transition is complete to maintain communication within and between agencies in the Region.

Most end user devices are owned by the agency using the device, not the agency owning the radio system Infrastructure. A few agencies own radios that are capable of P25 Phase 1 with a software upgrade; however, if a Phase 1 radio is used on a Phase 2 Infrastructure, the entire Talkgroup call will fall back to the less efficient Phase 1 (the call will use twice as much channel capacity). Most user agencies will not be able to afford new devices; therefore, the project should anticipate providing new P25 Phase 2 radios to all users in the Region.

Programming radios, installing Mobile radios in vehicles, and training users to operate the new equipment will be significant work items.

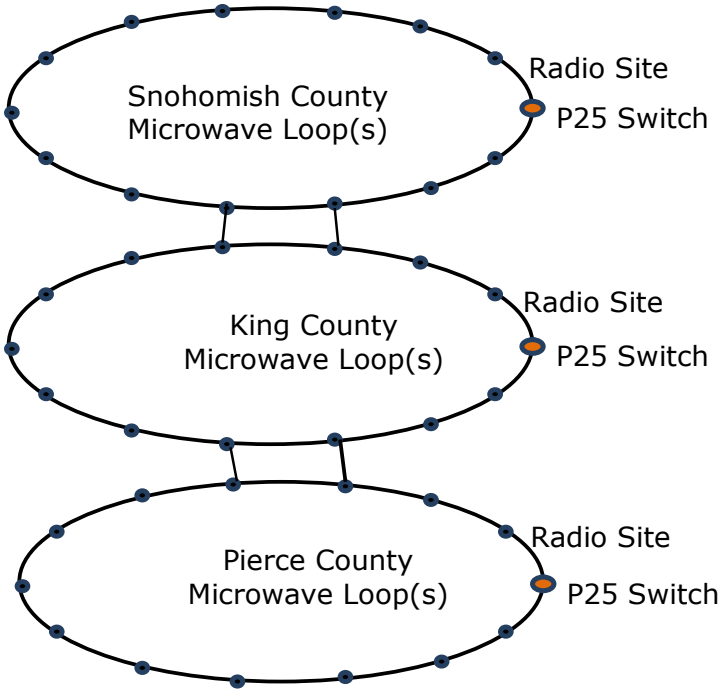
After the transition is complete, there will be more flexibility to purchase radios from a number of different manufacturers; however, if radios are purchased from same manufacturer, it will simplify operation and maintenance and allow a shared inventory of spare parts. Because features vary from manufacturer to manufacturer, the availability of features across the Region will be enhanced if all radios are purchased from the same manufacturer.

Users performing differing job functions will need radios with differing features. First responders will likely need high tier radios with robust feature sets whereas many non-first-responders (for example, utility personnel) may have their needs met with lower tiered, less expensive radios.

c. Radio system Infrastructure

Both alternatives would require the complete replacement of all radio system components: Switches, Radio Site electronics and Dispatch Consoles. New Infrastructure could be installed and tested independently of existing radio systems prior to putting any users on the new system. New Infrastructure would be compliant with P25 Phase 2 and allow increased functionalities.

Backhaul would be similar to the current combinations of Microwave and Fiber topologies used to provide highly reliable connectivity between Radio Sites, Switches, and Dispatch Consoles. Backhaul systems should be redundant to ensure the needed level of Reliability (see diagram below). Backhaul configurations could be different for sub-options 3A or 3B, depending upon the degree of Reliability and redundancy engineered into the Backhaul system.



d. System performance

This option would improve capacity, coverage, audio quality, and Interoperability across the Region over the legacy systems.

Most of today's systems were designed for the user to speak into a microphone the user holds in front of his or her mouth. That is not how most users currently work; they want their hands free for other tasks and thus employ shoulder-mounted microphones which do not work as well as the original design.

In addition, the Region's population has grown since the current systems were built, and some areas that were not then heavily populated have grown significantly. New system(s) would be designed to address these issues.

The system(s) would be designed to meet delivered audio quality of 3.4 (DAQ 3.4), the national standard for wireless public safety communication systems.

Spectrum

Available Spectrum should meet the transition need from the existing system to the new system.

Mobility and Interoperability

These sub-options should be able to meet the Mobility and Interoperability needs of the Region. If Subscriber Radios are from different vendors, there will be fewer common features than if all Subscriber Radios are from the same vendor.

Reliability

Both alternatives could be configured for highly reliable operations that are better than existing systems.

Scalability

Today, scalability is limited in some parts of the Region by system capacity or equipment availability. With a new system, scalability would not be an issue.

Local Service Delivery and Control

Local Service Delivery and Control could be somewhat the same as today with Sub-Option 3A. With Sub-option 3B, the Local Service Delivery and Control model would need to evolve into something similar to the model currently used for the King County Radio Communication System.

Other features

Both alternatives would provide P25 Phase 2 features like such as GPS enabled end user devices, over-the-air changes of Encryption keys and over-the-air programming of end user devices.

e. Transition

The key challenge to ensuring that the system is deployed in a timely, efficient, and effective manner is coordination between radio system owners and end user agencies. Implementation must be carefully planned and centrally coordinated to ensure that the Infrastructure is

available across the Region when users are migrated to the new system to minimize operational impact.

It will be more difficult to implement a new system (Option 3) than to upgrade the existing systems (Option 2) because of the demand for additional Spectrum and Radio Site resources (for example, physical space and electrical power in buildings) during the transition period.

All new radio system Infrastructure must be in place before putting any users on the new systems to keep the length of the transition period to a minimum. Once the Infrastructure is fully tested and ready for use, end users could be issued Portable radios and migrated to the new P25 Phase 2 system(s) in groups. Mobile radios could be installed in vehicles at later dates.

The migration approach must be designed to accommodate end user operational needs. In some cases, users will need the ability to operate on both old SmartZone and new P25 Phase 2 radio systems until implementation is complete. For this reason, the transition period must be kept to a minimum.

The installation and testing processes for a new system are not as potentially disruptive as upgrading existing systems. Since new radio system Infrastructure can be installed and tested independently of the existing systems, installation and testing processes will be more efficient than the upgrade option. Factory and field acceptance testing can be conducted prior to moving users onto the system.

f. Schedule

It is estimated that it will take 4 to 6 years to implement new system(s) once funding is available.

g. Key strengths, weaknesses, opportunities, and threats

The Project Steering Committee identified strengths, weaknesses, opportunities, and threats (SWOT) as part of its analysis of this option. Keys points are summarized below. The complete result of the Steering Committee's SWOT analysis is included in the Appendices.

Strengths	Weaknesses
• Would meet or exceed coverage, capacity, Reliability, Mobility, Interoperability, and other performance	• Transition will be more difficult than the migration approach (Option 2) if the Region selects a different vendor. The new

requirements. • Would allow radio system owners to add sites to improve coverage and/or add channels to improve capacity, if needed. • New P25 Phase 2 radio system(s) could be completely installed and tested prior to moving the first users onto the system. • Would allow existing governance and business/operations models to remain intact, if desired.	vendor will not have detailed technical and operational knowledge of existing systems, and old vendor will have less incentive to work with the Region to facilitate a smooth transition. If something does not work during transition, the Region will need to work with two vendors – new and old – to get resolution. • Implementation of a complete new system will be more difficult than the phased migration approach (Option 2). • System owners would need to continue operate and maintain existing SmartZone radio systems until the last end user in the Region is migrated over to the new P25 Phase 2 system(s) to preserve Interoperability. This will be an additional burden on system owners and require additional Spectrum for transition. • Complete, new system equipment must be installed next to existing equipment at Radio Sites, increasing building space and power requirements during transition. • If multiple Infrastructure vendors are selected, there would be a significant risk of incompatibility. Systems integration will become the responsibility of radio system owners, not a vendor. Vendor-specific features will not work across systems.
Opportunities	Threats
• Could re-architect radio system(s) to gain site and Spectrum efficiencies and mitigate interference. • Could bring in other	• Unless there is unified funding, project timelines will be determined by the last partner to secure funding. • Getting additional Spectrum

stakeholders (other counties and agencies • Other Switch configurations may be possible. We could improve upon the level of redundancy and Reliability. • Would require some changes to existing governance and business/operations models. While there could be some loss of local control and decision making (compared to existing radio systems), a new model could provide efficiencies, increase collaboration, and improve operations. • Would require changes to existing Backhaul networks and could result in a more flexible and increase overall Backhaul capacity (compared to the existing dedicated circuit approach).	would require re-management of existing 800 MHz channels (both within the current licensees and between licensees), use of Region 43 700 MHz channels, and/or use of State-controlled 700 MHz channels. We do not know for certain that the necessary additional Spectrum will be available. • The transition could extend over a significant period of time. Extended transition could necessitate multiple end-user training sessions for regional Interoperability.

Summary

Both Option 3 alternatives provide a reasonable path to achieving P25 Phase 2 radio systems in the Region and would provide significant improvements in capacity, coverage, and Reliability compared to legacy systems.

Implementation must be carefully planned and centrally coordinated to minimize operational impact. End user transition will be more difficult for a complete new system (Option 3) than for a phased migration (Option 2), particularly if a different vendor is selected. Implementation of a complete, new system will also be more difficult than a phased migration because of Spectrum and Radio Site constraints. However, Option 3 has an advantage over Option 2 in that system owners could do system-wide factory and field acceptance testing on the new P25 Phase 2 system(s) before moving any end users.

10. Analysis of Option 4

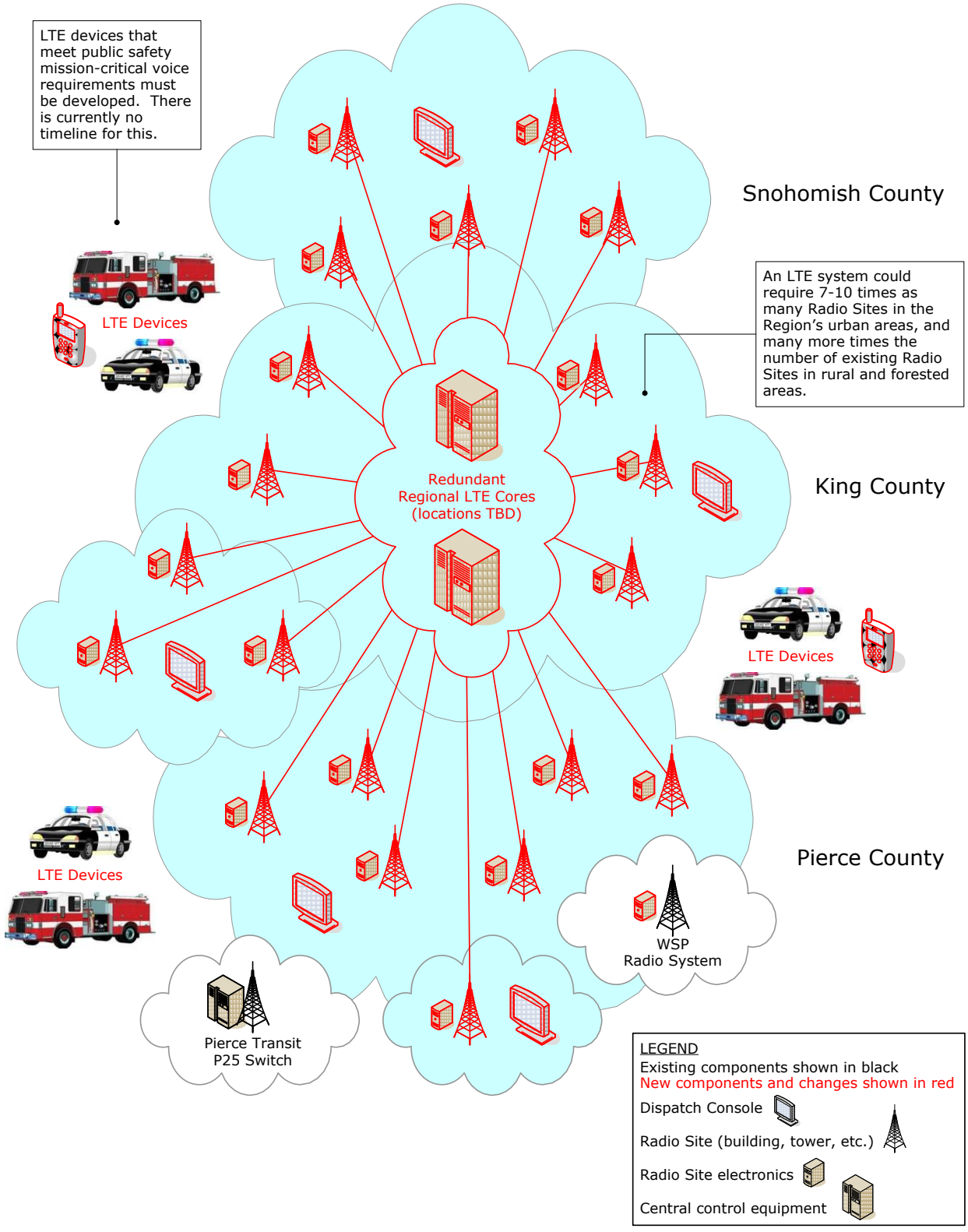
This section analyzes the option of constructing a Long Term Evolution (LTE) system for mission-critical voice intended to serve public safety and, if allowed, general government agencies throughout the geographies of King, Pierce, and Snohomish counties. This would be a purpose-built, government-owned system and could be expanded to serve a larger geographic area in the future.

The LTE system would include new redundant Core equipment, Radio Sites, high-capacity Backhaul, and end user devices. It would use the wireless Broadband Spectrum available to public safety at the time that the system is built. In the current regulatory environment, that means using the 700 MHz Public Safety Broadband (PSBB) block, 10 MHz of Spectrum divided into two 5 MHz blocks. If Congress enacts proposed legislation to reallocate the 700 MHz D-block to public safety, the Spectrum available for this system could double to 20 MHz total (in two 10 MHz blocks).

The Federal Communications Commission (FCC) has defined initial minimum requirements for coverage, data rates, reliability, and Interoperability for systems that use the 700 MHz PSBB Spectrum. This LTE system would meet or exceed the initial minimum requirements and any future requirements developed by the FCC. It would also need to fit within the national public safety wireless network architecture which has not yet been finalized. The national architecture could impact system design and define how certain components and functions of the system need to be managed.

Using LTE for mission-critical voice would represent a significant technology change for system operators and end user agencies in the Region. This option would require significant end user training and necessitate changes to existing operations and governance models.

Option 4: Regional LTE system for mission-critical voice



Other expected characteristics of the LTE system and changes relative to existing Land Mobile Radio (LMR) systems are described below.

a. Regional Interoperability

When mission-critical voice is available for LTE, the regional LTE system would provide a level of Interoperability equivalent to the other single-system options discussed in this report.

The industry expects that public safety LTE devices (those that use the 700 MHz PSBB Spectrum) will eventually be able to Roam over onto commercial LTE systems. That capability could provide significant improvements in Mobility and Interoperability, expanding the geography in which end user devices operate beyond the three counties in the Region to, potentially, the state and nation. Note, however, that commercial LTE systems do not provide ubiquitous coverage across the Region, state, or nation, nor do they necessarily meet all public safety requirements for performance and reliability.

Roaming between public safety LTE systems and commercial LTE systems will most likely be implemented for Broadband data first, and could later be extended to voice services.

There are other issues related to Roaming that are unresolved at this time:

- There is no architecture or agreement yet for the Infrastructure necessary to support Roaming (for example, the high-capacity backbone needed to connect public safety LTE systems to one another or connections to clearinghouse companies to enable commercial Roaming and billing);
- Carrier agreements have not been negotiated, so we do not know the financial impact of Roaming (Roaming charges and how those charges would be divided);
- Commercial carriers will need to allow quality of service and priority for public safety users on commercial networks to ensure that public safety has reliable service. (Public safety also desires preemption, but commercial carriers currently do not intend to allow that.) The details necessary to make this happen have not been finalized; and
- End user devices are typically designed to use specific radio Spectrum and are, thus, carrier-specific. Selecting a Roaming

partner could lock agencies into a single vendor for Roaming, which may not be desirable.

b. End user devices

LTE Devices

All end users would need new devices to use the regional LTE system. Production devices that operate in the 700 MHz PSBB Spectrum are not available yet. The first data-only devices are expected to be ready for evaluation in Interoperability test labs during 1Q2012.These first devices will be USB dongles and trunk-mounted modems designed to support Broadband data applications. As this point, there is no timeframe for mission-critical voice over LTE.

While not all LTE devices need to be ruggedized, some must be. Any device used by public safety will have to be more rugged than consumer devices.

Until a standard for mission-critical voice and ruggedized devices exist, LTE will not be a viable replacement for LMR.

c. Radio system Infrastructure

Central equipment | Radio Sites | Radio Site electronics | Dispatch Consoles

LTE system design requires a different approach than that used for LMR. To provide the same coverage as existing LMR systems, a new LTE system could require 7 to 10 times as many Radio Sites in the Region's urban areas, and many more times the number of existing LMR sites in rural and forested areas. It is important for LTE system design to minimize overlapping coverage between Radio Sites; consequently, LTE antennas are mounted lower on towers (typically about 90 feet above ground level versus hundreds of feet above ground level for LMR antennas) and cover much smaller geographic areas.

All existing LMR Switching and Radio Site equipment would be replaced with new LTE Core and Radio Site electronics. While a few existing buildings, towers, and Backhaul connections could be upgraded and reused, the majority of sites would be new and require new building space, tower space, power systems, and Backhaul systems. All new sites would need to be hardened to ensure that the LTE system could provide the same level of coverage reliability provided by existing LMR systems.

LTE Radio Sites would require 10-100 times as much Backhaul capacity as typically exists at LMR sites. The Region would need to build, acquire, or lease new Fiber routes, Microwave Radio systems, and high capacity telephone company circuits to connect all of the LTE sites to each of the geographically-diverse LTE Core sites.

Other significant considerations:

- Development of Radio Sites (acquisition, permitting, construction, etc.) is very expensive and time-consuming. Rural sites could be even more difficult to develop than urban sites. Because of the large number of new sites required, this factor would have a significant impact upon project cost and schedule.

- Traditionally, LMR sites are hardened with extensive back-up power systems, earthquake protection, and other enhancements that make them very reliable. Commercial carriers do not typically build to these specifications. LTE sites can be built to the same reliability levels, but it will be very expensive given the large number of LTE Radio Sites needed.

- Providing path redundancy for Backhaul (geographically-diverse, secondary connections between LTE Radio Sites and LTE Core equipment) may be cost prohibitive. However, without it, the LTE system would be less reliable than current LMR systems.

- LTE Dispatch Consoles do not exist yet. Consoles provide functionality and control that is critical to dispatch operation, especially during major incidents and life-threatening emergencies. We cannot be sure that LTE Consoles will provide the same functionality and meet public safety requirements until they are available and have been evaluated by the public safety community. LTE is not a viable replacement for existing LMR systems until that happens.

d. System performance

The National Public Safety Telecommunications Council (NPSTC) Broadband Working Group identified the following key elements of mission critical voice:[15]

- Direct or Talk Around: This mode of communications provides public safety with the ability to communicate unit-to-unit when out of range of a wireless network OR when working in a confined area where direct unit-to-unit communications is required.
- Push-to-Talk (PTT): This is the standard form of public safety voice communications today – the speaker pushes a button on the radio and transmits the voice message to other units. When they are done speaking they release the Push-to-Talk switch and return to the listen mode of operation.
- Full Duplex Voice Systems: This form of voice communications mimics that in use today on cellular or commercial wireless networks where the networks are interconnected to the Public Switched Telephone Network (PSTN).
- Group Call: This method of voice communications provides communications from one-to-many members of a group and is of vital importance to the public safety community.
- Talker Identification: This provides the ability for a user to identify who is speaking at any given time and could be equated to caller ID available on most commercial cellular systems today.
- Emergency Alerting: This indicates that a user has encountered a life-threatening condition and requires access to the system immediately and is, therefore, given the highest level or priority.
- Audio Quality: This is a vital ingredient for mission critical voice. The listener MUST be able to understand without repetition, and can identify the speaker, can detect stress in a speaker's voice, and be able to hear background sounds as well without interfering with the prime voice communications.

[15] See *NPSTC Functional Description MCV 083011 FINAL*, available by clicking here.

LTE does not currently have the standards or equipment to meet several of these requirements (talk around, push-to-talk, group call, emergency alerting, and audio quality) and we do not know when it will.

LTE is an Infrastructure-dependent technology and, unlike LMR, does not fail "gracefully" (continue to operate with some diminished capacity after a critical component failure). Unless the LTE Core, Backhaul, and Radio Sites are fully functional, LTE end user devices will not provide any communication capability. To guard against the risk of widespread outage due to a critical component failure, the Region would need fully-redundant Core equipment installed at geographically-diverse sites and diverse Backhaul (logical connections) from each LTE Core site to each LTE Radio Site.

Even if LTE met all mission-critical voice requirements today, there would be reasons to consider keeping voice communications on a separate LMR environment. LTE is still an emerging technology and has not had time to prove itself reliable enough to be the single system used for all public safety communication. An integrated voice/data LTE system could be a single point of failure, and early adopters could face significant risk. A more conservative approach would be to deploy LTE for public safety Broadband data first and later deploy mission critical voice over that same Infrastructure after all capabilities exist and the system has proven itself reliable enough for public safety.

e. Transition

There are too many unknowns to discuss transition in detail. For example, until end user devices exist, we cannot say how replacing Consoles will impact dispatch center operations or if Mobiles can be replaced in a manner that minimizes the impact on public safety operations.

In general terms, we know that a public safety LTE system would use completely new Infrastructure, devices, and Spectrum.

Substantial time and effort would be required to acquire and develop the large number of new sites required for LTE. Any existing sites that are reused could also require retrofits. While LTE equipment will be smaller than current LMR equipment, there may be space challenges during the transition (when the old LMR and new LTE systems are operating side-by-side at existing sites). Building out the significant

new Backhaul capacity necessary for LTE could also create space or structural challenges at some sites. These complexities will add cost and extend implementation time frames.

The LTE system would use different radio Spectrum than existing LMR systems. As a result, the Region would not need to manage complicated logistics to reuse LMR Spectrum in order to facilitate the transition. (In contrast, the P25 Phase 2 LMR solutions – Options 2 and 3 – depend upon reusing LMR frequencies, and will require careful management of details throughout transition.)

To minimize impact upon end users, the new LTE system would need to be fully operational before transition begins. Individual agencies would then be able to move end users from existing Portables and Mobiles over to new LTE devices in relatively short time frames. However this is done, transition would still include some period of time when communications would be Patched from existing LMR systems to the new LTE system. Some functionality would be lost over this Patch. Because mission-critical voice standards are not yet in place, we do not know exactly what capabilities would be lost during the time that LMR systems are Patched to the new LTE system.

The new LTE system would be different enough that end users would need training to understand how the system works (different beeps, failover procedures, etc.) and also how to interact with the system in various operational situations. Technical staff in the Region would also need significant training due to the complexity of LTE and the dissimilarity to existing LMR systems.

f. Schedule

At present, the timeline for development of a standard for mission-critical voice over LTE and equipment is highly speculative. There are many things that need to happen, over which we have no control, before this will be a reality.

The LTE standards are controlled by the 3rd Generation Partnership Project (3GPP), an organization made up of hundreds of private companies including commercial carriers, component manufacturers, equipment vendors, software developers, and others. There is little incentive for commercial carriers (that influence the direction of 3GPP) to embrace mission-critical voice capabilities such as Talk Around (the ability to communicate unit-to-unit when out of range of a wireless network). Talk Around can be seen as a competitive threat to

commercial carriers because it would enable public safety users to bypass the carriers' networks, stripping the carriers of a level of control and the opportunity to bill for minutes of use.

A best-case timeline for development of the standard and equipment that supports mission-critical voice is shown below.

Several steps are required to transform requirements into commercially-available equipment:

1. The public safety community needs to identify and reach consensus on the functional requirements for mission-critical voice. Definition of requirements is currently in progress and could be complete by the end of 2012.

2. 3GPP will need to translate the functional requirements into standards that incorporate the new functionality into a specific future release level of LTE. Estimated time required: 3 years.

3. The manufacturing community will then need to develop, manufacture, and test equipment compliant with the new standards. Estimated time required: 1 to 2 years.

4. Initial deployments, with the first generation of equipment, can then begin. Implementation time for LTE systems will vary dramatically based upon a variety of factors, and could take 2 years or more to complete.

In this hypothetical scenario, the first equipment capable of supporting mission-critical voice on LTE would be available during 2018 (approximately). First deployments could begin that year. More conservative deployments would likely begin later – perhaps in the 2020 time frame.

It could take the Region five years to implement an LTE system with broad enough coverage to meet mission-critical voice requirements.

Assuming that implementation began in 2020, the regional LTE system could be ready to begin migrating large groups of end users in the 2025 time frame – well beyond the end-of-support dates for existing LMR systems.

g. Key strengths, weaknesses, opportunities, and threats

The Project Steering Committee identified strengths, weaknesses, opportunities, and threats (SWOT) as part of its analysis of this option. Keys points are summarized below. The complete result of the Steering Committee's SWOT analysis is included in the Appendices.

Strengths	Weaknesses
• An LTE system would support Broadband-enabled end user devices.	• Agencies in the Region don't currently have enough Radio Sites to build an LTE system.LTE would require 7-10 times as many Radio Sites as existing LMR systems in the Region's urban areas, and many more times that in the Region's rural and forested areas. New site development is very expensive and time-consuming. • LTE would require a lot of high-capacity Backhaul (Fiber) that is not in place today. That will also be expensive. • Providing path redundancy (diverse, secondary Backhaul connections necessary to Radio Sites) could be cost prohibitive; however, reliability would suffer without it.
Opportunities	**Threats**
• Potential for smaller form factor end user devices • Potential for less expensive end user devices • Potential for integrated voice and data end user devices (for those users where it makes sense to carry a single device) • Potential opportunity to consolidate networks and build	• There is currently no standard for mission-critical voice on LTE, and no indication that the technology will be commercially available prior to end-of-support dates for existing LMR systems. • Mission-critical voice over LTE has not been vetted with the public safety community. We

a single, integrated voice and Broadband data network • Potentially enables Roaming outside of traditional LMR coverage areas through partnerships with commercial carriers and other public safety agencies. • Because LTE is an IP-based technology, it may be easier to incorporate new technologies and support new services than the other (LMR) options. • There is the promise of increased Interoperability with others outside the Region.	don't know that LTE devices will meet public safety end user requirements prior to end of life of existing LMR systems. • In the rural areas where the cost to build an LTE network is the highest, the number of users would be the lowest. Commercial carriers are least likely to build their networks in these areas, so Roaming to commercial systems may not be an option in remote areas. • There is not enough known about Roaming from public safety to commercial systems that anyone can reliably state that public safety will have priority on commercial systems.

Summary

LTE is not a viable replacement for LMR at this time because there is no standard for mission-critical voice over LTE and no firm timeline for development of that standard. Even after the standard is complete, it could take considerable time for manufacturers to develop products that comply with the standard. End-of-support dates for existing LMR systems in the Region could pass before mission-critical voice over LTE equipment is commercially available.

Because technology changes quickly, the PSC should review the status of LTE again, and confirm whether or not it supports public safety mission-critical voice requirements, prior to spending money to upgrade or replace existing LMR systems.

Although there are many unknowns, it is clear that a regional LTE system would be very expensive:

- It would require 7 to 10 times as many Radio Sites as existing LMR systems. Agencies in the Region don't currently have enough sites and would need to develop them. Development of new sites is very expensive.

- LTE would require an extensive Backhaul network that does not exist today. LTE radios sites need 10-100 times as much Backhaul as LMR sites. Having geographically-diverse Backhaul connections is necessary for reliability and would add significantly to the cost.

Because of the anticipated high cost, the Region is exploring alternate funding models, including public-private partnership opportunities, through a parallel RFI effort.

References

1. The National Public Safety Telecommunications Council (NPSTC) Broadband Working Group functional description of mission-critical voice is available by clicking here.

2. Wireless industry consultant Andrew Seybold writes regularly about LTE, mission critical voice, and other topics relevant to public safety communications for his "Public Safety Advocate" newsletter: http://andrewseybold.com/publications/public-safety-advocate-e-newsletter. Recent articles include:
   - Mission-Critical Voice Over LTE: What, When, and How? – 12.08.2011
   - Mission-Critical Voice and LTE: Be Careful! – 08.26.2011

3. The Department of Homeland Security's Office of Emergency Communications, in collaboration with SAFECOM and the National Council of Statewide Interoperability Coordinators, developed a brochure that describes the evolution of emergency communications and how traditional LMR communications used today may converge with wireless Broadband in the future if specific requirements are met. See *Public Safety Communications Evolution Brochure - November 2011* available by clicking here.

11. Comparison of Options

In this section, the Options and Sub-options are compared against each other based upon the criteria identified in Section 5c. Again, those criteria are:

- Coverage
- Spectrum
- Mobility and Interoperability
- Reliability
- Implementation and Transition
- Scalability
- Local Service Delivery and Control
- Encryption Key Management
- Over-the-Air Programming (OTAP) and End User Template Management
- GPS-Enabled End User Devices
- Broadband-Enabled End User Devices

Each jurisdiction participating on the Project Steering Committee (PSC) independently evaluated each option against each criterion. The PSC then collected the individual assessments and came to a consensus opinion about whether or not each option satisfied the criteria. The following rating system is used in this section to illustrate the PSC consensus opinion:

X	Does not meet the requirement
✓	Meets or exceeds the requirement
?	There are uncertainties (technical, regulatory, etc.) that prevent the PSC from definitively assessing this
n/a	Not applicable

Here are the conclusions of the PSC:

a. Coverage

The system(s) must provide service to the populated areas where responders work. Local and regional coverage goals were defined, and each option was characterized in terms of whether or not it would meet those coverage goals.

Option/Sub-option	1A	1B	2A	2B	3A	3B	4
PSC assessment	X	X	✓	✓	✓	✓	✓

The Next Generation Wireless Public Safety Network Problem Statement (Appendix B) notes that: "Several populated areas in the Region have little or no radio coverage, and the impact of this problem is likely to increase in all three counties as growth patterns change." This is no one's

fault – many areas that are densely populated today were not populated when existing radio systems were originally planned.

The PSC established the following coverage goals for the upgraded or new system(s):

- General Requirements:
  - 97% coverage in the bounded area[16] of each county
  - 97% coverage in each city (all cities should be included within the identified bounded areas)
  - 97% coverage along all major roadways (bounded areas include the following major roads, at a minimum: Interstate 90, State Highway 410, and U.S. Highway 2)
  - Coverage that meets the business requirements of agencies that respond to incidents in mountainous areas east of the bounded area of each county. (This could be VHF coverage.)
- In-building coverage:[17]
  - Low Density Buildings: 97%
  - Medium Density Buildings: 97%
  - High Density Buildings: Yes
  - SeaTac Airport: 97% throughout the entire airport, including buildings and tunnels

Sub-options 2A, 2B, 3A, and 3B could all successfully meet these coverage goals. With the installation of upgraded or new equipment and additional Radio Sites, coverage problems could be mitigated in populated areas.

Option 4 would result in a new system built from the ground up. As such, coverage is not inherently limited. The issue for Option 4 is cost: LTE systems require 7 to 10 times the number of sites per unit area as does a traditional LMR system to achieve the same level of coverage.

Sub-option 1A, doing nothing, does not address this issue. And it is impossible for SmartZone systems to address this problem under Sub-

[16] The bounded area includes the entire geography of each county west of the Cascade Mountain foothill boundary, all cities, and all major roadways. The foothill boundary is defined here as the first topographic contour that exceeds 750 feet of elevation as you travel eastward from Puget Sound.

[17] Engineers cannot fully predict in-building coverage within a given area. Instead, they design the Radio System to provide enough extra signal level at the outside of a building of a given assumed density that there is a strong statistical probability of coverage within buildings of a certain type. Coverage can also be enhanced within a structure through other means such as internal signal amplification systems (such as used at SeaTac Airport).

option 1B. Additional Radio Sites are needed to improve coverage, and system owners are unable to add Radio Sites because the vendor no longer sells the necessary equipment.

VHF systems could improve coverage by adding sites, if desired.

b. Spectrum

There must be sufficient Spectrum available to provide the needed capacity for the upgraded/rebuilt system(s) and to transition from existing systems to the upgraded/rebuilt system(s).

Option/Sub-option	1A	1B	2A	2B	3A	3B	4
PSC assessment	✓	✓	✓	✓	✓	✓	?

The Region should have sufficient Spectrum available to implement Sub-options 2A, 2B, 3A, and 3B. The transition for Sub-options 3A and 3B may present greater but manageable Spectrum challenges.

Sub-options 2B and 3B (the single, regional system alternatives) would make more efficient use of Spectrum and potentially require fewer Radio Sites than Sub-options 2A and 3A (the multiple system alternatives).

Sub-options 1A and 1B would not include actions that would impact Spectrum usage.

Spectrum issues around Option 4 are more complex. The Federal Government has allocated some 700MHz Spectrum for public safety wireless Broadband use. In the Region, only Seattle has a lease to use that Spectrum, although the City has applied to the FCC to have its waiver expanded to the Region. In addition, Congress has been considering legislation that would allocate additional Spectrum for this purpose (the 700 MHz D Block). There are questions about whether the Region would have sufficient Spectrum to meet its needs during large incidents if Congress does not allocate the D Block to public safety.

c. Mobility and Interoperability

The system(s) must support a limited number of Talkgroups (both unencrypted and encrypted) that provide users with the capability to move throughout the three-county area without having to make changes to their radios or Talkgroup selection.

Option/Sub-option	1A	1B	2A	2B	3A	3B	4
PSC assessment	X[18]	X	✓	✓	✓	✓	✓

Sub-options 2B, 3B and 4 would provide the highest level of Mobility and Interoperability. Having all users on a single system by definition ensures the highest level of Interoperability.

Sub-option 3A leaves open the possibility that individual radio systems in the Region could install Infrastructure from differing vendors. This would almost certainly lower the services available Region-wide.

Under Sub-options 1A and B, there would be no change in Mobility and Interoperability from what exists today. For purposes of this comparison, "today" is defined as including the combined capabilities of the current Tri-county Regional Interoperability System (TRIS) and the P25 ISSI Gateway capability that will be in place after the three P25 Switches (King County, Tacoma, and SERS) are installed after the ISSI interfaces are established.

Note that, under Sub-option 1A, TRIS capability would be at some risk. TRIS depends upon Dispatch Consoles, and the existing Gold Elite Consoles are nearing end of support. In order to sustain TRIS, all radio systems with Gold Elite Consoles may be required to replace them.

d. Reliability

End users need reliable service throughout the Region. At a minimum, central system control equipment (including simulcast controllers in systems that have that function) needs to be redundant and capable of being installed in geographically-diverse locations.

Option/Sub-option	1A	1B	2A	2B	3A	3B	4
PSC assessment	X[19]	X	✓	✓	✓	✓	?

Existing systems in the Region have been extremely reliable. SmartZone systems have a fall-back process that cushions the impact on the overall system if a component or site fails. As discussed in detail elsewhere, the risk for Option 1 is that our systems will deteriorate over time. This deterioration will progressively diminish Reliability, and recovering from

[18] Existing SmartZone systems provide a high level in Interoperability; however, they do not fully meet the requirement described here.

[19] Existing SmartZone systems have historically been very reliable, however, they do not offer the level of redundancy described here. Also, unless remedial action is taken, the Reliability of existing systems will decrease to unacceptable levels over time.

service-affecting system problems will become increasingly complex and expensive. Some systems are already seeing a need for increased repairs. The increasing costs will be noticeable in the increased level of human resources (both system staff and Motorola staff) required to diagnose and fix these problems.

As discussed elsewhere, certain parts for SmartZone systems are no longer available from the vendor. There is an aftermarket for parts; however, depending upon the aftermarket is risky and unreliable because components have to be at specific hardware/software versions (not all parts are compatible with existing systems) and because the condition and service history of used components is unknown. Relying upon the aftermarket would entail replacing used, unsupported parts with other used, unsupported parts.

Options 2, 3, and 4 could result in highly reliable systems. System owners currently harden their LMR sites by, for example, installing electrical generators and stocking back-up fuel for those generators to enable the equipment to operate for weeks if commercial power fails. Commercial LTE (cellular network) operators do not currently harden their systems in the same way as public safety systems. There is no technical reason why we could not harden LTE sites (Option 4). The issue will be that, because LTE systems require 7 to 10 times as many sites to cover the same area as current public safety LMR systems, hardening all of the LTE sites would be very expensive.

Sub-options 2B and 3B (the single, regional system alternatives) would potentially require less Switch equipment than Sub-options 2A and 3A (the multiple system alternatives). It could, therefore, cost less to build redundancy to meet Reliability goals with a single system. However, if all system users share a single regional system and the primary system fails and does not properly switch over to the redundant back-up system, the entire Region could be affected by the failure. In a multiple system design, such a failure would affect a smaller geographic area.

Unlike LMR, LTE cellular technology does not perform well if there are areas of overlapping coverage. Because you cannot intentionally design for overlapping coverage, if you lose an LTE Radio Site, the corresponding geographic area will be without any coverage. LTE is also Infrastructure dependent; unless end users are within range of an LTE Radio Site and that site is in service, they will not be able to use their communications devices. (LTE does not currently have a capability equivalent to talk around on LMR systems.)

e. Implementation and Transition

There must be minimal complexity and disruption to system users as they move from current systems to the future system(s). Transition, the process of moving end users from existing systems over to new or upgraded systems, was considered in three general frameworks:

- Communications capabilities: End users must maintain the ability to communicate on normal operational Talkgroups and designated Interoperability Talkgroups throughout transition. However, it may be acceptable to limit some other Trunked radio features during transition.
- Duration and certainty: The time required to complete transition needs to be limited and predictable to minimize impact on end user agencies and radio system owners.
- Timing flexibility: It is desirable that agencies have flexibility to meet their current planned life expectancy for existing system Infrastructure and Subscriber Radios and to be able to plan their own migration timeframes.

Option/Sub-option	1A	1B	2A	2B	3A	3B	4
PSC assessment	n/a	n/a	✓	✓	?	?	?

Options 2, 3, and 4 will all require significant implementation and transition work and result in functionally new systems. Because Option 2 involves the same vendor as the current SmartZone systems, this Option is probably easier and quicker than Options 3 and 4. Both Options 3 and 4 require building a parallel system from scratch. This would likely put more strain on space in existing site buildings, towers, power systems, Spectrum, etc.

Option 1 does not involve significant work for the SmartZone systems. There is no implementation and transition.

VHF system owners will need to do significant work to meet the FCC Narrowbanding mandate before January 1, 2013. For many systems, meeting the mandate will require the purchase and installation of a significant amount of new Infrastructure and Subscriber Radios.

f. Scalability

The system(s) must be able to expand to meet the growing needs of the Region and to incorporate additional counties, if desired.

Option/Sub-option	1A	1B	2A	2B	3A	3B	4
PSC assessment	X	X	✓	✓	✓	✓	✓

SmartZone system owners can no longer add Radio Sites to expand coverage, radio channels to increase capacity, or (in the case of Port of Seattle) Dispatch Consoles because the vendor no longer sells the necessary equipment. Option 1 lacks the ability to meet the increased needs of the Region through the 2030 planning horizon.

Options 2 and 3 could scale to meet the Region's needs. Though Spectrum is constrained by several factors, including our proximity to Canada, the added efficiency enabled by P25 Phase 2 should provide growth capacity to meet the Region's needs.

It is unclear how much capacity will be available for public safety LTE systems because of pending federal legislation; without knowing how much Spectrum will be available it is not possible to say whether there will be sufficient capacity for major incidents or for expanded capacity over time.

g. Local Service Delivery and Control

The system(s) must allow current radio system owners to maintain their current customer relationships and manage the service delivery process for their end users.

Option/Sub-option	1A	1B	2A	2B	3A	3B	4
PSC assessment	✓	✓	✓	✓	✓	✓	?[20]

Option 1, Sub-options 2A and 2B, and Sub-options 3A and 3B would not require changes in the current customer relationships or the management of the service delivery process.

Nothing would change under Option 1.

Sub-options 2B and 3B (the single system alternatives) define a regional architecture; however, even in a one-system architecture current customer relations could be retained. This is the current situation with the King County Radio System where there is a central Switch but separately-owned sites and separately-managed customer relationships.

[20] The level of Local Service Delivery and Control will depend upon the capabilities of the equipment and regional governance decisions.

Option 4 would deploy a single regional system and a new technology, and would necessarily require a new governance structure. The level of Local Service Delivery and Control available under Option 4 will depend upon the specific capabilities of the equipment and the governance put in place to manage and operate the new system.

h. Encryption Key Management

The system(s) must enable managers to control their local encryption keys. System-level (regional) key management capabilities should also be available. Even if regional key management capabilities are used, local jurisdictions still need to be able to manage their own keys.

Option/Sub-option	1A	1B	2A	2B	3A	3B	4
PSC assessment	X	X	✓	✓	✓	✓	✓

This criterion could be met with Options 2, 3, and 4. Encryption key management is not available for any of the current systems.

i. Over-the-Air Programming (OTAP) and End User Template Management

The system(s) should support over-the-air programming and the capability to centrally-manage the installation of radio/Talkgroup templates.

Option/Sub-option	1A	1B	2A	2B	3A	3B	4
PSC assessment	X	X	✓	✓	✓	✓	✓

This criterion could be met by Options 2, 3, or 4. Depending on the system, these may be standard features or available enhancements. These features are not available in any of the current systems.

j. GPS-Enabled End User Devices

The system(s) should support GPS-enabled end user devices and permit that GPS data to be used by other applications.

Option/Sub-option	1A	1B	2A	2B	3A	3B	4
PSC assessment	X	X	✓	✓	✓	✓	✓

This criterion could be met by Options 2, 3, or 4. The current SmartZone and VHF system Infrastructures do not support GPS-enabled end user devices.

k. Broadband-Enabled End User Devices

The system(s) should support Broadband-enabled end user devices in order to enhance situational awareness.

Option/Sub-option	1A	1B	2A	2B	3A	3B	4
PSC assessment	X	X	X	X	X	X	✓

Option 4, an LTE system, is the only option that would support Broadband-enabled end user devices.

l. Other considerations

(1) Costs

Sub-option 1A is the only option that does not require a large, up-front capital investment. However, doing nothing isn't free. It does not preserve the current cost profile due to the fact that increased equipment failures will require more service time and money in order to keep the system functional. Operational cost will increase in unpredictable ways.

Sub-option 1B will require modest capital investments by individual radio system owners and/or dispatch centers. In return, this sub-option will provide a modest extension of the useful life of existing systems.

Sub-options 2A, 2B, 3A, and 3B will all require large capital investments – potentially hundreds of millions of dollars. The new Infrastructure should serve the Region's voice communications needs through the planning horizon.

Option 4 will also require a large capital investment. An LTE system would require many additional Radio Sites – on the order of 7 to 10 times that of a traditional LMR system. Site development is very costly and time consuming. Many existing LMR sites would not be suitable for an LTE system (mountain top sites are not recommended, for example). This Option would also require a great deal of high capacity Backhaul (Fiber) that is not in place today.

(2) Practicality

Sub-option 1A does not meet public safety mission-critical voice requirements. While conceptually an option, it is not practical.

Sub-option 1B is practical only for the very short term. Operating under Sub-option 1B for an extended period of time is likely to force a piece-part system upgrade. As old parts that are no longer available fail, they will need to be replaced with upgraded components to restore the public safety system to service. This reactionary, unplanned system upgrade would result in service disruptions, increased costs compared to a planned upgrade or rebuild, and lost opportunity for a strategic design.

Sub-options 2A, 2B, 3A, and 3B are all practical, viable alternatives.

Option 4 is still an option in concept only. The technology does not meet mission-critical voice requirements, and we do not know when it will. It is not a practical solution for public safety.

(3) Ability to phase the project

Option 2 would allow radio system owners to phase the project and prioritize replacement of the oldest end-of-support components first to mitigate immediate risks. Some work at Radio Sites could be done channel-by-channel, lessening the impact during transition on limited resources such as Spectrum and space within Radio Site buildings and on towers.

Unlike Options 3 and 4, Option 2 would allow continued use of a number of current system components. Ongoing/future equipment purchases would be supported on the legacy SmartZone systems in place now and on the end-state P25 Phase 2 systems, when completed.

Option 2 (and Sub-option 2A especially) would allow individual radio system owners and end user agencies more flexibility to migrate groups of users over to P25 Phase 2 systems on their own schedules within an overall regional plan.

Option 3 would require that the complete new P25 Phase 2 system be built before any groups of users could migrate over to that system. The upside is that the complete, new system could be thoroughly tested before any public safety users are migrated over to that system. The downsides are that individual agencies would have less timing flexibility and there would be greater challenges related to Spectrum.

Option 3 has the additional burden of requiring more building space to stand up two separate radio systems at the same time. This could force additional building modifications beyond those needed for Option 2, thereby increasing overall implementation cost.

(4) Impact of changing vendors (possible under Options 3 and 4)

Changing vendors would provide the opportunity to reset vendor contract expectations. However, transition will be more difficult if we change vendors than if we stay with the existing vendor. If we change vendors, we would need to establish new relationships and trust, which takes a significant amount of time. There would need to be significant investments of time and money to train technical staff and system users (dispatch center personnel and Mobile/Portable radio users) to operate the new system. A new vendor would not have the detailed technical knowledge of our existing systems and customer needs, adding to the challenges we will face during implementation and transition. The current vendor and the new vendor would need to work with each other and with us to facilitate a smooth transition. If we encounter technical issues during transition and something doesn't work, we will have to work with two vendors to resolve the issues.

(5) Impact of having multiple vendors (possible under Options 3 and 4)

While it may seem attractive to have multiple vendors to encourage competitive pricing, the PSC does not recommend that approach for radio system Infrastructure. If individual system owners purchase Infrastructure equipment from multiple, different vendors, there could be very complex system integration and Interoperability issues that would negate some system features from working throughout the Region. It would also require having a larger compliment of spare parts, and potentially more technicians, because regional sharing of resources would be more limited than it is today.

(6) New capabilities

An LTE system (Option 4) would offer opportunities that are not available with any traditional LMR system. There will be the potential to integrate voice and high speed data into a single handheld device. An LTE system could allow Roaming outside of the traditional user area to virtually anywhere there is commercial LTE network coverage. This system would be part of a national

architecture and governance model that will enhance first responder Interoperability.

Summary

Most of our SmartZone radio systems are getting old and need an increasing number of repairs at the same time that the vendor is halting repairs and the sale of new parts. The risk for system users is the increasing likelihood of system degradation: holes in coverage, poorer voice quality, or system outages. It will take several years to put new or upgraded systems in place. The systems will need to be funded, contracted for, designed, built, and tested. Thus, the risks we must evaluate are the risks between today and the date any upgrade or replacement is completed.

All of the options identified in Section 4 of this report were considered and compared. While each Option and Sub-option had qualities that would be advantageous to public safety and local government, only Option 2 and Option 3 adequately meet the requirements identified in this report. This is the PSC's overall assessment:

Option/Sub-option	1A	1B	2A	2B	3A	3B	4
PSC overall assessment	X	X	✓	✓	✓	✓	X

Both Options 2 and 3 would result in P25 Phase 2 Land Mobile Radio systems and support operations through the planning horizon. Option 2, upgrading existing Land Mobile Radio systems, and Option 3, building new Land Mobile Radio systems, are capable of meeting all of the criteria except for Broadband-enabled end user devices.

It would likely be easier and quicker to transition from current Motorola SmartZone systems to Motorola P25 Phase 2 system(s) than it would be to build entirely new systems, but either option is feasible. Both options have challenges, but the analysis favors Option 2 as having the least negative transitional impact on end users.

LTE (Option 4) cannot currently provide mission-critical public safety voice services. No one can say exactly what steps will need to be taken to implement services that do not yet exist. What is known is that an LTE system would require 7 to 10 times as many sites as a LMR system covering the same area and population and that the sites must be upgraded from what commercial cellular network operators usually build to ensure adequate system Reliability for public safety.

LTE is the only option that could support Broadband-enabled end user devices. Data services are becoming increasingly valuable to first responders; however, they cannot yet replace mission-critical voice services.

Option 1 is a holding pattern. It does not meet several criteria identified in this study and does nothing to mitigate risk associated with the end of vendor support for existing SmartZone systems. Some people may speculate that, by delaying action, the Region could avoid the need to fund another generation of LMR systems and, perhaps, wait until public safety grade LTE is a viable choice. However, there is currently no way to know if or when that will be. The Department of Homeland Security's Office of Emergency Communications, in collaboration with SAFECOM and the National Council of Statewide Interoperability Coordinators, released a document in November 2011 that describes the evolution of emergency communications.[21] Among the conclusions in the report:

> **In the near term, wireless broadband will complement LMR, not replace it.** Wireless broadband does not currently meet the requirements for emergency response voice communications, therefore LMR will be around for years.
>
> **Investments in LMR will continue to be necessary now and well into the future.** Even with the emergence of broadband, it will still be years before emergency responders can rely on broadband technologies for their mission critical communications. Public safety must continue LMR investments as appropriate in this context.
>
> **Public safety is using broadband today for data applications**, but not for mission critical emergency response voice communications. Although initial data applications will not provide LMR type voice capabilities, they are vital and can dramatically improve emergency response.
>
> **In the future, broadband could support mission critical voice.** However, requirements must be met and multiple challenges must be addressed.

VHF and UHF systems must narrowband to meet the FCC mandate. (Sub-option 1A, doing nothing, is not a valid option for VHF/UHF systems.) This will mean purchasing and installing significant equipment before January

[21] See *Public Safety Communications Evolution Brochure - November 2011*, available by clicking here.

2013. Should they decide to do so, VHF/UHF systems can also improve coverage by adding Radio Sites.

12. Costs

The Project Steering Committee (PSC) discussed costs to the extent that it could without directly engaging vendors to engineer specific radio system solutions. Costs will ultimately depend upon the result of the procurement and the final design requirements for each system. The PSC believes that the Region needs to run a competitive bid process to get the lowest overall cost.

Considerations specific to each option are listed below.

a. Option 1: Keep existing Land Mobile Radio (LMR) systems in place

For Option 1, the assumption is that radio system owners would use existing vendor contracts to purchase the components necessary to make emergency repairs or to replace end-of-life Dispatch Consoles and other system components. Radio system owners would work directly with their vendors to determine costs for repairs and replacements projects, and would fund projects using their existing operational or capital funding mechanisms. (There would be no regionally-coordinated funding effort.)

b. Option 2: Follow Motorola's recommendations to migrate existing SmartZone LMR systems to P25 Phase 2 LMR systems

The PSC used component prices available through existing contracts to develop an estimated cost for Option 2.

To improve coverage, additional Radio Sites will be needed. The PSC included in its cost estimate an estimated number of new sites required and a genetic cost for new sites. Detailed engineering analysis is needed to determine the optimal locations and precise number of new Radio Sites necessary to meet coverage goals. Constructing new Radio Sites that meet public safety requirements is very expensive.

The PSC's estimate does not and cannot take into account volume purchase discounts or precise engineering and professional services costs. The PSC believes that the Region can get more accurate and lower costs via a combined RFP process that requests pricing for both Option 2 and Option 3.

c. Option 3: Build new P25 Phase 2 LMR system(s) to replace existing LMR systems

Option 3 will require a competitive bid process. The PSC believes that the competitive process will provide the region with the most accurate and lowest costs from the existing vendor and potential alternate vendors.

Additional Radio Sites will be required to improve coverage. Engineering information resulting from the competitive process should help determine the number of new sites required and approximate costs for those sites.

d. Option 4: Regional Long Term Evolution (LTE) system for mission-critical voice

The PSC could not develop costs for an LTE system. First, there are no end user devices that support mission-critical voice (thus, no costs), and it could be years before we have such information. Once devices become available, it is reasonable to expect that public safety-grade devices will be significantly more expensive than consumer-grade cellular phones because of the limited market (relative to mass market, consumer devices) and the unique requirements for public safety devices. In addition to supporting mission-critical voice features, public safety devices will need to operate on the national, designated Public Safety Broadband Spectrum and, potentially, commercial cellular carrier frequencies to permit Roaming. Hardened, specialized devices must also be available for certain first responders (for example, fire fighters that need to operate their devices in hot, wet environments and while wearing heavy gloves).

Second, there are vast uncertainties about LTE Infrastructure design. We do not know how mission-critical voice requirements will impact LTE site design nor do we know how system design will be affected by the national public safety LTE architecture which is not yet complete; we only know that both could have significant design implications that will ultimately affect cost. For example, providing reliable mission-critical voice service could necessitate having a very high number of LTE radio sites to ensure that there will be sufficient capacity to handle large, localized incidents.

Government agencies in the Region do not currently have access to many of the new tower sites that would be needed for an LTE system and would have to develop them at a very high cost. Sites need to be hardened to meet public safety requirements, and site costs will be significantly higher than typical commercial cellular sites. Because this cost could be so high, the Region has begun a parallel RFI effort to explore public-private partnership opportunities as a possible alternative to constructing a government-owned LTE system.[22]

[22] On December 9, 2011, City of Seattle, acting on behalf of the REPC, released a Request for Information (RFI) seeking information about public-private partnerships for the purpose of providing state-of-the-art wireless mission-critical voice and broadband data capabilities for public safety and general government.

13. Recommendations

Technical recommendation

From a technical perspective, based upon what we know about currently-available technology, the Project Steering Committee (PSC) recommends Option 2A, upgrading existing SmartZone Land Mobile Radio (LMR) systems to P25 Phase 2 LMR systems and having multiple upgraded systems linked together.

Procurement recommendation

Procurement has three major components: technical/functional, management/schedule, and pricing. As a technical solution, Option 2A rated the highest in comparative analysis; however, the differences among the Option 2 and Option 3 alternatives are small and procurement could be influenced by the other major components. For procurement, the PSC recommends an open RFP process. That RFP would invite the current vendor and other possible vendors to bid their best strategies to move from existing LMR systems to P25 Phase 2 LMR systems.

In addition to costs, we expect that an RFP process would produce additional information about:

- Radio system design. While bid responses would not likely include detailed designs, we could expect high-level designs produced by computerized modeling tools and lists of requirements and assumptions that would help us evaluate the feasibility and risks associated with each option and tabulate other costs (for example, an approximate number of new Radio Sites required), and
- Transitional impact upon end users. In addition to a schedule and project plan, bid responses should describe how implementation and transition will occur, provide detail about logistics and constraints, and help ascertain what will and will not be feasible.

Timing recommendation

Because existing SmartZone systems will be at increasing risk of serious degradation or failure until they have been upgraded or replaced, and because it could take 4-6 years to upgrade or replace systems after we have funding, contracts, and detailed designs, the PSC recommends that we begin work on the competitive bid process now.

All agencies with VHF and UHF radio systems need to act immediately to ensure that they are in compliance with the FCC Narrowbanding mandate prior to the January 1, 2013 deadline. (Note that many agencies, including Pierce County and the Washington State Patrol, are already executing plans to meet that objective.)

Why LMR (and not LTE)?

LMR meets public safety requirements for mission-critical voice today. LTE, while conceptually an option, is not a practical option. LTE does not currently support mission-critical voice and there is no certainty about when it will. Requirements have not been finalized, standards have not been developed, and end user devices and dispatch equipment don't exist. Even after such devices exist, the PSC would not recommend using the first generation of a new technology for public safety. The Region should wait until the technology has been thoroughly tested and other field deployments prove that LTE meets public safety requirements for mission-critical voice before it is deployed here as a replacement for LMR systems.

Because technology changes quickly, the PSC should review the status of LTE again, and confirm whether or not it supports public safety mission-critical voice requirements, prior to spending money to upgrade or replace existing LMR systems.

Why Option 2 (upgrade) over Option 3 (replacement)?

From a technical perspective, the phased upgrade approach allowed by Option 2 seems to make the most sense. For example:

- Option 2 would allow radio system owners to focus on upgrading the oldest radio system components first to begin driving risk related to unsupported equipment down sooner.
- Transition must be simple for end users to minimize impact upon public safety operations. In Option 2, old SmartZone Radio Sites and new P25 Phase 2 Radio Sites could be connected to the same Switch, allowing groups of users with either technology to communicate with one another and maintain existing functionality throughout the transition. This is particularly important because the transition could take years to complete.

However, there are details about how transition would work for Option 2 and Option 3 that we do not yet know. To sort out nuances and make a solid recommendation, the PSC needs additional information that should result from the development of the RFP.

Why multiple systems rather than one regional system?

Current technology will meet end user requirements whether we have multiple systems or a single system. The equipment available to link systems together is sophisticated enough that, from an end user perspective, multiple systems linked together could perform the same as a single system *provided* the same manufacturer is selected for all radio system Infrastructure.

The multiple systems approach would give system owners greater flexibility to implement P25 Phase 2 systems and transition end users over to those systems within their own time frames. This is important because it would allow radio system owners to meet their individual timing constraints:

- Pierce County can proceed with its plans to build out the Pierce Transit P25 system and migrate users from the old Pierce County VHF system to other systems prior to the Narrowbanding deadline.
- King County and Port of Seattle can act to upgrade or replace their aged systems whenever funding permits.
- Snohomish County can defer action, maintain a level of Interoperability, and upgrade to P25 Phase 2 after the bonds that funded the original system mature.

Note that, if the Region moves ahead with multiple systems, it will still have the option to merge multiple, independent systems into a single, regional system in the future, if desired. This means that system owners can respond to critical timing, as noted above, while the Region as a whole has additional time to consider and develop Region-wide governance and a unified funding strategy, if desired.

Why not defer action (Sub-option 1A)?

While doing nothing may be an option conceptually, it is not practical because these are public safety radio systems. The risk of serious degradation or failure will increase rapidly as the manufacturer phases out support for existing SmartZone equipment. Already, certain critical components are no longer sold by the manufacturer. Risks for many systems will increase significantly starting in 2013 when support for additional hardware and software is discontinued. The PSC believes that not taking action is too risky.

Sub-option 1A is not valid for VHF and UHF radio systems. System owners must either comply with the FCC Narrowbanding mandate or shut down their

radio systems by January 1, 2013. We cannot shut down public safety systems; agencies have to act.

Why not just make minimum investments (Sub-Option 1B)?

Making minimum investments (for example, replacing Gold Elite Dispatch Consoles) will extend the useful life of existing SmartZone LMR systems, but only for a few years. Support for other critical components of those systems is also being phased out, and the risk of serious degradation or failure will continue to increase until it reaches unacceptable levels. The PSC believes that risk will become unacceptable in the 2018-2020 time frame (depending upon the age of existing radio system equipment and other factors).

Replacing equipment piecemeal as it fails will cost radio system owners more money over the long term.

What about VHF/UHF systems?

Agencies with VHF and UHF radio systems need to comply with the FCC Narrowbanding mandate, as noted above. Aside from that, there is no regional consensus or strategy for VHF/UHF systems. The PSC recommends that there be a separate planning effort to develop a long-term strategy for VHF/UHF across the Region. The work of this planning group would include identifying the optimal VHF overlay for Statewide Interoperability channels and determining optimal coverage throughout the three counties using a combination of VHF radio (in rural/rugged terrain) and 700/800 MHz Trunked radio (in urban/suburban settings).

Other comments

To ensure that system operation is reliable, it is critical that a single manufacturer's equipment be used for all radio system Infrastructure. This means that one manufacturer's equipment should be used for all Infrastructure components within any single system (the Switch, Radio Site equipment, and Dispatch Consoles) and that the same manufacturer's equipment should be used for all radio systems within the Region.

Several manufacturers produce P25 Phase 2 Mobile and Portable Radios. After transition is complete and all radio systems in the Region are operating as P25 Phase 2 systems, agencies could choose to purchase Mobiles and Portables from various vendors provided those radios are approved for use by the respective radio system owners.

Appendices

A. Definitions

B. Problem Statement

C. Notes from Option 1 workshop

D. Notes from Option 2 workshop

E. Notes from Option 3 workshop

F. Notes from Option 4 workshop

G. Results from analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT)

H. Report Development Notes

I. Coverage Maps

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Appendix A

Definitions

700 MHz refers to a range of radio frequencies used in the design of new radio systems, particularly in regions where existing VHF, UHF, and 800 MHz radio frequencies have been exhausted. This term applies to Spectrum in the 746-806 MHz frequency range.

800 MHz refers to a range of radio frequencies that are often used in the design of radio systems, particularly in regions where existing VHF and UHF frequencies have been exhausted. This term applies to Spectrum in the 806-869 MHz frequency range.

Backhaul refers to communications facilities that connect radio system equipment in different geographic locations. Backhaul can include, but is not limited to, Microwave, Fiber, and circuits leased from a telephone company.

Broadband used here refers to systems that support data transmission rates greater than or equal to 2 Mbps.

Capacity refers to the number of users that can be served by the system simultaneously. In voice radio systems, capacity is often described by the number of radio channels available. In data systems, capacity is often described in terms of bandwidth available for use (for example, 2 Mbps).

Console (or **Dispatch Console**) is the equipment that 911 dispatchers use to communicate with first responders over a public safety radio system. A Console typically includes a personal computer and audio equipment (microphones, headsets, and speakers).

Conventional radio systems include basic Subscriber Radio-to-Subscriber Radio communication systems and complicated repeater-based radio systems. The distinguishing characteristic of Conventional systems is that they are not Trunked. (They do not automatically and dynamically allocate radio frequencies among many users.)

Core used here refers to the central control equipment for an LTE system.

Coverage refers to a geographic area where service is available (where the radio signal is strong enough to be useful for communications).

Encryption is the conversion of data into a form that cannot be easily understood by unauthorized people

Fiber used here refers to fiber optic cable used to provide Backhaul connections. Fiber permits transmission of data at very high data rates over long distances.

Fingertip Roaming is the capability for Mobile and Portable radios to travel from one radio system to another radio system on pre-designated Talkgroups by changing a setting on the radio.

Gateway refers to hardware and software that provides an interconnection between radio systems and that allows designated Talkgroups to operate across multiple radio systems.

Infrastructure refers to Master Site equipment, Radio Site equipment, Backhaul, Dispatch Consoles, power systems, and other "behind the scenes" equipment necessary to make a radio system operate. Infrastructure specifically excludes Subscriber Radios (Mobiles and Portables).

Interoperability means the ability to exchange information on demand, in real time, as authorized. Interoperability is not a single defined state; rather, there are levels of Interoperability. For example, a user may be able to talk to another user outside the coverage area of his home system, but other features that would normally work on his home system (such as the emergency button) may not work.

Within the context of this report, Interoperability refers to having the technical capabilities necessary to enable the exchange of information. Additional factors necessary to achieve Interoperability in the field (governance agreements, operating procedures, end user training, etc.) are not considered in this report.

Land Mobile Radio (LMR) denotes a wireless communications system intended for use by terrestrial users in vehicles (Mobiles) or on foot (Portables).

Local Service Delivery and Control means that a radio system operator is capable and authorized to serve and support individual end user agencies (for example, police and fire departments) that operate within its serving areas and meet their unique business requirements.

Long Term Evolution (LTE) is a worldwide mobile phone standard developed by the 3rd Generation Partnership Project (3GPP). LTE has been endorsed by public safety agencies in the U.S. as the preferred technology for 700 MHz public-safety Broadband systems.

Master Site means the central Switching equipment used to tie radio transmission equipment and Consoles together into a complete radio system to provide wide area communications. Master Site is also a specific term relevant to Motorola SmartZone 4.1 radio systems.

Microwave refers to fixed, high-capacity radio equipment used to provide Backhaul connections.

Mobile refers to a vehicle-mounted end user radio. Mobiles have more powerful transmitters than Portables and can generally operate across a larger geographic area than Portables.

Mobility refers to the ability to move freely from place to place while retaining the ability to communicate and fulfill one's primary mission.

Narrowbanding refers to a FCC Order issued in December 2004 that requires public safety and business/industrial land mobile radio systems operating in the VHF and UHF bands (below 512 MHz) to cease using 25 kHz "wideband" radio channels and begin using technology supporting 12.5 kHz radio channels (or narrower) by January 1, 2013.

Over-the-Air-Programming (OTAP) refers to the ability to program end user devices wirelessly over the radio network.

P25 is a suite of standards for digital two-way radio communications administered by the Telecommunications Industry Association (TIA). P25 has been adopted by federal, state, and local public safety agencies in North America to enable communication with other agencies and mutual aid response teams during emergencies.

Patch is a temporary or semi-permanent connection between radio channels or Talkgroups. Patches are often established by dispatchers on an ad hoc basis.

Portable refers to a hand-held end user radio. Portables have less powerful transmitters than Mobiles and can generally operate across a smaller geographic area than Mobiles.

Public Safety Interoperable Communications (PSIC) is a federal grant program intended to help agencies improve the Interoperability of public safety communications systems through the use of advanced technology solutions.

Radio Site (or **Site**) refers to a location where radio transmitting and receiving equipment is located. A Radio Site may include a building, tower, antennas, electric power equipment, and other components necessary to support operation of the radio transmitting and receiving equipment.

Radio System includes all components necessary to provide wide area radio communications within a specific geography. It includes Master Site equipment, Radio Site equipment, Backhaul, and Dispatch Consoles.

Rebanding refers to changes taking place with the 800 MHz band to reduce interference on public safety radio frequencies due to Enhanced Specialized Mobile Radio service providers – most notably Sprint Nextel.

Region used here means the geographic area of King, Pierce, and Snohomish counties.

Reliability is the ability of a system or component to perform its required function under stated conditions for a specified period of time. Reliability depends upon system architecture and design as well as the reliability of individual components (central control equipment, radio transmitter equipment, Mobiles, Portables, Consoles, Backhaul, power systems, etc.).

Roaming refers to the ability to use a device outside the users' home system coverage area and to move from one system coverage area to another.

Seamless Roaming is a desired capability that would allow system users to maintain critical communications anywhere they work within the coverage area of multiple systems without requiring any action on their part. With Seamless Roaming, system users would not need to change settings on their radios or contact a dispatch center to establish a Patch between systems when they travel outside their "home" system coverage area.

SmartZone is a proprietary radio system designed by Motorola for wide area voice communications.

Spectrum used here refers to radio frequencies used for wireless communication.

Subscriber Radio refers to an end user radio, a Mobile or Portable.

Switch used here refers to the central control equipment for a P25 land mobile radio system.

Talkgroup refers to a software-controlled identification system that allows a pre-determined group of users communicate on a Trunked radio system.

Trunked radio systems automatically and dynamically allocate radio frequencies among many users. Trunked radio systems serve a larger number of users with fewer frequencies, reduce user waiting time, and provide enhanced capabilities.

UHF (Ultra High Frequency) used here refers to public safety Spectrum in the 421-512 MHz frequency range.

VHF (Very High Frequency) used here refers to public safety Spectrum in the 150-174 MHz frequency range.

Appendix B

NEXT GENERATION WIRELESS EMERGENCY NETWORK PROBLEM STATEMENT

October 2, 2008

EXECUTIVE SUMMARY

The local radio networks used by emergency workers face service degradations that if not corrected will result in increase risks to the public and our first responders. These networks: dispatch police, fire, and emergency medical services; enable first responders at an incident to coordinate their efforts; provide an officer who has just made a traffic stop with important information about the driver; and are used by responders to call for help when they needs assistance. The networks in our three-county Region have previously been identified as national models. Now, however, we face significant service degradation because of age, technical obsolescence, wear, and the withdrawal of vendor support unless we begin acting soon. This degradation would take the form of service outages and interruptions leading to delays in response times, greater difficulty in incident coordination, and increased danger to our police officers, fire fighters, paramedics, and other first responders.

7-10 years will be required to move from funding to substantial completion of our next generation network. Therefore, we must begin work now to avoid this otherwise inevitable increase in risk to the public and our first responders.

Many agencies in Pierce, Snohomish, and King Counties (Region) frequently provide mutual assistance and engage in joint operations. To do this work, first responders must communicate and coordinate using the wireless systems where they are at the time. Currently there is limited Interoperability between all first responders within the Region due to disparate radio systems.

Some systems within the Region will require significant upgrades/replacement to meet federal regulatory requirements and changing technology, to accommodate population shifts, and to compensate for increased metropolitan building density. Current systems have demonstrated a lack of capacity for large scale events involving natural disasters or critical incident responses.

Public safety communication is no longer limited to voice communication. Police, Fire, and EMS first responders need to receive a range of information in the field from their Dispatch Centers, their departments from other field units, or data bases. This information may be in the form of photographs, streaming video, reports, fingerprints, or voice files. Likewise, they need to transmit similar

information from their vehicles back to these locations. Our next generation network must be capable of carrying this data for efficient service to the public and the safety of responders.

A Public Safety Data Network will also increase the likelihood of data system availability and prioritization during major events which is not available through commercial data providers today.

Our Region has experienced a multitude of criminal incidents and enterprises which cross jurisdictional lines. Public Safety Answering Points (PSAPs) and dispatch centers who answer the 911 call and collect information for dispatching are a key component in our Interoperability response capabilities. Common information platforms and interconnectivity will enable information to flow freely and immediately across jurisdictional boundaries.

DETAILED STATEMENT

Many agencies in Pierce, Snohomish, and King Counties (Region) frequently provide mutual assistance and engage in joint operations. To do this work, first responders must communicate and coordinate using the wireless systems where they are at the time. A coordinated and cooperatively designed system will increase our ability to quickly and efficiently respond to citizen's needs during any natural or manmade events in our three-county region.

The radio systems in the Region have one or more of the following problems:

- The equipment supplier for most of the networks in the Region has said it will stop repairing equipment and stop selling new equipment in the foreseeable future.
    - Systems may face parts shortages increasing the risk of service degradation.
    - Parts shortages may also limit agencies ability to add services.
- The system has insufficient capacity during a wide-scale emergency, such as the Nisqually earthquake.
- The system has insufficient capacity to support new services that would enable responders and other users to work more effectively and safely.
- The system does not adequately serve all of the populated areas in its county.
- The system is old and maintenance costs are rising as parts increasingly require repair and replacement.

- Service often stops when a radio user enters a high- or mid-rise building.

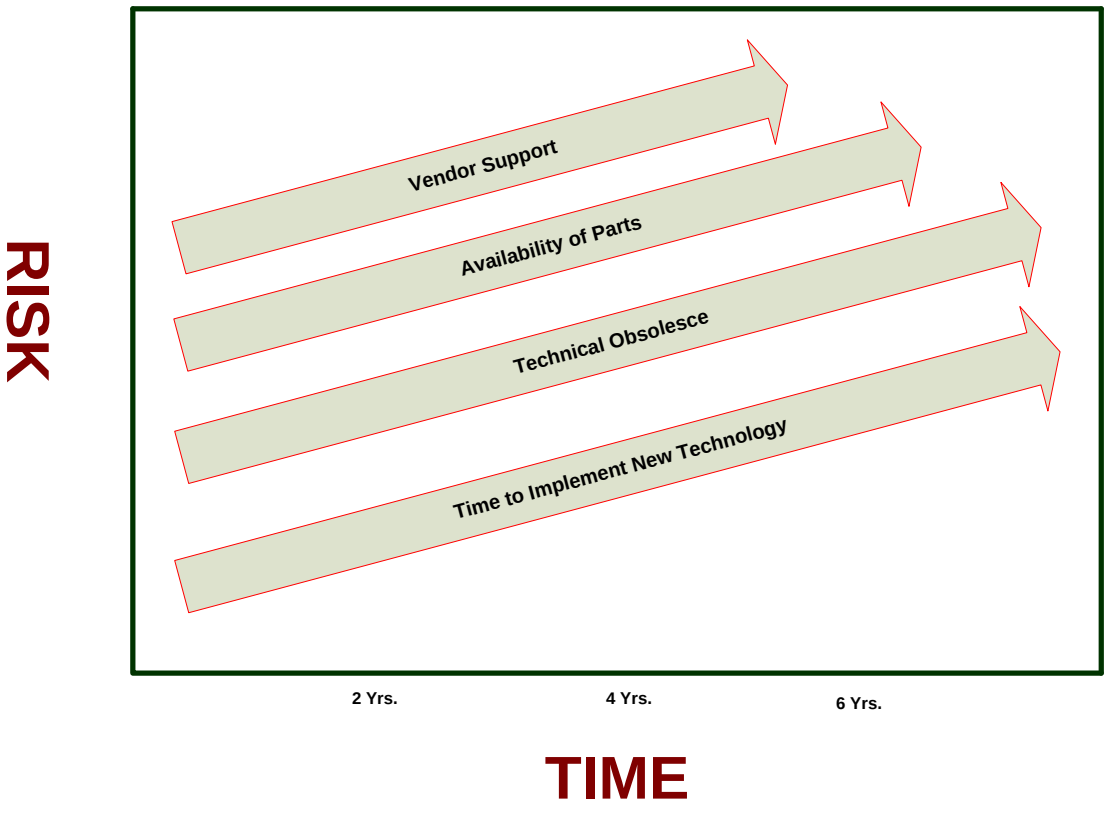
As we move to the Next Generation Network, we can do so in phases or do the work throughout the Region at the same time. We must be sure that as our systems are upgraded/replaced, we maintain and improve Interoperability (the ability to communicate and deliver needed services) among those agencies that are working together.

For the reasons discussed below, the risks that our networks will degrade due to component failure and face increasing repair costs are rising significantly. We will need to build the Next Generation Network to avoid these risks.

The intended benefits of a Next Generation integrated network will be realized, however, only if the equipment advances are accompanied by consistent, on-going, and timely training; there are no benefits from a system with improved services and functionality if the system's users are unable to use those services and functions or are unaware that they exist.

Portions of the King County's network are wearing out. Finished in 1997, parts in the network are increasingly failing and need repair or replacement.

At the same time, the equipment manufacturer for most of the current Radio systems in Pierce, Snohomish, and King Counties has told us it will stop selling and repairing the parts for our systems in the foreseeable future. Absent a new system, we face an increased risk of system failure.



It takes many years to replace this type of network. When we built the King County network, it took five years from the time funding was approved until the network was fully operational. Thus, we need to begin this planning several years in advance.

- *Most of the Region's systems use Motorola v. 4.1 controllers. Motorola has ceased developing new software for v.4.1 controllers. It will stop selling new Dispatch Consoles and the equipment needed to fill in the "holes" in coverage at the end of 2009. They are committed to provide technical support until 2015 and to do repairs as long as parts are available.*

Motorola's move to the next generation of technology does not mean that any system will be required to turn-off it system at any specific date; rather, the ability to expand a system to fill in "holes" or compensate for population growth decrease over time. Also, the availability of spare parts and repairs will lessen over time resulting in an increased risk of system degradation and higher repair costs. Parts will need to be obtained on the secondary market. Newer systems should require fewer repairs than older systems, but all v. 4.1 systems will be impacted to a considerable degree.

The VHF systems in use by Pierce County and many smaller fire districts also face FCC requirements to move to narrowband operations by 2013.This will require

upgrading these systems. This will be an opportunity to improve our Interoperability within the Region by bringing those agencies and users to a common platform.

Interoperability is a nationwide problem. The U.S. Homeland Security Department recently released a National Emergency Communications Plan which sets targets for emergency communications across multiple agencies and communities by 2010,

As the radio systems in the three-county area are upgraded/replaced, in-part or in-whole, it is crucial that as we upgrade/replace our systems, we maintain and improve our Interoperability, the ability to communicate and deliver needed services across the region.

Communications is especially crucial during major disasters and events. Our current systems cannot guarantee that first responders can communicate at these times.

When there is a major disaster or event, many public radio system users reach for their radios or phones. For example, after the Nisqually earthquake, many King County 800 MHz radio users tried unsuccessfully to get on the radio system only to get a busy signal.

The problem was worse with many commercial services. Many responders use commercial cell phone services to provide part of their communication support. After the last earthquake, so many cell phone users tried to use their phones that these systems were even more overwhelmed than the radio systems. This reduced the effectiveness of first responders to coordinate emergency responses.

In addition, many first responders did not have access to wireless data networks that were available and unburdened during the Nisqually quake.

Finally, commercial providers do not provide the coverage and up-time consistently that first responders need to ensure communications are available during normal operating periods as well as major emergencies.

These problems have three sources:

- *Current systems lack the capacity required for peak use times;*
- *When capacity is reached the systems are unable to provide the most important users with adequate priority access*
- *There is no economic or regulatory incentive for commercial wireless providers to improve coverage and availability for first responders.*

Any upgrade/rebuild must address these problems.

Systems should be rebuilt/upgraded so that for the first five years after the rebuild/upgrade systems will meet or exceed the following measurement: during the normal busy hour each day, no more than one percent of calls attempted generate a busy tone and the average busy length will be less than one second. This means that under normal conditions, during the normal busy hour each day there should not be any more than 1% busies and a wait no longer than 1 second to get a permit to talk tone.

Systems should be designed so that they can be further upgraded to meet this measurement throughout the systems' useful lives.

Problems with emergency communications across multiple agencies and communities are not limited to this Region they are a nation-wide problem. The Homeland Security Department recently released a National Emergency Communications Plan which sets targets for emergency communications capability across multiple agencies and communities by 2010.Any network built in the Region should meet or exceed those targets.

Multiband Interconnect

In addition to the existing 800 MHz System upgrades already mentioned as needed, the existing VHF and other interconnected legacy multiband systems need to be upgraded and expanded within the time frame of the NECP.

VHF, UHF, paging, and low band systems are important for parks, major utilities, and similar users. For example, the current VHF interconnect system, called MARS, is a legacy system but no less vital for communications with VHF users, particularly state agencies. We need to have a plan to create a link between these systems and more major systems.

In a new configuration, consideration should be given to adding a suite of VHF I/O channels including DNR common, REDNET, VTAC and OSCCR, and Search and Rescue, all analog.

The VHF systems in use by Pierce County and many smaller fire districts also face FCC requirements to move to narrowband operations by 2013.This will require upgrading these systems. This will be an opportunity to improve our Interoperability within the Region by bringing those agencies and users to a common platform.

We also need to consider Interoperability with non-government systems. Several private businesses have radio systems where interconnection could be highly desirable including private ambulance companies, utilities such as Puget Sound Energy and telephone service providers, and Boeing.

We want our systems to support important services they cannot currently support.

- *Users are asking for new and enhanced services they believe will help them do their job more effectively and safely**.** Examples include the ability to transmit Amber Alert pictures and building plans to the field, and to encrypt sensitive communication to prevent its interception during transport.*

We risk a potential loss of Interoperability if we move to diverse technical platforms as we conduct these upgrades. Conversely, through a coordinated effort we can improve our Interoperability and response to public safety needs.

The existing systems enable users to communicate with other responders on the network when they travel to a new area, often with some difficulty, but do not allow them to also communicate with their home area. Radios are sometimes programmed differently by different jurisdictions although it is possible to program them the same way today; users are uncertain of what channel to use when they travel to a new area. This should be easier with the Next Generation System.

Ideally, the systems would operate as a single network for users wherever they travel in the Region where a signal is available. Users should be able to push-to-talk and easily communicate with anyone else on the system in the three-county area.

In the best of circumstances, users would retain all of their systems' features, such as user identification, emergency (EMR) buttons, busy signals, etc., when talking with responders from other agencies and jurisdictions. However, users must be able to talk with each other quickly and easily even if some of the secondary features are lost,

Initially, planning will be done for Pierce, Snohomish, and King Counties; the REPC and Subcommittees will develop their recommendations so that additional jurisdictions may be added later, if they desire.

Several populated areas in the Region have little or no radio coverage, and the impact of this problem is likely to increase in all three counties in the future as growth patterns change.

- *To work safely and effectively, responders and other users need systems that enable them to communicate in all of the places they do their jobs. This is currently not possible. For example, the oldest system, the King County system, was built to cover the population centers in the County when it was designed in 1994; it was not designed to provide coverage in 100% of the*

County. The increase in high-rise buildings together with the increase and dispersal of population has resulted in an increase in the number of significant "holes" in coverage. Similarly, there are "holes" in the Pierce County systems' coverage. As our populations grow and shift location, we can expect additional holes to develop throughout the Region unless we act.

- *It will become more difficult to fill these holes as the supply of the needed equipment lessens. Our equipment supplier has indicated that it will end selling the current generation or equipment used to add sites (and thus expand coverage) in 2009.*
- *Population growth will also drive the need for additional responders and dispatchers. Again, our equipment supplier has told us that it will stop selling dispatcher Consoles for use with v. 4.1 systems by the end of 2009.*

In accordance with the U.S. Government's National Emergency Communications Policy our network should insure "that emergency responders can communicate:

- *As needed, on demand, and as authorized*
- *At all levels of government*
- *Across all disciplines*

There are places in the Region today were radio users lose coverage when they enter high-rise buildings or basements to pursue a suspect, fight a fire, or aid a patient; today's system was not designed to provide such coverage.

- *This makes it difficult for users inside these areas to coordinate activities or call for assistance, and for incident commanders outside these areas and responders inside these areas to communicate.*

Features and functions could be added to upgraded/rebuilt systems enabling users to do their work more effectively and safely.

- *The Enhanced 911 Program is exploring the possibility of collecting Amber Alert and suspect photographs, building plans, Computer Aided Dispatch (CAD), Records Management System (RMS) information, maps, and other information and then distributing it to officers in the field over this network.*
- Police units need to be able to send and receive information such as police reports, citation information, fingerprints, warrants, mug shots, photographs of missing persons and even streaming video. Tactical situations require the ability to access mapping information and government records and to be able to communicate with other entities in multi-jurisdictional incidents.

- Fire units need to be able to send and receive maps, hazardous material documentation, information on weather conditions to predict chemical plumes, and building and utility plans.

- Emergency Medical vehicles need to be able to send and receive patient records, and have real time access to relevant data bases.

- *Benefits may also result from connecting other systems and/or agencies together. Automatic vehicle location systems and paging would enable the better deployment of personnel and equipment. The Encryption of operational communications would decrease the likelihood that those communications would be intercepted by perpetrators and others.*

Many of these features and functions can be deployed only on upgraded/rebuilt systems with data capabilities. Wireless data services provided through a commercial wireless card often do not provide the needed security and dependability public safety requires.

Wireless data systems dedicated for public safety use are in place around the country. Snohomish County is currently involved in pilot testing (proof of concept) such a system. This technology is needed throughout Pierce, King, and Snohomish Counties.

System upgrades/rebuilds may result in efficiencies.

- A coordinated and cooperatively designed system will increase our ability to quickly and efficiently respond to citizen's needs during any natural or manmade events in our three-county Region.

- There are at least five radio systems in the Region. Operational efficiencies may result from doing the upgrades/rebuilds in a certain way and from the consolidation of certain tasks. It may be possible to reduce the number of system Switches in a regional system, for example.

Quantity discounts might also be available if we purchase equipment or services as a Region rather than as individual systems.

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Appendix C

Notes from Option 1 Workshop on August 29, 2011

Option 1 General Description – Keep existing Land Mobile Radio (LMR) systems in place.

General information and assumptions used to allow characterization and comparison of this Option to Options 2, 3 and 4:

- The SERS, King County, Port of Seattle, and Tacoma radio systems all use Motorola SmartZone 4.1 technology. A major driver for how long we can keep these systems in place without upgrading or replacing them is Motorola's decision to stop providing new parts, repairs, software fixes, and support desk services for these systems. Motorola will not do this all at once; rather, it will take these actions over a period of years.
- While the general strategy would be to sustain these systems substantially in their current configurations, this Option does not imply an absolute 'do nothing' posture. If issues of component support, component availability or system functionality impairment arose during this extended life period they would be dealt with as needed with the tools and techniques available at the time.
- The group will identify where significant risk elements exist over the next several years so they can help inform consideration of when movement to Options 2, 3 or 4 must be undertaken.
- At some point the risk elements may compound such that movement to Options 2, 3, or 4 are needed just to sustain the current levels of functionality.
- These risk-driven inflection points will likely be different for each system as each system owner (along with their respective user communities) will need to establish their own tolerance for risk balanced against their own service capabilities.
- It is also recognized that each of the existing system operations group will face their own unique set of operational and governance drivers that will factor into their short-term and long-term decisions.
- VHF/UHF systems should be evaluated to determine the level of narrowband compliant Infrastructure and user equipment that exist in the systems. For several years, all radio equipment manufactured has been narrowband

capable. VHF/UHF conventional equipment is not facing end of life issues as long as it is narrowband capable.

- The need to replace system Infrastructure is driven by supportability and capability issues related to system Infrastructure (Switch equipment, Radio Sites, and Dispatch Consoles).A significant portion of the current Subscriber Radio inventory could remain operational for several years (with the caveat that it meets both rebanding and Narrowbanding requirements).If individual user agencies are allowed to significantly extend the life of their Subscriber equipment, it will have a significant impact on transition timing and duration.

Option Evaluation Criteria – The following criteria were established to evaluate and compare the characteristics of each of the Options under consideration.

Coverage – Local and regional general coverage goals have been established and Sparling has submitted coverage area mapping showing current coverage and coverage based on the general parameters established. Each Option will be characterized in terms of how the Option would meet the coverage goals.

- For systems remaining in VHF or UHF Spectrum, Narrowbanding may require that they add sites to maintain coverage comparable to existing coverage.
- The current SmartZone 4.1 systems (King County, SERS, Port of Seattle, and Tacoma/Puyallup) can only expand their coverage with 800 MHz channels which are limited in availability (see notes in Spectrum).
- Coverage needs improvement in some areas in some of the SmartZone systems, but accomplishing this is constrained by more than just Spectrum limitations. Motorola is only able to support expansions of existing technologies for limited timeframes, and timelines for replacement technologies do not align perfectly. For example:
    - The last ship date for Digitac comparators is in 2011 so no further channels could be added to simulcast systems after this.
    - The last ship date for MTC 3600 controllers is in 2013 so even if comparators were available no additional sites could be added after this.
    - The last ship date for Quantar repeaters for use in IR sites is 2011 (they no longer ship Quantars for simulcast use), but the replacement GTR repeaters for use in SmartZone systems (3600 bps control channel) are not available until Q3 2013.
    - The last ship date for SmartX site interface units is in 2013.

- The practical reality of the various Motorola end-of-life announcements is that for the current SmartZone systems, Motorola supported expansion of simulcast subsystems can't be done after 2011 and IR sites can't be added after 2013 (since even though GTR repeaters would then be available the required SmartX units would not).

- There is some potential for acquiring after-market equipment that is coming out of service from other systems, but this strategy only has limited benefit since everything would be implemented without Motorola support and changes to system "codeplugs" would still be needed (with Motorola as the only source for those changes). Even if after market equipment can be obtained, it may not be of the proper version or have the proper firmware/software making it non-compatible, and thus unusable.

Spectrum – The potential opportunities and risks related to Spectrum utilization and availability will be characterized for each Option.

- Some capacity constraints are starting to become an issue in portions of the King County system. If system utilization increases between now and when replacement system(s) are in place this could have adverse impacts on user performance such as an increased number of busy signals for those trying to use a system.

- Expanding the capacity of the current 800 MHz systems requires use of additional 800 MHz Spectrum, and the current systems in the Region have effectively consumed all of the available public safety 800 MHz channels.

- The use of IR sites to expand coverage should be discouraged because of their negative impact on other system. These include negative impacts on Roaming between systems and on the reliability features such as site trunking, and because IR sites make inefficient use of Spectrum in an area where Spectrum is in short supply. (The use of IRs is appropriate in limited areas such as very remote sites or tunnels.)

- Therefore, to expand capacity in one portion of one of these systems it will likely be necessary to "find" Spectrum from some other portion of one of these systems. For example, if an existing IR site is converted to being a part of a simulcast system, the channels in the IR site would become available to expand capacity in some other portion of a system. However, this approach will not have universal success since the co-channel and adjacent-channel interference protection characteristics of the reuse of a channel in a simulcast subsystem may not be the same as the IR site.

- Further, even if channels could be identified for re-management in this fashion, the constraints of Motorola support for SmartZone expansions would be a limiting factor as discussed in other elements.

- VHF/UHF users have limited or no additional public safety frequencies available to meet the needs of first responders.

Mobility and Interoperability – A limited number of Talkgroups (both unencrypted and encrypted) from each of the current system operating areas will need to have the ability to move throughout the 3-county Region without the user having to make any changes to their radio or Talkgroup selection. Each Option will be characterized for how it would meet this need, including any constraints or enhanced capability it may have in meeting this need.

- In this Option, there would be no change in Mobility and Interoperability from what exists "today." For purposes of comparison, the PSC has agreed that "today" will be defined as including the combined capabilities of both the current Tri-county Regional Interoperability System (TRIS) and the P25 ISSI capability they will have once the three P25 Switches are installed (King County, SERS, and City of Tacoma) and ISSI interfaces are established.

- It is noted however that since TRIS is based on Gold Elite Console technology, being able to sustain this capability may be at some risk due to the 2013 end date for Motorola support of Gold Elite Console systems on SmartZone systems. Sustaining TRIS may require replacement with MCC7500 Consoles, similar to the MCC7500 Console system replacement being anticipated by the City of Seattle.

- Interoperability between VHF and 800 MHz users is achieved by hard Patches through dispatch centers. A Patch between LERN and an 800 MHz Talkgroup provides a common Interoperability capability.

- Another VHF to 800 MHz Patch is in place in Pierce County which allows Lakewood, DuPont, and Steilacoom to access LESA Records (a VHF channel) to access criminal justice information.

Reliability – End users of the systems need reliable service both within their normal operating areas and when operating outside their normal areas based on prescribed Mobility and Interoperability parameters. To accomplish this, at least the central system controller function and the simulcast subsystem controller function need to be implemented in a redundant manner, and preferably in a non-collocated fashion. Each Option will be characterized for how it would meet this design goal together with any associated operational or other considerations.

- Relative to the specific issue of central controller and simulcast controller redundancies, this Option would provide no change from the current architecture, so relative to these two specific points-of-failure there would be no increase or decrease in reliability in this Option.

- As Motorola phases out support for existing system technologies, the overall reliability of the regional SmartZone systems will begin to erode. Replacement parts/components may be available from after-market sources, but Motorola support of use of these may be limited or non-existent.

- As the systems age, recovering from service-affecting issues will become increasingly complex and expensive, and this trend has already been seen in the existing systems. The increasing costs are most noticeable in the increased level of human resources (both system owner staff and Motorola staff) required to both diagnose problems and then find and implement appropriate resolutions.

- Collecting a supply of spares does not guarantee a satisfactory response. Having a supply of new parts can be very expensive especially if a system wants to have a broad supply of spares. Having a supply of used parts can also be problematic since there is no way to know how much and how well they were previously treated. And unless a system has every part there is no guarantee that there will be a spare for any part that breaks.

- The ability of each of the system owners to react to these situations varies since each have adopted different approaches for their system support strategy. While all systems currently utilize Motorola for some level of system-level support, some follow a customer-owned-and-maintained (COAM) approach while others fully rely on Motorola for routine system maintenance and operations. This latter group will be at increased risk as Motorola's willingness to provide contracted maintenance and support for system components that are no longer supported.

- The timelines for the Gold Elite Console technology impact all the Trunked systems that have moved to P25 Switches (King County, SERS and Tacoma) and the TRIS Interoperability solution:

    - Q4 2013 is the last scheduled release of the P25 Switch software that will be compatible with Gold Elite Console systems (and the MGEG interface). If Gold Elite Console systems remain in the system past this date, the system owner will need to choose between freezing their system at this release level and replacing the Consoles with MCC7500 systems.

- For 2014 and beyond, there is increasing risk that Gold Elite Consoles may not provide a stable Console environment. This will initially be due to compatibility issues with 3rd party software elements and ultimately be due to the lack of compatible parts. Further, it is anticipated that support for Windows XP may end in 2014.
- Motorola's characterization of this risk is as follows:
  - 1-2 years – limited risk or "green"
  - 3-5 years – moderate risk or "yellow"
  - 6+ years – high risk or "red"

Implementation and Transition – Each Option will be characterized in terms of the process for moving from the current as-is state to the future to-be state within three general frameworks:

- During the entire implementation and transition time period, end users must maintain the ability to maintain voice communications across both normal operational Talkgroups and designated Interoperability Talkgroups. However, it will be acceptable for some other trunking features to be limited during transition. Each Option will be characterized for how it would provide continuing end user communications capability and a general overview of the features or functionality that would be limited during transition.
- The actual timeframe for the transitions of individual systems and for the transitions of individual end-user agencies need to be of limited and predictable durations to minimize impacts on both system owner/operators and on end-user agencies.
- Each Option will be characterized to describe the degree to which it allows the current system Infrastructure and end-user device inventories to be meet their currently planned life expectancy, and for how each system could plan their own migration timeframe versus having to be on a schedule determined by others.

- Since this Option leaves the existing systems in place, there would be no implementation or transition period where user functionality would be impacted. However, due to the ultimate end of Motorola support for SmartZone systems, Option 1 is only an alternative for a limited period of time before movement to either Option 2, 3 or 4 would be needed.

- Existing SmartZone system owners/sub-regions identified timelines for how long they feel they could sustain their current systems:
    - EPSCA (part of the King County regional system)
        - EPSCA is fully supported by Motorola so their timelines are predicated on their ability to negotiate continuing support agreements with Motorola. Their current support agreement runs through 2015.
        - If Motorola would not renew this agreement for the existing system architecture EPSCA would either need to migrate to a supported architecture or consider alternative support strategies.
        - EPSCA has no current plans to replace their Gold Elite Console systems on a separate timeline from the SmartZone system Infrastructure.
        - End user agencies do not plan to add P25 capability to Subscriber Radios as part of rebanding. Subscriber radios would need to be upgraded (if capable) or replaced with P25 phase 2 radios to work on a future P25 radio system.
    - Seattle (part of the King County regional system)
        - Seattle plans to replace Gold Elite Consoles with MCC7500 in the 2011/2012 timeframe, so Gold Elite supportability will not be a driving factor for them in considering a timeframe for SmartZone replacement.
        - Seattle is implementing P25 Phase 1 capable Subscriber Radios as part of rebanding, so they will be able to run on SmartZone as long as needed and then make a transition to P25 Phase 1 when needed without having to replace many radios. These radios should work with any option 2 or option 3 solution, but not an option 4 solution.
    - King County (part of the King County regional system)
        - Plan on continuing their COAM approach with Motorola system-level support.
        - No current plans to replace their Gold Elite Console system.
        - End user agencies do not plan to add P25 capability to Subscriber Radios as part of rebanding. Subscriber radios would need to be

upgraded (if capable) or replaced with P25 phase 2 radios to work on a future P25 radio system.

- Valley Communications Center (part of the King County regional system)
  - Plan on continuing their COAM approach (with King County providing the services) with Motorola system-level support.
  - No current plans to replace their Gold Elite Console system, but may consider that as part of the 2013 renewal of Motorola support.
  - End user agencies do not plan to add P25 capability to Subscriber Radios as part of rebanding. Subscriber radios would need to be upgraded (if capable) or replaced with P25 phase 2 radios to work on a future P25 radio system.
- SERS
  - Overall goal is to keep the current system running until 2020, but they recognize that work on a replacement system will need to begin sometime before that time so it is ready in time.
  - Plan on continuing their COAM approach with Motorola system-level support. Would consider stockpiling some components to sustain system operation through 2020 if they became unavailable from Motorola.
  - Would consider a strategy to replace Gold Elite Consoles sooner than 2020 if supporting Gold Elite became too problematic and if replacing the Console system helps them stretch the life of the SmartZone Infrastructure to 2020.
- Port of Seattle
  - Capital budget proposal is being developed for Fiscal Year 2012 for a replacement of their SmartZone controller with a P25 Switch and to replace Gold Elite Consoles with MCC7500. The simulcast RF Infrastructure would remain analog and operate over a SmartX interface.
  - Most of their public safety radios are P25 Phase 1 capable.
  - Plan on continuing their COAM approach with Motorola system-level support. Their current agreement runs through 2013.

- Tacoma
  - Have been planning on 2014/15 as the time frame for needing to migrate off of SmartZone.
  - View P25 Phase 1 as only a brief transition step to P25 Phase 2. Phase 1 doesn't provide any additional capacity over the current analog system. Also, if 700 MHz channels are used in any part of the system, they need to operate at Phase 2 by 2017.
  - As current radios have reached replacement cycles they are being replaced with P25 Phase 2 capable radios.
  - Considering the replacement of Gold Elite Console system with MCC7500 in the 2013 timeframe.
- Pierce County
  - Working on a plan with Motorola and Pierce Transit to implement a P25 trunking system as a primary communications platform for agencies currently operating on conventional systems. This plan could also include a VHF layer for Interoperability.
  - Also working to complete Narrowbanding of current VHF and UHF systems by the 2012 deadline.
  - Formed South Sound 911 Committee through Interlocal agreements to develop a single countywide P25 Phase 2 700/800 MHz Trunked radio system.
- Washington State Patrol
  - Developing bidding documents to allow them to proceed with a system replacement with a P25 conventional system (P25 Switch, Consoles, base stations, comparators, etc.) on currently licensed VHF channels. They plan on completing this implementation by the 2012 Narrowbanding deadline and not Narrowbanding any of their analog system.
  - Depending on the vendor selected, they will evaluate the potential to also use local systems (P25 or SmartZone) for either primary communications or local Interoperability.

Scalability – Each Option will be characterized for its ability to allow the complete management of capacities including sites, channels, Consoles, and end-user devices over a planning horizon extending to 2030.

- The current SmartZone systems are already limited in their ability to meet changing needs in sites, channels and Consoles (see notes in other sections above). They have no ability to meet the scalability needs of the Region to the 2030 planning horizon.

Local Service Delivery and Control – Maintaining the ability for the existing system owner/operator organizations to leverage their current customer relationships and manage the service delivery process with their end users needs to be the prevailing philosophy. Each Option will be characterized for how this could be accomplished.

- This Option keeps the current service delivery and control mechanisms in place. There would be no change from current practices.

Encryption Key Management –Each Option will be characterized to describe how local key management could be accommodated and describe potential system-level key management capabilities that may be available if desired. Even if region-level key management capabilities are utilized, the need for local jurisdictions to manage their own keys will remain.

- This Option keeps the current Encryption key management mechanisms in place, which are locally controlled and manually applied.

Over-the-Air-Programming (OTAP) and End-User Template Management – Each Option will be characterized for how it could support an OTAP capability and any centralized ability to manage end-user templates.

- This Option keeps the current mechanisms in place for template management and programming, which are locally controlled and manually applied.

GPS Enabled End User Devices – Each Option will be characterized to describe how it could support GPS enabled end user devices and how that GPS data could be made available for other uses.

- The current SmartZone systems have no ability to support GPS-enabled end user devices.

Broadband-Enabled End User Devices - Each Option will be characterized to describe how it could support Broadband-enabled end user devices in order to enhance situational awareness.

- Broadband capable end user devices would not be available in this option.

Other comments about Option 1 and the session notes above that were offered later (after the workshop on August 29):

It is important to note that in "doing nothing":

- Interoperability remains limited to Patches, Gateways and multi-band radios.
- Existing systems lack features such as OTAR, OTAP, text messaging, etc.

Two sub-options have been confused and combined. One is to "do nothing"; the other is to "extend the life of the current systems." These should be evaluated separately.

The main thrust of the analysis in this option should be to determine the extent, results, and timing of the risks. This information must be made very explicit.

It is essential that the significance of facts be explained. If something is a problem, what does that mean in practical terms? It is essential that the report do more than note problems. It must clarify whether the problem can be fixed and what it would take to fix it. For example, would fixing it take a lot of money or time or is it quick and easy to do? If it would take several years to fix, what would happen in the interim?

There needs to be clarification of what is the same and what is different for different systems. If Motorola stops selling or repairing a specific part for one system, they are stopping selling or repairing that part for all systems. This document seems to suggest there are different obsolescence horizons for the various SZ 4.1 systems in the area. In terms of how vendor support is available, or not, the dates are the same for all systems, but are indicated differently in this document.

Similarly, the report needs to indicate whether problems are technical, operational, political, or something else. E.g., is the problem that we have too little Spectrum or that IRs use Spectrum inefficiently?

The following points need to be clearly made:

- There are four Motorola SZ v. 4.1 systems in the Region. Over a period of years, Motorola is withdrawing support for that technology. (Define support). As a result, the risk of system degradation for all these systems increases over time.
- Here is a list of points where there is a significant increase in risk because of Motorola's withdrawal of support.

- Each system has its own risk profile resulting from a combination of system characteristics and Motorola action. System characteristics include the age of the system, how well it has been maintained, staff capabilities, and the spare parts the system has in reserve.
- It is possible that there may be instances when there is no cost efficient solution for a parts failure other than upgrading the part or system?
- Each jurisdiction must decide how much risk it wants to tolerate at any point in time.
- Jurisdictions wanting to avoid the likely risk at a future date must begin acting several years before that date. Implementing even the most simple change option, option 2, will take several years.

There needs to be a clear discussion of what would happen if some jurisdictions do nothing but retain their SZ v. 4.1 systems while others move to P25. (e.g. are there operational impacts related to programming or Interoperability?)

Somewhere in the document we will need a more general discussion of Spectrum and the expansion of coverage. This section would then include a discussion of whether and how we could expand coverage (adding site, reconfiguring one or more systems, etc.) keeping our basic systems in tact? Is there enough of the right kind of Spectrum? Is the necessary kind of equipment available? Etc.

The workshops and report should include the Pierce County and WSP systems, when appropriate.

Appendix D

Notes from Option 2 Workshop on August 2, 2011

Option 2 General Description – Upgrade existing systems to Project 25 Phase 2 capability

- Sub-Option 2A – Continue the current architecture with multiple systems remaining independent of each other.
    - Each system moves to Phase 2 individually and in timeframes established by their governance and business models, **but** this is done within a mutually accepted regional timeline so that each of the system owner/operators knows when to expect their neighbors to migrate.
    - Each system makes the coverage or capacity changes they need at the time they do the migration.
    - Each systems remains in their current governance and business/operations models.
    - Interoperability between the systems is accomplished through TRIS and ISSI links with possible migration to ISSI only once all systems are capable.
        -
- Sub-Option 2B – A single, regional system architecture is established with all three counties being served by this single system.
    - The full 3-county area would operate as a single system from a Switch technology standpoint with redundant system Switches.
    - Each county area and the Port of Seattle would make their own decisions about the density of coverage and the level of capacity they would support within their service areas.
    - Minimum system-wide coverage and capacity standards would be developed to provide acceptable levels of regional Mobility and Interoperability.

Option Evaluation Criteria – The following criteria were established to evaluate and compare the characteristics of each of the Options under consideration.

Coverage – Local and regional general coverage goals have been established and Sparling has submitted coverage area mapping based on the general parameters established. Each Option will be characterized in terms of how the Option would meet the coverage goals.

General observation on both Sub-Options – Either can meet the coverage goals established by the REPC.

Sub-Option 2A:

- Each individual system would continue the current practice of establishing some coverage outside their jurisdictional boundaries to meet their day-to-day user needs. This will continue the need for some duplication of coverage across the systems.
- Each individual system would continue the current practice of establishing their own system architecture and establish RF site selections and groupings to match their user agency usage patterns.

Sub-Option 2B:

- As a single system, the only overlapping coverage that would be intentionally designed into the system would be for reliability reasons.
- User agency usage patterns would be accommodated through both site groupings and Talkgroup access management processes.
- Likely to result in the lower total site count than 2A.

Spectrum – The potential opportunities and risks related to Spectrum utilization and availability will be characterized for each Option.

General observations on both Sub-Options:

- Both will require the use of more channels during migration than they will in their end states.
- Regardless of the Sub-Option selected, it is believed that there will be enough Spectrum available in the Puget Sound area to meet both the migration channel needs and the end-state channel needs, but this will require re-management of existing 800 MHz channels (both within current licensees and between licensees), use of Region 43 700 MHz narrowband channels, and temporary or permanent use of State 700 MHz narrowband channels.

- If one or more of the P25 features such as Over-the-Air Encryption Rekeying (OTAR), Over-the-Air Radio Programming (OTAP) or GPS enabled handsets are used, additional channels will be required to support both the required voice communications capacities and Motorola's Integrated Voice and Data (IV&D) technology that is required as a transport mechanisms for these features.

Sub-Option 2A:

- Would require the most amount of Spectrum since each system retains the need to meet both its own coverage and capacity needs and the capacity needed to allow inter-system Mobility and Interoperability.

Sub-Option 2B:

- Would likely require less aggregate Spectrum than 2A.

Mobility and Interoperability – A limited number of Talkgroups (both unencrypted and encrypted) from each of the current system operating areas will need to have the ability to move throughout the 3-county Region without the user having to make any changes to their radio or Talkgroup selection. Each Option will be characterized for how it would meet this need, including any constraints or enhanced capability it may have in meeting this need.

General observations on both Sub-Options:

- These criteria could be met with either alternative.
- During transition, some users will only have access to current Interoperability capabilities while others will have access to enhanced features. This could create some challenges in large multi-jurisdictional and multi-disciplinary incidents to make sure that appropriate capabilities are utilized.
- The longer the transition timeframe to whichever end-state architecture is chosen, the longer the challenge of differential capacities will be an issue.

Sub-Option 2A:

- The total combined Mobility and Interoperability in this architecture would essentially be equivalent to what will be in place once the three P25 Switches are completed in King, Snohomish, and Tacoma.

Sub-Option 2B:

- A single network configuration would provide the most flexibility and ease of adaptation for both Mobility and Interoperability needs.
- This configuration would likely allow a larger number of Talkgroups with regional Mobility to be identified and potentially make it easier to add/change/delete regional Interoperability Talkgroups.

Reliability – End users of the systems need reliable service both within their normal operating areas and when operating outside their normal areas based on prescribed Mobility and Interoperability parameters. To accomplish this, at least the central system controller function and the simulcast subsystem controller function need to be implemented in a redundant manner, and preferably in a non-collocated fashion[23]. Each Option will be characterized for how it would meet this design goal together with any associated operational or other considerations.

General observation on both Sub-Options – Any of the sub-options can meet the reliability goals established by the REPC. Design architectures with larger numbers of system Switches or larger numbers of simulcast site groups will cost proportionally more than design architectures with fewer system Switches or simulcast groups.

Sub-Option 2A:

- Each of the systems could be implemented with their own redundant Switch architectures.
- [Side Note] It could be possible for the architecture in 2A to be modified to enable a shared-Switch redundancy relationship. If this were done there would be fewer Switches throughout the Region **But**, this architecture would require that all systems remain at consistent version levels and remove much of the independent planning and execution flexibility generally framed into the Option 2A alternative. This architecture would require significant increases in regional Backhaul infrastructure to ensure proper levels of redundant interconnectivity between sites, simulcast site groupings, and the redundant Switch mesh.

Sub-Option 2B:

[23] The group identified the shared system core redundancy architecture and the redundant simulcast controller approach as ones they wanted to request further information from Motorola so they had a clear understanding of the functionality and constraints of these architectures.

- In a single regional system architecture a single pair of system Switches would be implemented to serve the entire region.
- This architecture would require a number of additional Backhaul infrastructure improvements to provide redundant connectivity to these Switches and the sites and communications centers arrayed across the three county area.

Implementation and Transition – Each Option will be characterized in terms of the process for moving from the current as-is state to the future to-be state within three general frameworks:

General observations on migration strategies from each of the participants:

- Both Option 2 alternatives are primarily influenced by Motorola's support timeline for SmartZone 4.1
- Converting their systems to P25 Switches has allowed the King, Snohomish and Tacoma systems to buy some additional time for their existing RF and Console Infrastructures.
- The Port of Seattle does not have this added SmartZone support time unless they also migrate to a P25 Switch or transition their RF and Console systems to operate off of one of the three P25 Switches already installed in the Region Absent a regional strategy that gets moving soon, they will either need to install their own P25 Switch and complete a migration by 2015. From a Port-only perspective this could be a Phase 2 system from the start, but they would also need to implement dual Phase 1 and Phase 2 capability to accommodate Interoperability with regional radios that were still not Phase 2 capable.
- The City of Tacoma has examined a number of different migration strategies they may face (including a direct migration from SmartZone 4.1 to P25 Phase 2 and a staged migration from SmartZone 4.1 to P25 Phase 1 and then to Phase 2), depending on whether they are looking at this as a migration strategy establishing a countywide system in Pierce County or in the broader context of establishing a Pierce County system in conjunctions with a regional REPC strategy. Regardless of the approach, they feel they need to be substantially into the next-generation architecture (whatever it ends up being) by ~2015.
- The City of Seattle has examined their Infrastructure and subscriber base, and their interactions with other King County system partners,

and believes an initial migration to P25 Phase 1 makes the best sense for them. They too see this as something that would need to be complete by ~2015, and then they would complete a migration to Phase 2 by ~2018 once all their Subscriber equipment was capable of Phase 2 operation.

- EPSCA believes Seattle's two-step approach would likely work best for them as well. They note that implementing a migration from SmartZone 4.1 to Project 25 (regardless of Phase 1 or Phase 2) will largely be driven by the funding identified for Subscriber Radio replacement. Since all the Subscriber Radios are owned by the individual agencies using the system, mechanisms will need to be found to fund the replacements of their radios on timelines consistent with the needs of Infrastructure progression.

- King County does not yet have a strong sense of the most appropriate migration model. While they do have direct influence on the migration strategy for about 50% of the user radios in their customer base, the other 50% are in the hands of individual agencies just like EPSCA and Valley Com.

- SERS has a similar situation to EPSCA, ValleyCom, and King County in that the Subscriber Radios are owned by the individual user agencies on the system. Further, they have a Switch Infrastructure that still has several years of financing to satisfy (thru 2020), and this will influence how aggressively they will be able to seek additional funding for a migration off of a system that is perceived as not yet paid for.

- The Port of Seattle has control over most all of their user radios and most are already P25 Phase 1 capable.

- All of the system owner/operators face even tougher challenges with the radios in use in general government functions, which typically are lower tier radios and not on a path to P25 capability. Mechanisms will be needed to get these radios replaced with system-compatible radios in consistent timeframes with public safety radios to prevent the collective system capabilities being adversely constrained by low-tier/low-functioning radios in these functions.

- All of the system owner/operators will face a need to expand or modify some of their currents sites and facilities to accommodate simultaneous operation of both legacy and new system equipment, or the need to construct new facilities to provide the coverage or capacity needs of the next-generation system design.

- During the entire implementation and transition time period, end users must maintain the ability to maintain voice communications across both normal operational Talkgroups and designated Interoperability Talkgroups. However, it will be acceptable for some other trunking features to be limited during transition. Each Option will be characterized for how it would provide continuing end user communications capability and a general overview of the features or functionality that would be limited during transition.

  Sub-Option 2A:

  - The current Mobility and Interoperability capabilities that are in place that migration to the new architecture would likely all remain operational during the entire transition timeframe. This could include both the existing TRIS capabilities and the capabilities that will be in place once all three P25 Switches are connected by ISSI. Interoperability with the Port of Seattle would continue through TRIS and cross-system Subscriber programming.

  - As each system moves through their independent migration process, they will be establishing additional Mobility and Interoperability capabilities specific to the interaction between P25 systems. This will create a period of time (potentially several years) where there will be differences in capabilities across systems that will require careful management and user training to make sure the appropriate capabilities are used in various operational settings.

  - By maintaining the existing systems' legacy analog SmartZone 4.1 Infrastructure (but at reduced channel capacities) for some period of transition time, and if each system also implemented dual-mode Phase 1 and Phase 2 capability, each system could support a variety of Subscriber migration timelines for their customers as they work towards all Phase 2 capable equipment.

  - Following this strategy would consume the maximum amount of Spectrum of all options, since appropriate system capacities would be needed for three concurrent technologies. End-state Spectrum needs would be significantly lower after migration to Phase 2 operations is complete.

  Sub-Option 2B:

  - Migration to this strategy would likely require an initial process of getting all current systems and users migrated to the new system ID,

which would most likely be one of the IDs already established within the three P25 Switches already installed.

- Once this step is accomplished, managing user capabilities and providing orderly transitions from existing capabilities to new capabilities, would likely be easier to manage since operability and Interoperability would all be "in-system" already rather than "cross-system."

- The actual timeframe for the transitions of individual systems and for the transitions of individual end-user agencies need to be of limited and predictable durations to minimize impacts on both system owner/operators and on end-user agencies.

  - See notes above in ***General observations on migration strategies from each of the participants***

  - Depending on the choices made by the Port of Seattle and how the Tacoma/Pierce County countywide system effort turns out, regional migration processes may begin as early as 2013 and stretch through 2020.

- Each Option will be characterized to describe the degree to which it allows the current system Infrastructure and end-user device inventories to be meet their currently planned life expectancy, and for how each system could plan their own migration timeframe versus having to be on a schedule determined by others.

  Sub-Option 2A:

  - This approach allows each individual system owner/operator to establish its own timelines with the lowest level of inter-system consistency being required.

  - System-to-system links (TRIS or ISSI) would likely be able to preserve all current inter-system user capabilities.

  Sub-Option 2B:

  - While this architecture could likely allow comparable migration flexibility as achieved in 2A, future flexibility would be constrained since the entire system Infrastructure would need to be sustained and consistent version levels.

Scalability – Each Option will be characterized for its ability to allow the complete management of capacities including sites, channels, Consoles, and end-user devices over a planning horizon extending to 2030.

General observations on both Sub-Options:

- Both Sub-Options could provide the required levels of control over system topology and capacities.
- Constraints on the number of sites in a single simulcast group, or the number of talk paths in a single site (whether a multicast site or a simulcast group of sites) will have significant impact on the overall topology and the relationships between simulcast coverage patterns and user operational profiles[24].

Local Service Delivery and Control – Maintaining the ability for the existing system owner/operator organizations to leverage their current customer relationships and manage the service delivery process with their end users needs to be the prevailing philosophy. Each Option will be characterized for how this could be accomplished.

General observations on both Sub-Options:

- There does not appear to be any inherent characteristic of either Sub-Option that would prevent a continuation of the current relationships established between the current system owner/operators and their user agencies/customers.

Sub-Option 2A:

- This sub-option will require close coordination of the timing and timeframes for both initial migrations and ongoing upgrades. This coordination will need to be much tighter than it is today, even with activities such as TRIS and ISSI coordination.
- Establishing shared pools of Infrastructure spares may be possible, but it would require careful coordination due to potential version level differences between the systems over time.

Sub-Option 2B:

[24] This is another area where the group wants to request further information from Motorola so they have a clear understanding of the configuration constraints they will face.

- As a single unified regional system, the current system owner/operators would no longer have individual control over system-wide issues such as upgrade timing.
- Regional governance model would need to establish effective mechanisms to reach consensus on design changes and upgrades, while also having mechanisms to prevent minorities of participants holding up broadly needed upgrades or feature enhancements.
- Upgrades and enhancements that may be needed by some may not be needed by others, and balancing this will be a crucial element of a successful governance model.
- As a single unified regional system, a regional pool of spare parts and equipment becomes a viable strategy.
- A system-level operations and maintenance process will need to be established for the system Switches, but regional models could be considered for elements like sites, RF Infrastructure, Backhaul networks, and Subscriber Radios. A full region-wide O&M model could also be considered.

Encryption Key Management –Each Option will be characterized to describe how local key management could be accommodated and describe potential system-level key management capabilities that may be available if desired. Even if region-level key management capabilities are utilized, the need for local jurisdictions to manage their own keys will remain.

Sub-Option 2A:

- As separate systems, it appears that the current ability to allow certain users to manage their own Encryption keys through manual key loaders would still be possible.
- As separate systems it appears that each system could make their own decision on whether to implement OTAR. As a system level feature, the Infrastructure to support the feature needs to be in place even if only a single user agency needs the feature.
- It is not clear if implementation of OTAR capability would eliminate the ability to also utilize manual key loaders. It is also not clear that if OTAR is implemented there would be some system-level equivalent for

individual agency control of identifying where their key could be installed[25].

- If the systems were joined together for Switch redundancy functionality, it is not clear if OTAR capability would then be extended across the separate systems (assuming the Infrastructure was in place to support it.

Sub-Option 2B:

- As a single unified regional system, it appears that OTAR key management capabilities would extend across the entire network uniformly.
- As a system level feature, the Infrastructure to support the feature needs to be in place even if only a single user agency needs the feature.
- It is not clear if implementation of OTAR capability would eliminate the ability to also utilize manual key loaders. It is also not clear that if OTAR is implemented there would be some system-level equivalent for individual agency control of identifying where their key could be installed.

Over-the-Air-Programming (OTAP) and End-User Template Management – Each Option will be characterized for how it could support an OTAP capability and any centralized ability to manage end-user templates.

Sub-Option 2A:

- As separate systems it appears that each system could make their own decision on whether to implement OTAP. As a system level feature, the Infrastructure to support the feature needs to be in place even if only a single user agency needs the feature.
- If separate systems are joined together for Switch redundancy capability, it is not clear if OTAP capability will also transcend system boundaries (assuming the Infrastructure was in place to support it)[26].

Sub-Option 2B:

[25] OTAR capability is another area where the group wants to request further information from Motorola so they have a clear understanding of the configuration constraints they will face.

[26] OTAP is also an area where the group wants to request further information from Motorola so they have a clear understanding of the configuration constraints they will face.

- As a single unified regional system, if this feature is implemented it would be available across the system as long as the appropriate Infrastructure is put in place.
- As a single unified regional system, the Infrastructure to support the feature needs to be in place even if only a single user agency needs the feature.

GPS Enabled End User Devices – Each Option will be characterized to describe how it could support GPS enabled end user devices and how that GPS data could be made available for other uses.

Sub-Option 2A:

- As separate systems it appears that each system could make their own decision on whether to implement GPS capability within their individual systems.
- As a system level feature, the Infrastructure to support the feature needs to be in place even if only a single user agency needs the feature.
- If separate systems are joined together for Switch redundancy capability, it is not clear if GPS information can be passed between systems so that location awareness was able to follow a radio that was operating outside its home system (assuming the Infrastructure was in place to support it)[27].
- As a system level feature, mechanisms would need to be identified to allow this data to be utilized by multiple off-system applications such as CAD, fleet tracking, asset management, etc.

Sub-Option 2B:

- As a single unified regional system, it appears that if the feature were implemented it would be available across the entire system.
- As a system level feature, the Infrastructure to support the feature needs to be in place even if only a single user agency needs the feature.

[27] This is another area where the group wants to request further information from Motorola so they have a clear understanding of the configuration constraints they will face.

- As a system level feature, mechanisms would need to be identified to allow this data to be utilized by multiple off-system applications such as CAD, fleet tracking, asset management, etc.

Broadband-Enabled End User Devices - Each Option will be characterized to describe how it could support Broadband-enabled end user devices in order to enhance situational awareness.

General observation on both Sub-Options – None of the Project 25 system alternatives provide this capability.

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Appendix E

Notes from Option 3 Workshop on September 13, 2011

This document contains two parts. The first part is the notes from the Option # 3 Workshop. The second part is material we think should be included in the Report write-up for this Option that was not part of the Workshop. Material in this second part is indicated in blue text.

Option 3 General Description – Build New Land Mobile radio system(s)

This option is to put out a bid for a new Land Mobile Radio (LMR) system(s) to serve three counties King, Snohomish, and Pierce. The new system will be 700/800 MHz P25 Phase 2 with a VHF system overlay. It should be noted that there has not been a consensus among the group on the definition of VHF system overlay. All vendors would be eligible to submit bids under this Option. Depending upon which vendor submitted the most advantageous bid, that bidder may choose to use some of the existing equipment in its "New" system.

SUB-OPTION 3A: 3-Countywide-system architecture (3 separate Switches)

There are several methods for connecting three one-county systems together. The capability of the resulting network will depend on which connection method is used. For example, if the systems are connected using ISSI, officers working outside the coverage area of their home system may be able to talk with both people on the system where they are now and people on the system back home, but their emergency button will not work back to their dispatcher.

SUB-OPTION 3B: Single regional system architecture (1 Switch)

This option will be centrally funded for the entire Infrastructure equipment and will replace Subscriber Radios that are not already P25 Phase 2 compliant. The subject of funding requires further discussion.

If Sub-Option 3A is selected, it is the regional agencies' desire that the Infrastructure equipment for all three countywide systems is provided by the same manufacturer. This is for the ease of on-going maintenance, operation, and upgrade coordination.

Option Evaluation Criteria – The following criteria were established to evaluate and compare the characteristics of each of the Options under consideration.

Coverage – Local and regional general coverage goals have been established and Sparling has submitted coverage area mapping based on the general parameters

established. Each Option will be characterized in terms of how the Option would meet the coverage goals.

Any of the sub-options can meet the coverage goals established by the REPC.

During the design phase, we need to look at the benefits and detriments of a new site location design a way to improve coverage. We should not simply assume sites will or won't remain where they are today.

Sub-Option 3A:

- More sites may need to be added to the current site configurations or some of current sites may need to be replaced with a new site. There may be some coverage improvements in the ability to arrange sites to match user agency usage pattern.

Sub-Option 3B:

- As a single system, the only overlapping coverage that would be intentionally designed into the system would be for reliability reasons. This is the group's recommendation; however, it may be a policy decision.
- More sites may need to be added to the current site configurations or some of current sites may need to be replaced with a new site. There may be some coverage improvements in the ability to arrange sites to match user agency usage pattern.
- User agency usage patterns would be accommodated through both site groupings and Talkgroup access management processes.
- Potentially to result in the less total site count compared to Sub-Option 3A.

Spectrum – The potential opportunities and risks related to Spectrum utilization and availability will be characterized for each Option.

The following is applied to both Sub-Option 3A and Sub-Option 3B.

- Additional Spectrum may be needed during system testing and migration.
- It is unclear how Pierce County will make Spectrum available for the new system.
- The Spectrum plan for regional system implementation is supplement current 800 MHz frequencies with 700 MHz frequencies from Snohomish, King, and Pierce and potentially supplement them with State allocated 700 MHz frequencies.
- For effective use of the Spectrum, the system is required to switch automatically between P25 Phase 1 and Phase 2 without user intervention. This is to accommodate users using Phase 1 radios.

- This option provides an opportunity to review Spectrum usage throughout the Region to make them more efficient for the new system (i.e. IR vs. Simulcast, Phase 2 vs. Phase 1). Consideration should be given to managing frequencies for the new system(s) on a regional rather than per agency basis.
- There will be Spectrum efficiency gains on the current Spectrum after the new digital P25 Phase 2 is fully implemented. For example, a 25 KHz control channel in the current system can provide two 12.5 KHz channels in the new system, and a 25 KHz voice channel in the current system can provide 4 voice paths equivalent in the new system. It is understood that it is not a straight forward efficiency ratio of 1:2 or 1:4, but if the Spectrum are managed and coordinated correctly the efficiency ratio could be achieved close to those ratios. While the above ratios are theoretically possible, the real limitation on channel counts or talk paths may in fact be the vendor technology, which appears to be limited to 30 talk paths by at least one vendor.

Mobility and Interoperability – A limited number of Talkgroups (both unencrypted and encrypted) from each of the current system operating areas will need to have the ability to move throughout the 3-county Region without the user having to make any changes to their radio or Talkgroup selection. Each Option will be characterized for how it would meet this need, including any constraints or enhanced capability it may have in meeting this need.

This criterion can be met with either Sub-Option 3A or Sub-Option 3B since both Infrastructure equipment and Subscriber Radios are P25 Phase 2 compliant and interconnected.

For Sub-Option 3A, the user radio functionality working across the Region will be different without user intervention depending on how the systems are connected together (i.e. emergency button may not work if the users move from one system to another if ISSI is used to connect the systems together).

Reliability – End users of the systems need reliable service both within their normal operating areas and when operating outside their normal areas based on prescribed Mobility and Interoperability parameters. To accomplish this, at least the central system controller function and the simulcast subsystem controller function need to be implemented in a redundant manner, and preferably in a non-collocated fashion. Each Option will be characterized for how it would meet this design goal together with any associated operational or other considerations.

Either Sub-Option 3A or Sub-Option 3B can meet the reliability goals established by the REPC.

Sub-Option 3A: As a separate system, each system could implement its own redundant architecture.

Sub-Option 3B: As a regional system, redundancy is only required for a single system.

Implementation and Transition – Each Option will be characterized in terms of the process for moving from the current as-is state to the future to-be state within three general frameworks:

- During the entire implementation and transition time period, end users must maintain the ability to maintain voice communications across both normal operational Talkgroups and designated Interoperability Talkgroups. However, it will be acceptable for some other trunking features to be limited during transition. Each Option will be characterized for how it would provide continuing end user communications capability and a general overview of the features or functionality that would be limited during transition.

- The actual timeframe for the transitions of individual systems and for the transitions of individual end-user agencies need to be of limited and predictable durations to minimize impacts on both system owner/operators and on end-user agencies.

- Each Option will be characterized to describe the degree to which it allows the current system Infrastructure and end-user device inventories to meet their currently planned life expectancy, and for how each system could plan their own migration timeframe versus having to be on a schedule determined by others.

The followings apply to both Sub-Option 3A and Sub-Option 3B.

Interoperability between new system and legacy system is critical to maintain user Talkgroups across the two systems during transitional period. This is potentially a major issue if there is a transitional period when the whole Region is not using the same vendor's technology. Gateways are required for Interoperability between the two systems. More Spectrum may be required to accommodate day-to-day operation for each group of users while they are being transitioned from the legacy system to new system.

Most of the radios currently used with the legacy 800 MHz systems are operating in Motorola proprietary analog format (SmartZone 4.1). During any transitional period, new Subscriber Radios must be capable of operating in this format in addition to P25 format if we want the users from one system to communicate on the neighboring systems. Currently, there are only two vendors

that offer Subscriber Radios that are capable of both Motorola's proprietary analog format and the P25 format. It is noted, however, that if new Subscriber Radios are commissioned on the new P25 regional system when Mobile radios are installed or Portable radios are issued, they do not require Motorola proprietary analog format.

If the region-wide P25 network is fully built out prior to users being migrated to the new system then P25 user radios would not be required to have analog capability.

The group has also identified other risks if new set of Infrastructure equipment has to be installed at the current sites prior to migrating the users over to the new system:

- Floor Space: Site floor space may need to be expanded or new facility added if existing sites will be used in the new system. If new sites are required, floor space should be planned accordingly.
- Tower Space: Most of the towers at the current sites are at or near maximum load capacity. Towers may need to be upgraded or new tower added. Analysis of tower loading capacity will need to be completed to get an accurate indication of status at each existing Radio Site.
- Electrical Power: Both commercial power and back-up generator power may not have enough spare capacity to accommodate a new set of equipment. Power and generator at the sites may need to be upgraded.
- These risks need to be mitigated prior to Infrastructure equipment installations.

Scalability – Each Option will be characterized for its ability to allow the complete management of capacities including sites, channels, Consoles, and end-user devices over a planning horizon extending to 2030.

Both Sub-Options could provide the required levels of control over system topology and capacities.

Local Service Delivery and Control – Maintaining the ability for the existing system owner/operator organizations to leverage their current customer relationships and manage the service delivery process with their end users needs to be the prevailing philosophy. Each Option will be characterized for how this could be accomplished.

There are two issues here: Does the Option and sub-Option allow for individual system control of some or all aspects and what, if any impact does that local

control have on the Region as a whole. In general, the more decisions that are turned over to a central governance body, the less control an individual system can exercise. Conversely, the more decisions that are turned over to a central governance body the more closely can technology and Spectrum be allocated for regional benefit.

Sub-Option 3A: This Sub-Option requires a close coordination of the timing and timeframes for both initial migration and ongoing upgrades and maintenance. Across the network capability is depending on how the systems are connected together.

Sub-Option 3B: As a regional system, the current system owner/operator would no longer have individual control over system-wide issues such as upgrade timing. Regional governance model would need to establish effective mechanisms to reach consensus on design changes and upgrades, while also having mechanisms to prevent minorities of participants holding up broadly needed upgrades or feature enhancements.

A regional pool of spare parts and equipment becomes a viable strategy. A system-level operations and maintenance process will need to be established for the system Switches, but regional models could be considered for elements like sites, RF Infrastructure, Backhaul networks, and Subscriber Radios. A full region-wide O&M model could also be considered.

Encryption Key Management –Each Option will be characterized to describe how local key management could be accommodated and describe potential system-level key management capabilities that may be available if desired. Even if region-level key management capabilities are utilized, the need for local jurisdictions to manage their own keys will remain.

Sub-Option 3A: As a separate system, each system could implement its own key management capability. Across the network capability is depending on how the systems are connected together.

Sub-Option 3B: As a regional system, key management capabilities would extend across the entire system.

Over-the-Air-Programming (OTAP) and End-User Template Management – Each Option will be characterized for how it could support an OTAP capability and any centralized ability to manage end-user templates.

Sub-Option 3A: As a separate system, each system could make its own decision to implement OTAP. Across the network capability is depending on how the systems are connected together.

Sub-Option 3B: As a regional system, OTAP feature could be implemented and available across the system.

GPS Enabled End User Devices – Each Option will be characterized to describe how it could support GPS enabled end user devices and how that GPS data could be made available for other uses.

Sub-Option 3A: As a separate system, each system could make their own decision to implement GPS capability for their users. Across the network capability is depending on how the systems are connected together.

Sub-Option 3B: As a regional system, GPS feature could be implemented and available to user agency that needs it.

Broadband-Enabled End User Devices - Each Option will be characterized to describe how it could support Broadband-enabled end user devices in order to enhance situational awareness.

Currently there are no commercially available Subscriber units that can provide both Motorola proprietary analog format and Broadband.

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Appendix F

Notes from the Option 4 Workshop on August 16, 2011

Option 4 General Description: Build a regional LTE system for mission critical voice

General information and assumptions used to allow characterization and comparison of this Option to Options 1, 2 and 3:

- It is currently unknown when public safety voice capability will be achieved within the LTE marketplace. If this is not achieved, this Option would not be under consideration as a replacement strategy for voice communications systems.
- A single LTE system Infrastructure would be established to serve at least the Snohomish, King and Pierce county areas, and this system Infrastructure may be expanded to serve a larger area in the future.
- This LTE Infrastructure would be a part of the national Broadband architecture and network, and could be part of state or regional architectures.
- The LTE Infrastructure would be based on the regulatory environment that is present today. This includes being constrained to the 5 X 5 MHz block of nationally licensed 700 MHz Broadband Spectrum and implementing under existing waiver, Spectrum lease, and FCC Interoperability rules. (The amount of 700 MHz Broadband Spectrum available could be doubled by the D Block legislation being debated in Congress.)
- The state of LTE technology will progress to the point that public safety caliber voice communications capabilities will be established within the LTE (3GPP) standards process. As a general reference, it is believed that public safety voice communications capabilities would essentially be defined as the mix of functional capabilities defined in the Statement of Requirements for Project 25 voice communications.
- It is also assumed that the LTE marketplace for public safety voice communications would be sufficiently robust that a mix of Mobile and Portable end user devices would be available to meet the unique physical demands of the public safety user community. Again, if this is not achieved, this Option would not be under consideration as a replacement strategy for voice communications systems.

- Even if all the functionality of P25 were present in the LTE environment, there may still be valid reasons to consider keeping voice communications on a separate LMR environment. These include the risks of an integrated voice/data LTE system being a single point of failure for all public safety communications, and that as an emerging technology merged LTE voice/data may have early-life challenges that reduce the overall reliability of voice communications below acceptable levels.

Option Evaluation Criteria – The following criteria were established to evaluate and compare the characteristics of each of the Options under consideration.

Coverage – Local and regional general coverage goals have been established and Sparling has submitted coverage area mapping based on the general parameters established. Each Option will be characterized in terms of how the Option would meet the coverage goals.

- In general terms, LTE sites will have lower Height Above Average Terrain (HAAT) profiles than existing LMR sites, and this reduces the area covered by each LTE site/sector. Based on previous conceptual designs for public safety LTE data systems in this Region it appears that an LTE system Infrastructure will require a significantly larger number of sites to achieve comparable overall coverage to current LMR voice radio systems. This ratio may be as high as 10:1 based on conceptual design work conducted for the City of Seattle, and may be much higher in the region's rural areas.

- Due to the general architecture of LTE Infrastructures and the smaller coverage area per site, there will be less opportunity to use intentional overlapping coverage as a design tool to provide coverage reliability. LTE adapts to the failure of a single site by providing lower capacity coverage through adjacent sites. If the levels of service from adjacent sites are of sufficient quality and reliability, this overlapping coverage may be sufficient to support voice communications. Otherwise, public safety LTE sites would need to be highly redundant and hardened beyond commercial carrier requirements to ensure the same level of coverage reliability provided by existing LMR systems.

- Providing wide area coverage in rural areas (particularly foothill areas) will be more challenging than in LMR system designs since the use of high HAAT sites creates signal overlaps that are difficult to manage and maintain overall network performance.

- Conversely, when site is lost a much smaller geographic area is impacted than when an LMR site is lost.

- Coverage enhancements may be possible by establishing Roaming relationships with commercial carriers that offer coverage in areas not practical to cover in the public safety LTE design; however, there are complex, unresolved issues related to Roaming. For example: end user devices with this capability do not yet exist and we don't know when they will; selecting a Roaming partner could lock the Region into a single vendor (end user devices are designed to use specific Spectrum and are therefore carrier-specific); and we do not yet know the financial impact (Roaming charges, and how those charges would be divided, etc.).

Spectrum – The potential opportunities and risks related to Spectrum utilization and availability will be characterized for each Option.

- The working assumption will need to be that the existing 5 X 5 MHz public safety allocation is all that is available. There is broad disagreement about whether or not this is sufficient Spectrum to meet public safety voice and data needs, and this will not be conclusively resolved until there is hard data from demonstration networks and early adopter networks.

- LTE will require a large increase in Backhaul connections among sites. Significant additional Spectrum and/or Fiber will be needed for adequate capacity, reliable Backhaul from LTE sites.

- It is not yet clear if Spectrum utilization policy in Canada will align with the U.S. utilization for this Spectrum (or for the additional 10 MHz of Spectrum if the D Block is also reallocated to Public Safety) so there may be some deployment challenges for sites with few physical obstructions between them and the Canadian border.

Mobility and Interoperability – A limited number of Talkgroups (both unencrypted and encrypted) from each of the current system operating areas will need to have the ability to move throughout the 3-county Region without the user having to make any changes to their radio or Talkgroup selection. Each Option will be characterized for how it would meet this need, including any constraints or enhanced capability it may have in meeting this need.

- As a regional system, the working assumption would be that these defined capabilities could be met.

- Further, it may be possible for a larger number of Talkgroups to have this regional capability than in an LMR system architecture, but this can't be determined until standards are in place for the required bandwidth and quality of service (QoS) requirements for public safety voice over LTE.

- There would also likely be the ability for public safety LTE devices to Roam to commercial systems. This could provide significant Mobility and Interoperability for data services, and comparable benefit to voice communications if the commercial systems support the public safety voice standards across their Infrastructures. However, it is not possible at this time to accurately predict whether these standards would be embraced across the commercial carrier marketplace. Also, as noted above, commercial systems are likely to not fully meet public safety's local coverage needs.

Reliability – End users of the systems need reliable service both within their normal operating areas and when operating outside their normal areas based on prescribed Mobility and Interoperability parameters. To accomplish this, at least the central system controller function and the simulcast subsystem controller function need to be implemented in a redundant manner, and preferably in a non-collocated fashion. Each Option will be characterized for how it would meet this design goal together with any associated operational or other considerations.

- It is assumed that a public safety voice over LTE architecture would allow for well defined levels of reliability for end users while operating within the public safety infrastructure. Reliability across Roamed-to commercial systems would require that appropriate QoS agreements and compatible technology be in place. Traditionally, LMR sites are hardened with extensive back-up power, earthquake protections, and other enhancements that give them a higher reliability level than cell sites. There is no reason that cell sites cannot be built to the same reliability levels but there would be a high cost given the greater number of cell sites per square mile.

- The underlying architecture of LTE and LMR systems allow for the use of non-collocated redundant system Cores.

- Since LTE technology is an Infrastructure-dependent architecture (for example, there is no capability like 'site trunking' at the eNodeB level), and since coverage from each individual LTE site becomes more critical to overall reliability to the end user for the geographic area served by that site, each site will require appropriate investments in reliable and/or redundant Backhaul capability and sustainable operating environments (power, temperature, humidity, etc.).

Implementation and Transition – Each Option will be characterized in terms of the process for moving from the current as-is state to the future to-be state within three general frameworks:

  - During the entire implementation and transition time period, end users must maintain the ability to maintain voice communications across both

normal operational Talkgroups and designated Interoperability Talkgroups. However, it will be acceptable for some features to be limited during transition. Each Option will be characterized for how it would provide continuing end user communications capability and a general overview of the features or functionality that would be limited during transition.

- The actual timeframe for the transitions of individual systems and for the transitions of individual end-user agencies need to be of limited and predictable durations to minimize impacts on both system owner/operators and on end-user agencies.

- Each Option will be characterized to describe the degree to which it allows the current system Infrastructure and end-user device inventories to be meet their currently planned life expectancy, and for how each system could plan their own migration timeframe versus having to be on a schedule determined by others.

- Since the implementation of a public safety LTE system would be a completely new Infrastructure and use completely new Subscriber devices, the process of 'transition' to the new system would need to include a period of time when communications on the existing systems would need to be 'Patched' to the LTE system. Some features going across the Patch would to be lost to the users of the receiving system. Since LTE public safety voice standards are not yet in place, it is not possible to determine how robust this cross-system Patching could be and what levels of tri-county capabilities could be maintained during the transition process.

- Since the new LTE Infrastructure and Subscriber units would need to be fully operational before transition took place, the actual transition timeframes could potentially be fairly short in duration for the system users themselves.

- Public safety voice over LTE will likely be different enough (different fail-over procedures, beeps) that there will be a need for significant end user training so they both understand how the system works and how to interact with the system in various operational situations.

- Due to both the complexity of LTE technology and its dissimilarity to existing LMR systems, there would need to be a substantial training effort for current LMR technical staff members if the future LTE business model includes having some or all of the network maintained by owner personnel.

- While the end-state equipment space requirements for LTE equipment at existing sites may be smaller than current LMR equipment, there may be

space and facility challenges during transition. Expanding Backhaul capacities from existing sites may also create space or structural challenges at some sites.

- The increased number of sites in the LTE system will require substantial efforts in site acquisition, site development, and Backhaul development that could result in an extended implementation cycle. However, if LTE is first pursued as a data-only strategy while further work is being done to resolve the public safety voice over LTE standards and designs, this extended implementation may not have much of an adverse impact on the timing for when an LTE Infrastructure could finally be used for PS voice.
- During the meeting, the group also outlined some current understandings about the potential timeframes the development of LTE may follow:
    - If LTE were to be deployed for data-only use, deployment could start today if funding were available. The technology is available and Seattle has a Spectrum waiver and lease in place. Deployment could start in Seattle and then expand to the surrounding communities as funding was established.
    - The timeline for public safety voice over LTE is highly speculative at this point. One possible scenario:
        - Step 1 – The public safety community reaches consensus on the functional requirements. Estimated completion at the end of 2012.
        - Step 2 – The 3GPP process then translates these functional requirements into a set of technical standards and documents to allow the functionality to be integrated to a release level of LTE. Estimated to take about 3 years.
        - Step 3 – The manufacturing community produces the Infrastructure hardware/software and end user equipment to support the new standards. Estimated to take 1 to 2 years.
        - Step 4 – System deployments take place, with early adopters perhaps deploying concurrent with the finalization of the 3GPP process. Depending on site counts and site acquisition and development cycles these deployments could stretch over 2 or more years.

- This would result in an overall timeline of the earliest possible full deployment of public safety voice over LTE being in the late 2018 timeframe at the earliest.
- It was noted though that if LTE deployment were to commence "now" for data usage, a significant portion of the physical Infrastructure could potentially be in place while the public safety voice over LTE standards process was running its course. Then, theoretically, through a system software upgrade the system could be 'converted' to accommodate both data and voice.
- It is not possible to determine at this time what challenges might be faced if a system were under deployment or in place using the current 5 X 5 MHz of Spectrum and then the D Block became available allowing a 10 X 10 MHz approach.

Scalability – Each Option will be characterized for its ability to allow the complete management of capacities including sites, channels, Consoles, and end-user devices over a planning horizon extending to 2030.

- LTE architecture is capable of being scaled to meet both expanded coverage and expanded capacity for at least the 2030 horizon and likely past that.
- The complexity in scaling up to more LTE sites will be in developing adequate capacity and sufficiently reliable Backhaul from each site so that they are capable of delivering the expected bandwidth/ performance for the area they serve. Meeting this Backhaul requirement may be difficult. There may be limited Spectrum or no direct line of sight path for Microwave Backhaul, and Fiber lines may be far away and expensive to install. (For example, it cost approximately $1M to bring a power line to the Deer Creek site.) And, as noted previously, not all first responder agencies and system managers are comfortable with Fiber as their primary Backhaul technology.

Local Service Delivery and Control – Maintaining the ability for the existing system owner/operator organizations to leverage their current customer relationships and manage the service delivery process with their end users needs to be the prevailing philosophy. Each Option will be characterized for how this could be accomplished.

- Due to increased complexity of the LTE architecture and the system being implemented to serve a large geographic area (that may go beyond the current 3-county area and that would need to work within the national public safety Broadband architecture), the working assumption is that responsibility

for the actual day-to-day operation and administration of the system would be placed within a single entity in the Region

- With appropriate training, there may be some ability to differentiate roles for field maintenance personnel for the Radio Access Network (RAN) equipment itself and have some of that remain the responsibility of existing local technical personnel.
- Responsibility for site and Backhaul M&O could quite likely remain a local responsibility.
- A number of other client-facing interactions could also likely remain at the local level, such as Subscriber unit provisioning, installation, first-tier maintenance, training, etc.

Encryption Key Management –Each Option will be characterized to describe how local key management could be accommodated and describe potential system-level key management capabilities that may be available if desired. Even if region-level key management capabilities are utilized, the need for local jurisdictions to manage their own keys will remain.

- Since the standards are not yet in place, the working assumption will need to be that public safety voice over LTE will be developed in manner that allows the appropriate levels of flexibility for both end-user and centralized key management.

Over-the-Air-Programming (OTAP) and End-User Template Management – Each Option will be characterized for how it could support an OTAP capability and any centralized ability to manage end-user templates.

- Since the standards are not yet in place, the working assumption will need to be that public safety voice over LTE will be developed in manner that allows the appropriate levels of flexibility for both over-the-air programming and centralized template management.

GPS Enabled End User Devices – Each Option will be characterized to describe how it could support GPS enabled end user devices and how that GPS data could be made available for other uses.

- Since public safety end user devices are not yet available, the working assumption will need to be that end user devices will include GPS capability and have the ability to make GPS data available to other systems for other uses.

Broadband-Enabled End User Devices - Each Option will be characterized to describe how it could support Broadband-enabled end user devices in order to enhance situational awareness.

- Broadband capable end user devices would be available in this option.

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Appendix G

Results from analysis of Strengths, Weaknesses, Opportunities, and Threats (SWOT)

Sub option 1A: Do nothing

Strengths	Weaknesses

• Cost. No immediate capital investment required for replacement systems.
• No immediate need to seek public funding for large dollar investments.
• No additional Spectrum needed (unlike options 2, 3 and 4)
• No transition required
• Local service and control stays the same
• Delays the need to replace trunking Subscriber radios to operate on a new system technology. (Create a chart showing risk inflection points.)
• No additional sites required to preserve current coverage.
	• Doing nothing isn't free. Doing nothing doesn't preserve the current cost profile. The cost of status quo will not stay the same.
	• Does nothing to protect against a lack of vendor-supplied/certified parts after manufacturer end-of-life dates.
	• Availability of aftermarket parts is unreliable. Cards have to be the correct hardware/software version – not all spare parts will work.
	• Used parts may not be reliable.
	• Cost of aftermarket parts is unknown.
	• Does nothing to protect against the pending end of vendor technical support.
	• We cannot improve coverage due to Spectrum availability and vendor-supported parts availability. Even if you can find aftermarket parts, we would still need Motorola "code plugs" to activate new sites.
	• We cannot increase channel capacity.
	• Does nothing to fulfill the need for:
	  ○ Over-the-Air-Programming (OTAP) and End-User Template Management
	  ○ GPS-Enabled End User Devices
	  ○ Broadband-Enabled End User Devices
	• Is not scalable. Cannot scale system up because parts will be unavailable.
	• If we do not adopt P25, we may not qualify for future federal grants.
	• Limits replacement Subscriber radios to two manufacturers.
	• Does nothing to meet the federal Narrowbanding mandate for VHF and UHF.

	Does not allow Pierce Co to share/join next generation technology currently in the Region.
Opportunities	Threats
• None noted	• Potential for a future catastrophic failure. • Potential future need to justify why failure was allowed to occur (why we took no action). • Some parts are not available today (e.g. 6809 site controllers). • Repair costs will increase in unpredictable ways. • Repair times will increase. • We may lose capacity because of our inability to obtain replacement parts • If VHF/UHF systems do not Narrowband, they could be fined and/or lose FCC license. • Limits ability to implement critical software fixes. Would need to freeze system software because vendor will no longer do compatibility testing. There is a date beyond which risks will go up noticeably - user experience could degrade and/or system could fail. • Third-party software/components will continue to evolve even as our system remains static. It will cost more time and money to replace software/components. If there is a hardware failure, we may not be able to install the old software on new commercial off-the-shelf hardware and therefore may not be able to repair broken components. We would assume the risk – cannot go back to vendor. • Existing TRIS Interoperability with Port, State, and feds is dependent upon components that are not supported after 2013 (tied to Console dates). We run the risk of having less Interoperability as components fail and/or technologies advance. • After Sept 2013, the Port will lose the ability to do a phased migration. The

	Port would need to replace all components of existing system, including Subscriber radios, at once. • Daily communications with Port, federal, state, and regional partners could be lost. • Vendor-supported agencies (as opposed to agencies that operate and maintain their own systems) are at greater risk. Exiting vendor contracts have finite timelines, and costs for service contracts will increase. This will widen the disparity between service availability in King Co sub-regions. Sub-regions could have to change their fundamental operation model, and therefore end-user rates, if they can no longer continue existing vendor support. This potentially impacts rates in a significant way. • Does not add Infrastructure to maintain the same level of coverage for Pierce Co and WSP (to compensate for losses expected due to Narrowbanding).

Sub-option 1B: make minimum necessary investments to preserve service levels and extend the useful life of the overall systems

Strengths	Weaknesses

• Gives a strategy to mitigate specific risks. Solves some problems for some agencies for a specific period of time. For example, agencies that upgrade Consoles by 2013 can alleviate the risk associated with vendor end of support for existing Consoles. (Does not apply to the Port – the Port cannot upgrade Consoles.)
• If proper component investments are made by 2013, there will be no greater risk of system component problems than exists today through 2016. This does not mitigate issues with coverage or capacity, however.
• This will require less immediate capital investment than options 2, 3 and 4. However, it is more costly over the planning horizon (2030).
• No additional Spectrum needed (unlike options 2, 3 and 4).
• Limited Infrastructure transitions and no Subscriber transition required (does not apply to the Port, Pierce Co and WSP)
• Local service and control stays the same
• Delays the need to replace trunking Subscriber radios to operate on a new system technology. (Create a chart showing risk inflection points.)
• Meets regulatory requirements for Narrowbanding.
• No additional sites required to preserve current 800 MHz Trunked coverage.
	• Does nothing to protect against a lack of vendor-supplied/certified parts after manufacturer end-of-life dates.
	• Availability of aftermarket parts is unreliable. Cards have to be the correct hardware/software version – not all spare parts will work.
	• Used parts may not be reliable.
	• Cost of aftermarket parts is unknown.
	• Does nothing to protect against the pending end of vendor technical support.
	• We cannot improve coverage due to Spectrum availability and vendor-supported parts availability. Even if you can find aftermarket parts, we would still need Motorola "code plugs" to activate new sites.
	• We cannot increase channel capacity.
	• Does nothing to fulfill the need for:
	  ○ Over-the-Air-Programming (OTAP) and End-User Template Management
	  ○ GPS-Enabled End User Devices
	  ○ Broadband-Enabled End User Devices
	• Limited scalability. Can add Consoles (add dispatchers in a comm. center) but not Radio Sites and channels (cannot improve coverage or capacity). (This does not apply to the Port. The Port is not able to scale up.)
	• If we do not adopt P25, we may not qualify for future federal grants.
	• Limits replacement Subscriber radios to two manufacturers.
	• This does nothing to extend the useful life for the Port's system. Unless the Port upgrades its Master Site (significant invest and technology change), its system will

	reach end of life in 2016. • Within each system, the sub-system or sub-region with the oldest equipment will gate the whole system. The ability to upgrade central system software is limited by software compatibility for the oldest components. All sub-regions within a radio system must act together to realize all of the benefits. • Requires additional Infrastructure to maintain the same level of coverage for Pierce Co and the WSP due to VHF/UHF Narrowbanding.
Opportunities	Threats
• Opportunity to tailor timing and amount of investment based upon needs of individual agencies to preserve service levels. • Provides the opportunity to invest in replacement equipment that is vendor-supported. • Can invest in equipment that can carry over into P25 (if the current vendor is selected for the next generation system). • Could allow Pierce Co to share/join next generation technology currently in the Region.	• Potential for a future catastrophic failure. • Potential future need to justify why failure was allowed to occur (why we took no action). • Some parts are not available today (e.g. 6809 site controllers). • Repair costs will increase in unpredictable ways. • Repair times will increase. • We may lose capacity because of our inability to obtain replacement parts. • Everyone within a radio system must act together to realize all of the benefits, otherwise, this limits ability to implement critical software fixes. Would need to freeze system software because vendor will no longer do compatibility testing. There is a date beyond which risks will go up noticeably - user experience could degrade and/or system could fail. • Third-party software/components will continue to evolve even as our system remains static. It will cost more time and money to replace software/components. If there is a hardware failure, you will not be able to install the old software on new commercial off-the-shelf hardware – may not be able to repair broken components. We would assume the risk – cannot go back to vendor.

	• After Sept 2013 the Port loses the ability to do a phased migration (Port would need to replace all components of existing system) • Vendor-supported agencies (as opposed to agencies that operate and maintain their own systems) are at greater risk. Exiting vendor contracts have finite timelines, and costs for service contracts will increase. This will widen the disparity between service availability in King Co sub-regions. Sub-regions could have to change their fundamental operation model, and therefore end-user rates, if they can no longer continue existing vendor support. This potentially impacts rates in a significant way. • There is a risk of some stranded capital investments. For example, MTC controllers would alleviate risk associated with 6809 site controllers; however, they have a short useful life. (Short-term investments would not necessarily lock or leverage radio systems into the present vendor for the next generation system.)

Sub-option 2A: Follow Motorola's recommendations to migrate existing SmartZone LMR systems to P25 Phase 2 LMR systems. End result would be multiple systems linked together.

Strengths	Weaknesses
• Each system (but not sub-system) could upgrade existing systems to P25 Phase 2 individually and in timeframes established by their governance and business models, including funding. However, this would need to be done within a mutually accepted regional timeline. • Would not require changes to existing governance and business/operations models. • Meets Mobility/Interoperability requirement. • There would be more flexibility in system software versions and upgrade timing (versus one system). • Each individual radio system could continue the current practice of establishing its own system architecture and selecting RF sites and groupings to match user agency usage patterns. • This would allow us to continue to use some existing equipment (Switches, Backhaul and some Mobile and Portable radios). • Agencies could start directing current and future equipment purchases (Consoles, Mobiles, and Portables) toward the next-generation system. Agencies could purchase equipment now, use it on existing system, and continue to use it on the new system. • Regarding evaluation criteria: o Mobility/Interoperability: There would be an adequate number of Talkgroups across Gateways to support communications between users on different systems. o Reliability: Network design for Backhaul would be less complicated for a smaller,	• There is a potential for different groups of users to be on different technologies/versions. • Use of Spectrum would not be as efficient as it would be on a single system. • Having multiple independent funding sources could mean that regional timelines would be determined by the last partner to secure funding. • Regarding evaluation criteria: o Reliability: It will require more central Switch equipment, and therefore more money, to build redundancy into multiple systems so that each meets Reliability goals. o Implementation/transition: Increased flexibility (each system having the ability to upgrade on its own schedule) will also mean additional complexity. Even if transition is carefully coordinated, the transition schedule will be less "tight" if systems are upgraded independently versus one regional implementation. During transition, this will complicate Interoperability throughout the Region for the end users. o Spectrum: Because there are multiple independent systems, there is a greater risk of not having enough Spectrum to manage transition. o Spectrum: We could need to share frequencies during transition. If one agency decides to go slowly, it will slow the whole process. o Spectrum: Daily operation of

individual system service area versus a multi-county Region. (Need to connect each Radio Site to both redundant Switches. This is less complicated, and potentially less expensive, for a smaller geographic area.) ○ Reliability: Because there would be multiple systems, any failure would be isolated to a smaller geographic region. ○ Implementation/transition: Transition will be easier than moving to a different vendor (under option 3) or a different technology (option 4) ○ GPS-enabled end user devices: Would be supported. • Actions taken by one system are less likely to have any effect on users of a separate system after everyone is cutover to P25 Phase 2 operations (compared to single system alternatives). • Local service and control is flexible and can remain the same as it is today • This option will move the Region to P25, the voice technology standard adopted by the REPC. • Option 2 allows you to replace equipment at the component level (could require less space in site buildings during transition than Option 3). • Would enable some sites to be transitioned from SmartZone to P25 on channel-by-channel basis (by making a software changes).	multiple systems is potentially less spectrally-efficient than daily operation of a single system. ○ Spectrum: Would need to keep analog/SmartZone sites in service to preserve Interoperability while end users transition over to the upgraded radio systems (requires additional Spectrum for transition). ○ Transition: With independent decision making the transition will be neither predictable nor of limited duration. ○ Until everyone is doing the same thing (e.g. P25 phase 2), there will be some burden on others. ○ On multiple systems, scalability may be more limited because of Spectrum constraints. ○ OTAP/OTAR: May be limited to home system coverage area ○ Mobility and Interoperability: Special capabilities supported in a single system may not be passed to other systems (e.g. passing aliases to home dispatch center when end user Roams onto another system) • Will not support Broadband-enabled end user devices.
Opportunities	Threats
• We can preserve vendor support for existing systems by following this upgrade path. • This preserves the option to move to sub-option 2B (a single system) at any time. Sub-option 2A is a gradual migration path, and we could alter	• Like other sub-options (2B, 3A, 3B), this would require additional narrowband Spectrum for transition. Getting the additional Spectrum would require re-management of existing 800 MHz channels (both within current licensees and between

our course later, with minimum abandoned investment, if that became more advantageous to the Region.	licensees), use of Region 43 700 MHz narrowband channels, and/or use of State 700 MHz narrowband channels. We do not know for certain that we have that additional Spectrum available. • Transition: Transition could extend longer and require more careful coordination because multiple systems would be involved. The increased flexibility will come with an increased transition time frame, and an increased time frame will increase project risk (cost). This would likely create an extended burden on end users and neighboring radio systems. • Extended transition will necessitate multiple end-user training sessions for regional Interoperability.

Sub-option 2B: Follow Motorola's recommendations to migrate existing SmartZone LMR systems to P25 Phase 2 LMR systems. End result would be one regional system.

Strengths	Weaknesses
• This would provide the highest level of feature functionality, Mobility, and Interoperability across the multi-county geographical area. • Would potentially require fewer Radio Sites and less Spectrum to meet coverage and capacity requirements across the multi-county geographical area (versus multiple systems). Could produce other, additional system efficiencies over multiple systems. • Would allow radio systems some flexibility as they migrate to P25 in consort with the overall plan. Sub-option 2B would have more flexibility than 3A/3B (if a different equipment vendor is chosen for the new system in 3A/3B). • Exceeds criteria for Mobility and Interoperability: This sub-option would likely allow more Talkgroups to have regional Mobility. It would also be easier to add, change, and delete regional Interoperability Talkgroups (compared to sub-options 1A, 1B, and 2A. • This would allow us to continue to use some existing equipment (Switches, Backhaul, and some Mobiles and Portables). • Agencies could start directing current and future equipment purchases (Consoles, Mobiles, and Portables) toward the next-generation system. Agencies could purchase equipment now, use it on existing system, and continue to use it on the new system. • Regarding evaluation criteria: o Spectrum: Daily operation of one system is potentially more spectrally-efficient than daily operations of multiple systems. o Reliability: It will require less	• While each system (but not sub-system) could upgrade to P25 Phase 2 individually, this would need to be done within a tightly-coordinated, mutually-accepted regional timeline. • There would be more coordination required and less flexibility than sub-option 2A. • In a single system scenario, there would be no flexibility in system software versions and upgrade timing. (For example, all Radio Site equipment across the Region would need to be on the same version.) If one agency delays making an upgrade, all agencies would be affected. • Individual agencies could not continue the current practice of establishing their own system architecture and selecting RF sites and groupings to match user agency usage patterns. • Without unified funding, regional timelines would be determined by the last partner to secure funding. • Regarding evaluation criteria: o Reliability: Network design for Backhaul would be more complicated for a multi-county Region versus an individual system serving area. (Need to connect each Radio Site to both redundant Switches. This is more complicated, and potentially more expensive, for a large multi-county area.) o Spectrum: Would need to keep analog/SmartZone sites in service to preserve Interoperability while end

central Switch equipment, and therefore less money, to build redundancy into a single system to meet Reliability goals (compared to multiple systems). ○ Implementation/transition: Transition will be easier than moving to a different vendor (under option 3) or a different technology (option 4) ○ Local service can remain the same. (Local control will change – see Threats). ○ OTAP/OTAR would be available throughout the multi-county Region. ○ GPS-enabled end user devices: Would be supported • This option will move the Region to P25, the voice technology standard adopted by the REPC. • Option 2 allows you to replace equipment at the component level (could require less space in site buildings during transition than Option 3). • Would enable some sites to be transitioned from SmartZone to P25 on channel-by-channel basis (by making a software changes).	users transition over to the upgraded radio systems (requires additional Spectrum for transition). ○ Until everyone is doing the same thing (e.g. P25 phase 2), there will be some burden on others. • Will not support Broadband-enabled end user devices.
Opportunities	Threats
• Would require some changes to existing radio system governance and business/operations models. A system-level operations and maintenance process will need to be established for the system Switches, but regional models could be considered for elements like Radio Sites, Backhaul networks, and Subscriber radios. A full Region-wide operations and maintenance model could also be considered. • Would require significant changes to the Backhaul network, and could result in a more flexible design, increased overall Backhaul capacity (compared to existing dedicated circuit approach).	• Like other sub-options (2A, 3A, 3B), this would require additional narrowband Spectrum for transition. Getting the additional Spectrum would require re-management of existing 800 MHz channels (both within current licensees and between licensees), use of Region 43 700 MHz narrowband channels, and/or use of State 700 MHz narrowband channels. We do not know for certain that we have that additional Spectrum available. • Transition could extend longer and require more careful coordination because multiple systems would be

• There would be some loss of local control and decision making (compared to existing radio systems) that could result in efficiencies, increased collaboration, and better operations. • Can keep vendor support for existing systems by upgrading. • Other controller configurations may be possible. We could improve upon the level of redundancy and Reliability.	involved. This would likely create an extended burden on end users and neighboring systems. • There would be some loss of local control and decision making (compared to existing radio systems). • This would put all users on one system. If the primary system fails and does not properly switch to the redundant backup system, it will affect the whole geography of the Region.

Sub-option 3A: Build new P25 Phase 2 LMR system(s) to replace existing LMR systems (assuming no re-used equipment). End result would be multiple systems linked together.

Strengths	Weaknesses

• Would not necessarily require changes to existing governance and business/operations models.
• Meets Mobility/Interoperability requirement.
• There would be more flexibility in system software versions and upgrade timing (versus one system).
• Each individual radio system could continue the current practice of establishing its own system architecture and selecting RF sites and groupings to match user agency usage patterns.
• Would be able to use some existing Backhaul.
• Would be able to reuse existing P25 Phase 2-capable, Mobile and Portable radios. This could reduce the number of Mobiles that need to be replaced as part of the transition process.
• Agencies could start buying radios that work on the current analog trunking systems that would also work on the new P25 Phase 2 systems.
• Regarding evaluation criteria:
  ○ Mobility/Interoperability: There would be an adequate number of Talkgroups across Gateways to support communications between users on different systems.
  ○ Reliability: Network design for Backhaul would be less complicated for a smaller, individual system service area versus a multi-county Region. (Need to connect each Radio Site to both redundant Switches. This is less complicated, and potentially less expensive, for a smaller
	• There is a potential for different groups of users to be on different technologies/versions.
	• Use of Spectrum would not be as efficient as it would be on a single system.
	• Having multiple independent funding sources could mean that regional timelines would be determined by the last partner to secure funding.
	• Regarding evaluation criteria:
	  ○ Reliability: It will require more central Switch equipment, and therefore more money, to build redundancy into multiple systems so that each meets Reliability goals.
	  ○ Implementation/transition: Increased flexibility (each system having the ability to transition on its own schedule) will also mean additional complexity. Even if transition is carefully coordinated, the transition schedule will be less "tight" if systems are upgraded independently versus one regional implementation. During transition, this will complicate Interoperability throughout the Region for the end users.
	  ○ Implementation/transition: Transition will be more difficult than staying with the existing vendor (under option 2)
	  ○ Spectrum: Because there are multiple independent systems, there is a greater risk of not having enough Spectrum to manage transition.
	  ○ Spectrum: We could need to share frequencies during

geographic area.) ○ Reliability: Because there are multiple systems, any failure would be isolated to a smaller geographic region. ○ Implementation/transition: Transition will be easier than moving to a different technology (option 4) ○ GPS-enabled end user devices: Would be supported. • Actions taken by one system are less likely to have any effect on users of a separate system after everyone is cutover to P25 Phase 2 operations (compared to single system alternatives). • Local service and control is flexible and can remain the same as it is today • This option will move the Region to P25, the voice technology standard adopted by the REPC. • Could do system-wide factory and field acceptance testing before moving users onto the system.	transition. If one agency decides to go slowly, it will slow the whole process. ○ Spectrum: Daily operation of multiple systems is potentially less spectrally-efficient than daily operation of a single system. ○ Spectrum: Would need to keep analog/SmartZone sites in service to preserve Interoperability while end users transition over to the new radio systems (requires additional Spectrum for transition). ○ Transition: With independent decision making the transition will be neither predictable nor of limited duration. ○ Until everyone is doing the same thing (e.g. P25 phase 2), there will be some burden on others. ○ On multiple systems, scalability may be more limited because of Spectrum constraints. ○ OTAP/OTAR: May be limited to home system coverage area ○ Mobility and Interoperability: Special capabilities (outside the mandatory P25 Phase 2 feature set) supported in a single system may not be passed to other systems (e.g. passing aliases to home dispatch center when end user Roams onto another system) ○ Will not support Broadband-enabled end user devices. • If multiple Infrastructure vendors are selected, we would need a larger compliment of spares (could not necessarily be shared across the Region). • If multiple Infrastructure vendors are selected, vendor-specific features will

	not work across systems.
	• During transition there are space constraints that may need to be mitigated.
	• Issues related to changing vendors:
	  ○ Need to establish new vendor relationships/trust.
	  ○ There will be a significant cost and time commitment to train technicians and end users (dispatchers and/or Mobile and Portable radio users) that is compounded because of the move to a different vendor's technology.
	  ○ Transition may be more difficult because the new vendor won't have detailed technical and operational knowledge of existing systems.
	  ○ The old vendor will have less incentive to work with us or with the incoming vendor to facilitate a smooth transition. If something doesn't work, you will have work with two vendors to resolve the issue.
	  ○ For purposes of transition, end user devices (Consoles, Mobiles, Portables, etc.) need to operate on two different systems - Motorola SmartZone 4.1 and the new system. Unless all Mobile and Portable radios operate on both systems before beginning transition, we could create service "islands."
	• If a different vendor is chosen, none of the existing CAD interfaces will be compatible.

Opportunities	Threats
• It allows the Region to establish a new set of vendor contract expectations. • This would allow radio systems to choose different Infrastructure vendors.	• Like other sub-options (2A, 2B, 3B), this would require additional narrowband Spectrum for transition. Getting the additional Spectrum would require re-management of existing 800 MHz channels (both

• Could re-architect the system to gain site efficiency, spectral efficiency, mitigate interference • Could standardize Subscriber units within groups	within current licensees and between licensees), use of Region 43 700 MHz narrowband channels, and/or use of State 700 MHz narrowband channels. We do not know for certain that we have that additional Spectrum available. • Transition: Transition could extend longer and require more careful coordination because multiple systems would be involved. The increased flexibility will come with an increased transition time frame, and an increased time frame will increase project risk (cost). This would likely create an extended burden on end users and neighboring radio systems. • Extended transition will necessitate multiple end-user training sessions for regional Interoperability. • Unless a single vendor is selected for Trunked radio system Infrastructure, the implementation could be much more complex. More vendors = more technical complexity.

Sub-option 3B: Build new P25 Phase 2 LMR system(s) to replace existing LMR systems (assuming no re-used equipment). End result would be one regional system.

Strengths	Weaknesses

• This would provide the highest level of feature functionality, Mobility, and Interoperability across the multi-county geographical area.
• Would potentially require fewer Radio Sites and less Spectrum to meet coverage and capacity requirements across the multi-county geographical area (versus multiple systems). Could produce other, additional system efficiencies over multiple systems.
• Exceeds criteria for Mobility and Interoperability: This sub-option would likely allow more Talkgroups to have regional Mobility. It would also be easier to add, change, and delete regional Interoperability Talkgroups (compared to sub-options 1A, 1B, 2A, and 3A).
• Regarding evaluation criteria:
  ○ Spectrum: Daily operation of one system is potentially more spectrally-efficient than daily operations of multiple systems.
  ○ Reliability: It will require less central Switch equipment, and therefore less money, to build redundancy into a single system to meet Reliability goals (compared to multiple systems).
  ○ Local service can remain the same. (Local control will change – see Threats).
  ○ OTAP/OTAR would be available throughout the multi-county Region.
  ○ GPS-enabled end user devices: Would be supported
• This option will move the Region to P25, the voice technology standard adopted by the REPC.
	• There would be more coordination required and less flexibility than sub-option 2A or 3A.
	• In a single system scenario, there would be no flexibility in system software versions and upgrade timing. (For example, all Radio Site equipment across the Region would need to be on the same version.) If one agency delays making an upgrade, all agencies would be affected.
	• Individual agencies could not continue the current practice of establishing their own system architecture and selecting RF sites and groupings to match user agency usage patterns.
	• Without unified funding, regional timelines would be determined by the last partner to secure funding.
	• Regarding evaluation criteria:
	  ○ Reliability: Network design for Backhaul would be more complicated for a multi-county Region versus an individual system serving area. (Need to connect each Radio Site to both redundant Switches. This is more complicated, and potentially more expensive, for a large multi-county area.)
	  ○ Spectrum: Would need to keep analog/SmartZone sites in service to preserve Interoperability while end users transition over to the new radio system (requires additional Spectrum for transition).
	  ○ Until everyone is on the new system, there will be some burden on others.

• Could do system-wide factory and field acceptance testing before moving users onto the system.	• Will not support Broadband-enabled end user devices.
Opportunities	Threats
• Would require some changes to existing radio system governance and business/operations models. A system-level operations and maintenance process will need to be established for the system, but regional models could be considered for elements like Radio Sites, Backhaul networks, and Subscriber radios. A full Region-wide operations and maintenance model could also be considered. • Would require significant changes to the Backhaul network, and could result in a more flexible design, increased overall Backhaul capacity (compared to existing dedicated circuit approach). • There would be some loss of local control and decision making (compared to existing radio systems) that could result in efficiencies, increased collaboration, and better operations. • Could bring in other stakeholders (e.g. other counties) • It allows the Region to establish a new set of vendor contract expectations. • This would allow radio systems to choose different Infrastructure vendors. • Could re-architect the system to gain site efficiency, spectral efficiency, mitigate interference • Could standardize Subscriber units within groups • Other controller configurations may be possible. We could improve upon the level of redundancy and Reliability.	• Like other sub-options (2A, 2B, 3A), this would require additional narrowband Spectrum for transition. Getting the additional Spectrum would require re-management of existing 800 MHz channels (both within current licensees and between licensees), use of Region 43 700 MHz narrowband channels, and/or use of State 700 MHz narrowband channels. We do not know for certain that we have that additional Spectrum available. • In comparison to Option 2, it is likely that some agencies would need to keep legacy systems running for a longer period of time, with increased risk. • There would be some loss of local control and decision making (compared to existing radio systems). • This option has maximum site capacity exposure on existing sites and towers (potentially a full duplication of equipment). • This would put all users on one system. If the primary system fails and does not properly switch to the redundant backup system, it will affect the whole geography of the Region.

Option 4: Build a regional Long Term Evolution (LTE) system for mission-critical voice

Strengths	Weaknesses
• Will support Broadband-enabled end user devices. • Transition could be clean because it would be a "green field" implementation. It does not depend upon reusing existing LMR frequencies. Out of all options, this transition will be the easiest. • Increased opportunities to collocate with existing sites/cellular carrier sites. (However, the existing site may need to be upgraded to meet public safety standards.) • It allows for a multi-vendor environment (e.g. LTE Core from one vendor, eNodeB equipment from another vendor, end user devices from other vendors). • Equipment could be purchased from any of multiple different vendors. • We could benefit from carriers' experience implementing the LTE Infrastructure.	• Coverage from an LTE system would require 7-10 times as many sites as we have today. Site development is very expensive and time-consuming. • Some of our current sites would not be suitable for LTE sites (e.g. high sites). • Rural sites are even more difficult to develop than urban sites. Site density and Backhaul are even bigger problems in rural areas. • Would require a lot of high capacity (Fiber) Backhaul that is not in place today. • Providing path redundancy (a secondary, alternative Fiber route) to improve the availability/Reliability of the LTE sites may be cost prohibitive. • LTE does not allow you to intentionally design the network with large areas of overlapping coverage to improve availability/Reliability in the same way that you can with LMR. If there is an LTE site outage, the geographic area around that site could be completely "off the air." • During transition, it is not clear that we could tie Talkgroups between the LMR and LTE systems together in a way that meets public safety mission critical voice requirements. • We would be an early implementer of mission-critical voice over LTE. • This is an Infrastructure-dependent technology. If there is a fundamental failure, there's not much that the end user can do to work around the failure. • We can't determine a transition plan for Mobiles and Dispatch Consoles until we know what the end user devices will look like. • There are additional regulatory requirements for LTE (defined in the

	waiver that authorizes use of the PSBB Spectrum) beyond what's required for LMR.
Opportunities	Threats
• Potential for a smaller form factor end user device. • Potential for a less expensive end user device. • Potential for an integrated voice and data end user device for those users where that makes sense. • Would potentially provide the opportunity to consolidate networks – to build and operate an integrated voice and Broadband data network. • This could allow Roaming outside of traditional coverage areas through partnerships with commercial carriers and/or other public safety agencies. • There is a mechanism within LTE to give public safety prioritization on a public network. (However, it has not been implemented yet in a way that lets us assess how it would work for public safety voice.) • Regardless of what governance model is selected locally, some level of control will be given over to regional, state, or national organizations. It is not clear that we can sustain existing business and operational models in an LTE environment.	• Mission critical voice on LTE is an unknown technology with an unknown timeline. There is currently no standard, and no indication that the technology will be commercially available prior to the end of life of existing LMR systems. • Mission critical voice over LTE has not been vetted with the public safety community. We don't know that LTE devices will meet public safety end user requirements prior to end of life of existing LMR systems. • It is not clear that the current 5+5 MHz Public Safety Broadband Spectrum is enough for a Region-wide voice and data system. • It is not yet clear if Spectrum policy in Canada will align with the US for the PSBB Spectrum (or for the additional 10 MHz of Spectrum if the D Block is also reallocated to Public Safety). There may be some deployment challenges for sites with few physical obstructions between them and the Canadian border. • There are no gradual failure modes in LTE (analogous to site trunking and "failsoft" modes in existing LMR systems). LTE components (eNodeB's) cannot operate without a connection to a Core. If there is a single, specific failure (Core, Backhaul) it could result in a widespread outage. • A single integrated voice and data LTE system would potentially introduce single point(s) of failure for all public safety communications. • LMR is a proven technology. LTE for mission-critical voice is not yet a proven technology. LTE may be generation away from being accepted by public safety for mission-critical

	voice. • In the rural areas where the cost to build an LTE network is the highest, the number of users would be the lowest (and the commercial carriers are least likely to build to enable Roaming). • There is not enough known about moving public safety voice across an LTE environment that anyone can reliably state that they can provide public safety priority.

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Appendix H

Report Development Notes

This document was a collaborative effort of the Project Steering Committee (PSC), a group of radio system professionals representing the following agencies:

- City of Seattle
- City of Tacoma
- Eastside Public Safety Communications Agency (EPSCA)
- King County
- Pierce County
- Port of Seattle
- Snohomish County Emergency Radio System (SERS)
- Valley Communications Center (ValleyCom)
- Washington State Patrol

The PSC held a series of working sessions to analyze options; identify strengths, weaknesses, opportunities, and threats (SWOT); work through technical differences of opinion; achieve consensus; and agree upon the final text of this report. A timeline of the PSC working sessions is listed below.

August 2, 2011:	Option 2 analysis
August 16:	Option 4 analysis
August 29:	Option 1 analysis
September 13:	Option 3 analysis
September 26:	SWOT session 1
September 30:	SWOT session 2
October 4:	SWOT session 3
October 6:	SWOT session 4
October 18:	SWOT session 5
October 24:	SWOT session 6
November 8:	SWOT session 7
November 15:	Comparative analysis of options
December 2:	Option 2 cost analysis
December 6:	Draft review/edit
December 8:	Draft review/edit
December 12:	Draft review/edit
December 14:	Draft review/edit
December 29:	Draft review/edit
January 11, 2012:	Draft review/edit
January 17:	Public Safety Stakeholder review
January 23:	Public Safety Stakeholder review
February 10:	Draft review/edit

February 13: Draft review/edit
February 17: Final draft review with Sparling

Appendix I

Coverage Maps

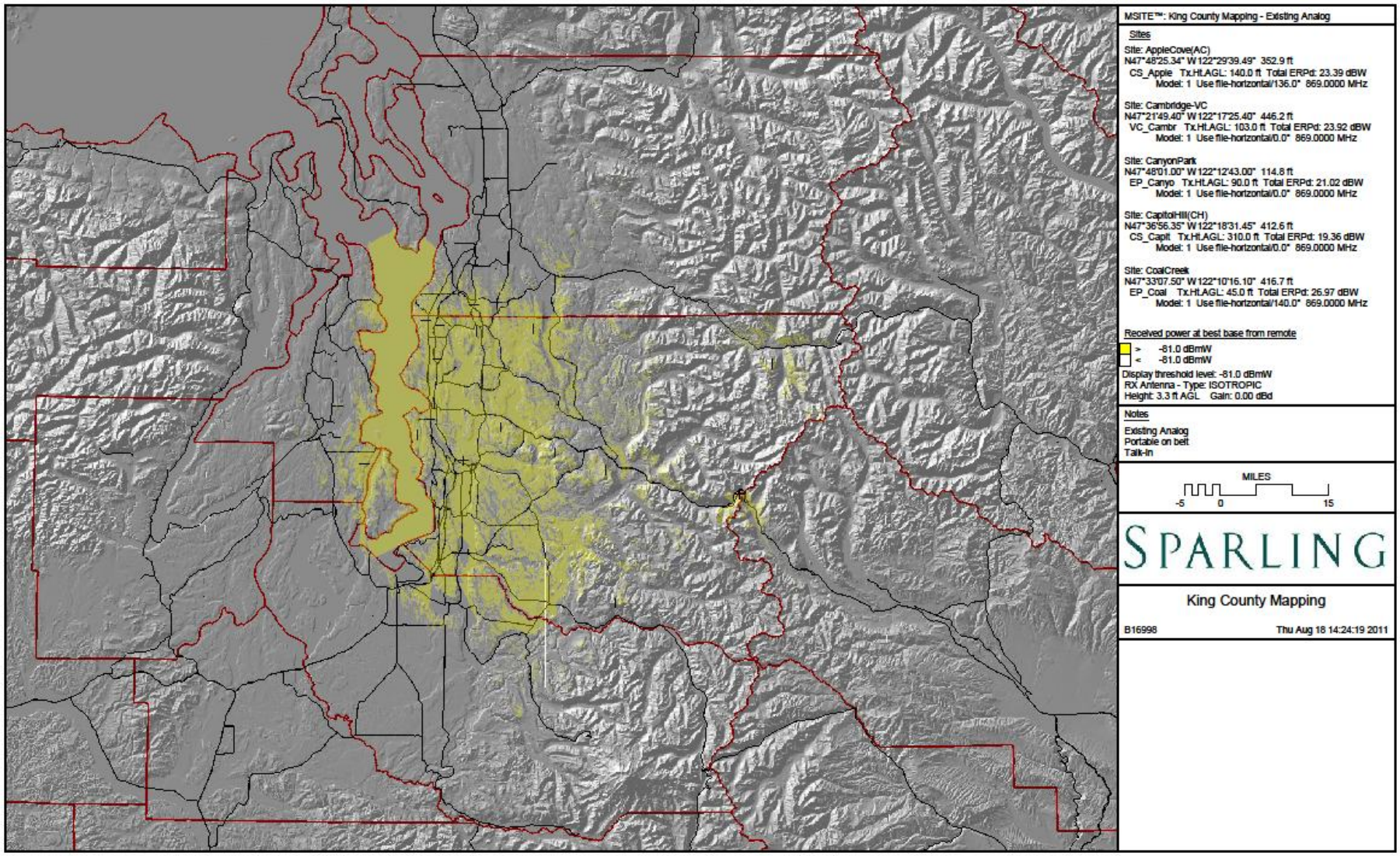
The Project Steering Committee hired Sparling to create coverage maps for planning purposes. Sparling created maps for existing SmartZone radio systems and for comparable P25 Phase 2 radio systems to illustrate expected differences in coverage if only existing Radio Sites are used.

The coverage maps included here show expected coverage for:

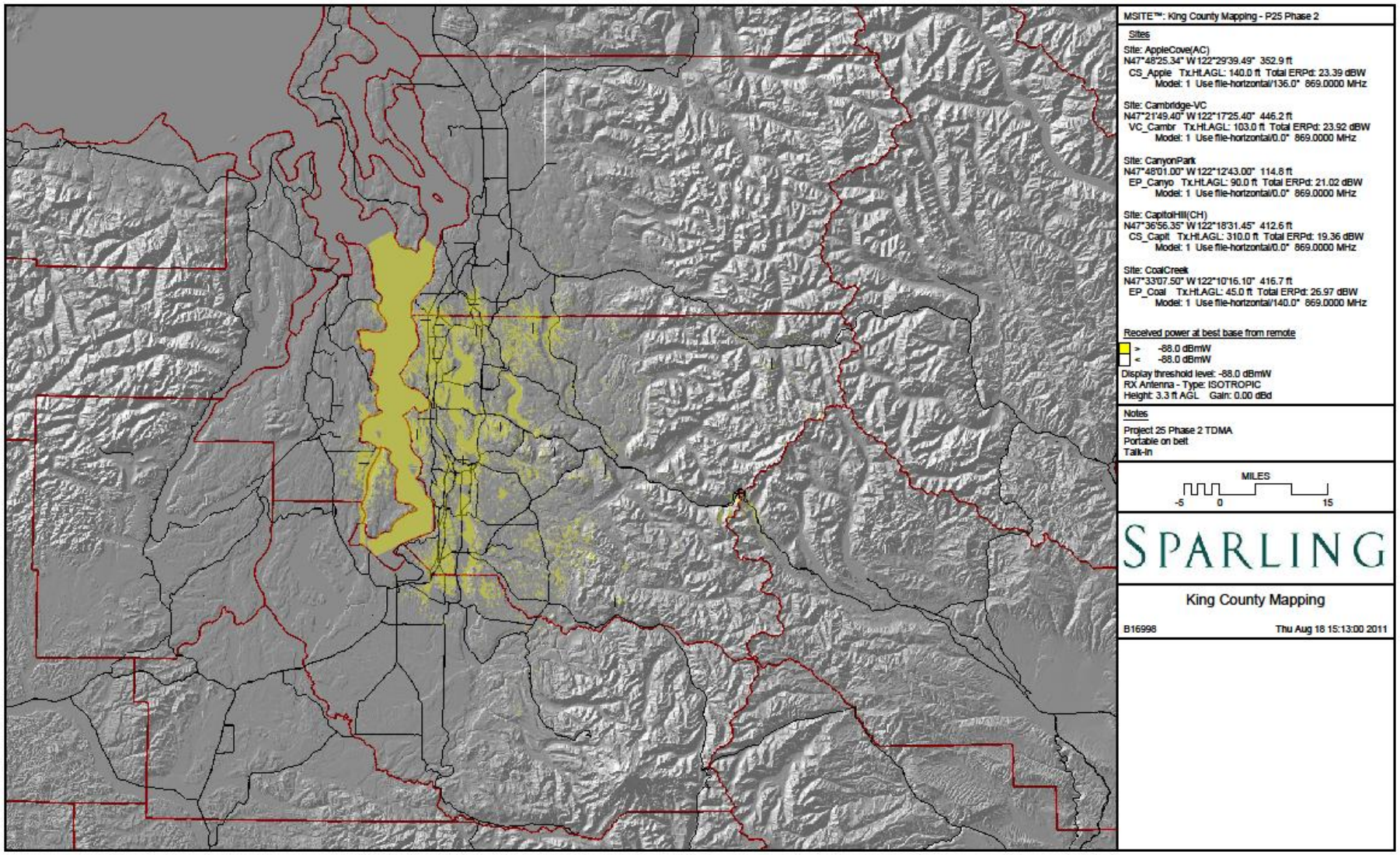
- King County sites only
- Pierce County sites only
- Snohomish County sites only
- King, Pierce, and Snohomish Counties combined

In all cases, the maps show coverage for Portable radios transmitting to Radio Sites (the worst case scenario).

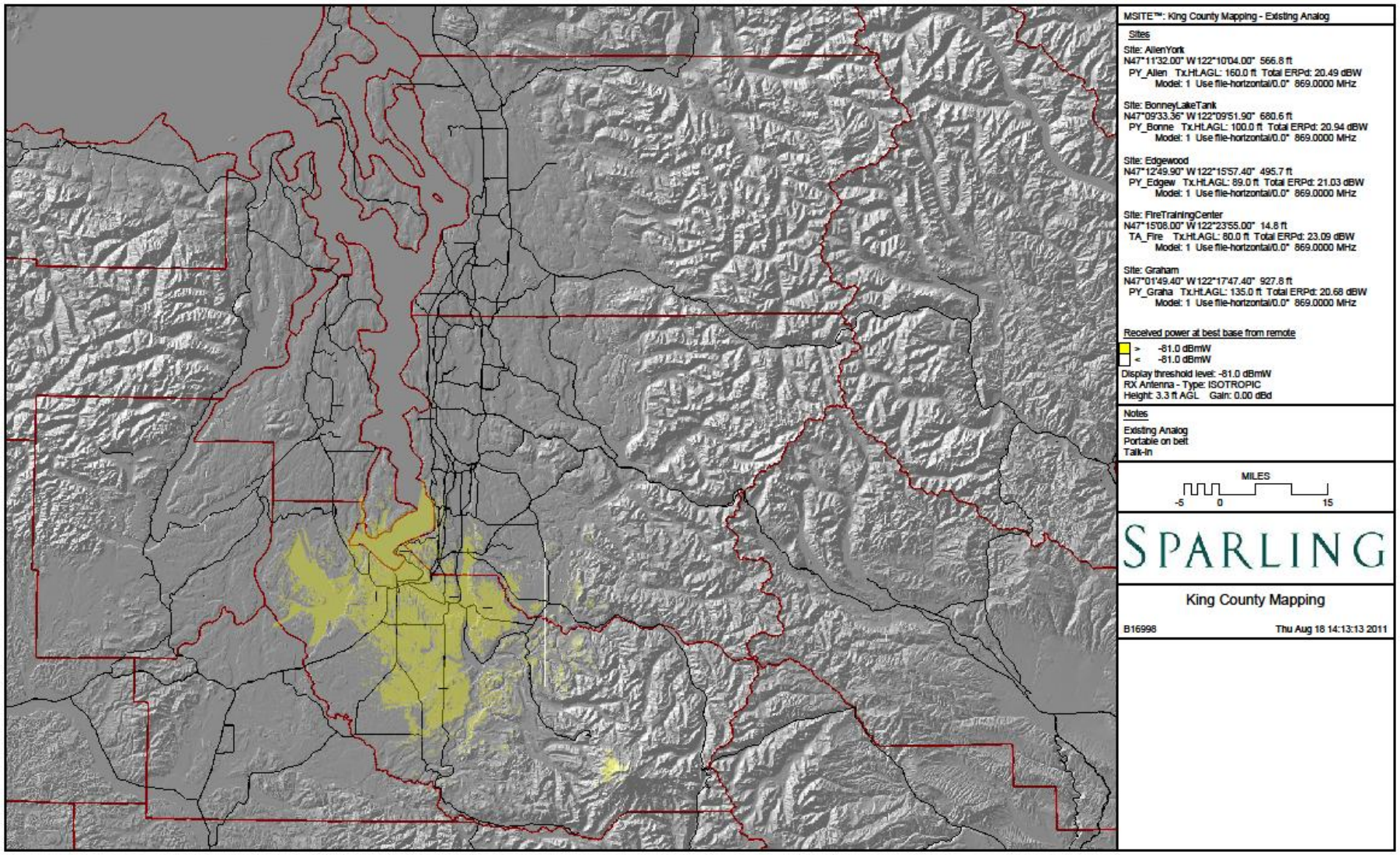
Existing coverage (SmartZone systems) – King County sites only



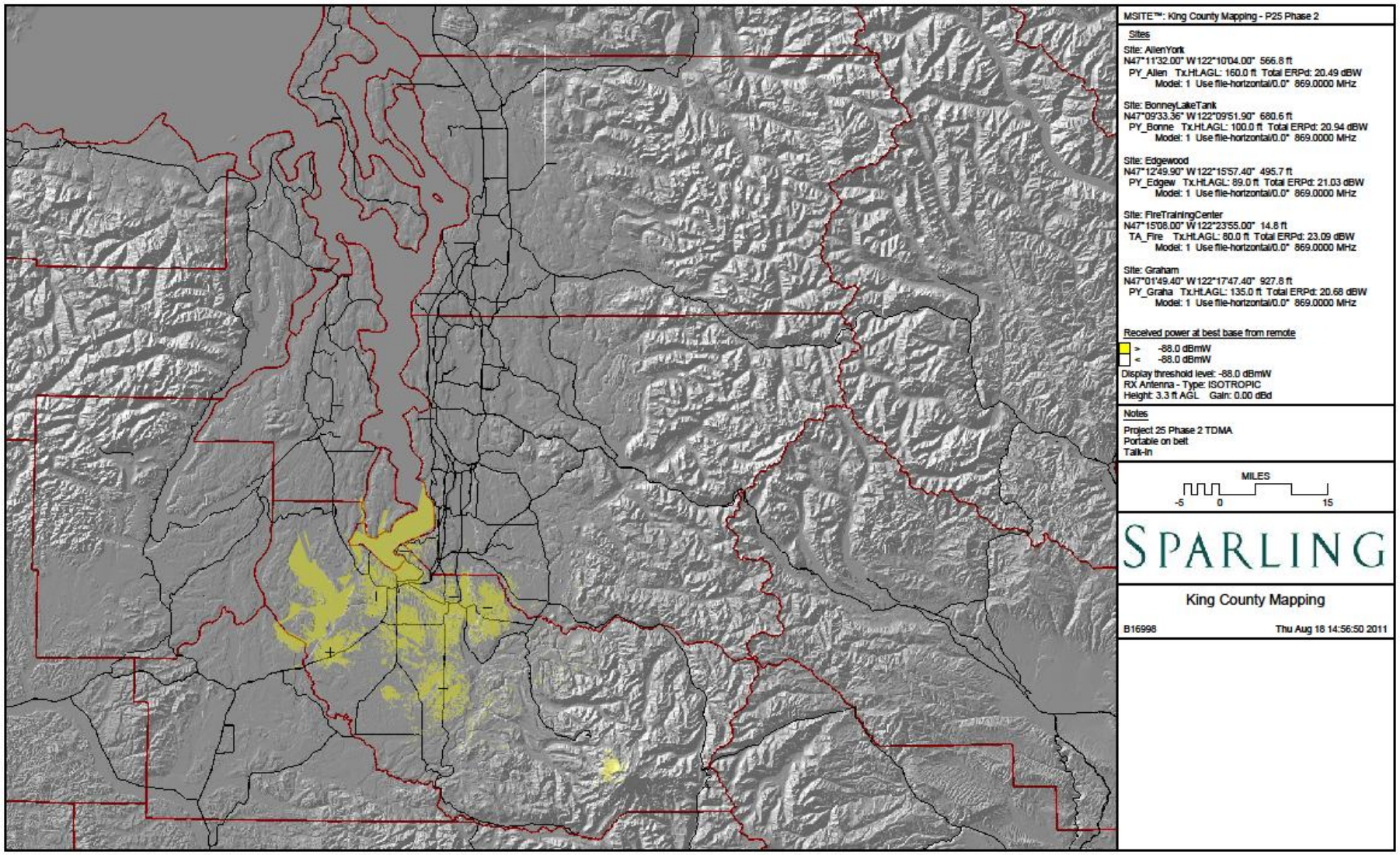
P25 Phase 2 coverage – King County sites only



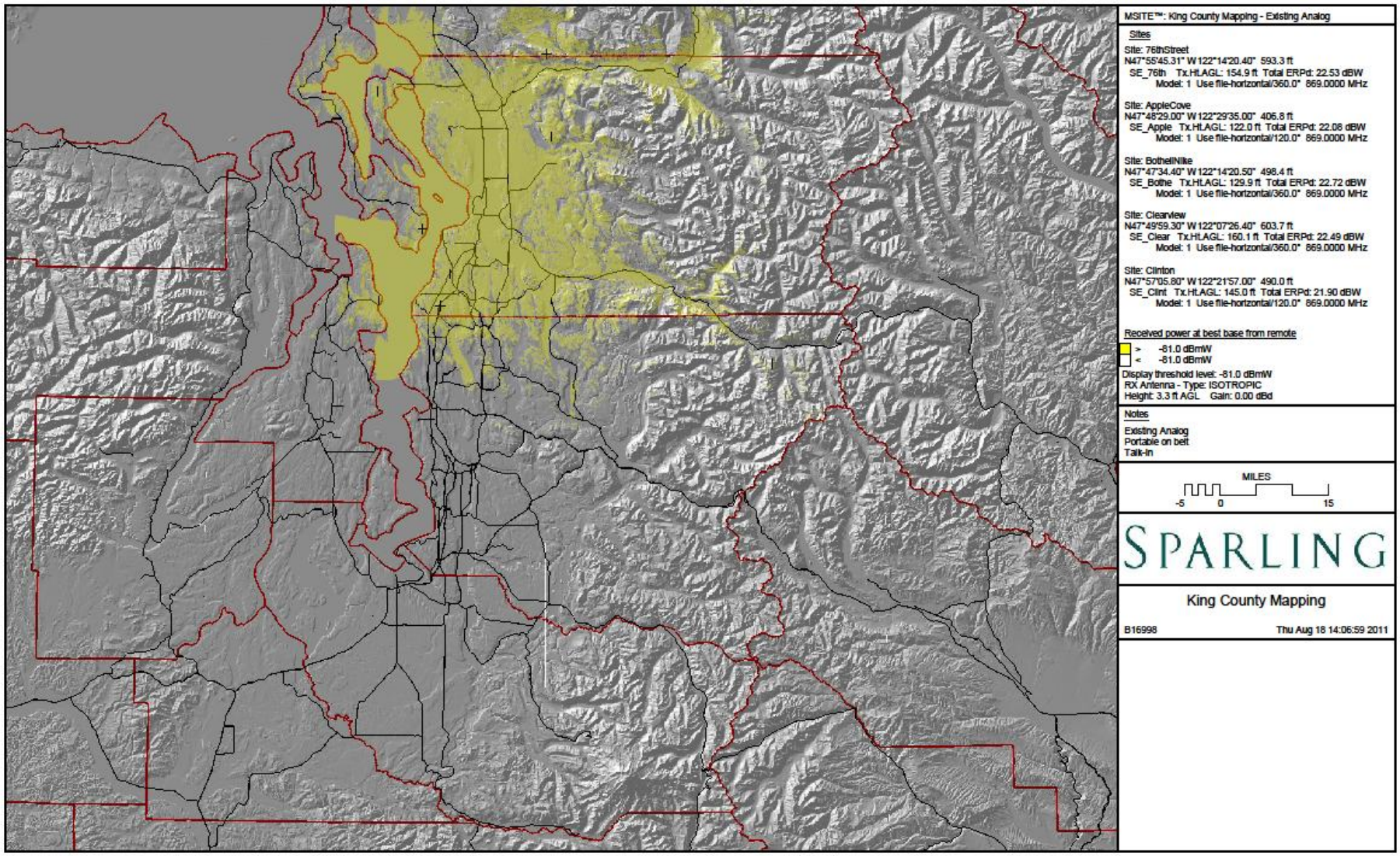
Existing coverage (SmartZone systems) – Pierce County sites only



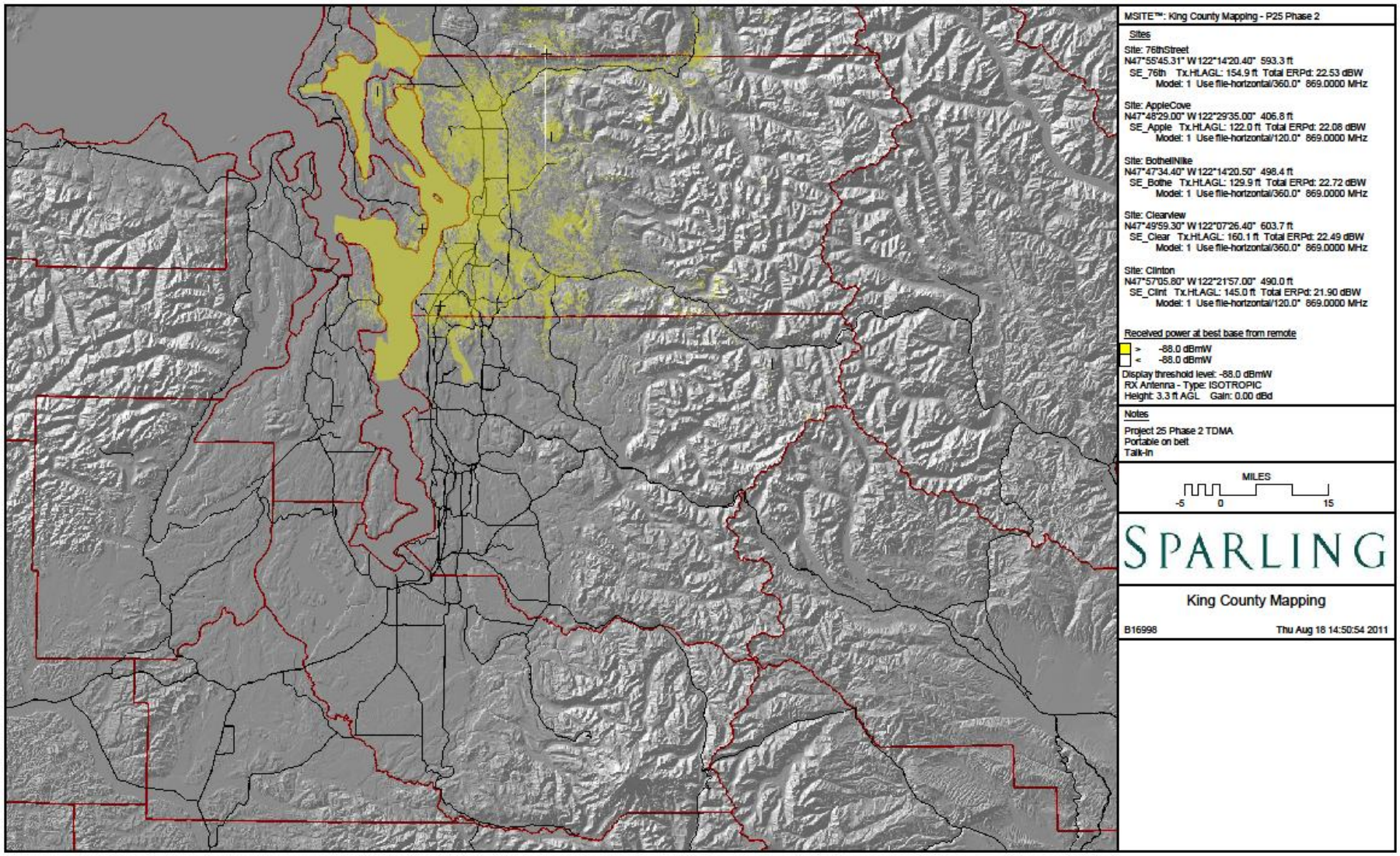
P25 Phase 2 Coverage – Pierce County sites only



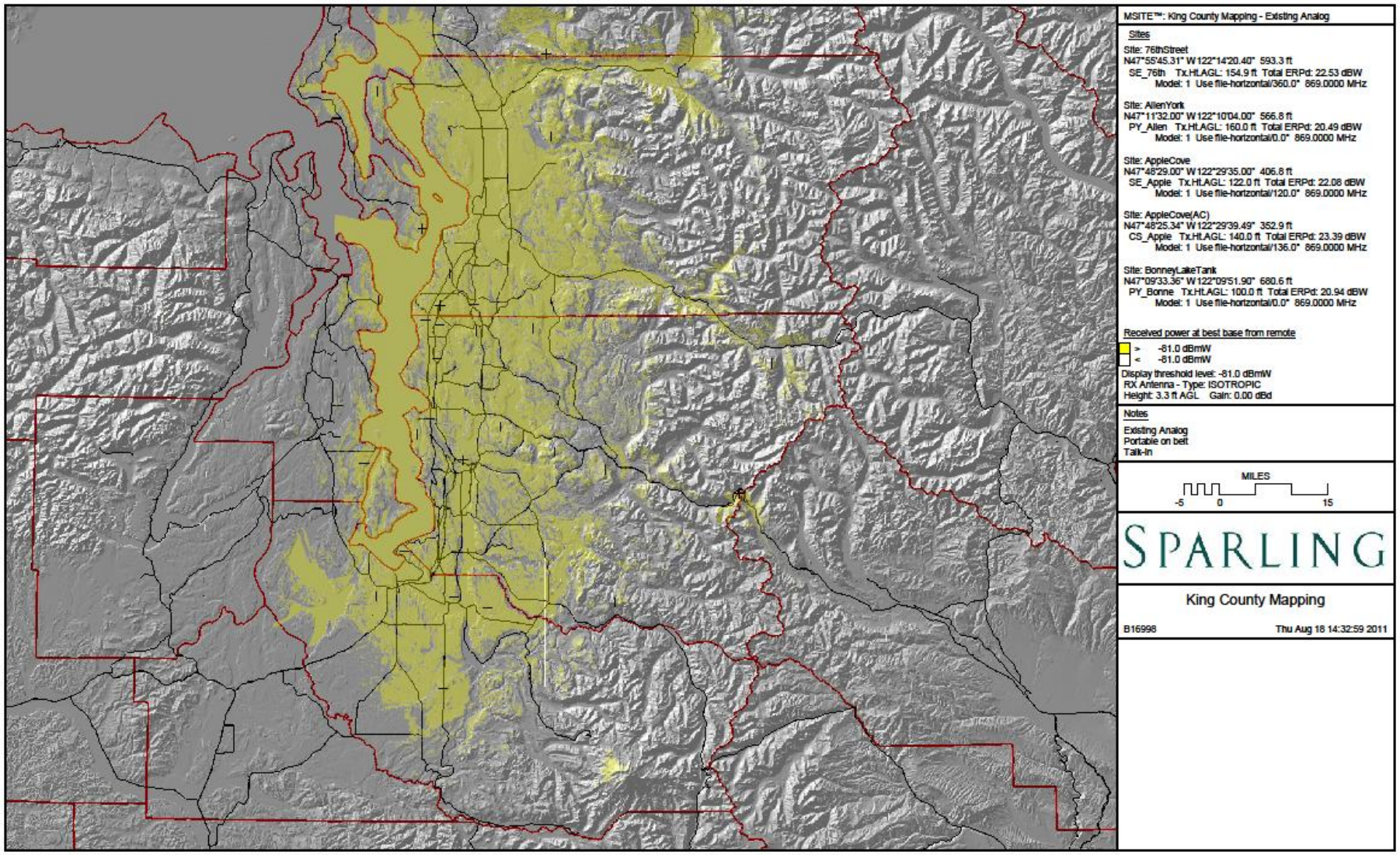
Existing coverage (SmartZone systems) – Snohomish County sites only



P25 Phase 2 coverage – Snohomish County sites only



Current Coverage (SmartZone systems) – King, Pierce, and Snohomish Counties combined



P25 Phase 2 Coverage – King, Pierce, and Snohomish Counties combined