

Public Safety Radio System Cost Model

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1 Executive Summary

This report, written by the Public Safety Special Interest Group (PSSIG) of the SDR Forum, describes a tool for estimating total lifecycle costs associated with any public safety radio system and a methodology for determining cost impact to that system for incorporating new SDR technologies. The information described herein will be of value for future cost tradeoff studies performed by the PSSIG as well as for use in the public safety community for planning new communications systems or modifications to existing systems. The lifecycle cost model, captured in an EXCEL spreadsheet, is organized in a user-friendly, hierarchical fashion. Total lifecycle costs are decomposed in the spreadsheet to progressively finer levels of detail; spreadsheet cost entries, for all levels of detail for a system, “roll up” into the total lifecycle costs.

The spreadsheet is useful for SDR technology cost tradeoffs because it enables “what-if” lifecycle cost comparisons of systems with new SDR technologies versus those without. For example, to compare system-level lifecycle costs for using multiband radios versus having separate radios for each band, costs and quantities of the individual portable radios in a system can be adjusted in the spreadsheet, along with other relevant system cost factors, and the spreadsheet will calculate the total lifecycle costs for each option. If one wishes to perform even more detailed cost tradeoff investigations regarding designs of individual equipment in a typical public safety system (e.g., hardware/software design tradeoffs for portable radios), costs are hierarchically decomposed in the spreadsheet into detailed costs of the components that make up the equipment (e.g., PA, RF components, baseband processors, software applications, etc.). The spreadsheet captures this detailed breakdown not only for the portables, but also all other components of a complete public safety radio system. This includes, but is not limited to, the base stations, mobiles, network equipment, and even site costs such as site preparation, generators, shelters, etc. Due to the large amount of information that the spreadsheet contains, care was taken to organize it to be logical, user friendly and enable overrides at any level of detail where finer cost detail is not available. The cost for a representative public safety radio system is discussed in this report to illustrate the spreadsheet’s use.

2 Introduction

2.1 Background

On 14 April 2006, the Public Safety Special Interest Group (PS-SIG) published a report entitled “Software Defined Radio for Public Safety”¹ that assesses the potential of and issues associated with SDR technology for the public safety/public protection and disaster response application area. The process by which these issues were identified and analyzed began with identifying key questions on the topic of SDR technology for public safety. These questions were published in a Request for Information (RFI), to which eight diverse organizations replied. The reply comments were then analyzed to identify areas of consensus and divergence among the comments and the Public Safety Special Interest Group. One of the key conclusions of the report that was the motivation for the work discussed herein is as follows:

“The economic, business, and cost implications of (new SDR technologies) are difficult to quantify at this point because there is a lack of models characterizing these factors that can be used to guide decision-making on research and development (R&D) investment strategies...better quantification of the total cost of ownership (to include maintenance, training, and upgrade costs) of SDR-based systems is needed to establish appropriate price points for SDR-based public safety communications equipment and systems.”

In particular, the report suggests the development of a model that would assist in calculating the costs for a Land Mobile Radio (LMR) system with considerations of current or future characteristics or attributes such as:

- New multi-service protocols added to a traditional LMR radio
- Multiple public safety protocols
- Multiband capability (adjacent bands and multi-octave)
- Deploying SDR in infrastructure versus terminal equipment;
- Software Communications Architecture (SCA) and other candidate interfaces for defining standards
- Public Safety requirements that are cost drivers (“what if” perturbations of the cost driving requirements such as transmitter adjacent channel power ratio, receiver adjacent channel rejection, environmental/ruggedness requirements, etc.)
- Partitioning of features, functions and services (“one size fits all” versus partitioning into more than one device)
- TX linearity
- Software downloads
- Cognitive radio functions
- Higher data rates
- Power output
- Portable size, weight, battery life

¹ http://www.sdrforum.org/uploads/pub_36302706_a_0001_v_0_00_public_safety_04_14_06.pdf

- Field costs in transitioning from current systems to more capable SDRs

To address these needs, the Cost Model Working Group (CMWG) was formed within the PS-SIG in mid 2006, and this report describes accomplishments of this group in developing a cost tradeoff methodology and a cost modeling tool.

2.2 Summary of Results

The CMWG found no publically available public safety cost modeling tools that could serve the needs of this study. As such, an EXCEL spreadsheet was developed by the CMWG with the primary purpose of facilitating tradeoff studies from the list in the preceding paragraph. The spreadsheet computes system life cycle costs based on the summation of its cost elements. Another potential use of these tools is to provide individuals in the public safety community that are planning a new public safety radio system a framework for estimating the total lifecycle costs of the system.

The cost elements are modeled in the spreadsheet in a hierarchical manner with high level cost categories broken down into increasing finer levels of detail. This enables determining how changes to costs of even low level cost elements (e.g., the power amplifier of a portable) “roll up to” the top- level life cycle costs.

To “shakedown” the spreadsheet and also have a baseline system cost for future cost tradeoffs, cost data for an actual public safety system was entered into the spreadsheet. Initially, a search was conducted for public-domain information that would have a cost breakdown for a “representative” complete public safety communications system. Even though such information is available from vendor members of the CMWG, this information was deemed by the vendors as company proprietary and was thus was not releasable to the SDR Forum. However, midway through our study, a report (*Gunn, 2007*) was released by the SDR Forum which contains a public-domain cost estimate/breakdown made by the Warner Group in 1999 for a complete radio system for the State of California. The system cost elements of the Gunn report were mapped to the Excel cost spreadsheet to establish a “representative” spreadsheet baseline cost model.

2.3 The SDR Forum Public Safety Special Interest Group

The SDR Forum is an open, non-profit corporation dedicated to supporting the development, deployment, and use of open architectures for advanced wireless systems, with a mission to accelerate the proliferation of SDR technologies in wireless networks to support the needs of civil, commercial, and military market sectors. Activities focus on:

- Developing requirements and/or standards for SDR technologies, including working in liaison with other organizations to ensure that Forum recommendations are easily adapted to existing and evolving wireless systems
- Cooperatively addressing the global regulatory environment
- Providing a common ground to codify global developments
- Serving as an industry meeting place

The Public Safety Special Interest Group is one of several special interest groups within the Forum that bring together developers, users, regulators, and educators to address issues specific to the application of SDR technology to a particular domain or market area. Goals of the Public Safety SIG are to interface with the public safety community (including both users and vendors), to raise awareness of SDR, to publicize the activities of the Forum in addressing those issues, and to increase participation of the public safety community in the SDR Forum. The Public Safety SIG also interacts with other committees and working groups within the Forum to provide the public safety community's inputs into the publications and initiatives undertaken by the Forum. It is a unique venue, because participation in the Public Safety SIG has historically included public safety organizations, land mobile radio vendors, manufacturers of SDR for military applications, software developers, and regulators.

2.4 Definitions

SDR- Software Defined Radio (SDRF CRWG, 2007) - Radio in which some or all of the physical layer functions are software defined.

Physical Layer (SDRF CRWG, 2007) - The layer within the wireless protocol in which processing of RF, IF, or baseband signals including channel coding occurs. It is the lowest layer of the ISO 7-layer model as adapted for wireless transmission and reception.

Lifecycle Costs (Business Dictionary.com)- Sum of all recurring and one-time (non-recurring) costs over the full life span or a specified period of a good, service, structure, or system. It includes purchase price, installation cost, operating cost, maintenance, and upgrade costs, and remaining (residual or salvage) value at the end of ownership or its useful life.

2.5 Assumptions

Major assumptions for this effort are as follows:

1. The baseline system cost is taken from the Public Safety Market Study² by Jim Gunn.
2. Cost is computed by the spreadsheet for a typical LMR public safety system including, but not limited to, the network, infrastructure, sites, property, buildings, dispatch centers, mobile (vehicle-mounted), and portable (hand-held) equipment. Broadband data equipment is not included.

3 Analysis

An initial task in this study was to perform a survey of the internet and other sources to ascertain whether any tools already existed for modeling cost of a complete public safety radio system. Unfortunately, none that were usable were found in the public domain.

The Excel cost spreadsheet developed by the CMWG is a tool that calculates total lifecycle costs of a public safety communications system based on cost entries for each portion of the system (denoted "component costs"). The spreadsheet provides a framework and methodology for quantifying the total cost of ownership of public safety radio systems, and enabling cost impact

assessments of incorporating new SDR technologies into the system. Simply stated, this is done with the following 3-step procedure:

1. Use the spreadsheet to calculate the baseline total system cost without the new SDR technologies
2. Identify cost components of the spreadsheet that are impacted by the new technology and make the appropriate adjustments to these costs in the spreadsheet, commensurate with that technology
3. Compare the cost calculated by the spreadsheet for Step 1 (baseline system) versus that calculated for Step 2 to gauge the cost impact at the system level.

The spreadsheet contains several worksheets that are organized as depicted in Figure 1. At the top of all worksheets in the spreadsheet are hypertext links that provide assistance in navigating through the workbook. One link is “*Cost Model Spreadsheet Instructions*” and when selected will bring the Instruction worksheet sheet to the front of the stack for the user to get help on the workbook. The second link, “*Main Sheet*”, is on all worksheets except the Main worksheet and takes the user back to the main sheet. On the Equipment category sheets there will be a third link “*Equipment Sheet*” that takes the user up to the equipment sheet.

There are a number of different colored cells in each of the worksheets. The cells with light blue background, across the top and down the left hand side, are labels for each of the cost elements in that sheet. On the Main Sheet and on the Equipment Sheet there are also hyperlinks to take the user to that worksheet to enter, edit or review the costs shown on that sheet. The cells that are crosshatched with a blue background are empty and should not be modified.

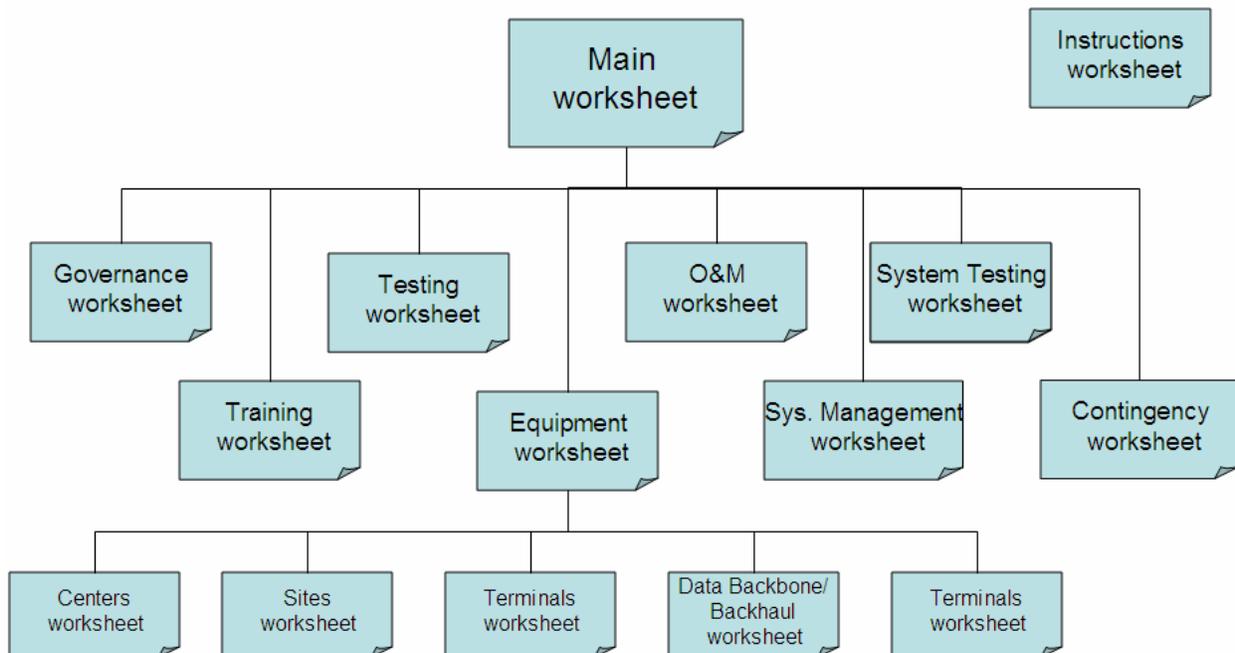


Figure 1: Cost Model Workbook Hierarchy

The remaining cells on each worksheet are arranged hierarchically to show how the costs roll up from the basic component costs to the costs of more complex portions of the items. As the user progresses through the worksheet, items that are at more detailed cost levels will have their data cell further to the right. These cells have either a yellow or a white background. The cells with a white background are at the lowest level for that portion of the cost model and the user should enter the best estimate or exact cost estimates here. The cells with a yellow background are dual purpose cells. They are typically calculated by summing up all of the yellow and white cells that are at a lower level. Or, the user can enter a value in the immediate cell to the right of them (orange “override” cell) as an estimate for the whole subsystem if the analyst does not have a good idea of the individual component costs.

3.1 Main Cost Model Sheet

Figure 2 is the spreadsheet page corresponding to the highest levels of cost detail. As an example illustrating how the spreadsheet can be used, numerical values are included corresponding to the representative State of California system discussed previously in paragraph 1.2.1. This worksheet is primarily a summary of all of the costs entered in the other worksheets. At the top of the sheet is a cell for entering a textual description of the configuration that is being modeled. Below that is a date field for the model.

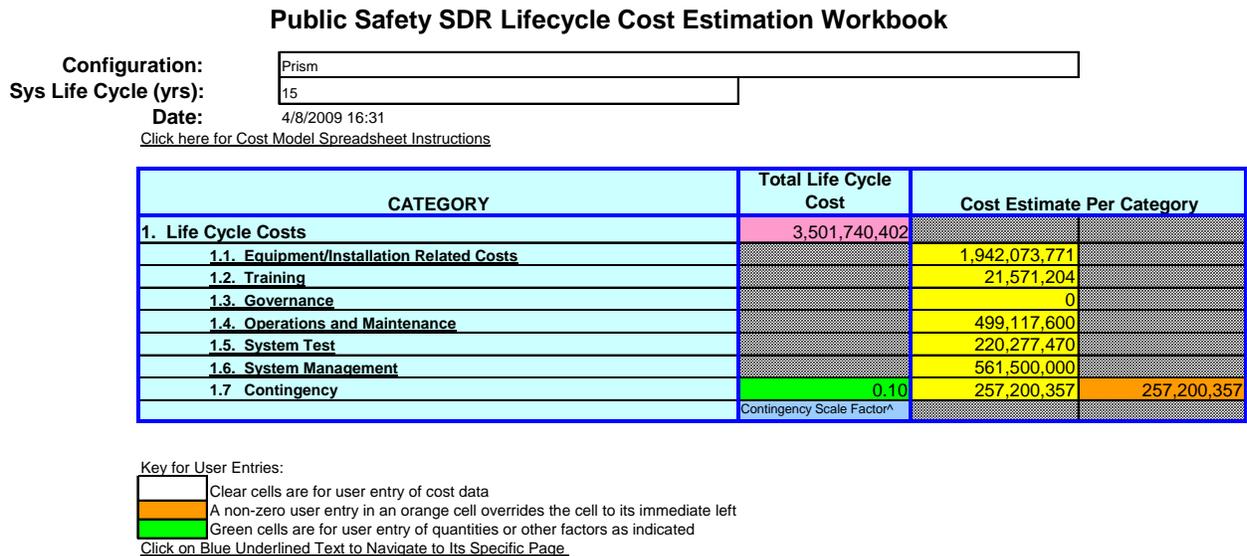


Figure 2: Main Cost Model Sheet

At the top of this sheet, the user enters a description of the configuration and the expected life cycle of the system in years. Both entries are for documentation purposes, and are not used in any formula elsewhere in the spreadsheet.²

² However, the system life cycle time should be considered by the spreadsheet user when entering individual quantities of equipment comprising the system elsewhere in the spreadsheet. If some equipment components have lifecycles that are shorter than the system life cycle, then the entry for the number of components may need to be revised accordingly. For example, if a radio’s life cycle is estimated to be 5 years and the system lifecycle is 15 years, the number of radios entered in the spreadsheet should be tripled.

The cost categories are numbered in a hierarchical manner, with each level of the hierarchy defined as a particular cost “level”. For example, the total life cycle cost (the cell with the pink background) is “level 1”, because it has only one number in its designation and is the highest level of cost in the entire spreadsheet. Cost components 1.1 through 1.7 are “level 2”. On subsequent sheets (to be discussed), these high level costs are further decomposed into more detailed levels 3, 4, 5, 6, 7, and even 8, as appropriate. Level 8 cost categories have eight numbers in their designations, separated by periods, and are at a very fine level of detail.

The cost contingency category 1.7 of Figure 2 is computed in the spreadsheet as a fraction of the sum of the other six level 2 categories shown; the fractional value is entered by the user in the green cell (10% for this example) and the result appears in the yellow computation cell to its immediate right. If the user does not wish to compute cost contingency in this way, the computation can be overridden by entering a different value (must be greater than zero) in the rightmost orange cell in the same row³. Six of these seven level 2 categories (with underlined, blue category titles) are further broken down into their major subcategories and summed on the spreadsheet’s other worksheets; the yellow background indicates a summation that cannot be written into by the user. Clicking on the name for any of these six major categories will open a new worksheet that has the further breakdown and summation. For example, the sheet shown in Figure 3 appears after clicking on “1.1 Equipment/Installation Related Costs”.

CATEGORY	Qty Per Higher Level Category	Cost Estimate Per Category			
1.1. Equipment/Installation Related Costs		1,942,073,771	0		
<u>1.1.1. Centers</u>			167,190,000		
<u>1.1.2. Sites</u>			1,088,749,675		
<u>1.1.3. Terminals</u>			360,160,400		
<u>1.1.4. Data Backbone/Backhaul</u>			148,305,800		
1.1.5 Inbuilding Coverage Systems (e.g., BDAs)	159	<Qty	7,950,000	50,000	<unit cost
1.1.6 Sales Tax on Equipment	0.05	<Tax Rate	137,173,524	137,173,524	
1.1.7 Spare Equipment Parts	0.10	<Spares Proportion	32,544,372	32,544,372	

Figure 3: Decomposition of Equipment/Installation Costs

3.2 Equipment/Installation Costs

On Figure 3, the level 2 “1.1 Equipment/Installation Related Costs” are further broken down by this sheet into the seven level 3 subcategories 1.1.1 through 1.1.7. Categories 1.1.1 through 1.1.4 have yellow cell shading and underlined blue category titles that indicate that they are a summation of a further breakdown of these components into their subcategories on subsequent spreadsheet pages; like the main sheet discussed previously, these can be navigated to by clicking on the blue underlined text.

The white cell on this page is indicative of the finest detail contained in the spreadsheet for this cost category, and requires a cost estimate entry to be typed in by the spreadsheet user. This category is a placeholder for all bi-directional amplifiers, leaky coax antennas, and other

³ For this State of California example, contingency was computed in a different manner to the method used in this spreadsheet, so the value from reference 1 (257,200,357) is entered directly in the orange override cell.

associated hardware that may be employed for inbuilding coverage enhancement, but excludes transmit/receive repeater sites that sometimes are used for coverage of, say, a large structure such as the Mall of America. The white cell entry is multiplied by the quantity of inbuilding systems (159 in this example) to give the total for all inbuilding systems (7,950,000) in the yellow cell. The summation of all level 3 cost categories (yellow shaded cells in rows for the 1.1.N categories) rolls up to the level 2 yellow shaded cell (value of 1,942,073,771 for the example).

The categories “Sales Tax on Equipment” and “Spare Equipment Parts” are at their lowest level of detail in this sheet. These are typically estimated as a percentage of the total equipment costs, with the fractional value for the percentages entered in the green cells (5% and 10% respectively for this example). However, the orange cells to the immediate right of their yellow summation values indicate that they too can be overridden, by a non-zero entry, if the spreadsheet user does not wish to have the spreadsheet calculate their values.

3.3 Equipment-Centers

Clicking on “1.1.1 Centers” in the Figure 2 worksheet sheet brings up the sheet shown in Figure 4. As the figure illustrates, this category includes the following level 4 subcategories:

Emergency Operations Center- Includes development and equipment costs for dispatch equipment, 911 center, System/network manager equipment, and buildings/sites that contain this equipment.

Network Equipment Centers- Includes development and equipment costs for voice/data network/routing equipment, network management equipment, and buildings/sites that contain this equipment.

Dispatch Centers- Includes console electronics, consoles, interfaces, and buildings/sites that contain this equipment.

Mobile Command Posts- Includes all transportable shelter equipment, remote dispatch equipment, and all other electronics and furnishings carried in the transportable shelter.

Traffic Management Centers- Includes Site preparation, building and furnishings, Towers and Antennas, and inside electronics.

Backup Centers- A placeholder for all equipment at a backup center, if applicable.

Each of the above subcategories is broken down on this sheet into the lowest levels of detail, so there is no further expansion of these categories in other worksheets.

For the cost categories that contain a green background “quantity” entry, the summation (yellow) cell is the product of the entered quantity with the summation of the subcategories associated with that category. For example, if the quantity of emergency operation centers (level 4 category 1.1.1.1) were changed from the indicated value of “1” to “2”, the yellow background cell would change to 140,000,000 from 70,000,000. The orange override box for this category can override, with a non-zero entry, the summation of the level 5 categories that forms the “per unit” summation.

All other orange override cells associated with other cost categories within this sheet also override the summation of the next higher level categories for that make up that category, if finer level of cost detail is not available. Override occurs with any non-zero entry in the orange cells.

Category	Qty Per Higher Level Category	Cost Estimate per Category			
1.1.1. Centers (Note: If a Center includes a TX and/or RX Site, Enter The Site Costs Under "sites")		167,190,000	0		
1.1.1.1. Emergency OP Center		70,000,000	0	<unit cost override	
1.1.1.1.1. Property		0	0	0	
1.1.1.1.1.1. Property cost				0	
1.1.1.1.1.2. Lease cost				0	
1.1.1.1.2. Site Development		0	0	0	
1.1.1.1.2.1. Preparation				0	
1.1.1.1.2.2. Fencing				0	
1.1.1.1.2.3. Road/Parking				0	
1.1.1.1.2.4. Grounding				0	
1.1.1.1.2.5. Grading				0	
1.1.1.1.2.6. Other				0	
1.1.1.1.3. Building Per Site		0	0	<unit cost override	
1.1.2.1.3.1. Purchase cost per building				0	
1.1.1.1.4. Grounding system				0	
1.1.1.1.5. HVAC				0	
1.1.1.1.6. Fire protection				0	
1.1.1.1.7. Utilities				0	
1.1.1.1.8. Other				0	
1.1.1.1.9. Tower Per Site		0	0	<unit cost override	
1.1.1.1.9.1. Purchase cost				0	
1.1.1.1.9.2. Lease cost				0	
1.1.1.1.9.3. Lighting				0	
1.1.1.1.9.4. Upgrade				0	
1.1.1.1.9.5. Antenna relocation				0	
1.1.1.1.9.6. Grounding				0	
1.1.1.1.9.7. Other				0	
1.1.1.1.10. Back Up Power systems		0	0	0	
1.1.1.1.10.1. Generator				0	
1.1.1.1.10.1.1. Purchase cost				0	
1.1.1.1.10.1.2. Fuel tank				0	
1.1.1.1.10.1.3. Other				0	
1.1.1.1.10.2. Battery/charger				0	
1.1.1.1.10.2.1. Purchase				0	
1.1.1.1.10.2.2. Other				0	
1.1.1.1.11. UPS		0	0	0	
1.1.1.1.11.1. Purchase				0	
1.1.1.1.12. Console Electronics		0	0	<unit cost override	
1.1.1.1.12.1. Display				0	
1.1.1.1.12.2. Keyboard				0	
1.1.1.1.12.3. Processor Equipment				0	
1.1.1.1.12.3.1. Interface cards				0	
1.1.1.1.12.3.2. Processor				0	
1.1.1.1.12.3.2.1. SW				0	
1.1.1.1.12.3.2.2. HW				0	
1.1.1.1.12.3.3. Cables/Enc/PWR Supply				0	
1.1.1.1.13. Console Positions		0	0	<unit cost override	
1.1.1.1.13.1. Furniture				0	
1.1.1.1.13.1.1. Operator				0	
1.1.1.1.13.1.2. Supervisor				0	
1.1.1.1.13.1.3. Training				0	
1.1.1.1.13.2. Accessories				0	
1.1.1.1.13.2.1. Foot Switch				0	
1.1.1.1.13.2.2. Microphone				0	
1.1.1.1.13.2.3. Headset				0	
1.1.1.1.13.2.4. Handset				0	
1.1.1.1.13.2.5. Speakers				0	
1.1.1.1.14. System Manager Positions	50	70,000,000	1,400,000	<unit cost override	
1.1.1.1.14.1. Furniture				0	
1.1.1.1.14.2. Display				0	
1.1.1.1.14.3. Keyboard				0	
1.1.1.1.14.4. Processor Equipment				0	
1.1.1.1.14.4.1. Interface cards				0	
1.1.1.1.14.4.2. Processor				0	
1.1.1.1.14.4.2.1. SW				0	
1.1.1.1.14.4.2.2. HW				0	
1.1.1.1.14.5. Cables/Enclosure(s)/PS				0	
1.1.1.1.14.6. Alarms				0	

Figure 4: Equipment Centers Worksheet (1 of 3)

1.1.1.15.	Logging Recorder			0			
1.1.1.16.	HVAC			0			
1.1.1.17.	Emergency Op Center Subsystem Integration			0	0		
1.1.1.17.1.	911				0		
1.1.1.17.2.	CAD				0		
1.1.1.17.3.	Logging Recorder				0		
1.1.1.17.4.	NCIC				0		
1.1.1.17.5.	EMD				0		
1.1.1.17.6.	Video Feed				0		
1.1.1.17.7.	Other				0		
1.1.1.2.	Network Switching/Control Center N	20		75,000,000	0	cunit cost override	
1.1.1.2.1.	Property				0	0	
1.1.1.2.1.1.	Property cost					0	
1.1.1.2.1.2.	Lease cost					0	
1.1.1.2.2.	Development				0	0	
1.1.1.2.2.1.	Preparation					0	
1.1.1.2.2.2.	Fencing					0	
1.1.1.2.2.3.	Road/Parking					0	
1.1.1.2.2.4.	Grounding					0	
1.1.1.2.2.5.	Grading					0	
1.1.1.2.2.6.	Other					0	
1.1.1.2.3.	Building Per Site				0	0	cunit cost override
1.1.1.2.3.1.	Purchase cost					0	
1.1.1.2.4.	Grounding system				0		
1.1.1.2.5.	HVAC				0		
1.1.1.2.6.	Fire protection				0		
1.1.1.2.7.	Utilities				0		
1.1.1.2.8.	Other				0		
1.1.1.2.9.	Tower Per Site				0	0	cunit cost override
1.1.1.2.9.1.	Purchase cost					0	
1.1.1.2.9.2.	Lease cost					0	
1.1.1.2.9.3.	Lighting					0	
1.1.1.2.9.4.	Upgrade					0	
1.1.1.2.9.5.	Antenna relocation					0	
1.1.1.2.9.6.	Grounding					0	
1.1.1.2.9.7.	Other					0	
1.1.1.2.10.	Back Up Power systems				0	0	
1.1.1.2.10.1.	Generator					0	0
1.1.1.2.10.1.1.	Purchase cost						0
1.1.1.2.10.1.2.	Fuel tank						0
1.1.1.2.10.1.3.	Other						0
1.1.1.2.10.2.	Battery/charger					0	0
1.1.1.2.10.2.1.	Purchase						0
1.1.1.2.10.2.2.	Other						0
1.1.1.2.11.	UPS				0	0	
1.1.1.2.11.1.	Purchase					0	
1.1.1.2.11.2.	Other					0	
1.1.1.2.12.	Data Message Switch			2,500,000			
1.1.1.2.13.	Voice Message Switch			0			
1.1.1.2.14.	Network Manager			1,250,000	1,250,000		
1.1.1.2.14.1.	HW					0	
1.1.1.2.14.2.	SW					0	
1.1.1.3.	Dispatch N (Repeat for Each Dispatch Location)	317		22,190,000	0	cunit cost override	
1.1.1.3.1.	Property				0	0	
1.1.1.3.1.1.	Property cost					0	
1.1.1.3.1.2.	Lease cost					0	
1.1.1.3.2.	Development				0	0	
1.1.1.3.2.1.	Preparation					0	
1.1.1.3.2.2.	Fencing					0	
1.1.1.3.2.3.	Road/Parking					0	
1.1.1.3.2.4.	Grounding					0	
1.1.1.3.2.5.	Grading					0	
1.1.1.3.2.6.	Other					0	
1.1.1.3.3.	Building Per Site				0	0	cunit cost override
1.1.1.3.3.1.	Purchase cost					0	
1.1.1.3.4.	Grounding system				0		
1.1.1.3.5.	HVAC				0		
1.1.1.3.6.	Fire protection				0		
1.1.1.3.7.	Utilities				0		
1.1.1.3.8.	Other				0		
1.1.1.3.9.	Tower Per Site				0	0	cunit cost override
1.1.1.3.9.1.	Purchase cost					0	
1.1.1.3.9.2.	Lease cost					0	
1.1.1.3.9.3.	Lighting					0	
1.1.1.3.9.4.	Upgrade					0	
1.1.1.3.9.5.	Antenna relocation					0	
1.1.1.3.9.6.	Grounding					0	
1.1.1.3.9.7.	Other					0	
1.1.1.3.10.	Back Up Power systems				0	0	
1.1.1.3.10.1.	Generator					0	0
1.1.1.3.10.1.1.	Purchase cost						0
1.1.1.3.10.1.2.	Fuel tank						0
1.1.1.3.10.1.3.	Other						0
1.1.1.3.10.2.	Battery/charger					0	0
1.1.1.3.10.2.1.	Purchase						0
1.1.1.3.10.2.2.	Other						0
1.1.1.3.11.	UPS				0	0	
1.1.1.3.11.1.	Purchase					0	
1.1.1.3.11.2.	Other					0	

Figure 4: Equipment Centers Worksheet (2 of 3)

1.1.1.3.12. Console Electronics				70,000	70,000	<unit cost override	
1.1.1.3.12.1. Display					0		
1.1.1.3.12.2. Keyboard					0		
1.1.1.3.12.3. Processor Equipment					0		
1.1.1.3.12.3.1. Interface					0		
1.1.1.3.12.3.2. Processor					0		0
1.1.1.3.12.3.2.1. SW							0
1.1.1.3.12.3.2.2. HW							0
1.1.1.3.12.3.3. Cables/Enc/PWR Supply							0
1.1.1.3.13 Console Positions				0	0	<unit cost override	
1.1.1.3.13.1. Furniture					0		0
1.1.1.3.13.1.1. Operator							0
1.1.1.3.13.1.2. Supervisor							0
1.1.1.3.13.1.3. Training							0
1.1.1.3.13.2. Accessories					0		0
1.1.1.3.13.2.1. Foot Switch							0
1.1.1.3.13.2.2. Microphone							0
1.1.1.3.13.2.3. Headset							0
1.1.1.3.13.2.4. Handset							0
1.1.1.3.13.2.5. Speakers							0
1.1.1.4. Mobile Command Post				0	0	<unit cost override	
1.1.1.4.1 Vehicle with furnishings, power, A/C, etc..					0		
1.1.1.4.2 Antennas w/portable towers					0		0
1.1.1.4.2.1 uwave							0
1.1.1.4.2.2 LMR							0
1.1.1.4.2.3 Other							0
1.1.1.4.3 Inside Electronics					0		0
1.1.1.4.3.1 Cellular							0
1.1.1.4.3.2 Landline							0
1.1.1.4.3.3 Satellite Phone							0
1.1.1.4.3.4 LMR							0
1.1.1.4.3.4 Repeaters							0
1.1.1.4.3.5 Control Stations							0
1.1.1.4.3.5 Portables cache							0
1.1.1.4.3.5 Video							0
1.1.1.4.3.6 Cameras							0
1.1.1.4.3.7 Hazmat Sensors							0
1.1.1.5. Traffic Management Center				0	0	<unit cost override	
1.1.1.5.1 Site prep					0		
1.1.1.5.2 Building and furnishings					0		
1.1.1.5.3 Towers and Antennas					0		
1.1.1.5.4 Inside Electronics					0		0
1.1.1.5.4.1 Dispatch (Include in 1.1.1.3)							0
1.1.1.5.4.2 Video Surveillance							0
1.1.1.5.4.3 ITS Control							0
1.1.1.5.4.4 Other Traffic Sensor Displays							0
1.1.1.5.5 Cellular							0
1.1.1.6. Backup				0			

Figure 4: Equipment Centers Worksheet (3 of 3)

3.4 Equipment-Sites

Clicking on “1.1.2 Sites” in the Figure 2 worksheet brings up the sheet shown in Figure 5. “Sites” are defined as the physical locations where the base stations/repeaters are located. The sheet includes breakdown for all tower equipment associated with the broadcast and reception of signals to and from the terminal handheld and vehicular-mounted radios, site preparation, tower rental fees, and site preparation. Also, sites that only have receivers, “cell” sites (smaller size sites that typically don’t require a building for housing the equipment), and simulcast control point equipment are included. This sheet includes all breakdown to the finest levels of detail for sites; i.e., there are no additional finer-detail sheets associated with this sheet.

CATEGORY	Qty Per Higher Level Category	Cost Estimate Per Category			
1.1.2. Sites-		1,088,749.675	0		
1.1.2.6 Full TX and RX Sites	1,025	1,021,829.675	0	<unit cost override	
Note: This includes any simulcast TX/RX sites; enter control point equipment in 1.1.2.5					
1.1.2.6.1 Property			425,268	0	
1.1.2.6.1.1 Property cost				99,512	
1.1.2.6.1.2 Lease cost (assume 15 years total)				325,756	
1.1.2.6.2 Development			172,488	172,488	
1.1.2.6.2.1 Preparation				0	
1.1.2.6.2.2 Fencing				0	
1.1.2.6.2.3 Road/Parking				0	
1.1.2.6.2.4 Grounding				0	
1.1.2.6.2.5 Grading				0	
1.1.2.6.2.6 Other				0	
1.1.2.6.3. Building Per Site	1		0	0	<unit cost override
1.1.2.6.3.1. Purchase cost				0	
1.1.2.6.4. Grounding system			0		
1.1.2.6.5. HVAC			0		
1.1.2.6.6. Fire protection			0		
1.1.2.6.7. Utilities			0		
1.1.2.6.8. Other			0		
1.1.2.6.9. Tower Per Site	1		0	0	<unit cost override
1.1.2.6.9.1. Purchase cost				0	
1.1.2.6.9.2. Lease cost				0	
1.1.2.6.9.3. Lighting				0	
1.1.2.6.9.4. Upgrade				0	
1.1.2.6.9.5. Antenna relocation				0	
1.1.2.6.9.6. Grounding				0	
1.1.2.6.9.7. Other				0	
1.1.2.6.10. Back Up Power systems			0	0	
1.1.2.6.10.1. Generator			0	0	0
1.1.2.6.10.1.1 Purchase cost				0	
1.1.2.6.10.1.2 Fuel tank				0	
1.1.2.6.10.1.3 Other				0	
1.1.2.6.10.2. Battery/charger			0	0	0
1.1.2.6.10.2.1 Purchase				0	
1.1.2.6.10.2.2 Other				0	
1.1.2.6.11. UPS			0	0	
1.1.2.6.11.1. Purchase				0	
1.1.2.6.11.2. Other				0	
1.1.2.6.12. Site Stations Equipment			315,000		
1.1.2.6.12.1. Base stations	5		315,000	35,000	<unit cost override
1.1.2.6.12.1.1. Software				0	0
1.1.2.6.12.1.1.1. Interface					0
1.1.2.6.12.1.1.2. Control					0
1.1.2.6.12.1.1.3. RX Signal processing					0
1.1.2.6.12.1.1.4. TX Signal Processing					0
1.1.2.6.12.1.1.5. Features Support					0
1.1.2.6.12.1.1.6. (Additional for SCA??)					0
1.1.2.6.12.1.1.7. Other SW					0
1.1.2.6.12.1.1.8. SW Integ/Test					0
1.1.2.6.12.1.2. Hardware				0	0
1.1.2.6.12.1.2.1. Interface					0
1.1.2.6.12.1.2.2. Control					0
1.1.2.6.12.1.2.3. RX Signal String				0	0
1.1.2.6.12.1.2.3.1. Front End					0
1.1.2.6.12.1.2.3.2. IF					0
1.1.2.6.12.1.2.3.3. Backend					0
1.1.2.6.12.1.2.3.4. Digital Processing					0
1.1.2.6.12.1.2.4. TX Signal String				0	0
1.1.2.6.12.1.2.4.1. Drivers/PALinearizer					0
1.1.2.6.12.1.2.4.2. IF					0
1.1.2.6.12.1.2.4.3. Baseband					0
1.1.2.6.12.1.2.4.4. Digital Processing					0
1.1.2.6.12.1.2.4.5. Others					0
1.1.2.6.12.1.2.5. Mechanical					0
1.1.2.6.13. Site Control Equipment			84,151		
1.1.2.2 RX Only Sites	1		0	0	<unit cost override
Note: This includes any simulcast RX-only sites; enter control point equipment in 1.1.2.5					
1.1.2.2.1 Property			0	0	
1.1.2.2.1.1 Property cost				0	
1.1.2.2.1.2 Lease cost				0	
1.1.2.2.2 Development			0	0	
1.1.2.2.2.1 Preparation				0	
1.1.2.2.2.2 Fencing				0	
1.1.2.2.2.3 Road/Parking				0	
1.1.2.2.2.4 Grounding				0	
1.1.2.2.2.5 Grading				0	
1.1.2.2.2.6 Other				0	
1.1.2.2.3. Building Per Site	1		0	0	<unit cost override
1.1.2.2.3.1. Purchase cost				0	
1.1.2.2.4. Grounding system			0		
1.1.2.2.5. HVAC			0		
1.1.2.2.6. Fire protection			0		
1.1.2.2.7. Utilities			0		
1.1.2.2.8. Other			0		
1.1.2.2.9. Tower Per Site	1		0	0	<unit cost override
1.1.2.2.9.1. Purchase cost				0	
1.1.2.2.9.2. Lease cost				0	
1.1.2.2.9.3. Lighting				0	
1.1.2.2.9.4. Upgrade				0	
1.1.2.2.9.5. Antenna relocation				0	
1.1.2.2.9.6. Grounding				0	
1.1.2.2.9.7. Other				0	

Figure 5: Equipment Sites Worksheet (1 of 4)

1.1.2.2.10.	Back Up Power systems			0	0			
1.1.2.2.10.1.	Generator			0	0	0		
1.1.2.2.10.1.1	Purchase cost					0		
1.1.2.2.10.1.2	Fuel tank					0		
1.1.2.2.10.1.3	Other					0		
1.1.2.2.10.2.	Battery/charger			0	0	0		
1.1.2.2.10.2.1.	Purchase					0		
1.1.2.2.10.2.2.	Other					0		
1.1.2.2.11.	UPS			0	0	0		
1.1.2.2.11.1.	Purchase					0		
1.1.2.2.11.2.	Other					0		
1.1.2.2.12.	Site Stations Equipment			0	0	0		
1.1.2.2.12.1.	Base stations			0	0	0		
1.1.2.2.12.1.1.	Software					0		<unit cost override
1.1.2.2.12.1.1.1.	Interface					0		
1.1.2.2.12.1.1.2.	Control					0		
1.1.2.2.12.1.1.3.	RX Signal processing					0		
1.1.2.2.12.1.1.4.	TX Signal Processing					0		
1.1.2.2.12.1.1.5.	Features Support					0		
1.1.2.2.12.1.1.6.	(Additional for SCA??)					0		
1.1.2.2.12.1.1.7.	Other SW					0		
1.1.2.2.12.1.1.8.	SW Integ/Test					0		
1.1.2.2.12.1.2.	Hardware					0		
1.1.2.2.12.1.2.1	Interface					0		
1.1.2.2.12.1.2.2.	Control					0		
1.1.2.2.12.1.2.3.	RX Signal String					0		
1.1.2.2.12.1.2.3.1	Front End					0		
1.1.2.2.12.1.2.3.2	IF					0		
1.1.2.2.12.1.2.3.3	Backend					0		
1.1.2.2.12.1.2.3.4	Digital Processing					0		
1.1.2.2.12.1.2.4.	TX Signal String					0		
1.1.2.2.12.1.2.4.1	Drivers/PALinearizer					0		
1.1.2.2.12.1.2.4.2	IF					0		
1.1.2.2.12.1.2.4.3	Baseband					0		
1.1.2.2.12.1.2.4.4	Digital Processing					0		
1.1.2.2.12.1.2.4.5	Others					0		
1.1.2.2.12.1.2.5.	Mechanical					0		
1.1.2.3	Cell Sites			0	0	0		<unit cost override
Note: This includes any simulcast cell sites; enter control point equipment in 1.1.2.5								
1.1.2.3.1	Property (if necessary)			0	0	0		
1.1.2.3.1.1	Property cost					0		
1.1.2.3.1.2	Lease cost					0		
1.1.2.3.2	Development (if necessary)			0	0	0		
1.1.2.3.2.1.	Preparation					0		
1.1.2.3.2.2.	Fencing					0		
1.1.2.3.2.3.	Road/Parking					0		
1.1.2.3.2.4.	Grounding					0		
1.1.2.3.2.5.	Grading					0		
1.1.2.3.2.6.	Other					0		
1.1.2.3.3.	Grounding system					0		
1.1.2.3.4.	Utilities					0		
1.1.2.3.5.	Other					0		
1.1.2.3.6.	Tower (or pole) Per Site			0	0	0		<unit cost override
1.1.2.3.6.1.	Purchase cost					0		
1.1.2.3.6.2.	Lease cost					0		
1.1.2.3.6.3.	Lighting					0		
1.1.2.3.6.4.	Upgrade					0		
1.1.2.3.6.5.	Antenna relocation					0		
1.1.2.3.6.6.	Grounding					0		
1.1.2.3.6.7.	Other					0		
1.1.2.3.7.	Back Up Power systems			0	0	0		
1.1.2.3.7.1.	Generator			0	0	0		
1.1.2.3.7.1.1	Purchase cost					0		
1.1.2.3.7.1.2.	Fuel tank					0		
1.1.2.3.7.1.3.	Other					0		
1.1.2.3.7.2.	Battery/charger			0	0	0		
1.1.2.3.7.2.1.	Purchase					0		
1.1.2.3.7.2.2.	Other					0		
1.1.2.3.8.	UPS			0	0	0		
1.1.2.3.8.1.	Purchase					0		
1.1.2.3.8.2.	Other					0		
1.1.2.3.9.	Site Stations Equipment			0	0	0		
1.1.2.3.9.1.	Base stations			0	0	0		<unit cost override
1.1.2.3.9.1.1.	Software					0		
1.1.2.3.9.1.1.1.	Interface					0		
1.1.2.3.9.1.1.2.	Control					0		
1.1.2.3.9.1.1.3.	RX Signal processing					0		
1.1.2.3.9.1.1.4.	TX Signal Processing					0		
1.1.2.3.9.1.1.5.	Features Support					0		
1.1.2.3.9.1.1.6.	(Additional for SCA??)					0		
1.1.2.3.9.1.1.7.	Other SW					0		
1.1.2.3.9.1.1.8.	SW Integ/Test					0		
1.1.2.3.9.1.2.	Hardware					0		
1.1.2.3.9.1.2.1	Interface					0		
1.1.2.3.9.1.2.2.	Control					0		
1.1.2.3.9.1.2.3.	RX Signal String					0		
1.1.2.3.9.1.2.3.1	Front End					0		
1.1.2.3.9.1.2.3.2	IF					0		
1.1.2.3.9.1.2.3.3	Backend					0		
1.1.2.3.9.1.2.3.4	Digital Processing					0		
1.1.2.3.9.1.2.4.	TX Signal String					0		
1.1.2.3.9.1.2.4.1	Drivers/PALinearizer					0		
1.1.2.3.9.1.2.4.2	IF					0		
1.1.2.3.9.1.2.4.3	Baseband					0		
1.1.2.3.9.1.2.4.4	Digital Processing					0		
1.1.2.3.9.1.2.4.5	Others					0		
1.1.2.3.9.1.2.5.	Mechanical					0		

Figure 5: Equipment Sites Worksheet (2 of 4)

1.1.2.4	Mobile Sites		0	0	<unit cost override		
1.1.2.4.1	Transport Vehicle/Trailer			0			
1.1.2.4.2	Development			0			
1.1.2.4.2.1.	Preparation			0			
1.1.2.4.2.2.	Other			0			
1.1.2.4.3.	Utilities			0			
1.1.2.4.4.	Other			0			
1.1.2.4.5.	Portable Tower (or pole) Per Site			0	0	<unit cost override	
1.1.2.4.5.1.	Purchase cost			0			
1.1.2.4.5.2.	Other			0			
1.1.2.4.6.	Back Up Power systems			0	0		
1.1.2.4.6.1.	Generator			0	0		
1.1.2.4.6.1.1.	Purchase cost			0			
1.1.2.4.6.1.2.	Fuel tank			0			
1.1.2.4.6.1.3.	Other			0			
1.1.2.4.6.2.	Battery/charger			0	0		
1.1.2.4.6.2.1.	Purchase			0			
1.1.2.4.6.2.2.	Other			0			
1.1.2.4.7.	UPS			0	0		
1.1.2.4.7.1.	Purchase			0			
1.1.2.4.7.2.	Other			0			
1.1.2.4.8.	Site Stations Equipment			0	0		
1.1.2.4.8.1.	Base stations			0	0	<unit cost override	
1.1.2.4.8.1.1.	Software			0	0		
1.1.2.4.8.1.1.1.	Interface			0			
1.1.2.4.8.1.1.2.	Control			0			
1.1.2.4.8.1.1.3.	RX Signal processing			0			
1.1.2.4.8.1.1.4.	TX Signal Processing			0			
1.1.2.4.8.1.1.5.	Features Support			0			
1.1.2.4.8.1.1.6.	(Additional for SCA??)			0			
1.1.2.4.8.1.1.7.	Other SW			0			
1.1.2.4.8.1.1.8.	SW Integ/Test			0			
1.1.2.4.8.1.2.	Hardware			0	0		
1.1.2.4.8.1.2.1.	Interface			0			
1.1.2.4.8.1.2.2.	Control			0			
1.1.2.4.8.1.2.3.	RX Signal String			0	0		
1.1.2.4.8.1.2.3.1.	Front End			0			
1.1.2.4.8.1.2.3.2.	IF			0			
1.1.2.4.8.1.2.3.3.	Backend			0			
1.1.2.4.8.1.2.3.4.	Digital Processing			0			
1.1.2.4.8.1.2.4.	TX Signal String			0	0		
1.1.2.4.8.1.2.4.1.	Drivers/PALinearizer			0			
1.1.2.4.8.1.2.4.2.	IF			0			
1.1.2.4.8.1.2.4.3.	Baseband			0			
1.1.2.4.8.1.2.4.4.	Digital Processing			0			
1.1.2.4.8.1.2.4.5.	Others			0			
1.1.2.4.8.1.2.5.	Mechanical			0	0		
1.1.2.5.	Simulcast Control Point Equipment		3,900,000	300,000	<unit cost override		
Note: This is for any unique items for the simulcast control point not covered under the previous sites categories							
1.1.2.5.1.	Property			0	0		
1.1.2.5.1.1.	Property cost			0			
1.1.2.5.1.2.	Lease cost			0			
1.1.2.5.2.	Development			0	0		
1.1.2.5.2.1.	Preparation			0			
1.1.2.5.2.2.	Fencing			0			
1.1.2.5.2.3.	Road/Parking			0			
1.1.2.5.2.4.	Grounding			0			
1.1.2.5.2.5.	Grading			0			
1.1.2.5.2.6.	Other			0			
1.1.2.5.3.	Building Per Site			0	0	<unit cost override	
1.1.2.5.3.1.	Purchase cost			0			
1.1.2.5.4.	Grounding system			0			
1.1.2.5.5.	HVAC			0			
1.1.2.5.6.	Fire protection			0			
1.1.2.5.7.	Utilities			0			
1.1.2.5.8.	Other			0			
1.1.2.5.9.	Tower Per Site			0	0	<unit cost override	
1.1.2.5.9.1.	Purchase cost			0			
1.1.2.5.9.2.	Lease cost			0			
1.1.2.5.9.3.	Lighting			0			
1.1.2.5.9.4.	Upgrade			0			
1.1.2.5.9.5.	Antenna relocation			0			
1.1.2.5.9.6.	Grounding			0			
1.1.2.5.9.7.	Other			0			
1.1.2.5.10.	Back Up Power systems			0	0		
1.1.2.5.10.1.	Generator			0	0		
1.1.2.5.10.1.1.	Purchase cost			0			
1.1.2.5.10.1.2.	Fuel tank			0			
1.1.2.5.10.1.3.	Other			0			
1.1.2.5.10.2.	Battery/charger			0	0		
1.1.2.5.10.2.1.	Purchase			0			
1.1.2.5.10.2.2.	Other			0			
1.1.2.5.11.	UPS			0	0		
1.1.2.5.11.1.	Purchase			0			
1.1.2.5.11.2.	Other			0			
1.1.2.5.12.	Control Point Equipment			0	0		
1.1.2.5.12.1.	HW			0			
1.1.2.5.12.2.	SW			0			

Figure 5: Equipment Sites Worksheet (3 of 4)

1.1.2.6 Full TX and RX Data Sites	1,538	61,520,000	0	<unit cost override			
Note: This includes any simulcast TX/RX sites: enter control point							
1.1.2.6.1 Property			0	0			
1.1.2.6.1.1 Property cost				0			
1.1.2.6.1.2 Lease cost				0			
1.1.2.6.2 Development			0	0			
1.1.2.6.2.1 Preparation				0			
1.1.2.6.2.2 Fencing				0			
1.1.2.6.2.3 Road/Parking				0			
1.1.2.6.2.4 Grounding				0			
1.1.2.6.2.5 Grading				0			
1.1.2.6.2.6 Other				0			
1.1.2.6.3 Building Per Site			0	0	<unit cost override		
1.1.2.6.3.1 Purchase cost				0			
1.1.2.6.4 Grounding system				0			
1.1.2.6.5 HVAC				0			
1.1.2.6.6 Fire protection				0			
1.1.2.6.7 Utilities				0			
1.1.2.6.8 Other				0			
1.1.2.6.9 Tower Per Site			0	0	<unit cost override		
1.1.2.6.9.1 Purchase cost				0			
1.1.2.6.9.2 Lease cost				0			
1.1.2.6.9.3 Lighting				0			
1.1.2.6.9.4 Upgrade				0			
1.1.2.6.9.5 Antenna relocation				0			
1.1.2.6.9.6 Grounding				0			
1.1.2.6.9.7 Other				0			
1.1.2.6.10 Back Up Power systems			0	0			
1.1.2.6.10.1 Generator				0	0		
1.1.2.6.10.1.1 Purchase cost					0		
1.1.2.6.10.1.2 Fuel tank					0		
1.1.2.6.10.1.3 Other					0		
1.1.2.6.10.2 Battery/charger				0	0		
1.1.2.6.10.2.1 Purchase					0		
1.1.2.6.10.2.2 Other					0		
1.1.2.6.11 UPS			0	0			
1.1.2.6.11.1 Purchase					0		
1.1.2.6.11.2 Other					0		
1.1.2.6.12 Site Stations Equipment			40,000	0			
1.1.2.6.12.1 Base stations				40,000	40,000	<unit cost override	
1.1.2.6.12.1.1 Software					0		
1.1.2.6.12.1.1.1 Interface					0		
1.1.2.6.12.1.1.2 Control					0		
1.1.2.6.12.1.1.3 RX Signal processing					0		
1.1.2.6.12.1.1.4 TX Signal Processing					0		
1.1.2.6.12.1.1.5 Features Support					0		
1.1.2.6.12.1.1.6 (Additional for SCA??)					0		
1.1.2.6.12.1.1.7 Other SW					0		
1.1.2.6.12.1.1.8 SW Integ/Test					0		
1.1.2.6.12.1.2 Hardware				0	0		
1.1.2.6.12.1.2.1 Interface					0		
1.1.2.6.12.1.2.2 Control					0		
1.1.2.6.12.1.2.3 RX Signal String					0		
1.1.2.6.12.1.2.3.1 Front End					0		
1.1.2.6.12.1.2.3.2 IF					0		
1.1.2.6.12.1.2.3.3 Backend					0		
1.1.2.6.12.1.2.3.4 Digital Processing					0		
1.1.2.6.12.1.2.4 TX Signal String					0		
1.1.2.6.12.1.2.4.1 Drivers/PA/Linearizer					0		
1.1.2.6.12.1.2.4.2 IF					0		
1.1.2.6.12.1.2.4.3 Baseband					0		
1.1.2.6.12.1.2.4.4 Digital Processing					0		
1.1.2.6.12.1.2.4.5 Others					0		
1.1.2.6.12.1.2.5 Mechanical					0		
1.1.2.7 Receive Only Sites Voting Systems	75	1,500,000	20,000	<unit cost override			

Figure 5: Equipment Sites Worksheet (4 of 4)

3.5 Equipment-Terminals

Clicking on “1.1.3 Terminals” in the Figure 2 worksheet brings up the sheet shown in Figure 6. Terminals are defined as the handheld two-way radios (portables) and vehicular two-way radios (mobiles) used by the officers in the field to communicate with each other directly (talkaround), simplex mode with the base stations at the system sites, and through repeaters at the system sites. Placeholders are included for mobiles and portables, and low- and high-tier versions for both. As Figure 6 shows, each of the above types of terminals are broken into fine levels of detail, down to the functional elements of the radio (e.g., hardware frontend, hardware digital processor, receive software, transmit software, etc.) This sheet includes all breakdown to the finest levels of detail for terminals; i.e., there are no additional finer-detail sheets associated with this sheet.

CATEGORY	Qty Per Higher Level Category	Cost Estimate Per Category			
1.1.3. Terminals		360,160,400	0		
1.1.3.1. Mobiles		103,272,400	0		
1.1.3.1.1. High Tier Digital Mobiles (Including Cache)	15757		56,725,200	3,600	omit cost override
1.1.3.1.1.1. Software				0	
1.1.3.1.1.1.1. Interface					0
1.1.3.1.1.1.2. Control					0
1.1.3.1.1.1.3. RX Signal processing					0
1.1.3.1.1.1.4. TX Signal Processing					0
1.1.3.1.1.1.5. Features Support					0
1.1.3.1.1.1.6. (Additional for SCA??)					0
1.1.3.1.1.1.7. Other SW					0
1.1.3.1.1.1.8. SW Integ/Test					0
1.1.3.1.1.2. Hardware				0	
1.1.3.1.1.2.1. Interface					0
1.1.3.1.1.2.2. Control					0
1.1.3.1.1.2.3. RX Signal String					0
1.1.3.1.1.2.3.1. Front End					0
1.1.3.1.1.2.3.2. IF					0
1.1.3.1.1.2.3.3. Backend					0
1.1.3.1.1.2.3.4. Digital Processing					0
1.1.3.1.1.2.4. TX Signal String					0
1.1.3.1.1.2.4.1. Drivers/PA/Linearizer					0
1.1.3.1.1.2.4.2. IF					0
1.1.3.1.1.2.4.3. Baseband					0
1.1.3.1.1.2.4.4. Digital Processing					0
1.1.3.1.1.2.5. Audio					0
1.1.3.1.1.2.5.1. CODEC					0
1.1.3.1.1.2.5.2. Microphone					0
1.1.3.1.1.2.5.3. Speaker					0
1.1.3.1.1.2.6. Keyboard					0
1.1.3.1.1.2.7. Case					0
1.1.3.1.1.2.8. Display					0
1.1.3.1.1.2.9. Mechanical					0
1.1.3.1.1.2.10. Antennas					0
1.1.3.1.1.2.11. Others					0
1.1.3.1.1.2.12. HW Integ/Test					0
1.1.3.1.1.3. HW/SW Integ/Test					0
1.1.3.1.2. Low Tier Mobiles(Including Cache)	16624		46,547,200	2,800	omit cost override
1.1.3.1.2.1. Software				0	
1.1.3.1.2.1.1. Interface					0
1.1.3.1.2.1.2. Control					0
1.1.3.1.2.1.3. RX Signal processing					0
1.1.3.1.2.1.4. TX Signal Processing					0
1.1.3.1.2.1.5. Features Support					0
1.1.3.1.2.1.6. (Additional for SCA??)					0
1.1.3.1.2.1.7. Other SW					0
1.1.3.1.2.1.8. SW Integ/Test					0
1.1.3.1.2.2. Hardware				0	
1.1.3.1.2.2.1. Interface					0
1.1.3.1.2.2.2. Control					0
1.1.3.1.2.2.3. RX Signal String					0
1.1.3.1.2.2.3.1. Front End					0
1.1.3.1.2.2.3.2. IF					0
1.1.3.1.2.2.3.3. Backend					0
1.1.3.1.2.2.3.4. Digital Processing					0
1.1.3.1.2.2.4. TX Signal String					0
1.1.3.1.2.2.4.1. Drivers/PA/Linearizer					0
1.1.3.1.2.2.4.2. IF					0
1.1.3.1.2.2.4.3. Baseband					0
1.1.3.1.2.2.4.4. Digital Processing					0
1.1.3.1.2.2.5. Audio					0
1.1.3.1.2.2.5.1. CODEC					0
1.1.3.1.2.2.5.2. Microphone					0
1.1.3.1.2.2.5.3. Speaker					0
1.1.3.1.2.2.6. Keyboard					0
1.1.3.1.2.2.7. Case					0
1.1.3.1.2.2.8. Display					0
1.1.3.1.2.2.9. Mechanical					0
1.1.3.1.2.2.10. Antennas					0
1.1.3.1.2.2.11. Others					0
1.1.3.1.2.2.12. HW Integ/Test					0
1.1.3.1.2.3. HW/SW Integ/Test					0

Figure 6: Equipment Terminals Worksheet (1 of 2)

1.1.3.2.	Portable Radios		95,899,500	0		
1.1.3.2.1.	High Tier Digital Portables (Including Cache)	21980		74,732,000	3,400	<unit cost override
1.1.3.2.1.1.	Software				0	0
1.1.3.2.1.1.1.	Interface					0
1.1.3.2.1.1.2.	Control					0
1.1.3.2.1.1.3.	RX Signal processing					0
1.1.3.2.1.1.4.	TX Signal Processing					0
1.1.3.2.1.1.5.	Features Support					0
1.1.3.2.1.1.6.	(Additional for SCA??)					0
1.1.3.2.1.1.7.	Other SW					0
1.1.3.2.1.1.8.	SW Integ/Test					0
1.1.3.2.1.2.	Hardware				0	0
1.1.3.2.1.2.1.	Interface					0
1.1.3.2.1.2.2.	Control					0
1.1.3.2.1.2.3.	RX Signal String					0
1.1.3.2.1.2.3.1.	Front End					0
1.1.3.2.1.2.3.2.	IF					0
1.1.3.2.1.2.3.3.	Backend					0
1.1.3.2.1.2.3.4.	Digital Processing					0
1.1.3.2.1.2.4.	TX Signal String					0
1.1.3.2.1.2.4.1.	Drivers/PALinearizer					0
1.1.3.2.1.2.4.2.	IF					0
1.1.3.2.1.2.4.3.	Baseband					0
1.1.3.2.1.2.4.4.	Digital Processing					0
1.1.3.2.1.2.5.	Audio					0
1.1.3.2.1.2.5.1.	CODEC					0
1.1.3.2.1.2.5.2.	Microphone					0
1.1.3.2.1.2.5.3.	Speaker					0
1.1.3.2.1.2.6.	Keyboard					0
1.1.3.2.1.2.7.	Case					0
1.1.3.2.1.2.8.	Display					0
1.1.3.2.1.2.9.	Mechanical					0
1.1.3.2.1.2.10.	Antennas					0
1.1.3.2.1.2.11.	Others					0
1.1.3.2.1.2.12.	HW Integ/Test					0
1.1.3.2.1.3.	HW/SW Integ/Test					0
1.1.3.2.2.	Low Tier Portables (Including Cache)	8467		21,167,500	2,500	<unit cost override
1.1.3.2.2.1.	Software				0	0
1.1.3.2.2.1.1.	Interface					0
1.1.3.2.2.1.2.	Control					0
1.1.3.2.2.1.3.	RX Signal processing					0
1.1.3.2.2.1.4.	TX Signal Processing					0
1.1.3.2.2.1.5.	Features Support					0
1.1.3.2.2.1.6.	(Additional for SCA??)					0
1.1.3.2.2.1.7.	Other SW					0
1.1.3.2.2.1.8.	SW Integ/Test					0
1.1.3.2.2.2.	Hardware				0	0
1.1.3.2.2.2.1.	Interface					0
1.1.3.2.2.2.2.	Control					0
1.1.3.2.2.2.3.	RX Signal String					0
1.1.3.2.2.2.3.1.	Front End					0
1.1.3.2.2.2.3.2.	IF					0
1.1.3.2.2.2.3.3.	Backend					0
1.1.3.2.2.2.3.4.	Digital Processing					0
1.1.3.2.2.2.4.	TX Signal String					0
1.1.3.2.2.2.4.1.	Drivers/PALinearizer					0
1.1.3.2.2.2.4.2.	IF					0
1.1.3.2.2.2.4.3.	Baseband					0
1.1.3.2.2.2.4.4.	Digital Processing					0
1.1.3.2.2.2.5.	Audio					0
1.1.3.2.2.2.5.1.	CODEC					0
1.1.3.2.2.2.5.2.	Microphone					0
1.1.3.2.2.2.5.3.	Speaker					0
1.1.3.2.2.2.6.	Keyboard					0
1.1.3.2.2.2.7.	Case					0
1.1.3.2.2.2.8.	Display					0
1.1.3.2.2.2.9.	Mechanical					0
1.1.3.2.2.2.10.	Antennas					0
1.1.3.2.2.2.11.	Others					0
1.1.3.2.2.2.12.	HW Integ/Test					0
1.1.3.2.2.3.	HW/SW Integ/Test					0
1.1.3.2.3.	Spare batteries	1		0	0	<unit cost
1.1.3.2.4.	Belt Swivel	1		0	0	<unit cost
1.1.3.2.5.	Speaker Mics	1		0	0	<unit cost
1.1.3.2.6.	Desk Chargers	1		0	0	<unit cost
	Per Unit Cost					0
1.1.3.3.	Data MDTs	1	0	0	0	<unit cost
1.1.3.4.	Laptops	1	0	0	0	<unit cost
1.1.3.5.	Vehicular Repeaters	1	0	0	0	<unit cost
1.1.3.6.	Removals		0	0	0	<unit cost
1.1.3.6.1.	Mobiles	1				<unit cost
1.1.3.6.2.	Control Stations	1				<unit cost
1.1.3.7.	Control Stations	1955	14,662,500	7,500		<unit cost
1.1.3.8.	Vehicular Repeaters	200	3,400,000	17,000		<unit cost
1.1.3.9.	Data Modems	1000	3,500,000	3,500		<unit cost
1.1.3.10.	Data User Equipment Transport Costs		5,544,000			
1.1.3.11.	Mobile Data Devices	19126	133,882,000	7,000		<unit cost

Figure 6: Equipment Terminals Worksheet (2 of 2)

3.6 Equipment- Backbone/Backhaul

Clicking on “Data Backbone/Backhaul” in the Figure 2 worksheet brings up the sheet shown in Figure 7. This includes all equipment for interfacing and transporting data between all the sites and centers identified elsewhere in the spreadsheet. This category includes microwave equipment or other types of point to point broadband interface links between all sites, emergency op centers, network switching/control centers, dispatch centers, hospital command centers, mobile command posts, traffic management centers, earth station links, and backup centers. Vehicular repeaters that use radio talk channels for relaying calls back to a fixed base station site are not included in this category.

CATEGORY	Qty Per Higher Level Category	Cost Estimate Per Category			
1.1.4. Data Backbone/Backhaul		148,305,800	0		
1.1.4.1. Emergency Op Center			0		
1.1.4.2. Network Switching/Control center			0		
1.1.4.3. Dispatch Center(s)			0		
1.1.4.4. Hospital Command Center			0		
1.1.4.5. Mobile Command Post			0		
1.1.4.6. Traffic Management Center			0		
1.1.4.7. Backup center			0		
1.1.4.8. Sites	775	148,049,800	191,032	<unit cost	
1.1.4.9 Earth Station links	32	256,000	8,000	<unit cost	

Figure 7: Equipment Data Backbone/Backhaul Worksheet

3.7 Training

Clicking on “Training” in the Figure 2 sheet brings up the sheet shown in Figure 8. This sheet includes entries for both “train the trainer” and “train the user” categories. Cost data for training the users is entered on a per-user basis, and then multiplied in the spreadsheet by the quantities of each type of user that is shown.

CATEGORY	Qty Per Higher Level Category	Cost Estimate Per Category			
1.2. Training		21,571,204	21,571,204		
1.2.1 Train the Trainer			0		
1.2.2 Train the Users			0		
1.2.2.1. User	1		0	0	/person
1.2.2.2. Dispatch	1		0	0	/person
1.2.2.3. System Admin	1		0	0	/person
1.2.2.4. Sys HW	1		0	0	/person
1.2.2.5. Sys SW	1		0	0	/person

Figure 8: Training Worksheet

3.8 Governance

The “Governance” category (Figure 9) includes governance documents (e.g., charter, by-laws, guidelines), preparation of procedures/plans, procurement activities (including research, specs, and following procurements), and administration costs such as meetings costs.

CATEGORY	Cost Estimate Per Category		
1.3. Governance	0	0	
1.3.1. Draft/update governance documents		0	0
1.3.1.1. Charter			0
1.3.1.2. By-laws			0
1.3.1.3. Guidelines			0
1.3.1.4. Other			0
1.3.2. Draft/update plans		0	
1.3.3. Draft/update SOPs		0	
1.3.4. Procurement activities		0	0
1.3.4.1. Researching Projects			0
1.3.4.2. Preparing Specs			0
1.3.4.3. Other			0
1.3.5. Admin costs (travel to meetinhgs, meeting costs, facilitators, etc.)		0	

Figure 9: Governance Worksheet.

3.9 Testing

Clicking on “Testing” in the Figure 2 sheet brings up the sheet shown in Figure 10. This category includes system integration and test, exercises, and customer acceptance tests.

CATEGORY	Cost Estimate Per Category		
1.5. System Test	220,277,470	220,277,470	
1.5.1. System Integration and Test		0	
1.5.2. Exercises		0	
1.5.3. Customer Acceptance Tests		0	0
1.5.3.1. Coverage			0
1.5.3.2. Functional			0
1.5.3.3. Other			0

Figure 10: System Test Worksheet

3.10 Operations and Maintenance

Clicking on “Operations and Maintenance” in the Figure 2 sheet brings up the sheet shown in Figure 11. As a baseline, it is assumed that all O&M costs that are entered here are for a 15 year period, although other time periods could be used without loss of generality provided that the assumptions are clearly stated in any backup information kept with the spreadsheet.

Subcategories include administrative costs, technical support costs (manpower for equipment repair/replacement), coverage analysis, event planning, frequency coordination/licensing, radio programming, technical support for system upgrades, and pre-implementation testing), non-radio maintenance (e.g., generator, UPS, HVAC, logging recorder, etc.), radio maintenance, and bug

fixes. Also, placeholders are included for any unique costs that might be associated with SDR software and/or hardware, if applicable.

Also, expected upgrade costs of hardware and/or software over the life cycle of the system can be entered in Category 1.4.8 “Upgrade Costs (Including Bug Fixes)”.

CATEGORY	Qty Per Higher Level Category	Cost Estimate Per Category			
1.4. Operations and Maintenance (Assume 15 Year Period)		499,117,600	0		
1.4.1. System Management		0	0		
1.4.1.1. Administrative Costs		0			
1.4.1.2. Technical support Costs		0	0		
1.4.1.2.1. Repair and Replace Equipment					
1.4.1.2.2. Coverage and interference analysis and mitigation					
1.4.1.2.3. Exercise and event planning					
1.4.1.2.4. Frequency coord. And lic. and reg compliance					
1.4.1.2.5. Radio Reprogramming					
1.4.1.2.6. Functional Upgrades					
1.4.1.2.7. Evaluation and testing of new devices prior to implementation					
1.4.1.3. System Financing costs			0		
1.4.2. Non-radio		0	0		
1.4.2.1. Generator			0	0	<unit cost
1.4.2.2. UPS			0	0	<unit cost
1.4.2.3. HVAC			0	0	<unit cost
1.4.2.4. Logging Rec			0	0	<unit cost
1.4.3. Radio		0	0		<unit cost
1.4.4. Preventative		0	0		
1.4.4.1. Fixed Equip			0	0	<unit cost
1.4.4.2. Non-fixed equip			0	0	<unit cost
1.4.5. SDR Software		0	0		<unit cost
1.4.6. SDR Hardware Platform		0	0		<unit cost
1.4.7. Engineering Support		499,117,600			
1.4.8. Upgrade Costs (Including Bug Fixes)		0	0		
1.4.8.1. Site Equipment			0	0	<unit cost
1.4.8.2. Terminals			0	0	<unit cost
1.4.9. Other		0	0		<unit cost

Figure 11: O&M Worksheet

3.11 Management

Clicking on “System Management” in the Figure 2 sheet brings up the sheet shown in Figure 12. This includes system, site, warranty, and licensing of spectrum (Includes filing with FCC).

CATEGORY	Cost Estimate Per Category	
1.6. System Management	561,500,000	561,500,000
1.6.1. System		0
1.6.2. Site		0
1.6.3. Warranty		0
1.6.4. Licensing of spectrum (Includes filing with FCC)		0

Figure 12: System Management Worksheet

3.12 Help Page

The “Help” page (Figure 13) contains high level instructions for using the spreadsheet, and can be invoked from any of the spreadsheet pages by clicking on “Cost Model Spreadsheet Instructions” in the upper left hand corner of each sheet.

Help Page: Public Safety SDR Lifecycle Costs

This is the help page for the SDR Forum Public Safety Special Interest Group (PS-SIG) cost model spreadsheet. On the main page you should enter the configuration name for this cost model in the config cell. Similar to that shown below.

Config:

On the main worksheet the Total life cycle cost is displayed in the pink shaded cell at the top of the grid on that page.

Pink shaded box is the Total Life Cycle Cost

The date cell will be filled in using the computers internal clock similar to that shown below.

Date:

The remainder of the worksheets in this workbook have similar cells for data entry. Please follow the guidelines below to fill out the worksheets. The cells that should not have data entered into them are protected and cannot be selected. Using the TAB key will jump to cell selection to the next valid cell for data entry on all sheets.

Make cost entries in white-shaded boxes
Make quantity entries in green shaded boxes
Yellow shaded cells contain formulas no input is needed
No input is Needed in Blue Crosshatched Boxes
Enter total to override summation of next lower level

Throughout the workbook there are hyper-links to navigate between the sheets. Use the following links to go to the specific worksheet in the work book.

1.0 Main Cost model sheet
1.1. Equipment/Installation Related Costs
1.1.1. Centers
1.1.2. Sites
1.1.3. Terminals
1.1.4. Data Backbone/Back haul network
1.2. Training
1.3. Governance
1.4. Operations and Maintenance (Assume 5 Year Period)
1.5. System Test
1.6. System Management

Figure 13: Cost Model Help Page

4 References

1. "Business Dictionary.com", [life cycle cost definition](#)
2. SDRF Cognitive Radio Definitions Document SDRF-06-R-0011-V1.0.0, 8 Nov 2007, http://www.sdrforum.org/pages/documentLibrary/documents/SDRF-06-R-0011-V1_0_0.pdf
3. "SDR Market Study, Task 4: The US Public Safety Market", May 2007, Jim Gunn Consultancy, http://www.sdrforum.org/admin/pub/documents/pub_433727SDRF-MarketStudy-Task4-PS-Final.pdf