APCO Broadband Business Modeling & Benchmarking Subcommittee Whitepaper

Exploring Business Tools for Leveraging Assets

DRAFT v9.1

May 6, 2013

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ABSTRACT

In the summer of 2012, the APCO Broadband Committee authorized the establishment of the *APCO BB Business Modeling & Benchmarking Subcommittee* (Subcommittee) who have worked together to identify and study salient business issues associated with the NPSBN. The purpose of this "*Exploring Business Tools for Leveraging Assets*" whitepaper is to explore business tools, methods and techniques that will fuel and support the leveraging of state, local, tribal (SLT) and commercial assets for use in building and operating the NPSBN—which could eventually amount to hundreds of millions, perhaps billions of dollars of contributions to the NSPBN for its deployment. The document focuses upon asset standardization and valuation methodologies that have the potential to greatly simplify negotiation, cost modeling, assessment and eventual use of SLT resources needed to establish PS LTE readiness, deployment and ongoing sustainment. This document will present recommendations, insights and open questions for NPSBN stakeholders and especially state and local agencies looking to provide in-kind contributions to the NPSBN.

1. Introduction

The First Responder Network Authority (FirstNet) is tasked with building and operating a Nationwide Public Safety Broadband Network (NPSBN) based upon the 3GPP standard, Long Term Evolution (LTE) and which operates on the Public Safety 700 MHz spectrum, Band Class 14. In the summer of 2012, the APCO Broadband Committee authorized the establishment of the *APCO BB Business Modeling & Benchmarking Subcommittee* (Subcommittee) who have worked together to identify and study salient business issues associated with the NPSBN.

The purpose of this "*Exploring Business Tools for Leveraging Assets*" whitepaper is to explore business tools, methods and techniques that will fuel and support the leveraging of state, local, tribal (SLT) and commercial assets for use in building and operating the NPSBN—which could eventually amount to hundreds of millions, perhaps billions of dollars of contributions to the NSPBN for its deployment.

The document focuses upon asset standardization and valuation methodologies that have the potential to greatly simplify negotiation, cost modeling, assessment and eventual use of SLT resources needed to establish PS LTE readiness, deployment and ongoing sustainment. This document will present recommendations, insights and open questions for NPSBN stakeholders and especially state and local agencies looking to provide in-kind contributions to the NPSBN.

The Subcommittee has identified a number of issues and questions which are beyond the scope of this effort to address, but which are valuable to preserve as ideas for future work efforts. These items are summarized in Appendix A.

Although the policies have not yet been finalized, this document assumes that any assets that are made available to FirstNet for the NPSBN should be considered as a lease of assets for FirstNet as opposed to FirstNet taking ownership of these assets. There are several compensation approaches which could be explored, for example, FirstNet could reduce per unit monthly user fees, they could develop a typical leasing arrangement, or some other FirstNet/jurisdiction agreed upon arrangement for compensation.

1.1 Relevant Needs and Problems

The work products around "Asset Standardization" methodologies, LTE Readiness, and providing streamlined financial tools address a variety of needs and problems that were identified by the team, these include:

- As directed in the legislation and for long-term sustainability, a mechanism to leverage existing state, local and tribal assets into the NPSBN is needed.
- State, local, and tribal entities must have incentives to participate and contribute resources to the NPSBN.
    - State, local, and tribal entities need to be fairly compensated for investments and contributions.
- State, local, and tribal entities need to have "skin in the game" in order to stay invested and want to participate.
- At the same time, it is impossible for FirstNet to negotiate independently with each such entity. A common, standard, methodology for valuing assets is required to simplify the task.

- The budget oversight bodies for state, local and tribal entities will need robust methods that will provide a clear picture of their assets' Return on Investment (RoI). This is especially important because many entities are very budget constrained, and might overvalue their assets.
- The need to keep overhead manageable by reducing the flow of inter-governmental cash resources, which is complex and cumbersome.
- The need to accommodate many different types of asset ownership models.

1.2 Overall Objectives of Subcommittee Project

The overall objectives of a successful Leverage and Asset Value Standardization program would include:

- Create opportunity for SLT to get "skin in the game," i.e. to have their assets used by FirstNet.
- Incent SLT participation; create fair compensation for leveraged SLT assets.
- Extend the reach and coverage of the NPSBN while stretching the $7B capital investment.
- Effectively manage complexity created by vast diversity in the Public Safety (PS) landscape.
- Reduce bureaucratic overhead required to acquire, provision and use SLT assets.
- Create effective cost modeling tools.
- Deploy a network within a viable and sustainable business model.
- Meet taxpayer expectations that government resources are leveraged as often and efficiently as possible.

2. Asset Standardization

The advantages and objectives for Asset Standardization include streamlining the process to avoid case-by-case evaluations that would be cumbersome and probably impractical, maintaining fairness and consistency to both FirstNet and contributing entities, and allowing for the planning and optimization of NPSBN deployments and design.

It is assumed by the Subcommittee that Public Safety agencies, cities, towns, counties, states, tribal entities and territories will be able to provide FirstNet with a list of resources that are already in place and available or which could be made available if a modest amount of improvements were made. The Subcommittee has developed a standardized methodology to assign values to these assets in order to provide a method of consistent reporting between the states and FirstNet.

2.1.1 Balancing Competing Needs

The Subcommittee submits that the most challenging aspect of constructing a methodology and guidance for Asset Standardization will be effectively "balancing" the various incentives to ensure the right outcome. If designed incorrectly, it could result in unintended negative consequences. A variety of these challenges have been identified and summarized below along with a summary of the strategies that could be employed to address them. It should be emphasized that these and similar factors will need to be monitored carefully throughout the development process.

- **Balancing the need to quickly and easily deploy using commercial assets with the imperative of using existing SLT assets**

- **Balancing the mandate to use cellular resources which could be negotiated in "bulk", with the imperative of using existing government assets, which is the right thing to do for US taxpayers.**
- **Balancing the need for early nationwide deployment with the need to allow time for SLT agencies to gather data so that their assets, especially site assets, can be considered in the initial design and avoiding a costly redesign at some point in the future.**
- **The model could potentially price Public Safety assets beyond market value, and therefore, create disincentives for their use.** The model needs to recognize that there are multiple sources of assets, and the Public Safety assets need to be competitive in the marketplace so that they don't create disincentives for their use. The Subcommittee attempted to include a "PS Need" component (that is, overvaluing assets in high-crime areas or environments where few assets exist and it is difficult to acquire new ones, such as a national park) in the assessment criteria but we found that by doing so we might inadvertently undermine the incentive to utilize Public Safety assets, essentially driving up the cost to FirstNet or a MNO, and therefore driving down the site's competitiveness as a viable asset. The process was then revised to use this analysis at the county or regional level, rather than at the "asset level," which reflects the guidance from NTIA in the recent State and Local Implementation Grant Program (SLIGP) guidelines, which call for a robust process to prioritize rural and other coverage areas. It is recommended that this be done on a county-by-county basis because county-level statistical data is readily available.
- **Balancing the need to provide consistency in streamlining agreements while providing SLT agencies the flexibility to negotiate their own terms.** This issue has been addressed by adding a "Negotiated Valuations" to the process maps reflecting the flexibility that needs to be retained in this key area. Ideas to address this issue include suggested terms and conditions, and contract templates.
    - The complexity of government negotiations and potentially protracted timelines for completion could potentially disrupt deployment schedules and create additional disincentives for use of SLT assets. Therefore, this issue either needs to be managed and addressed, or fully accounted for in the model.
- **Balancing the chore of gathering adequate technical and program information without burdening strained resources with gathering information about assets that are not eventually utilized by the PSBN.** To address this problem a screening or "filtering process" is suggested which would eliminate assets that do not meet basic entrance criteria. The team recommends collection of high level (low cost) data for all Public Safety assets and more detailed data collection on assets that are more likely to be used in the system.
- **Balancing the need for nationwide standards for asset valuation with the ability for asset owners to extract their required value and create usage incentives.** The committee recognizes the importance of providing asset owners with information regarding the value of their assets on the open market – allowing them to understand "fair" compensation levels. However, the asset holders will need flexibility to adjust their asset values to enable them to address their net business dynamic.

- **Employing these principles will increase Public Safety subscriptions on the network**. If Public Safety assets are utilized in the network and credits are secured by those agencies, the Public Safety agency is more likely to become and remain a customer of the NPSBN.

In summary, the Subcommittee asserts that designers of the final process will need to be mindful of maintaining a delicate balance among the various and often competing needs of stakeholders of the NSPBN. The items mentioned above are just a few among many that will likely be revealed as the development process continues.

2.1.2 Potential Assets Usable for the NPSBN

Although the text and descriptions refers to RF radio towers throughout this document, these methodologies and approaches should be considered generic strategies which could be applied to other resource categories, such as: backhaul, infrastructures, servers, facilities, even organizations and people. Due to the considerable expense of obtaining tower sites and great number of potential SLT tower sites, this analysis will focus on tower sites as a test case for the tool and data management planning.

State, local, and tribal entities, and their partner agencies, have a number of assets that will be valuable to FirstNet as it proceeds to build the NPSBN. The following is a list of examples to which this methodology may be applied:

- **(1) eNodeB sites –** RF sites include not just "towers" but buildings, bridges and other structures. These tower site resources are often located in areas that are difficult to where it is difficult to provide service for a variety of reasons:
    - Dense urban areas where new sites are expensive.
    - Vast rural areas including national forests, national parks, tribal areas, deserts and other areas where only the only feasible coverage options are publicly owned sites.
    - Areas where the local population will vehemently oppose new sites.
- **(2) Backhaul** (fiber optic cable and microwave) **–** LTE sites require very high speed, high capacity backhaul. State, local, and tribal agencies have a significant amount of such assets, e.g. fiber optic cable installed along roadways by transportation departments, BTOP and grant-funded middle mile fiber to connect critical government locations, and extensive locally funded fiber networks used for 911 and other Public Safety functions.
- **(3) Data Centers –** Most governments conduct extensive planning to support continuity of operations during disasters. They have both Tier IV data centers and backup centers. Such locations could be used to support the electronics and management systems required for the NPSBN.
- **(4) Assets Owned by Affiliated Entities –** Universities, public and private electric utilities, railroads, water utilities, transportation departments and similar agencies have significant assets usable for the NPSBN, and also are important to Public Safety operations in and of themselves as potential users of the NPSBN. For example, electric utilities have high-voltage electrical lines and towers crossing rural, remote, forested, mountainous and similar areas. Such lines also carry fiber optic cable and such towers can support NPSBN sites. Similarly, railroads will often cross rural or mountainous areas, providing both assets and potential users.

- **(5) People / Staffing / Program Management / "Tech Ops" –** The potential exists for SLT personnel resources to be used to support O&M functions, resourced by local agencies for basic functions such as routine maintenance or to respond no matter what time of day or night the network goes down.
    - For example, Harris County ITC is currently operating a PS LTE network and has already begun training maintenance personnel to directly maintain LTE equipment, enabling them to build upon the internal support teams they already have in place.
- **(6) Other Facilities –** Warehouse space for storage of spares; office space for FirstNet staff in the region.
- **(7) Deployables –** Many agencies have fleets of large and versatile deployable assets that could be easily outfitted with PS LTE equipment. This approach could potentially address a number of difficult coverage problems and is a great example of leveraging existing SLT assets.

Among the more spirited debates in the development of these methodologies is whether or not commercial assets, such as towers from a supplier such as Crown Castle, should be included. After much discussion, the general conclusion was that in order to perform the design holistically and comprehensively, ALL of the potential assets, regardless of their respective owners should be considered and evaluated. This is vital for both consistency and overall fairness of the result.

In summary, the proposed methodology for Standardizing Asset Values could be developed for many types of assets. All assets would have to meet a general set of "gating" criteria which would essentially be compliance to published "PS LTE Readiness" criteria capturing elements such as O&M, governance, training, access, ownership rights, legal support, decision making and staffing.

2.1.3 Possible Applications Asset Standardization

The subcommittee began the discussion of Asset Standardization to address the need for crediting users for any assets that would actually be used and deployed on the NPSBN. As the team looked at the larger picture, additional areas of overlapping need were identified:

- **Asset "Quick Screening" – Preliminary Assessment** – Tools and assessments will be needed to identify which assets, towers as an example, could possibly be used and would therefore be "flagged" for further analysis. Otherwise, large states with thousands of assets would be forced to provide a detailed assessment on every potential asset, which is impractical, expensive and unnecessary.
- **Asset Application Assessment** – Final determination would be an in-depth analysis of all aspects needed to verify whether or not the resource can/will be used in the NPSBN. The asset would by definition fulfill the criteria for "PS LTE Readiness."
- **Asset Credit Assessment** – Determine how many credits would be generated by the contribution of the asset, therefore driving a discount rate factor or other mechanism to "credit" the user for usage of the PSBN.
- **Data for Cost Modeling** – Any team which has pursued large system design understands the critical function of deployment cost modeling, which is inevitably required to justify and plan for

the funding required (by whomever). These high level models could easily be converted into cost modeling tools to support essential business processes.

2.2 High Level Asset Standardization Process: Site Example

Essentially the methodologies described in this paper can be applied in various forms and level of detail to multiple aspects of the network design and asset selection process. If these techniques could be put into a working framework and context, then the possible applications reveal themselves more readily. As the Subcommittee began examining how the business process would fit into the site deployment schemes, it became necessary to sketch out a view of wireless coverage design, which is a highly iterative and complex process. Please note that although an overall process is provided to provide the necessary framework to the discussion, the authors would like to acknowledge there are many other approaches, and the purpose of the framework is to highlight potential areas where tools can achieve greater efficiency, not necessarily to advocate the best overall approach.

Figure 1 provides a visual summary of the site selection process that concludes with an asset being utilized by the NPSBN and feeding the resulting analysis into a negotiated valuation to compensate the donating entity. A number of the processes below could be performed in parallel; however a linear illustration is used for greater clarity.

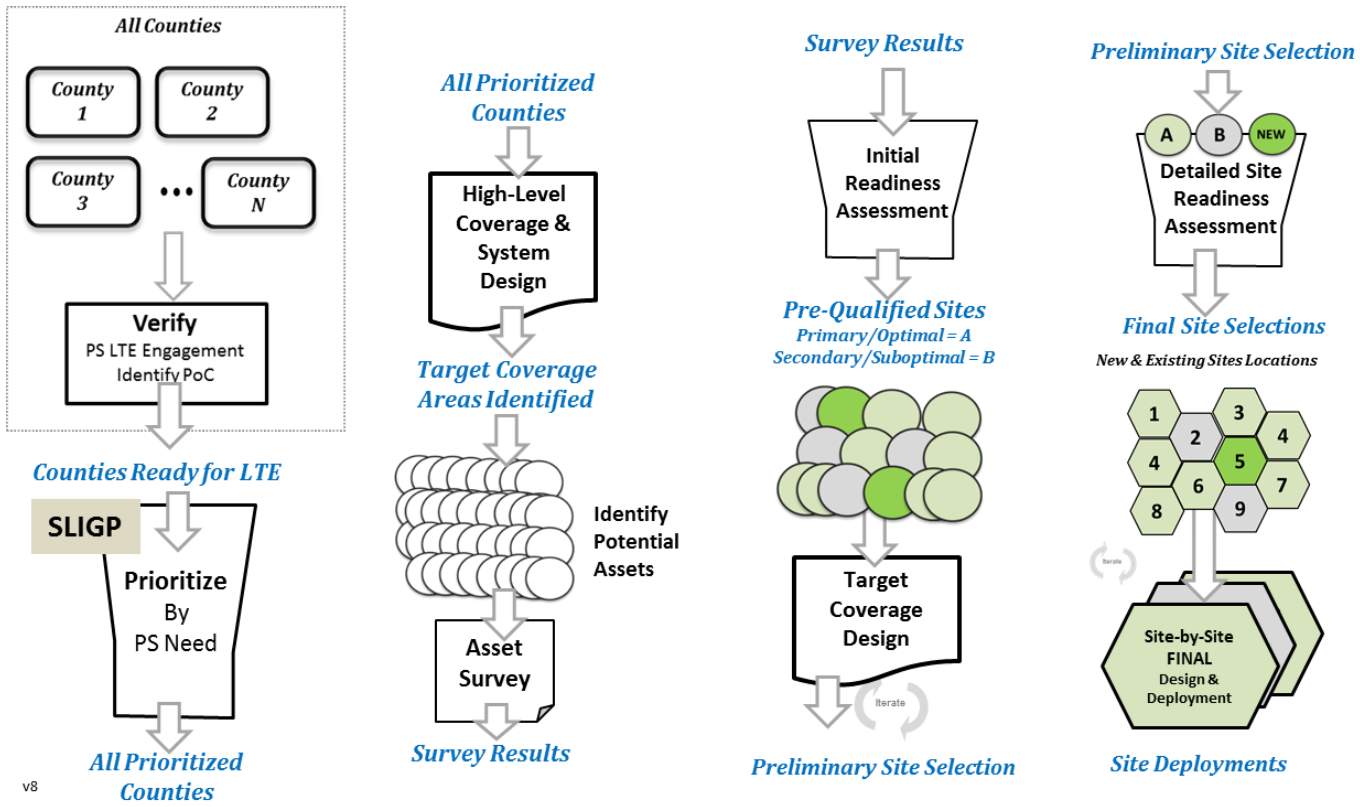
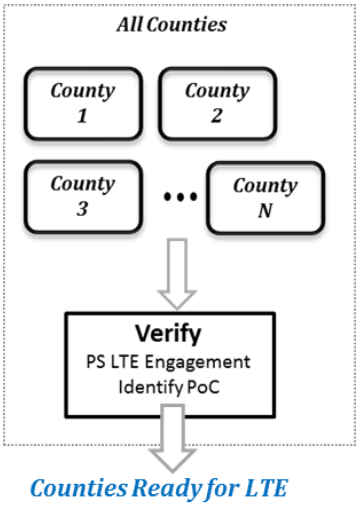


Figure 1 – Overall Process View

The elements of this process are identified and described further in the next sections.

2.2.4 Verify PS LTE Readiness: Get Counties Ready for PS LTE Engagement

In order to proceed with any type of deployment or analysis, the prospective region or county will need to verify that the region or county is ready to engage on PS LTE and for the purposes of this paper, prepared to engage to contribute assets. This "gating checkpoint" ensures that contacts have been identified and that the staffing, expertise and political support will be in place to support ongoing engagement.



Readiness information could include:

- Availability of Funding including ongoing sustainment funding
- Governance in place, Point of Contact identified, Executives engaged and supportive, political support in place to support the project.
- PS LTE Team trained to support PS LTE deployment, consultations and planning

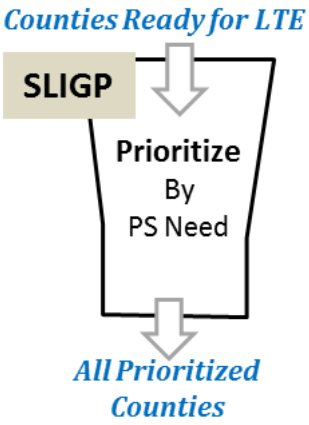
At a minimum this step in the process would produce Point of Contact information, a completed Public Safety needs survey and in general would enable initial analysis and engagement to commence.

2.2.5 Prioritize by Public Safety Need: Identify Prioritized Counties

The following approach was partially inspired by the guidance and directives in the NTIA State and Local Implementation Grant Program (SLIGP). Since this analysis is already funded and mandated by the SLIGP, prioritized coverage plans should be readily available from virtually the entire US footprint. The approach outlined below would utilize data-driven decision making, relying upon readily available county-level statistical data for population, geography and crime rates. The resulting analysis would produce prioritized counties based on most urgent PS Needs.

Assessment factors during this phase could include:

- **Population Density**
- **Prioritized Rural and tribal areas**
- **Crime Rate** – Areas with historically higher crime rates, as these areas will likely require a higher density of sites.
- **Critical Infrastructure** – The presence of critical infrastructure elements, such as stadiums, prisons, nuclear power plants and water, transportation (airports, interstates) or natural gas infrastructures.
- **Borders** – Managing coastal, international and state borders creates specialized interoperability needs such as coordination with Coast Guard, federal border protection or coordination with neighboring states.



- **Disaster Vulnerabilities** – Vulnerabilities to natural disasters including earthquake fault lines and areas vulnerable to hurricanes or wildfires.
- **Other special needs** – Terrorist targets, sensitive military installations, prison, college campuses, sensitive environmental areas

This process produces a prioritized list of counties, which can be combined with regional and other factors, to allow level coverage design to begin.

2.2.6 High Level Coverage & System Design: Establish Target Coverage Area

Once the counties have been selected and prioritized according to the specific needs and priorities of the region, then system designers will need to generate a high level system design which takes into account the footprint as a whole. Designers must consider locations for EPC equipment, existing backhaul, and ability to leverage adjacent regions for contiguous "corridors," among other complex factors.

2.2.6.1 Considering Location Factors in High Level Coverage Design

A key consideration when choosing a communications tower or other structure is the location of that structure. One of the main goals of an RF designer is to design a wireless communications system to provide the desired coverage and capacity while using the fewest number of sites in order to minimize both deployment and maintenance costs. Therefore, the location of a proposed communications structure can be the most important aspect of the facility. However, the best or optimal location for a wireless facility will vary for different wireless systems, based on the design goals for a particular system, the location of other sites in the system and based on status of the system design.

For example, systems designed for maximum coverage will typically use sites located on relatively high terrain with a broad and extensive line-of-sight to maximize the area covered. This is the approach commonly used for Public Safety voice communications systems where broad coverage is essential and capacity requirements are relatively low compared to commercial systems. On the other hand, systems that are designed with maximum capacity as a priority tend to favor sites in lower elevations with more limited coverage to allow for more successful frequency reuse. This design approach is more common for the commercial wireless cellular systems that require greater capacity. Commercial systems are also generally focused on providing service to a large population in order to maximize their return on investment.

This highlights one of the key areas in which the NPSBN diverges from commercial cellular in terms of the drivers for deployment. Clearly, in commercial cellular deployments are driven by market opportunity, and therefore almost entirely by population, or proximity to potential heavy use of the commercial network, e.g. Interstate highways or a popular tourist destination. Additionally, today's commercial system deployments are also handicapped by a more challenging RF link budget than

traditional Public Safety voice systems. This occurs due to the focus on higher data rates that require more advanced modulation techniques, as well as the generally lower power handheld devices used by consumers. Commercial cellular deployments are driven by market opportunity, focused upon population, or proximity to potential heavy use of the commercial network. This has resulted in many rural areas being sparsely or substantially underserved by commercial coverage, tending to exhibit itself as either actual holes in the service area or more generally lower data throughput potential, due to issues of link budget with the greater distance between the UE and the eNodeB itself. Public Safety's need, therefore, is driven by a number of different factors, only one of which is population. In fact, the NPSBN is required to provide substantial rural coverage as specifically indicated in the act: "*shall require deployment phases with substantial rural coverage milestones as part of each phase of the construction and deployment of the network.*"

However, deployment of the NPSBN will face many of the same challenges faced by modern commercial systems in order to realize higher data rates and the desire to support handheld devices similar to those developed for commercial applications. There is the potential that these issues will be addressed with ongoing work to standardize higher power devices, although much still has to occur before these devices are realized. Also, LTE technology has the flexibility to scale down the data rate if broader coverage is required.

The ultimate provider of the NPSBN will need to balance all of these design factors throughout the design process to determine the desired locations for the LTE sites in order to meet the coverage and capacity requirements established for the region. The list of desired location will then be used to choose the final site locations to be developed.

The output of this process would be a method to engage all counties who would be involved and enable them to complete a *Site Information Questionnaire*.

2.2.6.2 Site Information Questionnaire

The short questionnaire below provides an example of the amount and type of information needed for initial viability assessments. The Subcommittee recommends a high level questionnaire that would ask basic information in a 10-15 survey which, if designed correctly, should generate the information required to perform an initial asset viability assessment. This approach assumes that the SLT county contacts would identify potential assets within their jurisdictions.

A ROUGH DRAFT of the Site Information Questionnaire is presented below:

Site Address: _____

Coordinates: _____

ULS number: _____

Date Built: _____

Owner: _____

Type of Site: _____ (building, freestanding, mountaintop, Etc.)

Type of Tower: _____ (water tower, lattice, monopole)

Tower/Structure Height: _____

Potential Available RAD Center(s): _____

Date of Last Structural Analysis: _____

% Loading: _____

TIA 222 Rev F or G: ❑ F ❑ G ❑ Other:_____

Requires Building Permit: ❑ Yes ❑ No

Power Available: ❑ Yes ❑ No

[Insert high level PS LTE Power requirements= 3kW]

Back-up Power: ❑ Yes ❑ No

Type of Back-up Power: _____

Backhaul Available: ❑ Yes ❑ No

[Insert high level PS LTE backhaul requirements = 20-80M]

1 – 10 M ____ 11-30M _____ 31-100M _____

Back-up Backhaul Available: ❑ Yes ❑ No

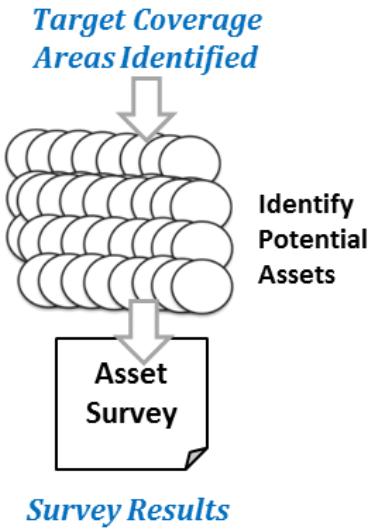
Type of Back-up Backhaul: _____

Shelter Space Available: ❑ Yes ❑ No

Land Space Available: ❑ Yes ❑ No

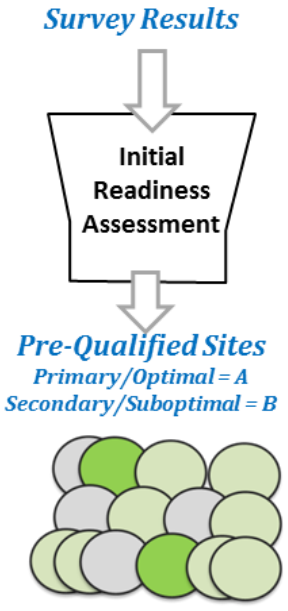
Accessibility: _____ (narrative)

Security: _____ (narrative)



This or similar data sets may be available in existing Public Safety databases, either customized for the agency or in other tools such as Communication Assets Survey and Mapping (CASM).

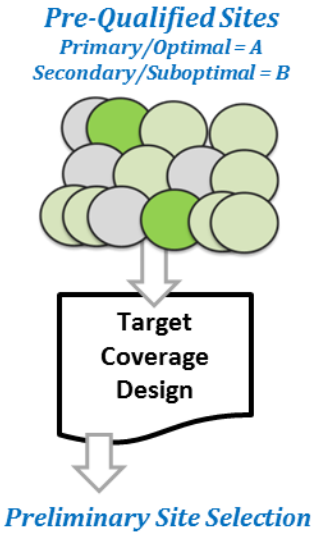
The output of this process would Survey Results which would be created as a database of information which would allow an efficient, perhaps automated site qualification process.



2.2.7 Initial Site Readiness Assessment: Identify Pre-Qualified Sites

The subteam assigned to this portion agreed that a simple MS Excel tool could be developed, perhaps during the data gathering phase, which would create distinct assessment criteria based upon data gathered (example above) and a set of weighting factors which would reflect the overall importance of each component of the assessment. Using this technique a simple assessment could be provided to system designers which would enable a "pre-qualification" of the site, essentially moving the location to the next stage of the analysis. At this juncture, we're envisioning a half-page profile per site which would provide the assessments and summarize all information gathered for that site.

The Initial Site Readiness Assessment Tool would identify qualified sites, using a multi-tiered assessment, a simple example is shown at left.



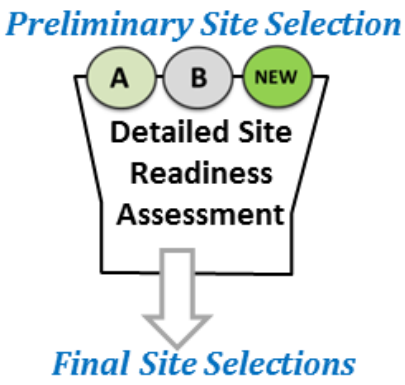
2.2.8 Target Coverage Design: Preliminary Site Selection

This phase would take the desired coverage footprint and pre-qualified site information and develop a detailed coverage design which would identify preliminary site selections. System designers iterate the design with sophisticated coverage modeling tools; this process must be performed holistically to create effective and contiguous coverage areas that meet target coverage and performance requirements.

This phase would produce a preliminary site location selection and identify locations for new or "greenfield" sites.

2.2.9 Detailed Site Readiness Assessment: Final Site Selections

Once all of the assessments have been made and the site locations have been identified as required to meet coverage needs, then the Detailed Site Readiness Assessment can begin. At this juncture, structural engineers and designers will need to visit, assess and prepare final assessments to determine viability, deployment plans and actual costs to deploy. To support this, a highly detailed analysis will be performed. These processes are well understood as they are performed every day to support wireless infrastructure deployments.

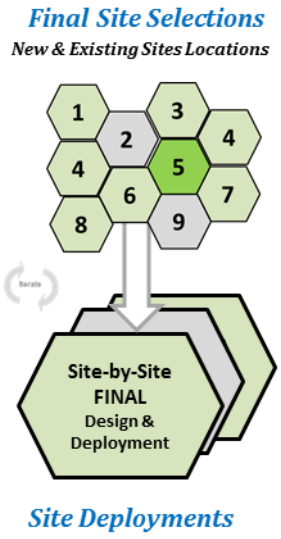


The recommended approach would create a "tool" which would objectively and numerically assess the suitability, readiness and "value" of a proposed PS tower site. The process would create Base Normalizations using common and quantifiable metrics. Some examples for which are described below.

- **Structural Loading (% Loaded)** - In considering which tower assets could be made available to FirstNet, the towers and sites must be assessed to determine if they have adequate capacity and ground space to accommodate LTE antennas and eNodeB equipment. This will require that the towers have sufficient space on them, and that the additional sectorized antennas (or omni-directional antenna in the more rural areas); can be accommodated on these towers in a location that will service a given area. The primary factor to determine readiness, in lieu of a detailed structural analysis, is to capture the available radiation centers on the tower and its current level of loading based upon most recent tower loading analysis.
    - For the Public Safety towers and structures, which may already be exceeding their rated loading, care must be taken in assigning a value to these assets, and a determination about the level of tower remediation which may be required.

        - Additional challenges may be presented by the adoption of TIA 222 Rev G, which is, in general, a more stringent loading specification than the previous version, Rev F.
- **Accommodating eNodeBs** – Non-outdoor temperature range eNodeBs must be able to be housed in existing shelters that are secure and climate controlled, or the equipment must be capable of withstanding a -30 to +50C temperature range for outdoor installations. Additionally, the eNodeB must have functional alarm systems and adequate power available.
- **Back-up Power** – Tower sites will need sufficient power and back-up power. A typical Public Safety site is equipped with UPS systems, 24-hour battery back-up, a generator and fuel tanks large enough to operate for three to five days. It is important to note that these capabilities and preparations were largely credited with keeping radio systems up and operational during the devastating aftermath of Super Storm Sandy.
    - Unlike LMR systems which normally operate on an 80-10-10 duty cycle ((80% standby, 10% receive, 10% transmit), the PSBN will require that the eNodeBs will be in continuous transmit operation 24/7. This increases power, battery and generator capacity and fuel requirements.
        - A typical 3-sector eNodeB draws between one and three kilowatts of continuous power, including LTE equipment, backhaul, and HVAC demands, and costs approximately $400 per month, including HVAC, in retail electricity rates.
        - Standby batteries will need to be assessed to determine if they can handle the continuous load that will be placed on them during power outages.
    - On the generator side, we need to know available capacity and how long the fuel supply lasts. Again, this is an "active" part of the system, so we need to take into account not only what Public Safety is offering from a static perspective, but also what will be needed on an ongoing basis in terms of maintenance plan, refueling services and response times.
- **Availability of Site Backhaul** - Backhaul for PS LTE requires between 20-80 Mbps to support a typical 3-sector, 5 MHz or 10 MHz data channel, in both directions (to the eNodeB and back to the network). If fiber and/or high-capacity microwave systems are already installed at the site, this is a benefit for FirstNet. If there is not sufficient backhaul, it must be determined how much it will cost to add fiber or additional microwave capacity or links to the site. Again, if microwave is the backhaul required, the tower will also need accommodate the additional wind loading of any additional microwave antenna equipment.
    - Assessments must capture important attributes such as guaranteed bandwidth, the type and path(s) they are physically deployed (fiber, microwave), the level of connectivity (will it make it back to the core, or do I have to spend even more money getting it back?), ownership (e.g., private or government owned), and the end-to-end level of route diversity. Since this is an active part of net availability, there are other SLA factors that will ultimately need to be conveyed to the MNO. Even if it's dark fiber, there is a maintenance element that has to be addressed.

- **Antenna Space –** The site must have sufficient space for required antennas and unobstructed line-of-site views for maximum performance. In addition, the antennas must be adequately spaced from other antennas to prevent harmful interference.
    - Antenna height flexibility could be a factor. Having available space on a tower or structure means having a location that is of sufficient height for the LTE antennas to meet the FirstNet system criteria.
    - Sectorized vs Omni – In most cases the NPSBN antenna configuration will require a sectorized configuration with a minimum of three panel antennas but typically six panels (two for each sector to achieve 2+2 MIMO), one for each of the 120 degree sectors. In some rural installations, however, one or more omni-directional antennas may be utilized.
- **Tower Land Availability** – The site must have outdoor land space to accommodate additional equipment, including shelters, generators, cabinets and fuel tanks as required.
- **Shelter Readiness** – Deployment may require that indoor shelter space be available to accommodate additional equipment, including rack space, power and backup as mentioned above. Sites may also utilize secure cabinet installations that are typical of many cellular deployments.
    - **Electrical and Grounding Systems** – Will either need to be capable of accommodating the additional equipment initially or expanded to do so.
    - **HVAC** – Shelters and buildings will need to be climate controlled so that current HVAC systems can handle the additional cooling required by the PS LTE equipment.
- **Adequate Physical Security** – Both the site and shelter will need to be assessed to determine if it is compliant with physical security requirements that protect the equipment from unauthorized access and acts of vandalism.
- **Tower Capabilities** – Structural information, TIA standard status, last structural analysis, and any additional enhancements that enable the tower's resistance to liquefaction, hurricane force wind speeds, lightening and power outages.
- **Environmental Aspects –** Some states and regions, notably California, have highly stringent environmental requirements that would need to be assessed and factored into the analysis.
- **Accessibility Factors –** Additionally, there are other attributes of a site that can affect the viability of that site for the NPSBN. Specifically, the accessibility of a site is a key factor. For instance, whether the site that easily accessible on a well-maintained road, limited access if they are not regularly maintained, or the site requires special access such as helicopter support.



In assessing the overall capabilities of assets, it will be important to implement methods of verifying the accuracy of the information provided. As with the level of detail, the amount of documentation and thoroughness of verification techniques would logically increase as the asset moves through the assessment process.

These are just a sampling of the many complex requirements and capabilities that must be deployed to enable mission critical network operations and must be driven by a detailed set of requirements which address the many layers of hardening required to create a mission critical network. This need was recently identified and prioritized as a topic for immediate work efforts by both APCO and NPSTC.

The output of the process will be "Final Site Selections" which would then proceed to site-by-site location designs and immediate deployment.

2.2.9.3 Use Same Analysis to Calculate Standardized Asset Valuation

Once the site has been officially selected and confirmed for deployment, all of the detailed information will be available to calculate a standardized asset valuation. The Subcommittee recommends that a consistent methodology and tool be applied across the NPSBN so that data can be compiled, exchanged and combined more readily. This addresses one of the risks of approaching this issue, that of potentially every state and territory developing their own approach, which could dramatically increase FirstNet's operational overhead.

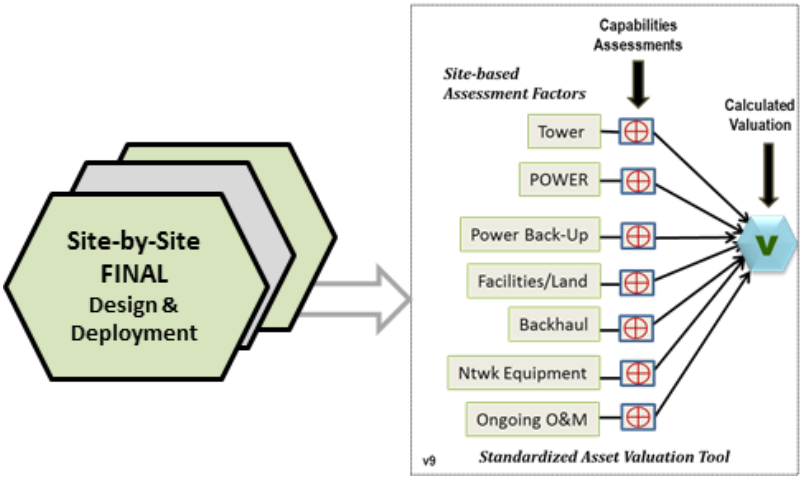


Figure 2 The actual data for the selected sites can be used to generate a precise, calculated valuation.

In summary, robust, straightforward, data-driven tools must be developed. These tools should provide a transparent method to objectively calculate and develop the most impactful and cost efficient deployment plan possible. The tools would be refined to create a "Calculated Valuation," which would simplify and provide a starting point for the Final Negotiated Valuation.

The Subcommittee recommends using the Early Builders, the initial BTOP grant recipients plus Texas, among others, and apply the data they have already gathered to see how the analytical models behave with real site data, as an example. By testing, providing feedback and refining, a prototype analytical tool project could be highly enlightening and a great example of how the experience of Early Builders can contribute to overall system development.

3. Resource "Exchange" Framework

A resource exchange framework (depicted in Figure 2) is anticipated to be the preferred model to fully leverage Public Safety's investments and compensate the asset owner for their contributions. One essential purpose of a resource exchange model is to reduce the overall net deployment and operating costs for FirstNet that helps address the largest risk to overall PSBN deployment, which is lack of funding.

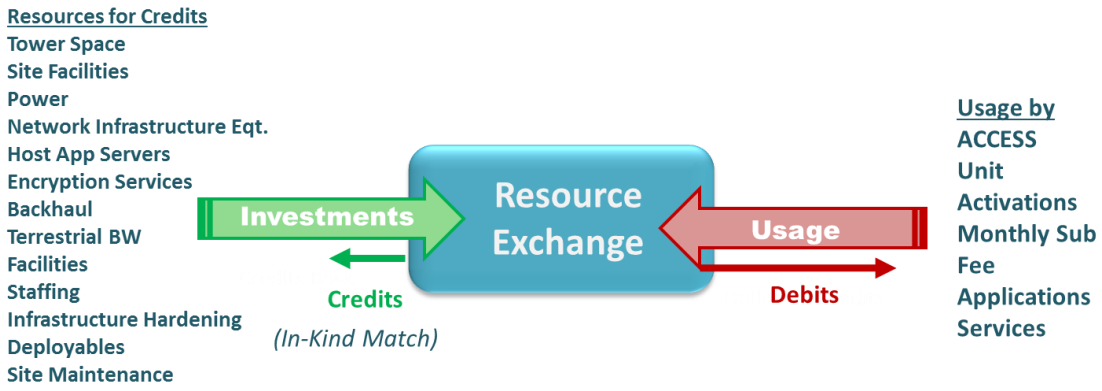


Figure 3 - Resource Exchange Framework

The Exchange tracks debits and credits for contributors and consumers. For example, a county may provide access to its tower and corresponding ground space. The model would credit the county for the use of that asset and offset those credits against the county's total broadband services fees. The specific owner of a resource would be credited, while consumers of a service or product would be debited, as shown in Figure 3. An advantage of an exchange model is it reduces the excessive transfer of funds, which can be problematic for many Public Safety agencies.

The framework mimics roaming settlement methods used by carriers. This model provides incentives for Public Safety agencies to contribute resources to the NPSBN and will tend to fortify their relationship with FirstNet. Through the credits applied for Public Safety and government resources, taxpayer investments are maximized through greater participation in the broadband network and ultimately enhanced benefit to Public Safety operations through increased subscribership or usage by the contributing agency.

3.1 Detailed Exchange Framework

State, local, and tribal contributions to a single exchange simplify their use in the NPSBN. Through the single exchange, FirstNet and its vendors can identify useful resources, their costs, and their attributes. This single information source regarding the resources then makes it far easier to assess how to maximize the impact of these contributions. Pooling these contributions to the Resource Exchange creates substantial efficiencies, not only in the net taxpayer cost but also in planning and developing of the network.

The framework solves some important problems. First, it reduces the number and complexity of cash transactions between FirstNet and contributing entities. It also provides an incentive for state, local, and tribal entities to work together toward contributing their assets towards a sustainable business model. It also quantifies their contributions so that they can gather the political support to use a resource.[1] A more detailed view of the framework is depicted in Figure 4.

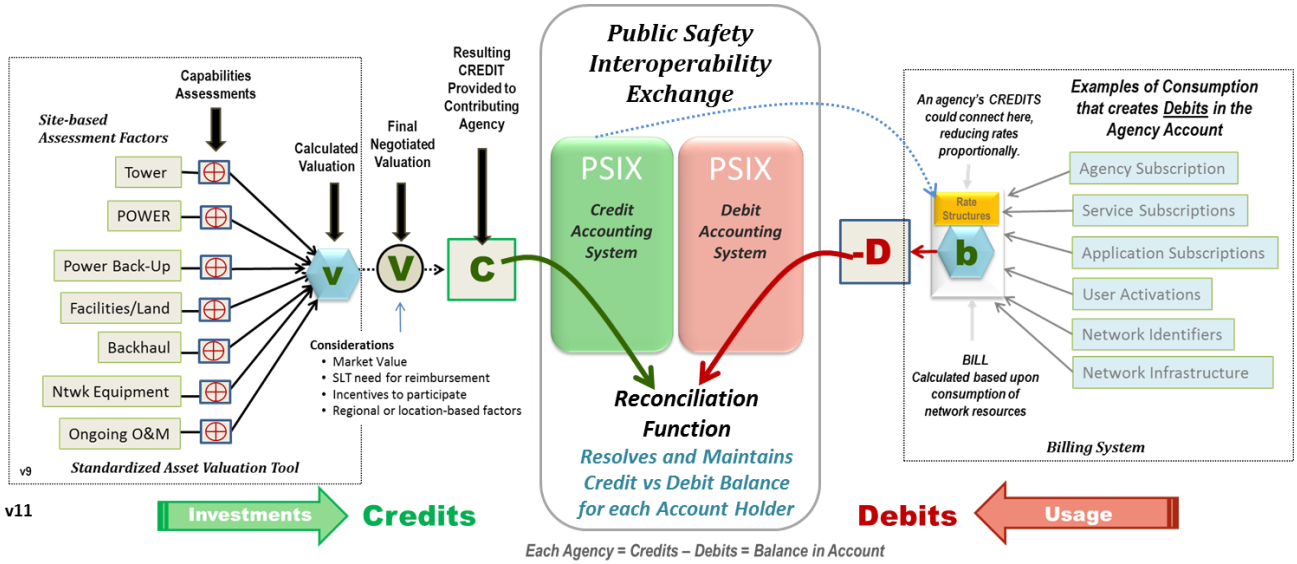


Figure 4 - Detailed Framework View

3.2 Key Benefits

The methodology proposes using a numerically equalized system of "Credits" and "Debits" which would capture the entities respective contribution and consumption of resources to and from the NPSBN. This approach accomplishes some important key benefits and has some additional requirements and attributes:

- Reduces cash transactions among government agencies
  - Same technique used for carrier roaming settlements
- Reflects and reconciles both contributions to and consumption of NPSBN resources
- Model needs to be roughed into a framework and tested against a variety of test cases and scenarios
- Consider using to establish Discount Structures– a straightforward way to use credits without exchanging actual funds
- Cash funds still need to be collected and dispersed

The centerpiece of the entire concept is what is labeled in Figure 3 as a "Public Safety Interoperability Exchange." This vital function would serve to resolve and reconcile credit versus debit, which would

[1] This is important in areas where, for example, modifications to existing towers, even adding an antenna, might encounter vehement opposition from homeowners.

ultimately be the amount the Account Holder would owe or be owed by the Exchange. This "magic in the middle" essentially ties the billing and asset valuation processes together to create an efficient and streamlined process.

4. Relevant Case Studies

As FirstNet contemplates the many complexities and challenges associated with deploying a Public Safety wireless communications network, it will be critical that FirstNet examines the current landscape of Public Safety network operators and their experiences, challenges and lessons learned. The following section highlights some of those examples.

4.1 Michigan Public Safety Communications System (MPSCS)

The Michigan Public Safety Communications System (MPSCS) is one of the largest Public Safety communications networks in the world, and was the first to deploy standards-based Project 25 trunked operation. MPSCS was also the first entity in the US to deploy a packet-based, P25 infrastructure.

Today, the system supports 11 million PTTs per year, and has grown from 180 to 244 tower sites, covering 57,000 square miles of the State of Michigan's land mass. The system has exploded in size and support since its early days as a system dedicated to the Michigan State Police. Since initial deployment, the System has grown from 8000 to 64,400 Public Safety users, from 180 to 244 tower sites and from 153 to over 1413 agencies.

To support and sustain the network, MPSCS uses a variety of funding mechanisms including annual subscriber fees. The fees are required of agencies and users unless they are used by State agencies or are for Emergency Management purposes, these are on a subscriber basis and are tiered by the number of talkgroups provided by the system. Some additional details of the existing MPSCS rate structures are provided below:

- MPSCS uses annual subscriber fees in tiered structure, roughly:
  - $200/yr, unlimited TalkGroups (TGs)
  - $150/yr, (16) TGs + base statewide/interop TGs
  - $50/yr, (8) TGs + base statewide/interop TGs
  - $0/yr, emergency management only template
  - Subscriber fees are paid by local, federal, private and tribal agencies
    - State agencies do NOT pay fees.

MPSCS leverages a "Credit" system driven by legal Integration Agreements that credit User Agencies who want to join the network and have local assets and resources to contribute. This approach, which helped inspire the proposal presented in this document, accomplishes some important objectives.

- Provides MPSCS with assets and resources which MPSCS probably could not otherwise afford

- Allows User Agencies to expand, supplement and design their network to meet their specific needs
    - A common scenario is the deployment of a Simulcast subsystem that provides more robust indoor coverage than is provided by the mobile designed MPSCS baseline coverage design. This approach is being used by (7+) number of counties in the State.
    - Allows User Agencies to offset costs
    - Potentially creates incentives for User Agencies to offer resources Since resources are integrated into the network, they become operational assets for other Users in the State

Because this example aligns with the Resource Exchange model proposed, the City of Detroit Background is provided.

4.1.1 MPSCS - City of Detroit Integration

In 2002, the City of Detroit strongly desired their own PS radio system, but in examining the costs and complexities of the plan, they began exploring the possibility of integrating into the existing statewide MPSCS. As the design proceeded, it became clear that the additional sites and the portable, in-building coverage required by City of Detroit operations exceeded the backbone design of network at that time.

The decision was made that the City of Detroit would supplement the MPSCS by deploying a new zone. This approach provided some distinct advantages:

- Added additional (7th) zone to system
- Allowed Detroit to “divorce” from MPSCS someday, if necessary
- Added coverage for MPSCS users
- Expanded footprint to statewide for Detroit users
- Agreement credited City at 50% of infrastructure value against subscriber fees
    - All infrastructure included
    - Towers, generators, repeaters, microwave
    - Time bound at 10 years
    - Agency pays no subscriber fee until credits expire (either by consumption or timeframe expiration)

The MPSCS has twenty-three similar integrations into the larger network, most notably large county simulcast systems that deliver enhanced in-building coverage and operational capabilities to PS users in their counties. The simulcast subsystems or additional multicast sites provide additional coverage and capacity, and by partnering with MPSCS, this program has been highly successful overall. In the fifteen years of operation, MPSCS has encountered some challenges that may be useful to outline here:

- Achieving local “buy-in” and trust from local agencies to participate in the statewide system is a common and ongoing challenge;

- Once the agreement expires and annual subscriber fees are required, MPSCS has had a constant and expensive challenge of instituting billing and getting agencies to pay for the services provided, since these expenses are often not proactively captured in planning budgets.
    - Turning off the network operation is politically awkward and not always a viable option.
- Covering the increasing overall System Lifecycle costs is an enormous challenge, especially as the scope and scale of the MPSCS network has dramatically expanded as described above.
- Similarly, the governance of the network has had to continuously evolve to match the increase in the number of users, the types of users and the complexity integration agreements.

4.2 BayRICS BayWEB

In 2010, Motorola Solutions, Inc. was awarded a $50.6 million federal Broadband Technology Opportunities Program (BTOP) grant to build BayWEB, a wireless broadband network for Public Safety in the San Francisco Bay Area. BayWEB is a partnership between Motorola, regional Public Safety agencies and the Bay Area Regional Interoperable Communications Systems Authority (BayRICS). Motorola, using BTOP funding and matching funds, will build, operate and maintain the network, consisting of Evolved Packet Core (EPC), microwave backhaul network and eNodeB Radio Access Network (RAN). Local Public Safety agencies contribute radio sites for the RAN and backhaul infrastructure (primarily dark fiber) through Site Use Agreements with Motorola. The BayRICS Authority provides regional governance and oversight and will also be responsible specific "local control" functions, such as billing, subscriber provisioning, prioritization and some training and support functions.

In 2011, the parties negotiated a master agreement and System Funding Plan (http://www.bayrics.net/uploads/1/2/4/6/12466172/bayrics_systems_funding_plan_1-19-2012.pdf) that defined the innovative partnership and operational business model. Under this model, Motorola would charge $38/user/month to cover the costs of operating the network. In addition, BayRICS would charge an additional $5/user/month as a surcharge to cover local control costs such as billing, provisioning and user support, resulting in a total cost to agencies of $43/user/month. However, the Plan points out that future system expansion, backhaul and system refresh costs may require increasing the surcharge to cover those costs in future years.

BayRICS, through its Technical Advisory Committee (TAC), did considerable research in identifying and estimating costs associated with contributions of sites and infrastructure, and the BayWEB funding plan identified specific costs to members, such as electrical costs, site maintenance/security and cost of staff time to interface with Motorola and escort contractors while on site. BayRICS also considered a number of ways to mitigate those costs, including plans to credit back some portion of the subscriber fees to those member agencies that contribute sites or backhaul. For example, BayRICS considered increasing the surcharge for agencies that did not contribute sites and then passing this revenue on to agencies

who did contribute sites, waiving the surcharge for contributing agencies, and offering "rebates" back to members to recover a portion of their actual site costs at the end of each year.

However, each of these plans created significant risk that BayWEB would fail to generate enough revenues to cover its operational costs, which would threaten the long-term sustainability of the project. Moreover, BayRICS' research indicated that $43/user/month was very near the upper limit of pricing that would still encourage high levels of Public Safety users to adopt the service. BayRICS also recognized that increasing the surcharge to members with no site contributions would be perceived as unfair and could have resulted in deterring significant Public Safety use of the network.

The challenge of sustainability versus compensation for site costs proved to be a complex part of the negotiations and resulted in costly delays for the project. In the end the System Funding Plan provided no compensation for member contributions of sites and infrastructure, but with the goal to revisit the question annually during budget development. If BayRICS determined that the revenues from the $5 surcharge exceeded operating costs, any excess revenues would be allocated among the site owning agencies.

The BayRICS Funding Plan identified other costs that Public Safety agencies will likely incur as they adopt FirstNet. For example, "back office" connectivity costs (i.e. the cost of connectivity to the agency's PSAP, dispatch and data servers) may be significant for some agencies not already connected by fiber. Also, there may be significant costs in upgrading or purchasing standardized applications if an agency's current CAD or data applications are not supported on the network. User training and support must be comprehensive and continuous to be effective, but will add additional costs. There will also be a cost of local control, such as support for governance, planning and decision-making for local and regional provisioning and prioritization activities. Lastly, the costs of user devices to operate on the new networks will be substantial and may prohibit many agencies from robust subscribership levels, especially until existing devices reach end of life. These costs must be considered when developing pricing and sustainability models for the nationwide network.

5. Summary Recommendations

The APCO Broadband Business Modeling & Benchmarking Subcommittee has provided recommendations and directives throughout this document. Additional items or clarifications are presented below.

- Further develop the methodologies, tools, checklists and procedures in this document.
- Test the methodology in real-world situations, i.e. specifically with the LTE BTOP jurisdictions and Texas. Such tests will further refine the concepts.
- FirstNet should either accelerate the gathering of asset information or delay the release of State RFPs in order to ensure that SLT assets can be included in the initial design.
- Build an iterative process: Start with basic information and iterate to increasing levels of detail, avoid having to reinvent along the way.
    - Leverage SLIGP so that this program and capabilities dovetails

- Basic assessment criteria, such as those outlined in 2.7.1, should be developed for all of the significant asset categories so that SLTs have the information they need to begin internal assessments as soon as possible.

We greatly appreciate your time and attention!

Sincerely,

Business Modeling & Benchmarking Subcommittee
APCO Broadband Committee

Appendices follow

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Appendix A – Notes, Open Issues, Questions and Topics for Future Consideration

The following questions and issues are captured here for further discussion and evaluation.

Question	Will agencies be willing to contribute more resources in order to reduce FirstNet (or State) deployment costs and thereby justifies Deployment Priority? In other words, will agencies pay more to get it earlier? Early Builders demonstrate this. Will agencies be willing to "discount" their assets to ensure they have their requirements met (e.g., to deliver in-building coverage)? [Cole]
Open Question	How does this look in the context of a "Hosted PS LTE Interoperability Cloud" or similar? Isn't an exchange model a type of cloud application? How are these business models similar? How are they different? [meeting notes]
Identified Issue	A big issue with regard to utilization of Public Safety assets is terms and conditions. If the MNO feels they have to negotiate 10,000 lease agreements, we've just created a huge disincentive for their use. So, it could be that the terms, regardless of the price, are too much of a risk for the MNO. [Ross]
Identified Issue	Billing systems can be very complex and costly – should FirstNet be approached to add a billing/authentication function at the core level so that local jurisdictions can all access usage data and reports in a common format. Besides, the enterprise level billing systems that carriers use are designed to be partitioned to accommodate MVNOs and the like. [Samples]
Suggestion	Standardized network monitoring and management metrics are needed, such that for the good of the network and all participating agencies, the data can be easily rolled up to higher level performance reporting and management. [Samples]
Suggestion	Processes should identify Key Performance Indicators (KPIs). Mel emphasizes need to establish these as a basis for Operations and Management costing assumptions, and it should be noted that KPIs are a well-established mechanism for managing metrics and expectations and could be applied throughout this process to ensure the processes produce desired results. [Samples]
Idea to consider	In considering how to compensate entities which contribute assets, an intriguing idea was presented. The question was asked whether a SLT entity could simply receive subscriber devices as "payment" for contributing infrastructure. This would be advantageous for a couple of reasons: the "deal" could be concluded immediately, avoiding ongoing maintenance, monitoring and billing; FirstNet wins because they could get tower space by providing devices rather than cash; FirstNet wins because they would get additional customers, SLT wins because they would avoid substantial capital outlay – it is assumed the SLT agency would pay ongoing monthly charges.

Idea to consider	In a project to add antennas to PS lattice sites, we had to call a group of structural experts to brainstorm ideas on a particularly obstinate tower. Among the creative ideas was to just “pop-up” a single monopole tower in the same area – reuse power, security, fencing, etc. Although not cost effective for 1-2 sites, on a larger scale this idea may have merit. Monopoles, especially short ones are not expensive, deployments could develop an “eNodeB site-on-a-pole-kit” or similar which could potentially generate substantial cost savings by creating volume purchases, standardized configurations, less training and more accurate cost projections. [Cole]