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November 7, 2011

James Arden Barnett, Jr., Rear Admiral (Ret)
Chief, Public Safety and Homeland Security Bureau
Federal Communications Commission
445 12th Street S.W.
Washington, D.C. 20554

Re: Response to Your October 12, 2011 Letter with Questions Relating to State of Texas Request for a Public Safety Broadband Network PLMN ID
PS Docket No. 06-229

Dear Admiral Barnett:

The attached is the State of Texas response to your letter to me of October 12, 2011 in which you posed six groups of questions related to the Texas request for a permanent Texas Public Safety Broadband Network PLMN ID.

Respectfully submitted for the State of Texas,

/s/ Michael Simpson
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A. Introduction

This document has been prepared in response to the October, 12, 2011 letter, from Admiral James Barnett (Ret.), Chief, Federal Communications Commission Public Safety Homeland Security Bureau (the "Bureau"), to Mike Simpson, Chief, Interoperable Communications, Texas Department of Public Safety, speaking on behalf of the State of Texas (the "State"), waiver recipient, regarding the Texas request for a PLMN ID, that was submitted in the revised Texas Quarterly Report #5, submitted to the FCC on August 18, 2011.

Primarily because the allocation schemes require more development, the numerical values, and specifics provided regarding allocation recommendations are ***for discussion and example only.*** This point is repeatedly emphasized throughout this document. Although substantial progress has been made toward establishing viable approaches for each major identifier, more work and analysis will be needed to fully refine them. It is also important to note that, if the allocation details were finalized, and actual identifier allocations were specifically identified, network security concerns would prevent the State from publicly sharing that information.

The responses are reordered from the sequence of questions presented in Admiral Barnett's letter. This was done to enable the State to reuse the background and narrative that it already had developed. The sequence is not intended to imply a priority of any kind. Each response section has a header with a bracketed "Q," followed by the question number from the October 12th letter.

Even though the State had just 26 days to respond, the level of engagement, information, and support received during the process of developing this response, has been significant. The material was circulated, in various stages of development, to approximately 150 persons and 60 organizations, made up of waiver recipients, public safety agencies, and commercial entities. The information was presented with very aggressive timeframes required for responses to the drafts. Despite this, the responders reviewed, asked many questions, and contributed thoughtful feedback and corrections. This was extremely useful, and for many topics, substantively flavored the State's responses to the questions. But this is the Texas response.

The State greatly appreciates the Bureau's confidence, and the tremendous opportunity to respond to such important and strategic network issues as were raised. The responses contained herein have been provided to the best knowledge and ability of the State, and of the document collaborators. The State realizes that all of the questions may not be fully answered. Texas strongly believes that the definitive answers should be determined based upon inputs from stakeholders, including public safety agencies, waiver recipients, future users, vendors, carriers, and national policy makers. The State would like to express a level of discomfort with asserting solutions, which deserve a national-level perspective and ownership, and not be reflective of just a single state's point of view. This discomfort has been the primary motivator for the outreach program, and Texas will endeavor to sponsor, continue, and expand this work, as described in the concluding recommendations.

The State of Texas has authored this document, and is solely responsible for its content. Although others have been consulted in its compilation, this document is the Texas response to the questions posed by Admiral Barnett. References for the primary source material are provided in the References section of the Appendix.

B. [Q6] Actions Needed

Admiral Barnett QUESTION [6a]: Based on your Interoperability Showing, Texas' Fifth Quarterly Report, and recent discussions, we understand that BIG-Net "Go Live" date is set at August 1, 2012, and the target completion date to obtain a permanent PLMN ID is February 1, 2012. Based on your responses above, what actions must be taken to ensure that you meet your deployment as scheduled?

Texas [6a] ANSWER: In the context of the network identifiers topic, and as described in the *Texas Interoperability Showing*, the initial Harris County BIG-Net layer is scheduled to initiate Service Availability[1] ("go-live") on or about August 1, 2012. In order to build out the necessary network infrastructure in a stable configuration, the State will need to be allocated what hopefully is a permanent PLMN ID (as opposed to a temporary, test-only PLMN ID), along with properly coordinated network identifiers, required to allow initial configuration of the network. In order to prevent this issue from impacting the Date of Service Availability, the BIG-Net deployment team needs the coordinated network identifiers by February 1, 2012.

To obtain stable identifiers, the State is assuming that the national allocation would need to follow a plan driven initially by an authorized and empowered ***Interim Nationwide Network Identifiers Management Entity***. Texas is assuming this entity would serve in the short run until such time that a potential nationwide public safety broadband corporation may become a reality.

Admiral Barnett QUESTION [6b]: To the extent that any action is dependent on parties not affiliated with Texas, how can you ensure that any action is done within the deployment timeframe?

Texas [6b] ANSWER: To the extent that actions required to accomplish the many objectives described in this document are dependent upon parties not affiliated with Texas, the State can only answer that the risks of early deployment are clearly understood, and more importantly, Texas pledges to continuing working with stakeholders beyond the borders of the State to reach consensus through a thoughtful and inclusive process. The State looks to the Bureau, and other stakeholders mentioned, to act upon the Texas recommendations in a manner which influences timely actions by parties not affiliated with Texas, but are needed to enable the State to meet its deployment timeframe as described.

[1] *See Interoperability Order*, DA 10-2342, PS Docket 06-229, December 10, 2010, ¶ 9, footnote 19. The term "Service Availability" is defined as when the system is being used on a day-to-day basis for operational functions by at least fifty users.

C. [Q5] IMSI Coordination

Admiral Barnett QUESTION [5a]: If Texas uses a single PLMN ID in common with other waiver jurisdictions, and, ultimately with a nationwide network, will there be a subsystem-of-identification of Texas and other jurisdictions?

Admiral Barnett QUESTION [5b]: Will such a subsystem use the seventh, eighth and perhaps higher order digits of the International Mobile Subscriber Identifier (IMSI) in order to identify the jurisdictions?

The following Sections C.1, C.2 & C.3 provide background for the answers to [5a] and [5b] which are concluded at the end of section C.3.

C.1 National IMSI Coordination Objectives

Objectives for a nationwide coordinated network identifiers management plan include:

- a fair and inclusive oversight process which allows critical stakeholders to be involved;
- An ongoing entity that will create the policies and implement the tools needed to maintain the program and establish the processes to accommodate evolution and change; and
- A business/funding model that allows the program to be independent and sustainable.

C.2 IMSI Coordination Background

The International Mobile Subscriber Identification ("IMSI" or "IM-zee") numbers are used to generate 4G SIM cards, which identify subscriptions on the PS LTE network, and are therefore directly related to the authentication and billing elements, which generate revenue and prevent fraud, as they do in cellular networks today. The IMSI numbering plan does not impact the planning of "dialable" 10 digit phone numbers (MS-ISDNs).

It should be noted that, as a network operator, and in this context the owner of the PLMN ID, it is a vital and fundamental responsibility to keep the IMSIs perfectly and globally unique. Additionally, it should be noted that, per the IMSI Usage Guidelines,[2] the IMSIs are a public resource. Essentially, at least for the interim, an entity needs to become the "steward" of the IMSI ID space (and for a particular PLMN ID), the Mobile Subscriber Identification Numbers ("MSIN"). The MSIN have a nine character numerical ID space of one billion.

This network configuration mandate is imposed by the underlying network architecture and creates a fundamental requirement that any entity operating and using the PLMN ID must agree and maintain the uniqueness of the identifiers they utilize. This fundamental requirement is a reality of the 3GPP ecosystem and does not need to be reinforced by institutionalized regulations or policies. To put it another way, the network is self-regulating in this regard; if an entity on the network doesn't comply, then the network does not work. This means that any entity requesting permission to use a particular PLMN ID must agree to abide by that PLMN ID's coordination plan in order to become part of the network.

[2] International Mobile Subscriber Identity (IMSI) Assignment and Management Guidelines and Procedures, ¶ 5.6, v 12.0, December 2010

To better understand the MSIN, see the overview of the PLMN ID, provided at right.

As described in the response to the roaming question [2a], allocating MSIN ranges to regional HSSs is used for supporting Subscriber Authentication. Additionally, MSIN ranges may also be used to identify QoS policies for users from other regions, as well as agency affiliations for usage tracking and billing purposes. Partitioning and allocation of the MSIN is completely within the purview of the PLMN Operator. As such, usage of MSIN partitions to identify regions and/or jurisdictions will not impact the ability to support roaming with commercial carrier networks.

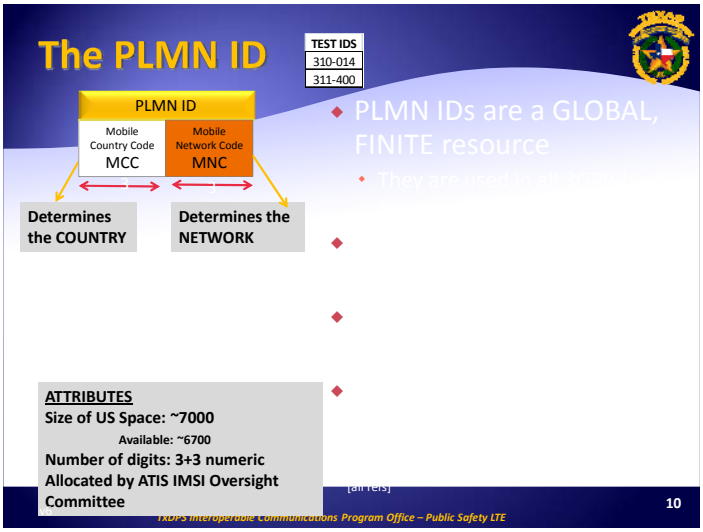

Fig 1. The PLMN ID *- The Public Land Mobile Network Identifier is the primary identifier for the network. It is made up of two 3-digit numbers, a Mobile Country Code (MCC) and a Mobile Network Code (MNC).*

C.3 MSIN Allocation Objectives

The State of Texas believes the MSIN allocation methodology implemented should have the following objectives:

- A numerical methodology should be used which is neutral, logical, and fair.
- Large reserves and "buffer zones" should be kept available to allow for growth and change.
- State-by-state allocations should be laid out in a manner which is logical and advantageous in managing network identifiers.
- Although this document uses a Federal Region illustration of the reserves, it is recommended that the reservations and allocations be performed on a state level basis.
- Ideally, each state should be able to comfortably fit within its allocation for 10-20 years.

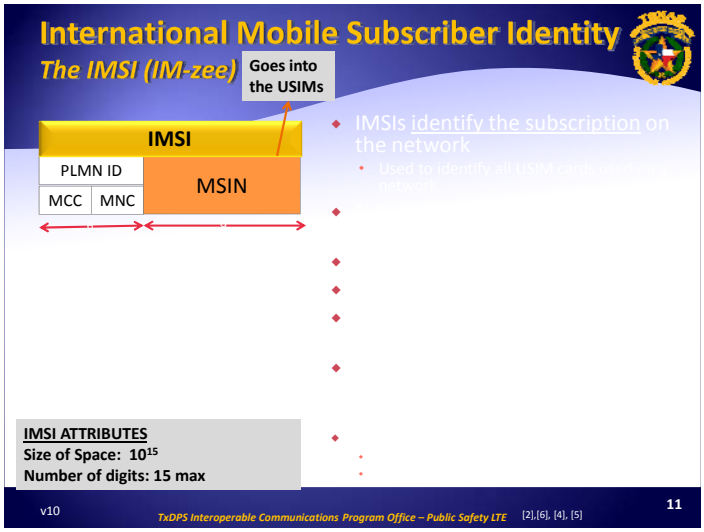

Fig 2. IMSI *- As shown in the illustration above, the IMSI is made up of the PLMN ID, which will be issued to the network operator(s) and the MSIN, which is the nine digit identifier that defines and identifies each subscription on the network.*

The State of Texas recommends that a fair and cohesive methodology for managing PS LTE Network Identifiers be established. In order to further the discussions around the development of a methodology, the State of Texas is offering a series of allocation examples, which are intended to:

- Illustrate what a final allocation will need to look like;
- Show different allocation approaches which could vary by identifier; and
- Clarify the scope of work involved to manage the identifiers effectively.

PLEASE NOTE THE FOLLOWING INFORMATION IS PRELIMINARY, FOR DISCUSSION ONLY AND SUBJECT TO CHANGE.

C.3.1 Initial MSIN Allocation Example: Reserve ~30% across lower 400M

The example below shows a reservation strategy which puts for PS LTE MSIN in the lower 400 million (M) of the billion range available, leaving the middle 100 million as a public safety Reserve and the upper 500 million for "Future Use."

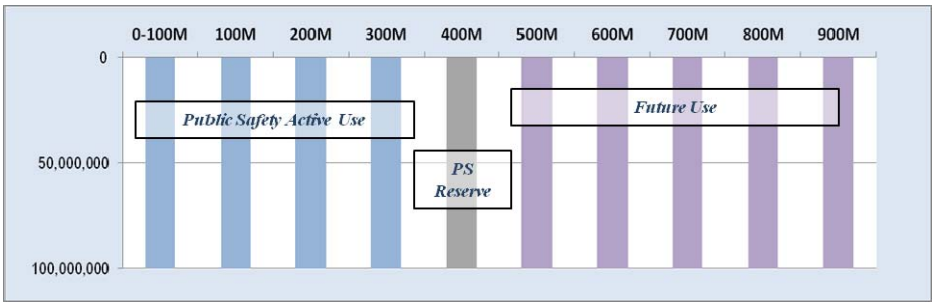

Fig. 3 Initial MSIN Allocation EXAMPLE *– This view shows an example in which about 300M initial PS allocations would be distributed in the lower 400M, 100M would be set aside for PS "Reserve", and the upper 500M would be set aside for future use.*

C.3.2 Initial MSIN Allocation Example: Show Region by Region View

Once general allocation objectives are set as above, region-by-region allocations are generated by weighting the precise numerical value for each state. In the current example, v2.1 shown at left, the following weightings and attributers were used: geography (55%), population (25%), crime rate (10%) and number of UASI regions (10%).

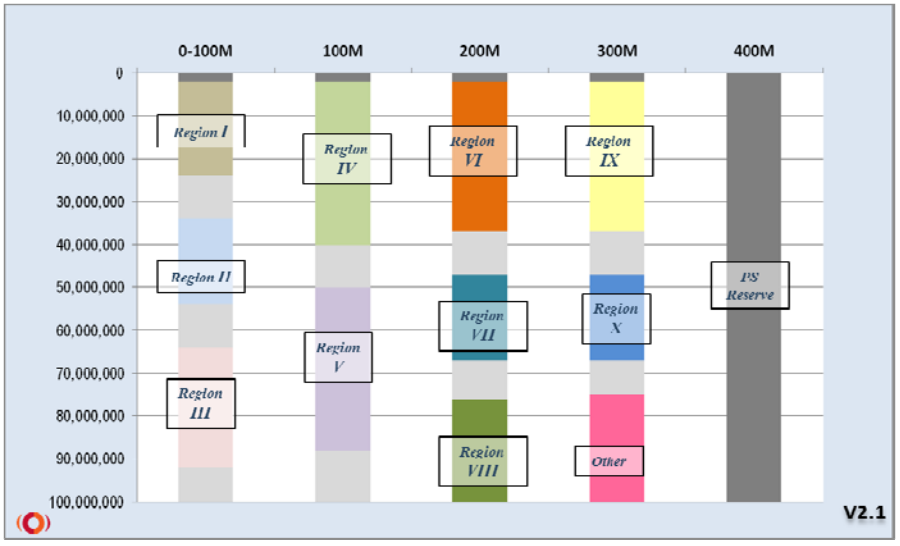

Fig. 4 EXAMPLE MSIN Allocation *– Flow from east to west, shown here by regions, reserves and allocations should be to state entities. This approach leaves ample room for growth and change.*

Combining the weighted attributes into a modeling tool, gives an output of

highly accurate multipliers or "x-factors" which, by overlaying the available allocation, results in the example shown above. The example MSIN allocation X-factors generated in this early analysis already reveal some obvious optimizations and adjustments, which need to be made, but the figures used here give an approximation of what a final allocation could look like.

It should be clarified that, although the allocations are shown based on Federal Regions, it is not meant to imply that a regional entity would necessarily need to be involved. It is envisioned and proposed, that the reserves and allocations be handled between the suggested ***Interim Nationwide Network Identifiers Management Entity*** and the individual states. The reference to the Federal Regions is only for the purposes of modeling the high-level reservation plan and for providing a clear, visual picture, of the overall design and approach. Unlike the states, the Federal Regions are not political subdivisions, and only exist in organizational functions.

C.3.3 State-by-State Allocation Examples

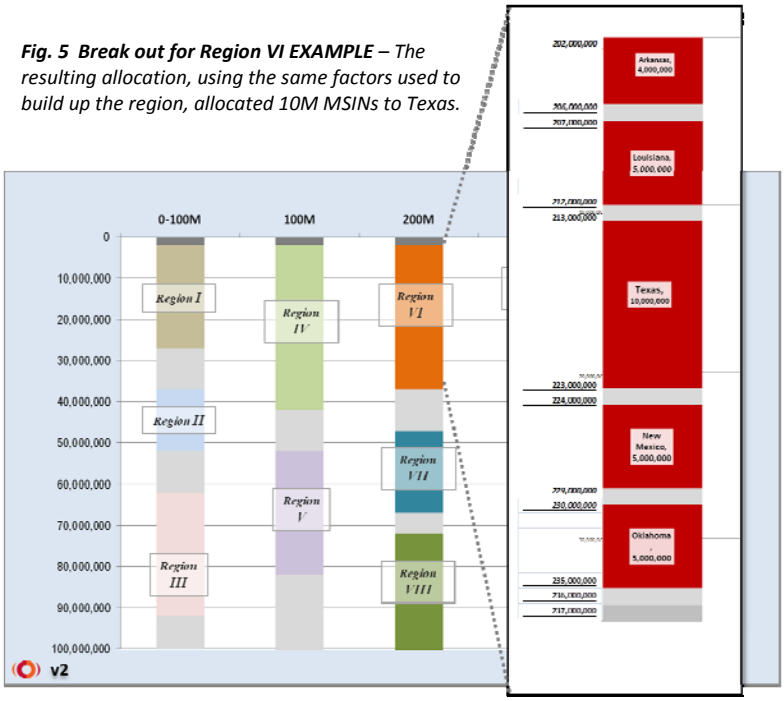

Fig. 5 Break out for Region VI EXAMPLE *– The resulting allocation, using the same factors used to build up the region, allocated 10M MSINs to Texas.*

Because the modeling tool is numerically driven, the same method can be used to generate a regional allocation, Region VI, in this example at right.

As shown in this example, the methodology would result in Texas being issued ten million (M) MSINs in the range of 213,000,000 to 223,000,000.

Admiral Barnett QUESTION [5a]: If Texas uses a single PLMN ID in common with other waiver jurisdictions, and, ultimately with a nationwide network, will there be a subsystem-of-identification of Texas and other jurisdictions?

Texas [5a,5b] ANSWER: Yes, Texas believes that using a subsystem-of-identification approach is one, among a variety of ways, in which MSINs could be coordinated and managed. Indeed, the examples outlined above utilize the seventh, eighth and ninth order digits, and those identifiers could be used to specify the state, Federal Region, and exact range reserved.

As Texas investigated its options in preparing this response, a variety of approaches were identified, which could be used to initially reserve, allocate, and manage the identifiers. A focused team of experts and stakeholders should be established to further investigate, and recommend alternatives.

In the example above, the methodology uses the federal regions "I" (one) through "X" (ten) to create a sequence of state-level reserves, which would be laid out beginning with Maine (Federal Region I) in the east, to Alaska (Federal Region X) in the west. When combined with the allocation factors, the result is the examples illustrated in Fig. 4, above. Showing the state-level detail in Fig. 5, the example would give the State of Texas "213-223," i.e., MSINS in the range between 213000000 and 223999999. Texas could subsequently decide to further subdivide its range, allocating "213-214" to BIG-Net in Harris County, and "215" to a future system in the Dallas/Fort Worth area, for example.

With this level of specificity, and a stable management and governing process that would ensure the allocations and reserves are coordinated and maintained over the long term, Texas believes this approach would meet the State's needs for the foreseeable future.

One of the draft response feedback submissions expressed a concern about injecting "intelligence" into the numerical schemes and sequences, e.g., associating them with a Federal Region or state. This could create, the submitter argues, a constant battle to overcome issues related to the initial allocation, if some areas have too many and others do not have enough. The State counters that this is the reason for the policies and tools that support this process. Texas wholeheartedly agrees that the flexibility of the program is essential. However, an "allocation-as-you-go" approach has other downsides as well, including the risk that later deployments have a higher barrier of entry.

The allocation of network identifiers by Federal Region or state should in no way inhibit connecting, sharing, or trading identifiers between network entities. This is not the intention, or a necessary implication. Indeed, one of the distinct advantages of this plan is that, if an entity (e.g., a region or a neighboring state) wants to connect across state lines, the entity would "bring" its identifier allocation with it, so that the host state does not have to consume its state or local allocations to accommodate the connecting entity.

Admiral Barnett QUESTION [5c]: If so, will this limit the number of individual users on the network or in any way impact the ability to support non-public safety users?

Texas [5c] ANSWER: Interestingly, in the early feedback on the Texas circulated material, the allocations look comfortable enough for public safety, but seem to potentially introduce some limitations should PS LTE network operators eventually be allowed to expand the users of the network to additional segments, such as federal government and critical infrastructure agencies, utilities, and others. Supported by a number of experts reviewing this material, it was agreed that it would be advantageous to replicate allocation in the upper range should the lower range become congested. This implies that every entity would essentially have an identical and corresponding allocation, which each could request be activated, as shown in the illustration, below. Both allocations keep a 100 million in "PS Reserve" to be used for other agencies, entities, or other unforeseen needs. Another important way to conserve identifiers would be to recycle them, reducing the overall rate of consumption.

C.3.4 Example MSIN Allocation – Long Term Expansion View

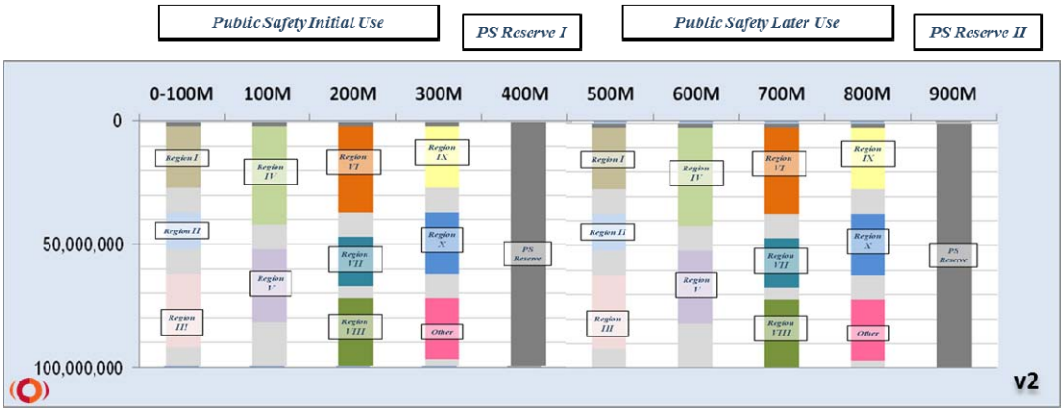

Fig. 6 Long Term View of MSIN ID Space *– This view shows a proposal in which the future needs require additional MSINS, at which time the entities could request additional IDs out of a replicated allocation in the upper range set aside for "Future Use."*

This approach, in the example allocation provided for Texas, yields 22 million MSINs for a 20-year period. Although this seems generous, based on the number of public safety users estimated for that time, there is the potential for explosive device growth – driven by machine-to-machine telemetry-supporting applications in fire equipment, biometrics, intelligent cameras, bulletproof vests, and vehicles. If recent Internet telemetry capabilities are indicative, a responder, and the responder's associated vehicle and equipment, could each easily consume scores of MSINs. It is the State's wish to avoid an "IPv4 to IPv6" problem in the future, which is full of historical examples where technologists underestimated the appetite and consumption of numbering schemes. For this reason, Texas believes it is prudent to establish as much flexibility as possible in the early allocations. In general, allocations that are too large are much less disruptive than allocations that become too small. In other words, it is better to have too many than not enough.

Texas agrees with many in the public safety community concerning the absolute essential need for interoperability with federal agency users. The State believes the network identifiers numbering plan should be flexible to accommodate potential expansion to federal agencies. For this reason, each identifier model proposed includes a category for "other" users as well as a "Public Safety Reserve," either of which could be used to gracefully absorb federal agency users onto the nationwide PS LTE network.

Admiral Barnett QUESTION [5d]: Since this is not the way that commercial entities use the code, are there other consequences that would impact the operation of the network?

Texas [5d] ANSWER: Although the approach being taken for public safety IMSI identifier coordination differs from the methodologies and approaches used by commercial cellular carriers, the carrier contacts who reviewed this material did not find any reasons why these differences would cause negative consequences to the PS LTE network or to the ability to roam, connect and interoperate. Indeed, an observation was made that because of public safety's underlying need for prioritization, an organized identifier approach may deliver substantial benefits. These issues and opportunities require further investigation, but as of the submission of this document, no negative consequences were identified.

Admiral Barnett QUESTION [5e]: If this is not the way Texas and other individual jurisdictions will be identified on the network, what method will be used?

Texas [5e] ANSWER: Texas agrees that the approach described in the answers given to the previous questions should be the method used to identify jurisdictions on the network.

D. [Q4] Coordinating Network Identifiers

Admiral Barnett QUESTION [4a]: What is Texas' plan for transition of the Texas network to a nationwide network with a single PLMN ID?

Texas [4a] ANSWER: In the context of the PLMN ID, and other coordinated network identifiers, a fundamental driver of the recommendations and initiatives provided in this response, is to proactively manage the risks associated with the potential costs, disruption, downtime, and effort required to lay the bedrock for a nationwide network. Using this foundation, the nationwide network would build upon the Texas experience and be easier; thus, the transition would be relatively elegant, and require the detailed effort as set forth in the answers to questions [2] and [3].

If the PS LTE network identifiers are not managed in a cohesive, nationwide fashion, then the following undesirable outcomes and impacts that are likely to occur:

- Each early-deployment entity would have to grapple with increased, highly complex, disruptive, and expensive reconfigurations. The risks are not only around increased service costs, but more concerning, will inevitably result in downtime, disruptions, and problems.
- Doing this in a piecemeal fashion may result in such entrenched system configurations that it likely would be difficult to recombine the plan into a national and cohesive structure.

In summary, the State of Texas believes that the work needed to manage this effort at a nationwide, coordinated level, would be considerably less costly than the issues which would result by not doing so. For these reasons, the State sees the designation of a ***Nationwide Network Identifiers Management Entity*** as critical to the overall nationwide success of the public safety LTE programs.

Admiral Barnett QUESTION [4b]: Has Texas coordinated such an approach with other waiver jurisdictions?

Texas [4b] ANSWER: Shortly after receipt of Admiral Barnett's letter dated October 12, 2011, the Texas team released background materials to various groups of public safety and commercial industry stakeholders, including the Public Safety Spectrum Trust (PSST) – Operator Advisory Committee (OAC), the Association of Public-Safety Communications Officials (APCO) Broadband Committee, Department of Commerce – Public Safety Communications Research Program (PSCR), Department of Homeland Security – Office of Emergency Communications, commercial cellular carriers, and the Region VI Public Safety LTE Interoperability Forum Network Architecture Working Group (NAWG). The Region VI NAWG is comprised of lead architects and technologists (from commercial LTE manufacturing and integration companies), whose dedication, engagement and involvement have become an essential resource for this entire process. The purpose of the background material was to provide a comprehensive overview of the network identifiers, which was used to "level set" the various teams, so that Texas could facilitate a productive discussion about how to approach the problems to be solved.

[4c] Admiral Barnett QUESTION [4c]: How will this transition of the Texas network into a nationwide network with one PLMN ID affect other network identification codes, such as:

a) Tracking Area Codes (TACs);

b) eNodeB Identifiers (eNBIDS);

c) Mobility Management Entity Group Identifiers (MMEGIs); and

d) PDN Identifiers (Access Point Names).

Admiral Barnett QUESTION [4d]: And how will they be managed technically and operationally?

Texas [4c] ANSWER:

A summary of the allocation is provided in the following sections, organized by identifier.

D.1 TRACKING AREA CODES (TACS)

The illustration on the right presents a potential approach for nationwide coordination of the Tracking Area Code. The Tracking Area Code (TAC) is based upon the input received. It is estimated that a typical system will need hundreds of TACs in its lifetime. In the 3GPP standard, the TAC field is a two octet hexadecimal field, with a total capacity (per PLMN ID) of 65,536.

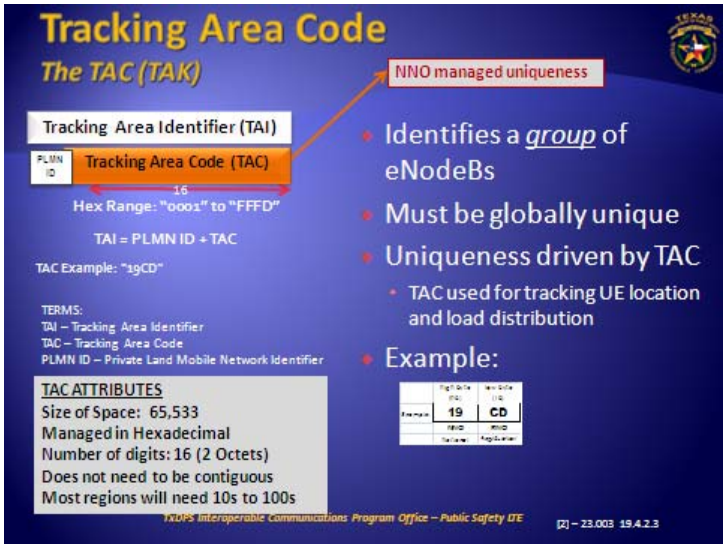

Fig. 7 Tracking Area Code (TAC) – The Tracking Area Identifier (TAI) is comprised of the Tracking Area Code plus the PLMN ID. The TAI enables a unique identification of groups of eNodeBs.

In order to further this vital discussion, the State of Texas recommends an approach indicated in Fig. 7 TAC Example, for managing Tracking Area Codes for the nationwide network. The State would like to strongly emphasize that more work, consultation, and technical information is needed to refine and finalize nationwide TAC allocations.

The next example, illustrated in Fig. 8 on the next page, shows a synthesized view produced from a combination of two ideas submitted. In this example, each Federal region is allocated a range corresponding to the 4th significant digit in the hexadecimal identifier. Because Tracking Area Codes are groups of eNodeB sites, the reservations use small (2048), medium (2816) and large (4096) "buckets" corresponding to the combined geographical contributions of the states in the region. This approach would be further allocated to provide each state with a specific and stable range to use for deployments. Because the consumption of these identifiers is expected to be very low for the next couple of years, this approach could be implemented with a detailed spreadsheet, kept under strict change control, and stored on a secure server.

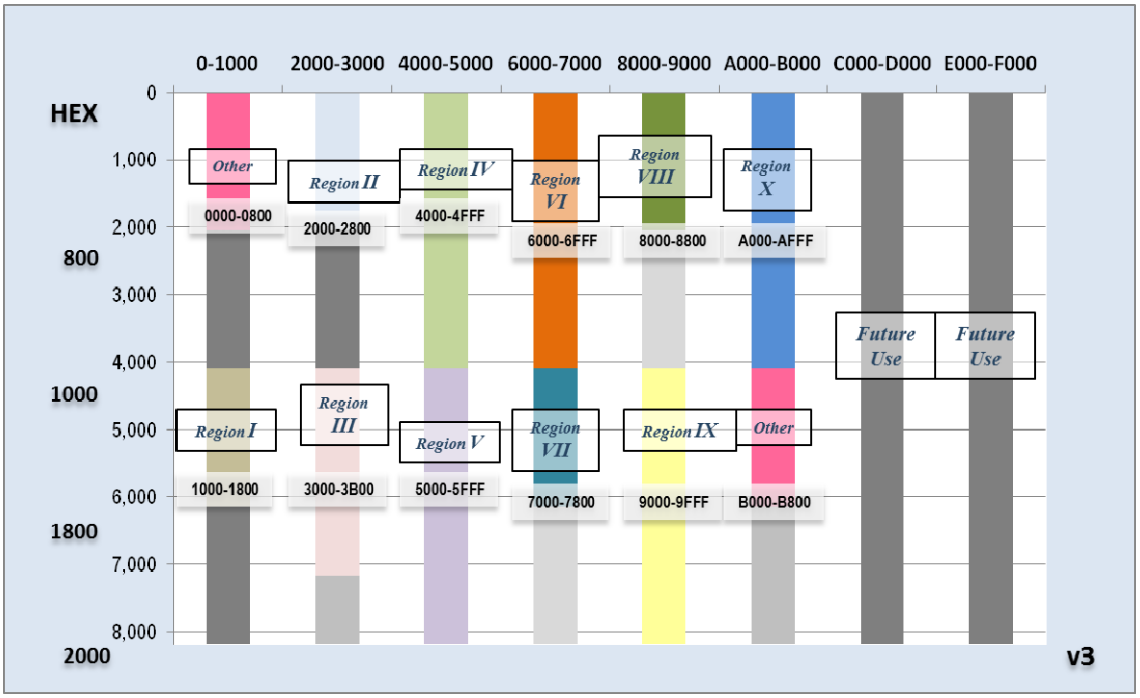

Fig.8: TAC EXAMPLE *– This example illustrates allocation reservations by region which are weighted by the relative geography. This approach keeps the 4th digit consistent with Federal Region, even though reservations would be done state by state.*

D.2 MOBILITY MANAGEMENT ENTITY GROUP ID (MMEGI) IDENTIFIERS

In Fig. 9 at right, the State presents a potential approach for nationwide coordination of MMEGIs. MMEGIs identify a group of MMEs, and must be unique within a PLMN ID. Because MMEs are very high capacity devices, it is expected that very few MME Group IDs will be needed, even over the life of the network. The coordination process will need to ensure that the MMEC is unique within the MME pool area, and, if overlapping pool areas are in use, that the MMEC is unique within the area of overlapping MME pools. This identifier could perhaps be managed with a "static" allocation by state, as shown in the example, below.

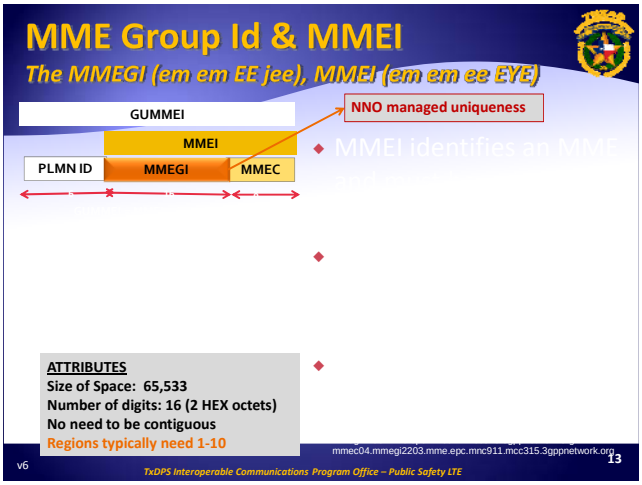

Fig. 9. MME Group ID & MMEI – The MMEGI identifies groups of Mobile Management Entities (MMEs), which must be kept unique globally.

In response to the recommendations of the reviewers of an earlier version, this approach to MMEGIs allocates 16 MMEGIs to each state, which is just 4% of the ID space in what is essentially a preliminary allocation, but one that could last for a number of years. Because the LTE protocols do not require contiguous MMEGIs, any state or entity that needed more MMEGIs beyond the initially reserved ID space, could simply get more from the more than 64,000 still available.

This approach numbers the states, similar to the other identifiers, using a regional and state index number, which is used in the actual hexadecimal value of the corresponding range. This approach reserves only the 16-bit (4 Hex digit) value, leaving the MME Code (MMEC) to be allocated by the regional operators, which means the actual reserve is 128 MME Codes per state.

STATE	index	Low HEX	Low Dec	HIGH HEX	HIGH Dec	CNT
Connecticut	1.1	110	272	11F	287	16
Maine	1.2	120	288	12F	303	16
Maryland	1.3	130	304	13F	319	16
Massachusetts	1.4	140	320	14F	335	16
New Hampshire	1.5	150	336	15F	351	16
Rhode Island	1.6	160	352	16F	367	16
Vermont	1.7	170	368	17F	383	16
New Jersey	2.1	210	528	21F	543	16
New York	2.2	220	544	23F	575	32
Delaware	3.1	310	784	31F	799	16
District of Columbia	3.2	320	800	32F	815	16
North Carolina	3.3	330	816	33F	831	16
Pennsylvania	3.4	340	832	34F	847	16
Virginia	3.5	350	848	35F	863	16
West Virginia	3.6	360	864	36F	879	16
Alabama	4.1	410	1040	41F	1055	16
Florida	4.2	420	1056	43F	1087	32
Georgia	4.3	440	1088	44F	1103	16
Kentucky	4.4	450	1104	45F	1119	16
Mississippi	4.5	460	1120	46F	1135	16
South Carolina	4.6	470	1136	47F	1151	16
Tennessee	4.7	480	1152	48F	1167	16

Fig. 9 MMEGI State by State Example EXCERPTED EXAMPLE *– This reuses the TAC approach but on a much smaller block of identifiers, utilizing the 3rd significant digit to correspond to the Region number. Reusing the TAC approach would mean leveraging tools, agreements and database modules which would help reduce overall management costs.*

In the process of gathering inputs for this response, other approaches were submitted. One possibility is to allocate a larger number of MMEGIs, such that each MME would be assigned a different MMEGI, and therefore leaving the MMECs all equal to "00". The single octet MMECs could then be deployed later, or as needed, as the number of MMEs deployed increases to accommodate evolving demands for increased performance, capacity, and redundancy. By introducing MMECs in this way, MMEC pooling can be gracefully introduced by assigning the new MME with the same MMEGI, but with a different MMEC.

As with the other examples described, this approach deserves more scrutiny and analysis by experts and stakeholders than was possible in the preparation for this response. As with the TACs, this approach could be implemented with a detailed spreadsheet, kept under strict change control, and stored on a secure server.

D.3 eNodeB Identifiers

Texas interprets the term "eNodeB Identifiers" to mean the eNodeB Identifier and the EUTRAN Cell Identity, which correspond in LTE networks to the Global eNodeB Identification (GeNBID) and the E-UTRAN Cell Global Identification (ECGI). These are used to identify the eNodeB base station and sector or "cell" that is being used on the network. The

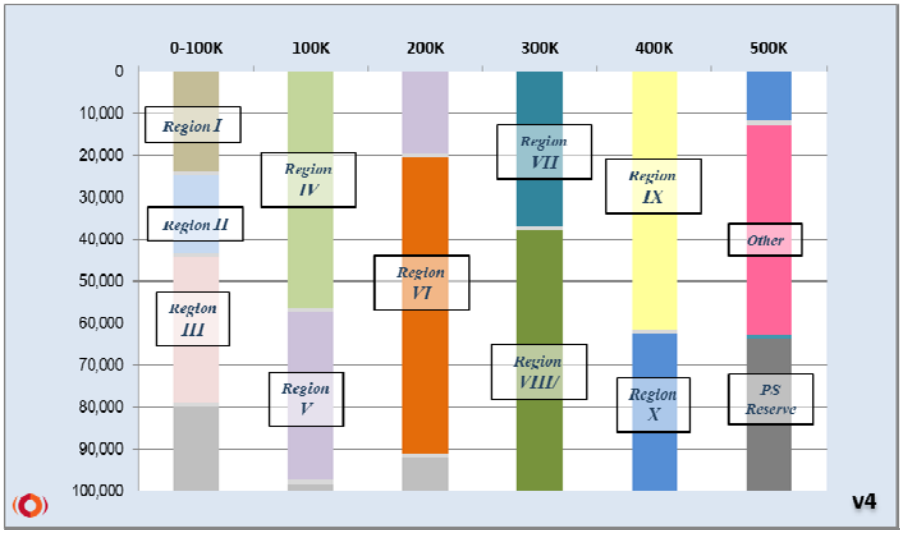

Fig. 10. eNodeB Identifiers EXAMPLE *– This federal regional illustration shows one approach which would allocate approximately half of the ID space based on a reservation formula which reflects a combination of geography, population and number of high risk urban areas in each state. Again, this view is presented by Federal regions but the Texas recommendation is that the identifiers would be reserved and allocated on a state by state basis.*

State expects a typical network to eventually require thousands of eNodeB base stations, and consequently, with an ID space of only one million, the State recommends a reservation approach that is weighted more heavily by geographic area. An example of this approach is illustrated in Fig. 10, above, and was generated by an allocation factor generated by a weighting of 70% geography, 20% population, and 10% UASI regions.

With a large number of required allocations and what will most likely be a steady consumption of them throughout the network, the eNodeB Identifiers will require the establishment of a database application to manage the eNodeB identifiers. The State would expect that a network operator would need to make a request for eNodeB identifiers several times per year. This database could be implemented as another set of tables in the database established for the MSINS.

D.4 Access Point Names (APNs)

The Access Point Names require a substantially different approach, because these are text-based identifiers instead of the numerically based identifiers, as discussed thus far. The current approach illustrated in Fig. 11 at right, outlines a recommended method, which would "reserve" the first label to the left of "APN." This label would indicate the name of the operator's network, which must be managed for national uniqueness. The remaining characters are available for use by the regional network operator, with the leftmost label, "label 1," reserved by interoperable services, which will be shared nationwide and therefore, must also be nationally coordinated.

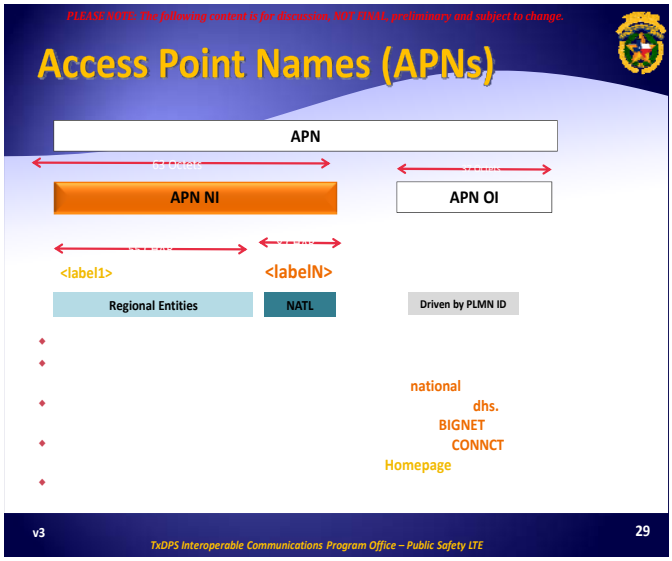

Fig. 11 Access Point Names Strategy Example *– This illustration identifiers would be reserved and allocated on a state by state basis.*

Although the APNs are not entirely numerical, as all the other previous identifiers, managing them would be similar. In addition to coordinating for uniqueness, this identifier set will also require the establishment of naming conventions. At a minimum, the database would need to support APNs for the services shared nationwide, and the unique regional network names.

Admiral Barnett QUESTION [4e]: What are the cost factors that would be involved?

Texas [4e] ANSWER: As described throughout this response, there are many unknown factors associated with managing network identifiers at the national level. The following Texas estimates are at a rough order of magnitude, and reflect the current understanding of the work needed to be overseen ***Long-Term Nationwide Network Identifiers Management Entity***. This entity would either hire staff to do the management work in-house, or contract with an outside entity to do the work.

The following assumptions apply:

- These estimates are provided for numerical PLMNID related sub-identifiers analyzed as part of this endeavor. These are the MSIN, MMEGI, TAC and eNodeB IDs.
- These estimates assume that the methodologies described in this document are used to allocate the identifiers.
- These estimates assume initial allocations for the MMEGI and TAC would be provided to early-deployment entities in a "flat" allocation at the state level.
- Estimates assume more management is required for MSINs and eNBIDs such that a database with portals to state or regional operational entities would need to be established.
- This does not include APNs, which, because they are text based, may need additional tools support.
- Quote does not include costs for setting-up an ***Interim Nationwide Network Identifiers Management Entity***
- Other than the MSIN software estimate, these are rough budgetary figures only.

DB Development MSIN	$120K
DB Development eNBID	$60K
MSIN Initial Allocation	$24K
eNBID Initial Allocation	$6K
MMEGI, TAC Initial Allocation	$0
2Y Ongoing Labor	$400K
2Y Ongoing Maintenance	$48K
Legal support for Usage agreements	$100K
Development of Usage Agreements	$50K
Total	**$808K**

These rough estimates result in a projected total of $808,000. At this juncture, the Texas recommends that entities considering this endeavor plan on spending $900,000 to $1.5 million to support the scope described herein. Savvy architecting of the support tools would consider the full range of identifiers so that the entire project could be funded by adding incremental costs to what is presented here. Still, these should be considered early and aggressive estimates.

Once the Initial Allocations have been made, the process evolves into an ongoing service. The talked-about, potential, future nationwide public safety broadband corporation would need a plan to staff and support this vital network function if and when it stands up. Texas estimates that staffing for the full maintenance of the Network Identifiers system at the nationwide level would require the funding of approximately 10-15 staff members, in addition to associated management, overhead, capital equipment, and maintenance. Again, the ***Interim Nationwide Network Identifiers Management Entity*** could either do the work within its own organization, or out-source it. But the management entity would still maintain management oversight of the work to be performed.

Background on Questions [2] and [3]

The Bureau outlined a number of interconnectivity and roaming requirements, which are the subject of the next two sets of questions. The Commission's December 2010 *Interoperability Order* states, "We find that each of the baseline requirements we establish herein is essential to achieving nationwide interoperability among early-deployed public safety broadband networks. These requirements address core aspects of interoperability, such as roaming capabilities and system identifiers that are crucial to ensuring that users of disparate networks are capable of communicating seamlessly….we are therefore requiring that early-deployed networks meet performance, coverage and other requirements necessary to ensure that early-deployed networks achieve a baseline of operability sufficient to support interoperable communications."[3]

The recommended requirements portion of the same order further states "ERIC recommends that technical roaming capability, for both home-routed traffic and local breakout traffic, must be available on the date that a Petitioner's network achieves service availability."[4] The letter goes on to clarify, "ERIC recommends that Petitioners be required to honor each other's written requests to support roaming."

For the purposes of this document, and because of the common confusion around the generic term "roaming" the following definitions are used for this discussion:

- **INTRA-System Roaming** – Defined as when a PS LTE device moves between sub-networks run by different PS sub-network operators that use the same nationwide PLMN ID. This term is <u>not</u> descriptive of a PS LTE device that moves from a PS LTE sub-network to a commercial carrier network.
- **INTER-System Roaming** – Defined as when a PS LTE device moves between networks which use different PLMN IDs. This is equivalent to the formal definition of "roaming" in the 3GPP standard, and is sometimes referred to as "carrier roaming" by technologists. An example of this type roaming is when a PS LTE device moves from a PS LTE sub-network to a commercial carrier network.

E. [Q2] Roaming

Admiral Barnett QUESTION [2a]: What is Texas' plan for roaming on to a commercial network when other waiver operations, if they have the same PLMN ID as Texas, may they also roam on to the same commercial networks?

Admiral Barnett QUESTION [2b]: How does this work technically and operationally?

Texas [2a,b] ANSWER: From technical and operational perspectives, there are three main areas which are impacted by a common PLMN ID when INTER-System Roaming onto commercial carriers (see INTRA-System and INTER-System Roaming definitions, above). These areas are:

- Subscriber Authentication;
- Packet Data Bearer Service Instantiation; and
- Financial Settlements.

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[3] *See* reference [9], *Interoperability Order*, DA 10-2342, ¶8.

[4] "*ERIC Recommendations for Waiver Recipients in the 700 MHz Public Safety Broadband Spectrum*", Jennifer Manner letter, DA 10-2342, November 22, 2010, ¶A

The following sections outline the approach for establishing solutions for each bulleted area, above.

E.1 SUBSCRIBER AUTHENTICATION

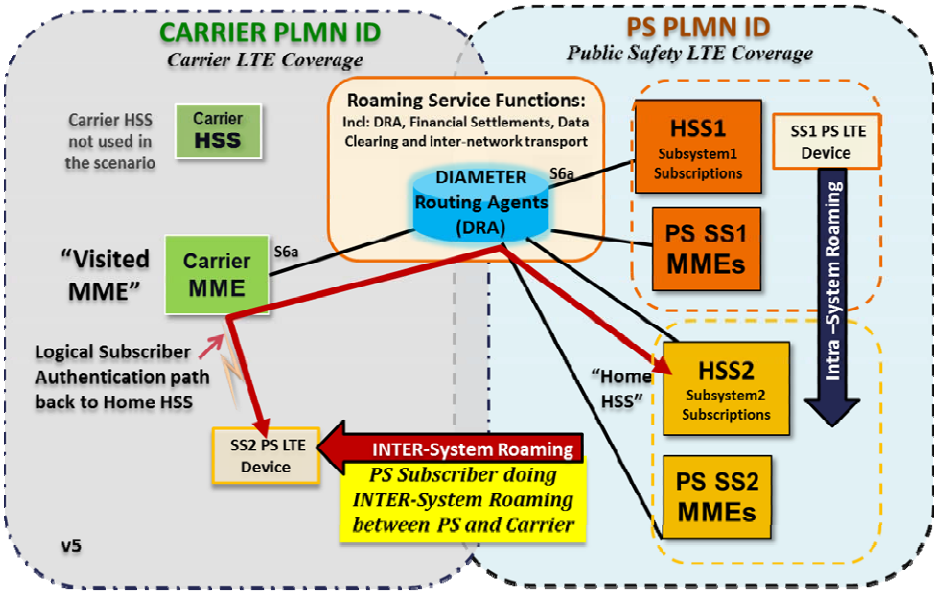

Fig. 12 Enabling "INTER-System Roaming" The illustration shows some of the mechanisms used by networks to facilitate inter-system roaming which is defined here to mean roaming between PS and carrier networks, each with a different PLMN ID.

When Inter-roaming onto a commercial carrier "visited" network, subscriber authentication requires that the MME in the visited network ("Visited MME") be capable of communicating with the public safety Home HSS2, as shown in the illustration. Because a single PLMN ID is assumed, then it is also known that the public safety LTE network will be comprised of multiple regional HSSs, which are actually built out of a single ID space, allocated among Regional HSSs, as shown. In order for any subscriber to authenticate on the carriers' network, the MMEs in the visited network will need to communicate with the specific HSS, Regional HSS2 in this example, which contains the public safety subscriber's authentication credentials and subscription data. The S6a interface is used for this purpose and is based on the DIAMETER protocol. The subscriber's IMSI is contained in the DIAMETER authentication messages and contains the Mobile Subscriber Identity Number (MSIN), as has been described.

The implication of this requirement is that a DIAMETER-based routing network will be instantiated to interconnect the regional HSSs using the S6a interface, which would be supported with one or more commercial IPX roaming service providers.

The DIAMETER-based routing network will be comprised of DIAMETER Routing Agents (DRAs) as well as underlying IP transport facilities and services. Although the topology of this DIAMETER-based routing network has not yet been determined, it is likely that gateway DRAs will be designated as ingress/egress points for the public safety DIAMETER network. These gateway DRAs, as well as other DRAs comprising the nationwide public safety network, will be configured with HSS routing information which corresponds to the MSIN range(s) that have been allocated to each regional HSS. The S9 interface is also based on the DIAMETER protocol, hence, interconnection of PCRFs in the home and visited networks can also be supported by the DIAMETER network supporting the S6a interface.

E.2 PACKET DATA BEARER SERVICE INSTANTIATION

Similar to the DIAMETER-based routing network, the nationwide public safety network will require an IP-based routing network to interconnect Serving Gateways (SGWs) in the visited network to Packet Data Gateways (PDWs) in the Home public safety regional network using the S8 interface. Interconnecting the SGWs in the commercial carrier network with the PGWs in the nationwide public safety network is required to provide packet data bearer services to subscribers roaming in commercial carrier networks.

The nationwide public safety network will be supported by an IP administration function which will establish requirements and manage IP address assignments to S8 interfaces on regional PGWs. Similar to the DIAMETER-based routing network, an IP-based routing network will be instantiated to interconnect the regional PGWs (via S8) with one or more commercial IPX roaming service providers. The IP-based routing network will be comprised of IP transport lines, switches, and routers and Domain Name (DNS) servers. The topology of this IP-based routing network has not yet been determined; however it is likely that gateway routers and DNS servers will be designated as ingress/egress points for the public safety IP routing network. These gateway routers, as well as DNS infrastructure, comprise the nationwide public safety network, and will be configured with PGW and MME routing information, corresponding to the IP address (or addresses), which have been allocated to each regional PGW component.

E.3 Financial Settlements (process used by the cellular industry to capture aspects permitting roaming charges to be reconciled among the network operators)

Lastly, INTER-System Roaming onto commercial networks would incur charges from the commercial carriers. As a nationwide network comprised of a single PLMN, the public safety network would look upon each of the commercial carriers as being one network, and the carriers would look at the PS LTE network as being one entity responsible for financial liabilities and financial settlements (the process used by the cellular industry to capture financial aspects permitting roaming charges to be reconciled among the network operators). As such, the nationwide public safety network would be supported by a billing administration function, which would receive roaming usage information from the commercial carrier via a data clearing house service provider, settle financial balances via a financial clearing service provider, and process subscriber usage records for regional-level billing services. It is likely that the billing administration function would also be involved with executing roaming agreements with the commercial carriers. Although the billing system architecture has not been determined, it is likely that a centralized billing system component would be required to interface with the data clearing house, financial clearing house, and regional-level billing functions. It would be reasonable to expect detailed reporting on the level of usage per end user, application, operator, and agency.

Admiral Barnett QUESTION [2c]: Is all the necessary equipment and software developed that will allow the use of the same PLMN ID between Texas, the waiver operators and commercial roaming networks?

Texas [2c] ANSWER: As described in the preceding response, there are several architectural and implementation aspects that are not yet resolved. As such, a response to this question cannot be provided with certainty. However, the State is confident that the requisite supporting technologies are currently in use by commercial carriers, such that fundamental technology development should not be required. From a practical perspective, the nationwide public safety network would have unique requirements as compared to commercial carrier networks, and therefore may require development of unique features and/or configurations of the commercially available equipment.

F. [Q3] Internetworking

Admiral Barnett QUESTION [3a]: What is Texas' plan to ensure internetworking (i.e., roaming and connectivity among waiver jurisdiction deployments) prior to full migration to a nationwide network?

TEXAS [3a] ANSWER: As with any internetworking project, by definition Texas would be interdependent upon its potential networking partners. As one of almost two dozen entities involved,

Texas alone cannot ensure internetworking among waiver recipients; however, the State pledges to continue working closely with its partners so that collectively, good decisions are made which balance the competing needs of functionality, costs, and long term versus shorter term goals. Texas will continue to work with its neighbors and partners to identify internetworking partnerships where they add operational value and strike an effective balance between the competing objectives mentioned.

Related area: Please refer to "INTRA-System Roaming" and "INTER-System Roaming" definitions provided in Section D.

Admiral Barnett QUESTION [3b]: How does this work technically and operationally?

TEXAS [3b] ANSWER: In the parlance of 3GPP terminology, per TS 21.905, roaming is defined as "The ability for a user to function in a serving network different from the home network. The serving network could be a shared network operated by two or more network operators." Further, Network Operator is defined as a PLMN operator, which is "The entity which offers telecommunications services over an air interface."

During the period of time before there is connectivity between the early deployment networks, it may be possible to enter a visiting user's credentials into the local HSS to support the visiting user as a "temporary home user." The ease, limitations, and practicality of this option need to be further investigated.

Texas will collaborate with the other waiver recipients to determine which interconnection method, and over what backbone services would best serve the need of public safety community. The State has explored using a number of national backbone options to connect all the waiver recipients, relying upon the standard 3GPP Release 8 functionalities as described in the question above to ensure that INTRA-System Roaming between Waiver Recipients functions properly.

To summarize the discussion around interconnectivity and INTRA-System Roaming, the State concurs with the policy of prioritizing ***operability*** over ***interoperability***. As asserted in the December 2010 *Interoperability Order*, "seamless interoperable communication is possible only across networks that are fully operable." Additionally, as stated in the National Emergency Communications Plan (NECP), "communications operability is a critical building block for interoperability; emergency response officials first must be able to establish communications within their own agency before they can interoperate with neighboring jurisdictions and other agencies**." Texas believes that a successful strategy would be a "slow-growth" approach, allowing portions of the network to be built-out in a manner which delivers immediate operational benefits to local users, while efforts proceed in earnest toward a fully interconnected, nationwide, interoperable PS LTE network.** In other words, let's first get ***operable.***

As described in the *Texas Interoperability Showing*, Harris County is in discussions with a carrier regarding an INTER-System Roaming Agreement. Texas would like to emphasize that other PS LTE sub-network operator requests for an INTRA-System Roaming and interconnectivity arrangement with the State of Texas will be honored and acted upon per rules and recommendations set forth by the Bureau.

G. [Q1] Single PLMN ID

Admiral Barnett QUESTION [1]: Please confirm Texas' preference for the use of a single PLMN ID for all waiver recipient networks, including Texas. If that is not your preference, what is?

Texas [1] ANSWER: The State reiterates its preference for the use of the single PLMN ID. This view was also expressed and documented in the September 29, 2011 waiver recipient conference call with the

FCC Public Safety and Homeland Security Bureau, and in a subsequent FCC Ex Parte filing by Bill Schrier, CTO City of Seattle and OAC Chair for the PSST. However, to implement a single PLMN ID, a number of significant network identifier management, design, and technology issues need to be resolved, many of which are addressed or discussed in this document. The State remains concerned as to whether these issues can be appropriately resolved by the requested February 1, 2012 target date. If not, Texas would be open to considering an alternate approach. Whichever way is decided, Texas strongly recommends that the selected approach include an element of flexibility to address unforeseen needs and demands. Although a PLMN ID has been requested by February 1, 2012, it is acknowledged that this target date may need to move later, if the decisions needed for network identifier management cannot be made by then. Although the State desires to move forward expeditiously, Texas realizes that these are significant decisions which could have far-reaching impact for the future of PS LTE, and therefore Texas urges that the aspects around these issues be thoughtfully and carefully considered and managed – even if it requires more time to do so. Essentially, Texas is pushing hard to get the decisions made by February 1, 2012, but if things do not feel right by that time, then we advocate pausing until the conditions are favorable to move forward.

A number of reviewers of this material expressed concern about "locking-in" to only a single PLMN ID. Texas strongly agrees that although the process may start with a single PLMN ID, there could be need for additional PLMN IDs in the future; thus, Texas advocates that leaving this option open is both prudent and advisable.

H. Concluding Recommendations

H.1 Network Identifiers Management Recommendations

In response to the Bureau's request for recommendations, the State of Texas has developed a series of specific strategies, recommendations, and timelines associated with designating an ***Interim Nationwide Network Identifiers Management Entity***. After examining the scope and challenges presented by this specific management task, and having discussed them with the public safety community and commercial industry partners, Texas recommends that the project be developed in three distinct and coordinated management components.

H.1.1 Establish a Temporary, Cross-functional Short-Term Technical Team to Create the Initial Allocations

The first and most urgent would be to designate an ad-hoc temporary and short-term technical team, which would work to leverage the technical output of the DoC-PSCR Study Item, as well as the suggestions and preferences expressed by the various broadband working groups, BTOP grant recipients, and others in the public safety community who are interested in participating. This is essentially a continuation of the Texas-lead collaborative work effort described in this document. The technical team would pursue the numerous areas of investigation identified herein, and build upon the substantial momentum this topic has gained in the weeks leading up to this submission. This temporary and short-term entity would be composed of volunteers from the numerous working groups already constituted, such that no additional funding would be needed. Texas agrees to continue its coordination effort, which would re-engage at the conclusion of the PSCR Network Identifiers meeting scheduled for November 30 to December 1, 2011 in Boulder, CO. Texas is not trying to dictate its ideas to the nationwide public safety community, but instead offers to continue to serve as a facilitator and coordinator, as demonstrated by Texas recent efforts to socialize and to promote consensus concerning development of the content of this document. The short-term team will be composed of carrier experts,

LTE architects, waiver recipients, financial settlement entities, and others. The deliverable of the team is an Initial Allocation to be used by each waiver recipient planning to deploy in 2012. The team would target to conclude its work by January 16, 2012. Texas sees the work of this group feeding into the ***Interim Nationwide Network Identifiers Management Entity,*** which would assume oversight of the network identifiers management function until the formation of a ***Long-Term Nationwide Network Identifiers Management Entity***. The long-term body would likely be the proposed nationwide public safety broadband corporation, if it comes to fruition. To be clear, the ***Interim Nationwide Network Identifiers Management Entity*** could do the work in-house, or out-source it to a contractor (see Texas answer to Question [4e] on page 15).

H.1.2 Recommendation to Designate the Public Safety Broadband Licensee (PSBL) as the Entity to "Authorize" the Initial Allocation

As the designated ***Interim Nationwide Network Identifiers Management Entity,*** the PSBL and its Operator Advisory Committee, would have three main objectives. The first objective would be to work in parallel with the short-term technical team's effort (which would start by mid-December, 2011, and conclude by January 16, 2012), so that when the Initial Allocation proposal is ready for review, a quick process is in place for authorizing the Initial Allocation as the network baseline. The PSBL, and its Operator Advisory Committee (OAC), would guide and supervise the technical team through the process. The second objective (as soon after January 16, 2012 as possible) would be an Initial Allocation which has sufficient buy-in, review, and inputs to become a stable, nationwide baseline. There would be a short period at the end of this process for FCC Public Safety and Homeland Security Bureau review, and hopefully its sanction, of the process outcome by February 1, 2012. The third objective would be the PSBL's securing of the single nationwide PLMN ID from the Alliance for Telecommunications Industry Solutions (ATIS), International Mobile Subscriber Identities Oversight Council (IOC), through its contractor, Telcordia by February 1, 2012 and providing Texas authority to use it. To meet the February 1, 2012 timeline, a number of the above steps would be happening almost simultaneously, or at least being moving forward in parallel.

H.1.3 Develop Long Term Sustainment Plan

The PSBL, in its role as the ***Interim Nationwide Network Identifiers Management Entity,*** would also begin examining the resources, tools, staffing and funding required for sustaining the program over the longer term. The process would begin this year and would continue until the discussed potential nationwide public safety broadband corporation comes to pass.

Texas agrees to continue to help drive and coordinate the efforts described above. The State does not see its role as one of "command and control" of the nationwide public safety landscape, but rather as a role of facilitator and coordinator. We are left with little choice, as the Harris County, Texas February 1, 2012 PLMN ID deployment date is largely driving the urgency of this endeavor. As this is a rather unusual role for a state to play, Texas would like to clarify a few points:

- Although Texas is sponsoring this project, the State pledges to facilitate the program to a fair and equitable conclusion, which would involve the entities who wish to join in, and endeavor to fairly represent even those who do not. Texas understands it is not "in charge" of this process, but only serving to help coordinate it.
- Texas is offering to provide the referenced work products, deliverables, and documentation, with the outcome being driven by consensus among those participating (which is the same process that the State has used in running up to the filing of this document – Texas has already proven it can do this support role).

- The State will push hard to meet the stated January 16, 2012 deadline, acknowledging that the previous two objectives will not be sacrificed just to do so.

In conclusion, it is important to remind the larger audience that the public safety community has been effectively managing network identifiers within its existing digital Land Mobile Radio (LMR) networks for many, many years. It is the Texas position that the nationwide public safety community will come together to make this happen. Once the baseline of understanding is established, the Initial Allocation is a straightforward and familiar task. Once the parameters are established, the Initial Allocation would only take five to ten business days to complete. This relatively minor time investment, balanced against the substantial benefits of performing properly and thoroughly in this highly formative stage of the PS LTE network, is well worth the State's time in sponsoring it to ensure that it happens in short order.

One of the key findings of the research around this topic is that there are many ways in which public safety LTE is *more difficult* than commercial 4G LTE, including diameter routing, interconnectivity, unpredictable build-outs, emergency preemption, mission critical voice, and managing priority and Quality of Service (QoS), just to name a few. In the particular area of managing network identifiers, public safety has a precious advantage. America will be deploying eNodeB RF sites, Evolved Packet Cores and end user devices (UEs) in numbers which are *exceptionally tiny* when compared to the ambitious commercial carrier deployments by companies as Verizon Wireless, AT&T / T-Mobile, and Sprint. For this reason, Texas asserts that with an almost negligible investment, and with tight time management, the Initial Allocation could be established by mid-January, 2012. The product produced would easily support the initial six to eight waiver recipient early deployment sub-layers for the nationwide PS LTE network planned for 2012. This approach allows the immediate need to adequately be met, while affording additional calendar time to establish a fully funded and robust entity needed to support a more significant PS broadband LTE deployment schedule in 2013 and beyond.

References

[1] 3GPP TS 36.401 v10.3.0 (9/2011)

[2] 3GPP TS 23.003 v10.3.0 (9/2011)

[3] *International IMSI Assignment and Management Guidelines and Procedures*, v12, December 2010.

[4] *National PLMN ID Management Framework*, Gino Scribano, MSI, Oct 2011 , draft, v2, 10/3/2011.

[5] *Network Identifiers & PLMN ID Myths*, APCO 2011, Emil Olbrich, PSCR, August 2011.

[6] 3GPP TS 36.413 v10.3.0 (9/2011)

[7] *LTE Network Identifiers* DRAFT, Bob Pavlak, Chris San-Gaspar, 6/2011.

[8] *Network ID Study Item Contribution*, Alcatel-Lucent, DC-Office of the Chief Technology Officer, Motorola Solutions, Texas, 9/6/2011.

[9] *Interoperability Order*, FCC PS Docket No. 06-229, DA 10-2342, December 10, 2010.

[10] *Texas Waiver Order*, FCC PS Docket No. 06-229, DA 11-893, May 12, 2011.

[11] *Re: PS Docket 06-229 Request for a PLMN ID, Letter to Mike Simpson*, Adm. James Barnett, 10/12/11.

[12] *Network Identifiers Management Overview*, Cynthia Wenzel Cole, Texas DPS Interoperable Communications Program Office, v15.0, 11/02/2011.