Network Identifiers Study Item Meeting #6

Public Safety Communications Research

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Agenda

- Disclaimer
- Study Item Deliverables
- Compilation of Study Item Research & Network Identifier Recommendations
- Discussion – Q&A
- Remaining Study Item Goals & Plan of Action

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PSCR Study Item Meeting Disclaimer

- This is an open, public meeting of the PSCR Broadband Demonstration Network Study Items. The intent of this meeting is to obtain information and viewpoints from individual attendees of this meeting. No consensus or recommendations will be sought from this group as a collective. PSCR will use individual inputs to guide any final decision making.
- PSCR will be the primary lead for each group, host the web portal and host the meetings of the group. Stakeholders are divided into two categories
  1. Collaborators – stakeholders who submit verbal or written comments
  2. Participants – attend meetings for informational purposes
- PSCR reserves the right to work with CRADA partners, collaborators or participants for specific Study Item Deliverables.

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Study Items/Deliverables

- Focus initial phase of study on 33 network identifiers (21 of 33 are "Permanent")
  - Validate feasibility of single PLMN ID for multiple jurisdictions nationwide; show model architecture of a nationwide network & use cases
  - Identify key issues to be solved (e.g., user ID to HSS resolution, subdomains, commercial roaming, etc.)
  - Identify which parameters need or should be "managed"
- Develop use cases & requirements for key issues (e.g., split IMSIs, TAIs, Diameter proxy agent, O&M, etc.)
- Identify relevant 3GPP and GSMA technical specification references and requirements.
  - Determine what GSMA IR.21 information is required for carrier roaming – may feed directly into Roaming and Clearing Study Item
- During first phase, identify additional network identifiers for second phase of study (e.g., ENUM, IMS, regional subscription zones, base station identity & color code, etc.)

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Network IDs Review

- PSCR determined five initial identifiers (with additional sub-identifiers) that require national management
  1. IMSI - – includes PLMN (MCC + MNC) & MSIN
  2. TAI – Tracking area ID
  3. GUTI – Globally Unique Temporary UE ID
  4. ECGI - E-UTRAN Cell Global ID
  5. APN – Access Point Name
- Further research showed that some "permanent" LTE (non-IMS) network identifiers need to be managed or coordinated at some level. This includes:

MMEI	MMEC	MMEGI	IMEI/SV*	TAC
ECI	Global eNB ID	eNB ID	IMEI*	HA-APN
GUMMEI	TAI List	P-GW ID	MSISDN**	*MBMS

*Partially out of scope
**Includes eNUM and all numbering plan info

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Nationwide Network Architecture

- Network Architecture would be managed nationwide and have an architected core network with:
  - A nationwide RAN utilizing one PLMN-ID (network identifier)
    - *Does not imply a single vendor*
  - Centrally managed subscriber database, authentication, security – with local control for provisioning/management as required
- Interoperability of multiple vendors equipment within the nationwide network would be tested before network/equipment deployment
- No roaming between public safety agencies within the nationwide PSBN (all in the same network)
- Roaming in this context means PSBN users accessing commercial networks (3G/4G)
- Governance/Administration would mean a single nationwide network operator with some local flexibility and regional operations

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Distributed Core Network Elements

- **Some functions of the core network will be centralized and others will be distributed. For example:**
  - The database that contains all of the users, policy control for QoS on the system may be centralized in functionality (geographically redundant). e.g. HSS, SLF, PCRF
  - Mobility management might be done locally/ regionally (East, Central, West). e.g MME
  - The components that provide access to the Internet or require high speed access might be at a sub-regional level (i.e. state or sub-state) to reduce transport costs. e.g. P-GW, S-GW

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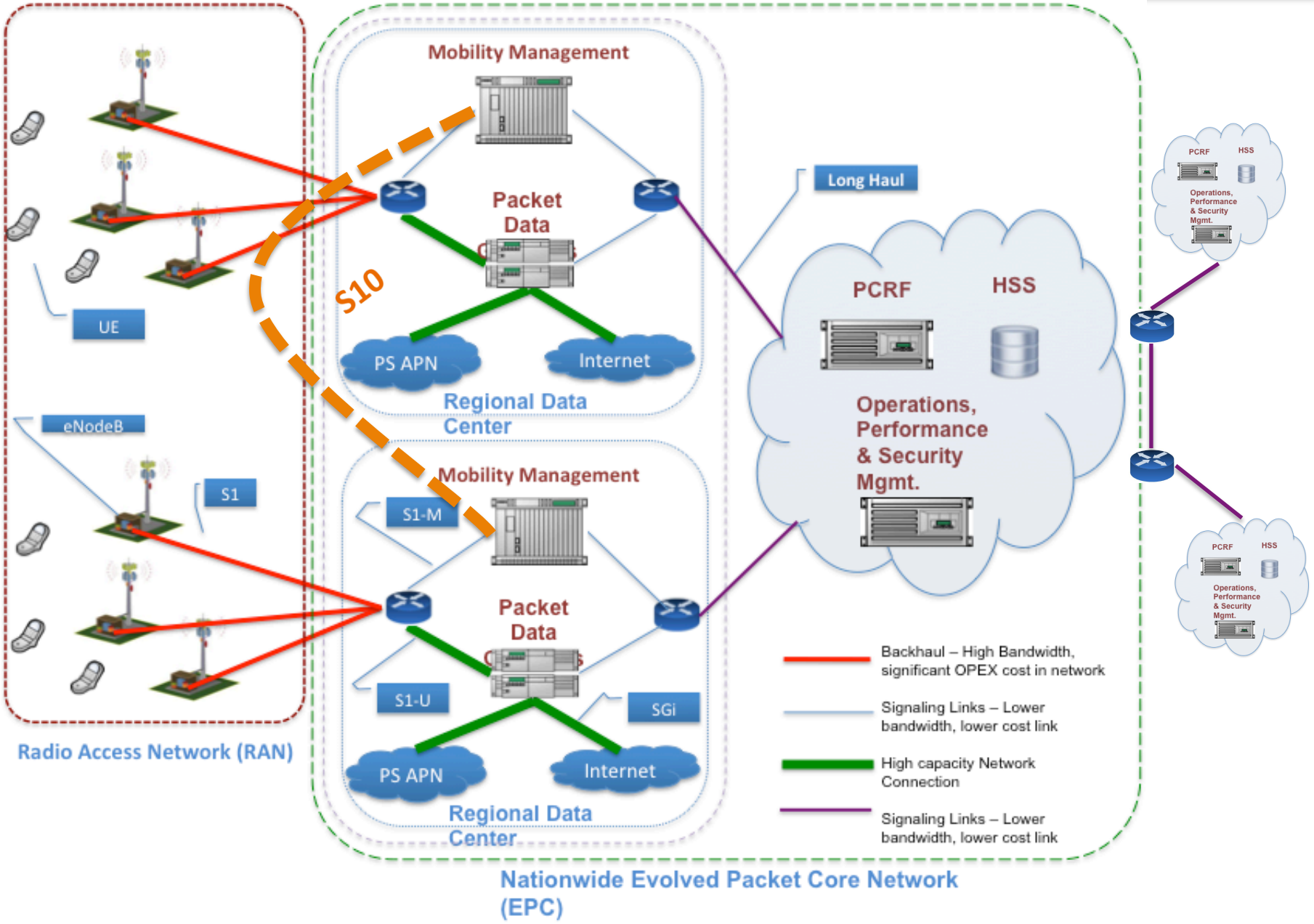
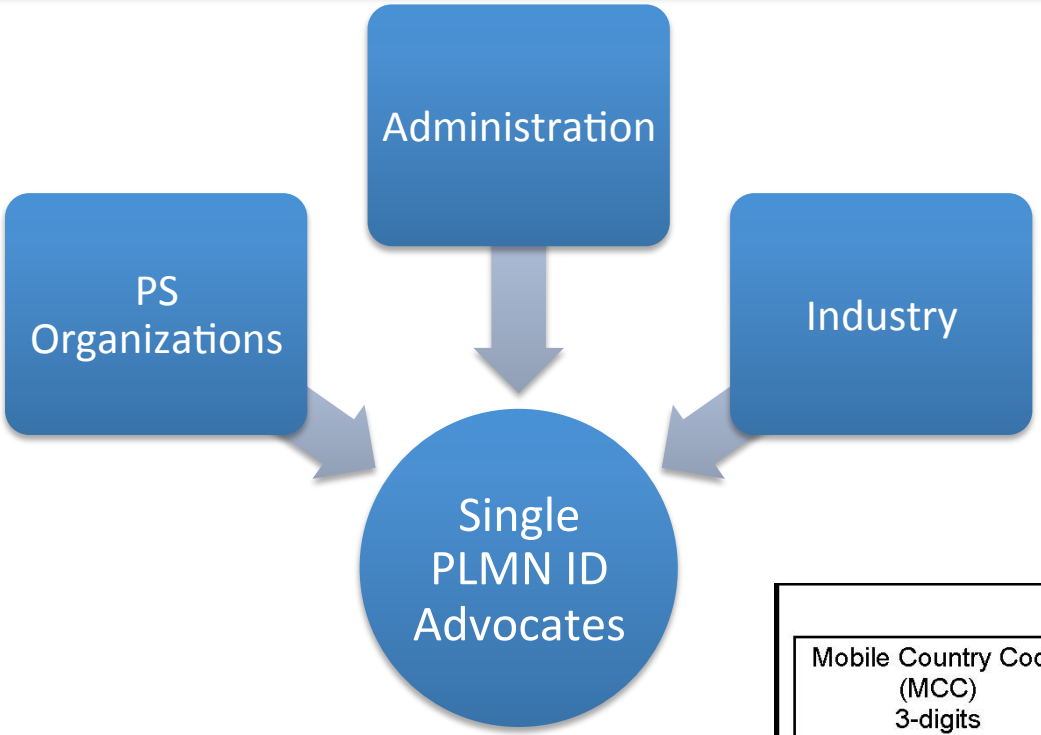
Nationwide Diagram

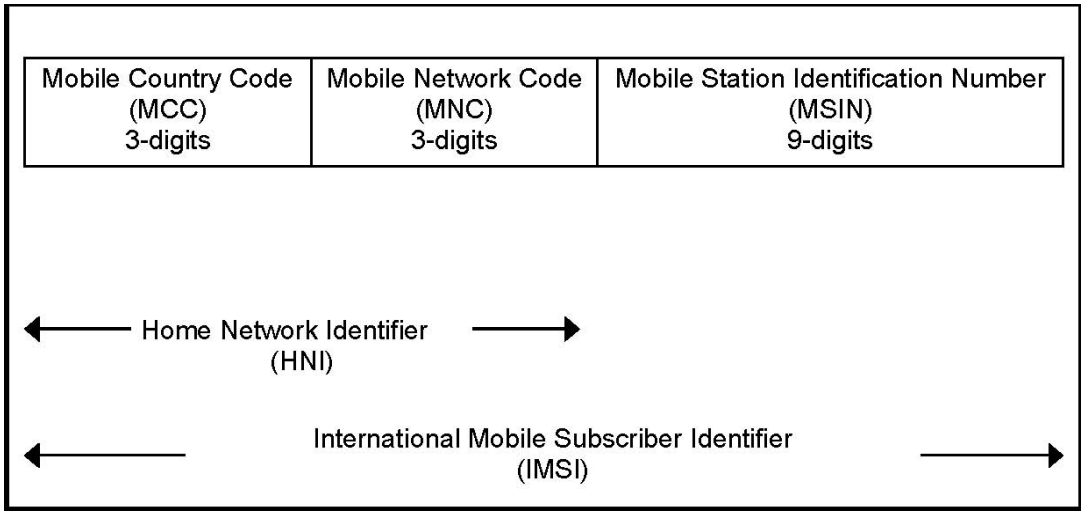


PLMN Construct



Use the single PLMN ID as the "common denominator" for remaining LTE network IDs

Design for use of a single PLMN ID within the Public Safety LTE Network



Public Land Mobile Network Identifier (PLMN ID) = Home Network Identifier (HNI)

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Future PLMN Work

- Investigate use cases for Multi Operator Core Network (MOCN) for PS
  - May allow for use of Equivalent PLMN (E-PLMN) ID to be used simultaneously for the following users:
    - Federal/DOD users e.g. CBP network on the borders
    - Secondary users like utilities that want/have infrastructure resources
    - Commercial users
  - Develop use cases for Public Safety e.g. PS eNB transmits PS H-PLMN and E-PLMN simultaneously but E-PLMN is routed to separate EPC (shared RAN)
  - Investigate standards effort versus equipment implementation (3GPP TS 23.251….R10+)
  - Investigate concerns about QoS, loading… etc.

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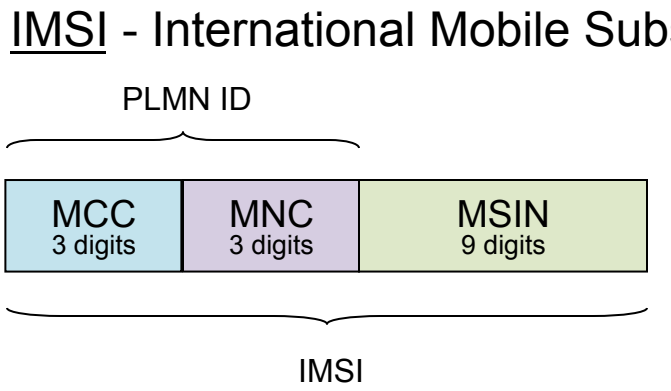
IMSI



- PLMN ID - Public Land Mobile Network Identifier
- MCC - Mobile Country Code
- MNC - Mobile Network Code
- MSIN - Mobile Subscriber Identification Number

- IMSI is globally unique for each individual user/device
- Assumptions
  - Single PLMN ID for all of Public Safety
    - E.g MCC=312 MNC=911 PLMN/HNI=312911
  - Unique MSIN differentiates IMSIs within a PLMN
  - MSIN assumption is 9 digits available for use (~1 Billion device IDs)
    - Approx. 2~5 million PS first responders (Roughly 5% of population)
    - Approx. 24 million potential devices (1st & 2nd responders, M2M, redundancy, future growth… etc.)

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MSIN Allocation Guidelines

1. Utilize ~10% of initial MSIN allocation under single PLMN = 100,000,000 MSIN Segment
   a. Future growth can then be allocated in 100M MSIN segments
   b. Allocate new 100M MSIN segment once overall usage is at 70%
2. Subdivide 100M MSIN segment into 50,000 MSIN block sizes = 2000 50K Blocks
   a. Allocate 50K blocks based on estimated initial waiver users needed
   b. Partition contiguous blocks of MSINs for each region – this is key to ensure proper routing.
   c. MSIN Blocks cannot be "split" between multiple HSSs
      i. Entire block(s) must be implemented within the HSS
   d. Partition additional, non-geographic contiguous blocks of MSINs for remote/cloud EPC support
   e. Allocate more blocks out of reserve for that "area" once 70% of previous allotment is used

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Future MSIN Implementation

- Diameter Routing Agent (DRA) required between all HSSs in network
- DRA will be required to perform IMSI range or full MSIN analysis for HSS routing
- HSS, MME and DRA will need to support use of new Attribute Value Pair (AVP) that is used to identify regions (Will likely require update to IETF RFC 3588)
  - AVP will have individual Regional Index (RI) value assigned for each MSIN e.g. RI= 1, RI=2… RI=10
  - Remote/Cloud EPC services could then be handled without geographic boundary issues
  - Investigate potential use (limitations) of additional AVP to identify specific user parameters

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MSIN Allocation & Implementation Example

- PLMN = 312 911 - IMSI Range = 31291 1000000000 – 312911 999999999
  - Nine 100M segments available
  - Start regional implementation at second MSIN segment (leave segment 1 for testing, cloud/remote, secondary users… etc)
    - Segment 2 = 312911 100000000 – 312911 199999999

- **Region 1 MSIN range 100000000-104549999**
- **Regional Index = 1 (future capability)**
- **Implement entire range in HSS and assign to users as needed**

State	50K Block Allocations	DHS Region
Connecticut	22	1
Maine	8	1
Massachusetts	41	1
New Hampshire	8	1
Rhode Island	7	1
Vermont	4	1
TOTAL FEMA I	90	

Remote/Cloud EPC

MSIN Start	MSIN Finish	State	DHS Region
101100000	101149999	Maine	1
101150000	101199999	Maine	1
101200000	101249999	Maine	1
101250000	101299999	Maine	1
101300000	101349999	Maine	1
101350000	101399999	Maine	1
101400000	101449999	Maine	1
101450000	101499999	Maine	1
104350000	104399999	Vermont	1
104400000	104449999	Vermont	1
104450000	104499999	Vermont	1
104500000	104549999	Vermont	1
095000000	095049999	Cloud 1	1
095050000	095099999	Cloud 2	1
095100000	095149999	Cloud 3	1
095150000	095199999	Cloud 4	1

Within HSS you *could sub-assign* regional block(s) to state or jurisdiction and allocate more once at 70% utilization.

NOTE: ***Assumption is use of regional or multi-regional HSS i.e. covering multiple regions with single HSS***

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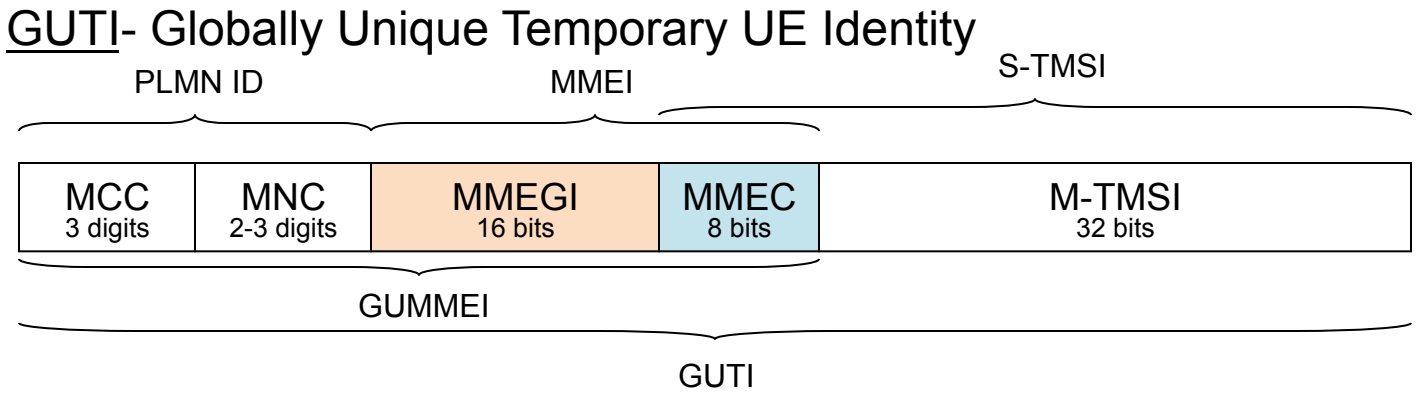
MME IDs



- Unique Identifiers – need to be managed & coordinated nationally
  - **MMEC** – MME Code that is unique in a MME Group, 8 bits (FF)
  - **MMEGI** – MME Group ID, 16 bits (FFFF)
- Derived Identifiers
  - MMEI – MME ID unique within a PLMN = MMEGI + MMEC, 24 bits
  - GUMMEI – Globally Unique MME ID = PLMN + MMEI, 48 bits
  - GUTI – Globally Unique Temporary UE ID = GUMMEI + M-TMSI, 80 bits

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MME ID Allocation Guidelines

1. Do not tie MMEGI to specific state or region
   a. May span multiple states/regions
   b. If more than one waiver recipient in a DHS region then minimize initial MMEGI allocation to **one unique MMEGI per waiver recipient within region**
2. Allocate MMEGI on an as needed basis pending specific implementation guidelines are met e.g.
   a. Scale to MME performance criteria (vendor specific)
      i. number of cells served i.e. 3000 cells
      ii. number of subscribers served i.e. 250,000 subs
   b. Ensure no overlap of areas with other MMEGI
   c. Ensure each MMEGI is unique per given area
   d. Other
3. Develop strict guidelines for assigning more MMEGIs beyond initial allocation
   a. ???

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MME ID Allocation Guidelines (2)

4. Assign static MMEGIs for *potential* future pooling, secondary use and Gateway Core Network (GWCN) network sharing configurations
   a. National MMEGI - common one for all regions (nationwide)
   b. Assign one unique MMEGI per Region - 10 total
5. MMEC – MME Code that is unique in a MME Group ID, 8 bits (FF)
   a. Provision each MME within a regional MMEGI with a *unique* MMEC
      i. Allocate as necessary for MME deployments e.g. allocate as needed for deployments (Max up to 255 per MMEGI)
   b. Assign MMEC ranges to MMEGI to prevent overlap of IDs
      i. Allocate enough practical MMEGI and MMEC IDs for PS deployment
      ii. May help facilitate future integration of network from waiver to nationwide network
6. FQDN required for MME routing – local DNS managed (e.g.)
   a. mmec<**MMEC**>.mmegi<**MMEGI**>.mme.epc.mnc<MNC>.mcc<MCC>.3gppnetwork.org
   b. mmec**255**.mmegi**4095**.mme.epc.mnc911.mcc312.3gppnetwork.org
7. FQDN required for MME pooling – local & root DNS managed (e.g.)
   a. mmegi<**MMEGI**>.mme.epc.mnc<MNC>.mcc<MCC>.3gppnetwork.org
   b. mmegi**4095**.mme.epc.mnc911.mcc312.3gppnetwork.org

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MME ID Allocation & Implementation Guideline

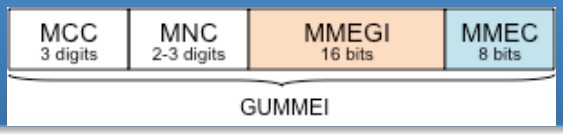
PLMN = 312911

MMEGI = FFF = 4095 **MMEC = FF = 255**

MMEI = **4095255** GUMMEI = 312911**4095255**

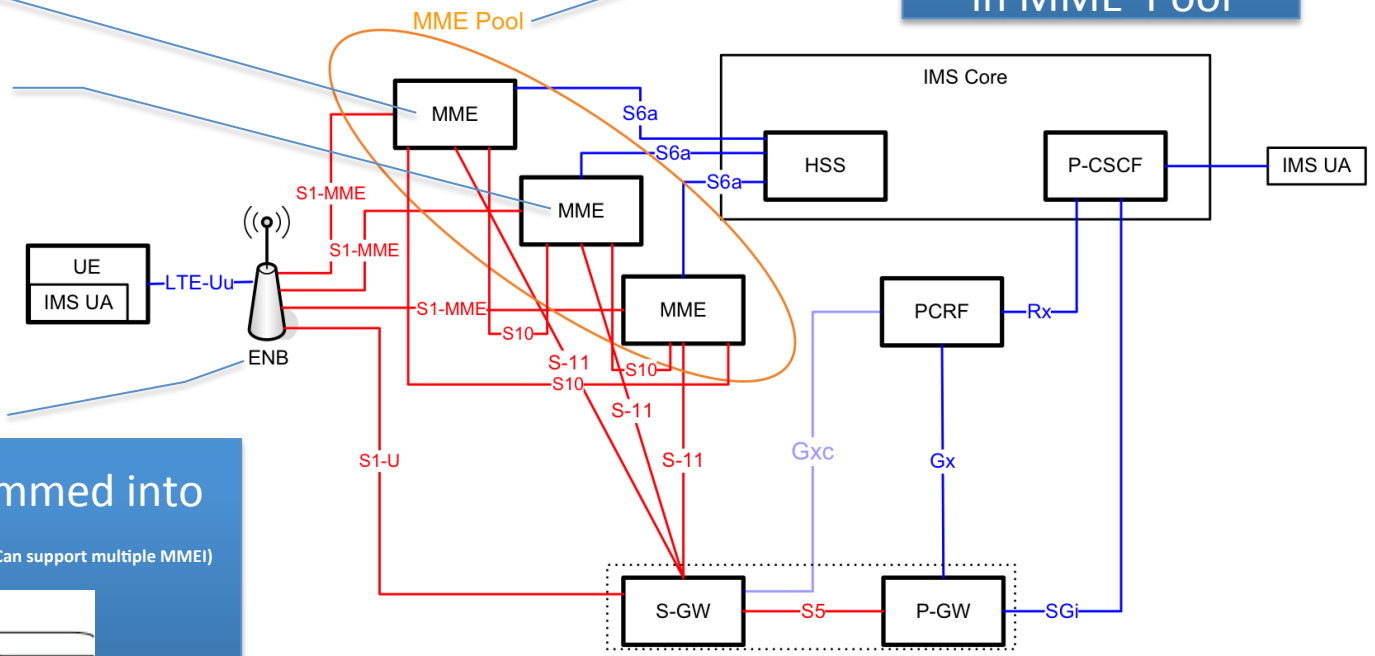
MME FQDN: mmec**255**.mmegi**4095**.mme.epc.mnc911.mcc312.3gppnetwork.org
Pool FQDN: mmegi**4095**.mme.epc.mnc911.mcc312.3gppnetwork.org

GUMMEI Programmed into each MME (Can support multiple GUMMEI)

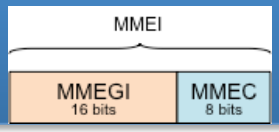


MMEGI Defines Which MMEs are in MME Pool

MMEC Defines specific MME



MMEI programmed into each eNodeB (Can support multiple MMEI)



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MME ID Testing

- Phase 3 Part I and Part 2 will encompass multiple MME testing based off of:
  - MSF2009.003 LTE IOT test plan from MSF
  - MSF2011.048.03 LTE EPC Certification Program
- GUMMEI iterations tested will be based off of this Study Item
- Tentatively will include multi-vendor MME Pooling tests (interoperability)
- PSCR soliciting use and test cases for Phase 3 currently
- Slated for 2012 Q2 start

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MME & eNodeB ID Recommendations

- **Based on latest configuration/allocation changes, MME ID allocations and pooling issues will be discussed at Boulder face-to-face meeting.**
  - **Specific MMEGI, MMEC allocations for the waiver recipients**
- **Additionally the eNodeB IDs – TAI, eNB 128 Block allocations & ECGI allocations will be discussed at Boulder face-to-face meeting.**
- **PSCR will present specific potential schemes for these allocations for the early deployments (BTOP & Texas) and general recommendations for the remaining waivers.**
- **PSCR still seeking more comments on eNB ID usage:**
  - **What specific features utilize ECGI? (e.g. SON)**
  - **What can we use ECGI for:**
    - **Specify eMBMS paging – targeted paging**
    - **Sector/Cell optimization**
    - **QoS support (emergency)**
    - **Others**

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RAN Identifiers

- RAN IDs are used for several things such as mobility management, identify specific cell sites and balance paging load.
  - E-UTRAN Cell Global Identifier (ECGI)
  - Tracking Area Identity (TAI)

ECGI	**E-UTRAN Cell Global Identifier**	**Unique cell ID (globally)**	**PLMN+ECI <= 52 bits**
ECI	**E-UTRAN Cell Identifier**	**Unique cell ID (in PLMN)**	**ECI(28bits)=eNB ID +Cell ID**
Global eNB ID	**Global eNodeB Identifier**	**Unique eNodeB ID (globally)**	**PLMN+eNB ID**
eNB ID	**eNodeB Identifier**	**Unique eNB (in PLMN)**	**20 bits**
Cell ID	**eNB Cell ID**	**Unique for each sector of a cell/ eNB**	**8 bits**
TAI	**Tracking Area Identity**	**Unique tracking area (globally)**	**PLMN + TAC**
TAC	**Tracking Area Code**	**Unique tracking area (in PLMN) Per cell in eNB**	**16 bits**
TAI List	**Tracking Area Identity List**	**UE can move to cells included in TAI List w/o location update**	**variable length**

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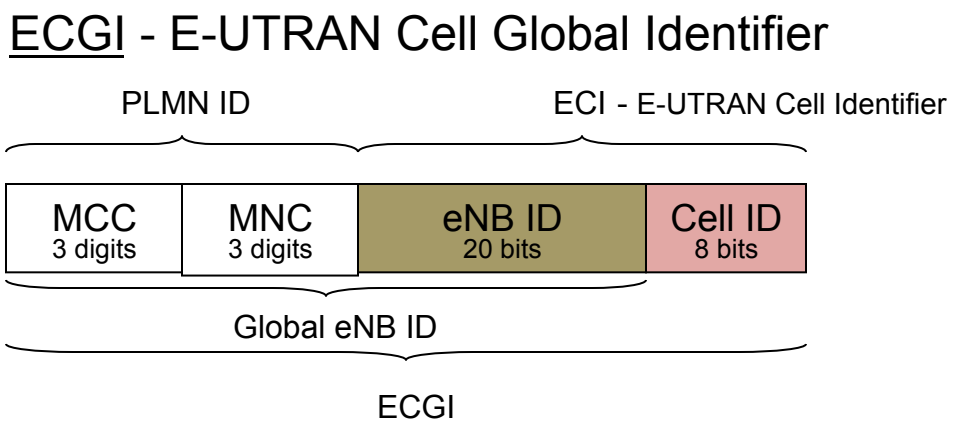
ECGI Allocation



- ECGI required at eNodeB for commissioning
  - eNB ID used to identify individual eNodeB (cell site) – does not necessarily need to be contiguous within network
    - **20 bits = FFFFF = 1,048,575 (7 digits)**
  - Use Cell ID 01-06 range to define specific cell (**cell = sector**) of eNB ID
    - **8 bits = FF = 255 (3 digits)**
  - *R10 requires a FQDN for the Global eNB ID*
    - *enb<eNodeB-ID>.enb.epc.mnc<MNC>.mcc<MCC>.3gppnetwork.org*
- *NOTE: Approximately 40,000 – 55,000 macro cell sites required for 98% population coverage (estimates on VZW & ATT network deployments)*
  - *CTIA estimates 256,920 total Cell sites in the US (www.ctia.org June 2011)*

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ECGI Allocation Guidelines

1. ECGI required for **every** PS eNB
   a. Must be *unique* for each eNB (macro, femto, pico)
2. Allocate 10% of eNB IDs for nationwide coverage
   a. Leave remaining in reserve for future use, femto/pico deployments
   b. 1,048,575 x 10% ~ **104,857 eNB IDs**

Region	# of eNB ID	# of eNB ID 128 Blocks	eNB ID Ranges
TOTAL FEMA I	4823	38	1-4823
TOTAL FEMA II	10695	84	4824-15519
TOTAL FEMA III	10066	79	15520-25586
TOTAL FEMA IV	19922	156	25587-45509
TOTAL FEMA V	17406	136	45510-62916
TOTAL FEMA VI	12897	101	62917-75814
TOTAL FEMA VII	4508	35	75815-80323
TOTAL FEMA VIII	3670	29	80324-83994
TOTAL FEMA IX	16043	125	83995-100038
TOTAL FEMA X	4299	34	100039-104338

3. Subdivide eNB IDs into 128 size blocks
   1. Allows build out for networks in manageable size
   2. Allocate eNB IDs per % population in each region
   3. Once eNB block usage hits 90%, allocate individual blocks as necessary from reserve
4. Use Cell ID 001-006 range to define specific cell (sector) of eNB ID - every sector must be identified within a cell
   a. Append 8 bits to right of eNB ID e.g.
      i. cell 1 (alpha sector) = 001, cell 2 (beta sector) = 002… cell 6 = 006
   b. Allow remaining digits to be used for future Home eNB or femto/pico use if necessary
5. *FQDN for each Global eNB ID =* *enb<eNodeB-ID>.enb.epc.mnc<MNC>.mcc<MCC>.3gppnetwork.org*
   a. E.g. FQDN = enb063FC.enb.epc.mnc911.mcc312.3gppnetwork.org

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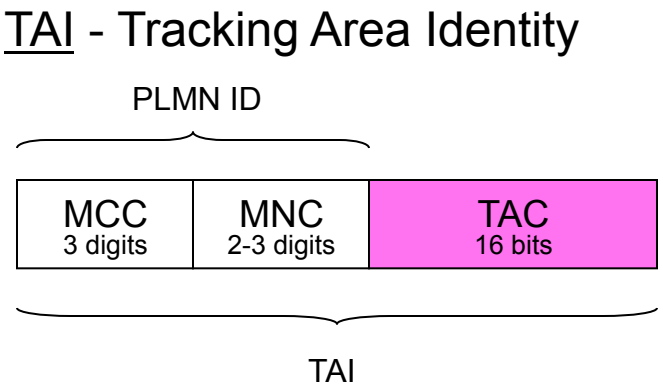
TAI Allocation



- TAC = Tracking Area Code, unique in PLMN, indicates per cell the tracking area for an eNB, 16 bits (FFFF) = 65,535 (5 digits)
  - TAC split into upper and lower bytes
  - eNB cell (sector) can only be part of one TAC **e.g. multiple eNodeBs are part of a TAC**
- TAI – Tracking Area Identity, globally unique, identifies tracking areas, 32 bits (FFFFFFFF)
- TAI List – Allows UE to move to cells in list without location update, globally unique

- TAI provisioned in eNB at commissioning - Necessary for Tracking Area Update (TAU) e.g. handover (active & idle)
  - TAI needs to be managed & engineered properly
    - *Too large may lead to excessive overhead messaging to cells*
    - *Too small may lead to unnecessary retries of messaging to cells*
  - TAI List used in MME
    - UE only uses first 16 TAI in TAI List
      - TAI List is important for mobility *if* location updates aren't working or updating in the MME properly

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TAI Allocation Guidelines

1. Allocate both upper and lower bytes of TAC to create unique TAC
   a. Ease of integration to nationwide network
   b. Simplify DNS entries
2. Allow maximum flexibility in allocation and reallocation of tracking areas
   a. PS LTE data usage unknown (active versus idle users i.e. Tracking Area Updates)
   b. PS LTE coverage footprint will change over time. Performance impacts may be seen and require changes to balance paging load
   c. Typically TAC planning based on mobility management requirement and capacity consideration of the network – PS LTE may require more granular updates or use TAC for jurisdictional boundaries
3. Considerations for TAC design should include
   a. End user device type – M2M (always on sensor), smartphone
   b. Applications used
   c. Paging capacity considerations e.g. placing multiple TACs in high density areas
4. Initially allocate 40% of TAC pool - leave remaining for growth, larger TAC areas for nationwide area
   a. 16 bits = FFFF = 65,535 x 40% = 26, 214 available TACs
   b. Allocate regionally but allow liberal usage policy by network performance requirements
   c. Once utilization hits 70% allocate more TACs from reserve pool
5. FQDN = **tac-lb<TAC-low-byte>.tac-hb<TAC-high-byte>.tac.epc.mnc<MNC>.mcc<MCC>.3gppnetwork.org**

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ECGI & TAI Implementation

PLMN = 312911 eNB ID = 03AC0

Cell ID = 001 ECI = 03AC0001

GeNB ID = 31291103AC0 ECGI = 31291103AC0001

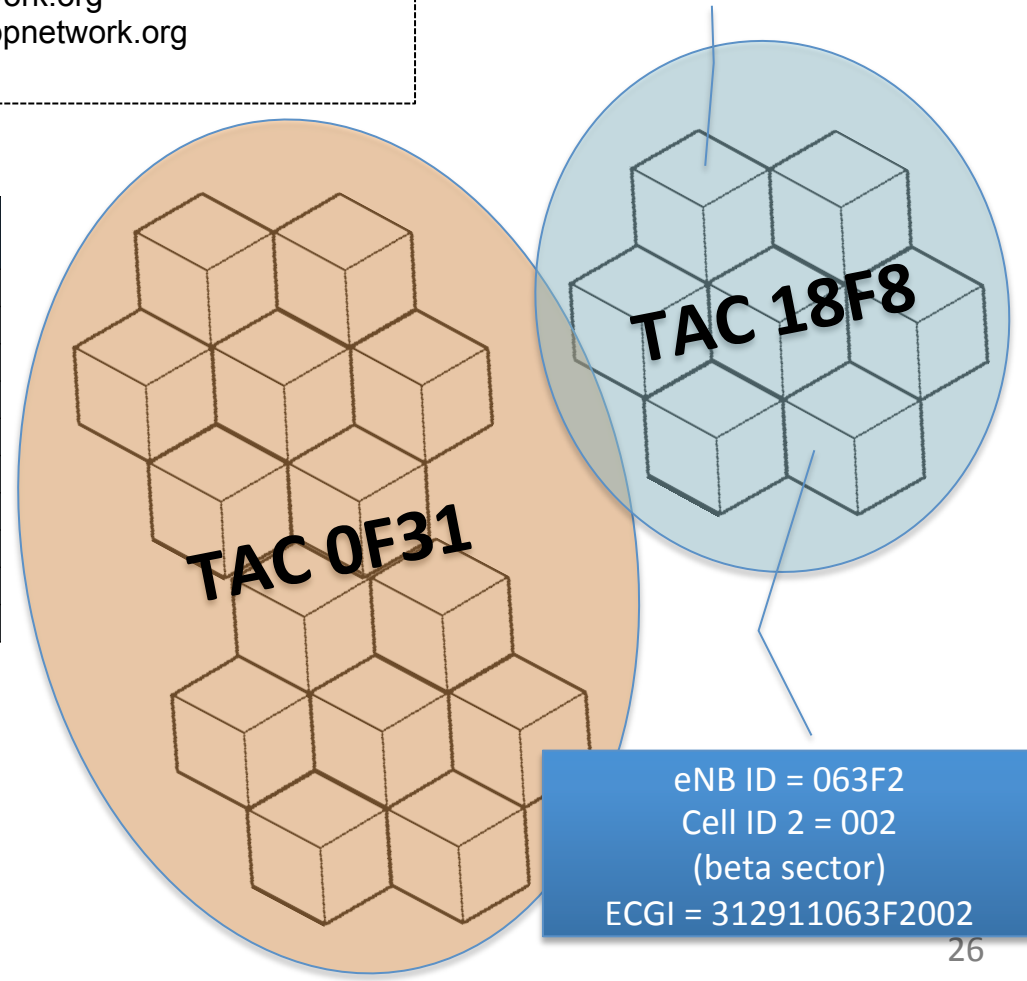
TAC = 18F8 TAI = 31291118F8

eNB FQDN: enb03AC0.enb.epc.mnc911.mcc312.3gppnetwork.org

TAC FQDN: tac-lbF8.tac-hb18.tac.epc.mnc911.mcc312.3gppnetwork.org

Region	# of TAIs	TAI Ranges	# of eNB IDs	# of eNB ID Blocks	eNB ID Ranges
TOTAL FEMA I	1214	0001-04BD	4823	38	00001-012D7
TOTAL FEMA II	2674	04BE-0F30	10695	84	012D8-03C9F
TOTAL FEMA III	2503	0F31-18F8	10066	79	03CA0-063F2
TOTAL FEMA IV	5125	18F9-2CFE	19922	156	063F3-0B1C5
TOTAL FEMA V	4341	2CFF-3DF4	17406	136	0B1C6-0F5C4
TOTAL FEMA VI	3222	3DF5-4A8B	12897	101	0F5C5-12826
TOTAL FEMA VII	1148	4A8C-4F08	4508	35	12827-139C3
TOTAL FEMA VIII	910	4F09-5297	3670	29	139C4-1481A
TOTAL FEMA IX	4003	5298-623B	16043	125	1481B-186C6
TOTAL FEMA X	1077	623C-6671	4299	34	186C7-19792

- TAI Rule List is programmed in MME
- UE uses top 16 in TAI Rule list



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APN Questions/Answers (1)

- What is the real need that typical agencies will want more than one local APN for their users to different parts of their network?
  - Apparent need to implement multiple local APNs but each would need to be approved by all the initial waiver network deployments to prevent naming domain issues
  - Practical limit on number of APNs for a UE is limited to EBI support of 11 simultaneous bearers (e.g. Impose soft limit of no more than 11 total APNs on a device)
- Emergency APN (Em-APN) usage could be beneficial for setting up temporary use APNs for disaster recovery teams – can these be standardized?
  - Setting up and implementing ad-hoc/dynamic APNs may not be very effective in emergency situations.
  - Better to develop standardized, pre-configured emergency APNs that can be utilized
- Is there a situation in which wildcards should be allowed? (Wildcard APN is a setting in the HSS to allow users to access any APN)
  - No obvious use case for enabling the wildcard APN for Public Safety networks.
  - Since wildcard APN setting bypasses a level of access control, it may compromise a level of APN security.

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APN Questions/Answers (2)

- What are the complications if a new nationwide network is implemented and/or there is an evolution in APN naming?
  - Careful and unified planning is needed up front for any common/national/ default APNs to prevent unnecessary outages ($$$) due to reconfigurations within the UE and EPC (HSS, S/P-GW)
  - Local APN changes will incur changes to the users in that particular waiver network. This likely will be service affecting and require reprogramming of all UEs
- Ensure ME standardized for APN allocation and updates in UE (OTADM)
  - Public Safety networks will need to establish a subscriber management system in their OSS architecture to provide a unified approach to device/ user management. This in-turn will allow for easier migration to a nationwide network and common procedures to be developed in the waivers.

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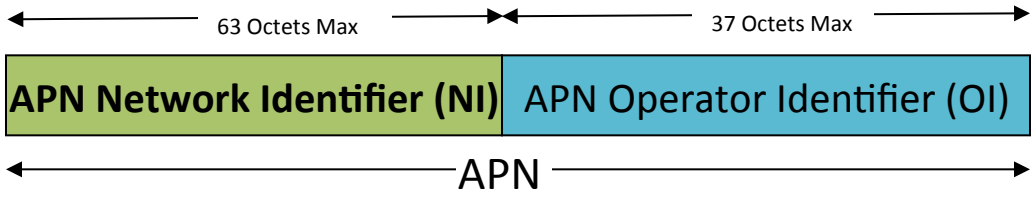
Nationwide APNs

- Required common national APNs in all UEs– APNs that provide common services to all users
  - **home.publicsafety** – connects into user's data center for secure & generic (e.g. VPN) access to data services and access to national crime information databases, even when accessing the PSBB network from another jurisdiction or commercial service for mutual aid and emergency situations to gain efficient access to local servers i.e. ICS, "Status/Info HomePage", etc. May be used for "local breakout" functionality in the future.
    - FQDN=home.publicsafety.apn.epc.mnc911.mcc312.3gppnetwork.org
  - **ims.publicsafety** - VoLTE telephony voice, SMS/MMS services, SIP related messages routed via Mw interface, OMA-DM support for Device Management
    - FQDN=ims.publicsafety.apn.epc.mnc911.mcc312.3gppnetwork.org
  - **mcvoice.publicsafety** – mission critical voice (Over-the-top) e.g. PTT, group call
    - FQDN=mcvoice.publicsafety.apn.epc.mnc911.mcc312.3gppnetwork.org
  - **mgmt.publicsafety** – APN is to be used only for LTE device management and supervisory/OAM functions that involve the UE
    - FQDN=mgmt.publicsafety.apn.epc.mnc911.mcc312.3gppnetwork.org
  - **<local APN name>.publicsafety** – where "local APN name" is the standardized custom APN (Multiple) that connects into local network for specific services (local application server)
    - FQDN=<local APN name>.publicsafety.apn.epc.mnc911.mcc312.3gppnetwork.org

PSCR

Custom APN Identifiers Guidelines



Access Point Name (APN) - used to identify a packet data network for UE connections

- APN OI set by PLMN
  - e.g. APN OI = apn.epc.mnc911.mcc312.3gppnetwork.org
- FQDN e.g. - <label1>.<label2>.<labeln>.<APN-OI>
- Allow multiple APN naming assignments for additional national services, local, state and federal public safety
- Two label scope classes: National (e.g. federal) scope and Sub-national (e.g. regional) scope
  - National scope label (i.e., the right-most label) of the APN-NI field is assigned by administrator to insure uniqueness, limit to 8 characters, leaving 55 characters for sub-national assignment.
    - **E.g. <…>.national.<APN-OI>, <…>.dhs .<APN-OI>, <…>.fema6 .<APN-OI>, <…>.ilstate.<APN-OI>**
  - Local entities would be responsible for insuring unique label names
    - Eg, **ims.**national, **securityalerts.**dhs, **adamsco.police.co.**fema8, **police.chi.cookco.**ilstate
    - FQDN = adamsco.police.co**.**fema8.apn.epc.mnc911.mcc312.3gppnetwork.org

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Custom APN Identifiers Guidelines (2)

- Create secure registration database for PS APNs
  - Ensures uniqueness in APNs and prevents routing conflicts
  - Single point of reference for DNS and UE programming
  - Creates common methodology for integrating new APNs
- Implement standardized process for APN allocation and updates in UE (OMA-DM)
  - Public Safety networks will need to establish a subscriber management system in their OSS architecture to provide a unified approach to device/ user management. This in-turn will allow for easier migration to a nationwide network and common procedures to be developed in the waivers.
- Suggest soft limit of 11 APNs per UE (can be changed over time)
  - EPS Bearer ID (EBI) limits amount of bearers based on 4 bits to 11 bearers

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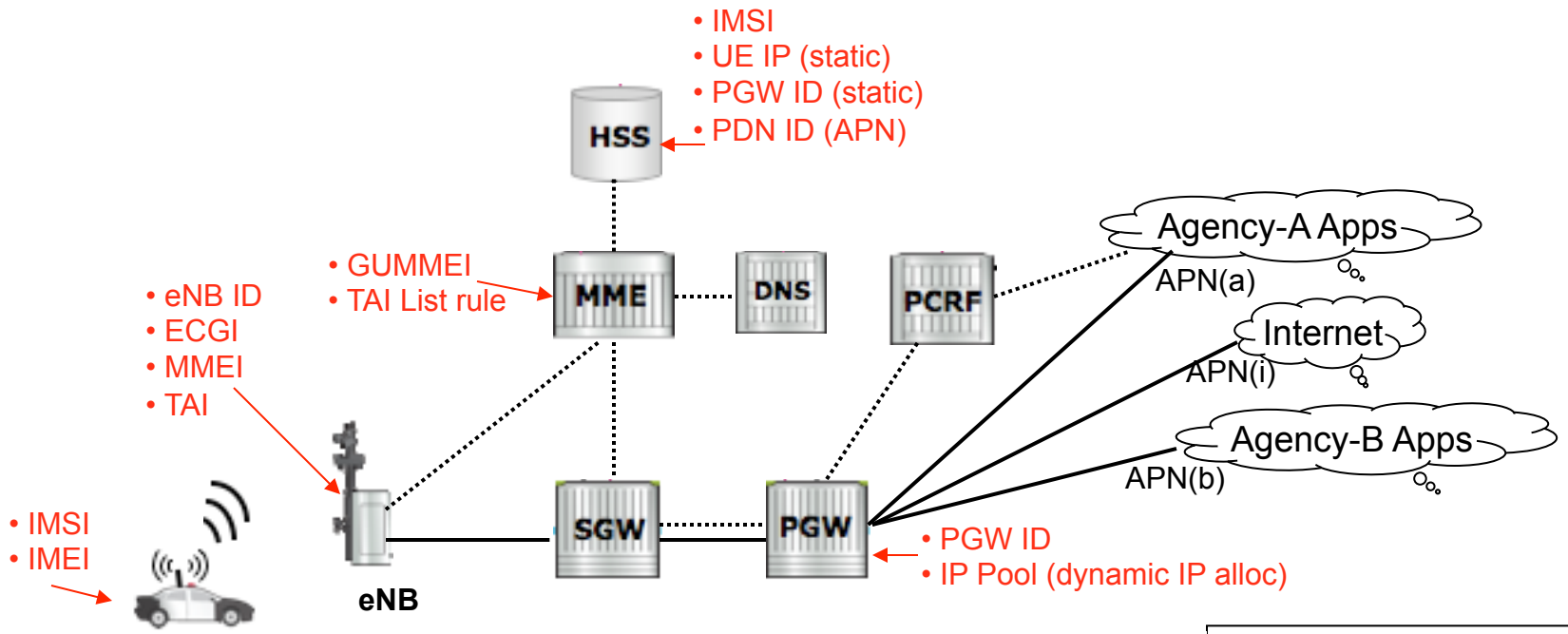
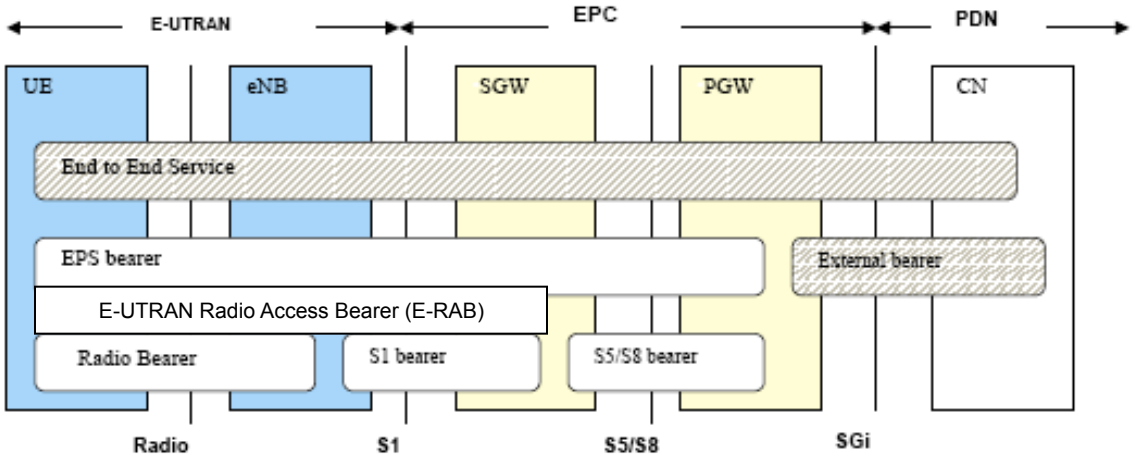
LTE Network Architecture & Identifiers





LEGEND:

eNB - evolved Node B

MME - Mobility Mgmt. Entity

HSS - Home Subscriber Server

DNS - Domain Name Server

SGW - Serving Gateway

PGW - Packet Data Network Gateway

PCRF - Policy & Charging Rules Function

RED - Permanent (provisioned)

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For Additional Information:
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