



Possibilities

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5G Enterprise Core Design in Industry Verticals

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DGTL-BRKSPM-2021



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Introduction



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Agenda

- Session 1
 - Private 4G and 5G Market
 - CBRS LTE Spectrum
- Session 2
 - CBRS LTE Architecture
- Session 3
 - Private LTE Deployment Options
- Session 4
 - 3GPP Private 5G Architecture

Session 1



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Next Generation Enterprise Wireless Needs

Then

Simple
information sharing

Industrial IoT, Machines,
Scanners

Cellular Voice | Wi-Fi

Now

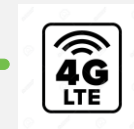


AR / VR /
Streaming Video 4K



Lighting / Badge / Vending Machine/
MRI / X-ray / Sensors/AGV's

Wi Fi



5G



Users expect immersive
experiences



IoT is the new mobile



Wireless is at an
inflection point

We are more dependent on the network than ever before

Private Cellular Verticals and Use Cases

Verticals



Industrial IoT



Oil and Gas



Mining



Sporting venues



Healthcare



Entertainment

Use Cases



Robots, AGVs, AMRs



Ruggedized tablet



Push to Talk



Sensors and remote controls



Security Cameras



Point of Sales



Critical voice & apps



Secure collaboration

Requirements for Private Networks



Isolation from Public Networks

Clean 3.5GHz LTE band



Extend Coverage

At least 10,000sqft per AP



Ease of Management

Enterprise Managed or SP Managed



Increase Security

SIM based authentication



Greater Reliability

LTE Reliability



Enterprise Owned

No Reliance on Cellular Operators



Clean spectrum

Eliminate interference



Power of 5G

Latency, throughput, scale



Mobility

Reliable handover for AGVs

Comparing WiFi 6, CBRS LTE and 5G

Criteria	WiFi 6	LTE	5G
Spectrum	2.4 and 5 GHz 6Ghz (USA Only, TBD in other regions)	Multiple bands including 5 Ghz with LAA and CBRS band	Sub 6 Ghz for coverage and mmwave for capacity (much higher bandwidth – 800 Mhz @ 28 Ghz band, 2 Ghz @ 39 Ghz band)
Bandwidth in US	Channel bandwidth @ 2.4 GHz: 50 MHz (2.412 – 2.462 GHz) Channel bandwidth @ 5 GHz: 665 MHz (5.170 – 5.835 GHz) Usage by AP <ul style="list-style-type: none"> • 20 or 40 or 60 Mhz @2.4 Ghz band • 80 + 80 Mhz or 160 MHz @ 5 Ghz band 	Limited below 3.5 Ghz band 150 Mhz @ 3.5 GHz CBRS band Usage by eNB Nx20 MHz up to 100 MHz with Carrier Aggregation (CA)	Limited below 3.5 Ghz band 150 Mhz @ 3.5 GHz CBRS band 700 Mhz @ 24 Ghz band 850 Mhz @28 Ghz band 1400 MHz @39 Ghz band etc. Usage by gNB NX100 Mhz usage with CA in sub -6 Ghz N x400 MHz with CA in mmwave
Capacity enhancement	Higher with 1048 QAM, 8x8 MIMO	Higher with 1048 QAM, 8x8 MIMO, Massive MIMO @ 2.5 GHz	Higher with 1048 QAM, + massive MIMO (64X64 or higher) @ 2.5 GHz and higher bands
Latency	Lower than 802.11ac with OFDMA Average one way application layer latency 2.2 ms @95% percentile for WiFi 5. WiFi 6 is better. However, latency will depend on congestion in the network. Higher congestion will lead to higher latency. Source: Doc:IEEE 802.11-18/1160r0	RTT ~ 20 -30 ms today with LTE with 1 ms TTI Target ~ 2 ms in future with 4.9 G Transmission Time Interval (TTI) 0.14 ms 4.9 G	Target E2E latency (RTT) 1 ms for URLLC services, TTI of 0.125 ms for URLLC
Handovers	Mobile Controlled Lossy and un-predictable	Network controlled Lossless and seamless	Network controlled Lossless and seamless
Interference protection	Limited due to unlicensed spectrum	Good for licensed spectrum, limited in unlicensed spectrum, medium in CBRS due SAS	Good for licensed spectrum, limited in unlicensed spectrum

CBRS Device Ecosystem (Q1/Q2 2020)



iPhone 11



Samsung S10*



Google Pixel 3/4



LG G8



Motorola 2-way radio



Cisco ISR C1101-4PLTEP



Cisco IR 1101



Multitech rCell 500



Multitech eCell 100



AMIT M2M



Sercomm Video bridge*



Sercomm USB Dongle*



Multitech USB Dongle



Foxconn M.2 USB module



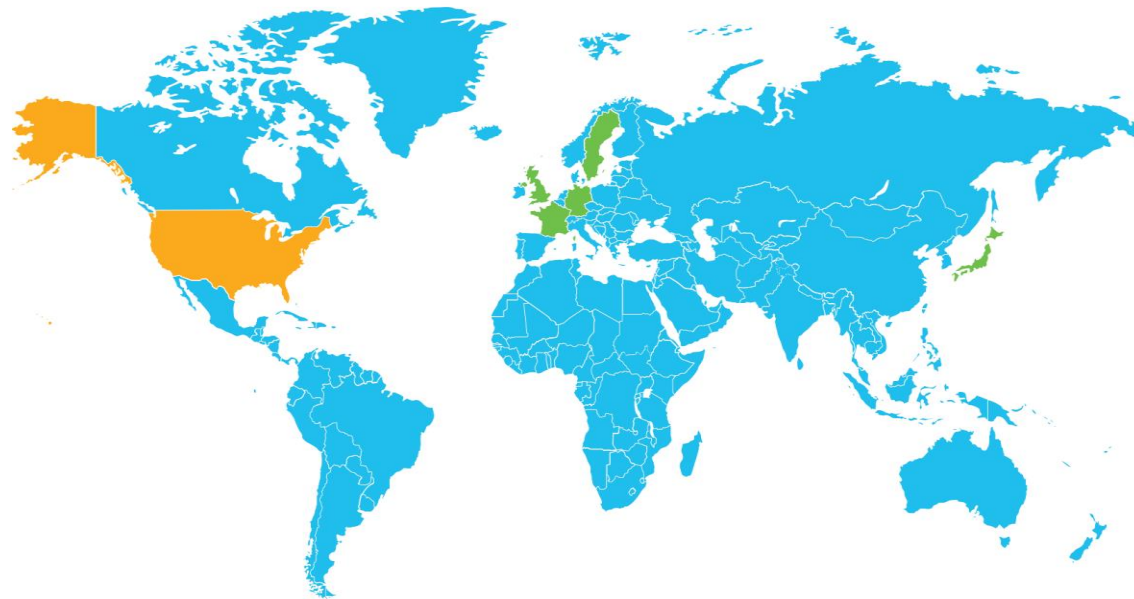
Zebra L10W Industrial Tablet



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Private/Shared LTE/5G Spectrum



Cellular (4G/5G)

Shared spectrum:

U.S.: 3.55-3.7 GHz CBRS

U.K: 1.8, 2.3 GHz, 3.8-4.2 GHz

Private/Locally-licensed spectrum:

Germany: 3.7-3.8 GHz

Sweden: 3.7GHz

UK: 3.8-4.2 low pwr, 1.8 & 2.3 GHz

France: 2.6 GHz (SP managed)

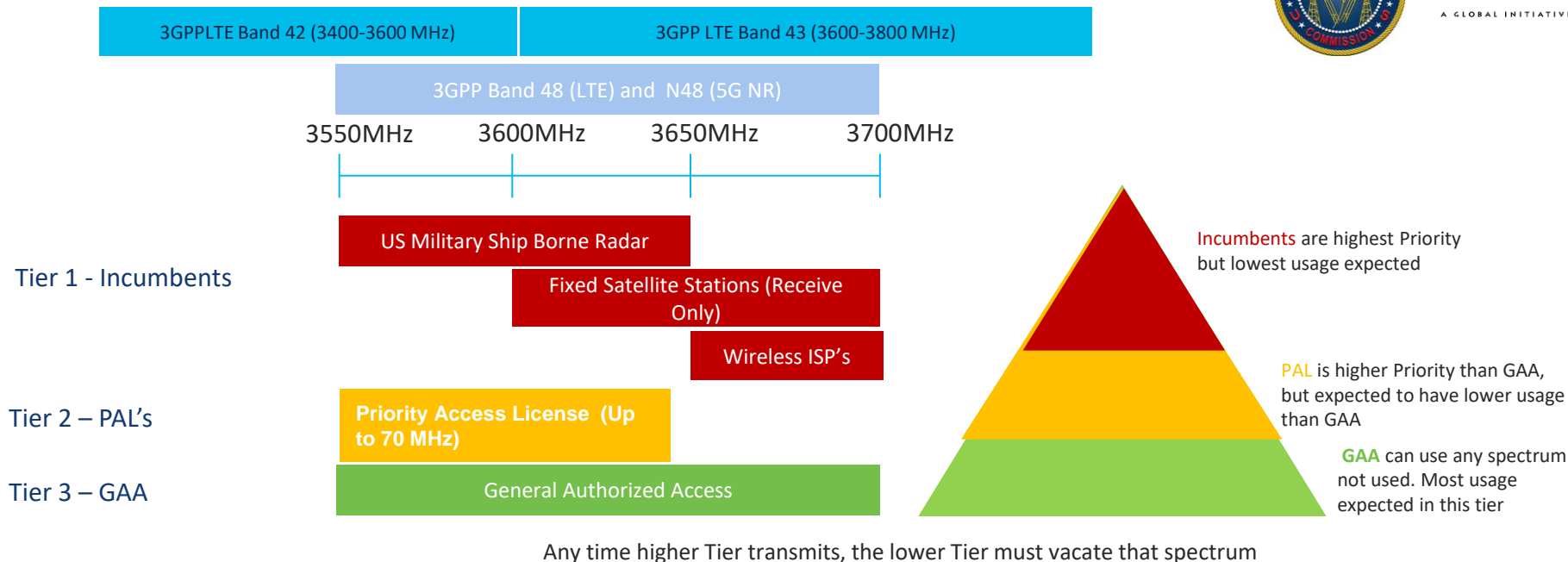
Japan: 28.2 GHz

Wi-Fi – Unlicensed

Worldwide: 2.4GHz, 5GHz

U.S., Europe: 6 GHz (future)

CBRS 3 Tier Spectrum Sharing Framework



- 3GPP is responsible for defining LTE Bands in US
- Federal Communication Commission authorizes which bands can be used in the US for which purpose

CBRS (Citizens Broadband Radio Service)

- CBRS is a LTE Band 48 and NR Band N48, 3.55GHz-3.70GHz spectrum that can support both voice and data
- Historically allocated for military use, now available as shared spectrum for commercial use under shared spectrum

Incumbents

Federal Government:

- Ship Borne Radar in coastal areas
- Ground Based Radars Inland
- Required to be detected by ESC system and SAS is subsequently made aware
- Protected from CBRS interference



Fixed satellite Service (FSS) Earth Station :

- Around 35 C Band Sites. Mostly on the coasts
- 3625 MHz and 3610 MHz range operation
- Protected from CBRS interference

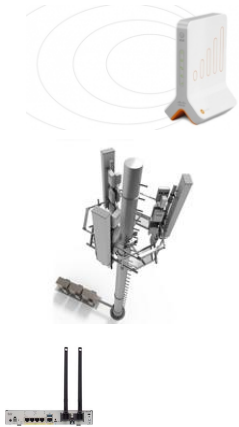


Wireless Broadband Service:

- Grandfathered Wireless Protection Zone (GWPZ)
- 3650 to 3700 MHz range operation
- 1000's of sites and transitioning to PAL or GAA by January 2023
- Protected from CBRS interference



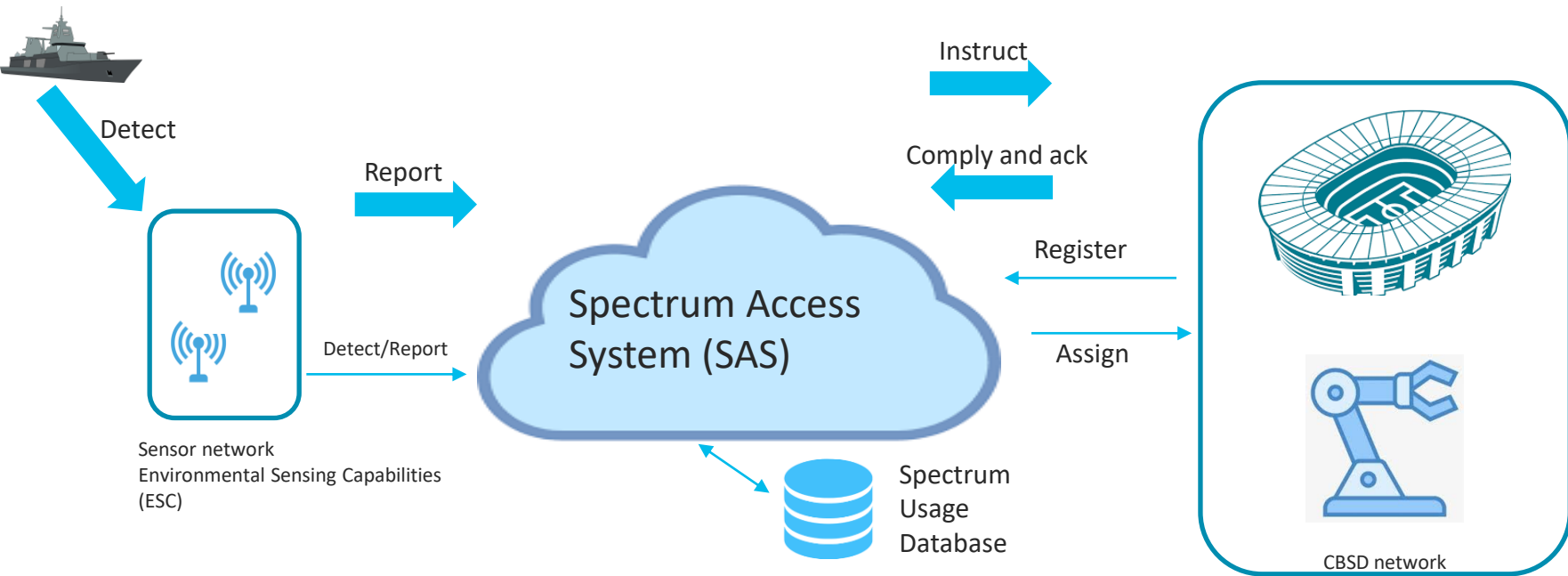
CBRS Device Types (CBSD and EUD)



Device Type	Power Tx (EIRP/10 MHz)	Indoor/Outdoor Operations	Installation Requirement
Cat A CBSD	1 Watt (30 dBm Max EIRP)	Indoor and Outdoor at below 6 Mts HAAT*	Certified Installer needed for Altitude precision rqmts (3 Mts vertical)
CAT B CBSD	50 Watt (47 dBm max EIRP)	Only Outdoor	Certified Professional Installer Required
EUD	200 mW	No requirements	Not Applicable

HAAT* -Height over average terrain

CBRS Operational Architecture

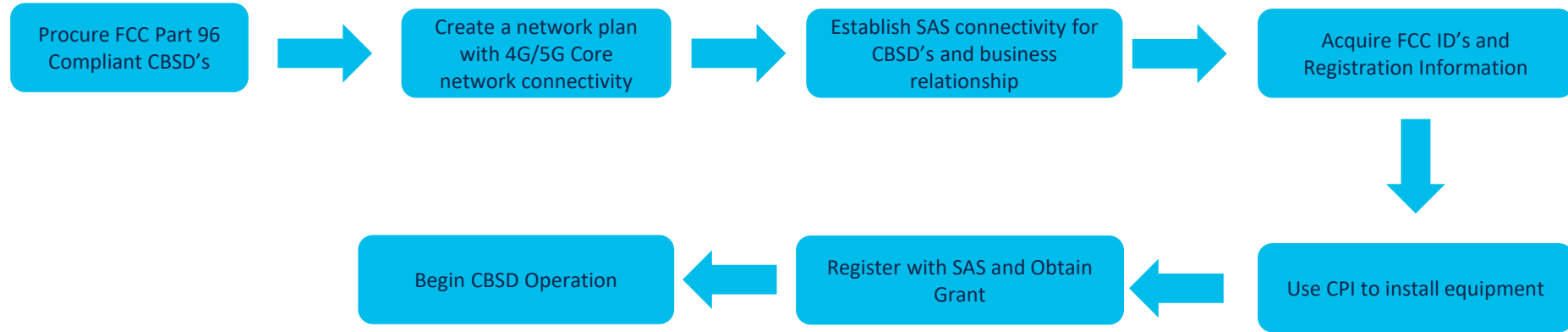


- Network of sensors that detect spectrum usage
- Deployed in Coastal areas for sensing navy ship born radar usage

- SAS keeps track of all spectrum use across all usage area
- Sensors report to SAS
- CBSD's must register with SAS to operate

- CBRS Devices aka CBSD's provide location, altitude, FCC ID, License Type, Device Type and other info in registration to SAS
- Installed by CPI and must register prior to operation

Steps to becoming Operational with CBRS



Additional References

FCC Part 96 - <https://www.fcc.gov/wireless/bureau-divisions/mobility-division/35-ghz-band/35-ghz-band-overview>

CBRS Alliance - <https://www.cbrsalliance.org/resource/>

SAS Providers - <https://federatedwireless.com/product/>
- <https://www.commscope.com/solutions/5g-mobile/spectrum-management-solutions/>

WinnForum CBRS Components Standardization - <https://cbrs.wirelessinnovation.org>

LTE TDD CBRS Band Definition from 3GPP - <https://www.3gpp.org/DynaReport/GanttChart-Level-2.htm#bm720195>

Summary

- The Emerging Need for Private Networks
- The Differences Between WiFi, LTE and 5G
- Device Ecosystem for CBRS
- Spectrum Allocation for CBRS in the US
- CBRS Architecture
- Steps to becoming operational with CBRS

5G Enterprise Core Design in Industry Verticals: Session 2

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The Cisco logo, consisting of seven vertical bars of increasing height from left to right, followed by the word "CISCO" in a bold, sans-serif font.

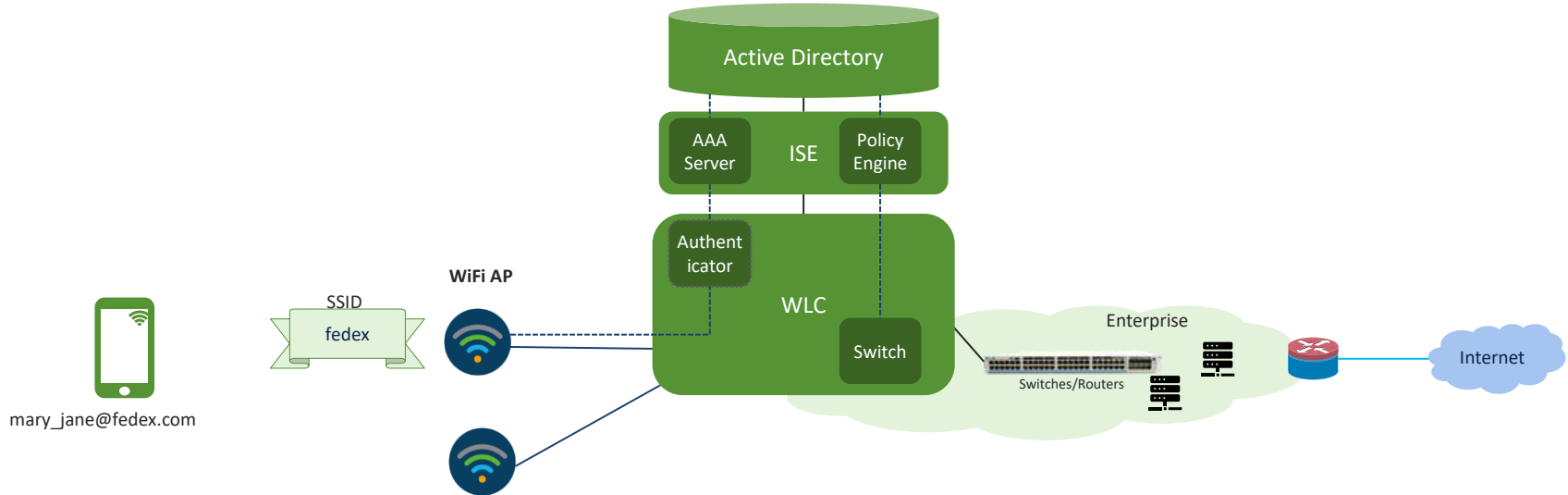
CISCO



Agenda

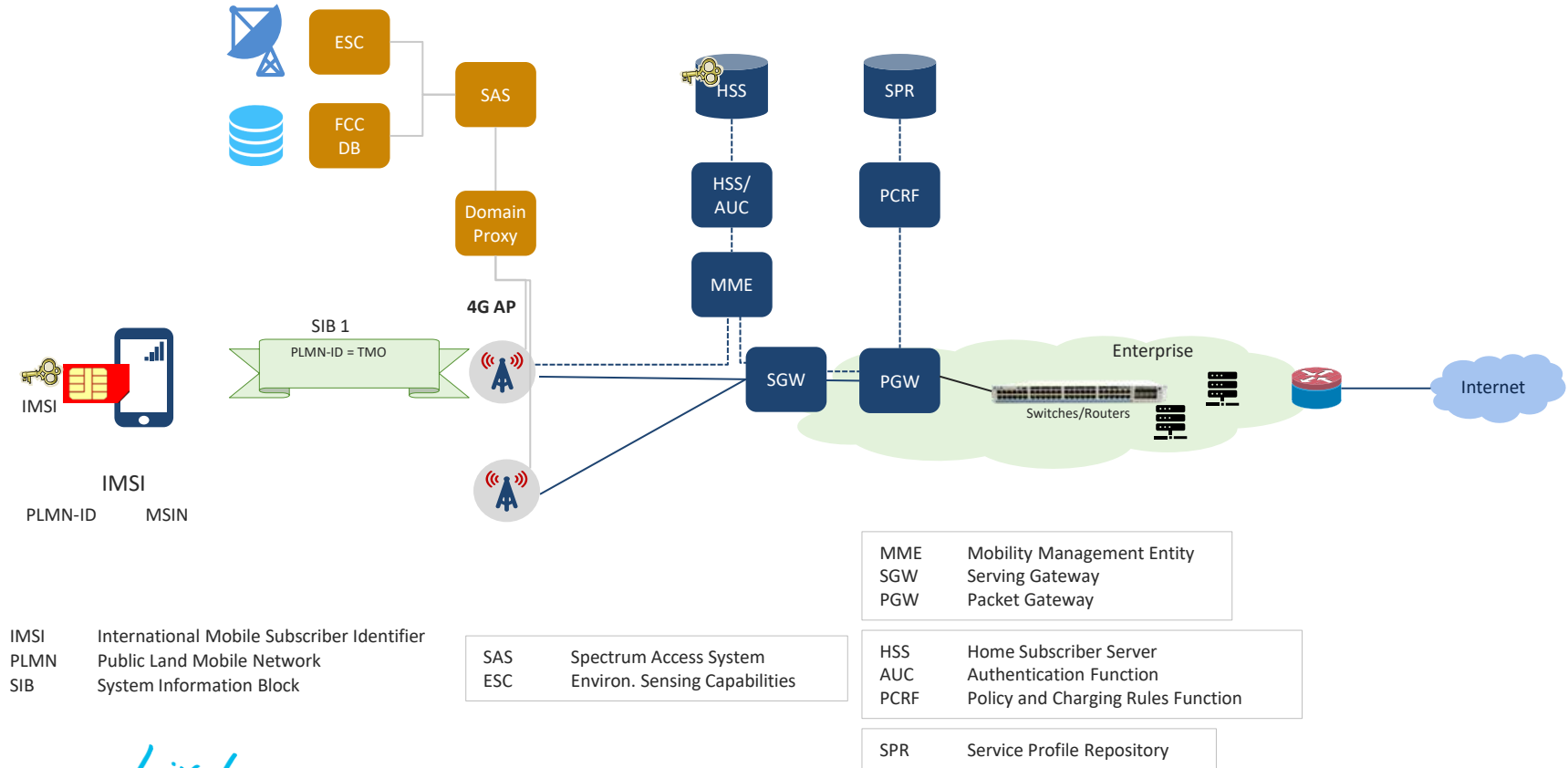
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Enterprise WiFi Architecture

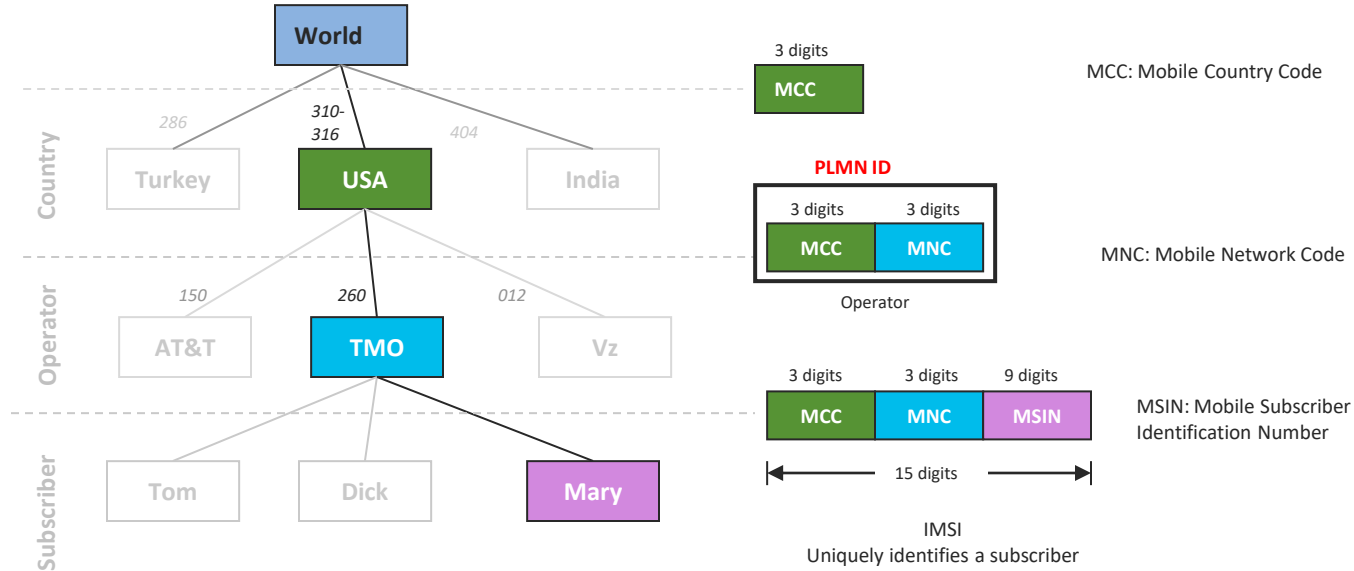


WLC	Wireless LAN Controller
ISE	Identity Services Engine

Enterprise 4G Network

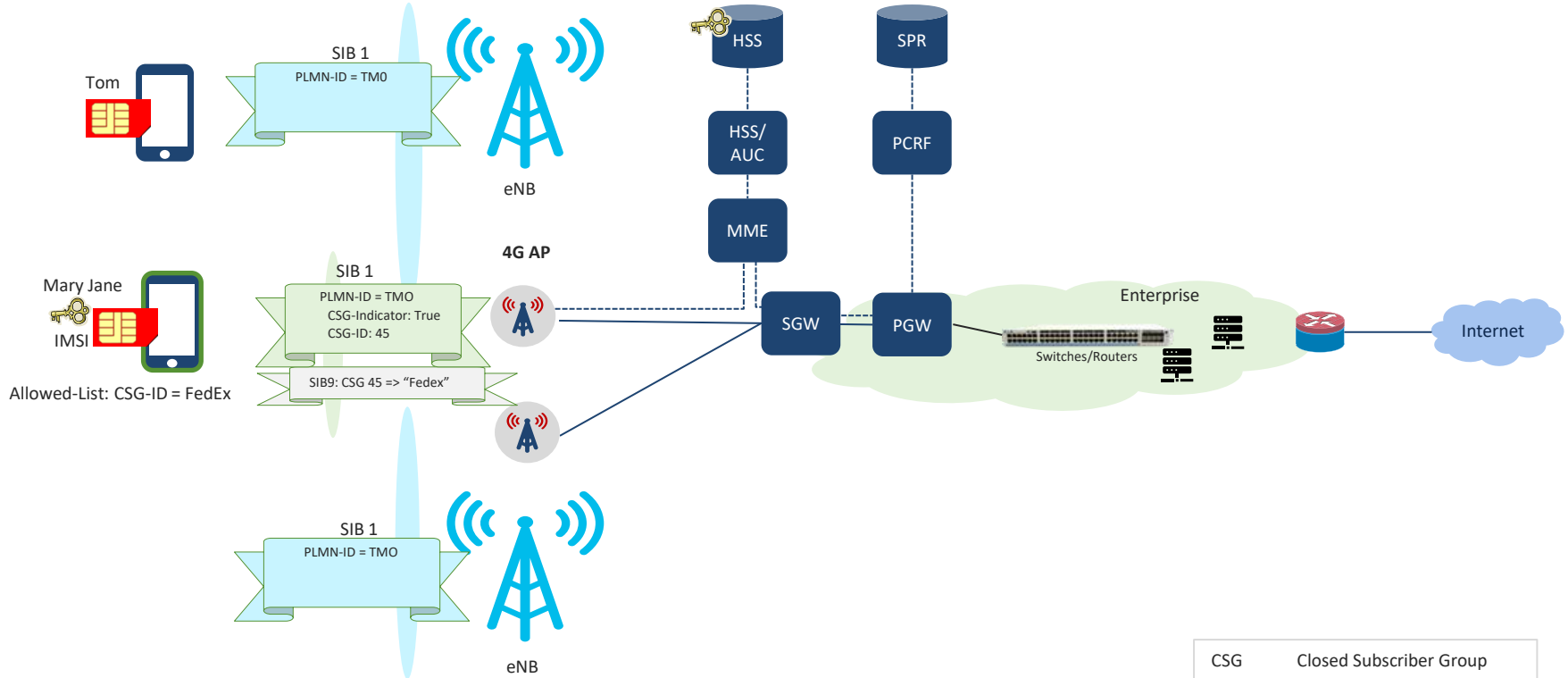


International Mobile Subscriber Identifier IMSI - Structure

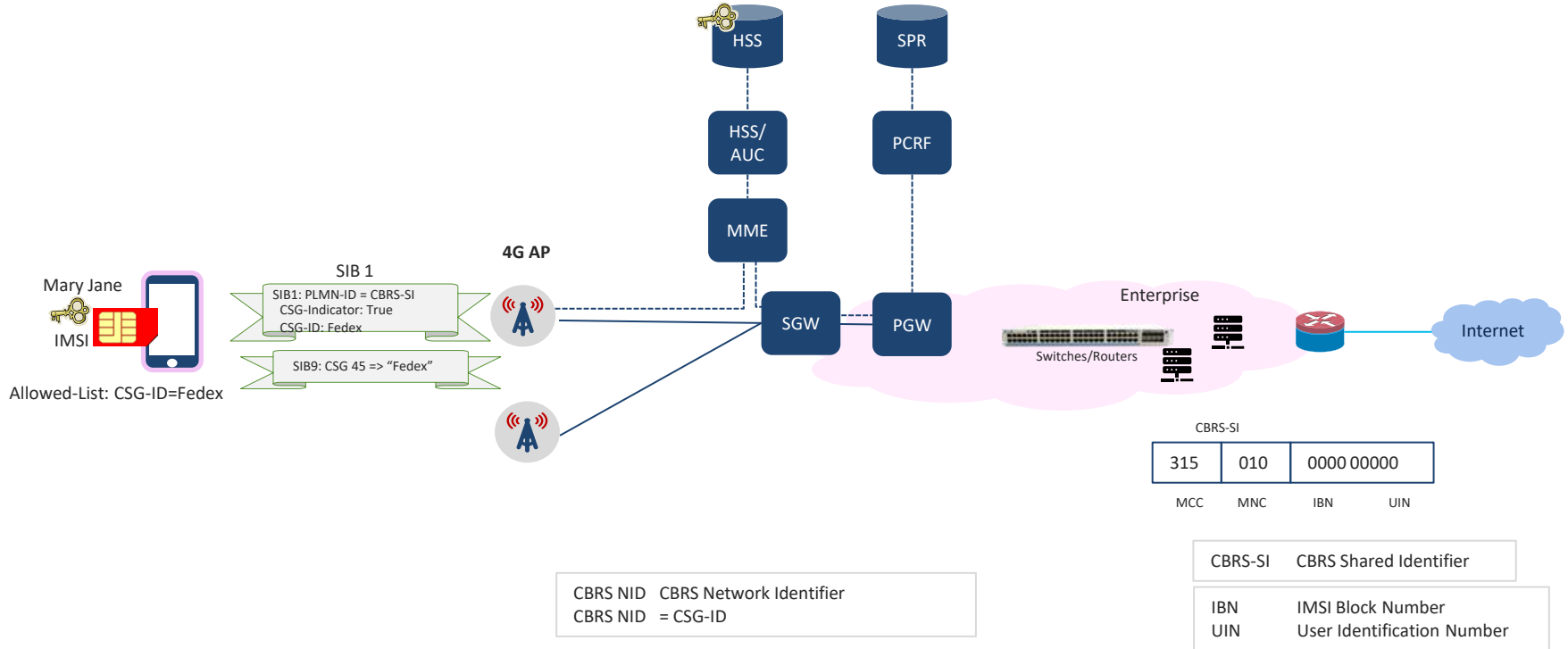


PLMN Public Land Mobile Network (Operator)

CBRS 4G Network: Operator provided



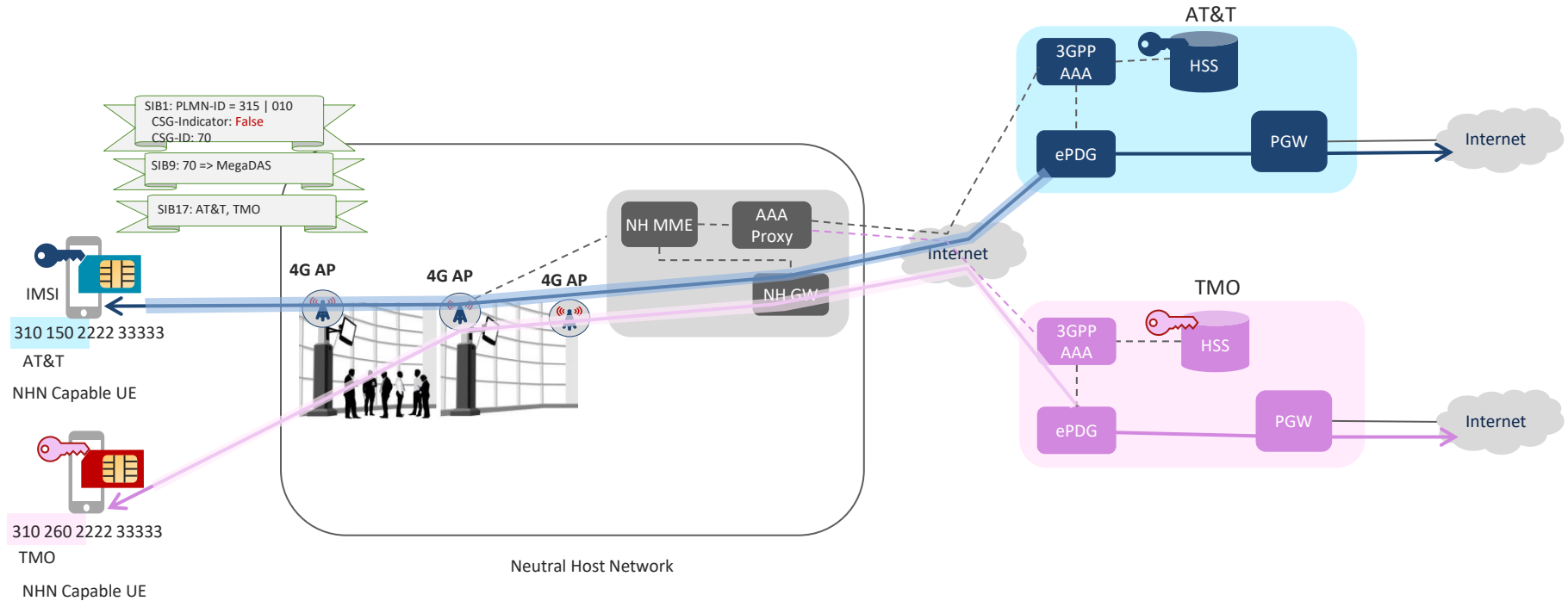
CBRS 4G Network: Enterprise Owned



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Neutral Host Network (NHN)



Summary: CBRS Private LTE

- CBRS Private LTE is based on 3GPP Specifications for Closed Subscriber Group
- Enterprise hosted CBRS Private LTE will use CBRS-SI
 - Enterprise need to coordinate with CBRS Alliance to get IMSI Block Number.
- Operator hosted CBRS Private LTE may use operator's PLMN-ID or CBRS-SI
- Credentials are still stored in SIM and authentication mechanism is EPS-AKA

5G Enterprise Core Design in Industry Verticals: Session 3

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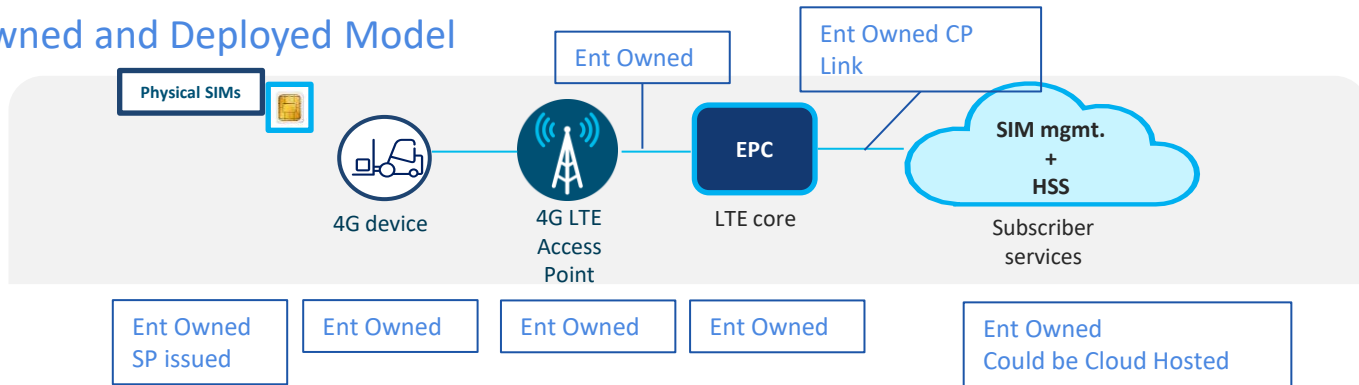
Agenda Topics

- Enterprise Owned Private Networks Vs. Operator Deployed Private Networks
- MOCN, Roaming and Spectrum Carrier Agg for Private Networks
- RAN Operating Models for Private Networks
- Core Network Options for Private Networks
- Advanced Requirements for Private Networks

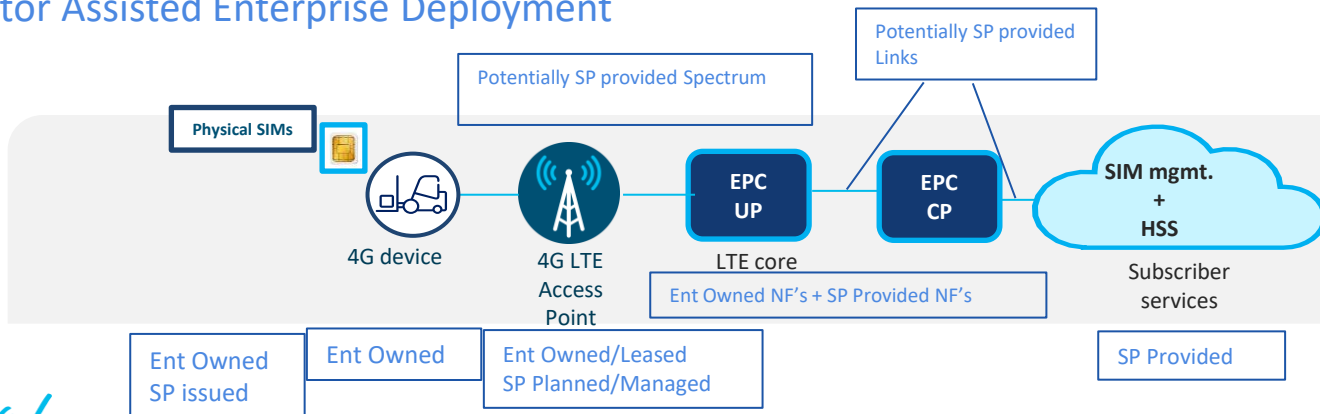
Private LTE Deployment Options

Two Distinct Models Emerging in the Private 4G/5G Network Deployments

A Enterprise Owned and Deployed Model



B Operator Assisted Enterprise Deployment



RAN Operating Models for Private LTE

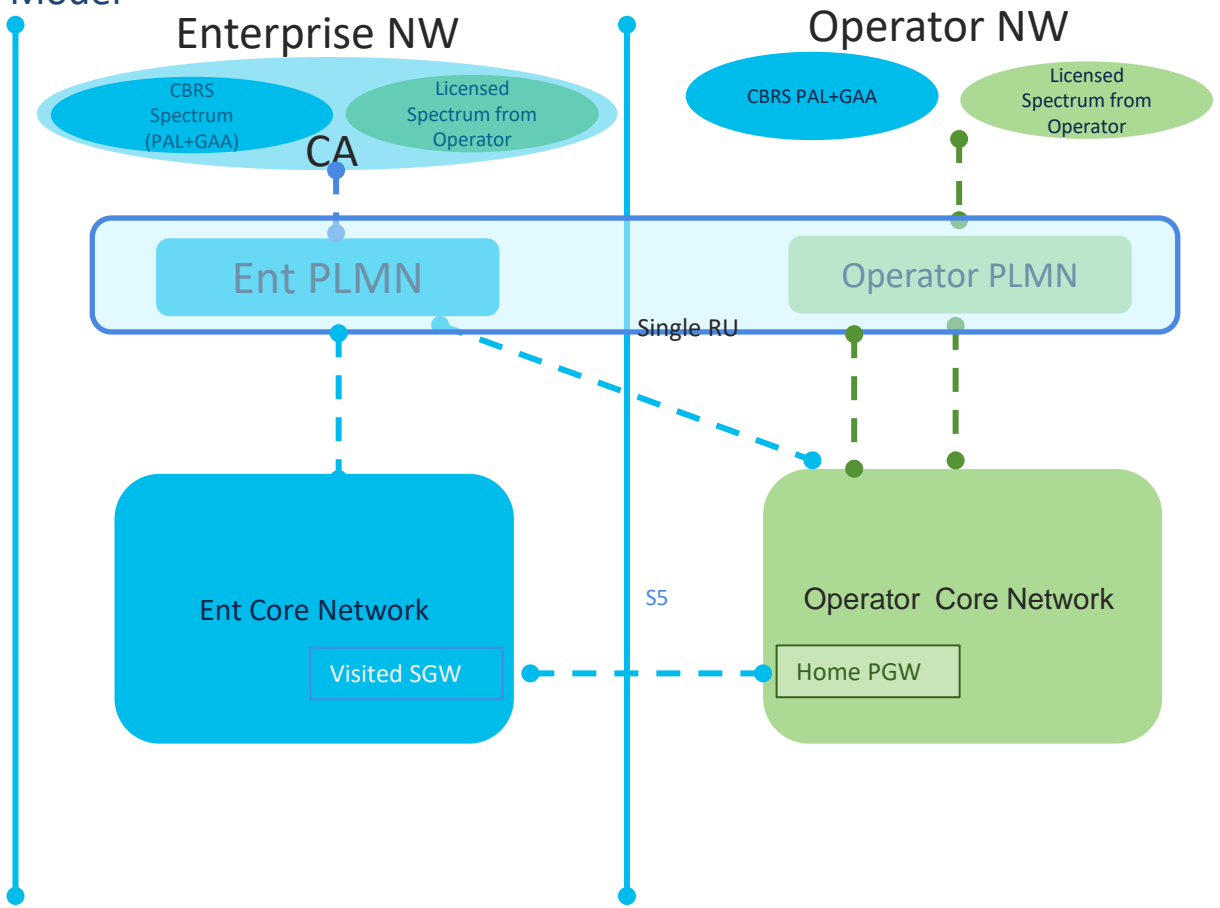
Operators Assisted LTE Deployment Model

Spectrum and CA

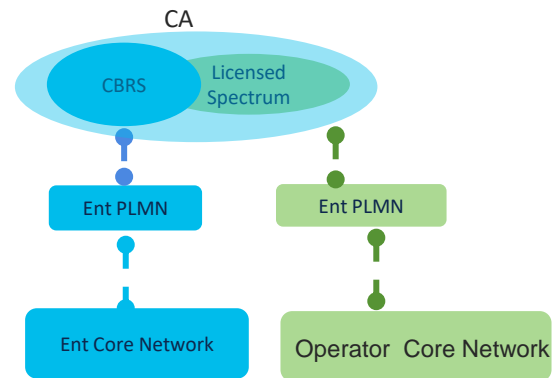
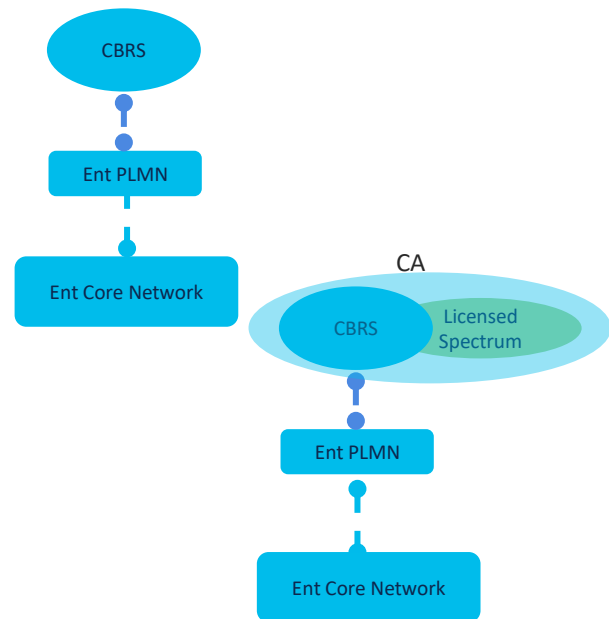
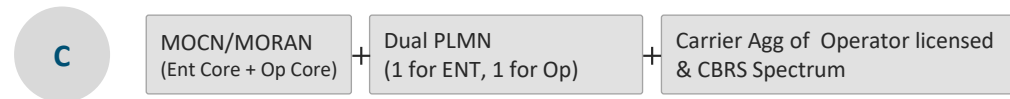
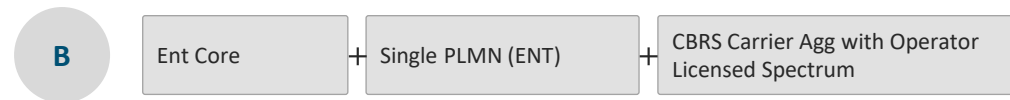
PLMN

MOCN

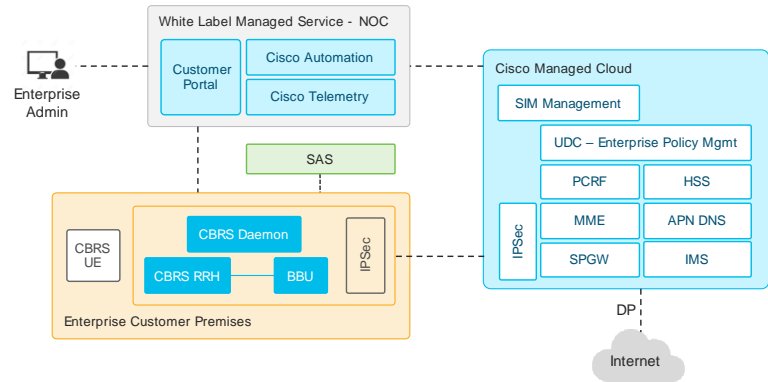
Roaming



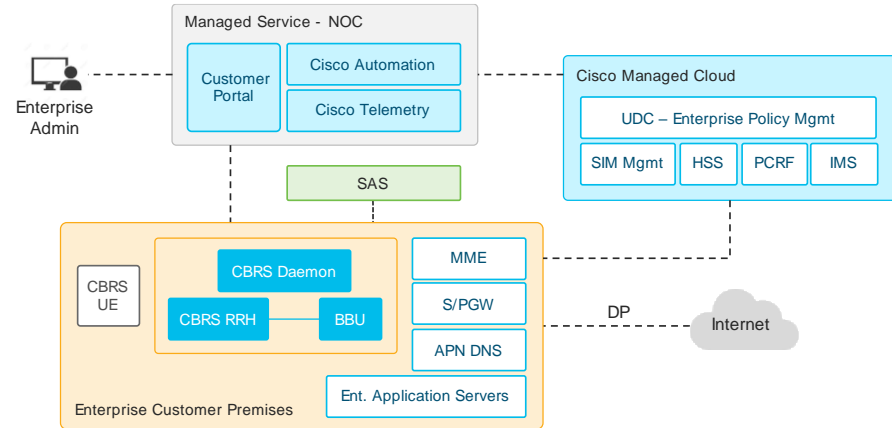
Three RAN Operating models for pLTE



Core Network Deployment Models for Private LTE (Cloud Hosted + Ent On-Prem)



Only Radios On Prem



EPC User Plane on Prem

Supports URLLC

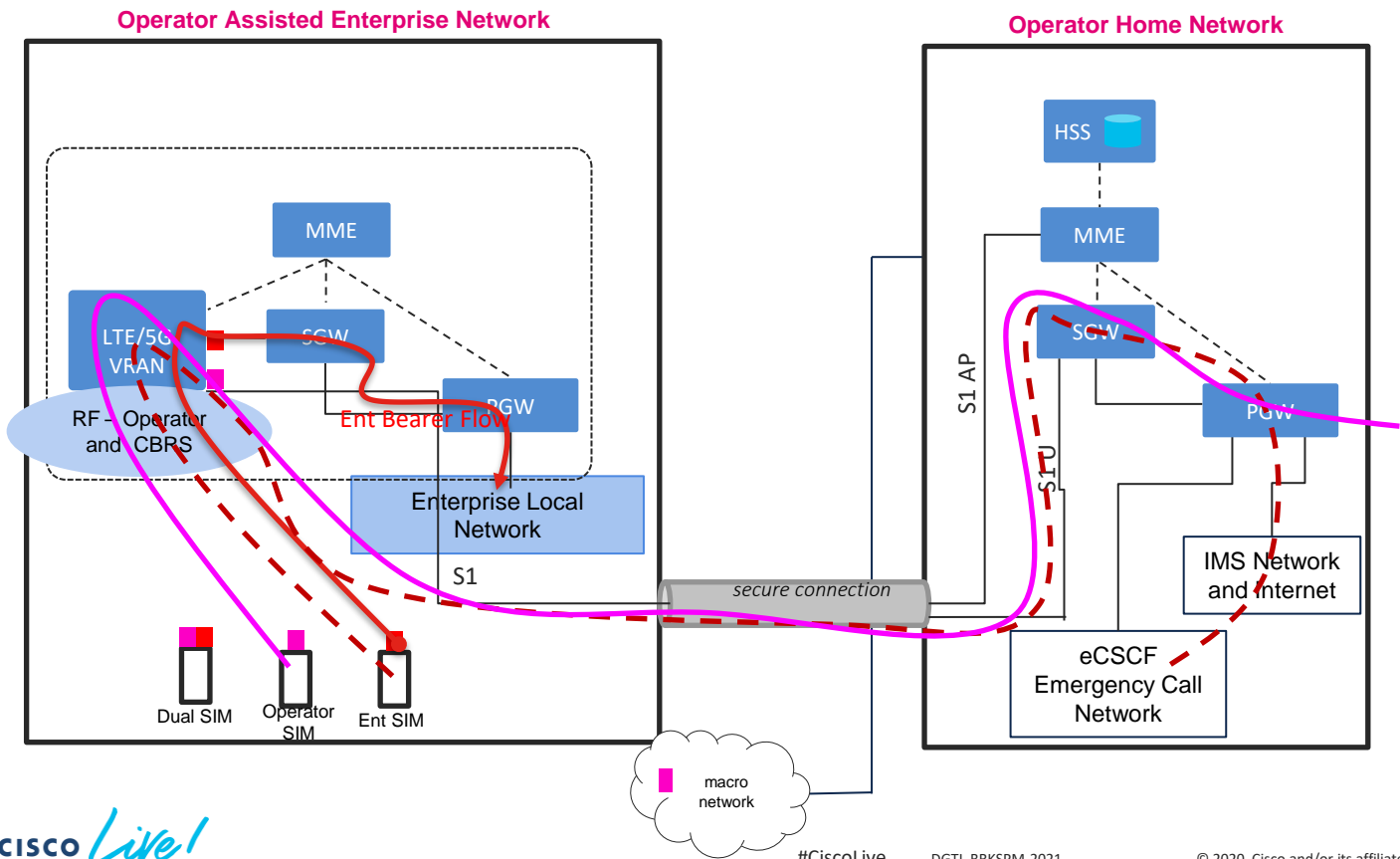
Both Models are valid core deployment models, one has lightest on-Prem equipment vs other has least latency for signaling and bearer plane

Emerging Requirements for pLTE Networks

- Emergency services support
 - Private LTE networks in some situations may need to support E911 services
- Emergency Services support in Enterprise Network is not trivial undertaking
 - GMLC/LRF and PSAP connectivity and other regulatory requirements get involved
 - The economics of building the Enterprise network will be very challenging

Emergency Services Support using MOCN Architecture in pLTE Networks

- Ent PLMN • Enterprise Devices only.
• No Emergency Attach
- Operator PLMN



Enterprise URLLC Data Flow

E911 Call Flow for Any UE and any PLMN

Data Flow for Operator UE

Handover from Ent to Macro for both Ent UE and Operator UE can be made to work with S1 Handovers

Summary

- There are quite a few choices for Private LTE network builds
 - On Prem vs On Cloud
 - Operator Assisted Vs Enterprise owned
 - Emergency services support Vs No Emergency Services support
 - MOCN Vs Roaming
- We have shown one example of leveraging operator assets like spectrum and E911 to build a pLTE network that is fairly advanced in implementation
- There could be quite a few permutations of these networks designs to suite each enterprises needs

5G Enterprise Core Design in Industry Verticals: Session 4

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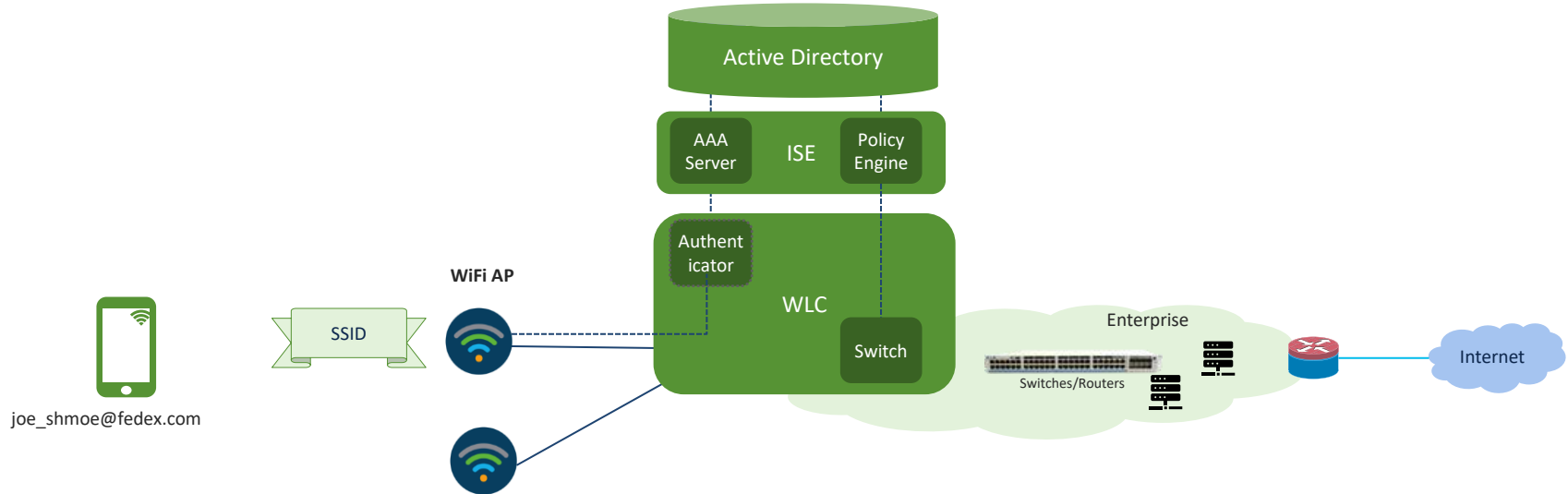




Agenda

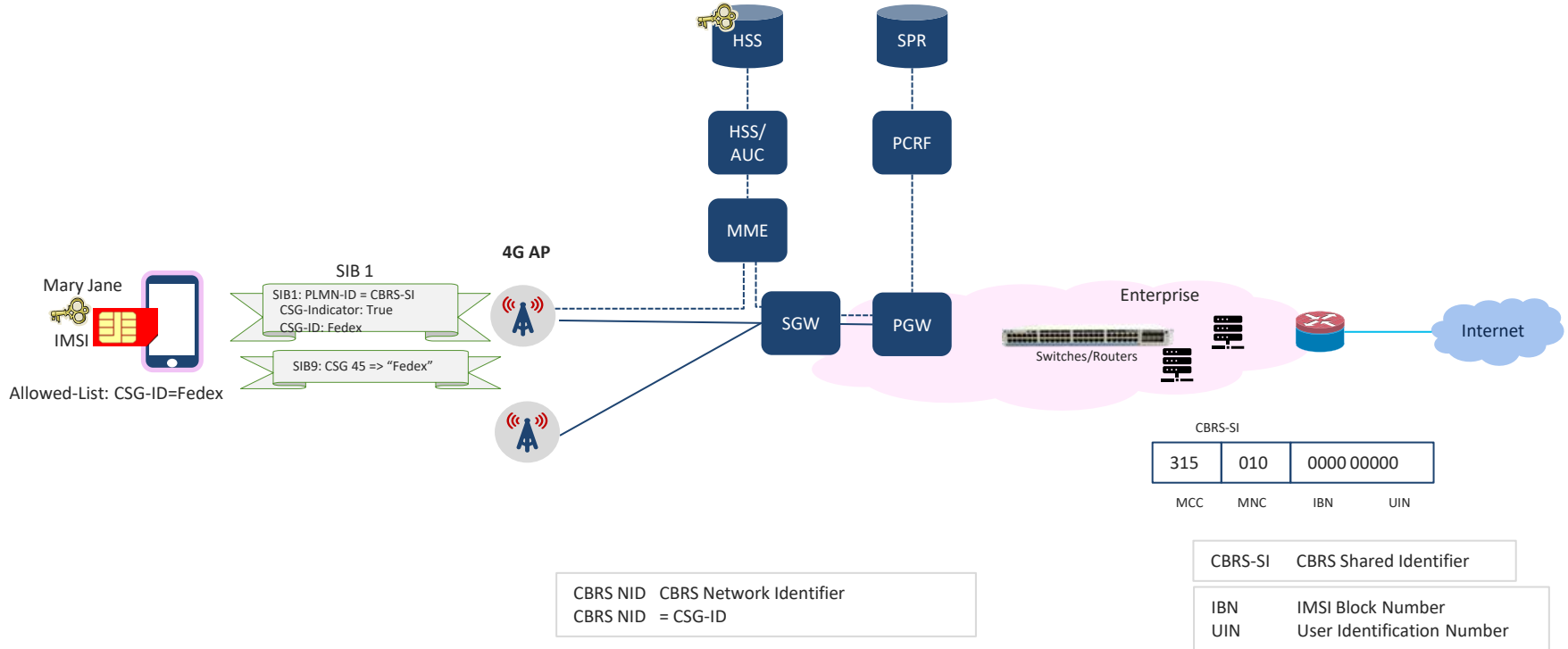
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Enterprise WiFi Architecture

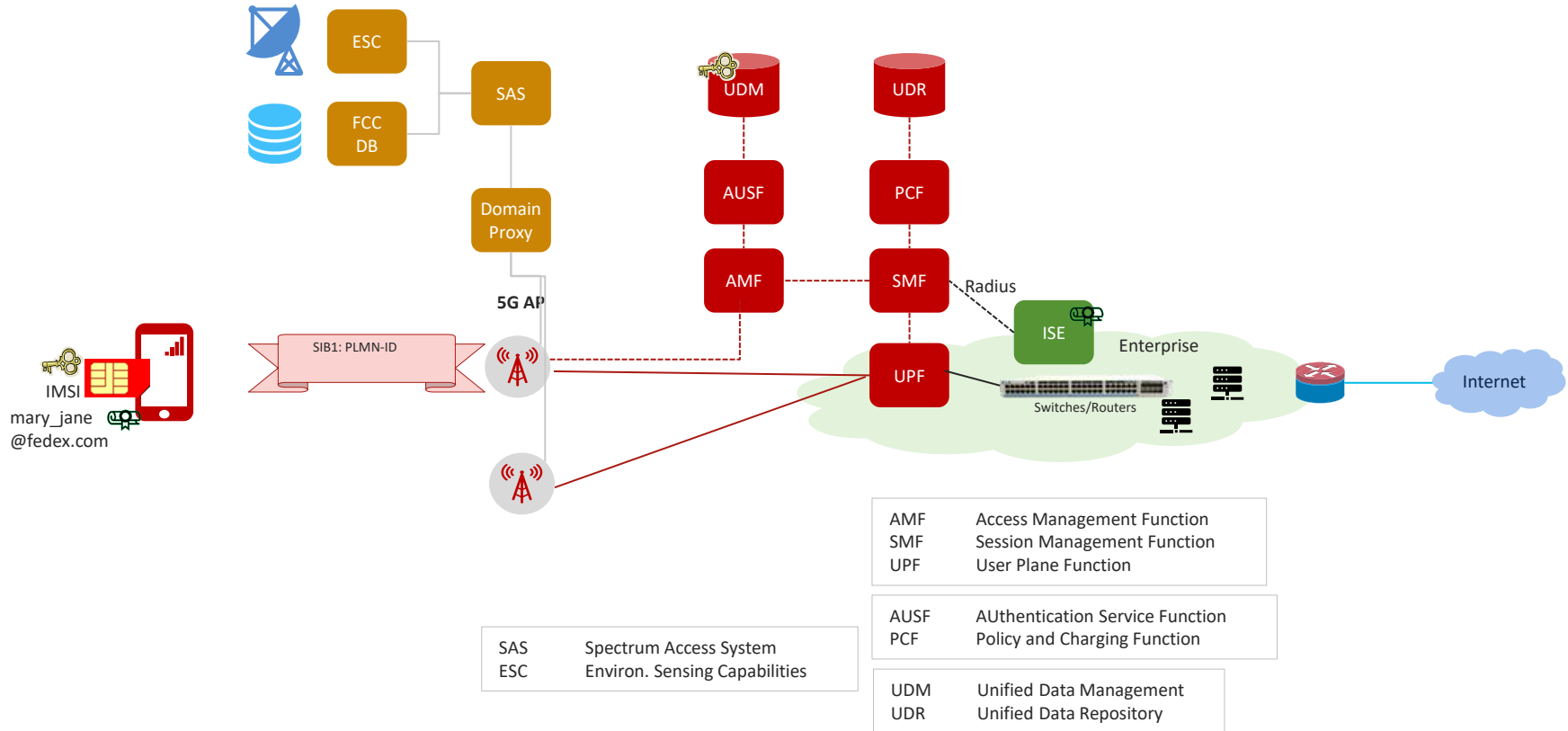


WLC	Wireless LAN Controller
ISE	Identity services Engine

CBRS 4G Network: Enterprise Owned

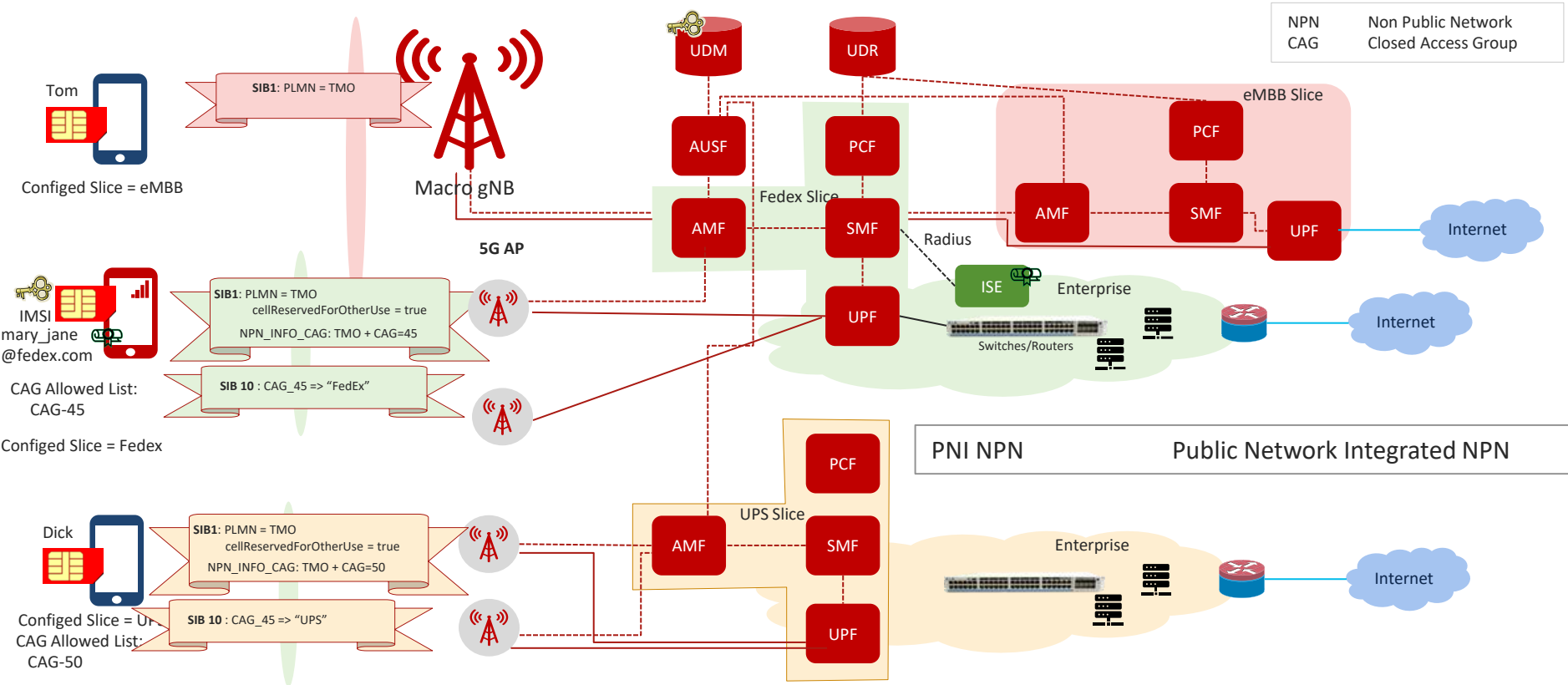


5G Architecture

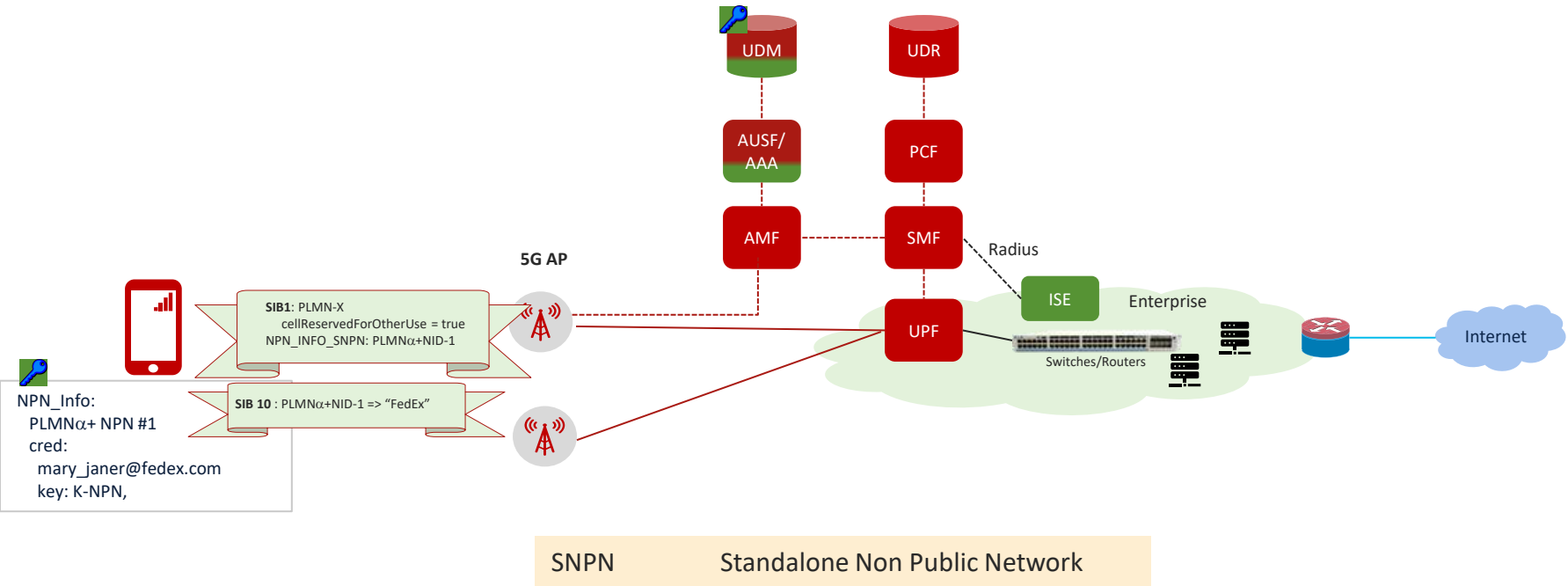


Private 5G: Operator Provided

NPN
CAG Non Public Network
Closed Access Group



Private 5G: Enterprise Provided



Summary: Private 5G Networks

- Support of Private 5G Networks standardized by 3GPP in Rel-16 (June 2020)
 - Commercial deployments using these standards will occur in 12-18 months timeframe
- **Operator hosted** Private 5G based on slicing and CAG features
- **Enterprise hosted** Private 5G supports enterprise friendly EAP methods and does not require SIM cards in mobiles.

Other SPM Session

SPM Sessions – June Release

Session ID	Session Title	Availability
DGTL-BRKSPM-2010	Applying Security in a 5G World	June 18th 2020
DGTL-BRKSPM-2013	Next-Generation Mobile Enterprise: 5G, Private LTE, and Wifi 6	June 18th 2020
DGTL-BRKSPM-2071	5G Technology Updates	June 18th 2020

SPM Sessions – July Release

Session ID	Session Title	Availability
DGTL-BRKSPM-2001	Accelerate Mobility deployment with Cisco Cloud Services Stack	July 15th 2020
DGTL-BRKSPM-2009	Design 5G Ready Distributed Telco DC with Cisco ACI	July 15th 2020
DGTL-BRKSPM-2016	5G network with SD-WAN for Enterprise Customers	July 15th 2020
DGTL-BRKSPM-2020	5G Mobile Edge Computing	July 15th 2020
DGTL-BRKSPM-2129	Deploying 5G and LTE for Enterprise and IoT	July 15th 2020
DGTL-BRKSPM-2950	Rakuten Mobile: All in the Cloud from RAN to Core	July 15th 2020

SPM Sessions – September Release

Session ID	Session Title	Availability
DGTL-BRKSPM-2002	5G CICD with Continues Deployment & Automation Framework	Sep 9th 2020
DGTL-BRKSPM-2015	Telco Cloud: your secret to a faster, smarter 5G network	Sep 9th 2020
DGTL-BRKSPM-2021	5G Enterprise Core Design in Industry Verticals	Sep 9th 2020
DGTL-BRKSPM-2023	Sprint Scalable Cloud with Cisco VIM	Sep 9th 2020

Thank you



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