The bridge to possible

Deployment of Cisco Catalyst Industrial Routers in Public and Private Cellular infrastructures

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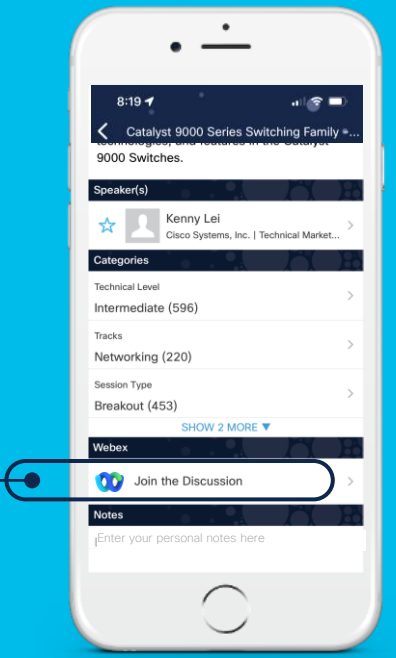
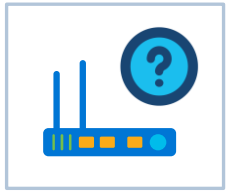


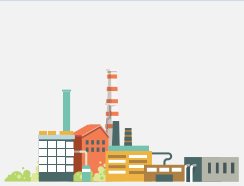
Wireless technologies are key pillars of IoT, but *one size does not fit all*



While Ethernet has always been the foundation for wired connectivity in industrial IoT spaces, how to select the appropriate wireless technologies?

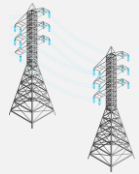
Wireless provides the flexibility and agility to upgrade, deploy and reconfigure a network with less operational downtime, while integrating autonomous devices.

As organizations expand their IoT deployments, the need to manage multiple access technologies will grow.



Manufacturing

Parking Lot



Utilities

Gas Station

Kiosk

Warehouse

Roadways

Oil & Gas

Airport

Fleet

Seaport

Distribution Center

Agenda

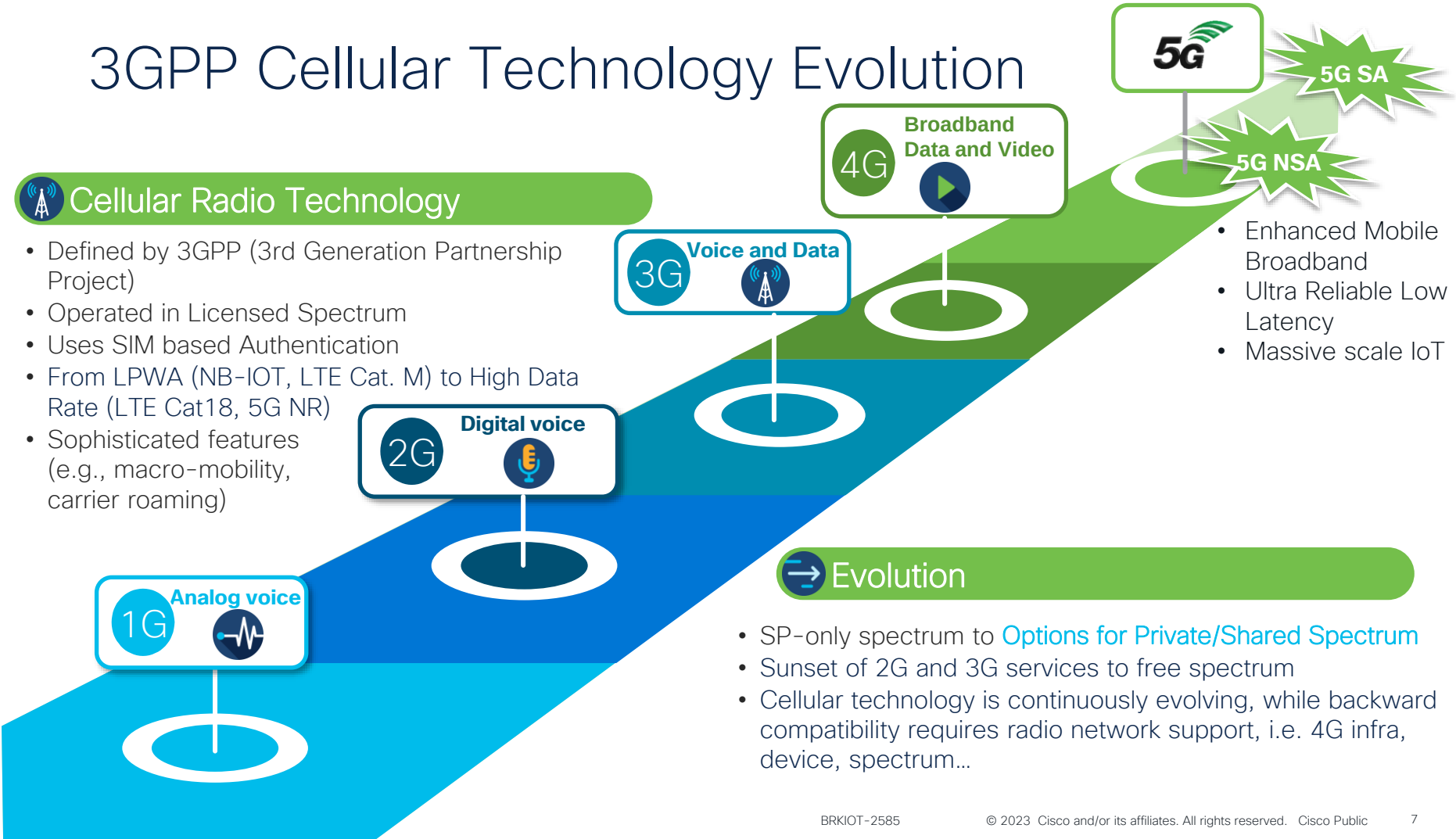
- Cellular technology evolution in Industrial IOT
- Cisco IR and IOS-XE Cellular configuration
- Network Design considerations

Cellular technology evolution in Industrial IOT

What can cellular technology do for Industrial IOT?

- *Cellular technology* provides the flexibility and agility to upgrade, deploy and reconfigure assets in secured and automated IP networks leveraging Public services or Private infrastructures.

3GPP Cellular Technology Evolution



Cellular Radio Technology

- Defined by 3GPP (3rd Generation Partnership Project)
- Operated in Licensed Spectrum
- Uses SIM based Authentication
- From LPWA (NB-IOT, LTE Cat. M) to High Data Rate (LTE Cat18, 5G NR)
- Sophisticated features (e.g., macro-mobility, carrier roaming)

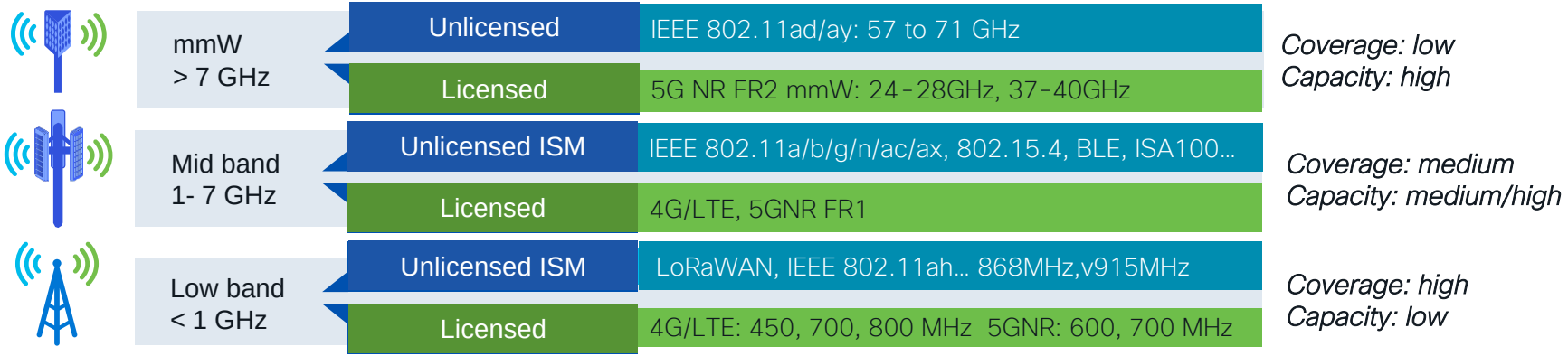
- Enhanced Mobile Broadband
- Ultra Reliable Low Latency
- Massive scale IoT

Evolution

- SP-only spectrum to Options for Private/Shared Spectrum
- Sunset of 2G and 3G services to free spectrum
- Cellular technology is continuously evolving, while backward compatibility requires radio network support, i.e. 4G infra, device, spectrum…

Wireless Technologies – Spectrum

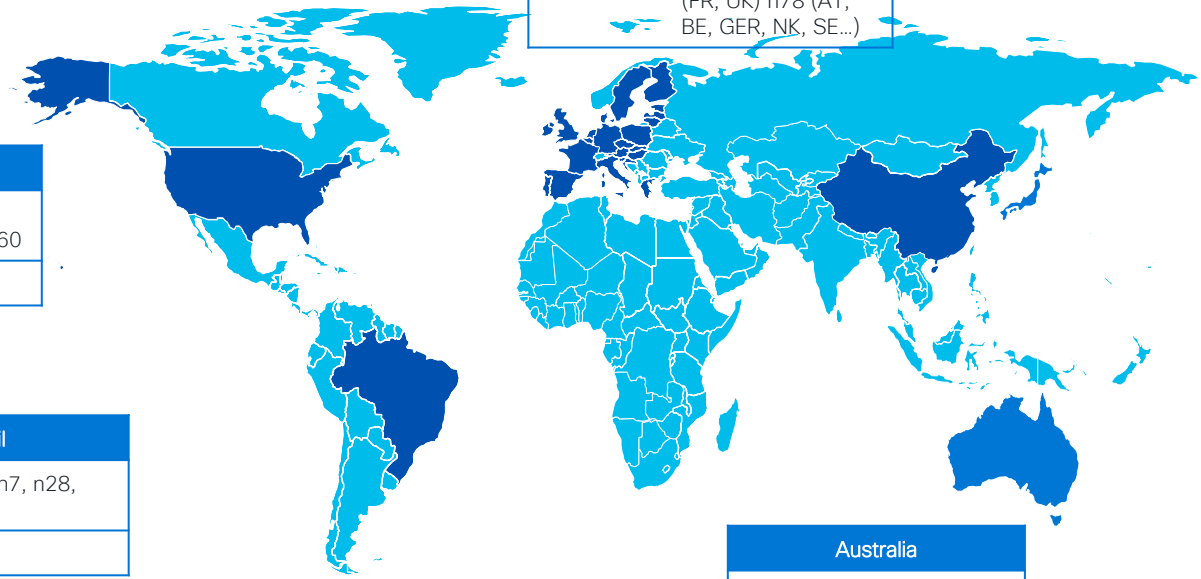
- Unlicensed: also known as ISM bands, generally free of charge, public, and private infrastructures, but regulated.
  - Different technologies may share the same frequency; co-existence definition in specifications
- Licensed: dedicated to SP (public services) or industries (private, critical infrastructures, i.e. U.S. Firstnet, Anterix, EU 450MHz…), paid license, allocated for several years.
  - Including “Locally Shared License” and “License-exempt Access” models.



GSMA https://www.gsma.com/spectrum/wp-content/uploads/2022/02/mid-band-5G-spectrum-benefits.p

5G Spectrum Landscape (non-exhaustive view)

Europe	
Public	n1, n3, n7, n28, n40, n78
Private	n38 (FR SP), n77 (FR, UK) n78 (AT, BE, GER, NK, SE…)



U.S.A.	
Public	n2, n5, n41, n66, n71, n260
Private	n48 (CBRS)

Japan	
Public	n77, n78, n79, n257
Private	n79, n257

China	
Public	n1, n41, n78, n79, *n258, n259, n260*
Private	

Brazil	
Public	n3, n7, n28, *n78*
Private	

Australia	
Public	n1, n3, n5, n40, n78, n258
Private	

Managing the Sunet of 2G and 3G services

- 2G and 3G services sunset around the world
  - Frequency bands reallocated to 5G services
  - Each technology gets its own sunset planning, dependent of the country and mobile carrier. For example:
    - U.S. 3G services shutdown by end of CY22.
    - In Europe,
      - Orange France – 2G will sunset by end of 2025.
      - Telefonica Germany - 3G sunset on December 2021.
      - Vodafone UK – 3G will sunset in 2023.

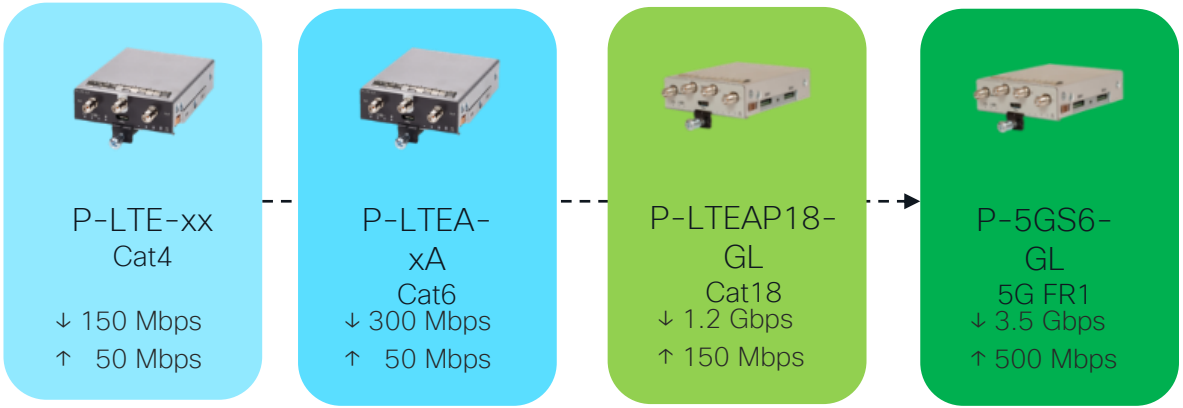
- For +10 years, all Cisco IOT routers support 4G/LTE, in addition of 2G and 3G
  - modularity is a key for easy evolution

- To prepare for 2G/3G sunset, review
  - SIM subscription -> must offer 4G services
  - Antennas -> must comply with 4G
  - Set "All-LTE-only" under "Controller Cellular x/y/z"

Cellular Modularity on Industrial IOT Routers

Specifications – Rel.8-10-13-14 | Rel.15-16 | Rel.17+ Evolution

Low Data Rate | **High Data Rate**



UE Category	3GPP release	Uplink/Downlink Data Rate (Mbs)
NB1	Rel. 13	HD: DL: 27kbs, UL: 62kbs
M1	Rel. 13	HD: DL: 300kbs, UL: 375kbs FD: DL/UL: 1
1	Rel. 8	DL: 10, UL: 5
3	Rel. 8	DL: 100, UL: 50
4	Rel. 8	DL: 150, UL: 50
6	Rel. 10	DL: 300, UL: 50
18	Rel. 14	DL: 1200, *UL: 150 (cat 13)*

Modularity = Future Proofing

LTE 450 MHz in Critical Infrastructures

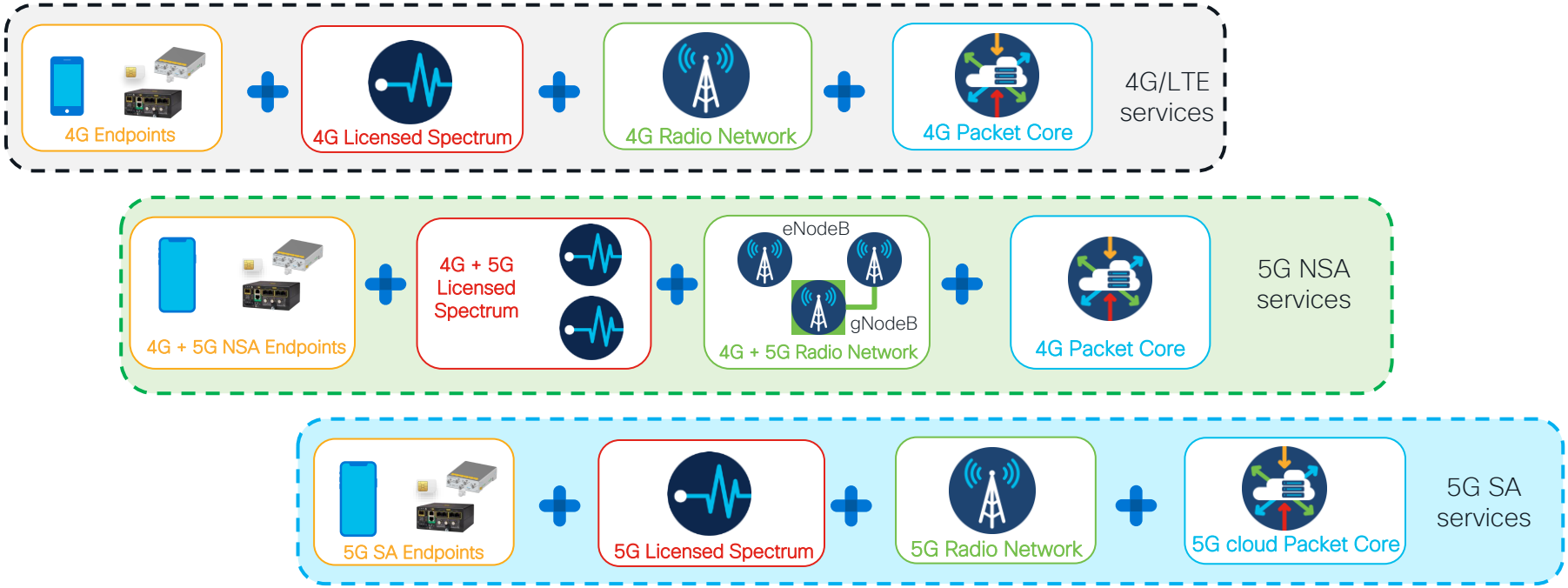
- New Sub-GHz band adoption enabling large coverage area and deep indoor penetration
  - Germany, Nordic, Poland…
- Promoted through LTE450 Alliance
  - https://450alliance.org/
- Low and medium-bandwidth traffic for SCADA & public safety use cases over dedicated infrastructure
- LTE 450 MHz characteristics – call for specific modem
  - Band 31: UL:452.5-457.5 DL:462.5- 467.5
  - Band 72: UL: 451-456 DL: 461-466
  - Channel bandwidth: 1.4 MHz, 3MHz and 5 MHz
- New LTE 450MHz cellular PIM on IR1101

Power Utilities
Distribution Automation/SCADA

Public Safety
Police Cars, Boats, Mobile Stations

Government
Coastal Radio Stations, Maritime Communication

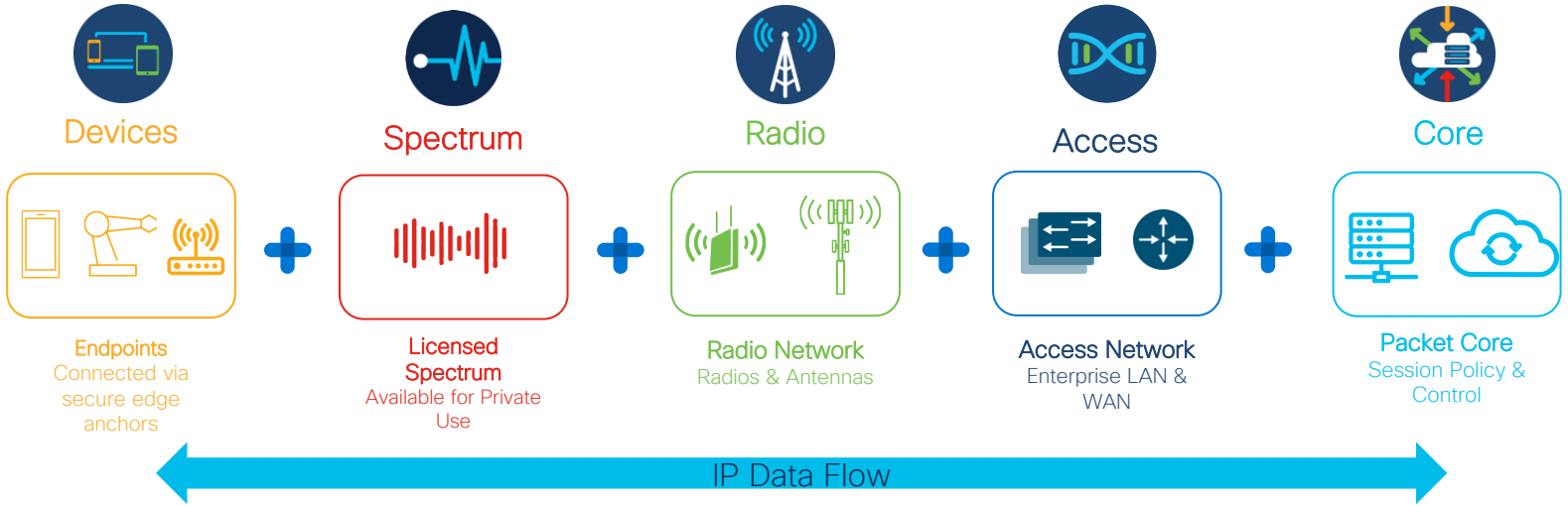
5G services adoption – 4G to 5G NSA to 5G SA



- 5G devices: 5G NSA or 5G SA ? refer to https://cacombos.com/
- Supported 5G bands for NSA may be different from SA on devices – modem and firmware dependent

What is Private 5G ?

A private network that is built using 3GPP 5G technology, dedicated to carrying traffic from a specific entity (e.g., an enterprise or public sector agency) in regulated radio spectrum



5G SA or 4G, unless deploying both 4G/5G RAN and spectrum

Cisco Catalyst Industrial Routers with 5G

Catalyst IR1101

Catalyst IR 1800

Catalyst IR8100

Catalyst IR8300

5G NR FR1	n1, n2, n3, n5, n7, n8, n12, n20, n25, n28, n38, n40, n41, n48, n66, n71, n77, n78, n79
4G LTE	B1-5, B7-8, B12-14, B20, B25-26, B28-30, B32, B34, B38-43, B46, B48, B66, B71
3G UMTS	B1, B2, B4, B5, B8, B9, B19 – *UMTS bands dependent from active firmware*

PIM, Sub-6GHz

Industrial Temp Range

CG522, Sub-6GHz

CG522-E, Commercial Temp Range

Utilities

Communities

Oil & Gas

Mining

Transportation

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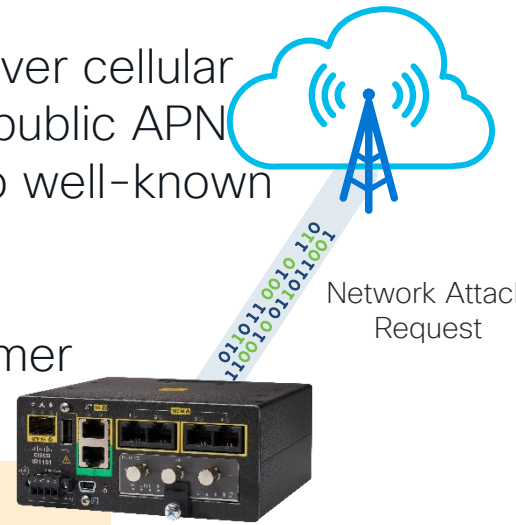
Cisco IR and IOS-XE Cellular configuration

Cellular APN

APN (Access Point Name)
5G SA DNN (Data Network Name)
- is a “Text value”, i.e. PRIVATE
- point of entry onto the IP services

- On Industrial IOT deployment, APN must be known before performing Day 0 provisioning (PnP process) over cellular
  - Cisco IOS-XE maintains a list of well-known public APN
- APN configuration is required when not attaching to well-known Public services, i.e.
  - APN defined by carrier for business services
  - Private APN – dedicated by SP to single customer
  - Private 4G or 5G infrastructure



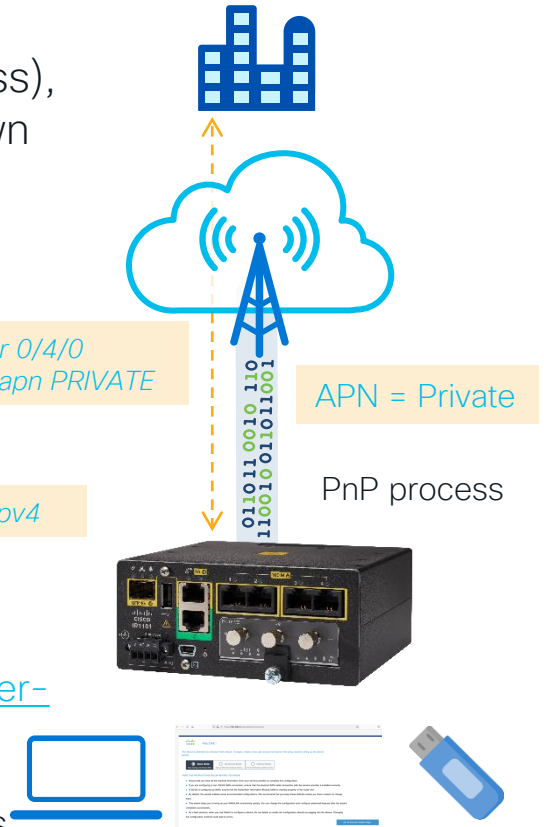
APN on Cellular PIM
- stored on the cellular modem per firmware's type
- Dual SIM – APN(s) per SIM
- Multi-PDN – one APN per PDN

Cellular APN configuration

- When performing Day 0 provisioning over Cellular (PnP process), APN is required to be configured when not using a “well-known public APN”.
- PnP process expects NO configuration on a router
  - Once set-up, APN is stored on the modem, IOS-XE configuration must be erased
- Configuration methods
  - IOS-XE CLI
    - Config command – IOS-XE 17.3.1 minimum
    - Exec command
  - IOS-XE WebUI Day 0 – IOS-XE 17.9.1 minimum
  - USB key – USB storage key can be prepared with minimum configuration that will be run by the PNP process to set-up the configuration. Refer: https://blogs.cisco.com/developer/dna-center-pnp-day-0
    - FAT-32 format, IOS-XE 17.3.1 (config. mode)
    - Text file named *ciscortr.cfg* to include the config commands

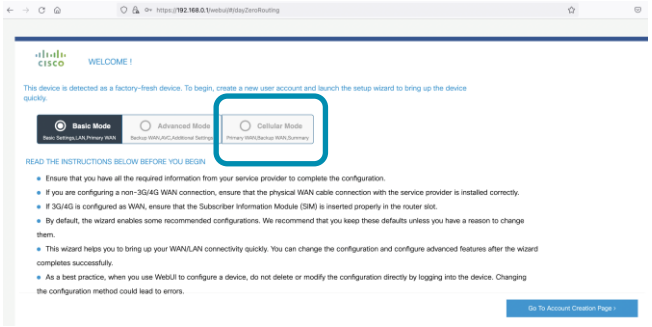
IR1800(config)# controller cellular 0/4/0
IR1800(config-ctrl)# lte profile 1 apn PRIVATE

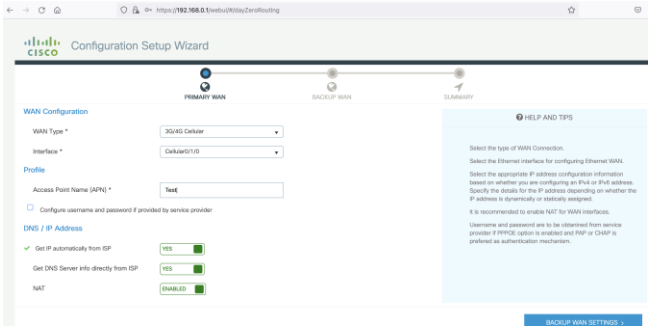
IR1831#cellular 0/4/0 lte profile create 1 PRIVATE none ipv4



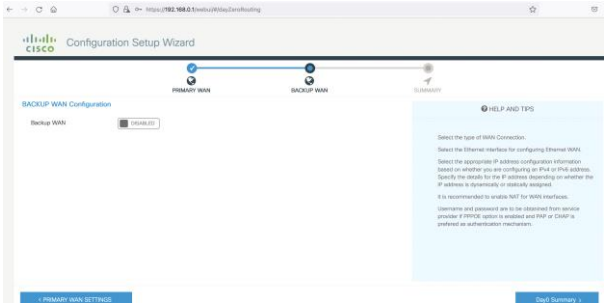
New
17.9.1

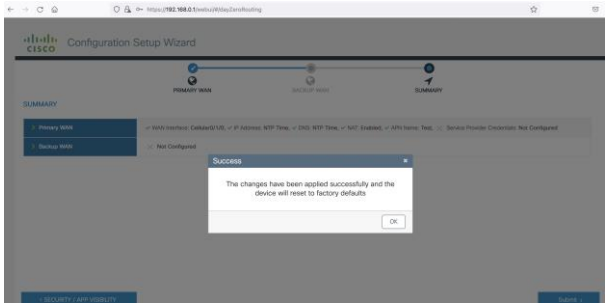
Cisco IOS-XE WebUI Day 0 Cellular Mode





New mode to configure cellular APN.
APN value is stored in the modem.
Once the unit reboots, it reset to factory-default, enabling the router to perform PnP over Cellular when private APN is used.





Cellular Interface initialization flow

- HW modem ready

- SIM ready
  - *Unlocked*
  - *Dual-SIM*

- Firmware activated
  - *Auto-SIM*

```
IR1831#show cellular 0/4/0 hardware
Modem Firmware Version = M0H.030200-B016
Host Firmware Version = A0H.000300-B016
Device Model ID =  FN980
International Mobile Subscriber Identity (IMSI) = 208150025885201
International Mobile Equipment Identity (IMEI) = 359661100043005
Integrated Circuit Card ID (ICCID) = 8933150020040155210
Mobile Subscriber Integrated Services
Digital Network-Number (MSISDN) = +33612345678
Modem Status = Modem Online
Current Modem Temperature = 32 deg C
PRI version = 0910-111, Carrier = Generic GCF
OEM PRI version = 0910-111
```

```
IR1831#show cellular 0/4/0 security
Active SIM = 0 ! SIM in slot #0
SIM switchover attempts = 0
Card Holder Verification (CHV1) = Disabled
SIM Status = OK
SIM User Operation Required = None
Number of CHV1 Retries remaining = 3
```

```
IR1831#show cellular 0/4/0 firmware
 Idx Carrier              FwVersion        PriVersion    Status
 1   Generic GCF          M0H.030200-B016  0910          Active
Firmware Activation mode  =  AUTO
Modem image running: Main
Mobile Network Operator: Generic GCF
Number of MNO's = 14
 Index MNO ID  MNO NAME
 1     0       Generic GCF
 2     1       Generic PTCRB
```

Cellular Interface initialization flow

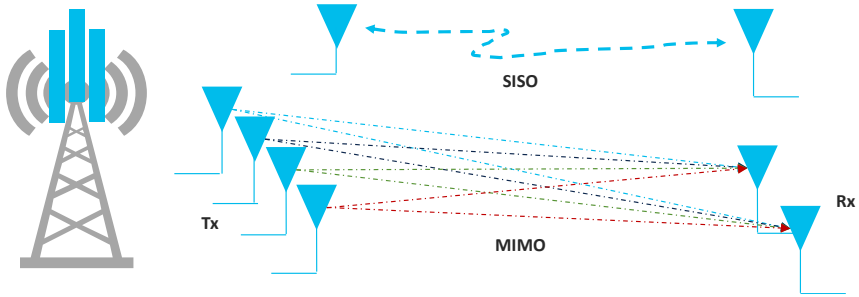
- **Network Attached**
  - *Profile is properly defined with APN*
  - *PLMN search/select*
- **Radio signal**
  - *Antennas*
  - *Signal strength*
  - *Bands filtering, i.e. 2G/3G sunset, P5G*
- **Profile activated**

```
IR1831#show cellular 0/4/0 profile
Profile 1 = ACTIVE* **
--------
PDP Type = IPv4
PDP address = 10.92.123.234
IPv4 PDP Connection is successful
Access Point Name (APN) = free
Authentication = None
        Primary DNS address = 212.27.40.240
        Secondary DNS address = 212.27.40.241
IR1831#show cellular 0/4/0 connection
Profile 1, Packet Session Status = ACTIVE
        Cellular0/4/0:
        Data Packets Transmitted = 497 ,  Received = 383
        Data Transmitted = 274800 bytes, Received = 67854 bytes
        IP address = 10.62.177.14
        Primary DNS address = 212.27.40.240
        Secondary DNS address = 212.27.40.241
```

```
IR1831#show cellular 0/4/0 network
Current System Time = Sun Jan 6 1:9:31 1980
Current Service Status = Normal
Current Service = Packet switched
Current Roaming Status = Home
Network Selection Mode = Automatic
Network = Free
Mobile Country Code (MCC) = 208
Mobile Network Code (MNC) = 15
Packet switch domain(PS) state = Attached
Registration state(EMM) = Registered
EMM Sub State = Normal Service
Tracking Area Code (TAC) = 9218
Cell ID = 102875473
Negotiated network MTU = 1416
```

```
IR1831#show cellular 0/4/0 radio
Radio power mode = Online
LTE Rx Channel Number(PCC) =  1675
LTE Tx Channel Number(PCC) =  19675
LTE Band =  3
LTE Bandwidth = 15 MHz
Current RSSI = -78 dBm
Current RSRP = -106 dBm
Current RSRQ = -11 dB
Current SNR = 5.2  dB
Physical Cell Id = 96
Number of nearby cells = 3
Idx      PCI (Physical Cell Id)
---------------------------------
1              96
2              97
3              447
Radio Access Technology(RAT) Preference = AUTO
Radio Access Technology(RAT) Selected = LTE
Network Change Event = activated 5G ENDC
```

Antennas and Radio Signal Quality !



Antenna diversity – 3G/LTE

- SP base station transmits (downlink) on 4 antennas from the cell tower
- Cisco IR series receive on 2 antennas, hence 4 x 2 MIMO,

(or 2 x 2 MIMO if the service provider uses older infrastructure)

Band	Receive				Transmit	
	Primary	Diversity			Primary	Secondary
	MIMO 1	MIMO 2	MIMO 3	MIMO 4	MIMO 1	MIMO2
N1	ANT0	ANT1	ANT2	ANT3	ANT0	ANT2
N2	ANT0	ANT1	ANT2	ANT3	ANT0	ANT2
N3	ANT0	ANT1	ANT2	ANT3	ANT0	ANT2
N5	ANT0	ANT1	N/A	N/A	ANT0	ANT1
N7	ANT0	ANT1	ANT2	ANT3	ANT0	ANT2
N8	ANT0	ANT1	N/A	N/A	ANT0	N/A
N12	ANT0	ANT1	N/A	N/A	ANT0	N/A
N20	ANT0	ANT1	N/A	N/A	ANT0	N/A
N25	ANT2	ANT3	N/A	N/A	ANT2	N/A
N28	ANT0	ANT1	N/A	N/A	ANT0	N/A
N38	ANT0	ANT1	ANT2	ANT3	ANT0	N/A
N40	ANT0	ANT1	ANT2	ANT3	ANT0	N/A
N41	ANT0	ANT1	ANT2	ANT3	ANT0	N/A
N48	ANT1	ANT0	ANT3	ANT2	ANT1	N/A
N66	ANT0	ANT1	ANT2	ANT3	ANT0	ANT2
N71	ANT0	ANT1	N/A	N/A	ANT0	N/A
N77	ANT1	ANT0	ANT3	ANT2	ANT0	ANT2
N78	ANT1	ANT0	ANT3	ANT2	ANT0	ANT2
N79	ANT1	ANT0	ANT3	ANT2	ANT0	ANT2

Antennas on LTEAP and 5G

- Bands split across antennas
- New antennas supporting high bands

Antenna Guide https://www.cisco.com/c/en/us/td/docs/routers/connectedgrid/antennas/installing-combined/b-cisco-industrial-routers-and-industrial-wireless-access-points-antenna-guide.html

Cellular Interface – Basic IP configuration

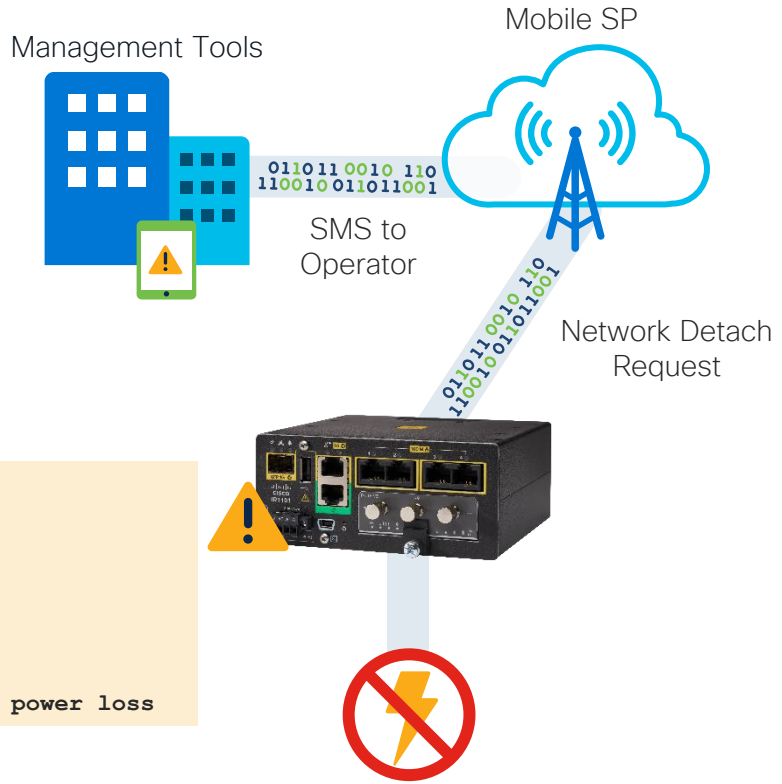
- Cellular interface up
  - *IPv4 and/or IPv6 addresses*
  - *On-demand vs Always-on*
  - *Default route*
  - *NAT rules*

```
IR1831#show ip interface cellular 0/4/0
Cellular0/4/0 is up, line protocol is up
  Internet address is 10.92.123.234
  Broadcast address is 255.255.255.255
  Address determined by IPCP
…
```

```
IR1831#show run
…
interface Cellular0/4/0
 ip address negotiated
 ip nat outside
 ip tcp adjust-mss 1460
 dialer in-band
 dialer idle-timeout 0
 dialer watch-group 1
 dialer-group 1
 ipv6 enable
 pulse-time 1

ip nat inside source list natout interface Cellular0/4/0 overload
ip route 0.0.0.0 0.0.0.0 Cellular0/4/0
ipv6 route ::/0 Cellular0/4/0

ip access-list standard natout
 10 permit any

dialer watch-list 1 ip 4.2.2.2 255.255.255.255
dialer watch-list 1 ip 8.8.8.8 255.255.255.255
dialer watch-list 1 delay route-check initial 60
dialer-list 1 protocol ip permit
!
IR1831#ping 8.8.8.8
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 8.8.8.8, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/72/200 ms
IR1831#
```

Dying Gasp – Operational Efficiency

- On Cisco Catalyst Industrial Routers, dying gasp is supported on
  - P-LTEA-EA
  - P-LTEA-LA
  - P-LTEAP18-GL
  - P-5GS6-GL
- When/If a power outage occurs, SMS can be sent to indicate the outage.




```
IR1101#Conf t
Enter configuration commands, one per line.  End with CNTL/Z.

IR1101(config)#controller cellular 0/1/0
IR1101(config-controller)#lte dyinggasp ?
  detach   Send Detach Request
  sms      SMS Commands
IR1101(config-controller)# lte dyinggasp detach enable
IR1101(config-controller)# lte dyinggasp sms send 1408525111111 IR1101 power loss
```

Cellular modem firmware upgrade

Cellular Interface Modules

								
P-LTE-GB Cat4 ↓ 150 Mbps ↑ 50 Mbps	P-LTE-US Cat4 ↓ 150 Mbps ↑ 50 Mbps	P-LTE-VZ Cat4 ↓ 150 Mbps ↑ 50 Mbps	P-LTE-MNA Cat4 ↓ 150 Mbps ↑ 50 Mbps	P-LTE-IN Cat4 ↓ 150 Mbps ↑ 50 Mbps	P-LTE-JN Cat4 ↓ 150 Mbps ↑ 50 Mbps	P-LTEA-EA P-LTEA-LA Cat6 ↓ 300 Mbps ↑ 50 Mbps	P-LTEAP18-GL Cat18 ↓ 1.2 Gbps ↑ 150 Mbps	P-5GS6-GL 5G Sub-6GHz ↓ 3.5 Gbps ↑ 500 Mbps

- Cellular modem firmware is modem dependent – firmware image is available from Cisco.com
  - Not part of Cisco IOS-XE upgrade
  - Modem may have different files (OEM and PRI), and carrier files (Global, AT&T, Verizon)
- Steps to upgrade cellular modem firmware
  - Copy each modem firmware file in a dedicated bootflash:[directory] – single file per directory
  - Upgrade the modem firmware – one by one, waiting for modem to come back online

Reference: https://www.cisco.com/c/dam/en/us/td/docs/routers/access/interfaces/firmware/Cisco-Firmware-Upgrade-Guide-for-4G-LTE-and-5G-Cellular-Modems.pdf

eSIM/eUICC overview & operations

SIM format on Cisco Cellular PIM

- SIM = Subscriber Identity Module or Subscriber Identification Module
  - Also known as UICC (universal integrated circuit card) – Traditionally associated with a single carrier network
  - Secure storage for ICCID (integrated circuit card identifier), IMSI (international mobile subscriber identity), MSISDN (phone number) and related keys and others (i.e. Service Provider name, SMS center, contacts…)
  - Allows the identification and authentication of subscribers
  - Initially defined by ETSI, now standardized under 3GPP
  - Today, none of Cisco IOT router's cellular interface has an embedded e-SIM

Full size SIM (1FF)
85.6 × 53.98 × 0.76 (mm)
Released: 1991

Standard / Mini-SIM (2FF)
25 × 15 × 0.76 (mm)
Released: 1996

Cellular PIM format

Micro-SIM (3FF)
15 x 12 × 0.76 (mm)
Released: 2003

Nano-SIM (4FF)
12.3 × 8.8 × 0.67 (mm)
Released: 2012

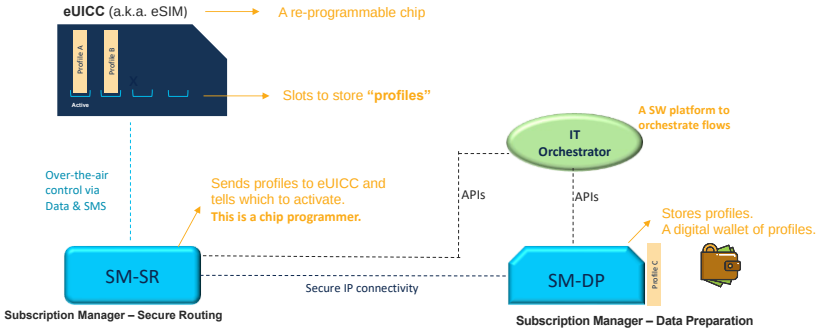
e-SIM
6 × 5 × (<0.65) (mm)
Released: 2016

i-SIM

Embedded on SoC/Modem

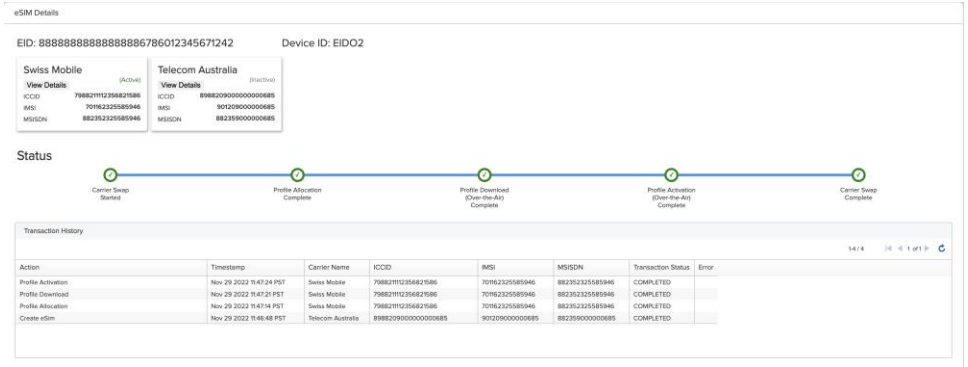
eUICC

- eUICC = Embedded Universal Integrated Circuit Card
  - eUICC (SW) is often associated to eSIM (HW), but eUICC can run on any SIM form factor
  - eUICC is the software component that runs on a UICC and provides the capability to store multiple network profiles that can be provisioned and managed over-the-air (OTA)
- The number of profiles that can be stored on an eUICC is limited only by the memory available in the SIM and the size of each operator's profile.
- eUICC is supported on modem from recent cellular PIMs HW, i.e. P-LTEA-xA, P-LTEAP18-GL and P-5GS6-GL, but Cisco IOS-XE support (monitoring) is a future deliverable



eUICC in Operations

- Day 0 – Zero Touch Deployment
  - Consumer devices (user action) vs IOT (Machine-to-Machine) devices (automation)
- Cisco eSIM Flex (BRKSPM-2672)
- Day 2 – switching device to a different mobile carriers during the lifetime of the device
  - Centralized remote management, i.e. Cisco eSIM Flex
    - Different from Multi-IMSI SIMs storage, as new profile must be loaded OTA
  - SP A subscription must still be active when loading SP B profile
  - Then, IP configuration (routing, ACL, QoS, VPN…) may need to be validated, making sure they are appropriate to the new carrier.



- SIM programmed with source operator credentials (IMSI_1, ICCID_1 and MSISDN_1). Connection to Cisco Control Center reporting info on Control Center portal
- APN(profile) change pushed from CC with target operator credentials (IMSI_2, ICCID_2 and MSISDN_2). Successful push and the SIM card is re-programmed
- On being reprogrammed, data session is reset (reflected as an interface reset) and the connection is re-established (cellular interface being up again).
- Modem check for target operator data session up

Network Design considerations

Industry and use-case driven technology selection criteria


MFG


Transportation


Mining


Utilities


Roadways

Customer Use Case:
AGV/AMR, Train to Trackside, Connected roadways Autonomous mining, Remote operations, AR/VR, ….

1 **What are the devices to connect?**

Devices

Local and global Eco-system

Handhelds, AGV/AMR, Dozer, Cranes, Rail

2 **What are the applications requirements?**

Resiliency

Latency, Reliability, Scalability, Ease of operations, throughput…

3 **Deployment Scenarios?**

Deployment

Regional regulations: spectrum ?
Specify Environment: Indoor / Outdoor
Access / backhaul
Cyber-security

4 **What are the potential technology options?**

Technology

Wired: Ethernet, serial,DSL
Wireless: Wi-Fi & Ultra-Reliable Wireless Backhaul, Cellular, Wi-SUN, LoRaWAN,…
Spectrum:
Unlicensed, Licensed: Private, Public, Shared

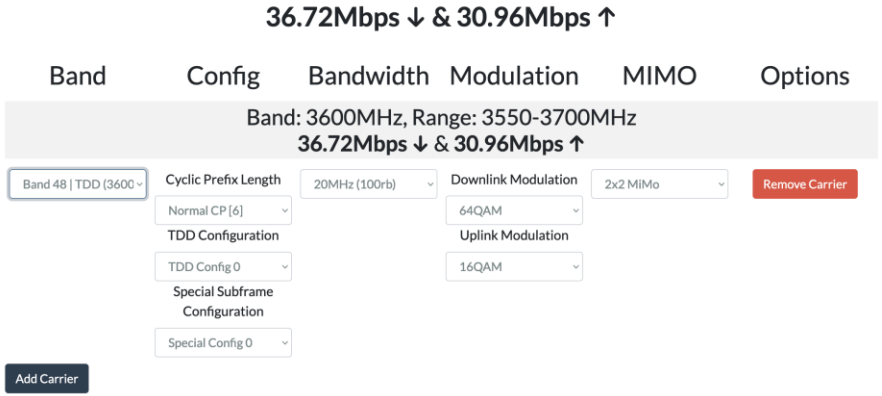
5 **What are the CapEx and OpEx Implication?**

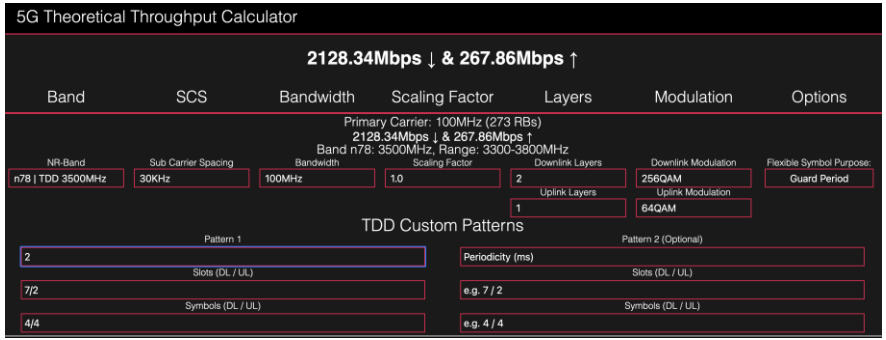
TCO

Product costs?
Operational costs?
Complexity?
Training?
Backward compatibility?

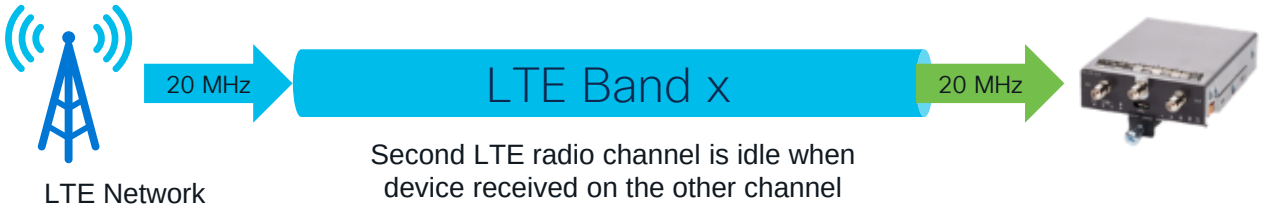
Evaluating Cellular Throughput Capacity

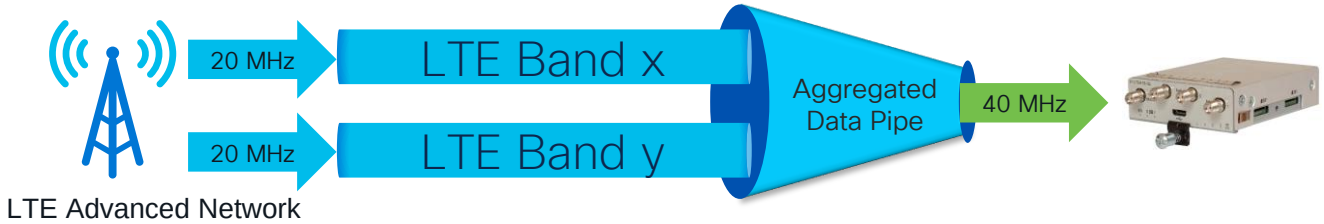
- Throughput capacity is dependent from several characteristics
  - FDD vs TDD
  - band, configuration, channel bandwidth, modulation, MiMo, options…
- Public cellular capacity is mostly asymmetric
  - Downstream greater than upstream

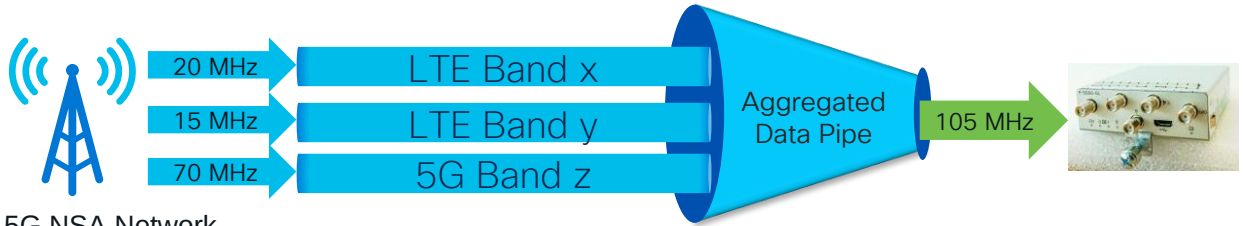




Increased Cellular Throughput with Carrier Aggregation







Modules	LTE Version	Carrier Aggregation
P-LTE-US	LTE	-
P-LTE-VZ	LTE	-
P-LTE-GB	LTE	-
P-LTE-MNA	LTE	-
P-LTE-EA	LTE Advanced	✓
P-LTE-LA	LTE Advanced	✓
P-LTEAP18-GL	LTE Advanced Pro	✓
P-5GS6-GL	LTE Advanced Pro And 5G NSA	✓

Example of Carrier Aggregation on 5G NSA service

```
IR1101#show cell 0/1/0 radio detail
 Modem Radio is Online
 Main 0 Antenna details:
 RSSI = -55 dBm
 RSRP = 83 dBm
 Diversity 0 Antenna details:
 RSSI = -61 dBm
 RSRP = 89 dBm

 SCC information available
 SCC[0]:
 PCI = 48
 State = Deactivated
 Band = 7
 Rx Channel Number = 3000
 Bandwidth = 20 MHz

SCC[1]:
 PCI = 48
 State = Deactivated
 Band = 3
 Rx Channel Number = 1300
 Bandwidth = 20 MHz

SCC[2]:
 PCI = 48
 State = Deactivated
 Band = 1
 Rx Channel Number = 524
 Bandwidth = 15 MHz
 SCC[3]: Not Available
```

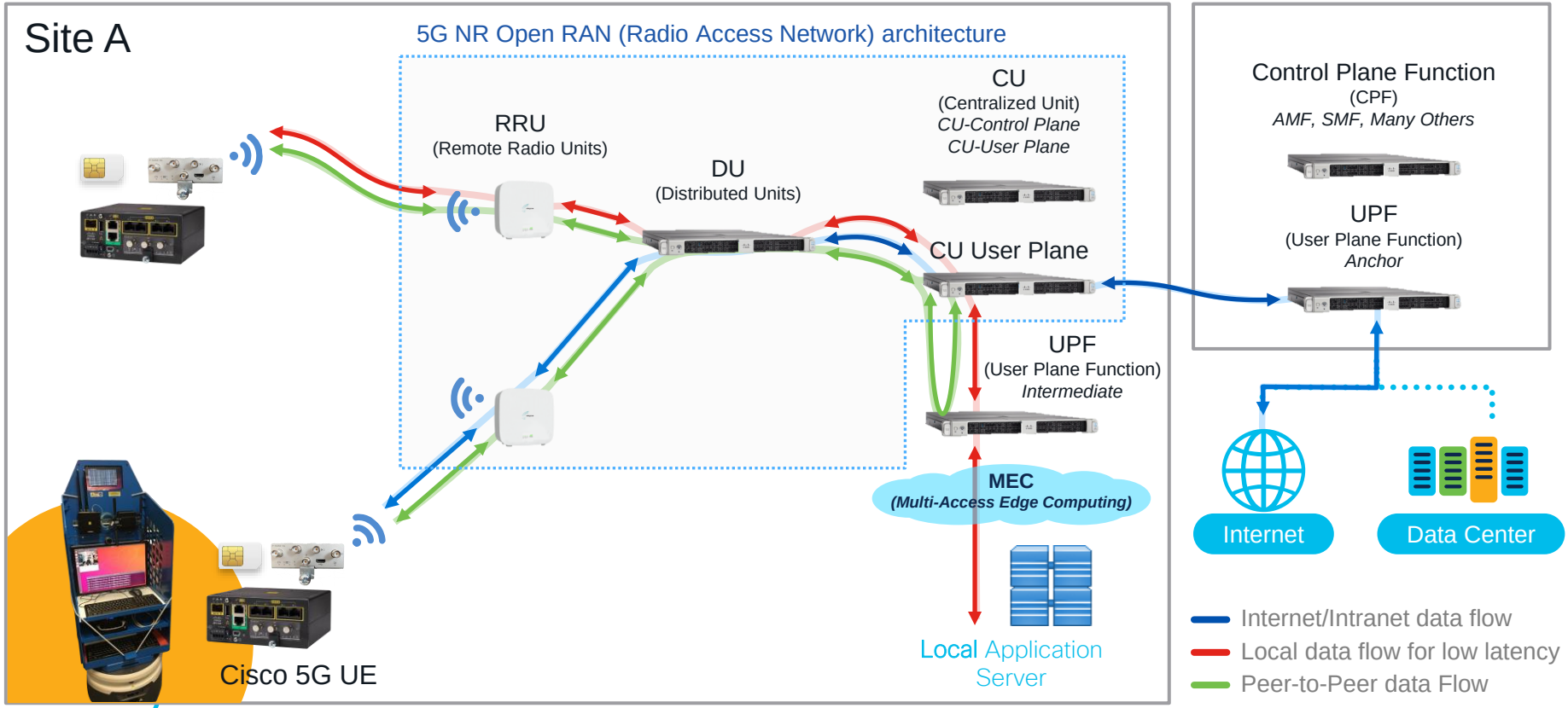
```
 PCC CA information:
 LTE band class = Band 28
 E-UTRA absolute radio frequency channel number of the serving cell = 9310
 Bandwidth = 10 MHz
 Physical Cell Id = 48
 Current RSRP in 1/10 dBm as measured by L1 = -84
 Current RSSI in 1/10 dBm as measured by L1 = -56
 Current RSRQ in 1/10 dBm as measured by L1 = -11
 Measured SINR in dB = 171
 Tracking area code information for LTE = 50443

SCC 0 CA information:
 LTE band class = Band 7
 E-UTRA absolute radio frequency channel number of the serving cell = 3000
 Bandwidth = 20 MHz
 Physical Cell Id = 48
 Current RSRP in 1/10 dBm as measured by L1 = -112
 Current RSSI in 1/10 dBm as measured by L1 = -91
 Current RSRQ in 1/10 dBm as measured by L1 = -3
 Measured SINR in dB = 0
 Current SCC state = Configured
```

```
5G CC information:
ENDC active band = 78
ENDC Bandwidth (MHz) = 90
ENDC active downlink channel = 650400
ENDC active uplink channel = 650400
ENDC Physical Cell Id = 99
Current ENDC RSRP in 1/10 dBm as measured by L1 = -111
Current ENDC RSSI in 1/10 dBm as measured by L1 = -100
Current ENDC RSRQ in 1/10 dBm as measured by L1 = -11
Measured ENDC SINR in dB = 85
```

```
SCC 1 CA information:
LTE band class = Band 3
E-UTRA absolute radio frequency channel number of the serving cell = 1300
Bandwidth = 20 MHz
Physical Cell Id = 48
Current RSRP in 1/10 dBm as measured by L1 = -98
Current RSSI in 1/10 dBm as measured by L1 = -77
Current RSRQ in 1/10 dBm as measured by L1 = -3
Measured SINR in dB = 0
Current SCC state = Configured

SCC 2 CA information:
LTE band class = Band 1
E-UTRA absolute radio frequency channel number of the serving cell = 524
Bandwidth = 15 MHz
Physical Cell Id = 48
Current RSRP in 1/10 dBm as measured by L1 = -103
Current RSSI in 1/10 dBm as measured by L1 = -81
Current RSRQ in 1/10 dBm as measured by L1 = -3
Measured SINR in dB = 0
Current SCC state = Configured
```

End-to-End IP Latency – 5G NR Example

End-to-End IP Latency = Devices + Radio network + User/Control plane + Core network + Internet/Intranet routing



To learn more on Network design considerations related to VPN and dual-cellular, please refer to previous
Cisco Live Lab LTRIOT-2570

Key Takeways

- Cellular is one of Multi-Access Wireless IOT, enabling digital transformation in Industrial IOT
  - Start from the problem use cases to solve, not force-fit technology
- Several generation of Cellular technology must be managed in Industrial IOT use cases
  - Be ready for Sunset of 2G and 3G
  - Benefit from new LTE Advanced Pro and 5G services – public/private
- Network design is done for end-to-end IP data flow
  - Understanding cellular technology is key for optimized operations
  - TCO matters

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IoT

Transform and Secure your IOT Infrastructure

In this new IoT world, the network is the nervous system that allows everything to work together. And while it's creating limitless possibilities, it also introduced more complexity. Today everything is a connected device, from a robot to a power transformer, from a vehicle to crane.

In these industrial IoT environments, the scale and associated attack surface increase exponentially. Also the extreme requirements for performance, availability and visibility raise the need to transform the way of thinking and designing these complex IoT networks, especially when agility and ease of use are a must. Secure network automation and orchestration lead the way and secure network transformation is the core platform for line of business innovation and resilience.

START

Feb 7 | 08:30

BRKIOT-2774

How Cisco addresses Reliability within Industrial Wireless Networks thanks to the Cisco's IoT Wireless Products

Feb 8 | 08:45

BRKIOT-2601

Deploying Indoor Wireless Mobility for Industry with Cisco Industrial Wireless

Feb 8 | 10:30

BRKIOT-2585

Deployment of Cisco Catalyst Industrial Routers in Public and Private Cellular infrastructures

Feb 9 | 10:30

BRKIOT-2356

Cisco Solutions for Mission-Critical Mobile Infrastructure in Industrial IOT Environments

Feb 9 | 13:45

BRKIOT-2875

Industrial Redundancy: PRP and HSR Best Practices

Feb 10 | 11:15

FINISH

BRKIOT-2882

Implementing Segmentation in Industrial Networks

If you are unable to attend a live session, you can watch it On Demand after the event.

IoT

Reimagine your IOT Applications and Use Cases

Applications are how services are delivered and consumed, including IoT network and security services. Also, the focus for line of business teams in Industrial companies is to achieve specific business outcomes and not to just acquire technology. We will demonstrate that Cisco IoT technology is that bridge between line of business needs/ requirements and the desired business outcomes for multiple Industries.

In these sessions we will learn how Cisco IoT technology and applications can impact operations and line of business inside industrial companies, improving business resilience, operational performance and efficiency, or introducing new services and revenue sources.

START

Feb 7 | 15:30
BRKIOT-1203
Connecting and Securing Renewable Energy - Enabling Green Technologies with Cisco IoT

Feb 7 | 16:45
BRKIOT-2720
Connected Factory Architecture

Feb 8 | 14:30
BRKIOT-2366
Simplified IT and Operations workflows for ruggedized outdoor industrial networks with IoT Operations Dashboard

Feb 8 | 16:30
BRKIOT-2015
The New Digital Substation - more efficient, more secure and ready for demanding modern Grid applications

Feb 9 | 08:30
BRKIOT-2544
Future-ready Shopfloor Architecture and How You Can Get to It – Step by Step

FINISH

Feb 9 | 12:00
BRKIOT-2354
Managing and Accessing Remote IoT Equipment with Cloud Management

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Additional resources

Papers

- Testing Wi-Fi 6, private LTE, and soon, 5G – with the help of robots
- For your industrial IoT deployment: A four-step guide to selecting a wireless
- How 5G/Wi-Fi 6 will transform multi-access networks in industrial IoT
- What-does-5g-look-like-for-industrial-iot

Manuals

- Cellular PIM configuration guide
- Antenna guide

Alliances

- LTE 450 https://450alliance.org/
- CBRS https://www.cbrsalliance.org/
- 5G EU observatory https://5gobservatory.eu/


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