

Private Wireless Networks: A Global "State of the Union" on CBRS and Unlicensed Cellular

Actility webinar:
**Private Wireless Networks:
A Global "State of the Union" on
CBRS and Unlicensed Cellular**

June 30th, 2023 17:00 CET
(11AM ET New York)



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AGENDA

ENTERPRISE WIRELESS & LPWAN UPDATE – Olivier HERSENT

CBRS OVERVIEW – Tom WHEELER

- The regulatory framework
- The technology
- CBRS Spectrum Allocations (US)

NTIA CBRS Study – Douglas BOULWARE

SHARED ACCESS – SPECTRUM FOR PRIVATE NETWORKS (OFCOM) – Jack HINDLEY/Paul CHAPMAN

ENTERPRISE PRIVATE CELLULAR APPLICATIONS – Daniel QUANT

THE NEED FOR MULTI-TECHNOLOGY IOT PLATFORM – Rohit GUPTA

- CBRS Demo Kit: CBRS as a backhaul for LoRaWAN Gateways

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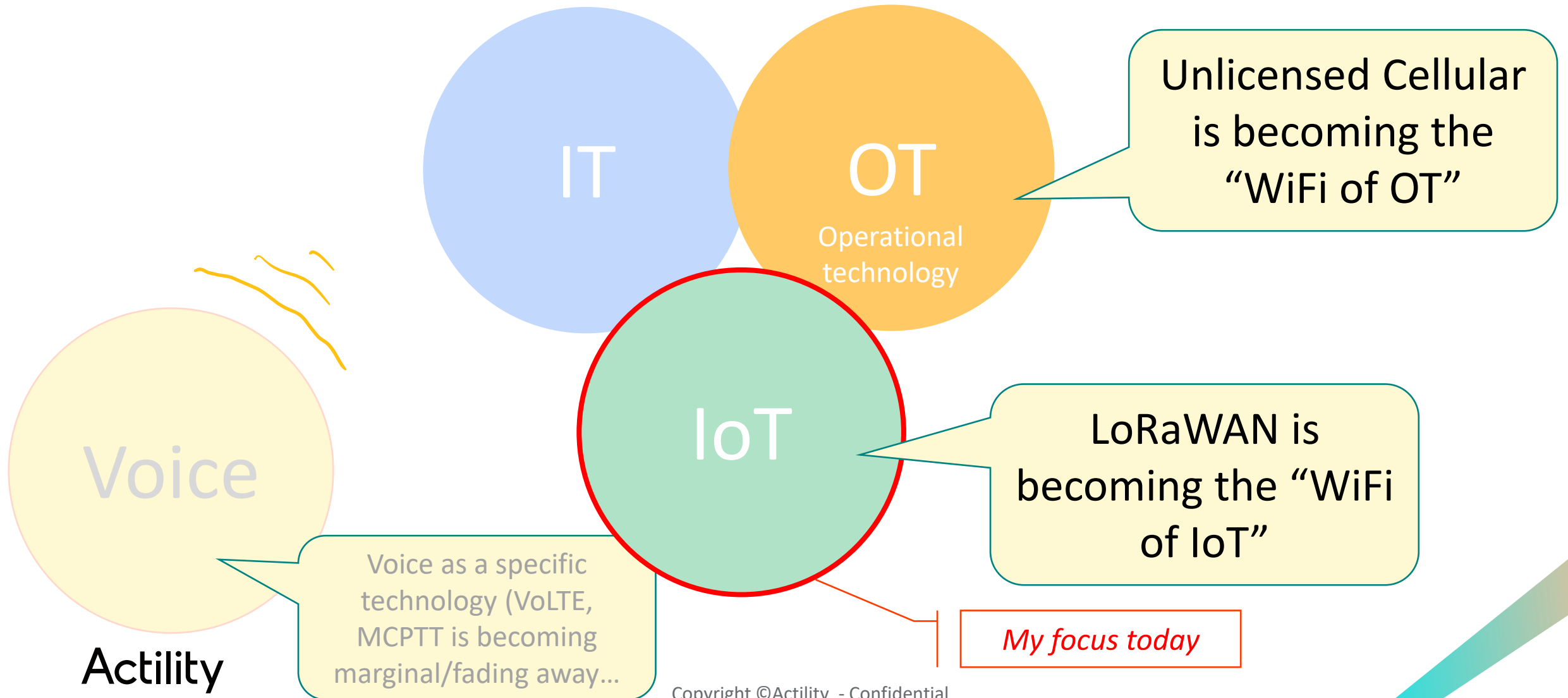


Enterprise Wireless & LPWAN update

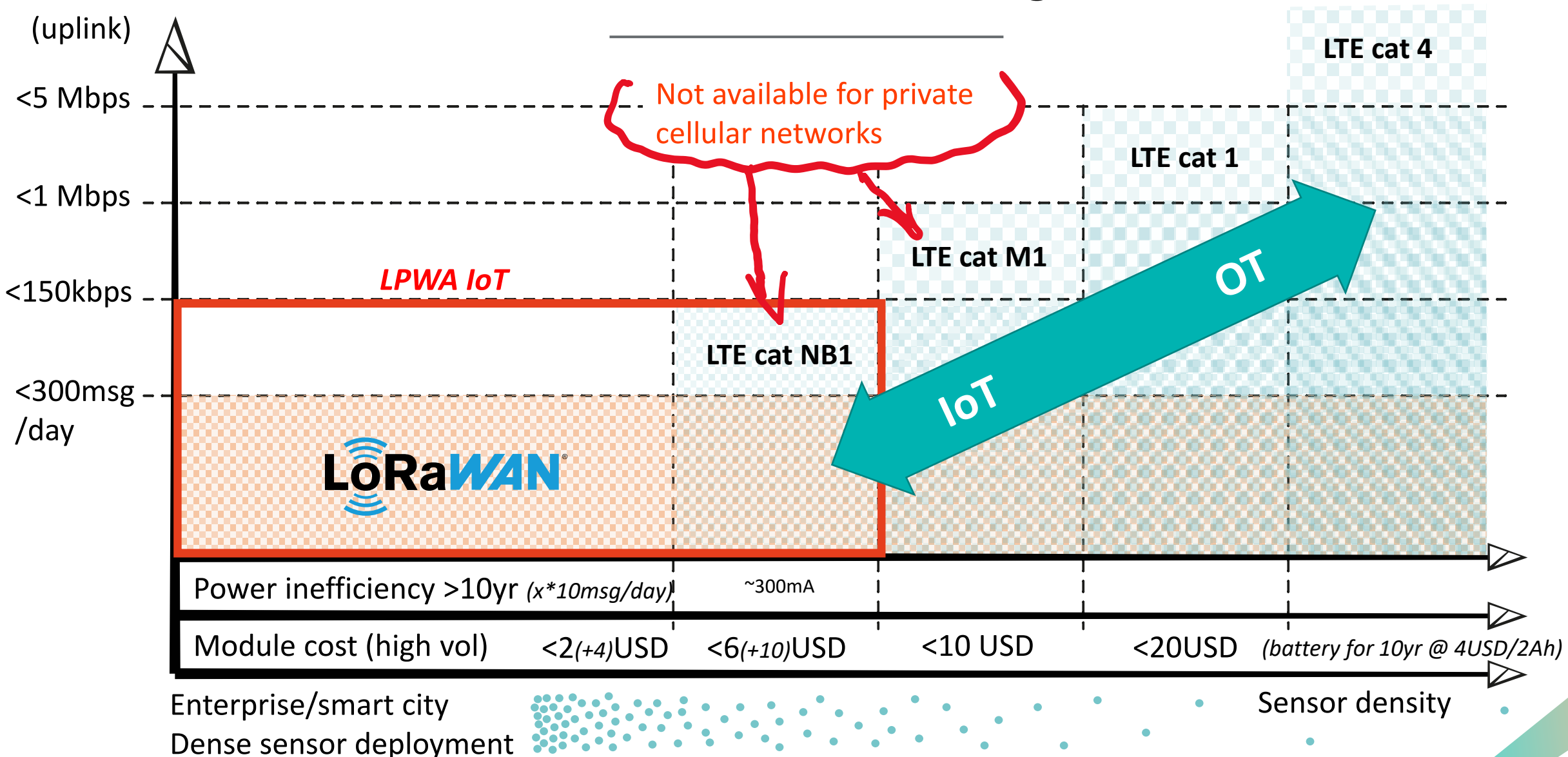
Enterprise Wireless is no longer just WiFi

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Enterprise Wireless: Meet The Newcomers...



Wireless IoT Technologies

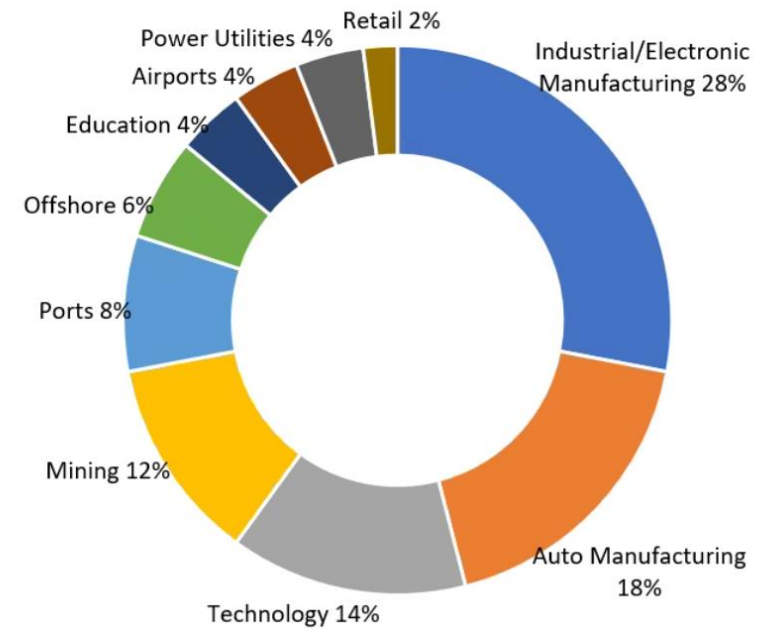
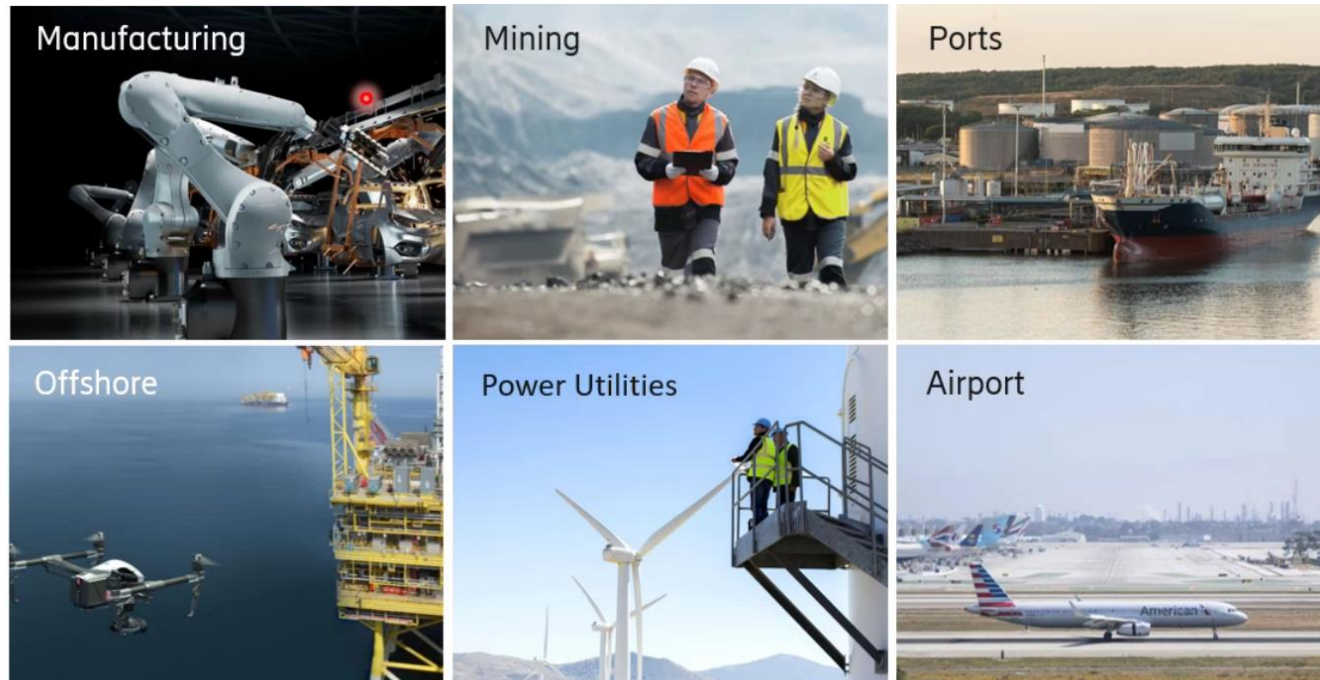




LPWAN market projections

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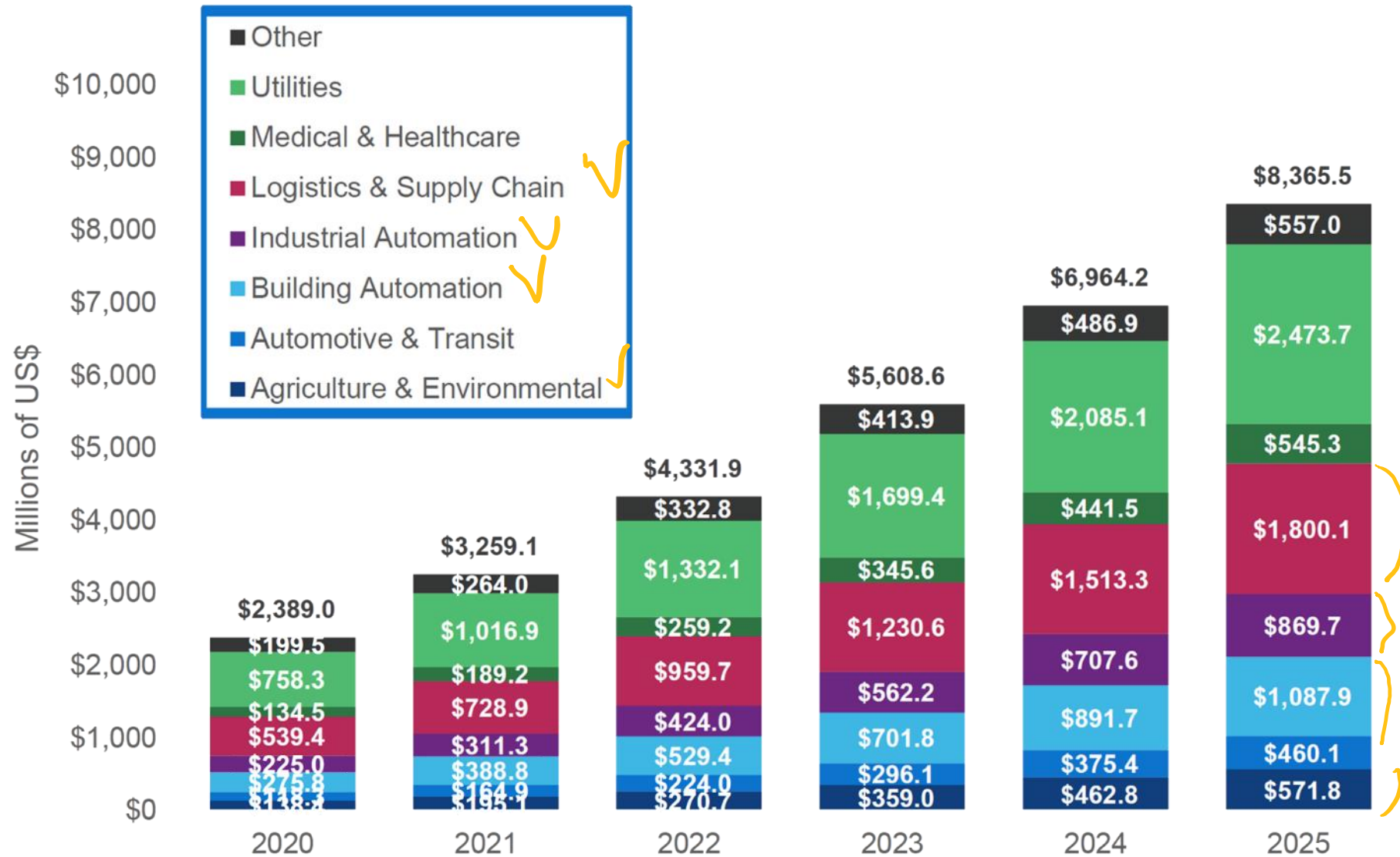
OT: Private Cellular Adoption by Industry



Source : Ericsson

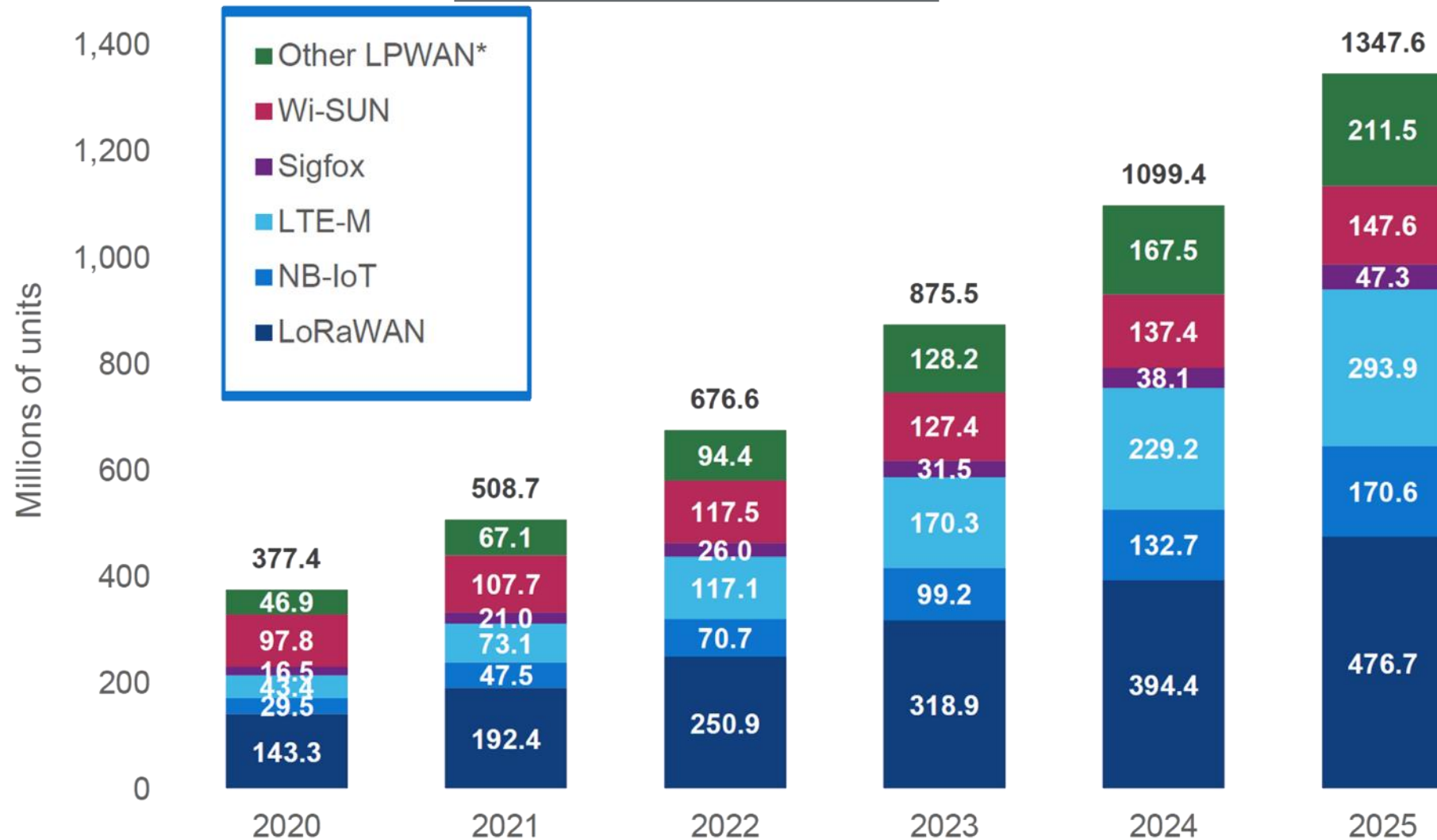
IoT: LPWAN Communication Services Revenue, per Vertical Market

Source: VDC Research, The Global Market for LPWAN, 2022



IoT : LPWAN Active Installed Base Excluding China, By Technology

Source: VDC Research, The Global Market for LPWAN, 2022



*Includes non-LoRaWAN LoRa

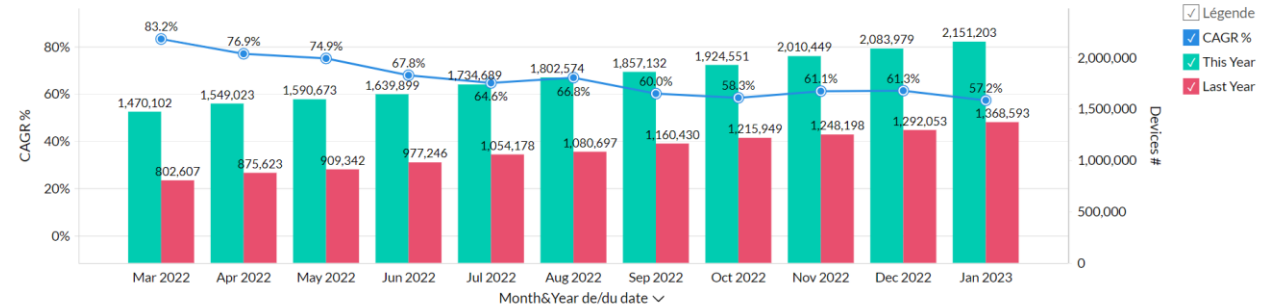
Our own numbers for IoT growth

- CAGR Devices : >50% YoY
- CAGR LoRaWAN GWs : >80% YoY

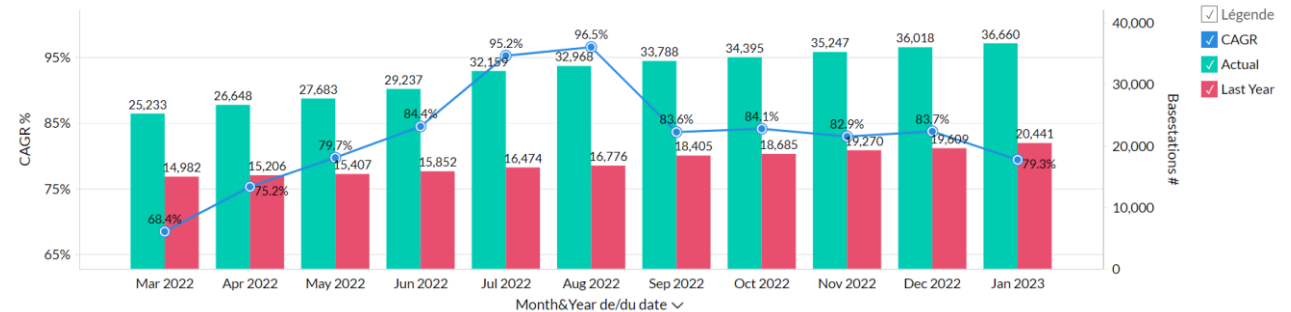
Driven by densification of public networks and private networks

- Private IoT networks are growing faster than public networks
 - Key drivers for private networks: Indoor-outdoor geolocation, indoor air quality, private metering, building automation
 - Key drivers for public networks: Water & gas metering, Smart Lighting, Geolocation

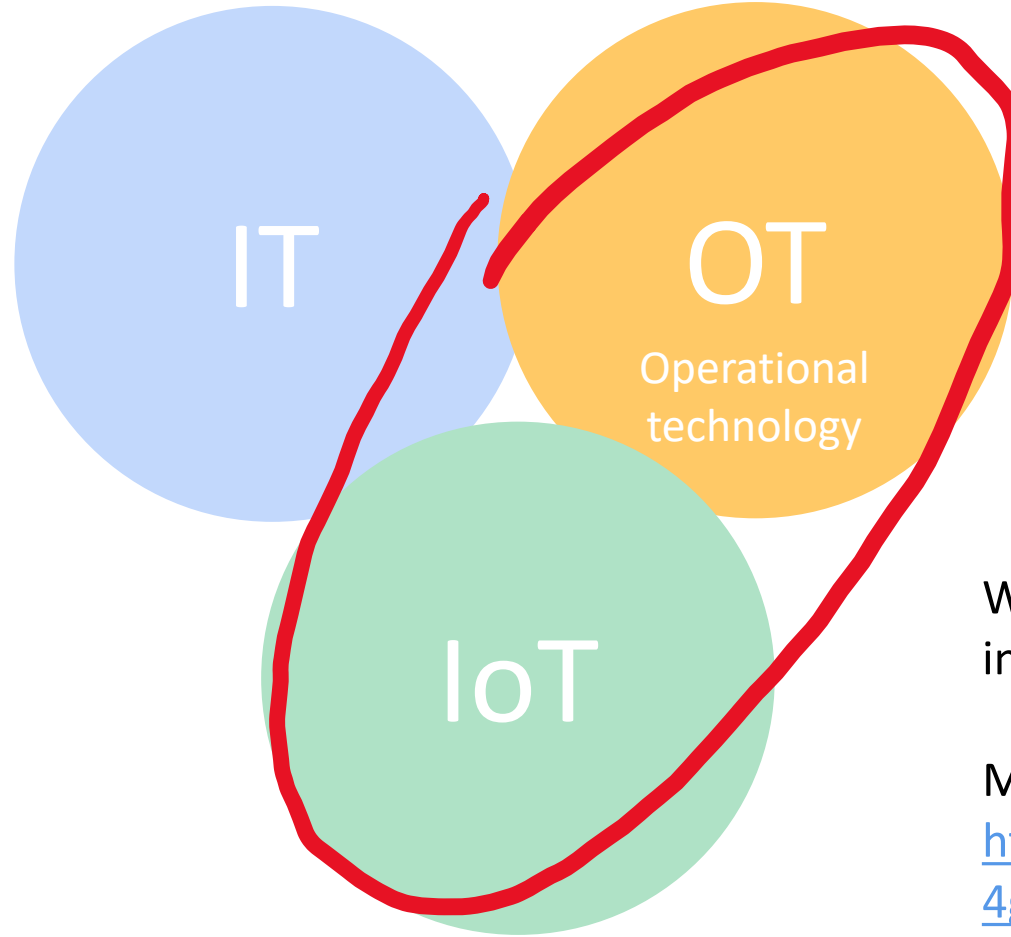
Active Devices CAGR Report



Active Basestations CAGR Report



What we do



Actility

ThingPark
Enterprise

We bring private wireless OT and IoT in one converged platform.

More info :

<https://www.actility.com/private-4g-5g-and-cbrs/>

Try it out: [here](#)





CBRS Overview

The future of Private LTE/5G

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Citizen Broadband Radio Service (CBRS) - US

- Three-Tier Framework



Tier 1: Protected from all other tiers

- Naval Bases
- Ground and airborne radar
- Fixed Satellite service

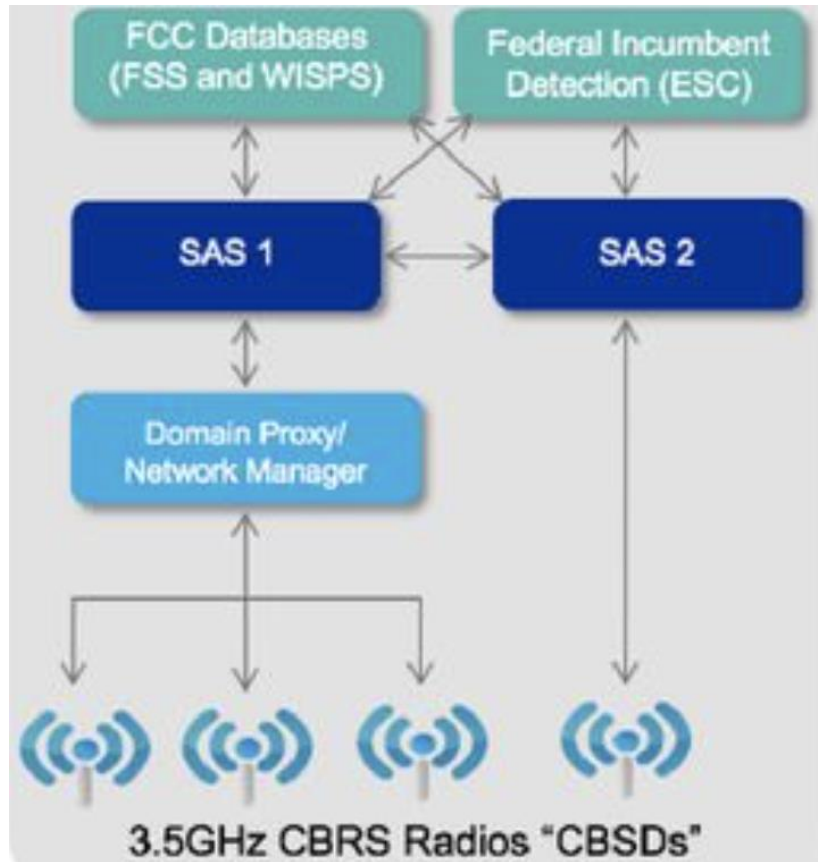
Tier 2: Priority over other users

- Licensed through auction
- Operates in the lower 100 MHz

Tier 3: Standard service for most users

- Unlicensed spectrum
- Can operator across entire 150 MHz

CBRS – Functional Components



Spectrum Access System (SAS)

- Centrally coordinates access to the shared spectrum and enforcing priorities

Environmental Sensing Capability (ESC)

- Detects federal incumbent activity and informs SAS about interference

Domain Proxy

- CBSD aggregation and proxy function for large networks

CBRS Device (CBSD)

- Radio nodes operating in the CBRS band

CBRS – Use Cases

Enterprise

Private LTE &
Industrial IoT



MNO

Network
Densification
& Capacity
expansion



MSO

Rural
broadband



Neutral Host

Cost Effective
DAS
alternative
for Venues

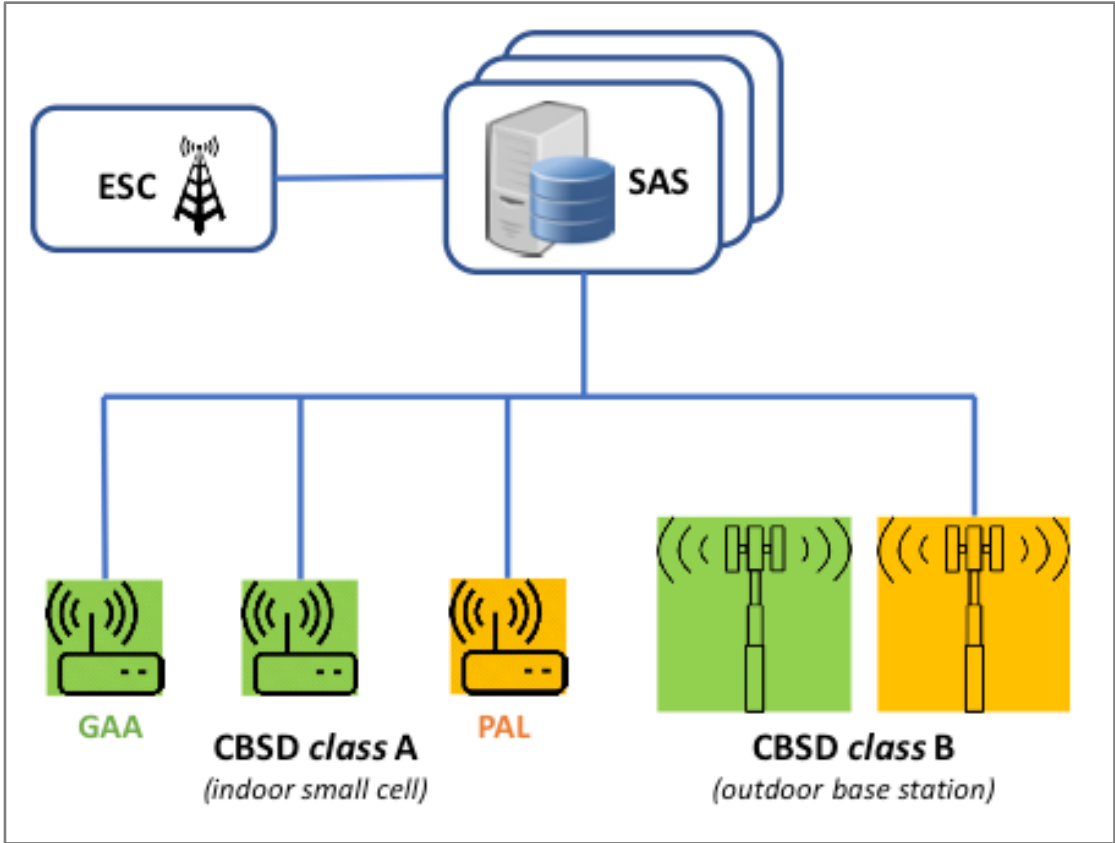


WISP

Wireless
MVNO
offload &
Smart Home



CBRS Device Types



Source: Mobile Experts, LLC

Device	Maximum EIRP (dBm/10 megahertz)	Maximum PSD (dBm/MHz)
End User Device	23	n/a
Category A CBSD	30	20
Category B CBSD*	47	37

* Category B CBSDs will only be authorized for use after an ESC is approved and commercially deployed

- CBSD and End User Devices must comply with the transmit power control and EIRP instructions received from SAS

Major Entities in CBRS Standardization/Authorization

US Government Agencies

- **FCC** – rules for the band, authorization of SASs, ESCs, and CBSDs
- **DoD/Navy** – federal incumbents, ship-based and a few inland locations
- **NTIA** – responsible for federal use of spectrum, including by DoD
 - **ITS** – a division of NTIA that the FCC has contracted to conduct the SAS and ESC testing



Industry Associations

- **Wireless Innovation Forum (WinnForum)** – operationalizing the CBRS framework
- **CBRS Alliance** – defining and optimizing LTE and 5G NR operation in the CBRS band





ITS: The Nation's Spectrum and Communications Lab

Realizing the full potential of telecommunications to drive a new era of innovation, development, and productivity

ITS Institute for Telecommunication Sciences

An Analysis of Aggregate CBRS Data from April 2021 to January 2023

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Disclaimer

- ▶ This presentation does not imply recommendation or endorsement by the National Telecommunications and Information Administration for any company.



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Background and Data Collection

- ▶ Grants are the mechanism by which a SAS authorizes a CBSD to use spectrum within CBRS.
 - A CBSD may request and receive multiple active grants.
 - A grant consists of a contiguous frequency range from a low frequency to a high frequency, and a maximum power (EIRP).
 - Bandwidth ranges from 5 MHz to 150 MHz.
 - May be issued as a PAL (Tier 2) or a GAA (Tier 3). A single grant cannot combine PAL and GAA spectrum, i.e., combined usage can only be achieved through multiple grants.
- ▶ SAS Full Activity Dump (FAD) provides grant and registration information for any CBSD with at least one active grant.
- ▶ NTIA coordinated with the SAS administrators and the FCC to determine data that would be appropriate for sharing with federal regulators to support this study.
 - Quantify the state and growth of CBRS
- ▶ ITS developed a Python script that the SAS administrators used to build aggregate datasets from full activity dump (FAD) data
 - Aggregate data provided quarterly starting from April 1, 2021
- ▶ Script failed to resolve the census block location of a small number of CBSDs.
 - < 0.1% of the total number of CBSDs in each dataset
 - The data for these CBSDs were still included in the aggregate and nationwide statistics except the urban and rural statistics
 - CBSDs in unknown census block locations are not included in the state and county statistics and maps.

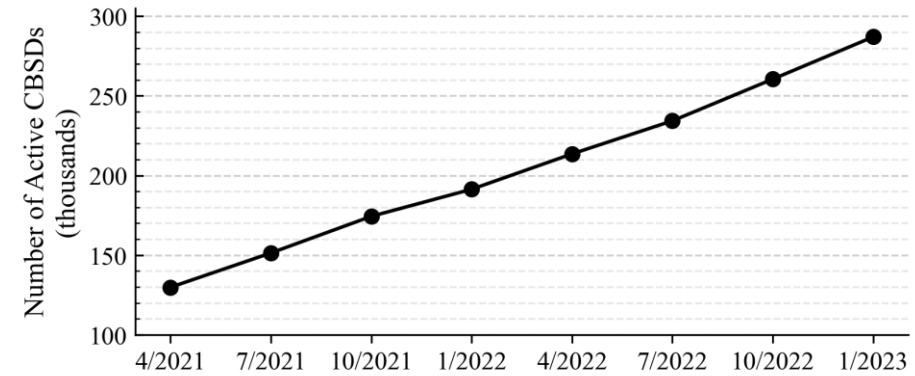
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      ">27-32": 0,
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      ">2-7": 0,
      "<=2": 0
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      "3690000000-3700000000": 0
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    "count": 3,
    "indoor_deployment_count": 0
  }
}
```

Example aggregate data

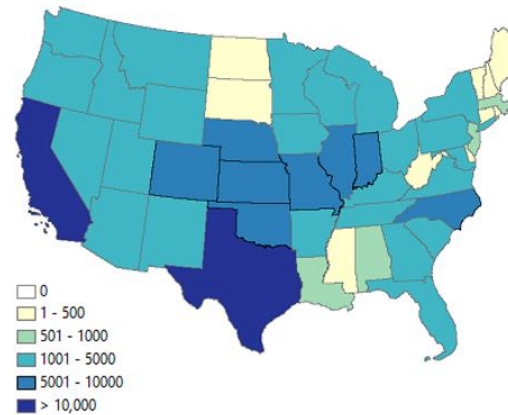


Number of Active CBSDs

- Number of active CBSDs increased by 157,251 (121.2%)
- Mean quarterly increase of 22,464 (12.0%)
- CBRS deployments increased in all states and island areas except Northern Mariana Islands (only state or island area without CBRS on 1/1/23)



Nationwide number of active CBSDs from 4/1/2021 to 1/1/2023.



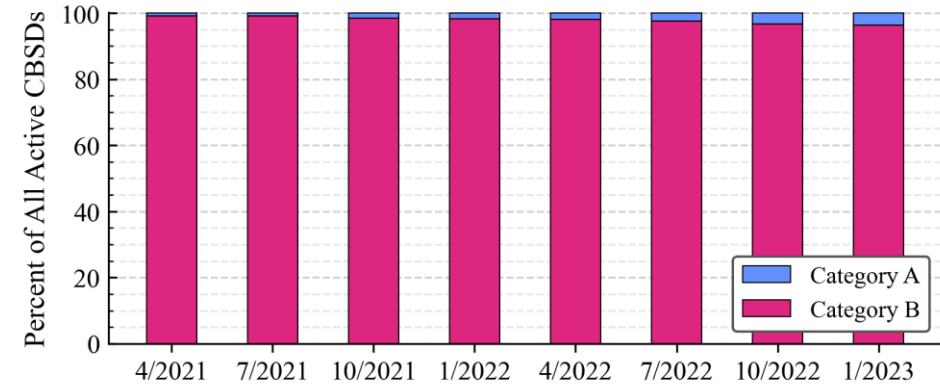
Increase in number of active CBSDs by state for CONUS from 4/1/2021 to 1/1/2023.



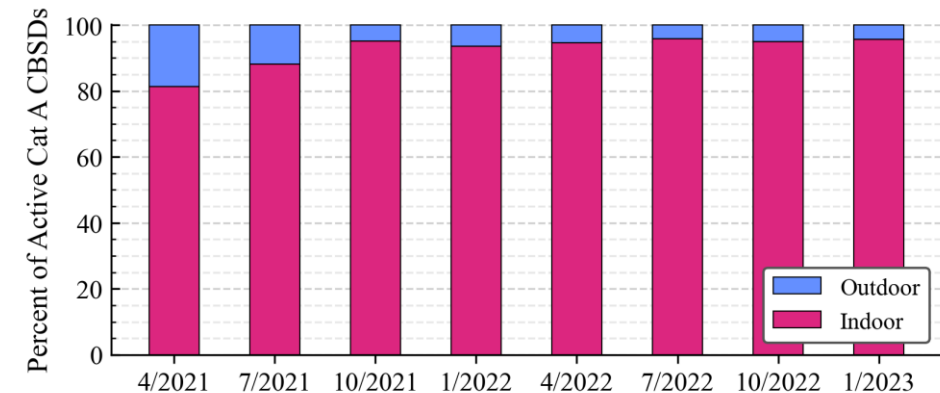
Increase in number of active CBSDs by state and island area for OCONUS from 4/1/2021 to 1/1/2023.

CBSD Type and Installation Type

- ▶ Cat B CBSDs dominated deployments
 - Represented at least 96% of all active CBSDs each quarter
- ▶ Cat A CBSDs increased by 9,431
- ▶ Cat B CBSDs increased by 147,820
- ▶ Cat A CBSDs accounted for a small portion of all active CBSDs, this percentage increased slightly over time, i.e., from 0.9% on April 1, 2021, to 3.7% on January 1, 2023
- ▶ Outdoor deployments became less common for Cat A CBSDs.
 - The percentage of active Cat A CBSDs deployed outdoors decreased from 18.7% on April 1, 2021, to only 4.4% on January 1, 2023



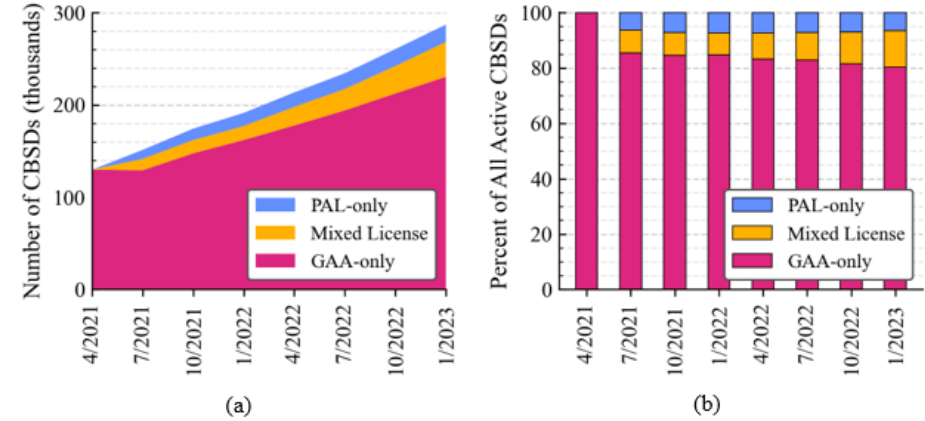
Nationwide percentage of active Cat A and Cat B CBSDs from 4/1/2021 to 1/1/2023.



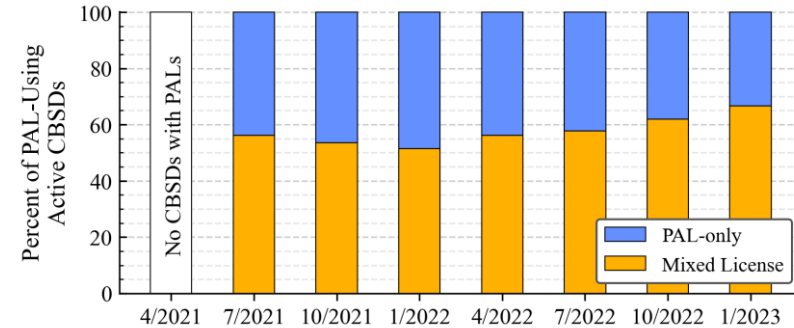
Nationwide percentage of active Cat A CBSDs with indoor versus outdoor installations from 4/1/2021 to 1/1/2023.

License Tier

- ▶ CBSDs with only GAA grants decreased by 603 CBSDs immediately after the introduction of PALs and thereafter steadily increased by 100,722 to a total of 230,504 active CBSDs
- ▶ The number of CBSDs with PAL grants grew quickly in the first quarter to 22,138 CBSDs on July 1, 2021
 - Growth slowed, but continued steadily to a total of 56,529 CBSDs on January 1, 2023
- ▶ The percentage of PAL-only and mixed license CBSDs increased after April 2021, but GAA-only CBSDs accounted for more than 80% of all CBSDs in every quarter
- ▶ GAA tier has been a popular supplement to PALs.
 - CBSDs with a PAL grant that were also using at least one GAA grant remained above 51% and reached a maximum of 66.7% on January 1, 2023



Nationwide number (a) and percentage (b) of active CBSDs with PAL-only, GAA-only, and mixed license from 4/1/2021 to 1/1/2023.

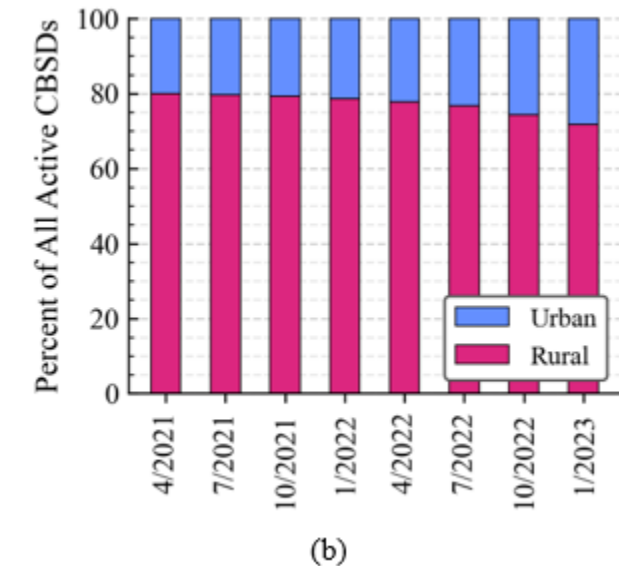
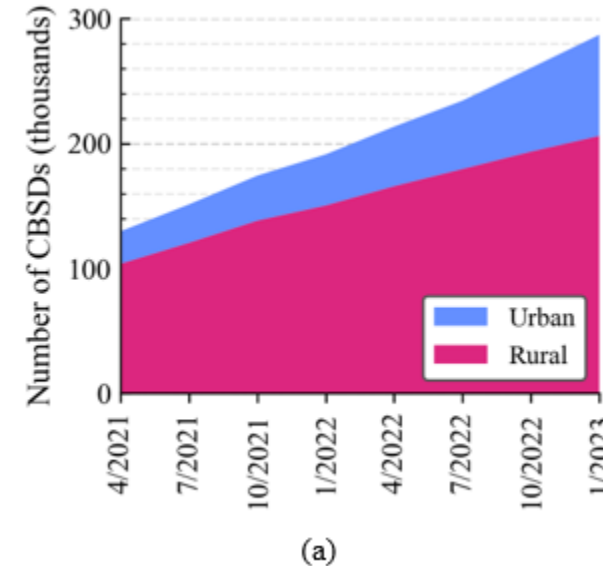


Nationwide percentage of active CBSDs with at least one PAL grant that were PAL-only versus mixed license from 4/1/2021 to 1/1/2023.



Location Type

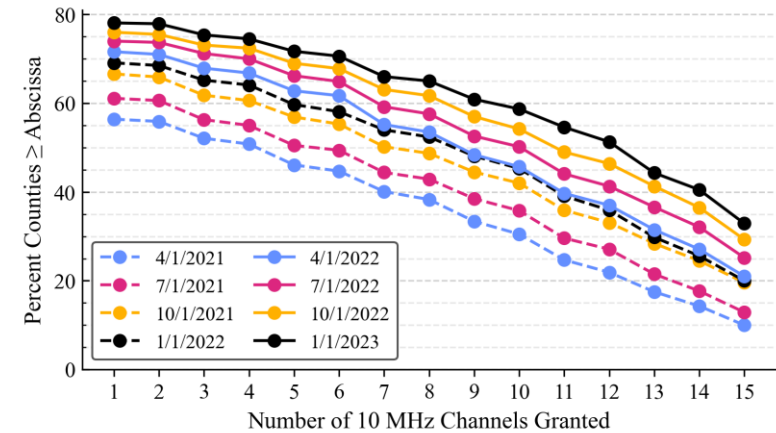
- ▶ Recent emphasis on closing the digital divide in rural America and speculation that CBRS may play a role in increasing broadband access in rural communities
- ▶ Both urban and rural CBSD deployments experienced significant and steady increases.
 - Rural CBSDs increased by 102,340 CBSDs (14,620 per quarter, on average)
 - Urban CBSDs increased by 54,893 (7,842 per quarter, on average).
- ▶ Urban CBSDs increased from 20.0% of all active CBSDs on April 1, 2021 to 28.2% on January 1, 2023



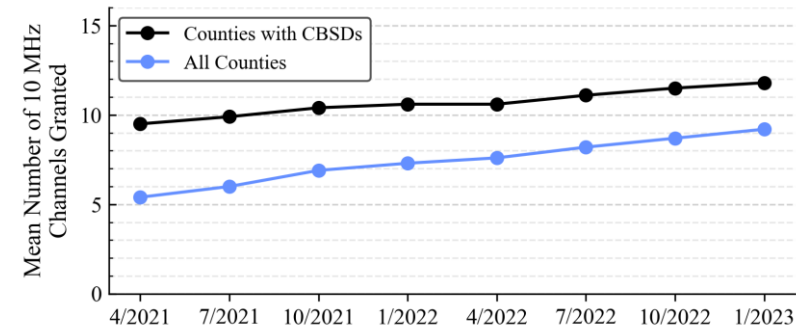
Nationwide number (a) and percentage (b) of urban and rural CBSDs from 4/1/2021 to 1/1/2023.

Band Utilization

- ▶ In each subsequent quarter, more counties used CBRS and counties using CBRS tended to increase the number of channels they used.
 - April 1, 2021: 56.4% of counties had at least one channel granted while 10% had all 15 channels granted.
 - January 1, 2023: 78.1% of all counties used at least 1 channel and 32.9% used all 15 channels.
- ▶ The mean number of 10 MHz channels granted rose from 5.4 to 9.2 across all counties.
- ▶ The mean number of channels granted in counties with at least one active CBSD rose from 9.5 on April 1, 2021 to 11.8 on January 1, 2023



Band utilization for each quarterly dataset from 4/1/2021 to 1/1/2023.

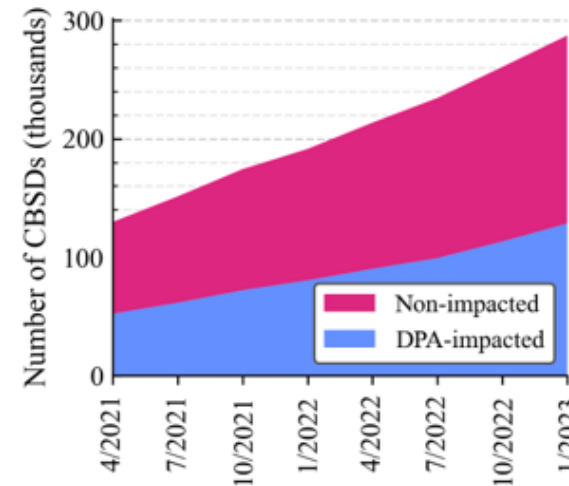


Mean band utilization in each quarterly dataset from 4/1/2021 to 1/1/2023.

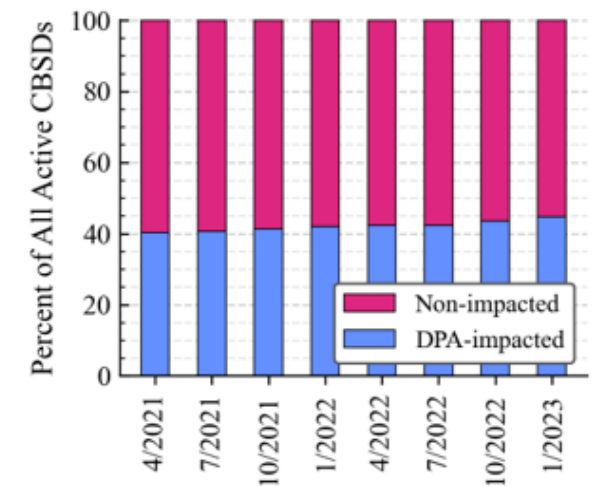


Dynamic Protection Area Neighborhoods

- ▶ Dynamic Protection Areas (DPAs) define the areas or points with frequency ranges where incumbent access users are protected from interference from PAL and GAA users
 - Areas in which commercial entrants' spectrum access may be affected by the presence of the federal incumbent
 - SAS will suspend or terminate grants of CBSDs within the neighborhood of the DPA until the predicted aggregate interference is below the protection threshold
- ▶ Both county types experienced significant and steady increases in CBSD deployments.
- ▶ The number of CBSDs in non-impacted counties increased by 81,173 compared to an increase of 76,060 in DPA-impacted
- ▶ CBSDs in DPA-impacted counties increased as a percentage of the total, from 40.3% on April 1, 2021 to 44.7% on January 1, 2023.
- ▶ On January 1, 2023 there were 128,351 CBSDs in DPA-impacted counties with a total population of 232,348,897 residents.
- ▶ Had DPA neighborhoods been designated as exclusion zones, those CBSDs could not have been deployed.



(a)

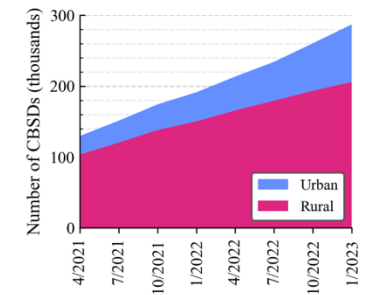
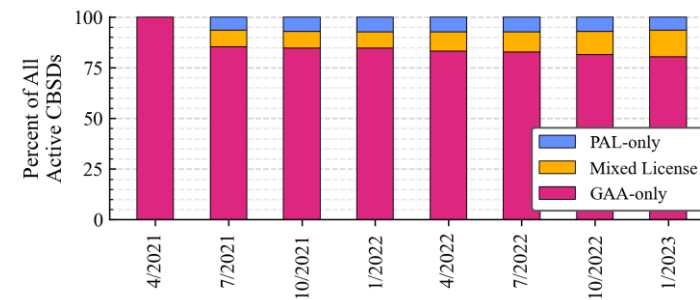
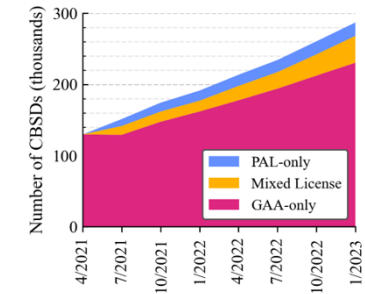
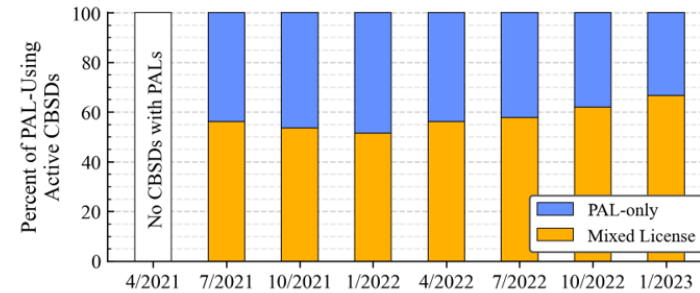
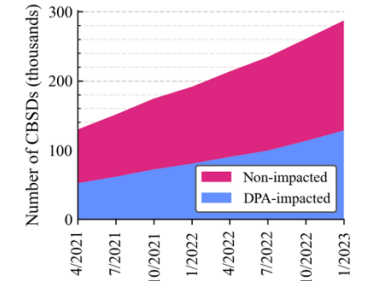
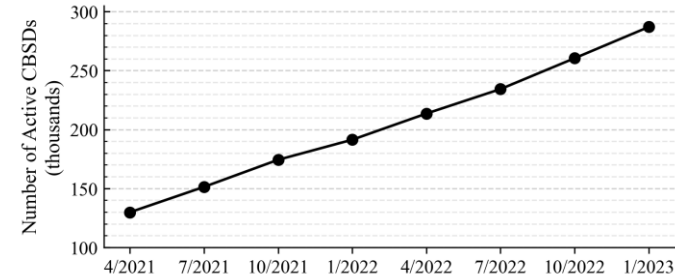


(b)

Nationwide number (a) and percentage (b) of CBSDs in DPA-impacted and non-impacted counties from 4/1/2021 to 1/1/2023

Summary

- ▶ CBRS deployments grew at a significant and steady rate
- ▶ Significant number of CBSD deployments in counties with dynamic spectrum sharing
- ▶ General Authorized Access (GAA) CBSDs dominated deployments
- ▶ Significant percentage and number of CBSDs deployed in rural areas
- ▶ Steady increase in band utilization



Shared Access – Spectrum for private networks

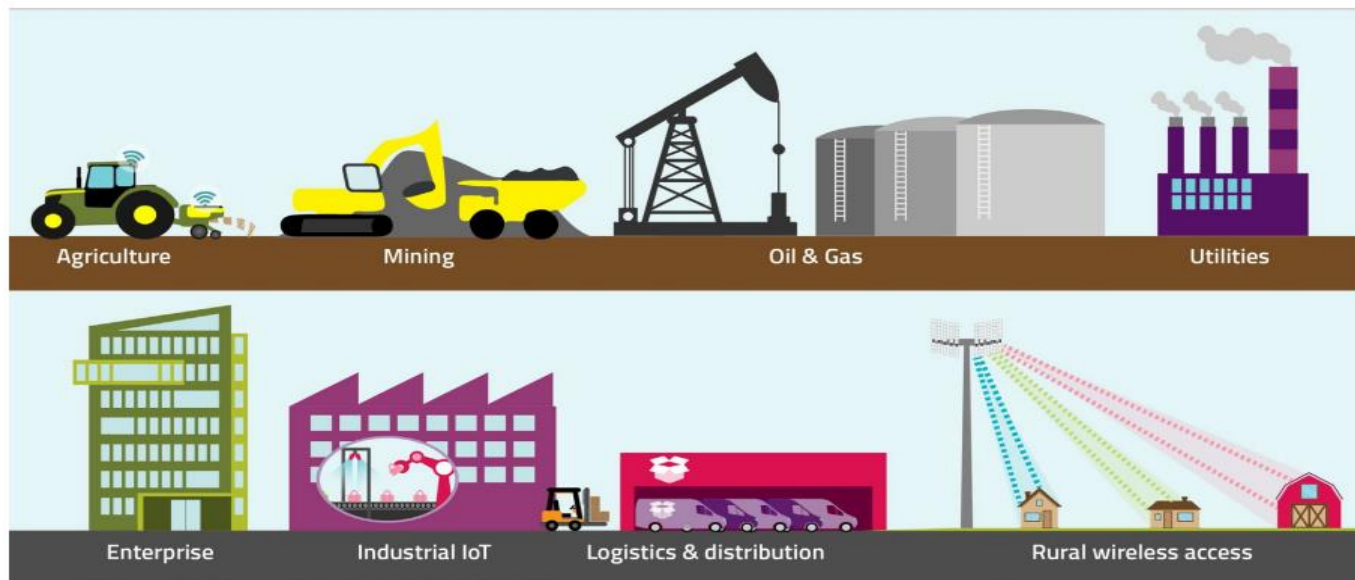
Paul Chapman, Principal Policy Manager (Authorisation)

Jack Hindley, Policy Principal (Policy & Analysis)

Paul.Chapman@ofcom.org.uk

Jack.Hindley@ofcom.org.uk

Shared spectrum and multi-usage applications



- We recognise that there is a growing demand for spectrum access from a range of players (new and old) supporting different applications;
- In 2019, we took steps to make mobile spectrum available with different usage rules and characteristics to suit different technical and business needs;
- We expect that in the future, we will continue to see growth in demand for:
 - private networks from industrial users;
 - existing and new communications providers ;
 - network integrators .

Uses	1800 MHz shared spectrum	2300 MHz shared spectrum	3.8-4.2 GHz	Lower 26 GHz band
Private network (e.g. industry uses)	✓ (narrowband)	✓	✓	✓ (indoor)
Mobile coverage (rural)	✓	Certain locations	×	×
Mobile coverage (indoor)	✓	✓	×	✓
Fixed wireless broadband	×	×	✓	Prior Authorisations

<https://www.ofcom.org.uk/manage-your-licence/radiocommunication-licences/non-operational-licences>

Ofcom's spectrum sharing framework

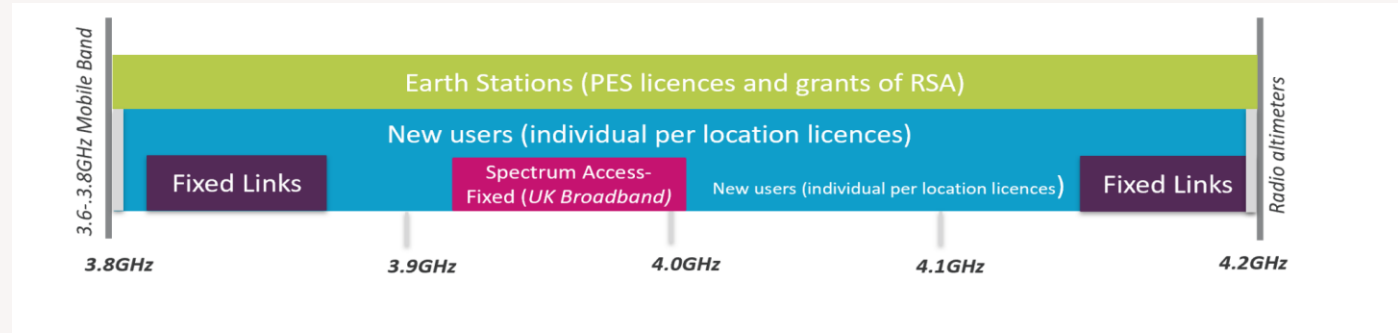
	Local Access licence (National mobile spectrum)	Shared Access licence (Shared spectrum)
Bands available	Spectrum licensed on a national basis to an MNO (700 MHz, 800 MHz, 900 MHz, 1400 MHz, 1800MHz, 2350-2390 MHz, 2.6 GHz, 3.4-3.8 GHz)	1800 MHz (2x 3.3 MHz) 2.39-2.4 GHz (10 MHz) indoor only 3.8 – 4.2 GHz (10 – 100 MHz) 24.25-26.5 GHz (50, 100, 200 MHz) indoor only*
Technical conditions	Specified by applicant	Low power (24 dBm) 50m area Medium power (42 dBm) single transmitter in rural areas only.
Access type	Ofcom liaises with MNO to see if they have a reasonable objection where it impacts their current and/or future deployment plans. Ofcom reviews evidence supplied and makes a decision.	Ofcom coordinates access for interference to/from other users on first come first served basis, deployment within 6 months
Licence duration	Finite period normally 3 years (but longer durations if agreement is reached with the MNO)	Indefinite subject to annual fee payment
Licence costs	£950 one-off cost	£80 per 10 MHz (all bands except 26 GHz) £320 flat fee (26 GHz)

* Proposals to extend Shared Access in 26 GHz as part of the upcoming award.

Shared Access headlines

Story so far

- 1676 Shared Access licences on issue (as of May 2023)
- Most new licences continue to be in 3.8-4.2 GHz band.



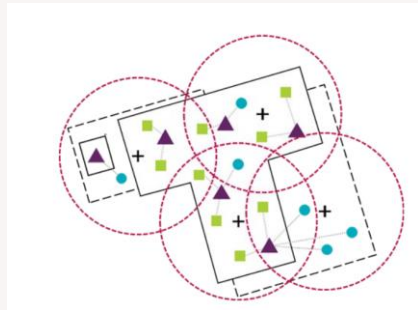
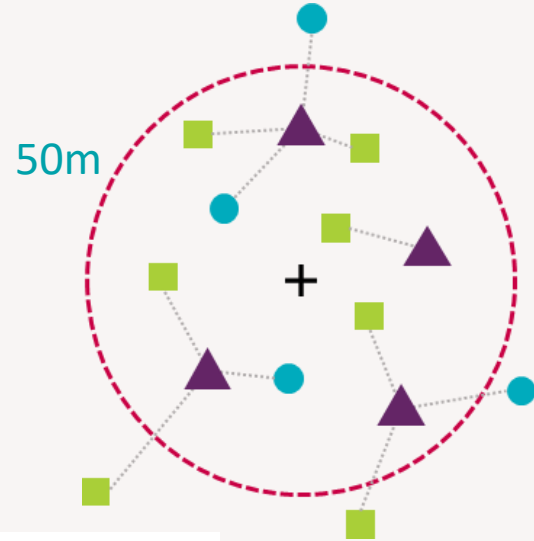
- Small number of additional licences issued under our I 'local access' product

Developments

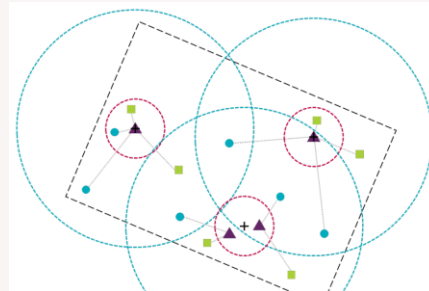
- Consultation on 26 & 40 GHz award (including SA) closed 22 May.
- Shared Access CFI closed 16 May, analysing responses and considering next steps
- Poland has announced it is going to allocate 3.8-4.2 GHz for local/private mobile in a similar way to the UK. This follows on from Norway.

Shared Access licence: Low and Medium power

Low power (24 dBm) area licence

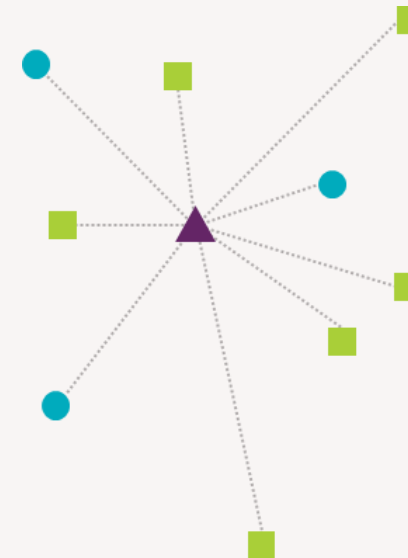


Multiple licensed areas to cover indoor and outdoor locations at a premises.



Multiple licensed areas to cover a large site. Terminals allowed to connect to base stations outside of licensed area.

Medium power (42 dBm) base station licence

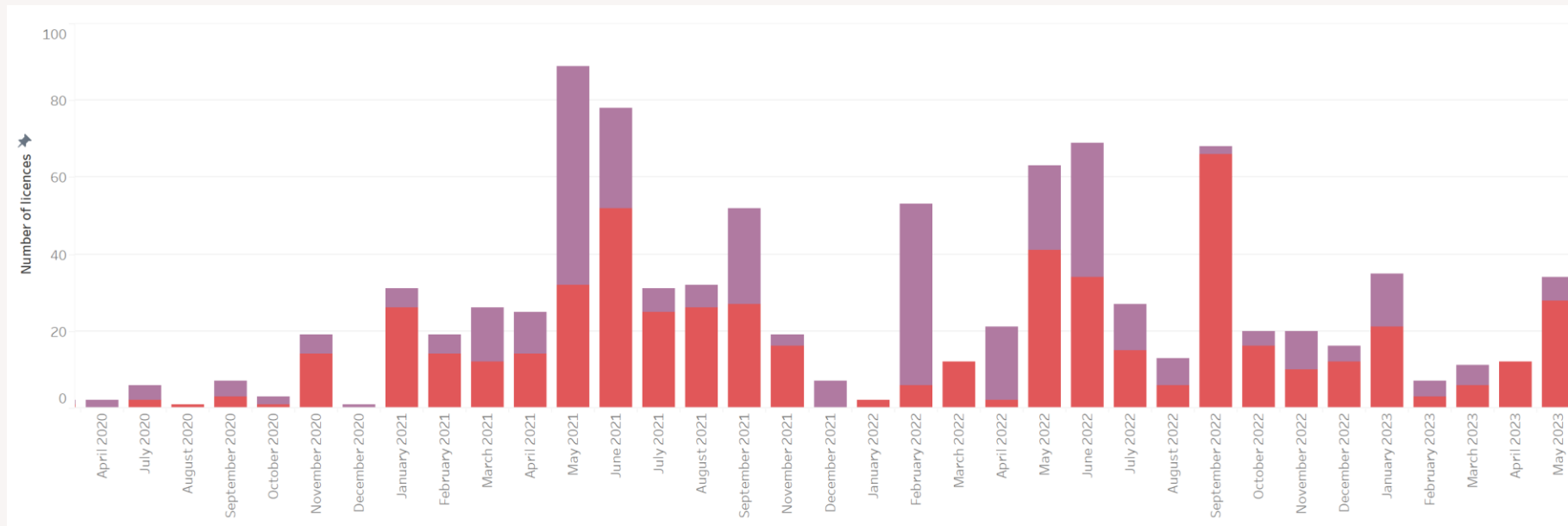


Legend

- | | |
|--|---|
| + Registered location | ▲ Base station |
| - - - 50m radius from registered location | ■ Fixed/installed terminal |
| — Wall of building | ● Mobile/nomadic terminal |
| - - - Perimeter of outdoor yard area | Base station/terminal connection |

Uptake (as of May 2023)

	1800 MHz	2390-2400 MHz	3.8-4.2 GHz	26 GHz	Total
Low Power	893	32	184	1	1110
Medium Power	95	-	470	-	565
Total	988	32	654	1	1676



■ Shared Access Low Power
■ Shared Access Medium Power

Automation

- Currently in the process of a major upgrade of our spectrum management licensing platform.
- New platform will provide a better online process for our stakeholders and enable us to continue to deliver an efficient spectrum licensing service into the future.
- Aim to is automate much of the Shared Access licensing process to allow users to better serve themselves.
- Automation should significantly reduce the time taken for licensees to receive their licences.

Shared Access Review – Reflecting on Use Cases & Demand



Future Demand

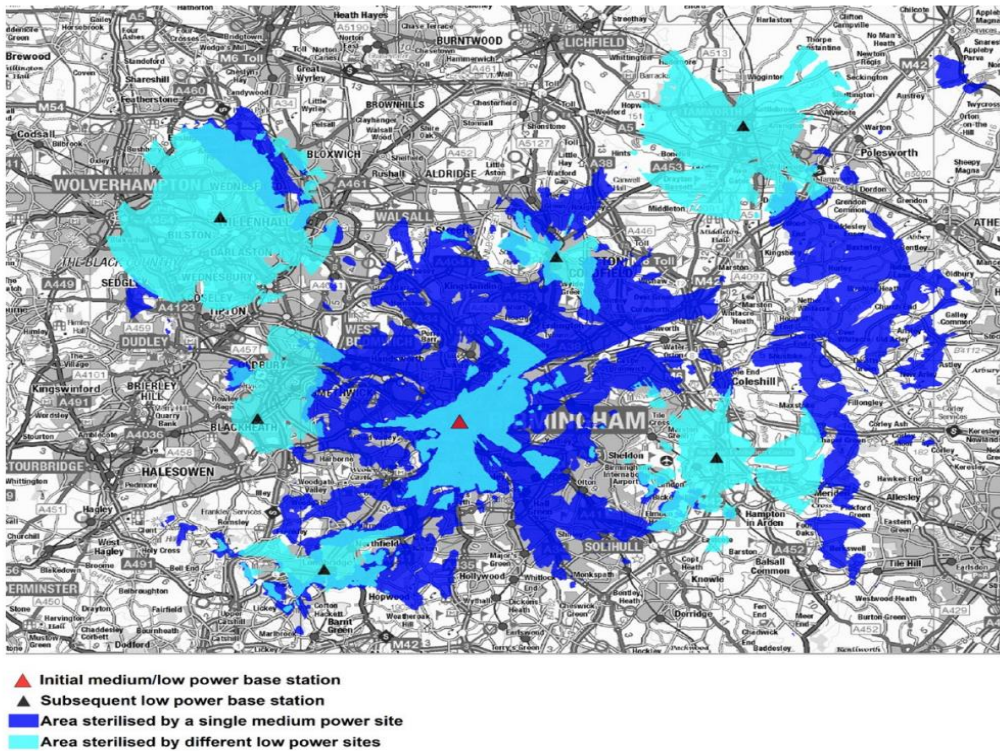


Future Use Cases



Elements of use cases that challenge the current framework

Power Levels and Exceptions



This image shows a hypothetical initial Shared Access base station (red) in Birmingham city centre, at medium power (dark blue) and low power (light blue).

The medium power sterilisation area would preclude the additional 6 low power base stations (in black).

Note that the gaps in the area sterilised by the medium power base station reflect the impacts of terrain and clutter.



Restrictions on medium power in urban areas



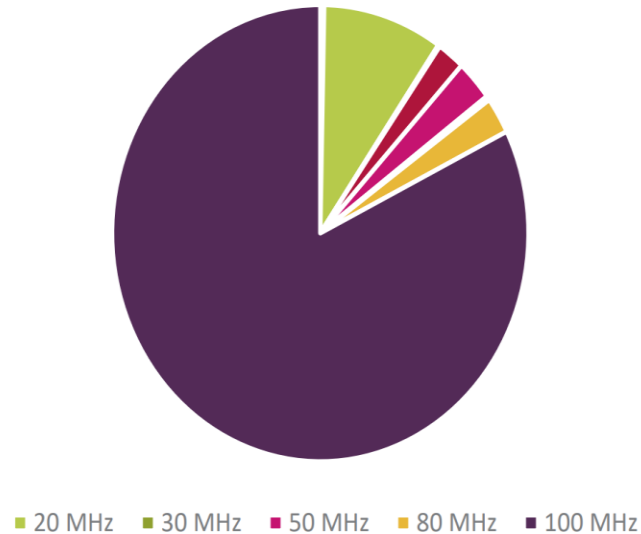
Scenarios where using a higher operating power may bring benefits



Exceptions Process

Equipment and Spectrum Supply

Figure 1.5: Analysis of the bandwidths (in MHz) of issued licences in 3.8-4.2 GHz⁹



We have seen a significant demand for large bandwidths, compared with the smaller 20-40 MHz we anticipated might be most common in our initial statement.

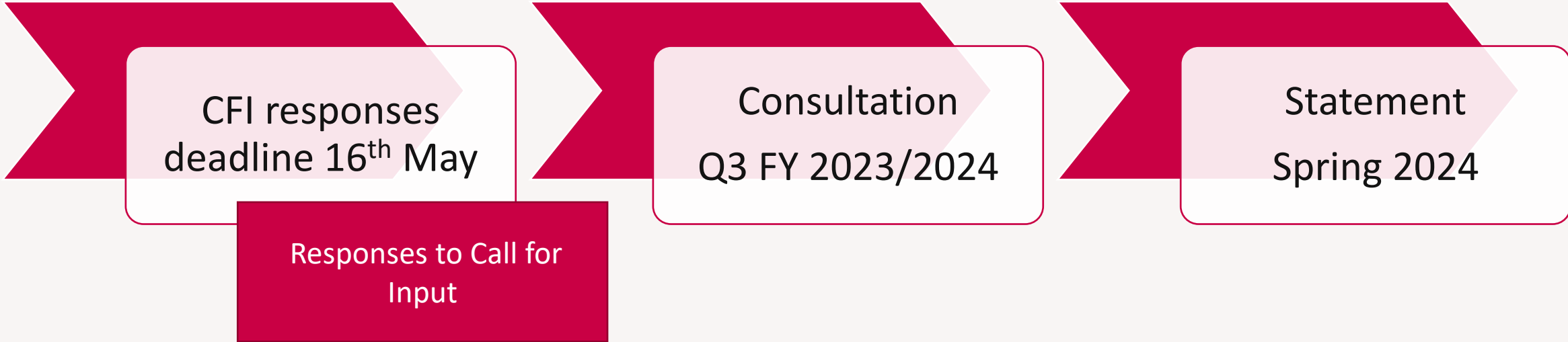
We also know that some vendor equipment may not currently support the full 3.8-4.2 GHz band (though believe this situation is improving).

When combined with pre-existing users of the band, we are considering impacts on additional and future users in some areas

Equipment availability

Suitability of existing spectrum for use cases + bands we propose to add to the framework

Shared Access Licence Review Timelines

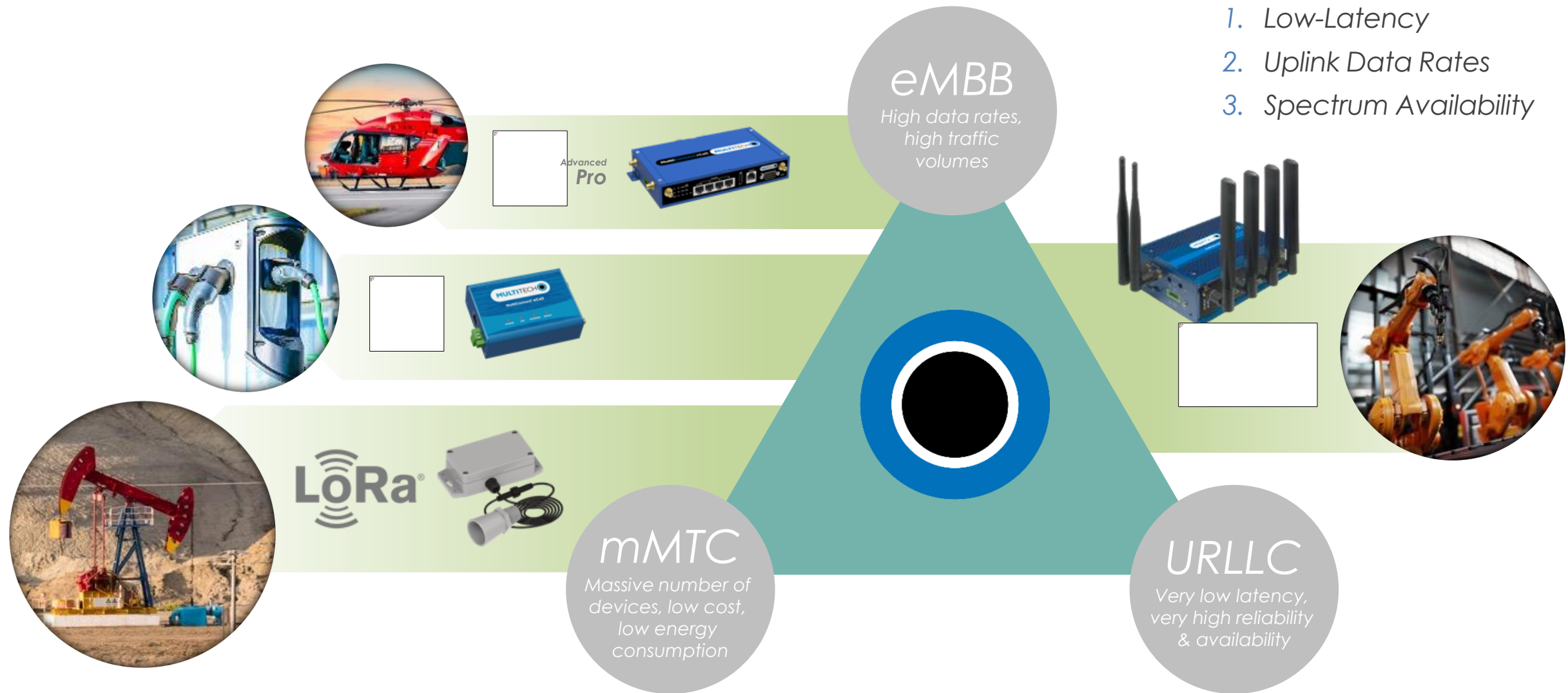




*Simplifying the Connected Product,
Connected Service Journey*

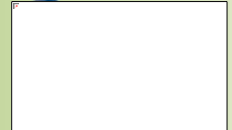
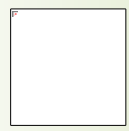
*Enterprise
Private Cellular
Applications*

5G Enterprise Connectivity



1. Low-Latency
2. Uplink Data Rates
3. Spectrum Availability

eMBB
High data rates,
high traffic
volumes



mMTC
Massive number of
devices, low cost,
low energy
consumption



URLLC
Very low latency,
very high reliability
& availability

Closing the Digital Divide

Student Remote Learning



Supports 128 concurrent Wi-Fi connections



MultiConnect rCell 600
Wi-Fi Multi-Port Router



MultiConnect microCell
CBRS Native - Chromebooks etc



MultiConnect eCell
Connect Wi-Fi, Camera's, Digital Signage etc



CBRS Wi-Fi Access Point
Wi-Fi Extender – Multiple connections



Virtual Table Inspections

Transportation



Lufthansa Technik

SETUP:

- BNetzA 3.7-3.8 GHz 5G
SA Rel'15 n78 network:

WHY:

- Collaborative decision making
- Improve safety and performance

REQUIREMENTS:

- Stability, Mobility,
Coverage & Security
- Predictable Latency 10-30 ms
- Deterministic data performance
 - Must see mm scratches
 - 25 MBps+ Uplink per device



Autonomous Forklift Vehicles

Warehouse Logistics

SETUP:

- FCC Band 48-CBRS 3.55-3.7 GHz
- 4G-LTE Cat 12

WHY:

- Expedited Supply chain Complexity
- Worker Shortages & Improved Safety
- Standardizing Workflows

REQUIREMENTS:

- Full Mobility with deterministic performance
- Coverage without white spots
- Highly scalable across locations
- Predictable Low-latency



Autonomous Mobile Robotics

Retail

SETUP:

- FCC Band 48-CBRS 3.55-3.7 GHz
- 4G-LTE Cat 12

WHY:

- Labor Shortages
- Stock Visibility & Inventory Management
- Price Tag Accuracy & Integrity
- Planogram Compliance
- Improved Health & Safety

REQUIREMENTS:

- Full Mobility with deterministic performance & latency >50ms
- Cost effective coverage
 - 10:1 improvement over Wi-Fi APs



Climate & Access Control

Commercial Real Estate

SETUP:

- *FCC Band 48-CBRS 3.55-3.7 GHz*
- *4G-LTE Cat 12*

WHY:

- *Secure & safer smart properties*
- *No costly cable runs*
- *Instant anywhere control & visibility*
- *Unauthorized access notifications*

REQUIREMENTS:

- *Deterministic latency under 50ms*
- *50 MB data performance*
- *Prioritized traffic profiles for different asset classes*



Water Leak Detection/ Shut-Off

Commercial Real Estate

SETUP:

- FCC Band 48-CBRS 3.55-3.7 GHz
- 4G-LTE Cat 6 : LoRaWAN 902-928 MHz

WHY:

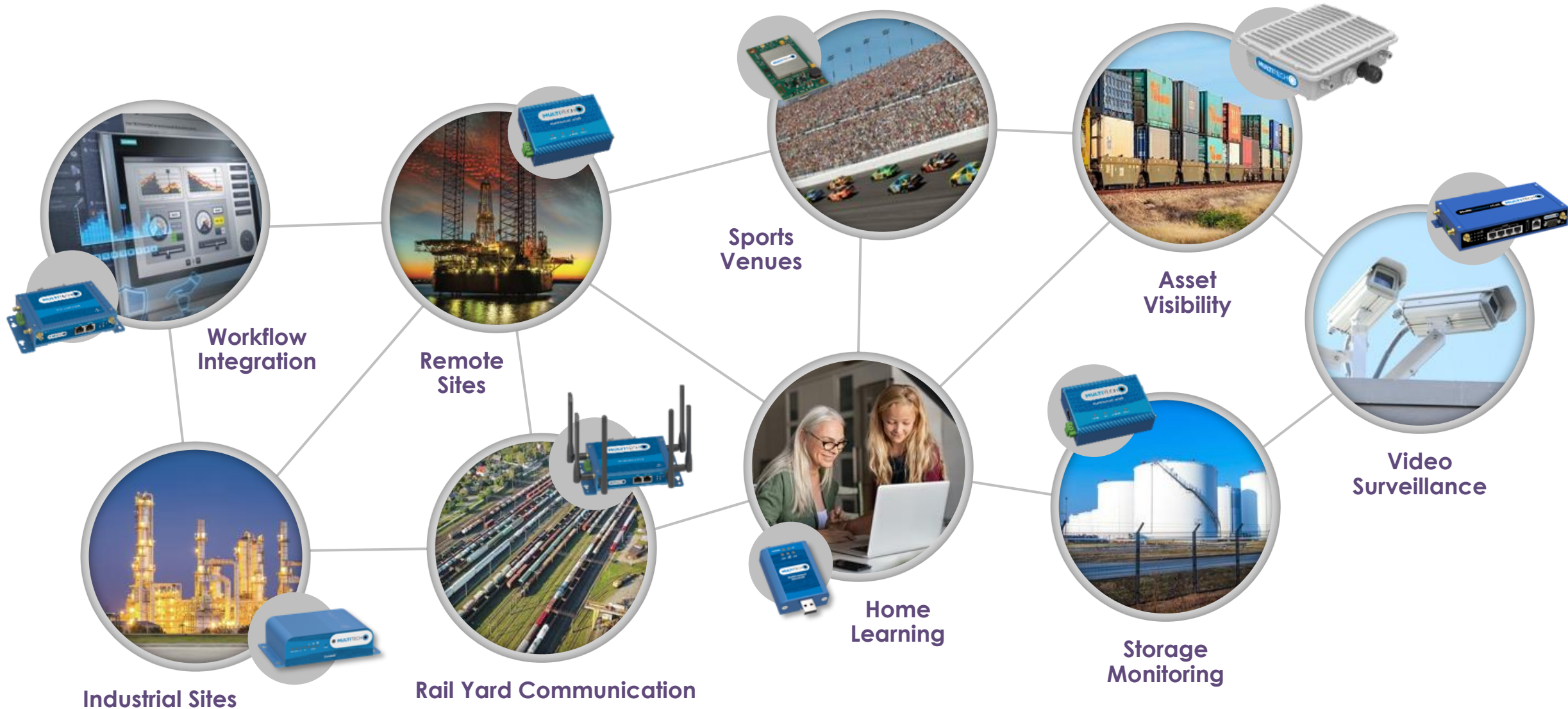
- Reduced risk of property damage
- Second largest insurance claim after Natural disasters
- Short commitment cycle for commercial Insurance
- Low-cost, simple-install no cabling costs

REQUIREMENTS:

- Easy install post-construction
- Leaks detected in minutes/hours



Private Wireless Applications





*Simplifying the Connected Product,
Connected Service Journey*

Thank You

*for additional questions
please contact:*

*Daniel Quant
612 203 1584 : Mobile
dquant@multitech.com*

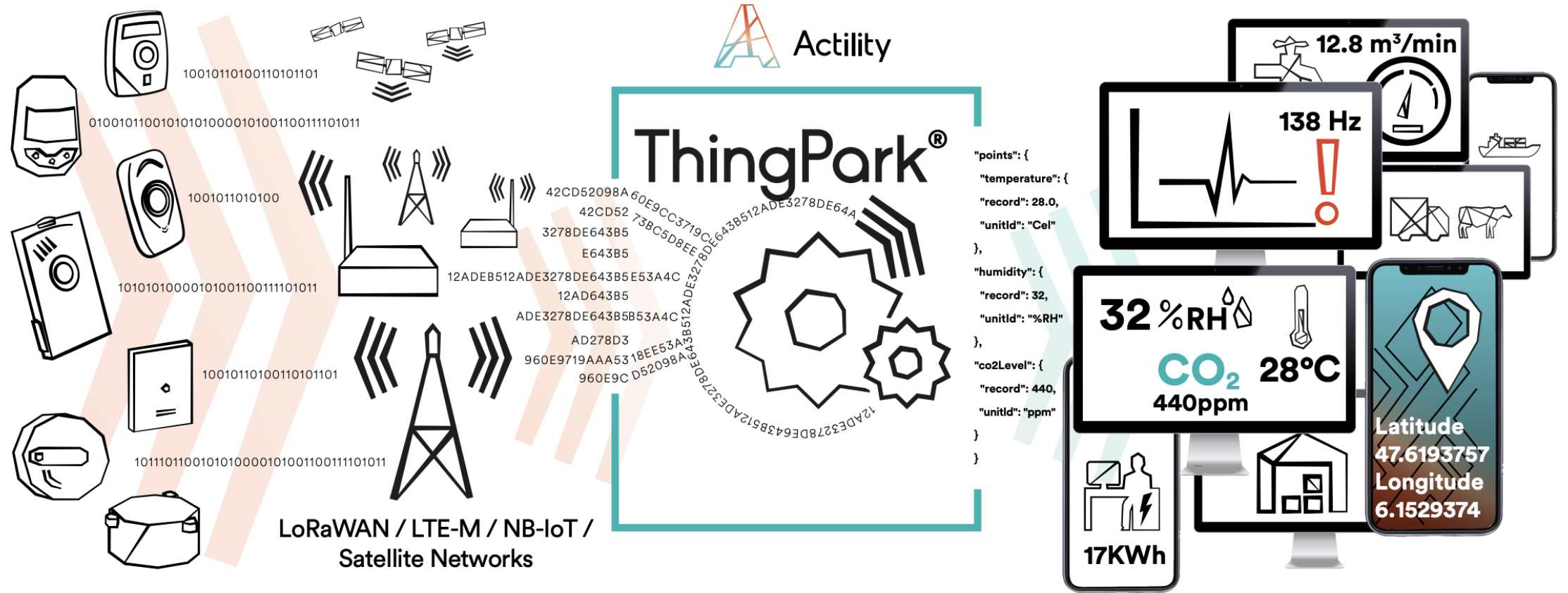


Actility & ThingPark

Multi-technology platform to democratize IoT innovation

Actility

ThingPark Wireless: Multi-technology IoT Platform



Sensors, Devices and Gateways

IoT Mediation Platform

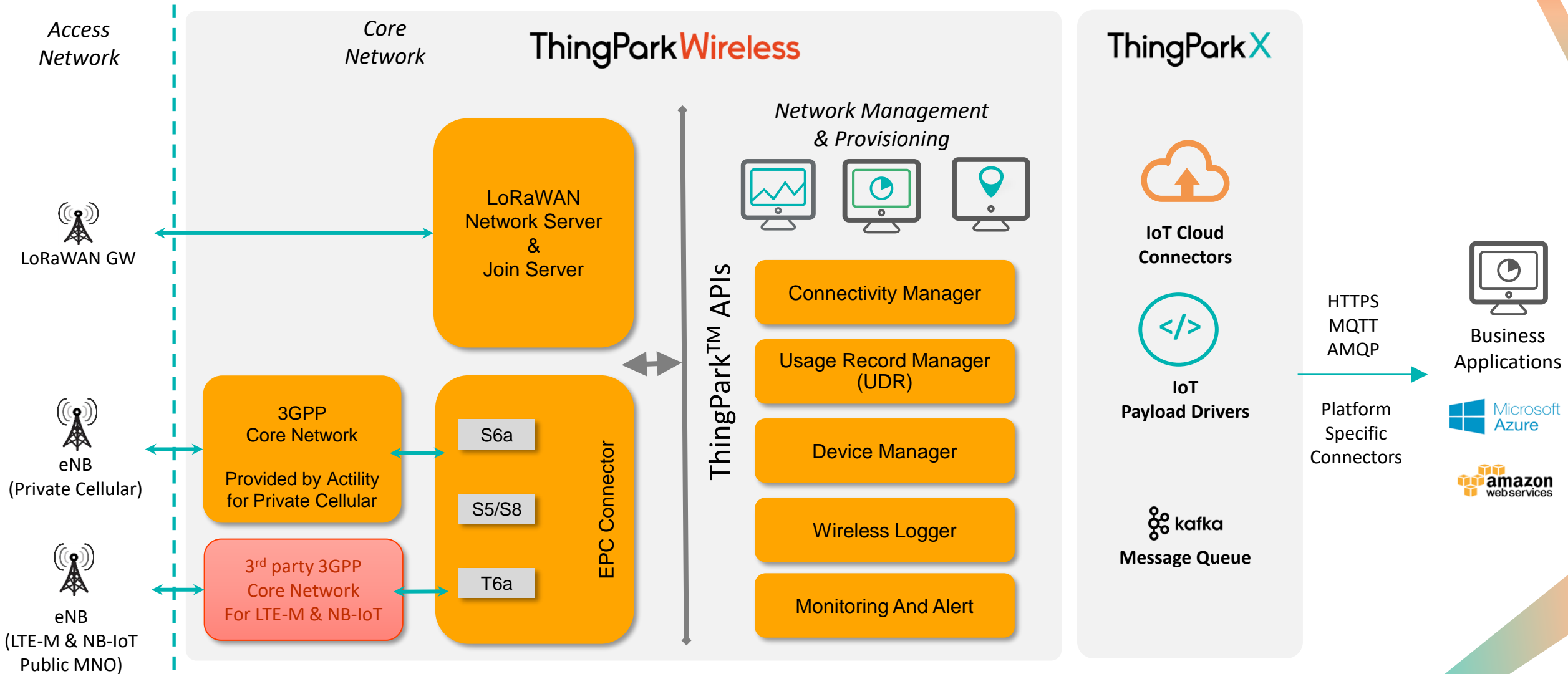
Business Applications & Cloud Connectors



Public and dedicated private network infrastructure controller, service enabler, devices & data management

Vertical apps and Azure IoT Central, AWS IoT, Cumulocity, Thingworx etc.

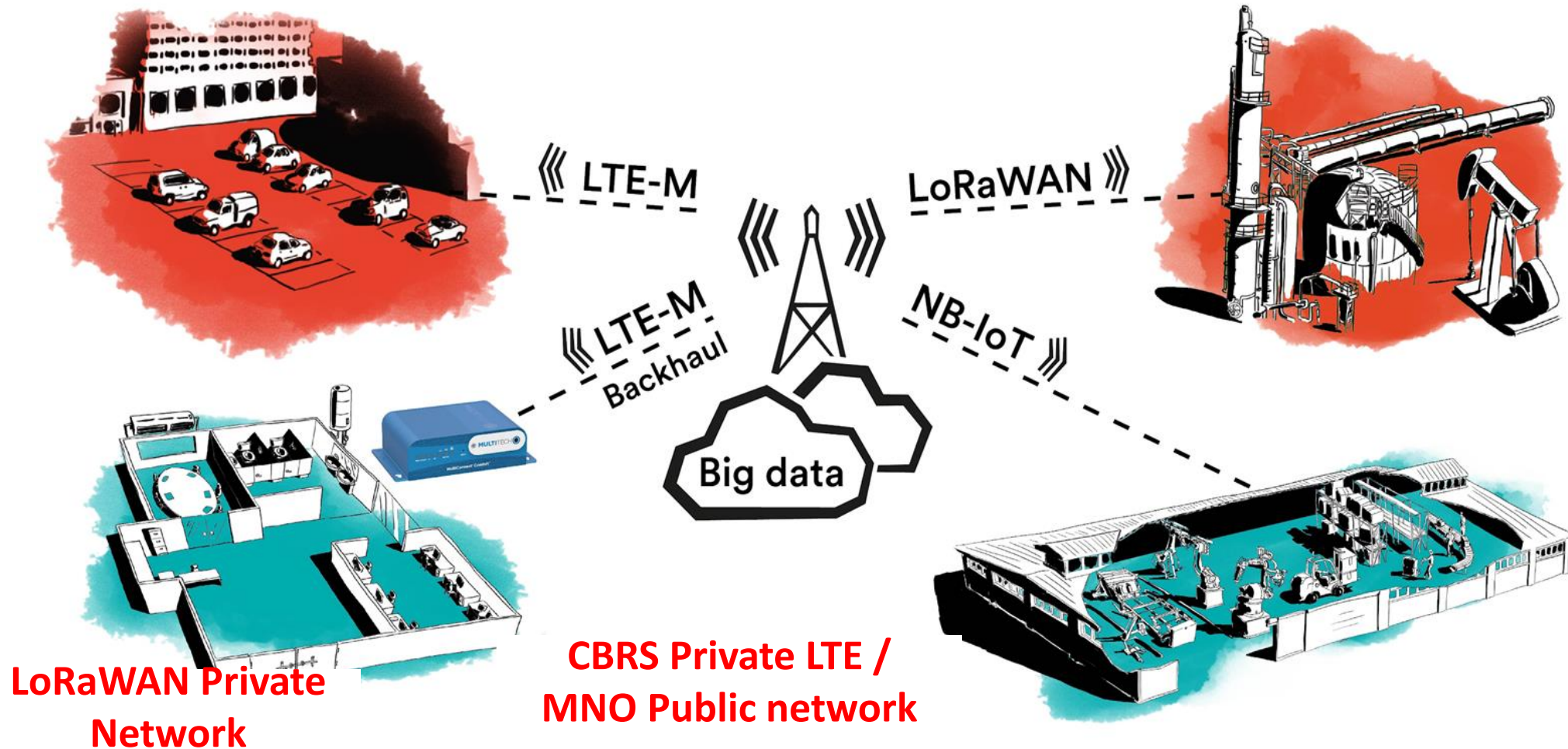
ThingPark Wireless as Multi-Technology Platform for 3GPP & LoRaWAN



Activity

CBRS as backhaul for LoRaWAN Gateways

CBRS based Private LTE networks allows operators to deploy LoRaWAN Gateways in remote areas



Private cellular solution components

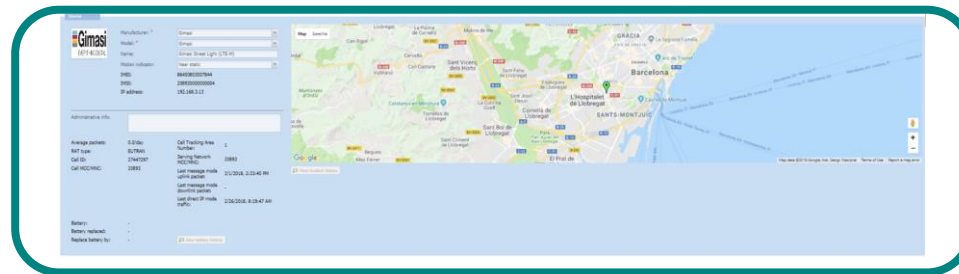
Subscriptions



ThingPark Services

(Device Mgmt, eNodeB mgmt*, Cloud connectors, EPC)

Customer View



CapEx

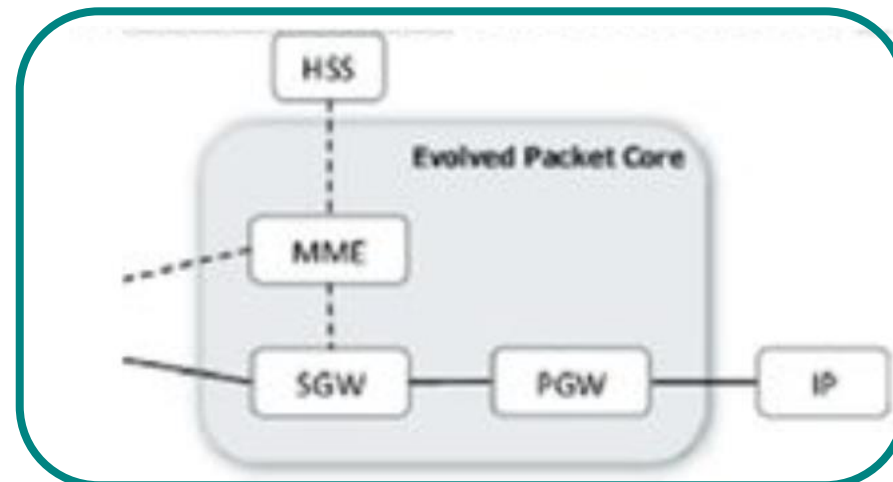


Cellular eNodeB**



Device SIMs

Activity 3GPP EPC (under the hood)



* Roadmap Item

Activity

** Ability to roam across 3GPP public networks worldwide with Activity MVNE partner

CBRS PoC Kit Contents

- Use Case: CBRS as a backhaul for LoRaWAN Gateways
- CBRS eNodeB:
 - [Sercomm LTE CBRS Indoor Small Cell - Englewood](#)
 - [Baicells Baicells pBS2120 3.5GHz Nova 227](#)
- CBRS Ethernet Router:
 - [Amit Wireless IDG500-C6012](#)
 - [Amit Wireless IDG500-CC501](#)
 - [Multitech eCell CBRS Ethernet Router](#)
- LoRaWAN Gateways:
 - [Multitech Conduit V1.5 Access Point 4G](#)
 - [Browan Pico Next Indoor Gateway \(8 Channels\)](#)
 - [Gemtek Micro 8CH V1.5 3G/4G Outdoor Gateway](#)
- 1x ThingPark Wireless (EU PROD) account for SIM Management
- 1x ThingPark Enterprise account for LoRaWAN Gateways
- Optional: Roaming over 3GPP Public Network (Alaska Wireless, US Cellular, T-Mobile USA)

We bring private wireless OT and IoT in one converged platform.

More info :

<https://www.actility.com/private-4g-5g-and-cbrs/>

Try it out: [here](#)



ThingPark Wireless Multi-technology Platform

- **Actility is the leading Multi-Technology LPWAN IoT Solutions Provider covering both LoRaWAN and Cellular IoT (NB-IoT, Cat-M1, LTE Cat-XX):**
 - ThingPark Wireless Platform is agnostic to radio
 - OSS Solutions with a focus on IoT to minimize OPEX
 - Data mediation layer for seamless application integration with IoT networks
 - Pre-integrated Marketplace of IoT Solutions to accelerate go-to market
 - Capability to deploy private LTE networks with devices roaming across public/private LTE networks
- **Converged Platform for lowest TCO**
 - Open and modular with APIs dedicated to IoT

Industrialize IoT Open Innovation

Whitepapers/Webinars

- Orange/Actility Webinar on LoRaWAN/3GPP complementariness:
 - <https://www.youtube.com/watch?v=pWiZ3XGUpCU>
 - <https://www.slideshare.net/erikagelinard/lorawan-and-3gpp-technologies-cover-all-industrial-iot-use-cases>
- Whitepaper on multi-technology Platform:
 - <https://www.slideshare.net/Actility/whitepaper-how-to-build-a-multitechnology-scalable-iot-connectivity-platform>
- Whitepaper on How LoRaWAN and Cellular IoT Complement each other:
 - <https://www.slideshare.net/Actility/whitepaper-lorawan-and-cellular-iot-nbiot-ltem-how-do-they-complement-each-other>

THANK YOU

