The Race to 5G: Preparing Your Network Infrastructure

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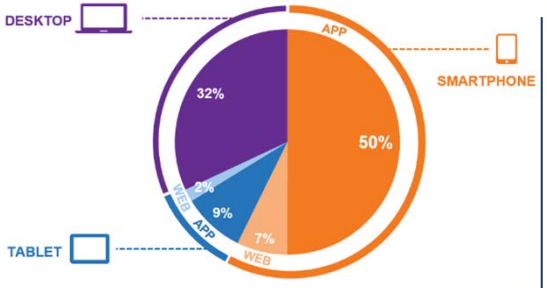
We Need Platform that can Deliver Critical Large Venue Needs

Future Ready, Today	Unmatched Multi-Carrier	Best-in-Class Performance	Flexible Software Modularity, Lowest Total Cost of Ownership
5G NR Support	Full Bandwidth, All Bands	Superior Uplink, Critical in Venues	Minimum CAPEX Investment
Overlay CBRS, Millimeter Wave	DISH and New T-Mobile Full Mid-Band Support Now	Lowest Failure Rates, Best in Class Support	Smallest Footprint (e.g. Remote-Side)

Upload Speed is as Critical as Download Speed

Likewise Uplink Performance in any DAS is as Important as Downlink Performance



Internet Access Statistics

Whether it is about FANs or TENANTs, today's communication is not about DOWNLOAD only…. Many Apps generate a tremendous amount of Uplink Traffic while uploading the content.

Quality Broadcast

Filtering per band, per remote minimizes distortion and ensures top performance in any location

Designed to provide superior speeds and coverage in high interference areas.

Passive Interference can be managed.

Foreign signal filtered

With Best in Class UL Interference mitigation, heavy UL usage in stadiums (photo & video sharing) leads to a better fan experience, increases attractiveness to fans to visit venue and generates more revenue.

Compromised Broadcast

Low quality systems have limited filtering – resulting in more distortion and lower uplink performance

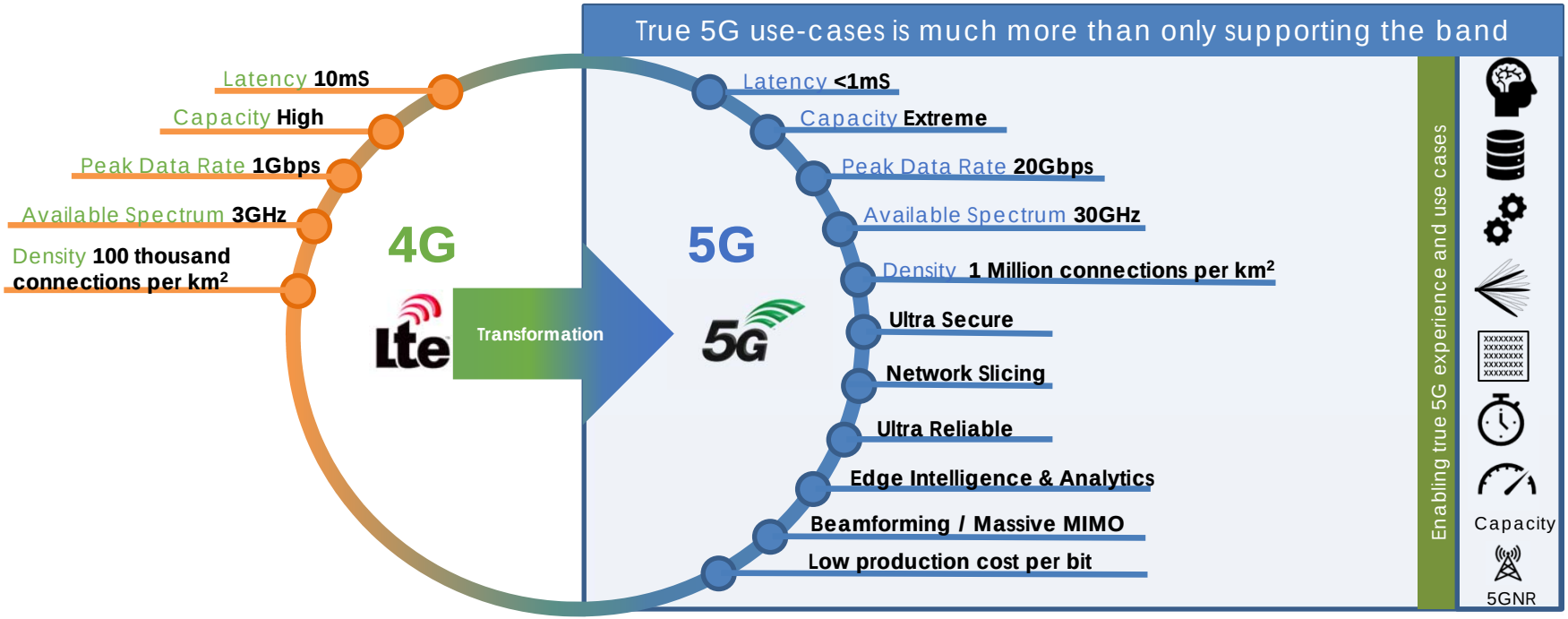
The noisier the area, the worse performance becomes. The most coveted areas are the worst performing

Active Interference is forever.

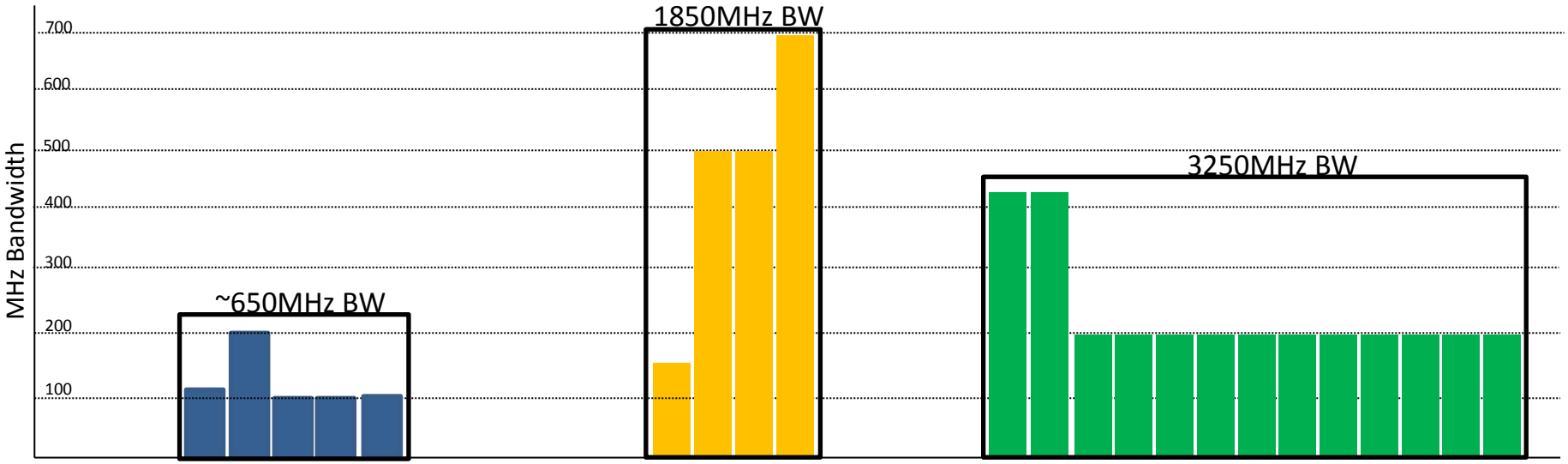
Foreign signal un-filtered, damaging uplink

5G is Needed to Deal With the Mobile Challenges

The transformation needs real 5G functionality



Venue Mobile Performance Roadmap



- Licensed 600 thru 2500MHz
- AT&T: 150MHz, Verizon: 115Mhz, T-Mobile: 110MHz, Sprint: 200MHz, Other: ~120MHz

- *3550 to 3700 MHz (150MHz) CBRS*
- 3700 to 4200 MHz (500MHz FCC)
- 5925 to 6425 MHz (500MHz FCC)
- 6425 to 7125 MHz (700MHz FCC)

- 27.5 – 28.35 GHz (2X425 Mhz)
- 37.6 – 38.6 GHz (5X200MHz)
- 38.6 – 40 GHz (7x200MHz)

Current Licensed Band Spectrum

Add Mid-Band Spectrum

Add mmWave Spectrum

Best-In-Class Performance

Uplink Quality

- Best in Class Interference Management
- Highest Upload Speed, Capacity

Downlink Performance

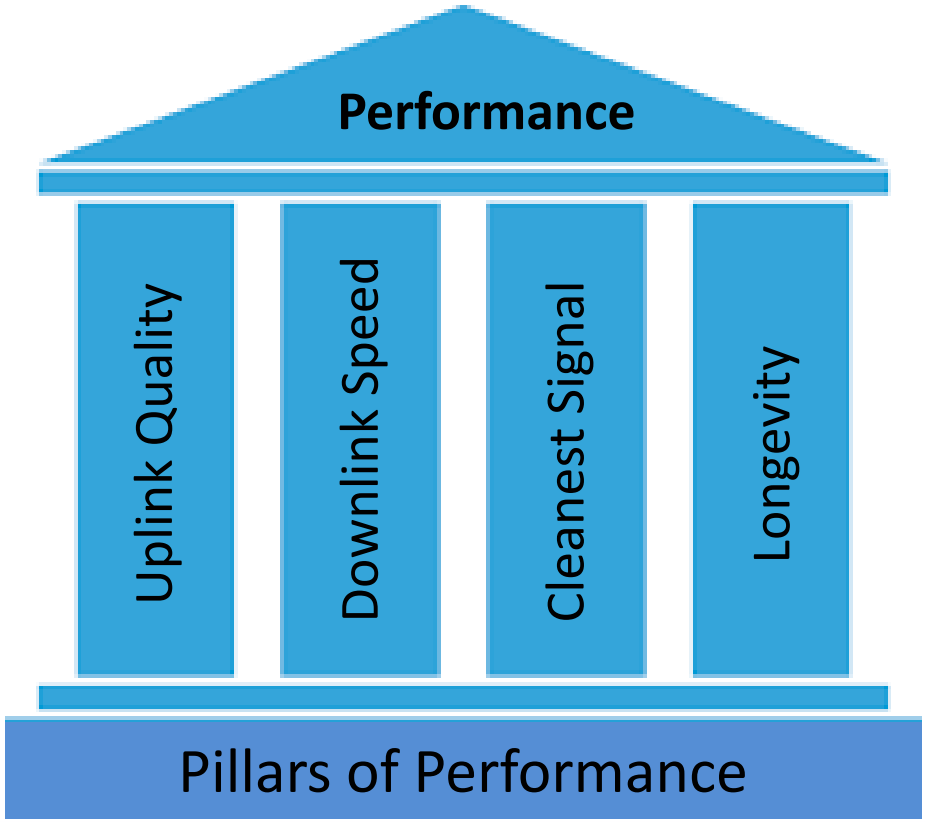
- High Peak to Average Power Ratio
- Multi Operator

Clean Signal = High Bandwidth

- Highest Offered Speeds, High Modulation
- Most Data Capacity

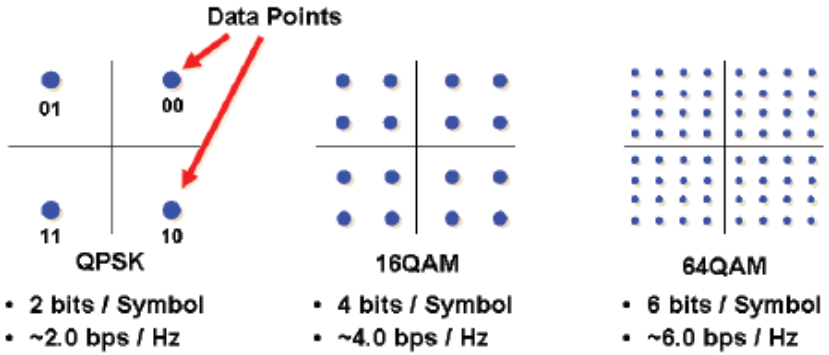
Built To Last

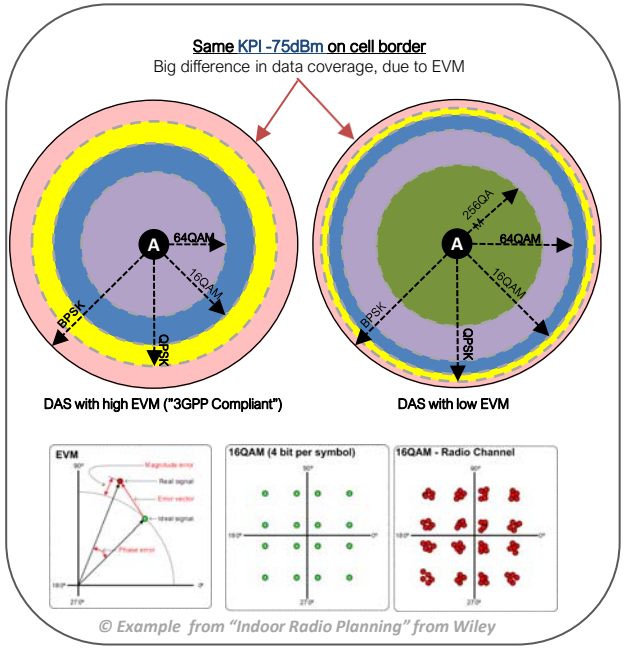
- Never Rip and Replace
- Industry's lowest fail rate <0.1%



Modulation Has an Impact in Capacity

Higher Modulation Schemes allow for more Capacity and Throughput but require a cleaner signal



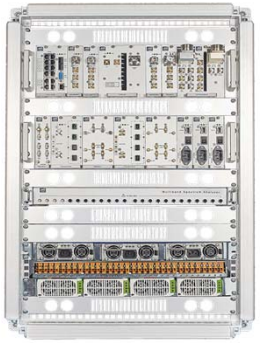


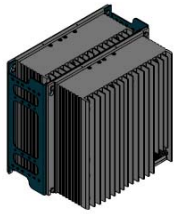
- How clean the signal is, defines the Modulation scheme
- It also defines how big of an area it will cover.

EVM in DAS of <1% allows for up to 1024QAM

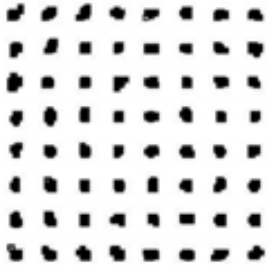
Signal Cleanliness is Future Readiness

Just like Music with Fuzz doesn't help an amplifier with Good Sound Quality, intolerable Noise in Signal is bad too!!





- **As modulations continue to grow (i.e. from 64 QAM to 256 QAM), an outdated DAS systems downgrade overall signal quality due to higher signal Noise (aka higher Error Vector Magnitude (EVM).**
- ***Future Ready DAS keeps pace due to its clean signal delivery with the lowest EVM in the market.***
- ***5G demands the lowest possible EVM.***
- ***256 & 1024 QAM require EVM < 2% & 1% respectively.***



Remotes that perform at a <1% EVM, i.e. Futureproof Gear with Safe Investments

Output Power That You Can Use at its Max (PAPR wise)

More and more people work from home, streaming services and connected devices are on the rise; meaning more users connected at the same time and data demand increases.

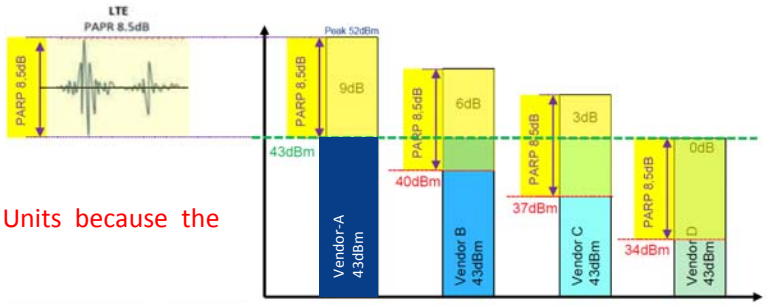
We need a system capable of handling all the users at the same time with the lowest number of Remote Units possible; Lower Cost and Less Points of Failure.

- RF Signal Source at times, transmit signals at higher power than Average.
- A good DAS is supposed to handle those unexpected Spikes efficiently without compromising output Power.

Vendor	Stated RU Power in datasheet	PAPR overhead	Actual transmitted 4G Power	No of extra Remotes needed to match
Vendor-A	**43dBm**	**9dB**	**43dBm**	**None (reference)**
Vendor-B	43dBm	6dB	40dBm	Factor 2
Vendor-C	43dBm	3dB	37dBm	Factor 4
Vendor-D	43dBm	0dB	34dBm	Factor 8

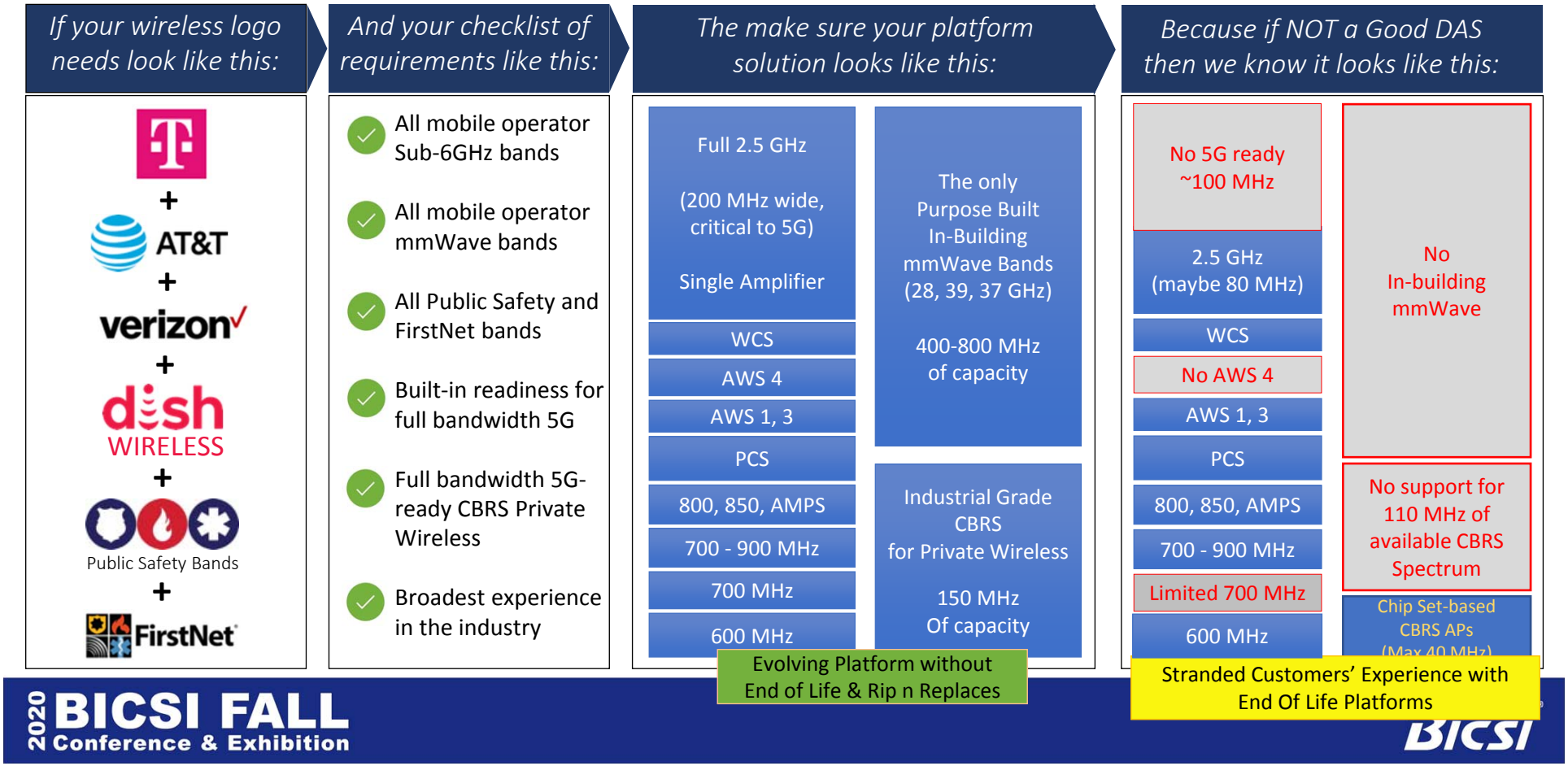
Quality Remote Units should have 9-12 dB of PAPR which guarantees the Maximum Output Power can be used.

LTE signals have a PAPR of up to 8.5dB.

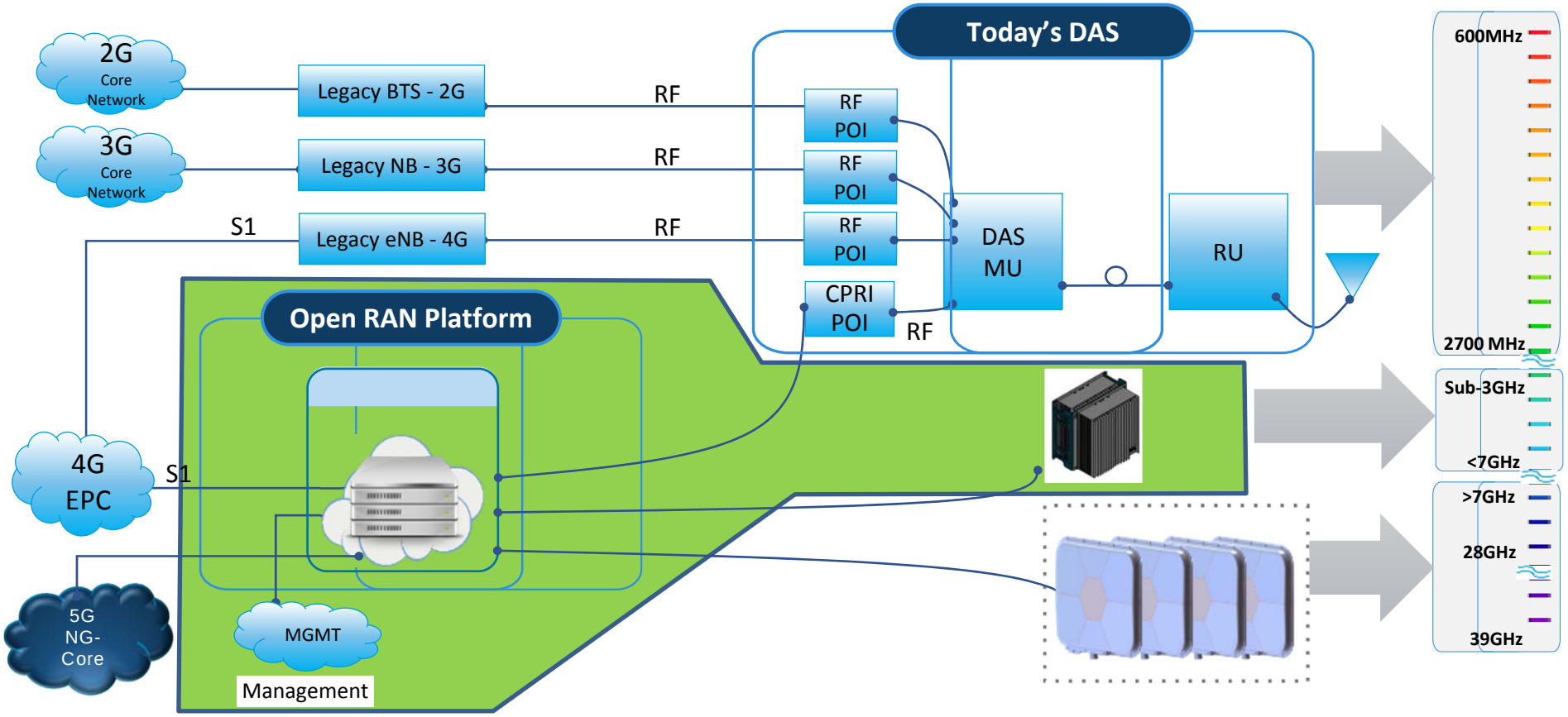


Having less PAPR leads to more Remote Units because the promised Output Power is not met.

The simple reason you select the best wireless platform in the industry.



System with Next Gen. Interoperability



New Jersey's American Dream Complex:
Case Study by ANS Advanced Network Systems

The Facility

- 600 Acre Entertainment and Retail Complex
- 3,000,000 Square Feet Indoor
- 450 Tenants and Attractions
- 100+ Facility IT Systems
- Adjacent to MetLife Stadium

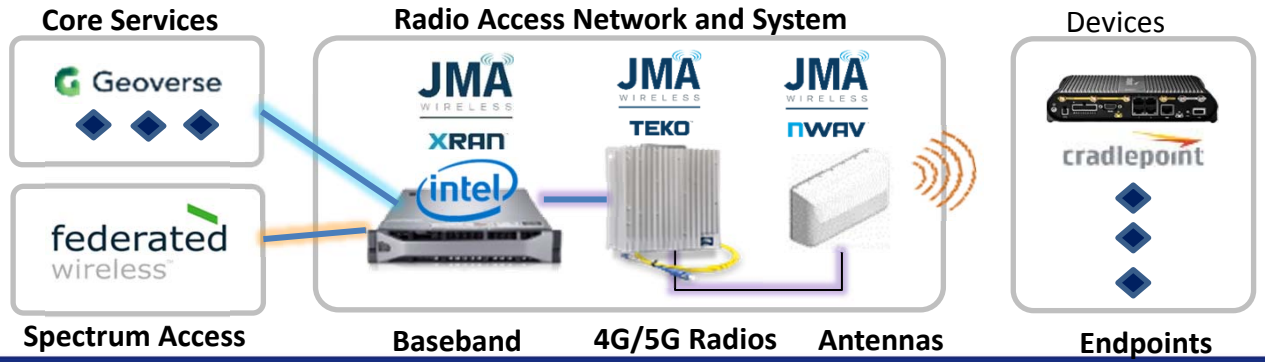
The Solution
Distributed Antenna System (DAS)

- Facility owned
- All major carriers participating
- 13 sectors of coverage and capacity
- Supporting all major carrier low band frequencies (600 MHz to 2700 MHz)
- System is software upgradeable to provide 5G on the supported frequencies

The Solution
Private LTE Network

- Private LTE utilizing CBRS frequency
- Local evolved packet core
- Phase 1 outdoor coverage
- Phase 2 indoor use cases
- Customer owned network
- 5G ready

- Use cases include:
  - Dynamic vehicle management
  - Security
  - Point of sale and store connectivity
  - Customer voice services
  - Roaming and capacity offload



ANS Agenda

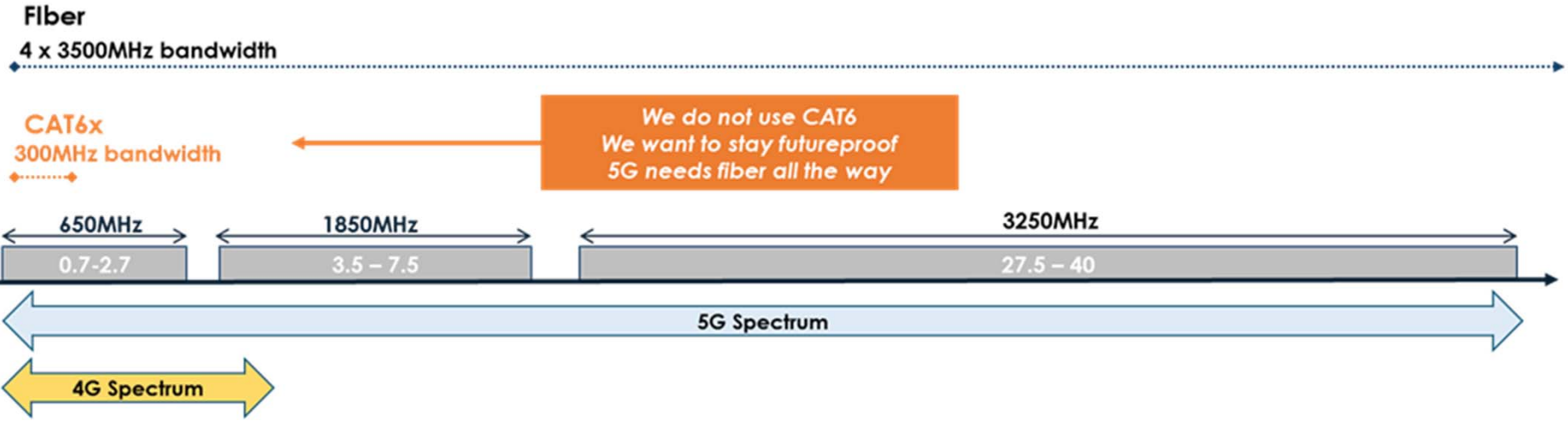
- **Physical Infrastructure**
  - Coax / passive path
  - Fiber
  - Best Practices
- **Challenges**
- **Solutions**
- **How we got there**
- **What we have enabled**

Cable Infrastructure to Support 5G

CAT6 will not do the job!

New spectrum for 5G

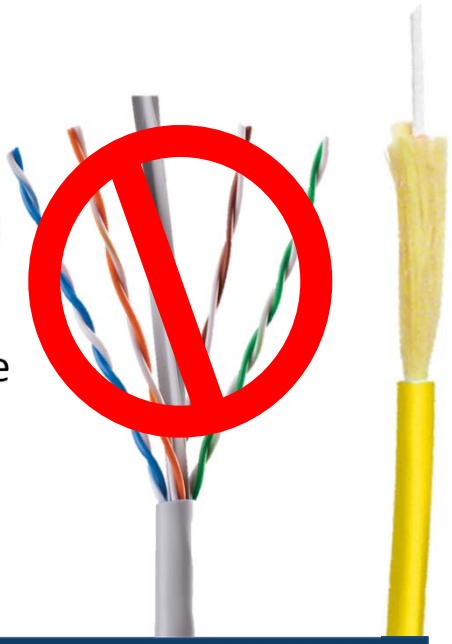
- 5G support will need up to 6GHz bandwidth
- Only fiber is futureproof, Fiber supports **4 x 3500MHz, range up to 20km**



Even for most 4G single and multi-operator solutions, Category cables will not suffice due to its limited bandwidth and reach. 5G will rely on even wider RF spectrum, only fiber can support the future.

Copper Category Limitations

- 4G multi-operator solution often requires far beyond what the CATx can support in RF bandwidth and RF power
- 5G support will need up to 6GHz bandwidth and long distances
- CATx supports 300 MHz to 100m
- CATx is often not available in the ceilings where the RF units are
- A cluster of CATx Nodes, generates high Uplink Noise Figures that will limit the Uplink capacity



- Only fiber is futureproof, Category copper cables will not do the job!
- The DAS must support the full bandwidth, with a range up to 20km ideally

Coax and The Passive Layer

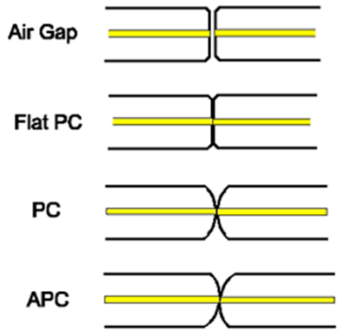
- Corrugated, not armored!
- Bend sensitive
- Pull with care

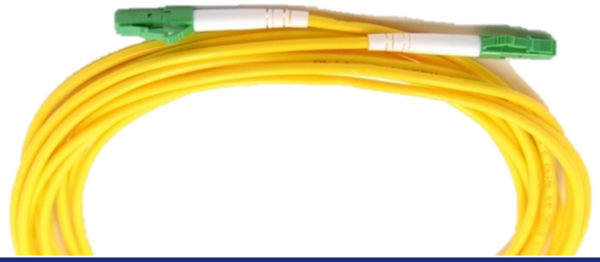
Coax and the Passive Layer

- Compression vs. 2-piece connectors
- Torque requirements
- Splitters and couplers
  - Support to 6Ghz
  - PIM rating
  - Public safety vs. carrier

Optical Infrastructure

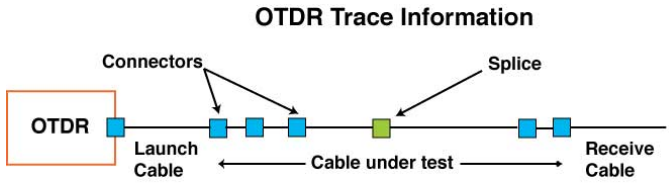
- Analog optical signal, reflectance and loss sensitive
- New vs. existing fiber plant
  - Re-terminate to APC
  - Standard of care

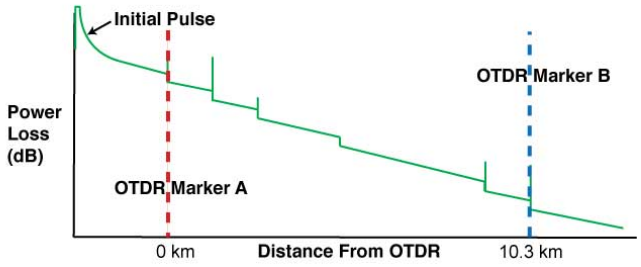




Optical Infrastructure

- Cleanliness is key
- Scope and clean
- OTDR testing





Connecting Today and Enabling Tomorrow

- User experience
- Public safety networks
- Next generation use cases
  - Private LTE networks
  - 5G readiness
  - Internet of Things (IoT)

Keeping in Mind

- Keep the system's integrator involved
- Understand the benefits and the why
- System maintenance

Thank You.
Q&A

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