The Next G:
What does 5G mean for Critical Communications and Electromagnetic Spectrum Dominance?

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NATIONAL INSTRUMENTS™

National Instruments Wireless Heritage
A leader in RF Prototyping & Test AND Software Defined Radio

NI and Wireless Standards

- Strong team of experienced standards engineers knowledgeable in PHY/MAC (5G, LTE, 802.11), mmWave, massive MIMO
- Attending 3GPP since 2010
- Multiple contributions and patents filed

NI and SDR

- Software Defined Instrumentation
  - PXI-based
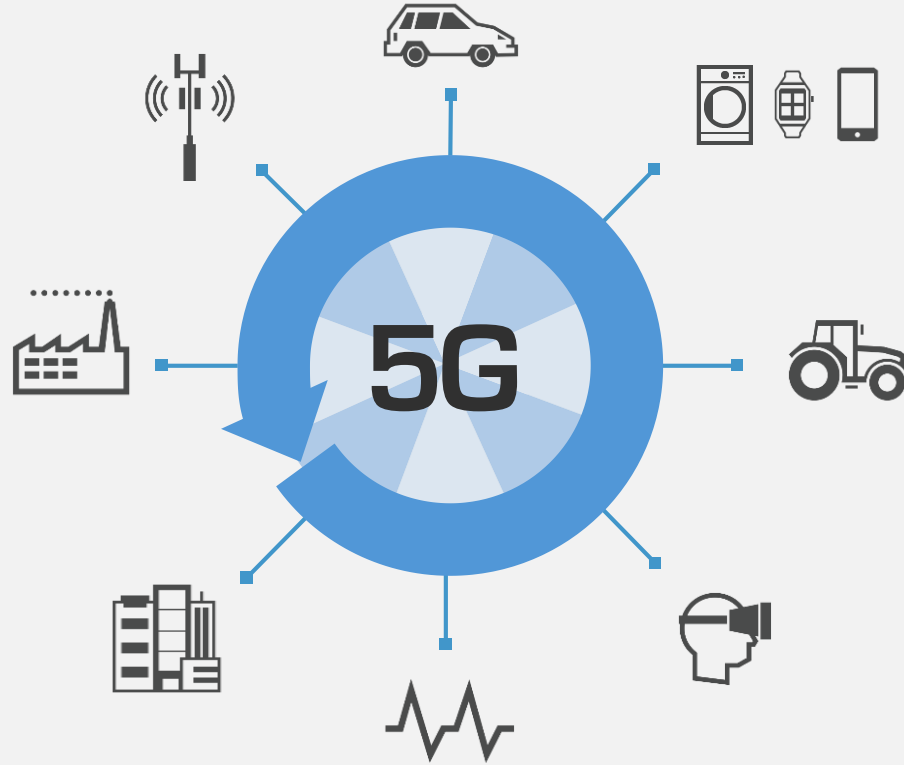- Software Defined Radio Acquisitions
  - Ettus Research – USRP "Universal Software Radio Peripheral", the leader in COTS SDR platforms
  - BEEcube – ATCA blades for massive compute density and throughput
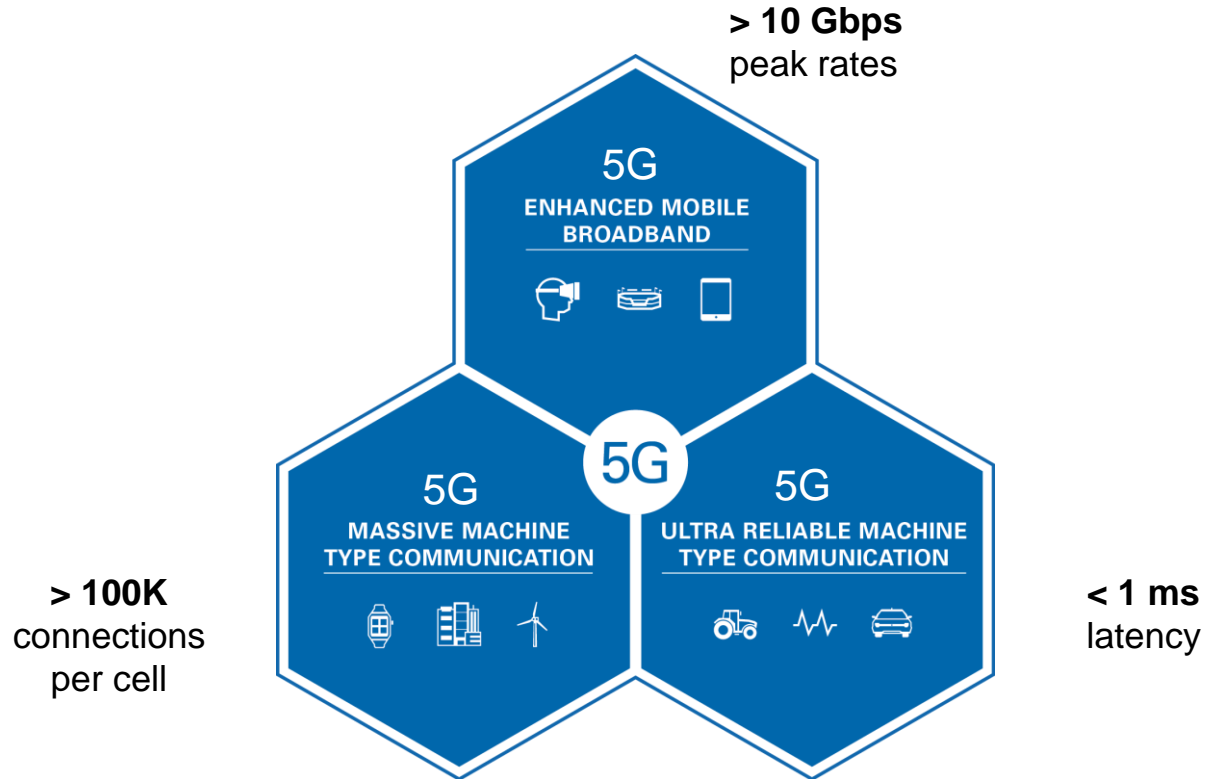- Putting the "S" in "SDR"
  - Support for graphical tools such as LabVIEW, GNU Radio (open source) and MATLAB, as well as native C++ and VHDL/Verilog
- RF coverage from DC to 76GHz

5G Will Be Everywhere

5G Will Push the Boundaries of Wireless Technology

> 10 Gbps peak rates

> 100K connections per cell

< 1 ms latency

5G
ENHANCED MOBILE BROADBAND

5G

5G
MASSIVE MACHINE TYPE COMMUNICATION

5G
ULTRA RELIABLE MACHINE TYPE COMMUNICATION

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The Key Use Cases Driving 5G

Enhanced Mobile Broadband (eMBB)

Gigabytes
In Seconds

3D Video, UHD

The Cloud

Smart Home

Augmented Reality

Mission Critical
(ex. Health Care)

Smart City

Industry Automation

Autonomous Driving

Massive MTC
(mMTC)

Ultra Reliable MTC
(uMTC, ULLC)

Source: ITU-R M.[IMT.VISION]

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So 5G will be "Everywhere"...
But What Does "Everywhere" Mean For Warfighters and First Responders?

Some Unique Requirements and Use Cases for Tactical and First Responder Networks

- No single point of failure
  - Ability to function without infrastructure via peer-to-peer communications, relay capability, mobile ad hoc networking
  - What about D2D or proximity services?
- Extended Range (thousands of meters)
  - HF/UHF/VHF
  - Powerful PAs
- Reliability
  - Ruggedness
  - QoS
- Secure
  - Unclassified and classified data

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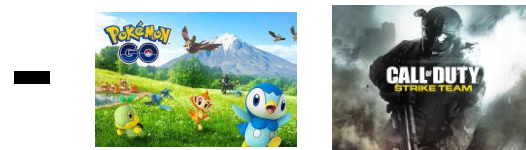
Is 5G <u>The</u> Solution for Critical Communications?

- 5G won't meet all the use cases and requirements of the warfighter and first responders

- But it has to be <u>part</u> of the solution – if the infrastructure is there and the usage fits the mission profile, use it!

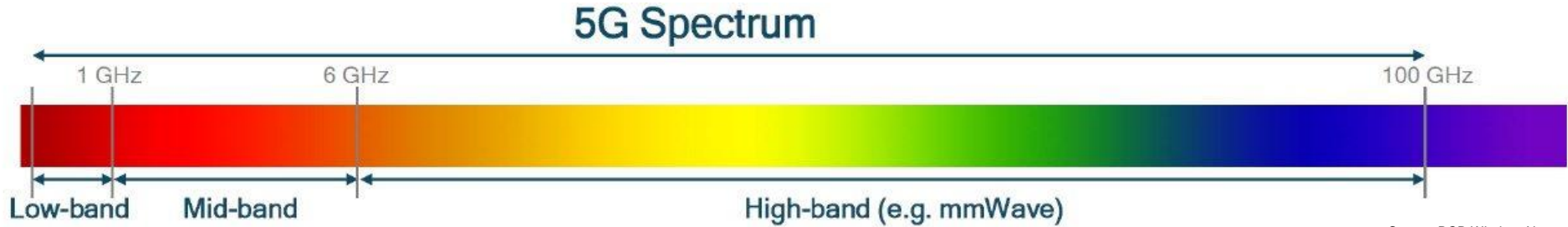- Military waveforms can greatly benefit from increased throughput, larger networks, and lower latency

Table 1-1. Cluster 5 Waveforms

WAVEFORM	Threshold	Objective
SINCGARS ESIP (VHF-FM Military Tactical AJ)	SFF, HH, M	
HAVE QUICK II (UHF-AM/FM/PSK Military Tactical AJ)	SFF, HH, M	
UHF SATCOM Military (181-182-183 DAMA)	M, HH, SFF	
Enhanced Position Location Reporting System (EPLRS)	SFF, HH, M	
Wideband Networking Waveform (WNW)	SFF, HH, M	
Link 16/TADL-J		M
UHF SATCOM Military Protocol (184)	SFF, HH, M	
HF Single Side Band (SSB) w/Automatic Link Establishment (ALE) AJ	M	HH
HF ATC Data Link	M	
VHF FM Military Tactical	M. HH	
VHF for ATC		M

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WAVEFORM	Threshold	Objective
VHF AM ATC	M, HH	
VHF/UHF FM LMR	SFF, HH, M	
VHF ATC Data Link (NEXCOM)	M	
UHF AM/FM PSK Military Tactical	M	
SATURN (UHF PSK AJ NATO)	M	
Soldier Radio & WLAN & Advanced Capability	SFF, HH, M	
COBRA	HH	
MUOS-CAI	SFF, HH, M	
Cellular Radio & PCS	SFF, HH, M	
Mobile Satellite Service (MSS)		M, HH
Integrated Broadcast Service (IBS)	M	

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What about 5G for SIGINT and EW?

5G Spectrum

1 GHz   6 GHz   100 GHz

Low-band   Mid-band   High-band (e.g. mmWave)
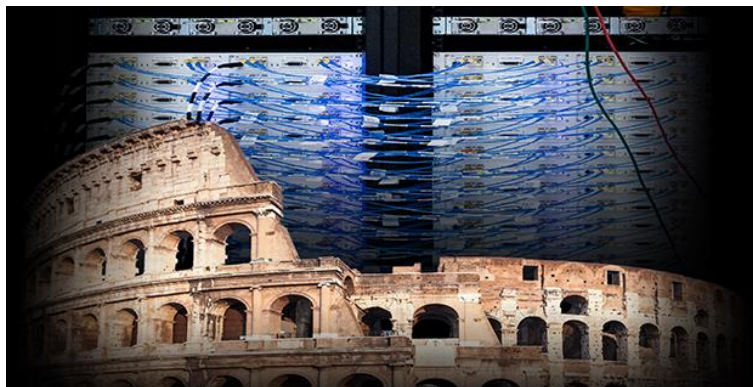
Source: RCR Wireless News

The new DC-to-Daylight!

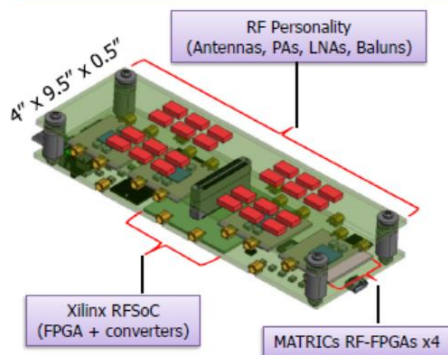# So How Do You Achieve EMS Dominance with 5G?

- How to deal with:
  - 100GHz of instantaneous bandwidth
  - A lot more data to monitor and turn into actionable intelligence
  - A lot more noise to sift through
- Artificial Intelligence and Machine Learning to the rescue?!
- Yes, 5G will use lots of AI and ML technology!
  - Interference mitigation
  - Dynamic spectrum access & cognitive radio
  - Network management
  - Network optimization
  - And many more applications!
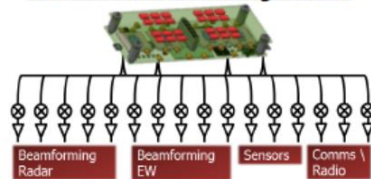
Some Answers for the 5G Future of SIGINT & EW?

Conclusions

- 5G isn't <u>The</u> solution for tactical and first responder networks, but using 5G should be part of the solution.

- Leveraging 5G technologies to increase throughput, support larger networks and enable lower latency for tactical and first responder networks is a must.

- EMS dominance will be a huge challenge.

- New 5G technologies will be needed to cover all bands of interest.

- AI and ML technologies being developed to support 5G will be needed to derive actionable intelligence.

- 5G will be <u>almost</u> everywhere!

- And 5G technology should be everywhere!