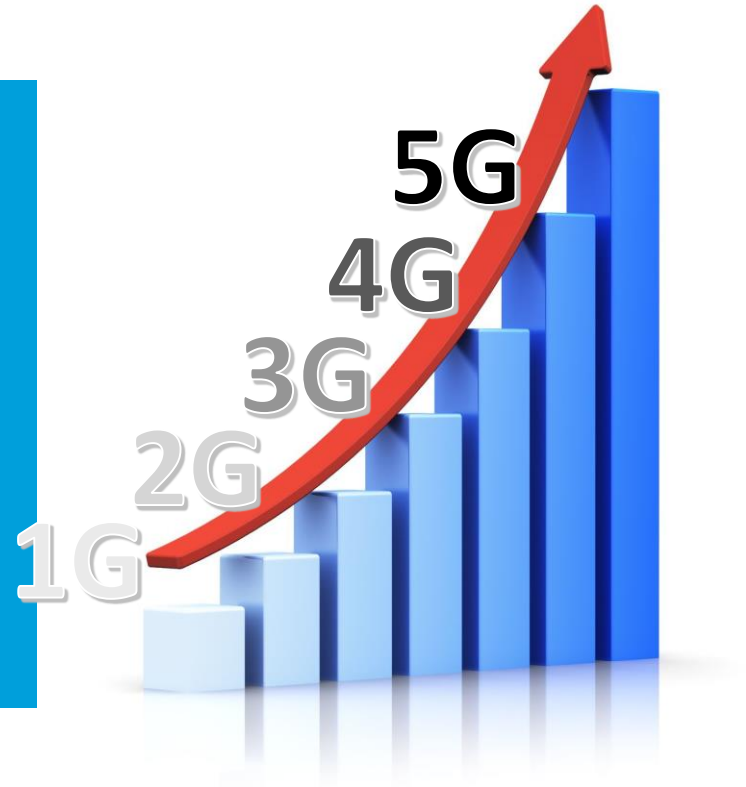


5G and Licensed/Unlicensed Convergence

WBA Conference
November 2016
Dave Wolter



Wireless Trends

- Continued rapid growth of data demand
- IoT will drive growth in connected devices
- Wireless Everything ... Everywhere
- By 2020, more than 5 billion people and 50 billion things will be internet connected
- Both cellular and WiFi are expected to be key communications standards for Broadband and IoT
 - Cost reductions will make cellular connected IoT more viable – Cat M, Cat M1
 - Cellular will perform aggregation and routing functions and enable reuse of cell functions (QoS, security, device mgt...) as well as direct connection

	15 billion	28 billion	CAGR 2015–2021
Cellular IoT	0.4	1.5	27%
Non-cellular IoT	4.2	14.2	22%
PC/laptop/tablet	1.7	1.8	1%
Mobile phones	7.1	8.6	3%
Fixed phones	1.3	1.4	0%

Ericsson Mobility Report – June 2016

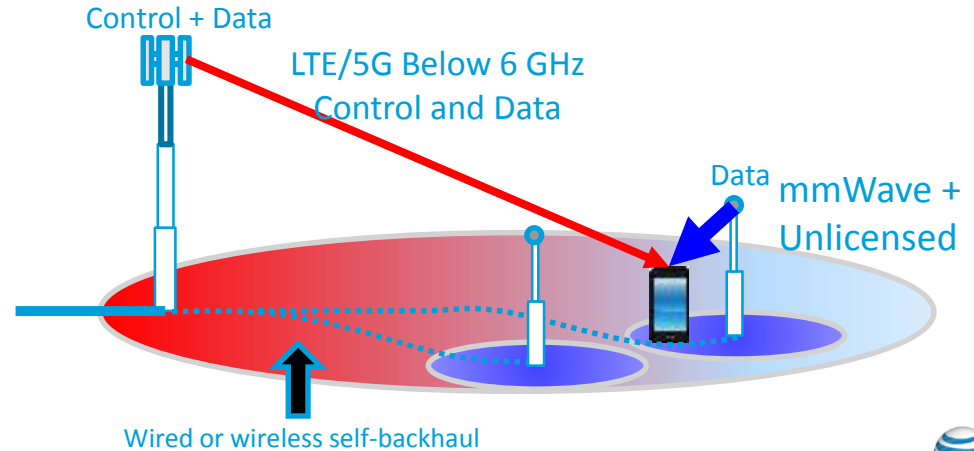
10,000 times more traffic will need to be carried through all mobile broadband technologies at some point between 2020 and 2030

Spectrum Reality

- Data demand is exploding – peak speed and capacity
 - Licensed spectrum is fragmented with small bandwidth
 - Carrier aggregation being used to increase peak speed
 - Unlicensed spectrum is used in many applications – home, enterprise, public
 - Mobile operators are integrating Wi-Fi to augment licensed spectrum
 - RAT selection (Wi-Fi Offload)
 - LTE-LAA
 - LWA
- Unlicensed Integration

5G Layers

- Multi-RAT System
 - Sub 6 GHz – macro or small cell
 - Improved spectral efficiency
 - Broadband
 - IoT
 - Control for mmWave mobility
 - mmWave – small cell only
 - Extremely high speeds
 - Integration of Other Networks
 - LTE
 - Unlicensed
- Access Agnostic Core
 - One of the primary objectives of NGxC is access independence.
 - The NGxC should have the native built-in ability to support multiple access technologies, wireline included.

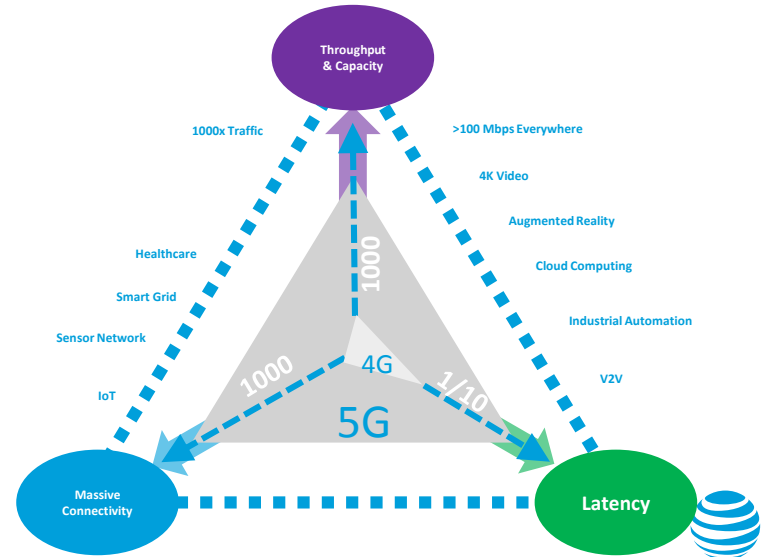
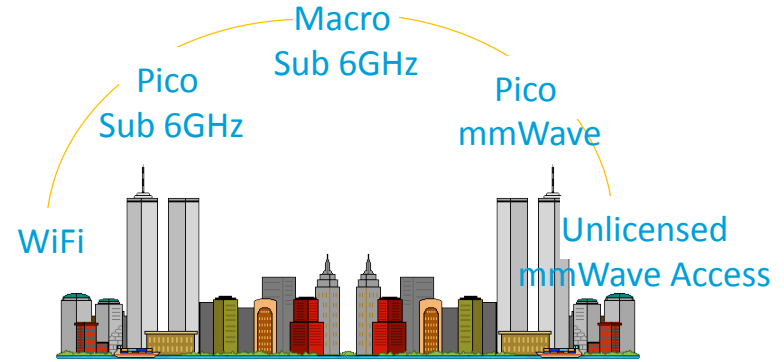


New Spectrum

- 600 MHz – currently in auction
- 3.5 GHz
- Spectrum above 24 GHz
 - 28 (850 MHz), 39 (3 GHz)
 - 64-71 GHz unlicensed – created 14 GHz of unlicensed spectrum
 - New bands under consideration in FNPRM (24 GHz – 90 GHz)
- New spectrum needed below 6 GHz
 - Increased throughput with lower latency
 - Anchor/control plane for mmWave
 - Massive IoT and URLLC

System Perspective

- Flexible and universal network platforms to cope with heterogeneous environments – SDN/NFV
- Network slicing – multiple logical networks on a common physical infrastructure
- Convergence between fixed and mobile networking services
- Communication networks will be replaced by the notion of a communication system
- Faster service creation and reduced development times
- Service/network management will evolve to use advanced automation and exploit Big Data for better QoS and QoE
- Unlicensed/Wi-Fi will continue to serve independent needs
- Unlicensed technologies become an integral part of this
 - Wi-Fi should continue to develop to be carrier grade, improved integration, better interference mitigation



Emerging Spectrum Trend

Dynamic Spectrum Sharing

- It is more challenging to obtain spectrum in which the incumbent vacates the spectrum and provides for exclusive use
- It is likely that future allocations will require some level of spectrum sharing on a geographic or temporal basis
- 3.5 GHz experiment - three tier sharing system: (1) the incumbent who will get protection, (2) a licensee who will be subordinate to the incumbent but will be protected from the (3) general authorized access or unlicensed
 - A spectrum access system (SAS) would be deployed to govern usage of the spectrum
 - Google is pushing the SAS idea in the 3.5 GHz band and elsewhere
 - SAS is unproven but is also being suggested for some of the mmWave bands.