5G Indoor network design

Vladan Jevremovic, PhD

November 27th, 2018

iBwave Wi-Fi Suite

iBwave
Unity

iBwave
Wi-Fi® Mobile

iBwave
Wi-Fi® (for PC)

5G Indoor network design

iBwave

Agenda

- 5G network
  - Network requirements
  - Use cases
  - Visions of 5G networks
  - 5G frequency bands
- Innovation and cost reduction
  - Beamforming and Massive MIMO
  - Network slicing
  - C-RAN with NFV
- Indoor network design strategies
  - Millimeter wave band
  - Sub-6 GHz bands

iBwave

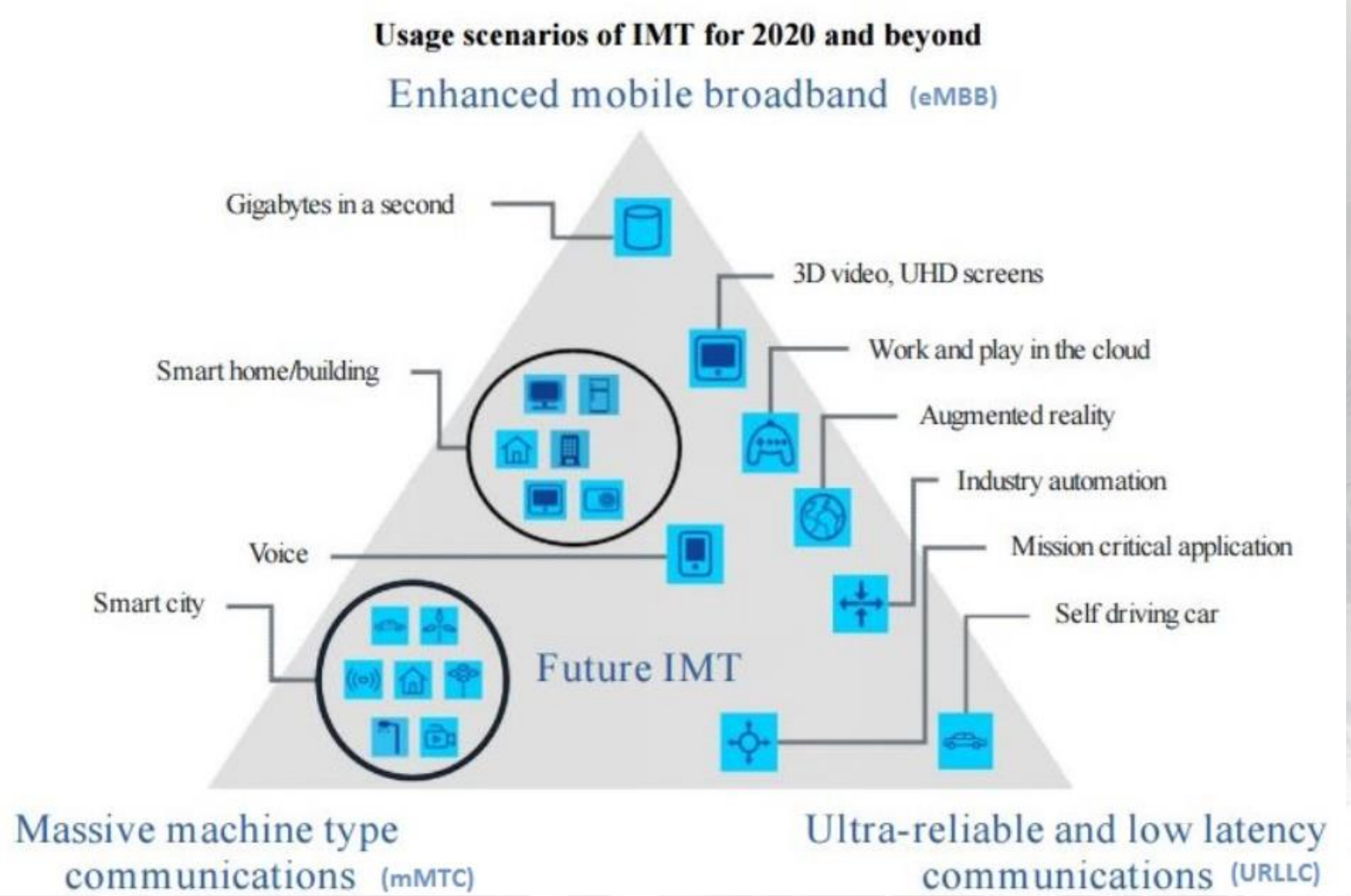
5G Network

- 5G Network Requirements compared to LTE-A
  - Higher device density
  - Higher device throughput
  - Lower latency
  - Better efficiency
    - Signaling efficiency
    - Energy efficiency

5G Network

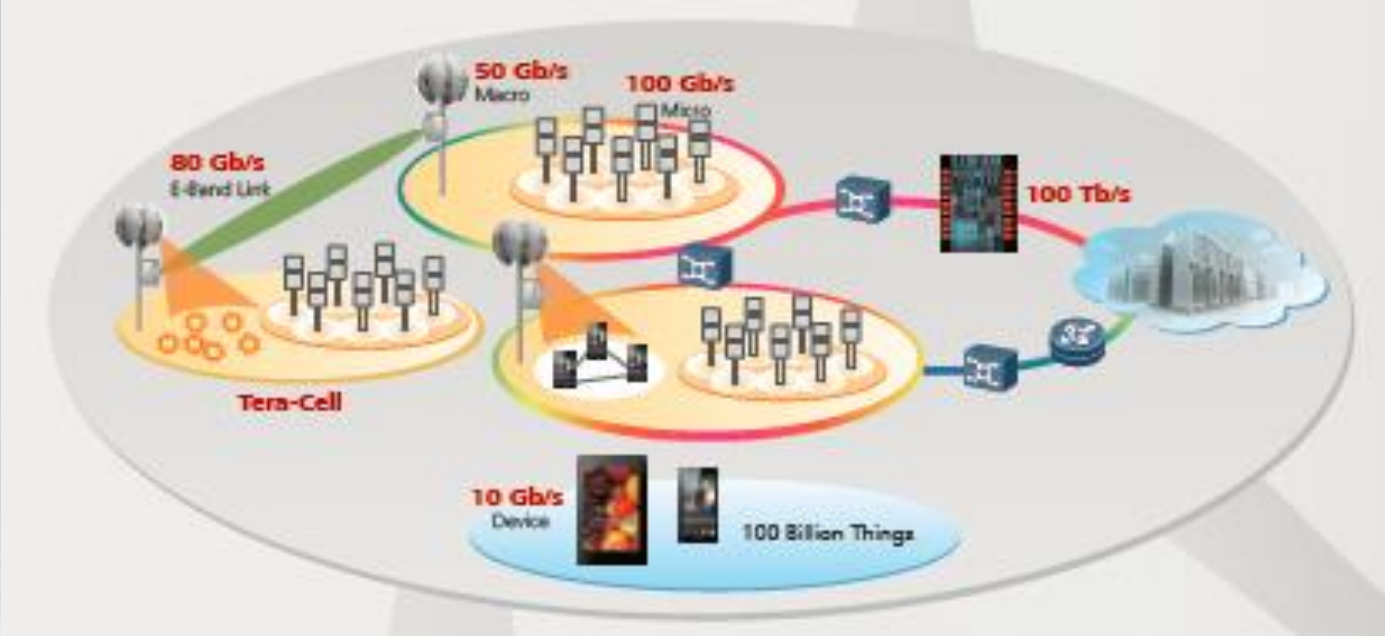
- Use Cases
  - 10 Gb/s to support mobile cloud service
  - 1 Gb/s to support Ultra HD video
  - 1 million connected IoT devices per square kilometer
  - 0.5ms latency for Vehicle to Vehicle application
  - 10ms switching time between technologies (4G⇔5G)
  - IoT battery life should be at least 10 years

5G Network


Usage scenarios of IMT for 2020 and beyond
Enhanced mobile broadband (eMBB)
Gigabytes in a second
3D video, UHD screens
Work and play in the cloud
Smart home/building
Augmented reality
Industry automation
Voice
Mission critical application
Smart city
Self driving car
Future IMT
Massive machine type communications (mMTC)
Ultra-reliable and low latency communications (URLLC)

5G Network Vision

- How would a 5G network look like?
  - Macro “umbrella” Tera cell, 50 Gb/s
  - Small cells underneath, 100 Gb/s
  - E band wireless backhaul, 80 Gb/s
  - Fiber ring, 100 Tb/s
  - A few UEs @ 10 Gb/s
  - Many IoTs @ few kb/s

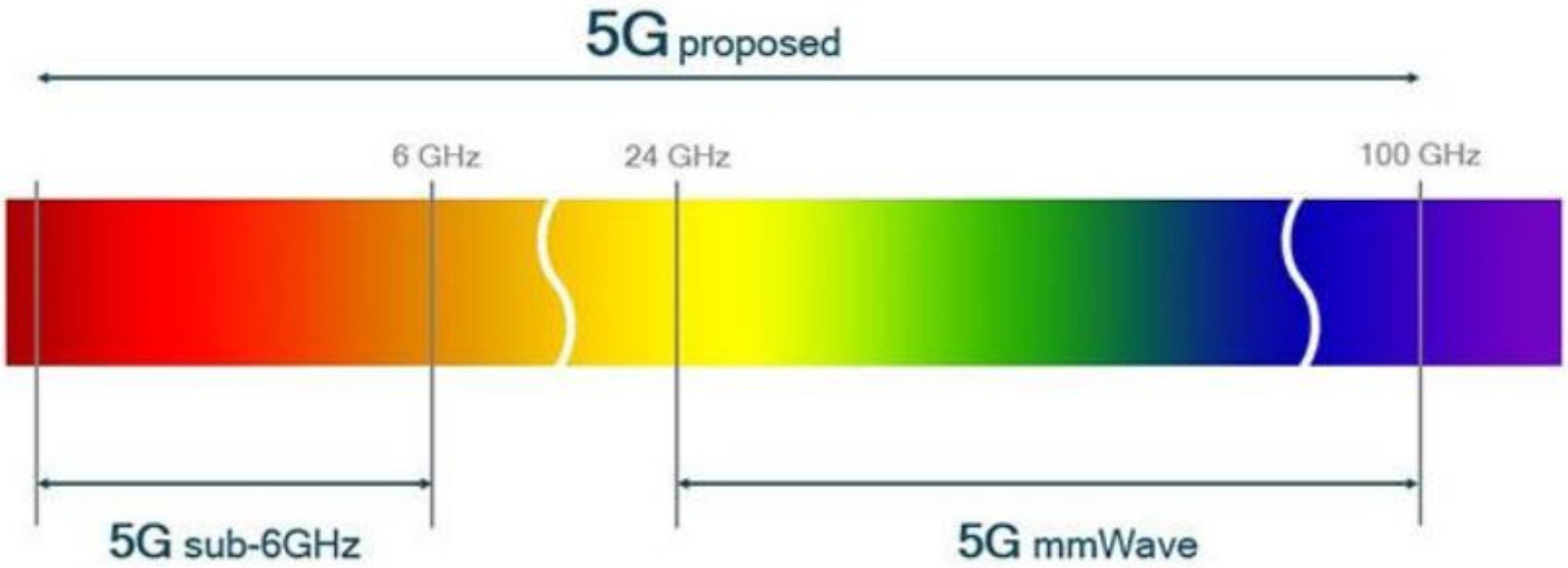


iBwave

5G Network Vision

- Enhanced Mobile Network
  - Same HetNet network like LTE, but much faster
  - Critical feature: mobility
  - Critical for success: Massive MIMO, availability of sub 6GHz spectrum
- Converged fiber wireless network
  - Short wireless links at the end of local fiber cable
  - Critical feature: super fast data rate
  - Critical for success: millimeter wave spectrum
- Super efficient network
  - Critical feature: efficiency
  - Critical for success: the cost to deploy drops faster than data demand rises

5G Network spectrum



5G Network spectrum

- Sub 6 GHz spectrum
  - This is divided into low band (f < 3 GHz) and mid-band (3 < f < 6 GHz) spectrum
  - This spectrum will be used for 5G coverage everywhere
  - Mobility will be supported
  - Massive MIMO and Beamforming will be supported
  - Most initial indoor deployments will be in this spectrum

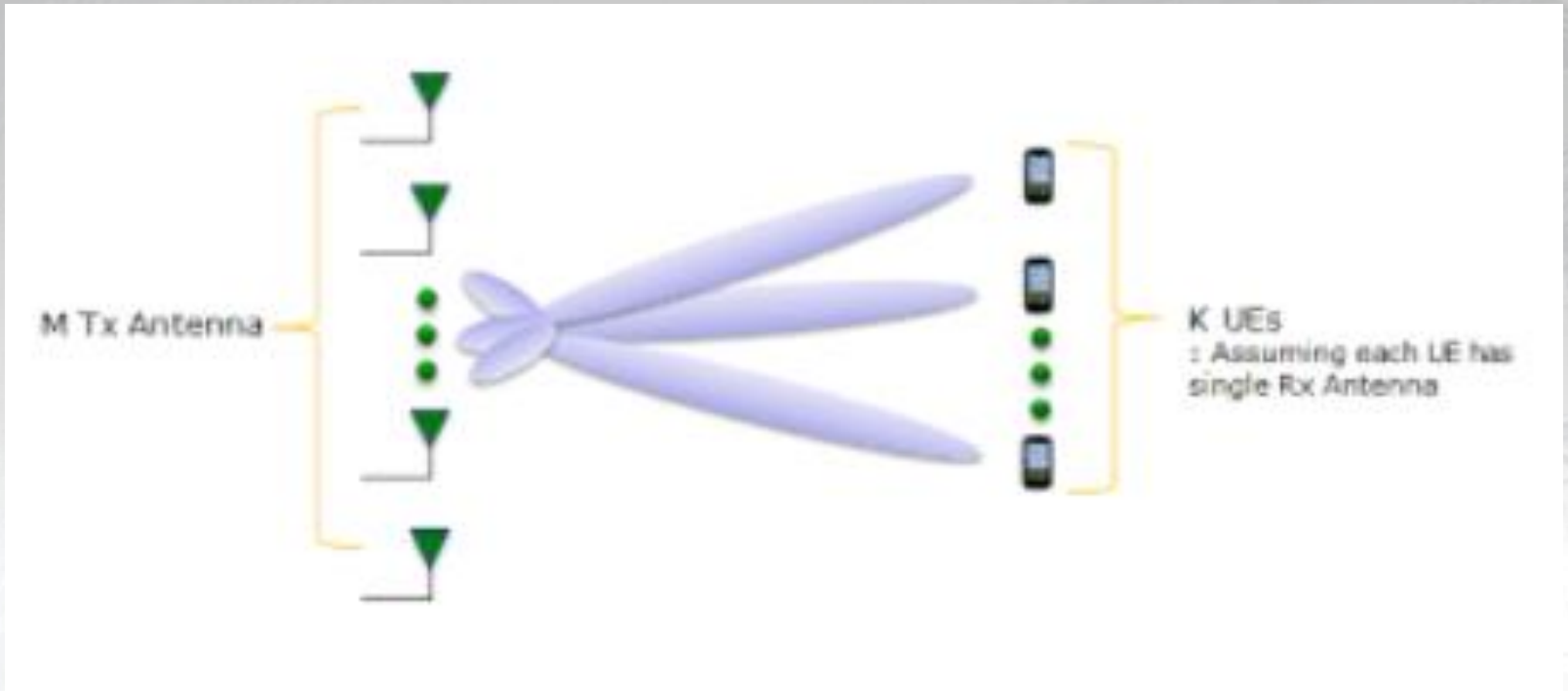
5G Network spectrum

- Millimeter wave spectrum (24 – 100 GHz)
  - No mobility support, short links (less than 200 meters)
  - Opportunistic deployment: Line of Sight (LOS) or Near LOS
  - Beamforming will be supported, but massive MIMO might not
  - First USA deployment in this spectrum uses 5G home routers

iBwave

Innovation and cost reduction

- Beamforming
  - Each UE gets its own optimized antenna array radiation pattern
  - The pattern maximizes the signal for the target UE & minimizes the interference for all other UEs



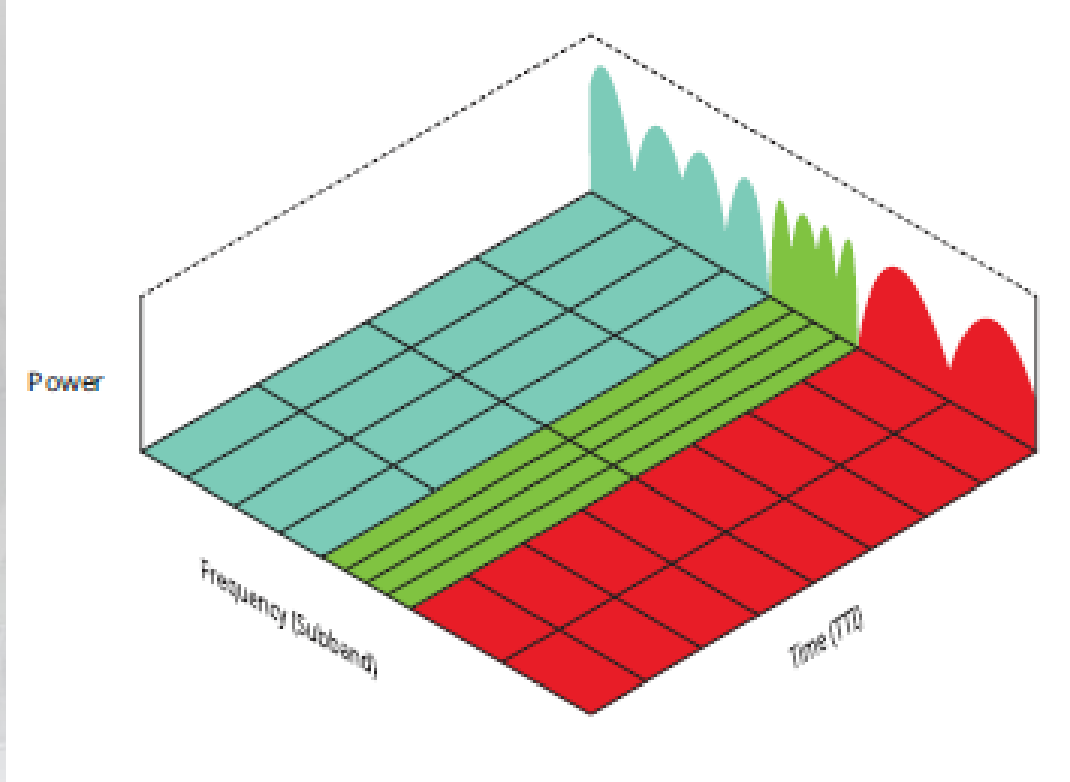
Innovation and cost reduction

- Massive MIMO
  - Up to 256 antennas at base station
  - Cross polarization is used to decorrelate signals
  - Each antenna has a separate RF connection back to transceiver
  - Lots of antennas, lots of beamforming circuits, lots of complexity
  - Big and expensive

iBwave

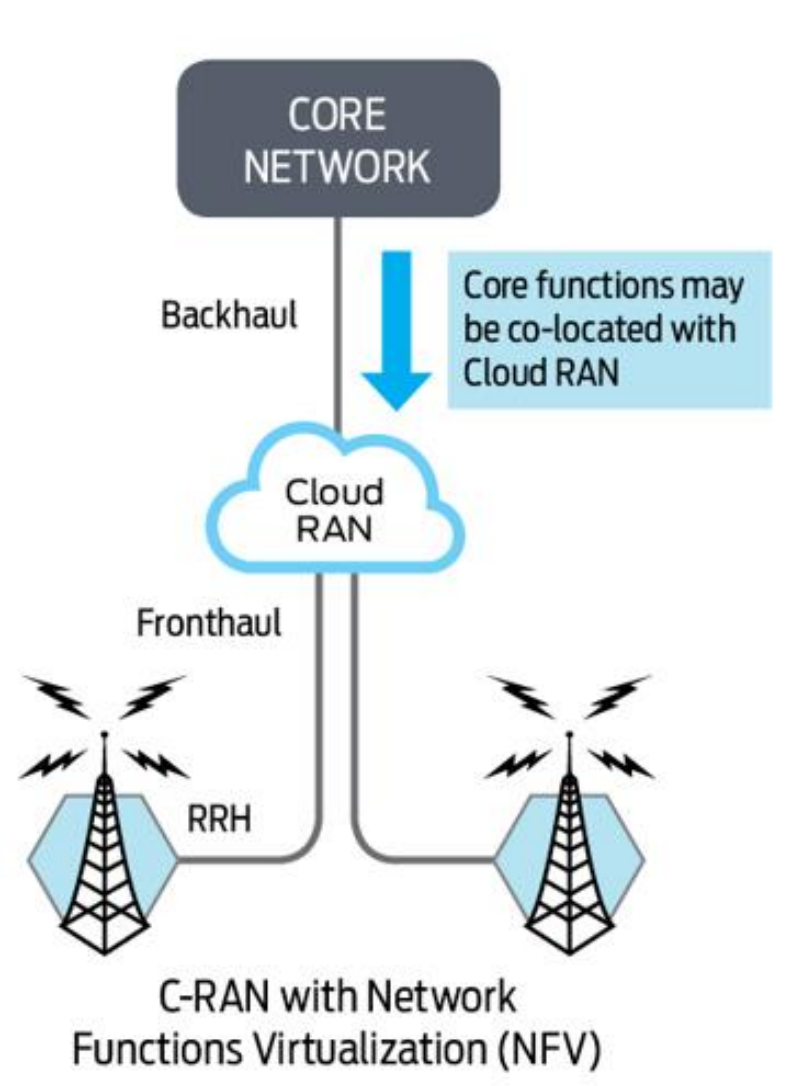
Innovation and cost reduction

- Network slicing
  - Network slicing is capability to address different use cases within the same RF channel
- How is it done?
  - Divide an RF channel into sub-bands with different Transmission Time Interval (TTI) and sub-channel spacing
  - In this example we have 3 sub-bands
    - Teal: TTI 1ms, sub-channel 30 kHz
    - Green: TTI 2ms, sub-channel 15 kHz
    - Red: TTI 0.5ms, sub-channel 60 kHz



Innovation and cost reduction

- C-RAN with NFV
  - Base Band Units (BBU) are centrally located, away from Remote Radio Heads (RRH)
  - BBU post processing is done by commercial servers in the cloud (NFV)
  - Fronthaul connectivity must be fiber
- Benefits
  - Real time BBU (capacity) allocation across many RRH
  - Less equipment at RRH saves electricity and reduces operating cost



Indoor network design strategies

- Millimeter wave band
  - Material penetration loss at millimeter wave is very high
  - To ensure indoor coverage, Line of Sight (LOS) between small cell and UE is required
  - Small cells with beamforming and Massive MIMO are big and expensive
  - To deploy these small cells at millimeter wave in every indoor venue, with LOS requirement, may be too expensive
- Solution:
  - Opportunistic deployments in venues with LOS and with lots of users
    - Stadiums
    - Convention centers
    - Train stations

iBwave

Indoor network design strategies

- Sub 6 GHz bands
  - Penetration loss is not a problem in this band
  - However, beamforming Massive MIMO small cells are big and expensive
  - What to do if there are not enough users at the venue to justify their deployment?
- Solution:
  - Deploy 4x4 MU-MIMO small cells
  - Fewer antennas, less equipment, lower cost
  - Performance is better than 4G, with similar deployment and operational cost

iBwave

2018 - SAN DIEGO

Wi-Fi TREK

Thank you!

iBwave

we keep the world connected