

5th Generation Air Interface Designs: Massive MIMO/Cloud RAN/Millimeter Wave/LBT

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- ◆ Looking beyond 4G
- ◆ India's needs
 - Universal rural connectivity – NOFN+wireless
 - Urban and rural middle mile solutions
 - Solutions for wireless back-haul
 - Ultra low latency is not *a critical* requirement
- ◆ Approach
 - Exploit spectrum in high frequency bands
 - Combined licensed and unlicensed mode of operation
 - Develop technologies that offer an order of magnitude increase in spectrum efficiency

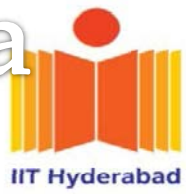
Smart cities program will be the key driver for early adoption of IoT and 5G

Technologies being Developed



- ◆ Cellular IoT for Massive Scale
 - Disruptive architectures on the unveil
- ◆ Scalable Systems Very High Data Rates
 - 100Mbps- Multiple Gbps
- ◆ Massive MIMO and Cloud RAN
 - Large antenna arrays create bandwidth: Co-located or Distributed
 - Unified design
- ◆ Multi-operator spectrum sharing
 - Listen-Before-Talk based protocols

Scalable System, Very High Data Rates



- ◆ Data rates of interest
 - 100Mbps- Multiple Gbps
 - Bandwidth supported: 20MHz-1GHz
- ◆ Frequency bands of operation: 5.5 GHz-80GHz
- ◆ Scalable PHY design
 - Significant new developments in air interface technology
 - High spectrum efficiency
 - Large radio range
 - Low energy consumption

First Field Trail Planned: 2016

- ◆ Massive MIMO
 - Large antenna arrays in a single base station
- ◆ Cloud RAN
 - Distributed antennas controlled by a cloud (Massive Network MIMO)
- ◆ Unified design to support Massive MIMO and Cloud RAN
 - An order of magnitude improvement in spectrum efficiency over conventional systems
 - New radio interface technologies developed

Cloud RAN Field Trail in Progress

Unlicensed Operation in 5G

- ◆ New family of Listen-Before-Talk (LBT) based protocols
- ◆ LBT based 5G networks
 - Multiple operators occupy the spectrum at the same time
 - Opportunistic placement of base stations
 - Unsynchronized networks
 - High spectrum efficiency: comparable to cellular systems
- ◆ Spectrum efficiency scales linearly with the number of operators
 - Cellular like spectrum efficiencies/operator
- ◆ Tightly converged licensed and unlicensed operation

LBT based Multi-Operator Spectrum Sharing Field Trail by mid 2016

Summary

India expected to drive 5G standards with deep technology know how, prototypes, field trails

Thank You