SCTE ISBE CABLE-TEC EXPO '16

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5G: Enabling Multi-Gigabit Residential & Enterprise Services in the Last Mile

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Ericsson Inc.

SCTE Society of Cable Telecommunications Engineers

ISBE International Society of Broadband Experts

#CableTecExpo

Essential Knowledge for Cable Professionals™

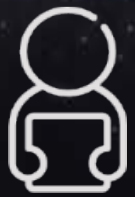
Mobility By 2021

9.1 Billion Mobile Subscriptions
90% Mobile Broadband
150 Million 5G Subscriptions

10X data Traffic
90% population coverage of MBB
75% LTE population coverage

28 Billion
Connected Devices

Evolution of Use Cases and Business Models



Full-length HD movie in seconds

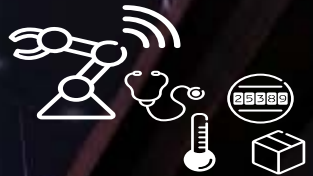
4G

5G

Stop a self-driving car faster

Fixed wireless broadband

Drone Control & Communication



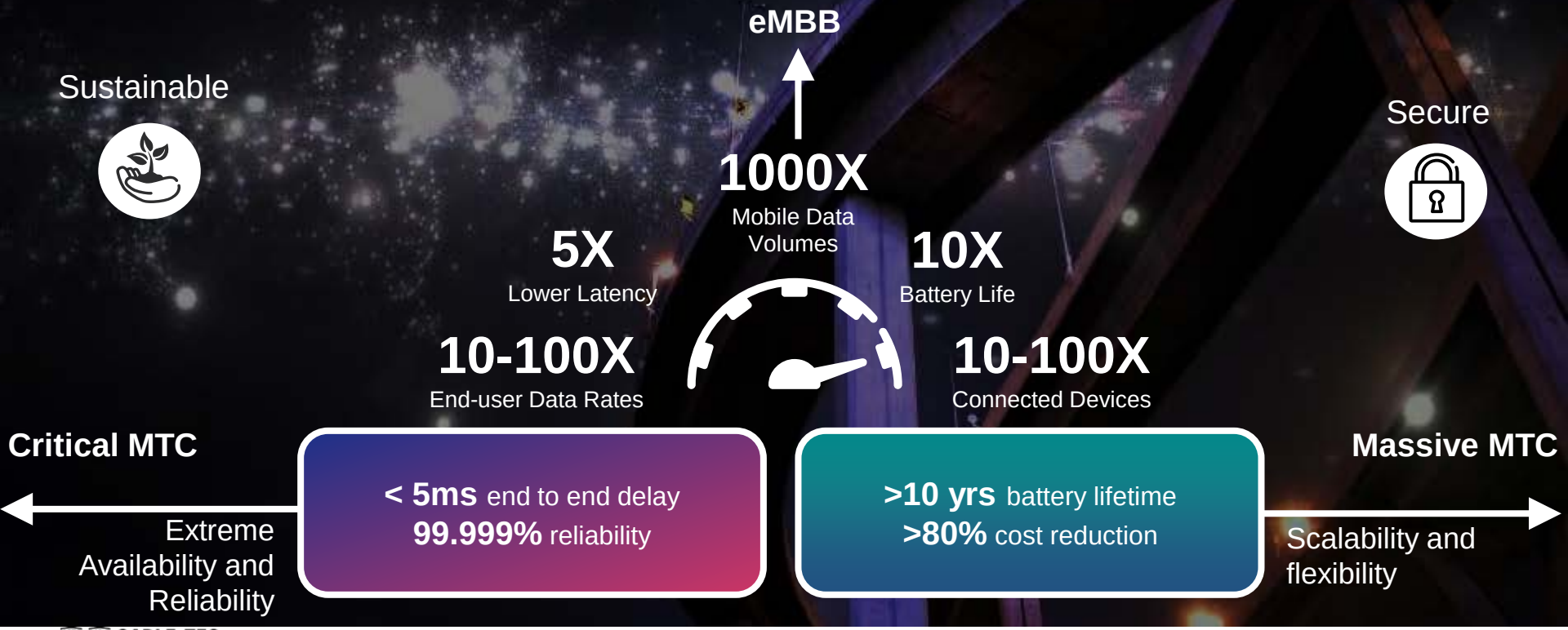
10 Year Battery Life for Remote Sensors

Virtual Reality / Hologram

Remotely Operate Robots

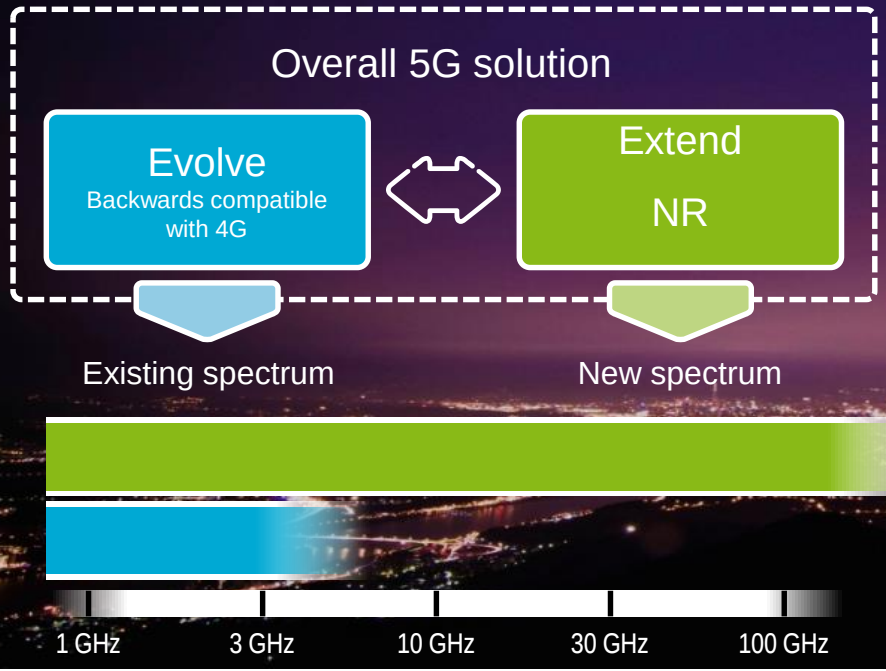
To enable new revenue streams, new business models, new use cases

Performance Requirements



Source: METIS

5G Radio Access



Evolution of existing technology adding new RAN technology

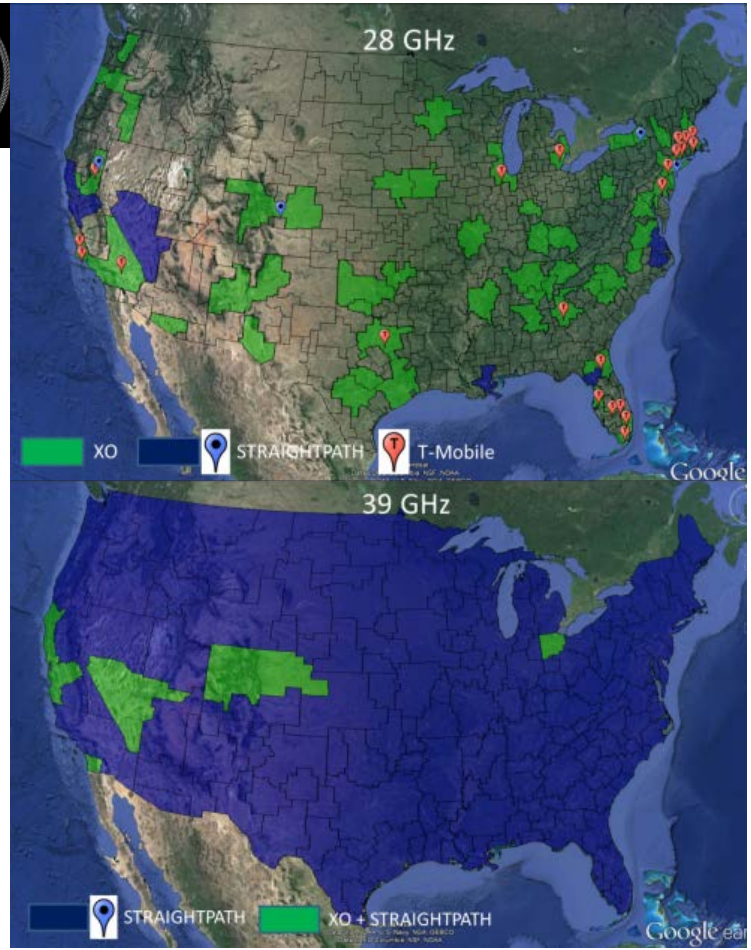
Combined allows rapid switching based on radio conditions

Gradual migration of new technology into existing spectrum

Flexible connections for multiple services

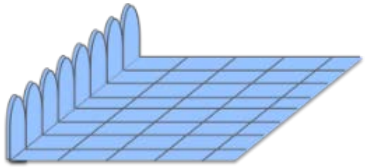
5G US Spectrum

- FCC 5G Order Expected in Summer 2016
- Initial Bands: 28 GHz, 37-40 GHz, 64-71 GHz
- Incumbents expected to get rights for 5G deployments – including leasing and sale of spectrum
- Non-sold spectrum will be auctioned
- Additional bands for comments
  - 24-25 GHz (24.25-24.45/25.05-25.25 GHz),
  - 32 GHz (31.8-33.4 GHz),
  - 42 GHz (42-42.5 GHz),
  - 48 GHz (47.2-50.2 GHz),
  - 51 GHz (50.4-52.6 GHz),
  - 70 GHz (71-76 GHz), and 80 GHz (81-86 GHz).
  - MVDDS holders (multichannel video distribution and data service) licensees interested to use their 12.2-12.7 gigahertz band spectrum for 5G



New Radio PHY Design

OFDM Waveform



- OFDM with flexible numerology
- Filtering and shaping by digital processing

Lower Latency

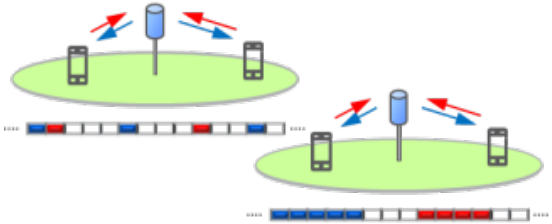
Larger Bandwidth

20 MHz

100 MHz +

- **Multiplexing** of wideband and narrowband devices on the same radio resource

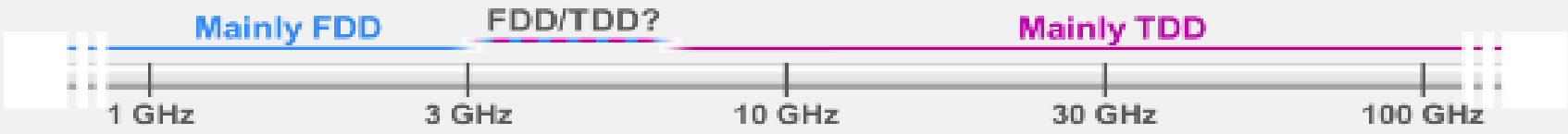
Spectrum Flexibility



- Support for various spectrum allocation schemes

Dynamic TDD
FDD

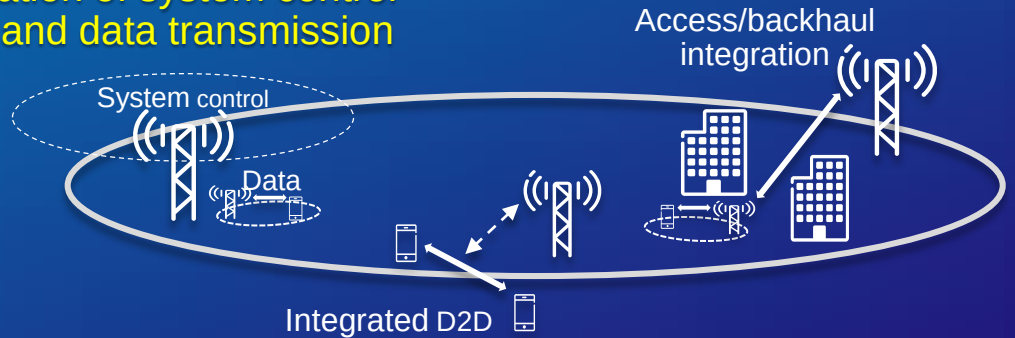
Extension to Higher Frequencies



5G Key Technology Components

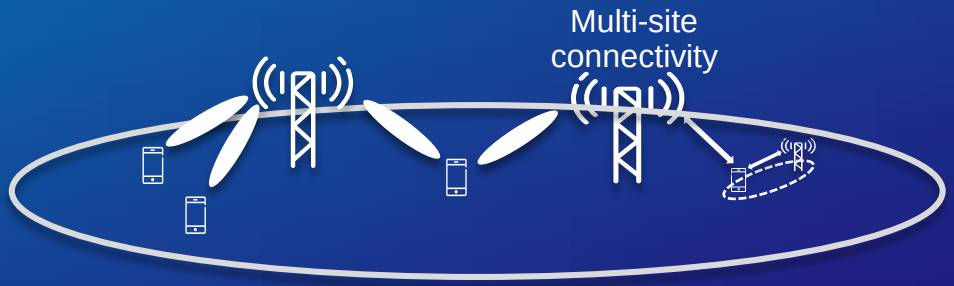
Technologies to support new use cases and deployments

Separation of system control plane and data transmission



Advanced Antenna technologies

- Beam-formed transmission
- Multi-User MIMO
- Distributed MIMO



Energy Efficiency and Forward Compatibility

Ultra-Lean Design

High Frequency Challenges

Propagation

Diffraction

Outdoor-to-indoor penetration

Rain/atmospheric attenuation

(Less of an issue for small cells)

Body loss

Regulation

Additional Tx power limitations above 6 GHz

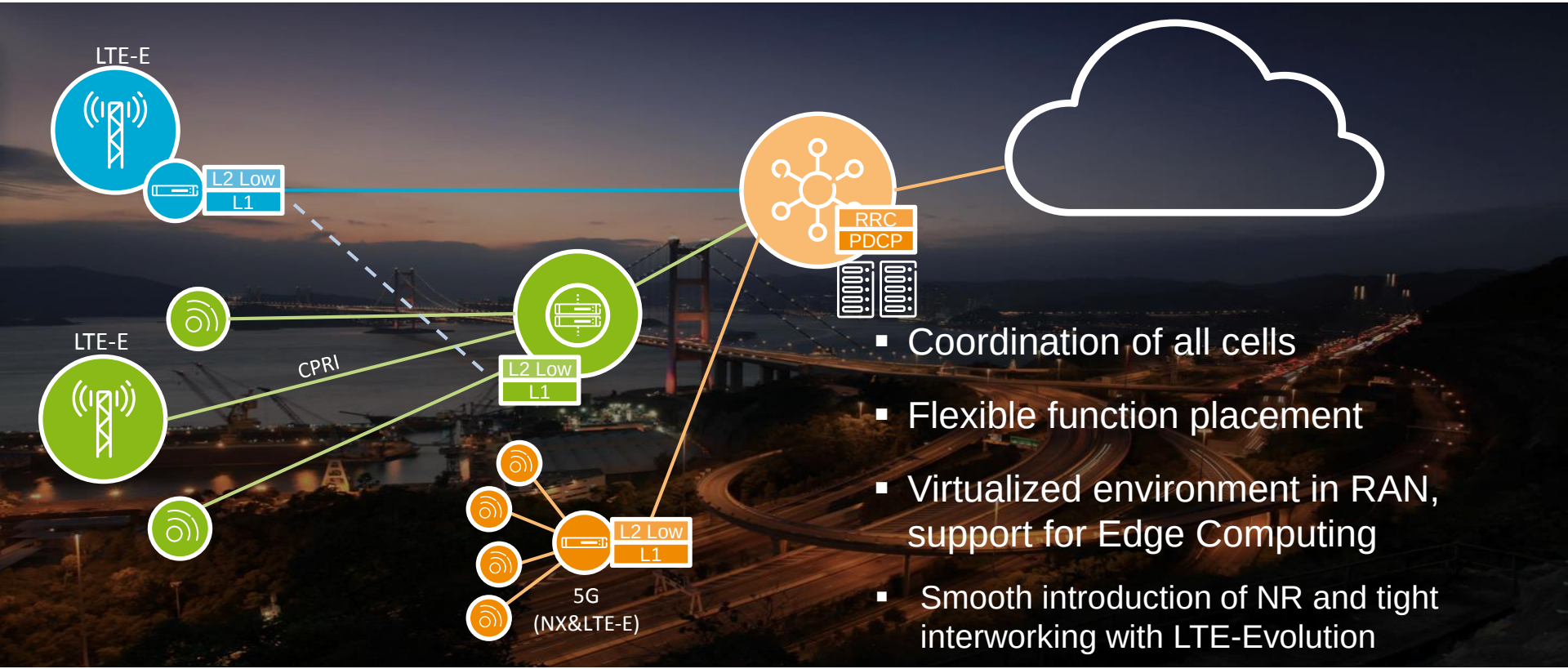
Implementation

Efficiency, dynamic range, output power, …

Beam-centric NR design

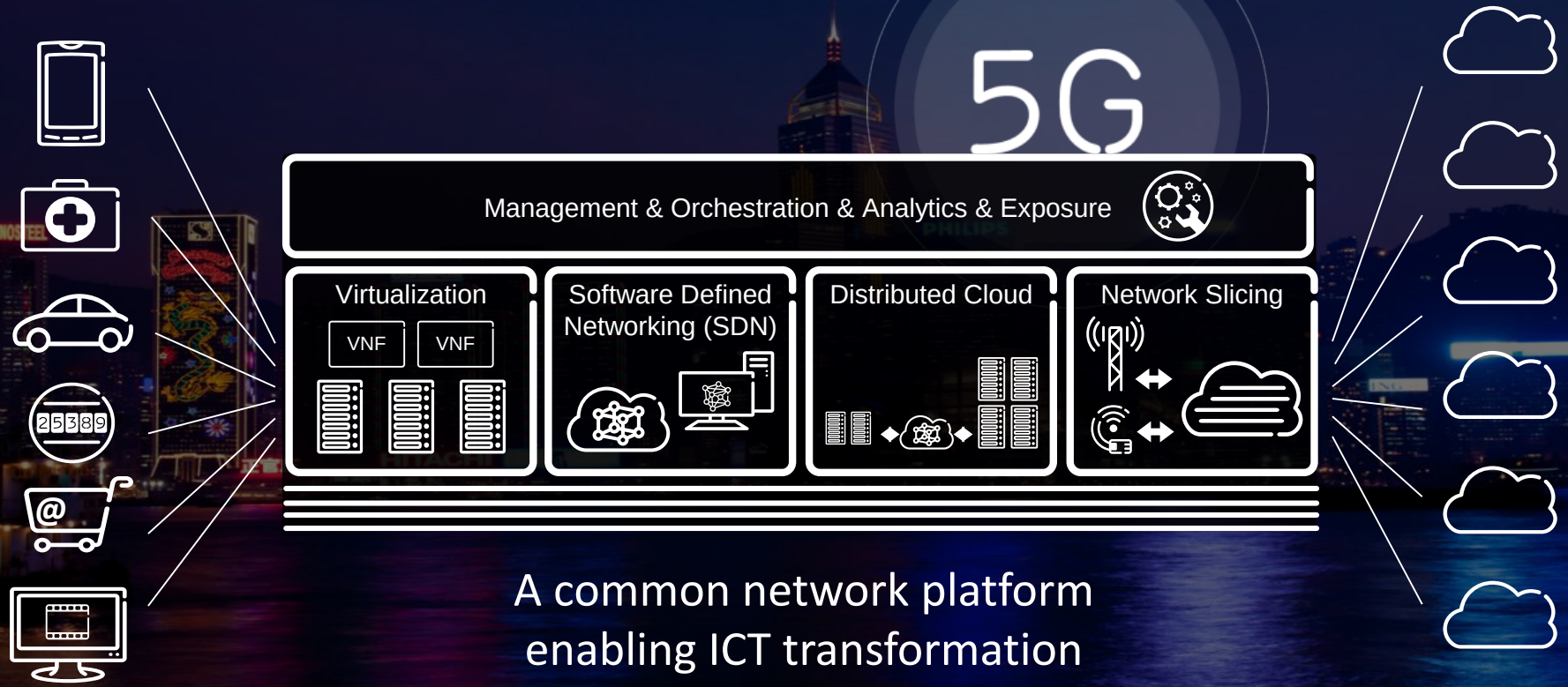
- High frequency ➔ high beamforming gain
- Self-contained data transmissions
- "Beam mobility" – Mobility between beams rather than nodes

RAN Architecture Evolution



- Coordination of all cells
- Flexible function placement
- Virtualized environment in RAN, support for Edge Computing
- Smooth introduction of NR and tight interworking with LTE-Evolution

Core Network Evolution



A common network platform enabling ICT transformation

ONE Network with Dynamic and Secure Network Slices

FWBB Suburban Region Assumptions and Modelling Approach

Map

- 1.3kmx1.3km map
- 1567 buildings (~1000 buildings/km^2)

Site deployment

- Utility Pole only
  - Site height 6m
- Hybrid: Utility Pole + Macro grid (ISD~1000m)
  - 4 macro sites in the area

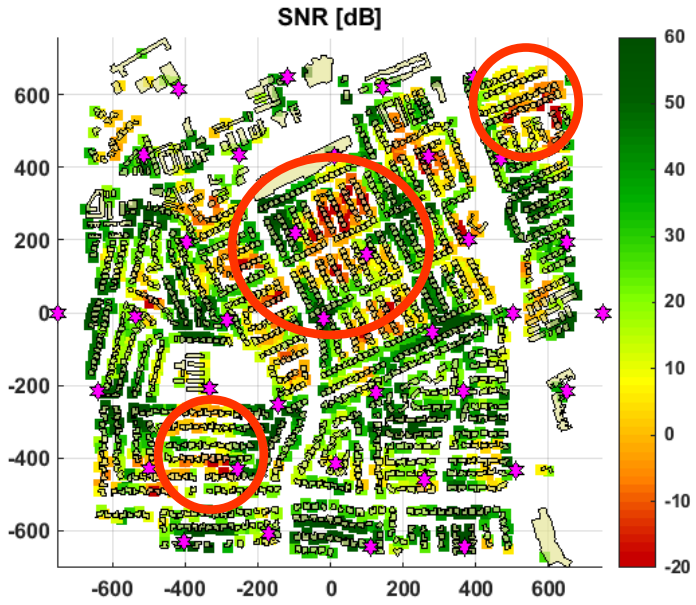
EIRP and BW

- 60 dBm for DL, 30+10=40 dBm for UL
- 200/400/800 MHz at 28GHz, TDD w 57% DL

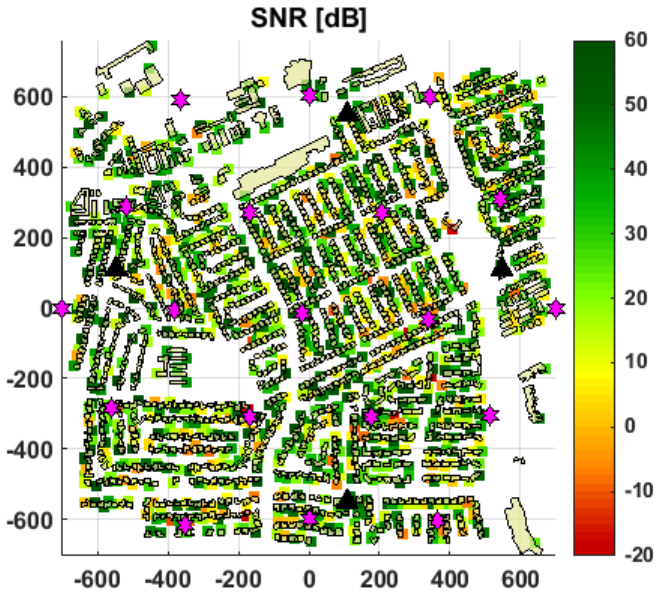
CPE antenna with 10 dBi gain at roof-top

Utilizing Existing Macro Sites is Very Helpful

Wall-mounted CPE, ISD=350m



Wall-mounted CPE, ISD=350m + 4 macro sites



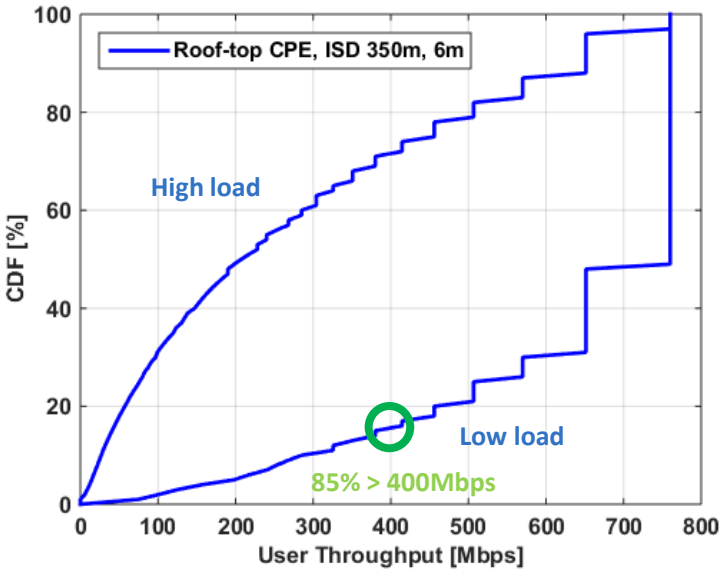
Problematic areas with bad coverage is solved using existing macro grid.

Roof-top CPEs, 350m ISD, 6M BS

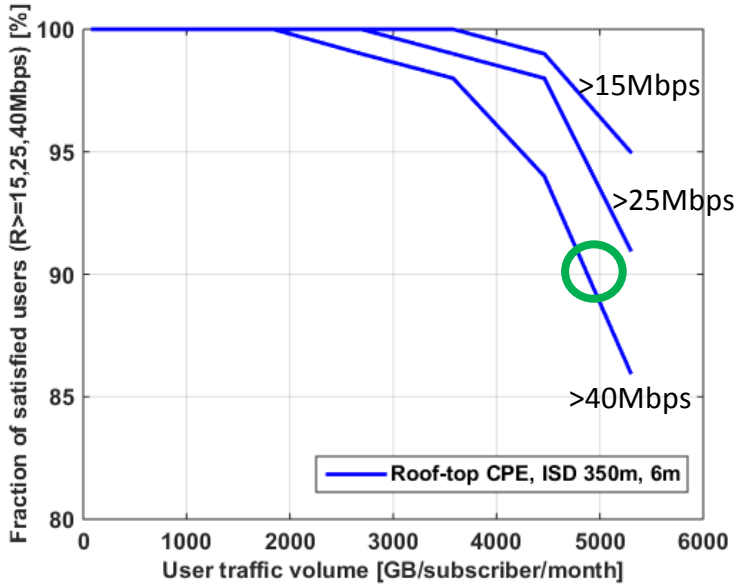
DL results

Very high datarates at low load

Reduction due to sharing and interference at high load



90% of homes above 40Mbps at traffic load of 5TB/month

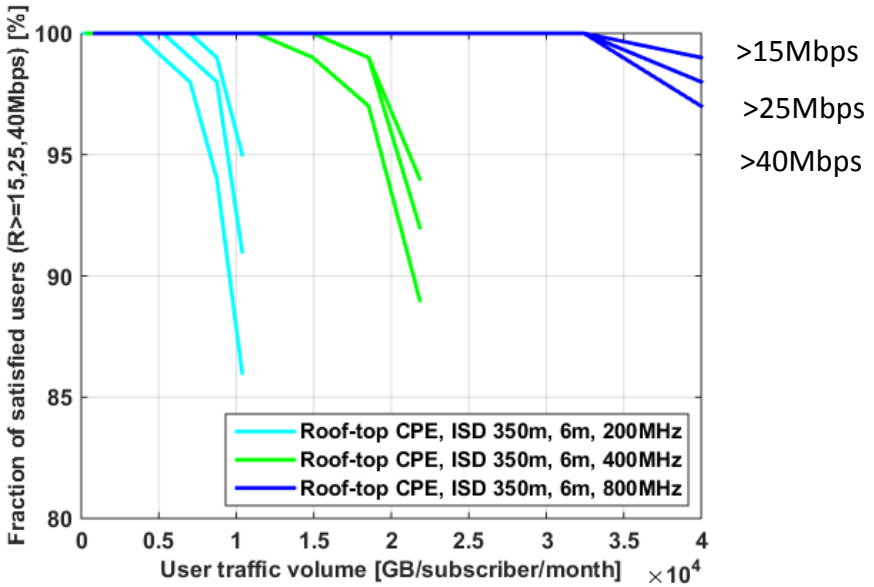


Capacity at Higher BW

For 200MHz ch BW, 90% of homes will experience speeds >40Mbps can consume up to 10TB per month

For 400MHz ch BW, 90% of homes will experience speeds >40Mbps , can consume up to 21TB/m

For 15Mbps at BH, monthly data around 2TB



Mobile Network and HFC Convergence

Key components for Mobile operations

- Spectrum
- Backhaul
- Outdoor Site (power, right of the way,..)
- Low- no cost indoor access

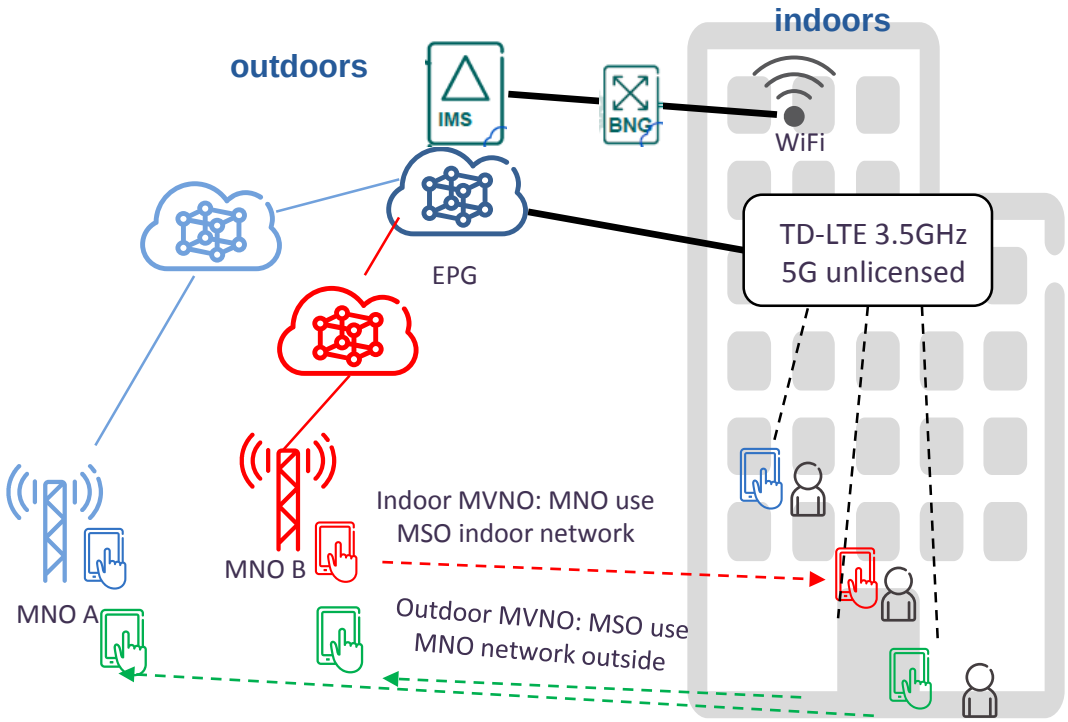
MSO assets to offer for 4G/5G deployment

- Site (power, right of the way,..)
  - outdoors and
  - indoors
- Backhaul services 100Mbps to 1Gbps
- From Wifi offloading to indoor 4G 3.5GHz and 5G unlicensed MVNO capacity offering

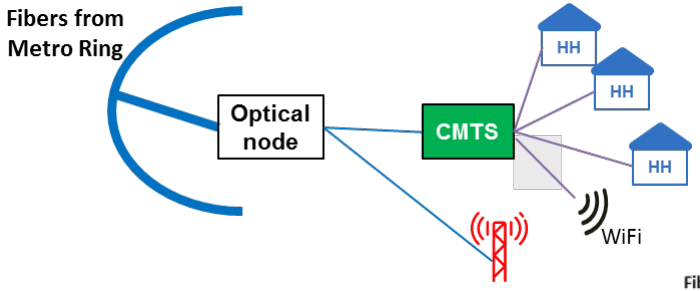
Wireless Strategy for MSO

Outdoor and indoor

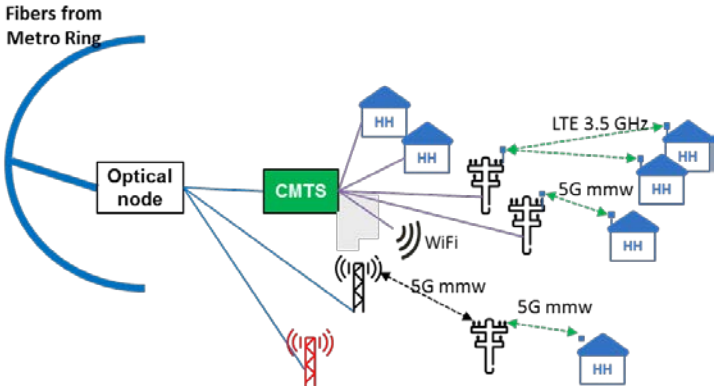
- Build own Mobile network outdoor
- Partner with Reciprocal MVNO
  - MSO own relationship to Enterprise, and building management build neutral host indoor and offer MVNO inside building
  - MNO own and operate Network → offer MVNO outdoors



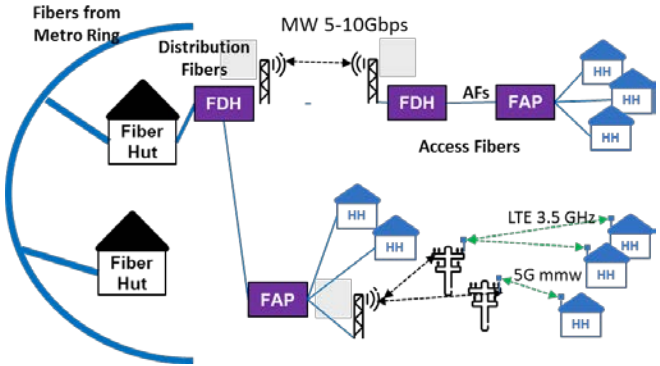
From HFC to HFCW



HFC MSO



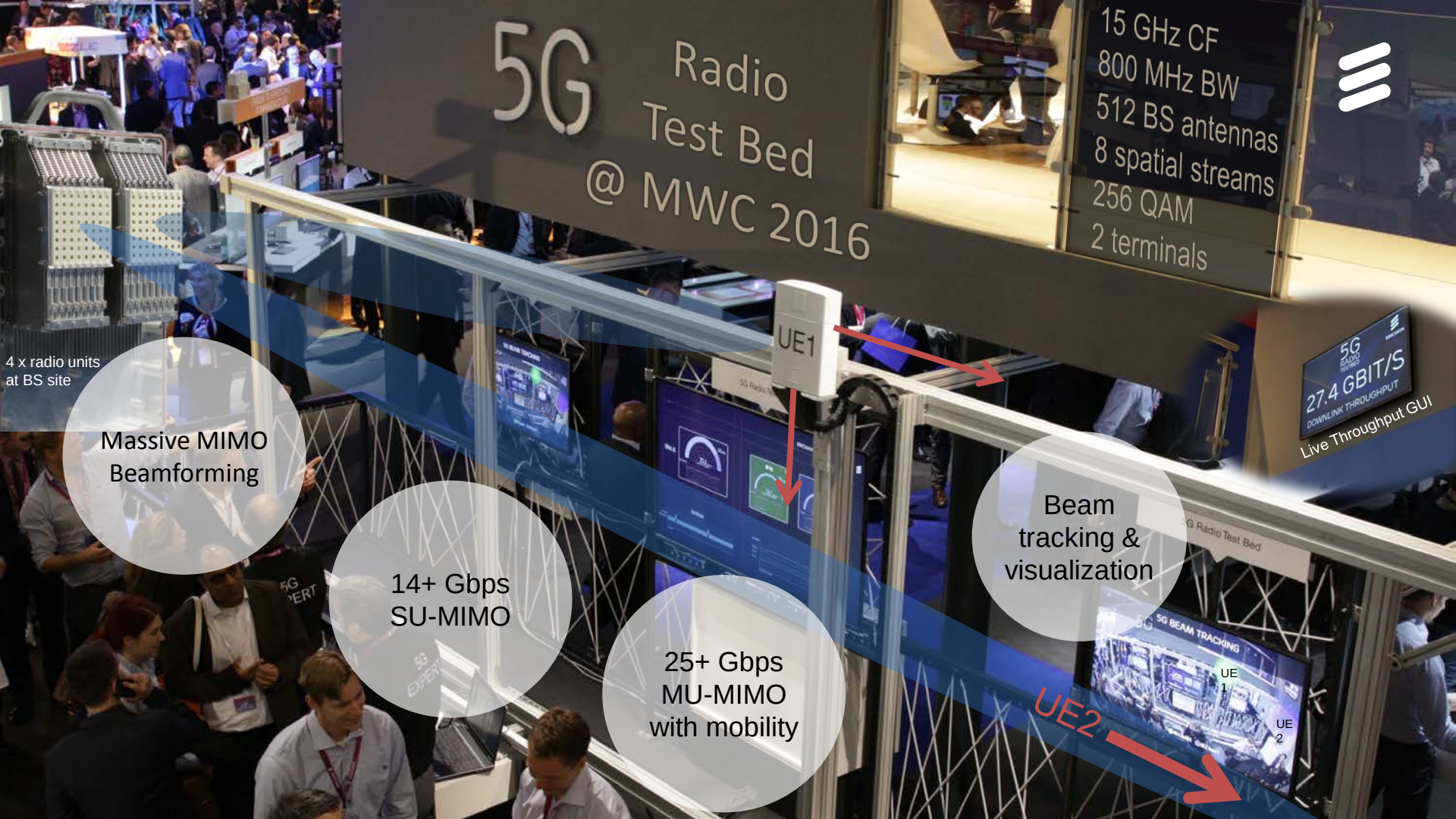
HFCW MSO



HFW Wireline and others

Mobile network with 3.5GHz shared spectrum and 5G unlicensed is another tool in the HFC network toolbox to enable convergence

5G: Key Enabler for Gigabit Network Convergence in the Networked Society


5G Radio Test Bed @ MWC 2016
15 GHz CF
800 MHz BW
512 BS antennas
8 spatial streams
256 QAM
2 terminals
4 x radio units at BS site
Massive MIMO Beamforming
14+ Gbps SU-MIMO
25+ Gbps MU-MIMO with mobility
Beam tracking & visualization
UE1
UE2
27.4 GBIT/S
DOWNLINK THROUGHPUT
Live Throughput GUI
5G BEAM TRACKING
UE 1
UE 2

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