



Understanding Het-Nets, Antennas and other Advanced Techniques in LTE-Advanced

Advanced Systems and Techniques

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LTE-Advanced: Understanding 3GPP Release 10 and Beyond

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The Need for Higher Capacity Density



- Demand for broadband mobile data is expected to rise 1000 fold by 2020
- New Metric: ***bps/Hz/m²*** or for a given spectrum how much capacity can be delivered per unit area
- More spectrum, better spectral efficiency and spatial reuse are mentioned as possible candidates
- Small cells and advanced antenna/MIMO techniques are most promising

Time Frequency Space

Methods for Increasing Capacity Density

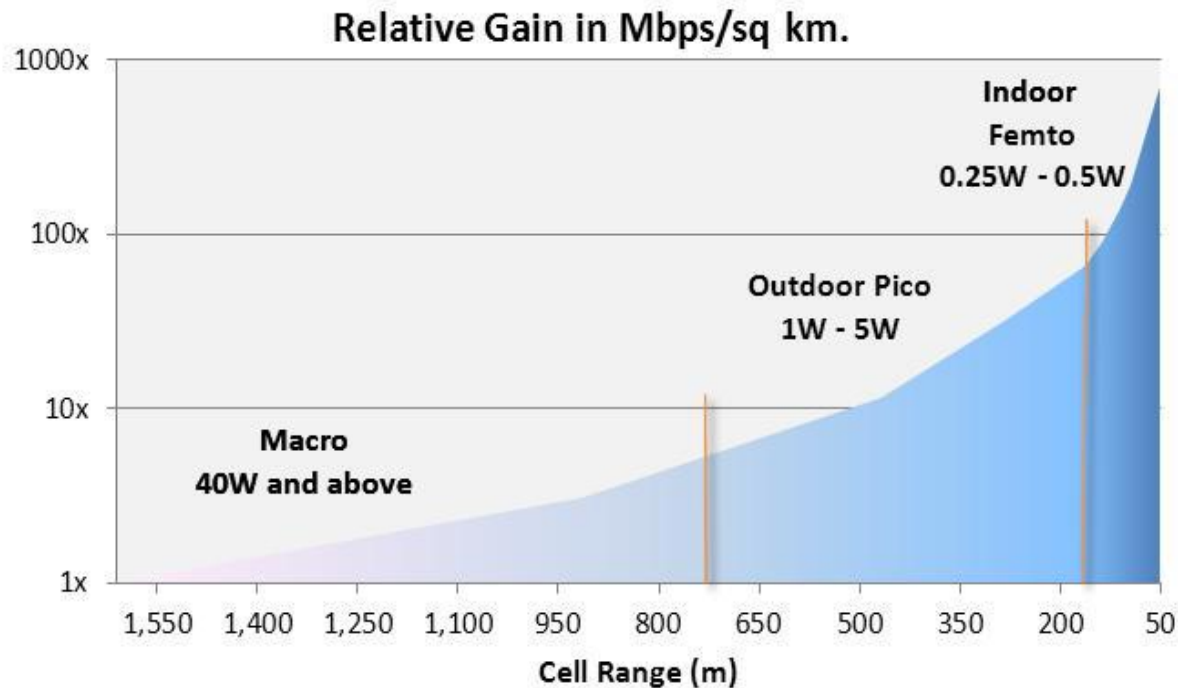


- Additional (licensed) Spectrum
- Improved Spectral Efficiency (bps/Hz ↑)
- Small Cells
- MIMO (higher-order/massive, MU)
- Beamforming
- WiFi Offloading
- Coordinated Multi-Point Transmission/Reception (CoMP)
- Carrier Aggregation (CA)

Small Cells



- Spatial reuse of the spectrum is necessary
- Multi RAT LTE/3G/WiFi

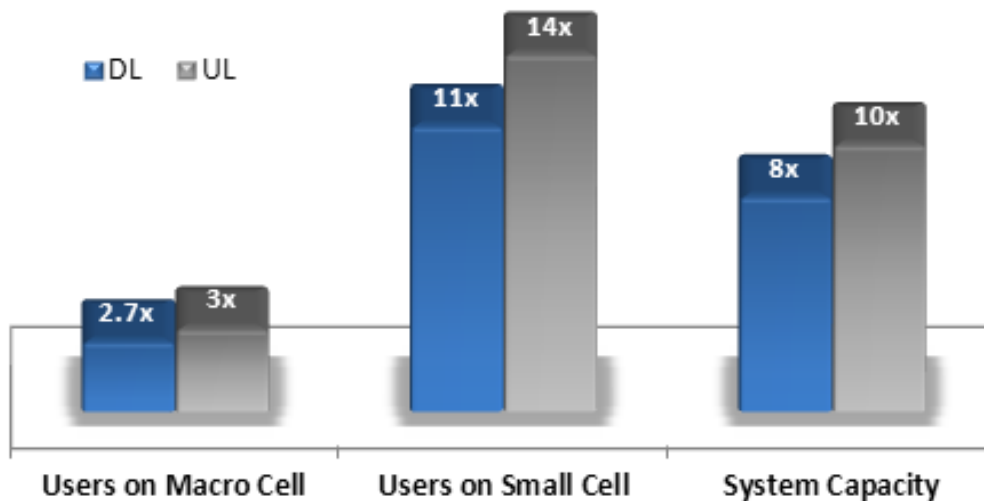


Small Cells



- Both Macro and Pico UE's will benefit

Gains in UE Throughput and System Capacity
(4 Outdoor Small Cells per Macro Cell)



Scenario : Macro & 4 Outdoor Picocells

- Macro ISD 1.732km
- 4 Outdoor Pico Cells per Macro
- 20 UE's uniformly distributed
- 40 UE's within Pico cluster
- Carrier Frequency : 700 MHz



Advanced MIMO Techniques

- Downlink 8-Layer SU-MIMO (up to 3 Gbps w/ CA 100 MHz)
- Downlink MU-MIMO for increased network capacity
- Uplink 4-Layer SU-MIMO (also MU-MIMO through pairing)
- Uplink transmit diversity for robustness (control channel)

| Capability requirement | LTE Release 8 capability | LTE-Advanced capability | IMT-Advanced (ITU-R) requirement | LTE-Advanced (3GPP) requirement |
|------------------------|--------------------------|-------------------------|----------------------------------|---------------------------------|
| Downlink | 16.3 (4 layers) | 30.6 (8 layers) | 15 | 30 |

Table 1. Peak spectrum efficiency requirements and capability of LTE-A DL (bits per second per Hertz).

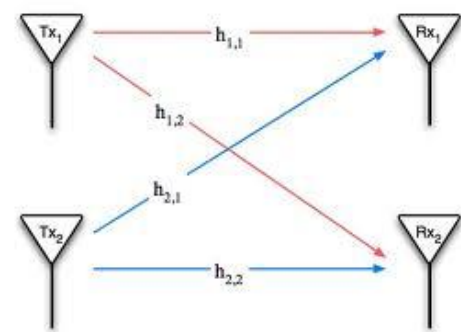
| Capability requirement | LTE Release 8 capability | LTE-Advanced capability | IMT-Advanced (ITU-R) requirement | LTE-Advanced (3GPP) requirement |
|------------------------|--------------------------|-------------------------|----------------------------------|---------------------------------|
| Uplink | 4.3 | 16.8 (4 layers) | 6.75 | 15 |

Table 2. Peak spectrum efficiency requirements and capability of LTE-A UL (bits/sec/Hz).

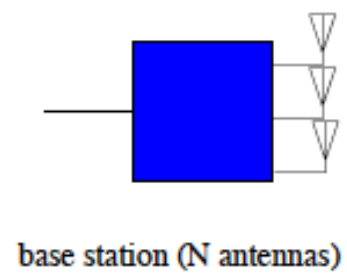


Paradigm Shift from SU to MU MIMO

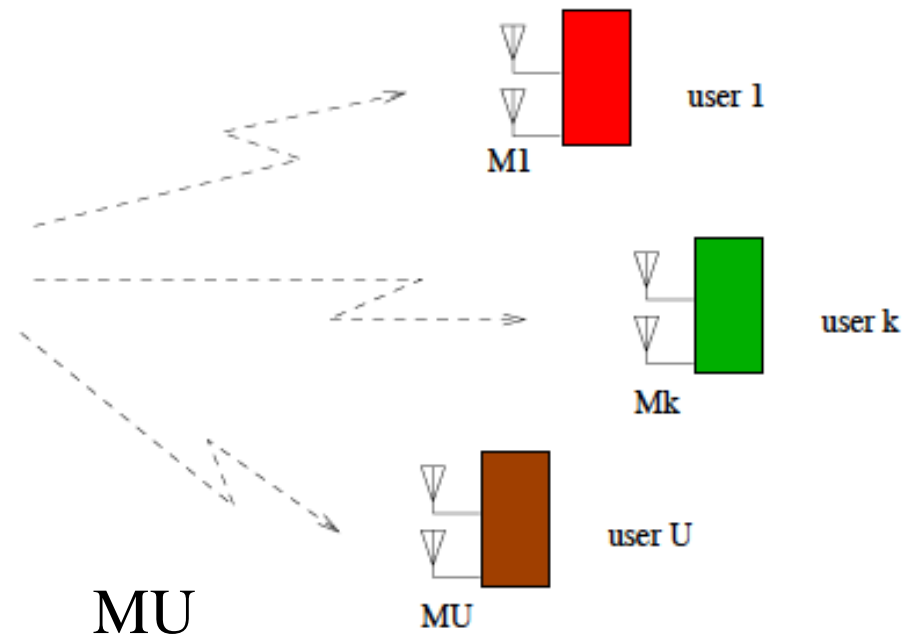
- Focus on aggregate capacity rather than peak user bitrate
- A BS communicates simultaneously w/ several multiple antennas terminals



SU



base station (N antennas)



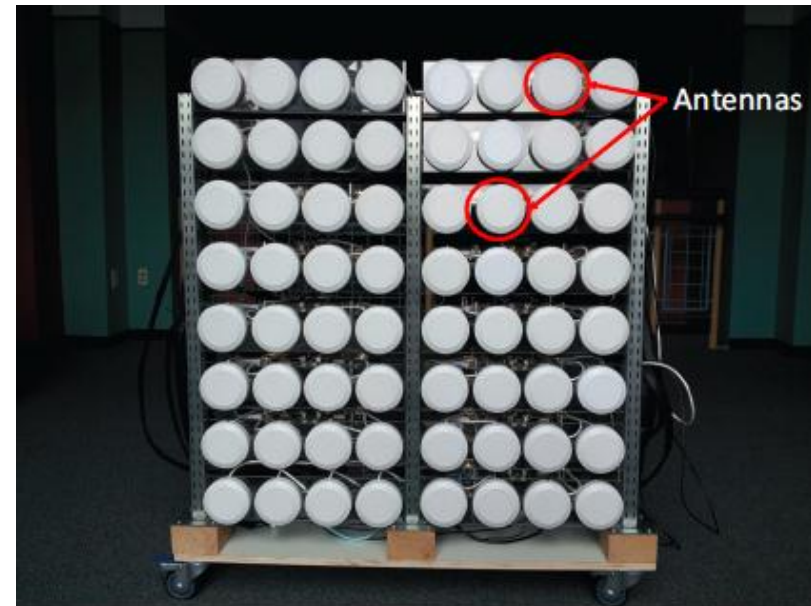
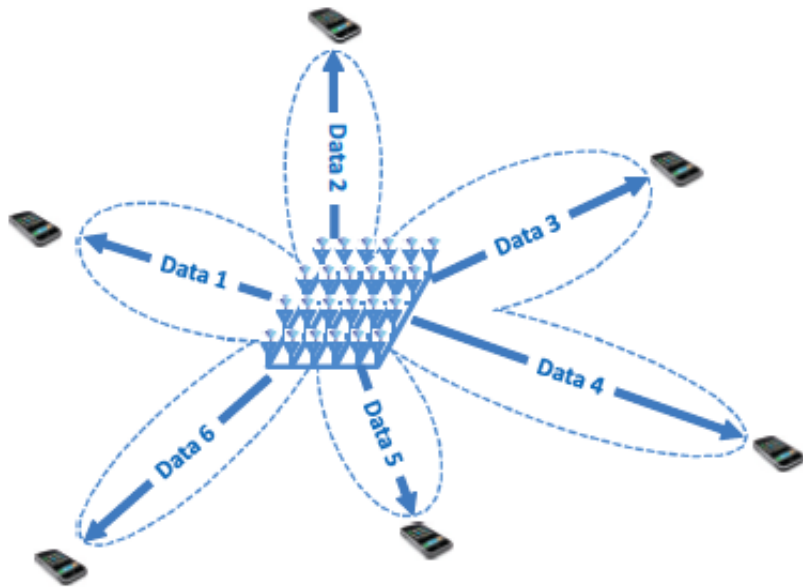
MU

U users (user k has Mk antennas)

Massive MIMO w/ Application to Beamforming



- Multi-user beamforming (MUBF) uses multiple antennas to send independent data streams to multiple terminals at the same time

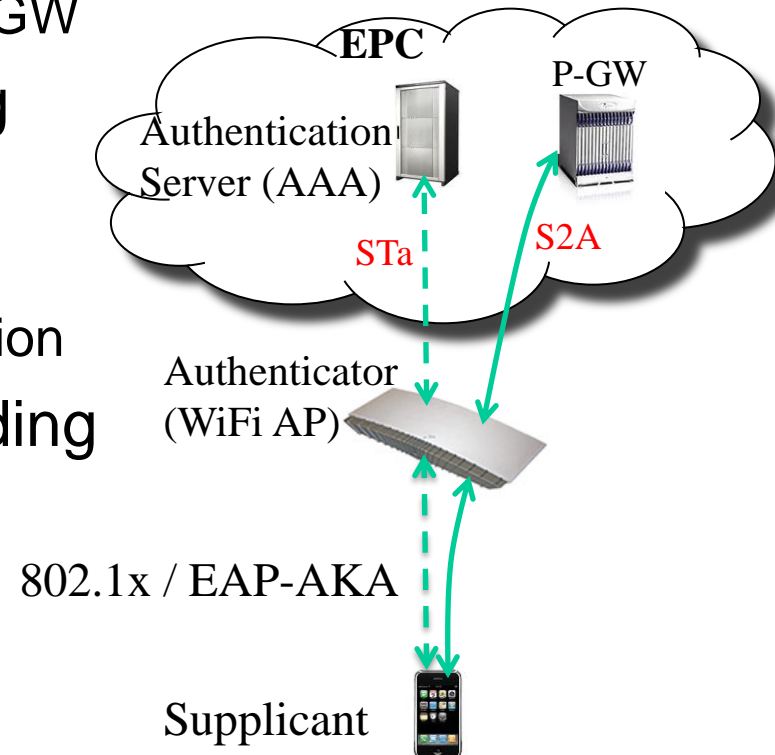


ARGOS – Achieving 6.7 capacity gain



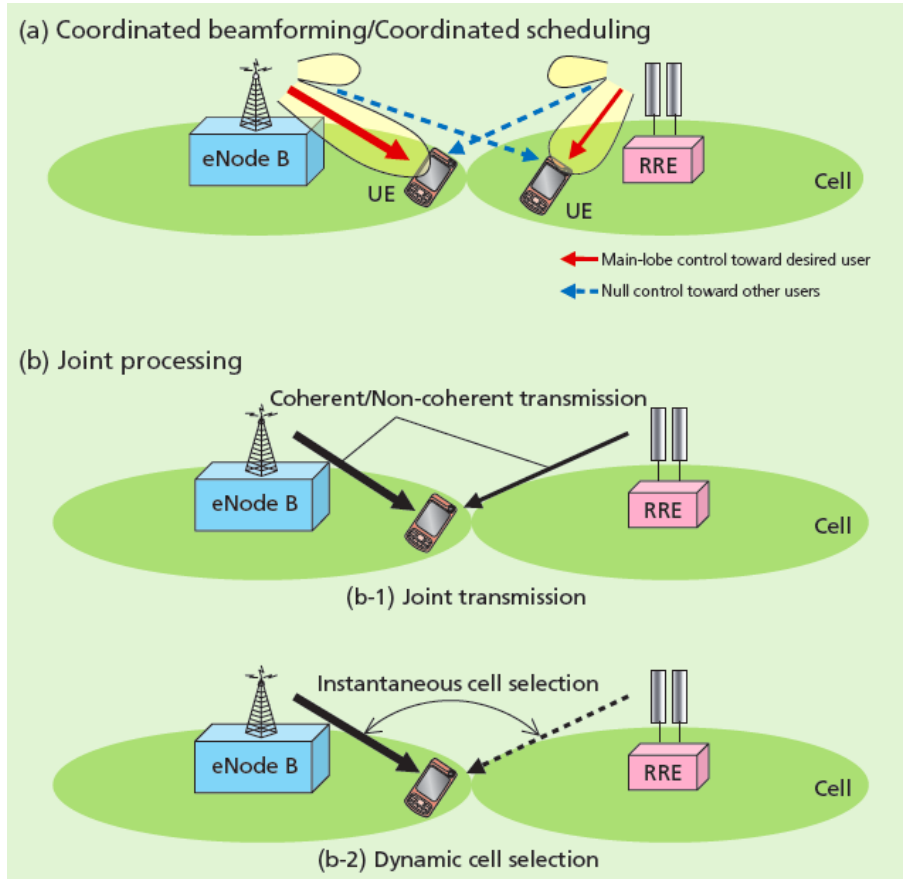
WiFi Integration to the Core

- Additional 300+ MHz (unlicensed) Spectrum
- WiFi will be integrated to the core network (trusted network)
 - S2A interface between WiFi AP and P-GW
- Hotspot2.0 and cellular-like roaming
 - 802.11u discovery and selection
 - 802.1x EAP-SIM/AKA authentication
 - 802.11i WPA2-enterprise, AES encryption
- Network managed offloading/onloading transparent to the user





Coordinated Multipoint Tx/Rx (CoMP)

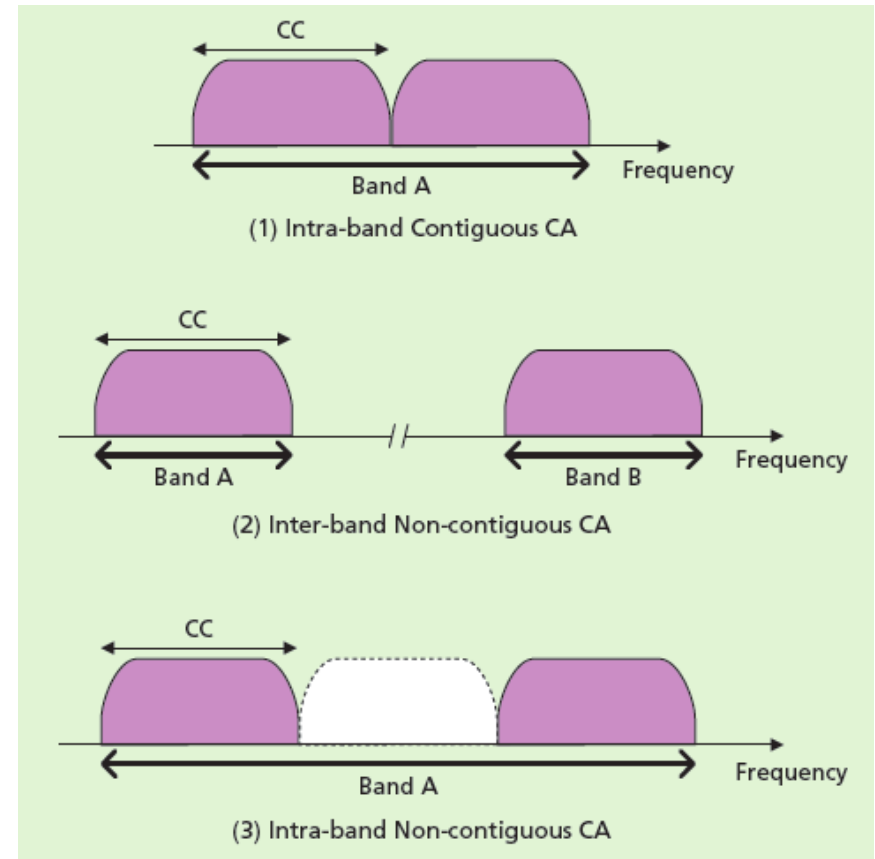


- Downlink Multi-cell Transmission
- Uplink Multi-cell Reception

Carrier Aggregation (CA)



- Bandwidth Extension – Simultaneous use of multiple LTE Carriers to increase peak bitrates
- Multi carriers/streams to the handset (from macro, pico, WiFi)



The Powerwave Ultra Broadband Picocell



A small, all-in-one
LTE base station and Wi-Fi hot spot
that delivers up to
200+ Mbps/mi² to 100+ users



Wall/Pole

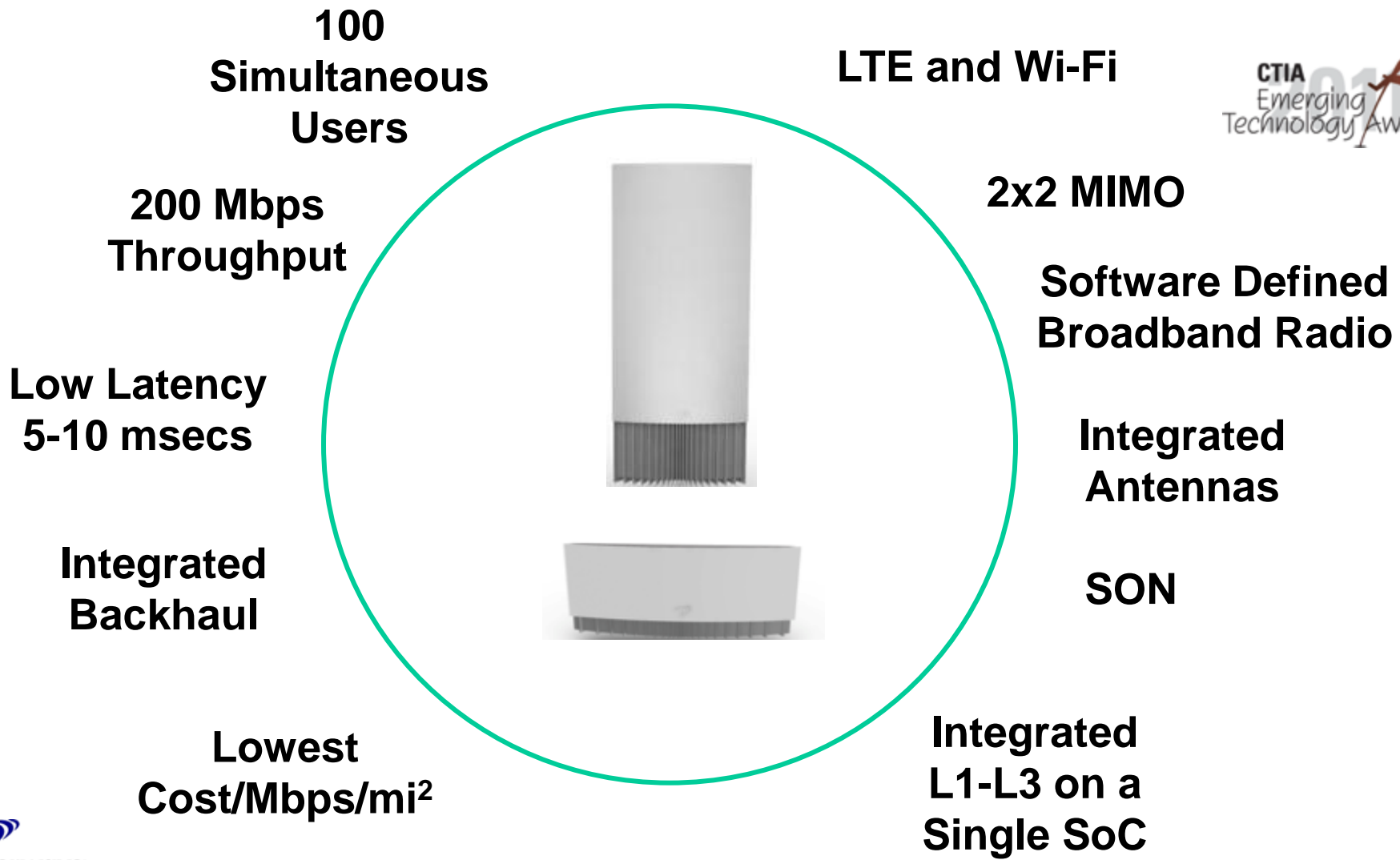


Strand-Mount



Indoor

What makes the Powerwave Pico different?





THANK YOU!

Jacob Sharony, VP, Innovation

