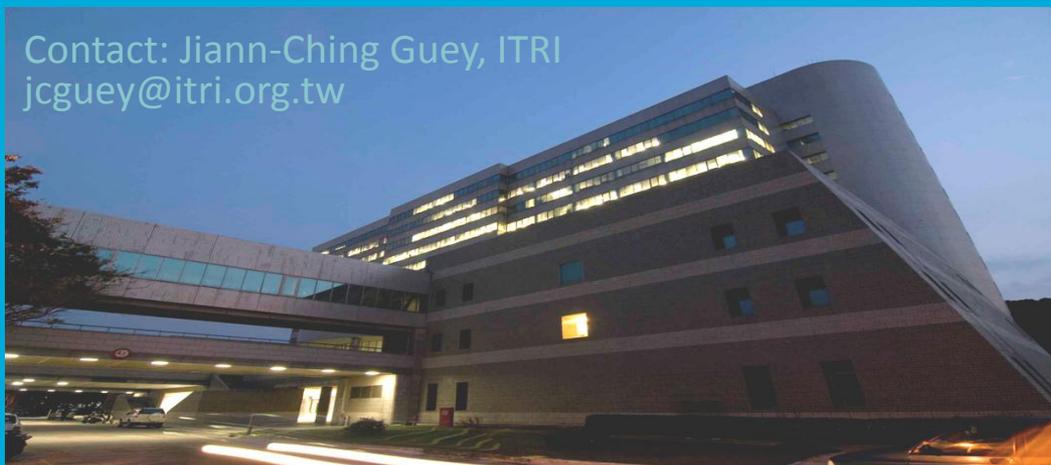




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Potential Technologies and Road Map for LTE Release 12 and Beyond

Contact: Jiann-Ching Guey, ITRI
jcguey@itri.org.tw

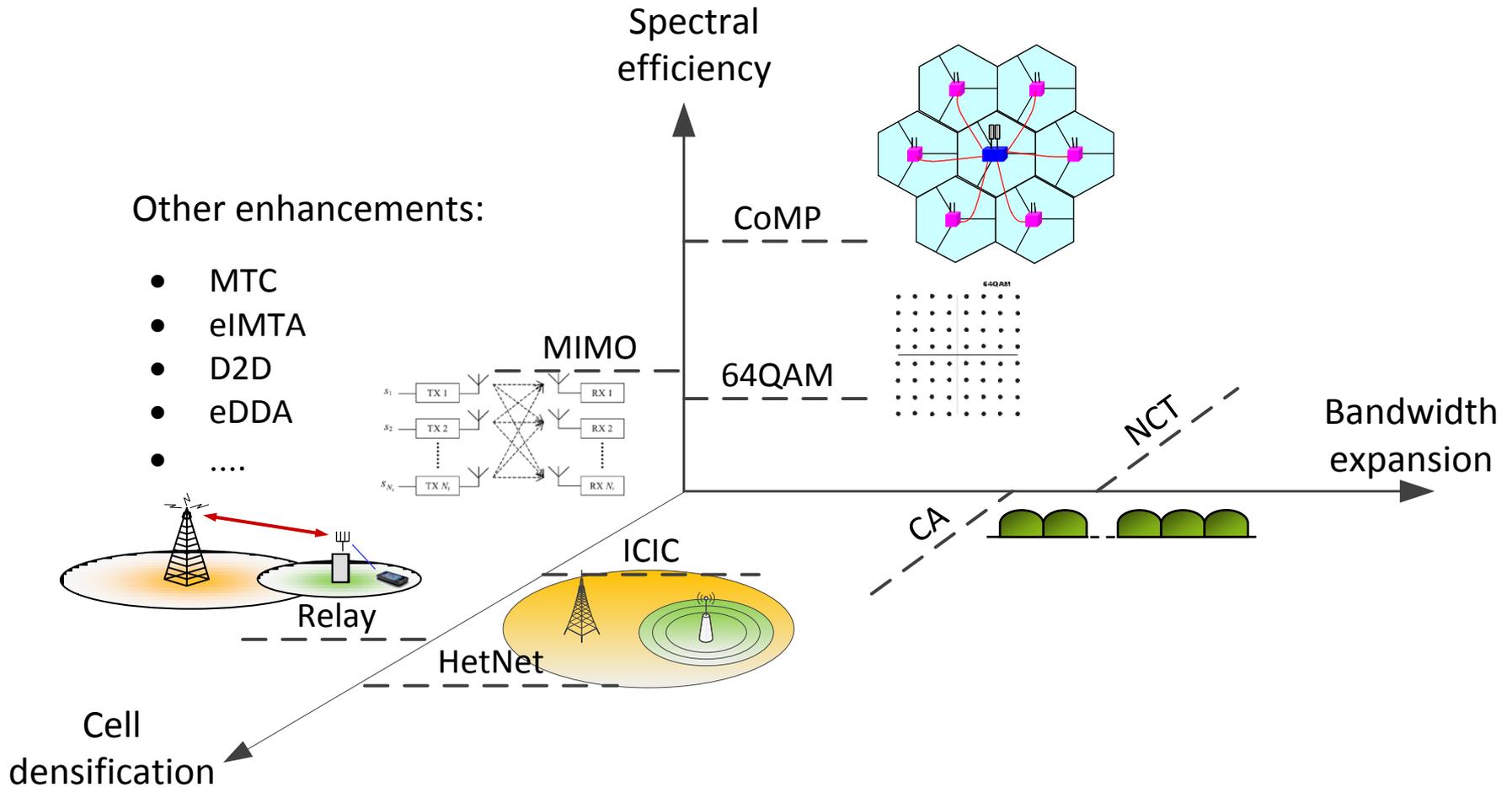


3GPP Workshop on Release 12 and onwards
11-12 June 2012, Ljubljana, Slovenia

Outline

- Overview
 - Where we are
 - How did we do
- Going forward–What’s awaiting us
- Potential Technologies
 - Pushing the envelope of spectral efficiency
 - Integration of 3GPP and non-3GPP families of technologies
 - Continue improving current system
- Technology Roadmap
- Conclusion

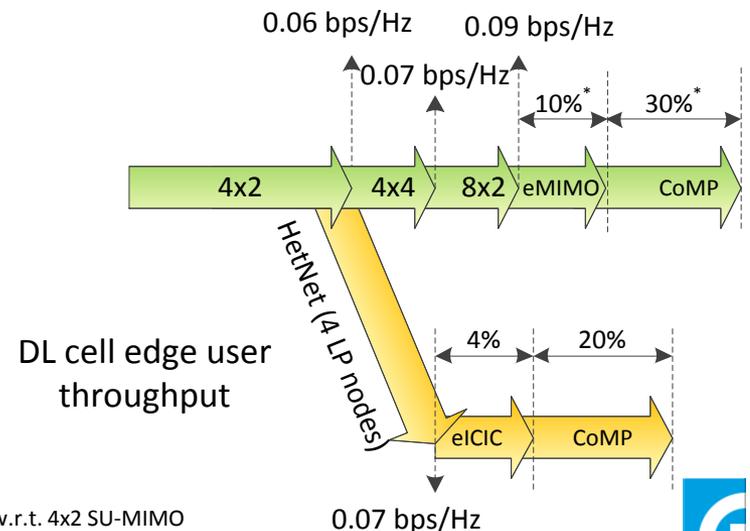
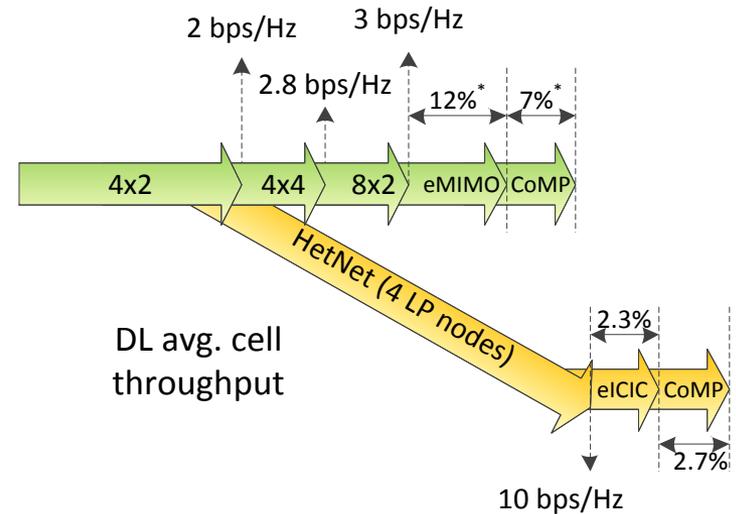
Overview where we are



Overview

How did we do?

- Bandwidth expansion
 - Signaling supporting up to 100 MHz from carrier aggregation
- Densification
 - HetNet interference management
 - Mobility management
- Spectral efficiency
 - CoMP
 - MIMO
 - More successful in fairness improvement than increasing spectral efficiency
 - Managed to bend the curves somewhat, but haven't been able to shift the curves much

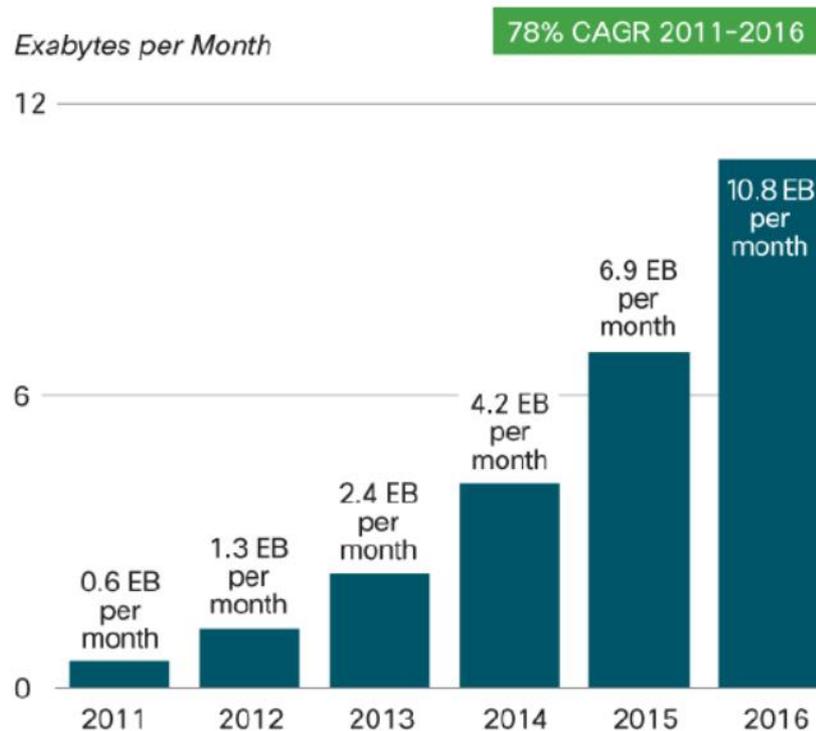


* w.r.t. 4x2 SU-MIMO

Going Forward

What's awaiting us?

Traffic Volume Prediction



Source: Cisco VNI Mobile, 2012

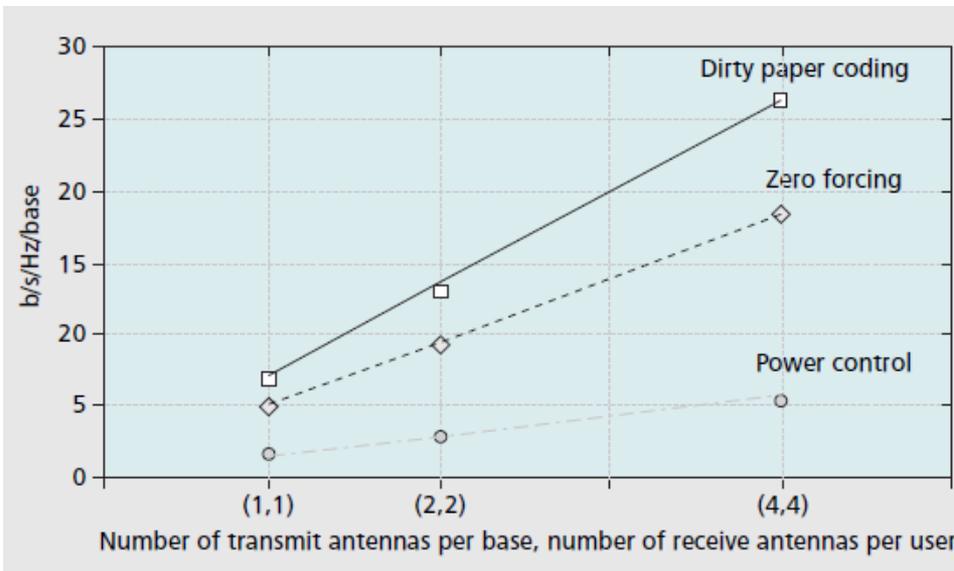
How do we keep up?

- Spectral efficiency
 - Overhaul of CoMP
- Bandwidth expansion
 - Tighter integration of other 3GPP and non-3GPP technologies
- Densification
 - Hierarchical and heterogeneous network
 - Mobility management

Potential Technologies

Overhauling DL CoMP

- Idea DL CoMP spectral efficiency gain approximately 3 to 5



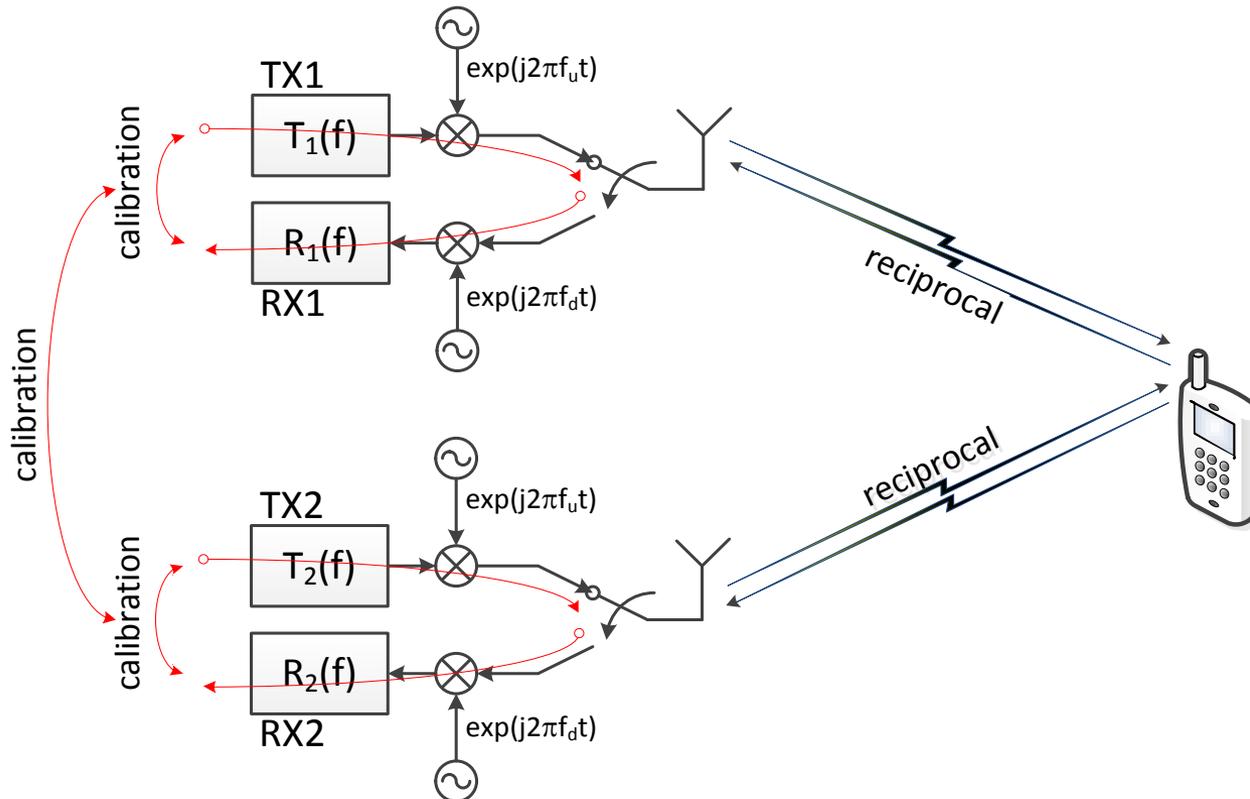
Source: IEEE Wireless Comm. Magazine, Aug. 2006, pp. 56—61.

- Large room for improvement, especially for interference-dominated small cells
- Efficient full CSI feedback mechanism
 - Has been brought up before, time to reconsider more seriously
 - TDD reciprocity
 - FDD channel representation below Nyquist rate
- Linear, non-codebook based TX schemes
- Introduced to new carrier type to alleviate backward compatibility issues

DL CoMP

TDD Reciprocity

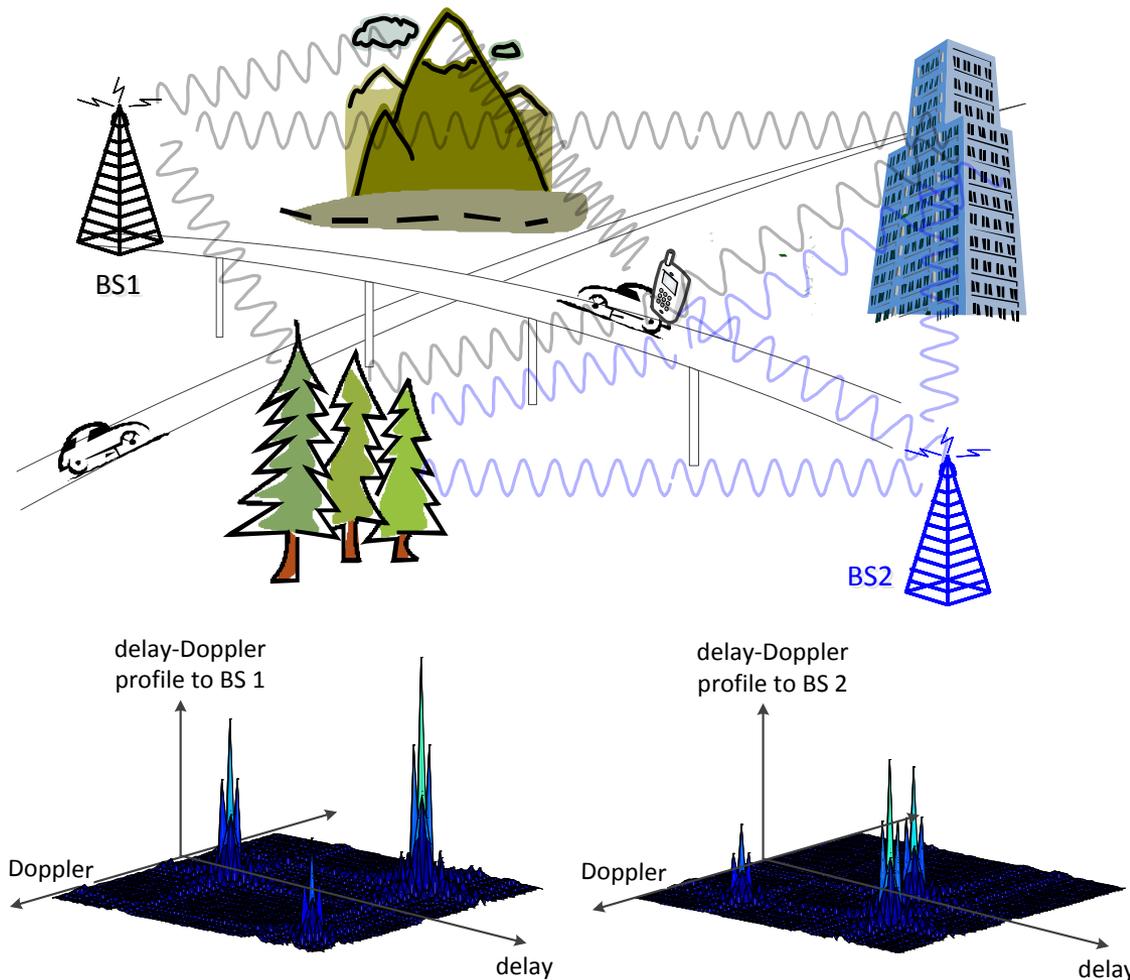
- Calibration & Synchronization maintenance of RF Transmit Chains across multiple transmit points
- Sounding signal design
- System performance evaluation



DL CoMP

FDD Channel Compaction

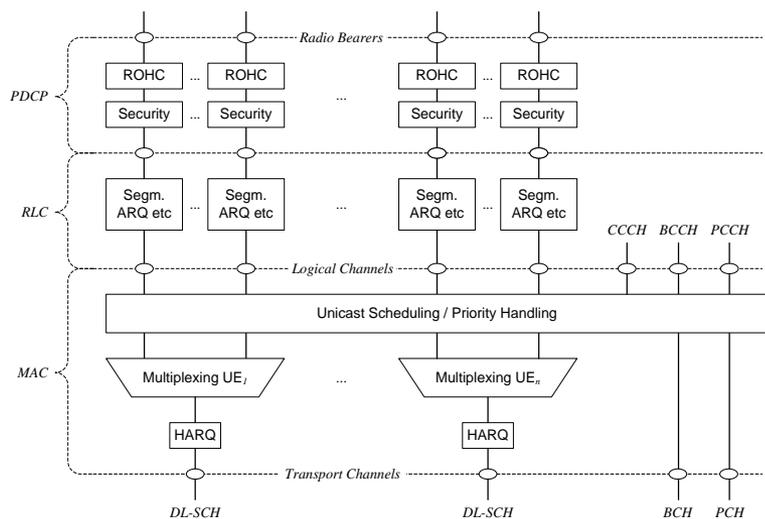
- Channel's delay-Doppler response usually sparse
 - May take less than we thought to feedback full CSI from all points in coordinating set
- Parametric representation of channel
 - quantized channel taps
- Non-parametric representation
 - Compressive sensing techniques



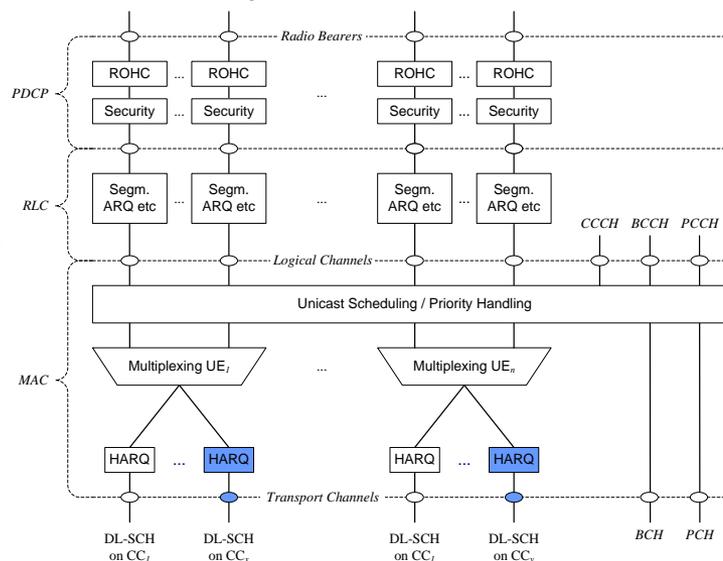
Potential Technologies

CA of Alternative Spectra

- Current Layer 2 structure has good flexibility and extensibility to aggregate 3GPP or non-3GPP families of technologies.
 - Not much impact on Layer 2 and upper layers
 - Better resource management for both LTE and non-LTE carriers
- Continue the success and bring in more spectra



Layer 2 Structure for DL



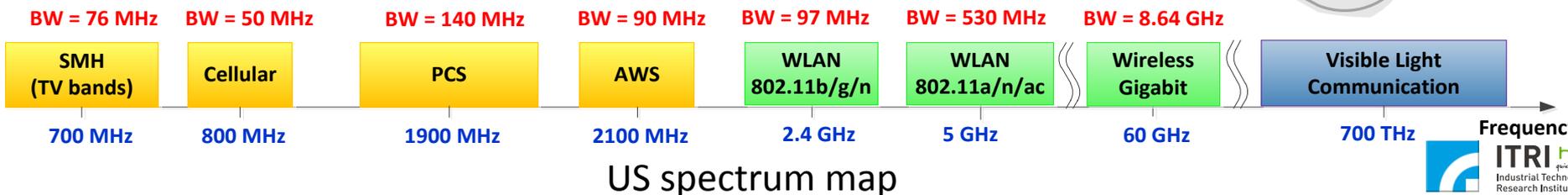
Layer 2 Structure for DL with CA

CA of Alternative Spectra

Candidates for Further Aggregation

- 3GPP family
 - LTE + **HSPA**, LTE FDD + **TDD**
- Non-3GPP based technologies
 - Unlicensed bands
 - Visible Light Communication (VLC) ideal for LTE CA
- Integration of WiFi happening in different levels
 - IP layer at PDN Gateway outside of core network
 - IP layer at nodeB or other nodes inside core network
- Elevated TSG SA working groups activities herald changes are coming
- RAN plays important role in 2nd level integration
- CA of WiFi can be a third and tightest level of integration

Utilize all available means of communication in a phone

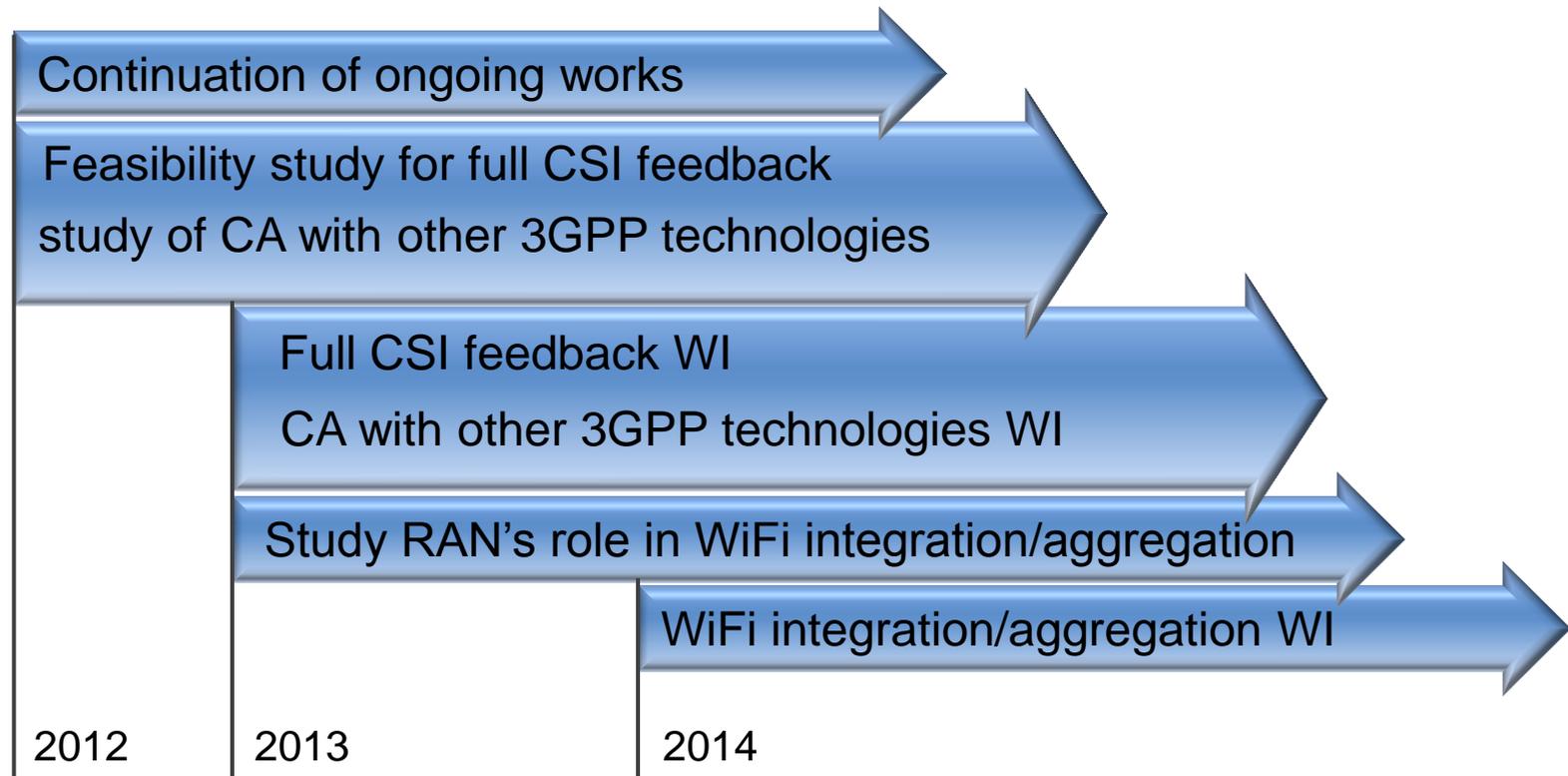


Potential Technologies

Continued improvement of ongoing works

- DL MIMO
 - Enhanced Codebook
 - Non-colocated antennas
 - Enhanced CSI report
 - Finer frequency-domain granularity
 - Additional feedback for MU-MIMO enhancement
- CoMP
 - Enhanced feedback for Coherent JT
- New Carrier Type
 - Stand-alone carrier
 - Advanced CoMP with full CSI feedback

Technology Roadmap



Summary

- Continuation of ongoing works, specifically
 - Enhanced codebook for non-colocated antennas
 - Enhanced CSI report
 - New carrier type
- Renew the drive for substantial spectral efficiency improvement
 - Study the feasibility of full CSI feedback and the potential gain of associated transmission technologies
- Integration of alternative spectra/technologies
 - CA with other 3GPP family members: HSPA, FDD+TDD
 - Supporting tighter integration of unlicensed band technologies: WiFi and millimeter wave
 - Visible light communication

ITRI *htc*
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THANK YOU!!

Q & A



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