3GPP RAN Workshop on Release 12 Onward
Ljubljana, Slovenia, 11-12 June, 2012

RWS-120039

Evolving RAN Towards Rel-12 and Beyond

Sharp corporation

Agenda

1 Requirement for Rel.12 and beyond

System Capacity

2 High Level Technical Direction

Introduction of Denser Network

Bandwidth Extension

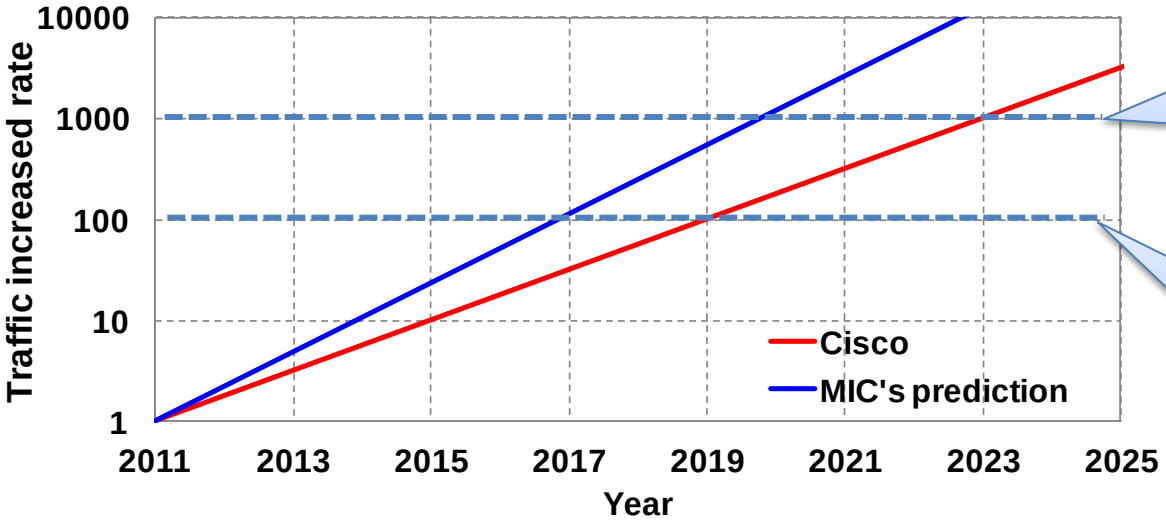
Further Spectrum and Transmission Efficiency Improvement

Rapid Traffic Growth

1. Cisco's prediction: 78% per a year [1]
2. MIC's prediction (Dec., 2011): 120% per a year [2]

[1] http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html
[2] http://www.soumu.go.jp/johotsusintokei/field/data/gt010602.pdf

MIC: Ministry of Internal affair and Communications (in Japan)



1000-times mobile traffic is expected in **2020** to **2023**

100-times mobile traffic is expected in **2017** to **2019**

Rel.12 & beyond target

To meet the expected **1000x** traffic growth the **system capacity** has to be increased significantly

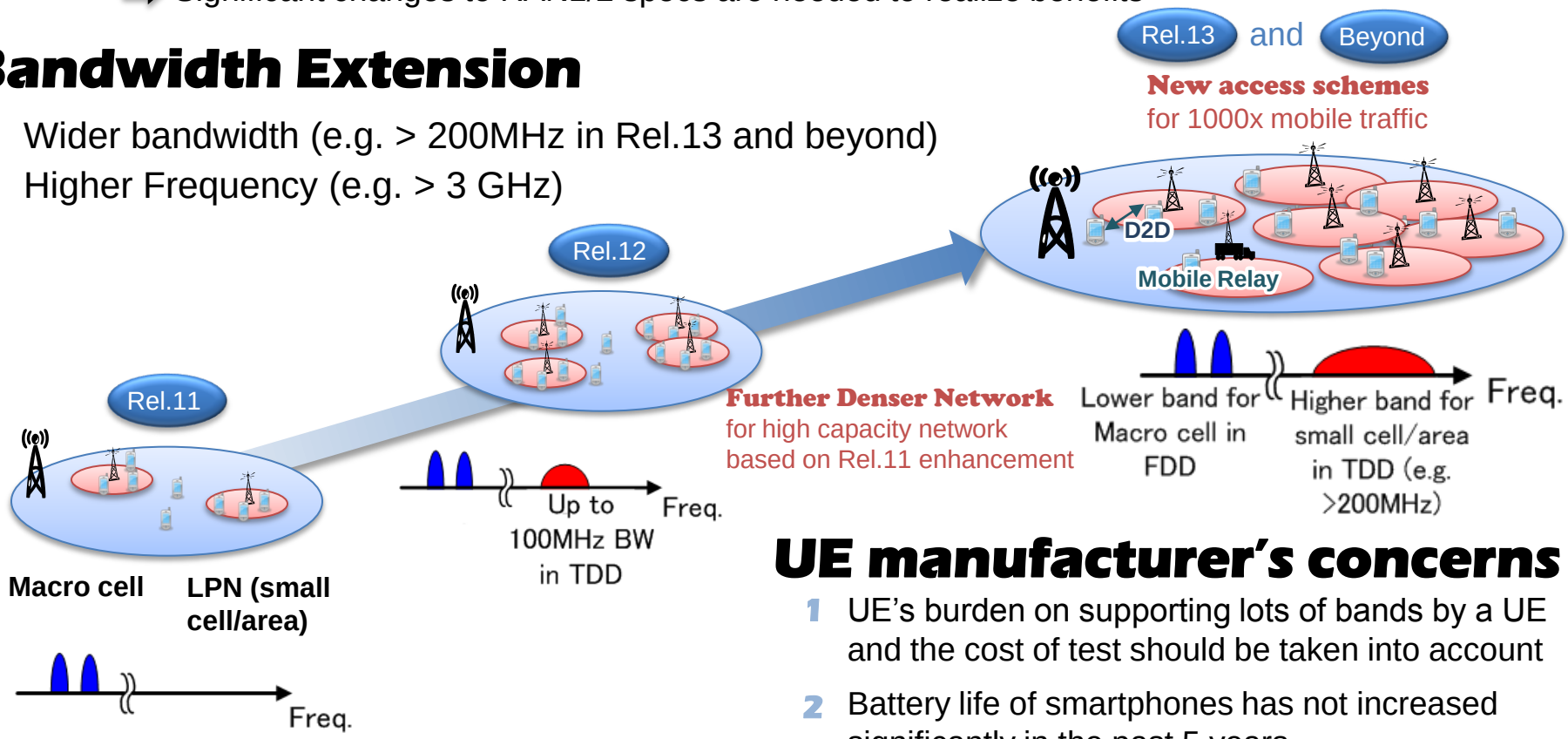
High Level Technical Direction
- Denser Network and Bandwidth Extension

Denser Network

1. TDD may be widely used in small cell (Local area) environment
2. Enhanced CoMP
3. D2D
   - Resource re-use by localizing resources to the group of UEs in communication with each other
   - Significant changes to RAN1/2 specs are needed to realize benefits

Bandwidth Extension

1. Wider bandwidth (e.g. > 200MHz in Rel.13 and beyond)
2. Higher Frequency (e.g. > 3 GHz)



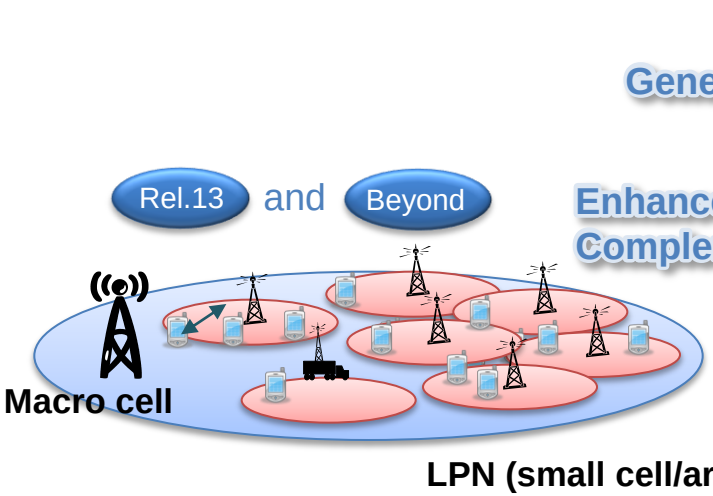
UE manufacturer's concerns

1. UE's burden on supporting lots of bands by a UE and the cost of test should be taken into account
2. Battery life of smartphones has not increased significantly in the past 5 years

Spectrum and Transmission Efficiency

1. Spectrum Efficiency has to be improved both in Macro and small cells (Local areas)
2. Complementary carrier type(s) (e.g. Rel-11/12/beyond Rel.12 New Carrier Type etc) should be optimized for small cell
3. Enhanced Access and Coding Schemes
4. Reference Receiver enhancement

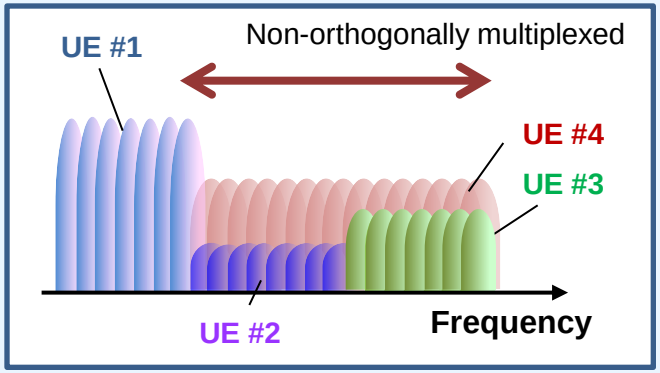
Spectrum Efficiency has to be enhanced both in **Macro cell** and **Small cell**



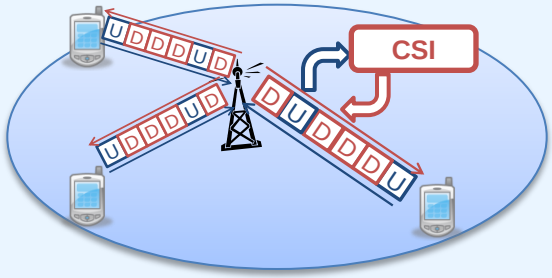
General Enhancement

Enhancement on Complementary carrier type

e.g. Non-orthogonal access



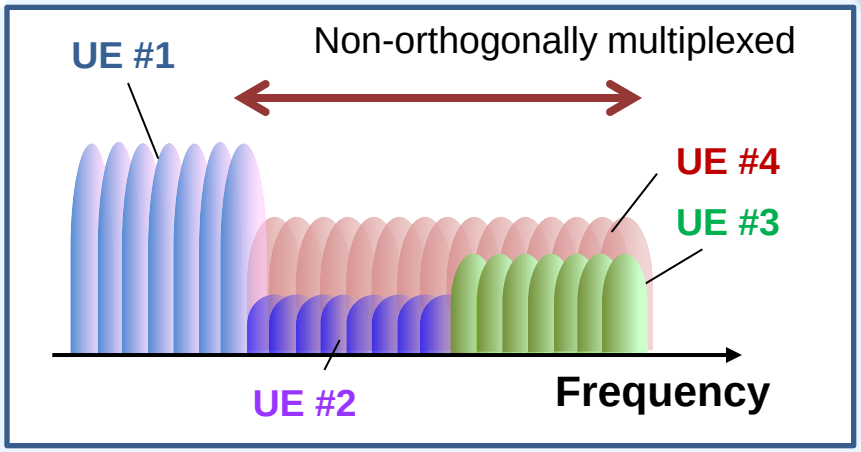
e.g. MU-MIMO enhancement



Non-Orthogonal Access

Downlink

OFDM based non-orthogonal multiple access



Candidate of transmission scheme

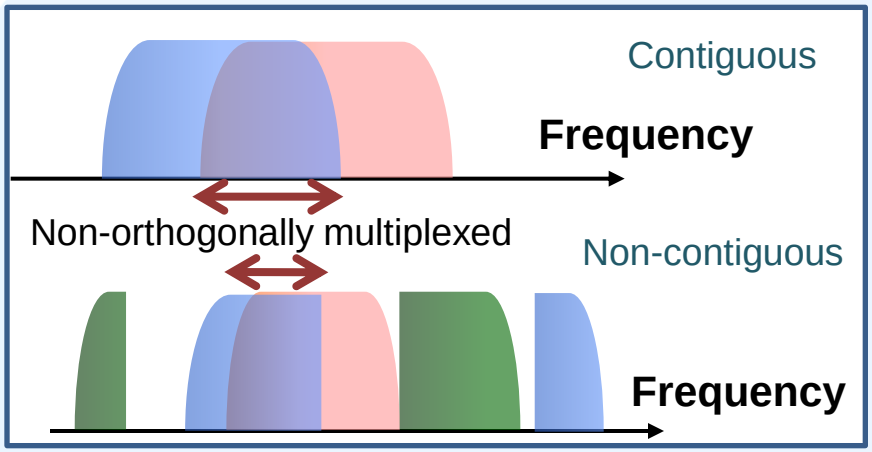
Superposition coding (e.g. Hierarchal modulation)

Non-linear receiver (e.g. Turbo SIC receiver)

This enables non-orthogonal access for UEs while retaining legacy capabilities

Uplink

Single carrier based non-orthogonal multiple access



Contiguous/Non-contiguous DFT-S-OFDM

Low PAPR/CM characteristics for macro area

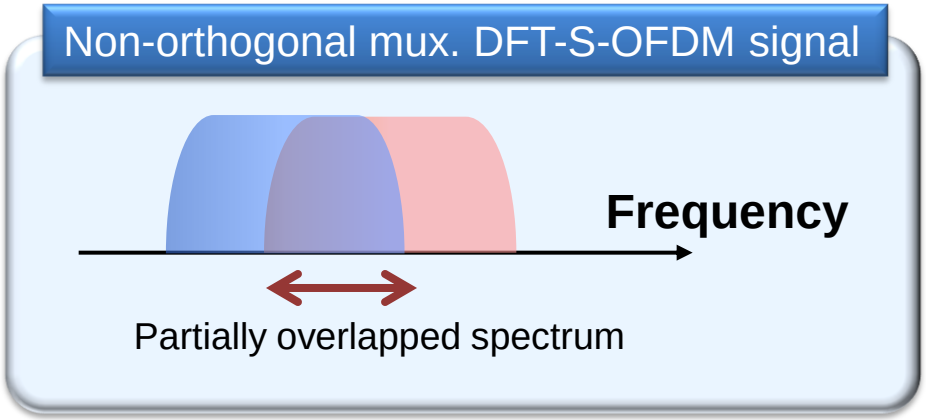
High affinity to turbo SIC receiver

Multi-user detection (MUD)

Turbo SIC is effective for non-orthogonal reception and will keep legacy capability.

Appropriate transmission power control parameters and overlapping rate can be selected to improve system throughput

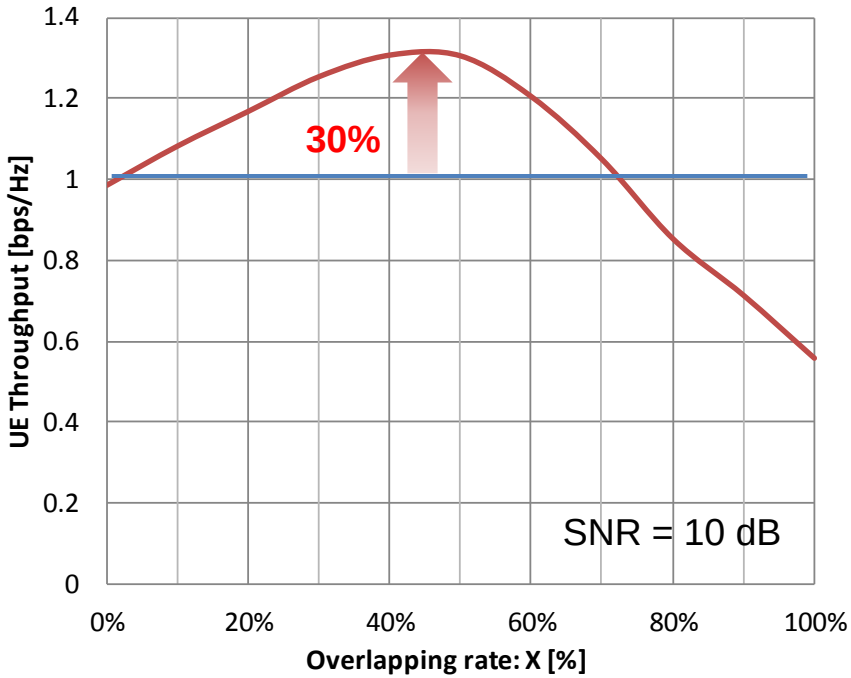
Non-Orthogonal Access
- One example of UE throughput gain



Simulation

1. Total UE power is constant
2. Turbo SIC receiver
3. 3GPP Turbo code
4. QPSK, r = 1/2
5. Overlapping rate

Throughput performance



$$\text{Overlapping rate: } X = \frac{\text{Number of overlapped subcarriers}}{\text{Number of allocated subcarriers}}$$

Channel model: ETU
Antenna configuration: 1 x 1

Non-orthogonal access can achieve at least **30% TP gain** compared with orthogonal access

Road Map of Reference Receiver Enhancements

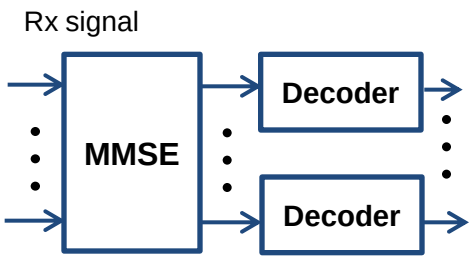
Rel.8/9
Frequency domain Linear processing (e.g. MMSE)

Rel.10
MMSE-SIC receiver
Multi-codeword transmission
Inter-layer interference cancellation

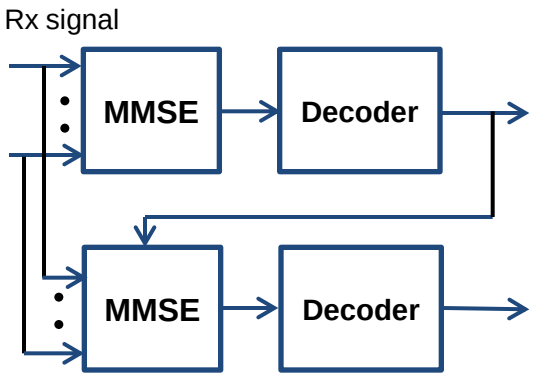
Rel.11
Interference rejection combining (2RX IRC)
Inter-cell interference suppression by interference covariance matrix

Rel.13 and Beyond
Turbo SIC (w/ IRC)

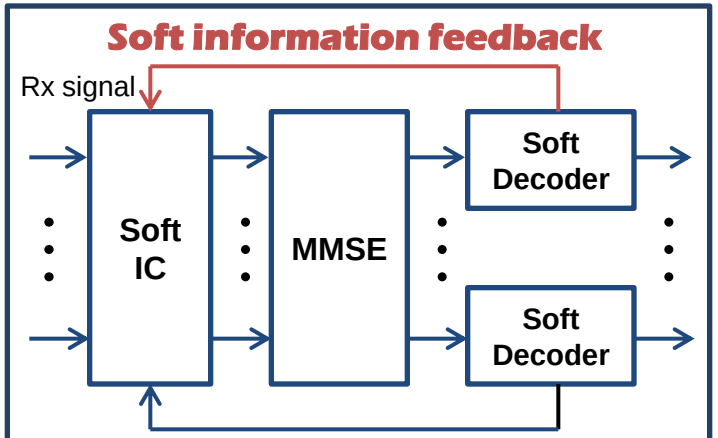
Non-orthogonal access
Signal cancellation capability is required for non-orthogonally multiplexed UEs



MMSE receiver



MMSE-SIC receiver

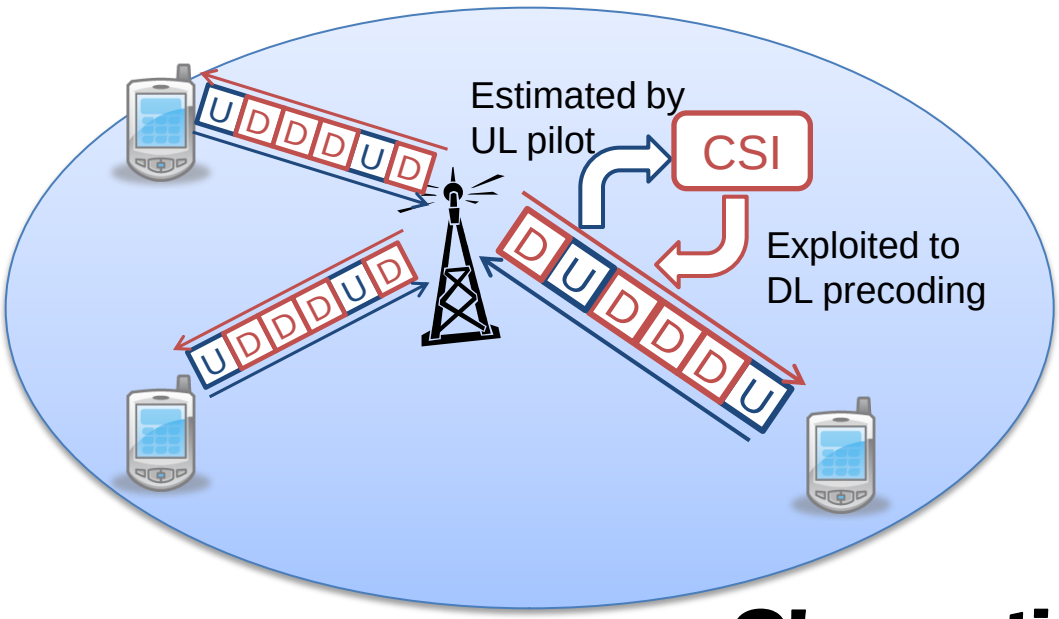


Turbo SIC receiver

Example of DL MU-MIMO Enhancement

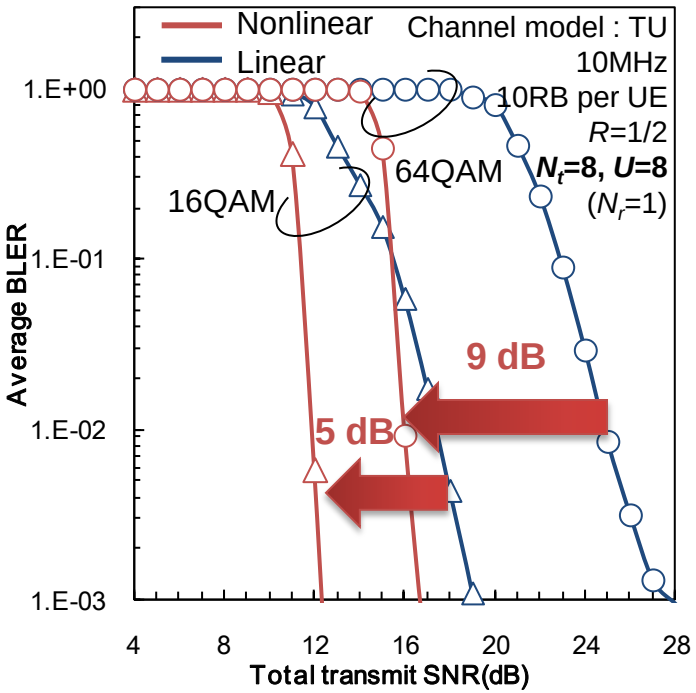
Dirty Paper Coding based DL MU-MIMO

1. The number of multiplexable UEs is increased
2. Relaxation of paring complexity
3. Minimization of transmission power



8 x 8 MU-MIMO (8UEs)

Vector perturbation (VP) case

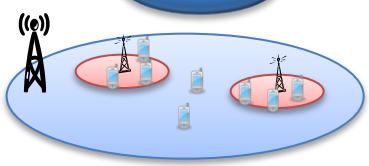


Observations

DPC based DL MU-MIMO can achieve better performance than linear precoding
Similar DPC techniques can be applied to broadcast and control/data/shared channels

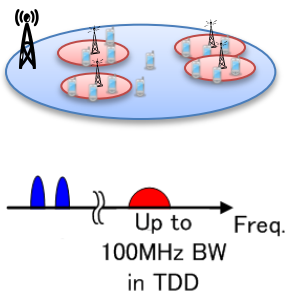
Potential Technologies

Rel.11



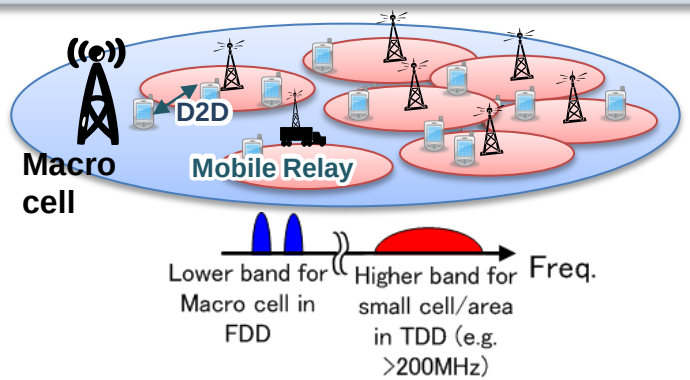
Rel.12

1. Small cell with Higher freq. band
2. Denser Network



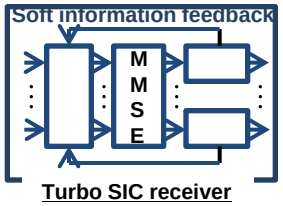
Rel.13 and Beyond

1. Small cell with Wider BW (>200 MHz)
2. Spectrum efficiency improvement (e.g. Non-orthogonal access, DPC)



Reference Receiver Enhancements

Interference rejection combining (2RX IRC)



Evaluation reference Receiver (e.g. Turbo-SIC w/IRC for Non-orthogonal access)

Conclusion

Requirement

To meet the expected 1000x traffic growth, the system capacity has to be increased significantly

High Level Technical Direction

1st Step: Denser Network & Higher frequency

1. Higher Frequency (e.g. > 3 GHz)
2. TDD may be widely used in small cell environment
3. Complementary carrier type(s) (e.g. Rel-11/12/beyond Rel.12 New Carrier Type etc) should be optimized for small cell

2nd Step: Bandwidth Extension & Spectrum and transmission efficiency

1. Wider Bandwidth (e.g. > 200 MHz in Rel.13 and beyond)
2. Spectrum Efficiency has to be improved both in Macro and Small cells/areas
3. Enhanced Access and Coding Schemes
4. Reference Receiver Enhancement

From UE manufacturer's point of view

1. UE's burden on supporting lots of bands by a UE and the cost of test should be taken into account
2. Battery life of UEs (both smartphones and M2M) should be taken into account in air interface design