

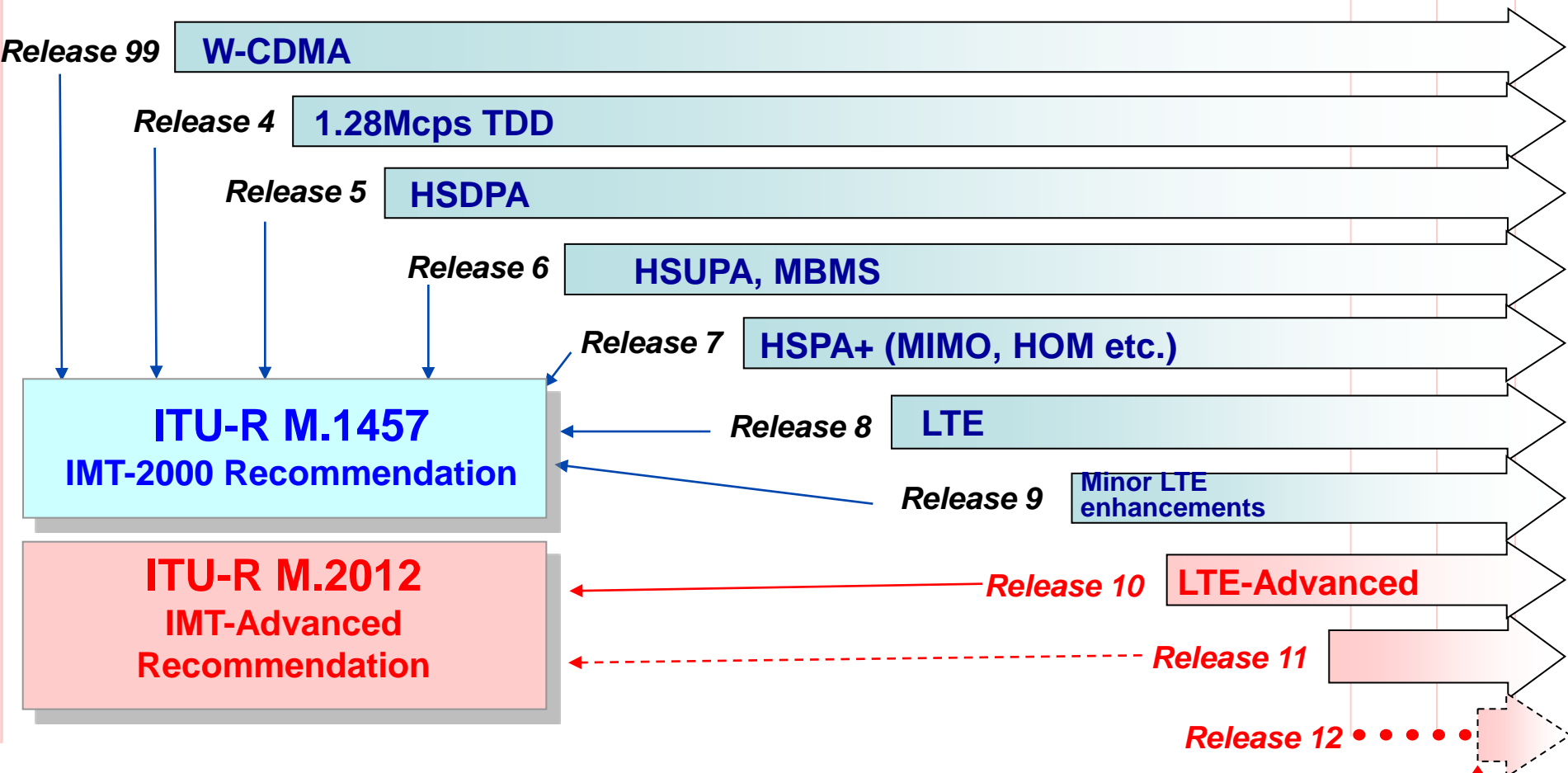
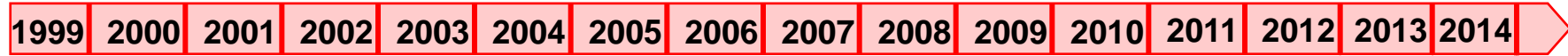
# LTE Release 12 and Beyond

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3GPP TSG-RAN

NTT DOCOMO

# Release of 3GPP specifications



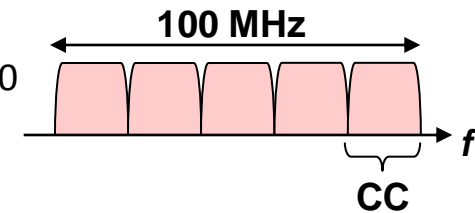
# 3GPP LTE Release 10 and 11

# Key Features in Release 10

## Support of Wider Bandwidth(Carrier Aggregation)

- Use of multiple component carriers(CC) to extend bandwidth up to 100 MHz
- Common physical layer parameters between component carrier and LTE Rel-8 carrier

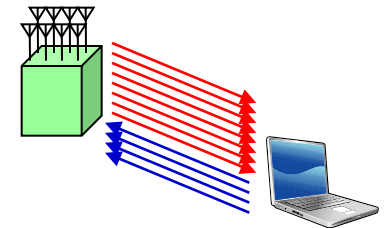
← Improvement of peak data rate, backward compatibility with LTE Rel-8



## Advanced MIMO techniques

- Extension to up to 8-layer transmission in downlink
- Introduction of single-user MIMO up to 4-layer transmission in uplink
- Enhancements of multi-user MIMO

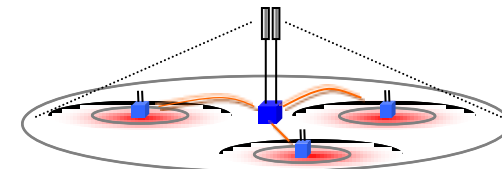
← Improvement of peak data rate and capacity



## Heterogeneous network and eICIC(enhanced Inter-Cell Interference Coordination)

- Interference coordination for overlaid deployment of cells with different Tx power

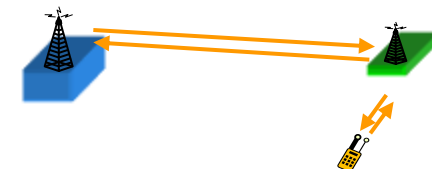
← Improvement of cell-edge throughput and coverage



## Relay

- Type 1 relay supports radio backhaul and creates a separate cell and appear as Rel. 8 LTE eNB to Rel. 8 LTE UEs

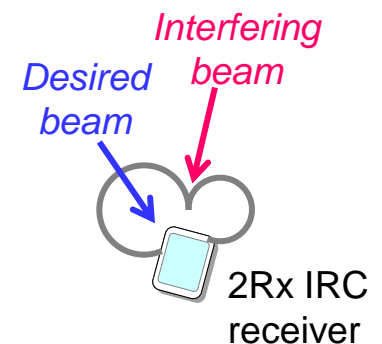
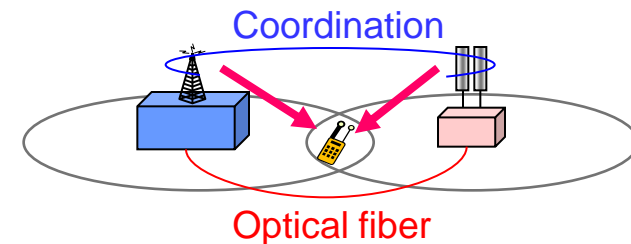
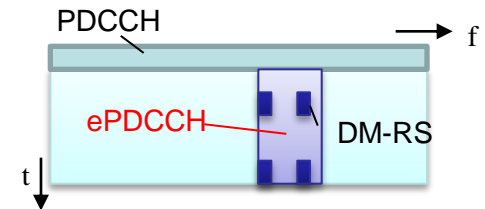
← Improvement of coverage and flexibility of service area extension



# Key Features in Release 11

## Physical layer aspects

- Carrier aggregation (CA) enhancements
  - Different TDD UL/DL configuration on different band
  - Multiple timing advances for UL CA
- Enhanced downlink control channel (E-PDCCH)
  - Enhanced DL control channel to support increased control channel capacity, freq. domain ICIC, beamforming and/or diversity
- CoMP transmission and reception
  - CoMP for Homogeneous/Heterogeneous NW
    - Enhancement on DL/UL reference signal, control signal
    - Channel state information feedback and measurement
- Further enhanced inter-cell interference coordination (FeICIC)
  - Interference cancellation technique for UE (e.g., CRS canceller from Macro-cell)
- Improved minimum performance requirements for E-UTRA: Interference rejection
  - Interference rejection combining (IRC) UE receiver



# Key Features in Release 11

## Higher layer aspects

- 📶 Enhancement of Minimization of Drive Tests (MDT)
  - Intention is to provide mechanisms to collect radio measurements together with location information from eNB/UE to reduce operator costs for performing manual drive tests
  - QoS measurements (e.g. throughput, traffic volume) added in Rel-11 specs
- 📶 RAN overload control for Machine-Type Communications (MTC)
  - Intention is to protect the NW from potentially very large number of MTC terminals
  - CN/RAN overload avoidance specific to MTC terminals added in Rel-11 specs
- 📶 Further self optimizing networks (SON) enhancements
  - Procedures for inter-RAT MRO added in Rel-11 specs
- 📶 Network Energy Saving
  - Procedures for inter-RAT energy saving added in Rel-11 specs
- 📶 LTE RAN Enhancements for Diverse Data Applications
  - Intention is to specify RAN improvements considering various data traffic, e.g. those generated by smartphones
  - Signaling for optimization of terminal battery consumption specified in Rel-11

# 3GPP LTE Release 12 (and Beyond?)

# Release 12 Status Overview

## (Physical Layer Aspects in June, 2013)

### Study Item

- Small Cell Enhancement
- 3D-channel model for Elevation Beamforming and Full Dimension-MIMO
- Network-Assisted Interference Cancellation and Suppression
- Device to Device (D2D) Proximity Services
  - Discovery/Communication
- Enhanced Coordination Multi-Point (CoMP) Transmission/Reception

### Work Item

- New Carrier Type (NCT)
  - Stand alone NCT/Non-stand alone NCT
- Further enhancements to TDD for DL/UL Interference Management and Traffic Adaptation (eIMTA)
- Further DL MIMO Enhancement
- Low cost & enhanced coverage MTC UE
  - Low cost MTC
  - Coverage enhancement
- TDD-FDD Carrier Aggregation
- Coverage Enhancements

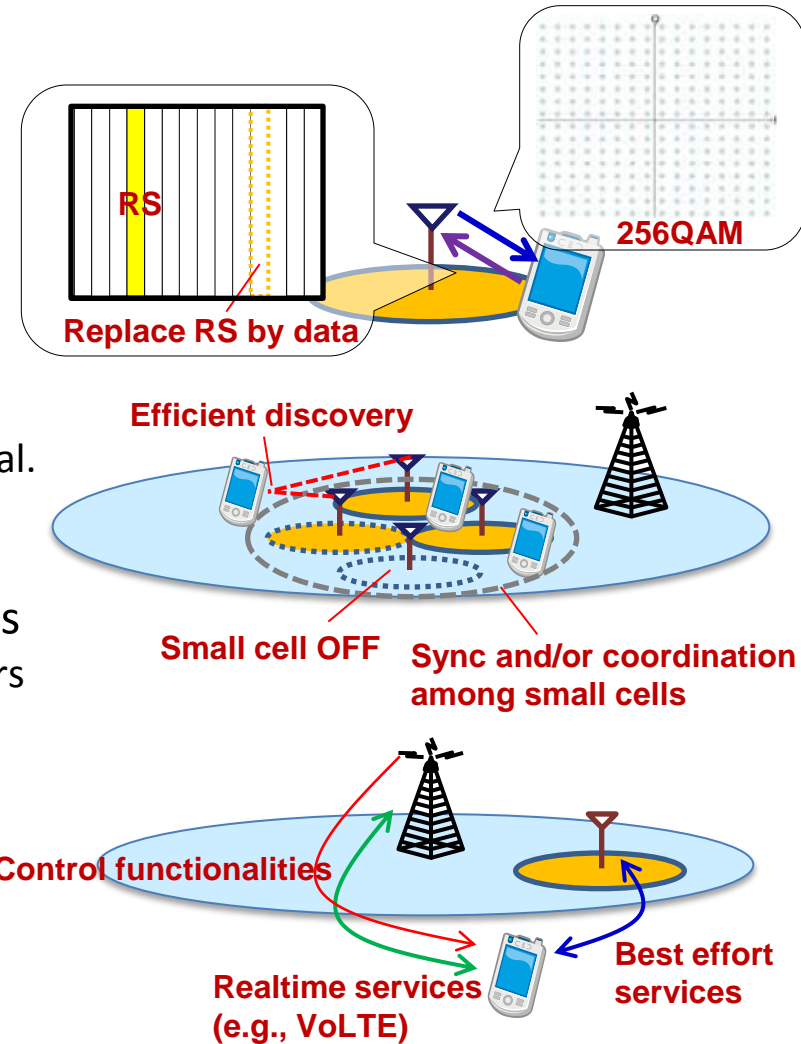


# Small Cell Enhancements -PHY aspects-

## Objective

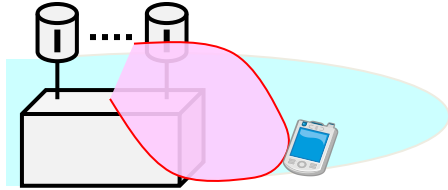
- Spectrum efficiency improvements
  - Higher order modulation (e.g., 256QAM)
  - Overhead reduction, control signaling enhancement
- Efficient small cell operation
  - Interference avoidance and coordination
  - Small cell ON/OFF, load balancing/shifting, et al.
  - Efficient small cell discovery
  - Radio Interface-based sync.
- Physical layer study for higher-layer aspects
  - Dual connectivity to macro and small cell layers
  - Mobility enhancements

Study will be closed and specification works for identified technologies will start in Sep. 2013



# MIMO Enhancements

## Rel-10 MIMO



- Max. 8-Tx (Max. 4-Tx for FDD)
- Achieves beamforming in azimuth angle

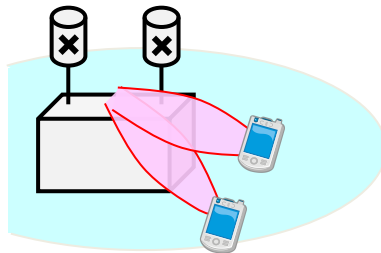
Optimization for realistic environment

Beamforming in azimuth/elevation angle

Enhancement of the number of antennas

## Rel-12 MIMO

### 2D MIMO enhancement

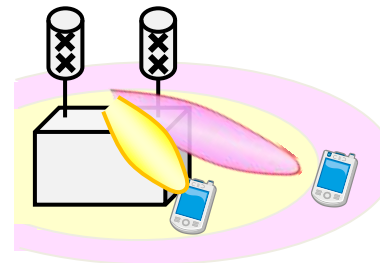


- 4-Tx codebook enhancement
- Feedback enhancement for MU-MIMO

### 3D MIMO using active antenna system

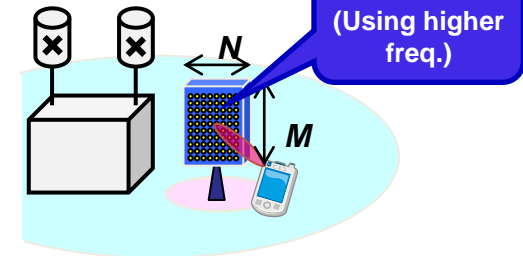
Study of 3D channel model (3D UE distribution, 3D pathloss, fast fading, etc)

#### Elevation beam forming



- Max. 8-Tx
- Beam gain and interference reduction using 3D beam

#### Full dimension-MIMO

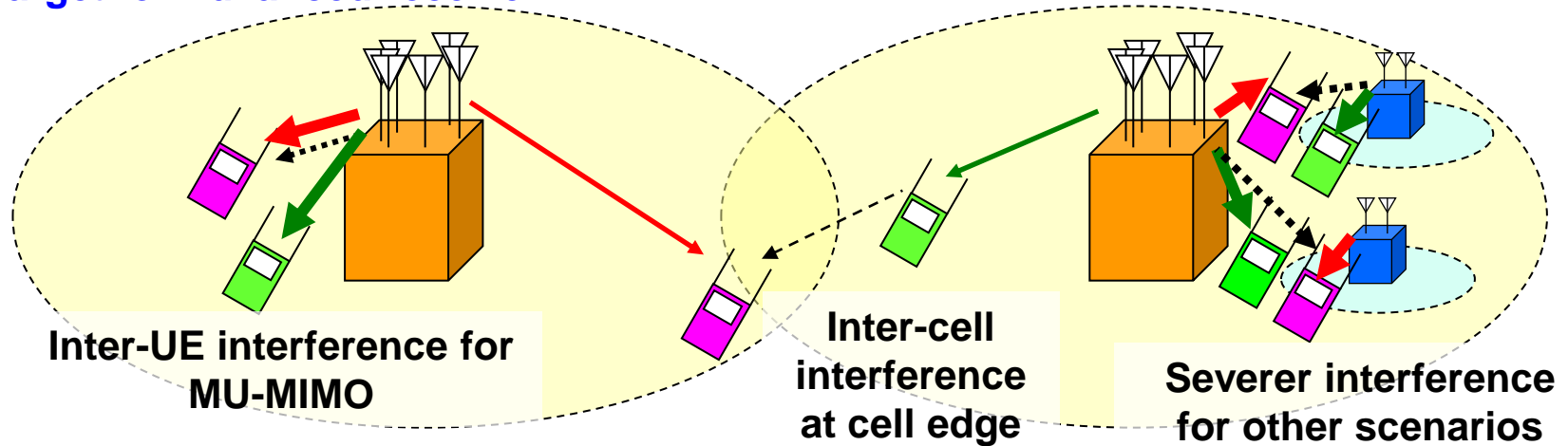


- More than 8-Tx (e.g., 16, 32, ...)
- Higher freq. (e.g., 3.5 GHz-)
- Progressive capacity enhancement in hotspot area

# NW-Assisted Interference Cancellation and Suppression

	Rel. 11 Advanced receiver	Rel. 12 Advanced receiver
Target for receiver	Interference limited areas, i.e., cell edge	All areas including cell edge

## ■ Target for Advanced receiver



📶 Study on a variety of receiver types and need of interference information (NW-assisted receiver)

- Interference suppression: Enhancement of Rel-11 receiver
- Interference cancellation: Subtraction of interference replica from received signal, e.g., SIC

# Device to Device (D2D) proximity service

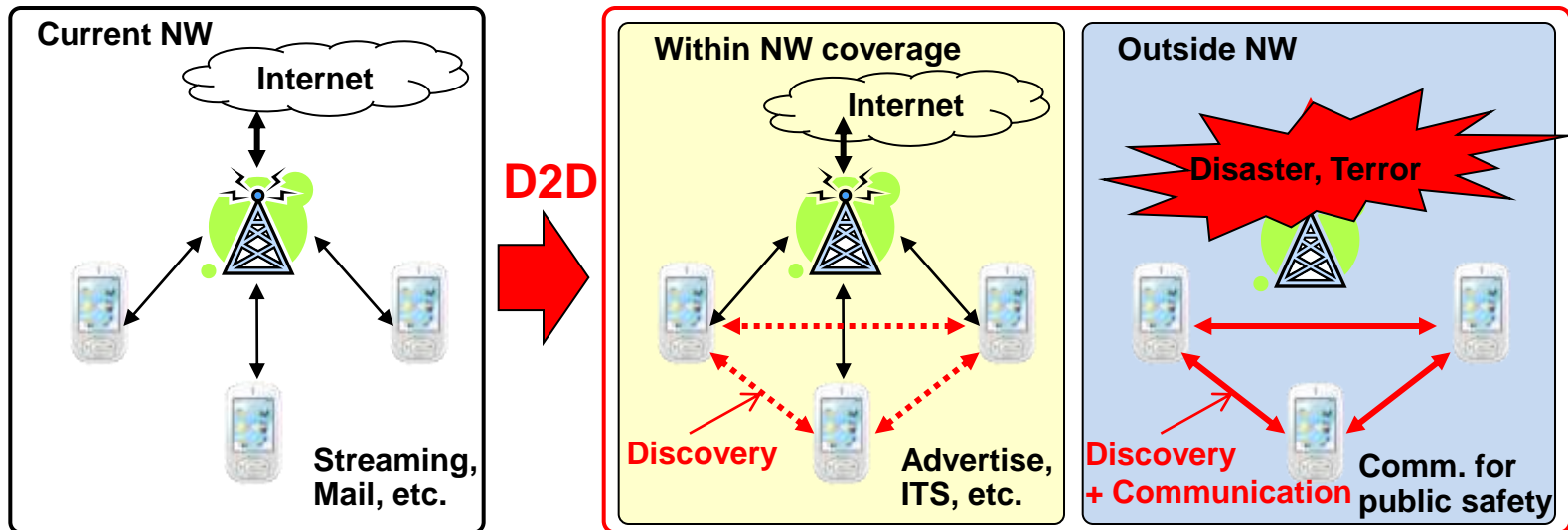
## Two kinds of objective

- Commercial use with NW coverage
- Public safety/critical communication with/without NW coverage

## Two kinds of technical topics

- D2D discovery
- D2D communication

	With NW coverage	Without NW coverage
Discovery	Required both for public safety & non-public safety	Public safety only
Communication	Required at least for public safety	Public safety only



# New Carrier Type (NCT)

## Objective

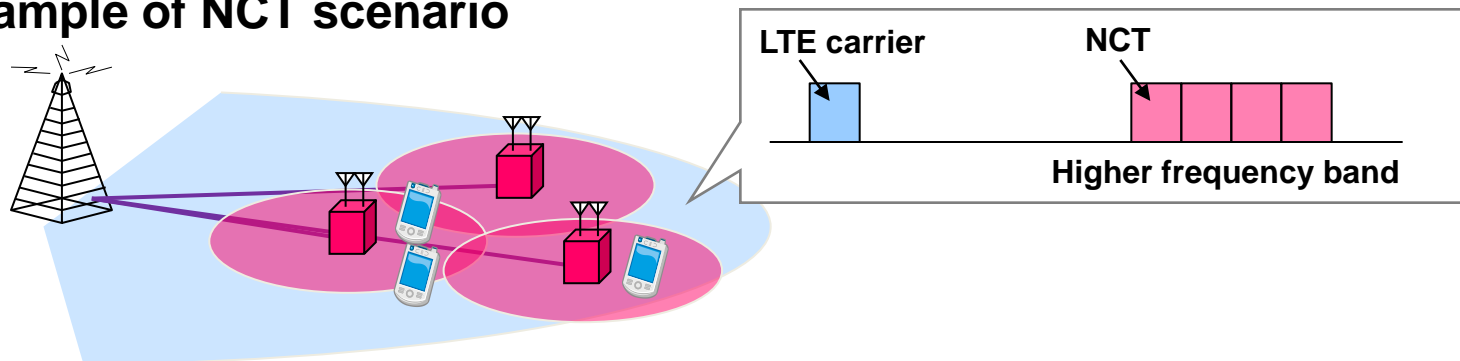
- Improve system performance allowing Non-backward compatible carrier (Non-support for legacy LTE UE)
  - Less frequent transmission of cell-specific reference signal (CRS)

## Identified advantages

- Enhanced spectrum efficiency by reducing overhead signal
- Improved support for HetNet by avoiding interference from CRS
- Energy efficiency by not transmitting DL signal

## Evaluating benefit of stand-alone NCT (support for idle mode UE)

### Example of NCT scenario

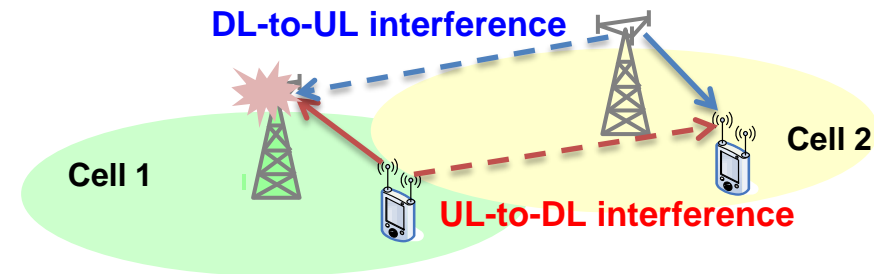


# eIMTA\* (Dynamic TDD)

\* eIMTA: Further enhancements to LTE TDD for DL-UL interference management and traffic adaptation

## Objective

- TDD UL-DL reconfiguration for traffic adaptation
- Interference mitigation with TDD UL-DL reconfiguration



## ✓ Interference mitigation schemes

<p><i>Scheme 1</i></p> <p><b>Cell clustering</b></p>	<p><i>Scheme 2</i></p> <p><b>Scheduling enhancement</b></p>
<p><i>Scheme 3</i></p> <p><b>Interference mitigation based on (F)eICIC</b></p>	<p><i>Scheme 4</i></p> <p><b>Interference suppressing and mitigation</b></p>

## Topics under discussion

- Reconfiguration mechanism
- Interference mitigation scheme

# LTE Operating Bands

## FDD

Band	Frequency(UL/DL)(MHz)	Remark
1	1920-1980/2110-2170	IMT Core band (EU, Africa, Asia, etc.)
2	1850-1910/1930-1990	PCS1900 band (US, Canada, Americas)
3	1710-1785/1805-1880	GSM1800 band (EU, Africa, Asia, etc.)
4	1710-1755/2110-2155	AWS-1 (US, Canada, Americas)
5	824-849/869-894	GSM850 band (US, Canada, Americas, Asia, etc.)
6	830-840/875-885	Not applicable
7	2500-2570/2620-2690	IMT extension band (EU, Africa, Asia, etc.)
8	880-915/925-960	GSM900 band (EU, Africa, etc.)
9	1749.9-1784.9/1844.9-1879.9	Japan
10	1710-1770/2110-2170	Expanded Band 4
11	1427.9-1447.9/ 1475.9-1495.9	Japan
12	699-716/729-746	700 Lower in US
13	777-787/746-756	700 Upper C in US
14	788-798/758-768	700 Upper D in US
17	704-716/734-746	700 Lower in US
18	815-830/860-875	Japan
19	830-845/875-890	Japan
20	832-862/791-821	EU Digital Dividend
21	1447.9-1462.9/1495.9-1510.9	Japan
22	3410-3490/3510-3590	EU 3.5GHz band
23	2000-2020/2180-2200	US S-band
24	1626.5-1660.5/1525-1559	US L-band
25	1850-1915/1930-1995	Expanded Band 2
26	814-849/859-894	E850 Upper band
27	807-824/852-869	E850 Lower band
28	703-748/858-803	APT700
29	NA/716-728	US DL only
30	2305-2315 / 2350-2360	US LTE WCS
31	451-458 / 461-468	Brazil LTE 450

## TDD

Band #	Frequency(MHz)	Remark
33	1900-1920	3G core band
34	2010-2025	3G core band
35	1850-1910	PCS1900 uplink band
36	1930-1990	PCS1900 downlink band
37	1910-1930	PCS Center Gap
38	2570-2620	3G extension band (EU, Africa, Asia, etc)
39	1880-1920	TD-SCDMA band in China
40	2300-2400	To be deployed in China
41	2496-2690	US 2.6 GHz band
42	3400-3600	EU 3.5GHz band
43	3600-3800	EU 3.5GHz band
44	698-806	APT 700

# LTE Carrier Aggregation RF Requirements

## 2 DL and 1 UL

### Inter-band

Band Comb.	Band Comb.
1+5	10+5/10(set 2)
3+7	4+5
4+13	4+7
4+17	5+17
7+20	8+20
5+12	11+18
4+12	2+29
2+17	4+29
3+5	1+8
10+5/10(set 1)	2+13
3+20	3+19
1+21	3+26
1+19	3+28
1+18	19+21
3+8	23+29

### Intra-band contiguous

Band
1 (set 1)
40
41
1 (set 2)

### Intra-band non-contiguous

Band
3
4
25
7

Many Work Items are on going and to be specified

## 2 DL and 2 UL

On going for 5 classes

- A1. Low-high band combination without harmonic relation between bands or intermodulation problem
- A2. Low-high band combination with harmonic relation between bands
- A3. Low-low or high-high band combination without intermodulation problem (low order IM)
- A4. Low-low, low-high or high-high band combination with intermodulation problem (low order IM)
- A5. Combination except for A1 – A4

## 3 DL and 1 UL

Work Items have been started from June 2013



# Thank you!

## Takehiro Nakamura 3GPP TSG-RAN



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**TSG Structure**

Project Co-ordination Group (PCG)

TSG-SCM	TSG-RAN	TSG-SA	TSG-CT
SCM WG1	RAN WG1	SA WG1	CT WG1
SCM WG2	RAN WG2	SA WG2	CT WG2
SCM WG3	RAN WG3	SA WG3	CT WG3
SCM WG4	RAN WG4	SA WG4	CT WG4
SCM WG5	RAN WG5	SA WG5	CT WG5
SCM WG6	RAN WG6	SA WG6	CT WG6
SCM WG7	RAN WG7	SA WG7	CT WG7
SCM WG8	RAN WG8	SA WG8	CT WG8
SCM WG9	RAN WG9	SA WG9	CT WG9
SCM WG10	RAN WG10	SA WG10	CT WG10
SCM WG11	RAN WG11	SA WG11	CT WG11
SCM WG12	RAN WG12	SA WG12	CT WG12
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