



LTE & LTE-A Evolution

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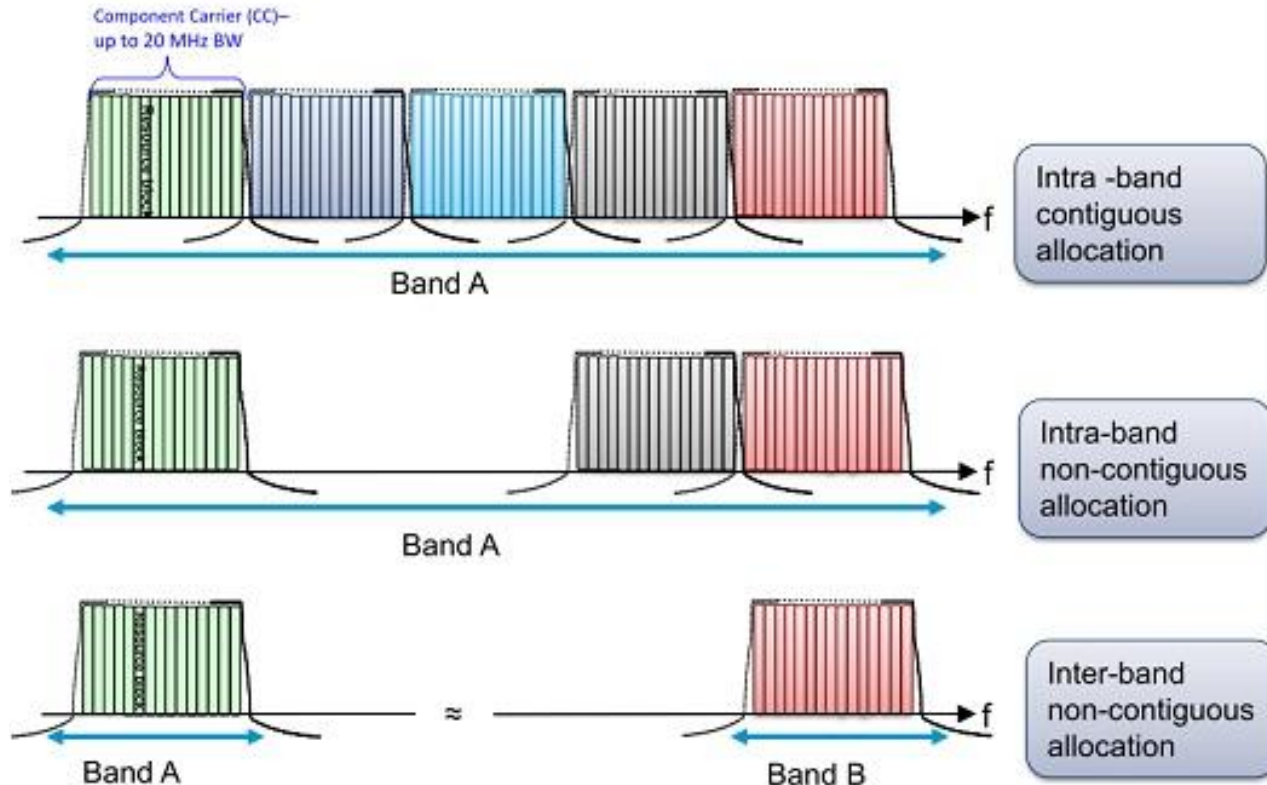
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Agenda

- Carrier Aggregation
- LTE-U (LAA)
- LTE + WiFi
- 5G
- eMBMS

Carrier Aggregation



- Up to 5 CC and 100 MHz
- Rel.10 defines only 3 combinations
- +25 combinations in Rel.11
- +74 combinations in Rel.12 (including 3 CC in DL and 2 CC in UL)

Carrier Aggregation Statistics

- 64 LTE-Advanced Systems commercially launched in 39 countries
 - 11 Category 4 (up to 150 Mbps peak DL throughput)
 - 52 Category 6 (above 150 Mbps up to 300 Mbps peak DL throughput)
 - 1 - clarifications needed
- 116 operators (around 30% of LTE operators) are investing in CA
- 13 Category 9 (up to 450 Mbps DL throughput) Systems are in deployment, trial or test phase
- 858 devices (almost 30% of all LTE devices) support Category 4
- 69 devices support Category 6

LTE-U (License Assisted Access)

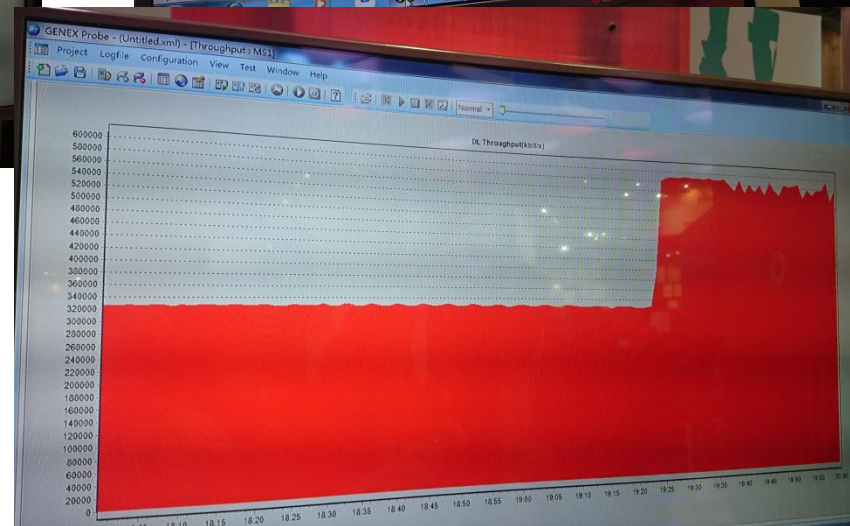
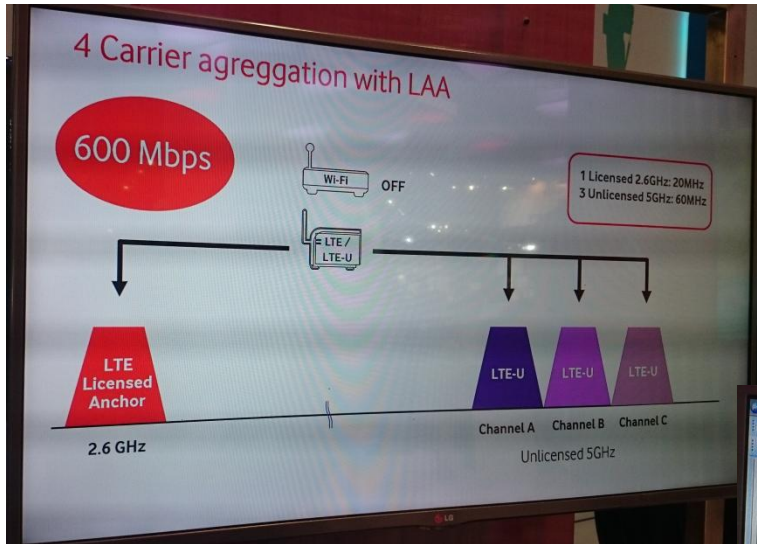


➤ LTE-U - utilize WiFi 5GHz band for LTE (when it's free)

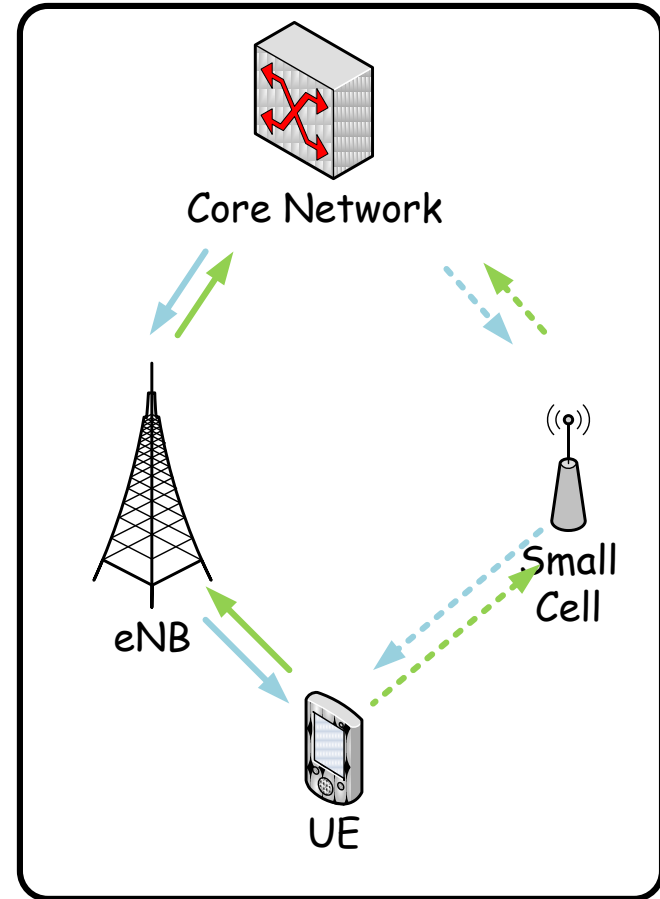
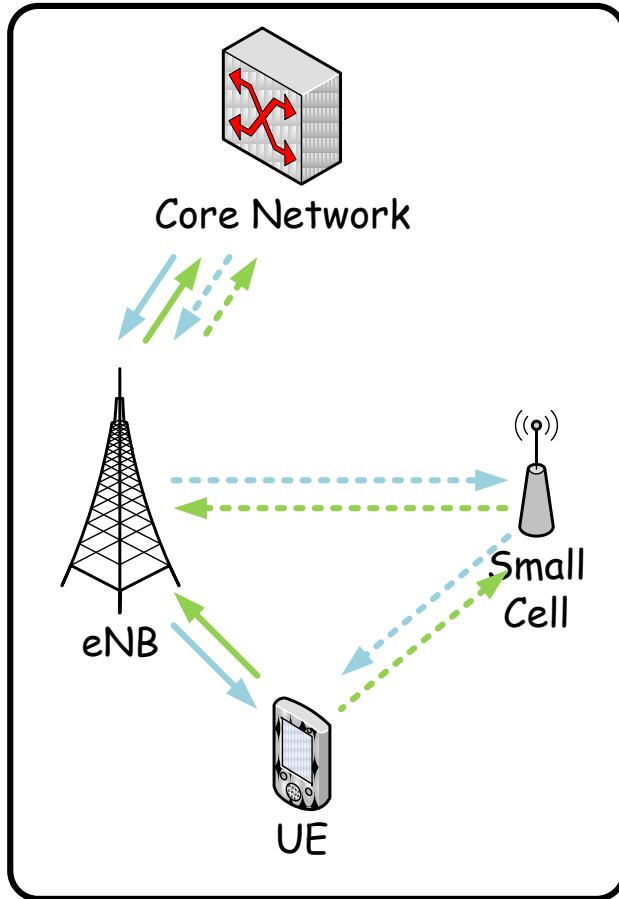
LTE-U Demos on MWC'15



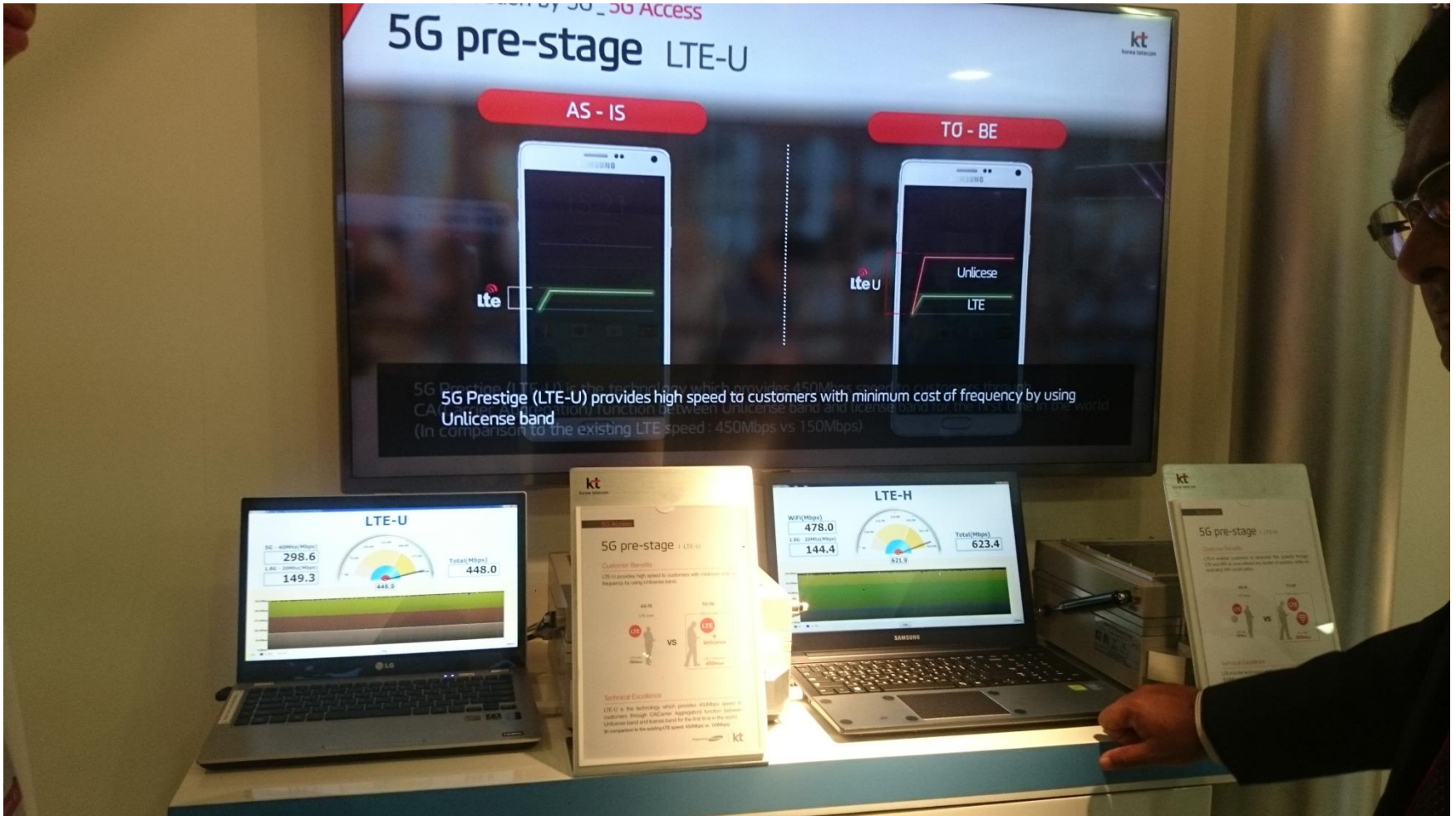
Vodafone LTE-U Demo



Dual Connectivity



LTE+WiFi Demo



5G Status

- There are a lot of working groups/projects/consortium (METIS, 5GPPP, IMT-2020, etc.)
- There is no 5G standard/specification yet
- Also there is no agreed requirements list yet (2017?)
 - Faster
 - Low latency
 - Much more connections (IoT -> IoE)
 - Lower TCO
 - Etc...

NTT DoCoMo 5G

NTT docomo X ERICSSON

New radio interface concept

- New numerology for wider band and low latency
- Ultra high data rate
- Beamforming with massive antenna

Achieved over 5Gbps in indoor trial

Achieved over 4.5Gbps in outdoor trial

5G trials with Eight leading mobile technology vendors

Existing bands UHF bands Ex. 800MHz, 2GHz

Exploitation of higher frequency bands

Low SHF bands 3-6GHz

High SHF bands 6-30GHz

EHF bands > 30GHz

Frequency

New partner Alcatel-Lucent HUAWEI FUJITSU NEC ERICSSON SAMSUNG

New partner MITSUBISHI ELECTRIC NOKIA

Non-Orthogonal Multiple Access (NOMA)

Advanced multiple access

- For further cellular enhancements
- Power-domain user multiplexing
- Advanced receiver (SIC)

OFDMA (LTE) **NOMA**

Intentional Non-Orthogonality

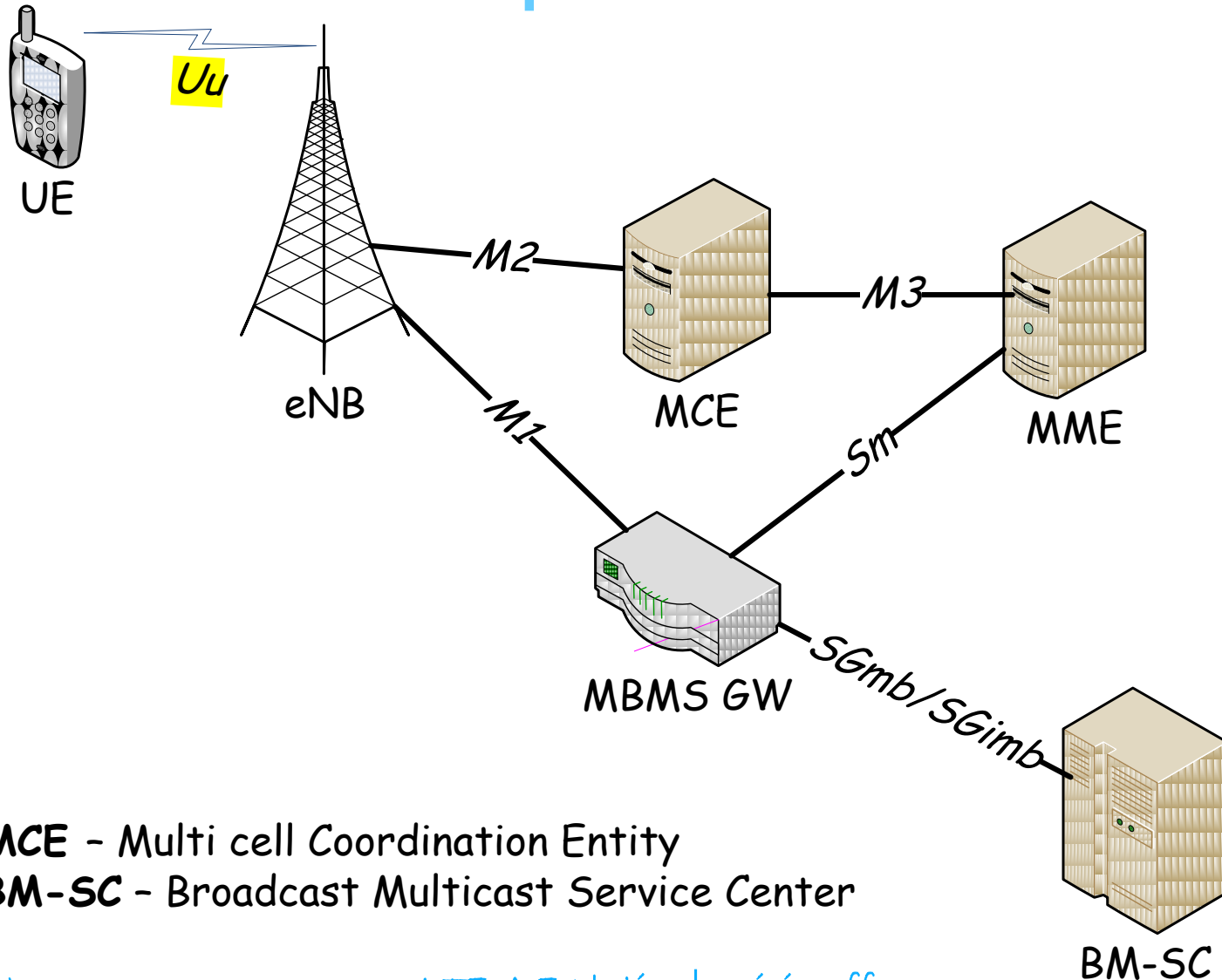
NTT docomo X NOKIA

mmW radio access @ 70GHz

- For dense small cells and indoor/hotspot
- Beam tracking for mobility
- Ultra-wideband (1GHz)

Achieved over 2Gbps in indoor trial

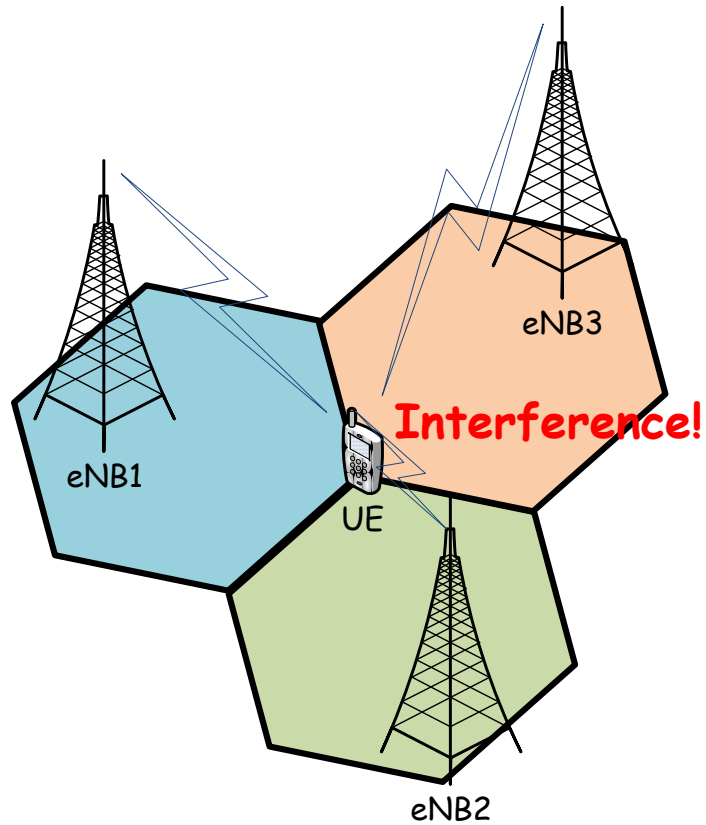
eMBMS Impact on Network



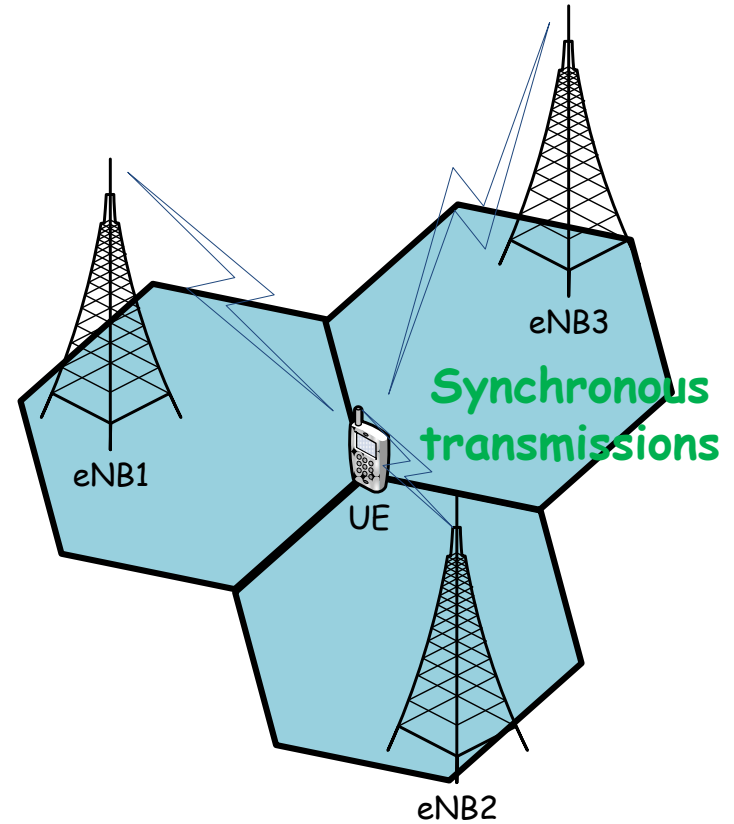
MCE - Multi cell Coordination Entity
BM-SC - Broadcast Multicast Service Center

Interference in eMBMS

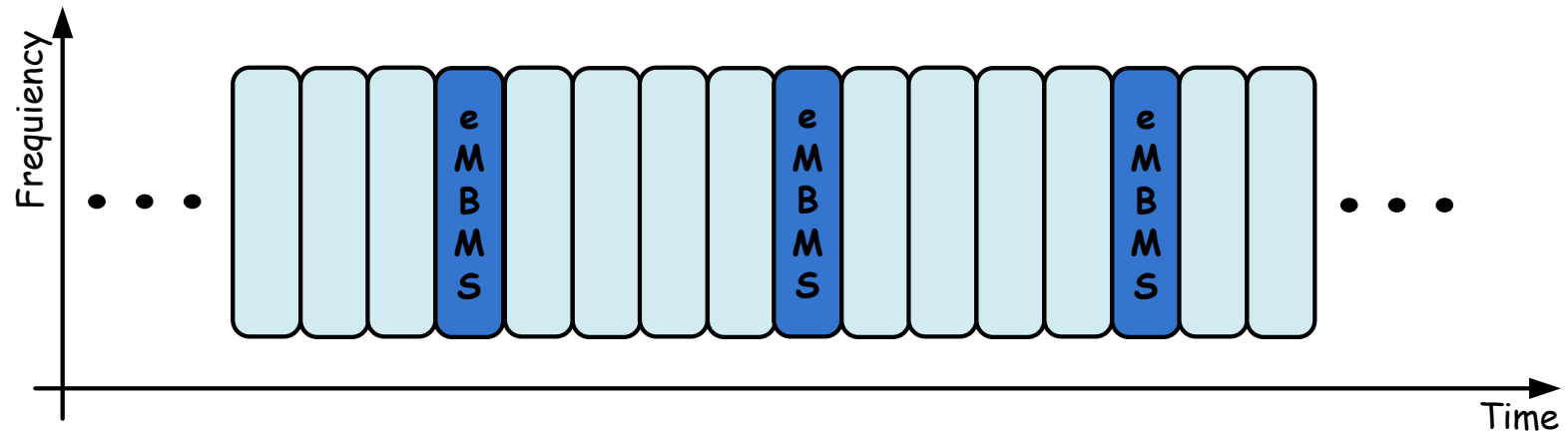
Unicast



Broadcast



eMBMS Throughput



- Flexible radio resource allocation for eMBMS
- 0.3% to 60% of resource can be allocated in case of FDD
- 0.3% to 50% of resource can be allocated in case of TDD
- Theoretical eMBMS data rate range in case of FDD and 10 MHz is 4.3 Kbps - 18 Mbps and in case of **20 MHz** is **8.6 Kbps - 36 Mbps**

eMBMS Use Cases

- Live event streaming
- Real-time TV streaming / Mobile TV
- Public Safety
- Kiosk services
- Newsfeeds
- Radio station streaming
- Media delivery
- Local advertising

eMBMS Status and Trials



eMBMS Trials List

Australia	Telstra	World's first stadium trial on January 31, 2014 during a cricket match at the Melbourne Cricket Ground (MCG)	Trialled
China	China Mobile	Public demonstration with LTE TDD mode in 2013	Trialled
China	China Telecom	Trialled June 2014 in Nanjing, Jiangsu Prov. Pre-commercial use for 2014 Summer Youth Olympic Games (August 16-28)	Pre-commercial use
France	Orange	Trialled during French Tennis Open 2014 at Roland Garros	Trialled
Germany	Vodafone	Europe's first stadium trial at Borussia Mönchengladbach soccer match. Also trialled at the Kieler Woche sailing event	Trialled
Germany	Institut für Rundfunktechnik	Trial in Munich using 700 MHz spectrum	Trialling
India	RJIL	Trialled in Mumbai	Trialled
Italy	Telecom Italia	Studying eMBMS technology	Studying
Netherlands	KPN	Trialled during Ajax soccer match on May 3, 2014	Trialled
Philippines	Globe	Showcased LTE eMBMS during the Globe Innovation Forum, targeting commercial launch in 2015 in selected areas	Trialled
Philippines	Smart	Trialled in 2013 using 2.1 GHz spectrum	Trialled
Poland	Polkomtel	Trialled during first game of FIVB Volleyball Men's World Championship using 300 terminals at the national stadium	Trialled
Portugal	Meo	Trialling	Trialling
Singapore	SingTel	Trialling in 2H 2014	Trialling
South Korea	KT	World's 1st commercial launch of LTE Broadcast: 27.01.14	Commercial
UAE	Etisalat	Trialling: network deployment planned in 2014	Trialling
UK	EE and the BBC	Demonstrated during Commonwealth Games 2014, Glasgow	Trialled
UK	Three UK	Trialled over its live LTE network in Maidenhead	Trialled
USA	AT&T	LTE Multicast commercial service targeted for 2015	Trialled
USA	Verizon Wireless	Trial during SuperBowl 2014 and on race day at Indy 500. LTE Multicast commercial service targeted for 2015	Trialled



Thank you!

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