# Mobile Network Evolution – Maintaining the WOW Factor!

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## Contents:

1. Introduction to EE

2. 2G, 3G & 4G network overview

3. LTE network performance and usage

4. LTE-Advanced

5. Deploying CA (Carrier Aggregation)

6. Small cells and Heterogeneous Networks

7. Coordinated transmission and reception

8. Cloud Radio Access Network (C-RAN)

9. Summary

# EE: THE BIGGEST AND BEST NETWORK
## Europe's fastest 4G rollout

> **The UK's biggest and fastest 4G network**
> - 4G in 131 cities and towns, and >60% population coverage
> - 98% 4G coverage by end of 2014
> - Double speed 4G in 20 major cities
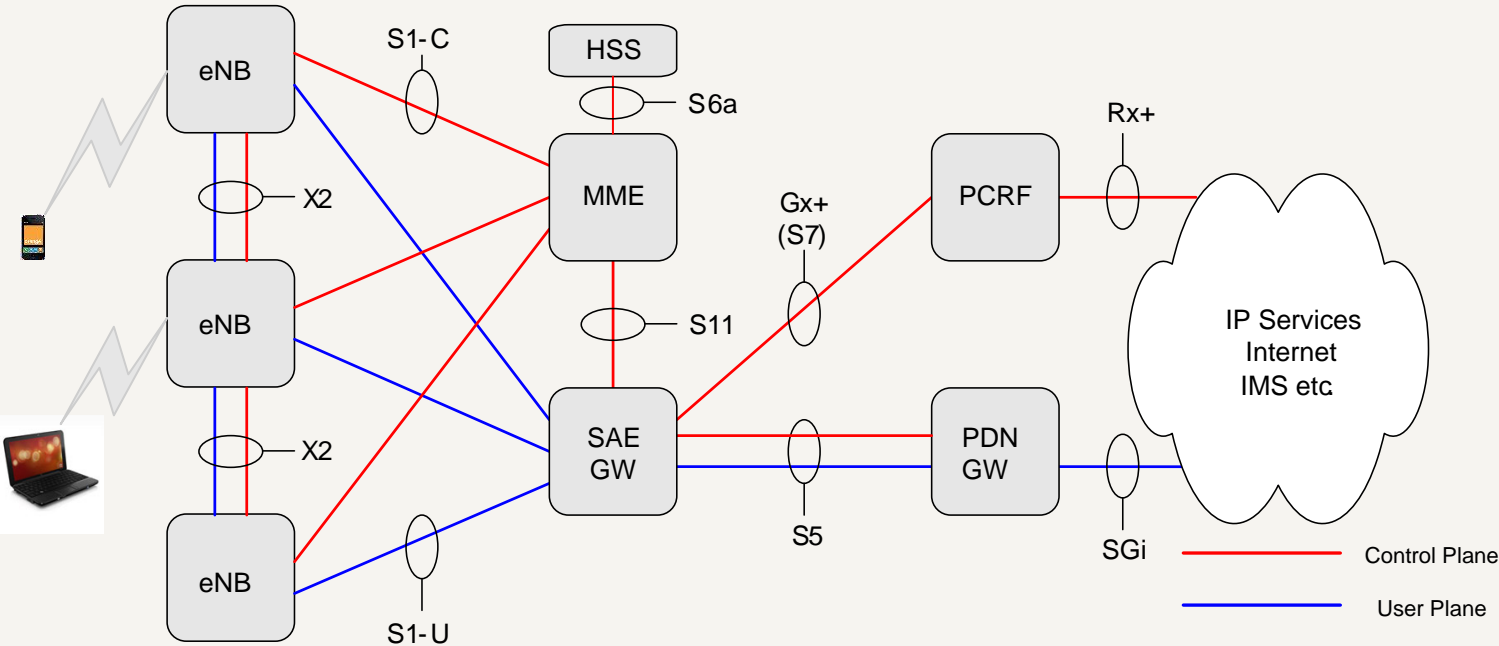
> **The UK's biggest 3G network**
> - DC-HSDPA covering 75% of the population (80% by December 2013)
> - 3G HSPA+21 across 95% of the population
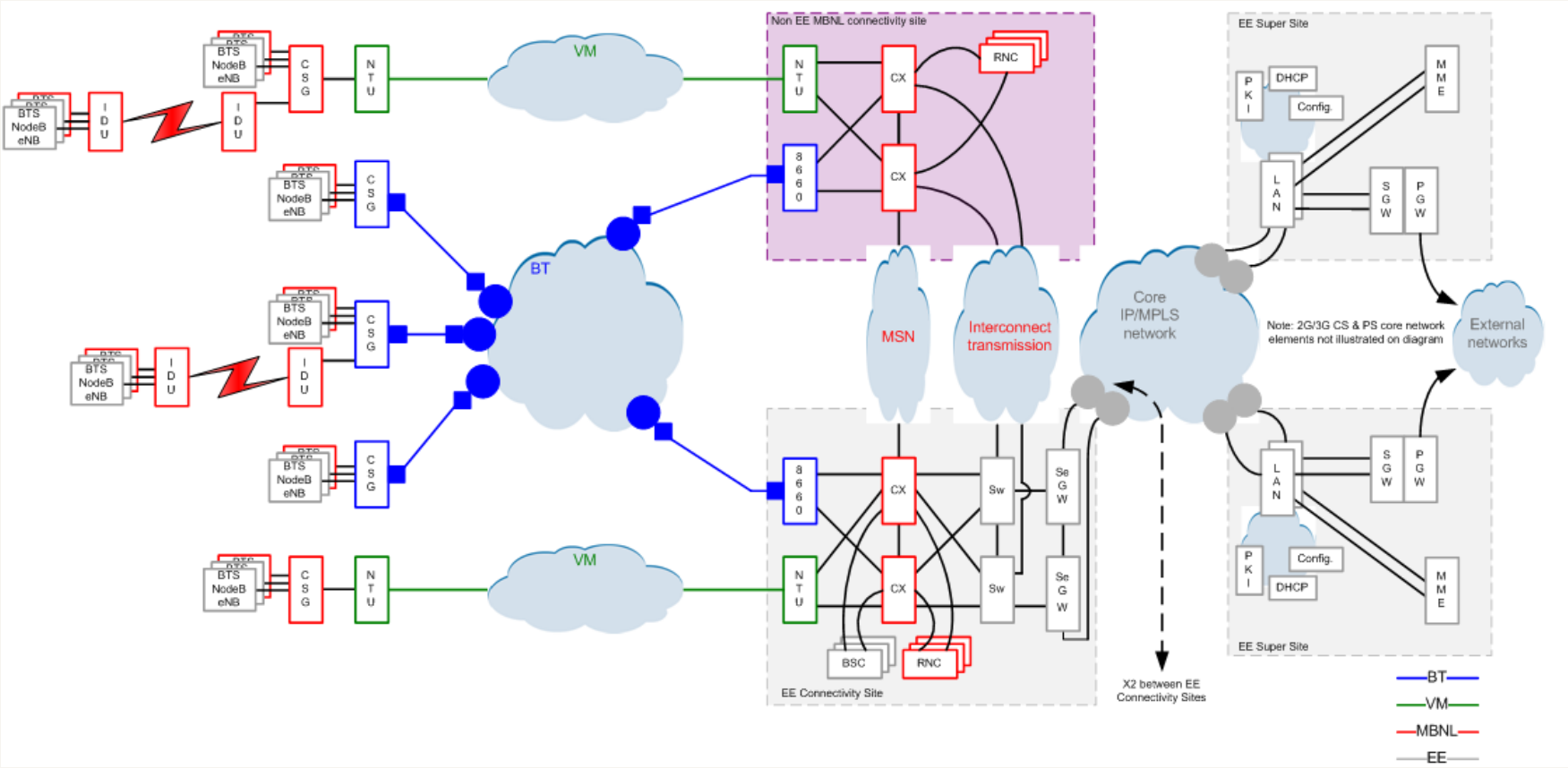
> **Fibre to 13m homes and businesses**

> **Evolving communication with VoWiFi, VoLTE, RCSe, and service with quality differentiation**



4G coverage
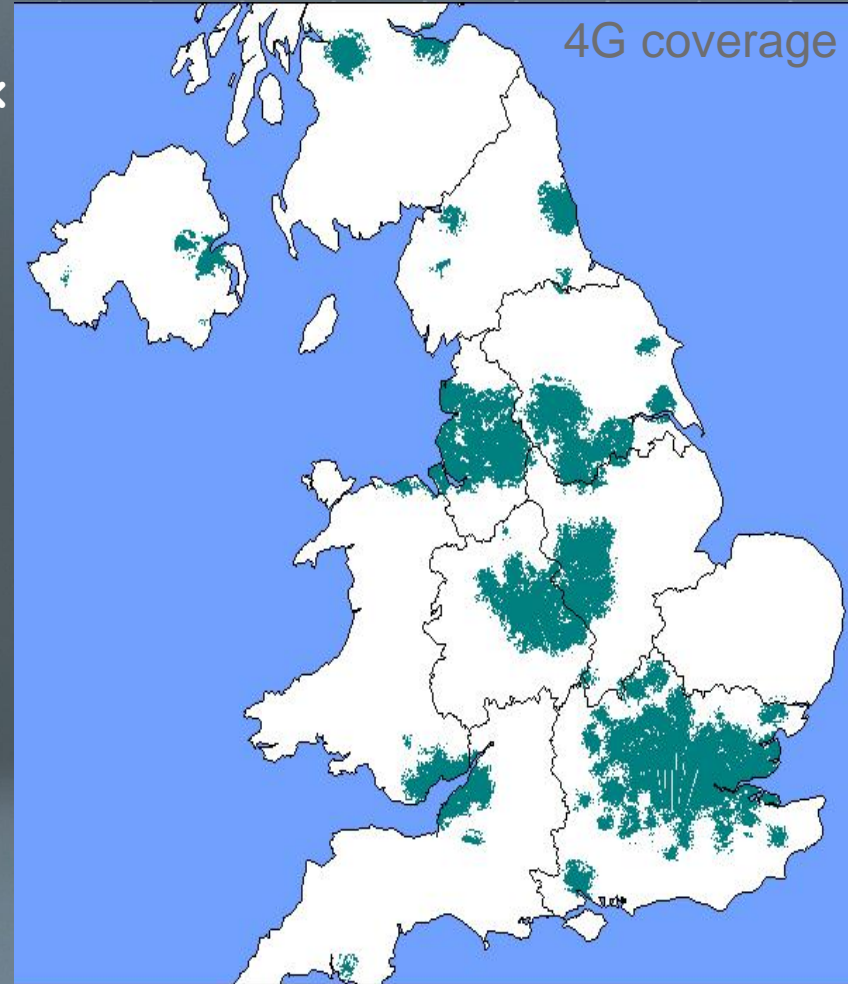
# LTE network diagram...

# Real LTE deployment in multi-RAT network

# LTE network performance

- High data rates with low latency by design

- Optimal network architecture, design and implementation will maximise the benefits of these 3GPP LTE system design attributes

- Data rate is determined by several factors which include:

  - Device category

  - Channel bandwidth

  - Loading on cell site

  - Distance/path from cell site

- Latency along with PDV and PELR are key network design considerations, they impact the network and application layer performance
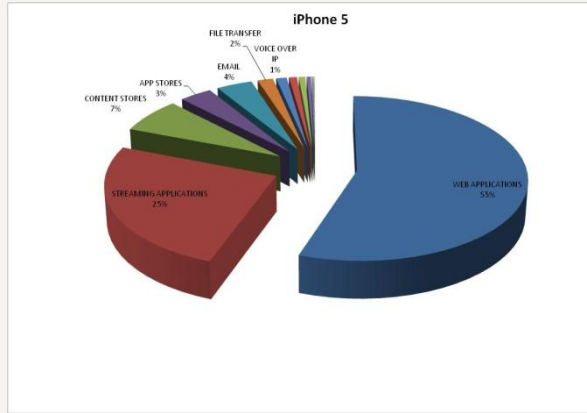


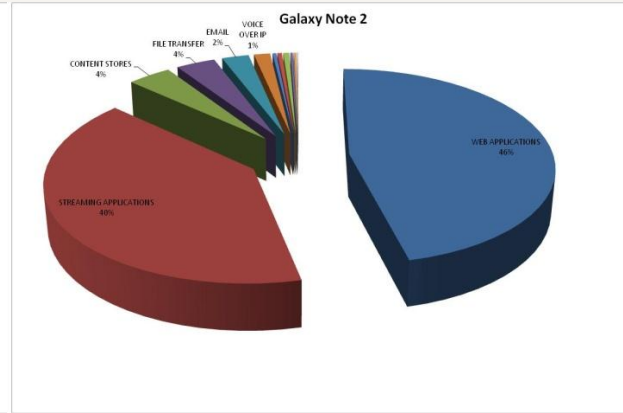*Speed-test on EE LTE network (20MHz FDD)*

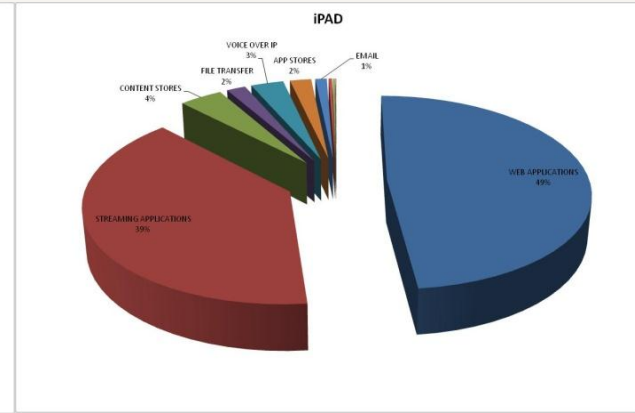# Screen size influences EE customer's behaviour

- Large screen devices stream more data

- Streaming accounts for 25% of the web usage data volume  for Apple iPhone and Samsung Galaxy S3

- Streaming accounts for ~40% or more of the web usage data volume for Apple iPad and Samsung Note 2


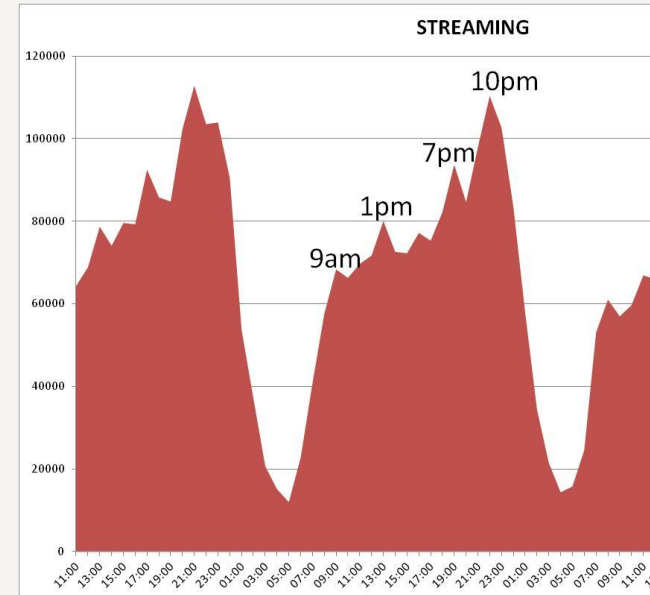
*Apple iPhone 25% streaming*

*Samsung Note 2: 40% streaming*

*Apple iPad: 39% streaming*

# EE network is used at different times for different services

- Web browsing happened earlier in the day and is more constant
- Streaming is biased towards the evening
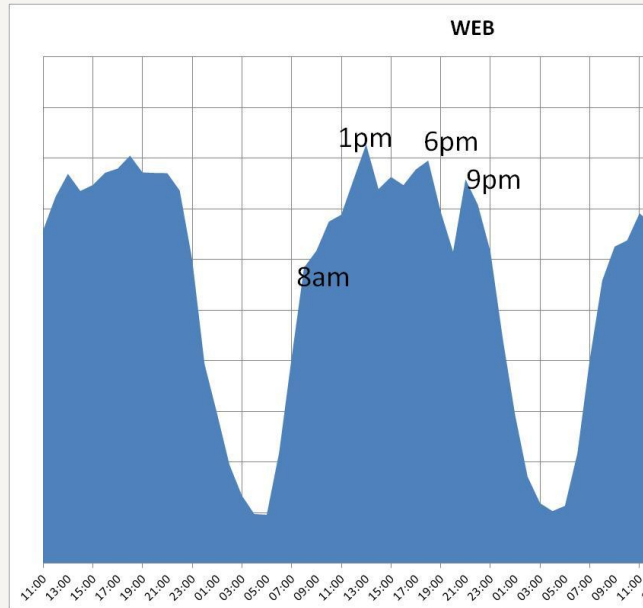
# Customer usage changes with activity

- iPad usage is more biased towards evenings- more sofa surfing
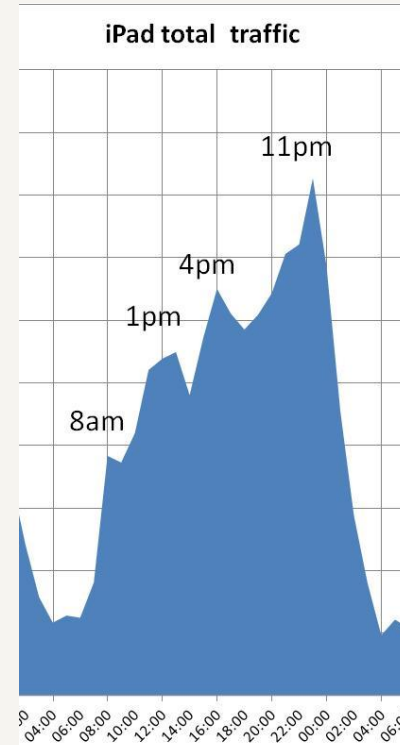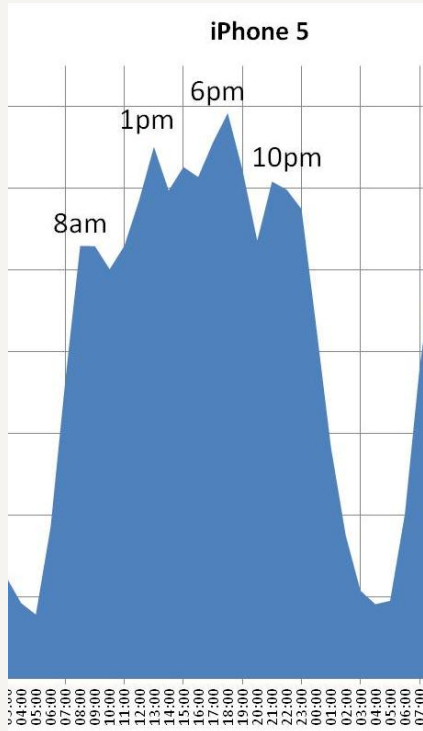
# 13% of EE 4G traffic is social media



For more information download the **4GEE Mobile Living Index** from: https://explore.ee.co.uk/our-company/newsroom/4gee-transforming-britain-into-nation-of-nomadic-sharers-streamers-and-shoppers

# LTE-Advanced



- LTE-Advanced features include:

- Downlink Carrier Aggregation

- Uplink Carrier Aggregation

- Downlink MIMO (>R8)
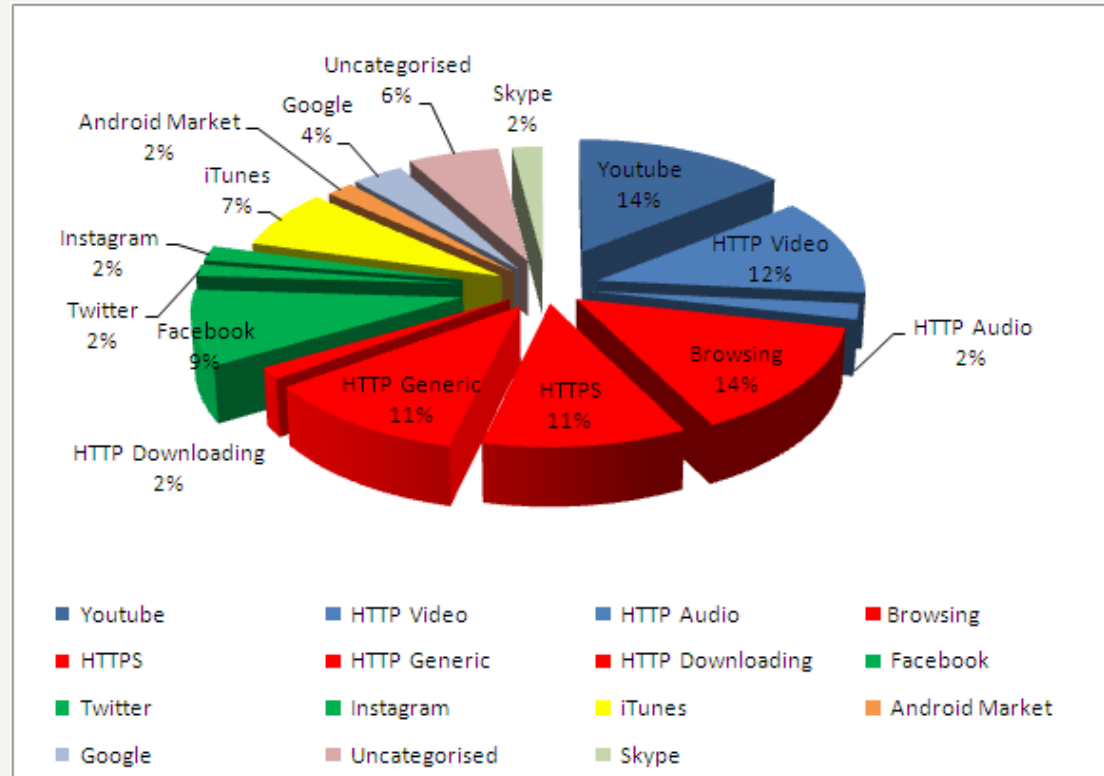
- Uplink MIMO

- Heterogeneous Networks (Het-Nets)

- Relays

- Self Organising Networks (SON)

- UE Advanced Receivers

- Coordinated Multipoint Transmission and Reception (CoMP)

## UK operator plans 300 megabit LTE
*03 July 2013*

EE doubles LTE speed to 150 megabits now and plans to launch LTE-A with 300 megabits in 2014

Read more: EE LTE LTE-Advanced carrier aggregation mobile broadband

UK operator EE is doubling its LTE speed to 150 megabits a second and plans a further doubling to 300 megabits in 2014.

CEO Olaf Swantee announced that the company would start doubling its speed — available to all LTE customers — from 4 July. An EE spokesman confirmed that the company would follow this with trials of carrier aggregation later in 2013 with the aim of launching a 300 meg service in 2014.

The immediate doubling is not strictly LTE-Advanced, the refinement of LTE which uses non-adjacent channels to expand available bandwidth. South Korea's SK Telecom announced the first LTE-A using carrier aggregation in late June 2013, claiming similar speeds to EE.

But EE, which was created in 2010 out of a merger of France Telecom's Orange UK and Deutsche Telekom's T-Mobile UK, is expanding its bandwidth by putting together channels acquired from the spectrum — all in the 1,800 megahertz band — owned by both its parents.

"It's not carrier aggregation in LTE-Advanced terms," said an EE official. "We've unified the Orange and T-Mobile spectrum. We now have as much spectrum as SK Telecom but without using LTE-Advanced."

However EE does plan to start aggregating 1,800 megahertz spectrum with some of its 2,600 megahertz spectrum in trials to start in London later in 2013. This should expand to a commercial service in 2014, said the official, pushing bandwidth to 300 megabits.

The current maximum offering of 150 megabits is available in 12 cities, said Swantee, giving 25% population coverage of the UK. "It should give average speeds of 24-30 megabits," he added. "This is absolutely in line with fibre broadband speeds."

The service is being offered "because we can", said Swantee. "It's faster than the US and faster than other countries in Europe. It's in line with the fastest networks in Korea."

EE has more than half a million customers on LTE, said the company, which is launching its first 4G pay-as-you-go offering.

*Source: http://www.globaltelecomsbusiness.com/article/3229002/UK-operator-plans-300-megabit-LTE.html*

# Hot off the press – 5th November 2013

- Mobile network company EE is switching on the fastest 4G mobile network in the world today in London.

- The network, which can reach speeds of 300Mbps, will initially cover East London's Tech City, and will be rolled out across London throughout 2014.

- Companies in the East London area will be selected to become exclusive EE partners, enabling them to experience the service before it becomes commercially available when compatible devices launch from mid-2014.

- The new network innovation, which has a theoretical maximum speed of 300Mbps, is enabled by carrier aggregation – bringing together 20MHz of 1800MHz spectrum and 20MHz of 2.6GHz spectrum.

- The EE selected user programme will launch using a CAT6 Huawei router – the first device of its kind in the world
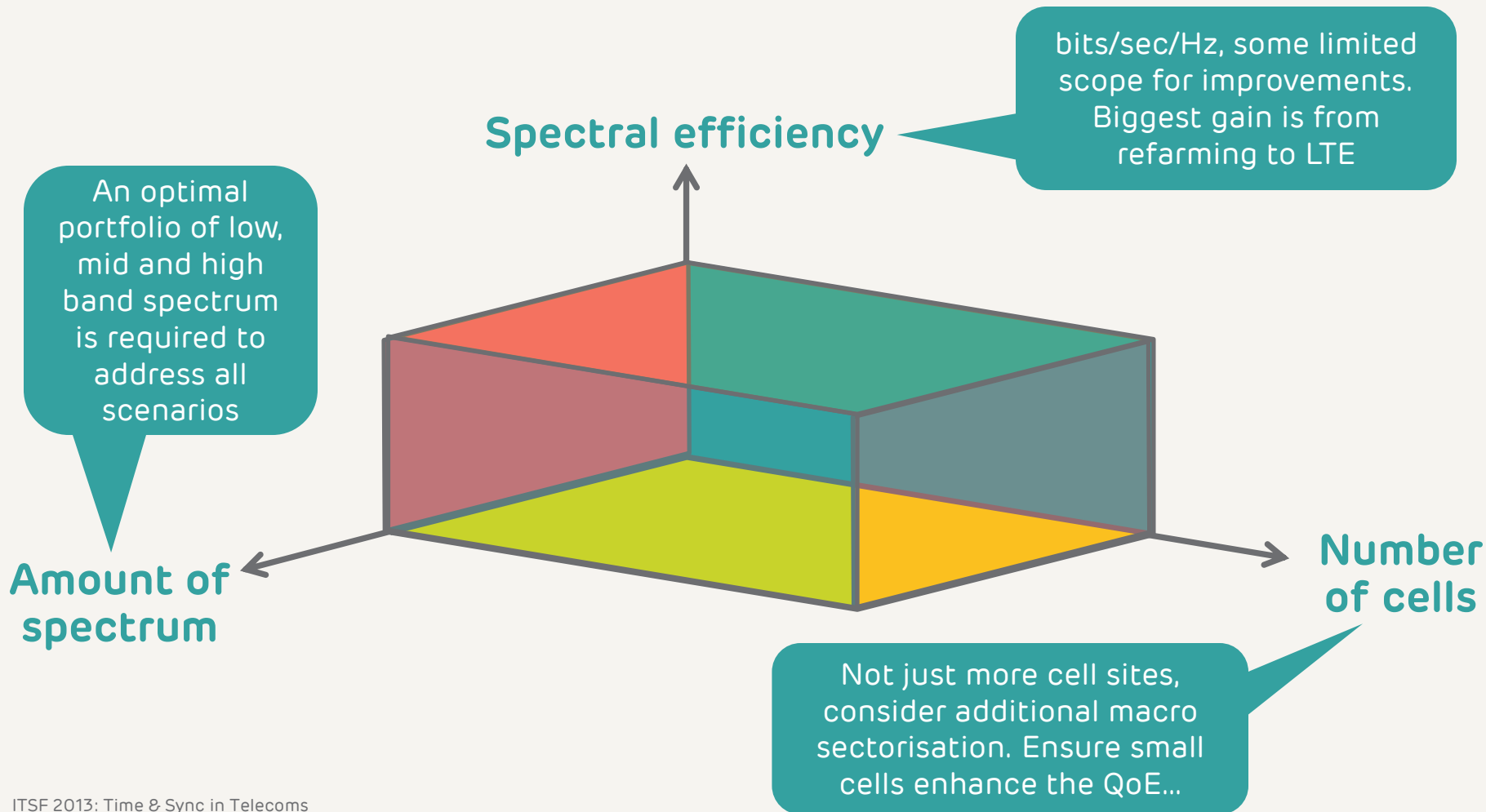
# Hot off the press – 5th November 2013

- EE CEO Olaf Swantee said: "Today we are introducing the next age of 4G mobile technology to the UK.

- "Our existing 4G network delivers incredible mobile data speeds and covers millions of people across the country, but we never stand still. We know that mobile data usage is going to keep increasing, and rapidly so.

- "Our analysts predict that data usage will grow significantly over the next three years. In fact, our trend-mapping shows that data usage is set to rise by 750 per cent in that period, as consumers and companies conduct more of their business and lives on-line.

- "The network we're switching on today in Tech City uses the spectrum that we acquired in the Ofcom spectrum auction earlier this year, and is the first part of an infrastructure that can meet the future demands of an increasingly data-hungry nation, enabling us to stay one-step ahead of the demand."

# Network capacity – maintaining the WOW factor!



Spectral efficiency

bits/sec/Hz, some limited scope for improvements. Biggest gain is from refarming to LTE

An optimal portfolio of low, mid and high band spectrum is required to address all scenarios

Amount of spectrum

Number of cells

Not just more cell sites, consider additional macro sectorisation. Ensure small cells enhance the QoE...

# We acquired more spectrum in the auction

| Licensee | Price |
|---|---|
| EE | £588,876,000 |
| Vodafone | £802,860,143 |
| O2 | £550,000,000 |
| 3 | £225,000,000 |
| Niche (BT) | £201,537,179 |

Spectrum acquired in the auction has increased the overall EE portfolio by 60%..........
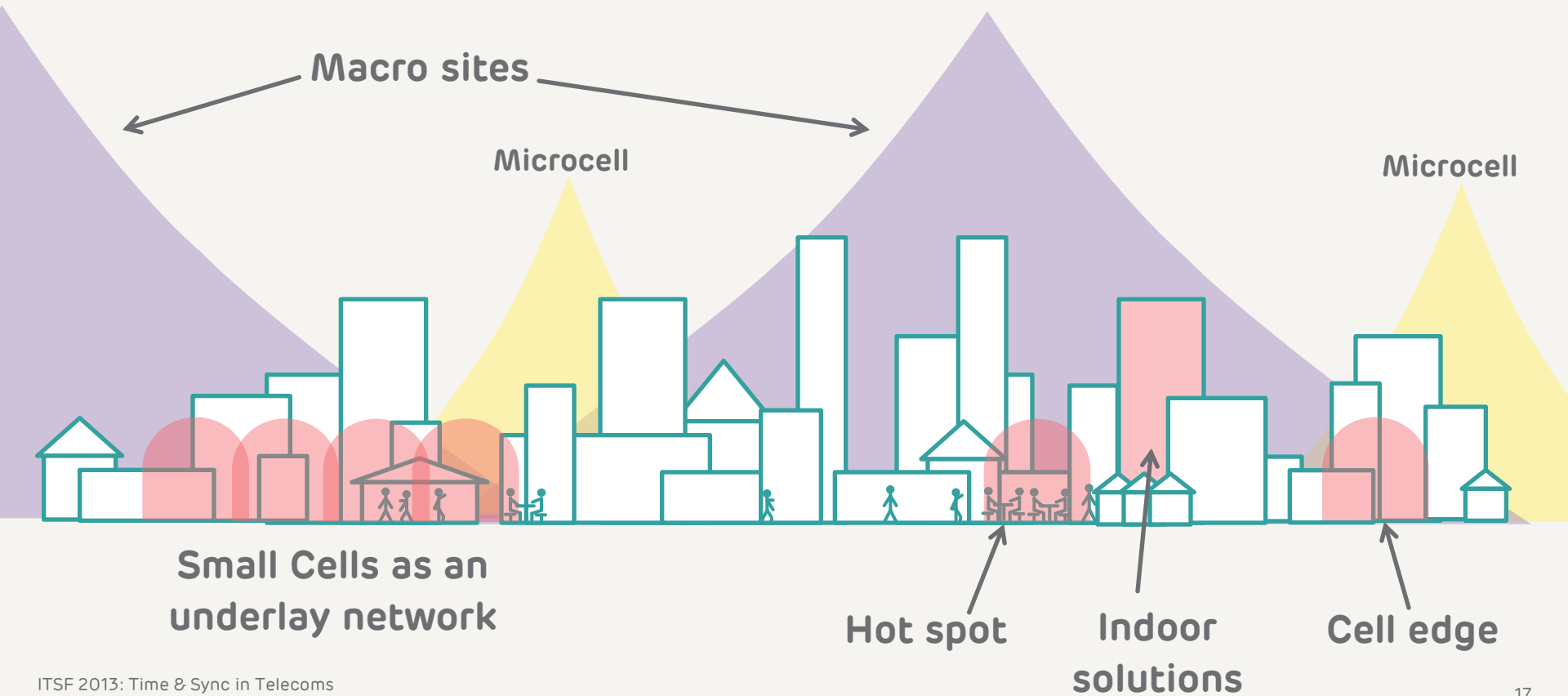


Legend:
- BT
- O2
- Vodafone
- H3G
- EE

# Carrier Aggregation (CA)

- CA is one of the essential features which enable LTE to meet the ITU-T IMT Advanced performance target

- Achieving the IMT-Advanced minimum downlink target of 1Gbps requires wider RF channels, it's impossible to achieve this with a single R8 LTE channels bandwidth (R8 maximum bandwidth = 20MHz)

- To guarantee backwards compatibility LTE-Advanced channels are implemented via component carriers (CC), these are based on R8 channel bandwidths

- The maximum specified LTE-Advanced channel bandwidth is 100MHz – maximum of 5 x 20MHz CC

- Initial deployment of true LTE-Advanced CA will be implemented with 2 x 20MHz CC

- Some operators are using CA to combine 2 x 10MHz however this doesn't offer any improvements over a single 20MHz channel

# Small cells and Heterogeneous Networks



Macro sites

Microcell

Microcell

Small Cells as an underlay network

Hot spot

Indoor solutions

Cell edge

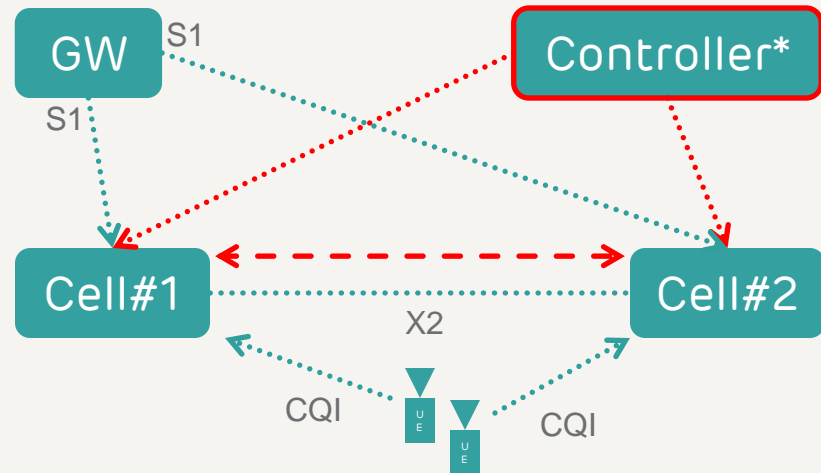# Network evolution - Super Macros, Small cells and in-building solutions...

Mobile backhaul may be integrated with the macro network or, decoupled (complete off-load) or, a hybrid of the two approaches...
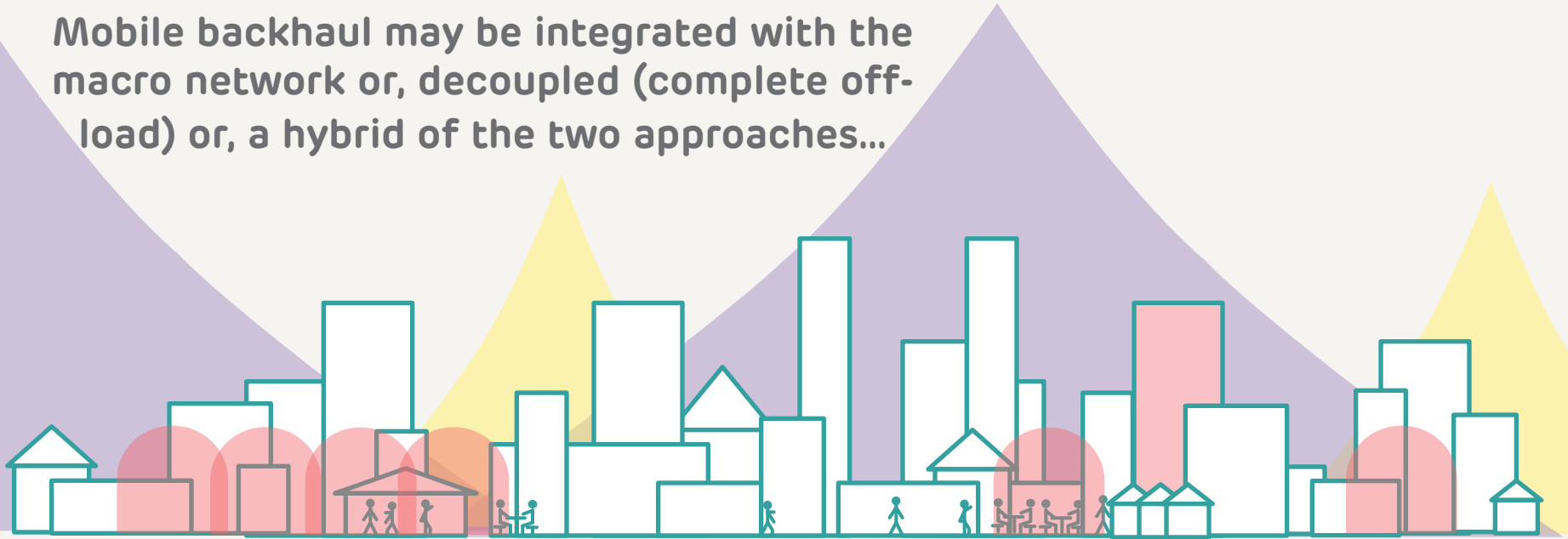
Several factors will influence decisions – deployment timeline, RAT, spectrum strategy and future network evolution strategy (co-ordination, C-RAN etc.)
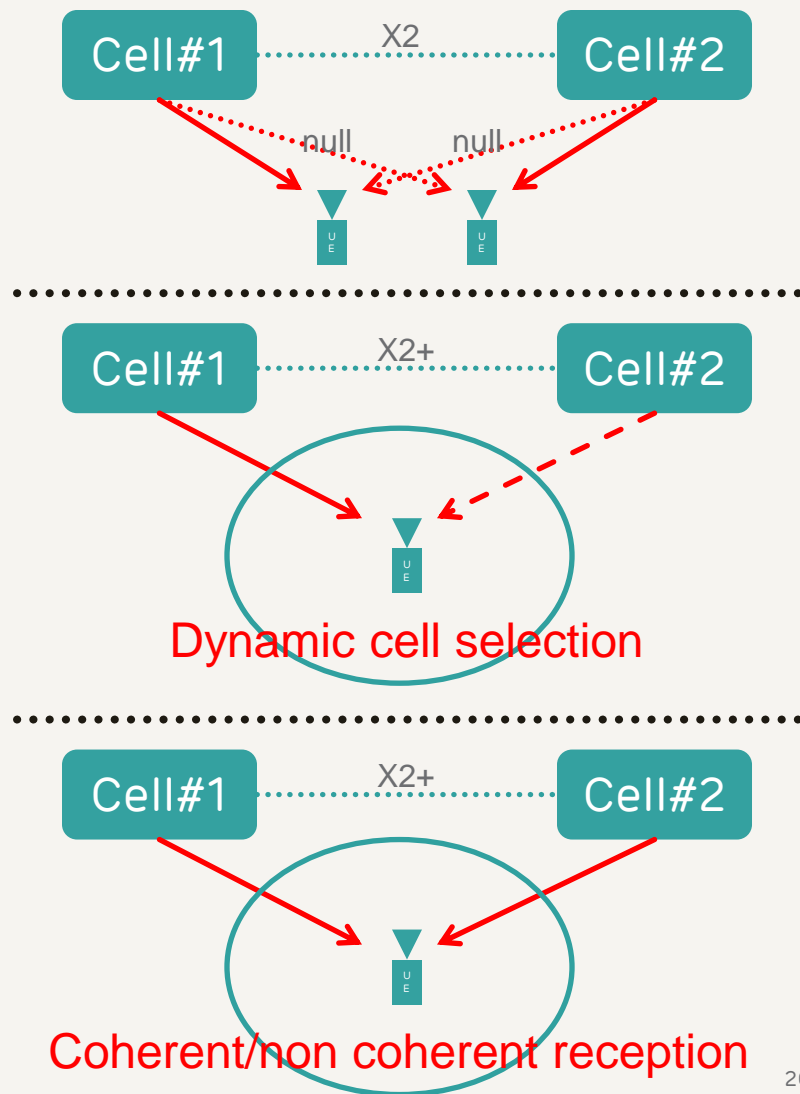
# Coordinated scheduling

- Coordinated scheduling

- Operates between RATs

- Operates between layers

- Currently attracting a great amount of attention and research amongst vendors and operators

- Could be an alternative optimisation to eICIC

- Won't offer "real-time" scheduling over non-ideal backhaul however may be sufficient...

- Time sync is required

2G / 3G / 4G

3G/4G/WiFi        3G/4G/WiFi

GW        S1        Controller*

S1

Cell#1        Cell#2

X2

CQI        CQI

UE        UE

* Scheduling controller is likely to be dedicated management plane function
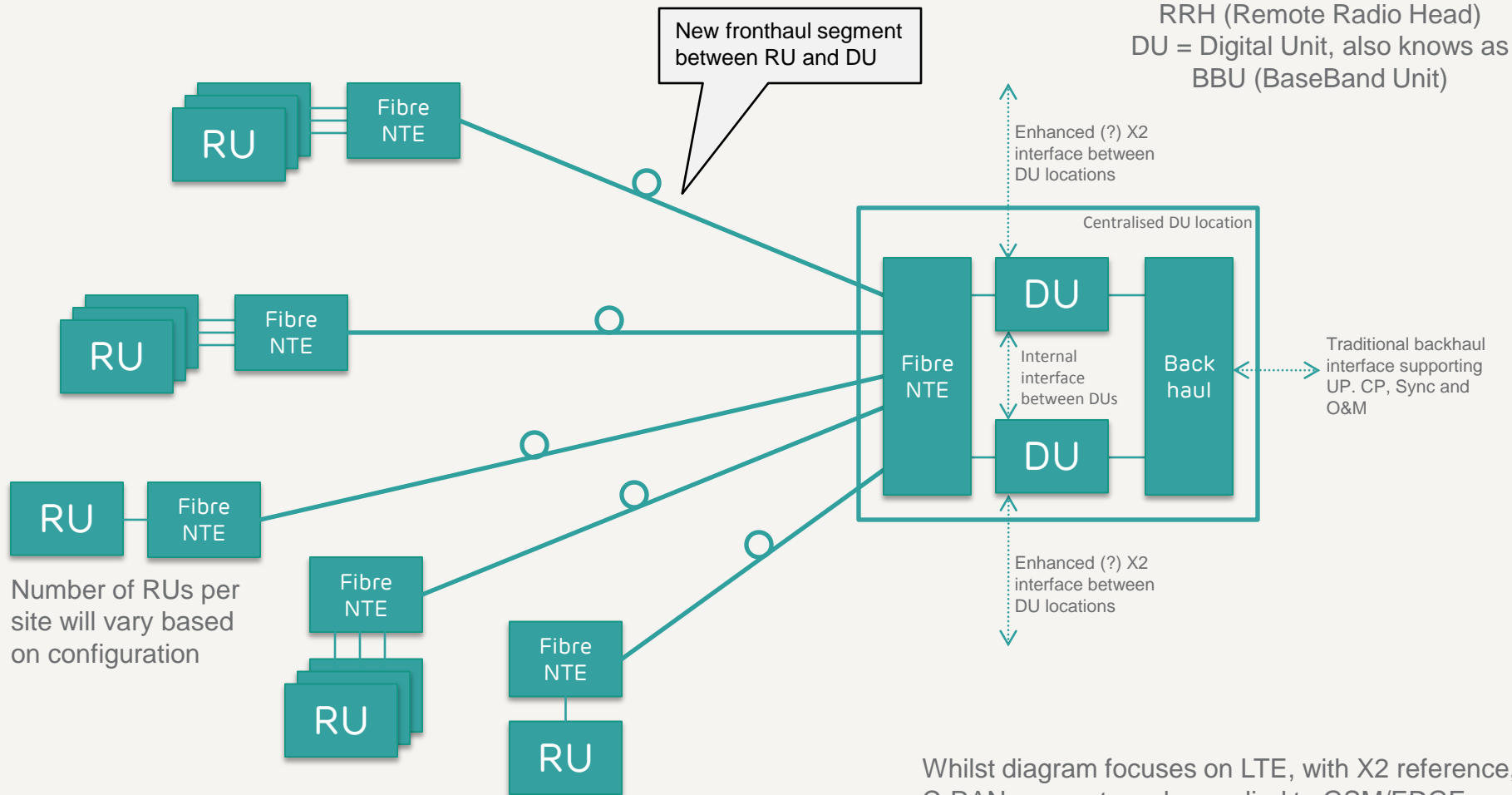
# Coordinated Multi-Point transmission/reception

- Several CoMP techniques are defined, these include coordinated scheduling/coordinated beamforming (CS/CB) and Joint Processing (JP)

- Two variants of JP exist; Dynamic Cell Selection (DCS) and Joint Transmission (JT)

- Enhanced, low latency X2 required for JP techniques

- CoMP over non-ideal backhaul is currently a study item within 3GPP

- CoMP over ideal backhaul effectively requires C-RAN architecture...

- JT requires very tight time sync - tbc...



Dynamic cell selection

Coherent/non coherent reception

# C-RAN architecture



RU = Radio Unit, also known as RRU (Remote Radio Unit) or RRH (Remote Radio Head)
DU = Digital Unit, also knows as BBU (BaseBand Unit)

New fronthaul segment between RU and DU

Enhanced (?) X2 interface between DU locations

Centralised DU location

Traditional backhaul interface supporting UP. CP, Sync and O&M

Internal interface between DUs

Enhanced (?) X2 interface between DU locations

Number of RUs per site will vary based on configuration

Fibre NTE

RU

DU

Back haul

Whilst diagram focuses on LTE, with X2 reference, C-RAN concept can be applied to GSM/EDGE, UMTS/HSPA(+) as well as LTE/LTE-A
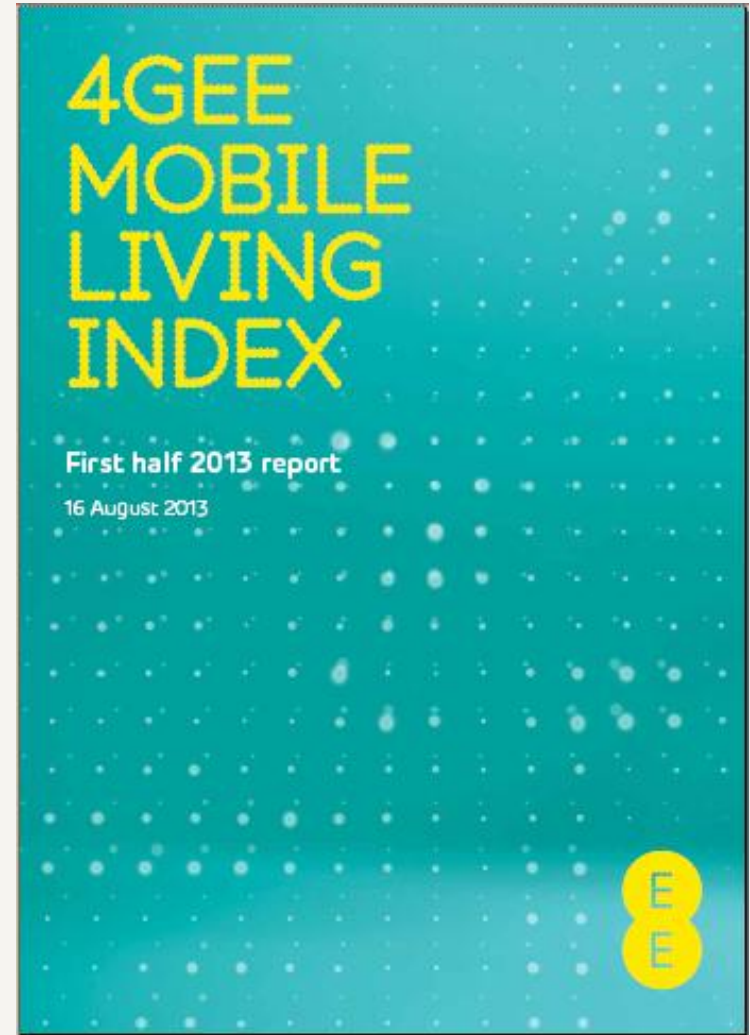
# Summary

- **Mobile Broadband networks will be multi-band, multi-RAT, multi-layered, multi-service environments...**

- **LTE is a game changing technology, low latency with high downlink and uplink throughput**

- **LTE-Advanced features will increase peak and average throughput rates and help maintain the wow factor as additional subscribers are added to the 4G service**

- **Gigabit Ethernet is becoming the norm for mobile backhaul, >1GE in the future!**

- **Frequency and time sync are critical enablers!**

# 4GEE Mobile Living Index

https://explore.ee.co.uk/our-company/newsroom/4gee-transforming-britain-into-nation-of-nomadic-sharers-streamers-and-shoppers

# THANK YOU

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