

An aerial photograph of the London skyline at sunset, featuring prominent skyscrapers like The Shard and the Gherkin. A large, colorful, abstract graphic of overlapping lines in red, orange, yellow, green, and blue flows from the top left corner across the image. A red triangular graphic is overlaid on the left side, containing the Arqiva logo and event information.

arqiva

Radio Services Carried over 4G

IBC September 2018

Simon Mason Head of Radio Technology

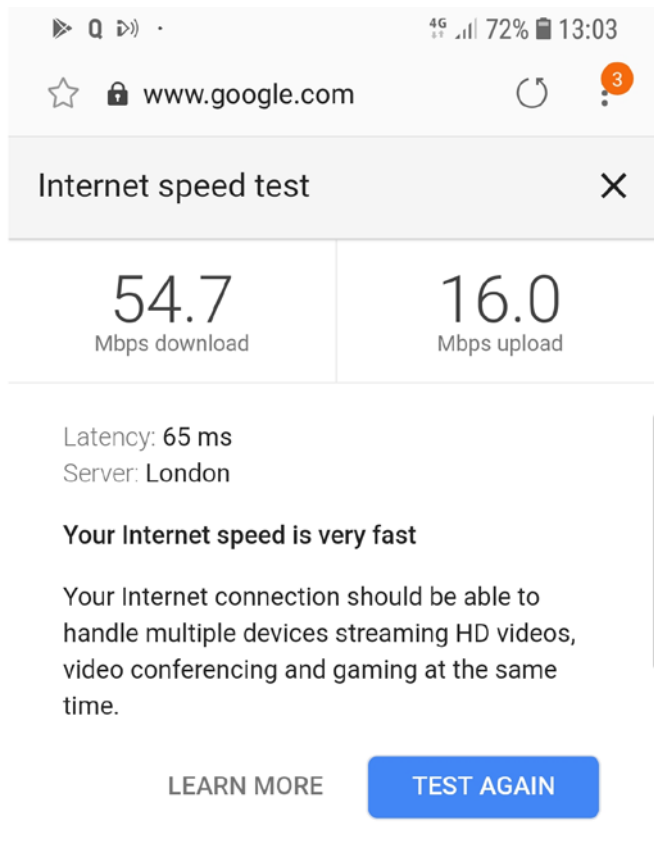
# The Exam Question

- ▶ How good are the 4G/3G networks in the UK at carrying mass audience Radio streams?
- ▶ Assumptions and background
  - ▶ While at home Consumers use their private Wi-Fi networks to deliver the Radio streams
  - ▶ While mobile they use the Mobile Network Operator networks
  - ▶ All test results and calculations are for the EE Network that supports in the region of a third of UK Subscribers
  - ▶ The test results are for the Samsung S8 handset – of all the phones we have analysed (non exhaustive) it is the best performer from an RF sensitivity and data through put (supports MIMO 4x4)
  - ▶ All long term listening was to the BBC Radio iPlayer

# In Arqiva's view best of everything

- ▶ Best Network
- ▶ Best Device
- ▶ Best Player

# 4G on EE - It is fast



The screenshot shows a mobile browser interface with a speed test overlay. The browser's address bar displays 'www.google.com' and the status bar at the top shows '4G', signal strength, '72%' battery, and '13:03'. The speed test overlay has a title bar 'Internet speed test' with a close button. The results are displayed in two columns: '54.7 Mbps download' and '16.0 Mbps upload'. Below the results, it shows 'Latency: 65 ms' and 'Server: London'. A message states 'Your Internet speed is very fast' and explains that the connection can handle multiple devices streaming HD videos, video conferencing, and gaming simultaneously. At the bottom, there are two buttons: 'LEARN MORE' and 'TEST AGAIN'.

4G 72% 13:03

www.google.com

Internet speed test

54.7  
Mbps download

16.0  
Mbps upload

Latency: 65 ms  
Server: London

**Your Internet speed is very fast**

Your Internet connection should be able to handle multiple devices streaming HD videos, video conferencing and gaming at the same time.

LEARN MORE TEST AGAIN

# EE Package for S8



## Samsung Galaxy S8

64GB ARCTIC SILVER



[Read 91 reviews >](#)

Capacity: 64GB

Colour: Arctic Silver



### Superfast delivery with expert set-up

Delivered free from today, with phone set-up by one of our experts.

[Check postcode \(London only\) >](#)

### In stock

Now in stock. Usually dispatched within 1 day to you or your local EE store.

### Already with EE?

[Log in or register to get this device >](#)

Business customer? Go to our [Business shop >](#)

Offer ends: 17 11 17 36  
days hrs mins secs

4GB  
data

£33

a month

Unlimited  
texts

Unlimited  
minutes

### Essential Plan

- ✓ 4G as fast as fibre broadband\*
- ✓ Talk, text & browse in the EU
- ✓ Watch the best live action with three months free access to the BT Sport app with casting to watch on tv

[See plan details](#)

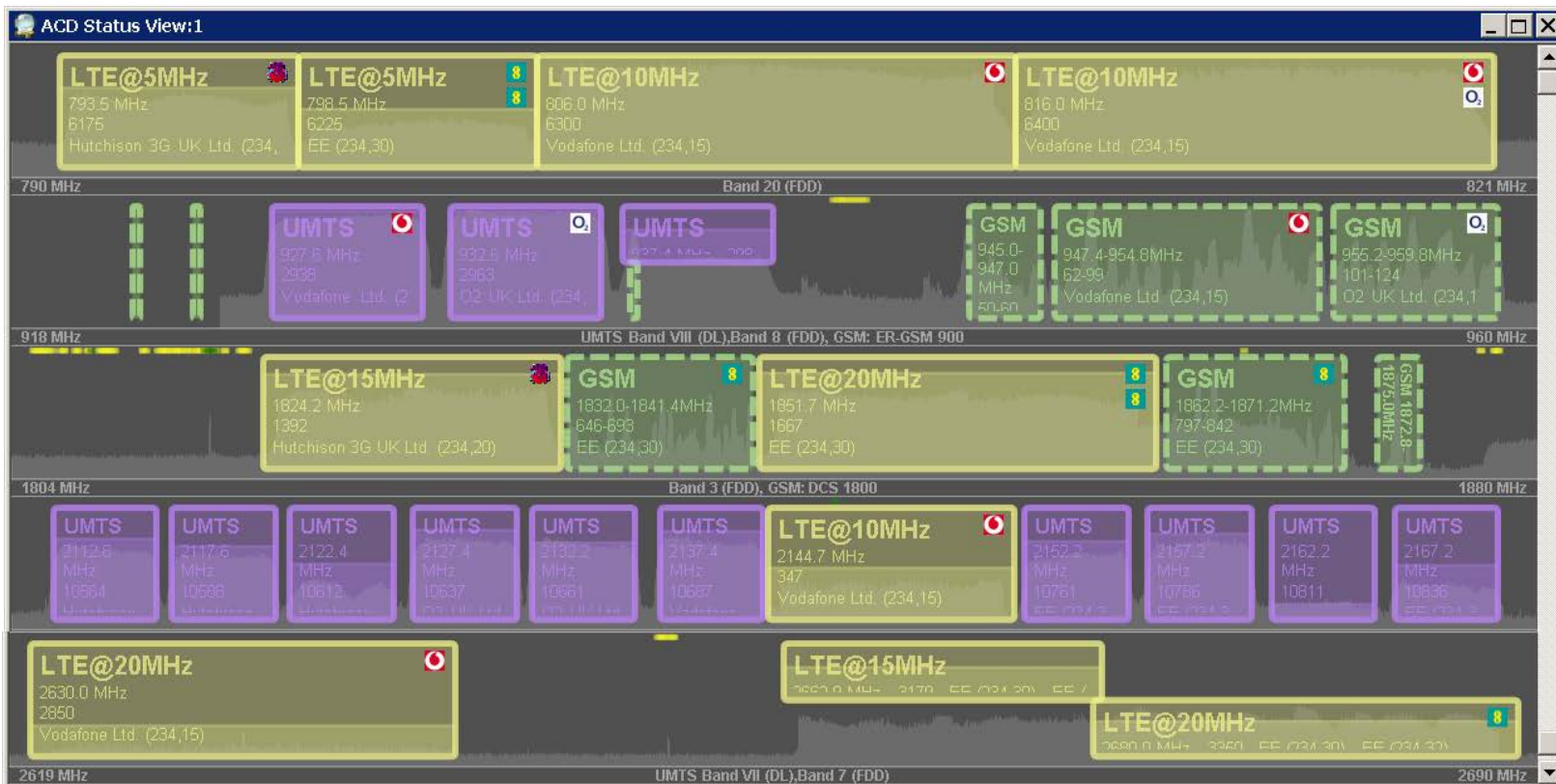
£50 £0 phone cost

[Choose this plan](#)

# What EE have said about their Network

- ▶ EE 4G footprint to overtake 2G by 2017, with **£1.5bn** investment over three years, delivering superfast 4G to more than 99% of the population. At present Arqiva cannot verify the 99% figure.
- ▶ **EE CEO Olaf Swantee said:** “Stage one of our Network strategy saw us overhaul UK mobile networks, launching 4G and changing the way people and businesses use their smart devices. This revolution of the mobile landscape has made the UK a leader in global communications once again.
- ▶ Arqiva observed; Other networks were not as good – typically less 4G deployment with less spectrum so less data capacity.

# Hedge End: Cotswold car-park

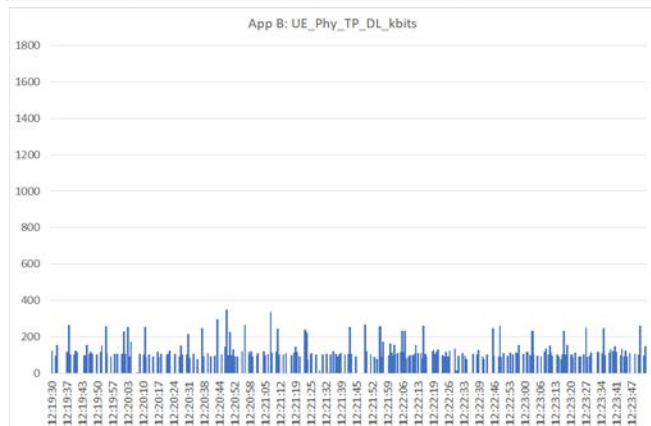
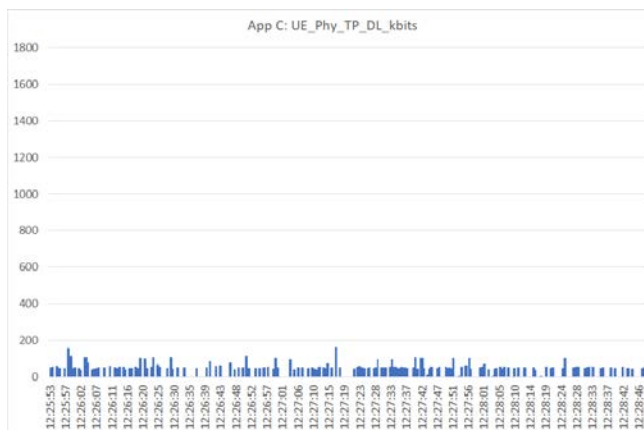
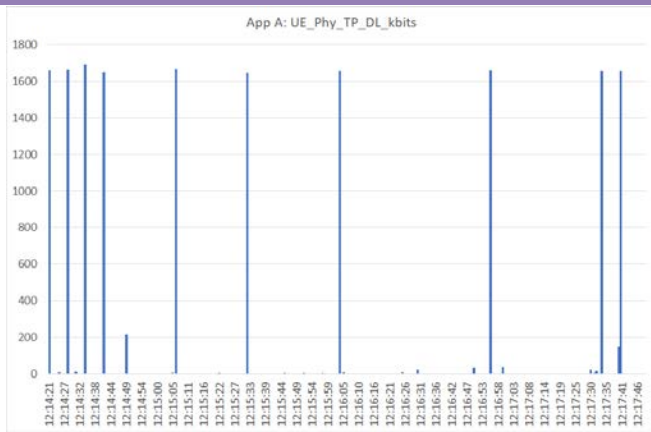


# Experience of drive testing

- ▶ While driving the major trunk routes of the UK the EE 4G network delivered – a very small number of drop outs (M25, M5, M6, M3)
- ▶ Arqiva tested rural areas of Wales and England, it failed in multiple locations, dropped back to 2G or no coverage, 80\* seconds later it failed
- ▶ Using different radio players, had a different experience, those that used large buffers or MPEG Dash with large segment sizes performed better as they could ‘fly wheel’ through imperfect connections in the underlying 4G network. This introduced significant delay. 80 seconds delay was measured in the best implemented player.



# Downlink throughput approx. 3 minutes, stationary



Service	maximum	average	% of measurements with throughput>0
App A	1691.8	55.1	7.8%
App B	345.8	63.2	50.4%
App C	160.3	30.5	52.4%

Downlink throughput, kbit/s  
 Statistics for approx. 3 minute period

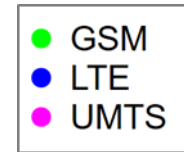
Recorded at Winnall Homebase car-park, M3 junction 9

# Failure mechanisms

- ▶ Rural areas poor coverage
- ▶ Locations where the service failed in populated areas were places of heavy foot fall of traffic, traffic jam on the M3 or in very busy commuting hot spots e.g. Clapham Junction and the City of London, it was random and the user had plenty of signal strength and no data through put
- ▶ So the service worked well on a lightly loaded networks, the buffering allowed the audio player on the device to continue to play audio even when it was starved of data for short periods.
- ▶ The audio player failed when starved of data by the underlying network either when it fell back to 2G for long periods or when there was not enough network capacity to share out to all devices

# Gaps in coverage

- ▶ 700m gap on the way into Winchester

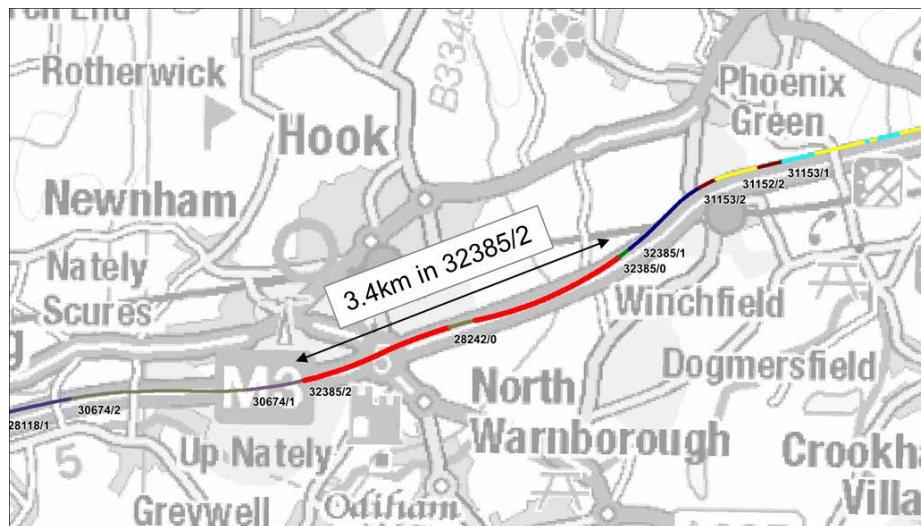


# How many people can listen on a motorway 4G cell?

- ▶ Only interested in down link for the delivering of streamed services to the handset.
- ▶ 20 MHz of spectrum - 100 resource blocks over 0.5ms
- ▶ Assume 2 x 2 MIMO works in 50% locations at all modulations
- ▶ Modulation can be 64 QAM, 16 QAM or QPSK switches with C/N (Carrier to Noise Ratio) at the handset
- ▶ Drive test measured split between modulation schemes – 64 QAM 31%, 16 QAM 23%, QPSK 46%
- ▶ The LTE downlink subcarriers are spaced 15 kHz apart from each other.
- ▶ A Resource Block is 7 symbols in 0.5 ms and is 12 carriers across.
- ▶ Using 100 resource blocks at QPSK give a throughput of 33.6 Mbits/s
- ▶ Using 100 resource blocks at 16 QAM gives a throughput of 67.2 Mbits/s
- ▶ Using 100 resource blocks at 64 QAM gives a throughput of 100 Mbits/s
- ▶ Assume 40% of capacity for FEC (Forward Error Correction), signalling, pilots, packet headers etc., this is an average value as FEC changes with C/N

# 260 km drive Winchester to Leicester, how many cells and what length?

	Number	Distance sum
Cells $\geq 3$ km	6	20.2km
Cells $\geq 2$ km	20	51.8km
Cells $\geq 1$ km	109	175.8km



# Traffic jam analysis

- ▶ 3 lanes, jam in one direction, 80% cars, 10% vans, 10% lorries, 3 km of the jam is covered by one EE sector, 1800 vehicles.
- ▶ One third are EE subscribers.
- ▶ 600 vehicles on 1800 MHz EE cell with 20 MHz spectrum
- ▶ If at 08:15 in the morning 50% of the vehicles listening to the radio and 7% watching video streams
- ▶ All other traffic in other bands
- ▶ 300 radio streams and 42 video streams required
- ▶ The network cannot support it, 50% over loaded

Phones are getting bigger – its all about video, bigger screen higher bit rates



# Conclusion

- ▶ With significant buffering the delivery of radio services on EE's 4G network worked well
  - ▶ Testing on other networks and handsets performance was significantly degraded
- ▶ Wide variation in player performance
- ▶ Coverage still an issue in rural locations
- ▶ Consumer pays for the data, the lower income (including some older people) may not be able to pay
- ▶ 4G base stations when stressed by multiple users cannot support the traffic, more investment required even on the best network in the UK
- ▶ Driverless cars, bigger device screens will drive more video consumption and will swamp the networks giving little room for Radio