Delivering Future Rail Connectivity

Alfonso Álvarez

Deputy MD, Cellnex UK

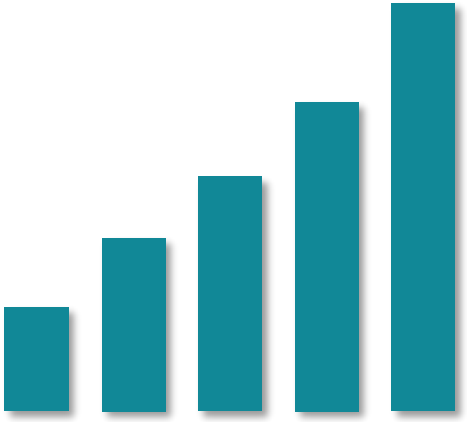
alfonso.alvarez@cellnextelecom.com

29th March 2022

cellnex
driving telecom connectivity

From Network Coverage >> Network Quality

Coverage is nothing if you can’t do anything practical with it…..



From Network Coverage to Network Quality

Concurrency is key to determining train capacity requirements

Service / App	2025e	Concurrency	2025e
Watching	12%	100%	12%
Listening	9%	50%	5%
Communicating	52%	5%	3%
Video Calls	2%	100%	2%
Gaming	3%	100%	3%
Reading/Browsing	22%	5%	1%
Total			**25%**
x People using phone			65%
= Concurrency			**16%**

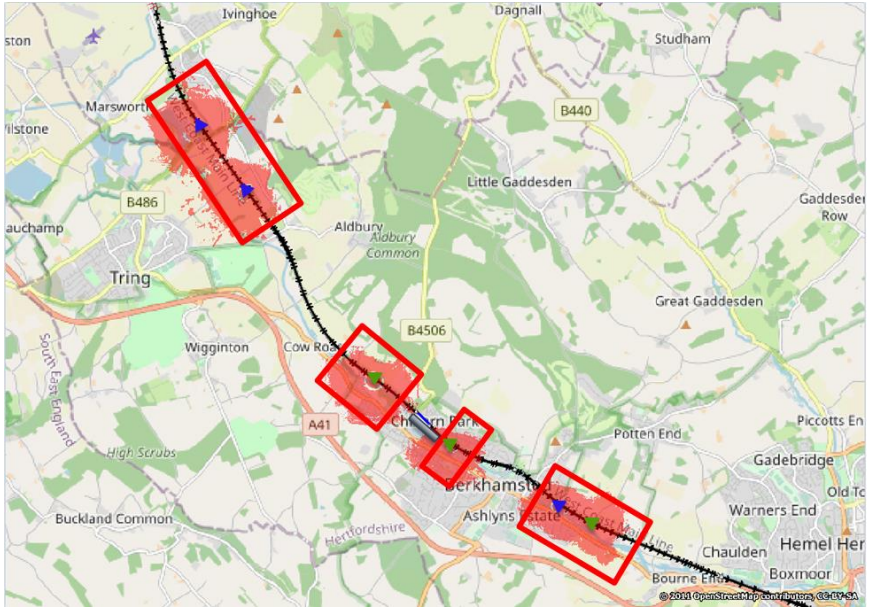
- 1,350 devices per train (i.e. 900 people x 1.5 devices)
- 16% of concurrent access to MNO signals
- Include attenuation of train windows and frames

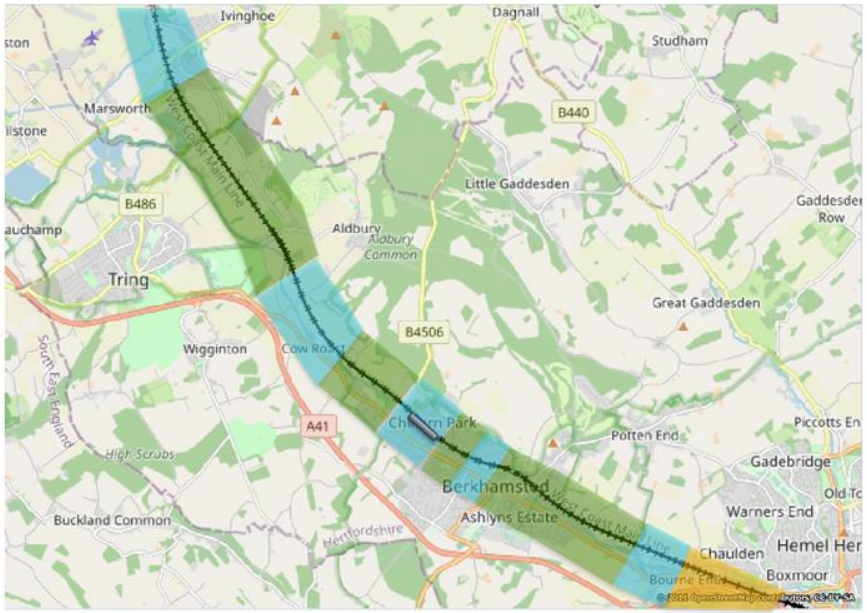
= throughput requirement of 100 and 120 Mbps per MNO

= mean signal strength of at least -105 dBm inside

Contiguous Coverage vs. Contiguous Performance

Infill approach results in a highly variable user experience





International Context

The UK has no rail specific connectivity targets/obligations via licences

- 100% population by 2027
- 99.6% territory by 2027
- **23,000 km railways by 2027**
- 55,000 km roads by 2030

➔ MNO funded, automatic 4G licence renewal if achieved

- 98% premises by 2022
- 100% toll roads by 2022
- 100% federal roads by 2024
- **100% railways by 2024**
- **100 Mbps roads, 50 Mbps rail**

➔ Licence obligations from 2.1 GHz and 3.5 GHz auctions

- No population target
- 95% territory by 2026
- **No railway targets**
- 16,000 km roads by 2026

➔ MNOs and DCMS to fund SRN achievement

Network Rail's Project Reach will seek to address this situation, but will need MNO buy in

International Context

We also use railways in different ways to other European countries

1

c.55% journeys in England were for commuting

Clearer split in other countries between:

- Commuting (mainly local <15 miles)
- Long distance (i.e. >100 miles)

2

30 miles average trip length

- France c.2x
- Sweden c.2x
- Germany c.1.5x

3

Fewer true long distance (i.e. >150 mile) journeys

- France = c.220 miles
- Germany = c.180 miles
- HS2 first real example

Lower propensity to connect to 'onboard' solutions

- Shorter 'dwell' time on train
- Dominance of 'mid-length' journeys
- Current performance also inhibits

This needs to be considered when determining 'the best' communication solution for passengers

Brighton Mainline Case Study

A partnership model designed to optimise the outcome

Performance

Concessionaire to provide **infrastructure with the functionality** to deliver uninterrupted cellular internet at >100 Mbps and contiguous voice

Operational Approach

Agreed **collaborative approach to manage operational constraints** and route condition enabling suitable project timeline and mutual benefit

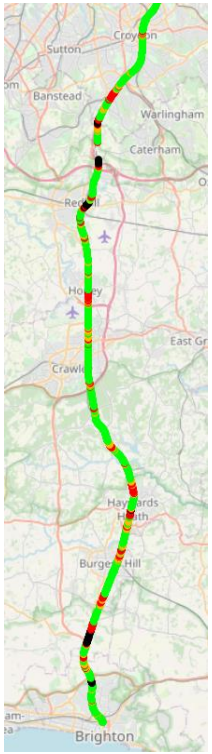
Solution Architecture

Agreement that **some 'off-rail' towers will be built** as part of the solution to optimise RF planning and economics of solution

Brighton Mainline Case Study

Existing coverage and performance on the line

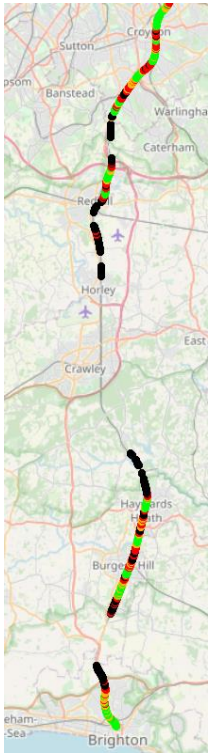
800 MHz



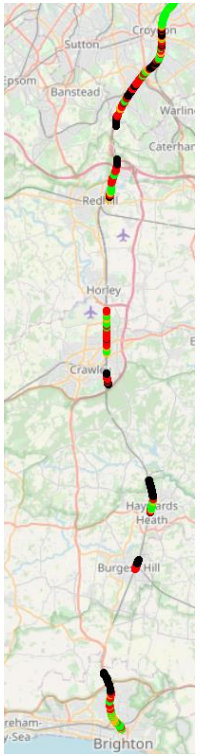
- Previous measurements before lockdown based on Best Server coverage, primarily 800 MHz
- Measurements after lockdown in the other bands shows, as expected, additional gaps
- More towers added to the radio planning to meet coverage and capacity requirements
- Capacity at 800 MHz hard to achieve, multiband solution required……see next slide

- -120 - -140dBm
- -110 - -120dBm
- -105 - -110dBm
- -1 - -105dBm

1800 MHz

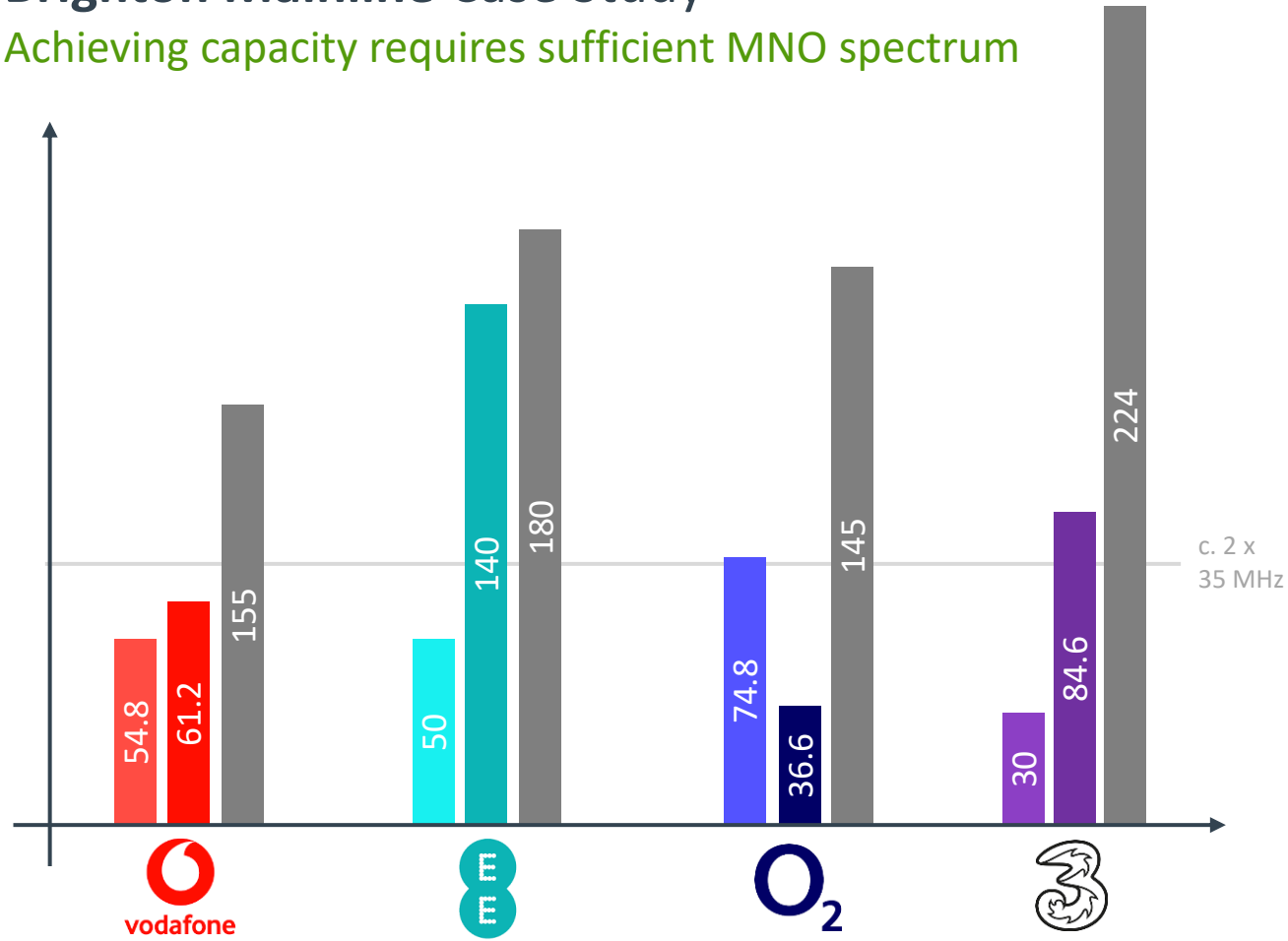


2100 MHz

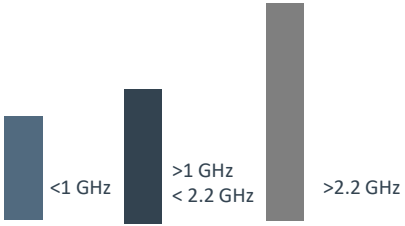


Brighton Mainline Case Study

Achieving capacity requires sufficient MNO spectrum



- c.2 x 35 MHz of spectrum required to achieve c.120 Mbps per MNO per train
- Holdings < 1 GHz generally insufficient
- Hence need to plan infrastructure to provider coverage in the 1.8 – 2.1 GHz range



Brighton Mainline Case Study

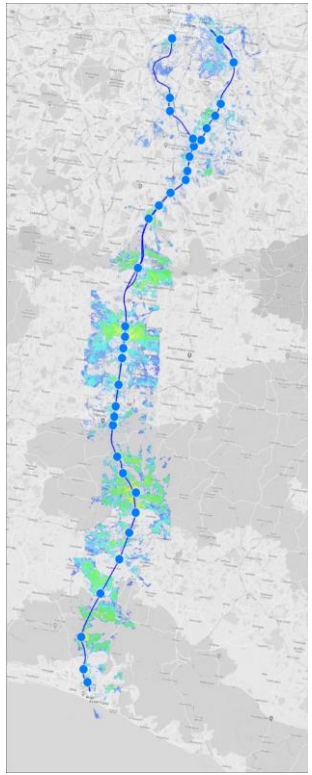
Technical Solution comprised of three elements

Macro Towers

New towers will be constructed ‘on-rail’ and ‘off-rail’ hosting MNO equipment, new towers will be built to a height of up 25 meters and be ‘5G ready’

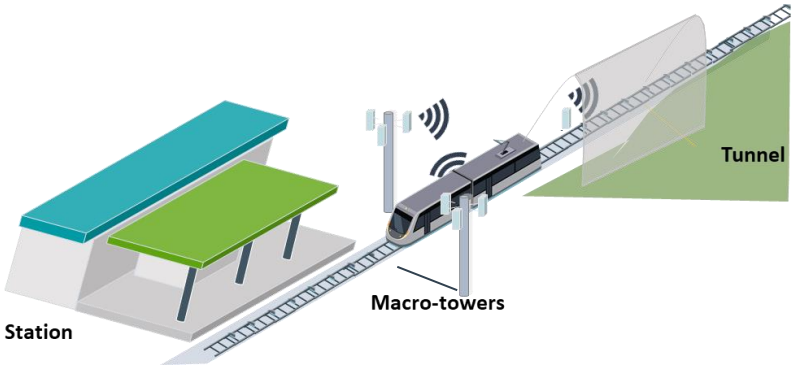
Fibre

High capacity dark fibre backbone of solution, provides connectivity opportunities to enterprise and businesses the length of the route



Distributed Antenna Systems

DAS equipment in stations, tunnels and cuttings, in conjunction with the macro sites, ensures end-to-end connectivity



Line-side communities and SMEs will benefit from ‘incidental ‘coverage and capacity improvements

Spectrum & Infrastructure Considerations

Mix of dedicated, MNO and shared, ideally leveraging common & existing infrastructure

Mission Critical	Passenger Connectivity		Operational Support
GSM-R evolution to FRMCS	Into train using public MNO networks	Onboard train solution	Public and/or non mission critical IoT networks (e.g. LoraWAN)
900, 2 x 5.6 MHz 1900, 10 MHz	Ideally <2 GHz **On and Off Rail** **No RS adapt**	26 – 28 GHz **100% On Rail** **RS adapt**	868 MHz + Further Bands

Common Infrastructure = Significant Economics & Environmental Benefit

Fibre	Towers & Poles	Power