5G Private Networks at the BBC

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'The BBC must secure the efficient use of the radio spectrum that is available for use by the BBC or its contractors' BBC Charter Agreement: Clause 46

Taking a step back – Remote Content Production

Remote Content Production - Connectivity

Public Networks – 4G and 5G

- Universal availability
- Bi-directional IP connectivity
- Generic Hardware
- Simple production workflows

No QoS guarantee

Remote Content Production – Connectivity QoS

How do we secure QoS on Public Networks?

Network Slicing?
Prioritised traffic on the public networks

PNI-NPN - Public Network Integrated NPN?
An NPN provided by the Telco within their infrastructure and spectrum

Commercial and practical solutions for short notice/short duration content production are not yet mature

Private Networks?

Remote Content Production - Connectivity

Public Networks	Private Networks
• Bi-directional IP connectivity	✓
• Generic Hardware	✓
• Simple production workflows	✓
• ‘Universal’ availability	X

For Private Networks we need suitable spectrum

5G Private Networks spectrum options

3GPP TS 38.101-1

Table 5.1-1: Definition of frequency ranges

Frequency range designation	Corresponding frequency range
FR1	410 MHz – 7125 MHz
FR2	24250 MHz – 52600 MHz

n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD

The European Commission has mandated the CEPT to evaluate the feasibility and the shared use of 3.8-4.2 GHz band by terrestrial wireless broadband systems providing local area network connectivity

CEPT PT1 and FM60 are carrying out that work including for content production but there is major competing interest from other applications

3800-4200MHz in the UK

- Ofcom launched Shared Access Licences for 3800-4200MHz and other bands in 2019
- The aim was to facilitate localised access to shared spectrum for innovative low power networks

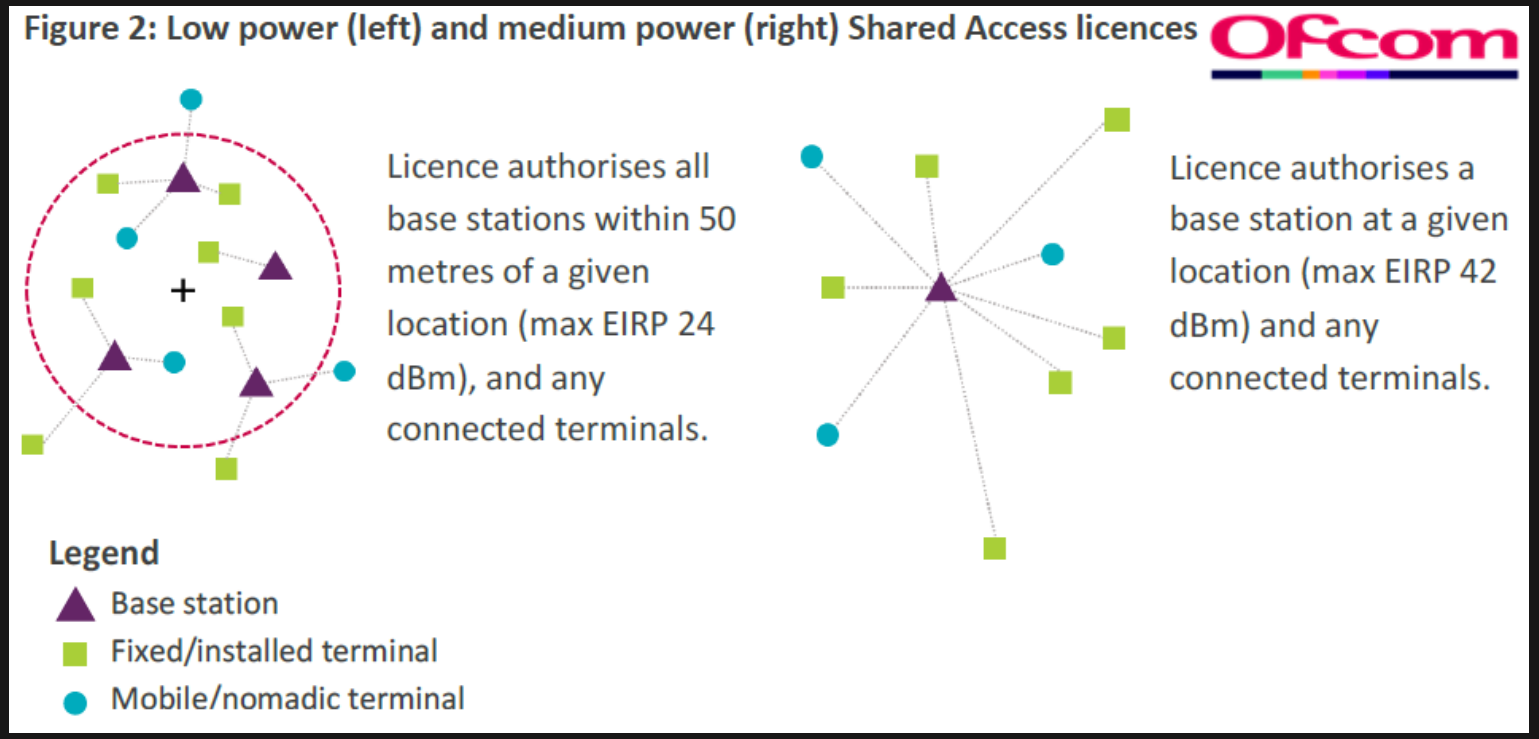
	1.8 GHz	2.3 GHz	3.8-4.2 GHz	26 GHz	Total
Low Power	888	27	189	1	1105
Medium Power	111	-	323	-	434
Total Licences	999	27	512	1	1539

(Licences to 10/23): Ofcom

- It has been successfully taken up by many applications including Content Production

5G Non-Public Networks – Shared Access Licences

- Good geographical availability, no requirement to synchronise with public networks



BBC Content Production NPN trials in 3800-4200MHz

- Commonwealth Games 2022 – Birmingham
- HM King Charles' Coronation 2023 - London
- North West 200 – International Motorcycle race 2024 – Northern Ireland

Commonwealth Games 2022

Two camera live into BBC1 in crowds with saturated public networks

Two cells, 4050MHz 100M0, 2W EIRP

Coronation 2023

Requirement from BBC News:

To provide dedicated bonded SIM connectivity to international newsgatherers on the Mall during the Coronation with congested public networks

- Partnered with Neutral Wireless and their SDR solution
- Stepping up the number of terminals to 30 so first trialled connectivity of 14 UEs

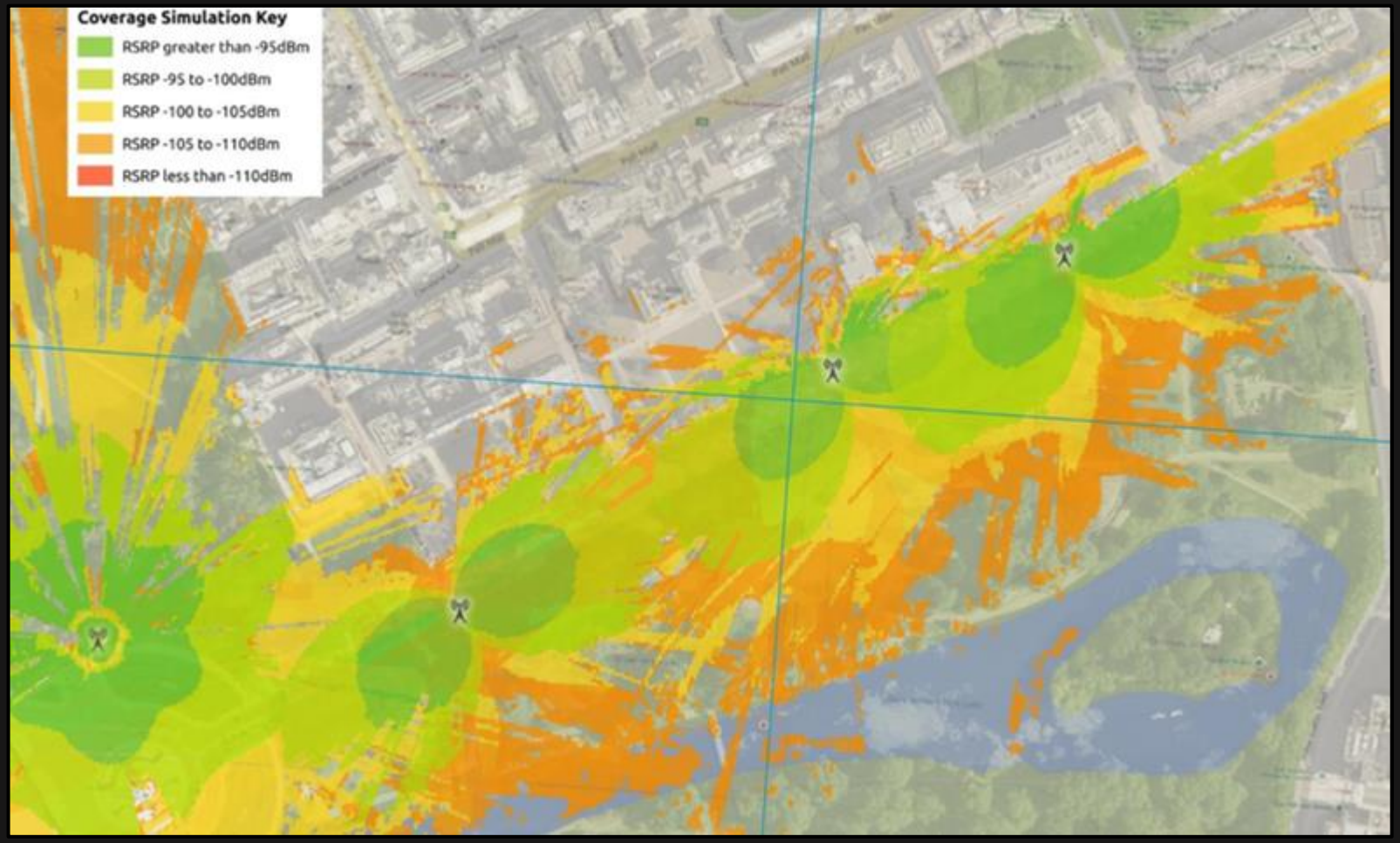
Coronation 2023

Trialled with partners using their existing equipment and testing workflows

Coronation 5G NPN – Trial outcomes

- Typical coverage of 200-400m for a single cell
- Some UEs better than others – e.g. external modems
- Bonded devices with two 5G NPN SIM cards best
- A multi-cell network would be required for the whole Mall
- New licences would be required and more power

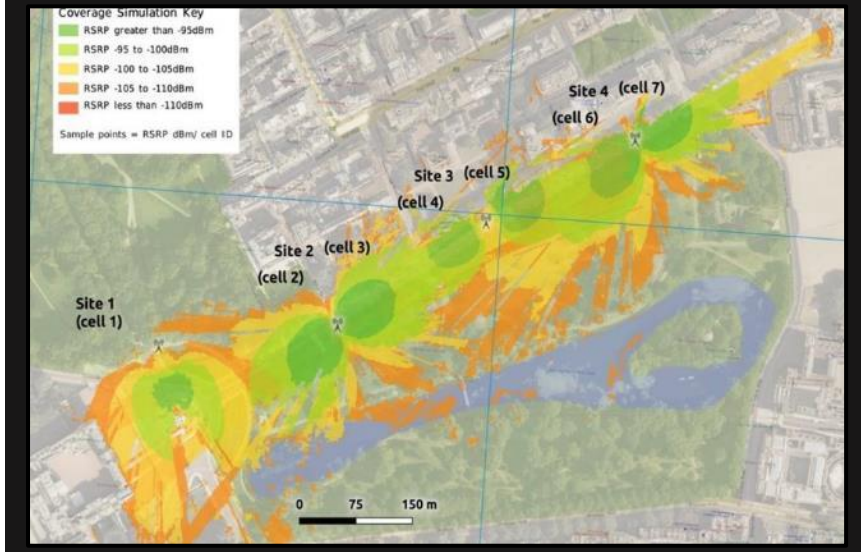
Coronation 2023 - 5G NPN Network Planning



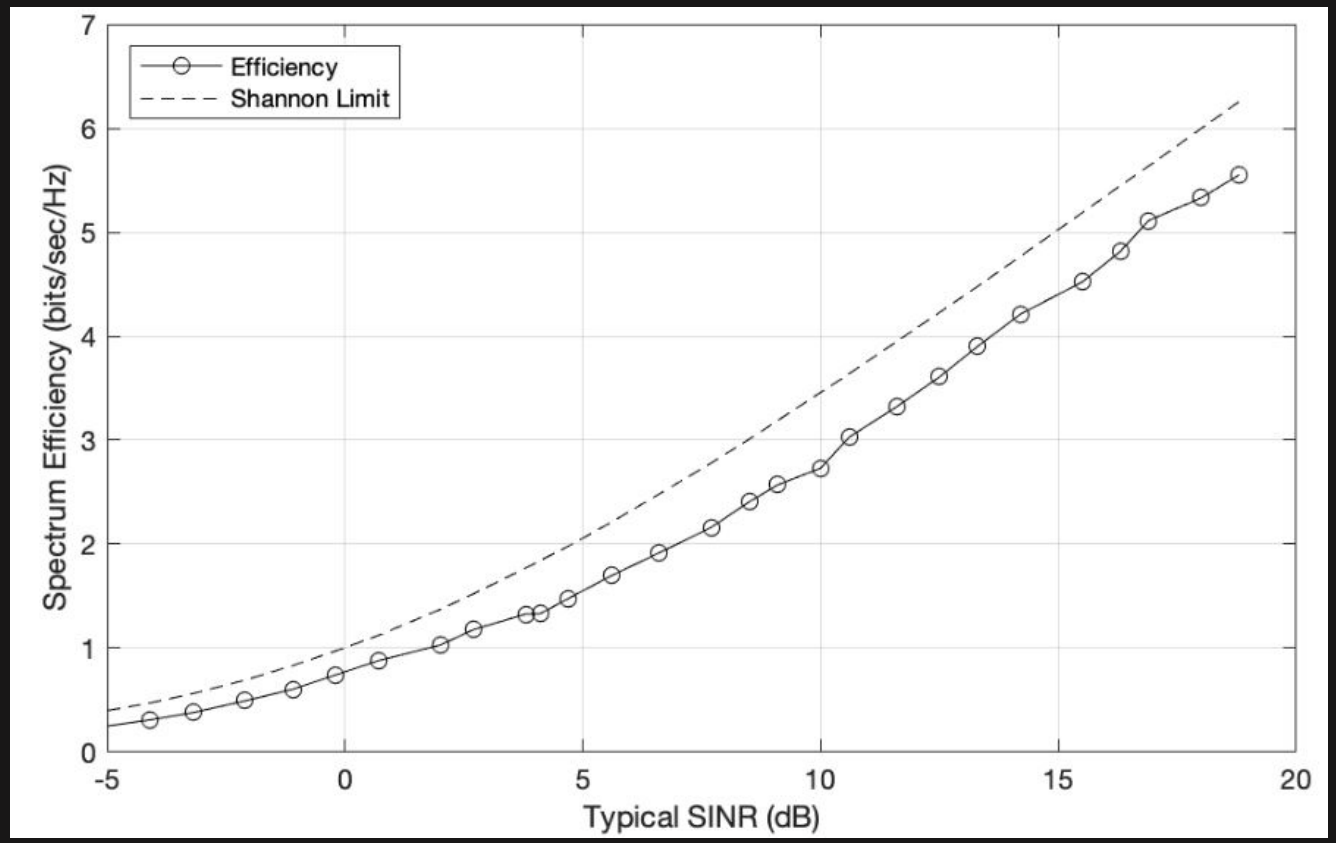
Coronation 5G NPN – Network Planning

Cell	Channel	TX power (dBm)	TX gain (dBi)	RX gain (dBi)	Radio Head TX/RX Mode
1	C	26	14.0	14.0	1Tx 2Rx (diversity)
2	B	26	15.7	15.7	1Tx 2Rx (diversity)
3	A	26	14.0	14.0	1Tx 2Rx (diversity)
4	B	26	15.7	15.7	1Tx 2Rx (diversity)
5	A	26	14.0	14.0	1Tx 2Rx (diversity)
6	B	26	15.7	15.7	1Tx 2Rx (diversity)
7	A	26	14.0	14.0	1Tx 2Rx (diversity)
R&D	A	26	3.0	3.0 + 14.0	2Tx 4Rx (diversity)

Table 1 – Network cell properties. Channels: A – 3815-3855 MHz [ARFCN 655666]; B – 3855-3895 MHz [ARFCN 658334]; and C – 3895-3935 MHz [ARFCN 661000].

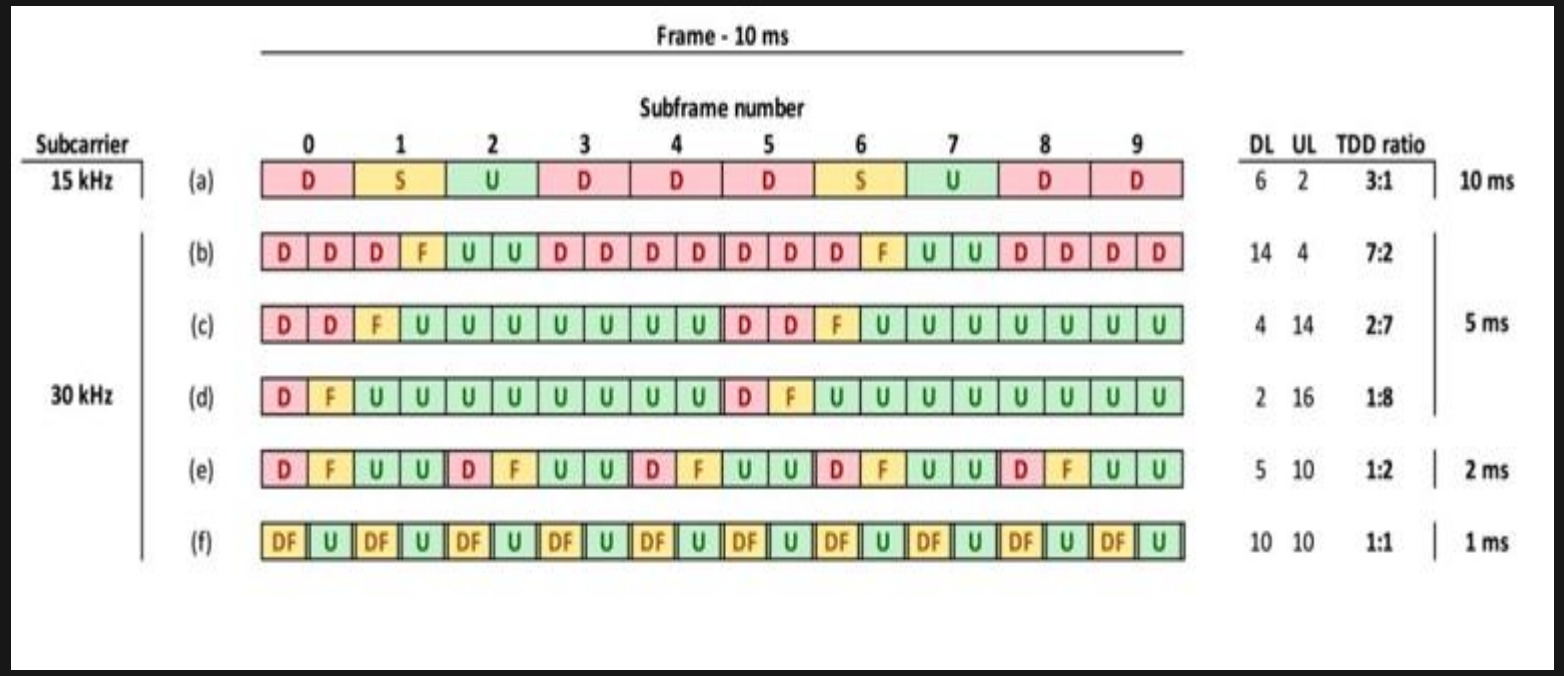


5G Non-Public Networks - Capacity



- For typical high order modulation schemes spectrum efficiencies of 4-5 bits/s/Hz can be achieved
- Uplink capacity approaching 160Mb/s/cell for a 40MHz bandwidth
- Typical HD ENG uplink around 10Mb/s with H.265 (HEVC) compression

5G Non-Public Networks – Uplink performance



Public networks are required to use a 3:1 (downlink/uplink) ratio

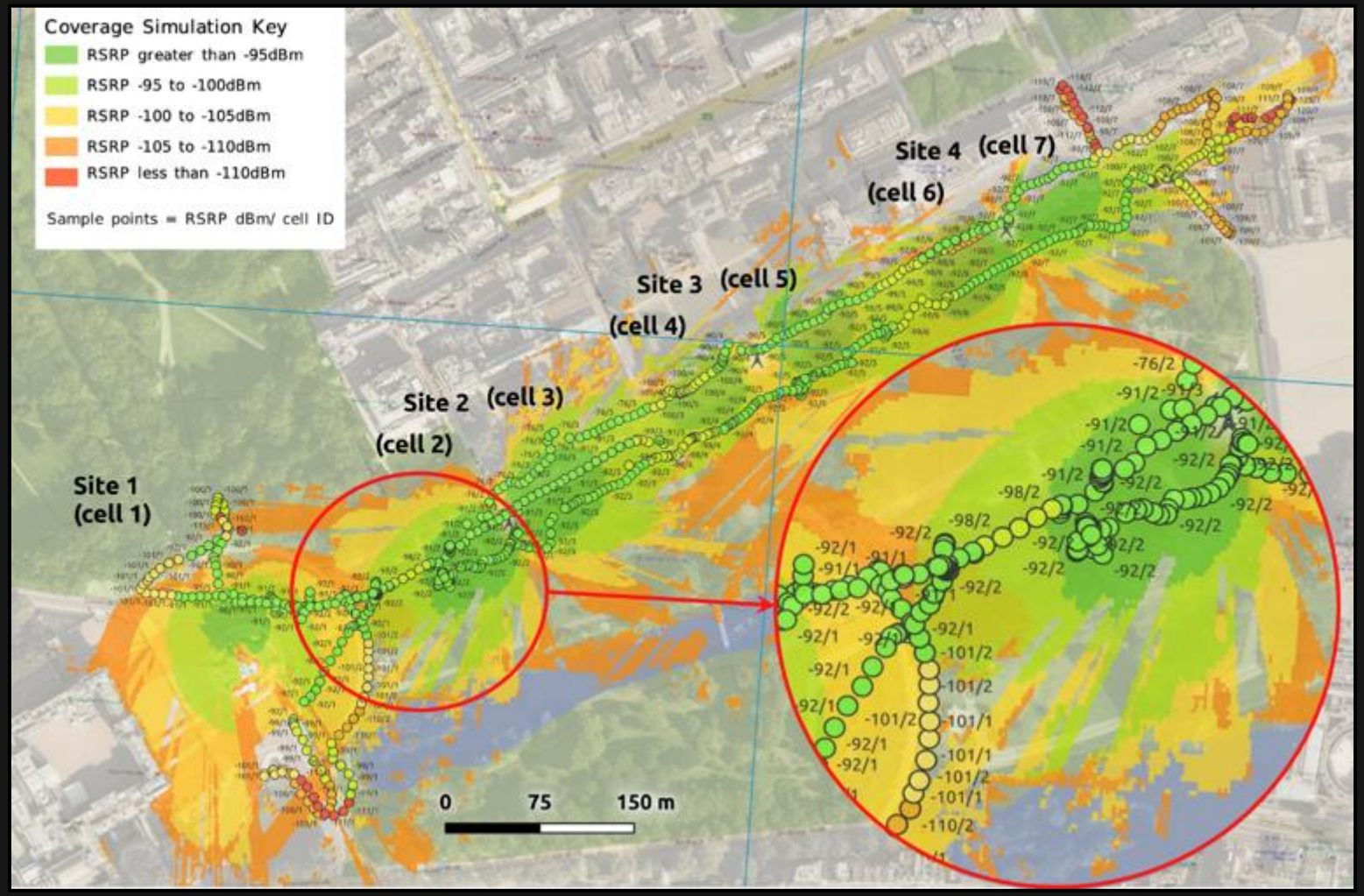
NPNs are able to use a 2:7 (downlink/uplink) ratio

40MHz: 40*5*7/(2+7)=156Mb/s

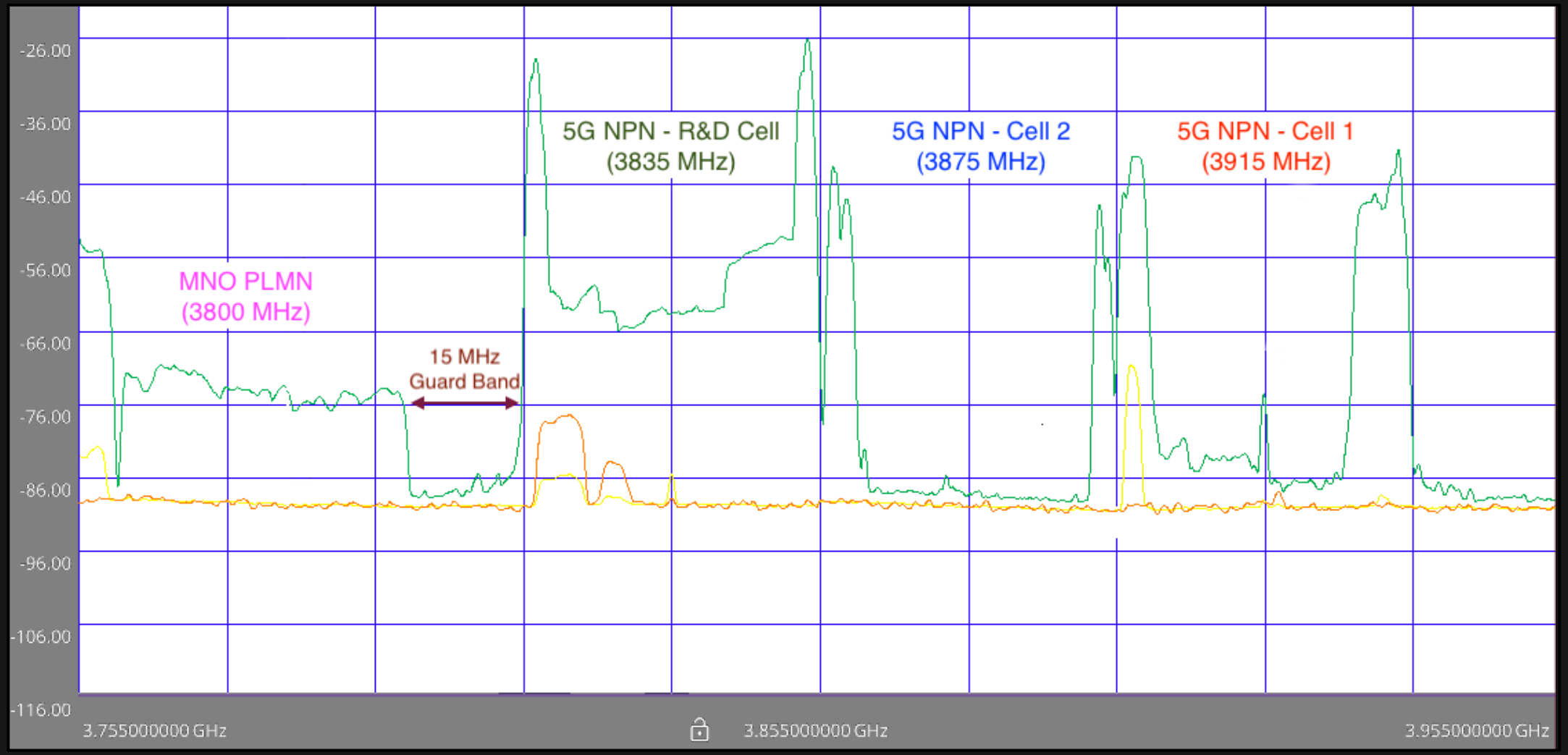
Coronation 5G NPN – Network Rigging




Coronation 5G NPN – Logged Coverage



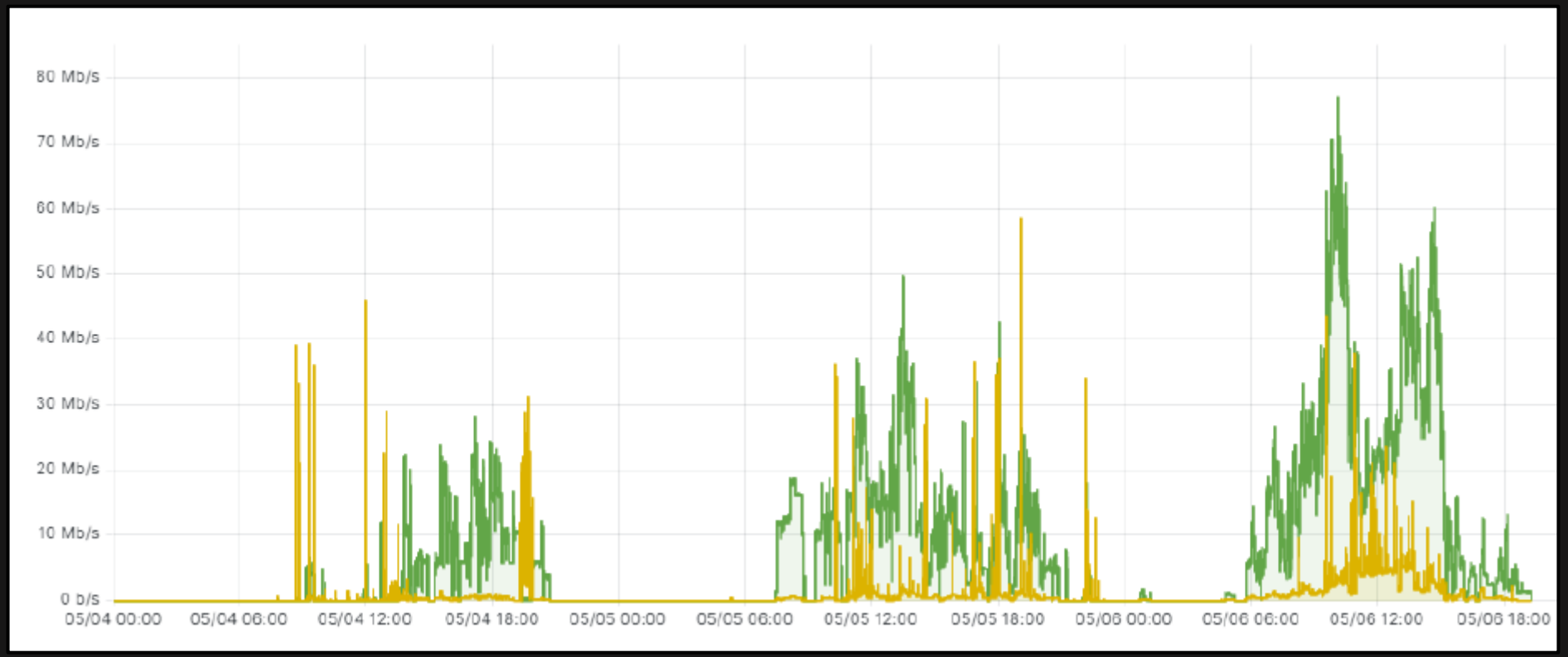
Coronation 5G NPN – Spectrum Measurement at site 1



Coronation 5G NPN – Happy Customers

Low latency not a priority but a reported packet Round Trip time (RTT) of 37ms to a decoder in France: transit time of 19ms for the 5G network, fibre backhaul and public internet connectivity.

Coronation 5G NPN – Network Performance



60 devices accessed the NPN in the week

54.4GB of uplink video

24.8GB of uplink video on Coronation Day

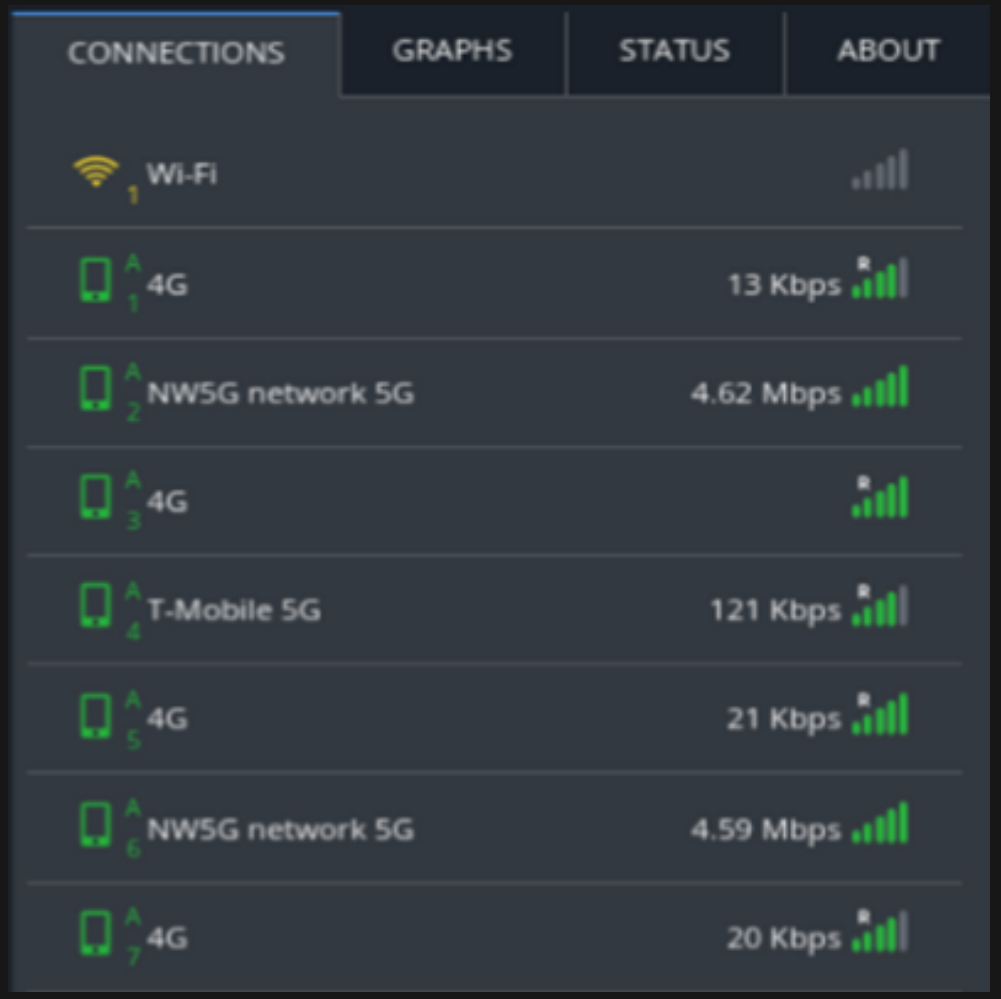
80Mb/s peak uplink

Uplink: Green Downlink: Yellow

https://www.youtube.com/watch?v=bQ6-qycpO2I

Coronation 5G NPN – Network Performance

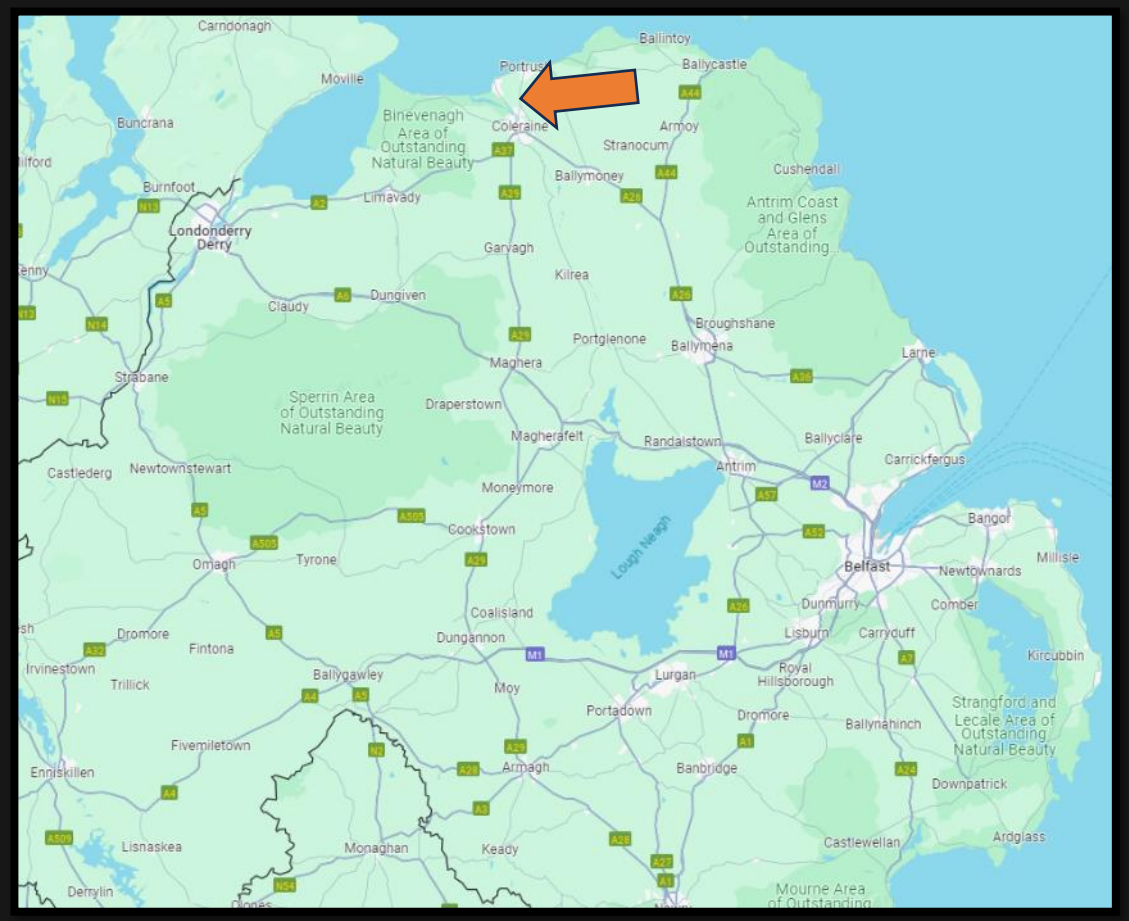
Uncongested MNO - before

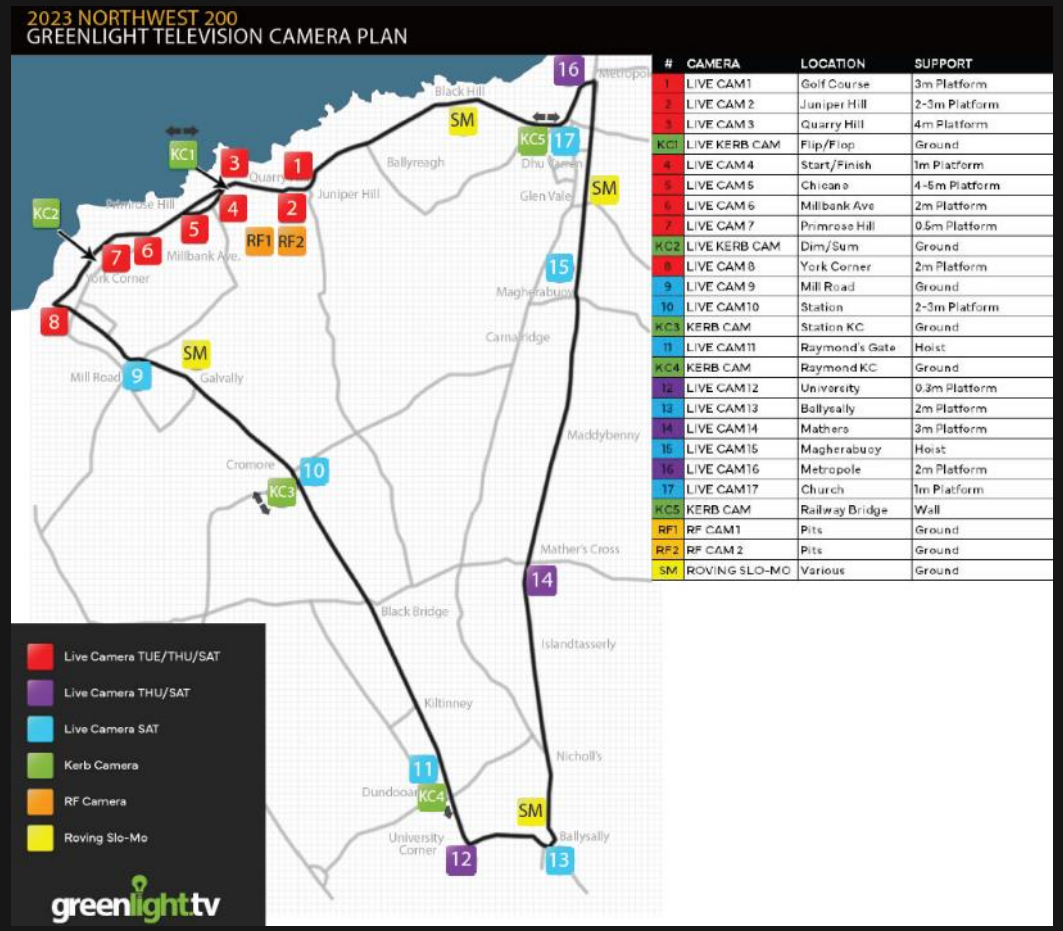


Congested MNO - during

NW200 North West 200

NW200 North West 200





#	CAMERA	LOCATION	SUPPORT
1	LIVE CAM 1	Golf Course	3m Platform
2	LIVE CAM 2	Juniper Hill	2-3m Platform
3	LIVE CAM 3	Quarry Hill	4m Platform
KC1	LIVE KERB CAM	Flip/Flop	Ground
4	LIVE CAM 4	Start/Finish	1m Platform
5	LIVE CAM 5	Chicane	4-5m Platform
6	LIVE CAM 6	Millbank Ave	2m Platform
7	LIVE CAM 7	Primrose Hill	0.5m Platform
KC2	LIVE KERB CAM	Dim/Sum	Ground
8	LIVE CAM 8	York Corner	2m Platform
9	LIVE CAM 9	Mill Road	Ground
10	LIVE CAM10	Station	2-3m Platform
KC3	KERB CAM	Station KC	Ground
11	LIVE CAM11	Raymond's Gate	Hoist
KC4	KERB CAM	Raymond KC	Ground
12	LIVE CAM12	University	0.3m Platform
13	LIVE CAM13	Ballysally	2m Platform
14	LIVE CAM14	Mathers	3m Platform
15	LIVE CAM15	Magherabuoy	Hoist
16	LIVE CAM16	Metropole	2m Platform
17	LIVE CAM17	Church	1m Platform
KC5	KERB CAM	Railway Bridge	Wall
RF1	RF CAM1	Pits	Ground
RF2	RF CAM 2	Pits	Ground
SM	ROVING SLO-MO	Various	Ground

NW200 North West 200

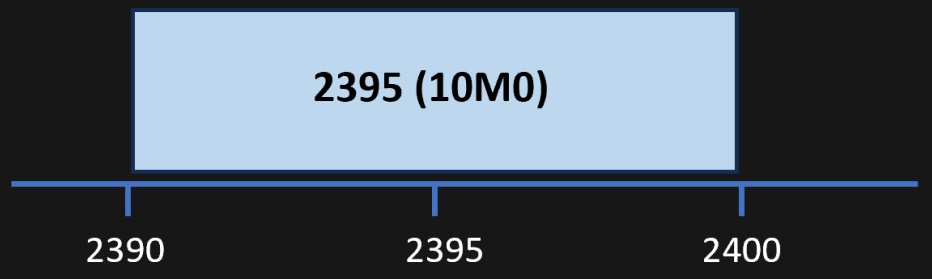
Event challenges

- Enhance coverage with more live camera positions
- Requirement to get close to the action - live
- Rural locations with poor traditional connectivity

NW200 North West 200

Spectrum challenges

- Little connectivity via public networks
- Solution for one or two cameras with robust links to connectivity points of presence
- n40 spectrum (2395MHz 10M0) appropriate but not permitted in Northern Ireland



NW200 North West 200

- Three additional camera positions relay wirelessly to existing points of presence
- Exceptional permission has been given for use of 2395MHz 10M0 (n40)
- 2 bits/Hz to give 20Mbps
- Better propagation than 3800-4200MHz

What have we achieved?

- Commonwealth Games – additional cost-effective coverage at a major event
- Coronation – dedicated newsgathering provision
- NW200 (by next month) – supplementing an existing sport OB with challenging connectivity

Aspirations?

Routine Tier 2 sports

Other modest productions

And the remaining major challenge to that……

TIMELY ACCESS TO SUITABLE SPECTRUM

Thank you