Your response

Your response should include details of:

- a description of the relevant technology;
- a view of the potential impact of the technology on the sectors we regulate, preferably identifying the impact against the criteria listed in section 3.16 of the call for inputs;
- the current state of development of the technology, including any demonstrations of feasibility;
- any unresolved issues which need to be addressed for the technology to achieve full potential;
- references to key publications and the leading groups working on the technology; and whether you would be open to discussing the technology in more detail with Ofcom.

Your response

Confidential? – N

The emerging technology we wish to highlight to Ofcom are 5G TDD (Time Division Duplex) RF repeaters in sub-6 GHz bands.

Introduction

FDD (Frequency Division Duplex) RF repeaters for 2G, 3G and 4G are in widespread use by mobile networks and end-users for indoor mobile coverage. In some countries their use has been opened up by regulator rulings and licence exemptions such as FCC part 20 in the USA, Ofcom IR2102.1 in the UK and S.I. No. 283 of 2018 in the Republic of Ireland.

Whilst for 4G in Europe, the predominant deployment mode was and is FDD, for 5G, whilst FDD will exist, the predominant mode (in terms of available and deployed spectrum) will be TDD.

There are some serious challenges for indoor coverage that 5G TDD will present:

- The large amounts of spectrum likely to be deployed in the mobile macro network for 5G will be above 3 GHz (because there is literally more of it available).
- Whilst this 3-6 GHz spectrum provides substantial capacity in terms of MHz and Mbits/s, it penetrates buildings very badly.
- Traditionally this type of situation can be addressed with RF repeaters, however no technical specifications for TDD RF repeaters exist from the well-known standards bodies such as ETSI and 3GPP. (The challenge is obviously timing and synchronization – turning on the uplink radio and downlink radio at the correct times in the RF repeater in the TDD frequency.)

We believe the technical challenge of 5G indoor coverage is understood well by the mobile networks, but is less well served by the mobile infrastructure manufacturers than it could be, and provides Ofcom with the opportunity to take a leadership position with 5G RF repeater-related regulation in the world.

Technology Description

RF repeaters typically take an RF signal that exists outside or around the edge of a building, and bring it into the interior of the building where it does not exist.

There are 2 main use-cases:

1) Antennas outside and inside a building with cables to connect them up (either in a passive way, or in an active way).
2) Unit with integrated antennas placed at the edge of a building (e.g. in a window alcove) with an antenna pointing outside and an antenna pointing inside.

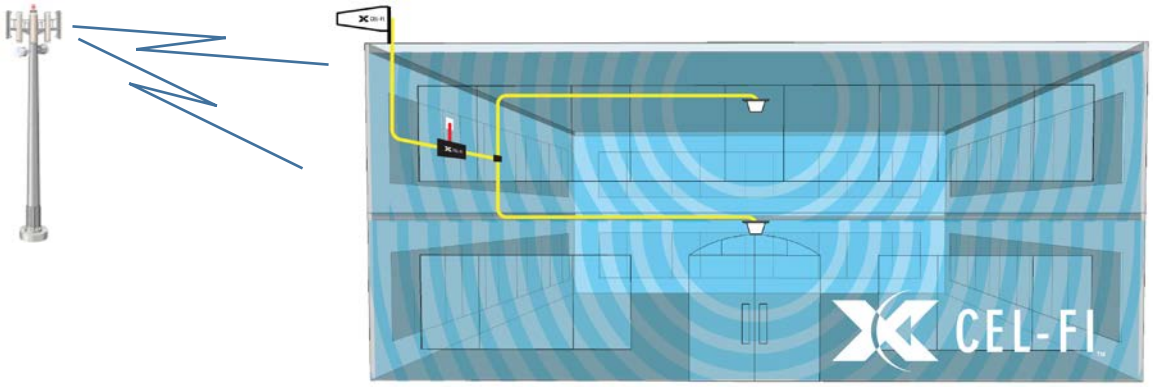

Figure 1: 5GNR TDD RF repeater with external and internal antennas

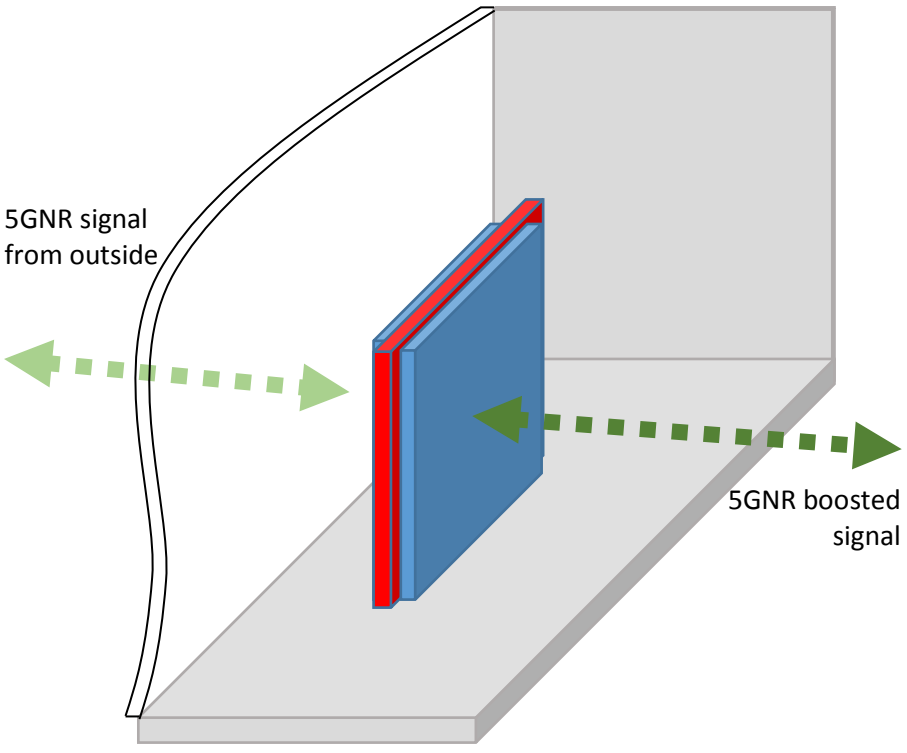

Figure 2: 5GNR TDD single-box RF Repeater

The main 5G capacity will come between 3GHz and 6GHz (initially in band N78 between 3.4 and 3.6GHz). Whilst massive capacity will exist outdoors (with networks having spectrum allocations of circa 100MHz for 5GNR deployment) the ability of that spectrum to reach indoors is very severely limited (the indoor footprint of a macro base station in band N78 will likely be an order of magnitude less, or worse than the outdoor footprint at any sort of reasonable speed, or put another way the cell radius indoors will be less than half of the cell radius outdoors).

Impact of the Technology

Looking at the criteria specified by Ofcom in turn

- Enable the delivery of **new services** which are valued highly by people and businesses.
- Broaden and deepen **access to services**.
- Increase the **performance of networks**, improving the experience for people.

The gigabit/s plus capacity of 5G TDD networks will likely only be available outdoors in a high percentage of geographical coverage, without a cost effective indoor coverage solution – widely available 5G TDD repeaters will open up this huge outdoor capacity (with the enhanced services that it brings) indoors, to a much broader range of users.

- **Lower barriers to entry** for providers, enabling choice for people.

5G TDD RF repeaters in the sub-6GHz bands, will allow mobile network service providers to deploy effective 5G indoor coverage based on the macro network signal without recourse to wired infrastructure, especially in cases where wired infrastructure provision is difficult or costly. If 5G TDD RF repeaters were made licence exempt, then this would allow customers access to an effective 5G indoor coverage solution without having to rely on the mobile network provider.

- **Reduce the cost** of delivering services, increasing access and maximising value for customers.
- Change the way we **authorise and regulate** networks and /services.
- **Reduces the total environmental impact** of delivery of communication services and associated activities.
- **Assure the security and resilience** of service delivery.
- **Reduce the total environmental impact** of delivery of communication services and associated activities.

To build-out 5G indoor coverage with gigabit-level service based on outdoor cells may require an unachievable density of base station assets and might even be just plain impossible for buildings with the highest standards of thermal insulation.

5G TDD RF repeaters in sub-6 GHz bands and especially in the 3-6gHz range will allow mobile network infrastructure to be built-out at appropriate and publicly acceptable density and still achieve a huge hike in the level of mobile network bandwidth indoors.

Current State of Development of The Technology

The most notable work on TDD repeaters has been in Korea, where there have been some public announcements, for instance: https://smallcells.3g4g.co.uk/2019/10/sk-telecoms-in-building-5g-nr-repeaters.html however such announcements notwithstanding, actual availability of 5G TDD repeaters does not yet appear to be a reality.

Nextivity currently has 4G TDD repeaters on the market, and will be bringing band N78 TDD repeaters to market in the next year or so.

Unresolved Issues which Need to Be Addressed

Development of a licence exemption specification for 5G TDD RF repeaters below 6GHz is an area which we believe Ofcom should be looking at.

Ofcom has done good work on this in the past for 2G, 3G and 4G FDD technologies and we believe now is the time to seriously look at this for the most widely deployed 5G spectrum below 6GHz