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# Community Cellular Network: Towards 5G

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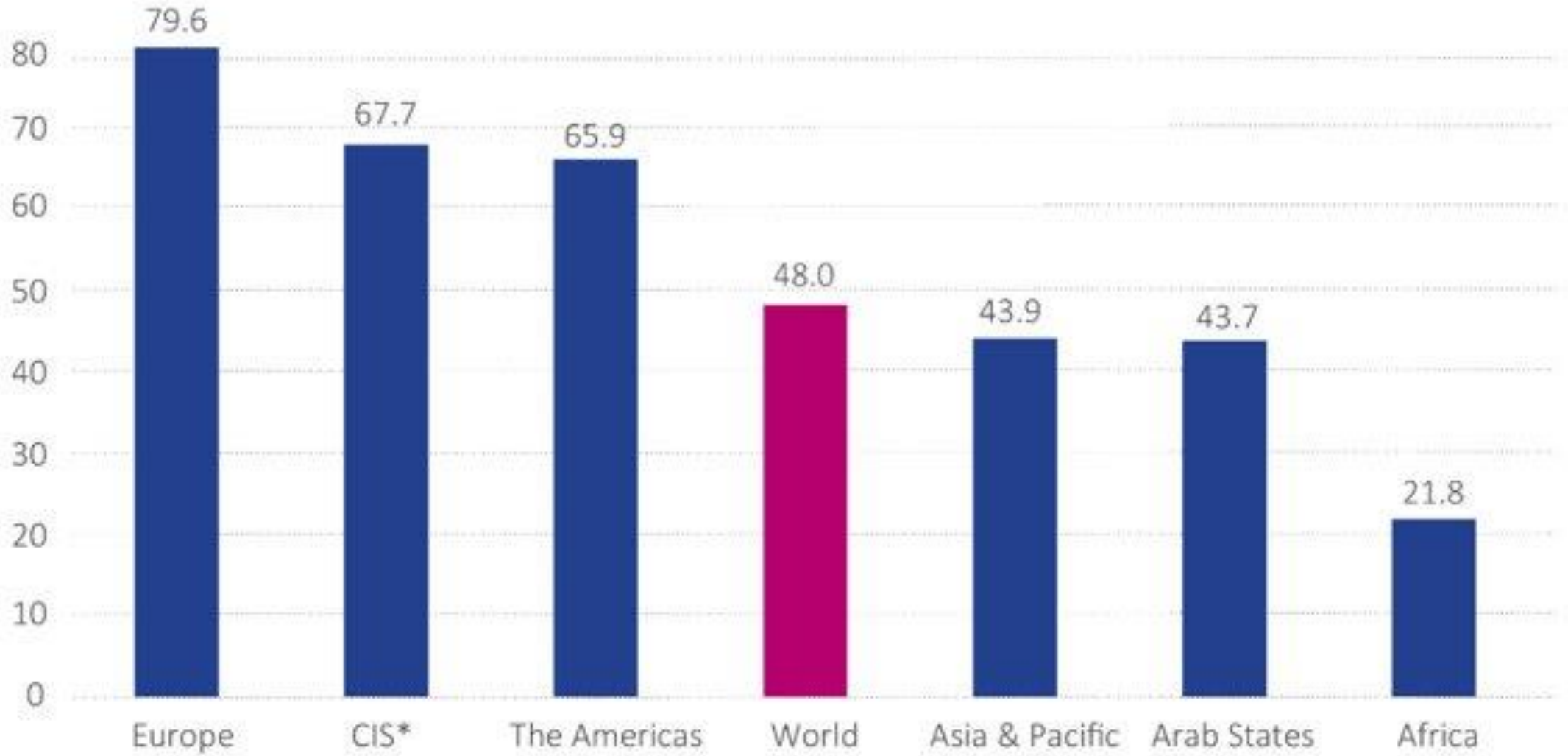
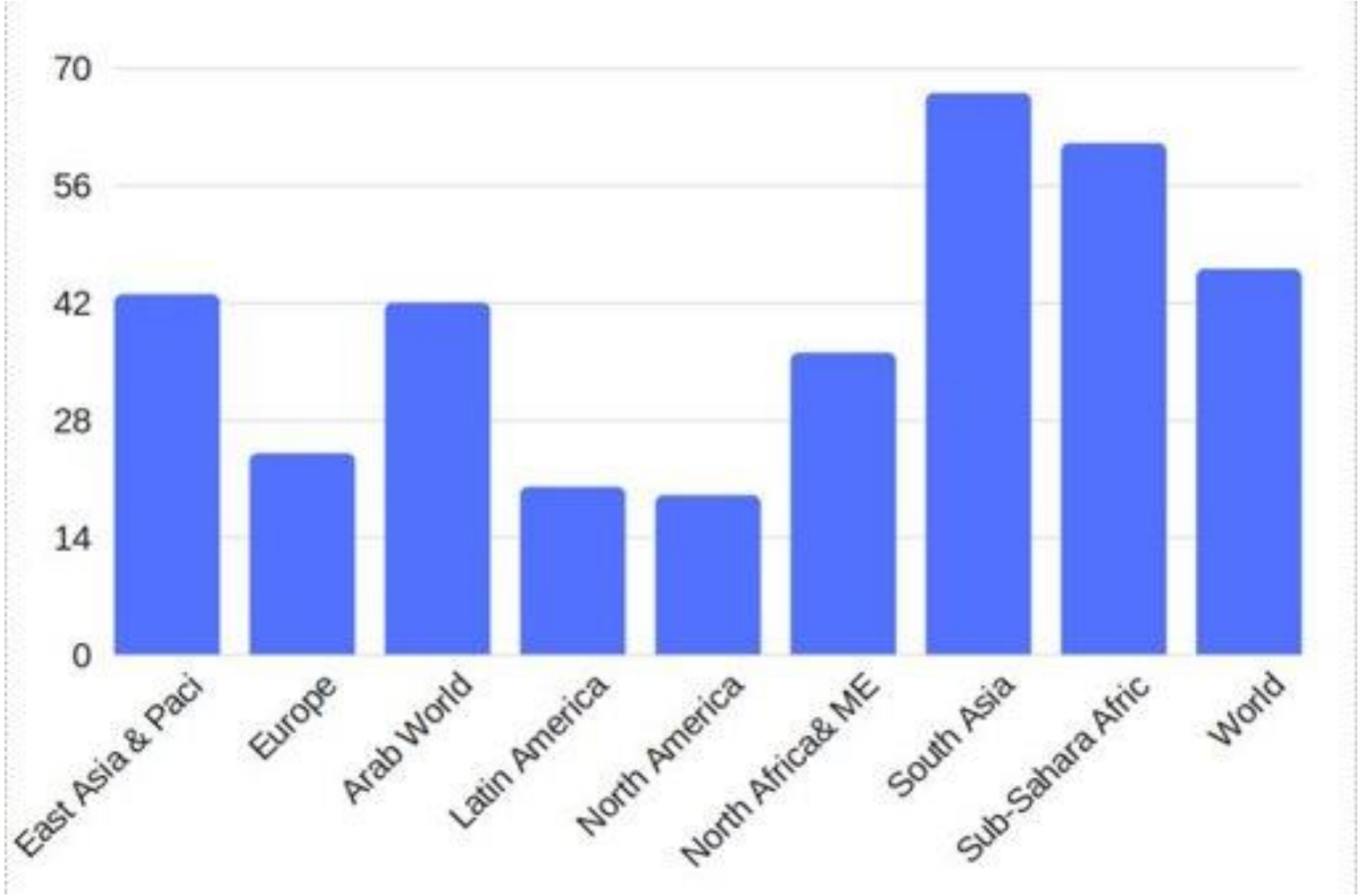
# Internet User Penetration as of 2017



# Rural Population Worldwide

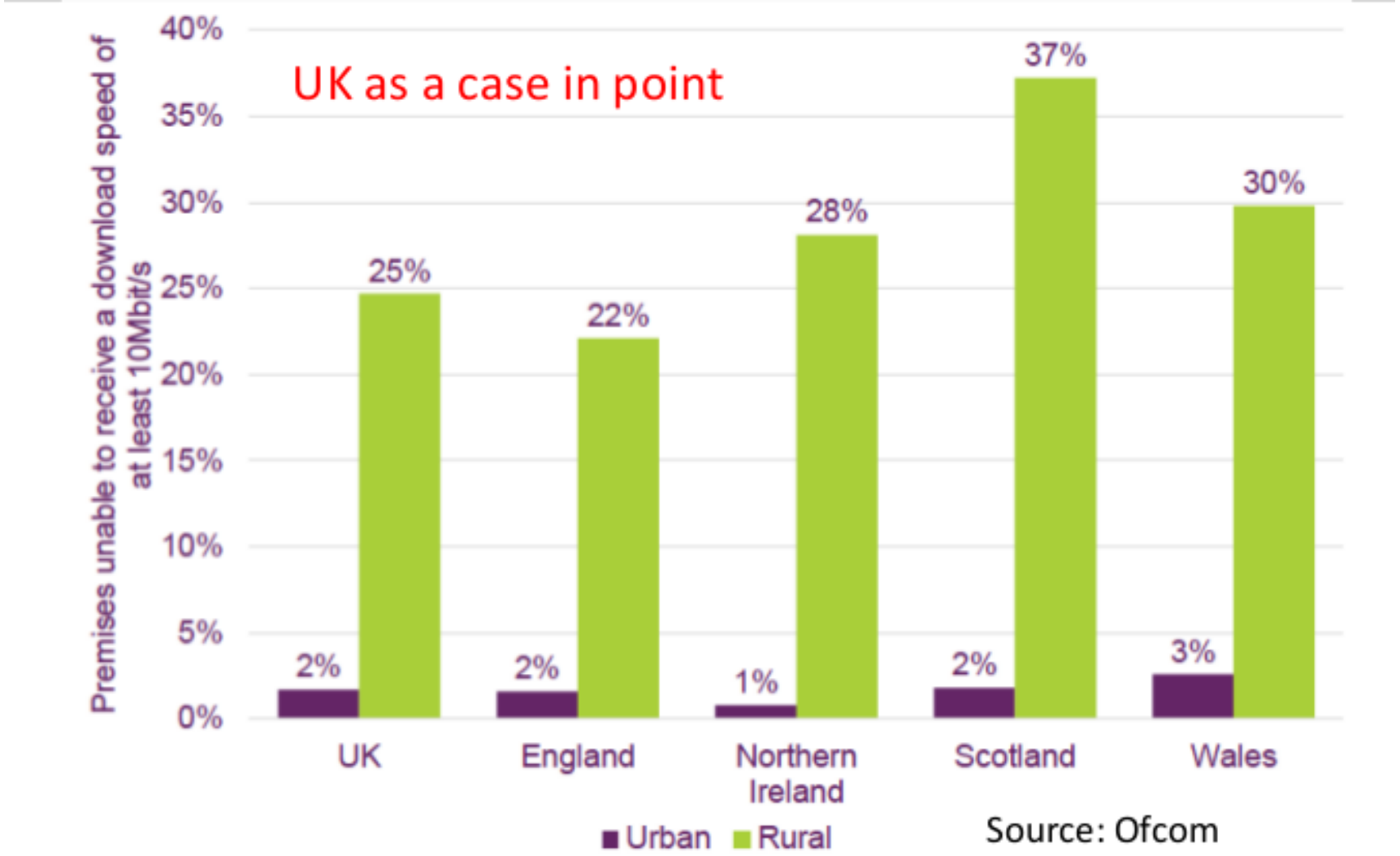
- > 40% world population live in rural areas
- The percentage is much higher in South Asia and Sub-Sahara Africa



**Infrastructure for Rural Connectivity**

**Non-Affordability**

# Key challenges for connecting the unconnected (52% of world population)




# Universal Internet access is not just a developing country issue

# 5G Objectives

- Extending the Internet connectivity is one of 5G objectives

- Towards that Universal Internet access, several solutions have been proposed in literature, including:
  - Leveraging the superior characteristics of low frequencies (e.g. 700 MHz)
  - Mobile base station such as unmanned aerial vehicles base station and Google balloon
  - Open source software-defined wireless access platform including OpenCellular (Facebook), openairinterface (Eurecom)

# New Deployment model for the cellular network in Rural areas (1/2)

- Design Principles:
  - Simplicity
    - Plug and Play deployment
    - Community driven
  - Scalability
  - Applicability to serve new emerged services
    - High Broadband speeds
  - Cost efficient
  - Adaptability

# New Deployment model for the cellular network in Rural areas (2/2)

- Three main components
  - Access Network platform
    - Either commercial plug and play LTE small cells
    - Or, software-defined access such as openairinterface.
  - TVWS backhauling link
    - We are using the 8 MHz channel commercial TVWS devices
  - Core in the cloud
    - Implements different core functions as a service
    - Flexibility

# New Deployment model for the cellular network in Rural areas

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# High Level Network Architecture

- High Broadband Speed as a use case
  - High capacity backhauling (Middle mile) infrastructure

- Building a low-cost middle mile infrastructure is crucial in order to achieve that objective in rural cellular network.

# TV White Space and Middle Mile Infrastructure

- To assess if the TVWS can be used to build a low-cost Middle mile infrastructure, we asked the following research questions:

  - How many *usable* channel are available?
  - How the spectrum is distributed? Contiguous or fragmented?

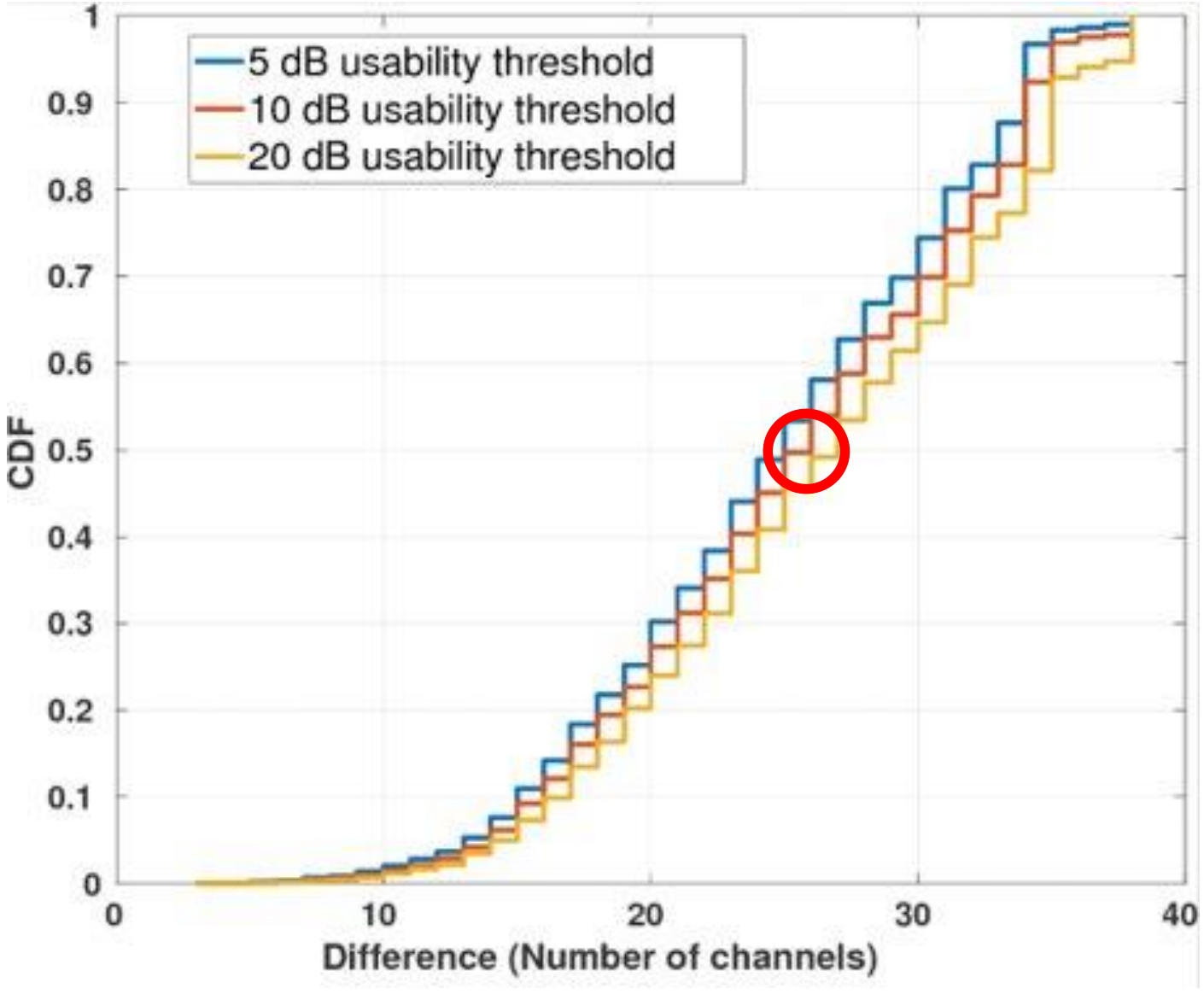
# TVWS Usability? (1/2)

- TVWS availability is the commonly used term in literature referring to the quantity of available/free channels.
  - Unrealistic/overoptimistic

- TVWS usability is more reliable and receiver-oriented.
- The key difference is:
  - TVWS usability identify the *quality* (I.e., in terms of SINR) of TV channel at a receiver side.
  - Different than TVWS availability which identify the quantity at the transmitter side.

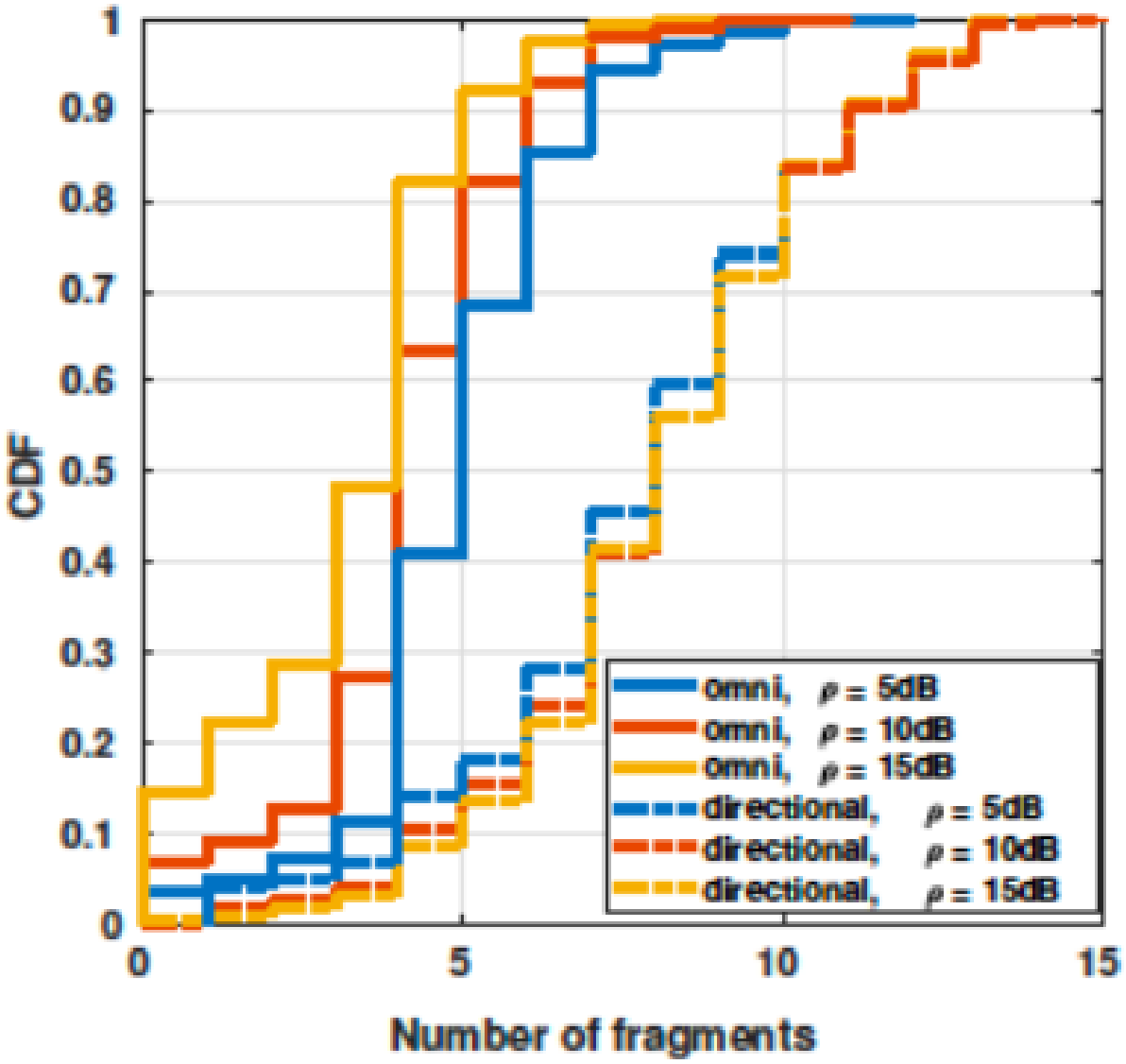
# TVWS Usability? (2/2)

- The difference between TVWS usability and availability is significant.
- The median is 25 channels = 200 MHz



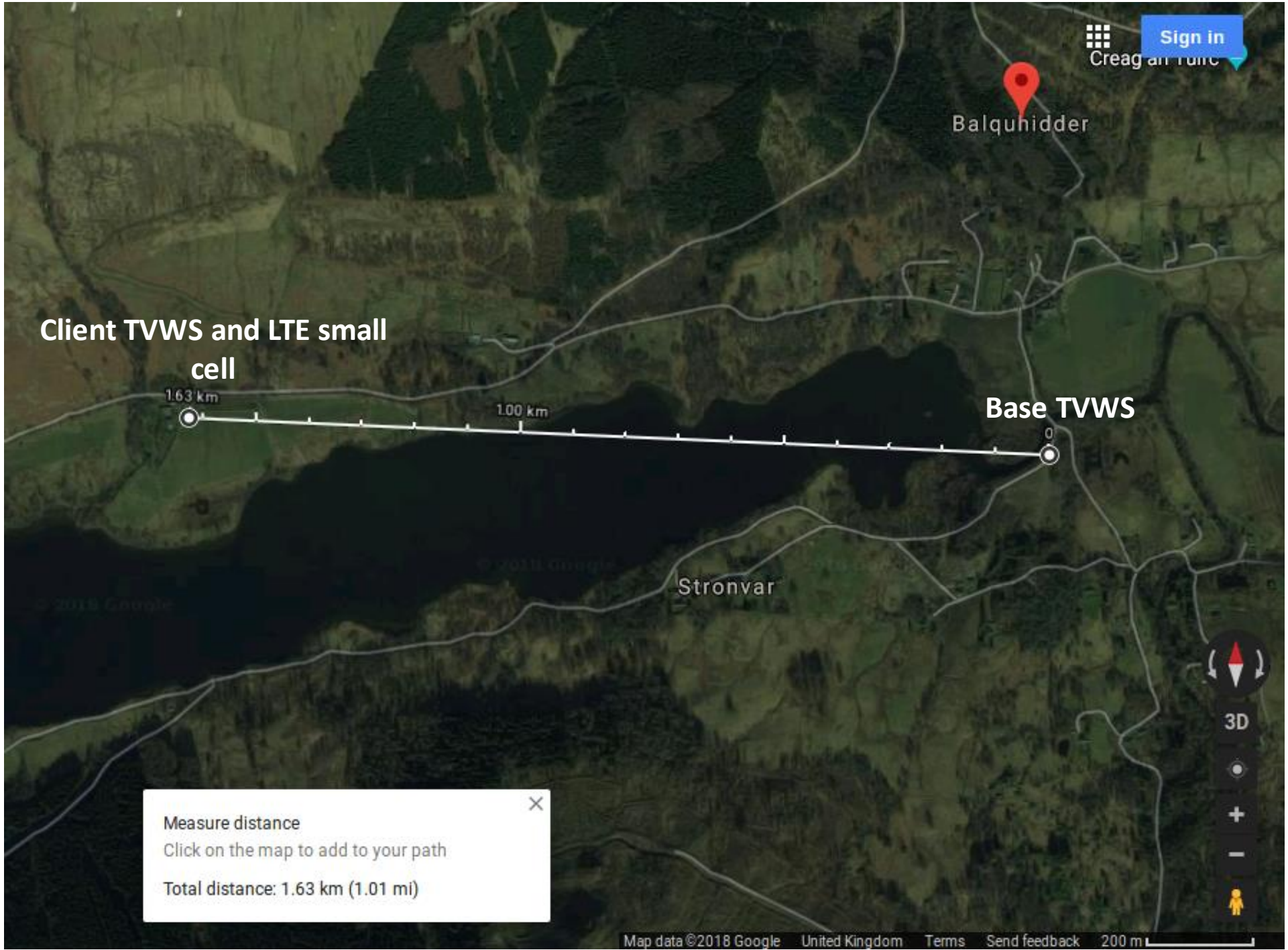
# Spectrum Fragmentation

- TVWS spectrum is fragmented.
- To achieve high capacity middle mile infrastructure, 6/8 MHz channel would not be sufficient
- Efficient aggregation techniques for adjacent and non-adjacent channels are crucial




Median number of fragments of usable spectrum around 8

# Rural Area Deployment: Balquhidder



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# Thank you