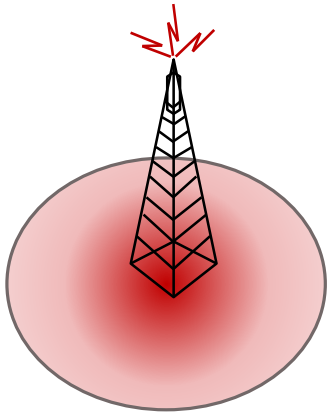
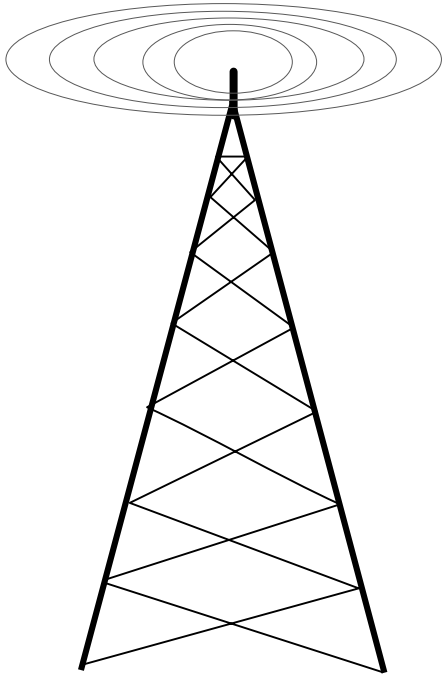
An Introduction to Macrocells & Small Cells

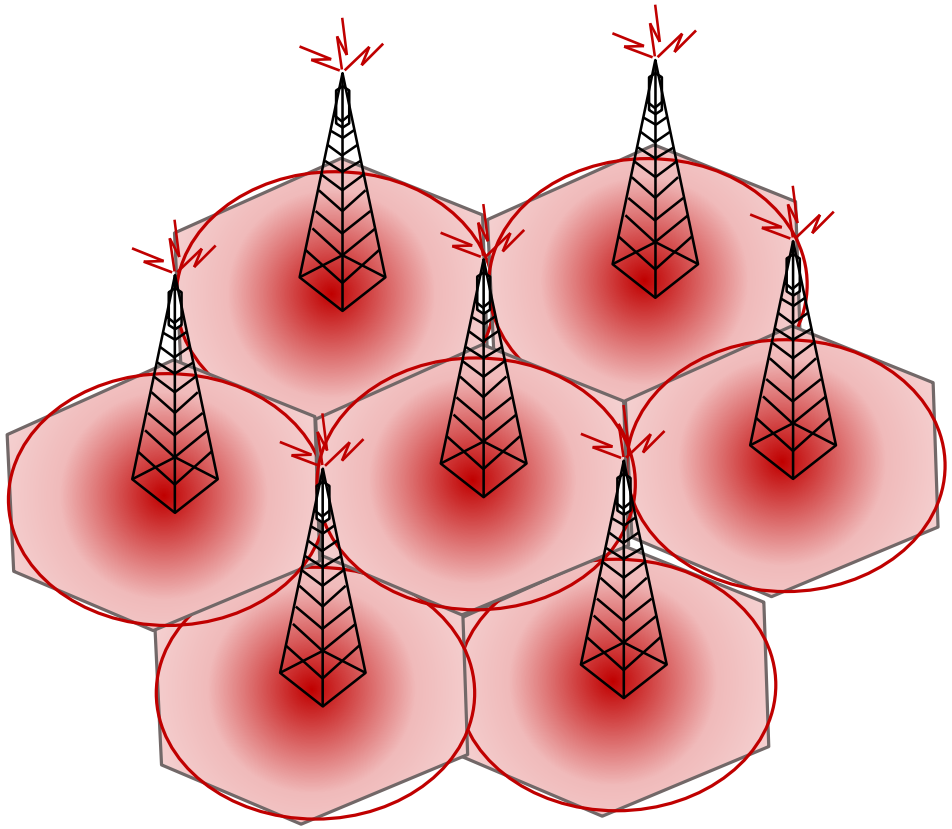
@3g4gUK

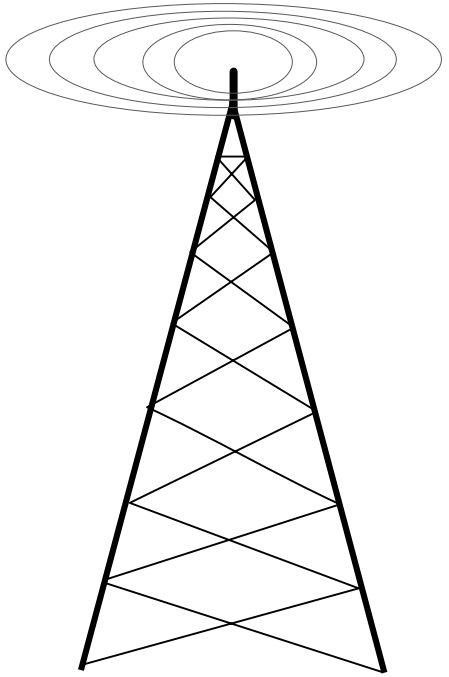
Mobile Towers in Theory



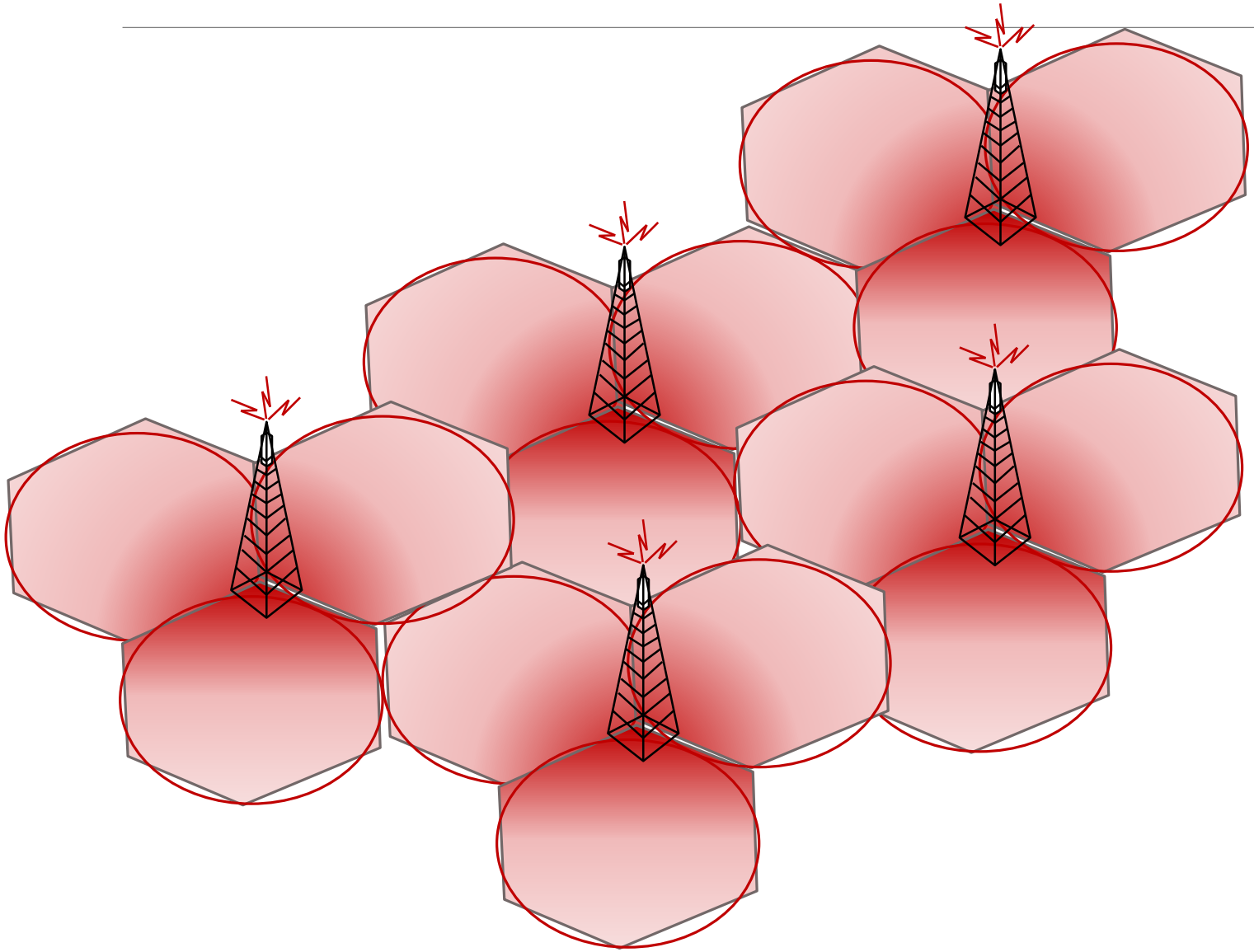


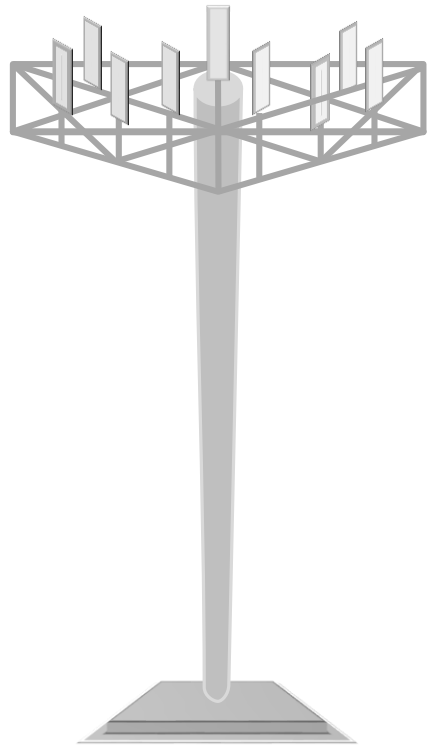
Mobile Towers in Theory



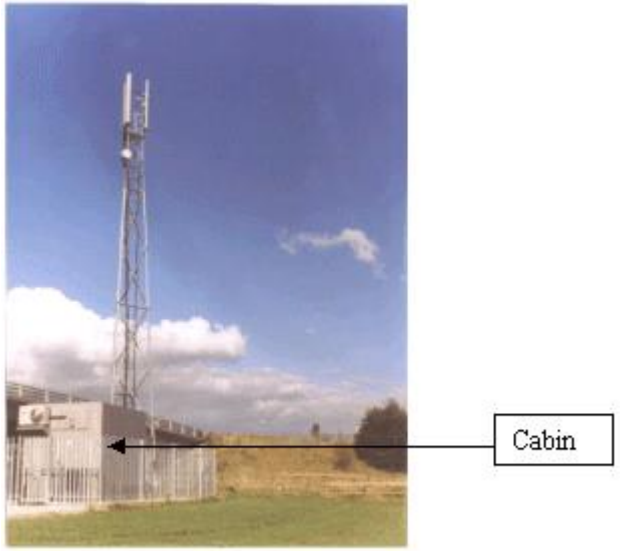


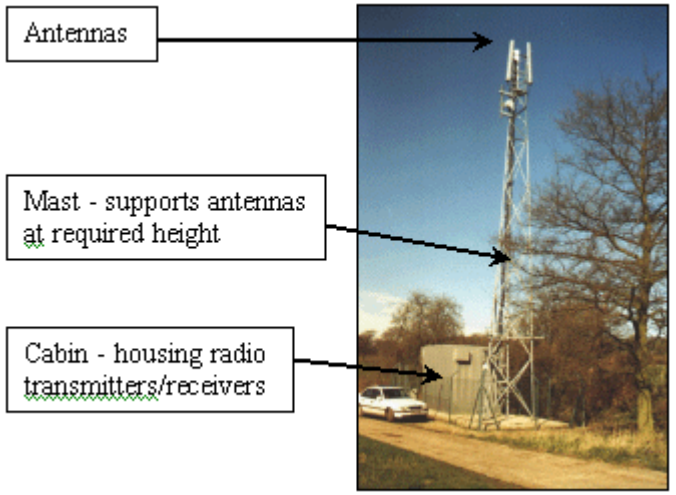
Mobile Towers in Practice





Mobile Towers in Real Life



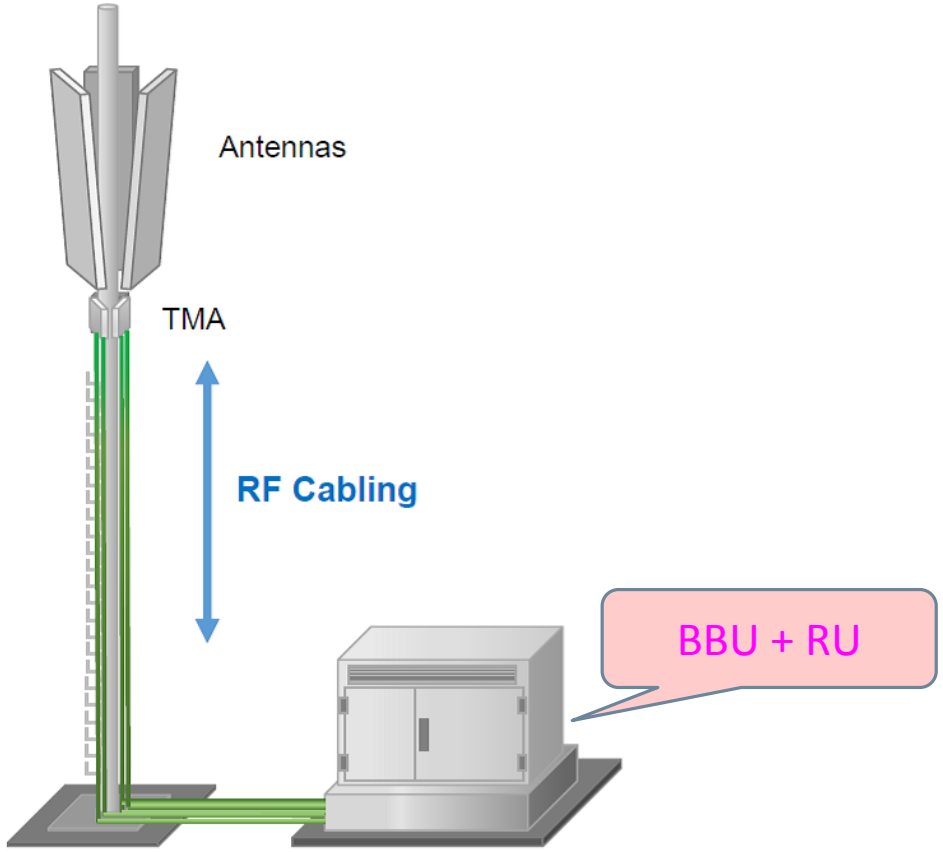


Source: Ofcom

Mobile Towers in Real Life

Mobile Towers in Real Life

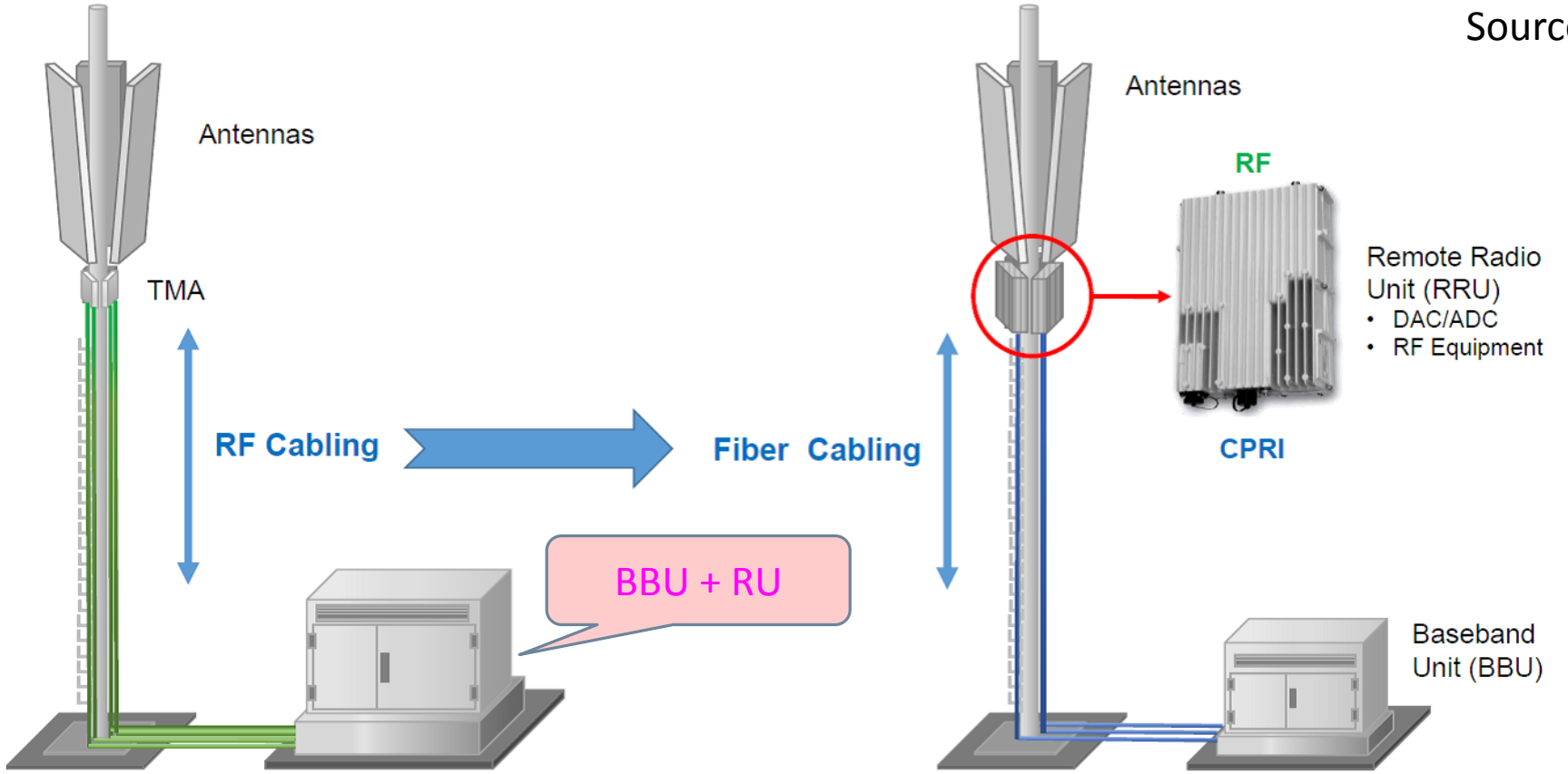
Source: National Instruments



Traditional Base Station
- Signal Processing
- RF Equipment
- Network Access
- Long RF Cables

Mobile Towers in Real Life

Source: National Instruments



Traditional Base Station
- Signal Processing
- RF Equipment
- Network Access
- Long RF Cables

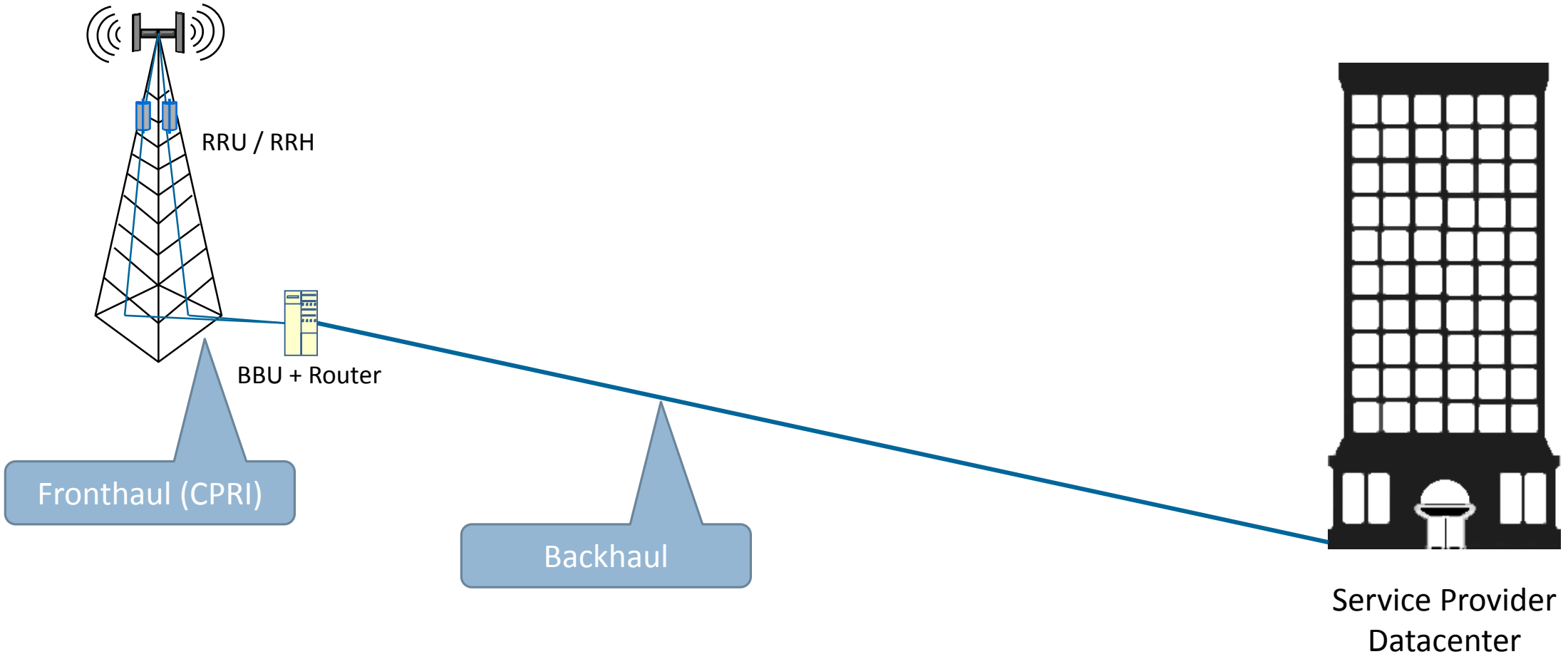
Contemporary Base Station
- Signal Processing
- Network Access
- Fiber Optic Cables

Macrocells

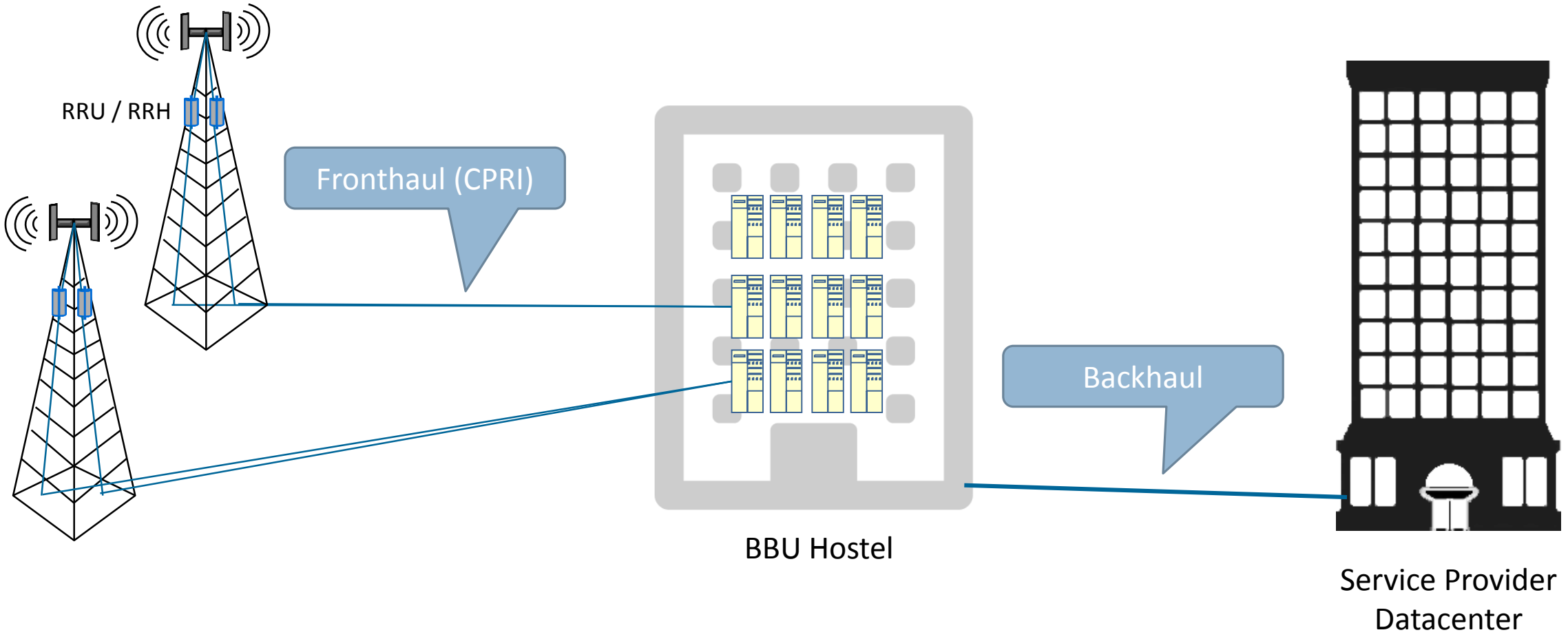
Macrocell:

- Typical Power: 20 – 40 watts
- Typical Height: 15 – 25 metres
- Coverage Area: 25 – 40 km
- Typical number of simultaneous users served: >200 per sector/per frequency
- Location: Tower (urban/rural), Top of buildings (urban)
- Backhaul: Fiber, Microwave, DSL
- Cost: $$$$$$$$$

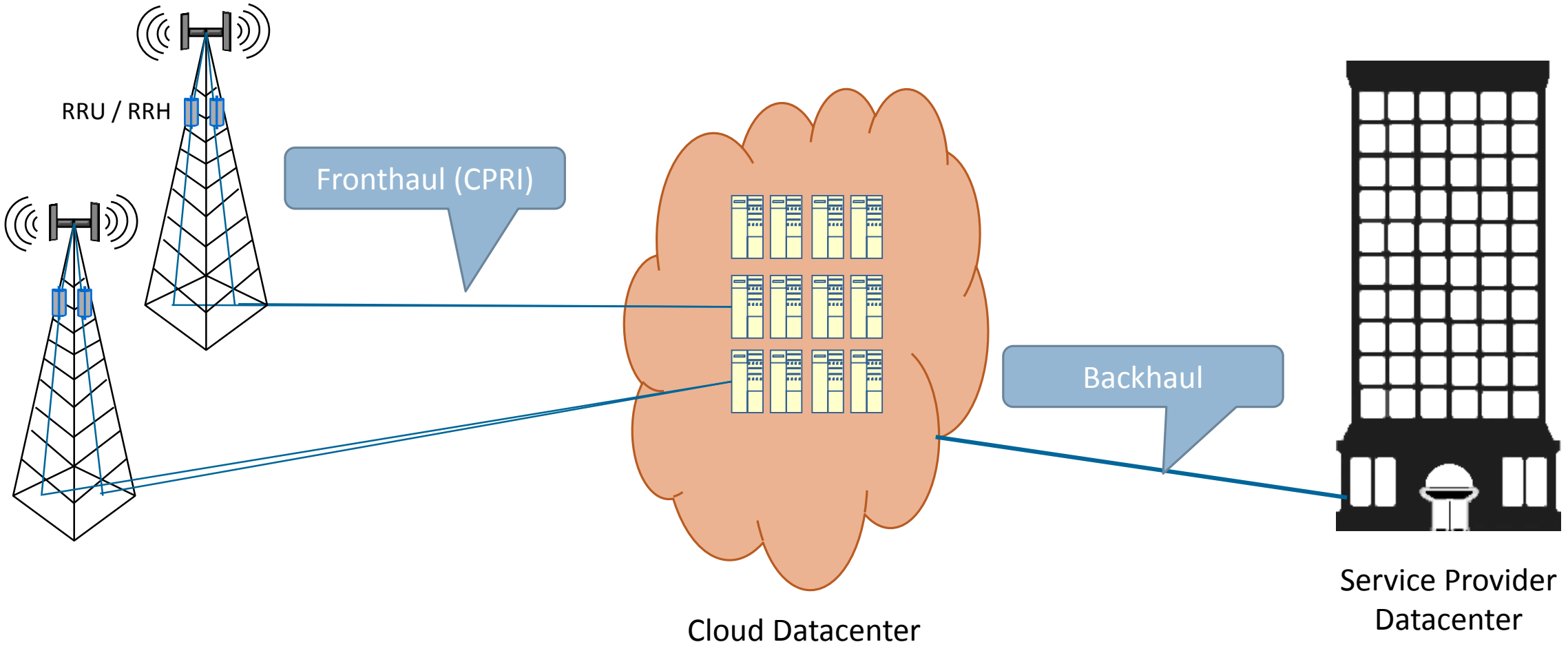
Macrocell Connections & Terminology



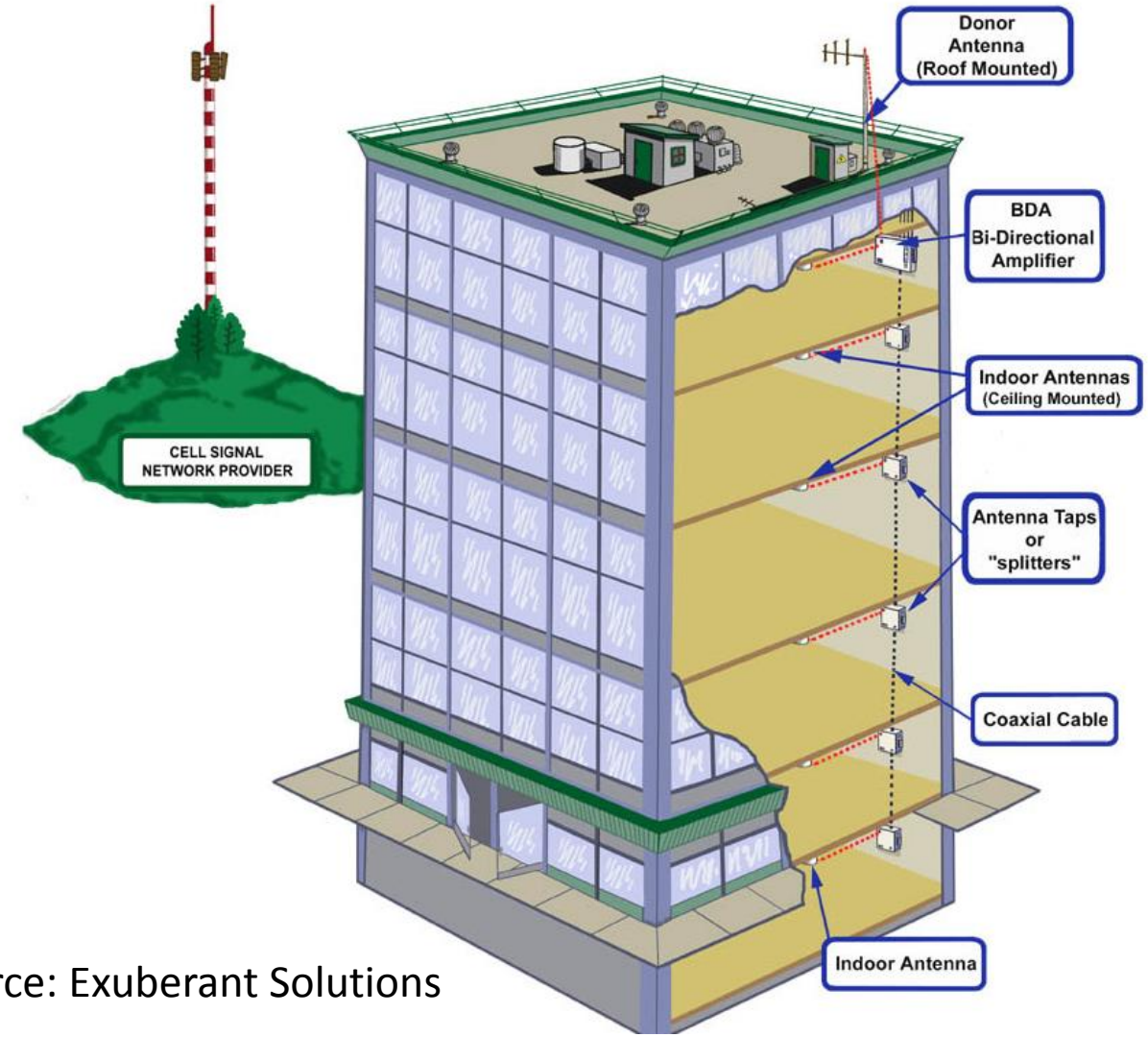
Centralized RAN (C-RAN) / BBU Hostelling



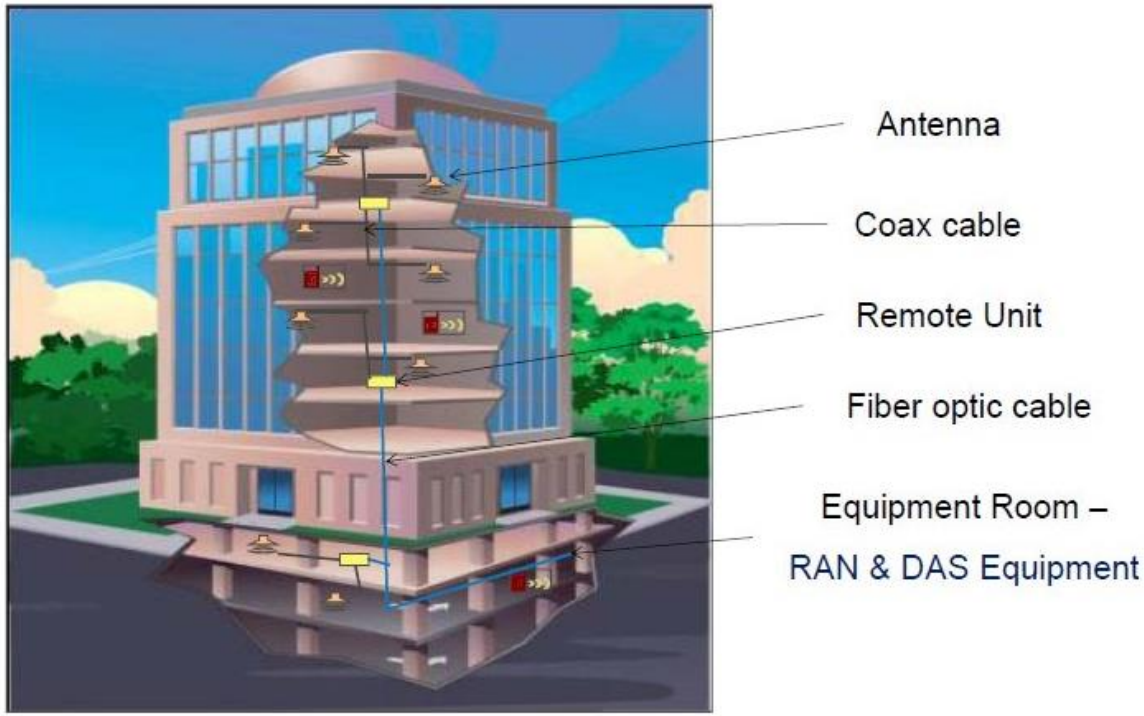
Cloud RAN (C-RAN)



Distributed Antenna System (DAS)



Source: Exuberant Solutions



Source: AT&T

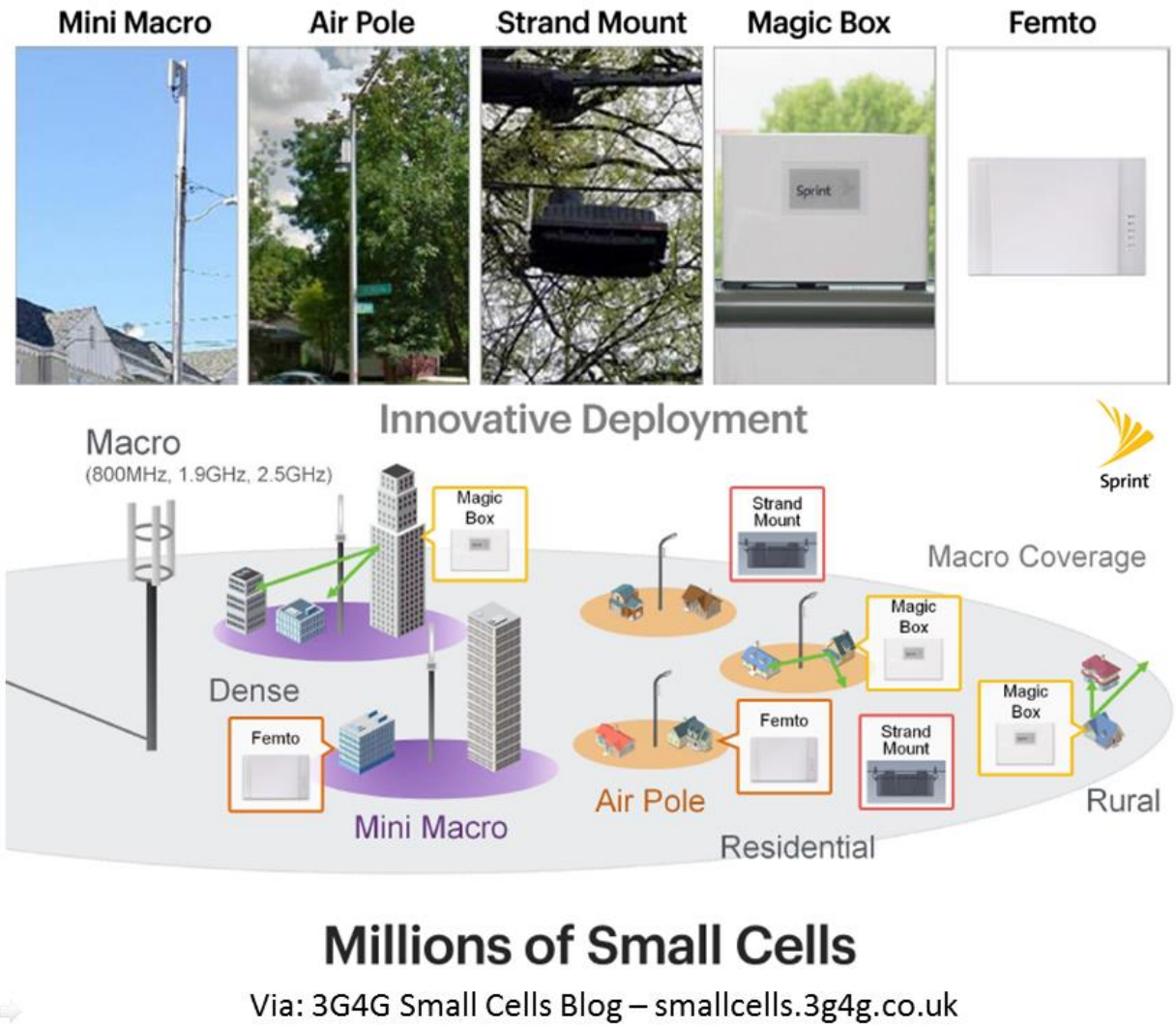
Mini-Macro

A mini-macro is the same as macrocell with the following differences:

- Single sector
- Single frequency
- Single RAT (e.g., 2G/3G/4G) or Multi-RAT (e.g., 3G & 4G)
- Antenna height typically: 8 – 10 meters
- Backhaul: Microwave, Mesh, Fiber, DSL – typically lower bandwidth than macrocell

Note: All the above is general guidance. Deployments can vary significantly for each operator

Mini-Macro



#Vodafone new Mini Macro mast with all the. Gear in the Base. As to be shortly deployed in #Porthcurno #Cornwall (but taller of course! 8m) - @Phonemast on Twitter

Mini-Macro

Installation Example

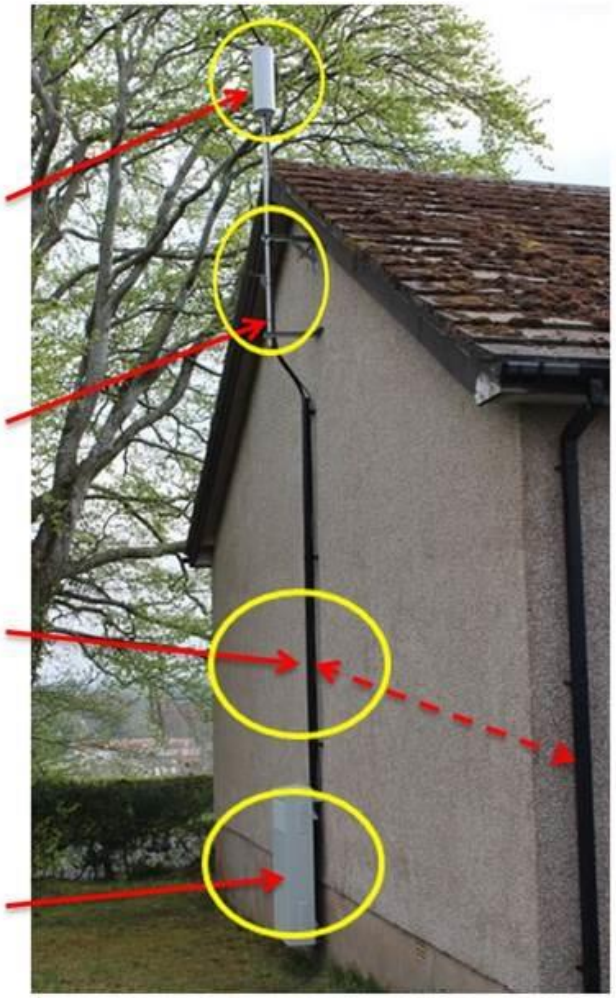
Solves municipal law restrictions

Discrete Compact **Integrated** Antenna Bundle containing Access and Mesh Antennas

Simple (not obscure) Mast Mounting Similar to TV Mast

Cable Run in Matching Conduit

Node ONLY Cabinet (nothing else is in the cabinet) for aesthetics and to meet zoning laws



Why do we need ‘Small Cells’

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Why do we need ‘Small Cells’

Source: Zahid Ghadialy

Source: The Telegraph

Why do we need ‘Small Cells’

Source: TravelSkills

Definition of Small Cells

Small cells or small cellular base stations encompass a number of different technologies but one could describe them as anything that's not a typical macro site. They are deployed to solve network capacity issues in a relatively small area, like a hot spot or an important zone that is a subset of the umbrella macro site coverage.

“From our world, everything is a small cell if its not nailed to a tower. So it could be Wi-Fi, Indoor / Outdoor, DAS, Femtocells, Metrocells, Remote Radioheads, Microcells and Signal Boosters as well…” - Iain Gillott, Founder and President, IGR Research

Definition of Small Cells

‘Small cells’ is an umbrella term for operator-controlled, low-powered radio access nodes, including those that operate in licensed spectrum and unlicensed carrier-grade Wi-Fi. Small cells typically have a range from 10 meters to several hundred meters.

Types of small cells include femtocells, picocells and microcells – broadly increasing in size from femtocells (the smallest) to microcells (the largest). Any or all of these small cells can be based on ‘femtocell technology’ – i.e. the collection of standards, software, open interfaces, chips and know-how that have powered the growth of femtocells.

My definition of ‘Small Cells’

- Small form factor
- Complete base station (contains BBU + RU + optionally Router)

Ericsson’s Radio Dot Small Cell

Radio Dot (RD or Dot)

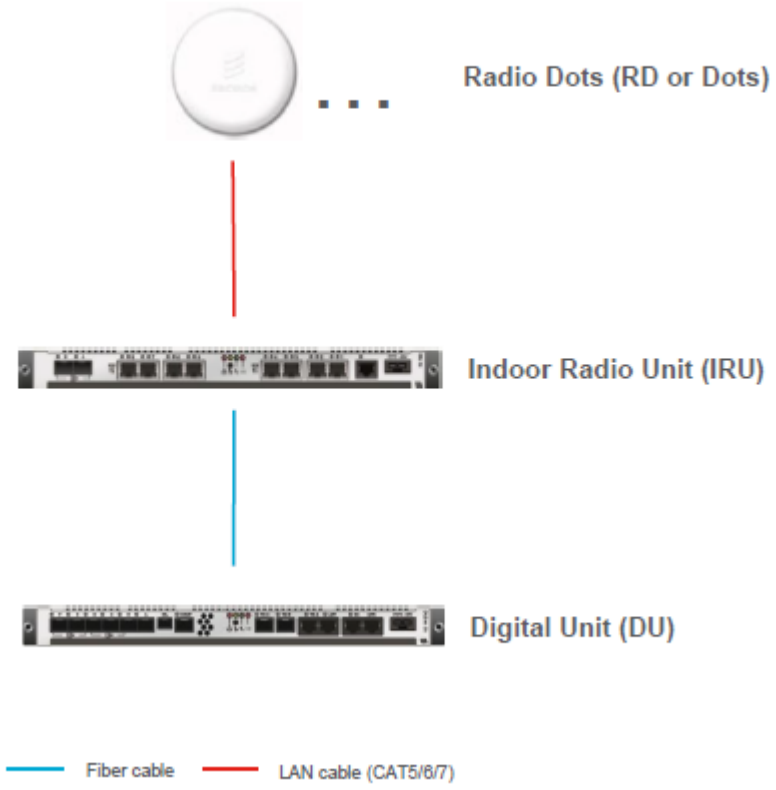
- Ultra compact radio
- Discreet and easy to install
- Radio and power over LAN cable

Indoor Radio Unit (IRU)

- Frequency independent
- Remote software upgrades
- Integrated powering

Digital Unit (DU)

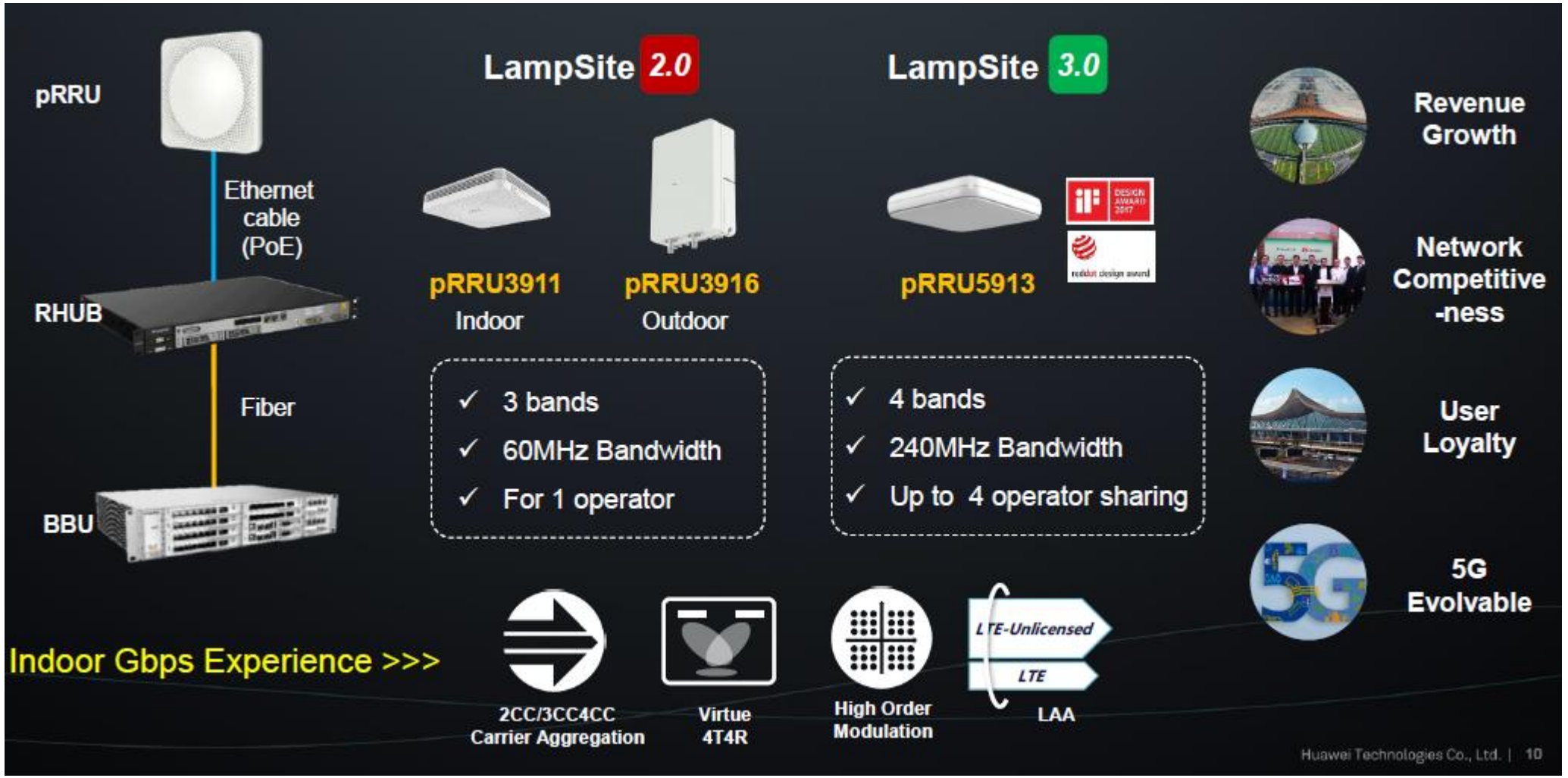
- Pooled baseband resources
- Feature parity and 3GPP evolution
- Leverages RBS 6000 baseband



Customer (Mobile Operator) Introduction - Radio Dot System | 2013-09-25

Source: Ericsson

Huawei's Lampsite



Source: [3G4G Small Cells Blog]

My definition of ‘Small Cells’

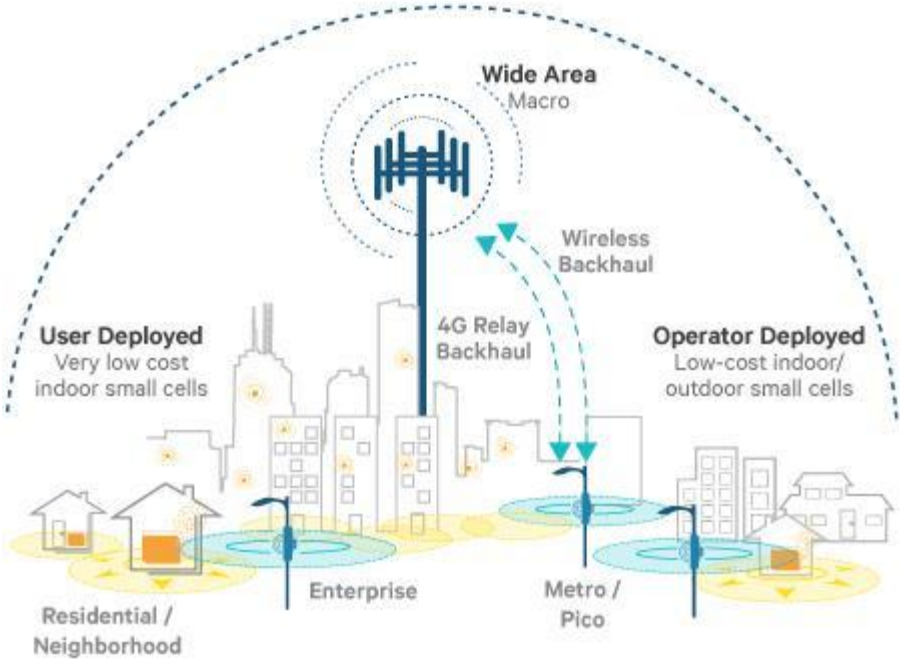
- Small form factor
- Complete base station (contains BBU + RU + optionally Router)
- Low power consumption → Not necessarily low power output
- ‘Licensed’ or ‘Unlicensed’ spectrum
- Does not include non-cellular technologies like Wi-Fi, etc., unless used in conjunction with cellular technologies
- ‘Indoor’ and/or ‘Outdoor’ deployment
- Deployed for ‘Coverage’, ‘Capacity’, ‘Densification’, ‘High Throughput’, ‘Improved Signal Quality’, ‘Improved User Experience’, ‘Value-added Services’, ‘Smart Application’, ‘Proximity marketing’, etc.

Characteristics of ‘Small Cells’

- Easy and straightforward to deploy
  - Femtocells should be deployed by the end-users themselves
  - Other types of small cells should be easily deployed by low-skilled installers
- SON capability (centralized, distributed or hybrid)
  - Self-configuration
  - Self-optimization and interference management for ad-hoc deployments
- Synchronized to the macro network
  - Mainly for urban & dense deployments
- Flexibility on backhaul capability

Types of Small Cells

- Femtocells – Residential & Enterprise
- Picocells – Sometimes referred to as ‘Indoor Metrocells’
- Microcells – Sometimes referred to as ‘Metrocells’ or ‘Outdoor Metrocells’
- Meadowcells – Rural Small Cells



Source: Qualcomm

Wi-Fi

Wi-Fi Access Point:

- Typical Power: 200 milliwatts
- Typical Height: N/a
- Coverage Area: Typically 100 metres
- Typical number of simultaneous users served: 250
- Location: Indoors or Outdoors
- Backhaul: Wired – (A)DSL / Fiber
- Cost: $

Femtocell (Residential & Enterprise)

Femtocell (Residential & Enterprise):

- Typical Power: 100 milliwatts
- Typical Height: N/a – Indoor locations
- Coverage Area: Typically 50 metres
- Typical number of simultaneous users served: 8 for residential, 16 for enterprise
- Location: Indoors
- Backhaul: Wired – (A)DSL / Fiber
- Cost: $$

Picocell / Indoor Metrocell

Picocell / Indoor Metrocell:

- Typical Power: 250 milliwatts
- Typical Height: N/a – Indoor locations
- Coverage Area: Typically 250 metres
- Typical number of simultaneous users served: 32 – 64
- Location: Indoors
- Backhaul: Wired – (A)DSL / Fiber
- Cost: $$$

Microcells / Outdoor Metrocells

Source: Commscope

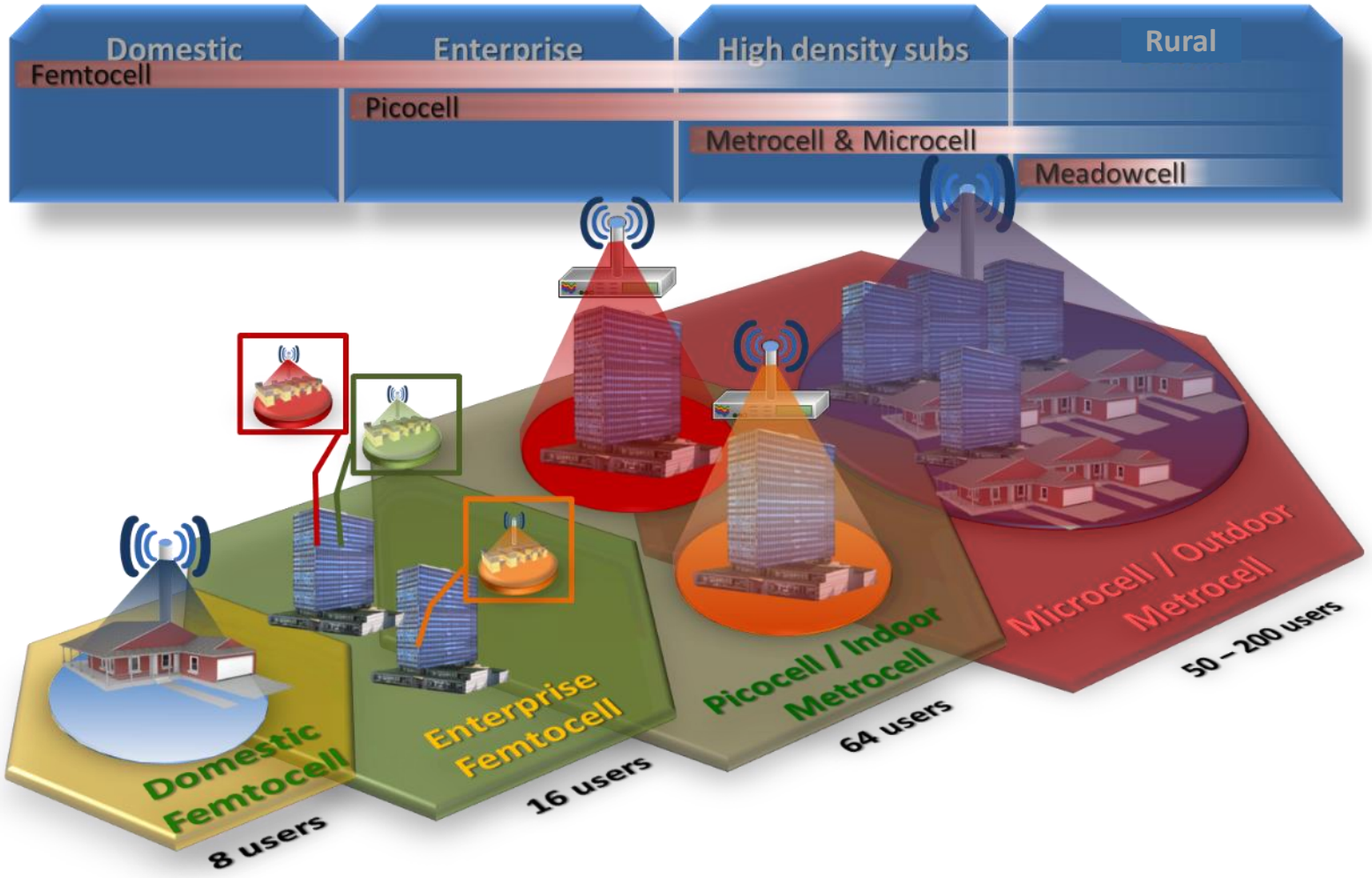
Microcells / Outdoor Metrocells:

- Typical Power: 2 – 5 watts
- Typical Height: 8 – 10 metres
- Coverage Area: 500m – 3km
- Typical number of simultaneous users served: 32 - 200
- Location: Small towers, Buildings, Lampposts
- Backhaul: Fiber, Microwave, Mesh, DSL
- Cost: $$$$

Meadowcells (Rural Small Cells)

Meadowcells (Rural Small Cells):

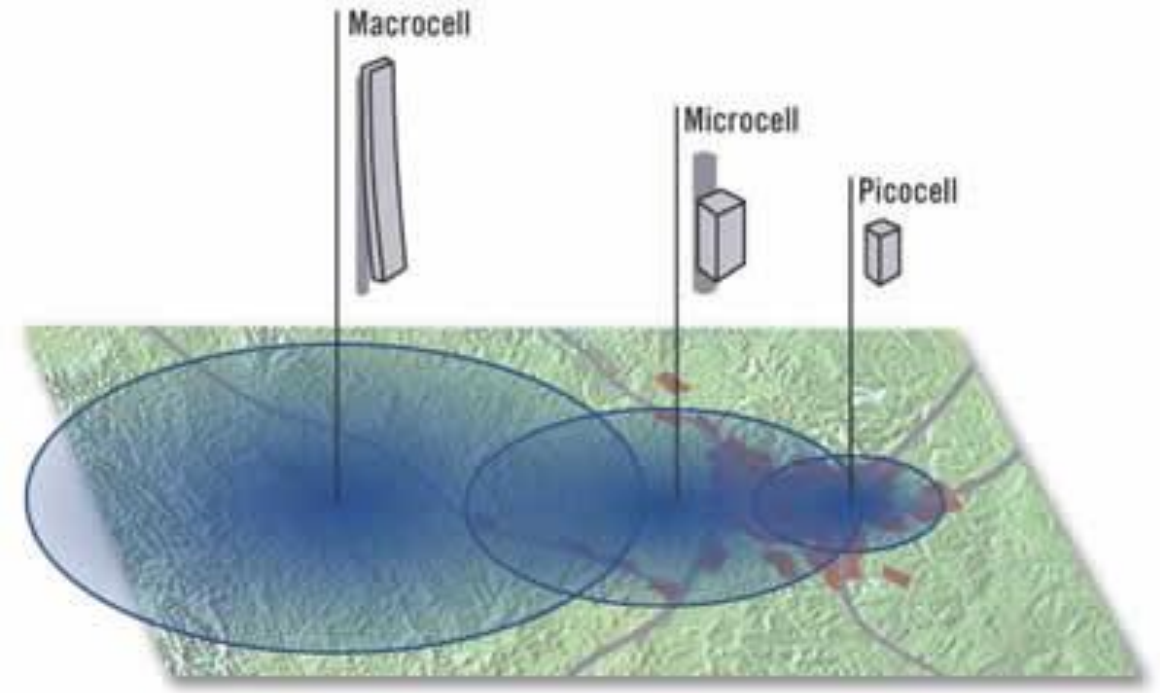
- Typical Power: 5 – 40 watts
- Typical Height: 5 – 15 metres
- Coverage Area: 1 – 10 km
- Typical number of simultaneous users served: 32 – 64
- Location: Tower, Buildings (top or side), Rooftop
- Backhaul: Satellite, Mesh, Microwave, (A)DSL, LTE Backhaul
- Cost: $$$$


Domestic
Enterprise
High density subs
Rural
Femtocell
Picocell
Metrocell & Microcell
Meadowcell
Domestic Femtocell
8 users
Enterprise Femtocell
16 users
Picocell / Indoor Metrocell
64 users
Microcell / Outdoor Metrocell
50 – 200 users

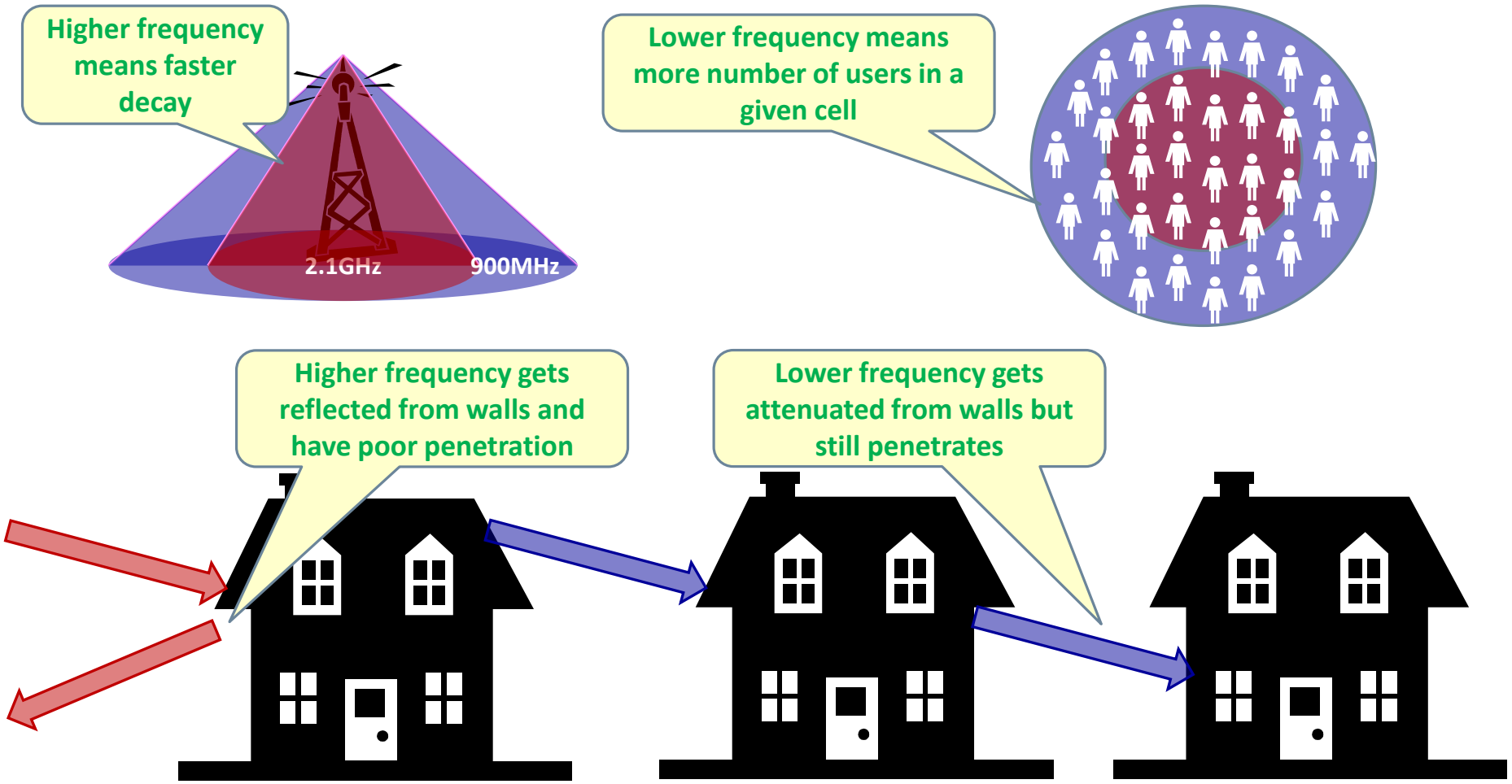
The Size of a Cell

Depends on:

- Antenna mast height and tilt
- Frequency
  - Higher frequency means smaller cell sizes
- Power
  - Higher power results in larger cell size



Importance of Frequency selection



More Examples of Small Cells

Telefónica LTE Nano

More Examples of Small Cells

Sprint's Magic Box on Drone

More Examples of Small Cells

In Development

- Flying COW - Helicopter
  - Higher powered LTE radios
    - 5 watts transmit power per radio branch (2TX/2RX)
    - Up to 4 radios per helicopter (20 watts)
    - 4,000 connected users per radio
  - Improved antennas – higher gain, optimum orientation
  - Improved tether units and power systems
- Flying COW - Extreme Weather
  - Tropical storm capable (heavy rain; 45-knot wind)
  - Lighter radio equipment – smaller UAV
  - Easier deployment
  - Smaller and lighter baseband unit for higher power radio heads (transportable BBU remains on ground)

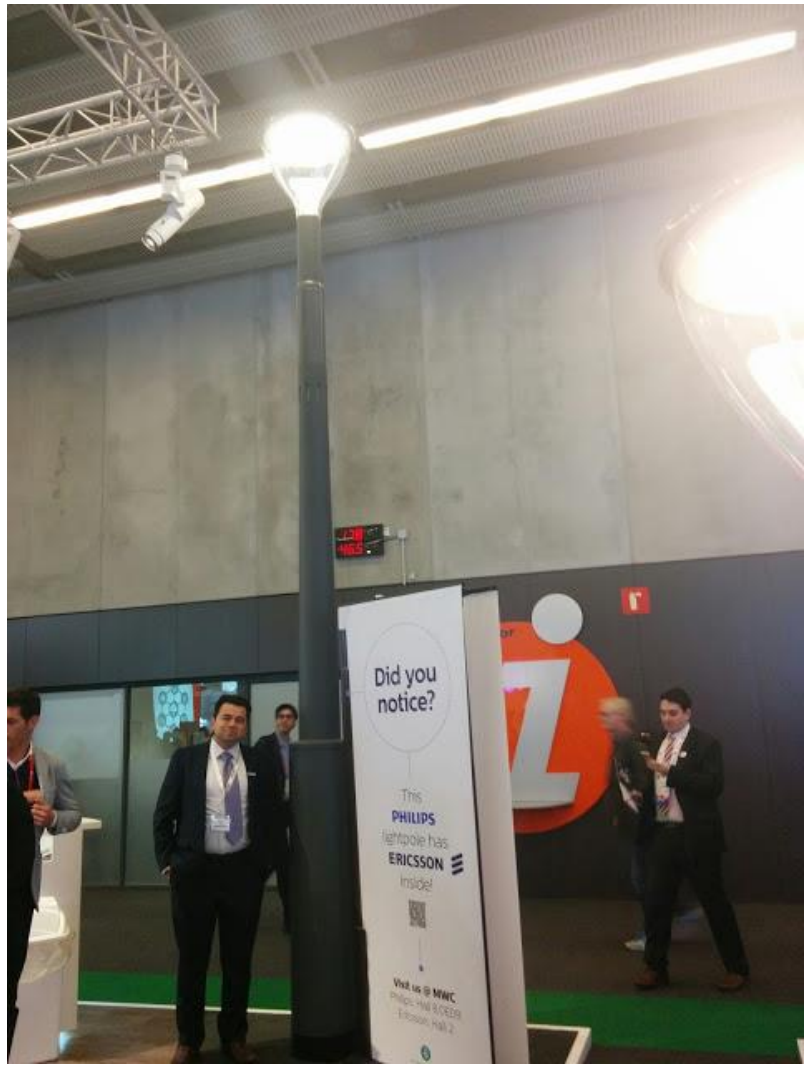
6

AT&T's Flying COW

More Examples of Small Cells

KDDI Small Cell Lamppost

More Examples of Small Cells



Ericsson & Philips Small Cells in Lampposts
Source: Left & Right

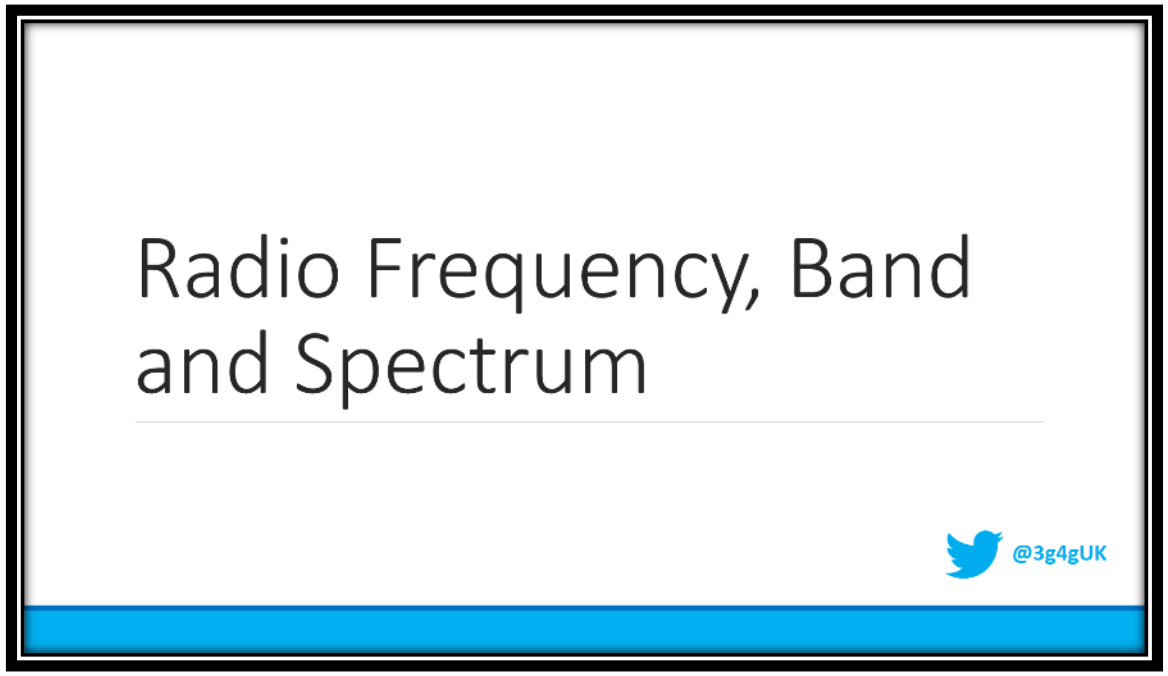
More Examples of Small Cells

BT/EE's Helikite for providing coverage during emergency and disaster recovery scenarios.

Repeaters vs Relays vs Small Cells

	Repeaters	Relays	Small Cells with LTE Backhaul
	Receive, Amplify and Re-transmit. Also known as 'Signal Booster' or 'Layer 1 Relay'. From a UE point of view, the repeater signal and macro signal would appear to be the same	Receive, Demodulate & Decode, Encode & Modulate, Amplify & Transmit. Also known as 'Layer 2 relay'. From a UE point of view, the relay signal and macro signal would appear to be the same (in case of in-band frequency)	Complete basestation with its own 'cell identity'.
Frequency	Same frequency, even though in theory it could be different frequency	Transmission can be in-band (same freq) or out-of-band (different frequency)	Transmission can be same or different frequency but interference mitigation may be required in case of in-band frequency.
Advantages	• Simple • Inexpensive • Very little extra latency introduced • No changes in base station needed	• Noise is eliminated	• Comparatively simpler operation • Noise is eliminated • No changes in base station needed
Disadvantages	• Noise is amplified along with the desired signal	• Radio functions may be needed between relay and base station • Complex and slightly expensive • Extra latency introduced	• More expensive than repeaters and relays • Higher latency than others

ICYMI


Radio Frequency, Band and Spectrum
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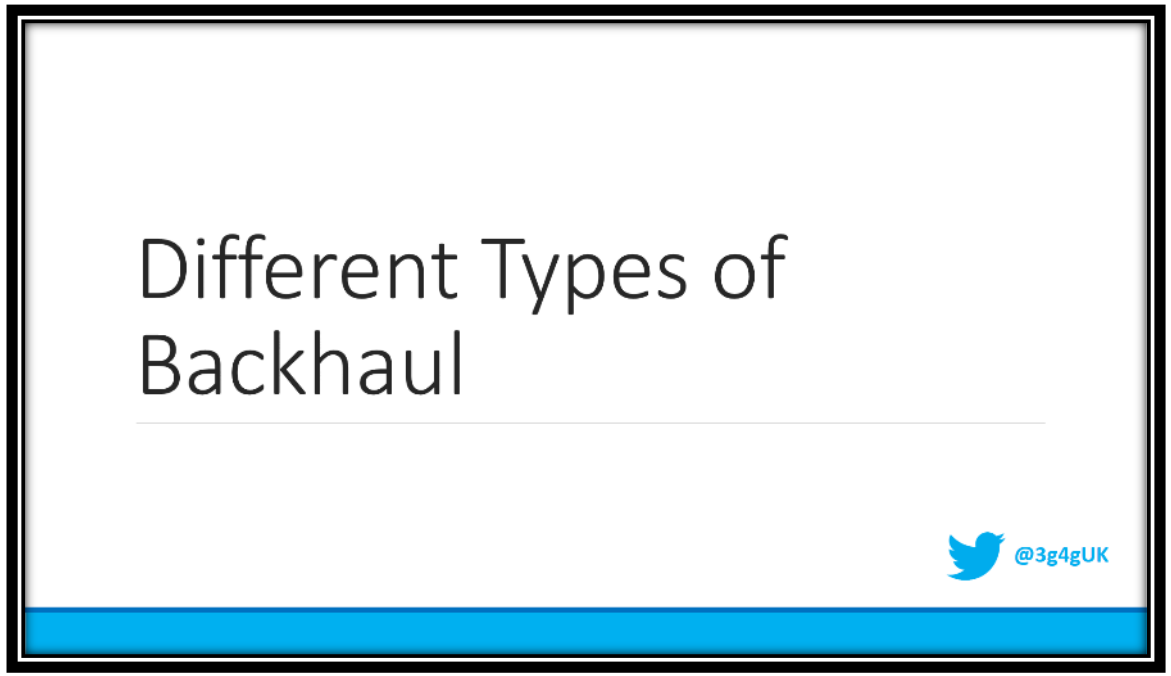
Different Types of Backhaul
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Thank You

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