

# Internet everywhere:

## Technology, regulatory and network-sharing solutions for the rural



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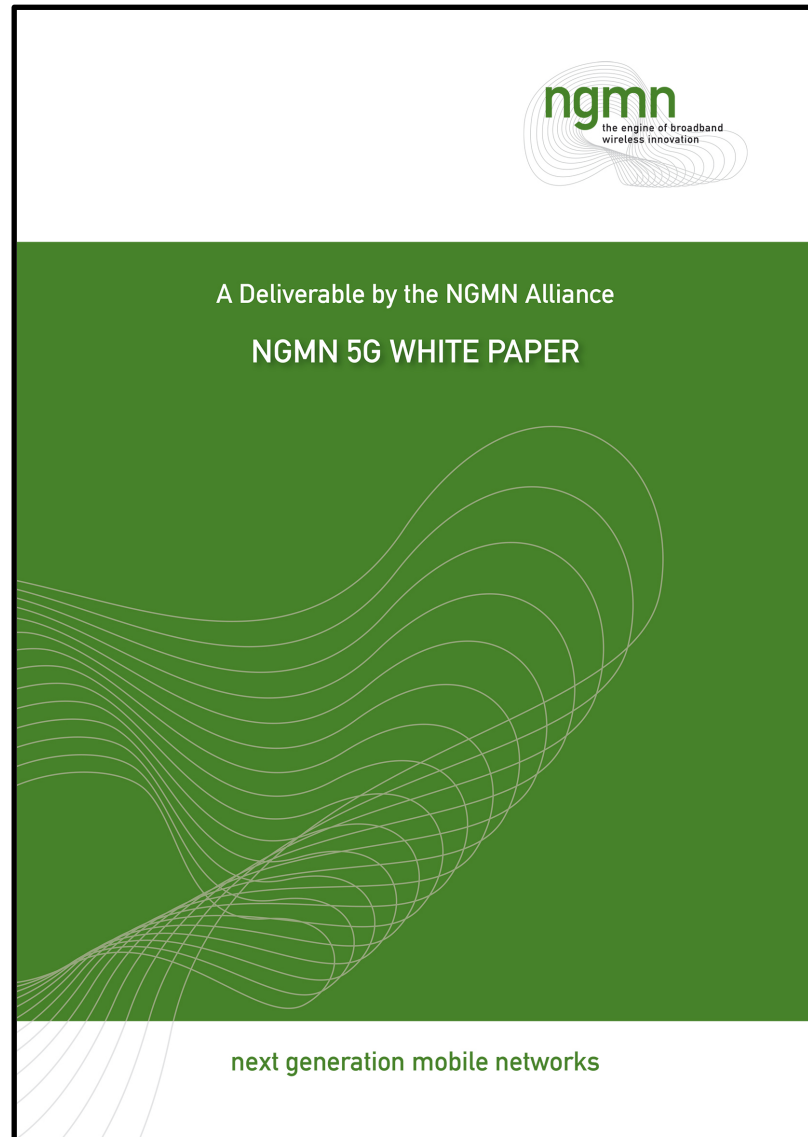


# *Rural* radio communications

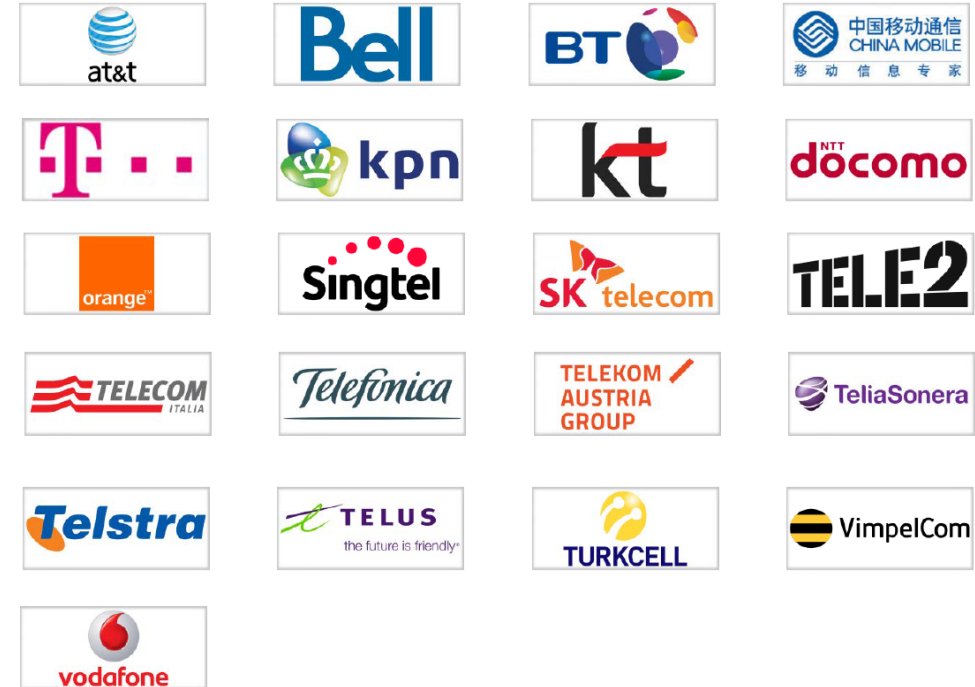
- limited access to roads/infrastructure
  - limited access till electricity
  - limited access to a backhaul
  - few people (per unit area)
  - abundance of radio spectrum
- 
- compare: the low-ARPU regime



# March 2015: “50 Mbps everywhere”



# Does **5G** deliver?



# 3GPP's 5G NR – an *urban* standard

## 3GPP TS 38.211 V15.0.0 (2017-12)

*Technical Specification*

**3rd Generation Partnership Project;  
Technical Specification Group Radio Access Network;  
NR;  
Physical channels and modulation  
(Release 15)**



today,  
areal coverage is not among  
marketed features by operators

**potential revenue**

rural: \$ 262 /square mile /year \*  
urban: \$248,000 /square mile /year \*

**based on residential end-users**

\* A.-M. Kovacs, "Regulation in Financial Translation: Will the Incentive Auction Increase Mobile-Broadband Competition in Rural America?", May 2014

# Increasing values in rurality

- economic values
  - forestry
  - mining
  - power
  - tourism
  - transport/logistics
  - maritime sector
- societal values
  - public services
  - democracy
  - attractive regions
  - migration / urbanization
  - safety / security

# *connectivity targets*



## European commission - goals:

by 2020:

**50%** EU citizens have access to at least **100 Mbit/s**

**100%** EU citizens have access to at least **30 Mbit/s**



## Swedish government –Broadband Strategy, Dec. 2016:

by 2025

**98%** access to at least **1 Gbit/s**

2% = 90000 households

**99.9%** access to at least **100 Mbit/s**

0.1% = 4500 households

**100%** access to at least **30 Mbit/s**

and: **mobile coverage** “wherever people reside and move”

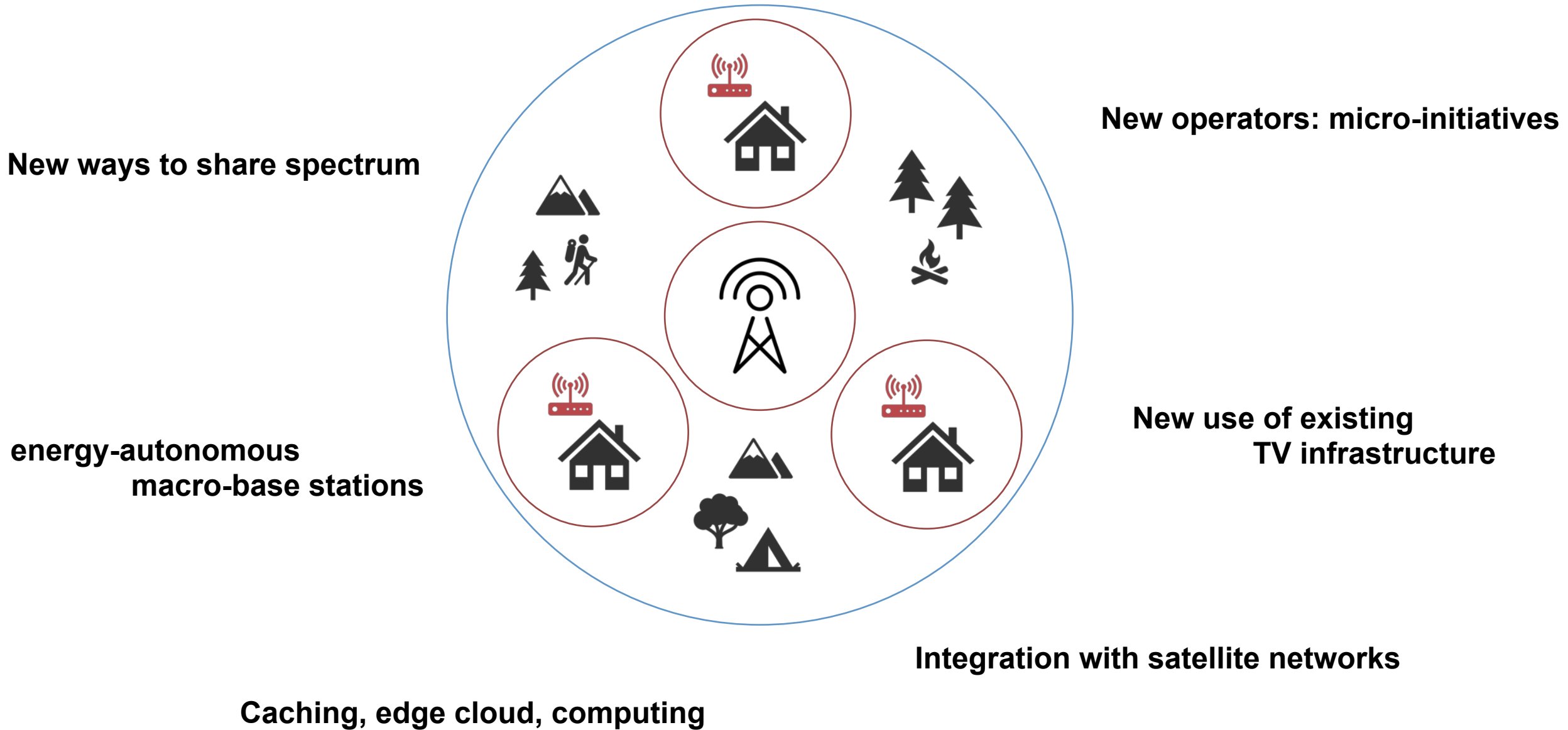
# digital oasis

- cluster of residences/working places
- remote
- peripheral to the "urban" Internet
- locally:
  - high-quality local network
  - high-quality local infrastructure
- surroundings
  - poor backhaul
  - poor infrastructure

Can/will 6G address this scenario?



# a digital oasis – rural hot spot



# new rural operators: local micro-initiatives

the urban

competitive  
markets



the rural

local monopolies

Current models work well here

Local initiatives deploy local networks

national roaming

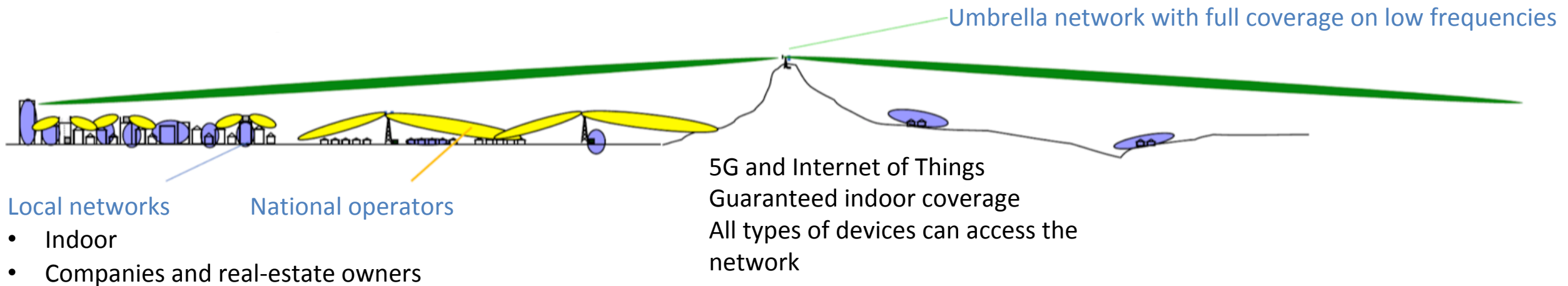
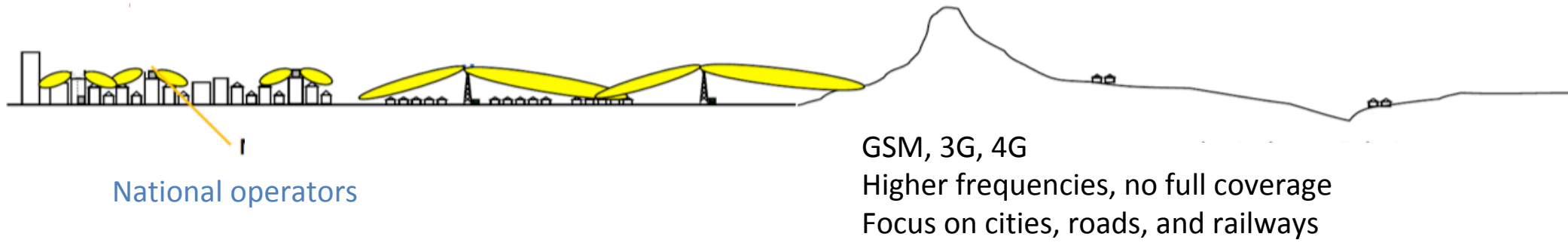
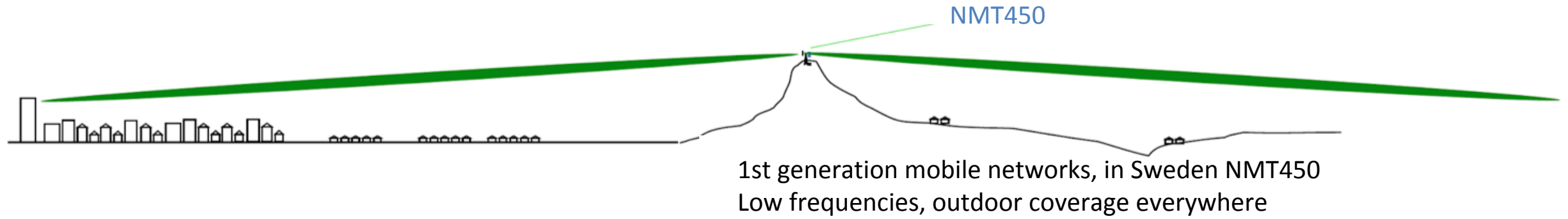
flexible spectrum licensing regimes

network sharing

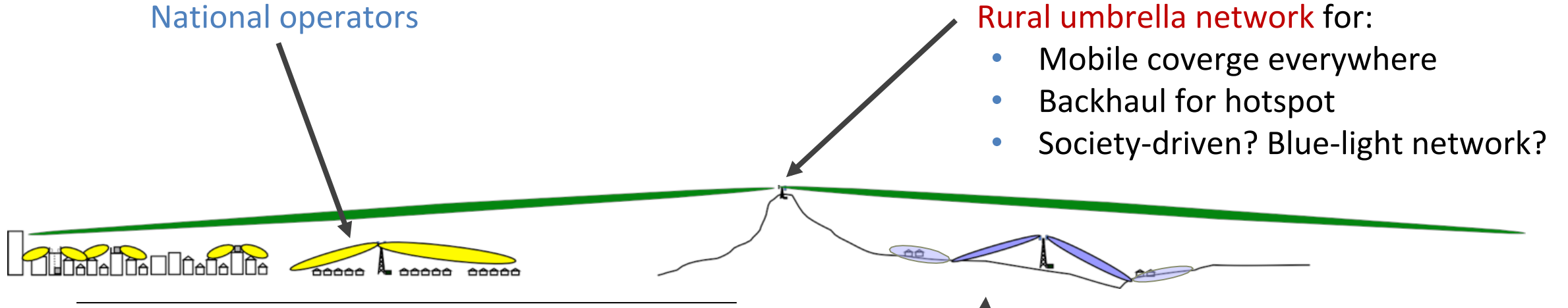
- Agriculture
- Municipalities
- tourism
- industrial sites
- blue-light services
- E-health stations

# New use of existing TV infrastructure



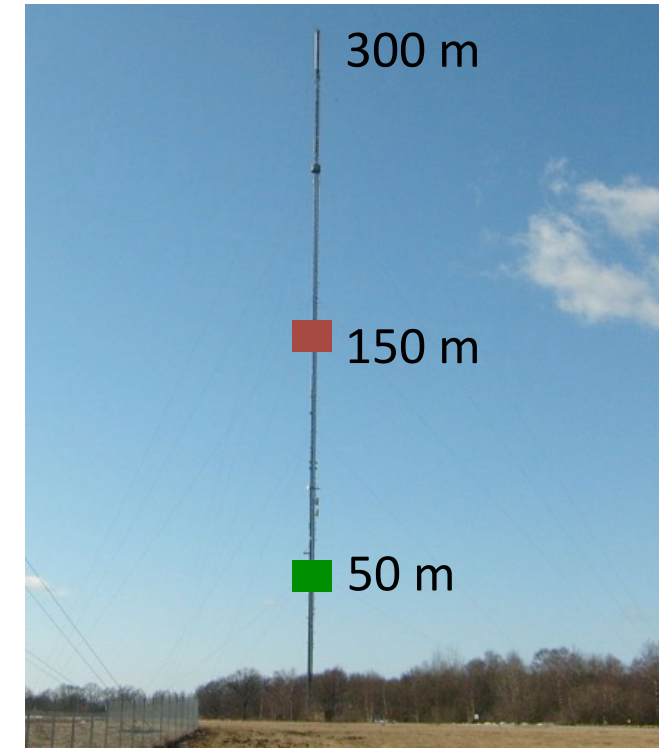
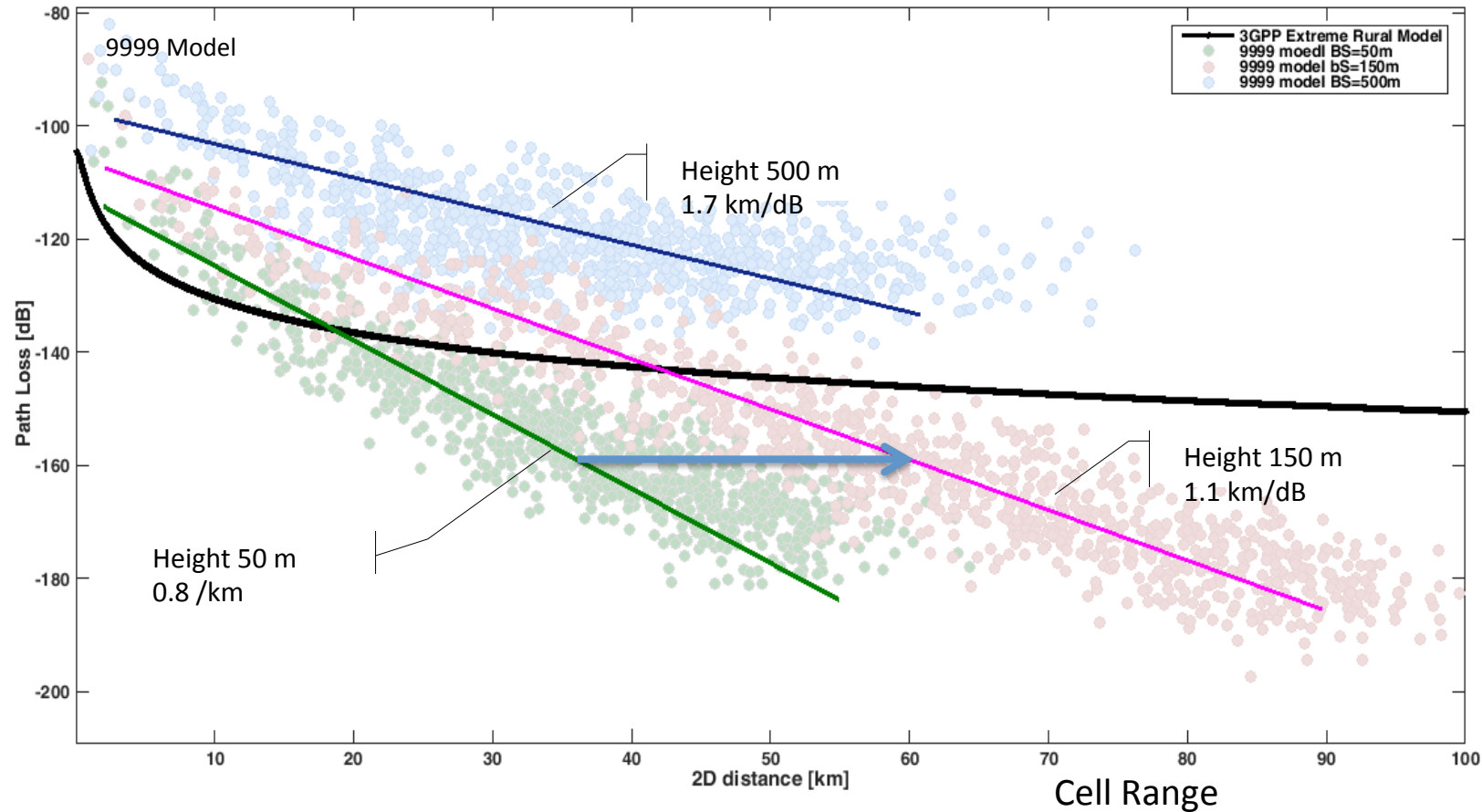


# RURAL 5G



- Combined coverage
- Mobility between networks
- Backhauling

# Base-station Side



On 150m: every additional dB adds a **1.1 km in cell range** and **1.9 km in ISD**

# Base-station sectorization and beamforming

TABLE I: ESTIMATED ANTENNA DIMENSIONS FOR DIFFERENT HALF-POWER BEAMWIDTHS (HPBW). DIMENSION ESTIMATES BASED ON ANTMOD [3], GAIN FIGURES AS GIVEN IN [1].

|                                   |    |    |    |    |    |    |    |    |      |    |
|-----------------------------------|----|----|----|----|----|----|----|----|------|----|
| Azim. HPBW ( ° )                  | 65 | 65 | 90 | 90 | 45 | 30 | 22 | 14 | 11   | 7  |
| Horizontal size<br>(# of columns) | 1  | 1  | 1  | 1  | 2  | 2  | 3  | 5  | 6    | 8  |
| Elev. HPBW ( ° )                  | 8  | 4  | 2  | 1  | 1  | 1  | 1  | 1  | 1    | 1  |
| Vertical size (m)                 | 1  | 2  | 4  | 8  | 8  | 8  | 8  | 8  | 8    | 8  |
| Gain (dBi)                        | 18 | 21 | 22 | 25 | 28 | 30 | 31 | 33 | 34.5 | 36 |

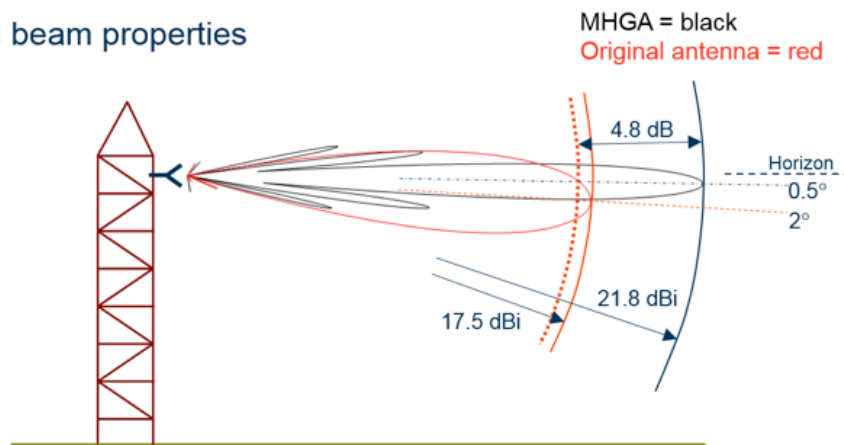
12 sectors      16 sectors      25 sectors



Modular high-gain antennas



Main beam properties



Sectorization/Antenna design: 16 sectors      +31 dB    [+ 30 km]

# Possible upgrade configurations

- base station
  - higher tower
  - higher power
  - MIMO, carrier aggregation
  - Higher sectorization
  - LTE-M
- user equipment
  - higher up (FWA)
  - high power UE
  - local booster relays (FWA)
- later: mMIMO

range up to 80 km possible

# conclusions

## emerging new drivers for areal coverage

- safety and security
  - 911 everywhere
  - blue-light services
- autonomous transports
  - on land (roads)
  - in the air (corridors)
- inclusive societies
  - driven by public sector

