

A man with glasses is taking a photo of a woman on a smartphone. The woman is smiling and looking towards the camera. The background shows other people at an outdoor gathering, possibly a picnic or a social event, with trees and a bright sky. The scene is captured in a warm, golden light, suggesting late afternoon or early evening. The smartphone screen shows a close-up of the woman's face.

# CESTA K MOBILNÍM SÍTÍM 5G

Karel Mikuláščík



LIFE IS FOR SHARING.

# ÚVOD

- budování 4G (LTE) sítí => datové připojení téměř pro každého obyv. ČR
- celostátní využití datových služeb až stovek Mbit/s: terminál + poskytovatel
- základní vrstva v pásmu 800 MHz, (téměř) totožná struktura jako u GSM

Systémové požadavky na 5G :

- řádově vyšší špičkové i uživatelské datové rychlosti, vyšší spolehlivost
- řádově nižší latence spojení, nižší spotřeba energie, lepší pokrytí než u 4G

Nekompromisní naplnění požadavků = obrovské investice do infrastruktury

- => opodstatnění poptávkou zákazníků i dostupností technologie (i terminálů)
- => snaha operátorů nabídnout uživatelskou zkušenost s 5G za využití již pořízené technologie i v rámci posílení možností stávajícího systému LTE



# How 5G changes our lives and work

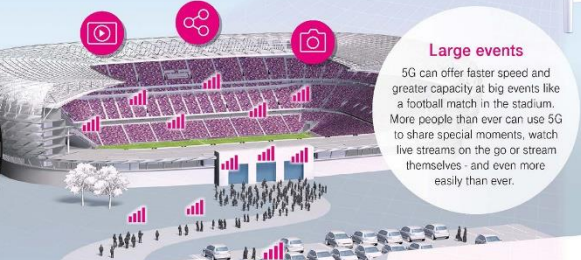


**5G is much more than just a new network standard.** It connects the digital with the tangible, the physical world. 5G offers minimum and reliable response times, significantly higher data rates and a higher connection density. This benefits both consumers and enterprises. 5G will unleash its full power first where many people or machines interact with each other in a localized area. In cities, stadiums, concerts, universities, administrations, factory buildings.



### Augmented Reality

With AR, real time information can be overlaid on the smartphone camera view. Thanks to 5G, AR enhanced applications merge reality with, for example navigational instructions or sightseeing tips, in the highest quality. This technology is also becoming increasingly interesting for gaming, even cloud gaming.



### Large events

5G can offer faster speed and greater capacity at big events like a football match in the stadium. More people than ever can use 5G to share special moments, watch live streams on the go or stream themselves - and even more easily than ever.

### Well on the way

Real-time map updates, video streaming during a long drive and improved safety in automated driving and parking are just three of the many applications 5G enables for automotive. This will enable a more comfortable autonomous driving experience in the future.

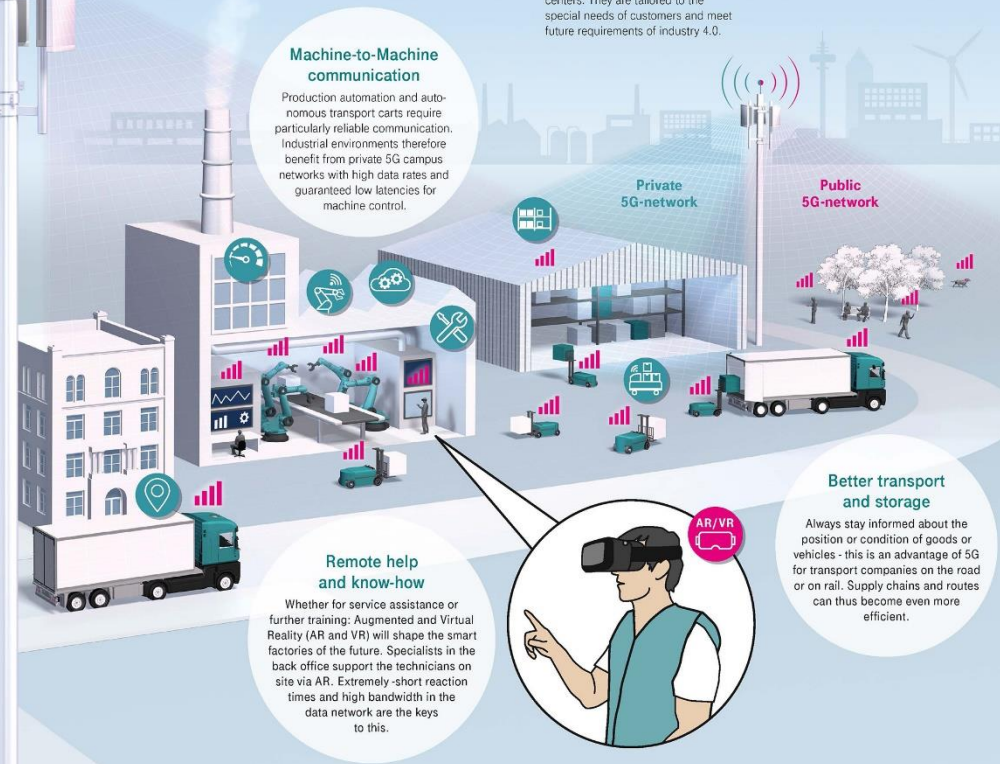


### Explained: Network slicing

In the future, 5G will enable the provision of several virtual network layers, so-called slices, on a common technical infrastructure. Slices can have different capabilities. For example, a slice with a short response time (latency) is critical for automated driving, or a high bandwidth slice for video streaming.

### Machine-to-Machine communication

Production automation and autonomous transport carts require particularly reliable communication. Industrial environments therefore benefit from private 5G campus networks with high data rates and guaranteed low latencies for machine control.



### Remote help and know-how

Whether for service assistance or further training: Augmented and Virtual Reality (AR and VR) will shape the smart factories of the future. Specialists in the back office support the technicians on site via AR. Extremely short reaction times and high bandwidth in the data network are the keys to this.



### Better transport and storage

Always stay informed about the position or condition of goods or vehicles - this is an advantage of 5G for transport companies on the road or on rail. Supply chains and routes can thus become even more efficient.

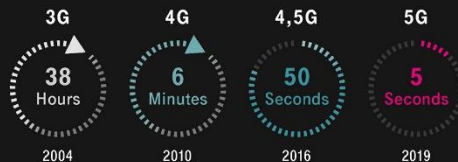
### Your own network

Campus networks are exclusive mobile networks for a company site or for example airports or logistics centers. They are tailored to the special needs of customers and meet future requirements of industry 4.0.

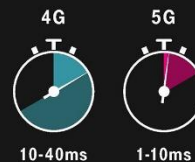
## 5G-Timeline

- 2017** Europe's **first 5G live connection** starts test operation in Berlin-Schöneberg.
- 2019** **First 5G cells** commercially launched in Austria.
- 2023** Commercial introduction of **5G Network Slicing**.
- 2025** **99 percent 5G population coverage** and 90 percent 5G area coverage in Germany.

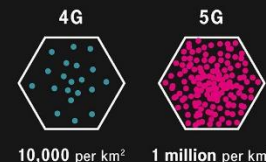
### Download Duration of a HD-Film with 6.6 GB size



### Latency Roundtrip



### Connection Density



### Contribution of Telekom

We invest in the best of all networks. We cooperate with the best partners worldwide. We are only satisfied when everyone can #takepart. By creating new experiences, products and business models we are laying the foundation for our consumer and enterprise customers' future. As by far the largest network builder, Deutsche Telekom is a strong partner for digitalization in Germany.

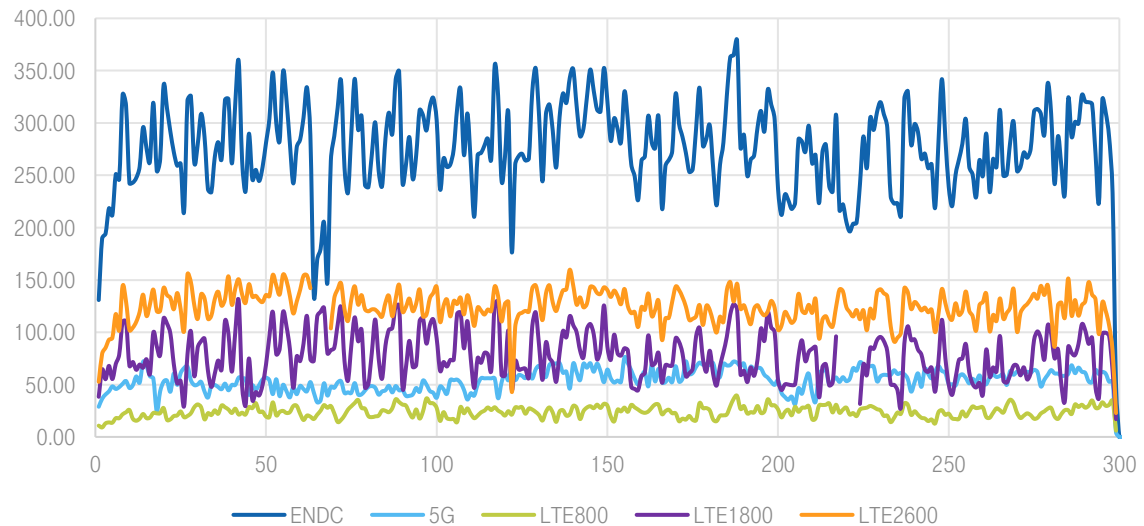
More informations: [www.telekom.com/5G](http://www.telekom.com/5G)



# LTE V PLNÉ PARÁDĚ

BW/MIMO	SISO	2x2	4x4
10 MHz	48.9	97.9	195.7
15 MHz	75.4	150.8	301.5
20 MHz	97.9	195.8	391.6

- Agregace nosných LTE800+LTE1800+LTE2100+LTE2600
- Postupné vypínání 3G – 4x5 MHz bloky => LTE2100 20 MHz (3G vypnuto)
- Doplnování vyšších vrstev dle kapacitních požadavků/souvislé pokrytí
- Také využití pro FWA (Fix Wireless Access)



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# ROZDĚLENÍ FREKVENCÍ PRO MOBILNÍ SÍŤ - ČR

Band 28 (700 MHz) FDD	
Downlink	Uplink
758-768	703-713
768-778	713-723
778-788	723-733

Band 20 (800 MHz) FDD

Downlink	Uplink
791-801	832-842
801-811	842-852
811-821	852-862

Band 8 (900 MHz) FDD (GSM)

Downlink	Uplink
925-935	880-890
935-947.5	890-902.5
947.5-960	902.5-915

Band 3 (1800 MHz) FDD

Downlink	Uplink
1805-1833	1710-1738
O2	
1833-1853	1738-1758
T-Mobile	
1853-1880	1758-1785
Vodafone	

Band 1 (2100 MHz) FDD

Downlink	Uplink
2110-2130	1920-1940
2130-2150	1940-1960
2150-2170	1960-1980

Band 7 (2600 MHz) FDD

Downlink	Uplink
2620-2640	2500-2520
2640-2660	2520-2540
2660-2680	2540-2560
2680-2690	2560-2570

Band 42 (3500 MHz) TDD

3400-3420
Centronet
3420-3440
3440-3460
3460-3480
3480-3500
T-Mobile
3500-3520
3520-3540
3540-3560
Vodafone
3560-3580
3580-3600

Band 43 (3700 MHz) TDD

3600-3620
PODA
3620-3640
3640-3660
O2
3660-3680
3680-3700
3700-3720
Nordic
3720-3740
3740-3760
3760-3780
3780-3800

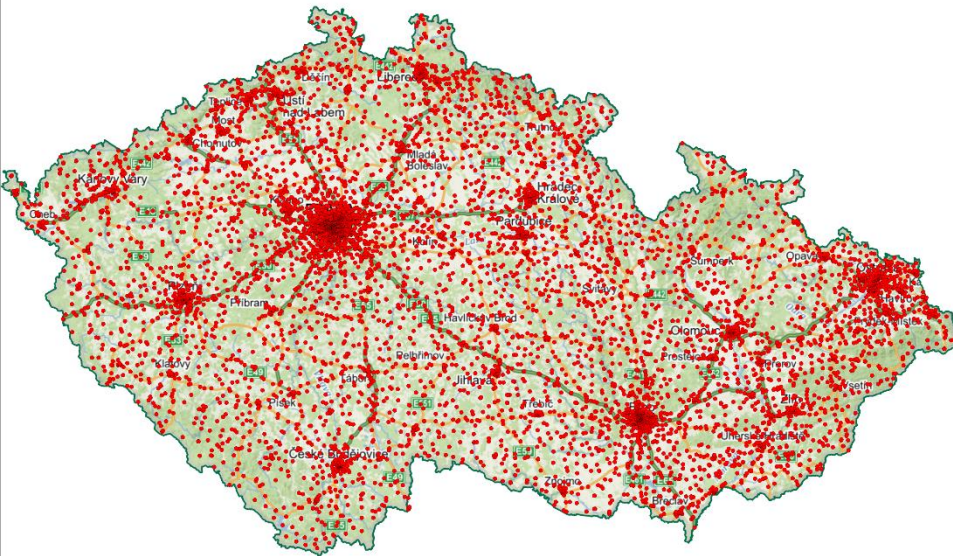
Band 38 (2600 MHz) TDD

2570-2595
2595-2620

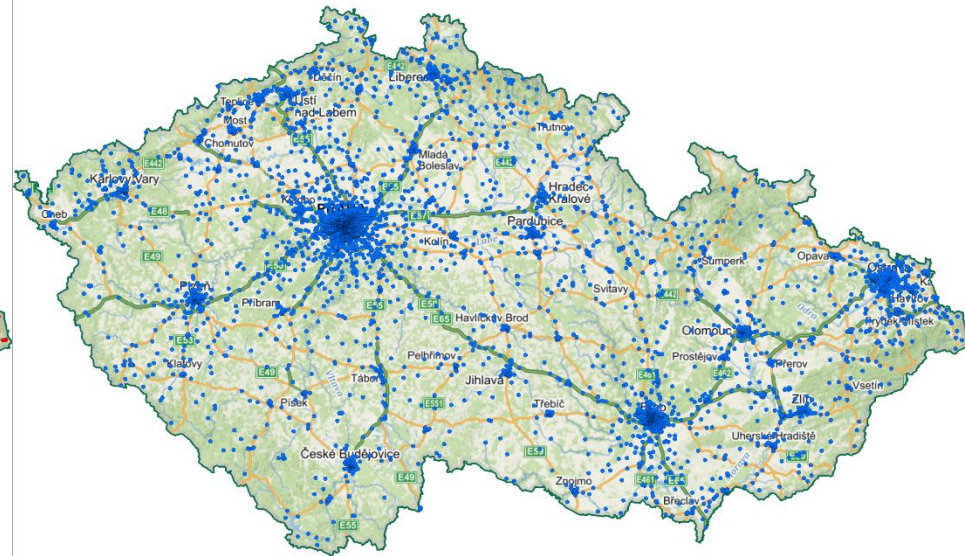


# LOKALITY PRO MOBILNÍ SÍTĚ V ČR - RŮZNÁ PÁSMA

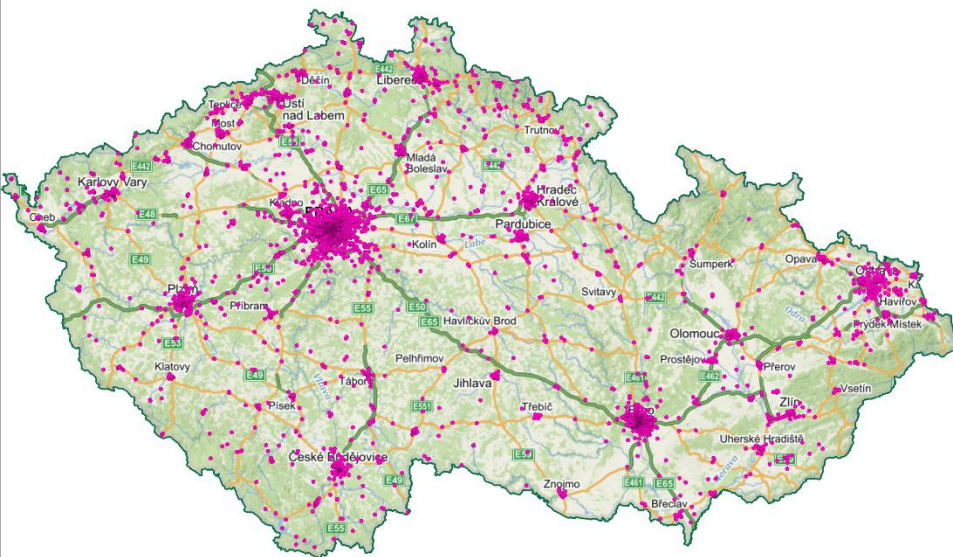
Mobilní sítě v ČR - lokality s LTE v pásmu 800 MHz



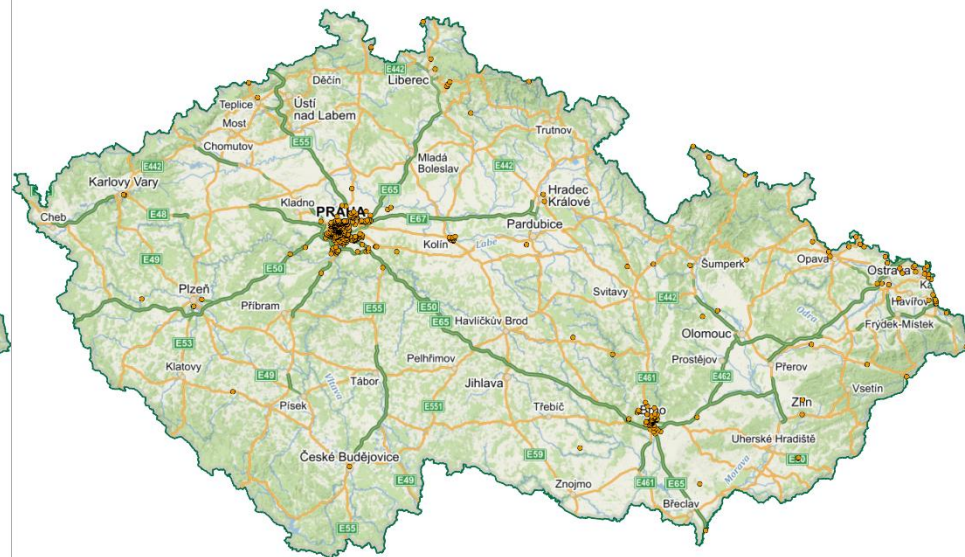
Mobilní sítě v ČR - lokality s LTE v pásmu 1800 MHz



Mobilní sítě v ČR - lokality s LTE v pásmu 2100 MHz



Mobilní sítě v ČR - lokality s LTE v pásmu 2600 MHz



GSMweb  
.CZ

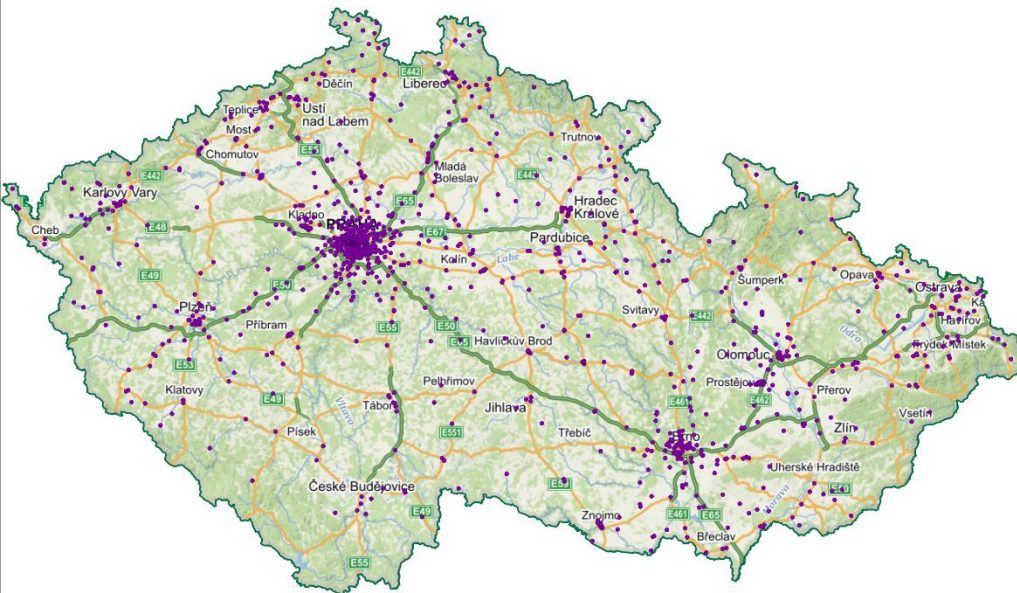


# STATISTIKA LOKALIT/BUNĚK MOBILNÍCH SÍTÍ V ČR

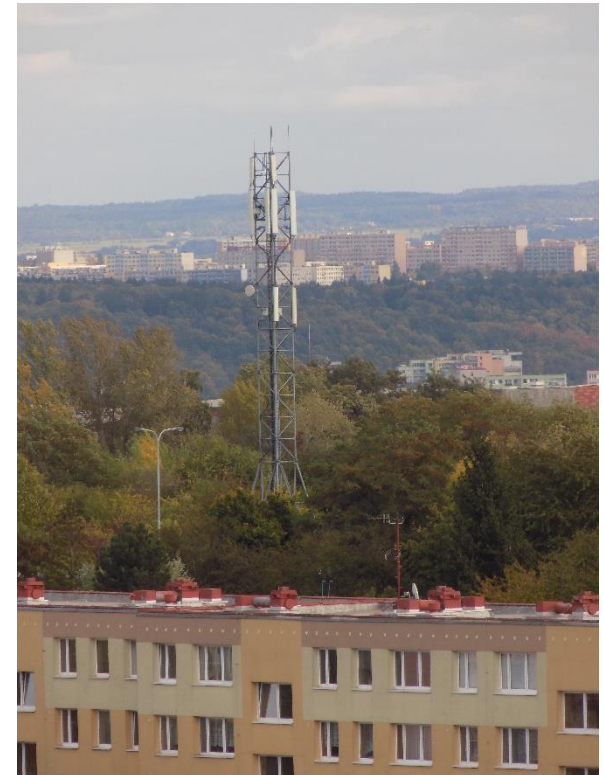
- Cca 11500 lokalit s LTE
- cca 95 tisíc LTE buněk v ČR
- Z toho cca 50 % LTE800, 25 % LTE1800, 16 % LTE2100, > 8 % LTE3700
- Osazení lokalit systémy/pásmy

LTE800	LTE1800	LTE2100	LTE2600	LTE3700
92%	60%	45%	4%	12%

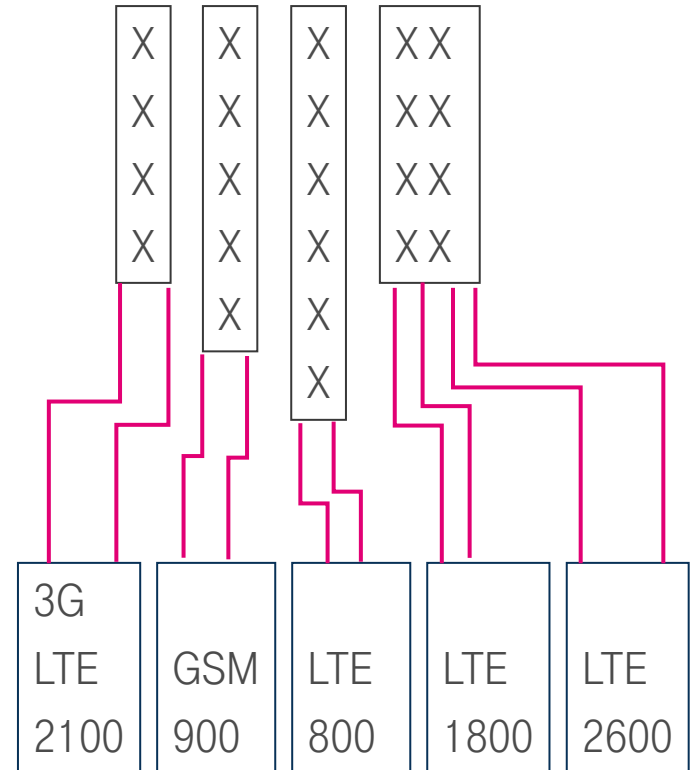
Mobilní sítě v ČR - lokality s LTE v pásmu 3700 MHz



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# EVOLUCE TECHNOLOGIE NA LOKALITÁCH - VÝCHOZÍ STAV



- Single band antény
- GSM – 2 RX diverzita
- LTE MIMO 2x2





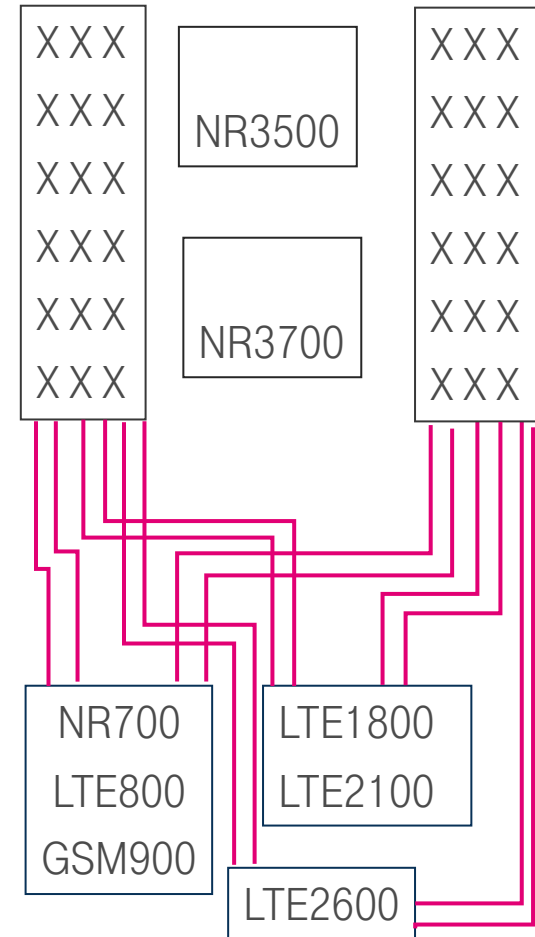
# EVOLUCE TECHNOLOGIE NA LOKALITÁCH - PŘÍPRAVA PRO 5G



- 3-band anténa
- 700 – 900 MHz
- 2\*1695 – 2690 MHz



- místo pro NR RRU
- MIMO 4x4, 8x8
- M-MIMO
- Beamforming

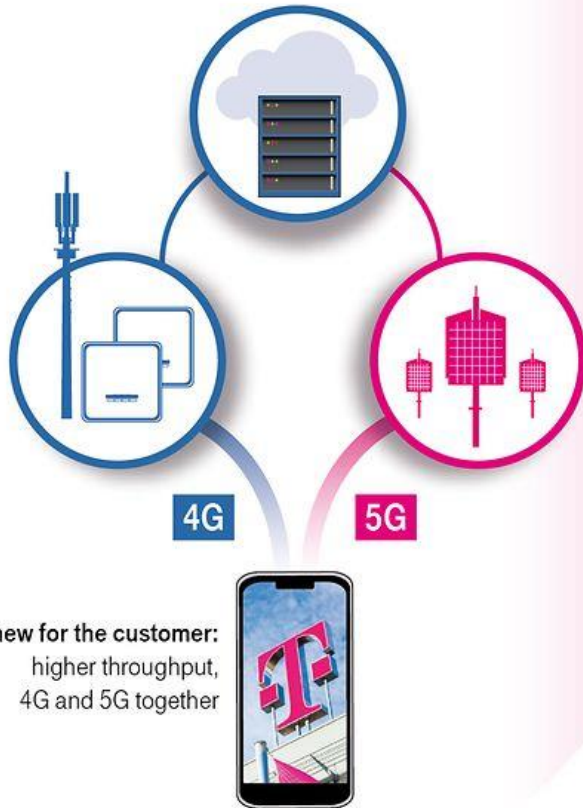


- Multi band RRU
- GSM – 4 RX diverzita
- LTE MIMO 4x4

# Evolution of 5G Network

## NON STANDALONE (NSA)

- 4G is the basis for 5G
- 5G at the base station, in core network still 4G



**new for the customer:**  
higher throughput,  
4G and 5G together

## STANDALONE (SA)

- end-to-end 5G
- 5G at the base station and in the core



**new for the customer:**  
lower latency,  
reliable communication,  
managed connectivity

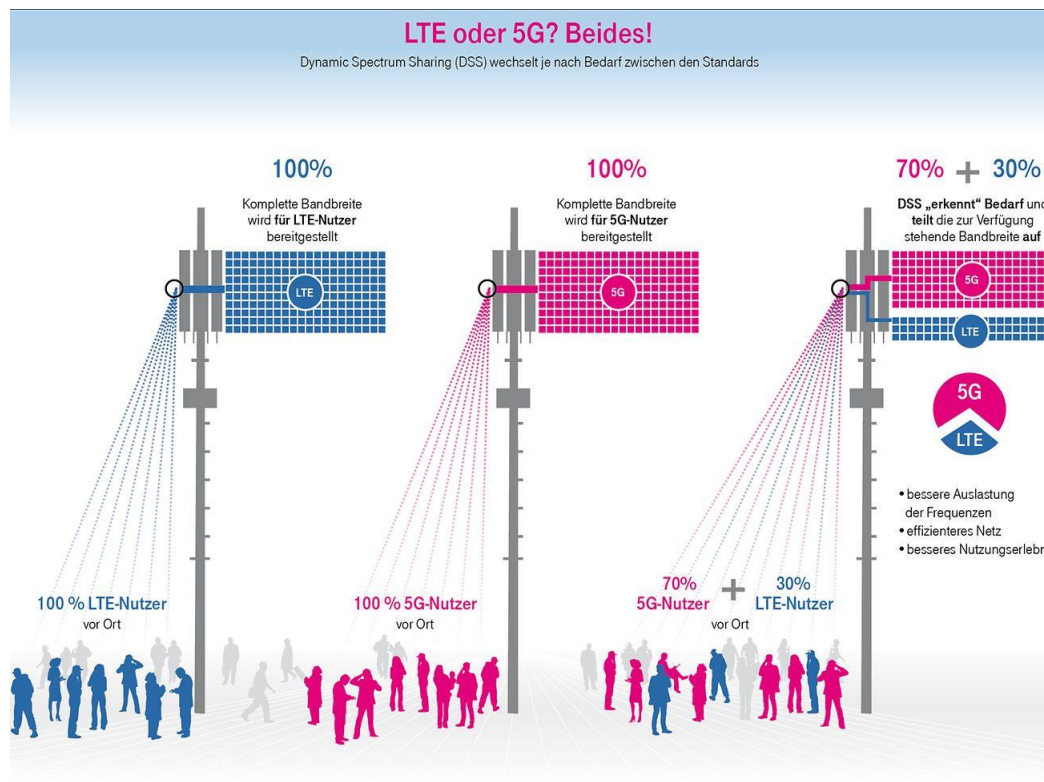
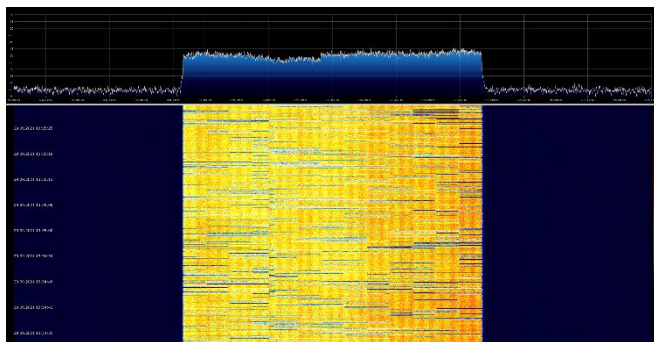


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# 5G-NR NSA POUŽITÁ FREKVENČNÍ PÁSMA V ČR



- 700 MHz (TM)
- 1800 MHz (DSS)
- 2100 MHz (DSS)
- 3700 MHz (O2)



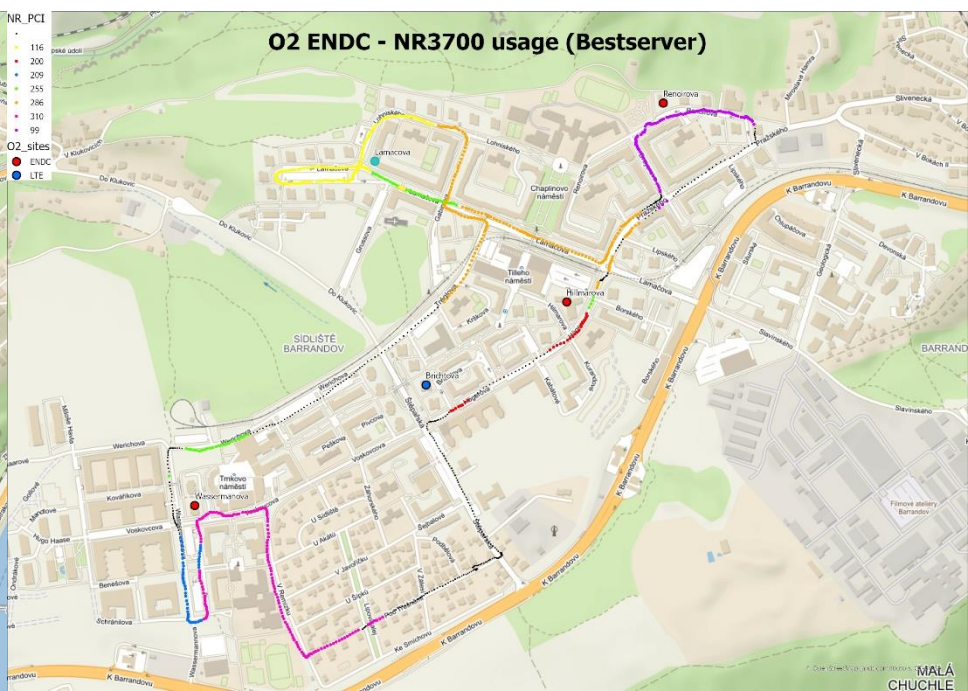
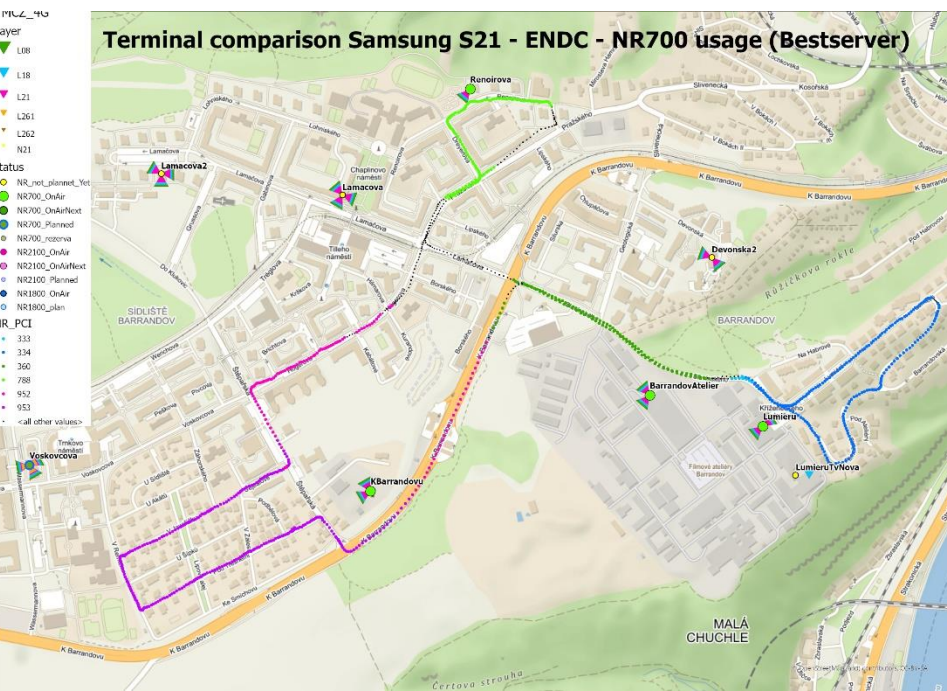
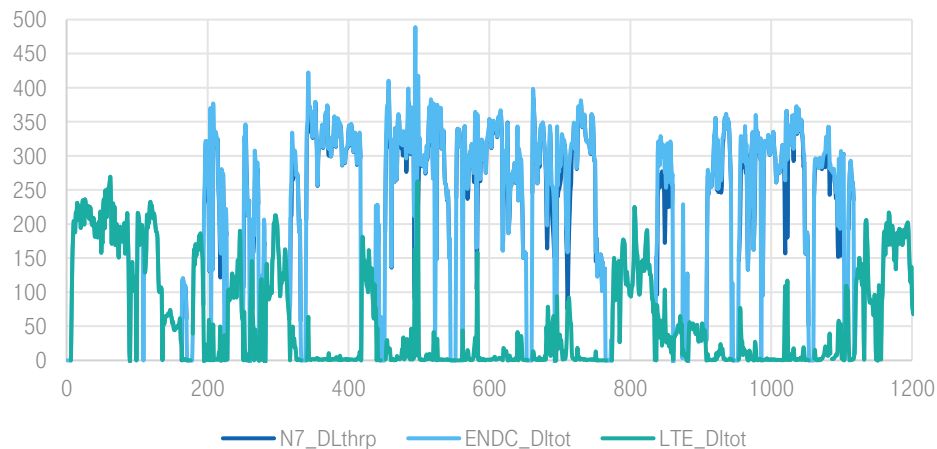
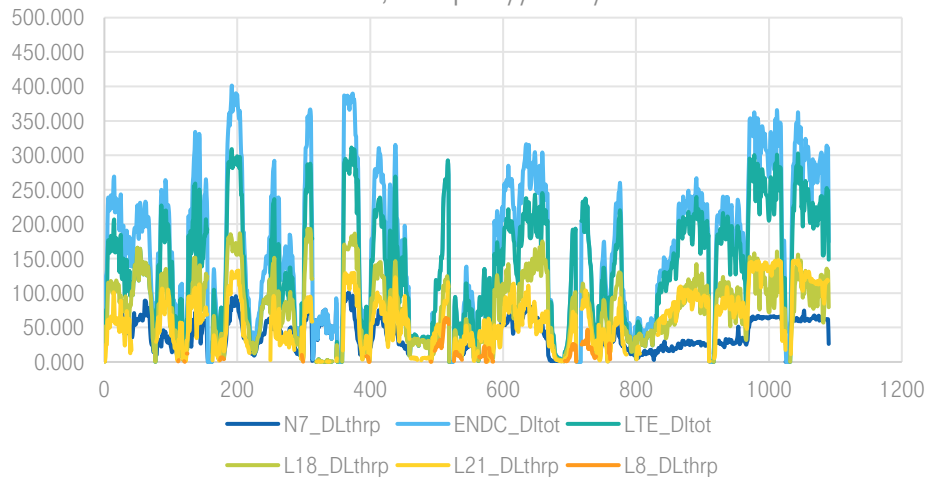
- LTE Anchor – povolené kombinace napříč pásmy
- možnosti terminálů



# UKÁZKA MĚŘENÍ EN-DC - NR700+LTE CA VS NR3700

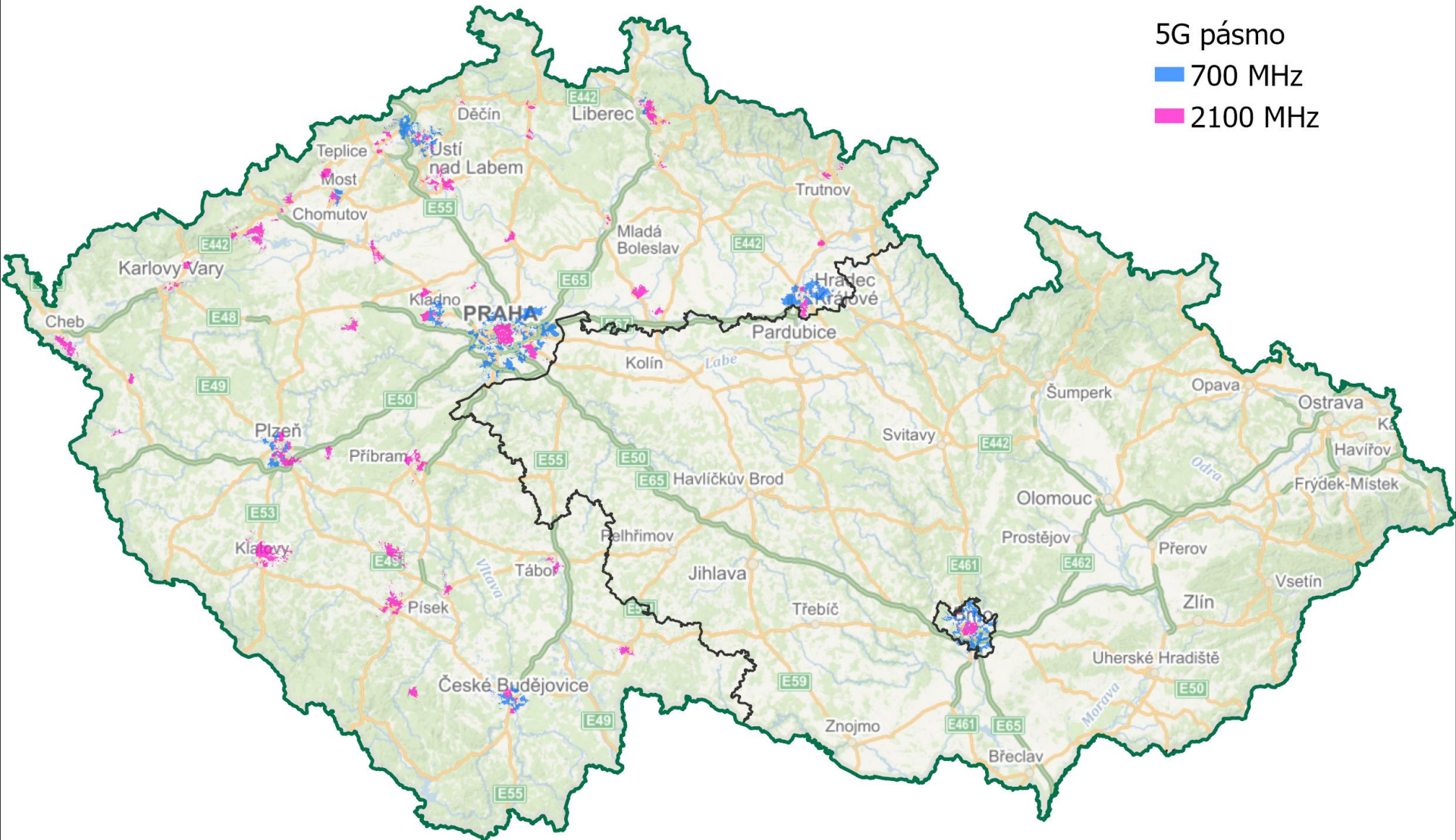
ENDC HTTP Download, Barrandov Samsung Galaxy S21, samples//Mbit/s

O2 ENDC HTTP Download, Barrandov B Samsung Galaxy S21, samples//Mbit/s



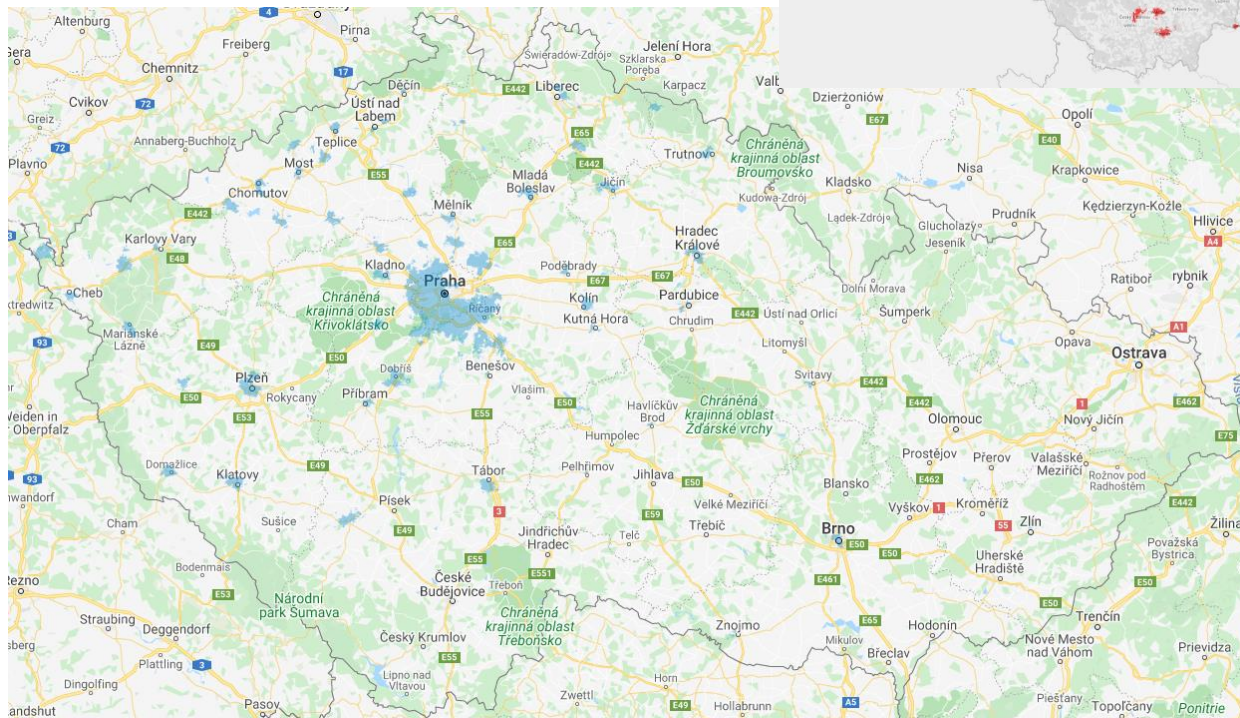
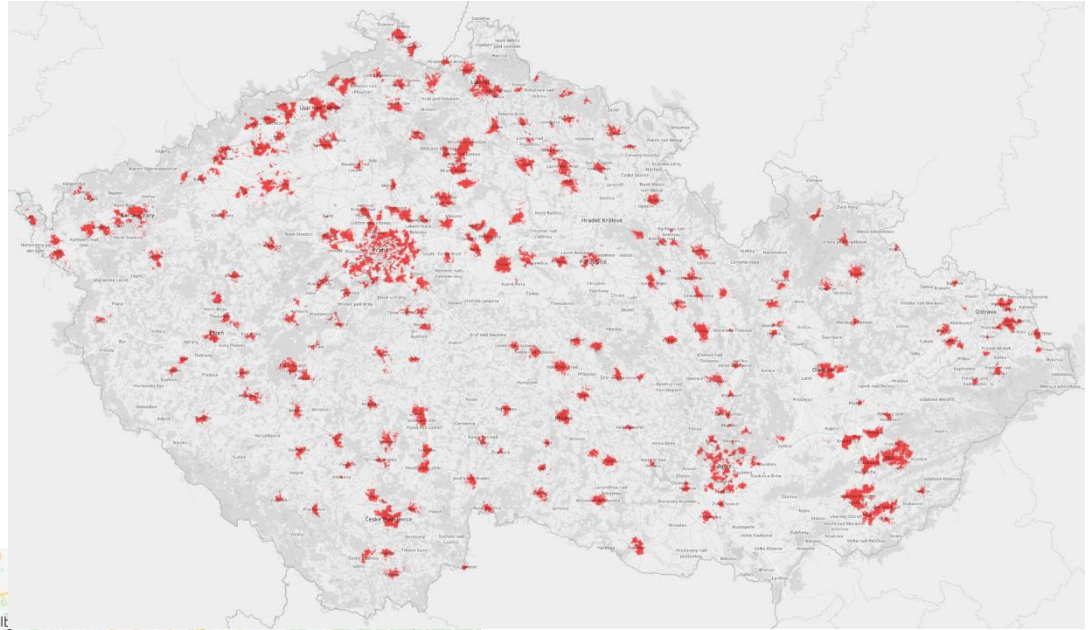


# T-MOBILE POKRYTÍ 5G





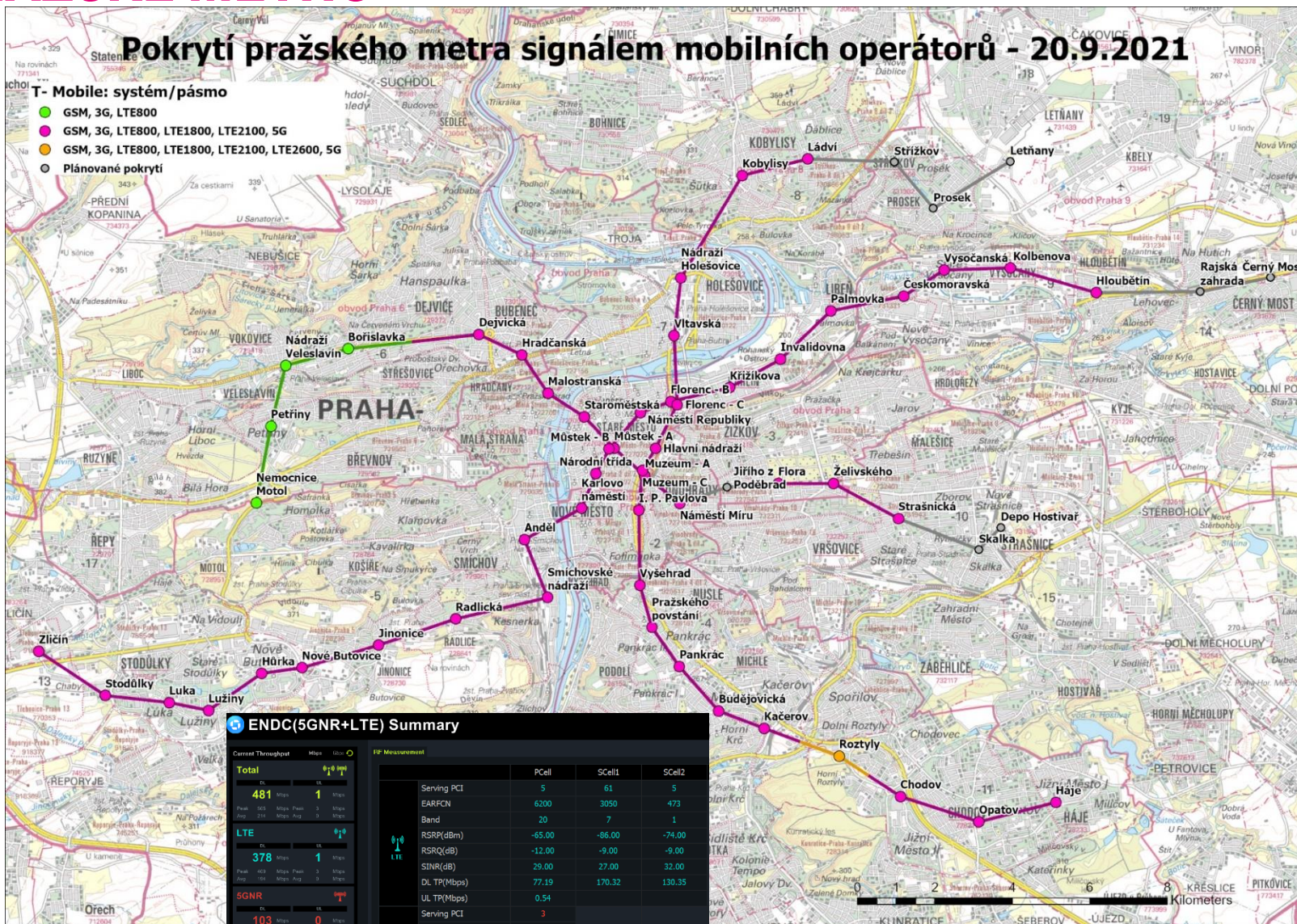
# O2 A VODAFONE POKRYTÍ 5G





# PRAŽSKÉ METRO

## Pokrytí pražského metra signálem mobilních operátorů - 20.9.2021



# PŘECHOD NA 5G STANDALONE

- 5G core
- základní vrstva 700 MHz, kapacitní vrstva 3500/3700 MHz (60 MHz!)
- postupná adopce pásem využívaných LTE
- použití kmitočtů ve vyšších pásmech např. 26 GHz, 50, 100, 200, 400 MHz BW
- řešení pro hlasové služby – VoNR – nutné pro opuštění GSM/VoLTE

# ZÁVĚR

- moderní technologie – efektivnější využití frekvenčních pásem, šetří energetické zdroje i prostor nutný k jejich provozu
- příprava lokalit pro 5G zároveň rozšiřuje možnosti 4G – MIMO 2x2 => 4x4
- z jedné radiové jednotky – signály více systémů i více mobilních operátorů
- jeden modul RRU pro více frekvenčních pásem
- Poptávka po „5G“ ano, po skutečných 5G službách zatím ne
- Řádově vyšší rychlosti poskytnou až mm pásma s šířkami kanálu > 100 MHz
- Využití M-MIMO a Beamforming – zatím ne