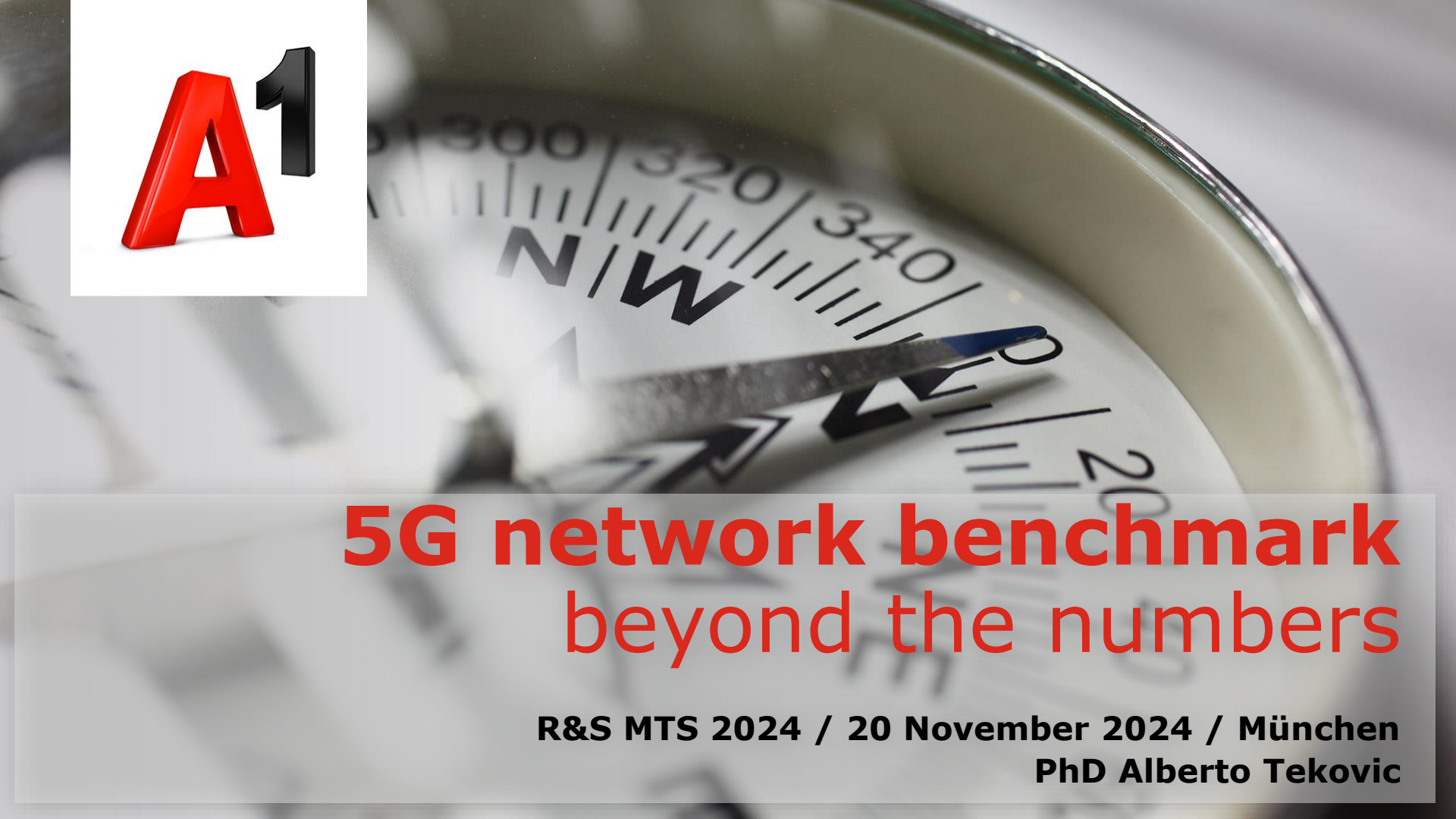
MOBILE TEST SUMMIT 2024

5G NETWORK BENCHMARK BEYOND THE NUMBERS

PhD Alberto Teković
Radio Network Optimization Principal
A1 Croatia

ROHDE&SCHWARZ
Make ideas real



5G network benchmark
beyond the numbers

R&S MTS 2024 / 20 November 2024 / München
PhD Alberto Tekovic

5G network benchmark beyond the numbers

Agenda

1. **Numbers**
   - QoS mobile network benchmark measurement, Croatia 2024

2. **Beyond the numbers, WHEN?**
   - Measurement, Time of day
   - Measurement, Date

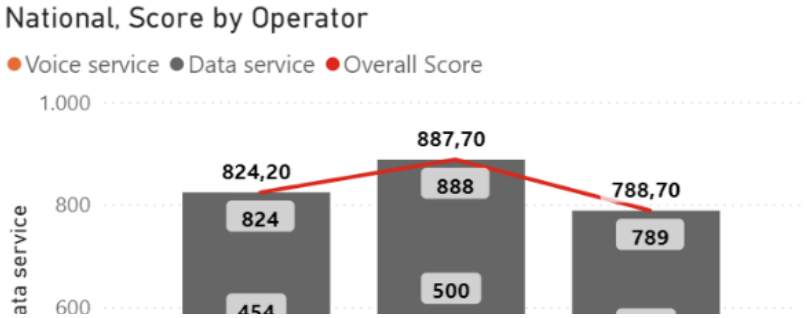
3. **Beyond the numbers, HOW?**
   - 5G services measured?
   - FWA coverage estimation @3500MHz based on drive test
   - Smartphone coverage estimation @3500MHz based on drive test

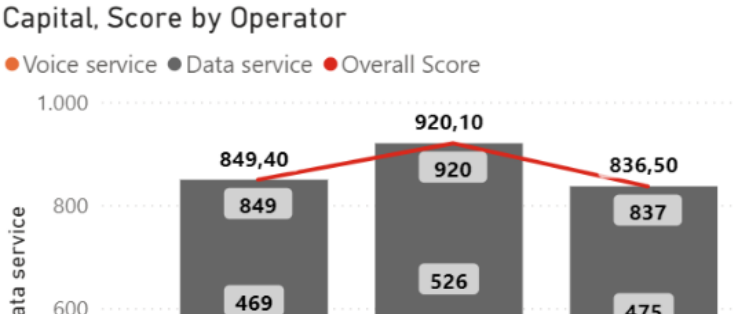
4. **Key takeaways and a question**

1. Numbers

Numbers

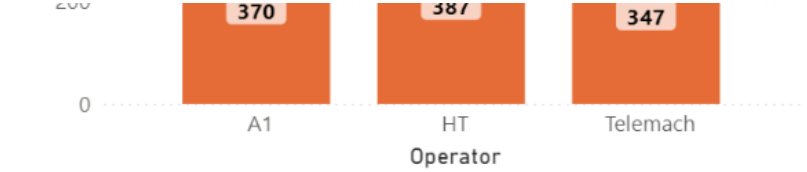
QoS mobile network benchmark measurement result

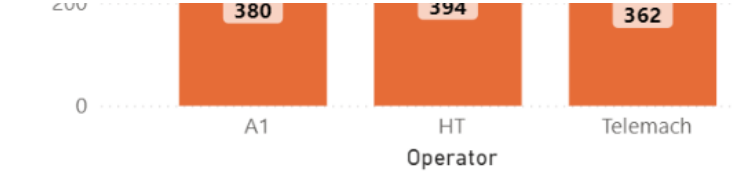




Commsquare:

„Based on Commsquare extensive drive testing & benchmarking experience in the last year across multiple EU countries, we can conclude that the voice success rates & data throughput performance of the Croatian Mobile Network Operators ***can be ranked amongst the top 30%"***





Source: https://www.hakom.hr/UserDocsImages/2024/dokumenti/Kvaliteta%20mre%C5%BEe%202024.pdf

Numbers

QoS mobile network benchmark measurement 5W1H

Who?

- Commsquare Hellas for Croatian Regulatory Authority for Network Industries HAKOM

Why?

- Monitoring progress towards the EU digital targets

What?

- Voice and Data free mode with SG S23+ on Rohde&Schwarz Freerider and SmartBenchmarker
- Network scanning with Rohde&Schwarz Scanner TSME6

Where?

- 31 cities and towns
- 5100 km driven

When?

- Campaign date 24.2.2024 – 14.3.2024
- Measurement time 09:00h – 17:00h
- Campaign duration 104 hours

How?

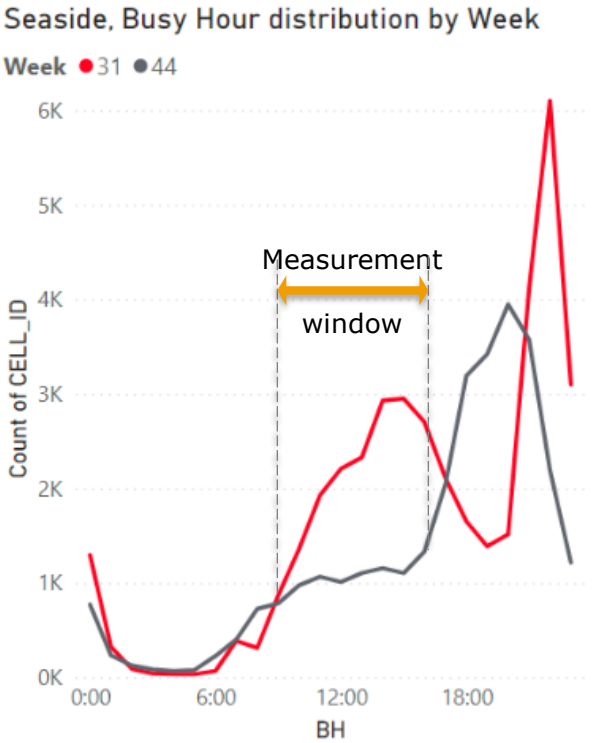
- ETSI TR 103 559, Drive test

Source: https://www.hakom.hr/UserDocsImages/2024/dokumenti/Kvaliteta%20mre%C5%BEe%202024.pdf

2. Beyond the numbers, WHEN?

Beyond the numbers, WHEN?

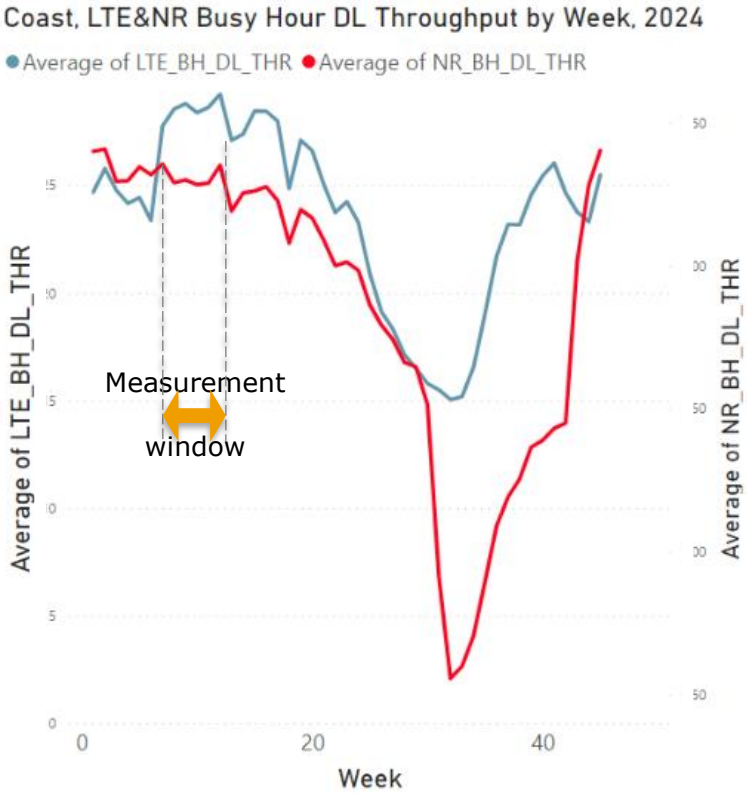
Measurement, Time of day (09:00h – 17:00h)



Source: K. Colak, Graduation Thesis, *„Performance analysis of data services for different traffic loads in the public LTE mobile network"*, Algebra University 2020

Beyond the numbers, WHEN?

Measurement, Date (24.2.2024 – 14.3.2024)



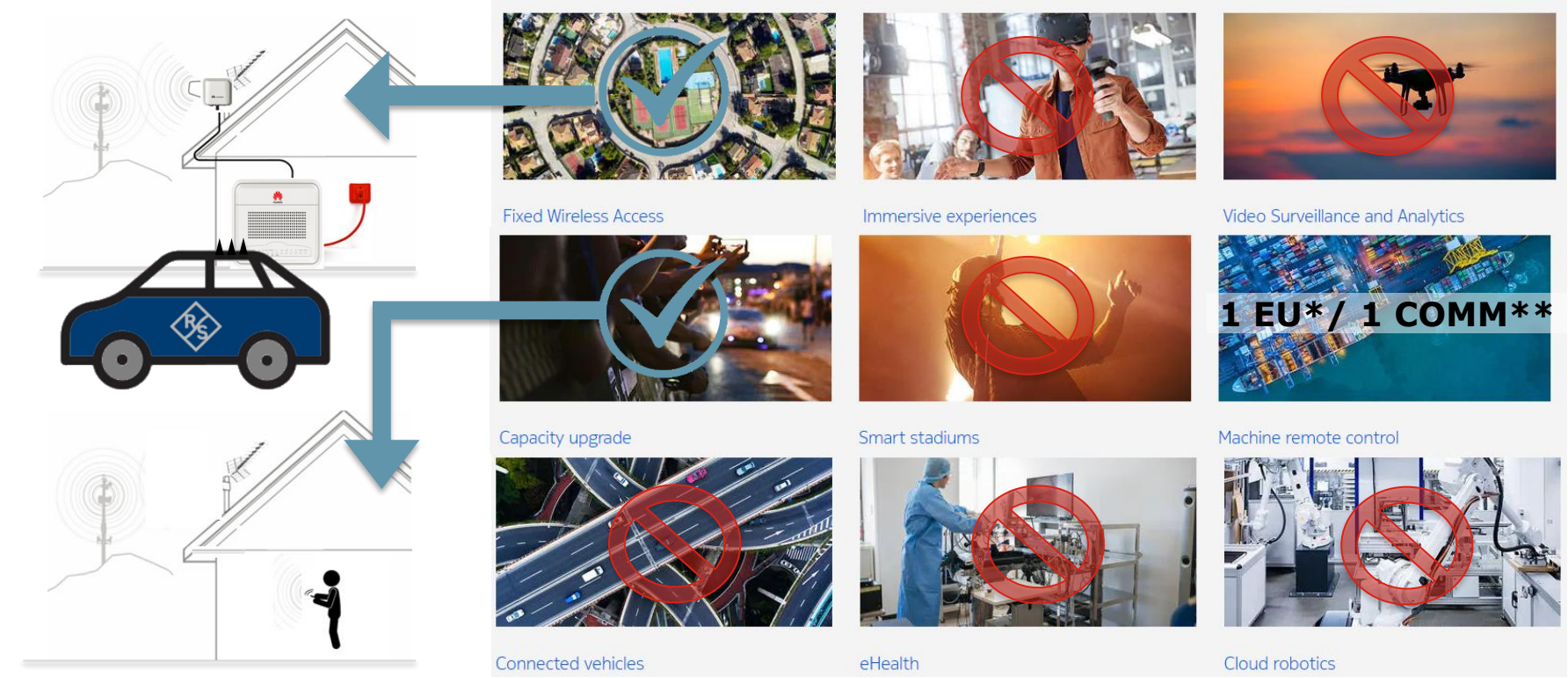
Population the coast 1,3M

Tourists on the coast 15,2M

3. Beyond the numbers, HOW?

Beyond the numbers, HOW?

5G services to be measured in a benchmark?



* Source: online, 22.4.2024. available at https://www.5g.hr/en/technology/port-of-ploce-to-become-first-smart-port-in-croatia/

** Source: online, 31.7.2024. available at https://www.5g.hr/en/news/hrvatski-telekom-rolls-out-5g-network-for-rijeka-container-terminal/

FWA coverage estimation @3500MHz based on drive test

Research1, measurement setup

Huawei B2338-168 FDD/TD-LTE Outdoor CPE

★★★★★ Be the first to review this product

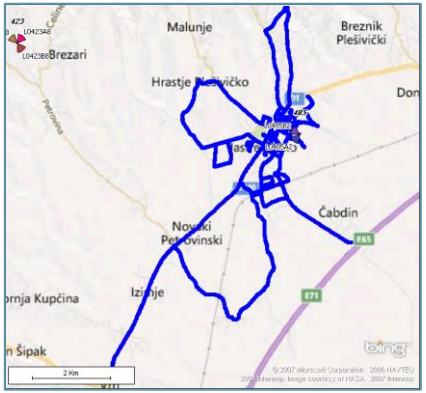
* Channel Bandwidth: 5 MHz, 10 MHz, 15 MHz, 20 MHz

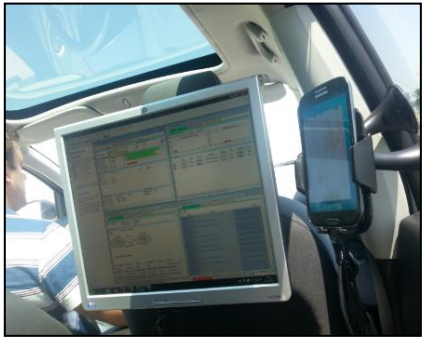
* TX Power: 23 dBm ± 2 dB

* Antenna
- LTE antenna: 1T4R
- 800-900MHz: 0 dBi
- 1710–2170 MHz: 6–7 dBi
- 2300–2690 MHz: 7–8 dBi
- 3400–3800 MHz: 8–9 dBi

* MIMO DL 2x2/4x4 MIMO

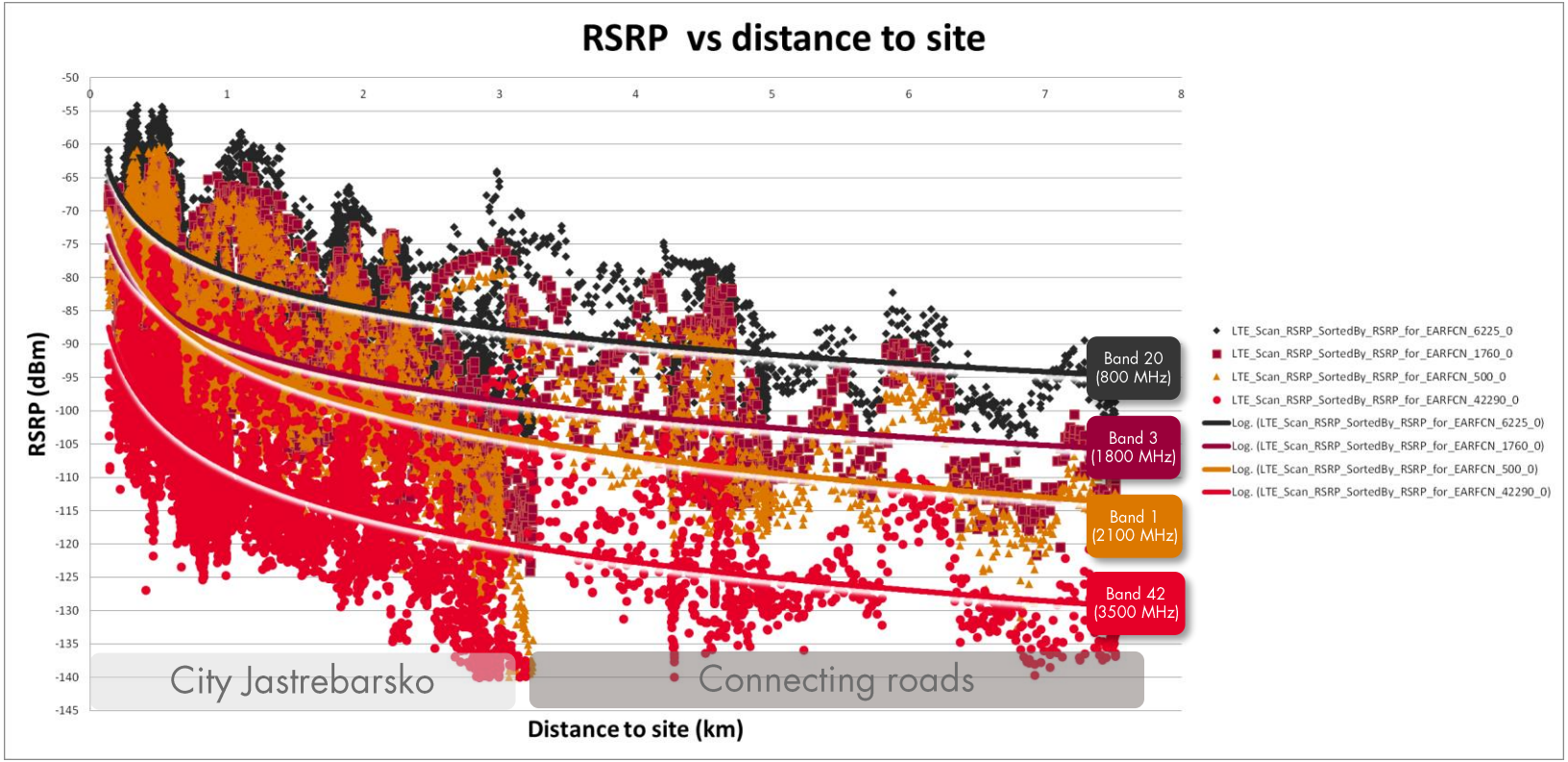
* LTE Transmission Mode
- LTE TDD: TM2, 3, 4, 7, 8, 9;
- DL 4*4 MIMO @ TM3/4/9
- LTE FDD: TM2, 3





FWA coverage estimation @3500MHz based on drive test

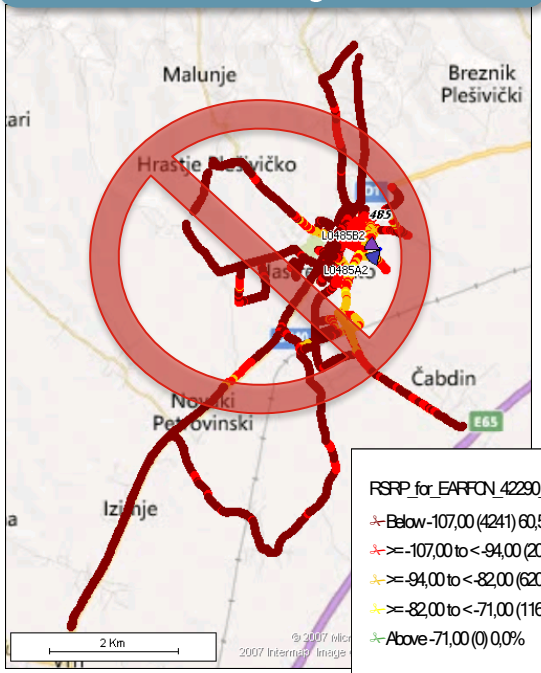
Research1, result



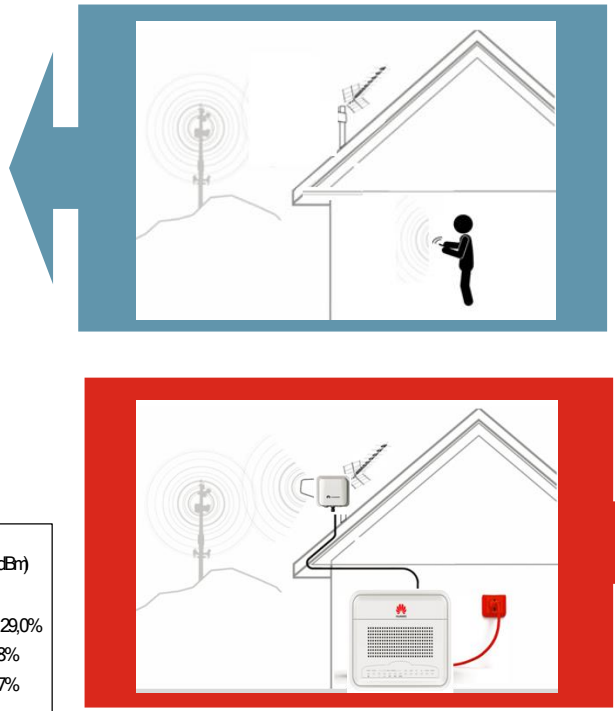
FWA coverage estimation @3500MHz based on drive test

Research1, estimation

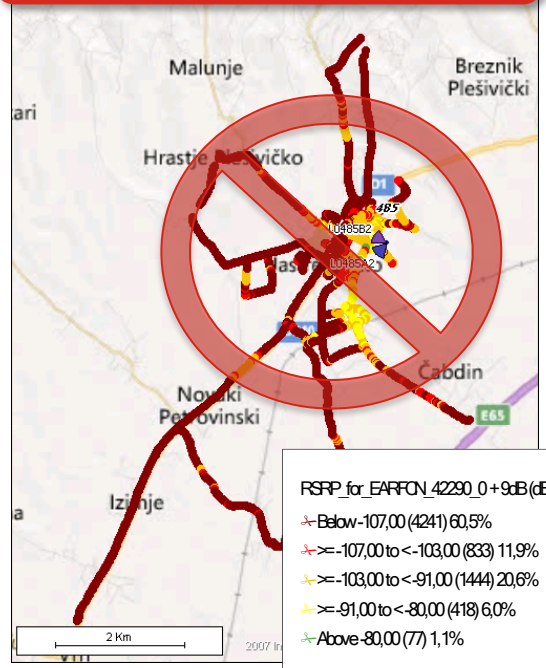
Smartphone
(Indoor propagation Loss)
Indoor coverage 1.7 %



RSRP_for_EARFCN_42290_0 (dBm)
- Below -107,00 (4241) 60,5%
- >=-107,00 to <-94,00 (2036) 29,0%
- >=-94,00 to <-82,00 (620) 8,8%
- >=-82,00 to <-71,00 (116) 1,7%
- Above -71,00 (0) 0,0%



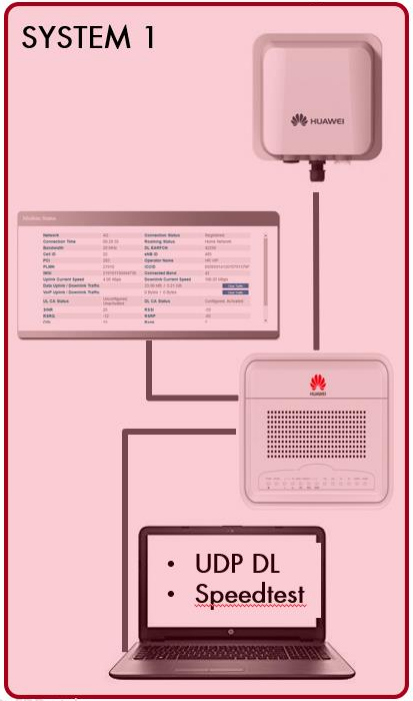
FWA, LTE Outdoor CPE
(+antenna gain 9 dB)
Outdoor coverage 39,6 %

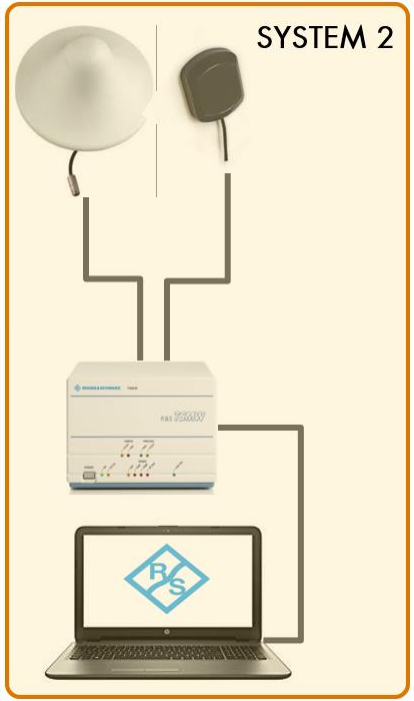


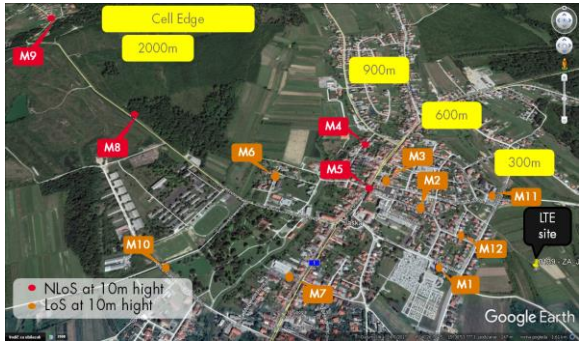
RSRP_for_EARFCN_42290_0+9dB (dBm)
- Below -107,00 (4241) 60,5%
- >=-107,00 to <-103,00 (833) 11,9%
- >=-103,00 to <-91,00 (1444) 20,6%
- >=-91,00 to <-80,00 (418) 6,0%
- Above -80,00 (77) 1,1%

FWA coverage estimation @3500MHz based on drive test

Research2, measurement setup







FWA coverage estimation @3500MHz based on drive test

Research2, result

		M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
LTE CPE dashboard	distance to site (m)	338	435	611	814	660	1012	865	1755	2850	1291	333	265

		average RSRP (dBm)
L2100	L2100 RSRP difference (RSRP_10m - RSRP_1.5m) for case LoS at 10m and LoS at 1.5m	**12.26**
	L2100 RSRP difference (RSRP_10m - RSRP_1.5m) for case NLoS at 10m and NLoS at 1.5m	**16.44**
	L2100 RSRP difference (RSRP_10m - RSRP_1.5m) for case LoS at 10m and NLoS at 1.5m	**20.52**
L3500	L3500 RSRP difference (RSRP_10m - RSRP_1.5m) for case LoS at 10m and LoS at 1.5m	**11.86**
	L3500 RSRP difference (RSRP_10m - RSRP_1.5m) for case NLoS at 10m and NLoS at 1.5m	**13.33**
	L3500 RSRP difference (RSRP_10m - RSRP_1.5m) for case LoS at 10m and NLoS at 1.5m	**23.33**

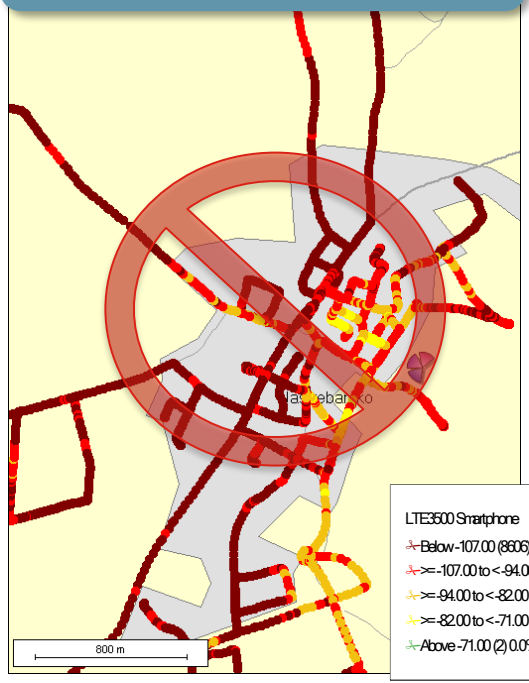
RS SINR L2100	23.65	23.14	24.98	16.54	16.90	21.08	18.05	15.26	1.95	20.71	21.18	18.80
*RSRP L3500	-67.28	-70.38	-73.18	-101.66	-101.67	-84.49	-77.35	-111.23	-114.41	-98.58	-71.41	-63.06
RS SINR L3500	20.50	19.59	21.62	9.54	6.42	18.75	19.08	0.95	-2.71	11.88	19.96	18.31

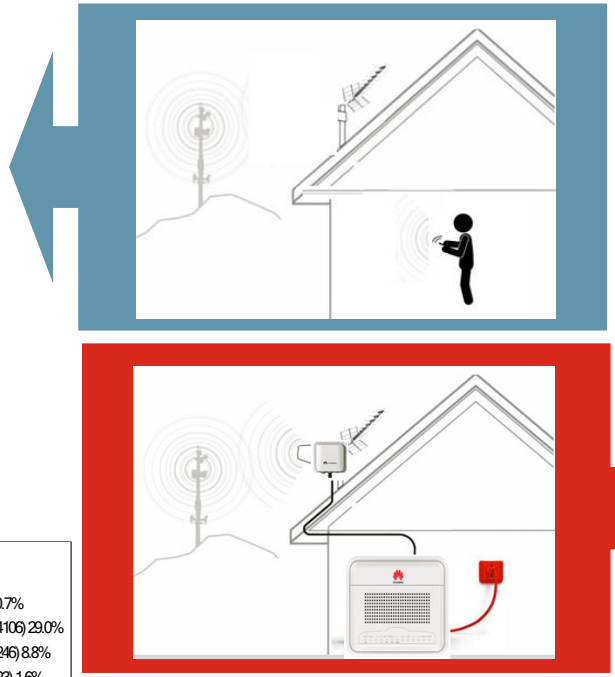
NLOS at 10m height
LOS at 10m height

FWA coverage estimation @3500MHz based on drive test

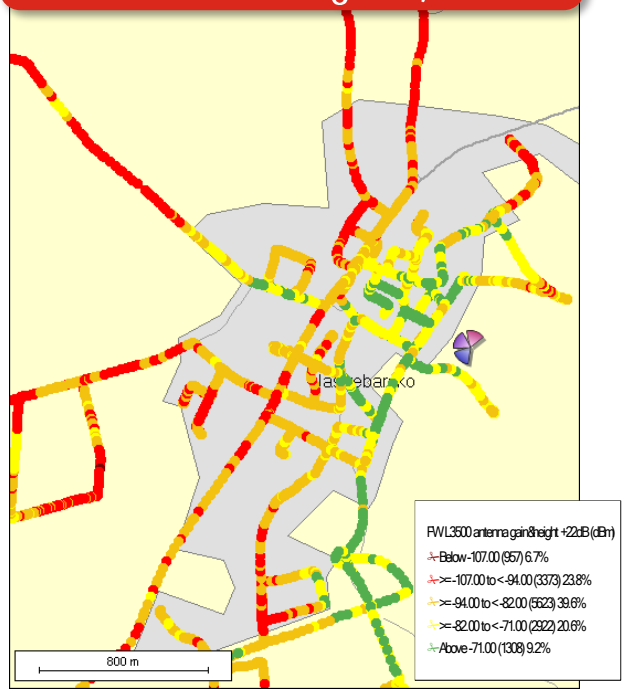
Research2, estimation

Smartphone (no additional gain)
Indoor coverage 1.7 %



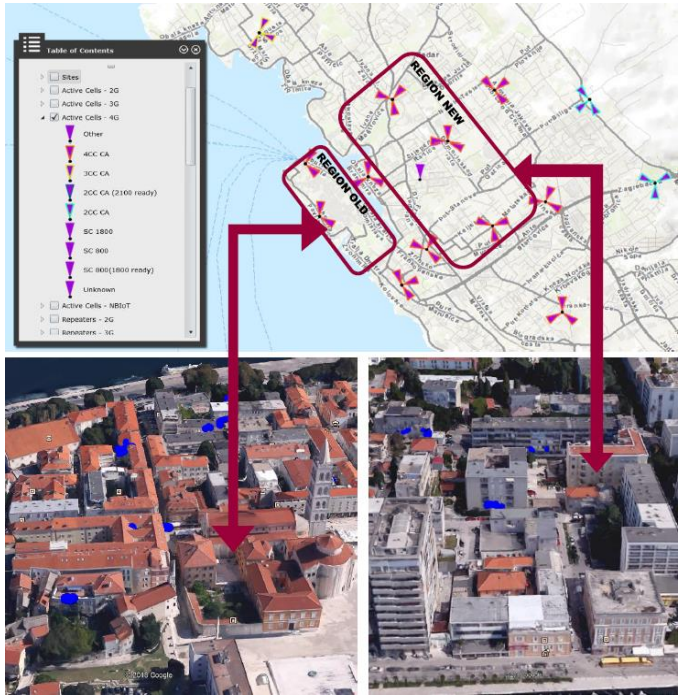


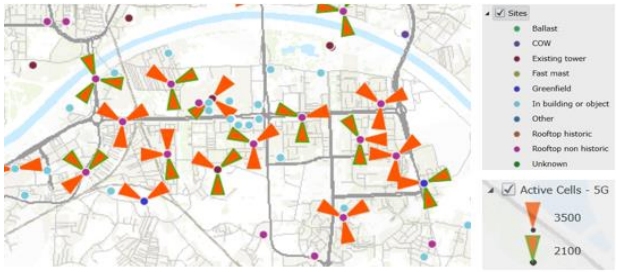
Fixed wireless, LTE Outdoor CPE
(antenna gain + antenna height gain)
Outdoor coverage 93,2 %

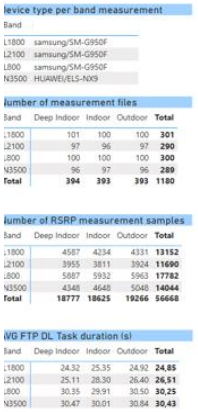


Indoor Propagation Loss 5G NR @3500MHz

Research, measurement setup



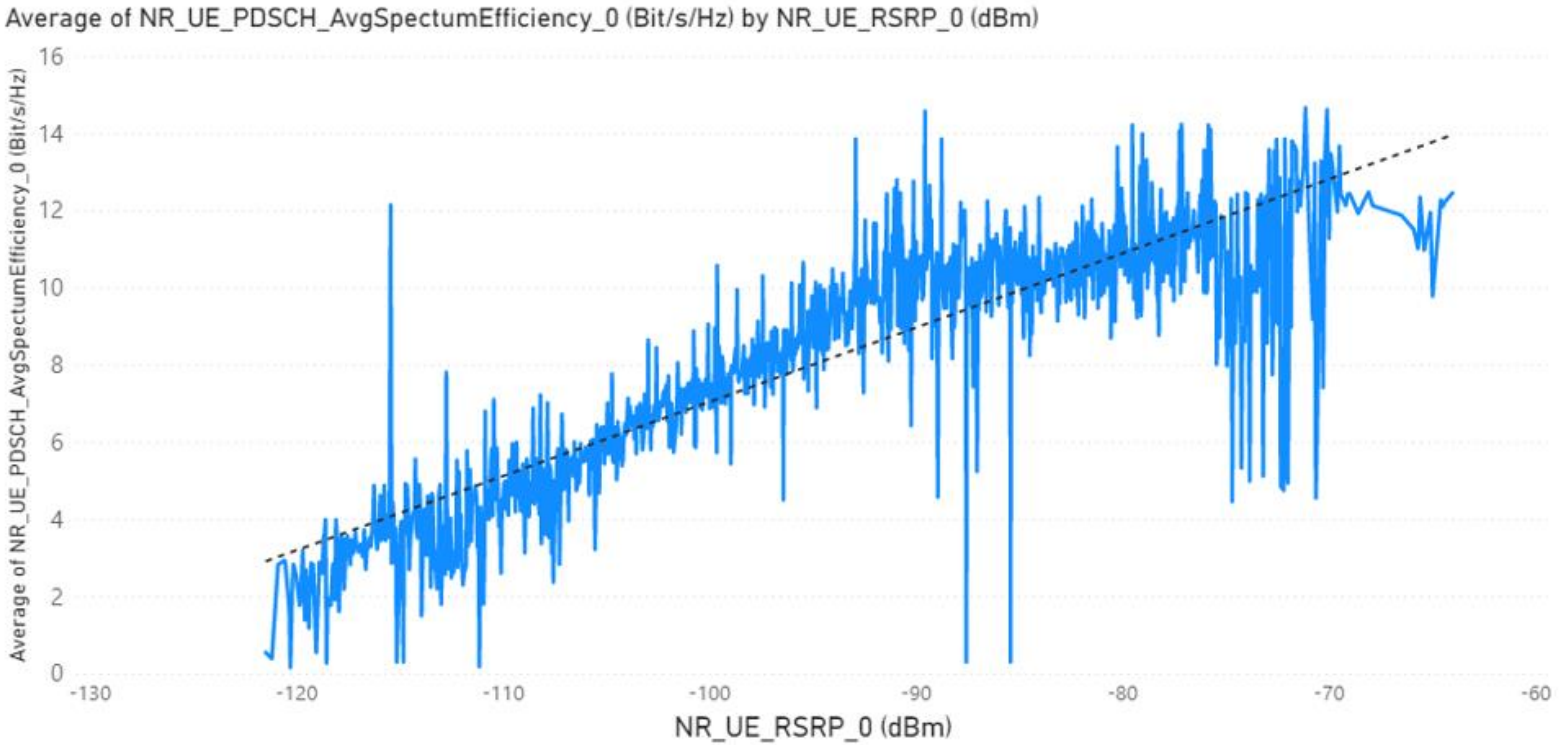




Source: T. Solina, Graduation Thesis, „Analysis of LTE Signal Propagation in Indoor at Frequency Bands 800MHz and 1800MHz ”, Zagreb University of Applied Sciences, July 2017
Source: J. Mijic, Graduation Thesis „ Measurement of EM wave propagation for the needs of the 5th generation public mobile network system in the 3.5 GHz frequency range” FER, 2019
Source: F. Colak, Graduation Thesis, *„Analyzing Signal Attenuation in Mobile Communications: Transitioning from Open to Closed Environments for Different Frequency Bands*”, FER, 2021

Indoor Propagation Loss 5G NR @3500MHz

Research, result



Indoor Propagation Loss 5G NR @3500MHz

Research, result

Measurement Location	RSRP_NR3500 (dBm)
Deep Indoor	-104,49
Indoor	-94,83
Outdoor	-87,07
Delta	
Deep Indoor/Indoor	-9,66
Indoor/Outdoor	-7,76
Deep Indoor/Outdoor	-17,42

NZagreb 2021

Band						
	Deep Indoor	Indoor	Outdoor	Diff. Deep Indoor/Indoor	Diff. Indoor/Outdoor	Total Diff (Deep Indoor/Outdoor)
band 7 (2600 MHz)						
band 1 (2100 MHz)	-109,53	-103,23	-93,87	6,30	9,86	16,15
band 3 (1800 MHz)	-102,23	-95,29	-86,45	6,94	8,84	15,79
band 20 (800 MHz)	-93,62	-89,17	-79,93	4,45	9,24	13,69

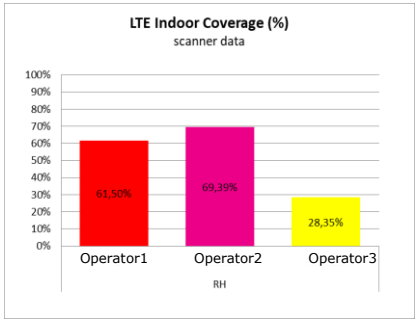
Zadar 2019

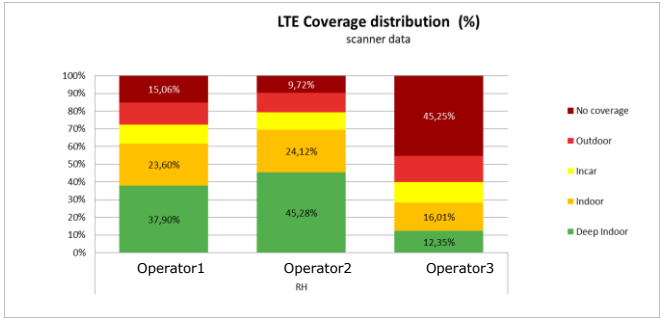
Band	Average RSRP (dBm)			Indoor Transmission Loss (dB)		
	Deep Indoor	Indoor	Outdoor	Diff. Deep Indoor/Indoor	Diff. Indoor/Outdoor	Total Diff (Deep Indoor/Outdoor)
band 7 (2600 MHz)	-118,31	-111,49	-99,98	6,82	11,51	18,33
band 1 (2100 MHz)	-116,38	-110,09	-98,63	6,29	11,46	17,75
band 3 (1800 MHz)	-110,15	-104,56	-93,92	5,59	10,65	16,23
band 20 (800 MHz)	-100,35	-96,59	-86,52	3,76	10,08	13,83

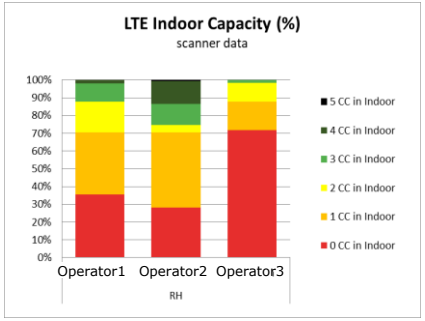
Thresholds	Deep Indoor >=	Indoor >=	Incar >=	Outdoor>=
NR 3500	**-80**	**-93**	**-99**	**-107**
LTE 2600	**-84**	**-94**	**-100**	**-107**
LTE 2100	**-86**	**-95**	**-100**	**-107**
LTE 1800	**-88**	**-96**	**-101**	**-107**
LTE 800	-91	-97	-102	-107

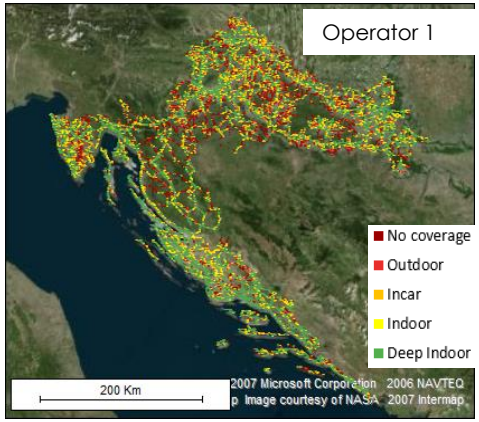
Indoor Propagation Loss 5G NR @3500MHz

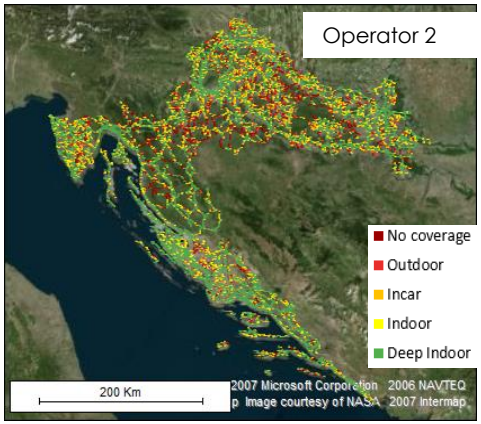
Research, estimation

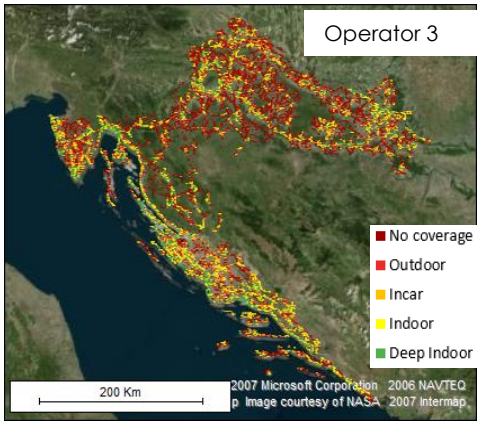












4. Key takeaways and a question

Key takeaways and a question

5W1H Framework for Benchmark Drive Test Measurement Analysis

- **What is 5W1H?**
  - Initially designed for journalism, the 5W1H questioning approach and a problem-solving method involves answering Who, What, When, Where, Why, and How questions in the lead paragraph of news articles. Today, it remains widely used by investigative journalists, detectives, and researchers to collect a complete and accurate story

- **5W1H Elements in Drive Test Measurement Analysis:**
  - Who – Who did it?
  - Why – Why is the drive test being performed (objectives, quality goals)?
  - What – What metrics are measured?
  - Where – Where are the tests conducted?
  - When – When were the measurements taken?
  - How – How are the measurements collected and analysed (tools, methods)?

- **Benefits of 5W1H in Drive Test Benchmarking**
  - Ensures a detailed and structured approach to benchmarking, covering all aspects of network performance measurement to highlight strengths and areas for improvement


Thank you

MOBILE TEST SUMMIT 2024

Test. Measure. Innovate

ROHDE&SCHWARZ

Make ideas real