SYSTEMICS Group
Network Quality Experts

5G in Europe – After First Implementations

KSTiT / KKRRiT , Łódź

September 2020

SYSTEMICS – WHO WE ARE?

WE MEASURE, MONITOR AND ANALYSE QOS OF MOBILE AND FIXED NETWORKS TO OPTIMISE CUSTOMER EXPERIENCE

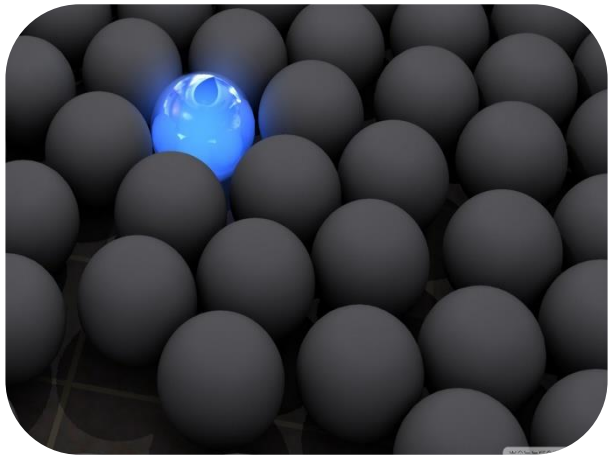
WE EXAMINE NETWORK HEALTH, IDENTIFY PROBLEMS AND RECOMMEND EFFECTIVE INTEGRATED SOLUTIONS TO IMPROVE PERFORMANCE AND SERVICE ASSURANCE

WE PRODUCE SMART ACTIONABLE INSIGHTS THAT IMPROVE USABILITY OF MULTI-TECHNOLOGY NETWORKS

Porfolio Overview - Services

BENCHMARKING

- National Benchmarks
- VoLTE, IoT, 5G Drivetesting
- Network Rollout/Swap Support
- Market Insights



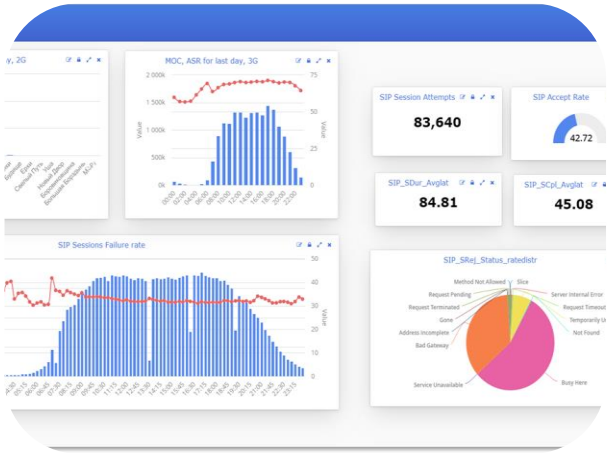
CONSULTANCY

- Root-cause Analysis
- Performance Improvement
- Managed Service SLA Verification
- Network Parameters Tuning

Porfolio Overview - Solutions

TESTING

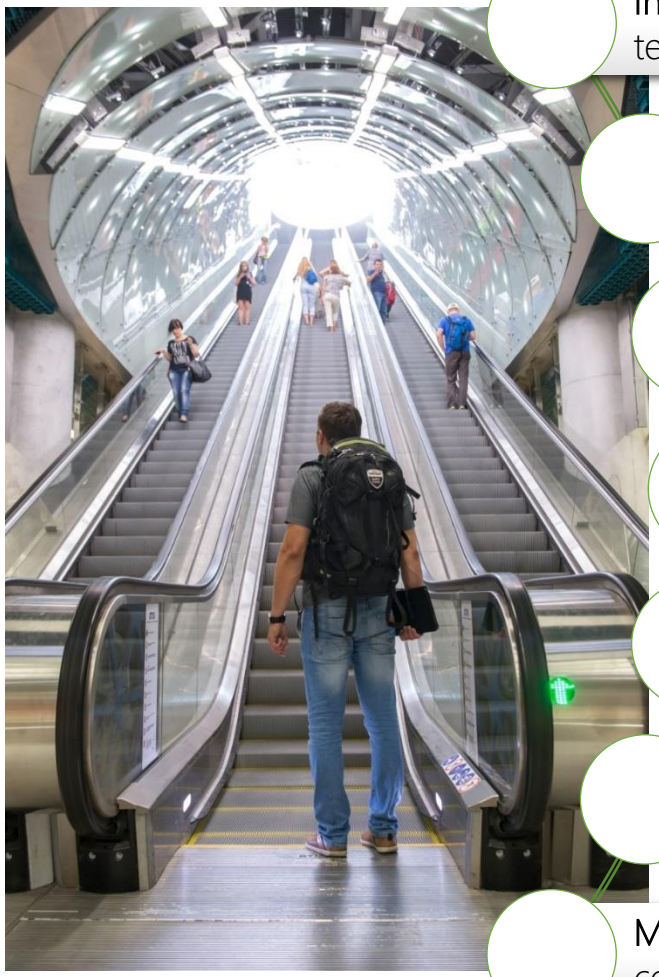
- Roaming Assurance
- In-Country Testing
- Service Assurance
- SLA Active Testing



MONITORING

- Shared Networks Monitoring
- RAN Monitoring
- Voice and Data Service Monitoring
- E2E Troubleshooting

Benchmarking Portfolio



Independent Certification Benchmarks – 'Best Network' public certificates underpinned by QoS benchmarking tests and ETSI-based scoring aimed at supporting marketing communications

Market Insights – comprehensive competitors network overview, use of spectrum, technologies, features

Targeted Benchmarking campaigns for 3G/4G, VoLTE, IoT and 5G

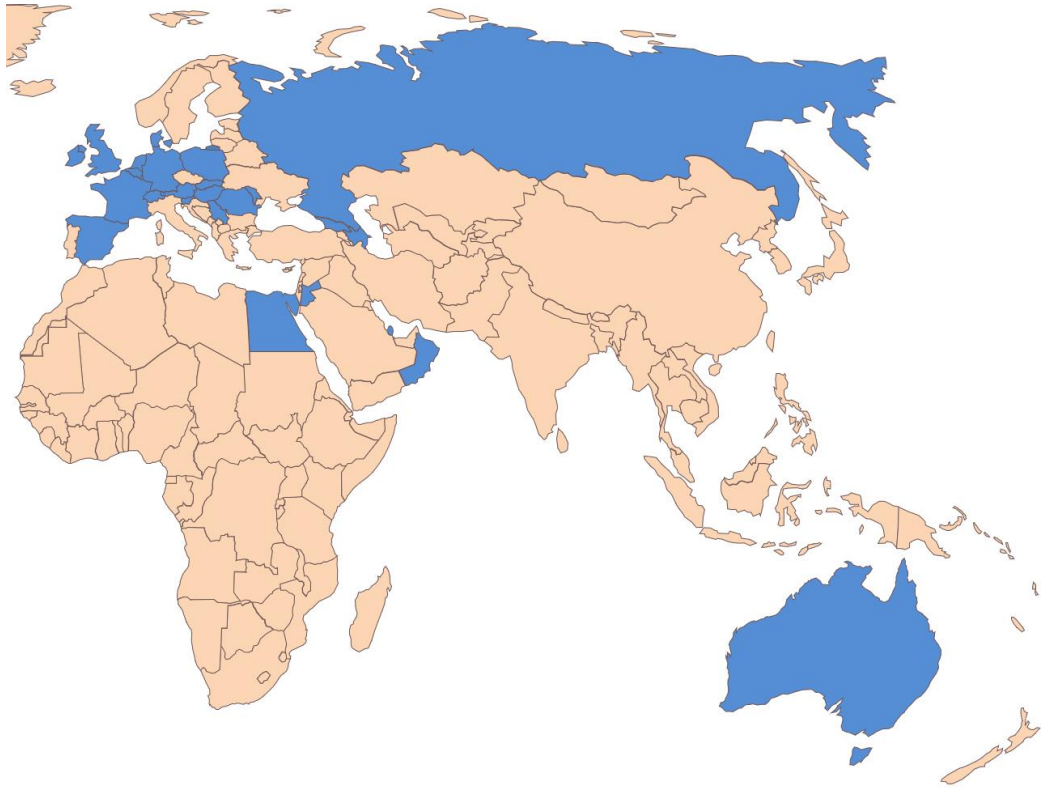
Network Infrastructure Upgrades Verification – independent measurements to validate QoS during network rollout, swaps, upgrades, etc.; single site verification, cluster acceptance, etc.

Managed Services SLA – independent drive-test validating SLA in Managed Service projects

Quality Improvement Projects – targeted E2E drive-tests followed by deep-dive analysis and recommendations based on our expert knowledge and experience

Multi-Country Benchmarks – large scale or specialised drivetests, consistency of measurements across countries, comparative performance analysis, technical network insights

Benchmarking and optimisation projects in 2018-2019



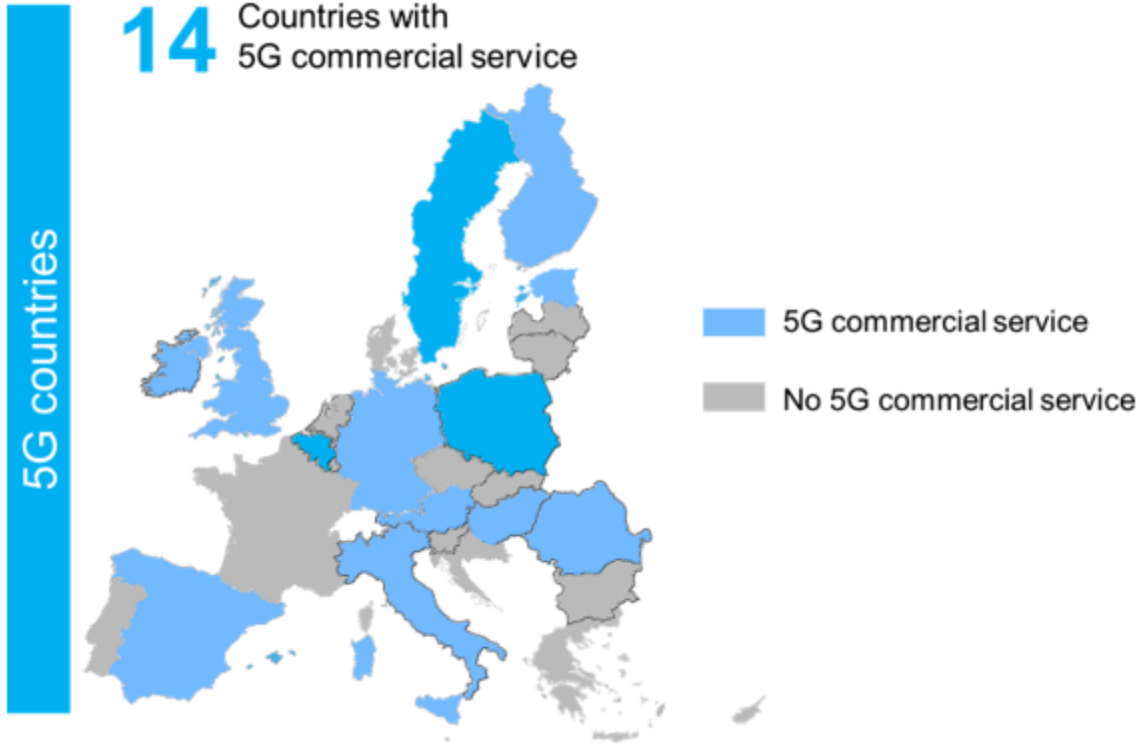
- IN 2019 BENCHMARKING AND OPTIMISATION PROJECTS PERFORMED IN 23 COUNTRIES
- FIRST TIME PROJECTS IN MAURITIUS, QATAR, DENMARK, GEORGIA, AZERBAIJAN, SLOVENIA, EGYPT
- MORE THAN 1 500 000 KM OF DRIVE ROUTE COVERED

5G issues found in measurement projects by Systemics

VARIETY OF SOLUTIONS	Auctioning process and available frequencies drives individual approached for network implementation
COVERAGE	Availability of 5G coverage and services is limited
INTEROPERABILITY	Interoperability and mobility is a key to the good customer experience
TERMINALS	Use of different approaches how to build the network results in terminal compatibility
PERFORMANCE	What matters?
NETWORK ASSESSMENT	Network scoring approaches and implementations

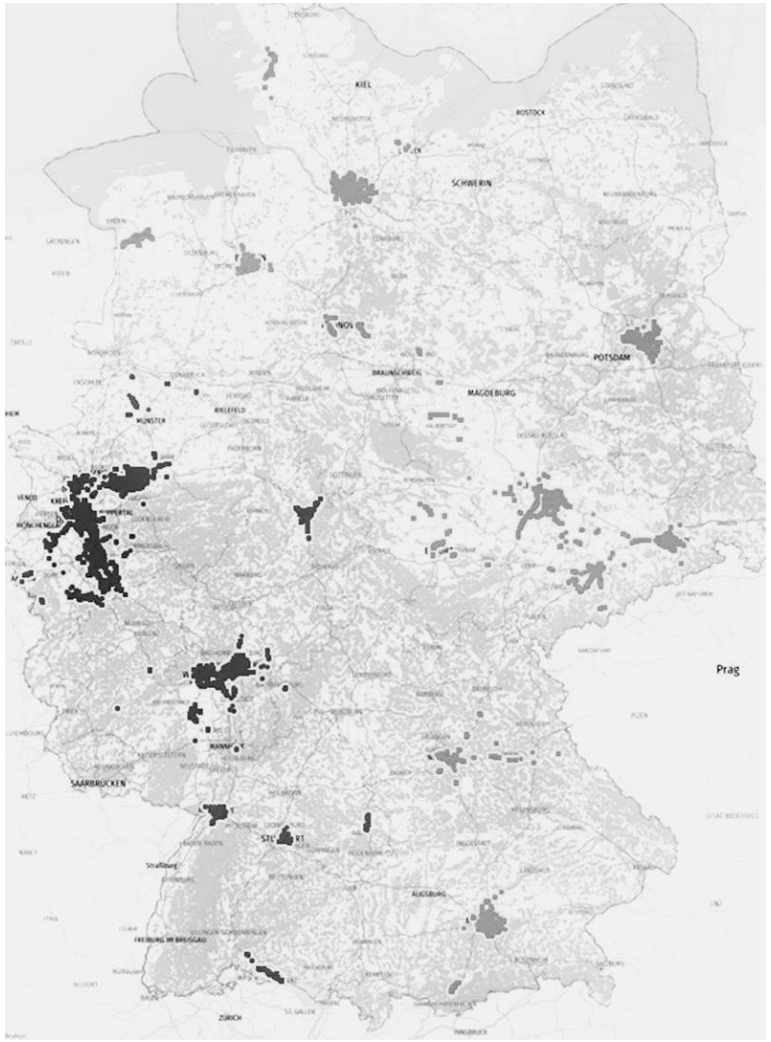
5G development in Europe is going on

- **The number of commercial 5G networks is growing**
- **Operators want to use already possessed frequencies to the highest extend**
- **Some of them reallocates bands used for 3G and LTE to be used for 5G**
- **Use of Dynamic Spectrum Sharing allows to start minimum 5G implementation without having dedicated resources**



Source: European 5G Observatory

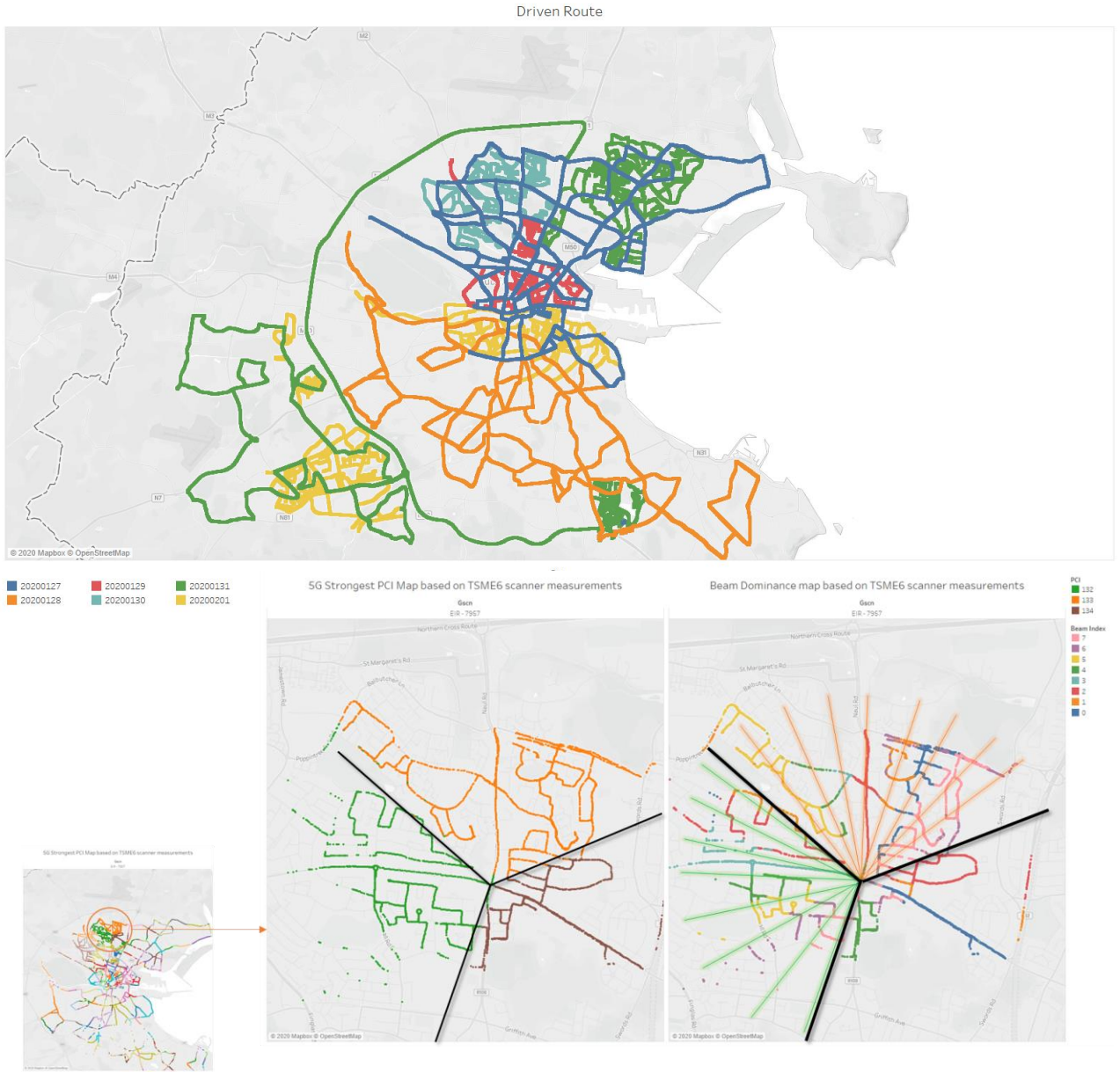
5G coverage



- **Systemics provided 5G measurement services in Ireland, Germany, Switzerland and others**
- **In Europe except Switzerland the coverage of 5G networks is very limited**
- **Almost all networks are implemented in NSA mode and very related to LTE services**

5G-NR scanner measurements

- **Coverage measurements are still one of the most popular issues on RF engineers radar**
- **Beam performance measurements are necessary to check if features works and could be used for offering services**
- **Scanner measurements are necessary to assess 5G NR radio signal quality in relations to 4G signal quality in order to provide proper functioning of DSS functionality**



Interoperability issues

- **Existing 5G implementation in all the cases are NSA**
- **Mobility management and RAT changing parametrisation is the key to the access to 5G layer**
- **Multi-Technology and Multi-band networks needs changes in layer selection process which in some places can destroy previous policy for mobility**

Measurement terminals

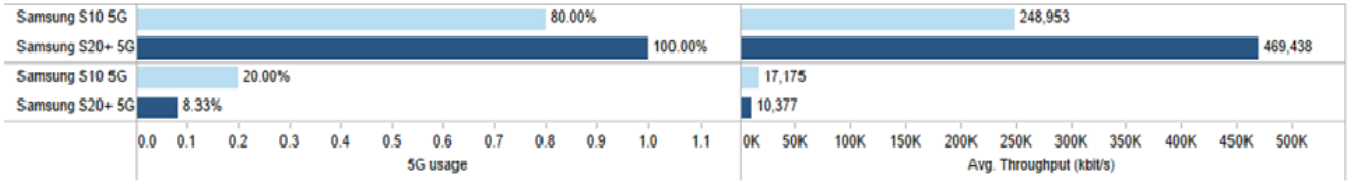
- **There is no universal terminal which works in all networks**
- **Terminals are dedicated to the network by means of firmware**
- **It is challenging for measurements to select proper terminal and to integrate different models to the measurement system**
- **Performance of different models is significantly different**

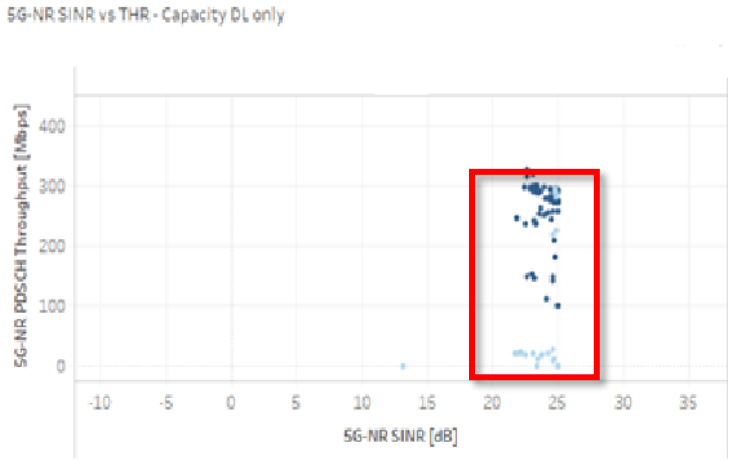
S20 vs S10 5G usage and throughput

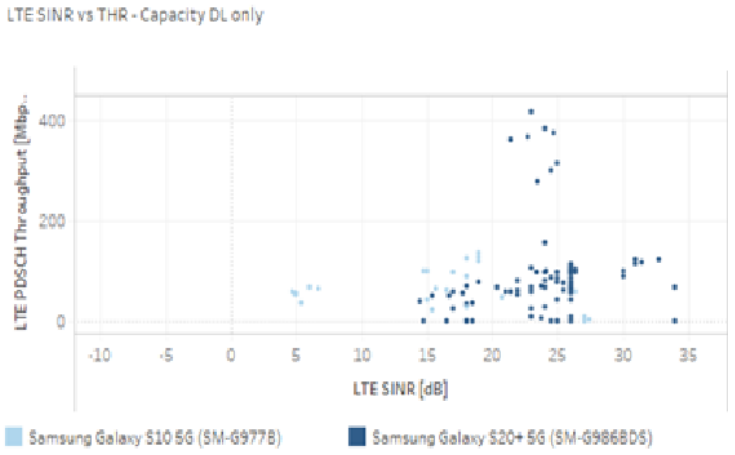
The data shown is from a stationary point with very good 5G usage on both devices.

Despite very high 5G usage in the test S10 had almost 2x lower thr compared to S20.

Both devices had very good RF conditions, but S20 had much better throughput on the 5G PDSCH „leg”







S20 vs S10 – RF resources – example case

Sum | PCC

5G NR PDSCH throughput (Sum)	17:12:10.908
Scheduled throughput [kbit/s]:	269238.91
Net-PDSCH throughput [kbit/s]:	249607.48

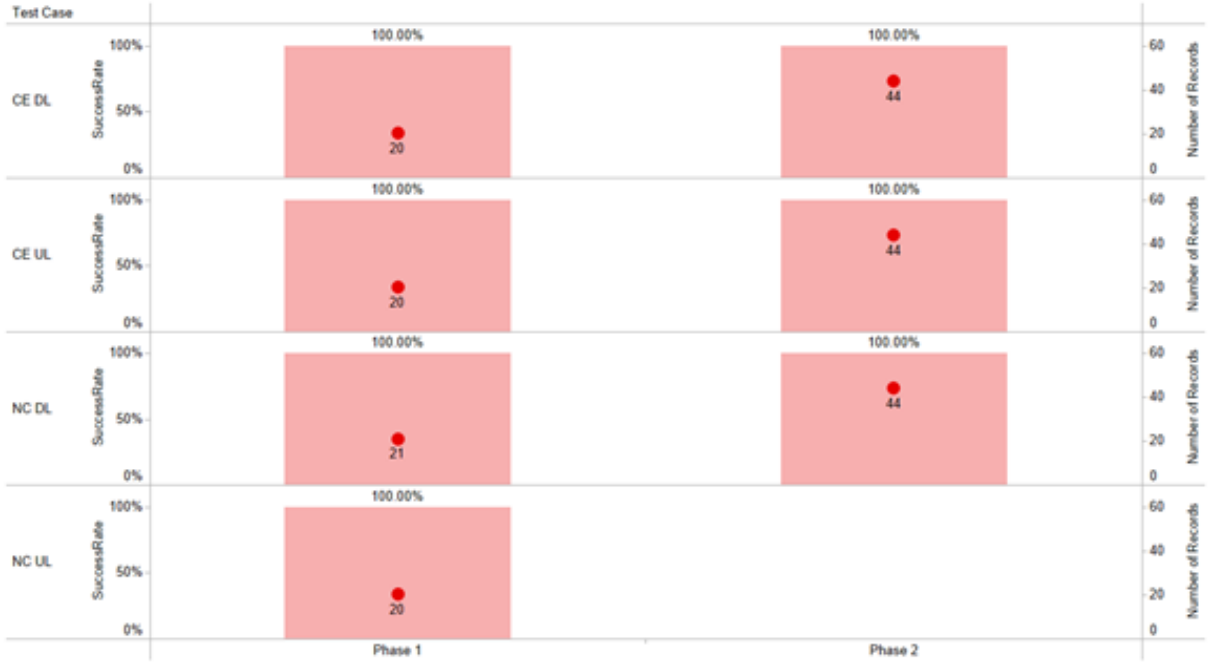
5G NR PDSCH statistics (Sum)	17:12:10.908	
Sub channel spacing:	30	
Number of Slots:	803	
Average RBs/Slot:		
Min RBs/Slot		
Max RBs/Slot		
Average allocated RE/TB:		
Min allocated RE/TB:		
Max allocated RE/TB:		
Average TB size:	21010.20	
Min TB size:	34	
Max TB size:	28185	
TB rate:	1601.80	
Number of TBs:	803	100 %
Bytes transferred:	16871213	
BLER [%]:	7.00	
Residual BLER:	0.00	
Number of New data indicator:	687	85.6 %
Number of CRC pass:	747	
Number of pass on first attempt:	687	85.6 %
Number with 1 retransmission:	60	7.5 %
Number with 2 retransmissions:	0	0.0 %
Number with 3 or more retransmissions:	0	0.0 %
Number of residual errors:	0	0.0 %
Number of Double Transmitted:	0	
MCS index (average):		
Average Code rate [%]:		
Number of allocated RBs:		
Max number of layers:		

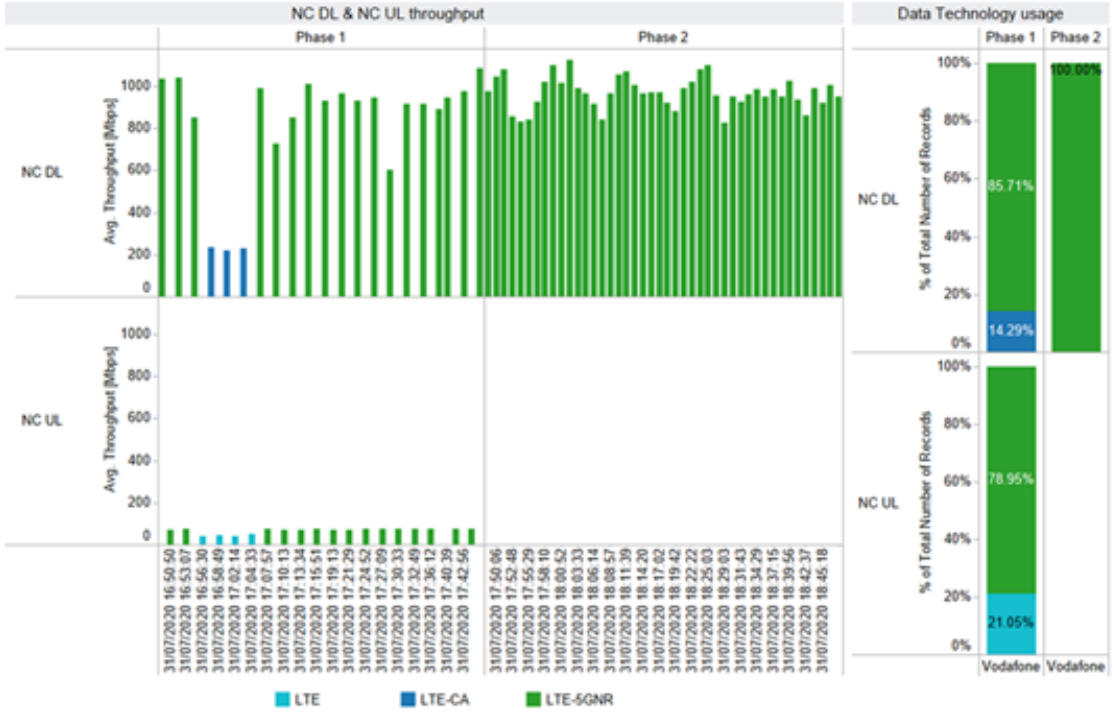
5G NR PDSCH throughput (Sum)	17:18:17.909
Scheduled throughput [kbit/s]:	168934.78
Net-PDSCH throughput [kbit/s]:	141066.92

5G NR PDSCH statistics (Sum)	17:18:17.909	
Sub channel spacing:	30	
Number of Slots:	375	
Average RBs/Slot:		
Min RBs/Slot		
Max RBs/Slot		
Average allocated RE/TB:		
Min allocated RE/TB:		
Max allocated RE/TB:		
Average TB size:	16713.20	
Min TB size:	34	
Max TB size:	29201	
TB rate:	1263.50	
Number of TBs:	375	100 %
Bytes transferred:	6267453	
BLER [%]:	12.50	
Residual BLER:	0.00	
Number of New data indicator:	281	74.9 %
Number of CRC pass:	328	
Number of pass on first attempt:	281	74.9 %
Number with 1 retransmission:	47	12.5 %
Number with 2 retransmissions:	0	0.0 %
Number with 3 or more retransmissions:	0	0.0 %
Number of residual errors:	0	0.0 %
Number of Double Transmitted:	0	
MCS index (average):		
Average Code rate [%]:		
Number of allocated RBs:		
Max number of layers:		

Performance issues

- **In places where present netwroks shows good performance and stability**
- **Measured throghputs are close to 1 Gbps**
- **Throughput is not always the most important**





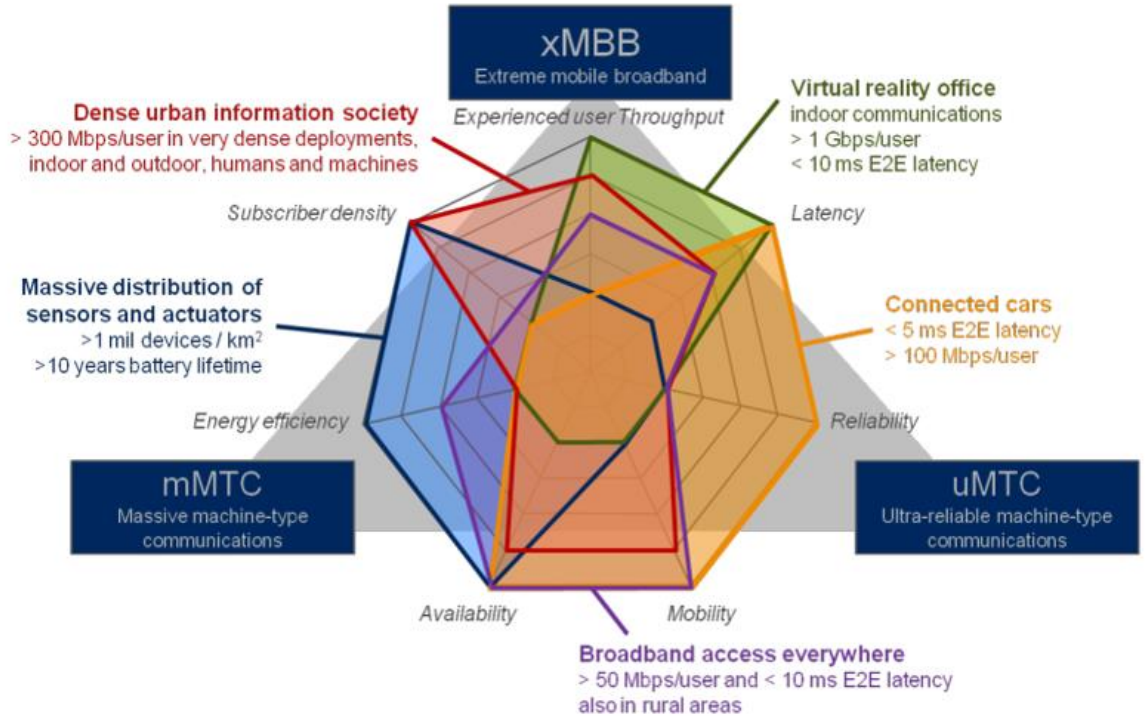
5G network Assessment

There is an interest from our customers to get the comparison of 5G services

There is no 5G specific agreed scoring method yet. ETSI continues the work on best practices for measurements and benchmarking.

For the time being Systemics is working on its own scoring which is able to assess how existing 5G networks conforms with expectations set to 5G.

The In accordance to the document created by Metis II (Mobile and wireless communications Enablers for the 2020 Information Society-II) we adopt 5 use cases to simulate the real scenarios which will be used by users of 5G networks



UC1 - Dense Urban Information Society

UC2 - Virtual Reality Office

UC3 - Broadband access everywhere

UC4 - Massive distribution of sensor and actuators

UC5 - Connected cars

The scoring concept

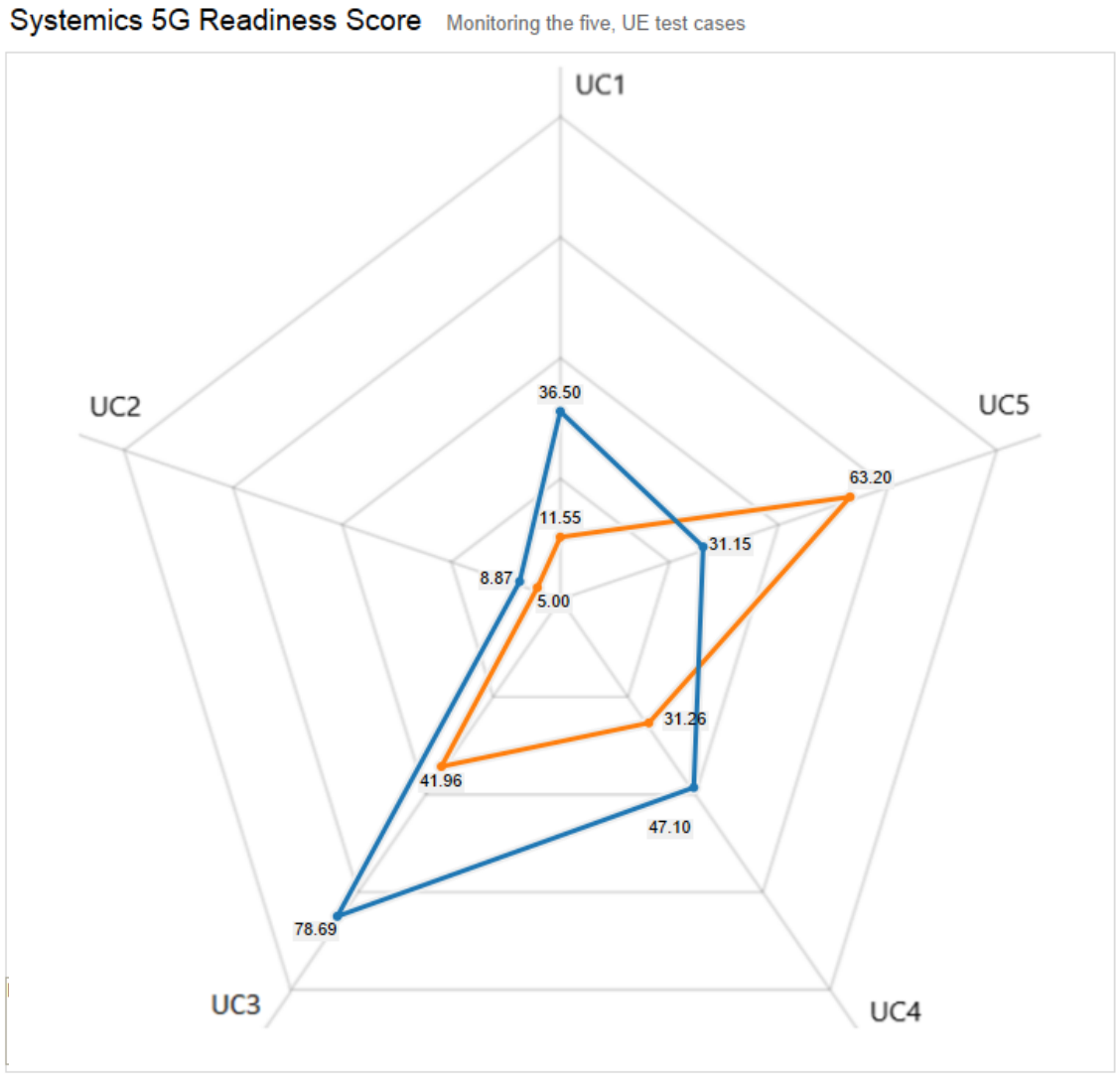
Each use case has defined acceptable level of KPIs as stipulated in METIS

Due to the fact that these values are very challenging for early 5G networks we propose a lighter version presented on the next slide

Use Case (UC)	Key Performance Indicator (KPI)	Requirement
UC1 Dense urban information society	Experienced user throughput	300 Mbps in DL and 50 Mbps in UL at 95% availability and 95% reliability
	E2E RTT latency	Less than 5 ms (augmented reality applications)
UC2 Virtual reality office	Experienced user throughput	5 (1) Gbps with 20% (95%) availability in DL 5 (1) Gbps with 20% (95%) availability in UL both with 99% reliability
UC3 Broadband access everywhere	Experienced user throughput	50 Mbps in DL and 25 Mbps in UL at 99% availability and 95% retainability
UC4 Massive distribution of sensors and actuators	Availability	99.9%
	Device density Traffic volume per device	1 000 000 devices/km^2 From few bytes per day to 125 bytes per second
UC5 Connected cars	E2E one-way latency	5 ms (traffic safety applications)
	Experienced user throughput	100 Mbps in DL and 20 Mbps in UL (service applications) at 99% availability and 95% reliability
	Vehicle velocity	Up to 250 km/h

Live network results – example (1)

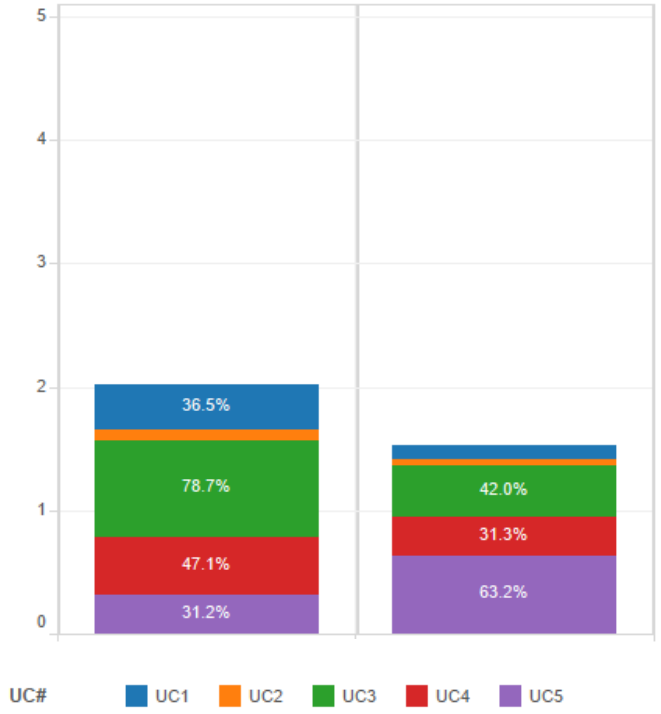
- Score obtained for each use case can be presented on a radar chart.
- Following is an example based on live data from 5G network.
- Each arm of the pentagram represents a score form zero (at the center) to 100% for each use case



SYSTEMICS PAB
Network Quality Experts

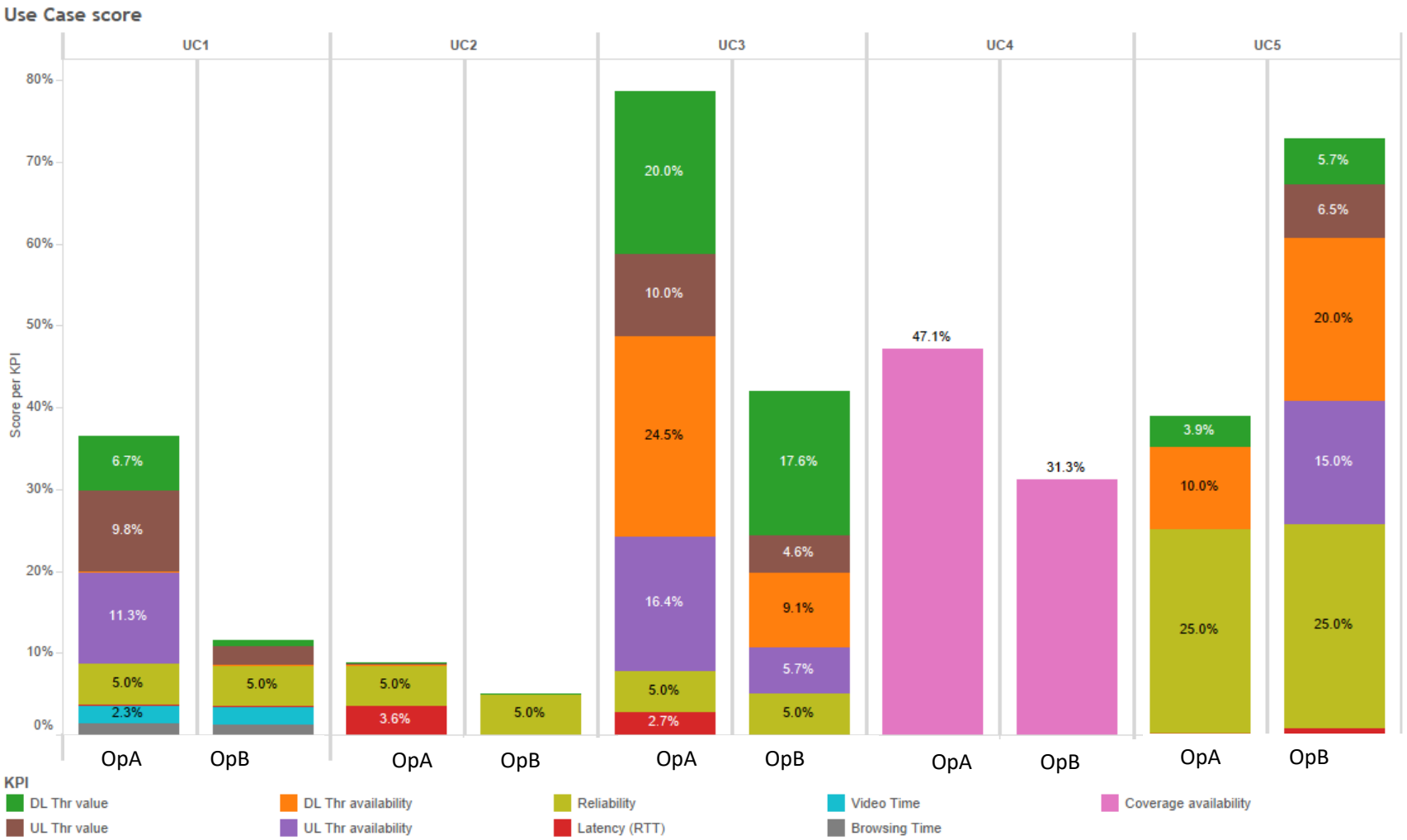
Scale range is zero to one, with zero at the center. The chart shows gradients from zero at 0.25, 0.50, 0.75, and then 1.

UC1 - Dense Urban Information Society
UC2 - Virtual Reality Office
UC3 - Broadband access everywhere
UC4 - 5G coverage availablility
UC5 - Connected cars



Live network results – example (2)

- More detailed view can present percentage of each KPI fulfilment for each operator
- Based on such representation KPIs can be compared between operators and locations



SYSTEMICS Group
Network Quality Experts

Interested? Contact Systemics for more …

Systemics-PAB Sp. z o.o.
46B Wolodyjowskiego St.
02-724 Warsaw, POLAND

j.kondej@syspab.eu

www.syspab.eu

Systemics-PAB