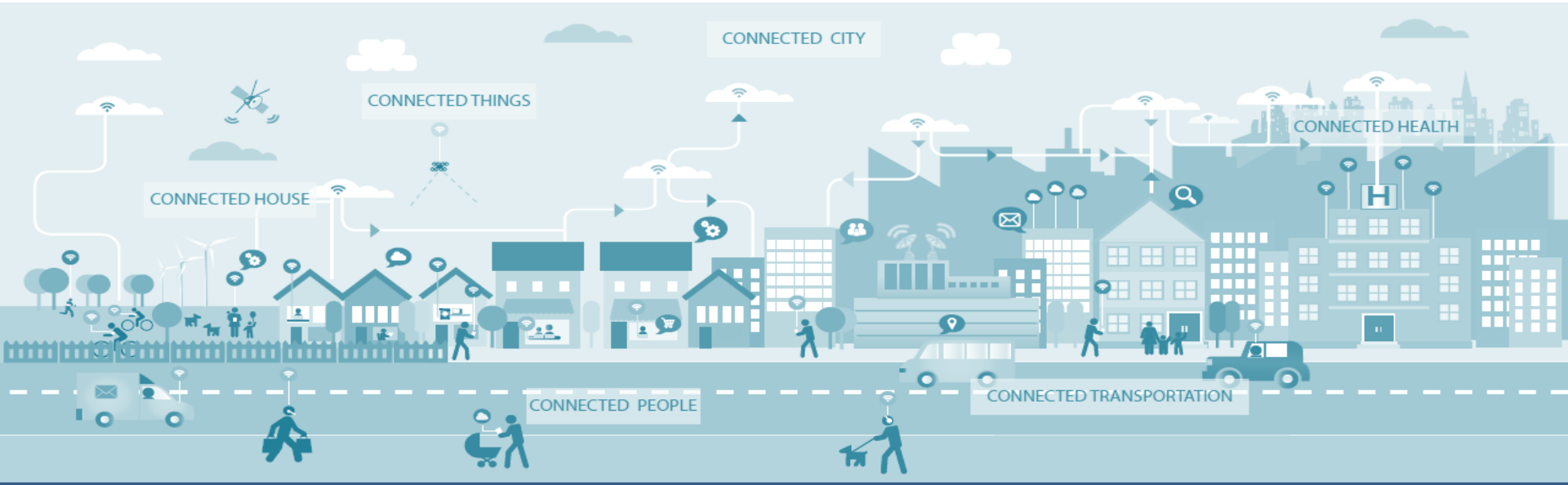
The 5G Infrastructure Public-Private Partnership

Performance impact factors of 5G experimentation results



Webinar on practical insights from 5G Test, Measurement and KPI Validation with vertical applications
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5G PPP TMV WG

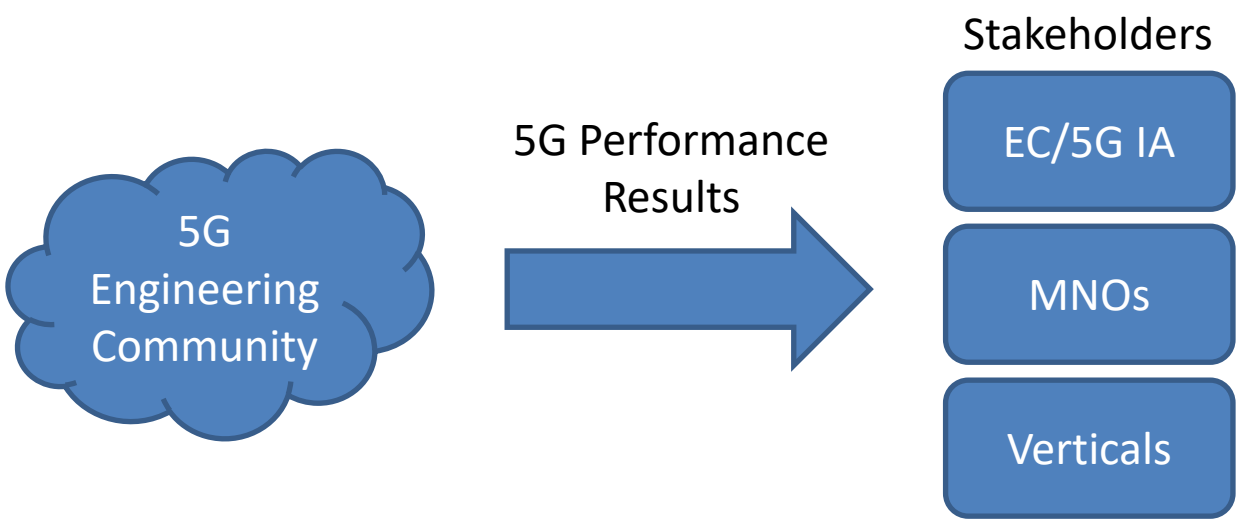
- Test, Measurement, and KPIs Validation (TMV) Working Group was founded **to promote commonalities** across projects on **T&M methodologies** to support vertical use cases in the **5G Trial Networks**

- TMV WG considers the following research areas and technology domains
  - KPI definition, KPI sources, collection procedures and analysis
  - Testing frameworks and tools
  - Testing and validation methodologies and procedures
  - Testing lifecycle
  - Common information models
  - Use / contribution towards open-source projects

TMV Whitepaper

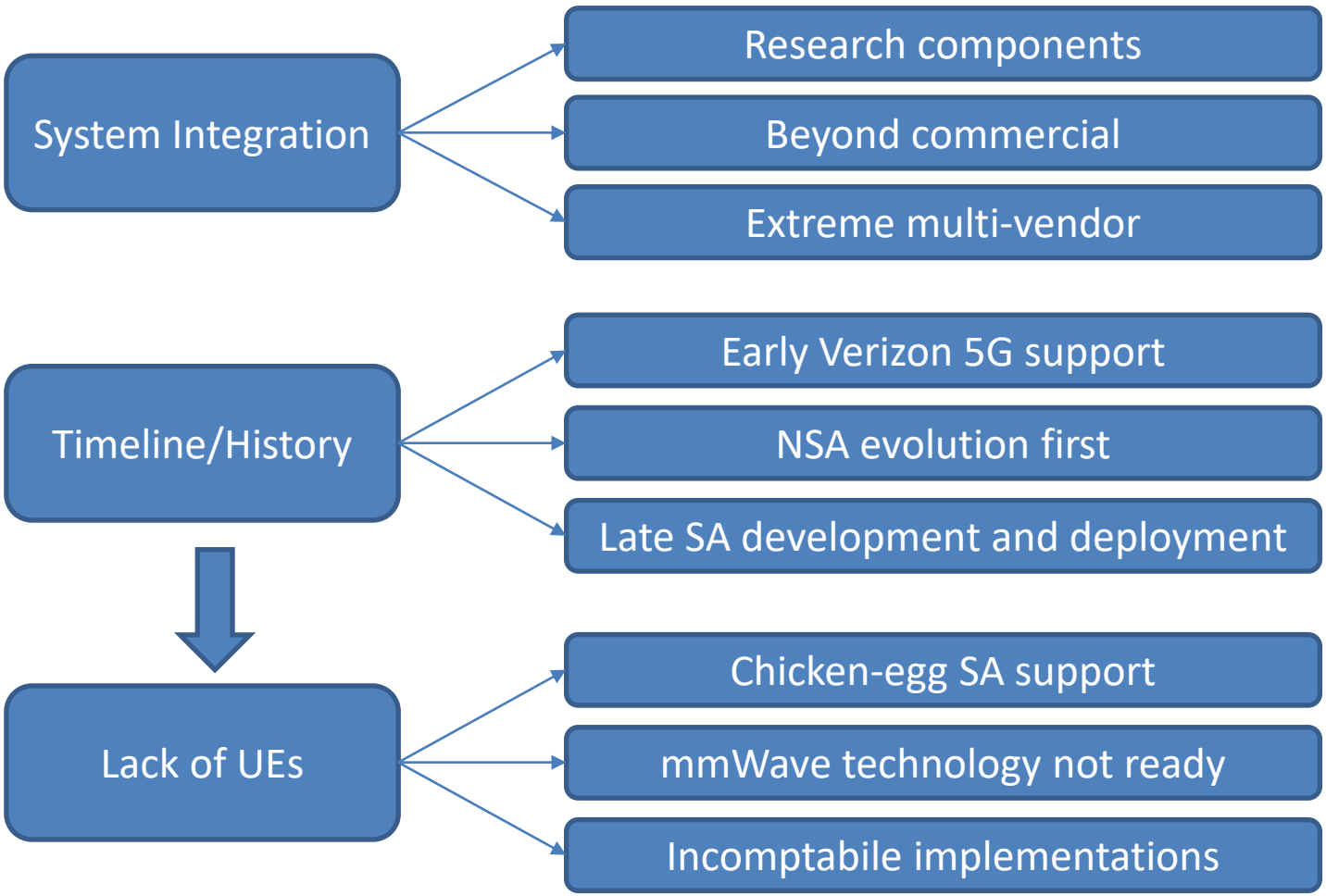
- Whitepaper: Understanding the Numbers - Contextualization and Impact Factors of 5G Performance Results
- Motivation
  - Execute analysis on the results from 5G PPP projects (starting from ICT-17 projects)
  - Clarify the details behind the performance numbers and provide a series of **interpretation guidelines**
  - Identify the **main impact factors** that affect the results and provide a high-level explanation that is clearly **understandable by non-experts**
  - Create a **bridge** between the telecommunications and verticals domains and reach a common understanding in explaining **what they can really expect from 5G**
  - To be updated **regularly** as new projects are onboarding and results are collected

The Perception Problem



	Results Expectations	Obtained Results
5G Engineering Community		
Stakeholders		

What are the bottlenecks?



What are the projects facing?

- **Limited resources**
  - Budget constrains vs expensive equipment
  - Limited deployment sizes (compute cloud, gNBs, scalability of research components)
  - Limited number of UEs (and availability of massive traffic testers)
- **Limited if no access to proper Spectrum**
  - Improper bands
  - Limited badwidth
- **Timeline issues: technology not ready when the projects needed it**
  - Waiting for commercial availability of components and features
- **Complexity in integration**
  - Never-seen-before setups
  - New, complex, multilayered configurations

The Perception Problem Explained

- Stakeholders have high expectations i terms of performance numbers.
- **Those numbers are top theoretical performance, we might never reach them.**
- We need to make an effort in understanding the context in which the actual performance is generated.
- This White Paper is an effort in this direction:
  - presenting the Impact Factors tha limit the performance.
  - Explaining the context in which the results are generated.

TMV Whitepaper - Performance impact factors

- Performance **impact factors**
  - Deployment and configuration aspects
    - Focus of current whitepaper
  - Testing/experimentation scenarios
    - Consider well-controlled scenarios (e.g. mobility of end devices, channel conditions, traffic type etc.)
  - Testing/experimentation procedures
    - Basic concepts on experimentation methodology for 5G KPIs already presented in earlier TMV WG whitepaper [1]

[1] 5GPPP White paper: Validating 5G Technology Performance Assessing 5G architecture and Application Scenarios, https://5g-ppp.eu/wp-content/uploads/2019/06/TMV-White-Paper-V1.1-25062019.pdf

TMV Whitepaper - Performance impact factors

- Deployment factors
  - Transport network characteristics
  - Network core deployment type
- Configuration aspects
  - Bandwidth size
  - MIMO layers in RAN
  - UL/DL intensive patterns
  - Scheduling approach
  - Target coverage

- Presented in detail during the next presentations
- Main results in the current presentation

Impact of transport network characteristics

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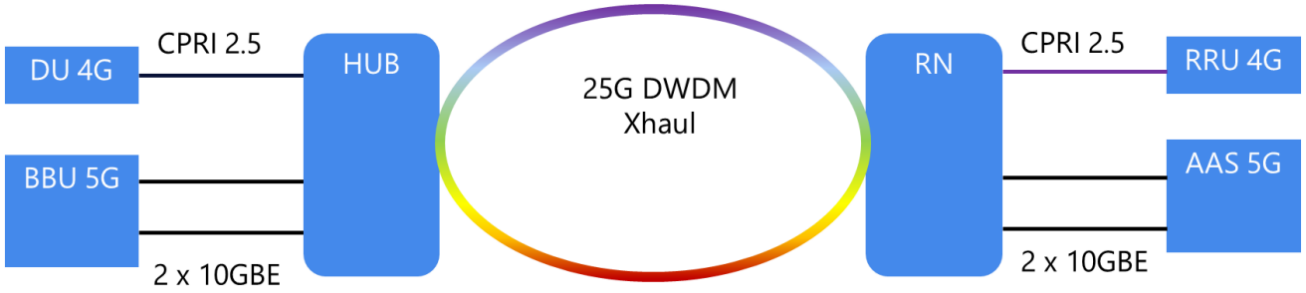
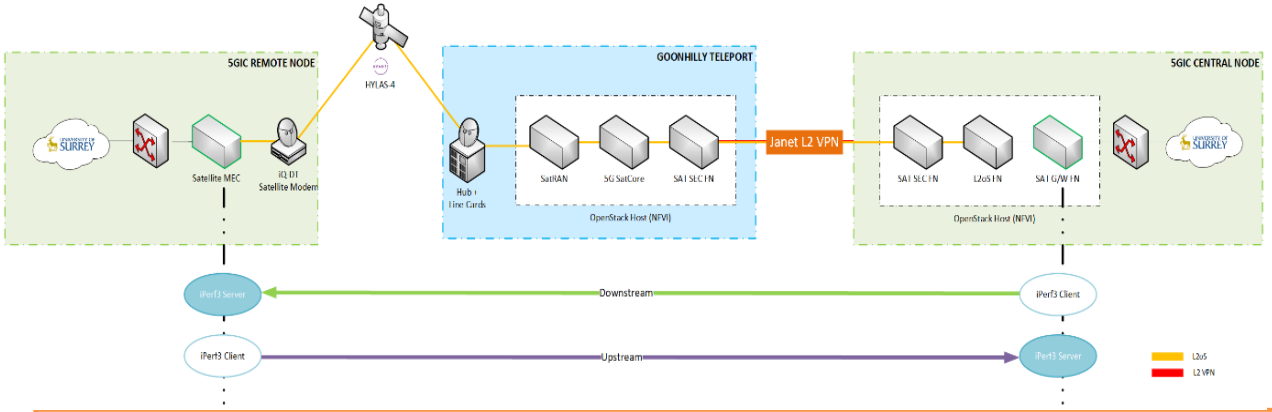
The European path towards global next generation communication network

Fiber optic fronthauling



Satellite fronthauling



Insights: Fiber optic transport network shows **negligible latency** (mainly dependent on the fiber length) and support for the required throughput **without packet loss**. Satellite link adds about **600ms** RTT latency and supports on average a rate of 25 Mbps.

Bandwidth impact

FR	BW (MHz)	Max CC	Total BW (MHz)	Subcarrier spacing options
FR1	50	16	800	15KHz, 30KHz, 60KHz,
	100		1600	
FR2	200		3200	120KHz, 240KHz
	400		6400	

Experiments in FR1 (3.5 GHz)

5G NR BW size (MHz)	DL/UL	Traffic Type	subcarrier Spacing	Throughput		Relevant theoretical peak values (achieved at the MAC layer, with SFI:28)
				Mean value	Peak value	
40	DL	UDP	15KHz	264.74 Mbps	269.88 Mbps	322 Mbps
50	DL	UDP	15KHz	369.27 Mbps	372.47 Mbps	402 Mbps
100	DL	TCP	30KHz	492.08 Mbps	738.08 Mbps	814 Mbps
	UL	TCP	30KHz	59.34 Mbps	73.40 Mbps	134 Mbps
	UL	UDP	30KHz	119.55 Mbps	125.08 Mbps	

Insights: Throughout results in FR1 are **close to theoretical values**. TCP experiments have lower performance than the UDP due to ACK/retransmissions.

MIMO layers impact

NSA Test Configuration with UE (NSA/TDD 7:2 mode)

Bandwidth (MHz)	MIMO	DL UDP (Mbps)	UL UDP (Mbps)	DL TCP (Mbps)	UL TCP (Mbps)
50	2x2	291	32,6	162 (multi)	22,1
50	1x1	184	17,3	180 (multi)	16,8
40	2x2	213	23,4	146 (multi)	25,1

Partly SA Test Configuration with UE (SA/TDD 7:2 mode)

Bandwidth (MHz)	MIMO	DL UDP (Mbps)	UL UDP(Mbps)	DL TCP (Mbps)	UL TCP (Mbps)
50	2x2	325	16,9	148 (multi)	20,2
50	1x1	Not obtained	Not obtained	Not obtained	Not obtained
40	1x1	101	15,2	30,8	25,7

Insights: In NSA mode, DL UDP transmissions with 2x2 MIMO achieves gain of about **50%**. In UL UDP case the gain is about **100%**. Results from SA is under further analysis.

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Thank You!!!