

ESSENTIAL PERFORMANCE LEARNINGS FROM PRIVATE AND PUBLIC 5G NETWORKS

Mr. Peter Busch
Market Development & Marketing MNT
Rohde & Schwarz



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Make ideas real

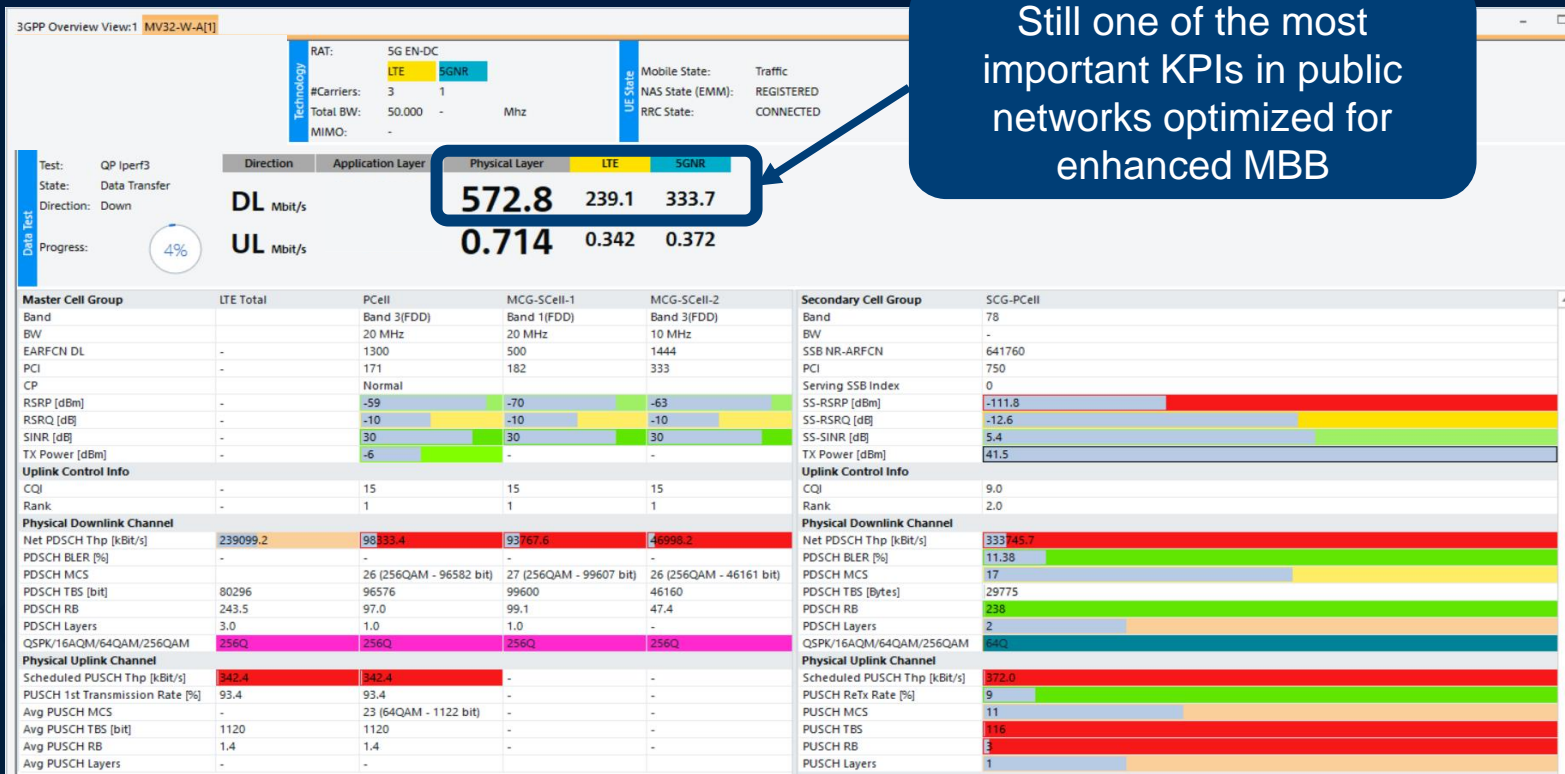


Essential performance learnings from private and public 5G networks

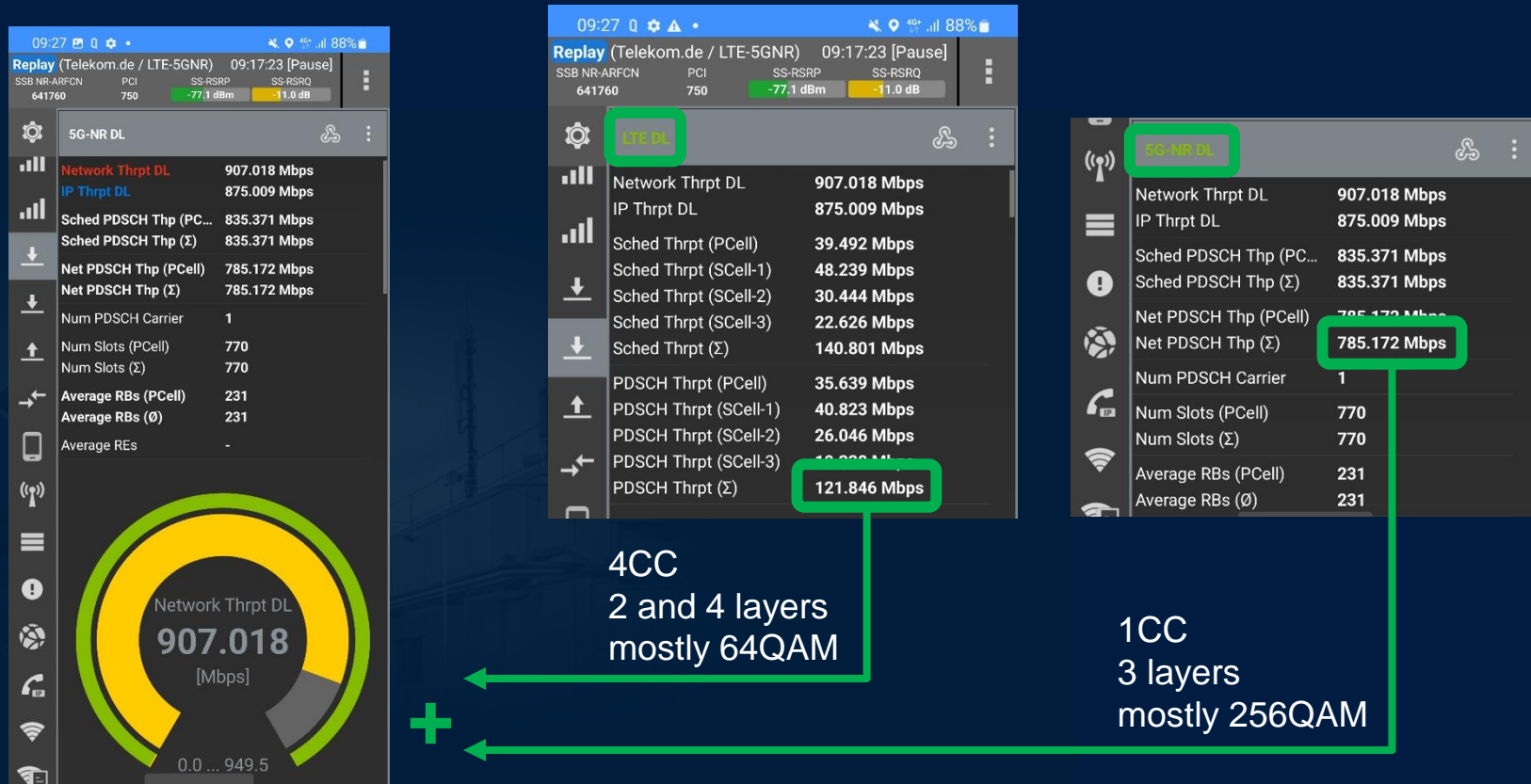
- ▶ Performance: Throughput and latency
- ▶ Measuring latency – why measuring for 40 hours?
- ▶ Synchronization of networks – what is the TDD challenge?
- ▶ How to stay ahead of all the troubles – automatic generation of insights
- ▶ Summary

Networks Data Rate Performance (2023 example)

Still one of the most important KPIs in public networks optimized for enhanced MBB

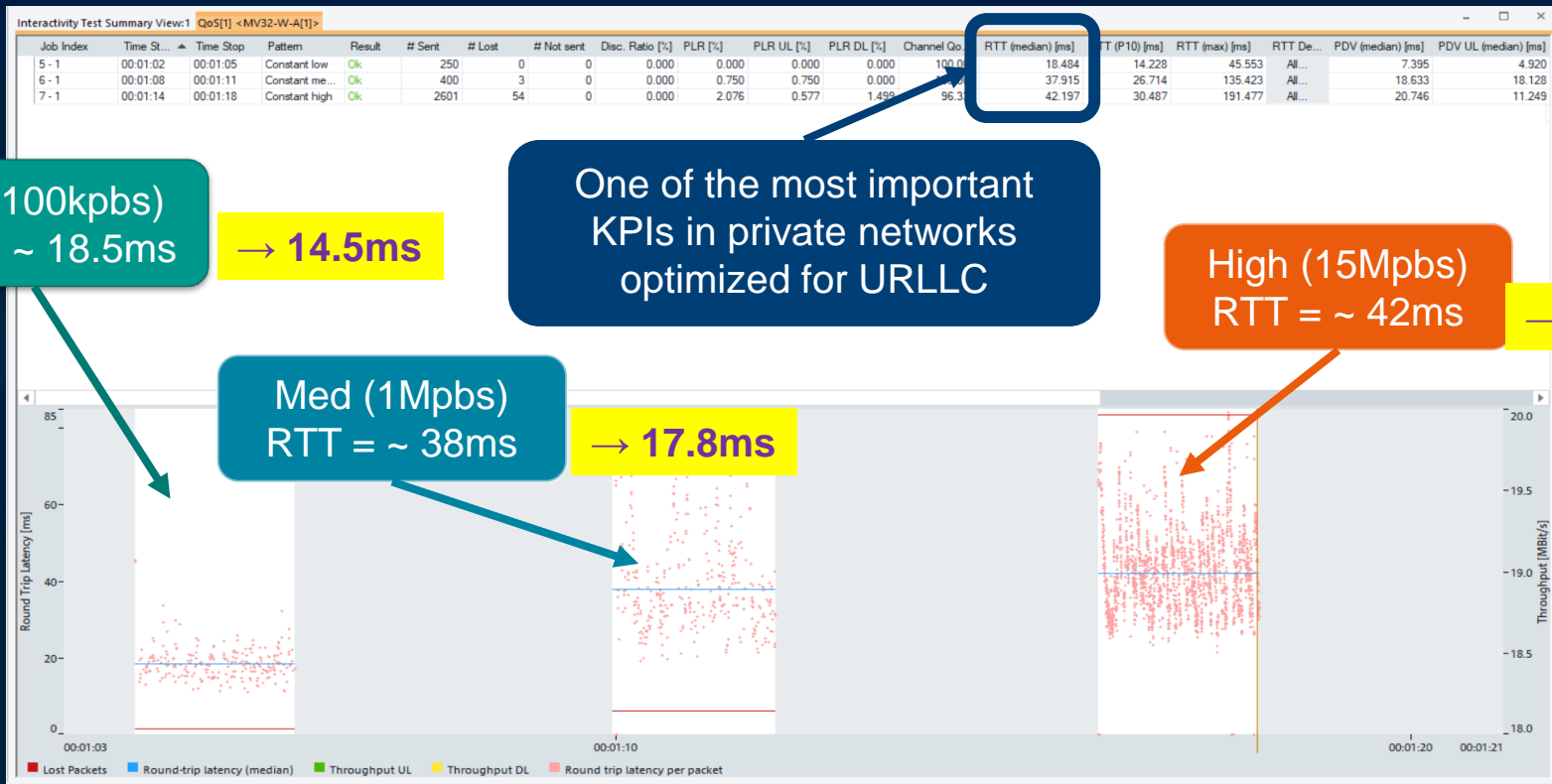


Networks Data Rate Performance (2024 example)



Networks Latency Performance (2023 Example)

Data Modem → Smartphone (2024 Example)



Essential performance learnings from private and public 5G networks

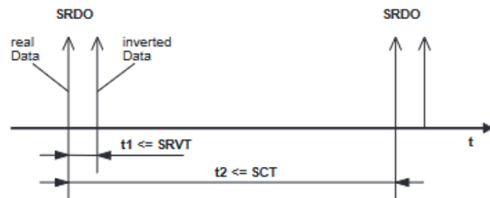
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Critical application: Heartbeats via 5G

CAN-bus application ensuring a device is still reachable (under control)
Periodically two messages are send -> and need to be received

- Safety Cycle Time (SCT): this is the time between two transmitted message in the sender side (transfer interval). This parameter is configured as 50 ms on sender side (radio controller). On the receiver side (crane) this parameter is configured as 100 ms. It means that the time between received messages (update time) has to be lower than 100 ms. If the time difference between receiving 2 periodic messages is longer than 100 ms, it leads to a failure in SRDO communication.
- Safety-Related Validation Time (SRVT): This parameter defines the time constraint in which the second (inverted msg) needs to arrive at the receiving side after the receiving of the first one. It is configured to 20ms on both sending and receiving side.

Figure 1 shows the SRDO and its two timing parameters.



Two main requirements on latency:

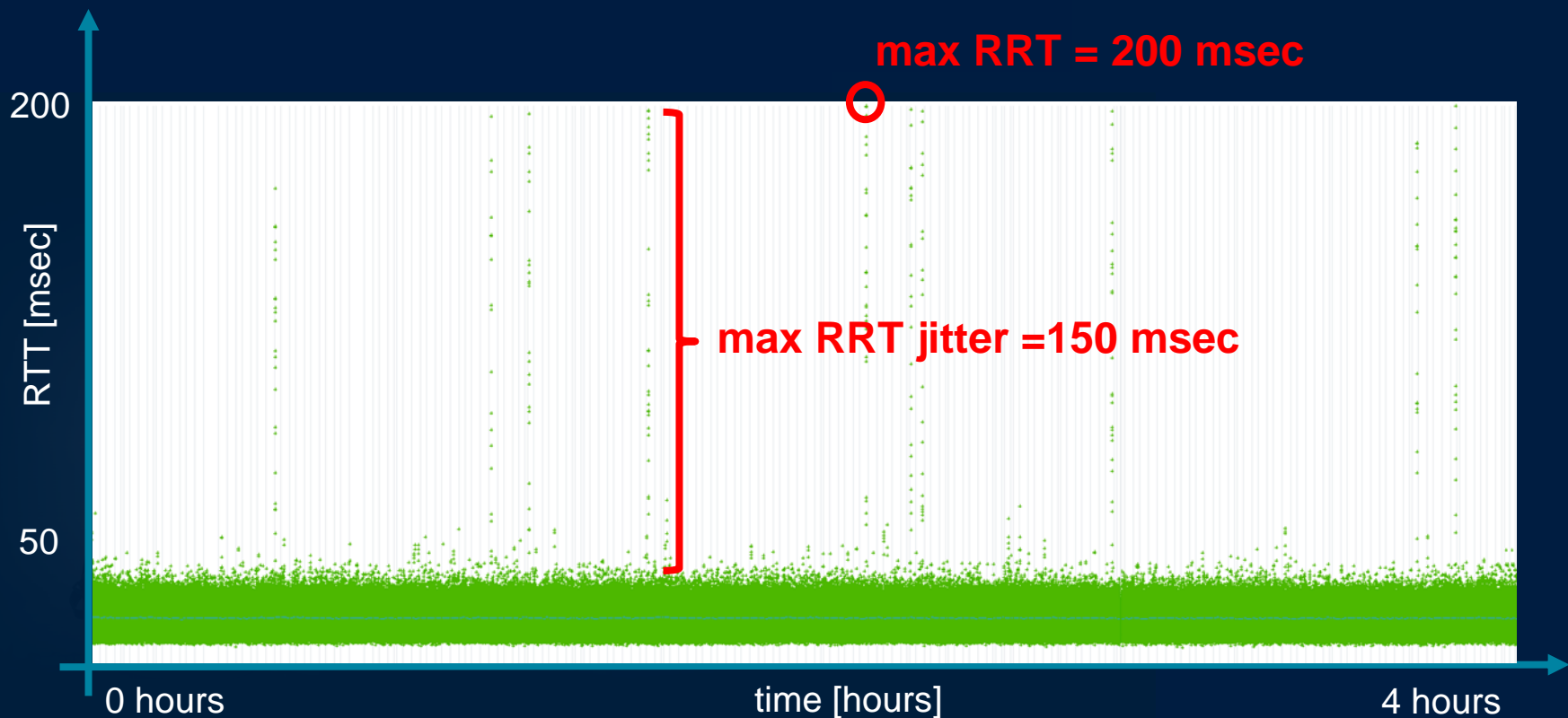
Maximum time between two packages
(in left example 100 msec)

-> max RRT for IP packages < 100 msec

Maximum time difference between two
messages
(in left example 20 msec)

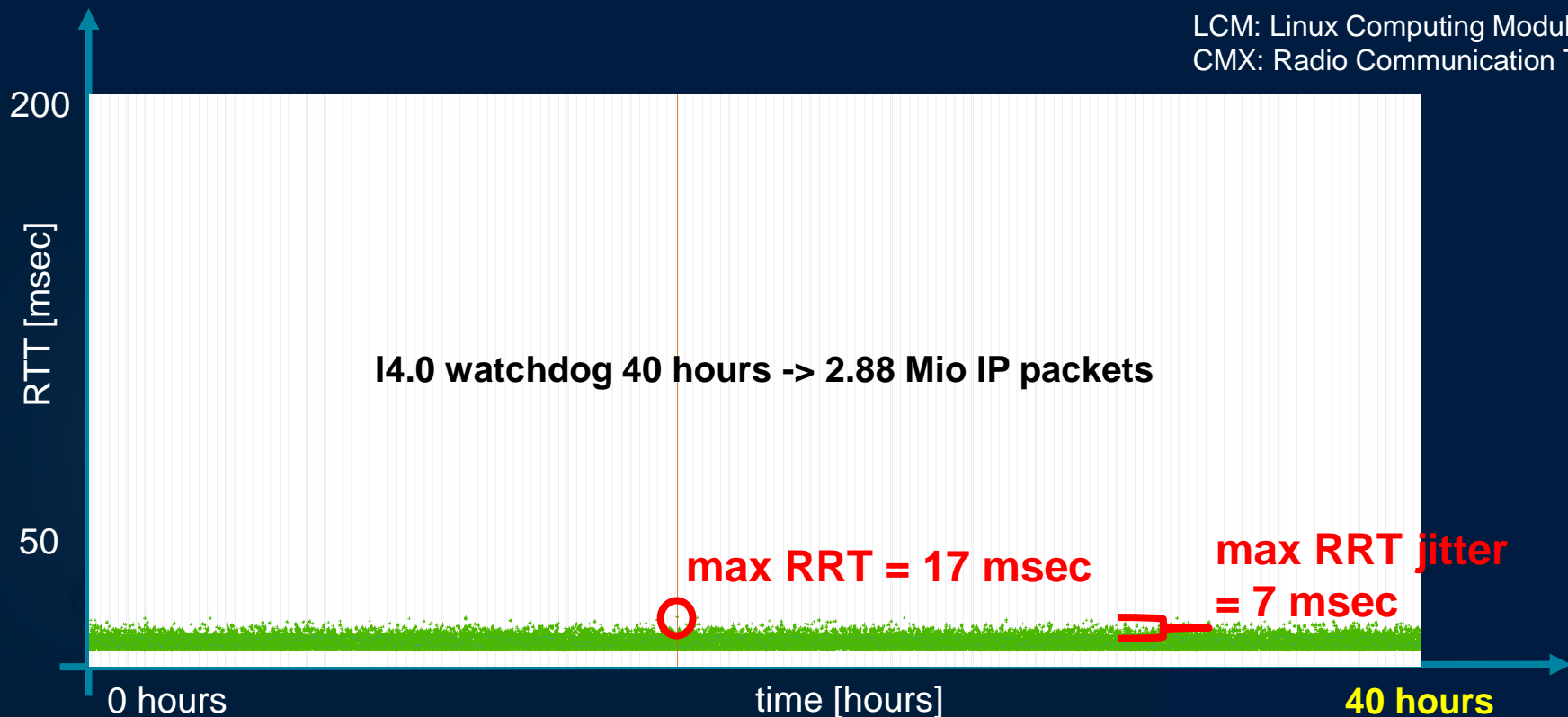
-> max RRT jitter for IP packages
< 20 msec

Measuring RRT of IP packages (real 5G network)



Measuring RRT of IP packages (LCM + CMX)

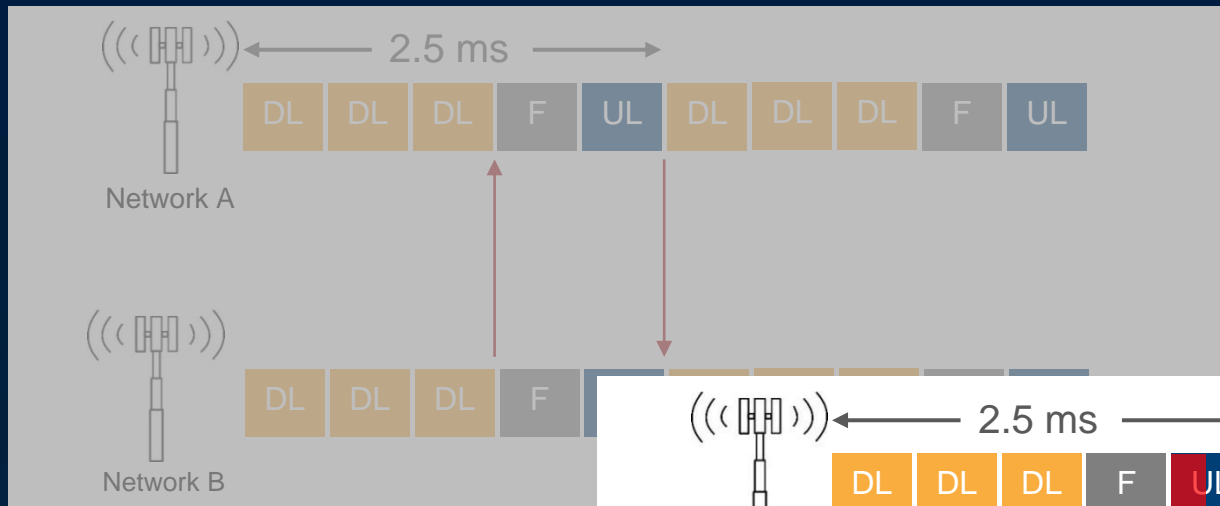
LCM: Linux Computing Module
CMX: Radio Communication Tester



Essential performance learnings from private and public 5G networks

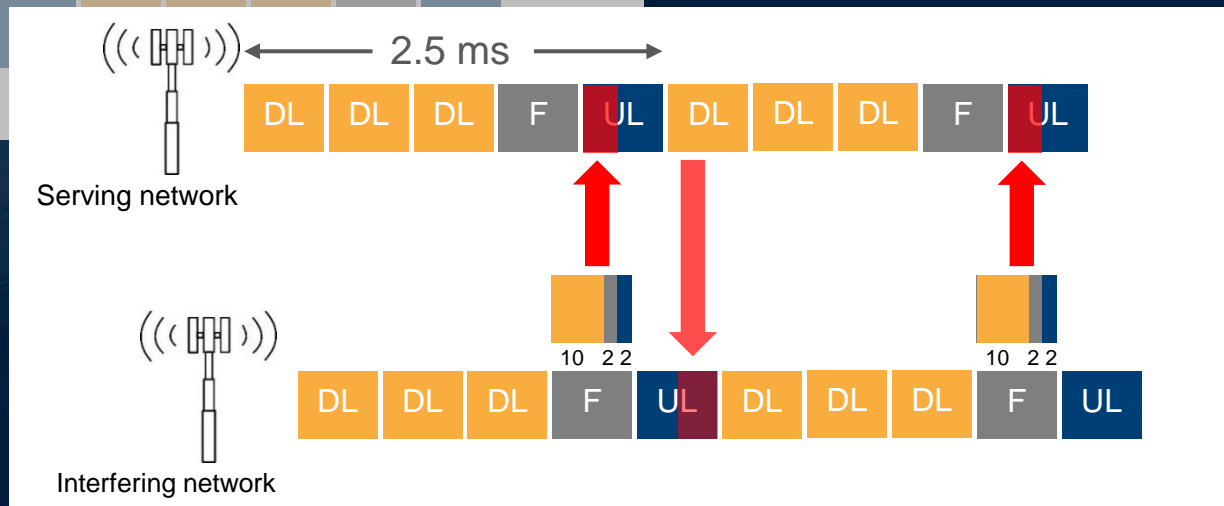
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What is TDD synchronization

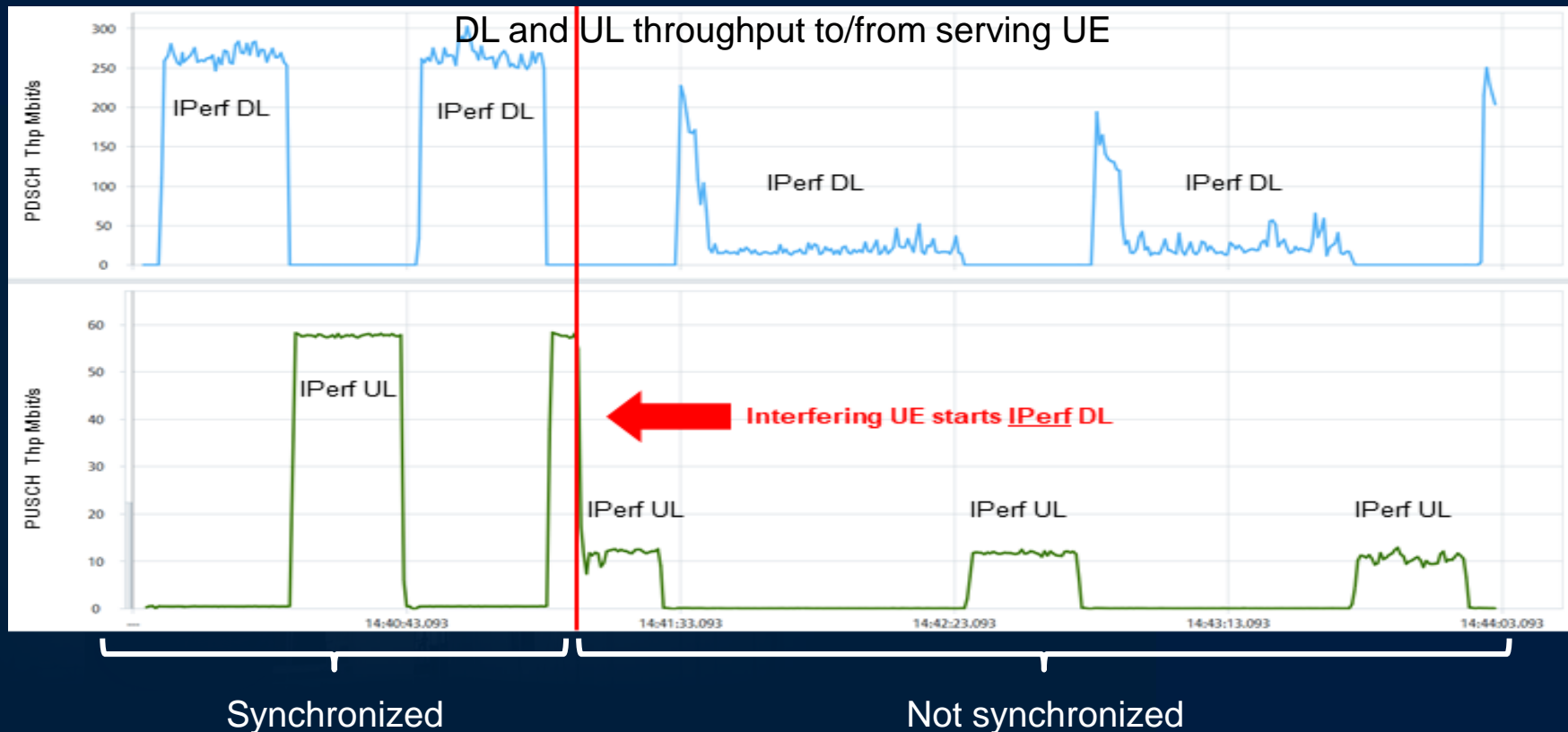


Synchronized

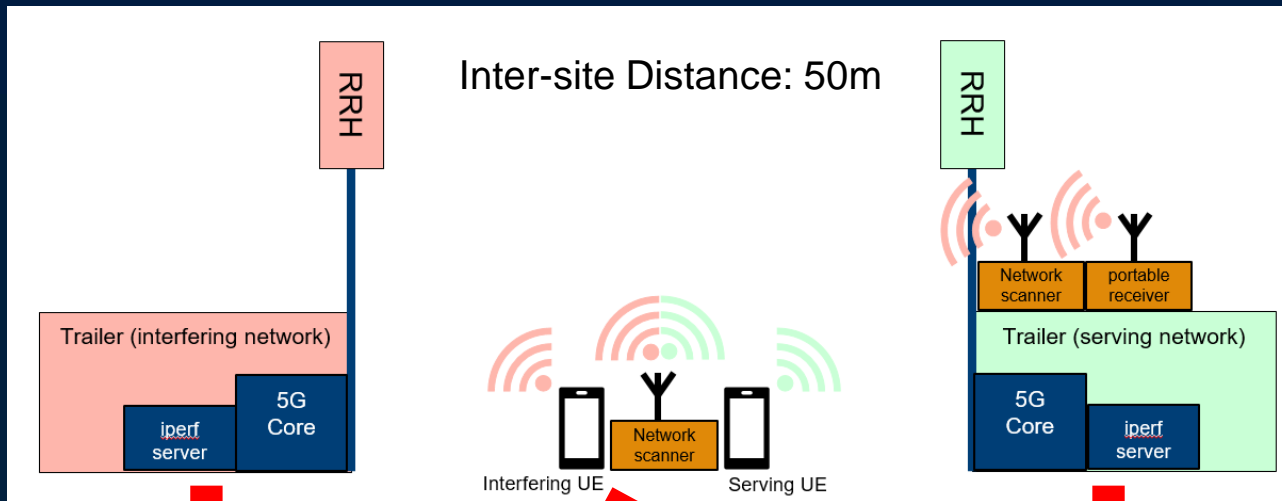
Not synchronized



Throughput effect - non synchronized TDD 5G networks



Measurement setup

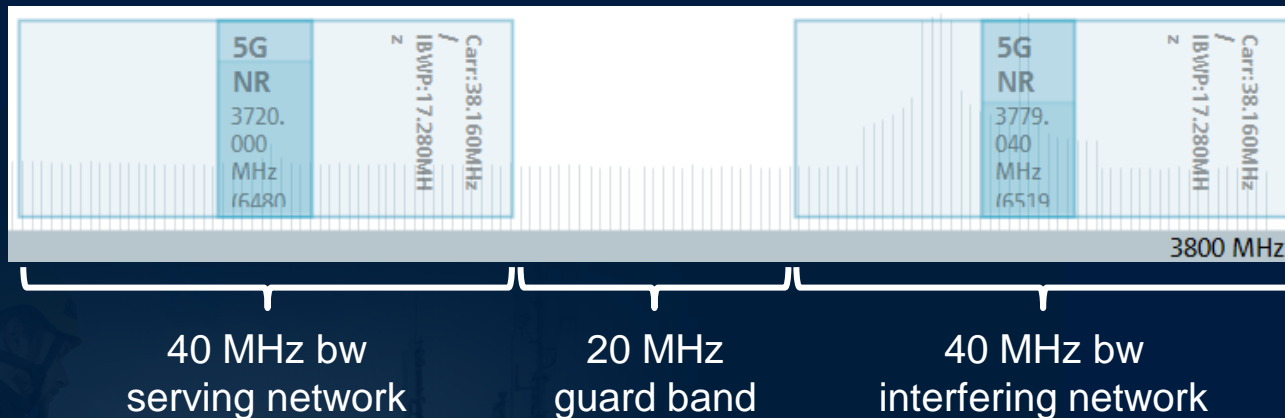


Each trailer: 5G system with two remote radio heads (RRH), a baseband unit (BBU), core network and a local edge cloud.

RRHs use a transit power of 8 W (39 dBm) connected to an antenna with 10 dB gain.



Measurement setup and intermodulation



[Performance degradation due to asynchronous 5G networks | Rohde & Schwarz](#)



[Webinar: Performance degradation due to asynchronous 5G networks | Rohde & Schwarz](#)

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Insights latency test failed threshold (20 msec)

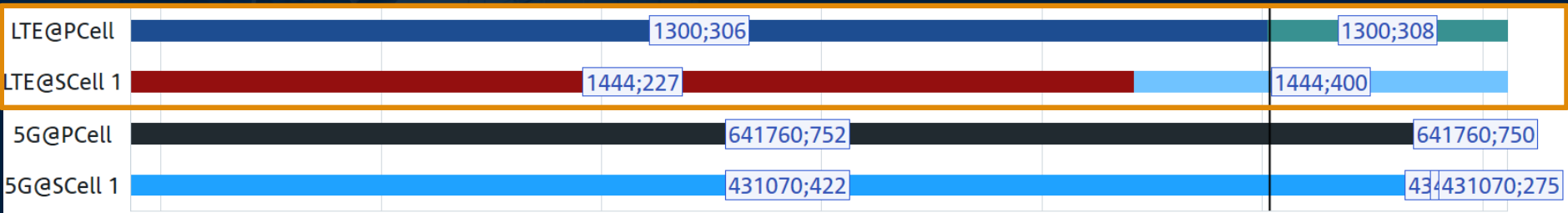
ROMES Insights Items List View

DQA Job List		User Entry										
?	Job Name	Start Time	Stop Time	Result	Threshold	Insights	Duration	RAT	RAT			
1	QP Interactivity	14:34:27.894	14:34:27.894	Succeeded	Achieved	None	0s	LTE	LTE			
2	QP Interactivity	14:34:27.894	14:34:27.894	Succeeded	Achieved	None	0s	LTE	LTE			
3	QP Interactivity	14:34:27.894	14:34:42.061	Succeeded	Achieved	None	14s	5G EN-DC, ...	5G EN-DC, ...			
4	QP Interactivity	14:34:44.829	14:35:17.024	Succeeded	Achieved	Available	32s	5G EN-DC	5G EN-DC			
5	QP Interactivity	14:35:19.443	14:35:50.659	Succeeded	Achieved	Available	31s	5G EN-DC	5G EN-DC			
6	QP Interactivity	14:35:54.314	14:36:25.515	Succeeded	Achieved	Available	31s	5G EN-DC	5G EN-DC			
7	QP Interactivity	14:36:27.199	14:36:58.459	Succeeded	Not Achieved	Available	31s	5G EN-DC	5G EN-DC			
8	QP Interactivity	14:37:00.530	14:37:31.759	Succeeded	Achieved	None	31s	5G EN-DC	5G EN-DC			
9	QP Interactivity	14:37:34.971	14:38:06.193	Succeeded	Achieved	None	31s	5G EN-DC	5G EN-DC			
10	QP Interactivity	14:38:08.871	14:38:40.193	Succeeded	Achieved	Available	31s	5G EN-DC	5G EN-DC			
11	QP Interactivity	14:38:42.836	14:39:14.070	Succeeded	Achieved	Available	31s	5G EN-DC	5G EN-DC			
12	QP Interactivity	14:39:16.593	14:39:47.860	Succeeded	Achieved	Available	31s	5G EN-DC	5G EN-DC			
13	QP Interactivity	14:39:51.108	14:40:22.336	Succeeded	Achieved	Available	31s	5G EN-DC	5G EN-DC			
14	QP Interactivity	14:40:23.961	14:40:55.155	Succeeded	Achieved	Available	31s	5G EN-DC	5G EN-DC			

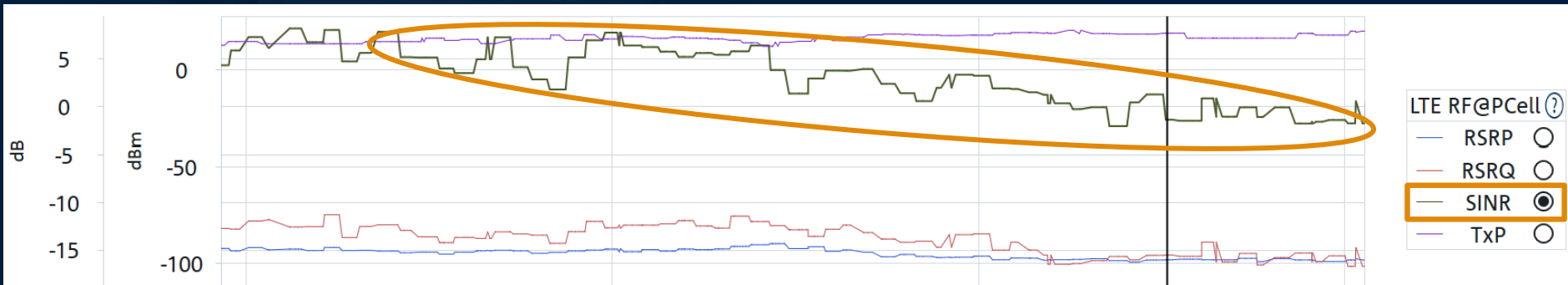
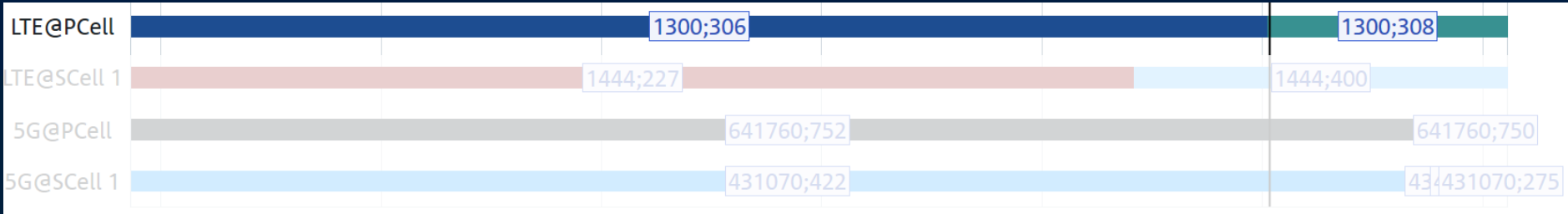
Insights handover – clearly readable insight

ROMES Insights View

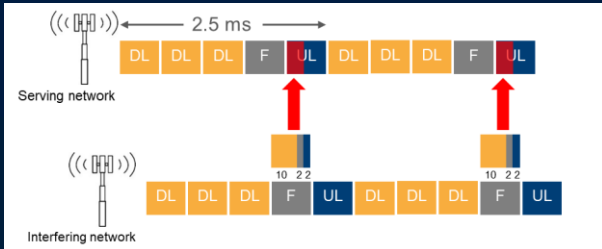
?	Time	Time End	Severity	Category	Sub-Categ...	Insight	Test	Information
1	14:36:18.351	14:36:27.951	high	RF (LTE)	DL Coverage	RSRQ exceeds Threshold	QP Interactivity	RSRQ exceeds Threshold for 9.600 seconds (3 times)
2	14:36:21.085	14:37:10.123	high	RF (5G NR)	DL Coverage	SINR exceeds Threshold	QP Interactivity	SINR exceeds Threshold for 49.038 seconds (5 times)
3	14:36:30.511	14:36:37.191	high	RF (LTE)	DL Coverage	RSRQ exceeds Threshold	QP Interactivity	RSRQ exceeds Threshold for 6.680 seconds
4	14:36:32.703	14:36:38.243	high	RF (5G NR)	DL Coverage	RSRQ exceeds Threshold	QP Interactivity	RSRQ exceeds Threshold for 5.540 seconds
5	14:36:42.228	14:37:15.137	high	RF (LTE)	DL Coverage	RSRQ exceeds Threshold	QP Interactivity	RSRQ exceeds Threshold for 32.909 seconds (3 times)
6	14:36:42.228	14:37:15.636	high	RF (LTE)	DL Coverage	SINR exceeds Threshold	QP Interactivity	SINR exceeds Threshold for 33.408 seconds (3 times)
7	14:36:43.303	14:37:05.623	high	RF (5G NR)	DL Coverage	RSRQ exceeds Threshold	QP Interactivity	RSRQ exceeds Threshold for 22.320 seconds (3 times)
8	14:36:58.459	n.a.	medium	Applicati...	RTT	Threshold of 20.00 ms i...	QP Interactivity	Threshold of 20.00 ms is not met by 23.61 ms



Insights handover – KPI view over time



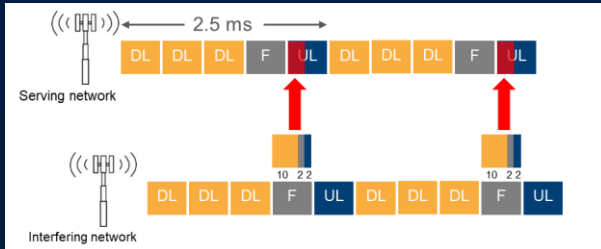
Insights synchronization



ROMES Insights View

?	Time	Time...	Severity	Category	Sub-Category	Insight
1	15:44:59.973	15:48:...	high	RF (5G NR)	ToA Out of Sync (Channel)	5G NR Scanner ToA Out of Sync
2	15:45:06.274	15:48:...	high	RF (5G NR)	ToA Out of Sync (Channel)	5G NR Scanner ToA Out of Sync
3	15:45:06.274	15:48:...	high	RF (5G NR)	ToA Out of Sync (Band)	5G NR Scanner ToA Out of Sync
4	15:45:06.982	15:48:...	high	RF (5G NR)	ToA Out of Sync (Channel)	5G NR Scanner ToA Out of Sync
5	15:45:51.391	n.a.	medium	L2 PDCP-RLC	Transfer	5G NR DL PDCP PDU out of order
6	15:47:23.062	n.a.	medium	L2 PDCP-RLC	Transfer	5G NR DL PDCP PDU out of order
7	15:46:07.984	n.a.	medium	PHY PDSCH	Transmission	Too many retransmission occurred 19888 ti

Insights synchronization



ROMES Insights View

? Information

- 1 5G NR Scanner ToA Out of Sync: NR-ARFCN 638304: 720-0 @ -109.44 dBm AND 921-0 @ -107.29 dBm, Max RSRP: -9...
- 2 5G NR Scanner ToA Out of Sync: NR-ARFCN 631968: 254-4 @ -109.17 dBm AND 337-3 @ -103.49 dBm, Max RSRP: -8...
- 3 5G NR Scanner ToA Out of Sync: Band 78: 648000-62-0 @ -69.74 dBm AND 651936-69-0 @ -59.7 dBm, Max RSRP: -59...
- 4 5G NR Scanner ToA Out of Sync: NR-ARFCN 641760: 699-1 @ -75.06 dBm AND 614-0 @ -94.58 dBm, Max RSRP: -72.3...

Summary

5G throughput is delivered as expected – private networks need more uplink

Latency needs to be improved – we do not need the 1 msec but reliable 20 msec

Long term measurements/monitoring essential to improve latency reliability

In TDD bands all networks need to be synchronized and use same TDD pattern

TDD pattern changes require measurements to prevent conflicts and apply filtering.

▶ Rohde & Schwarz – the one-stop-shop for 5G TDD network measurements in public and private networks

Test. Measure. Innovate

THANK YOU
VERY MUCH

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Make ideas real

