Cellular IoT verification with Keysight Nemo solutions

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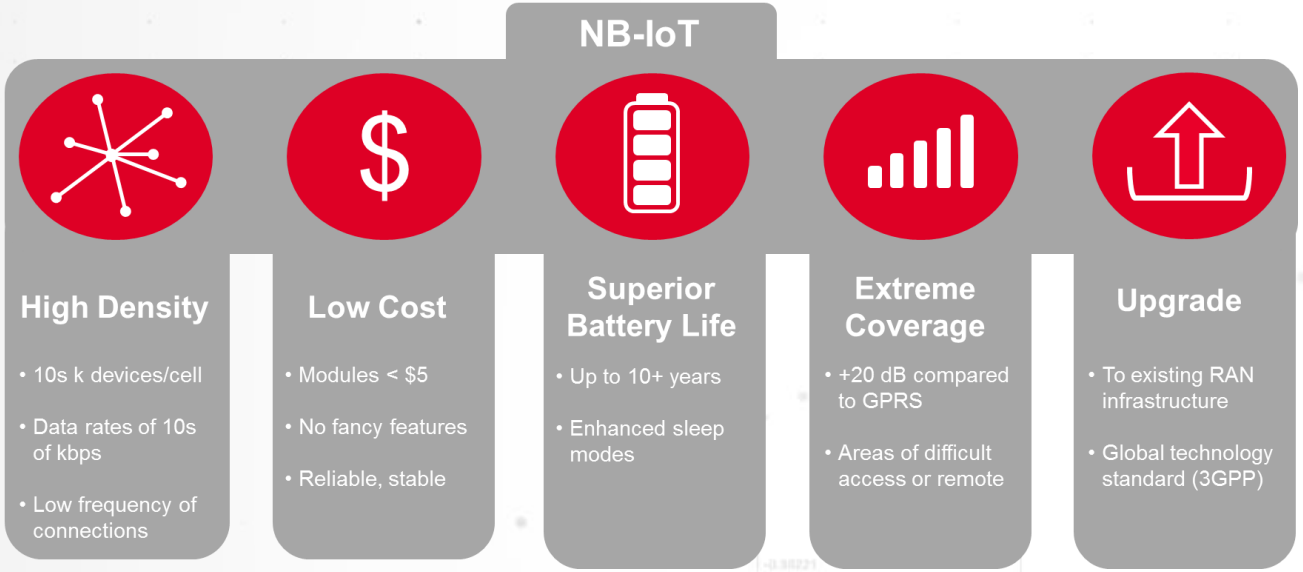
Keysight Nemo Wireless Network Solutions

KEYSIGHT TECHNOLOGIES

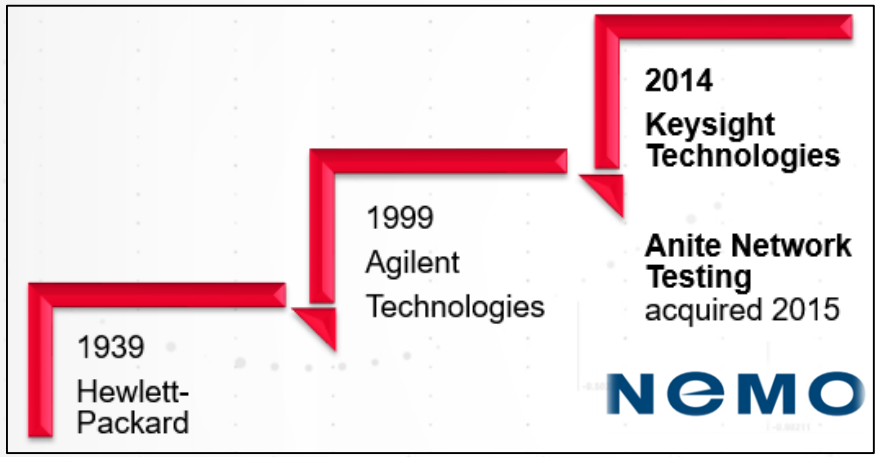
IoT Network coverage correlate with battery lifetime

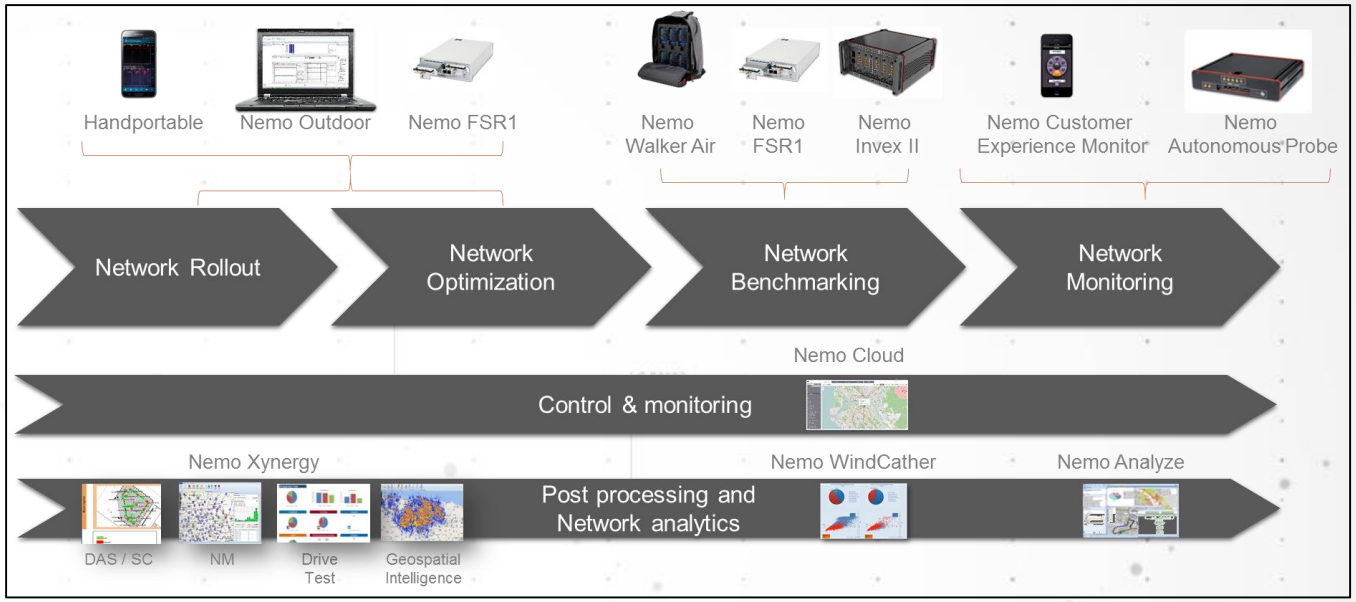


- IoT devices are typically installed into basements and cellars where the network signal is weak
- Need to verify good connection quality to ensure targeted 10 years battery lifetime of IoT device.
- Repetitions occur in weak conditions, consuming the battery fast

- IoT Service coverage
- Field performance
- Device power consumption
- Stability and reliability
- Network capacity verification

Keysight Nemo wireless network testing solutions



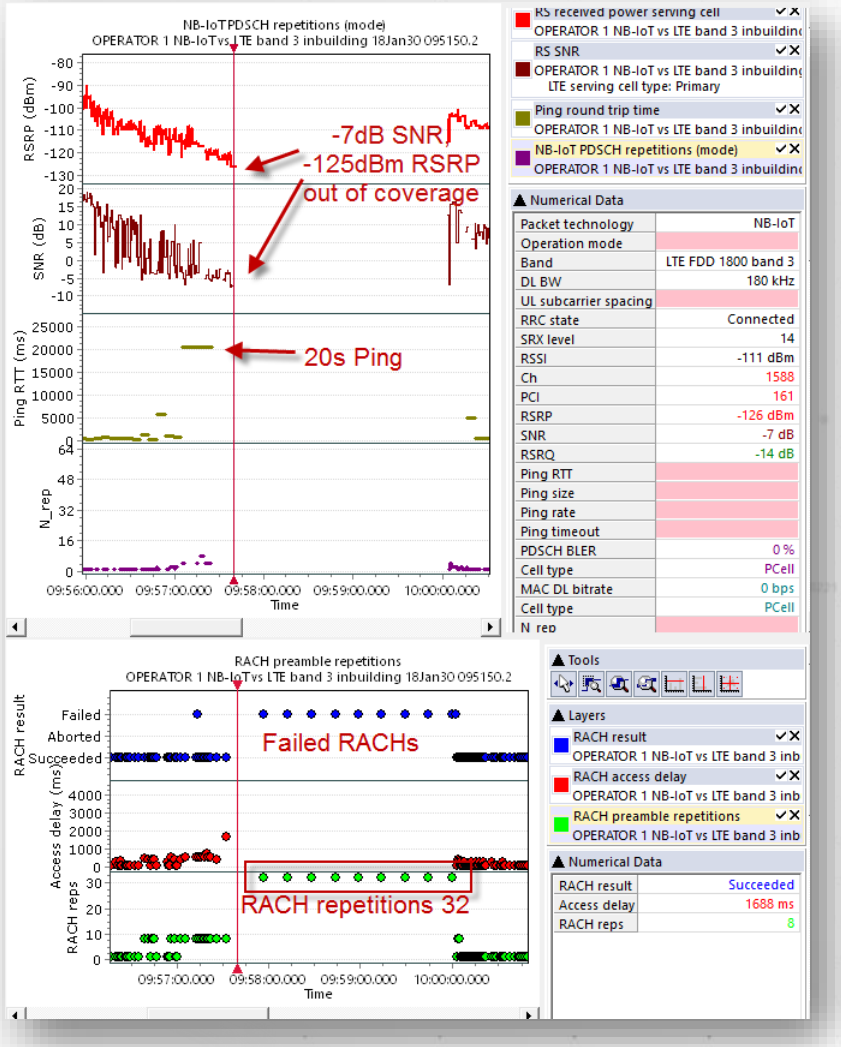


- Over 15 years expertice of all 3GPP technologies
- Nemo serves the wireless ecosystem:
  - Mobile operators
  - Network equipment manufacturers
  - Chipset vendors
  - Regulatory authorities
  - Service contractors

Nemo products are used by more than 400 mobile operators, network equipment manufacturers, service contractors and regulatory bodies from over 100 countries worldwide

Impressive Keysight Nemo IoT analytics as today

Advanced analytics



Over 130 KPI's

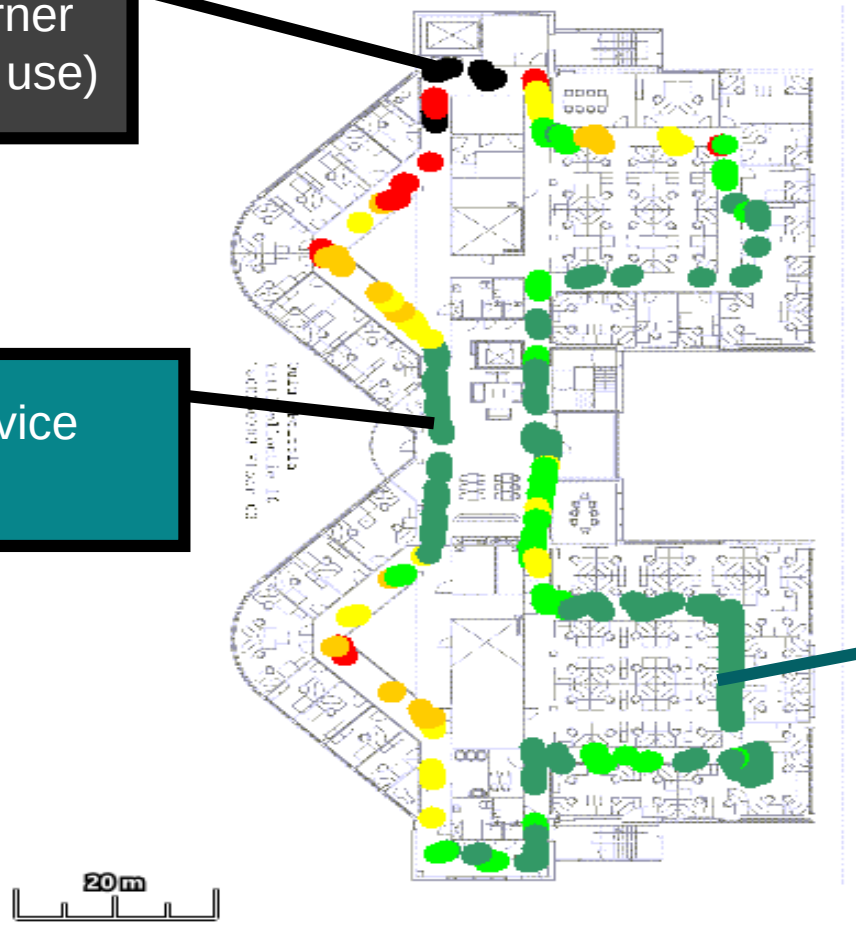
NB-IOT	Operator 1	Operator 2
RF Metrics		
RSRP serving cell Avg	-89.51 dBm	-72.27 dBm
RS SNR serving cell Avg	12.93 dB	14.74 dB
PRB utilization DL Avg	0.34 %	0.40 %
PRB utilization UL Avg	0.43 %	0.61 %
TX power PUSCH Min	-18.00 dBm	-9.00 dBm
TX power PUSCH Max	23.00 dBm	23.00 dBm
TX power PUSCH Avg	12.85 dBm	1157.36%
NB-IoT Metrics		
NB-IoT PUSCH subcarriers 1x3.75MHz	1.24%	
NB-IoT PUSCH subcarriers 1x15MHz	15.46%	100.00%
NB-IoT PUSCH subcarriers 12x15MHz	83.30%	
NB-IoT PUSCH repetitions Min	1	1
NB-IoT PUSCH repetitions Max	64	1
NB-IoT PUSCH repetitions Avg	1.45	1.00
NB-IoT PDSCH repetitions Min	1	1
NB-IoT PDSCH repetitions Max	32	1
NB-IoT PDSCH repetitions Avg	1.71	1.00
RACH Metrics		
RACH access delay Max	1659 ms	432 ms
RACH access delay Avg	126.02 ms	114.25 ms
RACH preamble repetitions Min	1	4
RACH preamble repetitions Max	8	4
RACH preamble repetitions Avg	1.46	4.00
RACH success	1178	299
RACH failed	28	2
RACH success rate	97.68 %	99.34 %
RACH preamble count Avg	1.06	1.00
RACH preamble initial TX power Max	23 dBm	15 dBm
RACH preamble initial TX power Avg	-4.67 dBm	-9.99 dBm
RACH PUSCH power Max	23 dBm	15 dBm
RACH PUSCH power Avg	-4.73 dBm	-9.95 dBm
RACH pathloss Avg	106.77 dB	91.97 dB

Can show any IoT KPI on a map

Verify coverage to minimize IoT device power consumption and secure connection quality

High power consumption corner (weak field ➔ 64 repetions in use)

Good places for IOT device installation



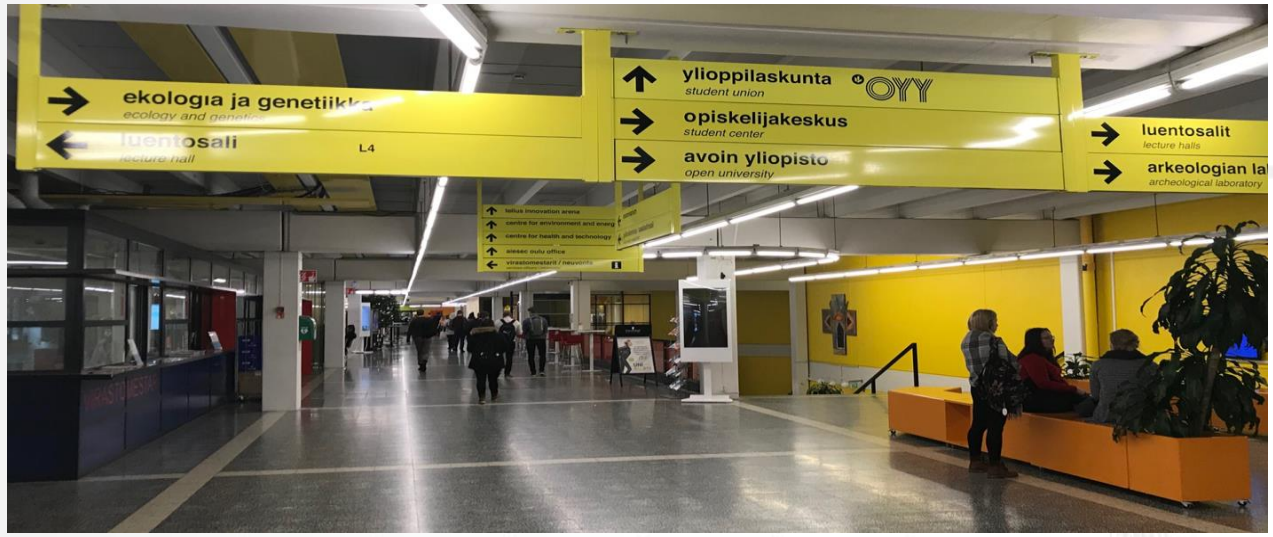
Layers
OPERATOR 1 NB iot vs LTE inbuilding floor 3 18Jan
TX power PUSCH (TX power (dBm))
Description = group3

Color Legends
TX power (dBm) [Distance/m]

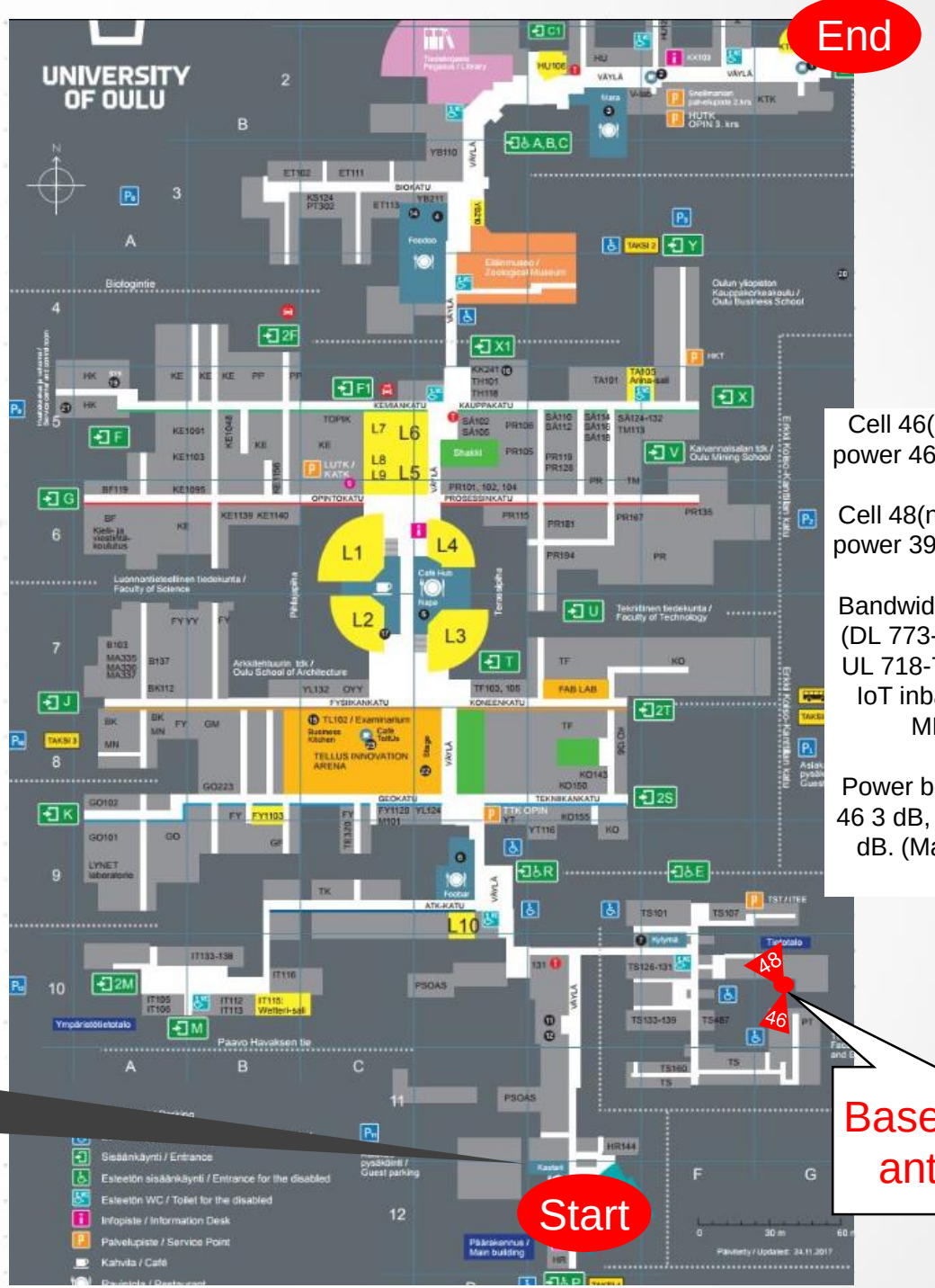
<= 0	103	42.92%
> 0 and <= 5	44	18.33%
> 5 and <= 10	37	15.42%
> 10 and <= 15	32	13.33%
> 15 and <= 20	14	5.83%
> 20	10	4.17%

Good places for IOT device installation

Tested IOT here in Oulu University



Started the measurement from Saalastinsali where we are now



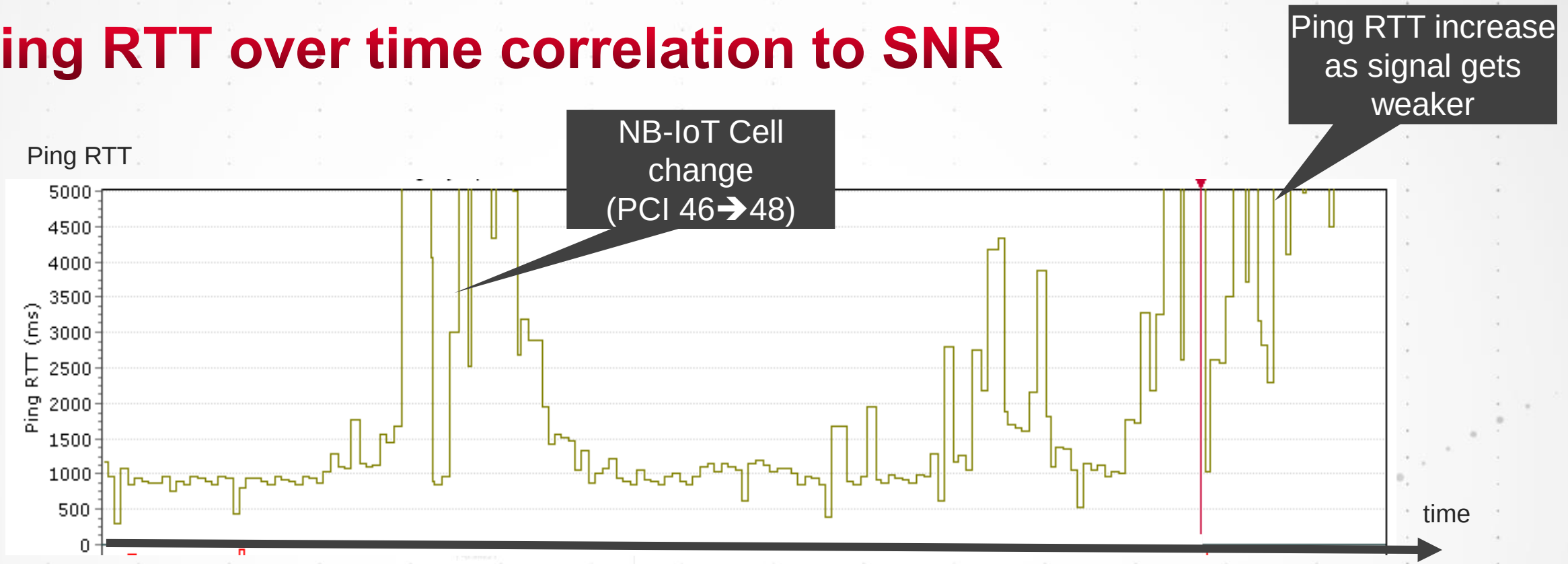
Cell 46(to south) power 46dBm/40W

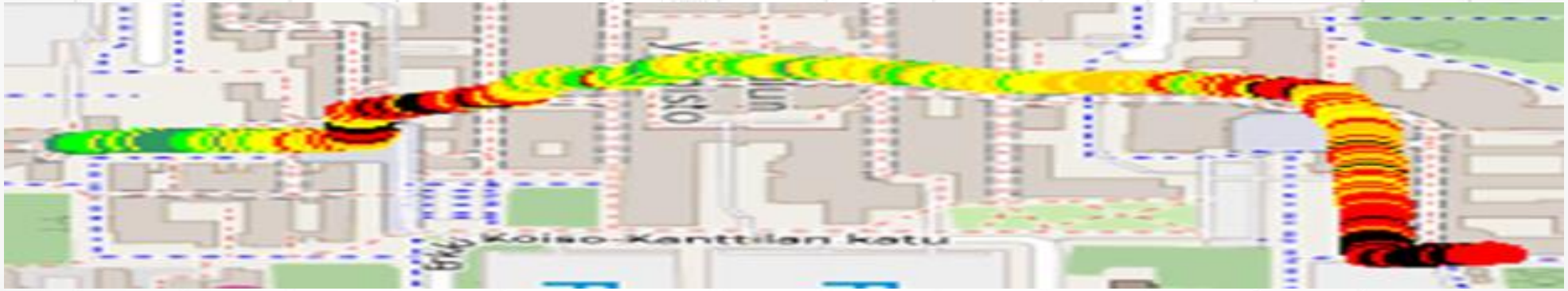
Cell 48(northwest) power 39 dBm/8W.

Bandwidth: 5 MHz (DL 773-778MHz, UL 718-723), NB-IoT inband: 0.2 MHz.

Power boost: Cell 46 3 dB, Cell 48: 0 dB. (Max. 6dB)

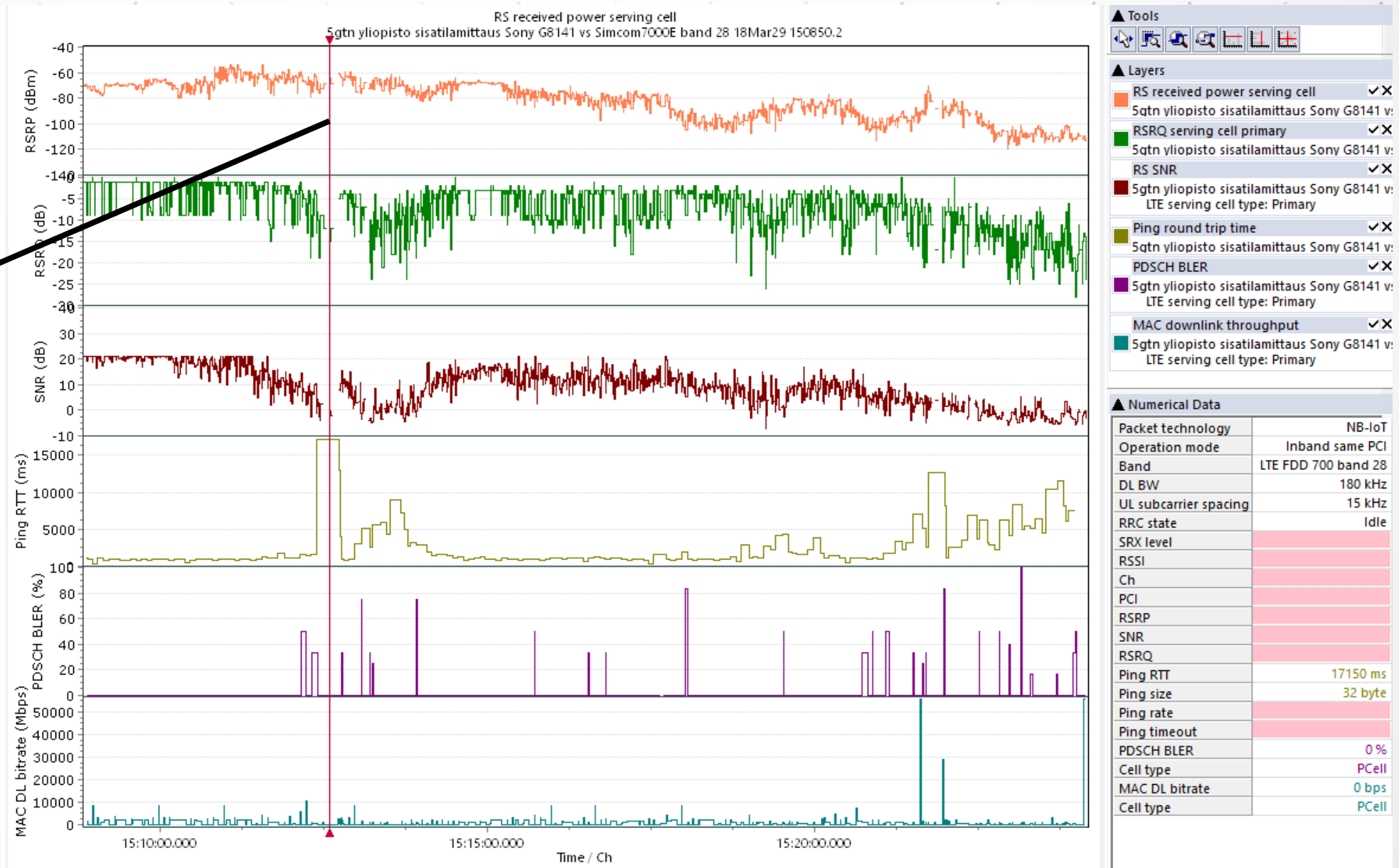
Ping RTT over time correlation to SNR





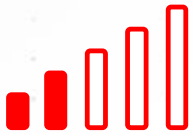
Nb-IoT Cell change caused Ping RTT to peak up

Cell change from PCI 46 to 48

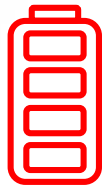


Other Keysight Nemo IoT use cases

✓ **Coverage**



✓ **Power consumption**



- **Early lab/field testing**
  - Understanding the IoT technology and its limits
  - Nemo Tools provide view of the complete radio stack, including application performance, key radio metrics, and control plane signalling

- **Device Benchmarking**
  - Differences in device performance and network interoperability due to antennas and housing
  - Verify device performance in field
  - Compare new devices to reference devices

- **Network Acceptance**
  - Key KPIs: Coverage and inbuilding penetration, Accessibility, Data Throughput, Latency
  - Stationary/Mobility testing

- **Network Benchmarking**
  - NB-IOT performance & coverage of competitor networks
  - Coverage impacts the battery life of IoT devices

- **SLA verification**
  - For virtual IoT service providers and verticals
  - Verify the service level and coverage
  - Battery life heavily dependent on coverage!

- **Troubleshooting of end to end IoT connectivity issues**
  - Root causes for air interface issues
  - Differentiating of device, radio, and core network issues
  - Full L3 and RRC signaling decoding
  - Signal coverage and quality
  - Detailed connection diagnostics: repetitions, modulation, subcarrier spacing, RACH metrics

- **Quick analysis** with predefined playback templates in Nemo Outdoor and Nemo Analyze

Keysight Nemo IoT Solution summary

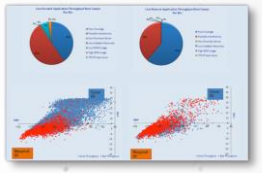
Key features

- All data collection form factors supported
- Over 165 detailed parameters and KPI's for Qualcomm and Neul chipset based IoT
- Easy to use graphical UI to control the IOT devices without need to know AT commands
- Effective troubleshooting and network optimization
- One comprehensive software platform with a holistic view for IoT KPI's
- Fast benchmarking of NB-IOT and LTE-M chipsets, devices, networks
- Comprehensive post processing analytics, customizable dashboards and KPI's e.g. IoT coverage and performance visualization on a map
- Script based automation

Analytics

Post-processing KPI's for NB-IoT and LTE-M

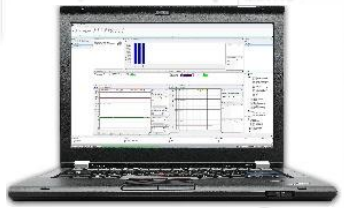
Nemo Analyze



Nemo WindCatcher

Control and monitoring

Troubleshooting, L1-L3 signaling, Real time metrics, Script based automation



Nemo Outdoor

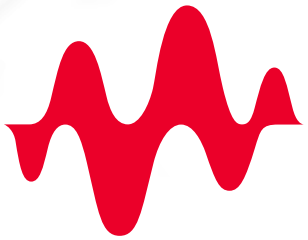
Data collection measurement tools

Handheld tools

Qualcomm chipsets based NB-IOT and LTE-M sticks

Neul chipsets based NB-IOT sticks

Scanners



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