# MACHINE LEARNING BASED QOE TESTING IN MOBILE NETWORKS

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Arnd Sibila – Technology Marketing Manager
Rohde & Schwarz Mobile Network Testing

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- AI/ML applied to Mobile Network Testing
- Case studies
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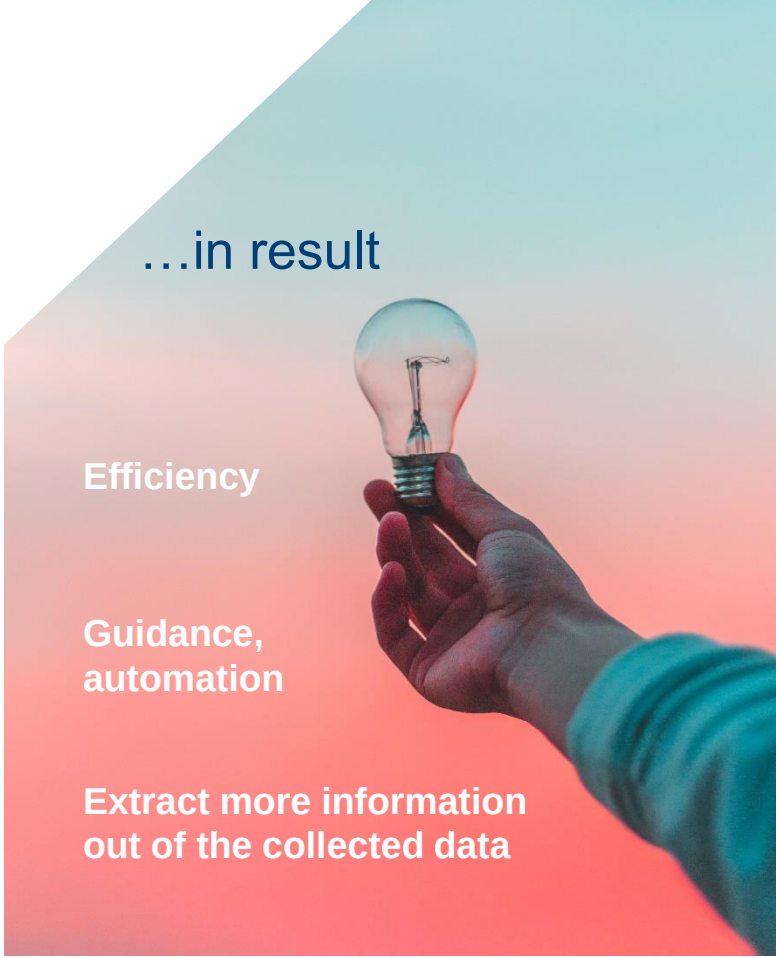
# CONTEXT AND DRIVERS FOR AI/ML IN MOBILE NETWORK TESTING

## Challenges

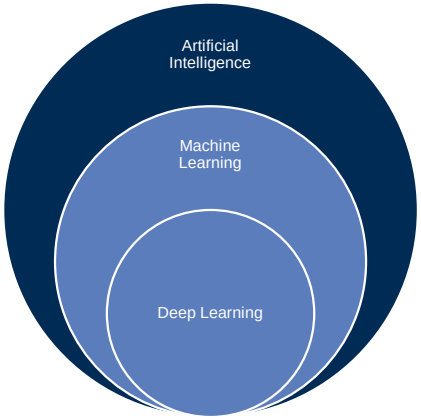
- Cost pressure
- Increased network complexity
  - 5G NR brings new use cases and flexibility
  - More critical performance and availability requirements
- Loss of Expertise
- Legacy, labor-intensive way to exploit data

MNO

## …in result



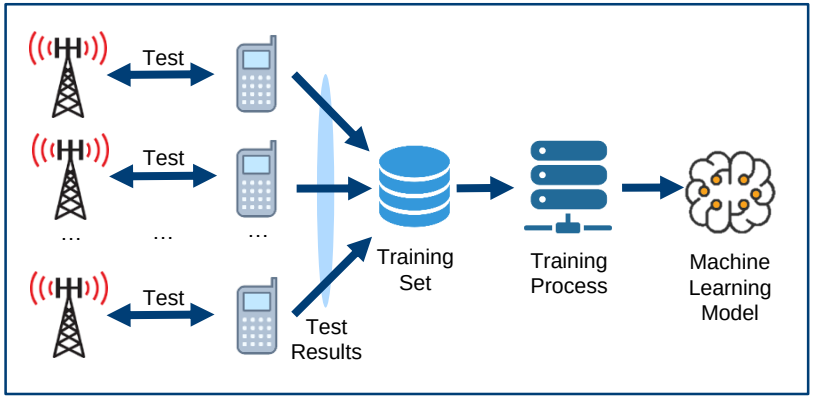
# MACHINE LEARNING ON MNT



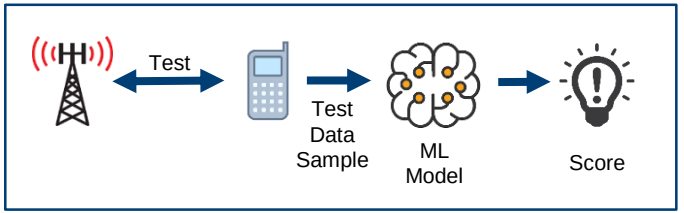

Types of machine learning:

- Supervised Learning
- Unsupervised Learning / Self-supervised Learning
- Semi-supervised Learning
- Reinforcement Learning
- Active Learning

**Training**



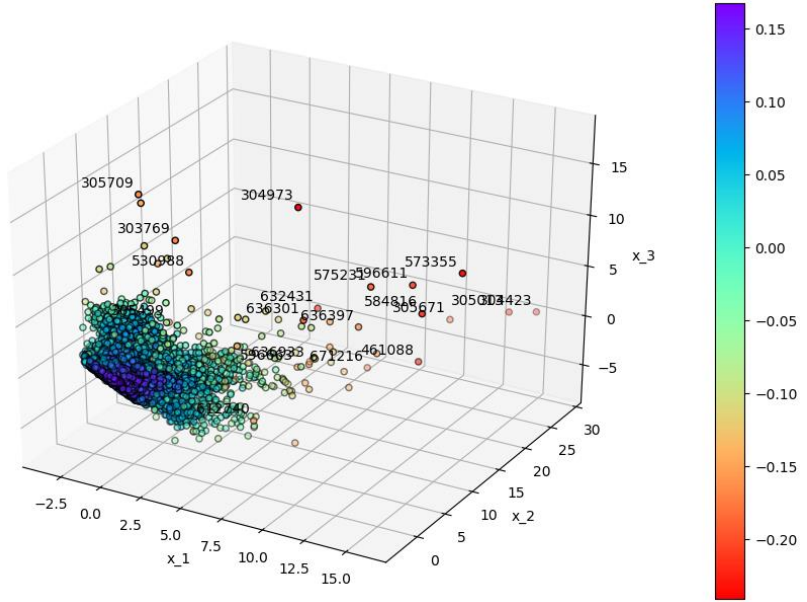

**Inference**



# USE CASES FOR MNT

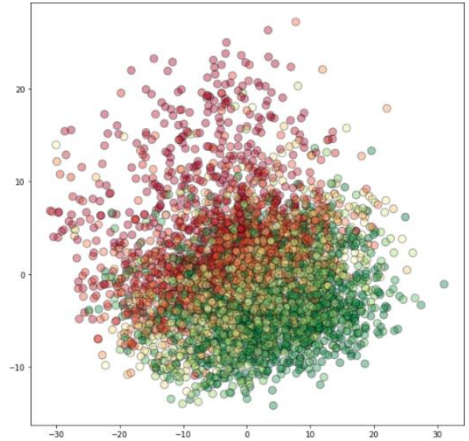
- Binary Test Scoring


- Time-based Anomaly Detection



# BINARY TEST SCORING

- Extract more value out of each test with binary result
- Patent pending
- Semi-supervised learning
- Applications:
  - Call Stability Score
  - Video Stability Score
  - Call Setup Score




Call Stability Score:

- Call Drop Rate (CDR) is a fundamental KPI to measure network performance.
- Measured from a binary result, the call either drops or not.

- We find levels of CDR of 1% (even less)
- Large number of calls to make the result statistically significant
- Calls may drop at different locations (chance factor)

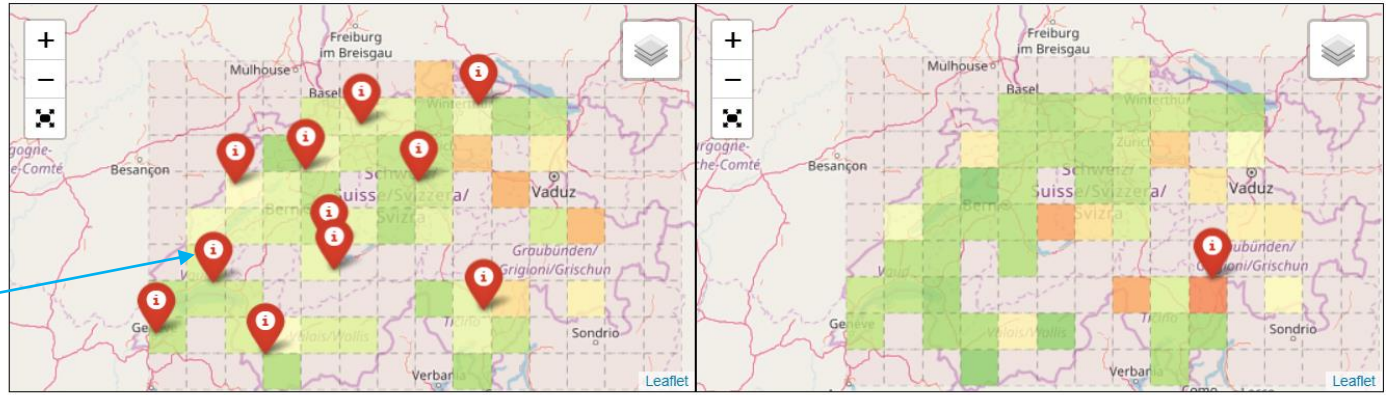
# CREATING MORE INSIGHTS THROUGH MACHINE LEARNING
## VISUALIZATION EXAMPLE

Operator A

Operator B

Aggregated call stability scores

Low stability scores markers

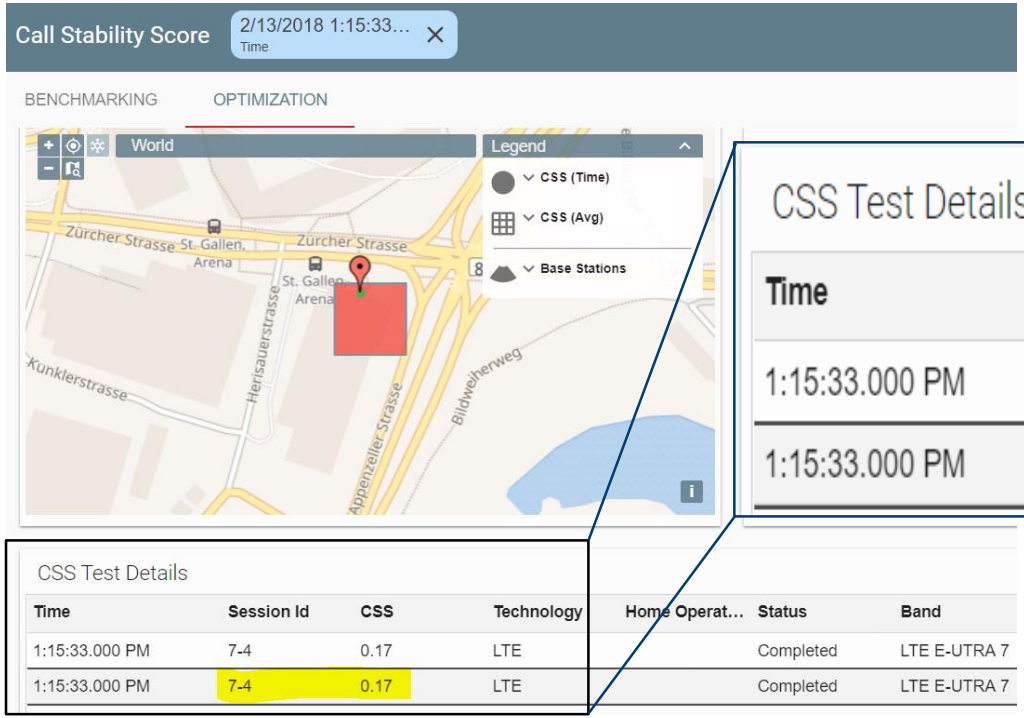


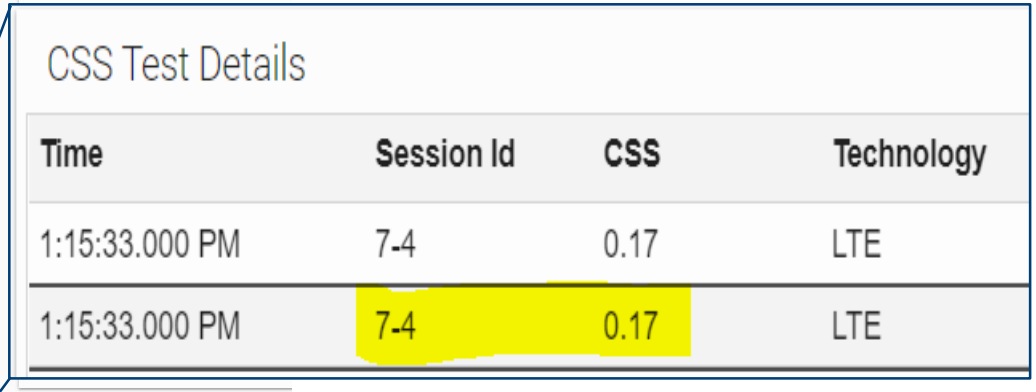

CDR: 0.20%
CSFR: 0.35%
Call Stability Score: 0.71

CDR: 0.25%
CSFR: 0.28%
Call Stability Score: 0.85

# CALL STABILITY SCORE – PROACTIVE IDENTIFICATION OF RISKY AREAS

1. **Drill-down: poor performing CSS area → and a guilty session with poor CSS, 0.17 (call was successful)**
2. Next step: straightforward session analysis



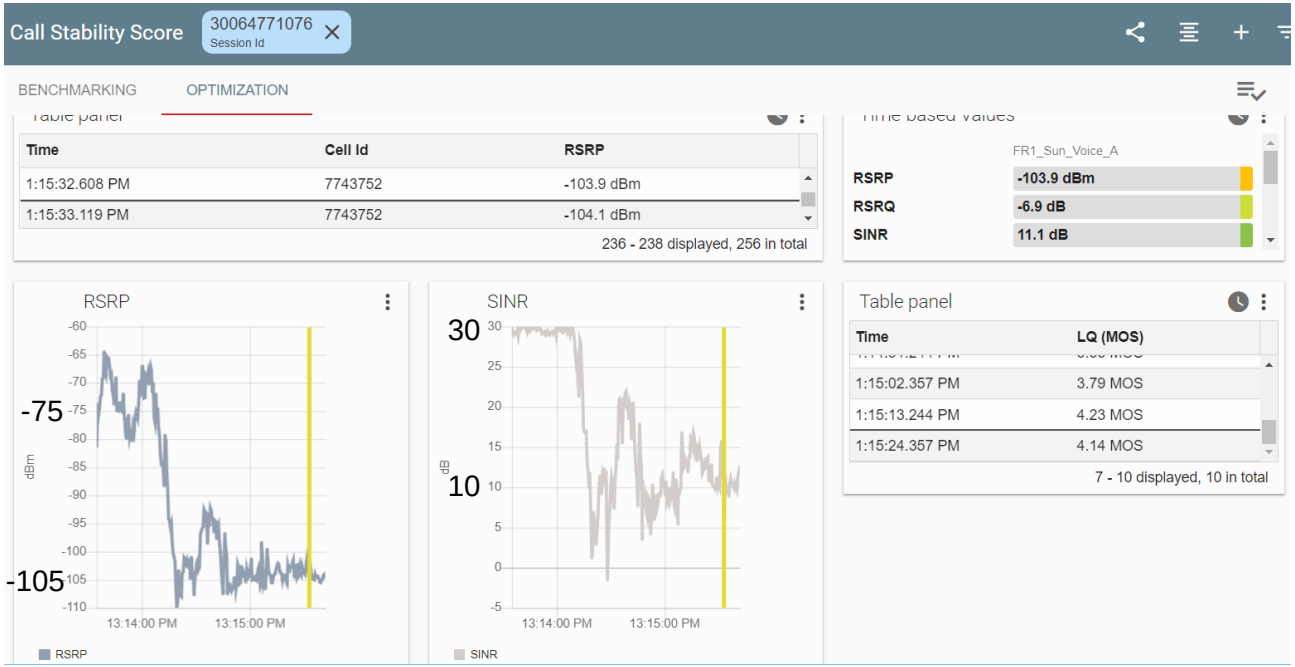



# CALL STABILITY SCORE – PROACTIVE IDENTIFICATION OF RISKY AREAS

1. Drill-down: poor performing CSS area → and a guilty session with poor CSS, 0.17 (call was successful)
2. **Next step: straightforward session analysis**

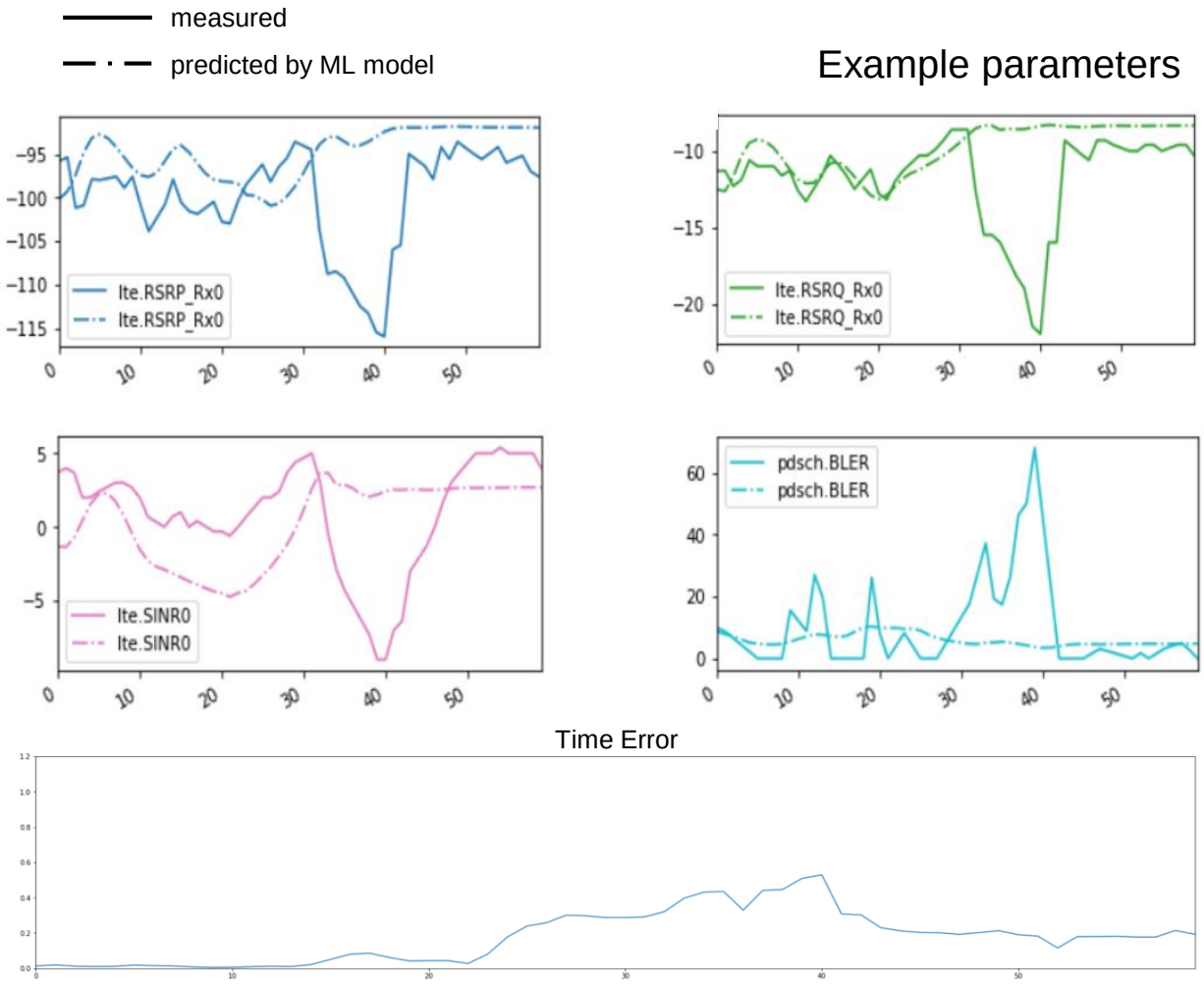
- Sudden drop of LTE RSRP and SINR
- Machine learning model provides a poor score
- Model learnt that calls with this behavior often dropped

- **Proactive identification of risky areas**
- **Obtain more value out of the collected data**
- **Expose previously hidden information**



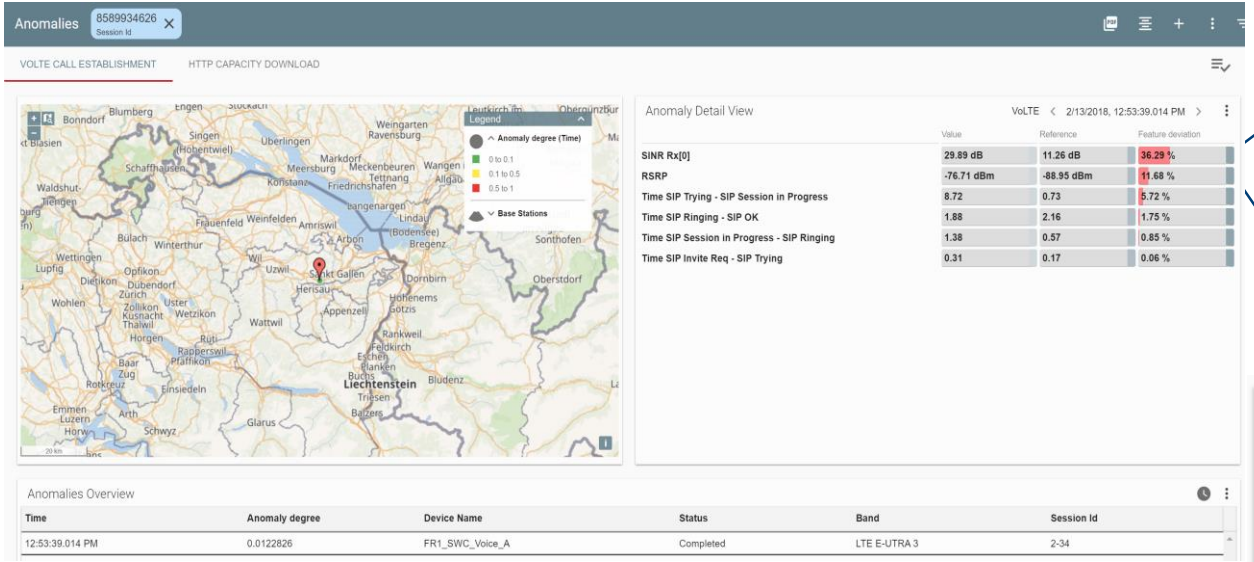
# TIME-BASED ANOMALIES

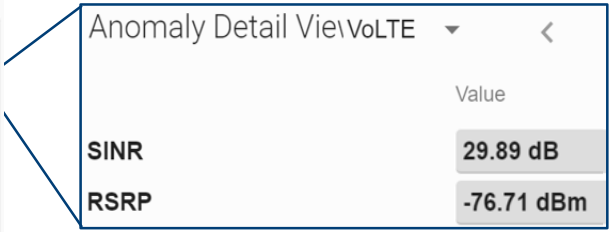
- Automate optimization by focusing on detected anomalies
- Unsupervised Learning
- Applications:
  - Call Setup
  - Capacity Download
  - Capacity Upload
  - Video Streaming
  - …

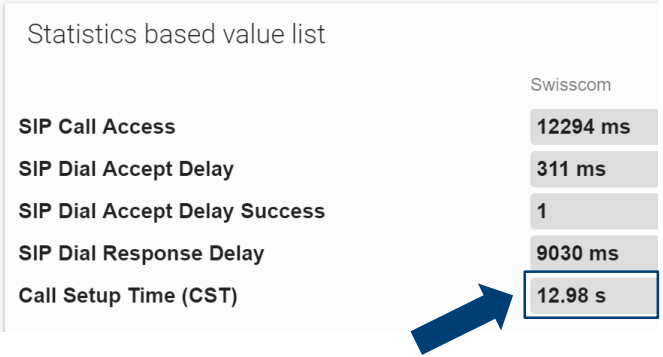


# ANOMALY DETECTION – GUIDING OPTIMIZATION

1. VoLTE call establishment
2. Establishment time is long (~13 sec) whilst having a very good radio environment




- Very good RSRP + very good SINR + very long CST = Anomaly!
- 5G: Time-based anomalies important due to many new parameters and high flexibility of data/configurations

# CREATING MORE INSIGHTS THROUGH MACHINE LEARNING
## SUMMARY OF THE BENEFITS

Extract more value out of the collected data

Efficiency

- Automatic calculation of the call stability score for every call. Every result becomes more meaningful. We maximize the number of usable/actionable test results by a dramatic factor
- Obtain meaningful results also from places where the “traditional” test result would not indicate any problem
- Less test data needed → save time in data collection
- Proactive identification of risky areas → ease network optimization
- Streamline analysis: Guided optimization
- 5G: ML-based models to detect and predict beam-forming related topics would be of high advantage

# LEARNINGS AND CONCLUSIONS

Increasing network complexity and cost-pressure

- More efficient / less labor-intensive methodology to extract key metrics

Machine Learning extremely valuable for mobile network analytics to extract deep insights into network performance

Call Stability Score and Anomaly Detection: identify risky areas and trends; guide optimization efforts

Outlook: 5G and Industry 4.0 offers many more use cases (high reliability → “data connection stability”, etc.)

https://blog.mobile-network-testing.com
www.rohde-schwarz.com/MNT-5G