Mobile Broadband Measurements Using

N RNET

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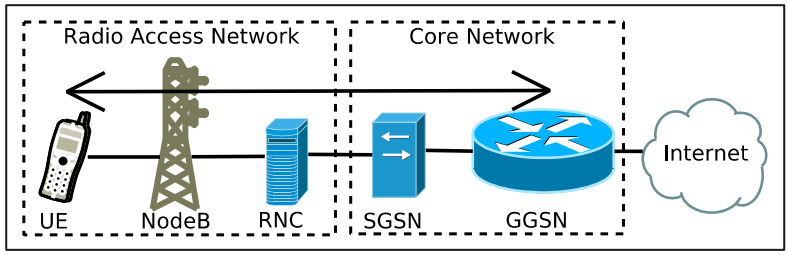
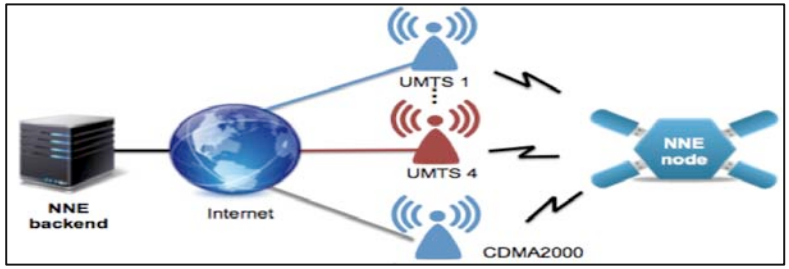
Simula Research Laboratory AS

28-Aug-14

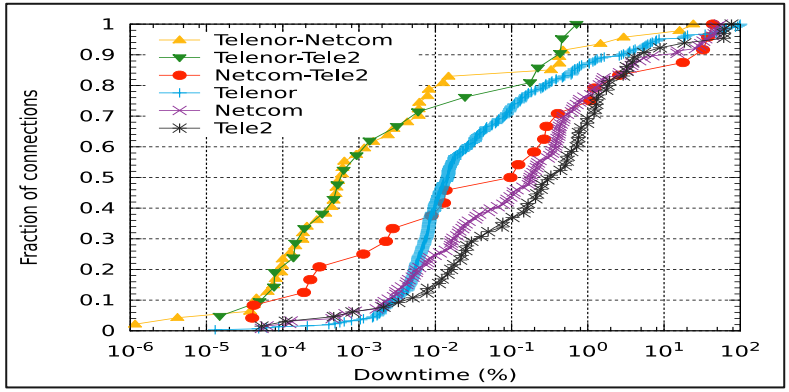
Agenda



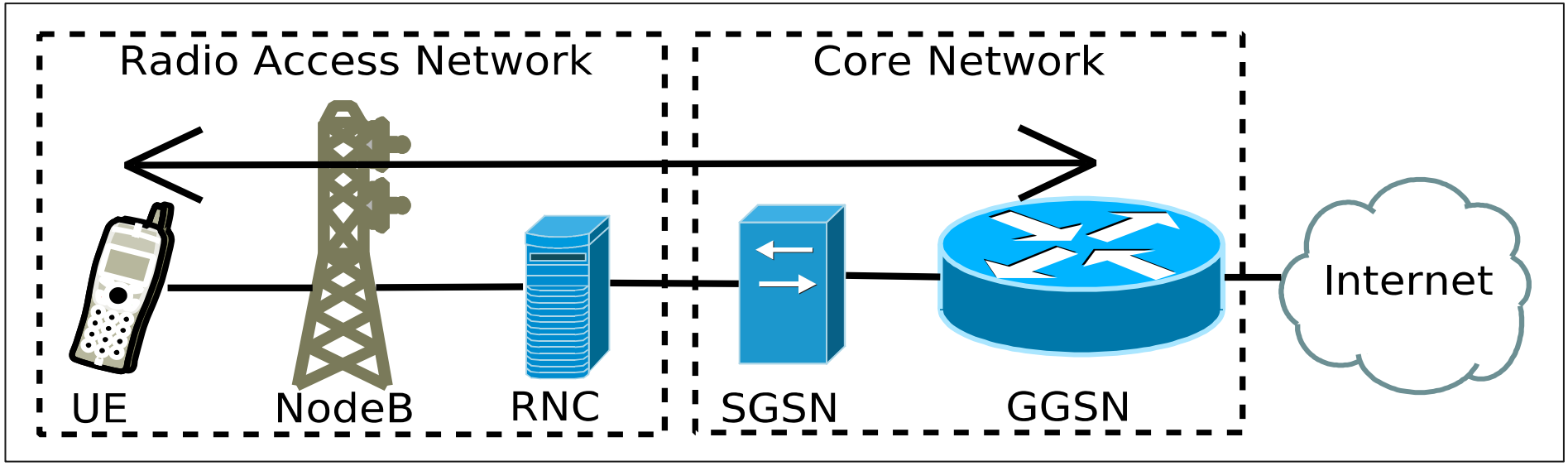
Introduction to measurement setup and MBB networks



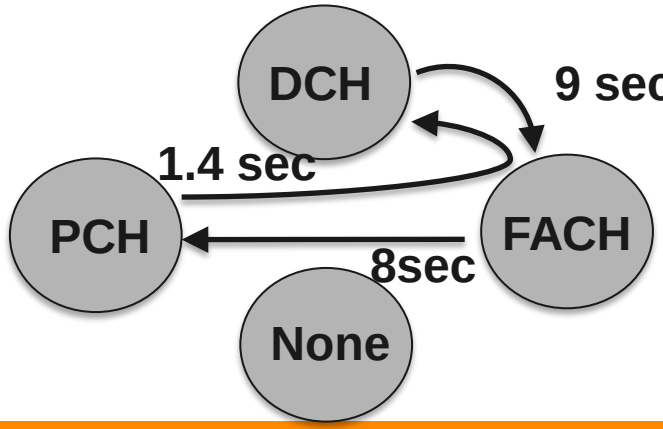
Measuring MBB reliability



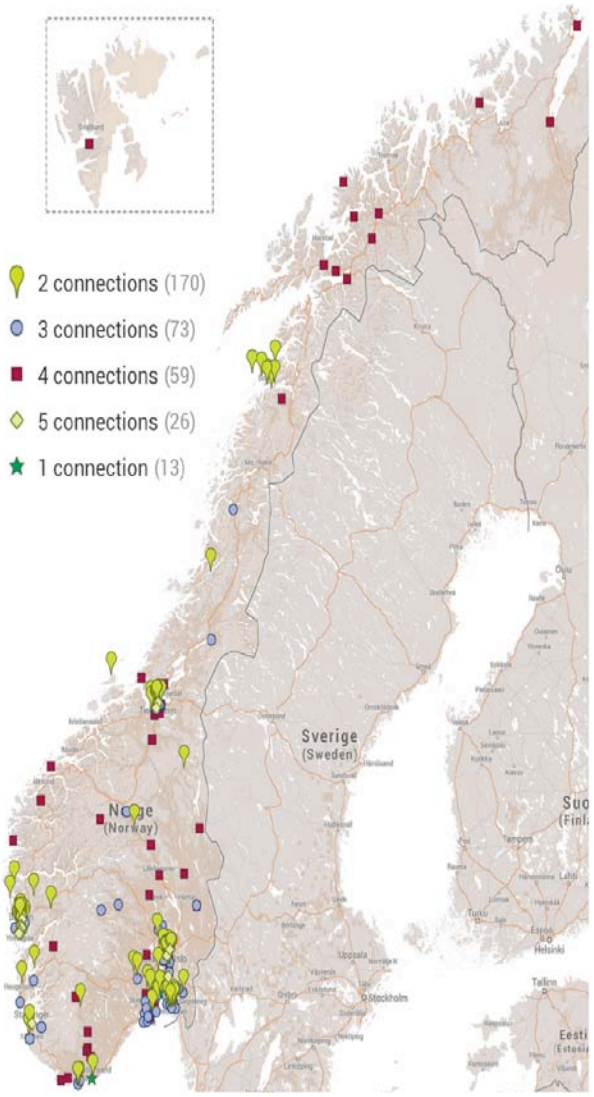
Can we improve MBB reliability?



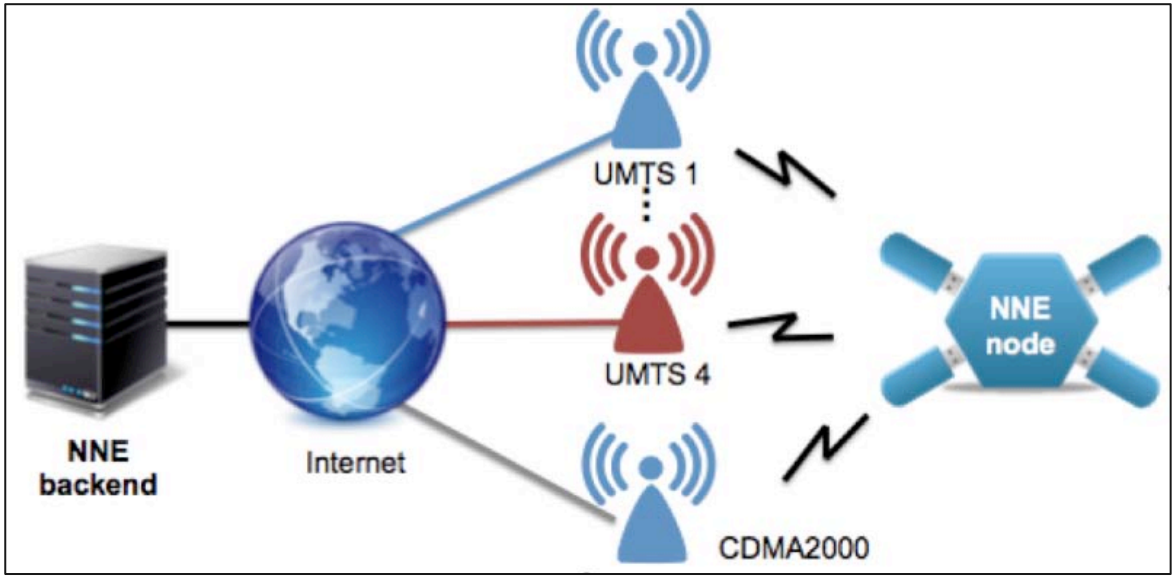
- **MBB networks are stateful**
- **Radio resources are managed and controlled via a comprehensive state machine**



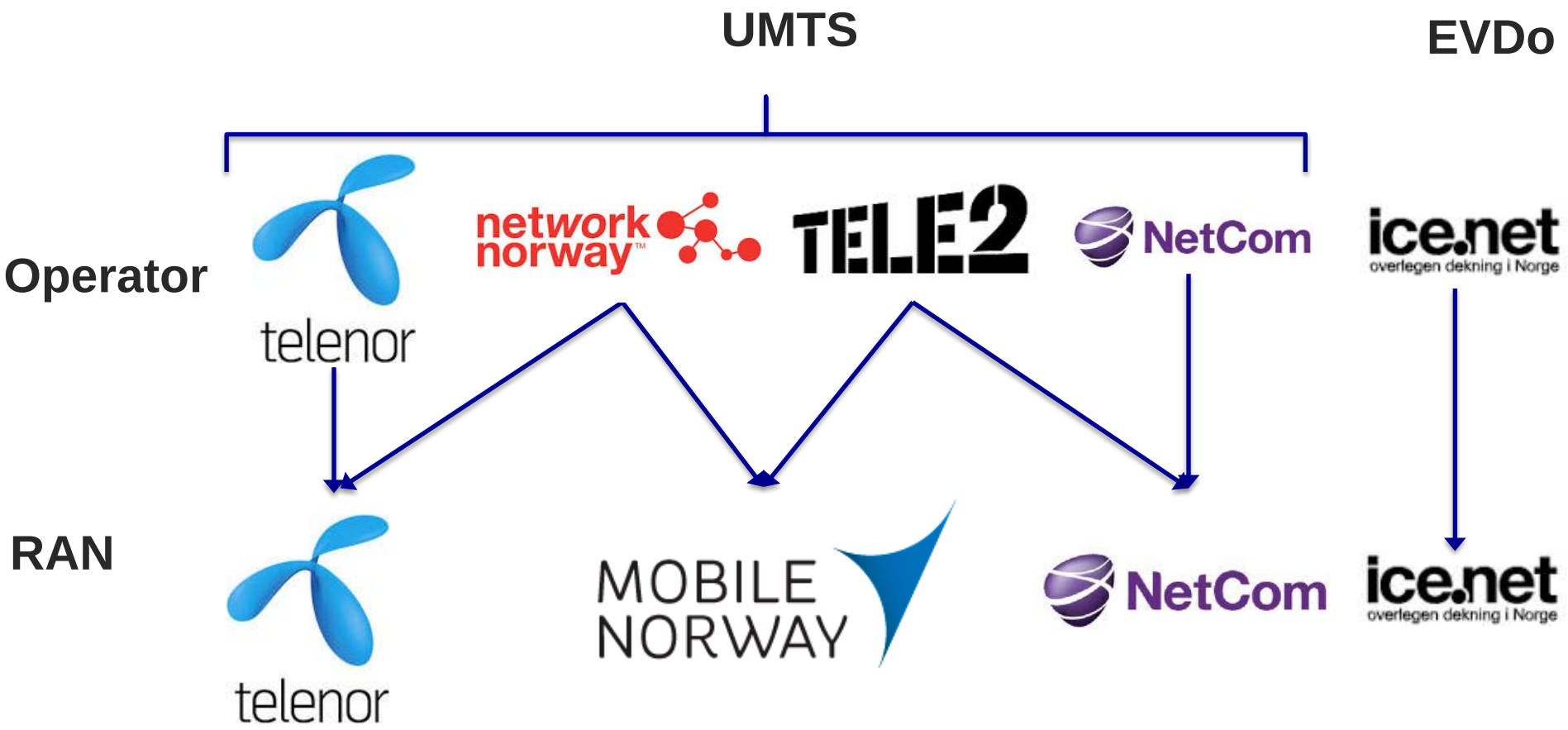
Nornet-Edge is a country-wide stationary infrastructure for measuring mobile broadband



- Hundreds of measurement nodes
- Five operators (4 UMTS+1 CDMA2000 1x Ev-DO)
- Fully operational since July 2013



A quick guide to the networks we measure



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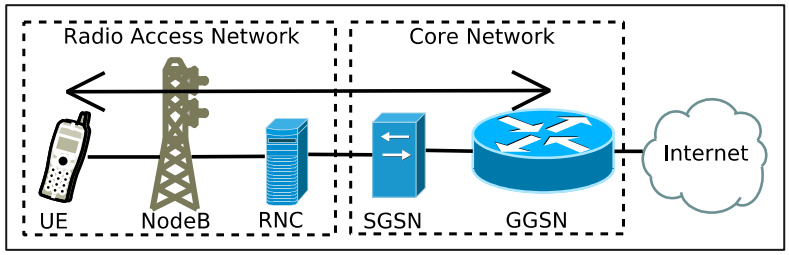
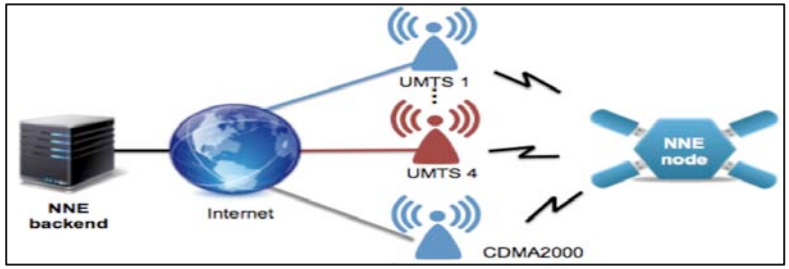


Introduction to MBB Networks and measurement setup



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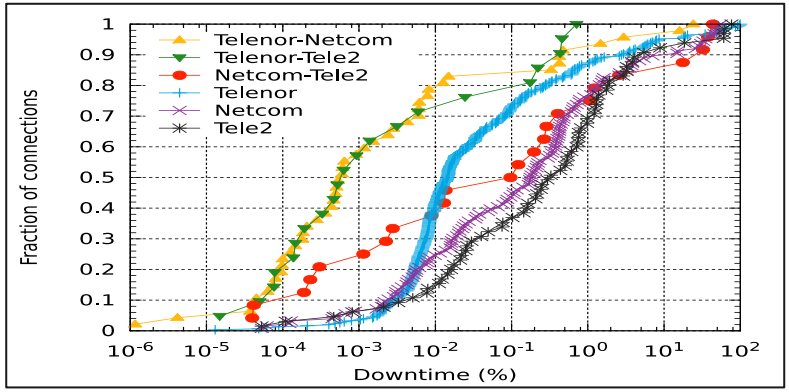
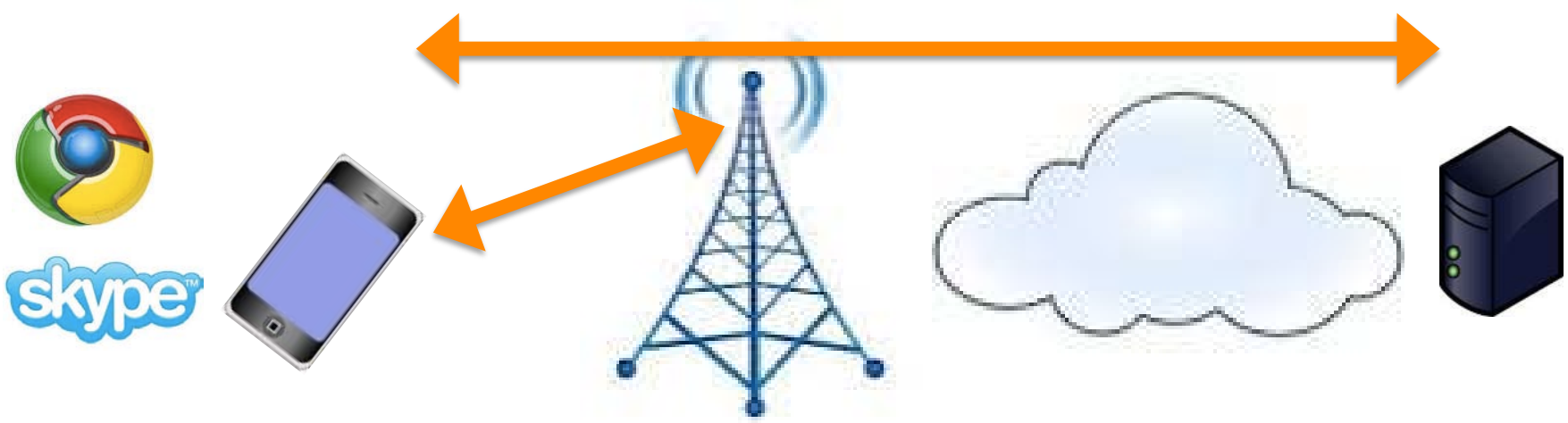


Can we improve MBB reliability?

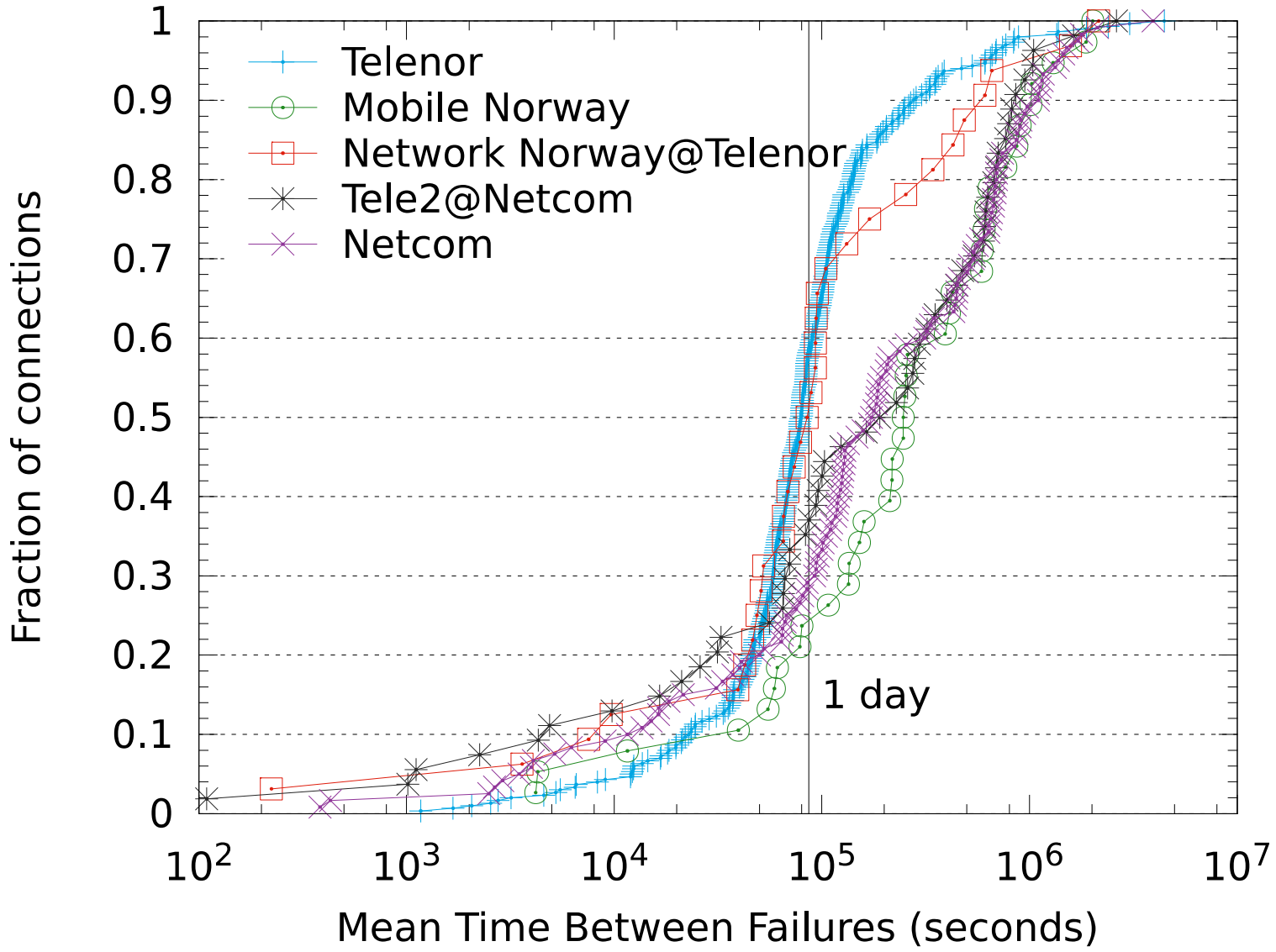
Reliability is a complex notion encompassing several stability and performance metrics

User experience	OSI layer	Metrics
Performance reliability	Application layer	HTTP throughput, VoIP success rate
Data plane reliability	Network layer	Packet loss, loss runs, large events
Network reliability	Link layer	Connection failures, radio conditions

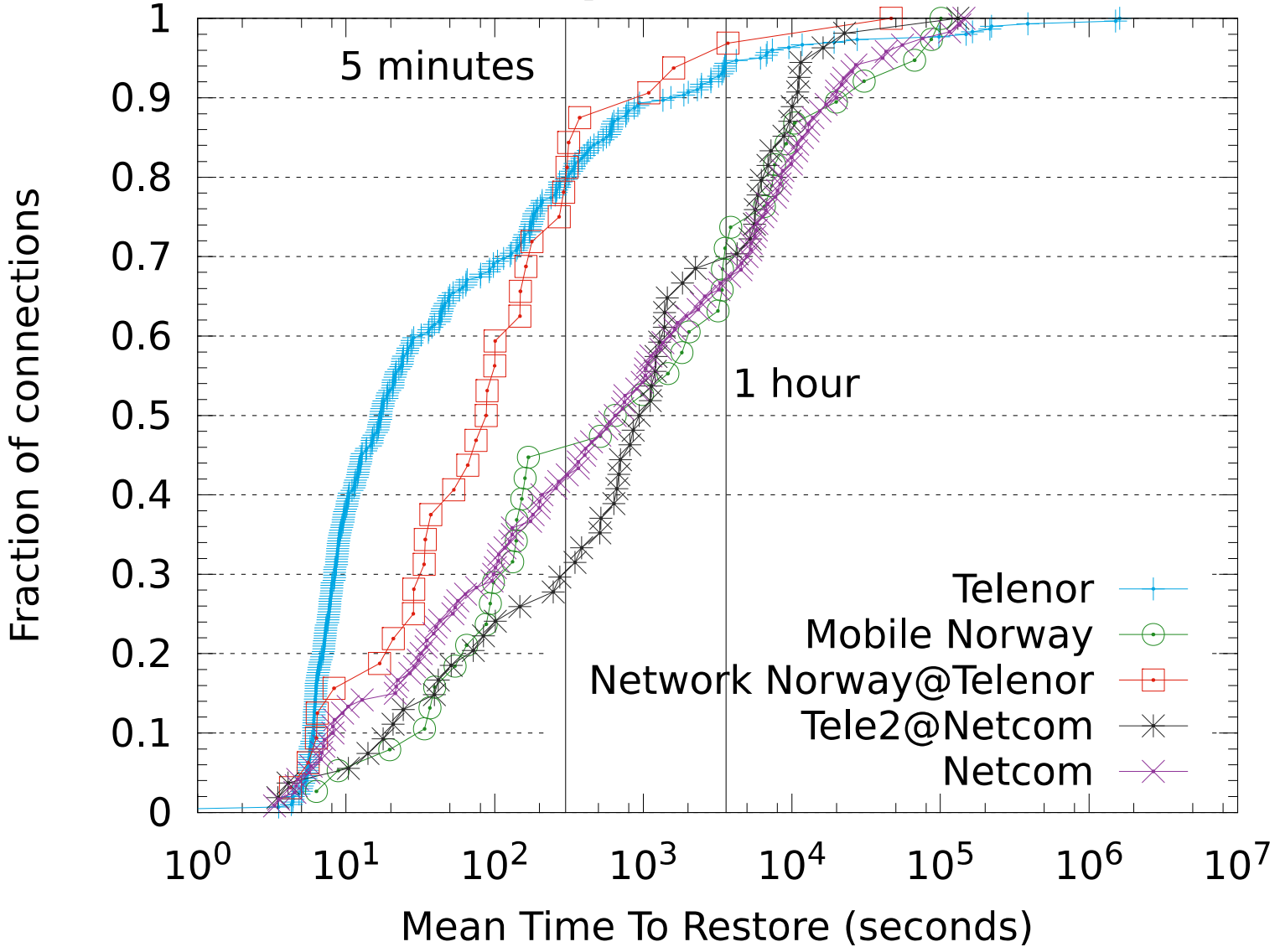
User value



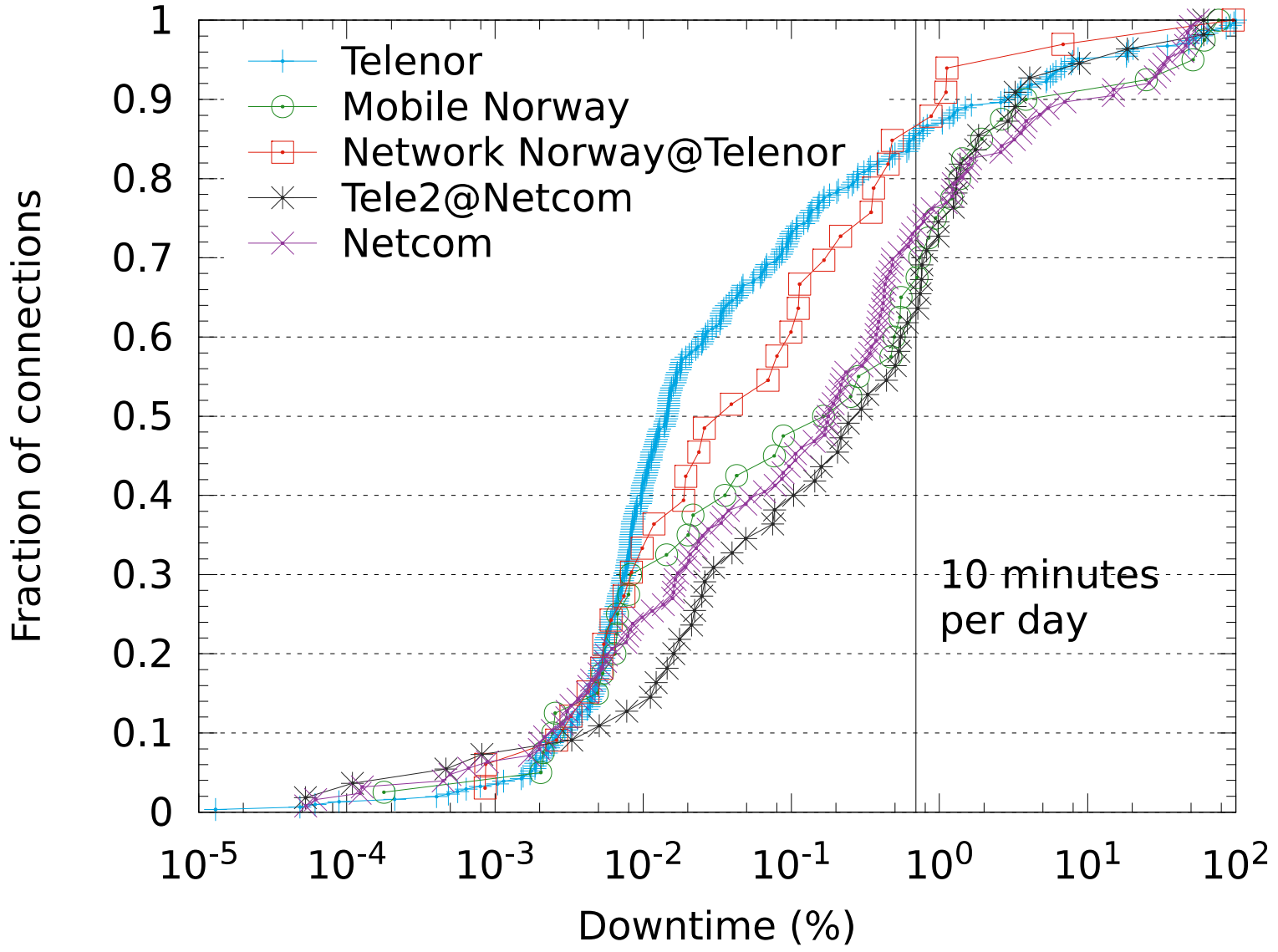
Connection stability varies widely across operators



Connection recovery also varies widely across operators



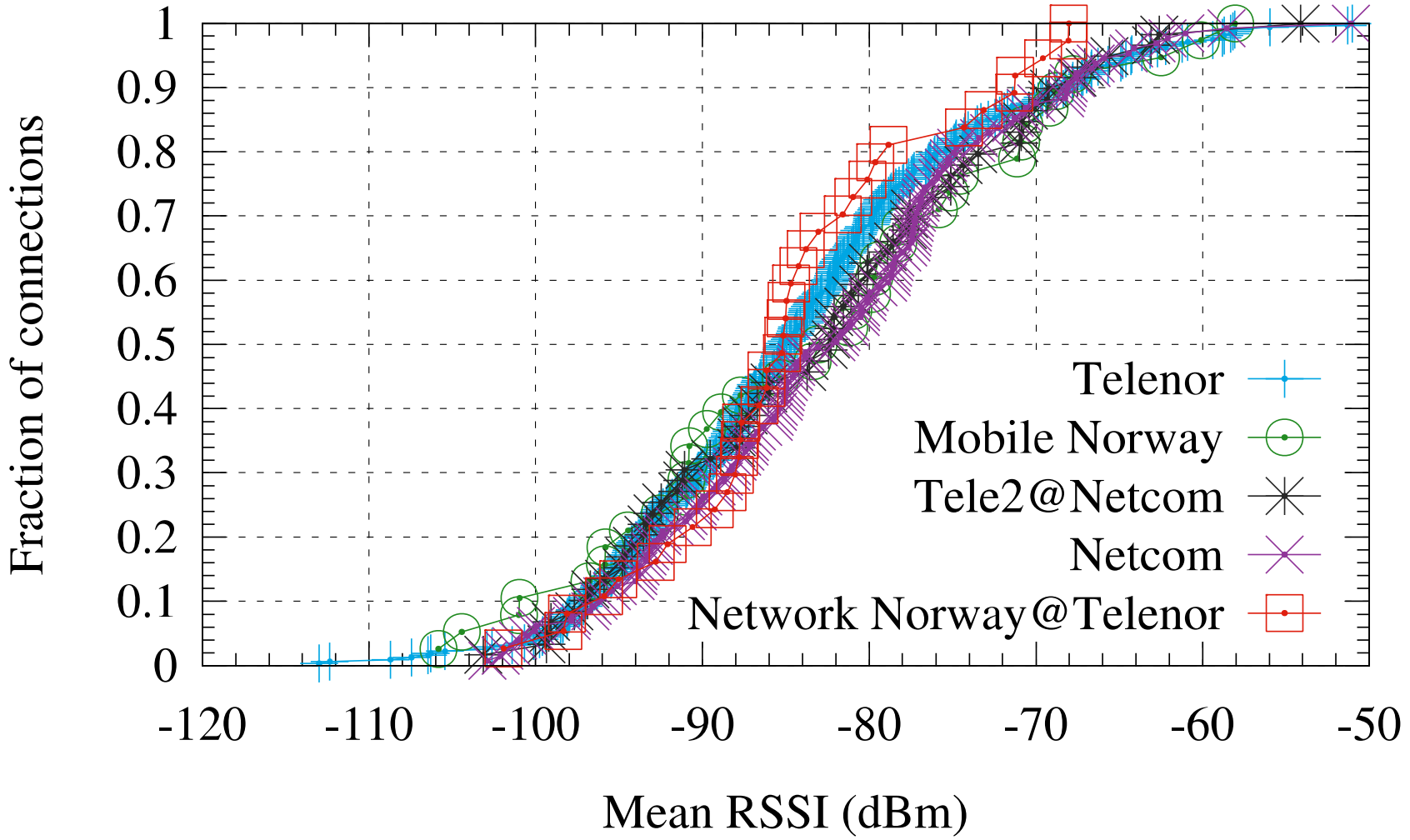
Clear differences in connection-stability between operators and as expected high dependency on the RAN



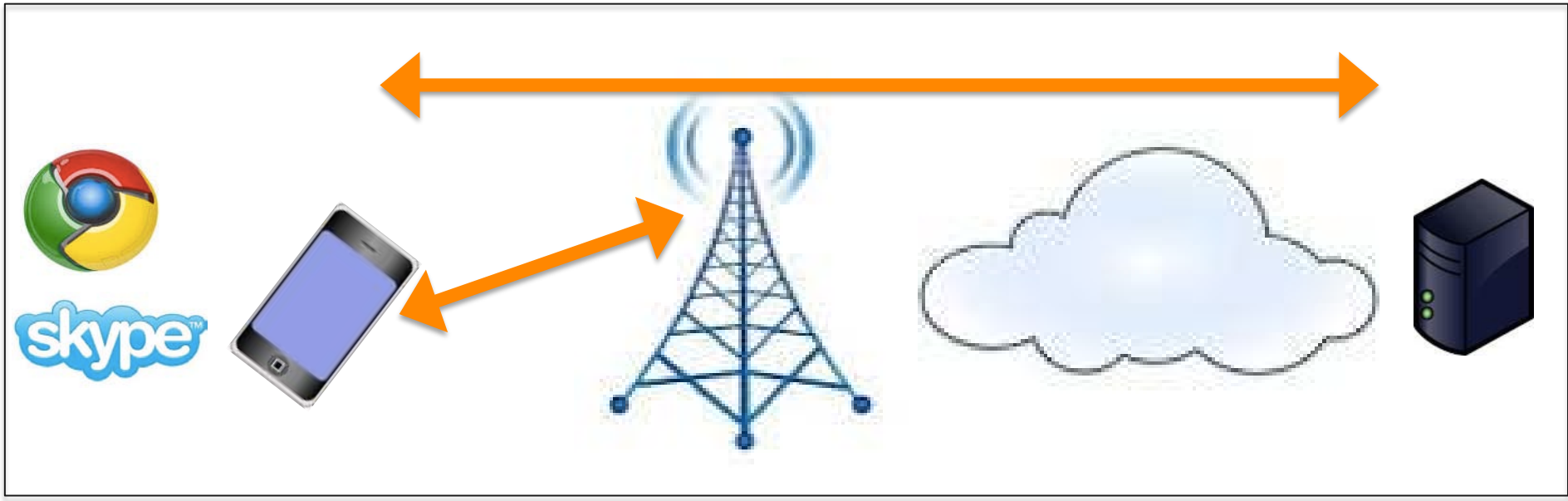
Higher failure likelihood during times with bad radio conditions

Ec/Io is a measure of signal to interference (noise) ratio

Differences between operators are not because of differences in coverage

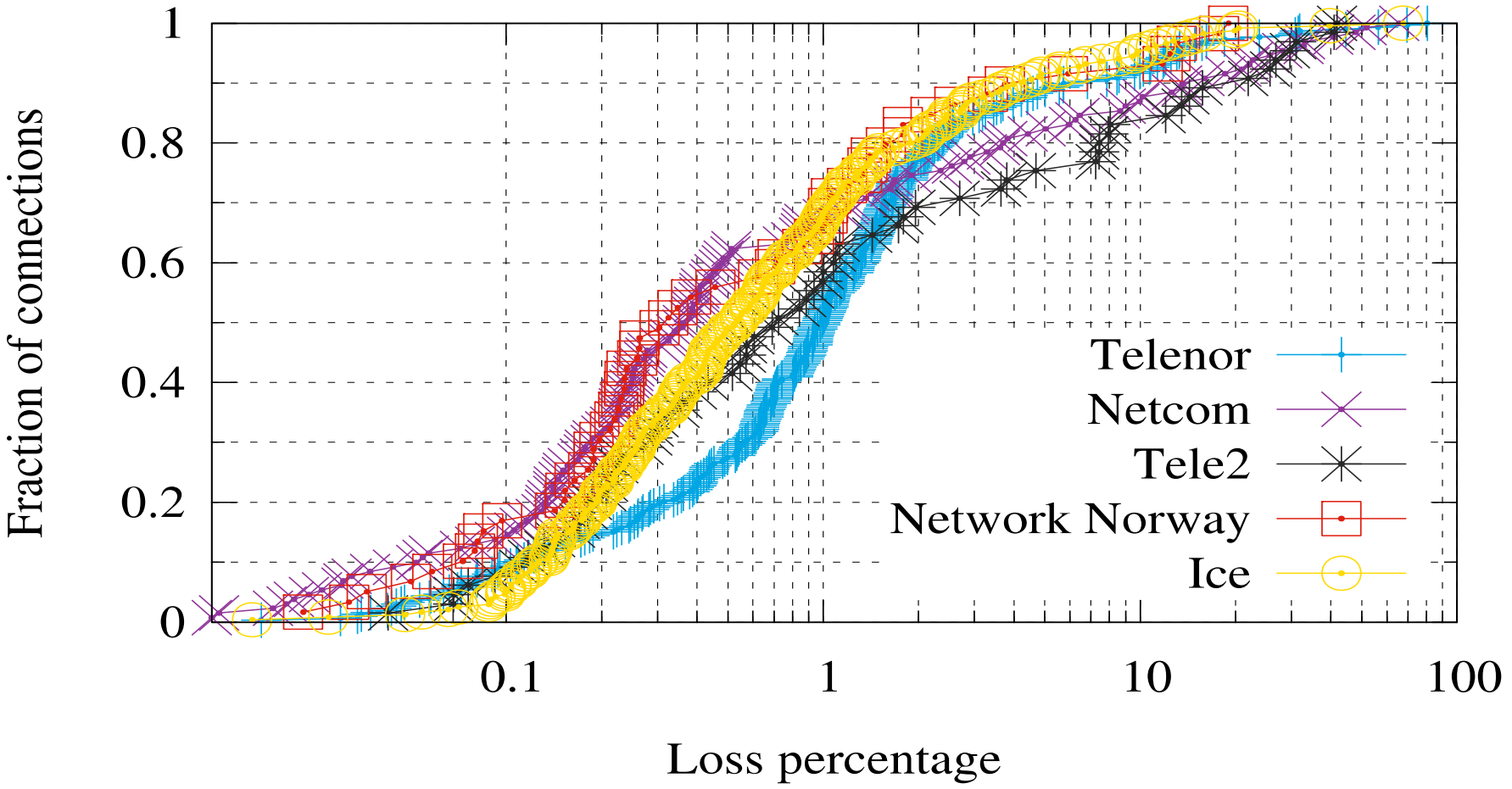


Data plane Reliability



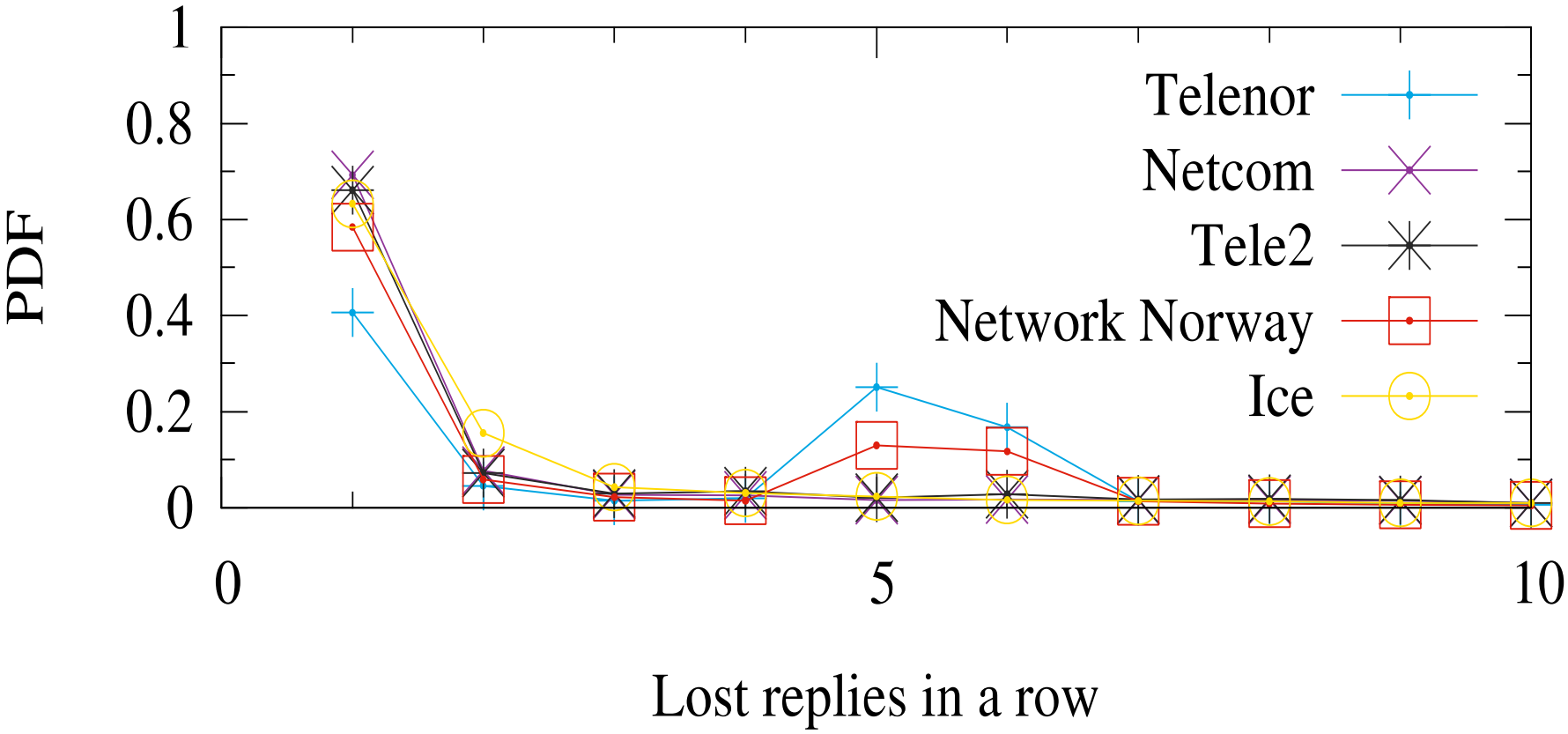
- Send a 20-bytes UDP packet to a server at Simula which echoes it back
- Measure packet loss, loss pattern, and correlations across connections

There are clear differences in packet loss between operators

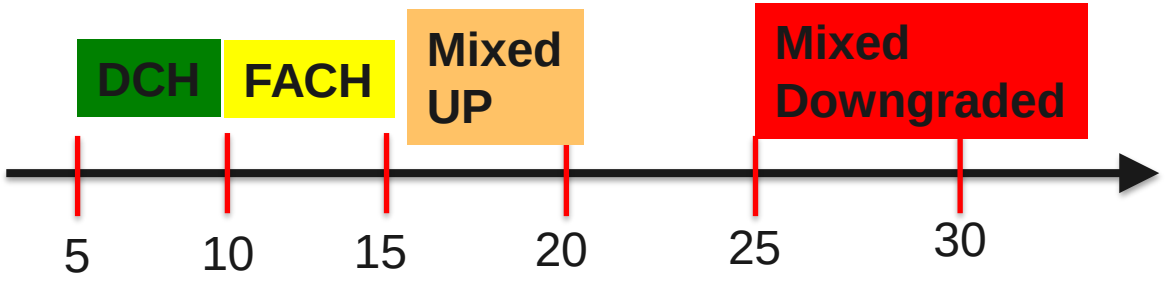


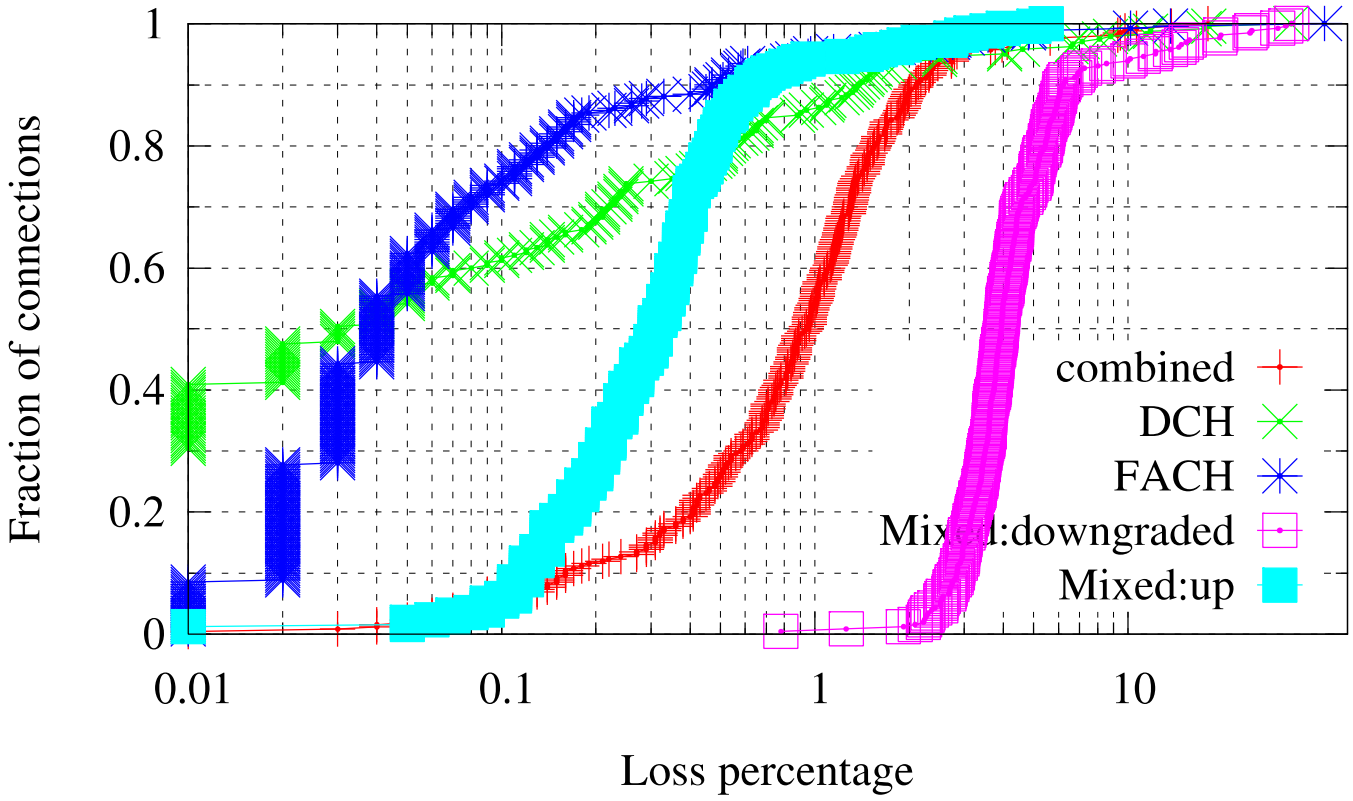
The measured loss is high given that MBB networks are retransmission heavy

Telenor (and Network Norway@Telenor) has a high number of loss runs of size 5 or 6

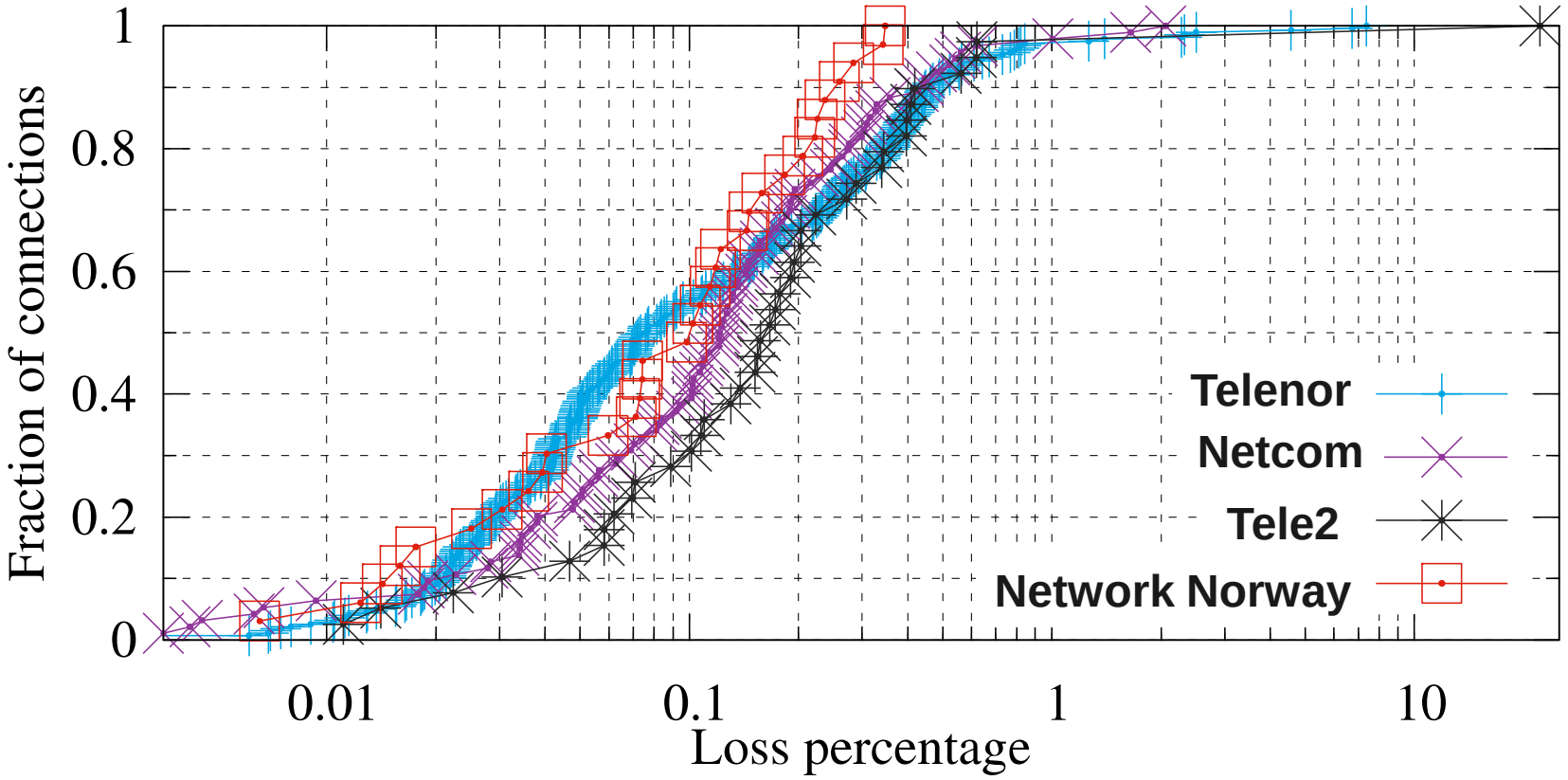


Most loss happens during RRC state transition

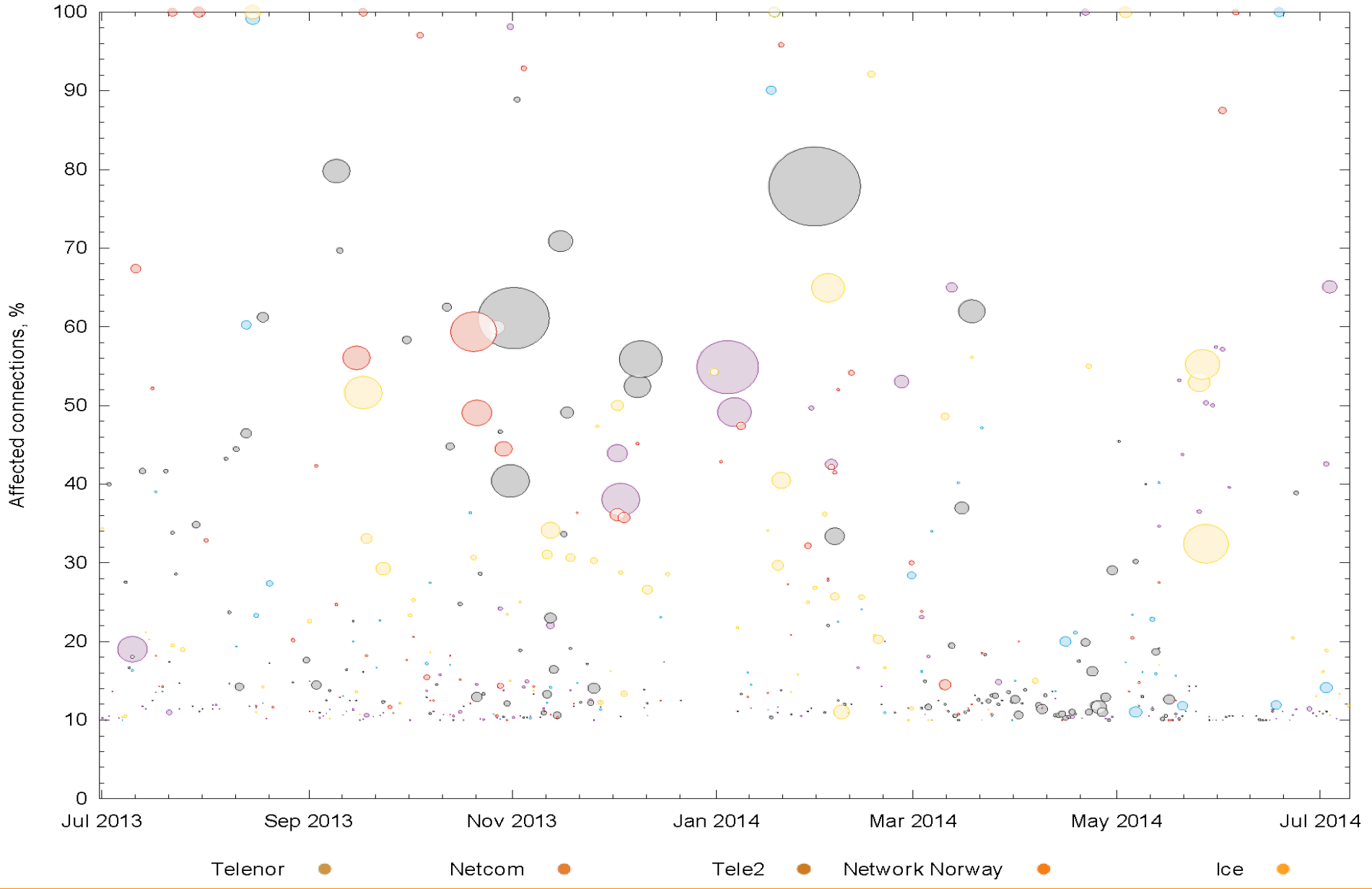




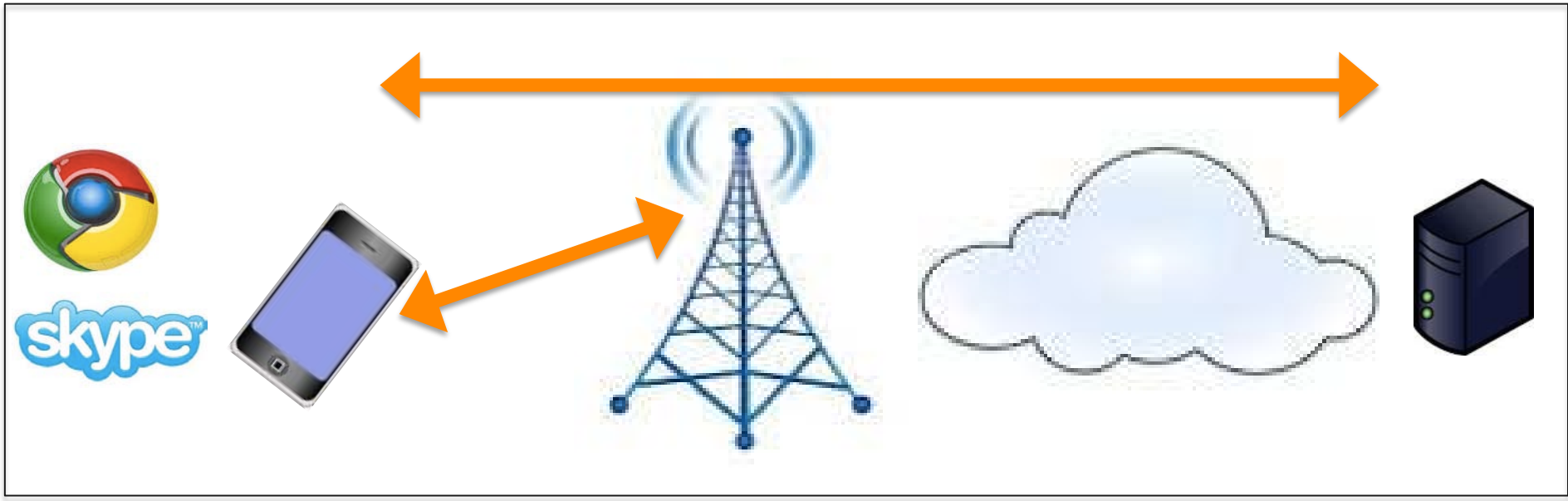
Difference in packet loss between operators fades away when avoiding downgraded RRC-transitions



Independent Measurements can help operators identifying problems that are hard to spot using network-side monitoring

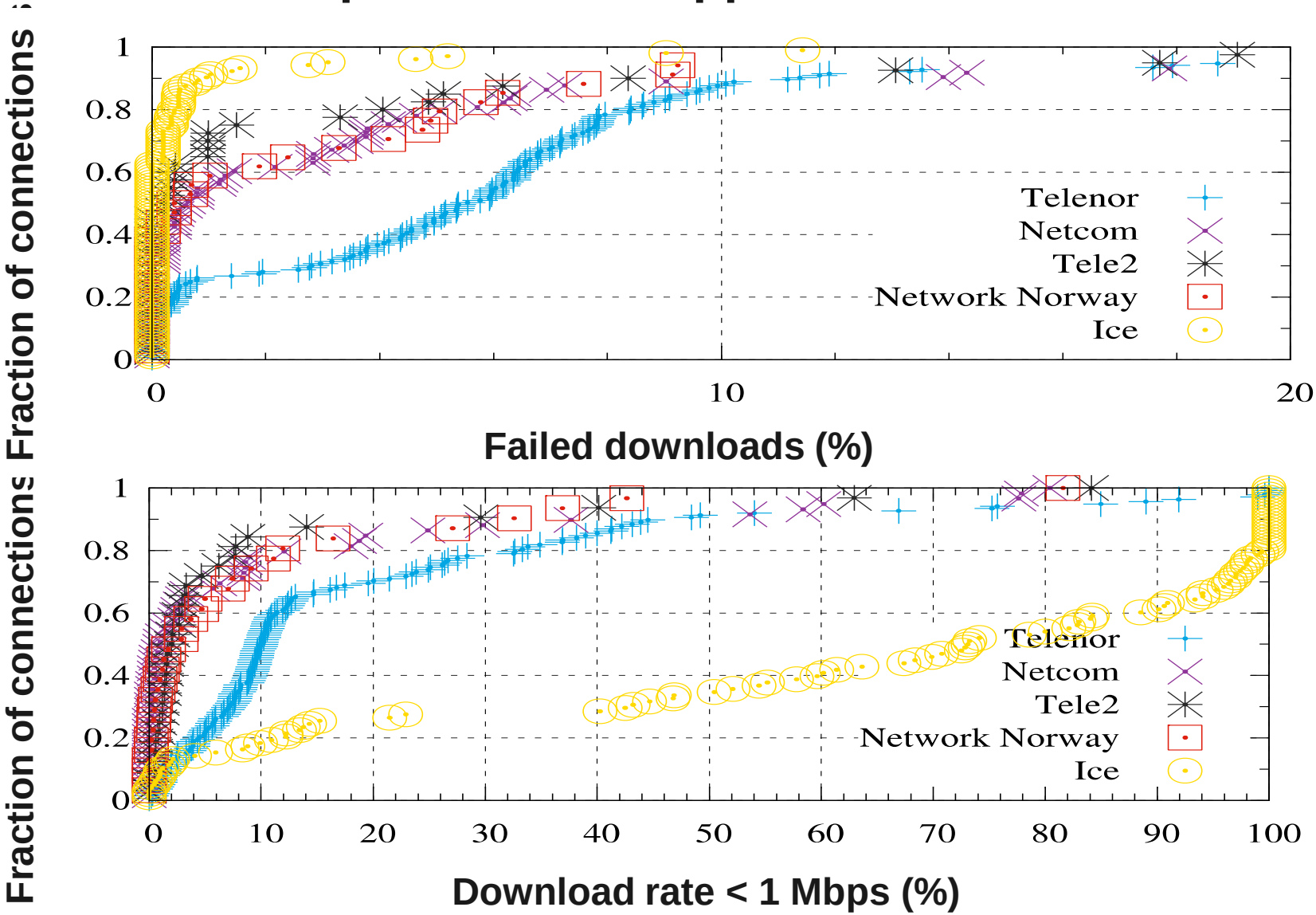


Performance Reliability



- We focus on the performance of two applications: HTTP downloads and VoIP using SIP
- We measure applications success rate and their ability to achieve a minimum level of quality

Short pauses in packet forwarding can lead to significant problems for applications



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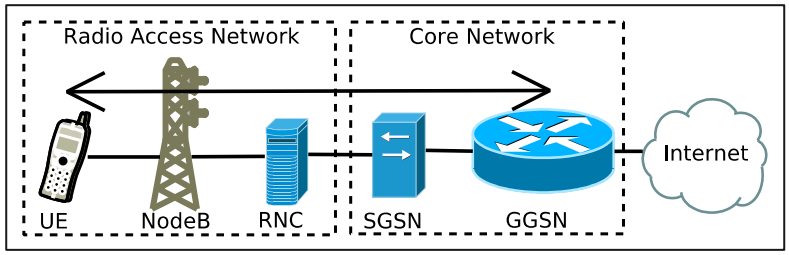

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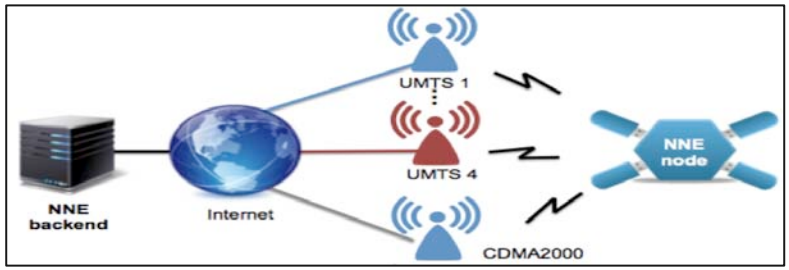

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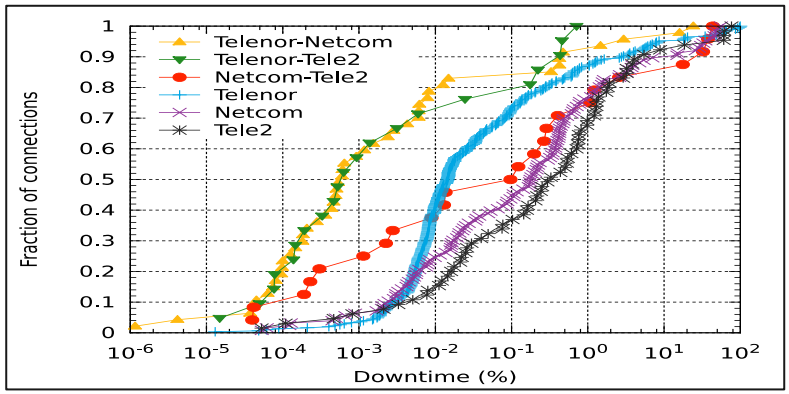
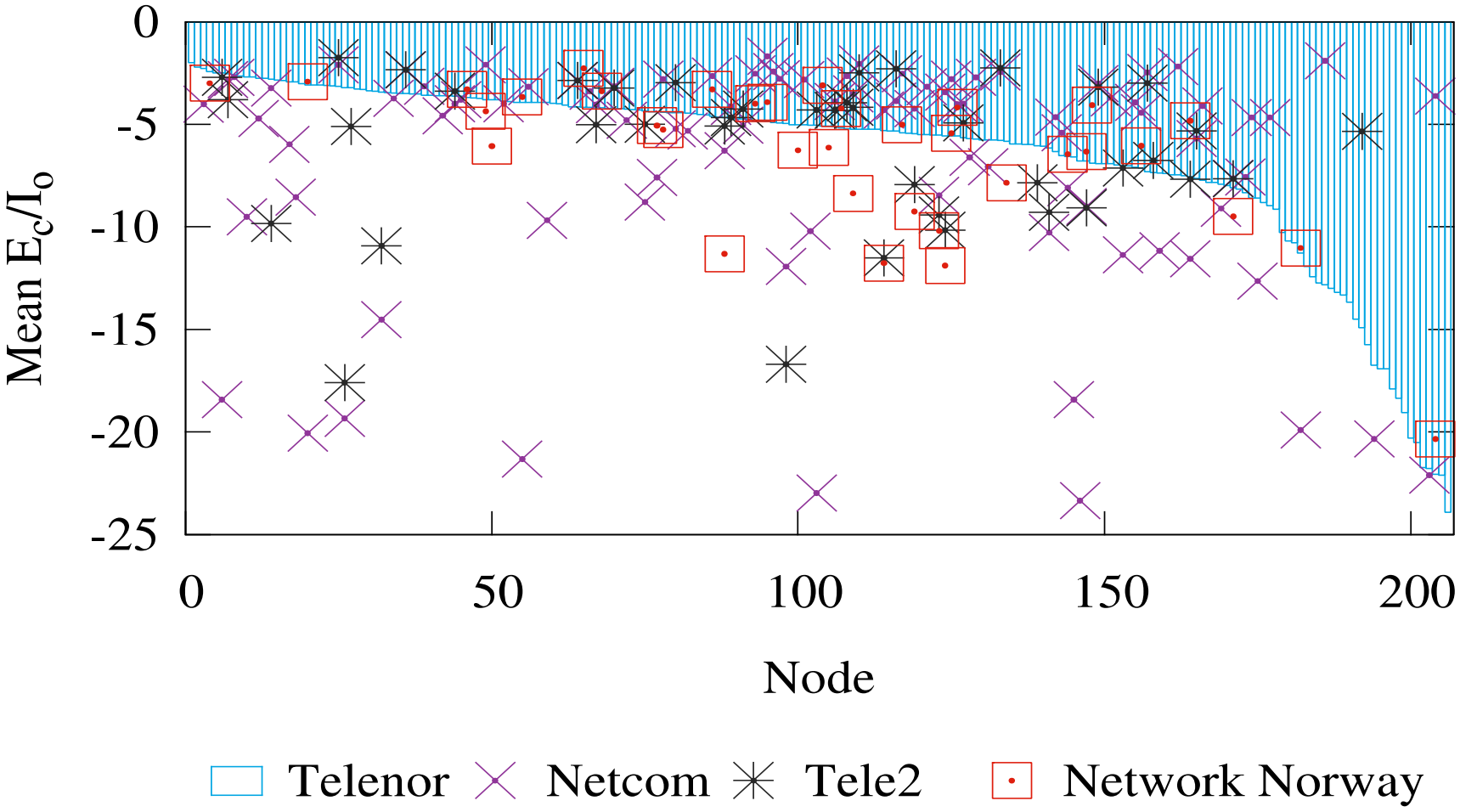
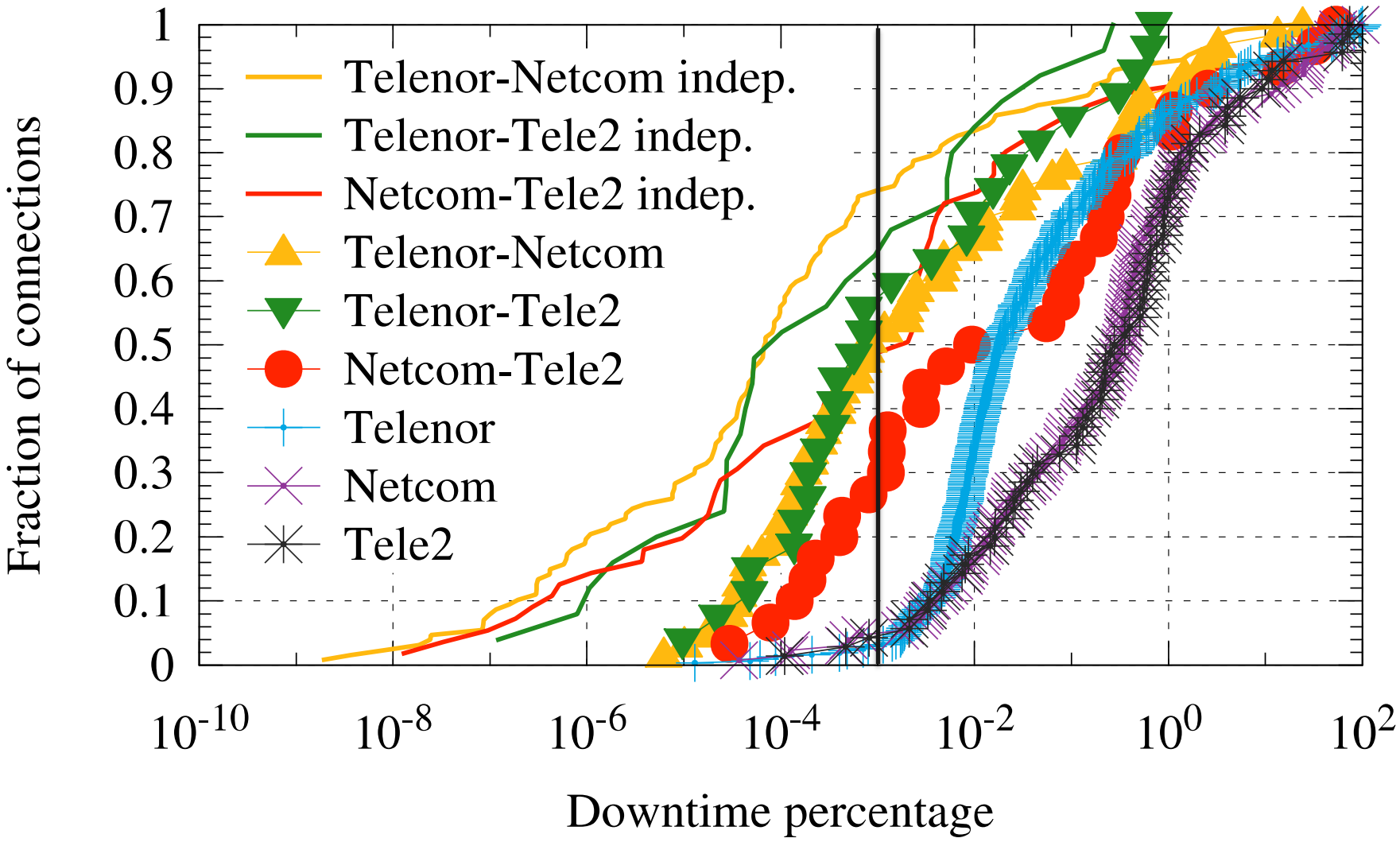


Can we improve MBB reliability?

Clear differences between operators in signal quality at a given location



Leveraging multi-connectivity enhances connection-stability significantly



Summary

- **MBB reliability must be assessed at multiple levels**
- **End-to-end active Measurements can give great insights into MBB networks performance**
- **The reliability of mobile broadband networks is lower than one could hope --** "*more than 20% of connections from were unavailable more than 10 minutes per day*"
- **We find that in most cases, our devices can achieve 99.999% ("five nines") connection availability by combining two operators.**

Questions ?

Ahmed AT simula.no