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Teconer

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Using Buses for Road Weather Data Collection

Topic 3-1 Sensing

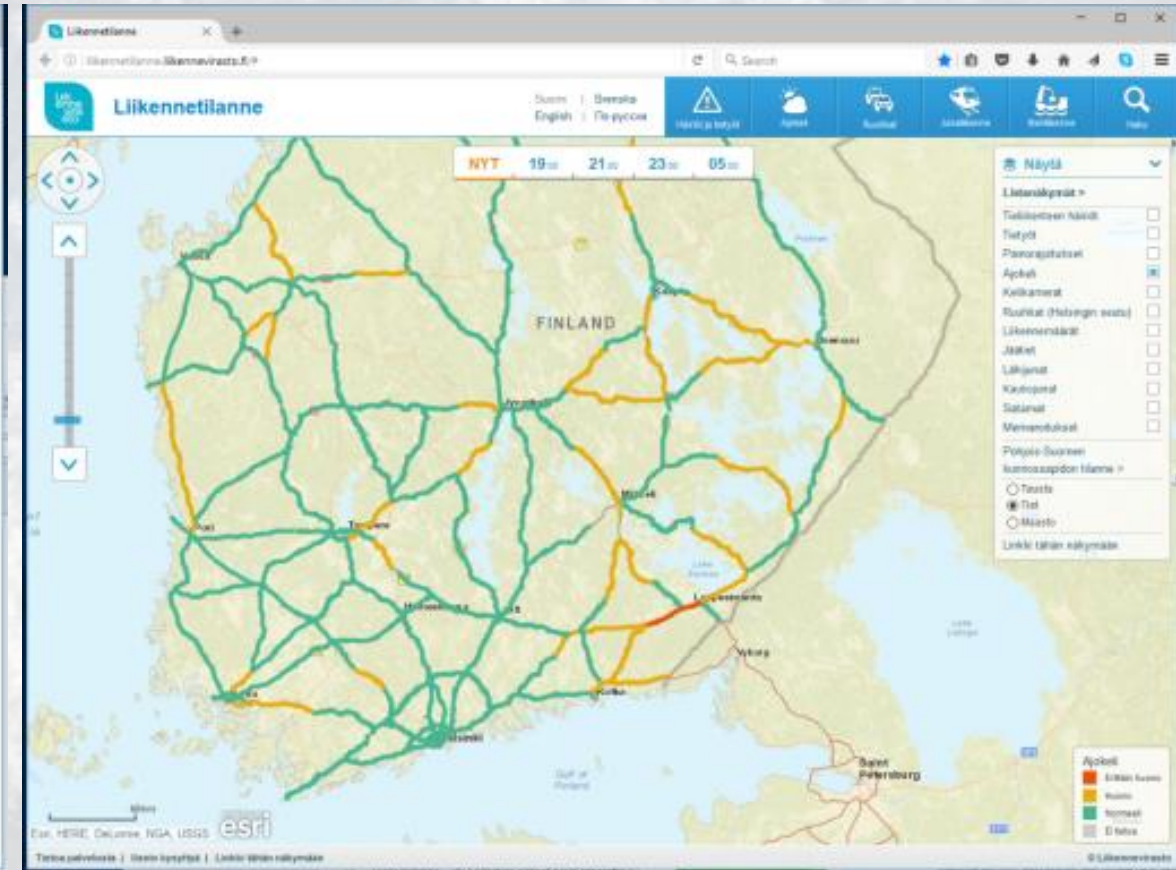
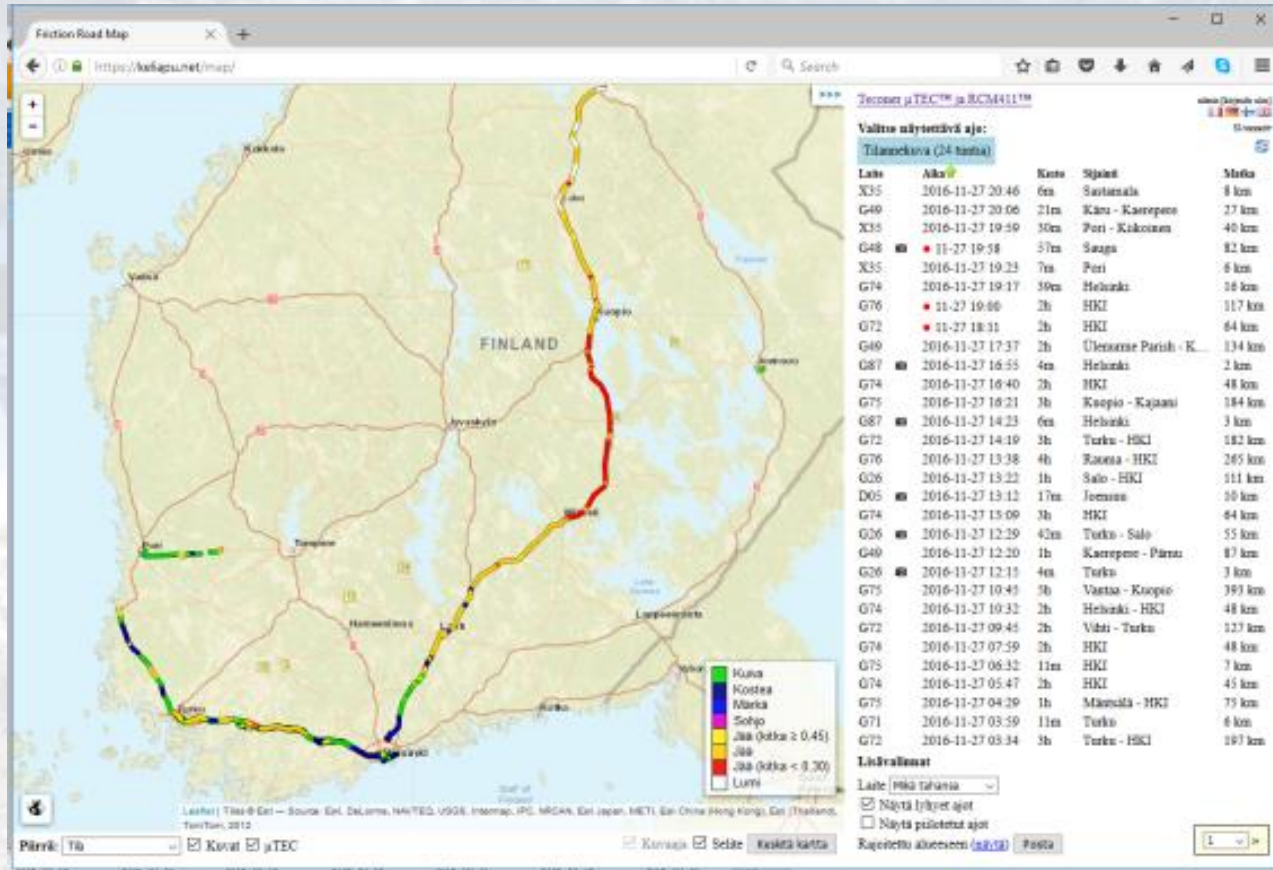
Background

- Fixed Road Weather Stations
 - traditional method for automated road weather data collection
 - good timeliness, poor spatial coverage (10-50 km)
- How to extrapolate data between stations?
 - mobile spatially continuous data may be the solution
 - is it feasible?

Mobile vs. Fixed Stations

Property	Fized Stations	Mobile measurements
Timeliness	Good	Poor
Spatial coverage	Poor	Good
Cost	Expensive	Modest
Service	Expensive	Low cost
Road conditions to drivers	Poorly applicable	Applicable
Sensors	Any sensor	Limited choice

Mobile vs. Fixed Stations



Project Target

1. Costs of mobile data collection
 - Annual costs per kilometer
2. Is it realistic to get fresh up to date data?
 - What is the minimum refresh rate of mobile data?
 - Service interval?
3. Applications?
 - Winter Maintenance and Quality Control
 - Road Condition Information to drivers
 - Autonomous driving, platooning, ...?

Installation

- Install road condition sensors to public transportation buses:
 - Helsinki-Turku-Rauma
 - 3 buses, 250 km route
 - Helsinki-Kuopio-Kajaani
 - 2 buses, 560 km route
 - One city bus in Helsinki





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Data Collection

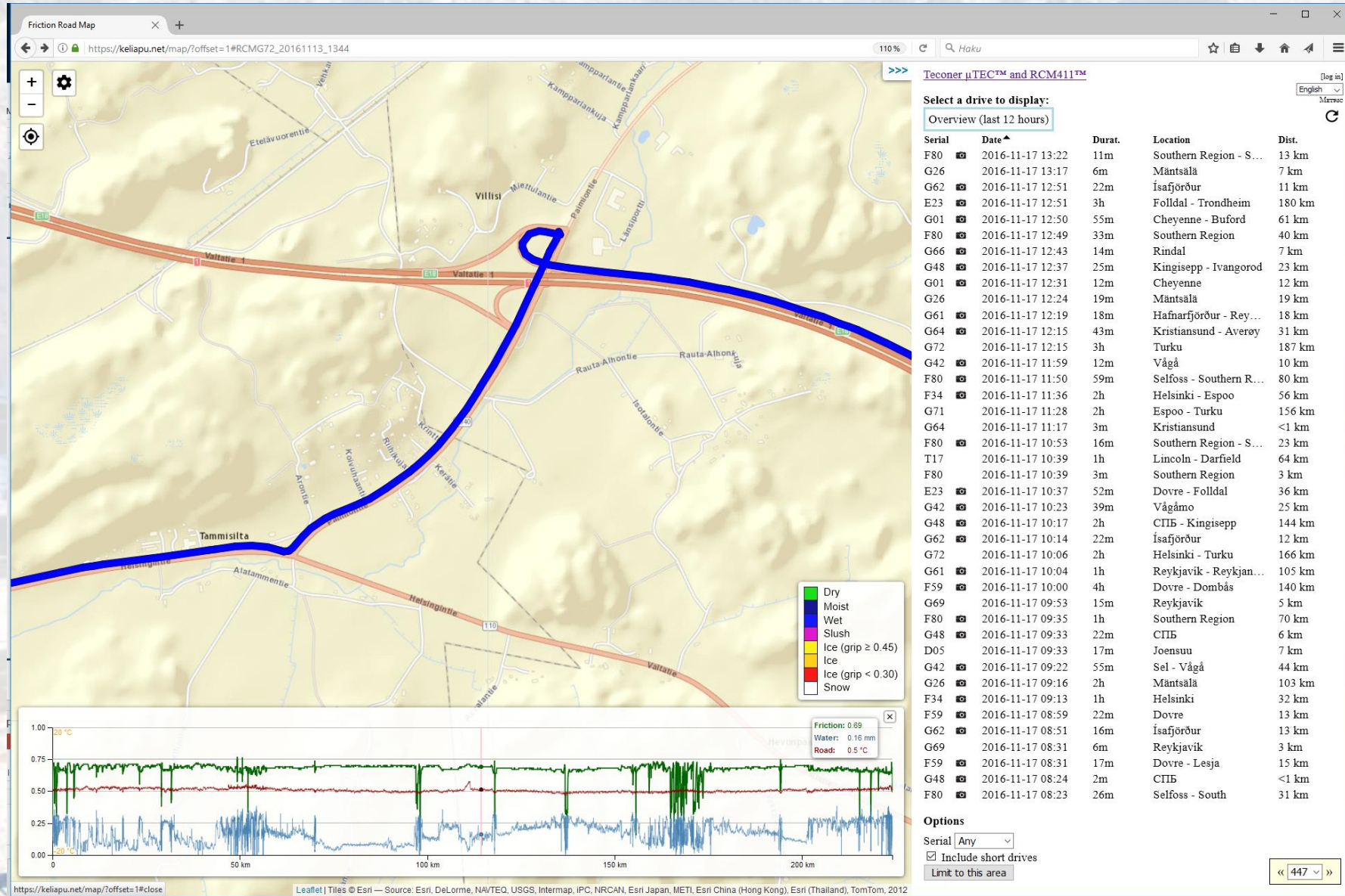
- Mobile phones or embedded hardware?
 - Mobile phones selected initially
 - photos feasible, but phones had to be hidden!
 - Starting Fall 2017 phones were replaced
 - embedded solution more stable
- Data amount
 - At best 1000 km/bus daily!
 - Average daily mileage 500 km, city bus 300 km

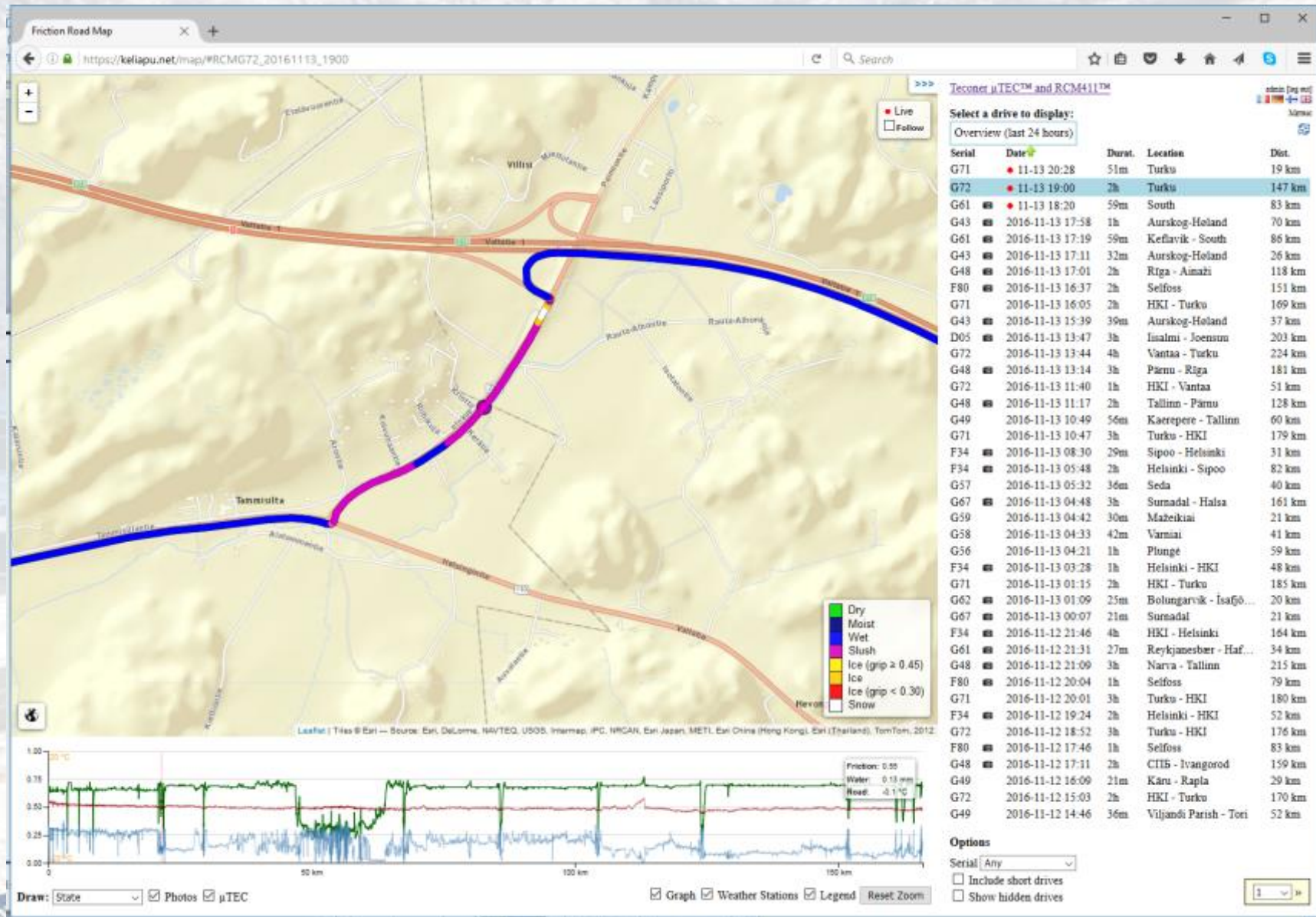
Timeliness

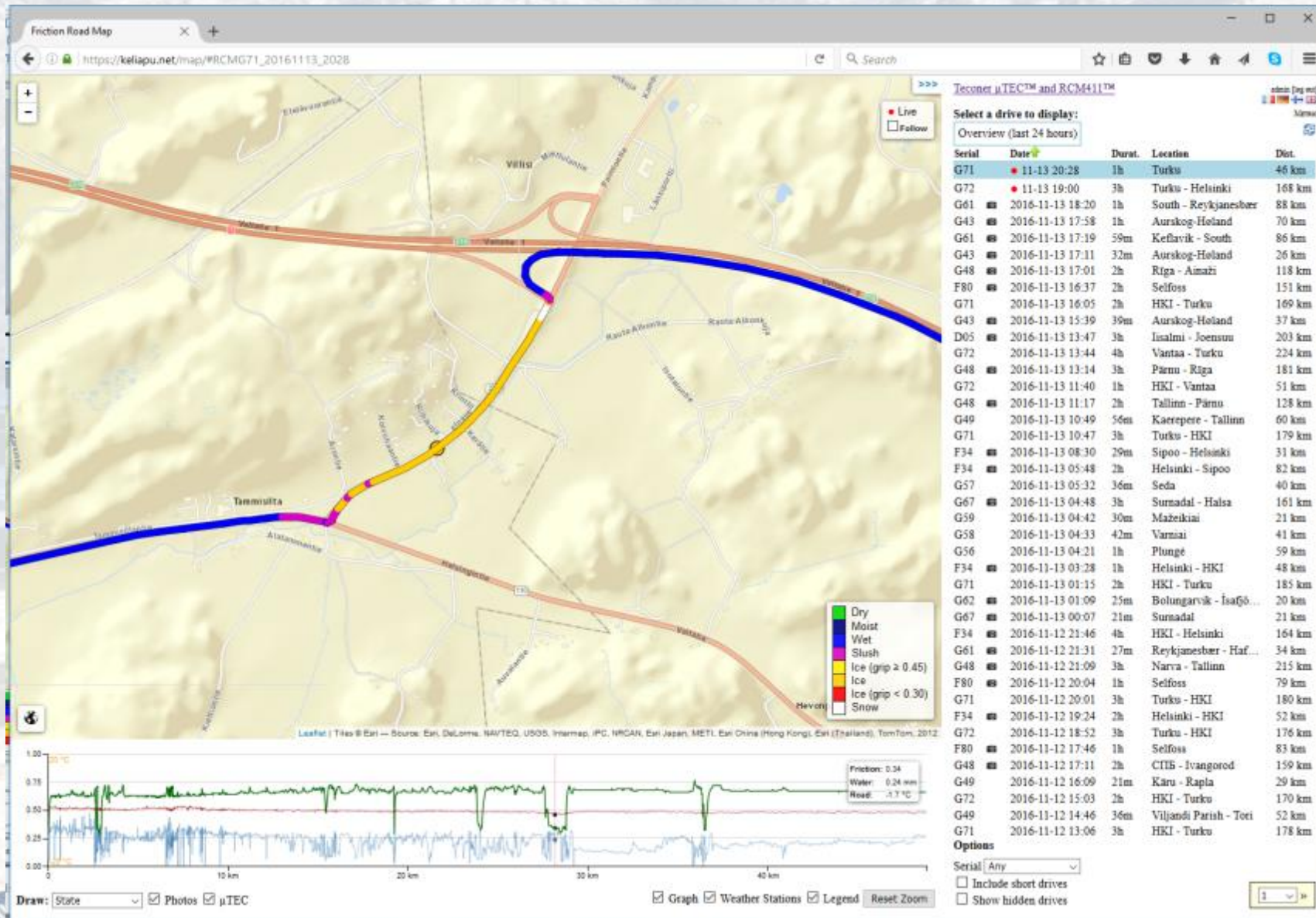
- Helsinki-Turku buses
 - 3 buses 3 times a day back and forth
 - refresh rate nearly 2 tuntia →
 - satisfactory to follow Road Conditions
- Challenge:
 - buses are off duty due to service and other reasons

Example case: 13.11.2016

- Paimiontie road 2340
 - connecting motorway E18 and highway 110
- light snow fall, afternoon all the roads were wet, later:
 - 19:30 condition becomes slushy
 - 20:30 road freezes
- Only Paimiontie freezes
 - How was the salting?








Video: Southern Finland, 2016-12



Cost Estimation

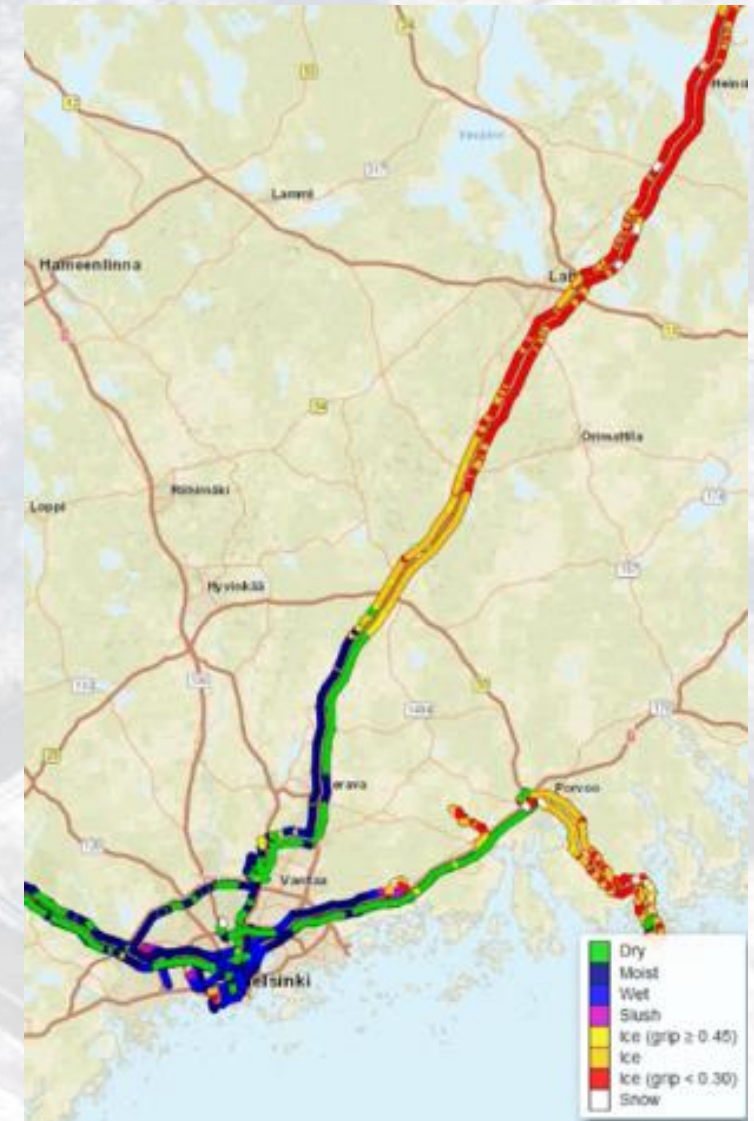
- Annual cost per bus 3000 €
 - depreciation, service, communication
- Expected daily mileage 500 km/bus
- About 2 h interval -> one bus covers 50 km ->
- Annual cost of mobile data about **60 €/km**
- Countrywide 13 000 km requires 260 buses
- Annual cost would be 780 000 €
 - nearly 2 hour interval

Comparison to Fixed Weather Stations

- Annual service cost of fixed stations
 - 1.5 M€ in Finland, formal coverage 13 000 km
 - About 4000 € per station
 - With depreciation costs included the cost will be about twice as much
- 
- Cost nearly **200 €/km**

In Conclusion

1. Mobile Road Condition measurements are feasible
 - service interval is long enough
2. Annual running cost is modest compared to fixed stations.
3. Bonus
 - higher quality of winter maintenance
 - information to drivers
 - other use ... (autonomous driving, platooning, ...)



on Delaware, WY/TEG, USGS, Intermap, IPC, NRCAN, Esri Japan, MBT, Esri China (Hong Kong), Esri (Thailand), TomTom, 2

Thank you for your attention

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