



ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

WINTER TESTING TRACK ENVIRONMENT FOR THE INTELLIGENT TRAFFIC ROAD WEATHER SERVICES DEVELOPMENT

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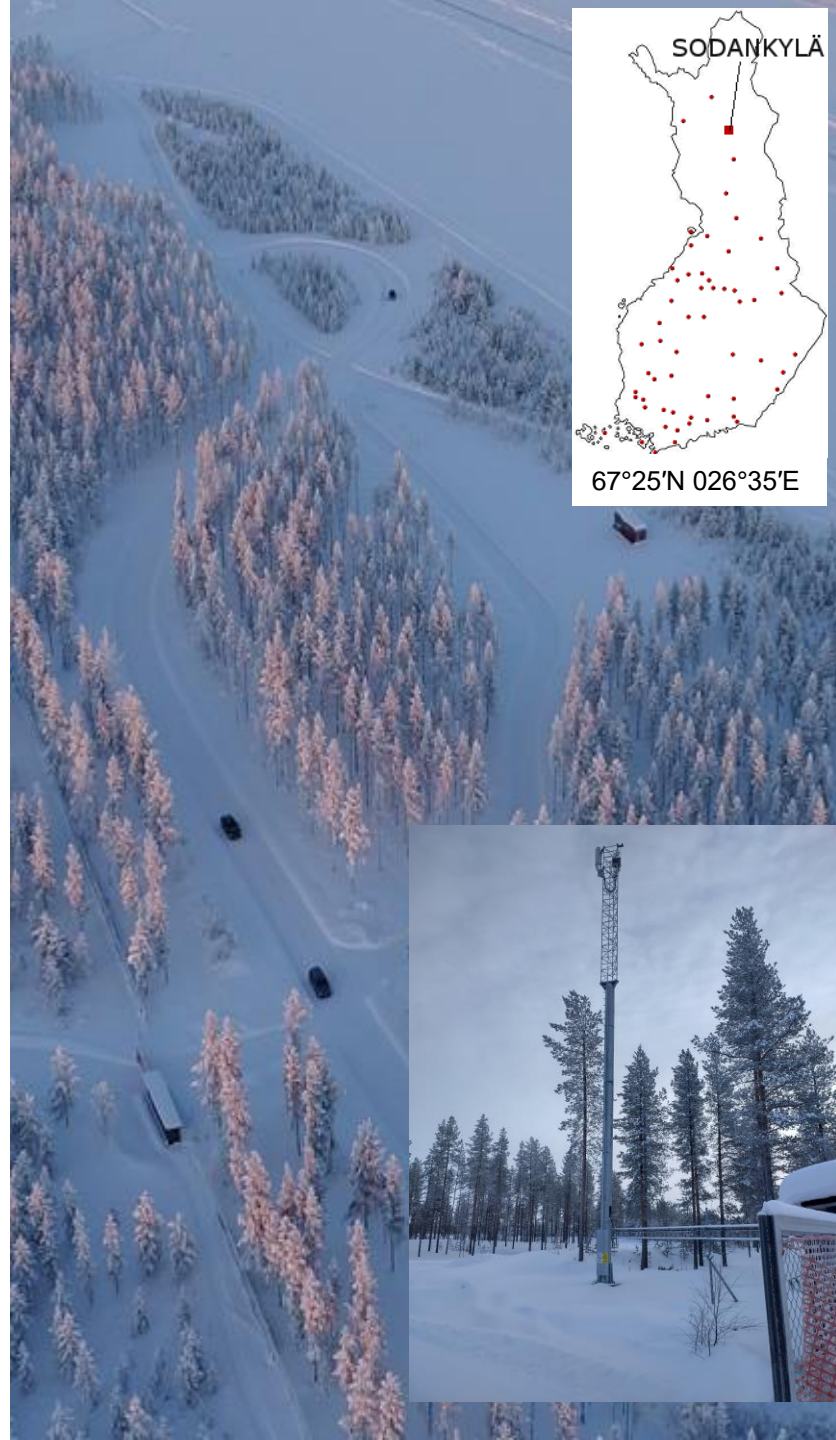
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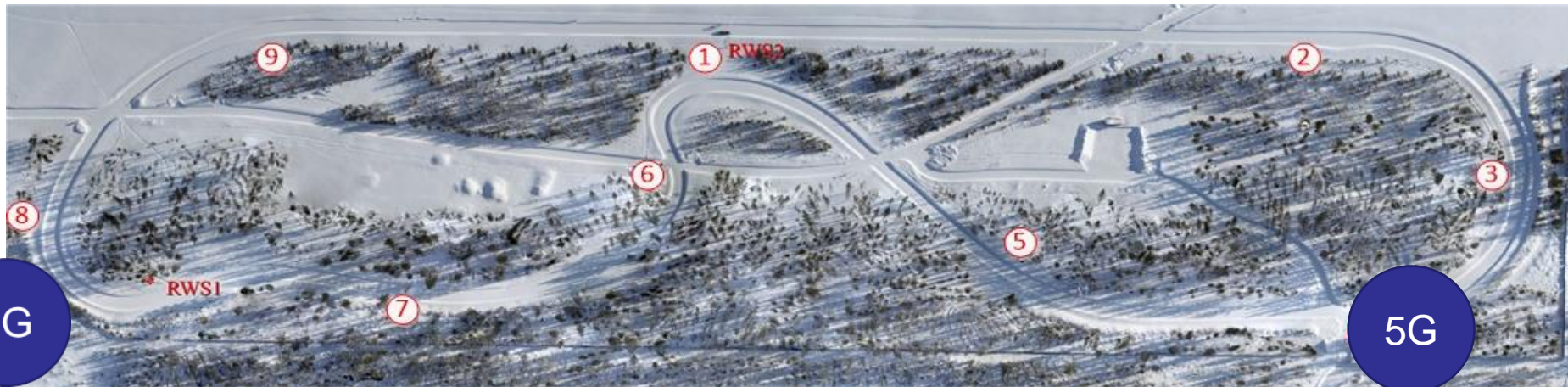
Introduction

- **Road weather services exploiting Intelligent Traffic Systems (ITS)**
 - **5G** enabled road weather services
 - **Road weather services** tailored for autonomous vehicles
 - **Digital Twin** modelling of test track
 - **Energy efficiency**, green tech
 - **Drone-assisted** traffic monitoring
- Sod5G – Vehicle winter testing track for combined intelligent traffic and road weather services development and testing
- **Testing and demonstration platform** for all intelligent traffic research projects
- **Permanent measurement infrastructure**



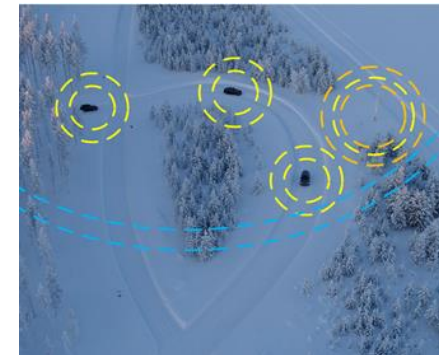
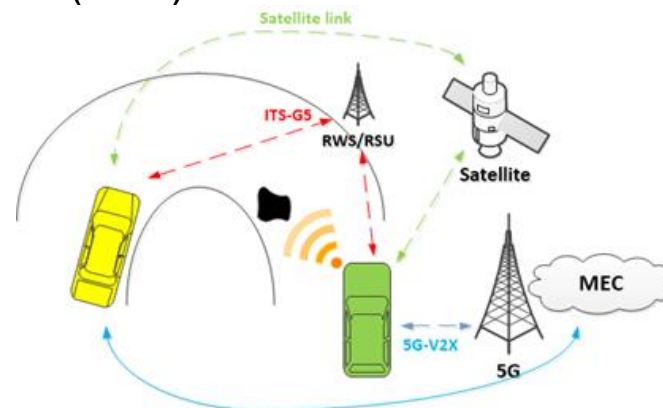
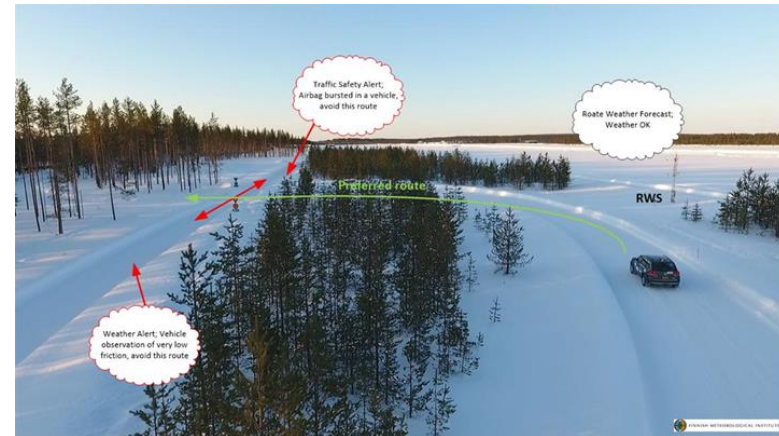
Test track permanent infrastructure

- Versatile vehicle winter testing track, 1.7 km main track (gravel/concrete)
- Non-standalone 5G in 3.5 GHz with narrowband IoT
- ITS-G5-test network (2 interactive RWS + mobile devices)
- Road weather obs infrastructure (2 RWS + mobile vehicular measurements with Vaisala MD30, Teconer RCM 411 and Luft MARWIS)
- LoraWAN IoT weather sensor network
- Surface-embedded weather sensors
- Autonomous miniature vehicle
- Luosto weather radar, supplying Nowcasting data
- Instrument pipelines in concrete section, for under-surface sensors
- <http://sod5g.fmi.fi>



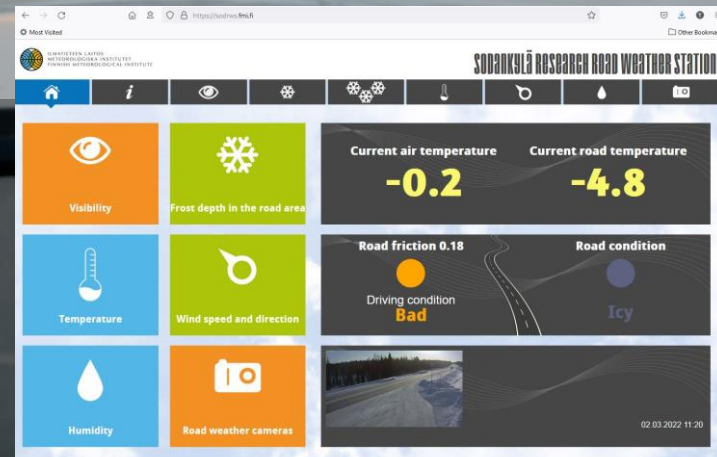
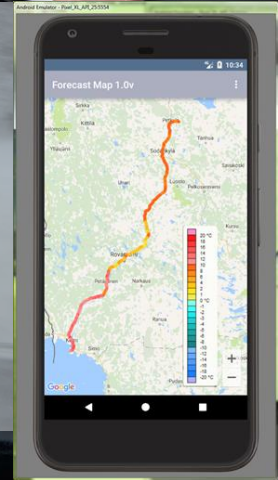
Test track interactive vehicular weather and safety services

- 5G-SAFE (2016-2018);
 - Road Weather Forecast
 - Traffic Safety Alert
 - Weather alert
 - Vehicle See-through
- 5G-SAFE-Plus (2020-2023);
 - 5G-enabled weather, road safety and maintenance services for CAV
 - Obstacle detection and warning with hybrid communication for CAV
 - Enhanced road weather services for CAV (in co-op with Vaisala)
 - Ultra-low delay services for CAV (VTT)
 - Pedestrian warning
 - Cyber-security issues (Wedge Networks)



Interactive road weather services

- The base; road weather forecast
- Supplemented with roadside and onboard measurements
 - Road weather stations
 - On-board systems (via CAN-bus)
 - On-board external sensors
- Real-time delivery of weather and safety services directly to the vehicles
- V2X communication
 - Cellular; 3G/4G/5G
 - Vehicular networking; ITS-G5, C-V2X (future work)
 - Hybrid



<https://sodrws.fmi.fi/>

Autonomous miniature vehicle

- Miniature vehicle
 - Less expensive and regulated, therefore easier and safer to deploy and operate
 - Carries all the monitoring instrumentation present in passenger vehicles
 - Provides all the sensor data composed by autonomous vehicle and can react to services linearly with autonomous passenger vehicles
- Current equipment
 - Pixhawk 4 Flight Controller, with internal IMU and compass
 - 5G-capable Flight Controller companion computer
 - 2x uBlox ZED-F9P RTK Moving Base antennae
 - Velodyne VLP-16 "Puck" 360° LiDAR
 - Teconer RCM411 Road Condition Monitor
 - Opt; vehicle radar, camera
- Current capabilities
 - Route-based driving with several routes
 - Alternative route manoeuvre as launched event or by ext. warning
 - Dodging manoeuvre as launched event or by ext. warning
 - Accepting different driving modes



Road weather services tailored for autonomous driving-status and future work



- **Tailored road weather services to autonomous driving**
 - Adapted parameters; driving speed and safety margins
 - Higher variety of driving modes, based on more accurate sensor-specific sensitivity
 - Road weather observation of sensor-specific parameters (e.g. visibility, density of snow)
 - Research vehicles of VTT and Unikie
 - Commercial autonomous vehicles
 - Accurate road weather information and driving adaptation based on weather enables safe and fluent autonomous driving in all conditions, key enabler of autonomous driving itself
- **More sophisticated analysis of sensor sensitivities**
 - More fine-tuned operation range for each instrument (camera, LiDAR, radars)
 - Sensors evaluation in varying weather conditions
 - Exploitation of autonomous vehicles sensor data in fine-tuning of road weather

Concluding remarks

ITS development infrastructure

- Vehicle winter testing track with 5G/ITS communication and advanced road weather services
- Operative heavy vehicle fleet as mobile test laboratory for advanced road weather observations and ITS services development
- Nation-wide Weather Radar network for high resolution weather
- Interactive research road weather station within public road

Intelligent traffic research team

- Research and development of intelligent traffic applications and advanced road weather services, with test track and operative fleet
- Maintaining and developing the infrastructure for the future applications

<http://sod5g.fmi.fi>

<http://5gsafeplus.fmi.fi>

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Thank you for your attention!

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