

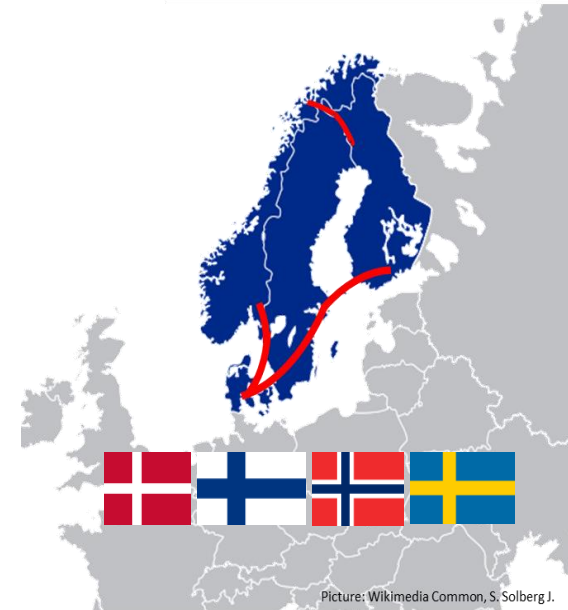
# NW2 Technical Evaluation Results

17.12.2020

Mikko Tarkiainen, Kimmo Kauvo



Co-financed by the European Union  
Connecting Europe Facility



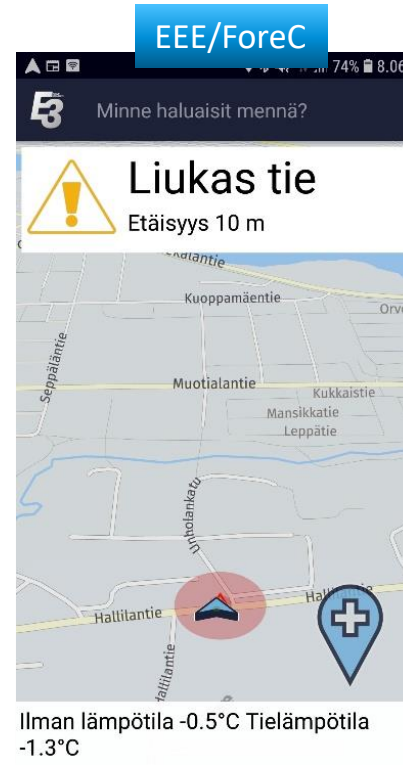
# Technical evaluation common KPIs

INDICATOR/KPI	UNIT	WHERE STUDIED		
		FI	NO	SE
Physical coverage	-	x	x	-
Number of vehicles equipped with <ul style="list-style-type: none"> <li>fully-functional C-ITS in-vehicle-device</li> <li>partially functional C-ITS in-vehicle-device</li> </ul>	Number	x x	x x	- -
Change in number of external data sources per C-ITS service	Number	-	x	-
Number of C-ITS service vehicles or users	Number	x	-	-
Number of C-ITS messages distributed per service and node	Number	x	-	-
Location accuracy	-	x	-	-
Latency <ul style="list-style-type: none"> <li>end-to-end</li> <li>between Federated interchange nodes</li> </ul>	s ms	x x	x -	x x
Message success rate	%	x	-	-
Cross-border continuity of services	Yes/no	x	x	x
Cross-organizational/cross-brands data sharing	Yes/no	x	x	-

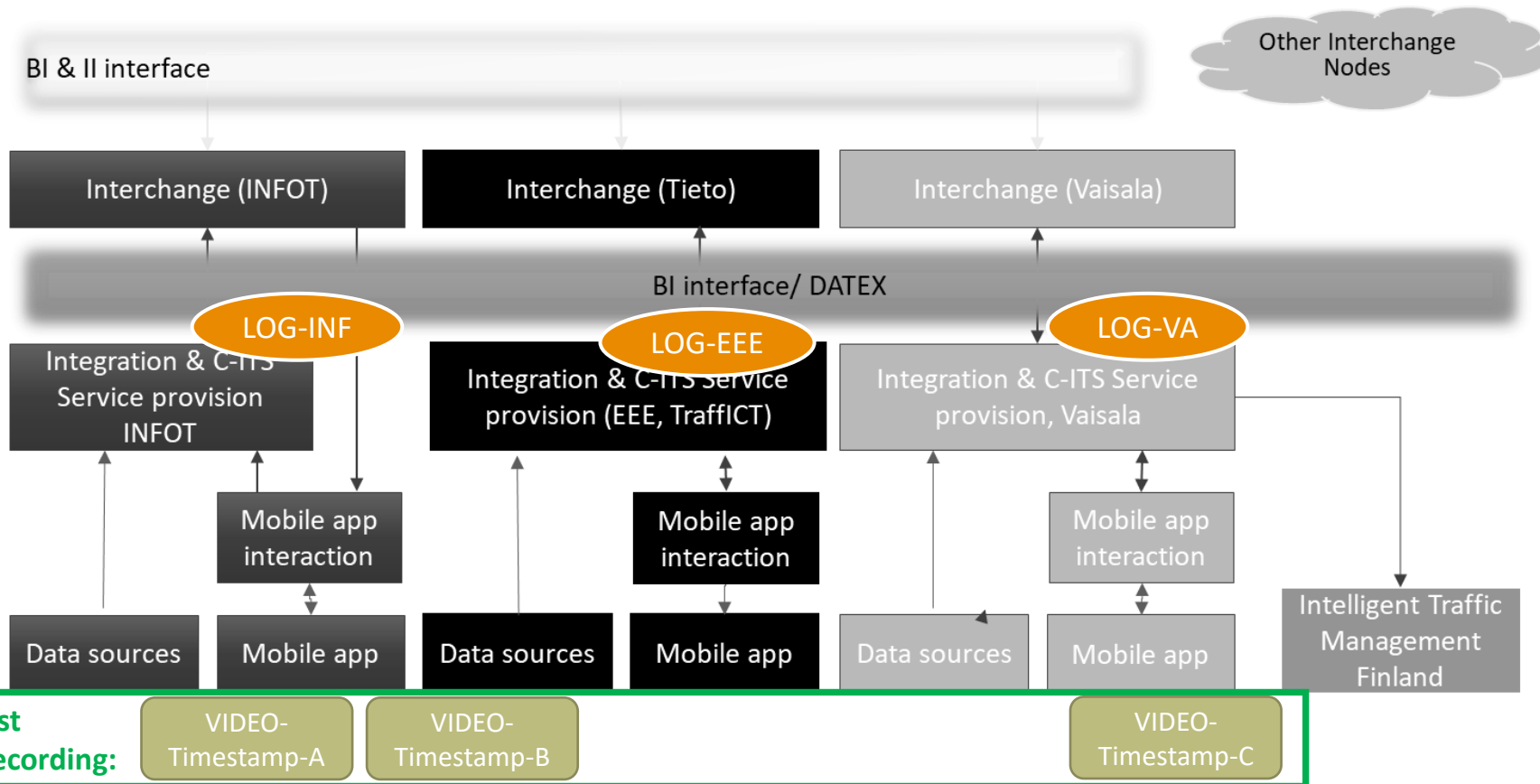


# Methods - Controlled field tests in FI

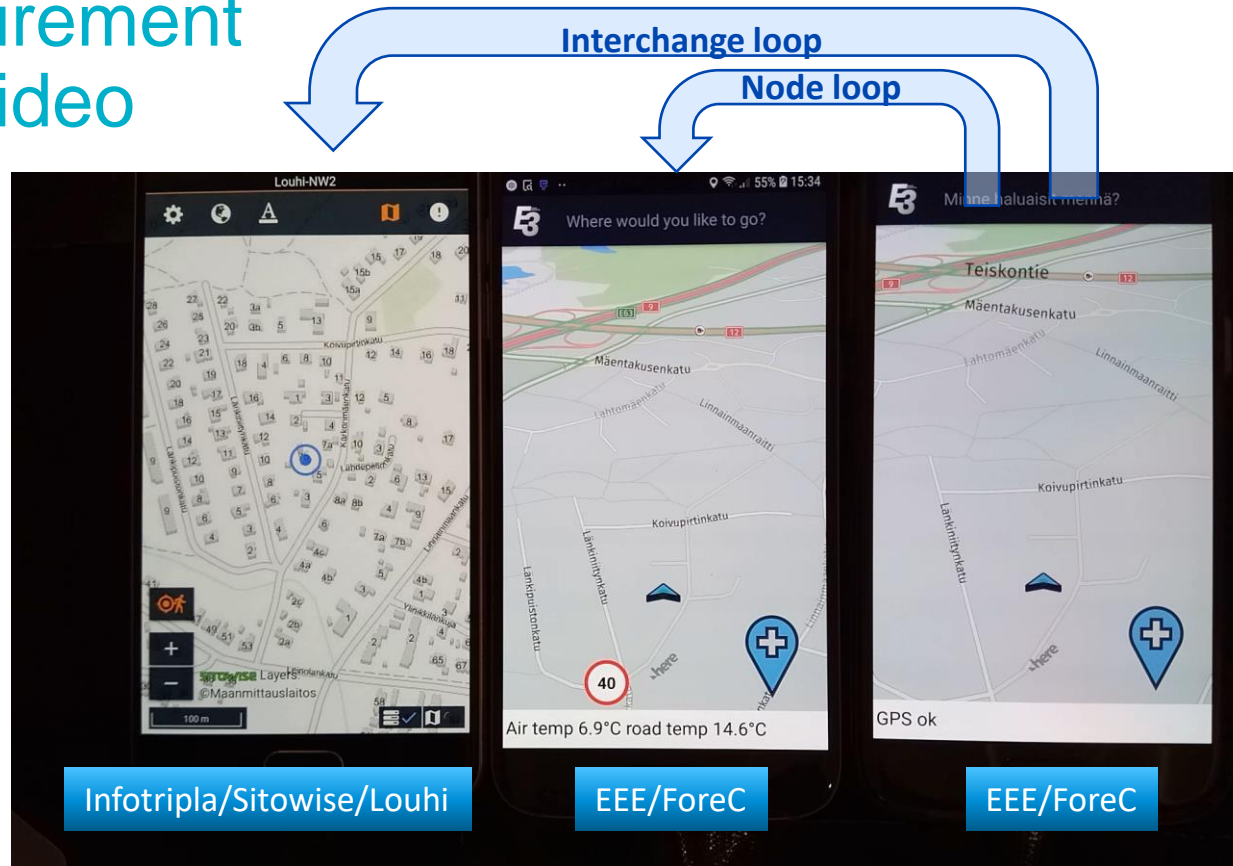
- Selected service to the test: Hazardous location notifications (slippery road)
- Testing with two mobile apps
  - ForeC (EEE Innovations),
  - Louhi (Sitowise)
- end-to-end testing included:
  - Overall functionality of the service
  - Location accuracy KPI measurements
  - End-to-end latency KPI measurements
- Stationary and driving tests in Tampere 27 – 29.4.2020



# Methods - Logging & Field test measurements



# e2e latency measurement from video



# Results – Scale of the pilots in FI & NO

KPI	DESCRIPTION	UNIT	RESULTS
Number of vehicles equipped	Change in number of vehicles equipped with fully functional C-ITS new mobile applications	Number	<b>FINLAND:</b> 860 - number of new mobile installations (during Jan - May 2020) <div>FI - Large scale pilot</div> <b>NORWAY:</b> 40 test vehicles with OBU <div>NO – PoC, local pilots</div>
Number of vehicles equipped (partially functional C-ITS in-vehicle-device)	Change in number of vehicles equipped with partially functional (only receiving or sending messages) C-ITS in-vehicle-device	Number	<b>FINLAND:</b> 120 new in-vehicle devices (during Jan - May 2020) <b>NORWAY:</b> 10 vehicles with mobile applications
Number of C-ITS service vehicles or users	Change in number of vehicles receiving C-ITS service(s), e.g. number of users	Number	<b>FINLAND:</b> 465 - number of active mobile users (per month)



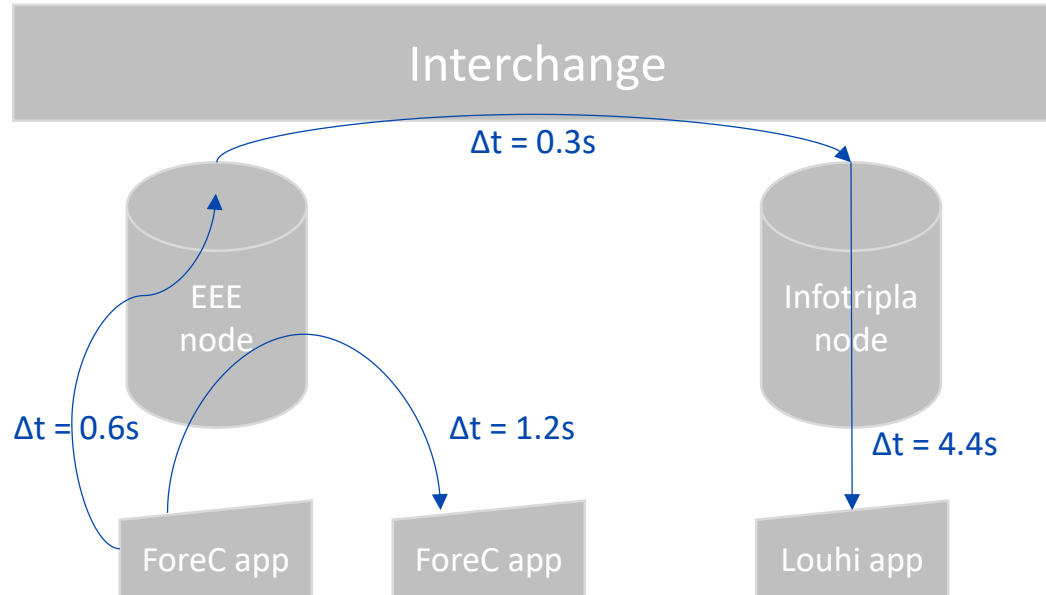
# Results – end-to-end (e2e) latencies

COUNTRY	MEASUREMENT DESCRIPTION	LATENCY	COMMENTS
Finland	Louhi app -> Interchange -> ForeC app	6.2 sec (median)	Controlled test, N=21 measured from video timestamps
	ForeC app -> Interchange -> Louhi app	5.3 sec (median)	Controlled test, N=25 measured from video timestamps
Sweden	Changing a geofence state in the GUI -> response in the vehicle	10 sec (average)	Dynamic controlled zone, controlled test, measured by the 'Stopwatch' method



# Median e2e latencies in FI controlled tests

## Node and Interchange loops



End-to-end latency [N=25]:  
Node loop: 1.2 sec  
Interchange loop: 5.3 sec



# Results – latency between federated interchange nodes

COUNTRY	MEASUREMENT DESCRIPTION	LATENCY	COMMENTS
Finland	Infotripla node -> Interchange -> EEE node	219 ms (median)	Mainly weather/road condition related warnings, N=2741
	EEE node -> Interchange -> Infotripla node	85 ms (median)	Mainly weather/road condition related warnings, N=358126
Sweden			
	Round trip time: Carmenta TrafficWatch -> Interchange node -> Volvo Cars Cloud	203 ms (average)	Emergency Vehicle Approaching warning, N=1813
	Traffic Light Controller -> Interchange node -> OEM clouds	Gothenburg: between 50 - 500ms (max)  Uppsala: between 675 - 1200ms (average)	Connected traffic signals, SPAT and MAP data
	Dynamic access control transmission -> reception in the application	300 ms (average)	Dynamic environmental zone, N=299



# Cross-border continuity of services

- Cross-border testing of the services was included the **Nordic Tour** tests: mobile application presented continuously messages from the interchange federation nodes.
- The interchange received events and messages from all countries and service providers
- Logging of messages and visual observations from the map view of a mobile application verified that the system was working well in all four countries. => **Cross-border continuity of services was verified**



# Lessons learnt



- Data logging have to be done according to common specifications which enables KPI analysis
- Latency calculations from logs need accurate synchronisation of the server clocks which needs to be monitored constantly  
  
=> enables also monitoring of the C-ITS services after the deployment
- Variability of the latency results in the pilot implementations highlights the need for monitoring of KPIs to ensure the service quality



# To conclude



## Quality of service: Is the quality of C-ITS services sufficient?

- End-to-end latency measurements proved that the cellular (4G-LTE) implementation of the piloted services over NW Interchange nodes **enables fully functional Day-1 C-ITS services** (most of which are **not time critical**)
- Cellular networks provides excellent economy of scale and nationwide road network coverage from the start and the networks will evolve
- Cross-organisational and cross-border data sharing across the federated Interchange system was confirmed => **the NordicWay works!**

CONCLUSIONS



Thank you!

Contact: Mikko Tarkiainen, [Mikko.Tarkiainen@vtt.fi](mailto:Mikko.Tarkiainen@vtt.fi)  
Kimmo Kauvo, [Kimmo.Kauvo@vtt.fi](mailto:Kimmo.Kauvo@vtt.fi)



Co-financed by the European Union  
Connecting Europe Facility