



bouvet

Nordic
WAY 2



Nordicway Interchange

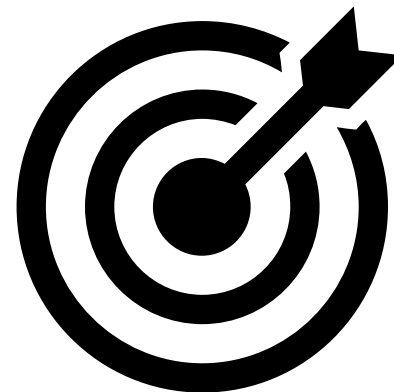
Heart of the NW ecosystem



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Goals

- Real time data exchange between many different actors' back end systems
- Highly scalable
- Minimum effort for data exchange



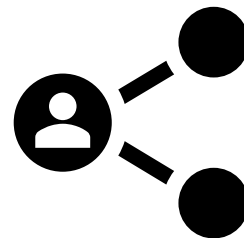
The data sharing problem

The problem is NOT:

- Lack of standardized data formats. Several data formats exist that cover a wide range of use cases.

The problem is:

- Lack of data sharing ecosystem.



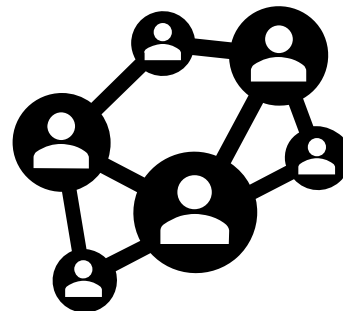
Specifically, the problem can be broken down in to two:

1. No way to know what data is available from what provider.
2. Existing solution mainly rely on one-to-one bilateral data exchange. This is expensive to build and maintain, and impossible to build large scale when the number of actors get large.



The interchange network

- Started working on a solution for these problems back in Nordicway 1
- AMQP based solution with automated service discovery and data subscription handling.
- Work picked up by C-ROADS
- The NordicWay 3 interchanges will be harmonized with the C-Roads specifications.
- During the NordicWay 2 project, 6 Interchanges were active. With 5 providing cross-border data flow (federation)



2020 test

- To confirm interoperability between two different implementations, a test was conducted between the Norwegian and Swedish node.
- We tested the average latency from end user to end user. (Not over cellular network!)
 - Ericsson(Swe) user located in Lund, Sweden. Ericsson Node also in Lund.
 - Bouvet(Nor) user located in Oslo, Norway. Bouvet Node located in Finland.
- Physical message route:
 - Lund(Client) -> Lund(Interchange) -> Finland(Interchange) -> Oslo(Client)
- User to user latency was 57.2 milliseconds on average for single messages.

If you were standing at one end of a bowling lane speaking to your friend, ~57ms is the time it would take for the sound of your voice to go from your mouth to your friend's ear.



Open-source implementation

- The Norwegian interchange node implementation is open source.
- Developed by Bouvet for the Norwegian Public Roads Administration.
- Available on Github: github.com/NordicWayInterchange/interchange

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NordicTour

Route and technology

120 hours of driving
6000 kilometres
3 border crossing while driving



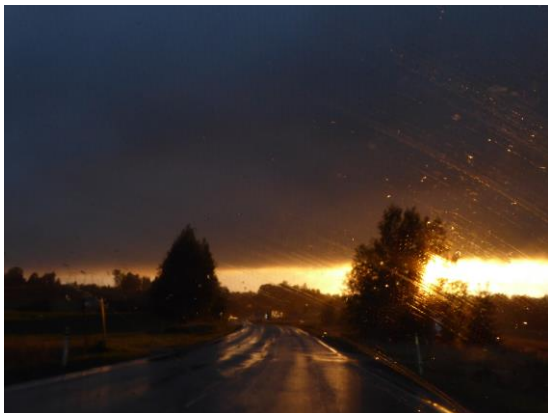
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Road and lane closure in the Nordics

A connected drive through Denmark, Sweden, Finland and Norway

RDS TMC Message – in Finnish ??????



Roadworks data challenges,
Ghost roadworks and unknown roadworks

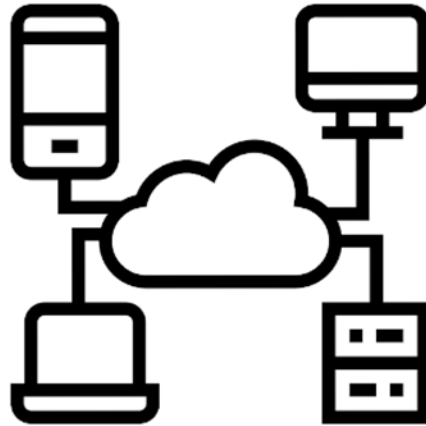


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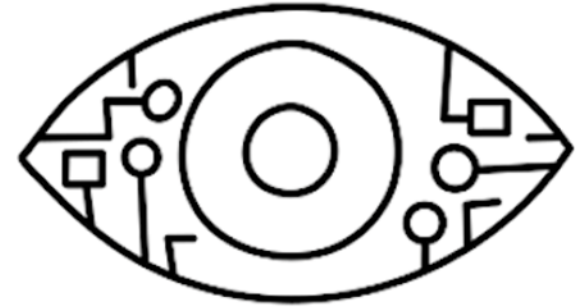
Readiness for automation



Positioning



Communication



Human machine-readable infrastructure



GNSS

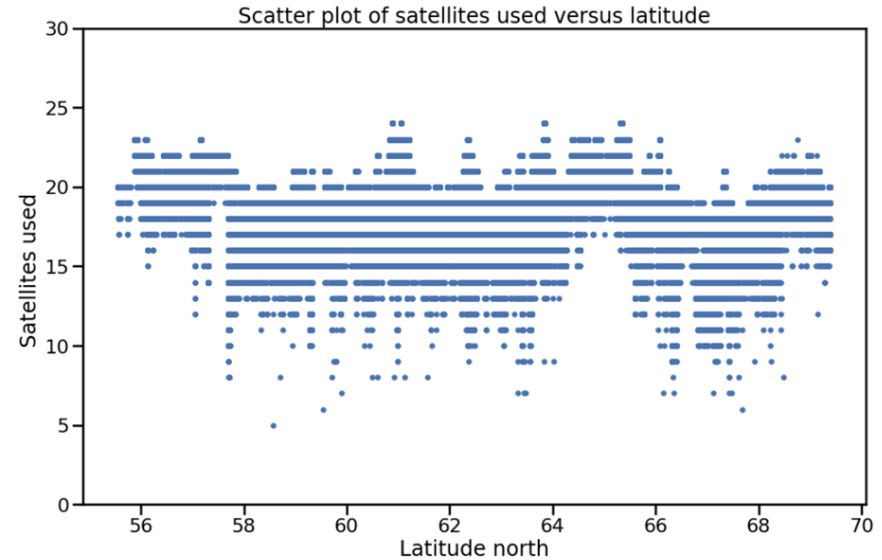
	count	mean	std	min	25%	50%	75%	max
country								
Denmark	11758.00	1.70	8.78	0.80	1.04	1.19	1.38	256.29
Finland	78898.00	1.07	2.00	0.47	0.79	1.01	1.25	403.05
Norway	103802.00	54.27	503.08	0.50	0.78	0.93	1.18	12156.42
Sweden	124612.00	2.45	28.42	0.53	1.09	1.44	1.73	1644.52

GPS jamming fact or fiction ?



GPS jammers exist in the wild, in additions we have suspect data in Kilpisjärvi, Mo i Rana and Trondheim.

C-ITS services are susceptible to GNSS interference – need for cooperation with experts in the field.



Tunnels are a problem, high latitudes are not, jamming is present – need for IMU supported GNSS

Cellular coverage

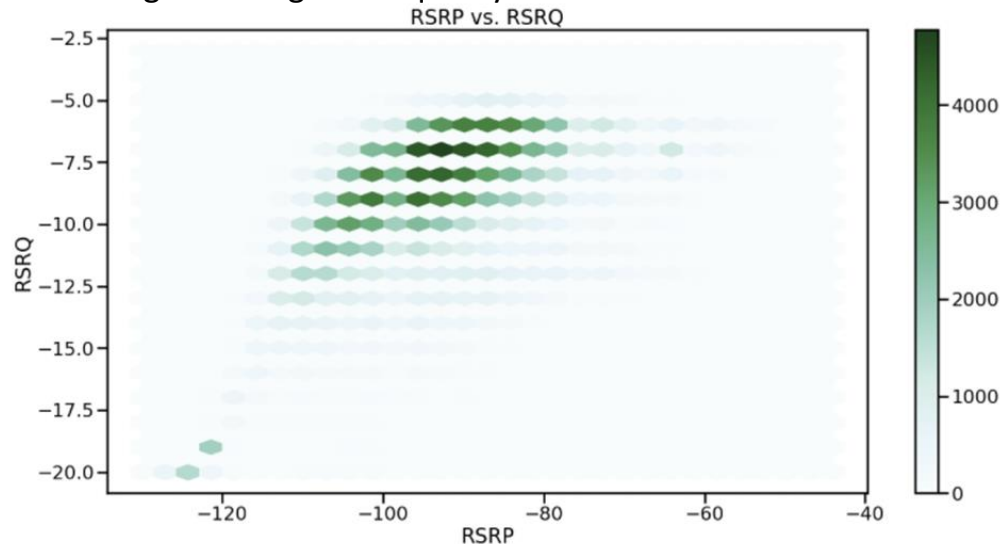
400 meter segment coverage, all technologies (2G,3G,4G) as percent of total segments

	Modem	Tablet	VCC_int	VCC_roof
Denmark	99,4	99,0	100,0	100,0
Finland	100,0	99,9	99,5	99,5
Norway	97,1	96,8	98,0	98,2
Sweden	99,7	99,7	98,3	96,8

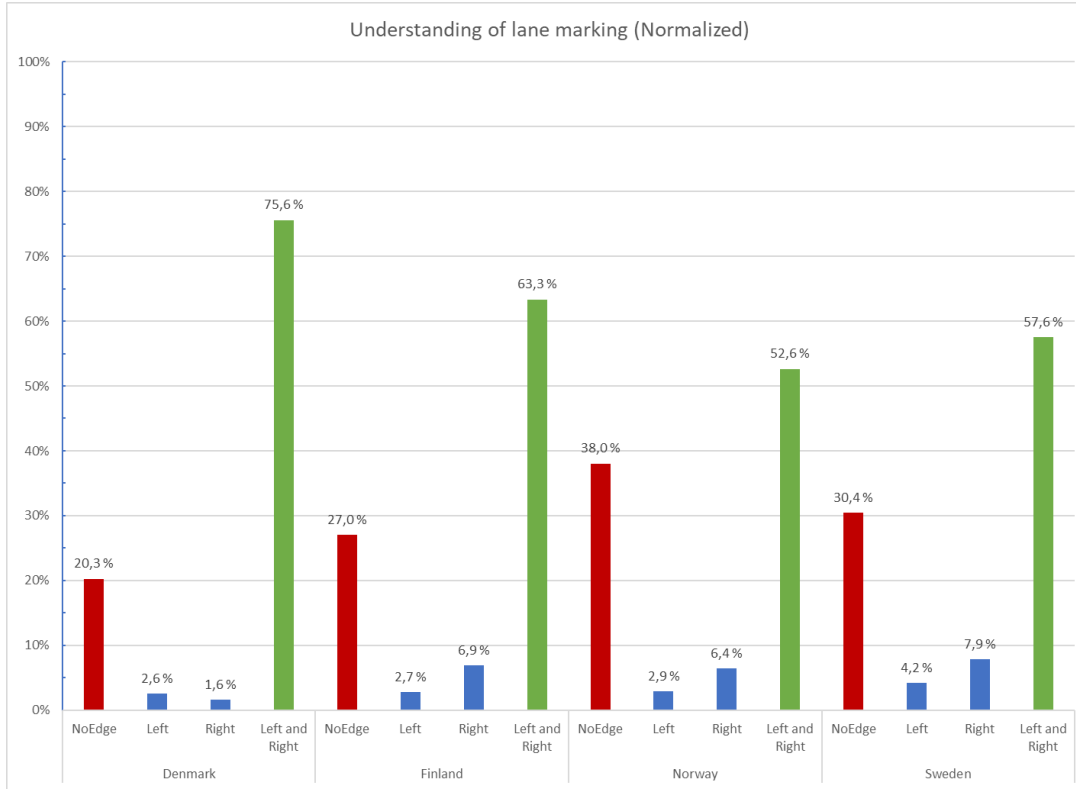
Notes:

- 1: Norway, issue with long tunnels
- 2: Sweden, software issue on the VCC equipment day 2

Signal strength and quality from Table all countries



Human/machine readable infrastructure



Note:

Design of systems play a significant impact – not a bug it is a feature!
60km/h and Norway

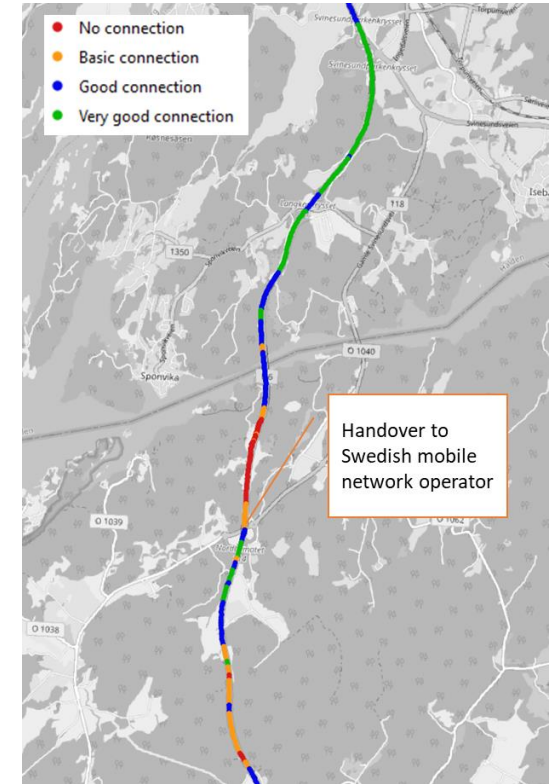
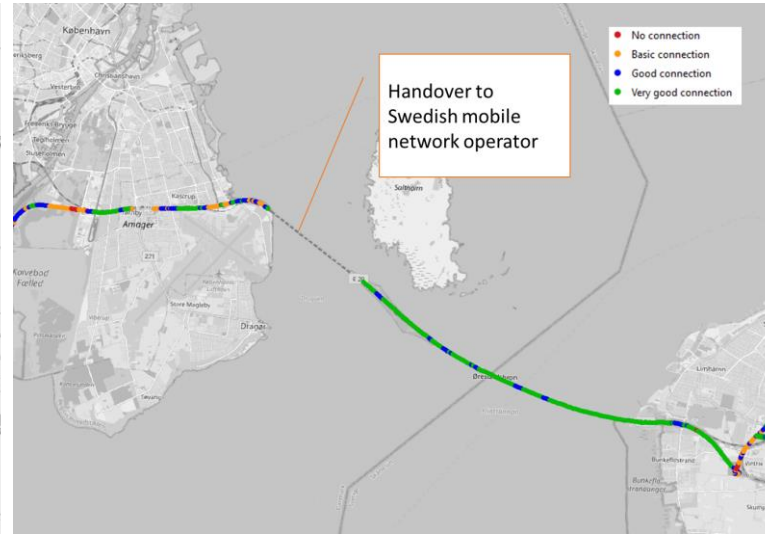
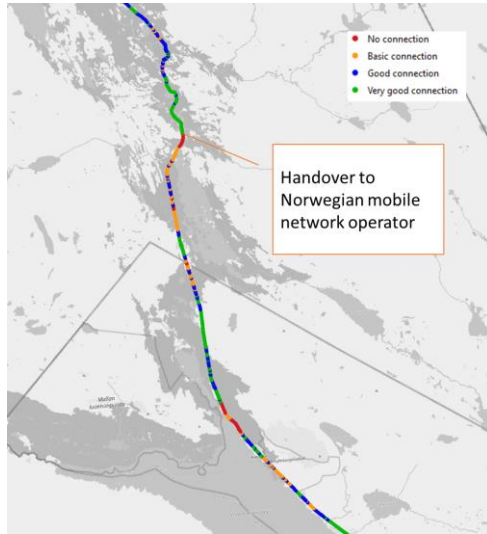
Dropouts are quite often – but for small stretches, typically 2-3 seconds – 23 seconds longest found – sharp turn



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Entry to bridge Efjorden, Nordland

Telco -border crossing



Border crossing still has some issues, there is typically a loss of reception before reestablishing connection. But same equipment may behave differently, two Samsung S9 phones behaved quite differently – seems a bit random or linked to activity?

