LUOTETTAVA JA TARKKA PAIKANNUS MAALLA JA MERELLÄ

Prof. Jarkko Koskinen
24/8/18


Helsinki 2010

CHALLENGES FOR FOR POSITIONING AND NAVIGATION IN ARCTIC CONDITIONS


Source: Finnish Transport Agency

- Coverage of GNSS constellations and satellite- or land-based augmentation systems is not optimal
- Access to radio navigation (other than GNSS) and communications is limited
- Atmospheric modeling
- Availability and quality of maps
- Presence of ice and snow

The challenge is to attain similar levels of navigation performance and reliability as in lower latitudes

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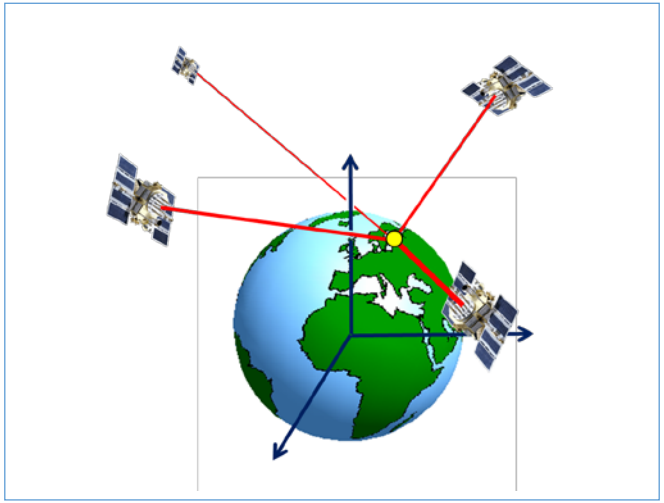
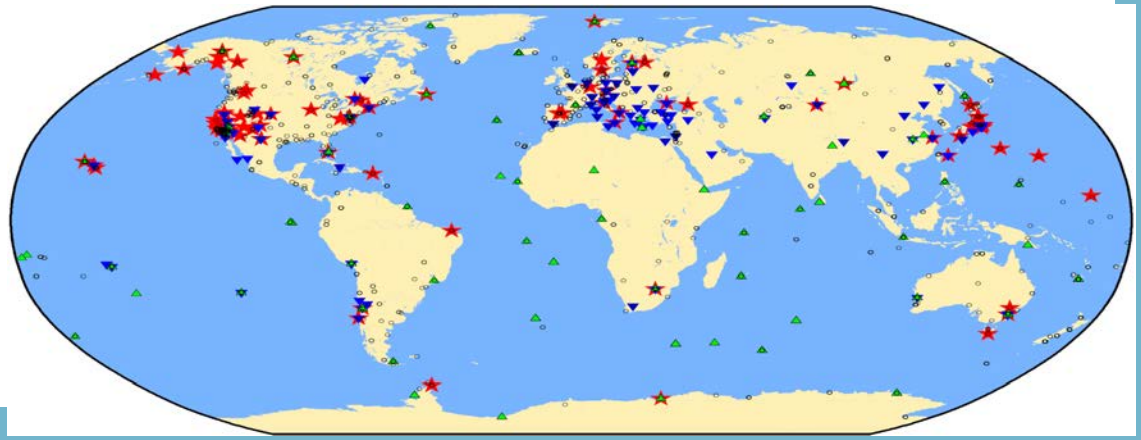
GLOBAL REFERENCE SYSTEM



With GNSS we are measuring in a global reference system.
We get absolute positions on the globe. Reference system is three-dimensional.
A reference system is realized with a global network of permanent geodetic observing stations. Stations defining the realization are on different continents

Continents are moving a few cm/year. This affects on global reference systems because coordinates of stations are changing.



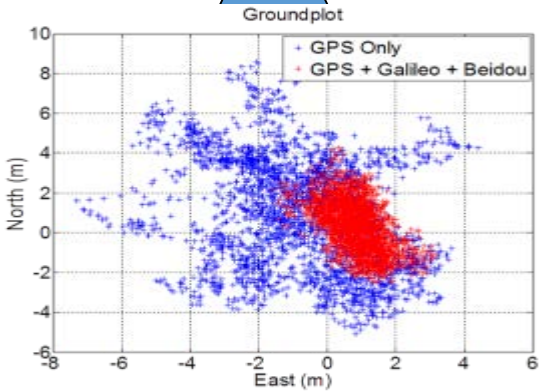
GNSS SYSTEM COMPARISON

	GPS	GALILEO	GLONASS	BeiDou
First launch	1978	2011	1982	2007
Full Operational Capability	1995	2018-19	2011	2020
Number of satellites	32	30	31	35
Orbital planes	6	3	3	3
Access Scheme	CDMA	CDMA	FDMA/CDMA	CDMA
Current Status	31 operational	20 operational / comissioning	24 operational	15 operational satellites, full coverage on Asia pacific region

- Single system accuracy ~ 5 m
- Vulnerable to interference, ionospheric disturbance etc.

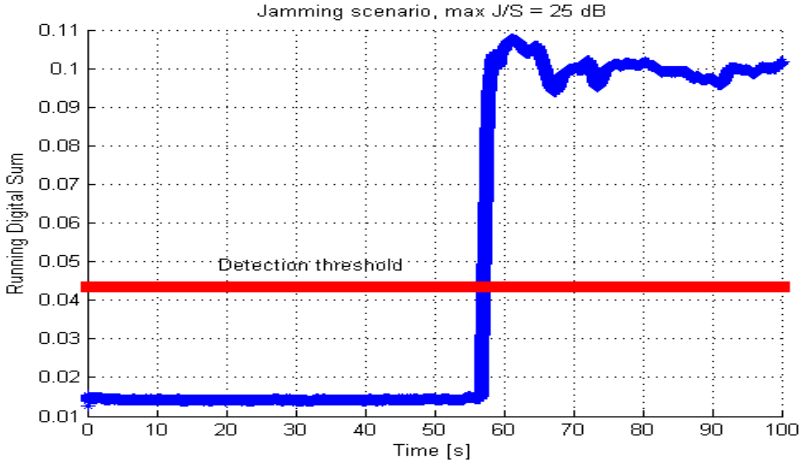
MULTI GNSS RECEIVER DESIGN

- FGI GNSS software development
- Improved accuracy with combined solutions
  - Multi-frequency multi-system
  - Interference monitors
  - Sensor support

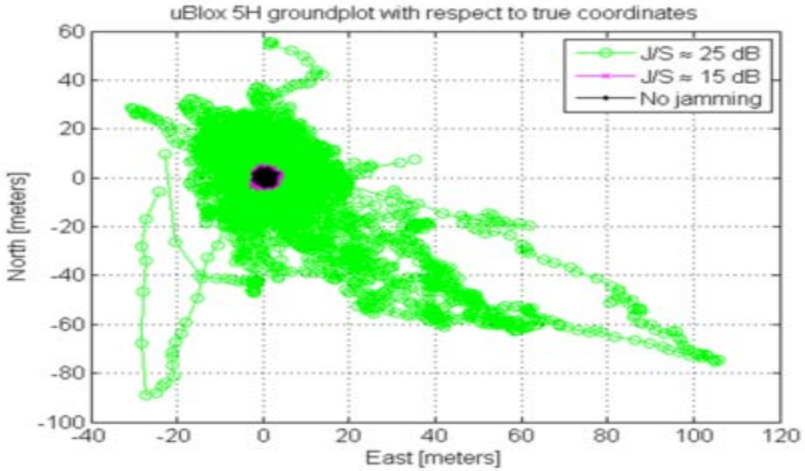


JAMMING AND SPOOFING

- Developing methods and algorithms both to detect and to mitigate intentional interference generated by Jamming and Spoofing devices on GNSS



Interference detector



Jamming effects on commercial receivers

Venäjä testasi uutta kyberasetta Mustallamerellä? Laivojen GPS-sijainti heitti yli 30 km

Perjantai 11.8.2017 klo 21.06

Satelliittinavigaattori väitti laivojen olevan sisämaassa.

Aluksen GPS-navigaattori väitti sen olevan 32 kilometrin päässä todellise

Yacht hijacking shows the potential power of GPS spoofing

By Kevin McCaney | Aug 01, 2013

Itseohjautuvat laivat lipuvat pian omalla testimerellä

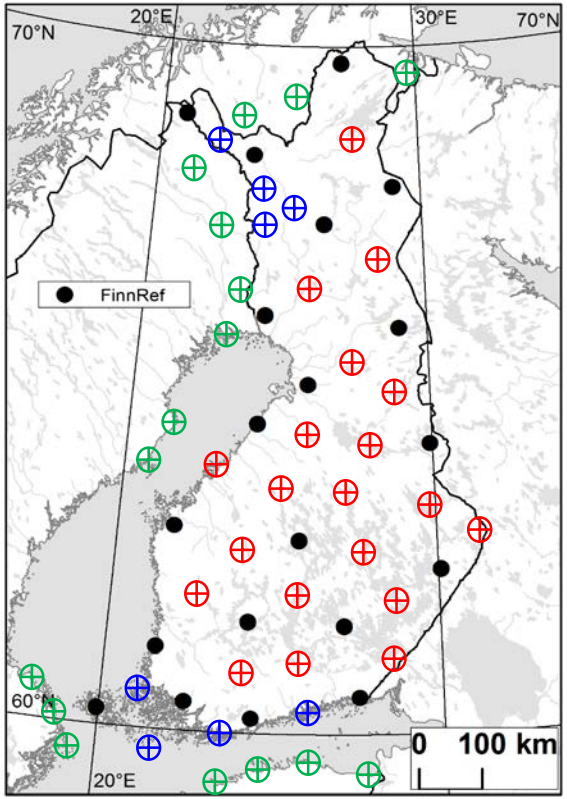
Eri toimialojen yhteistyö saavuttaa pian uuden virstanpylvään, kun Suomen ensimmäinen itseohjautuvien laivojen kokeilutestimeri avautuu Selkämerellä.

Itseohjautuva liikenne 15.8.2017 klo 09:02 | päivitetty 15.8.2017 klo 09:13

BENEFITS OF THE EUROPEAN GNSS - GALILEO

- Galileo is the GNSS which will bring positioning and timing autonomy from GPS or GLONASS
- GALILEO benefits:
  - increasing accuracy and reliability
  - higher level of signal
  - anti-spoofing capabilities with signal authentication
  - higher precision with Commercial Service and security with Public Regulated Service
  - civilian governance

FINNREF-NETWORK



- Current 20 FinnRef stations
- 21 new FinnRef stations
- 8 Co-operation stations
- 15 Data exchange stations

- Fundamental network of the national reference frame
- Established 1994 (13 GPS), updated 2013 (20 GNSS)
- Part of Nordic network, four stations in EPN and Metsähovi in global network

- Provide local correction data to GNSS receivers
- Assist in precise positioning using RTK, monitoring interference, etc.

NLS GNSS POSITIONING SERVICE

FinnRef-base station

Satellite data collection

Errors

Data

Data

Computer center

Real time error analysis

Data

Corrections to data

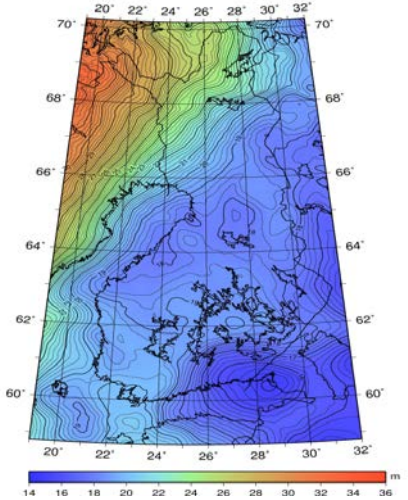
Users

Data + correction = accurate position

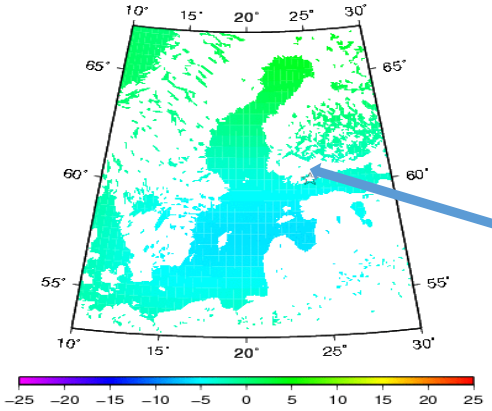
Satellite gravimetry in Finland

Finnish Geodetic Institute uses GRACE gravity satellite to compute changes in water mass distribution in the Fennoscandian area, e.g. of the Baltic Sea. Results are compared to the gravity changes observed with the super conducting gravimeter at the Metsähovi observatory and to tide gauge data.
GRACE and GOCE data are used in geoid modeling research.

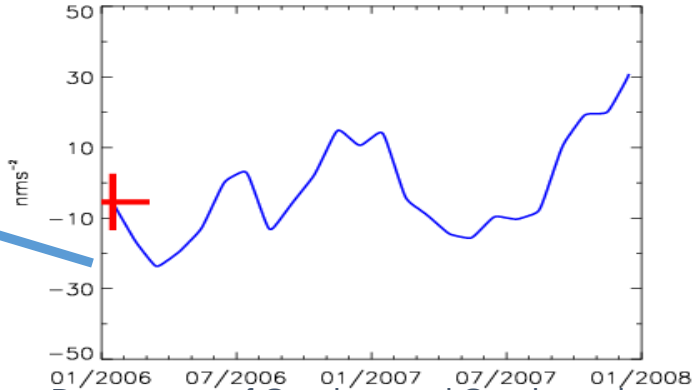
Geoid model



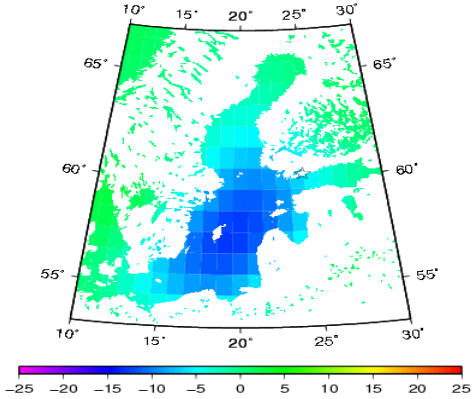
GRACE (cm)



Gravity change at Metsähovi

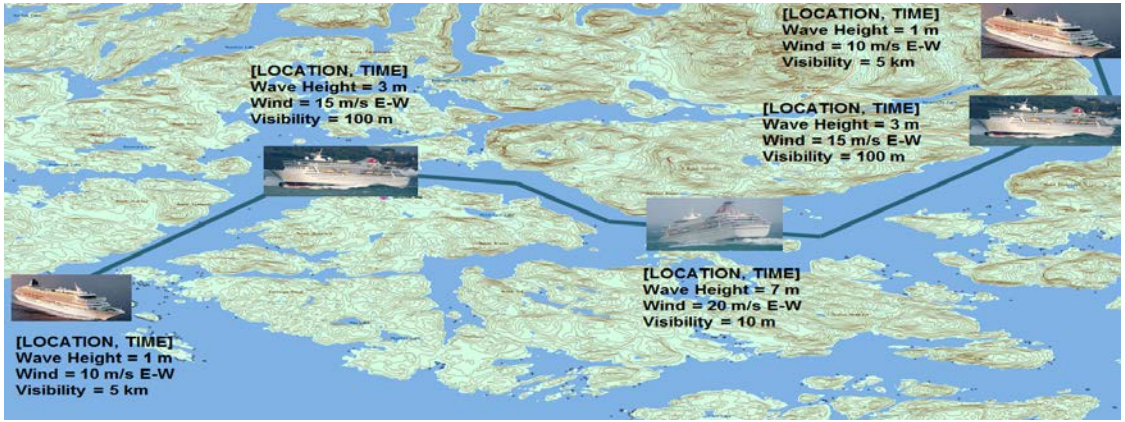


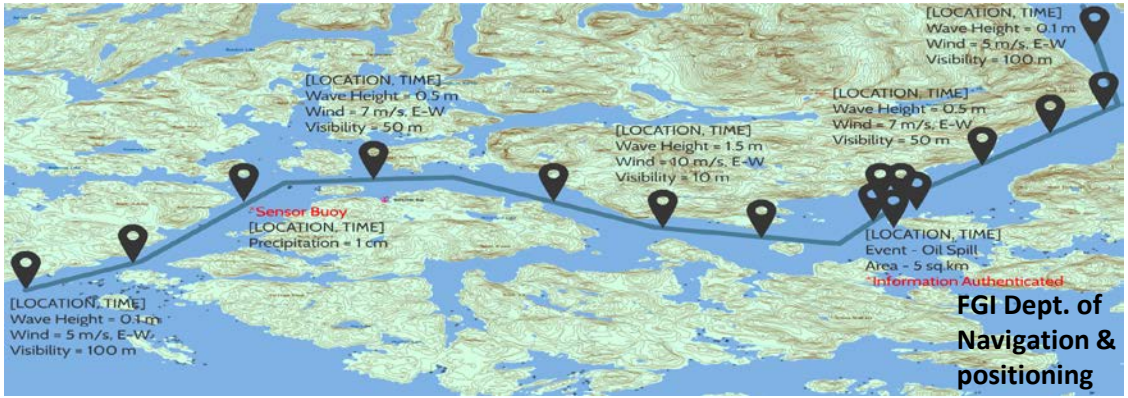
Sea level change (cm)



WHAT ABOUT MARITIME NAVIGATION UNDER ARCTIC CONDITIONS?

- Not feasible to install sensors along Arctic maritime routes
- Information ~~Crowdsourcing~~ Sharing Or, Information of Opprortunity
- Information about visibility and sea condition (drift ice, wave heights, strength of currents)
- …deep within an archipelago
- …can be distributed instantly and regularly
- …by a ship that has already passed through to future ships taking the same route…





SCENARIO – 2: SHARING SUCCESSFUL ICE ROUTES

Our vessel unable to find broken route in the dark. In snowstorm, spatial range of headlights degrade.

Our vessel reorients itself onto the broken route using the shared ice radar.

Ice-breaker in the front of the convoy shares its ice radar image showing the location of the broken route.

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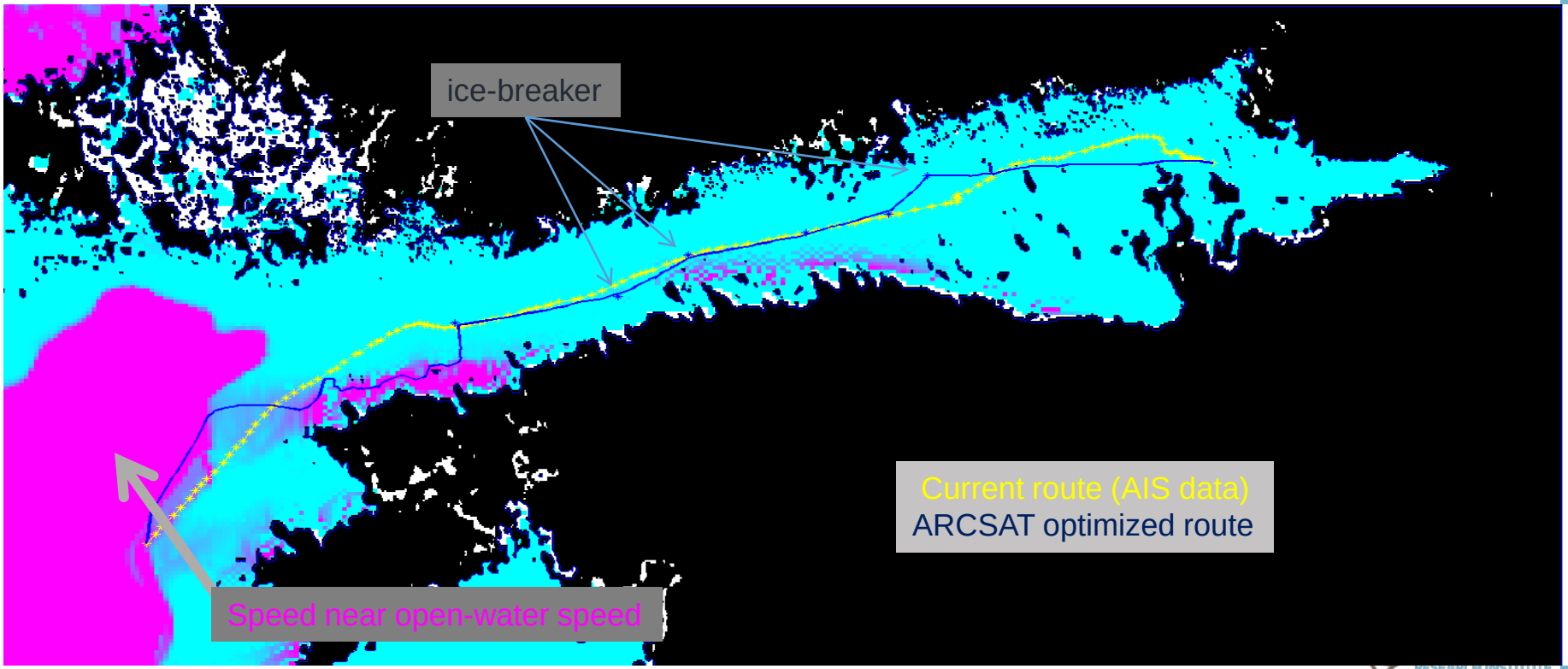
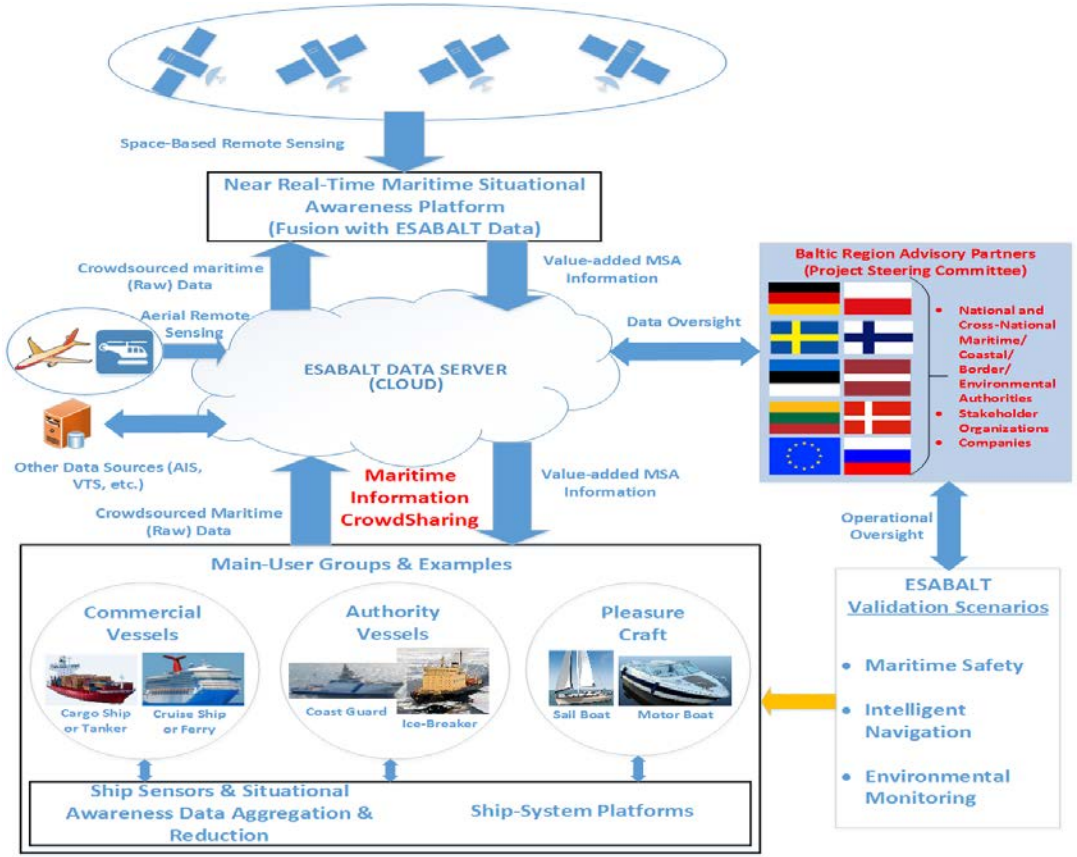
ICE-AWARE MARITIME ROUTE OPTIMIZATION



EU BONUS ESABALT*: ENHANCED SITUATIONAL AWARENESS TO IMPROVE MARITIME SAFETY IN THE BALTIC



*Flagship Project in the EU Strategy for Baltic Sea Region's Priority Area on Maritime Safety and Security

EUSBSR EU STRATEGY FOR THE BALTIC SEA REGION

POLICY AREA 'SAFE'

EU STRATEGY FOR THE BALTIC SEA REGION FLAGSHIP

BONUS SCIENCE FOR A BETTER FUTURE OF THE BALTIC SEA REGION

ESABALT

www.ESABALT.org

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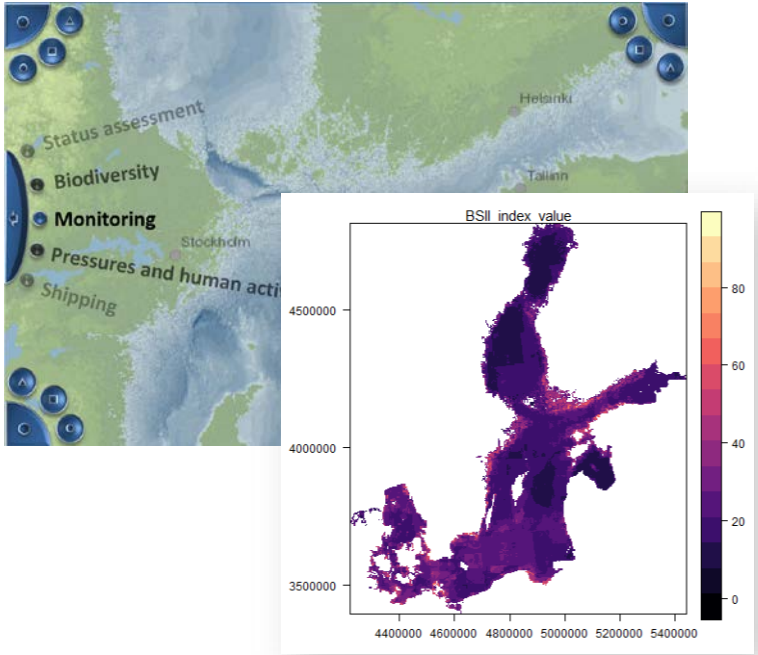
24.8.2018

BONUS BASMATI
Baltic Sea Maritime Spatial Planning for Sustainable Ecosystem Services

MERIALUESUUNNITTELUN INNOVATIIVISET TYÖKALUT

- FGI-GEOINFO koordinoi BONUS Basmati hankkeen paikkatietotyökalujen kehittämistä
- Tavoitteena **Baltic Explorer** – Spatiaalinen päätöksenteon tukijärjestelmä merialuesuunnitteluun
  - Data Explorer - dataselain
  - Mm. **vuorovaikutteinen** kumulatiivinen vaikutusarviointi ja soveltuvuusanalyysi – **paikkatietopohjainen teholaskenta**
  - Tukee **osallistavaa suunnittelua**
  - Soveltuu käytettäväksi **suurilla kosketusnäytöillä**
- Web sovellus, ilmainen käyttö



Konseptointi- ja prototyyppivaiheen luonnoksia Baltic Explorer työkalusta

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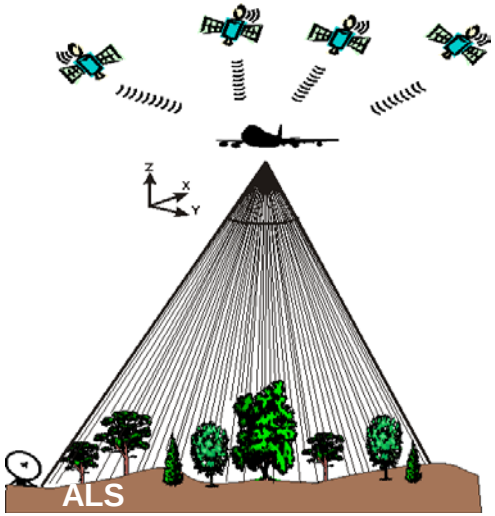
PLATFORMS FOR LASER SCANNING

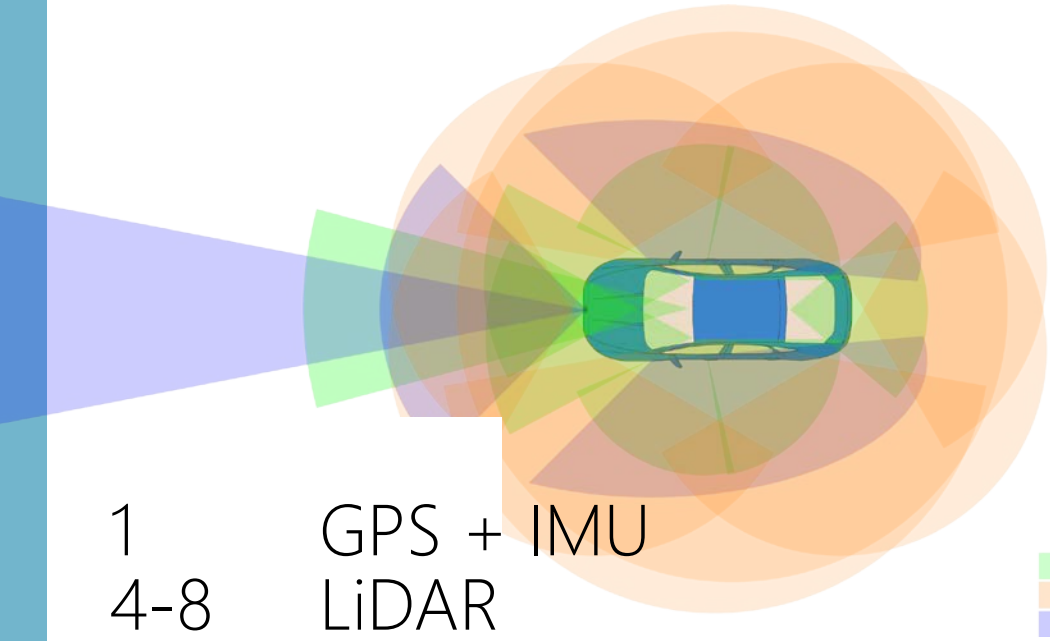


Airborne Laser Scanning

Terrestrial Laser Scanning

Mobile Laser Scanning

SENSORS IN AUTOMATED VEHICLE



1	GPS + IMU
4-8	LiDAR
8-12	Camera
4	Radar

No single positioning technology is sufficient for automated vehicle. Single technology approaches lacks the necessary accuracy and robustness for safety critical applications
WE need several independent positioning methods

- Satellite positioning and inertial positioning
- network positioning
- Sensors and HD-map positioning

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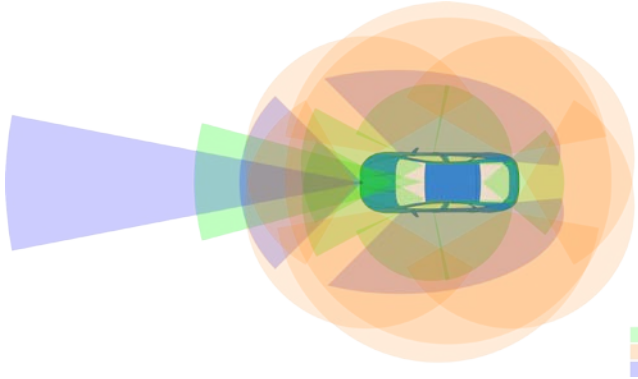
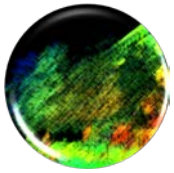
ESIMERKKEJÄ MAAILMALTA

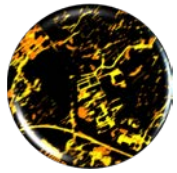


Own state



Environment

Objects



Mapping

aurora

1. Arctic testing for intelligent transport automation

Technology test sites
in real winter conditions with
broad selection of services

2. Digital transport infrastructure and connected cars

Accurate mapping of road infrastructure and signage enabling connected driving and analytics for traffic management

3. Intelligent infrastructure asset management

Data collection and refined traffic management and maintenance processes in the era of automation

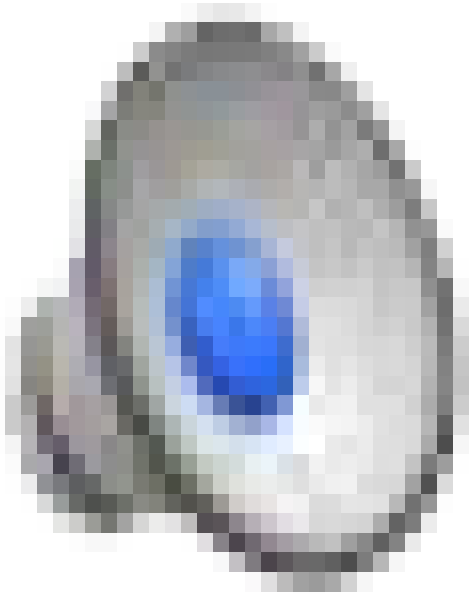
4. Mobility as a Service

Flexible and affordable mobility services for tourists and locals without car dependency

INTELLIGENT HIGHWAY E8

- In Finland the improvement of highway E8 is underway to meet the requirements of a public test area
  - Extensive data collection
  - 9 km technology test section

- Precise positioning in the Aurora region
  - High accuracy with professional GNSS receivers
- Cooperation with Norwegian Public Roads Administration
  - Borealis project to cooperate with Aurora in 2017 -2018
  - Joint development of cross-border ITS solutions on E8



SHOWING THE WAY

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