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SPACE SERVICES FOR ARCTIC OPERATIONS



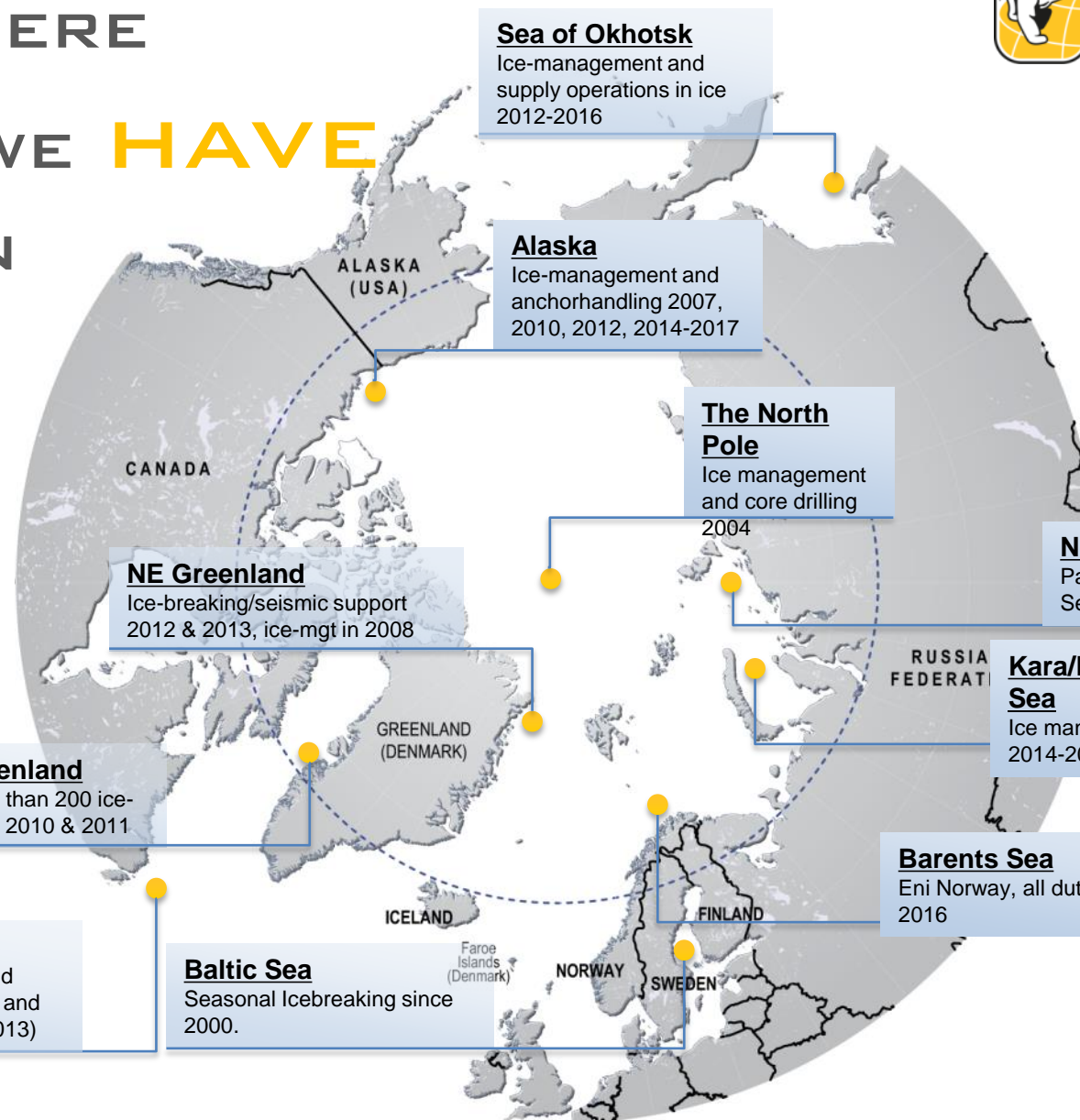
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VIKING ICE CONSULTANCY

- **A VIKING GROUP COMPANY**
- **BASED IN KRISTIANSAND, NORWAY**
- **A PART OF THE VIKING GROUP WITH AFFILIATED OFFICES IN RUSSIA AND CANADA**
- **OFFERS SERVICES WITHIN MARINE OPERATIONS IN THE ARCTIC AND COLD ENVIRONMENTS**
- **KNOWLEDGE AND EXPERIENCE FROM ALASKA, CANADIAN ARCTIC, GREENLAND, BARENTS SEA, RUSSIAN ARCTIC, SAKHALIN AND THE BALTIC**



WHERE WE HAVE BEEN



Sea of Okhotsk

Ice-management and supply operations in ice 2012-2016

Alaska

Ice-management and anchorhandling 2007, 2010, 2012, 2014-2017

The North Pole

Ice management and core drilling 2004

Northern Searoute

Passage of the Northern Searoute 6 times

Kara/Pechora Sea

Ice management 2014-2017

Barents Sea

Eni Norway, all duties 2011-2016

NE Greenland

Ice-breaking/seismic support 2012 & 2013, ice-mgt in 2008

West Greenland

Moved more than 200 icebergs during 2010 & 2011

Baltic Sea

Seasonal Icebreaking since 2000.

Canada

Ice berg management Grand Banks Canada for Chevron and Husky Energy (2012 and 2013)



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Prirazlomnaya Platform

THE INTEGRATED MET OCEAN, ICE AND LOGISTIC SERVICES

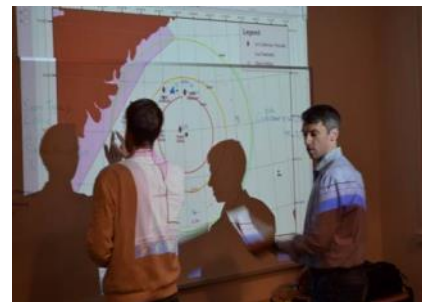
TURNKEY
SUPPLY





OUR SERVICES

- PROJECT MANAGEMENT
- TURNKEY SUPPLY
- ICE MANAGEMENT
- ICE ADVISORY
- LOGISTICS & TRANSPORTATION
- TRAINING
- TECHNOLOGY QUALIFICATION
- POLAR CODE COMPLIANCE ADVISORY



Dec 2015 NSR Transit

Why NSR instead of Panama from Seattle to Sweden








- Just finished seasonal work in Alaska Nov 15
- Shorter Distance 9500-7100 = 2400nm
- Be back in North Sea earlier for job opportunities
- Save Fuel?
- Good experiences with previous transits
- Increase Arctic in-house knowledge
- Good and reliable Ice and hydro metrological information from partners and suppliers
- Icebreaker from Rosatomflot in area

NSR Transit would not be started if Russian Icebreaker is not in area or poor availability of ice and met ocean information

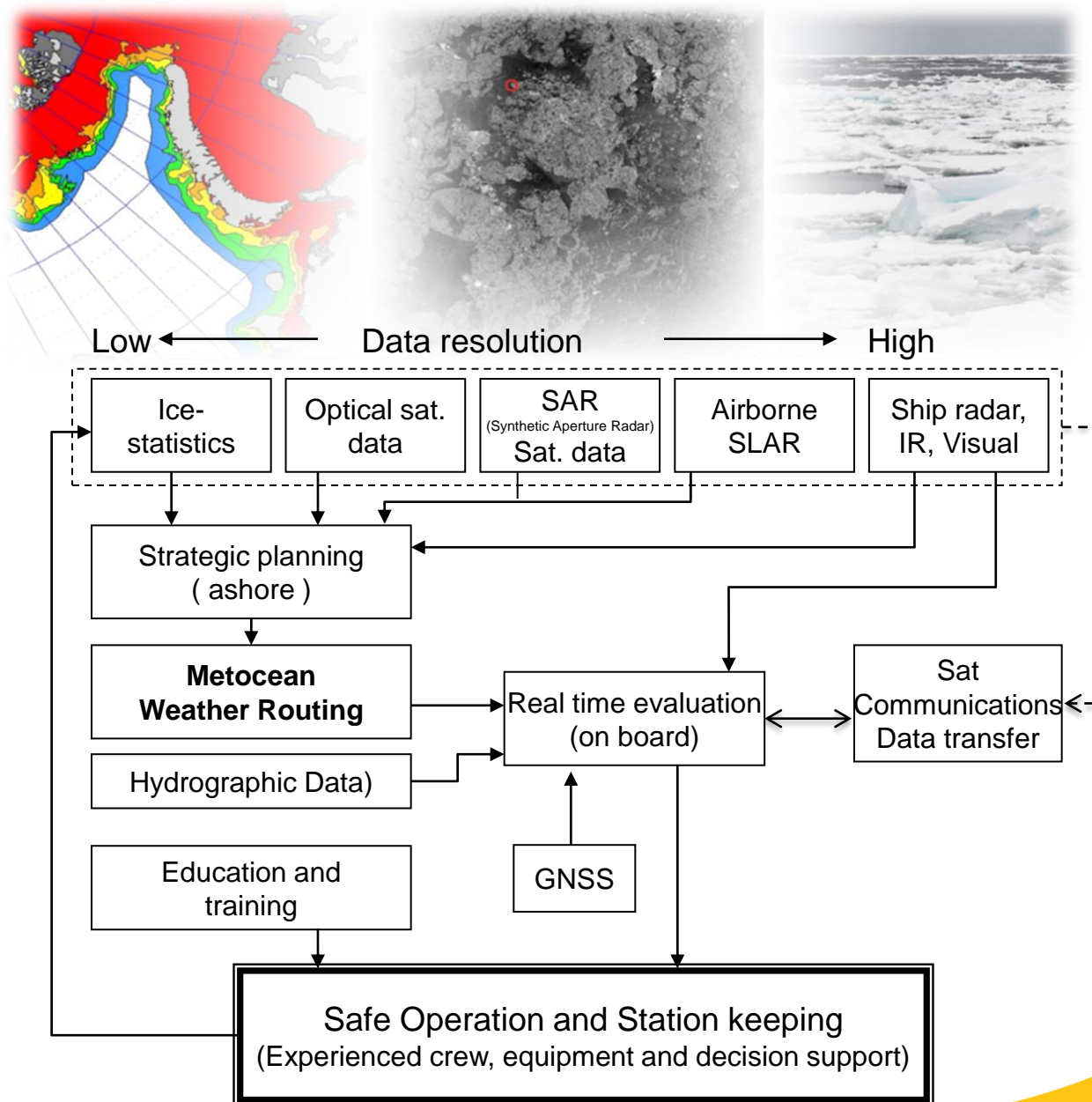
Viking Supply Ships – Fleet overview

12 of 18 vessels either high ice-class or ice-breaker

| | Loke Viking class | Tor Viking class | Odin Viking | Frigg Viking class | SMA Icebreakers |
|------------------|--|--|---|---|--|
| |  |  |  |  |  |
| | With it's high ice-class and winterization the Loke Viking class is the ideal vessel for sub-arctic operations | Combined Ice-breaker and AHTS suitable in harsh environment operations as well as the arctic | Medium sized AHTS suitable for world-wide operations, with a proven track-record in the North Sea | Medium sized PSV vessels with DP-2. | Icebreakers owned by Swedish Maritime Administration. VSS crewing and Technical management |
| Vessels | 4 | 3 | 1 | 5 | 5 |
| Design | VS-4622L | KMAR 808 | Moss Mar 424 | VS-470 Mk II | Icebreaker |
| Built | 2010-2012 | 2000-2001 | 2003 | 2003-2007 | 1973-1989 |
| Ice-class | Ice 1A, deice C | Icebreaker Ice-10/ARC 7 | N/A | N/A | 1A Super – Polar 20 |
| BP/ deck | 235-257 tonnes bollard pull | 202 tonnes bollard pull | 180 tonnes bollard pull | 710 sq. meters | 50-250 tonnes bollard pull |
| NSR | | 4 | | | 3 |



HIGH DATA RESOLUTION NEEDED TO OPERATE SAFE AND ECONOMICAL





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Ice and Met Ocean Products, Services and Delivery/Viewer used

Arctic and
Antarctic institute



Soumi NPP VIIRS (IR Sat)
res 750 m

IceAnalysis daily

Ice Forecast 24, 48, 72

Ice Pressure Forecast

Recommended Route

Metocean forecast

E Mail

Transas NaviSailor

Pdf, GeoTiff

Google Earth

StormGeo

StormGeo

Fleet DSS, Vessel
tracking and large area
weather info

Icing Warning Forecasts

Online COPD Portal
including daily high res
weather routing

Point Forecasts
(Vilkitsky)

E Mail

Installed SW

Online Portal

Pdf

Kongsberg
Satellite Services



Syntetic Aperture Radar
Imagery:

Scheduling/Portal

Sentinel 1A

Radarsat 2

Risat 1

ftp

Portal

Geotiff

Google Earth

Polar View Ice/
VTT/FMI



Polar View Ice
onboard/onshore client

Sentinel 1 EWS

Barents and Kara Ice
Thickness

PolarView Ice SW

Viking Ice
Consultancy



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Daily operational ice
products (GIS)

Ice advisory and daily
teleconference

E-Mail

Pdf

Geotiff

SAR most common products for ice surveillance

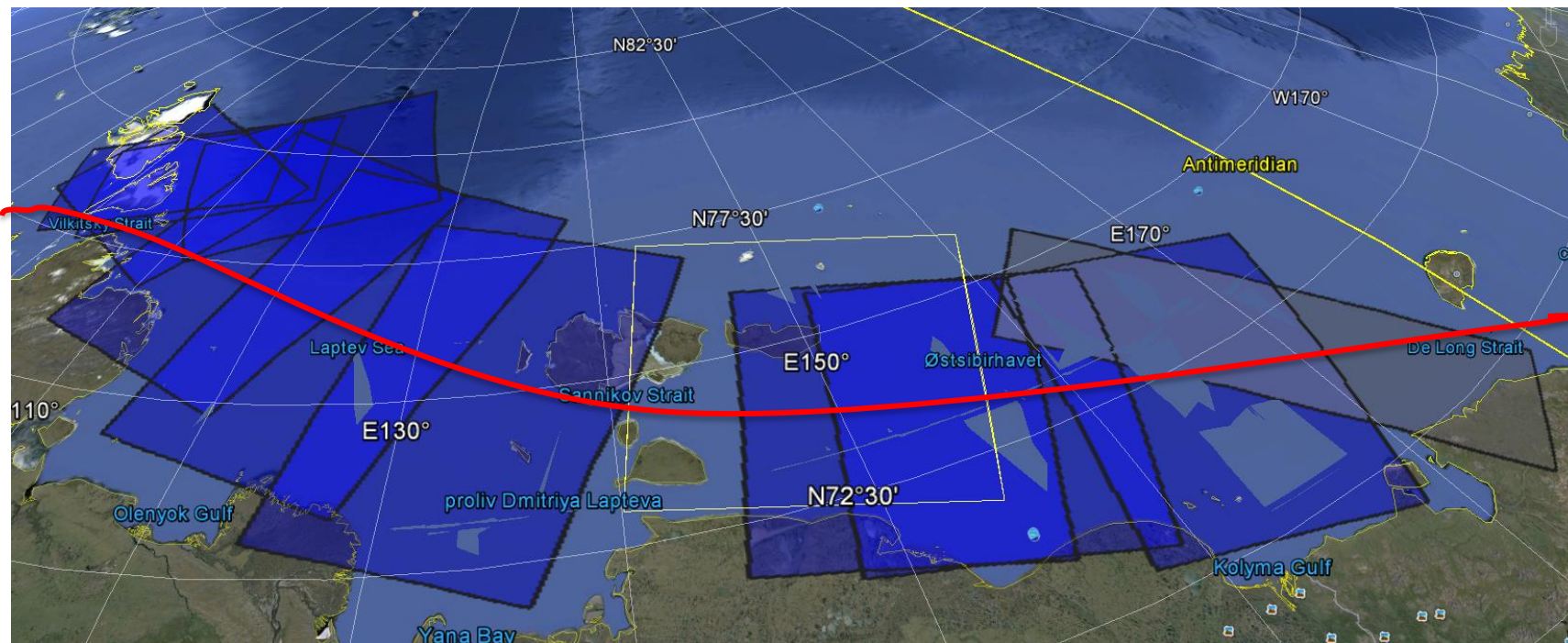
| Bird/Mode | Coverage | Resolution |
|----------------------------------|--|--------------|
| | | |
| Radarsat-2 | | |
| ScanSAR Narrow | 300x300 km | 50 meters |
| Standard | 100x100 km | 30 meters |
| Ultrafine (Growlers) | 20 x 20km | 3 meters |
| | | |
| CosmoSKY-med | | |
| ScanSAR Huge | 200x200km | 100 meters |
| ScanSAR Wide | 100x100km | 30 meters |
| HIMAGE | 40 x 40 km | 3 / 5 meters |
| | | |
| TerrasarX | | |
| ScanSAR | 100x150 km | 20 meters |
| StripMap | 30x50 km | 3-5 meters |
| Spotlight | 10x10 km | 1-3 meters |
| | | |
| Sentinel-1 | | |
| EWS (Extra wide Swath) | 400x400 km | 40 m |
| IWS (Interferometric Wide Swath) | 250x250 km | 20 m |
| Stripmap | 80 km | 5 m |
| | | |
| RISAT-1 | | |
| CRS (Coarse Resolution ScanSAR) | 223x223 km | 50 m |
| MRS (Medium Resolution ScanSAR) | 115x115 km | 25 m |
| FRS (Fine Resolution StripMap) | 25x25 km | 3 m |
| | | |
| Polarization | The electromagnetic waves transmitted from a SAR antenna is oscillating in a certain direction. Polarization indicates the orientation of the oscillating EM waves. Different materials can reflect polarization in different ways. Polarimetry can therefore be used to extract extra information from SAR imagery. It is also important to choose the right polarization for specific applications | |
| Ascending/descending | The current commercial SAR satellites are all polar dusk/dawn orbits. They will complete approximately 14 orbits around the earth during 24 hours. When the satellites are travelling north, it is in an ascending pass. When it travels south it is in a descending pass. | |



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SATELLITE IMAGERY SCHEDULING WITH ASSISTANCE OF KSAT/SAVOIR SW



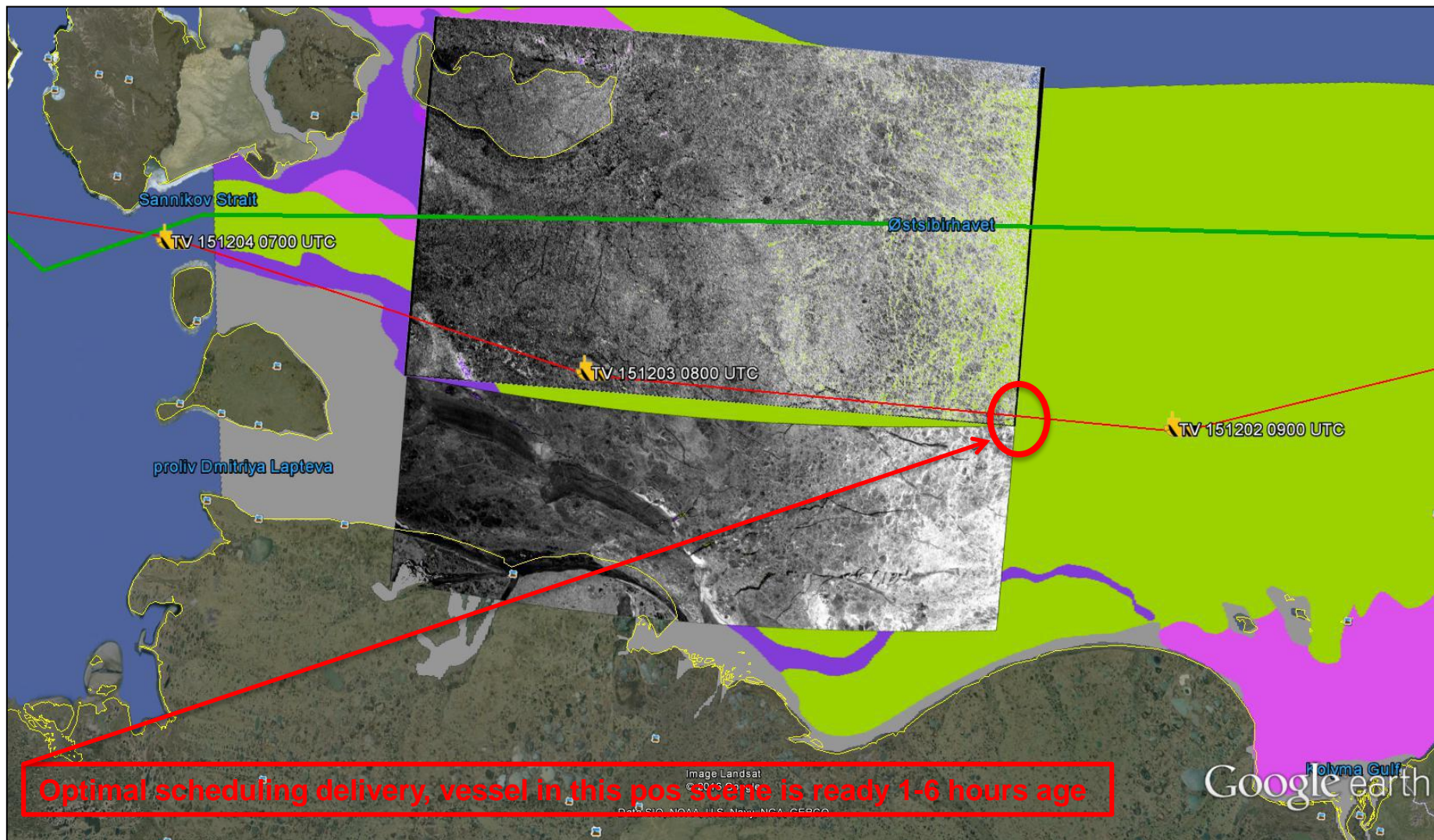
Blue frames, Sentinel 1 EWS 40 m resolution Coverage from 30 nov-5 dec 2015

- Started Planning on Dep Seattle approx 10 days before reaching Ice Edge
- See availability of free SAR imagery (Sentinel 1)
- Then fill in gaps with Commercial products (Radarsat 2, Risat1)
- Challenges to know exact ship speed for tasking (Weather, Ice conditions operational delay)
- Freshness is crucial 1-6 Hours optimum
- To slow delivery time or tasking, vessel have passed the scene
- Will the ordered product cover your route?

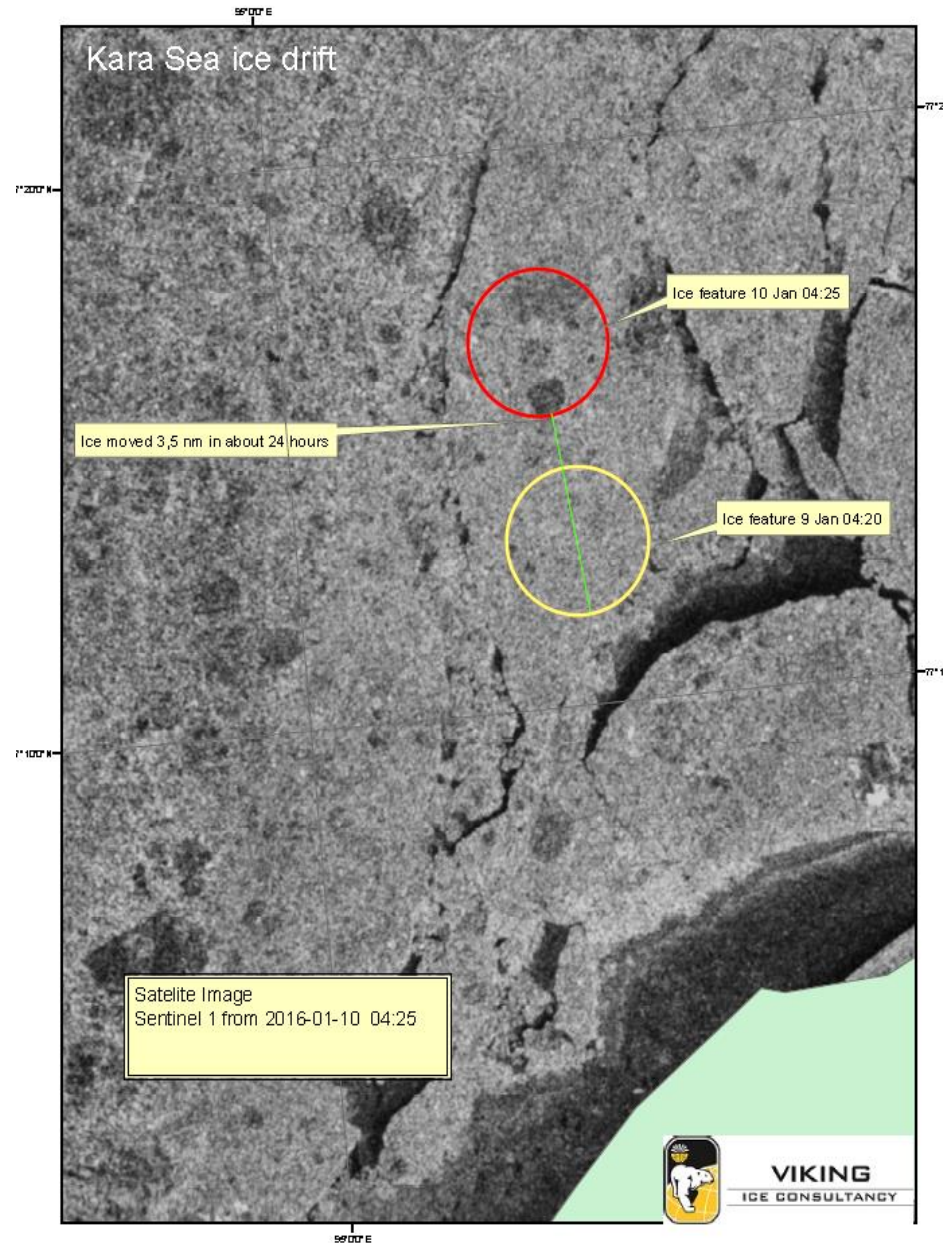
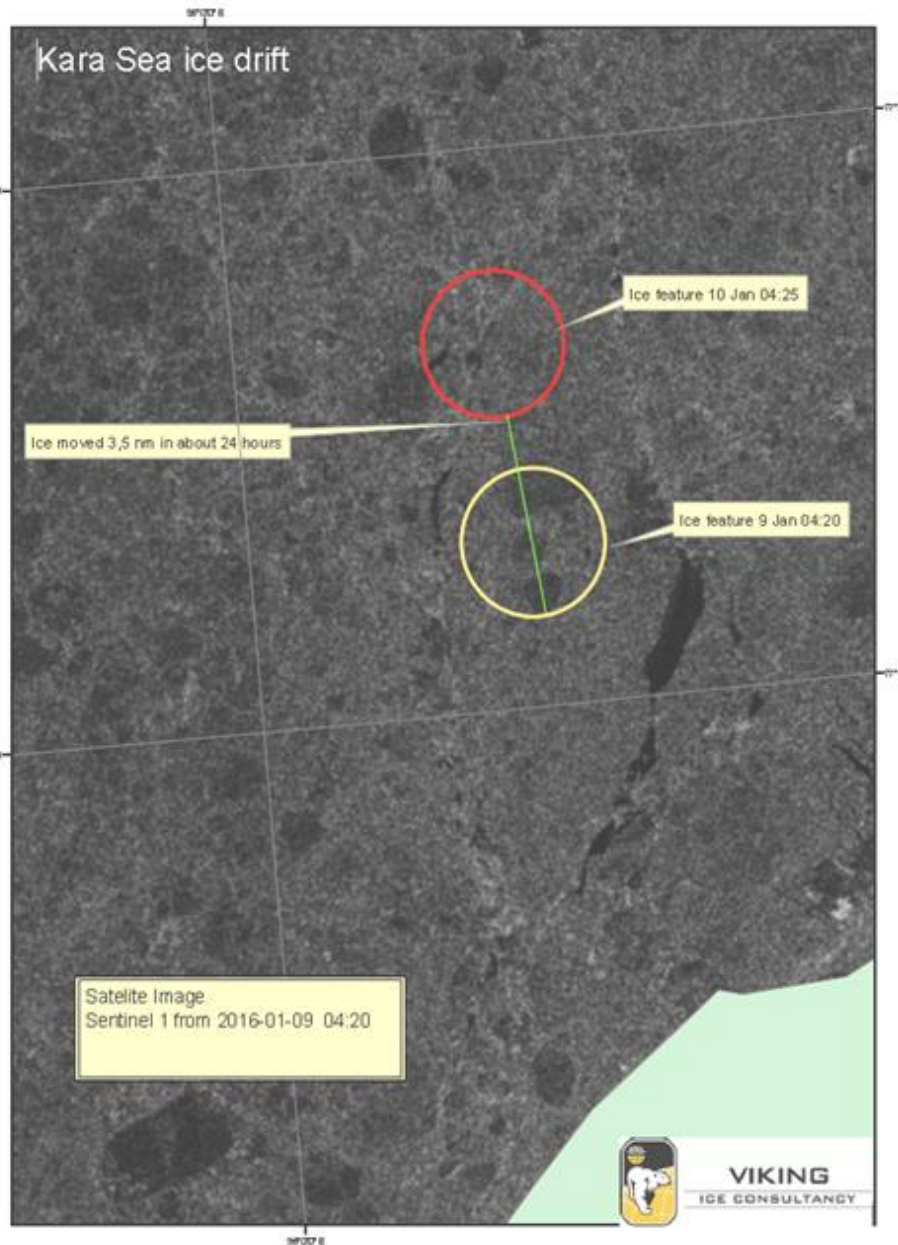


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OPTIMAL SATELLITE IMAGERY SCHEDULING

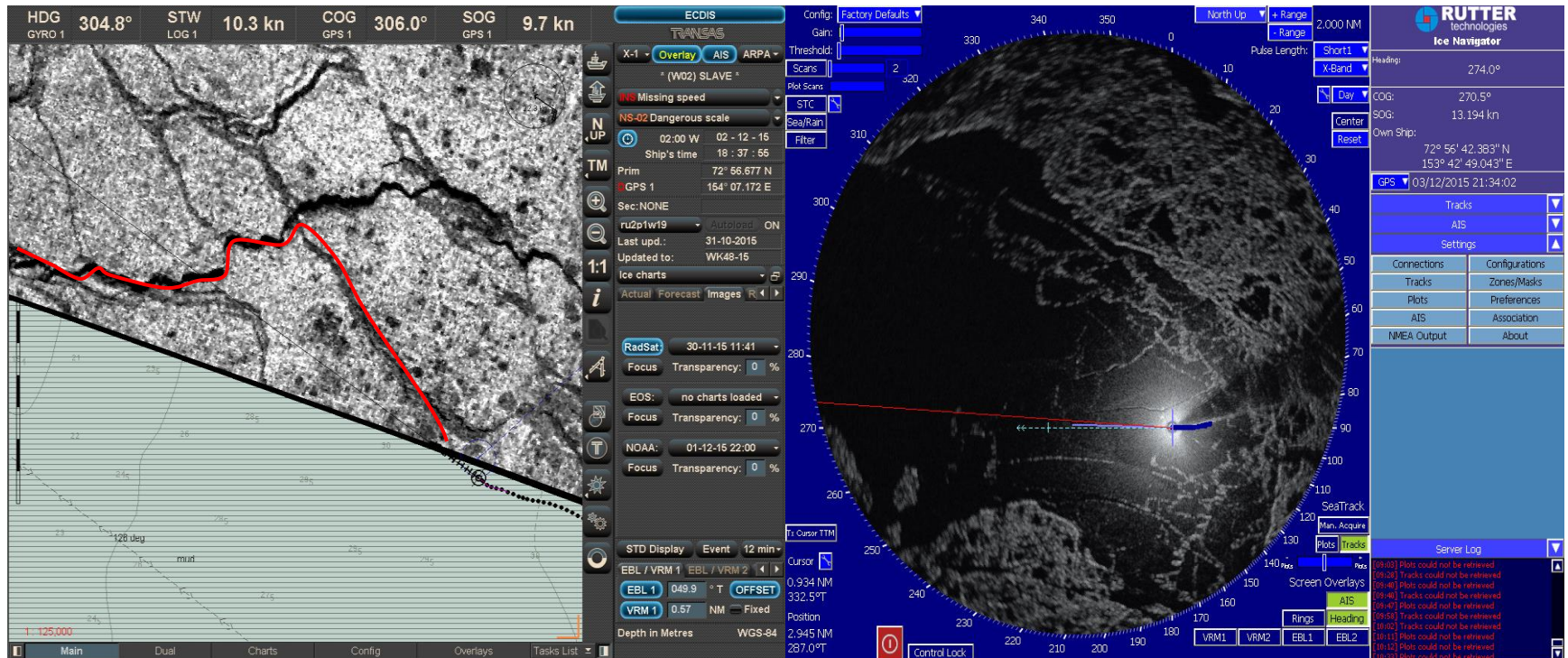


FRESHNESS IS ESSENTIAL



HOW TO USE ONBOARD

Video



- Methodology was to download satellite imagery to ECDIS system from PolarView Ice or KSAT Portal
- Stop in Ice to identify ice drift and offsets from time of scene acquisition
- Identify leads and cracks with light ice
- Then use ice radar to do the local area fine navigation.
- The ship could increase speed from 5 to 12 knots using 3 (of 4) engines finding those areas with lighter ice.

How to interpret SAR imagery onboard.

151201 1951 UTC Sentinel1 HH 40 m Res SAR Image trough PolarViewIce and KSAT

Tor Viking intersects Icebreaker Vaygach ice channel and follow the track to west

Track of Vaygach,
possible to
follow for
19hours

Track of Tor Viking

Areas of New Ice Snow flowers



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Track of Nuclear Icebreaker Vaygach assisting to the east with Tanker in notch



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USING SATELLITE AIS DIRECTLY AS WFS (WEB FEATURE SERVICE) IN GIS/ICE CHARTING TOOLS TO MONITOR VESSELS

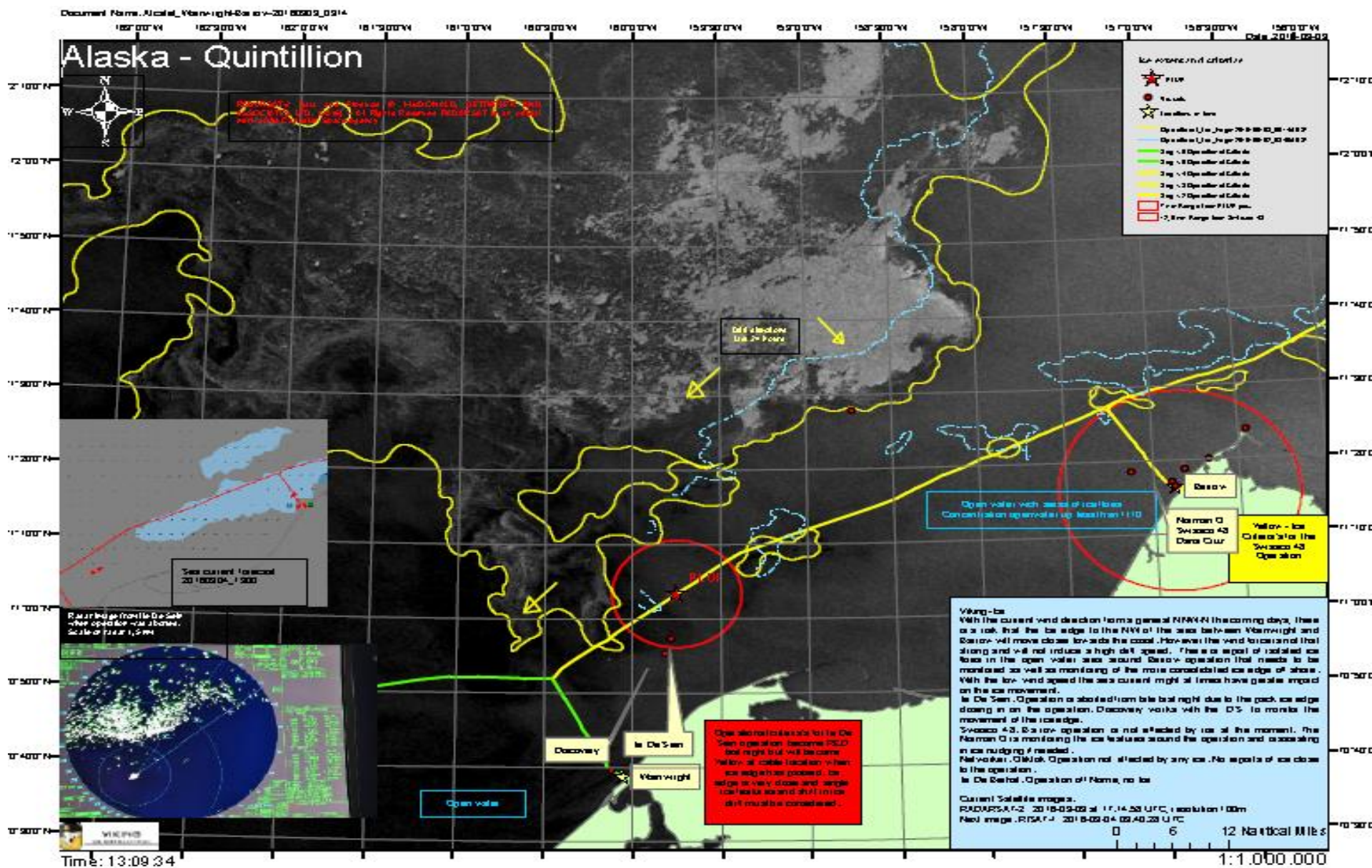


exactEarth®

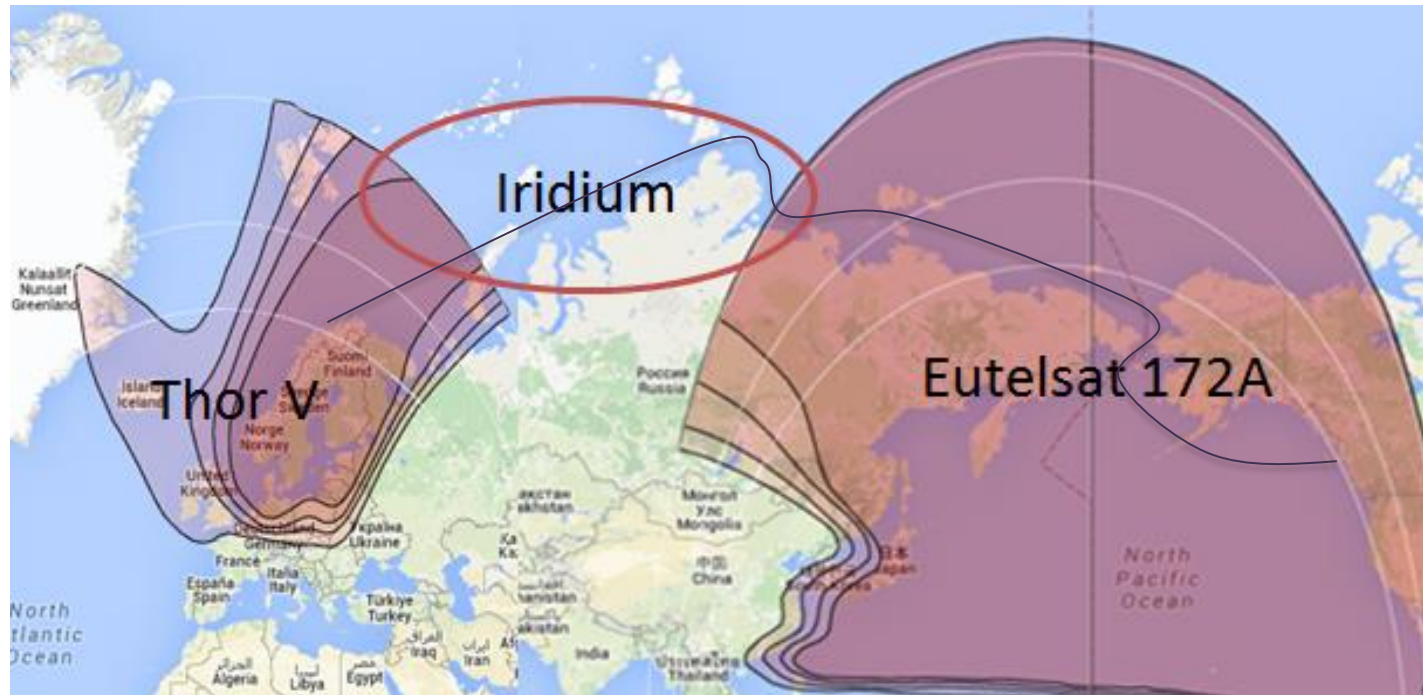
HARRIS®

 **Arc**
ESRI **GIS**

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Communication



- As expected VSAT communication coverage was kept to the middle of Laptev Sea on satellite Eutelsat 172 NP and no coverage until online on Thor V in the Barents sea. In the middle of the beams we had to change over to Iridium Pilot system where we had ordered a package of 1000 MB. Total Use in Iridium was 500 MB for this period of 5 days. Additionally Iridium voice 523 minutes.

PolarIce – ViewIce & ICEMAR how to order and upload

The screenshot displays the ViewIce version 3.1.22 (beta) software interface. The main window shows a map of the Arctic region with various data layers. A 'POLAR ICE Catalogue' panel on the left lists available products, including 'Sentinel-1 (EW) Arctic coverage' and 'AMSR2 Sea Ice Concentration map'. An 'Order product' dialog box is open, showing details for 'Sentinel-1 EW-GRDM / HH-Pol image: S1A_EW_G...'. The dialog includes fields for Product ID (208276), Feed ID (71), Product counter (26733), File name (IMS.S1A_EW_GRDM_1SS...), File size (170 MB), Published date (2015-11-30 07:50 Z), and Valid date (2015-11-29 03:37 Z). The 'Order product...' button is visible. Below the dialog, a table shows the estimated product file size (~8 MB) and a list of products. The background map shows the Arctic region with various data layers.

Order product

Product area

☒ Full area ☐ Cropped

File format and bit depth

GeoTIFF 8 Bit - percentile stretch

Map Projection

3413 - WGS84 / NSIDC Sea Ice Polar Stereogr. North

Resolution (m)

100.0 m

Sentinel-1 EW-GRDM / HH-Pol image: S1A_EW_GRDM

Estimated product file size:
Based on selected options and area size

~8 MB

Sentinel-1 EW-GRDM / HH-Pol image: S1A_EW_G...

| | |
|-----------------|------------------------|
| Product ID | 208276 |
| Feed ID | 71 |
| Product counter | 26733 |
| File name | IMS.S1A_EW_GRDM_1SS... |
| File size | 170 MB |
| Published | 2015-11-30 07:50 Z |
| Valid | 2015-11-29 03:37 Z |

Order product...

Subscriptions (1 active)

normally within 12 hours of data acquisition. The products are provided free of charge under the

| | |
|------------|-------------------------|
| Feed ID | 71 |
| Provider | BAS |
| Format | GeoTIFF |
| Resolution | 50.0 m |
| SRS | 3413 |
| File size | 97 MB..292 MB |
| Frequency | 20 - 40 products over t |

☆ Favourite feed

Subscribe to feed...

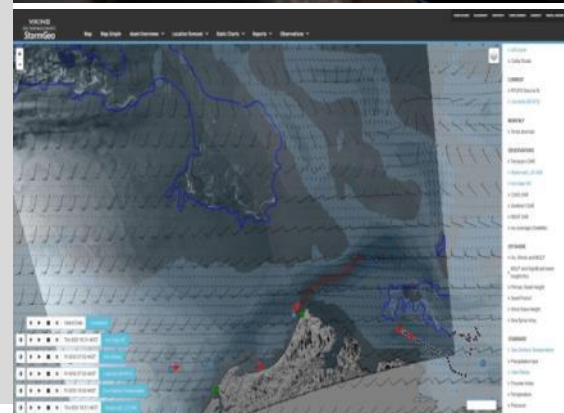
Catalogue showing available products and age for your area
Order/download and then transfer to ECDIS



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COMMON OPERATIONAL PICTURE

- **VIKING USE INHOUSE DEVELOPED TOGETHER WITH PARTNERS COMMON OPERATIONAL PICTURE DISPLAY (COPD) SOLUTIONS FOR ITS OPERATIONS**
- **BOTH STATIONARY AND WEB BASED - LAPTOP VERSIONS**
- **PHILOSOPHY: EVERYONE SEES EVERYTHING**
- **STRATEGIC AND TACTICAL PLANNING TOOL**
- **PARTNERS WITH WEATHER, MULTI MISSION SATELLITE DATA, ICE INFORMATION AND COMMUNICATIONS SERVICE PROVIDERS**

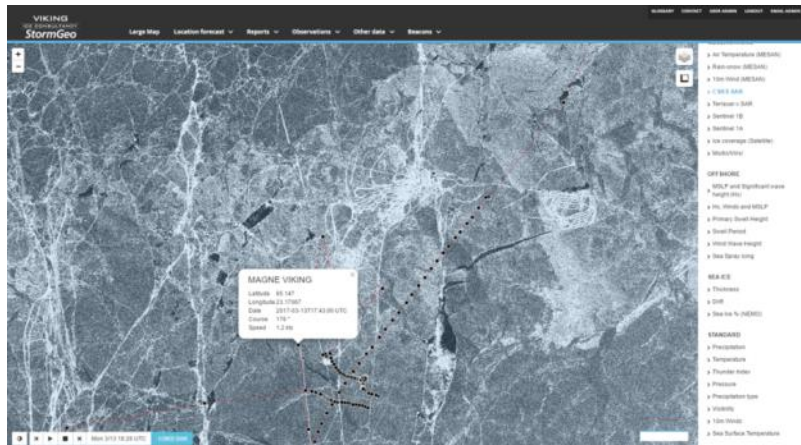




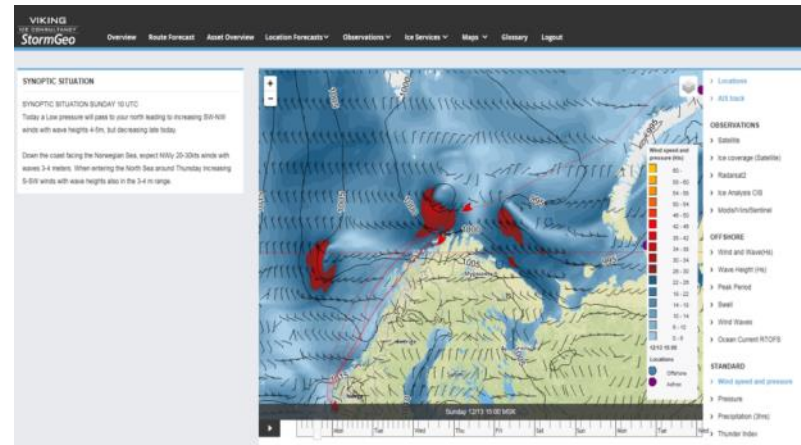
COMBINED MODE ICE
CONCENTRATION/DRIFT PREDICTION/
ACTUAL DRIFT (BEACONS)/ SAR/OPTICAL



DRIFT CALCULATION BASED ON
MULTIPLE SAR/OPTICAL IMAGES



PRESENTATION HIGH RES SAR AND AIS
TRACKING



POLAR LOW RISK FORECASTING AND REAL
TIME TRACKING



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MULDIARCOS - Multimission Data and Information services for Arctic Operations

- ESA ARTES IAP demonstration project – Integrated Application Promotion:
 - «The development of operational services for a wide range of users through the Integration of different space assets»
- Project Objective: Establish *ready-for-operations* service where a user on-board a vessel shall obtain access to multi mission Earth observation data and relevant information. The service shall be demonstrated in operational activities in the arctic (in or near ice).



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HURTIGRUTEN

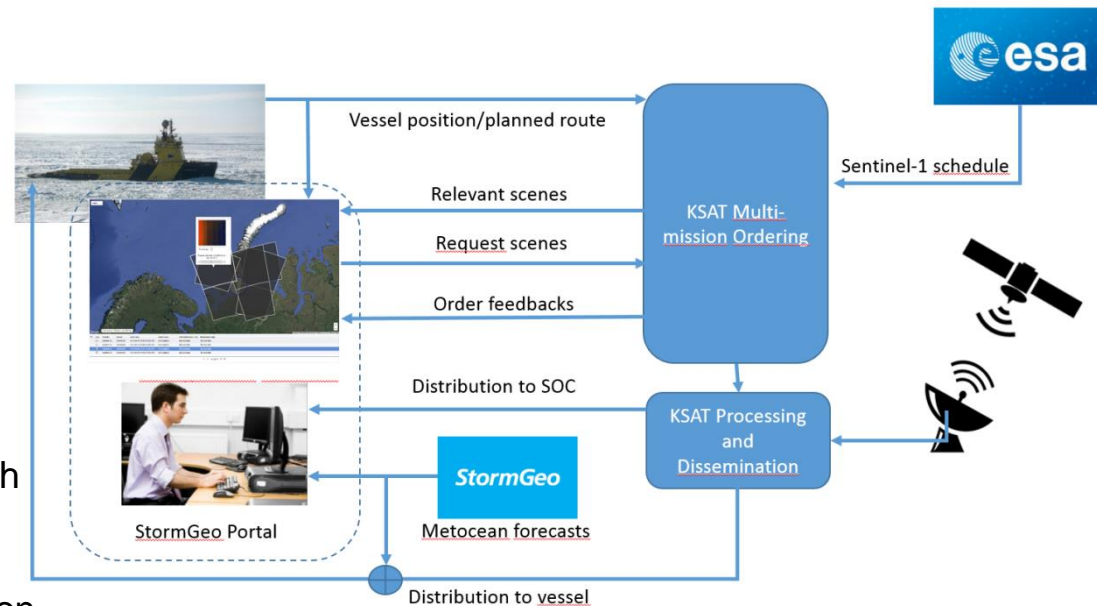
Muldiarcos Project concept



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Operational challenges:

- Different data access points
- Satellite data planning and ordering
- Timely status information
- Data access, interface and applications
- End-to-end satellite imagery delivery chain and user interface for arctic maritime operations.
- Order new acquisitions and access to pre-planned imagery and archived imagery
- Relevant met ocean and ice products
- Easy access to relevant information such as overview of ordered imagery, status information and possible acquisitions
- User interface with all relevant information



KSAT
KONGSBERG SATELLITE SERVICES

StormGeo



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HURTIGRUTEN

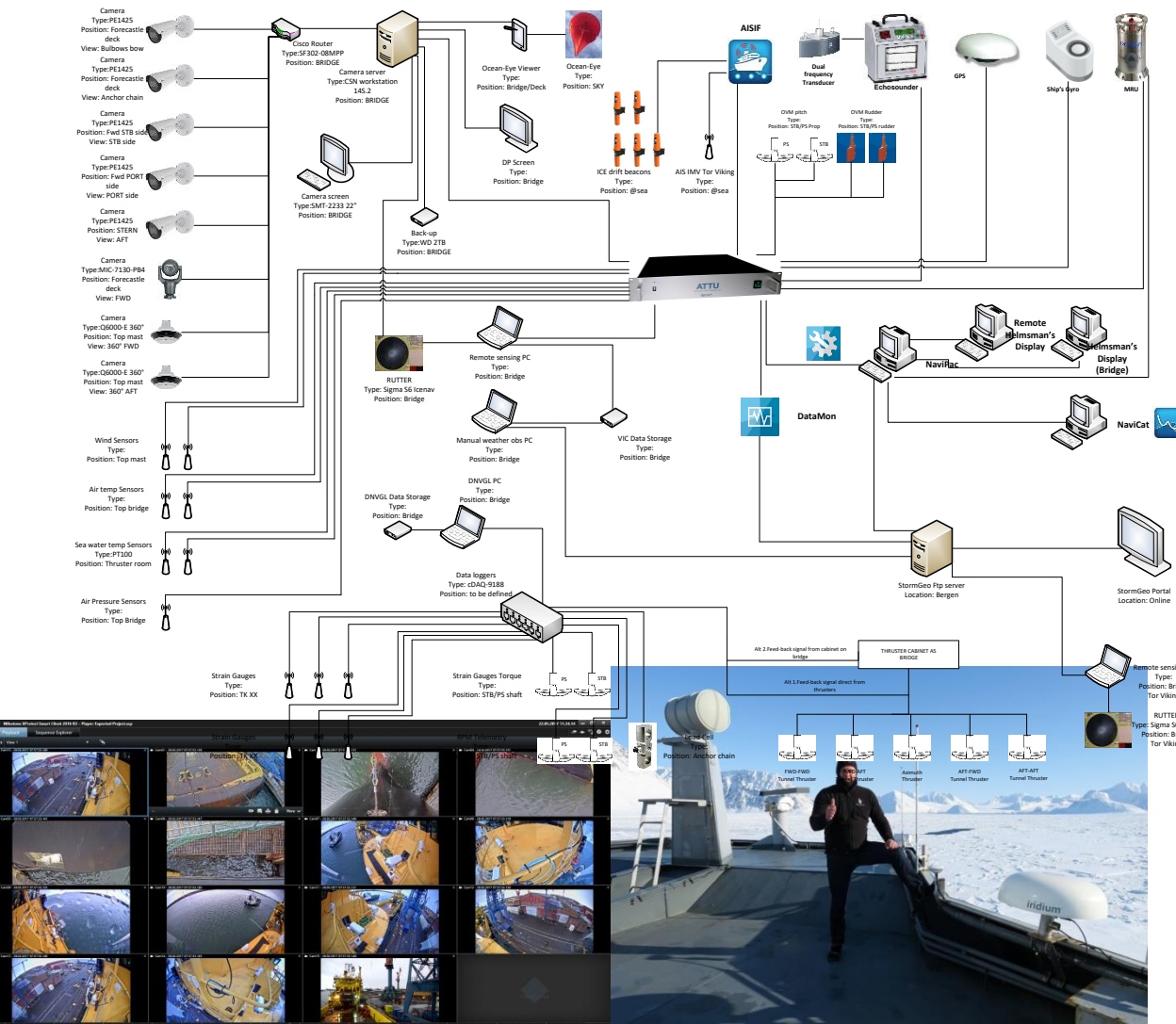
MORE
THAN A SHIPOWNER

THE COOLEST
PLACE TO WORK

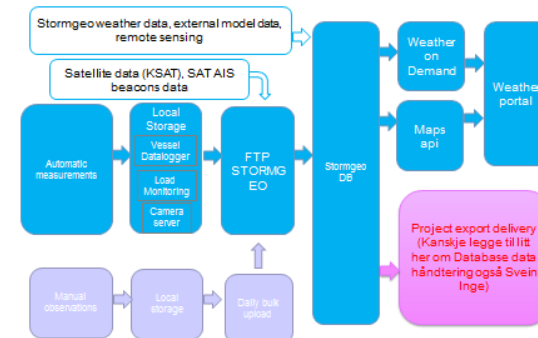
ALWAYS AHEAD OF
COMPETITION

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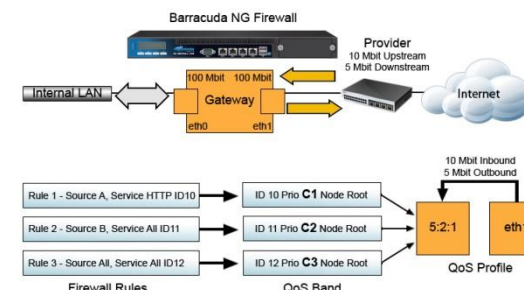
COMS, DATA HANDLING, AUTOMATIC REPORTING OF MET
OCEAN PARAMETERS AND ICE GROUND THRU THING FOR
DATABASE AND FORECAST IMPROVEMENT IN LOW
BANDWIDTH MODE



StormGeo
Control in a changing environment



3G/4G CELLULAR GSM
MBR/WIMAX
ICE/NET1 LONG-RANGE CDMA
VSAT SATELLITE
IRIDIUM SATELLITE



Ice Seafile 2015-11-19
 distance from Seale to Tormoo: 5047 NM.
 since in ice: 2545 NM
 in ice: 244 hours (10 days)
 time spent in ice: 10.4 knots.
 at Tormoo: 2015-12-14
 ice thickness up to 1 metre thick with ridges up to 4 m thick.
 recorded temperature: -27 °C



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CONTACTS

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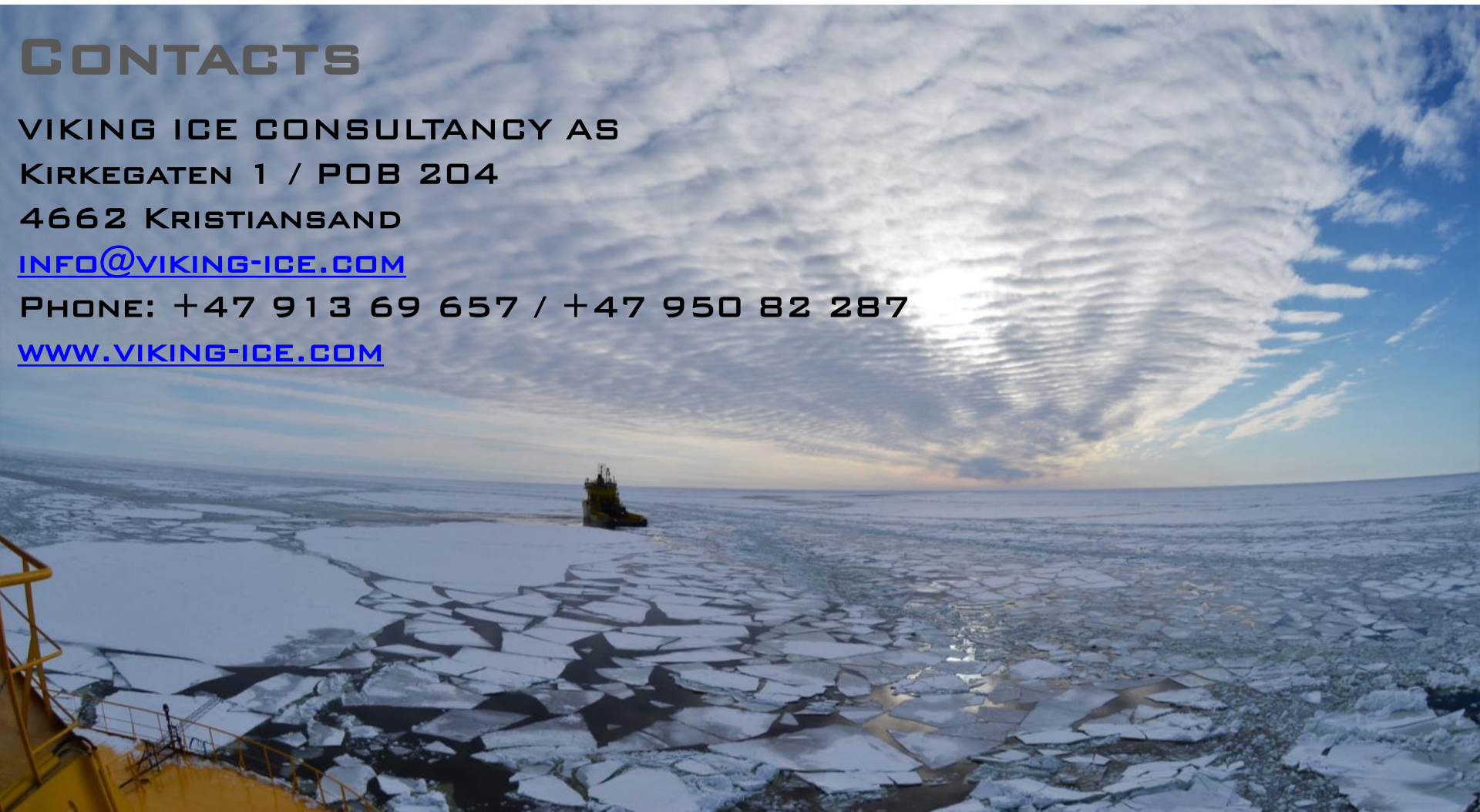
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