

SATCOM for ATM in High Latitudes

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Outline

- Rationale for ATM coverage in high latitudes
 - NORACON perspective
 - Norwegian perspective
- ESA's Iris program
- Candidate satellite systems and orbits
- HEO study
 - Coverage area considered
 - User categories
 - Services



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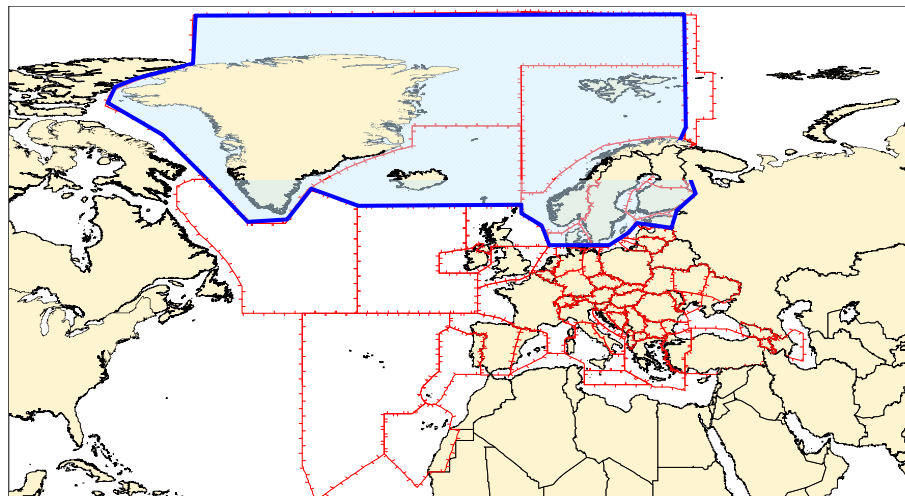
- SESAR JU Member
- Members: Austrocontrol and the ANSPs from the North European states Norway, Sweden, Denmark, Finland, Estonia, Iceland and Ireland.

- *“Polar and Oceanic Infrastructure and Applications are of strategic importance – and satellite technology must be explored”*

- Why
 - SESAR objectives within safety, capacity, efficiency, environmental protection, and availability are valid for the NORACON airspace



- NORACON together handles approximately 13% of the European IFR traffic and covers an even larger geographical area.
- Major parts of the NORACON airspace is OPR (Oceanic – Polar –Remote) above 60 degrees north up to the North Pole.
- Activities in this geographical area rely heavily on air transport.
- SESAR JU acknowledges
 - the need to ensure future air transport in Northern Europe by including this airspace in the future harmonized air transportation system
 - that specific issues related to the NORACON airspace must be addressed.





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- The challenges in the NORACON airspace differs from challenges in central European airspace in several ways
 - harsh environment, mountainous terrain and vast areas complicate the adoption of both terrestrial and space infrastructure
 - large number of small airports
 - remote and regional aircraft operations
 - off-shore operations
 - high latitudes require non-GEO satellite orbits
- NORACON will contribute to solutions as a cross cutting concern across various SESAR projects, with emphasis on SatCom and GNSS.
 - elicitation of CNS requirements
 - feasibility assessment
 - infrastructure validation for use cases and scenarios in high latitude, oceanic and remote airspace.
- SINTEF/NATMIG cooperates with AVINOR/NORACON on these issues.

Norwegian concerns

Norwegian Challenges: Geography and economic activity



Source: ACIA



Source: Norwegian Space Centre

Key items:

- Large territory
- Long distances
- Small population
- Arctic islands
- Large economic zone
- Fisheries, oil and gas
- Big shipping nation
- Fragile environment



Source: www.HYDRO.com

- Mainland area:
(58°N - 71°N,
5°E - 31°E):
323 758 km²
- EEZ:
878 575 km²
- Svalbard
protection
zone:
803 993 km²
- Jan Mayen
protection
zone:
296 611 km²
- ⇒ ~ **2 mill. km²**
- Straight coast
baseline:
2 532 km
- Continental
coastline:
25 148 km

Activities in North Sea and Barent Sea



ESAs Iris program

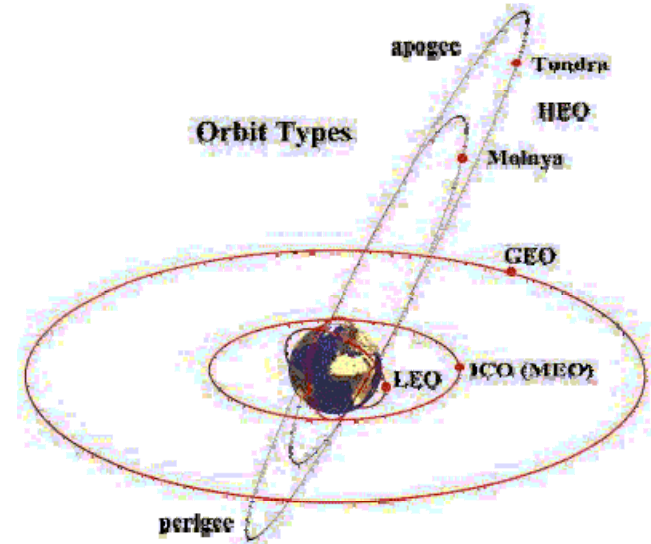
- Main concern: ECAC area up to 70 degrees latitude
- Polar coverage a potential extension

Target Coverage



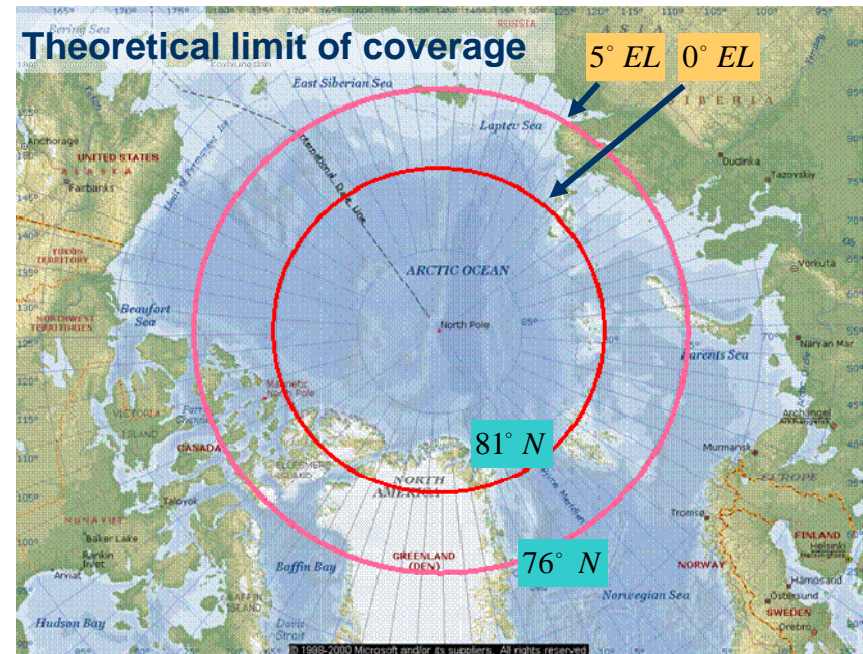
Alternative constellations

- GEO: Geostationary orbit
 - Inmarsat,...
- LEO: Low Earth Orbit
 - Iridium, Globalstar
- MEO: Medium Earth Orbit
 - Mostly navigation systems (GPS, Galileo,..)
- HEO: Highly Elliptical Orbit (Molniya/Tundra)



Geostationary satellite systems

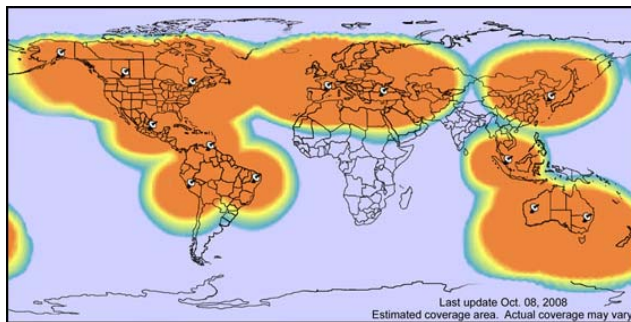
- No coverage at North Pole
- Low elevation angles at high latitudes
 - Reduced availability
 - Multipath propagation problems
 - Increased margins in link budgets required
 - More complex equipment



LEO satellite systems

■ Globalstar

- Inclination angle 53 degrees
- No coverage in polar areas



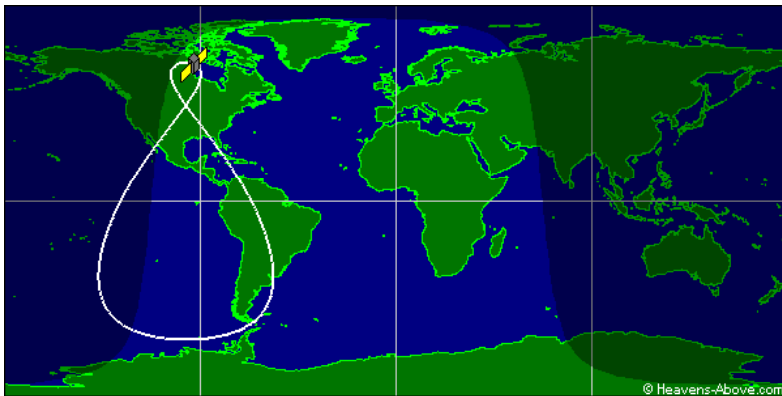
■ Iridium

- Polar orbits – good coverage in polar areas
- Iridium NEXT
 - Satellite launches planned from 2014



HEO satellite systems

■ Tundra orbit



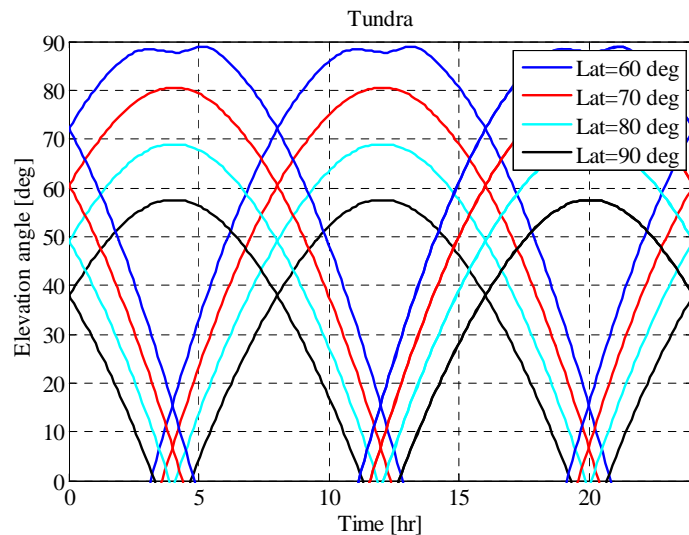
- *Period ~24 h*
- *Eccentricity ~0.27*
- *Inclination ~63.4°*
- *Perigee height ~24500 km*
- *Apogee height ~47000 km*

■ Molniya orbit

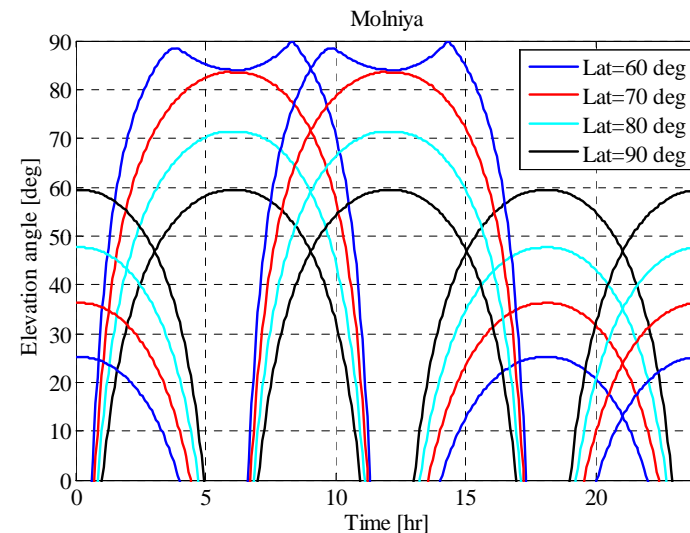


- *Period ~12 h*
- *Eccentricity ~0.71*
- *Inclination ~63.4°*
- *Perigee height ~1420 km*
- *Apogee height ~39000 km*

HEO satellite constellation visibility



- 3 satellites
- Minimum $\sim 39^\circ$ el at 90°N
- Minimum $\sim 72^\circ$ el at 60°N



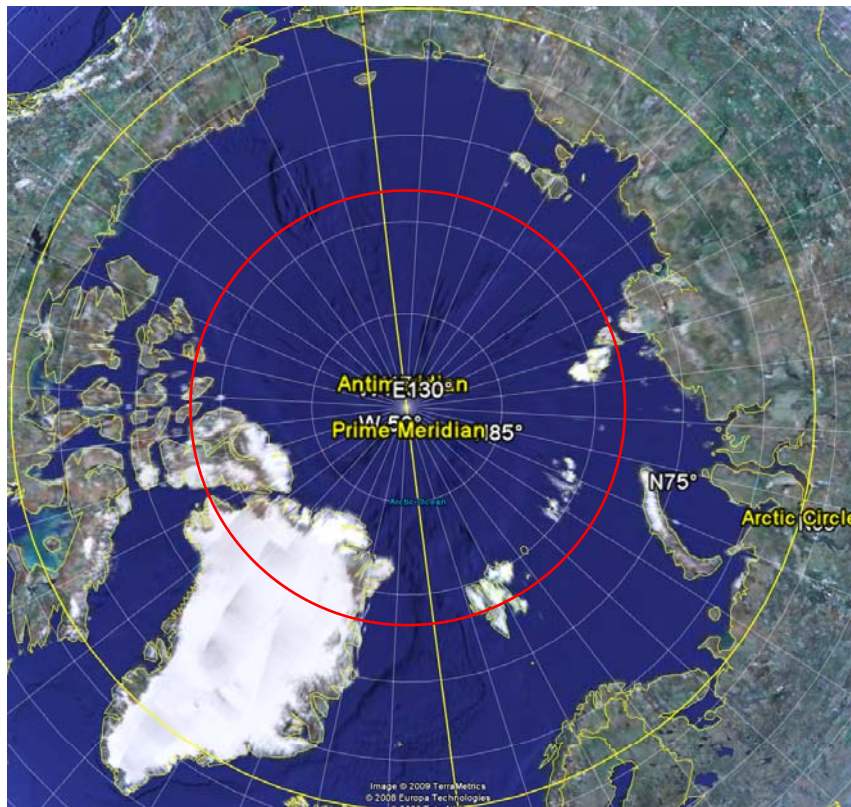
- 2 satellites
- Minimum $\sim 48^\circ$ el at 90°N
- Minimum $\sim 13^\circ$ el at 60°N

Coverage area

Iris - HEO SATCOM for ATM in high latitudes

- Polar area

- Latitude $> 78^{\circ}\text{N}$

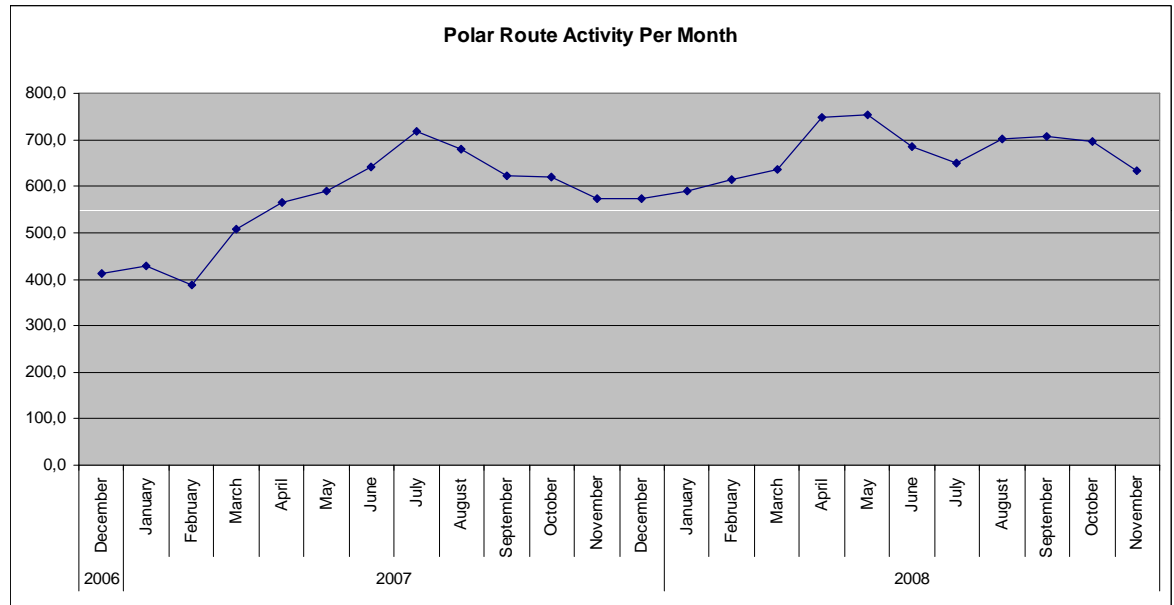
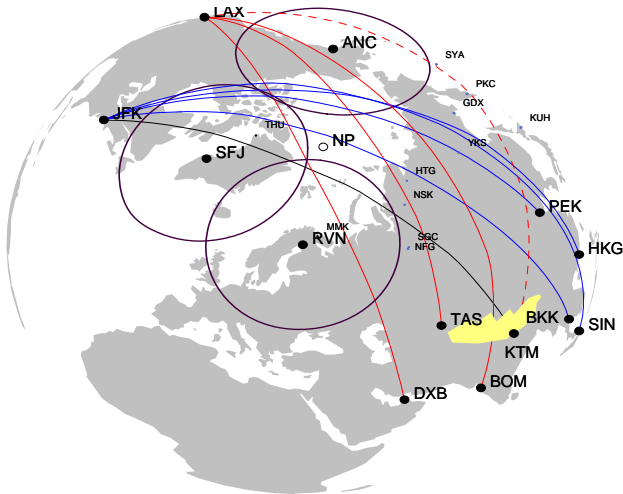


- Nordic countries

- Norway
- Sweden
- Finland



Cross polar air traffic



■ Estimated PIAC by University of Salzburg: 55

Nordic countries

Flight categories

- Scheduled flights
 - Incl. cargo
- Non-scheduled flights
 - Incl. ambulance and SAR flights
- Helicopter flights
 - Incl. continental shelf flights
- General Aviation
- Others
 - Incl. military

Services

- FCS (ECTRL/FAA) defined future ATM services in COCR report (2007).
 - SESAR baseline
- Iris project ICOS identified services for GEO-based system covering the ECAC area (2008).
 - Sub-set of services defined in COCR report
- A sub-set of ICOS data services relevant for HEO system
- In addition data services not included in ICOS-report
 - M-ADS or similar
- Voice

Conclusions

- Same level of ATM coverage required in high latitudes as in core ECAC area
- Providing required ATM coverage at high latitudes is a challenge
 - Polar routes
 - Helicopter traffic to offshore installations
 - Mountainous terrain in Nordic countries
- Low capacity requirements
 - PIAC values ECAC area: 6000
 - PIAC values polar area: 70
 - Additional traffic in high latitudes also low compared to core ECAC area
- Iridium NEXT and new HEO system alternative solutions