NCUBE-1 and 2
AIS Detection Probability

Bjørn T Narheim
btn@ffi.no

Norwegian Defence Research Establishment
www.ffi.no
The Challenge

Large Ocean Area under Norwegian Jurisdiction (blue)
The Modern Tools

Radar Satellites
(non-cooperative tool)

Ground-based AIS Networks
(cooperative tool)
The Current Status

Typical SAR and AIS coverage

The challenge remains!
The AIS Concept
The Question

Can elevated AIS sensors provide Long Range AIS services?
NCUBE Mission Objective

NCUBE

Ship

Reindeer w/GPS-AIS

GPS Position

AIS Messages

Ground station

Internet
Increased Coverage Area

Observation area:
- TDMA
- Aircraft
- Satellite

Elevated AIS sensors - A maritime wide area surveillance tool
Surface-based AIS-Sensor

Typical range of 20-50 nm radius
Elevated AIS-sensor (38000 feet)

Typical coverage of 440 nm diameter
The Penalty

Multiple TDMA areas become visible
Large Number of Messages

Simultaneous message arrival causes loss of messages
Even more messages at Low Earth Orbit

Many more TDMA areas become visible (2880 nm diameter)
Effects of AIS Message Collisions

The message collision problem

V1
V2
V3
V4

TS1  TS2

A0  TDMA

A1  < 800 nm

A2  > 800 nm

No messages received

Nadir
P_{det} with T_{obs} as parameter, ΔT=10s, r_{FOV}=250nm

Simulation results for a swath width of 500 nm (Type 1-3 messages)
Detection Probability - Satellite

Simulation results for a swath width of 2880 nm (Type 1-3 messages)
Vessel Density is Region Dependent

Low density in Polar regions, High in Europe
Two satellite passes

“AIS as is” will work in Polar regions
Global AIS Detection Probability Map

NOTE: This is an example only!!
Three Conclusions and a Question

- "AIS as is" seems well suited for aircraft-based identification and tracking of maritime vessels.

- "AIS as is" seems less suited for space-based global long range identification and tracking:
  - AIS-sensor saturation at vessel densities >2000

- "AIS as is" seems feasible for Norwegian ocean areas where the number of vessels is rather small.

- Can a small modification to the AIS concept reduce the number of messages received in space, and thereby enable global LR-AIS coverage?
AIS vs. LR-AIS Detection Probabilities

Simulation results for a satellite at 1000 km altitude

Requires a 3rd AIS frequency
LR-AIS Satellites

Can be based on low cost pico-satellites (TriCube)
Thank you for listening

Bjørn T Narheim (btn@ffi.no)
FFI, Kjeller, Norway