

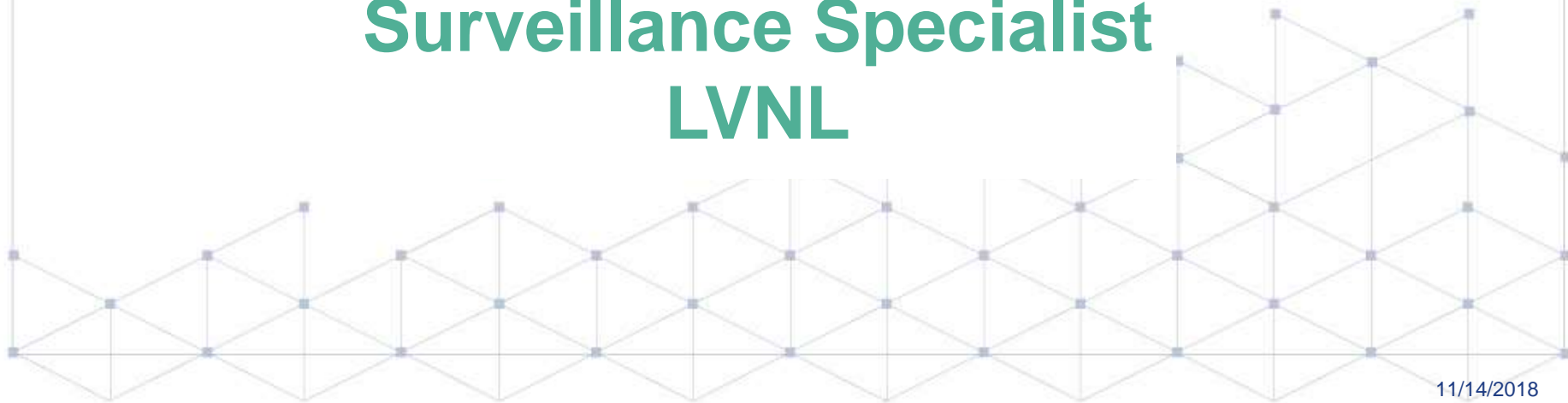


Van Primaire radar tot ADS-B





Ron van Scheppingen
Surveillance Specialist
LVNL



Waar gaan we het over hebben?



1. High level overview Surveillance systemen

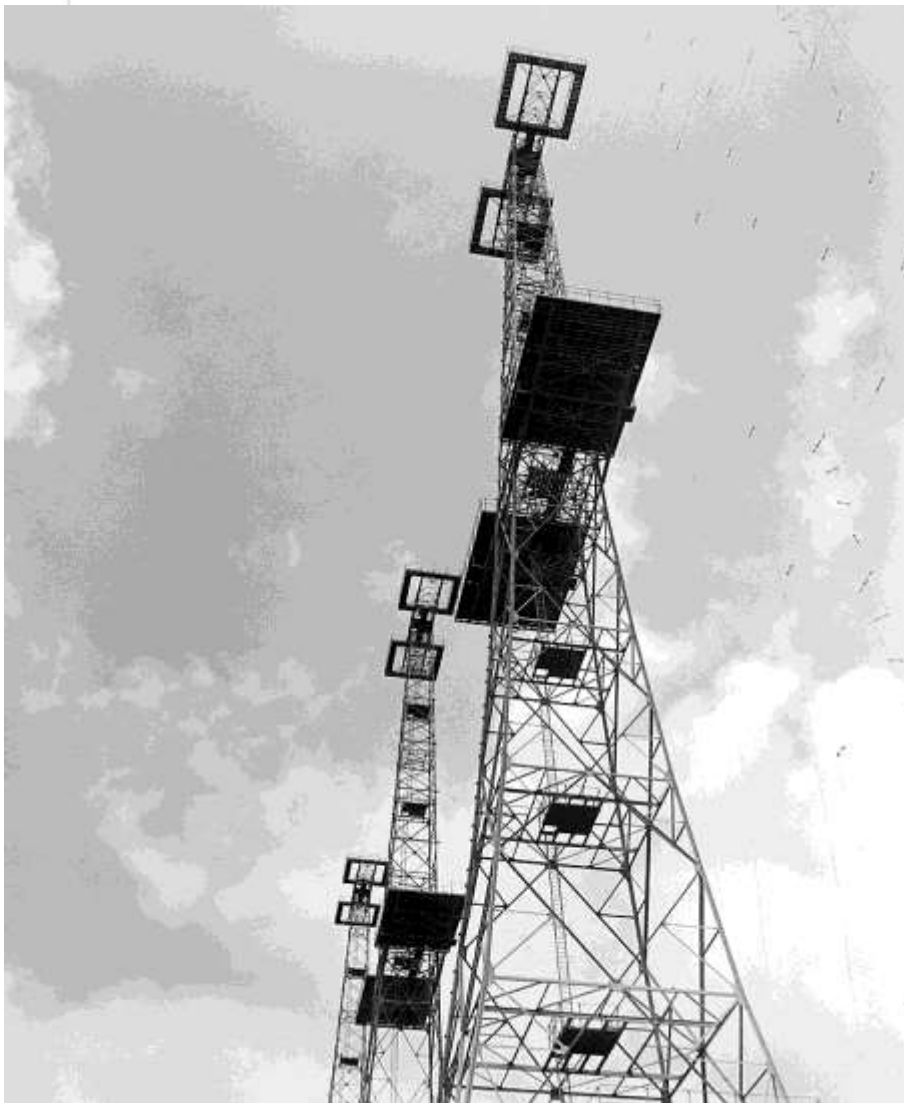
- PSR (Primary Surveillance Radar)
- SSR (Secondary Surveillance Radar)
- Mode-S (Mode - Select)
- MLT (Multilateratie)
- ADS-B (Automatic Dependent Surveillance - Broadcast)

2. Surveillance gebruik bij LVNL

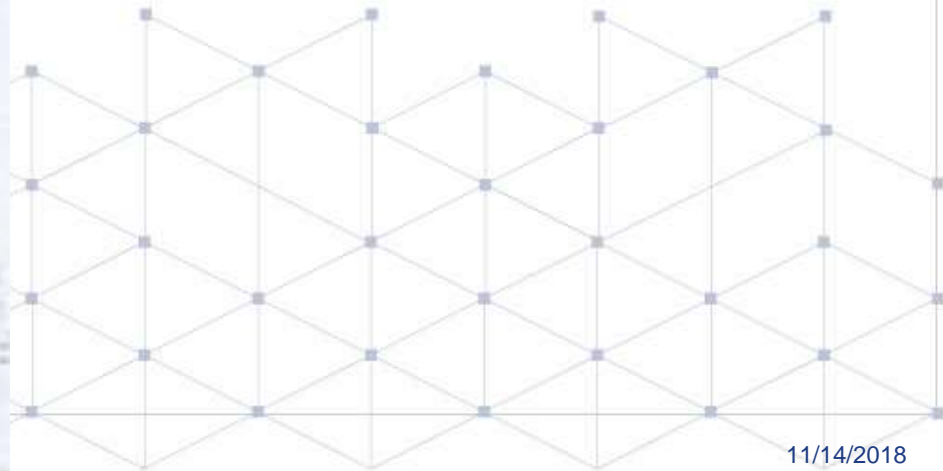
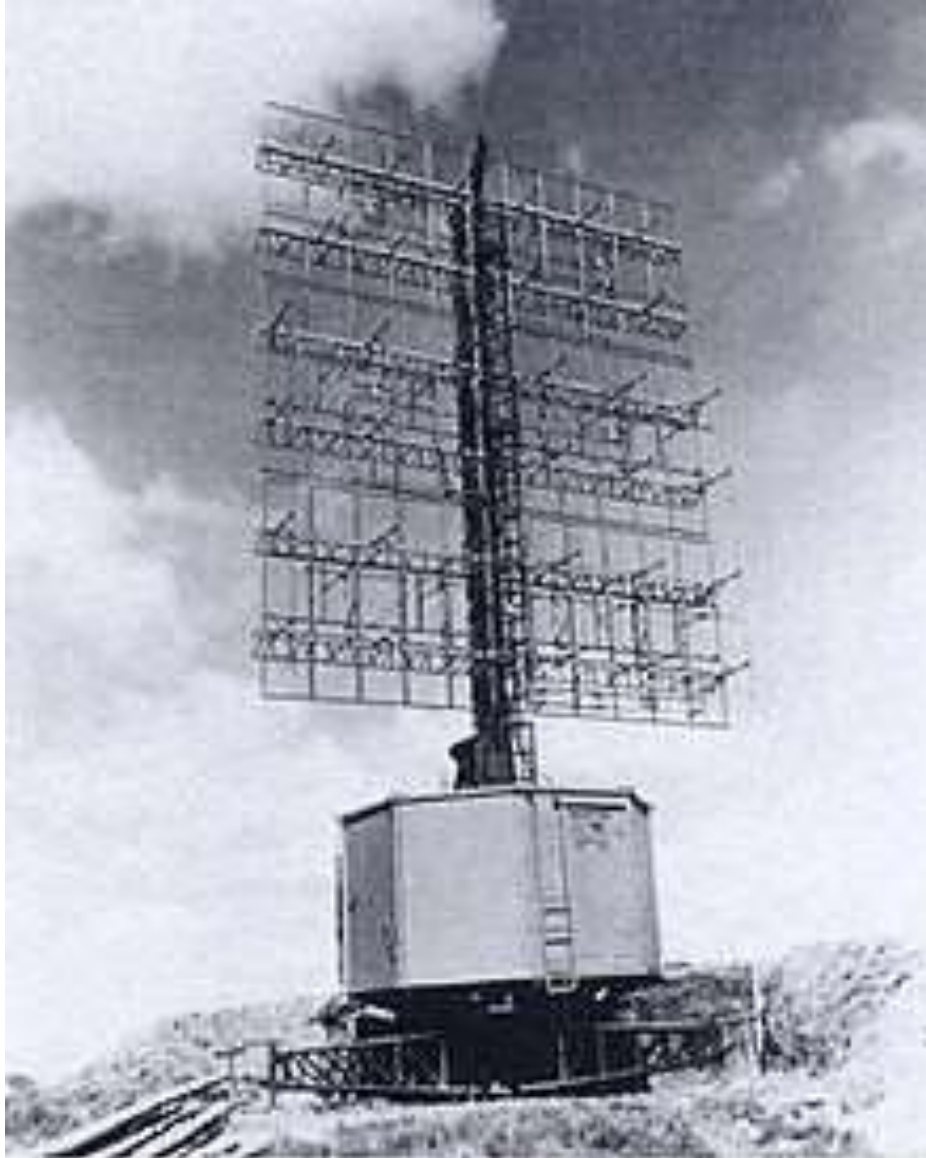
3. ADS-B voor de kleine luchtvaart

4. Vragen?

Primary Radar (Chain Home)



Primary radar (Freya)



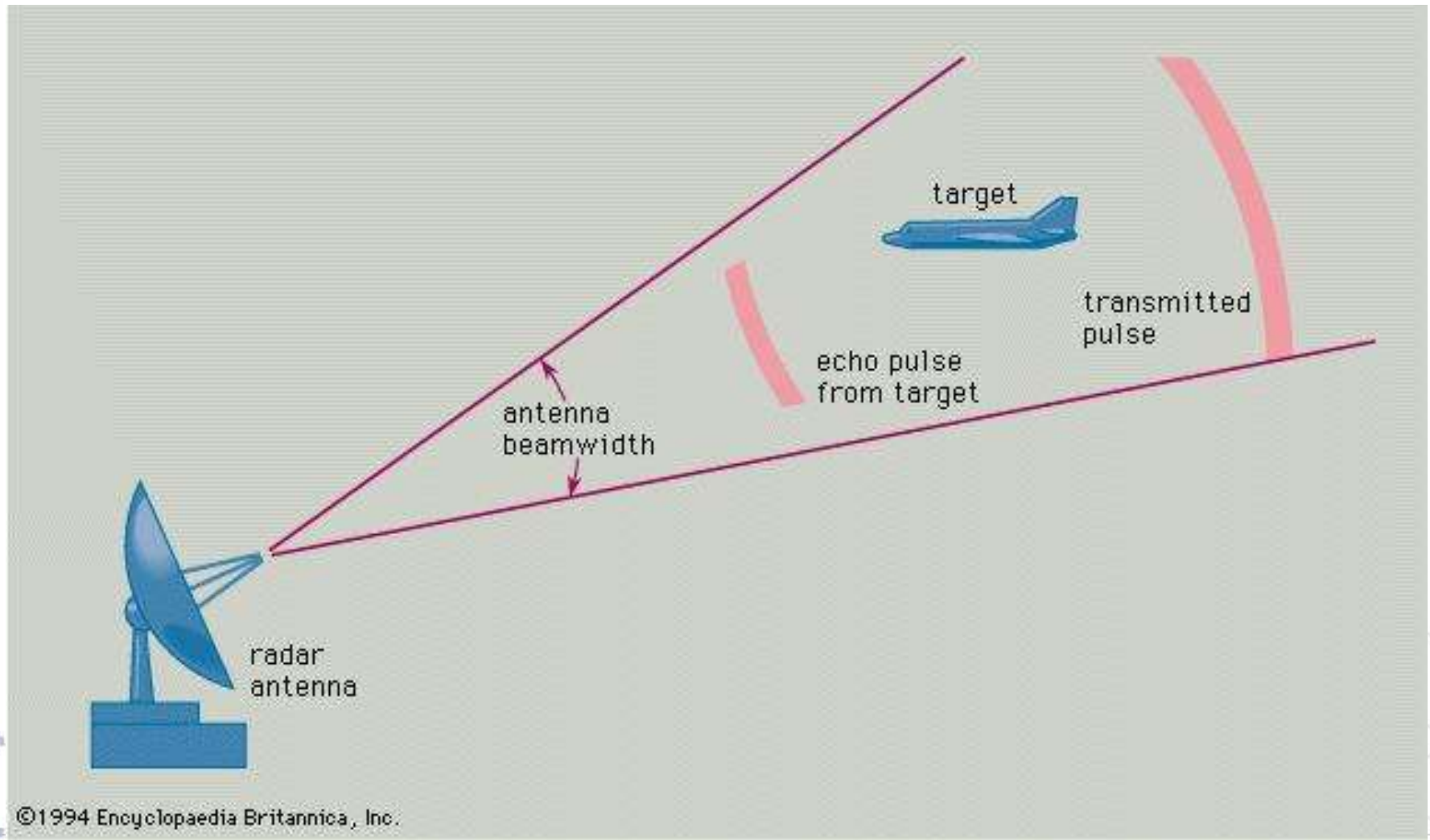
Primary radar (Modern)



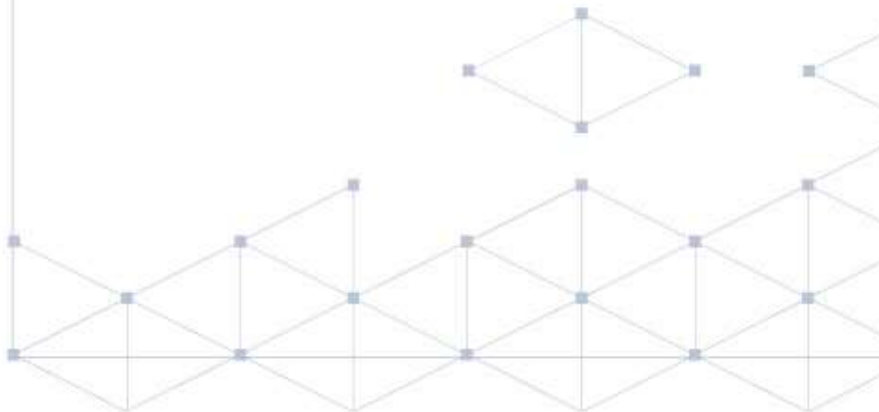
Air Defence radar (SMART-L)



Primary radar



Combined radar (TAR Schiphol West)



Secundaire radar



SSR Interrogation



Mode-3/A (4096 codes)

Mode-C (100ft resolution)



Mode-S radar



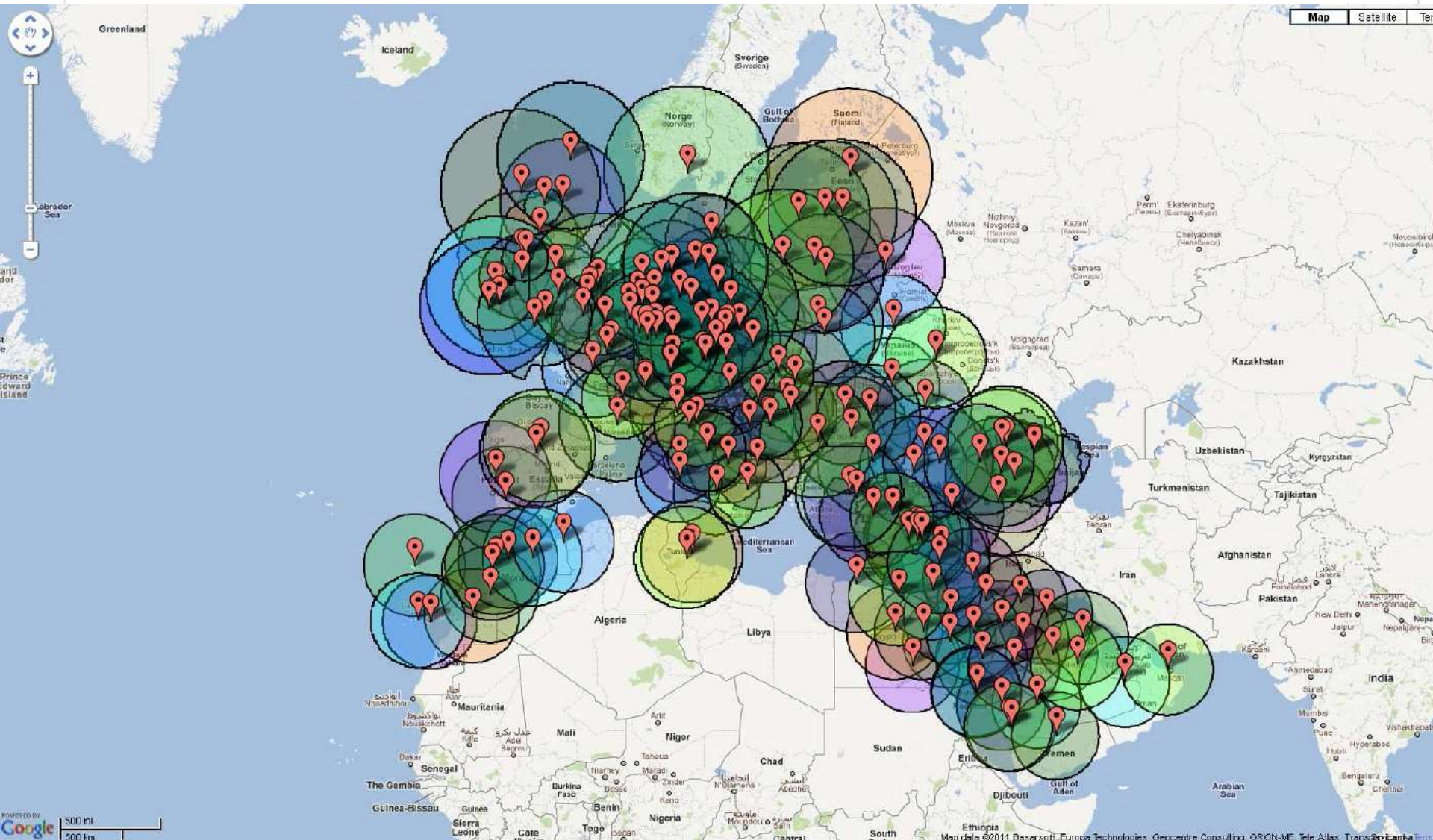
Mode-S Interrogation



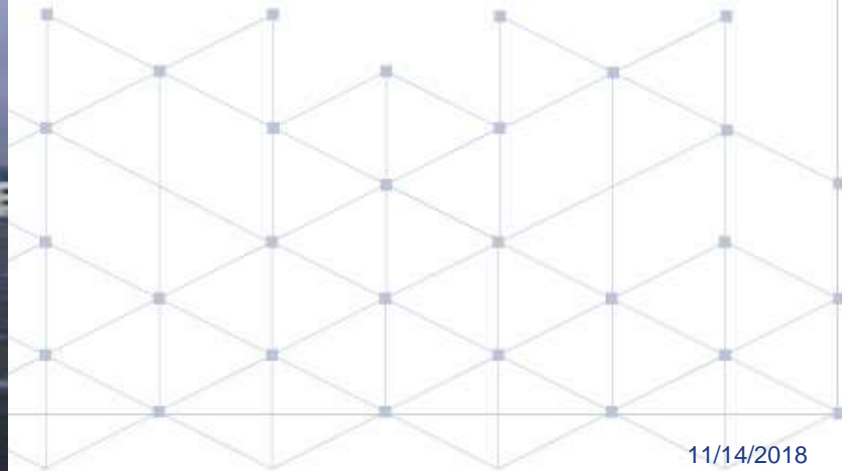
Voordelen Mode-S:

- 16 Miljoen Mode-S adressen
- Mode-C - 25ft resolution
- Geadresseerde Ondervraging (geen garbling)
- ELS: Aircraft ID (Callsign)
- EHS: Selected Altitude, Airspeed, Heading, etc.

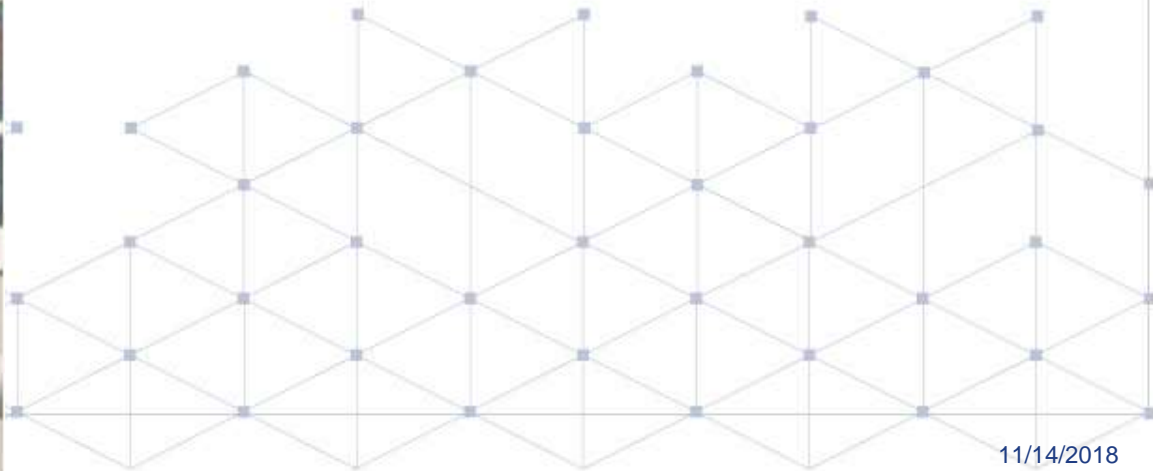
Mode-S in Europe



Multilateratie



WAM (Wide Area Multilateration)





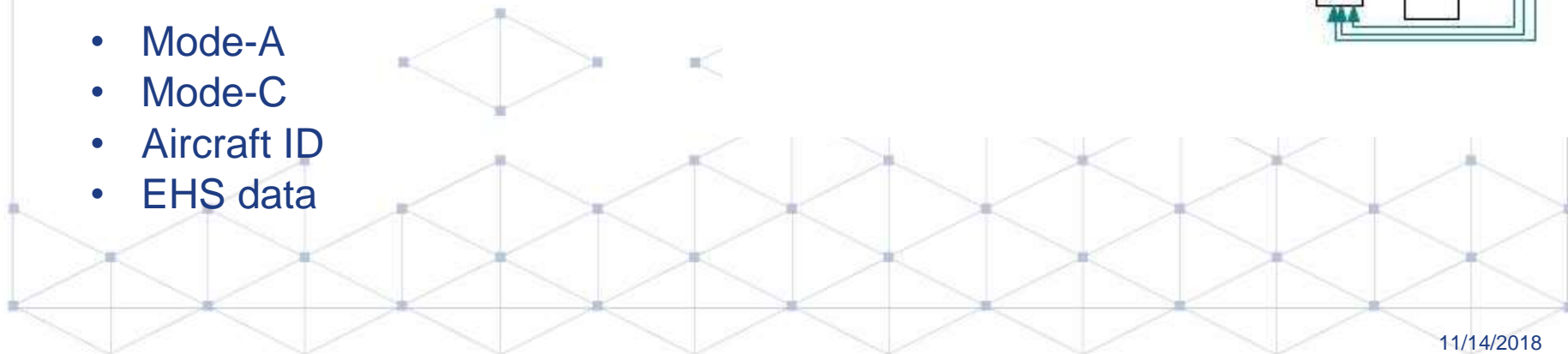
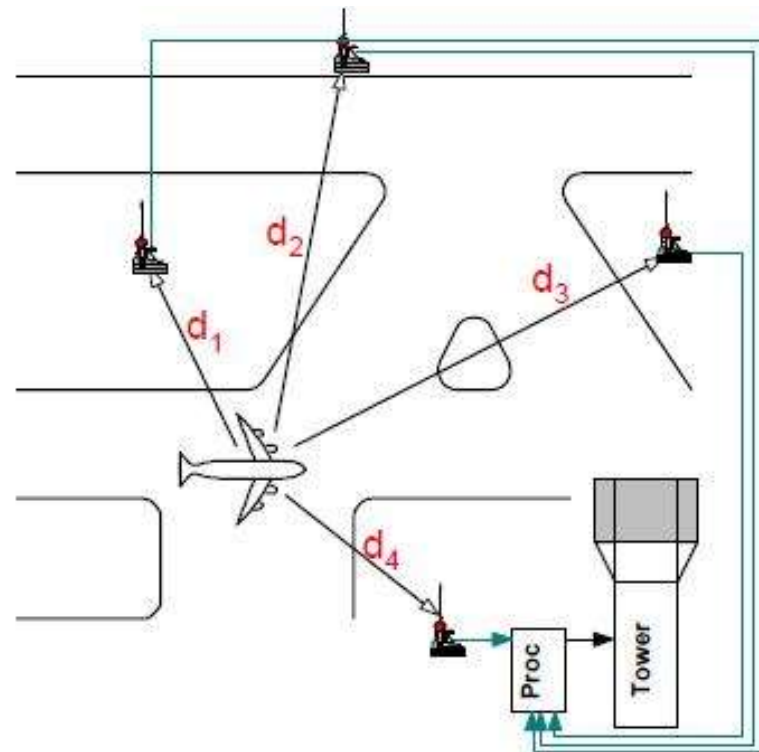
MLT (Multilateratie)

MLT maakt gebruik van signalen uit de transponder

Short squitter (voor TCAS 1 per seconde)
Extended squitter (ADS-B 6 per seconde)

MLT is in principe passief,
Maar Interrogation is nodig voor:

- Mode-A
- Mode-C
- Aircraft ID
- EHS data



ADS-B



ADS-B staat voor Automatic Dependent Surveillance – Broadcast:

- **Automatic** : Verzendt automatisch periodieke informatie.
- **Dependent** : De positie- en snelheidsvectoren zijn afgeleid van GPS (of andere navigatiesystemen).
- **Surveillance** : Driedimensionale positie en identificatie van vliegtuigen of voertuigen.
- **Broadcast** : Iedereen kan de informatie opvangen (met de juiste apparatuur)



ADS-B

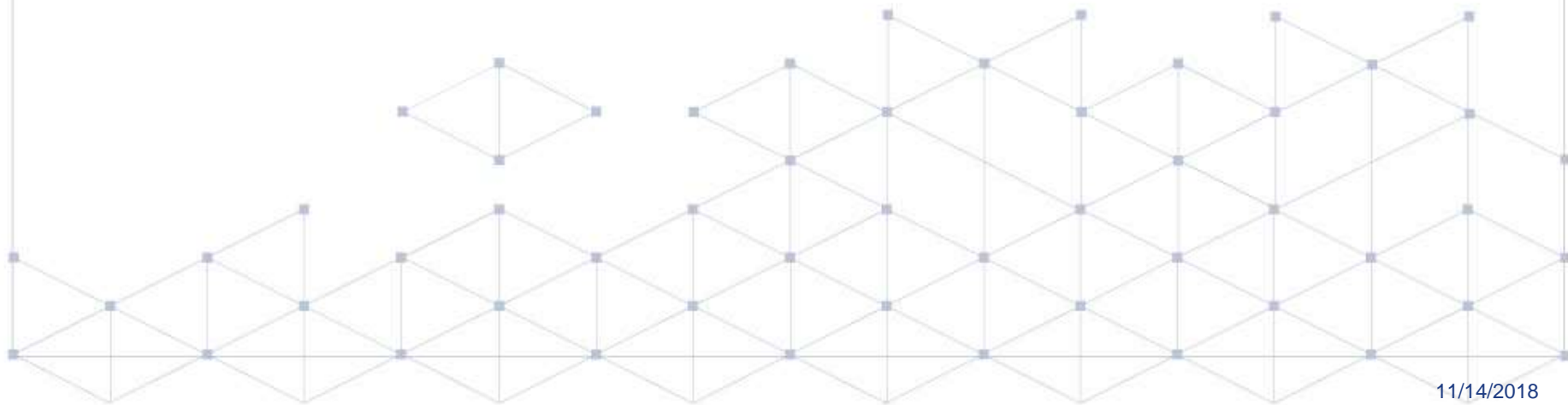
Extended Squitter Format (DF 17) -112bits



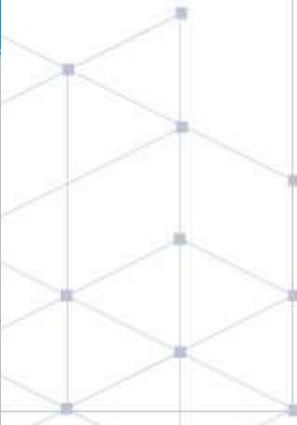
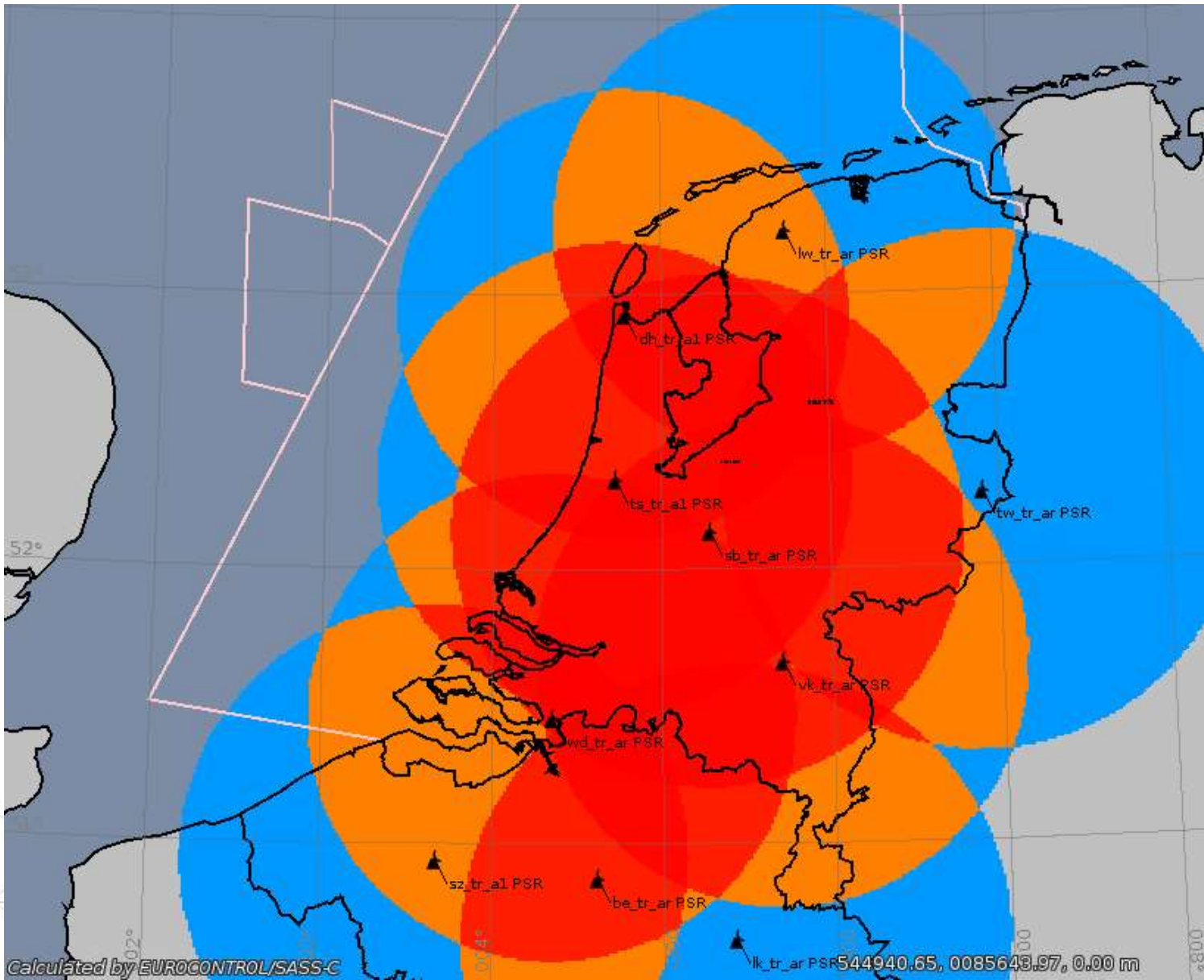
- Position (Lat, Long, Mode-C)
- Airspeed and Heading (or Ground Vector)
- ACID (Callsign)
- Geo Height
- Status Information
- Emergency codes



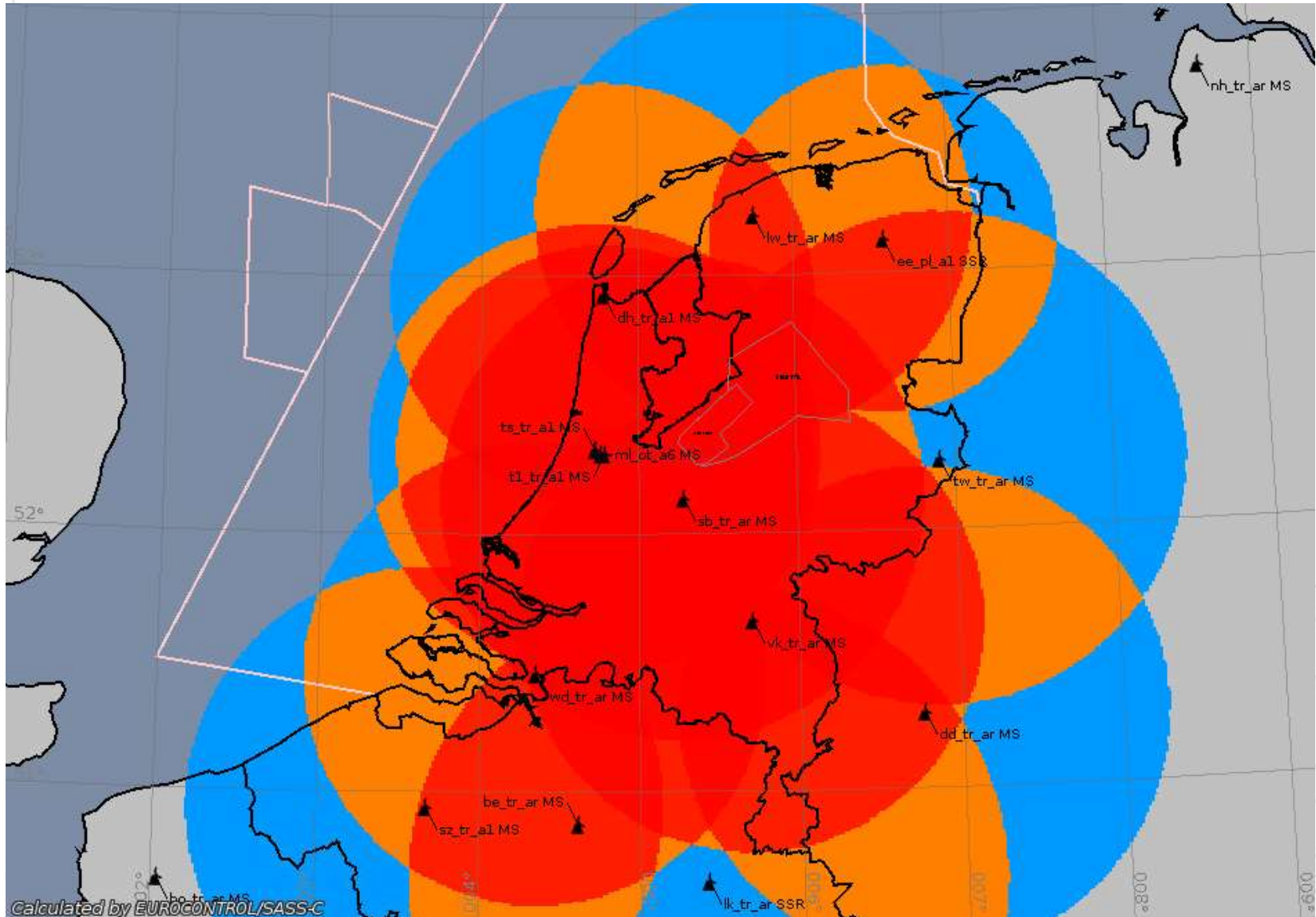
Surveillance gebruik bij LVNL



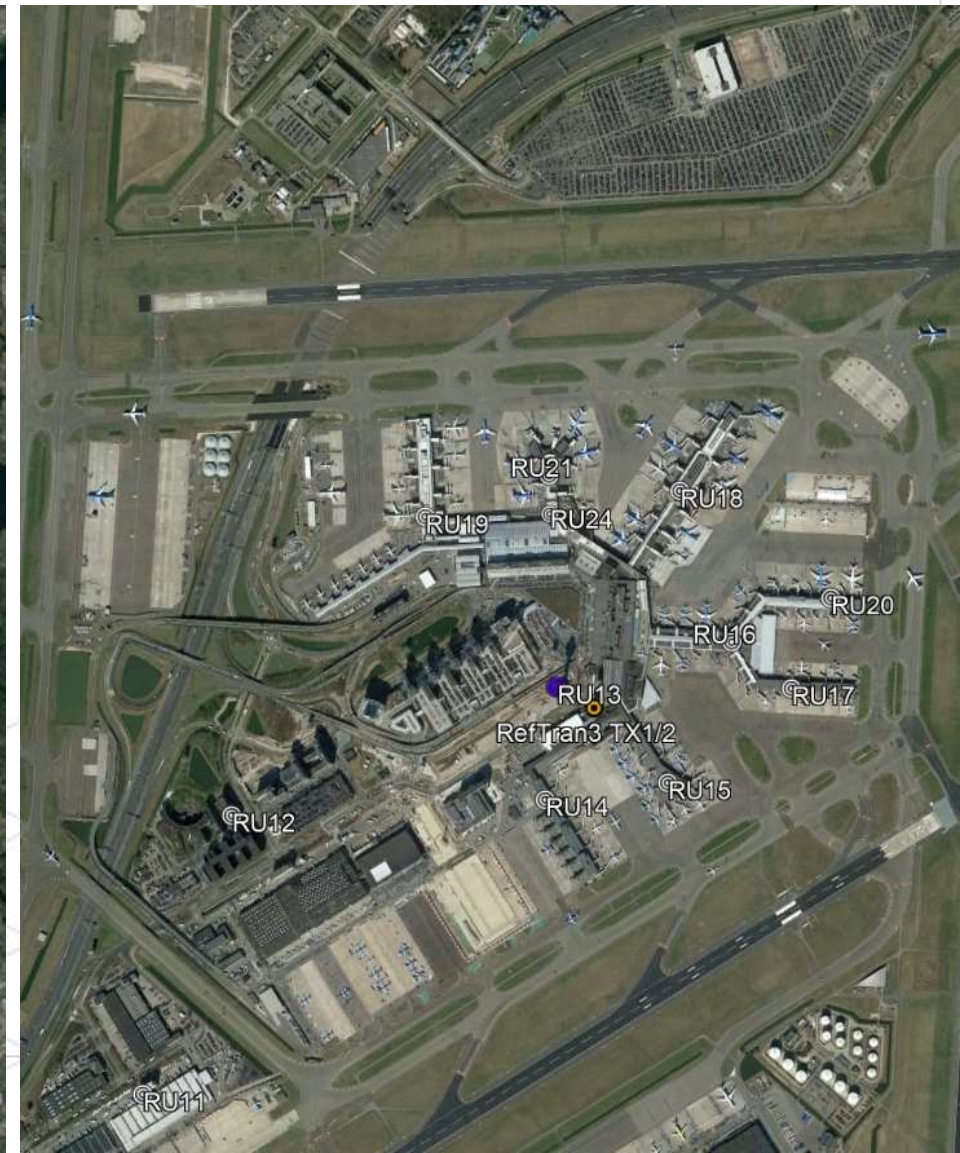
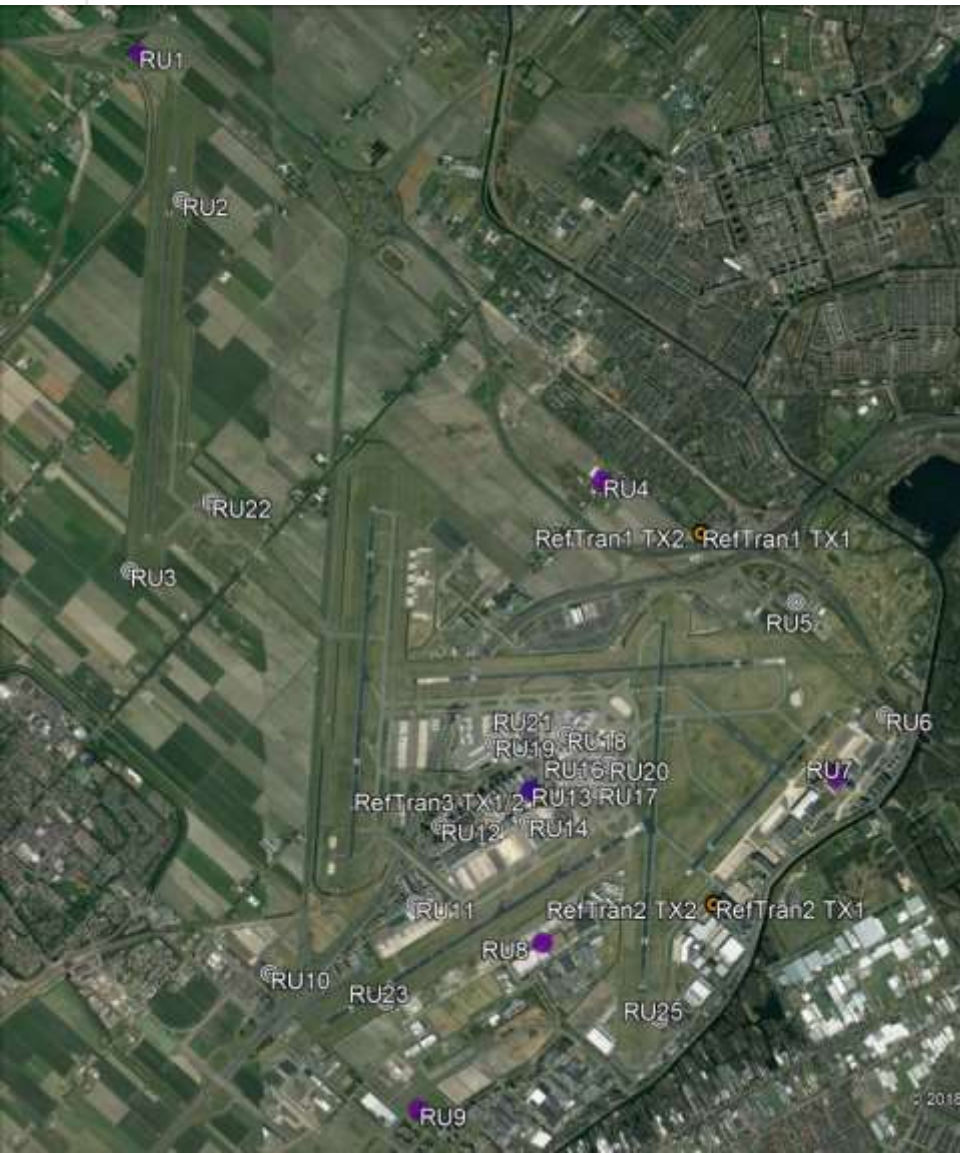
PSR coverage Dutch FIR (10000ft)



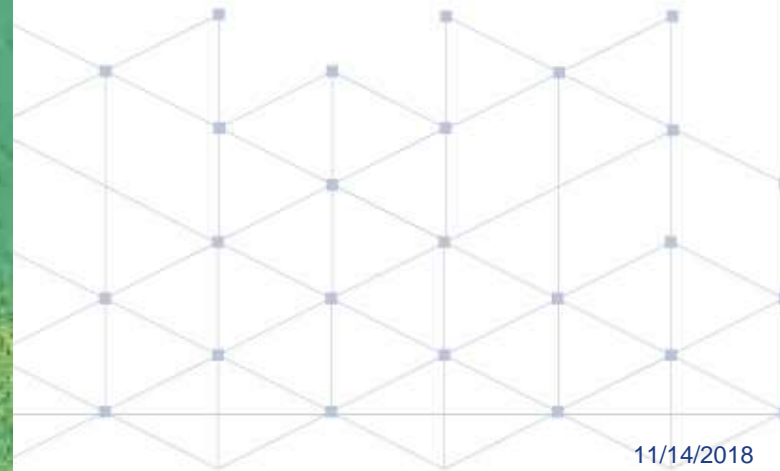
SSR / Mode-S coverage FIR (1000ft)



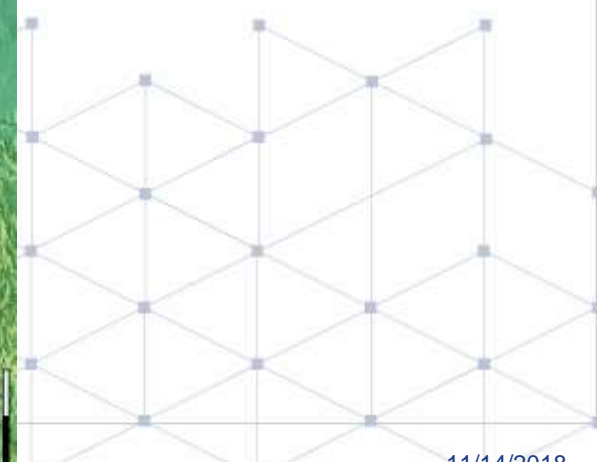
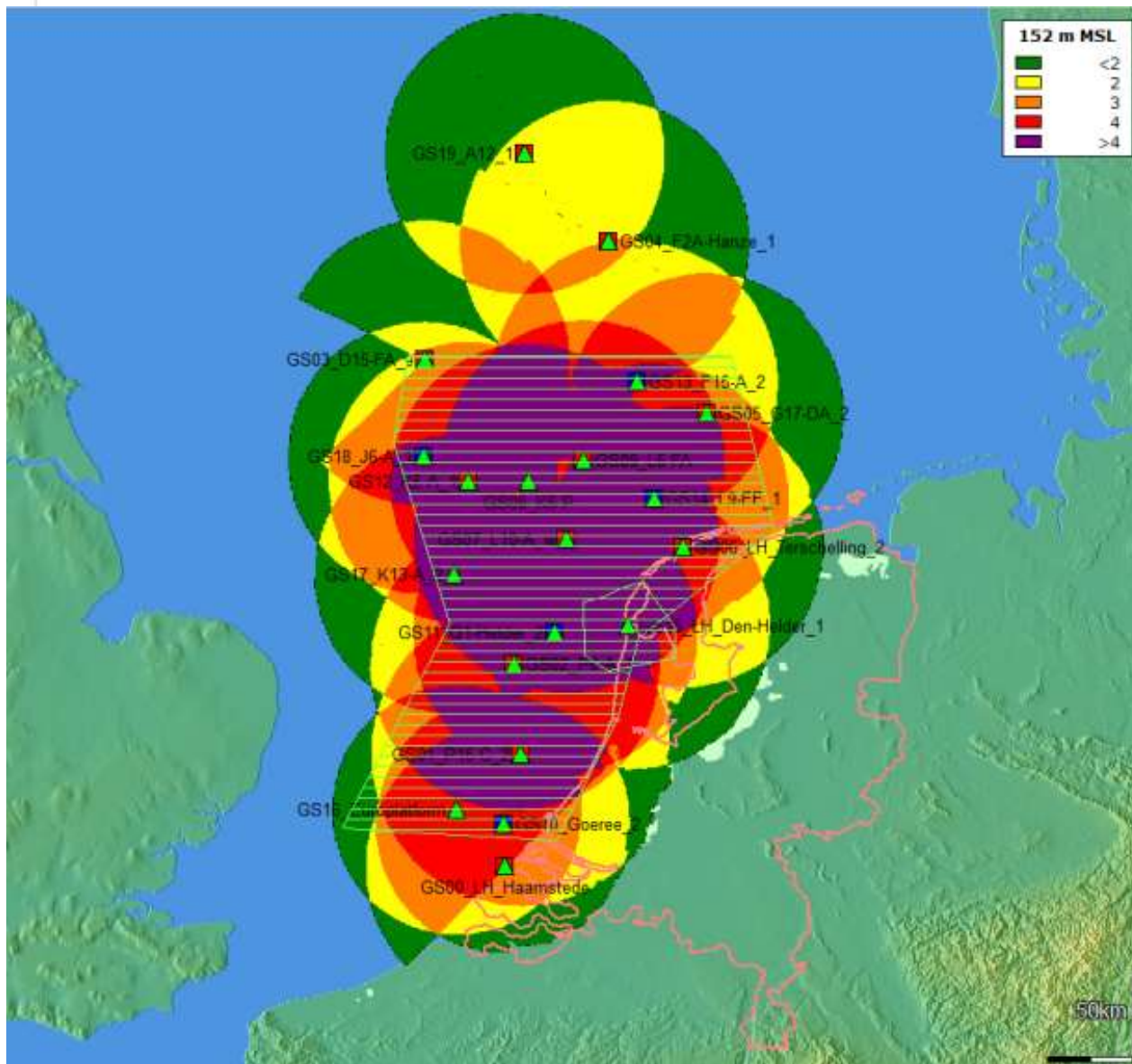
MLT op luchthaven Schiphol



WAM/ADS-B coverage North Sea

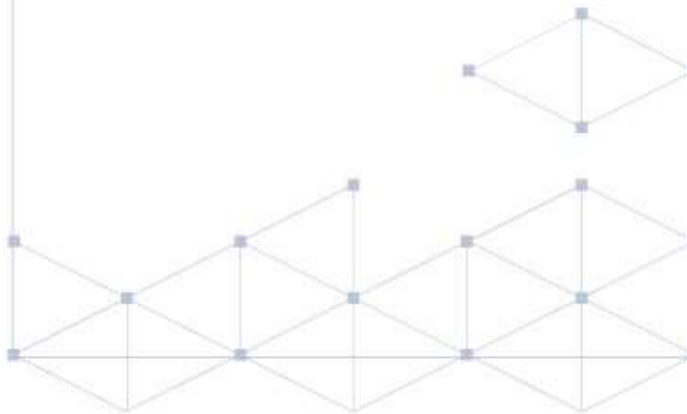


WAM/ADS-B coverage North Sea

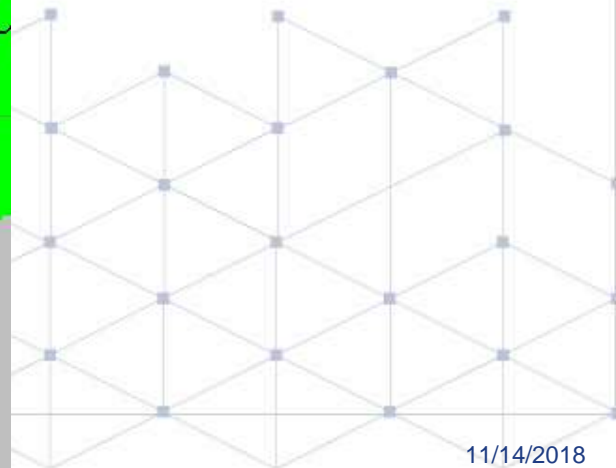
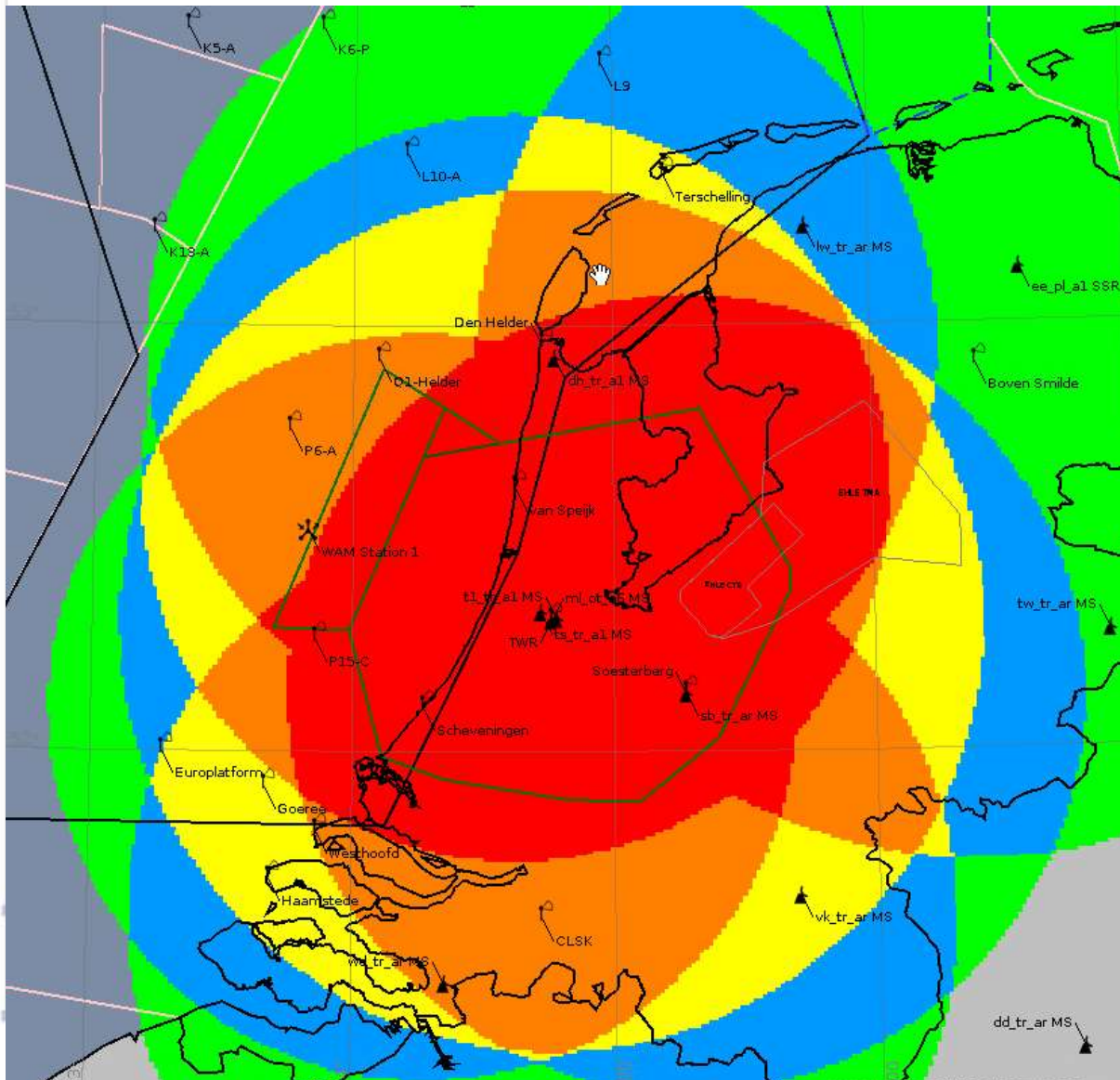


ADS-B

NSAA (Nort Sea Area Amsterdam)



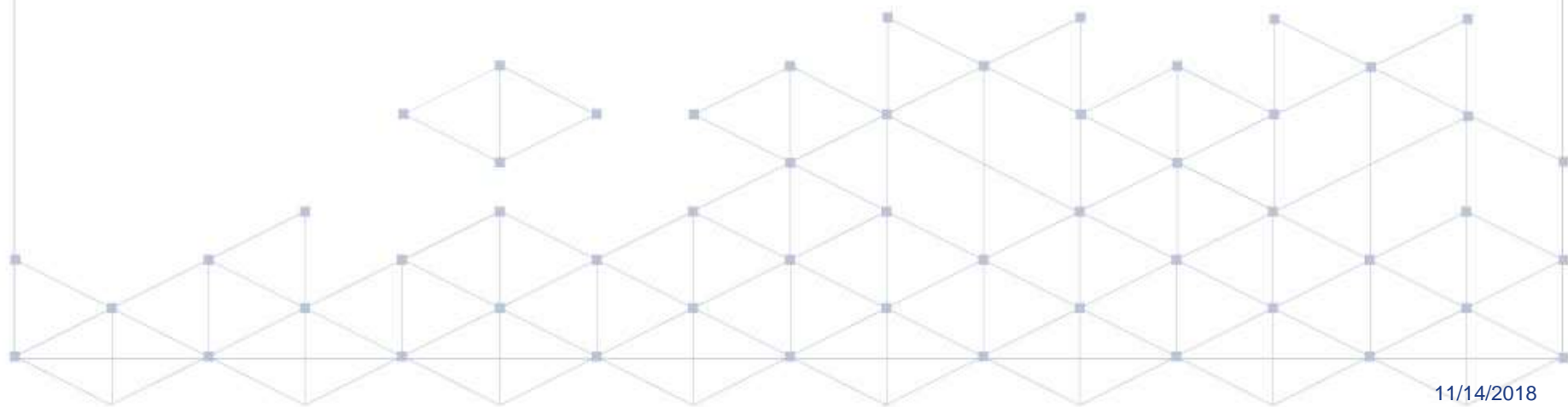
WAM/ADS-B coverage TMA-SPL (1000ft)



11/14/2018



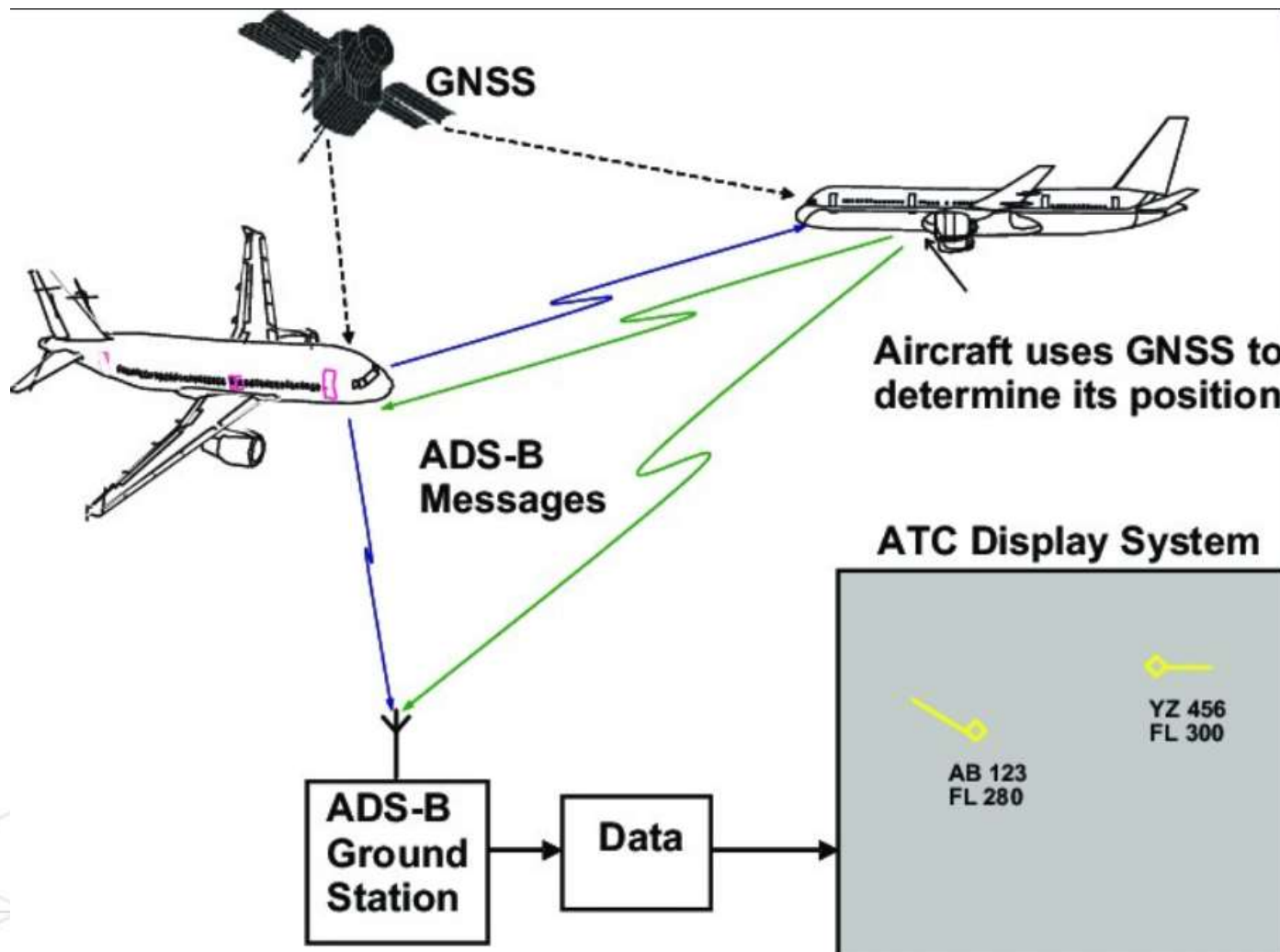
ADS-B voor de kleine luchtvaart





ADS-B out

ADS-B Out zendt 2 keer per seconde de GPS locatie en Mode-C (of GEO height) uit.

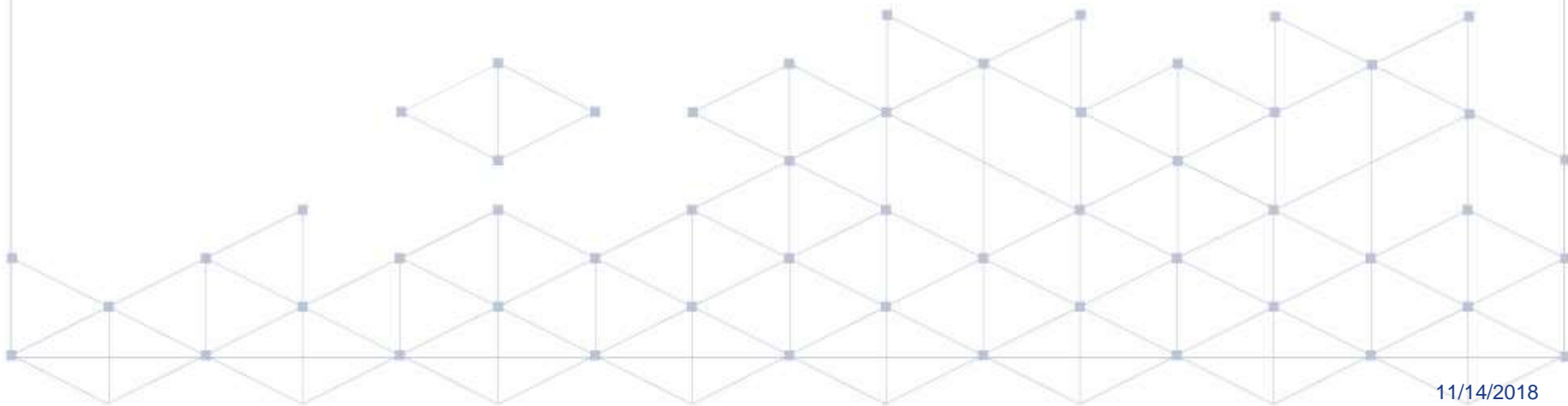


ADS-B in



ADS-B In: ontvangt de ADS-B out signalen van de vliegtuigen in de buurt.

Dit kan aangevuld worden door de posities van non ADS-B vliegtuigen (TIS-B)
en/of door Weer en Flight Information (FIS-B)

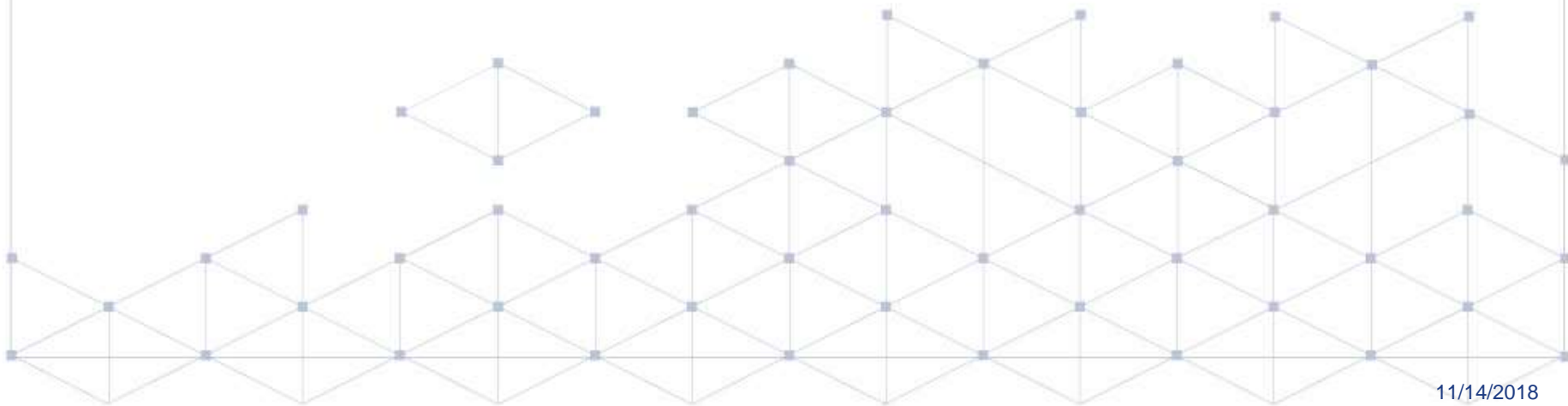


ADS-B out



FAA heeft een mandaat voor ADS-B voor alle vliegtuigen per 1 januari 2020

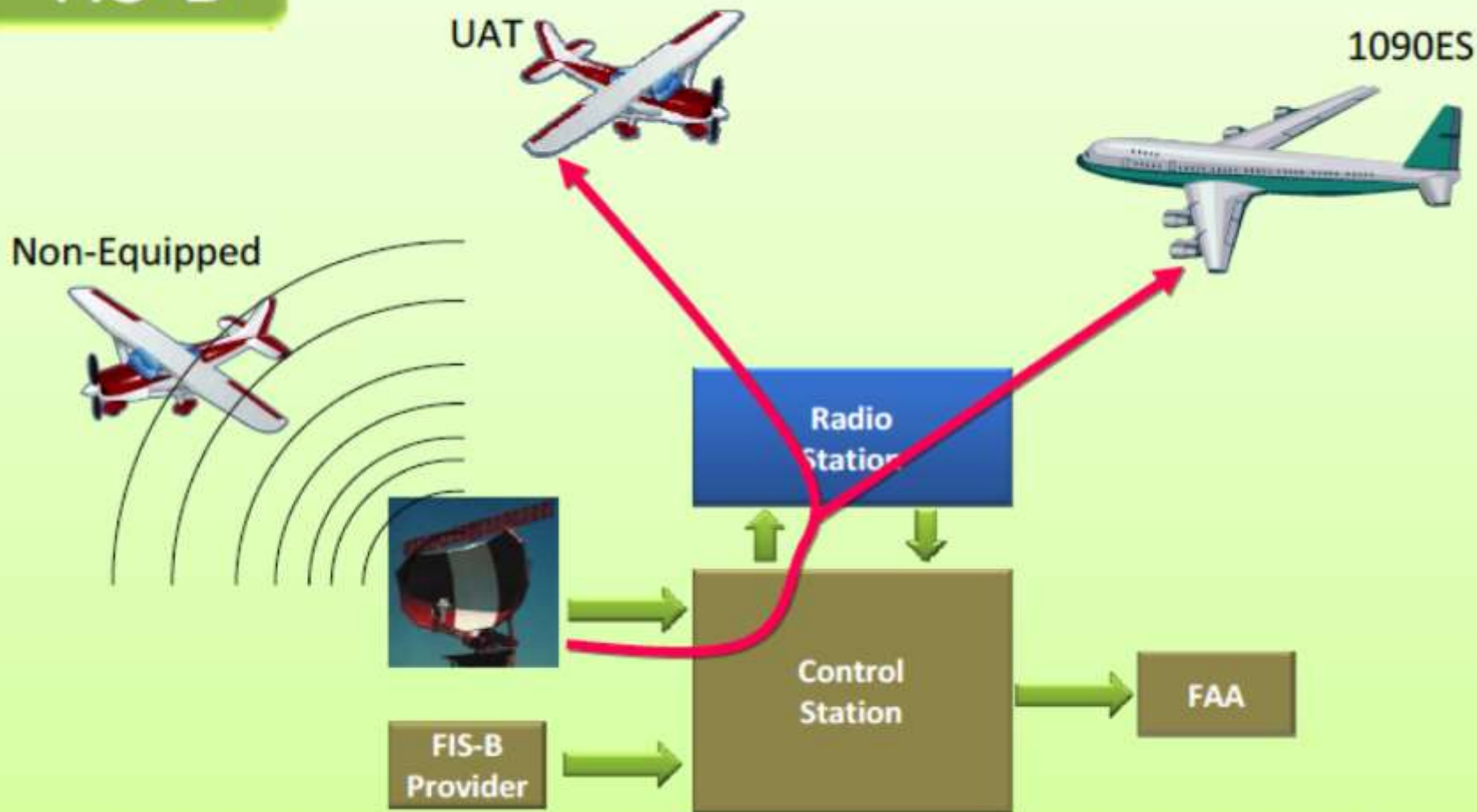
Europa zet in op een ADS-B verplichting per 1 juli 2020 voor alle vliegtuigen zwaarder dan 5700 kg of een kruissnelheid van 250 kts of meer.



TIS-B (Traffic Information Service – Broadcast)



TIS-B

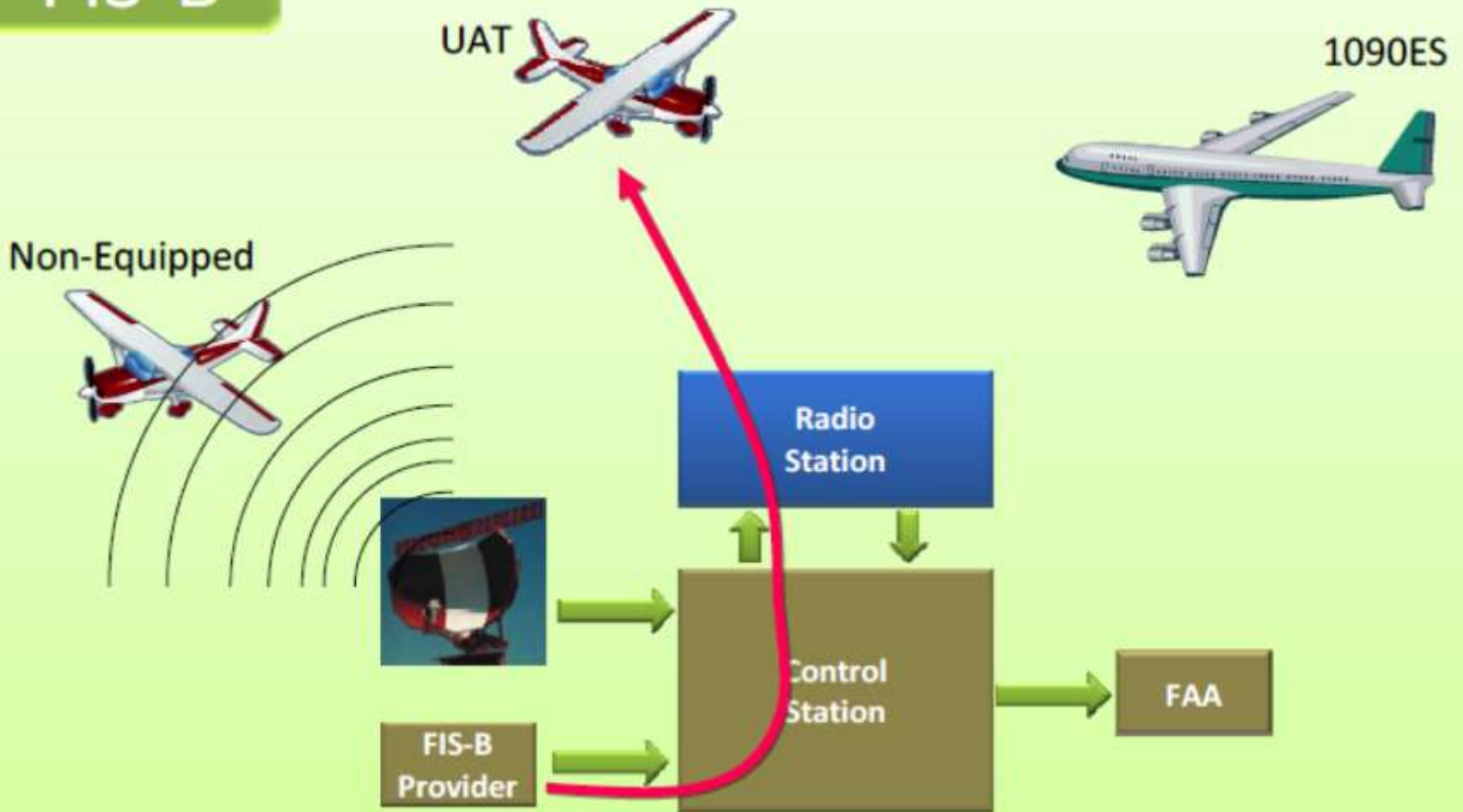


Uplink of Surveillance Data of Non-ADS-B equipped aircraft for Aircraft Situational Awareness

FIS-B (Flight Information Service – Broadcast)

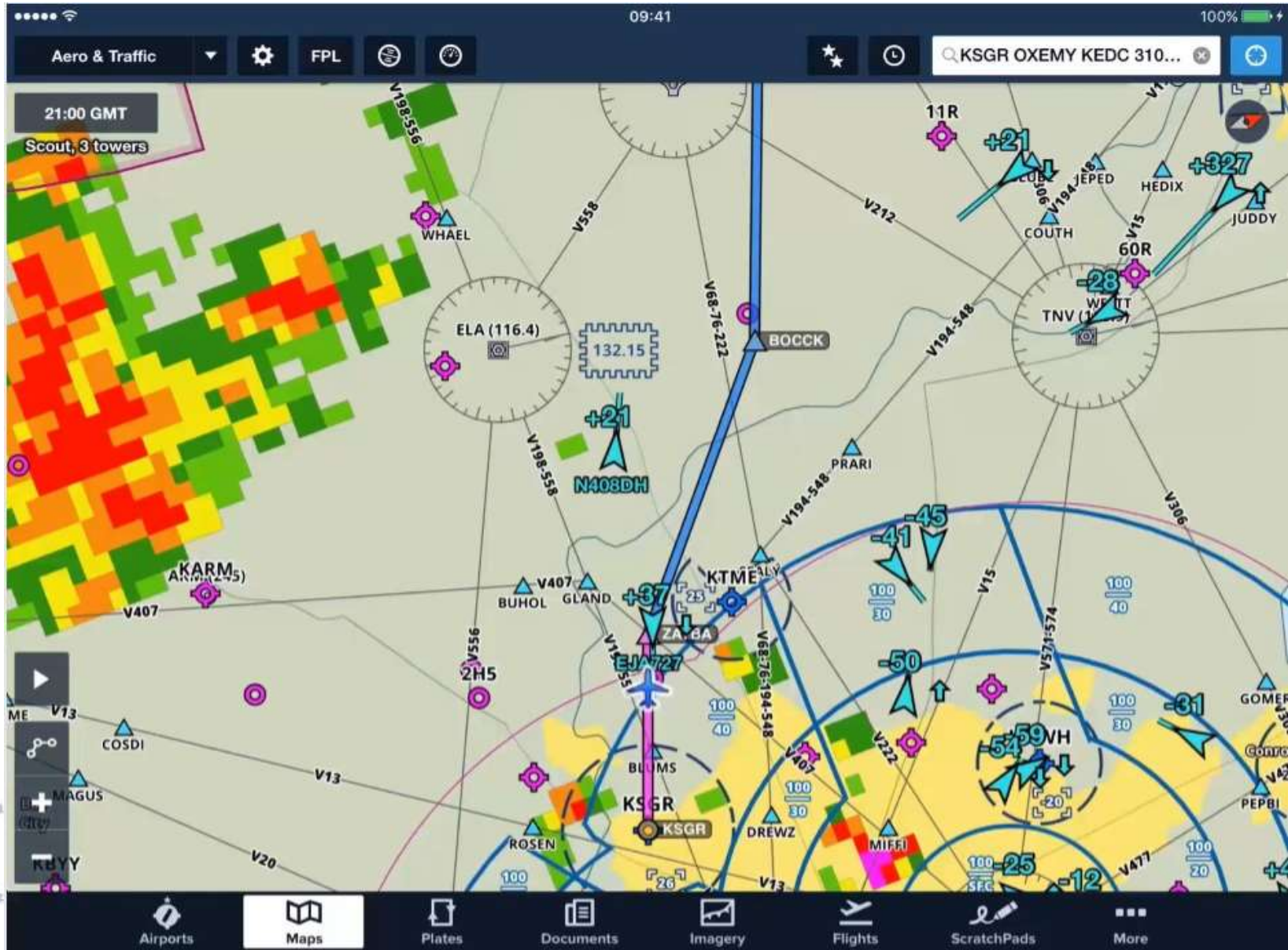


FIS-B

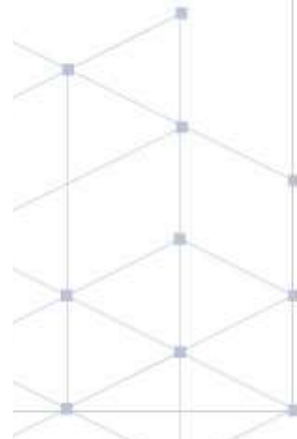
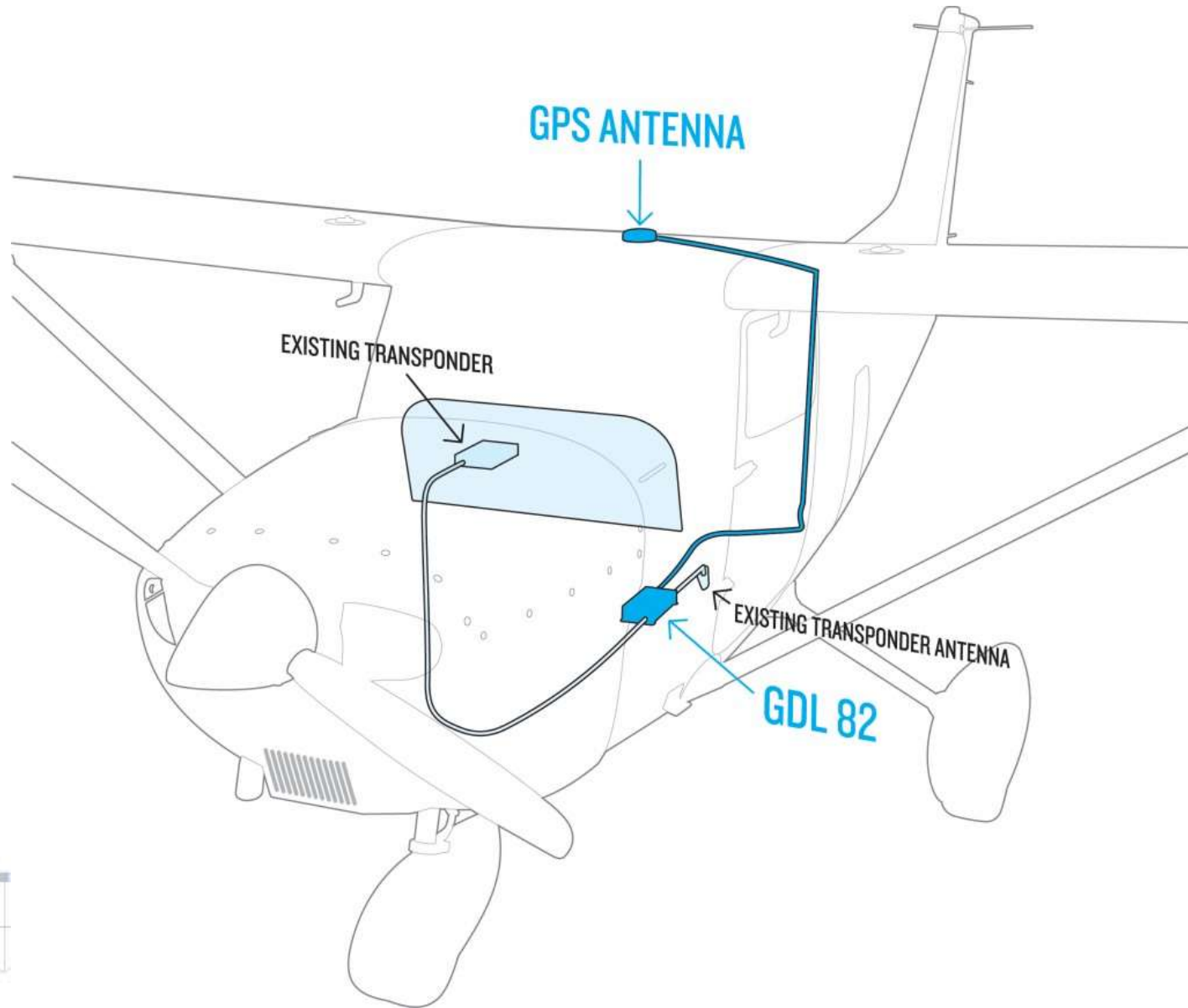


Uplink of Weather and other Flight Information for UAT Equipped Aircraft

ADS-B UAT presentatie van weer en verkeer (USA only)



Garmin GDL82 (UAT only)



Portable ADS-B equipment



SkyEcho

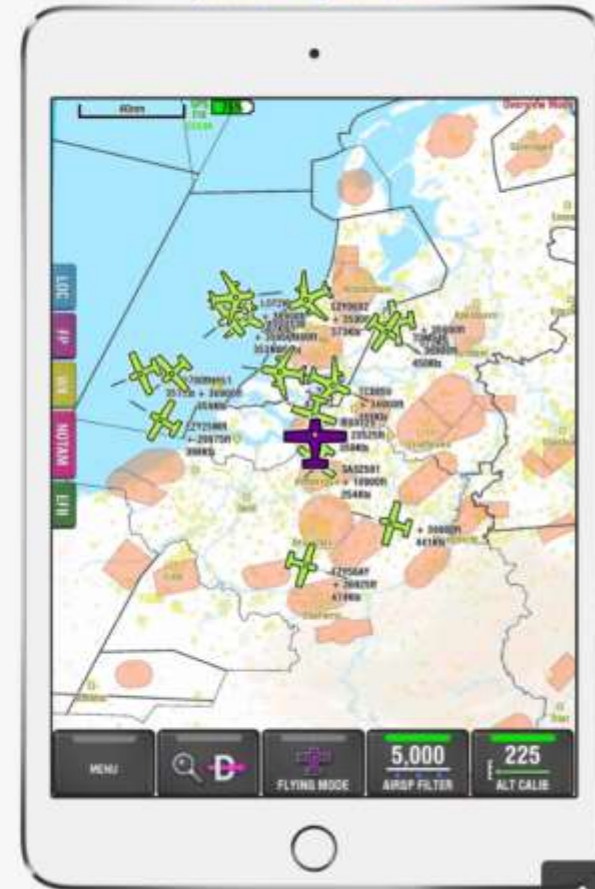
SkyEcho is the UK approved portable ADS-B In and Out solution including an integrated GPS, pressure altimeter, and battery pack

ADS-B-In 1090ES
ADS-B-Out on 1090ES

LET OP:

24 bit Mode-S
adres moet
gelijk zijn aan
het adres van
de Mode-S
transponder

SkyEcho Support Apps



FAA TSO-C199 Requirements for Traffic Awareness Beacon System (TABS)

- SDA=1 (1×10^{-3} or better)
- NACp=9 (30 meters or better)
- NACv=1 (10 m/s or better)
- NIC=6 (0.5 NM or better)
- SIL=1 (1×10^{-3} or better)
- Detect Step errors greater than 700 meters
- Capable of using SBAS integrity

ADS-B informatie die voldoet aan TSO-C199 kan gebruikt worden door een hybride TCAS II system.

Ground ADS-B equipment



pingStation



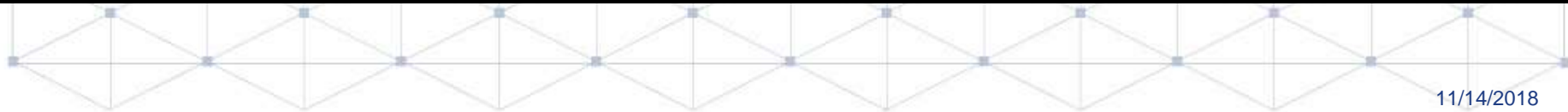
All-Weather Network Ready ADS-B Receiver



Drone

met een
PING1090
ADS-B
transceiver







Luchtverkeersleiding Nederland

Bezoekadres

Stationsplein ZuidWest 1001
1117 CV SCHIPHOL

Postadres

Postbus 75200
1117 ZT SCHIPHOL

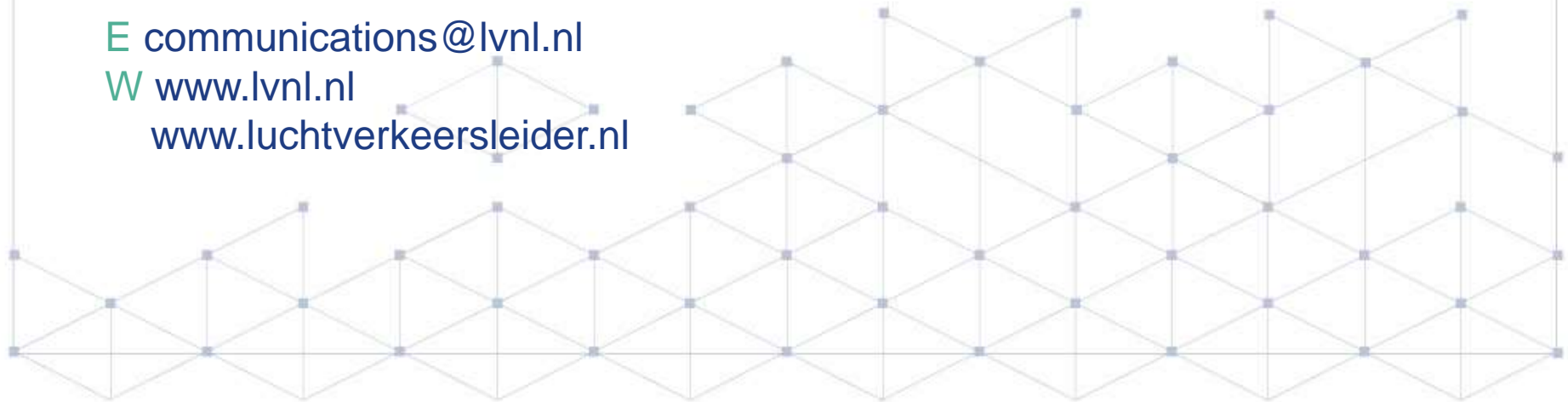
T +31 (0)20 4062000

F +31 (0)20 6484999

E communications@lvnl.nl

W www.lvnl.nl

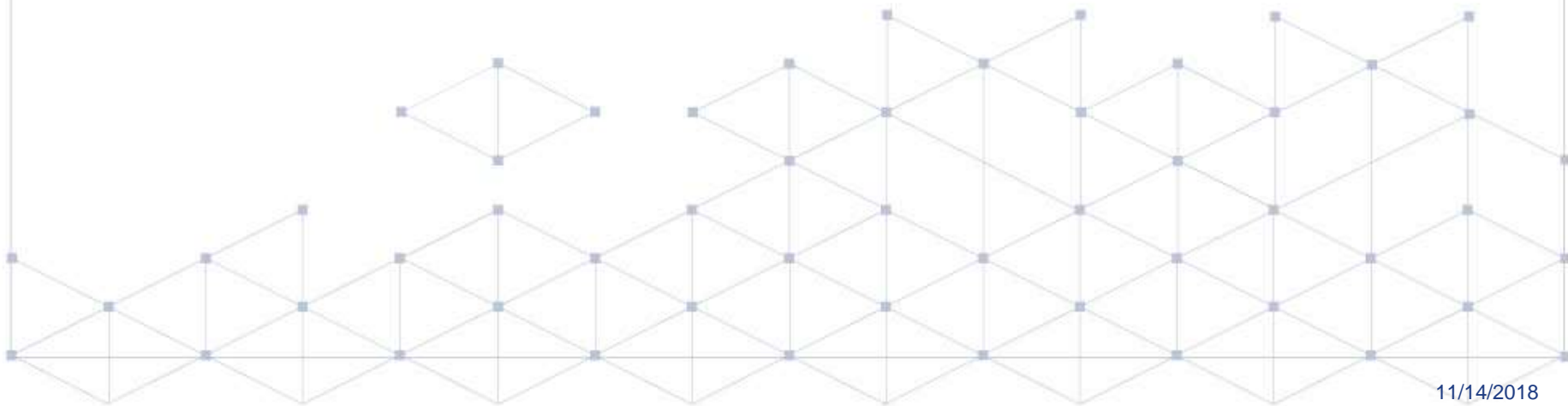
www.luchtverkeersleider.nl



ADS-B spoofing



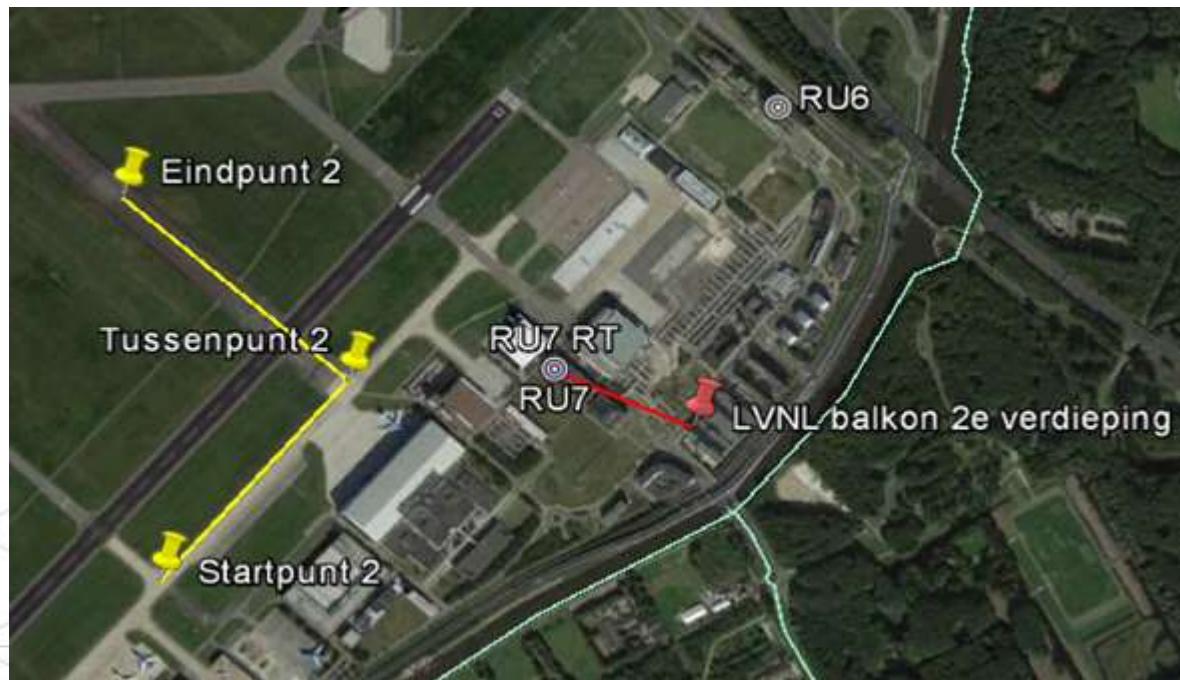
On Saturday the 8th of March 2014 an ADS-B spoofing trail was performed at Schiphol airport.



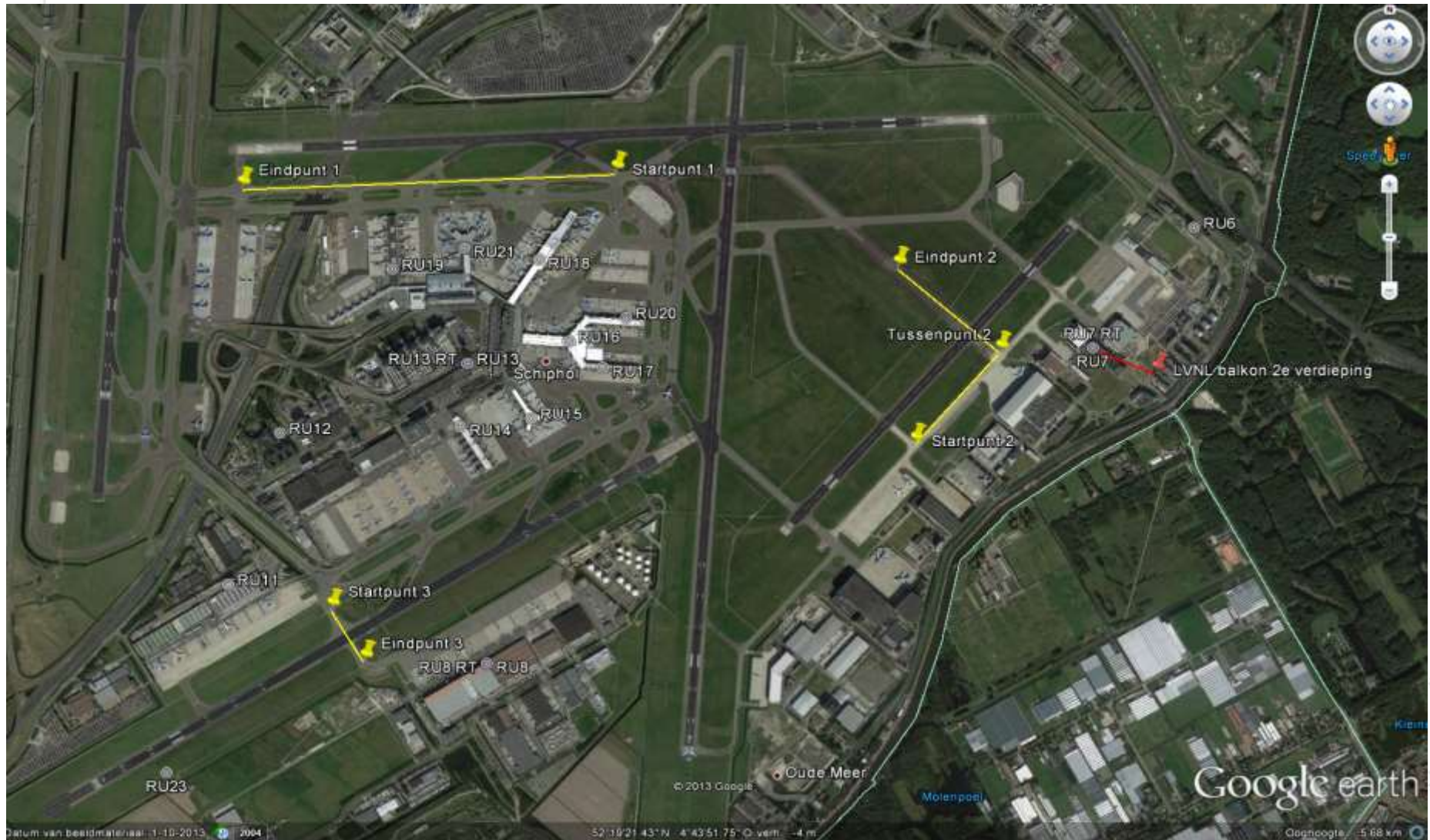
Location of the transmitter



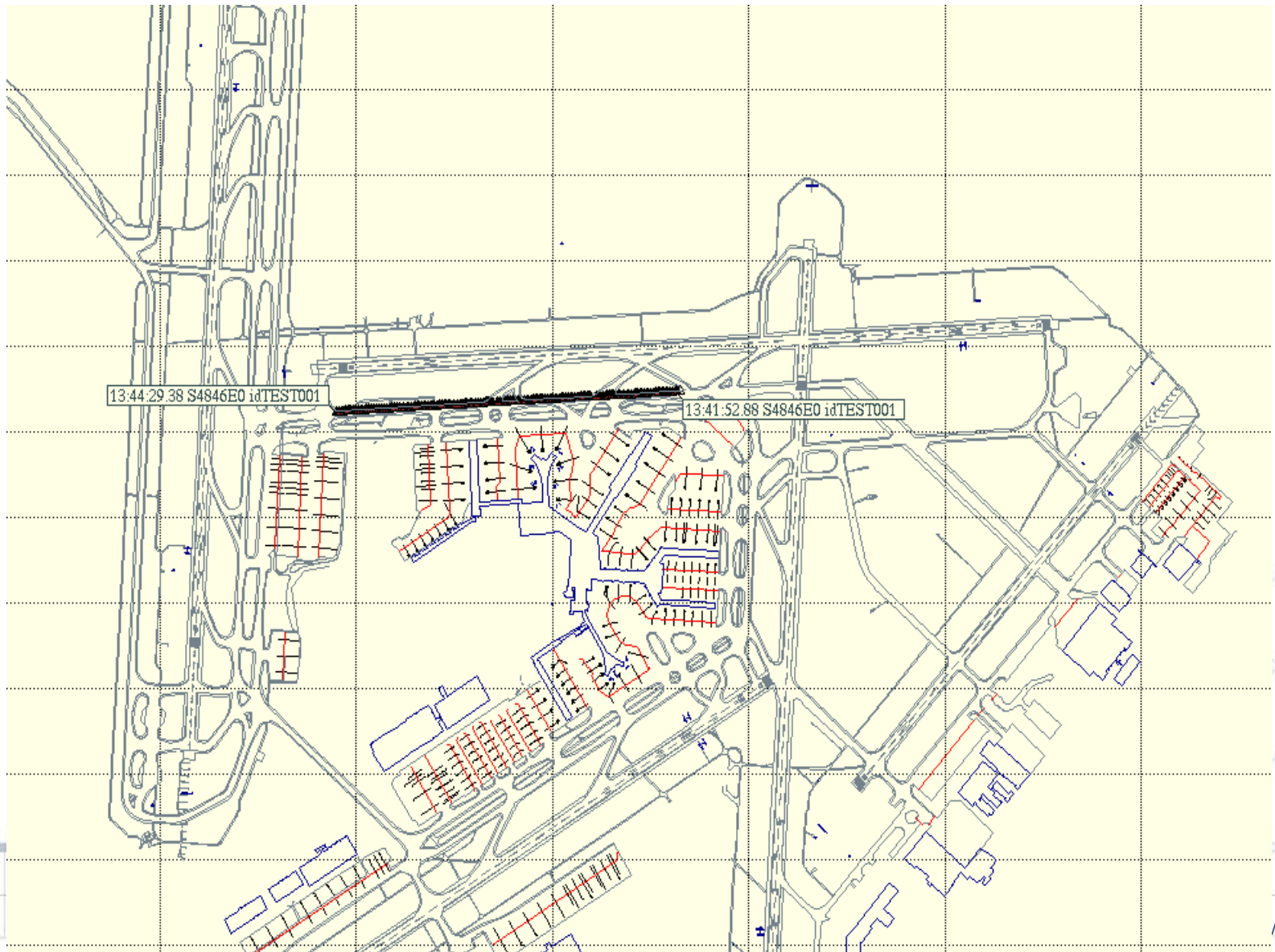
- The Intersoft equipment was installed on the balcony on the 2nd floor of the LVNL building.
- RU7 is located roughly 700 meters from that point.



Scenario for artificial ground vehicle



Result of first run with id: TEST001



Result of third run with id: TEST003

