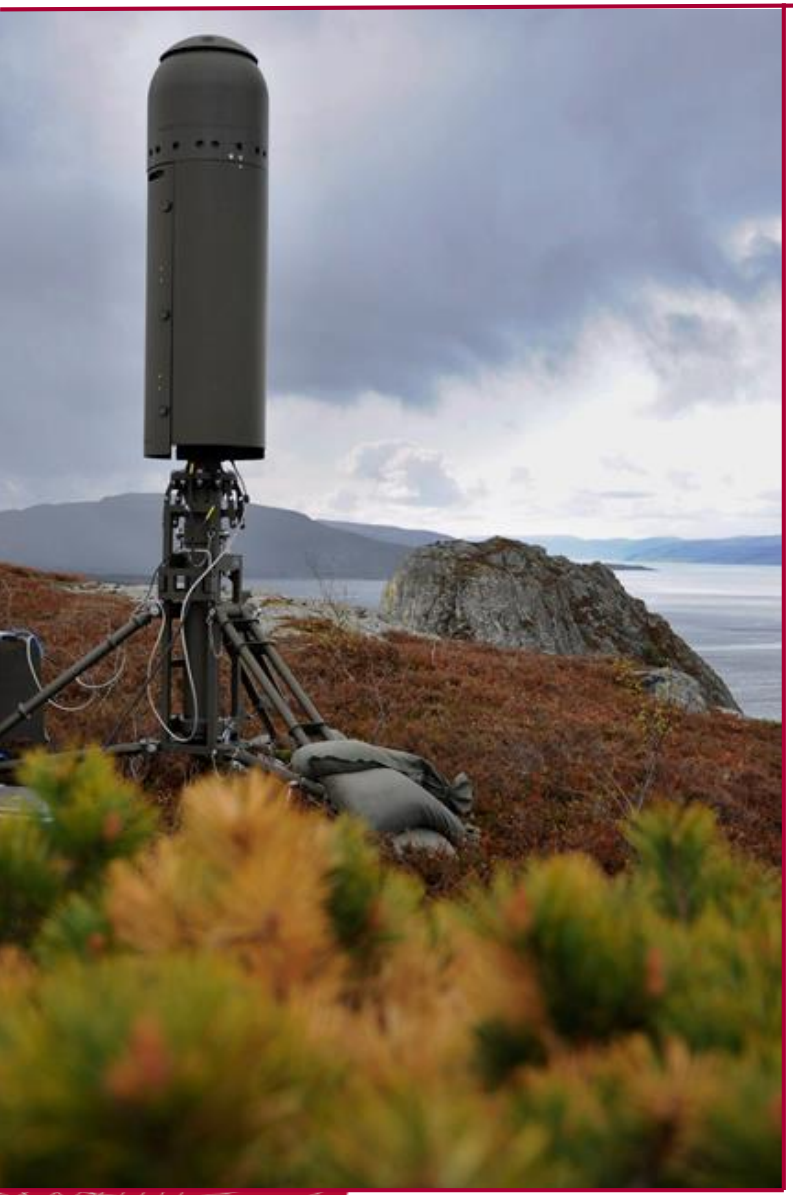
Beyond Radar

PET sensor VERA-NG as a part of GBAD

Presented by Vojtech Stejskal

(v.stejskal@era.aero)

NextGen Surveillance Solutions



Passive ESM Tracker (PET)

- What is PET system
- Principle and key properties
- PET use cases
  A. RECCE
  B. GBAD

Ground Based Air Defense (GBAD)

- PET integration into AD
- PET properties supporting GBAD
- EW simulator supporting AD training
- Fictive GBAD scenario supported by EW simulator

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Passive ESM Tracker (PET)

What is

„DPET (Deployable Passive Electronic Support Measures (ESM) Tracker) sensor provides long-, medium-, and short- range all altitude surveillance coverage of manned and unmanned fixed wing and rotary wing airborne vehicles (AVs) excluding Tactical Ballistic Missiles based on employing Time Difference of Arrival (TDOA) techniques exploiting any RF signal emitted by the AV, that optionally may be supported by Angle of Arrival (AOA) techniques.“

„In addition, the DPET system provides the principle source of non-cooperative target identification (NCTI) based on determination the waveform parameters of any AV emission and automatic comparison these to a system database.“

NCIA definition

Definition would desire extension by ground and naval platforms as a targets. PET origin is related with ballistic missile tracking.

What is not

Recent trend is to call also any Direction Finding (DF) system PET when DFs do not support real time target tracking as PET abbreviation claims.

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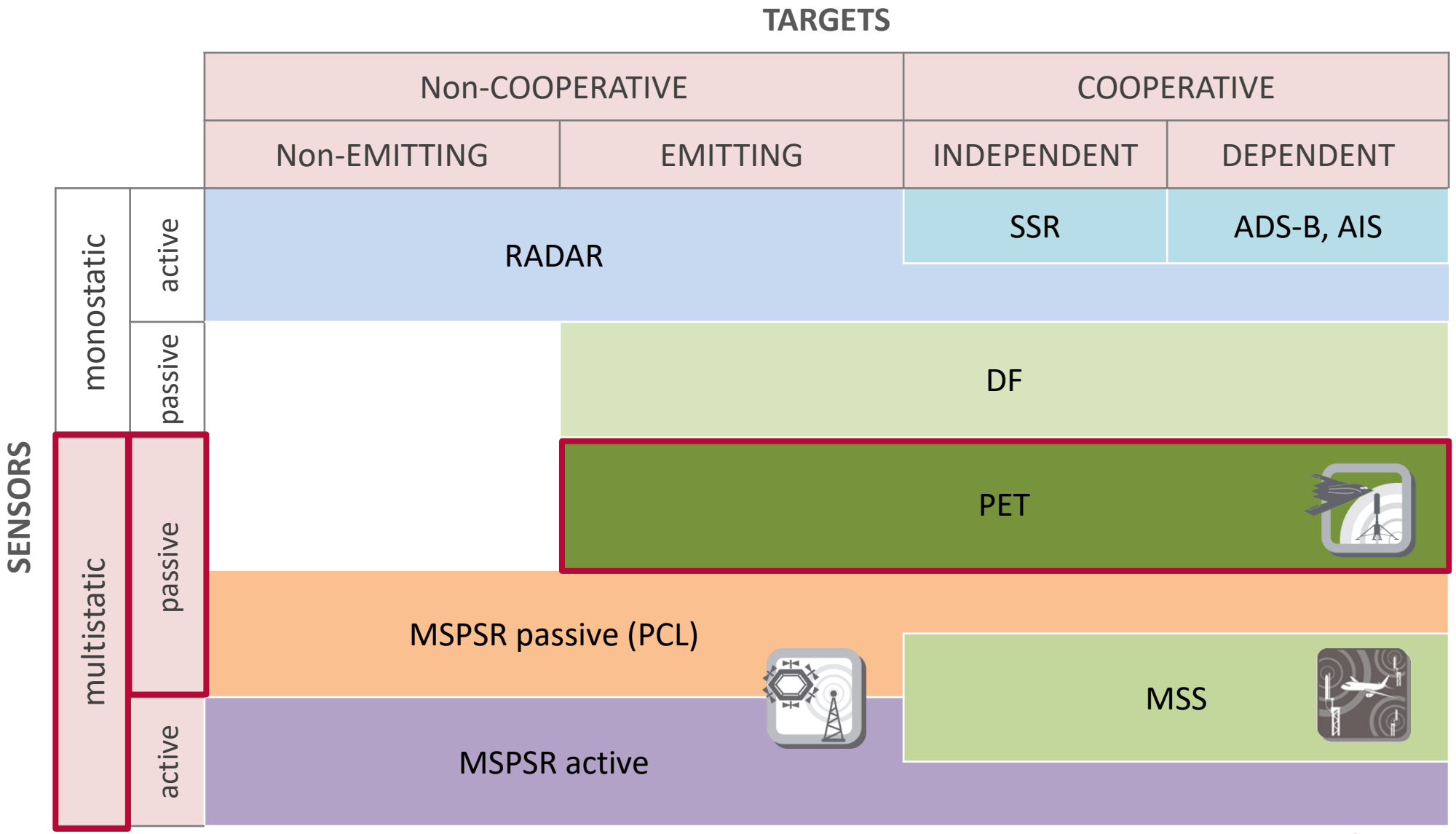
Surveillance sensor overview

Target detection, tracking and identification approaches

MONOSTATIC vs MULTISTATIC



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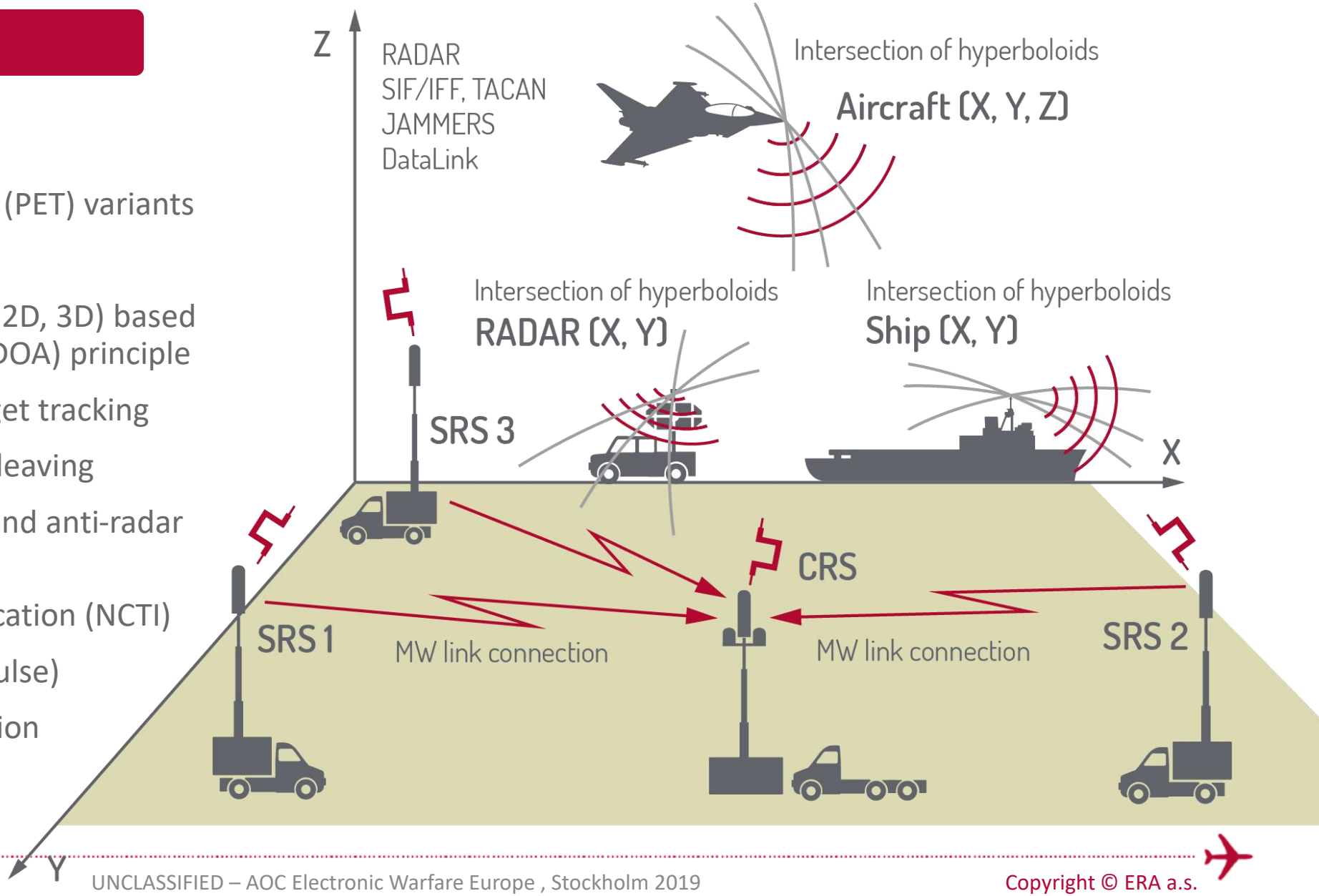
Passive ESM Tracker (PET) principles

Key Features

- Multisite sensor system
- Deployable (DPET) or stationary (PET) variants
- Covert mode of operation
- Target localization and tracking (2D, 3D) based on Time Difference of Arrival (TDOA) principle
- Real time and very accurate target tracking
- Parametrical and spatial deinterleaving
- Resistant to EM&GPS jamming and anti-radar missiles
- Non-Cooperative Target Identification (NCTI)
- ELINT analysis (inter and intra-pulse)
- Emitter Database (EDB) production



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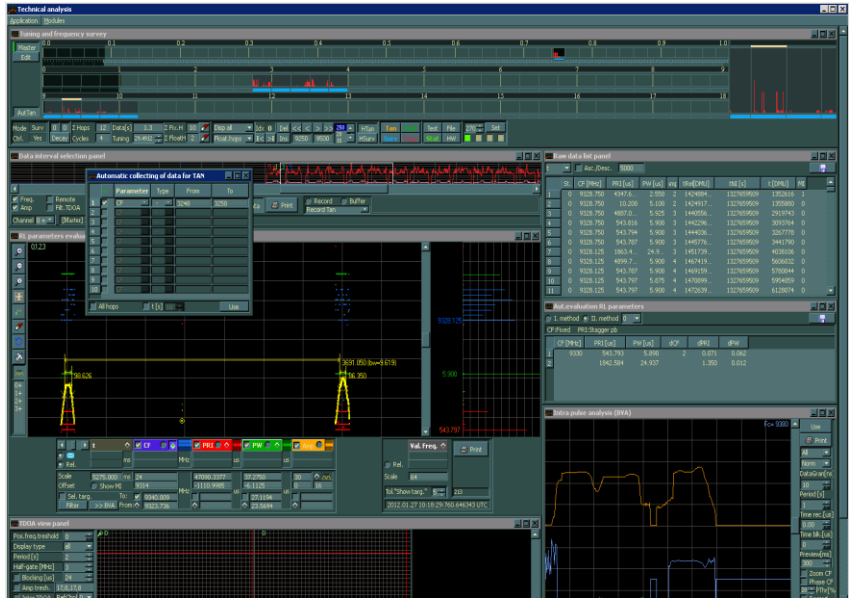
PET Use Cases

ROLE	Surveillance AD (Air Defence)	Reconnaissance EW (Electronic Warfare)
Tasks	Real-time target tracking Target identification (NCTI)	Signal analysis Target localization Emitter Database (EDB) production ELINT data distribution
Integration	Proprietary format ASTERIX, AWCIES	Proprietary format CESMO, EOB, NEDB
Customer	ACC/ARS/DARS/GBAD	EWCC/SEWOC/EDB authority

Sensor can support both use cases at the same time.

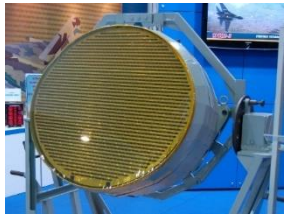
RECCE

Also for GBAD is good to know.



Challenges

- **Novel** sophisticated type of **emitters** with complex signals (multimode, random, MoP)
- To get clear **signal representation** in congested environments and assign it correctly to emitter/platform assignment
- To **rough definition of EDB content** (against automatic NCTI)
- **Data exchange** interoperability (in between platforms)

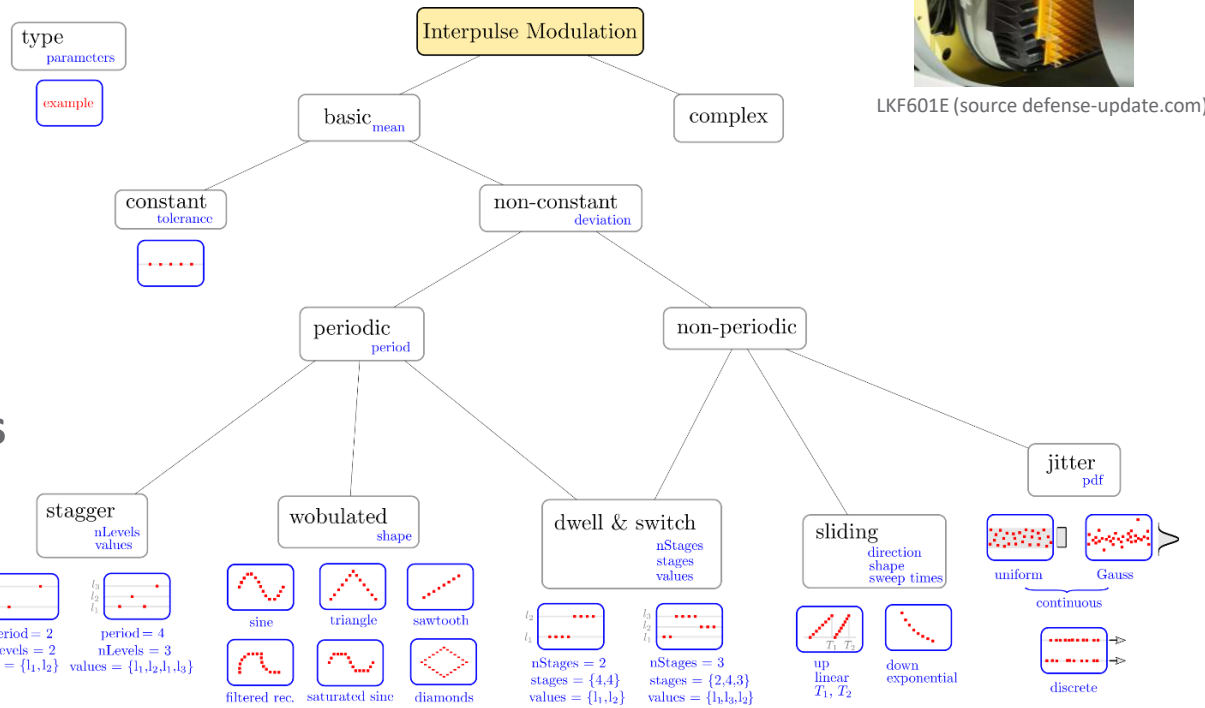


N036 Byelka (source Wikipedia).

LKF601E (source defense-update.com).

All about Emitter Database

- PET provide **very accurate EDB records** due to spatial deinterleaving
- PET also contributes to **exchange format modifications**
- PET **supports automatic NCTI**



Target identification is crucial for GBAD

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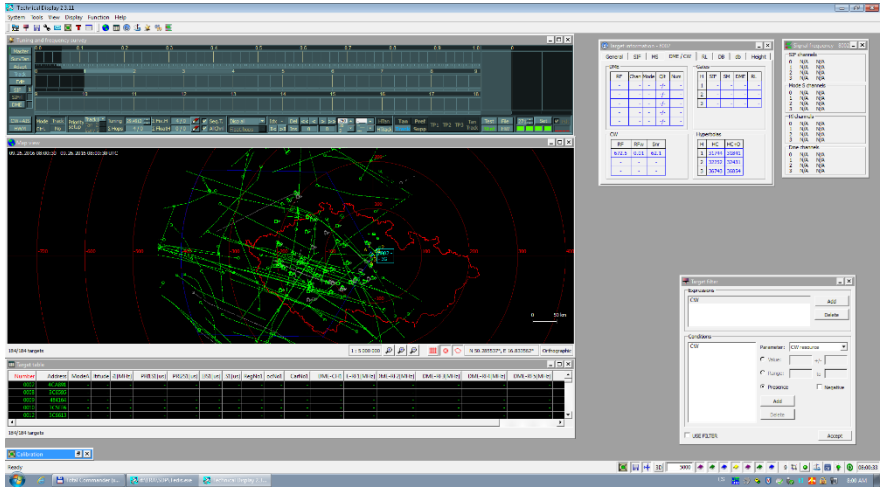
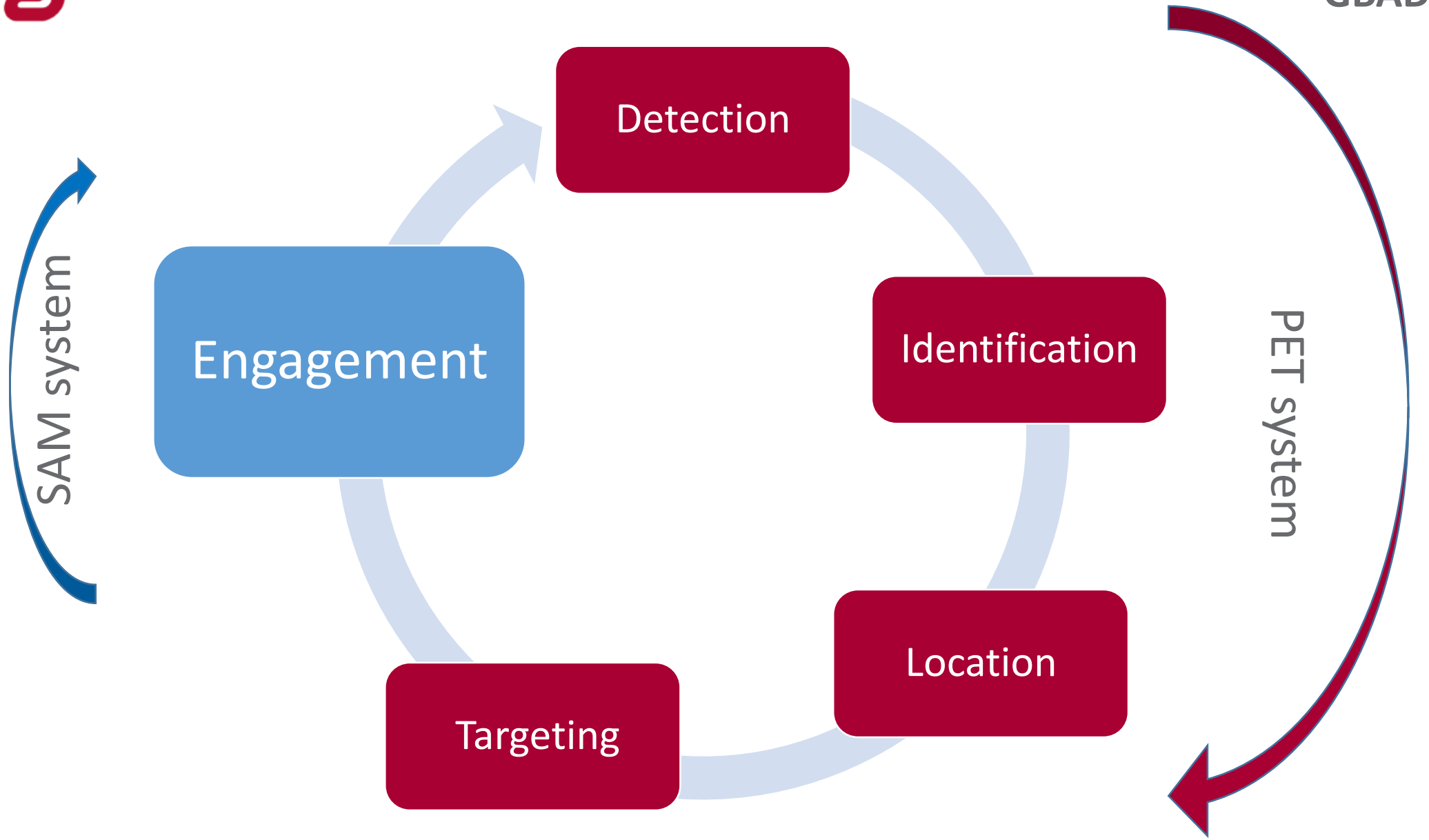
GBAD

It is good to know very quickly and precisely.



GBAD cycle



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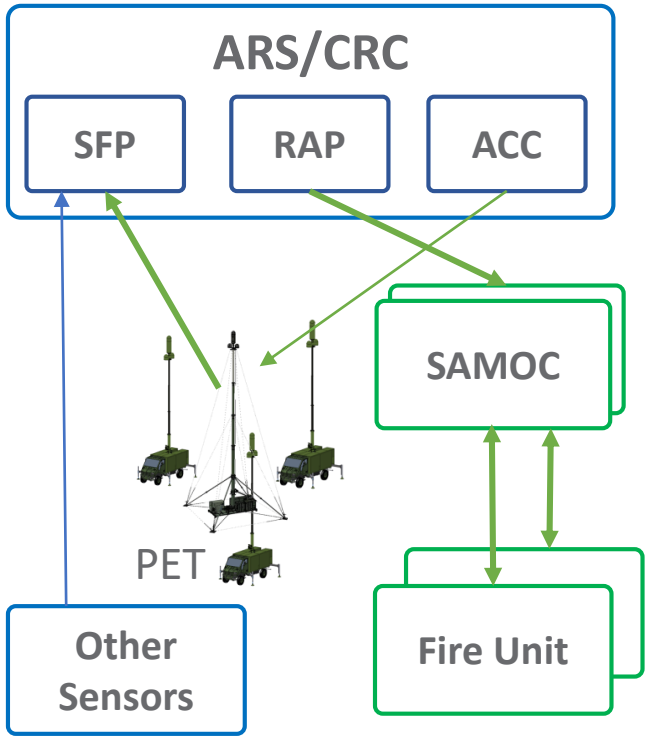
PET integration to GBAD

AirC2

PET fused with other sensors in SFP and distributed as RAP

PET is tasked from ARS

RAP latency of several seconds

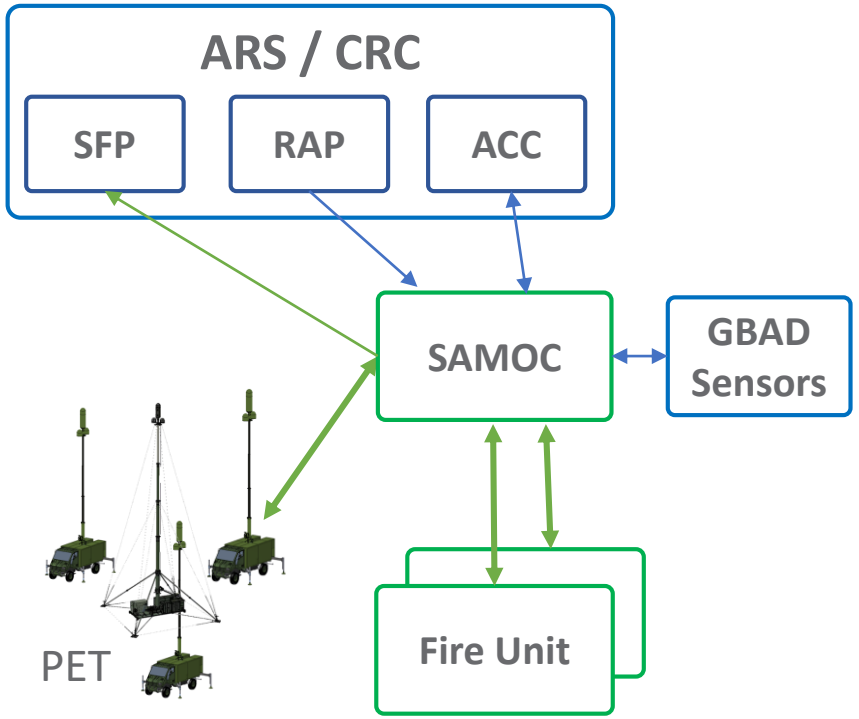


GBAD

PET is fused in SAMOC with GBAD sensors and provide information to ARS SFP -> RAP

PET is tasked from SAMOC

IFF and FU units support

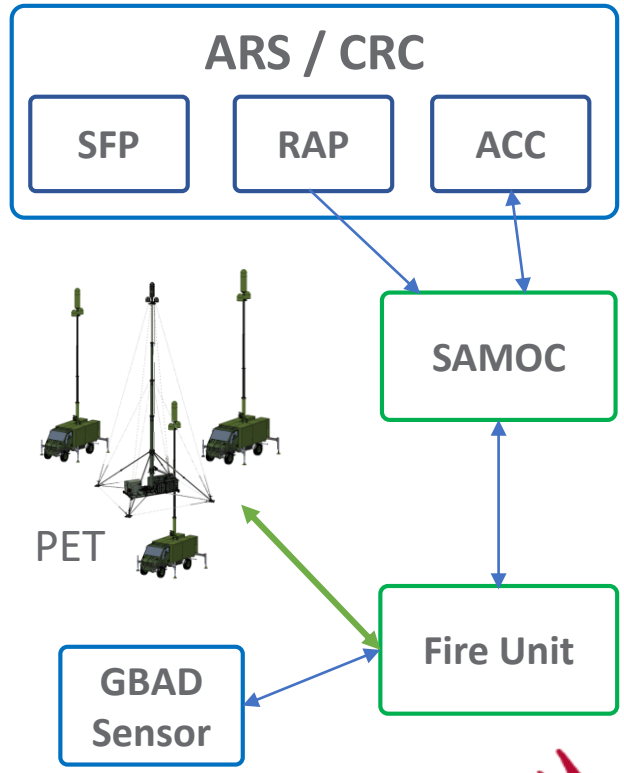


FU

PET is directly tight with FU and SAM system

Full PET control

Target acquisition and engagement



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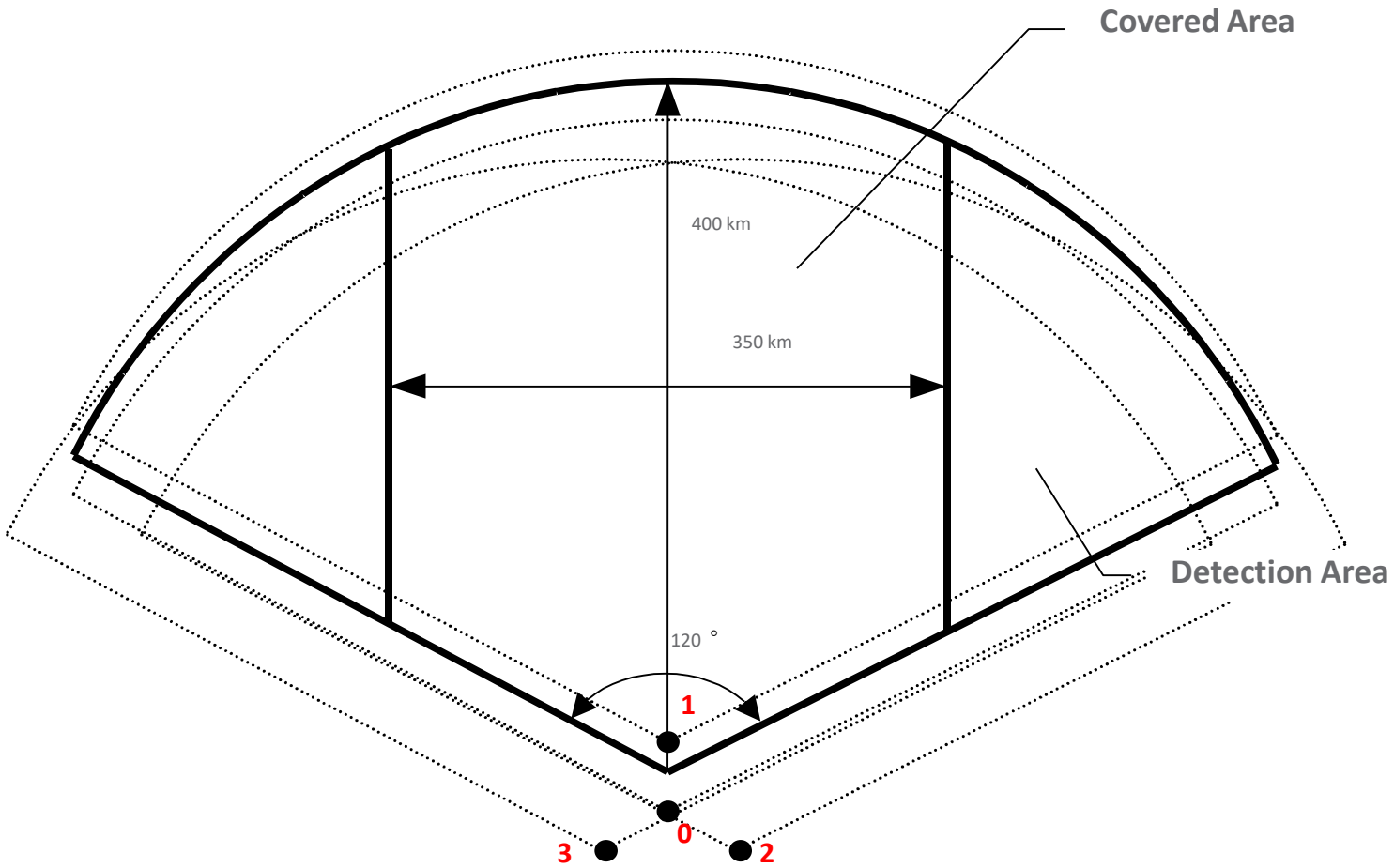
GBAD

Is PET information good enough?

PET parameters



Frequency range 50 MHz – 18GHz

Surveillance area up to 400 km

Up to 500 real time tracks

3 dimensional tracking capability

All weather conditions

Antenna 100 kg and 500x1720 mm

Modern emitters including radars, datalinks, jammers, navigation, identification and other signals.

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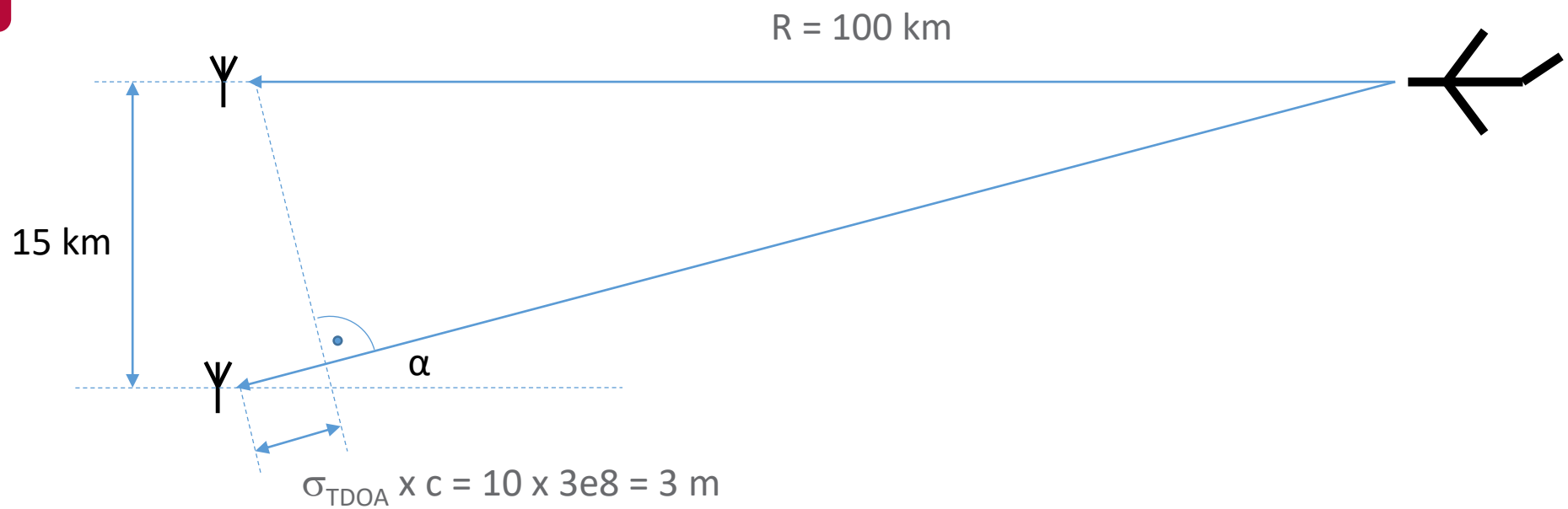
Example

Base - horizontal 15 km

Base - vertical 1500 m

Distance to target 100 km

σ_{TDOA} e.g. 10ns



Cross range angular error

α = 3/15000 = 0.0002 rad
= **0.01°**

Cross range error

Cross range error = α x R =
0.0002 x 100000 = **20 m**

Height angular error

α = 3/1500 = 0.002 rad
= **0.1°**

Height error

Height error = α x R
= 0.002 x 100000 =
200 m

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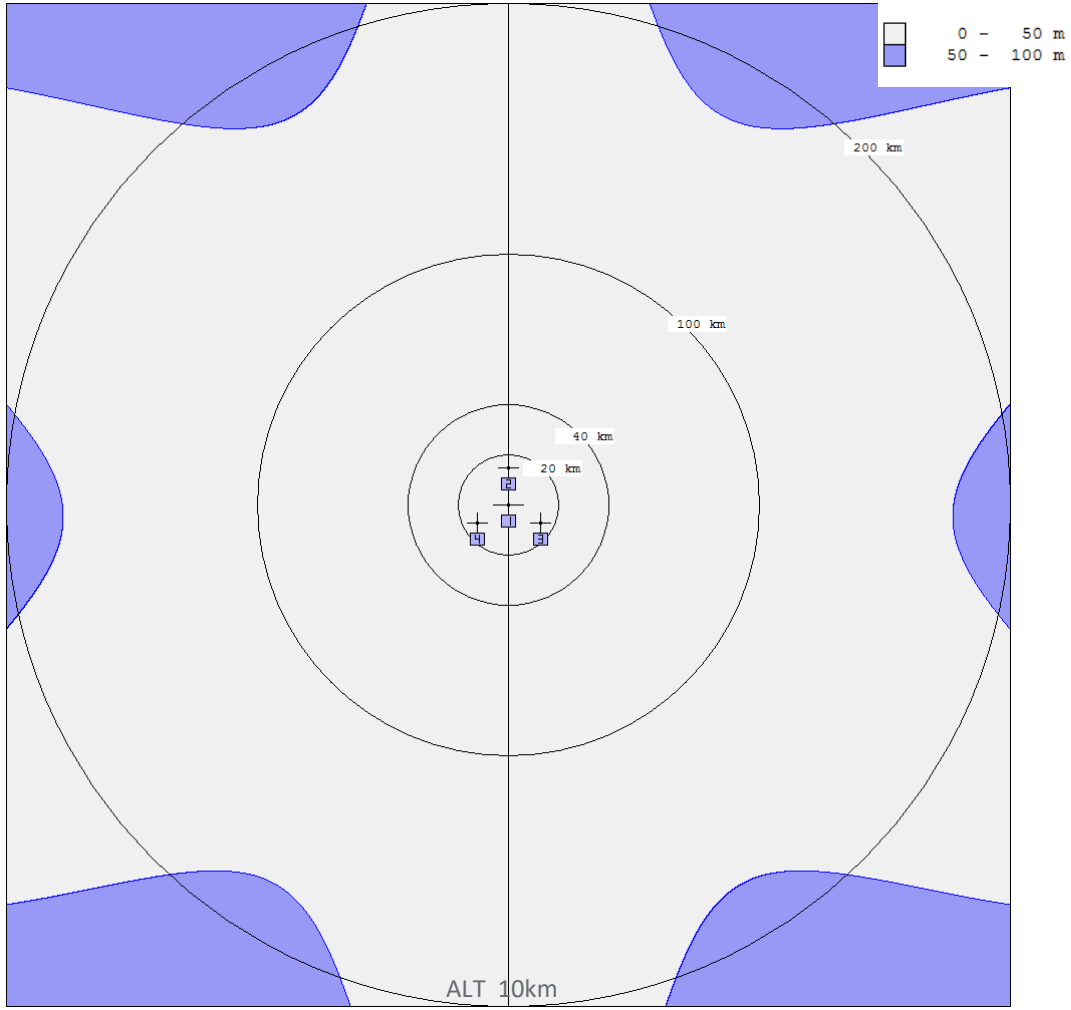
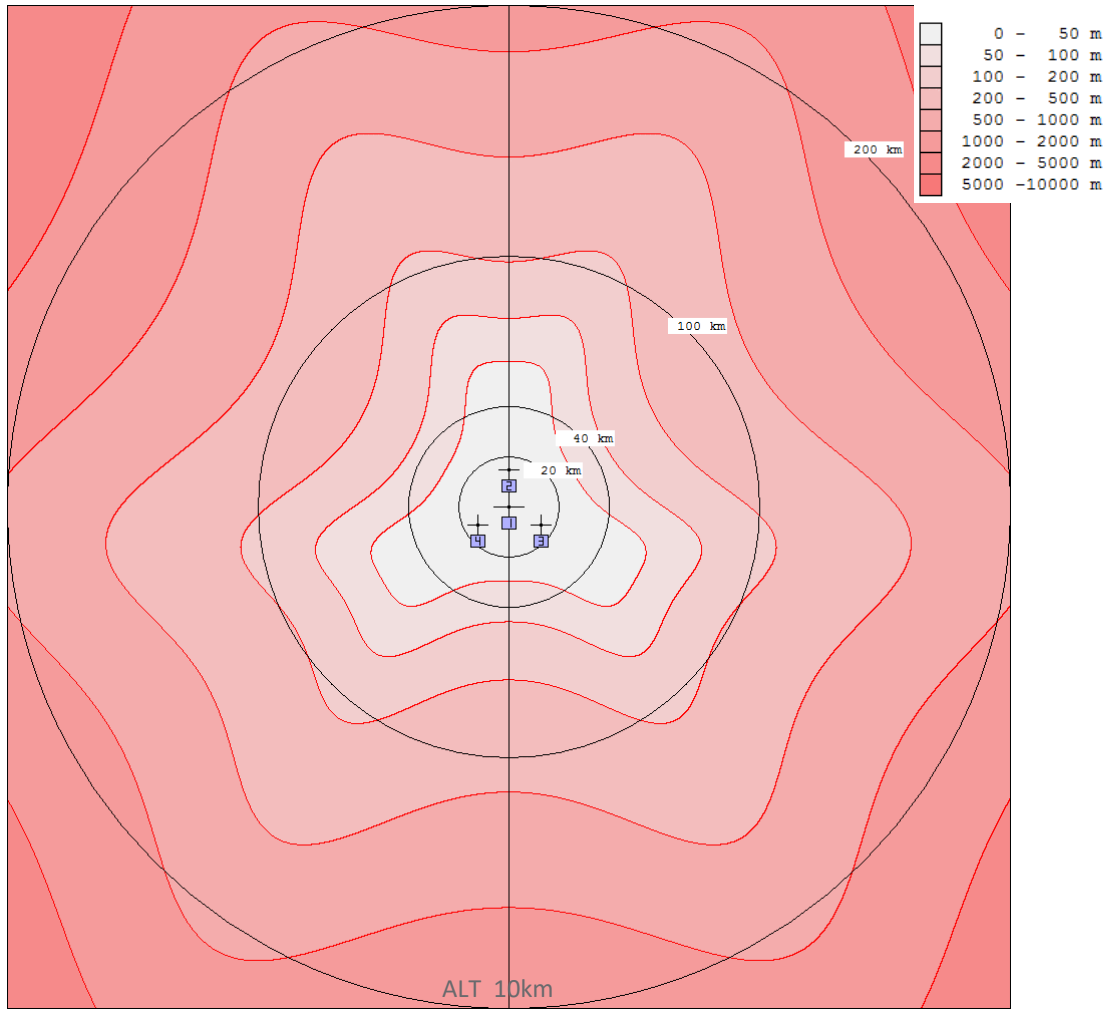
Error projection infuenced by GDOP

Cross range error



Vertical error



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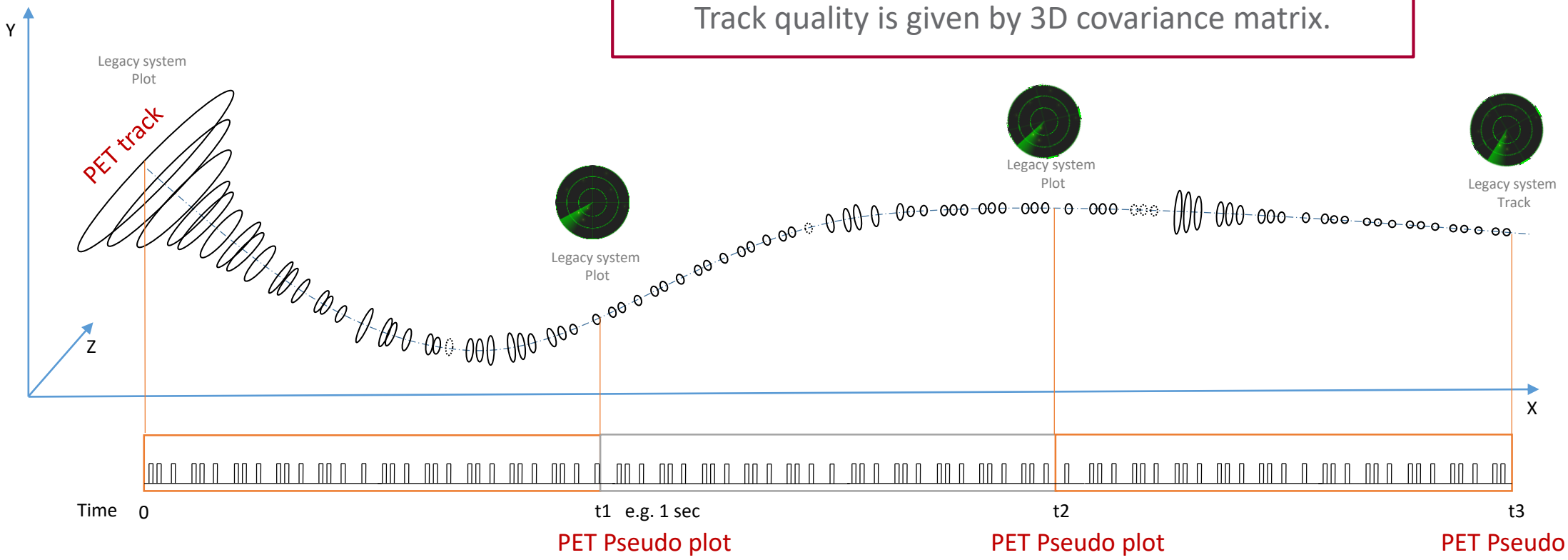
Track before plot

Target position is formed from the beginning as track.

Track quality is given by 3D covariance matrix.



- Output update rate is configurable (1-15 sec). Lower number is not feasible (hundreds targets at the same moment).
- **Priority targets with higher update rate** are optional.
- Multichannel output function (several AWCIES, AST, UFE outputs with different content regarding data consumer).

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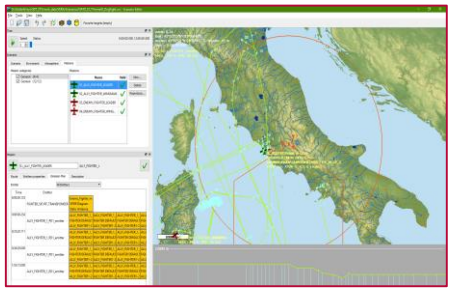
PET in action

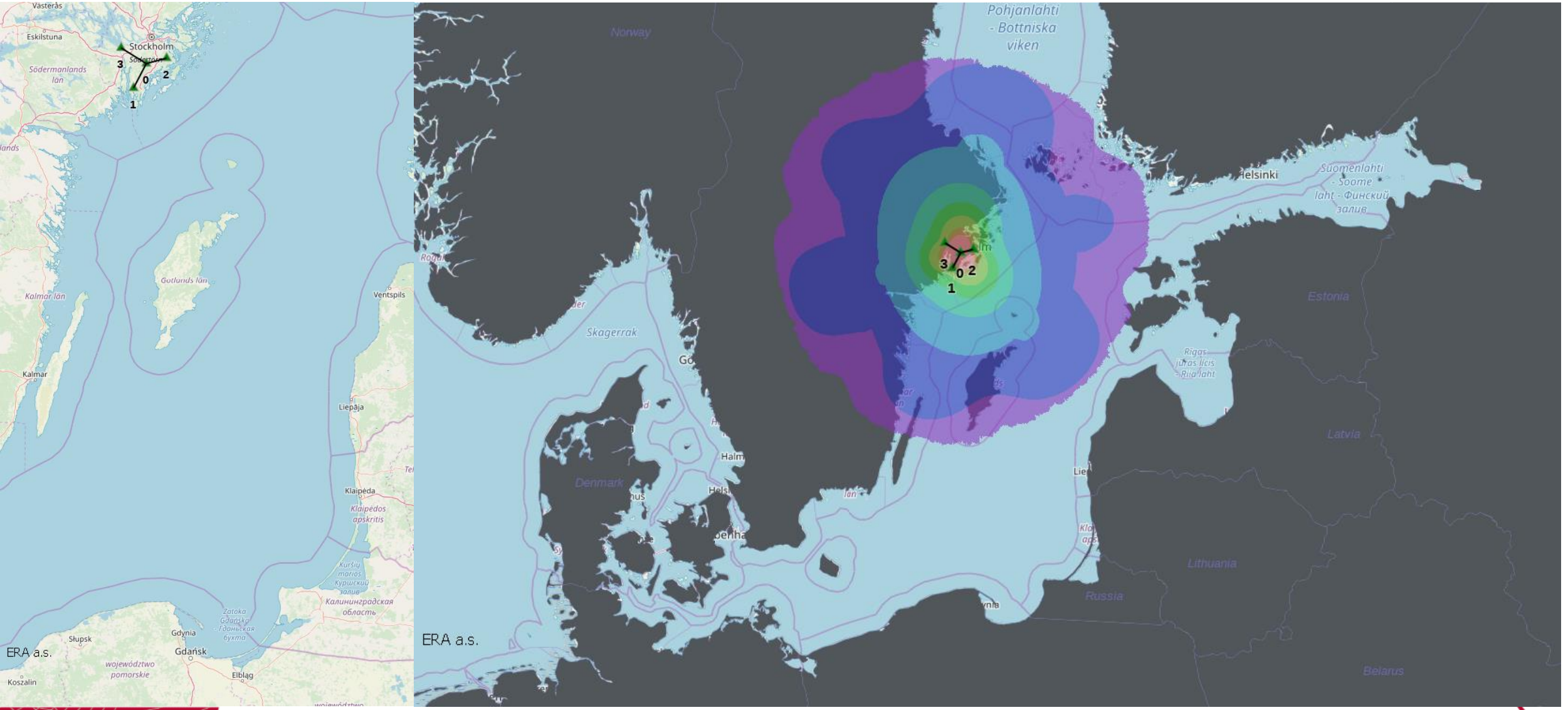
Fictive scenario when PET supports GBAD generated by ERA EW Simulator.

3D SCENARIO OVERVIEW

SCENARIO EDITOR



Fictive PET scenario



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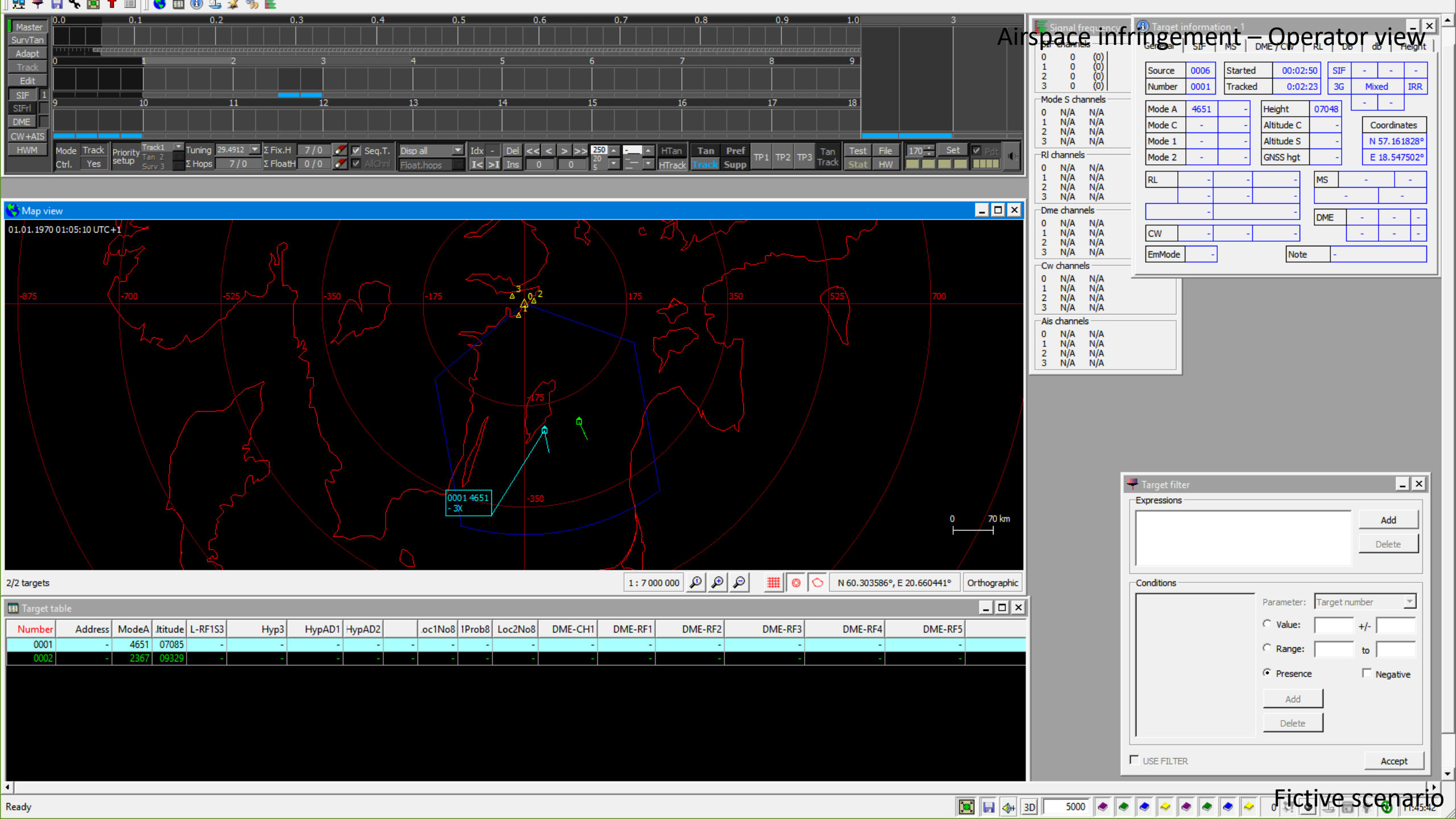
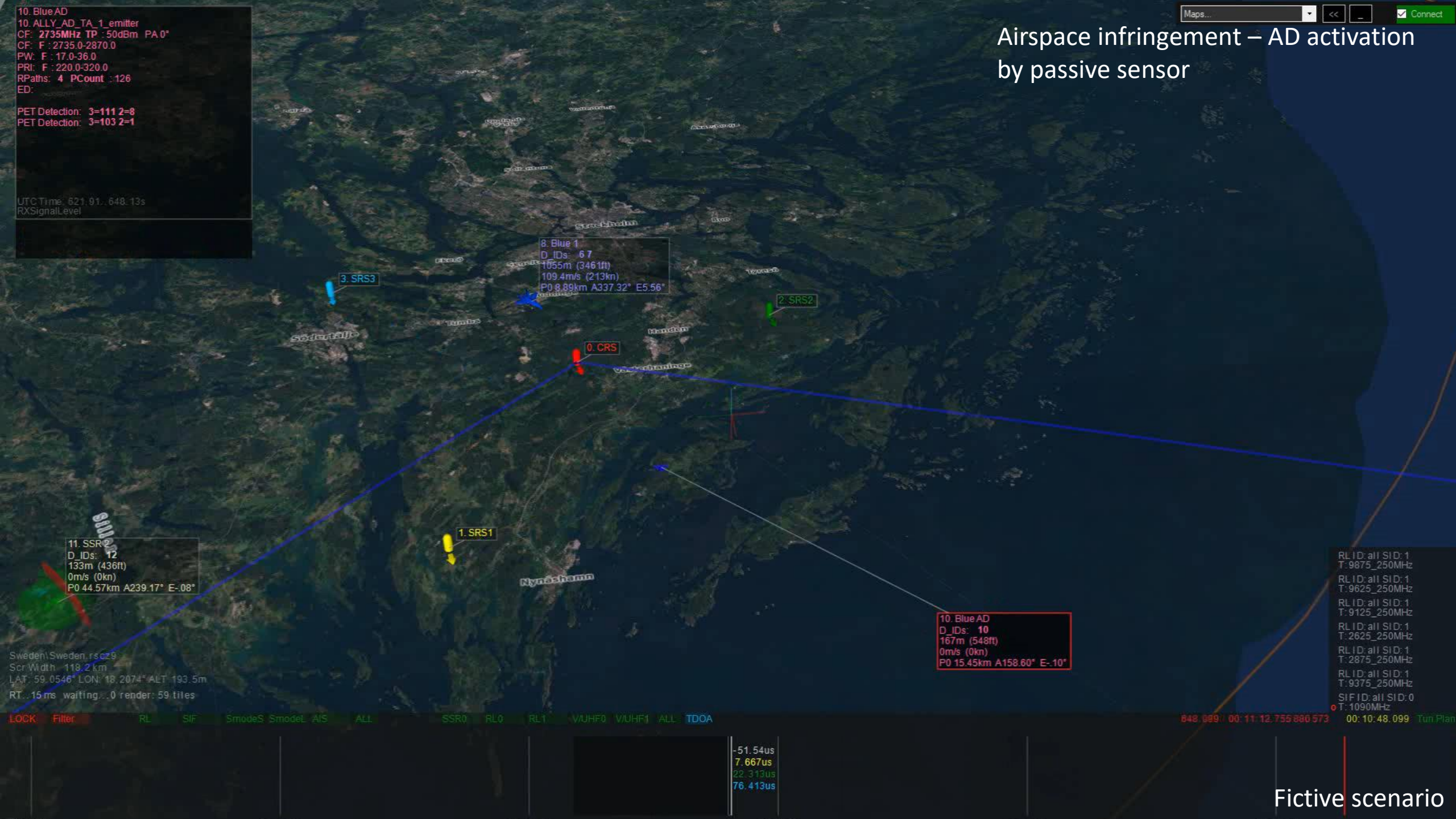
Airspace infringement – PET support

Fictive scenario

Airspace infringement – Operator view



Fictive scenario

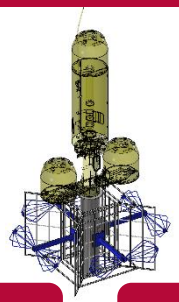

10. Blue AD
10. ALLY_AD_TA_1_emitter
CF: 2735MHz TP : 50dBm PA 0°
CF: F : 2735.0-2870.0
PW: F : 17.0-36.0
PRI: F : 220.0-320.0
RPaths: 4 PCount : 126
ED:
PET Detection: 3=111 2=8
PET Detection: 3=103 2=1
UTC Time 621.91..648.13s
RXSignalLevel
Maps...
<<
Connect
Airspace infringement – AD activation by passive sensor
8. Blue 1
D_IDs: 6 7
1055m (3461ft)
109.4m/s (213kn)
P0 8.89km A337.32° E5.56°
3. SRS3
2. SRS2
0. CRS
1. SRS1
11. SSR 2
D_IDs: 12
133m (436ft)
0m/s (0kn)
P0 44.57km A239.17° E-.08°
10. Blue AD
D_IDs: 10
167m (548ft)
0m/s (0kn)
P0 15.45km A158.60° E-.10°
Södertälje
Nynäshamn
Haninge
Tyresö
Sweden\Sweden.rscz9
Scr Width 118.2 km
LAT: 59.0546° LON: 18.2074° ALT: 193.5m
RT..15 ms waiting..0 render: 59 tiles
RL ID:all SID:1 T:9875_250MHz
RL ID:all SID:1 T:9625_250MHz
RL ID:all SID:1 T:9125_250MHz
RL ID:all SID:1 T:2625_250MHz
RL ID:all SID:1 T:2875_250MHz
RL ID:all SID:1 T:9375_250MHz
SIF ID:all SID:0 T:1090MHz
LOCK Filter RL SIF SmodeS SmodeL AIS ALL SSR0 RL0 RL1 V/UHF0 V/UHF1 ALL TDOA
848.989 00:11:12.755 880 573
00:10:48.099 Tun Plan
-51.54us
7.667us
22.313us
76.413us
Fictive scenario

Airspace infringement – engagement with PET
10. Blue AD
10. ALLY_AD_TA_1_emitter
CF: 2690MHz TP : 50dBm PA 0°
CF: F : 2690.0-2870.0
PW: F : 17.0-36.0
PRI: F : 220.0-320.0
RPaths: 4 PCount : 116
ED:
PET Detection: 1=111
PET Detection: 2=61 1=24
UTC Time: 892.73 919.00s
RXSignalLevel
10. Blue AD
D_IDs: 10
167m (548ft)
0m/s (0kn)
P0 15.45km A158.60° E-.10°
11. SSR 2
D_IDs: 12
133m (436ft)
0m/s (0kn)
P0 44.57km A239.17° E-.08°
1. SRS1
8. Blue 1
D_IDs: 6 7
1055m (3461ft)
126.1m/s (245kn)
P0 23.27km A139.77° E2.12°
4. Red 2
D_IDs: 3 4
104m (342ft)
250m/s (486kn)
P0 72.28km A166.76° E-.07°
2. Red 1
D_IDs: 1 2
101m (331ft)
250m/s (486kn)
P0 69.54km A177.80° E-.08°
Maps...
Connect
Sweden\Sweden.rscz11
Scr Width 184.7 km
LAT: 58.6794° LON: 17.6400° ALT: 193.5m
RT..6 ms waiting...0 render: 54 tiles
LOCK Filter RL SIF SmodeS SmodeL AIS ALL SSR0 RL0 RL1 V/UHF0 V/UHF1 ALL TDOA
-51.54us
7.667us
22.313us
76.413us
Fictive scenario

Modern Air Defense

Active and passive sensor synergy

MMR



PET-PCL

RADAR

Detection, Location, 3D Tracking

Co-operative IFF identification

PET

Detection, Localization, 3D Tracking

ELINT, Jammer processing, Covert mode of operation

Non-Cooperative Target Identification (NCTI)

Cost effectiveness

MSPSR

Detection, Localization, 3D Tracking

Covert mode of operation

Cost effectiveness, NCTI + silent targets tracking

Synergy

High resistance

High effectiveness

High quality RAP

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