The ADS-B Webinar

ICAO
MID & EUR/NAT

1090 Spectrum Consideration

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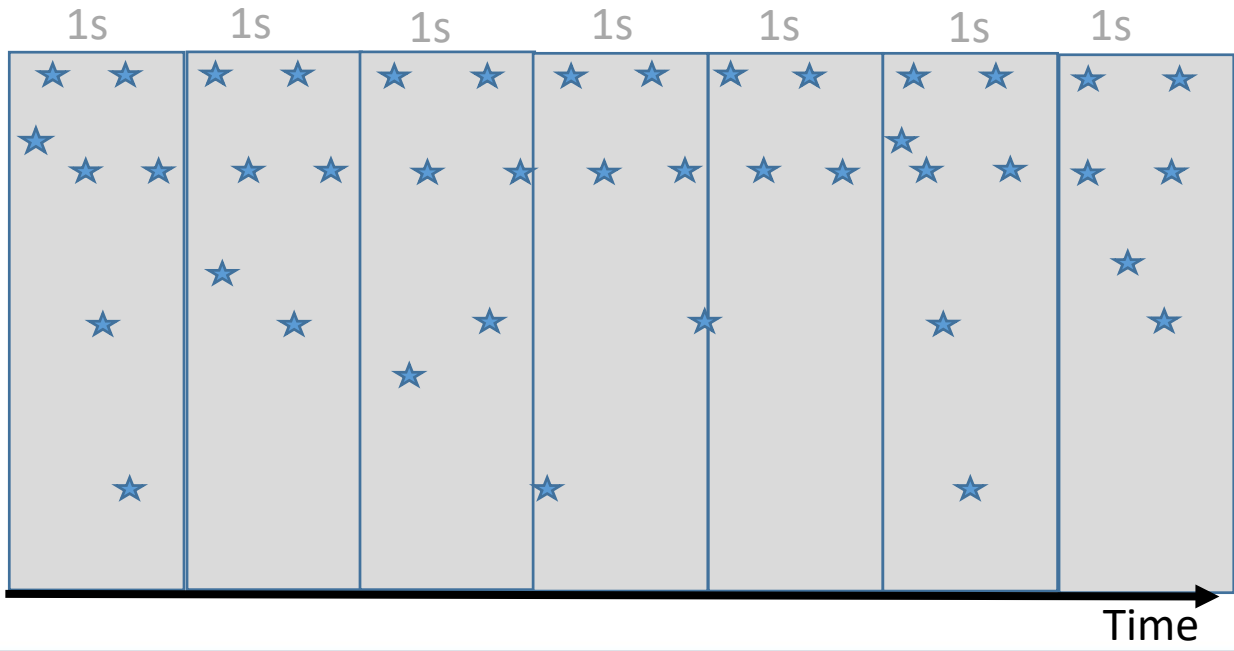
- Transmission on 1090 (MHz)
- 1090 RF model
- 1090 Monitoring in Europe
- 1090 Recommendations based on European experience

1090 ADS-B transmission

- 1090 MHz International link – big benefits (Interoperability …)
- Spontaneous transmission of messages (Extended Squitters) using Mode S waveform & format (DF17-DF18)

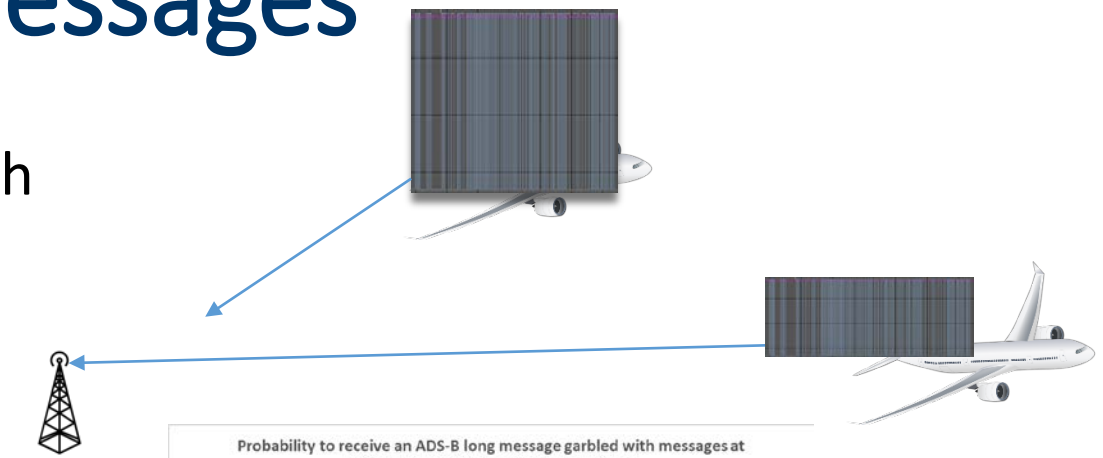
1090ES ADS-B Message	conditions	Airborne rate ADS-B V2
Airborne Position		2 / 1 second 0.4 – 0.6 ss
Surface Position		N/A
Aircraft Identification and Category		1 / 5 seconds 4.8 – 5.2 s
Airborne Velocity		2 / 1 second 0.4 – 0.6 s
Aircraft Status (TCAS RA Broadcast, Subtype=2		0.7 – 0.9 s
Aircraft Status (Emergency/Priority Status, Subtype=1)	Mode A Code Change	0.7 – 0.9 s
	No Mode A Change	4.8 – 5.2 s
Target State and Status (TSS)		1.2 – 1.3 s
Aircraft Status (UAS/RPAS Contingency Current TCP, Subtype=4)		4.8 – 5.2 s
Aircraft Status (UAS/RPAS Contingency Next TCP, Subtype=4		4.8 – 5.2 s
Aircraft Operational Status	TSS being broadcast or not No change in TCAS/NAC/SIL/NIC_{SUPP}	2.4 – 2.6 s
	TSS being broadcast Change in TCAS/NAC/SIL/NIC_{SUPP}	2.4 – 2.6 s

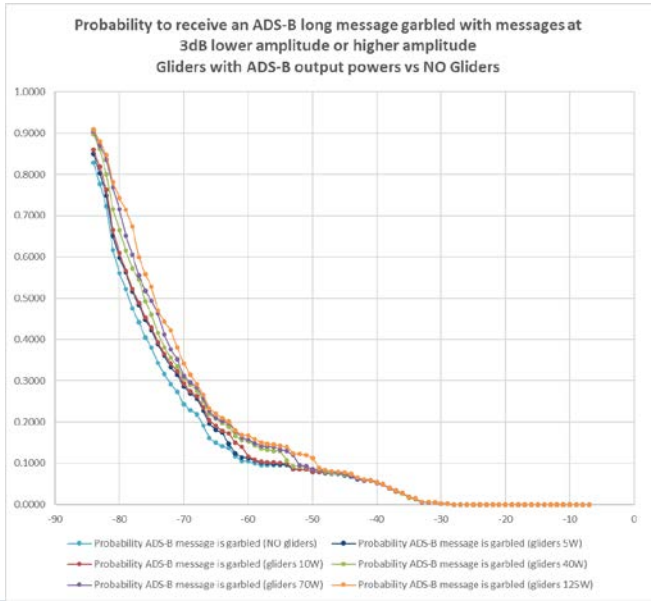


Reception of 1090 ADS-B messages

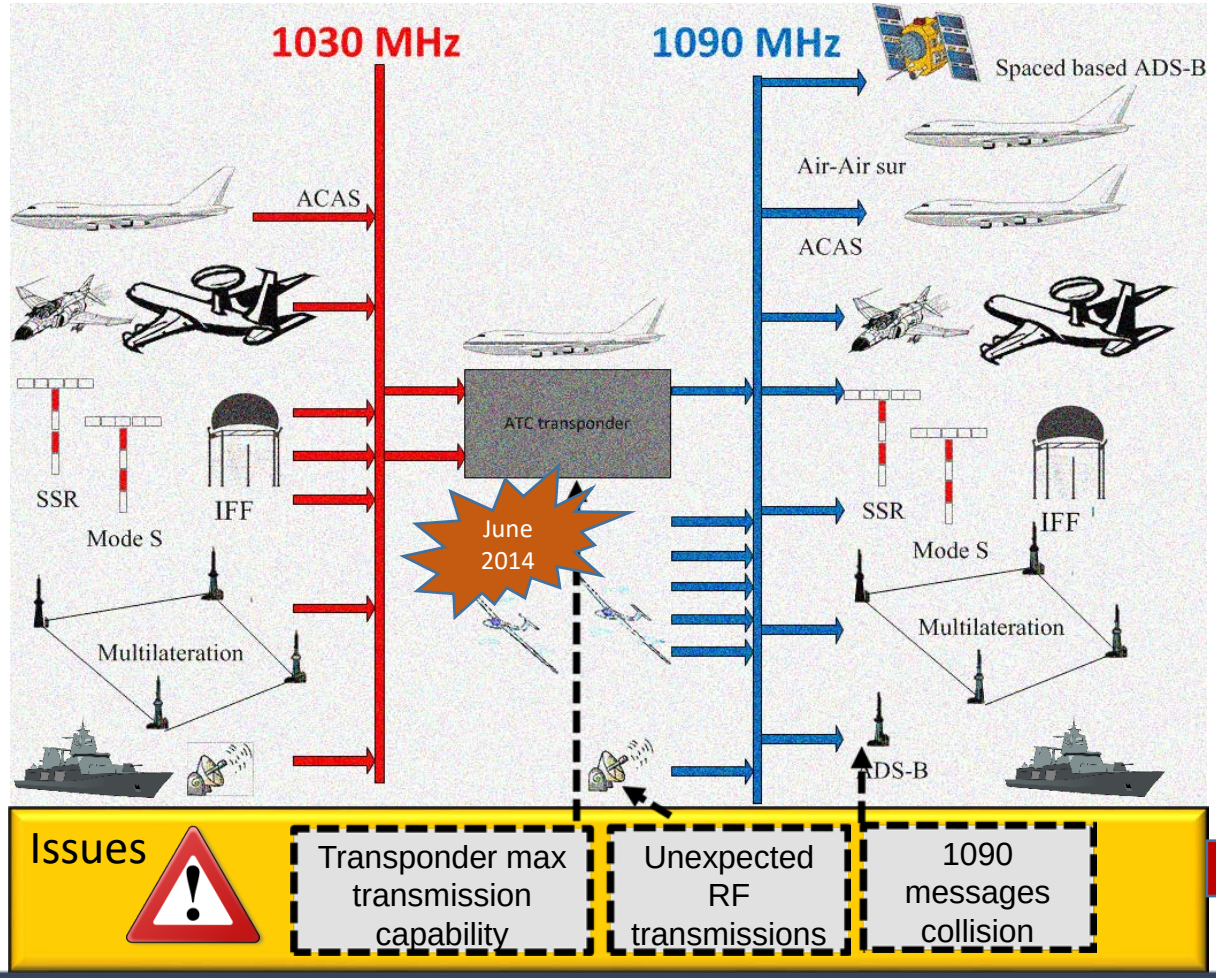
- Decoding performance affected by collision with other transmissions on 1090 MHz
  - ADS-B messages
  - Mode S replies triggered by radars/WAM
  - Mode S replies triggered by ACAS
  - Mode A/C replies

- Probability of decoding of one ADS-B message <<100% → need to wait for several messages in a period to have a useable decoded ADS-B information





ADS-B 1030/1090 MHz environment



Loss of surveillance

Reduction of surveillance **performance** requiring additional infrastructure investment

Need to look at what is happening on 1090 (1030) MHz to ensure right performance of ADS-B reception

1090 RF model

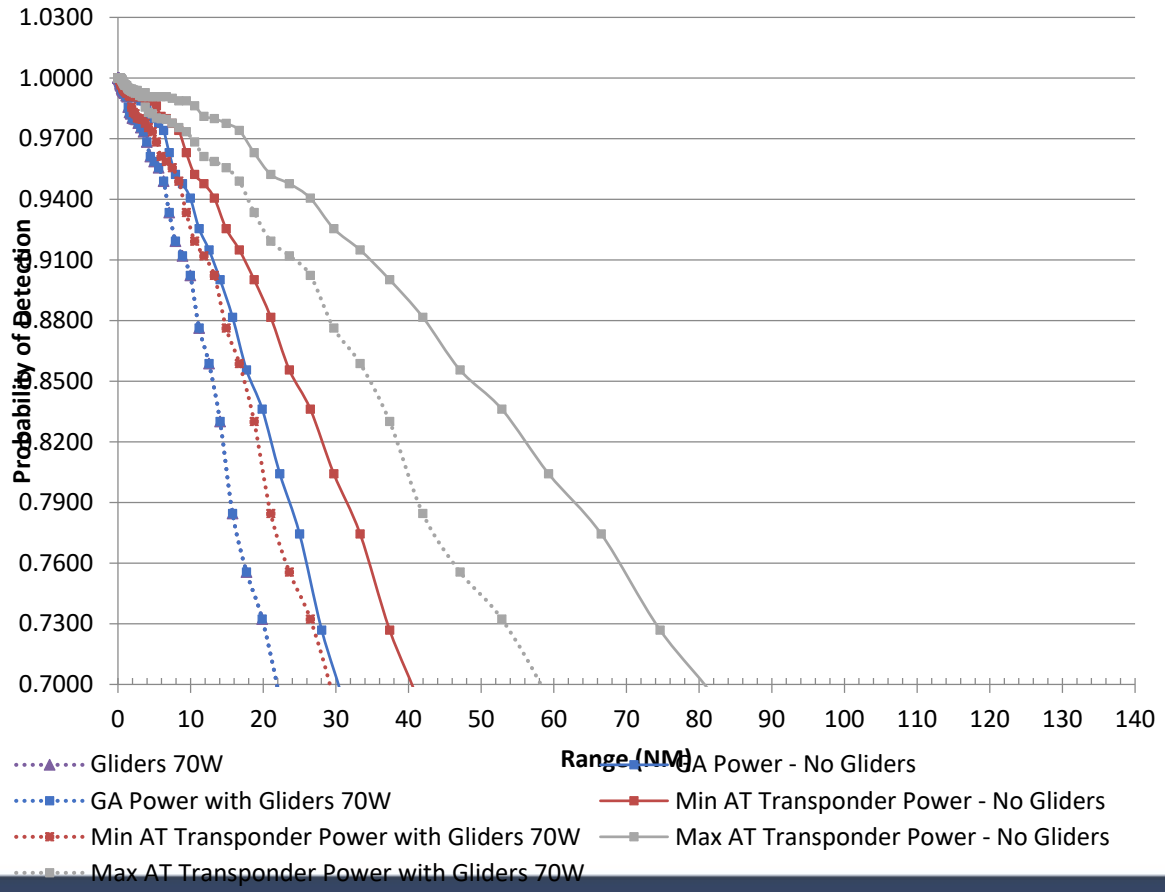
- Activity on 1090 = f(interrogation ground & air, traffic, traffic capability density,…)

- Use of a software RF model to estimate the transmissions (3 models in Europe)
  - Ground scenario with all interrogators and their characteristics
  - Airborne scenario
    - real traffic snapshot
    - future scenario applying traffic increase (European STATFOR) or including additional platforms (gliders, UAS,….)
    - aircraft capabilities including ACAS active interrogations

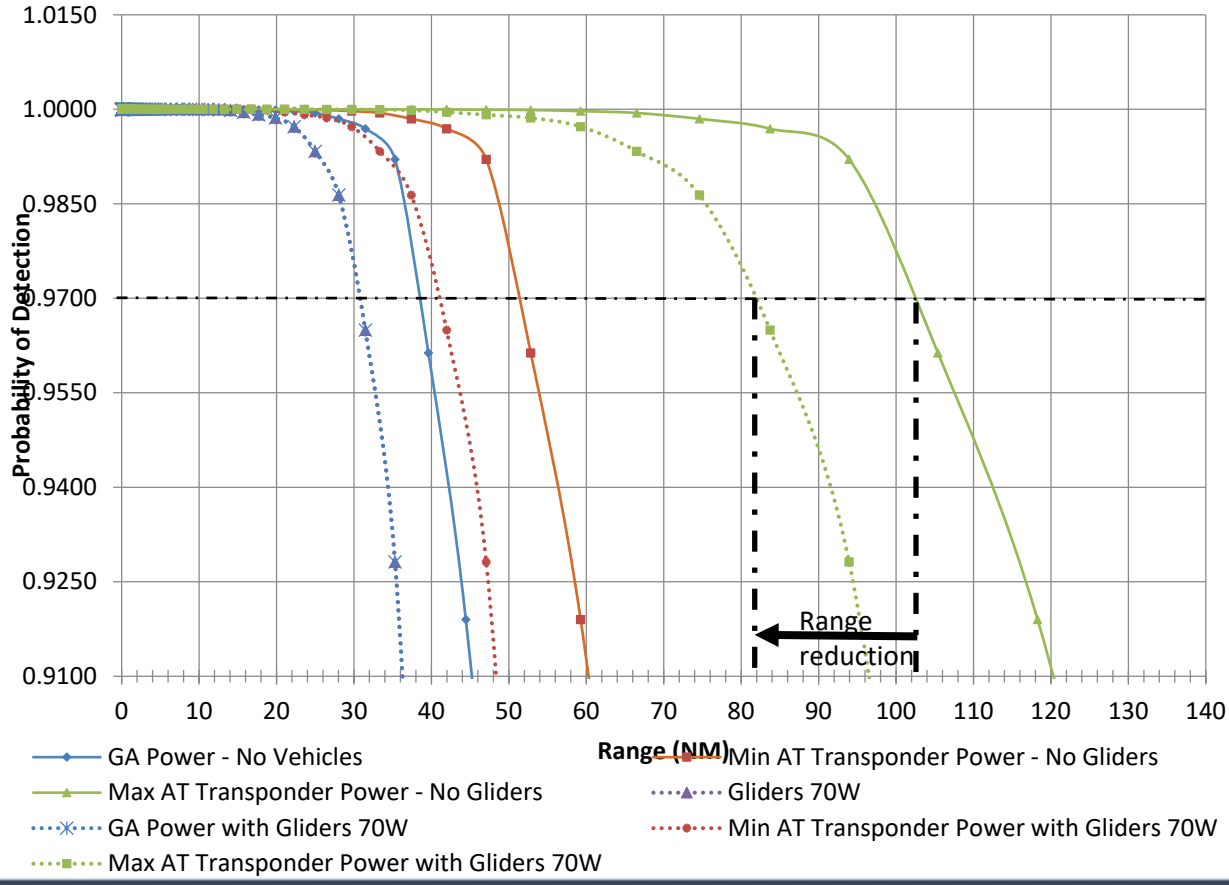
- Two types of model: probabilistic or temporal

1090 RF model example of use

Probability of detection of at least 1 position squitter over 1s depending on the transponder range and power



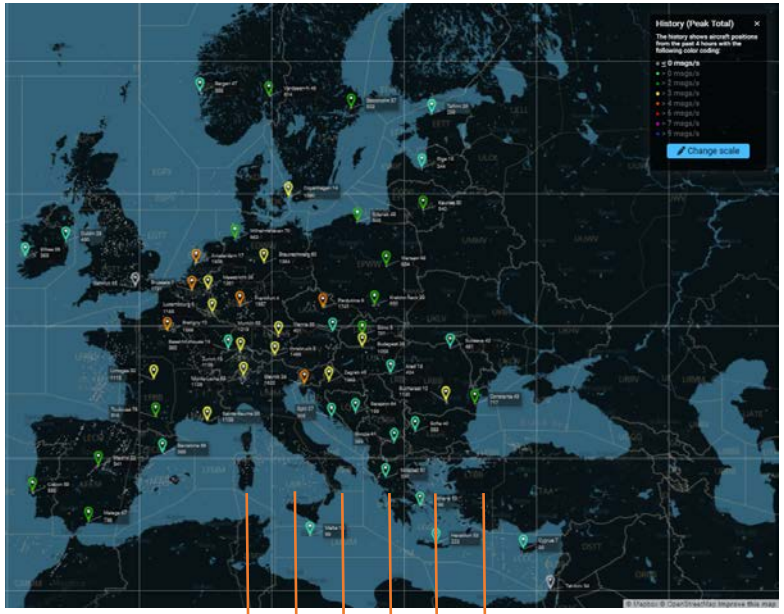
Probability of detection of at least 1 position squitter over 5s depending on the transponder range and power



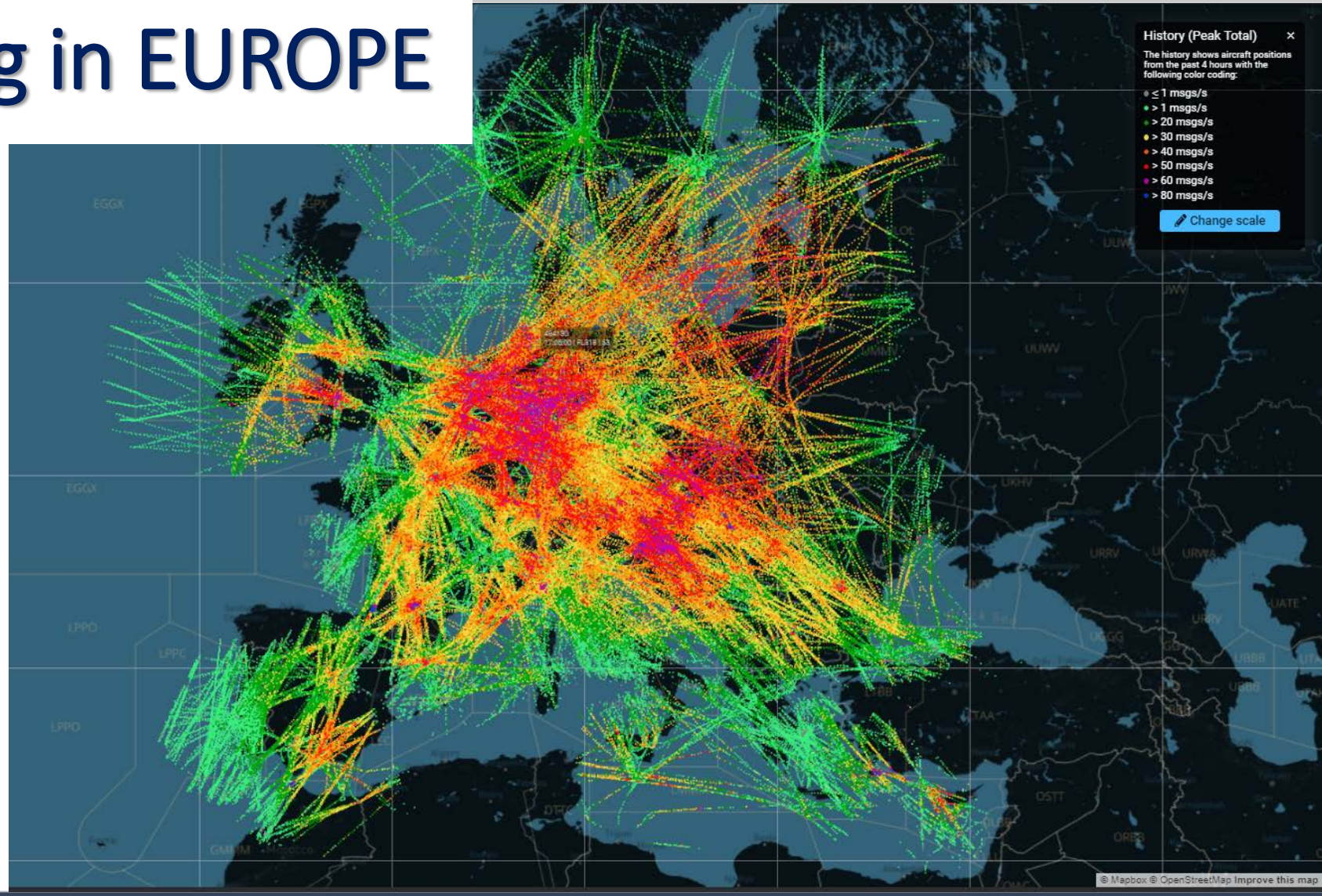
1090 RF model result examples

- A scenario of a set of 563 gliders (real event recording)
  - ADS-B normal messages
  - Various powers
  - Glider scenario moved around a big airport in Europe
  - Results ADS-B range reduction from 8% to 50% depending on power scenario
- Small UAS future scenario
  - Various densities of UAS (1.74 3.5 or 10.5 /NM^2 - up to 5736 UAS received)
  - Various low powers
  - Noticeable impact on ADS-B range - up to -40% with 1W of transmission
  - Support ICAO State letter (SP 44/2 - 19/77) requiring consideration before accepting 1090 on UAS

1090 Monitoring in EUROPE

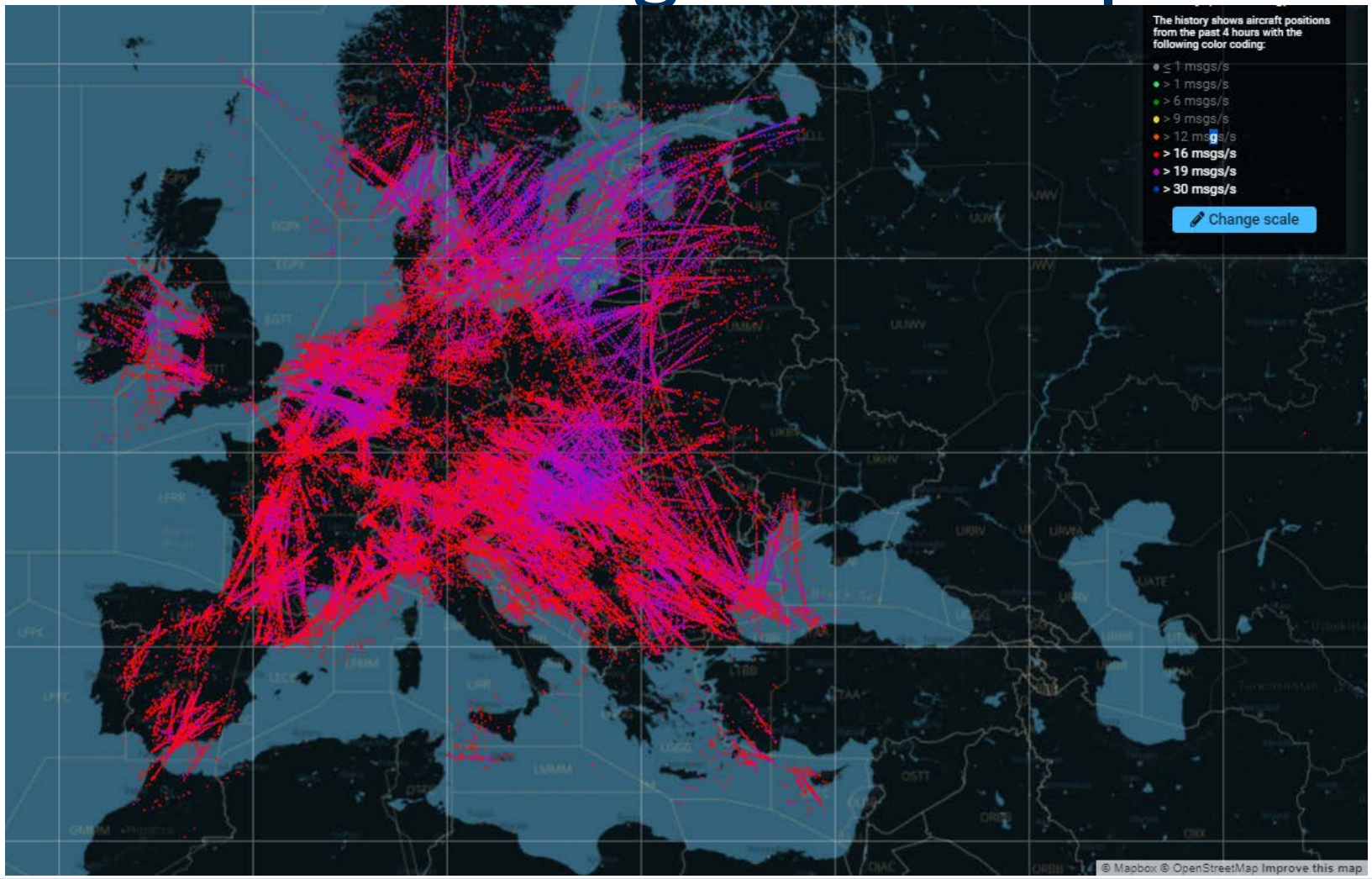


Central application
Euopean Monitoring



1090 Monitoring in EUROPE – long Mode S replies

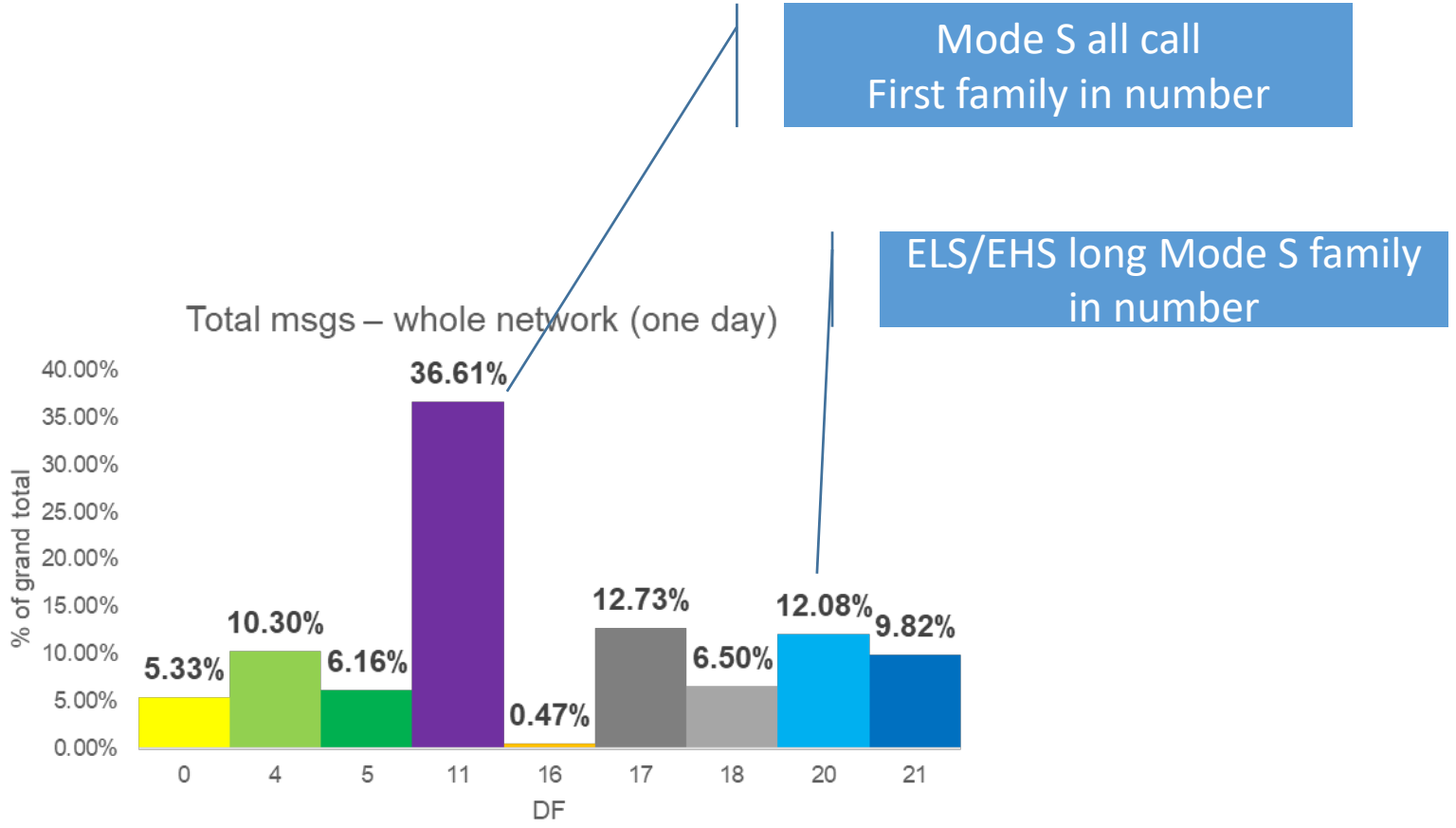
- Area >16 message /s /aircraft
- Network not yet covering all aisapce



1090 Monitoring in EUROPE – long Mode S replies

- Statistics 1 full day in June 2021 – full EUROCONTROL airspace

- Issue with All Call (DF11)
- Issue with DF20/21 (long Mode S replies used to support ELS and EHS)



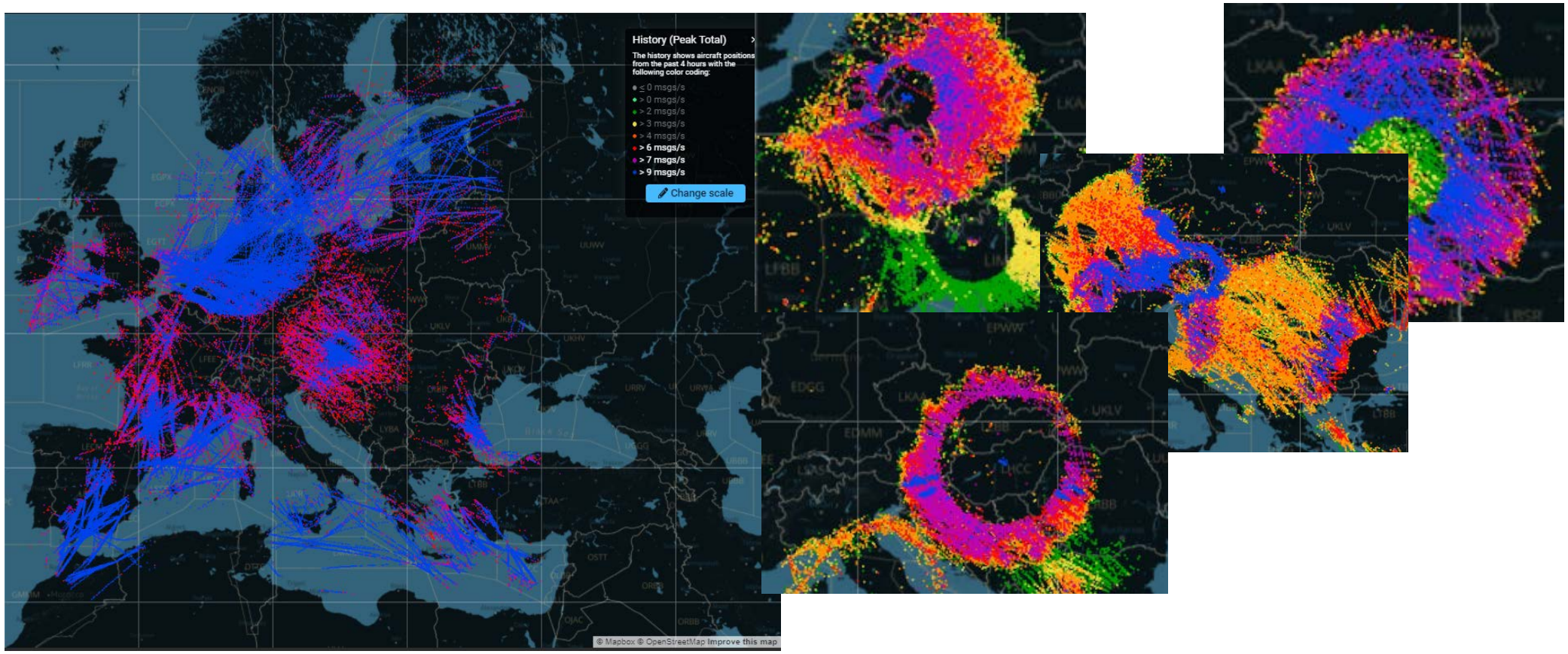
Current situation on 1090 MHz in Europe

- Still too many Mode A/C replies
  - level in number still 30 times above Mode S at some places
  - Great majority of civil infrastructure is Mode S (>600 Mode s radars in European region)

Transponder activity in Europe

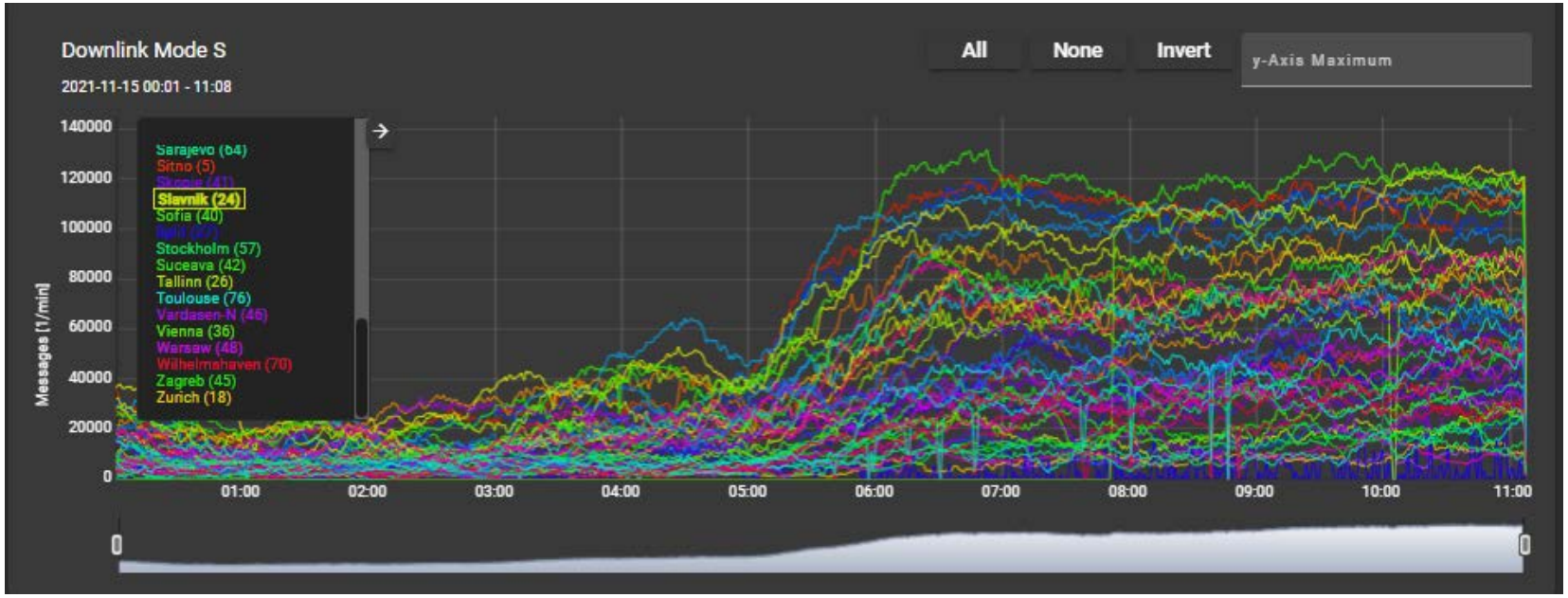
- Bad situation at transponder activity level
  - Too many transmissions on 1090MHz
    - Mode S reply rate / aircraft >> 50/S (peaks of several hundreds of Mode S replies /s)
    - Mode S long reply rate / aircraft >>16/second (area with more than 50/s)
  - Real issue encountered in June 2014
    - Some transponder transmitters too warm -> stop transmission of all messages including ADS-B to cool down

Examples of Mode S all call (DF11) pollution



Mode S/ADS-B 1090 MHz in Europe

- Receiver load very different from place to place



- Different performance & traffic increase possible

Recommendations for good use of 1090 MHz

- Decommission remaining Mode A/C interrogators
- Avoid/limit mobile interrogators using no lockout or lockout override
- Reduce all call pollution
  - Limit number of all call replies <6 /beam as specified in ICAO Annex 10 Volume IV → lower possible
  - correct configuration of lockout range/map
  - correct configuration of power transmitted
  - Reduce gaps between radar using the same IC (IC allocation, Clustering use)
- Avoid too many interrogators extracting transponder registers in the same area
- Use Airborne information Available in ADS-B rather than extracting using an interrogation
- Optimize system/ share data between different users

Summary

- 1090 MHz frequency is a resource to manage carefully (as any communication network resource)
  - Interrogator side
    - Check/optimize interrogator configuration
    - Before transmission → plan → authorize
    - During operation → verification
  - Airborne side – increase possible however ….
    - Consider which new types of platform to accept on 1090MHz with which capability
    - Consider ACAS types optimizing the use of 1090 by using ADS-B (Hybrid surveillance – extended - ACAS X)

THANK YOU