1030/1090MHz EHS Optimisation

NM User forum

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Jurgen De Clercq

member of FABEC

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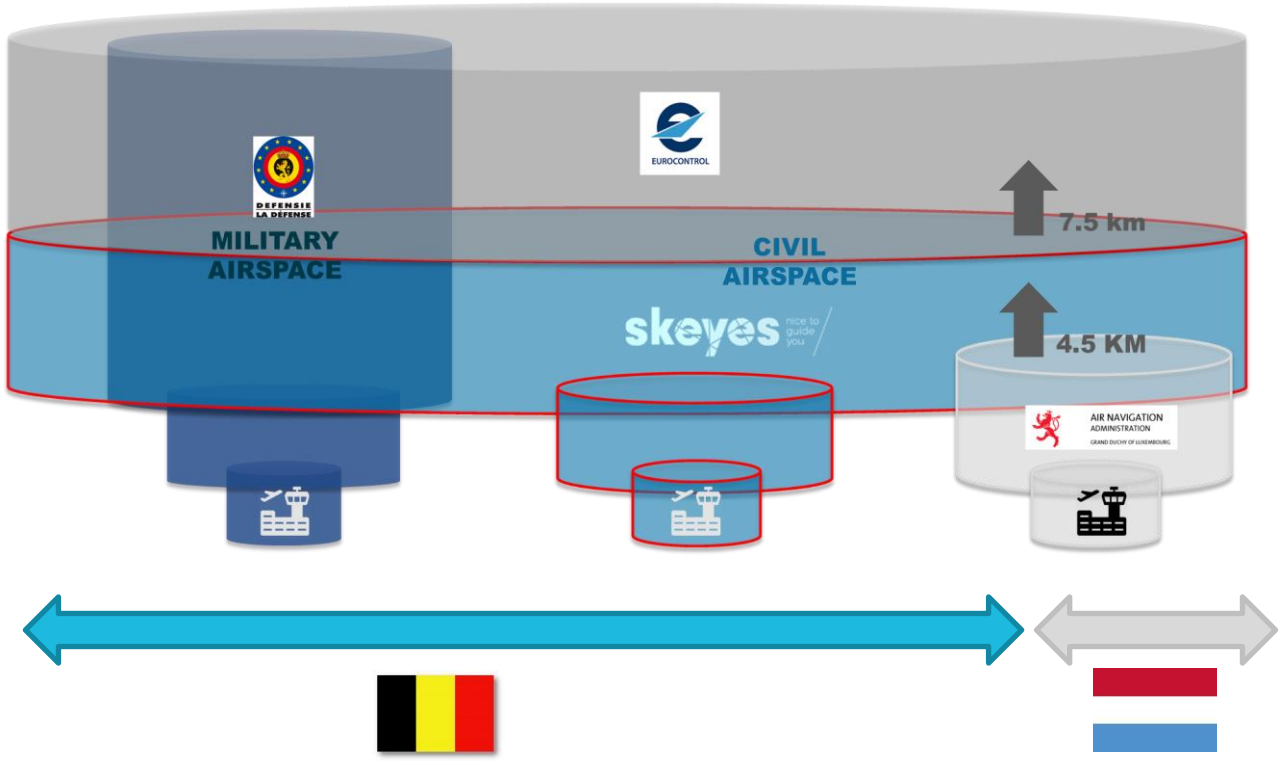
DEFENSIE
LA DÉFENSE
MILITARY AIRSPACE
EUROCONTROL
CIVIL AIRSPACE
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7.5 km
4.5 KM
AIR NAVIGATION ADMINISTRATION

How it all began

How it all began

skeyes' surveillance sensors:

- 1x 12s Combined PSR/Mode S radar
- 1x 12s Mode S radar
- 3x 4s Combined PSR/Mode S radars
- 1x 4s Combined PSR/MSSR radar
- 1x 4s MSSR radar
- 3x A-SMGCS systems (incl MLAT, SMR)

Trigger = EUROCONTROL's observations (→ EMIT):

- High rates of long Mode S replies for specific aircraft, mainly (but not exclusively) around Brussels
- Overall rate of long Mode S replies above min specs (ref. SPI-IR & ICAO Annex 10 vol. IV)

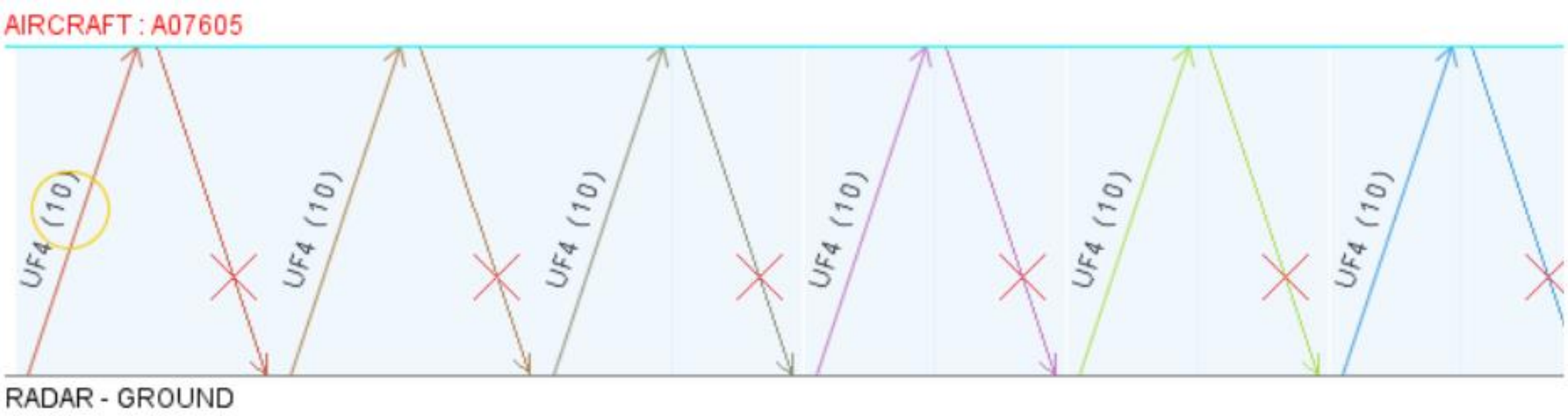
Internal measurement campaign:

- Analyses of all Mode S sensors via SASS-C
- Internal radar recordings including uplink & downlink at radar data processing level

Investigation conclusions (1/2)

High rate (peaks) of long Mode S replies on some targets were caused by **radar detection issues at low level coverage / cone of silence / end of range:**

- Radar re-interrogates without limits when target is in-beam
- XPDR replies each time
- Radar is not receiving the answer, and attempts again



Investigation conclusions (2/2)

Total long Mode S replies above min specs:

- MIP* & BDS** extraction setup done at a moment where 1090 MHz load was not identified as an issue
- All common BDS registers extracted each scan for each radar
- Above Belgium, high number of Mode S radars also contributing to a high 1090 MHz occupancy

* MIP: Mode S Interlaced Pattern
** BDS: Comm-B Data Selector

Modus operandi

Modus operandi

Internal project team

Project scope:

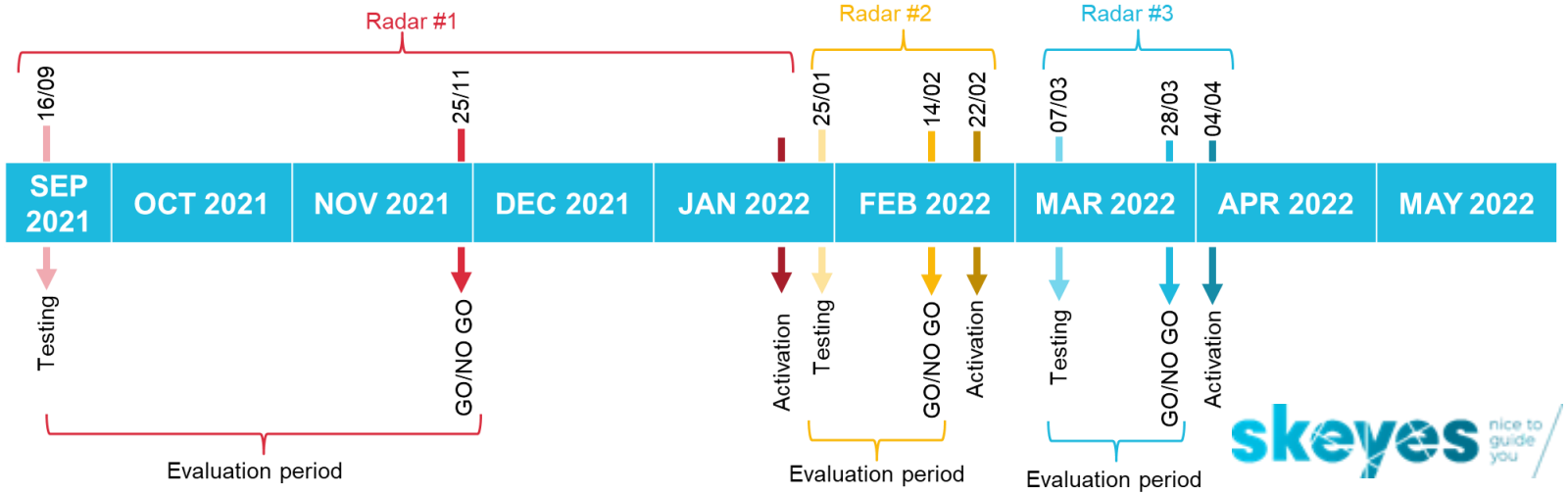
1. Reducing the excessive EHS re-interrogations on 2x Mode S radars
2. Optimising EHS extraction on 5x Mode S radars

Challenges:

- Internally raising awareness and prioritizing effort (*"where is the problem ?"*)
- "*When you can measure what you are speaking about, and express it in numbers, you know something about it*" – Lord Kelvin
- Safety & change process
- Coordination between different experts within the Surveillance chain

Project phases

1. Literature study
2. BDS usage - user needs
3. Test strategy covering the whole surveillance chain (from radar to CWP)
4. Define and test revised BDS extraction schedules, validate/decide
   - Radar manufacturer contracted to work out together with skeyes a solution within the current radar software
   - Several iterations were needed to eventually come to a compromise.
   - Each iteration was checked via simulations and on traffic of opportunity during validation tests
   - Essential to measure (and confirm the simulated improvement) while maintaining compliancy on Pd, AC and range/azimuth errors.
5. Implement/validate via a progressive implementation on several radars
6. Validate final solution



Technical solution

- Reducing the total roll-call time inside the scheduling
- Reducing the PRF*

New BDS extraction rate:

Register:	Previous:	New:
BDS40	4s (every scan)	8s (second scan)
BDS50	4s (every scan)	16s (fourth scan)
BDS60	4s (every scan)	12s (third scan)

* PRF: Pulse Repetition Frequency

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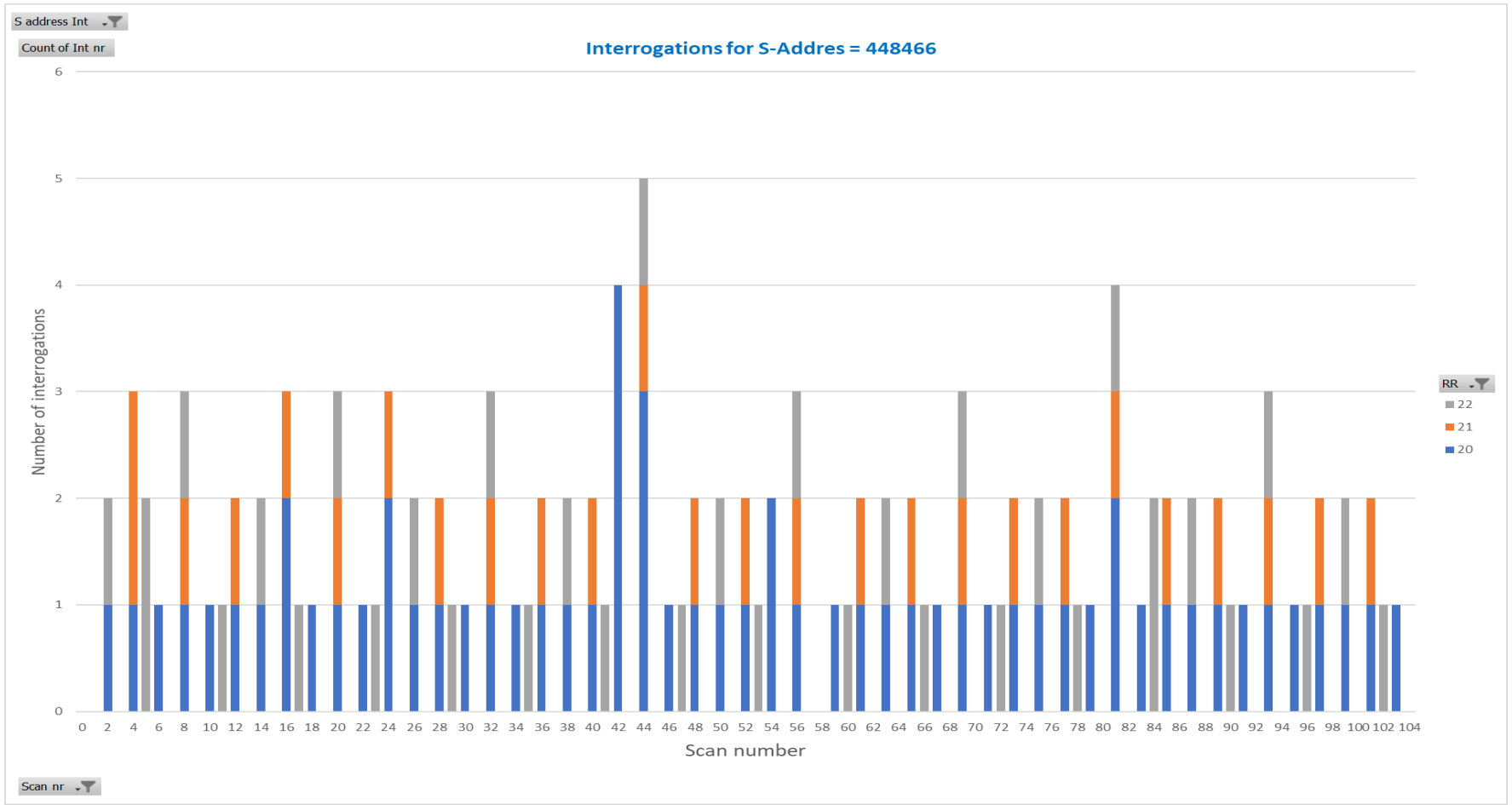
Evaluation & validation (1/2)

- SASS-C compliancy check
- Sensor level uplink & downlink validation to confirm radar behaviour



Legend:

RR20 = BDS40

RR21 = BDS50

RR22 = BDS60

Evaluation & validation (1/2)

- DAP* age evaluation (focus on CFL** in CTR)
- DSAM*** alert monitoring
- ATC validation

BDS	DAP	Time [sec]	Coverage 1500ft – 60FL				
			Nominal RecTST_210525_07 47846 updates	No APP Radar (BR-CI-OSCS) RecTST_210525_11 26462 updates	No ACC Radar (BT-SHCS) RecTST_210528_10 109816 updates	No National Radar RecTST_210525_13 33016 updates	National Radar only RecTST_210528_12 157528 updates
4,0	Barometric pressure setting	Average	2.75	3.25	2.75	3.50	3.00
		Min	0.75	0.75	0.75	0.75	0.75
		Max	22.25	21.75	22.50	23.25	23.75
		Std dev	2.25	2.39	2.52	2.34	3.20
	Selected altitude	Average	2.75	3.00	2.75	3.25	4.25
		Min	0.75	0.75	0.75	0.75	0.75
		Max	22.25	20.75	22.00	24.00	22.00
		Std dev	2.16	2.38	1.93	2.56	3.92
	Final state selected altitude	**Average**	**2.75**	**3.50**	**2.75**	**3.50**	**3.00**
		Min	**0.75**	**0.75**	**0.75**	**0.75**	**0.75**
		Max	**22.25**	**21.75**	**22.50**	**23.00**	**23.75**
		Std dev	**2.30**	**2.75**	**1.90**	**2.42**	**2.85**
5,0	True airspeed	Average	3.00	4.50	3.25	5.25	3.00
		Min	0.75	0.75	0.75	0.75	0.75
		Max	23.00	22.50	23.00	23.25	23.75
		Std dev	3.21	4.00	3.85	5.37	2.80
	Roll angle	Average	3.25	4.75	3.25	5.50	3.00
		Min	0.75	0.75	0.75	0.75	0.75
		Max	23.00	22.50	23.00	23.00	23.75
		Std dev	3.12	4.39	3.84	5.44	3.03
	Track angle rate	Average	3.00	4.50	3.00	5.75	3.00
		Min	0.75	0.75	0.75	0.75	0.75
		Max	23.00	22.50	23.00	22.00	23.00
		Std dev	3.25	4.26	3.46	5.67	3.25
	Track angle	Average	3.00	4.50	3.25	5.50	3.25
		Min	0.75	0.75	0.75	0.75	0.75
		Max	23.75	24.00	23.00	23.00	23.75
		Std dev	3.32	4.28	3.94	5.26	3.25
	Ground speed	Average	3.00	4.50	3.50	5.25	2.50
		Min	0.75	0.75	0.75	0.75	0.50
		Max	23.75	24.00	23.00	23.00	25.50
		Std dev	3.29	4.28	3.91	5.14	2.42
6,0	Indicated airspeed data	Average	2.75	3.25	2.50	3.50	3.00
		Min	0.75	0.75	0.75	0.75	0.75
		Max	24.00	21.50	22.00	23.25	23.75
		Std dev	1.90	2.33	2.03	2.23	2.81
	Mach number data	Average	2.50	3.25	2.75	3.50	3.00
		Min	0.75	0.75	0.75	0.75	0.75
		Max	24.00	21.50	22.00	23.00	23.75
		Std dev	2.25	2.30	1.71	2.22	2.86
	Magnetic heading	Average	2.75	3.50	2.50	2.50	3.00
		Min	0.75	0.75	0.75	0.75	0.75
		Max	24.00	21.50	22.00	22.75	23.75
		Std dev	2.06	2.50	2.03	1.82	3.02
	Barometric vertical rate	Average	2.75	3.25	2.50	3.50	3.00
		Min	0.75	0.75	0.75	0.75	0.75
		Max	24.00	21.50	22.00	23.25	23.75
		Std dev	1.90	2.33	2.03	2.23	2.81

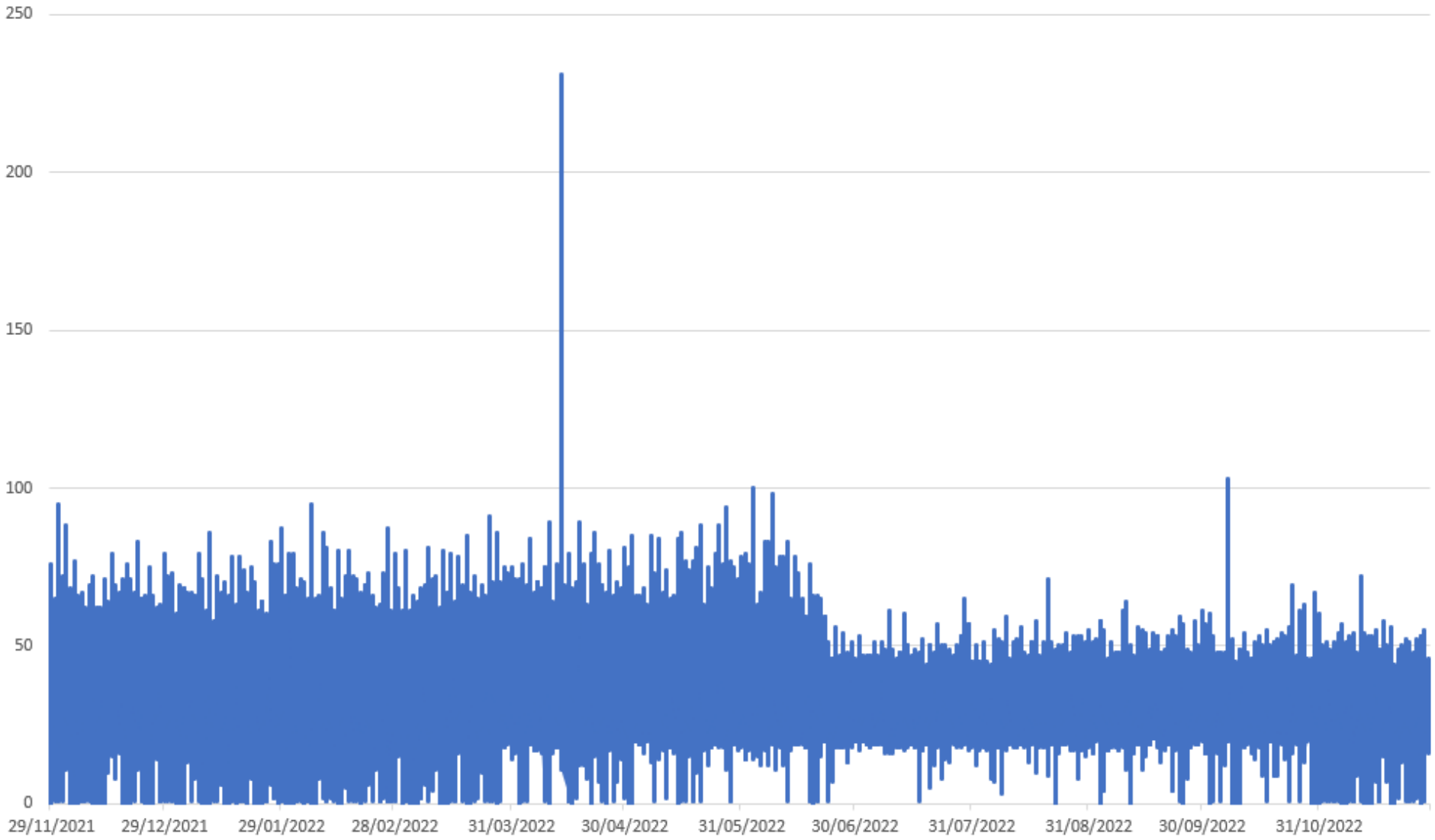
* DAP: Downlinked Aircraft Parameter

** CFL: Cleared Flight Level

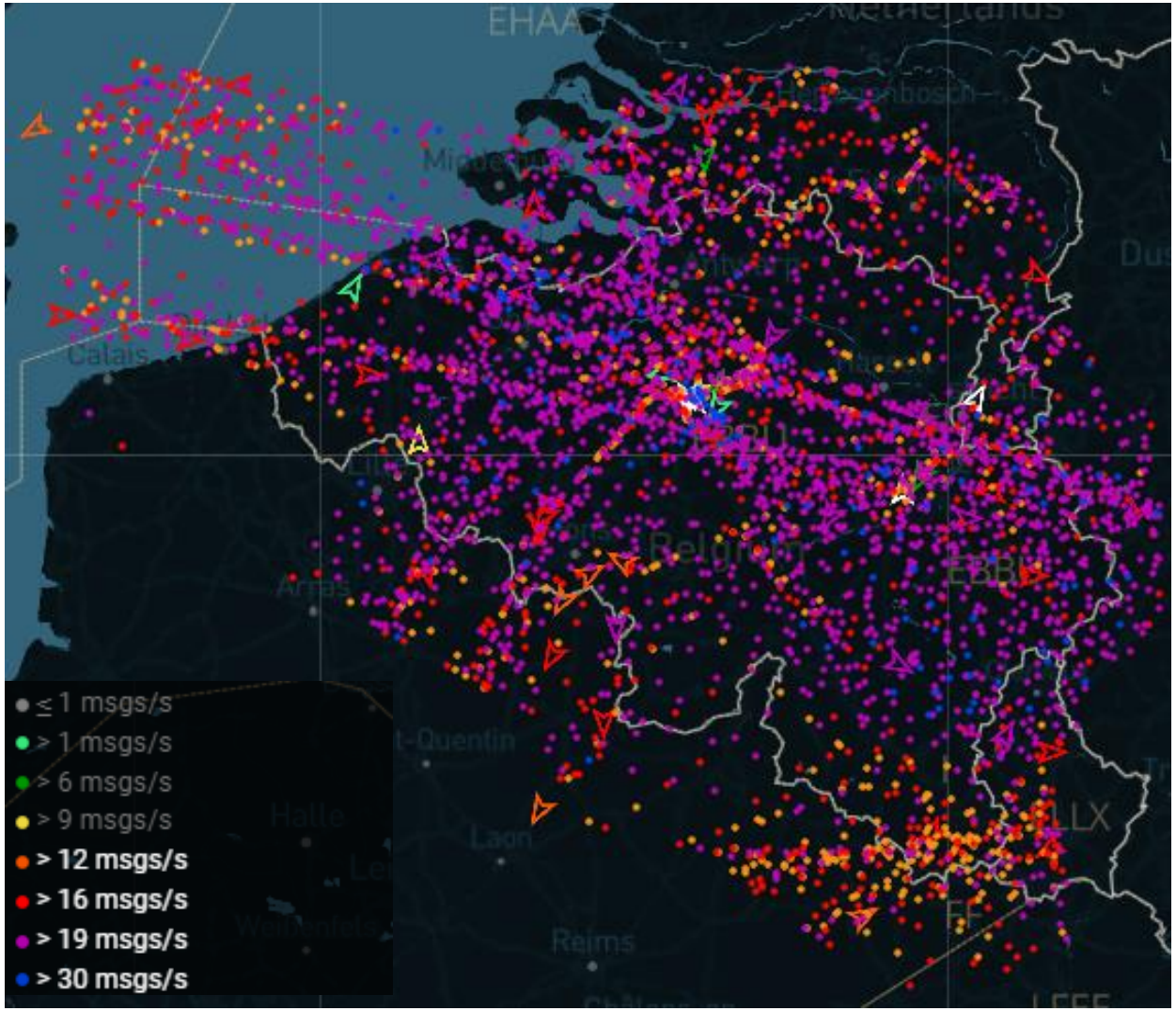
*** DSAM: Downlinked Selected Altitude Monitoring

Measured improvement

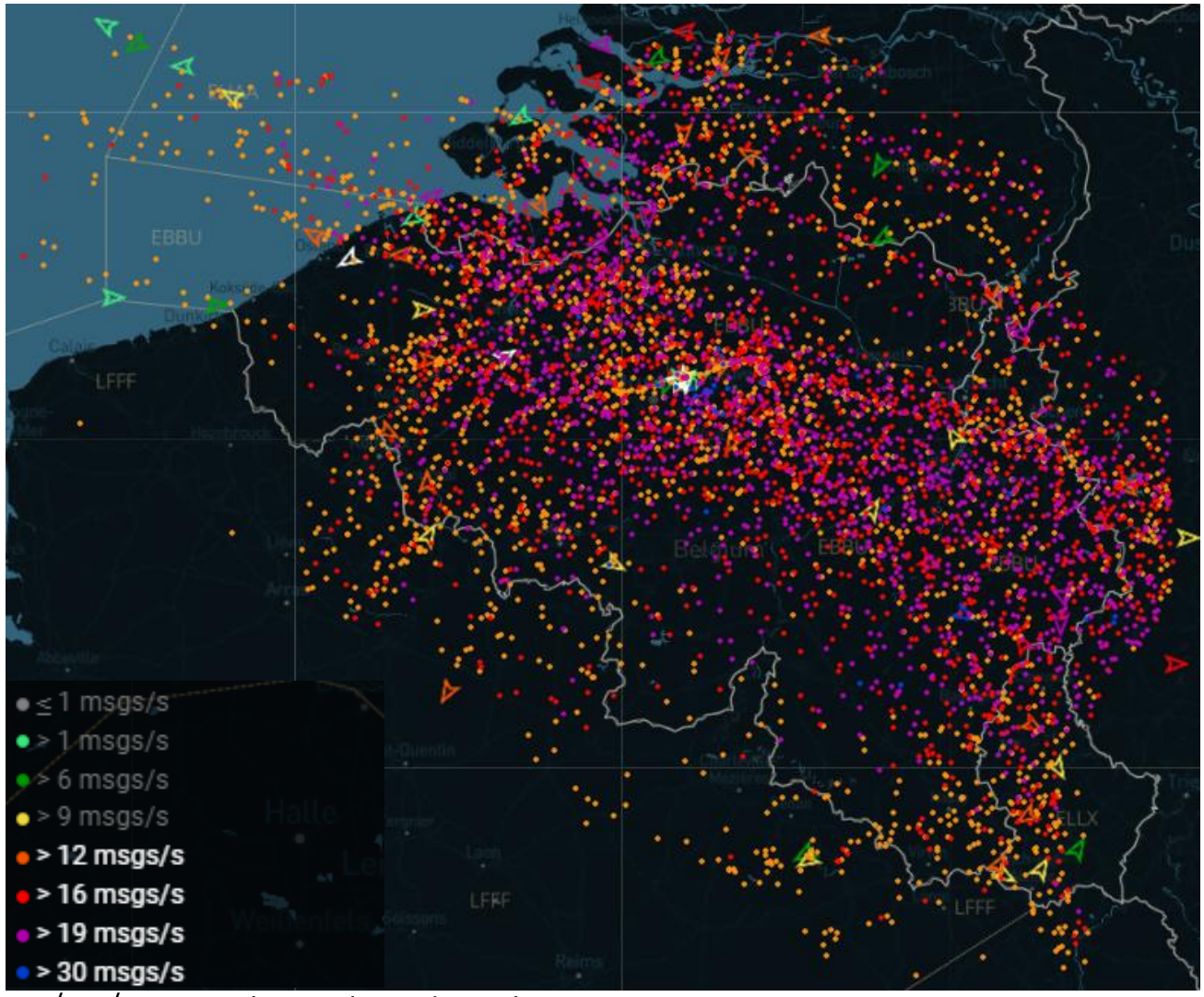
Long Mode S replies - Peaks



Long Mode S replies (total)

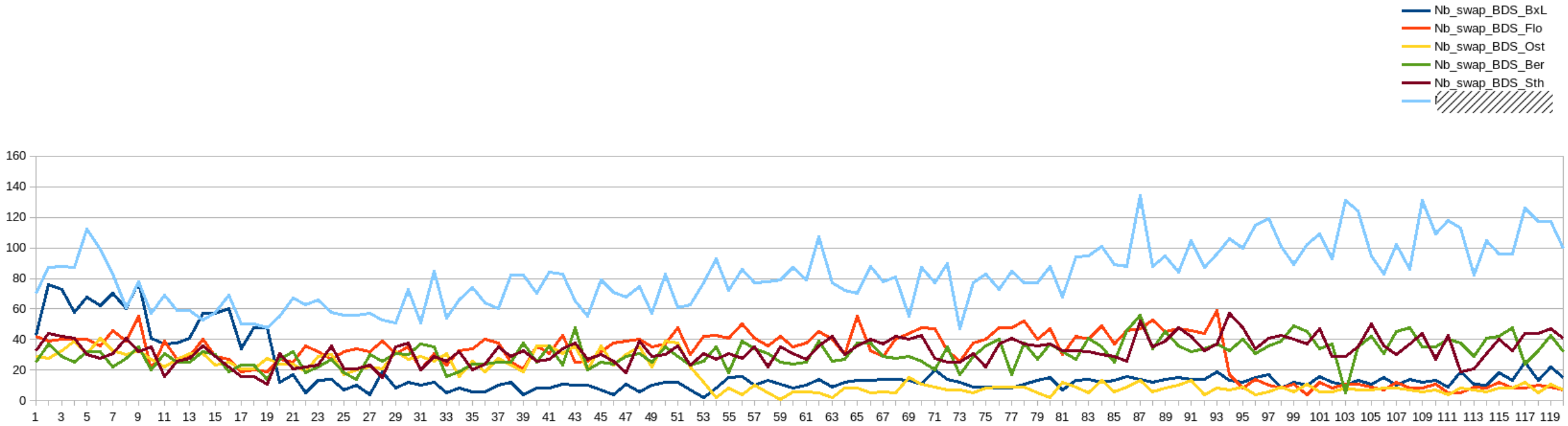


17/01/2022, 12h00, duration 2h



21/06/2022, 12h00, duration 2h

BDS swap reduction



Evaluation time: 01/01/2022 – 30/04/2022

And now?

Thank You