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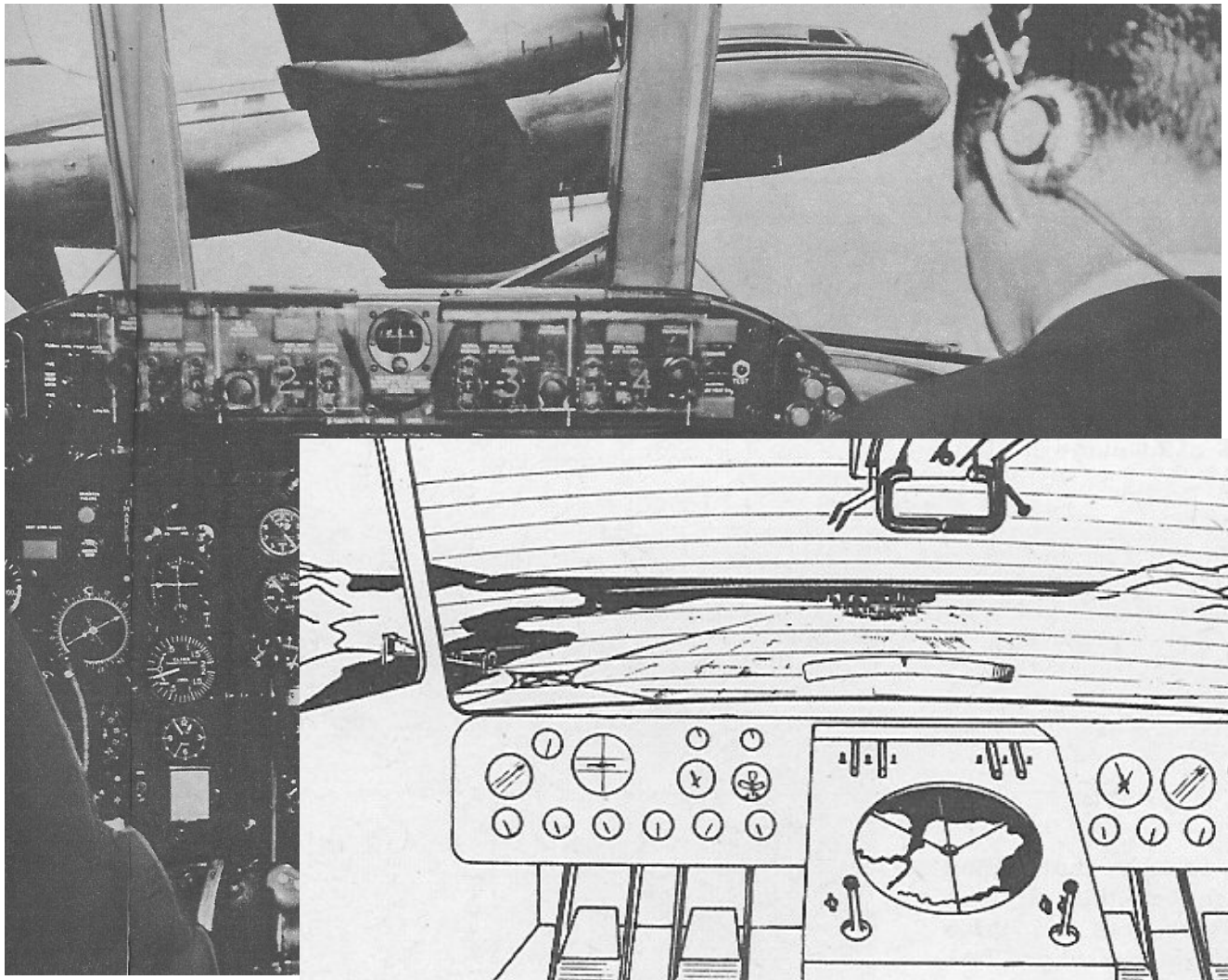
The 3 "S" of collision avoidance

ESASI FocusOn…webinar on investigating ATC events

3rd of December 2025

Daniel W. Knecht, Head of the aviation division STSB



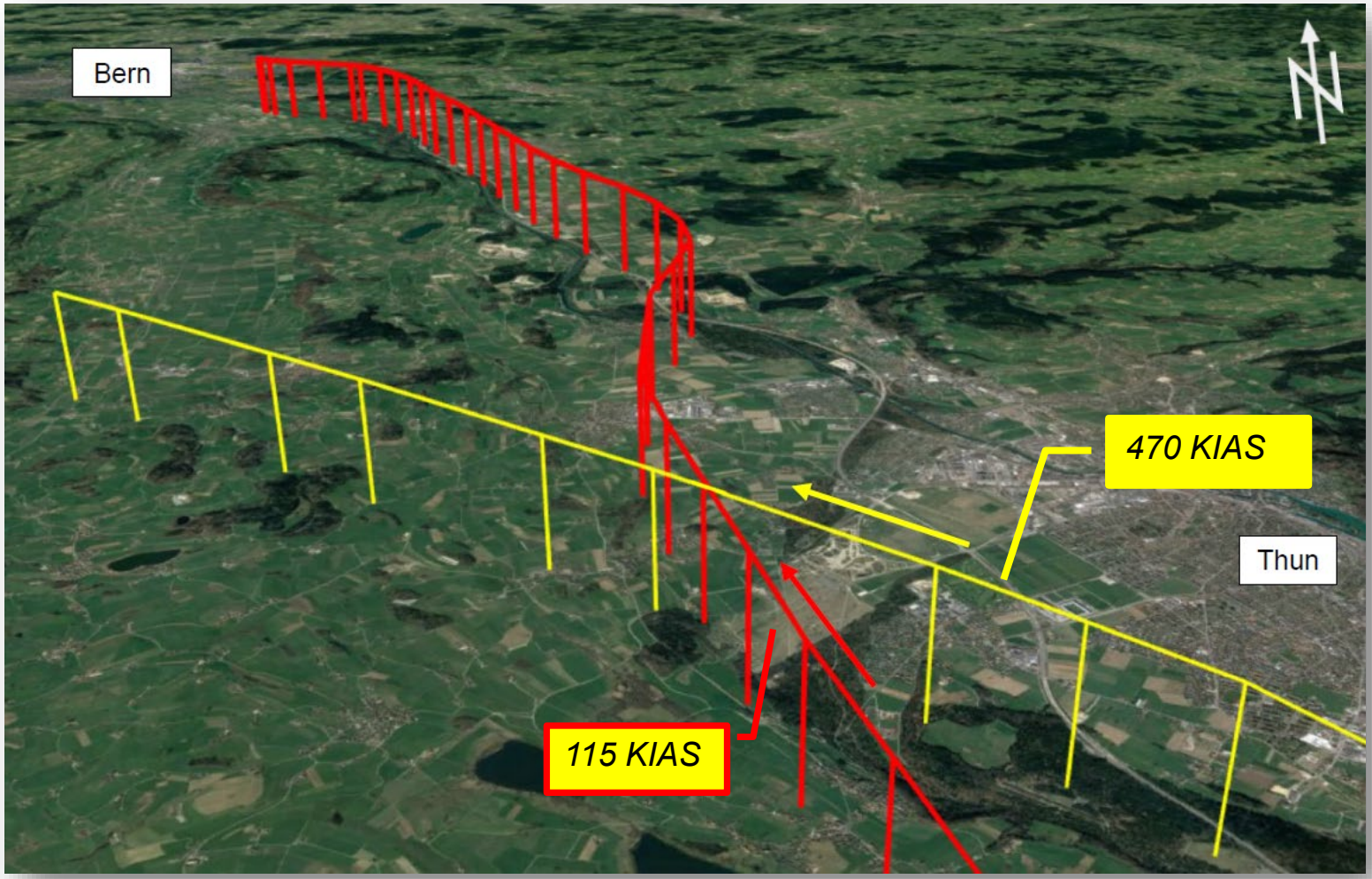
Unless otherwise noted, all photos here are courtesy, *The Air Line Pilot*, ALPA

Overview

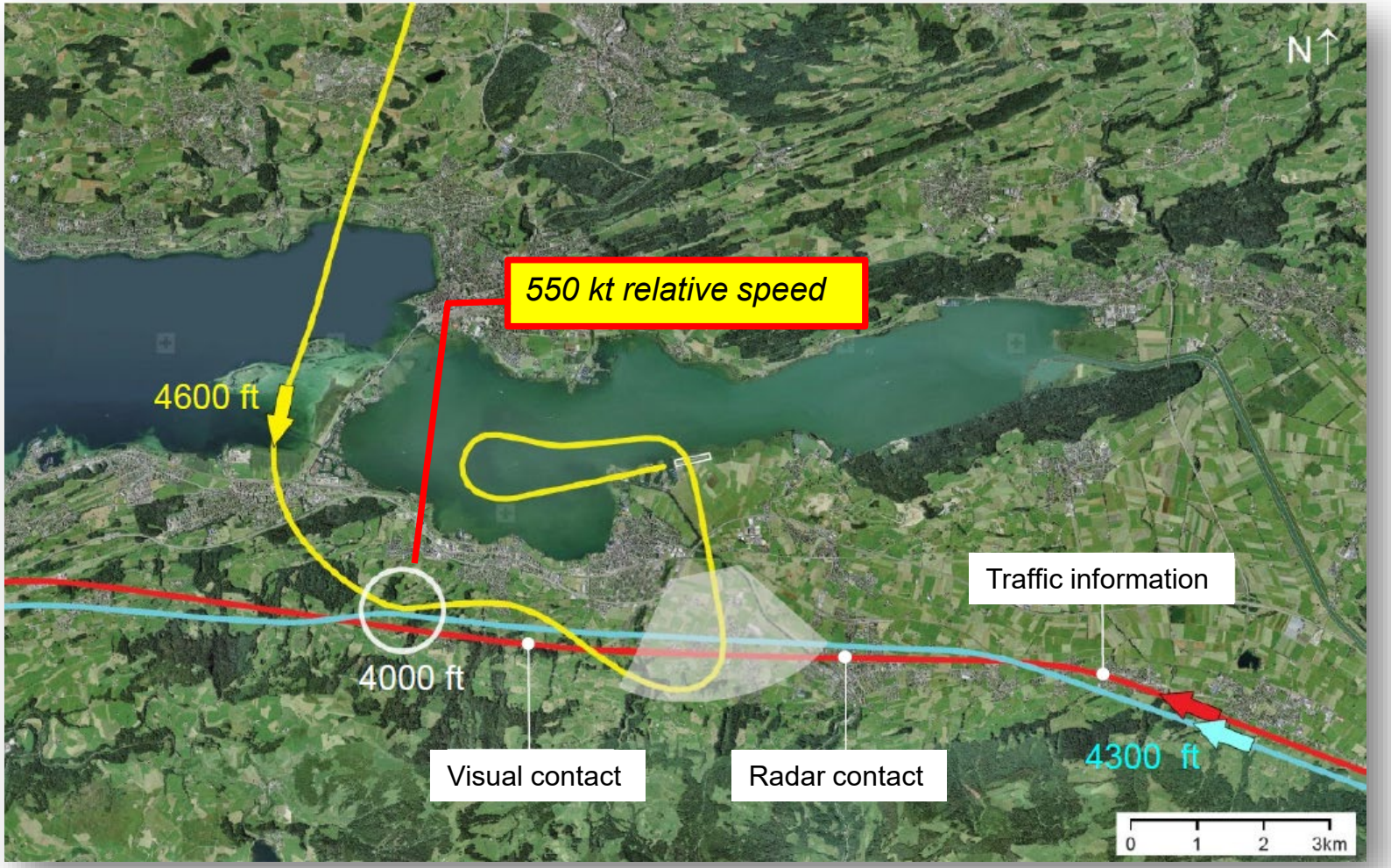
- The possibilities and limitations of
  - **S**ee
  - **S**ense
  - **S**egregate

  based on examples
- Summary

Near collision between a R44 helicopter and a section of F5E



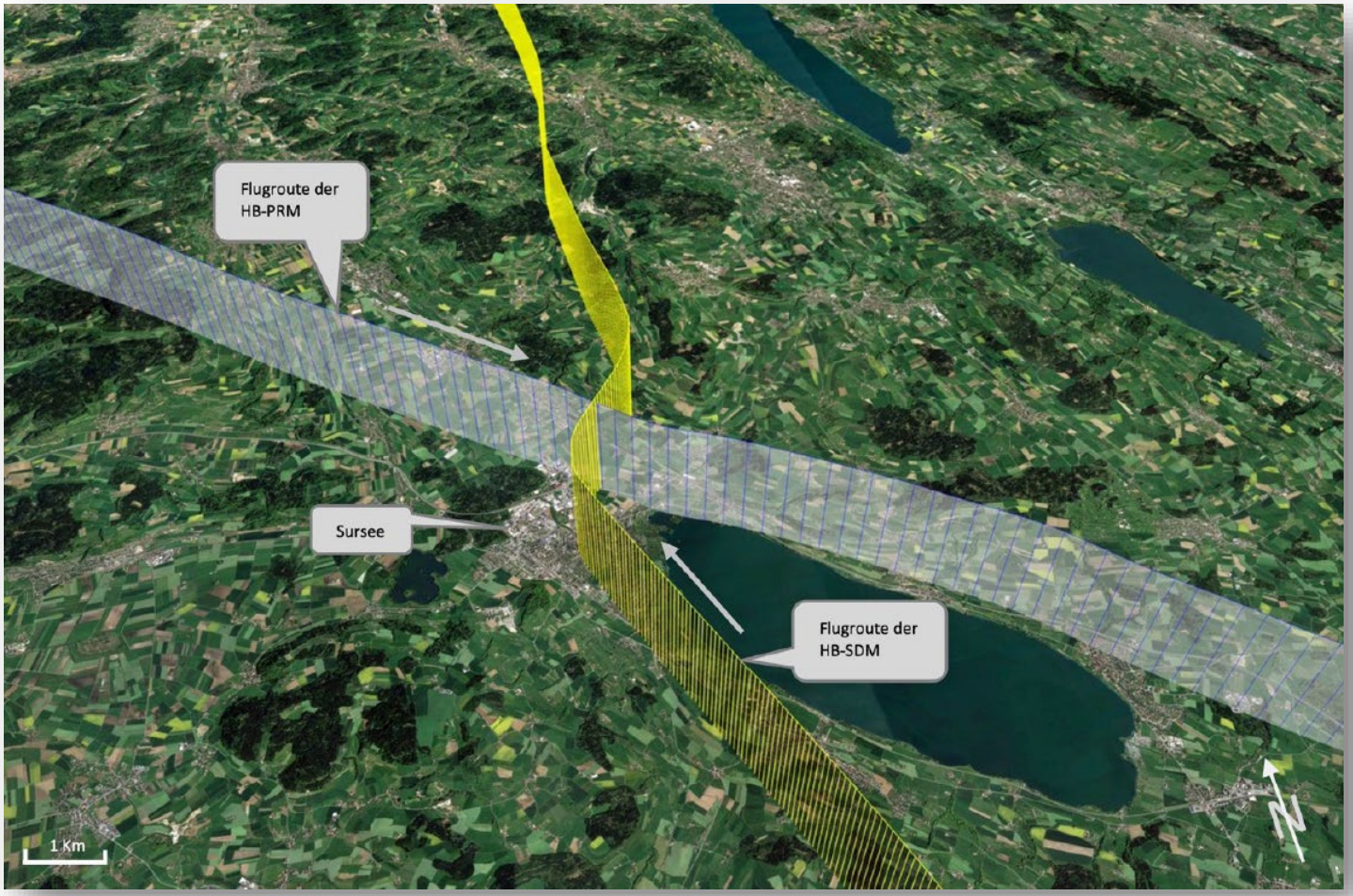
Near collision between a Mooney and a section of F/A-18



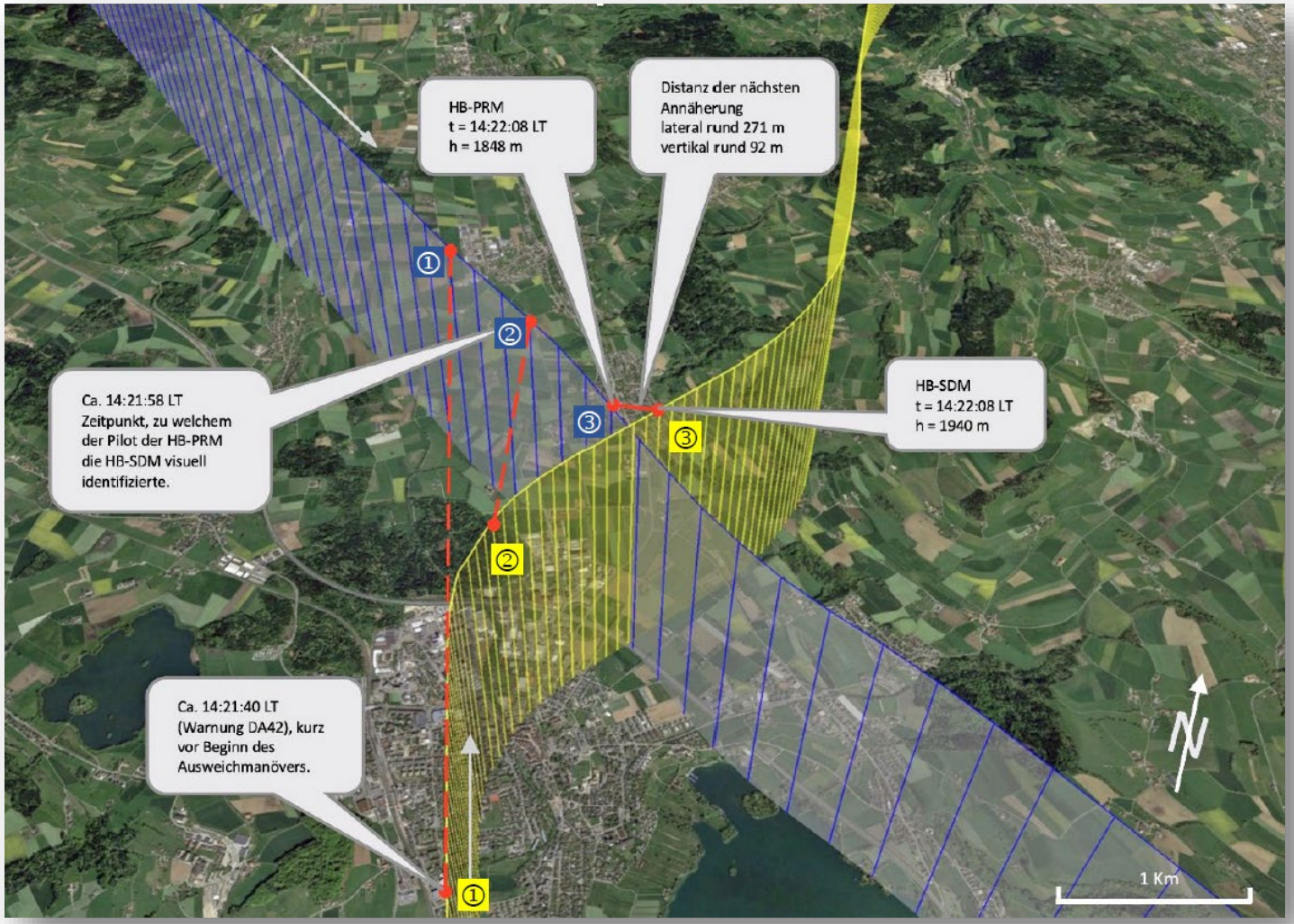
See – Lessons learned

- *Zone where no sensible reaction is possible*: 12 seconds × v [m/s] – up to 4 km
- Where is my focus – inside/outside?
- How do I scan correctly?
- Airforce: Awareness regarding the behaviour of civilian airspace users, limits of flight following

Dealing with collision warning systems – Near collision between Piper PA28 and Diamond DA42



Dealing with collision warning systems – Near collision between Piper PA28 and Diamond DA42



(In)compatibility of collision warning systems

Sender → / ↓ Empfänger	Transponder ohne ADS-B-*out*	Transponder mit ADS-B-*out*	Flarm oder PowerFlarm
Flugsicherung	✓	✓	✗
(passives) TAS	✓ *)	✓ *)	✗
TCAS, (aktives) TAS	✓	✓	✗
ADS-B-*in*	✗	✓	✗
Flarm	✗	✗	✓
PowerFlarm	✓ *)	✓	✓

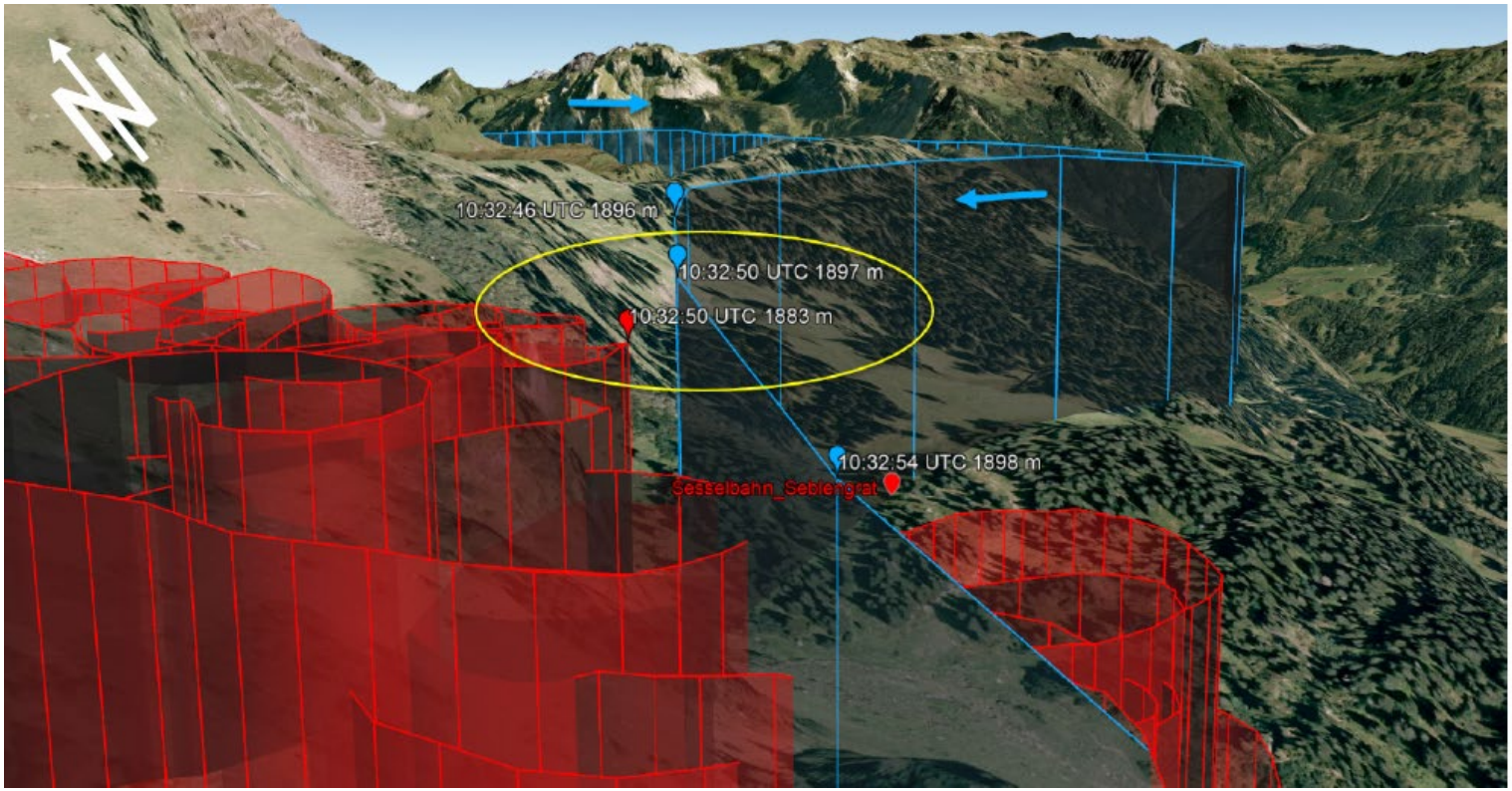
Overview of the transmission and reception capabilities of systems used for collision avoidance. An asterisk *) indicates that the transmitter can only be detected if it is within the range of a ground radar or an aircraft equipped with an interrogator. The yellow mark indicates that PowerFlarm warns of aircraft with transponders without ADS-B-out, but does not display their position.

Sense – lessons learned

- Based on TAS/FLARM warning, vertical evasive manoeuvre is advisable
- Lateral evasive manoeuvres are difficult...
- Incompatible or missing collision warning systems – *sense and avoid?*
- Warnings and notifications from technical systems in GA (*traffic advisory systems – TAS*) are intended to improve situational awareness and support visual search

Near collision between motorised aircraft and paraglider

Near collision between motorised aircraft and paraglider



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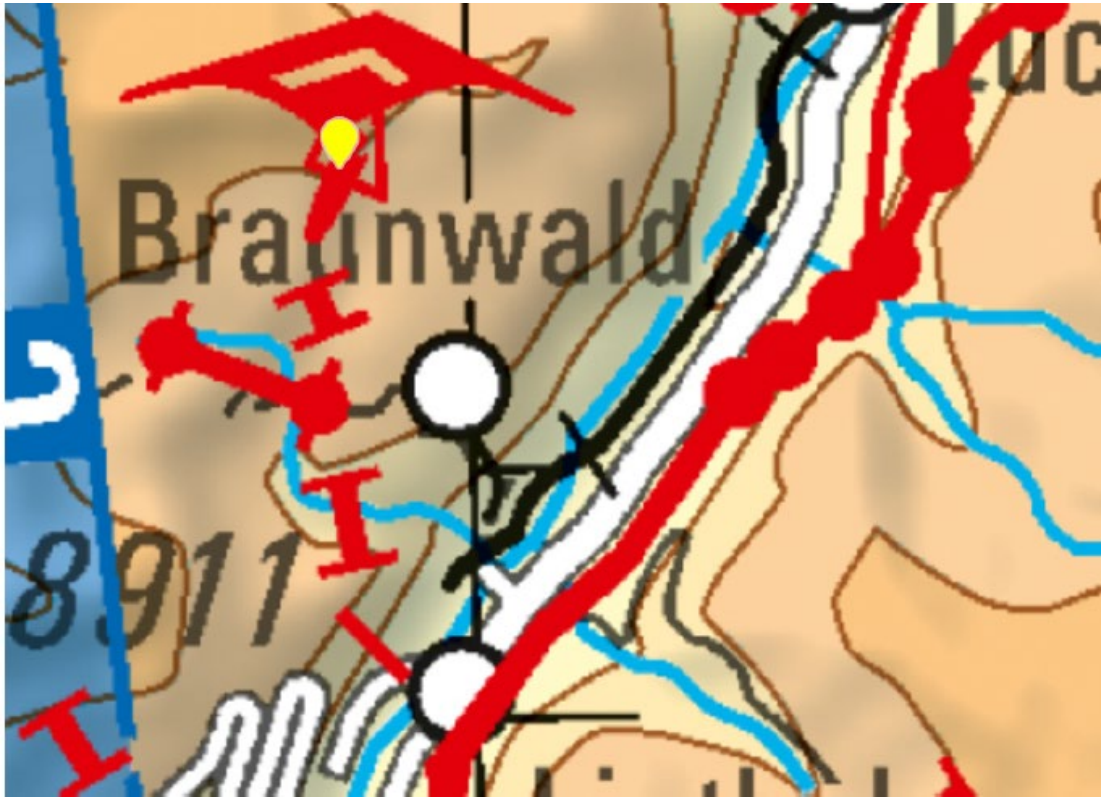

Segregate – near collisions in class G and E airspace – lessons learned

- Situational awareness – What else can I expect from other airspace users?
- Avoid known hot spots
- Carry functional warning systems
- See and avoid – knowing that its effectiveness is limited

Near collision between IFR training aircraft and two gliders

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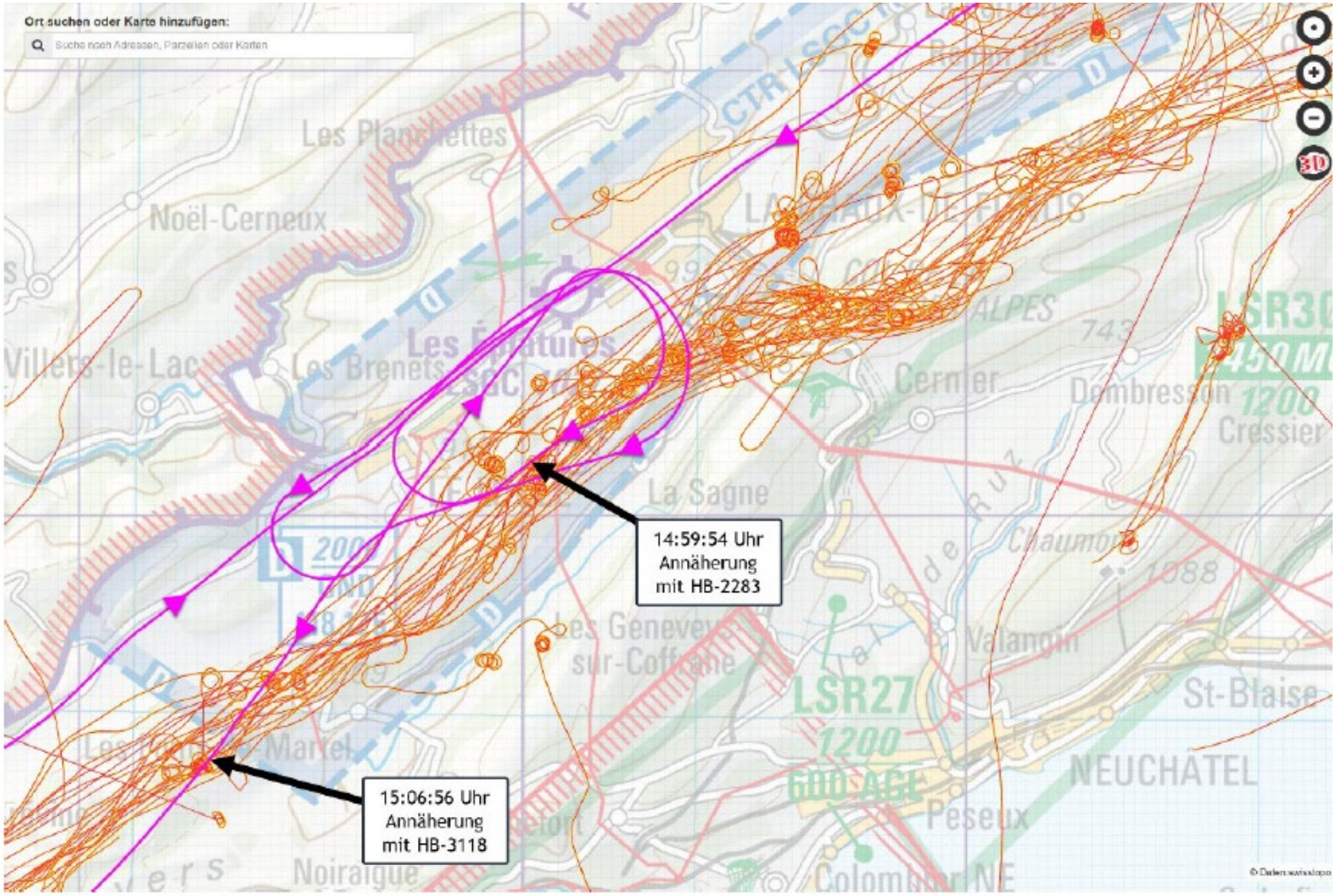

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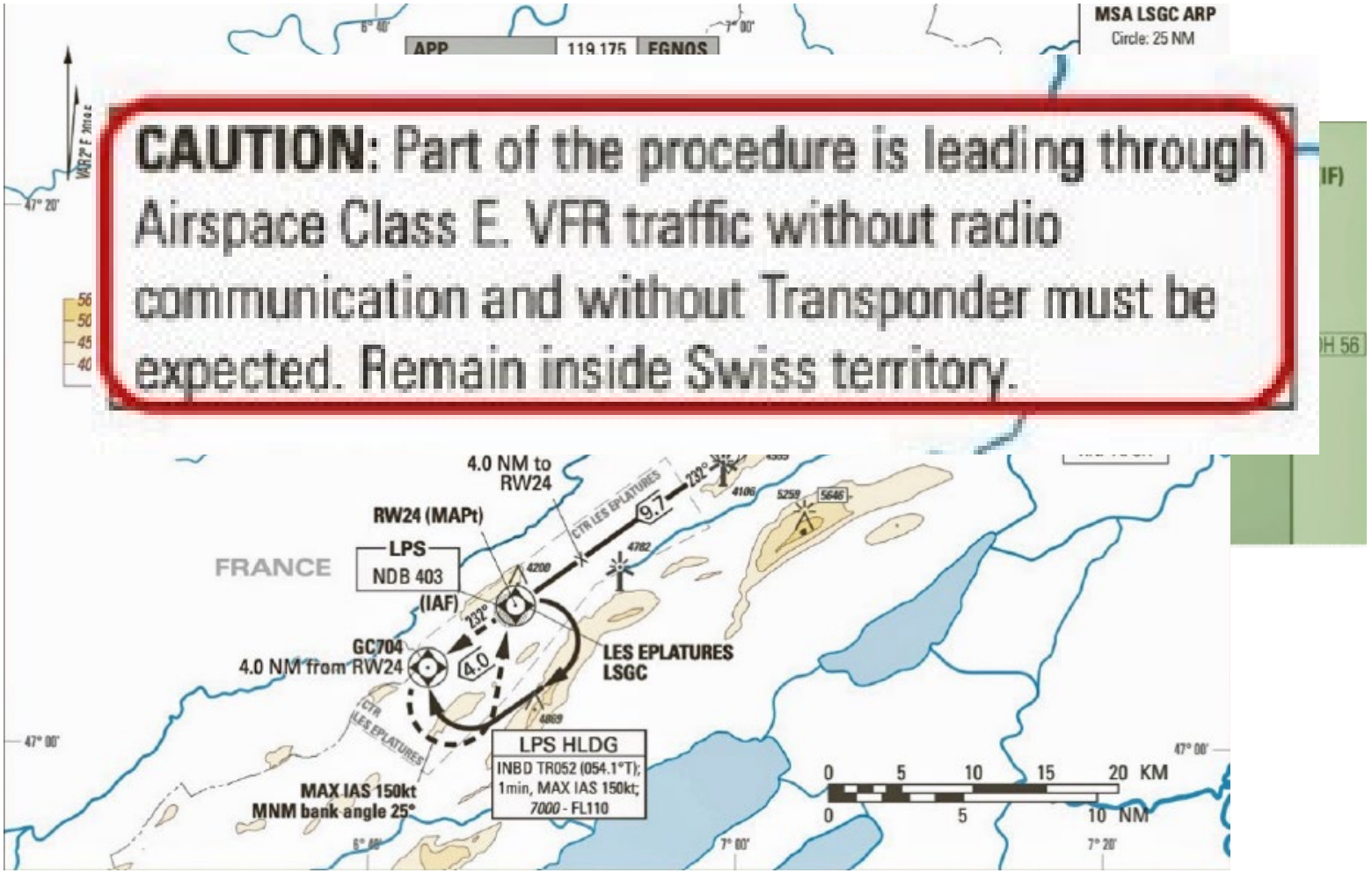
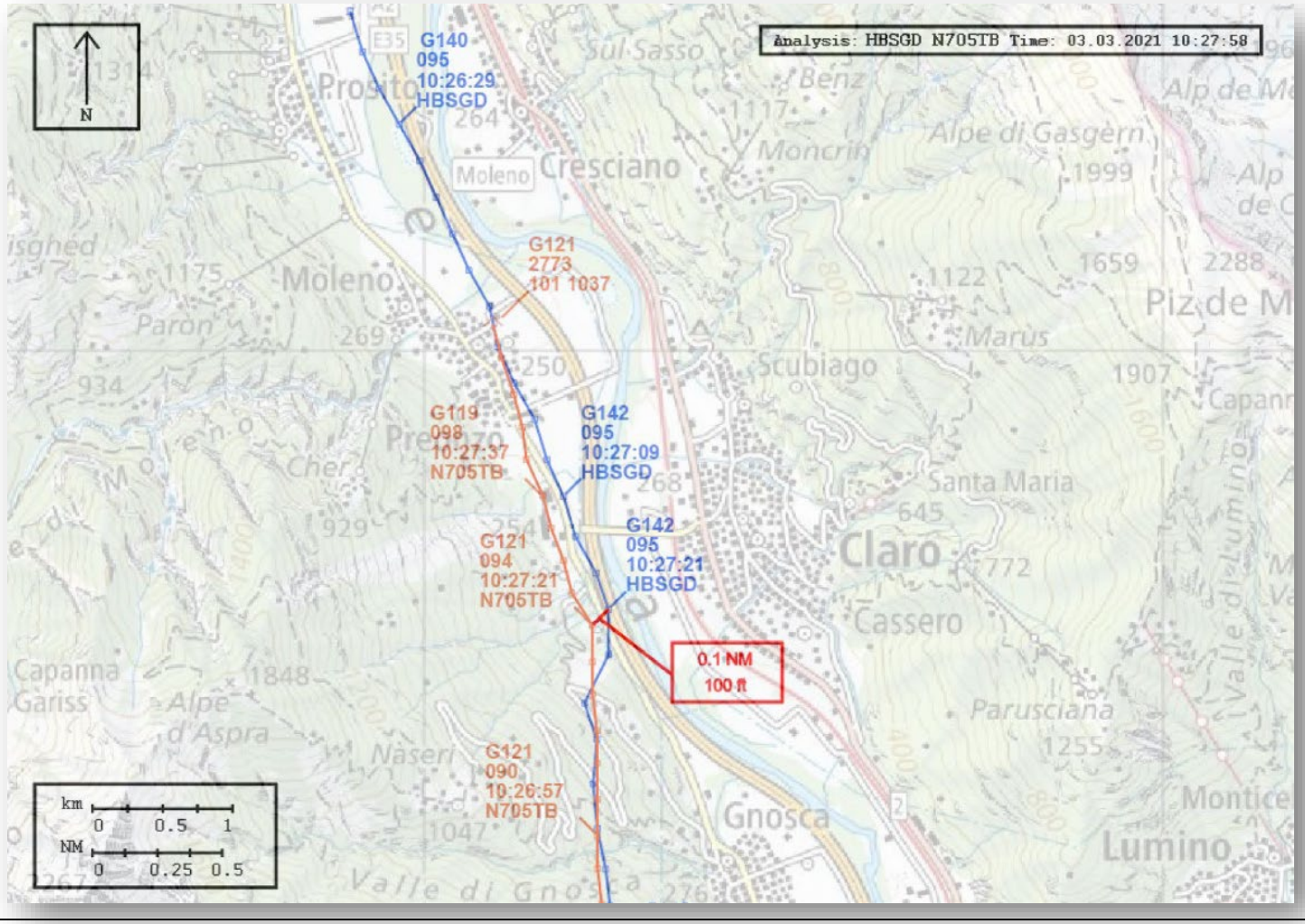


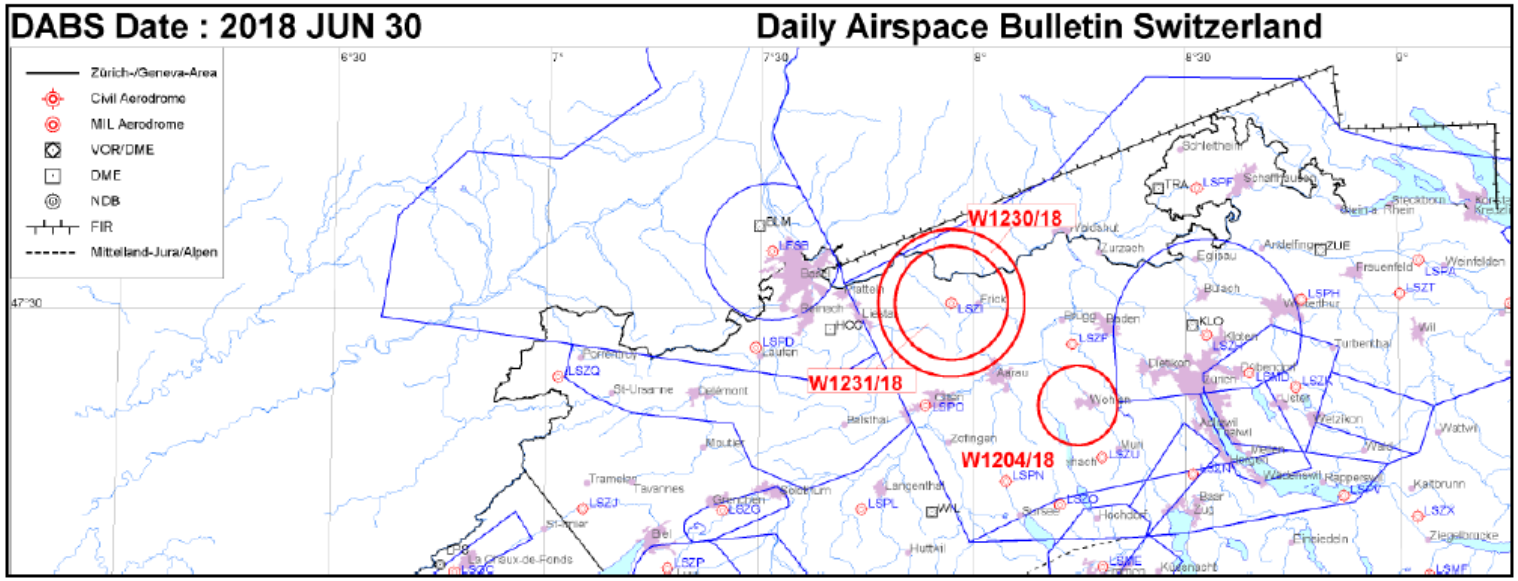
Low Flying Network waypoints – Precision leading to collision...



Segregate – mixed airspace – lessons learned

- Knowledge of probable flight paths of other airspace users
- LFN navigation points – intended for IFR traffic
- Civil air traffic information services in valleys have few precise radar systems and limited capacity
- Traffic rules – large vertical distance from clouds, semi-circular rules ...

Near collision between glider and an Airforce Display Team



NOTAM-Nr: **W1230/18** Gültigkeit: 1200 – 1315 UTC Untergrenze: GND Obergrenze: 2000m / 6500ft Zentrum: 473032N 0075700E Radius: 13.0 KM / 7.0 NM	TEMPO R-AREA ESTABLISHED AD FRICKTAL-SCHUPFART, RADIUS 13.0 KM (473032N0075700E RADIUS 7.0 NM). DUE TO AIRDISPLAY. WI AIRSPACE ECHO AND SIWSS TERRITORY ONLY. ENTRY PROHIBITED WHEN ACT, EXC HEL EMERG MEDICAL SER (HEMS) FLT. FOR INFO ON ACT AND HEMS COOR CTC FRICKTAL-SCHUPFART 119.550 MHZ.
NOTAM-Nr: **W1231/18** Gültigkeit: 1200 – 1315 UTC Untergrenze: 1700m / 5500ft Obergrenze: FL 120 Zentrum: 473032N 0075700E Radius: 10.0 KM / 5.4 NM	TEMPO R-AREA ESTABLISHED AD FRICKTAL-SCHUPFART, RADIUS 10.0 KM (473032N0075700E RADIUS 5.4 NM). DUE TO AIRDISPLAY. WI SIWSS TERRITORY ONLY. LOWER LIMIT AIRSPACE CLASS CHARLIE. ENTRY PROHIBITED WHEN ACT, EXC HEL EMERG MEDICAL SER (HEMS) FLT. FOR INFO ON ACT AND HEMS COOR CTC FRICKTAL-SCHUPFART 119.550 MHZ.

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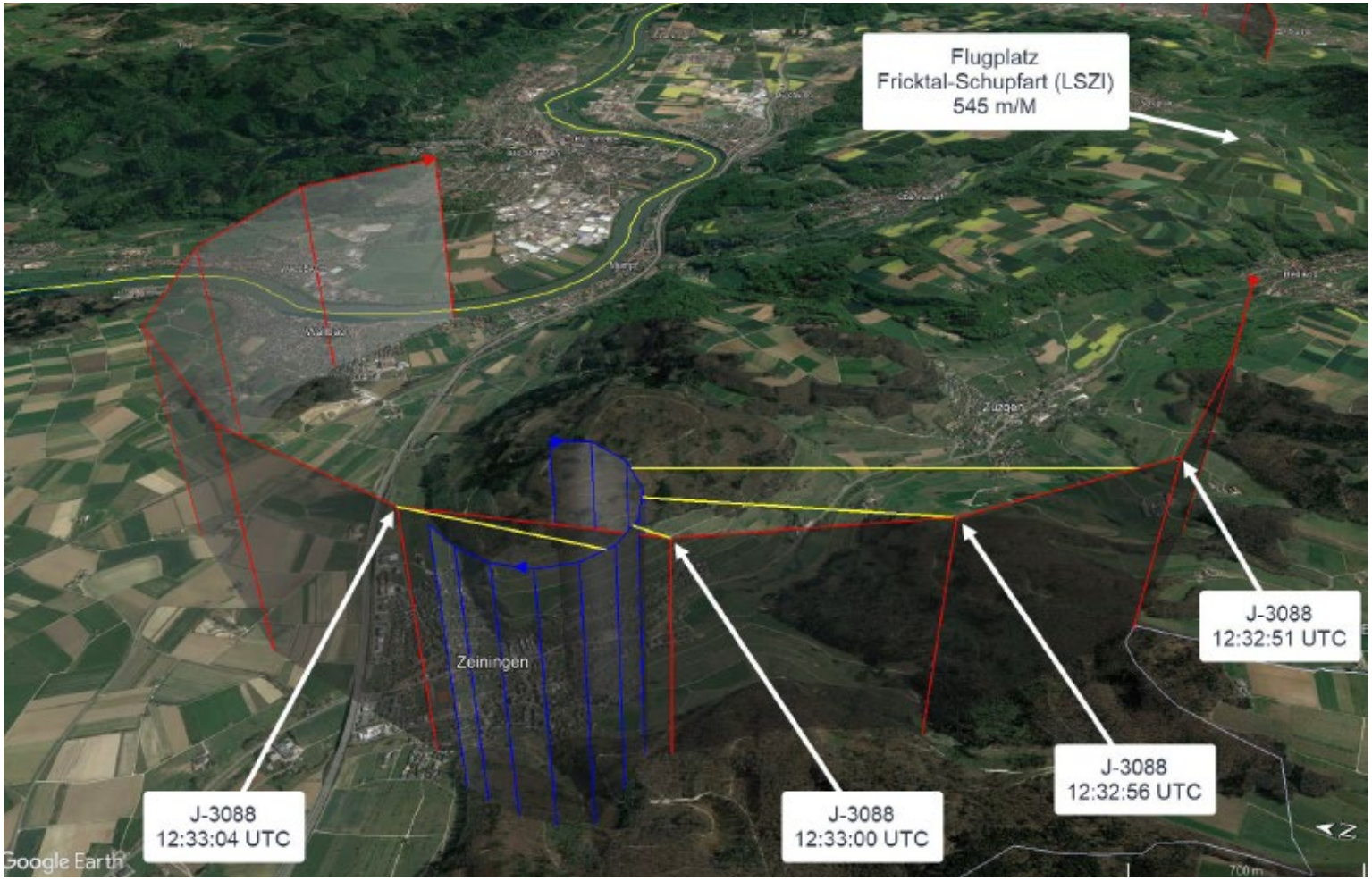
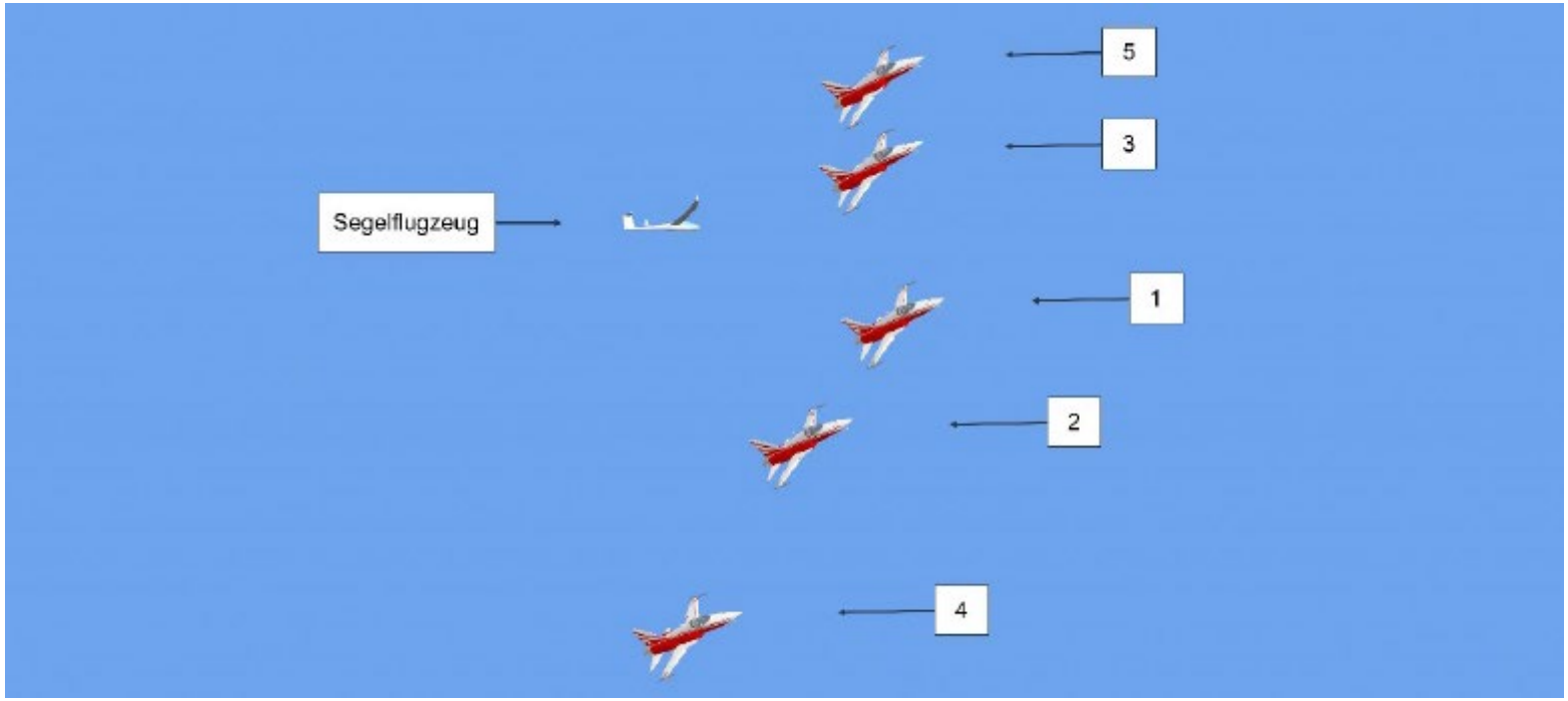


Near collision between glider and an Airforce Display Team



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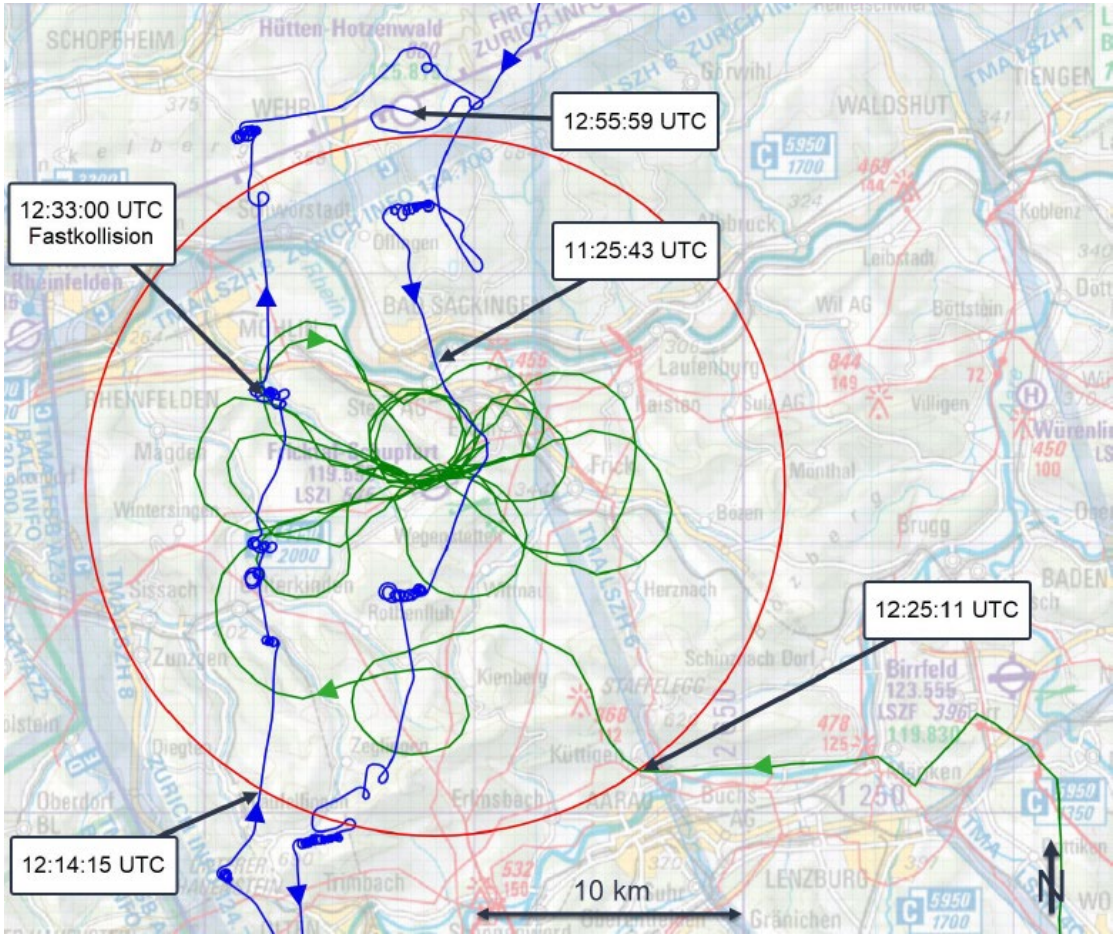
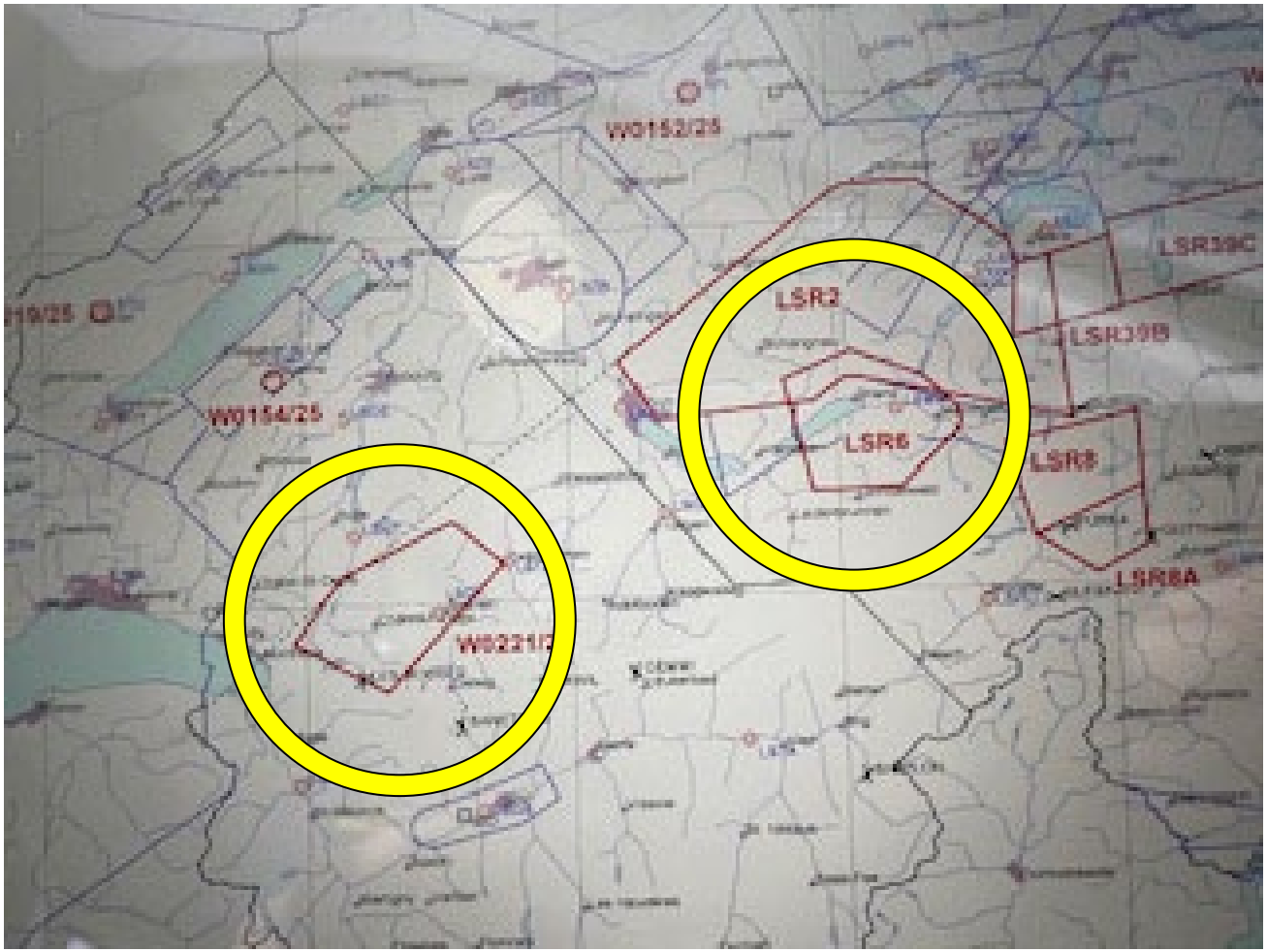
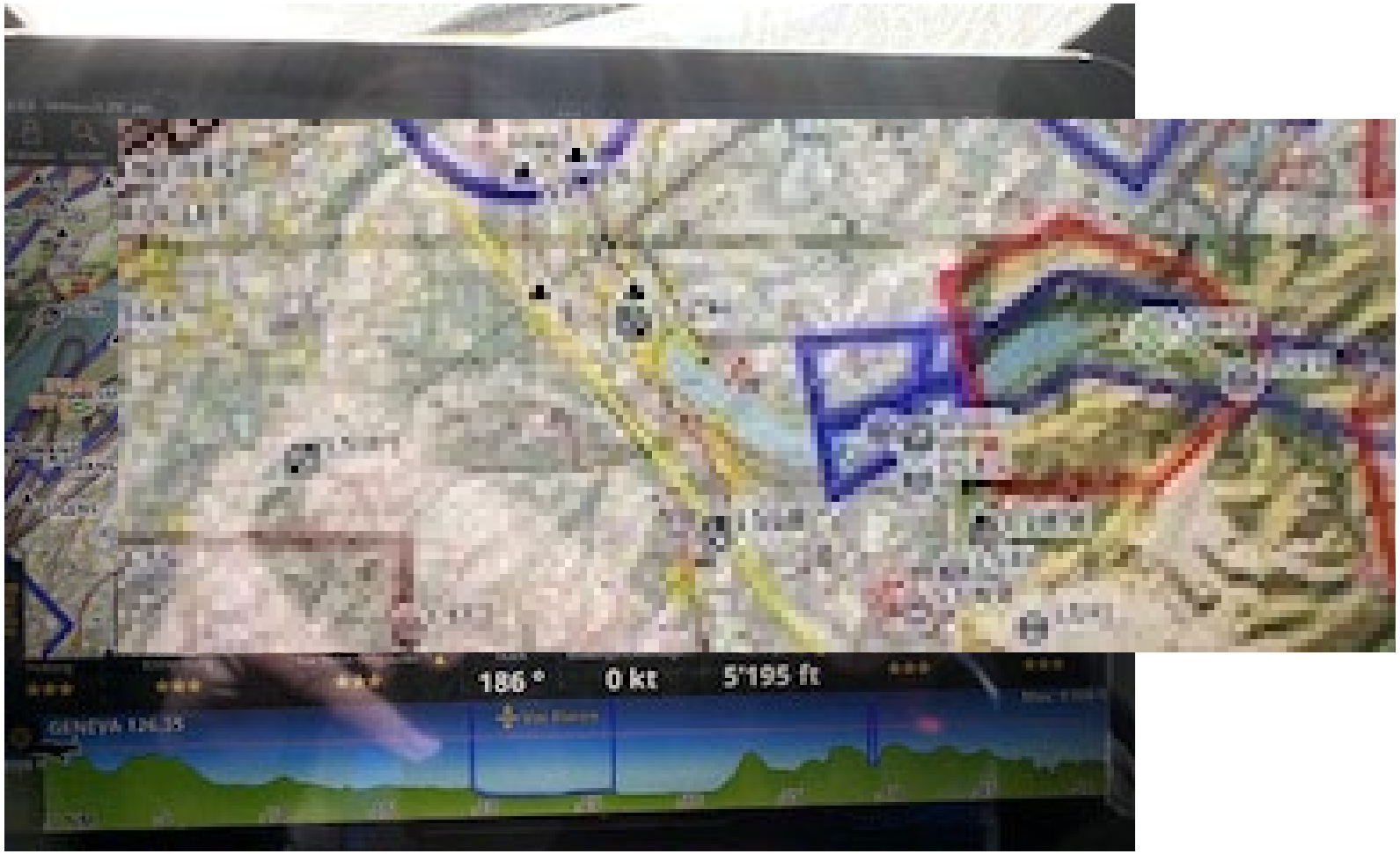


Danger and restricted areas on the Daily Airspace Bulletin



Danger and restricted areas in the EFB

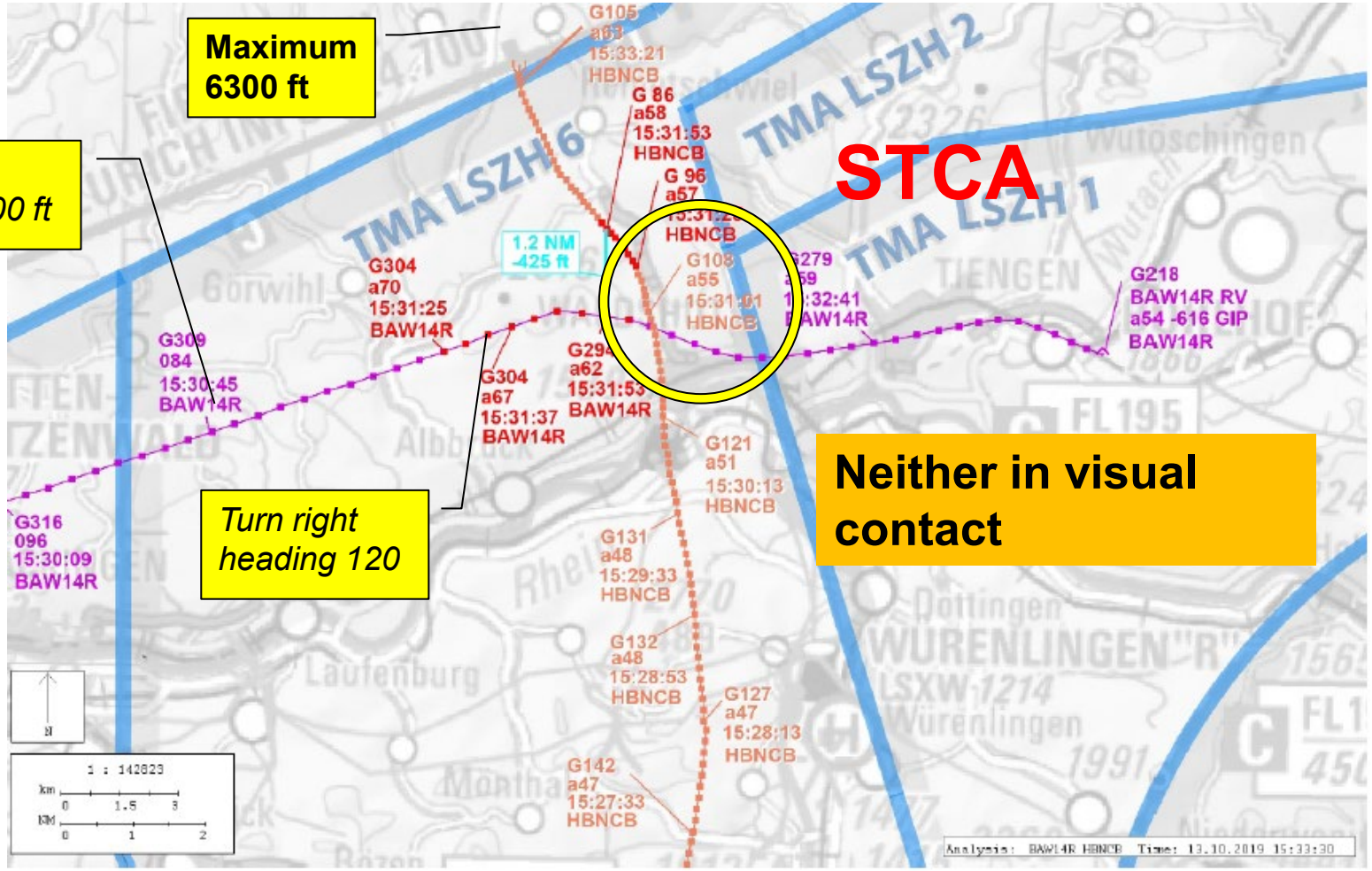
Danger and restricted areas – in the EFB



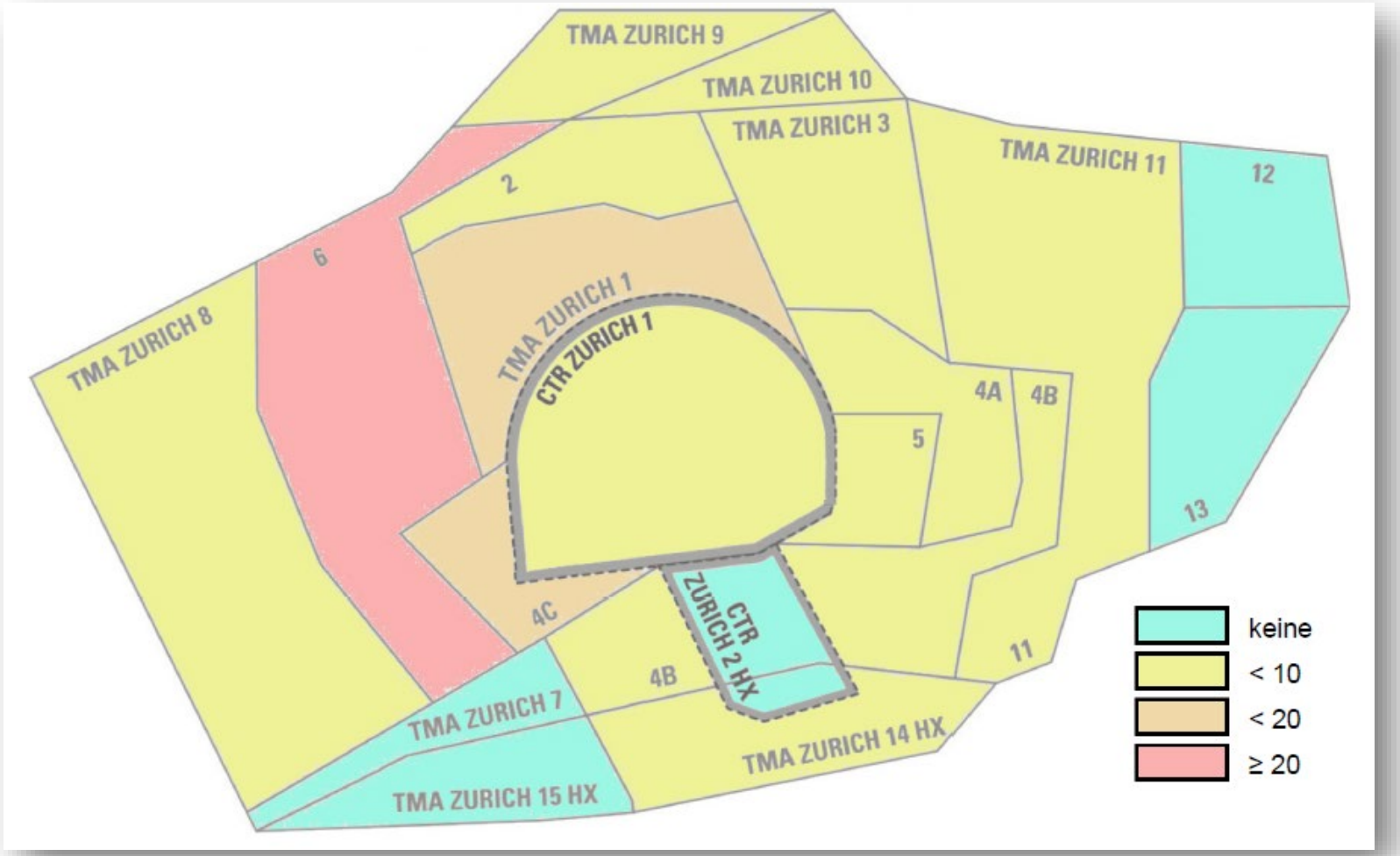
Segregate – dealing with restricted flight areas – lessons learned

- Use reliable information about restricted flight areas – especially for cross-border flights
- Be aware of and take into account the limitations of electronic information systems

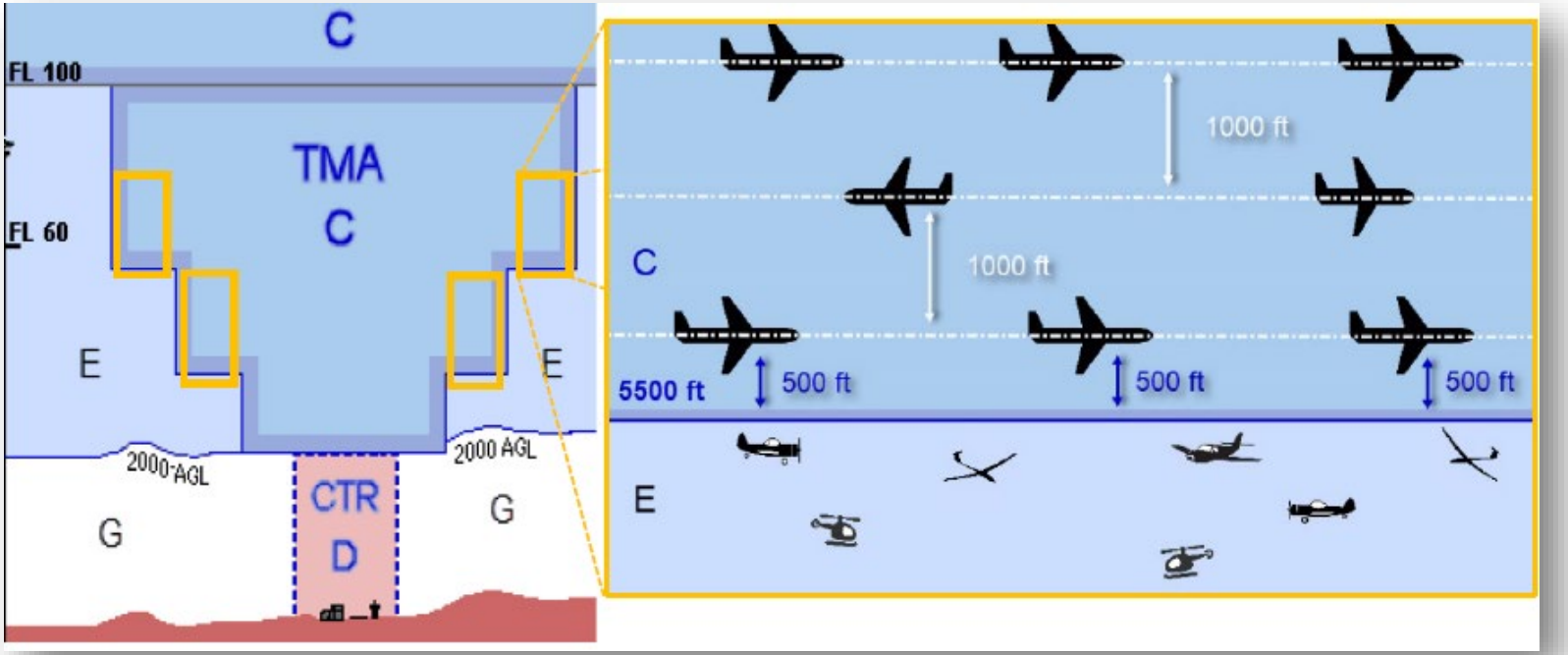
Segregate – Airprox at airspace boundaries



Airspace violations TMA LSZH 2018



IFR-VFR staggering – reduced distances in favour of GA



Segregate – airspace boundaries – lessons learned

- Small vertical distances between VFR traffic below TMA and IFR traffic within TMA – freedom of movement for general aviation – responsibility!
- Precise navigation in the area of airspace boundaries – how much risk am I willing to take?
- Avoid aerobatic manoeuvres with high climb rates to the airspace boundary

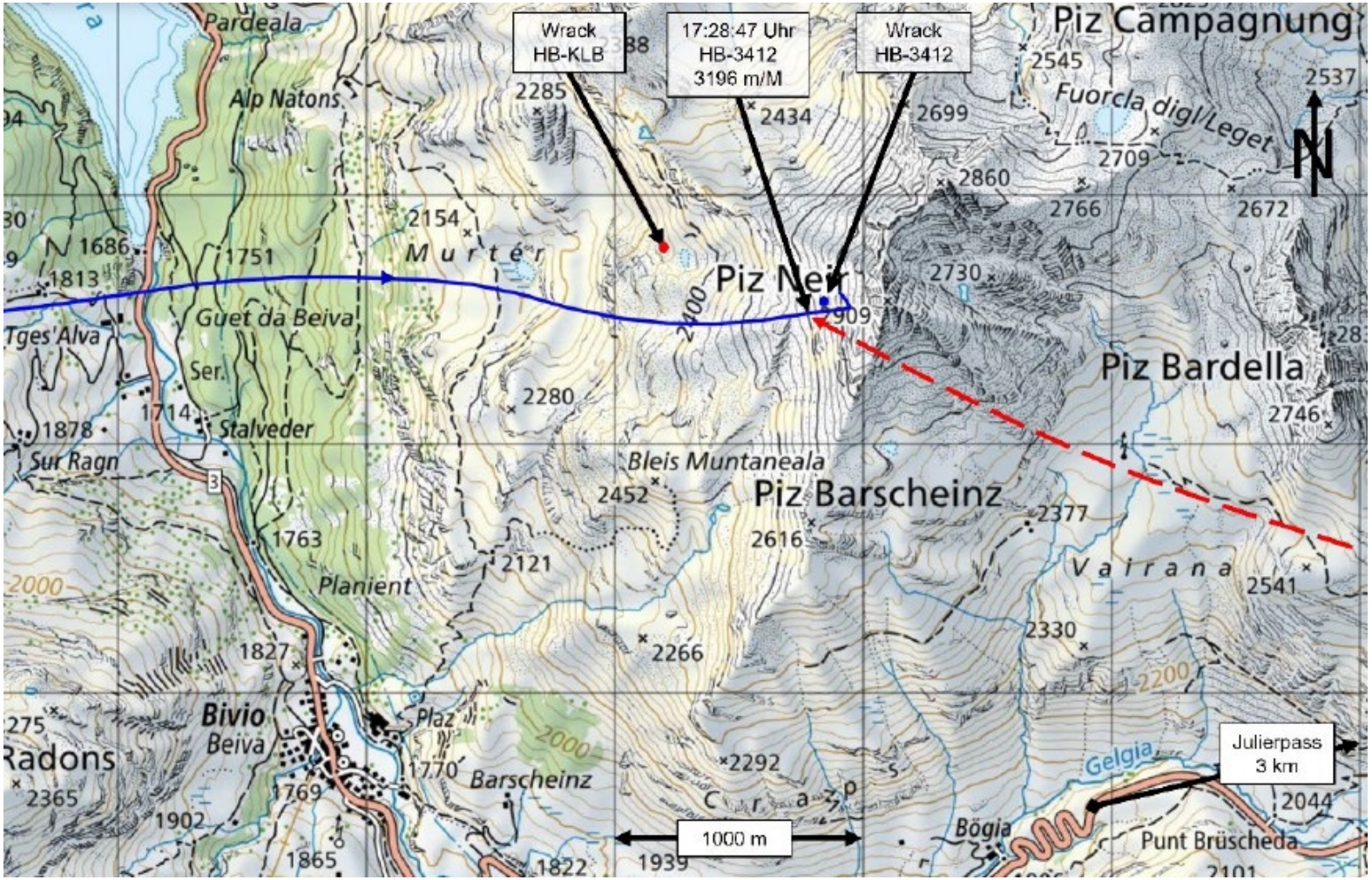
Near collision in the Transponder Mandatory Zone

Segregate – When rules are followed but danger still arises...

- Different communication rules in the same airspace
- Voluntary listening standby calls into question availability in case of need
- Understanding and applying listening squawk
- Rules in the AIP do not cover all cases

No See, Sense and Segregate – Mid-air collision DR 400 vs ASW 27

No See, Sense and Segregate – Mid-air collision DR 400 vs ASW 27

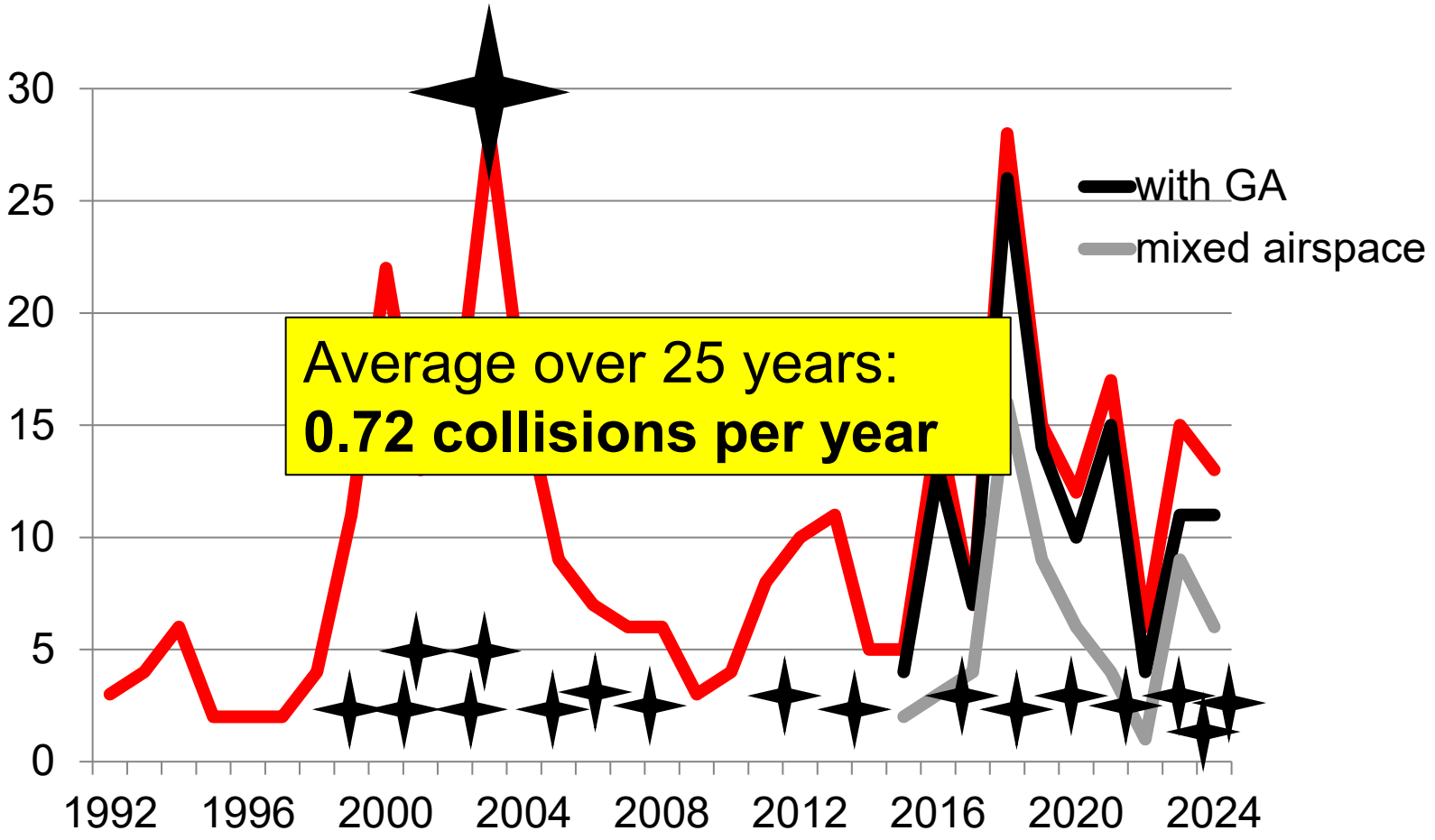


And one more thing...

No See, Sense and Segregate – lessons learned

- Using transponders
- Radio contact with information service
- Carry functional warning systems
- *See and avoid* – involve passengers too, beware of distractions
- SAR – leave traces...

Airprox with high collision risk and mid-air collisions 1992 to 2024



Summary

- Challenges with no foreseeable solution
  - **See** – important, but insufficient
  - **Sense** – incompatible systems, no transponder requirement, (still) no ADS-B ground stations
  - **Segregate** – airspace structure, density
- **Statistical probability of collisions is high**
  - **GA aircraft – GA aircraft**
  - **Commercial aircraft – GA aircraft**
  - **Air Force aircraft – GA aircraft**