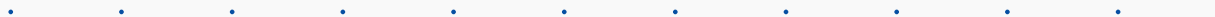


GALILEO

Division Communication, Navigation & Surveillance;
Skyguide; Swiss Air Navigation Services Ltd.



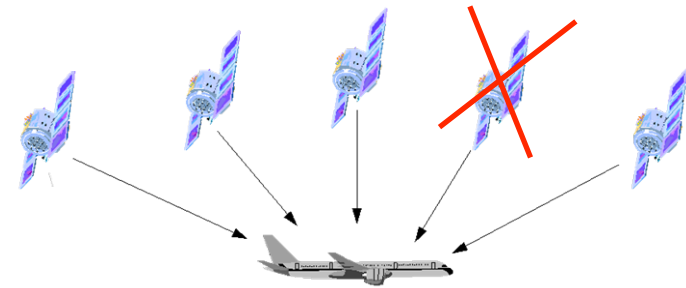
Guidelines for Aviation and ANSP (Air Navigation Service Provider)

- **safety**
commitment to highest practicable safety level
- **capacity**
increase capacity by optimising airspace,
while safety level is maintained
- **sustainability**
optimise flight paths and approaches
in order to limit noise and
reduce greenhouse gas emissions
- **cost efficiency**
although GNSS multi constellation
(GPS+GLONASS+GALILEO+...) might lead to limited terrestrial navigation systems,
ground backup will still be needed.

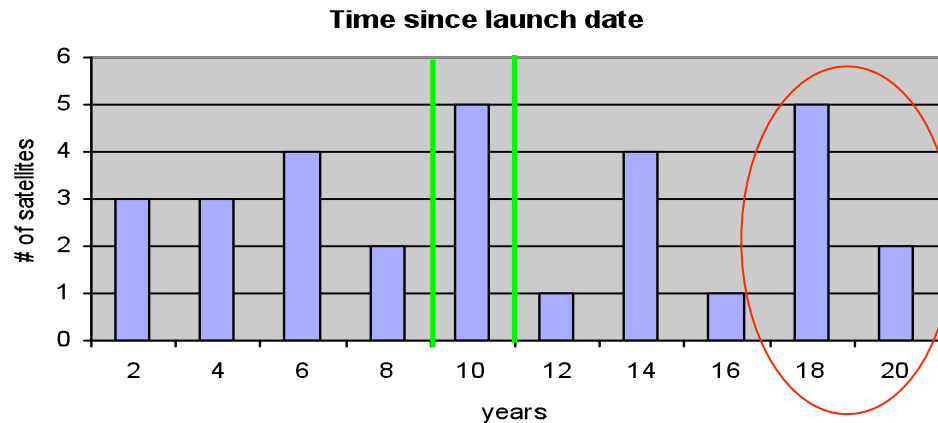


Satellite Systems in Navigation Today

- Today we use GPS, but standalone GPS is not adequate for many applications in terms of integrity.
- For **En-Route** GPS is standard, together with RAIM (Receiver Autonomous Integrity Monitoring) and INS (Inertial Navigation System)
 - no backup if GPS fails for a long time
 - **5+** satellites are needed for RAIM
- For **continental flights and terminal** conventional navigation systems are used together with GPS + RAIM + INS
- For **approaches**
 - GPS + RAIM together with barometer for vertical guidance
 - GPS + SBAS (Satellite Based Augmentation Systems), WAAS or EGNOS
 - GPS + GBAS (Ground Based Augmentation Systems), precision approaches
 - CAT II / III -> today with ILS (instrument landing systems)

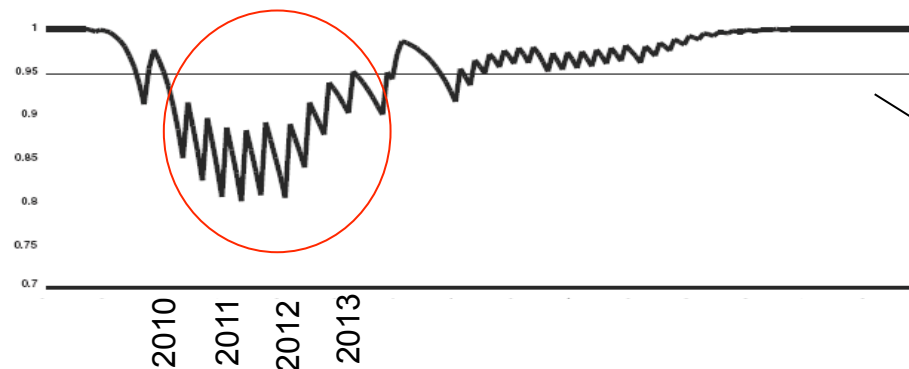


GNSS will have improved **availability**... ...through redundancy



expected lifetime of GPS satellites
II/II-A: 7.5 years
II-R/RM: 10 years

GAO (The U.S. Government Accountability, "congressional watchdog") report issued on GPS sustainability and modernization



probability of maintaining
a nominal constellation (N=24)

committed probability 95%

GNSS will have improved **availability** (cont.)

GPS Space and Control

Clock and Reaction Wheel Performance Status

CGSIC* Brief Lt Joe Riedesel (September 08)



*Civil Global Positioning System Service Interface Committee

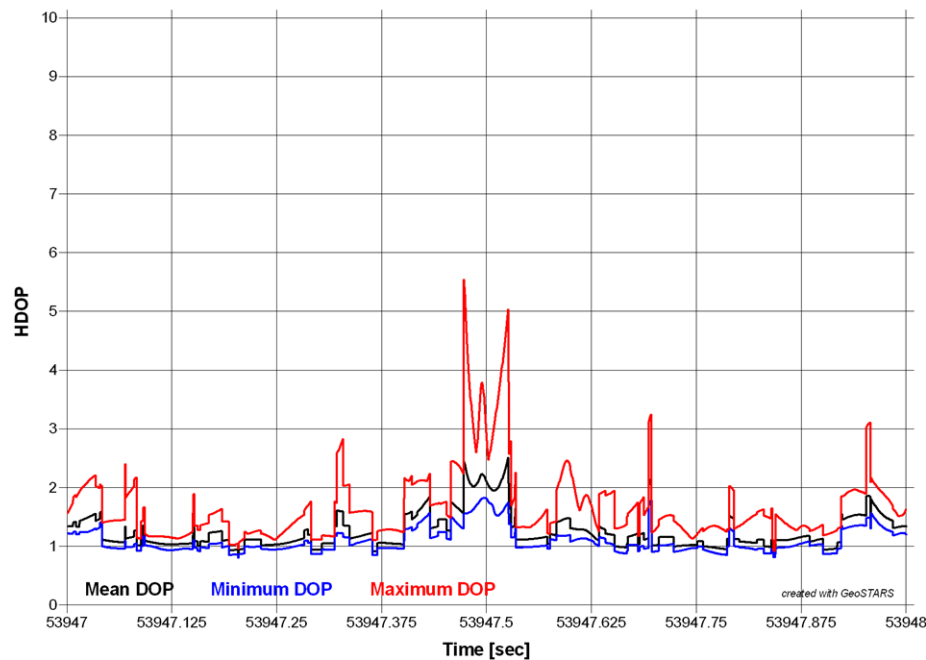
GNSS will have improved **availability** (cont.)

Typical airport in significant terrain (e.g. Lugano)

Simulation with N=30 satellites

Horizontal Dilution of Precision for N-1 Satellites

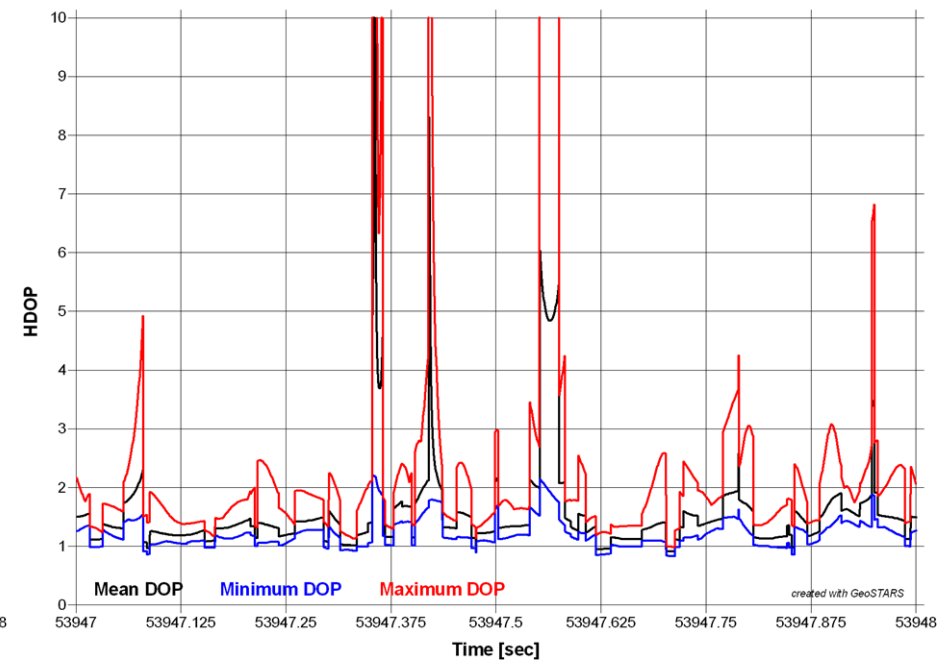
Start at: 31/7/2006 0:0:0 - Period: 86400 sec - Interval: 60 sec



Nominal constellation: N=24

Horizontal Dilution of Precision for N-1 Satellites

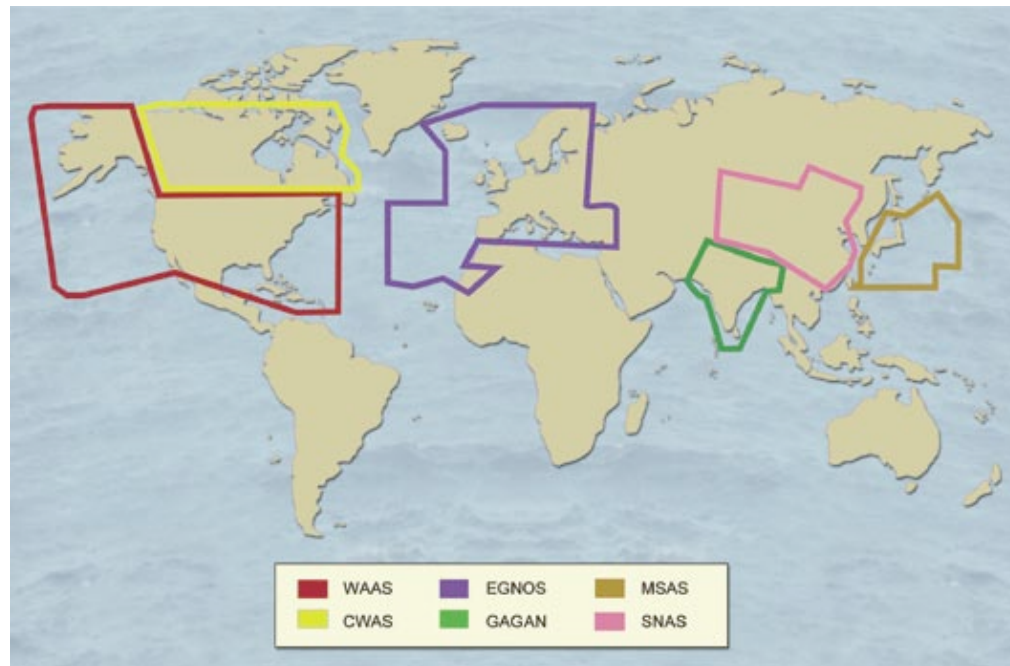
Start at: 31/7/2006 0:0:0 - Period: 86400 sec - Interval: 60 sec



GNSS will have improved **integrity** and **continuity**

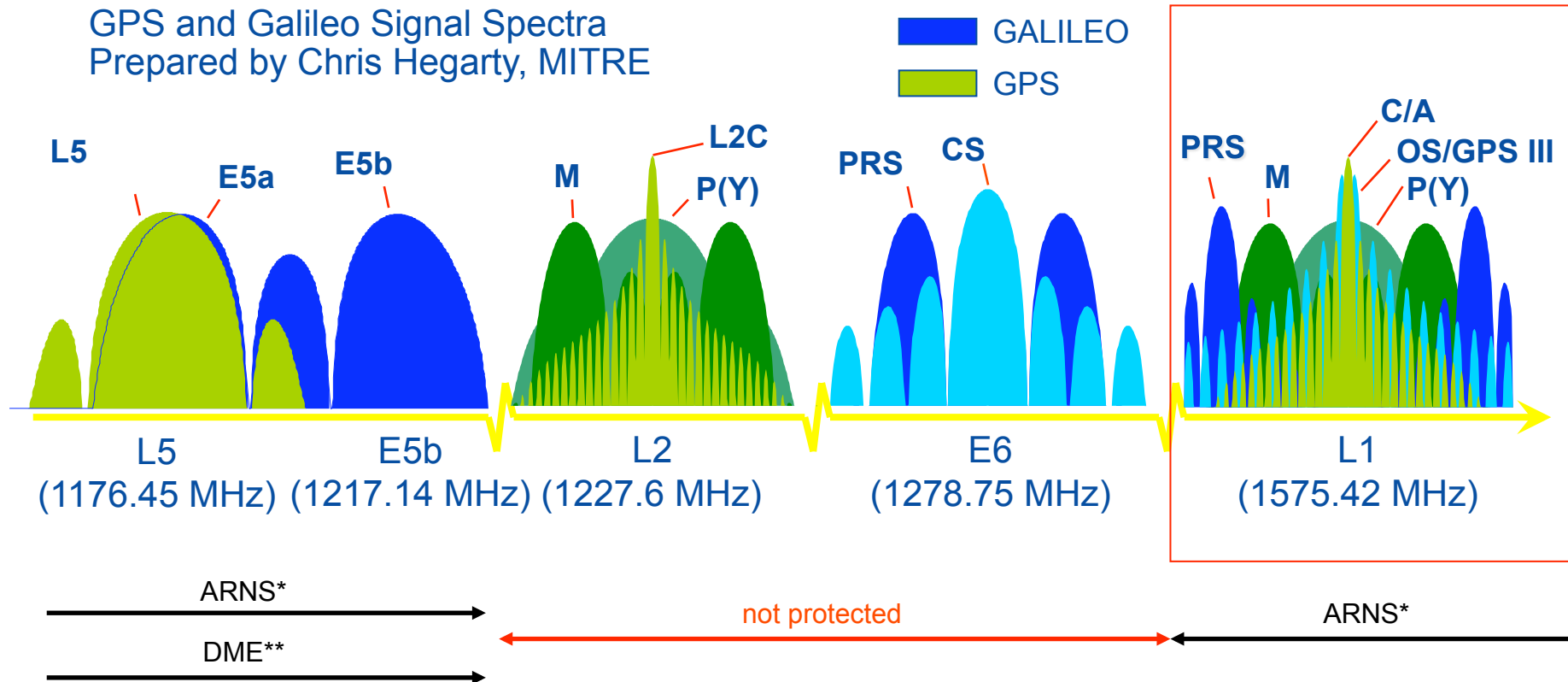
GALILEO provides warnings to users when it fails to meet certain margins of performance (safety-of-life service).

Other SBAS are restricted to certain areas. GALILEO shall be available worldwide.



GNSS will become **more robust**... ...against unintentional interference

GPS and Galileo Signal Spectra
Prepared by Chris Hegarty, MITRE



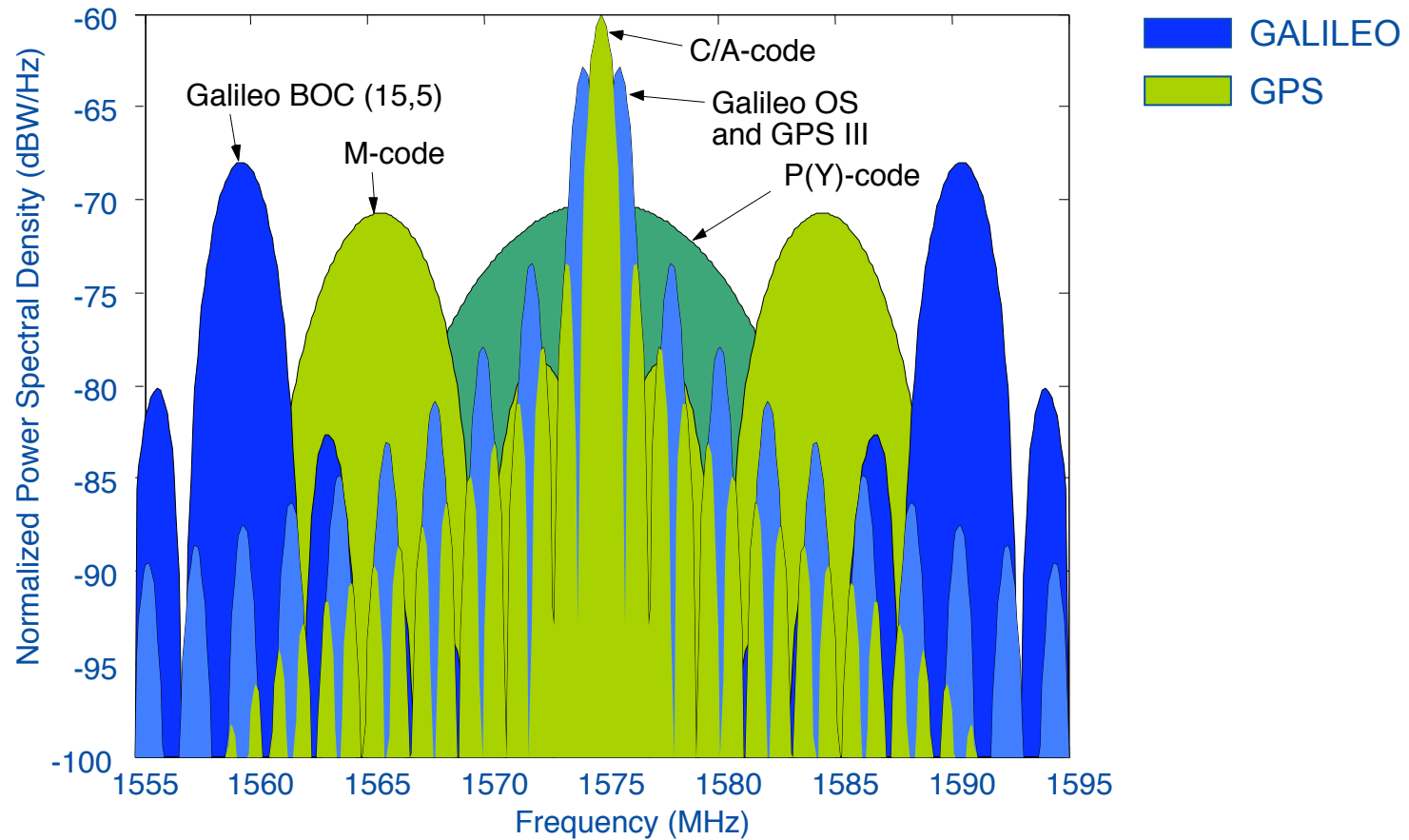
*Aeronautical Radio Navigation Services

**Distance measuring equipment

GNSS will become **more robust** (cont.)

L1 Signal Spectra

Prepared by Chris Hegarty, MITRE



Conclusions

- GALILEO will complement GNSS multi constellation.
- GALILEO will help to improve the performance of GNSS, while safety remains at the highest practical level.
- Availability will be improved through redundancy.
- GALILEO has an integrated safety-of-life service.
- GNSS will become more robust against unintentional interference.

