

Telespazio research initiatives on ionosphere

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PITHIA-NRF First Innovation Day
Rome, 21 June 2022



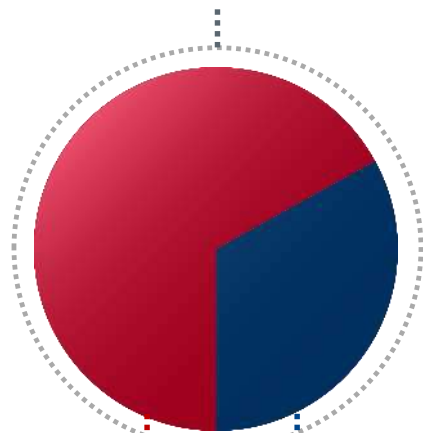
About Telespazio



Shareholders



100%



67%

33%

LEONARDO

THALES



~600M €

2021 REVENUES



+3K

EMPLOYEES



+60

YEARS OF EXPERIENCE



15

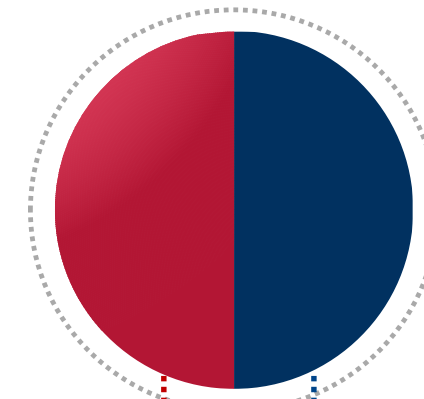
COUNTRIES OF PRESENCE



13

COMPANIES WORLDWIDE

Space Alliance



TELESPAZIO
a LEONARDO and THALES company

ThalesAlenia Space
a Thales / Leonardo company

33%

67%

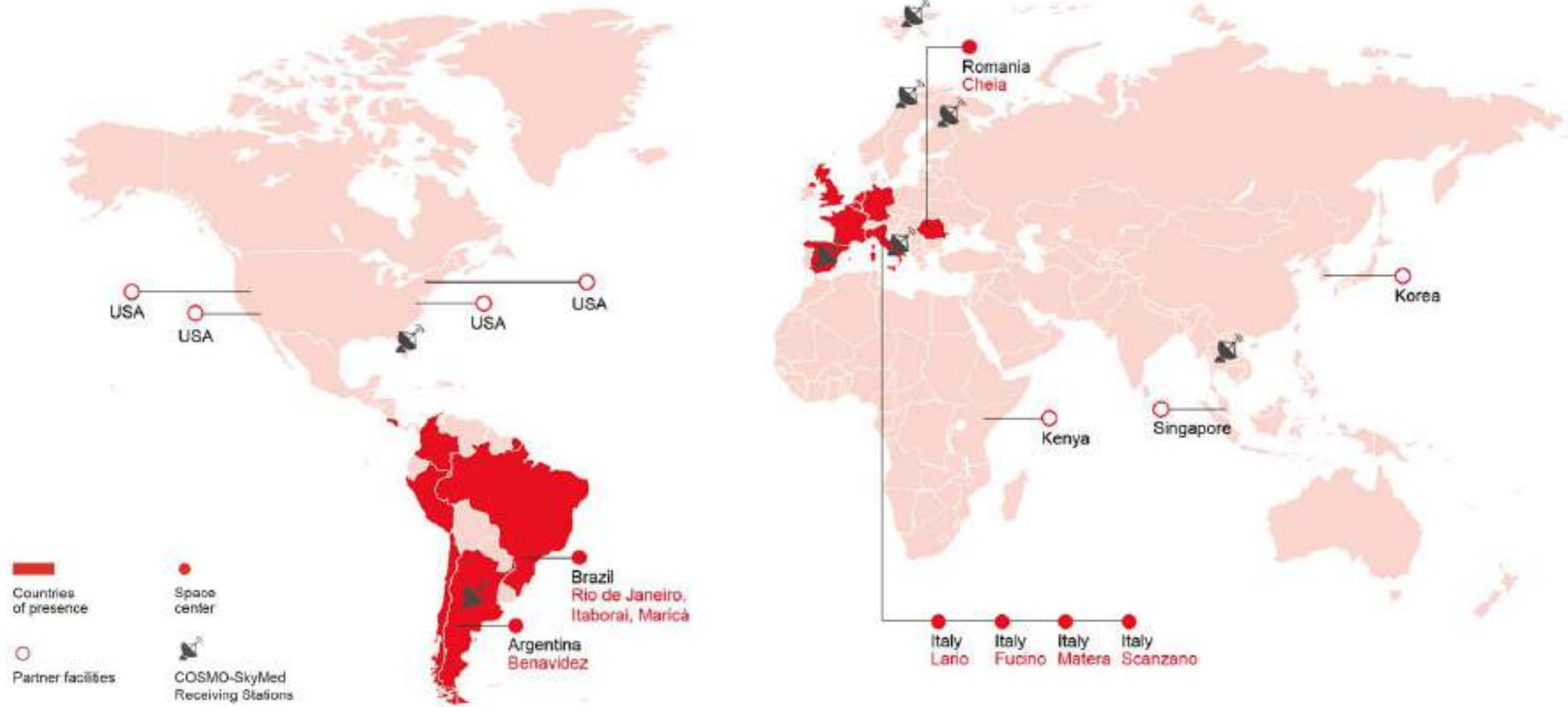
LEONARDO

THALES



A worldwide footprint

COSMO-SkyMed Receiving Stations



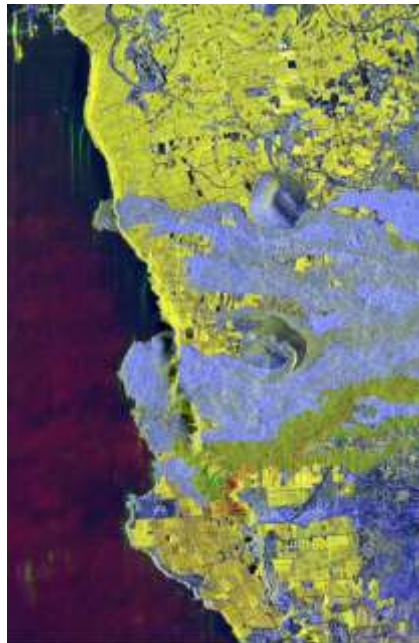
Pioneers in a constantly evolving market

Even today we still think like a start-up, transforming the space sector's momentous changes into opportunities.

GLOBAL SERVICE PROVIDER & LARGE MISSION INTEGRATOR



Geoinformation



Satellite Communications



Space Operations



Digital Ground Segment





Navigation services

Provision of innovative navigation services and future technologies for Positioning, Navigation and Timing based on Galileo and EGNOS.

- Services for **Aviation, UAS/RPAS, Maritime and Rail**
- Applications for **Intelligent Transport Systems** and autonomous driving.
- **Galileo's High Accuracy** and **PRS services**.
- **GNSS Performance and Availability**.
- **GNSS Laboratory facility As A Service**



Telespazio research initiatives on ionosphere



IONOLAB

- IONOLAB is an R&D initiative of the Telespazio Satellite Navigation group to develop the core elements to support GNSS-based ionosphere monitoring/forecasting and high accuracy & fast convergence positioning services.
- IONOLAB developments focus on three main areas:
 - Provision of real-time high-accuracy ionospheric corrections for PPP users
 - Effects of error sources (mainly ionosphere) on the performances of GNSS systems
 - Effects of ionosphere on communications.

Realtime high-accuracy ionospheric corrections

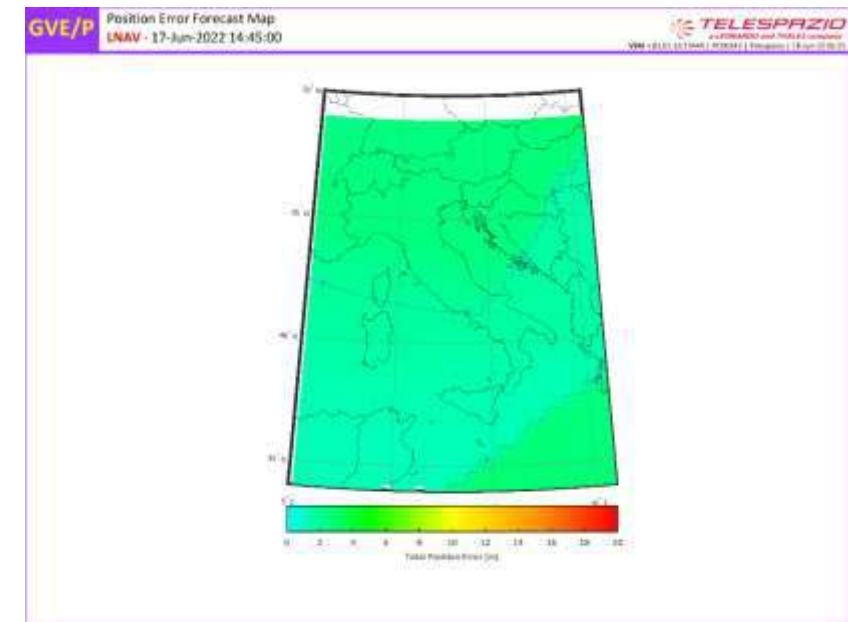
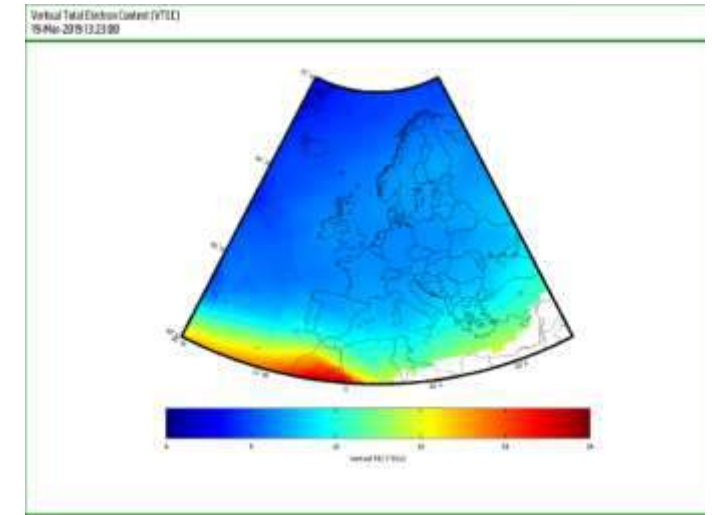
- Provision of high-accuracy ionospheric corrections for Galileo High Accuracy Services:
 - real-time
 - regional and global coverage
 - accuracy ~ 1 TECU
- Possible usage for Galileo HAS (High Accuracy Services)
 - source of ionospheric augmentation
 - **to enable fast-convergence positioning for “Fast-PPP” users**

Galileo HAS Service Characterisation

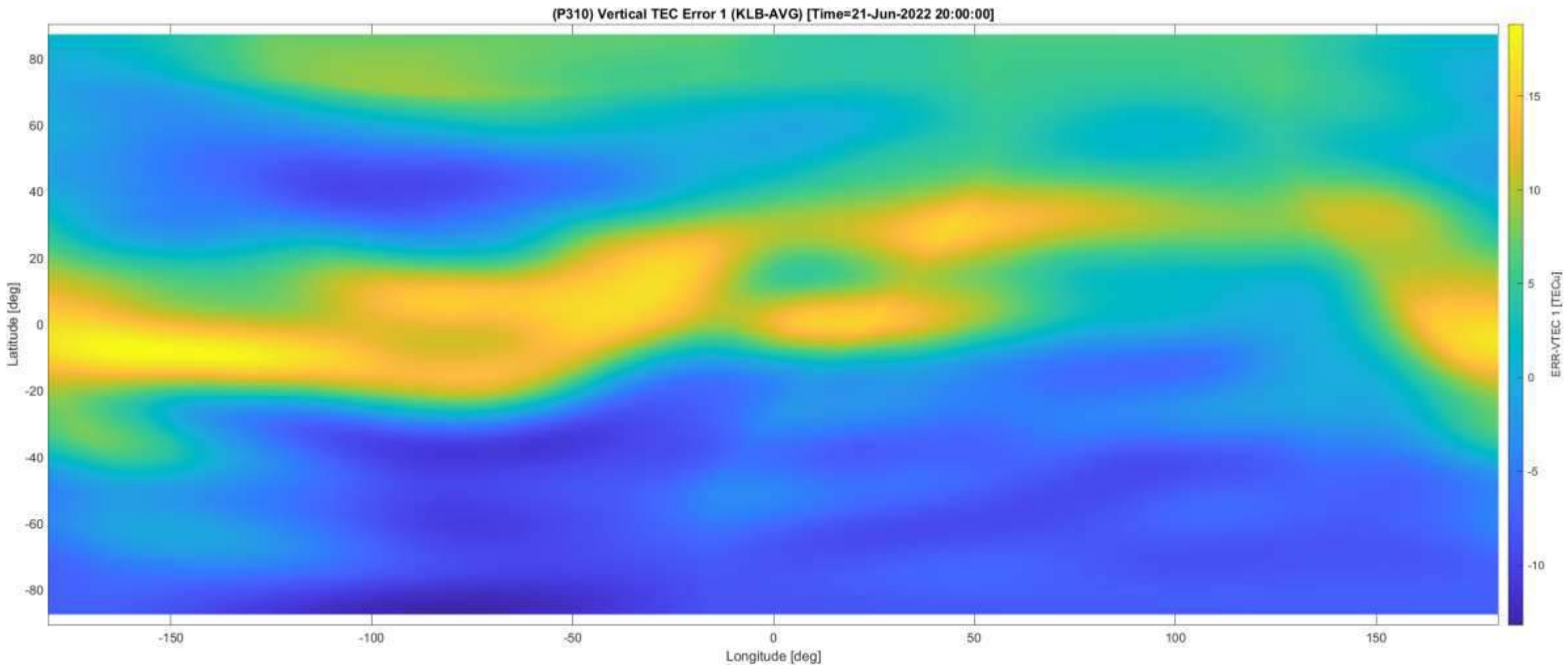
HAS	SERVICE LEVEL 1	SERVICE LEVEL 2
COVERAGE	Global	European Coverage Area (ECA)
TYPE OF CORRECTIONS	PPP - orbit, clock, biases (code and phase)	PPP - orbit, clock, biases (code and phase) incl. atmospheric corrections
FORMAT OF CORRECTIONS	Open format similar to Compact-SSR (CSSR)	Open format similar to Compact-SSR (CSSR)
DISSEMINATION OF CORRECTIONS	Galileo E6B using 448 bits per satellite per second / terrestrial (internet)	Galileo E6B using 448 bits per satellite per second / terrestrial (internet)
SUPPORTED CONSTELLATIONS	Galileo, GPS	Galileo, GPS
SUPPORTED FREQUENCIES	E1/E5a/E5b/E6; E5 AltBOC L1/L5; L2C	E1/E5a/E5b/E6; E5 AltBOC L1/L5; L2C
HORIZONTAL ACCURACY 95%	<20 cm	<20 cm
VERTICAL ACCURACY 95%	<40 cm	<40 cm
CONVERGENCE TIME	<300 s	<100 s
AVAILABILITY	99%	99%
USER HELPDESK	24/7	24/7

GNSS systems performance monitoring

- Such a service informs users on:
 - current status of solar and ionospheric activity
 - achievable level of positioning accuracy and integrity
(worldwide, regional, specific areas or volumes, trajectories)
 - degradation of GNSS services performances (position error and integrity forecast).
 - Ionospheric delay and scintillation prediction
 - Ionospheric error predictive models (ABAS, SBAS, SF/DF)
- Airspace users (ANSPs, airlines / pilots, drone operators)
- Strategic/tactical planning, flight-plan development



Ionospheric error prediction (Klobuchar – ref)



An example: PbNAV service

- Increase aircraft crew's awareness about the achievable performance level of on-board GNSS systems for en-route and non-precision approach operations (LNAV).
- It periodically computes forecast maps over global/local airspace volumes and trajectories for several GNSS performance parameters:
 - ABAS-based receiver H/V Position Error (horizontal/vertical errors)
 - HPL Horizontal Integrity (RAIM FDE Horizontal Protection Level)
 - other quantities, like accuracy, availability, continuity, integrity risk
- Prediction horizon that can range from few minutes to, potentially, 24 – 48 hrs.

GNSS Performance KPI Analysis Report (ABAS)

Daily Report (17-Jun-2022 00:00 - 17-Jun-2022 23:59)



Telespazio - PBNav (2005-2022)

ABAS-Augmented Receiver Model - RAIM FDE Algorithm compliance: DOA0040 3rd ed. 2017 - par. 7.8 (Monitoring and Recording of GNSS Data)
 Report created on: 17-Jun-2022 10:12 (local time)

Chapter 1: Report Summary

This chapter provides a quick overview of the results obtained for each KPI in the interval of analysis. In particular, the text in GREEN reveals that the KPIs are within the specified limits whereas the text in RED informs the user that the KPI is fully or partially outside the operational limits. Alarm thresholds are specified in the correspondent chapters 2 - 7, together with a more detailed description of the analysis results obtained for each KPI. Additional information can be found in the reference standard documents listed in the final chapter 8.

1.1. KPI 1: Position Accuracy

NO FAIL EVENTS DETECTED

1.2. KPI 2: Range Domain Accuracy (URE)

NO FAIL EVENTS DETECTED

1.3. KPI 3: Service Availability

NO FAIL EVENTS DETECTED

1.4. KPI 4: Probability of a Major Service Failure

NO FAIL EVENTS DETECTED

1.5. KPI 5: Continuity

NO FAIL EVENTS DETECTED

1.6. KPI 6: Probability of a Simultaneous Major Failure

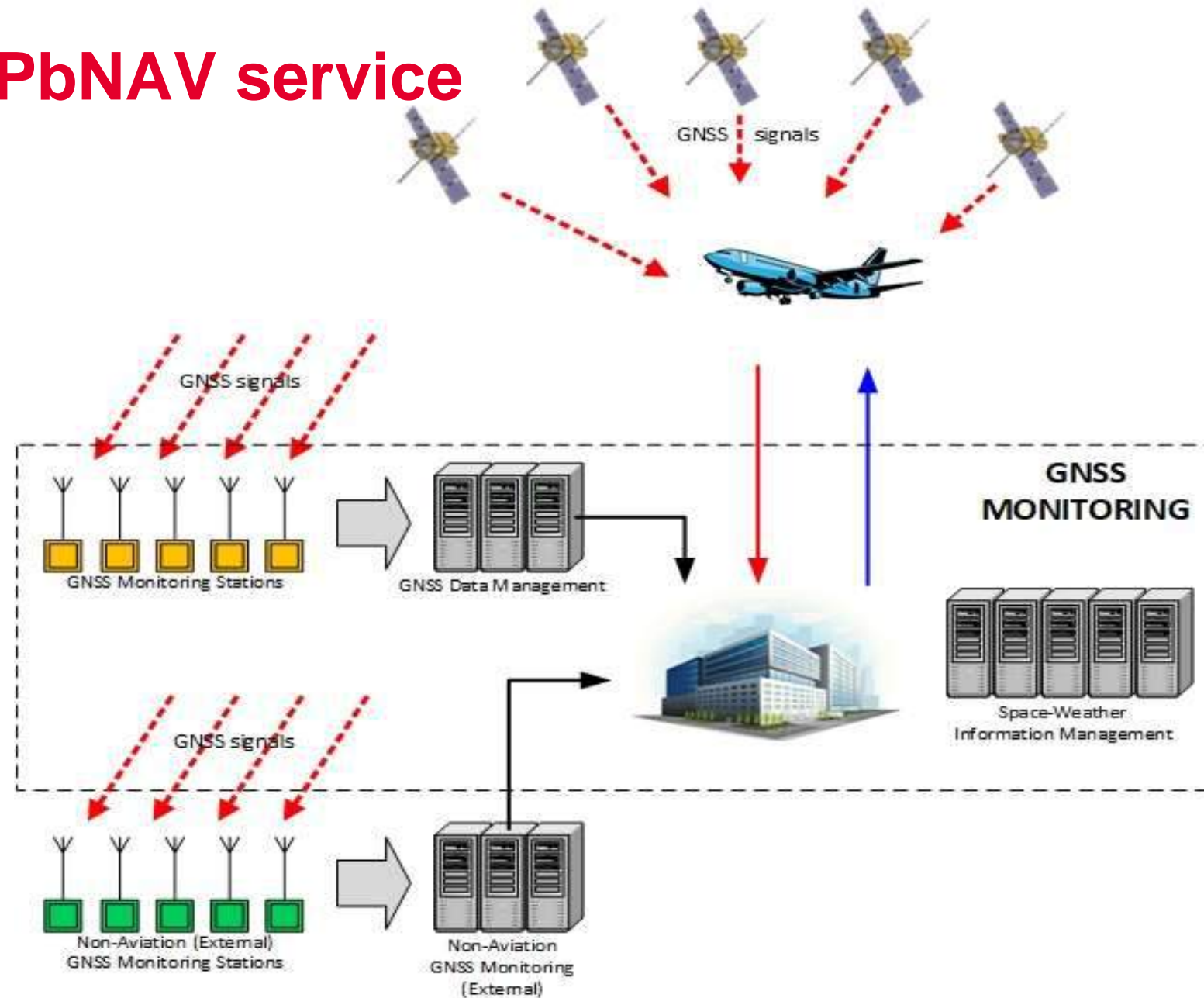
NO FAIL EVENTS DETECTED

1.7. KPI 7: Integrity Risk

NO FAIL EVENTS DETECTED

Chapter 2: Detailed report on KPI 1: Positioning Accuracy

An example: PbNAV service



Effects of ionosphere on COM services

- Effects of ionospheric scintillation:
 - satellite and terrestrial communication (VHF/UHF and higher frequency bands)
 - High-speed digital communication service degradation
 - disturbances on radar systems
 - civilian and military aviation, maritime, drone operators
- Short-term research interests:
 - Scintillation prediction
 - Scintillation modelling for Satellite-Earth communication links



Thank You

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 **TELESPAZIO**
a LEONARDO and THALES company