



SBAS solution GCC, Yemen and Iraq

System baseline and performance

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ThalesAlenia
a Thales / Leonardo company **Space**



SBAS services definition for Civil Aviation



NPA : Non Precision Approach - LNAV

- Provided to ensure horizontal guidance approach for aircraft using augmented GNSS.
- Vertical guidance being ensured by aircraft baro-altimeter or other conventional means.

APV-I : Precision Approach - LNAV/VNAV

- Provided to ensure precision approaches using augmented GNSS for horizontal and vertical aircraft guidance
- Decision Height: 250ft

SBAS performance allows RNAV5 and RNAV1 capabilities for “En-Route” and “Terminal Area” for aircraft using augmented GNSS.

Multiple Civil Aviation Services relying on a single SBAS infrastructure



Targeted Service Performances

Services performance:

1- Aeronautical (Safety of Life)

	En route	Terminal	NPA	APV-I
Time to Alarm	300 s	15 s	10 s	10 s
Horizontal Alert Limit	2 NM (3704m)	1NM(1852m)	0.3 NM (556m)	40m
Vertical Alert Limit	N/A	N/A	N/A	50 m
Integrity risk	1e-7 / h	1e-7 / h	1e-7 / h	2e-7 / approach
Continuity risk	2.5 to 5 10-4/h	2.5 to 5 10-4/h	2.5 to 5 10-4/h	10-3 to 10-5/15s
Horizontal accuracy (95%)	3700m (2.0 NM)	740m(0.4NM)	220 m(720feet)	16m(52 feet)
Vertical accuracy (95%)	N/A	N/A	N/A	20 m (66 feet)
Availability	0.99 to 0.999	0.99 to 0.999	0.99 to 0.999	0,99

2- Non Aeronautical (Positioning service -Non Safety of Life)

	Positioning Service
Horizontal accuracy	1 m
Vertical accuracy	2 m

APV-I the most demanding performance

Applicable Standards

SBAS and GPS applicable standards

- MOPS D with Change 1 (RTCA/DO-229D)
- SARPS (ICAO Annex 10 Vol 1)

SBAS interoperability ensured with international Standards



APV-I proposed Service Area



Edges of the proposed APV-I Service Area

This Service Area includes the following countries: Bahrain, Iraq, Kuwait, KSA, Oman, Qatar, UAE, Yemen. (GCC states plus Yemen and Iraq).

En route and NPA proposed Service Area



Edges of the proposed En route and NPA Service Area

Targeted service area:

25° < Longitude East < 65°
 5° < Latitude North < 45°

Definition of an Autonomous SBAS on GCC, Yemen and Iraq

Main features:

- **Services:** En route, NPA, APV-I for aviation and Positioning service for other domains.
- **APV-I Service Area:** Bahrain, Iraq, Kuwait, Kingdom of Saudi Arabia, Oman, Qatar, United Arab Emirates, Yemen.
- **Satellite configuration:** 24 GPS and 2 GEOs with SBAS ranging payloads
- **Reference station network:**
 - ✓ 24 Reference stations in total.
 - ✓ Most of the Reference stations will be installed inside the countries listed above and some outside the targeted area.
 - ✓ 5 Reference stations out of 24 will be located far from the Service Area. Need of these Reference stations for orbit algorithms.

Autonomous SBAS with a full sovereignty

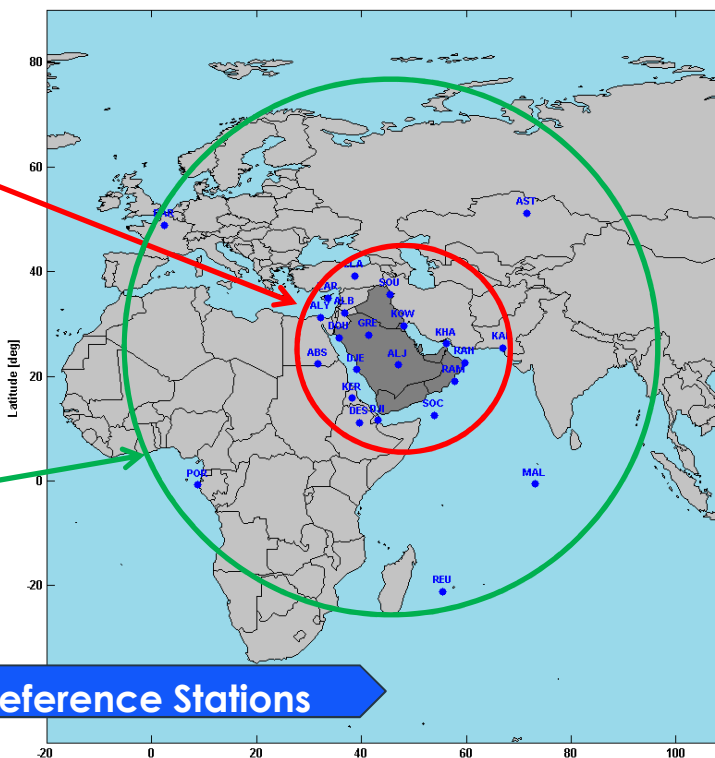


Reference stations network

24 reference stations network defined as baseline to ensure performance over the requested countries

19 Core stations network for GPS satellite and ionosphere delays monitoring

5 Stations for better GPS satellite orbit determination

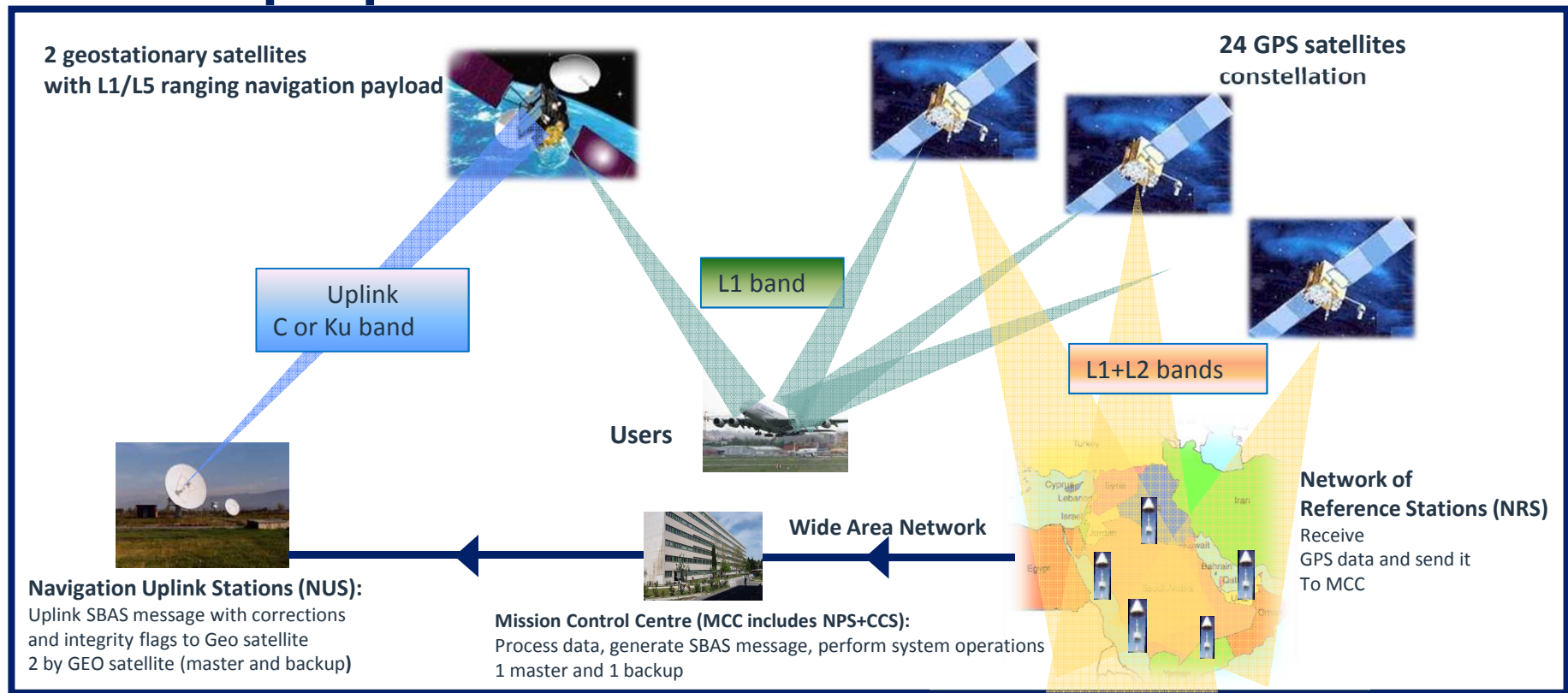


These Reference Station locations are depending upon many criteria such as:

- Optimisation of SBAS system performance;
- Clear RF environment;
- Availability of Hosting site with access to power supply and Data communication;
- Easiness of access for operation and maintenance.

Flexible location choices for Reference Stations

SBAS proposed architecture

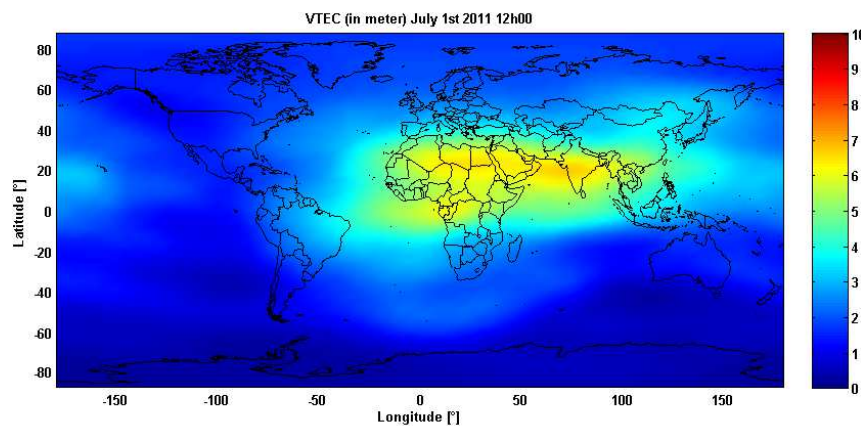


Distributed architecture with flexible location choices

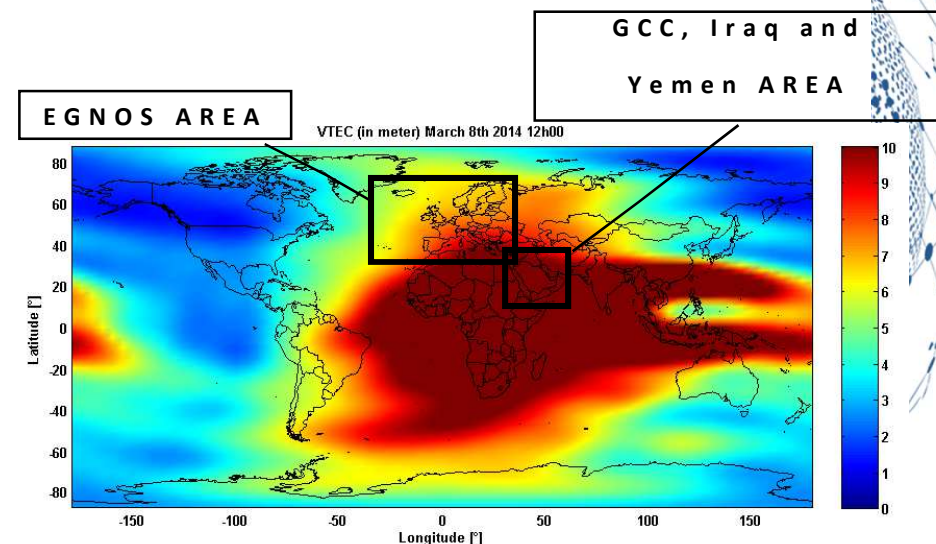
Ionosphere scenario for performance assessment

Middle East region undergoes equatorial ionosphere conditions which are impacting

- GNSS signals acquisition and tracking
- Positioning accuracy.



Nominal ionosphere condition day
(B-Class Solar Flare level)

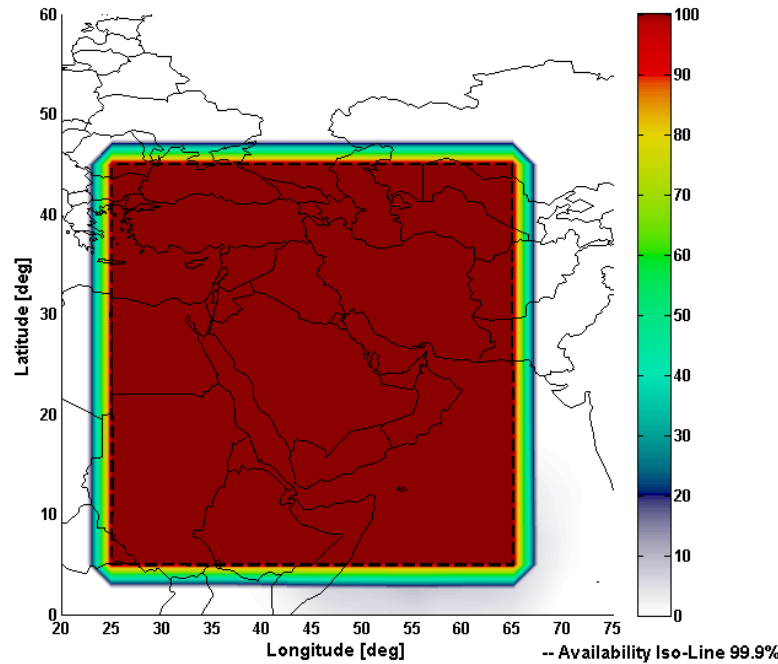


Day chosen for SBAS performance demonstration
(M-Class Solar Flare level) (March 8th 2014)

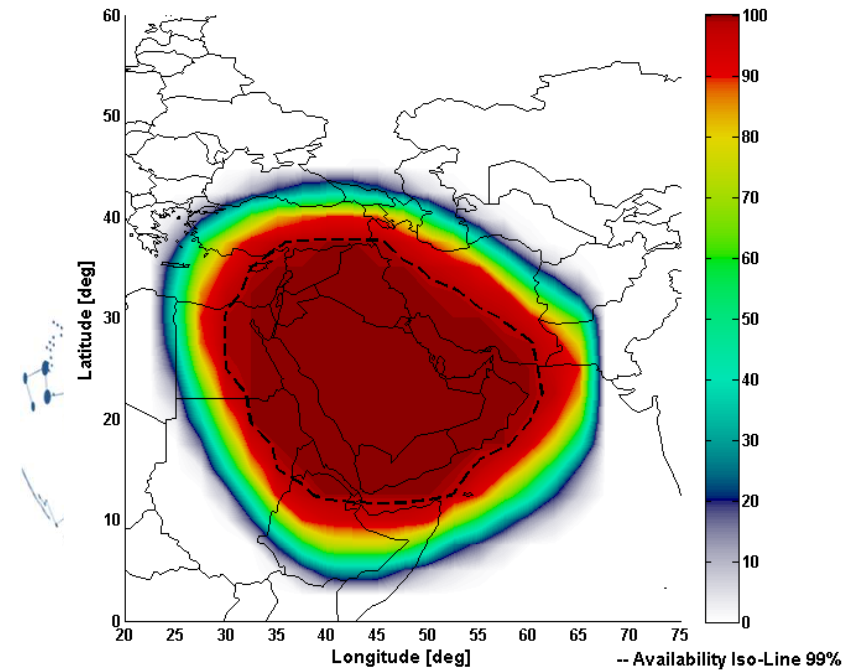
Performance assessment must be done with disturbed ionosphere condition day

Performance Results

SBAS Services Performance achieved using disturbed ionosphere data.



NPA service availability



APV-I service availability

Full performance achievement for APV-I and NPA services

Development of SBAS system

- **Development schedule** (until technical qualification)
 - About 4 years
- **Dates of need for GEO1 and GEO2 payloads in orbit** (for system testing)
 - Geo 1: 2,5 years
 - Geo 2 : 3 years

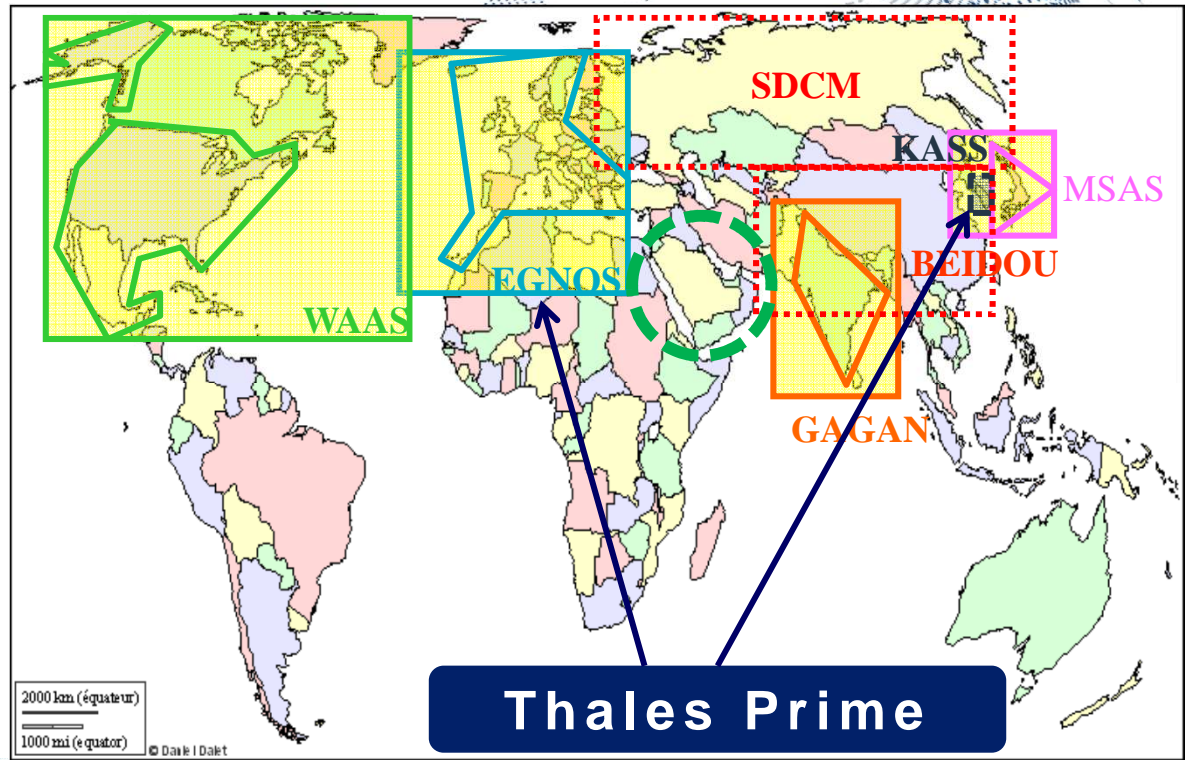
=> First Signal in Space available 3 months after Geo1 availability (for System testing period)
- **Service lifetime:** at least 20 years and more with upgrade.
- **Service available for all categories of airspace users:** Major Airlines, Regional aviation, General and Business aviation, Helicopters, Aerial work and Light aviation.

SBAS system suitable and certified to enhance Aviation Safety and foster adoption of ADS-B with integrity

SBAS: a Spreading Trend

SBAS in operation or in development

SBAS implementation is driven by benefits for Aviation and ICAO Policy "A37-11 resolution".



Acronym definition



SBAS: Space Based Augmentation system
EGNOS: European Global Navigation Overlay System
NRS: Navigation Reference Station(Reference sensors)
WAN: Wide Area Network (Data Communication Network)
NPS: Navigation Processing Station (Processing Set & Check Set)
CCS: Centralized Control Station
MCC: Mission Control Center
NUS: Navigation Uplink Station
TAS: Thales Alenia Space
GNSS: Global Navigation Satellite System
GPS: Global Positioning System

ICAO: International Civil Aviation Organization
MOPS: Minimum Operational Performance Standards
SARPS: Standards and Recommended Practices
NAVAIDs: Navigation Aids
ILS: Instrument Landing System
GBAS: Ground Based Augmentation System
CAT I: Category I
ADS-B: Automatic Dependent Surveillance Broadcast
LPV: Localizer Performance with Vertical Guidance
APV-I: Approach with Vertical guidance Category I
PBN: Performance Based Navigation
GPS L1: Aviation Radio Navigation Service (Cent. Freq. = 1575.42 MHz)
GPS L2: Radio Navigation Satellite Service (Cent. Freq. = 1227.6 MHz)

