GNSS Sensor Interface Harmonisation

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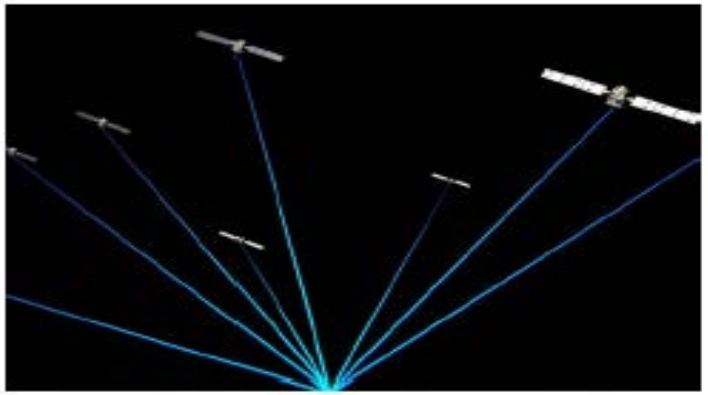
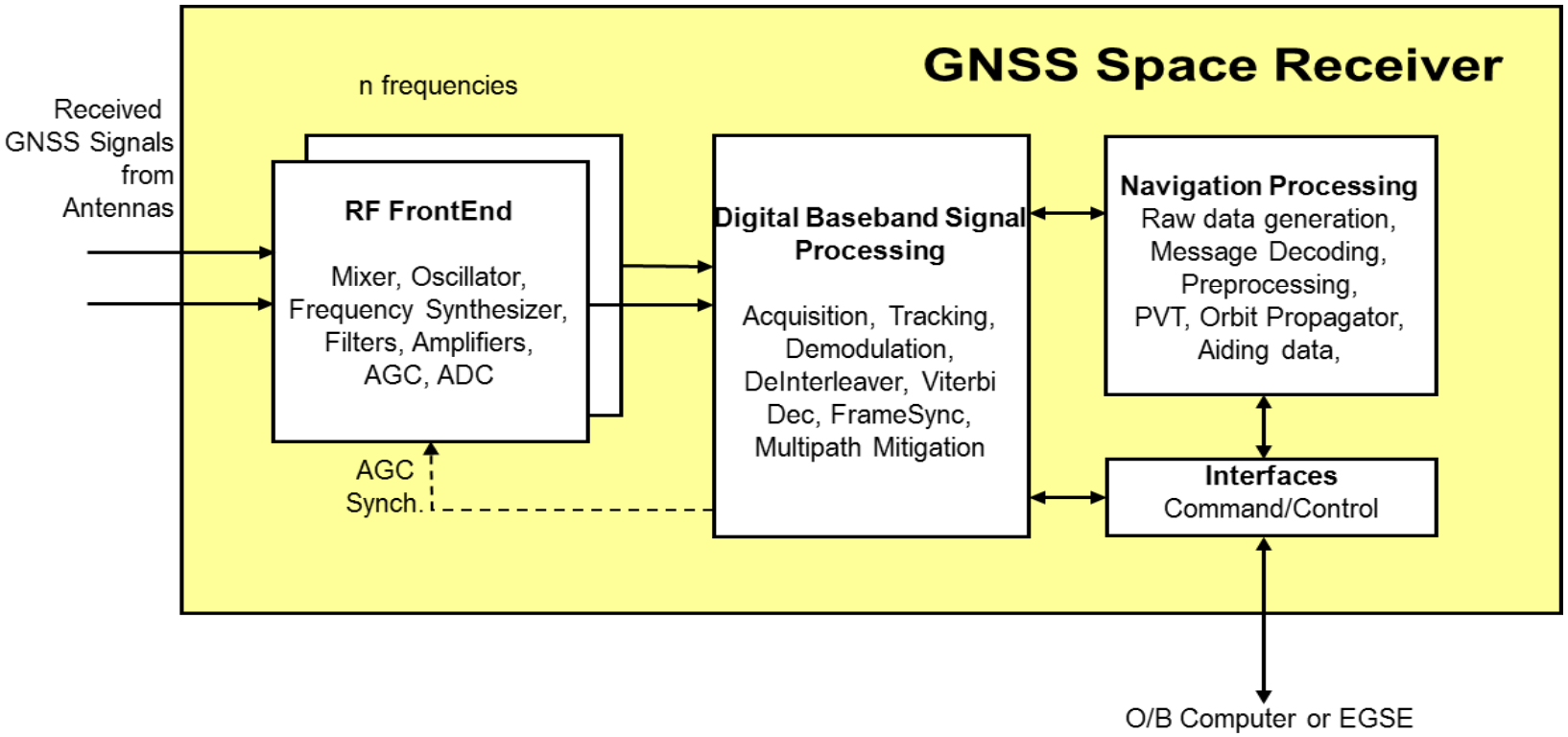
GNSS Space Receivers Overview

1. On Board Navigation Receivers are used on spacecrafts (S/C):
   a) As a **sensor** to determine the S/C PVT (Position, Velocity and Time)
   b) As a EO/Scientific **instrument,** (Radio Occultation, POD, Reflectrometry)

2. Different objectives:
   a) On board PVT enhances S/C autonomy and reduces mission costs.
   b) EO & Scientific applications demands high quality measurements, high precision and extensive data processing on-ground.



GNSS Space Receivers Overview



GNSS Space Applications

Application		Accuracy	Mission Examples	Orbit
Absolute Navigation (AOCS Sensor Rx)	**LEO Orbit**	10-20 m	PLEIADES, DMC, GlobalStar2G, Proba-2, Demeter, EarthCare COSMO-SKYMED, Radarsat-2	LEO
	On-board RT LEO POD	0.3-3 m	SWARM, GMES Sentinels, Topex-Poseidon	LEO
	GEO / HEO Orbit	50-150 m	STENTOR, SkyLAN, IntelSat, GMP, SmallGEO, STE-QUEST	GEO/ HEO
	Launchers	15 m	ARIANE 6, Evolutions of ARIANE V and VEGA	Grnd/ GTO
Relative Navigation (AOCS Sensor Rx)	**Rendezvous**	1cm – 10m	ATV	LEO
	FF	LEO: cms GEO: 1 m	GRACE, PRISMA, Proba-3, MMS, TerraSAR-X/TD-X,	LEO/ GEO

GNSS Space Applications

Application		Accuracy	Mission Examples	Orbit
Scientific Instruments	**POD**	0.01-2 m	GOCE, SWARM, GMES Sentinels, CHAMP, GRACE, BIOMASS, DEMETER, STE-QUEST	LEO
	Radio Occultation	cms- 0.1 mm/s	MetOp, CHAMP, MetOp2G, COSMIC, OCEANSAT-2, SAC-D, MEGHA-TROPIQUE	LEO
	Reflectmry		PARIS IOD, UK-DMC, CYGNSS	LEO
Support to other subsystems	**Attitude**	0.2° - 1°	PLEIADES, ROCSAT, TopSat	LEO
	Time Sync.	0.1 μs	GEO telecom, GlobalStar2G, O3B	LEO/ GEO
Exploration	**Moon**		Lunar Lander	LTO

Current GNSS Space Receivers

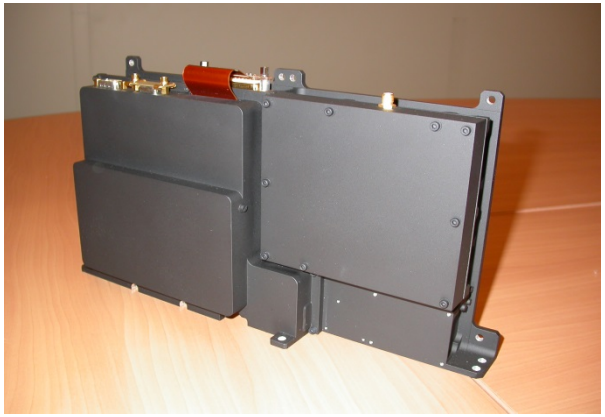
1. Currently, several European companies provide **space qualified GPS/GLONASS receivers** for LEO and GEO orbits
2. Different type of products are available:
    a. Single frequency L1 or dual frequency L1/L2
    b. GPS only or GPS/GLONASS
    c. Low cost, based on COTS components, or high-end performance
3. Main European players are: Airbus DS(D), TAS-I(I), TAS-F(F), RUAG Space(S), RUAG Space(A), DLR(D), SSTL(UK), Syrlinks(F)

4. **Most of them supports both I/Fs MilBus-1553 and UART RS-422**

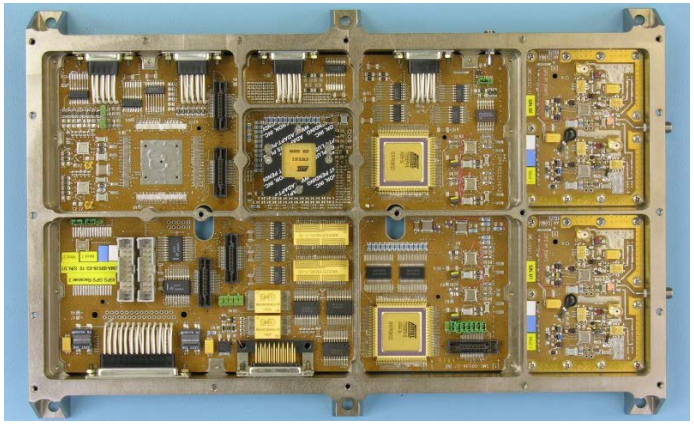
Current GNSS Space Receivers

1. Two parallel ESA developments completed in 2007, supporting GPS L1/L2C.
2. TopStar2G (TAS-F), with CNES support. Fly demonstration in Proba-2 satellite (2008), used also for GlobalStar2G and O3B constellations
3. RUAG (A), Saphyrion (CH). Selected by Swarm and GMES Sentinels missions.

PROBA2 L1/L2C FM receiver. TAS-F



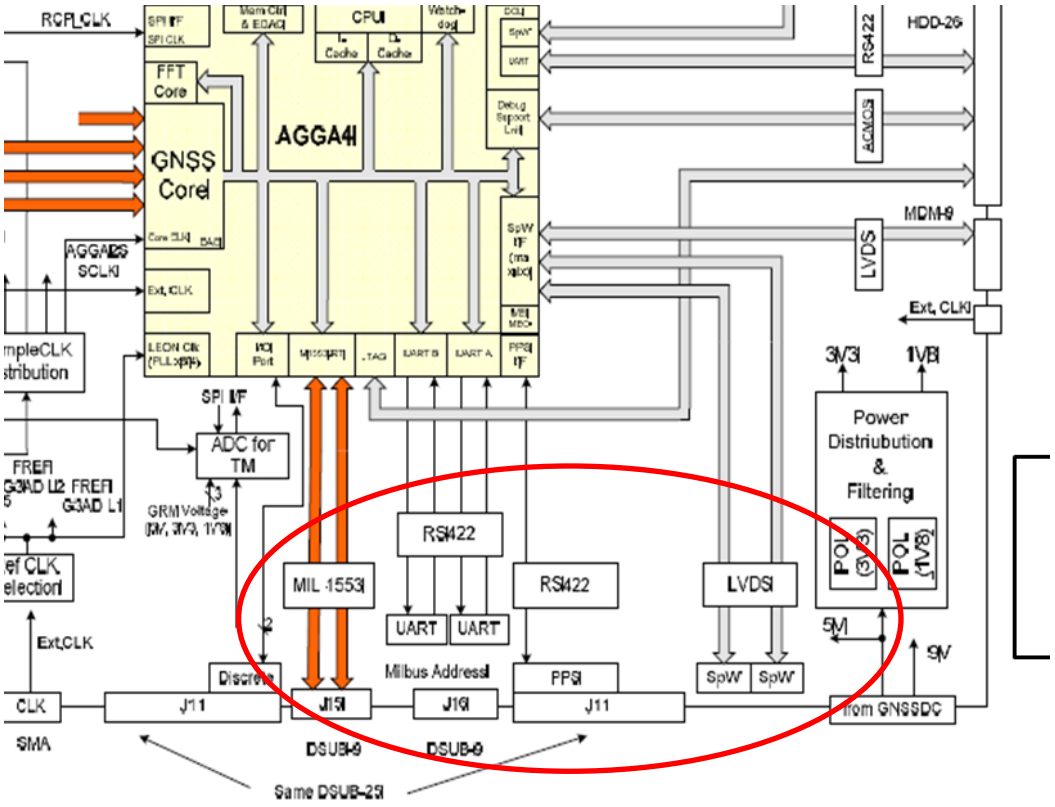
SWARM L1/L2 EM. RUAG (A)



GNSS Receivers New Generation

1. New GNSS systems are being deployed (Beidou, Galileo) and GPS/GLONASS start to transmit new signals
2. Several implementations are taking place in different European companies to include the new GPS signals (L2c,L5) and Galileo
3. ESA supports two parallel developments, GAMIR:
    a. GPS/Galileo multi-frequency Rx, tracking all Open signals
    b. Based on AGGA4 and Saphyrion chipset
    c. Supports all Interfaces: **SpaceWire, MilBus-1553 and UART RS-422**.
4. ESA missions request different types of GNSS I/F:
    a. MilBus-1553: GOCE, Sentinel-1,-2,-3, EarthCare, Jason CS.
    b. UART: Swarm, Proba-2,-3.
    c. Spacewire: MetOp-SG

GNSS Receivers New Generation



I/Fs

1. GAMIR development is internally prepared for any type of I/F
2. However, the external box I/F depends on the mission specification:
   a. GAMIR (Airbus) EM/EQM supports all of them, qual. MilBus-1553 (most common in ESA)
   b. GAMIR (RAUG) EM/EQM supports MilBus-1553, EQM Proba-3 UART

Conclusions

1. On board GNSS Receivers is a key technology for many different type of space applications and missions
2. New GNSS systems are being developed, and new signals transmitted
3. Different ESA missions requests different types of GNSS I/F: MilBus-1553, UART, Spacewire
4. I/F harmonization is always an important issue
5. GAMIR Receivers being developed by ESA are ready to support any I/F