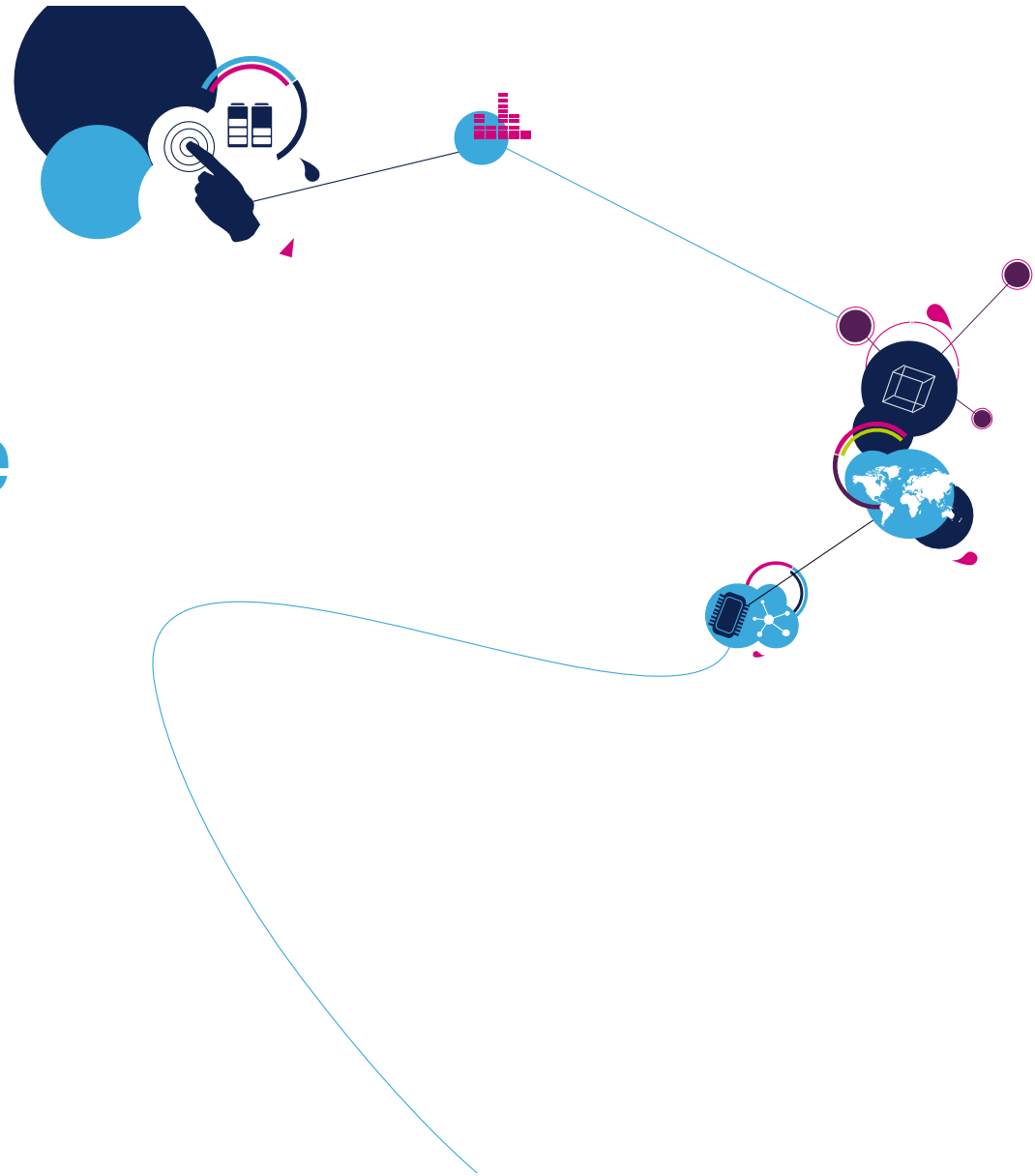


# Intro to GNSS & Teseo-LIV3F Module for IoT Positioning



## Presentation

Speaker

Mike Slade

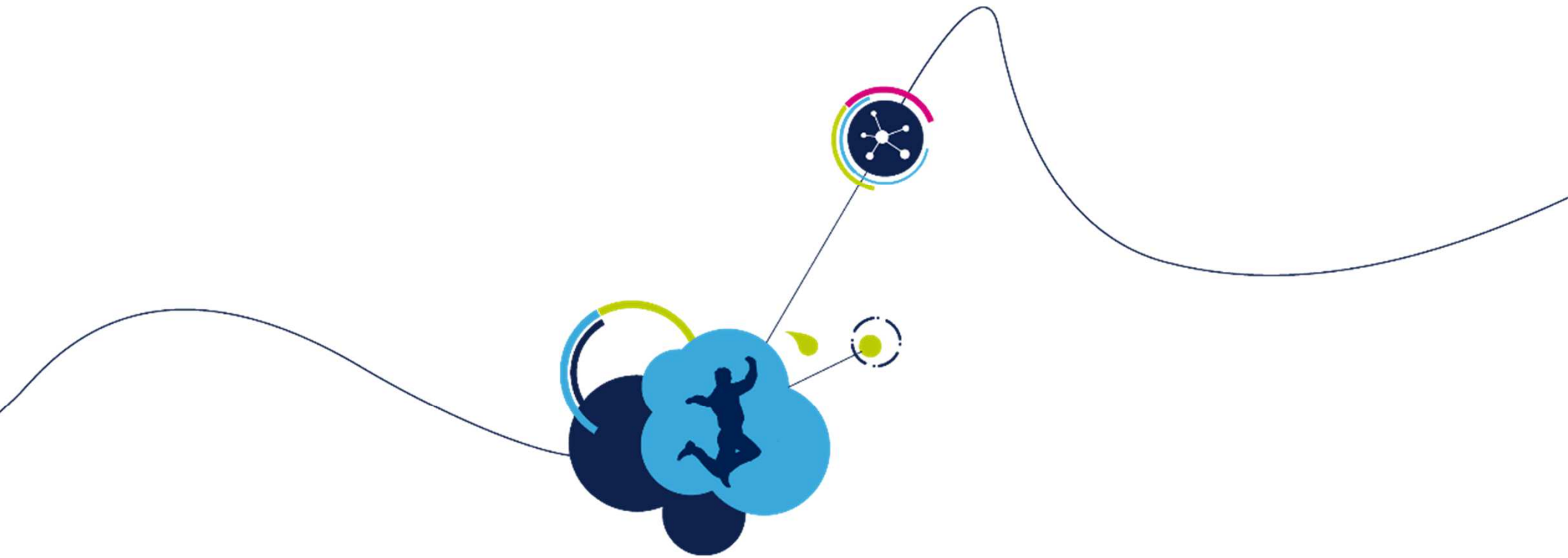
GPS Signal Overview  
GNSS Constellations

Teseo3 Chipset

- Overview
- Multi-Constellation Benefit

Teseo-LIV3F Module

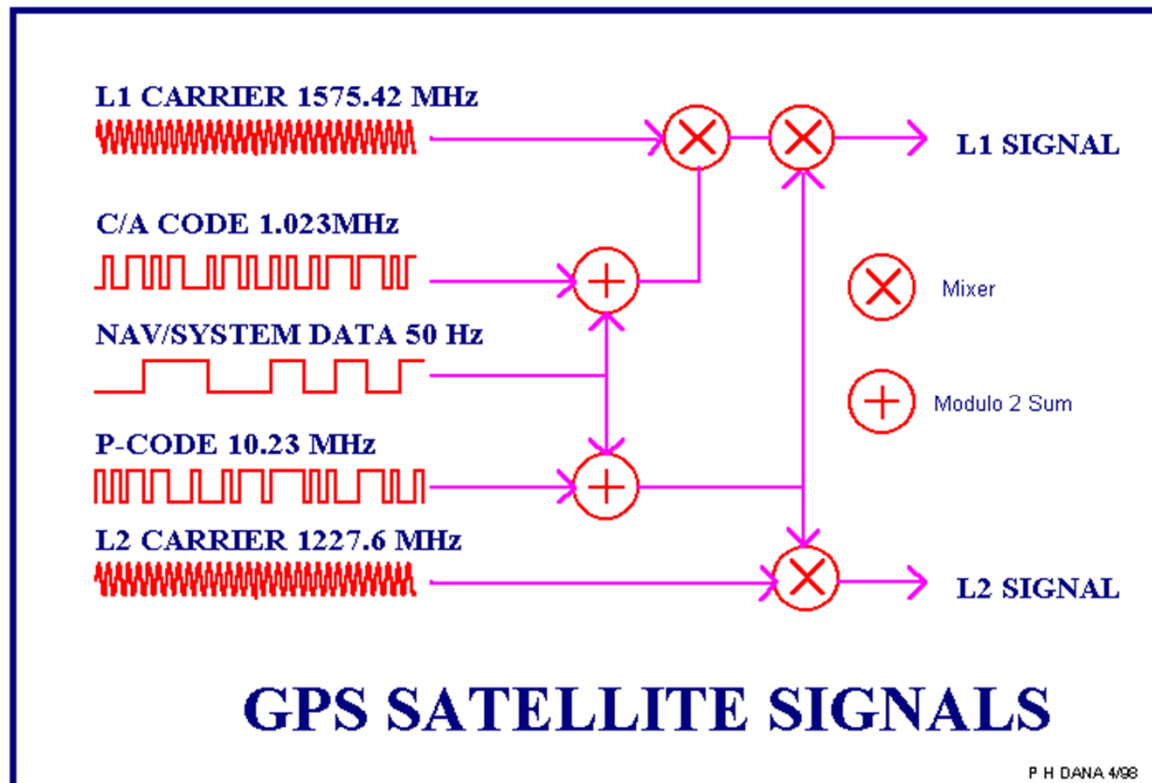
- Overview
- Performance & Features
- Advanced Features
- Tools



# GPS Signal Overview

# GPS L1 & L2 Signal Generation

4



# GPS L1 Signal Model

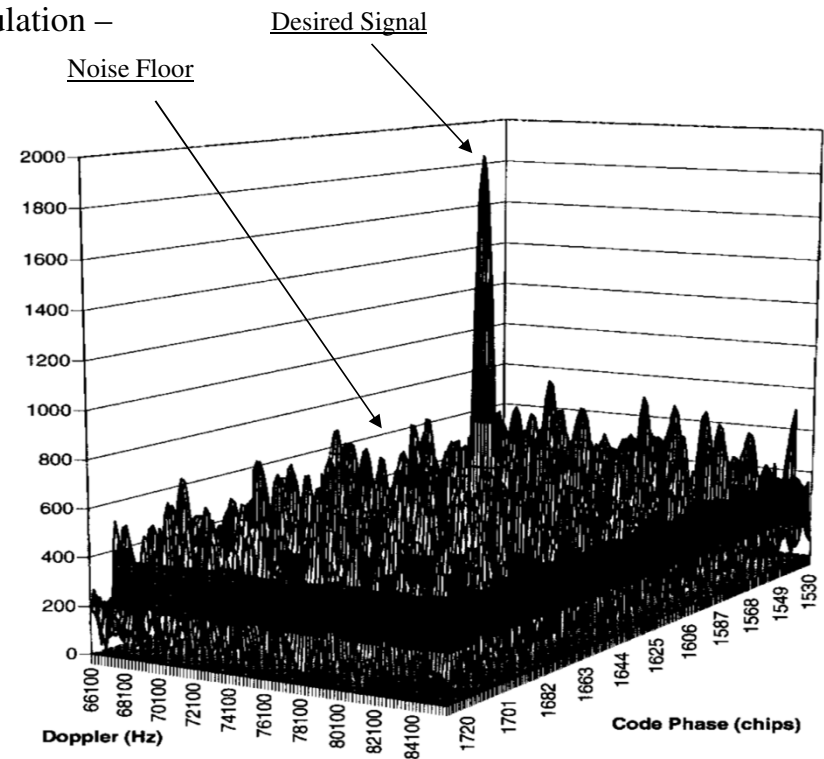
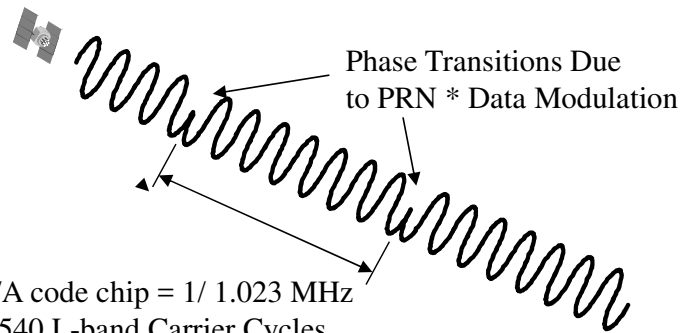
$$L1_i(t) = D_i(t)PY_i(t) \cos(\omega_1 t) + \sqrt{2}D_i(t)CA_i(t) \sin(\omega_1 t)$$

$D_i(t)$  Data modulation of 50 bit per second Navigation Message

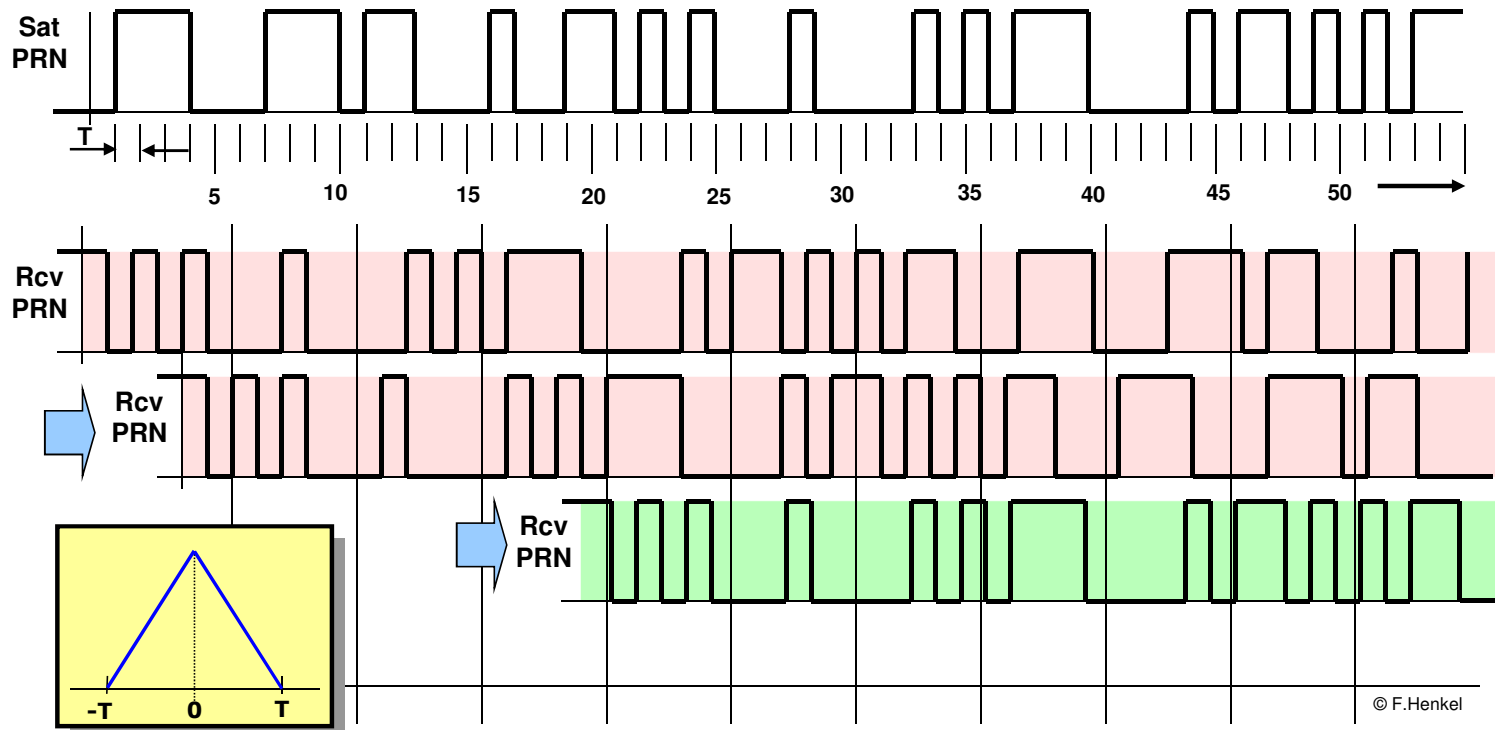
$CA_i(t)$  1.023 Mchip/sec Pseudo Random Noise (PRN) Modulation –  
unique “Gold” Code Sequence  
**1023 chip / 1 millisecond cycle**

$PY_i(t)$  10.23 Mchip/sec PRN Modulation –  
 unique “Long Secure” Code Sequence

$\omega_1$  GPS L1 Carrier Frequency **1575.42 MHz**

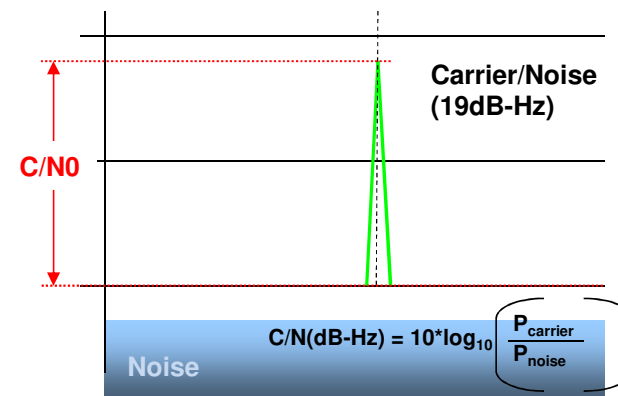
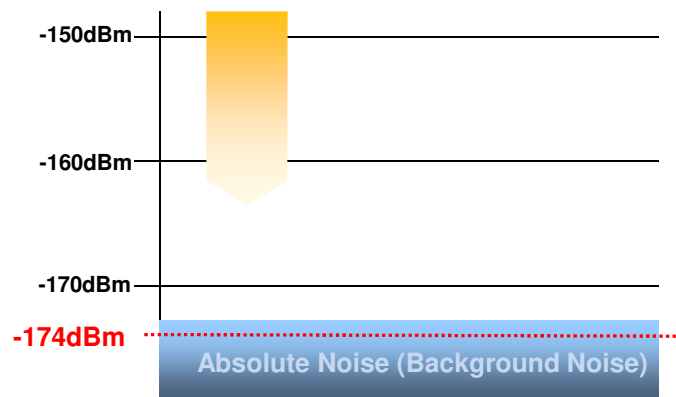
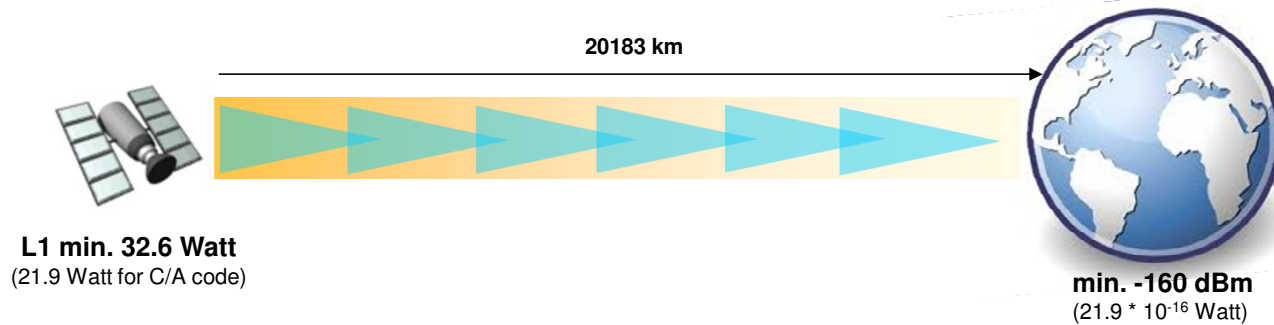


# PRN Correlation

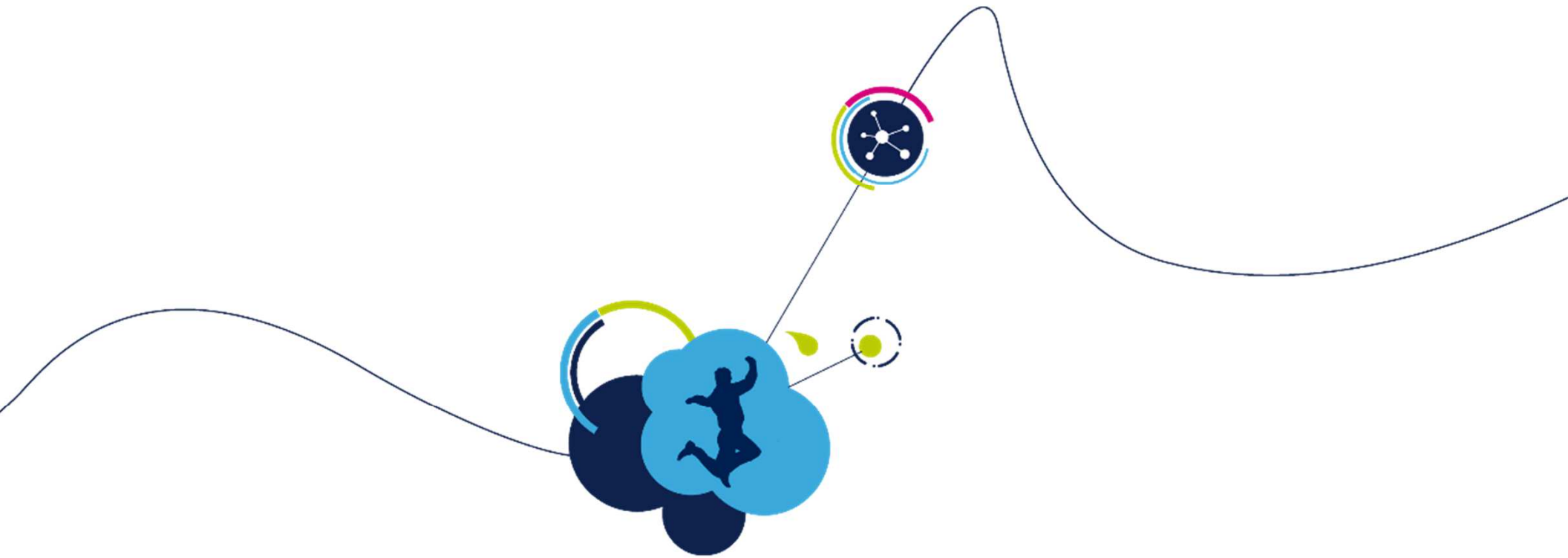


Shifting receiver generated PRN code to "find" a satellite is part of the "acquisition" process

# Satellite Signal Strength



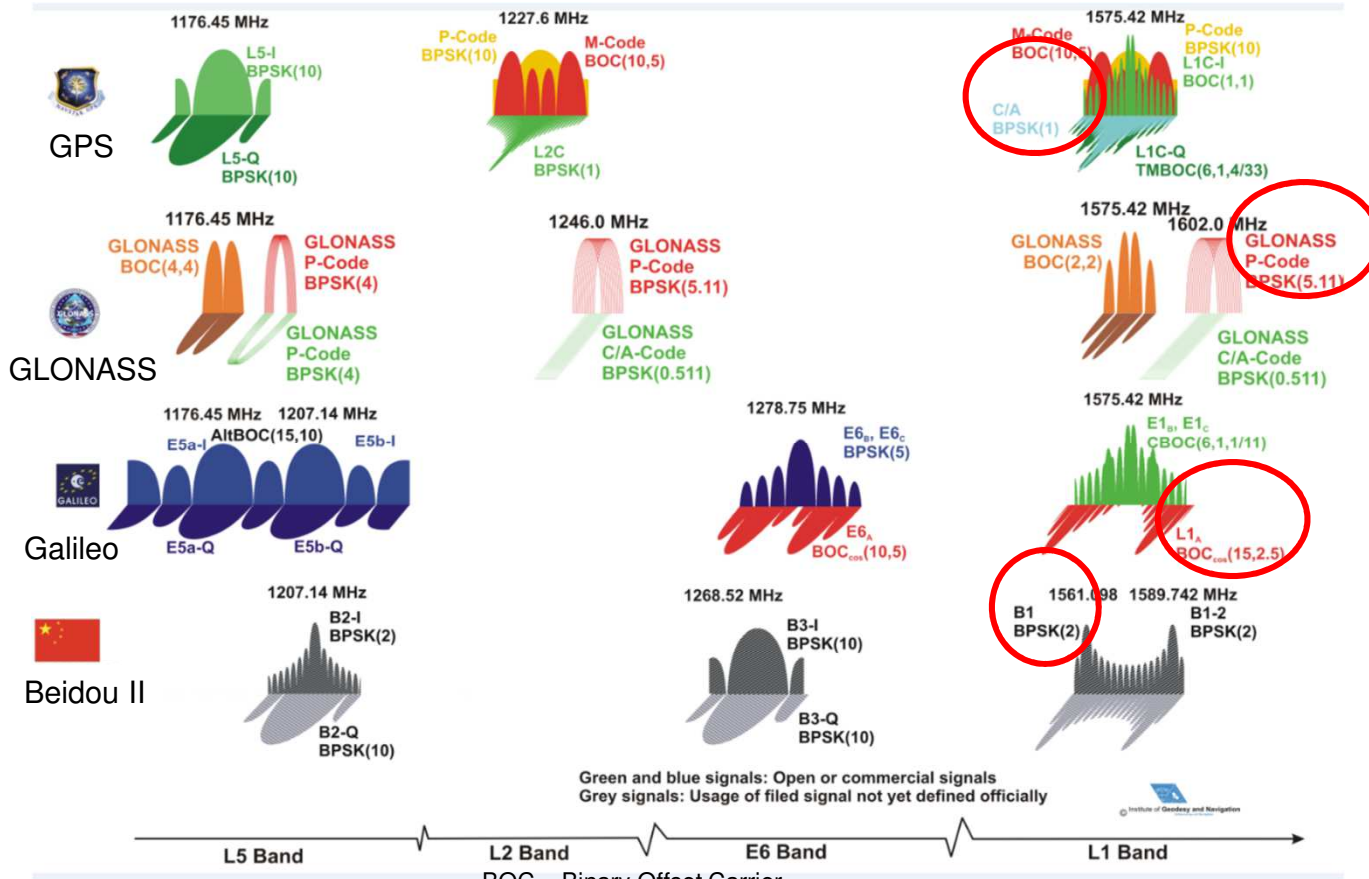
CN0 = referenced to 1 Hz bandwidth  
dBm = referenced to 1 milliwatt



# GNSS Constellations

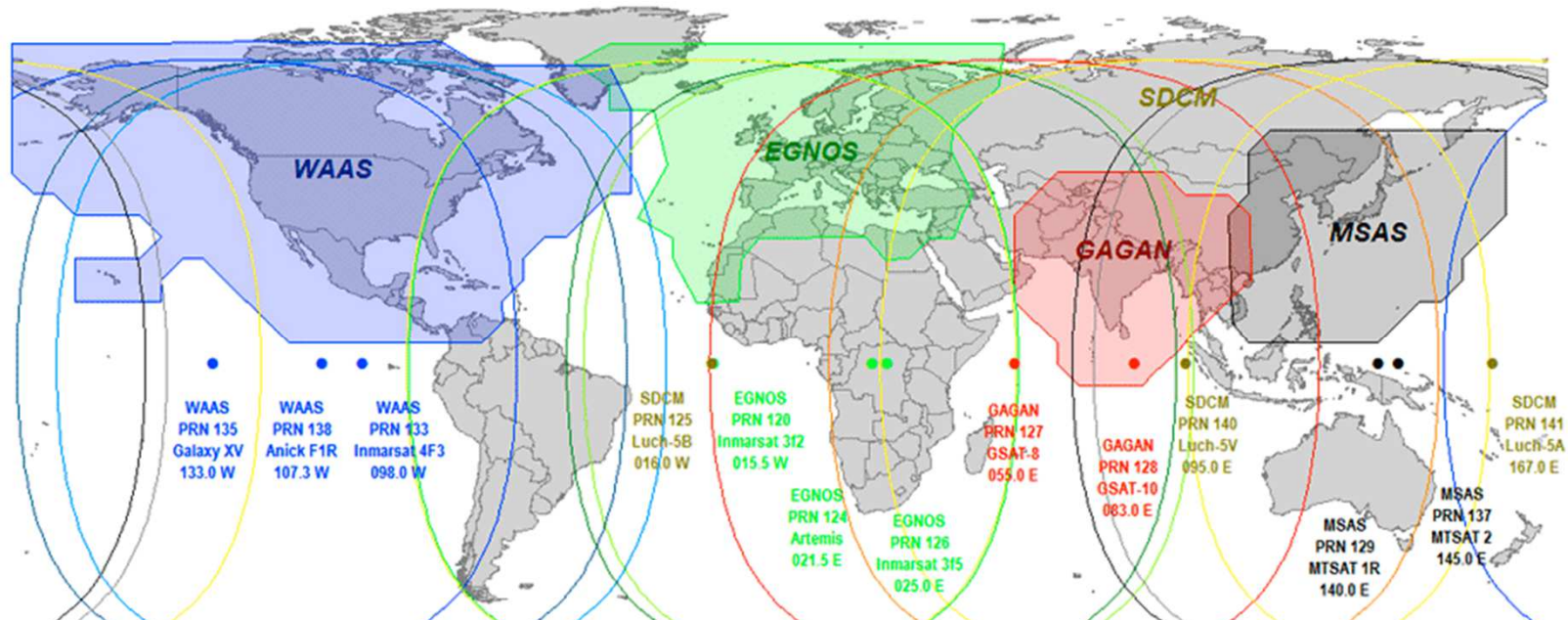


# GNSS Satellite Signals

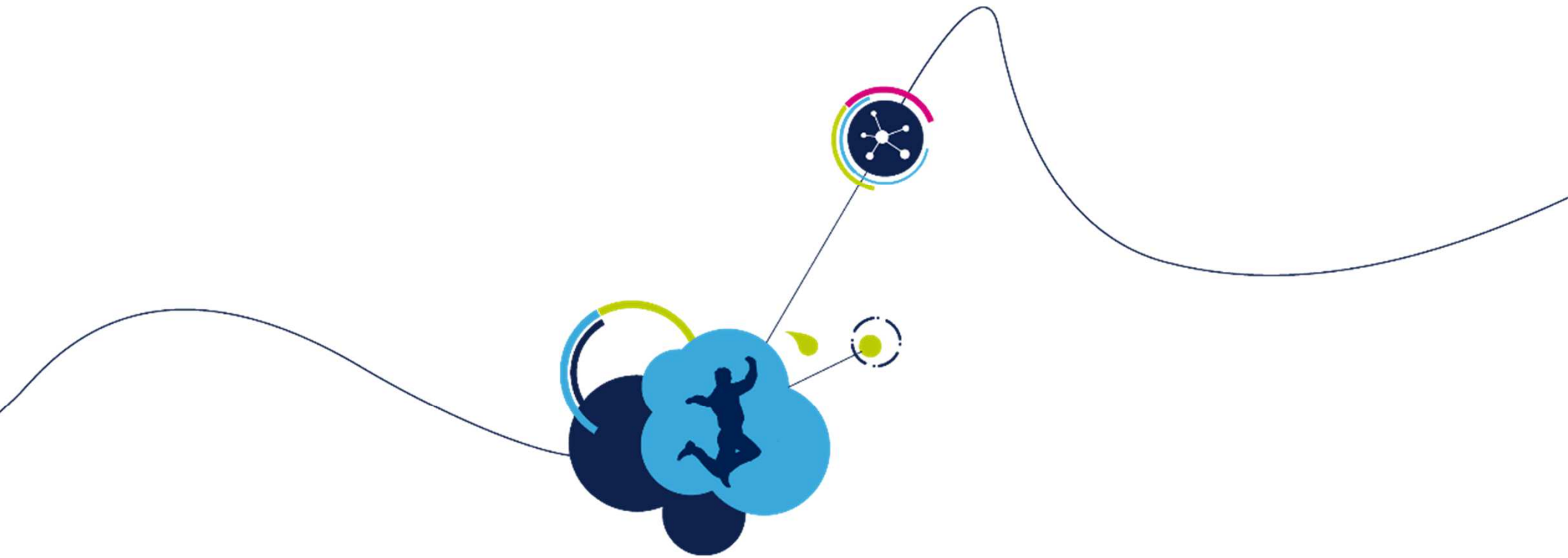


BOC = Binary Offset Carrier  
 BPSK = Binary Phase Shift Keyed

# Satellite Based Augmentation Systems (SBAS)



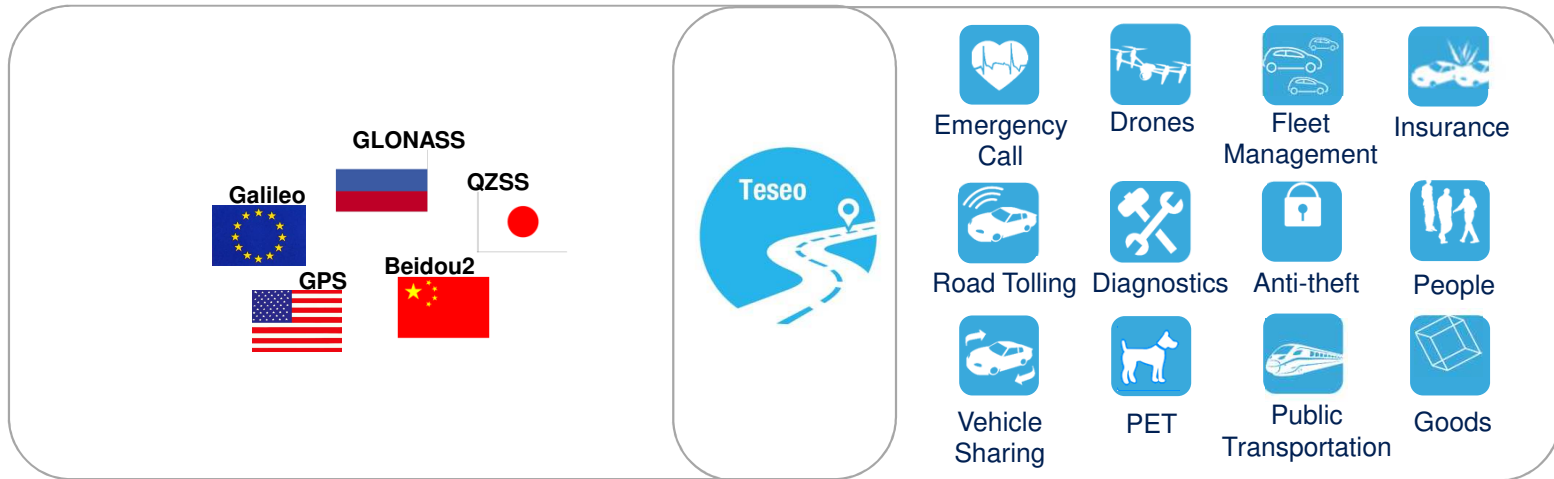
**SBAS Benefits:**  
Accuracy – Provide wide area corrections (Ionospheric, GPS satellite timing & orbit) for reducing GNSS ranging errors  
Integrity – Fast detection & indication to receivers when satellite signal errors occur  
Availability – If ranging signal is transmitted from SBAS satellite



# Teseo3 Chipset Overview



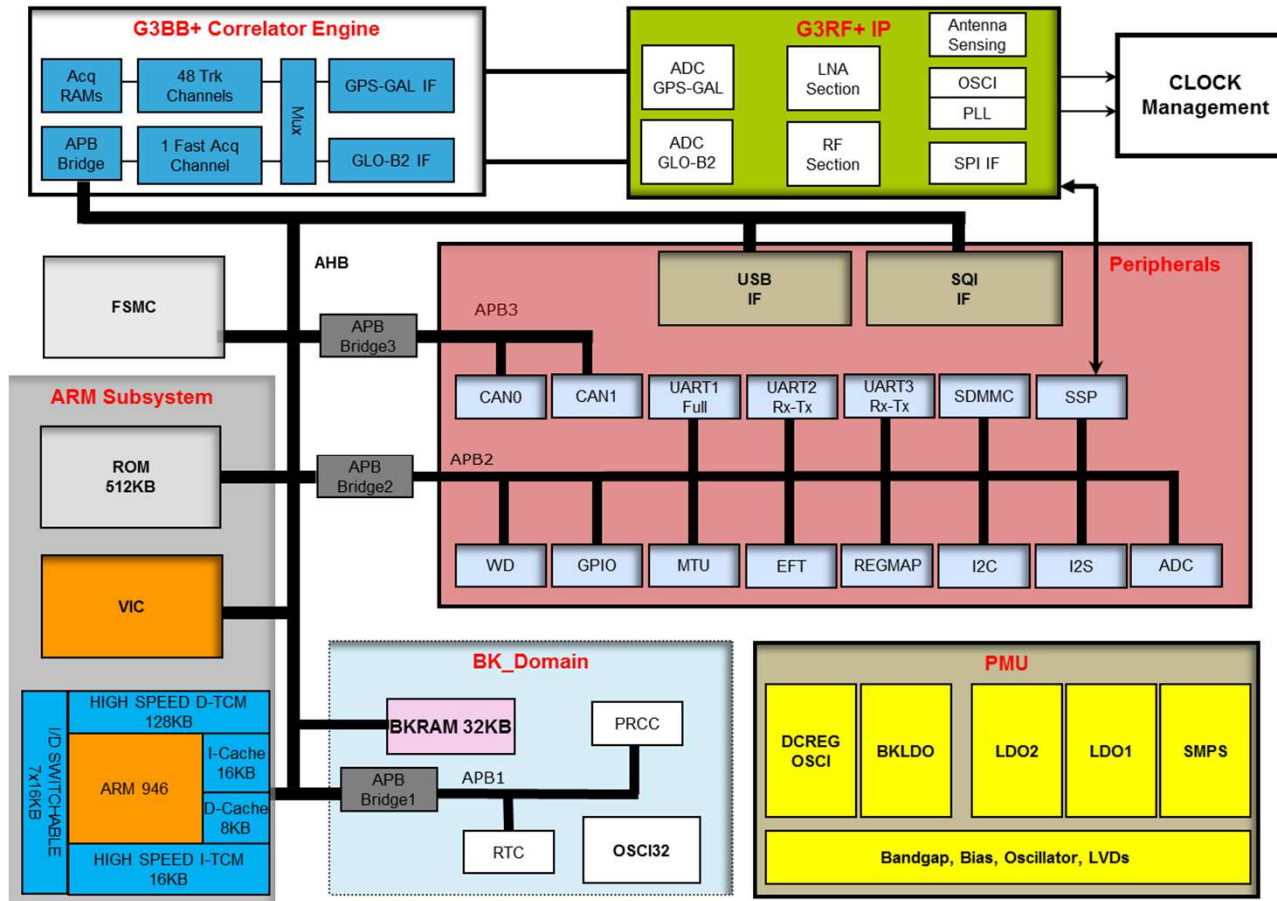
# What is Teseo ?



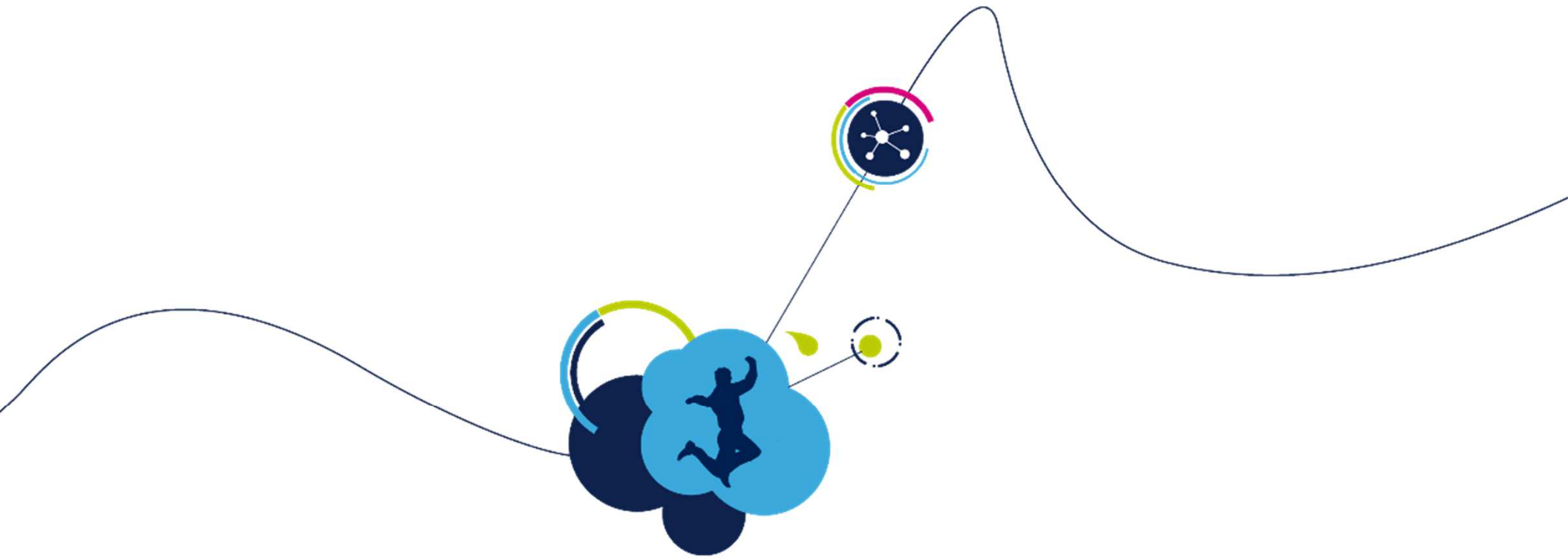
MultiConstellation GNSS

Numerous Applications

# Teseo3 Chipset Architecture

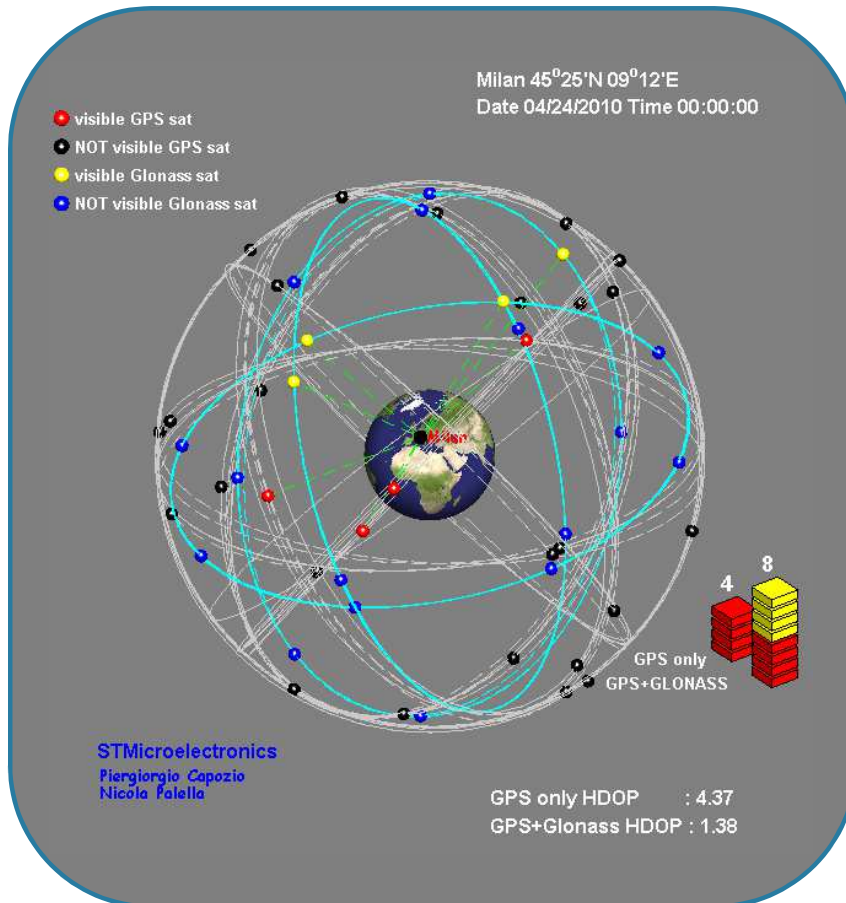






# Multi-Constellation Benefit

# Simultaneous Multi-Constellation Benefit



**More satellites**  
**Higher availability**  
**Better accuracy**



Constellation	GPS	GPS+Glonass
Visible Satellite*	4.4	7.8
No Fix	380 min	Never
HDOP*	5.3	2.1
Accuracy*	x meter	(x * 0.4) meter

\*Average Value (24hrs)





# GPS+Glonass

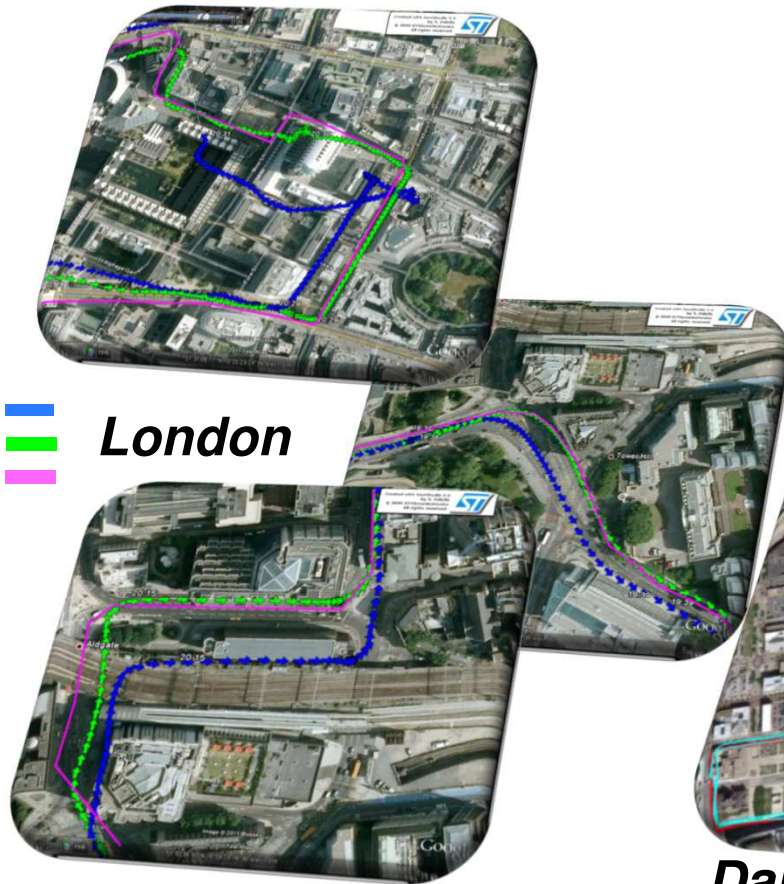
Chicago



GPS  
GPS+GLO  
TRUTH



London



GPS  
GPS+GLO  
TRUTH



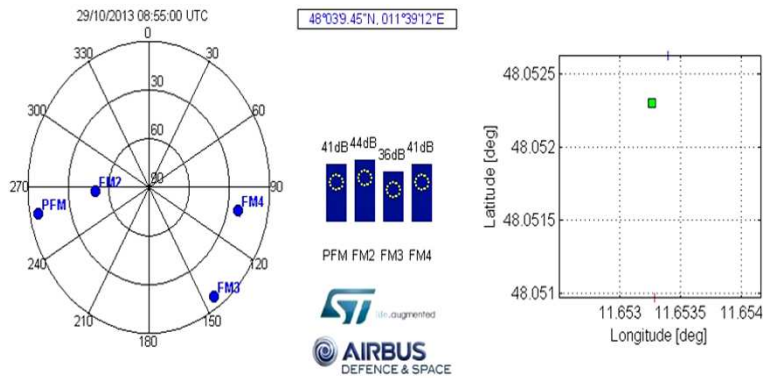
Dallas



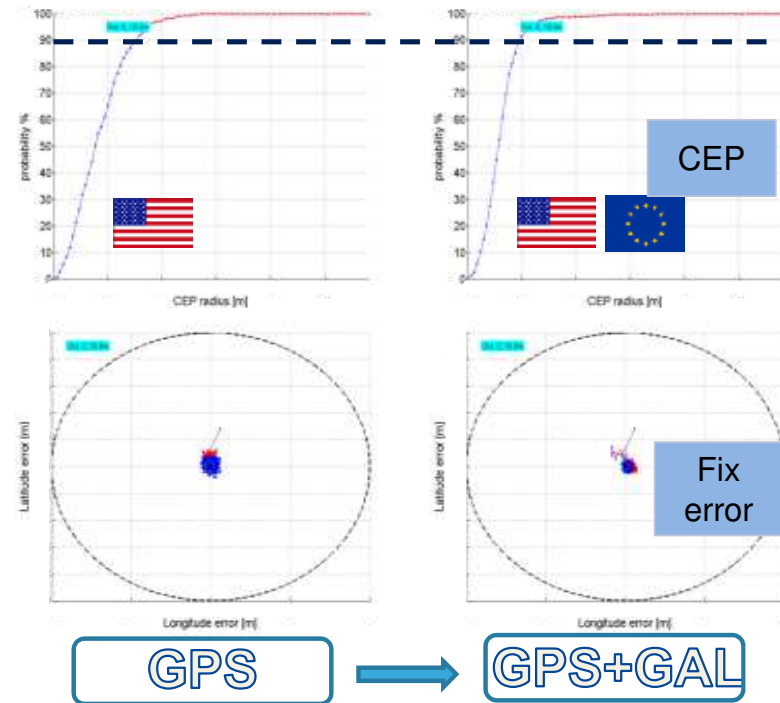
GPS Competitor  
GPS+GLO



## Real sky scenario with the 4 Galileo Sats



## Simulator ideal full sky scenario



>15% position accuracy improvement



# GPS+Beidou

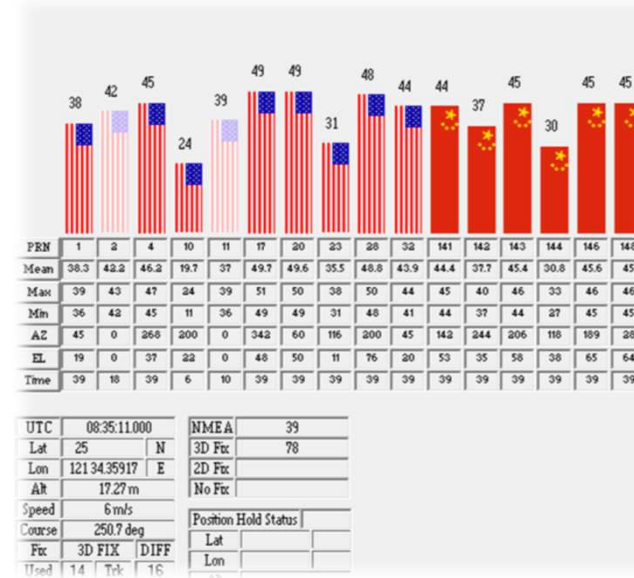
MEO / IGSO Satellites

GEO Satellites

Lat : 25:04.445 N  
 Lon : 121:34.516 E  
 Height : 78  
 Vel : N 0.022 E -0.076 V -0.005  
**User position valid**  
 Compass Week 1729 Time 442082.056

### Teseo III Log

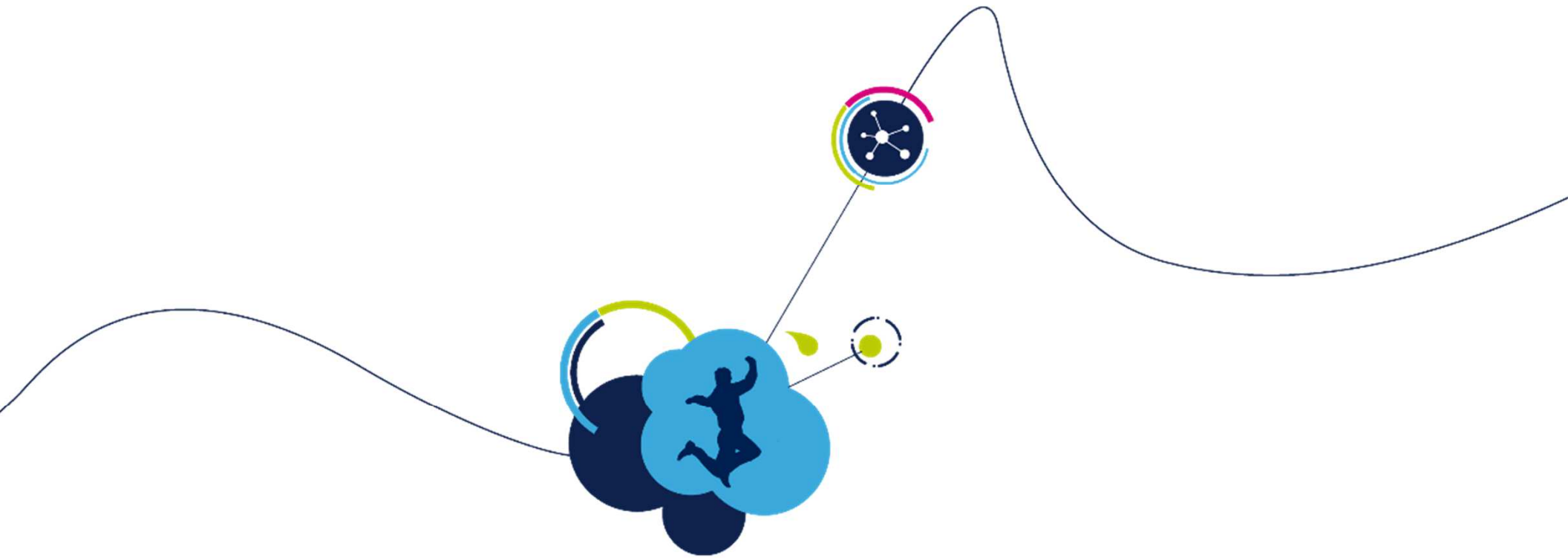
SAT	ST	TIMER	FREQ	PHERR	XCORR	XC40	NOISE	NOISE2	ATMO:
141	9	4004	65164	2806	4755	0	4957	19	13.4
150	10	3639	66515	2266	1458	2010	5384	217	0.0
143	9	3905	65149	2389	4755	0	4694	1	12.8
144	9	3997	65143	4150	4755	0	4530	-85	17.3
142	9	2330	65168	8763	4755	0	4440	-85	0.0
145	9	2690	65151	6511	4755	0	4568	97	0.0
148	10	1508	63599	2220	1306	2622	5428	104	28.6
146	10	1471	65585	2140	1356	2171	5573	-45	12.3
147	10	1470	66331	2247	1350	2787	5519	-68	13.3
149	10	1454	65548	2413	1460	1954	5353	69	14.3



## BD2 System Status

6 Op GEOs  
 6 Op / 2 Non-Op IGSOs(55deg)  
 3 Op / 11 Non-Op MEOs





# Teseo-LIV3F Overview



# Teseo-LIV3F Module

Best In Class Precision

Multi Constellation

 Assisted GNSS

Low Power Modes

Geofencing

Odometer

Datalogging

FW Upgrade & Configuration

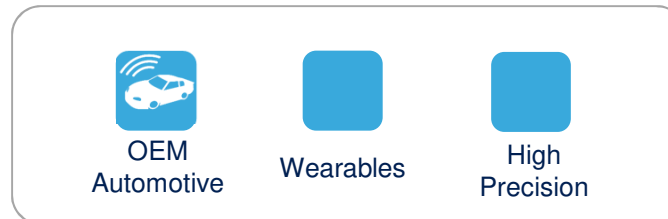




# Where does LIV3F fit ?



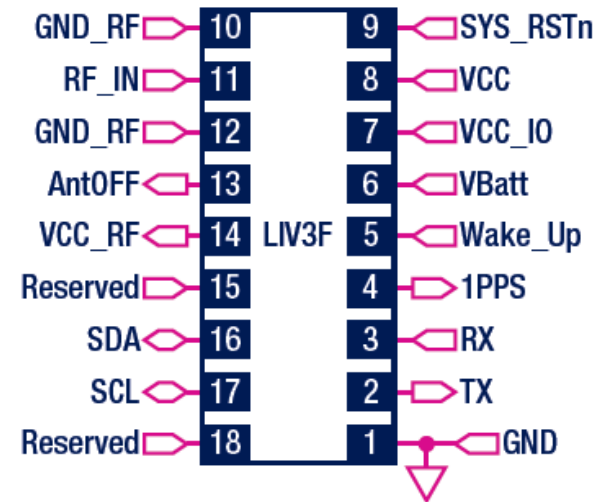
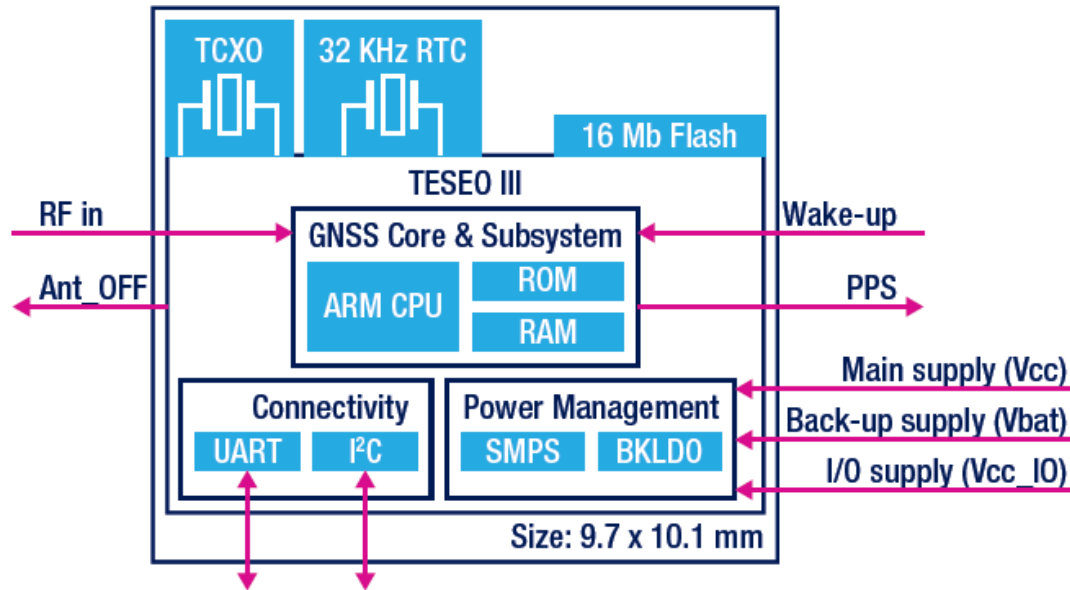
LIV3F fit



LIV3F not a fit

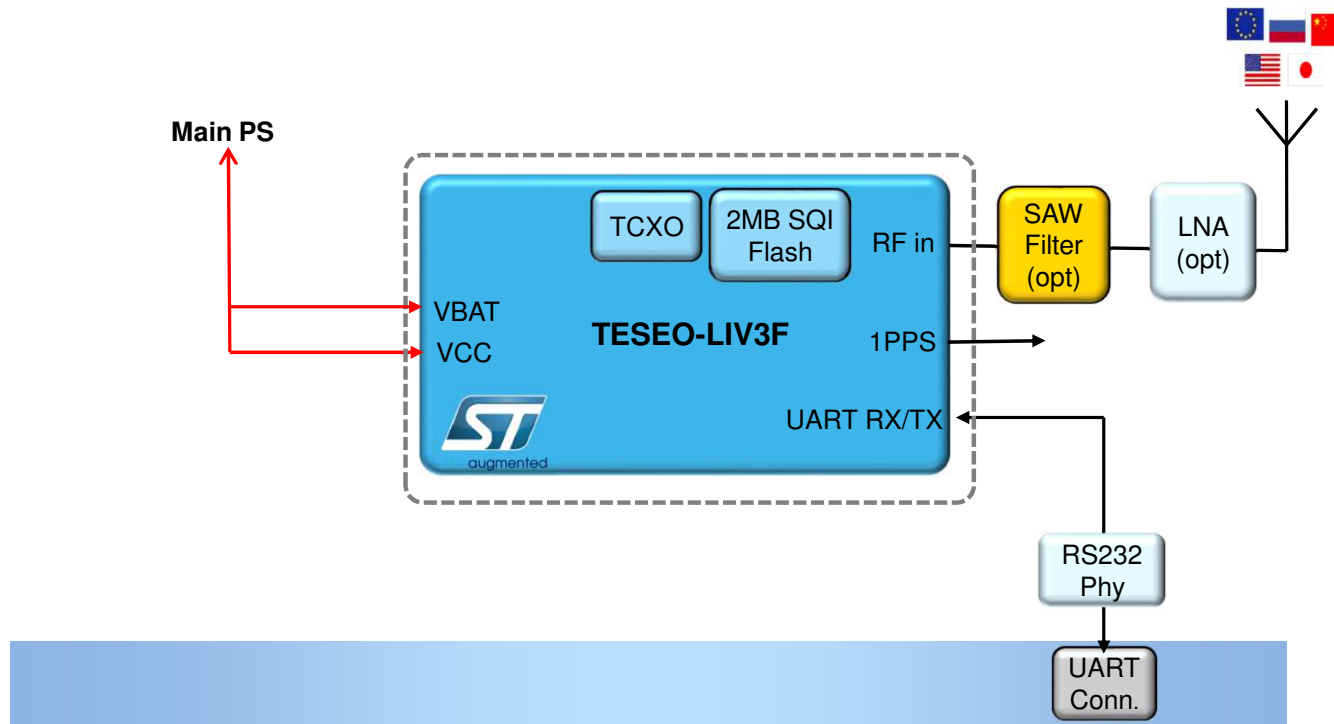


# Module Architecture

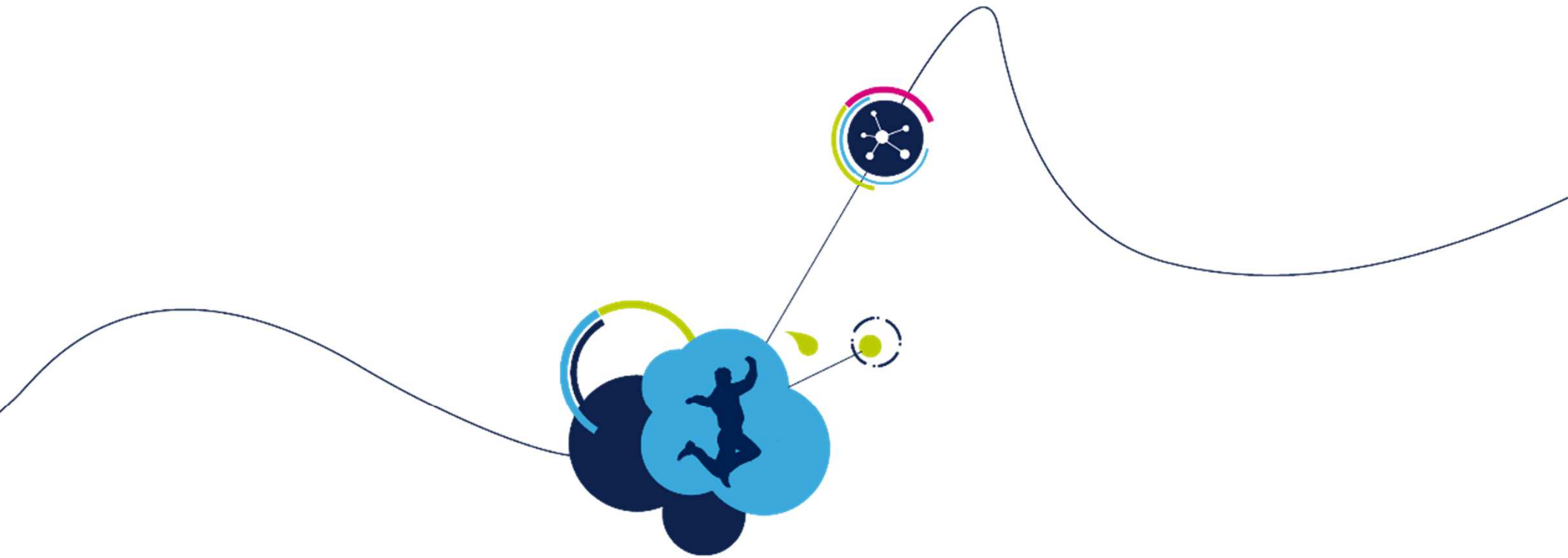




# Basic Design







# Teseo-LIV3F

## Performance & Features



# GNSS Performance

	Condition	GPS & GLONASS	GPS & BeiDou	GPS & Galileo
Time To First Fix (sec)	Cold start	< 32	< 36	< 30
	Warm start	< 25	< 29	< 26
	Hot start	< 1.5	< 2.5	< 2
Accuracy (CEP 50%)	Velocity (m/s)	0.01	-	0.01
	Heading (deg)	0.01	-	0.01
	Horizontal position with AGNSS (m)	< 1.8	< 1.5	-
	Horizontal position with SBAS (m)	< 1.5	-	-
Sensitivity (dBm)	Tracking	-163	-163	-163
	Navigation	-158	-158	-158
	Reacquisition	-156	-156	-156





# Standard Applications

## Datalogging

saves lat/lon to flash  
for retrieval by host



*Up to 12h data logging (1Hz)*  
*Logged data-fields configurable*  
*Memory full alarm*

## Geofencing

notifies when lat/lon is  
close to a defined  
circle



*Up to 8 configurable circles*  
*Crossing fence alarm*

## Odometer

computes distance  
travelled from position &  
velocity data



*Up to 3 TRIP counters*  
*Distance achieved alarm*



# Assistance Methods

## Self Trained

**ST-AGNSS** predicts satellite data based on previous observation of satellite broadcast data

Internet **NOT** needed

**6-day prediction**

TTFB ~1-4sec

## Predicted

**P-AGNSS** predicts satellite data based on data downloaded by an assistance server

Internet **NEEDED**  
(8kB data per download)

**14-day prediction**

TTFB ~1-4sec

## Real Time

**RT-AGNSS** uses real-time satellite data downloaded by an assistance server

Internet **NEEDED**  
(6kB data every 2hrs)

**Continuous/RealTime**

TTFB ~1sec





# Alternate Power Modes

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## Adaptive

**Apps requiring specific accuracy**  
GLONASS RF off when under  
EHPE threshold

GPS + GLONASS

**EHPE threshold  
configurable**

## Duty Cycle

**1 -> 5 sec per PVT output**  
GNSS RF & BB off 70% of  
every sec

GPS + GLONASS

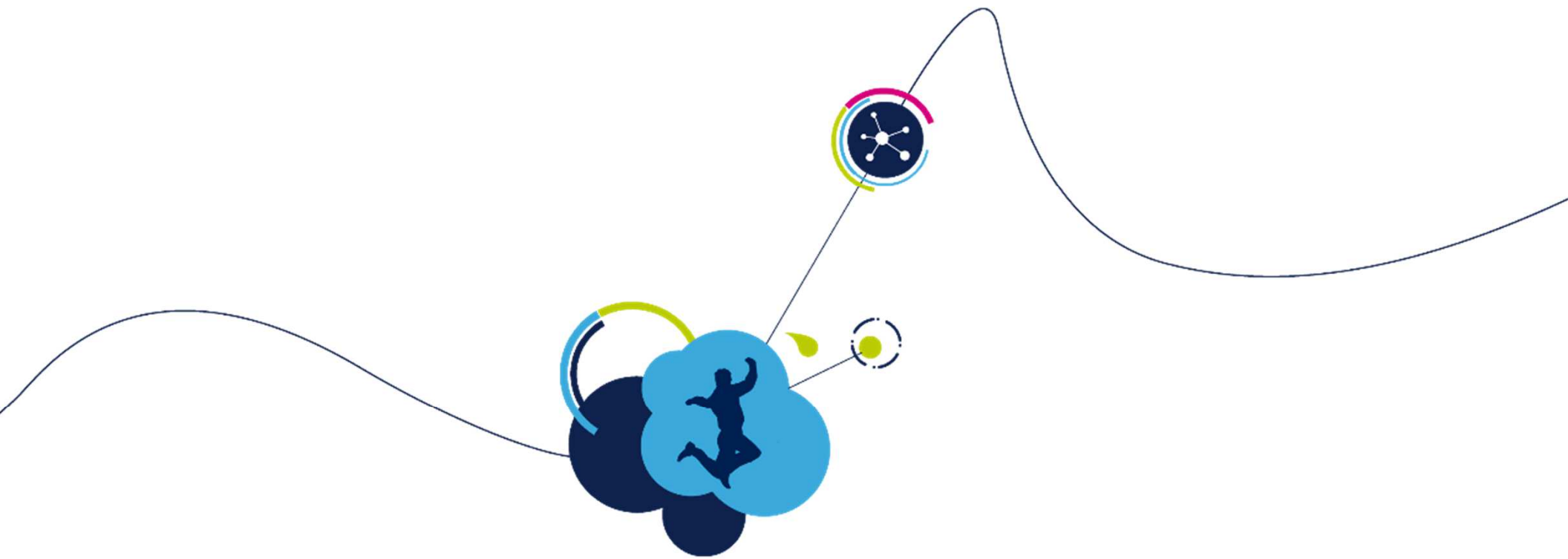
**Auto EPH update &  
continuous mode  
detect**

## Periodic

**5sec -> 18hr per PVT output**  
in Standby mode or OFF when  
not active

GPS only

**Lowest Average  
Power Option**



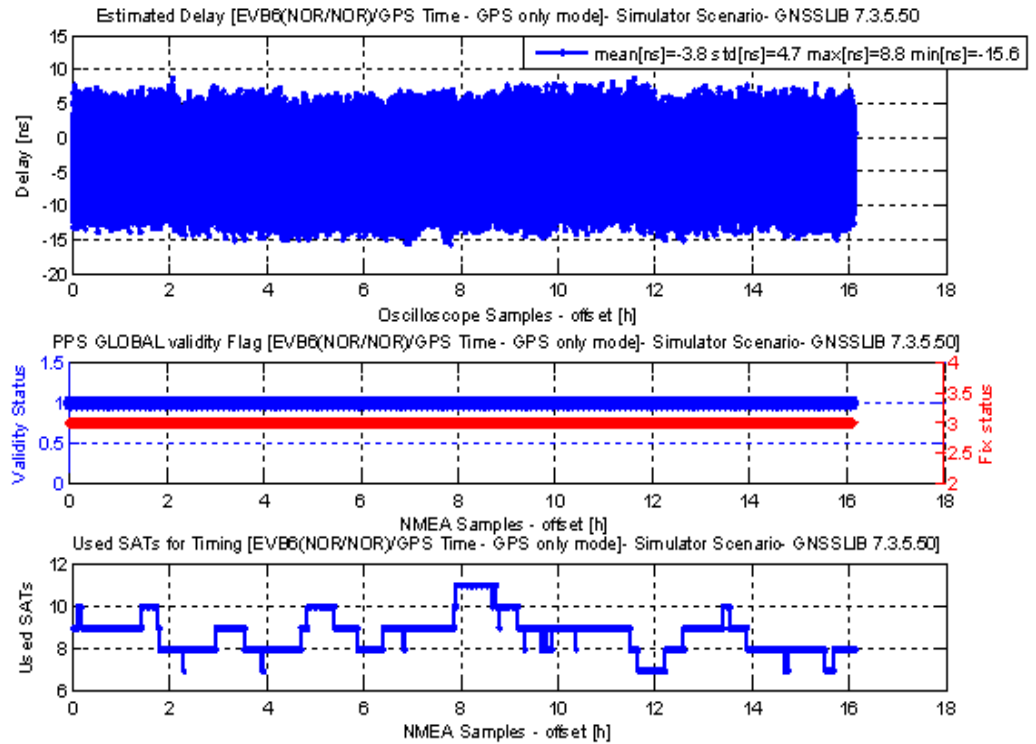
# Teseo-LIV3F Advanced Features

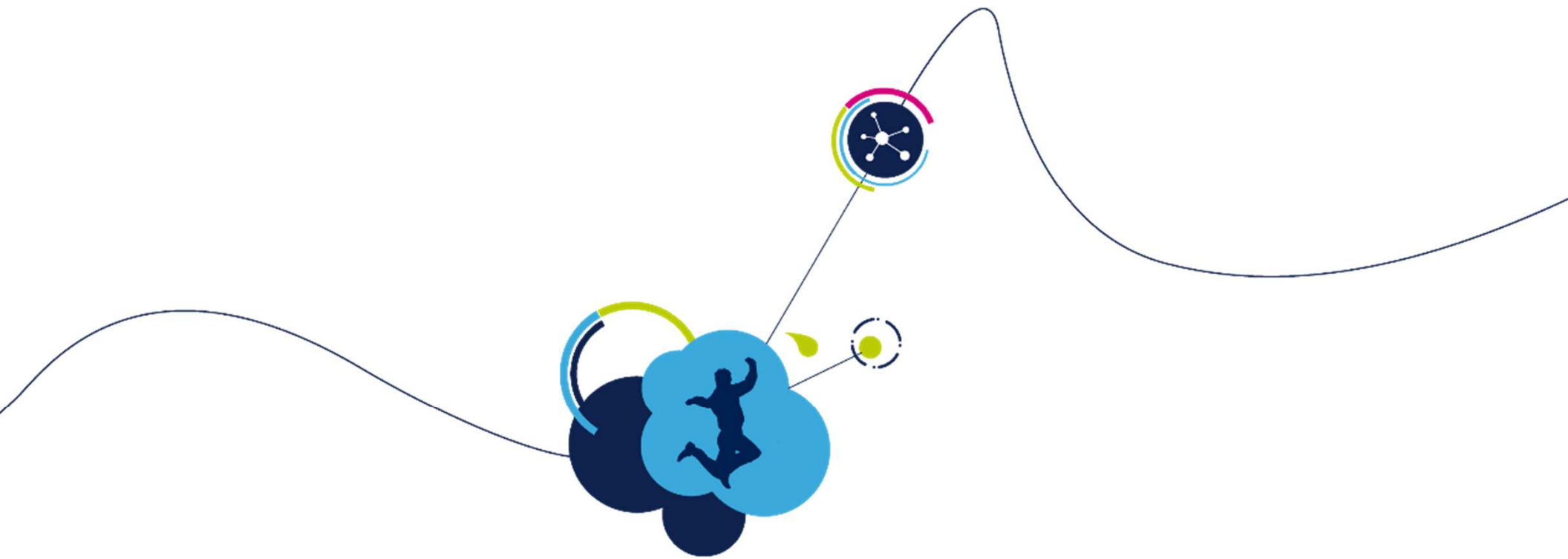


# Precise Timing

TEST Setup	
Reference time	GPS Time
Operation Mode	GPS Only
Timing Constellation Mask	0

PPS Accuracy - CDF	
SIMULATOR environment – GPS Time as reference, GPS only mode, Timing Mask set to 0	Error [ns]
PPS error (50%)	3.8
PPS error (90%)	7.4
PPS error (99%)	9.7
PPS error (100%)	12.5





# Teseo-LIV3F Tools





## X-Nucleo-GNSS1A1

For development on STM32 based design

- Includes:
  - X-CUBE-GNSS1 expansion package for STM32Cube
- Protocols:
  - NMEA
- Interfaces:
  - 1 UART
  - 1 DDC (I2C compliant)
  - Digital I/O configurable timepulse
  - 1 EXTINT input for Wakeup

# Boards



## EVB-LIV3F

For evaluation of LIV3F GNSS solution

- Protocols: NMEA
- Interfaces:
  - 1 UART
  - 1 DDC (I2C compliant)

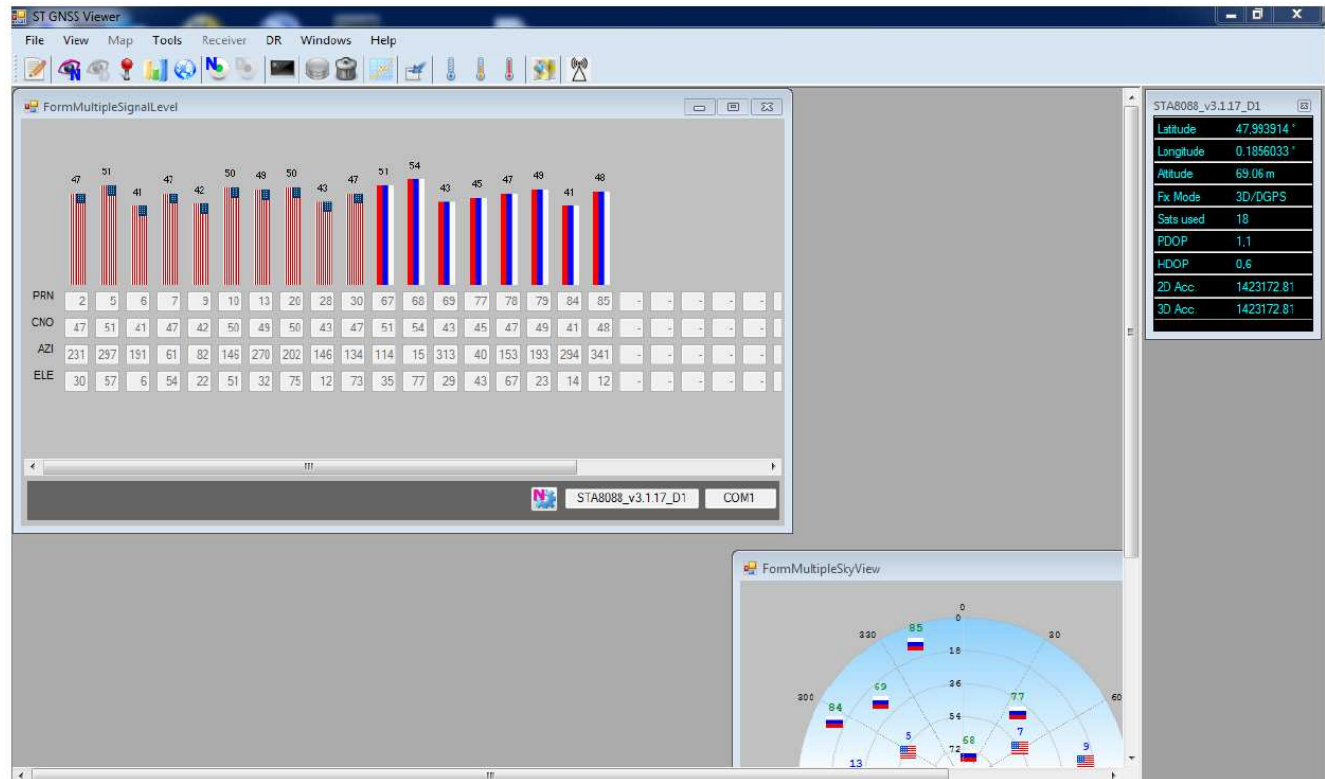




# Teseo Suite Lite

33

- View/Record/Playback NMEA & DEBUG
- View Graphics charts
  - Position
  - CNO
  - Sky view
  - Map view
- Send Commands
- Dedicated panels:
  - Assisted GPS
  - FW configurator
- TEST plan
- Embedded TOOLS:
  - FW Upgrade





# www.st.com/gnssmodules

[www.st.com/gnssmodules](http://www.st.com/gnssmodules)

Technical Documentation	
Datasheet	
Hardware User Manual	
Software User Manual	
Eval board data brief	
Firmware updates	
Schematics, Gerber and PCB	
Example C-Code	

The screenshot shows the product page for the Teseo-LIV3F module evaluation board on the ST website. The page includes a search bar, navigation menu, and product details. The main content area features a 'Download Datasheet' button and a navigation bar with tabs for 'QUICK VIEW', 'DESIGN', 'SAMPLE & BUY', and 'QUALITY & RELIABILITY'. The text describes the module as a standalone GNSS module with multiple constellation support (GPS/Galileo/Glonass/BeiDou/QZSS). It highlights the module's accuracy, compact size (9.7x10.1 mm), and features like data logging and autonomous assisted GNSS. A 'FEATURED VIDEOS' section is also visible on the right side of the page.



Thank you!

Q&A

