
GNSS Technology Update

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Oregon GNSS Users Group Annual Meeting

Bend, OR

June 15, 2018

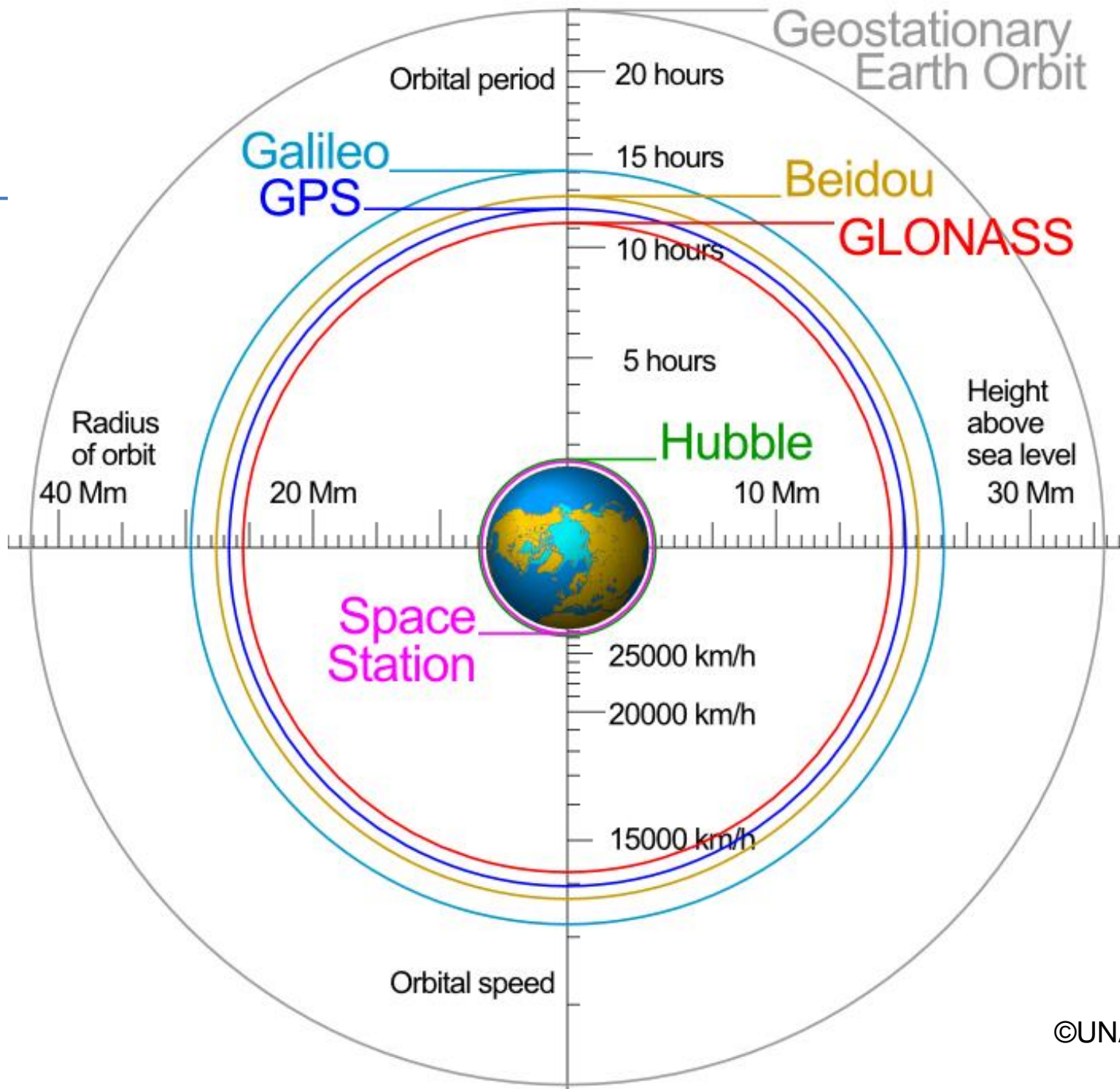
**“GNSS technology will change more in the next
3 years than it has in the past 15 years”**

GNSS

- **GPS:** US Air Force constellation of 31 satellites.
- **Glonass:** Russian military constellation of ~24 satellites.
- **Galileo:** European Union constellation. In development. 14 healthy. 18/30 sats deployed.
- **BeiDou:** Chinese constellation. In development. ~16 healthy of 35 regional and global sats deployed.

GNSS

- **GPS:** Constellation maxed out. GPS III is next up.
- **Glonass:** Constellation maxed out. Glonass-K next up.
- **Galileo:** Four more sched for launch in July.
- **BeiDou:** Eleven more sched for launch in 2018. Some regional.



**Do four constellations really make a difference
with RTK?**

PID: BBFY98
Designation: DMG1
Stamping: DMG1 2018
Stability: Monuments of questionable or unknown reliability
Setting: Pavement (street, sidewalk, curb, etc.)
Description: The mark is set in top of curb at the east edge of the parking lot behind the shared office building located at address: 15688 SW 72nd Ave., Tigard, OR
 References: From the back of the building to the disk is 39.50 feet. From the center line of the RR tracks to the disk is 38.00 feet. 103.00 feet north-northwest of the first cedar tree.
 The mark is used for GNSS position verification for various sensors.
Observed: 2018-05-22T12:57:00Z
Source: OPUS - page5 1603.24



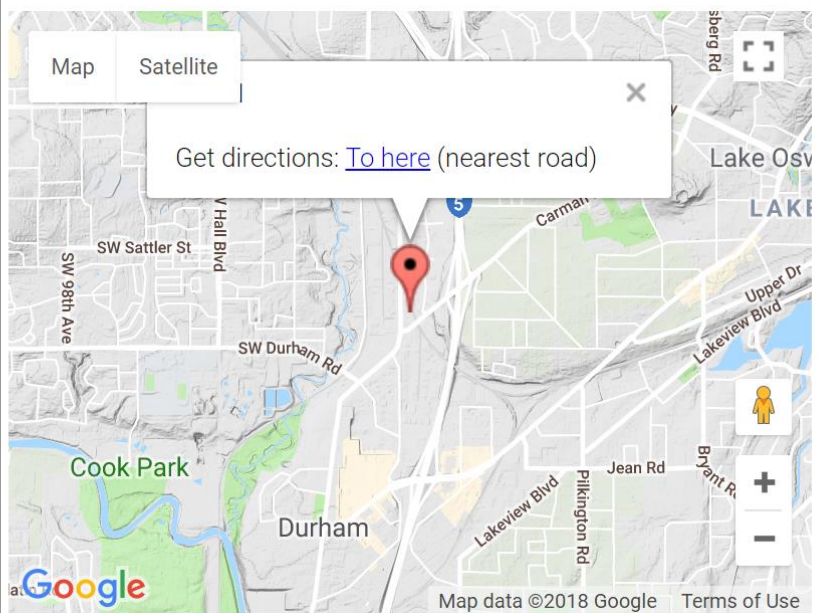
Close-up View

REF_FRAME: NAD_83(2011)	EPOCH: 2010.0000	SOURCE: NAVD88 (Computed using GEOID12B)	UNITS: m	SET PROFILE	DETAILS
LAT: 45° 24' 23.00375" ± 0.003 m					
LON: -122° 44' 53.75573" ± 0.002 m					
ELL HT: 26.119 ± 0.041 m					
X: -2426459.316 ± 0.015 m					
Y: -3772604.528 ± 0.022 m					
Z: 4519189.569 ± 0.031 m					
ORTHO HT: 48.996 ± 0.048 m					
		UTM 10	SPC 3601(OR N)		
		NORTHING: 5028127.601m	195770.052m		
		EASTING: 519699.776m	2324028.734m		
		CONVERGENCE: 0.17926182°	-1.59443844°		
		POINT SCALE: 0.99960477	0.99990317		
		COMBINED FACTOR: 0.99960068	0.99989908		

CONTRIBUTED BY
[mlarmstr](#)
 NONE



Horizon View



-Using WSRN RTN



-Using WSRN RTN

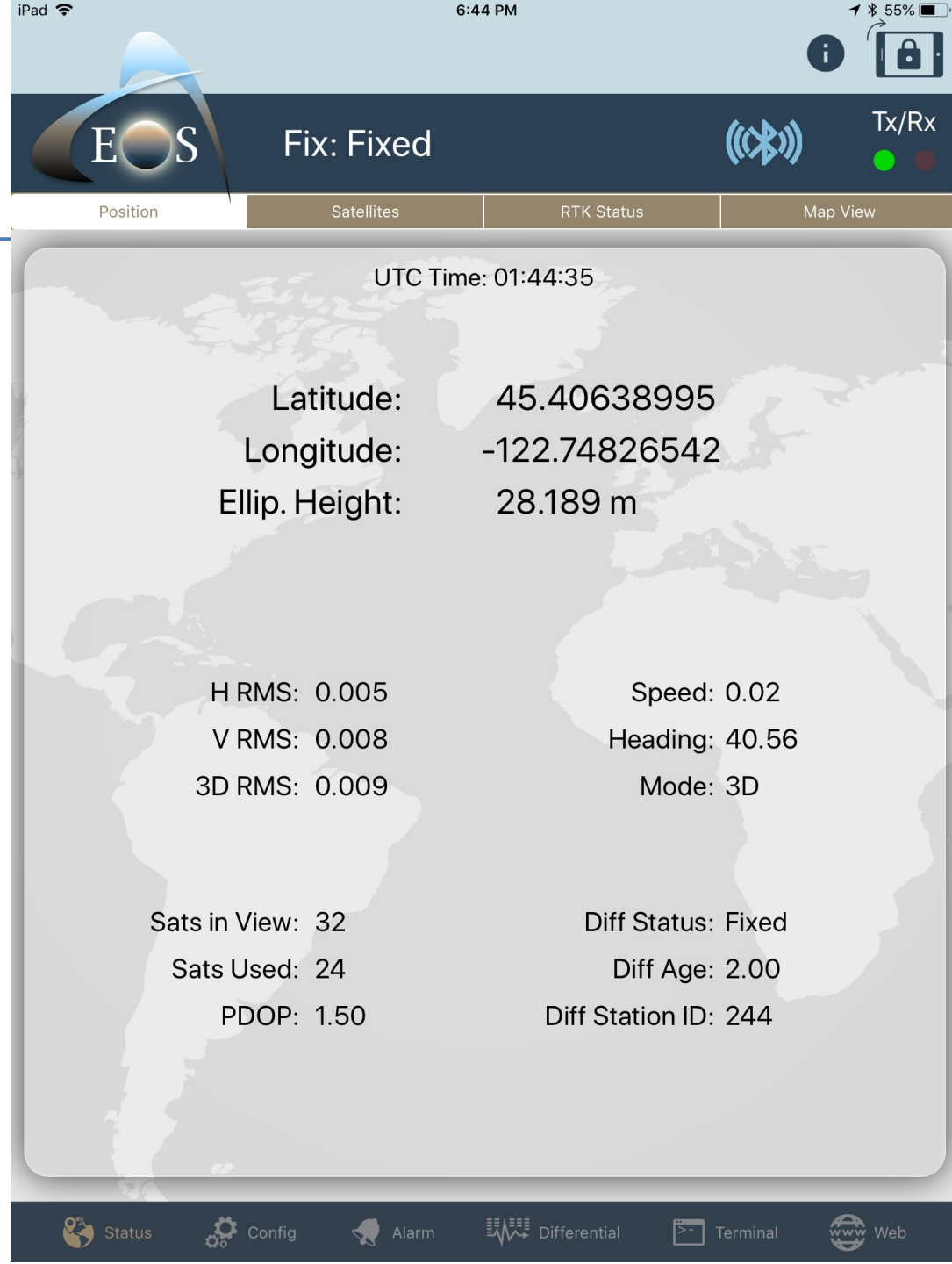


-Using DMG
-Single baseline



-Using DMG

-Single baseline



How far can you go?

- **Four constellation RTK single baseline testing last year. Occupying NGS markers. Multiple (tens) occupations. Multiple days. Horizontal only.**
- **0.25" - 8 mile baseline. 2-4 sec to FIX.**
- **2" - 40 mile baseline. 5-10 sec to FIX.**
- **3.5" - 60 mile baseline. 5-10 sec to FIX.**

One more slide on 4 constellations...

Where was I?



Fix: DGPS



Tx/Rx

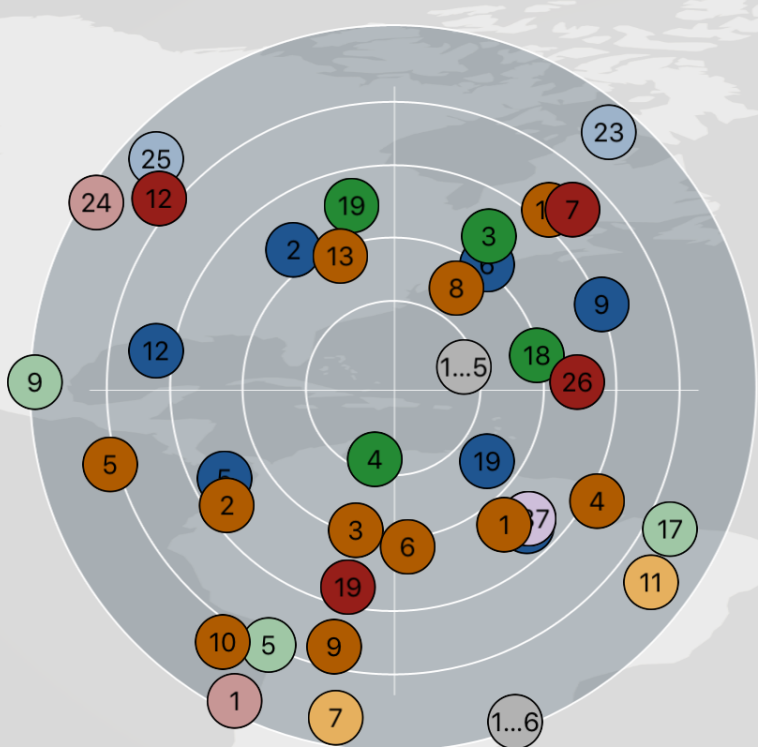


Position

Satellites

RTK Status

Map View



1 Used / 1 In View

Total Sats 26 / 39

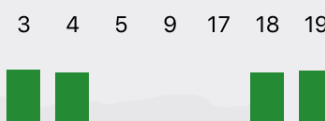
SBAS Tracked 2

SBAS Ranging 0

GPS 7 / 9



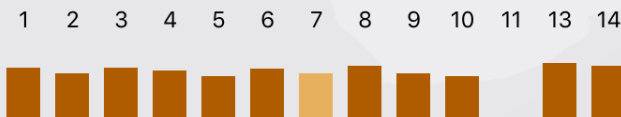
Glonass 4 / 7



Galileo 4 / 6



BeiDou 11 / 13



SBAS

129 137



QZSS 0 / 2

1844... 1844...





Mongolia

North Korea

Seoul
서울

South Korea

Yellow Sea

China

Huangshan
International Hotel
\$52

Taipei
台北

Taiwan

Hong Kong
香港

Philippine

Luzon

South China Sea

Philippines

Panay

Negros

Mindanao

Palawan

Thailand

Bangkok
กรุงเทพมหานคร

Vietnam

Cambodia

Ho Chi Minh City

Gulf of Thailand

Andaman Sea

Bangladesh

Nepal

Bhutan

India

New Delhi
नई दिल्ली

Mumbai
मुंबई

Bengaluru
ಬೆಂಗಳೂರು

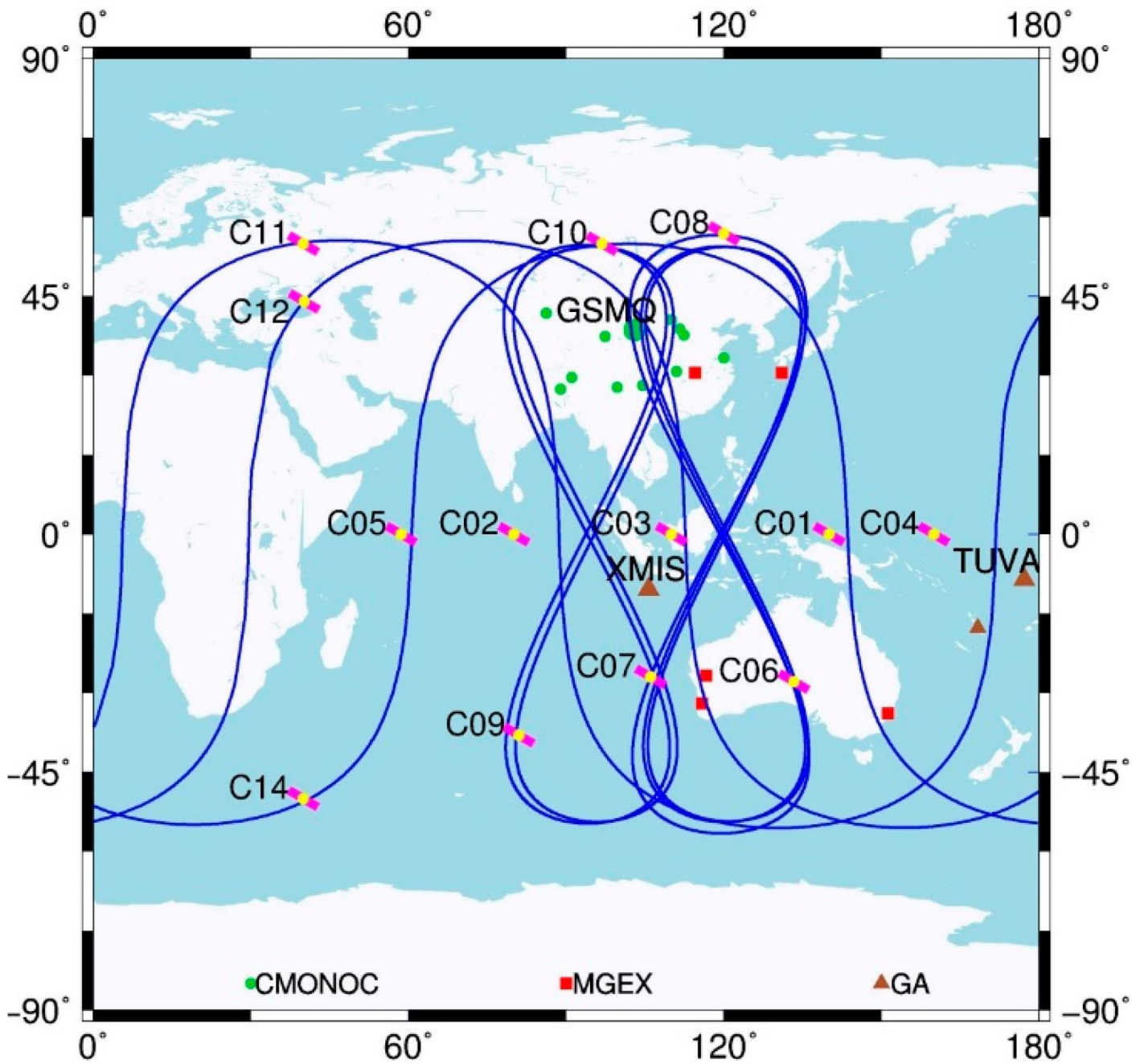
Sri Lanka



Satellite

Google

ial
ions



Single, Dual, Triple Frequency?

- **Single frequency:** An RTK GNSS receiver that uses only L1 GNSS frequency.
- **Dual frequency:** A GNSS receiver that uses both L1 and L2 frequencies.
- **Triple frequency:** A GNSS receiver that uses L1, L2 and L5 frequencies.

Glossary

- **RTK:** Real-time Kinematic. Real-time, 2 centimeter GNSS accuracy. Usually L1/L2.
- **RTK base station:** A stationary RTK GNSS receiver sending corrections to an RTK rover.
- **RTK network:** A group of RTK GNSS base stations networked together (eg. WSRN, ORGN).
- **L1 RTK:** An RTK GNSS receiver that uses only L1 GNSS frequency.

L1 - RTK

REACH RS+

RTK GNSS receiver
with an app as a controller

Reach RS is ever-ready to do surveying, mapping
and data collection with centimeter accuracy

Shipping in early August 2018

\$799

PRE-ORDER



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OK

L1 RTK – What they don't tell you

- Long initialization times – several minutes.
- Short baseline required.
- For practical purposes, you need a base/rover combo (e.g. No RTN) and clear sky environment.

But...cheap L1/L2/L5 RTK is coming?

u-blox high-precision GNSS module based on its F9 technology

April 27, 2018 - By [GPS World Staff](#)

Est. reading time: 1 minute ⌚

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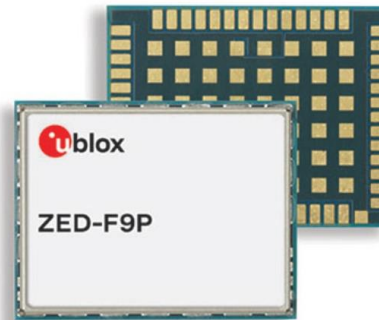
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u-blox, a global provider of leading positioning and wireless communication technologies, has released the **ZED-F9P multi-band GNSS module** with integrated multi-band real-time kinematics (RTK) technology for machine control, ground robotic vehicles and high-precision unmanned aerial vehicles (UAV) applications.



The ZED-F9P measures 22 x 17 x 2.4 millimeters and uses technology from the recently announced **u-blox F9 platform** to deliver robust high-precision positioning performance in seconds.

The u-blox ZED-F9P is a mass market multi-band receiver that concurrently uses GNSS signals from all four GNSS constellations (GPS, GLONASS, Galileo and BeiDou). Combining GNSS signals from multiple frequency bands (L1/L2/L5) and RTK technology lets the ZED-F9P achieve centimeter-level accuracy in seconds, the company said.

Receiving multiple satellite signals at any given time maximizes the availability of centimeter-level accuracy even in challenging environments such as in cities.

With its high update rate, the ZED-F9P is suitable for highly dynamic applications such as UAVs. Featuring on-chip integration of advanced multi-band RTK algorithms, it requires no additional hardware or third-party RTK libraries. Ready to use on delivery and easy to integrate, it helps product developers quickly bring their ideas to the market.

But...cheap L1/L2/L5 RTK is coming?

- Will it be reliable?
- Hardware is only part of the equation.
- RTK algorithm.

Then, there's software RTK receivers...

- \$350 hardware
- Subscription required
- RTK accuracy
- GPS + Galileo only, for now.
- Android-only.
- Cable required.



Is this where RTK is heading?

Trimble's GNSS positioning guides GM's hands-free Super Cruise

March 6, 2018 - By [Tracy Cozzens](#)

Est. reading time: 1:30 ⌚

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General Motors (GM) is using **Trimble RTX** (real-time eXtended) technology as the high-accuracy GNSS/GPS correction source to deliver absolute positioning to vehicles equipped with **GM's Super Cruise** hands-free highway driving system, now available on the 2018 Cadillac CT6.

GM customers using Super Cruise featuring Trimble RTX technology can have peace of mind on the road knowing that RTX plays an important role in maintaining lane position for hands-free driving on divided highways.



Super Cruise also uses precision lidar mapping data, a state-of-the-art driver attention system, and a network of camera and radar sensors.

Trimble RTX technology provides real-time, multi-constellation GNSS positioning capable of achieving better than 1.5 inches accuracy. Standard GPS signals can drift up to 25 feet which could cause incorrect lane identification

Remember the Piksi?

- 2013 Kickstarter
- Raised \$166k
- L1 RTK
- 2016 Intro
- L1/L2 RTK

Swift Navigation introduces Piksi Multi GNSS receiver at Intergeo 2016

November 9, 2016 - By [Joelle Harms](#)

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1 Comment



Swift Navigation debuted its newest product, Piksi Multi, at Intergeo 2016, which was held Sept. 11-13 in Hamburg, Germany. Piksi Multi is a multi-band, multi-constellation high-precision GNSS receiver for the mass market. A San Francisco-based startup, Swift Navigation introduced the first Piksi GNSS receiver in January.

Piksi today (SwiftNav)



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Navigate an Automated Future

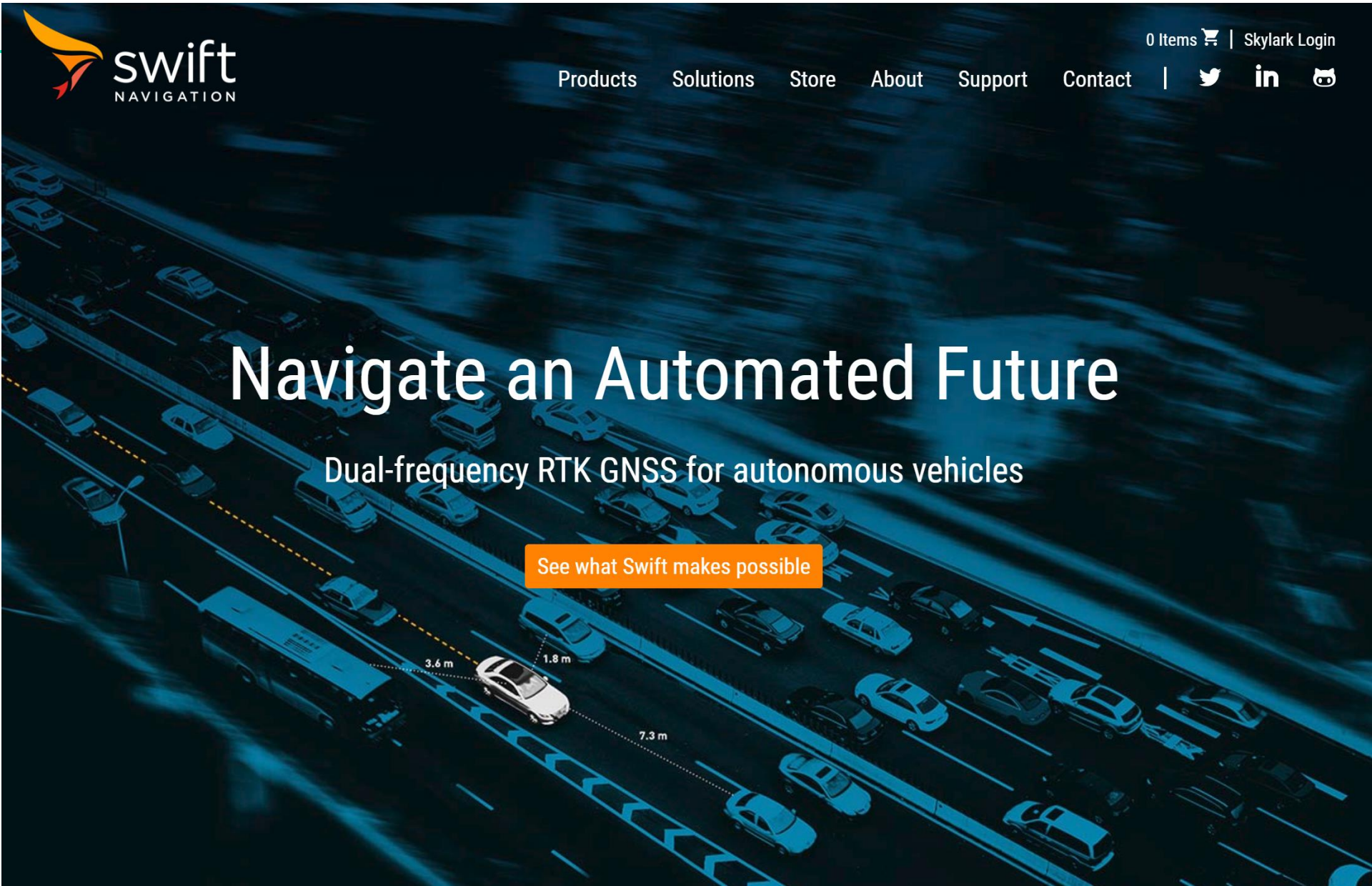
Dual-frequency RTK GNSS for autonomous vehicles

See what Swift makes possible

3.6 m

1.8 m

7.3 m



Also driving low-cost RTK technology...

New DJI Phantom 4 RTK model spotted

Haye Kesteloo - Dec. 20th 2017 9:20 pm ET



Also driving low-cost RTK technology...

- UAVs are a natural fit for low-cost L1 RTK.
- Short baseline.
- Clear sky environment.
- Several minute initialization is a non-factor.

The Good News...

- Our current GPS and GNSS equipment keeps working, albeit maybe a little slower.
- The consumer markets (autonomous vehicles and UAVs) will drive down the cost of RTK technology moving forward.
- More satellites (being launched) will improve GNSS performance in tougher environments.
- Consumer market performance expectations may drive RTK receiver innovations.

The Bad News...

- Windows Mobile devices have one foot in the grave. Microsoft has stuck a fork in it. It will be increasingly tough to find support if you have one of those devices.
- End of Life announced for Trimble Nomad handheld series. May 2018.

Questions?



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