

# The Future of High-Precision GPS/GNSS Technology

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# GNSS is the new GPS

- GNSS = Global Navigation Satellite Systems
- *“GNSS refers collectively to the world-wide positioning, navigation, and timing (PNT) determination capability available from one or more satellite constellations.”*

# GNSS is the new GPS

## ACTIVE GNSS:

-GPS (USA)

-GLONASS (Russia)

-SBAS:

WAAS (North America), MSAS (Japan)  
EGNOS (Europe)

-QZSS (Japan)

-DGPS/NDGPS

-RTK Networks

## PLANNED GNSS:

-Galileo (Europe)

-SBAS: GAGAN (India)

-Compass/BeiDou (China)

# GNSS Technology Advancement

GNSS technology in the next 5 years is going to advance significantly more than the past 5 years.

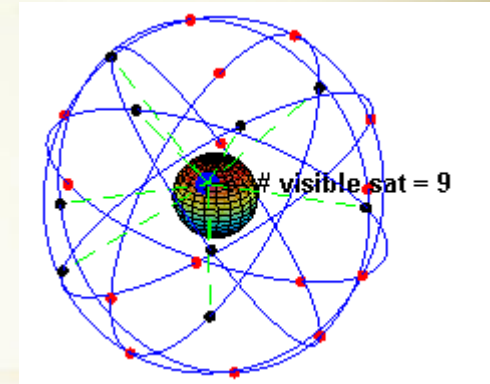
# Constantly Changing

- Not only is GNSS receiver technology evolving, so is the GNSS infrastructure (satellites, signals and control).
- These are the two primary reasons that the GNSS technology is so dynamic and will be for the foreseeable future.

# Constantly Changing

- Currently, there are 31 healthy GPS satellites comprised of...

- 22 IIA/IIR - L1 C/A, L1 P(Y), L2 P(Y)
- 7 IIR-M - L1 C/A, L2C, L1 P(Y), L2 P(Y)
- 2 IIF - L1 C/A, L2C, L5, L1 P(Y), L2 P(Y)



- Civil Signals (black, red), Military signals (blue)

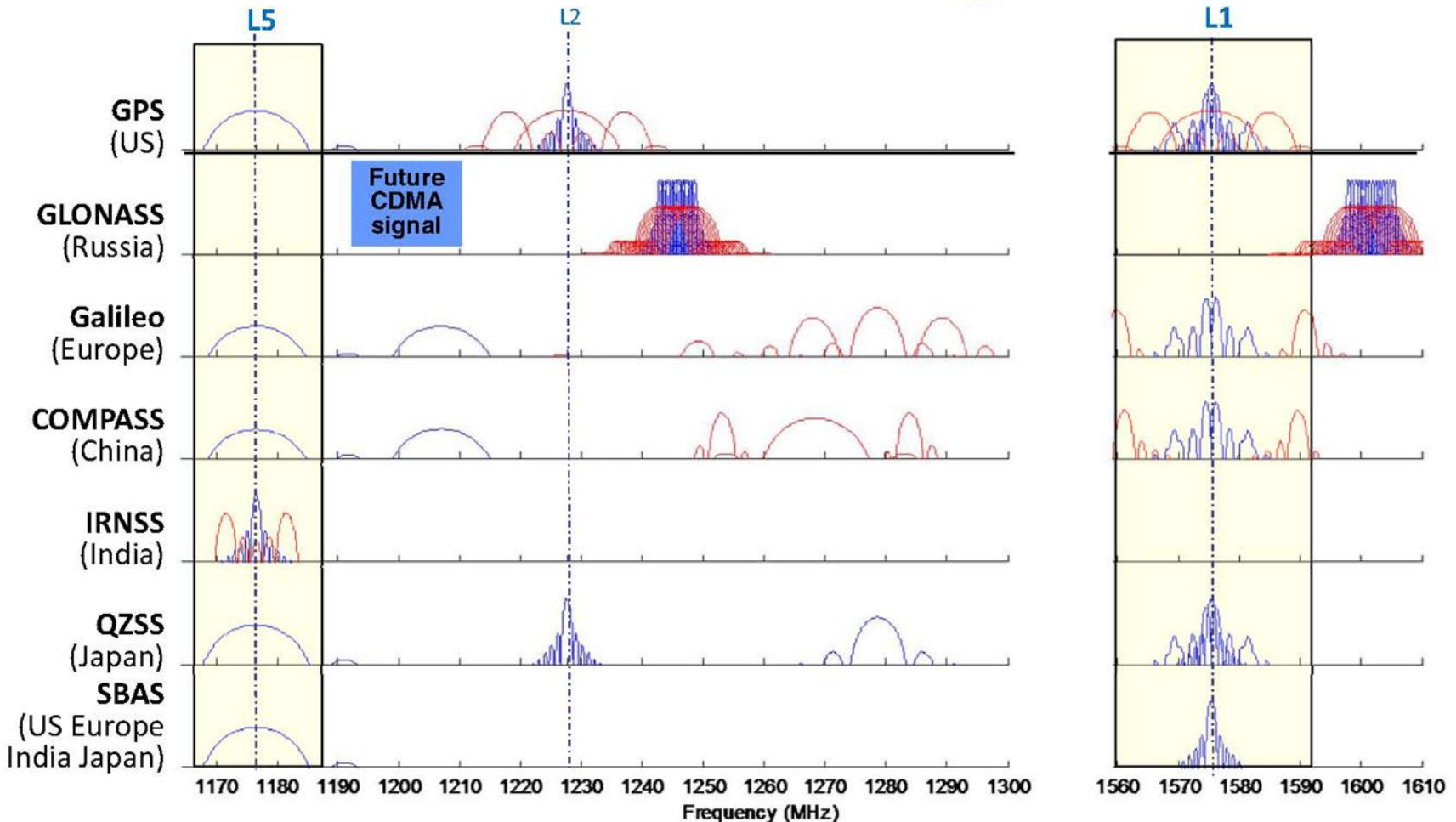
# Rapidly Changing

- May 2010 marked a new era of GPS with the launch of the first GPS satellite equipped to broadcast the new civilian L5 signal.
- According to the U.S. Gov't, a full constellation of 24 GPS satellites broadcasting L5 (and all legacy signals) will be in orbit by 2020.
- Europe's Galileo could accelerate a full L5 constellation as soon as 2015.



# Rapidly Changing

## Current International Signal Plans





# What is Special about L5?

- Open signal.
- Broadcast strength is  $\sim 4x$  more powerful than L2C.
- Longer code and error-correcting techniques for more robust tracking in difficult environments.
- Supported by other global GNSS and SBAS.
- Located in highly-protected aeronautical band.

# What is Special about L5?

- The current GPS satellite model being deployed is the IIF. A total of 12 are being built. The IIF supports L1 C/A, L2C and L5 in addition to the legacy and military signals.
- There are 10 more IIF's being produced. The next launch is scheduled for next week. It's projected that all 12 IIF satellites will all be in orbit in the 2014/2015 timeframe.
- The subsequent GPS satellite model is the III-A, which are projected to be ready for launch in the 2014/2015 timeframe. A 24-satellite constellation broadcasting GPS L5 is not expected until 2020.

# What is Special about L5?

Does that mean we won't be able to use L5 until  
2020?

Not necessarily, and here's why...

# What is Special about L5?

- The European Space Agency is planning to launch their third and fourth operational Galileo satellites next week (Oct. 12). They've contracted to have their first 18 satellites built and estimate they will be in orbit by the 2014/2015 timeframe.

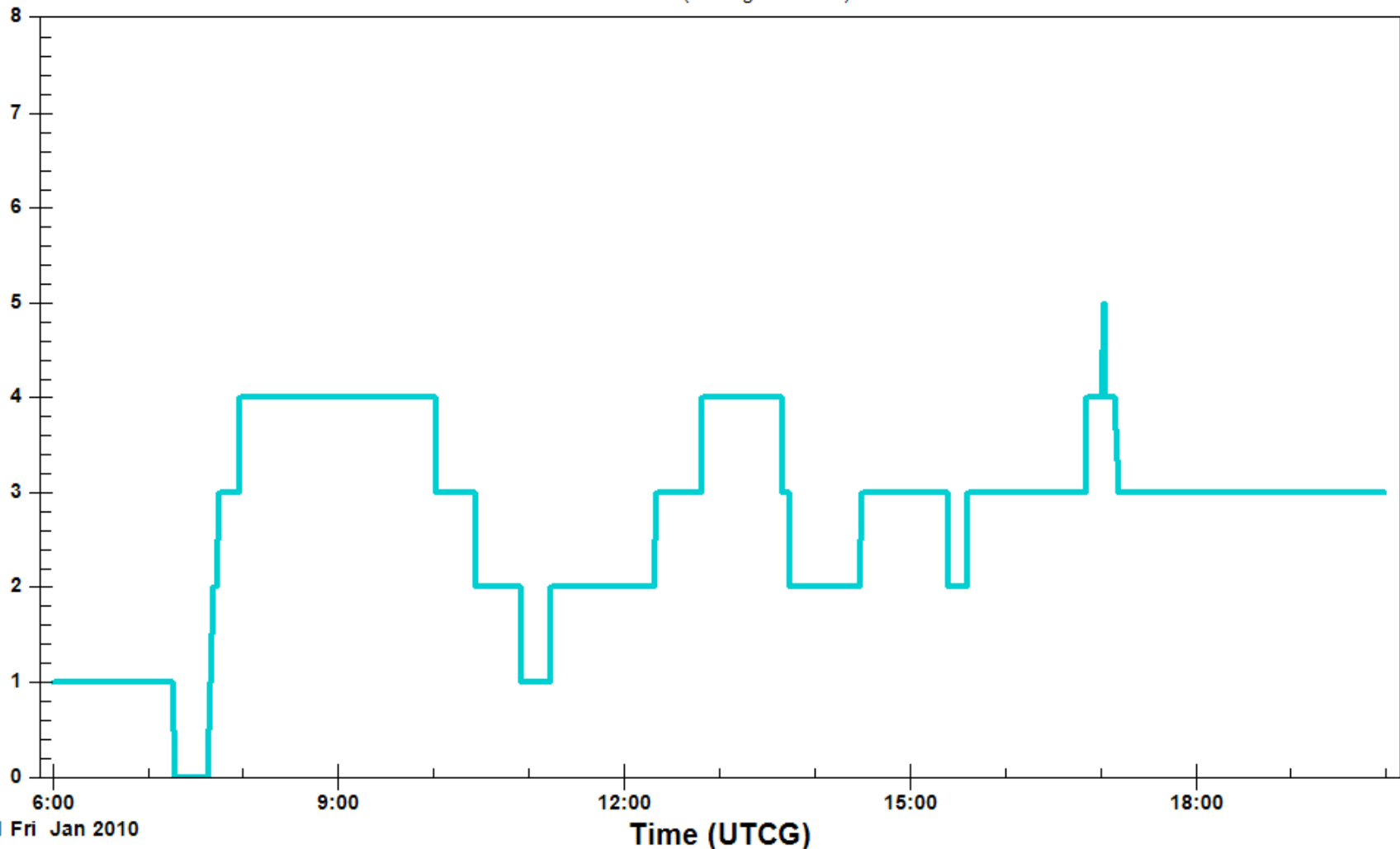
# What is Special about L5?

- If all 12 GPS IIF satellites are in orbit by 2014/2015 and 18 Galileo satellites are in orbit by 2014/2015, then there will be 30 satellites broadcasting L1/L5 in less than five years from now.
- Based on Galileo orbit data for the first 18 satellites, and estimating where the next 10 IIF GPS satellites will be inserted in the constellation, here's what the L1/L5 satellite visibility plots look like...

# When will L5 be Available?

*Number Of GPS IIF Satellites*

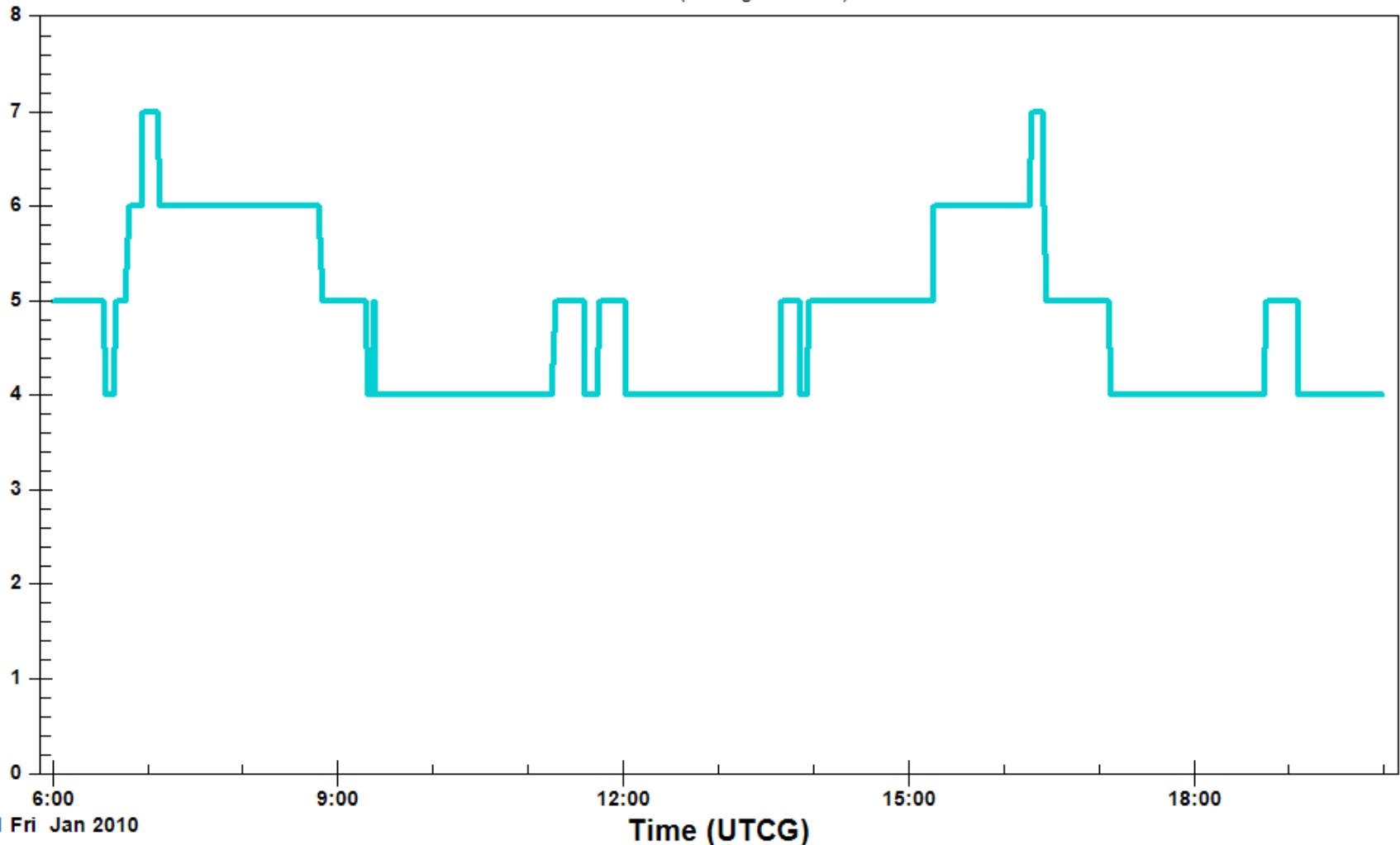
Portland (15 deg Elevation)





# When will L5 be Available?

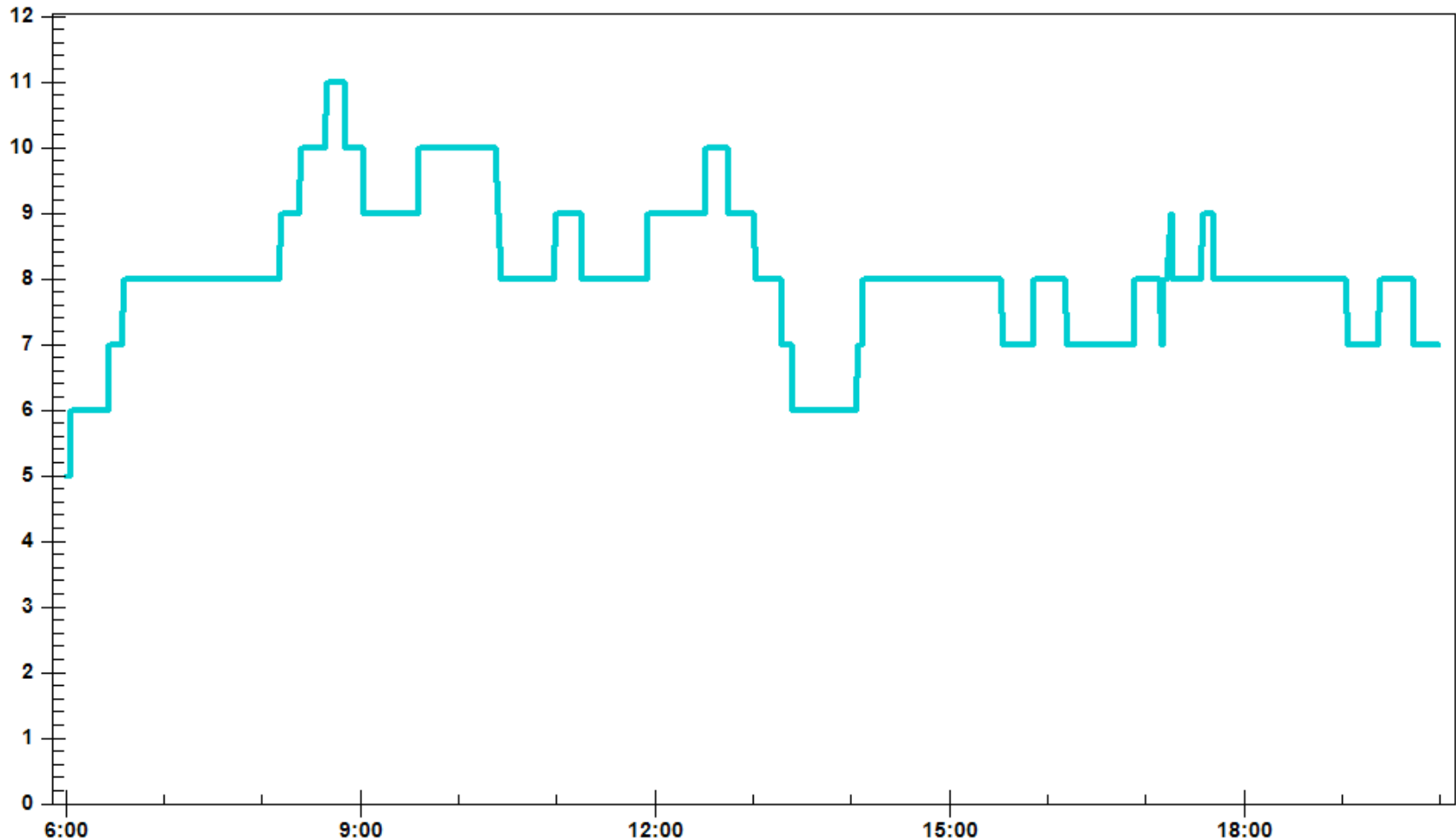
*Number Of Galileo Satellites*  
Portland (15 Deg Elevation)



# When will L5 be Available?

*Number Of Galileo & GPS IIF Satellites*

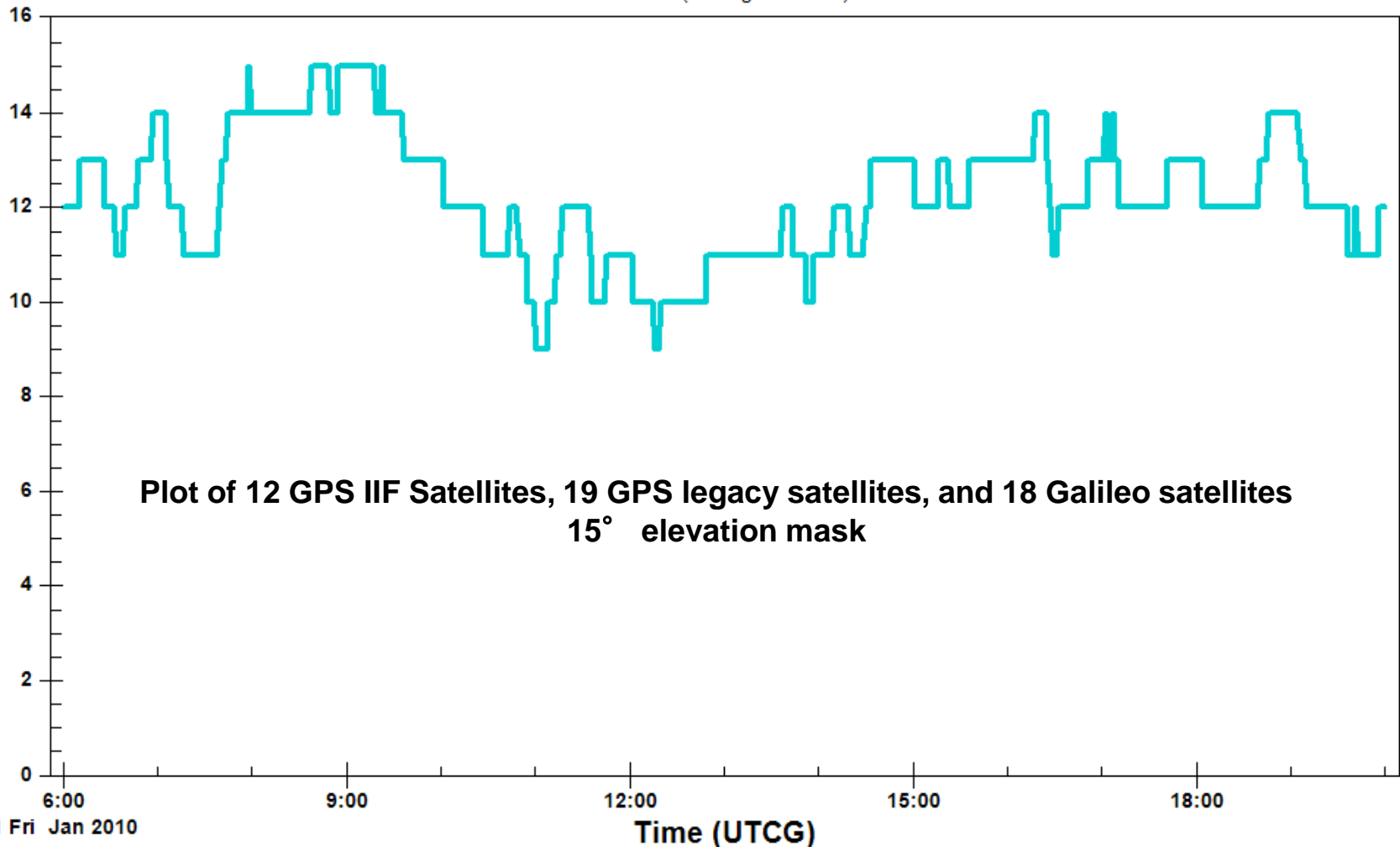
Portland (15 deg Elevation)



# When will L5 be Available?

**Number Of Galileo & GPS Legacy & IIF Satellites**

Portland (15 deg Elevation)



# When will L5 be Available?

- Galileo can accelerate the adoption of inexpensive, high-precision GNSS by as much as five years.

# Way Forward

- The new GPS L5 signal will result in very low-cost L1/L5 receivers capable of cm-level horizontal/vertical precision.
- The value of high-precision data (horizontal and vertical) will reduce substantially.
- Cm-level accuracy in consumer mobile devices?

# Is a Global Geospatial Consciousness Possible?





# Trends

- Trending towards inexpensive precise measurements (horizontal and vertical).
- Trending towards sensor-integration (accelerometer, gyro, laser rangefinding).
- Trending towards huge volumes of more precise and rich geographic data.
- = open doors to a tremendous opportunity for previously untapped geospatial applications.

# QUESTIONS?



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