



From GPS to GNSS Challenges and Prospects

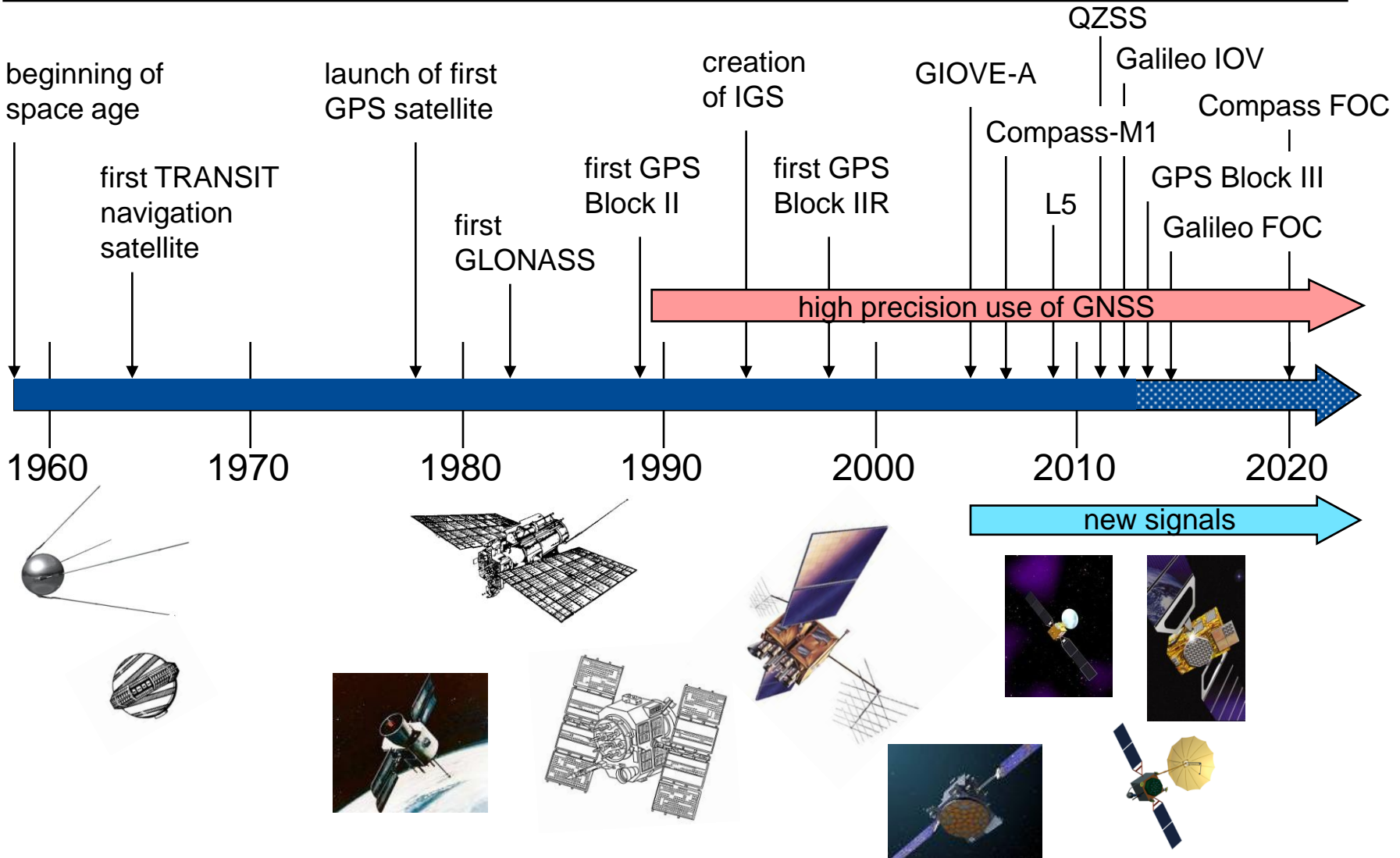
Urs Hugentobler

Institute for Astronomical and Physical Geodesy
Technische Universität München, Germany

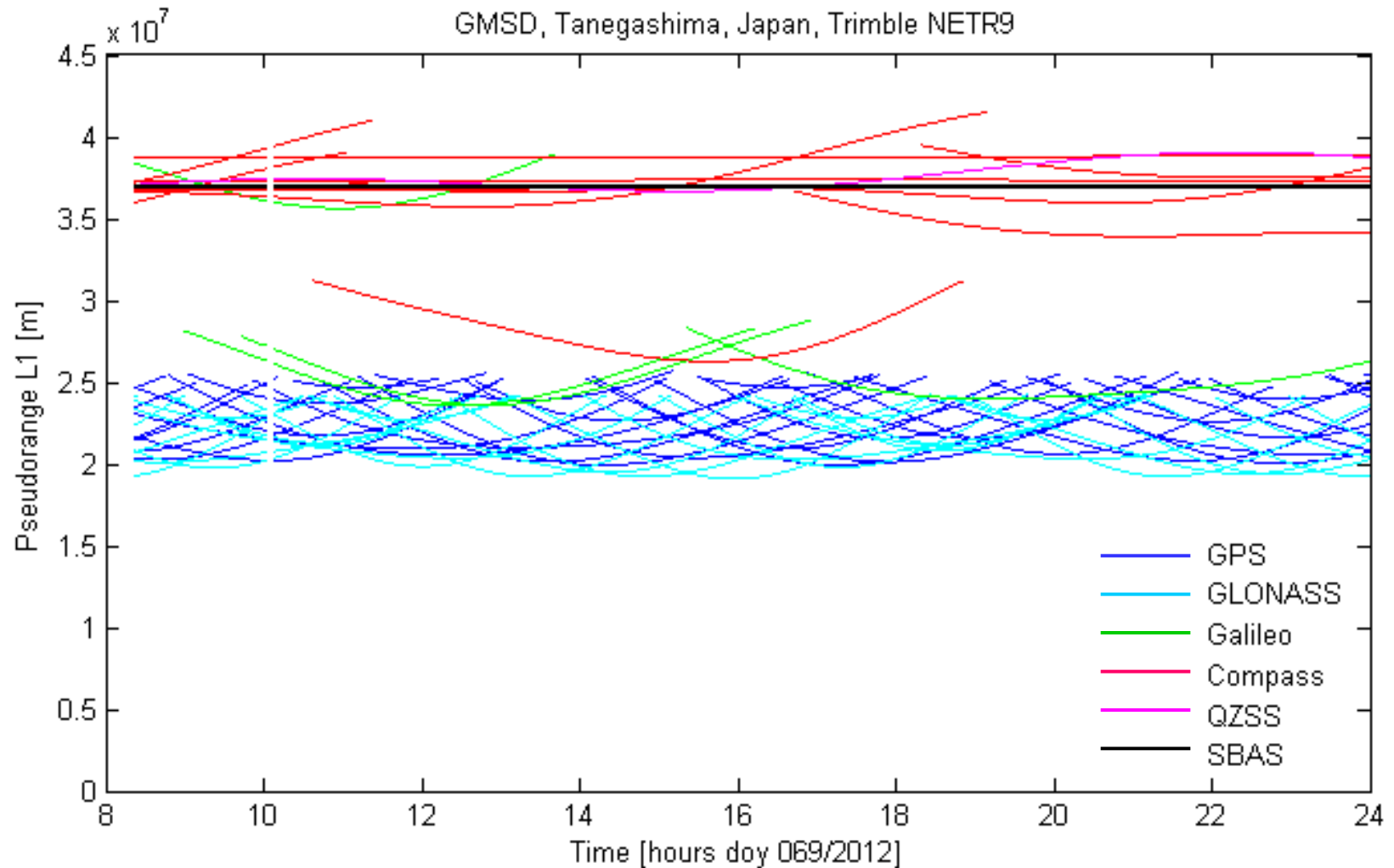
International GNSS Service (IGS)

PPP-RTK & Open Standards Symposium
Frankfurt a. M., March 12, 2012

Short History of Satellite Navigation



New Satellite Systems





RINEX 3.0 Observation File

```

3.00          OBSERVATION DATA      M (MIXED)          RINEX VERSION / TYPE
Bnx2Rnx          congo                20120309 082056 GMT PGM / RUN BY / DATE
Source NTRIP stream gnss.gsoc.dlr.de/GMSD1          COMMENT
GMSD1          MARKER NAME
M          MARKER NUMBER
Hauschild          DLR/GSOC          OBSERVER / AGENCY
5049K72188          TRIMBLE NETR9          4.43          REC # / TYPE / VERS
4938353448          TRM59800.00          SCIS          ANT # / TYPE
-3607665.0563  4147867.7288  3223716.9486          APPROX POSITION XYZ
          0.0000          0.0000          0.0000          ANTENNA: DELTA H/E/N
G  16  C1C L1C D1C S1C C2X L2X D2X S2X C2W L2W D2W S2W C5X  SYS / # / OBS TYPES
          L5X D5X S5X          SYS / # / OBS TYPES
R  20  C1C L1C D1C S1C C2C L2C D2C S2C C1P L1P D1P S1P C2P  SYS / # / OBS TYPES
          L2P D2P S2P C3X L3X D3X S3X          SYS / # / OBS TYPES
E  16  C1X L1X D1X S1X C5X L5X D5X S5X C7X L7X D7X S7X C8X  SYS / # / OBS TYPES
          L8X D8X S8X          SYS / # / OBS TYPES
S   8  C1C L1C D1C S1C C5X L5X D5X S5X          SYS / # / OBS TYPES
C  12  C2I L2I D2I S2I C6I L6I D6I S6I C7I L7I D7I S7I    SYS / # / OBS TYPES
J  24  C1C L1C D1C S1C C1X L1X D1X S1X C1Z L1Z D1Z S1Z C2X  SYS / # / OBS TYPES
          L2X D2X S2X C6X L6X D6X S6X C5X L5X D5X S5X          SYS / # / OBS TYPES

```

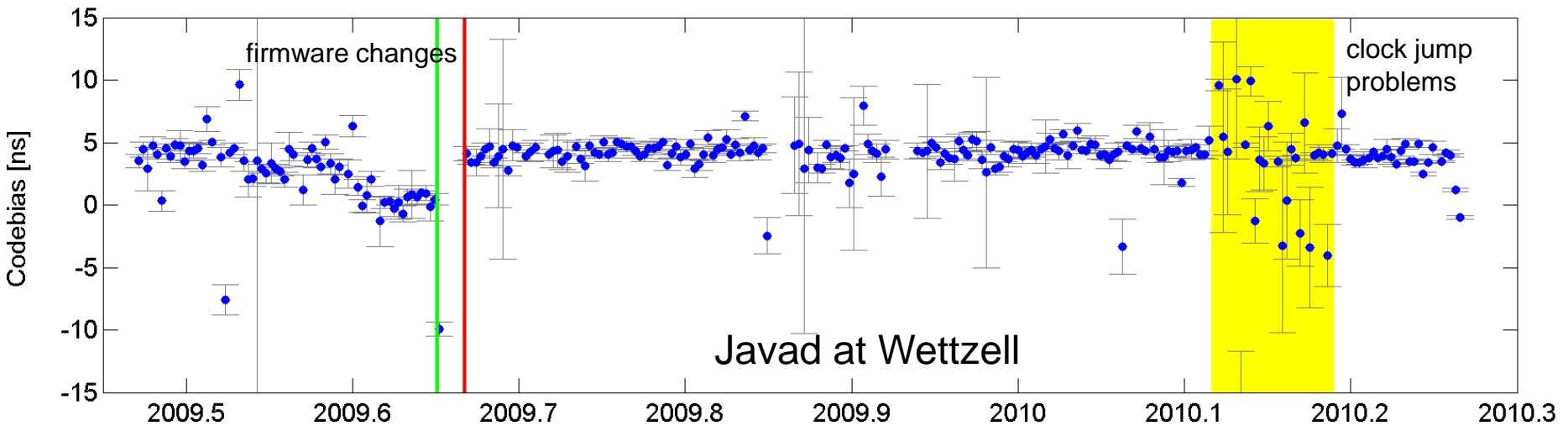
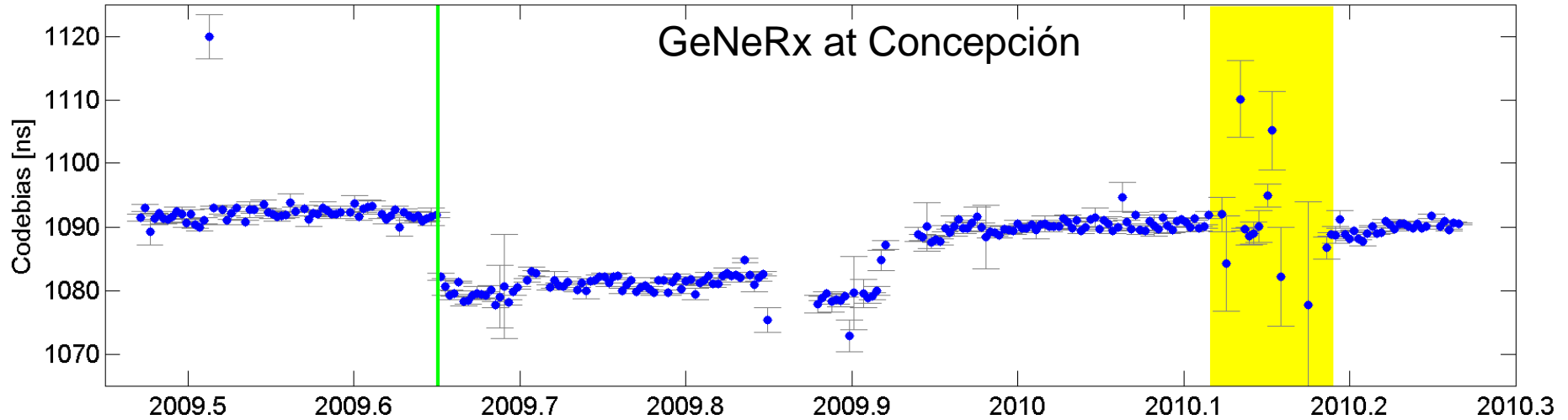
many new observation types

new systems

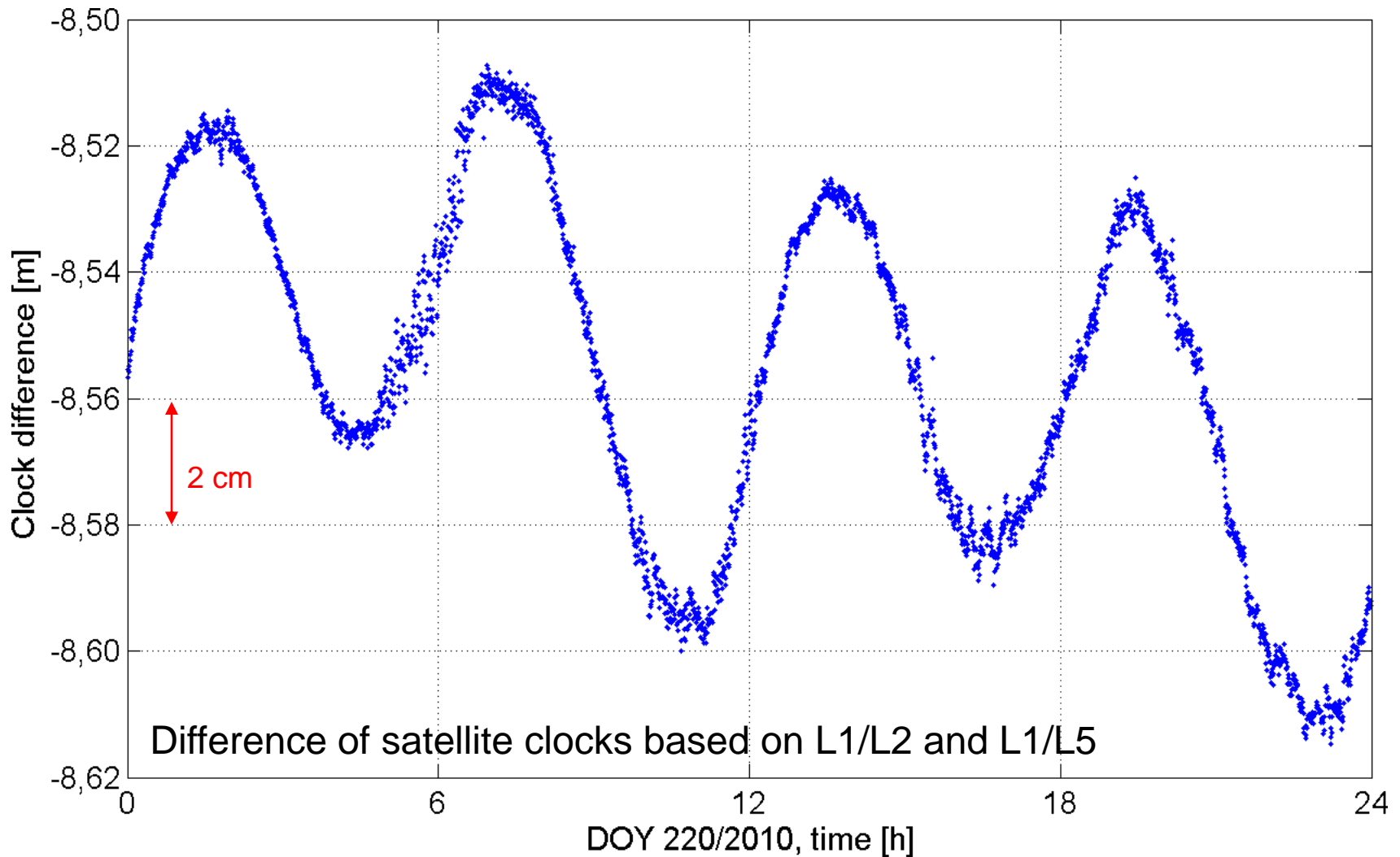
Galileo Signals

Galileo	E1	1575.42	A PRS	C1A	L1A							
			B I/NAV OS/CS/SoL	C1B	L1B						X	
			C no data	C1C	L1C	X						X
			B+C	C1X	L1X				X	X	X	
			A+B+C	C1Z	L1Z							
	E5a	1176.45	I F/NAV OS	C5I	L5I						X	
			Q no data	C5Q	L5Q	X						X
			I+Q	C5X	L5X				X	X	X	
	E5b	1207.140	I I/NAV OS/CS/SoL	C7I	L7I							
			Q no data	C7Q	L7Q							X
			I+Q	C7X	L7X				X		X	
	E5 (E5a+E5b)	1191.795	I	C8I	L8I							
			Q	C8Q	L8Q	X					X	
			I+Q	C8X	L8X				X		X	
	E6	1278.75	A PRS	C6A	L6A							
			B C/NAV CS	C6B	L6B							
			C no data	C6C	L6C							
			B+C	C6X	L6X							
			A+B+C	C6Z	L6Z							
				GeNeRx1								
			Novatel 15A									
			Leica GRX1200									
			JPS δ-G3TH									
			Trimble NETR9									
			Asterx3									

Receiver Specific Intersystem Biases



GPS PRN 25 L5 Signal

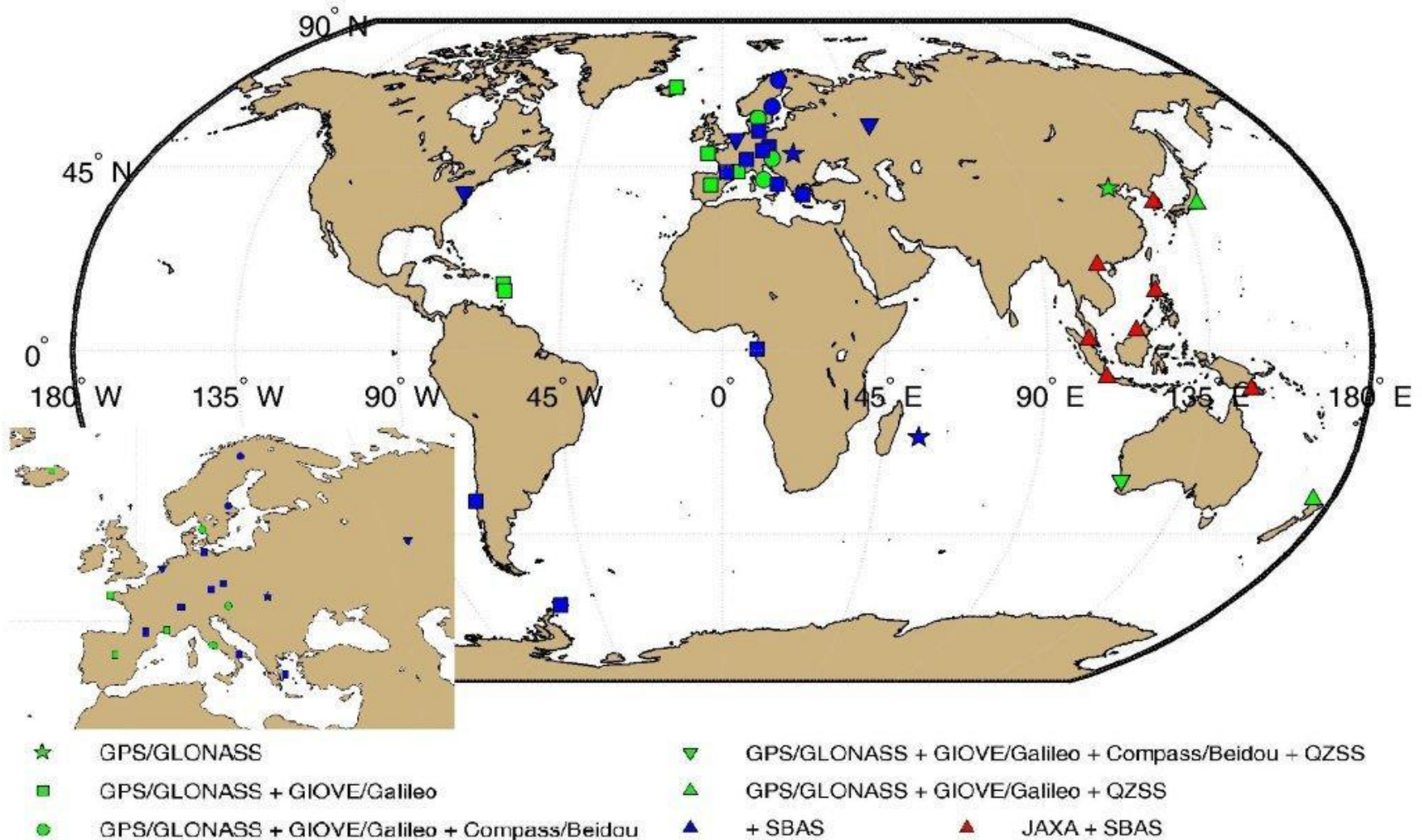




IGS CfP for Multi-GNSS Global Experiment

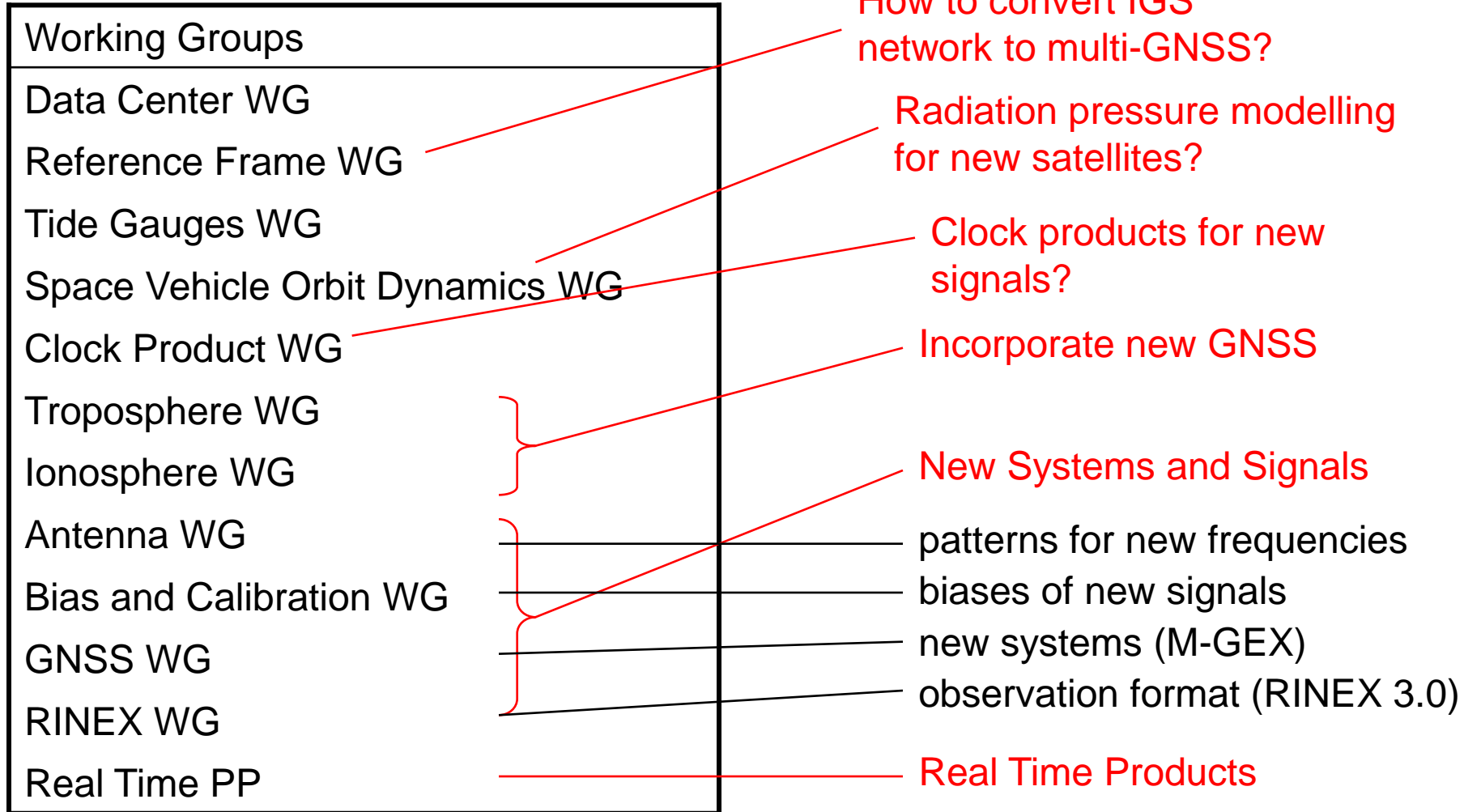
- IGS prepares for incorporation of new GNSS
- Goal of M-GEX
 - Experiment to operate an expanded network of new receivers capable of tracking new signals in addition to GPS & GLONASS
 - Support JAXA Multi-GNSS proposal activities
- Tasks
 - Set-up tracking network of Multi-GNSS equipment
 - Make tracking data publicly available
 - Experiment with data flow and signals, qualify equipment, signals, ...
 - Upgrade IGS network to Multi-GNSS
 - Generate Multi-GNSS products
- Status
 - Start of experiment 1. Feb. 2012
 - more than 24 proposals, for installing equipment, data center, analysis

IGS M-GEX Network



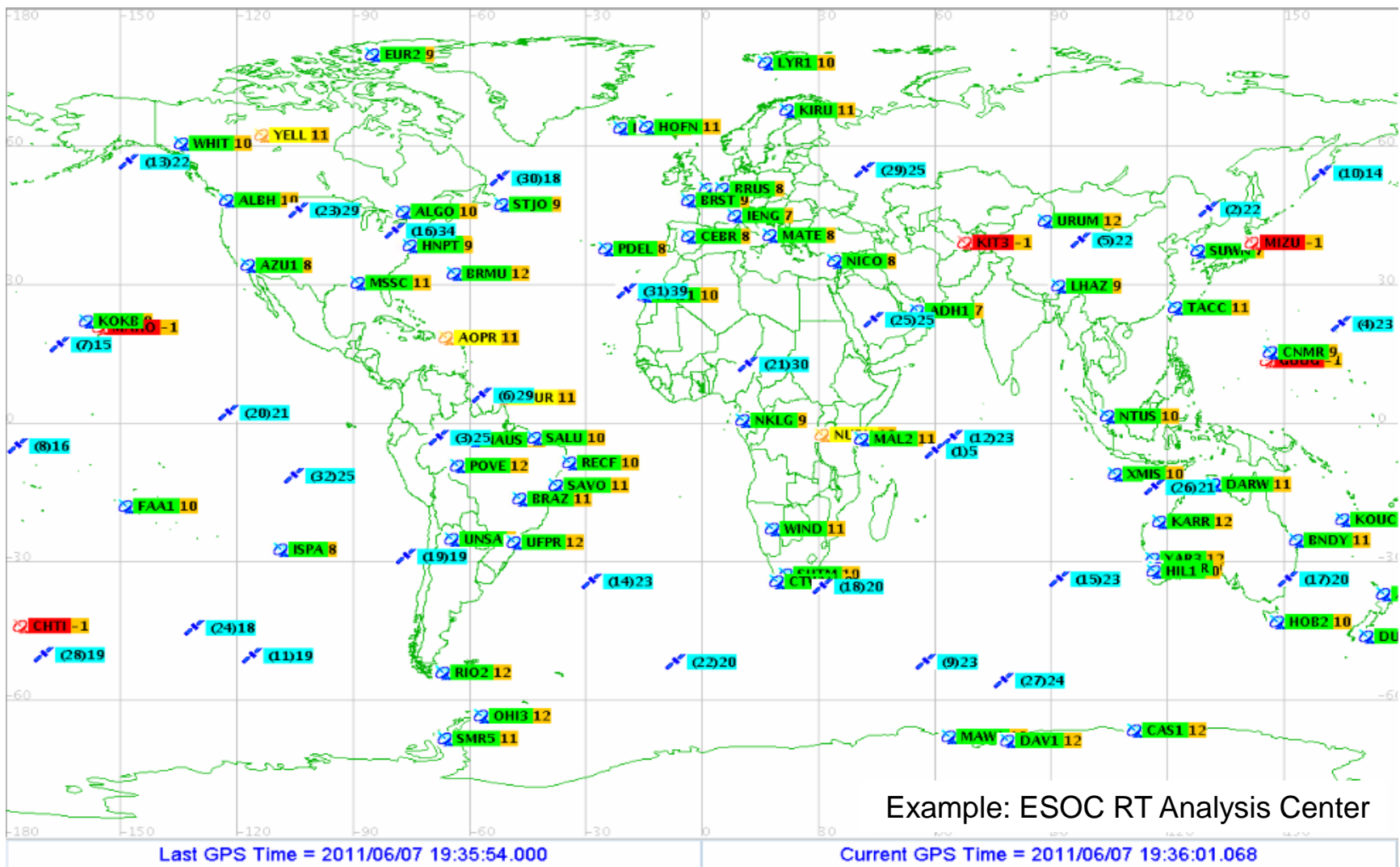


IGS Working Groups and Pilot Projects





Real-Time Pilot Project



Example: ESOC RT Analysis Center



Conclusions and Questions

Changing GNSS landscape

- new systems, new signals, new frequencies, new clocks, ...
- Multi-GNSS capable equipment gets available
- and user start to use it and generate files

Challenges

- heterogeneous systems, equipments
- users want to use the new systems as one system, in real-time
- many biases, need characterization and standardization

Questions

- what do we need to work with heterogeneous systems and equipments?
- shall receivers track a common minimum set of signals?
- what new products the users need?
- what new products IGS has to provide for a seamless transition to Multi-GNSS?



Role of the International GNSS Service

- IGS prepares for incorporation of new GNSS
 - M-GEX experiment
- IGS assumes leadership role in RINEX development and bias standardization
 - joint IGS-RTCM WG chaired by IGS
 - IGS Bias Workshop in January 2012
- IGS will provide Multi-GNSS products
- IGS goes Real-Time

IGS Network

- is the basis for the IGS's work
- is and will always be heterogeneous
 - Open Standards are essential for a consistent integration
- is the fundament for long-term stable highly precise global reference frame
 - how to upgrade it without compromising this fundamental product?

The future has started ...
... but there remains a lot to do

