

An Exciting and Challenging Future after Twenty Years of Service

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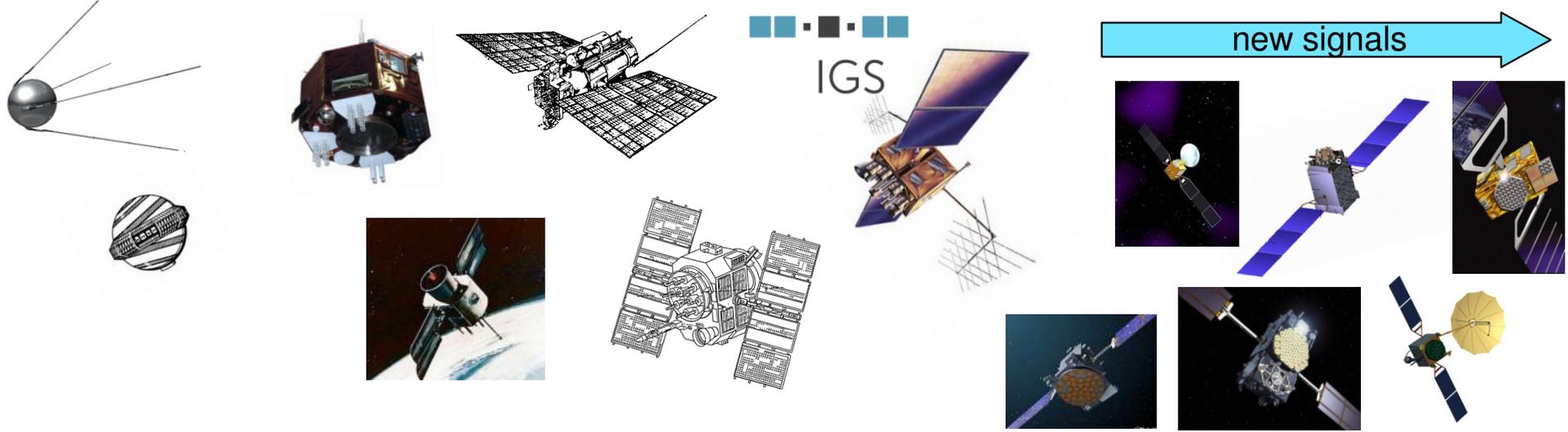
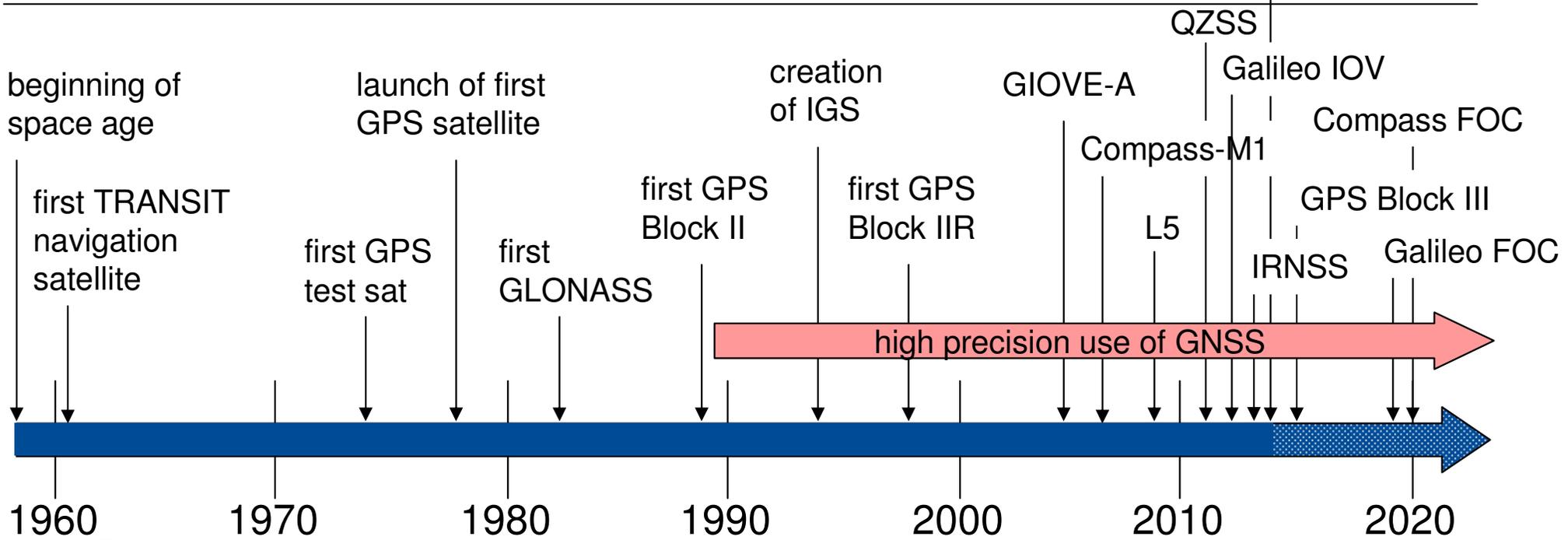
Mission of the IGS

"The International GNSS Service provides on an openly available basis the highest-quality GNSS data, products, and services in support of the terrestrial reference frame, Earth observations and research; positioning, navigation and timing; and other applications that benefit science and society."

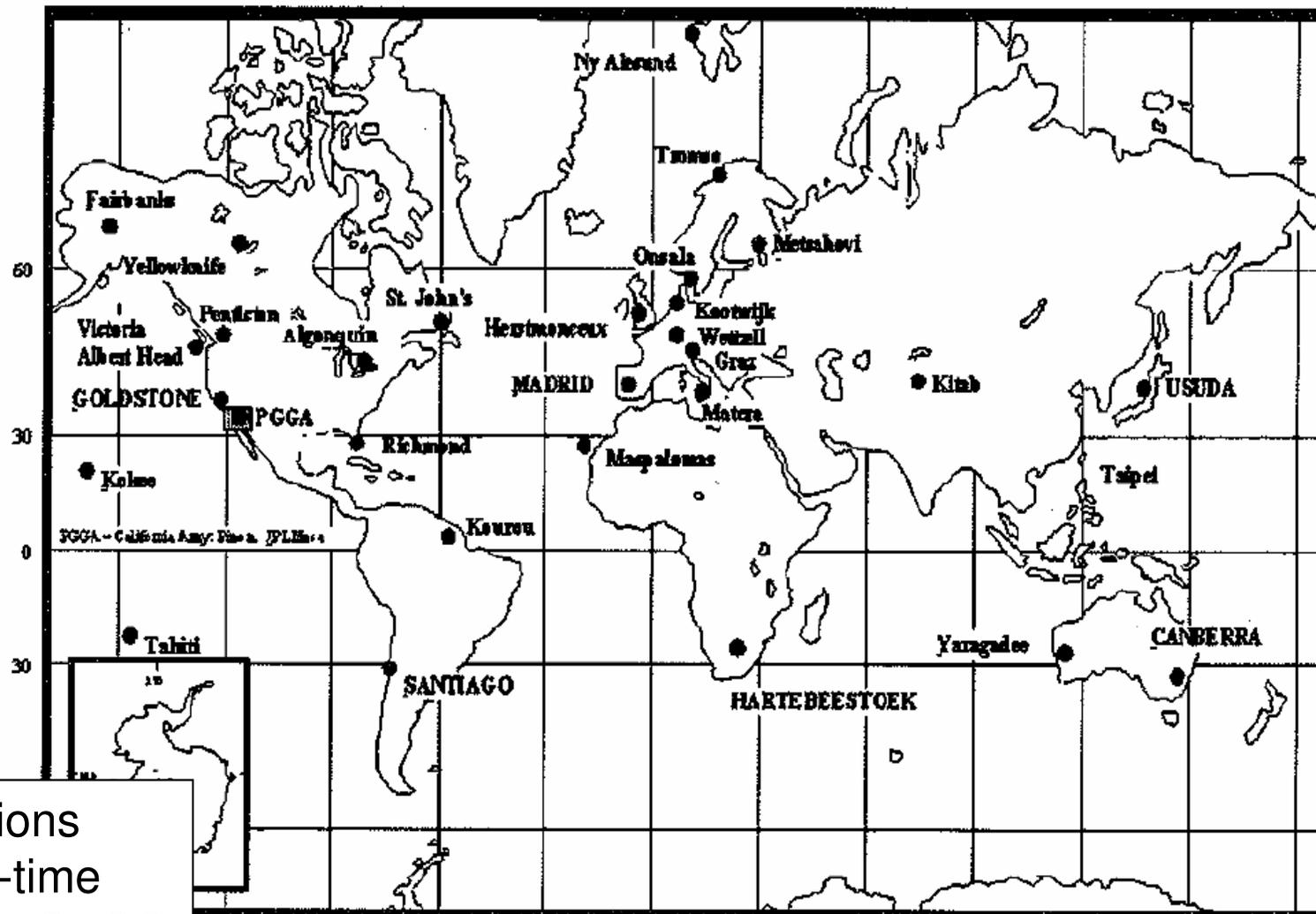


Short History of Satellite Navigation

20 years IGS



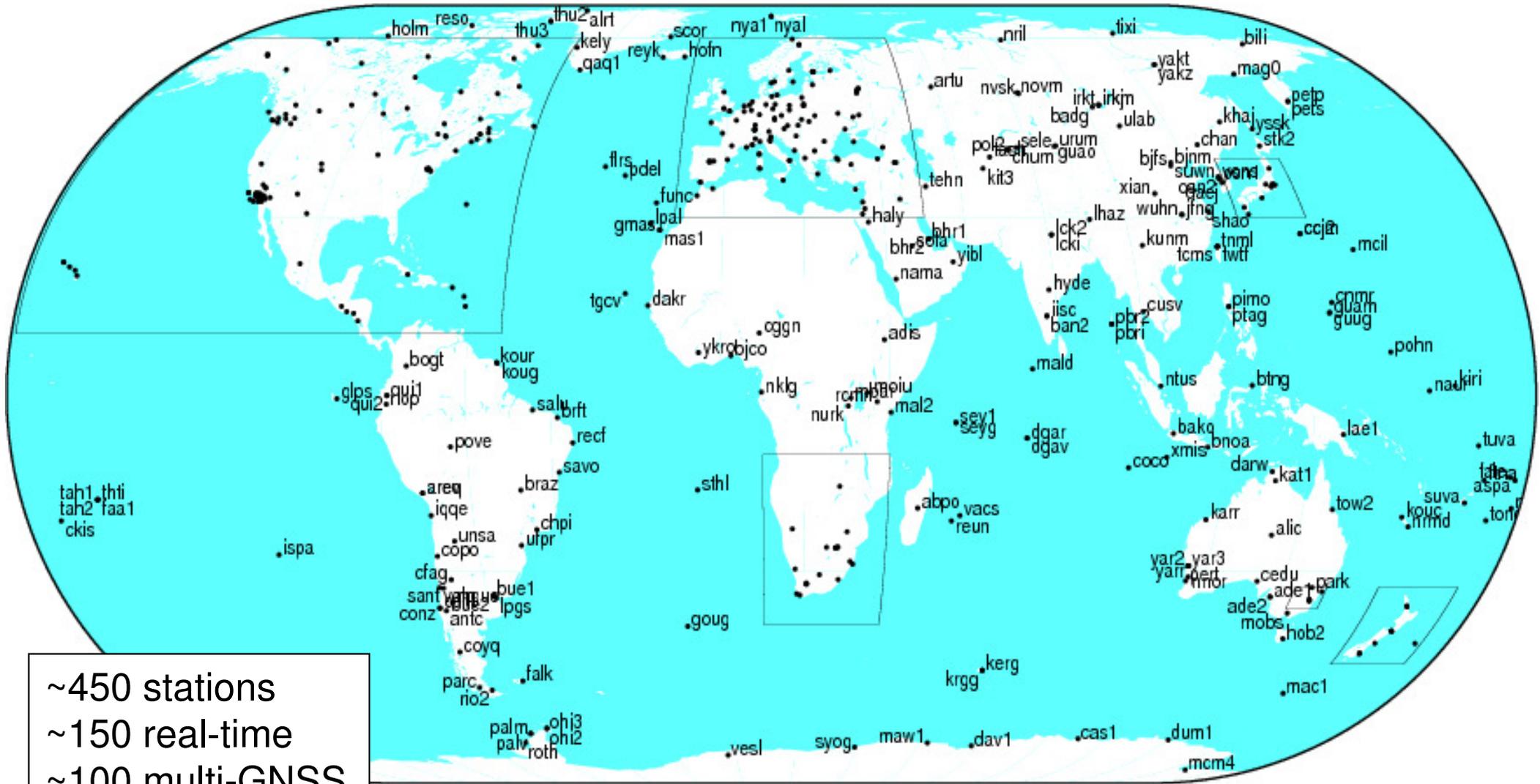
The IGS Network

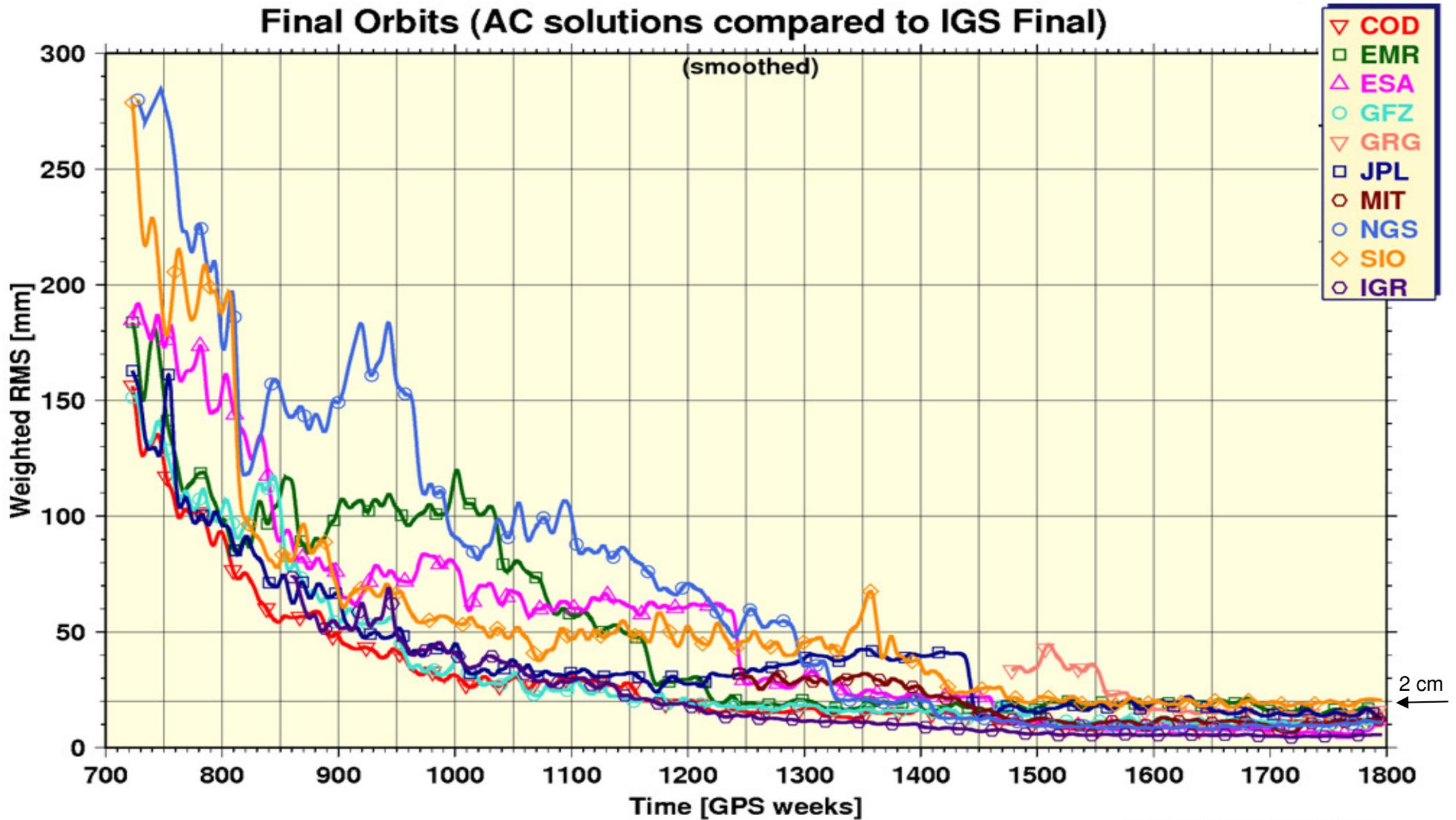


~450 stations
~150 real-time
~100 multi-GNSS

23 stations in 1993

The IGS Network





NOAA NGS, 20.06.2014 19:37 (GMT)



IGS

Workshop 2014

June 23-27

Pasadena, California, USA

Celebrating 20 Years of Service

1994 ★ 2014

| 2013 IGS Product Availability Metrics | | | | | | | | |
|---|--|--|---|-------------|---------------------------------|---------------------|---------------------------|---|
| Availability :percentage of time that accuracy, latency and continuity of service meet target specification | | | | | | | | |
| | | Sample Interval | Accuracy | Latency | Continuity | Target Availability | *2013 Actual Availability | Description of significant outages |
| GPS Satellite Ephemerides / Satellite and Station Clocks | | | | | | | | |
| Broadcast (for comparison) | Orbits Sat. Clocks | 1s | | | | | | |
| Ultra-Rapid (predicted half) | Orbits Sat. Clocks | 15 min | | | | | | |
| Ultra-Rapid (observed half) | Orbits Sat. Clocks | 15 min | | | | | | |
| Rapid | Orbits Sat. & Stn. Clocks | 15 min 5 min | | | | | | |
| Final | Orbits Sat. & Stn. Clocks | 15 min Sat: 30 s; Stn.: 5 min | | | | | | |
| Real-time | Orbits Sat. Clocks | 5-60 s 5 s | ~5 cm 300 ps RMS; 120 ps Sdev | 25 seconds | Continuous | 95% | 99.69% | <24 hour outage at BKG data center due to power failure. Redundant station data availability would have prevented it (since IOC Launch in April). |
| GLONASS Satellite Ephemerides | | | | | | | | |
| Final | | 15 min | ~3 cm | 12-18 days | weekly, every Thursday | 99% | 100% | |
| Geocentric Coordinates of IGS Tracking Stations (over 250 Sites) | | | | | | | | |
| Positions of Real-time Stations | Horizontal Vertical | daily | 3 mm 6 mm | 1-2 hours | daily | 99% | 100% | |
| Final Positions | Horizontal Vertical | weekly | 3 mm 6 mm | 11-17 days | weekly, every Wednesday | 99% | 100% | |
| Final Velocities | Horizontal Vertical | weekly | 2 mm/yr 3 mm/yr | 11-17 days | weekly, every Wednesday | 99% | 100% | |
| Earth Rotation Parameters | | | | | | | | |
| Ultra-Rapid (predicted half) | Polar Motion Polar Motion Rate Length-of-day | daily integrations at 00, 06 12, 18 UTC | ~200 μ s ~300 μ s/day ~50 μ s | real time | 4x daily, at 03, 09, 15, 21 UTC | 99% | 99.25% | |
| Ultra-Rapid (observed half) | Polar Motion Polar Motion Rate Length-of-day | daily integrations at 00, 06, 12, 18 UTC | ~50 μ s ~250 μ s/day ~10 μ s | 3-9 hours | 4x daily, at 03, 09, 15, 21 UTC | 99% | 99.25% | |
| Rapid | Polar Motion Polar Motion Rate Length-of-day | daily integrations at 12 UTC | ~40 μ s ~200 μ s/day ~10 μ s | 17-41 hours | daily at 17 UTC | 99% | 100% | |
| Final | Polar Motion Polar Motion Rate Length-of-day | daily integrations at 12 UTC | 0.03 mas ~150 μ s/day 0.01 ms | ~11-17 days | weekly, every Wednesday | 99% | 100% | |

- different product lines
- different latencies, from 2 weeks to real-time
- very high availability
- controlled high quality



IGS Users

- Large and diverse user community (from geophysics and surveying to time keeping and meteorology)

- User access statistics:

| | | |
|--|----------------|---------|
| www.igs.org : | # visits 2013: | 740,000 |
| | # users/month: | 21,800 |
| | # countries: | 146 |

| | | |
|---|---------------|-----------|
| ftp.igs.org : | # visits 2013 | 57,200 |
| | # users/month | 5,700 |
| | # files | 12,700,00 |
| | # countries | 113 |

| | | | |
|--|--------------------------------|-----------|----------|
| cddis.gsfc.nasa.gov : | # data files <i>per day</i> | 1,700,000 | (150 GB) |
| | # product files <i>per day</i> | 375,000 | (42 GB) |

The IGS Today

- Today the IGS is a *voluntary federation of more than 240* contributing organizations and institutions
- The IGS operates on a "*best effort*" basis, though with considerable redundancy
- All IGS data and products are available *free of charge*
- Geospatial applications and Earth science missions rely upon IGS products – IGS is the *gold standard*
- IGS products are critical to *ITRF* realization, maintenance and accessibility
- The IGS has a large and diverse *user community*
- The IGS is well-connected and respected beyond the scientific community

Challenges

- *Network*
 - long-term stability and upgrade to newest technology (discontinuities)
 - antenna calibrations
 - expansion to Africa, China, Siberia
- *Real-time*
 - reducing latency of product availability
 - redundant real-time infrastructure
- *Multi-GNSS*
 - new satellite constellations, frequencies, signals, clocks and new equipment forming a heterogeneous environment
 - transition to the International *GNSS* Service

IGS Real-Time Service



- Launched on April 1, 2013
- Innovative support for public benefit applications
- Open data, products and standards
- Enables real-time precise point positioning (PPP) at global scales for scientific and hazard detection applications, weather and space weather forecast, multi constellation performance monitoring
- Rapidly detecting, locating, and characterizing hazardous events such as earthquakes and tsunamis
- Contributing to GGOS Theme 2 “Natural Hazards”



IGS Real-time Service

- International effort of many contributions:
Station operations, Data Centers, Analysis Centers, Combination Centers, Analysis Coordination, caster operation, ...



Multi-GNSS

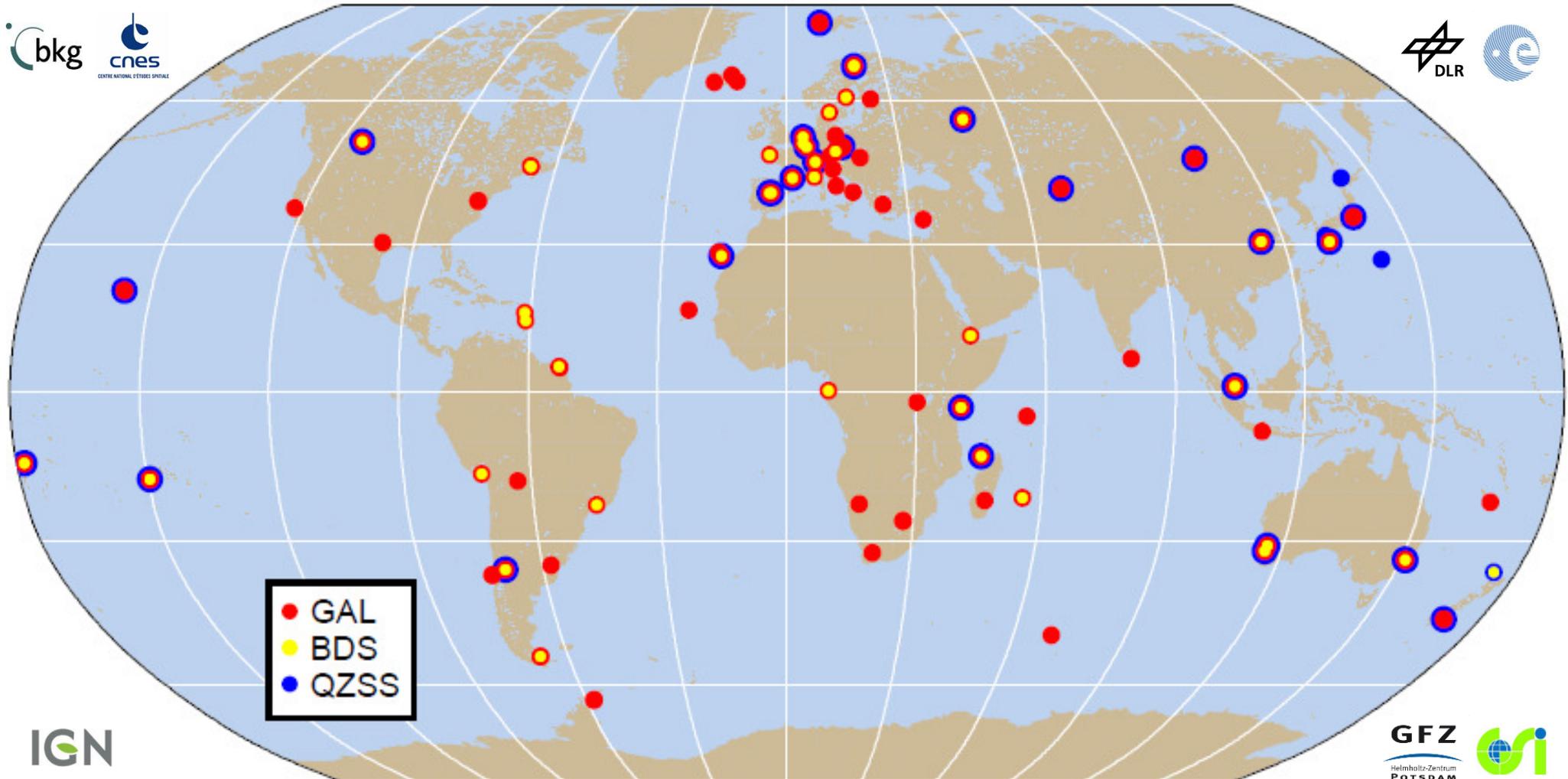
- Ongoing deployment of new GNSSs with new signals and satellites
 - Galileo, BeiDou, QZSS, IRNSS, SBAS
 - Soon more than 100 navigation satellites available
- New signals, new orbit types, better clocks
- New receivers and antennas
- More biases





IGS MGEX Network

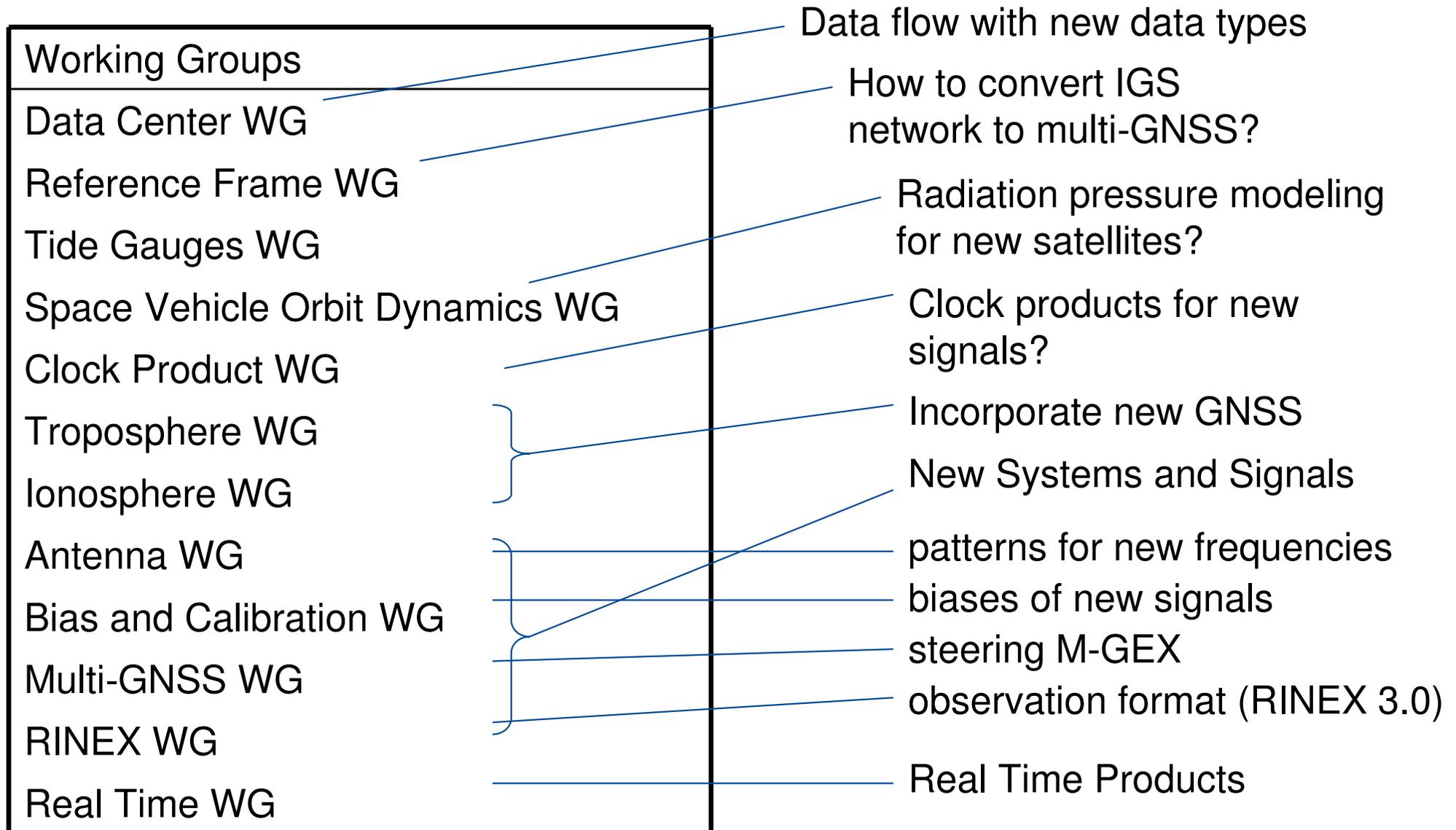
IGS



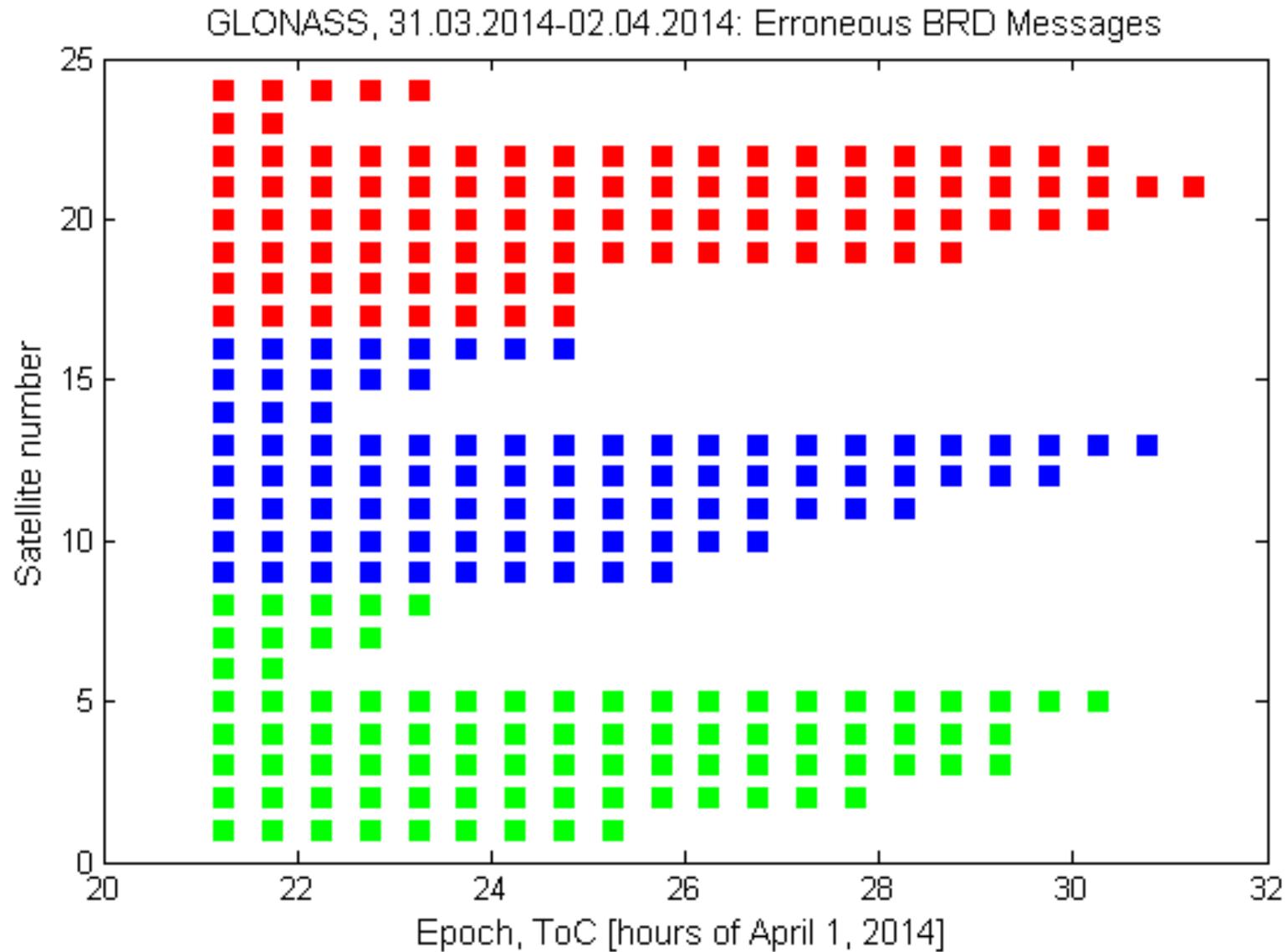
~100 stations, ~80 sites



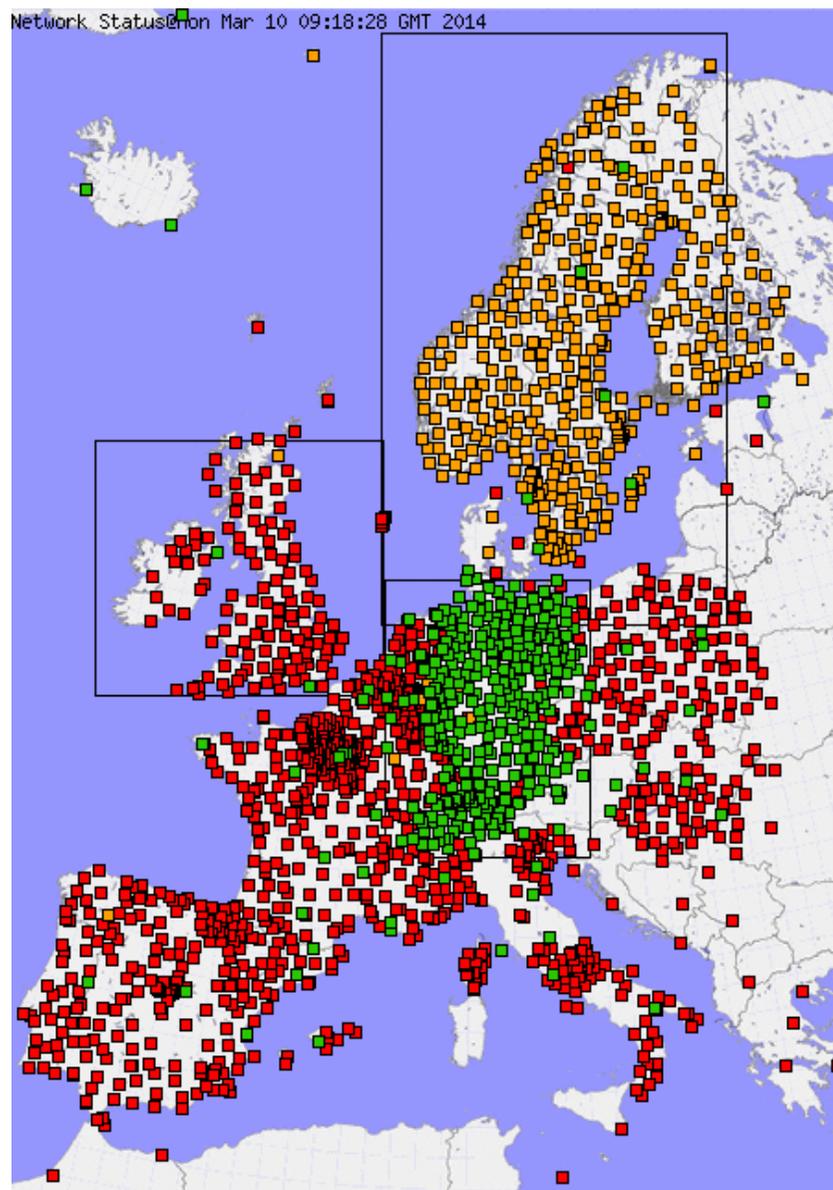
Effort of Entire IGS



GLONASS Event April 1



IGS Ultra March Event



- What if the IGS would not exist?

Courtesy Jan Dousa

The IGS Tomorrow?

- How will the IGS look in 20 years?
- *Multi-GNSS* is the big challenge, involving all components of the IGS; use of new constellations, signals, clocks; transition of data formats and data flow, development of AC software packages, transition of IGS network and products.
- *Reference frame* maintenance and access, essential contribution to the ITRF, requires highest network stability, regular reprocessing.
- New *Real-time* products, exploitation of the real-time capabilities for monitoring.
- All depends on *resources*
 - Engagement of new groups
 - Raise awareness of the work of IGS as an essential infrastructure of society





Attractive Workshop Program

IGS

| | | | | | |
|-------------|---|--|--|---|---|
| 09:00-09:30 | Welcome PY01: Opening Session | Plenary PY04: Reprocessing and reference frame | Plenary PY07: Progress and development of MGEX | Plenary PY08: Ionosphere modelling and GNSS biases | Plenary 10: Applications and theory of GNSS processing |
| 09:30-10:00 | | | | | |
| 10:00-10:30 | | | | | |
| 10:30-11:00 | <i>Break</i> | <i>Break</i> | <i>Break</i> | <i>Break</i> | <i>Break</i> |
| 11:00-11:30 | Plenary PY02: Celebrating 20 years of operational IGS service | Plenary PY05: Progress and Challenges in Orbit and Attitude Modelling for GNSS Space Vehicle | Poster 1: | Plenary PY09: a) GNSS-derived troposphere delays b) Applications of IGS products for geodesy and geophysics research | Closing Session: Splinter working group reports and recommendations |
| 11:30-12:00 | | | | | |
| 12:00-12:30 | | | | | |
| 12:30-13:00 | | | | | |
| 13:00-13:30 | <i>Lunch</i> | <i>Lunch</i> | <i>Lunch</i> | <i>Lunch</i> | <i>Lunch</i> |
| 13:30-14:00 | | | | | |
| 14:00-14:30 | Plenary PY03: IGS real-time service on the way to FOC | Plenary PY06: Infrastructure, Formats and Calibration | Poster 2: | Poster 3: | |
| 14:30-15:00 | | | | | |
| 15:00-15:30 | | | | | |
| 15:30-16:00 | <i>Break</i> | <i>Break</i> | <i>Break</i> | <i>Break</i> | |
| 16:00-16:30 | Splinter 1: 1) real-time | Splinter 2: 1) analysis centers, reference frame, clock | Splinter 3: 1) MGEX | Splinter 4: 1) antenna | |
| 16:30-17:00 | 2) orbit modelling | 2) ionosphere | 2) infrastructure | 2) TIGA | |
| 17:00-17:30 | 3) bias and calibration | | 3) troposphere | 3) data center | |

Summaries and Recommendations

IGS Workshop 2014

Pasadena/CA

Plenary Session / WG Splinter Meeting Summary and Recommendations

Session/Splinter Meeting Title:

Date:

Chair (& Co-Chair):

Rapporteur:

Procedure:

- Provide the filled form until Thursday evening (for sessions before Friday) electronically to urs.hugentobler@bv.tum.de and igscb@jpl.nasa.gov.
- The rapporteur will have 5 minutes for presenting the Recommendations in the Splinter Working Group Reports and Recommendations session of Friday.

Key Issues, Session / Discussion Highlights:

Please briefly summarize key issues or reports, ~ one paragraph each.

Address in particular issues related to IGS Infrastructure, M-GEX and Real-Time if appropriate.

Recommendations :

Please prioritize top three recommendations, and if recommendations are adopted, please suggest who is responsible to implement, and what timeframe is needed to accomplish.

Where appropriate attempt to harmonize your recommendations with those of other WGs.

Session and WG Chairs:

- Define a rapporteur
- Summarize key issues
- Address infrastructure, M-GEX, Real-time
- Prioritize top three recommendations
- Provide the filled form until Thursday evening.

Wishing

a productive Workshop

with fruitful discussions

scientific progress

celebration of the anniversary

reflection about the
directions of the IGS in
the next 20 years