



# ICG GNSS Monitoring Effort

- Project Initiated at International Committee on GNSS (ICG)
  - ICG Monitoring and Assessment Task Force (IGMA)
  - Trial project coordinated with International GNSS Service (IGS)
  - Beneficiary of IGS Multi-GNSS Experiment (MGEX)
- Six Entities Coordinating Under IGMA
  - Five GNSS Service Providers—Beidou, Galileo, GLONASS, GPS, and QZSS
  - IGS Governing Board

# IGMA GNSS Monitoring Trial Project

## □ IGMA—Ambitious Schedule

- Terms of Reference in place and Call for Participation completed Feb 2016
- IGS team has 17 organizations from around the globe
- ICG nominations expect all GNSS service providers

## □ Anticipated Products for Public Dissemination

- Periodic SIS performance against published standards
- Six product “feeds” (IGS, US, China, Russia, EU, Japan)
- Six individual repositories
- Reference URLs to be linked on ICG web portal

# ICG-IGS IGMA Terms of Reference

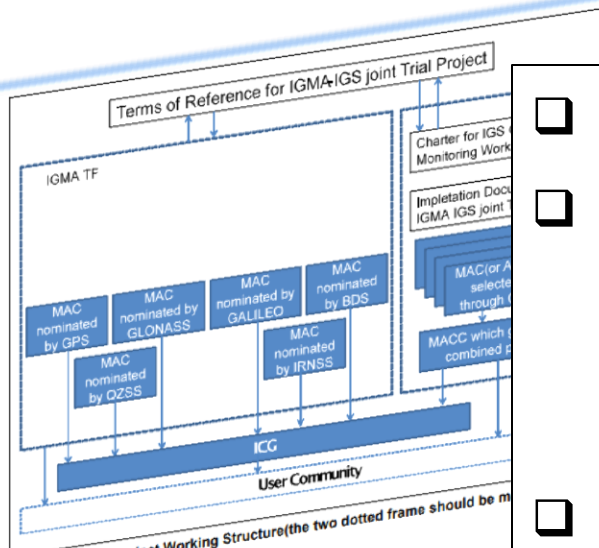


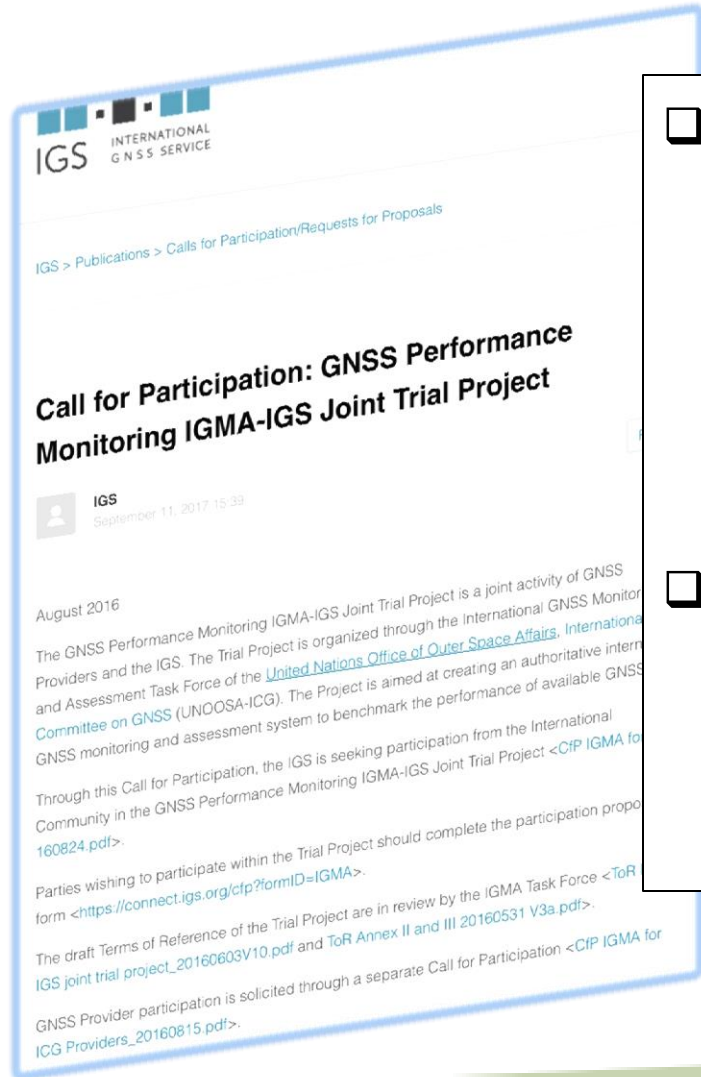
Figure1: Trial Project Working Structure (the two dotted frame should be m)

3. Objectives of Trial Project
  - To implement a monitoring system for all participating GNSS
    - > Monitoring a limited number of parameters
    - > Using existing monitoring infrastructures
    - > Developing a set of requirements for monitoring system(s) in phases of the project
  - To demonstrate user benefits of
    - > Consolidated monitoring system products
    - > Combined use of multi-constellations
  - To promote trust in GNSS via an ICG endorsed monitoring system
4. Monitoring and Monitored Parameter List
 

Monitoring means observing and reporting of an agreed upon list of p each GNSS. The desired GNSS constellations set to be monitored in the initial pho

- ❑ Consensus Document from ICG WG-S & IGS
- ❑ Phased List of Monitored Parameters
  - Trial Project: PDOP, orbit error, UTC offset, URE
  - Long-term objective is all Performance Standard (PS) entries published for each GNSS
- ❑ Parallel WG-S Effort to Form GNSS-PS Template
  - Introductory edition will be consolidated GNSSs
  - Future objective is a multi-GNSS service performance standard

# IGS Call for Participation (CfP)



## ❑ Four Support Center Types

- Monitoring Stations: receivers, pre-processing
- Data Centers: networking, storage, & retrieval
- Analysis Center: measurement processing and parameter estimation
- Coordination Center: administrative control

## ❑ Cooperative Effort

- Expressly opened to new IGS participants
- Individually contributed resources
- Sharing of knowledge

# IGS Collaborators Responding to CfP

## IGS IGMA Proposals



IGS

- 1 Richard Langley, University of New Brunswick, Canada
- 2 Rafal Sieradzki, Pawel Wielgosz, University of Warmia and Mazury in Olsztyn, Poland
- 3 Sungpil Yoon, Kevin Choi, National Geodetic Survey, Silver Spring, USA
- 4 Anna Maria Baron Isanta, Joel Grau Bellet, Ernest Bosch Llopart, Institut Cartogràfic i Geològic de Catalunya, Barcelona, Spain
- 5 Carey Noll, CDDIS, GSFC, NASA, Greenbelt, USA
- 6 Joao Monico, Universidade Estadual Paulista, Presidente Prudente, Brasil
- 7 Jan Douša, Pavel Václavovic, Pavel Novák, Research Institute of Geodesy, Topography and Cartography, Onrejev, Czech Republic
- 8 Peter Steigenberger, Oliver Montenbruck, Deutsches Zentrum für Luft- und Raumfahrt, Oberpfaffenhofen, Germany
- 9 Furqan Ahmed, Srinivas Bettadpur, The University of Texas at Austin, USA
- 10 Yanming Feng, Charles Wang, Queensland University of Technology, School of electrical Engineering and computer science, Brisbane, Australia
- 11 Zhiguo Deng, GFZ German Research Centre for Geosciences, Potsdam, Germany
- 12 Yuki Hatanaka, Geospatial Information Authority of Japan (GSI), Tsukuba, Japan
- 13 Werner Enderle, ESA/ESOC, Darmstadt, Germany
- 14 Qile Zhao, Min Li, Chuang Shi, Wuhan University, GNSS Research Center, China
- 15 Junping Chen, Shanghai Astronomical Observatory, Tonji University, China
- 16 Irma Rodriguez Perez, Guillermo Tobias Gonzalez, GMV, Madrid, Spain
- 17 Ahmed Mohamed Ali, Dubai Municipality, United Arab Emirates

<http://igs.org>

IGMA WS, Shanghai, 22 May 2017

# IGS Collaboration Center Types

## IGS IGMA Proposals

IGS

Proposal	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
<b>Sites</b>	X	X	X	X		X			X			X	X	X	X		
<b>Data Center</b>				X	X								X	X			
<b>Analysis parameters</b>				X		X	X	X	X	X	X		X	X	X	X	X
• Broadcast orbits				X			X	X	X	X	X		X	X	X	X	
• Broadcast clocks				X			X	X	X	X	X		X	X	X	X	
• SIS User Range Error				X			X	X	X	X			X	X	X	X	
• SIS UTC Offset Error				X					X	X			X	X	X	X	
• PDOP for defined sites				X		X	X		X	X			X	X	X	X	
<b>for</b>																	
• BDS				X			X	X		X	X		X	X	X	X	X
• GALILEO				X		X	X	X	X	X	X		X	X	X	X	X
• GLONASS				X			X	X	X		X		X	X	X	X	X
• GPS				X		X	X	X	X	X	X		X	X	X	X	X
• QZSS							X			X	X		X	X	X	X	X
<b>ACC</b>													X	X			

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# USG Work on ICG-IGS Trial Project

- ❑ Basis of Monitoring Requirements: Terms of Reference (ToR)
  - US submitted proposal to ICG-IGS Trial Project at ICG-11 (Sochi)
  - Four monitored elements—UTC offset, PDOP, URE, Orbits (Clock & Ephemeris)
  - Initially monitor only US open signal (GPS L1 C/A)
- ❑ Proposed US Monitoring Analysis Center (MAC)
  - Leverage USG available data
  - Intermediate processing of raw observables for four data products
  - Data repository at USCG Navcen site
  - Publishing of data links to GPS.GOV and ICG web portal
- ❑ Potential Expansion of Data Products in Later Phases
  - Modernized GPS signals (L5, L2C, L1C)
  - GNSS open signals from other Service Providers BDS, GAL, GLN
  - Additional monitored elements if/when ToR is expanded
  - Internationally located tracking sites



# Data Sources(1 of 3): Tracking Sites

- ❑ FAA Technical Center SBAS Reference Network
- ❑ Six Monitoring Stations
  - Boston, Honolulu, Los Angeles, Miami, Juneau, Merida
  - WAAS GIII reference receiver, Cs frequency standard
  - Raw data collected near-real-time, processed daily
- ❑ Signals of Interest
  - GPS L1 C/A fully processed
  - Modernized GPS and other GNSS signals under consideration
- ❑ Provide Observations for PDOP and URE monitoring

# Data Sources(2of3): UTC Time Scale

- ❑ US Naval Observatory UTC Reference
  - Time Scale provided daily
  - UTC-GPS Offset evaluated on each Time Scale update

# Data Sources(3of3): Orbit Parameters

- ❑ Provided Through National Geodetic Survey
  - Reference GPS orbit data available daily
  - Produced in accordance with IGS “final” products
- ❑ Orbit Accuracy Processing
  - Processed daily with each reference orbit update
  - Broadcast orbits to be evaluated on IODEs
- ❑ Future Consideration of Other GNSS Orbits
  - IGS independent ephemerides are of interest
  - Not likely in trial timeframe
  - Other clock observations possible

# IGMA Forward-look

## □ ICG Meeting & Coordination Rhythm

- Two to three meetings per year
- Both technical and administrative exchanges
- IGMA reporting to WG-S at annual ICG meetings

## □ US Effort Anticipated Milestones

- Dec '17: USDOT co-leading data model definitions
- Mar '18: US prototype running end-to-end
- Dec '18: US product feed connected to ICG
- Jun '19: Phase two scope determination

## Questions?

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