

Real-Time and Multi-GNSS – Key Projects of the International GNSS Service

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IGS Mission



"The International GNSS Service provides the highest quality GNSS data, products, and services in support of the terrestrial reference frame; Earth observations and research; Positioning, Navigation and Timing (PNT); and other applications that benefit the scientific community and society."

From IGS Strategic Plan 2013-2016

IGS Key Projects



- Real-time Service (RTS)
 - Launched April 1, 2013
- Multi-GNSS Experiment (MGEX)
 - Launched February 2012

IGS Real-time Service



- Maintain and extend real-time infrastructure (data transfer, broadcasting, product generation, combination, quality control)
- Develop necessary standard data formats and transmission protocols together with RTCM SC104
- Deliver (initially) real-time orbit and clock products
- Support scientific and other applications

IGS Real-time Service



• International effort of many contributions:

Station operations, Data Centers, Analysis Centers, Combination Centers, Analysis Coordination, caster operation, ...



IGS Real-time Tracking Network



150+ stations

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IGS Real-time Service



- Larger network than any private network, 150+ stations
- Real-time orbits at few cm, clocks at sub-ns
- Compelling redundancy concept
- But no service guarantee
- Open data policy
- Using open standards

http://rts.igs.org

IGS RTS Products



- Service launched on April 1, 2013
- Initial Operational Capability (IOC), Full Operational Capability (FOC) expected later this year
- Rapidly developing into a multi-GNSS service
- Two GPS products and one experimental GPS+GLONASS product:

IGS01/IGC01	GPS-only	orb & clk	single epoch combo	1.8 kb/s
IGS02	GPS-only	orb & clk	Kalman combo	0.6 kb/s
IGS03	GPS+GLO	orb & clk	Kalman combo	0.8 kb/s

- Broadcast stream GPS+GLONASS+Gal (RTCM3EPH)
- Reference is ITRF2008



• Satellite orbit RMS (compared to IGS Rapid)





• Satellite clock std.dev. (compared to IGS Rapid)





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IGS RTS Product Access



- BKG Ntrip Client (BNC) or RTKLIB
- BKG Ntrip Client (BNC, Open Source) with its GUI and range of supported Operating Systems represents a perfect platform to process many broadcast corrections streams in parallel for Precise Point Positioning or other applications
- BNC allows an instantaneous Quality Check of the combination process also in the PPP domain

IGS RTS Product Access



 BNC supports RINEX-3, teqc-like stream conversion, file editing and concatenation

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BKG Ntrip Client (Bl	NC) Version 2.6						_	Network General	RINEX Observations	RINEX Ephemeris	RINEX Editing & QC	Broadcast Corrections	Feed Engine	Seri
Help								RINEX file editing, con	catenation and quality c	heck.				
								Action	Edit/Concatenate	•	Set Edit Options			
Network General	RINEX Observations	RINEX Ephemeris	RINEX Ed	liting & QC	Broad	lcast Correc	tions Feed	Input files (full path)	cut0255a*.120	Obs	Nav			
aving RINEX observation	n files.							Output files (full path)	cut0255a.12o	Obs	Nav			
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3KG (Bundesamt fuer Geo	daesie und Kartographie	:)												
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IGS RTS Applications





- Innovative support for public benefit applications
- 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"

		3	3	53	13
By Organization Type	5	AP1 30	AP1/15	1 ¹²¹ 10	Nº 20
Academic	23	38	41	41	43
Aerospace	4	2	2	2	2
Civil Aviation Authority	1	1	1	1	1
Engineering Services/Consulting	25	40	44	44	48
GNSS Equipment/Software	15	34	36	36	36
Government (General)	-	4	4	4	4
Government (Geodetic/Mapping)	2	9	10	12	13
Government (Geological/Geophysical)	3	4	4	4	4
Government (Meteorology)	1	1	1	1	1
Military/Defense	0	1	1	1	1
Positioning Services	2	2	2	2	2
Telecommunications	2	4	5	5	5
Other	2	10	10	10	10

Ву Арр	lication	Category
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		3	13	13	
By Application Category	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	AP. 13	N37 10	NNº 24	No
Academic Research/Instruction	24	24	24	24	
Agriculture	4	4	4	4	
Automotive/Vehicle Navigation	1	1	1	2	
Aviation/Runway Mapping/Integrity Monitoring	1	1	1	1	
Control Surveying	2	2	2	2	
Meteorology	2	2	2	2	
Mining/Oil/Gas	1	1	1	1	
Photogrammetry/Airborne LIDAR	0	0	0	0	
Radiation Monitoring	0	0	0	0	
Receiver/Software Development	9	9	9	9	
Robotics	2	2	2	2	
SBAS Development	0	0	0	0	
Seismology/Earthquake Warning	7	7	7	7	
Single Frequency PPP development	16	16	16	16	1
Space Weather	0	0	0	0	
Surveying/Mapping/GIS	30	34	36	39	
Targeting/Guidance	3	3	3	3	
Telecommunications/Smart Phone Positioning	4	5	5	5	
Testing/Comparison of Positioning Systems	37	41	41	44	
Time Syncronization	4	6	6	6	
Other	3	3	3	3	

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By Country	/ 5	1	13	/ ^	/ >	/ ^/
Australia	6	8	9	10	10	10
Austria	1	1	1	1	1	1
Belgium	0	1	1	1	1	1
Bosnia and Herzegovina	2	2	2	2	2	2
Brazil	5	6	6	3	6	6
Bulgaria	2	2	2	2	2	2
Canada	7	9	10	11	11	11
China	2	5	6	6	6	6
Croatia	0	1	1	1	1	1
Cuba	0	1	1	1	1	1
Czech Republic	0	4	4	4	4	4
Egypt	1	1	2	2	2	2
Finland	1	1	1	1	1	1
France	2	2	3	4	4	4
Germany	2	4	4	4	4	5
Greece	1	1	1	1	1	1
Indonesia	1	2	2	3	3	3
Iran	2	2	2	2	2	2
Italy	3	3	3	3	3	4
Japan	5	9	9	9	9	10
Kenya	1	1	1	1	1	1
Malaysia	3	3	3	3	3	3
Namibia	0	0	0	1	1	1
Netherlands	0	1	1	1	1	1
New Zealand	0	1	1	1	1	1
Norway	0	1	1	1	1	1
Peru	0	1	1	1	1	1
Phillippines	1	1	1	1	1	1
Poland	0	1	1	1	1	1
Romania	2	3	3	3	3	3
Russia	5	15	16	17	17	18
Saudi Arabia	2	2	2	2	2	2
Spain	2	4	4	4	4	4
South Korea	2	4	5	6	6	7
Switzerland	0	0	0	2	2	2
Taiwan	0	2	2	2	2	2
υк	3	6	7	7	7	7
Ukraine	1	1	1	1	1	2
Uruguay	1	1	1	1	1	1
USA	14	27	28	30	32	33
Vietnam	0	1	1	1	1	1
TOTAL	80	141	150	158	163	170

IGS Real-time Service Web Page



🕙 IGS.org - Real-time Service - Mozilla	Firefox								
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International GNSS Service Formerly the International GPS Service									
	Products	Network	Projects	Events	Organization				
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Real-time Service

User Access Products RTS Monitoring Contributors More Information Support

The International GNSS Service (IGS) has ensured the availability of open access, high-quality GNSS data products since 1994. These products enable access to the definitive global reference frame for scientific, educational, and commercial applications – a tremendous benefit to the public.

Through the Real-time Service (RTS), the IGS extends its capability to support applications requiring real-time access to IGS products. RTS is a GNSS orbit and clock correction service that enables precise point positioning (PPP) and related applications, such as time synchronization and disaster monitoring, at worldwide scales. RTS is based on the IGS global infrastructure of network stations, data centers and analysis centers that provide world standard high-precision GNSS data products.

The RTS is currently offered as a GPS-only beta service for the development and testing of applications. The Russian GLONASS is initially provided as an experimental product and will be included within the service when the RTS reaches its full operating capability at the end of 2013. Other GNSS constellations will be added as they become available.

The RTS is operated by the IGS as a public service. Users are offered open and readily available access through subscription.



http://rts.igs.org

http://igs.org

IGS Real-time Service Registration

Real-time Service

User Access	s Products	RTS Monitoring	Contributors	More Information	Support
Name*:					
Organization/Agency*:					
Street*:					
City*:					
Country*:					
Phone:					
Email*:					
Username*:					
Password*:					
Application*:	Please be as usage.	s descriptive as p	oossible regar	ding your real-tin	ie service data
Number of Streams:	Please conta	act support if ad	ditional stream	ns are desired.	
Terms of Service*:	The IGS RTS and/or usin and also act otherwise, f accepts that that these e Subscriber s harmless fre relating to t	is provided free g the Service, the knowledges that or the accuracy t the Service can vents can rende shall indemnify, om any loss or d he data services	ely to all users e Subscriber a the IGS make or availability have outages r the Service u defend and he amage resulti provided und	. By completing the agrees to accept the s no assurances, i of the Service. The and degradations insuitable for any old the IGS and its ng from any claim ler this agreement	nis registration ne Service as is, mplied or e Subscriber also s in accuracy and use. The affiliates n by any person



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Multi-GNSS

- IGS is the International GNSS Service
 - Well established infrastructure, data and service for GPS (+ GLONASS)
 - IGS Strategic Plan foresees extension to all new GNSSs
- Ongoing deployment of new GNSSs with new signals and satellites
 - BeiDou, Galileo, QZSS, IRNSS, SBAS
 - Soon more than 100 navigation satellites available





Multi-GNSS Experiment (MGEX)



- Multi-GNSS Experiment (MGEX)
 - MGEX call-for-participation released mid-2011 (ongoing)
 - Steered by Multi-GNSS Working Group
- Some 10 contributing agencies
- About 74 stations worldwide, numerous real-time stations
- 6 major receiver types, 7 major antenna types
- Tracking of Galileo, BeiDou, QZSS
- Data archives at CDDIS, IGN, BKG in RINEX 3.x
- Free data/product access

ftp://cddis.gsfc.nasa.gov/pub/gps/data/campaign/mgex/ ftp://cddis.gsfc.nasa.gov/pub/gps/products/mgex/

IGS MGEX Network





74 stations (June 2013)

IGS MGEX Real-time Network





63 stations (June 2013)

IGS Working Groups and Pilot Projects



	Data flow with new data types
Working Groups	
Data Center WG	How to convert IGS
	network to multi-GNSS?
Reference Frame WG	— Radiation pressure modelling
Tide Gauges WG	for new satellites?
Space Vehicle Orbit Dynamics WG	Clock products for new
Clock Product WG	signals?
Troposphere WG	Incorporate new GNSS
Ionosphere WG	New Systems and Signals
Antenna WG	patterns for new frequencies
Bias and Calibration WG	— biases of new signals
Multi-GNSS WG	
RINEX WG	observation format (RINEX 3.0)
Real Time WG	Real Time Products

IGS MGEX Products



- Currently Galileo and QZSS orbits and clocks
- Four contributing analysis centers: CODE, GFZ, CNES/CLS/GRGS, TUM
- Orbits at decimeter level accuracy
- Available at ftp://cddis.gsfc.nasa.gov/pub/gps/products/mgex/
- SLR residuals for Galileo IOV satellites:



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IGS MGEX Products



- Assessment of MGEX QZSS Products
- Comparison of TUM solution with JAXA precise orbit products (27 Jan 2013 – 2 Feb 2013)
- Approx. 0.5 m 3D rms consistency



- Continued interactions of Multi-GNSS WG with
 - System providers
 - Equipment manufacturers
 - Other IGS Working Groups
- Recommendations, conventions and processing standards
 - Attitude models
 - Antenna offsets and patterns
- Data formats
 - Observations and navigation data (RINEX, RTCM3-MSM)
 - Biases (Bias SINEX?)
 - Orbits





IGS MGEX – http://igs.org/mgex/



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	MGEX					Stations W	/orking Group		
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	Scope								
	The Multi-GNS	S Experiment (MGEX) has b	een set-up by the IGS to f	track, collate and analyze a	II available GNSS signals.	This includes signal	Is from		
	the BeiDou, Ga	alileo and QZSS systems, as	well as from modernized	GPS and GLONASS satellit	es and any space-based	augmentation system	m (SBAS)		
	software capat	ole of handling multiple GNS	S observation data.	pration plases, compare eq	ulpinent performance and		Juessing		
	MGEX Ne	WS							
	2012/03/01	All participating institution	s have now transitionend	to the RINEX3 format for ot	servation and navigation	files submitted to th	e MGEX		
	2012/00/01	data archives. RINEX2 ha	s been discontinued for N	MGEX purposes (but continu	ues to be used for the ope	rational IGS network	k).		
	2012/12/17	First release of QZSS pro	iducts by JAXA (see section	on Products)					
	2012/11/10	Provision of orbit and clo	ck products for Galileo an	id QZSS (see section Produ	icts)				
	2012/11/10	Revised interactive netwo	ork map (see section Netw	vork)					
	2012/11/10	Draft parameters for Beil	ou processing (see BeiD	ou page)					
	2012/10/25	Recommended paramete	rs for Galileo and GIOVE	processing (see Galileo pa	ge)				
	2012/10/25	Recommended paramete	rs for QZSS processing (:	see QZSS page)					
	Constella	tion Status							
	Constend	lion otatas							
	Status informa	tion for the various navigatio	n satellite systems can be	e obtained by clicking on the	e icons below. Primary atte	ention is given to the	Э		
	emerging cons	teliations that are currently (rebioyed and undergoing	initial validation.					
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IGS Multi-GNSS Plan





Summary, Remarks



- IGS Key Projects support the transition to a full multi-GNSS Service with much reduced product latency:
 - Launch of Real-time Service on April 1, 2013
 - Establishment of Multi-GNSS Experiment beginning of 2012
- IGS Real-time Service:
 - High accuracy and redundancy
 - Transition to multi-GNSS RTS
- Multi-GNSS Experiment:
 - Targeting a multi-GNSS Pilot Service
 - Developing new products
 - Recruitment of additional analysis centers is required

