The IGS Real-Time Service: Status and Developments

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I. IGS Real-Time Service and it’s Global Infrastructure

- 2007: CfP “IGS Real-time Pilot Project”
  - RT Tracking Stations
  - RT Data Centers
  - RT Analysis Centers
  - RT Associate Analysis Centers
  - RT Analysis Center Coordinator
  - RT Network Management and Monitoring
  - RT Users

- 2013: IGS Real-Time Service (RTS) Pilot Project
- 2017: IGS Real-Time Service (RTS) operational
I. IGS Real-Time Service and it’s Global Infrastructure

- 500+ IGS Stations -> ~265 RT Stations (~ 235 at BKG www.igs-ip.net caster)
I. IGS Real-Time Service and it’s Global Infrastructure

- Several Data Centers / Casters
  - Global broadcasters: BKG, CDDIS, IGSCB
  - Continental / regional broadcasters, e.g. EUREF (ASI, BKG, ROB), APREF (GA); SIRGAS experimental caster?
  - National / local broadcasters, e.g. IBGE (Brasil)

- Strategy / Goal
  - Each RT data stream available at all global broadcasters
  - Identical mountpoint name at each global caster
  - Upload independently to, at least, two different casters
I. IGS Real-Time Service and it’s Global Infrastructure

- Several Analysis Centers
  - GPS: ESA/ESOC, NRCan
  - GPS+GLONASS: BKG
  - Multi-GNSS: CAS, CNES, DLR, GFZ, GMV, WHU

- Combination Center(s)
  - ESA/ESOC (GPS – 9 ACs), BKG (GPS+GLO – 7 ACs)
  - Mountpoints from combined solutions
    - IGS01 -> SSRA01IGS0
    - IGS02 -> SSRA02IGS0
    - IGS03 -> SSRA03IGS0
    - IGC01 -> SSRC01IGS0
I. IGS Real-Time Service and it’s Global Infrastructure

GPS Clock Standard Deviation (ns) Against IGS Rapids

L. Agrotis, 2020
I. IGS Real-Time Service and it’s Global Infrastructure

GLONASS Clock Standard Deviation (ns) Against ESA Rapids

L. Agrotis, 2020

![Graph showing GLONASS Clock Standard Deviation against ESA Rapids. The x-axis represents dates from 21.04.2014 to 20.03.2020, and the y-axis represents a range from 0 to 1. Different markers represent different satellites and services, such as BKG_11, CNES_91, DLR_21, GMV_80, and IGS03.](image-url)
I. IGS Real-Time Service and it’s Global Infrastructure

- **Real-Time Management** within the IGS:
  - IGS Real-Time Working Group, chaired by André Hauschild from DLR
    - mountpoint naming conventions
    - organisation of broadcaster structure
    - compiling IGS broadcaster guidelines
    - cooperation with IGS SSR Task Force
    - future RT data and product dissemination
    - establishment of the SSR Task Force to develop a format for Real-Time IGS products
II. Open Data and Open Formats

- Formats for **multi-GNSS Real-Time Observation Data**
  - Legacy RTCM Message Types
    - For GPS: 1001-4 and
    - For GLONASS: 1009-12
  - Replaced by RTCM **Multiple Signal Messages** (MSM)
    - For maximum compatibility with RINEX version 3
    - Universality for all existing and future GNSS
    - MSM1-5: standard precision messages
    - MSM6-7: high precision messages
    - MSM5/7: with GNSS phase range rates in addition
    - MSM5: for transmission of a complete set of RINEX v3 observations
    - MSM7: for transmission of a complete set of RINEX v3 observations with extended resolution
II. Open Data and Open Formats

- Formats for multi-GNSS Real-Time Observation Data
  - Available RTCM Multiple Signal Messages:
    - 1071-77 MSM1-7 for GPS
    - 1081-87 MSM1-7 for GLONASS
    - 1091-97 MSM1-7 for Galileo
    - 1101-07 MSM1-7 for SBAS
    - 1111-17 MSM1-7 for QZSS
    - 1121-27 MSM1-7 for BDS
    - 1131-37 MSM1-7 for IRNSS/NaviC
  - Recommended MSM type within the IGS Real-Time Network:
    - MSM7
    - MSM5 if the bandwidth for transmission is limited
II. Open Data and Open Formats

- Formats for **multi-GNSS Real-Time Navigation Data**
  - RTCM Message Type 1019 for GPS
  - RTCM Message Type 1020 for GLONASS
  - RTCM Message Type 1045 for Galileo F/NAV
  - RTCM Message Type 1046 for Galileo I/NAV, reference for SSR corrections
  - RTCM Message Type 1042 for BDS
  - RTCM Message Type 1043 for SBAS
  - RTCM Message Type 1044 for QZSS
  - RTCM Message Type 1041 for IRNSS/NaviC
## II. Open Data and Open Formats

### Formats for multi-GNSS Real-Time Products

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<th>Multi-stage/scalability</th>
<th>RTCM-SSR</th>
<th>IGS-SSR</th>
<th>Compact SSR</th>
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II. Open Data and Open Formats

- Open Source Real-Time Software provided by BKG
  - **BKG Ntrip Client (BNC)**
    - current version BNC v2.12 supports Open Real-Time Formats for
      - Observation Data: Legacy RTCM and RTCM MSM 3-7 messages
      - Navigation Data: RTCM Messages for GPS, GLONASS, Galileo, QZSS, SBAS, BDS, IRNSS
      - SSR-Products: RTCM-SSR (standardized and proposed messages) and IGS-SSR
    - Development version BNC v2.13 will support
      - Different PPP approaches for 4 G: GPS, GLONASS, Galileo, BDS
      - Clock combination for 4 G: GPS, GLONASS, Galileo, BDS
  - **BKG Professional Ntrip Caster**
    - Current version is 2.0.37
III. Naming Conventions for IGS Real-Time Data Streams

- 10-character **mountpoint naming convention** of the IGS real-time working group (IGS-RTWG)
  
  - 2014 – Agreement on a new concept of file names based on the 9-digit station IDs, in connection with the introduction of the RINEX 3.02 file format ([ftp://igs.org/pub/data/format/rinex302.pdf](ftp://igs.org/pub/data/format/rinex302.pdf))
  
  - 2018 - Approval of the proposal by the IGS-RTWG in February 2018
  - 2020 - Final implementation at all IGS Global Casters (BKG, CDDIS, IGSCB)
III. Naming Conventions for IGS Real-Time Data Streams

- 10-character **Observation Data Stream** "TTTTMRAAASF", where
  - TTTT: station marker name
  - M: monument or marker number (0-9)
  - R: receiver number (0-9)
  - AAA: three-letter ISO country code
  - F: data stream format, recommended to use “0” for the best RTCM3 data stream (e.g. RTCM3 MSM7)

Examples for station WT21 (Wettzell)
- WT2100DEU0 - Station WT21, LEICA receiver, RTCM data stream
- WT2100DEU9 - Station WT21, LEICA receiver, LB2 data stream
- WT2101DEU0 - Station WT21, JAVAD receiver, RTCM data stream
- WT2101DEU9 - Station WT21, JAVAD receiver, SBF data stream
III. Naming Conventions for IGS Real-Time Data Streams

- 10-character Navigation or Product Data Stream "TTTTXXAAAxF", where
  - **TTTT**: stream type (SSRA, SSRC, IONO, BCEP, etc.)
  - **XX**: two-digit solution ID
  - **AAA**: three-letter agency code
  - **F**: one digit format ID (0: RTCM3, 1: SAPA, 2-9: reserved)

- Stream types **TTTT** could be as follows:
  - SSRA/SSRC: state space correction streams, referring to APC/CoM
  - DCBS: state space correction stream (DCBs only)
  - IONO: ionospheric correction stream
  - TROP: tropospheric correction stream
  - BCEP: broadcast navigation data (ephemeris) stream

Example: **BCEP00BKG0** - global broadcast ephemerides from BKG
IV. To Do / Open Issues

- **IGS**
  - Broadcaster guidelines
  - SSR Task Force: Publication of the new IGS SSR Format v1.0 (October 05, 2020)

- **SIRGAS**
  - At least one IGS reference station in each country
  - Experimental SIRGAS regional caster becoming operational

- **General**
  - Implementation of open SSR corrections within hardware (receivers)
Thank you for your kind attention!

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