

GSFC IVS Technology Development Center Biennial Report Submission

Ed Himwich, John Gipson, Dave Horsley, Mario Bérubé

Abstract This report summarizes the activities of the GSFC Technology Development Center (TDC) and describes plans for the future. The GSFC TDC develops station software including the Field System (FS), station monitoring software, scheduling software (*sked*), hardware including tools for station timing and meteorology, scheduling algorithms, and operational procedures. It provides a pool of individuals to assist with station implementation, check-out, upgrades, and training.

1 General Information

The GSFC IVS Technology Development Center (TDC) develops hardware, software, algorithms, and operational procedures. It provides manpower for station visits for training and upgrades. Other technology development areas at GSFC are covered by other IVS components such as the GSFC Analysis Center. The current staff of the GSFC TDC consists of John Gipson, Ed Himwich, Dave Horsley, and Mario Bérubé. The remainder of this report covers the status of the main areas supported by the TDC.

2 Field System

The GSFC TDC is responsible for development, maintenance, and documentation of the Field System (FS)

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software package. The FS provides equipment control at VLBI stations. It interprets the `.snp` schedule and `.prc` procedure files (both as prepared by *drudg* from the `.skd` schedule). The FS controls the antenna, data acquisition hardware, and related ancillary equipment needed for making VLBI measurements. All major VLBI data acquisition backends are supported. The FS is customizable to allow it to control station specific equipment. It is used at almost all of the IVS Network Stations (more than 35) and also at many stations that perform VLBI only for astronomical observations. The only major VLBI facilities not using it are the LBO and VERA.

There are two major branches of the FS, currently — the “main” branch, which is used for most operational observing, and the “VGOS” branch, which is used in the operational test observations at VGOS stations. In the main branch, there were three major releases of the FS (9.11.7, 9.11.8, and 9.11.17) during this period and two minor releases (9.11.18 and 9.11.19). Full details can be found in the FS release notes. The most significant changes were:

- Support for the Mark 5C and FlexBuff recorders running the *jive5ab* control program. This allows support for recording VDIF formatted data for systems with FiLa10G modules.
- Support for the DBBC DDC personality version v105E/F, which supports up to 2 Gbps data rates.
- Support for the DBBC PFB personality, which supports data rates up to 4 Gbps. Support for the PFB personality only covers non-continuous calibration at this time.
- Unification of station SNAP procedures for all supported DBBC personalities and calibration schemes. As a result, it is no longer necessary

to have different procedure libraries for different configurations. This change relies heavily on the new *if* command.

- New *if* command to allow conditional execution of commands. The number of conditions currently supported for testing is limited to those that help to implement the unification of DBBC SNAP station procedures, but this number can easily be increased in the future.
- Improvements to the *HOLOG* program to make it more useful for other non-holography measurements.
- The new *fesh* and *plog* utilities to automate fetching/*drudg*ing of IVS schedules and pushing logs to the IVS Data Centers, respectively.

In the VGOS branch of the FS, there was ten minor releases (9.12.2-9.12.11) during this period. The most significant changes were:

- Support for Mark 6 recorders.
- Support for initially one, and then two, FiLa10Gs in *FMSET*.
- Support for an updated RDBE server, including VDIF epoch control/monitoring and attenuation control.
- Updated re-sync features for RDBEs.

In addition other projects were underway. These include:

- Unified Patriot 12-m (GGAO) and ISI 12-m (Kokee Park) antenna interface code. This allowed a common code base to be used for the two very similar Antenna Control Units (ACUs). Several improvements were implemented that supported both ACUs.
- An initial version of the new Telegraf-InfluxDB-Grafana (TIG) monitoring, data archiving, and display system was developed. This allows an operator to view the long- and short-term trends of station systems, which will assist in the early detection and troubleshooting of problems. In the future, these tools will also enable automated alerts and assist remote monitoring. TIG was developed at the GGAO station. Documentation was written for the system for users in the greater VLBI community and released to a set of stations for testing.
- Support for NMEA standard wind sensors.

2.1 Plans for Next Year

Several other improvements are expected in future releases, including:

- Support for continuous calibration with the DBBC PFB personality.
- Support for chopper-wheel and hot/cold load calibration methods.
- Implementation of a publication/subscription model for FS display, log, and error report output.
- Use of eRemoteControl for remote operation.
- A complete update to the documentation and conversion to a more modern format that will be easier to use and maintain.
- Conversion of the FORTRAN source to use the *gfortran* compiler, which will enable use of the source level debugger, *gdb*, for development and field debugging.
- Support for 64-bit Linux OSs.
- *Chekr* support for Mark 5A and Mark 5B systems.
- FS Linux 10, based on Debian *Stretch*.
- Support for periodic firing of the noise diode during observations.
- Completion of the VEX2 standard and implementation of it.

3 *Sked* and *Drudg*

The GSFC TDC is responsible for the development, maintenance, and documentation of *sked* and *drudg*. These two programs are very closely related, and they operate as a pair for the preparation of the detailed observing schedule for a VLBI session and its proper execution in the field. In the normal data flow for geodetic schedules, first *sked* is run at the Operation Centers to generate the `.skd` file that contains the full network observing schedule. Then stations use the `.skd` file as input to *drudg* for making the control files and procedures for their station. Catalogs are used to define the equipment, stations, sources, and observing modes which are selected when writing a schedule with *sked*.

Changes to *sked* and *drudg* are driven by changes in equipment and by feedback from the users. The following summarizes some of the important changes to these programs during 2015—2016 and plans for the future. This list includes only the most important bugs

which were found and fixed over this period. A more complete summary of the changes can be found in the `change_log.txt` files associated with *sked* and *drudg*.

3.1 *Sked* Changes

- Combination of the experimental ‘broadband’ version of *sked* with the standard version. There is a new \$BROADBAND section. Each line contains the name of a station, the bandwidth of each band, the data rate, and the sink rate (the rate that data can be written to disk). *Sked* uses this information to compute approximate values for the SNR. If the data rate is larger than the sink rate, *sked* allows extra time to write the data to disk before the next scan starts.
- Recognition of many more kinds of recorders and racks, e.g., Mark 5c, Mark 6, FlexBuff, DBBC, RDBE, etc.
- For short sessions, such as Intensives, printing out of required media in Gbytes instead of Tbytes.
- New *Fill* command. Previously an antenna would stop observing as soon as it reached its SNR target. It would then move to the next commanded source and wait until all of the other antennas for that scan were on source. This meant that there was a fair amount of idle time. The *Fill* command is executed once a schedule is done. *Sked* will go through the schedule and, for each scan, increase the observing time of each station as much as possible while making sure that it can arrive at the next scan on time. This has the effect of reducing idle time and increasing observation time.
- *Group* command. This command allows the user to specify groups of sources that can be observed sequentially. This might be used, for example, in astrometric VLBI where you want to observe several near-by sources.
- Fix of a bug that occurred if the first scan in the schedule was near the boundary of “W” (counter-clock-wise) and neutral sections.
- Fix of a bug in tag-along mode. The previous version assumed that the tag-along stations always started in the neutral cable wrap.

3.2 *Drudg* Changes

- Recognition and support for many more kinds of recorders and racks, e.g., Mark 5C, Mark 6, FlexBuff, DBBC, RDBE, etc.
- Setting of the Rack and Recorder types to ‘None’ if they were unrecognized.

3.3 *Catalog* Changes

The *sked* catalogs were updated during 2015—2016 to reflect the new stations coming on line — RAE-GYEB, KOKEE12M, WETTZ13S, WETTZ13N, ISH-IOKA, and IRBENE — or older stations that observed in IVS sessions, such as DSS34 and DSS36.

The catalogs were also modified to reflect equipment changes as more and more stations switched from analog to digital equipment.

3.4 *Plans for Next Year*

Plans for next year include the following:

- We will update the *sked* catalogs as new stations come on line or as equipment changes.
- We will modify the *sked* catalogs to support VEX2.
- We will support VEX2 files for both *sked* and *drudg* if and when they become available.
- We will convert *sked* to compile using a freely available compiler such as *gfortran*.