GSFC Technology Development Center Report

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Abstract This report summarizes the activities of the GSFC Technology Development Center (TDC) and describes plans for next year. The GSFC TDC develops station software including the Field System (FS), 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 Technology Center Activities

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, and Rich Strand, all employed by NVI, Inc. 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) 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 VLBA and VERA.

There were six minor releases of the FS (9.11.1-9.11.6) during this year. Full details can be found in the FS release notes, but most changes were fairly minor. The most significant changes were:

- The addition of the *bit_streams* command for specification of active channels for recording T_{sys} when no supported recorder is being controlled. This is typically used for e-VLBI.
- Support for DBBC version v104.
- Specification of the Mark 5B clock rate from a control file.
- A time-out feature for the ONSOURCE command to support local testing.
- Support for FSL9 kernel distribution, based on Debian *Wheezy*.
- Enhancements for support of *jive5ab* controlled Mark 5B recorders.

In addition several development projects were underway. These include:

- Patriot 12 m Interface. Development of the interface for the Patriot Antenna Control Unit (ACU) continued. Several improvements were

made, including the handling and the reporting of status-word-represented errors and improvements in cable-wrap handling to make it independent of the limits for any particular antenna.

- VEX2. Considerable effort has gone into defining the second version of VEX, which will provide schedule file format support for new "sampling-before-channelization" systems such as the RDBE.

2.1 Plans for Next Year

Several other improvements are expected in future releases, including:

- Support for parallel use of multiple RDBEG racks for VGOS observing modes.
- Support for parallel use of multiple Mark 6 recorders, using *cplane* for control, for VGOS observing modes.
- Support for single Mark 5C/Mark 6/Flexbuff recorders that are running the *jive5ab* control program.
- Support for DBBC PFB personality.
- Use of *idl2rpc* 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.
- *Chekr* support for Mark 5A and Mark 5B systems.
- FS Linux 10, based on Debian *Jessie*.
- Support for periodic firing of the noise diode during observations.
- Support for NMEA standard wind sensors.
- 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 ob-serving 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 this year and plans for next year.

3.1 *Sked* Changes

- The tagging along of a new station to a schedule without that station was improved. The issue is that internally *sked* uses one-letter codes as station identifiers, where the default one-letter codes come from the catalogs. There were problems if the new station had the same one-letter code as a station already in the schedule. *sked* was modified to use a new unused letter for the new station.
- *sked* was made more robust for observations near the cable wrap.
- *sked* previously used two different routines for calculating similar quantities, SNR and duration. This led to inconsistencies. Both pieces of code were modified to call a subroutine.
- *sked* was modified to write VEX files differently depending on whether the data was processed by the VLBA or by BONN. This reduced hand-editing of VEX files.
- Some cleanup was done in terms of removing tape-related parameters such as pass, footage, etc. This was necessitated because *sked* could not read in some VEX files that did not have this information. There is still a fair amount of vestigial code dealing with tapes, and this will be removed as time permits.
- The handling of the case in which *sked* does not recognize the rack or recorder was improved. Previously both the rack and recorder had to belong to a set list of valid types which was hard-coded. If this was not the case, *sked* would close with an error message. It will now continue running.

3.2 *Drudg* **Changes**

- Support for Mark 5C.
- Some cleanup was done in terms of removing tape-related parameters such as pass, footage, etc. This was done because *drudg* could not read in a VEX file that did not have pass information.
- Support for LSB first LOs. Previously this existed for Mark III '.skd' files, but not for VEX files.
- Support for new hardware at the VLBA.

3.3 **Plans for Next Year**

Plans for next year include the following:

- We will support VEX2 files for both *sked* and *drudg* if and when they become available.
- We plan to expand support for RDBEs and DBBCs. This will involve changes to *sked*, *drudg*, and the catalogs.
- If time permits we will convert *sked* to compile using a freely available compiler such as *gfortran*.