GSFC Technology Development Center Report

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Abstract

This report summarizes the activities of the GSFC Technology Development Center (TDC) for 2010 and forecasts planned activities for 2011. The GSFC TDC develops station software including the Field System, 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 and Ed Himwich, both 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 all the IVS network stations (i.e., more than 30) and also at many stations that do VLBI only for astronomical observations. The only major VLBI facilities not using it are the VLBA and VERA.

There were no new releases of the FS during this period. However, several development projects were started:

- Patriot 12-m Interface. A preliminary interface to Patriot 12-m antennas was developed. This was implemented using the position and velocity tracking mode in the Patriot antenna controller. All aspects of this appear to work, but final testing is delayed until next year when a receiver will be available.
- Satellite Tracking. A satellite tracking capability was developed for the FS. This will allow an antenna to be pointed at a satellite in one of three modes: (1) Ephemeris, (2) Az-El, or (3) RA-Dec. The Ephemeris tracking mode is the most flexible and precise. A one second ephemeris for several hours is built in memory, which the *antcn* antenna interface can use to guide the antenna. However, this requires special programming of the antenna interface, and some antennas may not be able to support this mode. The Az-El mode is useful for geo-synchronous or possibly slowly moving satellites, if the antenna being used supports commanding with fixed Az-El coordinates. The RA-Dec mode is the most universal since all antennas support RA-Dec pointing, but it may have limited usefulness if the satellite is not

moving at a nearly sidereal rate. It is expected that the Az-El and RA-Dec modes will be enhanced to allow periodic recommanding of the position. This may help with tracking slow moving objects. However, depending on the behavior of the antenna, this may introduce unacceptable jumps in the antenna tracking. The open source *predict* program is used to calculate the pointing angles from the orbital elements.

- Holography. A new SNAP command **holog** was developed to support holographic measurements of antennas. In it simplest form, this command will move an antenna in a boustrophedon pattern around a grid centered on either an Az-El or RA-Dec commanded position. A user-defined SNAP procedure is run to collect data at each grid point. Various options are available including specifying a "return to center" interval for recalibration, changing the order in which the grid points are visited, and allowing single "cuts" to be made on each axis.

These new capabilities will be included in FS releases next year. Several other improvements are expected in future releases, including:

- Support for DBBC and RDBE racks
- Support for Mark 5C recorders
- 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
- Conversion of the FORTRAN source to use the *gfortran* compiler; this will enable use of the source level debugger, *gdb*, for development and field debugging
- *Chekr* support for Mark 5A and Mark 5B systems
- Use of the Mark IV Decoder for phase-cal extraction in the field
- FS Linux 9 (based on Debian *squeeze*) distribution
- Support for periodic firing of the noise diode during observations
- Distribution of the new *gnplt*.

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 in 2010 and plans for 2011.

3.1. SKED

The following changes were made to SKED:

- A station is no longer scheduled in tag-along mode if the station is "down" (not available for observing).
- **StatWt** was made its own command and given more flexibility. The user can now give independent weights to each of the stations to try to increase the number of observations that are scheduled.
- The command **SrcWt** was introduced. This is analogous to **StatWt** in that the user instructs SKED to preferentially select scans involving certain stations.
- A new command **Coverage** was introduced which calculates and reports sky coverage at the stations.
- Previously the user needed to specify the full path for use in the master command. This meant, for example, that the user had to change the directory specified in skedf.ctl in order to use this command for Intensives or if the year changed. Now all the user needs to do is specify the directory where the master-files are kept, and SKED will search all of master-files.
- Many internal references to tape were removed. The motivation was that many calculations were no longer necessary since it is no longer necessary to worry about rewinding tapes and ensuring that there is enough space left at the end of a tape. Some of these calculations actually led to incorrect schedules or resulted in increased idle time.
- All reported bugs were fixed. For the most part these occurred in unusual circumstances.
- The formatting of some error messages was improved to aid the user in understanding exactly what the problem was.

In addition we worked on updating the SKED documentation. The last time this was completely updated was in the 1990s.

Plans for the next year include: (1) releasing the updated documentation, (2) making VEX format native, and (3) modifying SKED as necessary to support VLBI2010.

3.2. DRUDG

The only changes made to DRUDG were in the calculation of BBC frequencies. In some unusual cases the printed results were incorrect because of round-off errors. This was fixed by making the intermediate calculations in double precision.

Plans for the next year include: (1) a documentation update and (2) support for VLBI2010.