GSFC Technology Development Center Report

Ed Himwich, John Gipson

Abstract

This report summarizes the activities of the GSFC Technology Development Center (TDC) for 2011 and forecasts planned activities for 2012. 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 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 underway:

- 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 the antenna controller and receiver will be more nearly in their final configuration.
- 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 its 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 2011 and plans for 2012.

3.1. SKED

The only changes made to SKED this year were bug fixes and minor enhancements. The following is a list of bug fixes:

- Fixed a problem with writing out the lower sideband in VEX files.
- Fixed an issue in writing schedule files if the fan-out mode varied from station to station.
- Fixed a bug in **tag-along** mode that affects the calculation of slewing time. Previously the slewing time started from the last time the antenna was used. However, if the last time a station observed was a long time ago, the calculation was not accurate and could lead to problems with cable wrap.
- Made the list of valid correlators consistent with the list in the VLBI master files.

Following is a list of minor enhancements:

- Added the parameter **MaxAngle** which specifies the maximum distance to move.
- Added the command **NOW <time>** which sets the time of all stations to the current time. This was done to aid in the scheduling of CONT11.
- Increased the number of **downtimes** from 20 to 2000. CONT11 required around 450.

In addition we continued working on updating the SKED documentation. The last time the documentation was revised was in 1996. We expect to finish this project in 2012.

3.2. DRUDG

No changes were made to drudg during 2011.

3.3. Plans for Next Year

Plans for next year include:

- Releasing the new SKED documentation;
- Making VEX the native format for SKED and DRUDG
- Better source modeling
- Modifying SKED and DRUDG as necessary to support VLBI2010.