Continuous VLBI Scheduling: The CONT14 Example

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Introduction

The **Continuous VLBI Campaign 2014 (CONT14)** was observed in the time period May 6–20, 2014 on an observing network of 17 stations (at 16 sites). One of the main goals of the campaign was to collect VLBI observations over a time period of 15 days without interruptions. In order to achieve this observational continuity some aspects of the standard, session-wise scheduling procedure had to be modified. These modifications are described in the following.
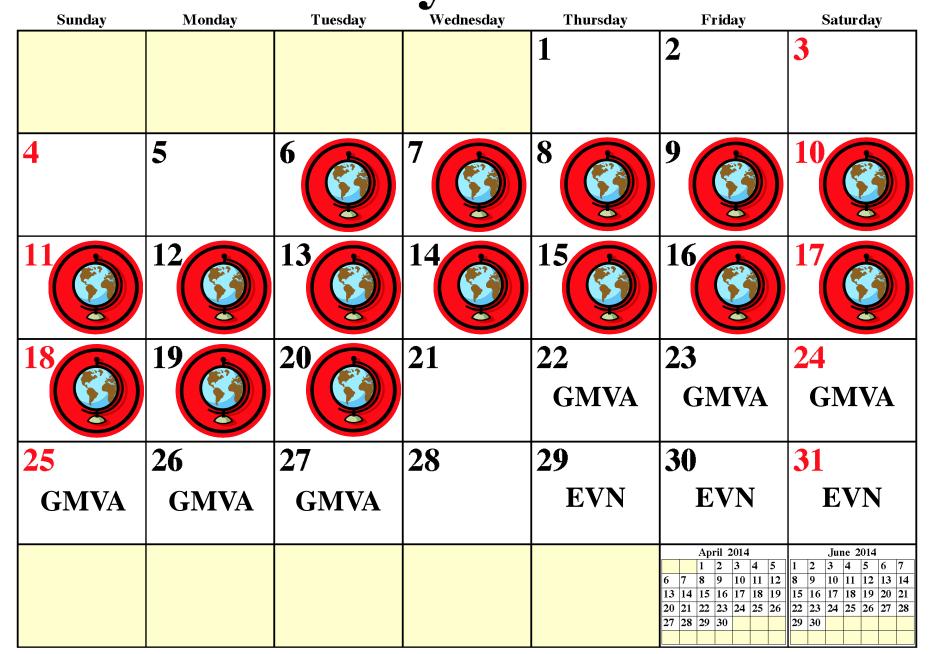
May 2014

General CONT14 Scheduling Features

- UT-day observing: days running from 0 UT to 24 UT
- continuous VLBI: 15 consecutive days with 3 minutes between days for schedule changes
- station check times: 1-hour and 2-hour slots in staggered fashion for days 2 through 14
- data rate: 512 Mbps (same as CONT11)

Session-wise Scheduling

Traditionally IVS observing has been organized in sessions of 24-hour length (e.g., R1, T2, EURO, CRF, RDV, R4) or 1-hour length (Intensives). In order to optimize the shipment time from the stations to the correlator, the observing week for 24-hour sessions starts on Monday @ 17:00 UT and ends on Friday @ 18:30 UT. The additional 1.5 hours at the end comes into being, because after each 24-hour session there is a break of 0.5 hours to allow for schedule changes at the stations. The Intensive sessions either overlap the 24-hour sessions (Int1), are observed over the weekend (Int2), or run prior to the start of the 24-hour observing sessions (Int3). "Overlapping Intensives" have a cushion of 15 min at each end to allow the Intensive stations to make the necessary schedule changes.

The schedules for the individual sessions are thus completely independent of each other: no information needs to be carried over from one schedule to the next. This also allows different Operations Centers to write the observing schedules for their supported sessions without additional information.

Earlier CONT Scheduling

In earlier CONT campaigns (e.g., CONT05) the same principles were applied to writing the schedules: each day was treated independently and there was a gap of 0.5 hours between days to allow for schedule changes and station checks. However, the observational gaps between days resulted in unrealistic swings in the sub-daily EOP time series derived from the CONT data.

Hence, starting with CONT08, staggered station check times were introduced. The daily station checks (e.g., pointing) were decoupled from the change of schedules and were instead introduced at convenient and well-coordinated times for the stations (i.e., different daily check times for each station). In this way, it was possible to avoid longer observational gaps. The time for changes between schedules was reduced to a minimum of 3 min.

CONT14 Station Checks

For CONT14 the station check times were organized in the usual staggered fashion, so that they were scheduled during regular working hours and never coinciding (except for Intensive stations). This ensured that at any given time more than ten stations were available for observing. For the case that a station could return to regular observing before the end of the station check time slot, each station was tagged along for their check period.

The Intensive stations (Bd, Kk, Ts, Wz, and Zc) had 2-hour slots (blue). They first ran their respective Intensive sessions (Int1, Int2, or Ru-U) and then performed their checks. All other stations had 1-hour check times (black).

The process of filling in observations into the staggered station check time slots has evolved from CONT08 to CONT14. In the early going, the slot was kept observation-free using *sked*'s 'downtime' command and then at the very end was filled by making use of the 'tagalong' command. The disadvantages of this procedure were that the cable-wrap information was not carried forward across the "downtime gaps" and that the tagalong procedure resulted in possible conflicting cable wrap settings at the end of the check time slot requiring manual editing at times. In CONT14, the scheduling was done in hourly steps using subnets and tagalong, always retaining the cable wrap information.

Using *sked* in Batch Mode

The actual schedule files for CONT14 were created by running *sked* in batch mode with the necessary parameters being input from a text file at the shell level. Using interactive mode would have been too error prone and tedious. The main focus was on retaining and continuing the cable wrap information across boundaries. The scheduling procedure can be summarized as follows:
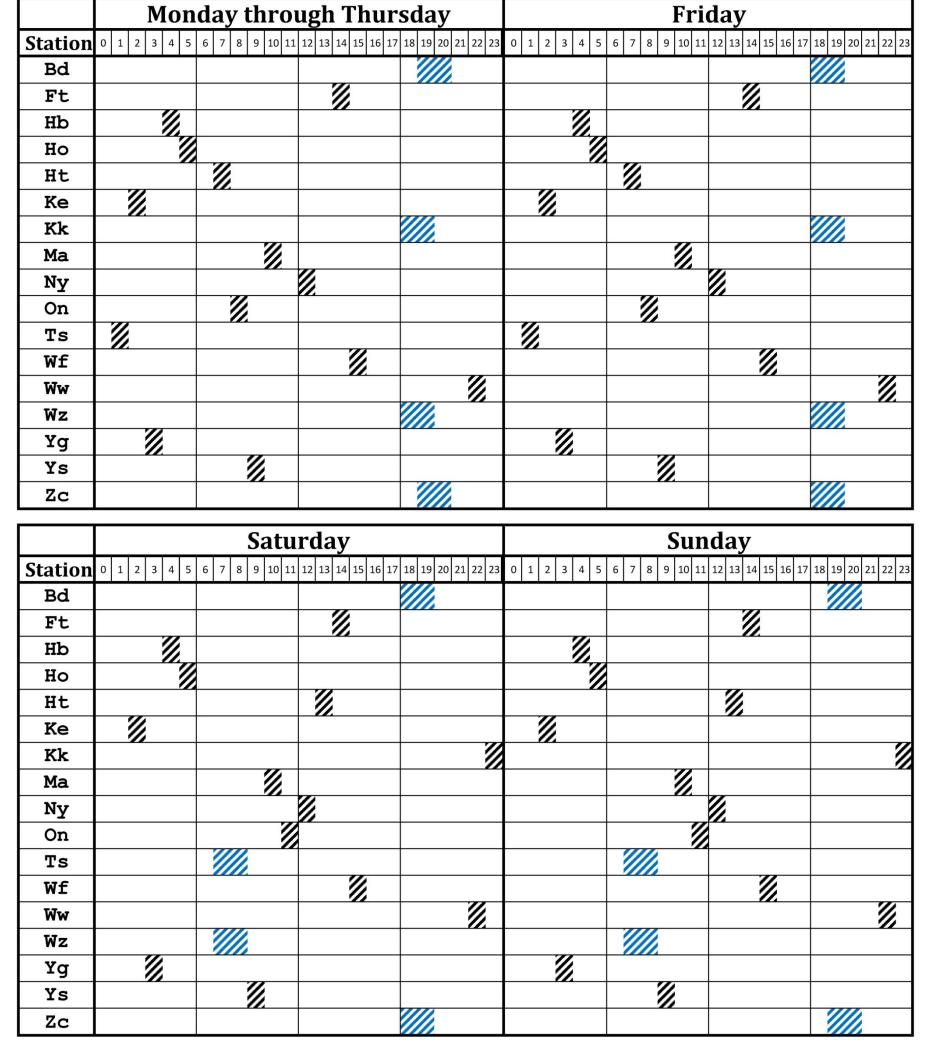
1. Prepare a 'seed' schedule file with the proper setup for the stations and observing mode (e.g., recording mode, target SNRs)
2. Using the seed schedule file, create one complete schedule for all 15 UT days:
   - use 'downtime' command to keep the last 3 min of each UT day free of observations (except the final CONT day)
   - schedule scans in hourly blocks for the predefined subnets and immediately tagalong the non-subnet stations (i.e., Intensive stations, stations performing station checks)
3. Save the 15-day schedule file
4. Cut the 15-day schedule file into 15 single UT days:
   - load the 15-day schedule file
   - remove the scans prior to and after the individual day boundaries for each individual day using *sked*'s 'delete' command
   - save the individual schedule files, write schedule summary and cable wrap information files
5. Check if the number of scans are identical between the 15-day schedule and the 15 individual days; take corrective action if necessary
6. Check the cable wrap setting at day boundaries to uncover any problems and rectify.

The number of *sked* commands used in the input file amounted to 1445. A full scheduling run (without manual control at the end) took about 20 min to execute.

Conclusions

For scheduling continuous VLBI observations using individual schedule files for subsequent observing days, it is essential to maintain information about the antenna state across (day) boundaries. In particular, the cable wrap information needs to be carried forward. The *sked* program was altered to retain the cable wrap setting for a longer time period (in an earlier version it forgot about the cable wrap after about 10 min). An information exchange among Operations Centers may be a challenge.

In order to facilitate a change of schedules, a 3-min change-over time was needed. This may also be the case for VGOS scheduling; but probably reduced to <1 min.