Mapping Session Codes to Session Types for the v2.0 Master File Format

Christopher Dieck[1], Dirk Behrend[2], Mario Bérubé[2], Phillip Haftings[1], Cynthia Thomas[2]

Abstract In support of the transition to the new vgosDB naming convention, a new IVS master file format was created, version 2.0. All IVS master files have been converted to the new format. As part of the conversion, session types had to be developed so that each session contained in the master files could be associated with a session type. The session types are intended to serve as a means of associating sessions observed as part of the same program with each other. We document here the methods used to develop session types and their names, as well as highlights from assigning to session types the $\sim$22,000 sessions from 1979–2023.

Keywords vgosDB, Master File, conventions, formats

1 Introduction

In support of the future cooperative observations and analysis by components of the International VLBI Service for Geodesy and Astrometry (IVS), the IVS recently adopted a new convention for naming its vgosDBs. The changes involved a change to the date format and the inclusion of the session code instead of the database code (DBC) (i.e., `19JAN03XU` became `20190103-i19003`). The desired future flexibility of VLBI Global Observing System (VGOS) observing programs was also constrained by the length of the session code, so that length needed to be increased.

1. US Naval Observatory
2. NVI, Inc. / NASA GSFC

To facilitate the creation of vgosDBs in the new naming convention, with longer session codes, an updated version (version 2.0[1], hereafter 'v2') of the master file format was developed in 2022 and was first deployed by the IVS Coordinating Center for 2023. In the original master file format (version 1.0[2], hereafter 'v1'), each session had an ostensibly unique session name, a unique session code, and a DBC that, when combined with the date, would make a unique database name. By removing the session name and the DBC in the v2 format, along with using the new database naming convention, there is now only one unique identifier for each session: the session code.

There was some valuable information in the session name, though, that still needed to be captured in the v2 files. Analysts will want to know which sessions are from the same series, those sessions that have the same purpose and similar observational parameters. This is why, among several changes from the v1 format to the v2 format, a new field was created: `SESSION TYPE`.

Before the v2 master files could be created, all of the nearly 22,000 sessions contained in the master files from 1979–2023 needed to be associated with a session type. For 2024 and beyond, the master files are natively constructed with the session type defined, rather than requiring conversion. The specific changes to the master file format, the effort to develop the set of session types and map each session to one of them, and discussions of the creating of several specific session types are documented in the following sections.

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[1]   `https://cddis.nasa.gov/archive/vlbi/ivsformats/master-format.txt`

[2]   `https://cddis.nasa.gov/archive/vlbi/ivsformats/master-format_v1.0.txt`

2 Master File Modifications from Version 1.0 to Version 2.0

The modifications to the master file format are in service of achieving the same goals that motivated the development of the new vgosDB naming convention. There were two principal motivations. The first was to alleviate the current restrictions imposed by the previous convention and thus provide flexibility for the future. The second was to simplify the handling of data to make it more accessible. Many changes to the master file format enable the community to address the problems and achieve the goals. The differences between the file formats are illustrated in Figures 1 and 2 showing the same sessions in the v1 and v2 formats, respectively.

A large modification to the master file format that supported both of these motivations was with regard to the treatment of dates. The format of all dates was modified to conform to the basic format of the ISO 8601 standard. This first applied to the year identifier in the file name, which now uses the full-length year (currently four digits) rather than the truncated two-digit year. One of the major benefits of this is that there will no longer be a degeneracy in 2079 and beyond. For the `DATE` and `STATUS` fields the format was set to be `yyyymmdd`. The format describing times in the `DUR` and `TIME` fields was unified by changing the format of the `DUR` field to be `h:mm`, rather than integer or decimal hours. Flexibility of future operations was supported by increasing the possible options for session codes, the unique identifiers, by extending the possible length of these from six to twelve characters. It was also decided to change the contents of the `SESSION CODE` field from upper case characters to lower case characters.

As time has passed, and operations have changed, elements of the master file format that are present in the v1 format no longer apply to current and anticipated future operations. Thus, the `SESSION NAME`, `PF`, and `MK4 NUM` fields were removed in the v2 format specification. Other fields are still relevant and were left unchanged. These are the `DOY`, `TIME`, `STATIONS`, `SKED`, `CORR`, `SUBM`, and `DEL` fields. To help with readily reading the vgosDB name from the master file, both by machines and humans, the `DATE` field was moved to the left of the `SESSION CODE` field. Finally, and the subject of the rest of this work, the new field of `SESSION TYPE` was inserted as the first field.

3 Developing Session Types

The purpose of the session types is to group similar sessions for users of IVS data, such as IVS Analysis Centers. Such a user would then be able to query the master files to generate a list of all sessions of a given type. The IVS Coordinating Center also intends to have a description for each session type linked from the record for a session on the web-based interactive master schedules so that users can better understand the purpose and objectives of any session or series of sessions.

To determine what the session types are, all sessions needed to be reviewed so that ultimately each session was associated with a session type. The combination of a session's name, code, and DBC allowed most sessions to be associated with similar sessions. To start, this information was used to make a rough grouping of sessions into 206 proposed types. However, because session names were inconsistent and session code conventions changed over the years, some sessions that should be of the same type were not initially associated, and some sessions that were initially labeled with the same type should not have been. To properly evaluate each session code and each proposed session type, each author was assigned a set of draft types to review in greater detail. Recommendations for modifications to the type name and which sessions it included were then shared and debated before reaching a consensus on the group of session codes and its session type name. The investigations into some sessions and their proposed types required finding papers, proceedings, and reports from before the establishment of the IVS. The final report of NASA's Crustal Dynamics Project (CDP) was particularly helpful in understanding the sessions in the master files from 1979–1991 (Ryan, Ma, and Caprette, 1993). Table 2.1 of that report lists the database name (in the old convention), the session code, and a session type. This formed the foundation of many of the new session types and their associated sessions.

For those sessions identified in the CDP report, the final name of the session type was not drawn directly from the report but was modified to align with the ap-

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## Master file format version 1.0         2001.08.21 CCT&NRV

                      1995 MULTI-AGENCY SCHEDULE

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  SESSION   SESSION DATE  DOY TIME  DUR        STATIONS         SKED CORR STATUS  PF   DBC  SUBM  DEL MK4
   NAME      CODE  mondd  ddd hh:mm hr                                    yymondd      CODE       days NUM
------------------------------------------------------------------------------------------------------------
|NEOS-A088 |NA088 |JAN03|  3|18:00|24|FtG3KkWz                  |USNO|WASH|        |    |XE  |NASA|    |    |
|IRIS-S86  |IS086 |JAN09|  9|13:00|24|FtHhWfWz                  |BONN|BONN|        |    |XH  |NASA|    |    |
|NEOS-A089 |NA089 |JAN10| 10|18:00|24|FtG3GcKkWz                |USNO|WASH|        |    |XE  |NASA|    |    |
|NEOS-A090 |NA090 |JAN17| 17|18:00|24|FtG3KkWz                  |USNO|WASH|        |    |XE  |NASA|    |    |
|KSP-95017 |K95017|JAN17| 17|08:00|22|KbKz                      |CRL |CRL |        |    |XX  |NASA|    |    |
|CRF-N1    |CRFN1 |JAN18| 18|20:00|24|ApG3GcWz                  |USNO|WASH|        |    |XN  |NASA|    |    |
|KSP-95019 |K95019|JAN19| 19|00:00|24|K3Kb                      |CRL |CRL |        |    |XX  |NASA|    |    |
|R&D-1     |RD9501|JAN23| 23|16:00|24|FdGcKkLaOnWfWz            |NASA|HAYS|        |    |XC  |NASA|    |    |
|NAPS-1    |NAP951|JAN23| 23|16:00|24|ApBrHnKpOv                |NASA|HAYS|        |    |XB  |NASA|    |    |
|GLOBL-TRF1|RDGTR1|JAN23| 23|16:00|24|FtG3HhHoMaMkPtScSmSt      |USNO|WASH|        |    |XA  |NASA|    |    |
|NEOS-A091 |NA091 |JAN24| 24|18:00|24|FtG3GcKkWz                |USNO|WASH|        |    |XE  |NASA|    |    |
|STH-TRF-01|STRF01|JAN26| 26|14:00|24|FtHhHoKkOhSt              |BONN|BONN|        |    |XA  |NASA|    |    |
|POLAR-S1  |PL95S1|JAN30| 30|14:00|24|HhHoOhSt                  |NASA|WASH|        |    |XA  |NASA|    |    |
|NEOS-A092 |NA092 |JAN31| 31|18:00|24|FtG3KkWz                  |USNO|WASH|        |    |XE  |NASA|    |    |

|POLRZATON1|PLZ951|FEB01| 32|20:00|24|FdHnKpLa                  |NASA|HAYS|        |    |XE  |NASA|    |    |
|NAPS-2    |NAP952|FEB01| 32|20:00|24|ApBrNlOvWf                |NASA|WASH|        |    |XA  |NASA|    |    |
|EUROPE-23 |EUR023|FEB01| 32|20:00|24|65MaMcNtNyOnSmWz          |BONN|BONN|        |    |XC  |NASA|    |    |
|GEOCAT-N1 |GC95N1|FEB01| 32|20:00|24|GcMkPt                    |NASA|HAYS|        |    |XB  |NASA|    |    |
|GEOCAT-S  |GC95S |FEB01| 32|20:00|24|FtHhScSt                  |NASA|HAYS|        |    |XD  |NASA|    |    |
|R&D-2     |RD9502|FEB02| 33|22:00|24|FdGcKkLaNyOnWfWz          |NASA|HAYS|        |    |XB  |NASA|    |    |
|GGAO-RD-21|RDGG21|FEB02| 33|22:00|24|ApGgHnNlSc                |NASA|HAYS|        |    |XA  |NASA|    |    |
|PHSE-DELY1|PD9501|FEB02| 33|22:00|24|BrKpMkOvPt                |NASA|HAYS|        |    |XC  |NASA|    |    |
|NEOS-A093 |NA093 |FEB07| 38|18:00|24|FtG3GcGnKkWz              |USNO|WASH|        |    |XE  |NASA|    |    |
|POLAR-S2  |PL95S2|FEB13| 44|14:00|24|45HhHoOhSt                |NASA|WASH|        |    |XA  |NASA|    |    |
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Fig. 1 Excerpt of the v1 master file for 1995, `master95.txt`.

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## Master file format version 2.0         2022.11.01 CAD&CCT

                      1995 MULTI-AGENCY SCHEDULE

                   Last Updated - December 27, 2007 - CCT


  SESSION      DATE     SESSION    DOY TIME  DUR        STATIONS         SKED CORR STATUS  DBC  SUBM DEL
   TYPE      yyyymmdd    CODE      ddd hh:mm h:mm                                 yyyymmdd CODE      days
------------------------------------------------------------------------------------------------------------
|NEOS-RAPID    |19950103|na088    |  3|18:00|24:00|FtG3KkWz              |USNO|WASH|        |  XE |NASA|    |
|IRIS-SOUTH    |19950109|is086    |  9|13:00|24:00|FtHhWfWz              |BONN|BONN|        |  XH |NASA|    |
|NEOS-RAPID    |19950110|na089    | 10|18:00|24:00|FtG3GcKkWz            |USNO|WASH|        |  XE |NASA|    |
|TRF-TIE       |19950117|k95017   | 17|08:00|22:00|KbKz                  |CRL |CRL |        |  XX |NASA|    |
|NEOS-RAPID    |19950117|na090    | 17|18:00|24:00|FtG3KkWz              |USNO|WASH|        |  XE |NASA|    |
|CRF-N         |19950118|crfn1    | 18|20:00|24:00|ApG3GcWz              |USNO|WASH|        |  XN |NASA|    |
|TRF-TIE       |19950119|k95019   | 19|00:00|24:00|K3Kb                  |CRL |CRL |        |  XX |NASA|    |
|CDP-GLOBAL    |19950123|rdgtr1   | 23|16:00|24:00|FtG3HhHoMaMkPtScSmSt  |USNO|WASH|        |  XA |NASA|    |
|CDP-NAPS      |19950123|nap951   | 23|16:00|24:00|ApBrHnKpOv            |NASA|HAYS|        |  XB |NASA|    |
|CDP-RD        |19950123|rd9501   | 23|16:00|24:00|FdGcKkLaOnWfWz        |NASA|HAYS|        |  XC |NASA|    |
|NEOS-RAPID    |19950124|na091    | 24|18:00|24:00|FtG3GcKkWz            |USNO|WASH|        |  XE |NASA|    |
|SOUTH-TRF     |19950126|strf01   | 26|14:00|24:00|FtHhHoKkOhSt          |BONN|BONN|        |  XA |NASA|    |
|CDP-POLAR     |19950130|pl95s1   | 30|14:00|24:00|HhHoOhSt              |NASA|WASH|        |  XA |NASA|    |
|NEOS-RAPID    |19950131|na092    | 31|18:00|24:00|FtG3KkWz              |USNO|WASH|        |  XE |NASA|    |

|CDP-NAPS      |19950201|nap952   | 32|20:00|24:00|ApBrNlOvWf            |NASA|WASH|        |  XA |NASA|    |
|CDP-RD-PLRZ   |19950201|plz951   | 32|20:00|24:00|FdHnKpLa              |NASA|HAYS|        |  XE |NASA|    |
|EUROPE        |19950201|euro23   | 32|20:00|24:00|65MaMcNtNyOnSmWz      |BONN|BONN|        |  XC |NASA|    |
|GEO-CAT       |19950201|gc95n1   | 32|20:00|24:00|GcMkPt                |NASA|HAYS|        |  XB |NASA|    |
|GEO-CAT       |19950201|gc95s    | 32|20:00|24:00|FtHhScSt              |NASA|HAYS|        |  XD |NASA|    |
|CDP-RD        |19950202|rd9502   | 33|22:00|24:00|FdGcKkLaNyOnWfWz      |NASA|HAYS|        |  XB |NASA|    |
|CDP-RD-PHASE  |19950202|pd9501   | 33|22:00|24:00|BrKpMkOvPt            |NASA|HAYS|        |  XC |NASA|    |
|GGAO-RD       |19950202|rdgg21   | 33|22:00|24:00|ApGgHnNlSc            |NASA|HAYS|        |  XA |NASA|    |
|NEOS-RAPID    |19950207|na093    | 38|18:00|24:00|FtG3GcGnKkWz          |USNO|WASH|        |  XE |NASA|    |
|CDP-POLAR     |19950213|pl95s2   | 44|14:00|24:00|45HhHoOhSt            |NASA|WASH|        |  XA |NASA|    |
```

Fig. 2 Excerpt of the v2 master file for 1995, `master1995.txt`.

proach that was taken with all of the other session types. Their names were developed largely following the guidelines that:

1. If there was a project name given to the series from its inception, that project name was given to the session type (e.g., `GNUT`, `MERIT`),
2. Series of sessions with the same purpose and similar observing setups that were organized by the same organization were given a name constructed of the standard abbreviation for the sponsoring organization, a word or abbreviation describing the general purpose of the sessions, and/or differentiating character(s) if needed, all separated by a dash (e.g., `IVS-R4`, `VGOS-INT-A`, `CDP-ALASKA`),
3. Session types containing a variety of sessions with similar purpose, though potentially from different sponsoring organizations and with different participating stations, were given a broadly descriptive name (e.g., `TRF-TIE`, `EDUCATIONAL`, `EUR-MOBILE`).

For some session type names, these loose conventions were not applied and, to be consistent with how they have generally been known, the original series names were preserved. Future sessions that do not belong to an existing session type will result in the development of a new session type in conjunction with the IVS Coordinating Center (IVSCC).

After determining which sessions belonged together and what to call that session type, this mapping to the now 150 session types was encoded in a JSON file. This file is called in the master file reader/converter/writer that is part of the Washington Correlator's VLBI software available on GitHub (USNO VLBI, 2022–2024). This software was used by the IVSCC to do the conversion of the IVS master files from v1 to v2 before posting the v2 master files to the IVS Data Centers.

4 Notable Mapping Examples

4.1 Handling Sessions that Continued Observing When the IVS Was Established

Though the IVS was established in 1999, the IVS-specific observing program was introduced in 2002.

It included the `IVS-R1` and `IVS-R4` sessions among others. Also at that time the convention of the session name of several series changed as they became coordinated by the IVS. In keeping with the timing of that change, the new mapping keeps those sessions prior to 2002 in one session type and those in 2002 and beyond in another group. For instance, the Intensives between the `KOKEE` and `WETTZELL` stations that began in mid-2000 were originally named `INTYY-DOY` (where `YY` is the two-digit year and `DOY` is the day of year) and were changed to `IN1YY-DOY` in 2002. For the new session types, the sessions of those Intensives observed prior to 2002 are put in the `INTENSIVE` session type while those from 2002 and beyond are labeled with the `IVS-INT-1` session type.

4.2 Unifying the Continuous Campaign Types

Continuous campaigns have been observed in some form since 1989, though they were not called `CONT`s until 1994. Literature contemporary with the sessions refers to each of these efforts in different ways. Following the session type naming precepts outlined above, the 1989 series retained the name `ERDE`, and the 1992 series retained the name `SEARCH-92`. All subsequent continuous campaigns were named `CONT-YY-DESG`, where `YY` denotes the two-digit year and `DESG` denotes the array on which it was observed if there was more than one. For instance three different networks observed in 2017, and those session types are called `CONT-17-L1`, `CONT-17-L2`, and `CONT-17-VGOS`.

4.3 Identifying Sessions Observed on the VLBA

Some of the more challenging session codes to group were those that used only stations of the Very Long Baseline Array (VLBA). In the v1 master files, the only identifying characteristic often was the session name, which was the same as the session code. This gave no indication of the purpose of the session. By reviewing the VLBA archives and the literature, all sessions were associated with specific projects related to astrometry and geodesy executed on the VLBA. These

include the six epochs of the VLBA Calibrator Survey (called `VLBA-CS-#`, where # is a number representing the epoch) and the Second VLBA Calibrator Survey (`VLBA-CSII`) as well as numerous dedicated astrometric campaigns at S/X (`VLBA-CRF-SX`) and K/Q (`VLBA-CRF-KQ`). There were also several sessions that were initiated by NASA personnel associated with the Crustal Dynamics Project that were done as research and development programs on the VLBA and sometimes in conjunction with other stations. These were associated with CDP and called `CDP-RD-GEOD` and `CDP-RD-PLRZ` depending on the reported purpose of the sessions.

4.4 Creating the `TRF-TIE` Session Type

Many sessions have been initiated for the express purpose of locating a station in the VLBI terrestrial reference frame or establishing a tie vector between stations. Often there are only one or a few sessions to accomplish this. Rather than making a separate session type for each station for which this was done, all sessions for which station positioning was the purpose and in which there are only a few sessions for each station are included in a single session type for all of them called `TRF-TIE`. This session type encompasses at least 22 sub-groups and a total of 64 sessions.

Acknowledgements

References

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