Automatic processing of Intensives at GSFC VLBI Analysis Center

S. Bolotin, K. Baver and M. Bérubé

NVI, Inc. / NASA Goddard Space Flight Center, Greenbelt, Maryland 20770

Introduction

VLBI Intensive (INT) sessions are conducted to determine the change in Earth rotation, which is measured as a correction to UT1. This correction varies unpredictably over time. Because UT1 is used in precise navigation, particularly GNSS, rapid turnaround is very important. The decrease of time elapsed from observations to obtained results can be shortened with the automatic data processing of new INT sessions at the analysis stage.

ADAP/APS software

The automatic processing of intensives is part of the Automated Data Acquisition and Processing (ADAP) system developed to support many activities at GSFC. The ADAP system was built around a database for rapid access and validation of information and a message broker for controlling data flow between processes.

The system monitors IVS Data Centers, correlator ftp or http sites and other specific servers for new data files required in processing VLBI sessions. The web crawlers, or scanners, are monitoring at regular intervals more than ten servers. When new information is detected, the scanner informs the message broker that dispatches the information via the “VLBI Exchange” to the appropriate process using ‘key words’ based on file types. Each file type has one or many specific processes to validate and process it. Using many small applications facilitates maintenance and detection of problems. The same system maintains the IVS Sessions web pages with no duplication. Figure 1 shows part of the ADAP data flow related to analysis. Most of the processes ensure that all files required for processing are available and valid.

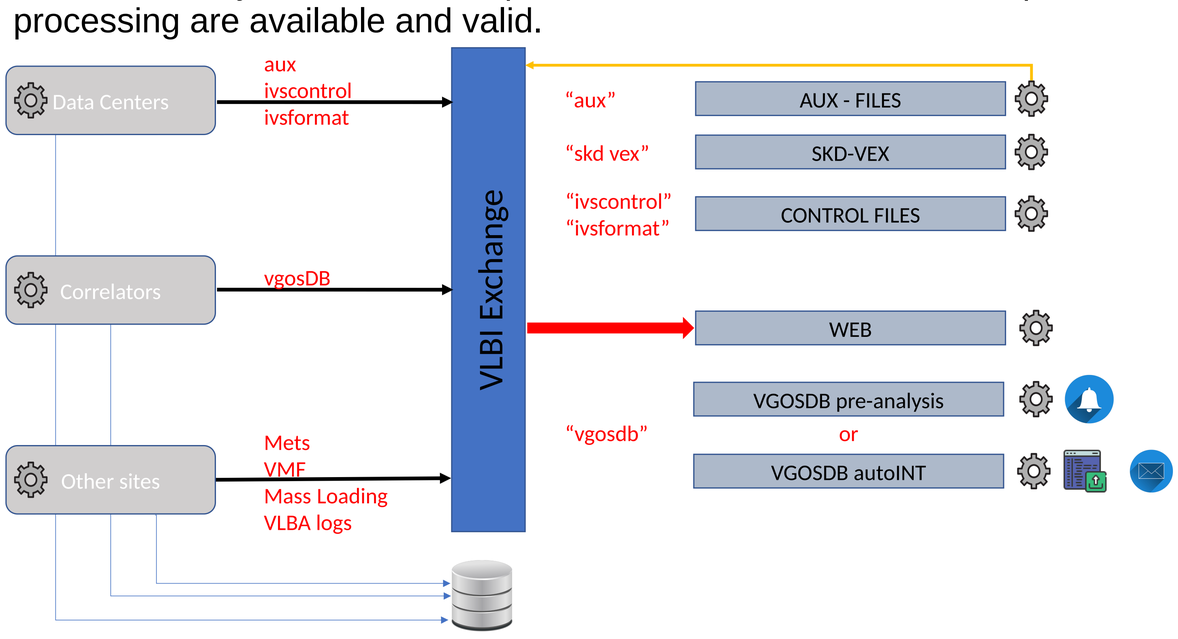

Figure 1. Automated Data Acquisition and Processing system data flow.

The “VGOSDB autoINT” process is dedicated to automatic processing of intensive sessions, submission of products and reports. Figure 2 shows the processes involved.

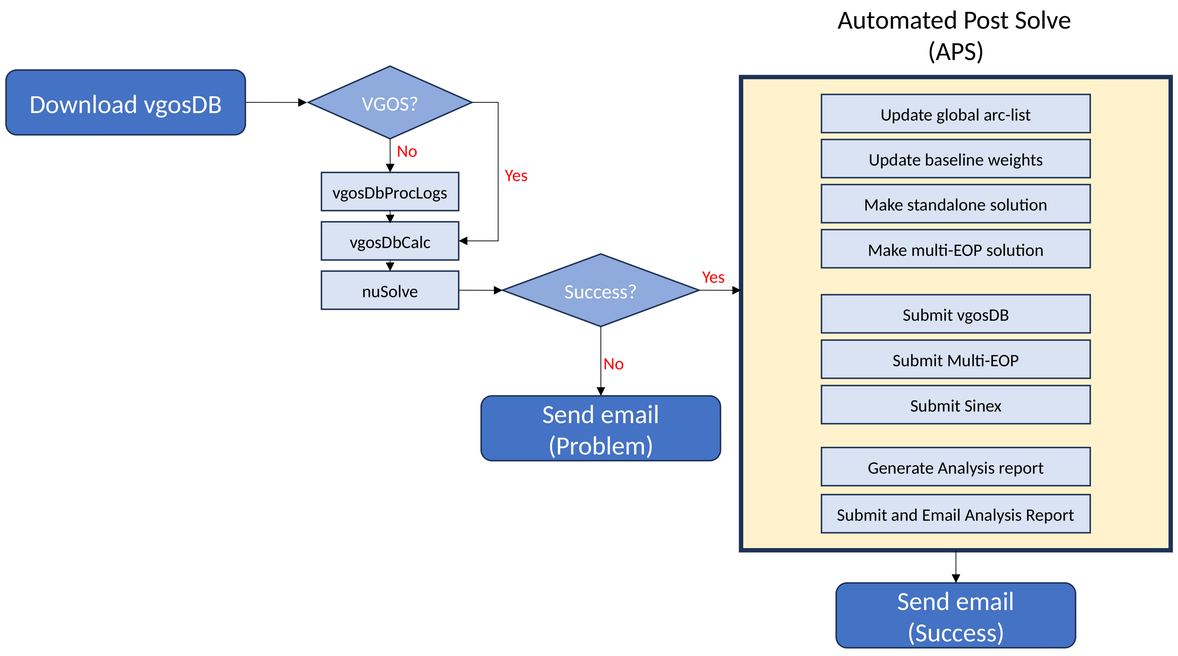

Figure 2. Data flow of the automated processing of INT sessions at GSFC.

νSolve software

To develop an application for automated analysis of an INT session, we used the script mode of the VLBI data processing software nuSolve [1]. In the script mode, νSolve reads commands from a script file and executes them.

We developed a script called autoINT.js that reads a database with a new INT session, processes it and creates a new version of the database [2]. The script performs preliminary analysis, resolves ambiguities in each band, evaluates the ionosphere corrections, reweights observations and handles outliers.

The use of the autoINT.js script is integrated into ADAP/APS software to process INT sessions in automated mode.

Automatic processing of INT sessions

In April-May 2023, NASA GSFC underwent intensive tests of the autoINT.js script. From the beginning of June 2023, routine processing of INT sessions has been transferred to automatic mode.

During the analysis, the script checks various criteria for validity of the solution. A huge WRMS, large standard deviations of the dUT1, or a large number of observations rejected as outliers are considered as a failure of the script and the session is then analyzed by an operator.

The Figure 3 shows the success/failure rate for the period since the beginning of the use of automated processing of INT sessions.

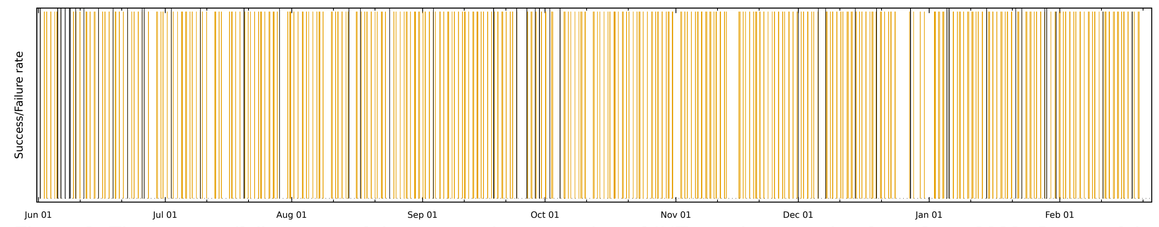

Figure 3. The success/failure rate of the automatic processing of INT sessions starting from June 2023. Successful solutions are painted as orange bars, the sessions that required manual processing are shown as black bars.

Latency times

Primary latency: An interval of time elapsed since the last observation of a session until the results were obtained.

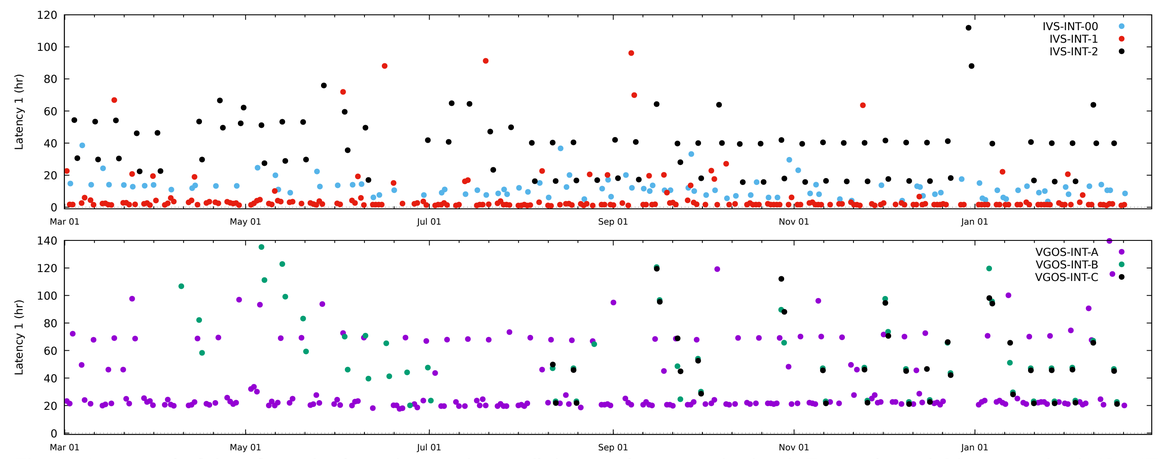

Figure 4. Interval of time from the last observation until the results were obtained. Top: selected S/X networks (IVS-INT-1, IVS-INT-2 and IVS-INT-00); bottom: selected VGOS networks (VGOS-INT-A, VGOS-INT-B and VGOS-INT-C). Several points (sessions) are not shown.

Table 1. Median average primary latency for the selected INT networks before and after the use of automated processing.

	IVS-INT-00	IVS-INT-1	IVS-INT-2	IVS-INT-3	IVS-INT-S	VGOS-INT-A	VGOS-INT-B	VGOS-INT-C
Jan 2023 to Jun 2023	$14^h\ 5^m$	$2^h\ 54^m$	$2^d\ 4^h\ 19^m$	$7^h\ 55^m$	$2^d\ 8^h\ 38^m$	$23^h\ 38^m$	$5^d\ 2^h\ 52^m$	$39^d\ 0^h\ 26^m$
Jun 2023 to Feb 2024	$10^h\ 5^m$	$1^h\ 37^m$	$1^d\ 15^h\ 54^m$	$5^h\ 47^m$	$1^d\ 6^h\ 16^m$	$22^h\ 15^m$	$1^d\ 23^h\ 7^m$	$2^d\ 4^h\ 36^m$

Secondary latency: an interval of time from when the database was downloaded to the servers of GSFC until the results were obtained.

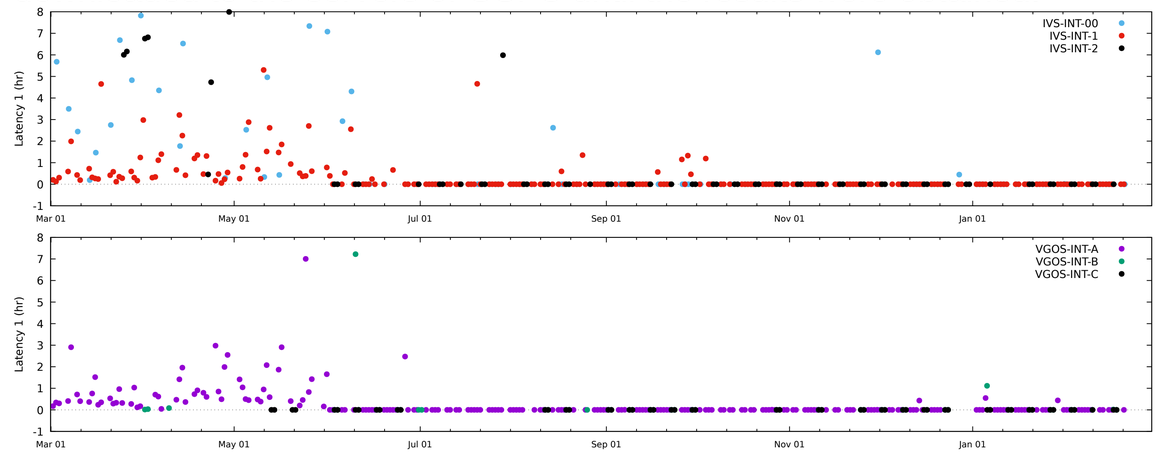

Figure 5. Interval of time from when a new database was downloaded until the results were obtained. Top: selected S/X networks (IVS-INT-1, IVS-INT-2 and IVS-INT-00); bottom: selected VGOS networks (VGOS-INT-A, VGOS-INT-B and VGOS-INT-C). Several points (sessions) are not shown.

Table 2. Median average secondary latency for the selected INT networks before and after the use of automated processing.

	IVS-INT-00	IVS-INT-1	IVS-INT-2	IVS-INT-3	IVS-INT-S	VGOS-INT-A	VGOS-INT-B	VGOS-INT-C
Jan 2023 to Jun 2023	$2^h\ 32^m$	28^m	$8^h\ 35^m$	$1^h\ 20^m$	$2^h\ 19^m$	29^m	$13^h\ 34^m$	$12^h\ 45^m$
Jun 2023 to Feb 2024	2^s	2^s	2^s	16^m	2^s	1^s	2^s	2^s

Availability of the autoINT.js script

The script autoINT.js is a part of νSolve distribution. It is available starting with the nusolve-0.7.3 version of the distribution and is being improved with each new version. The distribution is available at SourceForge:

https://sourceforge.net/projects/nusolve

References

1. *S. Bolotin, K. Baver, J.M. Gipson, D. Gordon and D. MacMillan.* **The VLBI data analysis software νSolve: development progress and plans for the future**. *In 8th IVS General Meeting Proc., ISBN 978-7-03-042974-2, Science Press, Beijing, China, pages 253–257. 2014.*
2. *S. Bolotin, K. Baver, M.* Bérubé *and J. Gipson.* **Automatic Processing of INT Sessions with nuSolve**. *In 12th IVS General Meeting Proc., NASA/CP–20220018789, pp. 159–163. 2023.*

e-mail: sergei.bolotin@nasa.gov