Status Report of VLBI Measuring System Based on China Deep Space Network

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Introduction

On Oct 24, 2007, China successfully launched ChangE-1 lunar exploration satellite, opened the first step towards deep space exploration. As an important part of the TT&C system, Chinese VLBI Network(CVN) assisted the existing USB spaceflight TT&C network to complete the orbit measuring and determination of ChangE-1.

China Deep Space Network(CDSN) combines the CVN will form a more precise, complete observation network. CVN and CDSN mainly include Urumqi(UR), Miyun(MY), Kunming(KM), Sheshan(SS), Tianma(TM), Jiamusi(JM) and Kashi(KS) 7 stations. During May 2013, China observation network associated with the CEB and NNO station(belong to European VLBI Network) and made an observation of the Venus Express spacecraft, and participated in the ChangE-3 mission in Dec 2013. The stations distribution of CDSN and CVN is shown in Figure1.

Introduction

Fig1. Stations Distribution of CDSN and CVN

Main Equipment

(1). DBBC

CDSN is equipped with a DBBC which includes astronomy and spacecraft navigation two kinds of modes. The DBBC is input IF analog signal, supports narrowband and wideband modes, including VSI and VSR two kinds of observation recording modes. The VSI mode utilizes the international VLBI standard interface, the mode structure is uniform channelization and direct digital baseband conversion, the data format is MARK5B. The VSR mode structure is under the parallel direct digital frequency conversion, the data format is RDEF.

VLBI DBBC includes CPCI IPC, signal conditioning unit, data acquisition and baseband conversion unit, data transmission board, etc. The system composition block diagram is shown in Figure2.

Mainequipment

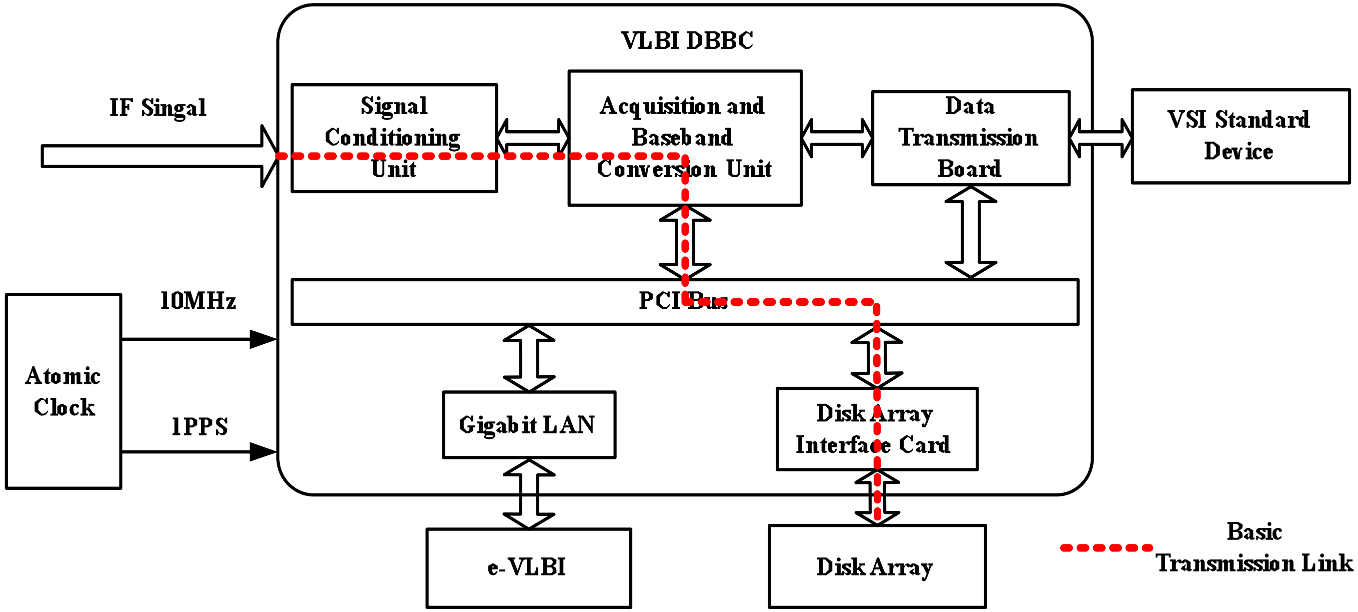

Fig2. Composition Block Diagram of DBBC

The IF signal accesses to the conditioning unit, completes AGC and filtering, and then through data acquisition and baseband conversion unit to complete digital sampling, baseband conversion, data format editing. Finally, the baseband data is transmitted to the different destinations by three different ways. The most basic way is to store the data files in the disk array for local subsequent processing. The other two ways are to transmit the data files to the correlation center through the e-VLBI network, or to the VSI standard equipment through transmission board.

Mainequipment

(2). Correlator

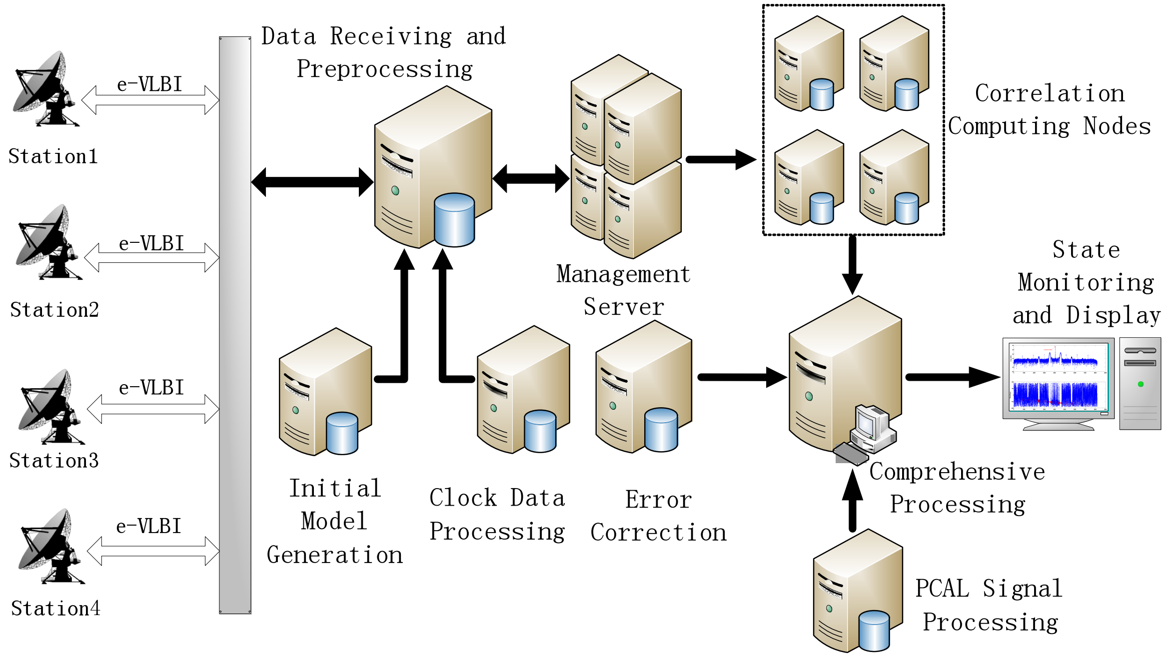

Fig2. The Correlator System Structure of CDSN

The system completes data receiving, storage, preprocessing, data distribution and correlation, etc. The specific work includes the initial delay model calculation, time synchronization information processing, preprocessing of raw data, correlation, postprocessing and PCAL signal processing, etc. In the internal system, the computer system group is divided into data acquisition and preprocessing subsystem, correlation subsystem and monitoring subsystem according to data processing phases, which can support DOR/DOD and ΔDOR/ΔDOD observation modes.

Situation of Observation Tests

(2). ChangE-3 Mission

ChangE-3 was launched successfully on Dec 2, 2013. CDSN combined CVN and CEB and NNO to complete a series interferometry tests. Since Dec 2, we observed a strong radio source every morning and evening, and made a DOR observation or ΔDOR observation in the daytime.

The cross-correlation spectrum and fringe phase of JM-KS baseline is shown in Figure4.

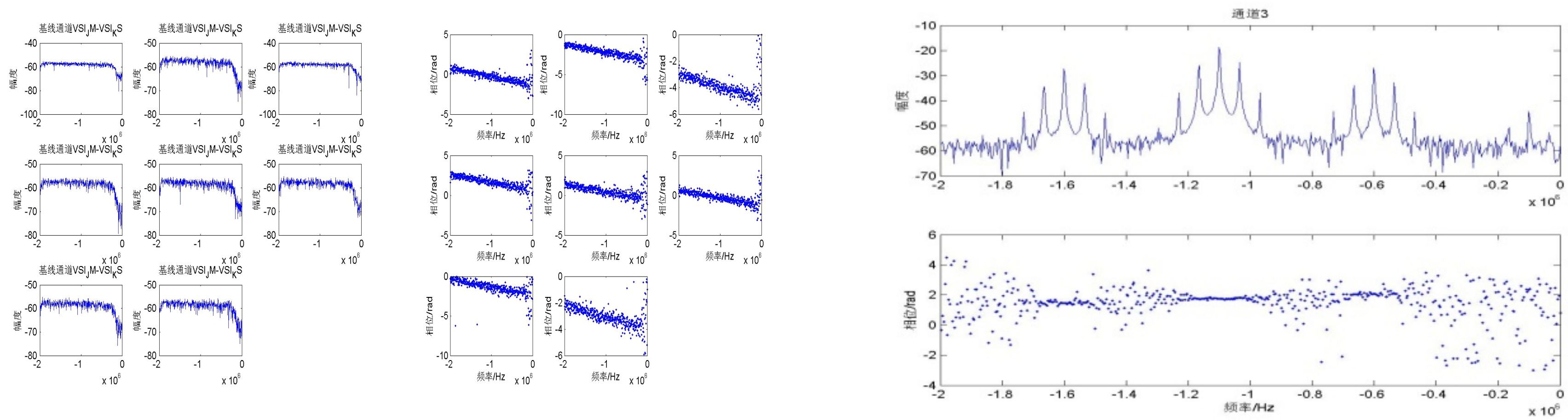

Fig4. The Spectrum and Fringe Phase of Radio Source and ChangE-3

Situation of Observation Tests

We utilize the correlation result of strong radio resource on Dec 12 to calibrate the spacecraft and compare the result with the precise orbit. Due to the initial model of was calculated by the precise orbit. So the difference of residual delay between the spacecraft and radio source is the accuracy of DOR result. As shown in Figure5, the red dots on both ends are radio source results, the green and red dots in the middle are the results of spacecraft and radio source. The following figure shows the difference of spacecraft and radio source, and the DOR accuracy is less than 1.5ns.

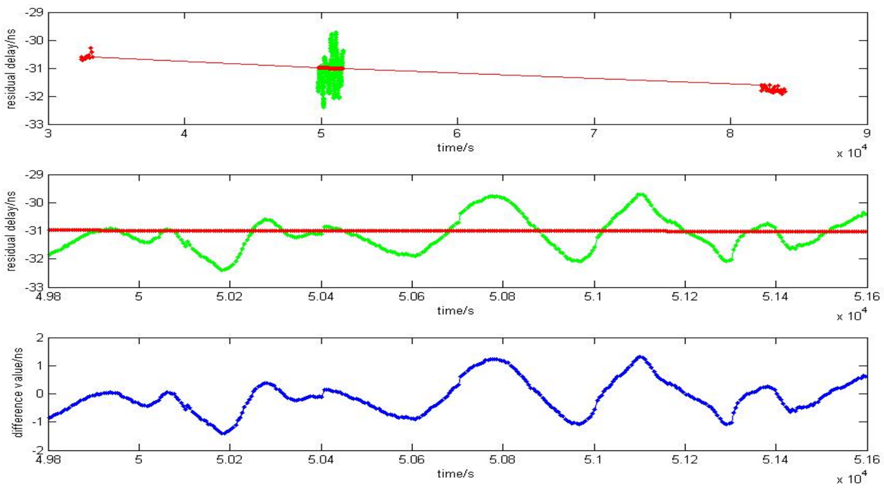

Fig4. The DOR Result of JM-KS Baseline

Situation of Observation Tests

We made a ΔDOR observation on Dec 8, which utilized the scan1-scan5 alternate observation data. Among them, scan1, scan3, scan5 were spacecraft observations, scan2 and scan4 were radio source observations.

The result of JM-KS baseline is shown in Figure6. The upper part of the red dots at the ends are the scan2 and scan4 radio source residual delay result, the middle red dots are the interpolation of spacecraft residual delay at the same time. The lower part of the blue dots is the difference of the residual delay between the spacecraft and radio source, which is the accuracy of ΔDOR result. The accuracy of less than 1.5ns.

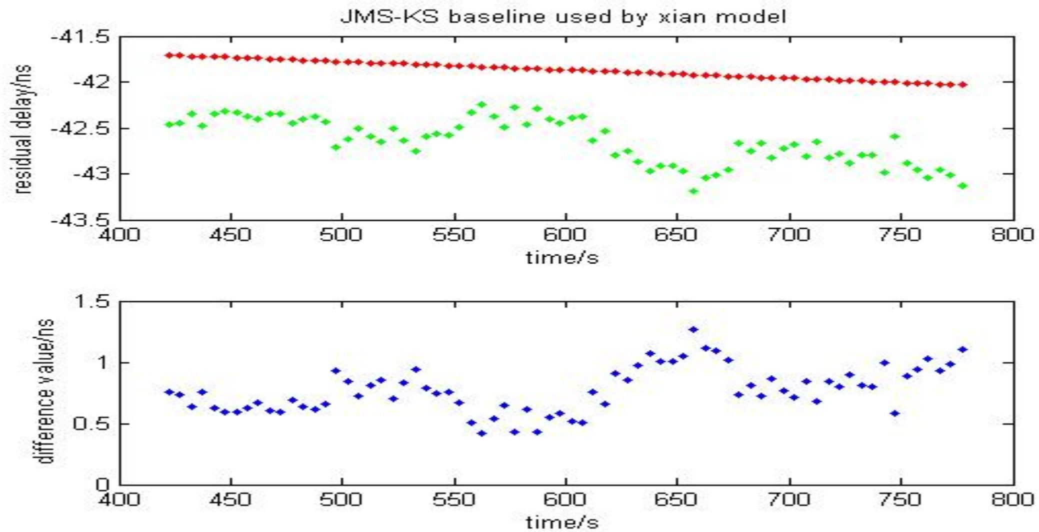

Fig4. The ΔDOR Result of JM-KS Baseline

Conclusion

CDSN is still under construction currently, which has participated the VEX, ChangE-3 observation and obtained some experience. The data processing result showed that the whole system has reached the expected target.

Next Project

- station coordinates
- radio source catalogues
- EOP calculation

Thank you for your attention!