Sep. 11, 2006

Report from NICT, Japan

NICT and major T&F institutes in the Asia-Pacific region, such as NMIJ of Japan, NMIA of Australia, NTSC of China, TL of Chinese Taipei, KRISS of Korea, and SPRING of Singapore, are cooperatively constructing a TWSTFT network in this region as shown in Fig.1. To operate those links, we are using multi-channel modem (NICT modem)[1] developed by NICT. Time transfer is regularly performed and hourly data are reported to BIPM. Fig.2 and 3 show the comparisons between TWSTFT (5 minute averaged data by NICT modem) and GPS (P3 all-in view data) for NICT-TL and NICT-KRISS. We consider the performance of the NICT modem was confirmed for regular operation.

A financial problem forces us not to continue the contract for current three satellites. We might give up the PAS-8 link and plan to change the assignment of the links to the satellites.

NICT carried out calibration trips using a portable station (see Fig.4) first to a domestic LF station Ootakadoya-yama on December 2005, and to TL on February 2006 to achieve the accuracy of about 1 ns for the instrumental delay, which is consistent with the value calculated from Circular-T. The detail is described in a report sent to BIPM[2]. We will also carry out a calibration trip to another domestic LF station Hagane-yama this September, and to KRISS this October.

For a TWSTFT link to Europe, a link between NICT and PTB was established in July 2005[3]. The NICT modem is used for this link. The time transfer is regularly performed and hourly data are also reported to BIPM. We found a diurnal variation up to 3 ns p-p in this link on both NICT-PTB link and KRISS-PTB link. Fig.5 shows the difference between TWSTFT data and GPS data. This kind of variation is not detected on the short baseline using one satellite transponder such as NICT-KRISS link. The reason of this variation is now investigated. Since such a distant link requires different satellite transponders for each beam, that might be the reason.

A TWSTFT link to USA has been experimentally started between NICT and USNO using a SATRE modem via VDB station since April 2006. But the data quality is not quite satisfactory. We plan to change the relay station to Hawaii and hope to begin operation from next fiscal year. We are coordinating this issue with USNO.

Most devices used in our earth station for JCSAT are contained in a temperature-stabilized box (see Fig.6) and the delay variation is monitored (see Fig.7). Recent (January to June) variation is measured as 50 ps/day.

We are trying new methods to widen the effective bandwidth while reducing the cost of the satellite transponder. We hope to make a progress report about this issue in the near future.

For precise time comparison between a satellite and a ground station, we have two projects. The ETS-8 satellite, which possesses an on-board two-way carrier phase time comparison equipment, will be launched onto the geostationary orbit in this December. And the QZSS (Quasi-Zenith Satellite System; see Fig.8) with a Ku-band on-board two-way time comparison unit will be launched in FY 2009.

[1] Imae et.al., "Two Way Satellite Time and Frequency Transfer", J. of NICT Vol.50 Nos1/2, 2003
[2] Fujieda et.al., "Calibration of Two-way time transfer between NICT and TL", NICT internal report, April 7, 2006
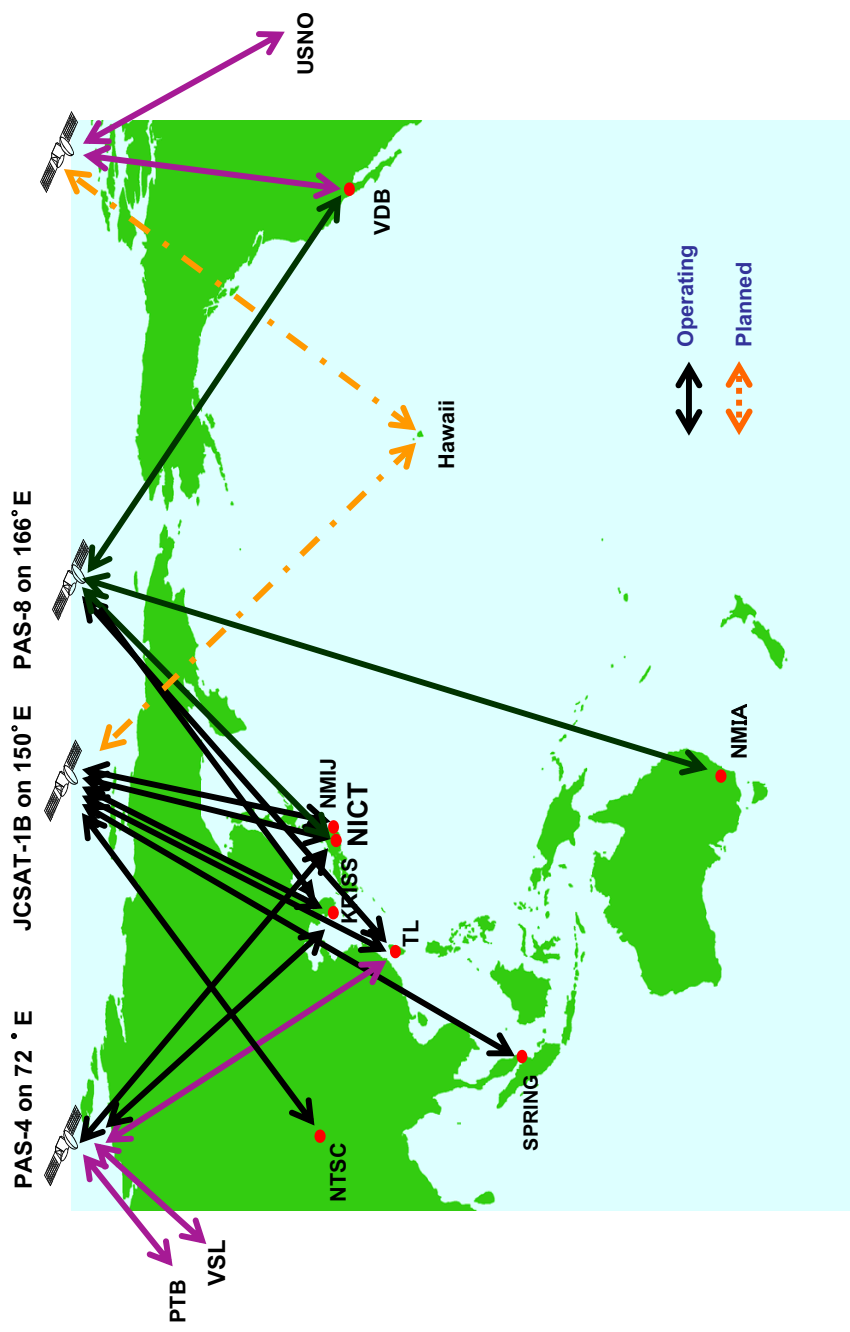[3] Maeno, et.al., "Establishment of a TWSTFT link between Asia and Europe connecting NICT and PTB", EFTF 2006
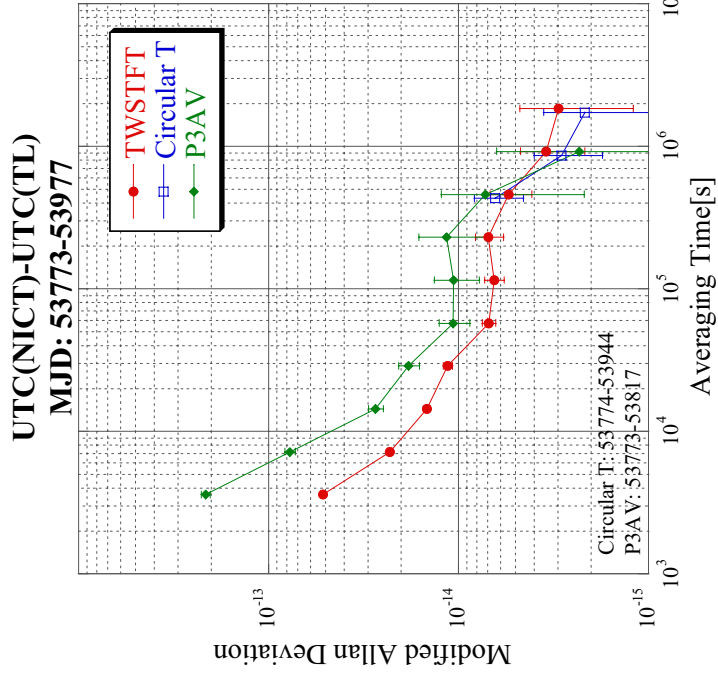
Fig.1 TWSTFT network related to NICT

USNO

VDB

PAS-8 on 166° E

Hawaii

JCSAT-1B on 150° E

NMIJ
NICT
KRISS
TL

PAS-4 on 72 ˙ E

NTSC

SPRING

NMIA

Operating
Planned

PTB
VSL

UTC(NICT)-UTC(TL)
MJD: 53773-53977

TWSTFT
Circular T
P3AV

Modified Allan Deviation

Averaging Time[s]

Circular T:53774-53944
P3AV:53773-53817

Fig.2 TWSTFT (NICT modem) data
compared to GPS data on NICT-TL

UTC(NICT)-UTC(KRIS)
MJD: 53773-53977

TWSTFT
Circular T
P3AV

Modified Allan Deviation

Averaging Time[s]
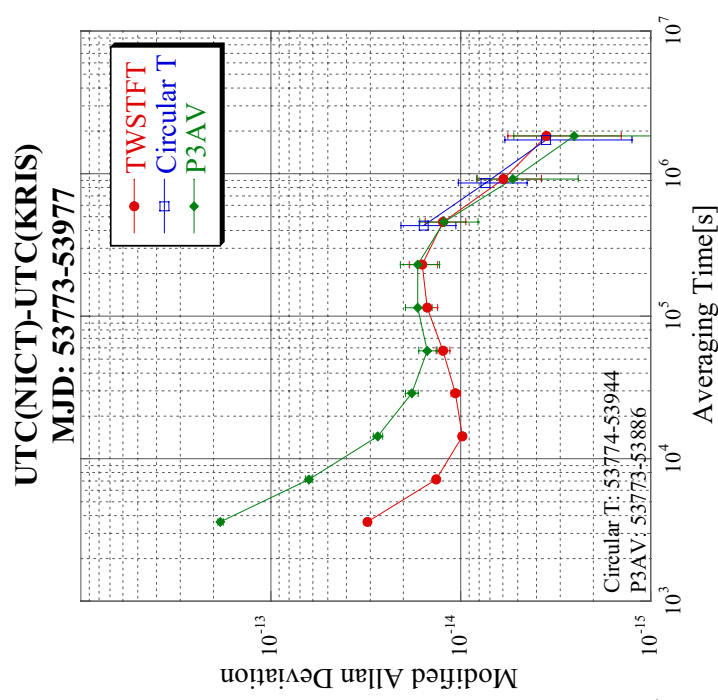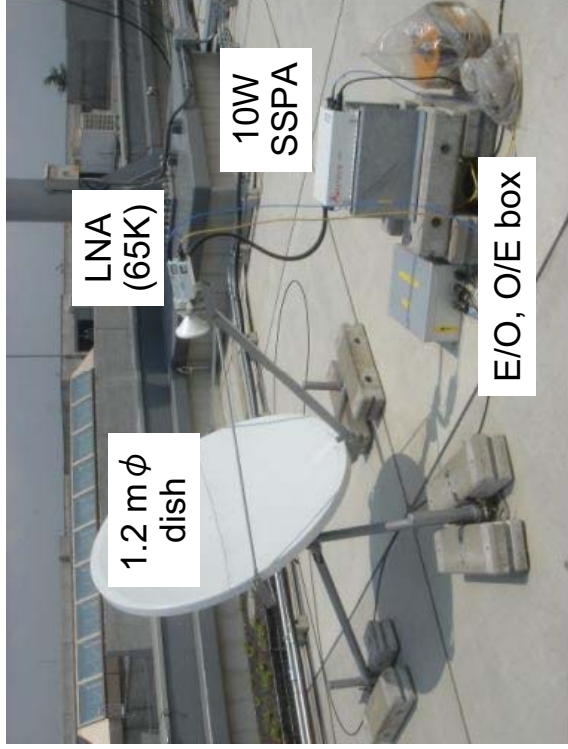
Circular T: 53774-53944
P3AV: 53773-53886

Fig.3 TWSTFT (NICT modem) data
compared to GPS data on NICT-KRISS

E/O, O/E box

TIC

U/C, D/C

NICT
Modem
TX:1ch
RX:2ch

Fig.4 Portable Station of NICT
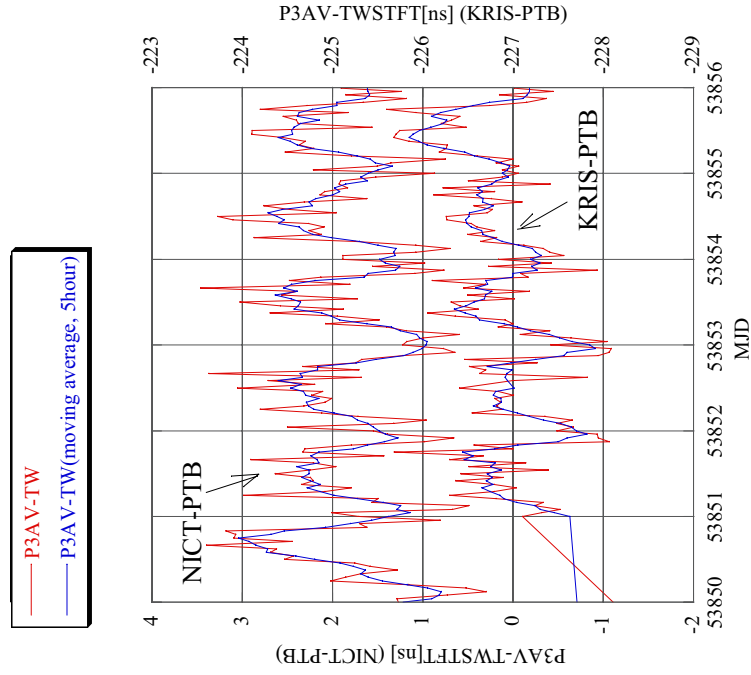
10W
SSPA

LNA
(65K)

E/O, O/E box

1.2 m φ
dish

Fig.7 Delay Variation in NICT
earth station for JCSAT

Outdoor Temperature [℃]

Delay [ns]

2006/1 – 2006/6

For JCSAT-1B
At UTC 0:00

Earth Station Delay
(Tx - Rx)/2

Outdoor Temperature

MJD

Fig.5 Diurnal variation for
NICT-PTB and KRISS-PTB

P3AV-TWSTFT[ns] (KRIS-PTB)

P3AV-TWSTFT[ns] (NICT-PTB)

MJD

NICT-PTB

KRIS-PTB

P3AV-TW
P3AV-TW(moving average, 5hour)

Delay measurement system in NICT

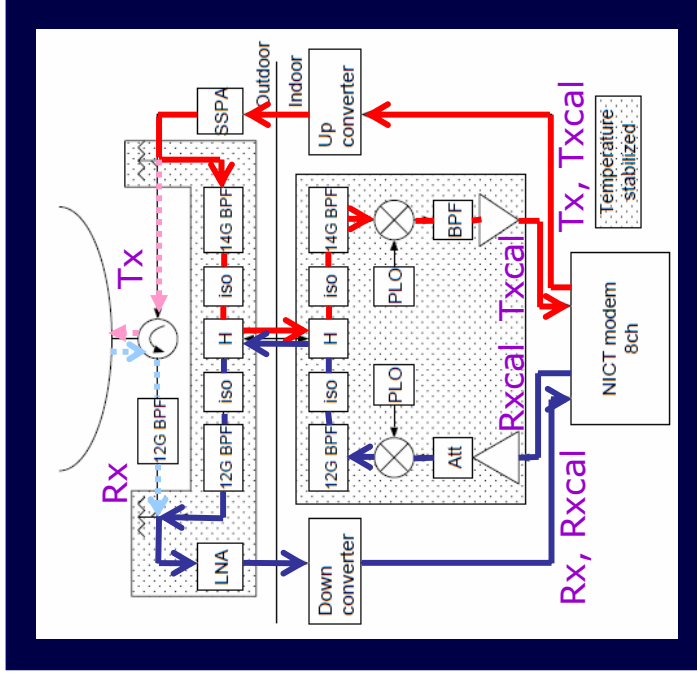*We have monitored delay variation in earth station for JCSAT-1B.

*Txcal = delay in red path
Rxcal = delay in blue path

*NICT modem has 2 Tx ch.
One is used for regular Tx, another one is used for Rxcal.

*NICT modem has 8 Rx ch.
It can measure Txcal and Rxcal as well as regular Rx from other laboratories at the same time.

Txcal input is physically distinguished from its own round-trip signal.

for details, see M. Fujieda et al, CPEM 2006

Tx : PN#0   Rx: PN#0,1,2,3,4,5
Txcal: PN#0 Rxcal: PN#6

Fig.6 Block diagram of earth station for JCSAT-1B

Precise comparison on QZS between on-board clocks and ground stations

USNO

QZS

GEO

GPS

time management station (TMS) at NICT, Tokyo

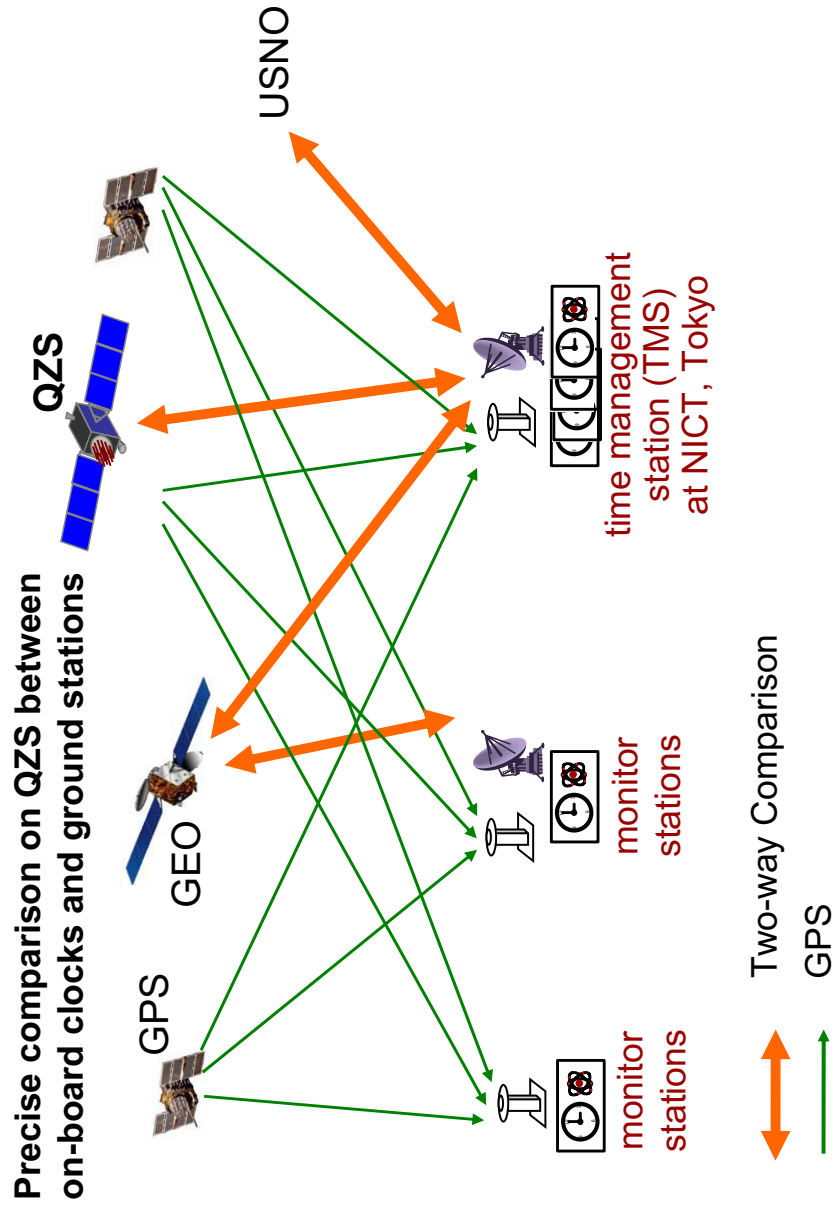monitor stations

monitor stations

Two-way Comparison
GPS

Fig.8 Time Management System for QZSS (Quasi-Zenith Satellite System)