UPDATE ON TIME AND FREQUENCY ACTIVITIES AT NIS

Safaa Samuel , Ahmed Hisham and Ghada Mamdouh
National Institute For Standards
Egypt

Abstract:

The time and frequency Laboratory of NIS, as the national lab for time and frequency metrology in Egypt , is charged with the realization and dissemination of the national time and frequency standards .
Concerning the realization of the national timescale and its international traceability, NIS participates with the BIPM in the UTC generation using the GPS and GLONASS multichannel receivers.
The mission of the time and frequency laboratory will be reviewed and a discussion will be presented of recent activities. Among the major recent milestones has been the cooperation of NIS with the ground station of NILESAT for domestic time and frequency dissemination system.

1. Introduction:

The Time and Frequency laboratory of the Egyptian National Institute for Standards (NIS) is responsible for the maintenance and development of the standards in time and frequency, specifically the laboratory is responsible for the following standards: time, frequency, phase angle, speed, pulse rise-time and pulse characterization and time interval.
The national standard for time in Egypt consists of three commercial cesium beam atomic clocks high performance Agilent 5071A (formerly Hewlett Packard). Time transfer is performed using multi channel Global Positioning System (GPS) and Global Navigation Satellite System (GLONASS) receiver. The Egyptian (NIS) and CSIR-NML (South Africa) are the only contributors in Africa of time transfer data to the Bureau International des Pois et Mesures (BIPM). The task of BIPM is to ensure international uniformity of measurements and traceability to the International System Units (SI).
In addition to its standard activities the time & frequency laboratory is charged with the responsibility of the dissemination of standard time and frequency information.
The national frequency standard is used as the reference standard for the calibration services. Figure 1 shows the system of the time keeping and dissemination of Time & Frequency standards in NIS, Egypt.

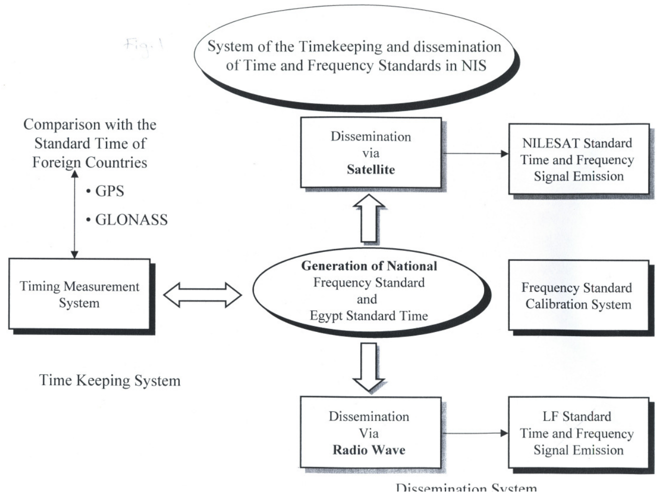

Fig.1 System of Timekeeping and dissemination of Time and Frequency Standard in NIS

2. Time Transfer Systems:

Currently there are two global time and frequency transfer systems , the Global Positioning System (GPS) and the Global Navigation System (GLONASS) and one under development, the GALILEO navigation system.

GPS is a navigation and positioning service that produce time and frequency information. The Russian GLONASS has similar characteristics to those of the GPS for time synchronization. The BIPM started the coordination of GLONASS common-views in January 1996.

In December 1997, a multi-channel GPS/GLONASS common-view scheme was adopted by the CGGTTS (Consultive Committee for Time and Frequency sub-group on GPS and GLONASS Time Transfer Standards) [1,2] . The NIS uses a multi-channel GPS/GLONASS receiver, which tracks all satellites in view, to participate with BIPM in the UTC generation; the measurements are then processed to generate the REF-GPS and REF-GLONASS in the standard 13 minute format. The 16 minute interval is selected to give the receiver 2 minutes to lock on the satellite signal, 13 minutes of common-view measurements, and 1 minute separation between tracks. BIPM publishes UTC (NIS)-GPS in its monthly Circular-T and annual report. The comparison data are sent to BIPM every week via the internet. Over the last three years, NIS has been working on improving its time keeping system, and better results are achieved (Table 1).

Date 2006/07 0h UTC	DEC 30	JAN 4	JAN 9	JAN 14	JAN 19	JAN 24	JA
MJD	54099	54104	54109	54114	54119	54124	5
Laboratory k				[UTC-UTC(k)]/ns			
NIS (Cairo)	3.1	-5.3	-6.0	-6.8	-6.6	-2.2	
NIST (Boulder)	15.9	16.7	16.1	16.5	15.5	14.7	
NMIJ (Tsukuba)	41.0	41.3	39.7	35.3	33.6	30.8	
NMLS (Sepang)	-682.8	-687.7	-694.6	-694.8	-702.2	-705.6	-7
NPL (Teddington)	20.3	19.1	16.6	15.7	12.9	10.0	
NPLI (New-Delhi)	123.8	146.2	167.2	-	-100.7	-89.5	-
NRC (Ottawa)	-58.1	-65.7	-77.8	-80.3	-77.2	-74.2	-
NTSC (Lintong)	3.8	-0.7	-1.1	-5.0	-10.2	-9.3	
ONBA (Buenos Aires)	-11609.4	-11688.1	-11801.2	-11826.1	-11320.5	-11227.0	-112
ONRJ (Rio de Janeiro)	-19.0	-10.2	-4.1	-8.5	-0.6	5.3	

Table 1 Circular T, UTC NIS - GPS

3. Time and Frequency Dissemination by Satellite:

There are only two one-way time and frequency dissemination systems using geostationary satellites currently in operation around the world, these are Indian Domestic Geostationary satellite (INSAT), and the Geostationary Operational Environmental System (GEOS) from the United States. [3, 4]

The INSAT provides service to the Indian subcontinents through the National Physical Laboratory (NPL) in New Delhi; the INSAT service is very similar to the GOES system.

The Egyptian satellite company has lunched two geostationary Direct-to-Home television, radio, and data transmitting satellites that serve the Northern Africa and Middle East regions.

3.1 Time and Frequency Dissemination System using the Egyptian Geostationary Satellites (NILESAT):

Time and Frequency Dissemination System using the Egyptian Geostationary Satellite is under operational stage. The main purpose of such system is to provide Egypt with two kinds of services: a frequency standard signal and a time code for time synchronization of a level of a few microseconds. Information to disseminate includes local time (hour, minute, seconds), day of the year.

The Time and Frequency Division at the National Institute of Standards and Technology (NIST) in the United States is acting as a consultant through a grant from the US-Egypt Joint Science and Technology Program.

3.2 Description of NILESAT :

NILESAT delivers Direct-to Home (DTH) Broadcasting satellites to antennas of only 60 cm diameter. The satellite covers most of the Arab countries as well as the southern regions of some European countries (from Morocco in the west to the Arabian Gulf in the East) .[5]

The NILESAT Broadcasting Center is in 6^{th} of October city, Giza, 20 Km distant from NIS. The NILSAT 101 geostationary satellite is located at 7^{o} west with an uplink frequency band of 17.3-17.7 GHz bandwidth. The effective isotropic radiated power (EIRP) is shown in figure 2, with a maximum EIRP of 50.5 dBW. Table 2 shows the EIRP for several locations across the region. The NILESAT broadcast is a Direct-to-Home service which provides Digital Video Broadcasting (DVB), audio broadcasting, and high-speed data services.

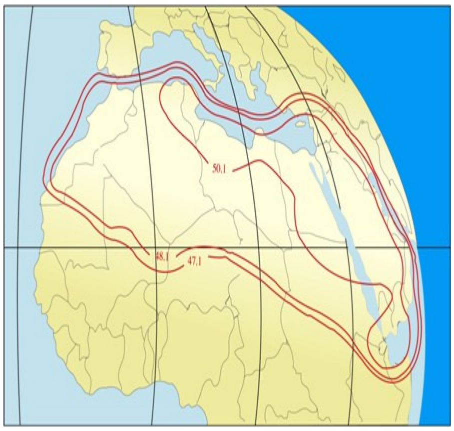

fig.2 EIRP contour map for NILESAT 101 satellite

EIRP in Main Cities

City	EIRP (dBW)	City	EIRP (dBW)
Abu Dhabi	48.9	**Doha**	49.2
Aden	50.3	**Jerusalem**	50.2
Alexandria	50.3	**Khartoum**	48.2
Algeria	47.3	**Kuwait**	50.3
Amman	50.3	**Manama**	49.2
Aswan	50.2	**Marrakech**	47.7
Baghdad	48.2	**Mecca**	50.1
Beirut	50.2	**Mogadishu**	47.2
Cairo	50.5	**Muscat**	48
Casablanca	47.7	**Nouakchott**	47.2
Comoros Islands	33.5	**Riyadh**	50.2
Damascus	50.3	**Tripoli (Libya)**	50.2
Djibouti	48.2	**Tunis**	50.2

Table 2. List of major cities within coverage area and their respective EIRP values

3.3 Transmitting System:

The transmission setup (fig. 3) is located at the NILESAT Broadcasting center. It consists of time code generator which takes 1 MHz and 1pps as input from NIS Cesium standard.
The broadcast includes a stabilized reference carrier frequency, a modified IRIG-B time code (fig. 4) and an audible time-of-day announcement.

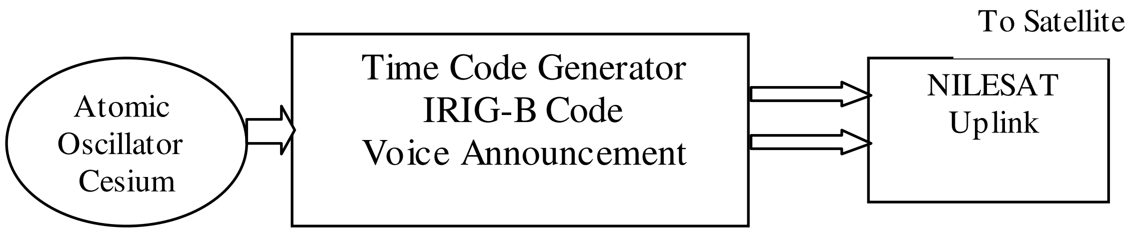

Fig. 3 Setup at the earth station for transmission to NILESAT

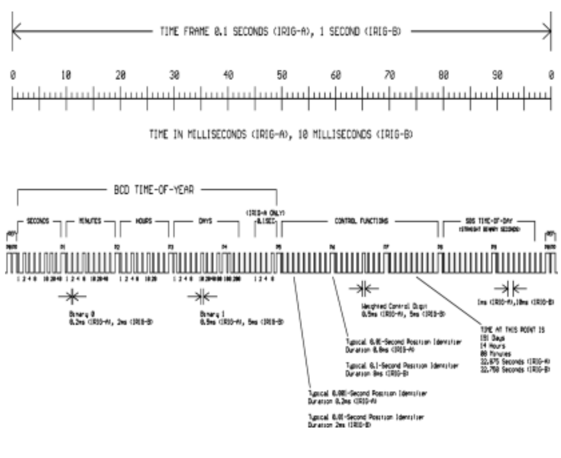

Fig.4 Format of the signal code via NILESAT

3.4 Receiving System :

A schematic diagram of the receiving system is shown in fig. 5 . The signal is received using a 60 cm dish. The complete assembly of the dish, receiver and the decoder is available commercially in the local market in Egypt.

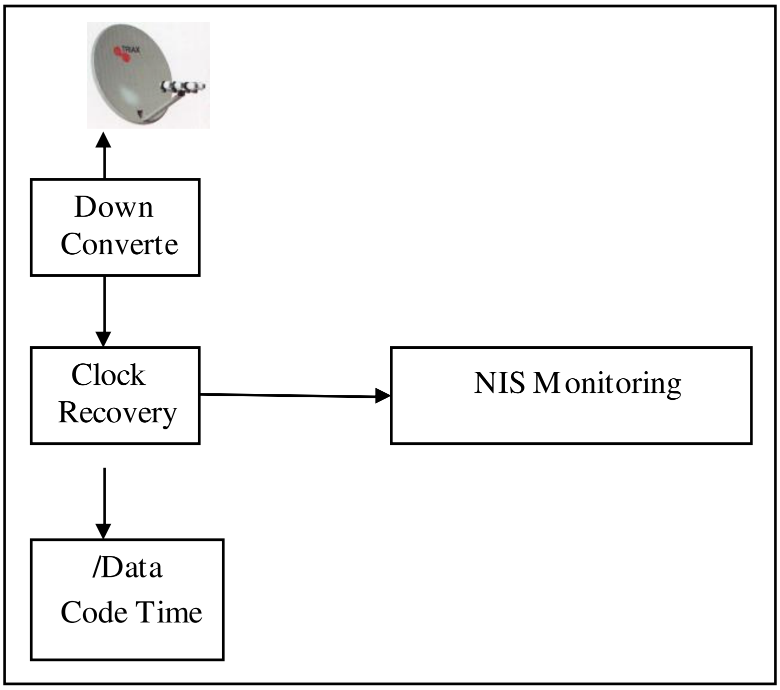

Fig 5. set up for time signal reception from NILESAT

4. Research Activities:

4.1 Oscillator Proficiency testing and Comparison System using common view:

It is hard to tell that if a clock is traceable to some reference without a special mechanism between them. To make this traceability possible, it requires media in each other for comparison. GPS common view is a good choice.

By the use of GPS common view, two clocks located at different sites can compare with each other by means of the GPS time derived by the two GPS receivers. In this technique two GPS receivers simultaneously observe the same GPS satellite. Since the GPS time is common, the difference between the outputs from the two GPS receivers is simply the difference between the two clocks.

4.2 Establishment of NILESAT monitoring stations:

Once four monitoring stations are established and by using orbital phase equation method, a stabilized frequency reference will be broadcast that can be used to calibrate oscillators.

5. Conclusion:

Coded standard time and frequency signal will be broadcasted on one of the radio networking channels of NILESAT. It is likely to provide continuous service in the near future.
This broadcast can be received all over Egypt and some of the Arab countries and can provide an on-line synchronization to the Egyptian standard time (EST).

6. Reference:

[1] Wlodzimierz Lewandowski and Jacques Azoubib, " GPS + GLONASS: Toward sub-nanosecond Time Transfer", GPS World, pp. 30-39, November 1998.
[2] 2005 Annual Report of the BIPM Time Section.
[3] A. Sen Gupta, Ashok K. Hanjura, and Bhupendra S.Mathur, "Satellite Broadcasting of Time and Frequency Signal ", Proc. IEEE, vol.79, pp. 973-982 , July 1991.
[4] Roger Beehler, Dick Davis, and John Milton, "GOES Satellite Time Code Dissemination, Description and Operation", NBS special Publication 250-30, January 1988.
[5] Jan Veldhuis, "The NILESAT DVB Facilities in Cairo", International Broadcast Engineer, pp.32-33, March 1999.
[6] John Lowe, Wayne Hanson, Mohamed A. Swidan, Safaa Samuel, and Ahmed Hisham, "Time and Frequency Broadcasts for the Middle East Region by Satellite", Proc. NCL International 2001 workshop & symposium, August 2001.
[7] John Lowe, Jason Heidecker, Safaa Samuel, Ahmed Hisham, and Mohamed Swidan, "Standard Time and Frequency Dissemination via Egyptian Digital Satellite", to be published.