Selected Paper

The advanced technologies on satellite transponders

- The Development Trend of Onboard Processor -

Tomoki Obuchi

November 2002

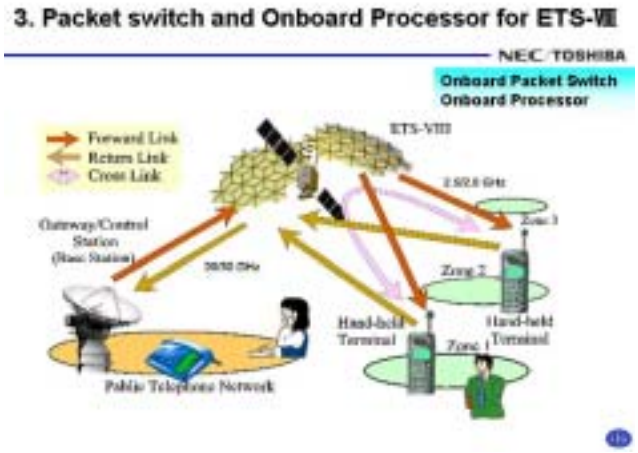
Presented by:
Tomoki Obuchi - Executive Director
Commercial Satellite Sales
Network Solutions Division

2002 年 11 月に韓国ソウル市で開催された APSCC にて発表された「主題：衛星搭載トランスポンダの先端技術、副題：オンボードプロセッサーの開発の流れ」と題する論文についてご紹介します。衛星通信システムは常に地上通信システムと競合と協調をしながら技術革新をしてきました。近年、インターネットの普及によって、通信要求の拡大と通信形態の多様性は顕著です。通信需要に機動的に対応する方法について多用なアイデアが開発されています。そのコア技術としてオンボードプロセッサーの改革の変遷について紹介しています。　発表論文は英語ですので内容についてはそのまま和訳を入れず掲載しました。

The satellite communication system always competes and cooperates with the ground communication systems and it is remarkable development by working hard together. In recent years, with the spread of the Internet, the expansion of the communication demand and the diversity of the communication formula are conspicuous. Various ideas are developed about the way to correspond to the communication demand flexibly, too.

For example:

- *To control EIRP variably according to the communication traffic demand by Multi Port Amplifier for Multi Beam Satellite.*
- *To exchange in the communication connection according to the address tag in the satellite with re-generative transponder by the OBP.*
- *To correspond to the communication demands by frequency re-use technology of Multi Beam Antenna.*



In this paper, I would like to focus the OBP, and to introduce our development trend and the current status.

Why is necessary Satellite On-board Processor?

The following merit is introduced on OBP.

(1) It can optimize the satellite communication Systems. Because up link and down link signal can be separated. For example, the communication system that differs in up/down can be applied, such as SCPC for up link and TDM for down link.

(2) Up link noise isn't added to down link noise. Therefore, the reception S/N ratio of User Terminal can be 3 dB improved.

(3) By processing on-board of the satellite in FEC (Forward Error Correction), the delay time to the re-sending request to the ground station is reduced.

(4) In the Multi Beam Satellite, the connection among each Beam becomes necessary. OBP is one of important systems.

(5) The globalization of the satellites are required the inter-satellite connection. Then, OBP is one of necessary technology.

The figure-1 & 2 show the development trends of OBP. At the beginning phase of OBP, it was started by analog technologies, because of difficulty of digital processing by G/A.

The system was consisted of On-board Switch Matrix for SS-TDMA system. There are many kinds of systems as shown in the Figure-3. The analog type OBPs were continued to improve the system since 1978 up to 1993. At first, we developed 4x4 switch matrix for AMES on 1979. After then, several capacity switch matrixes were developed up to 1993. And at the end of 20th Century, the large G/A rapidly developed with the spread of Internet. Then, the OBP system totally changed the analog type to digital.

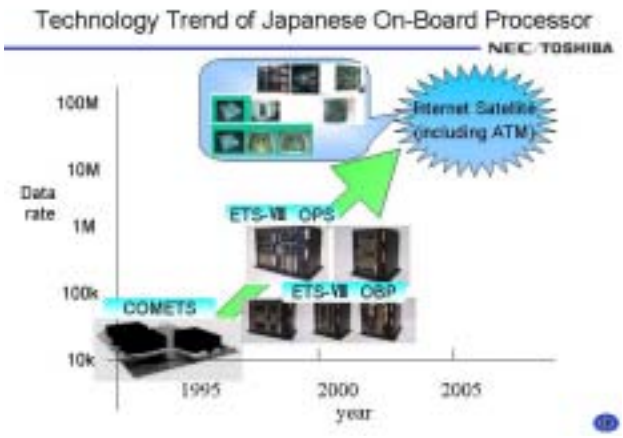


Figure-1 technology trend of Japanese OBP

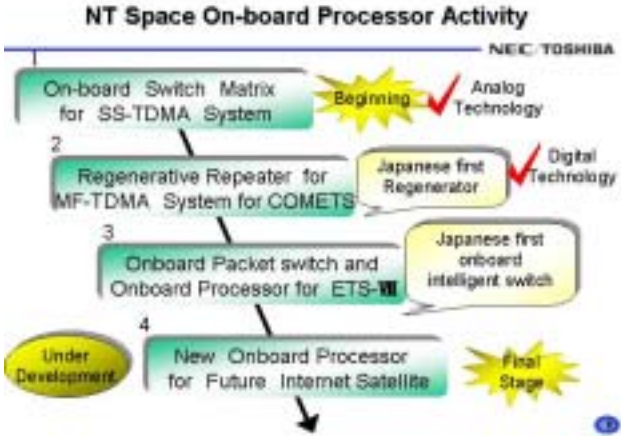


Figure-2 technology trend of NTSpace OBP

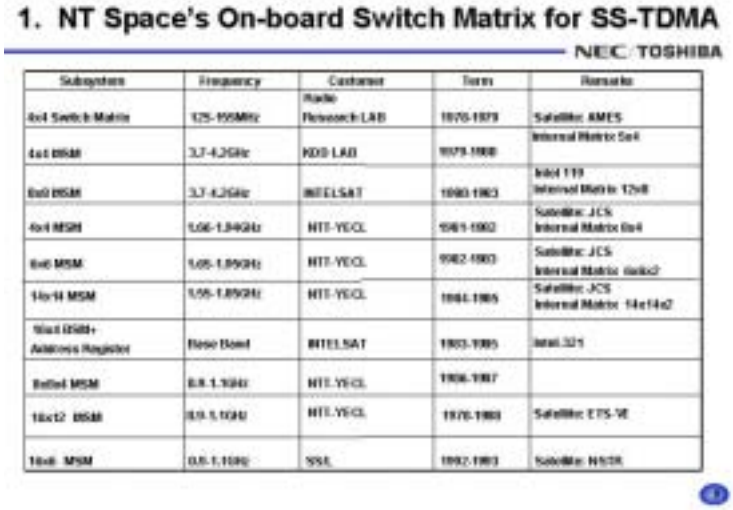


Figure-3 On-board Switch Matrix for SS-TDMA

On the COMETS of Japan, we got a chance to develop the regenerative repeater for MF-TDMA system. The COMETS was installed a Japanese first on-board regenerator by digital technology. The Figure-4 shows COMETS Regenerative Repeater for MF-TDMA. The OBP was MF-TDMA, and the up link was SCPC and down link was TDM. Input data rate was 12 – 2.4 kbps, and output was 192- 38.4 kbps. The transmissions CHs were 16.

By the diffusion of Internet, it became to ask for corresponding of Multi media communications. We developed On-board Packet Switches (OPS) and On-board

Processors (OBP) for ETS-8. The Figure-5 is the block diagram of ETS-8. Feeder link is Ka-band, and Mobile link is S-band. The transmission data CHs are 256 by each telephone CHs of 16 kbps. The data rate is 1M bytes. The satellite will be launched on 2003 by H-2A.

We are now under developments new On-board processors for future Internet satellite. This OBP is consisting of ATM switches as well as ground commercial ATM switches. The detail describes in the later section.

The Figure-6 image shows ETS-8 Onboard processing systems. There are consisted of OPS and OBP. This system can handle via Gateway and Mobile terminal to Mobile. The transmission exchange capacity is treated 500 lines per one time.

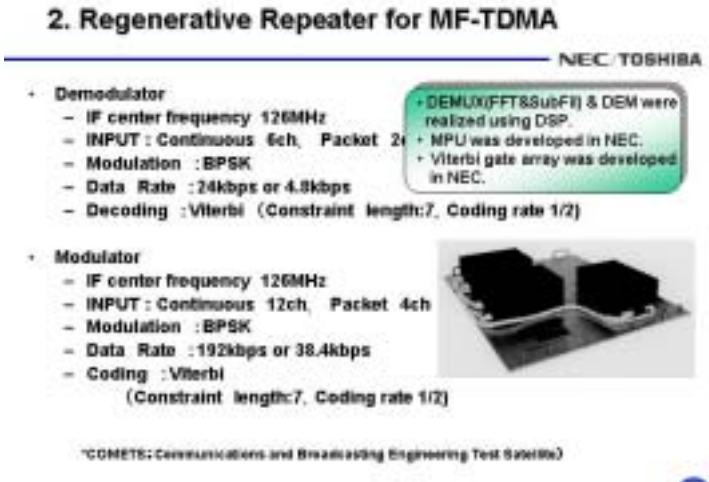


Figure-4 COMETS Regenerative Repeater for MF-TDMA

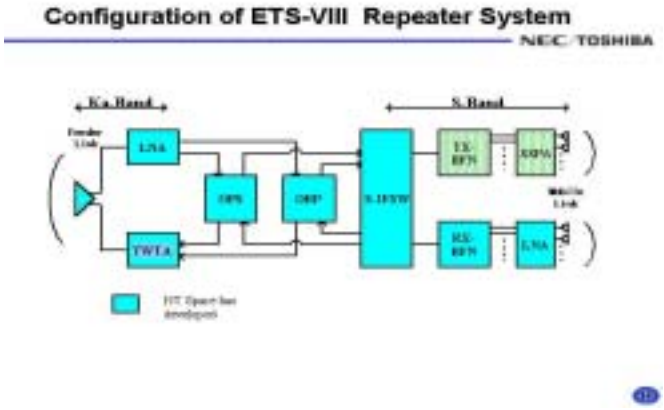


Figure-5 ETS-8 Repeater Configuration

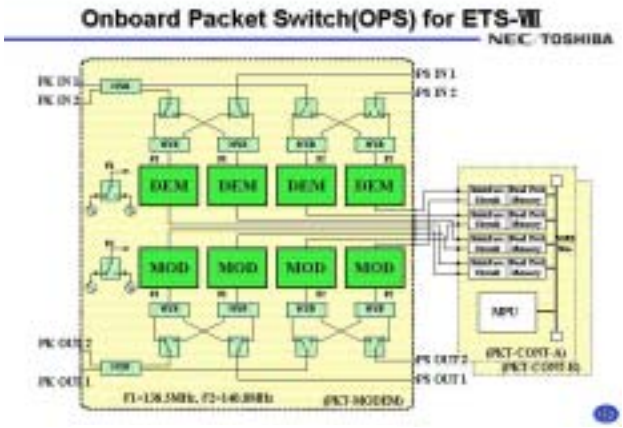


Figure-6 ETS-8 OPS

The Figure-7 shows OPS's Modem, Controller, DEM G/A and Viterbi G/A. OPS and OBP, and the transmission data are 256 CHs by each telephone channel of 16 kbps. The data rate is 1 M bytes.

At the future ATM system, we are designing to handle more than 100M data rate.

The Figure-8 is the On-board Packet Switch (OPS) for ETS-8. There are four modem ports. Those ports are connected two feeder link channels, and two mobile links. Modulation is coherent detection. Information rate is 512 kbps with FEC and 1024 kbps without FEC. MPU is 32 bit RISC/20 M Bites. Main memory is 128 M Bites ECC coded.

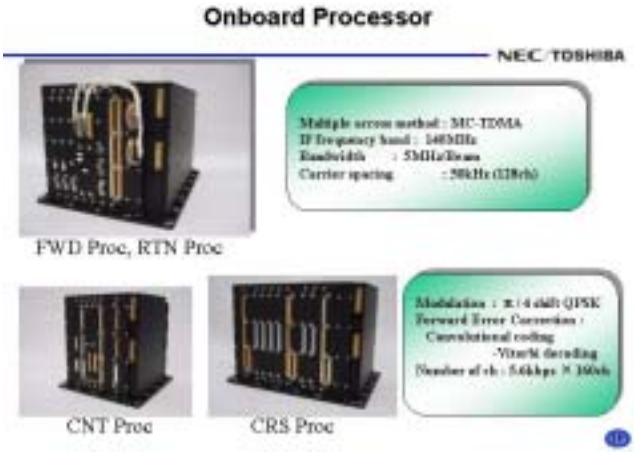


Figure-7 ETS-8 OPS H/W

The Figure-9 graphs show Bit performance and Burst wave spectrum of OPS. As shown in these charts, OPS of ETS-8 were achieved low degradation, wide capture range and large side lobe suppression and low spurious.

The Figure-10's pictures are shown the actual overviews of each processors.

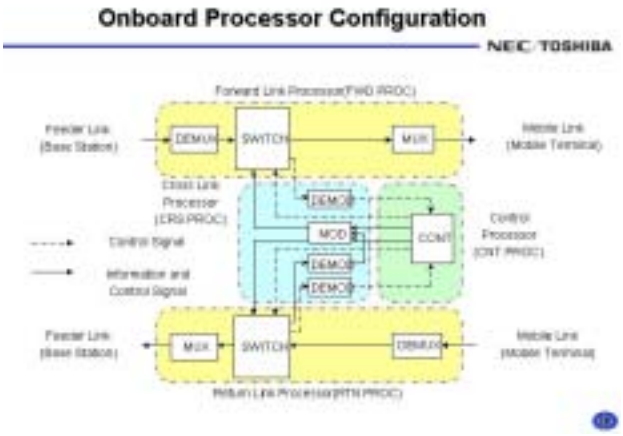


Figure-8 ETS-8 OPS Configuration

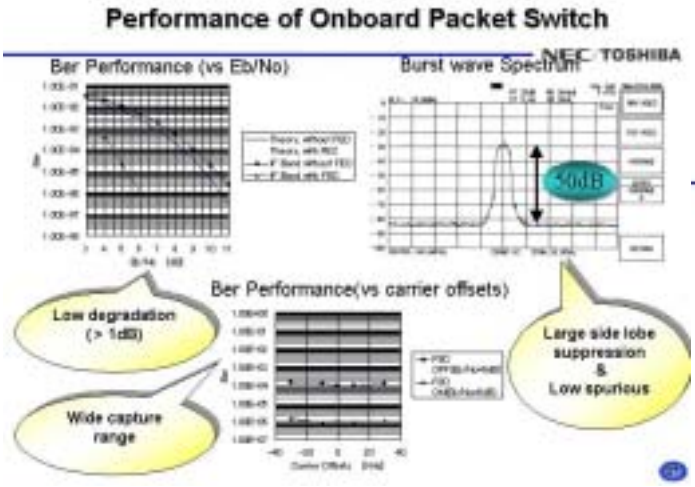


Figure-9 COMETS OPS Performance

Figure-10 ETS-8 OBP

We are now developing ATM switch for High rate Internet satellite. We developed four kinds G/As.

The Figure-11's picture shows BBM ATM switch matrix circuits. ATM switch capacity is 622Mbps and 2.5G bps max. There are 3-input and 3-output lines. Each line handles 155M bps/line.

The Figure-12 shows Demodulator for ATM System. Digital technology in ground terrestrial system is rapid development, and that technology is adapted to space.

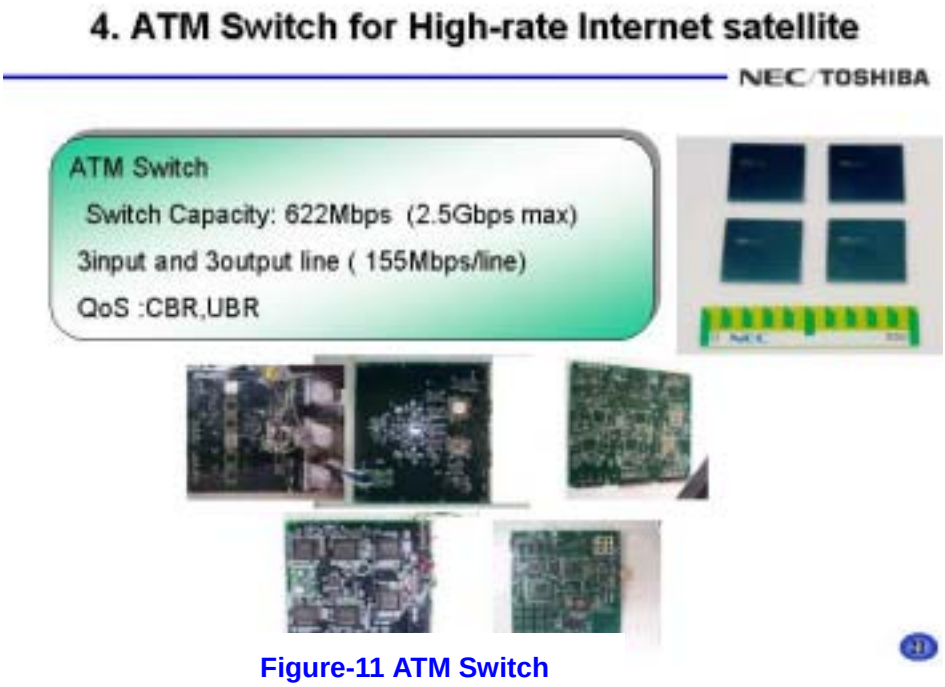


Figure-11 ATM Switch

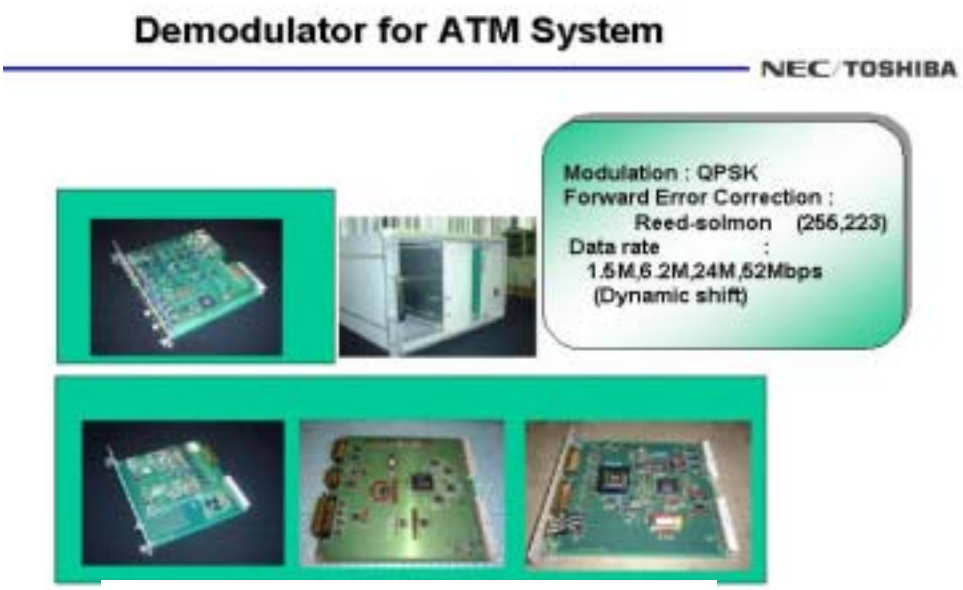


Figure-12 Demodulator for ATM System

The core technologies for ATM Switch a is summarized in the Figure-13

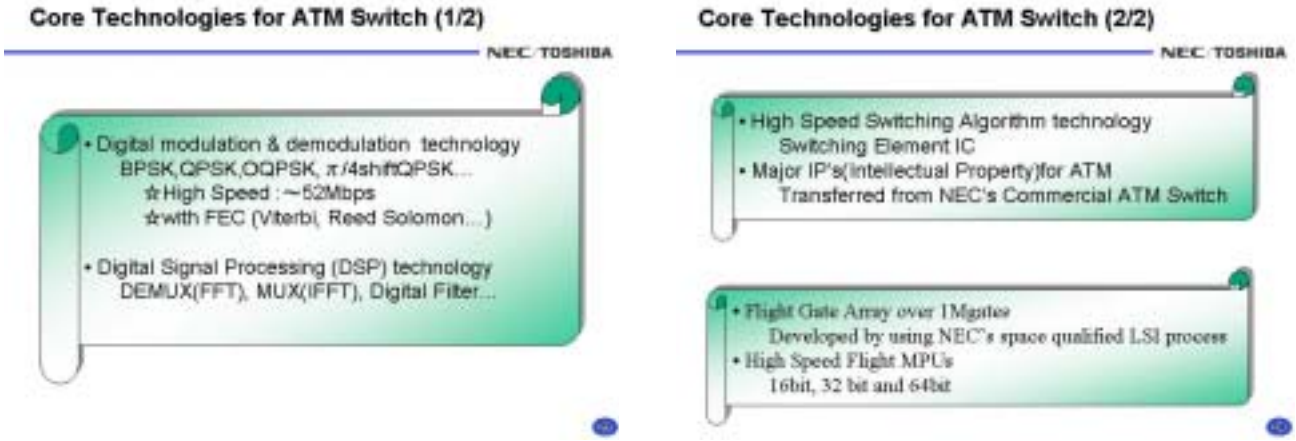


Figure-13 Core Technologies for ATM Switch

The Figure-14 shows a service image of the Multimedia satellite system. Our final target is to utilize the satellite for several kinds of medias for Dual Directional communication, Multicasting, Multi-channel Broadcasting, so-called Information technology. Those key technologies are OBP, OPS and ATM. This paper introduced NT Space development trends of the On-board processing system for Multi-media satellite communication systems for 21st century.

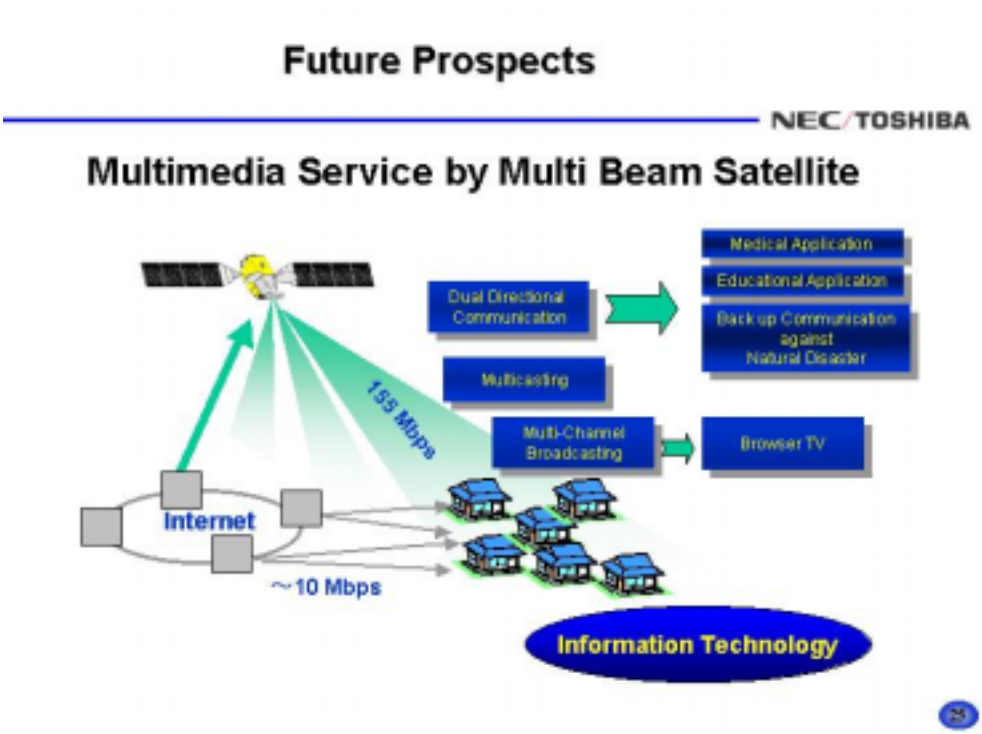


Figure-14 Core Technologies for ATM Switch