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# BSP and ISP; the Internet and Synchronous TDMA DSB Network

## - New Applications based on the Integration of Communication and Broadcasting-

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**Abstract**

A new business method called Broadcast Service Provider (BSP) is proposed. The BSP is significantly different from the conventional Broadcasters in the following points. The Broadcasters own both the broadcasting systems and the broadcast contents. The BSP providers own only the broadcast systems which they provide for the general public for broadcasting services. Thus the function of the BSP is very similar to that of ISP (Internet Service Provider) in the Internet.

The separation of the provision of the broadcast system and the contents was introduced at the advent of the satellite broadcasting around the turn of the centuries. In Japanese CS broadcast system, for example, the contents providers and the broadcast system providers are separated. At present about 200 TV and audio broadcasting channels are provided through CS transponders provided by JSAT.

The BSP proposed herein extends the ranges of the contents providers from hundreds to millions as it provides the broadcasting services for the general public. Typical broadcast type applications include direct nationwide advertisement by local industries, public relations (PR) announcements by local governments, NPO and other organizations.

The BSP and ISP can combine their systems to provide the Internet with full multicast or broadcast capability for their Internet users or two-way interactive nationwide broadcast network for their broadcast subscribers. This is a true integration of the Internet and nationwide broadcasting network and can provide effective conference type services to the general public. Conventionally users of the satellite teleconferences have been limited to big companies or governments with many branch offices over wide areas. For the Internet users the web conference is quite useful but the number and location of participants is very limited. The combined BSP and ISP can provide the nationwide teleconferences to the general public regardless of the locations and numbers of the participants.

The synchronous TDMA DSB network plays an important role for the creation of BSP industry. Up until today the wide area broadcasting has been limited to a small number of service providers in most countries. In some countries the broadcasting are under strict control of the governments. This highly centralized structure of broadcasting is apparently unsuitable for the highly distributed and independent nature of the BSP. The synchronous TDMA enables direct transmission of DSB signals from multiple sites anywhere and reception of the signals with conventional DSB receivers everywhere under the coverage of the satellites. Thus it is very effective to realize the distributed structure of the broadcasters all over the countries. Those local broadcasters may grow to be BSP by providing the nationwide DSB network for the local industries, governments and the general public.

**Keyword**

DSB; Direct Satellite Broadcasting, BSP; Broadcast Service Provider, ISP; Internet Service Provider, TDMA; Time Division Multiple Access, VSAT ;Very Small Aperture Terminal, WAN; Wide Area Network, LAN; Local Area Network, CS; Communication Satellite

### 1. Introduction

Integration of communication and broadcasting has been a keyword in IT industry for many years. One of the key services for promotion of optical fiber to the home (FTTH) access lines is delivery of movies and live broadcasting. However, the delivery of broadband contents through the Internet can never be broadcasting in its strict definition. The Internet is inherently one-to-one communication and the information is transmitted through step by step transfer of the data packets from a router to the next forming the wide area network (WAN). The time delays, wanders and jitters through the inter-router packet transfer makes real time, synchronous data transfer difficult. The multicast in the Internet requires implementation of additional protocols such as IGMP, which not all ISP are willing to implement. The simultaneous number of the receivers of the broadband contents through the Internet is always limited unless more complex Contents Delivery Networks (CDN) are used.

On the other hand, the Direct Satellite Broadcasting (DSB) can conduct nationwide broadcasting through the satellite with only one hop repetition. However, the DSB markets came to saturation well before reach of the expected markets. Also the integration of DSB networks into the Internet as user access links (DSB Internet) did not really take off as the terrestrial broadband networks grew so rapidly. The author has conducted a study and pointed out some causes of the problems and suggested some possible solutions in previous reports [1], [2].

The fundamental problem with the DSB lies, in my opinion, in the very centralized structure of DSB networks in many countries. In Japan not only the transmit earth stations exist only in Tokyo area, but also the provision of DSB links is monopolized by a company (SkyPerfecTV). There is no direct access from other parts of Japan for the satellite broadcasting. This monopoly and centralized structure of CS broadcasting network tends to impoverish the broadcast contents hence the market has come to a premature saturation.

The Synchronous TDMA applied to CS broadcasting allows direct transmission with VSAT from anywhere and reception of the signals with conventional DSB receivers existing everywhere under the coverage of Communication Satellites (CS). Thus new, fresh and more versatile contents from remote areas can be directly delivered for the CS DSB

subscribers all over Japan. The Synchronized TDMA DSB will give a means for direct nationwide advertisement for the local industries, public relations (PR) announcements for the local governments, NPO, NGO and other organizations. The local broadcasters can expand their coverage areas from local to nationwide scales. Thus the proposed DSB can realize a highly distributed broadcasting network consisted of many local broadcasters for the nationwide broadcasting services. The system will then give new business opportunities for the local industries, local governments, NPO, community organizations and he local broadcasters themselves. Indeed, the local broadcasters will grow to be BSP who provide access to the broadcast network for the above mentioned users.

The growth of local broadcasters to BSP will become complete by the joint effort of BSP and ISP. Then the Internet will be integrated with the DSB network. They can provide the Internet users with a truly real time and synchronous broadcasting or multicasting functions. They can also provide the DSB subscribers with a truly two-way and interactive broadcasting network. A typical application is satellite conferences to which the participants can join even from their homes through the Internet and the DSB networks. For example a nationwide town meeting can be made quite easily. Every participant all over the country can listen to the speaker anywhere accessible through the Internet and the DSB networks. By definition it is nothing but a LAN, hence the author proposes to call it the Direct Satellite LAN (DS-LAN).

The DS-LAN can create new applications for everyone under the coverage of the satellites and will help to solve many problems facing us today as described in the following sections.

## 2. Synchronous TDMA DSB network

### 2.1 Overview of the system

In the Time Division Multiple Access system, one station designated as the reference station transmits its burst signal (Reference Burst) once every Frame period (Figure 2-1). In this proposal, the Frame period is 30 ms, which is the frame frequency of TV pictures. Other stations transmit their bursts to the time position designated to them by a pre-determined TDMA Burst Time Plan. Thus the bursts signals from all the Broadcasting Earth Stations are combined on the satellite. The bursts signals from the Broadcast Stations are timing controlled to avoid collision on the satellite. In Synchronous TDMA, the timing control is made by a satellite loop phase lock technique (Figure 2-2). Each Broadcasting Station receives the combined signal from the satellite, recovers the timing (clock) signal from the Reference burst, and compares its own timing difference against the Reference clock by a phase comparator, and the detected phase error signal controls the voltage controlled oscillator which generates its transmit timing (clock). Thus each Broadcasting Earth Station conducts a satellite loop phase lock control of its signal timing against the reference bursts. In Japan the system was put into practice about twenty years ago. A very accurate phase lock performance was achieved. For more details, see Ref [3].

As the downlink TDMA bursts are completely synchronized, the signals look just as if transmitted from the same station. Therefore it can be received by existing DSB receivers.

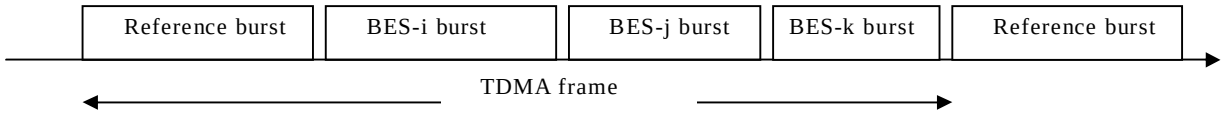


Figure 2-1 TDMA frame structure

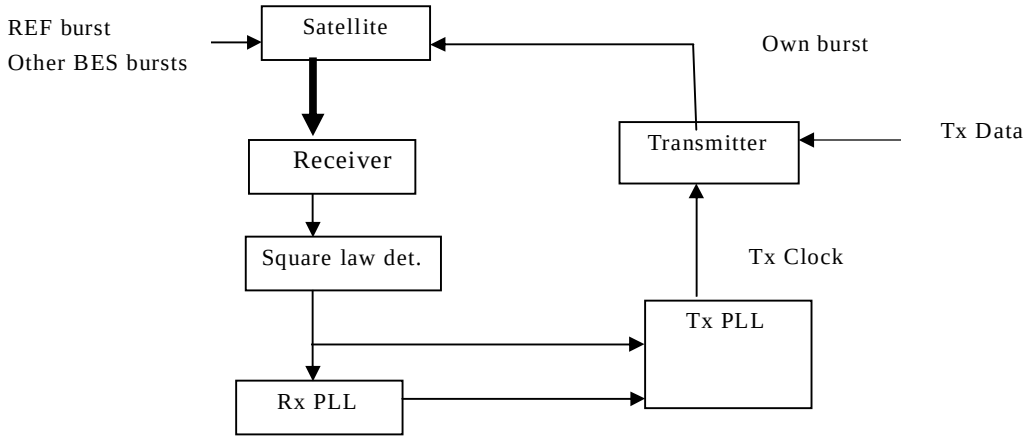


Figure 2-2 Structure of Clock Synchronization System

**2.2. TDMA Frame structure** (for JCSAT-4 class satellite)

[1] Frame period - 30 (ms) ; Frame frequency of TV ; 29.97 Hz

[2] Modulation rates ; 42.192Mbps

[3] Information rates (Mbps) ; 19.4 (1/2), 25.9 (2/3), 29.2 (3/4), 32.4 (5/6), 34.0 (7/8) (Punkture Ratio )

[4] Multiplex method

(1) A number N of TS packets (188 bytes) form a burst. N is allocated to the BES by the system.

(2) The Reed-Solomon coding is applied based on DVB-S specification to form 204-byte TS packets.

(3) TS packet length = 204 x 4/3 (puncture rate) = 272 (bytes) = 2176 (bits)

(4) The burst is composed of multiples of 8 packets; processing unit for FEC puncturing and randomization

(5) Example TDMA frame

Number of packets per frame ; 648 (1,410,048 bits)

Frame frequency ; 42.192 (MHz) / Number of bits = 29.92 (Hz)

(6) Typically N= 5 stations in TDMA. The average burst length is 130 TS packets.

**2.3 Earth Stations and User Terminals**

A link power budget [1] for JSAT-4 satellite enables the following sizes of the ES and UT (user terminal)

Broadcasting Station (BS); - Antenna with 1.2m diameter

- Clear sky transmit power ; 20 (Watts)

User Terminal (UT) - Conventional DSB receiver (G/T= 10 dB/k)

Thus a direct live broadcasting from remote sites by SNG (satellite news gathering) vehicles will be also possible.

**3. Direct Satellite LAN (DS-LAN)**

The BSP and the ISP can combine the Internet and the DSB network as depicted in the following figure.

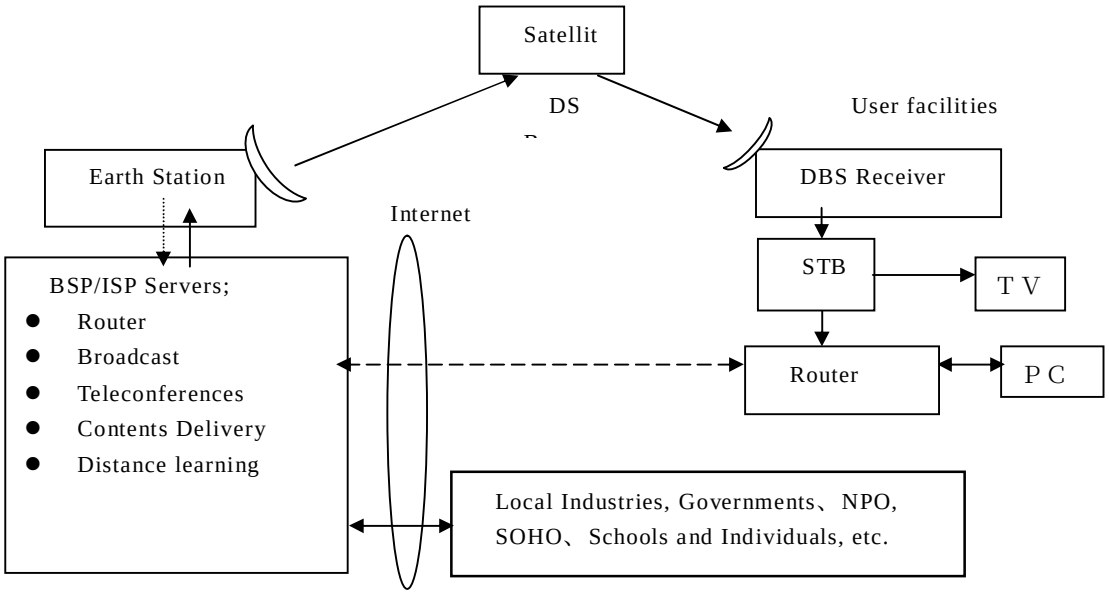


Figure 3-1 System Architecture of Direct Satellite Local Area Network (DS-LAN)

The BSP provides the DSB network including the Earth Station. The ISP provides the Internet services for the general public and the contents providers. The joint BSP/ISP provides the DS-LAN servers which are accessible from both the Internet and the DSB network.

The DS-LAN servers provide value added services including the following;

a. Broadcast server

This server is used to provide the DSB service including the conventional TV broadcasting and the Internet broadcasting. The Internet broadcast is delivered to the user PC through the STB (Set Top Box). The Internet Broadcast through the DSB network is effective to provide far more channels as the data rates can be much reduced and processed in the PC. For example instead of one standard quality TV (3Mbps), ten times more channels can be provided with slow moving pictures (300kbps).

b. Tele-Conference server

Provides a teleconference where the speaker can speak through the Internet and every participant can listen through the DSB network. This is a true integration of communication and broadcasting and can provide such communications as nationwide town meeting which have been even unimaginable.

c. Contents Delivery Server

This server can provide delivery of contents to a group of users in an instantaneous mode or in reservation mode. The instantaneous mode is the same as satellite multicasting. The reservation mode is made as follows. The server consists of two parts; Contents Library and Delivery Controller. The users search the Contents Library for their wanted contents. If a material is selected by a user, the Delivery Controller notifies the user about the time of the delivery, contents identification code, scrambling key, etc. necessary for reception of the data through the DSB network. The reservation process accumulates the number of receivers by the actual delivery time to make the best use of the wide area simulcast nature of the satellite communication.

d. Distance Learning

With the above functions, the DS-LAN provides an ideal means for distance learning. The education materials can be distributed in advance through the contents delivery service, and interactive lesson can be made through the tele-conference for a large number of participants regardless of their locations.

e. Router

This provides the users in the remote areas with the Internet access through DSB links. It is the satellite Internet in its narrow sense. Because of its low volume, it did not much grow in the past but it will become viable combined with the other services and provide valuable service for the users in remote areas.

## 4. Steps to BSP

**Step 1. Consortium of Synchronous TDMA DSB Broadcasters**

The local broadcasters form a consortium. The consortium rents a transponder from a DSB satellite provider. The consortium provides a new broadcasting service for the existing DSB subscribers through the transponder. A transponder has a capacity of about 30Mbps, or up to ten TV channels. The members of the consortium share the transponder in a reservation mode; the future broadcast program is shared by the consortium members for reservation. The present broadcast program is open to the DSB subscribers just as done today. The Consortium members directly broadcast from their facility according to the broadcast program in the Synchronous TDMA DSB mode. The local broadcasters thus can expand their broadcast areas from local to national scales. This will not only disseminate new, versatile and direct information from all over the country but also provide a nationwide advertisement channel for the local industries and communities.

**Step 2. Growth to BSP**

The consortium members can offer their DSB system for the local industries, governments, organizations, communities and even individuals for the nationwide broadcasting. The local industries can then promote their products in much more details than by advertisement. Other community organizations can promote their areas and activities much more effectively through the broadcasting network.

**Step 3. DS-LAN by BSP/ISP**

The local BSP and ISP can build the DS-LAN by their joint effort and provide those integrated services of communication and broadcasting as described in the previous section.

## 5. Business Scenarios for the Steps to BSP

An example of business scenario is now studied. In Japan, there are about 120 local broadcasters serving each local area of about the size of a prefecture. Those local stations broadcast their original contents only 10 to 20% of the total broadcast time. The majority of the broadcast contents are provided by nationwide broadcasters called Key Stations. Thus division of provision of the broadcast systems and contents already exists between the Local and Key stations. The

Local stations now suffer from the great financial burden required for digitalization of their broadcast systems. Also excessive dependence on the Key stations for the broadcast contents needs to be amended to maintain independent and impartial position as a mass media. The proposed system can solve those problems.

**Step 1 Business Scenario**

Let us assume about 50 Local stations form the consortium. The consortium rents a transponder from JSAT on a long term basis. The annual rent is about US$ 5 millions, the average cost for a member station is US$ 100 thousands. It is said that each Local station needs to spend about US$ 50 millions for digitalization of her local broadcast system. Luckily the terrestrial digital broadcasting and DSB systems adopt the same MPEG-2 specifications. The only differences are in the radio transmission parts of the systems. The DSB earth station can be a VSAT already mass produced for many years. Therefore the additional cost for the DSB earth station is negligible compared with the total digitalization cost, and the benefit is quite significant; the service area can be instantly expanded from prefecture to nationwide scales.

The annual rent of the satellite transponder is $5million, which is $13,700 per day, which is $570 per hour. The transponder can support up to ten TV channels. If we assume 6 TV channels are simultaneously broadcast on the average, the satellite usage cost for each TV channel is about $100 per hour. On the other hand each member station can use 6/50 DSB TV channel, or about 3 hours a day. The member station can broadcast some of their local contents or additional special contents through the DSB network. The local industries can then sponsor those programs and broadcast advertisement for the wide area market.

**Step 2 Business Scenario**

The consortium members can provide their DSB system to the local users for nationwide broadcasting. The local industries can promote their products by promotion programs instead of advertisement. The local government can broadcast public relations announcements, e.g. local news, introduction of the local area and her history and thus promote their sight seeing industry. NPO and other groups and even individuals can utilize the DSB network for promotion of their activities.

Thus the DSB consortium member will naturally evolve to BSP. In a sense it is an expansion of the contents provider from the Key stations to the local industries, governments and the general public. If the BSP can offer the TV channel to her users for $300 per hour, she can gain $200 coarse profit per hour. The end user cost of $300 per hour for nationwide TV broadcasting seems to me sufficiently competitive against any other media.

**Step 3 Business Scenario**

Once step 2 is achieved, the evolution to step 3 will be straight forward. The ISP and other Internet service providers such as ASP and CDN will naturally promote joint effort to build DS-LAN. For example, the ASP can expand their teleconferences services both in geography and sizes of the conferences. The Contents Delivery Network (CDN) providers can skip the long distance links and complex multicast processing to disseminate the contents to the cache servers close to their end users. A direct delivery of the Internet broadcast to the end users is also possible. The Internet is WAN (wide area network). The ISP together with the BSP can add a single LAN which has geographically wide area coverage to form the DS-LAN.

## 6. Global trends

The system and application proposed in this paper is unknown even among IT industries. However, there are some global trends that support the concepts.

### 6.1 SkyPlex

This is a DSB network operated by ESA providing direct broadcasting from many European countries for all over Europe. In Europe there are many countries with many different languages. With the political integration of European countries into EU (European Union), the distributed, independent and direct DSB network covering the whole Europe became essential. ESA (European Satellite Agency) developed Skyplex just to meet the demand. There are now 12 systems in operation. Some description is quoted from ESA HP.

For more details please visit; http://www.esa.int/esaCP/SEM6YM2PGQD_index_0.html ;

SkyPlex is a payload designed for onboard digital multiplexing. The multiplexing facility provides much more flexibility and lower operating costs because broadcasters can uplink services directly. SkyPlex can receive video, audio and data uplink signals from several different geographic locations and multiplex them into a single DVB downlink signal.

Applications include single digital TV programme broadcasting, digital radio broadcasting, interactive multimedia services and Internet connectivity.

The SkyPlex payload also offers a wide area coverage for broadcasters with instant access to a very large installed base of DVB (digital video broadcasting) receivers. Regional, local and

thematic broadcasters can therefore benefit from easy and direct satellite access into millions of homes.

A simple 90 cm, 2 watt antenna is enough to "board" the satellite. Users have their own receiving/transmitting antenna, as small as today's ones for satellite television, mounted on the roof of their home.
;

The Skyplex allows a very small broadcast station by signal demodulation/regeneration and conversion to standard DSB format functions on board the SkyPlex satellite. It is very useful but very specialized satellites are required. The Synchronous TDMA DSB requires no such on-board processing, hence applicable to any DSB networks in the world.

**6.2 Public Access for Broadcasting Network**

In Korea, Germany and some other countries, t is regulated that the public broadcasting corporations give certain ratio of their broadcast time for the programs produced by the general public. In Japan, some of the community broadcast networks open their networks for the citizens in the community. Also NHK gives some programs open to the public. The open programs "Japan for the future" have participants at the studios and from all over Japan through telecommunication networks. The programs have provided valuable opportunities for the nation to participate in the candid and direct discussions on various selected topics.

Those examples of public access to the broadcasting network show a global and fundamental trend for the future.

**7. Conclusion**

The BSP proposed in this paper will open new markets for the broadcasting. The local broadcasters can expand their broadcast areas from local to national scales by Synchronous TDMA DSB network. It will give the local industries, governments and communities for nationwide promotion of their business and Public Relations. The broadcasters grow to BSP by opening the broadcast system to the general public. It will strengthen the position of the local broadcasters as they become less dependent on Key stations for the broadcast contents. The BSP and ISP can together build a true integration of the Internet and DSB which is called DS-LAN. A typical application of DS-LAN is nationwide town meeting which has been even unimaginable. The DS-LAN enhances the conventional Internet and DSB services and can develop many new applications.

The BSP offers public access to the general public. This will enlarge the sources of information by many times. Great varieties of information will flow all over the country. This broadened information basis will be essential for the promotion of local industries and well balanced development of the countries. Unlike the Internet the public access will maintain the quality of the information as the sources of the broadcast are clear and the contents can be watched by all the spectators and participants. Through the history, the mass media have been occupied by the governments or small numbers of powerful groups in the society. The general public can gain the full public access for the first time by BSP. This historical evolution will strengthen the democracy as well as promote new industry in the 21 century.

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