SATELLITE AND SPACE COMMUNICATIONS **SSC**
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IEEE COMMUNICATIONS SOCIETY

SSC Newsletter **Vol. 23, No. 1, June 2013**

CONTENTS

The Satellite and Space Communications (SSC) Committee is a volunteer group actively involved in advancing satellite and space communication technologies within the IEEE. This committee is approved by the IEEE Communications Society and is governed by the constitution and bylaws of the IEEE as well as the other twenty-three Technical Committees in the Society. The committee belongs to the Technical Committee Clusters of Communication/Signal Processing (C/SP).

SATELLITE & SPACE

- JOIN US -

All conference attendees are welcome to join us in the SSC Committee meeting.

Location: Vaszary - Sofitel Hotel
Date: Mon 10th June, 2013
Time: 12:30 – 14:00

Future SSC Meetings
Dec. 2013, Atlanta, USA
June 2014, Sydney, Australia
Dec. 2014, Austin, TX, USA

ICC2013 SSC Committee Activities:

Symposium on Selected Areas in Communications:

- *Tuesday, 11 June 2013 • 16:00 – 18:00*
  Location: Duna Salon I

SA-SSC-01 Satellite and Space Communications 1
Chair: Dr. Igor Bisio, University of Genoa, Italy

- *Wednesday, 12 June 2013 • 16:00– 18:00*
  Location: Lanchid A

SAC-SSC-02 Satellite and Space Communications 2
Chair:

HOW TO JOIN SSC COMMITTEE AND MAILING LIST

If you like to join SSC Technical Committee: Please send your name and e-mail address to the SSC Secretary, optionally include your mail address, telephone and fax numbers.
If you like to join SSC Mailing List: Instructions on how to subscribe/unsubscribe are available at http://lists.scnl.dist.unige.it/listinfo/ssc/.

SSC COMMITTEE OFFICERS

MESSAGE FROM THE CHAIR

Prof. Igor Bisio

The Satellite and Space Communications (SSC) Technical Committee (TC) members will meet again on Monday 10 June 2013, at 12:30 in Budapest during IEEE ICC2013.

In my first message, I shared some ideas about possible actions, discussed with the Officers and during the last SSC meeting held in Anaheim, where took place IEEE GC2012, last December. The ideas and the consequence actions are aimed at reaching very important goals such as the publication of the SSC related research in prestigious journals and magazines, the organization and sponsorship of Symposia, conferences and workshops.

With the occasion of this message I would like to propose a sort of updating of

the actions carried out and the obtained results. I think that it constitute a "canvas" for a further fruitful discussion during the meeting among the members.

In more detail, about *Policies and Procedures (P&P)* we confirm that the SSC TC has P&P coherent with the IEEE ComSoc rules. Actually, the study of possible modifications of the current P&P is ongoing. Anyway, possible upgrading of the last version, released in 1999, will be proposed. In particular, voting procedures could be definitively fixed for example by using the recent on-line tools now made available by the IEEE and a Standard Liaison has to be nominated by following the *Technical Activity Committee* (TAC) requirements.

Concerning *Membership Management*, we can confirm that SSC TC has a good number of members but, recently, a very limited number of researchers asked to be member of our Committee. This reinforce the need to persevere with the action of involving old and new members in the TC activities (as Symposium Chairs, Guest Editors, etc.). Several initiatives in this sense have been proposed through the SSC mailing-list: *i)* after a "Call for Volunteers" and the related selection, were set up two work-groups that are working on two very important editorial proposals (more detail is reported below); *ii)* a "Call for Webminar Speaker" has been proposed as well as *iii)* a "Call for IEEE Distinguished Lecturers". Unfortunately, the proposals *i)* and *ii)* have not received any feedback. I do hope that with the occasion of the next meeting, interest Colleagues can join the mentioned prestigious initiatives. Finally, *iv)* several candidatures for the role of Symposium Co-Chair have been proposed to the ICC/GC organizing committees by involving several members of the TC (particulars have been reported below).

As discussed in the last message, the nature of the SSC TC allows significantly extending the cooperation with Industries, Research Institutes, Standardization Institutes (e.g., CCSDS, ETSI), Space Agencies (such as NASA, JAXA, ESA) and other Societies such the IEEE Aerospace & Electronic Systems Society, the IEEE Signal Processing Society and the AIAA and other similar societies. It deals with the *Extended Cooperation* and the aforementioned initiatives are totally coherent with the recalled need: the work-groups related to the two parallel editorial initiatives are with Academia, Industries, Research Institutes and Space Agencies of several World regions.

It also represents a first step towards a concrete proposal of *Review of the Advisory Committee* that will be reconsidered also coherently with the envisaged P&P review and modifications.

Concerning the *SSC Website and Mailing List*, it has been agreed that the SSC web site needed a partial revision by reporting only essential information. The Secretary Dr. Tomaso de Cola has evaluated, proposed and implemented several modifications. I want to deeply thank the Secretary for this precious contribution.

As mentioned above an intense work has been done to develop the activity about *Journals/Magazines*. In more detail, as previously said a "Call for Volunteers" has been sent to all members by employing the SSC mailing-list. The request concerned a possible future Special Issue of the IEEE Journal of Selected Areas in Communications (JSAC) about satellite communications and networking. Given the large number of expressions of interest received by the SSC community, it was eventually proposed to work on two special issue proposals: one in IEEE Communications Magazine (COMMAG) and one in the IEEE JSAC as originally

planned. This opportunity has been already discussed with the Editors in Chief of both the journals and we received positive answers about the interest for a SSC related special issue. As a consequence, starting from the received candidatures two work-groups have started their work to prepare and submit the mentioned Special Issue proposals to the JSAC and COMMAG Editorial Boards. The work-groups are composed by Kul Bahsin (NASA, USA), Naoto Kadowaki (NICT, Japan), Fred Vong (AsiaSat, China) and Claudio Sacchi (University of Trento, Italy) in the case of the COMMAG initiative and by Nei Kato (Tohoku University, Japan), Sandro Scalise (German Aerospace Center, Germany), Frederik Simoens (Newtech, Belgium), Alessandro Vanelli-Coralli (University of Bologna, Italy) in the case of the JSAC. Prof. Sacchi and Prof. Vanelli-Coralli are leading the two teams. I want to thoroughly thank the teams: their work represents a fundamental milestone for the overall SSC TC.

A satisfactory level of involvement has been reached also in terms of *IEEE ICC/GC Symposia* representatives of our TC. As suggested by our Past Chair Prof. Nei Kato during the last meeting, the SSC TC has been encouraged by the GITC to propose Symposium Co-Chairs for several Symposia and not only a representative for the SAC Symposium. Following this encouragement, for IEEE ICC2015, whose organization is beginning, the TC Officers team has proposed the nomination of Dr. Chonggang Wang (InterDigital Communications, USA) as Symposium Co-Chair of the Wireless Networking Symposium, Prof. Takaya Yamazato (Nagoya University, Japan) as Symposium Co-Chair of the Wireless Communications Symposium, Dr. Tomaso de Cola (German Aerospace Center, Germany) as Symposium Co-Chair of the SAC Symposium (SSC Track).

Concerning this activity, being the TC representative, I take the opportunity of this column to report the SSC Track submission statistics of IEEE GC2013. Actually, the number of submissions is quite limited with respect to previous SSC tracks. The SAC Symposium received 328 submissions and concerning each single track the submissions are: Access Networks and Systems Track 30 (9%), Data Storage Track 17 (5%), e-Health Track 28 (8.5%), Game Theory for Communications Track 39 (12%), Green Communication Systems and Networks Track 92 (28%), Internet of Thing Track 37 (11.5%), Power Line Communications Track 16 (5%), Satellite and Space Communications Track 29 (9%) and Social Networks 40 (12%). From the reported percentages, the track with higher number of submissions are the Green Communication Systems and Networks and Social Networks tracks, which deal with very fashionable topics.

As usual the *SSC Newsletter* has been prepared. It has been edited by our Vice-Chair Dr. Hiromitsu Wakana that I want to deeply thank. As discussed in Anaheim, starting from this meeting the Newsletter is managed electronically. It will be sent to all members before the meeting and few printouts will be distributed to the TC meeting attendants and in the IEEE ICC 2013 Exhibition Area.

Finally, I want to remember the SSC Award initiative. As usual the deadline for nominations is 15th August, 2013.

Prof. Igor Bisio, Chair
Satellite and Space Communications TC

SCANNING THE WORLD

Dr. Hiromitsu Wakana

This article introduces some topics of recent R&D of satellite communications as well as new products and services. Here, I would like to describe an activity of Japan's satellite communications R&D after the Great East Japan Earthquake on March 11, 2011, which was the triple disaster of giant earthquake, huge tsunami waves and Fukushima nuclear plant failure. Especially, in coastal areas, the tsunami destroyed away most infrastructures of telecommunication network as well as roads, railways, and power lines; about 29,000 base stations of mobile communications and 1.9 million lines of fixed-line communication stopped working. Since mobile phone calls jumped up to 50 - 60 times, telecommunication service providers suppressed 70-95% of voice calls. In spite of such traffic suppression, emergency communications links among local governments, emergency services, fire departments, hospitals and lifeline companies were not available, and appropriate initial rescue activities could not be conducted.

What we learned from the Earthquake, in terms of telecommunications, is i) telecommunications networks have become critical infrastructure for our daily lives; ii) the current telecommunication network is not sufficiently robust against large-scale natural disasters. Since March in 2012, a Japan's national R&D project aiming to establish "resilient ICT" networks and technologies under collaboration with industry, academia and government, has been carried out. Two main themes are technologies for reducing the incidence of mobile-telephony congestion during disasters and for autonomous recovery of disaster-damaged infrastructure.

In terms of satellite communications, satellite communication services supported lifesaving and relief activities, even when fixed telephone and mobile phone were not available. VSAT systems ensured voice communications, entrance networks of mobile phone, temporary telephone booth, and access networks to the Internet. Earthquake early warning signals were transmitted to the public and local governments using "J-ALERT" system operated by Local Authorities Satellite Communications (LASCOM). Since installing VSAT requires a skilled engineer, it is difficult to install it in a required place immediately after an unexpected natural disaster. Especially a Ku-band VSAT with a linearly polarized feed requires not only an antenna pointing but also an adjustment of the polarization plane.

In this project, SkyPerfect JSAT has developed a Ku-band small-size and light-weight (40kg) VSAT, which is equipped with automatic satellite-capture and -tracking functions as well as an automatically operated uplink access test capability.

The National Institute of Information and Communications Technology (NICT) has also developed a Ka-band VSAT, which has an automatic operation function, with a 1m-diameter antenna, and 51 Mbps/155 Mbps for uplink/downlink. Moreover, they have developed an earth station for mobile vehicles with a 65cm-diameter reflector antenna, 3-axis gimbal satellite tracking function (0.2 degrees accuracy), and 51/155Mbps for uplink/downlink. On a moving vehicle, high definition images such as those observed at disaster areas and high capacity data can be transmitted and received, even where communication links are not available. The NICT, moreover, has developed earth stations installed on an airplane, a helicopter and a vessel in Ku band or Ka band. Broadband mobile satellite communications will play more important role in future disaster monitoring and management systems.

Dr. Hiromitsu Wakana, Vice Chair
Satellite and Space Communications TC

FORTHCOMING GLOBECOM AND ICC CONFERENCES

MILCOM 2013

November 17-20, 2013, San Diego, CA, USA

http://www.milcom.org/

MILCOM 2013 is soliciting unclassified and classified (DoD Secret) technical papers and proposals for tutorials and panels on current topics of interest applicable to military communications networking, timing, services, and applications. Professionals in industry, academia, and government worldwide are encouraged to contribute and participate. Technical tracks will include waveforms and signal processing, networking protocols and performance, cyber security and trusted computing, system perspectives, services and applications, selected topics in communications, international perspectives on communications and more.

GLOBECOM 2013

December 9-13, 2013, Atlanta, GA, USA

http://www.ieee-globecom.org/2013/

The IEEE GLOBECOM 2013 will feature a comprehensive technical program including 13 technical symposia and a number of tutorials and workshops. IEEE GLOBECOM 2013 will also include an attractive industrial and forum program featuring keynote speakers, various business, technology and industry fora, and vendor exhibits. Prospective authors are invited to submit original technical papers for presentation at the conference and publication in the proceedings. Proposals for tutorials and workshops are also invited. Visit the IEEE GLOBECOM 2013 website, http://www.ieee-globecom.org/2013, for details and submission information. Deadline of paper submissions is 15 March 2013.

COSPONSORING / RELATED CONFERENCES AND WORKSHOPS

ICC 2014

June 10-14, 2014, Sydney, Australia

http://www.ieee-icc.org/2014/

The 2014 IEEE International Conference on Communications (ICC) will be held in the beautiful city of Sydney, Australia from 10-14 June 2014. Themed "Communications: The Centrepoint of the Digital Economy," this flagship conference of IEEE Communications Society will feature a comprehensive technical program including twelve Symposia and a number of Tutorials and Workshops. IEEE ICC 2014 will also include an exceptional expo program including keynote speakers and Industry Forum & Exhibition.

CONFERENCES CALENDAR

CONFERENCE	DATE & LOCATION	INFORMATION
International Conference on Localization and GNSS	June 25-27, 2013 Torino, Italy	http://www.icl-gnss.org/2013/
SPECTS 2013 International Symposium on Performance Evaluation of Computer and Telecommunication Systems	July 7-10, 2013 Toronto, Canada	http://atc.udg.edu/SPECTS2013/
19th **Ka and Broadband** Communications Navigation and Earth Observation Conference 2013/31st AIAA International Communications Satellite Systems Conference (**ICSSC**)	Oct. 14-17, 2013 Florence, Italy	http://www.kaconf.org/
ITST-2013 12th International Conference on Telecommunications for Intelligent Transport Systems	Oct. 16-18, 2013 Tampere, Finland	http://www.itst2013.org/
IEEE Aerospace Conference	Mar. 1-7, 2014 Yellow Stone Conference Center in Big Sky, Montana, USA	http://www.aeroconf.org/
WCNC 2014 IEEE Wireless Communications and Networking Conference	Apr. 6-9, 2014 Istanbul, Turkey	http://wcnc2014.ieee-wcnc.org/
CITS 2014 International Conference on Computer, Information and Telecommunication Systems	Jul. 10-11, 2014 Jeju Island, South Korea	http://atc.udg.edu/CITS2014/
ASMS/SPSC2014 7th Advanced Satellite Multimedia Systems Conference & 13th Signal Processing for Space Communications Workshop	TBD Livorno, Italy	http://www.asms2014.org/

To all SSC members: If your postal address, telephone or fax numbers have changed, please update them with the committee secretary. You can review our current records on our web page at http://committees.comsoc.org/ssc/.

PERSPECTIVE ARTICLE June 2013

Satellite Communication Networks Valid for Disaster Recovery

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Abstract — **As a result of the great east Japan earthquake, terrestrial communication infrastructure was seriously damaged. Thus the importance of secure satellite communication measures based on very small aperture antenna terminal (VSAT) systems has been recognized. In order to satisfy the various demands for urgent life line recovery, we have started an R&D project of "Satellite Communication Networks Valid for Disaster Recovery" as the next generation VSAT system supported by the Ministry of Internal Affairs and Communications of Japan. This project contains following three research topics. (1) multi-mode VSAT's based on software defined radio (SDR) technology, (2) low power consumption VSAT's and (3) emergency mode adaptive bandwidth control technique for HUB earth station.**

INTRODUCTION

This project has been proposed to usage model of VSAT as was done at the time of the great east Japan earthquake [1]-[2] which is based on Rep. ITU-R S.2151-1 (Sep. 2012). The Rep. ITU-R S.2151 classifies the roles and usage of satellite communications into three phases as follows: 1) Relief Phase, 2) Restoration Phase and 3) Reconstruction Phase.

In the relief phase, emergency links for connecting people to each other and conveying damage status information are most important. A Japanese satellite communications operator allocated additional bandwidth (amounting to about 500 MHz on its entire fleet) for priority use, such as rescue, government, and so on, and this bandwidth was utilized by governmental organizations, local authorities and/or information media to transmit information (mainly voice and video) between the affected area (including naval vessels) and emergency command posts. This operator also distributed satellite phones (MSS terminals) to customers through joint efforts of a group company of this operator and a global remote communications solutions provider. The ITU also deployed 78 Thuraya satellite phones, 13 Iridium satellite phones, 32 Inmarsat broadband global area network terminals and 30 Inmarsat global satellite phone services terminals through the Japanese Administration.

The restoration phase covered efforts to establish evacuation shelters for people, to restore the administrative functions of local communities, and to rebuild the basic infrastructure of daily life. Satellite communications during this phase were used mainly as a backup and/or substitute for interrupted landlines for the lifeline infrastructure, such as telephone, cell phone, power, gas, railway companies, etc.

In the reconstruction phase, the communication infrastructure necessary for the rebuilding of the disaster affected area must be provided. This operator formed dedicated teams within its organization and worked together with the Tohoku Bureau of Telecommunications of the Ministry of Internal Affairs and Communications (local agency of the Administration) and a PC manufacturer, under financial support provided by the Administration. These teams installed VSAT equipment and set up wireless LANs and PCs at more than 180 sites before the end of fiscal year 2011.

VSAT systems to be used in the event of great natural disasters in order to accommodate a sudden increase in the communications traffic are quite important. As for the current satellite communication, dedicated earth station devices are required because various communication methods are used by different operators' services and different management organizations. Therefore earth stations (VSATs) are not compatible between different communication systems [3]-[4]. In addition the generated capacity was limited in the situation of large-scale electric power failure.

For the purpose of rapid resolution of the problems by means of technical methods, in order to secure communications line smoothly to meet the needs by satellite communications in areas where the communication infrastructure is destroyed by earthquake or tsunami, the technologies to make one VSAT compatible with multiple communication methods

are being researched and developed. This R&D focuses on resolving the following issues of satellite communications:

1) Shortage of VSATs required for disaster area;
   Target: Multi-mode SDR VSAT Technology
2) Prolonged electric power failure causes deactivation of VSAT equipment;
   Target: Low-power consumption VSAT technology
3) Satellite network traffic congestion;
   Target: Bandwidth optimization control technology

These technologies will enable VSAT to be available within 12 hours after occurrence of a great disaster in the affected area. VSAT will be used from relief phase to restoration and reconstruction phases as shown in Fig.1.

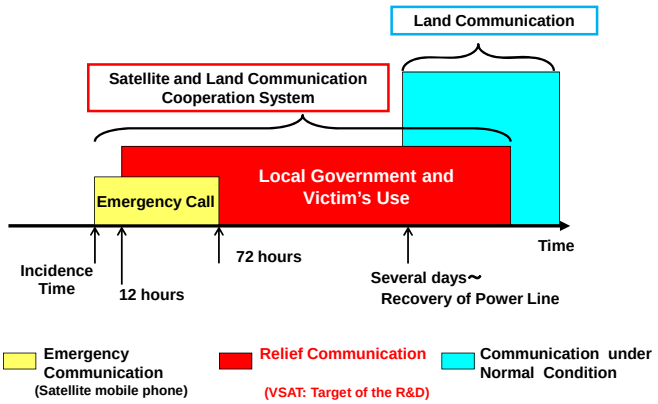

Figure 1. Scenario of information communication network in the big disaster.

OVERVIEW OF R&D

Figure 2 shows the R&D overview of multi-mode SDR VSAT system. The R&D of SDR VSAT with small size antenna and algorithms to allow access to multiple communication satellites would make it possible to communicate between different satellites communication systems with single VSAT. Multi-mode VSAT technologies which accommodate these functions enable the establishment of a robust satellite communication system sustainable for heavy traffic congestion in time of disaster.

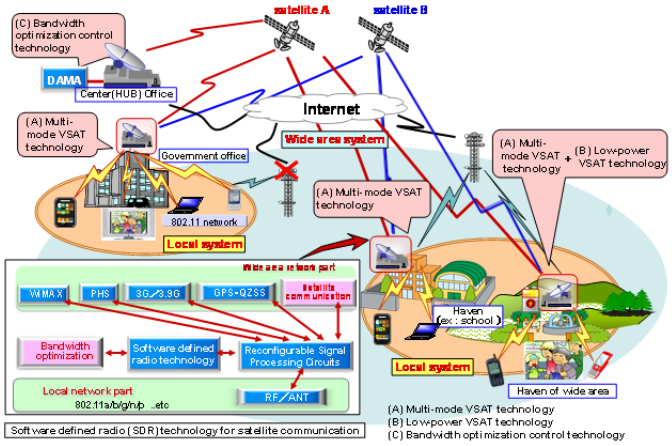

Figure 2. R&D overview of multi-mode SDR VSAT system.

(A) Multi-mode SDR VSAT Technology: When satellite communication system A is unavailable because of traffic congestion, VSAT can access another satellite communication system B which will be available as substitution by means of developed multi-mode VSAT. In this project, we assume that system A is the local authorities satellite communications network system by the Local Authorities Satellite Communications Organization (LASCOM) and system B is EsBird system by SKY perfect JSAT, Japan. This SDR VSAT will be developed based on the terrestrial cognitive router [5], which has wireless terminal functions of 3G cellular, GPS and Wireless-LAN. In the event of disaster, it can be used as multi-mode VSAT and evacuated people can use VSAT from their personal terminals (i.e. smart phones, PC) via Wireless-LAN. In the normal situation, the VSAT indoor unit (IDU) can be used as 3G cellular/wireless-LAN router.

(B) Low-power consumption VSAT technology: The R&D of a practical portable satellite terminal adopts new low power technologies for an essential communication tool in a great disaster as follows:

1) Practical power management and control scheme for saving power consumption.
2) Practical integrated ODU/IDU with enhanced maintainability.

(C) Bandwidth optimization control technology: The R&D of satellite bandwidth optimization control is different from bandwidth control schemes for terrestrial wired communications system. DAMA (Demand Assignment Multiple Access) controller allocates the optimum bandwidth on a session-by session basis in order to avoid traffic congestion in satellite communications system.

MULTI-MODE SDR VSAT Technology

Since several VSAT exist, multi-mode VSAT terminal is preferable for the next resilient wireless communication network. In Japan, the EsBird system (provided by SKY perfect JSAT corp.) is popular VSAT system for private communication network and used at shelters, temporary houses and hospitals to provide Internet environment. The local authorities satellite communications network system (provided by LASCOM) is used for governments / prefectural offices / city/town halls communication. These systems are similar from the viewpoints of bit-rates (32kbps-8Mbps), modulation schemes (BPSK, QPSK, etc.) and RF frequencies range (Ku-band), but are not compatible. Introduction of SDR technology into the VSAT is to realize the multi-mode functionality which covers both LASCOM system and EsBird system with no need of specialist's assistance in the event of disasters.

To realize multi-mode SDR VSAT, following technologies have been studied.

1) SDR technology for VSAT,
2) Digital Front-End technology,
3) Flexible access technology for plural satellite systems,
4) Ku/Ka dual-band antenna/feed technology,

Details of technologies are as follows:

1) SDR technology for VSAT

Multi-mode/variable bit rate VSAT MODEM is implemented in the software. In order to develop the SDR VSAT's soft-

ware, multi-mode VSAT software evaluation system with a SDR terminal processor board (Terminal side) and a VSAT link control / DATA management board (HUB station side) are developed based on the cognitive router for terrestrial wireless communication [5]. The software development setup is shown in Fig.3.

Figure 4 shows the fabricated prototype of multi-mode SDR VSAT. The IDU size is 287 (L) x 212 (W) x 183mm (H).

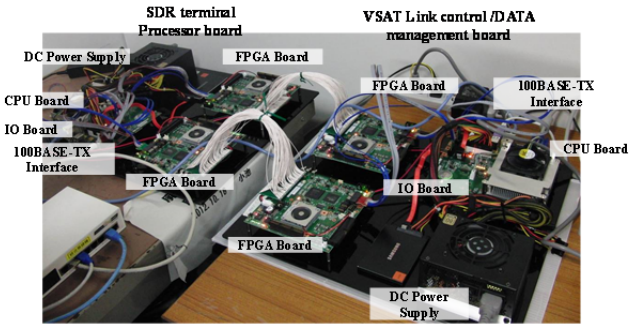

Figure 3. SDR VSAT's software development setup.

Figure 4. Prototype of multi-mode SDR VSAT IDU.

2) Digital Front-End technology

In order to achieve smaller size and lower power consumption SDR VSAT, SDR MODEM LSI chipset and multi-mode RFIC technology for VSAT is under development.

3) Flexible access technology for plural satellite systems

In order to communicate through plural satellite communication systems with single SDR VSAT terminal, flexible access technology, in other words correctly and quickly has been developed.

4) Ku/Ka dual-band antenna/feed technology

In order to avoid the satellite network traffic congestion in the event of large-scale disaster, the use of Ka-band becomes important for future VSAT. Small size Ku/Ka dual-band antenna/feed technology for portable VSAT outdoor unit (ODU) has been discussed and prototypes of Ku/Ka dual-band antenna feed for aperture antenna and a multiplexer/de-multiplexer unit have been fabricated.

Multi-mode SDR VSAT technologies which accommodate these functions enable to establish a robust satellite communication system sustainable for heavy traffic congestion in time of disaster.

Low-Power Consumption VSAT Technology

There were severe power supply problems in the great east Japan earthquake. Research and Development of a practical portable satellite terminal has been studied in order to enable to adopt low power consumption technologies for an essential communication tool in a great disaster. R&D focused on following studies;

1) Practical power management and control scheme for saving power consumption.

Power supply controller orders for power supply circuits to cut power when VSAT transmits or receives no data individually, mainly in transmitter part in Fig.5. It is able to control for each power supply circuit such as HPA, IF amplifier and so on. Optimum power ON/OFF timing for each amplifier has been developed.

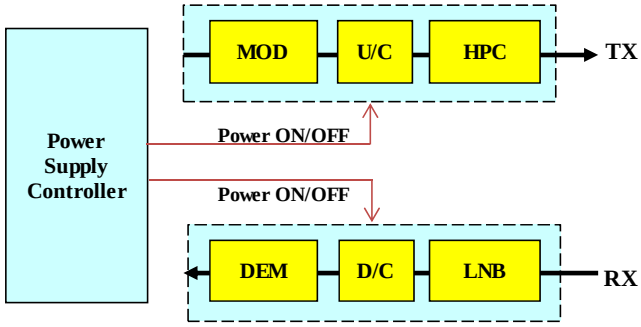

Figure 5. VSAT power consumption management.

2) Practical integrated ODU/IDU with enhanced maintainability.

Conventional VSAT is used to have ODU and IDU separately. In order to improve transportability of VSAT when carrying it to disaster area and to make set up time short, prototype of small integrated ODU/IDU has been fabricated. The ODU/IDU size is 310 (L) x 200 (W) x 117mm (H), and weight is 7.8kg except OMT in Fig.6.

Figure 6. Prototype of integrated ODU/IDU.

Bandwidth Optimization Control Technology

Bandwidth on demand (BOD) is a well-known technology to efficiently use bandwidth in a system with limited bandwidth capacity. Certain VSAT systems operated in Japan utilize this technology but allocation efficiency is minimal and these systems operate sufficiently without BOD.

In FDMA VSAT systems, especially based on a Demand Assigned Multiple Access (DAMA) system, BOD technology allocates bandwidth by monitoring the total traffic transmitted and maintains the allocated bandwidth while the VSAT transmits within the upper and lower thresholds. If the VSAT traffic exceeds the upper limit, the VSAT requests the DAMA a step-increase to the next bandwidth, given that the DAMA has sufficient surplus bandwidth. Conversely, if the VSAT traffic transmits below the lower threshold, the VSAT requests a step-decrease to a lower bandwidth.

In this algorithm, ineffective/inefficient bandwidth allocations were determined under the following conditions:

- Bandwidth remained allocated while VSAT traffic exceeded the lower threshold, regardless of the type of traffic.
- When an application, such as a video conferencing system, required a certain amount of bandwidth at the beginning of a session, DAMA allocated bandwidth in step-increments, which as a result terminated the application due to insufficient bandwidth.
- When an application concluded its session, DAMA released bandwidth in step-decrements, even though the application was not transmitting any traffic.

In order to allocate bandwidth more efficiently, following algorithms were studied.

1) Protocol Recognition & Analysis Algorithm,
2) Optimized Bandwidth Allocation Algorithm,
3) Optimized BOD Algorithm,
4) Protocol-based Alive Monitoring Algorithm.

Detailed description of each algorithm is as follows.

1) Recognition and analysis of IP traffic over satellite links to determine upper layer protocols used over satellite links, and reporting algorithm of these protocols to DAMA.
2) Optimization bandwidth allocation based on upper layer protocols.
3) Optimized conventional BOD technology to release bandwidth based on upper layer traffic.
4) Aliveness monitoring based on upper layer protocols to promptly release unnecessary bandwidth in the case of multiple protocols usage over a satellite link.

These studies showed different characteristics of upper layer protocols, such as RTP/UDP and TCP, to be significant in optimizing bandwidth allocation with respect to robustness against throughput variance. TCP, a protocol designed for accuracy, can withstand throughput degradation resulting from network congestion, traffic load balancing, etc. Therefore, TCP sessions could operate with minimal bandwidth allocation while RTP/UDP, protocols designed for real-time applications, required sufficient bandwidth.

Utilizing algorithm 1), algorithm 2) allocates the appropriate bandwidth for each protocol. Given a limited bandwidth capacity, if a VSAT requests RTP/UDP bandwidth allocation, DAMA reduces the TCP traffic and creates bandwidth for RTP/UDP. Figure 7 compares conventional bandwidth allocation with Optimized Bandwidth Allocation with reduction in TCP allocation.

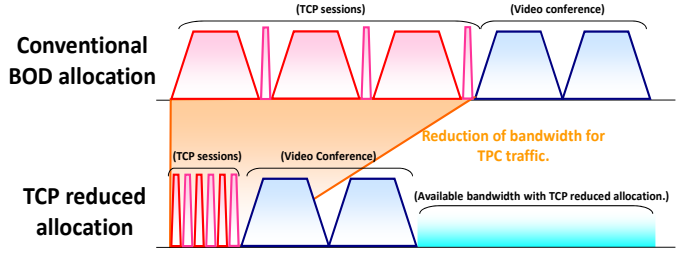

Figure 7. Conventional bandwidth allocation vs. optimized bandwidth allocation (Reduction of TCP bandwidth).

Prototype DAMA showed reduction of TCP bandwidth when allocation of RTP/TCP bandwidth was requested from VSATs, illustrating the efficient bandwidth algorithm per the Optimized Bandwidth Allocation Algorithm.

Algorithm 3) and 4) are implemented to run RTP/UDP applications smoothly compared to conventional BOD

Figure 8 is an example of bandwidth allocation for RTP/UDP traffic generated with a video conferencing system. As shown with blue line, required bandwidth for the video conference was allocated instantly at the start of the session and was promptly released as it ended. This implementation ensures a smooth start of video conferencing applications and a rapid release of unnecessary bandwidth. The area under the curve represents the total bandwidth occupied in a specified duration (kHz*sec) and Figure 8 illustrates the significant difference in bandwidth occupied between conventional and optimized BOD algorithms.

Implementation of these developed algorithms will be vital in efficiently managing bandwidth for DAMA systems and allocating them to applications with high priorities, especially if bandwidth becomes scarce in event of a natural disaster.

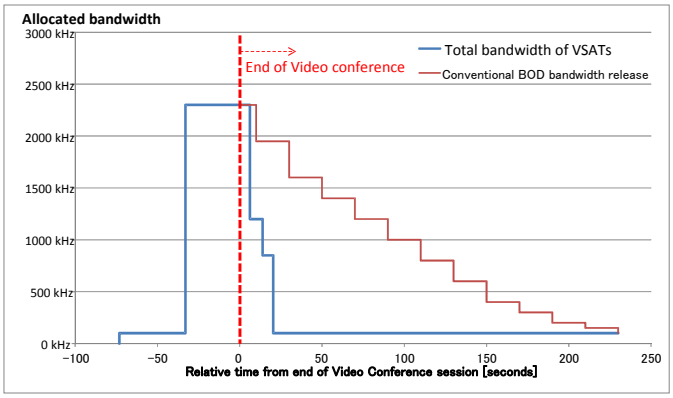

Figure 8. Comparison of bandwidth allocation between conventional BOD and optimized BOD.

Conclusion

With the goal of dependable VSAT terminals and systems for the use in large-scale disasters, multi-mode VSAT technologies, low power consumption VSAT's technology and adaptive bandwidth control technique are under development. These technologies will enable VSAT to be available within 12 hours after occurrence of a great disaster in the affected area. The detail of multi-mode VSAT technologies will be presented on European Microwave Conference 2013, October.

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