SATELLITE AND SPACE COMMUNICATIONS **SSC**

http://www.comsoc.org/socstr/org/operation/techcom/satellite.html

IEEE COMMUNICATIONS SOCIETY

SSC Newsletter **Vol. 14, No. 1, June 2004**

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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 Technical Committees in the Society.

SATELLITE & SPACE

- JOIN US -

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

Location: **Newport Bay Club Hotel Convention Center**
Room: **Room Nantucket**
Date: **Tuesday, June 22, 2004**
Time: **Start Time: 12:30 PM**
End Time: 2:30 PM

Future SSC Meetings

Dec. 2004 Dallas, Texas, USA
May 2005 Seoul, Korea

ICC 2004 SSC Committee Activities

TUTORIALS (June 20 and 24, 2004)

T23 - ARCHITECTURE AND REQUIREMENTS OF NEXT-GENERATION WIRELESS NETWORKS

Duration: Half-Day – Thursday 24 June – 13:30 - 17:00

Instructor: Abbas Jamalipour, University of Sydney

TECHNICAL SYMPOSIA (June 21-23, 2004)

Session QS12: Wireless Networks, Wednesday, 23 June, 14:30 – 17:30, Room: Chambord, Newport Bay Club

Session WC12: Satellite and Optical Wireless Communications, Tuesday, 22 June, 14:30 -17:30, Room: Panthéon, Hotel New York

Session WN09: Quality of Service Issues I, Tuesday, 22 June, 9:30 -12:30, Room: Bastille, Hotel New York

Session WN19: Topics in Wireless Networks, Wednesday, 23 June, 14:30 - 17:30, Room: Odéon, Hotel New York

EXECUTIVE AND EXPERT PANELS

P-6– The Role of Satellites in Future Broadband Networks

Tuesday, 22 June – 11:10-12:30

Room: Champs Elysées, Hotel New York

Organizer: Riccardo De Gaudenzi, Head of Communications Systems Section, European Space Agency

Panelists:

Roberto Campitelli, Chairman Hughes Network Systems Europe;
Olivier Guilbert, Alcatel Space Systems and Network Marketing Director;
Benjamin Pontano, President, Viasat Comsat Labs;
Harald Skinnemoen, R&D Product Manager, Nera SatCom

ICC 2004
20-24 June 2004 - Paris
Gate to the Global Information Society

ICC GLOBECOM COMSOC IEEE

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MESSAGE FROM THE CHAIR

Ron P. Smith

This is my last entry in this column as my term of office expires after ICC 2004. Elections for SSC TC officers will be held at our meeting at that conference. It has been a great pleasure serving as a TC officer and I encourage all of my colleagues to consider this rewarding activity or to serve in other ways, of which I list a few below. Thank you all for your support and I look forward to working with you in the future.

The Satellite and Space Communications (SSC) Technical Committee is an international volunteer organization governed by the IEEE Communications Society. SSC has been providing a forum for technical advancement of space borne communications since our founding in 1962. Please help us to continue our contributions to this exciting field by finding you own way to participate in our committee. SSC meets twice per year at ICC and Globecom conferences, and there are numerous ways to be active through the Internet by visiting our web site.

Our last meeting was at Globecom 2003 in San Francisco, California. I would like to thank our committee members who were able to attend, as well as those who have contributed electronically to conferences and publications as authors, organizers, editors and reviewers. Your volunteer efforts directly contribute the advancement of knowledge in the field of satellite and space communications.

SSC is actively involved in organizing sessions and workshops for major IEEE ComSoc conferences such as ICC and Globecom. You can help us by volunteering to serve as a technical program representative or as a paper reviewer. If you have suggestions for workshops or tutorials, you can submit your ideas directly to the conferences as well as coming to SSC for support. We are always interested in participating in other events cosponsored by the IEEE, such as the AIAA International Communications Satellite Systems Conference (www.aiaa-icssc.org), so please contact us if SSC can help with your favorite event.

In recent years there has been increasing convergence of technologies involved in satellite communication. SSC recognizes this as an opportunity to collaborate with our colleagues in other ComSoc TCs such as Communication Theory (CT), Personal Communications (PC) and Communications Systems Integration & Modeling (CSIM) TCs, as well as with other organizations such as the AIAA Technical Committee on Communications Systems and the IEE Satellite Communications Group. We have a number of liaisons with technical committees and publications listed on our web site. Please let us know of other sources of collaboration or volunteer to be one of our liaisons.

Publications are a major instrument in furthering our goals of advancing satcom technology and professional development in our field. The IEEE Communications Magazine is an excellent publication for reaching a wide technical audience and the IEEE Journal on Selected Areas of Communication provides a great opportunity for in depth examination of technical developments. Both of these publications organize featured topics with multiple papers on a subject in a single issue. SSC members help to organize these features by submitting recommendations to the editorial boards and serving as guest editors and reviewers. SSC encourages publication by presenting the "Distinguished Contributions to Satellite Communications Award." Information about this award and the nomination procedure can be found on our web site. Please nominate one of your deserving colleagues for this award.

As you can see, there are numerous ways for you to participate with SSC to help advance our field and the professional careers of our members and yourself. I have found this to be a rewarding endeavor and invite you to join us.

Dr Ron P. Smith, Chair
Satellite and Space Communications Technical Committee

SCANNING THE WORLD

Abbas Jamalipour

For this issue of SSC Newsletter I decided to write some news about the introduction of in-flight broadband Internet service via satellites. Coincidently this happens to be one of my research projects funded by the Australian Government. It is also a coincidence that you are receiving this Newsletter during IEEE ICC2004 in Paris, and the first airline to introduce this broadband service also belongs to an European country.

In-flight Internet broadband services are taking off at a rapid rate whilst airline giants are continually implementing new technologies. Whether it's broadband by Boeing, or Narrowband by Tenzing, there is a fierce competition against cost, time and quality of service. This report will outline the current systems available now and in the near future.

Connexion by Boeing (CBB) is the leading broadband Internet service provider for aeronautical applications. It provides high-speed Internet connectivity for passengers, with applications ranging from email and web access to entertainment services, all using their personal laptops or web-enabled PDAs.

CBB recently signed a contract with SES Americom for satellite coverage over the North Pacific regions. By the end of 2005, SES will provide a new hybrid "Worldsat-3" satellite positioned at 172 degrees East, with Ku-band transponders which will be used by Connexion for satellite coverage reaching Singapore, Korea, Australia and New Zealand and as far as the western coast of US. Until then Connexion will use other existing satellite service providers. Boeing also signed a lease agreement for the use of Ku-band capacity on AsiaSat 3S located at 105.5 degrees East, for providing in-flight broadband services on the Asia-to-Europe flights.

Connexion by Boeing used Eutelsat II-F4 satellite for European coverage from 2002 to 2003 until it was de-orbited in October 2003. In September CBB signed up a contract with Intelsat its Intelsat services on trans-Atlantic airliners in 2004. The satellite used would be the Intelsat 907 satellite located at 332.5 degrees East. The contract enables CBB to use two transponders of the 907's Ku-band Spot 1 beam for real-time transmission and reception of web pages, email, data and entertainment content. Another spot beam may be re-pointed to CBB for North Atlantic routes once commercial services begin in 2004.

In December 2003, CBB signed a contract with Intersputnik International Organization of Space Communications for transponder capacity of the Yamal-200 geostationary satellite to provide broadband communication services to passengers of commercial airlines and private jets flying over Europe and Asia. CBB will initially use one Ku-band transponder (72MHz bandwidth) of the Yamal-200 #1 satellite situated at 90 degrees East. This satellite will cover the areas of Russia, CIS, Eastern Europe, Middle East and Central Asia.

Another GEO satellite being used by Connexion is the Estrela do Sul 1/Telstart 14 located at 63 degrees West, manufactured for Loral Skynet do Brasil by Space Systems/Loral. It contains 51 Ku-band transponders, covering the Latin America and offers connectivity into North America and north Atlantic regions. It was launched in January 2004.

On May 14, 2004, Lufthansa passengers became the first to experience this high-speed Internet access at costs ranging between \$9.95 ~ \$30 per flight. The downstream channel will run at a speed of 5 Mbps, while upstream traffic will run at 1 Mbps, which is faster per user than ISDN.

Considering the costs of the service installation, hovering around \$4 million and two weeks downtime for each aircraft, the broadband service is surely not the most economical option.

The other competitor in in-flight Internet services, Tenzing associated with Airbus, is taking up Inmarsat's connectivity for its in-flight narrowband

Internet access. The satellites used by this service are the four Inmarsat-3's, located at 54 degrees West, 15.5 degrees West, 64 degrees East, and 178 degrees East.

Inmarsat's 64 kbps service is provided by SITA's AIRCOM FlightLink which is based on the Swift64, Inmarsat's Satellite High Speed Data Service. The advantage of this system over the Connexion is that it can work with existing aircraft communication infrastructure to provide internet services, including email, web access, video conferencing, and ftp. It can also work with the high-gain antennas already installed on most long haul airliners and many corporate jets. Already 80 percent of modern long haul commercial aircraft and more than 1000 corporate jets have the necessary antenna infrastructure needed for Swift64 services.

Of course this system can be later upgraded when the Inmarsat-4s begin operation in 2005. This system would then be able to provide data rates up to 432kbps for each channel of bandwidth used for data transfer, including Inmarsat's Broadband Global Area Network (BGAN). The three Inmarsat 4 satellites will be positioned over the Atlantic, Indian Ocean, and one will be initially used as spare. Each satellite will transmit approximately 240 spot beams, each carrying a number of independent channels for greater capacity. It is speculated that the three Inmarsat 4 satellites will be in full operation by 2006, where they would displace three Inmarsat 3s.

With regards to cost, the total installation costs range from $30,000 to 50,000 per aircraft and the downtime would be around five hours. Thus when comparing the cost of initial narrowband service to the broadband, the time and cost advantages are self-explanatory.

Prof. Abbas Jamalipour, Vice Chair
Satellite and Space Communications
Technical Committee

FORTHCOMING GLOBECOM AND ICC CONFERENCES

COSPONSORING / RELATED CONFERENCES AND WORKSHOPS

GLOBECOM 2004
Nov. 29 – Dec. 3, 2004,
Dallas, Texas, USA
The theme of Globecom '04 "Emerging Technologies Applications and Services" characterizes the continuing pervasiveness of telecommunications in all aspects of global society, industry, and government. The technical sessions of Globecom '04 will be presented in seven Symposia: Global Internet and Next Generation Networks, Wireless Communications, Networks and Systems, Communication Theory, Security and Network Management, Optical Communications, Networks, and Systems, Signal Processing for Communications, General Symposium. In addition Globecom'04 will feature keynote sessions presented by leaders of the industry, a full tutorial program, and a "Designers and Developers Forum" with papers, panels and exhibits of products.

MILCOM 2004
Oct. 31 – Nov. 3, 2004,
Monterey, CA, USA
MILCOM 2004 will focus on capabilities enabled by harnessing the power of new and emerging communications and information systems technologies. MILCOM 2004 is soliciting unclassified and classified papers (up to DoD SECRET and releasable to foreign nationals) relevant to communications and information system capabilities that address the 21st century challenges of national defense and homeland security.

ICC 2005
May 15 - 19, 2005,
Seoul, Korea
Today, the major trend of telecommunication networks and services is 'convergence' and 'seamless provision.' Reflecting this trend, ICC05 choses 'towards the era of ubiquitous networks' as the theme of ICC 2005. Under this theme, ICC 2005 will feature the latest developments in telecommunications from a technical perspective and discuss likely trends with leading technical specialists from all over the world. At the same time, influential business figures will be invited to add business flavor to ICC 2005.

ICSSC 2005
September 26 - 30, 2005,
Rome, Italy.

CONFERENCE CALENDAR

CONFERENCE	LOCATION	INFORMATION
SPECTS'04 International Symposium on Performance Evaluation of Computer and Telecommunication Systems	July 25 - 29, 2004, San Jose, CA, USA	http://www.scs.org/confernc/ssimc/ssimc04/programs/spects04AdvanceProgram.htm
VTC 2004 Fall The 60th IEEE Semiannual Vehicular Technology Conference	September 26-29, 2004 Los Angeles, CA, USA	http://www.aero.org/conferences/vtc2004fall/
MILCOM 2004 IEEE/AFCEA Military Communications Conference	October 31 – November 3, 2004, Monterey, CA, USA	http://www.milcom.org/2004/
GLOBECOM 2004 IEEE Global Communications Conference	November 29 – December 3, 2004, Dallas, Texas, USA	http://www.globecom2004.org/
ICC 2005 International Conference on Communications	May 16 - 20, 2005, Seoul, Korea	http://www.icc05.org/
VTC 2005 Spring The 61st IEEE Semiannual Vehicular Technology Conference	May 29 – June 1 2005 Stockholm, Sweden	http://ewh.ieee.org/soc/vts/conf/vtsconf.html
INFOCOM 2005 The IEEE Conference on Computer Communications	March 13-17, 2005 Miami, FL, USA	http://www.ieee-infocom.org/2005/
WCNC 2005 IEEE Wireless Communications & Networking Conference	March 13-17, 2005 New Orleans, LA, USA	http://www.ieee-wcnc.org/
ICSSC 2005 23rd AIAA International Communications Satellite Systems Conference	September 26 - 30, 2005, Rome, Italy	www.aiaa-icssc.org
MILCOM 2005 IEEE/AFCEA Military Communications Conference	October 17-21, 2005, Atlantic City, NJ, USA	not yet available

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://www.comsoc.org/~ssc/.
If you like to join SSC Mailing List, the indications how to subscribe/unsubscribe are reported at http://cassius.ee.usyd.edu.au/mailman/listinfo/ssc.

Real-Time Simulation of Satellite Systems

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Introduction

Satellite communications have many advantages with respect to terrestrial communications: the architecture is scalable; the diffusion throughout the land is wide; the satellite bandwidth; the multicast service is very simple; satellite links are often private lines.

On the other hand, satellite networks amplify also many problems already existing in terrestrial networks. The Quality of Service (QoS) issue is only an example of particular relevance in the satellite environment, involving the study of architectures, access schemes, management, propagation, antennas. Differently from cables in terrestrial networks, satellite channels vary their characteristics depending on the weather and the effect of fading heavily affects the performance of the whole system, in particular for systems operating in the Ka-band (20-30 GHz) [1, 2], which is very sensitive to rain fading. Another issue of topical importance concerns the transport layer (typically TCP): an essential quantity is the "delay per bandwidth" product. The transport layer performance problems arise when the bandwidth delay product is large. In more detail, within a geostationary large delay per bandwidth product environment, the acknowledgement mechanism takes a long time to recover errors. Moreover, another problem concerning TCP over satellite networks is represented by each loss, which is considered as a congestion event by the TCP. On the contrary, satellite links being heavily affected by noise, loss is often due to transmission errors. While the large delay per bandwidth product mainly characterizes geostationary (GEO) links, transmission errors represent an important component of Low Earth Orbit (LEO) systems, which also require a fast data transfer, due to the limited time of visibility. Heterogeneous scenarios, composed of LEO and GEO portions, are a hot research topic.

Considering also trends [3] in telecommunication systems, which affect the satellite environment, as the growing importance of services and the technology convergence for cabled and wireless communications, there is, on one hand, the opportunity of extending the use of satellite networks and the need of developing new instruments and schemes to improve the efficiency of the communications; on the other hand, it is important to observe the difficulty to test the solutions. A satellite system may be hardly studied on the field. Such testing is expensive and it often concerns only software components for earth stations. Alternatives are necessary to investigate new systems and to evaluate the performance. The first one is the analytical study. It is very attractive but complex. It often requires simplifications and approximations. The second alternative is non-real-time simulation. The behavior of a system is simulated via software. It is possible to by-pass the complexity of real systems, and solutions not yet technically feasible may be tested in view of future evolutions. The drawback is the need of modeling. A model is often not accurate enough to consider all the aspects of a real system. A third alternative, which seems to summarize most of the advantages of the solutions mentioned, is real time simulation (also called emulation). Emulation is composed of hardware and software components that behave as a real system. An emulator allows using real traffic and it is similar to the real system also from the point of view of the physical architecture.

Requirements

The design of a telecommunication network simulator (and, in particular, of a satellite simulator), heavily depends on the business field of users and on the scope of the simulation. Business modeling and service demonstration, for instance, require different characteristics than design or validation or performance evaluation. A tool useful for a University and a Research and Development Center is different from an instrument suited for a Satellite Provider, a Satellite Operator and a Small/Medium Enterprise (SME). The European Space Agency has recently developed a questionnaire to review the future evolution of satellite systems simulation capabilities across Europe and Canada. For this reason parallel studies, focusing at satcom systems, have been initiated in the context of ESA New Media Support Centre, and are aimed at identifying current and future simulation needs and identify potential users, in order to prioritise the needs and derive the Terms of Reference and Capabilities of a set of system simulations facilities, taking into account the potential benefit to users.

The authors, in the following, have tried to summarize the requirements a real-time satellite simulator [4], oriented to research and development and performance evaluation, should have, to match the requests of a large number of users with a special attention to the real-time issue.

- Aim. The aim is the emulation of a real satellite network composed of earth stations and satellite devices including the satellite itself.
- Scope. The emulation should range from Geostationary (GEO) to Low Earth Orbit (LEO) satellite systems. Earth stations may be connected to external PCs implementing algorithms oriented to the QoS (Quality of Service) at the network layer and new implementations at the transport layer. It should be possible to test different types of data link layers and different packet encapsulation formats at the data link layer.
- Modeling. The statistics about losses and delays should take into account the real system and the status of the channels.
- Transparency. The emulator should result as more transparent as possible towards the external world; it means that it should be seen as a real satellite device (e.g. a modem or a hardware card) by the external users (e.g. Personal Computers (PCs), routers, switches).
- Scalability. The complexity of the overall system should be, as much as possible, independent of the enlargement of the emulated network. Adding a new component to the system (e.g. a new earth station) may increase the traffic and the computational load; but it should not affect the architectural structure of the emulator.
- Traffic class support. The emulator should support different traffic classes at the MAC layer.
- Reliability. The results obtained by the emulator should be as close as possible to the results obtained by a real satellite system that implements the same packet switching strategy.
- Architecture. It is not necessary that the internal architecture of the emulator is a mirror of the real system at a physical and topological level (e.g. not necessarily each hardware component of the emulator should correspond to each device of the real system).
- Simplicity. The emulator should result very simple from the point of view of the computational load.
- Real time. The tool should work under stringent time constraints; in particular, at the interface with the external world.
- Implementation. The implementation should use, as much as possible, hardware and software material already implemented in other projects.
- Interface. The hardware interface towards the external PCs should be represented by devices (actually PCs, properly configured for this), called Gateways (GTW). The communication between the layers should be guaranteed by the use of exchanging Protocol Data Units (PDUs), where the information coming from the external PCs is encapsulated.
- Core. The core of the emulator should be represented by a single tool, which imposes losses, delay and jitters, following a statistics, to each single PDU entering the emulator.
- Transport of information. Each single PDU should be transported from the input to the output gateway.
- QoS (Quality of Service). The PCs that utilize the emulator should be able to implement bandwidth reservation schemes and allocation algorithms to guarantee QoS to the users.

Revision of a Real System

A satellite system is constituted by a certain number of ground stations (each composed of a satellite modem that acts both at the physical and at the data link layer) and a satellite that communicates with the ground station over the satellite channel. The modem may be an independent hardware entity connected to other units by means of a cable (as Fig. 1) or also a network adapter card plugged into a unit (e.g. the router itself or a PC), as in Fig. 2. In practice, it can be though as a data link layer of an overall protocol stack. For example, if an IP router is directly connected to the modem, the IP layer of the router interacts with the modem by sending and receiving traffic PDUs. Whenever a satellite modem receives a PDU from the upper layers, its main function is to send it towards the desired destination. On the other hand, when a modem receives a PDU from the satellite network, it must deliver it to the upper layers. The emulator should allow testing various kinds of protocols, switching systems, and whatever else, in order to evaluate suitable solutions to be adopted. It is possible to identify, in a real satellite system, the following main parts: a modem with an interface towards the upper layers (namely the network layer); a channel characterized by its own peculiarities; a data link protocol over the satellite channel and a satellite with its on-board switching capabilities.

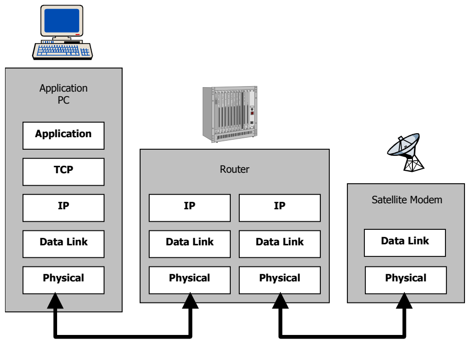

Fig. 1. Architecture of the real system.

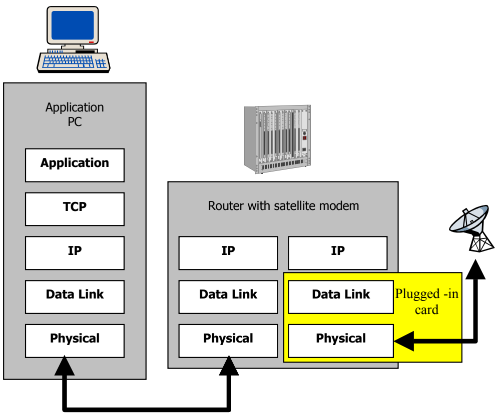

Fig. 2. Plugged-in card.

General Architecture

The reference architecture of the emulator is shown in Fig. 3, along with one possible system to be emulated enclosed in the cloud (a GEO satellite system has been depicted in this case). Different units called Gateways (GTW) operate as interface among the emulator and the external PCs. Each GTW is composed of a PC with two network interfaces: one towards the external world (a 10/100 Mbps Ethernet card), the other towards the emulator. An Elaboration Unit (EU), which has a powerful processing capacity, carries out most of the emulation, such as the decision about the "destiny" of each PDU.
The interface towards the external world concerns the GTWs; the loss, delay and any statistics of each PDU regard the EU; the real transport of the information PDU through the network concerns the input GTW and the output GTW.
The various components are connected via a 100 Mbps network, completely isolated by a full-duplex switch. In such way, the emulator has an available bandwidth much wider than the real system to be emulated, which should not overcome a maximum overall bandwidth of 10/20 Mbps.
Fig. 4 shows how the different parts of the real system (modem, data link protocol, channel and switching system, as mentioned in the previous sub-section) are mapped onto the different components of the emulator.
The earth station, identified by the gray rectangle, is divided, in the emulator, into two parts (GTW and EU). The network layer, the network interface towards the external world and the interface between the network layer and the satellite modem are contained in the Gateway (GTW).
The other parts of the modem (i.e. the data link layer, protocol and encapsulation), the overall transmission characteristics (e.g. bit error ratio, channel fading, lost and delayed packets), the on-board switching architecture as well as the queuing strategies are contained in the Elaboration Unit (EU).

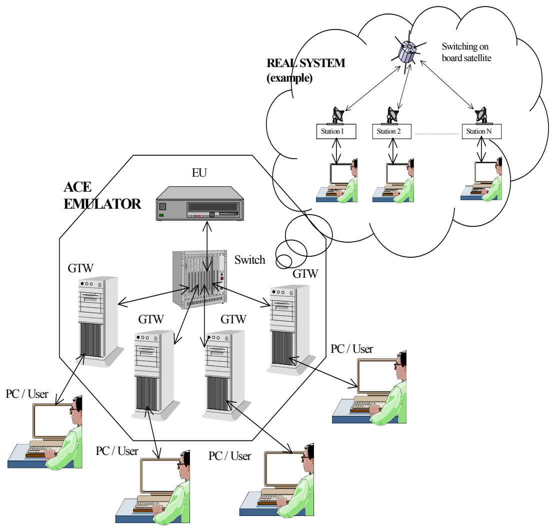

Fig. 3. Overall Emulator Architecture - Real System.

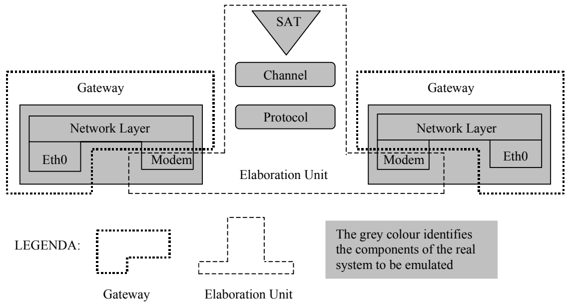

Fig. 4. Emulator versus Real System.

References

[1] Richard T. Gedney e Thom A. Coney, “Effective Use of Rain Fade Compensation for Ka-Band Satellites”. Proc. of Ka Band Utilization Conference, Italy, pp. 153-160, September 1997.
[2] Roberto J. Acosta, “Rain Fade Compensation Alternatives for Ka-Band Communication Satellites”. Proc. Fourth Ka Band Utilization Conference, September 1997. Italy, pp. 145-152.
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[4] M. Marchese, M. Perrando, "A Packet-Switching Satellite Emulator: A Proposal about Architecture and Implementation ", ICC2002, New York, April 2002, ICC02 CD-ROM.