



CONTENTS

| | |
|--|----|
| FUTURE CSIM MEETINGS | 1 |
| HOW TO JOIN CSIM | 1 |
| CSIM OFFICERS | 2 |
| A WORD FROM THE E-LETTER E-I-CS | 3 |
| COSPONSORING/RELATED CONFERENCES & WORKSHOPS | 3 |
| CONFERENCE CALENDAR | 4 |
| CSIM INTEREST GROUPS | 7 |
| AWARDS | 10 |
| MESSAGE FROM THE COMMITTEE CHAIRS | 11 |
| MTENS: A COMPLETE SIMULATOR FOR MPLS TRAFFIC ENGINEERING NETWORKS | 13 |
| CALL FOR CONTRIBUTIONS | 17 |

simulation, analytical tools and measurement of communications links and networks 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.

Communication Systems Integration and Modeling

The Communication Systems Integration and Modeling technical committee focus its activities on

- JOIN US -

All conference attendees are welcomed to join us in the CSIM Committee meetings at Globecom 2009, ICC 2010 & Globecom 2010.

Future CSIM Meetings

Globecom 2009, 30 Nov - 4 Dec 2008 / Honolulu, USA
ICC 2010, 23 - 27 May 2010 / Cape Town, South Africa
Globecom 2010, 6 - 10 Dec 2010 / Miami, USA

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Joining CSIM is easy. Simply send an email to csim-request@comsoc.org. In the body of the message put either subscribe name@domain.com or unsubscribe name@domain.com.

The mailing list, csim@comsoc.org is the communication channel with the CSIM. To post a message send e-mail to csim@comsoc.org.

For any question, please contact Fabrizio Granelli at granelli@dit.unitn.it

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A WORD FROM THE E-LETTER E-I-Cs*Charalabos Skianis
Stefano Giordano*

The E-Letter of the CSIM TC arrives to complement and promote a highly active committee within COMSOC that sponsors its traditional workshop CAMAD, as well as special issues in the IEEE Communications Magazine and in the IEEE Journal on Selected Areas in Communications. CSIM is very active in ICC and in GLOBECOM and was one of the co-founders of MILCOM. CSIM has its roots on the Communications Systems Engineering Technical committee and has been chaired by:

| | | | | |
|------|---|------|---|------------------------|
| 2009 | - | now | - | Fabrizio Granelli |
| 2007 | - | 2009 | - | Pascal Lorenz |
| 2005 | - | 2007 | - | Nelson L.S. da Fonseca |
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| 1999 | - | 2000 | - | Hussein Mouftah |
| 1996 | - | 1999 | - | Guy Omydar |
| 1994 | - | 1996 | - | Bill Tranter |

The goal of the E-Letter is to disseminate issues that focus on opinions, initiatives, scientific achievements and perspectives of communication systems integration and modeling.

The fourth issue of the E-Letter features, apart from its informative material on ComSoc related activities, columns reporting on the Special Interest Groups (SiG) within CSIM and a message from the committee chair Fabrizio Granelli. The issue is further complemented by one perspective article entitled 'MTENS: a Complete Simulator for MPLS Traffic Engineering Networks' by Davide Adami, Christian Callegari, Stefano Giordano, and Michele Pagano.

We renew the invitation to everyone to become regular contributor by submitting proposals for columns, perspective articles and annotated bibliographies.

Information for submissions can be found at the CSIM website: <http://www.comsoc.org/~csim/>

Enjoy this issue!

Stefano Giordano
Charalabos Skianis
Editor-in-Chiefs E-Letter

COSPONSORING / RELATED CONFERENCES AND WORKSHOPS**Globecom 2009**

30 Nov – 4 Dec 2009, Honolulu, USA

Support of 'Performance Modeling, QoS and Reliability' Technical Symposium

ICC 2010

23-27 May 2010, Cape Town, South Africa

Support of 'Communication QoS, Reliability and Modelling Symposium' Technical Symposium

Globecom 2010

6-10 Dec 2010, Miami, USA

Support of 'Communications Quality of Service, Reliability, and Performance Modeling' Technical Symposium

CAMAD 2010

3-4 Dec 2010, Miami, USA

15th International Workshop on Computer Aided Modeling and Design of Communication Links and Networks

CONFERENCE CALENDAR

| ACRONYM/YR | CONFERENCE NAME | Conf Date | CITY |
|---------------------------------|---|-------------------------|----------------|
| <u>COMSNETS 2010</u> | The Second International Conference on Communications Systems and Networks | 01/06/2010 - 01/10/2010 | Bangalore |
| <u>IEEE CCNC 2010</u> | IEEE Consumer Communications & Networking Conference | 01/09/2010 - 01/12/2010 | Las Vegas |
| <u>RWS 2010</u> | The 2010 IEEE Radio and Wireless Symposium | 01/10/2010 - 01/14/2010 | New Orleans |
| <u>SCC 2010</u> | 8th International ITG Conference on Source and Channel Coding | 01/18/2010 - 01/24/2010 | Siegen |
| <u>NCC 2010</u> | National Conference on Communications | 01/29/2010 - 01/31/2010 | Chennai |
| <u>ONDM 2010</u> | 14th Conference on Optical Network Design and Modeling | 02/01/2010 - 02/03/2010 | Kyoto |
| <u>WONS 2010</u> | 7th International Conference on Wireless On-Demand Network Systems and Services | 02/03/2010 - 02/05/2010 | Kranjska Gora |
| <u>ICACT 2010</u> | The 12th International Conference on Advanced Communication Technology | 02/07/2010 - 02/10/2010 | GangWon-Do |
| <u>WSA 2010</u> | International ITG Workshop on Smart Antennas | 02/23/2010 - 02/24/2010 | Bremen |
| <u>MCIT 2010</u> | International Conference on Multimedia Computing & Information Technology | 03/02/2010 - 03/04/2010 | Sharjah |
| <u>IEEE INFOCOM 2010</u> | IEEE Conference on Computer Communications | 03/15/2010 - 03/19/2010 | San Diego |
| <u>OFC/NFOEC 2010</u> | Optical Fiber Communication Conference and Exposition and the National Fiber Optic Engineers Conference | 03/21/2010 - 03/25/2010 | San Diego |
| <u>IEEE ISPLC 2010</u> | 14th IEEE International Symposium on Power Line Communications and its Applications | 03/28/2010 - 03/31/2010 | Rio de Janiero |
| <u>ICT 2010</u> | The 17th International Conference on Telecommunications | 04/04/2010 - 04/07/2010 | Doha |
| <u>IEEE DYSPAN 2010</u> | IEEE International Symposium on New Frontiers in Dynamic Spectrum Access Networks | 04/06/2010 - 04/09/2010 | Singapore |
| <u>EW 2010</u> | EUROPEAN WIRELESS 2010 | 04/12/2010 - 04/15/2010 | Lucca |
| <u>WAMICON 2010</u> | IEEE WIRELESS AND MICROWAVE TECHNOLOGY CONFERENCE | 04/12/2010 - 04/13/2010 | Melbourne |
| <u>IEEE SARNOFF 2010</u> | 33rd IEEE SARNOFF Symposium 2010 | 04/12/2010 - 04/14/2010 | Princeton |
| <u>IEEE RFID 2010</u> | IEEE International Conference on RFID 2010 | 04/14/2010 - 04/15/2010 | Orlando |

CSIM E-Letter

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|-----------------------------------|--|-------------------------|-------------|
| <u>IEEE WCNC 2010</u> | IEEE Wireless Communications and Networking Conference | 04/18/2010 - 04/21/2010 | Sydney |
| <u>IEEE/IFIP NOMS 2010</u> | IEEE/IFIP Network Operations and Management Symposium 2010 | 04/19/2010 - 04/23/2010 | Osaka |
| <u>WTS 2010</u> | Wireless Telecommunications Symposium 2010 | 04/21/2010 - 04/23/2010 | Tampa |
| <u>IEEE LAN/MAN 2010</u> | The 17th IEEE Workshop on Local and Metropolitan Area Networks | 05/05/2010 - 05/07/2010 | Long Branch |
| <u>CNSR 2010</u> | Communication Networks and Services Research 2010 Conference | 05/12/2010 - 05/14/2010 | Montreal |
| <u>IEEE ICC 2010</u> | IEEE International Conference on Communications | 05/23/2010 - 05/27/2010 | Capetown |
| <u>IEEE CQR 2010</u> | IEEE Communications Society 2010 International Communications Quality and Reliability (CQR) Workshop | 06/08/2010 - 06/10/2010 | Vancouver |
| <u>HPSR 2010</u> | 2010 International Conference on High Performance Switching and Routing | 06/14/2010 - 06/16/2010 | Dallas |
| <u>APSITT 2010</u> | 8th Asia-Pacific Symposium on Information and Telecommunication Technologies | 06/15/2010 - 06/18/2010 | Kuching |
| <u>IEEE IWQOS 2010</u> | 18th IEEE International Workshop on Quality of Service | 06/16/2010 - 06/18/2010 | Beijing |
| <u>SECON 2010</u> | IEEE Communications Society Conference on Sensor, Mesh and Ad Hoc Communications and Networks 2010 | 06/21/2010 - 06/25/2010 | Boston |
| <u>ISCC 2010</u> | IEEE Symposium on Computers and Communications | 06/22/2010 - 06/25/2010 | Riccione |
| <u>SPECTS 2010</u> | 2010 International Symposium on Performance Evaluation of Computer and Telecommunication Systems | 07/11/2010 - 07/14/2010 | Ottawa |
| <u>IEEE ICME 2010</u> | IEEE International Conference on Multimedia & Expo | 07/19/2010 - 07/23/2010 | Singapore |
| <u>ICWITS 2010</u> | 2010 IEEE International Conference on Wireless Information Technology and Systems | 08/28/2010 - 09/03/2010 | Honolulu |
| <u>ISTC 2010</u> | International Symposium on Turbo Codes & Iterative Information Processing | 09/06/2010 - 09/10/2010 | Brest |
| <u>ICUWB 2010</u> | 2010 IEEE International Conference on Ultra-Wideband | 09/20/2010 - 09/23/2010 | Nanjing |
| <u>PIMRC 2010</u> | The 21st Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications | 09/26/2010 - 09/30/2010 | Istanbul |
| <u>CNC 2010</u> | International Conference on Advances in Communication, Network, and Computing 2010 | 10/04/2010 - 10/05/2010 | Calicut |
| <u>IEEE ARRAY 2010</u> | 2010 IEEE International Symposium on Phased Array Systems & Technology | 10/12/2010 - 10/15/2010 | Boston |
| <u>EDOC 2010</u> | The 14th IEEE International EDOC Conference | 10/25/2010 - 10/29/2010 | Vitória |
| <u>MILCOM 2010</u> | Military Communications Conference | 10/31/2010 - 11/03/2010 | San Jose |

CSIM E-Letter

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|----------------------------------|---|-------------------------|-------|
| <u>IEEE CAMAD 2010</u> | 2010 IEEE 15th International Workshop on Computer Aided Modeling and Design of Communication Links and Networks | 12/03/2010 - 12/04/2010 | Miami |
| <u>IEEE GLOBECOM 2010</u> | IEEE Global Communications Conference | 12/06/2010 - 12/10/2010 | Miami |

CSIM INTEREST GROUPS

Based on the research interests of CSIM members, there is an ongoing process of formulating several IGs led by experts and active researchers in each area. Detailed info about the IG charters, focus areas of each IG, and their activities are announced at the CSIM website: <http://www.comsoc.org/~csim/>.

IG Membership: Membership is free. Information about how to join each IG will also be available at each IG will be available at the CSIM Web site.

New IG Proposal: Experts and Active researchers are encouraged to propose new IG to the chair of CSIM at lorenz@ieee.org.

SIG on “Cross-layering”

Coordinator: Fabrizio Granelli

In the framework of modern communication systems, a need is emerging for novel design paradigms to support performance optimization and in general to increase control over the behaviour of networks. Indeed, several limitations in today’s networks are due to the layering principle which enabled fast design and deployment of interoperable network and applications protocols but limited the interaction between protocols operating at different layers of the protocol stack.

In this scenario, cross-layering emerged as a promising tool to enable higher control on the functionalities at different layers. Nevertheless, a balance is needed between performance and interoperability, which in general is controllable by the degree of the introduced cross-layer interactions.

As a general rule, cross-layer interactions are present also in layered protocol stacks, and they are demonstrated by the fact that, for example, TCP performance is influenced by the medium access control scheme at the link layer, and so on.

Within the broader scope of the IEEE ComSoc CSIM Technical Committee, the special interest group (SiG) on cross-layering specifically addresses the issues related to cross-layering technology as a mean both to provide tight integration among the protocol layers of communication devices and to model the resulting communication architectures.

Topics addressed by the SiG on cross-layering include:

- modeling of cross-layering interactions
- modeling of cross-layering processes
- architectures for cross-layering signalling
- performance of cross-layering schemes

Activities of the SiG are focused to facilitate interactions among experts operating in the field and

provide a forum for analysis and exchange of information about potential costs and benefits of the cross-layering paradigm, especially in comparison to standard layering design of communication networks. The interaction among the SiG members are performed through the SiG website:

<http://groups.google.it/group/csim-crosslayering>

which consists of a set of webpages, discussion groups and file repository – with the purpose to enable collaboration of people worldwide through the Internet.

At the moment, 10 experts are registered on the collaborative website, and the webpages receive an average of 50-70 visits per week.

Achieved results by the special interest group include the preparation of a survey chapter on formal methods for cross-layer modelling:

D. Kliazovich, M. Devetsikiotis, F. Granelli, “FORMAL METHODS IN CROSS LAYER MODELING AND OPTIMIZATION OF WIRELESS NETWORKS: STATE OF THE ART AND FUTURE DIRECTIONS”, in “Heterogeneous Next Generation Networking: Innovations and Platforms”, edited by Prof. Stavros Kotsopoulos and Dr. Konstantinos Ioannou.

We look forward to receiving your valuable contribution to our discussion and your help in building new initiatives!

Fabrizio Granelli
CSIM SiG on Cross-Layering Coordinator

Website: <http://groups.google.it/group/csim-crosslayering>

E-mail: granelli@disi.unitn.it

SIG on “Services Modeling and Simulation”

Coordinator: Mike Devetsikiotis

The CSIM SiG on services modeling will specifically address the issues related to the emerging area of network and information technology services as a mean to model the architectures and methods used for service implementation, delivery and capacity planning.

Topics addressed by the proposed SiG include:

- modeling of network service performance

- modeling of service delivery and intermediary architectures
 - modelling of service workload and traffic
 - efficient simulation of service frameworks
 - scalable simulation of very large service systems
- Expected activities of the SiG are mainly to facilitate interactions among experts operating in the field and provide a forum for analysis and exchange of information about service modelling and simulation.

SIG on “Measurements”

Coordinator: Antonio Pescape

The CSIM SiG on "Internet Measurements" will specifically address issues related to the emerging topics in the field of network and traffic measurements, especially when their purpose is to improve and secure the current Internet. In this context, the topics addressed by the SiG include:

- techniques, tools, and environments looking at reproducibility in network and traffic measurements (topology discovery, capacity and bandwidth estimation, and QoS parameter measurement)
- capture, analysis, characterization, and modeling of network traffic

- techniques, tools, and platforms for traffic identification and classification
- measurement and characterization of malware and unwanted traffic, network anomaly detection, and security threats
- measurement-inspired modeling, control, and management

The expected main activities of the SiG will be devoted to both foster interaction among experts researching and operating in the field of "Internet Measurements" and provide an open forum to exchange information and to facilitate new and even more stimulating collaboration activities.

Webpage: <http://wpage.unina.it/pescape/sim.htm>

Email: pescape@unina.it

SIG on “Future Internet Testbeds”

Coordinator: Harry Skianis

Lately, there is much interest on the definition of the Future Internet with international research efforts and programs, such as GENI and FIND in USA, FIRE in Europe, u-Japan in Japan, that work towards the challenges behind the current Internet as well as the Future Internet Design (FIND).

This effort needs large scale experimental facilities to exhaustively test evolutionary and revolutionary approaches towards Future Internet and all aspects of it such as networks and services.

The new SIG - FIT will span its activities on several aspects of mainly large scale experimental platforms on the Future Internet and its interconnection aspects (federation aspects of heterogeneous platforms, security, authentication, privacy, routing, ect).

Currently FIT is formulating consortia of experts for NSF & EC supported R&D activities. JOIN US !!

Email: cskianis@aegean.gr

SIG on “Modeling and Simulation Tools”

Coordinator: Joel Rodriguez

Nowadays, simulation is one of the most used technique for performance evaluation of communication and multimedia technologies, in comparison with in situ measurements and analytical tools.

The scope of this SIG is the diffusion and promotion of Modeling and Simulation Tools. It also includes the creation of new Modules and Graphic User Interfaces (GUI) for existing simulation tools.

This SIG is a forum to share and disseminate information related with construction and utilization of modeling and simulation tools on communications and multimedia.

Webpage: <http://mst.it.ubi.pt/>

Email: joel@ubi.pt

AWARDS

Distinguished Service Award – Given to a CSIM member for exemplary service to CSIM TC over a sustained period of time.

Eligibility: The nominee must have been a CSIM TC member for a sustained period of time.

Career Achievement Award – Given to a CSIM member for outstanding contribution over a sustained period of time or a breakthrough contribution.

Eligibility: The nominee must have exhibited outstanding contribution over a sustained period of time or a breakthrough contribution.

Conference Best Paper Award – Given to an outstanding conference paper with a topic consistent with the focus of the CSIM TC.

Eligibility: Any paper published in the proceedings of an IEEE ComSoc- and/or CSIM- sponsored congress/conference/workshop/symposium, in the two years preceding the nomination.

Selection process: The chair of the event from which a paper will be selected shall indicate not less than

three consistent within the scope of the CSIM TC. The chair of the conference should select the papers among the ones best ranked. The chair of the conference shall not rank the selected papers when indicating them to the award subcommittee.

Best Paper Award – Given to an outstanding paper with a topic consistent with the focus of the CSIM TC.

Eligibility: Any paper published in an IEEE ComSoc journal/magazine or in the proceedings of an IEEE ComSoc-sponsored conference/workshop/symposium in the previous three years of the nomination. At least three papers should be considered for selection.

Integration and Modelling of Communication Systems: Future Perspectives and CSIM Activities

Fabrizio Granelli

As communications systems continuously evolve and gain more and more pervasiveness, the topics related to integration and cooperation among different standards is becoming an ever-growing issue for network engineers and researchers. Just to mention the need for convergence of all communication and access technologies, driven by the mobile users need to gain access to network resource on a “anytime-anywhere” basis.

On the other side, widespread diffusion of social networking platforms is re-shaping the Internet and leading to novel paradigms where applications and networks become single entities. In this scenario, growing interest from the research community on novel design paradigms such as crosslayering and architectures (cognitive radios and networks, active networking) brings attention to an aspect which is currently left out from most enthusiast researchers: to define appropriate modeling tools and approaches to bridge the gap between theory and implementation, currently unbalanced to empirical / simulation / testing methodologies. As an example, no formal framework is available to support the design of cross-layer architectures or to analyze the behaviour of an self-adaptive cognitive network.

In this scenario, within IEEE Communication Society, the Technical Committee on Communication Systems Integration and Modeling (CSIM) plays a relevant role, as a potential place able to provide the know-how required to face the challenges described above as well as a discussion forum for the research community interested in such topics.

Indeed, the IEEE Communications Society CSIM TC is in fact concerned with disciplines and modelling tools to facilitate the integration of information-transport equipment, subsystems, and networks into communications systems.

The activities of the CSIM technical committee are focused on simulation, analytical tools and measurement of communications links and networks.

Historically, CSIM has its roots on the Communications Systems Engineering Technical committee.

CSIM TC is very active in supporting worldwide top-level scientific events and journals, with workshops, symposia and issues related to modeling and integration of communication systems and networks. More in details, it sponsors a traditional workshop (CAMAD, from 2006 on a yearly basis), as well as special issues in the IEEE Communications Magazine and in the IEEE Journal on Selected Areas in Communications. Moreover, CSIM is very active in ICC and GLOBECOM (providing technical sponsorship and TPC member to several symposia) and was one of TCs co-founders of MILCOM.

Major achievements in the last years include:

- a. CSIM co-sponsored and provided TPC co-chairs for the symposium on “Communications QoS, Reliability and Performance Modeling” in ICC and Globecom from 2007 to 2009.
- b. The committee organized his flagship workshop (CAMAD) in 2007 (in conjunction with PIMRC), in 2008 (in conjunction with ICC 2008, Beijing, PRC), and in 2009 (in Pisa, as an official IEEE workshop).
- c. CAMAD is now an official IEEE ComSoc workshop.
- d. In 2007, CSIM founded and provided chairs for the “International Workshop on Enabling the Future Service Oriented Internet” (EFSOI), held every year in conjunction with Globecom.

Moreover, CSIM is co-founder and provided General and TPC Chair for the IEEE Latin-American Conference on Communications (IEEE LATICOM 2009), and is actively supporting the activities of the ComSoc Education Board.

CSIM E-Letter

In order to better organize technical activities, five special interest groups (SIGs) are active to study specific issues in the framework of the committee scope:

- SIG on “Cross-layering”
- SIG on “Services Modeling and Simulation”
- SIG on “Measurements
- SIG on “Future Internet Testbeds”
- SIG on “Modeling and Simulation Tools”

In general, CSIM activities are mainly discussed during meetings held twice per year, in conjunction with ICC and GLOBECOM, the ComSoc flagship conferences. The other instruments for discussion and collaboration are the mailing list of the committee, csim@comsoc.org, where meetings and other initiatives are advertised, and the committee website, <http://www.comsoc.org/~csim/>, where all information related to CSIM activities is published as well as a calendar with CSIM-related events along the year.

To further enable collaborations from all the world, CSIM is present on LinkedIn (<http://www.linkedin.com/groups?gid=1888981>) and Twitter (<http://twitter.com/csimtc>). Relevant effort is also provided to enable remote participation to the committee meetings, by means of remote conferencing facilities.

Current CSIM officers are Fabrizio Granelli (Chair, University of Trento, Italy), Charalabos Skianis (Vice-Chair, University of the Aegean, Samos, Greece) and Stefano Giordano (Secretary, University of Pisa, Italy), which are available for clarifications and discussions on the CSIM involvement in the aforementioned activities as well as for discussion on relevant topics.

For more information, visit our website at <http://www.comsoc.org/~csim/>

We welcome your active participation and contribution to the committee goals!

Fabrizio Granelli (CSIM TC, Vice-Chair)

MTENS: a Complete Simulator for MPLS Traffic Engineering Networks*Davide Adami, Christian Callegari, Stefano Giordano, and Michele Pagano*

Department of Information Engineering
University of Pisa
email: *name.surname@iet.unipi.it*

I. INTRODUCTION

Over the last years, the number and variety of heterogeneous applications running on IP networks have increasingly grown. Meanwhile, the convergence of high-speed Internet access, IPTV and VoIP over a single broadband connection has pushed Internet Service Providers (ISPs) to deploy IP/MPLS network infrastructures [1][2].

Conceived for network services with coarse requirements in terms of delay, jitter and bandwidth, MPLS allows ISPs to achieve relevant cost savings. Indeed, Traffic Engineering (TE) support makes network resource utilization more efficient, whereas Virtual Private Networking capabilities allows to create several logical networks over a single physical infrastructure.

Moreover, MPLS-based networks may provide reliable services through a set of procedures (fault detection, notification and recovery) which, in case of a Label Switched Path (LSP) failure, seek to redirect the traffic to a recovery path. MPLS can also be combined with Quality of Service (QoS) architectures, so as to meet different QoS requirements at IP level.

MPLS Traffic Engineering (MPLS-TE) [3] has emerged as a scalable solution to provide QoS support while simultaneously enabling TE functionalities. In MPLS networks, constraint-based path computation algorithms are a key architectural component to offer TE support as well as to determine paths that meet specific QoS requirements [4].

A critical situation arises when a network architect has to simultaneously combine TE mechanisms, recovery strategies and QoS constraints in network design and planning. Indeed, it is not easy to envisage the steady and dynamic behaviour of

MPLS networks where many architectural components and functionalities are put together.

In the last years, therefore, our efforts have focused on the implementation of an open-source, flexible and customizable simulation environment which could assist the design of MPLS networks [7][8][9][10].

Starting from the Network Simulator (NS2) [5], patched with MPLS Network Simulator (MNS) [6], our work has led to the development of a new simulation environment, called MTENS (MPLS-TE Network Simulator), which implements: signalling protocols and mechanisms, TE routing protocols extensions, path computation algorithms, and LSP recovery strategies.

This paper firstly aims to highlight all MTENS functionalities and then to show how the simulator permits to analyze a specific network design problem.

The paper is organized as follows. Section II contains an overview of the architecture of the new MPLS node, that we have implemented in MTENS, while section III presents the main functionalities regarding the LSPs establishment and rerouting. Finally, section IV concludes the paper with some final remarks.

II. MTENS NETWORK SIMULATOR

This section illustrates the software modules that have been developed to provide a complete MPLS-TE simulation environment. More specifically, we provide a detailed description of the new functional blocks introduced within the MPLS node.

II.a MPLS node architecture

Control and data planes functionalities are strictly separated in the MPLS node architecture. Therefore, our work dealt with the addition of new control plane components (RSVP-TE[15], OSPF-TE[11], PCE[14]) and the introduction of the related communication mechanisms with the data plane, whereas the forwarding mechanisms remained unchanged. Fig. 1 sketches the new reference model of the MPLS node.

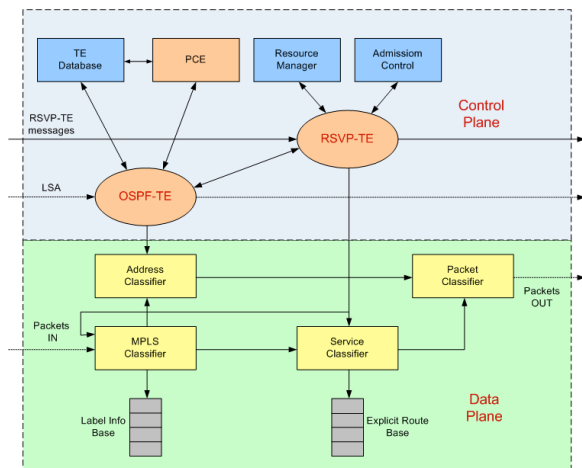


Figure 1 Reference model of the MPLS node

II.b Control Plane

Label distribution and allocation are performed by the RSVP-TE agent according to the information from the OSPF-TE block. In addition to the algorithms and protocol extensions required by the above mentioned blocks, we also implemented the communication mechanisms between them.

To set-up an LSP with QoS constraints, an MPLS node performs the following actions:

- the MPLS node receives an LSP set-up request between two LERs;
- the request is processed by the RSVP-TE agent;
- the RSVP-TE agent sends a request to the OSPF-TE module for the next-hop or the explicit route (computed by the PCE) between the specified LERs according to the request type;
- the OSPF-TE agent returns the explicit path to the RSVP-TE module which carries out the required operations to set-up the LSP.

To perform such actions, the OSPF-TE agent must be able to collect, store and flood TE information. Hence, the OSPF-TE agent periodically checks the status of the links directly connected to the node interfaces and updates a data structure called LsLinkState. This structure has been extended to store TE information, such as the link available bandwidth and delay. The OSPF selective flooding mechanism has been extended with opaque LSAs [13] support.

Advertisement messages are sent periodically or every time there is a relevant change in the stored TE information. For example, the flooding algorithm is triggered owing to a link failure or a variation of the available bandwidth due to a new LSP establishment.

Once the forwarding information is available, the RSVP-TE agent performs downstream on demand labels allocation and upstream distribution. Labels are received by downstream LSRs and passed to the MPLS classifier, so as to create the tables used for label switching.

The RSVP-TE agent is able to perform two additional procedures: Label Stacking and Penultimate Hop Popping. The former, which consists in managing multiple labels in a packet, is used to create a level of hierarchy in large networks, improving traffic flows scalability. The latter, instead, is used to simplify the operations executed on a labelled packet by the egress LER. This means that the penultimate LSR executes label popping, instead of label swapping. Then, it forwards an unlabelled packet towards the egress LER. To enable such a feature, the Label Information Base (LIB, see Data Plane description) has to contain additional information about the operation to be executed for the specific LSP.

The RSVP-TE agent is also responsible for the resource allocation process. In particular, it supports three reservation styles [15]:

- FF - Fixed Filter (the only already supported in the original NS2 RSVP module): a distinct reservation is made for each sender;
- WF - Wildcard Filter: a single reservation is shared by all the senders in the session;

- SE - Shared Explicit: a single reservation is shared by a set of senders, explicitly specified in the reservation message.

It is relevant to highlight that in MPLS networks, when RSVP-TE is used as signalling protocol, LSPs should be established in SE manner. This procedure is required by RSVP-TE to allow bandwidth sharing among several LSPs over common links.

II.c Data Plane

The data plane operations are the following:

- when a packet is received by an LSR, the MPLS classifier checks the packet headers;
- if the packet has a label or may be associated to a Forwarding Equivalence Class (FEC), the MPLS classifier executes label-based forwarding; otherwise, the packet is sent to the Address Classifier and standard IP routing is executed.

In the MTENS implementation, an MPLS node handles three tables to perform label switching:

- the Label Information Base (LIB), which include bindings between incoming (label, interface) and outgoing (label, interface) pairs;
- the Partial Forwarding Table (PFT), containing a subset of the information of the LIB;
- the Explicit Route information Base (ERB), which contain information about the Explicit-Route LSP (ER-LSP).

Upon receiving a labelled packet, a LSR performs a LIB look up to find the entry corresponding to the incoming label. Afterwards, two different procedures can be executed:

- if the LSR is the penultimate one, the label is removed. The packet is passed to the address classifier and forwarded according to the Layer 3 routing protocol, otherwise, the LSR replaces the incoming label with the outgoing one (Label Swapping) and performs label-based forwarding.
- If the packet has to be forwarded in an explicit way, the MPLS node also uses the ERB, which is managed by the service classifier, to map a flow into an Explicitly-

Routed LSP (ER-LSP). The PFT is used in packet forwarding only by the ingress LER. In this case, the node receives an unlabelled packet and uses the PFT to associate a label to the packet itself, which is then forwarded according to label switching mechanisms.

III MAIN FUNCTIONALITIES

In this section we describe the main MTENS functionalities, focusing on mechanisms for LSPs signaling (set-up, release) and recovery from failures, since they represent some of the most relevant features added to the simulator.

III.a LSP Establishment

The MPLS-TE network simulator allows the creation of different types of LSPs:

- basic: specifies that the LSP should be set-up, without any bandwidth reservation, following a path given by traditional routing protocols;
- rsvp-te-ff, rsvp-te-wf, rsvp-te-se: specify that bandwidth should be allocated according to the FF, WF, SE RSVP styles, respectively;
- erlsp: specifies that the LSP should be set-up along an explicit path, indicated in the script;
- crlsp-cspf, crlsp-wc, crlsp-wcs: specify that the LSP should be created using the path computed by the CSPF, Wang-Crowcroft (WC) [4] and Wang-Crowcroft with Sorting (WCS) [10] algorithms, respectively.

In all the cases, the Path message sent by the ingress LSR contains, in addition to the classical RSVP objects, a LABEL_REQUEST object, used to request the label to the downstream node.

Moreover, if the LSP is created following an explicit path (specified in the command or computed by the PCE), an EXPLICIT_ROUTE_OBJECT (ERO) is inserted in the Path message.

III.b LSP Recovery

Several MPLS recovery strategies can be handled by the MPLS-TE network simulator [16][17]:

- pre-allocated: specifies that protection switching is enabled;
- pre-computed: specifies that fast rerouting is enabled;
- reroute-cspf, reroute-wc: specify that on-the-fly rerouting is enabled. The backup LSP is created on demand, after the failure, using the path computed by CSPF or WC algorithm.

In all the cases, after a failure has occurred on a link of the primary LSP, a Path Error message and a Resv Error message are sent towards the ingress and the egress LER, respectively. Thus, the resource are released by the tear down messages and the scheduled recovery technique is activated.

IV. CONCLUSIONS

The paper highlights the most relevant features of MTENS, a new simulator specifically developed to aid network engineers in planning MPLS-TE networks. Basically, MTENS provides all the standard functionalities typically available in MPLS-TE networks, such as recovery strategies and traffic engineering extensions.

In addition, MTENS includes some constraint-based path computation algorithms that allow to allocate LSPs taking also into account their QoS requirements.

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CALL FOR CONTRIBUTIONS

Call for Contributions per Annotated Bibliographies for *The Communications Systems Integration and Modeling Technical Committee* **E-Letter**

Editors in Chief: Stefano Giordano, Charalabos Skianis
IEEE Communications Society

The E-letter of the Communications Systems Integration and Modelling Technical Committee of the IEEE Communications Society is an electronic publication that welcomes submissions of annotated bibliographies.

A considerable barrier to entry into a new field of research is to become aware of the existing literature on the topic. The Internet and search engines -such as IEEEExplore and, more recently, Google Scholar- have made access conference proceedings and journals immensely easier than it used to be.

However, speed and ease of access, by themselves, do not solve the problem of understanding the state of the art in a given field. Some form of intelligence is needed to filter the raw data represented by the very large number of available publications. Such intelligence may be acquired, in due time, by reading and attending conferences - or it may come from experts already working in the field.

To help fellow engineers and researchers to gain easier access to new fields of activities, the E-Letter of the Communications Systems Integration and Modelling Technical Committee (CSIM) invites experts in the field to submit annotated bibliographies on topics of their choosing.

It is expected that the annotated bibliographies could be of various kinds – from tutorial level bibliographies on the general field of multimedia communications to bibliographies on very specialized subtopics.

If technically feasible, we will adopt an open approach to bibliographies development. Instruments such as wiki are, in fact, making very easy to build knowledge repositories in a collaborative fashion, as shown, for instance, by the astounding success of wikipedia.org. Initial contributions could, therefore, if the original author agrees, be placed on a CSIM wiki to be integrated by comments and modifications made by the community at large. The E-letter will

periodically publish selected annotated bibliographies.

Possible topics for annotated bibliographies include, but are not limited to:

- Modeling and Simulation techniques for Integrated Communication Systems
- Simulation techniques for large-scale Networks
- Validation of Simulation Models with Measurements
- Wireless, Mobile, Ad hoc and Sensor Networks
- Integration of wireless/cellular networks and the Internet
- Next Generation Internet
- Autonomic Communication Systems
- Traffic Engineering and Analysis
- Overlay and Virtual Networks
- Cross-Layer Protocol Design
- Network Monitoring
- Internet Traffic Modeling
- Network Measurements
- Simulation and Fast Simulation Techniques
- Modeling, Design of Wireless Ad Hoc Networks
- Network Optimization and Resource Provisioning

Annotated bibliographies will be subject to peer review and, upon acceptance, published in an upcoming issue of the E-Letter. All authors should consider the general nature of the E-Letter's readers. Annotated bibliographies should not have been previously published and must not be submitted for publication as well.

Submission guidelines are as follows: length should be no more than 3000 words (four double column pages).

Annotated bibliographies should be submitted in pdf format by e-mail to the E-Letter Editor S. Giordano at s.giordano@iet.unipi.it.

Deadlines:

Our deadline for receiving annotated bibliographies articles is 60 days prior to the cover date.

CALL FOR CONTRIBUTIONS

Call for Perspective Articles for
The Communications Systems Integration and Modeling Technical Committee
E-Letter

 Editors in Chief: Stefano Giordano, Charalabos Skianis
 IEEE Communications Society

Present and future generation networks are offered as a combination of highly diversified technologies in the access, backhaul and core (e.g., wireless, mobile, fixed lines) enabling provision of heterogeneous services. For that reason communication systems integration and modelling exploits important innovations in technical parallel fields, from the physical layer up to the application layer. A beneficial aspect of this phenomenon is that it is pulling together an extremely diverse group of experts specializing in technical converging areas. Even though such an ever-evolving environment promotes interdisciplinary fusion, however, teachers, researchers and professionals of the discipline need access to the most current information about the concepts, issues, trends and technologies in this emerging field. The **E-Letter** of the **Communications Systems Integration and Modeling Technical Committee** wishes to become a fast medium that provides a comprehensive coverage of the most important definitions, concepts, issues, trends and technologies in the field of multimedia communications technology. To this aim, the **E-Letter** of the Communications Systems Integration and Modeling Technical Committee welcomes submissions of Perspective Articles. Perspectives are articles written from the point of view of an expert in the multimedia technology field. They should focus on a particular technology or technology-related issue and how that technology or technology-related issue is being implemented and is impacting the multimedia arena. The E-Letter is seeking perspective articles on the subject of multimedia as it applies to the broad spectrum of multimedia communications. Also manuscripts for short essays and opinions may be considered.

Possible topics include, but are not limited to:

- Modeling and Simulation techniques for Integrated Communication Systems
- Simulation techniques for large-scale Networks
- Validation of Simulation Models with Measurements

- Wireless, Mobile, Ad hoc and Sensor Networks
- Integration of wireless/cellular networks and the Internet
- Next Generation Internet
- Autonomic Communication Systems
- Traffic Engineering and Analysis
- Overlay and Virtual Networks
- Cross-Layer Protocol Design
- Network Monitoring
- Internet Traffic Modeling
- Network Measurements
- Simulation and Fast Simulation Techniques
- Modeling, Design of Wireless Ad Hoc Networks
- Network Optimization and Resource Provisioning

Selected articles will be peer-reviewed and, upon acceptance, published in an upcoming issue of the E-Letter. All authors should consider the general nature of *E-Letter's* readership. Manuscripts should not have been previously published and must not be submitted for publication elsewhere. The **basic format to follow** is:

- Introduce the technology or issue being discussed.
- Discuss the technology's current or future impact on multimedia communications.
- Discuss pros and cons of the technology/issue.
- Discuss what the author is doing regarding this technology/issue.

Other Guidelines are as follows:

- Length should be no more than 2,000 words (three double-column pages).
- Articles should contain no more than 3 Figures. Figures and tables count for 300 words.
- Articles must contain no more than six references.
- Articles should be submitted in a .pdf format by e-mail to the E-Letter Editor S. Giordano at s.giordano@iet.unipi.it.

Deadlines:

Our deadline for receiving completed articles is 60 days prior to the cover date.

CALL FOR CONTRIBUTIONS

Call for Columns for

The Communications Systems Integration and Modeling Technical Committee

E-Letter

Editors in Chief: Stefano Giordano, Charalabos Skianis
IEEE Communications Society

The **E-Letter** of the **Communications Systems Integration and Modeling Technical Committee** features columns written by recognized experts in all the technological fields related to Communications Systems Integration and Modeling. Columns should give to all the communications systems community partners a possibility to voice their views on the issues, challenges, and opportunities facing industry and academia in connection with the field of Communications Systems Integration and Modeling. Columns featured by the E-Letter of the Communications Systems Integration and Modeling Technical Committee are intended to become a fast medium that provides a comprehensive coverage of the most important issues, concepts, definitions, trends and techniques in the field. To this aim, the E-Letter is looking for a group of insightful and diligent volunteers to serve as regular (or sporadic) columnists on the 2006-2007 term. Columns will be considered on all the aspects of Communications Systems Integration and Modeling. The E-Letter offers an unparalleled opportunity for potential columnists to express thoughts and opinions to a community-wide audience provided that the following instructions are followed.

What does it mean to be a columnist for the E-LETTER?

It means keeping informed about Communications Systems Integration and Modeling issues, as well as news and scientific headlines. It means thinking about the issues that matter to readers in the context of the Communications Systems Integration and Modeling community. It means undertaking substantial research. It means writing clearly and effectively (perhaps provocatively) to demonstrate an opinion piece that can be easily followed.

What is a column for the E-Letter?

Columns are very brief articles in form of opinions, short essays, or news written from the point of view of an expert. Even though a column is, in essence, a timely and relevant piece of opinion writing, each

good E-Letter column should relate an opinion to the most relevant topics of the Communications Systems Integration and Modeling community. Also controversial issues can make for a great column, but only if they sound interesting for the Communications Systems Integration and Modeling community.

Who can be a columnist for the E-Letter?

Well known experts, skilled practitioners, professionals and researchers are welcome to submit ideas for E-Letter columns. Also contributions from Chairs or members of the various Interest Groups of the Communications Systems Integration and Modeling Technical Committee, as well as from any member of ComSoc, discussing issues related to the activities of their groups, are greatly appreciated. The real and final qualification is having something interesting to say about Communications Systems Integration and Modeling and its surrounding community, and a willingness to put in the necessary time and effort.

Selected columns will be evaluated by the E-Letter Editors and, upon approval, published in an upcoming issue of the E-Letter. The basic format to follow is:

- Length should be no more than 700 words in length (one double-column page).
- Columns should contain no Figures.
- Columns should contain no References.
- Columns should be submitted as plain text (ASCII) by e-mail to E-Letter Editor S. Giordano at s.giordano@iet.unipi.it.

Deadlines:

Our deadline for receiving columns is 15 days prior to the cover date.