TECHNICAL PROGRAM CHAIRS MESSAGE

Foreword

The 19th International Conference on Software, Telecommunications and Computer Networks (SoftCOM 2011) will be held in attractive ambience of the Amfora hotel September 15 & 16, and aboard the ship “Marko Polo”, September 17, visiting Dubrovnik. The Conference is organized by the University of Split, Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture under the auspices of the Ministry of Science, Education and Sports. The Conference is technically co-sponsored by the IEEE Communications Society (ComSoc).

Researchers and experts from industry, research institutes and universities from 31 countries all around the world have submitted in total 172 papers for presentation SoftCOM 2011. Submitted papers have been reviewed by more than 200 scientists from universities, institutes and ICT companies all over the world. All accepted papers have been carefully selected based on their contribution, relevance, conceptual clearness and overall quality. 54% of submitted papers have been recommended for presentation within the technical program.

The conference program features three special sessions, ten general conference sessions and a professional workshop dedicated to the wide spectra of topics in ICT. Besides that, the conference program features a symposium dedicated to the environmental electromagnetic compatibility and symposium on RFID technologies. In addition three half day tutorials will be held by worldwide recognized experts.

In conjunction with the SoftCOM 2011 conference a Business Forum has been organized featuring invited talks, round tables, presentations with participation of managers, executives, experts, government and institution representatives who will discuss and exchange opinions and experiences on a number of hot topics in contemporary and future ICT industry and market including business, technological and social aspects. A symposium on Roger Joseph Boscovich and presentation of Ericsson summer camp 2011 will be held too.

On behalf of the Program committee we would like to thank and credit the authors for their excellent contributions. Particular thanks to the reviewers for their great job as well as to the IEEE Communications Society (ComSoc) Technical Committee of Communication Software for the support. The fruitful collaboration with the universities from Ancona, Lecce, Colmar, Beira, Zagreb, and London has contributed to the quality of the Program significantly.

Program Committee Co-chairs
Nikola Rozic, Dinko Begusic
Tracks

- General Conference
- Symposia and Special Session
- Workshop on The Electronic Communications Regulatory Challenges - Experiences from the Looking to the Future Project
- Workshop on Information and Communication Technologies
- Symposium on Roger Joseph Boscovich, Dalmatian Prophet of Science
General Conference

- S1 - Communication Theory
- S2 - Interfaces and Communication Protocols
- S3 - Information Infrastructure and Security
- S4 - Consumer Communications Technologies
- S5 - Mobile and Wireless Communications I
- S6 - Networks Operations and Management
- S7 - Mobile and Wireless Communications II
- S8 - Internet and IP Based Environments
- S9 - Mobile and Wireless Communications III
- S10 - Communications Software
Symposia and Special Sessions

- Symposium on RFID technologies & the Internet of things
- Symposium on Environmental Electromagnetic Compatibility (EEMC)
- Special Session on Ad Hoc and Sensor Networks
- Special Session on Green Networking
- Special Session on QoS in Wired and Wireless Networks
Symposium on RFID technologies & the Internet of things

Symposium organizer: Luigi Patrono, University of Lecce, Italy
Symposium chair: Luigi Patrono, University of Lecce, Italy

- **SYM1 / I** - Symposium on RFID technologies & the Internet of things I
- **SYM1 / II** - Symposium on RFID technologies & the Internet of things II
- **SYM1 / III** - Symposium on RFID technologies & the Internet of things III
- **SYM1 / IV** - Symposium on RFID technologies & the Internet of things IV
SYM 1/I - Symposium on RFID technologies & the Internet of things

Symposium organizer: Luigi Patrono, University of Lecce, Italy
Chair: Luigi Patrono, University of Lecce, Italy

- RFID Tag Readability around White Wine Bottles
  Isabel Exposito, Iñigo Cuiñas (University of Vigo, Spain)

- Towards RFID Traceability Systems of Farmed Fish Supply Chain
  Mira Trebar, Andrej Grah (University of Ljubljana, Slovenia); Alejandro Alvarez-Melcon, Alfredo Parreño (Technical University of Cartagena, Spain)

- RFID and WSNs for Traceability of Agricultural Goods from Farm to Fork: Electromagnetic and Deployment Aspects on Wine Test-Cases
  Luca Catarinucci (University of Salento, Italy); Iñigo Cuiñas, Isabel Exposito (University of Vigo, Spain); Riccardo Colella (University of Salento, Italy); Jose Antonio Gay Fernandez (University of Vigo, Spain); Luciano Tarricone (University of Salento, Italy)

- Evolution of Wireless Sensor Networks towards the Internet of Things: a Survey
  Luca Mainetti, Luigi Patrono (University of Salento, Italy); Antonio Vilei (STMicroelectronics, Italy)

- Path Following for Indoor Robots with RFID Received Signal Strength
  Ran Liu, Philipp Vorst, Artur Koch, Andreas Zell (University of Tuebingen, Germany)
SYM 1/II - Symposium on RFID technologies & the Internet of things

Symposium organizer: Luigi Patrono, University of Lecce, Italy
Chair: Luigi Patrono, University of Lecce, Italy

- Towards a framework for evaluating the benefits of RFID adoption in supply chains
  Luca Cremona, Matteo Della Bordella (Università Carlo Cattaneo); Luca Mainetti (University of Salento, Italy); Luca Mari (Università Carlo Cattaneo); Luigi Patrono (University of Salento, Italy); Aurelio Ravarini (Università Carlo Cattaneo)

- Lightweight Matrix-based Authentication Protocol for RFID
  Vinod Ramachandra, Md. Musfiq Rahman, Srinivas Sampalli (Dalhousie University, Canada)

- On the Weakness of Contactless System under Relay Attacks
  Pierre-Henri Thevenon, Olivier Savry (CEA, France); Smail Tedjini (LCIS, France)

- Minimization of energy consumption in passive HF contactless and RFID systems
  Pierre-Henri Thevenon, Olivier Savry (CEA, France); Smail Tedjini (LCIS, France)

- Design and Development of a Social Shopping Experience in the IoT domain: the ShopLovers solution
  Ugo Biader Ceipidor, Carlo Maria Medaglia, Valentina Volpi, Alice Moroni, Serena Sposato, Manuele Tamburrano (Sapienza University of Rome, Italy)
SYM 1/III - Symposium on RFID technologies & the Internet of things

Symposium organizer: Luigi Patrono, University of Lecce, Italy
Chair: Luigi Patrono, University of Lecce, Italy

- Experimental Validation of Wireless Localization Techniques in IEEE802.15.4 Networks
  Besem Abid, Matteo Petracca, Paolo Pagano, Stefano Bocchino, Daniele Alessandrelli (Scuola Superiore Sant'Anna, Italy)

- Event-based Location Detection
  Johannes Westhuis, Jürgen Dunkel, Ralf Bruns (Hanover University of Applied Sciences and Arts, Germany)

- Signal Modeling and Processing for Physiological Sensing through UWB Radars
  Marco Baldi, Franco Chiaraluce, Matteo Moretti, Francesco Venieri, Blerina Zanaj (Università Politecnica delle Marche, Italy)

- 0.469 PDFSA protocol for RFID Arbitration
  Luca Barletta, Flaminio Borgonovo, Matteo Cesana (Politecnico di Milano, Italy)

- SystemC Modeling of RFID Systems for Robustness Analysis
  Gilles Fritz (Grenoble INP - LCIS, France); Vincent Berouille (Lcis-Esisar-Inpg, France); Oum-El-Kheir Aktouf, David Hély (Grenoble INP - LCIS, France)
SYM 1/IV - Symposium on RFID technologies & the Internet of things

Symposium organizer: Luigi Patrono, University of Lecce, Italy
Chair: Luigi Patrono, University of Lecce, Italy

- Use of NFC and QR code Identification in an Electronic Ticket System for Public Transport
  Luka Finžgar, Mira Trebar (University of Ljubljana, Slovenia)

- Distributed Monitoring System for Material Handling
  Heinz Lugo (Loughborough University, United Kingdom); Julien Viret (Research Associate, United Kingdom); Axel Bindel, Paul Conway, Andrew West (Loughborough University, United Kingdom)

- Design and FDTD Analysis of Single-Band and Dual-Band Antennas for RFID and WiMAX Applications
  Nazish Irfan, Mustapha C.E. Yagoub (University of Ottawa, Canada); Khelifa Hettak (Communications Research Centre (CRC), Canada)
Symposium on Environmental Electromagnetic Compatibility

Symposium organizers: Dragan Poljak, Vesna Roje, University of Split, Croatia
Symposium co-chairs: Dragan Poljak, Vesna Roje, University of Split, Croatia

- SYM2 / I - Symposium on Environmental Electromagnetic Compatibility I
- SYM2 / II - Symposium on Environmental Electromagnetic Compatibility II
- SYM2 / III - Symposium on Environmental Electromagnetic Compatibility III
SYM2 / I - Symposium on EEMC

Symposium organizers: Dragan Poljak, Vesna Roje, University of Split, Croatia
Symposium co-chairs: Dragan Poljak, Vesna Roje, University of Split, Croatia

- An Improved Algorithm for Indirect Time domain Analysis of Thin Wire Structures
  Sinisa Antonijevic, Vicko Doric, Dragan Poljak (University of Split, Croatia)

- Assessment of SAR Distribution in the Human Eye and Pregnant Woman Models at GSM Frequencies Using FEKO Software Package
  Zlatko Zivkovic, Duje Despalatovic, Dragan Poljak, Antonio Sarolic (University of Split, Croatia);
  Khalil El Khamlchi Drissi (Universite Blaise Pascal, France)

- Analysis of Arrays of Printed Strip Dipole Antennas
  Ruzhdi Sefa (University of Prishtina, Kosova); Faton Tefiku (Nokia, Inc, USA); Arianit Maraj
  (University of Prizren, Kosova)

- Design and Testing of a Diode-Based Electric Field Probe Prototype
  Zlatko Zivkovic, Damir Senic, Antonio Sarolic, Ante Vucic (University of Split, Croatia)

- Influence of Human Head and Hand on PIFA Antenna Matching Properties and SAR
  Antonio Sarolic, Damir Senic, Zlatko Zivkovic, Ante Zorica (University of Split, Croatia)
SYM2 / II - Symposium on EEMC

Symposium organizers: Dragan Poljak, Vesna Roje, University of Split, Croatia
Symposium co-chairs: Dragan Poljak, Vesna Roje, University of Split, Croatia

- **Full Wave Model versus Transmission Line Representation of Tesla's Wave Propagation: 155th Anniversary of Birth of Nikola Tesla**
  Dragan Poljak, Zoran Blažević, Silvestar Sesnic, Mario Cvetković (University of Split, Croatia)

- **HF Comparison of Image and TL Models of a Horizontal Thin-Wire Conductor in Finitely Conductive Earth**
  Vesna Arnautovski-Toseva (University Blaise Pascal, France); Khalil El Khamlichi Drissi (Universite Blaise Pascal & LASMEA Laboratory, France); Kamal Kerroum (University of Clermont Ferrand, France)

- **Analysis of Grounding Electrode Input Impedance Calculation**
  Damir Cavka, Dragan Poljak (University of Split, Croatia)

- **Lightning electromagnetic field of a double-peaked channel-base current**
  Vesna Javor (University of Nis, Faculty of Electronic Engineering, Serbia)
SYM2 / III - Symposium on EEMC

Symposium organizers: Dragana Poljak, Vesna Roje, University of Split, Croatia
Symposium co-chairs: Dragana Poljak, Vesna Roje, University of Split, Croatia

- **An Algorithm to Simulate Impulsive Noise**
  Pablo Torío, Manuel García Sánchez, Iñigo Cuiñas (University of Vigo, Spain)

- **Impulsive Noise Rejection by Polarization Orthogonality in OFDM**
  Pablo Torío, Manuel García Sánchez (University of Vigo, Spain)

- **Researching the Different Polarizations of Impulsive Noise**
  Pablo Torío, Manuel García Sánchez (University of Vigo, Spain)

- **Using Wavelets to Define and Detect Harmonic Fingerprints in Non-Sinusoidal Waveforms**
  Ileana Nicolae, Marian-Stefan Nicolae (University of Craiova, Romania)
SS1 - Special Session on Ad Hoc and Sensor Networks

Special Session organizer: Joel Rodrigues, University of Beira Interior, Portugal
Chair: Mario Čagalj, University of Split, Croatia

- Hierarchical Duty Cycle Management (HDCM) protocol
  Danilo Blasi (STMicroelectronics, Italy)

- A Collaborative Target Tracking Algorithm Considering Energy Constraint in WSNs
  Vinh Tran-Quang (Shibaura Institute of Technology & Hanoi University of Technology, Japan); Phat Nguyen Huu, Takumi Miyoshi (Shibaura Institute of Technology, Japan)

  Emmanuel Baccelli, Matthias Philipp (INRIA, France); Mukul Goyal (University of Wisconsin - Milwaukee, USA)

- Efficient Motion Estimation Algorithm Using Edge Feature and Arithmetic Coding for Video Compression on WVSNs
  Phat Nguyen Huu (Shibaura Institute of Technology, Japan); Vinh Tran-Quang (Shibaura Institute of Technology & Hanoi University of Technology, Japan); Takumi Miyoshi (Shibaura Institute of Technology, Japan)

- Hybrid Detection Method for Cognitive Radio
  Tanuja Dhope, Dina Simunic (University of Zagreb, Croatia); Ramjee Prasad (Aalborg University, Denmark)
SS2 - Special Session on Green Networking

Special Session Organizers: Antonio Capone, Politecnico di Milano, Italy; Josip Lorincz, University of Split, Croatia
Chair: Josip Lorincz, University of Split, Croatia

- **Energy-efficient cryptography: application of KATAN**
  Sergey P Panasenko, Sergey Smagin (Ancud Ltd., Russia)

- **Energy-aware flow allocation algorithm for Energy Efficient Ethernet networks**
  Isaac Seoane, José Alberto Hernández (Universidad Carlos III de Madrid, Spain); Pedro Reviriego (Universidad Antonio de Nebrija, Spain); D. Larrabeiti (Universidad Carlos III de Madrid, Spain)

- **Energy-Aware Retransmission Scheme for Multimedia Delivery over Wireless Networks**
  Deema Abdallah, Sanaa Sharafeddine (Lebanese American University, Lebanon)
**SS3 - Special Session on QoS in Wired and Wireless Networks**

**Special Session organizer:** Pascal Lorenz, University of Haute Alsace, France  
**Chair:** Pascal Lorenz, University of Haute Alsace, France

- Using Temporal Neural Networks to Forecasting of Broadband network faults  
  Željko Deljac (HT-Hrvatski telekom, Croatia); Marijan Kunstic (University of Zagreb, Croatia); Boris Spahija (HT-Hrvatski telekom, Croatia)

- Capacity Maximizing Cell-Selection in Heterogeneous Cellular Networks  
  Jeong Soo Park, Gil-Su Heo, Yong-Hwan Lee (Seoul National University, Korea)

- Infrastructure-Dependent Wireless Multicast over 802.11n WLAN  
  Jean Vella, Saviour Zammit (University of Malta, Malta)
Workshop on The Electronic Communications Regulatory Challenges - Experiences from the Looking to the Future Project

Session Chair: Antun Caric, HAKOM, Croatia

- **Broadband Ecosystem for Rural Areas in the Republic of Croatia**
  Antun Caric (Croatian Agency for Post and Electronic Communications, Croatia); Danijel Mileta (Ministry of the Sea, Transport and Infrastructure, Croatia); Josip Šajnović (Croatian Post and Electronic Communications Agency, Croatia)

- **Next Generation Network and Regulatory Challenges**
  Ignac Lovrek (University of Zagreb, Croatia); Dražen Lučić, Gašper Gaćina (Croatian Post and Electronic Communications Agency, Croatia)

- **Workshop: The Electronic Communications Regulatory Challenges - Experiences from the Looking to the Future Project Croatian approach to Digital Dividend**
  Ivančica Sakal, Željko Tabaković (Croatian Post and Electronic Communications Agency, Croatia); Sonja Grgic, Dijana Tralić (University of Zagreb, Croatia)

- **Overview of Looking to the Future Project**
  Mario Weber (Croatian Post and Electronic Communications Agency, Croatia); Gordan Jezic (University of Zagreb, Croatia); Miljenko Krvisek (Croatian Post and Electronic Communications Agency, Croatia)
Workshop on The Electronic Communications Regulatory Challenges - Experiences from the Looking to the Future Project

Session Chair: Antun Caric, HAKOM, Croatia

- Findings of the Public Consultation on Network Neutrality in Croatia: Report and Analysis
  Zdravko Jukic, Mario Weber (Croatian Post and Electronic Communications Agency, Croatia); Maja Matijasevic (University of Zagreb, Croatia)

- Next Generation Access and Investment issues
  Ivana Dražić Lutilsky (University of Zagreb, Croatia); Domagoj Jurjević (HAKOM, Croatia); Marina Ivic (University of Zagreb, Croatia)

- Towards Assessment of IPv6 Readiness, Deployment and Transition Plans in Croatia
  Velimir Švedek (Croatian Post and Electronic Communications Agency, Croatia); Ognjen Dobrijevic, Maja Matijasevic (University of Zagreb, Croatia); Ivana Golub, Tomislav Stivojevic (CARNet, Croatia)
S1 - Communication Theory

Session Chair: Fulvio Babich, University of Trieste, Italy

- System Performance Enhancement for T-Code Family
  S. Saleh Hosseini Bidaki, Mostafa Shahabinejad (Shahid Bahonar University of Kerman, Iran)

- The Enhancement of System Performance in Quasi-Orthogonal Space-Time-Frequency Codes
  Mostafa Shahabinejad, Alireza Morsali (Shahid Bahonar University of Kerman, Iran)

- Turbo Codes Construction for Robust Hybrid Multitransmission Schemes
  Fulvio Babich, Francesca Vatta (University of Trieste, Italy)

- Distortion Estimation Algorithms for Real-Time Video Streaming: an Application Scenario
  Fulvio Babich, Marco D'Orlando, Francesca Vatta (University of Trieste, Italy)
S2 - Interfaces and Communication Protocols

Session Chair: Mladen Russo, University of Split, Croatia

- A Channel-Aware Reservation Protocol for Cooperative Content Distribution over OFDMA Networks
  Elias Yaacoub (Qatar University Wireless Innovations Center (QUWIC), Qatar); Lina Al-Kanj, Zaher Dawy (American University of Beirut, Lebanon); Sanaa Sharafeddine (Lebanese American University, Lebanon); Adnan Abu-Dayya (QUWIC, Qatar)

- QoS-enabled IPv6 Emulation Environment Based on the Open IMS Core
  Tomislav Grgic, Niko Boskovic, Maja Matijasevic (University of Zagreb, Croatia)

- Throughput Analysis of a Cognitive Multi-hop IEEE 802.11-based WLAN Overlaid on a Cellular Network
  Hosein Soleimani, Farid Ashtiani (Sharif University of Technology, Iran)

- Context-Based Natural Image Parsing: A Critical Survey
  Toma Roncevic, Maja Braovic, Darko Stipaničev (University of Split, Croatia)

- Accelerometer-Based Gesture Classification Using Principal Component Analysis
  Tea Marasović, Vladan Papic (University of Split, Croatia)
S3 - Information Infrastructure and Security

Session Chair: Hrvoje Dujmić, University of Split, Croatia

- Massey Omura Multiple Users Key Distribution
  Danilo Merlanti, Gianluca Mazzini (University of Ferrara, Italy)

- XCS based hidden firmware modification on embedded devices
  Boldizsár Bencsáth, Levente Buttyan, Tamás Paulik (Budapest University of Technology and Economics, Hungary)

- An architecture for threats detection in mobile operators networks
  Mario Di Mauro, Roberto Garufi (Co.Ri.Tel, Italy); Fabio Postiglione, Paolo Addesso, Rocco Restaino, Maurizio Longo (University of Salerno, Italy); Andrea Senatore, Anton Luca Robustelli (Ericsson, Italy);

- Proof of Proximity with 802.11 Wireless LAN
  Till Wollenberg, Thomas Mundt (University of Rostock, Germany)
A Linear Regression based Cost Function for WSN Localization
Frank Vanheel (Ghent University & University College Ghent, Belgium); Jo Verhaevert (University College Ghent, Belgium); Eric Laermans (UGent, Belgium); Ingrid Moerman (Ghent University - IBBT, Belgium); Piet Demeester (Ghent University, Belgium)

RecoMMobile: A spatiotemporal recommender system for mobile users
Igor Sambolec, Ivan Rukavina, Vedran Podobnik (University of Zagreb, Croatia)

MHP Application for a Self Evaluation Service
Elisa Benetti, Gianluca Mazzini (University of Ferrara, Italy)

Validation of PM MAPPER aerosol optical thickness retrievals at 1×1 km2 of spatial resolution
Piero Campalalani (University of Ferrara & MEEO Srl, Italy); Thi Nhat Thanh Nguyen (University of Ferrara, Italy); Simone Mantovani (Meeo Srl, Italy); Maurizio Bottoni (SISTEMA GmbH, Austria); Gianluca Mazzini (University of Ferrara, Italy)
S5 - Mobile and Wireless Communications I

Session Chair: Dragana Krstic, University of Niš, Serbia

- Joint Modeling of Network Related Events with Multi-Dimensional Markov Modulated Deterministic Processes
  Paulo Salvador, António Nogueira, Rui Valadas (University of Aveiro & Instituto de Telecomunicações, Portugal); António Pacheco (CEMAT, Portugal)

- Optimized Resource Allocation for Video Transmission over Multihop Networks with End-to-End Statistical Delay Bound
  Amin Abdel Khalek (The University of Texas at Austin, USA); Zaher Dawy (American University of Beirut, Lebanon)

- The Application of GIS in Designing of Wireless Communication Systems with SC Combining in the Presence of Ricean Fading
  Dragana Krstic, Goran Stamenović (University of Niš, Serbia); Stefan Panic (Faculty of Natural Sciences and Mathematics, Serbia); Zoran Popović, Dejan Rancic, Mihajlo Stefanovic (University of Niš, Serbia)
Implicit SIP Proxy Overload Detection Mechanism based on Response Behavior
Marco Happenhofer, Christoph Egger (Vienna University of Technology, Austria)

SIP Proxy High-Load Detection by continuous Analysis of Response Delay Values
Christoph Egger, Marco Happenhofer (Vienna University of Technology, Austria); Peter Reichl
(Telecommunications Research Center Vienna (FTW) & Université Européenne de Bretagne,
Rennes, Austria)

Multistage SPIT Detection in Transit VoIP
Muhammad Ajmal Azad, Ricardo Morla (University of Porto, Portugal)

Availability Modeling of Grid Computing Environments Using SANs
Reza Entezari-Maleki, Ali Movaghar (Sharif University of Technology, Iran)

Modeling Filtering Predicates Composition with Finite State Automata
Marco Leogrande, Luigi Ciminiera, Fulvio Risso (Politecnico di Torino, Italy)
S7 - Mobile and Wireless Communications II

Session Chair: Alice Masini, University of Ferrara, Italy

- **Code Assignment and Reassignment to reduce new code blocking in WCDMA networks**
  Vipin Balyan, Davinder Singh Saini (Jaypee University of Information Technology, India)

- **Multi Code Assignment with Minimum Number of Rakes for OVSF CDMA**
  Vipin Balyan, Davinder Singh Saini (Jaypee University of Information Technology, India)

- **Mutual Interference Evaluation in Cognitive Radio Networks with Log-normal Shadowing**
  Alice Masini, Gianluca Mazzini (University of Ferrara, Italy); Guido Riva (Fondazione Ugo Bordoni, Italy)

- **Reducing the Number of Iterations in Iterative Demodulation with Turbo Decoding**
  Salim Haddad, Amer Baghdadi, Michel Jezequel (Telecom Bretagne, France)

- **Wireless Security Threats: Eavesdropping and Detecting of Active RFIDs and Remote Controls in the Wild**
  Timo Kasper, David Oswald, Christof Paar (Ruhr-University Bochum, Germany)
S8 - Internet and IP Based Environments

Session Chair: Miljenko Mikuc, University of Zagreb

- Deploying New Hash Algorithms in Secure Neighbor Discovery
  Valter Vasić, Ana Kukec, Miljenko Mikuc (University of Zagreb, Croatia)

- Peer-to-Peer for Unreliable Multicast
  Danilo Merlanti, Gianluca Mazzini (University of Ferrara, Italy)

- A Multi-Variate Classification Approach for the Detection of Illicit Traffic
  Eduardo Rocha, Paulo Salvador, António Nogueira (University of Aveiro & Instituto de Telecomunicações, Portugal)

- Observer network Web based statistical evaluation
  Ljiljana Seric, Tihana Bodrožić, Darko Stipaničev, Toni Jakovcevic (University of Split, Croatia)

- Design and Implementation of Web Service Honeypot
  Abdallah Ghourabi, Tarek Abbes, Adel Bouhoula (University of Carthage, Tunisia)
S9 - Mobile and Wireless Communications III

Session Chair: Vicko Doric, University of Split

- **Power Efficient Femtocell Distribution Strategies**
  Yoram Haddad (Ben Gurion University of the Negev & Jerusalem College of Technology, Israel); Yisroel A Mirsky (Jerusalem College of Technology, Israel)

- **MPeersim: Simulation Environment for Mobile P2P Networks**
  Muhammad Adeel, Laurissa N. Tokarchuk (Queen Mary University of London, United Kingdom)

- **Performance Analysis of a new Mobility/QoS-aware Architecture**
  Nuno Vasco Lopes, Maria João M. R. da C. Nicolau (University of Minho, Portugal); Alexandre Santos (University of Minho & R&D Centre Algoritmi, Portugal)

- **A Desktop Ultra-Wideband Radio Channel Analysis**
  Zoran Blažević, Duje Čoko, Ivan Plavčić, Toni Jurišić Sokić (University of Split, Croatia)
Evaluation of A New Multipath Congestion Control Scheme using the NetPerfMeter Tool-Chain
Thomas Dreibholz, Martin Becke, Hakim Adhari, Erwin P. Rathgeb (University of Duisburg-Essen, Germany);

NEPI: An Integration Framework for Network Experimentation
Alina Quereilhac (INRIA, France); Mathieu Lacage (INRIA Sophia Antipolis, France); Claudio Freire, Thierry Turletti, Walid Dabbous (INRIA, France)

Multicore SIP Parsing with Imperative and Declarative Implementations
Ivan Skuliber (Ericsson Nikola Tesla corp. & Faculty of Electrical Engineering and Computing, University of Zagreb, Croatia); Vedrana Jankovic, Ruzica Zec (Faculty of Electrical Engineering and Computing, Croatia)

Case Study on Performance of a Group Communication System in the realm of Voice over IP
Stefan Kohlhauser, Thomas Turek, Josef Mitterbauer, Heimo Zeilinger (Vienna University of Technology, Austria); Michael Kreilmeier (Frequentis AG, Austria)
Case Study on Performance of a Group Communication System in the realm of Voice over IP

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Abstract: To achieve availability and reliability, distributing data over several nodes within a network is widely used today. But distributing data to all nodes within a network becomes complicated if data should stay consistent while all of the nodes are allowed to insert, update or delete data. Common approaches focus on solutions where applications rely on replication algorithms and mechanisms provided by database systems. Instead the authors take another approach where the distribution of data is performed before the data is actually committed to the database system and thus, freeing the database system from the task of replication. To do so, a system that provides reliable data distribution and ordering mechanisms is necessary, placed between the application and the database system. In this paper we present a prototype of a redundant SIP-server that uses a Group Communication System to distribute data wherein the Group Communication System takes care of reliably delivering transactions to the nodes of a distributed database system in the same order. The implementation is explained and the corresponding results of a few test cases are presented.

1. INTRODUCTION

The increasing rate at which new concepts and technologies are being introduced alters not only equipment and tools we use in our daily lives but also alters the way we communicate. Innovations in telecommunications reinforce this trend. Voice over Internet Protocol (VoIP) is a concept and technology to make calls using packet-switched networks instead of circuit-switched networks, offering efficiency and flexibility. The former derives from consolidation of network components and links whereas the latter derives from open and standardized architectures and protocols. Thus, solutions based on VoIP have found their way into domains that long have been the market of closed (proprietary) instead of open communication systems e.g. in safety and security critical application areas. In this paper, safety is considered as “…the ability of a system not to cause environmentally harming events, due to loss of mission critical information” [1, p. 1] whereas security is considered as “…the protection of assets from threats, where threats are categorized as the potential for abuse of protected assets” [2, p. 21].

As mission critical communication systems consist of numerous hardware and software components, any of these can cause faults and lead to failures, resulting in network and service downtimes. Thus, redundancy has to be added to all sections of the communication system. A common approach for keeping information within a group of systems or devices up-to-date is based on replication algorithms and mechanisms. In this case replication is defined, according to [3, p. 273-275], as managing several copies of the same data. Different approaches have been discussed for data replication and consistency. Examples would be the primary/backup approach [4], invalidation or write-back in shared virtual memory [5], or quorum based protocols for replicated data [6]. Most of these mechanisms are concerned with who is allowed to write a certain data set in order to keep the data consistent.

In contrast, the approach presented by the authors uses a Group Communication System (GCS) for the ordered distribution of data instead of using database replication mechanisms. The main difference to the aforementioned mechanisms is that the write operations are performed in the same order on all replicas of the data sets and thus, preserving the consistency of the replicas.

The main goal of the work was not to implement a complete replication mechanism based on a GCS, because this has been done already by others (e.g. [7]). In contrast to [8] discussing performance and scalability issues in implementations of open source GCSs, the focus of this work lies in the integration of a GCS into a network of SIP-server for data distribution. The data distribution becomes necessary if one of the servers is not reachable anymore. Especially the performance potentials of this approach were of interest.

Chapter 2 describes the two common strategies for GCSs. In Chapter 3 the OpenSER SIP-server and Spread Toolkit are presented. Chapter 4 describes the test cases and results.

2. STATE OF THE ART

The idea of using GCSs for data replication is not new. Wiesmann [9] describes some of the issues of data replication using GCSs. Some issues mentioned are for example determinism of the execution in the database, high-level transaction decomposition, or unilateral aborts. These issues have been addressed at one point or another, for example in [10]. However, issues regarding the database itself will not be addressed in detail in this section, since they were not in the focus of the presented work. This is due to the fact that the data distribution is decoupled from the actual execution of the transaction on the database.
The implementation of the data distribution system described in this paper relies on GCSs for handling the connection and message transfer tasks. GCSs are software platforms which allow clusters of computers to connect with each other in virtual groups. The first main task of a GCS is to keep track of the computer nodes, which are currently members of a group. The second main task of a GCS is to reliably distribute messages between the group members.

If a node is connected to a group it can send messages to the group which are distributed among the members via multicast. If a node does not receive a message it can be retransmitted via unicast.

Basically GCSs can rely on two different strategies of how they are handling group membership and data distribution. The first is 2 phase / 3 phase commit. The second is (extended) virtual synchrony. The downsides of the 2 phase / 3 phase commit are the central coordinator for the transactions which poses as a single point of failure. Also the members and coordinator are blocked during the voting process. In the following we will take a closer look at extended virtual synchrony which is used by Spread Toolkit.

In contrast to 2 phase / 3 phase commit in virtual synchrony there is no central coordinator. At every point in time a certain number of nodes is part of a group. This collection of current members is called a view. If a member joins or leaves the group a new view is installed and distributed among the group members. If a member is sending a multicast message to the group it is distributed among the nodes included in the current view.

The important part of virtual synchrony is that a group view poses as a barrier that no multicast can pass. If a message is sent during a view it has to be received by all the members of the view or by none. If a change of the group view should take place, it can only happen after all previous messages have been delivered to all members of the previous group view.

The messages can be delivered in orderings of differing strictness. Tanenbaum and van Steen [3, p. 351-352] mentions four different modes of message ordering:

- Reliable unsorted multicast
- First In / First Out (FIFO) ordered multicast
- Causally ordered multicast
- Totally ordered multicast

Only the last message ordering mode is of interest here where the GCS guarantees that the messages are delivered to all applications in the same order. However, it is sometimes necessary that messages are delivered despite the fact that the sender disconnected before the message has been delivered to all the group members. Another problem that has to be dealt with is the possibility of a network partitioning. In extended virtual synchrony a transitional view can be installed, which provides an intermediate group view that is maintained until all pending messages have been delivered and a regular group view can be installed.

3. CONCEPT

The system we are about to present consists of two main parts: The OpenSER SIP-server and the Spread Toolkit as Group Communication System. These will be described shortly in the following. For a more detailed description on these parts refer to the relevant documentation.

3.1 OpenSER

OpenSER [11] is a free server application for the Session Initiation Protocol (SIP). Its task is to be an exchange authority in Voice over IP (VoIP) or other communications. It is written in C and runs on Unix/Linux systems.

SIP is a protocol on the application layer for the establishment, modification and termination of multimedia sessions, which is considered to be an exchange of messages between one or more participants. It is specified in RFC3261 [12]. As its name suggests, it is mainly concerned with the signaling part of data exchange. For the negotiation of multimedia session parameters e. g. media transport protocol, ports, codecs, etc. Session Description Protocol (SDP, RFC4566 [13]) is used.

The communication between SIP endpoints (phones, soft phones, etc.) is based on the client/server model. For this, certain information is stored by the OpenSER. This information can be for example a user’s logical and physical identity or its location. Usually, this is done by maintaining a database about the user’s identity and location.

OpenSER consists mainly of two parts. The core functionality and the modules which make OpenSER adaptable. The main concern for this paper is the database functionality. An interface with database API functions is provided for the modules allowing different database management systems (DBMS) to be used. OpenSER comes with a simple in memory database called dbText. In its original implementation the database entries are stored as a sequential list. If performance is an issue this can become the bottleneck for database operations. In the worst case for an operation, the whole set of database entries has to be searched resulting in an O(n) execution time. Since this would be the limiting factor of the system the structure of the data sets in memory was changed to a tree structure. This results in a worst case search time for a specific data set of O(log n).

3.2 Spread Toolkit

The Spread Toolkit [14] is an open source GCS developed by Spread Concepts LLC implementing the mechanisms of extended virtual synchrony.

Central for the GCS functionality and message delivery are the Spread demons. In the config file the demons are pooled into segments. Only demons represented in the segment can communicate with each other. All demons share the same group view but they can also join multiple groups.
The segment is represented as a list. The first running node in this list becomes the token master for the group.

In Spread the sending of messages is coordinated through the usage of a token. Some timeout properties for the token can be set in the source code. By this the performance of the Spread system can be tweaked to some extent.

If an application wants to use the functionality of Spread it has to connect to a local or remote Spread demon. After the connection is established the application has to join a group. The sending of messages happens via a multicast which can be sent to one or several groups. The standard send function allows sending char messages of a length up to 100 Kbytes. Any data type, even complex data types, can be sent using a Spread specific struct. After the message has been converted the message can be delivered to the other members of the group.

4. PROOF OF CONCEPT

4.1 Prototype implementation

The created module for data replication via a GCS is called dbReplicate_gcs. The new module was placed between the OpenSER database API, the Sped Toolkit and the dbText database module. This setup is depicted in Figure 1.

The transaction information is sent to the dbReplicate_gcs via the database API functions. The information has then to be converted to a char array for sending via the Spread Toolkit.

One of the interesting parts of these tests was of course the measuring of the time for sending these messages and inserting them into the database. As can be seen in Scenario B in Figure 3 some of the timing tests were done across the network. This means that some timings had to be taken when one computer was sending the message and another was receiving and inserting the data in to the database.

In order to make a valid statement about the time measurements the clocks of the involved computers had to be synchronized. This was done using the Network Time Protocol (NTP). After the message encoding the time at the current computer was taken and added to the message before it was sent.

The encoded message was then passed to the sending function of the Spread Toolkit. Spread was sending the messages via multicast to the other nodes. For message delivery a total ordering was chosen. After receiving the message a separated thread in the dbReplicate_gcs fetched the message from Spread. The message was decoded and parsed back into the initial data structure. The resulting data structure was then passed to the dbText database module. The time was taken between the message decoding and the insertion into the database and again after the insertion. These results were inserted into a log file and an average of the timings was calculated.

When a data set is inserted into the dbText a unique identifier is given to the data set. This identifier is a sequential number. This was used in order to check for the ordering of the messages. If there were any differences in the transaction sequence of the databases the identifier and the rest of the data set would have been a mismatch. However, using a Python script for comparing the database entries, no differences were found, which indicates that the transactions were done to the databases in the same order.

4.2 Simulation and results

In order to validate and verify the prototype implementation, a few tests have been performed by an architecture consisting of servers running SIPp [15], an open-source test tool for SIP, the new module dbReplicate_gcs, located between OpenSER and its module dbText (in-memory database) and Spread Toolkit.

In the author’s point of view two scenarios are worth to be discussed:

- One application connects to its local Spread daemon and passes the location data (registration information) to it. The Spread daemon in turn passes the location data (registration information) back to the application (scenario A, see Figure 2).
- One or more applications connect to their local Spread daemons and pass the location data (registration information) to them. The Spread daemons cooperate and in turn pass the location data (registration information) back to the applications (scenario B, see Figure 3).

In both scenarios, two test-cases with different message rates have been performed to observe the timings of the overall system. The first test-case is referred to inserting new location data (registration information) whereas the latter test-case is referred to updating existing location data (registration information).
Scenario A is depicted in Figure 2 wherein one SIP User Agent (SIPp1) sends SIP messages to one application (App1). The application in turn forwards the location data (registration information) to the local Spread daemon (Sd1). The local Spread daemon returns the location data (registration information) to the application. Described in more detail, the new module dbReplicate_gcs, located between OpenSER and its module dbText (in-memory database) as well as a Spread daemon are running on the same server (S1). Thus, the new module dbReplicate_gcs running on S1 is connected to the Spread daemon running on S1. In case of processing SIP messages, OpenSER passes the location data (registration information) to the new module dbReplicate_gcs which in turn forwards it to the local Spread daemon. The local Spread daemon returns the location data (registration information) to the new module dbReplicate_gcs, storing it on S1 by the use of the module dbText (in-memory database).

The test-results of scenario A are listed in Table 1, showing the minimum, maximum and average delay (time difference between sending messages to and receiving messages from the Spread daemon). It is calculated by the new module dbReplicate_gcs running on S1.

Table 1 - Results scenario A (server S1)

<table>
<thead>
<tr>
<th>Message rate [msg/s]</th>
<th>Server</th>
<th>Delay [ms]</th>
<th>New registrations</th>
<th>Update registrations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>100</td>
<td>S1</td>
<td>0,30</td>
<td>61,04</td>
<td>0,33</td>
</tr>
<tr>
<td>500</td>
<td>S1</td>
<td>0,29</td>
<td>65,75</td>
<td>0,36</td>
</tr>
<tr>
<td>1000</td>
<td>S1</td>
<td>0,16</td>
<td>60,94</td>
<td>0,74</td>
</tr>
</tbody>
</table>

Scenario B is depicted in Figure 3 wherein two SIP User Agents (SIPp1, SIPp2) send SIP messages to two applications (App1, App2). The applications in turn forward the location data (registration information) to the local Spread daemons (Sd1, Sd2). The local Spread daemons cooperate and return the location data (registration information) to the applications. In other words, the new modules dbReplicate_gcs, located between OpenSER and its module dbText (in-memory database) as well as Spread daemons are running on the same servers (S1, S2). Thus, the new module dbReplicate_gcs running on S1 is connected to the Spread daemon running on S1 whereas the new module dbReplicate_gcs running on S2 is connected to the Spread daemon running on S2. In case of processing SIP messages, OpenSER pass the location data (registration information) to the new modules dbReplicate_gcs which in turn forward them to the local Spread daemons. The local Spread daemons cooperate and return the location data (registration information) to the new modules dbReplicate_gcs, storing it on S1 and S2 by the use of the module dbText (in-memory database). As a result, identical replicas exist on S1 as well as S2.

The test-results of scenario B are listed in Table 2 and Table 3, again showing the minimum, maximum and average delay (time difference between sending messages to and receiving messages from the spread daemon). It is calculated by the new module dbReplicate_gcs running on S1 and S2.

Table 2 is related to the use-case when SIPp1 is generating SIP messages whose associated location data (registration information) is stored locally on S1 and remotely on S2 by the use of the module dbText (in-memory database) (see workflow represented by black arrows in Figure 3) whereas Table 3 is related to the use-case when SIPp2 is generating SIP messages whose associated location data (registration information) is stored locally on S2 and remotely on S1 by the use of the module dbText (in-memory database) (see workflow represented by grey arrows in Figure 3).
already been stored in a database, the presented approach (registration information). Spread daemon to distribute and replicate location data OpenSER and its database module dbText, cooperates with a that the new module dbReplicate_gcs, located between systems themselves. The prototype is based on the principle of common data replication mechanisms provided by database taking advantage of Group Communication Systems instead presented a new approach for a redundant SIP-server solution case for the work presented in this paper. The authors have and best-practices cannot fully be applied. This is also the setting up different requirements, so that common approaches (registration information) happens not until all messages have been exchanged between all members of a group and thus, ensuring consistency of the replicas among all members of a group. However, further investigations with respect to performance and scalability have to be done that (may) lead to improvements but the authors are convinced that the presented approach is able to fulfill the requirements for safety and security critical communication systems. Synter point which has to be considered in future work is a restart mechanism. The presented approach is based on the assumption that the databases are synchronized when the system starts up. If a node crashes or the network is partitioned the nodes have to be synchronized again. Solving these issues may lead to a new paradigm in reliable data distribution and replication.

### 5. CONCLUSION

Although considerable work has been done in the area of data distribution and replication, every application area is setting up different requirements, so that common approaches and best-practices cannot fully be applied. This is also the case for the work presented in this paper. The authors have presented a new approach for a redundant SIP-server solution taking advantage of Group Communication Systems instead of common data replication mechanisms provided by database systems themselves. The prototype is based on the principle that the new module dbReplicate_gcs, located between OpenSER and its database module dbText, cooperates with a Spread daemon to distribute and replicate location data (registration information).

As common approaches and best-practices deal with solutions where location data (registration information) has already been stored in a database, the presented approach works before the location data (registration information) is stored in the database. In other words, storage of location data (registration information) happens not until all messages have been exchanged between all members of a group and thus, ensuring consistency of the replicas among all members of a group. However, further investigations with respect to performance and scalability have to be done that (may) lead to improvements but the authors are convinced that the presented approach is able to fulfill the requirements for safety and security critical communication systems. Synter point which has to be considered in future work is a restart mechanism. The presented approach is based on the assumption that the databases are synchronized when the system starts up. If a node crashes or the network is partitioned the nodes have to be synchronized again. Solving these issues may lead to a new paradigm in reliable data distribution and replication.

### REFERENCES


