

Personal Satellite Services

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Abstract

Future Personal Satellite Services (PSATS) represent a trendy research area due to its importance that it may have in our daily lives. Being the personal services related to users, they deal with services and devices whose nature is pervasive. All these concepts have been clearly addressed in the Personal Satellite Services 2011 Conference (PSATS'11) through different interesting talks and in this special issue where original contributions selected from the set of papers presented to PSATS'11, have been extended and published after a severe two-round review process. In more detail, among the topics that deal with Personal Satellite Services, this special issue focuses on four topics: *i*) dual frequency receivers performance for Galileo-based tracking services; *ii*) integrated radio systems; *iii*) transport layer protocols; *iv*) security issues in Delay Tolerant Networks.

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1. Introduction

The concept of *Personal Satellite Services* (PSAT) deals with the next generation satellite services, which will cater the demands of personal services by bringing terminals directly to the hands of the users.

Scientific and Technological advances in satellite communications and networking have made it possible by bringing such value added services directly to the users and by reducing the overall cost. Obviously, it has been possible by addressing, and solving, many technical challenges such as supporting mobility, having miniaturized antennas and terminal sizes, and providing high data rate links.

To reach the aim of the development of the personal services through satellite systems, the synergy between satellite and terrestrial networks must be exploited because it provides immense opportunities for disseminating wideband multimedia services to a wide range of audiences over large geographical areas. It is evident that satellite will play a complementary, but essential, role in delivering

services to infrastructure-less regions where terrestrial high-bandwidth communication infrastructures are unavailable. The services enabled by PSATS not only cover the requirements of an ordinary citizen but also provide defense personal services such as tracking, visualization and virtualization in a highly secure communication environment. It matches one of the more delicate needs of the modern society.

All these concepts have been clearly addressed in the Personal Satellite Services 2011 Conference (PSATS'11) [1], during which several interesting talks were given. In this special issue, original contributions selected from high quality papers presented to PSATS'11, are extended and published after a severe two-round review process.

2. A survey of the Conference PSATS 2011

As previously said, this special issue comes from the Third International ICST Conference on Personal Satellite Services 2011 (PSATS'11). The conference was held at the Hotel Sol Principe, Malaga, Spain in February 2011 and the final results have been surveyed in detail by a member of the

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PSATS steering committee Dr. Kandeepan Sithamparamanathan, Senior Lecturer, School of Electrical & Computer Engineering, RMIT University) in [2] and briefly recalled here for the sake of completeness.

PSATS'11 was organized by *University of Siena* (Italy), *University of Trento* (Italy), *University of Malaga* (Spain), EUTELSAT (France), *European Alliance of Innovation* (EAI) and CRATE-NET Research Centre (Italy) and supported by the European Commission's technology platform called *Integral Satcom Initiative* (ISI).

The conference explored satellite communications and networking technical advances, bringing together academics, industries (such as *Avanti*, *Astrium*, *Selex Communications*, *Inmarsat*, *Telespazio*, *Thales*, and *Triagnosys*), the European Space Agency (ESA), practitioners, and students interested in future techniques relating to satellite communications, networking, technology, systems, and applications.

Thirty-six high quality technical papers were accepted and the conference was enriched with two keynotes: Paul Febvre, the head of *INMARSAT's BGAN Evolution Team*, and Dr. Haitham Cruickshank from the *University of Surrey*.

The former addressed the topic "Personal Satellite Access Terminals: Observations with a 40-year Perspective" while the latter issues related to "Satellite Communications Security with Current Status and Future Expectations".

In addition three special sessions have been organized by *Thales Alenia Space* (Spain), the *University of Bradford* (UK), and the *SatNEXIII* project partners together two invited talks from *Eutelsat* and *ESA*.

Finally, in 2011, PSATS was organized outside Italy, in Malaga, Spain, which is a very interesting location for its history, painting culture, and enchanting beaches.

The organizing committee at-large, starting from the General Co-Chairs Claudio Sacchi, *University of Trento*, Italy, and Giovanni Giambene, *University of Siena*, Italy, the TPC Co-Chairs, ourselves, the TPC members and the conference coordinator Aza Swedin, *EAI*, led its work towards the greatly successful congress. Finally, PSATS'12 has been organized in UK and PSATS'13 is expected to reach Melbourne, Australia, in 2013.

3. Personal Satellite Services: Services in a pervasive communications environment

In this article, we present a brief survey of a Personal Satellite Services, which represents a trendy research area due to the importance that it may have in our daily lives. Being the personal services related to users, they deals with services and devices whose nature is pervasive.

The general concept of Pervasive Communications Environment (PCE), known in the literature, is based on multi-modal access to integrated communications infrastructures that have combined text, audio, video, and voice capabilities [1]. It enhances the dynamic of human interactions and enables complex forms of cooperation and collective action. From the technical viewpoint, the PCE paradigm envisages a world where a wide set of quantities -

such as vibrations, heat, light, pressure, magnetic fields, human behaviour - are acquired through sensors and transmitted through suitable seamless communication systems for information, decision, and control aims.

On the other hand, new media devices such as smartphone, portable computers, and digital recording devices, link people into an increasingly larger and integrated communication infrastructure, broadly known as the Internet, encouraging a much enlarged pervasive communication environment.

In this context, satellite communications will be very important. Since 80s, R. L. Harvey from the Lincoln Laboratory of the Massachusetts Institute of Technology (USA) already envisioned such a development trend [2]. In fact, he addressed the critical technical issues about waveform design, spacecraft technology, satellite launch options and costs.

Today, on one hand most of the problems he highlighted have been fixed, on the other hand new challenges are now open. In this sense, a recent inspiring paper [3] describes the necessary interdisciplinary advances required in the PCE field such as new communication and networking solutions, less complex operating systems, miniaturized memory, innovative algorithms, efficient signal processing, and context-aware solutions.

These solutions are aimed at creating networks of heterogeneous devices that communicate seamlessly so connecting anything, from anyplace, at anytime. These are the common keywords of the satellite and space communications research field: it implies adding to the classical problems (QoS, mobility and security) the peculiarities of PCE such as intermittent connectivity, disruptive links, variable delays, and high bit error rates.

These problems, from our viewpoint, represent fascinating challenges, which may contribute to several applicative scenarios where monitoring and connecting the physical world through satellite is important such as civil protection, transportation, underwater exploration and monitoring, space monitoring and tele-medicine, among others.

In particular, tele-medicine, is a very important example showing the impact of pervasive communications realized by satellite systems. In fact, satellite broadband communication technologies offer wide-area broadband connectivity for telemedicine applications, even in remote areas and isolated regions where terrestrial technologies may deem uneconomical to be deployed [4].

These application areas and the mentioned research challenges constitute interesting fields of cooperation and new research topics for the satellite and space communications and networking scientific community.

4. The Special Issue contributions

As previously said, Personal Satellite Services include several topics. In this special issue, four topics have been

developed in the accepted papers. They have been reported in Fig. 1 and are briefly introduced below.

4.1. Dual Frequency Receivers

Jie Zhang and Elena-Simona Lohan proposes a work about the employment of dual-frequency receiver that will greatly enhance the performance of satellite navigation in the framework of the emerging European global satellite system Galileo, which has gained much public interest regarding location and position services.

They consider two Galileo Open Service signals, namely E1 and E5 that will provide the frequency diversity, and highlights that dual-frequency receiver becomes more complex since it needs to process two signals.

The article analyzed the effect of signal superposition on code tracking. The evaluation was conducted with a Simulink simulator, including signal transmitters, propagation channels, front-end filter and signal tracking stages. The simulation results showed that the overlapping of two signal bands did not have much effect on either signal's code tracking. However, the noise level was increased greatly, especially on E1 signal.

The work also evaluated the effect of interference introduced from one signal band to another signal band. The results showed that there were significantly effects on code tracking accuracy. If the interference introduced by E5 signal was not located in the E1 signal band after the superposition, the code tracking performance was still affected by the interference. The results also indicated that the E5 signal was more robust against interference than E1 signal.

The authors envisaged for future work to take advantage of common baseband structure in the dual frequency receiver to avoid interference and improve the tracking performance.

4.2. Integrated Radio Communications Systems

J.Baddoo, P. Gillick, P. Pillai, R. Morrey, M. Naylor, A. Waller, A. Smith, K. Xu, M. Ali and Y Cheng describe the Single European Sky Air Traffic Management (ATM) research programme SESAR, which has identified continued growth in the demand for aircraft communications as air traffic increases and communications become more network centric.

Alongside existing systems such as VHF Data Link Mode 2, new systems such as LDACS and AeroMACS are being proposed along with satellite communications. This growth is likely to increase the size, weight and cost of avionics radio communication equipment, so the authors claim that there is a need to examine new radio architectures which will help limit these increases.

To reach this aim, they present the results of the European FP7 project SANDRA aimed at designing and

demonstrating an integrated communications system using software defined radio techniques.

In the paper, the concepts behind the integrated communications system are described, including improved modularity using high-speed digital links, security, redundancy and certification. The specific requirements of the integrated radio and the details of the proof-of-concept demonstrator are also outlined.

The work also presents a Collaborative Radio Resource Management (CRRM) scheme to support seamless aeronautical communications using satellite and terrestrial access technologies. The CRRM adopts and extends the IEEE 802.21 Media Independent Handover (MIH) framework and the ETSI Broadband Satellite Multimedia (BSM) SI-SAP concept to split the CRRM functions between the upper layers (layer 3 and above) and the lower layers (link layer and physical layer) of an aircraft terminal.

A Joint Radio Resource Manager (JRRM) provides the abstraction layer for mapping higher layer functions into lower layer functions to enable collaboration. The CRRM scheme and its associated general signalling procedures are described in detail.

Through the CRRM scheme, the connection establishment functions and seamless handovers between different radio technologies are performed by combining Media Independent Handover (MIH) primitives and Broadband Satellite Multimedia (BSM) primitives.

4.3. Transport Layer Protocols

Giovanni Giambene, Silvia Marchi and Sastri Kota discussed the employment of GEO satellite communication systems as efficient approach for broadband Internet provision to high-speed trains.

They claim that some work is still needed to allow a seamless service. In particular, in the railway scenario, satellite communications suffer from strong variations in the received signal power and need suitable solutions to deal with long channel disruptions due to tunnels.

The approach they envisaged is based on a hybrid network (satellite and terrestrial WiFi coverage) and a Vertical Handover (VHO) procedure to switch seamlessly from one segment to another whenever link quality degrades and a new segment is available. The paper deals with the TCP performance in the presence of VHOs (based on the IEEE 802.21 Media Independent Handover, MIH, standard) from the satellite to a terrestrial wireless segment and vice versa to cover tunnels. Details are provided for the adoption of MIH and MIPv6 in conjunction with the BSM standard.

Design criteria for the WiFi coverage extension outside the tunnel are also presented. Finally, we have shown that TCP goodput behaviour and convergence time can be improved by means of suitable accelerated TCP versions or using cross-layer methods.

The main outcomes of the article can be summarized as follows: *i)* Design of the WiFi coverage extension for an uninterrupted Internet access; *ii)* Proposal of cross-layer methods based on ssthresh update to improve TCP

performance at VHO; *iii*) Tradeoff for the selection of the transport layer protocol.

As future work, the authors propose a further study needed to consider: *i*) Comparisons with the NASA Space Communications Protocol Specification - Transport Protocol (SCPS-TP) with two transport layer alternatives; *ii*) A Performance Enhanced Proxy (PEP) for the satellite segment.

4.4. Security Issues

G. Ansa, H. Cruickshank and Z. Sun discuss the Delay tolerant networks (DTN), targeting highly constrained networking environment that are low in resources such as memory, bandwidth, battery and processing power. In opportunistic DTNs, nodes cooperatively forward packets for each other through the carry-store-and-forward paradigm.

In particular the authors highlight that opportunistic data forwarding can be abused by an adversary by injecting bogus packets in order to waste the resources of the network. The article proposes to guard against such attacks by authenticating packets at intermediate nodes. Packet authentication in itself comes with overheads such as computation cost and energy consumption which can be exploited by an attacker to mount Denial of Service (DOS)

attacks. The paper proposes the use of light-weight DTN-cookies to protect this vital security service from such malicious exploitation.

The proposed mechanisms are light weight and hard to forge. Simulation results shown the performance of described mechanisms and demonstrate the effectiveness and efficiency of the proposed scheme. As future work, the authors intend to investigate compromised node detection.

Conclusions

In this special issue four original contributions, written starting from a selection of papers presented to PSATS'11, have been published after a severe two-round review process. The papers focus on four topics: *i*) dual frequency receivers performance for Galileo-based tracking services; *ii*) integrated radio systems; *iii*) transport layer protocols; *iv*) security issues in Delay Tolerant Networks.

All of them propose novel solutions for future Personal Satellite Services and open the doors to future developments. In general the special issue represents the first step of the development of an innovative literature about Personal Satellite Services, which represent a trendy research area being related to services and devices whose nature is pervasive.

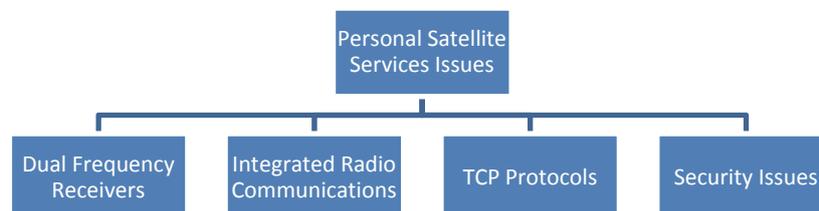


Figure 1. The Special Issue topics.

References

- [1] Web site: <http://www.psats.eu/2011/cfp.shtml> (last visit March 14th, 2012)
- [2] Web site: <http://eai.eu/discussion/conference-report-personal-satellite-services-2011-psats'11> (last visit March 14th, 2012)
- [3] Coopman, T. M. (2009) *Toward a Pervasive Communication Environment Perspective*, First Monday, Volume 14, Number 1-5.
- [4] Harvey, R. L. (1980) *The Critical Satellite Technical issues of Future Pervasive Broadband Low-cost Communication Networks*, Acta Astronautica, Volume 7, Issue 10.
- [5] Marchese, M. (2011) *Interplanetary and Pervasive Communications*, IEEE Aerospace and Electronic Systems Magazine, Volume 26, Issue 2.
- [6] Vouyioukas, D., Maglogiannis, I., Pasiadis V. (2007) *Pervasive E-health Services Using the DVB-RCS Communication Technology*, Journal of Medical Systems, Volume 31, Number 4.