



## SatNEX (Phase III) – Satellite Communication Network of Experts

SatNEX is a European Network of Experts for satellite communications, coordinated by the German Aerospace Center DLR. The first two phases of SatNEX were funded by the EU from 2004 to 2009. The third phase, SatNEX-III, comprises 17 partners and is funded by ESA from 2010 to 2013. A core team consisting of DLR, University of Surrey, and University of Bologna is coordinating the SatNEX-III research activities. Specific research tasks are contracted to partners in the frame of annual “Call-off Orders”.

### Partners:

- DLR, Institute of Communications and Navigation (Co-ordinator)
- University of Surrey, Centre for Communication Systems Research (UniS)
- University of Bologna, Department of Electronics, Computer Science, and Systems (UoB)
- Aristotle University of Thessaloniki, Department of Electrical and Computer Engineering (Auth)
- University of Bradford, Communication Systems Engineering Research Group (BRU)
- Consorzio Nazionale Interuniversitario per le Telecomunicazioni (CNIT)
- Italian National Research Council CNR, Istit. di Scienza e Tecnologie dell'Inform. “A. Faedo” (CNR-ISTI)
- Centre Tecnologic de Telecomunicacions de Catalunya (CTTC)
- National Observatory of Athens Institute for Space Applications and Remote Sensing (ISARS)
- Office National d'Études et de Recherches Aérospatiales (ONERA)
- University of Salzburg, Department of Computer Sciences (SBG)
- TeSA Association, Institut Supérieur de l'Aéronautique et de l'Espace (TeSA)
- Graz University of Technology, Institute of Communication Networks and SatComs (TUG)
- Universitat Autònoma de Barcelona, Dept. Telecomunicació i Enginyeria de Sistemes (UAB)
- University of Aberdeen, King's College, Department of Engineering (UoA)
- Università Degli Studi di Roma “Tor Vergata”, Department of Electronics (UROMA2)
- Universidade de Vigo, Department of Signal Theory and Communications (UVI)



## Overall Project Description

The primary goal of SatNEx under European Union (EU) sponsorship was to achieve long-lasting integration of the European research in satellite communications and to develop a common base of knowledge. SatNEx was formed in 2004 by 22 partner research organisations and universities with the support of the EU FP6 programme as one of several new Networks of Excellence (NoE). In 2006, funding was renewed by the EU to continue with SatNEx-II up to 2009.

Apart from establishing a critical mass of research effort in satellite communications in Europe, SatNEx has established a series of annual summer schools for new researchers, providing a comprehensive programme of advanced technical and scientific lectures which cover specific areas in satellite communications. Also, SatNEx has sponsored and coordinated several satellite conferences, has produced many journal and conference papers as well as four books, and has provided inputs to standards bodies and participated in forming standards.

Now, the third stage of SatNEx, **SatNEx-III**, continues with the support of ESA with a more focused approach. SatNEx III is comprised of 17 European research organisations and universities. The German Aerospace Center DLR with its Institute of Communications and Navigation leads the team with close support by the core team partners University of Surrey, Centre for Communication Systems Research, and University of Bologna. In general, SatNEx-III will:

- play an important role in exploring new satcom techniques supporting ESA in selecting the right avenues for R&D work plans (TRP, ARTES 1, ARTES 5)
- support ESA in ad-hoc technical actions related to satcom standards
- identify promising terrestrial technology spin-in into space
- play a pivotal role in forming young professionals for satcom.

Throughout the three-years duration of SatNEx-III, **horizontal activities** will be pursued in the following areas:

- Long-term development of satcom visions and systems
- Development of physical and access layer technologies
- Development of networking technologies and protocols
- Satcom training activities and dissemination of SatNEx-III results.

In addition, ESA will activate each year a number of **specific advanced research** areas. In the first project year, SatNEx-III has been charged with the following tasks:

- Concept development for a Terabit/s satellite system
- Exploration of hybrid space/ground signal processing techniques
- Investigation of new protocols for disruption tolerant satellite communications.

## SatNEx-III Horizontal Activities

The horizontal activities last throughout the three-years duration of SatNEx-III, and are performed by the core team consisting of the German Aerospace Center DLR / Institute of Communications and Navigation, University of Surrey / Centre for Communication Systems Research, and University of Bologna. A brief description of the horizontal activities is as follows:

### Long-term Development of Satcom Visions and Systems (lead: University of Surrey)

- Identify new satcom applications and related requirements
- Devise new system architectures which can satisfy the new applications and requirements

- Investigate the best options for integrating satellite networks with terrestrial systems
- Identify new research areas in view of the identified satcom applications and requirements
- Exchange and consolidate the results with ESA and other key players (e.g. satellite operators and industry).

### **Development of Physical and Access Layer Technologies** (lead: University of Bologna)

- Report on terrestrial trends and possible reuse of emerging terrestrial wireless physical and access layers standards and solutions in satellite networks
- Identify new research areas and assess their suitability to the satellite scenarios identified in the visions and systems task
- Identify physical and access layers standardisation areas of interest to satcoms.

### **Development of Networking Technologies and Protocols** (lead: DLR)

- Report on terrestrial trends and possible reuse of emerging terrestrial networking and standard solutions in satellite networks
- Identify new research areas and assess their suitability to the satellite scenarios identified in the visions and systems task.
- Identify networking and protocol standardisation areas of interest for satcoms.

### **Satcom Training Activities and Dissemination of SatNEx-III Results** (lead: DLR)

- Support exchanges of researchers between partners
- Ensure dissemination of results to ESA, delegations, industry and satellite operators
- Maintain the SatNEx web site
- Secure representation of SatNEx-III in major satellite conferences
- Raise funds for maintaining the current SatNEx summer school initiative for PhD students
- Give annual lectures at ESTEC on subjects of common interest to ESA and SatNEx.

### **SatNEx-III Specific Research 2010 (Call-off Order 1)**

Three specific advanced research topics, activated by ESA, are investigated every year by specific task teams. In the first project year, SatNEx-III has been charged with the following tasks:

#### **Concept Development for a Terabit/s Satellite System**

lead: University of Surrey; partners: ISARS, ONERA, TeSA, UAB

In this task, the team investigates a number of critical technical system aspects related to the development of a Terabit/s satellite system. More specifically, we will:

- define a reference system architecture and related system assumptions, with particular emphasis on frequency bands for the user and feeder links, and number of beams required
- investigate approaches to achieve flexible resource allocation over the coverage region
- investigate physical and access layer techniques able to efficiently cope with unbalanced traffic distribution
- investigate countermeasures at system/network/user terminal level to cope with the residual ground beams displacement

- assess the fading impact for both the feeder link and the user link and define fading countermeasures
- investigate smart feeder link concepts.

### **Exploration of Hybrid Space/Ground Signal Processing Techniques**

lead: University of Bologna; partners: CTTC, TUG, UniS, UVI

In this task the team investigates the potential applicability of hybrid space ground processing techniques with signal digitalisation on-board the satellite. In particular, the following tasks are being performed:

- define a reference system architecture and related system assumptions
- Review of literature in the field of data compression, beam forming, Multi User (MU) Multiple Input Multiple Output (MIMO) algorithms with apportionment of tasks between the space and the ground segment
- Pre-select candidate architectures and algorithms for hybrid space ground processing relevant to the selected reference system
- perform a detailed trade-off among different options for the hybrid space ground processing in terms of performance and complexity
- Make recommendations for further R&D activities in this field.

### **Investigation of New Protocols for Delay Tolerant Satellite Communications**

lead: DLR; partners: CNIT, CNR-ISTI, SBG, UniS, UoA, UoB, UROMA2

In this task the team investigates the applicability of new DTN protocols to satellite communication systems. In particular, the following tasks are being performed:

- Review the state-of-the-art in Delay and Disruption Tolerant Networks (DTN) and current level of definitions, standardisation, and demonstration achieved
- Investigate the potential applicability and advantages/drawbacks of DTN to:
  - mobile satellite telecom networks to efficiently cope with possible link interruptions
  - broadband satellite telecom networks to efficiently cope with transmission delays, avoiding the use of Proximity Enhancement Proxies (PEP)
  - deep space communications.

Consider aspect such as the impact on applications support, overall data transfer data efficiency and reliability, as well as delay

- collect DTN emulation software modules able to demonstrate the performance in selected application cases
- Make recommendations for further R&D activities in this field.

**Link to SatNEx-III Webpage:** [www.satnexus.org](http://www.satnexus.org)

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