PROGRAMME

SIXTH FRAMEWORK

Satellite Communications Network of Excellence

Third SatNEx International Summer School 2007

Pisa (Italy), August 27-31, 2007

PROGRAM OF THE SCHOOL

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ISTITUTO DI SCIENZA E TECNOLOGIE DELL'INFORMAZIONE "A. FAEDO"

Monday August 27, 2007

Lecturer: Prof. Giovanni E. Corazza

DEIS/ARCES – University of Bologna, Italy
e-mail: gecorazza@deis.unibo.it
Title: State-of-the-art and new trends in the physical layer of digital satellite communications

Abstract: *The full-day lecture will be devoted to a review of the main principles that form the basis for the design and analysis of digital satellite communication links, as well as to their application to state-of-the-art and future air interfaces. We will touch upon information, detection, and estimation theories, to establish the cornerstones for physical layer design. Then we will go into details for broadband DVB-S2, mobile broadcasting DVB-SH, and long-term 4G satellite air interfaces.*

1. ***Introduction to digital communications***
2. ***Advanced coding and modulation schemes***
3. ***Synchronization and parameter estimation in digital receivers***
4. ***The DVB-S2 air interface***
5. ***The DVB-SH air interface***
6. ***4G air interfaces***
7. ***Test***

Lecturer's Short Bio

Giovanni Corazza was born in Trieste (Italy) in 1964. He received the Dr. Ing. degree (summa cum laude) in Electronic Engineering in 1988 from the University of Bologna (Bologna, Italy), and a Ph.D. in 1995 from the University of Rome "Tor Vergata" (Roma, Italy). He is currently a Full Professor at the Department of Electronics, Computer Science, and Systems (DEIS) of the University of Bologna. He is responsible for the area of Wireless Communications inside the Advanced Research Centre for Electronic Systems (ARCES) of the University of Bologna. In the years 2000-2003, he held the Chair for Telecommunications inside the Faculty of Engineering. He is the Chairman of the Integral Satcom Initiative (ISI) and of the Advanced Satellite Mobile Systems Task Force (ASMS-TF), European fora on satellite communications with more than 140 industrial partners, under the auspices of the European Commission and of the European Space Agency.

Prof. Corazza has research interests in the areas of communication and information theory, wireless communications systems (including cellular, satellite, and fixed systems), spread-spectrum techniques with emphasis on CDMA, synchronization and parameter estimation, MAC layer protocols, multicast protocols. He is author or co-author of more than 150 papers published in International Journals and Conference Proceedings. Since 1997, he joined the Editorial Board of the IEEE Transactions on Communications as Associate Editor for Spread Spectrum. He received the Marconi International Fellowship Young Scientist Award in 1995. He was co-recipient of the Best Paper Award at the IEEE Fifth International Symposium on Spread Spectrum Techniques & Applications, ISSSTA'98, Sept. 2-4, 1998, (Sun City, South Africa), and of the Best Paper Award at the IEEE International Conference on Telecommunications 2001, ICT2001, 4-7 June 2001, (Bucharest, Romania). He was co-recipient of the 2002 IEEE VTS Best System Paper Award for the paper entitled "Wide-Band CDMA for the UMTS/IMT-2000 Satellite Component", published on IEEE Transactions on Vehicular Technologies in March 2002. He holds a patent on "Closed Loop Resource Allocation", devoted to resource management for high data rate wireless networks. He chaired sessions and was member of the Technical Committee of several conferences, Chairman of the ASMS2004 and of the ASMS2006 Conferences and of the upcoming IEEE ISSSTA 2008 Conference.

Tuesday August 28, 2007

Lecturer: Dr. Zhili Sun

University of Surrey, Guildford, UK
e-mail: Z.Sun@surrey.ac.uk
Title: Satellite Networking & Time Series Analysis

Abstract: This lecture aims to cover the fundamental concepts of satellite networking including satellite services and network services, circuit and packet switching, network protocols and reference models, Internet services and applications, internetworking between satellite and terrestrial networks, and convergence of network technologies and protocols. It also covers main techniques for Time Series Analysis including identify patterns in time series data, general class of model for time series data presentations and predictions, and some simple and commonly used modelling and forecasting techniques based on linear regression.

1. Satellite networking

- Applications and services of satellite networks
- ITU-R definitions of satellite services
- ITU-T definitions of network services
- Internet services and applications
- Internet protocols reference model
- Satellite network
- Characteristics of satellite networks
- Internetworking with terrestrial networks
- Network traffic, QoS and performance issues
- Network resource management
- Internet protocols
- IP packet encapsulation
- Internet quality of service (IP QoS)
- Integrated services (Intserv) architectures for QoS
- Differentiated services (Diffserv) for QoS

2. Time Series Analysis

- General Introduction
- Two Main Goals
- Identifying Patterns in Time Series Data
- Systematic pattern and random noise
- Two general aspects of time series patterns
- Trend Analysis
- Analysis of Seasonality

3. ARIMA and Autocorrelations

- General Introduction
- Two Common Processes
- ARIMA Methodology
- Identification Phase

- Parameter Estimation
- Evaluation of the Model

4. Interrupted Time Series

5. Exponential Smoothing

- General Introduction
- Simple Exponential Smoothing
- Choosing the Best Value for Parameter a (alpha)
- Indices of Lack of Fit (Error)
- Seasonal and Non-seasonal Models With or Without Trend

6. Distributed Lags Analysis

- General Purpose
- General Model
- Almon Distributed Lag

7.Cross-spectrum Analysis

- General Introduction
- Basic Notation and Principles
- Results for Each Variable
- The Cross-periodogram, Cross-density, Quadrature-density, and Cross-amplitude
- Squared Coherency, Gain, and Phase Shift
- How the Example Data were Created

8. Spectrum Analysis - Basic Notations and Principles

- Frequency and Period
- The General Structural Model
- A Simple Example
- Periodogram
- The Problem of Leakage
- Padding the Time Series
- Tapering
- Data Windows and Spectral Density Estimates
- Preparing the Data for Analysis

9. Results when no Periodicity in the Series Exists

10. Test

Lecturer's Short Bio

Professor Zhili Sun has been work in the area of satellite networking since 1993. He got his BSc in Mathematics from Nanjing University in 1982, and PhD in Computer Science from Lancaster University in 1990. He worked as a postdoctoral research fellow in Queen Mary University of London from 1989 to 1993. He has been a principal investigator and technical co-ordinator in many European

projects including the ESPRIT BISANTE project on evaluation of broadband traffic over satellite using simulation approach, VIP-TEN project on Quality of Service (QoS) of IP telephony over satellite, EU 5th and 6th Framework Programme GEOCAST project on IP Multicast over satellites, ICEBERGS project on IP based Multimedia Conference over Satellite, SatLife project on IP over DVB-S/RCS, SATSIX project on IPv6 over satellite, Euro-NGI project on next generation Internet. He has also been a principal investigator in UK EPSRC, European Space Agency (ESA) and industrial projects on IP multicast security. He has supervised many PhDs and research fellows. He published a book titled "satellite networking" by Wiley and over 120 papers in International journals, book chapters and conferences. He has also been a member of technical committee of international conferences and member of reviewers of major EU and UK research proposals. He has acted as external examiner for PhD viva in many universities in UK, France, Spain, Singapore and China. He also teaches MSc, undergraduate and industrial courses on satellite networking, computer and data networks, Internet traffic engineering and mobile operating systems.

Please visit: http://www.ee.surrey.ac.uk/CCSR/people/networks/academics.html

Wednesday August 29, 2007

Lecturer: Mr. Sandro Scalise and Prof. Vittorio Degli Esposti

DLR, Oberpfaffenhofen (Germany) / University of Bologna (Italy)
e-mail: Sandro.Scalise@dlr.de / vdegliesposti@deis.unibo.it
Title: Propagation and Packet Error Models for Mobile Wireless Channels

Abstract: A good understanding of the impairments introduced by the propagation channel is of paramount importance in the design of a satellite-based communications system. The relevant sources of channel impairments depend upon several factors, among them the considered scenario (e.g. mobile vs. fixed terminals, rural vs. urban etc…), the carrier frequency and the employed access scheme. For instance, effects like shadowing and blockage are typical of mobile reception. On the other hand, atmospheric attenuation phenomena can be safely disregarded at frequency bands below some GHz, whereas they start to become relevant as the carrier frequency increases.

Since terminals are often located in urban areas, where also repeaters and gap fillers may be adopted, also terrestrial, multipath propagation represents a major concern. Urban multipath propagation and its impact on the radio channel characteristics will be therefore addressed, with a particular focus on deterministic models such as ray tracing.

Furthermore, a formal methodology to derive packet error models complementing a purely propagational model with considerations related to the adopted waveform and coding scheme will be presented.

Each of the main parts of this lecture will be organized as an independent module. In general, the main focus will be on specific results and considerations derived by models and measurements, rather than on reviewing the well-known theory of channel characterization and modelling. Nevertheless, the most important definitions will be recalled for the sake of clarity and adequate references provided.

The lecture will be concluded by a short talk concerning the ongoing revision of DVB-RCS standard towards the full support of mobility.

1. Introduction

2. Characterization of Linear Time-Variant Propagation Channels (0.5 h)

- Channel Characteristic functions
- Channel Parameters and Classification
- First and Second Order Channel Statistics

3. Propagation Channel Models for Satellite Channels at Different Frequency Bands and for Different Environments (1.5 h)

- Single-State First-Order Characterization for Frequency Non-Selective Channels
- Multi-State Markov Chain Models for Frequency Non-Selective Channels
- Doppler Spectrum Models
- Modelling of Frequency Selective Channels
- Examples of Models and Measurements

4. Propagation and Channel Modelling for Terrestrial Links in the Urban Environment (2h)

- Introduction to urban propagation
    - Power attenuation with distance
    - Macro- and micro-cellular propagation
    - Need for multi-dimensional models
- Classification of urban propagation and channel models
- Deterministic ray models
    - Environment representation issues
    - Geometrical Optics basics
    - ray tracing and ray launching
    - Hybrid ray models and diffuse scattering
- Multidimensional prediction by ray tracing
- Deterministic channel modelling by ray tracing

5. From Propagation Models to Packet Error Models (1 h)

- <to be further detailed>

6. Tests (0.5 h)

Overview about the ongoing revision of DVB-RCS standard towards the full support of mobility (0.5 h)

Lecturer's Short Bio
Sandro Scalise was born in Utrecht, Holland in April 1973. In July 1999 he graduated in Electronic Engineering specialising in Telecommunications (with honours) from University of Ferrara, Italy. Since 2001, he is with the Institute for Communications and Navigation, DLR (German Aerospace Centre), Germany. Since October 2004, he is leading the Mobile Satellite Systems Group. His research activity deals with forward error correction and synchronization schemes for mobile satellite applications, land mobile satellite channel modelling and link performance evaluation. He is co-author of many international journal and conference papers, was co-chairman of the 3rd Advanced Satellite Mobile Systems Conference in 2006 and editor of a chapter devoted to satellite channel impairments in the framework of a book devoted to satellite communications to be published by Springer.

Please visit: http://www.dlr.de/kn/institut/abteilungen/dn/satcom/index

Thursday August 30, 2007

Lecturer: Prof. Franco Davoli

CNIT-RU.Genoa, University of Genoa, Italy
e-mail: franco@dist.unige.it
Title: Control and Optimization Techniques Applied to Satellite Communications

Abstract: The course aims at introducing some basic aspects in the control of dynamic systems with complete observation of the state. In particular, functional and parametric optimization problems will be defined, and some techniques for their solution will be outlined. Control and optimization applications in networking will be treated, with respect to problems in admission control and bandwidth allocation to network flows. The specific environment of satellite communications and networking will be considered, and some examples will be surveyed.

1. Preliminaries on Markov Decision Processes:

- Optimal control of discrete-time dynamic systems with complete state observation
- Functional and parametric control laws
- Dynamic programming
- Finite- and infinite-horizon cost functionals
- Stationary strategies
- Optimal control of linear systems with quadratic cost (LQ)
- Functional approximations (neural networks)
- Parametric optimization techniques

2. Admission control for network flows and dynamic bandwidth allocation:

- Strategies that preserve or not Product Form Solutions
- Coordinate convex strategies
- Complete sharing, complete partitioning, partitioning, threshold
- Trunk reservation

3. Control of flows over packet networks:

- Multiplexing across VCs and service separation
- Dynamic bandwidth allocation at the MAC and network layer
- Linear approximation and LQ control of queues
- QoS mapping

4. Overview of some applications in satellite communications:

- ARAM (Alagöz et al.)
- DCA (Le-Ngoc et al.)
- OP, OC, CLARA (Celandroni et al.)
- IPA-based methods (Marchese et al.)
- DCA with prediction (Chiti et al.)

5. Test

Lecturer's Short Bio

Franco Davoli (M'90-SM'99) received the "laurea" degree in Electronic Engineering in 1975 from the University of Genoa, Italy. Since 1990 he has been Full Professor of Telecommunication Networks at the University of Genoa, where he is with the Department of Communications, Computer and Systems Science (DIST). From 1989 to 1991 and from 1993 to 1996 he was also with the University of Parma, Italy. His current research interests are in bandwidth allocation, admission control and routing in multiservice networks, wireless mobile and satellite networks and multimedia communications and services. He has co-authored over 200 scientific publications in international journals, book chapters and conference proceedings. He is a member of the Editorial Board of the International Journal of Communication Systems (Wiley) and of the international journal Studies in Informatics and Control, and an Area Editor of Simulation – Transactions of the SCS. He has been a guest co-editor of two Special Issues of the European Transactions on Telecommunications and of a Special Issue of the International Journal of Communication Systems. In 2004, he has been the recipient of an Erskine Fellowship from the University of Canterbury, Christchurch, New Zealand, as Visiting Professor. He has been Principal Investigator in a large number of projects and has served in several positions in the Italian National Consortium for Telecommunications (CNIT). He was the Head of the CNIT National Laboratory for Multimedia Communications in Naples in the years 2004-2005. He is currently Vice-President of the CNIT Management Board and coordinates the participation of the Consortium in the *SatNEx* European Network of Excellence.

Friday August 31, 2007

Lecturer: Prof. Giovanni Giambene
University of Siena, Italy
e-mail: giambene@unisi.it
Title: Scheduling Techniques, Access Schemes and Mobile Internet Protocols for Wireless Communication Systems

Abstract: Aim of this course is to provide a survey on radio resource management techniques for satellite systems also considering the characteristics of terrestrial cellular and wireless systems in the aim of an integrated network. A survey on QoS requirements, traffic classes, and traffic models will be provided since these aspects are instrumental to resource management issues. Moreover, analytical methods will be described that are based on queuing theory. Finally, suitable basic characteristics of mobile Internet and satellite IP networks will be surveyed.

1. *General Concepts on Radio Resource Management*
    - Introduction on satellite communication systems
    - Orbital options and architectures
    - Traffic flows:
        - Classes
        - Characteristics
        - QoS requirements
    - Survey on physical constraints such as round trip delays and channel issues
    - Introduction to resource management
        - Survey on the resource space of DVB-S2/-RCS (layers 1 and 2)
        - Survey on the resource space of S-UMTS (layers 1 and 2)

2. *RRM Techniques*
    - Scheduling schemes:
        - Weighted Fair Queuing (WFQ), Earliest Deadline First (EDF), Idealized Wireless Fair Queuing (IWFQ), Proportional Fair (PF), PF with Exponential Rule (PF-ER)
        - Scheduling example for Satellite-HSDPA
    - Access protocols: Aloha-based, PRMA-based, DAMA, S-RACH
    - Cross-layer methods: interactions between layer 2 and other layers.

3. *RRM in Hybrid and Wireless Networks*
    - Hybrid wireless and satellite systems (GEO and non-GEO): scenarios and examples
    - WCDMA
    - WiFi (IEEE 802.11e)
    - WiMAX (IEEE 802.16d, IEEE 802.16e)

4. *Analytical Methods for RRM*
    - Markov Chains
    - M/G/1 theory
    - EPA analysis
    - Application example: performance evaluation and stability analysis

5. *Models for Traffic Generation*
    - Short-range dependent traffic models
        - MMPP

- Long-range dependent traffic models
  - Pareto-based

6. Mobile Internet Protocols
- Satellite IP networks (BSM architecture)
- Mobile-IP
- PEP issues

7. Test

Lecturer's Short Bio

Giovanni Giambene was born in Florence, Italy, in 1966. He received the Dr. Ing. degree in Electronics from the University of Florence, Italy, in 1993 and the Ph.D. degree in Telecommunications and Informatics from the University of Florence, Italy, in 1997. From 1994 to 1997, he was with the Electronic Engineering Department of the University of Florence, Italy. From 1997 to 1998, he was with OTE of the Marconi Group, Florence, Italy, where he was involved in a GSM development program. In the same period he also contributed to the COST 252 Action research activities by studying the performance of PRMA protocols suitable for supporting voice and data transmissions in low earth orbit mobile satellite systems. In 1999 he joined the Information Engineering Department of the University of Siena, Italy, first as research associate and then as assistant professor. He teaches the advanced course of Telecommunication Networks at the University of Siena. At present, he is involved in the SatNEx network of excellence (www.satnex.org) of the FP6 programme in the satellite field, as work package leader on radio resource management techniques (ja2330) and cross-layer air interface design (ja2230). He is also vice-Chair of the COST 290 Action (www.cost290.org), entitled "Traffic and QoS Management in Wireless Multimedia Networks" (Wi-QoST). He has recently published a book entitled "Queuing Theory and Telecommunications: Networks and Applications", Springer (May 2005). His research interests include third-generation mobile communication systems, medium access control protocols, traffic scheduling algorithms, and queuing theory.

Please visit http://marconi.ltt.dii.unisi.it/~giambene/

Aim of the Daily Test

At the end of each lecture/day, the lecturer will propose a test to the attendees. These tests will allow PhD students to grant credits for their PhD courses.