Wireless Networking & Embedded Systems (WING)

Introduction and Research Projects

Denmark

Aalborg university

Population January 1995
Total: 5,215,718. Men: 2,573,324. Women: 2,642,394. The population is distributed over 2.4 million households.
Aalborg University

Aalborg university was founded in 1974 and now has 12,000 students. Approximately 800 of these are from abroad;

Under the Faculty of Engineering and Science the Electronic Engineering Education has approximately 650 students for the B.Sc. E.E. and M.Sc. E.E. degrees. Yearly turnout of candidates: 100;

Since 1996 AAU has offered engineering programmes conducted in English to obtain the International M.Sc. E.E. degree:

- Mobile Communications;
- Digital Communications;
- Acoustics;
- Multimedia Communication;
- RF Technology

Wired / Wireless network       Computer/Communication

Convergence is the key challenge
Center for Teleinfrastructure (CTIF)
Director: Ramjee Prasad,
Co-directors: Ole Brun Madsen and Peter Koch

Antennas & Propagation
Patrick Eggers

Cellular Systems
Prabir Mogensen

Digital Communications
Bernard Fleury

RF Integrated Systems and Circuits
Torben Larsen

Wireless & Embedded Systems
[Ramjee Prasad]

Speech and Multimedia Communications
Borge Lindberg

Network Planning
Ole Brun Madsen

Aalborg University SPACE Center
Jens F.D. Nielsen

Wireless Computing and Security
Henrik Larsen

Wireless Perspective
Bent Dalum

Center for Teleinfrastructure (CTIF)
Director: Ramjee Prasad,
Co-directors: Ole Brun Madsen and Peter Koch

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Wireless Networking and Embedded Systems
[Ramjee Prasad], group leader

Embedded Systems
Peter Koch (L)
Ole Olsen
Yannick Le Moulic
Daniel Cuadrado
Jens Peter Holgaard
Anders B. Olsen
Søren S. Christensen

Hans-Peter Schwefel (L)
Marjan Bozinovski
Thibault Renier
Kim Larsen
Yaoda Liu
Hanane Fathi
Homare Murakami
Rasmus Olsen
Joao Figueiras
Liljana Gavrilovska*
Ljupco Jorguseski*

Flemming Frederiksen (L)
Albena Mihovska
Imadur Rahman
Suva Sekhar
Basak Can
Jesper Christensen
Yasushi Takatori
Martin Kuipers*
Ernestina Ciance*

Frank Fitzek (L)
Tatiana Madsen
Petar Popovski
Simone Frattasi
Nicola Marcetti
Daniel Figueiredo
Megumi Kaneko
Hiroyuki Yomo
Huan Cong Ngueyn

** Siemens-CTIF Research Lab (SCRL)

** - external researcher

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WING: Research Scope

**Future Vision**
- Ad-hoc networking
- Personal Area Networks
- Device discovery mechanisms
- Content encoding/Multiple Description Coding
- Advanced MAC and routing protocols

**Access Technology**
- Wideband Multimedia Solutions
- OFDM and HYBRID-OFDM Systems
- OFDM-MIMO systems
- WLAN, Mobile Broadband
- Beyond 3G/4G

**IP based Networks**
- IP Mobility & Routing
- Quality of Service & Performance
- Security
- Reliability/Resilience
- Enhanced Methodology of Analysis
  - Analytic Models & Simulation Techniques

**Embedded Systems**
- Computational models
- Heterogeneous distributed Simulation
- HW/SW co-design
- Low-power software
- Reconfigurable HW Platforms

WING: Current Projects & Activities

**External Collaborations:**
- My Adaptive Global NETwork, MAGNET (EU), 01/04-12/05
- Power-Aware Communications for Wireless OptiMized personal Area Networks, PACWOMAN (EU), 03/02-02/05
- WWI New Radio, WINNER (EU), 01/04-12/05
- Joint Advanced Development Enabling 4G, JADE (Samsung), 01/04 – 12/05
- Enhanced Mobility Support in Future Wireless Networks (Siemens) 03/04-09/05
  - Enhanced Macro-mobility support for IMS users
- Dependable service provisioning in next generation networks (Siemens/CTIF) 05/01-01/05
- Center for Network and Service Convergence, CNTK (Danish Gov. & local industries), 12/02-12/05
  - User-perceived Quality of Service
- Wireless Access Networks, Devices & Applications, WANDA (Danish Gov. & local industries), 08/04-08/07
- Center for embedded Software Systems, CISS, (Danish Gov. & local industries), 04/03-04/06
  - HW/SW co-design; low-power devices

**AAU/CTIF Internal Projects:**
- Future Adaptive Communication Environments, FACE, 01/02-02/05

**Teaching:** Master/PhD Courses, External Courses, Master Projects & Semester Projects
**PACWOMAN**

PACWOMAN: Power Aware Communications for Wireless OptiMized personal Area Networks

**WING involvement:**
- WPAN/CAN architecture + System definition
- Adaptive/QoS aware MAC protocols for different PHY technologies
- Link-layer enhancement (protocol boosters)
- Mobility models
- Evaluation of ad-hoc routing protocols in PAN-like scenarios
- Clustering and cluster-head selection
- Provisioning of end-to-end security

**My Personal Adaptive Global Network --MAGNET**

Extension of PAN concept to Personal Networks

- Logical networks, defined by appropriate security associations
- Potential huge geographical/topological span
- Consisting of ad-hoc and infrastructure networks
- User centric definition

**WING involvement**
- Network aspects (WP2): architecture, service discovery, naming
- Air interface/MAC (WP3): cross-layer optimization
- Security (WP4)
- Platforms (WP5)
Highly available IP-based networks and services

Started April 2001, in cooperation with Siemens ICM N

- Fault-tolerant Session Control in 3GPP IMS
  - Distributed Redundancy
  - Cluster Approach

Performance Evaluation & Modeling

- Prototype Implementation & Analytic Models


Center for Network and Service Convergence (CNTK)

Duration: 01/2003 -- 7/2006

Partners

- Universities/Research Institutes:
  Aalborg University, Dept. of Comm. Techn. (SMC & WING)
  Danish Technical University, COM center
  Danish Technological Institute
- Industrial Partners:
  Ericsson Telebit
  Sonofon
  Nettest

Objective

- Develop networking concepts and user-interfaces for provisioning of Quality of Service in future multi-service networks with heterogeneous wired and wireless access
- taking into account
  - User perception of quality
  - future applications and requirements
Wireless Access Networks, Devices & Applications (WANDA)

Duration: 02/2004 -- 10/2007

Partners

Universities/Research Institutes:
- Aalborg University/CTIF (RISC & WING)
- Danish Technological Institute

Industrial Partners:
- BLIP Systems
- RF Micro Devices
- Texas Instruments
- Siemens ICM MP

Objectives (WING part)
- Development and Evaluation of methods to obtain device locations
- Architectures & Protocols for mixed wired/wireless NWs (mixed ad-hoc/infrastructure)
- Protocol optimization based on location information

Example:
Accuracy of positioning in Bluetooth

Evaluation Approaches: Experimental System

Recent Student Projects:
- Wireless TCP
- Bluetooth Location Information
- WLAN Performance
- QoS for Gaming Applications
- Security Concept
- vertical Handover performance

Scan to come: W-CDMA

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Evaluation approaches (cntd.)

Additional experimental networks
- Service Availability (RSerPool, RTP)
- Bluetooth multi-hop access network (WANDA)
- MAGNET testbed (service discovery, naming)
- Header Compression
- OFDM

Analytic approaches
- Stochastic availability models
- Queueing models with ‘realistic’ traffic models (matrix-analytic approaches)
- Multi-hop MAC performance models (WLAN)
- Wireless TCP models
  [Advanced Simulation techniques, Importance Sampling]

... In close cooperation with Mathematics department at AAU and Arhus University as well as Network Planning Group within CTIF

Teaching: AAU specifics

AAU’s approach: Problem Based Learning
- Large semester projects (ca. 60% of students' working hours)
- Teamwork (4-7 students)
- Related to specific semester topic (e.g. Network management, dynamic channels etc.)

Project Examples
- See previous slide (dealing with experimental investigations)

Simulation Projects
- Radio Resource Management in GPRS Networks (TBF Assignment, Scheduling)
- Evaluation of ad-hoc routing protocols
- Buffer management strategies for video streaming
- Adaptive Header Compression for VoIP over Bluetooth
- Traffic Modeling for GPRS Networks

... frequently performed in cooperation with industry
Since 1998 WPMC has become a successful symposium and is now an annual event which has been held in Europe, Asia and USA.

The 8th symposium will address the open challenges to realize ubiquitous wireless networks seen from a human point of view.