

# AGORA



UNIVERSITY OF JYVÄSKYLÄ

## Innovations in Business, Communication and Technology (InBCT) 2001-2004

### Agora Center



Kuva: Jussi Järvinen

# Innovations in Business, Communication and Technology (InBCT)

## -hanke 1.11.2001 – 31.12.2004

Hankkeen keskeisiä lähtökohtia ovat ydinosaamisen vahvistaminen, strategisen perustutkimuksen vahvistaminen, uutta teknologiaa soveltavat tutkimusprojektit, uusien innovatiivisten tuotteiden ja palvelujen kehittäminen.

### Tavoitteet

Hankkeen tavoitteena on synnyttää uutta osaamista alueella ja olemassa olevan osaamisen kehittäminen, sekä tämän osaamisen siirtäminen siellä toimiviin yrityksiin. Tavoitteena on myös synnyttää uusia yrityksiä ja parantaa toiminnan edellytyksiä alueelle asetuville yrityksille. Yhtenä keskeisimpänä tavoitteena on luoda ihmislähtöisen tietoteknologian kansainvälinen huippuosaamiskeskus, jossa on monipuolinen synerginen osaaminen ja haasteiden edellyttämä volyyymi, sekä edistää konseptin ympärillä tapahtuvaa perustutkimusta ja osaamista.

Ohjelmassa on neljä pääohjelmaa, jotka ovat tieteidenvälisiä, ja ne yhdistävät viestintätieteiden, käyttäytymistieteiden, liiketaloustieteiden ja informaatioteknologian näkökulmat ja lähestymistavat innovaatioiden kehittämiseen. Suluisa on osaohjelman johtaja (professori, joka virkatyönä johtaa osahanketta):

#### 1. Ihminen, vuorovaikutus ja luottamus (prof. Maarit Valo)

- 1.1 Vuorovaikutus ja yhteisöllisyys verkoissa (prof. Pertti Hurme)
- 1.2 Luottamuksen psykologiset perusteet teknologisten sovellusten kehittämisessä ja liiketoiminnassa (tri Hannakaisa Isomäki ja tri Marja Kokkonen)

#### 2. Käyttäjät verkottuneessa toimintaympäristössä (prof. joht. Heikki Lyytinen)

- 2.1 Uudet tiedonhallintamenetelmät (tri Tuomas Lukka)
- 2.2 Mukautuvat käyttöliittymät (tutkija Pekka Räsänen)
- 2.3 Uusien tuotesukupolvien käyttäjien kognition huomioivat kehittämisperusteet (prof. Pertti Saariluoma)
- 2.4 Koulutusteknologian laboratorio (prof. Päivi Häkkinen)

#### 3. Industrial IT (prof. Jarkko Vuori)

- 3.1 Industrial IT Centre (prof. joht. Pekka Neittaanmäki)
- 3.2 Peer-to-Peer communication/computation in M2M environment (prof. Jarkko Vuori)
- 3.3 Adaptive Service Aggregation (tri Aleksandru Murgu)
- 3.4 Ad hoc -radioverkon liikenteen optimointi variaatioepäyhtälöiden avulla (dos., tri Erkki Laitinen)

#### 4. Uudet liiketoimintomallit (prof. Minna Mattila)

- 4.2 Laajakaistaisten pakettiverkkojen tuotemahdollisuudet (prof. Minna Mattila)

### Hankkeen koordinointi

Hanke toteutetaan Jyväskylän yliopiston Agora Centerissä. Se toteutetaan yhteistyössä alueella toimivien yritysten kanssa. Jyväskylän Teknologiakeskus Oy on merkittävä yhteistyökumppani hankkeessa. Hanke on osa Keski-Suomen ICT -strategiaohjelmaa. Hanke toteutetaan Tekesin EAKR -rahoituksella 3 -vuotisena teknologiahankeena.

Hankkeen vastaava johtaja on professori, johtaja Pekka Neittaanmäki (Agora Center). Ohjelman vastuullinen koordinaattori on projektipäällikkö KTM Esa Kannisto (Agora Center).

### Johtoryhmä

Johtoryhmän jäsenet ovat organisaatioista, jotka ovat sitoutuneet panostamaan ohjelmaan: Teknologiajohtaja Veikko Hara, Sonera; Teknologiajohtaja Ari Hirvonen, TietoEnator; Teknologiajohtaja Mikko Karvinen, Metso; Senior Manager Kaisa Kautto-Koivula, Nokia; Johtaja Seppo Kortelainen, Yomi Solutions; puheenjohtaja, Toimialapäällikkö Jutta Nyblom, JTK Oy; Teknologia-asiantuntija Jari Kovanen, TEKES; Professori ja johtaja Pekka Neittaanmäki, JY / Agora Center. Projektipäällikkö Esa Kannisto toimii johtoryhmän sihteerinä.

# Innovations in Business, Communication and Technology Project (InBCT-project) 1.11.2001 - 31.12.2004

The central starting points for the project are: strengthening of the core know-how, strengthening of the strategic basic research, applying new technology in the research projects to develop new innovative products and services, and supporting new business activities in the SME- sector.

## Objectives

One primary objective of this project is to create new and improve existing know-how in the area, and then to deploy this know-how within the operating companies. Another primary objective is to create new companies, and to improve the business conditions for the companies settling in the area. One of the foremost objectives is to promote basic research and know-how related to the above objectives, and to create a HUMAN CENTERED INFORMATION TECHNOLOGY CENTER that will be an international center of excellence, with extensive synergetic know-how to meet the challenges posed.

There are four main interdisciplinary programs in InBCT. In their viewpoints and approaches towards the development of innovations they combine communication sciences, behavioral sciences, business administration and economics, and information technology. Project leaders in parenthesis.

### 1. Human, Interaction and Trust (Prof. Maarit Valo)

- 1.1 Human, Interaction and Trust in the Web (Dr. Pertti Hurme)
- 1.2 The psychological basis of trust in business and development of technological applications (Dr. Hannakaisa Isomäki and Dr. Marja Kokkonen)

### 2. User in Network Environment (Prof. Heikki Lyytinen)

- 2.1 Hyperstructural information architecture and visualization (Dr. Tuomas Lukka)
- 2.2 Adaptable user interfaces (Neuropsychologist Pekka Räsänen)
- 2.3 Cognitive foundation for developing new product generations (Prof. Pertti Saariluoma)
- 2.4 AGORA Learning Laboratory (ALL) (Prof. Päivi Häkkinen)

### 3. Industrial IT (Prof. Jarkko Vuori)

- 3.1 Industrial IT Centre (Prof. Pekka Neittaanmäki)
- 3.2 Peer to peer communication/computation in M2M-environment (Prof. Jarkko Vuori)
- 3.3 Adaptive Service Aggregation (Dr. Aleksandru Murgu)
- 3.4 Traffic Optimization of Ad-Hoc Radio Network with variational inequalities (Dr. Erkki Laitinen)

### 4. New business models (Prof. Minna Mattila)

- 4.2 Commercialisation of broadband products (Prof. Minna Mattila)

## Project Coordination

The project will be carried out in the Agora Center at the University of Jyväskylä. It will be conducted in cooperation with companies engaged in business activities in the area. Jyväskylä Science Park Ltd. is a significant partner in the project. The project is a part of the ICT strategy programme of Central Finland. This three year regional project is carried out with European Union funding.

The project director is Prof. Pekka Neittaanmäki. The coordinator for the program is project manager Esa Kannisto (Agora Center).

## Management Team

Industry representatives on the management team come from the investing companies: Senior Vice President Veikko Hara, Sonera Ltd.; Technology Director Ari Hirvonen, TietoEnator Ltd.; Technology Director Mikko Karvinen, Metso Ltd.; Senior Manager Kaisa Kautto-Koivula, Nokia Ltd.; Director, Chairman Seppo Kortelainen, Yomi Solutions Ltd.; Manager Jutta Nyblom, JSP Ltd.; Senior Technical Advisor Jari Kovanen, Tekes (the National Technology Agency); Professor and Director Pekka Neittaanmäki, Agora Center. Agora Center Project Manager Esa Kannisto, acts as the secretary of the management team.



## InBCT 1.1.

# Human Interaction and Communities in the Web

*Team Leaders:* Prof., Dr. Pertti Hurme, Finnish University Network of Communication Sciences and Prof., Dr. Maarit Valo, University of Jyväskylä, Department of Communication

### Focus

This project focuses on human interaction in web environments and on changing organizational communication concomitant with the diffusion of web technologies. Research is conducted on competence and trust in computer-mediated communication contexts. Special attention is given to the efficiency of distributed organizations, work-groups and teams. In addition, the mechanisms of interaction and the requirements for sense of community are analyzed from the perspective of interactive web services.

The aim is to examine the requirements for successful communication that may be applied in the development of innovations in information and communication technologies.

### Activities

A fundamental study on trust in face-to-face and technology-mediated communication has been prepared. The report, "Trust in Interaction: Technology-Mediated Interaction and the Building of Trust," by Ella Marila and Annaleena Ylinen, will be published in the Agora series. Two other reports, "Interactive Recruitment in Company Web Pages," by Minna Neittaanmäki, and, "Almost Face-to-Face: Perspectives on Technology-Mediated Communication," by Mikko Jäkälä, are being prepared.

The project has given rise to a novel perspective on research and future applications; this perspective of interaction and community in web environments combines speech communication and organizational communication to technological expertise and research.

Five research projects have begun:

- Mikko Jäkälä: "Private and Public Identity in a Community Based on Technologically-Mediated Communication"
- Ella Marila: "Communication Technology as a Tool in Building Intercultural Trust in International Civic Organizations"
- Marko Siitonen: "Sense of Community and Trust in Web Environments"
- Anu Sivunen: "Group Processes and Interaction as Factors in the Commitment of Young Employees in Project Organizations, Based on Technologically-Mediated Communication"
- Annaleena Ylinen: "Technologically Mediated Interpersonal Relationships in Peer Support Groups"

### Content Dimensions

Web processes: technology-mediated communication, human interaction, communicative relationships, interactive web services, group processes, trust, commitment, sense of community, identity, recruitment.

Web contexts: companies, public organizations, civic organizations, support groups, project organizations, virtual teams, distributed organizations, age and sex of users.

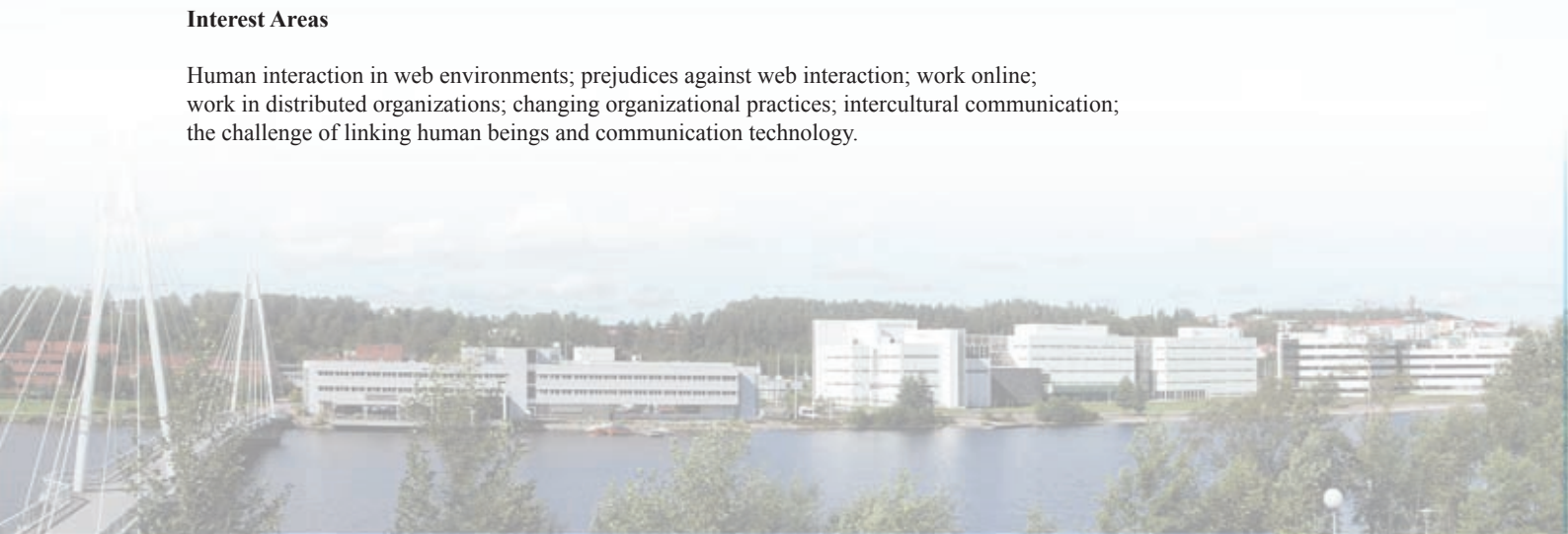
Web dialectics: local/global, national/international, private/public, face-to-face/mediated, analog/digital.

### Central Concepts

Interactive relationships; sense of community; various types of organizations; small group communication; trust; technology-mediated communication; information and communication technology.

### Interest Areas

Human interaction in web environments; prejudices against web interaction; work online; work in distributed organizations; changing organizational practices; intercultural communication; the challenge of linking human beings and communication technology.





**InBCT 1.2.**

## **PRUDETEA The Psychological basis of tRUst and DEvelopment of TEchnological Applications (PRUDETEA-project)**

*Team Leaders:* Dr. Hannakaisa Isomäki, Department of Computer Science and Information Systems and Dr. Marja Kokkonen, Department of Psychology

*Research Assistants:* Anni Tirkkonen, Emmi Ignatius, Jani Ruotsalainen

### **Progress to Date**

The PRUDETEA project examines the emotion of trust among people, and the ability of modern information and communication technology (ICT) to convey the emotion of trust between humans and technology, as well as between humans in technological environments. During 2002 the emphasis has been on the psychological basis of trust, and individual differences in experiencing trust in human-technology interaction. The project has followed the previously presented research plan, and has proceeded as follows:

March-May 2002: literature review on trust, a search and selection of the appropriate measures of trust, consultation with other researchers/research groups.

June 2002: English-Finnish translation and testing of the trust measures, development of the final measurement techniques (both electronic and paper-and-pencil versions), contact with two participating IT-companies, writing of the review article on trust.

July 2002: data collection in two IT-companies, saving data, submission of the review article on psychological trust for publication (Ignatius & Kokkonen: Psykologinen luottamus: riskinottoa ja odotuksia)

August 2002: preparations for collecting data in two other additional organizations, planning for our collaboration with the University of Portsmouth, U.K.

September 2002: data collection in two additional organization starts, saving data, analysis of the IT-data begins.

October-November 2002: data collection in Portsmouth will start (Jani Ruotsalainen), pro gradu studies on trust will begin (Emmi Ignatius), feedback for IT-companies. The second phase of research begins by collecting data.

December 2002: evaluation and planning for 2003

### **Cooperation with Organizations**

The PRUDETEA-project has successfully collected data from two IT-companies, and is starting data collection in two educational institutions. Scientific collaboration will also take place with the Department of Psychology, University of Portsmouth, U.K.

### **Interest Areas**

Human-computer interaction; the psychology of trust: risk-taking and expectations; trust, burn-out and jobsatisfaction; human adaptation in technological environments; the dynamics of trust in humancomputer interaction; user interface design.



## InBCT 2.1.

# GZZ

*Team Leader:* Dr. Tuomas Lukka, Agora Center

### General Description

We investigate using hyperstructure and flexible user interfaces together as a solution to the information flood from the net.

### Goals

- Interactive hyperstructure: the user can connect any two “items” which will then be “near” each other in hyperspace, easily visible and accessible from one to the other.
- Ad hoc teamwork: non-centralized P2P version control of structured data. Two or more persons can form a small team to change an object and subsequently submit those changes for consideration by a larger group. The software will manage all versioning.

### Results

Storm (formerly mediaserver)

Fillets: a perceptually motivated improvement to graph drawing (see report)

Procedural textures: Gzz

### Plan

- Release version 0.8 (our current version, 0.8alpha1, is operational but incomplete)
- Usability tests for several subtopics
- True P2P networking using Storm

### Risks, Problems

Last spring we experienced problems with our software engineering process but these were, for the most part, solved during summer through the introduction of more formal processes. Other risks include possible negative results from usability tests indicating a wrong overall direction. We also run the risk of not recruiting enough graduate students with the necessary qualifications.

### Cooperation Opportunities

- Access to office information structures in a mobile environment: using hyperstructure could make browsing document data within the limitations (bandwidth, screen, memory, UI) of a mobile environment far more feasible.
- User interfaces to relational data. Writing a graphically intensive OpenGL front-end to a relational database with the ability to create ad hoc structures on top.

### Topic Map

- Object/document identity in user interfaces
- P2P Ad hoc networking for teamwork support
- Interactive creation of hyperstructure
- Bi-directional linking
- Xanalogical hypertext
- Relational data
- Document management

### Research Reports

- HyperText'02
- Information Visualization '02
- In preparation
- Procedural textures
- Explanation of the urn-5 namespace registered to our group
- Position paper on Storm

## Adaptive User Interfaces: A Psychological Approach for Atypical Users Personalization

*Team Leader:* Neuropsychologist Pekka Räsänen, Niilo Mäki Institute

*Project Staff:* Technical Manager; Janne Ylinen, Oleksander Maslov, Developer; Iryna Yevseyeva, Developer; Mykola Pechenizkiy, Ph.D. student

### Overview

The Adaptive User Interfaces project develops a virtual environment for R&D with build-in, easy-to-use construction tools for researchers / developers. These tools integrate a number of AI techniques and enable building AI-based adaptive e-learning and e-assessment materials to be used via the Internet. The testing, validation and refinement of the system will be done in the context of personalization of atypical users, including studies on adaptive e-learning for those who otherwise have exhibited difficulties in learning similar contents.

### Objectives vs. Results

The first prototype of the program will be accomplished according to the planned schedule during autumn 2002. The ES and IRT techniques are now being implemented and integrated. Likewise, the first field experiments focused on analyses of individual differences in cognitive strategies will be started in 2002.

The implementation of data mining techniques, including a set of feature extraction methods, classification model and MC DM techniques and their integration into the e-learning environment will be the main goal of the year 2003.

### Known Risks and Problems

Some targeted end-users of the system (among the researchers and developers of the e-learning contents) do not have expertise in the area of adaptivity and personalization of automated assessment processes. Thus, there is the possibility that "spreading around" of the developed tools among researchers/developers will be hindered despite the easy-to-use properties. In order to minimize this risk the special demos/manuals/briefs course need to be produced.

The measurement error inflicted by the Internet may not be sufficiently controlled for certain psychometric personalization tasks limiting the usability of the program. Research on methodologies to control these errors is needed.

### Cooperation Possibilities

Research on adaptivity and personalization based on multidimensional data, including psychological data and AI and statistical techniques.

Direct discussion about research (and development) co-operation with participating companies will start in 2003.

Contact person: technical manager Janne Ylinen.

### Fields of Interest

#### Technology

- Java Distributed systems
- Visual constructor of scripts
- Netexperimentation
- E-learning environment

#### Adaptivity

- Expert systems
- Multi-criteria decision making
- Feature extraction & Classification
- Item response theory
- Data mining

#### Psychology

- Multidimensional data
- Cognitive processing
- Personalization
- E-learning
- (E)-learning disabilities



## The Cognitions of the User

*Team Leader:* Prof., Dr. Pertti Saariluoma, Department of Computer Science and Information Systems

*Researchers:* Mr. Sacha Helfenstein, Mr. Pauli Salo *and additional authors*

### Key Interest Areas and Concepts

HCI and usability, learning and transfer, cognitive engineering, mental content and representations, complexity, consumer psychology, marketing, preference, attachment and commitment

### Relevance

Much is at stake when a newly developed technological system or device is put into the user's hand. In a tiny fraction of the time invested into its development it will be decided whether and how the user learns to operate it, and how he or she "likes it." In order to effectively address these issues we need not only a firm understanding of the individual's psychological functioning, but we must also look at what the user already knows or doesn't know.

Of key interest must be how users understand and behave in interaction with practical innovations, on the basis of their prior experiences. This is the focus of research in transfer of learning, and thus, one of the principal pillars of practical valuable progress within cognitive science.

Finally, while the user-problem is crucial for successful design and engineering, a full account of the transfer issue must attend to the individual as a consumer in a market. It is the distinct aim of this project to embed the user's cognition into an investigation of its socio-emotional context.

### Approach

The research design equally addresses the need to strengthen the theoretical foundation of transfer and the objective to present new empirical results. Its current weights lie on the development of a solid understanding of the phenomenon of learning, the development of a new theoretical approach to transfer on the basis of a foundational analysis of the theories and empirical results presented over the last century, and the investigation of transfer within virtual and naturalistic settings of real-life tasks.

The researchers see it as vital to invite co-funding and participating enterprises to communicate their expertise and application issues in order to harmonize investigative progress with practical needs.

### "Work in Progress"

- Article on interrupts submitted in *International Journal of Human Computer Studies* (Antti Oulasvirta & Pertti Saariluoma)
- An Article to be submitted on co-operation of memory systems in language revision to be submitted in *Journal of Memory and Language* (Antti Oulasvirta & Pertti Saariluoma)
- A large paper (47 p) on demographic parameters for IT design in press *HIIT publications* (Antti Oulasvirta, Sauli Tiitta & Pertti Saariluoma)
- An article on the *reconstruction of cognitive transfer* (Sacha Helfenstein & Pertti Saariluoma), to be submitted to a relevant psychological journal within weeks time
- A larger manuscript on the phenomenon of learning (Pertti Saariluoma & Pauli Salo), being developed to a monograph for submission in the beginning of 2003)
- Manuscripts on concept learning and complexity (Pauli Salo), to be submitted to the international philosophical journal *Mind* and published in *Minds and Machines* respectively
- A manuscript on reasons for failures to find meaningful transfer (Sacha Helfenstein & Pertti Saariluoma)
- An investigation into socio-emotional dimensions of transfer, involving an examination of commitments and aversions within the Linux and Windows societies (Sacha Helfenstein & Pertti Saariluoma)
- A Win/Delphi computer environment has been programmed (Pauli Salo) to study transfer in the context of menu-navigation, using a mobile phone environment. Pilots have started; results and reports are to be expected this fall.
- In addition, COMAS student Marketta Niemelä is conducting experiments on search and recall, that are relevant to this project in collaboration with Pertti Saariluoma.



## **InBCT 2.4. (I)**

# **Agora Learning Laboratory (ALL)**

*Team Leader:* Prof., Dr. Päivi Häkkinen Institute for Educational Research

### **Areas of Interest**

E-Learning, virtual learning environments, networked learning, computer supported collaborative learning, digital portfolios, shared expertise, learning at work, tacit knowledge, career development, evaluation methods and criteria for the pedagogical use of ICT, visualization and awareness tools for online communities

The research projects in ALL aim to promote research-based evaluation and development of virtual learning environments for various educational levels, work areas and contexts. The aim is to develop an e-learning model collaboratively with basic research and company applications. Agora's laboratory for educational technology will be a research and development unit and a researcher-training environment of high international standard, the activities of which are supported by the University of Jyväskylä's multidisciplinary expertise. The laboratory's operational dimension consists of both research projects and cooperative networks.

### **Activities**

During the year 2002 several all research projects have commenced in connection with: 1) development and design of networked environments, 2) formulation of evaluation criteria for the environments, 3) application of innovative evaluation methods. In the area of development of networked environments, 2002 has seen the start on the development of visualization environments (a separate report), the utilization of a learning environment for experimental research methodology, and the application of several network-based learning environments for different user categories.

### **Evaluation Criteria for Virtual Learning Environments**

A preliminary survey undertaken at ALL suggests that learning environments are evaluated in descriptive terms, and often from the technological viewpoint. For example, the potential of collaborative environments as a catalyst for learning is often overstated. Although "virtual learning" or "e-learning" are some of today's buzzwords, independent research findings about ways in which information networks could support human learning and expertise have played a minor role in system development. ALL has produced evaluation criteria to assess the learning environment's pedagogical impact. The evaluation criteria will be further developed during the autumn, and the end result will be published in the form of a guide to support the evaluation and design of learning environments.

### **Digital Portfolios as Innovative Evaluation Methods**

The creation of the evaluation criteria is connected with the development of technology supported innovative evaluation methods. In 2002, a research project dealing with digital portfolios was commenced at the laboratory. Its purpose was to apply and analyze digital portfolios as an instrument in documentation and evaluation that is supported by information technology for learning, know-how and expert career development. The application area consists of different educational levels, public organizations and private companies. The project combines the use of portfolios for pedagogical purposes with the design, development and evaluation of network-based environments. The research has investigated innovative portfolio applications, the development of which will be analyzed during 2002 and 2003. Portfolio cases are supported in the pedagogical implementation of a digital portfolio, and in the design and research & development of the networked environments to be utilized. The theoretical development is based on a doctoral dissertation published in 2002. Together with the international research community, the laboratory is also engaged in assessing the uses of information technology in innovative teaching and developing methods of evaluation for network based teaching and cooperative learning.

### **Collaborative Network**

The laboratory also coordinates know-how in the area of e-learning at the University of Jyväskylä and is building a collaborative network in this area. The operational collaborative network of the laboratory for educational technology will consist of the central participating actors at the University of Jyväskylä, companies in InBCT, and international partners. The survey of collaborative networks will act as the starting point for building the laboratory's scientific framework, mapping the participating actors, planning common projects, and for the general development of operations. The activities of the collaborative network commenced in June 2002 with the opening of a seminar series. Approximately once a month the seminar series introduces each participating actor with the help of short presentations and a discussion.



## InBCT 2.4. (II)

### The Role of the Companies and Possibilities for Collaboration in the Research on Learning Environments

One of the aims of ALL is to develop a sound e-learning model in cooperation with the basic research at the university and applied company solutions. The role of the companies is twofold. Some of the companies participate in business activities connected with the learning environment products, whereas some are mainly interested in utilizing these learning environments in their own organizations to transfer expertise, and in training. This project can offer opportunities for collaboration on both fronts: in the design and evaluation of both learning environment products and companies' customized e-learning solutions. Preliminary collaboration is taking place in both of these areas already, and will be intensified especially on the basis of the company interviews in the autumn of 2002.

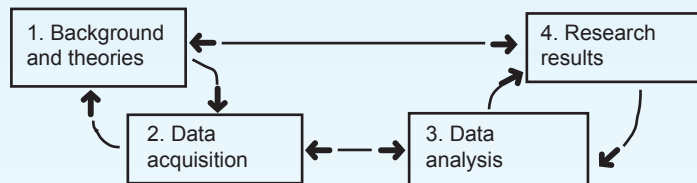
## A-KIT = Agora Exploratory Environment for Knowledge Discovery

*Team Leader:* Prof., Dr. Tommi Kärkkäinen, Department of Mathematical Information Technology

Agora Center's common research infrastructure is being developed in connection with this Agora Learning Laboratory (ALL) part project. The goal of the A-KIT project is to design and implement a software application that gives integrated support for questionnaire studies especially, and also supports acquisition of data, visualization and interactive, qualitative/quantitative analysis.

### A-Kit System: The Basic Structure

The overall process dealing with the management of the research problem is described with the following stages in the A-KIT system.



The information technology solution supporting the management of the research problem encompasses the stages 2 and 3. In addition, the theory background of the stage 1 can be linked to a questionnaire designed on the basis of the solution.

1. The questionnaire is produced as an XML document
2. The XML document is automatically converted (DTD + XSL) to an HTML page.
3. The HTML page is published in the server.
4. The target population responds to the questionnaire. Their replies are directed and automatically stored in an A-KIT server.
5. Replies obtained are formatted (dimension compression, format change), in the A-KIT server, as required by the visualization tool.
6. The inspection and analysis of the replies with the visualization tool takes place in the user's work station.

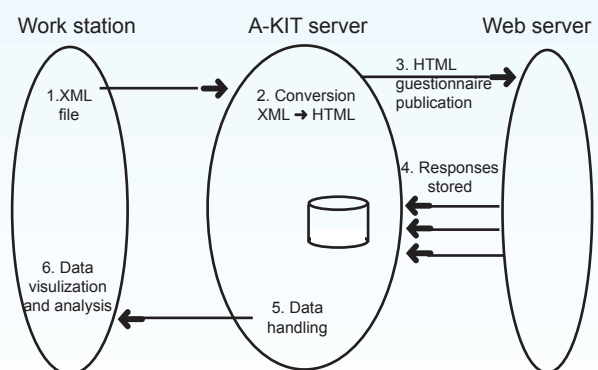


Figure 2. A-KIT system architecture



**InBCT 3.1.**

## **Industrial Information Technology Center**

*Team Leader:* Prof., Director, Dr. Pekka Neittaanmäki, Agora Center

The starting points for building the core competence group are promising. The group includes fields with the following know-how: modeling and numerical simulation methods, control and optimization theory (deterministic and stochastic), learning and intelligent systems, statistical methods, signal processing, network planning, mobile data processing, embedded systems, and software engineering.

Industrial IT centre will occupy a strategic position in the regional technology programs and transfer of new technology to the business world.

The group includes eight professors, 10 senior researchers and 20 doctoral students, forming part of the COMAS Research School (20 education places, director Pekka Neittaanmäki). The group has extensive national and international connections. One of its most essential tasks is to create an international network of top know-how, allowing the transfer of that know-how between the participants.

The main priority is to establish regular working relationships with the following countries and institutions: USA (MIT, Berkeley, Houston), Japan (Waseda University, Tokyo), France (Paris VI, INRIA), Germany (CEASAR Institut Bonn GMD St August) and Israel (Weizman Institute).



## Peer-to-Peer Computing Progress Report

*Team Leader:* Prof., Dr. Jarkko Vuori, Department of Mathematical Information Technology

### Background

Distributed systems have traditionally been based on the client-server architecture, in which centralized servers are used in communication. This solution is unsuitable for systems in which fault tolerance and load balancing play a prominent part, because server performance usually forms the bottleneck in these kinds of systems. Also, networks with rapidly changing topologies are generally difficult to manage in a centralized manner. Peer-to-Peer networks (Napster and Gnutella, for example, for the distribution of music files) are now challenging the client-server solution. They represent a fundamental change in the distributed systems' architecture. Each node in the P2P networks acts both as a server and the client. As a result, data storage and processing can be distributed, and the bottleneck found in the client-server architecture can be eliminated.

The Cheese Factory project investigates the distribution of computational processing to many equal processing units. This is known as Peer-to-Peer processing. P2P processing does not employ any Master unit to manage the system: supervisory functions (task sharing, for example) are also distributed. The advantages of this solution are fault tolerance and ease of maintenance and supervision. Its disadvantages are complexity of management algorithms and greater need of resources.

### Project Status

During the first half a year period we have defined the operations of the Chedar distributed platform, and the goal is to complete a functional prototype before the end of year 2002.

The other half of the research project consists of a process in which the aim is to place a data fusion application on top of the Chedar distributed platform. Data fusion was selected for a test application, because its processing and data acquisition requirements are relatively demanding.

### The project results for the year 2002 will consist of:

- A prototype of the Chedar distribution platform (Java component library)
- A distance management and measuring application for the Chedar network
- Publication: Weaknesses of centralized topology in Grid Computing environments
- Master's Thesis: Data fusion algorithms and their evaluation in Java environments
- Master's Thesis: Peer-to-Peer network architecture for data fusion applications

### Future

Once the prototype is completed, we will investigate the behavior of Chedar's adaptive search algorithms in a malfunctioning workstation network, and will publish a system level description about the distributed platform. Due to some faults in Sun's JXTA platform, we have commenced an experimental implementation of a streamlined JXTA substitute. This enables us to develop our own lower level data communication algorithms (search operation, for example) and compare them with JXTA. Another aim is to investigate scalability with the help of Network Simulator 2, which we anticipate will give us new know-how for the development of Chedar.

### Potential Applications

As embedded intelligence is becoming more and more common with everyday devices due to the lowered costs of component technology, the need for networking these devices increases (for example, the mobile phone or a voting procedure can be used to control house temperature). Typically, these networks have several mobile components (a mobile phone, car, etc.). P2P networks are very practical in many respects for the management of these types of tasks – they can make resource lookup and communication between the participating peers more efficient.

For example, if the aim is to determine the room temperature by voting without divulging the participants' preferences, P2P processing is an excellent way to do this. A mobile phone sends its temperature preference encrypted by a public key to another mobile phone, which sums them up (within certain limits, messages protected by a public key can be summed up without de-encrypting them). Once all the temperature preferences have been added up using the P2P network formed by the mobile phones, the room temperature control gets the sum total and can, with its key, average the sum, hiding all the private preferences. With this P2P network based method all kinds of polls can be conducted without divulging private opinions.





## SERAMON - Adaptive Service Aggregation in IP Mobile Networks

*Team Leader:* Dr. Alexandru Murgu, Department of Mathematical Information Technology

### Results

- Heterogeneous user population characterizing the present available services is considered in mobile IP networks in terms of QoS / CoS differentiation.
- Adaptive multiservice management is based on the dynamic estimation of built-in features of user populations on a long-term basis (trends on traffic samples and similarities). IP service management reformulated to detect statistical traffic abrupt changes of QoS and class of service parameters.
- The existing dynamic trade-off between the IP resources and service flexibility is encoded via entropy aggregation towards the implementation of IP session control mechanisms.

### Reports/Papers

- A. Murgu, "Fuzzy Aggregation of Input-Output Service Level Dynamics in Multimedia Networks," in *Advances in Computer Cybernetics*, Vol. XI, G.E. Lassker (ed.), pp. 54-62, 2002
- A. Murgu, "Multicalls Service Dynamics Replication Using Evolutionary Selection Games," in *Proc. of 10<sup>th</sup> Intern. Symp. on Dynamic Games, ISDG-2002*, St. Petersburg, Russia
- A. Murgu, "Fuzzy Successive Averaging method in Multistage Optimization Systems," in *Proc. of Intern. Joint Conf. on Neural Networks, IJCNN-2001*, Washington, D.C., USA
- A. Murgu, "Minimum Cross Entropy Control in Stochastic Switching Systems," in *Proc. of Intern. Symp. on Information Theory, ISIT-2001*, Washington, D.C., USA
- A. Murgu, "Switching Envelope Analysis for Statistical Aggregation of Traffic Flow Batches," in *Proc. of 9<sup>th</sup> Intern. Symp. on Dynamic Games, ISDG-2000*, Adelaide, Australia

### Future Research Issues

- QoS adaptivity of network response to different requirements of multimedia communications (voice, data, video, web) aggregating addresses at the core servers (used in unicasting); multicast addresses are aggregated to encapsulate the multicast addresses containing the location information on group members; aggregation schemes for aggregate addresses either through a group identifier approach or an interface approach
- interface approach: addresses aggregated at the interface to allow group members and address allocation to be totally random

### Keywords

Stochastic Services, Mobile IP Networks, Maximum Entropy Aggregation.



InBCT 3.4.

## Traffic Optimization of Ad-Hoc Radio Network with Variational Inequalities

*Team Leader:* Dr. Erkki Laitinen, Agora Center

### Aim

Characteristic of an ad hoc network is its dynamic and spontaneous operation. A wireless ad hoc network can be created and can disappear wherever and whenever without any fixed routers, hosts, or support stations. Routing and capacity optimization for the ad hoc network is difficult due to its dynamic and changing topology. The project aims to find new methods to optimize the ad hoc network's routing and capacity. New methods that are being researched in order to solve the problem are variational inequalities and genetic algorithms.

### Results and Observations

The universities of Jyväskylä, Oulu and Kajaani have collaborated in the research. The preliminary research has engendered research reports and visits by the researchers. The research has mainly consisted of literature surveys and of becoming better acquainted with the research area. The project has programmatically tested the use of variational inequalities in static network balancing. It seems probable that the method can be developed to apply it to networks where the nodes are mobile.

### Future Plans

The research continues according to the research plan. Professor I. Konnov from the Kasan University will visit Oulu in October 2002. The occasion will include a modest research seminar with the project's research personnel. The aim during the autumn is to investigate the network balancing using a diverse criteria, because the ad hoc network's optimal routing is dependent on many different factors. The group, together with the University of Oulu's Centre of Wireless Communication (Professor Petri Mähönen), has also sought membership in Infotech Oulu organization.

### Research Reports

- Konnov I: "*Convergence Properties of Combined Relaxation Methods*," preprint, March 2002, University of Oulu, ISBN 951-42-6687-0
- Konnov I, Laitinen E: "*Theory and Applications of Variational Inequalities*," preprint, April 2002, University of Oulu, ISBN 951-42-6688-9
- Jaana Oksa: "*Variaatioepäyhtälöistä ja Ad-Hoc Verkon Reitityksestä*," to be published in the autumn of 2002
- Georgiy Shenekov: "*Ad-Hoc Verkon Reititysprotokollista*," to be published in the autumn of 2002

### Areas of Interest

ad hoc routing, multiparameter optimization, variational inequalities, genetic algorithms



## Broad-Band Packet Network Products and Their Commercialization: Multimedia Messaging Services

*Team Leader:* Prof., Dr. Minna Mattila, School of Business and Economics

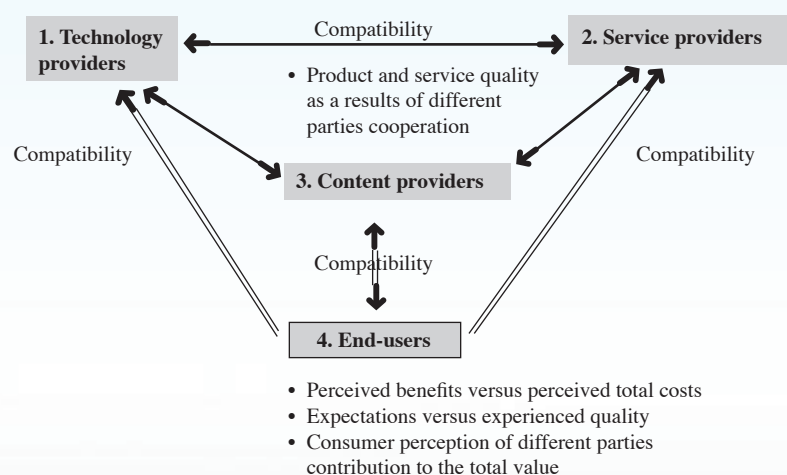
### Observations

Researcher Mari Suoranta has studied Multimedia Messaging Services (MMS) in the Business-to-Consumer sector. The studied mobile services were divided into four groups: commercial, entertainment, news, and professional. The special issues included, but were not limited to, the following key areas: what is the possible future killer application, what are the triggers in the non/usage of mobile services, which factors add to perceived value, what is the optimal product range in terms of particular customer segment needs, and what are the next steps in the technological developments. Also touched upon were remote diagnostics, mobile radio, and video screening. The preliminary research results indicate that consumers are interested in new mobile services. There is a correlation between age and intent to use mobile services, but the adoption itself does not seem to unambiguously follow the traditional diffusion theories. The value proposition of mobile services must be highly visible to the consumers. The majority of consumers are first going to adopt services that ease their daily routines instead of providing pure entertainment value. The main concerns among consumers are the ethical values of service providers (possible spamming) and pricing issues.

Researchers Kaapo Heikkinen and Ari-Jaakko Järvinen have studied Multimedia Messaging Services in the Business-to-Business sector. The main focus has been on MMS enhanced problem solving in the business environment. The special issues include, but are not limited to, the following key areas: does MMS enable more efficient problem solving, in what kind of problem solving situations MMS is most likely to be applied, in what stages of problem solving MMS provide the highest perceived value, and what are the strengths, weaknesses, opportunities, and threats that MMS poses in organizational problem solving processes. A cognitive model is being developed based on the research findings. The preliminary research results indicate that MMS in fact contributes to organizational problem solving situations in many ways. As a part of remote diagnostics used in after-sales services, MMS can be exploited in international communication between headquarters and subsidiaries. These research results provide, not only practical tools for product developers and service providers but they also contribute significantly to the field of science.

### Plans

The research team is willing to deepen this MMS-project, and re-direct it into new areas according to the best interest of participating firms. Researcher Juha Munnukka has joined this project as a Ph.D. candidate. Earlier studies have indicated that future research is needed, especially in the field of price formation. Munnukka's research focus is on studying the relationship between pricing and mobile service adoption.





UNIVERSITY OF JYVÄSKYLÄ

AGORA CENTER

## **Agora Center Mission Statement**

The Agora Human Technologies Center, functioning as an multidisciplinary consortium, shall organize and conduct high-level research, development and teaching in an interdisciplinary context, combining the fields of social sciences, education, humanities, sport and health sciences, natural sciences, economics and information technology.

The Center's research teams shall develop and deploy new holistic, technology-based paradigms that focus on the areas of human development and information and communication technologies. This research shall be conducted as projects of fixed duration and in collaboration with the University of Jyväskylä's faculties and external organizations, including various internationally recognized institutes as well as entities in the public and business sectors.

Postal address:	Tel.	+358 14 260 4641
P.O. Box 35 (Agora)	Mobile	+358 400 707 628
FIN-40014 University of Jyväskylä	Fax	+358 14 260 4400
Finland	E-mail:	esa.kannisto@jyu.fi

Street address:

Agora, Mattilanniemi 2

e-mail: