HIIT's Future Internet Program

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The Vision of the Future

- User expectations:
    - Future applications and platforms will be **context-sensitive, adaptive, and personalized**
    - They need to be run, in a reasonable and secure manner, on a variety of execution environments: **anywhere, anyhow, anytime, by anyone**
- Required system properties:
    - self-aware, distributable, reconfigurable, proactive, collaborative, secure, trusted, privacy providing, mobile, diversely accessible, extendable, incrementally deployable, resource-aware, …

Research Challenges in Future Internet

- Research Challenges:
    - Security-Trust-Privacy
    - Mobile Always-on Connectivity
    - Scalable Open Service Architectures

- Solutions are sought in distributed algorithms and structures, middleware, and protocols.
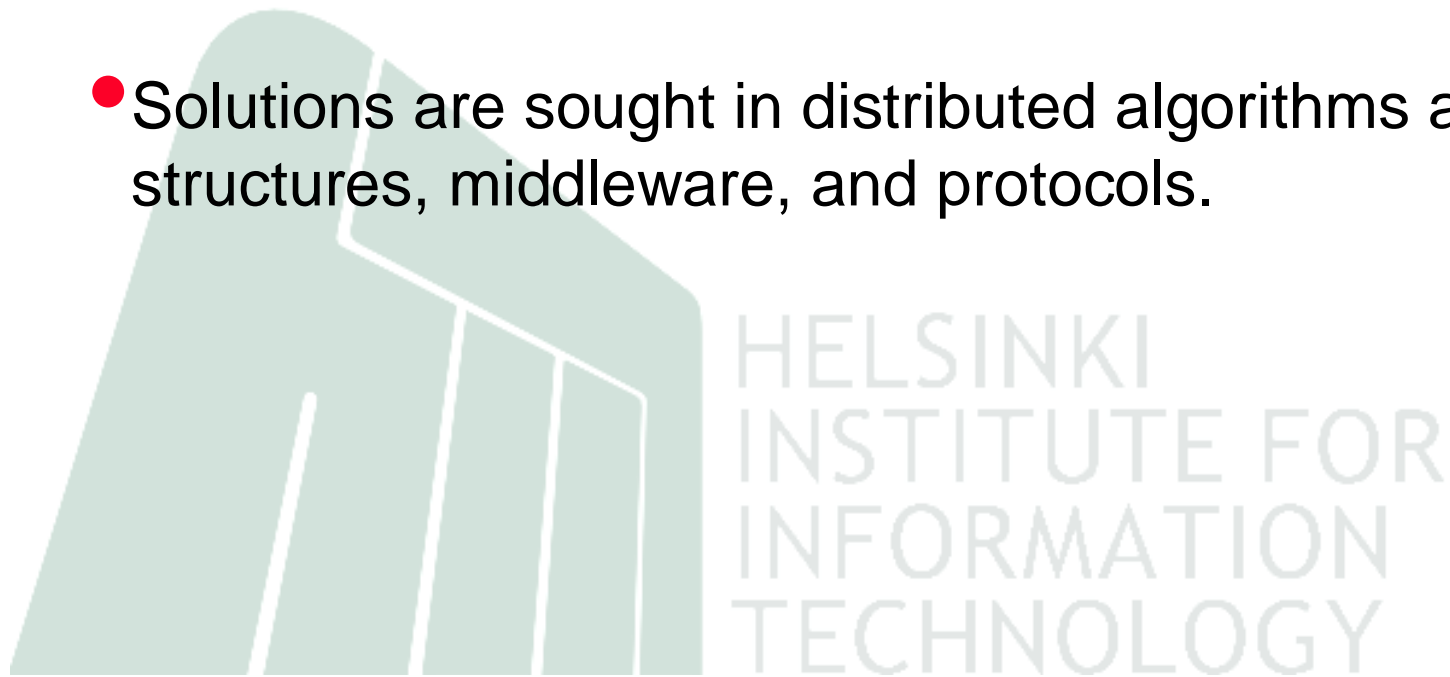
Security-Trust-Privacy

- The current Internet is vulnerable
  - Internet protocols were designed for friendly environments

- "Add it later" does not work!

- Dynamic security-trust-privacy requirements

Mobile Always-on Connectivity

- Mobility
  - User mobility
  - Host mobility
  - Network mobility

- Communications protocols
  - Need reasonable solutions at each layer

Scalable Open Service Architectures

- Service provisioning needs to scale

- Middleware has a crucial role
  - Interoperability
  - Rapid and fault-tolerant service provision
  - Context-awareness support

- Overlay networks
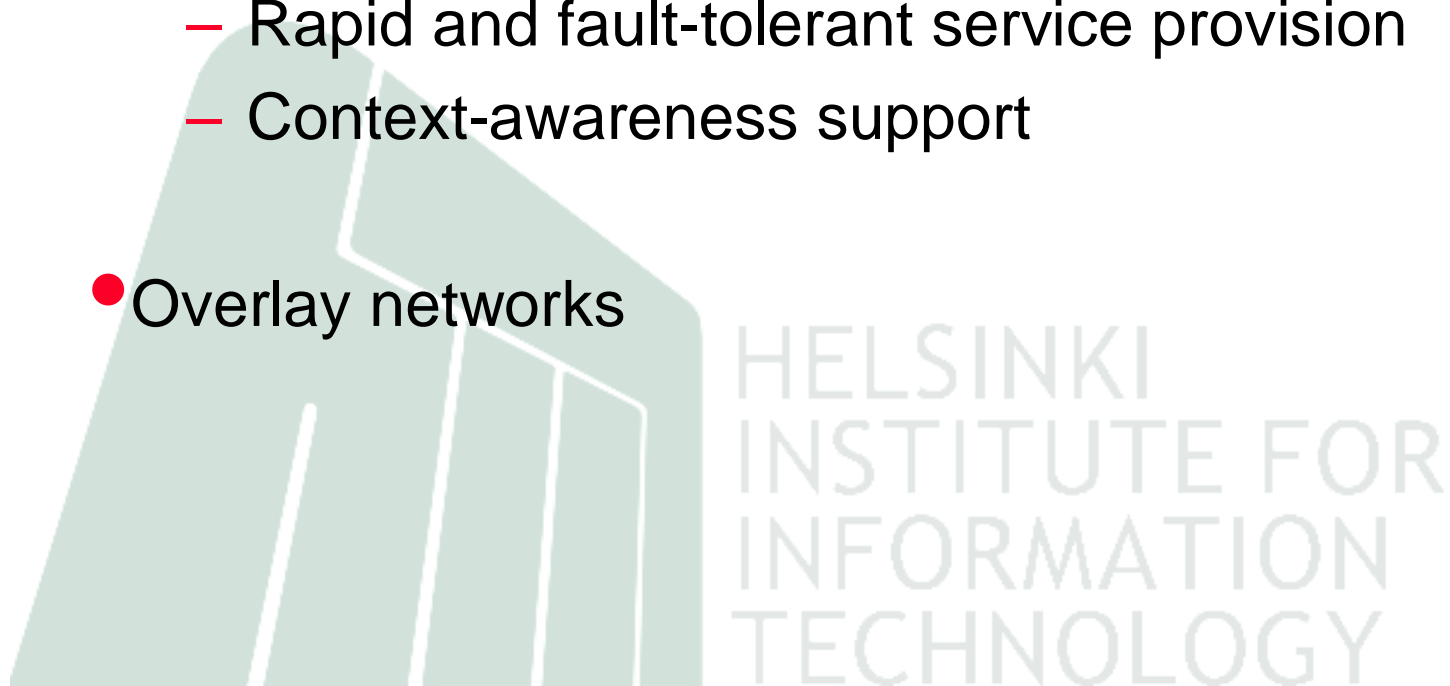
FI Team

- Director: Prof. Kimmo Raatikainen
- Research co-ordinator: Oriana Riva
- Seniors:
  - Adj. Prof. Patrik Floréen
  - Adj. Prof. Andrei Gurtov
  - Dr. Arto Karila
  - Univ. Lect. Markku Kojo
  - Prof. Jukka Manner
  - Dr. Pekka Nikander
  - Dr. Ken Rimey
  - Dr. Sasu Tarkoma
  - Prof. Antti Ylä-Jääski

Current (or Recently-ended) Projects

MobiLife	DYNAMOS

Services for All	Trust for All

Future Mobility Middleware	Web Services In Ad Hoc and Mobile Infra

Location Privacy and Authentication In Massively Distributed Systems

Trustworthy Internet

InfraHIP	NordicHIP

MERCONE
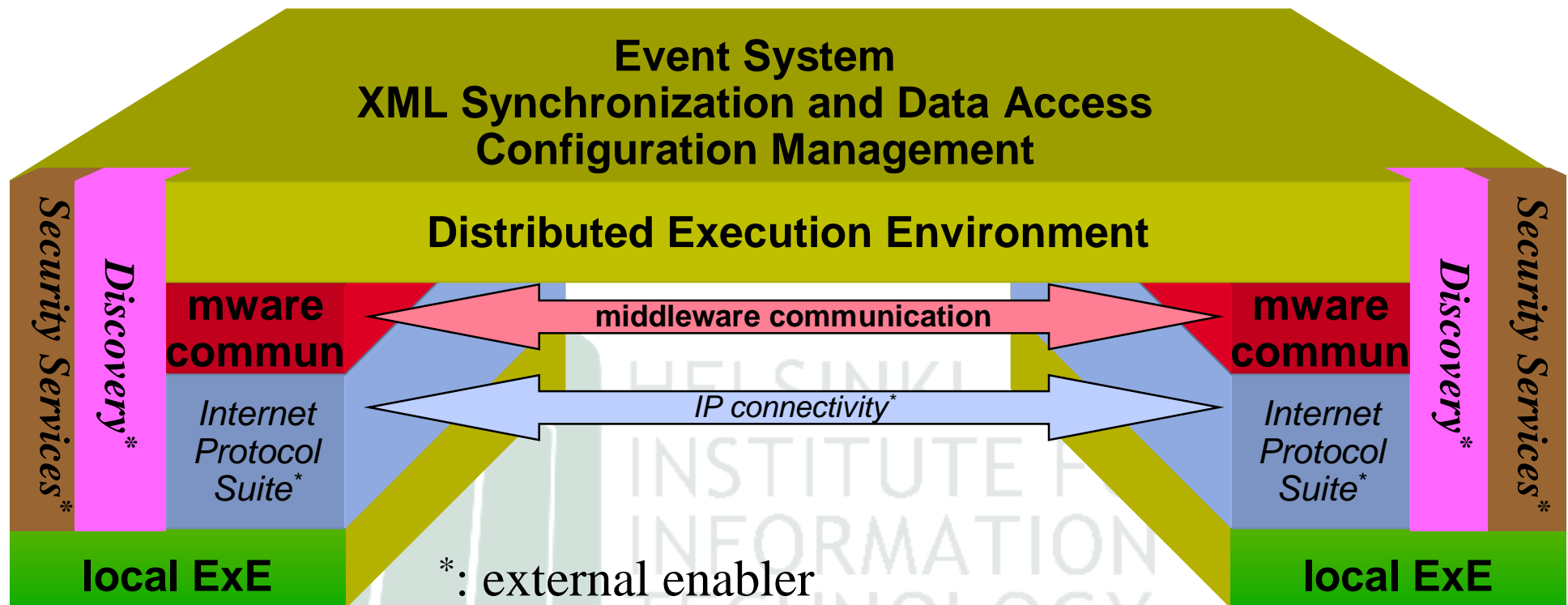
ABI

INHONETS

Fuego Core 2005/7

- XML processing and messaging

- Mobile distributed events

- XML synchronization and data access

- Configuration management

Event System
XML Synchronization and Data Access
Configuration Management

Distributed Execution Environment

Security Services*

Discovery*

mware commun

middleware communication

*Internet Protocol Suite**

*IP connectivity**

mware commun

Discovery*

Security Services*

*Internet Protocol Suite**

local ExE

*: external enabler

local ExE

Fuego Results

- The Fuego middleware service set
  - Data communications
    - Efficient wireless SOAP
    - Efficient content-based routing
  - XML-aware data synchronization
  - Software configuration management

- Contributions to standardization
  - Efficient XML Interchange WG (W3C)
  - WWRF

ITEA Services for All (S4ALL)
2005 – 1H2007

- Vision: A world of user-centric services that are easy to create, share, and use

- Consortium: France, Finland, Spain, Germany

- Finnish partners: HIIT, Nokia, Capricode Oy

- Volume at HIIT: ~4 py/y

- Contact: Ken Rimey

S4ALL at HIIT

Focus on handheld devices:

- Prototyping of an *Interactive Service Composer for the Mobile End User* (MSc thesis)
- Use case: Controlling a device management server from the phone (in collaboration with Capricode and Nokia)
- Tools for exposing Symbian C++ system interfaces in *Python for S60* for rapid service development
- Utilizing BPEL in a device management server (MSc thesis)

Service Composer Prototype

- Runs on S60 mobile phones
- Enables creation of linear workflows for execution on the phone
- Component actions are either web service invocations or functions of the phone
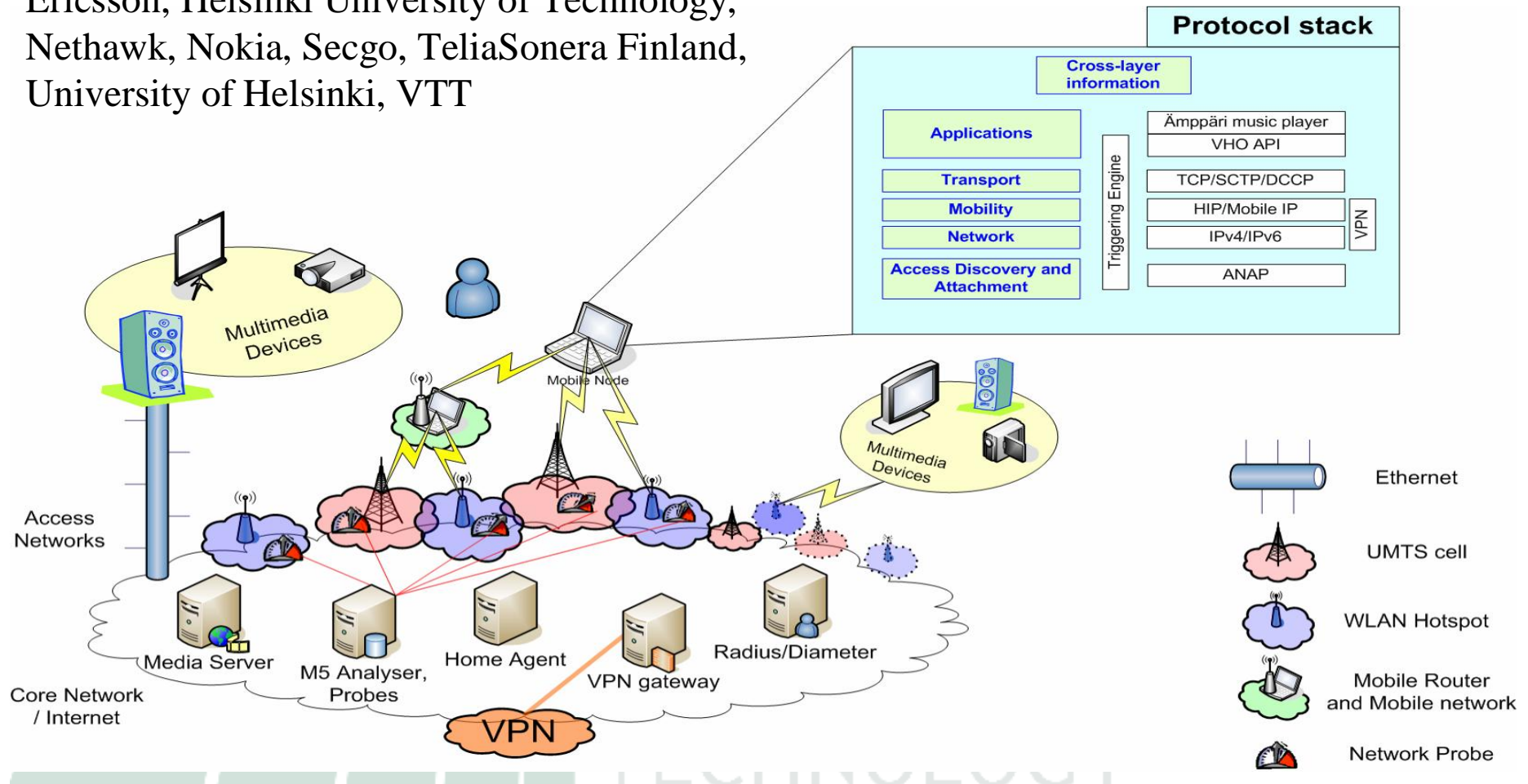- An early-stage prototype

MERCoNe

Multiaccess Experimentation in Real Converging Networks

Partners:

Ericsson, Helsinki University of Technology, Nethawk, Nokia, Secgo, TeliaSonera Finland, University of Helsinki, VTT

MERCoNe Project Objectives

- Investigate the challenges in a heterogeneous multi-access and multi-operator environment and develop new solutions
- Study the interactions between different Internet protocols in a real network environment, seeking for enhancements and needs for further development
- Optimize wireless networking systems in terms of signaling overhead and network performance
- Employ cross-layer notifications and triggers for enhanced overall networking performance
- Prototype implementations, experimental evaluation and standardization play a key role

MERCoNe at Kumpula

- Contributes mainly to WP2 - *Transport Protocol Enhancements and Experimentations* with the **goal** of
    - Achieving deep understanding of transport protocol behavior and performance in a multi-access environment with vertical handoffs
    - Developing transport protocol enhancements for efficient operation in a multi-access environment
    - Applying cross-layer design with explicit notifications and inter-layer co-operation
    - Implementing a selected set of algorithms and protocols in Linux to experiment in a real multi-access environment

Networking Research Group

- Research, experimentation and standardization of architecturally-sound secure Internet supporting host mobility and multihoming
- Location: Spektri (Otaniemi)
- Group leader: Andrei Gurtov
- Ongoing projects
  - InfraHIP
  - TrustInet
  - MERCoNe
  - NordicHIP
  - LPAMDS

Infrastructure for HIP (InfraHIP)

- Standardization, implementation and research of Host Identity Protocol (HIP)
  - integrating mobility, multihoming and security for Internet
- Successfully completed in March 2007
  - over 20 publications on HIP naming mechanisms, firewall design, NAT traversal, privacy extensions,...
- HIP on Linux implementation
  - Open-source userspace, kernel parts accepted to official Linux kernel
  - Updating according to latest IETF specifications
  - Interoperability testing; a moderate user base

InfraHIP II - Plans

- Funding decision pending from Tekes

- Focus on experimentation and deployment of HIP

  – Technology transfer to industry, EU projects

- Agenda

  – Improving the HIP on Linux implementation, userspace and kernel parts

  – Easy installation, pushing towards Linux distributions

  – Deployment in the test network using a proxy

  – Standardization of NAT traversal and API in IETF

  – Publishing a book on HIP

  – Integration of HIP with VoIP (SIP) and other applications

Trustworthy Internet

- GIGA three-year strategic project focusing on secure (overlay) routing, trust networks, usable security
- *Trust chains.* Can a centralized PGP system be distributed so that public keys and signatures are stored in a public repository such as OpenDHT?
- *DHTs and overlays.* Evaluating scalability of DHT and overlay systems up to millions of users. Can routing be optimized dynamically to improve latency and reliability of queries?
- *Future network architectures.* The traditional send-receive Internet architecture is failing against volumes of SPAM, Denial-of-Service, and phishing.

Trustworthy Internet - status

- Teemu Koponen visits ICSI Berkeley for 1 year
  - Paper on data-oriented network architecture (DONA) was accepted to ACM Sigcomm'2007
- Completed HIP usability evaluation – testing security on real users
- HIP-OpenDHT interface is re-written and tested. Storage of certificates to DHT is being evaluated.
- Measurements of overlay routes using PlanetLab (planet-scale international testbed of about 700 servers)
- Ongoing implementation of integrated demo of secure and spam-free voice/video/chat application on Nokia Internet tablets with P2PSIP

MERCoNe at Spektri

- Mostly contributing to WP 1: *Mobility in heterogeneous environment*
- Ported Host Identity Protocol on Linux (HIPL) to Nokia 770 Internet Tablet
  - Installation packages publicly available and used
  - Upgrading to N800 in progress
- Measured performance of Tablet-PC and Tablet-Tablet HIP transfers and handovers
  - Submitted an article on implementation and measurements
- Symbian implementation of HIP on E60 smart phone ongoing

NordicHIP

- HIIT and Swedish Institute of Computer Science (SICS), Dr. Bengt Ahlgren
- Serve as a collaboration tool for national HIP activities in Finland and Sweden
  - mutual seminars, researcher exchange
  - research work on
    - HIP rendezvous service
    - IPv4/v6 co-existence
    - naming infrastructure
- Collaboration activity with NorduGRID
- Connections to the Ambient Networks EU project

Location Privacy and Authentication In Massively Distributed Systems

- Co-operation between HIIT and RWTH Aachen
  - With Prof. Klaus Wehrle, funded by Academy of Finland/DAAD
- Research focus on
  - HIP for lightweight devices, WLAN authentication with HIP, location privacy
- Diploma thesis on Lightweight HIP completed at HIIT by RWTH student T. Heer in 2006
- Dagstuhl Seminar on Internet naming organized in Germany in 2006
- In summer 2007, HIIT researchers will visit RWTH: Oleg Ponomarev (3 months), Miika Komu (1 month)

ITEA Trust4All

- Subcontracted from Nokia Research Centre
- Trust4All is an ITEA/EUREKA project with 16 partners from 4 countries (NRC one partner)
- 1.10.2005-31.12.2007
- Robocop middleware for embedded/resource-constrained devices
- Builds on preceding projects Robocop and Space4U
- HIIT works in Trust4All on security and containment mechanisms

Algorithms for Broadband Internet (ABI)

- A strategic project of the GIGA program of Tekes 2006-2008 (started ~april 2006)
- Partners: VTT, UH, TKK, Ericsson, Nokia, F-Secure, TDC Song, BaseN
- Three focus areas:
  - Wireless mesh access networks
  - Overlay networks
  - Traffic monitoring and analysis

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ABI – Key results so far

- The UH group so far:
  - State-of-the-art review of wireless mesh networking: mobility management, link layer designs, products and testbeds
  - Design of a new messaging application for network nodes
  - Design of a new mobility management scheme for distributed mesh networks

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ABI – Key objectives 2007

- Implement messaging application and mobility scheme, experiment & evaluate
- Extend mobility management to advanced use cases
- Design more messaging applications and use cases
- Design a point-to-multipoint message routing scheme
- Investigate reverse-routing (IP Traceback)
- Provide a C-based GIST implementation with multicast support
- Look into DCCP and VoIP application integration
- Write papers and IETF contributions

Web Services in Ad Hoc and Mobile Infrastructure (WeSAHMI)

- The goal of the project is to create technological conditions for realizing web services based systems in the mobile environment
- Partners: TUT, UH, TKK, Elisa, Finnair, Finnet, Nokia, TietoEnator, BookIt
- Primary case study Finnair client services over wireless
- Main work items:
  - SOAP over SIP
  - Push and Pull services over SIP Presence services
  - XSmiles XML-browser
  - Service and application integration

WeSAHMI – Key results 2006

- Results by the UH and TKK teams:
  - Case studies of the Finnair business
  - Integration of the XSmiles browser with SIP-based notifications
  - Several proof-of-concept prototype demonstrations of transferring SOAP messages to client XML-browser over SIP presence services
  - Integration with SLP announcements
  - Security analysis

WeSAHMI – Targets for 2007

- Full implementation of the security framework

- C- and Java-based APIs for a generic push and pull service over SIP (done, add asynchronous API)

- Enable new secure mobile PUSH and PULL of RSS feeds

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Interconnected Broadband Home Networks (InHoNets)

- This project focuses on both wireless broadband home networks and on seamless internetworking between several home networks through broadband access networks.

- This research aims at ensuring reliable and secured broadband end-to-end connectivity between peer devices within one home; the peer devices can also be in multiple sites in several wireless home networks.

- Partners: TKK, TUT, Nokia, Ericsson, Digita, YLE, Elisa

InHoNets – Key results 2006

- IPv6 connectivity and service reachability to the home gateway; user mobility & service discovery without losing connectivity to the home network

- IPv4 connectivity with NSIS protocol suite; remote UPnP connectivity between networks

- User study of home network users

- Survey of secure association technologies for device pairing and usability testing of the pairing procedures

- Industry scenarios based on expert interviews on key players of mobile business

- Implementation of a distributed media center application, remote user interfaces running in PCs, PDAs and mobile phones, UPnP device simulators, midlets and media application proxies

InHoNets - Targets for 2007

- Extended studies on user mobility in IPv6
- Content-sharing architecture
- UPnP extended connectivity between multiple homes
- Implementing UI for home network security management
- Bluetooth simple pairing and group associations extensions
- Privacy improvements to PAN communication
- Implementation of industry scenarios into Mobile Business Game

Hoslab

- The Helsinki Open Source Lab (Hoslab) is service to host open source research projects done by
    - Research groups,
    - Students, and
    - Staff of UH, TKK and HIIT.
- Purpose is to have a single repository to promote our open source software
- Register your project and make your software available at:

hoslab.cs.helsinki.fi