Επισκόπηση Ερευνητικών Δραστηριοτήτων

Εργαστήριο Ασυρμάτων Δικτύων και Πολυμεσικών Τηλεπικοινωνιών

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ΗΡΑΚΛΕΙΤΟΣ ΙΙ / «Το ΟΠΑ Ερευνά»

Mobile Multimedia Laboratory

- **Μέλη ΔΕΠ**
  - Γεώργιος Πολύζος, Διευθυντής
  - Ιορδάνης Κουτσόπουλος
  - Ιωάννης Μαριάς
  - Γεώργιος Ξυλωμένος
  - Βασίλειος Σύρης
  - Σταύρος Τουμπής
  - κ.α. λιγότερο στενά συνδεδεμένοι
- **Επισκέπτης Ερευνητής**
  - Μερκούριος Καραλιόπουλος, PhD
- **Υποψήφιοι Διδάκτορες**
  - Ξενοφών Βασιλάκος
  - Βαγγέλης Δούρος
  - Γιάννης Θωμάς
  - Χάρης Στάης
  - Χρήστος Τσιλόπουλος
  - Νίκος Φωτίου

http://mm.aueb.gr/

- Μεταπτυχιακοί φοιτητές
- Πτυχιούχοι, ερευνητές
- Προπτυχιακοί φοιτητές

Alumni

- Ph.D.
  - Pantelis **Frangoudis** (2012)
    - PostDoc, INRIA
  - Konstantinos **Katsaros** (2010)
    - PostDoc, UCL
  - Christopher **Ververidis** (2008)
    - Researcher, AIT
  - Elias **Efstathiou** (2006)
    - Manager @ OTE
- M.Sc.
  - Sergios **Soursos**, PhD
    - Researcher, Intracom Telecom
  - Emanouil Panaousis, PhD
    - PostDoc, Queen Mary U. London
- Undergraduate
  - Vasilios Kemerlis
    - PhD candidate, Columbia U., NY
  - Ioannis Gasparis
    - PhD candidate, UCR, CA

- **M.Sc.**
- D. Sykaras, “Femtocell Networks: Interference Management and Business Models,” 2012.
- D. Charoulis, “Simulating Mobility in a Realistic Networking Environment,” 2012.
- K. Kokoli, “Attribute-Based and Context-Aware Information Lookup for the Internet of Things,” 2012.
- M. Giannikos, “Secure and context aware information retrieval for the Internet of Things,” 2012.
- V. Giannaki, “Smart Caches for Mobility Support in a Publish/Subscribe Network Architecture,” 2011.
- D. Zografos, “Spectrum Sensing and Reporting on WLANs,” 2009.
- V. Kalaitzidakis, “Botnet Detection Using Honeypots,” 2009.
- E. Trouva, “The Mobile Phone as a Platform for Assisting the Independent Living of Aging People,” 2009.
- M. Syrigos, “Design and Implementation of a System to Record and Recognize Activities of Daily Living,” 2009.
- K. Dasoulas, “Study and Implementation of an Integrated System for Recording the Actions of Individuals Outdours,” 2009.
- G. Plakia, “Structure and Evolution of a Large-Scale Wireless Community Network—The case of the Athens Wireless Metropolitan Network,” 2009.
- M. Sidiropoulos, “Botnets: Detection and Evasion Techniques,” 2009.
- G. Papamatthaiakis, “Design and Implementation of an Intelligent System for the Analysis and Evaluation of Space Sensor Data,” 2008 (in Greek).
- E. Panaousis, “Optimizing IEEE 802.11 WLAN Performance in a Dense Shared Spectrum Environment,” 2008.
- E. Douros, “Transmission Power Control for WLANs for the Optimization of Social Fairness,” 2008 (in Greek).
- S. Dimopoulos, “Global Scale WLAN Roaming: Architecture & Evaluation,” 2007 (in Greek).
- Ch. Stefanidis, “A Protocol for Enterprise Network Interconnection,” 2007 (in Greek).
- M. Kontopoulou, “Evaluation of Grid User Behavior with Trust Measurement Mechanisms,” 2007 (in Greek).
- S. Athanaileas, “An Extension of the AODV Routing for Service Discovery in MANETs,” 2007 (in Greek).
- J. Aggelopoulos, “Application of Network Tomography iu Wireless Sensor Networks,” 2007 (in Greek).
- E.C. Stefanis, “Reciprocity Strategies in the Peer-to-Peer Wireless Network Confederation: Building Trust in an Anarchic Setup,” 2006.
- D. Paraskevaidis, “Services Architecture on top of the Peer-to-Peer Wireless Network Confederation,” 2006.
- D. Pediaditakis, “In-Network Processing and Data Aggregation in Wireless Sensor Networks,” 2006.
- P. Frangoudis, “The Peer-to-Peer Wireless Network Confederation Protocol: Design Specification and Performance Analysis,” 2005.
- S. Papageorgiou, “Wireless Multicast Security with Mobile Hosts,” 2005 (in Greek).

MMlab Awards

- ***Future Internet Award*** to the EU FP7 research project "**PURSUIT**"
  - awarded during the Future Internet Assembly, Dublin, Ireland 10 May 2013
  - http://www.fp7-pursuit.eu/PursuitWeb/?p=967
- Best paper
  - N. Fotiou, G.F. Marias, G.C. Polyzos, "**Access Control Enforcement Delegation for Information-Centric Networking Architectures**," ACM SIGCOMM workshop on 'Information-Centric Networking,' Helsinki, Finland, August 2012.
- Best student paper
  - **N. Fotiou**, G.F. Marias, G.C. Polyzos, "**Fighting Spam in Publish/Subscribe Networks Using Information Ranking**," 6th Euro-NF Conference on Next Generation Internet, Paris, France, June 2010.
- **ΑΡΙΣΤΕΙΑ ΙΙ** (ΓΓΕΤ)
  - **I-CAN: "Information-Centric Future Mobile and Wireless Access Networks"**
- **Microsoft Research**: *Cell Phone as a Platform for Healthcare Award*
  - ARCHANGEL: 1 of 10 universities around the world
- Competitive Research Projects
  - EU: FP6, FP7; European Space Agency; ΓΓΕΤ (Θαλής, Ηράκλειτος, Πυθαγόρας…)

Selected Research Projects

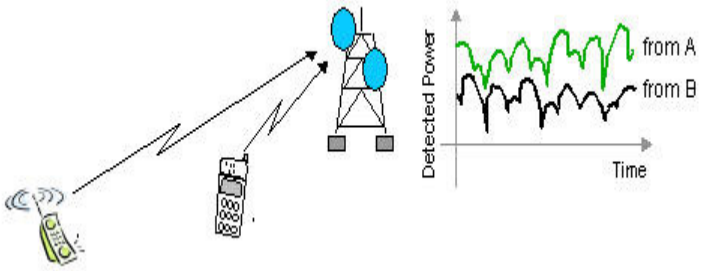
Mobile Multimedia Laboratory

- EU FP7 (2007-2013)
  - **EIFFEL**: Evolved Internet Future for European Leadership
  - Anticipating the Network of the Future-From Theory to Design (**Euro-NF**)
    - Network of Excellence
      - **ASPECTS**: Agile SPECTRum Security
      - Governance and Privacy Implications of the '***Internet of Things***'
      - Energy-Aware Key Management in ***Mobile Wireless Sensor Networks***
  - **PSIRP:** Publish-Subscribe Internet Routing Paradigm
  - **PURSUIT:** Publish-Subscribe Internet Technology
- European Space Agency
  - φSAT: The role of SatCom in the Future Internet
  - Service Delivery over Integrated Satellite and Terrestrial Networks
- Microsoft Research: Cell Phone as a Platform for Healthcare Award
  - ARCHANGEL: 1 of 10 universities around the world
- EU FP6 (2002-2006) and other projects

Interference in Wireless Networks

- Heterogeneous wireless networks cover diverse needs
- Many (mostly) selfish devices share the limited spectrum and compete for better QoS
- How can they efficiently co-exist?

Interference Management in Wireless Networks

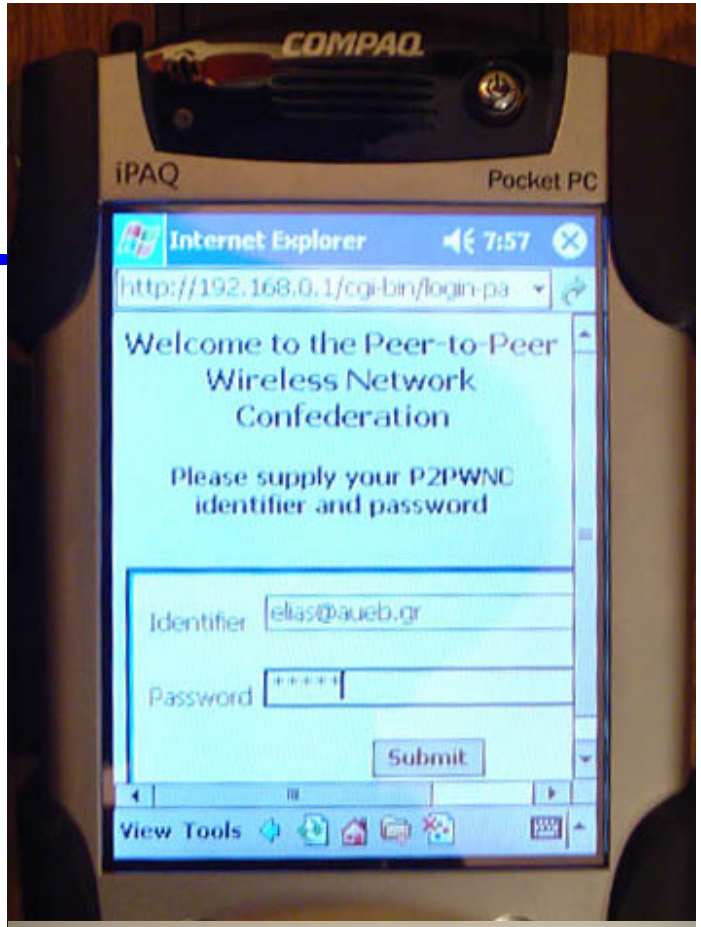


- Our approach: power control along with game theory and bargaining to design distributed schemes that fulfill the QoS constraints
- Key issues: Existence/uniqueness of a Nash Equilibrium, how we can find it, how efficient it is

Embedded Software for Wi-Fi and other Wireless Systems

P2PWNC: P2P Wireless Network Confederation

- Λογισμικό που εκτελείται σε φτηνό οικιακό εξοπλισμό ασύρματων δικτύων και σε φορητούς υπολογιστές / PDAs
- Embedded Linux on Access Points
- Λογισμικό ανοιχτού κώδικα, ελεύθερα διαθέσιμο από:
  - **http://mm.aueb.gr/research/p2pwnc/**
- Πρωτόκολλα με ανοιχτές προδιαγραφές
- Ισχυρή κρυπτογραφία δημοσίου κλειδιού:
  - RSA
  - Elliptic Curve Cryptography



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ARCHANGEL: An architecture for ubiquitous, intelligent, transparent activities monitoring for active ageing and independent living through the early detection of signs of medical problems

- Funding from **Microsoft Research** through a *Cell Phone as a Platform for Healthcare Award*

1. Project Highlights

- **Sensor-based system** for monitoring and modeling the activities of the **elderly** and people with special needs.
- Applies to the **home** life and possibly to the person **outside the home**
- Monitored person caries GPS-enabled cellular phone and/or other localization devices
- Deploy off-the-self sensors to home, other locations

2. Objectives

- **Learn the daily activities** of the monitored individuals
- **Detect changes** in individuals' routines and health status
- **Provide alerts** and **preliminary diagnosis** as quickly as possible when something out of the ordinary occurs
- **Actuator-based automation** of certain tasks in the home

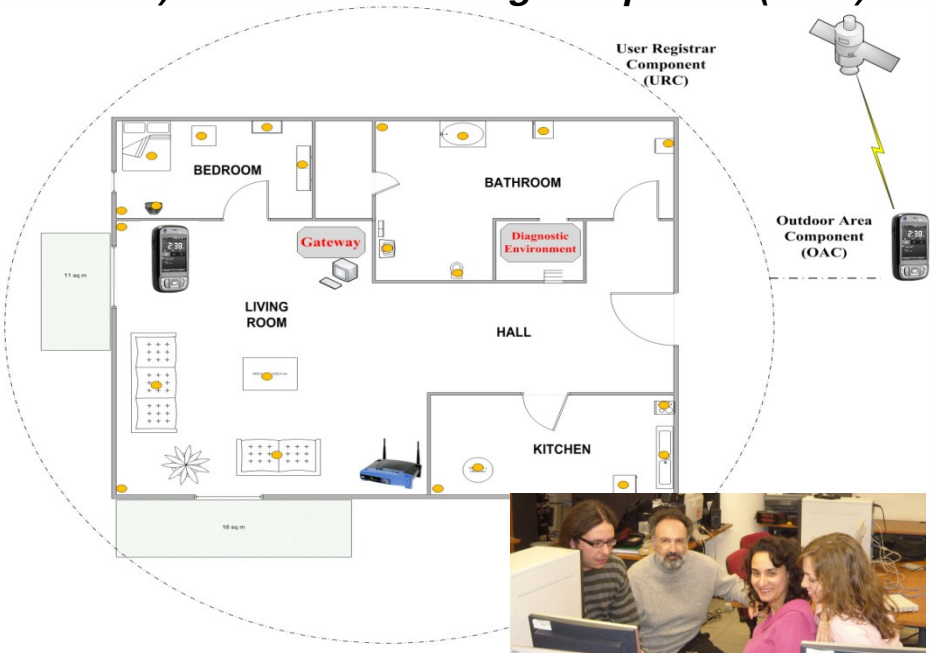
3. System Architecture

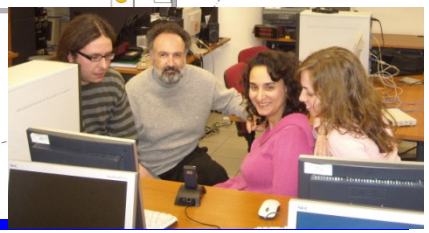
A. Monitoring Environment

- ***1) Indoor Area Component (IAC)***
- ***2) Outdoor Area Component (OAC)***
- ***3) User Registrar Component (URC)***

B. Diagnostic Environment

- ***1) Event Recognizer Component (ERC)***
- ***2) Activities Modeling Component (AMC)***





Internet Clean-Slate Design

- At the beginning
  - Cooperation/Collaboration
  - **NO** commercial traffic allowed!
  - Endpoint-centric services

- What developed:

  real ***inter***-network
- What about:
  - Trust?
  - Legitimacy of E2E?
    - NAT, firewalls, middleboxes…
  - Role of overlays? P2P?
  - **Information centrism**?
    - **>50% video access & ↑**

Clean-slate design…

- Question ALL fundamentals
  - take nothing for granted
    - including industry structures

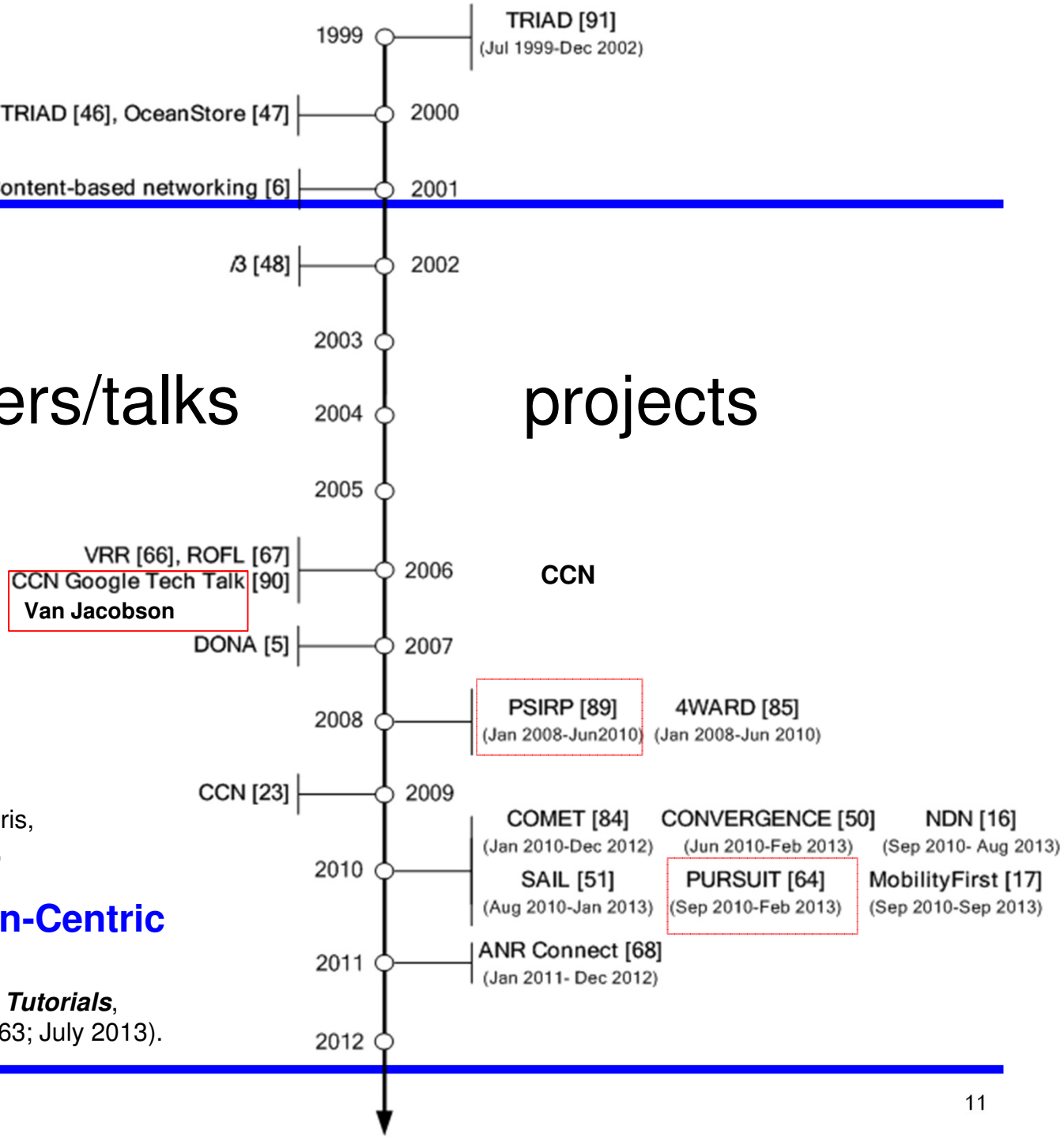
…with late binding (to reality)

- Consider migration and evolvability
  - From designs into real deployments
    - e.g., overlay vs. IP replacement
- Consider necessary evolution of the industry (and regulatory) structures

From

- connecting wires… to
- connecting machines… to
- **connecting information!**

ICN timeline



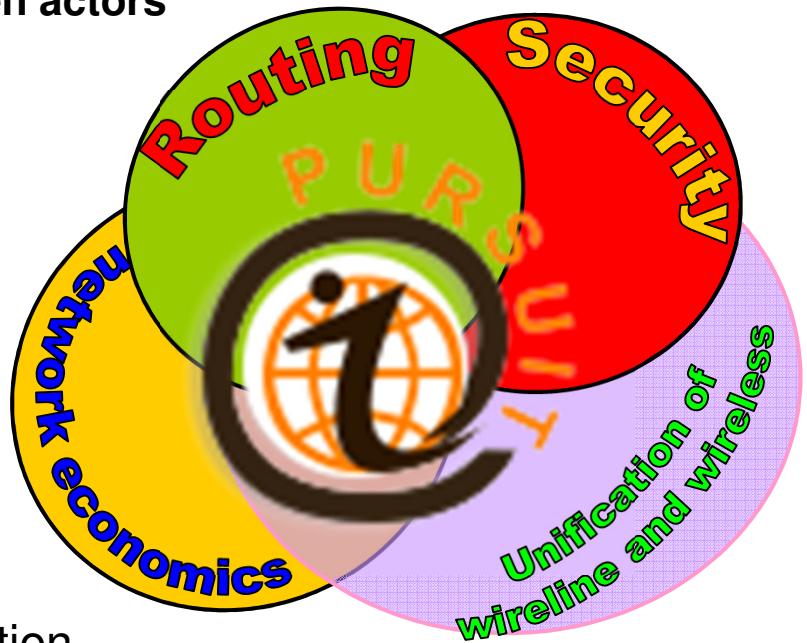
G. Xylomenos, C.N. Ververidis, V.A. Siris, N. Fotiou, C. Tsilopoulos, X. Vasilakos, K.V. Katsaros, G.C. Polyzos,

"**A Survey of Information-Centric Networking Research**"

IEEE Communications Surveys and Tutorials, (DOI 10.1109/SURV.2013.070813.00063; July 2013).

Publish-Subscribe Internet Vision

- **information centrism**
  - **everything is information & information is everything**
- **Recursive** & and generalized use of **publish-subscribe**
  - **enables dynamic change of roles between actors**
  - Network cache
    - publishes info (cached)
    - subscribes to get info to cache
  - Access Points publish ID
    - mobiles subscribe

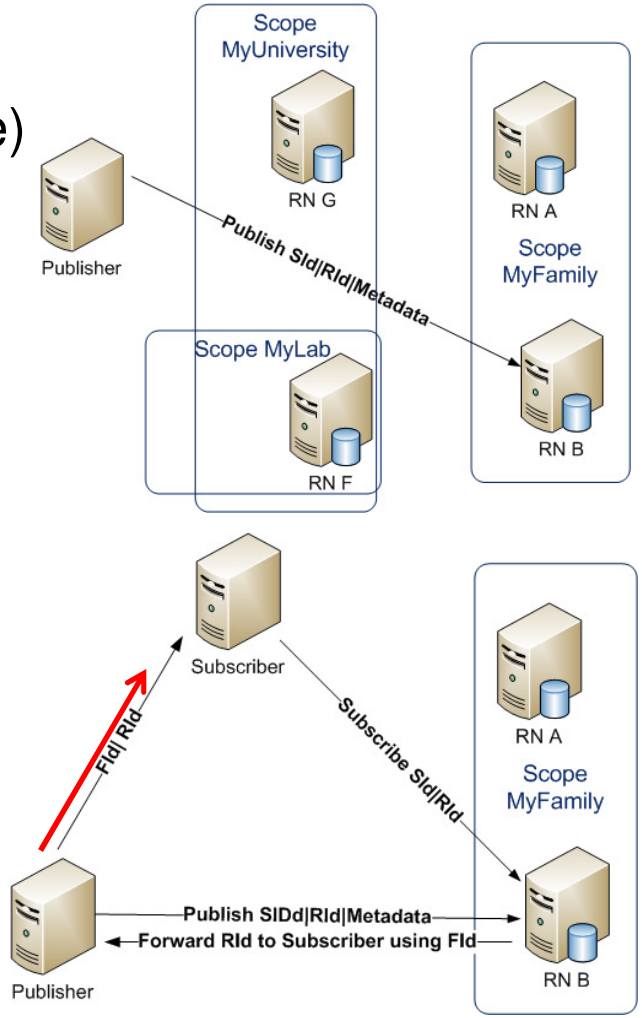


Objectives

- Specify, implement, & test
  an internetworked pub/sub architecture
  - follow a **clean-slate design** approach
- Perform qualitative and quantitative evaluation
  - **Security and socio-economics important!**
  - Migration and incentive scenarios important (e.g., overlay)!

PSI Key Functions and Components

- publish – subscribe – rendezvous
  - Rendezvous **ID: hash of content** (/name)
    - asynchronous and multicast
    - restores the imbalance of power sender/receiver(s)
    - + Scope ID: aggregation, policies…
- PSI Basic Functions: RTF
  - ***R**endezvous*: Matches *publications* with *subscriptions* and initializes forwarding
  - ***T**opology*: Monitors the network and creates information delivery paths
  - ***F**orwarding*



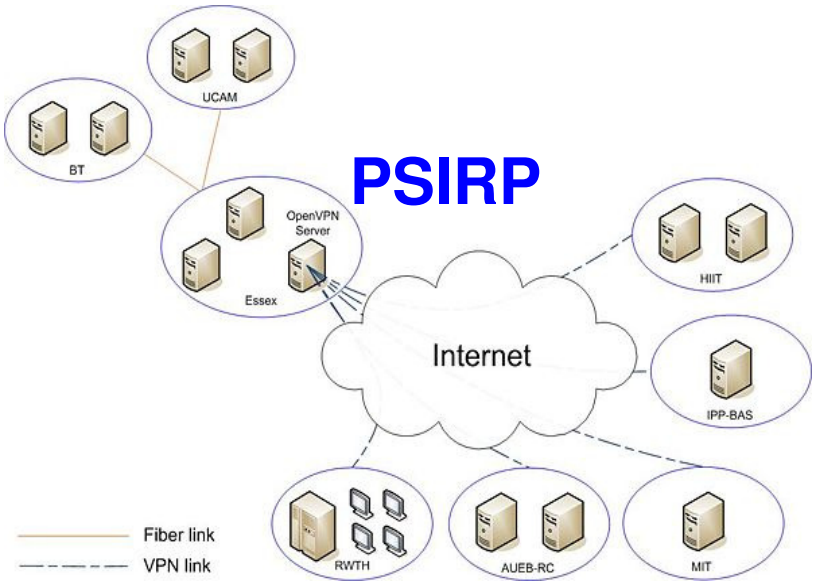
G. Xylomenos et al., "**Caching and Mobility Support in a Publish-Subscribe Internet Architecture,**" ***IEEE Communications Magazine***, July 2012.

PSI Unique Features

- Fast forwarding
  - Bloom filter based forwarding ($\rightarrow$ forwarding identifiers)
    - simple, stateless, fast forwarding
    - incl. for multicast
  - path ('source') routing
    - path as compact Bloom filter carried on packets
- Centralized – 'SDN compatible' approach
  - (intra-domain) routing/resource allocation
  - topology discovery/management
- 'recursive' use of pub/sub …
  - object level
  - chunk/packet level…
    - pull transport, error control, rcvr flow control

    = slow & fast rendezvous
  - topology formation: handover = subscribe to network…

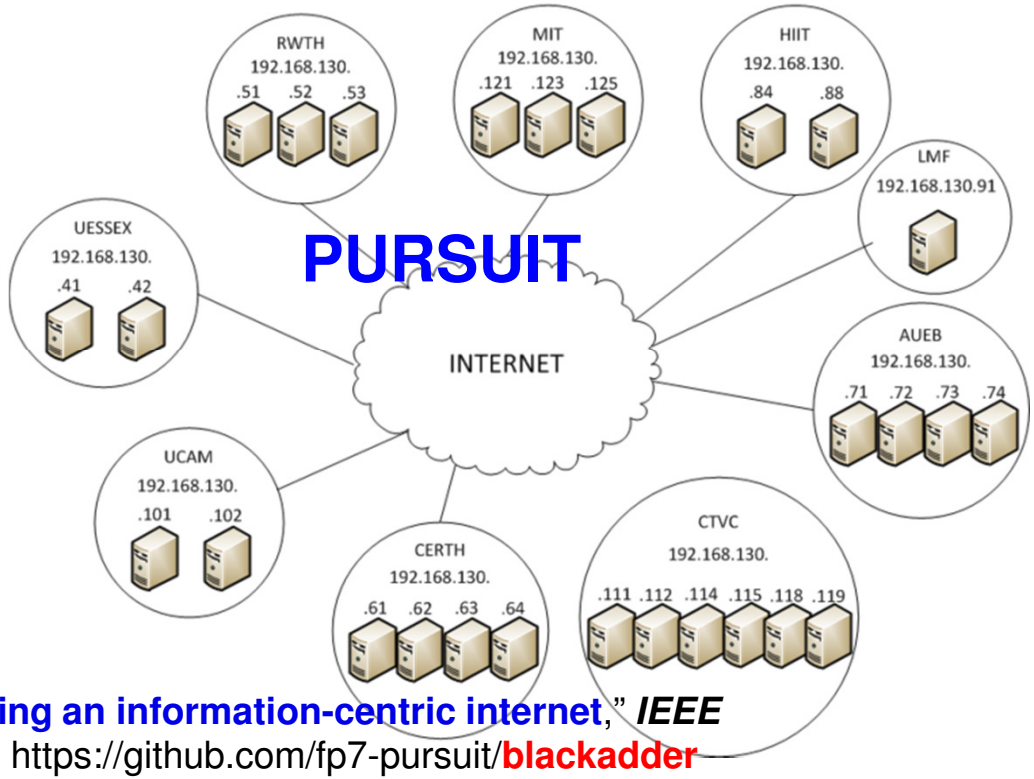
Prototype Implementations & Testbeds



1. PSIRP Testbed (w/ Blackhawk)
- 6 countries: UK, FI, GR, D, BU, **US**
  - In addition: Belgium during ICT demos
- Tunneled over the public Internet
  - +**dedicated fiber** where available

3. φSAT Testbed w/ SAT emulation

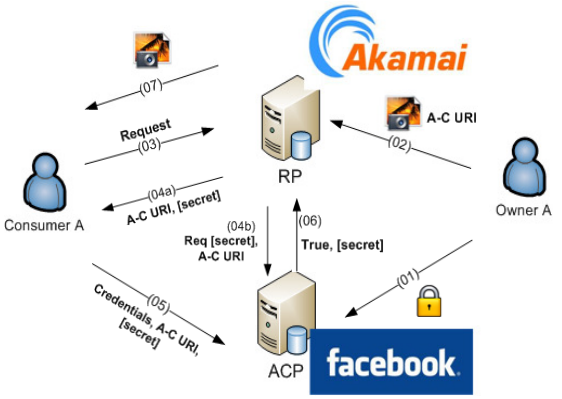
2. PURSUIT Testbed (w/ Blackadder)
- 25 nodes
- 5 countries: UK, FI, GR, D, **US**
- Tunneled (VPN)
  - over the public Internet



D. Trossen and G. Parisis, "**Designing and realizing an information-centric internet**," ***IEEE Communications Magazine***, vol. 50, July 2012. - https://github.com/fp7-pursuit/**blackadder**

PSI Security & Privacy

- … in addition to intrinsic ICN security features…
- Publisher and Subscriber do not know each other
  - Scopes: PSI's information firewalls
  - Bloom filter path cannot be replayed (later)
    - rotation of link IDs…
    - DoS attacks to publishers/subscribers eradicated
  - Rendezvous (point/network) knows much…
  - Privacy wrt:
    - publisher: great… (at network & higher layers)
    - rendezvous (broker): bad…
    - proposal: use **Homomorphic Encryption**



N. Fotiou, D. Trossen, G.F. Marias, A. Kostopoulos, G.C. Polyzos, "**Enhancing Information Lookup Privacy through Homomorphic Encryption**," ***Security and Communication Networks*** (to appear).

- Access Control Delegation
  - important for fast effective and efficient caching

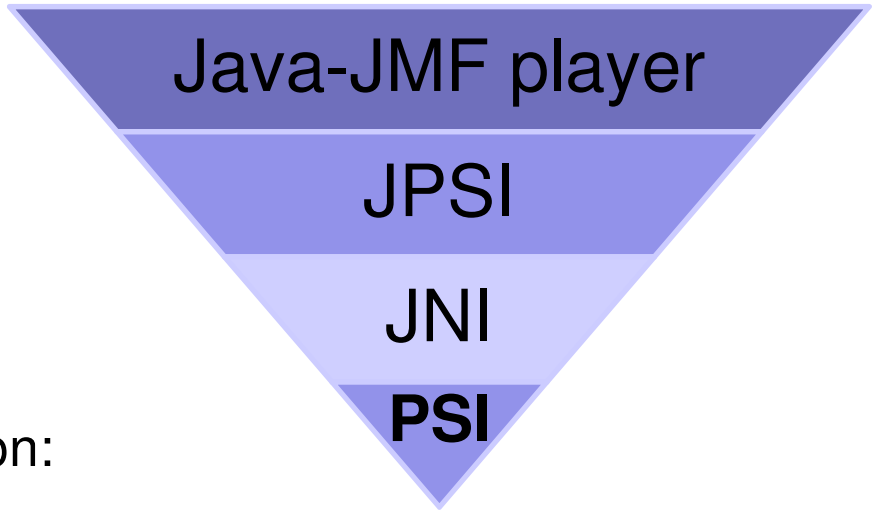
N. Fotiou, G.F. Marias, G.C. Polyzos, "**Access Control Enforcement Delegation for Information-Centric Networking Architectures**," ACM SIGCOMM ***Computer Communication Review***, Vol. 42, No. 4, Oct. 2012.

Multimedia (streaming) over PSI

- Motivation:
  - “YouTube” a la PSI …
- Streaming videos
  - without RTP/TCP/IP
  - only native PSI
- Basic Components of the application:
  - **Publisher**: the owner of the video
  - **Subscriber**: the user that seeks to view the video

C. Tsilopoulos, G. Xylomenos, G.C. Polyzos, **“Are Information-Centric Networks Video-Ready?”** Proc. Intern. Packet Video Workshop, San Jose, CA, Dec. 2013.

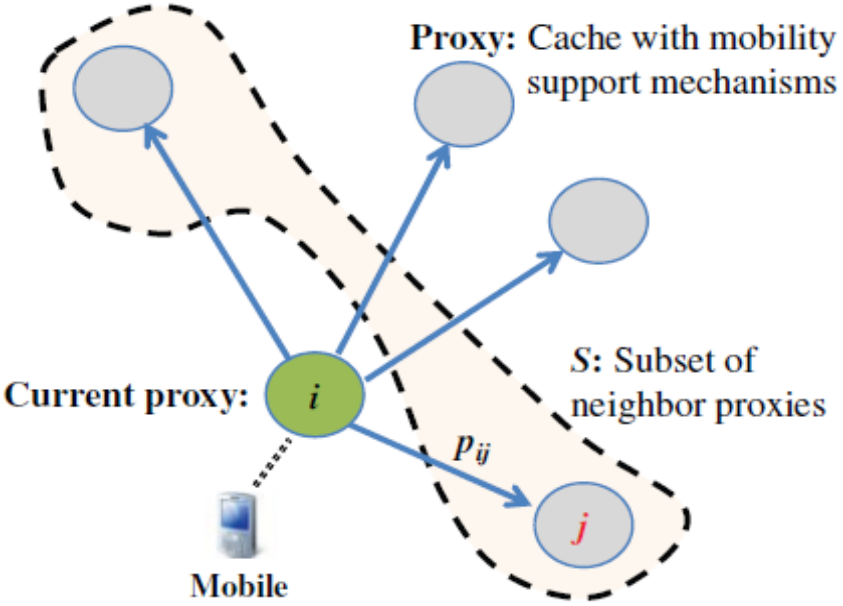
- Technologies Involved



- We tried different applications
  - Video
  - Audio/voice (VoPSI)
  - ...

Proactive Selective Neighbor Caching for enhancing Mobility Support in ICN

- Delay can be reduced by using proxies to pre-fetch and cache data
  - Mobile obtains data from local cache rather than remote server
  - Local network can have low capacity backhaul (e.g. femto/small-cells, hotspots)
- Proactive Selective Neighbor Caching
  - mobile initially connected to proxy i
  - ICN receiver-driven model reveals which data items are requested
  - select optimum subset of neighbor proxies to proactively cache requested data
  - if mobile connects to one of these proxies it can immediately receive data not obtained due to disconnection
- Selection of neighbor caches to pre-fetch data depends on
  - probability mobile connects to caches
  - available cache space
  - delay reduction gains



X. Vasilakos et al. "**Proactive Selective Neighbor Caching for enhancing Mobility Support in Information-Centric Networks**," Proc. ACM SIGCOMM ICN, August 2012.

ICN Research Community

- workshops…
  - with ACM SIGCOMM
    - ICN 2011 (Toronto)
    - ICN 2012 (Helsinki)
    - ICN 2013 (Hong Kong)
  - with IEEE INFOCOM
    - NOMEN 2012, 2013

SIGCOMM 2012 HELSINKI

SIGCOMM 2013 Hong Kong

- 1st ACM ICN **Conference**
  - Paris, France, (end of) **Sept. 2014**
- ICNRG@IERTF
- Journal & Magazines Special Issues

Ευχαριστώ!

Γεώργιος Κ. Πολύζος

Εργαστήριο

Ασυρμάτων Δικτύων και Πολυμεσικών Τηλεπικοινωνιών

Mobile Multimedia Laboratory

Τμήμα Πληροφορικής

Σχολή Επιστημών και Τεχνολογίας της Πληροφορίας

Οικονομικό Πανεπιστήμιο Αθηνών

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