# PEPITO
# Peer-to-Peer Implementation and Theory

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Global Computing Negotiation Meeting

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Swedish Institute of Computer Science (SICS)

Ecole Polytechnique Fédérale de Lausanne (EPFL)

Institut National de Recherche en Informatique et Automatique (INRIA)

Kungliga Tekniska Högskolan (KTH)

University of Cambridge (UCAM)

Université catholique de Louvain (UCL)

# Context

- Peer-to-peer is a paradigm for distributed computing on WAN in which single-user applications are connected to a shared network as *peers*, i.e., with potentially the same capabilities and responsibilities
- Currently popular applications include file-sharing (e.g., Napster, Morpheus), storage-sharing (e.g., OceanStore), and compute-sharing (e.g., SETI@home)

# Overall Objective

- To investigate completely decentralized models of peer-to-peer computing

- We assume peers can have four simultaneous roles: client (user of services), server (provide services), router (forward requests), and cache (store information)
- We assume a virtual network topology that is dynamic with transient failures. Nodes do not possess a fixed IP address.

# Context and objectives

- Study use models: perception by users and possible classes of applications
- Study system architectures and formal models
- Study new distributed algorithms:
  - for multi-consistent computing (simultaneous inconsistent views)
  - for diffusion-based computing (completely decentralized)
- Design of language-independent middleware for peer-to-peer
- Adapt languages and systems (connecting actual virtual machines for Java and Oz)
- Build demonstrators in area of collaboration

# Potential of peer-to-peer

- Full use of network resources (at the network edge)
- Better scalability than server-centric techniques (e.g., the Morpheus file-sharing application currently has around 400,000 simultaneous users)
- Device mobility (using peer-to-peer identity and not IP address)
- Individual publishing
- Anonymous networks (virtual private networks without decentralized controls)

# Innovations

- Multi-consistent computing
  - New issues: focus on collaboration, rich failure modes, variable network behavior, dynamic connectivity, no permanent failure detection, large number of nodes
  - Advance the state-of-the-art in consistency models
  - Techniques for computing with inconsistent information
- Diffusion-based computing
  - Fully decentralized computing with only neighbor communication
  - Extend standard algorithms (membership, search & retrieval, caching, replication) for peer-to-peer
  - Extend programming techniques (transactions) for peer-to-peer
- Network topologies
  - How to organize large peer-to-peer systems to achieve desirable properties, e.g., Small World topologies

# Innovations

- Foundational models
  - Identify the essence of peer-to-peer computation and collaboration
- Language-independent platform for peer-to-peer
  - Basic services and protocols, including reliable message sending, failure and partitioning detection
  - Network topology management including naming and addressing
  - Management of simultaneous inconsistent views
  - Distributed garbage collection for WAN with partial failure
  - Capabilities and security, including unforgeable references, encrypted communication

# Innovations

- Language innovations
  - Language constructs and programming techniques
  - The language should have exactly the right constructs to make it as easy as possible to exploit peer-to-peer

# Workpackage structure

- WP1: Formal Models (UCAM)
- WP2: Distributed Algorithms and Services (KTH)
- WP3: Programming Languages and Systems (EPFL)
- WP4: Distribution Subsystem (SICS)
- WP5: Demonstrator Applications (UCL)
- WP6: Project Management (SICS)

# Project Management

- Management
  - Scientific coordinator: Prof. Seif Haridi of KTH
  - Administrative coordinator: Thomas Sjöland of SICS
  - Partner managers: Per Brand (SICS), Uwe Nestmann (EPFL), Jean-Jacques Lévy (INRIA), Seif Haridi (KTH), Peter Sewell (UCAM), Peter Van Roy (UCL)
- Dissemination and exploitation
  - Web site, yearly open workshop, publications
- Assessment and evaluation
  - Yearly evaluation of each workpackage according to criteria to be determined in WP6
  - Evaluation criteria: scientific quality, working middleware, convincing demonstrator applications