**Esprit**
IST-2001-33234


# PEPITO - PEer-to-Peer: Implementation and TheOry

EU-program: EU IST FET Proactive Initiative 2001 Global Computing (GC)

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Starting date: 1st of January 2002

Duration: 36 months

**Project abstract**
Traditional centralized system architectures are ever more inadequate. A good understanding is lacking of future decentralized peer-to-peer (P2P) models for collaboration and computing, both of how to build them robustly and of what can be built. The PEPITO project will investigate completely decentralized models of P2P computing. It will (1) study the use models of P2P systems, ie, how they are perceived by users and what new applications are possible; (2) develop the foundations of P2P computing, including formal foundations (calculi, proof techniques, security and resource models) and new distributed algorithms (for diffusing information and coping with multi-consistent views); (3) provide a language-independent distribution subsystem tailored for P2P computing; and (4) provide programming languages and platforms using this, showing that they are useful by implementing convincing demonstrator applications.

**Objectives**
Peer-to-peer computing (P2P) is a paradigm in which applications are connected to a shared network as peers, ie, with the same capabilities and responsibilities. Current P2P applications are limited to information exchange. The objectives are to remove this limitation by: developing formal models to understand P2P computing, developing the distributed algorithms required for implementation, implementing a language-independent set of basic services, implementing languages and devise programming techniques and convincing demonstrator applications. Further objectives are: better using resources at the network's edge, scaling better than server-centric computing, allowing device mobility (independence of IP address), allowing individuals to publish information and services, and to allow individuals to collaborate while remaining anonymous.

**Description of Work**
PEPITO will assume a completely decentralized architecture in which a peer can have four simultaneous roles: it may use services, provide services, forward requests, and provide caching of information. We also assume that peer nodes connect through a virtual network that is dynamic and intermittent, and that nodes do not possess a fixed IP address. To successfully deal with the complexity of P2P systems (in which failure, reconfiguration and security are central) it is important to pursue use-model analysis, theoretical work and prototyping in a closely-linked style. The complementary expertise of the PEPITO partners will make this possible: the objectives will be addressed, but the enabling of interaction between them is crucial. Use-model analysis of this type of system will investigate how they are perceived by users, and what new applications are possible. Theoretical work will study the foundational concepts of P2P systems. This includes mathematical models (calculi, proof techniques, security and resource models) and new distributed algorithms (decentralized algorithms for diffusing information, and for coping with multi-consistent computing -- with simultaneous inconsistent views of entities). System Design and Prototyping will develop prototypes of programming languages and programming platforms (middleware) suitable for peer-to-peer computing (such platforms are lacking today; those existing are server-centric). One aspect will be a scalable and robust name/directory service based on our algorithms. Together, all these will enable development of applications that: handle dynamic connectivity and device mobility; allow individuals to become publishers of information and services; permit full use of existing network resources at the edge of the network; and permit applications to scale better than server-centric designs.

**Milestones and expected results**
- Develop a formal model for peer-to-peer computing
- Develop novel distributed algorithms for peer-to-peer computing
- Develop a scalable and robust name/directory service based on these algorithms
- Provide a language independent peer-to-peer distribution subsystem
- Provide languages and platforms for peer-to-peer computing
- Provide convincing demonstrators for peer-to-peer applications

| **Participants** | |
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**Total cost: 2 741 418 € (community funding 1 771 000 €)**
**Start date 1 jan 2002, Duration 36 months**
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