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Special theme:

Smart Energy Systems

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PaaSage – An €8.4 Million Investment for Bridging Clouds

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A Projector as Mobile Visualization Device on an Assistive Robot

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Smart Energy Systems – A European Perspective

The European Union has adopted ambitious energy and climate change objectives to be achieved by the year 2020: greenhouse gas emissions should be reduced by 20% while the share of renewable energy is to be increased and energy efficiency to be improved by this amount. Furthermore, the EU has made a long term commitment to cut emissions by at least 80% by 2050.

So far the current strategies are unlikely to achieve all 2020 targets; whilst the goal to increase the share of renewables seems to be attainable, we are likely to fail on the improvement of efficiency. Also, the strategies in place seem inadequate to meet the longer term challenges. Use of renewable energy is still limited because the development of efficient energy transport is lagging. The internal energy market is still fragmented and needs improvement regarding transparency, accessibility and choice. Fragmentation of national regulation limits companies to act on multi-national markets and sets barriers to fair competition. The EU must take urgent action to select the right tools to make the energy change happen and to move towards a sustainable energy future.

The current situation exhibits a number of major challenges. Large-scale renewable energy generation is currently largely based on wind, and plants may be installed far from existing power infrastructure, thus connection to the grid can present a challenge. Owing to the inherent variability and weather dependence of energy production and the limited capacity for energy storage, balancing supply and demand becomes also far more difficult.

The deployment of distributed energy resources can mitigate the uncertainties connected to large plants and at the same time exploit the potential of dispersed resources, although the integration of distributed energy resources is extremely challenging both from a market and a technical point of view. Decentralization supports scalability and robustness and facilitates access to the energy market for prosumers, thereby

Ariane Sutor
Siemens AG
EIT ICT Labs "Smart Energy Systems" Action Line Leader

supporting changes to consumer behaviour and social acceptance. It is imperative that consumers understand and trust the process and receive clear benefits, eg energy savings, more transparent billing and a business case for electric vehicles, heat pumps and smart appliances. Demand response is also a central theme where consumers' load reductions are aggregated to offer flexible services to other stakeholders in the electricity system.

One key to the integration of intermittent and dispersed renewable energy and to increased energy efficiency is the introduction of Smart Grids. In addition to building new lines and substations, it is essential to make the electricity system smarter through the introduction of Information and Communication Technologies (ICT). Smart Grids can be described as advanced electricity networks enabling two-way exchange of power and information between suppliers and consumers based on the introduction of intelligent communication, monitoring and management systems. An open and secure ICT infrastructure is at the core of the implementation of the Smart Grid. Interoperability, data privacy and security thereby play a crucial role. Currently a convergence towards proven communication standards and industry best practices is observed, eg Internet Protocol communication.

For smart grids to exhibit their full potential the realization of physical infrastructures is needed as well as new business models and regulations. There is a critical need to adopt a European energy policy to overcome the fragmentation related to national and regional policies. Management bodies at EU level include the Directorate Generals for Energy and for Research (DG ENER, RTD) and the Joint Research Centre JRC.A recent update of the European Strategic Energy Technology Plan (SET Plan) describes the strategy to accelerate the development and deployment of cost-effective low carbon technologies. Other related bodies include: the Smart Grids Task Force SGTF on European regulation and standardization, the Smart Grids European Technology Platform ETP providing the European strategic research agendas SRA 2020 and 2035 as well as industry driven consortia like ENTSO-E and EDSO of European transmission and distribution system operators respectively. The European Institute of Innovation and Technology (EIT) is an institution of the EU with the mission to increase European sustainable growth and competitiveness by reinforcing innovation capacity. Within EIT ICT Labs the action line Smart Energy Systems drives European innovation for smart energy systems regarding user involvement, business models and ICT-enabled infrastructures and mobilizes a strong network of industrial partners, research institutes and technical universities.

A large number of European-level research, demonstration and deployment projects focusing on the development of smart grids are currently underway. Most projects are supported by FP6 and FP7 but many, including the Portuguese National Strategic Reference Framework (QREN), the Spanish Centre for Industrial Technology Development (CDTI) and the German funding program "E-Energy", also benefit from substantial national co-funding. A major part of future funding will be included in the upcoming Horizon 2020. The European Commission funds a whole series of different issues concerning the implementation of smart grid technologies. Large investments are foreseen to extend existing grids to cope with the intermittent nature of renewable sources, eg new lines, additional capacities but also balancing area extension, re-designed market mechanisms and storage integration. Research projects are addressing the problem of distributed energy resources, with a focus on online coordination of distributed generators and storage devices such as electric vehicles to enhance grid stability and optimization of energy resources.

Smart, sustainable and inclusive growth for Europe includes a shift in our energy policy leading to increasing renewable resources and improved energy efficiency. Smart Grids are the key enabler to achieve the policy objectives and to maintain a leading European technological and competitive position. In addition to new technologies, real pan-European regulations and markets are required. To this end, it will be paramount that partners from industry, research institutes and universities continue to join forces.

Ariane Sutor

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ATLAAS-P2P: A Two-Layer Architecture for Approximated Search in Peer to Peer

by Ranieri Baraglia, Patrizio Dazzi, Matteo Mordacchini and Laura Ricci

ATLAAS-P2P is a two-layered peer-to-peer (P2P) architecture for developing systems, providing resource aggregation and approximated discovery in P2P networks. It gives users a flexible and easy means of searching for resources and also benefits resource providers by assisting users to find them.

The process of identifying useful resources in a P2P network is highly dependent on query formulation. Users should be able to easily express their needs, and an efficient query resolution mechanism should efficiently find relevant resources and limit the number of messages exchanged. Common techniques for searching resources in P2P systems are based on range queries over a set of attributes. However, the volume of resources in a P2P network may be very large and heterogeneous, and users rarely have the appropriate knowledge about the available resources to allow them to properly formulate their queries. A user may, however, be able to define their "ideal" resource and ask the search system to find resources close to such an entity. Thus, instead of having to specify precise ranges on all attributes, the user simply has to provide an example of what is needed.

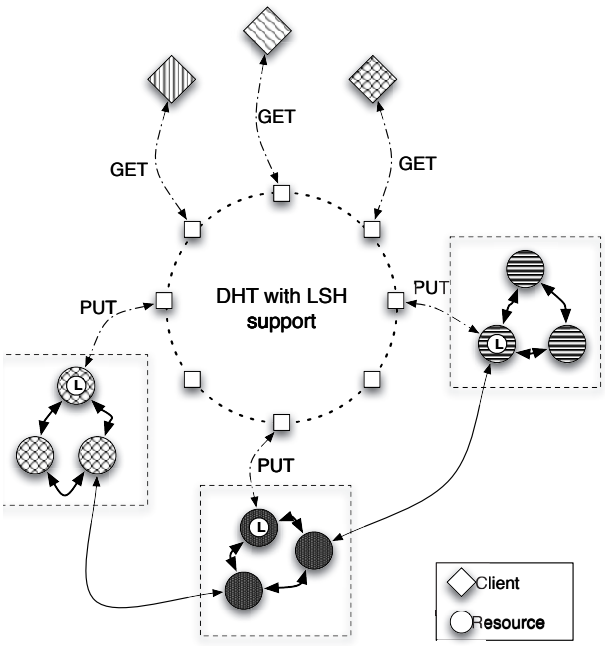

Figure 1: The overall architecture of ATLAAS-P2P

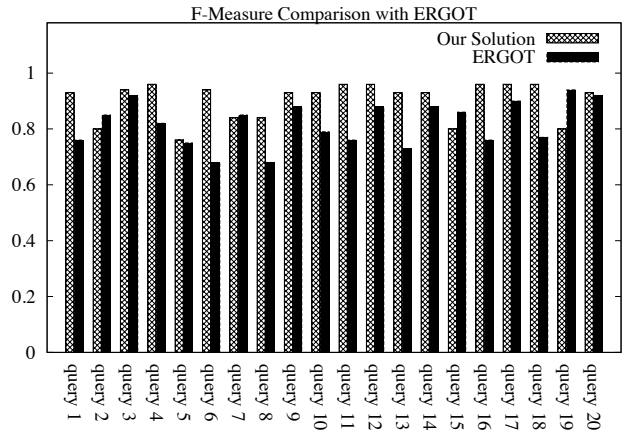

Figure 2: ATLAAS-P2P performances

This mechanism would simplify the work for users and lead to a more efficient exploitation of the search system. Moreover, it would provide an effective infrastructure for advertising for resource providers, facilitating their discovery by users.

ATLAAS-P2P consists of a P2P system that provides flexibility in the way that users express their requirements and an effective solution for enabling users' requests to reach resource providers. It is based on a two-layer architecture, where peers in the network represent the resources of providers. The lower layer is an unstructured, gossip-based, P2P network allowing peers to efficiently gather in logical groups of nodes representing similar resources. The role of this layer is to automatically capture the affinities existing between resources belonging to different providers and to group them in common communities. Those communities distributively elect their own representatives. The profiles of these representatives are used as the descriptors of such communities. Once elected, each representative registers itself on the higher layer, a structured, DHT-based network.

The structured network has been extended to support approximated searches over the community representatives. Users can submit the queries to this network by providing sample resources consisting of prototypes of the resources they are searching for. Gossip-based protocols are used to find and select similar representatives to forward the query within their community. This means that when none of the resources available in the system matches a user's request, the user is offered suitable alternatives.

The overall architecture of ATLAAS-P2P is sketched in Figure 1. Peers (circles) form distinct communities built on a similarity basis in the unstructured gossip-based layer. Each community elects a representative, denoted with an L in the figure. Each representative is in charge of registering itself on the higher structured layer. Users of the systems (rhombus) can query the structured network searching for the resources they need. Results will consist of the most significative community profiles and their representatives. The representatives will act as entry points to further forward queries to the peers of the represented community.

Instead of searching for peers whose profile is similar to that specified by the user this architecture searches for communities. This reduces both the number of comparisons to perform and the number of peers to contact. As a consequence, the amount of generated network traffic also decreases.

The ability of ATLASS-P2P to return significant resources has been tested using a dataset of 200 word domain labels organized in a hierarchical structure built by exploiting the WordNet domain [1]. The content of this dataset has been used to generate textual descriptions. Such descriptions have been assigned to 5000 peers according to a Zipf distribution for building the peer profiles.

ATLAAS-P2P performances are presented in Figure 2, in which they are compared with those provided by ERGOT [2], a solution for this task, which is based on semantic overlay networks.

References:
[1] B. Magnini, G. Cavaglia: "Integrating subject field codes into wordnet", in proc. of LREC 2000
[2] G.Pirrò, D.Talia, P.Trunfio: "A DHT-based semantic overlay network for service discovery", Future Generation Computer Systems 28 (4), 2012

Please contact:
Patrizio Dazzi, ISTI-CNR, Italy
E-mail: patrizio.dazzi@isti.cnr.it

Epeerdemics: A Peer-to-Peer Simulator Targeting Epidemic-Based Protocols

by Patrizio Dazzi and Emanuele Carlini

Since the late 'nineties, peer-to-peer (P2P) protocols have become increasingly popular. Traditionally, these systems have been used to implement widely distributed applications, such as file-sharing services, as they provide efficient support for the discovery and distribution of information.

Several different structured P2P protocols have been proposed for distributed networks. "Structured", in this context, refers to the protocol's ability to organize network links and data to provide specific guarantees and bounds on performances. Recently, P2P protocols have also been exploited for information diffusion and aggregation, including resource discovery and system monitoring and community-based information dissemination. These applications introduce new requirements to P2P protocols, since information freshness, rather than information precision, is their main focus.

Epidemic-based (also known as gossip-based) P2P protocols are unstructured communication approaches that disseminate information in a manner similar to the spread of viruses in a biological community. They are often used to solve problems that might be difficult to tackle in other ways owing to the complex structure and dimension of the network and the fast rate of information change.

These developments have fostered an increasing interest within the research community in the conception and design of novel epidemic protocols. A typical issue is the need to consider classical non-functional requirements, such as scale and performance as foundational aspects of protocol design. Indeed, these protocols fit networks comprising hundreds of thousands of nodes characterized by frequent changes in shared data and affected by considerable churn rates.

Since it is unfeasible to obtain access to thousands of machines worldwide, the performances and limits of epidemic protocols are normally studied through simulations. In this sense, well-designed simulators facilitate the development of new protocols allowing for the simulation of many nodes within limited computational units. Properly designed simulators also ease the deployment of the protocols on a real infrastructure with minimal disruption to the code.

In the last decade, several P2P simulators have been proposed. Essentially, they differ in the level of abstraction provided, the programming language used and flexibility in developing protocols. To ease the evaluation and comparison of protocols, these simulators are often bundled with several well-known protocols. Unfortunately, only a few P2P simulators are specific to unstructured protocols and only a subset of them provide a bundle of epidemic-based protocols as baselines for testing.

We developed Epeerdemics with the aim of filling this void. Epeerdemics is an extension to Overlay Weaver [1], an overlay construction toolkit widely diffused in the P2P community, mainly used for developing structured protocols. Epeerdemics is specifically designed to ease the develop-

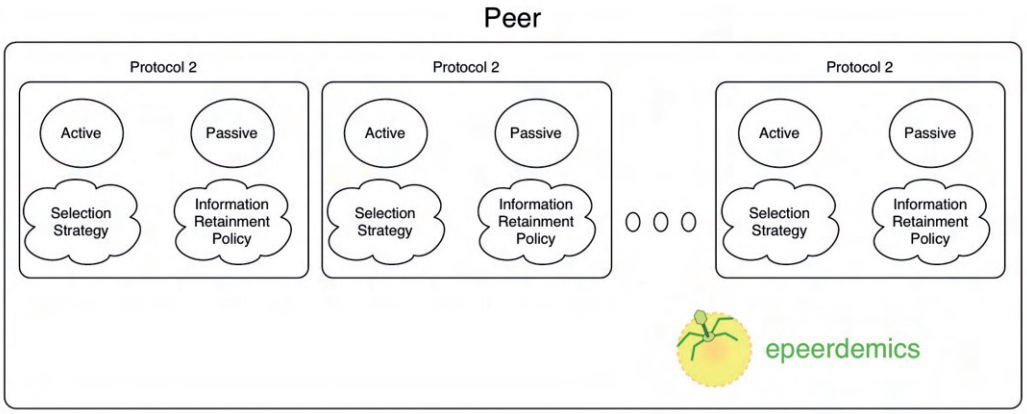

Figure 1: Epeerdemics protocol architecture.