P2P Open Agent Networks for Decision Making

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Peer-to-Peer (P2P) computing, a recently developed network architecture for distributed systems, is currently receiving ever increasing attention of both academia and industry. It has become a driving force for many new ideas and opportunities in design and implementation of modern large scale applications composed of highly autonomous entities. Recent efforts intended to integrate multi-agent, service-orients and P2P architectures aim to make these very promising opportunities happen.

Indeed, in many cases multi-agent system (MAS) may be thought of as a set of autonomous entities, and, therefore, structuring the agents of MAS as a P2P network of nodes may result in architecture providing new dimension for design of open MAS composed of highly transient population of agents. Such architecture should potentially meet requirements to many modern, often critical, applications. An example of such applications of greatest concerns is remote sensing and information fusion for monitoring of large scale geospatial regions intended for detection and prediction of natural anomalies (tsunamis, hurricanes, earthquakes, etc.). Rapidly developing ad-hoc service-oriented networks of mobile devices, large scale embedded systems of various purposes (e.g. Smart Home applications), anti-terrorist systems, etc. exemplify other applications where P2P service-oriented MAS may be highly effective.

One of the key problem here is to provide seamless integration of the MAS technology and P2P networking supporting transparency of interaction of agents which know nothing about particular implementation of P2P networking, on the one hand, and, at the same time, know very few or nothing about existence and particular functionalities of most of or even all agents of MAS. In other words, "transparency" of agent interaction means that the agents have not to care how P2P networking is provided: they have to have an impression of direct interaction with the whole network of agents using semantic queries for services and/or, in their turn, providing the requested services in reply to semantic queries from the network.

The talk presents the developed open P2P service-oriented MAS architecture and its software implementation demonstrated by several software prototypes of particular applications of various types solving prediction, classification, pattern recognition and control tasks in pure P2P style while having no centralized server managing either coordination of the distributed decision making procedure or routing the messages the agents exchange during interactions.

The developed and implemented architecture consists of three vertically interacting overlay networks. The first of them is an overlay network of P2P providers (nodes of P2P communication network) set up on top of TCP/IP transport. Using P2P services via standard interfaces, applications may have available all functionalities and possibilities of P2P systems such as communication channels between peer devices, distributed search of peers and their services over network and so on.

The second one corresponds to the distributed P2P agent platform instances intended for providing transparent interactions of applied agents of MAS. This overlay network set up on top of P2P communication network is able to manage agents. It realizes distributed Yellow and White pages and generic agent services implementing interaction with P2P agent platform. Each instance of agent platform is a component of distributed knowledge base representing distributed services and thus making it possible interaction of agents on semantic level.

The third overlay network, which, in its turn, is set up on top of the network of P2P agent platform instances, is composed of applied agents which are interpreted as consumers and providers of the services specified in distributed Yellow pages. In distributed decision making systems, the agents may be consumers of information of particular data and information sources.

It is important to note that the developed architecture and its software implementation is FIPA compatible.

The particular case studies from various application domains developed as open P2P agent–based service–oriented systems are used for explanation the basic ideas as well as for verification and validation of the basic research results. The set of case studies includes P2P intrusion detection system, P2P distributed ground object recognition system set up on board of unmanned aerial vehicles, P2P intelligent sensor network for prediction EI Nino ocean current and air traffic deconfliction system intended for use in emergent situation.