

THE CONCEPT AND TECHNOLOGY OF PLUG AND PLAY BUSINESS

Paul Davidsson¹, Anders Hederstierna², Andreas Jacobsson¹ and Jan A. Persson¹
Bengt Carlsson¹, Stefan J. Johansson¹, Anders Nilsson², Gunnar Ågren² and Stefan Östholm¹

¹*School of Engineering*, ²*School of Management*
Blekinge Institute of Technology, S-372 25 Ronneby, Sweden.

Keywords: Enterprise collaboration, entrepreneurial business, innovation, intelligent agents, interoperability, match-making, recommendation systems, virtual enterprise.

Abstract: Several barriers to turn innovative ideas into growth-oriented businesses with a global outlook are identified. The Plug and Play Business concept is suggested to lower these barriers by making it possible for the innovator to plug into a network of actors or potential collaborators with automated entrepreneurial functions. A P2P paradigm with intelligent agents is proposed to realize an environment that manages a dynamic network of roles and business relations. It is suggested that a critical characteristic of the Plug and Play Business software is to facilitate trust in-between the actors.

1 INTRODUCTION

The fact that innovations are important to create both private and social values, including economic growth and employment is well-known. Innovations as such are not sufficient for economic growth; there is also a need to develop the innovation from an idea into a business. From an innovator's perspective there are some common obstacles for realizing the potential of innovations, such as:

- shortage of time to spend on commercialization activities,
- lack of business knowledge,
- underdeveloped business network, and
- limited financial resources.

This implies that the innovator requires support to develop the idea into business, something often seen as the specific role of the entrepreneur. As Leibenstein (1978) explains, entrepreneurs are needed to search, discover, evaluate opportunities and marshal the financial resources necessary, among other things. In some but not all cases, the innovator and entrepreneur may be the same person.

To play the role as innovator or entrepreneur in the networked economy requires in many instances a global outlook. New trade and production patterns as well as the emergence of new markets point towards

a more efficient use of global resources. Information and Communications Technology (ICT) already plays an important role as a facilitator in this development. We believe that better economic growth can be achieved when the innovation and the entrepreneur can compete and solve problems on a global market place. To enable this, there is a need of a deep understanding of supply and demand in a global economy.

In order to support the idea of a business based on global matching of resources to needs, it is important to facilitate not only for entrepreneurs but also for mediating actors, i.e., such with new ideas of matching resources on a global scale. We call them *Hi-Know Enterprises*, i.e., post-industrial businesses based on an advanced understanding of supply and demand in the global economy including, for example, global production and distribution systems.

The vision of *Plug and Play Business* is to develop an integrated set of ICT-tools, in particular for innovators and supporting business roles. The tools should support the creation and management of business despite limited time, business knowledge, network, and/or financial resources of the innovator. The innovations considered are not limited to physical products, but may concern new services as well as making or organizing businesses in new ways. Such innovations will be commercialized in the

competitive and sometimes hostile networked environment of today, engaged in complex business processes, and requiring new forms for collaboration. Together with the autonomy, heterogeneity, and possibly conflicting goals of the involved parties, this requires ICT-solutions that are able to handle dynamically evolving and distributed business partnerships and processes that cross the borders of various enterprises.

2 PLUG AND PLAY BUSINESS

Three important ideas for implementing the concept of Plug and Play Business are:

- *Internet communities*: Enterprises join a Plug and Play Business community by installing the Plug and Play Business software and by describing and validating the resources of the enterprise, e.g., production capacity, distribution network, intellectual capital, etc. The community is dynamic in the sense that enterprises may (in principle) join and leave the community at any time. However, there may be a need for a specific *gate-keeper* that regulates the entering and leaving of the community, thus making it a *semi-open artificial society*.
- *Roles*: Each member of the Plug and Play Business community plays one or more roles, e.g., innovator, supplier/provider (of goods, services, expertise, etc.), distributor, marketer, financier, seller, etc. An important role in the life cycle of businesses is the *entrepreneur*. There is a variety of definitions of entrepreneur and we have adopted the classical idea originating from Schumpeter where an entrepreneur is someone who turns an innovative idea into a business by identifying market opportunities (Schumpeter, 1934; Kirzner, 1982). With that definition, we try to make a distinction between the role as innovator and entrepreneur. One of the purposes of Plug and Play Business is to automate as much of the entrepreneurial role as possible, for instance by using *intelligent agent technology*, thus increasing the probability of turning an innovative idea into a business.
- *Crystallization*: A member of the Plug and Play Business community, typically an innovator, may at any time initiate an attempt to form a collaborative coalition in-between the members. This process may be viewed analogous to *crystallization*, where a catalyst (innovator) initiates a process resulting in a precise form of collaboration, i.e., the crystal (cf. the formation of a *virtual enterprise* as described below). The main role of the

entrepreneur, which to a large extent is automated by the Plug and Play Business software, is to drive this process. It may be a more or less elaborate process starting with just a seed of an innovative idea without any pre-defined business structure, or it may be a full-fledged business idea with well-defined needs to be met by potential collaborators.

In order to realize this vision, the Plug and Play Business technology should include tools that can enable the different community members to use their resources efficiently in business solutions (crystals). This requires for example the following functions related to *match-making* activities:

- *Finding*: To find candidates suitable for a potential collaboration is an important function. It primarily concerns finding candidates within the community, but possibly also candidates currently outside the community. The finding functionality may include the possibility both for search, based on specific needs specified by criteria, e.g., role, type of products, and business model, as well as for posting general needs or ideas that other members may suggest solutions and/or resources for.
- *Selection*: When a set of potential collaborators have been found they need to be evaluated. Plug and Play Business technology should provide the feature of suggesting actors for collaboration based on, for example, content-based recommendation (previous interests of actors) and collaborative recommendations (based on preferences of similar actors). This requires the support for using track records and potentially support for certification schemes of, for instance, the trustworthiness of the actors. Further, decision support for evaluating trade-offs between a number of characteristics are needed, e.g., trade-offs between cost of product/service, cost of transportation, and time to delivery of product/service. Which actors to choose for the collaboration (i.e., crystallization) should be based on the evaluation and the estimated value of collaboration with other actors in a crystal.
- *Negotiation*: When the catalyst has selected actors for the necessary roles of the crystal, agreements between the actors with respect to financial and product/service agreements need to be settled. The Plug and Play Business technology should provide support for different types of agreements/contracts including support for intellectual property rights.

When the crystallization phase is finished, the Plug and Play Business technology should provide support also for the *collaboration phase*, i.e., the man-

agement of the actual business activities. This support may be on a quite shallow level, e.g., transactions of information between actors. On a deeper level, the Plug and Play Business technology should support and facilitate complex coordination and synchronization of activities. A wide range of information types needs to be transferred in an efficient way in order to reduce the administrative costs of the actors as well as reducing the risk of inaccuracy in information. The management of the crystal requires support for controlling the flow of activities between the involved actors. It concerns activities with potential long-term consequences (e.g., initiating product development) as well as regular business activities (e.g., decisions of production and distribution).

There is a set of criteria that should consider different aspects of a cost effective system. Some criteria that should be met by the collaboration-supporting software are, e.g., interoperability (including with the relevant legacy information systems used by the involved parties), scalability, adaptability (handling shifting collaborator needs), independence (avoiding technological lock-in and high entry-costs), affordability, simplicity and usability, system dynamicity (maintaining system functionality, e.g., when members are entering or leaving), as well as security (i.e., preventing unintended exposure of sensitive information) and robustness in terms of the resilience of the system, especially when under stress or when confronted with invalid input. We discriminate between three dimensions of such collaboration:

- *The level of collaboration:* This is related to the content and purpose of the exchanged information with tasks ranging from administrative information exchange to complex operations planning. An example of a simple administrative task is ordering and invoicing, whereas a more complex task may concern making critical information available to the collaborating partners, in order to improve operations by better and more efficient planning and scheduling, i.e., resource optimization.
- *The number of involved enterprises:* The more parties involved in the collaboration, the more complex the solutions may be. The simplest case concerns collaboration between only two enterprises (one-to-one collaboration), whereas the general case involves a large number of enterprises collaborating with each other in different ways (many-to-many collaboration).
- *The dynamics of the collaboration:* In the simple static case, the actors involved in a specific collaboration are known from the start and will not

change. In a truly dynamic collaboration, on the other hand, actors may join and leave at any time with short time to build trustful relationships.

In particular, we believe a critical requirement of the Plug and Play Business technology is to facilitate trust in-between the actors. The reason is that the success partly relies on that members are willing to contribute with information about their own core business resources which may include, e.g., intellectual property. Trust can be boosted by enhancing security. Security problems arise in that the difficulties for guaranteeing that information, which may be sensitive to one party, is not being misused by other parties in the network. Also, when many companies are involved in collaboration, access to available data is difficult to restrict. Some security features that help to ensure security and trust in partner selection and collaboration may be, e.g., identification and authentication of participants, encryption of data, access control mechanisms, intrusion detection capabilities, and possibly some trusted third party involvement. However, security features must be carefully considered so that they do not interfere with agility, dynamicity, interoperability, and low cost.

In reaching the potential of Plug and Play Business, the use of open source software and freeware components comes well at hand. This suffices for agile operations since it among other things presents enterprises with the option to speed up software, and to share knowledge of security risks and patches. This also enables participating companies to develop proprietary functions of the software, and it is also a form of cost avoidance or cost sharing.

We believe that a fully decentralized paradigm such as peer-to-peer (P2P) can be a preferable alternative for the Plug and Play Business software, because no central authority determines how the participants interact or coordinates them in order to accomplish some task. A P2P infrastructure self-configures and nodes can coordinate autonomously in order to search for resources, find them and interact together. P2P being a paradigm that allows building dynamic overlay networks, it can be used in order to realize an environment that manages a dynamic network of business relations. Dealing with business sensitive assets (e.g., innovators' knowledge), searching and retrieval of contents, as well as discovery, composition and invocation of new services, should be made secure and trustable. The P2P infrastructure realizes an environment in which every organization can make its knowledge and services available to other organizations. In a P2P infrastructure, each organization can autonomously

manage this task without having to delegate it to an external central authority.

From a business perspective, the long term result of Plug and Play Business software will be increased possibilities for innovators to obtain, e.g.:

- transactional value: effectiveness in finding and managing business relations,
- scope value: opportunity to carry out business on a global basis at a lower cost, and
- strategic value: better informed and more adaptive to new market options.

From a societal perspective it will increase the possibilities for economic growth on a global, national as well as regional level. It may lead to lower barriers to turn innovative ideas into business activities, especially by less dependence on local concentration of the different types of resources necessary for doing business.

3 RELATED WORK

In the networked economy with lower transaction costs, organizations concentrate more and more on their core business processes and join temporary business alliances in order to solve market needs, thereby forming *Virtual Enterprises* (VE). In a VE, a company initiates collaboration by assembling a temporary coalition of partners and services for a certain purpose (Petrie and Bussler, 2003). Unlike their traditional counterparts, VEs are flexible, can be any size or any type and can reconfigure themselves quickly and temporarily in response to varying market demands. One of the main advantages of VEs is reduced cost as well as time-to-market. Hi-Know Enterprises may be treated as the initiator or catalyst of the formation of a VE. The Plug and Play Business software is intended as a framework for integrated ICT-support for implementing VEs that act in a dynamic networked environment, which also may be hostile due to sharp competition amongst rival companies (cf. Carlsson and Jacobsson (2005)). The idea of Plug and Play Business has some resemblance to the work described by Chituc and Azevedo (2005) in that dynamic collaboration processes for agile VEs are emphasized. However, they do not provide an integrated framework as they leave out crucial aspects, such as, the match-making task and security management.

Regarding match-making activities, the tasks of finding and selection (e.g., business partners) has been the object of a lot of research within the area of *recommendation systems* (cf. Adomavicius and Tuzhilin (2005)). Here, the main idea is to automate the process of “word-of-mouth” by which people

recommend products or services to one another. So far, recommendation systems have successfully been deployed primarily in consumer markets. As most existing recommendation systems are not developed for B2B applications, they generally exclude the negotiation process. However, there is a long tradition in the area of agent-based systems of studying this topic (cf. Rosenschein and Zlotkin (1994)), for instance using the contract net protocol and computational auctions.

As pointed out earlier, the task of multi-lateral collaboration and information resource sharing must be adjusted for a dynamically evolving networked environment marked by strong competition. In our view, ICT solutions that support multi-lateral collaboration should therefore meet the requirements of interoperability and scalability as well as security and robustness. There is no approach available that meets all of these criteria. It seems that Microsoft's BizTalk Server is the most sophisticated solution for collaboration. However, BizTalk only supports one-to-one party collaboration, and is currently not fit for information resource sharing (even though it is claimed that the next version will contain a limited extent of such capabilities). BizTalk is based upon a central server through which all exchanged information pass, it uses XML and supports the main protocols for email and http. Also, being a centralized proprietary client-server solution it has several disadvantages, such as, making the actors dependent of a third party, being expensive and having possible risks for communication bottlenecks. In enabling Plug and Play Business technology, one promising alternative for multi-lateral collaboration is the use of decentralized intelligent agents. In (Davidsson et al., 2005), a general wrapper agent solution is described based on open source freeware that makes it possible (in principle) for any business system to exchange information with any other business system. In (Carlsson et al., 2005), further improvements on the wrapper agent technology are suggested by addressing security issues as well as an extended, possibly dynamic, set of involved companies and higher levels of collaboration (i.e., information resource sharing).

3.1 What is New in this Research?

We are not aware of any integrated ICT-tool for implementing VEs. We argue that the Plug and Play Business technology remedies this situation and has the ability to realize the potential of VEs. In addition, we focus on an important role in a VE that has been largely ignored, namely that of the innovator. We believe that tools are missing for supporting the

entrepreneurial activities related to the commercialization of innovations. Below, we make a technological assessment of our approach compared to the current state of the art:

- **Match-making:** We believe that a Plug and Play Business technology can deploy ideas and solutions from existing recommendation systems (in particular hybrid approaches based on both collaborative filtering and context-based systems) in order to locate and select new partners, and agent-based technologies in negotiating terms of collaboration. However, since match-making activities typically are based upon incomplete information (for instance because potential partners are not interested in revealing business opportunities or publishing their business critical information), aspects of security and trust must also be incorporated within the task.
- **Collaboration:** We believe that an agent-based approach can be used in order to enhance multi-lateral collaboration in dynamic networked environments. However, compared to current state of the art, the envisioned Plug and Play Business technology must focus more on cost efficiency, e.g., by using open source software, meeting criteria such as interoperability and scalability, as well as providing better support for security and robustness.

4 FUTURE WORK

Future work on Plug and Play Business will be focused on developing:

- detailed requirements specifications of Plug and Play Business software,
- a validated technological model of the Plug and Play Business software platform,
- partial prototypes indicating the viability of the Plug and Play Business concept,
- demonstrators illustrating the Plug and Play Business concept.

To further support secure collaboration, (automated) methods for valuating risks and comprehensive models for secure information asset management will be addressed ahead. Finally, we will also study information infrastructure architectures and business models supporting the implementation of agile and secure Plug and Play Business communities.

ACKNOWLEDGEMENTS

This work has been funded by the project “Integration between different SMEs’ business systems”, financially supported by “Sparbanks-stiftelsen Kronan”.

REFERENCES

- Adomavicius, G. and Tuzhilin, A. (2005, June). Toward the Next Generation of Recommender Systems: A Survey of the State-of-the-Art and Possible Extensions. *IEEE Transactions on Knowledge and Data Engineering*, vol. 17, No. 6.
- Carlsson, B., Davidsson, P., Jacobsson, A., Johansson, S.J., and Persson, J.A. (2005). Security Aspects on Inter-Organizational Cooperation Using Wrapper Agents. *Proceedings of the Second Workshop on Agent-Based Technologies and Applications for Enterprise Interoperability (ATOP) within the 4th International Joint Conference on Autonomous Agents and Agent Systems*.
- Carlsson, B. and Jacobsson, A. (2006). Security Consistency in Information Ecosystems – Structuring the Risk Environment on the Internet. To be published in the *Journal of Information Systems Security*.
- Chituc, C.-M. and Azevedo, A.L. (2005). Enablers and Technologies Supporting Self-Forming Networked Organizations. *Interoperability of Enterprise Software and Applications – Workshops of the INTEROP-ESA International Conference EI2N, WSI, ISIDI and IEHENA 2005*, ed. H. Panetto, Hermes Science Publishing, London UK.
- Davidsson, P., Ramstedt, L., and Törnquist, J. (2005). Inter-Organization Interoperability in Transport Chains Using Adapters Based on Open Source Freeware. *Interoperability of Enterprise Software and Applications*, Springer Verlag, Berlin Germany.
- Kirzner, M. (1982). The Theory of Entrepreneurship in Economic Growth. *Encyclopedia of Entrepreneurship*, ed C.A. Kent, D.L. Sexton and K.H. Vesper, Prentice-Hall, Englewood Cliff NJ.
- Leibenstein, H. (1968). Entrepreneurship and Development. *The American Economic Review*, pp. 72-83, Vol. 58.
- Petrie, C. and Bussler, C. (2003, July/August). Service Agents and Virtual Enterprises: A Survey. *IEEE Internet Computing*, pp. 2-12.
- Rosenschein, J.S. and Zlotkin, G. (1994). *Rules of Encounter: Designing Conventions for Automated Negotiation among Computers*. MIT Press, Cambridge MA.
- Schumpeter, J.A. (1934). *The Theory of Economic Development*. Harvard University Press, Cambridge MA.