Smart business networks: architectural aspects, risks and related asynchronous business interactions

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Abstract. This paper summarizes key attributes and the uniqueness of smart business networks [1], to propose thereafter operational implementation architecture. It involves, amongst others, the embedding of business logic specific to a network of business partners, inside the communications control networks. It also involves the definition of business protocols between these partners and the joint management of some common functions relying on open networking standards. This implies some key paradigm changes, both of a technical and of a business nature, which are offered here for discussion via a set of propositions. Ultimately, smart business networks reshuffle the very notion of linear life cycles in software systems development, to replace it with asynchronous interaction protocols between parties to the development.

Keywords: Smart business networks, Business protocols, Architecture, Communications networks, Signalling

1. Introduction to Smart Business networks

The intelligence of a network is augmented by its functionality: its ability to distribute, store, assemble, or modify information. Transmission networks are technically complex, but business-wise they are "dumb" pipes that transport information without enhancing it. A network augmented by business relationships can be "smart"; it can improve the utility of information in multiple ways. That is synonymous with creating economic value.

This paper is about architectural trade-offs and risks enabling the relationship between the intelligence of networks and the smartness of the businesses that use these networks. Some basic concepts for "smart business networks" (SBN's) have been laid in [1] and possibly in other related best practices [15]. Ultimately, smart business networks reshuffle the very notion of linear life cycles in software systems development, to replace it with asynchronous interaction protocols between parties to the development.

All three words in the title "smart business networks" are necessary. In management, the adjective "smart" is attributed to an action that is novel and different, hence thought of as innovative. Smart actions create remarkable, "better

than usual" business results. Smart has a connotation with fashionable and distinguished, but also with short-lived. . The word "smart" in smart business networks is therefore not an absolute but a relative term. Smartness is a property whereby the network can create "better" results than other, less smart business networks or other forms of business arrangements. While intelligence in the communications systems and networks may have a more absolute meaning, smartness of business networks is relative, time-bound and situation-bound.

The pair of words "smart business" can apply to any business without a network. a "smart network" can apply to a network that is not used for business or organization. A "business network" is generic and includes both smart and not-so-smart business networks. A "smart business network" (SBN) is defined , inspired from [1], but defined here more operationally, as:

- A group of participating businesses - organizational entities or "actors" - that form the nodes ,and this group is not necessary visible to the outside ;
- Linked together via one or more communication networks forming the links, or lines, between the nodes;
- Linked together as well by a set, possibly ontology based, of bilateral or SBN network wide , agreements or service level agreements (SLA's) of a temporary nature
- Interacting in novel ways they could not implement on their own, or possibly with other parties ; this is the SBN network benefit ;
- Perceived by each participant as increasing his own value ,meaning that while overall goals/utility functions may be different , some can be shared within the network with estimated derived positive benefits ; the basic equilibrium concept is one of a non-cooperative Nash game, and not of a collaborative Pareto game ;
- Sustainable over some time as a network, subject to agreed upon termination rules ;
- Resilient if one or more businesses, nodes in the network, drop out, disappears, or malfunctions.

A "smart business network" is not a rigid physical supply network governed by static agreements, and described by graph theory alone via a static graph. The networked business environment is fast and agile. Supply trees are selected from the network frequently and rapidly, and they usually have short lifetimes because the commercial or expertise sharing opportunities have short lifetimes. Smart Business Networks develop not only because technology permits them to develop, but more significantly because markets and modern business competitiveness require such networks in order to survive and thrive. Management attention then focuses on managing the network, on the processes for joining or leaving a network, and on processes by which to select supplier trees from the network. . We can now go one stage further and say that the fundamental competitive capability is to construct and manage a smart business network.

Whereas some physical supply networks exhibit the attributes of smart business networks, already today most of their attributes can be found to some extent in ,e.g.:
-mobile content delivery networks, where quick-connect must be done in quasi real-time with content /DRM owners at end user request [2];

-electronic CAD networks, where building blocks get assembled with custom blocks, simulated, tested and prototyped;
-health management insurance networks where specific expertise in a localized way has to be assembled together with service delivery facilities such as clinics.
Business networks that are smart, display quick connect and quick disconnect capabilities; they can pick the best capabilities from many network actors, plug these capabilities together, and make these play in unison; they also control, or own, the business logic for multi-actor execution of business processes.

The smart business networks discussed in the paper involve a unique life-cycle, where the architectural design supports the next phase, where particular business processes can be composed on-the-fly and immediately executed. This is also fully in line with Open Group [2] and also OMG's recent Dynamic Business Activity Models RFI:
http://www.omg.org/techprocess/meetings/schedule/Dynamic_Business_Activity_Models_RFI.html

2. Smart Business Network Capabilities

The following capabilities are seen in smart business networks:

- Establishment of common understandings: of meanings, words, ontologies, ethics and informal commitments, and of the principles followed in contractual obligations;
- Membership selection: the capabilities to decide which business entities can act as nodes of the network; it includes a search-and-select behaviour by the actors. Once the appropriate actor, or node, is found, and the connection has been established, the process of performing a business transaction can begin.
- Membership ending rules and procedures over time; the capability to *quickly disconnect*, is a process greatly influenced by risk and reward division [3]. This will be a vital element of a smart business network, because unless it is agreed ahead of time how risk and reward will be allocated, serious problems of mistrust can develop ;
- Linking: the positioning and connecting of nodes to the other parts of the network. The linking processes can include the directories (search and select) and routing (path finding) through the network as well as communications infrastructure elements such as authentication, trust establishment , firewalls , and network management;
- Goal selection and dynamic conflict resolution : the coordination mechanisms that determine the limited shared goals in the business network and the tasks and responsibilities assigned to each member node;
- Interaction and sharing : the shared expertise, management and capabilities that make the network generate novel results, preferably those that no single member could achieve on its own;

- Risk and reward management: the division of material results (profit and loss in a monetary but also know-how, intellectual property rights , customer data ,etc ..) and the perceived value by each of the participating business entities of its share;
- Resilience, fault tolerance/recovery and risk management: risk measuring and distribution rules, and conflict resolution processes; clearly connections in a smart business network are much more complicated to achieve and require higher levels of mutual trust.

3 From business process to business network

Once process logic can be abstracted from its runtime environment it is possible to divide process modules over a number of different actors - defined as organizational entities - that are connected together via a communications infrastructure (see Figure 1).

Generally, one of the major stumbling blocks to swift process co-ordination in general, is the distribution of business and process logic over actors which all rely on one or several third party communication networks, sometimes incompatible at least as to application specific interfaces or middleware.

Within the smart business network itself, the architectural question is how to achieve this on-the-fly coordination without relying on third party communications and transactions' provisioning. The business problem of path finding and resource allocation within a smart business network is also very similar to the issues surrounding naming/ addressing/ routing and capacity utilization in traditional communications network design and management.

To cater to the needs of smart business networks, and the completion of their capabilities, this paper endeavors a novel approach to embedding the shared business logic (specific to and within a smart business network) , into the control layers of communications networks ,under the control of the smart business network parties [11-12].

4 The business Process impact of on-the-fly user-driven management of smart business network support architectures

What is specifically proposed to enable smart business networks is to use the control network to carry business protocols and fulfillment / settlement between members in smart business networks, while maintaining the tight separation control networks have been built around [7]. The control networks already ensure interoperability between the information & communication networks of the members in a smart business network .But it is quite possible to use the control communication networks, for yet another purpose, which is the coordination of smart business network processes, their synchronization, and the transport functions needed by the business protocols the

smart business network members have agreed to use between themselves. There are however legacy considerations to be taken into consideration, as the use of these control networks by the parties themselves require freedom to do so.

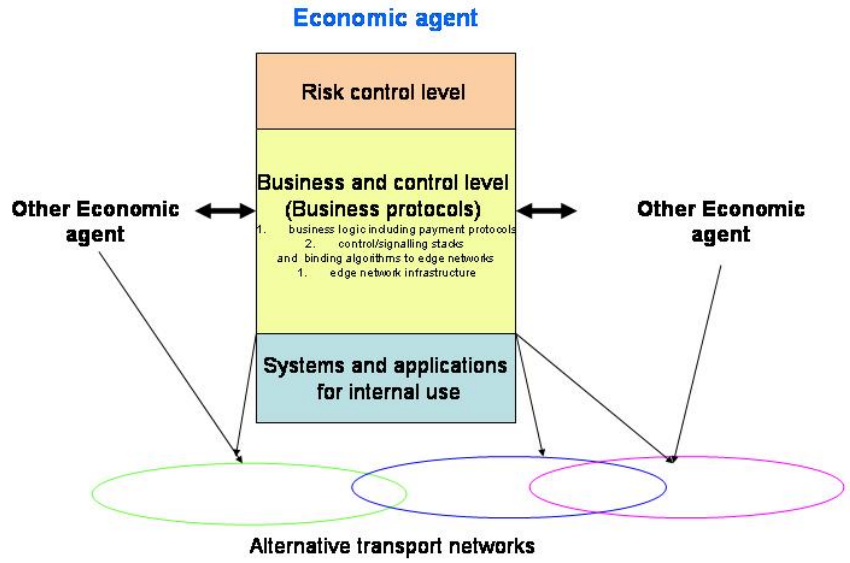

Fig. 1. Economic agent which interacts with other economic agents without general trade and payment intermediaries; this agent has imported into its communications and computer systems the network control functions, and merged these with his own business logic and processes (trade, payment, ERP, etc...)

6. Smart business network architectural elements

While workflows define how a process should run, the business logic enacts, monitors and controls the process flow in the technical environments of each of the smart business network actors; where necessary it passes control over to external systems to perform a task. This logic is controlled by business rules that take decisions on events depending on the state of the various machines and processes linked to it. There are two critical components to this: the monitoring of all resources in the smart business network, and management through the equivalent of, or rule-based event-correlation. It checks the events it receives against the current rules and "fires" the rules when their conditions are met.

This leads to the selection of the key components of the architecture supporting a smart business network internally as well as externally, at the:

A. *Operational level*: after the management decisions supporting its capabilities:

a1. a common and unique authentification capability with full trust support by all smart business network parties;

a2.a common set of external suppliers and customers interfaces supporting both order handling, classification, payment, certification, fulfillment, SLA's etc..; typically this would be enabled by the selection of an e-Commerce platform or a set of standards by all the smart business network members, such as OMG's MDA, Service oriented computing SOC, or Web services described in W3C's WSDL (on top of SOA);

a3. the joint adoption of programmable interfaces to the control networks (offered by one or several transport infrastructure providers) ,such as IEEE P1520, SIP or equivalent ,for the execution of the business protocols inside the smart business network [8-9]; the combination of these interfaces and of the underlying control networks used, can be called the business control network of the smart business network ; please observe that if ad-hoc or active network [10] controls are applied , this element a3. should still apply

a4. management principles, operating procedures, and technical support as to naming services (OMA), catalogs and directories (eg. via LDAP or equivalents), which however remain under control of each smart business network member;

a5. the set of smart business protocols shared by the smart business network members for their internal use, and some for use towards joint customers , suppliers or infrastructure/tools / capabilities providers .;these protocols pulled together with their initialization/activation conditions constitute the rule-based event correlation

a6. a distributed smart business network monitoring tool, restricted to operate on the jointly shared business control network, and with equal access to the monitoring actions to all smart business network members (duly authentified); this monitoring tool should not just be a traffic and alarm handling tool, but much more importantly a toll giving status of the use and execution of the business protocols

On top of the above operational layer, two layers must exist (not discussed here, but in [1]):

B. *Management of an individual business*: described in a networked systems concept as asset and event management;
C. *The dynamic control and governance of the business network.*

The creation of logic by individual actors in the business networks takes a new meaning once this is linked together and managed through business protocols, independent of the originating actor(s). Whereas some look at this capability as a "business operating system" [1] for tight coordination , this is not supported here as it is not likely that a monolithic and identical "business operating system" will be viewed as supporting ultimate smart business network partner identity/ independence , nor the agility this network must exhibit . The architecture proposed above on the other hand, while only exhibiting looser coordination, does not preclude other processes and controls to operate within each smart business network partner, and does not either force him to change his own operating and organizational environment: it is a much more network focussed view as opposed to a centralized view of the smart business network operations. The portability of business processes is still possible as well as the end-to-end management thereof.

8. Risks involved in smart business networks and some research challenges

This paper investigates a novel way to embed business logic into the control layers of communications networks at the edges of the backbones. This is motivated e.g. by initial encouraging work at the Rotterdam School of Management in the field of logistics, wireless, and content distribution networks.

Also, as process events can be linked very quickly, and economic agents may recompose themselves and/or their functions, the dynamic resource optimization across many economic agents will be increasingly complicated. We suggest that some genetic and bio-informatics algorithms are useful to realize the corresponding adaptation selection and recalculations of the business logic embedded at the communications level [11].

Smartness may emerge spontaneously and not be intentionally designed, and conversely if designed smartness may not deliver its promises and even enhance some business risks .While much theoretical and experimental research is still needed to identify the causal relations leading to smart business network risk formation, some of the underlying forces are the following:

- Bounded group rationality that limits the actors' group mind share in a same way as for individuals [12]. Measurements suggest that not only individual human beings are limited by an inability to digest intense input of data: a group of people, or a network of nodes, show comparable limitations;
- Dynamic emergence and decay of key information brokers, information creators, and information users. Measurement on networks shows that most nodes can be categorized as one of these three types;
- Lack of agreed upon and transparent confidence and trust maintenance procedures
- Changing behaviors due to the networking itself ; cases have already shown [13] that when a company organized itself as a smart business network, it ultimately disappeared as the entities felt their accountability, initiatives ,discipline, focus and expertise did not require the same attention as this was "taken care of by others in the network"
- What should be the granularity of the operations at each smart business network member when networked; too high granularity leads to overlaps, inefficiencies and conflicts, while too low granularity reduces innovation and flexibility; the notion discussed here is not the one of modularity [4-6] in a linearized supply chain, but the scope of the activities at each business partner in a smart network, which can be formalized by task graph decomposition within a network.

Finally, such an approach opens the way technically to individualized communications tariffs and process costs or each agent, with settlement not only by operators or financial institutions [14].

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