The Need for Second Order Interoperation
A View Beyond Traditional Concepts*

Wided Guédria[1] and Henderik A. Proper[1,2]

[1] CRP Henri Tudor, Luxembourg
[2] Radboud University Nijmegen, The Netherlands EE-Team**
wided.guedria@tudor.lu, e.proper@acm.org

Abstract. Modern day enterprises need to be continuously "on the move" to deal with the many challenges and opportunities that confront them. The resulting changes can take shape as top-down and premeditated efforts, but are more likely to also take the form of numerous small changes that emerge bottom-up in a seemingly spontaneous fashion. Additionally, fixed organizational structures are being replaced by more dynamic networked enterprises, also blurring borderlines between existing enterprises within the same value web/chain.

We argue that the change processes of modern day enterprises are a key business process, next to the regular business processes involved in the operational activities. We therefore suggest to refer to the change processes as *second order* business processes, as they essentially change the regular (*first order*) business processes and their supportive structures. Second order business processes need the supported of information systems that capture, manipulate and disseminate information concerning different structural aspects (e.g. from value propositions, via business processes and supporting applications, to the underlying IT infrastructures) of a networked enterprise and its environment. We refer to such information systems as *second order information systems*.

In this position paper, we specifically zoom in on the need for interoperation of such second order information systems within networked enterprises that are "on the move". This is what we will refer to as *second-order interoperation*.

1 Introduction

To deal with the many challenges and opportunities that confront them, modern day enterprises need to be continuously "on the move". Socio-economic challenges, such as the financial crisis, mergers, acquisitions, innovations, novel technologies, new business models, servitisation of the economy, reduced protectionism, increased global competition, etc., provide key drivers for change. These challenges are fuelled even more by advances in (information) technology. The resulting changes can materialise in different forms. They might, for example, take shape as top-down and premeditated efforts,

* This work has been partially sponsored by the *Fonds National de la Recherche Luxembourg* (www.fnr.lu), via the PEARL and CORE programmes.

** The EE-Team is a collaboration between CRP Henri Tudor, the Radboud University Nijmegen, the HAN University of Applied Sciences, the Utrecht University of Applied Sciences, and the University of Luxembourg (www.ee-team.eu).

R. Meersman et al. (Eds.): OTM 2014 Workshops, LNCS 8842, pp. 255–264, 2014.

but might also occur as numerous small changes that emerge bottom-up in a seemingly spontaneous fashion.

Operating in such environment requires flexibility and cooperation between enterprises, sharing their core competencies in order to exploit the market opportunities. Exchanges are needed for both operational control, solving interoperation problems and to a larger extent for the decision making process during the establishment of cooperation, including opportunity exploration, planning and implementation. These developments have also prompted enterprises to re-structure themselves in terms of more flexible network structures [11, 15, 9]. Traditional fixed organizational structures are being replaced by more dynamic networked enterprises [8, 26], also blurring the borderlines between existing enterprises within the same value chain/web.

In our view, change processes should be regarded as a key business process in an enterprise, next to the regular business processes involving in the operational activities. More specifically, we suggest to consider the change processes as a *second order* business processes. This will be elaborated upon in Section 2, which is based on earlier work as reported in [19, 18].

Furthermore, in fast moving networked enterprises, it is important for senior management, as well as the workers in the enterprise and other participants in the value web in and around the enterprise, to have insight in the workings of the enterprise as a whole. This insight might be needed to e.g. coordinate change, manage compliance, manage risks, assess performance, etc. As a result, information concerning different structural aspects (e.g. from value propositions, via business processes and supporting applications, to the underlying IT infrastructures) of the different elements of the networked enterprise and its environment is needed. We refer to such information systems as *second order information systems*.

In the case of a networked enterprise, the *second order information systems* are likely to run across multiple nodes in the associated network of organizations. This leads to a major challenge for the interoperation between these second order systems. It is acknowledged that one of the major issues in global collaboration and cooperation is the development of interoperability between enterprises. Hence, interoperability has become a key factor to success of enterprises and thus requires considerable attention. In this position paper, we specifically zoom in on the need for interoperation of the second order information systems within dynamic networked enterprises. This is what we will refer to as *second order interoperation*. We will elaborate on the concept of second order interoperation in Section 3, while Section 4 will connect it more explicitly into the need to steer the motion of enterprises.

2 Enterprises in Motion

In line with [6], we consider an enterprise to primarily be a social system, in particular a social system with a purpose. The social individuals, i.e. humans, making up the enterprise will typically use different technological artefacts to (better) achieve their purpose. As a result, enterprises are generally regarded as being socio-technical systems. In using the term enterprise we will therefore also refer to the used technological artefacts.

As a result of the socio-economical and technical challenges, enterprises need to change continuously. Different kinds of, and views on, change in enterprise exist. Some examples include:

- *Enterprise transformation* [21, 12], concerned with pre-meditated and fundamental changes to an enterprise's relationships with one or more key constituencies, e.g., customers, employees, suppliers, and investors.
- *Business innovation* [7], dealing with continuous innovation of the business, its products and/or services.
- *Continuous process improvement* and other forms of *business process reengineering* [5, 20].

These different flavours of change in enterprises are generalized as "*enterprises in motion*", where the word *motion* refers to "*an act, process, or instance of changing place*" [16].

It is important to note that enterprises do not just change by means of pre-meditated change programs. We even go as far as to argue that small changes actually make up the bulk of an enterprise's motion. As such, these seemingly small changes should be taken into due consideration as well. For example, it is quite common that business processes are *not* executed as designed. People working in an enterprise are likely to make changes to the design of business processes just 'to make it work'. Either to make it work for the individual worker, or because the designers did not realize all the variety and complexity one has to deal with in the day to day operations of the enterprise. One might even argue that business processes only work, because people will *make* them work, even if they are not designed well enough.

Given the needs of modern day enterprises to be constantly in motion to meet ever changing challenges, we argue that the continuous motion of an enterprise is actually one of its primary business processes, next to the 'normal' operational business processes. As such, the business process for continuous motion deserves careful design and management. They are 2nd order business processes, and as such, will require the support of 2nd order information systems.

3 The Need for Second Order Interoperation

We now turn to the need of enterprise interoperability, and do so more specifically in the context of steering the motion of a *networked* enterprise.

3.1 Enterprise Interoperability

Interoperability is defined as the "*ability of two or more systems or components to exchange information and to use the information that has been exchanged*" [14]. Having this ability, allows enterprises, organizations and more generally systems to interoperate. In line with this definition, interoperability begins with a theoretical idea of the following structures having symmetry: software components, hardware components, the interaction between software and hardware components, and the communication between systems exchanging information. Being interoperable means that the system is

able to avoid/solve interoperability problems and interoperate with its partner. According to [4, 25], there are three kinds of interoperability problems:

- *Conceptual* problems are mainly concerned with the syntactic and semantic incompatibilities of information to be exchanged or to be used during an interoperation.
- *Technological* problems refer to the use of computer or ICT (Information and Communication Technologies) to communicate and exchange information (i.e. language, architecture & platforms, infrastructure, . . .). These problems concern the standards to use, store, exchange, processes or computerized data.
- *Organizational* problems relate to the definition of responsibilities and authorities so that interoperability can take place under good and well-established conditions.

In order to quickly overcome these interoperability problems and thus support enterprises to better interoperate with their partners, clients, providers, etc. Enterprise Interoperability (EI) requires continuous assessment and improvement.

3.2 Second-Order Interoperation

Preparing, maintaining and improving interoperability should be considered as a business process that should be designed (to prepare interoperability), assessed (e.g. using maturity models), improved (i.e. by reaching higher levels of interoperability) and maintained.

In line with the terminology used for aspect systems in an enterprise in motion [19], the running-producing system can be regarded as a first order interoperation. This requires the running system, to have the 'ability to interoperate' before interoperating, we refer to as 1st order interoperability. On the other hand, the motion-steering system can be regarded as a second order interoperation that needs also second order interoperability. These are illustrated in Figure 1. First order interoperation is an operational process within organizations (1st order business process). Motioning interoperation, by solving problems or improving it is a 2nd order business process that should be steered and supported. Consequently, enterprise interoperation focuses on those properties of an enterprise that are necessary and sufficient to meet its essential requirements for interoperability. This includes, in principle, all aspects of Figure 3, in particular the running, motioning, producing, and steering aspect systems.

3.3 Steering Areas of Interoperability

The establishment or diagnosis of enterprise interoperability leads to identify the different operational levels that are concerned. Four areas of interoperability, called Enterprise Interoperability (EI) concerns, have been defined, namely business, process, service and data [4].

- Interoperability of data aims to make work together different data models with different query languages to share information coming from heterogeneous systems.
- Interoperability of services aims at making it possible for various services or applications (designed and implemented independently) to work together by solving the syntactic and semantic differences.

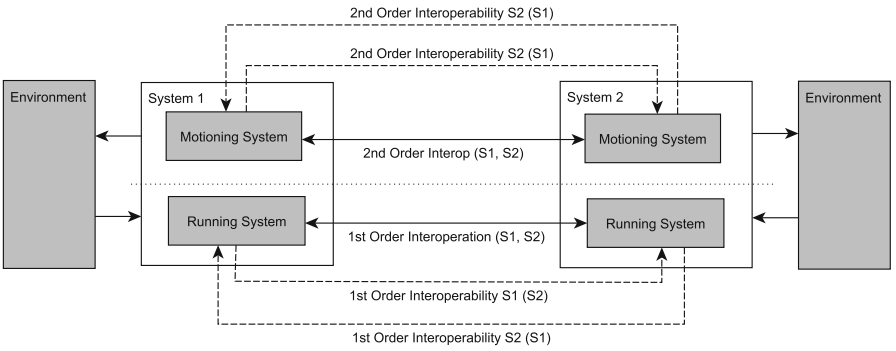

Fig. 1. Second order Interoperability and Interoperation

- Interoperability of processes aims to make various processes work together. In the interworked enterprise, the aim will be to connect internal processes of two companies to create a common process.
- Interoperability of business aims to work in a harmonized way to share and develop business between companies despite the difference of methods, decision making, culture of the enterprises or, the commercial making.

Given the needs to be constantly in motion to meet ever changing challenges, we argue that the continuous motion of each one of these interoperability concerns is actually one of its primary business processes, next to the normal operational business processes. As such, each business process for continuous motion deserves careful design and management.

3.4 Levels of Steering

Given the fact that an enterprise architecture forms a bridge between strategy and design [17], it follows that the motion-steering system actually involves (at least) three levels of steering. These are illustrated in Figure 2 [19]. At the top level we find the steering of strategically relevant issues. This concerns the definition and evolution of the enterprise's strategy. Depending on the goals and concerns that are involved in the strategic thinking level, the border between the strategic level and the architectural level would need to be adjusted. Needless to say, that this border cannot be fixed a priori. It will depend on the situations and concerns as they evolve.

At the next level, we find the architectural level. There the same applies. Depending on the essential requirements that follow from the strategic level, as well as the goals and concerns of the stakeholders, the border between the architectural level and design level can be adjusted. Again, this border cannot be fixed *a priori* as well. For example, a shifting societal focus towards e.g. the carbon footprint of the production of services and goods, may all of a suden trigger the architectural need to study the carbon impact of the enterprise's business processes. This would entail the need to, at an architectural level, now consider and design business processes at a finer level of detail then before.

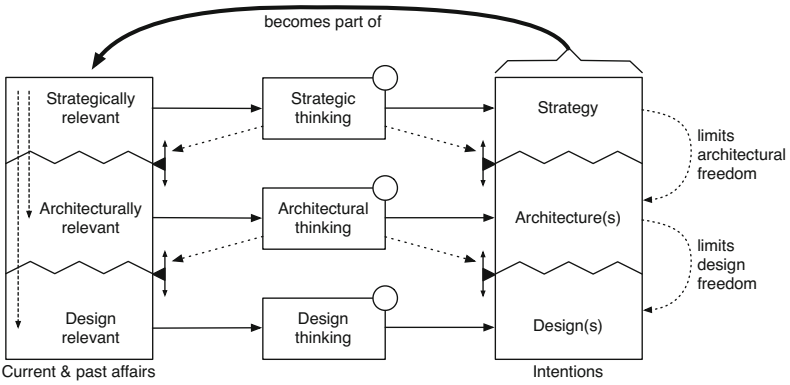

Fig. 2. Steering-Levels, taken from [19]

The last level of the steering system involves the design level. This design level is filled in by e.g. system development projects and/or decisions by self-steering teams on how they plan/organize their work.

The left hand side of Figure 2 shows the input, i.e. the abstraction (typically in terms of models) of the sensing activities, to the thinking activities. To stress the fact that this should not just involve the current state, but rather a historical perspective and current trends of the entire enterprise, we refer to this input as the *current & past affairs*[1]. The dotted arrows on the left side of Figure 2 illustrate that the lower levels can take the the higher levels of information as (contextual) input.

The right hand side of Figure 2, represents the results of the thinking activities. In other words, the intentions/plans for action. The dotted arrows illustrated the fact that the lower levels need to be compliant to the higher levels. As such, the (higher level) intentions are also a part of the input for the at the lower level. This is signified by the fat arrow running across the top of the diagram.

3.5 2nd Order Interoperability and Systemic Properties

Systems theory is a way to view the world [10]. It can be used as a paradigm to understand interoperability: interoperating systems, systems interoperation and interoperability problems as well as solutions. This is particularly relevant since interoperability is about relations between systems. This section proposes that 2nd order interoperability can also benefit from a systemic approach. Several characteristics of a system can influence its ability to interoperate. Based on [27], the main ones are the following:

– The openness of a system refers to the relationship between the system and its environment. Open systems affect and are affected by their environment [10]. The opposite of an open system is a closed system that does not have any interaction

[1] `http://en.wikipedia.org/wiki/Current_affairs_(news_format)`

with its environment. As a result of being closed, such a system cannot be interoperable.
- The stability of a system should be considered. An unstable system will be prone to create interoperability problems due to its changing nature.
- The adaptability of a system is an important factor. A system that can react to changes and adapt its structure or behaviour accordingly while keeping its original objective has a greater interoperability potential.
- The reversibility is one of the properties that interoperable system should have: even if the implementation of the interoperability between two systems leads to their adaptation or modification, these systems have to be able to come back to their initial state when interoperation ends (both from the point of view of structure and behaviour).

4 Steering the Motion of Enterprises

Given the potential impact which the challenges may have on an enterprise, and that as a consequence enterprise are continuously in motion, we argue that there is a need to steer this motion. It needs to be ensured that the motion is in line with the overal purpose and strategy of the enterprise, while also staying within the bounds of e.g. external regulations.

4.1 Steering

Based on the view that enterprises are continiously in motion and given the need to steer this motion, a distinction between four aspects systems is needed : the *running* aspect system, the *motioning* aspect system, the *producing* aspect system and the *steering* aspect system. The production aspect is concerned with the actual performance of activities of e.g. the motioning system (i.e. making changes) or the running system (e.g. producing products or delivering services). The steering aspect is concerned with the overall steering of the activities of the production system, such as ensuring their mutual alignment, efficiency and contribution to the overall goals (e.g. the purpose of the enterprise), as well as compliance to external regulations. According to the dictionary [16], to *steer* specifically means:

1. *to control the direction in which something (such as a ship, car, or airplane) moves;*
2. *to be moved or guided in a particular direction or along a particular course.*

We consider this to be applicable to the motion of an enterprise as well. Depending on the enterprise, its purposes, context, and concerns, the steering system can use different styles of steering. For example, a restrictive top-down style of control approach, or a more laissez-faire based care-taking/stewarding approach. It may also apply different rhythms towards steering the activities in the producing system. For example, a regular planning-based approach or a more evolutionary/agile approach.

4.2 The Sense-Think-Act Paradigm

The role of the steering system can be illustrated more specifically in terms of the control paradigm from management science. From a theoretical point of view, the control paradigm is based on the more general notions of cybernetics [2] and feedback systems [3]. The field of robotics has developed a variation of the control paradigm in the form of the Sense-Think-Act paradigm [22]. In terms of the requirements on a controlling system, we would have the following correspondence:

1. *Sense*: (1) the current & anticipated coordinative goals and constraints, (2) the state & motion of the object's environment, (3) the state & motion of the object itself and (4) the impact of earlier coordinative interventions.
2. *Think*: (1) perform a SWOT analysis of the motion of the object and its environment, in relation to the coordinative goals and constraints, as well as earlier intervention actions, and (2) formulate (when needed/desired) an intervention plan to influence the object and/or its environment.
3. *Act*: perform an intervention plan.

We argue that *sensing*, *thinking* and *acting* are actually more specific aspect systems of the *steering* system. For enterprises in motion, this leads to the situation as shown in Figure 3. The *sensing* aspect system observes the environment, the performing of motioning system, as well as the running system as a whole. It *acts* by influencing the performance part of the motioning system.

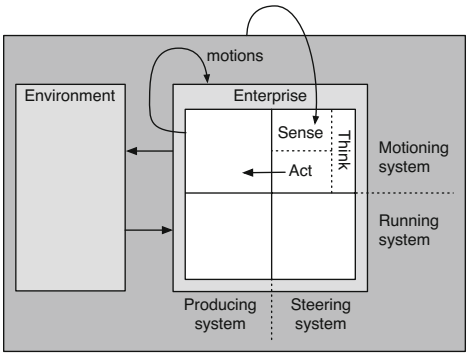

Fig. 3. Sense, Think and Act aspect systems added

4.3 Second Order Information Systems

The motion-steering system can be regarded as a second order information system [13]. As such, it is actually to be regarded an information system in the broad sense, as it involves both human and computerised actors. Needless to say, that IT can play an important role in this information system [18].

In this vein, techniques such as process mining [1], software cartography [24, 23] and enterprise cartography [24] are examples of IT based techniques that can support the sensing activities of the motion-steering system. Similarly, IT based techniques can be used to support the thinking and acting activities.

5 Conclusion

Operating in a dynamic environment requires flexibility and cooperation between enterprises. This needs the ability to be continuously "on the move" and the need to steer this motion. In this postion paper, we have focused on interoperation and defined second order interoperation/interoperability. We argued that the motion-steering system of an enterprise is essentially a second order information system, yielding several future challenges for the field of information systems [18]. We defined the change/motioning interoperation processes as second order interoperation, as it essentially changes the regular (first order) interoperation and its supportive structures. Based on this, we also identified different levels of steering enterprises in motion, positioning architectural steering (and thinking) in between strategic level steering and design level steering. Finally, we suggested the key ingredients of enterprise architecture as being: an engagement framework, a motivation framework, a design framework, a communication framework, and a process framework.

References

1. van der Aalst, W.M.P.: Process Mining: Discovery, Conformance and Enhancement of Business Processes. Springer, Heidelberg (2011)
2. Ashby, W.R.: An Introduction to Cybernetics. Chapman & Hall, London (1956)
3. Åström, K.J., Murray, R.M.: Feedback Systems: An Introduction for Scientists and Engineers. Princeton University Press (2008)
4. Chen, D.: Enterprise interoperability framework. In: Missikoff, M., Nicola, A.D., D'Antonio, F. (eds.) EMOI-INTEROP. CEUR Workshop Proceedings, vol. 200, CEUR-WS.org (2006)
5. Davenport, T.H.: Process Innovation: Reengineering work through information technology. Harvard Business School Press, Boston (1993)
6. Dietz, J.L.G., Hoogervorst, J.A.P., Albani, A., Aveiro, D., Babkin, E., Barjis, J., Caetano, A., Huysmans, P., Iijima, J., van Kervel, S.J.H., Mulder, H., Op't Land, M., Proper, H.A., Sanz, J., Terlouw, L., Tribolet, J., Verelst, J., Winter, R.: The discipline of enterprise engineering. International Journal Organisational Design and Engineering 3(1), 86–114 (2013)
7. Drucker, P.F.: Innovation and Entrepreneurship. Harper Collins (2006)
8. Friedman, T.L.: The World is Flat: A Brief History of the Twenty-first Century. Farrar, Straus and Giroux, New York (2005)
9. Galbraith, J.R.: Designing the Global Corporation. Jossey-Bass, San Fransisco, California (2000)
10. Giachetti, R.E.: Design of Enterprise Systems: Theory, Architecture, and Methods, 1st edn. CRC Press, Inc, Boca Raton (2010)
11. Hagel III, J., Singer, M.: Unbundling the Corporation. Harvard Business Review (March 1999)
12. Harmsen, F., Proper, H.A.E., Kok, N.: Informed governance of enterprise transformations. In: Proper, E., Harmsen, F., Dietz, J.L.G. (eds.) PRET 2009. Lecture Notes in Business Information Processing, vol. 28, pp. 155–180. Springer, Heidelberg (2009)

13. Hoppenbrouwers, S.J.B.A., Proper, H.A.: A Communicative Perspective on Second Order Information Systems. In: Lasker, G.E. (ed.) Proceedings of the 16th International Conference on System Research, Informatics and Cybernetics, Baden–Baden, Germany, IIAS (2004)
14. Institute of Electrical and Electronics Engineers. IEEE standard computer dictionary: A compilation of IEEE standard computer glossaries (1990)
15. Malone, T.: Making the Decision to Decentralize. Harvard Business School – Working Knowledge for Business Leaders (March 2004)
16. Meriam–Webster. Meriam–Webster Online, Collegiate Dictionary (2003)
17. Op't Land, M., Proper, H.A., Waage, M., Cloo, J., Steghuis, C.: Enterprise Architecture – Creating Value by Informed Governance. Enterprise Engineering SeriesGermany. Springer, Heidelberg (2008)
18. Proper, H.A.: Business informatics for enterprise transformations. In: 2013 IEEE 6th International Conference on Service-Oriented Computing and Applications (SOCA), pp. 251–251 (December 2013)
19. Proper, H.A.: Enterprise Architecture – Informed steering of enterprises in motion. In: Proceedings of the 15th International Conference, ICEIS 2013, Angers, France - Revised Selected Papers. LNBIP, Springer, Heidelberg (to appear, 2014)
20. Pyzdek, T.: The Six Sigma Handbook: The Complete Guide for Greenbelts, Blackbelts, and Managers at All Levels, Revised and Expanded Edition, 2nd edn. McGraw–Hill, New York (2003)
21. Rouse, W.B.: A theory of enterprise transformation. Systems Engineering 8(4), 279–295 (2005)
22. Siegel, M.: The sense-think-act paradigm revisited. In: 1st International Workshop on Robotic Sensing, ROSE 2003, pp. 5–10 (June 2003)
23. Sousa, P., Lima, J., Sampaio, A., Pereira, C.: An approach for creating and managing enterprise blueprints: A case for IT blueprints. In: Albani, A., Barjis, J., Dietz, J.L.G. (eds.) CIAO! 2009. LNBIP, vol. 34, pp. 70–84. Springer, Heidelberg (2009)
24. Sousa, P., Gabriel, R., Tadao, G., Carvalho, R., Sousa, P.M., Sampaio, A.: Enterprise transformation: The serasa experian case. In: Harmsen, F., Grahlmann, K., Proper, E. (eds.) PRET 2011. LNBIP, vol. 89, pp. 134–145. Springer, Heidelberg (2011)
25. Ullberg, J., Chen, D., Johnson, P.: Barriers to Enterprise Interoperability. In: Poler, R., van Sinderen, M., Sanchis, R. (eds.) IWEI 2009. LNBIP, vol. 38, pp. 13–24. Springer, Heidelberg (2009)
26. Umar, A.: IT infrastructure to enable next generation enterprises. Information Systems Frontiers 7(3), 217–256 (2005)
27. Walliser, B.: Systemes et modeles, introduction critique a l'analyse des systemes. Editions du Seuil (1977)