

## ENTERPRISE INTEROPERABILITY ASSESSMENT

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**ABSTRACT:** *Interoperability as a key to the global market is often hindered by a lack of continuity of IT solutions but also by organizational and cultural differences between companies. The paper describes a methodology for assessment of Enterprise Interoperability leading to a possible solution by Enterprise Interoperability Management. An initial concept for assessment shown with a practical example will be illustrated to ensure enterprise interoperability.*

**KEYWORDS:** *Enterprise Interoperability, Assessment, Maturity, Management system.*

### 1 INTRODUCTION

With growing business globalization, worldwide collaboration of manufacturing companies, and the increasing number of ICT applications, a seamless exchange of products, services and information, within and across enterprises is urgently required. Both vendors and users are making serious efforts to improve enterprise interoperation for instance in supply chains or collaborating enterprise networks. However, only very limited success has been made due to the ongoing evolution of systems, the speed of market changes and growing complexity.

There exist numerous definitions of interoperability, interoperation, interaction, portability. A careful chosen web search produced 22 entries on interoperability. Examples from literature are:

- Interoperability: ability of two or more systems or components to exchange information and to use the information that has been exchanged (IEEE, 1990)
- Interoperability: (computer science) the ability to exchange and use information (usually in a large heterogeneous network made up of several local area networks (WordNet 2.1))
- Interoperation: implies that one system performs an operation on behalf of another (Chen, Doumeingts, 2003)
- Enterprise Interoperability (EI) is defined as the Capacity of an enterprise software or application to interact with others (INTEROP definition, 2007).

The originality of the INTEROP-VLab approach to elaborate Enterprise Interoperability (EI) solutions is to take a multidisciplinary vision by merging three research areas supporting the development of Enterprise Interoperability:

- Information and Communications Technology: the technological base of interoperable systems.
- Enterprise Modeling: to define Interoperability requirements and to support solution implementation.
- Ontology: to ensure the semantically consistency of networked organizations and solutions.

Starting from a brief analysis of the current situation in industry and research, the goal of the approach will be defined. This is followed by a first sketch describing initial ideas and concepts about Enterprise Interoperability Management as well as tentative ways of its implementation.

### 2 SITUATION AND PROBLEM DESCRIPTION

A typical global enterprise collaboration scenario: Ensure the timely supply of raw materials from USA, production of high quality components in Germany, use of spare production capacity in Russia, do the construction in an assembly plant in China, ensure the quality of the whole production process and supply chain simultaneously and guaranty the traceability of products in the product life cycle from a location in Germany.

Exploiting market opportunities quickly and flexibly, requires close cooperation between different core competencies and their bundling into common supply chain networks. This is nowadays in many cases hindered by a lack of coherence between IT solutions. But also organizational and cultural differences between companies create barriers such as misunderstandings, delay in response, unexpected situations, differences in expectations, etc.

Therefore, it is necessary to build bridges between business models, organizational structures and software systems, see fig. 1. The target is a higher efficiency of the

processes between organizations. Consequently, the interoperability-capability within and between organizations is a key competence independent of the size of a company. Concluding, business globalization requires fast and easy exchange of products, services and all related information and, therefore, enterprise interoperability support. Indeed the implementation of EI solutions is still considered a difficult exercise. However at the same time industry addresses the need of cooperation on demand, seamless information exchange, and the necessity of process transparency.

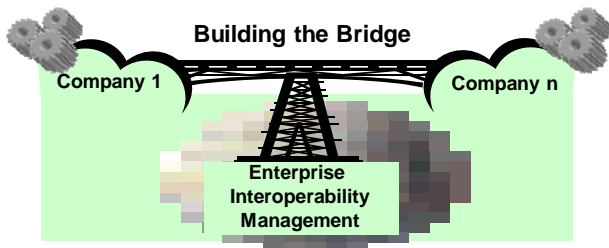


Figure 1: Building the bridge

At the current state of enterprise interoperability artifacts, it is difficult for industry to understand all interrelations.

Several initiatives propose concepts and methods so called “interoperability solutions”. Examples are “interoperability by design”, various partially overlapping interoperability standards, the open source philosophy, interoperability maturity and assessment approaches, web service approaches, semantic web, approaches regarding intercultural cooperation, ontologies, levels of interoperability and last not least various of research projects.

Regarding the described situation it is very difficult to answer if the industry asks for “the interoperability solution”. A solution that solves enterprise interoperability problems in general is not seen so far. But common components of related frameworks are well known (IDEAS, 2003), (Athena, 2007), (INTEROP, 2007):

- Organizations and processes
- Semantics and knowledge
- IT-applications and infrastructures

Methods and tools can be derived for this consideration such as:

- Enterprise modeling
- Terminology, Ontology and knowledge management approaches
- Software engineering approaches and IT architectures

This can be further combined with the MDA approach from OMG and the MDI concept.

In principle it can be identified what a company needs and also what a company has to know to be interoperable. This can be independent from the processes and IT systems the company apply and also from its organizational structure and knowledge. Maturity assessment approaches go this way but might be harmonized and standardized to be wider applicable. This can lead to a certification of enterprise interoperability. In general an add-on for the business is required to substantiate the effort needed to implement interoperability in a company. An Enterprise Interoperability Management certification approach would be a specific tool which can be used by industry to achieve better enterprise interoperability.

## 2.1 Goal of the Approach

The goal of this effort is to help Industry - for instance a partner company in a supply chain - to understand Enterprise Interoperability (EI), to assess capability and prove economical benefits of EI. Further to illustrate the usage of methods and tools towards EI and to demonstrate how to introduce and implement EI. This could demonstrate the interoperability capability to potential customers. Establishing an Enterprise Interoperability Management certificate must meet the following objectives:

1. To create a schema allowing organizations to provide evidence about their interoperability aptitude. The approach is similar to assess process quality via ISO 9000 certifications and audits.
2. To elaborate a methodology to measure the capability and efficiency of collaboration between enterprises – via assessment of interoperability to reach the compliance of systems, architectures and services, thereby using existing open standards as much as possible.
3. To validate the above schema and methodology employing real life use case scenarios.

## 2.2 Scope

Assessment of Interoperability assures customers that products meet the relevant standards and work together, thereby reducing implementation time and associated costs. Related standardization efforts are taking place in the area of Enterprise Application Integration (EAI) (OMG, 2006) and Future Internet Enterprise Systems (European Commission, 2009). Organizations like CEN (European Committee for Standardization) or UN/CEFACT (United Nations Centre for Trade Facilitation and Electronic Business) are developing standards for eBusiness and ICT. In addition, industry consortia like OASIS (Organization for the Advancement of Structured Information Standards) lead efforts towards open standards, sometimes with focus on one domain or industry sector proposing a data model plus a set of generic services and several protocol bindings for these services.

Enterprise collaboration processes and maturity assessment have been investigated in the European project ATHENA (Athena, 2005). The goal was to better understand the use of enterprise models, the level of competence and skill in performing corporate business, in communicating with suppliers, customers and other stakeholders, and in common use of ICT and knowledge sharing.

In this paper, we will investigate the interoperability capability of collaborating enterprises under the aspects of Business, Organization, Engineering, Process orientation, employing enterprise modeling in a holistic approach.

We will present a methodology to assess the interoperability capability of an enterprise. The purpose of the certification is to assure the implementation and multiple usages of high quality interoperability solutions. The certification methodology will be based on the Interoperability Assessment Process using principles and procedures from the European Foundation for Quality Management (EFQM) (EFQM, 2003a), (EFQM, 2003b), (EFQM, 2003c). We will apply well-established quality procedures and employ categories defining levels of interoperability, leading to a clearly specified assessment, and an Interoperability Impact Analysis.

Key Performance Indicators (KPI) and success factors critical to interoperability are expected to be introduced to measure the quality of an EI implementation. KPIs must be defined in way independent of a specific software product or a software vendor company. As the final result, a set of clear and traceable rules have to be established and documented as a so called interoperability certificate.

### 2.3 Related Standards

With the globalization of manufacturing activities and increased requirements on interoperability, standardization will play an important role in R&D activities and in the day-to-day operation related to enterprise integration and engineering (Chen, D. and Doumeingts, G., 2004). Indeed, standards can act as a foundation of enterprise interoperability. They must be part of the certification and determine the criteria of the assessment procedure.

A number of standards are considered particularly relevant for the effort, namely ISO 11354-1 Framework for enterprise interoperability (ISO TC 184/SC5, 2009), ISO 9000-2001 concerned with process based Certification of Quality Management Systems and ISO 14000 Environmental Management Systems ([www.iso.org](http://www.iso.org), 2006).

## 3 ENTERPRISE INTEROPERABILITY ASSESSMENT

### 3.1 Basic Quality Principles and Procedures

The Interoperability Assessment Process using principles and procedures from European Foundation for Quality Management (EFQM) assessment process which is employed for the assessment of organisations and also from the Capability Maturity Model (CMM), which is used for the assessment of Software Engineering Processes (Adler, P. S., 2005), (Paulk, M. C. et al., 1993). The reason is that, the idea of interoperability does not fit binary choices like “yes” or “no”, but is multifaceted. Consequently, there is a need for distinguishing different interoperability levels. Checklists provide a yes/no binary response to a single ‘good practice’ proposition and Likert-scale questionnaires generally provide mostly descriptive phrases. But using a maturity grid it is able to capture a range of good and not-so-good practice. Hence, the structure of the Interoperability Assessment is inspired by existing excellence models like the EFQM Excellence Model or the Capability Maturity Model. In the following section the Levels of Interoperability and the Assessment Process are only described in more detail according to the End User Certificate.

### 3.2 Levels of interoperability

However, unlike with EFQM and CMM, a higher level of interoperability is not necessarily a sign of excellence or maturity, due to the fact that the optimum level of interoperability depends on “fit” between interoperability and its contingencies. E.g. related to the End User Certificate, the highest level of business interoperability represents the maximum value, i.e. the fact that an enterprise is fully interoperable in the sense that new business relationships can be established at low costs involved. It does not necessarily represent the optimum level for the specific organization, but could also be the result of an over-investment in interoperability.

In order to cover the life-cycle aspect of IT-supported relationships, the Interoperability Assessment applies the RADAR logic from the EFQM model:

- The organization plans and develops interoperability approaches and methods to realize its business targets.
- The organization deploys the approach to ensure the realization of these targets.
- The organization assesses and reviews the approaches and their application through monitoring and analysis of the achieved results. The organization identifies, prioritizes and plans improvements and implements it.

No.	Interoperability Levels	Description
(1)	None	No awareness of external relationships; interaction with external partners is not planned or performed ad-hoc
(2)	Minimum	No provisions for interoperability; individual design of each external relationship
(3)	Moderate	Relevance of business interoperability is “understood”; Measures for improving interoperability have been taken, but substantial room for improvement remains
(4)	Qualified	External relationships are designed for improved business interoperability; only few factors missing on the way to full interoperability
(5)	Fully interoperable Fully interoperable	Maximum level of business interoperability; external relationships can be established at no or few cost involved

Table 1 : The five levels within of interoperability assessment for end users (ATHENA 2006)

### 3.3 Specific Assessment Model – The Business Interoperability Framework (BIF)

Business interoperability characterizes the business relationships of an enterprise and its external partners, e.g. customers, suppliers or service providers. The objective of the Business Interoperability Framework is to describe the main constituents of business interoperability and to outline how an enterprise may assess and improve its business interoperability. To this purpose, the BIF distinguishes 4 categories:

- Management of External Relationships
- Employees & Culture
- Collaborative Processes
- Information System

Building on the Contingency Theory of Organizations, the Business Interoperability Framework postulates that the optimum interorganizational design fits external (environmental) and internal contingencies.

The core of the Business Interoperability Framework describes and assesses the IT-supported business relationships of an organization. It comprises the following elements:

The four categories represent the fundamental concepts of business interoperability as identified in the state of the art analysis. They cover governance, behavioral, operational and technical perspectives. The technical perspective comprises key decisions related to the type and depth of electronic interaction with business partners and are considered an integral part of the organizational design, thus reflecting a business driven view on IT (ATHENA – IP 507849, 2006).

Each of these categories is operationalized by a set of criteria (or sub-categories) which outline the key business decisions companies have to solve when establishing interoperable IT-supported business relationships. Metaphorically speaking, criteria are parameters that can be tuned in order to increase interoperability of an enterprise as shown in Table 2 and Table 3.

The interoperability levels per criteria serve as a basis for assessment and a guideline towards higher levels of interoperability. To this purpose, the BIF considers the life-cycle aspect IT distinguishes the aspects of approach, deploy and assess & review (ATHENA – IP 507849, 2006):

- The organization plans and develops approaches and methods to define and realize IT supported relationships.
- The organization deploys the approach.
- The organization assesses and reviews the approaches and their application through monitoring and analysis of the achieved results. The organization identifies, prioritizes and plans improvements and implements it.

### 3.4 Assessment Approach

We will take a three step approach in order to assess the interoperability capability of a specific enterprise. First of all, we will describe the contingencies which impact the enterprise’s optimum level of interoperability. Although the coordination area is the outcome of strategic decisions, its characteristics are considered an internal contingency for the design of inter-organizational relationships. In the second step, the actual assessment of the scenario, the level of business interoperability (from 1 “none” to 5 “fully interoperable”) is defined for every criterion and life-cycle perspective. The base for this assessment is adequate data and information about the enterprise and its external relationships. Sources can be (structured) interviews, self-assessment based on questionnaires, or secondary data. Finally, the result needs to be interpreted as represented in Table 4. The interpretation depends on the objective of the assessment, which could be benchmarking with other organizations or industries, or identification of potential for improvement in the design of external relationships. For the comparison of two results, it is essential to consider that the contingencies influence the level of interoperability (ATHENA – IP 507849, 2006).

Category	Perspective	Description
Management of Business Relationships	"How do we manage and control business relationships?" (Governance Perspective)	<b>Interoperable organisations manage and monitor their business relationships.</b>
Employees & Culture	"How do we behave towards our business partners?" (Behavioural Perspective)	<b>Interoperable organisations promote relationships with business partners at an individual, team-based and organisational level.</b>
Collaborative Business Processes	"How do we collaborate with business partners?" (Operational Perspective)	<b>Interoperable organisations can quickly and inexpensively establish and conduct electronic collaboration with business partners.</b>
Information Systems	"How do we connect with business partners?" (Technical Perspective)	<b>Interoperable ICT systems can be linked up to other ICT systems quickly and inexpensively and support the cooperation strategy of the organisation.</b>

Category	Perspective	Description
Internal Contingencies	"What are the characteristics of the business relationship?"	<b>Cooperation targets and transactional characteristics impact the required level of business interoperability.</b>
External Contingencies	"Which environmental factors affect the business relationships?"	<b>E-Business maturity, legislation and industry dynamics determine preconditions in the specific context.</b>

Table 2 and Table 3: Business interoperability framework – categories and contingencies

Criteria	Definition	Life Cycle	Level of Business Interoperability					Description
			5 (fully interoperable)	4 (qualified)	3 (moderate)	2 (minimum)	1 (none)	
<b>Management of External Relationships - "How do we manage and control external relationships?"</b>								
Cooperation process (management)	Process for initiating, managing and controlling external relationships is in place	App	Strategic importance of cooperations is embedded in company strategy	Importance of cooperations is addressed in company strategy	Cooperations are addressed in company strategy, some evaluation criteria for partner choice exist, process covers only parts of the cooperation life-cycle	Cooperations are addressed in company strategy, some evaluation criteria for partner choice exist, process covers only parts of the cooperation life-cycle	Cooperations are not part of company strategy, partners are chosen ad hoc	1: cooperation process of no relevance 2: cooperations are of strategic importance and cooperation process is in place
		Deploy	Partner selection process is advanced	Partner selection process is used in most partnerships	Process is used in some (new) partnerships	Process is used in some (new) partnerships	Cooperations are not part of company strategy, partners are chosen ad hoc	
Cooperation targets	Plans and objectives, partners participating in the cooperation are defined and communicated with partners before the cooperation starts	App	Cooperation targets are co-developed with partner built by partner	All partners are involved in target setting	Targets are specified by one (dominant) partner	Targets are defined individually	No target setting	1: Each partner has individual targets, which are not communicated among partners 2: Targets are identified by BMW and communicated to partners
		Deploy	Targets are documented and openly communicated and shared with all partners ("common purpose")	Targets are documented and openly communicated and shared with all partners ("common purpose")	Dominant partner communicates targets to partners, but may pursue other hidden aims	Targets are defined individually	Targets are defined individually	

Table 4: Structure and application of the BIF

#### 4 APPLICATION OF BIF FOR ASSESSMENT

The following section demonstrates the application of the Business Interoperability Framework in a case study which analyses the supplier relationships of a large retailer. Depending on the availability of information as well as on the goals of the assessment, the focus is on specific aspects of the BIF.

Competition among European retailers is strong today. Consumers not only demand for low prices but also for high quality services and products. At the same time, a number of inefficiencies in the retail supply chain still

prevail, e.g. incorrect ordering and deliveries, low levels of shelf availability, and inventory inaccuracies. A promising concept for coping with these problems is "Efficient Consumer Response (ECR)". ECR denotes a strategy of close cooperation between the retailers and their business partners in order to eliminate costs while improving customer value. As a consequence, both parties need to develop organisational and operational abilities to seamlessly integrate their business activities. In this context, the key question to be answered is which level of interoperability is necessary to establish a certain form of cooperation. It is against this background that we investigate the example of Metro Group in order to make

statements on the need for interoperability in the retail supply chain (ATHENA – IP 507849, 2006).

The level of interoperability was determined for the categories (a) management of external relationships, (b) collaborative business processes, and (c) information systems. For each category, we present a number of criteria and their actual values that help us to determine the respective interoperability levels. The assessment is based on public information provided by Metro supplemented by interviews and questionnaires.

When looking at the assessment summarised in Table 5, some particularities can be identified which lead to the following questions (ATHENA – IP 507849, 2006):

- a) Why does being fully interoperable not always seem to be the optimum level from Metro Group's perspective? Being fully interoperable means that a company is able to establish new IT-supported business relationships at low or no costs. However, the higher the level of interoperability the higher the required investments for all involved parties. According to this background, the optimum level is the level where these accumulated investments outbalance the benefits. For instance, the fact that ECR projects are rolled out only to big suppliers (i.e. moderate level for the cooperation process) is primarily due to the high costs involved which makes this solution not feasible for small and medium sized companies.
- b) What is the reason for ambiguity of interoperability levels within the deployment? Our assessment shows ambiguous results for the deployment in the case of the cooperation architecture and the semantics of data. This observation can be explained by the suppliers' different financial and technical capabilities. For instance, in contrast to small and medium sized suppliers, big suppliers are able to finance and implement EDI and to integrate a master data portal into their processes. Thus, as Metro Group relies on a pool of different suppliers, the company must provide different modes of electronic cooperation which is reflected in a heterogeneous architecture and different levels of interoperability (ATHENA – IP 507849, 2006).

## 5 CONCLUSION

The paper proposes an assessment methodology for enterprise interoperability.

The proposed methodology provides a schema which enables organizations to understand their aptitude, status and readiness vis-à-vis enterprise interoperability and network oriented collaboration in the context of supporting open standards.

Against the background of the case example of Metro Group, we have applied an existing framework for interoperability assessment to the cooperation between a retailer and its suppliers. In a second step, we have discussed the causes and motives for the resulting interoperability ratings.

Based on the investigations, potential can be seen for further research in various directions. Reference models need to be developed for different industries that allow for the benchmarking of existing applications. Finally, besides identifying areas of improvement, methodologies and specific techniques will be required which support practitioners in the adjustment of their company's level of interoperability.

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Category	Description	Life-Cycle	Level of Business Interoperability				
			5 (fully interoperable)	4 (qualified)	3 (moderate)	2 (minimum)	1 (none)
<b>Management of External Relationships - "How do we manage and control external relationships?"</b>							
Cooperation model	<i>Strategic dimension:</i> A cooperation model has been defined serving as the frame for external relationships	Approach	Strategic importance of cooperations is recognized and embedded in company strategy (senior management commitment); cooperation models with external partners are co-defined and embedded in a network business model	Strategic importance of external cooperation is recognized and embedded in company strategy (senior management commitment); the cooperation model with external partners are documented	Significance of external partnerships is recognised; a cooperation model with external partners has been outlined	Cooperation model is not explicitly defined; cooperations are established with well-know partners	No awareness of external relationships; ad-hoc setup external relationships
		Deploy	Applied in all partnerships	Applied in most partnerships	Applied in all strategic partnerships (focussing on "A partners")	Applied in some (new) partnerships	Not (yet) applied
		Assess & Review	Systematic review and assessment of cooperations with partners, "lessons learned" (positive and negative) are integrated in cooperation model	Periodic evaluation of success factors is performed and leads to adaption of cooperation model	Sporadic or occasional evaluation of success factors is performed and leads to adaption of cooperation model	Updates and changes are an exception and only occur as reaction to external pressure (e.g. when imposed by legislation or external partners)	No review
Cooperation targets	<i>Economic dimension:</i> Plans and objectives, that partners pursue in the cooperation, are defined and reconciled with partners, monitored and adjusted	Approach	Cooperation targets are defined and re-conciled with partners, jointly monitored and re-adjusted	Cooperation targets are individually defined and shared among the partners; individual targets that are not communicated remain	Cooperation targets are explicitly defined, but imposed by one (dominant) partner	Partners pursue individual cooperation targets and do not communicate them to partners	No definition of cooperation targets
		Deploy	Applied in all partnerships	Applied in most partnerships	Applied in all strategic partnerships (focussing on "A partners")	Applied in some (new) partnerships	Not (yet) applied
		Assess & Review	Systematic review and assessment, "lessons learned" (positive and negative) are integrated in target setting and controlling approach	Periodic evaluation of success factors is performed and leads to adaption of target setting and controlling approach	Sporadic or occasional evaluation of success factors is performed and leads to adaption of target setting and controlling approach	Updates and changes are an exception and only occur as reaction to external pressure (e.g. when imposed by legislation or external partners)	No review
Cooperation management (processes)	<i>Organisational dimension:</i> The processes for initiation, realisation, control and monitoring of cooperations are managed; provisions for risk and conflict management have been taken	Approach	Cooperations are actively managed along the entire life-cycle; escalation procedures are defined for conflict resolution	Partner management processes have been defined and cover most phases of the life-cycle; rigorous partner selection is applied	Guidelines for partner management exist for the most critical phases of the cooperation live-cycle; main focus is on partner selection	No formal cooperation processes; cooperations are set up individually with each partner based on previous experiences	Partners are chosen ad hoc and with no pre-defined evaluation criteria; no guidelines or processes exist
		Deploy	Applied in all partnerships	Applied in most partnerships	Applied in all strategic partnerships (focussing on "A partners")	Applied in some (new) partnerships	Not (yet) applied
		Assess & Review	Systematic review and assessment, "lessons learned" (positive and negative) are integrated in partner management approach	Periodic evaluation of success factors is performed and leads to adaption of partner management approach	Sporadic or occasional evaluation of success factors is performed and leads to adaption of partner management approach	Updates and changes are an exception and only occur due to external pressure (e.g. when imposed by legislation or external partners)	No review
<b>Cross-Organisational Business processes - "How do we collaborate with business partners?"</b>							
Public Process	<i>Pragmatics:</i> A public process describes how companies interact. It establishes a common understanding of the roles, activities and in particular the organisational interfaces. Ideally public processes are built by consensus and reflect multilateral agreements, industry or domain standards (m:n).	Approach	Public processes have been defined and documented; they are built by consensus and reflect multilateral agreements, industry or domain standards (m:n)	Public processes have been defined and documented; they have been defined for a broader number of relationships (1:n) taking into account previous and future requirements (building variants with limited deviations)	Cross-organisational processes are defined bilaterally (1:1)	Cross-organisational processes are imposed by one of the partners	Cross-organisational interaction is performed ad-hoc
		Deploy	Applied in all partnerships	Applied in most partnerships	Applied in all strategic partnerships (focussing on "A partners")	Applied in some (new) partnerships	Not (yet) applied
		Review & Assess	Cross-organisational process is managed and subject to continuous improvement	Cross-organisational process is monitored and adapted regularly to include important changes and new requirements	Sporadic or occasional evaluation of success factors is performed and leads to adaption of cross-organisational process design	Updates / changes are an exception and initiated external events (requested by dominant partner, changes in legal requirements, ...)	No monitoring or improvement of the cross-organisational processes
Business semantics (business documents)	<i>Semantics:</i> A common business vocabulary establishes a joint understanding of the content and structure of business documents as well as the meaning of its elements. The semantics for main business documents / messages should be defined, commonly accepted and reflect industry standards.	Approach	Business vocabulary of reference is defined; it is built by consensus and reflects multilateral agreements, industry or domain standards (m:n)	Business vocabulary of reference is defined for a broader number of relationships (1:n)	Business vocabulary is defined bilaterally (1:1)	Proprietary business vocabulary of one of the partners is imposed	Use of proprietary semantic
		Deploy	Applied in all partnerships	Applied in most partnerships	Applied in all strategic partnerships (focussing on "A partners")	Applied in some (new) partnerships	Not (yet) applied
		Review & Assess	Business semantics and information quality are managed and subject to continuous improvement	Business semantics and information quality are monitored; they adapted regularly to include important changes and new requirements	Sporadic or occasional evaluation of success factors is performed and leads to adaption of business semantics	Updates/changes are initiated externally (requested by dominant partner, changes in legal requirements, ...)	None
Business semantics (information context)	<i>Semantics:</i> A common business vocabulary establishes a joint understanding of the identification, description and classification of relevant information context (e.g. product, partner, ...). The semantics for master data should be defined, commonly accepted and reflect industry standards.	Approach	Business vocabulary of reference is defined; it is built by consensus and reflects multilateral agreements, industry or domain standards (m:n)	Business vocabulary of reference is defined for a broader number of relationships (1:n)	business vocabulary is defined bilaterally (1:1)	Proprietary business vocabulary of one of the partners is imposed	Use of proprietary semantic
		Deploy	Applied in all partnerships	Applied in most partnerships	Applied in all strategic partnerships (focussing on "A partners")	Applied in some (new) partnerships	Not (yet) applied
		Review & Assess	Business semantics and information quality are managed and subject to continuous improvement	Business semantics and information quality are monitored; they adapted regularly to include important changes and new requirements	Sporadic or occasional evaluation of success factors is performed and leads to adaption of business semantics	Updates/changes are initiated externally (requested by dominant partner, changes in legal requirements, ...)	None

Employee & Culture - "How do we behave towards our external business partners?"							
Visibility	Behavioral dimension - organizational level: Information sharing and accessibility of internal information for business partners. A certain visibility of the internal business processes (e.g. status information, availability, inventories, ...) allows for cross-organizational optimization.	Approach	Pro-active information sharing and full accessibility of relevant information for external partners	The relevant information is accessible for external partners	Certain visibility focusing on the most critical pieces of information is provided to external partners	Visibility is only provided "on demand", i.e. only in case of request by the external partner	No visibility for external partners
		Deploy	Applied in all partnerships	Applied in most partnerships	Applied in all strategic partnerships (focussing on "A partners")	Applied in some (new) partnerships	Not (yet) applied
		Review & Assess	Periodic review and assessment of the information needs and practices	Periodic evaluation of success factors is performed and leads to adaption of information sharing practices	Sporadic or occasional evaluation of success factors is performed and leads to adaption of information sharing practices	Updates/changes are only initiated in case of conflicts or pressure by the external parties	No review
Information Systems - "How do we connect with business partners?"							
Interaction type	The depth of electronic interaction with partners may differ between human-to-human, human-to-machine or machine-to-machine. Interaction.	Approach	Advanced machine-to-machine interaction	Minimum machine-to-machine interaction by simple file exchange of machine-readable documents	Advanced human-to-machine interaction (e.g. online services on portal); information is provided by electronic means, but needs to manually be processed	Minimum human-to-machine interaction (e.g. static website); information is provided by electronic means, but needs to manually be processed	Human-to-human interaction (e.g. phone, fax, e-mail)
		Deploy	Applied in all partnerships	Applied in most partnerships	Applied in all strategic partnerships (focussing on "A partners")	Applied in some (new) partnerships	Not (yet) applied
		Review & Assess	Periodic review and assessment, "lessons learned" (positive and negative) are integrated in the set of electronic channels offered and the related interaction type	Periodic evaluation of success factors is performed and leads to adaption of electronic channels and interaction type	Sporadic or occasional evaluation of success factors is performed and leads to adaption of electronic channels and interaction type	Updates and changes are an exception and only occur due to external pressure (e.g. when imposed by legislation or external partners)	No review
Connectivity / Collaboration platform	A high connectivity is achieved by replacing individual connections (1:1) with many-to-many connections (m:n); The collaboration architecture supports external relationships in an appropriate manner.	Approach	B2B architecture with m:n connectivity; using a common set of technologies, protocols and interfaces that reflect open or industry standards	B2B architecture with 1:n connections; using a set of proprietary technologies, protocols and interfaces from the dominant partner	B2B architecture with 1:n connections; using a set of proprietary technologies, protocols and interfaces from the dominant partner	Close 1:1 integration with proprietary technologies, protocols and interfaces	No architectural considerations
		Deploy	Applied in all partnerships	Applied in most partnerships	Applied in all strategic partnerships (focussing on "A partners")	Applied in some (new) partnerships	Not (yet) applied
		Review & Assess	Periodic review and assessment, "lessons learned" (positive and negative) are integrated in B2B cooperation architecture	Periodic evaluation of success factors is performed and leads to adaption of B2B cooperation architecture	Sporadic or occasional evaluation of success factors is performed and leads to adaption of B2B integration approach	Updates and changes are an exception and only occur due to external pressure (e.g. when imposed by legislation or external partners)	No review
Security & Privacy	Electronic transactions respect the business partner's privacy and security concerns, and comply with e-business legislation.	Approach	Security & privacy issues are defined and documented; they are built by consensus and reflect multilateral agreements, industry or domain standards (m:n)	Security & privacy issues are defined for a broader number of relationships (1:n)	Security & privacy issues are defined bilaterally (1:1)	Relevance of security & privacy issues is recognised; parallel manual or paper-based processes are in place in order to fulfill requirements	Cooperation is not aware of security & privacy issues
		Deploy	Applied in all partnerships	Applied in most partnerships	Applied in all strategic partnerships (focussing on "A partners")	Applied in some (new) partnerships	Not (yet) applied
		Review & Assess	Periodic review and assessment, "lessons learned" (positive and negative) are integrated in B2B integration approach	Periodic evaluation of success factors is performed and leads to adaption of B2B integration approach	Sporadic or occasional evaluation of success factors is performed and leads to adaption of B2B integration approach	Updates and changes are an exception and only occur due to external pressure (e.g. when imposed by legislation or external partners)	No review

Table 5: Assessment of the levels of interoperability for Metro Group

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