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Extending Enterprise Modeling for Decentralized Organizations

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Abstract. New business models imply decentralization of organizations and subsequent change of their management and operation styles. Originally designed for classical (bureaucratic) organizations, many Enterprise Modeling (EM) methods do not explicitly address decentralization and thus require "case-based" adaptations when applied to modern organizations. In this work, we analyze various organizational taxonomies presented in the literature focusing on criteria of organization decentralization. Using two case examples, we demonstrate how the application of the For Enterprise Modeling (4EM) method, efficient for a centralized organization, becomes more challenging for a decentralized organization. We discuss how this method can be extended in order to provide an explicit support for organizational decentralization.

1 Introduction

Cloud computing, mobile computing, social networks, peer production, open innovation - are examples of paradigms and technologies that enable new business models today. Adhering to these models, modern organization tend to abandon bureaucratic organizational structures based on formal planning and centralized decision-making and to adopt less formal, decentralized structures and management styles.

Since organizations rely increasingly on their information and communication technologies (ICT), any organizational transformation implies (and depends on) a transformation of its ICT. This is often addressed as Business-IT alignment. While many examples of progressive decentralization in the organizations can be seen (e.g., diversification, adopting flat management style, coopetition, virtual and networked organizations), very little is known about how decentralization impacts the organizational IT.

In order to continuously support Business-IT alignment in organizations seeking decentralization, the latter needs to be explicitly addressed by enterprise models, enterprise architecture, IT governance and other related disciplines. In this work, we are focusing on Enterprise Modeling (EM).

Our motivating question is: *How the existing methods of Enterprise Modeling (EM) support the decentralization?*

This paper is grounded on the earlier works presented in [13][17][2]. In [2], we studied how decentralization is captured by enterprise modeling methods, in particular "For Enterprise Modeling (4EM)" as an example of an Enterprise Modeling framework [12]. We selected this method because it covers all the essential aspects of an organization (4EM defines six sub-models focused on goals, rules, processes, actors and resources, concepts, requirements and technical components respectively). A predecessor of 4EM, the EKD approach [3], is proven to be efficient by a number of industrial projects. In addition, the documentation for 4EM is publicly available.

Decentralization is widely discussed in the literature [2][13][17][4]: it is considered as one of the design parameters that predefine performance and evolution of a firm. No general agreement, however, can be seen about the criteria that define (and can be used to evaluate) the (de)centralization of a firm. In this work, we identify the criteria of organizational decentralization provided in the literature, propose their synthetic summary and illustrate them on two examples inspired by real companies: a traditional (centralized) and a decentralized organization. We synthesize our experience and the evidences presented in the literature and identify several challenges that modeling experts can face while creating an enterprise model for a decentralized organization. These challenges are typically handled on the "case basis" and resolved thanks to the experience and often informal communication between practitioners. However, we consider that the integration of the explicit knowledge about decentralization and its specifics into enterprise modeling methods can be very useful. We propose to adapt the EM methods by explicitly decoupling the enterprise models that reflect the corporate (centrally managed) and the local (distributed) elements (e.g., goals, rules, processes, requirements etc.), by providing the relations between these decoupled models and by specifying the coordination and communication processes that would be needed to create and validate these models across an organization. Whereas for traditional, centralized organizations, the local elements will have very little or no impact on the overall EM model, for the post-modern organizations with decentralized structure and distributed decision-making, local models will play a leading role. We illustrate our proposal on the example of 4EM method.

This paper is organized as follows: In Section 2, we discuss the literature on the organizational structures and enterprise modeling methods. In Section 3, we identify and synthesize the criteria of centralization/decentralization and present two examples that illustrate the typical characteristics.We discuss how the enterprise modeling in these organizations can be conducted and identify some challenges related to the decentralization in the latter case. In Section 4 we propose some extensions to EM methods in order to address these challenges. We illustrate our proposal on the example of 4EM. Section 5 presents our conclusions and defines various objectives for future work.

2 Related Work

2.1 Organizational Structure and Decentralization

The terms centralization and decentralization often refer to the power over the decisions made in the organization. According to Henry Mintzberg [6], when all the power for decision making rests at a single point in the organization - the structure should be called *centralized*; to the extent that the power is dispersed among many entities, the structure should be called *decentralized*. Another type of organization may be defined between these two [17]: the *federation*, where some decisions are top-down while some are lateral.

Military organizations are typically examples of centralized organizations. They have an explicit hierarchy, with responsibilities and decision making power clearly defined and fixed for the positions within this hierarchy. Many public organizations have a hierarchical structure with federated decision making, where decisions are made by a group of individuals (a board or committee) appointed by the authority or government. This also applies to their IT. Centralized and Federated organizations are very stable and robust but they cannot respond easily to change and are slow to act.

A number of organizational structures supporting decentralized decision making have recently emerged and became popular. These structures are often addressed as "post-modern" organizations. These organizations are grounded on the principles of social P2P [15], implementing peer-production, peer-trust, peer-review, and peer-vote mechanisms for decentralized communication and decision making. The examples of post-modern organizations include Collaborative Network (CN), Virtual Organization, Coopetitions, and Sociocratic organizations. They distinguish from both centrally and federally governed organizations and from anarchies.

New branches that incorporate some of Endenburg's principles of sociocracy include holacracy. The examples of holacratic organizations include Sun Hydraulics, Valve, W. L. Gore, GitHub, Zappos. Among the core principles behind the post-modern organizations are self-organization and peer-to-peer (P2P) that were extensively studied in the literature.

While decentralization is widely addressed in the organizational science literature, very few works discuss the impact of organizational structure and decentralization on the organizational IT. In [11], the authors specify four operational models (Diversification, Coordination, Replication and Unification) that refer to different organizational structures of a company. Authors show that an operational model defines the requirements of process standardization and integration and thus has a direct impact on the enterprise architecture of the company.

In [16] the same authors propose a framework to help firms design and communicate IT governance. This framework considers five major areas in the IT where the decisions have to be made and six decision-making archetypes that reflect the organizational structure of a company.

2.2 Organizational Structures and Enterprise Modeling

Our current research is focused on Enterprise Modeling (EM), "a technique that helps to capture the different elements and structures of an enterprise as well as to visualize the inter-dependencies between the elements" [12].

The type of organizational structure can affect the process of enterprise modeling: the answers to the questions "which types of enterprise models do we need?", "who will be involved in modeling/validation?", "how/in which order the model(s) need to be created?" can vary depending on the organizational structure. For example, a problem owner and a project leader can be formally identified within a centralized organization whereas in a decentralized organization this is not always the case. Moreover, the information required for modeling can be formalized and controlled by one designated team/expert/role in the organization or can be non-formalized, distributed within a community. The decision making becomes a collaborative process that can involve conflicts of interests (individual vs. team vs. corporation). Without a proper technical support and facilitation, such a process can take more time and efforts in a decentralized environment.

To reduce the risks of project failure due to lack of expertise, the EM methods need to be enhanced providing better guidance in case of decentralized organizations.

2.3 4EM

4EM (For Enterprise Modeling) is an EM method and framework developed in the academia [12][1]. The 4EM method is comprised of three core elements:

- A defined procedure for modeling using a defined notation for representing the modeling product (defined modeling process and product)
- Performance of EM in the form of a project with predetermined roles (project organization and roles)
- A participatory process to involve stakeholders and domain experts (stakeholder participation)

"The 4EM method uses six interrelated sub-models, which complement each other and capture different views of the enterprise which can also be considered as perspectives" [12][Ch. 7.2 p. 77]. Each sub-model contains its own notations and rules to generate a diagram.

- Goal Model shows the goals the organization wants to achieve, or to avoid.
- Business Rules Model is used to define and maintain explicitly formulated business rules, consistent with the Goals Model. Business Rules may be seen as operationalization or limits of goals.
- Business Process Model is used to define enterprise processes, the way they interact and the way they handle information as well as material.
- Concepts Model is used to strictly define the "things" and "phenomena" one is talking about in the other models.

– Actors & Resources Model is used to describe how different actors and resources are related to each other and how they are related to components of the Goals Model and Business Processes Model.
– Technical Components & Requirements Model is focused on the technical system that is needed to support the goals, processes, and actors of the enterprise.

Enterprise modeling (EM) projects are conducted in response to some problems identified in a company.

The EM process defined by 4EM includes 10 steps [1], and involves various actors (usually Problem owner, Domain expert, EM project leader, EM facilitator, and Tool expert). In each step, one of the actors is typically assigned as a Responsible, and one or several other actors as Participants. This is illustrated in Table 1 taken from [9]:

Table 1. Actor involvement in the EM process steps (R- responsible, P- participates)

Process step (1-10)	Problem owner	Domain expert	EM project leader	EM facilitator	Tool expert
1) Define scope and objectives of the project	R	-	P	-	-
2) Plan for project activities and resources	R	-	P	P	-
3) Plan for modeling session	P	-	R	P	-
4) Gather and analyse background information	-	-	P	R	-
5) Interview modeling participants	-	P	-	R	-
6) Prepare modeling session	P	-	P	R	-
7) Conduct modeling session	-	P	-	R	P
8) Write meeting minutes	-	-	P	R	P
9) Analyse and refine models	P	-	P	R	P
10) Present the results to stakeholders	R	P	P	P	-

For example, in (1), the Problem Owner - an organizational actor that will benefit from solving the problem - is assigned as a responsible for the step. The EM project leader ensures the communication between the domain experts and the rest of the project team. The problem owner and the EM project leader should discuss the problem boundaries, prospective solutions and outcomes.

4EM does not prescribe a particular list of sub-models to be focused on or the order in which they should be created - this is also a part of the EM project. Steps (3)-(9) can be replicated for all the sub-models defined by 4EM.

The original version of 4EM provides a set of generic concepts not particularly tailored for decentralization. In the next section we discuss how 4EM can be applied in the case of a decentralized organization.

3 Applying 4EM on Centralized and Decentralized Organizations

In this section, we first explain criteria used to explain centralization and decentralization, then we illustrate application of 4EM for two fictional companies

inspired by real companies and studios[3]: one with centralized and one with decentralized organization.

3.1 Criteria of Decentralization

Criteria according to Mintzberg: In [6], the five organizational structures are defined: simple structure, machine bureaucracy, professional bureaucracy, divisionalized form, and adhocracy. These organizational structures are defined based on their coordinating mechanism, the key part of the organization and type/degree of decentralization:

MI1 The key part of the organization.
One (or combination) of the following six components can be a key part: *the strategic apex* or top management, *the operative core* or the workers performing actual tasks and providing direct services, *the middle line* or middle management, *the technostructure* or analysts who design, plan, change, train the operating core, *the support staff* or the workers providing indirect services.

MI2 The prime coordinating mechanism.
The major method the organization uses to coordinate its activities: *Direct supervision* where one individual is responsible of the work of others, *standardization of work process*, *standardization of skills*, *standardization of output*, *mutual adjustment* when work is coordinated through informal communication.

MI3 The type of decentralization used.
Mintzberg specifies the extent to which the organization involves subordinates in the decision-making process. Three types of decentralization are identified: *Vertical decentralization* is the distribution of power down the chain of command, or shared authority between superordinates and subordinates in any organization. *Horizontal decentralization* is the extent to which non administrators (including operators sometimes) make decisions, or share authority between line and staff. Horizontal decentralization is related to the coordinating mechanisms, with direct supervision corresponding to more horizontally centralized, and mutual adjustment to more horizontally decentralized organizations accordingly. *Selective decentralization* is the extent to which decision-making power is distributed between different units within the organization.

Criteria according to Morgan: In [7], five types of organizational structure are identified: (1) Hierarchical organizations, based on multiple management layers, top-down communication and rigid rules for decision making; (2) Flatter organizations, seeking to reduce the number of hierarchical levels and to support both top-down and bottom-up communication flow; (3) Flat organizations, where all entities are equal and no hierarchy is defined (4) Flatarchies that can be found in

[3] Electronic Arts (www.ea.com), Take 2 (www.take2games.com), and many others for centralized case. Valve Corporation [15] for decentralized case (known for its ease in adjustment and creation of internal teams without hierarchy).

between hierarchies and flat organizations, with temporarily formed hierarchies out of flat teams; (5) Holacratic organizations focusing on distributed decision making while giving everyone the opportunity to work on what they do best. Morgan distinguishes the organizational structures based on those criteria [7]:

M1 A number of hierarchical levels that the organization defines.
Centralized organizations tend to have more levels and as a consequence more elaborated chain of commands and coordination protocols;

M2 Flexibility of hierarchical levels.
Centralized organizations tend to have fixed, not evolving hierarchies;

M3 Flexibility of decision making rules.
Centralized organizations tend to have decision making power concentrated in the top hierarchical levels, coordination and decision making rules are formalized and fixed. For the decentralized organizations, according to Morgan, decision making rules are not fixed and the power is distributed between entities.

Criteria according to Luthans: Luthans described 3 criteria [5].

L1 Geographical/territorial concentration or dispersion of operations.
The extreme centralization case would be a single huge factory creating the final product from raw materials. In contrary, extreme decentralization case implies one factory per transformation or service.

L2 Geographical/territorial concentration or dispersion of functions.
The most centralized case would describe a facility containing the whole functions like production, sales, finance, and direction (typically one facility with factory and headquarter inside, like in the beginning of the XXth century, or more recently small industries).

L3 Extent of concentration or delegation of decision making powers.
Decisions may be taken by a single person for everything (CEO), partially delegated (middle management), or even shared by the whole employees (workers' cooperative).

Criteria according to CIGREF: The CIGREF (Club Informatique des Grandes Entreprises Françaises - large french corporations IT workgroup) defined 4 levels of centralization [4]: (1) Concentration that is characterized by grouping of action and control capabilities in one location, under one top position; (2) centralization characterized by grouping of action and control capabilities in one or more locations, under one top position; (3) deconcentration characterized by scattering of action and control capabilities in one or more locations, where local directors make decisions, but they still follow a central top position; (4) decentralization that is similar to deconcentration, but without the central top position. The following characteristics can be identified from those 4 levels:

CIG1 Concentration/Dispersion of the actions (IT production, development team) and control (quality management, organization analysts) capabilities.

CIG2 Allocation of decision rights (top/middle layer in large corporations context).

Criteria according to Pearlson & Saunders: They propose 3 criteria [14][8].

PS1 Allocation of decision rights (one top position, or every employees). Decision making is kept within one person at the top hierarchy or the whole workforce, the two dimensions "quantity" and "hierarchical level" are taken into account.

PS2 Structure of communication lines (by hierarchy, or direct communication). Communication between teams are either made by a strict process involving hierarchy, or without any formal method and people exchange directly information.

PS3 Forms of coordination (vertical coordination, or lateral coordination). Coordination is achieved by an exchange of information about the state of the work, or by standards accepted by all teams. Within *vertical coordination*, management transfers information and plans objectives with specific rules and standards, besides *horizontal coordination*, people align themselves by exchanging information directly and create work team if it is necessary.

Table 2. Criteria of organizational centralization/decentralization

	Characteristic	Decentralized	Centralized	Criteria in the literature
1	**Concentration of operations**	**Dispersed operations in multiple locations** (Multiple facilities containing different processes)	**Concentration in the HQ** (One facility containing the whole production processes)	L1, CIG1
2	**Concentration of functions**	**Dispersed functions in different locations** (Multiple facilities containing one or more functions)	**Concentration in the HQ** (One facility with all the functions)	L2, CIG1
3	**Forms of coordination**	**Horizontal coordination**; **Mutual adjustment** (peer-to-peer)	**Vertical coordination**; **Direct supervision** (hierarchy); **Standardization of work process**, **output**, and/or **skills**	MI2, MI3, CIG1, PS3
4	**Allocation of decision rights**	**Distributed in the whole organization** (democratic); **Vertical and Horizontal decentralization**; **Selective decentralization** (decision making power shared within the organization)	**Top position / Hierarchy** (decision making power in the upper hierarchy); **Vertical centralization** or **Horizontal centralization**	MI1, MI3, M3, L3, CIG2, PS1
5	**Structure of communication**	**Direct communication** (informal communication between peers)	**Hierarchy / Formal communication** (strict processes of communication)	MI3, PS2
6	**Number of hierarchical levels**	**Few levels** (Flat organizations, managers of ad-hoc teams)	**Multiple levels** (Top hierarchy, middle line managers, team managers, with various ramifications)	M1
7	**Flexibility of hierarchical levels**	**Regular reorganization** (Changing roles/shape of organization, adaptation to the environment)	**Fixed hierarchies** (Fixed roles and/or peoples, slow change management)	M2
8	**Key Part of the organization**	**Technostructure** (Structure and Processes of the organization)	**Strategic apex and Operating core** (Decision making power and Production)	MI1

3.2 Case 1 : Application of 4EM on Centralized Corporation

Centralized Corporation is an American developer, publisher and distributor of video games (inspired by Electronic Arts, Take 2, and many others).

Centralized Corporation is producing and distributing video games through the dematerialized retail store; it also publishes games in a physical form (gameboxes, DVD) for distribution in regular stores, using subcontractors for packaging production. The competitive advantage comes from the studios and subsidiaries specialized in different themes and franchises (dedicated studio for sports, adventure, etc). Strategic decisions (financial goal, supporting or discontinuing games, retail strategies, and so on) are taken by a CEO and a board of studio directors, technical decisions (design, packaging, and so on) are taken within each studio (see MI1-L3-PS1-PS2). Hierarchical levels are limited (Corporation level, design studio level, project level) and fixed (M1-M2), allowing each level to report formally to its direct supervisor (L3-PS1-PS2). Standardization of skills and outputs are used for coordination, and direct communication are used within each studio, forming a limited vertical decentralization (MI3-L3-PS1-PS2). The board of directors and the operating core (designers) are the key parts of the company (MI1).

Enterprise Modeling for Centralized Corporation: Consider a project, integration of a new IS supporting design and development of games in Virtual Reality (VR) format. This project requires creation or modification of (some of) the 4EM submodels (see [12]). It will be conducted following the process described in section 2.3. In the Centralized Corporation, a studio director (if the system is requested by one studio only) or a board of directors including CEO (if the system is demanded by a group of studios) can be considered as a Problem Owner. A middle manager will be appointed as a EM project leader. The project leader will create a transverse team of domain experts (from different studios) if necessary and will supervise the project. An internal or external EM experts will join the team to ensure that the methodology (4EM in our case) is respected and that the models are understood by all the stakeholders. The process defined by 4EM will be implemented with respect to the guidelines: for example, at the step 3)*Plan for modeling session* the project leader will set up the meeting with the studio director and with the 4EM expert (EM facilitator) in order to plan a specific questions to be addressed during a modeling session and to identify the domain experts (e.g., managers, developers, VR experts, designers) to participate in the modeling sessions. At the step 7)*Conduct modeling session*, the 4EM experts will produce the models together with the appointed domain experts. Creating different models involves different domain experts: for example, elaboration of a Goal model will require a participation of studio directors and CEO; business managers in the studios will be involved in definition of Business Rules and Processes; technical experts will be participating in Process and Concept modeling; specification of technical Requirements and preparation of deployment plan for Technical Components will involve technical experts, developers and testers. In the Centralized Corporation, the domain experts will be defined and appointed by a project leader.

3.3 Case 2 : Application of 4EM on Decentralized Corporation

Decentralized Corporation is an American digital distributor of video game, and game developer (inspired by Valve Corporation [15]).

Decentralized Corporation is distributing video games through its own dematerialized worldwide retail store, it also creates games. It is specialized in the development of an international platform providing games, updates, multiplayer support based on friend lists, worldwide ranking, through cloud technologies. Independent developers are invited to propose their projects on the platform, and even to put their games on it for publication.

Concentration of operations and functions: The company is located in one building (Headquarters) where all the teams are placed[4]. The teams are working together on different projects; the employees are focusing on game design, developing, testing, marketing and sales. The non-core functions such as infrastructure management (data center, development and testing environment), network and security management are outsourced to the external service providers or used "in the cloud" (see L1-L2).

An employee of the Decentralized Corporation can choose a project or a team to work with; the roles and the competences required for these roles are defined, but the team members can switch the roles freely. If an employee wants to launch a project, he can create a team. No micromanagement exists: for example, the founder of the company works within his own team. Thus, all the employees can be considered at one hierarchical level (see MI2-MI3).

Coordination and governance of Decentralized Corporation: Teams coordinate themselves by mutual adjustment (MI2), a form of horizontal coordination (MI3-PS3). Decision making power is distributed in the whole operative core (MI1-MI3-L3-PS1), according to Mintzberg [6][Ch. 11 p. 210], this organization corresponds to the type E (Vertical and Horizontal Decentralization). The employees are very skilled and free, this allows the company to produce innovative services.

Form of Communication: No formal reporting is defined; the teams use direct communication. This type of communication is linked with the mutual adjustment; any difficulty in coordination will be corrected by immediate discussion between teams (see MI2-MI3-PS2).

Key part of the organization: The decentralized company mainly lies on its operative core. There is no need of technostructure or analysts for adapting the processes; a team can be modified any time for a better coordination between projects.

Enterprise Modeling for Decentralized Corporation: Consider the same project, integration of a new IS supporting design and development of games in Virtual Reality (VR) format. In the Decentralized Corporation, the project is launched by one or multiple teams. The new project team is formed and the roles are distributed by the team members.

[4] As in many organizations, some characteristics of the Decentralized Corporation correspond to centralization and some to decentralization according to Table 2.

Decentralization implies less formal relations and communication patterns, thus information about how the company is functioning and "who does what" is scattered. *Distributing the roles within an EM project* team will be different compared to a centralized company: The same group will also form the project team and share the role of the project leader. The EM facilitator and tool experts will be external consultants (the company maintains a focused set of skills and EM is not a field of expertise they want to develop in-house). These consultants will join the company for the project and will work on modeling in collaboration with the employees. In the Decentralized Corporation, voluntarily participation in a project is one of the main principles. Thus, the experts cannot be "assigned" and should nominate themselves for participation in the modeling session.

Implementation of the 4EM process (the 10 steps) will also vary compared to a centralized company: First of all, for the Decentralized Corporation, a process cannot be imposed (no manager to do so) but should be agreed upon. Conducting modeling sessions (step 5) and refining the models (step 9) will require participation from different employees and will rely strongly on their interest in the project and willingness to cooperate. Due to the distributed knowledge, gathering the background information (step 4) can take more time and efforts.

Creating the 4EM sub-models for Decentralized Corporation would also face some challenges: Since there is no executive level in the company, setting up the corporate goals, definition of the business rules, concepts and processes should be done through a collaborative process between the employees. Project-specific or team-specific concepts should be separated from the core concepts accepted by the company as a whole to avoid the information overload. Teams can have their local goals or priorities that are not always related to the corporate goals. Conflicts of interests need to be considered in such cases. Whereas the corporate processes are required to support the smooth collaboration between the teams and to ensure the corporate goals are met, each team can specify its own process(es) and working style. Since the actors and resources are identified by the project teams based on their current needs and can change all the time, the relations between actors and resources and the elements of a (corporate) goal model become difficult to capture within a single corporate Actors & Resources model.

4 Discussion

During this work, we identified some problems that need to be systematically resolved while applying the 4EM method in decentralized organizations. These problems are related to:

- Distributing the roles within an EM project
- Implementation of the modeling process defined by 4EM (10 steps)
- Creating the 4EM sub-models

Depending on degree of decentralization[5], the described problems can be more or less apparent.

Distribution of roles and implementation of the modeling process defined by the original 4EM are challenging in decentralized organizations. Lack of explicit knowledge and use of informal communication can be overcome with advanced methods of knowledge management and communication around the project.

The employees can choose to participate or not in a project (compared to being assigned by a manager) - therefore, some efforts should be made to promote the EM project and to explain its importance to all the potential stakeholders.

Collaborative nature of work requires specific communication platforms and tools (social networks, groupware, etc.) in order to reduce the time needed to reach an agreement or to inform all interested participants.

To overcome the challenges related to the creation of the main sub-models defined by 4EM, we propose the following extensions illustrated in Figure 1:

1 We propose to decouple the local (created by each team) and the corporate (created for the whole organization) models;
2 We propose to create a "goal model loop" that specifies the dependencies between local and corporate models;
3 We propose to add relations between Actors & Resources and Concepts models
4 We propose to add relations between Business Processes, Actors & Resources, and Technical Components & Requirements models

The idea behind the separation between local and corporate models has been explored by the FEA with the segments (*core mission-area* and *business-services*) [10] [Ch. FEA, The FEA Perspective on EA], where some segments may be local or shared according to their scope. Two types of corporate models are possible : a concrete model containing various local models parts, and an implicit model based on lateral communications between peers (using only local models). In this work, we explore the first one, where a model is built upon local models to maintain a corporate vision about the full organization. This choice is close to a federated model, but it matches a compromise between the two cases presented (the centralized case can use the corporate model, and the decentralized case has more flexibility than before for modeling). Goal model, Business Rule model, Business Process model and other models can be seen on the corporate level and on the business unit (BU) or team level for the decentralized organizations (yellow rectangles in Figure 1). The goal model allows sharing of common values across the company: for example,*increasing the number of players* can be considered as corporate goals and shared between the game development team, the cloud client team, and the new console development team. The teams can use the local Goal model to define their internal goals. These goals can support the corporate goals, can complement them or can be defined independently. The

[5] Evaluation of "degree of decentralization" for a given company remains beyond the scope of this work. For simplicity, one can consider a company "more decentralized" if it exhibits more "Decentralized" characteristics from Table 2.

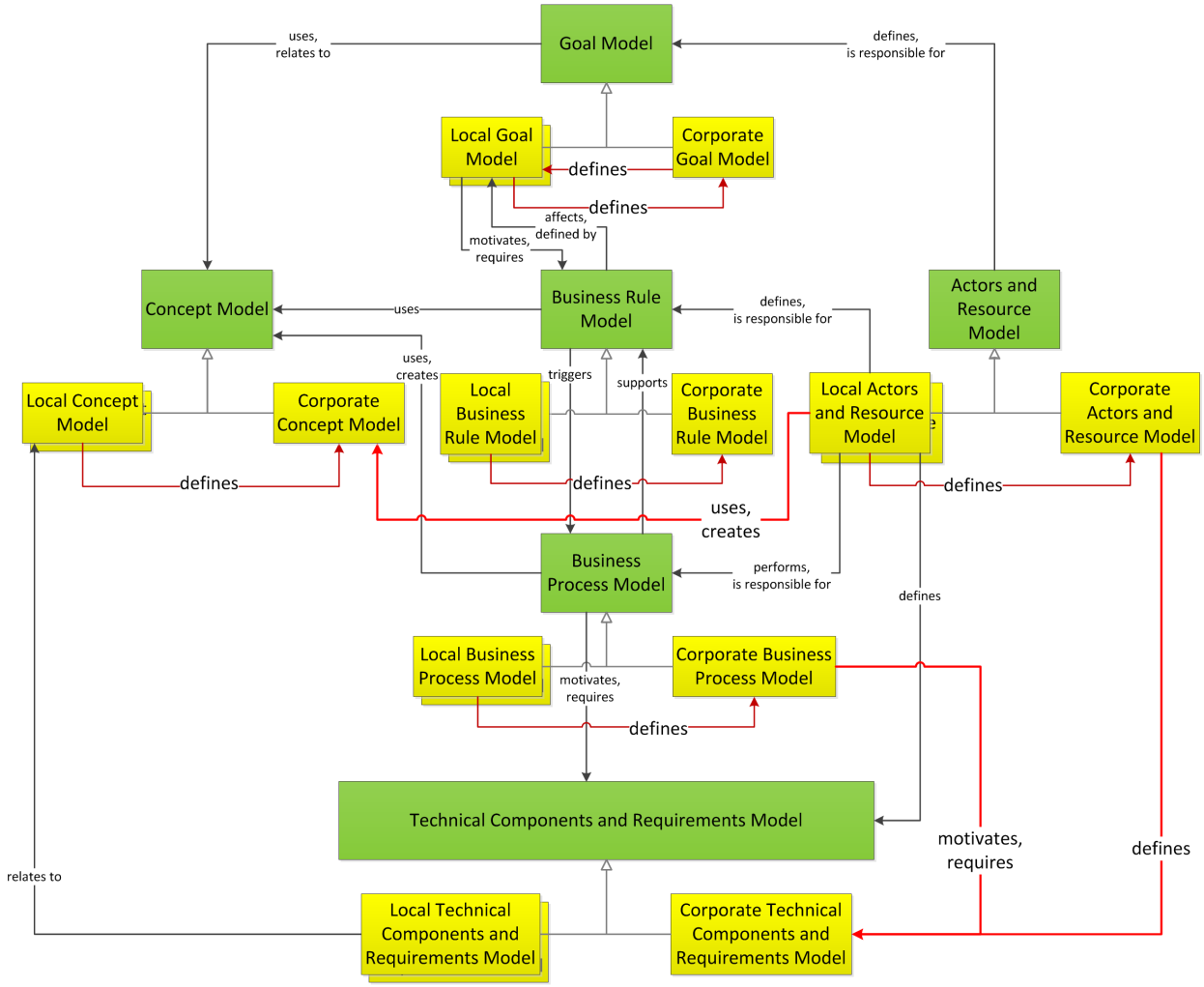

Fig. 1. The extended 4EM for decentralized organizations

role of Corporate Business Process model in a decentralized organization is to specify the processes shared by BUs, including core business processes (if any) that can be standard for all BUs, collaborative processes where the activities or sub-processes are performed by different BUs or teams and supporting processes ensuring coordination and communication among BUs. Each BU can also have its own (local) processes. For example, different teams can follow their own process in order to fulfill a sub-process of a corporate process. The Corporate Concept model specifies the concepts shared by the BUs and those required for the communication between the teams. Local model specifies the local concepts, specific for a BU, a team or a project. Similarly, the corporate and local versions of Actors & Resource model and Technical Components & Requirements model

can be defined.

In order to identify how the local (internal) goals of each team are related to the shared (corporate) goals, we add the cyclic relation (a loop) between local and corporate goal models. This loop specifies that the local goals can be defined by the corporate goals as well as the corporate goals can be defined by the local goals. Indeed, compared to the centralized organization, where the corporate goals define the local goals of each team, in decentralized organizations, we need to consider the situations when the team goals can be leveraged to the corporate level: for example, an innovative solution for a new game console can set up the goals for the game developers. Distributed decision making (L3-PS1) is acknowledged since each team decides locally on its goal model.

In a decentralized organization, resources and actors are shared between teams. Compared to traditional (centralized) organizations, it is the resources and actors of all the teams that define the resources and actors of a corporation and not the other way round. This is reflected by a relation between the corresponding models in Figure 1. We also add a relationship between Actors & Resources and Concepts Models since the concepts should also be attached to their owners (or creators) in a company. This relationship reflects the concept of direct communication defined in MI3 and PS2.

To create each local model, internal meetings has to be made regularly to ask questions and change their processes : what are the new objectives ? where could the work be optimized ? Thereby, each team decides internally its way of working. In the decentralized context, representatives of each team meet occasionally together to establish corporate goals and acknowledge the change in their services interfaces (services they offer to other teams, like an API for development, a version control system, etc.). Thus, if a team needs to use or create a service, it may check if another is already serving it (no duplication). To extend this way of working, we may assume that a subscription to external services implies subscription about their updates. Then, at least one component must be shared in the whole organization : the services catalog (supported by centralized or decentralized technologies). This process assumes teams are collaborating and have the capacities to make meetings (physically or not), as collaboration and communication are important in decentralized organizations.

This discussion is limited to the presented cases; more empirical work and experimentation is required.

5 Conclusion and Perspectives

In this paper, we study how decentralization impacts the enterprise modeling methods in the organizations. We gather centralization and decentralization criteria in Table 2, then we propose four extensions to the EM methods in order to better capture the specifics of decentralized organizations. We illustrate our proposal on the example of 4EM in Figure 1. We described a corporate model updated by a meeting of representatives of each team composing the organization, but other ways may be explored where peers review their productions and decisions continuously. This work is a step in a larger research project study-

ing decentralization and its impact on the organizational IT. More studies on post-modern organizations and their business models will be done to better understand the possibilities offered by modern technologies (P2P, mobile, cloud, virtualization, etc.).

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