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# Anything Relationship Management (xRM) as Management Layer for the Hyper-connected Society

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**Abstract.** There is a strong consensus that collaboration and co-creation will become one of the main business drivers in the future. However, the question of how to set-up inter-organizational relationships and involve stakeholders in an efficient way still remains largely unsolved. This paper proposes Anything Relationship Management (xRM) as managerial and technological foundation and platform providing interoperability between different stakeholder groups. It provides an overview of the evolution of the relationship management concept, analyzes the current status of the xRM solution market and proposes an xRM-framework for collaborative networks and cyber-physical systems.

**Keywords:** Anything Relationship Management, Collaborative Networks, Cyber-physical Systems, Internet of Services, Internet of Things

## 1 Introduction

Collaborative networks (CNs) have been long since recognized as an essential scientific discipline [1] with an important industrial impact [2]. However, looking at practice, failure to achieve successful relationships and collaborations still remains very high: empirical studies show rates reaching 50-70% [3; 4; 5].

At the same time the digital revolution is accelerating, the pace of technology is changing so rapidly that our skills and traditional organizations are not keeping up [6]. Recent advances in the domain of cyber-physical systems (CPS) that are built from and depend upon the synergy of computational and physical components demonstrate this clearly. In the recent past, we have seen a plethora of isolated projects in this domain. Examples of the CPS application areas include the smart electric grid, smart transportation, smart buildings, smart medical technologies, and advanced manufacturing. The combination of the technical innovations in CPS and scientific organizational advancements in CNs will lead to a new societal paradigm, the long foreseen hyper-connected world [7].

However, most approaches taken so far are isolated; complex business scenarios involving large collaborative networks as organizational basis for collaborative CPS societies are not adequately tackled. Interoperability across CPS, standardized management approaches for the targeted hyper-connected world are not yet adequately

deployed and accepted. Therefore, especially small and medium-sized companies are reluctant or fail to have the resources to engage themselves in the intersection of CNs and CPS.

The authors propose Anything Relationship Management (xRM) as management layer for the hyper-connected society. The paper provides an overview of the evolution of the relationship management concept, analyzes the current status of the xRM solution market and proposes an xRM-framework for CNs and CPS.

## 2 Relevant Definitions

In this chapter, we will point out some important definitions concerning the hyper connected society and Anything Relationship Management.

**Relationship Management (RM):** According to Smyth [8], Relationship Management includes the following aspects: "Developing close relationships and understanding of client and stakeholder expectations [...]; Developing services to match expectations where realistic [...]; Delivering services to engender client and stakeholder satisfaction, which includes promise fulfillment [...]; Increasing satisfaction and long-term maintenance of relationships to engender loyalty, repeat business and/or increased referral business, which concerns internal stakeholders; Increasing satisfaction to maintain and preferably increase market reputation, which concerns external stakeholders."

**Collaborative Network (CN):** A Collaborative Network is a network "consisting by a variety of entities (e.g. organizations and people [or intelligent machines]) that are largely autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital, and goals"; that network collaborates to better achieve "common or compatible goals, and its interactions are supported by a computer network". [1]

**Cyber-physical System (CPS):** According to Lee [9], Cyber-physical Systems are "integrations of computation with a physical process. Embedded computers and networks monitor and control the physical process, usually with feedback loops where physical processes affect computations and vice versa." CPS integrate the dynamics of physical processes with those of software and networking, providing abstractions and modeling, design, and analysis techniques to an integrated whole.

**Internet of Services (IoS):** According to the European commission, Internet of Services "is a vision of the Internet of the Future where everything that is needed to use software applications is available as a service on the Internet, such as the software itself, the tools to develop the software, the platform (servers, storage, and communication) to run the software." [10]

**Internet of Things (IoT):** According to Martinez [11], the Internet of Things "is a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual 'things' have identities, physical attributes and virtual personalities and use intelligent interfaces and are seamlessly integrated into the information network."

### 3 Anything Relationship Management

#### 3.1 Evolution of the Relationship Management Concept

xRM builds upon the basic logic of RM solutions and the focus on profitable long-term relations with existing customers [12]. Since its introduction in the early 1980s, the theoretical concept of relationship marketing has been further developed and increasingly supported by software solutions. By the end of the 1990s, these solutions were rebranded as "Customer Relationship Management" (CRM) [13]. CRM systems put the emphasis on the customer side and experienced a period of high popularity growth around the millennium [14]. CRM was designed to mainly deal with conventional cross-enterprise relationships between two parties, typically between one buyer and one seller organization (1:1 relations). Thus, the complexity of relationships and the diversity of relationship entities covered can be characterized as rather low.

Already early, parallel to the rise of CRM, several companies promoted a concept for the management of a broader variety of stakeholders [15]. This approach was titled "Extended Relationship Management" (XRM, with a capital "X") and was firstly analyzed in detail by Forrester Research in 2001 [16]. Starting around 2005, XRM-labeled systems for different stakeholder groups and different kinds of organizations appeared on the market. They had in common that they transported the CRM ideas to different environments, resulting in solutions for Member RM, Citizen RM, Employee RM, etc. Also, due to the growing availability of new technologies like mobile high-speed data connections, navigation services, and social media, the possibilities of relationship-based solutions reached a new quality: relations could now be maintained anywhere, in real-time, with a broader data basis, on a more fine-grained entity level, and through interactive social media channels involving communication between one sender and many receivers and vice versa (1:n and n:1 relations). In sum, the complexity of relationships and the entities involved in relationship structures had started to increase significantly. This trend has continued in the last years. Particularly since 2008, the idea of a holistic and integrated management of all stakeholder relations of an organization has been receiving growing attention [17]. Promoted by Microsoft as "Anything Relationship Management" (xRM, now mostly with a lowercased "x"), this new concept attempts to design and optimize complex relationship structures [18]. By shifting away from a single system towards a customizable platform/app architecture, xRM solutions provide a means with which various relationship-specific application scenarios can be realized. xRM supports the vision of the networked organization in which all levels of relationships involving organizations, human beings, intelligent objects, object service providers, and ubiquitous computing are coordinated and transparent, interactive, many-to-many relations and processes are created. Future xRM platforms are therefore likely to link both real and virtual entities dynamically with respect to the context, using a variety of applications including CNs and CPSs.

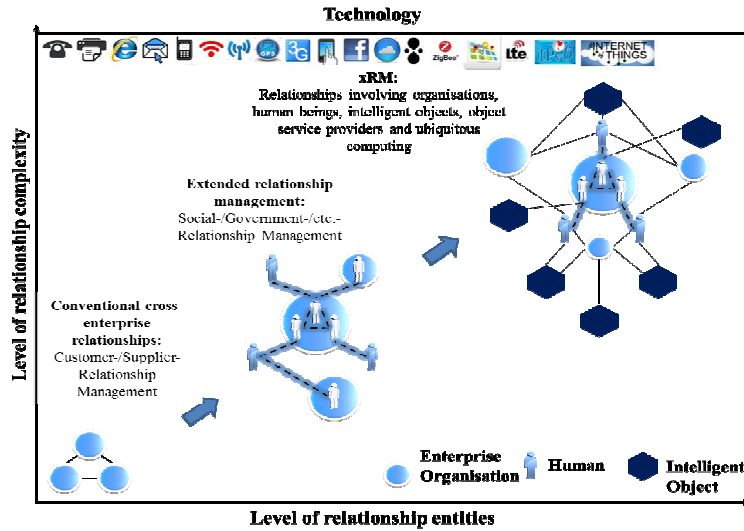


Fig. 1. Evolutionary steps of relationship management.

### 3.2 Market Overview and Use Cases

The evolution of a RM concept is linked closely with the market for its underlying IT solutions. The table below shows an excerpt of the worldwide market, covering ten producers of popular RM software as well as two producers of social collaboration software. Based on the producers self-description on their web pages, the authors ranked the scope of relationships which are covered by the solutions, and the usage of the label "xRM" (emphasized: ++, mentioned: +). There has been a notable shift in the market in the last years: none of the solutions sighted is limited to the exclusive management of customer relationships anymore. At least, relations with other stakeholders like employees, partners, suppliers, or – in industry-specific offerings – with members, patients, citizens, etc. are covered. Also common today is the integration of virtual assets (documents, events, patents, trials, etc.) in relationship structures. The possibility to manage physical assets (inventory, not intelligent objects) is frequently mentioned as well. Most solutions are however still marketed under the label "CRM"; the diffusion of the term "xRM" is rather low. Interestingly, solutions for social project management like Basecamp or Podio, which originally focused on employee management, are also heading into the xRM direction. The similarities with traditional RM solutions can be observed in the feature list depicted in table 1.

Most producers emphasize their solutions to be easily customizable platforms, not standardized single CRM systems. Deployment in the cloud as Platform-as-a-Service (PaaS) has become the norm. On top, most platforms offer a marketplace for first-party and third-party apps, which allow enhancing the solutions according to customer's needs. The integration of social media, e.g. through activity streams, social media analysis, etc. is mentioned by more than half of the companies in the sample.

**Table 1.** xRM solution market: scope of relationships covered, usage of xRM label.

Maker	Solution	Stakeholder	Virtual Assets	Physical Assets	Label xRM	Platform	Cloud	Marketplace	Social Media
CAS Software	Open	++	++	+	++	++	++		
Infor	Epiphany	++	+						++
Microsoft	Dynamics CRM	++	++	++	++	++	++	++	
Netsuite	CRM+	++	++	++		++	++	++	
Oracle	CRM On Demand	++	++	+			++		
Sage	CRM	++	+			++	++	++	++
salesforce.com	Platform	++	++	+		++	++	++	++
SAP	Business ByDesign	++	++	++		++	++	++	
SugarCRM	Sugar	++	+	+	+	++	++	++	++
Zoho	CRM	++	++	++		++	++	++	++
37signals	Basecamp	++	++			++	++	++	++
Citrix	Podio	++	++	++		++	++	++	++

Looking at the broader market, many smaller software producers and consulting firms offer xRM software and services for different industries and target groups, mostly based on the listed platforms of the bigger vendors. In practice, xRM use cases can be found in many areas:

- A non-profit organization has developed xRM apps "to organize charitable events, grant management and outreach for fundraising efforts" [19].
- A health care company has designed RM applications to manage patient intake and streamline operations. Among other things, the xRM apps provide "a real-time view of the availability of each bed at its facilities" [20].
- A government department has developed multiple RM solutions using an xRM platform, "including a consumer affairs reporting tool, an energy safety intelligence application and a grants information management system" [21].
- A logistics company has designed an xRM solution for its truck drivers. The drivers can interact with local operations centers and select their preferred choice of loads [21].
- A manufacturing firm has implemented xRM-based apps for customer service and order management, inventory and warranty management, production planning, etc. [20].

### 3.3 Derivation of an xRM-Definition

The analysis of the software producers' web pages has indicated that the market for RM solutions is currently in an early transition phase between XRM and xRM. RM is

not limited to customers anymore, it is increasingly offered as scalable PaaS, it is extensible through apps, and it covers the real-time analysis and management of complex relationship structures. These features build an optimal basis for a future integration of intelligent objects, object service providers and ubiquitous computing and are the basis for collaborations between entities. As a conclusion, we define xRM as:

*Anything Relationship Management (xRM) is the next evolutionary step of CRM. The concept describes the holistic management of relations within and between organizations, human beings, and virtual and physical objects. Linking IoS and IoT, xRM provides the management layer for CnS and CPS. The implementation of the xRM concept is based on platforms and modular, domain-specific applications building upon these platforms.*

#### **4 Framework Proposal**

In this section, the authors propose an xRM framework as a Management Layer for the hyper-connected Society. In our case, the framework is a layered structure indicating what kind of applications can or should be built and how they would interrelate. The framework should indicate a set of functions within the system and how they interrelate, the layers of an application subsystem, how communication should be standardized at some level of a network, and so forth.

xRM platforms can be highly connected and integrated in multiple ways, even across business operations and domain boundaries. Achieving effectively networked, cooperating, and human-interactive systems will be an integral factor in the adoption of such solutions in the future. Some of the key questions to be considered include what is needed to enable streamlined and predictable development, and evolution of networked and integrated xRM solutions – particularly as systems become interconnected with legacy systems and across industry boundaries. How to effectively achieve compositionality within heterogeneous, dissimilar but connected systems? How to model and integrate the role of humans in systems with variable levels of autonomy?

New solutions will have characteristics that enable compositionality within dissimilar but connected systems, while also considering the integration of humans into systems with variable levels of autonomy.

So far, the technical environments do not have governance or business models in place to motivate the development of networked, cooperating, human-interactive systems. Developers must assume the risk of sharing proprietary information with competitors and the liability of integrating their systems with external systems to ensure high levels of performance and functionality. Building an infrastructure foundation that is interoperable, contains open source and proprietary information in balance, and operates under the same standards will provide a protected starting point from which interoperable issues are minimized and system development could be profitable. Building from a standard foundation will save time and cost by sharing critical information and will avoid the liability of a solely proprietary product. The

proposed xRM-framework is based on the cloud-computing framework. A cloud is a powerful combination of cloud computing, networking, storage, management solutions, and business applications that facilitate innovative IT and consumer services. These services are available on demand and are delivered economically without compromising security or functionality. We are moving to an interconnected "world of many clouds". This will allow for an interconnected system giving services, companies, human beings, and intelligent objects access to services any time, on any device, anywhere in the world. To take full advantage of an xRM-based cloud computing solution, enterprises need to evolve their IT strategy.

In order to have a market impact, the xRM-framework must integrate the various components and abstractions that will be needed to enable co-design of software, communications, and interacting subsystems. The above depicted generic system topology of an xRM-framework proposes to have the interconnection between the various stakeholders (human beings, companies, intelligent objects) either on the Infrastructure as a Service level (with distinct IP-addresses once (Internet Protocol version 6) IPv6 is widely deployed) or on the PaaS-level (e.g. web services interacting between the cloud-framework and the intelligent object framework consisting of intelligent objects, embedded systems, CPS, etc.). The user interaction is based on the Software as a Service level allowing also apps to be the user frontend.

## 5 Conclusion

In this paper, the authors provided an overview of the evolution of the relationship management concept, defined xRM, analyzed the current status of the xRM solution market and proposed an xRM-framework for CNs and CPSs. The key argument was that moving beyond an IoT towards CPSs requires more than simply upgrading micro-electronic objects that communicate with one another. Linking objects to one another, or the internet, requires clear relationship structures, and therefore, an xRM framework. At the heart of this approach is the expansion of web-based services, the IoS, to the IoT. An xRM platform links both real and virtual entities dynamically with respect to the context, and this is done using a variety of applications.

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