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Communities and Media – Towards a Reconstruction of Communities on Media

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Abstract

Media are explored as model to envision, to design, to formalize and to implement platforms for communities. We consider communities of both natural and artificial agents and aim at designing media which facilitate collaboration within such a community.
Our approach is based on the media concept and the media model. The media concept envisions media as platforms for multi-agent systems and the media reference model determines the main components of a medium and guides its application as, e.g., for ECommerce or Knowledge Management. We present a formalization of those models that facilitates artificial agents to act according to the description given in this formalization.
We explore the notion of community and various interrelations communities and their media. We discuss the representation of a community on a platform and how technology enables and influences the constitution of communities. We reconstruct communities on media and explore formalization, redesign and reconsideration of aspects of communities.

Keywords. Media, Agent, Multi-Agent System, Electronic Commerce , Logic.

1. Motivation and Introduction

The buzzword "New Media" is often being associated with multi-media or virtual worlds, where the representation of information is poised to make media attractive for human users. We think of media in applications in ECommerce, EBusiness or Knowledge Management, as e.g., online shops, online auction houses, Intranets, CSCW or CSCL systems and we are interested in the means for information representation, organization, communication and processing.
Media (conventional media as well as media provided by information and communication technology) constitute communities by facilitating communication among the members of the community. The role and value of communities for media, in particular, for media on Internet is being explored, e.g, in [1,9,13,19,25]: It is the community that constitutes economic value – not the platform.
A community is a set of agents together with a medium, i.e., *Community = set of agents + medium.*
A medium is more than a platform, i.e., a physical entity for the transport of information. We follow the notion of a medium as developed in sociology. Societies can be defined as 'system of places', where every agent has an place with rights and obligations. Those societies are called *media* and they bind the agent at a place [21].
Clans, firms, nations, marketplaces, or fan clubs are examples for communities consisting of agents and media.
Agents may be humans, software agents, organizational units – any entity that may play a role in the game of exchange and communication constituting the community under consideration. Software agents may represent humans or companies in those spheres in autonomously gathering information, evaluating information and performing transactions. For a discussion on ideas and concepts implemented by agents see, e.g., [2,6,10,15,21].
This paper contributes to the design of media for communities in which human and artificial agents collaborate. The focus of our design is the medium (not the agent).
We observe that media, in particular, the ones implemented in Web-technology, are designed for communities of human agents – not for artificial agents. There are agents on platforms on the Internet and platforms as, e.g., the Kasbah [14] designed for artificial agents. However, those agents have limited capabilities of reasoning, they are governed by the platform and confined to it.
We envision agents to roam media – alike humans and communities of natural and artificial agents performing transactions on those media.
We observe that there is a distinctive lack of information that allows agents to "understand" media, to learn about media, i.e., a lack of formal models, architectures and descriptions of media.
The design of media for communities of natural and artificial collaborating agents is more than a mere formalization and representation of the agents and their communication on a platform. We argue that it takes a reconstruction of community to design communities and platforms. Information and communication technology, establishes media with open, distributed structures (e.g., Internet). Accordingly, community or aspects of it have to be redesigned, even reconsidered to work on those novel structures. Hereby, formalization of information and general architectures are a prerequisite to facilitate artificial agents to act within communities and to reflect upon themselves, the medium and the community.

Our approach is based on two models for media, the media concept and framework [20,21]. From those models, we obtain the general architectures and the concept of formalization. We analyze the notion of community, kinds of communities and relations community-medium, how a medium constitutes a community, how organization is implemented on platforms, how a community is motivated to communicate on and with the medium. This analysis however does not aim at contributing to the discussion on communities – it describes relevant issues and how they can be transposed to communities of natural and artificial agents and the respective platforms. We study the redesign and reconsideration of aspects of communities on media. We give an outline of a formalization of media according to the models.

This paper is organized as follows. In Sect.2, the concept of media and in Sect.3 the media reference model are introduced. The notion of communities and the role of communities for media is being explored in Sect.4. Our approach for the reconstruction of communities on media is presented in Sect.5. The formalization of media and their communities is explored in Sect.6. Sect.7 concludes with a discussion of our approach.

2. The Concept of Media

With the media concept, we capture *how* to envision and model media, i.e., the metaphor and paradigm according to which platforms are being modeled and it describes which components have to be formalized.

As a metaphor, the media concept envisions media as spheres for communities of agents. Media are modeled as organized channel systems of multi-agent systems and they form physically (open) structures which are distributed over space and time.

Media are described in terms of three main components [20,22]:

1. A *logical space* with syntax and semantics of the information to be available on the platform, i.e., that may be communicated via its channels. Note that this includes information about some domain (worlds), as well as information about the medium itself, i.e., its organization and channel system as well as the agents.
2. *A system of channels* to distribute information over space and time. Note, that the channels correspond to a medium considered as a mere carrier of information.
3. *An organizational system* to describe with *roles* the types of its agents, i.e., the behavior expected from agents, and with *protocols* the interactions of agents with the channel system of the medium.

A medium consists of a channel system for the transport of information over space and time, a logic, for capturing syntax and semantics of the information and an organizational system (roles and protocols) for structuring the behavior of its agents.

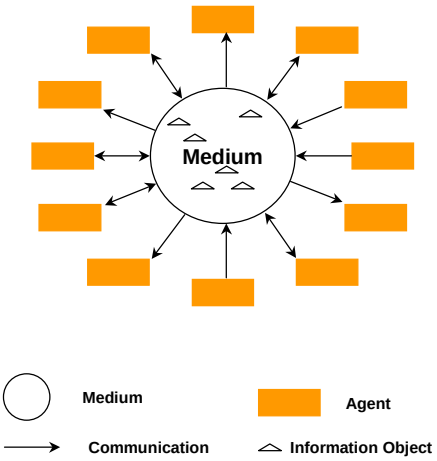

Fig. 1 Medium as Sphere for Communities of Agents

A community is an ensemble of agents sharing a common language and world, common values and pursuing common interests. The agents are connected via a medium on which they act in roles.

Agents are proactive, autonomous entities, capable of processing information. Agents dispose of a representation of their environment and their desire and are able to act according to desire and environment and to simulate possible worlds. See, e.g., [18]. (This Model is open for thumb agents as well.)

Let us motivate the definition and components of media. A common logical space, including a language or symbol system and the semantics space is prerequisite for communication within a community. An organization is necessary to capture the places of agents and the rules of interaction the agents have to comply in communication. The organizational component is necessary in a system of communicating agents, i.e., rules of interaction have to be given. Organization it is prerequisite and typically elaborate in a collection of collaborating agents.

The logical space comprises the means to capture possible worlds. Those possible worlds might be internal worlds, i.e., media or components of media, or an aspect of the external "real world". The logical space contains syntax and semantics, i.e., symbol system and its meaning. In communication it is prerequisite that both are common to the party and therefore we need to define them.

3. The Media Reference Model

The media reference model (MRM) captures the notions and components necessary to model media for applications in, e.g., ECommerce or Knowledge Management. The MRM describes *what is to be modeled* (while the media model describes how to envision and what to formalize – the three main components). The MRM captures and distinguishes the semantics of communication acts and it refines the main components of the media concept and establishes the relations between them.

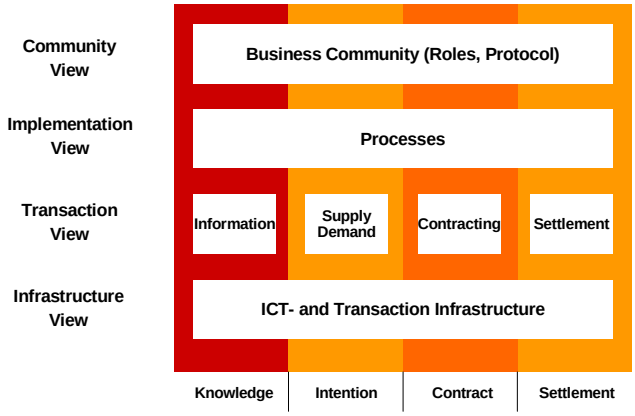

Fig. 2 Media Reference Model (MRM)

The media reference model distinguishes according to four action types four phases and four layers or views. We give a brief description of action types phases and layers. For more detailed description, we refer to [22,23]. Note that for each of the phases and layers the adequate logical space has to be provided.

3.1. Views of the MRM

The layers or views relate the platform, implemented on information- and communication technology with the community's agent:

The *community view* deals with the aspects relevant for modeling the community, i.e., its organizational structure as the shared roles, protocols, the interests and values behind it, as well as its languages. The common goal of the community and of sub-communities, the protocol(s) to reach the goal or the constraints imposed on the agents are being described here. Thus, the organizational structure (roles and protocols) of the community is part of in this view. The specification of the organizational component is further structured by (inter-)action types: knowledge, intention, contracting and settlement (see below).

The *service view* (transaction view) provides the generic interaction or communication services, as e.g., signaling of intentions, as supply and demand, or contracting and agreement on contracts and the resulting bindings, or for the performance of the transaction in the settlement of contracts. The services are structured according to the action types agents perform (see below).

The *process view* implements the specified community design, i.e., the community view specifications, as data structures and (business) processes on the services (channels) offered by the service layer, i.e., the roles and protocols of the community view.

The *infra-structure view* provides the means to physically implement the services of the service layer, i.e., process information and performative acts, to transport it over space and time. Here, the respective needs for security, or safety of the infra-structure are being provided.

3.2. Phases of the MRM

The phases distinguish the various kinds of communication acts within the organization, i.e., between the agents [22]:

In the *Knowledge Phase*, assertive information about the world, the agents, or the medium is provided and communicated. Here, the common logical space with syntax and semantics, as prerequisite of the interaction in the three remaining phases is being established. This common logical space typically includes information about some domain, the channel system as well as the organization, such that agents may obtain knowledge about the behavior expected from them, about the channels on which to exchange information, about the protocols to follow in communication. This might even include a meta-level of information about the language and its semantics employed on the medium.

In the *Intention Phase*, agents signal their intentions, developed from the knowledge provided in the knowledge phase, and from their desires and goals and by linguistic means of the common logical space (here, some type of modal logic), and services provided by the service layer for signaling, following their role (description) and the protocols. Supply and demand are the generic intentions agents signal within this phase.

In the *Contracting Phase*, agents negotiate contracts. The messages in this phase are binding, in the sense that they oblige agents to act as indicated in those messages. Offer, counteroffer, accept and reject are such messages. This phase ends – in the case of success- with a contract, i.e., with an externalization of a binding protocol.

In the *Settlement Phase*, agents act according the negotiated contract, using services offered for this purpose by the service layer. In commerce, this means, e.g., shipping of goods and transaction of money. The actions within this phase are performed according to the protocols (among them the contracts).

Note that the phases are designed to distinguish, what is called in speech act theory the illocution of the messages [5,28]: Making an offer is a binding act that obliges the agent to act according to the offer, while signaling is not binding. Thus, we consider as the illocution of a message the organizational change it induces. Other illocutions are changes in the channel system or the information to be distributed. Thus, when relating media concept and media reference model, the notion of communicating agents is enriched to collaborating agents or to a contract net.

Let us consider the relations between the action types and phases. All actions or transactions are within the common syntax and semantics established in the knowledge phase. The intentions refine hereby the general set of facts and rules that is established within the knowledge phase. The transactions of the contracting phase are refinements of the transactions of the intention phase – a offer or any other transaction is within the range of the intentions of an agent. Accordingly, the transactions of the settlement

phase are implementations of the transactions of the contracting phase and, in particular, the contract.
Note that the knowledge phase establishes the common logical space which is prerequisite for the remaining three phases and which is refined in the remaining three phases. Thus, we distinguish two different "levels" (1) the meta-level of the knowledge phase and (2) the object-level in the remaining three phases. Information about a medium and a knowledge phase is prerequisite for open structures.

4. Communities and their Media

A community consists of a set of agents and a medium. The medium comprises the platform, a logical space and an organization, i.e., the medium establishes a sphere in which agents interact. There are various interrelations between a set of agents and the medium in forming a medium: a medium constitutes a community by facilitating communication; the community constitutes the economic value of a medium; a community is represented on its medium.
The media, we are interested in, are capable of processing information and they may play an active part in the relation community-medium. In this section, we explore three relations medium-community and illustrate for each of the relations the active role a medium may play in the community. Thus, the notion of a medium being employed to transport information is replaced by a medium as a constituent part of a community, with an importance equal to agents and the interrelation medium-community can often by captured in a knowledge cycle [24].
Note, that we do not aim at giving an exhaustive or interdisciplinary discussion of communities. We restrict ourselves to literature in the field of ECommerce and discuss communities, classification, motivation and representation of communities only to learn about the reconstruction of communities on a platform and how the platform can contribute to a medium.

4.1. Facilitation and Constitution

Media constitute communities by facilitating communication among community. We distinguish two cases: (1) a community may design a medium to employ it for communication. The community may decide on the organization it implements on the medium. (2) a community may be constituted by employing the same medium. The need for coordination in employing the same medium may let a common logical space and an organization emerge.
Examples for a medium selected by a community are platforms for EBusiness or ECommerce. Examples for emergent communities on media are self-organizing systems as, e.g., described in Artificial Life or the communities of users of a channel, with limited transfer capacity.
Thus, a platform can be explicitly designed and externalized to support a community and a community may implicitly emerge on platform. Typically, communities evolve, in particular, on platform supporting organizational transition. Then, one expects to find a cycle composed from the two converse relations given above, such that the medium contributes to the organization. Note that only on an externalized organization enforcement is feasible and that only an externalized organization is adequate for an open system – allowing agents to learn about it.

4.2. Representation

Media as spheres agents have to provide some representation for the community and its organization. Let us review how organization and the single agents are represented on media. We distinguish (1) the implementation of organization on media and (2) the organization emerging on media.
In the implementation of organization on media, it is the operating system or a group-ware of some kind that provides the means to describe the identities as accounts and with groups a system of roles with permissions to access, use or alter some resources as files, processors or devices. The protocols for determining access of resources are implemented in such systems. For communication, those systems rely on communication services as, e.g., email or ftp, rcp, chat-rooms or news-groups. Most online services, as, e.g., free email provide the means to create identities online. Groupware, CSCL-, or CSCW systems provide advanced means to interact and support some sort of work-flow.
One observes that the representation of community and organization is mainly for restricting agents in interaction, that the means for representing organization are insufficient, static and the description of organization is not available in an explicit way and that those societies are mostly closed.
Organization and identities may emerge on media by employing a medium. In particular, platforms on Internet attempt to identify the community with its organization. Behavior of users on a platform, as, e.g., Web-Sites measure number of visitors, the pages read, and their behavior. Incentives motivate users to provide information about themselves. Cookies and IP-addresses allow to assign observations to individuals or at least individual computers. Gathering and evaluation of information, e.g., in collaborative filtering facilitates to establish abstractions of behavior and allow to identify roles, i.e., the profiles, for single users. Based on this community communication services are established that facilitate personalized and customized communication.
Note that this concept is adequate for open societies, and it aims at identifying the community to facilitate better communication. Note that the organization established here is explicitly available at the platforms and that it supports an evolving organization.
Thus, again, there is a duality of organization implemented on a platform and organization emerging on a

platform. Note that one organization is mainly for restricting communication, while the other is mainly for facilitating better communication, e.g., by customization. The organization emerging is explicit on the platform. Both the data and the evaluation must be gathered or provided by the platform.

4.3. Interest and Motivation

A community is characterized by a common interest the agents pursue. This common interest motivates the agents to communicate. This motivation may stem from pursuing a common goal with the means of the medium – or by the mere need for coordination in the use of the medium (see Sect. 4.1). We distinguish in pursuing some interest (1) the motivation to employ a medium for communication and (2) the motivation for an interaction agent-platform. In the later, we distinguish again (a) the explicit contribution of an agent to the platform and (b) the implicit gathering of information about the agent.

In considering interest, Hagel/Armstrong distinguish communities of interest, or phantasy, of relationship and of transaction [9,25].

The interest in employing a medium for communication – as it is typical for conventional media – is in media as spheres for agents an interest on some exchange with the platform (or with an agent representing a human). Let us discuss how medium and agent may interact and how the community may contribute to the platform.

Community as attractor. The community is itself the reason to visit a platform and join a community. Examples are communities of interest, (e.g., on the medium Newsgroup) [19,25].

Communities of design. For some communities, the main interest is the design of the platform itself. E.g., GNU, Linux, Mozilla all have "their" communities.

Community as source of knowledge. The knowledge of the community and the means to represent this knowledge on the platform can provide valuable information to the community. The knowledge of the community can, e.g., compensate for lack of competent shop-clerks on the platform. This knowledge may either be provided by the members of the community, e.g., as comments, reviews or experience reports or it can be the externalization of information gathered on the platform from the users [25]. Examples for such platforms are product catalogues allowing for annotations or customer reviews, as well as recommendation services or annotation systems [8,26,27].

Community as trust-generating environment: The community and the awareness of the community creates trust that is prerequisite for performing transactions [4]. "Real" communities have social relations grown over time and means of signaling trustworthiness that lack in online-communities. The community and the awareness of the community may reconstruct social relations and the signaling of reliability and safety [27]. Awareness of the community may generate "trust by commonality" [30].

Thus, when an community plays an active role in contributing to the platform, then it constitutes *economic value* for the medium. It establishes the basis for the locking cost on the market and switching costs for the members of the community [29].

Let us analyze the interest of agents to communicate within the community and in the communication medium-agent. (1) Agents may explicitly contribute by providing information about some application, about themselves or about the community. (2) The platform may gather information from and possibly by the community, e.g., by analyzing click-streams and collaborative filtering. Thus, an agent contributes explicitly or by the means of the platform. The motivation to communicate and a common interest may constitute a community. In pursuing a common interest, the agents communicate with each other and with the platform. The platform may provide information, it might externalize information and it may even gain knowledge about the community and individual agents. Note that agents as interfaces allow some abstraction from the actual user [15,25]. The platform may gather information about the users (their behavior), while the agents contribute their knowledge. Observation may be so close to the knowledge of users that the platform itself may gain the knowledge of users in gathering information about users. E.g., let us consider the recommendation services of Amazon. Amazon gathers information, e.g., about users and the books the buy. Agents have knowledge about relevant books – those that get bought at Amazon. In observing agents, Amazon learns about relevant books. Prerequisite is a congruence of the logical space of agents and of the platform. Here, the formalization and reconstruction is based on a common and well-elaborated and well-formalized logical space.

5. Reconstruction of Community

We envision media to be spheres for communities of artificial and human agents. In those spheres, various kinds of transaction for, e.g., ECommerce or Knowledge Management are being carried out. Thus, the communities of natural and artificial agents have to resemble the notion of community as humans experience them in "reality" and the transactions that take place in those Online Communities have to resemble the transactions taking place in "reality". However, media and communities distinguish themselves from what one is used to in communities communicating on conventional media. The media are open, distributed communication structures and the communities are open, distributed societies of natural and artificial agents. Those media basically lack the means for enforcing organization. Moreover, a community and the social relations within a community are often prerequisite for establishing transactions. However, the role of

the community itself and the aspects of communities that are relevant for a transaction to be initiated and to be successful are typically implicit in the transactions, the communication to initiate the transaction to negotiate it and to settle it. Thus, information which is implicit and relevant for those transactions to happen is not being represented on the media, the roles and processes relevant for this transaction and the logical space itself. An example for such a notion is trust. Trust among the members of the community is prerequisite for performing transactions – even in a community of interest the members have to trust each other to believe information (see e.g., [11])[30]. In communities trust may emerge over time, and there are means for signaling trustworthiness, e.g., through face-to-face communication and by an adequate business stetting as it is expressed in clothing, behavior, prestigious accessories and office space.

Thus, it is necessary to "reconstruct communities" on those media and formalization is just one aspect of reconstruction. In this section, we deal with the design of the media and with the question, what has to be formalized and implemented. First, we study Amazon.com and second, we provide a general framework.

5.1. Case Amazon.com

Amazon.com is considered to be a successful model of an Online shop. We restrict ourselves to the book-seller and to the platform Amazon.com and do by no means claim completeness of our study. We consider the community of customers together with Amazon.com.

We explore, how the notion of a community is represented on the platform of Amazon.com. We discuss, which aspects of community are formalized, which are redesigned and which are reconsidered. We proceed as follows. We study the common logical space, organization and the common values, in particular trust and for each of those aspects their implementation on the platform in the views of the MRM.

Logical Space. We distinguish the logical spaces

(A) to communicate about books. The information on books comprises title, authors, price, ISBN-No. It also includes table of contents, picture of the title-page, reviews by the author or by customers, sales rankings.

(B) to communicate about medium Amazon.com, the transactions or legal issues

(C) to communicate about the community. This logical spaces includes the means to represent the users with all the information gathered about them or provided by them relevant for the platform.

The process view relates transactions to communicate about books and the process of selling books (logical space A) with the transactions to access help pages (B) and the transactions for gathering information about the customer (C). The processes are implemented as series of linked html pages, progress can be achieved by pressing buttons or selecting links.

Note that for (B) only assertoric transactions are provided, since the logical space (B) is provided by Amazon and at no means subject to modification in normal transactions.

This information is organized in services (process view) (1) for an syntactic access (according to the representation), e.g., by the search engine, (2) for a semantic access (according to the contents of the books) in a directory and (3) dynamic semantic w.r.t. relevance to customers with similar profile in the recommendation service.

Organization. The *organization* of the community has the roles Amazon.com and customer and for each of the customers an individual role, which is an abstraction of the information gathered about the agents.

The role "customers" can be described to be permitted to search for information or for books on the platform, and to accept the offer of Amazon to sell books. Amazon is obliged to sell books as described in its offer on Internet.

The processes enable the customer to take advantages of all the permitted actions at any time – Amazon has only the option to receive the orders from the customers.

Interest. The *interest* of Amazon is defined in its business model. [1] analyzes that establishing a community and managing it is one of the key interests of Amazon.com.

The interest of the users lies in obtaining information about books or in buying books. The interest of Amazon is reflected by the design of the platform.

Value. The *value trust* necessary to perform the transaction is created by (1) Amazons concepts of trust and fraught management and (2) by the community which is employed to create a trust-generating environment and (3) by establishing the mega-brand "Amazon.com" and the respective marketing (e.g., through conventional marketing in newspapers, radio and television, through the attention it creates as a classical example for ECommerce and by its performance the stock market). The protocols for risk and fraught management reduce the risk of the customer by taking over the risk of credit card abuse, by allowing to return any book within 30 days of purchase. In the protocol of payment by credit card the vendor and credit card company take over (most of) the risk.

All book descriptions create awareness of the community, e.g., by the recommendation services, the reviews and sales rankings. At the process, transaction and infrastructure view, trust translates to quality, transparency of processes in which Amazon takes the risk and security of transactions (e.g., SSL-encryption).

Discussion. Let us discuss some of the issues. First, Amazon is a platform for human agents, not for artificial agents, since there is hardly any formalized information available. Only the logical space facilitating representing the community on Amazon is given in some formal, machine accessible language.

The notion of a product catalogue on books is quite literally translated on new media. The means for searching for

books, for browsing for books and for switching between the two different organization forms is much easier than it would be on a paper-based catalogue. The processes of selling and buying books is attached to the product catalogue. The representation and organization of books in catalogues and the metaphor catalogue and shops are well-understood.
The selling and buying process has been partly redesigned. E.g., Amazon confirms an order in an Email and the credit card information has to be provided by the user.
The customer services provided in conventional media as bookstores are reconsidered. The competence of a shop clerk is being replaced by the knowledge of the community of customers. This is implemented in the profiling and collaborative filtering. The customer services can be customized and personalized.
The notion of a community of customers is being reconsidered. The detailed profiles are particular to new media, the attempt to motivate the customer to participate in the medium. The reviews, rankings and recommendation services create a "community feeling" and community awareness generates trust.
The one-click shopping as protocol for buying is a reconsideration of the normal buying process: after finishing a buying process, new items may added to an order.

5.2. Reconstruction of Community

The platforms, i.e., the physical carriers may provide the means to facilitate communication and to process information. Those facilities can be employed to let the platform or artificial play an active role in the platform. The facilitation of communication of a platform may be the cause for an emerging community with common logical space and organization.
The motivation of a community to communicate may be transferred to a motivation to interact with the platform and to means of externalizing information provided by the community or gathered about the community. Through observation of the community, the platform gathers knowledge about the domain the community interacts and the way it interacts. Thus, knowledge is emergent on those platforms. Again for the representation of community on platforms. On traditional closed system community and its organization is implemented on the platform, while in an open society the platform learns about the community and its organization. Again knowledge and organization are emergent. Thus, it has to be the goal to establish the means that a platform may contribute to the new media.
Whether aspects of communities have to be formalized, need some redesign or reconsideration, depends how well understood the domain is or whether the whole metaphor can be reconstructed on the media. Whenever aspects rely on properties of channel systems or communities, the communities we are interested in do not have, a redesign is necessary. Thus, security or protocols and processes have to be at least redesigned. Community itself must be reconsidered for various aspects of new media.
Note, that for a community of artificial agents both formalization and redesign as well as reconstruction are prerequisite. E.g., in trust, community awareness fosters trust among human agents but only security of the protocols of transactions might foster trust among artificial agents, since there is hardly any means to formalize and evaluate community awareness on a server. Note however, that humans probably have to rely on community awareness, since the members of the community are most likely not capable of judging on their own on the security of protocols. Thus, reconstruction of communities involves formalization, redesign and reconsideration.

6. Formalization of Media

In the previous sections, general models for media have been introduced and the reconstruction of communities on media has being explored. Formalization is prerequisite to implement the platforms and for artificial agents to reflect upon themselves and the medium. In this section, we introduce our concept for formalization. Note that the concept of this formalization has been first suggested in [20] and [12]. The formalization that we present here is note complete.
Let us make some remarks on the level of modeling and the general goal of modeling. For the formalization, we make suggestions for languages and requirements towards languages to capture essential features of media. We aim at developing a general architecture which can be instantiated with various formalisms for descriptions. Moreover, instead of providing a general language for modeling all components, we provide a framework with relations between languages, to be able to have a small language for each component and to relate them adequately. Recall that the goal of such a formalization is also to make as much information as necessary explicit in the model.
General Logic [3] is our framework, to select the languages for modeling components of a medium from. and to establish the relations between the component-specific formalisms. A general logic captures syntax, semantics of descriptions and the relations between descriptions.
Definition General Logic [3]. A general logic L is given by L= (Sign, *sen*, Mod, |-, |=), where
- Sign is a category of elements called signatures.,
- *sen*: Sign→Set maps each $\Sigma \in |\text{Sign}|$ a set of Σ–sentences *sen*(Σ), called Σ–language,
- Mod: $\text{Sign}^{op} \rightarrow \text{Cat}$ is a function assigning each $\Sigma \in |\text{Sign}|$ a category Mod(Σ), whose objects are called Σ-*Models*,
- |- is a function that determines for each $\Sigma \in |\text{Sign}|$ a relation $|-_\Sigma \subseteq P(sen(\Sigma)) \times sen(\Sigma)$, called Σ-*entailment* that is reflexive, monotonic, transitive and preserves |- translation along signature morphisms, and

– |= is a function assigning each signature $\Sigma \in |\text{Sign}|$ a relation $|=_\Sigma \subseteq |\text{Mod}(\Sigma)| \times sen(\Sigma)$, called Σ–*satisfaction* for which for all $\sigma : \Sigma \rightarrow \Sigma' \in |\text{Sign}|$, $M' \in |\text{Mod}(\Sigma')|$, $\phi \in sen(\Sigma)$, holds $M' |=_{\Sigma'} sen(\sigma)(\phi) \Leftrightarrow \text{Mod}(\sigma)(M') |=_\Sigma \phi$.

A theory (Σ,Γ) is given by a signature Σ together with a set of sentences Γ of Σ. A functor Th_0 assigns a signature Σ its category of theories. The mappings sen and Mod can be extended to mappings on theories straightforward [3].

Labelled Deductive Systems (LDS) [7] are our second framework for modeling. We employ them for combining formalisms and levels of reasoning into a single structure.

Definition Labelled Deductive System [7]: A Labelled Deductive System LDS = (A, L, R), where

- A is an algebra of labels with constructors, functions and relations,
- L is a logical language with connectors and well-formed formulas, and
- R is a labelling discipline determining, how formulas, i.e., elements from L are labelled with elements from A.

(t : Γ) is called a *declarative unit*, where t is an element of A, called the label, and Γ is a set of formulas from L. A database is a declarative unit or has the form (D,F,d,U), where D is a finite diagram of labels, d is a label, and U the set of all terms. A diagram of labels is a finite set of labels together with formulas $\pm R(t1,....tn)$, such that $ti \in D$ and R is a predicate symbol.

In this paper, we present databases as sets of declarative units with a relation between the labels. We apply the construction of LDS several times, declarative units become formulas in a next level of LDS and abbreviate, e.g., (l : (m : f)) by l : m : f.

For formalizing a medium, the languages are selected from a General Logic and the architecture is given by Labelled Deductive Systems. Let us give the formal definition first and explain it afterwards.

Definition Medium: Let L = (Sign, *sen*, Mod, |-, |=) be a general logic, Th_0 its category of theories. A medium description MD is given by

MD = ((Sign, sen, Mod, |-, |=),
(Th_D,Th_C,Th_R,Th_P),
(R_{DC}, R_{DCRP})).

where

- $\Sigma_D, \Sigma_C, \Sigma_R, \Sigma_P \in |\text{Sign}|$, Σ_D is for modeling a domain, Σ_C for the channel system, Σ_R for roles, Σ_P for protocols,
- Th_D, Th_C, Th_R, Th_P are the respective theories,
- Σ_{xy}, Th_{xy} denote the pushouts of signatures and theories with indexes x and y,
- R_{DC} is a theory for relating Th_D and Th_C,
- R_{DCRP} is a theory for relating Th_D, Th_C, Th_R and Th_P,

Let N be a set of names, i.e., a set of elements of $sen(\Sigma_C)$.

A medium M is given by:

M(N) =

L : Σ_{RC} : Th_{PC} : Prot´(N) : P : Prot(N)
L : Σ_{RC} : Th_{RC} : Rol´(N) : R : Rol(N)
L : Σ_{DC} : Th_{DC} : $(b_1:A_1)$´ : n_1 : A_1
.....
L : Σ_{DC} : Th_{DC} : $(b_n:A_1)$: n_n : A_n
L : Σ_{DC} : Th_{DC} : $D_C(B)$: $D_C(N)$
L : Σ_{DCRP} : Th_{DCRP} : $D_{DCRP}(B,A,D_C(N),Rol´(B),Prot´(B))$
L : Σ_{DCRP} : $D_{Th}(Th_{PC},Th_{RC},Th_{DCO})$
L : $D_\Sigma(\Sigma_{OC}, \Sigma_{AC}, \Sigma_{ACO})$
where $n_1.....n_n \in B$ and $B,P,R \in N$

Let us motivate this definition. For a medium description, the set of languages and theories to describe the components of a medium and to characterize the properties of those components or the information has to be given. The relation between names and information to be distributed has to be modeled (R_{DC}) and the relation among names, the channels, has to be captured ($D_C(N)$). The information to be relevant for relating information (Prot´(N),Rol´(N),$(bi_1:A_i)$´) and channels to roles and protocols have to be provided, the relation itself is modeled in ($D_{DCRP}(B,A,D_C(N),Rol´(B),Prot´(B))$). Information explicitly available on the medium has to be understood within in a theory modeling the context (Th_{xy}). $D_{Th}(Th_{PC},Th_{RC},Th_{DCO})$ denotes the relation among the theories. The languages, i.e., the signatures $(\Sigma_D,\Sigma_C,\Sigma_R,\Sigma_P)$ capture the language information is modeled in.

A medium is an abstraction of a set of names, namely the name of the roles (here, R), the name of the protocols (here P), the set of names of information to be distributed (here $n_1,....,n_n$).

Let us motivate and describe general structure for modeling a medium by discussing the colums from right to left.

At the rightmost column, the information to be distributed is given. This information are the protocols (Prot(B)), the roles (Roles(B)), and domain specific information (A_i).

The names or addresses of the information (P,R,$n_1.....n_n$) are given in the next column. A diagram D_C relates the names and models the channel system.

The next column relates the various formalisms and theories, the column itself contains the information necessary to capture this relation. Diagram $D_{DCO}(...)$ describes this relation. One example for such a diagram is the usual relation between a concrete description, i.e., a program and some abstract properties to be required to hold for the executable program to terms and declarative units, i.e.,

$\text{Mod}(Th_{DC}(B)),(n_1: A_1 \ldots n_n: A_n) \models \text{Rol}(B)$ implies
$\text{Mod}(Th_{DC}(B)),n_1: A_1 \ldots n_n: A_n) \models \text{Prot}(B)$

The next column relates the general theories with the information to be distributed. This is the information, that has to be known in order to understand the right columns The diagram $D_{Th}(\ldots)$ relates this information.

The next column captures the syntax of the languages, the theories are given in, the labels are here the various signatures. Those signatures are some sort of name of the language within the Web of languages and models.

The leftmost column is the „backbone of common understanding“, i.e., the information and general structure that

has to be known to understand and to relate the various languages and theories. We employ general logics.

Note, that in such a structure, the theories as well as the organizations are explicit part of the description – they can change over time, they are given explicitly within the medium such that agents can learn about the organization. In conventional models, organization, theories and languages are implicit and static, i.e., some abstract specification of protocols or roles is required hold for an agent-channel system. Neither the relation agent-channel system nor the organization are explicit in the system and subject to specification. Moreover, organization and the agent channel system may not change over time.

Let us now continue with the formalization of the media reference model. We distinguish domain specific information and the general media structure.

The language to be implemented is given by Σ_D and we require Σ_D to include (in addition to equality) a relation », where ϕ » γ when ϕ is more general than γ and a relation $\approx$, where $\phi \approx \gamma$ if ϕ matches γ. We require for the domain:

Σ_D = (sort Domain .
ops » ≈ : Domain Domain → Bool)

For the channel system, we employ a set of names to distinguish information (which might be generated in some algebra and some predicates) and a predicate isrel describing which Set of Names is related to describe the channels. Thus, we require the signature to include at least the sorts Name and Nameset and a predicate isrel:

Σ_C = (sorts Name Nameset .
op isrel : NameSet → Bool)

For the generic transactions we choose a set of messages. Messages are parameterized with some domain specific information as well as some set of names, indicating to whom the message is being sent.

Σ_T = (protecting Σ_C , Σ_D .
sort Ta .
op assert : NameSet Domain → Ta .
ops supply demand: NameSet Domain → Ta .
op offer : NameSet Domain → Ta .
op counteroffer : NameSet Domain Ta → Ta .
ops accept, reject : NameSet Ta → Ta .
ops send : NameSet Ta → Ta .)

The domain specific relation » and ≈ have to be extended to transactions, e.g., in a conservative extension:

spec DomainToTransaction = (
protecting Domain .
eq m(M,ϕ) » m(N,γ) if M » N and ϕ » γ
for all transactions m
eq m(M,ϕ) ≈ m(N,γ) if M ≈ N and $\phi \approx \gamma$
for all transactions m)

For the description of the organization of the medium, we employ deontic logic with the two modalities Obl(m) and Per(m). Obl(m) says that transaction m is obliged to happen, while Per(m) says that transaction m is permitted. See, e.g., [16,31]. Roles have a name and they are defined by the permissions, obligations and domain specific predicates.

Σ_R = (protecting Σ_C, Σ_D, Σ_T .
sort Role .
op Obl, Per : Transaction Role → Role .
op dtr : Domain → Role .
ops tt ff : → Role .
ops vee wedge : Role Role → Role .)

As language to define the relations between the processes, we employ a standard construction of processes following, e.g., [17]. We refrain from giving this specification.

After defining the languages various relations – the diagrams of the various labeled deductive systems have to be given. Let us give the refinement relations between the transactions, following [32] for the relation supply-offer:

spec Transactions = (
supply(N_I,ϕ_I) ⇒
$\exists \phi_I$ »ϕ_N, N_I»N_N: Sometimes(offer(N_N, ϕ_N))
offer(N_N,ϕ_N) ⇒
$\exists \phi_I$ » ϕ_N, N_I » N_N : Eventually^P(supply(N_I,ϕ_I))...)

The relation between transaction view and organization, i.e., between agent-channel system and organization is being defined as a relation between a protocol component with name O and information stored in N1 and N2:

spec OrganizationRelAgentChannels = (...
O : Shop(N1), Customer(N2)
N1 : offer(N_N,ϕ_N)
N2 : accept(N_1,ϕ_N)
=> O : Shop(N1), Customer(N2), contract(N_1,$N_{2,}$,ϕ_N)
N1 : contract(N_1,$N_{2,}$,ϕ_N)
N2 : contract(N_1, N_2,ϕ_N)
if N2 ∈ customers(N1) .)

Let us explain this rule. Provided that there is an offer and an accept with appropriate relations between the parameters, then this is equivalent to a contract. A contract typically requires a number of things to perform in order to settle it. With rules that describe the relation between the messages and their organizational counterpart, we model the illocution of a message and lift a simple message to a transaction.

The specifications illustrate how to give the relevant information in an explicitly and formal style and how to establish a structure that suits the current Web paradigm. From a web of languages, we design a web of media components, which can be composed in a modular way.

7. Concluding remarks

Communities of human and artificial agents on media is a general vision that demands for a reconstruction of the notion of community on media, and as part of this reconstruction, a formalization of the relevant aspects based on general architectures and concepts. We explore the relation community and its medium and the duality of community of aspects implemented on it and the aspects

emerging from the medium. This analysis illustrates how to proceed in reconstruction and redesign of communities on platforms provided by information and communication technology, and in particular on open distributed structures. The general models, the media concept and the media reference model guide both the analysis, redesign and reconsideration as well as the formalization. We present an approach towards a formalization of the models capable of capturing the notions we analyze to be modeled. It remains to consider the sociological and economic implications of the concepts and formalizations of communities as we envision them here.

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