Three-Tier based Global Awareness: A comprehensive Mashup Model using Semantic Networks, GIS and Web3D

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ABSTRACT

Geographically distributed development has consistently had to deal with the challenge of intense awareness extensively more than locally concentrated development. Awareness marks the state of being informed incorporated with an understanding of project-related activities, states or relationships of each individual employee within a given group as a whole. In multifarious offices, where social interaction is necessary in order to distribute and locate information together with experts, awareness becomes a concurrent process which amplifies the exigency of easy routes for staff to be able to access this information, deferred or decentralized, in a formalized and problem-oriented way. Although the subject of Awareness has immensely increased in importance, there is extensive disagreement about how this transparency can be conceptually and technically implemented [1]. This paper introduces a model in order to visualize and navigate this information in three tiers using semantic networks, GIS and Web3D.

Keywords: Distributed development, collaboration, Real World Awareness (RWA), visualization, semantic networks, Web3D.

INTRODUCTION

Awareness is an integral CSCW (computer Supported Cooperative Work) research component which Dourish and Bellotti define as follows [2]:

> *"...awareness is an understanding of the activities of others, which provides a context for your own activity."*

With growth in area of sensor technology and RFID, a new expression of Awareness has been established, which expands awareness, via the phrase Real World Awareness, around the aspect of the ability to perceive information of persons as well as of systems in real-time and to react on that information quickly and effectively [3]:

> *"Real World Awareness is the ability to sense information in real-time from people, IT sources, and physical objects – by using technologies like RFID and sensors – and then to respond quickly and effectively."*

From a perspective of RWA a media disruption is considered a causal factor for lack of awareness. RWA is intended to reduce or dissolve media disruptions, and thus reduce or even close the gap between natural and virtual worlds. The natural world exists in the physical and operational reality such as persons, products and resources and as a virtual in information technology such as, for example, ERP and SCM systems as well as local, regional and global information networks.

The RWA concept is based on the trend towards data input and retrieval being increasingly automated, which increases the abundance of stored information. The literature (see [3], [4], [5]) reflected the basic idea behind Real World Awareness and can be summarized on the basis of following three essential points:

- The natural world is portrayed in current and accurate detail in an IT system.
- The transparency in corporate supply networks or in the entire value chain increases.
- Exceptions occur on both short-termed and constantly-changing business environmental conditions, on which accordingly can be react.

There is a majority consensus on the use of semantic networks in order to portray objects including their relations to each other. See the Aether model [6], the event oriented model [7] and the Model of Modulated Awareness, shortly termed as MoMA [8]. Semantic networks are well-structured, flexible and intuitive. They allow transparency in important relationships and allow for a context-menu of Concept chains. In the search for objects, access paths are predefined through the directional edges. A concrete implementation of semantic networks is Topic Maps (TM), its conceptual and technical aspects are held by the Topic Maps standard family (for an overview see [9]).

A Topic Map consists of Topics, Associations and Occurrences (the so-called TAO principle). Topics illustrate things that exist in reality, which are connected to each other through associations in their relationship Occurrences are references to further information on topics in external documents. The informational content is not included in the Topic Map itself.

The definition for Web3D is extensive. In a wider sense, Web3D is a generic term for all techniques identifying the three-dimensional visualization of the content on the Internet. It involves the use of three-dimensional computer graphics in web applications, usually through a browser plug-in for the use of 3D models. In the strictest sense, this means the standard *X3D (Extensible 3D)* that is developed and maintained by the Web3D Consortium. This standard can be used for the web-based depiction of three-dimensional objects and scenes described in XML and because of its backward compatibility, importing existing VRML models.

The three-dimensional visualization of the business environment of companies represents a new application which is known as Enterprise Ecosystem Visualization. On the basis of mashups, business information of certain users, such as the regional sales of a certain product is represented in 3D on a map or virtual globe. These applications give an insight into the transactions that extend across corporate boundaries and enable company-wide business scenarios and illustrative projections. Assistance of Web services for weather or traffic data, for example, allows linking their data with those from own operational Applications (e.g. SAP) as well from other services, such as market research firms. The resulting mashup often delivers impressive 3D insight into the business environment of companies. The use of a so called Service-Oriented Architecture (SOA) proved itself particularly in the GIS world: whether the nearest shopping centre is being sought or the delivery status of a shipment needs to be traced.

Two aspects of this technique, with consideration to their integration using the model that has been introduced in this paper, are:

- The intuitive navigation and visualization of large quantities of information with the help of semantic networks, and
- The interaction of project members in different location or times in the four-dimensional time-space-system as world metaphors, close to reality based on cartographic geo-visualization

Using simple collaboration scenarios, this model will be further examined in the next section.

THREE-TIER ARCHITECTURE

The core requirement of a model for the visualization of collaboration lies in its illustrative aptitude for depicting the essential characteristics of a coalition; including the amount of people involved, activities they do and objects they use, as well as their relations to each other.

The model presented here distinguishes three levels of representation, which all serve as a kind of detail:

- World view (macro view): Core members of the global development network and channels between them;
- Location of view (meso view): Local offices/business units, located partners and relevant site-related infrastructure
- View of the business unit (micro view): workplace, roles, responsibilities and artifacts.

Staff and project activities are specifically presented to each case at each corresponding level. The above threefold division is pragmatic – in very large organizations even intermediate stages could be conceived. Entities in the micro view (roles) are atomic. The elements of a level are displayed using a semantic network. And particular elements may be detailed by a semantic network of a lower level. Their technical implementation may, for example, be realized by using TM-frameworks [10], [11].

The user can apply the information needed to filter out criteria at each level. Relevant criteria include projects and their components, enterprise, skills, industries and artifacts. The filtration itself is based on a search using semantic query languages for Topic Maps like Tolog or TMQL (Topic Map Query Language).

Macro view

The first level looks at the locations of the core members, including their connections. This can be, for example, a software development office in Munich and a testing division overseas with a (possibly automated) transfer of test artifacts and result protocols. It takes into account the principle and the available channels between these locations. These connection types can differ from lines of communication to those used for people, data or material handling. Each connection contains sensitive information such as formats to be used for data exchange, timetables, transportation policies, organization-specific requirements, limitations or forms.

An established connection between two entities is a channel in accordance with this model. Here, however, this can differ from the concrete form. The internal representation as well as the visualization looks at the mail server, data pathways and user devices as one entity, similar to travel routes consisting of flight connections, taxi connections and intersections (e.g. an international airport). The existence of a channel, not merely its appearance, is thus the main focus.

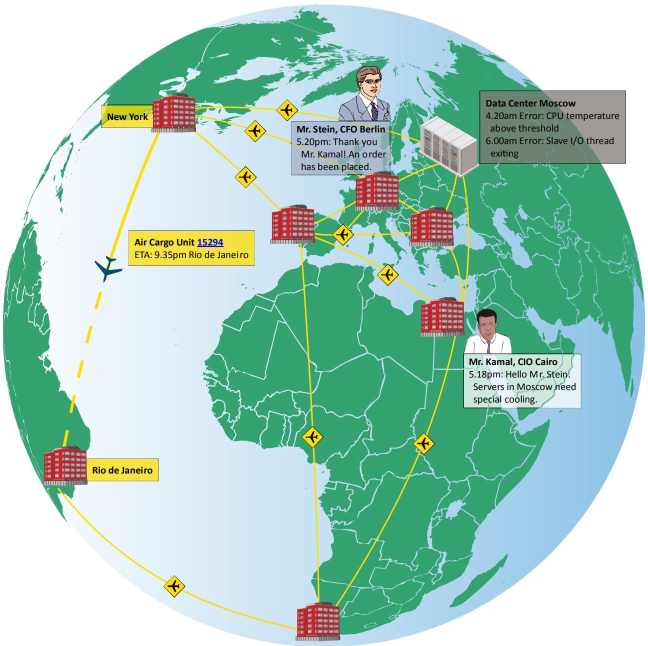

Figure 1: The world-view of global collaboration

Meso view

The second presented layer provides a detailed view of individual sites. It lists those sites and channels that are only noteworthy for establishments of network development at any one particular regional site. These include advertising agencies, hardware suppliers, travel agencies or office suppliers; who are only interested in this particular regional site to implement and maintain its value-added work. Their existence is not of any interest for network members in other locations as there would already be one's own regional supply network at the other locations. No doubt, this also includes the most expedient regional delivery services such as those implemented for pizza delivery – which keeps up the performance and morale of employees working extra shifts.

Analogous to the macro view, this view also shows the established link between regional locations. The focus on visualization is once more primarily on the mere existence of these connections rather than their actual design. On the other hand, there are institutions which act as an interface in order to facilitate connecting with other sites and to function as regionally significant sites. Thus, an airport is not part of a regional connection but is an end junction of a separate component of regional infrastructure. There may be a user who retrains the power to cross-site links.

The exemplary scenario displayed in figure 2 shows an urban area, in the business' warehouse, web design and marketing operation. This is displayed together with flight, bus and taxi connections. Individual documents, such as project reports, flight schedules or delivery confirmations are linked together and are formed in the Topic Map. Other visualized elements in the second representational level, are links to courier services and telephone accessibility.

Micro view

The third and final level is semantically linked to the places of employment, positions, roles and project artifacts. This level details the view of individual business units. It further displays the principle as well as all of the available channels. Jobs are associated with artifacts (documents), whereby job descriptions or access rights act as additional information which can be complemented in the form of *occurrences*.

The micro view also extends to the people; but as a topic they are assigned to their according jobs, positions and roles. Links may be between jobs, positions and given roles. Such connections signify the exchange of documents, which belong to their related objects. Direct links between separate actors represent the exchange of tacit knowledge. Personal knowledge may not be treated as an attachment to a job, position or role.

Actors are yet another feature by which they can exercise any detail. Human actors (artificial actors are also possible in principal) also have the ability to use the channels which are visually available in the macro, meso and micro views. When they are in the relevant period of use in any one given channel, then they will be visualized. Additional information about the current activity will be then be treated as an occurrence and suitably displayed.

Activities are always addressed by at least one actor and are treated as topics. The visualization not only show those as directly neighboring objects of the involved actors, but also at the depicted connection lines which offer the channel for this activity. These are relationships between activities and actors as well as those with each other are displayed spatially. Topics, and in particular, activities, may vary according to their temporal occurrence and can be faded in and out. This provides an opportunity to visualize temporal relationships.

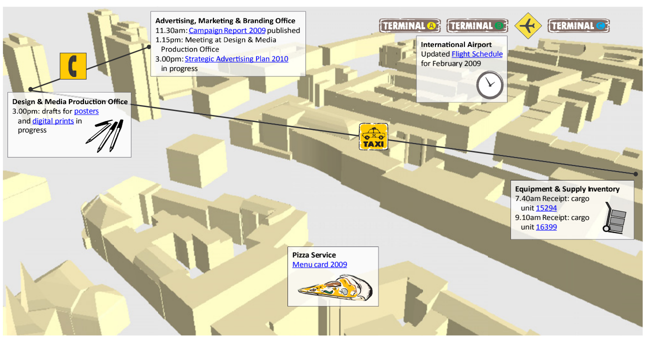

Figure 2: Departments and local infrastructure (rendered with LandXplorer CityGML Viewer)

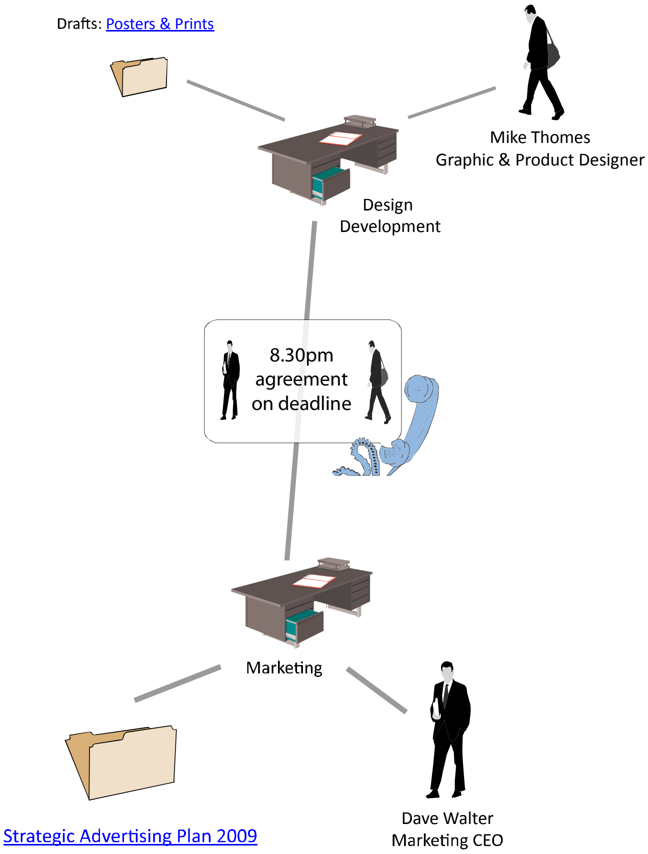

Figure 3: Employees, Artifacts and Activities

Figure 3 shows the structure of a business unit in dynamic view. It serves to show how two actors interact with each other. This could be, for example, a phone call or a sent fax.

Various activities of actors have already been featured in figure 1. The communication aspect was related to the first level (macro view) of project members blended in at globally distributed sites to synchronously communicate with each other, such as instant messaging or VoIP (Voice over IP)-conferences.

LIMITATIONS

The success of this collaborative model and the subsequent building tools produced depends not only on the quality and quantity of data, which is the basis for the visualization of the collaboration form, but simultaneously on several other conditions. Data production can be technically complicated and can either take up copious amounts of time or virtually no time at all. Discipline and personnel involvement are, however, required for productivity, too. The key to finding the right balance between benefit and burden must be identified by each user individually.

On major problem is how to coordinate the paradigmatic necessity of transparency in order to support work coordination juxtaposed against the privacy rights of the workers observed [2]. When personal data is at hand, data protection rules must sufficiently be taken into account. This challenge, however, has to be made with almost all measures related to knowledge management. Nonetheless, without the consent and voluntary participation of the users such a tool cannot be fully utilized because the employees are not only users but are also participants who should ideally be voluntarily entering into the non-informal, non-automated activities. Indubitably, then, on the employee-level, the real importance of balancing the difference between individual benefits and burdens is presented.

EVALUATION IN COMPANY PRACTICE

In order to evaluate the current model, a prototype was presented to appropriate companies whose requirements according to their special needs will be discussed and expanded subsequently.

A company which operates in the field of the pharmaceutical business suggested that one of their needs is a track & trace capability of delivered products throughout their global locations. This necessity stems from one major problem; namely, the disappearance of medical products - the content of which is often replaced by artificial lower level medicals. In which case, the customer cannot be sure if the medical product is original or not. In this case Mobile and RFID Technology is used for transmitting geo positions.

Another example presents a company operating as a courier business which not only wants to made visible storage depots and routes for supply transportation on a visual globe but also the cargo itself at its current location. This company also communicated the desire to display important routes as well as weather and traffic conditions, which can be retrieved by several external Services from Third Party.

Yet another example is a company which manages and operates server farms expressed the aspiration to display its datacenters which are covered all over the world together with current power consumption and electricity rate which depends on each location.

These are all preliminary results of evaluating the model in diverse companies. This evaluation is in currently in progress and will result in specific requirement specifications for individual business needs.

GLOBAL AWARENESS IN THE CONTEXT OF META-ENGINEERING

This Awareness-approach was originally created in the context of knowledge management for distributed software engineering. Knowledge management can be characterized by the suggestion of a sustainable and effective implementation of knowledge, with the focus on business and process goals, and by the dissemination of information through access to knowledge [13]. Consequently, the presented models do not represent engineering knowledge itself. This knowledge is strictly personal, externalized in documents or implied in activities or products. Instead the knowledge of this knowledge is represented: Who uses what knowledge and in what context, how often and at what time, and in what order etc.? These models help to carry out functions of the meta-engineering. Callaos defines meta-engineering as follows [14]:

> *„Meta-Engineering is the development of new Knowledge (scientia), new 'made things' (techné) and/or new ways of working and doing (praxis) with the purpose of creating new useful products (artifacts) or services for engineers or engineering organizations.“*

The function of the meta-engineering in relation to the engineering knowledge is capturing, representing and transmitting/sharing it [14]. This is consistent with the general functions of knowledge management (see Figure 4) [13], [15].

The Awareness model aims to visualize other aspects of knowledge management. These include the dimension of workflow-related organizational coverage (activity, process, and network), the dimension of the structure-related organizational coverage (interorganizational, organizational, and individual) and the dimension of the personnel coverage (knowledge workers, knowledge managers and managers). Depending on the desired perspective, the filter for proper visualization can be set.

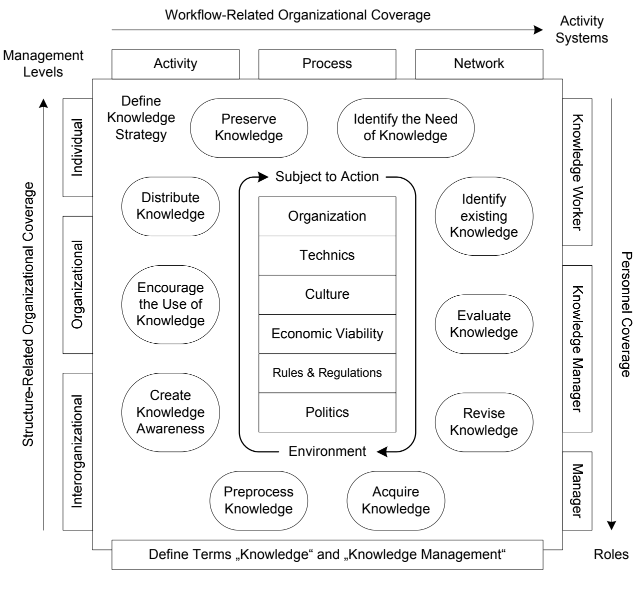

Figure 4: Potsdam Knowledge-Management Model

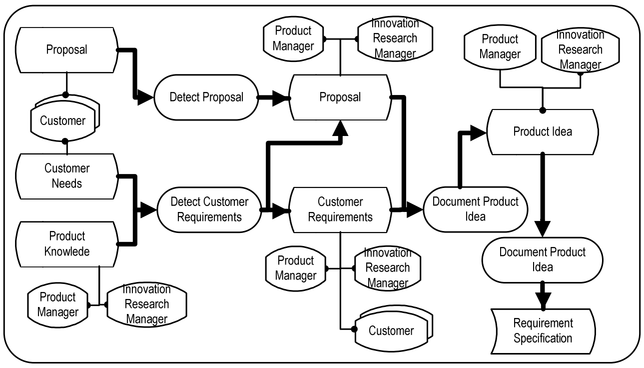

Figure 5: Example of a KMDL-Process

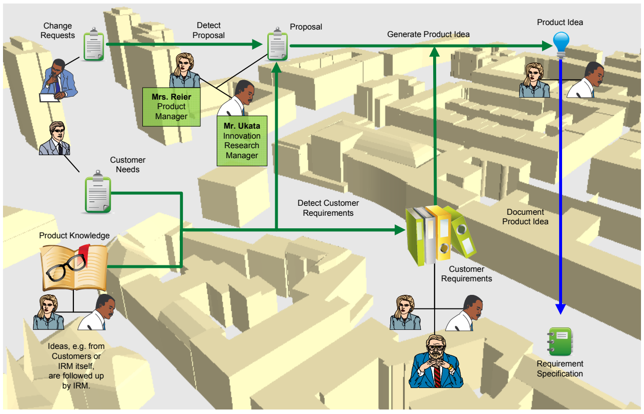

Figure 6: Transfer of the KMDL-Process into the Meso-View

It is not the primary intention of this approach to present process models. Nevertheless, it provides an extension for common process tools. On one hand, the immediate environment in which the business processes run is shown; on the other hand, such activities that appear unsystematic or have no direct value-added characteristics are presented and can also be taken into consideration. Information on such informal activities (i.e. conversations in the corridor, spontaneous discussions and long-term training on a subject) cannot be extracted from databases. There are modeling and survey methods such as KMDL (Knowledge Modeling and Description Language) to formally capture informal trains of thought, typical for any personal form of knowledge [16], [17].

The visualized results of model transfers are shown in Figs 5 and 6. Using filters and zoom factors, process models can be depicted in an arbitrarily "thinned out" manner, for example where the focus is only on actors and their relationships, and the process-characteristic is no longer evident. Figure 3, however, presents an unfiltered transfer. The initial model (see Figure 2) was created with the description language KMDL [2], [3] and here it shows actors, informational objects, knowledge related objects and knowledge-processing activities. In the cockpit-visualization (The city-model graphics were created with the LandXplorer CityGML viewer tool by 3D Geo GmbH.) actors and objects are arranged in terms of their actual geographic position. When temporal information is available, model elements are gradually apparent or unapparent according to their chronological presence.

FURTHER APPLICATIONS AND OUTLOOK

A visualization of one's own collaboration is only one purpose for the presented model. It can also apply to the activities of competitors that are developing similar products, where often the same regional partners are involved. The crucial keyword here is product piracy and its defense [18]. Important decisions will provide the average amount of one's own Topic Map, and those representing the competitors. Who, from where and to which network has had contact with whom, when, how and why? This tool can be used as a monitoring device to control one's own network so that the contacts and knowledge flow to competitors and their partners can be purposely channeled out.

Search engines are used to quickly locate required objects and always exist in data from a collected part and from a query part. The introduced method for the visualization of collaborative networks as well as the navigation through the functions of these is covered by a search engine. It is a semantic search, which allows a user to choose an entry point within the graphically visualized topic map, and to navigate from topic to topic. The visual background of using Web3D technologies provides an extensive GUI (Graphical User Interface) for semantic search, and additionally prepares the search results without omitting the visual context.

An implementation of the approach presented in this work is done here at the University of Potsdam. Addressed here are the various sub-disciplines of applied and practical computer sciences, such as semantic technologies, process management, geographic information systems, and experience from the software engineering, knowledge management and web technologies.

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