

# 4I (FOR EYE) TECHNOLOGY

## *Intelligent Interface for Integrated Information*

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**Abstract:** Next generation of integration systems will utilize different methods and techniques to achieve the vision of ubiquitous knowledge: Semantic Web and Web Services, Agent Technologies and Mobility. Nowadays, unlimited interoperability and collaboration are the important things for industry, business, education and research, health and wellness, and other areas of people life. All the parties in a collaboration process have to share data as well as information about actions they are performing. Development of Global Understanding eNvironment (GUN) (Kaykova et al., 2005), which would support interoperation between all the resources (GUN-Resources) and exchange of shared information, is a very profit-promising and challenging task. And generally, a graphical user interface, that helps to perform this interoperation and collaboration processes in handy and easy for human/expert way, is one of the important things in a process performing, and creation. Following new technological trends, it is time to start a new stage in user visual interface development – a stage of semantic-based context-dependent multidimensional resource visualization. Presented 4i technology is a step to achieve this goal.

## 1 INTRODUCTION

Nowadays, unlimited interoperability and collaboration are the important things for industry, business, education and research, health and wellness, and other areas of people life. Thus, we need an open environment to allow different heterogeneous resources (software, data, devices, humans, organizations, processes and etc.) communicate and interoperate with each other. And as usually, graphical user interface is one of the important things in performing and creation of interoperation and collaboration processes, and it is one of the challenging tasks during the middleware development.

Several information visualization techniques have been developed in the last years due to the need of representing and analyzing the huge amount of data generated by several applications or made available through the World Wide Web. Previously, we had a deal with data visualization, precisely with a data format representation. Depending on a data format, whether it is a text, an image or a video, graphical user interface presents the data in certain way. On the next stage, small step has been done in visualization of object part-of relations, namely as a

tree visualization. The second step was a step when we came to semantic definition of the objects, and have found a need to represent ontology concept tree and semantic graph (Yuxin et al., 2005). But it was just a step to semantics and ontology representation. Next generation of integration systems will utilize different methods and techniques to achieve the vision of ubiquitous knowledge: Semantic Web and Web Services, Agent Technologies and Mobility. Recent expectations regarding a new generation of the Web strongly depend on a success of Semantic Web technology. Integration of heterogeneous applications and data sources into an interoperable system is one of the most relevant challenges for many knowledge-based corporations nowadays. Development of Global Understanding eNvironment (GUN), which would support interoperation between all the resources and exchange of shared information, is a very profit-promising and challenging.

Following new technological trends, we have a need somehow to visualize resource properties (in specific way, different from “directed arc between objects” representation), various relations between resources and inter-resource communication process. And even more, we have a need to make context

dependent visualization, to be able to represent information in handy and adequate to a certain case (context) way, to reach a plasticity of UIs (Thevenin and Coutaz, 1999). Thus, the main focus in GUI development will be concentrated on the resource visualization aspects. Now, we have a challenging task of *semantic-based context-dependent multidimensional resource visualization*.

Regarding to the core characteristics of Web 2.0, a website is no longer a static page to be viewed in a browser, but is a dynamic platform upon which users can generate their own experience. The richness of this experience is powered by the implicit threads of knowledge that can be derived from the content supplied by users and how they interact with the site. Another aspect of this Web as platform is sites which provide users with access to their data through well defined APIs and hence encourage new uses of that data, e.g. through its integration with other data sources.

The paper describes a technology for context-aware intelligent visualization of integrated information and a vision to groupware collaboration approach.

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Now it has become evident that we cannot separate visual aspects of both data representation and graphical interface from interaction mechanisms that help a user to browse and query a data set through its visual representation. Following GUN-Resource centric approach, let us consider user interfaces for context-based resource access and contextually related information retrieving. The challenging task is to create a visual interface that provides integrated information from variety of information providers in context-dependent way.

### 2.1 Information Retrieving/Access and Representation

All GUN-Resources have a set of properties, and some of these properties can be a basis for specific visualization view of a resource and other related to it resources. For example, part-of relation (if it concerns physical relation of resources) can be visualized as a 3D model of nested or somehow connected resources; or 2D model, if third dimension is not valuable (for example to present the resources on a map, if they are part-of the World). From the other side, part-of relation of a GUN-Resource can be abstract and cannot mean any

physical contact with other resource. Resource can be a part of some (business) process. In this case, there is no physical contact between the parts and such relation should be represented in different way (relation graph). Or, if we consider contextual property such as family relation of a person, then visualization can be presented in a way of a genealogical tree. Thus, depending on a context, human/expert needs information (information related to subject resource) to be visualized in certain way. At the same time, an interface for access to a resource also should be context depended. This gives us one of the requirements for visual interfaces – ability to represent information regarding to chosen contextual property of a resource. Such interface should allow user to simply choose a context for data representation, and should even support cases of multiple contextual property selection for complex views and filtering purposes. Such requirements can be met by MetaProviders - sui generis portals of GUN-Resources with specific visualization view. It is named as MetaProvider in a sense that it provides an access and presents other resources, which in turn are providers of own information (data). All GUN-Resources have certain own location (physical and digital). But it does not mean that they should have just one way to get an access to them. MetaProvider is an interface-mediator that gives a possibility to mark/select a resource (object) on its interface and provide the link to original resource location. In other words, it allows resource registration for further access to its data. At the same time, any resource can be registered on variety of different MetaProviders in different views. The main feature of MetaProviders is each party that take care of some GUN-Resource registers the resource itself. It causes fast filling of information accessible through MetaProvider. And each user/resource in one moment has an access to related information of amount of others. But such interoperability brings a new requirement for the MetaProviders and users. They should share common ontology to be interoperable on semantic level. Additionally to semantic interoperability, GUN-Resources are proactive/goal-driven resources and supplied with a Resource Agent for resource-to-resource (R2R)/ agent-to-agent (A2A) communication.

MetaProviders can play three main roles: *MetaProvider as a point of access to GUN-Resource* (based on a resource contextual property), *MetaProvider as a context-based search service for InformationProviders/Consumer* retrieving, *MetaProvider as an interface for integrated*

information visualization (with context-aware intelligent semantic filtering mechanism to present just relevant information and avoid a glut of it).

## 2.2 Intelligent Context-aware GUI for Integrated Information

Now we can define an intelligent context-aware graphical user interface for integrated information representation. It is a smart ensemble of Intelligent GUI-Shell (smart middleware for context dependent use and combination of a variety of different MetaProviders depending on the user needs) and MetaProviders as graphical interfaces that visualise filtered integrated information (see Figure 1). The figure shows us a principle of such smart ensemble work. There are three GUN-Resources (power line, forest and weather) that are registered on a set of MetaProviders. Let us consider GUN-Resource that presents a power line as a main initiator of a visualization process. Intelligent GUI, as a part of GUN Platform, provides an opportunity for user to initiate context-based search process that returns appropriate MetaProvider or a set of them. Search process can be performed via centralised or decentralised system of MetaProviders registration.

Depending on a contextual property, Intelligent GUI Shell provides an access to filtered set of retrieved MetaProviders. Then user can register the resource (if it is not registered yet) or/and get related to the resource integrated information on MetaProvider interface. It is not necessary that search result will contain just one instance of a fit class of MetaProviders. This is an open environment and there is can be a set of various realizations of MetaProviders from different producers. Also, GUI Shell allows dynamic switching between MetaProviders for more suitable information representation, depending on a context (a set of contextual resource properties). From other side, MetaProvider provides API to specify information filtering context – a context for visualization of appropriate resources and their necessary properties. In this scenario user asks the MetaProvider to show resources in certain area around the subject resource (power line) in the context of physical damaging and relevant to this resource properties.

Thus, physical conditions of other two resources (forest and weather that are shown in the figure) have been requested and the values of correspondent properties have shown on the interface. Now, when

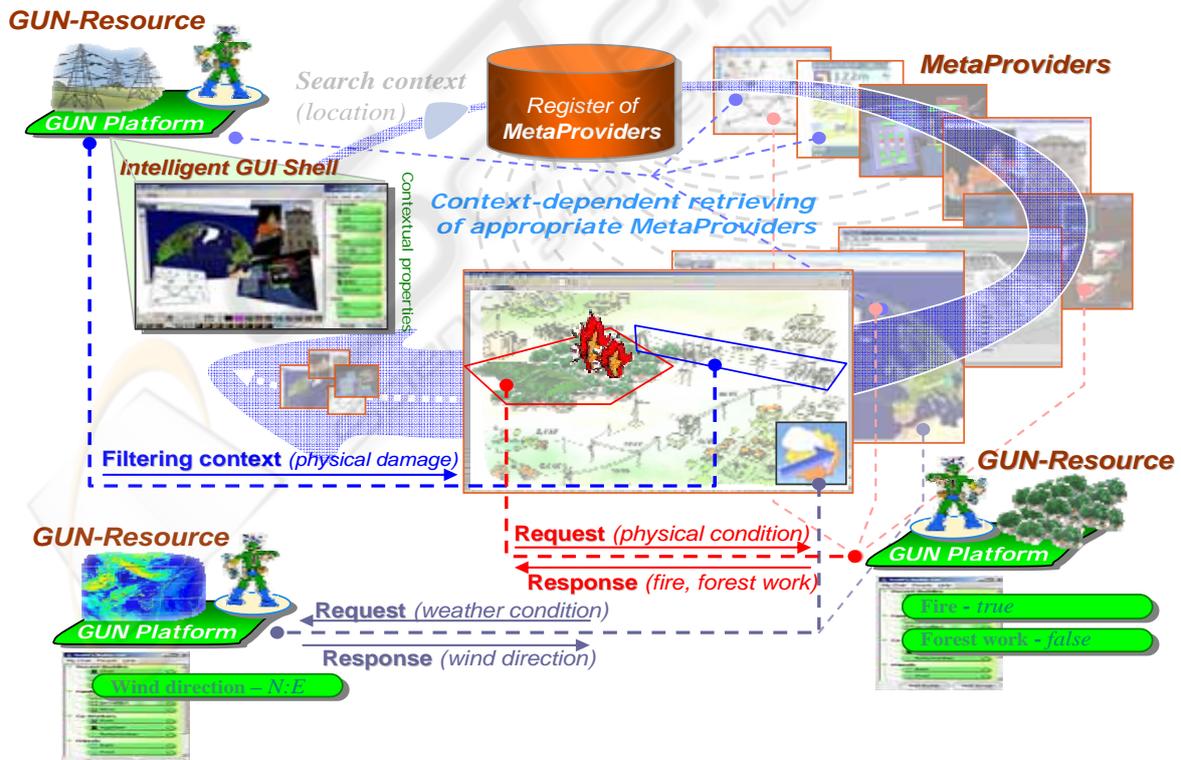


Figure 1: Intelligent Interface for Integrated Information (4i technology).

expert has recognised alarm situation, he/she need, for example, to change the architecture of the electrical chain (electricity supplying) and for this purpose can easily switch to another MetaProvider with more appropriate internal view of power line architecture. Another valuable benefit of such smart ensemble architecture is possibility to perform autonomous agent-based resource communication via MetaProvider's and GUI Shell APIs. It is an open environment for MetaProviders and it is a good base for different business models that can be built on it. Thus, with a purpose to be an interoperable part of open environment, each player has to be supplied with API and should be semantically adapted to understand the requests and to provide understandable response.

### 3 CONCLUSION

Now, when human becomes very dynamic and proactive resource of a large integration environment with a huge amount of different heterogeneous data, it is quite necessary to provide a technology and tools for easy and handy human information access and manipulation. Semantic-based context-dependent multidimensional resource visualization provides an opportunity to create intelligent visual interface that presents relevant information in more suitable and personalized for user form. Context-awareness and intelligence of such interface brings a new feature that gives a possibility for user to get not just raw data, but required information based on a specified context. 4i (FOR EYE) is an ensemble of Platform Intelligent GUI Shell and visualization modules – MetaProviders that provide context-dependent representation view of resource data and integration on two levels. These are: information (data) integration of the resources to be visualized; and integration of resource representation views with a handy resource browsing in different dimensions.

There are already a lot of developed domain-oriented software applications, which try to visualize the data in domain specific and suitable for human way (graphics software from SmartDraw<sup>1</sup>, concept-browser Conzilla<sup>2</sup> and Human Semantic Web browser Conzilla2, Google Maps, etc.) Now, when unlimited interoperability and collaboration demand data and information sharing, we need more open semantic-based applications that are able to

interoperate and collaborate with each other. Ability of the system to perform semantically enhanced resource search/browsing based on resource semantic description brings a valuable benefit for today Web and for the Web of the future with unlimited amount of resources. Subscribing to an opinion of (Nixon, 2006), bridging the gap between the emerging folksonomies of Web 2.0 and the formal semantics of Semantic Web, ontologies would benefit the Semantic Web community with being able to leverage the content and knowledge that Web 2.0 is already generating from its users and making available over standardized APIs. Proposed technology allows creation of a Human-centric open environment for resource collaboration with an enhanced semantic and context-based visual resource browsing. It can be considered as a new valuable extension of text-based Semantic MediaWiki to Context-based Visual Semantic MediaWiki. This is a good basis for the different business, production, maintenance, healthcare, social process models creation and multimedia content management.

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<sup>1</sup> SmartDraw® - [www.smartdraw.com](http://www.smartdraw.com)

<sup>2</sup> Conzilla concept-browser – [www.conzilla.org](http://www.conzilla.org)