BRIDGE

Enabling Multimedia in the Semantic Web

17 October 2001

Proposal No: IST-2001-34085

Part B:

Description of scientific/technological objectives and workplan

B2. Content List

B3. Objectives

BRIDGE aims to develop an **ontology-based multimedia infrastructure** that provides a user-friendly system supporting the creation, maintenance of and access to complex digital information spaces. BRIDGE focuses on researching and providing new methods and tools that allow the easy realization of innovative, multimedia applications using ontologies, thus realizing the full potential of the **Multimedia Semantic Web**. Such an interactive, open, and multimodal system sustains the activation of adaptive discourses using **intelligent dynamic user interfaces** that provide an immediate way of increasing accessibility of knowledge and supply means to make other users aware of available sources.

With BRIDGE we address the tremendous socio-economic changes in the field of electronic media-based information generation, presentation, and distribution, as currently emphasized through the Semantic Web initiative [Semantic Web 2001]. The Semantic Web should bring machine-processable content to Web pages, being an extension of the current Web. Recently, means for adding ontology-based metadata on simple text or HTML documents have been explored (e.g., IST funded On-To-Knowledge [On-To-Knowledge 2001] or DARPA-funded DAML+OIL [DAML+OIL 2001]). However, what has still been neglected so far is the fact that the WWW has evolved far beyond mere HTML pages to a distributed, heterogeneous, and collaborative *multi*media information system established through media rich documents, comprising video, audio, animation, and full-fledged synchronised multimedia presentations, between which multifaceted relations exist. Existing initiatives provide standardised descriptions and exchange formats for this variety of content (MPEG-7, Dublin Core, CDWA, RDF(S)). Such *metadata* offer first steps to more semantics in multimedia, but beyond this, further advances with higher semantic depth and machine processability are both needed and possible. BRIDGE is addressing this problem by supplying interoperability between the different standards.

The BRIDGE project will demonstrate new technological solutions providing **semantic services** for the generation, visualisation and maintenance of complex knowledge spaces that function across various multimedia-oriented domains, such as museum spaces for the Fine arts, education spaces for medicine or chemistry, or exploration spaces for architecture. Doing so, BRIDGE will advance the state-of-the-art of web-based information provision by demonstrating the benefits of ontologies and complex structured metadata in relation to multimedia applications. BRIDGE's innovation will be to explore and test semantic-web technologies and emerging standards for the benefit of multimedia scenarios and applications. Special emphasis will be placed on the **scalability** of the BRIDGE system and the development of **generic tools** and **portability** of the project results (models and software) for different types of applications in the area of digital multimedia information spaces.

In order to support the **authoring** and the **accessibility** of the information space for various purposes (for professional comprehensive scientific analysis, and information gathering by the general public), the system must account for different user types and their specific kinds of usages and tasks, providing a **supportive working environment**.

The professionally interested user, such as a domain expert, takes an active part in working with different multimedia materials, gathering information, evaluating the materials and adding valuable information to the growing system. As a side effect of this work of schema development and schema instantiation, the developing information space not only represents the current results of the research but also provides the development history. Therefore, it is the central objective of BRIDGE to provide an infrastructure offering generic, integrated **semantic-based** and **ontology-driven** services and tools supporting the technical (e.g., material gathering and digitisation) and creative (e.g., interactive content creation, content discussion on various levels of expertise, etc.) aspects of rapid **media-based knowledge production.** The semantic services will make use of standards as far as possible to facilitate the seamless integration in the heterogeneous environment of the World Wide Web.

The general public will typically access an information space either for pleasure or for educational purposes in the context of life-long learning. Since the user will not be in the position to fully understand the complex structure of the information network, he or she will be able to navigate without querying (**ostensive browsing**) based on **hybrid search/browsing techniques** that obtain relevance information from users on the basis of their recent search history and media preferences. Furthermore, the view onto the information space will be specifically adapted to the particular user's profile. This intuitive way of accessing information

in a non-linear way based on supportive **context-based presentation mechanisms** assures a high level of **user friendliness,** especially since the user can now be provided with the full relevant multimedia data. BRIDGE will thus contribute substantially to the technologies that will form the Semantic Web.

The domain to which the BRIDGE environment will be initially applied is the disciplinary context of **museums for the fine arts.** Through two consortium members BRIDGE has access to large digitised collections of graphic and art, covering all of the major art-historical epochs from the Ancient Egyptian and Greek and Roman Antiquities to the contemporary Modern. Moreover, both institutions do not only provide these magnificent collections but also perform research on a large scale regarding technique, provenance, function, and significance of covered epochs. The advantage for the two museum partners in using BRIDGE technology is twofold. First, by offering an extensive virtual knowledge space both are in the position to present a large number of artefacts that usually would be hidden in their archives. Second, the BRIDGE environment will demonstrate how complex research tasks, such as the creation of an interconnected theoretical system, and everyday user requirements, such as accessing the system and its subsystems for further reflection, can be better supported in an incorporating, non-linear digital media environment. Simultaneous comparison of theoretical train of thought and the full actual media data can be provided in such a way. Thus, services to provide information for the general public can be improved. Thus, the **digital collection** (i.e., digitised audio fragments, photos and scanned-in text documents) together with the associated metadata and domain knowledge will serve as a test case for the applicability and acceptability of the BRIDGE environment paving the way to potential commercial exploitation.

The main initial users of the BRIDGE semantic information environment are:

- two major European fine art museums – mainly providing the source material – of which most is already available in digital form,
- domain experts – composing the digital collection in such a way that cross-media references within the material will be made interactively accessible,
- the general public as users of the two different museum spaces.

The technology providers in the consortium join their particular renowned expertise (i.e., in media retrieval, databases, ontology-based semantic description, automated presentation generation, standards, including ontology, multimedia, presentation, user profiles) to accomplish the challenging project goals.

BRIDGE approaches the objective of commercial exploitation along the following strands:

- a solid scientific basis for new **semantic web models** for large media-based information spaces will be formed, leading to an **improvement of the evolving web standards;**
- different **software tools for back-end semantic services for multimedia information enrichment** as well as **front-end user-centred tools for establishing semantically enriched multimedia applications** will be developed and tested during the project and then made available through the consortium to interested organizations after the project;
- two museum information space demonstrators carried out during the project will be commercialised at the end of the project as electronic **information spaces for fine arts** in the form of an advanced Web information service by the participating museums. These pilots are sufficiently large and complexly structured digital collections that are intended to further grow after the end of the project. The **economic model** concerning payment schemata (subscription-based, item-based, advertisement-based), fee distribution between infrastructure provider, authors and users, access rights, etc., will be investigated during the project,
- an essential part of these pilots will be the development of an **ontology for the fine arts.**

B4. Contribution to programme/key action objectives

The general objectives of Key Action III are "… cover new models, methods, technologies and systems for creating, processing, managing, networking, accessing and exploiting digital content, including audio-visual content. An important research dimension will be new socio-economic and technological models for representing information, knowledge and know-how.", and to develop "… systems for creating, processing, managing, networking, accessing and exploiting digital cultural content, including audio-visual content." [IST Work Programme 2001, p. 32]. Action Line III.4.1 concerns the "Semantic Web Technology", focusing on "Methods and tools for coding and structuring digital content, for defining and declaring its semantics, … Interactive workflow procedures for handling radically new combinations of highly visual and interactive media form, … Methods and tools for the derivation of semantic attributes of Web-based content (in particular video, audio and images) through, for example, automatic feature detection, video segmentation and post-processing, … Semantics based tools for knowledge discovery and intelligent filtering and profiling such as information agents and specific query languages. Semantics based tools for collaborative filtering and knowledge sharing in specific or general user communities, … Information visualisation: intelligent and visual interfaces which take advantage of semantic information structures to provide users with radical new ways to navigate and search naturally through unknown and complex information spaces." [IST Work Programme 2001, p. 40].

The goals and scope of BRIDGE precisely correspond with these objectives – with respect to **coding and structuring content** (ontology-based annotation of audio-visual media), **knowledge discovery and filtering** (development of advanced software supporting the analysis and manipulation of heterogeneous, dynamic and adaptive sources), and **information visualisation** (the generic generation of digital multimedia material for user adaptive web interfaces).

The main technical contribution of the BRIDGE project to the IST Programme is a set of highly **advanced annotation and presentation tools** for use by holders of large and complex knowledge spaces, where BRIDGE uses the domain of museums for the Fine arts as the case study. The showcase contribution of the project is therefore related to Key Action Line III.1.6**, virtual representation of cultural and scientific objects**, with a focus *on* **creation of virtual cultural knowledge spaces**.

The proposed approach is **content-centric** and **user-driven** supporting **large-scale multimedia asset management** by offering **advanced content**, **knowledge representation,** and **management tools** that will be employed to support the creation of knowledge by evaluating (indexing, annotating, and interlinking) the existing digitised multimedia materials. The access to and resulting presentations of relevant information in an appropriate stylistic way, i.e., shaped rhythmically and thematically into rich information textures, requires a perspective management, as provided by BRIDGE in the form of a **dynamic and adaptive generation of information presentation**.

The BRIDGE consortium is also aware of a number of other recent IST projects as well as international activities that are relevant to this work. For this reason, the consortium has developed a dissemination plan, which includes integration and networking activities in the relevant scientific and commercial communities. Contacts with relevant international standards organisations and projects will be established, and mutual support and information exchange agreements will be sought.

BRIDGE supports the overall objectives of the IST Programme by introducing open and platform-independent technologies such as Java and XML, exemplified by the use of emerging multimedia presentation standards including MPEG-7, SMIL 2.0, the MPEG-21 framework and ontology and meta-data standards including the Resource Description Framework [RDF(S) 2001] and DAML+OIL [DAML+OIL 2001].

Importantly, BRIDGE implements a semantic-based information environment that integrates knowledge-based technologies with various media representation and presentation methods. This is a pre-requisite for publishing semantically rich content on web-based platforms. The project will act as a "trail blazer" by bringing together non-technical holders of specialist, non-standardised knowledge; by developing an agreed ontology of cultural studies; and by supporting generic information presentation of semantically rich contents to the consumer as multimedia objects.

B5. Innovation

Since virtual media-based knowledge spaces for museum environments are used to demonstrate the applicability and acceptability of the BRIDGE technology, we will first provide a quick overview on several initiatives dealing with the development of online or virtual museums.

Guggenheim.Com is a commercial initiative that claims to "set new standards for artistic content online by collaborating to provide an unprecedented level of expertise and collective talent from existing Guggenheim museums and partners from around the world" [Guggenheim 2001]. The site that will be launched at the end of 2001 will deliver a comprehensive menu of programs, services and commercial opportunities. Visitors to the site will find content across all genres of culture organized into several different categories for easy and quick exploration, including: visual arts, performing arts, news and information, travel, and a wide range of e-commerce and related opportunities.

The Museum Informatic Projects [MIP 2001] is a collaborative effort at the University of California, Berkeley, to coordinate the application of information technology in museums and other organized, non-book collections. This WWW page offers access to online collections databases, a hypertext-based page of Museum Standards Groups and Activities, a hypertext directory of campus museum and non-book collections, and detailed descriptions of active projects underway at MIP.

ARTISTE (An Integrated Art Analysis and Navigation Environment) is an EU-IST funded project that aims to provide galleries and museums, publishers, distributors, researchers and users of art images information, as well as the multimedia information market as a whole, a more efficient system for storing, classifying, linking, matching and retrieving art images [ARTISTE 2001].

COVAX [COVAX 2001] is an EU-IST funded project and has four basic aims: dissemination of European Culture Heritage, facilitating access for European citizens to primary sources of intellectual, cultural and scientific heritage stored in archives, libraries and museums; exploitation over the Internet of existing cultural infrastructures; the use of standards in the field of information structure and retrieval and interoperability between systems (interoperable access to distributed resources) based on the complementary capabilities of each partner.

These projects and initiatives understand the various media items as isolated artefacts within an e-commerce-oriented environment. Thus they focus on simple media combinations, such as image and text. However, they neglect the fact that the WWW has evolved far beyond mere text-based HTML pages with some images to a distributed *multi*media information system comprising videos (e.g., MPEG-2, MPEG-4, RealVideo, Windows Media Video), audio (e.g., MP3, RealAudio, Windows Media Audio), animation (e.g., Flash, Shockwave, VRML, X3D), and full-fledged synchronised multimedia presentations (e.g., SMIL, HTML+TIME).

The aim of this project is to bridge the gap between (standardised) multimedia content, (standardised) metadata, and high-level (standardised) ontological description of domain knowledge. BRIDGE will develop a new generation of ontology-based and metadata-driven multimedia applications to establish and exploit complexly structured, media-based information spaces. The distinctive advantages over existing and foreseen research prototypes and commercial products can be classified as follows:

- Networks of Concepts - Ontologies for Multimedia
- Emergent Standards for the Multimedia Semantic Web
- Semi-Automatic, Relational Annotations for Multimedia
- Fast Generation of Virtual Information Spaces: Browsing and Retrieval, Ontology-driven Multimedia Presentations
- User Modelling for Multimedia Environments

Networks of Concepts – Ontologies for Multimedia

Ontologies are universally recognised as an essential technology to achieve the Semantic Web. Ontologies provide both human-understandable and machine-processable semantic mechanisms. Thus, they offer a semantic – content and meaning based – approach to digitally stored data, to improve organisation, management, and understanding of the meaning of data. An ontology is a conceptual information model that describes "the things that exist" in a domain (hence the name): concepts, properties, facts, rules and relationships, in a consensual and formal way. An ontology thus acts as a reference model, providing a stable

baseline for shared understanding of some domain that can be communicated between people and different application systems. This provides a principled way to handle areas that must deal with vast amounts of distributed and heterogeneous computer-based information such as electronic business.

An important paradigm in developing and using ontologies is that one is considering concepts (instead of just using symbols, e.g., words). Thus, one tries to formalize concepts, referred to by symbols, by embedding them in a concept (or semantic) network with typed relations to other concepts. Networks of concepts in the form of ontologies feature three significant functions, which make them suitable as a platform for supporting the needs of the multimedia information society:

- They provide semantic structures that allow the definition of factual knowledge at a very fine-grained level
- They facilitate the dynamic use of different kinds of media material using links, enabling the connection from multi-layered concepts to data on different levels (e.g., media, metadata).
- They enable the semantic connection between concepts at different levels using typed relations, thus structuring the information on a semantic as well as a syntactic level.

BRIDGE will combine much of the functionality that is currently available in recent prototypes or products in at least three different domains (1) authoring and presentation tools for the web, (2) multimedia servers and repositories, and (3) knowledge management systems and prototypical Semantic Web applications. While each of these technologies alone cannot meet the requirements of authoring as well as accessing complex multimedia applications, the adaptation and integration of currently disconnected functionalities provide an environment where complex domain knowledge can be studied, discussed, commented, published and demonstrated – thus preserving and developing information artefacts.

Emergent Standards for the Multimedia Semantic Web

The WWW is a distributed heterogeneous collaborative multimedia information system, consisting of text, images, audio and video. The Semantic Web is being built as a meta-web on top of the existing WWW. Thus, to realize the vision of the Semantic Web large amounts of non-textual data have to be enriched with ontology-based metadata. Figure 1 provides an overview on XML-based standards for document and knowledge representations.

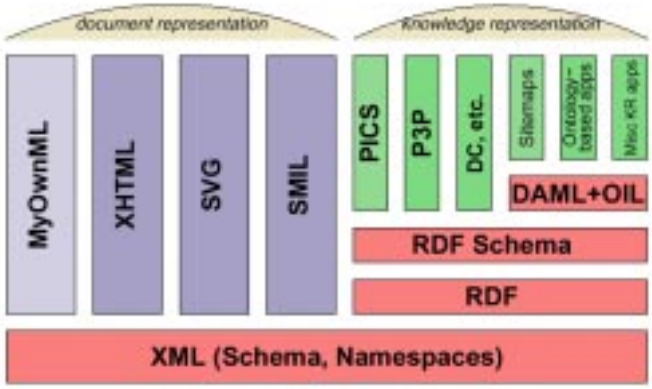

Figure 1: Current XML-based standards available for the semantic web

BRIDGE goes beyond the state-of-the-art towards the automatic processing of multimedia content using ontologies. BRIDGE combines multimedia standards (like MPEG-7, SMIL) with recently established Semantic Web technologies (RDF(S), DAML+OIL, [12, 30] [1]) to describe explicit, relational metadata with a formal semantics. For example to make MPEG-7 accessible, re-usable and interoperable with other application domains the semantics of the MPEG-7 metadata terms also need to be expressed in an ontology using a machine-understandable language (Hunter [2001] describes the modelling of MPEG-7 in an ontology).

[1] To ensure anonymity, citations of publications by project participants are numbered here, and the full bibliographical references are listed in the Annex to Part C of this proposal.

BRIDGE will investigate and propose specific data types geared to multimedia content (e.g., sample rates and sizes, colour spaces, loudness levels) and media specific data types (e.g., texture and shape for images) and make these representation primitives available for the public using specific BRIDGE namespaces. One important vision pursued by the BRIDGE consortium is to establish or further improve interoperability in multimedia (meta-)data and content supported by multiple Semantic Web representations, such as Dublin Core for Multimedia, Core Multimedia primitives based on MPEG-7 primitives, etc.

The challenge for BRIDGE is to allow for the inclusion of multimedia content that is described at different levels using multiple standards. The BRIDGE Semantic Services will consist of generic components for storing and accessing media, metadata, and different kinds of ontologies.

Semi-Automatic, Relational Annotations for Multimedia

An important aspect of the BRIDGE approach is to connect distributed knowledge sources such as domain ontologies (e.g., Getty's Art and Architecture Thesaurus (AAT), Library of Congress Thesaurus of Graphic Materials (LCTGM), or the Developments in International Museum and Cultural Heritage Information Standards [CIDOC 2001]) or application ontologies with the media repository.

The process of semantic annotation connects the media repository with the knowledge schemata by creating formal instances and relations between them. The current state-of-the-art of image annotation and indexing in archives (e.g., such as GETTYONE [2001]) typically require excessive labour by trained personnel to define a set of keywords that describe an image. This approach has severe problems: the consistency of the vocabulary is hard to enforce, there is no approach around that allows the definition of relations between keywords, and, this method does not scale up to hundreds of thousands of images because precision becomes very low. BRIDGE pursues a semi-automatic approach for semantic annotation, similar to [11,13]. One of the research challenges will be to establish a mapping from low-level features such as colour, texture, and shape to formal semantics and higher-level content-oriented descriptions.

Rather than restricting annotators to rigid predefined sets of metadata tags or unmanageable free text, a more balanced approach is pursued by BRIDGE. It allows users to define their own ontologies and provide means of extending them. Just as librarians have systems for updating their classification schemes, so must online media annotation schemes be able to grow. BRIDGE will tackle these limitations in order to jump from simple keyword-based, manual annotations towards complex, semantic-driven and semi-automatic annotations ([18]). The development of the BRIDGE annotation environment will facilitate solutions to the following questions:

- How can we combine fragments of different ontologies (e.g., parts of different thesauri) and manage multiple ontologies in general? (see [16])
- How can annotation collection be made part of the production process?
- How can we define a mapping from low-level features like colour, texture, and shape to formal semantics and real content-oriented descriptions? Thus, a challenge is to reuse existing feature extraction algorithms and combine their outputs to allow for semi-automatic semantic-driven annotations.
- How can we come up with agreed-upon media specific descriptions?

Ontology-driven Retrieval, Browsing and Multimedia Presentations from Large Media Repositories

Image-based information is a key component of human progress in a number of distinct subject domains. Digital image retrieval is a fast-growing research area with regard to both still and moving images. However, the increasing availability of potentially interesting image-based information on the web for nearly any domain raises a fundamental problem: how can the desirable information be accessed and, even more important, how can the retrieved results be presented so that the user can easily interpret and evaluate them. BRIDGE approaches this problem using different innovative strategies that may be roughly separated into retrieving, browsing, and presenting.

The overall presentation goal in BRIDGE is to generate customised user context-dependent interfaces and multimedia presentations on the fly. BRIDGE will use ostensive browsing techniques [Campell 2000, Crestani et al. 1998], an approach to capturing the intentionality of an information need that is assumed to be developing during the searching session. The capture of such spatio-temporal units is inherent to the concept of ostension, i.e., the explanation of a word/concept by presenting, pointing at, or otherwise indicating, one or more objects to which it applies. The relevance of an information unit is based on the degree to which evidence from the unit is representative/indicative of the current information need. The basis of ostensive

browsing in BRIDGE is the fine arts ontology developed by the domain experts, thus guarantying quality and integrity. Since the experts can also specify relation types, the virtual information space automatically provides access points and browsing directions to the user.

The dynamic "Access and Presentation Tool Suite (APTS)" provides the user with a browser interface, which maps the **current information need** of the user with the **actual position in the information space** and generates the new most relevant information presentation obtained from the **user** on the basis of the **recent search history** and **information and media type preferences** [15]. The screen is not understood as a window but rather as a dynamic frame. The dynamic concept of the browser allows the representation of the **relevance of information** based on spatial, textual and temporal properties of the different information units (e.g., important information is centred, in the foreground, whereas less important information is presented in the background, etc), which are retrieved from the physical description of the related information node. Thus, users can investigate an unknown space provided with the most relevant material and its annotations for the actual moment, allowing a progressing experience of completing the understanding of complex concepts in procedural, and participatory means (i.e., interactive and investigative in a navigable encyclopaedic space, providing access to the full temporal and spatial means of the media items). To achieve the functionality introduced above, we will

- Develop semantic services that allow for comprehensive, multi-level retrieval
- Adapt ostensive browsing techniques to the ontology-based multimedia application scenario
- Develop new presentation techniques, combining presentation independent knowledge (e.g., user profile – generated over time during the browsing session, graphic design rules, and domain knowledge as described by the expert) and an automated generation process on different abstract level, i.e., communicational devices (hypermedia design patterns [20,21,22]), qualitative, quantitative and multidimensional constraints [25,26,27], and media integration (e.g., assigning filters on media object to vary their presentation for integration to be other than what it would be under normal circumstances [32,34]).
- We will combine MPEG-4, SMIL and RDF technology. This combinatorial approach provides the required flexibility for dynamic user centred presentation, which current state-of-the-art web technology either in form of presentational languages such as SMIL (integration of media style), SVG (with CSS for graphics) and XHTML (with CSS for formatted text), or transformational methods such as XSLT (document transformation) and CSS (control of style appearance) cannot provide.

User Modelling for Multimedia Environments

Within BRIDGE we intend to build a user-driven multimedia environment [2, 6]. As mentioned earlier, BRIDGE tries to bring standards together. User modelling is very valuable and needs to be shared in the future, perhaps between different systems. Within BRIDGE we will analyse existing user modelling standards (e.g., UMIRL [UMIRL 2001], CPEX [CPEX 2001]) and extend them for the specific needs in multimedia.

In general there exist two ways for developing a user model. Firstly, there is the approach of an explicit user model based on survey, dialog or any other methods to obtain the user knowledge directly. Secondly, an implicit user model can be obtained by observing the user's behaviour using machine-learning methods or by inferring from existing domain knowledge.

Due to the fact that BRIDGE is oriented towards public knowledge spaces it seems not plausible to ask a visitor to undergo an extensive survey. Moreover, the problem with casual visitors is that they neither would allow storing the data on their machine, nor would they appreciate it if this information is stored centrally on a server. Thus, for this group of users BRIDGE will provide an interface that guides the user into an appropriate pre-defined user profile (e.g., available time and interest) and then observe the user's behaviour, gathering statistics for improving the system's aiding capabilities.

On the other side we also investigate in BRIDGE the possibilities of subscription-based services (where we can experiment with a mix of user history-based models and survey/dialogue approaches to facilitate access to information and support **socio-contributions** (i.e., pay by providing new information, either in form of material - audio, video, text, or by suggesting new relations). It is the belief of the BRIDGE project that the Semantic Web will only unleash its full potential if the borders of different communities are crossed and their standards, tools, experience, and competence are brought together: *multimedia*, *metadata*, and *ontologies* – as BRIDGE tries to achieve.

B6. Project workplan

In order to realize an operational version of the proposed framework for digital creation and access of complex information spaces, using the domain of museums focussed on fine arts as a case study, and to evaluate its functions in a realistic environment involving real end-users, the BRIDGE project will focus on the following activities:

- overall system specification based on a comprehensive *analysis of domain/use/technical requirements*;
- research on and development of a *task model* that covers different types of usages of the BRIDGE tool suite (function blocks of the annotation/indexing/access interface);
- development of set of semantic services (media &metadata manager, ontology manager, presentation style manager, user content manager, and presentation generator) and related tool suites (authoring and management tool suite, and access and presentation tool suite)
- analysis of the interaction between the emerging standards for representing multimedia, presentation, ontologies/metadata and user profiles.
- development of new user profiling techniques for open knowledge environments as well as for subscription-based information spaces
- application of (semi-)automatic *image analysis tools* and its relation to ontology and metadata standards;
- integration of all system components and tools;
- research on and design of a business model, which can be applied by the technology providers after the project;

The full list of activities – broken down into workpackages and specific tasks – will be given in sections B6.4 (project planning and timetable) and in B6.5 (workpackage list).

In the following section (B6.1) we first outline the already existing expertise, software components and knowledge bases, which will be utilized throughout the project. The system's functions and components will be related to workpackages (WPs) in B6.2. The subsequent four sections provide an overview of the temporal and organizational project structure including workpackage and deliverable lists. Finally, each workpackage is described in detail.

B6.1 Baseline of the project

In this section, we outline already existing software modules or techniques provided by project participants, which will be further developed, adapted and integrated into the final BRIDGE system during the project. The advances that the BRIDGE project aims to achieve at an European and international level require a wide range of European expertise that covers the following fields: Multimedia technologies, Semantic Web technologies, standardisation activities, a wide range of applications. As mentioned earlier the BRIDGE technology build on and extend existing standards, technologies and software tools, where the project participants have an outstanding experience.

Semantic Services and Tools for Ontology and Metadata Technology

In the BRIDGE project, RDF (the Resource Description Framework) and its schema extensions RDF-Schema and DAML+OIL will be used as the uniform internal representation language in which metadata and ontologies will be coded. The generated models will be serialized in XML. XML will be used as the exchange format for the communication between the BRIDGE components.

There exists a wide range of parsers and application programming interfaces for RDF-based applications. We will use the W3C RDF parser SiRPAC [SiRPAC 2001] as a baseline tool for processing RDF statements. On top of the parser several application programming interfaces (e.g., for the access to ontologies, or specific DAML+OIL APIs, etc.) have been developed in several related projects, e.g., the Simple Logic-based RDF

Interpreter [SiLRI 2001], the first logic-based inference engine for processing RDF statements implemented in Java ([10]).

The BRIDGE management and authoring tool suite will build on and extend existing work in this area. For the engineering and management of ontologies we will focus on existing tools for ontology-engineering, like Protégé-2000 [Protégé 2001], OntoEdit [OntoEdit 2001], [16], OilEd [OilEd 2001]. The consortium considers the extension of existing work as an important step. Thus, as much as possible code from existing engineering environments will we reused and adopted for the BRIDGE requirements. The engineering and management of metadata will rely on existing work, e.g., the Sourceforge project On-To-Mat [On-To-Mat 2001] and [13]. First steps towards semi-automatic image annotation will be achieved by reusing MPEG-7 feature extraction algorithms [ISO MPEG-7 2000]. These algorithms will be embedded into the ontology-based metadata environments. Database technology for the persistent storage of media, metadata and ontologies will be used. For media storage we will use commercial database technology (e.g., Informix).

The main impact will be made by a platform for the creation and usage of ontologies/semantic networks developed by one partner. This tool suite is a set of modules, which can be combined into different systems. Editing tools allow the creation and maintenance of the ontology / semantic network, usage tools take advantage of the knowledge modelled in the ontology. With another tool, documents can be authored and indexed with concepts from the ontology / semantic network The other parts of this environment are described in the section Presentation Standards further below.

Emergent Standards for the Multimedia Semantic Web

As mentioned above, BRIDGE tries through its research to connect existing standards to bring the Multimedia Semantic Web to its full potential. The partners have a strong research background and long standing practical expertise on emergent standards. One of the partners play in fact not only a major role in a number of W3C XML working groups, but also in ISO's MPEG-4 and MPEG-7 working groups, both using XML in their standardization activities: in MPEG-4 as the Extensible MPEG-4 Textual Format (XMT), and in MPEG-7 as the Description Definition Language (DDL), the multimedia content description interface. These links into the relevant standardisation bodies allow us not only to incorporate the latest results into the project but also to shape the outcome of the standardisation process. One of the partners has a tight relationship to the W3C Semantic Web Activity.

Presentation Standards

The approach for the presentation generator is based on two environments. On the one hand there is the environment for the information gathering and presentation design, and on the other hand there will be the automatic generation engine for the dynamic presentation user interface.

The 'Access and Presentation Tool Suite' will provide the presentation designer with a GUI to define platform dependent presentation styles, incorporating temporal, spatial, and stylistic constraints. The underlying encoding processor generates the internal XML schemata, which are used by the presentation generation engine.

Regarding the design of the "Presentation Style Manager" the consortium can build on work provided by two partners [32,26,27, 33,34]. The presentation generation engine will use the semantic service available from a constraint-based planning system, based on IC-Park's ECLiPSe system. ECLiPSe is a logic-based software system for the cost-effective development and deployment of constraint programming applications, e.g., in the areas of planning, scheduling, resource allocation, etc. It contains several constraint solver libraries, a high-level modelling and control language, interfaces to third-party solvers, an integrated development environment and interfaces for embedding into host environments. The constraints system will be used for solving the user related constraints (taken from the user, search history and context model) and design-based constraints.

Another tool that will be used is Apache's Cocoon. Cocoon is a Java publishing framework that relies on new W3C technologies (such as DOM, XML, and XSL) to provide web content. The fact that Cocoon distinguishes between document content, style and logic make it the ideal tool for transforming the presentation structures generated by the constrains engine into a SMIL presentation. Since Cocoon is modular it allows the use of domain specific DTDs or Schemata, which DEMUS will provide. However,

even if cocoon is currently used by one of the partners within their presentation generation engine, this partner is also investigating tools such as VPRO's Mmbase and Zope's ZOPE system.

Finally, we have access to the tool suite developed by one partner that offers a graphical and tabular view and allows for schema definition. Another set of tools are browser-based components. The semantic based components allow structured and "fuzzy" semantic searches. With the navigation components the ontology / semantic network can be graphically explored. Search results are automatically displayed as HTML-pages by the Layout-Engine. All components can be integrated with other tools through XML interfaces.

B6.2 System components and their relation to workpackages

In the following we will first provide an overview of the functional system layers and the components and then discuss the system architecture proposed to realize the functionality.

The BRIDGE ontology-based multimedia environment is a multi-functional software package integrating a large variety of functions, which will be realized by cooperating software modules. In the following we will first provide an overview of the functional system layers and the related data types and then discuss the system architecture proposed to realize the functionality.

At first glance, the BRIDGE system provides three different services (see the layers in *Figure 2*):

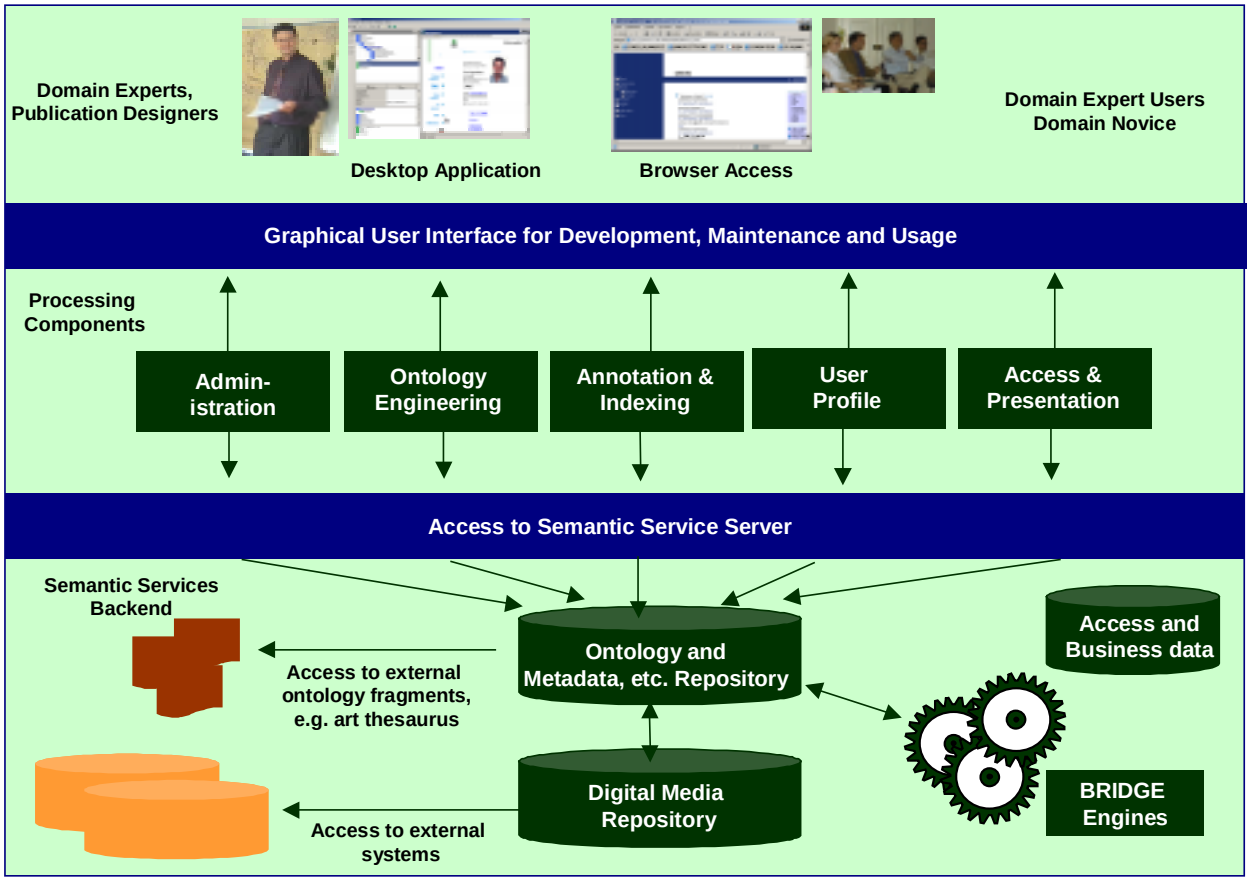

Figure 2: *BRIDGE service layer*

The **first, lowest layer** builds a comprehensive semantic server for multimedia data. It includes a digital media repository for the storage of images, text, and associated information. It connects to existing external systems, e.g., image repositories. On top of the media repository, the ontology and metadata repository is build. A tight integration between media and the semantic structures contained in the ontology is established.

Additionally, several bridge engines deliver added value on top of the repositories. Finally, access and business data is stored in a separate database.

The **second layer** consists of the BRIDGE processing components, the management suite that supports the development of an ontology-based multimedia application. It consists of an ontology engineering and management component, a semi-automatic annotation and indexing system, user profile and management component and the access and presentation manager. One further component is dedicated to administration purposes.

The **third layer** uses these processing components and makes them available to the different users introduced earlier via graphical user interface and client layer for development, maintenance and usage of BRIDGE applications. We distinguish between desktop applications (implemented as Java-Swing clients) and web-browser based applications (implemented using a web application server, such as ZOPE)

The system architecture sketched below in Figure 3 describes the main BRIDGE modules and the way in which they interact with each other.

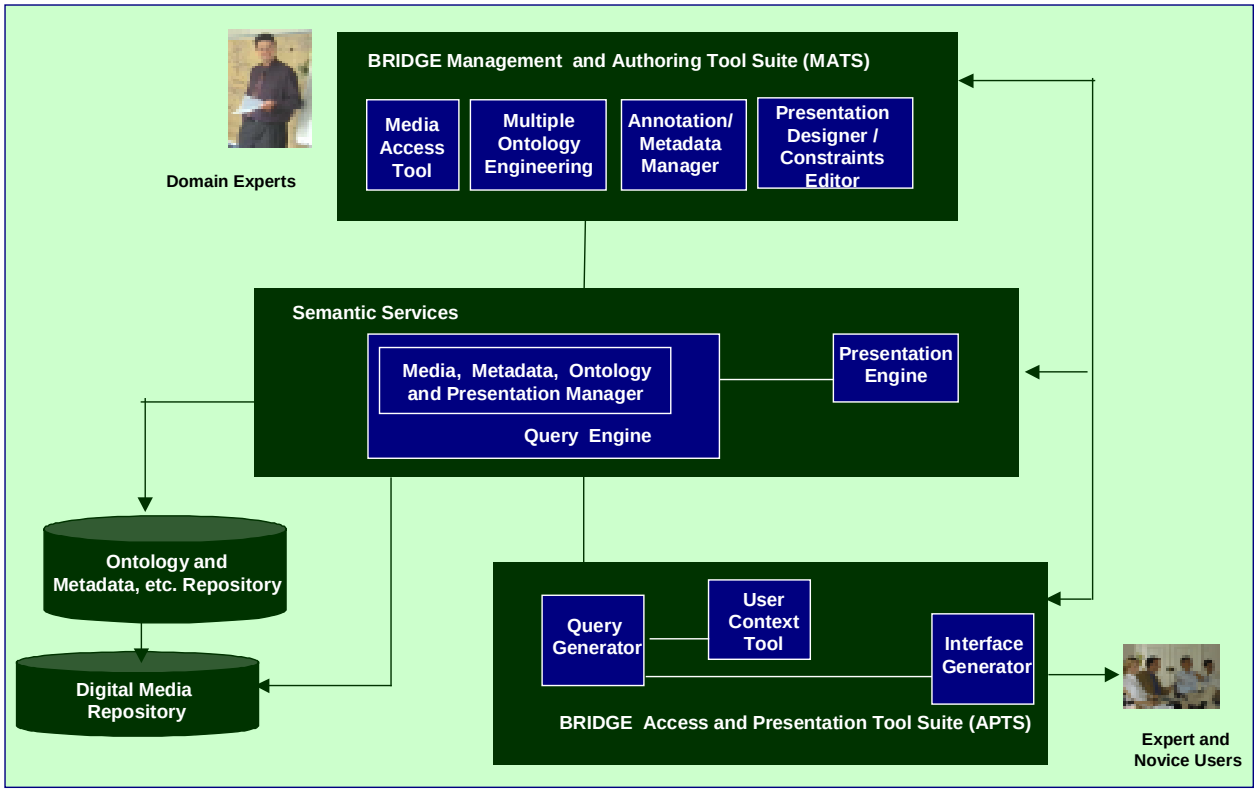

Figure 3: BRIDGE System Architecture

The **BRIDGE management and authoring tool suite (MATS)** (WP 6) serves the specific needs of the domain expert, it includes

- The **Media Access** Tool allows to import existing media elements, such as images and associated text documents, to import into MATS.
- The **Multiple Ontology Engineering** Tool allows to import and refine existing concepts, taxonomic and non-taxonomic relations and axioms. Moreover it supplies the definition and maintenance of new concepts, taxonomic and non-taxonomic relations and axioms. It allows to combine fragments of distributed ontologies to reuse as much as possible conceptual structures that have been already defined and are accepted (e.g., such as the AAT thesaurus)
- The **Metadata Generation / Annotation** Tool constitutes a graphical front end to the Metadata Manager. It allows the comfortable, semi-automatic annotation of media with metadata and the high-level concepts taken from the domain ontology and its associated information. It allows a fine-granulated description of media content.
- The **Presentation Style** Designer facilitates the definition of presentation style guidelines (layout, colours, etc.) for the generation of presentations.

BRIDGE-MATS accesses a comprehensive server backend, provided by the **BRIDGE Semantic Services** (WP 5). The BRIDGE Semantic Services include processing and management components for the media data, metadata, ontologies, user context and presentation style. These components access: *(i)* different repository modules for persistent storage (e.g., for ontologies & metadata, media data), and, *(ii)* different processing engines, such as the ECLiPSe presentation engine. BRIDGE semantic services are accessible via the BRIDGE application programming interface and via a query language. The Presentation Style Manager keeps track of presentation style guidelines (layout, colours, etc.) that are obeyed during presentation generation.

The **BRIDGE access and presentation tool suite (APTS)** (WP 7) allows users of various levels of expertise to investigate the associated information space (the content presentation is based on compilation on demand rather then pre-generated templates). As introduced earlier the main goal for this component is to allow the user ostensive browsing. The **query generator** transforms the current context, user profile, and next user interest into a request for content and an XML-based browser/player integrated in a web environment, that allows the presentation of the interactive interface generated by the presentation generator. The user context tool is on the one hand an administrative component that allows the creation and modification of users and user profiles. On the other hand the user context tool encompasses the functionality operating in the background, invisible to the user, which monitors the user's behaviour and updates the user profile.

B6.3 Project organization

In this section we outline the global logical (and implicit temporal) structure of the project, broken down into workpackages (WPs). A more fine-grained view – including also the specific tasks in the workpackages – will be given in section B6.4 (project planning and timetable).

In *Figure* 3 the arrows show which workpackage results contribute to and are prerequisite for other technical WPs (in the grey-shaded area). This illustrates how all the workpackages planned for BRIDGE are closely intertwined, which is essential to a successful project.

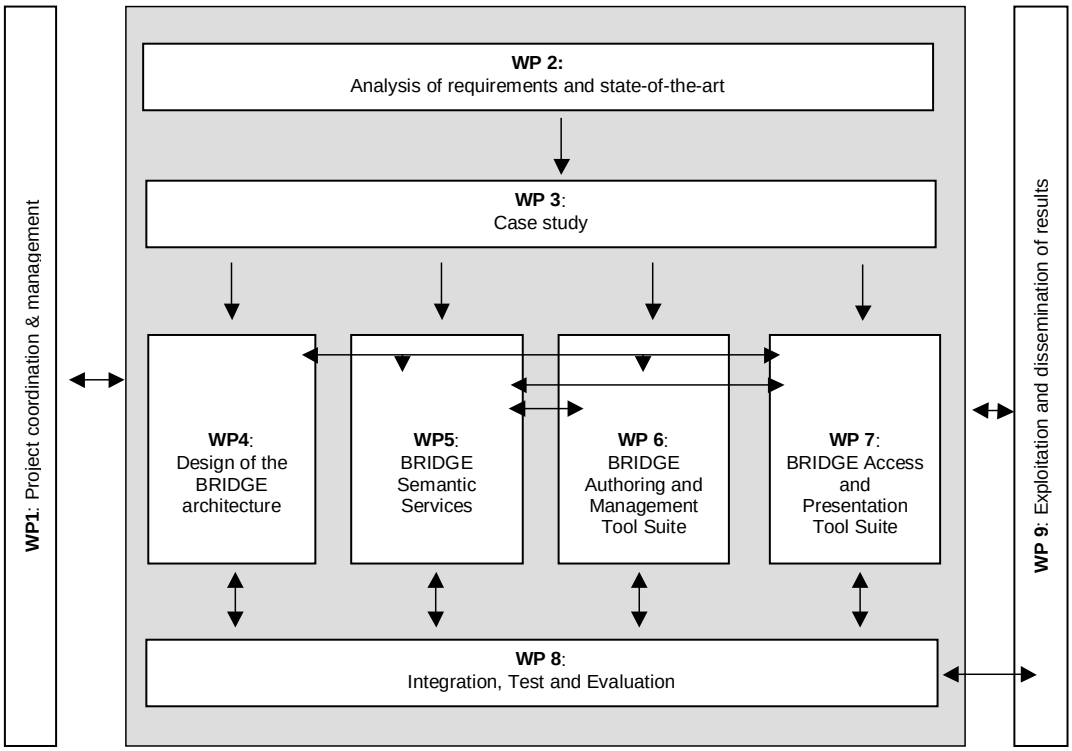

Figure 3: Workpackages and their interrelationships

The development of BRIDGE reflects very much the underlying holistic approach of establishing large information spaces. This means that the development process is complex, distributed and requires a high level of communication and synchronisation between the involved partners. Thus, it is essential that each workpackage leader is not only responsible for the temporal and content organisation within their own package but also supports the overall complex synchronisation on project level – as provided by WP1.

Due to the interweaved relation between research and development in this project providing an elaborating improvement circle, there are no endpoints of research or implementation development, except month 36 marking the end of the project.

BRIDGE will have 3 iterations of tool development and validation. The idea is to make a fast start and achieve good cohesion between the non-technical user groups and the technical tool developers and to make both groups acquainted with the basic terminology used in each field.

The first iteration will start at the kick-off meeting (WP 2 and WP 3), with a workshop to define authors' tool requirements and usage scenarios. The outcome will be a first demonstrator realising some crucial parts of the requirements capture, design, and implementation/adaptation. Over the following 8 month several iterations will provide information used for the representation models of required information node types, grades of descriptive granularity, relation types, media types and formats, etc., as well as for the overall interface design and user modelling. The results of this phase, i.e., the ontology for fine arts and the final demonstrator, will serve as input for the second iteration of tool development and validation. At the end of month 8, there will be a consolidation meeting at which the user and developer groups can sign-off the requirements and clear problems with the tools, face to face.

The second iteration of tool development and validation begins at month nine, with the design of the BRIDGE system architecture (WP4), which will be finished at month 11. The design will simultaneously influence and be influenced by the work on the BRIDGE Semantic services (WP 5), the necessary BRIDGE Authoring and Management Tool Suite (WP6) and the BRIDGE Access and Presentation Tool Suite (WP7), which all start at month 9 as well. The development of these environments will last until month 14, using rapid prototyping to support quick evolution cycles. The second iteration phase comes to an end with the integration phase (WP 8), where the various tools are gathered to form the first BRIDGE prototype. There will still be time to consider issues arising from this integration process. At month 18 the prototype will be made fully available to the museum and the first web-based museum space will be released to the general public. The second iteration phase will be finished off with the evaluation of the prototype and the information spaces. This evaluation will provide an objective assessment of the current status of the project on a technical as well as on usability level, i.e., an assessment of the system effectivity and user satisfaction with the user interfaces. The outcome will stimulate further improvements of the already established functionality of the system architecture/functionality as well as expert and user environments for the second half of the project. At the beginning of month 20 there will be a meeting with all consortium members at which the final set of functionality and requirements both on a technical and service level will be signed off.

From month 20 the third iteration of tool development and validation begins. This phase is entirely devoted to the improvement of the BRIDGE prototype (WP4, WP5, WP6 and WP7) and constant testing of tools and system design by experts from the museum partners and the established information spaces through users accessing the museum web environments (WP8). The latter will ensure user participation in the development process and thus to guarantee the user friendliness and function range of the final tool suite.

From month 20 to 22 the BRIDGE architecture will be adapted to the findings of the first evaluation report. The further development of the various tool suites and the BRIDGE services will follow the development line agreed upon by all partners. However, the stepwise refinement and corrections of design assumptions will also take into consideration the results of the project internal tests. In month 32 the final release of tools is handed over to the last integration phase (WP8), where last changes on tools can be performed. Month 34 to 36 will see the last evaluation of the environment and the established information spaces for Fine arts. The results of this evaluation will supply a list of suggestions of further improvements to be used in the final report as an indicator for additional developments.

The objective of the final release (tools and information space) is to provide tools that can be used by the museum partner, thus disseminating the results of the project into the wider user community.

The BRIDGE consortium follows a stepwise approach in exploiting the project results. The goal is to acquire know-how in the establishment of ontology-based multimedia applications for the Semantic Web and to commercialise the results as a business best practice.

1. Successful completion of the baseline project and development (collection and packaging) of "Best Practice Reference“ for generic use.
2. Starting with dissemination activities after the first indications of successful results → Presentation of "hands-on-adoption“ lessons learnt.
3. In case of a successful baseline, adaptation of tools and technology for all processes/projects of the various consortium partners.

The BRIDGE partners have identified the further exploitation of the project results as integrated part of their optimisation activities and have the strong will to disseminate the outcome results to the best of any interested party in the European Community. We will follow a multi-step dissemination approach in order to reach different target groups. On the one hand we will address directly the relevant industry-sectors and potential customers of both the technology providers and technology validation group and on the other hand we approach the wider region of all participants with localised demonstrations and awareness actions of the technologies and the use-case.

At the very beginning of the project WWW-pages will be established on our Internet server, providing current information on project’s objectives, the consortium and the up-to-date information about the current state of BRIDGE. All partners will contribute to the preparation and regular update of this WEB site. After the end of the project, the site will continue to exist providing information about the project’s results. The consortium will publish a report containing strategies and recommendations for the creation and maintenance of multimedia information spaces. In the first part of this brochure they will work out common tasks of a strategic and technological management for the application of BRIDGE technology. In the second part they will describe its experiences within the frame of BRIDGE and its concrete museum applications. The brochure aims to show innovative companies which is the best way to build up and use the BRIDGE technology.

During the course of the project we will execute various dissemination activities:

1. Organisation of seminars presenting the achievements of the project and sensitising the industry about prospects on the European market, dynamic networked organisations and the value of strategic international partnerships,
2. Publications in marketing journals.
3. Publication of the information space for fine arts and its ontology in a web environment
4. Academic publishing in arts and computer science
5. Publication of brochures.

After the end of the project we will disseminate the harmonised results with:

1. press conferences to ensure the presentation of the results in leading business magazines,
2. participation at the relevant fairs (CeBIT, ICE etc.)
3. academic publishing in arts and computer science with reference to our experiences within BRIDGE,
4. publication of a report comprising both collected and harmonised results of the project,
6. organising economic seminars for software technology SMEs and users on the basis of the results of BRIDGE.

The aim of all the above dissemination activities is to raise the awareness of the academic and industrial community about the prospects, benefits and hurdles of setting up multimedia information spaces and about efficient business best practices on how to implement organisational and technological methods and tools for the BRIDGE technology. A detailed description of the exploitation strategies is provided in part C8 of this proposal.

B6.4 Project planning and timetable

Workpackages & Tasks \ Temporal duration in month	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
WP1 Project Coordination & Management																		
1.1 Administrative and financial Co-ordination	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
1.2 Technical project management	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
WP2 Analysis of requirements and state-of-the-art	**M**																	
2.1 Analysis of application/domain requirements	■	■																
2.2 State-of-the-Art analysis	■	■																
2.3 Definition of final application scenario	■	■																
WP3 Case Study				**M**														
3.1 Ontology development for Fine arts	■	■	■	■														
3.2 Demonstrator development	■	■	■	■														
WP4 Design of the BRIDGE architecture						**M**					**M**							
4.1 System interface architecture					■	■					■							
4.2 Semantic services					■	■					■							
4.3 Authoring and management tool site					■	■					■							
4.4 Access and presentation tool suite					■	■					■							
WP5 BRIDGE Semantic Services								**M**								**M**		
5.1 Media & metadata manager					■	■	■	■	▒	▒	■	■	■	■	■	■	▒	▒
5.2 Ontology manager					■	■	■	■	▒	▒	■	■	■	■	■	■	▒	▒
5.3 Presentation style manager					■	■	■	■	▒	▒	■	■	■	■	■	■	▒	▒
5.4 User context manager					■	■	■	■	▒	▒	■	■	■	■	■	■	▒	▒
5.5 Presentation generator					■	■	■	■	▒	▒	■	■	■	■	■	■	▒	▒
WP6 BRIDGE Authoring and Management Tool Suite								**M**								**M**		
6.1 Media Manager Tool & Metadata Generation Tool					■	■	■	■	▒	▒	■	■	■	■	■	■	▒	▒
6.2 Ontology Engineering					■	■	■	■	▒	▒	■	■	■	■	■	■	▒	▒
6.3 Presentation style designer					■	■	■	■	▒	▒	■	■	■	■	■	■	▒	▒
WP7 BRIDGE Access and Presentation Tool Suite								**M**								**M**		
7.1 Presentation engine					■	■	■	■	▒	▒	■	■	■	■	■	■	▒	▒
7.2 User context tool					■	■	■	■	▒	▒	■	■	■	■	■	■	▒	▒
WP8 Integration, Test & Evaluation									**M**	**M**							**M**	**M**
8.1 First Prototype									**I**	**E**								
8.2 Refined Prototype											■	■	■	■	■	■	**I**	**E**
WP9 Exploitation & dissemination of results																		**M**
9.1 Dissemination of results	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
9.2 Commercial strategies for exploitation	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

M= Milestone I= Integration E= Evaluation ■ = Treatment ▒ = Adaptation

B6.5 Workpackage list

Work-package No	Workpackage title	Lead contractor No[2]	Person-months	Start month	End month	Ph	Deliverable No
WP1	**Project Coordination & Management**	**1**	**21**	**0**	**36**		D 1.1- D 1.7
WP2	**Analysis of requirements and state of the art**	**1**	**10**	**0**	**3**		D2.1
2.1	Analysis of application/domain requirements	4	4	0	3		
2.2	State-of-the-Art analysis (technical)	1	4	0	3		
2.3	Definition of final application scenario	3	2	0	3		
WP3	**Case Study**	**4**	**37**	**0**	**6**		
3.1	Ontology development for Fine arts	4	17	0	6		D3.1
3.2	Demonstrator development	3	20	0	6		D3.2 D3.3
WP4	**Design of the BRIDGE architecture**	**2**	**30**	**6**	**22**		
4.1	System interface architecture	2	2	6	22		D4.1 D4.2
4.2	Semantic services	2	12	6	22		D4.1 D4.2
4.3	Authoring and management tool site	3	8	6	22		D4.1 D4.2
4.4	Access and presentation tool suite	1	8	6	22		D4.1 D4.2
WP5	**BRIDGE Semantic Services**	**2**	**68**	**9**	**32**		
5.1	Media & metadata manager	2	22	9	32		D5.1 D5.2
5.2	Ontology manager	3	22	9	32		D5.1 D5.2
5.3	Presentation style manager	1	2	9	32		D5.1 D5.2
5.4	User context manager	2	2	9	32		D5.1 D5.2
5.5	Presentation generator	1	20	9	32		D5.1 D5.2
WP6	**Management and Authoring Tool Suite**	**3**	**41**	**9**	**32**		
6.1	Media Manager & Metadata Generation Tool	2	10	9	32		D6.1 D62
6.2	Ontology Engineering	3	21	9	32		D6.1 D62
6.3	Presentation style designer	1	10	9	32		D6.1 D62
WP7	**Access and Presentation Tool Suite**	**1**	**23**	**9**	**32**		
7.1	Presentation engine	1	15	9	32		D7.1 D7.2
7.2	User context tool	2	8	9	32		D7.1 D7.2
WP8	**Integration, Test & Evaluation**	**3**	**48**	**16**	**36**		
8.1	First prototype	3	24	16	20		D8.1 D8.2
8.2	Revised prototype	1	24	16	36		D8.3 D8.4
WP9	**Exploitation & dissemination of results**	**4**	**55**	**0**	**36**		
9.1	Dissemination of results	2	18	0	36		D9.1
9.2	Commercial strategies for exploitation	4	27	0	36		D9.2 D9.3
	TOTAL		**333**				

[2] Number of the contractor leading the work in this workpackage.

B6.6 Deliverables list

Deliverable No	Deliverable title	Delivery date	Nature [3]	Dissemination level [4]
D 2.1	Specification of the final application scenario	2	R	PP
D 3.1	Implementation of the demonstrator	4	D	RE
D 3.2	Final version of the demonstrator, structures and functions	8	R	RE
D 3.3	Final design of the ontology and knowledge model for Fine arts	8	R	RE
D 4.1	First design of the BRIDGE architecture	11	R	RE
D 4.2	Revised design of the BRIDGE architecture	22	R	RE
D 5.1	First implementation of the BRIDGE Semantic Services	16	P	RE
D 5.2	Revised implementation of the BRIDGE Semantic Services	32	P	RE
D 6.1	First implementation of the BRIDGE Management and Authoring Tool Suite	16	P	RE
D 6.2	Revised implementation of the BRIDGE Management and Authoring Tool Suite	32	P	RE
D 7.1	Prototype of Access and Presentation Tool Suite (version 1)	16	P	RE
D 7.2	Prototype of Access and Presentation Tool Suite (final version)	32	P	RE
D 8.1	Basic prototype version	18	P	PU
D 8.2	Basic prototype: Evaluation and performance report	20	R	PU
D 8.3	Revised prototype version	34	P	PU
D 8.4	Revised prototype: Evaluation and performance report	36	R	PU
D 9.1	Dissemination of results	36	R	RE
D 9.2	Commercial strategies for exploitation	36	R	CO
D 9.3	Business Plan for ongoing commercial development and service provision	36	R	CO
D 1.1	Project Management Report 1-1	6	R	CO
D 1.2	Project Management Report 1-2	12	R	CO
D 1.3	Project Management Report 2-1	18	R	CO
D 1.4	Project Management Report 2-2	24	R	CO
D 1.5	Project Management Report 3-1	30	R	CO
D 1.6	Project Management Report 3-2	36	R	CO
D 1.7	Final Project Report	36	R	RE

[3] Please indicate the nature of the deliverable using one of the following codes:

R = Report **P** = Prototype **D** = Demonstrator **O** = Other

[4] Please indicate the dissemination level using one of the following codes:

PU = Public

PP = Restricted to other programme participants (including the Commission Services).

RE = Restricted to a group specified by the consortium (including the Commission Services).

CO = Confidential, only for members of the consortium (including the Commission Services).

B6.7 Workpackage descriptions

Workpackage number:	1	**Start date or starting event:**			Month 0			
Participant number:	1	2	3	4	5	6		
Person-months per participant:	9	8	1	1	1	1		

Objectives

The project management encompasses the administrative and financial management inside the project, and between the project and the European Commission. The objectives are: to ensure timely and qualitative performance of the project (technical management) and to provide timely and efficient administration and financial co-ordination.

Description of work

This workpackage will ensure that the project partners are constantly in communication and share their obtained results inside the consortium, leading the project to fulfill its established objectives. Also, it includes the financial management and control of the project resources

- Financial and administrative Project Management

The financial administration covers: establishing and maintaining financial records, the co-ordination of cost statement submissions, preliminary checks of individual cost statements against known criteria (contractual commitments, progress reports, delivery of results approved by project Q.A.) and consolidation of cost statements, follow-up of EU payments, distribution of partner shares. Moreover, the financial administration embraces the legal issues between the members of the consortium and between the consortium and the Commission. Finally, it handles the progress report preparation, the gathering of partner inputs and their submission.

- Technical Project Management

The technical co-ordination will cover among others: work-package and task co-ordination, work plan maintenance, monitoring of project progress, identification and trouble shooting of technical or organisational problems. Frequent meetings will be fixed to exchange information between the partners and to share their experiences (project progress review, decision-making and conflict resolution). The technical project management will in particular pay attention to the co-ordination of timely production of deliverables and the quality control against technical and contractual aspects, in particular the results o the evaluation of the BRIDGE prototype (WP8), in order to ensure that the evidence gained is used for the subsequent system design and development. At the end of the development phase, a final Project Report will be provided. This will include a compilation of the conclusions obtained in the other activities, an integrative analysis of the development results, introducing some recommendations about the possible next research paths and evolution steps which may arise from the BRIDGE project.

The specific management structure and procedures to be followed in the project are described in detail in Part C of this proposal.

Deliverables

D 1.1 – D 1.6	Project Management Reports – technical and financial	two PMRs per year
D.1.7	Final Project Report	Month 36

Milestones[5] and expected result

Final Project Report (PR), summarizing the major results provided in the Deliverables and Project Management Reports (PMRs), including a comprehensive evaluation and discussion of the project results — Month 36.

[5] Milestones are control points at which decisions are needed; for example concerning which of several technologies will be adopted as the basis for the next phase of the project.

Workpackage number:	2	**Start date or starting event:**			Month 0			
Participant number:	1	2	3	4	5	6		
Person-months per participant:	2	1	1	2	2	2		

Objectives

The main goal of this workpackage is to collect the requirements of the application partners and to provide a comprehensive state-of-the-art evaluation of existing market products, standards (RDF, DAMIL+OLI, MPEG-7, etc), or hardware and software brought in by the technical partners.

Description of work

This workpackage specifies the scope of the BRIDGE application in the domain of information spaces for museums of the fine arts. The tasks of this working package are:

- to establish a detailed descriptions of the user requirements by the museum partners of the consortium. This incorporates a description of the artefacts and art domains to be included into the prototype and an outline of the usage scenarios.
- to provide an analysis of the application requirements. This includes an update on the latest developments of software and prototypes provided by the technical partners of the consortium during the time of proposal writing and start of the project.
- to supply a market and competitor overview, regarding hardware and software components, existing ontologies and thesauri developed during proposal writing and start of project,
- to analyse the latest versions of existing standards for semantic descriptions and presentation generation from standardisation bodies such as the as W3C and ISO,
- to define the final application scenarios that form the basis for the ongoing development.

Deliverables

D2.1 Specification of final application scenarios, including the application description, requirements and state-of-the-art analysis Month 3

Milestones and expected result

Study of application requirements. Detailed state-of-the-arts analysis of existing tools and standards. The results of this WP will be used for the design and implementation of the prototype (WP 3) — Month 3.

Workpackage number:	3	**Start date or starting event:**		Month 0				
Participant number:	1	2	3	4	5	6		
Person-months per participant:	1	1	5	20	5	5		

Objectives

- Development of a descriptor (authoring and usage tools) as basis for the prototype development
- Building of ontology

Description of work

In WP3, BRIDGE will use semantic web tools and presentation prototyping environments to develop a BRIDGE demonstrator. In order to ensure a fast start and significant progress, there will be three workshops in the first six months. During that time, several iterations of requirements capture, design, and implementation/adaptation will be made, leading into the basic prototype. This knowledge elicitation process will provide information used for the representation models of required information node types, grades of descriptive granularity, relation types, media types and formats, etc. (BRIDGE Semantic Services), as well as for the overall interface design and user modelling (Management and Authoring Tool Suite, Access and Presentation Tool Suite).

Tasks

- Development of an ontology for Fine arts

  Knowledge engineers and experts will define a standard ontology of Fine arts. On the basis of this ontology, the application partner in cooperation with the technical partner responsible for the basic prototype will design showcases. There will be several iterations of the knowledge model: at a kick-off-workshop, an initial knowledge model will be established. Afterwards this ontology has to be refined, i.e., extended by adding more elements to the basis. This allows designing the authoring and usage tools using the extended and modified ontology in the further progress of the project, as described in WP8.
- Demonstrator for Management and Authoring Tool Suite (MATS)

  Based on the usage scenarios worked out in WP2, and being able to build on experience with existing knowledge management tools we will enhance these tools with the desired functionalities, using rapid prototyping for quick evolution cycles of components in the implementation of component-based, object-oriented design. At the kick-off meeting, the application partner and the tool developer will define an initial set of requirements. The consortium will also agree on basic use cases for the first release of the authoring tools.
- Demonstrator for the Access and Presentation Tool Suite (APTS)

  A set of usage tools has to be designed. to fulfil the absolute requirement for "understanding" the contents of a knowledge network-based data pool which is the possibility to explore the information on the subject level and to relate concepts to each other. Thus the user has to be provided with a compact extract of the knowledge network, which implies the needed solution to be of high typographical quality in dynamically generated websites as well as in printed reports. Layouts are to be put together following typographical rules and the stylistic guidelines and constraints posed by the application partner. The application partner and the tool developer use the results of the prototype to define an initial set of requirements also for APTS. An agreement concerning basic use cases for the first release of the tool suites will also be aimed at the kick-off meeting.

The results of this WP impact WP4, WP5, WP6, and WP7.

Deliverables

D 3.1: Implementation of the descriptor	Month 4
D 3.2: Final version of the interfaces, structures and functions	Month 8
D 3.3: Final design of the ontology and knowledge model for Fine arts	Month 8

Milestones and expected result

First prototype of authoring Tools — Month 8
First prototype usage tools — Month 8
Ontology / knowledge model of Fine arts — Month 8

Workpackage number:	4	**Start date or starting event:**			Month 6			
Participant number:	1	2	3	4	5	6		
Person-months per participant:	8	12	8	2	-	-		

Objectives

The main objective of this work package is the design of the BRIGBE architecture, which includes the

- Definition of the BRIDGE Semantic Services for the management of and access to media data, metadata, ontologies, user context and presentation style. These services facilitate also the context driven presentation generation.
- Definition of the BRIDGE Authoring and Management Tool Suite, that comprises tools for the management of the media data, the engineering of ontologies and instances of ontologies, the generation of metadata, the knowledge annotation and design of presentation styles.
- Definition of the BRIDGE Access and Presentation Tool Suite, that provides the user context modelling and the presentation services.

Description of work

Based on the results of the requirements analysis (D 2.1) and the case study and first prototype (D 3.1 and D 3.2), this workpackage addresses the elaboration the detailed BRIDGE system architecture. For each of the intended system components the functionality, interfaces, and interaction with other system components are determined:

- For the BRIDGE semantic services the components Media Manager, Ontology Manager, Metadata Manager, Presentation Style Manager, User Context Manager and Presentation Generation are defined. In addition, the interaction of the components of the BRIDGE semantic services is specified. The results of this specification are input to WP 5.
- For the BRIDGE Authoring and Management Tool Suite a Media Manager Tool, a Presentation Style Designer, a Ontology Engineering Tool, a Metadata Generation Tool and a Knowledge Annotation Tool are defined. Furthermore the interfaces of the tools to the BRIDGE Semantic Services are specified. The results of this specification are input to WP 6.
- For the BRIDGE Access and Presentation Tool Suite a Presentation Engine and a User Context Tool are defined. Furthermore the interfaces of the tools to the BRIDGE Semantic Services are specified. The results of this specification are input to WP 7.
- Based on the results of the evaluation of the first BRIDGE prototype (D 8.1), the BRIDGE architecture is revised. The revision impacts WP 5, WP 6 and WP 7.

Deliverables

D4.1: First design of the BRIDGE architecture Month 11
D4.2: Revised design of the BRIDGE architecture Month 22

Milestones and expected result

This workpackage lays the foundation for the development of the BRIDGE Semantic Services, the Authoring and Management Tool Suite and the Access and Presentation Tool Suite for the first prototype (month 11) and the revised version (month 22).

Workpackage number:	5	**Start date or starting event:**			Month 9			
Participant number:	1	2	3	4	5	6		
Person-months per participant:	22	24	22	-	-	-		

Objectives

The objective of WP 5 is the implementation of the BRIDGE Semantic Services, essential components designed during WP 4 providing a kernel of semantic web services. In particular, these are the:

- Media Manager
- Metadata Manager
- Ontology Manager
- Presentation Style Manager
- User Context Manager
- Presentation Generator

Description of work

The implementation of the BRIDGE Semantic Services is tightly coupled to WP 4 and WP 8. Outgoing from the initial design of the BRIDGE architecture (D 4.1), a first version of the components of the BRIDGE Semantic Services is implemented (D 5.1). In WP 8, the implementation results are then incorporated into the first prototype (D 8.1) and exposed to the users of BRIDGE. Based on the experiences made and the errors unveiled while operating the first prototype and the inevitable subsequent changes to the design of WP 4 (D 4.2), the implementation of the components of the BRIDGE Semantic Services is revised (D 5.2) and integrated into the revised prototype (D 8.2). In more detail, the implementation of the BRIDGE Semantic Services includes implementations of the following components:

- *Media Manager & Metadata Manager:* The Media Manager is a service providing storage and access to the various media produced during the project. The Metadata Manager is a standard-conformant (MPEG-7, RDF) authority controlling low-level descriptive metadata for these media as well as their relationships to the high-level concepts of the ontology of fine arts (D 3.1) available at the Ontology Manager.
- *Ontology Manager:* The Ontology Manager manages the high level knowledge of the application domain using the ontology developed in WP 3 (D 3.1). It is open to relevant standards (RDF Schema, OIL, DAML).
- *Presentation Style Manager:* The Presentation Style Manager keeps track of presentation style guidelines (layout, colours, etc.) that are obeyed during presentation generation.
- *User Context Manager:* The User Context Manager manages the descriptions of the contexts (preferences, education, infrastructure) of the users and user groups of BRIDGE.
- *Presentation Generator:* The Presentation Generator is a service providing the automatic generation of personalised multimedia presentations out of the media managed by the Media Manager. For presentation generation, it considers descriptions of the media available at the Metadata Manager, the domain knowledge managed by the Ontology Manager, as well as user contexts and presentation styles available at the User Context Manager and the Presentation Style Manager.

Deliverables

D 5.1 First implementation of the BRIDGE Semantic Services, as part of the first prototype Month 16
D 5.2 Revised implementation of the BRIDGE Semantic Services, as part of the final prototype Month 32

Milestones and expected result

Availability of the basic implementation of the BRIDGE Semantic Services — Month 16

Availability of the revised implementation of the BRIDGE Semantic Services — Month 32

Workpackage number:	6	**Start date or starting event:**		Month 9				
Participant number:	1	2	3	4	5	6		
Person-months per participant:	10	10	21	-	-	-		

Objectives

The objective of WP 6 is the implementation of the BRIDGE Authoring and Management Tool Suite (MATS), a graphical, easy to use authoring front-end to the BRIDGE Semantic Services of WP 5 according to the design specifications of WP 4. In particular, the BRIDGE Authoring and Management Tool Suite consists of the:

- Media Manager Tool
- Ontology Engineering Tool
- Metadata Generation Tool
- Presentation Style Designer

Description of work

The implementation of the BRIDGE MATS is tightly coupled to WP 4 and WP 8. Outgoing from the initial design of the BRIDGE architecture (D 4.1), a first version of the tool suite is implemented (D 6.1). In WP 8, the implementation results are incorporated into the first prototype (D 8.1) and exposed to the users of BRIDGE. Based on the experiences made while operating the first prototype and the inevitable subsequent changes to the design of WP 4 (D 4.2), the implementation of the components of the BRIDGE Semantic Services is revised (D 6.2) and integrated into the revised prototype (D 8.2) in WP 8. In more detail, the implementation of the tool suite includes the following components:

- *Media Manager Tool:* The Media Manager Tool is a graphical front end to the Media Manager allowing the import/export of media to/from BRIDGE.
- *Ontology Engineering Tool:* The Ontology Engineering Tool provides a graphical user interface to the Ontology Manager offering profound support for the whole process of ontology construction. It is used to create the ontology for fine arts.
- *Metadata Generation Tool:* The Metadata Generation Tool constitutes a graphical front end to the Metadata Manager. It allows the comfortable, semi-automatic annotation of media with metadata and the high-level concepts taken from the domain ontology of fine arts.
- *Presentation Style Designer:* Being a front end to the Presentation Style Manager, the Presentation Style Designer facilitates the definition of presentation style guidelines (layout, colours, etc.) for the generation of presentations.

Deliverables

D 6.1 First implementation of the BRIDGE Authoring and Management Tool Suite, as part of the first prototype – Month 16

D 6.2 Revised implementation of the BRIDGE Authoring and Management Tool Suite, as part of the final prototype Month 32

Milestones and expected result

Availability of the basic implementation of the BRIDGE Authoring and Management Tool Suite — Month 16
Availability of the revised implementation of the BRIDGE Authoring and Management Tool Suite — Month 32

Workpackage number:	7	**Start date or starting event:**		Month 9				
Participant number:	1	2	3	4	5	6		
Person-months per participant:	10	7	2	4	-	-		

Objectives

This workpackage encompasses the development of the Access and Presentation Tool Suite (APTS), which allows users of various levels of expertise to investigate the associated information space (the content presentation is based on compilation on demand rather then pre-generated templates).

The main goal for the interface is to allow the user ostensive browsing. We envision a system that allows a flexible presentation depending on the characteristics of the objects found and reflecting the changing focus of the user's information interest by adequate content selection and a sensible presentation at the appropriate abstraction level. The request for information is based on the current context and the user profile. The presentation is based on the stylistic structures embedded in the information space, layout functions for media composition using the structural mark-up of the selected material, if available.

Description of work

This workpackage specifies and implements the APTS system, which allows the service provider, i.e., the museum, to specify the presentation design, and provides the retrieval and presentation interface for users interested in the content of the information space. The implementation of the APTS is tightly coupled to WP 4 and WP 8. Outgoing from the initial design of the BRIDGE architecture (D 4.1), a first version of the tool suite is implemented (D 7.2). In WP 8, the implementation results are incorporated into the first prototype (D 8.1). The first prototype will be evaluated after the first half of the project on a technical and usability level as described in WP8. The suggested improvements and further developments serve as guidelines for research and development issues for the second half of the project (WP 4 and WP 7). The final prototype will again be evaluated as described in WP 8.

The implementation of the tool suite includes the following components:

- The *presentation engine*: It will contain a *query generator*, which transforms the current context, user profile, and next user interest into a request for content and an XML- based browser/player integrated in a web environment, that allows the presentation of the interactive interface generated by the presentation generator (WP 5).
- The *user context tool*: It detects and maintains the user context
- The first prototype will be evaluated after the first half of the project on a technical and usability level as described in WP8. The suggested improvements and further developments serve as guidelines for research and development issues for the second half of the project.

Deliverables

D7.1	APTS prototype, as part of the first prototype	Month 16
D7.2	APTS final version, as part of the final prototype	Month 32

Milestones and expected result

APTS prototype (Month 16) providing the means for browsing in the pilot presentation on various expertise levels with dynamic/adaptive content presentation. This is part of the first prototype, that is finalised I month 18 after the integration performed in WP 8.

The successfully implementation of the improved final version of APTS (Month 32), will serve as part of the improved BRIDGE prototype that will be established after the integration work as described in WP (month 34).

Workpackage number:	8	**Start date or starting event:**			Month 16			
Participant number:	1	2	3	4	5	6		
Person-months per participant:	4	4	6	18	8	8		

Objectives

- Integration of the system components developed and adapted by all project activities
- Validation of the user perspectives of all system components (functionality) and the corresponding user interfaces
- Evaluation of the gained results, which serve as feedback for improvements and further developments for the final prototype.
- Evaluation of the quality of generated metadata and knowledge structures
- Performance analysis of the single system components and the overall system
- Other preparatory work that will contribute to a successful prototype deployment (methodology & organization change issues, development of applications, etc.).

Description of work

This work package addresses the consolidation and integration of the components into the definition of a platform (and associated methodology), which can be deployed in a user site. More specifically, this includes the integration of the following components to form the operational platform on which the prototype t test will be run:

- BRIDGE Semantic Services
- BRIDGE Management and Authoring Tool Suite
- BRIDGE Access and Presentation Tool Suite

Over the entire extent of the project a permanent user care will be run to ensure their participation in the development process and thus to ensure the user friendliness and function range of the final tool suite. This allows a constant testing of tools and system design over the complete duration of the project.

The general public will test the established information spaces through access via the museum partners web environments. Here the emphasis will be put on the evaluation of the social indexing mechanisms, allowing general users to provide new nodes or relations.

The evaluation of the prototype will take place twice, in the middle of the project and at the end. The first evaluation (Month 18) will be carried out at half-time of the project, providing an objective assessment of the current status of the project on a technical as well as on usability level, i.e., an assessment of the system effectivity and user satisfaction with the user interfaces. The outcome will be the basis for WP8 (exploitation) and WP1 (project management) to stimulate further improvements of the already established functionality of the system architecture/functionality as well as expert and user environments for the second half of the project.

The aim is to offer as much as possible a fully functional, error-free platform, some initial content and associated methodology to the subsequent work packages (WP4, WP5, WP6 and WP7).

Deliverables

D8.1: Basic prototype version, including of the pilot web-based museums space	Month 18
D8.2: Basic prototype: Evaluation and performance report	Month 20
D8.3: Revised prototype version, including revised pilot web-based museums space	Month 34
D8.4: Revised prototype: Evaluation and performance report	Month 36

Milestones and expected result

Alpha version of the first system prototype (month 18). The final BRIDGE prototype (Month 34) will be evaluated, resulting in a list of suggestions of further improvements to be used in the final report as an indicator for additional developments.

Workpackage number:	9	**Start date or starting event:**			Month 0			
Participant number:	1	2	3	4	5	6		
Person-months per participant:	6	6	6	17	10	10		

Objectives

This workpackage will

- implement the information dissemination mechanisms,
- assess the utility of the BRIDGE technology in a commercial context,
- investigate the routes by which the partners can secure a successful downstream exploitation of the BRIDGE derivates, both as commercial products and as information services built upon the products, and carry out dissemination activities, to raise international awareness and interest in project activities and achieved results in the scientific and commercial community.
- contribute the relevant project results to the corresponding standardisation bodies.

Description of work

For this workpackage, the activities of BRIDGE project partners will follow two main lines:

- exploitation and marketing of work results (of both the content-related information space services and the software developments);
- dissemination efforts (e.g., publications and presentation of project results at international conferences and exhibitions).

Activities related to exploitation and dissemination activities will be continuous, i.e., they start as soon as results from the domain requirements analyses and market study are obtained (WP2) and will be intensified after the system specification is completed and the first version of the BRIDGE prototype is implemented.

Exploitation efforts will include the production of two virtual, interactive, and generic information spaces for fine arts (it is assumed by all partners that the created information spaces will represent the start point of an emerging information space) in form of an advanced Web information service used by the participating museum partners, as well as marketing of the software (modules) developed in BRIDGE. In order to guarantee that exploitation of results is not precluded by the lack of agreement between partners in matters affecting the licensing of foreground and background information, a Consortium Agreement will be signed upon project start-up. The Consortium Agreement will follow the rules stated in the contract signed with the Commission.

Besides the use of BRIDGE in the present context, the tool developers will demonstrate how the BRIDGE environment can be adapted to new application domains. This will lead to the development of a determined business plan. A detailed description of the exploitation plans is given in Part C8 of this proposal.

Dissemination activities will include the production of *brochures* and establishment of a *Web site* with detailed information on the BRIDGE project. The consortium will organize workshops where project results will be presented, and network with other groups who work in similar areas, at international and European level. Members of the consortium will participate in workshops, conferences, fairs and exhibitions, and publish project results in relevant scientific journals and conference proceedings to allow for a high international visibility of BRIDGE tools as enabling technology in non-technical fields.

Deliverables

D 9.1: Dissemination of results, including brochures and the BRIDGE Website Month 36
D 9.2: Commercial strategies for exploitation Month 36
D 9.3: Business Plan for ongoing commercial development and service provision. Month 36

Milestones and expected result

Web-based information spaces using the basic BRIDGE prototype — Month 18.
Web-based information spaces using the basic BRIDGE prototype — Month 34

B7. ANNEX – Bibliography & Hot Links

ARTISTE (2001). http://www.artisteweb.org/

Campell, I. (2000). Interactive Evaluation of the Ostensive Model Using a New test Collection of Images with Multiple relevance Assessment. Information Retrieval, Vol 2, 1, pp. 87 – 114, Kluwer Academic Publishers, Boston.

CIDOC (2001). http://www.cidoc.icom.org

COVAX (2001). http://www.covax.org

CPEX (2001). http://www.cpexchange.org

Crestani, F, Lalmas, M, Van Rijsbergen, C J, & Campbell, I. (1998). Is this document relevant?..probably": a survey of probabilistic models in information retrieval, ACM Computing Surveys, Volume 30, No. 4 (Dec. 1998), pp. 528-552.

CSS - Cascading Style Sheets , level 1(1996). W3C Recommendations are available at http://www.w3.org/TR/REC-CSS1 December 1996

CSS - Cascading Style Sheets, level 2 CSS2 Specification (1998). W3C Recommendations are available at http://www.w3.org/TR/REC-CSS2 May 12, 1998

DAML+OIL (2001). http://www.daml.org

Gettyone (2001). http://www.gettyone.com

Guggenheim (2001). http://www.guggenheim.com

HTML (2001). http://www.w3.org/MarkUp/

Hunter, J. (2001). Adding Multimedia to the Semantic Web – Building an MPEG-7 Ontology. Proceedings of the First Semantic Web Working Symposium SWWS-01, California, USA, 2001. http://archive.dstc.edu.au/RDU/staff/jane-hunter/semweb/paper.html

ISO MPEG-7(2000e). "Text of ISO/IEC 15938-5/CD Information Technology - Multimedia Content Description Interface - Part 5 Multimedia Description Schemes", ISO/IEC JTC 1/SC 29/WG 11 N3705, October 2000

IST Work Programme (2001). Information Society Technologies - Programme for Research, Technology Development and Demonstration under the 5th Framework Programme. http://www.cordis.lu/ist/bwp_en4.htm

MIP (2001). http://www.mip.berkeley.edu

OilEd (2001). http://img.cs.man.ac.uk/oil/

OntoEdit (2001). http://www.ontoprise.de/download/

On-To-Knowledge (2001). http://www.ontoknowledge.org

On-To-Mat(2001). http://ontobroker.semanticweb.org/annotation/ontomat/

RDF (2001). http://www.w3.org/RDF/

RDF(S) (2001). http://www.w3.org/RDF/, http://www.w3.org/TR/2000/CR-rdf-schema-20000327/

SilRI (2001). http://ontobroker.semanticweb.org/silri/

SiRPAC(2001). http://www.w3.org/RDF/Validator/

SMIL (2001). http://www.w3.org/TR/2001/REC-smil20-20010807/

SMIL Animation (2000). Work in progress. W3C Working Drafts are available at http://www.w3.org/TR/ 31 July 2000

UMIRL (2001). http://www.media.mit.edu/~chaiwei/papers/usermodeling.pdf

XHTML 1.0 - The Extensible HyperText Markup Language (2000). A Reformulation of HTML 4.0 in XML 1.0

W3C Recommendations are available at http://www.w3.org/TR/xhtml1 January 26, 2000

XSL Transformations (XSLT) Version 1.0 (1999). W3C Recommendations are available at http://www.w3.org/TR/xslt .