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Request for Quotation (RFQ)
and
Call for Participation (CFP)

AECOO Testbed – Phase 1
(AECOO-1)

Annex A

Management and Business Overview (Part A)

Work Breakdown Structure and Work Items (Part B)

RFQ Issuance Date: May 2, 2008

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1 Introduction and Summary

This Annex is directed at Executives, Senior and Product Management personnel and those involved in making a decision about participation in the AECOO-1 Testbed.

- Part A of Annex A describes the rationale for the AECOO Testbed as well as a topical presentation of issues to be dealt with in AECOO-1. In this Part we discuss the traditional nature of standards, the influences of technology on standards, a brief look at legacy standards development as practiced by the building and capital facilities industries and the migration to open standards. The concepts about open standards, interoperability and non-interoperability, the issues surrounding risk and the role of both information and communications standards for better business practices are presented in light of the kinds of work we will undertake in AECOO-1.
- Part B describes the Work Breakdown Structure (WBS) and the work items for the Testbed. The Work Items are segregated into three threads. Each thread classifies work items in Phases, for funded and unfunded items, by current sponsors.

This Annex A document is an integral part of the AECOO-1 RFQ/CFP.

The AECOO Testbed is a short-term, intensive, multi-participant "spiral engineering" activity to develop, test, and promote the use of open standards for building information. This activity is designed to be iterative and to build on accomplishments of past work completed by previous testbeds, and infused from projects now underway under the umbrella of buildingSMART alliance, buildingSMART International and research accomplishments from industry and academia.

The AECOO Testbed is a joint initiative of the OGC and buildingSMART alliance and sponsored by leading AEC (Architect Engineering Construction) software user organizations. OGC and buildingSMART alliance believe OGC's Interoperability Program and its method for defining market driven interoperability solutions through global IT standards can positively influence technical and market transformation issues that hinder the industry's efficiency and growth.

The interoperability requirements presented in this Annex are based upon a collaborative effort between Sponsors of the AECOO Testbed – Phase 1 (AECOO-1), OGC's Interoperability Program Team (IPTeam), and buildingSMART alliance staff. The architecture team used results from previous and ongoing OGC Interoperability Program initiatives, the AECOO Testbed Request for Technology, buildingSMART alliance and buildingSMART International activities, publicly available documentation from related standards initiatives, and elsewhere.

OGC has active Memorandums of Understanding with both buildingSMART International and the National Institute of Building Sciences (NIBS). The knowledge and recommendations coming from the AECOO Testbed will be provided back to BuildingSMART International, the National Building Information Model Standard/buildingSMART alliance housed within NIBS. Other standards and trade organizations are also involved in supporting AECOO-1 Testbed including Associated General Contractors and the International Code Council and the Construction Specification Institute.

1.1 *OGC's Interoperability Program*

The OGC operates an Interoperability Program that is a global, hands-on and collaborative rapid prototyping program designed to develop and deliver proven candidate specifications into OGC's Specification Program that can then be formalized for public release as standards. In OGC's

Interoperability Initiatives, international technology developers and providers team together to solve specific geo-processing interoperability problems posed by the initiative's sponsoring organizations. OGC Interoperability Initiatives include test beds, pilot projects, interoperability experiments, and interoperability support services – all designed to encourage rapid development, testing, validation and adoption of open, consensus based standards specifications.

1.2 *Adapting OGC's Interoperability Program for buildingSMART Standardization*

The buildingSMART alliance and OGC have agreed to the Interoperability Program approach to encourage broad international participation on well-defined sets of AECOO community problems. It is expected that testbeds dealing with AECOO requirements will yield accelerated alignments of industry on open standards solutions. The AECOO Testbed, more than anything else, is positioned to help the AECOO community understand how to plan and conduct successful standards development using market driven approaches; to bridge cooperation among and between standards bodies whose mission crosses boundaries for information sharing and dissemination; and to achieve outcomes greater than what can be achieved alone.

OGC's goal is to develop joint initiatives with the AECOO community because we believe collectively we all can be more efficient in the future in addressing issues of geospatial and AEC information convergence.

Testbeds are a way to encourage broad international participation on well-defined sets of problems. AECOO Testbeds run on functional requirements that the Sponsors wish to see the vendor community address from an interoperability standpoint. The AECOO Testbed directly addresses several key interoperability issues defined as important to the industry. In this testbed, the sponsors have requested we begin to build out the communications foundation that underlies the BIM concept. This testbed will exercise the IFC information model, IDM, and MVD information practices.

Service interfaces will be collaboratively designed and shown to work using IFCs to articulate BIM-centric messaging between stakeholders in the AECOO community dealing with building lifecycle activities. Specific areas of work are to focus on

- Decision support across energy and costing business practice
- Prototype cost estimation using Quantity Takeoffs
- Prototype energy analysis
- Design intent for building performance and constraints

Previous work during the Concept Development phase of the AECOO-1 Testbed indicates clearly that the market desires to change the ways they wish to scale and collaborative interoperate. Pre-web techniques the support information interaction and sharing do not scale. The means for beginning to bridge this gap in information sharing requires that work be done at the level of information architecture.

Part A. – Management Information - Industry Driven Interoperability for Buildings and Capital Facilities

2 History as Precedent

In the 1850's, James Rothschild complained that it was a "crying shame that the telegraph was invented" because suddenly anyone "can get the news." The Rothschild banking empire was built through private couriers who rode from one European trading center to another, profiting from market-moving news about business and trade. The telegraph ended such exclusive access. Almost as annoying, information became a constant.

This early Information Age became "real time" when Queen Victoria sent President James Buchanan the first trans-Atlantic cable. "The Atlantic is dried up, and we become in reality as well as in wish one country," editorialized the Times of London. The telegraph shrank the world, upended business practices, democratized information and confounded government regulators.

Today's digital world makes the challenges of the telegraph era seem quaint. The Information Age we are now engulfed in affects us as consumers, businesspeople and citizens. The effect and impact of new technology for public policy and business are alike and accelerates a rash of difficult questions to consider.

For example, does the easy availability of information necessarily mean not only the advance of knowledge and wisdom, but also the advance of business advantage and flexibility? Building design innovation requires information from many sources. Constructing the innovative design requires even more. To the ultimate user, the sources may or may not be as trustworthy as human generated, paper-based and analog-era processes like building plans and construction blue prints. But if we can create the same sense of trust and accountability with humans and machines, we can make a significant dent in time and effort, and would that not be a true and lasting benefit?

The AECOO community today is not unlike where others were 8 years ago – pre 9/11. For example, national security now requires not only collecting information from multiple sources, but also how well those dots of information about threats can be connected to make informed analysis. This requires sophistication about mining and linking information through open, yet secure systems. These new ways of working with information often conflict with the cultures of government bureaucracies. Likewise, the global capital facilities market with all its stakeholders and paper-based, analog ways of communicating amidst fragmented horizontal organizational structures have similar requirements that are often enunciated as being inefficient.

Despite the historical importance to the economy brought by technological innovation, public policy combined with organizational fear can stymie timely business modernization. Rules for telecommunications, intellectual property, contracts, design, product supply, energy analysis, and costing to name just a few, need to be updated for today's technologies and the speed that business happens. It is enlightening to see that in the case of buildings, it is governments from around the world that are leading the evolution of design and construction techniques with BIM and virtual construction.

The good news is that almost any form of information can be made available with ease and a user can access that information at the click of a mouse; the bad news is that unfiltered information can overflow and leave people as confused as James Rothschild was in 1850. In a period of rapid change, it is often difficult for architects, construction managers and supply partners to stay sufficiently informed to make good decisions about technology. The technology presented to us everyday is often overwhelming in volume, hype, and rate of appearance in new products. Thus, in hindsight, we often see that resources have been applied less effectively than they might have been. This sense of confusion and disorder is amplified by the latest phase in the communications revolution in which almost all computers are attached to a vast network. The Web is potentially a wonderful thing, but besides unleashing evils like viruses and spam, it has shown that our applications often don't work very well together. That is, they are often non-interoperable.

2.1 *Non-Interoperability, Risk and Standards*

Non-interoperability impedes the sharing of data and the sharing of computing resources, causing organizations to spend much more than necessary on data, software, and hardware. Since the AECOO market has acknowledged it is under "economic constraints," the issue of non-interoperability is one that obviously needs to be resolved quickly.

Companies making up the capital facilities market are risk-averse. Non-interoperability increases technology risks, which are a function of 1) the probability that a technology will not deliver its expected benefit and 2) the consequence to the system (and users) of the technology not delivering that benefit. Risk assessment must take into account evolving requirements and support costs. Some technology risks derive from being locked in to one vendor, others from choosing a standard that the market later abandons.

The direst risks associated with non-interoperability are real-world risks. Today, lives and property depend on digital information flowing smoothly from one information system to another. Public safety, energy efficiency and disaster management increasingly depend on communication between dissimilar systems used by groups with different but related missions. No single organization produces all the data (so it's inconsistent) and no single vendor provides all the systems (so the systems use different system architectures, which are usually based on different proprietary interfaces). Thus, there is the potential for real world havoc.

As information becomes more accessible, individuals gain choice, control and freedom. Established organizations – governments, large companies and special-interest groups – need to work harder to justify their purpose and often their business model. And it is not just harder per se, but the work itself is often times seen as an invasion, rather than as cooperative – where a rising tide raises all boats. As information and knowledge spread, financial and human capital become more global and more competitive. The uncertainties and dislocations from new technology can be wrenching, but genies don't go back into bottles. The uncertainties and dislocations from new technology can also be the framework for new modes of operation and new opportunities for closer, symbiotic relationships with partners and customers.

The dot-com era a decade ago was over hyped, but now the Web is THE INFORMATION UTILITY, increasingly available anywhere for any purpose. This Information Age is mature, and it is several magnitudes greater in scope and effect than the Information Age of 1850. The building and capital facilities industry with its economic scale and size must now take advantage of the "network effect" delivered to your desktops. To do this with minimal risk, competitive fairness, and economy of scale requires investments in open standards.

3 Standards and Open Standards for Buildings and Capital Facilities

Few kinds of information are more complex than information about the nature, type, and components of buildings and capital facilities. One reason for this is that there are many fundamentally different kinds of information systems for creating, storing, retrieving, processing, and displaying building data. These include CAD, BIM, project management, energy management, code and regulatory, and a host of others for roads, sewers, bridges, surveying, location based services, sensors, facilities management, etc. Numerous vendors work within each of these technology domains and normally do not consult with their competitors to form agreements on how information should be structured and how these diverse systems might communicate. This lack of communication coupled with the many different ways each user may need that information expressed in the form of measurement and other quantities produce a complex and non-interoperable information environment. Added to this "havoc" are the user-side semantic issues: Without coordination, no two architects, for example, will use the same attribute schemas, measurement types, and data types in describing building elements. Their "metadata" (data describing their data sets) will also use different schemas, making automated data discovery and data sharing difficult.

For most of the first hundred and fifty years of standard setting for buildings and capital facilities, standards developers focused their attention on the attributes of tangible objects like tensile strength of steel beams or the right size of nuts and bolts for connecting parts of an elevator. The standards they developed specified dimensions, materials and other physical attributes, and to the extent that they addressed intangibles, those elements were result-oriented, such as performance and safety. Similarly, interoperability standards (although not called that at the time) were about physical standards, intended to ensure that part A would fit with part B. Domain experts within the AEC marketplace and all its niches that produced the products involved created these standards. Usually, problems requiring these kinds of standards solutions could be addressed by a single standard setting organization. This kind of work as it applies to the capital facilities market is a continuing requirement today and for the foreseeable future.

With the advent of the computer age the need arose for new types of consensus-based open standards - not as a substitution per se, but rather as an extension of past practices. As technological innovation increased across market disciplines, there became the need to extend the information standards contained in a document relating to tangible objects so that they may be implemented in software and hardware to serve the needs of broader, cross industry, product companies and suppliers. With the explosive success of the Internet, the utility and value of globally accessible, networked products, services and content has become enormous.

3.1 *What the AECOO Testbed Request for Technology Told Us*

When OGC, buildingSMART alliance and the sponsors commenced the AECOO Testbed in October 2007, we started with a blank sheet and a large and comprehensive set of resources, industry reports, standards, professional papers, and academic research. This treasure trove was additionally supplemented by recent developments from international, regional and national industry trade associations and alliances to re-promote their missions with focus on higher levels of cooperation and information sharing among all stakeholders.

A Request for Technology (RFT) was released for industry and stakeholder comment and input in February 2008. In preparing the RFT we found 'across the board' reservations by the sponsors about whether foundation open standards for building information - IFC and the proposed information organization mechanisms like IDM, OmniClass and IFD were up to the task.

Cooperation is necessary to solve difficult interoperability issues in the AECOO marketplace. On the content side, for over 12 years the industry has waged an uphill battle to break many logjams that stifle industry efficiency. For the most part, many stakeholder groups and standards setting bodies have worked diligently to secure information and content foundations for modern design, construction and management business practices – albeit in isolation of each other.

On the systems and software side, we discovered a large void. Over the past decade, little or no progress has been made to position these information standards for "up take" by the market.

We also discovered the IFC to be a rich information model for sharing data about buildings. The model is most assuredly extensible. However, due to a lack of work to standardize how IFC information is delivered by software, we have no basis about other parts of the interoperability puzzle that make for a smoother transition for sharing information and other required benefits.

We also discovered a level of discomfort – not with the way the IFC model is designed, but the way it is being delivered and the way industry is going about structuring its implementation and the consistency of that delivery. IAI (buildingSMART International) left industry to their own devices for how to put IFC into their product line up and how it is delivered to their customers.

Industry up take has been chaotic. The work buildingSMART International has accomplished is noteworthy and commendable, however, they stopped too soon. We need to understand how to deliver IFC's reliably. Now that Pandora's Box is open, we need to discover how to build and deliver systems that use IFC, that both scale up and scale across systems, and understand how software, information, and hardware that runs and stores all these pieces need to optimally perform.

Responders to the RFT confirmed an overarching and unanimous determination to shape an interoperability context for buildingSMART based on minimal data duplication, increased cooperation and strong impetus for information sharing both vertically within industry segments and horizontally across the building life cycle.

Respondents generally found the methodological approaches for organizing information across the life cycle - the Information Exchange Template, BIM Exchange Database, the Information Delivery Manual (IDM), and Model View Definition (MVD) as defined by NBIMS – as important activities that together support project-based information management. These methods are considered evolutionary best practice for information exchanges at a project level and are to be exercised in the testbed.

The Information Exchange Template and BIM Exchange Database are envisioned as web-based tools and component services that can provide search, discovery, and selection of defined exchanges for planning a project and to enable continuing conversations between stakeholders during any project phase. The IDM service should have hooks to both IFC compliant data repositories and IFD libraries.

An overarching objective of the testbed is to create and demonstrate a well-defined method to provide this information so these kinds of conversations may take place.

IDM is the user-facing context for NBIMS exchange with results typically expressed in human readable form. MVD is the software developer-facing context of exchange standard development. MVD is conceptually the process that integrates Exchange Requirements (ERs) coming from many IDM processes to the most logical Model Views supported by software applications.

3.2 *What is open standardization and how does it relate to interoperability?*

Open standardization is the reason for the success of the Internet, the World Wide Web, e-Commerce, and the wireless revolution. The reason is simple: our world is going through a communications revolution on top of a computing revolution.

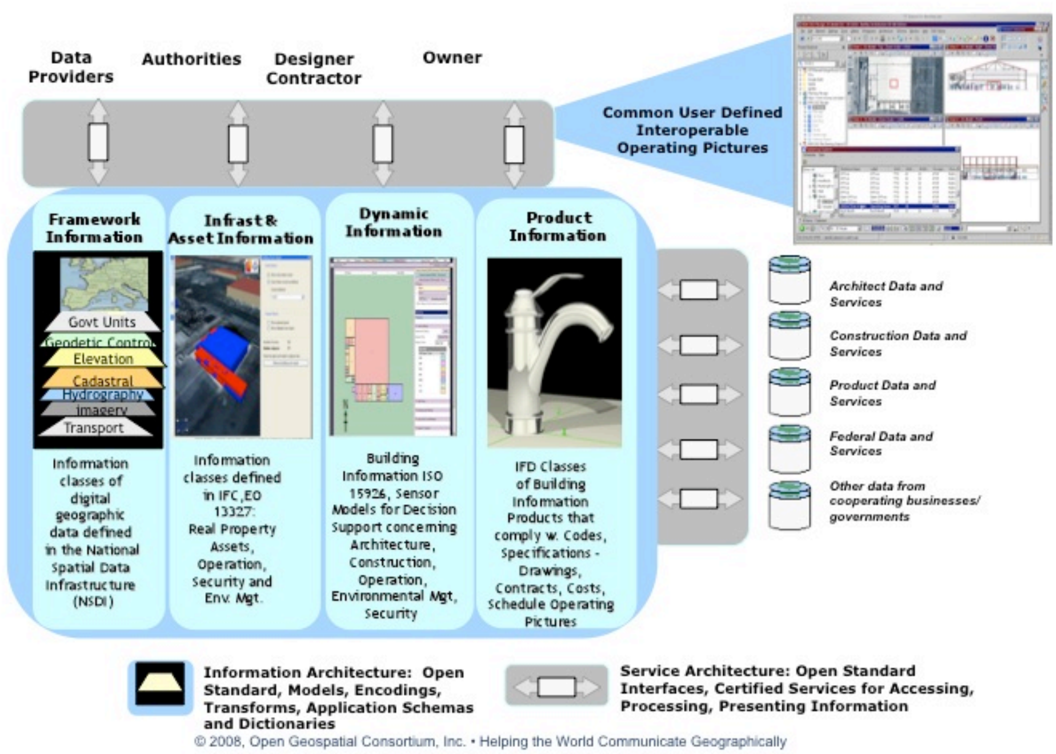
Open standardization means "agreeing on a common definitions of terms and names, attributes and properties of information." At the fundamental levels this type of open standardization has been developed by

- buildingSMART International: IFC and IFD
- Associated General Contractors with buildingSMART alliance: AGCxml
- International Code Council: SmartCodes
- Construction Specification Institute: OmniClass

Open standardization also means agreeing on common means for communication – the actions of "transmitting or exchanging through a common system of symbols, signs or behavior concerning that information and how it needs to be delivered, presented or made capable".

Put together, open standards for information and communications causes interoperability to happen. Figure 1 depicts this relationship:

Figure 1: Information and Service Standard Cooperation



Software interoperability describes the ability of locally managed and dissimilar systems to exchange data and instructions in real time to provide services (computing services as in "client/server" or "Web Services"). Interoperable systems are generally distributed (i.e., at different places on the network), but may also apply to different types of systems or similar systems from different vendors communicating while running on the same computer.

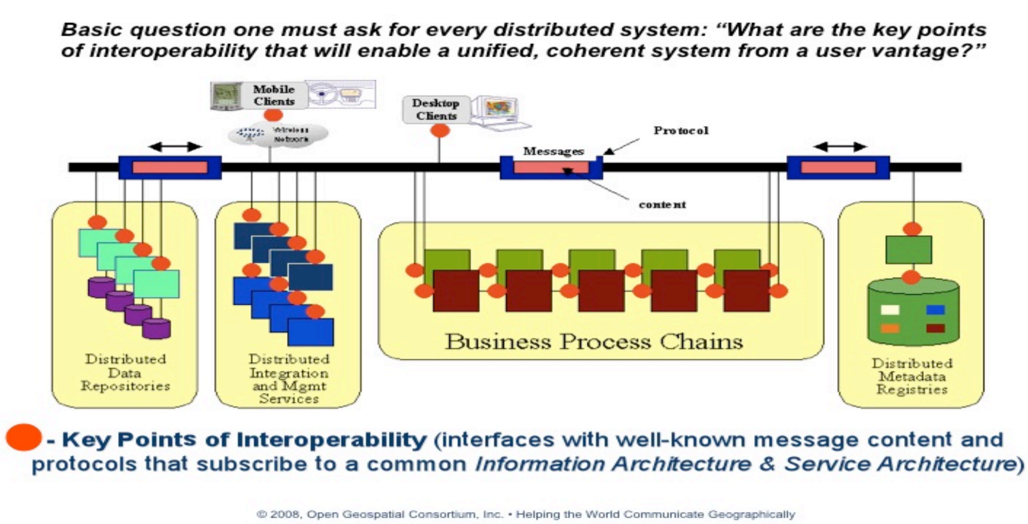
In the building industry someone needs to set standards to help people publish, discover, display, and use digital information about buildings. The interoperability challenge, successfully met by means of consensus reached in inclusive processes, is to balance the users' need for compatibility with the autonomy and heterogeneity of the interoperating systems. This happens with users and vendors cooperating on the definition of *open interfaces*.

The work done or now underway by a number membership based organizations (e.g., ICC for code checks, CSI for framework dictionaries, AGC for business documents and others throughout the world) to define information models and encoding for the building industry are connecting through buildingSMART alliance and buildingSMART International. These important activities are interlocking parts of the interoperability framework that together with open interfaces and protocols will guide developers to supply the software that meet the needs of particular enterprises based on their user needs, including business models and work flows. It serves both providers and users of the technology to have a collective of international, open, inclusive standards-setting bodies and tightly coordinated processes responsible for this kind of work.

It is important to remember that proprietary algorithms typically run unseen in the "black box" component whose public face is the open interface. Some server components will outperform others and/or offer capabilities not offered by others, though they may all communicate with clients through a common interface. In an interoperable environment, competition among vendors is based on such differences in capabilities and performance, and is not based on which format the user’s data is stored in, or which software provides the display function.

The definition of open systems has changed over time, but today open systems are usually considered systems that interoperate through open interfaces. An interface is simply a common boundary, a means to make a connection between two software components. An interface on the client presents an ordered set of parameters (with specific names and data types) and instructions (with specific names and functions) to an interface on the server that is structured to read and respond to just such a set of parameters and instructions. Thus, an interface enables one processing component to exchange data and instructions with another processing component. Figure 2 illustrates this relationship

Figure 2: Interoperating Systems for Data Exchange



Some interfaces satisfy part but not all of the "openness" definition above. The information technology world has been steadily evolving toward greater openness, so many older systems still in use interoperate in what now appear to be limited ways. Such systems from a variety of AEC software companies use interfaces that the companies have published for coding by integrators and application developers. Reaching that situation was progress, considering that at one time, few proprietary interfaces were published. From today's perspective, however, there are reasons not to depend on such published, but proprietary interfaces.

In the old paradigm, a client system needs a separate interface for each vendor's system. The biggest advantage of open interfaces is "build one, access many." With truly open systems, solution providers no longer need to build custom interfaces. Users are no longer isolated in technology stovepipes and no longer captive to ("locked in to") single vendor solutions. "Stovepipe" is a metaphor commonly used to describe systems that are integrated "from top to bottom" but isolated laterally, i.e., from other systems. A stovepipe system might be a system from a single vendor or it might be a system built by an integrator, but it is not an open system.

From time to time, vendors change or enhance their interfaces, forcing client systems to change and forcing users to upgrade, perhaps without notice or opportunity for input. In contrast, the consensus process gives integrators and application developers both notice and opportunity for input, increasing the level of continuity in new releases. Open standards impose a few constraints on developers, but they open huge opportunities, as demonstrated by the explosion of innovation and business opportunity that has resulted from the Web.

Integrators and application developers will probably spend more time learning how to use the proprietary interfaces than they will spend learning how to use open interfaces. One bad result of the old paradigm has been that integrators tended to learn and then use one system exclusively simply because the cost of mastering more than one is too high, which further limits the choices available to the user. One reason open systems result in greater innovation is that they remove this burden from development budgets, freeing resources for innovation.

Interoperability also refers to interoperability across time (evolution of systems over time with backward and forward compatibility). When users participate in standard setting, backward and forward compatibility have a high priority.

3.3 *How is interoperability achieved with open interface standards?*

Software interoperability is achieved through five interrelated steps:

1) Industry/community partnership for standards requirements

2) Rapid prototype processes for standards development to develop ***workable specifications,***

3) Specifications are then submitted for consensus,

4) Implementation of standards by the vendor community, and

5) Product conformance testing.

Each of these has an important role in reducing variability in intercommunication software and enhancing a common understanding of the end goal to be achieved.

If these five steps are followed, then the market can begin to move forward because:

- ***Users reduce their technology risk***– if the commercial market collaborates and cooperates to develop and validate new open specifications consistent with user needs that are build outs on top of current product, then the breeding ground for broad implementation of open standards by the marketplace is created. The AECOO Testbed encourages the market to do the integration and deliver these results to the market.
- ***Users improve choice and competition***– no single application package meets the needs of all users. The step wise approach to standards development normalizes hyper competitive product markets and yield users and their front line suppliers the business and technical flexibility to choose standards-based products from multiple or single vendors that can be plugged into their enterprise.
- ***Users reduce their technology life cycle costs*** – by increasing use of standards based COTS, organizations can more readily reduce custom solutions and associated maintenance costs.
- ***Users may more rapidly insert new technology*** – By working with industry and other stakeholders to implement the specifications in their offerings, organizations can maximize their ability to rapidly transfer new solutions into use.
- ***Users quickly get workable standards*** - Rapid prototype specification development yields ***workable standards in 4-6 months*** vice years for traditional standards processes; these are then submitted for consensus.
- ***Vendors validate and demonstrate standards integrity*** - by implementing candidate specifications in their products and passing well defined conformance tests.

4 What problems is this Testbed attempting to solve?

One might argue that governments, the building industry, the professions and disciplines that make up the industry, have an absolute obligation to their stakeholders to organize consensus-based strategic activities for the purpose of creating the shared information framework that will optimally support their work in the future.

Today, much of data needed to design, construct and operate a facility resides in off-line repositories. Most of these data are stored in different data formats, using different data models, geometry models, custom property sets, etc. Thus, sharing building information requires considerable effort, time, expertise and special software.

OGC's experience suggests that resolving these issues happens best in an inclusive, structured, consensus-based specification process with ample input from rapid prototyping testbeds and other real world testing situations. The AECOO testbed is a short-term, intensive, multi-participant "spiral engineering" activity to develop, test, and promote the use of open standards for building information. This activity is designed to be iterative and to build up accomplishment of past work completed by previous testbeds and infused with research accomplishments from industry and academia.

The goal of this Testbed is to begin a global industry and community sanctioned process to provide a comprehensive suite of open interface and information specifications that enable developers to write *interoperating components* that provide building information sharing capabilities.

Testbeds provide an opportunity for user organizations to steer the direction of technology by providing their interoperability requirements. These requirements are the main guiding factor so that results are quickly implemented in commercial products.

To ignore this opportunity and leave interoperability to vendors' de facto standards is to condemn users to far more risk and more years of havoc. Vendors play essential roles, of course, because the actual development, maintenance, customization, and service of software require special skills. Success, however, lies in the ability to engage these experts in the process that is about to start.

4.1 *General Requirements*

The work to be done in this testbed involves creating interoperating interface specifications for commercial software that work with existing and emerging standard encodings and information models to maximize the value of past and future investments in CAD, BIM, CM systems and data. This general requirement points to three specific classes of user needs:

1. The need to share and reuse data in order to decrease costs (avoid redundant data collection and re-entry), get more or better information sooner, and increase the value of data holdings.

2. The need to choose the best tool for the job, and to reduce technology and procurement risk (i.e., the need to avoid being locked in to one vendor).

3. The need for more people with less training to benefit from using building information in more applications: That is, the need to leverage investments in software and data.

These three classes of user needs point to the following still more specific needs:

1. The need for organizations involved in a building project to have access to each other's building information without copying and converting whole data sets. This includes:

- The need for passing data, or specific views and instructions between different vendor's systems,
- The need to more easily use data according to the activity or business purpose they are executing regardless of data model, data format, or geometry,
- The need to visually integrate views and display them from either the same or different data servers and applications,
- The need to find and evaluate data and any required application service held in other locations, and
- The need to understand and overcome the differences between different data models.

2. The need to have the pieces of a solution work together. This includes:

- The need to add or replace a capability in a current system, regardless of vendor, with minimal integration costs, and have it work seamlessly, and
- The need to understand the interoperability requirements of related information communities and to ensure there are information sharing strategies and practices for each.

3. The need to begin migrating BIM software applications to the World Wide Web open architecture. This includes:

- The need to follow common best practices, to create 'reusable' data and components.
- The need to organize and make seamlessly accessible building information stored in text, video, audio, and other media.
- The need to access and process on-line building information captured from sensors or other sources.
- The need for portable access across devices, networks, and providers that pinpoint building components.
- The need to apply different symbology to building information for different purposes.

4.2 *AECOO-1 Threads*

From this context, the sponsors posed three questions that were the subject of the RFT published in February 2008. These questions were repositioned as testbed threads. Each thread topic and our general findings, expressed as requirements based on sponsor discussions and responses to the RFT are reviewed below.

4.2.1 Quantity Takeoff and Cost Estimation (QTO)

What data exchanges need to happen between BIM software and cost estimating software during design?

While we recognize that QTO is only a small part of the total cost estimating process, it is part of the initial stage of identifying the quantitative aspect of the input needed. Qualitative information is needed to produce accurate estimates. Our ultimate goal is to progressively improve the information within the estimate and provide an information continuum from budget through final estimate. This end is accomplished with information systems that more or less automatically capture metadata about the quality of each aspect of the estimate. With that information, we will be able to better predict the quality of the estimate itself, so that at early stages we may be able to state, for example that it is plus or minus 20%, while later in the process we may ultimately attain an accurate installed cost of the facility.

All respondents reported the challenges that users face to produce accurate quantity take off information from BIM models for use in cost estimating processes. These challenges are both on the process transformation side and on the technology side. In response to market demand, a number of respondents are developing and piloting solutions to create more optimal "quantity takeoff " information work flows between BIM models and cost estimating solutions (both COTS and customer home grown).

There are currently many items that are not depicted in models that need to be priced, these include excavation and shoring as well as formwork, and other temporary items used during construction and later removed.

Information is also need to be able to provide visualization of what objects have been included in the estimate and which have not yet been priced, or are unable to be priced. Again, metadata concerning the quality of the price are important pieces of information to be captured and used to qualify the pricing at any point within the life cycle.

From a standardization perspective, cost estimating points to an evolving best practice that contains building type scenarios and reference demonstrations that incorporate cost estimating as a component of the life cycle cost. Several respondents suggested a number of best practice information model approaches.

A number of respondents recommended a pragmatic approach to build capability to map BIM objects in design & construction models and items in costing databases.

A number of respondents reported they possess IFC export feature for relating building elements and assemblies to cost estimating. However, they also acknowledged two major challenges to interoperability that need to be addressed.

- First, vendors are not required to intelligently round trip export and import functionality. For instance if a model is exported from most major BIM applications and then imported back into the same or different BIM application, imported IFC objects behave differently to native objects.

- Second, non-native property sets are often times not carried forward as part of the import mechanism and data are lost.

One of the larger challenges with cost estimating and integration with BIM is the alignment of the parametric properties in the BIM and the formulas and variables defined in the cost estimating systems. Even though all estimating vendors provide databases containing line items and assemblies, respondents found that nearly every general contractor customizes these since there is currently a significant lack of standardization. Without some sort of broader intervention to standardize building system definitions at finer grained levels, the variables and formulas that drive their cost quantification cannot be fully assured. The upshot of this is that in nearly all cases there is no standardized method of taking off (evaluating) construction systems. Thus, most vendors take the approach of providing relatively simple mechanisms for users to map custom variables and formulas from the end users proprietary cost database with parametric properties. Linking OmniClass tables, which include Uniformat and MasterFormat with cost estimating, will help eliminate this problem. Parametric services have been identified as a topic matter for a future testbed.

4.2.2 Building Performance and Energy Analysis (BPEA)

During design, what information exchanges need to happen to facilitate more seamless exchanges between BIM software and energy modeling software?

There was general agreement by most respondents that outputs of energy analysis results need to be considered in the mix for decision support and cost analysis across the life cycle. It was also generally acknowledged that better utilization of IFC's are in order to support business communication along with energy analysis using global ID property, OwnerHistory entity and ChangeAction property support using a variety of techniques that fit with the amalgam of software programming approaches that can be used on the Internet Platform including

- AJAX, .NET, etc.
- Model Server Architecture
- Single and multiple data store locations that support merged views

Other issues raised by respondents included:

- Defining IFC based document management approaches combined with outputs from energy analysis
- Integration of data exchange based approaches with building life cycle information flows and business processes
- Using IDM processes as a organizing principle for project teams, project information systems and information capture
- Using MVD as a means for just in time views as driven by user requirements – both expert and non expert

There was sufficient detail provided by respondents to suggest potential candidate best practices for these issues.

Other important findings related to Energy Analysis:

1. Portions of respondents detail define where human interaction is now required that seem to be candidates for workflow services.
2. Recognition that post processing information and results do not need to be IFC compatible.
3. Post processing and results do have to be coordinated with decision support and general communications as defined by Thread 3.

4. It would be advantageous to test common energy analysis terminologies based on energy codes and to connect these with the possible best practices for analysis and code compliance.
5. Energy analysis demands parsers for IFC.
6. Industry alignments at the M&A level have yielded proprietary development of energy export and import capabilities in several major engineering modeling tools. A number of these involve use of GBxml. Since GBxml is virtually a defacto industry standard schema, it is suggested that this technology be considered as an authoritative standard. A number of respondents requested OGC and buildingSMART alliance to include GBxml and work toward harmonizing it with IFC based information model.
7. Other respondents look at energy analysis from the viewpoint of DOE2 and Energy Plus. It is recognized that both play important roles and means for better exchange are necessary.

4.2.3 Communications, Project Delivery, and Decision Support

What information needs to be exchanged between software systems that support formalized business processes, including design management, construction management, contract-required communication, and others; and how is this information integrated with the BIM and contract documents that are developed in parallel with these processes?

Poor communication between organizations and teams is the root cause of many problems throughout the building lifecycle and has the greatest impact on cost, schedule, scope and quality. A majority, but not all respondents support a web service context for business communications. AGCxml is thought to be an important component for maturing this capability.

Two parts of the business communication problem shed need to be addressed in this testbed. One is to galvanize industry to support current business processes and the other is the need to address the potential of the industry to act collaboratively organizationally and support them within systems. In an ideal world these would be complementary to each other. In reality they are not. Trying to address both of these needs concurrently is a source of confusion about generic and general sentiment about files/services, xml, libraries, models, contracts, information sharing arise. Each aspect has its place, but not in isolation.

The industry norm today is for a file-based exchange of information. The files typically being exchanged are not IFCs. There has not been enough of a push by industry to the vendors for higher quality IFC exchanges. For example, there is very little or no ability to filter a partial IFC exports from some BIM applications. It is all or nothing, typically a huge IFC file that takes a long time to save and open. In a service based architecture this problem can be addressed.

The question of the "readiness of the industry" to move from file transfer to a service based architecture for exchanging the same type of information was discussed by almost every respondent. In summary, the software industry serving AECOO communities today, know little about what a service based architecture is, and, only via cooperative efforts will light be shed on industry benefit and opportunity. On the other hand, the management of inefficient file transfer based exchanges drives significant aspects of the problem we have in the industry today. Leading companies have expressed an interest for the testbed to expose the potential of a service-based architecture.

A good number of respondents suggested focus on the exploitation of the IFC model and its underlying constructs to promote meaningful bi-directional query and editing within a BIM model, and to see that information become a context for project and business processes. The data conjoined with communication based decision trails can assist to define practical solutions sooner. All respondents agreed that:

- Applications need to support business processes by providing a common way to import, display, query a building model,
- Aggregate it into a more complete BIM model,
- Disaggregate the model to suit a particular purpose,
- Add new information to it, and
- Output additional information in ways that facilitate decisions without the need to override the original model.

Building/authoring the model is viewed as a separate operation from sharing information that is contained in the model. Web services can be used to deliver specific "parts" of the model and can support (Model View Definition) MVD. Web services will also tend to maintain the right level of information detail from the model at an appropriate level for that user. Too much information creates complexity that is not needed and too little information will not provide a basis for decision-making. The status quo is to get too much information and then require each user to filter out what is needed. This is time consuming and gets increasingly more complex as the amount of data increases – particularly when the authoring system is tightly integrated with the information exchange mechanisms that are part of the lifecycle.

Giving access to BIM data without needing to be a BIM expert is the tipping point for BIM to be mainstream and an accepted part of any business process. The conventional view of BIM today is being focused on a few specific complex BIM applications that keep authoring and sharing information in a walled garden. Breaking the walled garden is not critical to the creation of BIM, but is critical for BIM to have a clear path for information ubiquity within the industry.

Consumers of data created by BIM will vary widely as the range of users and types of data referenced in BIM increases. It is inconceivable to imagine that each user will have access to all the tools that created the data but it is conceivable that they may want to access any of the data from the tool of their choice. For example an owner operator may want to know the total energy consumption as a percentage of life cycle cost of a project being designed, but may not care to know how to use the tool that generated that calculation. He may also want to know the total projected construction cost but may not care about how it was calculated. Other actors in the decision calculus will wish to know these more practice-based findings, and we need to be sure to provide ways for both to be satisfied. By making BIM data accessible to wider range of consumers and related users make the "reason to BIM" much clearer since the value chain is apparent. These concepts are similar to the success of the Internet.

Defining standard access through simple, domain specific, high level API (that eventually could be extended to SOA) will simplify access to the data and significantly reduce the barrier of entry for implementers as well as "would-be" implementers. Find-bind-publish patterns of architecture is seen as a fitting way to start e.g., "Publishing" of a read only version of the BIM model, that can be queried, counted and quantified, according to the tastes of individual cost estimators for example could then happen without the need to learn a complex BIM authoring tool.

Capturing decisions and defining standards of design for single buildings or entire enterprise strategies for facilities is critical. BIM and model servers have the ability to satisfy this requirement if the data is accessible and user input is captured. With proper architecture and set up by company's and project teams, these systems can self-maintain themselves from cradle to grave. For example, space standards are typically kept in some sort of a database at best, or in PDF or paper format at worst. The standards are not connected to BIM, and users have to manually transfer the space requirements from the standards documents to BIM. This leads to errors and uneven interpretations of the standard. If space standards are made more accessible to designers than editing and resulting decisions are recorded and can be published on the fly.

Administrators can define standards or adjust them based on expert user input. Decisions are saved in the system for future projects. Errors that were not apparent in PDF or Excel files surface in the user interface and are adjusted. By focusing on creating a self learning system, the life expectancy of the standards or other captured processes as a liability decreases and the system itself becomes and asset to support continuous updates.

With service architecture helping to manage BIM information decision documents can be made more understandable and connectable. Respondents agree that common IDs be established for levels of information detail from the concept to the individual component. The notion of this kind of ID goes well beyond what is provided by OmniClass. Unique IDs enable tracking each piece, each discussion about that piece and each decision involving that piece.

A high number of respondents believe that a key missing component for better information exchange is the standardization of IFC-based exchange with supporting project information. A means needs to be found for referencing and relating building elements to the way business is actually conducted. The unstructured nature of both IFC and supporting project information, captured in many different file formats, creates a particularly vexing problem in the traditional metadata tagging model. However, their relevance in the context of the building element is critical to understanding the decision tree behind the current state of what is recorded in a building information model.

Bridging the gap between all of the supporting project information that is used for decision-making and the content recorded in a building information model would provide the AECOO industry with a significant step forward toward the promise of the Integrated Project Delivery objectives. By creating a method to facilitate the bi-directional relationships between disparate data sources and documents, the AECOO Testbed could publish an open data standard that allows for a natural workflow traversal between interrelated items and the ability to capture and maintain critical dependencies (i.e. process based interoperability between actors and software applications).

A process or workflow context should be the key driver for any semantics associated with building elements. When using a tool that enables process-driven workflow, it is possible to have software automatically enable metadata associations with building elements. However, depending on the nature of the process, it is not guaranteed that the building element metadata can be fully populated. In fact, it could be argued that these will always be incomplete, or at best, unverified. This should be explicitly identified.

Another facet of this problem is consistency and relevance of metadata capture. Given the complexity of workflow variations that project teams will undertake it may be non trivial to standardize at anything but the highest levels, and virtually impossible to enforce compliance. In practicality, it may be more desirable to provide the means for query enabling documents either in part, or in their entirety for additional context. These references form a crucial relationship between unstructured yet relevant documents (e.g., email messages, specifications sections, meeting notes, etc.).

A focus solely on metadata limits the opportunity to encompass how many times the building element is referenced in communications amongst actors. For example, a building element that is query enabled so that email communications can take place intelligently about the design intent, relationships to the RFI or submittals process, cost reduction discussion and decisions, etc., is far more meaningful to downstream actors.

4.2.4 IFC2x3 and IfcXML

There was considerable feedback about how IFCs would interact in a loosely coupled architecture such as Web Services[1]. In 2004, buildingSMART International began a project to recast IFC from STEP to XML. A methodology for generating .xsd from EXPRESS definitions was developed. It is thought that ifcXML is suitable for a variety of uses like those being addressed in AECOO-1.

IFC or ifcXML are established as requirements for testing. Participants have the choice of each or proposing a hybrid. Specification access to IFC STEP and ifcXML are provided in Section 3.1.1 of Annex B.

4.2.5 Information Architecture Patterns

One of the major reasons the AECOO-1 Management Team issued the Request for Technology was to offer all interested parties an opportunity to weigh in on broader issues of technology use and adoption within the industry, as well as to define their interest in working a select set of problem areas of concern to the sponsors.

In most cases of standardization of communications technology, a testbed architecture is the preferred means for organization and understanding. Annex presents the Testbed Architecture, which is based on the current "mainstream" approach for file transfer and the architectural style for REST-based services.

Representational State Transfer (REST) is a style of architecture based on a set of principles that describe how networked resources are defined and addressed[2]. REST-based services are scalable and extensible and offer an excellent migration path for the AECOO community. These architectural patterns were selected to provide the best opportunity for meeting the sponsors' requirements. This architecture is not intended to drive the physical system configuration, but to identify the interfaces and protocols within the current mainstream approach for sharing information and information processing resources. For example, details of the initial interfaces and protocols and how they are distributed across physical systems in the initiative are not included in the Architecture – those decisions will be left to the participants.

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[1] Loose coupling describes an approach where interfaces are developed with minimal assumptions between the sending/receiving parties, thus reducing the risk that a change in one application/module will force a change in another application/module. Loosely coupled services, even if they use incompatible system technologies, may be joined to create composite services, or disassembled just as easily into their functional components, and enables shared semantic frameworks to ensure messages retain a consistent meaning across participating services.

Integration between two applications may be loosely coupled in time using message-oriented middleware, meaning the availability of one system does not affect the other and enables data transformation, meaning differences in data models do not prevent integration.

[2] See http://roy.gbiv.com/pubs/dissertation/top.htm

Part B. – Work Breakdown Structure

5 Sponsor Priorities by Thread

Table 1 shows the AECOO-1 Deliverables and Work Items in each of the three threads. Work items that are designated with an "f" are work items that are currently funded. Those that have a "u" are within scope of this RFQ but may not be funded. Those who are responding to the AECOO-1 RFQ fall in two categories: (a) Proposing Organizations, or (b) Participants. Proposing organizations can provide proposals for any work items that are funded. Participants are those organizations who wish to provide "In-Kind Contribution" for *any* of the work items. For cost sharing funds, proposing organizations should focus on funded work items only. Any submission (or relevant section thereof) that addresses unfunded work items will be viewed and treated as a proposal for In-Kind Contribution.

5.1 *Deliverables and Work Items*

Table 1 - AECOO-1 Deliverables and Work Items

DELIVERABLE	PRIORITY	TYPE	PRIMARY DELIVERY TO
Quantity Takeoff and Cost Estimation (QTO)			
IDM for QTO of Building Enclosures (process maps, exchange requirements, functional parts)	1f	Engineering Report	NBIMS/buildingSMART alliance American Institute of Architects Construction Specification Institute NIST
ifcXML Model View Definition for QTO	2f	Engineering Report	NBIMS/buildingSMART alliance buildingSMART International
QTO Model View Service	2f	Software Component	OGC - Candidate standard interface NIST
QTO Model View client	2f	Software Component	OGC – Candidate standard interface
Model View Catalog	2u	Software Component	OGC – Candidate standard interface
Building Performance and Energy Analysis (BPEA)			
IDMs for peak loading analysis	1f	Engineering Report	NBIMS/buildingSMART alliance International Code Council American Institute of Architects US Department of Energy NIST

DELIVERABLE	PRIORITY	TYPE	PRIMARY DELIVERY TO
IDM for annual energy performance analysis	1f	Engineering Report	NBIMS/buildingSMART alliance International Code Council American Institute of Architects US Department of Energy NIST
Model View Definition for thermal loading	2f	Engineering Report	NBIMS/buildingSMART alliance buildingSMART International
Model View Definition for building performance modeling	2f	Engineering Report	NBIMS/buildingSMART alliance buildingSMART International
BPEA Model View Services	2f	Software Component	OGC – candidate standard interface NIST US Department of Energy
BPEA Model View clients	1f	Software Component	OGC – candidate standard interface NIST US Department of Energy
Communications, Project Delivery and Decision Support (CPD)			
AGCxml/IFC Harmonization	1u	Engineering Report	Associated General Contractors NBIMS/buildingSMART alliance
IDM for RFIs	1u	Engineering Report	Associated General Contractors American Association of Architects
CPD Information Server	1u	Software Component	OGC – candidate interface
CPD information viewer	2u	Software Component	OGC – candidate interface

6 Interoperability Initiative Process Framework

This section describes a flexible framework of standards, repeatable processes, which can be combined and adapted as necessary to address the requirements of each Interoperability Initiative. These tasks are executed with a Virtual Team Infrastructure. This Process Framework forms the basis for the AECOO-1 Initiative Work Breakdown Structure. Figure 1 shows Interoperability Initiative Process Framework.

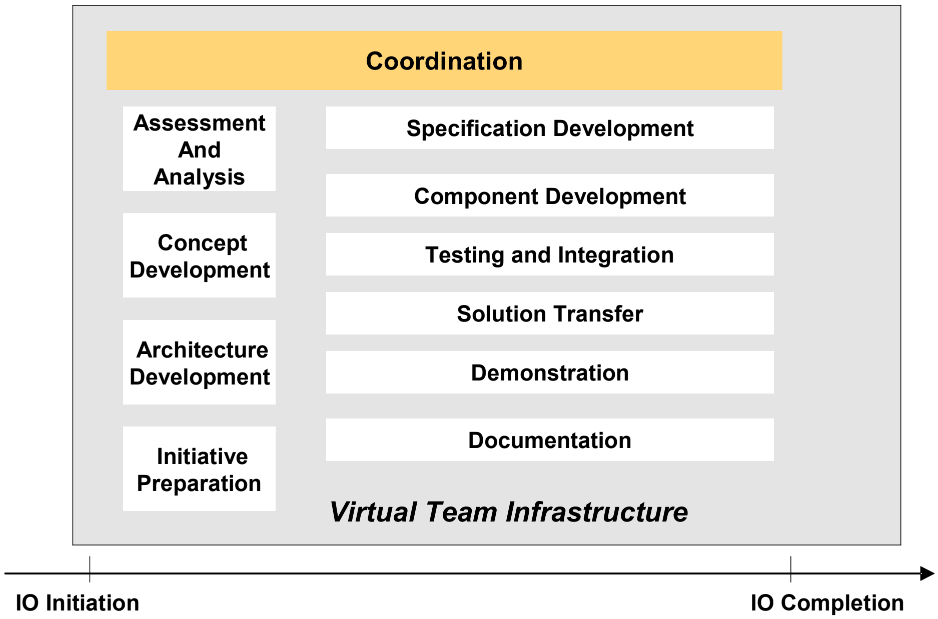

Figure 1: Interoperability Initiative Process Framework.

6.1 *Tasks*

6.1.1 Coordination

This task enables overall coordination among assigned OGC Staff, OGC Interoperability Program (IP) Team, Sponsors, selected organizations, and other TC/PC Members as needed to perform the following Subtasks:

- **Collaborative Environment -** OGC IP Team provides synchronous and asynchronous collaboration environments for cross organizational, globally distributed, virtual teams working interdependently to execute Initiative Orders Activities under this subtask include reading email, engaging in collaborative discussions and attending teleconferences.
- **Initiative Plan Development** – Support development of Project Plans, Project Schedules and Work Breakdown Structures (Work Package). Input may include technical and project management approach, tasks/schedules, communications plan, resource plans, risk and mitigation strategies, and definition of the specifications, standards, and component development and integration tasks necessary to realize the Enterprise, Computational, and Information Architecture views.
- **Management** – Project management services include requirement, cost, schedule and performance monitoring and status reporting. The PM must ensure that assigned project tasks are performed within the budgets, the work is progressing according to the agreed schedule, and any changes to requirements or personnel are managed to reduce the risk of cost overrun and schedule delay.

- **Communication** – Includes communicating status and issues of concern for ongoing Project related activities and planned Initiative to OGC and other organizations e.g. ISO. This task does not include IP Business Development functions.

6.1.2 Assessment and Analysis

This task requires assessment/evaluation and analysis of issues and documentation of an organization's or domains existing capabilities, and assessment of requirements for OGC-compliant technology. This task is implemented during Planning Studies.

6.1.3 Concept Development

This task conducts a Feasibility Study that assesses emerging technologies and architectures capable of supporting eventual Interoperability Initiatives (e.g. Testbed). Part of the concept development process is the use of a Request for Technology (RFT) to gain a better understanding of the current state of a potential technology thrust and the architecture(s) used in support of that technology. The feasibility study examines alternative prototype mechanisms that enable commercial web-services technology to interoperate. The study may also assess the costs and benefits of the architectural approaches, technologies, and candidate components to be utilized in a testbed and potential demonstration. This task also collates Sponsor requirements and assesses the applicability of current specifications.

6.1.4 Architecture Development

This task defines the architectural views for any given Initiative. In the context of the OGC Interoperability Program, there are three – and perhaps more –architectural views for any given effort. These views are the Enterprise View, Information View and Computational View (Based on RM-ODP). Part of the Architecture Development task may be the use of an RFQ to industry to enable organizations interested in participating in an Interoperability Initiative to respond with a proposal. This task may also be implemented during Planning Studies.

6.1.5 Initiative Preparation

This task defines the participant budget (if any), develops and executes agreements and contracts that outline roles and responsibilities of each participant. This task may refine the Work Package.

6.1.6 Specification Development

This task defines and develops models, schemas, encodings, and interfaces necessary to realize required Architectures. It includes specification Pre-design and Design tasks. This task may include activities to coordinate ongoing Initiatives with Specification Program activities.

6.1.7 Component Development

This task develops prototype interoperable commercial software components based on draft candidate implementation specifications or adopted specifications necessary to realize the required Architecture.

6.1.8 Testing and Integration

This task integrates, documents and tests functioning interoperable components and infrastructures that execute operational elements, assigned tasks, and information flows required to fulfill a set of user requirements. It includes Technology Integration Experiments (TIEs).

6.1.9 Solution Transfer

This task prepares prototypical interoperable components so that they can be assembled at required sites.

6.1.10 Demonstration

This task defines, develops and deploys functioning interoperable components and infrastructures that execute operational elements, assigned tasks, and information flows required to fulfill a set of user requirements.

6.1.11 Documentation

This Task ensures development and maintenance of the pre-specification, pre-conformant interoperable OpenGIS technologies (including Draft Interoperability Program Reports and Interoperability Program Reports), and the systems level documentation (example user documentation, etc.) necessary to execute the Initiative. This task may include coordination with OGC Specification Program activities including the Documentation Team.

6.1.12 Compliance Testing

This Task ensures development of draft compliance test guidelines (at a minimum) and test suites for engineering specifications detailed in Interoperability Program Reports. This task includes coordination with OGC Specification Program activities including the Compliance Testing and Interoperability Evaluation Subcommittee.

7 AECOO-1 Work Breakdown Structure (WBS)

The following Work Breakdown Structure (WBS) is derived from the OGC Interoperability Initiative Process Framework. This WBS should be interpreted in the following manner:

- Items that are grayed out are either IP Team tasks, have already been completed, or are not required for the AECOO-1 Initiative.
- Bold text is a task grouping or subtask grouping.
- Plain text indicates tasks against which proposing organizations should respond.
- Italic text indicates the task explanation (These task explanations are valid only for AECOO-1; subsequent initiatives will issue appropriate task explanations).

A proposing organization does not have to respond to all tasks below. However, bold italic text in the task explanation indicates which tasks are mandatory or conditional. Conditional tasks are those that are mandatory if a selected organization takes on certain non-mandatory tasks. All responses shall use this WBS to structure their responses. Evaluations of responses will be based on whether a proposal addresses the work items within the WBS. This is a mandatory requirement. The AECOO-1 project management plan and schedule will use the WBS during the contract performance period.

7.1 *Coordination*

7.1.1 Collaborative Environment

The following tasks are mandatory for selected organizations.

7.1.1.1 Routine and ad hoc telecons as assigned

The selected organization shall provide a technical representative and an alternate to participate in regularly scheduled telecoms or an ad hoc telecom.

7.1.1.2 E-mail review and comment

Selected organization shall provide technical representatives to participate in specification and prototypical component development discussions via the AECOO-1 mail list.

7.1.1.3 Action Item status reporting

Selected organizations shall report the status of their work in response to any action item accepted by them in whole or part. Action Items will be assigned to relevant work groups with an identified work group leader. Action item status shall be reported to the relevant work group leader.

7.1.2 Initiative Plan Development

7.1.2.1 Project Plan Development

7.1.2.2 Project Schedule Development

7.1.2.3 WBS Development

7.1.2.4 Concept of Operations Development

7.1.3 Management

The following tasks are mandatory for selected organizations.

7.1.3.1 Status Reporting

All status reporting will be conducted within the portal. Business/contract representatives for selected organizations shall report the status of their work as assigned to and accepted by them in their SOW following the structure of this WBS. Status reports will reflect the WBS item number and name, the "health" of the effort with green indicating optimal; yellow indicating issues have arisen that appear resolvable; and red indicating that issues have arisen that require immediate resolution or the effort will not succeed, and finally the report will describe the work done to fulfill the WBS item. Status reports will be submitted to the Thread Architects on a <u>Monthly</u> basis on the portal for compilation to an overall thread and initiative status. The first status reports after Kickoff will be due on <u>the third of the month or the first Monday thereafter</u>. A one-time Kickoff status report shall be provided that includes a list of personnel assigned to support the AECOO-1 initiative. The kickoff status report shall be submitted to the portal and the

AECOO-1 Initiative Manager no later than the first day of the AECOO-1 kickoff in soft copy format only.

7.1.3.2 Initiative Accounting

Business/contract representatives for selected organizations shall submit an invoice to the OGC Business Office at OGC Headquarters. The invoice shall include the OGC Accounting Job Code provided in the contract, the work completed during the prior month, and itemized list of Deliverables. The invoice shall include the budgetary not to exceed amount.

7.1.4 Communication

7.1.4.1 OGC Internal IP Status Briefings

7.1.4.2 OGC External IP Status Briefings

7.2 *Assessments and Analysis*

7.2.1 Organizational Capability Review

7.2.2 Organizational OGC Requirements Review

7.3 *Concept Development*

7.3.1 Sponsor Feasibility Study Review

7.3.2 RFT Development

7.3.3 RFT Response Analysis

7.3.4 RFT Response Review

7.4 *Architecture Development*

7.4.1 Enterprise View Development

7.4.2 Information View Development

7.4.3 Computational View Development

7.5 *Initiative Preparation*

7.5.1 Sponsor Planning TEMs

7.5.2 RFQ Development

7.5.3 Participant Budget Development

7.5.4 Contract Development

7.5.5 SOW/SOP Development

7.6 *Specification Development*

The proposal shall include brief resume(s) or qualifications of technical representative(s) to lead Specification Development effort for each or applicable tasks listed below. All selected organizations shall send technical representatives to the AECOO-1 Kickoff meeting. The attendance at this meeting will be mandatory for all selected organizations.

7.6.1 Model Development

Technical representatives of selected organizations shall develop or support the development of models that represent a service, interface, operation, message, or encoding that is being developed for the AECOO-1 initiative. These models may be in UML or some other appropriate modeling language. All models developed in the initiative will be posted to OGC Network™.

7.6.2 Schema Development

Technical representatives of selected organizations shall develop or support the development of schemas that specify an interface that is being developed for the AECOO-1 initiative. These schemas will be written in XML Schema or some other appropriate language. All schemas developed in the initiative will be posted to OGC Network™.

7.6.3 Encoding Development

Technical representatives of selected organizations shall develop or support the development of encodings that specify an interface that is being developed for the AECOO-1 initiative. These encodings will be specified in XML Schema or some other appropriate language. As applicable, all encodings developed in the initiative will be posted to OGC Network™.

7.6.4 Interface Development

Technical representatives of selected organizations shall develop or support the development of interfaces that specify operations, encodings or messages that are being developed for the AECOO-1 initiative. These interfaces will be specified in XML Schema or some other appropriate language. As applicable, all interfaces developed in the initiative will be posted to OGC Network™.

7.6.5 Specification Program Coordination

Technical representatives of selected organizations shall submit Engineering Reports pertaining to interface developments for AECOO-1 to the OGC Technical Committee for review. Those representatives shall present said Reports to relevant OGC TC special interest groups and work with SIG members to resolve issues that the members may raise with regard to the IPR and the interface(s) described therein.

7.7 *Component Development*

The proposal shall include brief resume(s) or qualifications of technical representative(s) to lead Component Development effort for each or applicable tasks listed below.

7.7.1 Prototype Interoperable Software Development

The proposal shall include the resume(s) of technical representative(s) to lead Prototypical Interoperable Software Development effort outlined below.

7.7.1.1 Server software development

Selected organizations shall develop server software or modify existing product server software to exercise the interfaces developed under the Specification Development tasks in item 6 above. The selected organizations will make this server software available for sponsor review and input during the initial period of the AECOO-1 initiative.

7.7.1.2 Client software development

Selected organizations shall develop client software or modify existing product client software to exercise the servers developed under the Component Development tasks of AECOO-1. The selected organizations will make this client software available for sponsor review and input during the initial period of the AECOO-1 initiative. Selected organizations shall develop client software to support their server software or make arrangements with other participants to use their client software to exercise their server during the course of the initiative. This is subject to approval by the sponsors and IP Team to ensure that the third party client is appropriate for exercising the functionality of the relevant server. If the proposing organization is developing server software and client software, then the client software shall exercise all AECOO-1 or other OGC services provided by their server.

7.7.2 Special Adaptation Development

Selected organizations shall adapt client or server software to exercise relevant mainstream IT technology and standards such as PKI and e-commerce technologies.

7.8 *Testing and Integration*

7.8.1 Configuration Management

7.8.1.1 CM Plan Development

Selected organization shall provide a representative to develop a configuration management plan for interfaces and components developed during the AECOO-1 initiative.

7.8.1.2 Initiative CM

Selected organization shall provide a representative to exercise the configuration management plan for interfaces and components developed during the AECOO-1 initiative.

7.8.2 Infrastructure Setup

7.8.2.1 Operating Systems

7.8.2.2 Networks

7.8.2.3 Web Server

7.8.2.4 Database Server

7.8.2.5 Web Browsers

7.8.2.6 SW Installation & Integration

7.8.2.7 Data Loading

7.8.3 Technology Integration Experiments

7.8.3.1 Iterations 1-N

7.8.3.1.1 Component Interface Test

Task Explanation-The Proposing organization shall provide a technical representative to conduct formal Technology Integration experiments that exercise server and/or client component software's ability to properly implement the interfaces, operations, encodings, and messages developed during AECOO-1. There will be multiple TIEs during the course of AECOO-1 that will exercise various interfaces, operations, encodings, and messages developed during AECOO-1. There may also be multiple iterations of a particular TIE or set thereof. ***This item is mandatory for all organizations proposing to deploy server interfaces for AECOO-1***

7.8.3.1.2 *Test Result Analysis*

Task Explanation-The Proposing organization shall provide a technical representative to report the outcome and relevant software reporting messages from TIEs in which the proposing organization participates. These TIE results shall be submitted to the AECOO-1 email list and within Monthly Status Report to be courtesy copied to the initiative architect. ***This item is mandatory for all organizations proposing to develop deploy server interfaces for AECOO-1.***

7.8.4 System Tests

7.8.4.1 Functional Test

7.8.4.2 Interface Test

7.8.4.3 Performance Test

7.9 *Solution Transfer*

7.9.1 Software Installation

Selected organization shall provide a licensed copy of AECOO-1 relevant software components for installation/integration onto the OGC Network. This could be accomplished by making the software component(s) available from an open site on their network OR by installing it on a sponsor or other host machine on the OGC Network. If the latter option is taken, then the selected organization shall provide a technical representative to install the software component(s). ***This is mandatory for all organizations proposing to develop software components for AECOO-1.***

7.9.2 Software Integration

7.9.3 Data Loading

Selected organization shall provide a technical representative to load data to any server components the proposing organization may develop. This task includes data loading to OGC Network based servers. ***This item is mandatory for all organizations proposing to develop server components for AECOO-1.***

7.10 *Demonstration*

7.10.1 Use Case Development

Selected organization shall provide a technical representative to develop or support the development of use cases that define and explain the utility of the interfaces developed during AECOO-1. These use cases shall be used to provide a basis for demonstration storyboards and the demonstration itself.

7.10.2 Storyboard Development

Selected organization shall provide a technical or business representative to develop or support the development of the demonstration storyboards that will define the structure and content of the demonstration.

7.10.3 Venue Access

7.10.4 Data Requirements Assessment

7.10.5 Data Acquisition and Distribution

7.10.6 Demonstration Preparation and Delivery

Selected organization shall provide a technical and/or business representative to develop or support the development of demonstration that will exercise the functionality of the interfaces developed during AECOO-1. The representative(s) will also support the demonstration event(s) as required. Selected organization will maintain server and client software for a period of no less than one year after the completion of the AECOO-1 demonstration. ***This item is mandatory for all organizations proposing to develop software components for AECOO-1.***

7.11 *Documentation*

7.11.1 Engineering Report Development

Selected organization shall provide a technical representative to serve as editor of a relevant Engineering Report (ER). Not all organizations responding to this item will be required to provide an editor; alternatively however they shall support the editor by providing authors for sections of the ER. The ER is the deliverable of the work items within AECOO-1 WBS.

Participants shall use the appropriate ER Document template posted on the OGC portal at the following location when preparing IP reports for submittal as part of this testbed initiative:

http://portal.opengeospatial.org/index.php?m=projects&a=view&project_id=147&tab=2&artifact_id=10533)

7.11.2 System Documentation Development

7.11.2.1 Functional Specification

7.11.2.1.1 Architectural Overview

Selected organization shall provide a technical representative to develop an architectural overview of their software component(s) relevant to the AECOO-1 architecture. ***This item is mandatory for all organizations proposing to deploy server interfaces for AECOO-1.***

7.11.2.1.2 Use Cases

Selected organization shall provide a technical representative to develop use cases to show the functionality of their software components in the context of the AECOO-1 architecture. ***This item is mandatory for all organizations proposing to deploy server interfaces for AECOO-1.***

7.11.2.1.3 UML System Models

7.11.2.1.4 System Configuration

Selected organization shall provide a technical representative to develop a detailed document describing the combined environment of hardware and software component(s) that compose their contribution to AECOO-1. This item is mandatory for all organizations proposing to develop software components for AECOO-1 to be installed at sponsor or other host sites connected to the OGC Network.

7.11.2.2 Installation Guide

Selected organization shall provide a technical representative to develop an installation guide for their software component(s). This item is mandatory for all organizations proposing to develop software components for AECOO-1 to be installed at sponsor or other host sites connected to the OGC Network.

7.11.2.3 Training Material & Users Guide

Selected organization shall provide a technical representative to develop a User's Guide and Training Materials pertaining to their software component(s) developed or modified for AECOO-1. The documents shall be provided to sponsors and IP Team to support their ability to demonstrate the proposing organization's contributions to the AECOO-1 initiative. ***This item is mandatory for all organizations proposing to develop software components for AECOO-1***.

7.11.3 Planning Study Report

7.12 *Compliance Test Development*

Technical representatives of selected organizations shall develop draft compliance test documentation pertaining to an interface developed or enhanced for AECOO-1. For candidate specifications, this test documentation shall, at a minimum, consist of test guidelines that would form the basis for development of more detailed and complete test scripts as the specification matures toward an approved specification. For mature candidate specifications, that are believed to be ready for vote to become approved specifications, participants shall evolve existing or prepare test scripts to form a complete set of tests to fully test an implementation of a *specification for compliance with its requirements. Compliance test documentation shall be included in an Interoperability Program Report. This task includes coordination with OGC Specification Program activities including the Compliance Testing and Interoperability Evaluation Subcommittee. Proposals shall address this task along with Task 6, Specification Development and Task 11, Documentation in this Annex.*

7.12.1 Summarize TIEs, demo results and data issues

Technical representatives of selected organizations shall include information detailing progress pertaining to the implementation of the interface by including TIE results, lessons-learned from the demo, and particular data issues.

7.12.2 Compliance Test

Technical representatives of selected organizations shall outline all of the necessary information to conduct a valid compliance test of the interface, including the sub items below

7.12.2.1 Test Cases

Technical representatives of selected organizations shall outline a valid compliance test for the interface. A valid compliance test will include identification of all required and optional server requests in the interface, the acceptable results for testing servers, the syntax checks to perform for testing client requests; an explanation of an acceptable verification of the results (machine, human, etc); a list of expected/valid warnings or exceptions to interface behavior; a matrix of test dependencies and explanation of ordering tests appropriately for inherent tests and dependencies.

7.12.2.2 Data

Technical representatives of selected organizations shall identify appropriate data sets for use in conducting a compliance test for an interface.

7.12.2.3 Recommendations

Technical representatives of selected organizations shall document recommendations to resolve issues with the current state of the interface, or with the compliance tests.