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A KEY POLICY ATTRIBUTE BASED ENCRYPTION MODEL FOR CLOUD COMPUTING IN BUILDING INFORMATION MANAGEMENT

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Abstract: **A Building Information Model (BIM) is a digital collection of data which represents a building during its life cycle can be used during the design, construction and maintenance phases. Here AEC (Architecture Engineering and Construction) sector highly uses the building information model. This sector allows the data for the data sharing and processing the requirements which leads to the challenge of the management of those building data. In this paper we provide the data sharing capability with the help of cloud computing based on the two key contributions. They are i) This Governance model is used for the building data using extensive research and industry consultation. This model delivers how to relate each other's individual data artefacts and how to protect the data from the unauthorized access. ii) This governance model utilizes the CometCloud autonomic cloud computing engine with a Master/Work Paradigm. This prototype successfully store and manage the building data, develops a security using defined policy language and demonstrate the Scale-out in case of node failure or increasing demand. Our prototype is evaluated qualitatively and quantitatively by integrating with the 3D modeling software Google Sketchup. Our experimental results show the prototype performance when scaling to utilize additional nodes in the cloud**

***Index Terms*—Cloud computing, building information modelling, data management, distributed tuple space**

I INTRODUCTION:

The cloud computing model is comprised of a front end and a back end. These two elements are connected through a network. The front end is the vehicle by which the user interacts with the system and the back end is the cloud itself. The front end is composed of a client computer, or the computer network of an enterprise, and the applications used to access the cloud. The back end provides the applications, computers, servers, and data storage that creates the cloud of services. Cloud computing describes a type of outsourcing of computer services, similar to the way in which the supply of electricity is outsourced. Users can simply use it. They do not need to worry where the electricity is from, how it is produced, or transported. In cloud, services allowing users to easily access resources anywhere anytime.

Users can pay for a service and access the resources made available during their subscriptions until the subscribed periods expire. Users are then forced to demand such resources if they want to access them also after the subscribed periods. We mainly focused on the service provision issues on IaaS, which abstracts hardware resources into pool of computing resources and virtualization infrastructure. IaaS providers build flexible cloud solutions according to the hardware requirements of customers; furthermore it let customers run operating systems and software applications on virtual machine (VMs).Customers merely pay for the resources that are actually used. To host web application services, service operators would apply resource subscription plans to dynamically adjust service capacity to satisfy a time-varying demand.

While subscribing IaaS resources, the web service

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operators aimed to provide a certain level Agreement (SLA) with their clients, e.g.,a guarantee on request response time. The resource provisioning of IaaS allows consumers to elastically increase or decrease the system capacity by changing configurations of computing resources. Moreover, cloud providers have multiple usage based pricing models based on different VM configurations, such as different CPU cores, memory size, and rental costs.

When you store your photos online instead of on your home computer, or use webmail or a social networking site, you are using a "cloud computing" service. If you are an organization, and you want to use, for example, an online invoicing service instead of updating the in-house one you have been using for many years, that online invoicing service is a "cloud computing" service. Cloud computing refers to the delivery of computing resources over the Internet. Instead of keeping data on your own hard drive or updating applications for your needs, you use a service over the Internet, at another location, to store your information or use its applications. Doing so may give rise to certain privacy implications.

Cloud Computing is the delivery of computing services over the Internet. Cloud services allow individuals and businesses to use software and hardware that are managed by third parties at remote locations. Examples of cloud services include online file storage, social networking sites, webmail, and online business applications. The cloud computing model allows access to information and computer resources from anywhere that a network connection is available. Cloud computing provides a shared pool of resources, including data storage space, networks, computer processing power, and specialized corporate and user applications. The following definition of cloud computing has been developed by the U.S. National Institute of Standards and Technology (NIST): Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and is composed of five essential characteristics, three service models, and four deployment models.

Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition. Traditional building design was largely reliant upon two-dimensional technical drawings (plans, elevations, sections, etc.). Building information modeling extends this beyond 3D, augmenting the three primary spatial dimensions (width, height and depth) with time as the fourth dimension (4D) and cost as the fifth (5D). BIM therefore covers more than just geometry. It also covers spatial relationships, light analysis, geographic information, and quantities and properties of building components (for example, manufacturers' details).

BIM involves representing a design as combinations of "objects" – vague and undefined, generic or product-specific, solid shapes or void-space oriented (like the shape of a room), that carry their geometry, relations and attributes. BIM design tools allow extraction of different views from a building model for drawing production and other uses. These different views are automatically consistent, being based on a single definition of each object instance. BIM software also defines objects parametrically; that is, the objects are defined as parameters and relations to other objects, so that if a related object is amended, dependent ones will automatically also change. Each model element can carry attributes for selecting and ordering them automatically, providing cost estimates as well as material tracking and ordering.

For the professionals involved in a project, BIM enables a virtual information model to be handed from the design team (architects, landscape, surveyors, civil, structural and building services engineers, etc.) to the main contractor and subcontractors and then on to the owner/operator each professional adds discipline-specific data to the single shared model. This reduces information losses that traditionally occurred when a new team takes 'ownership' of the project, and provides more extensive information to owners of complex structures.

Data management is the development and execution of architectures, policies, practices and procedures in order to manage the information lifecycle needs of an enterprise in an effective manner.

Data life cycle management (DLM) is a policy-based approach to managing the flow of an information system's data throughout its life cycle: from creation and initial storage to the time when it becomes obsolete and is deleted. Several vendors offer DLM products but effective data management involves well-thought-out procedures and adherence to best practices as well as applications.

There are various approaches to data management. Master data management (MDM), for example, is a comprehensive method of enabling an enterprise to link all of its critical data to one file, called a master file that provides a common point of reference.

In this paper, we propose a governance model which is based on key policy attribute based encryption used for the building data using extensive research and industry consultation. This model explains how to relate each other's individual data artefacts and allows how to protect the data from the access. Our governance model utilizes the CometCloud autonomic cloud computing engine with a Master/Work Paradigm. This prototype successfully store and manage the building data, develops a security using defined policy language and demonstrate the Scale-out in case of node failure or increasing demand.

II BACKGROUND

1. Building Information Modelling

Construction and Civil engineering are highly regulated, fragmented, data intensive, project-based industries dependent on a large number of very different professions and firms, with increasing data sharing and processing requirements The process of designing, re-purposing, constructing and operating a building or facility involves a large number of disciplines including: Architecture, Structure, Mechanical & Electrical, Energy and Sustainability. Within the industry, project failure has been common over the past decades and, amongst the notable common causes of failure is the lack of effective project team integration across the supply chain .It has been found that inadequate information management is one of the key contributing factors to delays and construction waste. A lack of compatible information systems, defacto standards and protocols, and the varying perspectives and requirements of clients and designers limit effective collaboration .

2. Comet Cloud

We make use of the CometCloud system due to its successful deployment in other data sharing scenarios within computational finance area . CometCloud uses a Linda-like tuple space referred ‘‘CometSpace’’Vwhich is implemented using a Peer-2-Peer overlay network. In this way, a virtual shared for storing data can be implemented by aggregating capability of a number of distributed storage and compute resources.

CometCloud therefore provides a scalable backend deployment platform that can combine resources across a number of different providers dynamicallyVa key requirement for an AEC project. The overarching goal of CometCloud is to realize a virtual computational cloud with resizable computing capability, which integrates local computational environments and public cloud services on-demand, and provides abstractions and mechanisms to support a range of programming paradigms and application requirements.Specifically, CometCloud enables policy-based autonomic cloudbridging and cloudbursting.

Autonomic cloudbridging enables on-the-fly integration of local computational environments (datacenters, Grids) and public cloud services (such as Amazon EC2 and Eucalyptus), and autonomic cloudbursting enables dynamic application scale-out to address dynamic workloads and spikes in demand. Cloudbridging is useful when specialist capability available in-house needs to be integrated with high throughput computation that can be outsourced to an external cloud provider such as Amazon. Cloudbursting, on the other hand, enables scale-out of inhouse computation and may not necessarily involve a change in capability between in-house and outsourced providers. CometCloud has been shown to be highly scalable (e.g., integrating over 2500 cores across several HPC systems and Amazon EC2) in different federation scenarios involving High Performance Computing (HPC) and Cloud environments

3 .BIM Adoption in the AEC Sector

A number of commercial solutions addressing the problem of BIMdata storage have been developed. Commercial BIM servers are today available, including the Onuma system Revit Server (www.autodesk.com),ProjectWise and AssetWise Graphisoft BIM Server (www.graphisoft.com) and EDMmodelServer (www.jotne.com). However, these servers often require local infrastructure and maintenance within the organisation that is using themVtending to utilise either central (accessible to all team members over the WAN) or local (accessible to team members over the LAN) connectivity. Recently software vendors, such as Bentley Systems and Autodesk, have begun offering hosted solutions for building data.

Additionally 4Projects (4Projects.com) offer a specific project collaboration service for the AEC sector including document and drawing management, contract management, and procurement management. Many such projects make use of their own proprietary file formats(especially in relation to 3D building models). While import/export functionality to standardised formats exist, there are still issues with data interoperation, i.e. complete mapping between different formats is not possible due to the use of proprietary extensions. In addition to software to support collaboration within the AEC sector, a number of semantic resources and information management standards have been developed for the construction domain. One of the key developments is the Industry Foundation Classes (IFC) [2]. The IFCs are becoming a commonly used form for BIM. They are open data model specifications for defining building components' geometry and other physical properties in a way that enables CAD users to transfer design data between different software applications.

They are intended to provide an authoritative semantic definition of building elements, their properties and interrelationships. Data associated with IFC can include: textual data, images (such as building schematics); structured documents, numerical models and designer/project manager annotations . The IFC specification is developed andmaintained by BuildingSmart and has been included in several ISO standards. The IFC with its standard set of rules for data storage, data exchange and protocols provides an ideal framework to manage data related to a building throughout its lifecycle . As-well as the IFCs, other developments within the industry include COBie (Construction Operations Building Information Exchange).

III BIM GOVERNANCE MODEL

As outlined in Section 2 the Building Information Modeln(BIM) can be viewed as a collection of documents 316 IEEE TRANSACTIONS ON SERVICES COMPUTING, VOL. 8, NO. 2, MARCH-APRIL 2015 generated during the lifecycle of a particular AEC project. As a project matures, information is progressively added by participants who engage with the project. Such information may consist of a 3D model, or may include a schedule, spreadsheet, database, or text document .The key challenges in this context include the ability to:

1. aggregate documents, related to a particular facet (such as structural analysis) needed at particular stages of a AEC project lifecycle;
2. trace back when and who added a feature to a design;
3. check conformance to the BIM data model;
4. ensure that constraints identified in the design are not subsequently violated in other parts of the project lifecycle.

cation for structured informationexchange.

1. Document Types and Relationships

When using BIM, it is rare for any two documents to be treated as completely separate entities and many documents will have relationships with others. Incremental refinements within our focus groups consultation led to four types of relationships: versioning, composition, derivation and concurrency.

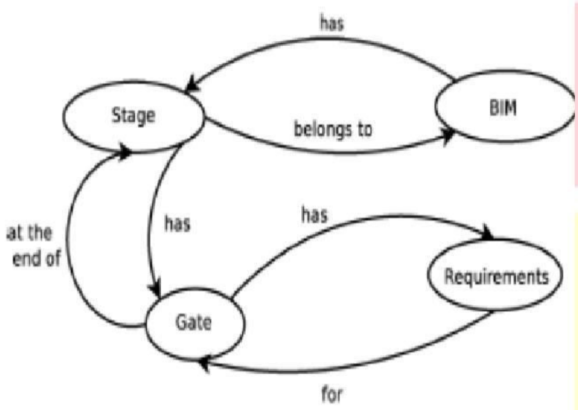

Fig. 1. Structure of a BIM.

Each of which have different implications as to how data within the BIM as a whole is affected when a new document is added. These are discussed below, with the variable B used to represent BIM: No relationship: A new Document Da is added to theBIM so that: B ¼ B þ Da. Versioning: A new document Db is created, based on an existing document Da with changes made such that Db ¼ Da þ X _ Y where X is the addition and Y the removal of data from Da. Derivation: Given that a document Db for use by discipline j is derived from document Da which was created for discipline i then Db ¼ fi jðDaÞ þ X where fij is function to filter data and X is the new data added. Composition: New data is added to the BIM model forming part of an existing document. For example, if the top level document is Da and each floor within a building isrepresented as a document layer Df0 . . .Df3 then Da ¼ Df0 þ Df1 þ Df2 þ Df3. Each document in the composition may possess different access rights.

Concurrency: This relationship models a situation where two documents are developed in parallel and illustrates a dependency between the two. In this relationshipthe contents of the documents are linked such that Da ¼ X þ Db and Db ¼ Y þ Da where X and Y are the actual contents of Da and Db respectively.

2 Process and Access Rights

In our approach we consider BIM to consist of a series of stages, at the end of which there is a gate, identifying a set of either mandatory or optional requirements such as the presence of data within the BIM, the accuracy of dataVas illustrated in Fig. 1. For instance, in early stages of a building lifecycle, energy efficiency figures may be rough estimates which need to be refined in later stages (when results of detailed simulations become available). This division into stages allows the tracking of the BIM model throughout the project. In essence each stage within the model can be viewed, once it has completed, as a snapshot of the BIM as it was at that time.

This functionality will enable the use of the governance model as support for project managers, enabling the creation of reports that can be used to facilitate design making and ensuring BIM compliance with standards, whether imposed by legislation, the client, or internally.

3 Multi User Collaboration

describes the various components that make up a BIM document. Currently we define five document types (based on who can access them):

1. private: document only for use of owner;
2. team: document only for use at a team level;
3. finalised: document is finalised for use by other teams;
4. ClientVdocument is ready for release to client;
5. ArchivedVdocument has reached end of its lifecycle and no further alterations will be made.

A transaction occurs whenever a relationship between documents is created by a user . The transaction entity is generated automatically, whereas the decision entity enables the user to make explicit the reasons for creating the relationship. also shows all the metadata that is stored, using as a base-line, the Dublin Core metadata standard. This ensures that all elements defined in this standard are either provided explicitly within the Document object, or implicitly by its relation to data stored in other related objects within the data model.

IV CONCEPTUAL ARCHITECTURE & POLICY DESCRIPTIONS

A proof of concept prototype, called CloudBIM, has been constructed using the Master/Worker programming model supported by CometCloud. The prototype supports a multiactor project, with several different organisations participating, each providing a set of workstations which connect to a master node. To a user it appears as if this master provides the data for the entire BIM, whereas in reality the data is distributed amongst the workers. The master nodes do not store data, but they are responsible for integrating with the workers in the cloud by way of queries.

The architecture illustrated in Fig. 2 describes how the master and worker capability is integrated into existing software, such as Autodesk Revit (used widely in the AEC domain). In this three layer model the application plugin for Google sketch up communicates with the master nodeVeither by explicitly requesting a documentby URI or querying the governance model. The master node then communicates with the worker nodes that actually store the data and enforce the rules set by the governance model.

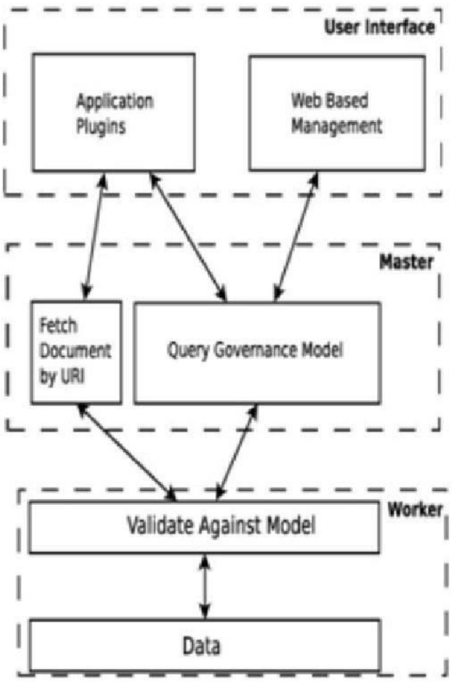

Fig 2.CloudBIM Architecture

V CLOUD IMPLEMENTATION & EVALUATION

Our implementation strategy focused on two possible uses of the governance model: as a capability that could be integrated into a custom user interface implemented for a specific project; . as a capability integrated within existing software as a plug-in (such as existing CAD systems like Autodesk Revit [28] or Google sketchup. Both of these are demonstrated in this section and implemented as a set of queries. The prototype CloudBIM query language is specified in Fig. 5 in Extended Bachus Naur Form (EBNF) notation. For the sake of brevity the terms ID (a unique ID) and VALUE (a string) are not defined, also omitted are commands used to authenticate a user. The CloudBIM query language defines six key commands: get, add, delete, update, adddoc, and fetchdoc. These commands allow the manipulation of objects within the governance model, however it should be noted that not all objects are able to be directly manipulated by users, some are created/updated as a side effect of other queries i.e., specifying the relationship of a new document will lead to the automatic creation of Relationship and Transaction objects as necessary by using data supplied in the adddoc command.

VI PROTOTYPE VALIDATION

Initial validation of the CloudBIM concept, its associated data model and security policy is carried out in two ways. The first involves describing the prototype using a number of use cases supplied by our construction project management industry partnerVinvolving the development of a specialist user interface in Java and integration with Google sketchup. The second, described in Section 6.1, involves carrying our a performance analysis of using the operations in our query language and the fault tolerance capability described in Section

VII CONCLUSION:

Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility The work in this system demonstrate how the cloud computing can be used for supporting collaborative working in the AEC sector with the emerging reference called Building Information Model standard (BIM) and integration with 3D open source tools for rendering process

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called Google Sketchup. This work use a cloud prototype based on CometCloud system, that provides a bridging between in-house computational infrastructures at the participating sites involved in the AEC project. Here the Linda like tuple space model is used for developing a distributed, shared "space" for exchanging data between participants.

VIII FUTURE WORK:

In our Future work, we propose a governance model by using Ciphertext policy Attribute based access policy which is used to enable the dynamic modification of the access rights associated with the data objects based on the activities and responsibilities within the virtual enterprise, assign to the subjects within the system. This process works like master/Work paradigm that specifies the user access in the files.

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