A COLLABORATIVE RESOURCE-BASED CLOUD ARCHITECTURE FOR FREIGHT LOGISTICS

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Abstract: Collaborative Cloud is the set of Cloud infrastructure, processes and standards, that allows companies to expose data and information as virtual resources, and manage them in collaboration with their partners and customers. The concept of Collaborative Cloud is realised with technologies such as global identifiers, data oriented services and content based messaging. The paper illustrates the application of Collaborative Cloud to a shipping logistics business to government (B2G) scenario called Single Window.

1 INTRODUCTION

In today's IT, the Cloud is better known as a paradigm for utilising distributed computing resources to meet elastic demand (Armbrust et al, 2010).

A less well understood application of Cloud is as a tool for collaboration between organisations through the sharing of Cloud based resources. The Cloud, thanks to its elastic capacity allows companies to share resources while controlling what and with whom it will be shared, at the same time without worrying about the up or down-scaling of the shared resources availability, as this is taken care by the Cloud infrastructure.

Sharing of resources first requires the ability to locate them. Unlike with older Web based collaboration approaches, in Cloud based collaboration, shared resources do not 'live' in a particular Web address or server, i.e. their location is virtualised. Thus, resources need to be referenced in a location independent way, using methods such as universal identifiers (UUIDs) and symbolic URIS that do not necessarily resolve to a network address .

In this paper we consider the problem of independent entities (business organisations and government authorities) that use the collaborative Cloud to carry out business transactions. Previously, such business to business (B2B) and business to government (B2G) interactions were described using sequences (or choreographies) of message exchanges. Messages are typically described in an XML based language such as OASIS ebXML, while the choreographies of messages in a web service language such as BPEL. Such approaches however, requires tight integration between the two transacting parties, in the sense that the different parties not only must agree on the messages that will be exchanged, but also on the sequence of such exchanges.

Our approach has been influenced by web based architectural concepts and styles such as WOA (Hinchcliff, 2008) and REST (Fielding, 2000).

In the remaining of this paper we illustrate our collaborative Cloud approach, by first introducing its main concepts and features. Next, we demonstrate the application of the approach in a transport logistics Business to Government (B2G) scenario called Single Window. Finally, we analyse the cost and other benefits of the proposed approach and identify areas for future research.

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2 CONCEPTS AND FEATURES OF THE COLLABORATIVE CLOUD

Cloud has recently started to move from its original purpose as a vehicle for sharing computing resources to a platform for collaboration. For example, Cloud as a technology for supply chain management has started to emerge in many industries (Gardner, 2009).

The Collaborative Cloud shares its foundations with other service computing paradigms such as REST (Fielding, 2000) and WOA (Hinchcliff, 2008). Both REST and WOA put emphasis on services as resources not as computation.

2.1 Accessing and Manipulating Resources on the Cloud

To be uniquely identifiable, Cloud resources have globally unique identifiers (UUIDs). A resource factory is responsible for generating a UUID upon request from a client to create a resource. Below is a UUID for a business resource of type Shipping Notice

```
ShippingNotice6E09886B-DC6E-439F-82D1-
7C83746352B
```

As proposed by the REST approach, resource representations can be manipulated using standard HTTP commands. In short, the HTTP set of operations: PUT, DELETE, POST, GET is used for retrieving and manipulating resource information.

Resources can be updated using HTTP POST commands and created using PUT. The following HTTP operation updates the property Estimated Time of Arrival (ETA) for a resource of type shipping notice with unique identifier:

```
ShippingNotice6E09886B-DC6E-439F-82D1-
7C83746352B
POST ShippingNotice6E09886B-DC6E-439F-
82D1-7C83746352B?{"ETA" :
{"21/1/10:21:40"}
```

The above operation may require authorisation; if the client was not authorised, a 'not authorised error (like HTTP 401) would be produced upon issuing the above command.

3 APPLYING THE COLLABORATIVE CLOUD TO SINGLE WINDOW

Logistics companies are tasked with transporting shipments (cargo) between locations by air, sea or land. Movements of vehicles and cargo are restricted by international and national rules and legislations that specify the documents that need to be submitted at the different legs of the journey depending on the type of cargo, arrival and departure points and so on.

The single Window concept refers to the ability of a logistics company to submit a *single document* regarding a voyage, to a single authority that receives information, either on paper or electronically, disseminates this information to all relevant governmental authorities, and co-ordinates interactions. The traditional approach to the International Trade Single Window has been to think of it as a centralised IT application, capable of accepting single submissions from industry users and then distributing them to all Government agencies concerned. This would be in conformance with UN/CEFACT Recommendation 33 on Single Windows (UN/CEFACT, 2004).

However, there are several practical problems with this approach, especially in countries where already many different systems are in existence. The cost of integrating such systems is likely to be greater than the resulting benefits. There are also technical obstacles with the timing of submissions relative to the availability of data, and the sheer scope and transaction volumes. Also, reporting regulations change quite frequently, making the updating a centralised system a daunting task.

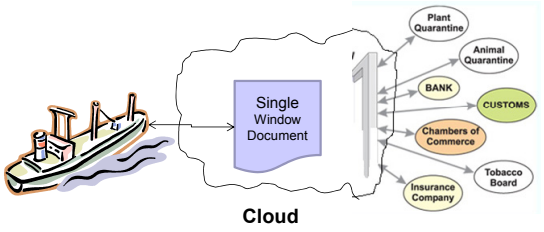

Figure 1: Cloud for single window concept.

We propose therefore, that the concept of Single Window can be better realised by a distributed collaborative Cloud approach. The shared Cloud resource in this context corresponds to the multiple physical documents that a ship needs to submit to various authorities as it approaches or departs from ports. We call this resource Single Window Document (SWD), as in Figure 1.

SWD is created prior to, or upon the start of a voyage and shared from then on amongst the ship and the various authorities and agencies. A SWD is a resource that has several properties describing the ship, voyage and cargo. It is important to ensure that the properties values are described according to particular reporting requirements

Currently, as a ship enters different national waters in its voyage, it typically has to prepare and submit several documents for each different country or authority it approaches. In the Cloud approach, the ship master or other agent creates a new single SWD resource that contains information meeting all reporting requirements.

A Cloud notification service then informs the different authorities/agencies that are interested in this resource. Validation services assist the ship users in complying with the different reporting requirements.

To achieve that, a Cloud service analyses the ship's voyage plan (a property of SWD) and identifies the calling ports. This is possible because names of ports is standardised using the UN/LOCODE (Code for Ports and other Locations) recommendation**.** For each port of call the reporting requirements can be established.

```
"movement" : [{"from" : {"UNLOCODE":
"AEAUH"}, {"to" : {"UNLOCODE":
"BEZEE"}}, {"ETA" :
{"21/1/10:21:40"}]
```

For example, the above structure states that the next leg of the journey is from Abu Dhabi ("AEAUH") to Zeebruge, with an estimated time of arrival 21.40 on 21/1/10. Based on the ETA and the port of arrival, the Cloud service establishes the reporting requirements for Zeebruge Port Authority, as well as for other related authorities (e.g. Customs). A validation function is carried out by the Cloud on the submitted SWD. The validation function compares the value of the document properties with the expected value of the property based on the schema of the report expected by the relevant authority, The validation returns the list of properties that do not meet the reporting criteria, as well as missing properties.

Missing properties from SWD needs to be added, by perhaps inferring them from other available information. If, for example, hazardous information needs to be notified (see Figure 2), it can be inferred from the goods description property of SWD. If some goods carried are defined as belonging to Class 2.1 (flammable gases) of the International Maritime code (IMO) then hazardous cargo report must be submitted. If the goods status cannot be inferred from existing data, this will get flagged and notified to a human operator for further action.

3.1 Push vs. Pull Mode of Collaboration

The Cloud approach described here allows a mixed push/pull approach where the different parties take the initiative to submit and validate documents. A ship can operate a monitoring application that checks if its submitted documents are in a valid state (e,g "approved", or "submitted for approval"). The authority or agency can employ monitoring applications that check new ship documents as they are submitted and validate or reject them. A ship can proactively check the validity of a document by accessing the validation functions of the different ports and authorities it plans to visit. If a port or other authority provides online schemas for the various reports it requires, the whole reporting process can be automated. A Cloud service can access the port report schema(s) and modify parts of the SWD, based on the schema, to create a port compliant report. For example, If the next port of call is Antwerp (unique identifier: BEANR) a Cloud service will get information about port arrival notice resource schema by

```
GET BEANR\port-arrival-notices
```

A comparison service can compare the current port arrival notices with the ship's current SWD (SWDxxxx) and return any discrepancies as follows.

```
validate?  SWD=SWDxxxx&port-arrival-
notices= BEANR\port-arrival-notices
```

Periodic updates to the status of the journey must be made available to different parties. These updates can be in *pull* or *push* mode. Pull can be based on periodic requests initiated by various participants requesting updates about the transport progress. Pull notifications can use resource filtering however, because of latency issues it is best not to be used for time sensitive notifications.

4 FINDINGS AND CONCLUSIONS

The Cloud can provide an ideal platform for online collaboration, as it allows resources to be totally

virtualised both in terms of ownership, content as well as in terms of location. A Cloud infrastructure can allow resources to be referenced using virtual names and addresses and to be manipulated using a small and universal set of operators. Finally, resources can be collaboratively edited without reference to an underlying physical infrastructure, such as server address or names of the physical databases that contain the resources. Thus, the idea of collaborative Cloud as described in this paper is summarised as follows:

- Reporting procedures can be streamlined;
- documents can be submitted once
- documents can be automatically modified to comply with reporting requirements
- once a document is submitted the decision of who needs to be notified lies with the Cloud than the sender (client). This simplifies the need to maintain business logic to support different applications and workflows.

There is a minimum set of requirement for coordination between the different parties. A minimum requirement, Is to maintain a set of common names for the different business documents and their properties.

A rough estimation of the cost advantages of this approach, can be gained by considering the annual traffic of about 70000 ship calls to Finnish ports (UN/CEFACT, 2005). If we put the cost of filling in and submitting a single form at 1 person-hour, and by assuming an average of 10 forms per ship per voyage, this can amount to 700000 hours or approximately 120000 working days or 400 person years of effort. If the number of forms is reduced to a single document, there can be savings of 90% or up to 360 person years, just in a single country. Also, these savings represents only the ship side and does not take into account any savings made in the administrative (port and agencies) side.

In addition to cost, there are other types of benefits for government agencies such as more effective and efficient deployment of resources, correct and increased revenue yield , Improved compliance, enhanced security and Increased integrity and transparency

From the users perspective, apart from the financial (cost cutting) benefits_, the Single Window can realise benefits such as faster clearance and release for entering and leaving ports, easier compliance with rules and regulations and more effective and efficient deployment of resources and Increased transparency.

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REFERENCES

Armbrust, M, Fox, A, Griffith, R, Joseph, A.D., Katz,R, Konwinski,A, Lee, G, Patterson, D, Rabkin, A, Stoica, I, and Zaharia. M. (2010) A view of Cloud Computing. *Communications of the ACM* , vol. 53, no. 4.

Fielding, RT (2000) Architectural Styles and the Design of Network-based Software Architectures PhD Thesis, University of California, Irvine.

Gardner, D. (2009). How the Cloud Aids Supply Chain Recalls Cloud computing uniquely enables product and food recall processes across supply chains.*Cloud Computing Journa*l AUGUST 25, 2009

Hinchcliff, D (2008). What Is WOA? It's The Future of Service-Oriented Architecture (SOA). Available from http://hinchcliffe.org/archive/2008/02/27/16617.aspx

UN/CEFACT (2004). United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) Recommendation and Guidelines on Establishing a Single Window, ECE/TRADE/352.

UN/CEFACT (2005). United Nations Centre for Trade Facilitation and Electronic Business Case Studies on Implementing a Single Window to enhance the efficient exchange of information between trade and government.