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Model for Incident Ticket Correlation for Inter-Organizational Service Delivery

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Abstract: The providers of IT services are under constant pressure to reduce cost and improve the quality of the services they provide. Customers and service providers have the choice of which internal service delivery team or external service provider they assign to parts of a service process. The delivery of a service is therefore the responsibility of more than one provider's organization. These processes are critical for successful delivery of the services, as is stressed by the IT Infrastructure Library (ITIL). The Incident and Problem Management Process is supported by various tools including Incident Ticket Systems (ITS). In this paper we offer a system and method for correlation of incidents reported by consumers with those of different provider organizations. We further consider different inter-organizational service delivery models on the basis of two business scenarios, based on static inter-organizational collaboration.

1. Introduction

In recent years IT Service Management (ITSM) has become one of the most researched areas of the computer science. ITSM focuses on the development of methodologies and tools that facilitate providing high quality service with maximum efficiency. Incident and Problem Management processes of ITSM are critical for successful delivery as stressed by IT Infrastructure Library (ITIL) as best practice in the management of the IT infrastructure, development and operations [1] as well as by the ISO-IEC 20000-1 ITSM-Standard [2].

The Incident Management Process is supported by various tools including Incident Ticket Systems (ITS). These are software systems used in an organization to record information about service failures or malfunctions and about the interventions made by technical support staff or third parties on behalf of the end user who reported the incident. This record is called a *ticket*. Organizations make efforts to develop, enhance, coordinate and operationalize the Incident Management process to conform to ITIL.

The delivery of a service within an organization is usually a well-understood and controlled process. Delivery processes that span various organizations are not investigated enough. Since many providers participate in the delivery of a composed service, the root cause of an incident issued by the customer is not easy to identify. Tracking the progress of the incident's resolution is very difficult. The inter-organizational ITSM (ioITSM), and an inter-organizational Incident Management as its imperative part, aims to support the management of the processes that engage various organizations [3]. We realize a correlation model that consolidates and supports the inter-organizational Incident Management. This model is used in the correlation of incidents from different provider organizations. We further consider different service provider organizational structures to understand how ioITSM complies with their inter-organizational needs.

The paper is structured as follows. Section 2 describes the different inter-organizational service delivery models and our scenarios. Section 3 introduces new concepts and describes the inter-organizational incident ticket correlation method. The benefits of our model are outlined in Section 4. Section 5 concludes the paper by identifying open issues and describing further research in this area.

2. Inter-Organizational Service Delivery Models

We consider two categories of service delivery inter-organizational structures: hierarchical and heterarchical structures.

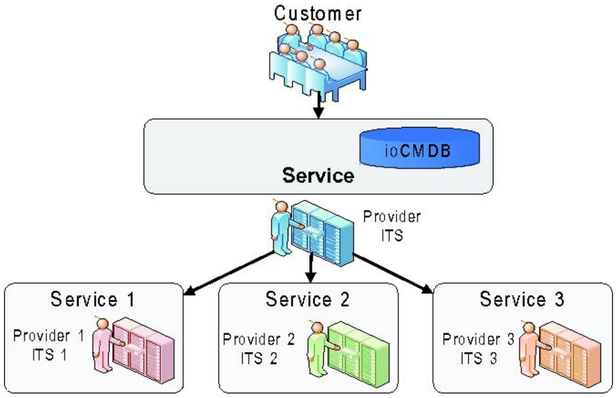

Figure 1 The Hierarchical Inter-Organizational Model of Service Delivery

2.1 Hierarchical Organization Model of Service Delivery

The hierarchical organization structure is a vertical chain of providers in which the service provider (SP) has sole responsibility for the service that is being consumed by the customer (and its users) and is a single point of contact for customers. Figure 2 shows an example of a hierarchical organization model with a service provider that subscribes Service 1, Service 2 and Service 3 provided by Provider 1-3. Each of the providers communicates with the service provider, which is the single point of contact with the customer.

In this type of organization of service delivery, the Service Provider (SP) has a responsibility to customers for the overall services and therefore the SP requires detailed knowledge of service delivery model. The ioCMDB aims to help the Service Provider to facilitate service incident localization.

Scenario 1: In the IntegraTUM project [4] founded by the German Research Foundation (DFG) and the German Federal Ministry of Education and Research (BMBF) and hosted by the Technische Universität München (TUM), multiple IT-Services which were former operated by the involved institutions themselves, have been reorganized and recentralized at Leibniz Supercomputing Center (LRZ). The students of the TUM have automated access to e-learning portals and learning management systems or computer labs. TUM is the Customer of LRZ and they follow the rules of above described hierarchical inter-organizational service delivery model. Both of the two organizations are using different Trouble Ticket Systems (TUM: OTRS and LRZ: ARS).

2.2 Heterarchical Organization Model of Service Delivery

Heterarchy is defined by Hedlund in [5], were he is pointing out the restrictions that exist in the hierarchical organizational structure for service delivery. The heterarchy is the "alternative" solution to hierarchical organizational structures for service delivery. The concept of heterarchy in IT Services as horizontally chained services is also further researched in [7].

We cal the structure of horizontally chained providers that cooperatively deliver services to a customer is named Service Provider Coalition (SPC), which is further described in Subsection 3.1). These kinds of organizational structures are used, for example, for providing services in complex distributed environments, such as multinational projects and those that require task and data parallelism, dynamic data access to large data sets or long running computations.

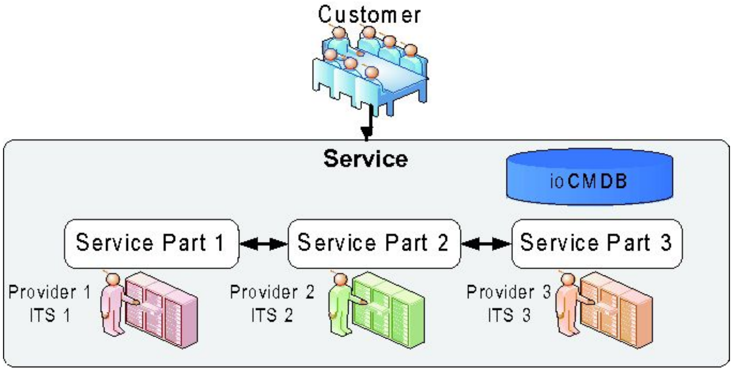

Figure 2 Heterarchical Inter-Organizational Model of Service Delivery

Scenario2: An example of service delivered by a heterarchical service provider organization is the End-to-End (E2E) Link service in the GÉANT2 multinational network [6]. Co-funded by the EC and Europe's national research and education networks (NRENs)), and managed by DANTE, the GÉANT2 network connects 34 countries through 30 NRENs, using multiple 10Gbps wavelengths. One representative project is the provisioning of the infrastructure for the Large Hadron Collider (LHC) at CERN in Switzerland. It is expected that its experiments produce 15 Petabytes yearly. In order to meet the requirements of large-scale research projects, dedicated optical E2E Links will be set up. These will span over multiple countries and allow unrestricted utilization of available bandwidth. E2E Links connect organizations located in different countries and cross the networks of different providers (domains). In providing the E2E Link services the provider (member of the service provider coalition) has to collaborate in setup, maintenance and management tasks. One of the major problems in the realization of this service is tool heterogeneity (e.g. different ITS's in different domains).

In this paper we only take in account static inter-organizational scenarios. As we are aware that dynamic collaborations are vital especially for example for the Business Grid community, the concept defined here will be enhanced in a future work.

3. Technology Description (System and Method of Correlation)

In our approach we use the inter-organizational Configuration Management Database (ioCMDB) depicted in [3] as an enabler for inter-organizational IT Service Management (ioITSM). This describes processes for ioCMDB usage and an ioCMDB information model. ioCMDB stores references to information in the CMDBs of different organizations participating in the inter-organizational service delivery, we will use ioCMDB for facilitation of exchange of incident information between providers of a service delivered by a Service Provider Coalition.

In this section we describe two new concepts: Service Provider Coalition and Incident Manifest, the components involved in the correlation and the method of correlation.

3.1 Service Provider Coalition

A Service Provider Coalition (SPC) is a group of providers that together supply a composed service and have group authority and responsibility to consumers of their services. In this kind of organizational structure each of the SPC's members provides a part of the service to a customer.

For example, a SPC could provide a service composed of a horizontal chain of atomic services by different providers. In other cases services provided by SPC could be represented as a fully connected graph. Effective management of service delivery by SPC requires a cooperative ticket information system as the communications medium across providers' organizations. As complex services are decomposed into small atomic services, see for example in [8], often with market or geographically oriented rather than hierarchical coordination, the suppliers might also be consumers of services provided by others.

The flow of information and provider-consumer relationships could be established at the time of service design and hard-wired into the ticket information system, making it is easy for the SPC to relate ticket information. However, the goal of the SPC is to achieve maximal availability of the services for the consumers, and the delivery platform of SPC allows organizing providers' services in such a way that it could easily be combined in late-binding services. [9]. In this case the model for the sharing of ticket information has to include information that is necessary in order to identify providers that took part in a specific instance of fulfillment process.

One of the difficulties in dealing with the SPC is a missing single point of contact between the customer and the provider. Service Provider Coalitions have a negotiator entity (as defined in [7]) that coordinates interactions with a customer for the service delivery. One of the providers or an independent party could serve as the negotiator.

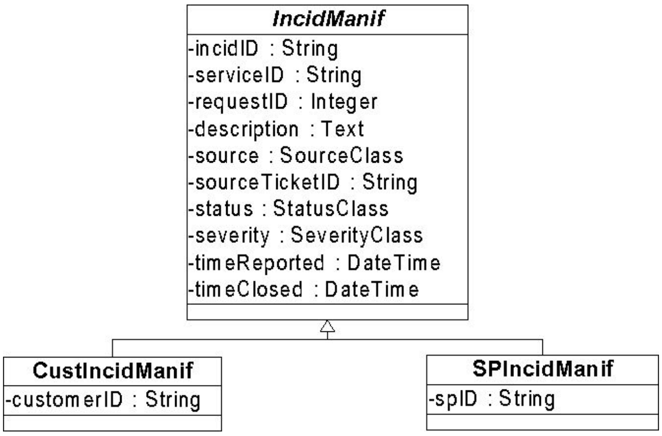

Figure 3 Incident Manifest Class Hierarchy

3.2 Incident Manifest

In our approach we rely on [10], on the proposed format of a trouble report. This extends the Customer Service Management (a management entity that addresses the relationship between customer and provider) towards bidirectional inter-domain Problem Management. A generic interface and a generic set of information are defined. This can be applied independently of the service and the position in the hierarchy. While it is a valid approach in inter-organizational problem management, it doesn't take into account other organizational structures besides hierarchy.

The *incident manifest* represents information that is provided by the participants of service's delivery in order to enable communication with the goal of achieving quality of overall service. The incident manifest is needed in order to restrict the information that will be exchanged between the different ITS's. The smaller the set of information communicated between the ITS's, the easier the correlation between tickets is.

As shown in Figure 3, we consider the abstract class **IncidManif** with the two child classes **CustIncidManif**, customer incident manifest, representing the information the customer has to publish to report an incident affecting service delivery, and **SPIncidManif**, service provider incident manifest, representing the information published by the service provider.

The class **IncidManif** has following attributes:

- *incidID*: the unique identifier for the incident manifest represented as string.
- *serviceID*: the unique identifier for the service on which the consumer and SP or SPC have agreed upon.
- *requestID*: identifies the task requested by the customer of the SP or SPC when the incident occurred, and provides a method for a SPC to locate which service provider was handling the service for that customer at that time. As with serviceID this requires agreement between customer and provider. Examples from different service fields include session ID, job number, lot number, etc.
- *description*: a human-readable text field with the description of the incident.
- *sourceTicketID*: represents a ticket ID in the service provider system.
- *status*: the reported status of the incident, which can be new, pending, closed or other gradation on which the customer and the SP or SPC have already agreed.
- *severity*: represents the degree to which the service is affected as perceived by customer or by provider respectively to the source. This should be defined in advance and agreed upon between consumer and SP or SPC.
- *timeReported*: the time when the incident was reported.
- *timeClosed*: the time when the incident was closed. These two attributes are relevant for statistical information (incident resolution time) and evaluation for the compliance to the SLA.

The class **CustIncidManif** has an additional attribute *customerID* that denotes which customer published the information about failing service. Likewise has the class **SPIncidManif** an additional attribute *spID* that represents the unique identifier for the service provider.

Example: In the Table 1 examples of customer incident manifest (customer TUM and it's users students respectively staff) and SP incident manifest (LRZ).

	CustIncidManif	**SPIncidManif**
Attribute	**Value**	**Value**
incidID	320054D	453999
serviceID	eduroam	vpn
requestID	eduroamConfigDebian	
description	vpncs loses connection	Backbone router down
source	customer	provider
sourceTicketID	2009042210000069	TT0032190
status	pending	new
severity		medium
timeReported	20090422021102	20090424100914
timeClosed		
customerID	student@tum.de	
spID		lrz

Table 1. Example of Incident Manifest for Customer and for Provider

Note that providers can act as service providers for their customers as well as consumers of other services. Therefore customerID and spID could have same value in CustIncidManif and in SPIncidManif.

3.3 Components Involved in the Inter-Organizational Incident Correlation

On the inter-organizational level we have to extrapolate the system and components used for ticket correlation within an organization. In a former work [11] in which we propose a model to correlate incident tickets within an organization, we have as central components the correlator and the CMDB.

1) The Correlation Engine. is a module in which all the activities concerning the association (correlation) of the information in different ITS's (provider's or customer's) occur.

2) The ioCMDB. stores information about customers, providers, services as agreed upon between the consumers and providers, incident manifests and some transactional information for tracking purposes.

a*) Service Catalog.* The ioCMDB provides customers and providers with an interface for service registration during the **design and initialization process**. Following information are provided in the service catalog:

- type of participant (customer, provider, spc)
- entityID as unique identifier for the customer or provider
- serviceID representing the unique identifier of the service
- updateMode: identifies the mode for subsequent updates on the incident status. It could be pull or push.

b*) Customer Incident Manifest Catalog.* Customer Incident Manifests are stored in the ioCMDB as they are created from a customer incident report or received from a customer ITS.

c*) SP Incident Manifest Catalog.* Provider Incident Manifests are stored in the ioCMDB as they are generated from the data received from a provider ITS or received from the ioCMDB of a SPC.

d*) Transaction Record.* Every SP Incident Manifest handle generates a record of the transaction, including the customer ID, incident ID, service ID. Also, the relationships connecting the transaction to the corresponding entries in the Service Catalog, Customer Incident Manifest Catalog and SP Incident Manifest Catalog are maintained in the ioCMDB. This record is used to bypass the correlation process for updates.

3.4 Method of Correlation

We will extend here our previous work [11]. According to the algorithm described there the correlation happens in three stages. First a category-based correlation that relies on matching service identifiers with associated resource identifiers is performed using similarity rules. The correlation of configuration items, critical to the failed service with previously identified resource tickets to optimize the topological comparison follows. Constraint adaptive probing is finally done to minimize the correlation interval for temporally correlated tickets. The method of correlation in this paper is an extrapolation of the cited work for ITS correlation in complex inter-organizational environment.

In the correlation three kinds of processes are involved: initial registration, submission of a customer incident report, and update. During the **initial registration** each ITS registers with its ioCMDB announcing which services it provides. During the period from the initial incident report until the final resolution, the customer could request periodic status report **updates**. The customer will certainly want the ability to request these updates *ad hoc* (i.e., *data pull*) but it is also desirable to offer registration for updates as on a schedule or as the ticket status changes (*data push*). The initial registration process and update process won't further be handled in this paper. We concentrate on the submission of a customer incident manifest which is described in this section.

Figure 4 is showing the activity diagram for the correlation of incident manifests triggered by the submission of a new customer incident management. The four swim lines correspond to the components described in 3.3.

The customer performs the first activity in the diagram: If the customer has an ITS, this report will be in the form of an instance of the class CustIncidManifest. Otherwise, the correlation engine is responsible for parsing the report and creating a customer incident manifest from the contents.

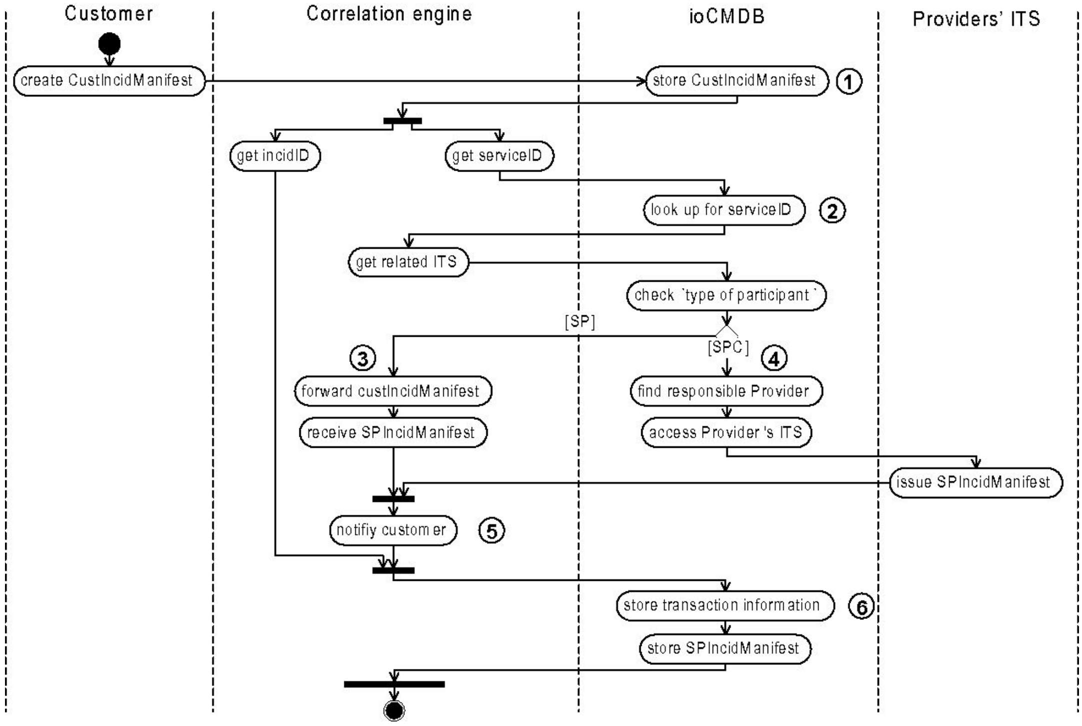

Figure 4. Activity Diagram for the Correlation of Incident Manifests

This manifest is stored in the next step in the Customer Incident Manifest Catalog of the ioCMDB ①. The service ID from the manifest is then used to look up the SPs or SPCs that may have been responsible for the service in the Service Catalog ②. In the case of a SP ③, the correlation engine requests from the provider's ITS whether the provider had actually processed the request identified in the incident report. If so, it requests a ticket ID for the service that was either created when the request was processed or was already open at that time. In a heterarchy ④, it is possible that a provider did process the request without error because another provider in the service chain encountered the error: in this case the correlation engine requests the provider ID that the provider had sent the request on to and adds it to the list of SPs to query. The correlation continues until a ticket has been found or all potential providers are queried and no ticket exists.

In the case that the service may have been provided by an SPC, the provider forwards the Customer Incident Manifest to the SPC and receives the corresponding SP Incident Manifest. Otherwise the correlation engine is responsible for constructing an SP Incident Manifest containing the ticket information. In either case, the SP Incident Manifest is sent to the customer ⑤ and is also stored in the SP Incident Manifest Catalog, and a transaction record is generated ⑥.

4. Business Benefits

The business benefits of described approach were demonstrated in these two examples.

IntegraTUM project Example: The process workflow was implemented; partly automated partly manually. Let's take the case when a ticket was opened by a student respectively by a staff of TUM. If this cannot be resolved within TUM, this may be the result of an incident which occurs in LRZ. So the service desk of TUM issues manually a ticket at the LRZ which than can be correlated within this organization. The resolution time was reduced after introducing this process. Nevertheless a full automation is rather difficult to realize because of the diversity of tools, methods and human factors.

Géant2 project Example: As these organizations are NRENs, huge network infrastructures within a country, the process encountered resistance from different sides. The problems which appear were manifold: cultural, human, language factors were predominant. The gaps between different stages of technological evolution and the wide distribution of the systems to be monitored are additional points which make difficult the implementation of the process. In spite of these impediments, a service desk and an incident management were established. The "coordination unit" (E2ECU) acts like a service desk for the customers which use E2E services. The collaboration between the providers of the service provider coalition is guided by a multilateral Memorandum of Understanding (MoU).

5. Conclusions

In this paper we consider different ways of organizing inter-organizational collaboration to enable IT problem and change management. In addition to the usually considered hierarchical model of inter-organizational collaboration we consider a heterarchical way of collaboration in which different organizations cooperatively deliver a service. A typical example of such collaboration is the End-To-End link service in the large multinational network supporting the Large Hadron Collider (LHC) in CERN, Switzerland. In this paper we outline inter-organizational collaboration and introduce elements of the delivery platform which are necessary for its implementation.

We are planning to compare the effectiveness of different inter-organizational collaborations and to consider alternative algorithms for problem and change management. We believe that another promising topic for further research is the formalization of the inter-organizational responsibilities during such collaboration.

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