Integrated Trouble Management to Support Service Quality Assurance in a Multi-Provider Context

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Abstract. Liberalisation of telecommunications encourages competition between the various actors in the Open Service Market (OSM). In this highly competitive context, Connectivity Service Providers (CSPs) and Value Added Service Providers (VASPs) are investigating opportunities to provide differentiated Service Quality related Service Layer Agreements (SLAs) to their customers. The services provided will span several administrative domains which makes their management complex. The key element for end users when choosing a particular service is the guarantee of support to be provided when using the service and the desire to interact with as few actors as possible. On the other hand, key issues for network operators and service providers are the cost-effective maintenance of equipment and services. The aim of this paper is to present a novel architecture that provides the necessary infrastructure, models and mechanisms to help VASPs and CSPs to rapidly introduce customer care services for user quality assurance in a Multi-Domain environment. The architecture aims at integrating TINA, TMF and TMN concepts as well as established *legacy* in-house customer care and help desk systems. This work is being undertaken within the Assurance part of the CEC ACTS project FlowThru.

1 Introduction

The ongoing liberalisation of the telecommunication market is making the industry in this area very active and subject to many changes. These changes are breaking down the traditional barriers between public and private domains and encouraging more relationships to be made between the various actors in telecommunications for the purpose of end-to-end service provisioning. This is permitting the emergence of what is now called an Open Service Market (OSM). This liberated market provides an open area where network and service providers can co-operate and compete to improve their business.

To be efficient in such a market, operator and service providers need to develop novel solutions that permit the rapid introduction and maintenance of new telecommunication services [33]. These solutions should permit the rapid deployment of co-operative policies by means of interoperable interfaces at the network and service levels so that new services can be set up quickly and efficiently. Furthermore, if customers have accepted a service offer, the overall end-to-end service quality has to be assured by the service provider. Service management systems are required to help reduce operating costs and to interact efficiently with customers and suppliers [1].

From this perspective, the provisioning of a particular service can necessitate complex configuration and maintenance that involves a number of actors: service providers, connectivity providers[1] and also service brokers. The TINA Business Model [19] gives a good model of such actors and their interactions. However, this multiplicity of intermediate actors makes the process complex and should be hidden, e.g. by the retailer business role, from the customer. Hence, differentiation between service providers will be based on the capability of the provider to offer the customer flexible differentiating

[1] In this paper we use the TINA term connectivity service provider. In other contexts, terms such as Public Network Operator (PNO) are used.

or customised SLAs (Service Level Agreements) and related problem facilities that permit the customer to monitor and control the QoS provisioning, and hence as a means of deciding on particular service providers.

In this paper, we present an integrated framework for service quality assurance in an OSM supporting various sets of customer and service providers. This framework is based on TINA-C, TMF, OMG, TMN, and Internet management concepts and solution sets.

The concepts outlined below are addressed in the context of the European ACTS project *FlowThru* [9]. This project focuses on the information "flow through" between customers and multiple service providers in a multi-domain OSM environment. It covers the overall service life cycle of service provisioning, including fulfilment, assurance and billing. Furthermore, it defines guidelines for the development of distributed management systems [11].The problem handling process is treated in the network and service quality assurance part, which is described in this paper. The objective of the assurance part of the project is to automate the interaction between customers, service providers and network operators for the purpose of problem identification, awareness distribution and resolution, SLA production, assurance, SLA fulfilment assessment and discounting in case of failure.

This paper is organised in five sections. Section 1 provides a short description of the problem and the general approach. It also outlines major recent initiatives in the area. Section 2 describes the overall goal of the project and the general component architecture of the solution. Section 3 is an internal description of the TINA Trouble Report System and Section 4 introduces details of the TMN based TTS. Finally a conclusion and perspectives are outlined in Section 5.

1.1 Problem Description

Problem handling is an already known aspect in telecommunication network management but will become increasingly important in the near future. This problem is also more and more concerning the service level where differentiation between service providers is moving towards Quality of Service (QoS) and discount policy competition.

Connectivity Service Providers (CSP, also referred to as a NO Network Operator) and Value Added Service Providers (VASPs) are investigating opportunities to provide differentiated Service Quality related Service Layer Agreements (SLAs) to their customers [13]. When a Service Provider offers a telecommunications service, there is always a possibility that there will be a partial or total failure of that service. Such a problem is known as a 'trouble' and the process of trouble administration is concerned with identifying and resolving that trouble. The existence of a trouble has an adverse effect on the quality of the service as perceived by the Customer.

Violation of SLAs by 'troubles' and the production of evidence of the performance provided (or more generally the QoS) is still a major issue. Furthermore, the impact of SLA violations on tariffs and accounting should be taken into account to satisfy customer expectations. Because of QoS dependencies between service and networks levels, these issues require a more integrated network and service management environment. However, this process is made complex by the deregulated market as the service can span a number of service provider domains. Thus the processes of detection, localisation and resolution are becoming more difficult in such an OSM environment. Furthermore, it is quite complex to associate network related faults with specific services, customers or users. Therefore, the provisioning of QoS based SLAs and Service Quality assurance requires a more general Service Quality Management Framework, as being developed in the Eurescom project P806 [13] and as specified in the TMF [TMF-501, TMF-503].

1.2 General concepts for Inter-Domain Problem Management

To support the needs of the various actors in the growing OSM a "multi-domain problem management support system" is required. Such a system should enhance the functionality of

established *customer care centres* and of *in-house trouble ticketing systems*, not changing the current often phone based service but enabling the additional exchange[2] of TTs via standardised interfaces. This would require "embedding" *legacy trouble ticketing systems* such as the well-established Remedy ARS product [14], as depicted in Figure 1. This figure depicts the general principles of multi-domain problem management.

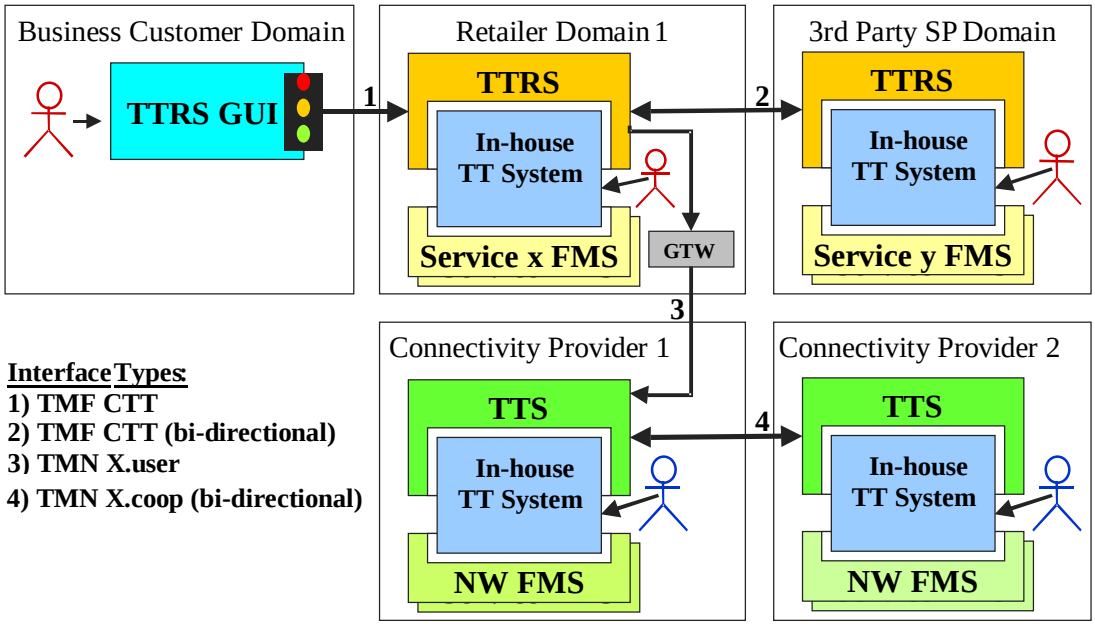

Figure 1: Principles of multi-domain Problem Management

For connectivity service providers a TMN based solution [34] might be more suitable. The same principle of "embedding" the legacy *in-house TT-System* can be used. To exchange TTs between the customer and connectivity provider domains (i/f type 4) or between connectivity provider domains, standardised interfaces (i/f type 5) based on GDMO / CMIP specifications of Eurescom project P612 [8] will be used.

The exchange of TTs between connectivity provider and value added service provider domains requires a mapping between TMN and Corba technologies. This can be done by a gateway which maps CMIS to IDL interfaces, e.g. based on the JIDM standards [35], [36].

1.3 Recent Initiatives

Different consortia have undertaken initial work to handle problem management processes up to now more or less independently at the network or the service level. Furthermore, today's TT-System products are mainly designed to support the internal needs of a service provider, enabling in some cases customer access (e.g. ARWeb). The concepts introduced below have been selected pragmatically as contributions for our architectural design and the implementation of the FlowThru Quality Assurance Trial System.

1.3.1 ITU-T Contribution

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[2] More generally: Remote Trouble Handling enables TT/TRs to be created, cancelled, monitored, updated, escalated and closed as well as the verification of problem resolution.

Quoting from [34], "*this Recommendation is concerned with the management of malfunction in systems and communications networks from the perspective of a provider of service and user of that service. In the Recommendation these malfunctions are referred to as "troubles". A report format is defined to allow a user to report a trouble, which will then be progressed to resolution by a provider. During problem resolution by the service provider, the service user may determine the current state of resolution by issuing a request for this information. When a trouble has been cleared the provider may notify the user.*"

Defined in 1995, this Recommendation specifies the Trouble Management functionality for:

- Reporting of troubles on services or resources on a managed network or system;
- Tracking the progress of the trouble to resolution;
- Clearing and closure of the trouble.

The recommendation follows the TMN X series approach by using the GDMO interface specification language as a vehicle for defining the management functionality.

To support the largest possible deployment, the format of the trouble report is made up, with few exceptions, only from (a large number of) conditional packages. That implies for a particular implementation project a preliminary effort of 'profiling' the X.790 GDMO for its specific purposes.

Both, Eurescom Project P612 and the TMF CTT specifications, as introduced below, are based on the principles as defined in this ITU-T Standard.

1.3.2 Eurescom P612 Contribution

The aim of Eurescom [8] is to carry out pre-competitive R&D projects in order to support the Shareholders (European Telcos) in establishing future-oriented telecom networks and services. The Eurescom P612 project was a purely TMN project, focused on taking the International Recommendation ITU-T X.790 Trouble Management [34], developing it and validating practical implementations of this standard in the EURESCOM Pan European TMN Laboratory environment.

The main objectives of this project were to:

- Carry out a requirement analysis for trouble management functions in a number of operational telecommunications service environments, and to capture a set of operational scenarios to guide and test the technical work. The final aim was the development of a generic, interoperable trouble ticketing (TT) process.
- Profile the management functionality of the base ITU-T Rec. X.790 and its associated information model to match the functional requirements and the operational scenarios. This should be done on the essential X interfaces involved in trouble management [P612-D2]:
    - X.user interface between a CSP Management Domain and a Customer Network Management Domain and
    - X.coop interface between two peer CSP Management Domains (that have to cooperate in order to resolve some Customer problem by exchanging information between them);
- Carry out interoperability tests between different implementations in different laboratories based on previously developed test suites.

One important conclusion of this project was that the flow of messages on the X.coop interface is similar to that on the X.user, adding the fact that the same message can flow in both directions depending on the role taken by the CSP with respect to a specific Trouble Report. The specifications of P612 have been used to design and implement the IMA TTS (see section 4).

1.3.3 TeleManagement Forum Contribution

TeleManagement Forum [24] is a non-profit, global organisation that provides the telecom industry with leadership on the most effective ways to streamline the management of communications

networks and services. Membership includes Network Operators, Telecommunication Service Providers, Telecommunication Systems Vendors, etc.

TMF's principal mission is to enable the development of 'standardised' Management System solutions. In order to move standardised Telecommunications Management Services forward, the TMF uses as a focal point a framework of agreed business processes. The current focus is upon the integration of all these processes into process "flow-through" services built around three high level processes of Fulfilment, Assurance and Billing of Telecommunication services. Collectively, the TMF calls this set of agreed business processes an "Operations Map" [31]. Use of the agreed business processes makes it considerably easier for service providers to work together to deliver global services, enable customer access and control of services, etc.

Within the scope of the TOM framework the TMF has defined a set of detailed specifications to support important customer-to-business and business-to business management processes. Within the scope of multi-domain problem handling the following documents have been taken into account:

- Service Provider to Customer Performance Reporting Business Agreement [26]
- Performance Reporting Definitions Document [28],

In both documents, requirements, concepts and terms have been defined for service level agreements, QoS measurement and performance reporting. These concepts have been used to define SLAs in the context of the Assurance Trial System.

- Trouble Administration Business Agreement [25],
- Customer to Service Provider (SP) Trouble Administration Information Agreement [27],
- Customer to Service Provider Trouble Administration Analysis Specification [29]
- Corba Interface Specification for Customer to SP Trouble Administration [30]

The first two documents listed above define requirements, concepts and terms for problem management between customer and service provider. The latter two documents specify the interfaces for Corba based systems. They have been used for the TTRS design (see section 4).

1.3.4 TINA-C Contribution

Over 40 of the world's leading network operators, telecommunications equipment and computer equipment manufacturers have formed the Telecommunications Information Networking Architecture Consortium [18] to define and validate a common and open software architecture for the provision of telecommunication and information services, known as TINA.

TINA defines a set of concepts, principles, rules and guidelines for constructing, deploying, and operating TINA services. The major principles are based on the Reference Model for Open Distributed Processing [15]. The purpose of these principles is to insure interoperability, portability and reusability of software components and independence from specific technologies, and to share the burden of creating and managing a complex system among different business stakeholders, such as consumers, service providers, and connectivity providers [19]. Reference Points are defined to specify conformance requirements for TINA products [22].

TINA provides a set of specifications, e.g. Computing Architecture, Distributed Processing Environment Architecture, Service Architecture and Network Resource Architecture [TINA-CA,TINA-DPE,TINA-SA,TINA-NRA], which formed the basis for the development of the PLATIN TINA Service Platform [37] and used in the FlowThru Service Quality Assurance System Trials.

Although TINA covers the major market requirements caused by deregulation and globalisation (multi-provider environment, need for flexibility, customisability, etc) the service quality assurance and fault management issues are not sufficiently covered. While fault management in the context of network resource management is covered by the Network Resource Architecture, the Service Architecture stresses, but does not define, these issues in the service management context. The

concepts described below could be used to enhance useful TINA concepts with problem management related solutions.

2 Service Quality Assurance Proposal in the OSM

The availability and quality of communications services[3] are of increasing importance as businesses automate and rely heavily on computer-based applications. The actual objective of all telecommunication actors is the rapid, accurate and reliable exchange of trouble information between the customer and its service providers to minimise the trouble resolution time and to optimise customer satisfaction in case of SLA violations. In anticipation of an OSM environment, the customer has only to interact with the retailer (one stop shopping) and does not want to be concerned with the various supporting actors/providers. For the Assurance scenario, subscription of the customers and the necessary network and service configurations have already been specified for the fulfilment phase.

The service level problem management service, implemented by the TTRS, will be offered to customers as a TINA service. It makes use of TINA SA principles and enhances the current definitions and reference point specifications to support distributed problem management business processes. The TTRS also makes use of enhanced definitions of reference points between retailers and 3rd Party service providers [3].

2.1 Scenario Description

To validate the general concepts for a multi-domain service quality assurance framework as introduced in Section 1.2, an integrated Network and Service Quality Assurance Trial System is being developed in the EC/ACTS project FlowThru. The objective is to evaluate, according to business related use cases, how service quality assurance can be improved by multi-domain problem management. This will cover the exchange of the service level trouble reports (TRs) and the network level trouble tickets (TTs) event correlation as well as partially automated problem resolution.

The trial scenario focuses on the information flow between the components of the inter-domain problem management system distributed in the various autonomous administrative domains of the OSM environment. The TINA Trouble Report System (TTRS) concentrates on the service level management issues (see section 3) whereas the TMN Trouble Ticketing system (TTS) focuses on the issues at the connectivity service management level and the network and network element levels below (see section 4)

The assurance trial system is being developed to demonstrate the following aspects:

- service offers to customers based on differentiated (Gold, Silver) or customer specific (customisable) Service Level Agreements (SLAs)
- customer controlled problem handling, i.e. to enable customers to generate TRs and to monitor problem resolution in a multi-provider service environment
- exchange of Trouble Tickets (TTs) between customer and connectivity service provider domains and connectivity-connectivity provider domains based on X.790, EURESCOM P612 (TMN-based) specifications
- exchange of Trouble Reports (TRs) according to TMF specifications (Corba-based)
- exchange of TTs between TMN and Corba technology by JIDM based TMN/Corba gateways
- correlation of problem events, e.g. where the same trouble is identified by different sources
- discounting if a QoS / SLA violation has occurred for a user, customer or set of customers depending on specific SLAs

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[3] Covering connectivity as well as value added services

The assurance business process of the FlowThru system shows the interaction between these different levels of problem management, based on the various defined use cases. All elements of the Assurance System scenarios will be demonstrated to show how to improve significantly the distributed problem handling process [31] and the information *Flow Through*. This would increase customer satisfaction and can reduce the overall maintenance costs and SLA violation related penalties.

2.2 The Business Model

Figure 2 describes the various domains involved in the Business Model of the FlowThru Assurance Scenario. It identifies the customer domain and a set of co-operating service provider domains (based on the TINA Business Model) [19] and major personnel roles. The connectivity service being offered is a premium IP service over an ATM network infrastructure. The value-added service being offered, *MusicShop*, is a Web based public (but secure) file system allowing up- and downloading of multimedia documents for individuals or globally distributed user groups.

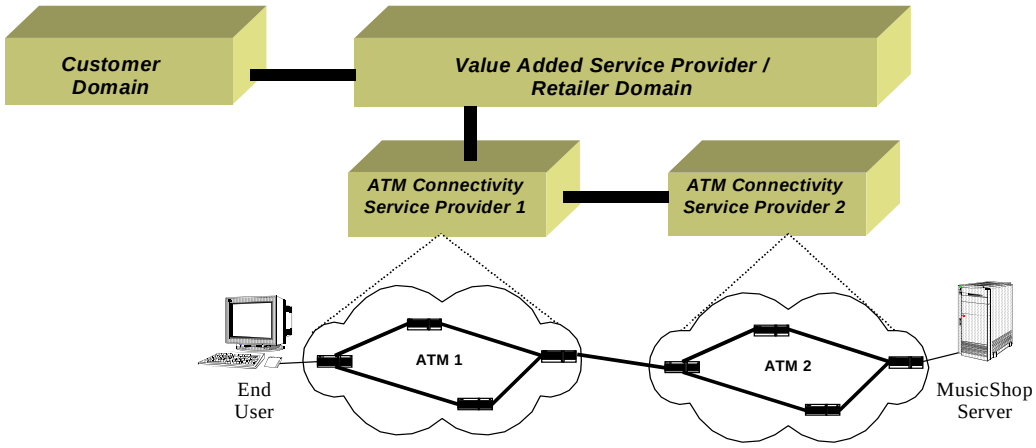

Figure 2: Business Model

For the Assurance Trial scenarios, two different CSPs were introduced to reflect the possibility that the connectivity service may span a number of network infrastructures. Furthermore, it was decided to not differentiate the service retailer from the 3rd Party service provider domain, but to avoid additional complexity we have considered that both business roles are performed by the same actor.

2.3 The Scenario Use Cases

The functional overview for the Assurance Trial System is given in terms of use cases and their relations to external actors. These are based around:

- the occurrence of troubles in the different systems, e.g. in the network or the service;
- the persons or components that identify those troubles, e.g. the service provider, local/remote connectivity providers or the customers themselves;
- how information related to these troubles navigates through the system and is subsequently used to resolve the troubles by appropriate fault management systems;
- the subsequent impact of the troubles once they have been resolved, e.g. discounts given to affected customers should the troubles violate customer SLAs.

2.4 The Technical Approach

All service providers (including the CSPs) will offer their services as TINA services. Information will be exchanged at TINA reference points [3] making use of Corba [4] or TMN [12] technology at the network level. The use of enhanced TINA subscription concepts allows connectivity or value added service troubles to be associated with affected services, customers and/or user sessions. An integration of the TINA Trouble Report System (TTRS) and TINA accounting systems will enable discounts in case of SLA violations.

Figure 3 depicts a simplified computational model of the Assurance Trial System configuration at the TINA service level. The TINA Service Environment provides the infrastructure to run the FlowThru service quality assurance trial. A precondition for the scenarios is that the customers have already subscribed to the MusicShop, the assurance trial service, and the required premium IP connectivity services, which enable authorised end users to use the MusicShop service at any time.

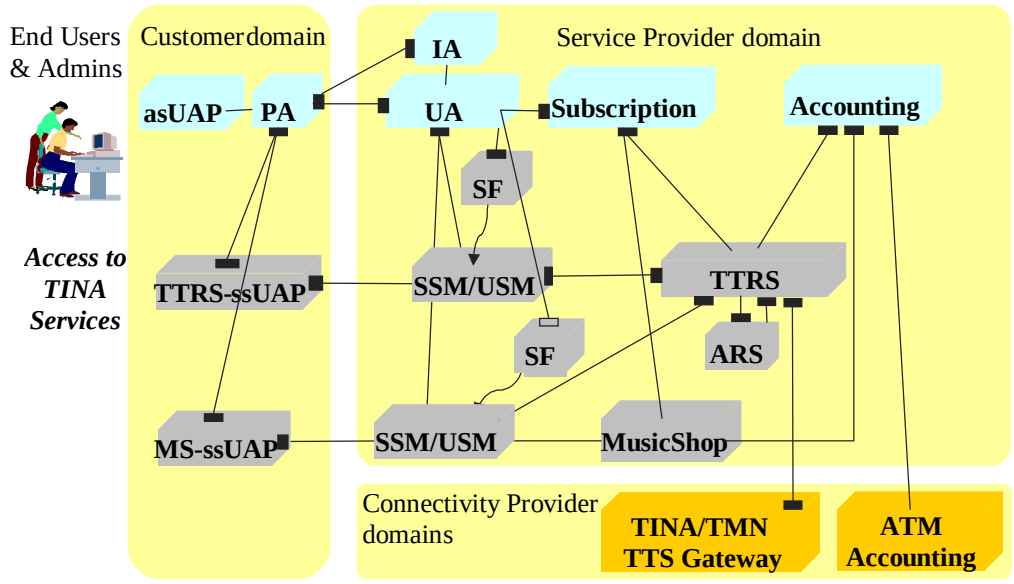

Figure 3: Description of the TINA based Assurance System Components

The MusicShop service and the TINA TR management service are embedded within the PLATIN TINA Platform Y.TSP [37] which provides an implementation of the major TINA service architecture components. They are configured for the assurance trial (service templates, tariffs, customer and user profiles) to enable the services to be offered to the end users.

- The **access session components** (asUap, PA, IA, UA) enable service selection and secure service access in a TINA environment. The interface between the customer and service provider domain is based on the TINA Retailer reference point definition [22].
- The **Subscription Component** contains information related to registered customers, the existing services and SLAs between the service provider and customers on the use of services subscribed to, e.g. the negotiated QoS. It also contains information on customer connectivity access points.
- The **Accounting Component** is responsible for the accounting of the service and network usage. The TINA Accounting System is connected with the **ATM Accounting System** to exchange network usage charge records and with the **MusicShop** to exchange service usage charge records. The interface to the TTRS allows granting of discounts in case of SLA violations.
- The Assurance Trial service, i.e. the **MusicShop** (MS-ssUap, USM/SSM, MusicShop) is a TINA Service offered to customers. Authorised users can access the service from different network access points to up/download documents. This service is used to demonstrate problem handling and discounting at the TINA service level.

- The **TINA Trouble Report System (TTRS)** implements a management process that permits the handling of the quality assurance process at the TINA service level of the FlowThru trial system, including SLA management. The TTRS is considered as a specific TINA management service embedded in the TINA environment through the required components (SSM/USM, SF, ssUAp). The SSM/USM components are required in TINA environments to maintain user specific service sessions and the interface to the ssUAP in the customer domain.

3 The Service Level TINA Trouble Report System (TTRS)

As mentioned above, the TTRS could be considered as an additional component for the TINA Service Architecture for Problem Management, supporting service quality assurance and customer care. It is designed to exchange Trouble Reports between the customer, retailer, 3rd party service provider and connectivity provider domains. It also supports SLA handling as well as initiating discounts in case of SLA violations. The TTRS encapsulates an in-house trouble ticketing system which handles trouble tickets between the help desk and the 1st and 2nd level support. Customers interact with the TTRS using the TINA compliant TR management service (ssUAP-SSM/USM). These are started automatically within the user access session to enable problem notifications to be delivered.

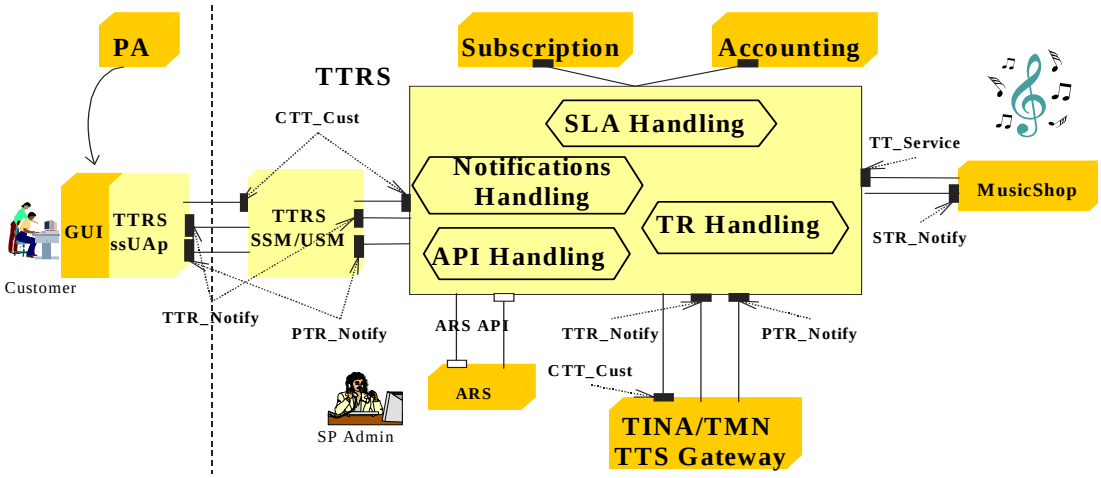

Figure 4: TTRS Interfaces and Component Architecture

3.1 Description of the Interfaces

The following interfaces are associated with the TINA Trouble Reporting System (see Figure 4):

- The **CTT_Cust** interface is used by a customer to create, modify, track the status of, view, verify, delete, and cancel trouble tickets; to grant an authorisation for repair activities or to escalate a trouble ticket. The service provider exports this interface so that its customers can manage the lifecycle of trouble tickets effectively.
- The **TTR_Notify** interface is used by a customer to receive notifications from the service provider about trouble tickets, for example that a trouble ticket has been created due to a problem that another user, the service or connectivity provider or some remote service or connectivity provider has identified. This interface also allows customers to be notified about modifications to existing trouble tickets, status updates of trouble tickets, deletion notifications of existing trouble tickets and cancellation notifications of trouble tickets.

- The **PTR_Notify** interface is used by customers to receive notifications from service providers about trouble tickets associated with scheduled maintenance.

The IDL for these interfaces is provided in the TM Forum interface specification document [30]. The TTRS component provides a CORBA based wrapper around the Remedy ARS component so that it can be incorporated into the Service Quality Assurance System using open CORBA interfaces.

- The **TT_Service** and **STR_Notify** interfaces between the TTRS and MusicShop components correspond to a subset of the functionality of the CTT_Cust, PTR_Notify and TTR_Notify interfaces. More precisely, the TT_Service interface is used by the MusicShop service to inform the TTRS of intended maintenance periods for the service and to request that trouble tickets are created for problems identified by the MusicShop service trouble management system (and their states changed when necessary, etc.). The STR_Notify interface is used for receiving notifications from the TTRS component related to trouble tickets, e.g. the TTRS might inform the MusicShop service trouble management system that it has created a trouble ticket when the problem lies with the MusicShop service itself.

The TTRS also possesses interfaces to the TINA accounting and subscription components. The interface to the accounting component is used primarily for issuing discounts to users who have incurred some form of SLA violation for one of the services they use. The interface to the subscription component is used for several purposes. First, it is used for querying whether users who complain about services are actually subscribers to those services. If so, the subscription component returns subscription information about the user and any other customers affected. This includes both the normal subscription information and service properties that they might have as well as the SLA that they agreed to when subscribing to those services. These are subsequently used by the TTRS when deciding whether a SLA violation has taken place and if so, how much the discount should be.

3.2 Underlying Technology Aspects

The TTRS prototype is being implemented as a TINA service in the PLATIN TINA platform Y.TSP. It is being developed using Java to enable easy installation and porting over various operating systems, such as UNIX and Windows/NT. To enable an integration with the customer care or help desk related business process, the trouble report database is based on a well-established product for trouble ticket management, the Remedy ARS product. This use of existing technologies permits an enhancement of the normal business process to support automated exchange of trouble reports over administrative domain boundaries making use of well established technologies, i.e. Remedy, Corba/IDL, Java, JIDM based Corba/TMN Gateway, etc.

4 The Network Level Trouble Ticketing System (TTS)

At the connectivity provider level of the multi-domain problem management system, the Trouble Ticketing System (TTS) component is used. It is based on a TMN compliant product [6] that implemented the P612 specifications and was extended for the FlowThru service quality assurance system. Its function is to implement the Trouble Ticketing Service for connectivity service providers or Network Operators.The overall model is depicted in Figure 5.

4.1 Description of Interfaces

The system presents 4 interfaces:

- a **TMN X.user** interface that allows the Value Added Service Provider, e.g. the MusicShop provider, using a CMIP/Corba Gateway, to act as a Customer to the Network Operator for the Trouble Ticketing Service requirements [5];
- a **TMN X.coop** interface that allows two Network Operators to co-operate in deploying ATM VP connections for end users to exchange trouble tickets relating to these connections;
- a **TT.Q** interface allows a connectivity provider call centre to dispatch a trouble report to one of its regional areas for resolution. This dispatching is operationally identical to the referral of a trouble report between two co-operating network operators. The only difference is that this dispatching may be executed in a single direction. From the point of view of the TTS agent it is identical with the one used for the X.coop interface – apart from the configuration parameters.
- Besides these interfaces, a local interface should exist for carrying out some parts of the trouble resolution process. Depending on the pre-existing SLAs and the complexity of the legacy systems, the ratio between human and automatic activities involved in the trouble resolution process may vary. Even if this ratio is zero for common daily activities, it may still be necessary to resort to human intervention for unforeseen cases. So this local interface has to be preserved.

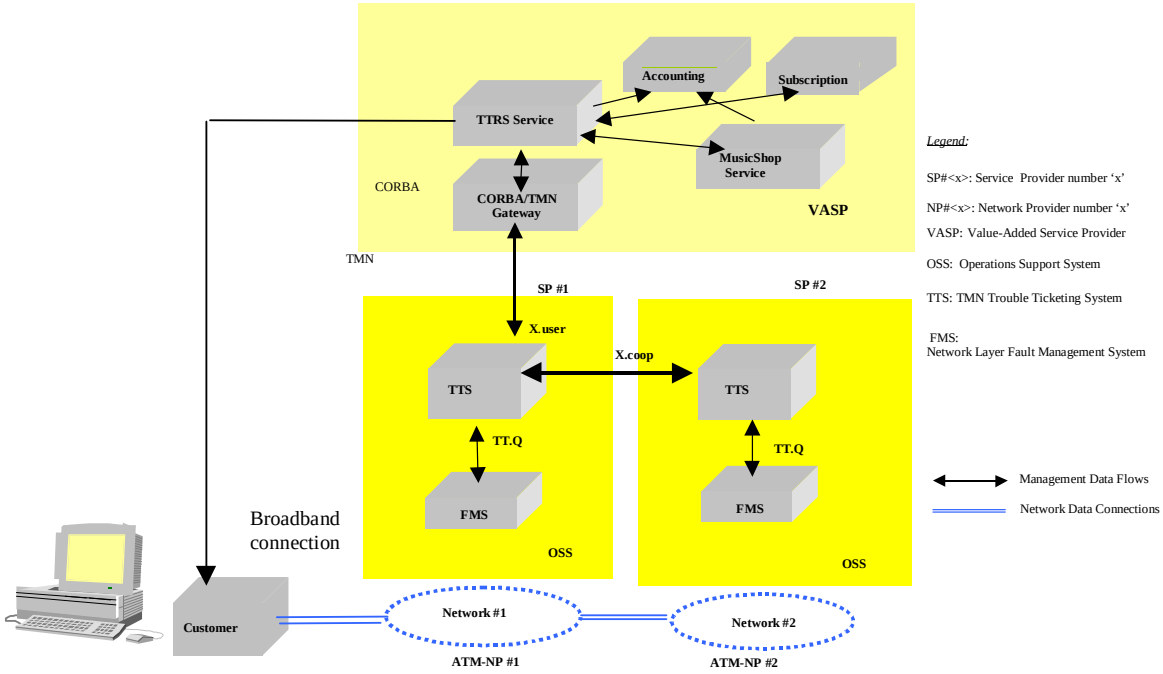

Figure 5: TTS position in FlowThru

For brevity we do not discuss the details of the connectivity and fault management systems of the ATM based network providers. We note however that they consist of simulated network element management systems, network management systems and fault management systems based on Q3ADE technologies. In addition we note that the fault management system itself supports trouble ticket management functionality where trouble tickets are created based upon notifications from the network management system, or from requests from the TTS component.

4.2 Underlying Technology Aspects

Internally the TTS product is based on the Hewlett-Packard Open View Distributed Management (HP [10] platform supporting the OSI protocol stack for CMIP and the HP OV Managed Object Toolkit for rapid generation/implementation of a TMN agent starting from its GDMO specification.

It is to be mentioned that the C++ classes have a stub automatically generated by the MOT generation utility from the GDMO specification. These stubs are subsequently extended by manually writing the implementation of behavioural statements of the GDMO specification and the functionality not exposed at the manager interface.

5 Conclusion

This work has shown how existing but independently developed concepts from different problem domains have been integrated to design and develop a trial system to enable multi-domain service quality assurance through an automation of the problem handling business process. Through the architecture proposed here, generic and reusable components have been designed and implemented which can be used to support the differentiation of service provision through a QoS assurance process. These include TINA based components (TTRS) that allow users to be informed (or themselves be the informers) of problems with offered services or the networks those services use. Similarly, generic TMN based network provider trouble ticketing systems (TTS) have been developed which support trouble management and administration between the service and network management domains, as well as network-network management domains.

To support the integration between TMN and CORBA based technological domains, gateways have been developed. These support the flow through of trouble information necessary to provide an integrated solution to trouble management in a multi-provider domain.

We conclude by emphasising that the FlowThru assurance trial is an open solution and not some overly prescriptive, non-reusable “one off” scenario. The components themselves can be applied to a myriad of CORBA based services and TMN based networks. Similarly the gateways are generic and largely independent of the specific instances of services and networks that they are associated with.

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