Accounting Management in a TINA-Based Service and Network Environment

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Abstract. The ACTS FlowThru project aims to build a management system which supports the flow of management information across organisational and technological domains by reusing components that have been developed by other ACTS projects. After analysis of the available components, it was decided to split the trial business system into three parts. The problems addressed by each of the three subsystems were taken from each of the three business process areas identified in the TeleManagement Forum (TMF) Telecoms Operations Map: fulfilment (i.e. service provisioning and configuration management); assurance (i.e. adherence to SLAs, fault and performance management) and accounting (i.e. service and network metering and charging). This paper elaborates on the realisation of the accounting system. This system consists of a TINA-based implementation of multimedia service access and control on top of ATM switching networks. Accounting components are introduced both at the service and network level. The accounting components are responsible for correlating network and service level accountable events, resulting in a single bill for the service subscribers. Using the Accounting system as an example, the paper also illustrates the development methodology and guidelines adhered to by the FlowThru project. The reader is assumed to be familiar with the TINA business model [1] and to have at least a high-level overview of the TINA service [2] and network resource architecture [3] concepts. Some notion of the notational conventions adopted by the Unified Modelling Language (UML) is also assumed [9].

1 Introduction - FlowThru Objectives and Scope

Effective telecommunications management relies critically on the integration of different management functions. In a liberalised telecommunications market, this integration has to occur over multiple organisational and technological domains. Existing management applications are often designed according to a specific architecture and implemented to be deployed on a specific technology platform. On the other hand, in any realistic scenario, large-scale management integration must rely

instead on the effective reuse of well-understood patterns of design and the reuse of specifications and component implementations.

The ACTS FlowThru project aims to build a management system which supports the flow of management information across organisational and technological domains by reusing components that have been developed by other ACTS projects. Management components from these projects have been analysed for their suitability in supporting the necessary management information flows and interactions. A multitude of components are being adapted and integrated within a common trial business scenario.

The trial business scenario selected to support the goals of FlowThru considers the following actors from the TINA business model: the Consumer, the Service Retailer, the 3rd Party Service Provider and the Connectivity Provider. The *3rd Party Service Provider* offers a set TINA-conformant managed multimedia services to the *Consumers*. Both interactive and information retrieval service types are supported. The *Service Retailer* offers secure customer access to these 3rd party services as well as to its own subscription management and accounting management function. The *Connectivity Provider* manages an ATM-based transport network and offers an end-to-end ATM connectivity service. *The 3rd Party Service Provider* does not provide wide area connectivity directly, but makes use of whatever ATM services are offered by the various Connectivity Providers that serve areas in which the Retailer's Consumers are located. This is a typical scenario that may evolve in a deregulated European telecommunications market. Workflow management techniques are used to co-ordinate the activities and information flow between the Retailer's internal processes and those of its suppliers. In such a scenario the automation of business processes is essential to the competitiveness of the Service Retailer, and key to the integration with the business process of its customers - the Consumers - and its suppliers - the 3rd Party Service Providers and the Connectivity Providers.

To keep the scope of the actual trial implementation achievable, the overall scenario has been subdivided into three specific business systems: Accounting, Fulfilment and Assurance. The *Fulfilment* system concentrates on aspects associated with the appropriate network planning and provisioning activities for the delivery of ATM connectivity services. The system is used at the 'pre-service' phase of the service lifecycle: system set-up and ordering/subscription. The *Assurance* system concentrates on problem handling aspects of the in-service phase. It makes use of Service Level Agreements (SLA) established at subscription time, as defined in the Fulfilment system, to identify SLA violations. Since SLA violations may have an impact on accounting/billing, a discounting scenario has been considered to highlight closely related interactions with the Accounting system. The *Accounting* system is itself the main subject of this paper.

2 The FlowThru Development Methodology and Guidelines

FlowThru aims to provide industry with concrete guidance on how to build optimum solutions to specific management problems from the wide range of architectural and technological approaches currently available from bodies such as the ITU-T, ISO, TM

Forum, TINA-C, OMG, ETSI and EURESCOM, among others. In particular, guidance is given on the design issues needed to create reusable telecommunications management components, which may be integrated together from a number of sources to provide operational support system solutions. Such guidance will allow developers of service management systems to make reasoned selections from existing solutions (standardised or otherwise) while ensuring the integrity of the information flows required to satisfy business requirements. The overall approach identifies two paths. First, the business context of the systems is approached through careful business modelling and analysis and with respect to realistic requirements, based on the TMF Business Process Model. This top-down analysis involves the identification of business actors, their roles and responsibilities in the context of business scenarios that are based on real telecommunications management requirements. Second, the system context of the FlowThru Business Systems is analysed. Complete system descriptions are given in terms of capabilities, interactions and information flows that will be supported given the existing components and the trial scenarios being considered. At the same time, the possible adaptations and re-engineering of the existing components are identified through careful component use-case analysis. This second path is based on a bottom-up approach where existing pieces of software are analysed and reengineered with the minimum possible implementation cost, in order to be integrated into business systems and support the system use-cases and trial scenarios.

Several issues need to be tackled while maturing a suitable technique for the development of evolving systems. The task of analysing management components from different sources is complicated by the varying methods used to document them. For example OSI MIBs are documented in GDMO, SNMP MIBs in SMI, CORBA designs use IDL while TINA uses ODP viewpoints incorporating a variety of notations including quasi-GDMO, OMT and ODL. A common notation would greatly ease this process, and in FlowThru the Unified Modelling Language (UML) has been adopted for this. UML has been ratified by the OMG as the notation for CORBA--based object-oriented designs. UML is already supported by several popular CASE tools as a graphical object modelling language. The TMF INFOMOD group is also examining the use of OMT for protocol neutral object design with automated mapping between OMT, GDMO, IDL and SMI being investigated (both to and from OMT). The class and object modelling parts of UML are closely related to OMT, so this provides a route to mapping existing GDMO and SMI models into UML. UML, however, only provides a common notation for modelling components. In addition, a common approach is needed both for the development of new components and the semantic structure used to document existing ones. FlowThru promotes an iterative design cycle with specific analysis, design, testing and integration phases. The analysis phase of the cycle involves the use of role and stakeholder analysis for multi-domain situations, and then use-case analysis, as described by Jacobsen's OOSE technique, to determine requirements. Objects identified in the requirements analysis are refined using graphical object modelling techniques that include both static class diagrams and interaction diagrams for dynamic behaviour; these should reflect the operations described in the use-cases. Finally the use-cases are also used as the basis for generating test specifications. UML now provides notations for each of these stages.

Obviously, availability of CASE tools has a very significant impact on decisions about which modelling techniques to employ. If a CASE tool that provides a common object repository is used, then it is much easier for the modeller to generate complimentary views of a system with a high level of automated consistency checking. It may also enable them to generate a larger number of views or components of those views such as diagrams, since the CASE tools makes drawing, and, more importantly, maintaining these diagrams easier. Developers that previously had to generate models by hand may be encouraged to develop fewer viewpoints and to structure them so that they are more self consistent, i.e. there is less of a requirement to perform manual consistency checks between views when maintaining the model. Within FlowThru, both Paradigm Plus and Rational Rose tools were used for UML modelling.

3 The Accounting Trial – Business Model

3.1 Business System

The business environment of the Accounting system is first modelled in a diagram identifying the specific business actors, the business roles and responsibilities they are assigned as well as the relationships between those business roles. An overview figure is presented in Figure 1. On the highest level of abstraction the Accounting system addresses 3 business actors: Service Customer, Service Provider and Network Provider. The *Service Customer* contains the business roles *Customer Administrator* and *User* (or End User). The *Service Provider* contains the business roles *Service Retailer, Service Operator, Service Subscription Manager* and *Service Accounting Manager*. The Service Subscription Manager role is responsible for contract negotiation between the Customer Administrator and the Service Retailer, and for the mapping of subscriptions onto accounts managed by the Service Accounting Manager role. The Service Retailer role regulates the access to services by Users playing different roles in accordance with the subscription contracts managed by the Service Subscription Manager. The Service Operator role provides a User with the usage facilities of the service and provides the Service Accounting Manager role with service usage statistics on which to base charging information. The Service Accounting Manager role provides the Service Customer with service usage statistics and charges based on these statistics. In addition, it provides billing information to the Service Customer in the Customer Administrator role. Analogously, the *Network Provider* contains the business roles *Network Retailer, Network Operator, Network Subscription Manager* and *Network Accounting Manager*. These roles are indeed analogous to the roles in the Service Provider domain, but it ought to be noted that the Network Provider provides a pure connectivity service, with the Service Provider acting as the customer of this service.

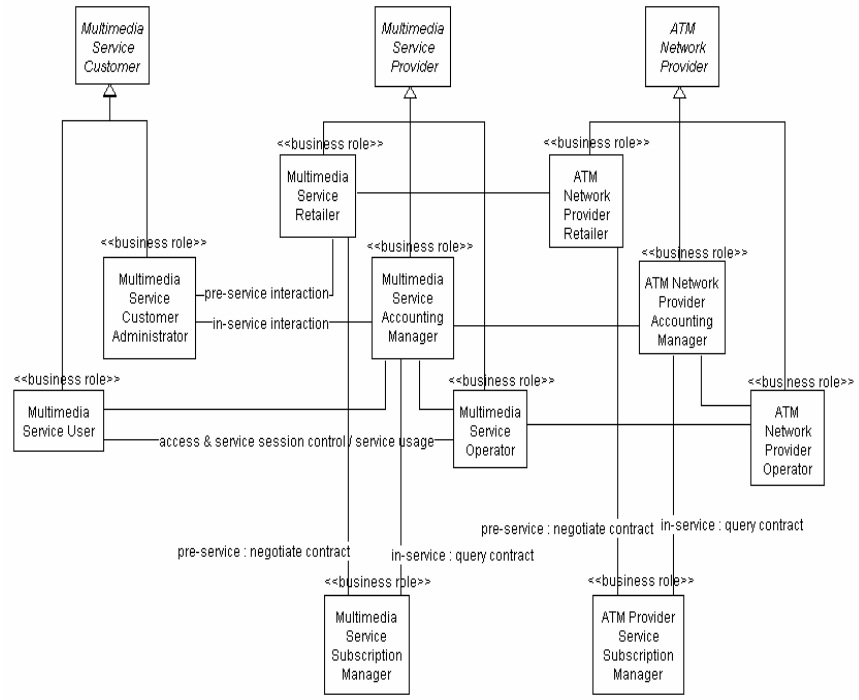

Fig. 1. Accounting Trial – Business Roles

3.2 Business Scenarios

Subsequently, this business model is used as the basis to define the overall functional model, consisting of the system's external boundaries and functional requirements with respect to the business scenarios where it is to be used. These requirements are outlined within the descriptions of the use-cases that are supported by each system – each use-case corresponding to a business scenario. Detailed descriptions of each use-case are provided within the FlowThru deliverable, but this paper only includes one diagram as a summary in Figure 2.

The *getBill* use-case reflects the Customer Administrator requesting the Accounting system to generate a bill for a certain billing period. The bill might also be automatically issued at the end of a billing period as negotiated and defined in the Customer's contract. The Accounting system generates the bill based on charging information from records of accountable events generated by the service, charging information from the Network Provider and subscription information. The *listSessions* use-case represents the Customer Administrator requesting a list of the currently active accounting management service sessions from the Accounting system. These

sessions mirror the lifecycle of multimedia service sessions, but exist only to collect and collate usage data for them. The *getSessionCharges* and *getUserCharges* use-cases represent the Service User or Customer Administrator requesting the charges based on the usage data for one particular service session and one particular service user, respectively. When a Service User participates in a particular service session, this generates accountable events for each event defined at subscription. This scenario is captured by the *generateAccountableEvents* use-case. The provisioning of the service itself is covered by the *provideMultimediaService* –by the Service Provider- and *provideNetworkService* –by the Network Provider- use-cases.

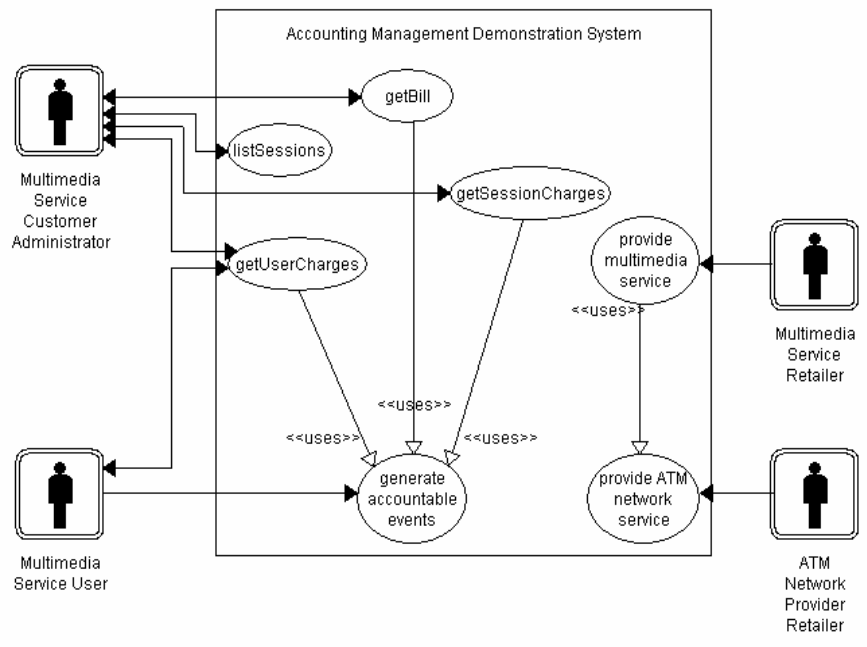

Fig. 2. Accounting Trial - Use-case Summary

3.3 Mapping of TMF Business Processes to TINA Business Model

The accounting system is a realisation of the TMF Billing business process, which is itself comprised of the following processes: *Invoicing/Collection*, *Rating/Discounting* and *Network Data Management*. Figure 3 provides an overview of the TMF business processes and highlights the processes addressed by the Accounting system. Since the components that FlowThru re-engineers and integrates for accounting were originally built using TINA architectural and modelling concepts, a mapping of the above processes onto TINA business roles was required. Invoicing/Collection were seen as

the responsibility of the Retailer, while Rating/Discounting were seen as the responsibility of the Broker, Retailer and Third-Party Service Provider, enabling each to apply its own discounts and rates. Network Data Management could be considered to be the responsibility of the Connectivity provider. However, certain TINA accounting concepts cannot be mapped directly onto the TMF model, because of the separation between service level and network level accounting in the TINA model. For this reason, 'Network Data Management' is renamed to 'Usage/Performance Data Collection' to better signify its role in both the service and network layers. This results in mapping the Usage/Performance Data Collection to the responsibility of both the 3rd Party Service Provider and the Connectivity Provider.

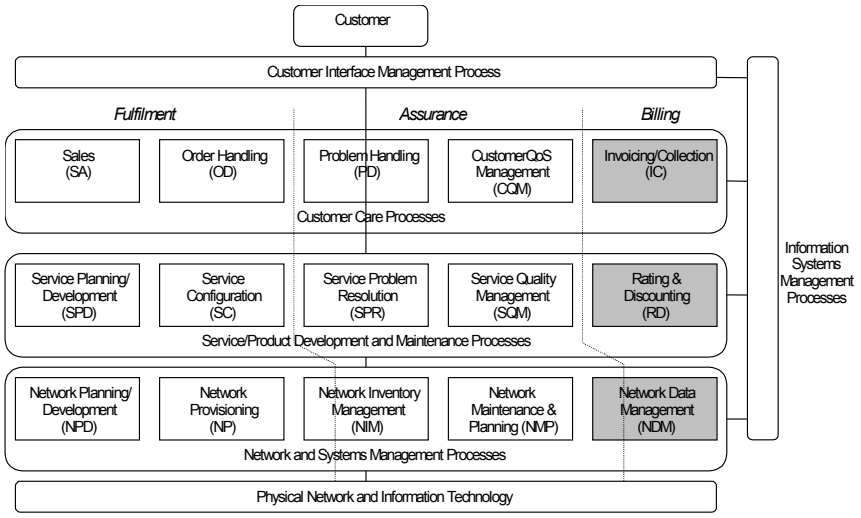

Fig. 3. Accounting Trial – Business Processes

4 The Accounting Trial - System Overview

Figure 4 shows the boundary objects of all the components comprising the Accounting system, their interfaces and their interactions. Components should be interpreted here as the units of reuse. The components can themselves be decomposed into finer grained computational or engineering objects. The overview only highlights the boundary objects within the components, their interfaces and their interactions. The system consists of six separate components, covering different aspects of service and network control and management. The *Access Session* component is responsible for allowing access to subscribed services by establishing a secure context for interactions between the Consumer and the Retailer. The *Service Session* component is responsible for the actual usage of a specific service by a Consumer. This

component is specialised to cater for two different service paradigms: a multimedia information retrieval service, the 'Digital Library', and an interactive multimedia service, the 'Desktop Video Audio Conference'.

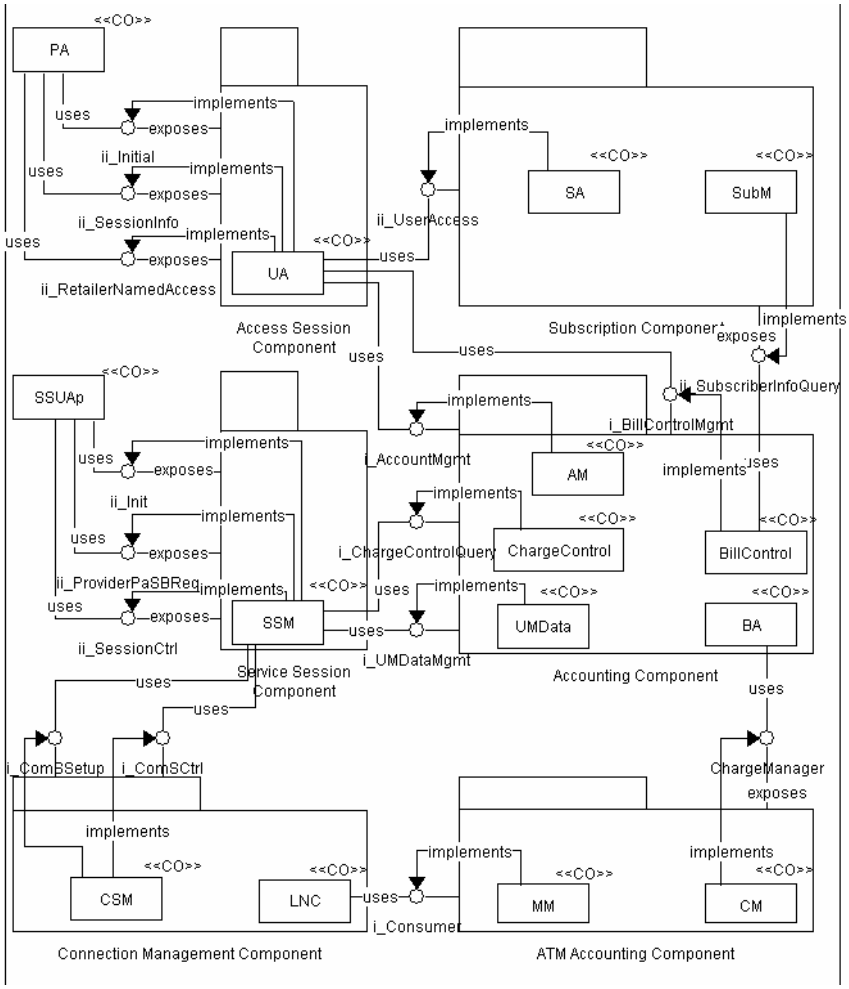

Fig. 4. Accounting Business System Components and Interactions

The *Subscription* component is responsible for the management of subscription contracts between the Consumer and the Retailer and ensuring access to services is in accordance with these contracts. The *Accounting* component is responsible for collecting and collating service level usage data, generating charges based on this usage data and combining these charges with those collected at network level.

Furthermore, this component generates the bill for the Consumer, based on guidelines laid down in the contracts controlled by the Subscription component. The *ATM Accounting* component is responsible for collecting network level usage data, generating charges based on this data and forwarding these charges to the Accounting component. The *Connection Management* component is responsible for providing ATM connectivity between end-user equipment and for generating network level usage data for the ATM Accounting component. It should be noted that the difference between the Accounting and ATM Accounting components is that they operate on different management levels. The Accounting component operates on the service level, while the ATM Accounting operates at the network level. As already stated, these components where identified as a result of the TINA business model separation between service and connectivity provisioning. From a business process perspective, they both map onto the Usage/Performance Data Collection TMF business process.

The components outlined above are envisaged to co-operate in the following fashion. In the 'pre-service' phase, a Consumer subscribes to a specific service offered via a service Retailer, in this case either the 'Digital Library' or the 'Desktop Video Audio Conference'. A Consumer who engages in a service subscription is specialised into a Customer Administrator. The Customer Administrator is responsible for subscription administration for one or more End Users, who are themselves another specialisation of the Consumer role. When a new subscription is created, the SubM (Subscriber Manager – boundary object within the Subscription component) creates a new contract and calls on the AM (Account Manager – boundary object within the Accounting component) to create a new account. During the 'in-service' phase, an End User can gain access to his subscribed services by establishing an access session with the Retailer through the UA (User Agent - boundary object within the Access Session component), which represents the End User in the Retailer domain. Subsequently, the End-User can create new service sessions and/or join existing service sessions. The service functionality is implemented by the SSM (Service Session Manager – boundary object in the Service Session component). When the usage of the service implies stream connectivity between different End User equipment, a connection request is generated by the SSM towards the CSM (Communication Session Manager – boundary object within the Connection Management Component), resulting in the creation of communication session context shared between SSM and CSM. During the lifetime of the connection, the MM (Metering Manager – boundary object within the ATM Accounting component) receives, collects and collates accountable events generated by the LNC (Layer Network Co-ordinator – boundary object within the Connection Management Component). Meanwhile, at the service level, the UMData (Usage Metering Data – boundary object within the Accounting component) receives, collects and collates accountable events (usage data) generated the SSM. The End-User can obtain in-session charges for service usage up to a certain time, resulting in the SSM retrieving this information from the CC (Charge Control – boundary object within the Accounting component). The Customer Administrator can request the charges for any specific service session through the same boundary object of the Accounting component. In the 'post-service' phase, or at the end of a pre-defined period stipulated within the subscription contract, the Customer Administrator receives a bill from the BC (Bill Control – boundary object within the Accounting component). Generating

this bill requires the generation of charges by the CC object, based on information contained in the contract managed by the SubM object. These charges are to be correlated by the BA (Billing Aggregation – boundary object within the Accounting component) with the charges collected at network level by the CM (Charge Manager – boundary object within the ATM Accounting Component).

Notice that the FlowThru accounting trial realisation supports all business roles identified in section 3.1, except for the Retailer and Subscription Manager roles within the Network Provider domain.

5 The Accounting System – Components

This section lists the major functionalities provided by each of the components and points to the ACTS project from which the component originates. It also lists the adjustments required to comply with the identified trial use-cases. For extensive analysis models and use-case descriptions of the individual components, the reader is referred to [8].

The *Accounting* component is based on the TINA accounting management specifications as defined in [2]. The component was originally developed within the Prospect project. Some extensions of the Prospect system were deemed necessary by the presence of network level accounting in the Accounting trial. The accounting component contains functionality that covers all areas of the TMF "Billing" high-level business process. It maps certain TMF processes onto TINA business roles, and in some cases concentrates on specific low-level activities within the processes. The component implements the invoicing part (i.e. production of the final bill) of TMF "Invoicing and Collection" process, but not the collection part of it (i.e. payment of the bill). It also offers on-line billing functionality, enabling users and administrators to see the charges accrued so far in a particular service session.

The *Access Session* component is aligned with the latest TINA Ret RP [4] and Service Component Specifications [5]. The component was originally developed within the VITAL project. The component supports the creation of a secure context between Consumer and Retailer, and the access from the consumer to the subscribed services. A Consumer needs to have an access session established before he can engage in any service. The functionality of the component is extended within FlowThru to allow the Consumer to retrieve his bill related to his service usage from the Retailer.

The *Service Session* component is also aligned with the latest TINA Ret RP and Service Component Specifications and was also developed within the VITAL project. This component supports the participation of one or more users in a service session. The component aims to support service common feature-sets, which can be used in most of the services. These feature sets contain various functions such as: joining a service session, inviting parties in the service session, establishing stream connectivity requirements, issuing voting, etc. These functions are functionally grouped into the feature sets, such as 'basic', 'multiparty', 'stream-binding', 'voting', etc. In the FlowThru project two services will be used to test the service session component: the "Digital Library" and the "Digital Video Audio Conference". Each

service inherits from the service common feature sets it requires, and adds its own service specific features to it, thus defining the new service. The component is extended within FlowThru to generate accountable events for the Accounting component and to allow the Consumer to retrieve on-line billing information about an ongoing service session.

The *Subscription* component is based on the TINA subscription management specifications as defined in [2]. The component is a slimmed-down version of the Subscription management component developed by Prospect, but comprises all management functions needed in order to define service offerings, administer customers and users, and manage the details of service provisioning. For instance, the component allows for authorisation and barring of users' access to specific services. The component implementation is tuned specifically with respect to the actors and use-cases identified within the Accounting trial scenarios.

The *Connection Management* component is based on the TINA Network Resource Architecture [3] and TINA Network Resource Information Model [6] specifications. The component was originally developed within the ReTINA project. The component provides procedures to set-up, control and release connections in the underlying telecommunications network. Although it offers a technology independent connectivity service to the *Service Session* component, it is internally specialised to control ATM-based networks. The component is extended within FlowThru to generate accountable events for the ATM Accounting component.

The *ATM Accounting* component is designed to capture ATM based charging schemes and apply these schemes to usage data gathered from ATM connection metering. This component is used in both the Assurance and Accounting business systems. The system is capable of producing individual charges, or amalgamated charges (bills) based on this usage data, which are stored in a relational database, or produced in simple report form. The component is designed and implemented specifically for the FlowThru project; it is not based on an existing component implementation.

6 Conclusions

This paper provides an overview of the FlowThru trial system, by presenting the modelling at business system level as well as at component level. It exhibits the application of the management system development methodology guidelines as outlined by the project in deliverable [7]. In essence, this paper provides an example of how solutions to telecommunication management business problems can be analysed in a way that facilitates their construction from reusable components. The process results in a real-world example of the application of FlowThru's guidelines for systems development, component re-use and integration. It triggers the assessment of the effectiveness of such guidelines in addressing the requirements of management system development. In addition to re-usability and integration of existing components, the ability of the assembled business systems to support trial scenarios that satisfy real telecommunication management requirements is emphasised The paper also emphasises the application of the guidelines to realise the accounting and

billing business system trial. The mapping of relevant TMF business process onto TINA business and computational models turned out to be relatively straightforward, although the separation between service and connectivity provider within the TINA model forced some adaptations to the TMF model. The modelling, analysis and specifications produced both at system and component level were passed onto the project's system implementation workgroup, where the work is being undertaken with respect to the detailed interface specification, adaptation and integration of the identified components. This will result in the realisation of the FlowThru business trials, which are planned to be undertaken during the final phase of the project.

Acknowledgements

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