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## **Features of eBusiness Transactions and Their Management**

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Tiivistelmä – Referat – Abstract <p>eBusiness collaboration is carried out in a long-running inter-organizational business processes which consists of eBusiness transactions. The execution of an eBusiness transaction is considered as a entity whose internal logic is to be either fully competed or aborted. Traditional database ACID concepts don't support this type of execution in case of the eBusiness transaction. That's why extended ACID properties need to be defined. eBusiness transactions can be managed using a three-level business process framework. It coordinates distributed autonomous business functionality and guarantees wanted outcomes for trading organizations. Abstract Transaction Constructs (ATCs) are the building blocks of Business Transaction Framework (BTF). BTF guarantees the flexible and reliable process execution.</p>			
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# 1 Introduction

In the first chapter an eBusiness Collaboration is introduced using an example of a selling and delivering process of a mobile phone. The eBusiness collaboration is implemented using a Service Oriented Architecture (SOA). The features of an eBusiness transaction are explained in the second chapter and also additional execution requirements of eBusiness Transaction are listed. The management of the features of eBusiness transactions starts at the third chapter. The atomicity requirements for eBusiness transactions are explained and a three-dimensional framework of eBusiness transactions atomicity criteria is shown. Spheres of atomicity model are defined. In the fourth chapter a three-level eBusiness Process Framework is explained. An Abstract Transaction Construct (ATC) concept and its composition for service-oriented business processes is defined in the fifth chapter. In the last chapter are the conclusions of the topic.

## eBusiness Collaboration

Organizations want to focus on their core business and that's why they buy some services from their partners. By combining bought services to its core business processes the organization will reach its business goals [GLA02]. Example for a telecommunication operator selling mobile phones is a core business but delivering them isn't. So the telecommunication operator will buy a delivery service from a logistics provider.

Electronic business, eBusiness methods enable organization to link its internal data processing systems to partners' external data processing systems. Because of the effectiveness the selection of the partner and linking to its data processing system should be done automatically. Partner's services must fit into organization's core business process so that it will be one *automated* process. In figure 1 is a selling and delivering process of a mobile phone [GLA02]. A telecommunication operator sells a gsm phone to a customer, handles the sale e.g. connects a gsm phone to network and finalizes the sale after getting a confirmation of the delivery to the customer. A logistics providers offer a mobile phone delivery service to the operator. So selling and delivering a mobile phone to a customer is an automated process for telecommunication operator.

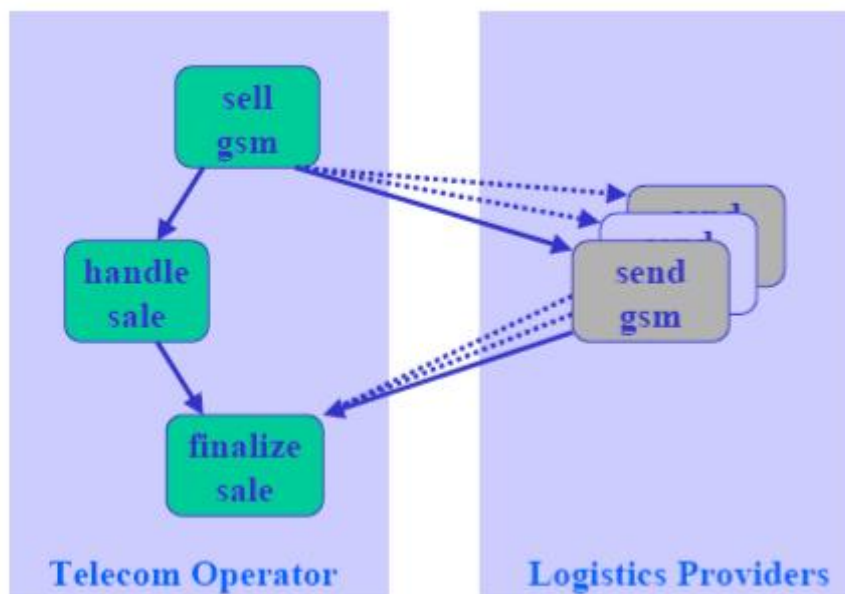


Figure 1. A selling and delivering process of a mobile phone [GLA02].

To better satisfy the needs and expectations of its customers the organization wants to decide as late as possible whose service is the best thinking about the effectiveness, quality, price of the service etc. The organization determines dynamically the service it will use. So there are *several organizations* which offer the same needed service and service buyer can collaborate with all of them. In figure 1 the operator selects and buys the suitable service based on its shipping requirements and current offers of logistics providers [GLA02]. So operator collaborates with selected provider which can vary each time the delivery service is needed.

To finish a service of a business process may take several days. Eg. in figure 1 to send a mobile phone to an end customer can take one to three days depending on how the mobile phone is delivered by mail or using a courier service. So the service of the business process is *long-running* if compared to saving one piece of data into a data base.

A business process of an organization can consists of several services and many of them can be bought from different business partner organizations. A service of a business partner can consist of several services [PAP03]. Example in figure 2 above a white line is described a send gsm –service of logistics provider (figure 1). The service, sending a mobile phone to an end customer, consists of three services: planning transport, collecting the mobile phone and delivering the mobile phone [GLA02]. Some of the services can be bought from the third business partner organizations. Example a logistics provider's services: collecting the mobile phone and actual delivering of it can be bought from post office, UPS, DHL or FedEx etc. The division of a service into several services which can

be divided further into several services and that there can be several organizations which enacts these services causes that the service can be very *complex*.

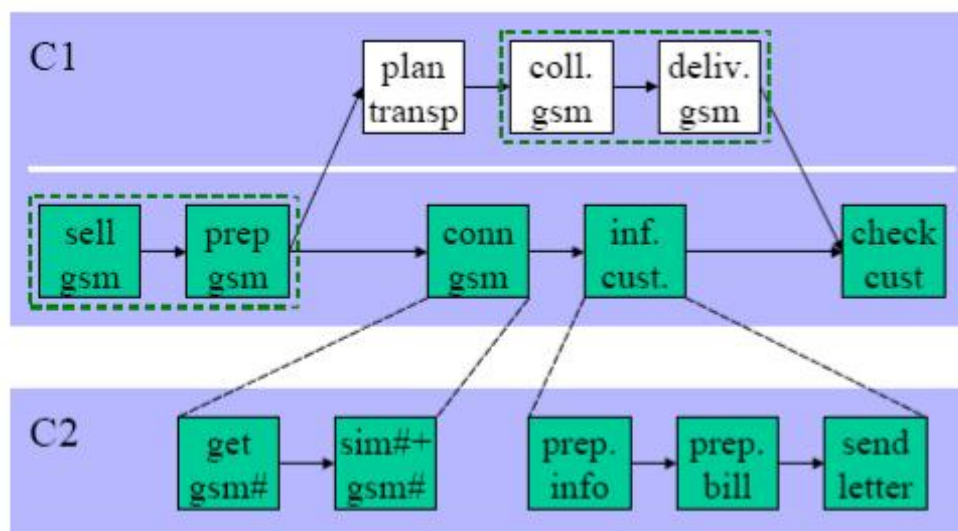


Figure 2. A selling and delivering process of a mobile phone specified in an abstract technique at the conceptual level [GLA02].

### Service Oriented Architecture in eBusiness Collaboration

A Service Oriented Architecture (SOA) is used to implement an eBusiness collaboration. There are three kinds of participants in SOA: service aggregator, service provider and service client [PAP03]. A service client buys a service from a service provider. The service aggregator creates services by combining services. There is a basic SOA in the figure 3 and that's why only service provider and service client is mentioned in it. The service provider describes the interface of a service using WSDL (Web Service Description Language) -description language and publishes it in a service registry or repository [PAP03]. Every service has an individual URI (Uniform Resource Identifier)-identification.

A service client searches for a suitable service from UDDI (Universal Description, Discovery and Integration) –repository by checking the detailed information of the description of the service [PG03]. The desired service is bound to service client's software system by SOAP(Simple Object Access Protocol)-calls currying XML-messages (which contents data and the service description) using HTTP-protocol [PG03]. The service aggregator uses e.g. BPEL4WS (Business Process Execution Language for Web Services) –language to create composite services which consists of other services and are published in UDDI-repository [PG03].

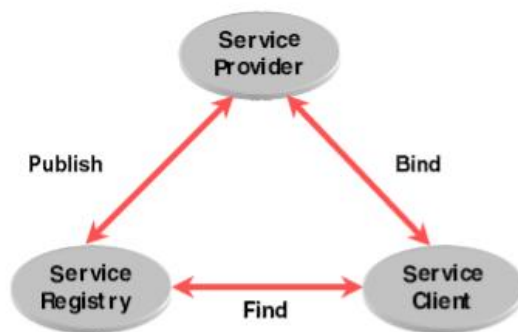


Figure 3. The basic Service Oriented Architecture [PAP03].

## 2 Features of eBusiness Transactions

### Features and Additional Execution Requirements of eBusiness Transaction

eBusiness collaboration is carried out in inter-organizational business processes. A business process can consist of several services. A service is a meaningful business functionality [PAP03]. In eBusiness collaboration a service has nearly the same meaning than an eBusiness transaction because an eBusiness transaction is an interaction between several business partners that are aimed towards achieving a predefined goal [HA02]. But several features differentiate an eBusiness transaction from a classical database transaction and set additional requirements for the execution of the eBusiness transaction [HA02]. The features of eBusiness transaction and the aspects of additional execution requirements of it [HA02] are listed in a table 1.

A feature of eBusiness transaction	An aspect of additional execution requirements of eBusiness transaction
complex	granularity, cohesion
loosely coupled	coupling
long-running	duration, longevity
difficult to reverse	reversibility
recoverable	recoverability
reliable	reliability
concurrent	concurrency
reusable	reusability

Table 1. The features of eBusiness transaction and the aspects of additional execution requirements of it [HA02].

An execution of an eBusiness transaction is performed in several steps and distributed in many systems what makes the eBusiness transaction *complex*. It causes that conversation between systems must be controlled, a capacity of recourses must be planned and data messages between systems have to be compatible.

The eBusiness transaction is *loosely coupled* which means that there is a limited number of data and control dependencies between transactions. This makes a requirement that a service buyer must be able to use a service without knowing its implementation, internal structure or implementation environment [PAP03].

The eBusiness transaction is *long-running*, because it often contains long-running services. A time when the transaction is finished is difficult to predict. Therefore a protocol used in execution of the eBusiness transaction must pay attention to duration of execution and business deadlines.

It is not possible to use a simple rollback to reverse the eBusiness transaction. So it is possible to say that the eBusiness transaction is *difficult to reverse*. A protocol used in execution of the eBusiness transaction must have a mechanism for compensation and a contingency plan.

Because the result of a eBusiness step, sub-transaction, can be saved the eBusiness transaction is *recoverable* if another sub-transaction or even the whole transaction fails. That's why there have to be logging, save points and context security mechanisms available.

The eBusiness transaction is *reliable* if an execution time of each sub-transaction is kept in the promised timeframe. So a mechanism for it and for a compensation of each sub-transaction is needed.

Because there can be many *concurrent* implementations of the same service and also it can be a sub-transaction of another service the concurrency of the eBusiness transaction is much higher than the concurrency of the traditional data base transaction. Therefore a property of isolation has to be extended to selected isolation which allows that some data elements are not locked during the execution of the eBusiness transaction.

The eBusiness transaction is *reusable* when the requirements of loosely coupling are fulfilled so that the eBusiness transaction is encapsulated as a service.

### 3 Management of the Features of eBusiness Transactions

#### Atomicity Requirements for eBusiness Transactions

An eBusiness transaction is considered as an entity whose internal logic is to be either fully completed or aborted when it is executed [HA02]. Traditional database ACID concepts don't support this type of execution in case of the eBusiness transaction [HA02]. That's why extended ACID properties need to be defined.

There are eight atomicity properties of the eBusiness transaction. They can be expressed using taxonomy which is introduced in the figure 4. All atomicity requirements are not relevant in all transaction phases [HA02]. That's why an eBusiness transaction is organized in three phases: pre-transaction, transaction and post-transaction phase [HA02]. The pre-transactional phase is the time before the execution of the eBusiness transaction and post-transaction is the time after the execution.

Infrastructure atomicity requirements takes care of that there is a reliable environment for eBusiness transaction [HA02]. All four infrastructure atomicity requirements in figure 4 are for pre-transactional phase: service request, conversation, non-repudiation and context atomicity [HA02].

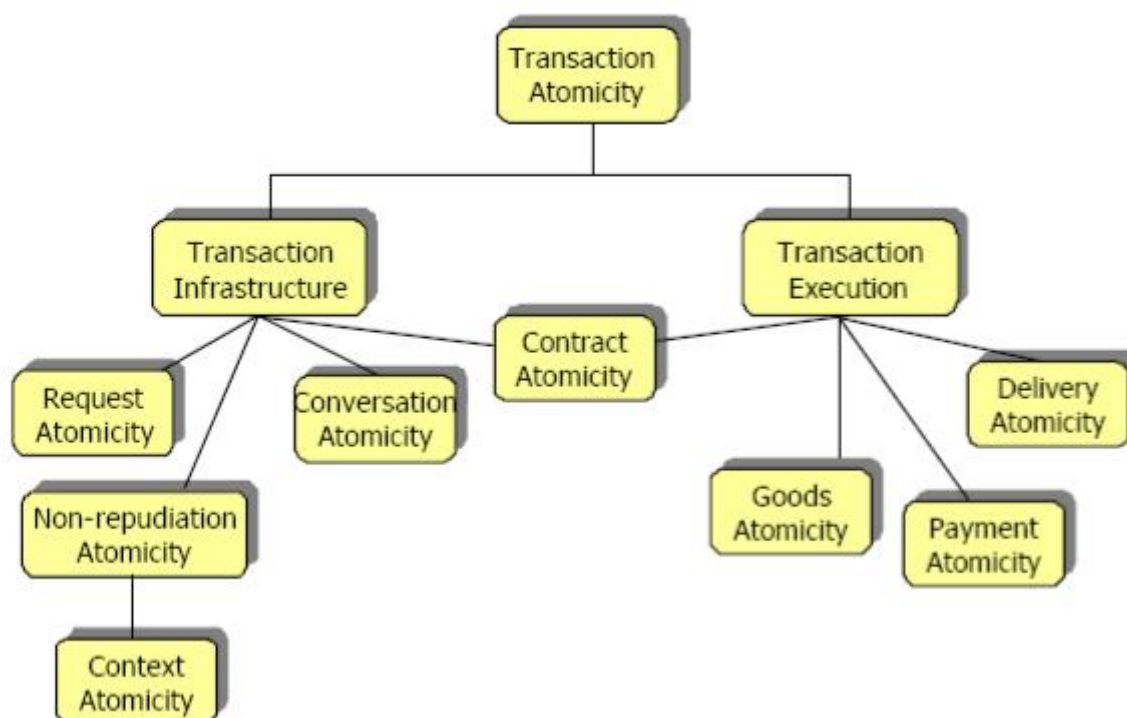


Figure 4. A taxonomy of atomicity criteria for eBusiness transactions [HA02].

A service request atomicity guarantees for a service buyer that the eBusiness transaction is an atomic work flow. The conversation atomicity defines who structures, monitors and controls the conversation between service buyer and provider. The non-repudiation atomicity specifies the non-repudiation provisions. The context atomicity confirms that there is an implemented mechanism to ensure correctness of context of the eBusiness transaction during the execution.

There are three execution atomicity requirements in figure 4 for transaction phase of the eBusiness transaction: goods, payment and certified delivery atomicity [HA02]. The goods delivery atomicity demands that goods or services are identifiable and can be delivered as agreed beforehand. The payment atomicity indicates for a service buyer to pay for the provided service. The certified delivery atomicity is possible to reach if a document of the delivery can be send to the all involved parties of eBusiness transaction. Contract atomicity belongs to a special category and defines a contract between involved parties of eBusiness transaction.

### **Three-Dimensional Framework of eBusiness Transactions Atomicity Criteria**

Atomicity requirements of an eBusiness transaction can be set in a *time* scale which is divided based on the phases of an eBusiness transaction: pre-transaction, transaction and post-transaction phase. On the other hand the atomicity criteria of a sub-transaction phase can be seen from *behavioural* view point [HA02]. A static atomicity requirement creates a stabile and independent foundation. A dynamic atomicity requirement reflects the transaction execution flow. The behavioural view specifies minimum atomicity criteria for transacting organizations.

The third perspective is *design* dimension [HA02]. The declarative definition of eBusiness transaction provides non-functional information about it. A procedural definition describes an implementation of the eBusiness transaction and its control flow. These three dimensions: design, behavioural and time creates a framework for atomicity criteria for eBusiness transactions what is illustrated in the figure 5. In that figure several infrastructure and execution atomicity criteria pairs express that the both criteria are instantiated each time for a new business transaction [HA02].

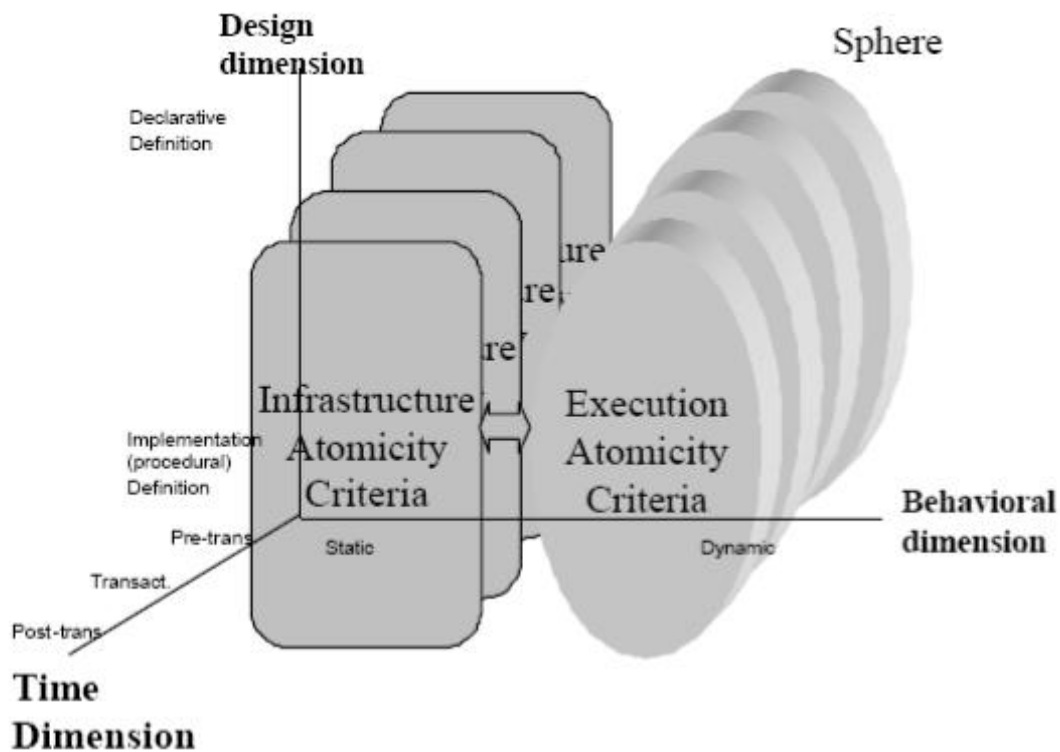


Figure 5. The three dimensions of an eBusiness transaction: design, behavioural and time [HA02].

### Spheres of Atomicity Model

An atomic sphere is defined to create a mechanism for enactment of eBusiness transactions so that it can be totally committed or aborted. The atomic sphere consist of a collection of actions looked from the external perspective which totally commits or aborts including all sub-actions [HA02].

The atomic sphere has two characteristics: behaviour and persistence [HA02]. The behaviour of the atomic sphere causes that the sphere expands and truncates during the execution of the atomic sphere. The expansion of the sphere happens when an additional party involves to the action of organizations. When that interaction is concluded the sphere is truncated. The persistence is taken care by recording dependencies of all steps of the eBusiness process. The persistence is required to indicate the set of atomicity criteria that are applicable to it.

There are two categories of atomic spheres: infrastructure and execution sphere [HA02]. In infrastructure sphere belong the atomic spheres that take care of that there is a reliable environment for eBusiness transaction. They also creates contract between the parties of the eBusiness process and notice if further interaction won't be performed for some reason. Infrastructure sphere includes all four infrastructure atomicity requirements:

service request, conversation, non-repudiation and context atomicity [HA02]. The execution sphere covers an execution of an eBusiness transaction. It confirms that the payment has done, goods or services has been delivered and that they are as initially agreed. There are three execution atomicity requirements in execution sphere: goods, payment and certified delivery atomicity [HA02]. The atomicity model includes these two main spheres: infrastructure and execution sphere [HA02].

There is an example of the transaction model based on the atomicity spheres in the figure 6 [HA02]. A factory is producing and delivering goods to a service requester. There are six actions for doing it in an eBusiness transaction. All of them create an infrastructure and also an execution atomicity sphere. The control flow is shown using arrows. The upper route is the perspective of the service provider and the lower route is the perspective of the service requester. The parties of the eBusiness transaction are not mentioned in the figure 6. A certified delivery atomicity sphere has two actions: certified delivery and finalizing transaction. A payment atomicity sphere has the previous sphere and a payment action. A contract atomicity consists of two previous spheres and contract definition and production of goods actions.

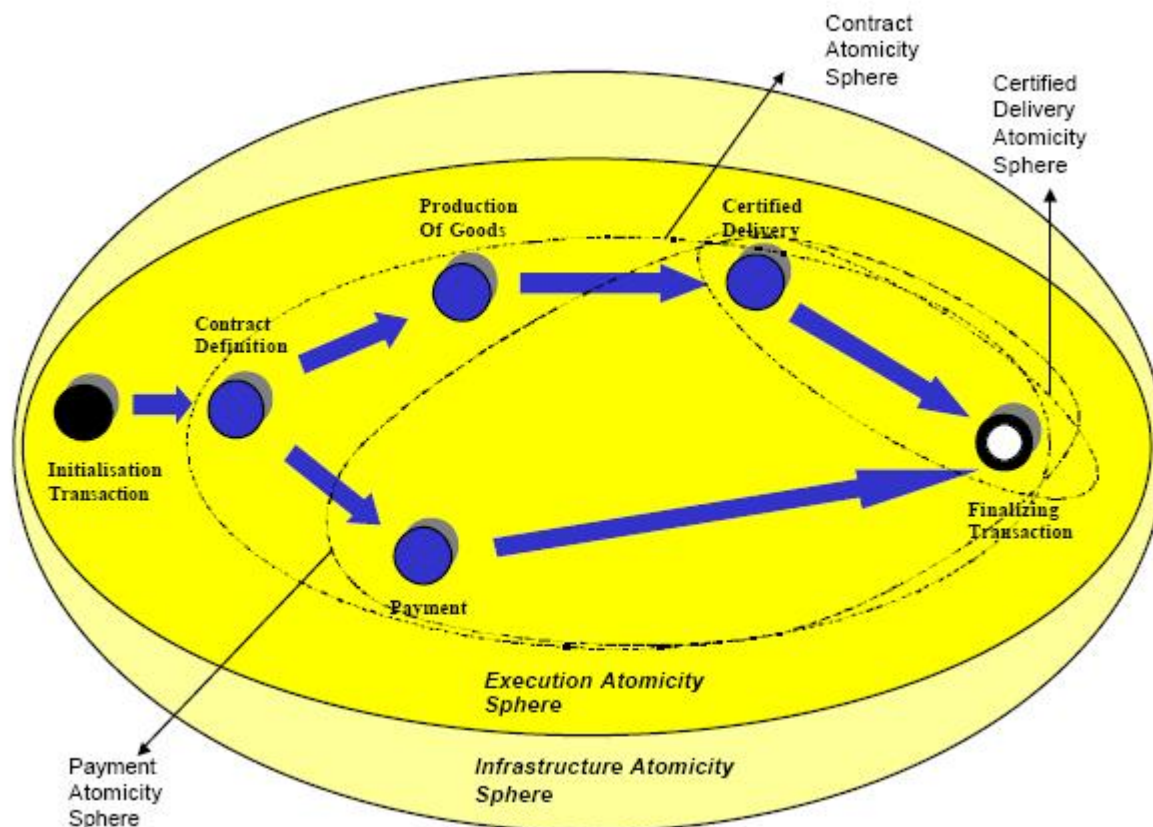


Figure 6. Example of a transaction model based on atomicity spheres [HA02].

## 4 Three-Level eBusiness Process Framework

There is a need for a description of an eBusiness process so that parties involved to it get all the information they need for interaction. E.g. a service requester need to find a suitable service that fits to its process based on the specification of the service. On that level of the eBusiness process description the main characteristics is interoperability [GLA02].

When the eBusiness process will be implemented there is a need for description of process enactment systems of the involved parties. They may have various systems e.g. service oriented or legacy systems and the systems may be running on different kind of platforms. On this level of description the emphasis is on executability [GLA02].

To guard the quality of the eBusiness process structure in a design, an analysis and a validation phase a middle level description is needed [GLA02]. It bridges a high interoperability and a low executability level with respect to specific details of semantics at those two levels [GLA02].

To fulfil the need for a description of the eBusiness process on different levels a three level eBusiness process framework has been introduced. There is on the highest level of the framework an external level in a figure 7[GLA02]. It represents an eBusiness process specification of interaction between organisations. It only shows the information related to that process between interaction parties nothing else. It hides other processes of the interaction parties. So it projects that part of the organization's process which is related to interaction process to external level [GLA02]. That is marked in the figure 7. If the interaction parties use different system to describe the process they must be translated to the same system [GLA02].

There is a conceptual level in the middle level of the framework [GLA02]. The idea of it is illustrate all eBusiness processes of a organization so that they can be used in design and analysis purposes. The illustration is done using an abstraction and aggregation of the lower implementation level [GLA02]. The conceptual level doesn't show the platform specific things and it doesn't depend on its use on the external level [GLA02].

On the lowest level of the framework is an internal level [GLA02]. Internal level is used to describe enactment of processes of the organization participating interaction of organizations. The internal level is mapped to the conceptual level in figure 7. The mapping uses refinement and specialization for a specific platform [GLA02].

The three levels of eBusiness process framework separates business concerns of eBusiness process design. That increases quality, flexibility and reusability of process specifications [GLA02]. The separation of concerns is important as the complexity of automated inter-organizational process has grown besides the growth of eBusiness.

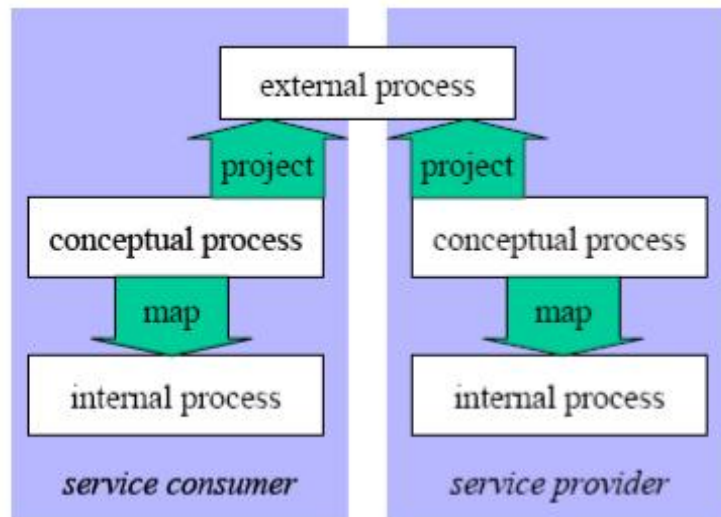


Figure 7. The three levels of eBusiness process framework [GLA02].

## 5 Abstract Transaction Construct for Service-Oriented Business Processes

A reliable process execution is guaranteed with transaction management. Although a traditional transaction management (with locking the shared resources per access) can't take care of complex and long-lasting processes.

Business Transaction Framework (BTF) [PA03] is a solution. It provides comprehensive and flexible transaction support for service-oriented business process. The idea of BTF is to abstract existing transaction models into Abstract Transaction Constructs (ATCs) and compose proper ATCs into a transaction scheme to provide on-demand transaction support [WGV06]. A life cycle of BTF is divided to three phases: definition, composition and execution phase [WGV06]. ATC templates are designed in definition phase. In composition phase a transaction scheme is build from needed ATCs according to the process specification. The scheme can be changed later if needed. In execution phase real business transactions are instantiated and executed. ATCs are the building blocks of the BTF. The contracts between eBusiness organizations are used to define the Transactional Quality of Service (Tx-QoS) of ATCs [WGV06]. So ATCs based BTF with Tx-QoS specifications guarantees a reliable and robust eBusiness process.

### Abstract Transaction Construct (ATC) Concept

ATCs are abstract constructs which represent the existing transaction models in semantic means. Actually they are transactional services that encapsulate transactional semantics and behaviour [WGV06]. An ATC has the following listed characteristics. The ATC has an *internal structure*: flat, sequence, complex and tree [WGV06]. A flat ATC represent an ADIC transaction. A sequence has an internal chained or Saga structure. A complex ATC has the internal structure of mixed type of sequences or parallels of a complex workflow transaction model. Example a ATC F represents a complex process operated by another party. The complexity of F depends the transparency level agreed by two parties. A tree ATC has an internal tree structure which is like nested or similar transaction model.

ATCs are composed in a *recursive* manner [WGV06]. Example in figure 9 a top level ATC A consist of second level ATCs B, C, D, E and F. A eBusiness process is a single transaction. A ATC guarantees a specific *transactional qualities* which are Tx-QoS [WGV06]. In service-oriented environment they can be enclosed in the service description

or service agreements. A ATC has a *parameterizable* interface contain information of characteristics listed so far [WGV06]. There are three types of parameters. The first type specifies the internal structure of ATC. The second type specifies the composition of the ATC like its predecessors, successors and parallels. The third specifies the transactional qualities e.g. atomicity and consistency.

### Abstract Transaction Construct (ATC) Composition

When a specification of a process is received a proper ATCs are picked from an ATC library and recursively composed into a top level ATC for later enactment [WGV06]. There is a example of a booking process of a travel agency in a figure 8.

Customers can create a trip by selecting a hotel, transportation, and an optional rental car (in parallel), after which the costs are calculated and the trip can be booked. Then in parallel the required documents are prepared and the financial issues are dealt with (i.e., invoicing and payment checking), after which the documents are sent to the customer. Being a small travel bureau, the financial dealings are outsourced to a specialized organization, which offers this function through a Web Service. The internal of this Web service consists of invoicing and payment activities, which in turn consist of other activities not relevant for the example. [WGV06]

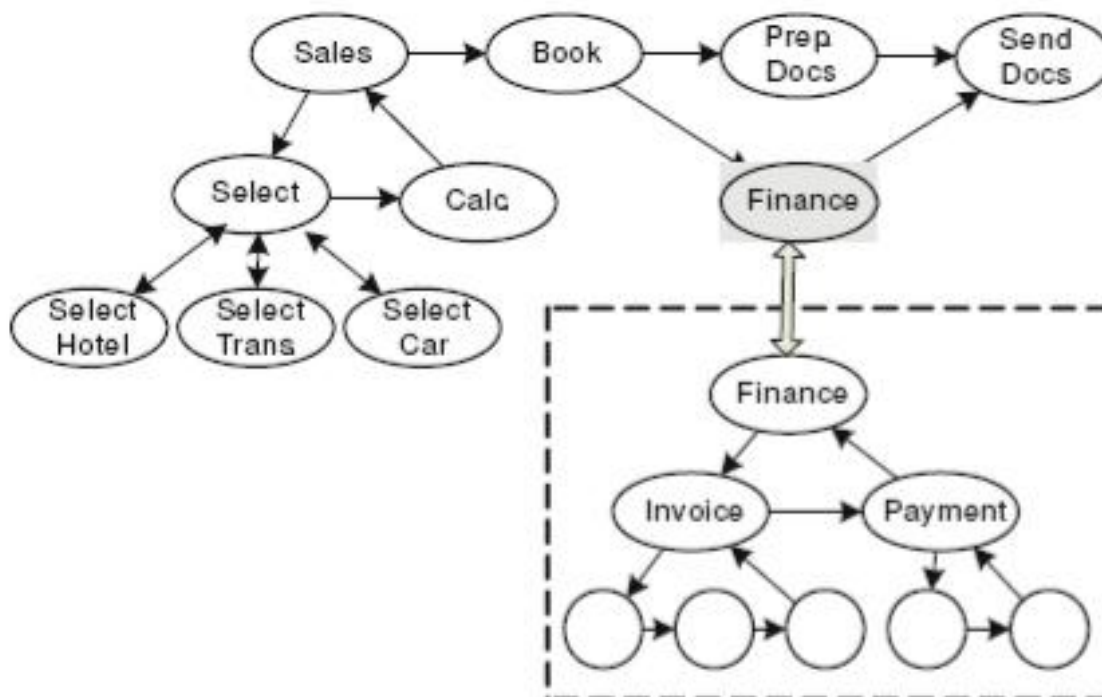


Figure 8. A booking process of a travel agency [WGV06].

The resulting ATC composition for the example is shown in the figure 9 where ATCs are represented by rectangles and the dashed lines represent encapsulation. Eight ATCs are identified and named 'A' through 'H', which correspond to the activities/services shown in the figure 8. Note that the unnamed activities that belong to activities 'G' and 'H' are also ATCs but not relevant here. [WGV06]

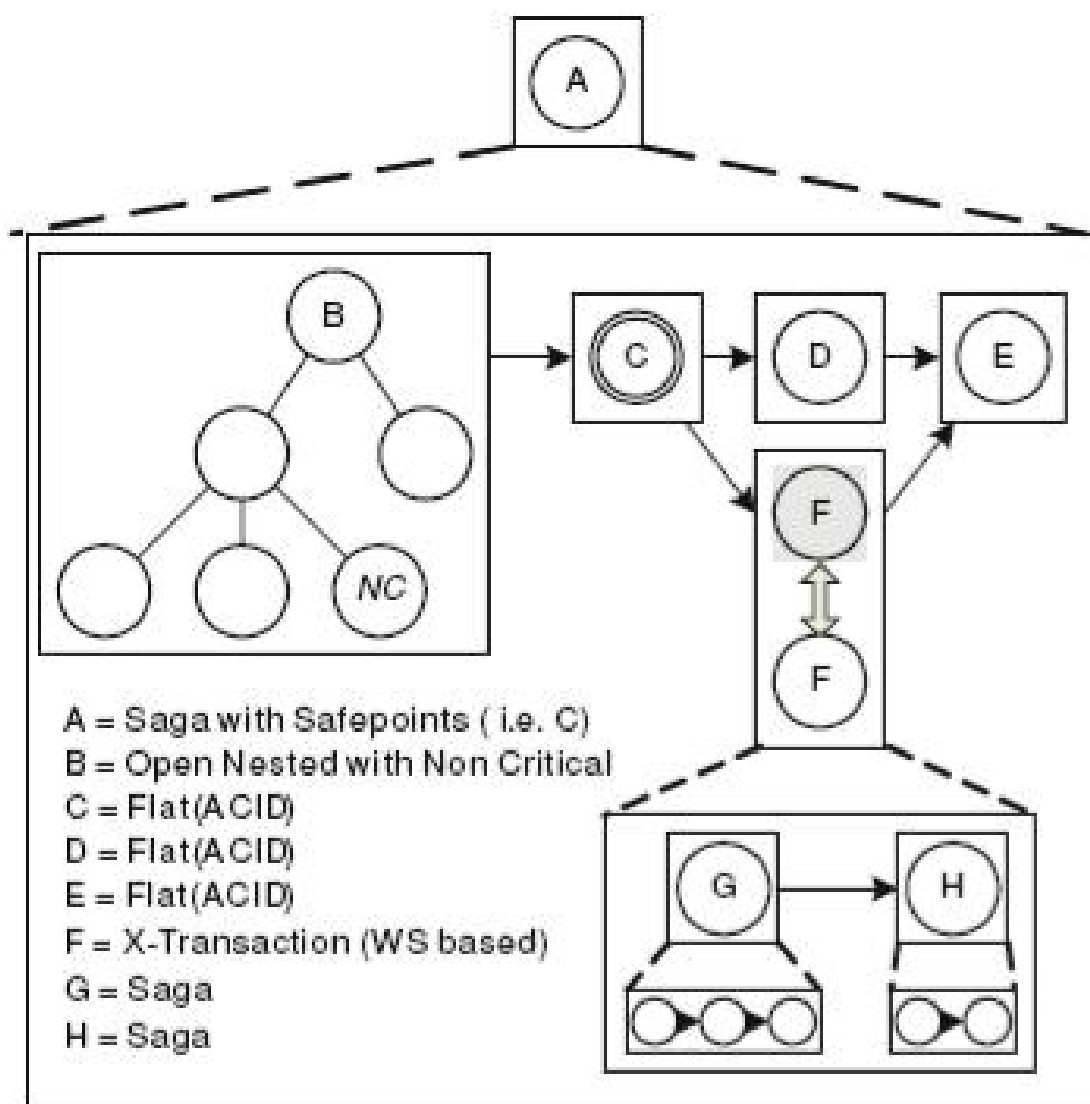


Figure 9. Recursive ATC composition of a booking process of a travel agency [WGV06].

## 6 Conclusions

In eBusiness collaboration a business process can be described with the words inter-organizational, automated, long-running and complex. A service has nearly the same meaning than an eBusiness transaction, but several features differentiate an eBusiness transaction from a classical data base transaction and set additional requirements for the execution of the eBusiness transaction.

There are eight atomicity properties of the eBusiness transaction, but all atomicity requirements are not relevant in all transaction phases. That's why it is organized in three phases: pre-transaction, transaction and post-transaction phase. Atomicity spheres can be used to ensure the atomicity of long-lived and nested eBusiness transactions.

The three levels of eBusiness process framework separates business concerns of eBusiness process design. That increases quality, flexibility and reusability of process specifications and helps manage the complexity of automated inter-organizational processes.

Abstract Transaction Constructs (ATCs) are the building blocks of Business Transaction Framework (BTF). BTF provides transaction support for service-oriented business processes and guarantees the flexible and reliable process execution for complex and long-lasting eBusiness processes.

In this paper were introduced three solutions which help to manage eBusiness transactions: a transaction model based on atomicity spheres, the three levels of eBusiness process framework and the Business Transaction Framework. There is no conflict between them so they are not exclusive.

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