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A FRAMEWORK FOR MODELLING E-BUSINESS RESOURCES

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Die Arbeitsberichte des Instituts für Wirtschaftsinformatik dienen der Darstellung vorläufiger Ergebnisse, die i.d.R. noch für spätere Veröffentlichungen überarbeitet werden. Die Autoren sind deshalb für kritische Hinweise dankbar.

The "Arbeitsberichte des Instituts für Wirtschaftsinformatik" comprise preliminary results which will usually be revised for subsequent publications. Critical comments would be appreciated by the authors.

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1. Introduction

This paper presents the conceptualisation of a framework of e-business-related resources. The framework consists of the – not yet finalised - specification of a resource modelling language and the documentation of a number of generic resource types. The specification of the resource modelling language is based on work done in two research projects at the University of Koblenz. The first research project aims to develop a general resource modelling language[1]. The second one focuses on the modelling and evaluation of information systems[2]. We will outline common resources which are typical for the usage in e-business processes. The resource modelling language aims to satisfy the needs of different user types in the e-business domain. The language has to be applicable by domain experts and offer domain specific resources by presenting adequate abstractions on resources. This resource modelling language is an extension to an existing process modelling language - OrgML (Organisation Modelling Language) - which is part of the integrated enterprise modelling method MEMO (Multi-Perspective Enterprise MOdelling)[3]. It will be utilised to document the resource requirements of business processes modelled in the context of the project ECOMOD[4].

1.1. E-Business

The terms *e-business* and *e-commerce* sometimes seem to be rather well-worn buzz-words. One evident fact supporting this assumption is the absence of a commonly accepted definition[5] of the terms. There exists a plethora of different definitions and explanations which sometimes state that e-business and e-commerce are concepts which almost certainly will result in great success after implementation. As a consequence many companies that were founded in the era of booming internet based commerce (*dot-coms*) ended up bankrupt a very short time afterwards. As a matter of fact this experience has lead to somewhat more conservative attitudes. E-business now is often reduced to its essence, i.e. the support of processes in business and commerce and thereby to simplify and accelerate commercial transactions[6].

Information technology plays a very important role today and a lot of different systems are available for the implementation of information systems. These systems comprise computer hardware, communication technology and business-process-oriented software. The range of application of computers is covering general-purpose workstations as well as server-platforms or even mobile devices. All this computer platforms can be integrated by fixed-line or mobile communication. The abstraction of business processes - represented by process-oriented software - is situated on top of the technical layer consisting of hardware and communication infrastructure. Technology for electronically supported business processes is available today: powerful computers in client/server-environment as well as high-speed data interchange. Software systems are also available, but the decision for one or more specific system is not trivial. There exists a plethora of applications, document formats and protocols. These have – in consideration of the business processes of an enterprise - to be analysed and implemented.

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[1] More information on the resource modelling language can be found in [Jung03].
[2] An introduction to this topic is given in [Kirc03].
[3] cf. [Fra99a]
[4] ECOMOD (E-Commerce Modelling) is a research project funded by the Deutsche Forschungsgemeinschaft (DFG). It aims at creating reference business process models for small and medium enterprises in the area of e-commerce. Be related to [FrLa04a] for further information about the project.
[5] Furthermore, there seem to be no exact definition in a lot of publications at all (cf. [OBLP02]).
[6] More information about the benefits of e-business can be found in [IFC03].

Hence, business process models are a reasonably valuable tool for the implementation of e-business technology.
As the availability of well-established technology offers new opportunities, the need for faster and at the same time cheaper execution of transactions forces companies to revise their processes. There are a number of strategies for a company to differentiate itself from competitors: For example, a company might sell its products cheaper or improve their quality. Those strategies usually correspond directly to measures for the reduction of costs or the optimisation of business processes. These aspects outline the demand-pull-side of e-business. On the one hand, the availability of IT supports the push of new technology into new fields (technology push). On the other hand, demand pull reveals the need for support for the efficient execution of business transactions. Again, the implementation of e-business-technology depends on the business processes of an enterprise. Hence, process models are an important tool for the conceptualisation of an e-business system.

1.2. Process Modelling

The analysis, representation and management of knowledge about an organisation and its processes has always been very important[7]. A lot of work has been conducted on the development and evaluation of ontologies for process modelling[8], the specification of process modelling languages[9] as well as on business process modelling methods and concepts[10]. Business process models can be used for different kinds of purposes:

- Documentation of processes of an organisation to foster communication[11]
- Analysis of business processes[12]
- Simulation of processes[13]
- Support for business process re-engineering[14]
- Generation of workflow schemata[15]
- Software development of process-oriented applications[16]

Documenting an organisation's processes (as well as other organisational aspects like its structure or strategy) fosters communication with new employees or external consultants[17]. Business process models represent a common medium for the communication of domain experts and novices. They offer domain level concepts[18] and enable a broader distribution of knowledge among other business-related people with different skills and knowledge of an organisation.

The analysis of business processes relies on a relatively detailed description of process models and according concepts. Depending on the analysis' purpose, a modelling language has to offer domain-specific language features representing the analyst’s perspective. Analysis

[7] cf. [KoPl00]
[8] cf. [WaWe89a], [WaWe89b], [WaWe90a], [WaWe90b], [WaWe93], [Web97] and [Gree99].
[9] cf. [EJL+99], [Ober96], [SuOs97] and [AaHe02]
[10] cf. [Herb97] and [Öste95]
[11] cf. [Fra99a], [Ober96]
[12] cf. [EJL+99], [BeJo01] and [Sche99a]
[13] cf. [Baum96]
[14] cf. [CKO92] and [Ober96]
[15] cf. [CKO92] and [Ober96]
[16] cf. [Fra99a], [Öste95], [Sche92], [Sche98] and [CKO92]
[17] cf. [Fra99a], [Ober96]
[18] In contrast to other modelling purposes and languages, the level of abstraction is very high with respect to the degree of formalisation.

might for example support the detection of shortcomings in existing processes[19]. Appropriate language features provided by a process modelling language support the determination of media clashes[20], unnecessary processes or potentials for further optimisations. Depending on identified weaknesses, a business process re-engineering might be applicable[21].

Simulation supports the detection of flaws of a business process model[22]. In contrast to analysis, simulation does not exclusively rely on structural properties of a business process. Simulation generally allows the prototypical execution of previously designed processes on the basis of concrete entities. Depending on the process and the selected entities, a prototypical execution of a certain process can be started and observed by the designer. A simulation usually allows the observation of a processes execution depending on given input parameters. It is in some extend more powerful with respect to expressiveness than a static analysis. Simulation can focus on aspects of a model which have not been considered before. Hence, simulation enables the detection of additional properties by the observation of the behaviour of a process. It also shows unknown properties and restrictions regarding a new business process. Simulation depends on a prototypical instantiations of a process model[23]. Typical instances of objects and their values (e.g. a specific processing time or accounting information) are added to the model and the execution of a process can be observed. Depending on the objectives, business process re-engineering supports the redesign of processes with respect to weaknesses identified by an analysis or a simulation[24].
Business process models might also be a preliminary stage for an information system's (IS) design. A workflow management-system (WfMS) or a newly developed software system are alternatives for such an IS[25]. The distinction between a workflow schema and a software system is the level of coding. Workflow schemata are usually directly derived from a process-model. Process types are mapped to atomic workflows and resources are assigned accordingly. This is because of the predefined semantics of WfMS. A workflow is only described by its processes and associated applications. Hence, the applicability of such systems is restricted to classical computer supported processes. The extend of these capabilities is usually determined by the WfMS. In contrast to this, the development of a new information system does not depend on the limitations of a given workflow framework[26]. Such a system is usually build using low-level programming languages and domain-specific frameworks.
Resources are essential for the modelling of processes[27]. Processes and their relationships mainly describe dynamic aspects and the order of events. Resources assigned to processes additionally specify subjects and objects of business processes. Resources are usually not available in an unlimited amount[28]. Hence, the usage of scarce resources has to be taken into account for the analysis or simulation of processes as well as for the development of a workflow application or an information system. Bottlenecks resulting from scarce resources can be identified and compensated by assigning alternative resources which may replace the

[19] cf. [EJL+99], [BeJo01] and [Sche99]
[20] If different kinds of media are included.
[21] cf. [CKO92] and [Ober96]
[22] cf. [Baum96]
[23] The prototypical instantiation of a process model means the mapping of a conceptual process model to a simulation model with additional properties of an instance. Such an instance might correspond to the instance of a process and an instance of associated entities as well.
[24] cf. [CKO92] and [Ober96]
[25] cf. [Fra99a], [Sche98], [Öste95], [Sche92] and [CKO92]
[26] like a workflow management system
[27] cf. [PSO99]
[28] cf. [Nübe01] and [PSO99]

original resource in case of a failure. But, the quality of analysis, simulation, and system development depend on the conceptual power of the resource modelling language.

1.3. Structure of this Report

The paper at hand is structured into five chapters. After this introductory chapter the basic resource concepts (human resource, physical resource and intangible resource) of the presented modelling language will be described in chapter 2. Chapter 3 contains advanced concepts of the language like generic associations between resources, external partners and solutions. Following in chapter 4 is a more detailed look into the concept *solution* and its use for the resource documentation of e-business processes. Concluding the paper is a summary in chapter 5 which includes information about possible future work.

2. Resources in E-Business Processes

E-Business requires special resources, which are associated with or correlated to electronically supported processes. As an integral characteristic every e-business-process depends on given resources, allocated to it. In the following sections we will present different kinds of e-business-resources. These resources are part of a general resource specification framework[29] but represent general e-business-specific concepts.

2.1. General Resource Types

We generally distinguish between elementary and composed resources. A composed resource consists of one or more elementary resources. In the context of our e-business-model we will call composed resources *solution*. Solutions will be presented in section 3.3. Regarding elementary resources we basically distinguish between three kinds of resources on a conceptual level. These are human, physical and intangible resources (cf. Figure 1). A human resource is an abstraction on different perspectives on staff. Examples for such perspectives are concrete employees, roles filled by employees or business-oriented functions. Physical resources comprise all tangible objects used within a business process. Examples for physical resources are production plants, raw material or computer hardware. In contrast to this, intangible resources do not have a physical manifestation. Examples for intangible resources are data, information, software or even knowledge. Every type of resource can directly be associated with a business process (cf. Figure 2).

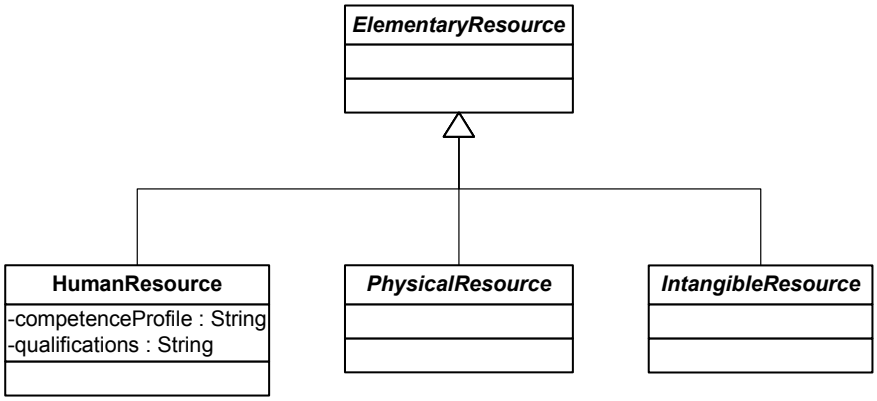

Figure 1: General Resource Types

The following description of the language concepts as well as possible types bases on three different levels of abstraction:

- Meta-level: Common language concepts are described on the meta-level. This level comprises all language features which specify the relevant concepts for a modelling language. Regarding human resources the main concept is the class labelled HumanResource.
- Type-level: Concepts on a type-level are instances of types on the meta-level. For example a concept called SystemAdministrator on the type (or conceptual) level is an instance of a human resource type in the meta-model.
- Instance-level: Instances of the SystemAdministrator type are specific administrators for networks, databases or networks.

[29] Cf. [Jung03]

These reflections generally result in a three-tiered abstraction: General concepts are specified in the meta-model and prototypically instantiated for e-business-related resource-types. Types correlate with concrete instances. Those instances can be associated with concrete objects in a business process model.
Hence, there are different types of model elements for different types of abstractions. General concepts can be found as language feature descriptions in the meta-model. Every instance of a meta-model's type is a concept on the model type's level. Instances of a meta-model's concept called HumanResource are specific human resource types like administrators or developers. Those types are instances of the meta-type HumanResource and are specified by their special usage and qualification. Those instances, usages and qualifications are usually not expressed in a resource model. Furthermore, there is an explicit instance layer, which comprises prototypical instances.
E-business-related concepts will be presented in the following manner:

- Explanation of every concept in the meta-model[30].
- Presentation of prototypical types of resources for e-business-processes[31].
- Description of some selected instances of resource types.

In the following chapters, we will present resources on the three levels of abstraction: meta-model, model and instance level.

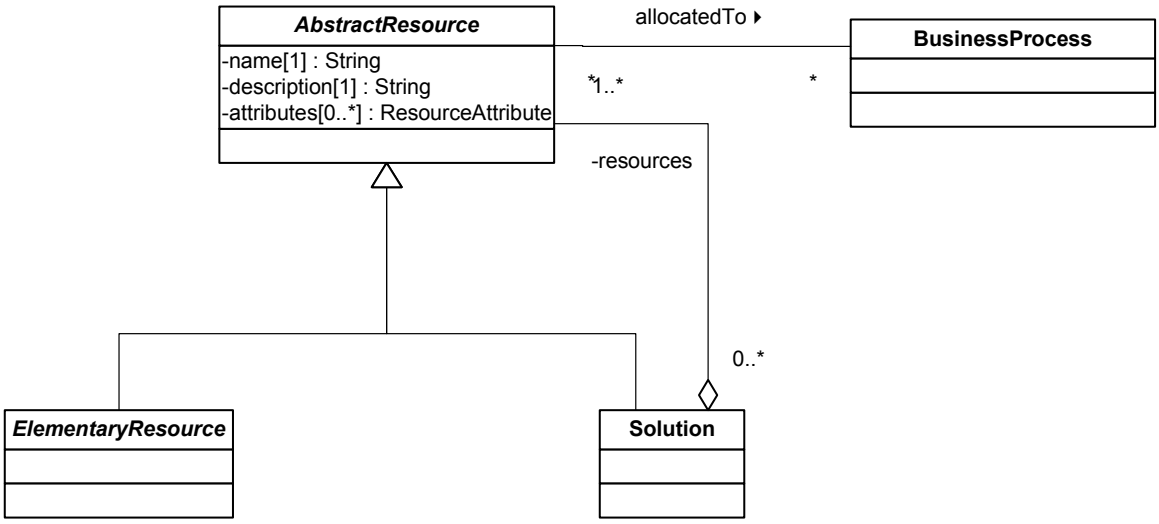

Figure 2: Core Resource Model

2.2. Human Resources

Human resources are an abstraction on persons, employees, roles or other staff-related perspectives. They might be associated with concrete persons or employees of an organisation as well as abstract organisational units in an organisational chart. Hence, a human resource can be characterised by different aspects. A human resource …

[30] A preliminary notation will be introduced later.

[31] If more than one attribute value of an exemplary type seems to fit the context (e.g. meta-type ComputingDevice, type Workstation, attribute computingPerformance, see paragraph 2.3.1), we state the values in the form *value1 to value2* (in our example *medium to high*). Thereby we show a range between two expedient limit values of the attribute computingPerformance of the type Workstation. Sometimes we just enumerate possible values. Therefore in these cases we leave the final choice to the modeler.

- … can play an active role
- … may be responsible for the execution of e-business processes
- … needs some qualification and competences for its job

In the following paragraphs, we will outline our conceptualisation of human resources in e-business. This conceptualisation comprises the description of the meta-model and selected human resource types.

2.2.1. Language Specification for Human Resources

The type HumanResource is a subtype of ElementaryResource and has the two major attributes competenceProfile and qualifications, both of type String (cf. Figure 1). Qualifications correspond to the formally certified capabilities of a human resource and the competenceProfile addresses so called *soft skills*. The qualification of a human being for a job is usually based on his or her qualification and skills. A qualification has the advantage of being certifiable in a formal way. Skills do not have that characteristic. Nevertheless they have to be included in an enterprise model.

- **qualification**: The qualification is an objectively describable criterion for the capabilities of a human resource. Usually, the qualification certificate is issued by an established educational body
- **competence**: The competence of a human resource reflects personal skill of human beings. Hence, a competence profile corresponds to personal strengths.

The basic conceptualisation of human resources will be given in the meta-model in Figure 1.

2.2.2. Types of Human Resources in E-Business

Human resources in e-business correspond to employees, which are responsible for the execution of electronically supported business processes. We distinguish between human resources which develop and maintain e-business-systems on one hand and on the other hand resources which work with such systems. System administrator and developer are typical roles involved in implementing IT and keeping systems running. Domain specific human resources deal with operational processes of an enterprise. Within this paper, we focus on human resources working in business processes supported by e-business-systems.

System Administrator

A system administrator is a human resource which is responsible for the installation and maintenance of an information system or parts of it. Despite the fact that there are special administrators for different kinds of systems, boundaries between the qualifications of administrators are not clear. Nevertheless, we outline some examples for prototypical administrators:

- A *database administrator* specialises in the administration of database systems (DBS). Such a system consists of a database management system (DBMS)[32] and one or more databases (DB). The database administrator is able to install and configure a DBMS as well as to create new databases for e-business applications.

[32] See also paragraph 2.4.3.1 Software

- A *network administrator* is responsible for the installation, maintenance and extension of a corporate network (local area network; LAN). He conceptualises the appropriate network infrastructure on the basis of organisational structures and the structure of buildings. Those structures might result in the installation of several sub-networks which are connected by network routers. A special kind of a sub-network is a wireless LAN (WLAN). Maintenance tasks consist of adding new computers to the network, keeping routing-software up to date or the management of users. A network administrator will also have to solve spontaneous arising network problems.
- The administrator of a web-server installs the web-server-software on a server-computer[33] and maintains the system. A web-server enables an interface to the world-wide web and might therefore be subject to attacks from computer criminals. Its installation should be up-to-date and all known security holes have to be closed by new updates. Hence, a *web-server administrator* has to look for periodically available updates and news from well known security bulletins.
- Corporate Information System (CIS) form a large and heterogeneous class of software systems. A *CIS-administrator* has to install and maintain such a corporate information system. Because of heterogeneity and complexity of such systems, the qualification of CIS-administrator is not clearly given but has to be documented in a concrete context.

Generally, a system administrator has to have knowledge on computer hardware, operating systems, DBMSs, computer networks and application software. Specialised administrators only differ in their focus. A prototypical specification for administrators is given in the following table:

Type	HumanResource
Name	SystemAdministrator
Description	A system administrator is responsible for the installation and maintenance of a system.
Qualification	- basic computer science knowledge - expert in the kind of system he has to administer
Competence	- self-reliance - ability to communicate with other employees

The same representation is used for the description of database administrators.

Type	HumanResource
Name	DatabaseAdministrator
Description	A database administrator is responsible for the installation and maintenance of a DBMS and corporate databases.
Qualification	- basic computer science knowledge - qualification in database technology - knowledge in database design
Competence	- self-reliance - ability to communicate with other employees - cooperation with administrative staff

[33] See also paragraph 2.3.1 Computing

Developer

Once, an e-business system is installed and running it might be subject to changes. E-business related technology is evolving and the research field of e-business is growing. Hence, the technological basis for electronically supported business processes is changing over time. Hence, there have to be software or service developers which are able to implement new business services. A general developer has to be capable of algorithmic and abstract thinking. Depending on the kind of software systems, he has to know different domain-specific concepts and principles. The competence profile for developers is hard to formalise – this is generally inherent to the formalisation of soft skills.

Type	HumanResource
Name	Developer
Description	A developer is responsible for the development, installation and maintenance of new services.
Qualification	- basic computer science knowledge - qualification in software development - knowledge in domain specific languages
Competence	- ability to communicate with employees and administrative staff - algorithmic and abstract thinking

A web-developer mainly implements services which are accessible over the internet. He has to know at least one programming paradigm but also some web-related languages. Those languages correspond to programming logic or presentation of information. Examples for web-related languages and technologies are:

- document description languages: e.g. HyperText Markup Language (HTML)
- Scripting languages like PHP, Perl, …
- Application server: Java2 Enterprise Edition

Web-based information systems will never be finally developed. Furthermore, changing business concepts as well as emerging technology will influence e-business-processes. Hence, e-business-solution will always be subject to changes and express the dynamic in this field. Consequently, the development and enhancement of e-business-solutions can not solely be performed by executive managers but also requires web-developers. Within this paper, we emphasise the potential of web-developers in the identification and implementation of new business processes. This capability will be subsumed under the *sense for innovation*. An administrative employee might be able to identify his need for e-business-support. This analysis will base on available services and requirements. A web-developer can be instrumental in identifying new e-business-supported processes, but his conclusions are rather based on available technology than current services. *Sense of innovation* means in this context, that a developer is responsible for the identification of new services.

Type	HumanResource
Name	WebDeveloper
Description	A web-developer is responsible for the development, installation and maintenance of new e-business services for the world wide web.
Qualification	- basic computer science knowledge - qualification in software development - knowledge in web-specific languages
Competence	- ability to communicate with employees and administrative staff - algorithmic and abstract thinking - sense for innovation

Development efforts are not only restricted to the design of an appropriate web-interface but also comprise extensions to existing corporate information systems. Changes to those systems are usually very hard to realise since they tend to be very complex. Nevertheless, changes might be realised in terms of interfaces to other systems or converters between data formats.

Operational Employee

Operational employees are usually associated with the core-processes of an enterprise. Examples for such employees are workers in production or – in general – employees on an operational level. They might work in production, procurement, distribution as well as service departments.

Type	HumanResource
Name	OperationalEmployee
Description	An operational employee is directly associated with core processes of an enterprise.
Qualification	- domain expert - knowledge of the company
Competence	- collaboration with colleagues

Operational employees are usually experts in their domain. By domain, we refer to the area of expertise of such an employee (trade, knowledge on production machines or a special college degree). These qualifications can usually be documented by a formal certificate (e.g. diploma) or a long-term occupation in this field. Additionally, a worker has to know a few aspects of his company. He has to know the process of his work as well as its context. Such a kind of knowledge cannot be documented by a diploma but by a long-term occupation in a company and a strong commitment in corporate affairs. The capability of collaboration is rather a soft skill. Nevertheless, it is very important for employees working in teams.

Employee in Administration

Administrative staff is usually entrusted with the planning and organising of business tasks[34]. They usually have a higher degree in business, economics or administration. An employee in business and administration does not work directly in the core processes of a company but keeps the enterprise working. Hence, he has to know the company and its situation and is

[34] cf. [Gut83]

skilled in planning and organisation tasks. His soft skills consist of capabilities in collaboration with colleagues as well as planning and organisation.

Type	HumanResource
Name	BAEmployee
Description	An employee in business and administration (BAEmployee) works on administrative processes. Those processes do not directly correspond to the core processes of an enterprise. They represent supporting tasks which keep the core processes running. The usual tasks consist of organisation and planning activities.
Qualification	- Degree in Business and Administration - knowledge of the company - qualification in planning and organising
Competence	- collaboration with colleagues - endowment in planning and organisation

2.3. Physical Resources

Physical resources comprise all tangible objects used within a business process and are neither human nor intangible. According to Heinen[35] - in the context of industrial production - it can be differentiated between non-consumable resources (*Potentialfaktoren*) and consumable resources (*Repetierfaktoren*). Non-consumable resources are not used up during a manufacturing process and are still available afterwards whereas consumable resources are either becoming a part of the resulting product or are being used up and therefore are not available anymore[36]. In the paper at hand we abstract from consumable resources, because these are not relevant in our context of e-commerce and the perspectives we present on it. The business processes that we refer to are created from a strategical perspective (top down) rather than the operational level (bottom up). Therefore the following discussed physical resources will be non-consumable resources exclusively, because the typically used consumable resources (like printer paper etc.) are considered neglectable in the authors´ approach.

[35] see [Hei88], p. 242
[36] see [SS01], pp. 89-90

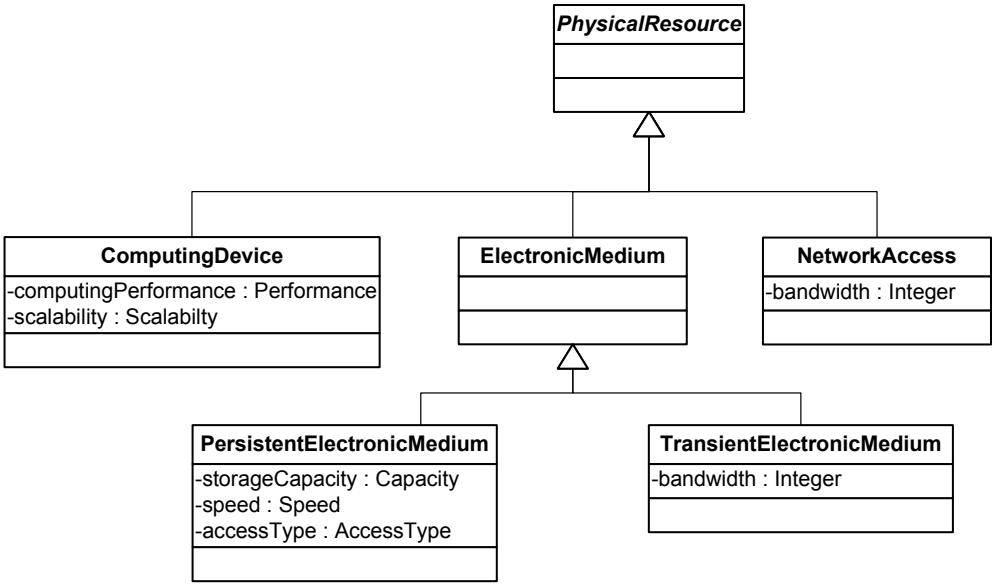

Figure 3: Physical Resources

As depicted in Figure 3 PhysicalResource is specialised in ComputingDevice, EletronicMedium and NetworkAccess. The following paragraphs explain the meaning of the meta-subtypes, their attributes and the further specialisation of ElectronicMedium as well as the associations between the different meta-subtypes (see Figure 4). Also presented are exemplary types on model-level which can be created using the language given.

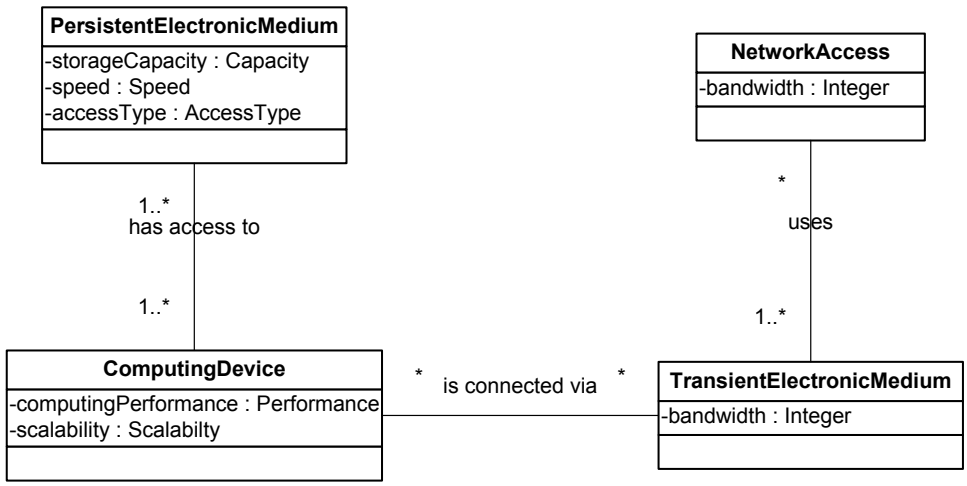

Figure 4: Associations between Physical Resources

2.3.1. Computing Devices

A ComputingDevice is a data processing unit. The assigned attributes computingPerformance and scalability of the types Performance and Scalability (see Figure 8) respectively can both have three different valid values: *high*, *medium* and *low*.
We differentiate between three kinds of computing devices: server, workstation and mobile device. This differentiation is based on different functions of computers in e-business. It does not represent concrete types of devices but their possible field of application.

The type Server is an instance of the meta-type ComputingDevice. A server in our context has to have a high computing performance and a high scalability (see below). The latter means it is to be composed modular in a way that certain key components can be exchanged without having to exchange the whole system. Of course a Server also has to hold some constraints (as do the other types), which are explained in the following.

Server

Type	ComputingDevice
Name	Server
Description	A server is a computer that offers high computing performance. Its main task is running software, storing data and offering services that can be accessed by other computing devices.
ComputingPerformance	- high performance system regarding CPU and RAM
Scalability	- high scalability for fast reaction to changed requirements
Constraints	- has to be equipped with a persistent medium (PersistentElectronicMedium) with medium to high storage capacity and high speed (depending on type of server). This will usually be one or more hard disks - has to be equipped with or connected to a device that is equipped with a persistent medium (PersistentElectronicMedium) with medium to high capacity and low speed for backup purposes. This can be a streamer tape, a DVD writer etc. - has to be connected to a transient medium (TransientElectronicMedium) with a high bandwidth (which in turn connects to some network infrastructure)

Servers could be further differentiated into database-server, web-server or application-server which all have their own performance requirements. But since in reality one server machine seldom runs just one server software, the required performance of the computing device is determined by the total amount of software that runs on it. Therefore a further differentiation does not make sense in our case and is abstracted from.

Workstation

Type	ComputingDevice
Name	Workstation
Description	A workstation is a computer that offers low to high performance and is usually connected to some network. It usually relies on the services that are offered by server devices.
ComputingPerformance	- low to high performance system regarding CPU and RAM, dependent on task.
Scalability	- medium scalability, requirements are not expected to change very sudden or often but may eventually change
Constraints	- has to be equipped with a persistent medium (PersistentElectronicMedium) with low to medium storage capacity (larger amount of data are usually stored on a server) and high speed. This will usually be a hard disk. - has to be connected to a transient medium (TransientElectronicMedium) with a low to high bandwidth

As with servers the performance that a workstation has to offer depends directly on the software that is running on the machine. Therefore further differentiation will not take place at this point and it is referred to the section 3.3 how performance values are determined.

Mobile Device

Type	ComputingDevice
Name	MobileDevice
Description	A mobile device is a small computer by its size that usually offers a lower performance than stationary devices and is required for performing tasks that are not restricted to one location.
ComputingPerformance	- low to medium performance system regarding CPU and RAM
Scalability	- low scalability
Constraints	- has to be equipped with a persistent medium (PersistentElectronicMedium) with low to medium storage capacity and low to medium speed. This can be hard disks (in notebooks), flash memory (in PDAs) etc.

Mobile devices emphasise mobility and compact dimensions and therefore usually yield a low scalability. This is an essential characteristic. The smaller the device the worse usually the scalability will be. A notebook as a concrete type of a mobile device has a lower scalability as a comparable desktop computer, but a PDA (e.g. Compaq iPaq or Casio Cassiopeia) as an even smaller device has the lowest scalability of the afore mentioned. As a result the choice of which kind of mobile device should be acquired is not only determined by the degree of

mobility but also by the expected rate of change of requirements in the future. This of course holds for all computing devices but is exceptionally crucial for mobile devices.

2.3.2. Electronic Media

The abstract meta-type ElectronicMedium is further specialised into PersistentElectronicMedium and TransientElectronicMedium. An electronic medium is a carrier of digital information. As a carrier it can store this information over an indefinite period of time (persistent) or just transport it from one device to another without storing the information (transient). In the following persistent and transient media are described in detail.

2.3.2.1. Persistent Electronic Media

A PersistentElectronicMedium is a durable storage for information. Persistence is the ability of keeping data or information even after the termination of an according application. This type of medium has three attributes: storageCapacity, speed and accessType of the types Capacity, Speed and AccessType respectively. storageCapacity can have the values *low*, *medium* and *high* and qualitatively describes the amount of data that can be stored. speed also can have the values *low*, *medium* and *high*. High speed media would be devices like hard disks, of medium speed would be CDs or DVDs and of low speed e.g. streamer tapes. It could be further necessary to differentiate between the transfer rate and the average access time of a persistent electronic medium or between read and write speed, but at the time being we use the attribute speed to describe all that properties combined in one attribute. This might change while the project advances and is therefore a possible subject to changes.
The attribute accessType can have the values *RO*, *WORM* and *RW* which stands for read-only, write-once read-many and read-write respectively. A RO-medium e.g. is a CD, a WORM-medium a CD-Recordable and a RW-medium a hard disk, a CD-Rewritable, a streamer tape etc.
The following table shows possible types of persistent media and some meaningful attribute values:

Name	accessType	speed	storageCapacity
Hard Disk	RW	high	medium to high
CD	RO	medium	medium
CD-R	WORM	medium	medium
CD-RW	RW	medium	medium
DVD	R	medium	medium
DVD-R	WORM	medium	medium
Streamer	RW	low	medium to high
Smartcard	RW	medium	low
Flash-Memory	RW	medium	low

The above list is far from complete but is just a guideline of how to create useful types of persistent media with the present language.

2.3.2.2. Transient Electronic Media

A TransientElectronicMedium transports information from one device to another without storing it permanently. This transportation – or transmission – can be cable based or wireless (radio waves). The attribute bandwidth determines the maximum speed of data transfer. It is of the type Integer and usually measured in Bit (e.g. 768 KBit or 2 MBit). The level of

abstraction that we hold here implies that a transient medium is not just the physical means of transportation of data (piece of cable, the air as the medium for radio waves). It rather includes the interface and protocol which are used to logically connect the participating communication partners. Therefore we think in terms of communicating access points that establish a WLAN instead of pure physical media.

CableBasedMedium

Type	TransientElectronicMedium
Name	CableBasedMedium
Description	Cable based media usually are network infrastructure components like BNC or Firewire.
bandwidth	- high bandwidth (e.g. > 54 MBit)

WirelessMedium

Type	TransientElectronicMedium
Name	WirelessMedium
Description	Wireless media usually are radio wave based network infrastructure components like GSM, GPRS or WLAN.
bandwidth	- low to medium bandwidth (e.g. 2-54 MBit)

2.3.3. Network Access

The meta-type NetworkAccess generally represents the ability for having access to all kinds of network infrastructures. It is counted among physical resources because it is interpreted as an aggregation of physical devices that implement the access and therefore is not intangible. Such devices would be router, modems, switches etc. which we abstract from and leave it to the user to determine which devices he wants to use for realising a required network access.
NetworkAccess has an attribute bandwidth which determines the speed of the connection to the according network. It is of the type Integer and usually given in Bit (cf. paragraph 2.3.2.2).Of course an instance of NetworkAccess would have to hold the constraint that the respective transient electronic medium - that provides the physical connection – would have an according bandwidth. An example is a connection to a 100 MBit intranet, which needs a physical connection that provides the appropriate bandwidth (e.g. Twisted Pair).
The following types of networks among others can be represented with NetworkAccess:

Type	Bandwidth	Comment
Internet	64 KBit – 32 MBit	depending on ISP
Extranet	64 KBit – 32 MBit	depending on Internet access
Intranet	1 MBit – 1 GBit	depending on technology (WLAN, TP)

2.4. Intangible Resources

As already explained in paragraph 2.1 intangible resources are resources without a physical manifestation. We specialise IntangibleResource into three different types: Specification, License and IntellectualProperty (see Figure 5). The latter is further specialised into Software and Information. The following paragraphs explain the meaning of the meta-subtypes, their attributes and the further specialisation of IntellectualProperty as well as the

associations between the different meta-subtypes. Also presented are exemplary types on model-level which can be created using the language given.

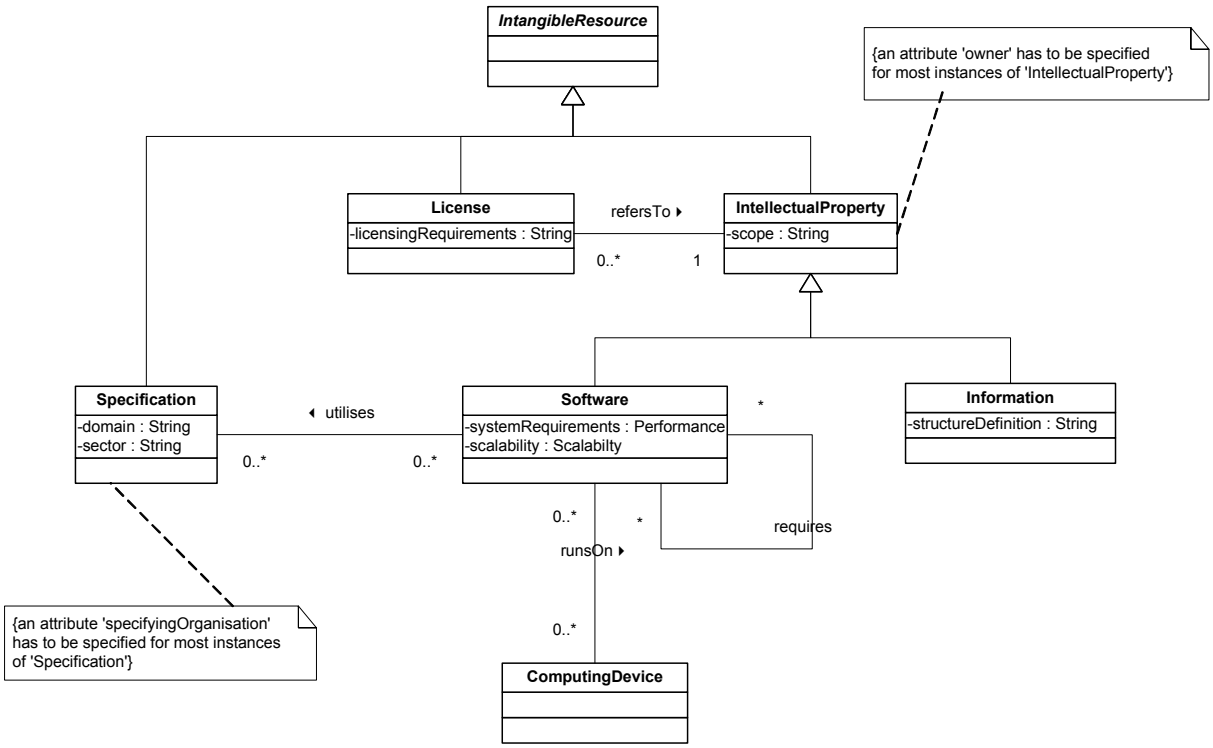

Figure 5: Intangible Resources

2.4.1. Specification

A specification (as used in the area of software engineering) usually is regarded as a written definition of a system or device, describing its structure, behaviour and possible limiting values[37]. In the context of IT and e-business we have possible specifications for hardware devices (e.g. processors, network components) as well as for software units like protocols, documents etc. Specification as it appears in our meta-model has two attributes: domain and sector of the types String respectively. The attribute domain describes which part of the real world is concerned by the specification type. This could be the storage of documents or the regulation of communication among other things. sector would be *general* if the specification type is independent of any industrial sector and would hold the name of the sector or several sectors if it is not independent.
The constraint, that most instances of specifications must provide an attribute specifyingOrganisation, covers the fact that most specifications are submitted by on or more organisation which can be tracked via this attribute. Nonetheless despite the term "must" this feature remains optional.
Possible Types of specifications are discussed below.

[37] See e.g. in [Gabl97], key word „Spezifikation".

DocumentFormat

Type	Specification
Name	DocumentFormat
Description	Describes the format (i.e. structure) which is used for storing documents on persistent electronic media. This can be a standard like XML or a proprietary format like MS Word
domain	- electronic documents
sector	- general

Possible instances of DocumentFormat:

Name	Specifying Organisation
Word	Microsoft
XML	W3C
PDF	Adobe
…	…

CommunicationProtocol

Type	Specification
Name	CommunicationProtocol
Description	A communication protocol describes the communication between two (electronic) communication partners.
domain	- electronic communication
sector	- general

Possible instances of CommunicationProtocol:

Name	Specifying Organisation
TCP/IP	IEEE
HTTP	W3C
GPRS	ETSI
…	…

PaymentMethod

Type	Specification
Name	PaymentMethod
Description	A method for transferring currency (preferably electronic)
domain	- payment
sector	- general or banking

Possible instances of PaymentMethod[38]:

[38] An overview over electronic payment methods can be found in [Bünt04].

Name	Specifying Organisation
T-Pay	Deutsche Telekom AG
paybox	Moxmo Deutschland AG[39]
m-pay	Vodafone
…	…

2.4.2. License

According to [Gabl97] a license is a warrant to use the patented property of another person in whole or part for commercial purposes[40]. Therefore we can interpret a license as the right to use the intellectual property of other persons or organisations, which is protected by law. Examples can be licenses for using software (software license) or reproducing processes. Licenses can be granted for free (e.g. GNU General Public License[41]) or acquired for a fee (license costs).
The meta-type License has one attribute licensingRequirements, which is of type String and describes conditions under which the license can be acquired. This could be general information about the price of a license or the possibility of use in commercial environment.
License is associated to IntellectualProperty, which is described in the next paragraph. This indicates that intellectual property like software or information can be licensed by a company.

2.4.3. Intellectual Property

A general meaning of the term *intellectual property* is given by the following definition: "intellectual property is any product of the human intellect that is unique, novel, and unobvious (and has some value in the marketplace)"[42]. According to the WTO (World Trade Organisation) "Intellectual property rights are the rights given to persons over the creations of their minds. They usually give the creator an exclusive right over the use of his/her creation for a certain period of time."[43] Credited as intellectual property can be inventions, copyrightable works, trademarks and discoveries among other things. Most organisations and nations have different laws to protect intellectual property but this fact is not part of the focus of our paper.
The meta-type IntellectualPoperty has one attribute scope, which is of type String and can hold the scope of the property. This relates to the typical area or period of validity regarding the protection of the intellectual property. The above mentioned invention, trademarks etc. are possible types of IntellectualProperty on model-level.

2.4.3.1. Software

Software in terms of a set of programs that run on a computer hardware is a key resource in the process of supporting e-business processes. It comprises the business logic on application level and provides a basis for the complete IT- infrastructure on system level. The meta-type Software in our meta-model has two attributes: systemRequirements of type Performance and scalability of type Scalability. Both attributes can have the possible values *low*, *medium* and *high*. These attributes directly correspond to the attributes

[39] Moxmo took over the insolvent Paybox AG in 2003 and continued the payment system invented by Paybox.
[40] In German: "Die Befugnis, das (patentierte) Recht eines anderen (partiell oder insgesamt) gewerblich zu benutzen, …" key word „Lizenz".
[41] This license is granted by the Free Software Foundation (www.fsf.com).
[42] E.g. to find on the web-pages of the University of Texas in Arlington, Office of Technology Transfer (http://www.uta.edu/tto/ip-defs.htm, January 29, 2004).
[43] http://www.wto.org/english/tratop_e/trips_e/intel1_e.htm, January 29, 2004.

performance and scalability of ComputingDevice which implies some constraints that must be heeded (see tables below). Also it is possible that some types of software directly require some other type of software which is also to be accounted for. As an example we may give an office suite that will not work without the proper underlying operating system.
In the following we give some examples for software types.

Client Operating System

Type	Software
Name	ClientOperatingSystem
Description	Basic software that works as a mediator between the hardware and the application software on a client computer.
systemRequirements	- medium
scalablity	- low

Examples: MS Windows XP, Linux, MacOS

Server Operating System

Type	Software
Name	ServerOperatingSystem
Description	Basic software that works as a mediator between the hardware and the application software on a server computer.
systemRequirements	- high
scalablity	- medium to high

Examples: MS Windows 2000 Server, Linux

Personal Database Management System

Type	Software
Name	PersonalDBMS
Description	Database Management System mainly for single user operation
systemRequirements	- medium
scalablity	- low to medium

Examples: MS Access, Personal Oracle 8i

Server Data Base Management System

Type	Software
Name	ServerDBMS
Description	Database Management System for server-based multi user operation
systemRequirements	- high
scalablity	- medium to high

Examples: MS SQL Server, MySQL Server

Web-Server

Type	Software
Name	WebServer
Description	Server-based software for hosting websites and establish a web-presence
systemRequirements	- medium to high
scalablity	- medium to high

Examples: Apache, MS Internet Information Server

Office Suite

Type	Software
Name	OfficeSuite
Description	Client-based bundle software usually including word-processor, spreadsheet program, basic graphics program etc.
systemRequirements	- low to medium
scalablity	- low

Examples: MS Office Suite, Star Office Suite

2.4.3.2. Information

The meta-type Information was created to represent information or knowledge that is relevant in the context of e-business. It has an attribute structureDefinition of type String which describes how the information is structured and documented and therefore serves as a means of differentiation. Examples for information are certain customer data or enterprise knowledge of some kind.

3. Advanced Concepts for Resources

Chapter 2 predominantly focuses on the presentation and specification of different types of resources in e-business-related processes. Only core concepts are given at the meta-model-level as well as on the type-level. Prototypical instances are mentioned as examples for the different types given. The context of resources as well as the relationships between resources or between resources and their context are abstracted from. Associations between resources will be presented in the following section 3.1. External partners for e-business are outlined in section 3.2. Finally, the special composed resource Solution is being introduced.

3.1. Associations between Resources

Usually, not only a single resource is assigned to a business process but plenty of different resources. Additionally there might be relationships between resources, also regarding different views. Examples for relationships between resources are:

Relationship	Description
IS-A	The IS-A-Relationship (resource B is a special kind of resource A) connects a more specific resource (B) with a more general resource (A).[44]
Requires	Resource A requires a resource B: If A is required for the execution of a process also B will be required. I.o.w.: The availability of A depends on the availability of B. [45]
Composition	Resource C is composed of other resources A_i(i=1,..,n). While the requires-relationship only addresses a loose coupling between resources, the composition is stronger. The concept of composition comprises existence-dependency and exclusivity. Existence-dependency means, that the existence of a part depends on the one of its composite. If C is removed also all A_i(i=1,..,n) will be deleted. Exclusivity correlates to the fact, that one resource can only be part of one and only one composite. It can't be shared between several composites.[46]
Substitution	Resource A may substitute resource B if in every occurrence of B also A can be used. [47]

The examples for relationships between resources given above all correspond to general relationships between any to kinds of resources. Additionally there might be relationships for special types of resources (e.g.):

- Software *runs on* a computer platform
- A computer *needs* a special administrator
- Financial transactions *require a secured* channel

Generally, there are a lot of different relationship types between resources of different levels of abstractions. Hence, in our first, preliminary language for the modelling of e-business-resources, we define a generic association (cf. Figure 6). This generic association (ResourceAssociation) has a character string representing its name (qualifier) and to ends

[44] cf. [PSO99, pp. 4]
[45] cf. [PSO99, pp. 4]
[46] Composition of resources is presented in [PSO99, pp. 4] (called Whole-Part-Relationship). One example for the semantics of the composition-relationship is given in [SeGu99, pp. 52].
[47] cf. [BL91, p. 105] and [Ker88, p. 127]

(*AssociationEnd*). Each association end is correlated to exactly one association and one resource (AbstractResource) and might define the resource's cardinality and role regarding to the association.

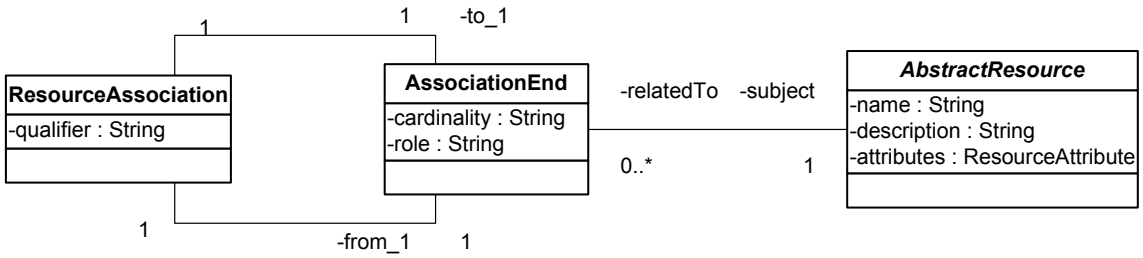

Figure 6: Relationships between Resources

3.2. External Partners

Usually, e-business-processes not only require internal resources but they also need services offered by external partners. At first view, an external partner, i.e. the services he provides, seems to be equivalent to a resource seen from the company´s perspective: The external partners´ services may be subject to scarcity as their usage generates costs. Nevertheless, external partners yield at least one major difference to internal resources: They are independent organisations and cannot be accessed and controlled like internal assets. Therefore they usually require a different handling. In our context of e-commerce we consider an external partner as a representative for the corresponding service offered on the market.
The meta-type ExternalPartner has two attributes name and description as well as an association with BusinessProcess which allows expressing a relation of an external partner with a business process without the necessity to assign the external partner to a solution.
Some examples for external partners will be given below. Additional attributes will be left out if not applicable. The context of ExternalPartner in the meta-model is depicted in Figure 7.

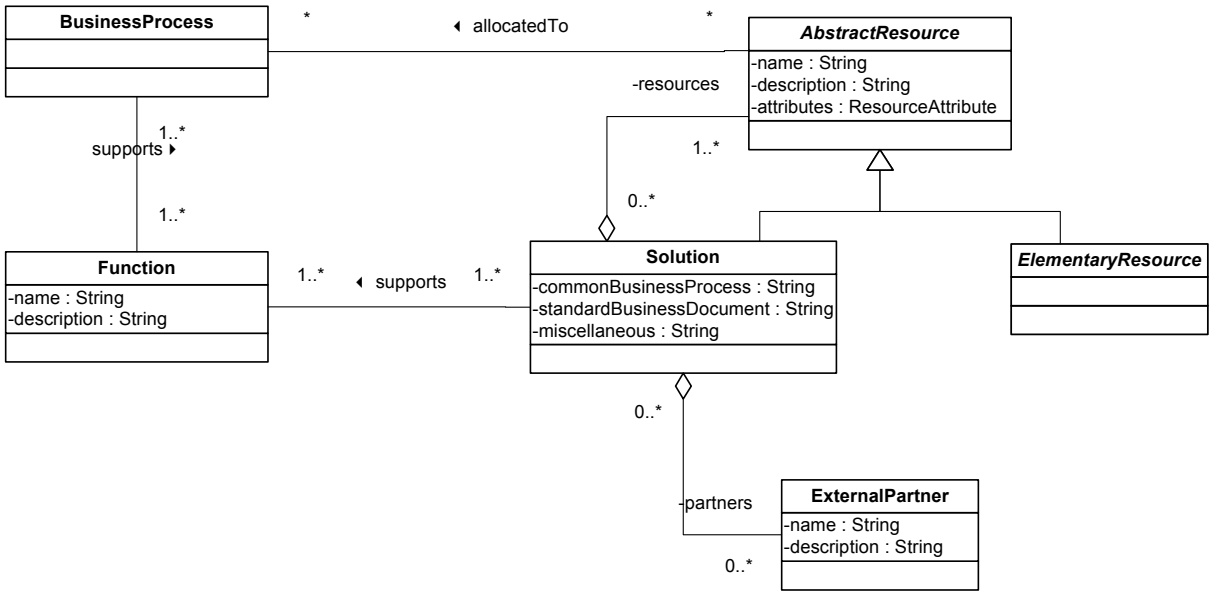

Figure 7: Language Specification for ExternalPartner and Solution

Provider

A special external partner is the internet-provider, which realises a company's access to the internet. An internet provider *provides* (sometimes) hardware and a physical connection to a world wide internet infrastructure.

Type	ExternalPartner
Name	Provider
Description	A provider is an external partner which provides access to the internet.

Hoster

A *hoster* provides, manages and administrates servers for its customers. He rents buildings and installs standardised computers with an external interface to the internet. Its services comprise the provision of server capacity, persistent memory and network bandwidth. Generally speaking, a hoster may replace an in-house server-parc. All responsibility for installation and maintenance is the task of the hoster.

Type	ExternalPartner
Name	Hoster
Description	A hoster is an external partner which provides server computer capacity.

Financial Partner

E-business does not only emphasise the exchange of goods and services but also electronically supported payment. A company can either implement its own department for the collection of debts or transfer its liabilities to an external partner.

Type	ExternalPartner
Name	FinancialPartner
Description	A financial partner is responsible for the transfer of monetary values. There might be external partners which take on the financial liabilities for a company.

Clearing Center

A Clearing Center is a service provided by a third organisation that hosts standardised (in the scope of the center) data of enterprises and their business partners. An important part of being user of Clearing Center is that a certain terminology (document content and structure) is being held. This ensures an efficient communication between all business partners.

Type	ExternalPartner
Name	ClearingCenter
Description	A Clearing Center provides an infrastructure for the standardised communication with business partners.

Logistical Partner

A logistical partner is responsible for the distribution of goods from the company to the customers. Generally, a logistical partner focuses on physical goods and plans the distribution (route planning as well as intermediate storage sites) of prefabricated goods.

Type	ExternalPartner
Name	LogisticalPartner
Description	A logistical partner provides services for the distribution of goods.

3.3. Solutions

A solution is a special type of resource comprising abstract resources and external partners. Every solution is a subclass as well as an aggregate of abstract resource. It therefore inherits the attributes name and description and encompasses all kinds of elementary resources. Additionally, every solution helps to support a business function (class Function in Figure 7), which might be directly correlated to a business process. A function may also correspond to an enterprise strategy on operational level as described in [FrLa04b] or an activity as part of a business process as in [LaFr04]. Additionally a solution includes a textual description of related business processes (commonBusinessProcess), standardised business documents, which can be used in the solution's context (standardBusinessDocuments), and a text-field for miscellaneous remarks (miscellaneous). More concrete examples for solutions will be described in chapter 4.

4. E-Business Solutions

A solution – as described in the above chapter – aggregates several types of resources to a higher-level concept. This enables the modeler during the process of documenting the resource requirements of business processes to refer to "resource bundles" that support a task rather than just enumerating single resources. A solution also can serve as a template for preparing and providing exemplary solutions (or reference solutions) which can further simplify documentation. A template for the documentation of a business process in e-business is presented in [FJK04]. The solution as described in this chapter is a part of this template. Its document structure is derived from the structure of the meta-model and appears as follows:

Solution

- Supported Functions
- Human Resources
- Physical Resources
    - Computing Devices
    - Electronic Media
        - Persistent Electronic Media
        - Transient Electronic Media
    - Network Access
- Intangible Resources
    - Specifications
    - Intellectual Property
        - Software
        - Information
    - Licenses
- External Partners
- Additional Information
    - Common Business Process
    - Business Document
    - Miscellaneous

A thus defined solution can possibly be looked upon as an architectural description on a high level of abstraction since it resembles some definitions of architecture[48]. A solution provides - just as an architectural description - the documentation of information system components and their relations with each other among other things. Therefore it also aims at giving assistance in planning and implementing an information system. Nonetheless we prefer the point of view that a solution can be a part of an existing architecture specification. This for example applies to the below internal web-server solution which can be regarded as a component in a web architecture like the three-tier-architecture.
An exemplary description of a solution that supports an e-business process is showed in the following table:

[48] A general definition of the term *architecture* can be found in [Jung00], p. 27.

Solution: Internal Web-Server Solution

Meta-Type	Types	Comments
Function	• Establish web presence • Gather potential customer data	
HumanResource	• Web Administrator • Web Developer • System Administrator • Operative Employee	These are roles, not concrete persons.
ComputingDevice	• Server • Workstation	Number of servers depends on expected load. Additional servers can allow load balancing. Number of workstations depends on the number of employees assigned with the web solution.
PersistentMedium	a) Backup storage: WORM or RW b) Fast and safe RW storage	A possible instance for a) would be a streamer, for b) a RAID system
Transient Media	Cable Based Media	Cable based networks recommended due to minimal mobility needs and lower costs
NetworkAccess	a) Internet b) Intranet	A possible instance for a) would be T1, for b) Fast Ethernet
Specification	• HTTP, HTTPS • SQL	SQL dialect depends on selected DBMS
IntellectualProperty		
Software	a) ServerOS b) Web-Server c) Application-Server (optional) d) DBMS	Possible instances would be: a) Linux, Windows Server b) Apache, MS IIS c) Tomcat, ZOPE d) MySQL, DB/2
Information	Customer information	Concrete customer information can be the customer address or the customer profile
License		Software under GNU Public License (GPL) is free and might be preferred regarding economic aspects (e.g. Linux, MySQL, Apache, …)
ExternalPartner	Provider	Internet Service Provider (ISP)

Additional Information	
Common Business Processes	*Request Account Setup* (RosettaNet PIP 1A1) *Maintain Account* (RosettaNet PIP 1A2) …
Business Documents	EDIFACT: *PARTIN* X12: *838* BOD: *007_sync_customer_004*
Miscellaneous	-

The above tabular description deals with resources that are required by a company to establish some web presence and gather information about potential customers (like addresses and customer profiles. As the technical backbone one ore more computers that work as servers and one more computers as workstations will be required. Advice on the network infrastructure (intranet and internet), expedient software - including licenses - as well as utilised standards is given. Also required human resources (in form of roles) are described and the necessity of an external partner (ISP) is stated. As additional information are regarded obvious similarities or relations with common business processes[49] and the possible exchange of standardised business documents[50]. These aspects should also be adhered to because they contain possible information that has some influence on the decision for or against additional information system components (e.g. an EDIFACT converter). Finally any additional comments or facts that do not fit into the other categories are listed in the miscellaneous column. This may include a hint to critical relations between resources not mentioned in any other field, risks connected with certain technology, an estimated implementation expense or other important information.
The above tabular structure can be used as a template for the documentation of resources of ECOMOD reference business processes and published as a part of the overall process documentation.

[49] As listed in [OASI01]. According to OASIS a common business process is defined as "industry neutral and re-usable business processes." ([OASI01], p. 6). Similarities to

[50] As defined in the specifications of UN/EDIFACT (http://www.unece.org/trade/untdid), (ASC) X12 (http://www.x12.org) and OAG BODs (http://www.openapplications.org) among others.

5. Summary and Future Work

The main purpose the paper at hand serves is to create the means to document resource requirements of e-business processes. Therefore in chapter 2 we introduced, after an introductory motivation in chapter 1, a concept for modelling resources in that special context. The basic resource categories described here include *Human Resources*, *Physical* and *Intangible Resources*. Exemplary types of the resource meta-types are given. Additionally we present possible instances of several of the types. Chapter 4 deals with advanced concepts of resource representation and starts with a discussion of the possible associations between resources. Thereafter we introduce the concept *External Partner* and – as the primary means of documentation – the concept *Solution*. A solution basically is an aggregation of resources and external partners and therefore describes *bundles* of resources that are can be used as a combination to support certain functions and business processes. The syntax of such a documentation is provided via an example in chapter 4.

At this point we are able to define and describe the required resources of an e-business process. The level of abstraction that we hold will allow us to give recommendations to a company who wants to get into e-business or invent new processes in that area regarding the required resources. Of course it is possible and rather likely that changes in the meta-model will be conducted due to the experience gathered during the process of creating business process models in ECOMOD. This will have further impact on the language and possibly enforce some rethinking of certain concepts. Such changes will be documented in future papers.

What is still missing and could be instrumental in documenting larger systems is a notation for the visual representation of resources and their associations to each other. This will also be subject – along with a catalog consisting of reference solutions (resource building blocks) that allow a quick documentation of processes – of succeeding papers.

Appendix

Figure 8 shows the support types that are used as types of attributes by many of the types in the meta-model of our language.

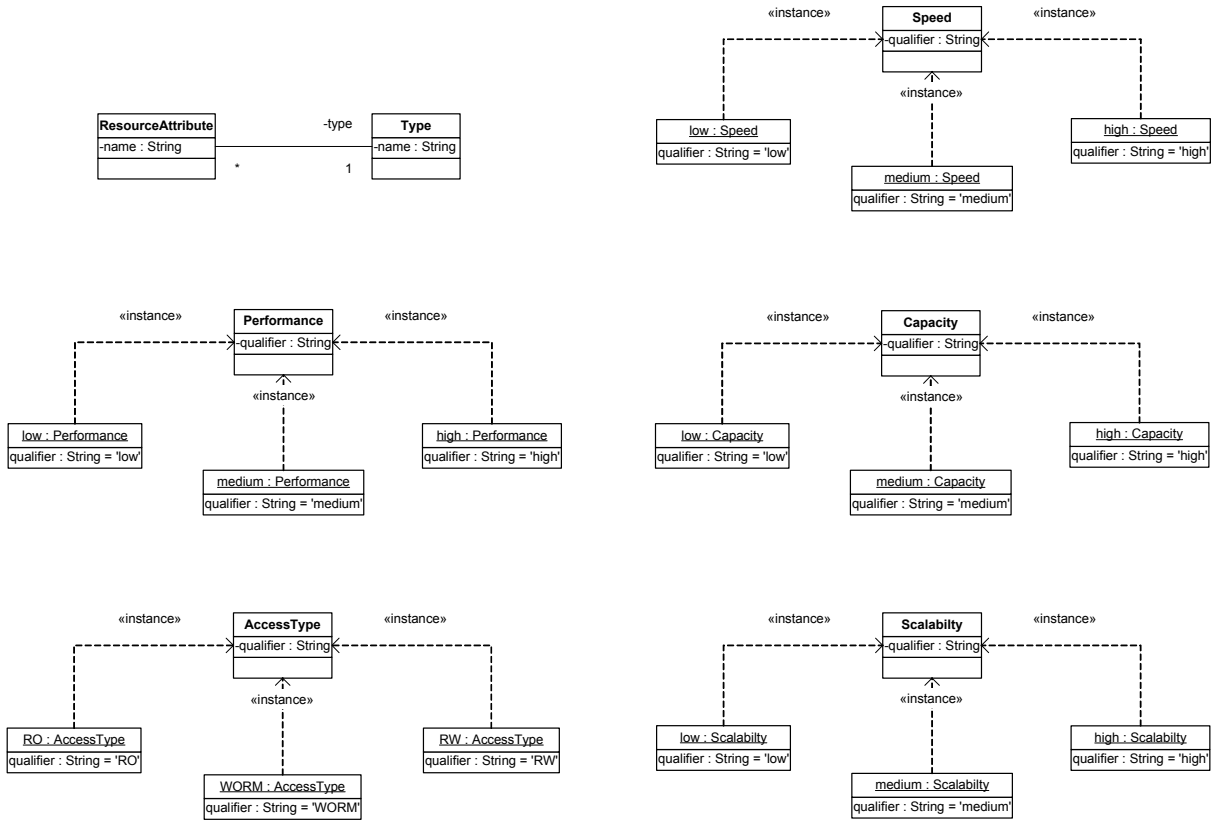

Figure 8: Support Types

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