Personalised Customer Interaction for the Configuration of Products and Services in a Supply Chain

Ralph SCHÄFER[1], Wilken SCHÜTZ[2], Xavier CEUGNIET[3], Jonathan MITCHENER[4], Liliana ARDISSONO[5], Anna GOY[5], Markus ZANKER[6], Dietmar JANNACH[6], Alexander FELFERNIG[6], Rossana SIMEONI[7], Roberto GAVAZZI[7]

[1] DFKI GmbH, Saarbrücken, Germany, Tel: +49 681 302 5264; Fax: +49 681 302 5264; Email: Ralph.Schäfer@dfki.de

[2] DFKI GmbH, Saarbrücken, Germany, Email: schuetz@dfki.de

[3] ILOG, France, Email: ceugniet@ilog.fr

[4] British Telecommunications plc, Great Britain, Email: Jonathan.Mitchener@bt.com

[5] Università degli Studi diTorino, Italy, Email: {liliana, goy}@di.unito.it

[6] Universität Klagenfurt, Austria, Email: {markus, dietmar, alf}@ifit.uni-klu.ac.at

[7] Telecom Italia Lab, Italy, {Rossana.Simeoni, Roberto.Gavazzi}@tilab.com

Abstract. Within CAWICOMS a configuration workbench for customisable products and services will be developed which will have the following advantages versus current commercially available configuration technology: It will automate over the Web the skills of salespersons by developing adaptation and personalisation technology for inclusion in Web based configurators. The interaction with the user will be tailored according to his/her skills and needs. CAWICOMS will enable integration and collaboration of distributed Web based configurators, thus supporting suppliers which use customisable products and services of their sub-suppliers.

The prototype will be demonstrated in two domains: In the configuration of IP-VPNs the customer specifies his/her needs regarding a virtual private network. In another application, telecommunication switches (including end-user devices) have to be configured. CAWICOMS will have benefits both for customers (who will be able to better specify their needs and to select the most appropriate solution) and for suppliers (who will get support for their co-operation along the supply chain).

1. Introduction

The focus of CAWICOMS[i] is to enable businesses to market complex customisable products and services by the new methods of e-commerce (cf. [4]). Within CAWICOMS, the technology will be developed for a) configurators that will be able to deal simultaneously with multiple suppliers over a network, to interact with other configurators as well as with component catalogues and b) Web based human computer interaction that will be able to adapt the interaction according to the skill-level, preferences, and needs of the customer (also called the user). The goals of CAWICOMS are as follows:

- *Enabling Integration and Collaboration of Distributed Web Based Configurators:* Currently, most of the available Web configurators are stand-alone solutions, which are not connected to other configurators.

  In CAWICOMS, we will develop techniques and will implement a configurator prototype that will be able to co-operate with existing configurator applications and external product or component catalogues over a network (e.g. the Internet). The benefits will be easier purchasing and shorter response times for the customers as well as products that better match their needs and preferences.

- *Providing adaptation and personalisation of user interactions with configurators:* Current configurators offer only one standard user interface and interaction styles that cannot adapt flexibly to the customers' different needs and skills. Consequently, their user interfaces are either simple, but cannot take advantage of all customisation possibilities; or they are too complex and cannot be used by inexperienced customers. In CAWICOMS the problem is even more striking, because the potential complexity of the interaction will increase. CAWICOMS will identify the users' skills and needs and support them in finding the product or service that yields the maximum customer satisfaction by personalising the interaction.
- *Developing a prototype configurator workbench:* The implementation of a prototype will demonstrate that the developed techniques can be combined and applied to realistic e-commerce contexts, i.e. they are not restricted to one application domain. The prototype will be applied to two different business scenarios which will be described in the following.

2. Guiding Application Scenarios

2.1 Guiding Application 1: Configuration of IP-VPNs

One of the guiding application scenarios chosen within the project is the ordering, provision and configuration of Internet Protocol – Virtual Private Networks (IP-VPN). This was chosen from an industrial perspective for a number of reasons. First, true IP-VPNs represent a service which has a reasonably long expected life. It is important that the case study is still relevant by the time the research is completed and results actually appear in deployable products. Secondly, it was important to identify a service rather than a product to apply configurator technology, in order to stretch the capabilities required as well as to ensure that the differences between product and service are catered for – which is important for the communications service provider industry.

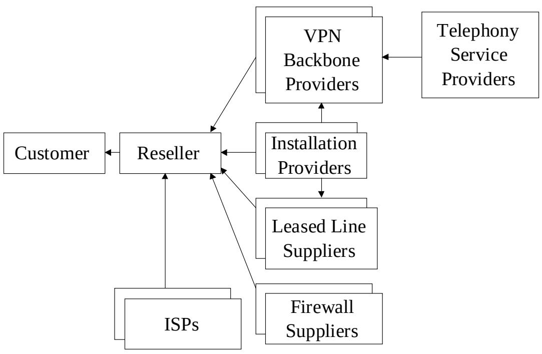

Figure 1: Typical IP-VPN supply chain

The basic IP-VPN scenario involves customers purchasing VPNs from an integrator/reseller. The customer's networks manager sits down with a reseller technical sales person in front of their VPN configurator. Together they use the configurator's input screens to specify the requirements. A number of parameters are required, (e.g. the geographic addresses involved). The selected type of VPN also determines which information is required (e.g. managed firewall solution or a direct link to the VPN backbone). Other overall information to be supplied will include, e.g. a connectivity matrix and service level guarantees (uptime as a percentage of the year, time to repair). The configurator then needs to devise a solution by utilising a complex supply chain of the sort shown in Figure 1.

2.2 Guiding Application 2: Configuration of Telecommunication Switches

The second application domain is telephone switching systems. Here, we consider two uses of these electronic systems, switching telephone connections in both public networks and in private enterprise networks. Such systems consist of modules plugged into frames that are mounted on racks. Cables connect the modules and frames, resulting in a network topology imposed on top of the hierarchical physical structure. In addition, several external hardware components and subsystems such as PCs or routers are connected to the switching node. Further the functionality of the system depends on a set of software applications that are installed on the hardware. Therefore, the whole system can be decomposed into subsystems that are supplied by different organisational units or independent companies.

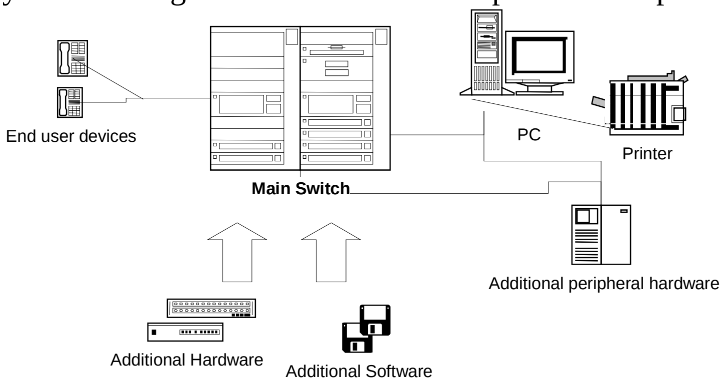

Figure 2: Outline of a telecommunication switch

3. Architecture

The main component of the CAWICOMS system is the *CAWICOMS Configuration Server* which consists of two parts: The *Frontend* is responsible for the personalised interaction with the user (see Section 3.1). The *Backend* provides distributed configuration problem solving functionality (see Section 3.2).

3.1 Frontend: Personalised Interaction with the User

The Frontend performs the following activities: Management of user models specifying the individual customer's characteristics; provision of personalised defaults to carry out the configuration process without asking the user about all the configuration parameters; dynamic generation of the user interface pages (created on-demand, by exploiting suitable personalisation strategies for the generation of questions and for the presentation of the configuration solutions); management of the interaction between Frontend and Backend; and translation of the user-oriented knowledge about products and services into a more technical, configuration-oriented perspective, exploited within the Backend.

Management of the user models. The characteristics of the individual user are estimated by observing his/her behaviour during several configuration sessions. Bayesian Networks (BN) (see [3]) are used as an inference mechanism to estimate user's characteristics relevant for the personalisation of the interaction, i.e. *knowledge* and *interests*. In an idealisation, we ascribe *Multi-Attribute-Utility Theory (MAUT)* (see [1]) as evaluation process to the user. In this way, the configurable artifact can be characterised by a set of high-level properties (that we call *dimensions*), depending on its technical characteristics. The user’s interests and knowledge about such dimensions can then be exploited as a high-level, compact description.

During a configuration session, user actions such as asking for help on a configuration parameter, or setting a value for a configuration parameter, are fed to a BN as (negative or positive) evidence to estimate the user’s domain knowledge. Similarly, BNs are used for estimating the user’s interests on the basis of their configuration choices and of their reactions to the system’s proposals (e.g. the user may accept/reject certain solutions or change a parameter value).

Personalisation of the user interface. The customisation of the user interface is based on the use of personalisation rules, represented within a rule-based system (ILOG JRules). As the user interface is dynamically generated during the interaction with the customer, the level of detail addressed during the configuration process can be adapted to the most recent hypotheses about his/her knowledge and interests.

Several aspects of the interaction can be customised: For instance, the layout of the interface, the amount of information to be displayed and the type of questions asked for. As far as the last issue is concerned, the user model and the dependencies among user interests for dimensions and the related configuration parameters (as provided by the Domain Ontology) are used to predict the user’s configuration choices and limit the number of questions to them. Given a partial configuration solution, the system identifies the configuration parameters that have not yet been set. Then, it invokes the rule-based system to identify the appropriate strategy for filling in the parameters. The personalisation rules discriminate among various alternatives - for instance, asking the user a direct question (e.g. because the parameter is too critical to be set by the system), or using a personalised default. Personalized defaults support a targeted assignment of values, depending on the user’s characteristics (e.g. nationality), or on his/her interests for product dimensions. The user is also able to manually define personal default values, which of course override the default values estimated by the system. Finally, indirect questions can be exploited when the predictions of the user model are too uncertain enough to support the use of defaults. In this case, the system can ask questions about concepts more abstract than the configuration parameters to be filled in, or about related product dimensions. Depending on the user’s answer, a suitable parameter value will be applied.

3.2 Backend: Distributed Configuration Problem Solving Functionality

The main component of the *CAWICOMS Backend* provides functionality for the distributed problem-solving task. At the main vendor's site a configurator with facilitation capabilities is located that has an integrated view on the supplier's products. Note, that this integrated view only contains relevant portions of the supplier's product structures and is constructed during the knowledge acquisition phase based on common ontological concepts. The CAWICOMS Backend processes requests (e.g. selection of options or initiation of compatibility checks) entered by the user and provided by the CAWICOMS Frontend. When a request for a configuration solution is entered, the facilitator initiates the distributed problem solving process and contacts the supplying configurators if needed.

From a technological point of view the following techniques are applied in our framework. We use and extend the state-of-the-art industrial configuration library ILOG Configurator (cf. [2]) as the basis for the distributed problem-solving component. We extend it with a modular component that enables the communication of partial configurations and configuration requests to the suppliers. Furthermore a generic layer is developed that facilitates the exchange of complex data structures (that are typically used in the configuration domain, e.g., partial configurations). The exchange of information can be done both in terms of JAVA data structures as well as by means of XML documents. In addition, this layer not only defines a protocol for data exchange (e.g., passing user choices or partial configurations) and also for method invocation, e.g., initiation of the solving process. This data-exchange layer and protocol are used both for the communication between configurators along the supply chain and for communication to the Frontend. This means that the individual components of the CAWICOMS Configuration server (e.g., the configurator at the main vendor site or even the user interface generation component) can be replaced by other tools Finally, the option to exchange XML documents using a protocol between co-operating configurators allows easy integration of existing configurators at the supplier's site.

3.3 Example Scenario

In this section, a simple example shows a CAWICOMS configuration session. It illustrates the workflow within the system.

During the *initialisation phase* the user browses through a catalogue of (configurable) products using a B2B/ERP platform. As a consequence of placing a configurable item into the shopping cart, the Frontend receives the request to configure this item. Then the user is identified and may be asked some questions in order to provide the system with information needed to initialise the user model. The user is categorised in a stereotypical user class. Based on the User Model and the information about the product, an adequate personalisation policy is determined. In the *product parameters specification phase* the Frontend specifies the values of the parameters necessary for starting the configuration. The Frontend decides whether

- to use user preferences (estimated based on interests stored in the user model),
- to use default values (stored, e.g. in the form of rules), or
- to ask the user.

Dependent on the user behaviour during this phase, the User Model is updated. In the next phase, the *configuration phase*, a configuration request is sent to the Backend which begins a configuration process. The *Distributed Problem Solving Component* (DPSC) is responsible for the co-ordination of the distributed problem solving process and forwards local configuration requests to the *Configuration Engine (CE)*. The CE calculates a local solution and returns the result to the DPSC. The DPSC investigates the local results and retrieves a set of suppliers which must be contacted in order to provide a configuration of the relevant supplier parts. Thereafter the DPSC calculates requests (from the local solution) which are communicated to the supplier configurators.

If one of the supplier configurators has a response time exceeding real time requirements, the current configuration context is stored and the Frontend is informed about this delay. The Frontend informs the user about the delay and later notifies them, e.g. by email, when the process can be resumed.

After the Backend has calculated a partial configuration, this result is passed to the Frontend and the Frontend determines a set of parameters which still must be instantiated. The Frontend elicits the parameters as described above. Then, a configuration phase starts again.

When all parameters are instantiated, i.e. the Backend has calculated a complete configuration, this result is passed to the Frontend and the *presentation and feedback phase* starts. Here, the Frontend starts a personalised presentation of the results. The user gives feedback on the solution. If the user agrees with the solution and decides to order the product, the ordering phase starts. Otherwise, some parameters have to be changed and the configuration phase is started again. Finally, in the *ordering phase***,** the configurator passes the information (selected features or bill-of-materials) to the underlying *B2B/ERP platform* which generates a purchase order.

4. Benefits of CAWICOMS

CAWICOMS will have benefits both regarding the user interaction and also the for the configuration process and result. These benefits will be explained in the following with respect to the guiding applications.

4.1 Benefits regarding the telecommunication B2B context

In the telecommunication B2B context (such as the selling of telecommunication switches) competition is continuously increasing, and the Internet is an important selling channel for telecommunications wholesale markets. A proper portal for e-selling can probably lead to revenue increase and cost reduction.

The main current problem in implementing a sales portal for telecommunication wholesale services is the complexity of the services offered. This complexity, derived from many different service choices and prices can confuse the customer and typically it takes a long time and much human interaction between sales engineer and customer to understand the real needs and to find the right solution. This increases the sales cost for the telecommunication companies (*telcos*) as well as the purchase cost for the customer. It is also possible for a customer to end up buying a service that is not really the most suitable for their needs.

So a configurator which actively supports the during the selection (pre-sales) phase represents a dramatic improvement by improving the probability that the service bought is really what the customer needs and by reducing the time spent in the pre-selling phase both for customer and telco. This means a high level of customer satisfaction implying a higher customer loyalty increasing the chance to perform up-selling and cross-selling (very important for telecommunication wholesale services). The consequences are *low churn rate*, *revenue increase*, and *higher competitiveness*. Another expected benefit is the increase in market share attracting more new customers. This is possible since customers often select an offer (and consequently a telco) simply on the grounds of perceived suitability rather than just price.

In conclusion, from industrial point of view, telcos today have a regard the Web as a higher priority channel and an important way to increase sales revenue. To achieve this result improvements like the adaptive Web interface developed within CAWICOMS are cruicial The current immaturity of e-commerce in the telecommunications wholesale market precludes a quantitative estimation of expected revenue increase and cost reduction.

4.2 Benefits regarding the configurations of IP-VPNs

As already hinted in the section that describes the IP-VPN Scenario, current configurator technology focuses on traditional products (e.g. cars or bicycles) rather than providing and configuring services. Services are different in a number of fundamental ways. Firstly, they are continuous in nature: the provider doesn't simply manufacture the product and then deliver it and leave the customer to use it. For a service, the provider is typically involved throughout the use of it by the customer. There are continuous parameters associated with services such as service quality for example. Configurator technology for services therefore needs to accommodate the configuration of such things as Service Level Agreements (SLA) for example. Secondly, a service such as IP-VPNs is likely to be provided from a number of suppliers in perhaps quite a complex supply chain where requirements are in terms of dynamic components (e.g. bandwidth availability) rather than from static components.

These components may be priced by availability for example, compared to the simple look-up type price list often associated with traditional product based configurators.

CAWICOMS is helping advance the development of configurator technology so that it becomes more relevant to many more uses within applications which are important to service provider organisations. However these are complex configuration problems and so any progress along the way is an important step. The other area where CAWICOMS can assist in this domain is that of involving the customer in the provisioning process to a greater extent by simplifying the complex issues associated with specifying the parameters for an IP-VPN service, for example. Customers will generally understand the geography of their sites and the uses to which they wish to put their IP-VPN, but will be unconcerned with the details of what parameters should be set to achieve this. Both of these requirements on CAWICOMS are quite stretching compared to the ability of today's configurator examples and so we expect the project to begin to make progress on them rather than to provide a complete solution.

If progress can be made, the benefits to service providers include deskilling of the service provision process and more significant customer involvement in the process. These both help to reduce the costs of providing such services. Satisfaction of customers generally increases as they are involved with the process, since for example they may get a faster response.

5. Conclusions

CAWICOMS is aimed at the next generation of electronic commerce solutions for customisable products and services. Techniques both for enabling integration and collaboration of distributed Web based configurators and providing adaptation and personalisation of user interactions with configurators will be developed.

In this way, CAWICOMS will have benefits both for customers and suppliers: Personalisation will help consumers to better specify their needs and to select the most appropriate solution when buying goods and services over the Web than today. CAWICOMS also contributes to supplier co-operation along the supply chain by addressing the interoperability of product configuration. Since services are also considered, the proposed solution widens the application configurators to co-operating service providers rather than just product suppliers.

References

[1] Winterfeld, D. von and Edwards, W. (1986). *Decision analysis and behavioral research*. Cambridge, England: Cambridge UniversityPress.

[2] Mailharro, D. A Classification and Constraint-based Framework for Configuration, AI EDAM, Vol. 12 (1998), Cambridge University Press, 1998.

[3] Pearl, J. (1988). *Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference.* San Meteo, CA: Morgan Kaufmann.

[4] CAWICOMS Consortium (2000). *Deliverable D01 - Requirements, Application Scenarios, Overall Architecture, and Test Specification.* Available via http://www.cawicoms.org

---

[i] CAWICOMS is the acronym of "**C**ustomer-**A**daptive **W**eb **I**nterface for the **Co**nfiguration of Products and Services with **M**ultiple **S**uppliers". This project is being supported by the EC through its IST-Programme under contract no. IST-1999-10688.