Designing and Modelling B2B-Markets

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Abstract

The traditional way of making business has dramatically changed due to the progress of the information technology in last two decades. These changes were coupled with new kind of freedom in respect of time and place for making business and with a number of advantages like reduction of search costs, increase of efficiency, and overall reduction of transaction costs. However, creating suitable market models is a time-consuming, costly, and risky task that is hardly supported by standardized modelling methods. This paper presents a market modelling language and a generic trading platform. They support the generation and research of new computer supported market models by improving the market modelling task through supporting the communication between stakeholders and by providing expressive constructions for market modelling.

Keywords

market modelling, B2B-markets, generic trading system, market modelling language, auction

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Introduction

The traditional way of making business has dramatically changed due to the progress of the information technology in last two decades. These changes were coupled with new kind of freedom in respect of time and place for making business and with a number of advantages like reduction of search costs, increase of efficiency, and overall reduction of transaction costs (Bakos 1991, Bakos 1998, and Levecq & Weber 2002). However, this freedom leaded also to new kind of problems and questions never existed before. For example, the design of products, processes, and services in electronic business requires more attention and needs to be planned carefully because they must be implemented in some sort of information system. For instance, the appearance of B2B-markets has generated a shift from fixed pricing systems in traditional markets to dynamic pricing in the B2B-markets (cf. Herschlag & Zwick 2002). From the economic point of view the question arises about the kind of pricing mechanisms. Further, electronic negotiations can be expected to take place more in electronic markets than in traditional markets (Ströbel 2000). Here arise questions, for example, about the social implications of electronic markets and technical feasibility of the concatenation of a negotiation system with an auction mechanism.

Although the importance to find correct answers is imposingly shown within the costly disappearance of B2B-marketplaces the answers to these questions are poorly known and single observed occasions of electronic markets can only hardly be separated from their context. In 1999 more than 1,000 electronic markets existed (Dalton 1999) generating a turnover of approximately $ 8.7 billion. A steady growth of the total number of electronic markets was estimated. For example, Gartner Group suggested more than 1,400 marketplaces operating in the year 2001, and a turnover of $ 7,290 billion in the year 2004 (Knight 2000). Today we know that those estimates have not come true in the projected timeframe.

Searching for the reasons for the decline of electronic market one can point out that the number of various electronic markets was too high resulting a fragmentation of the liquidity. Consequently, only few electronic markets surpassed the critical order mass. As a consequence, practitioners and researchers agreed that a consolidation process among the electronic markets will cure the marketplace industry. However, to avoid the repetition of the disaster, analytical methods, powerful software tools, experience, and knowledge about the reasons are required (Neumann 2004, Neumann & Holtmann 2004, and Weinhardt et al. 2003).

The aim of this paper is to present the market modelling language (MML) – a tool that supports economists in rapid prototyping of electronic markets and briefly to describe the build-up of the MML components that are executable in the generic electronic market platform Meet2Trade. The Meet2Trade platform supports ranging form bilateral negotiations like chatting, to auction mechanisms, or even more complex negotiation protocols the automation of trading and negotiation processes. The platform provides the infrastructure and all necessary services to set up and test electronic markets for electronic negotiations.

The remainder of the paper is structured as follows: The second Section presents some characteristics of B2B markets followed with a Section presenting the generic trading platform Meet2Trade. The fourth and fifth sections attend to the market modelling language MML and its requirements. Conclusion closes this paper with a summary and motivates future research in the field.

Electronic markets for B2B

According to Smith, a microeconomic system consists of two distinct component elements: an environment and an institution, whereby the environment is defined as a "set of initial circumstances which can not be altered by the agents or the institutions within which they interact" (Smith 1982).

An economical environment consists of economic agents (market participants), commodities (transaction object), and characteristics of each agent. The institution defines the language of the market, the communication rules for agents, and the condition under which the communication takes place (Smith 2001).

The rules, which define an institution, can be subdivided into market microstructure, business structure, and infrastructure. The market microstructure defines the trading rules, the infrastructure defines rules given by the computerization of markets, and the business

structure defines rules for the fee structure of the market. The disjunction between market microstructure and infrastructure is particularly relevant for electronic markets. Generally speaking, the market modelling language facilitates the modelling of microeconomic systems. The above definitions describe microeconomic systems by giving a general survey about the elements a microeconomic system consists of. McAfee and McMillan 1987 define an auction as a market institution with an explicit set of rules determining resource allocation and prices on the basis of bids from the market participants.

Microeconomic systems can be supported by computer systems (cf. Levecq & Weber 2002). Wurman, Wellman and Walsh, for instance, present in Wurman et al. 2001 a price based general platform supporting multiple simultaneous running auctions. Arguing that the "task of designing negotiation rules is that of designing auctions" they define a classification of auctions in form of a parameterization of the auction design space focusing on the operational perspective of auctions. The authors mention that a well-defined set of parameters and associated values can describe a special group of electronic negotiation processes and auctions. Auctions are widely used in electronic support of B2B-markets.

Electronic markets support electronically transaction processes, enabling multiple buyers and sellers to trade with technical aids, like computer, to fulfil their and other information carriers needs in respect of information dissemination and exchange. The conditions for the exchange are determined by institutional rules. In contradiction to traditional non-electronic markets, which institutional rules evolve over time without interference of any central planner (Richter & Furubotn 1997), electronic markets and their institutional rules need to be designed carefully to provide the desired result. The facts that on the one hand “the institution of electronic markets requires conscious design” and on the other hand, “conscious design turns out to be a practical extremely demanding endeavour” (Neumann & Holtmann 2004) lead to questions about reasonable design and implementation of institutional rules of electronic market considering all their interdependencies. But, the fundamental problem for the design and implementation of electronic markets seems to be the gap that exists between the economics designing electronic markets and the software engineers, who are responsible for the implementation of electronic markets. Hence, it is desirable that the economics are supported in modelling and implementation of electronic markets by some tools. Such a tool should provide a high level of abstraction in market modelling and enable the market designer to focus the essential points of the market and such enable on the one hand the consideration of the market as a whole and freeing him from details (Mäkiö et al. 2004).

New and interesting market mechanisms are used in B2B-markets. Some mechanisms are based on conventional auction procedures. However, needs arising from the B2B context, can not be fulfilled solely by using traditional ways of auctioning leading more complex matching and pricing mechanisms for products, which are either difficult to describe or which have high trust and security requirements. For example, Rassenti proposed with colleges an auction mechanism for the allocation airport time-slots demonstrating the advantage combinatorial auctions compared with noncombinatorial mechanism (Rassenti et al. 1982). At the present time, consulting firms have detected a business change in offering services to conduct procurement auctions where a single buyer and several suppliers meet to generate exchanges.

Normally, procurement auctions are initiated by the buyer. Occasionally the buyer place additional restrictions respecting the final allocation. These restrictions may consider, for

example, who may participate in the auction, whether the suppliers are allowed to change their bids during the auction is running, how many bids suppliers are permitted to submit, or other institutional rules of the game. These rules play a significant role for the success of the auction, since both parties are interested in the efficient market outcome.

In B2B markets, procurement auctions are getting more and more popular since they enable buyers to save money. Firstly, procurement organized by auctions is cheaper than procurement organized in traditional way; secondly, the competition among the suppliers with in an auction beats down the prices; and thirdly offers are easier to compare with each other, making the procurement more transparent and clear. Thus, combinatorial auctions are getting more interest by multiple companies, particularly in markets with static suppliers groups.

To establish auctions in B2B, Electronic markets can be described by their behaviour. Concentration on the "what" instead of the "how" question in the modelling of electronic markets requires a high level of abstraction that frees the modeller from details e.g. to concentrate on the “what” in electronic markets instead on the how.

The generic trading system Meet2trade

The Meet2Trade is a client-server based generic trading system that was developed to support the research of various phenomena in auction-based electronic markets. As the Meet2Trade provides multiple features for the design, creation, testing, and introduction of auction-based electronic markets, it consists of various system components to support these tasks.

Largely, the Meet2Trade server consists of (i) communication modules to manage the communication between the trading server and trading client, (ii) storage functionalities, which are responsible for the log in of data produced in the trading, and (iii) auction runtime environment ARTE – the main component of the generic trading system.

The design and creation of auctions is supported by the market modelling language MML and by a hot deployment mechanism, which allows the deployment or redeployment of auctions without having to shutdown/restart the auction container.

The design of auctions is based on the parameterization approach – i.e. auctions can be described by a set of parameters which represent the auction rules. These rules specify the trading process using auction templates. To create new auctions, these rules just have to be configured. The advantage of templates is that the creation of new auctions need not to be started from scratch, but can be based on pre-defined sets of rules, which are specific for various auction types.

The configuration of new auctions or the updating exiting ones is supported by the MML-Editor – a graphical editor that enables the creation of auction descriptions in easy manner. Competed auction descriptions are transmitted into ARTE, which generates from the descriptions executable auction instances.

Thus, MML provides terms to configure rules that manage the interplay of auction combinations. These rules are either time- or event-based. Time-based rules are configured

with specific points of time. The time specified can be either absolute or relative. Event-based rules are configured with events which may occur in the market and which may influence the coexistence of auctions. Such an event is, for example, in financial markets a low price reached in an auction leading to a volatility interruption. The ability to combine multiple auctions makes Meet2Trade to a powerful tool, for example, when investigating complex market structures as in financial markets commonly used.

As aforementioned, Meet2Trade is a generic trading platform. Its genericity is based on two soils: the generic trading process supporting any kinds of auctions, and the generic order structure enabling the definition of various product characteristics of transaction objects. The definition of the transaction object is uncoupled from the trading process.

The generic trading process follows the process-oriented approach to define auctions. The genericity means that the basic structure of the auction execution process is usable in all auctions. The archetypes of this approach are the Media Reference Model introduced by Schmid & Lindemann 1998 and the negotiation process execution tasks presented by Ströbel & Weinhardt 2003. The process-oriented approach to design auctions reduces the design task into the configuration of the generic trading process with auction specific rules (cf. Mäkiö 2004).

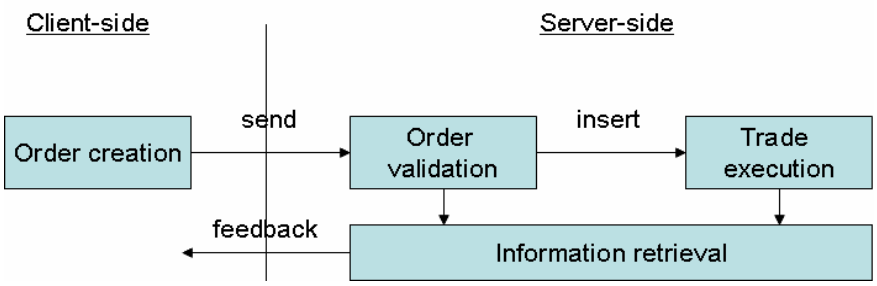

Figure 1. Generic trading process in Meet2Trade

Figure 1 provides a high-level depiction of the generic trading process. The client-side is responsible for the order generation. In the server-side the submitted order is first validated. In a successful case, the order is forwarded into the trade execution. Both, the order validation and the trade execution generate process information as feedback for the client-side.

The trade execution is detached from the domain and from the transaction object as well as from the domain-specific behaviour of market participants. The focus is on the offer life-cycle i.e. what happens with the order during the negotiation process execution.

The trade execution consists of three major phases: matching, allocation, and execution. Each phase depends on the current auction type. During the matching phase for an order a set of potential counterpart orders are computed. In ordinary single-attribute auctions the prices of the opposite market side are sorted in a suitable way. In multi-attribute and in combinatorial auctions the computation is more complex but the output is the same as in the more simple case. The allocation phase gets the results from the matching phase as input. During the allocation phase, conditions for the trade execution are computed and the execution price is determined. The execution phase gets as input from the allocation phase a list of allocation object containing among others the buy orders and sell orders, execution prices and other

conditions. Depending on the current auction form, the economic agents are informed about the execution.

The following Section discusses requirements of the MML – a XML-based modelling language to configure auctions within Meet2Trade.

Requirements of MML

A model is at the one hand an abstraction from a real world problem and on the other hand an abstraction from the implementation details. The purpose of a modelling language is the creation, description, and exchange of high-quality models. The determination of its requirements dictates the properties of MML. Analysing for what the MML is needed and what from it is expected, or rather required, can detect these requirements. Other, more concrete requirements can be derived from the appraisal of these results.

Using MML for the modelling of B2B markets, all aspects of a market are summarized into one model. Therefore, MML contains three basic elements:

- model elements: in the meta model of MML described modelling concepts, which are used to define new markets,
- notation: graphical description of the model elements, and
- guidelines: modelling rules e.g. syntax of MML.

The heart of the MML lies on the model elements describing the negotiation rules and the negotiation execution tasks. The whole landscape of the market modelling process has to be analyzed for a deeper understanding of single elements needed for MML.

MML facilitates the definition of concrete structure characteristics and trading rules of a market. Ideally, MML supports the users' way of thinking abstractly about a market construction problem using real-world concepts of market modelling and allowing both the modelling of the structure (static) and the behavioural (dynamical) aspects and elements of markets, like algorithms for price determination and matching. To support both aspects, the terminology used by economists to describe market models should be mapped into the MML. Unfortunately, such general statements do not clarify how MML looks like, and which instructions it needs to fulfil its purpose.

In Wurman et al. 2001 the authors state that "the task of designing negotiation rules is essentially that of designing auctions". Because a market model is defined through concrete market structure characteristics and a market model lays down the basic trading rules of a market, the terms of MML contain market structure characteristics and rules to combine them.

The market-modelling task fixes the trading rules of a market. These rules determine both the dynamic and the static elements of a market model. Dynamic elements describe the trading process of a market. Such elements are, for instance, the rules for matching and price determination as well as the determination of the bidding language or adjustment process rules, specifying the time or conditions under which the agents are allowed to submit their bids. The modelling of the infrastructure requires knowledge about the impact of rules deduced from the computerization of markets. For example, in the electronic markets there

are much more possibilities for the configuration and implementation of the transparency rule which defines the availability of the current process status information for the agents involved in the actual trading process than in conventional markets. Further aspects, like the average access time from the trading client to the trading server system, have to be modelled in the infrastructure.

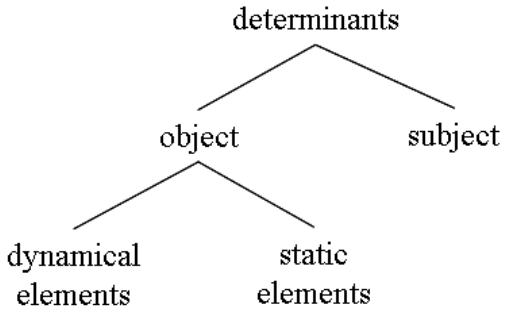

Figure 2. Determinants of the requirements for MML

Summarizing the determinants of the requirements for MML, there are three open issues for further discussion and analysis (cf. Figure 2): dynamic elements, static elements, and subject. Dynamic elements describe the behavioural aspects of a market; static elements describe the setting of the market structure parameters, and the subjects are persons involved with the market-modelling task. After an analysis of the needs of the object "(electronic) market", we will discuss more generally the requirements of MML from the view of the subject ("market designer").

Market Modelling Language - MML

The main goals of MML are the creation, description, and exchange of high-quality market models. Thus, using MML for market modelling, all aspects of a market can be summarized into one model.

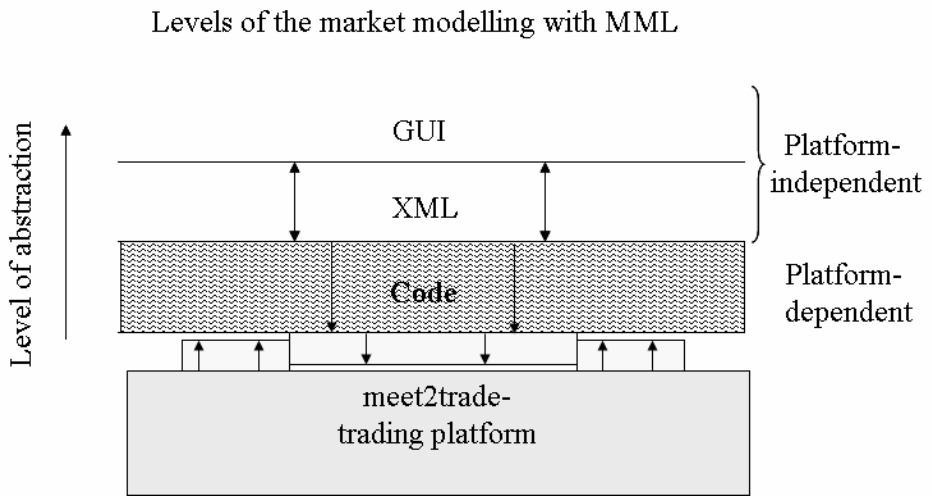

Figure 3. Abstraction levels of the MML

As aforementioned, the MML is a platform independent market modelling language that supports the definition of electronic markets and negotiations. MML supports market modelling at a high level of abstraction freeing the market designer from implementation details. The reasoning for this is twofold. Firstly, since the communication level in lower-level programming languages easily leads to situations where the designer's intentions are hidden behind the details, such languages do not suit the modelling task as well as higher-level modelling languages (such as unified modelling language UML cf. Booch et al. 1999). Secondly, people modelling markets seldom have skills in any traditional programming language. Therefore, MML needs to be such that no special skills are required.

Figure 3 outlines a technical overview of the market modelling. The MML itself is a XML schema based language that consists of a set of parameters needed to describe an electronic market. The setting of the market parameters is supported by a graphical user interface. MML descriptions are analyzed in the Meet2Trade and computed into running electronic markets.

The power and the flexibility of the MML are based on the model elements which are subdivided into three groups. The first group of elements describes institutional rules of a market model. For example, the rules for a bilateral negotiation or the rules for an English auction are defined here. The second group of rules is used for the composition of single market models into complex market structures (cf. Mäkiö & Weber 2004). For example, the stock exchange of Deutsche Boerse Xetra consists of many different market models simultaneously and where classical trading forms coexist with the services for private investors' order processing. The third group defines the coexistence of single market models. It defines, for example, the rules for the starting and stopping of single market structures.

Implementation of MML

This Section proffers a brief overview of the implementation of MML. As aforementioned, MML is designed and implemented for the easy generation of any new auction based market models. The basic idea by the implementation of MML is that electronic markets can be designed by parameterization. Thus, on the technical level, MML is a XML schema based language. The relevant parameters are embedded and hierarchically organized into a XML schema that prescribes the syntax of the MML.

The hierarchy of the MML is presented in Figure 4. From top to down, the highest level is GUI (Graphical User Interface). This level is supported by especially for MML implemented editor. The output of the MML editor is a XML file that contains a description of one particular market model.

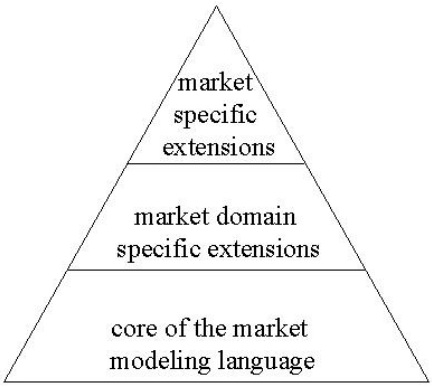

Figure 4. Hierarchy of the extensions in MML

The MML description of a market model is platform independent. The platform independency can be understood twofold. Firstly, it is independent from the underlying operation system and trading platform that finally is the run time environment for the electronic markets. Secondly, some parts of the MML description can be transformed into source code in some specific programming language. The result of the transformation is compiled into software components that are executable in the underlying auction runtime environment.

On the lowest level of the hierarchy is the auction runtime environment. It provides various services, like timer service and logging service, at electronic markets. These services can be used by each market: they just have to register themselves onto the services. Whether markets register themselves or not is a part of the MML specification.

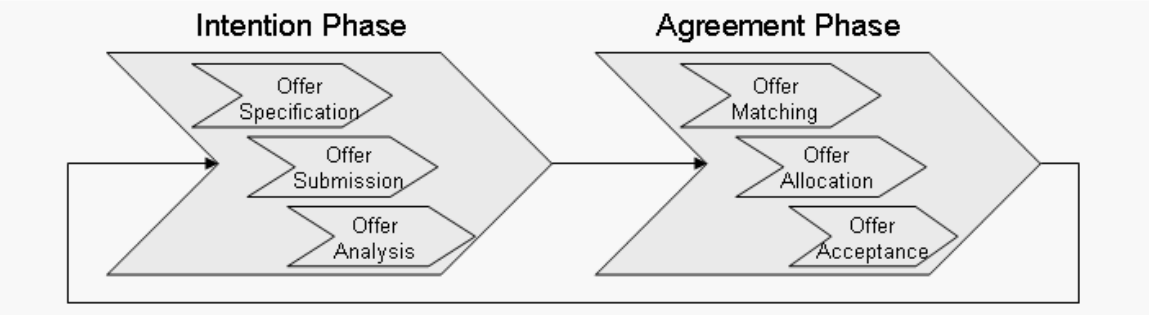

Figure 5. Negotiation transaction phases according to Ströbel & Weinhardt 2003

Besides of the components above, the MML implementation supports the modelling of trading phases of electronic markets. The trading phases (cf. Figure 5) are implemented within the market runtime environment. Because each auction has its specific path through the trading phases, they can also be configured. In some cases market specific components have to be generated, but the generation uses the information from the MML description. For example, the matching of orders is a market specific procedure. (We define the matching as a function that generates for one offer O_1 in ascending order a ranked list of offers from the counterpart side (cf. Veit 2003). The ordering criteria are given in the MML.) In price based auctions one generic matching component can be used. If further attributes of the order are used for the matching then these components have to be generated according to the order type specification that is as well an integral part of the MML. The order type specification

describes the structure (e.g. what attributes the order consists of) of orders in the current market.

The focus within the platform is not only on the well-known auctions but also on more complex auction formats and varieties of these. Basically, Meet2Trade supports *single-sided* and *double-sided* auctions.

Single-sided auctions: In the ascending auction, comprising the stereotype of an English auction, the price is rising as long as bids are submitted; whereas in the descending auction the price will be lowered, starting from a high price, until a bidder accepts the current price. The well-known auction of this descending type is the Dutch auction. Auctions with a single buyer and several sellers are called reverse auctions or procurement auction; the price in these auctions is lowered as long as bidders still participating in that auction. The first-price sealed-bid and second-price sealed-bid (Vickrey) auctions are the most famous auctions among the group of sealed-bid auctions. Both auctions are special cases of the general implemented k^{th}-price sealed-bid auction (k = 1 equals the first-price sealed-bid auction and k = 2 the Vickrey auction). The reverse k^{th}-price sealed-bid auction is the sealed-bid format with one single buyer and m sellers and k determining the k^{th} lowest price to pay. Moreover, Meet2Trade supports multi-unit auctions with a generalized uniform pricing rule as well as multi-attribute auctions. In the multi-unit auctions the bidders demand multiple units of the item being auctioned. The bidder with the lowest amount to bid among the highest bidder who wins the auction determines the price. Concerning the multi-attribute auctions two forms of the ascending and reverse auction format are implemented: (1) orders are matched to maximize the revenue of the owner of the orders, (2) orders are matched with the aim of maximizing the welfare (Gimpel et al. 2004). The number of attributes is not limited.

Double-sided auctions: Focusing on the double-sided auctions with *m* sellers and *n* buyers the classical auction formats of Continuous Double Auction (CDA) and Call Market are implemented. In the CDA each submitted order will be directly executed as soon as it is matched; in the Call Market all orders are collected until the execution of the matching. Besides price-based double-sided auctions, Meet2Trade supports multi-attribute CDA (cf. Gimbel et al. 2005).

All auction types mentioned above can be configured and combined within the platform Meet2Trade into complex market structures by parameters integrated into the MML. The configuration is supported by about 100 parameters that have been identified in order to specify the components from a static view and trigger activities and processes from a dynamic view. About 50 parameters are used for the configuration of the generic transaction process, e.g. specifying the ending rules of auctions (closed or opened), controlling matching and execution of submitted bids or orders, or determining additional aspects like buy prices or discounts. The combination of auctions into complex market structures is supported by further 41 parameters. These parameters control the combination of market mechanisms, either (i) sequentially, (ii) parallel or both, (iii) sequentially and parallel.

Conclusion

This paper presented the market modelling language MML and the generic trading platform Meet2Trade. MML is used to configure auctions running in the Meet2Trade. Further, some auctions used especially in B2B-markets are discussed. Further, requirements of MML are analyzed. The starting points in our discussion about the requirements were the questions:

- What for do we need MML and
- What do we expect, or rather require from it?

We stated that the purpose of a modelling language is the creation and exchange of high-quality models. For this purpose MML should be user-friendly, precise and extensible as well as it should take into account both dynamical and static elements of markets. We discussed various aspects of market modelling and determined that a deeper understanding of a market modelling process is needed and a definition of a precise terminology for market modelling is a necessary precondition for the construction of MML.

Today's requirements for electronic markets are manifold. New and innovative auction formats have become an important success factor for B2B-markets. However, the knowledge of interdependencies of the market structure and the market outcome is still in its infants. Meet2Trade facilitates the evaluation of electronic markets and provides a high degree of flexibility in auction design.

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