Design and Implementation of a Payment System for Virtual Worlds

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***Abstract*—**Virtual Worlds offer their users new possibilities to interact with each other through the Internet within a 3D environment. Gaming, socializing, communicating and even learning are just a few examples of the possibilities which virtual worlds offer and thus can enrich classic applications with the new functionalities of a 3D environment. These worlds also offer users the possibility to create their own content within the virtual environment. These user created objects can even be shared with other users in the 3D world. Right now different technologies are created which allow the development of virtual 3D environments. A very important functionality of traditional e-commerce applications is the possibility to use electronic payment methods in order to purchase products. Payment methods are also a very important factor for virtual worlds in order to enable e-commerce within these environments. Right now, no payment system exists which can be used concurrently within different virtual worlds. This paper illustrates an innovative concept of a payment system which can be used within different virtual worlds. A prototype of the payment system was implemented in order to prove the concept of the proposed payment system.

***Keywords*—**E-commerce, payment system, virtual business, virtual worlds

I. Introduction

VIRTUAL WORLDS are defined as digital 3D environments where users can interact with each other through a virtual user, called avatar [18]. The potential of virtual environments can be described with the keywords 3D world, community, creation and commerce [17] [19]. Users can interact with other users within the community of a 3D world. Users can move freely within these environments and even social communities can be formed. A very important feature of virtual worlds is the possibility to create and own virtual objects. This virtual content can even be bought or sold by other users and thus commerce can be integrated in these environments [17].

Since 2006, when a media hype has been triggered around the virtual world Second Life [16], virtual worlds became known to the public. Just within one year more than ten million users joined this environment and discovered the new possibilities of interacting with each other in a 3D virtual world. In the second quarter of 2009, 144 million US Dollars have been spent by users within the virtual world Second Life. This was the highest value of user to user transactions in the history of this virtual world [15]. This figure demonstrates clearly that virtual environments do have a high potential for future e-commerce applications. Even Gartner Research Inc. predicts that 80 percent of Internet users will participate in virtual 3D worlds until the year 2011 [5].

Furthermore, virtual world platforms have been developed which allow users to create their own virtual environments. Examples for such virtual environments are OpenSim [13] and Sun Wonderland [21]. These platforms offer the possibility to create virtual environments which are pretty similar to the virtual world Second Life and also allow users the possibility to communicate with each other and create their own content within the virtual environment [12]. A problem which these platforms right now have is, that unlike Second Life, these platforms do not have a payment system included yet which could enable users of these platforms to buy and sell virtual goods within the 3D environment. Moreover, no payment system exists which can be used within different virtual worlds. Which means that a user can switch between different virtual worlds and can still spend money there. Also no comprehensive payment system for virtual worlds does exist yet. Proposals how a payment system could be integrated in a, for example, OpenSim environment do exist [13], but no official payment solution for these platforms exists yet.

Nevertheless, the figures of the amount of money transactions within the virtual world Second Life and the prediction of Gartner Research Inc., that virtual worlds will have an impact in the future, show that a payment system for these environments is clearly an important factor in order to enable e-commerce applications for these environments [3].

This paper discusses the concept of a payment system for virtual worlds which solves the problem of using a payment system within different 3D virtual worlds. The concept of the proposed payment system in this paper deals with the problem that several virtual worlds exist and users should have the possibility to use one payment system for any virtual world they visit. In order to demonstrate the concept of the payment system a prototype of the payment system was developed and was evaluated within a virtual world which is based on the OpenSim platform.

The OpenSim platform itself is not a virtual world, it is just

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the underlying software to create virtual worlds [4]. Virtual worlds which are created based on the OpenSim platform look pretty similar to the virtual world Second Life. Virtual 3D worlds which are based on OpenSim can be accessed through a special client software in order to explore the virtual environment, create content for the virtual world and also allow to program the created objects by using certain scripting languages [12].

This paper is organized as follows: the requirements for a payment system for virtual worlds will be formulated and it will be outlined which issues have to be solved in order to enable users to spend money in a 3D world. Based on that, the use cases which have to be covered by a payment system for virtual worlds will be listed. The use cases which are implemented within the payment system will be discussed in detail. Finally the architecture of the implemented prototype will be revealed.

II. Requirements for the Payment System

The possibility to use electronic payment methods in order to purchase products online is a very important functionality for e-commerce applications. Especially in the scope of e-commerce within virtual worlds, where most transactions are micro payment transaction with less than five Euros spent during each transaction, payment methods must allow their users to acquire goods in an uncomplicated and fast way. Trust between customers and merchants, consumer privacy and security are important factors within e-commerce applications [10]. In a process where a user buys a product, very often two parties are opposing each other. An important question which this two parties ask themselves is if they can trust the other entity in the virtual world, the owner of the virtual world himself and can thus complete the transaction within the virtual environment [6].

General requirements for the presented payment system in this paper are atomicity, consistency, independence and durability [22]. The payment system for virtual worlds has to guarantee that a transaction gets processed completely or the transaction does not get processed at all. It is important to care for all kinds of technical interrupts which could happen during a transaction. All parties which are involved in the transaction must have the same information about the transaction. The basic information which should be available in every payment operation is the amount of money which is spent, the purpose of a transaction and the date when the transaction took palace. This implies that the information of a payment must not be modified after completing the transaction. Additionally, all payments have to be independent. Various payments must not affect each other [22].

Beside the general requirements of the payment system, also security requirements have to be considered. Identification and authentication, authorization, confidentiality, integrity, non-repudiation and availability can be seen as must requirements which have to be implemented [10]. It must not be possible for anyone except the owner of a payment account to create payments drawn on his account. The payer and payee have to be able to prove that the involved party in a transaction received money from his account and also the purpose of the transaction should be clear. It is important to ensure that it is not possible to forge transactions. A summarizing feature of the payment system has to be that it is resistant to fraud [7].

Another important functionality from the viewpoint of a user of the payment system is, that the system can be used within different virtual worlds. No matter if the user visits a virtual world which is based on an OpenSim or a Sun Wonderland platform. A user should have one account at the payment system and should be able to spend money within different virtual worlds which are built on different platforms. The payment system itself has to be independent from any virtual world platform. Operators of virtual worlds do not have to install any special software on their virtual world platforms in order to use the payment system.

It is not trivial to ensure that all these requirements are fulfilled. Especially in virtual 3D environments where users often do not know with whom they interact in the virtual environment. Very often it is also unclear who the operator of a virtual world is. It is also unclear for a user if the operator of a certain virtual world is trustworthy or not. There is always a risk that the entered data in these environments gets eavesdropped. Thus, confidential information like a username or a password should never be entered within a virtual world environment [10].

The ultimate requirement of the presented payment system for virtual 3D worlds in this paper has to be to be able to transfer money between users without any risk in an untrustworthy environment.

III. Payment Procedure

The listed requirements in the last section clarified that security is one of the main requirements of the presented payment system and likewise this requirement is very hard to accomplish in a virtual world environment. It always depends on the operator of a virtual world if the environment is trustworthy or not. Thus, a user must not assume that information which he enters in a virtual world cannot be intercepted and manipulated by a third party. Furthermore, no security standards or encryption methods exist which could ensure a secure communication within the virtual world.

For the design of the payment process this circumstances mean that a transaction cannot be authorized within a virtual world environment. A payment process will be triggered within the virtual world environment, but it was decided to take the process step of authorizing a money transaction out of the virtual world environment. A transaction can only be authorized within the secure environment of a web application which allows to encrypt the sent information. This approach should ensure that users of the system do not have to worry that transactions take place without their knowledge and agreement. Moreover, during the payment process it has to be considered within several steps of a payment procedure that

messages have been modified by a third party. The payment system has the task to check what has happened to the information of a certain process within every process step of a money transaction. Figure 1 displays the general process of authorizing a transaction with the designed payment system.

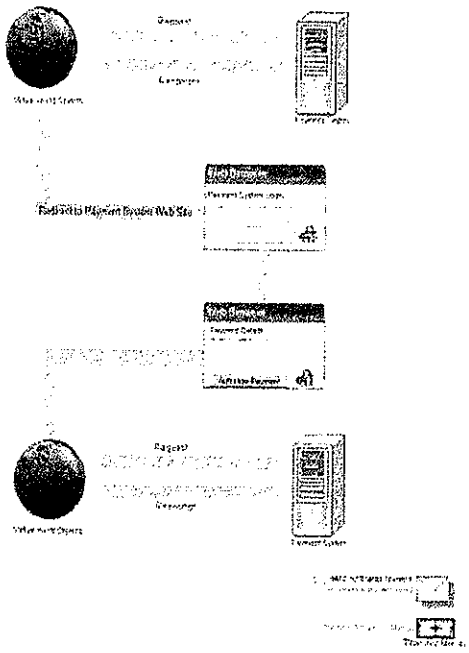

Fig. 1 General Payment Process

The general process of completing a transaction with the proposed payment system gets adapted within every use case which is supported by the presented system. Every transaction gets triggered in the virtual 3D world. A user, for example, interacts with a virtual object which he wants to buy. The virtual object sends a request to the payment system and if the payment system can verify the given information, a new transaction for the user who wants to spend money will be created. The user will then be redirected to the web site of the payment system. The user has to log into the web application. All relevant information of the transaction will be displayed for the user. The user can authorize a payment within the web application. This step is necessary because the communication within a virtual world is not forgery-proof. After authorizing the transaction at the web site, the involved virtual world objects will be notified from the payment system that the transaction was authorized. "Money" gets transferred from one account to another if the user authorizes the transaction at the web site of the payment system. This step ensures that no money leaves the account of its owner without his knowledge.

Additionally, a user receives two virtual objects when he registers at the payment system which should help the user to complete transaction within the virtual world environment. This objects are a head up display and a virtual tip box. The head up display is responsible for communicating with virtual objects within the 3D environment which a user wants to buy. The head up display, for example, notifies the objects a user wants to buy when the user has authorized a transaction at the web site of the payment system. The head up display can also give additional information to its owner, like the actual amount of money which he has on his account. The virtual tip box, which a user also receives when he registers at the payment system, is used to receive money from other users within the virtual world environment.

A very important step during the design of the payment process was to identify the use cases which should be supported by the payment system for virtual worlds. Three use cases were identified:

1) Avatar gives money to other avatar
2) Avatar gives money to virtual world object
3) Object gives money to avatar

This use cases have been implemented in order to demonstrate the functionality of the prototype of the payment system. Representative for this three uses cases, the use case "Avatar gives money to other avatar" will be discussed in detail. The other use cases are equal to this representative use case, only the involved parties differ. Figure 2 illustrates a sequence diagram which gives a detailed view of the payment process "Avatar gives money to other avatar".

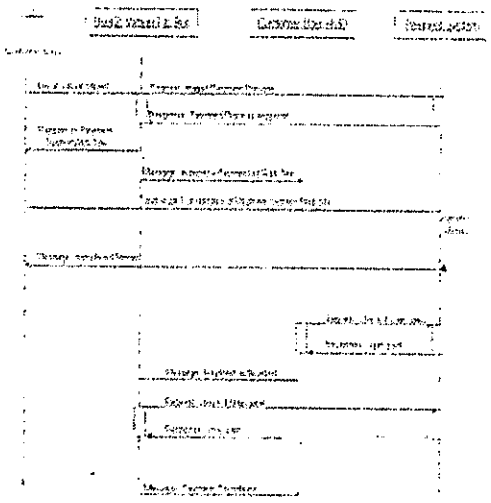

Fig. 2 Sequence Diagram "Avatar gives money to other avatar"

A user is able to receive money within the virtual world environment from another user by using the virtual tip box. The use case starts when a user, who wants to give money to another user, interacts with the virtual tip box of the user who receives money. By clicking on the virtual tip box, the virtual object opens a pop up window within the virtual environment and asks the user if he wants to give money. If the user agrees, the virtual tip box sends a message to the payment system in order to create a new transaction for the user. The payment system evaluates the message from the virtual tip box, it checks the identity of the virtual tip box and the identity of the user who wants to spend money. If the owner of the virtual tip box and the user who wants to give money are registered at the payment system, the system creates a new transaction for the user. This transaction is only available for five minutes. Within this timeframe the user is able to log into the web application of the payment system in order to authorized the transaction, otherwise the transaction will be deleted.

When the payment system has created a new transaction, the payment system will send this message back into the virtual world to the virtual tip box. The virtual tip box then will send a message to the user in the virtual environment and thus notifies him that he can authorize the transaction at the web site of the payment system.

At the same moment, when the virtual tip box notifies the user, the virtual tip box sends a message to the head up display of the user who wants to give money and signals the head up display that an open transaction has been created for its user. The head up display displays this message to the user and starts sending messages to the payment system in order to request if the user has already authorized the transaction.

In the next step, the user logs into the web application of the payment system and directly gets displayed all details of the respective transaction. The date and time of the transaction, the name of the object and the name of the owner of the virtual world object will be displayed to the user. He can enter an amount of money which he wants to give to the other user. By pressing a button at the web application, the user authorizes the transaction. The money gets transferred from the user's account to the account of the user who receives the money

The head up display of the user who spent money receives the message from the payment system and forwards this message to the virtual tip box of the user who received money. The virtual tip box sends again a message to the payment system and requests if the transaction has really been authorized. If the payment system responds that the transaction has been authorized successfully, the virtual tip box sends a message to the user who has spent money and notifies him that the payment process has been concluded. Additionally, both parties, the user who spent money and the user who received money, get an email from the payment system which summarizes all transaction details. Furthermore, both users can see the details of completed transactions at the web site of the payment system when they log into the application.

The payment process was designed flexibly which, for example, would also allow the virtual tip box to send requests to the payment system in order to request if a user has already completed a transaction at the web site of the payment system. It is not required that the head up display of the user who gives money sends requests to the payment system in order to determine when a user has authorized a transaction. The payment processes are adjustable, only the authorization of a transaction has to proceed at the web site of the payment system. An overview of the different methods of the application programming interface of the payment system will be given in the next section.

Another important functionality of the payment system is the support of an exchange rate mechanism. Different virtual worlds can exist which all make use of different currencies [24]. The payment system has to deal with the task to calculate an exchange rate mechanism between all these virtual currencies and thus make it possible for a user to always purchase products within a virtual world with the virtual currency of the virtual world where he has registered initially. The huge advantage of this functionality is that users of a certain virtual world, who want to use the presented payment system in this paper, do not have to use or adapt a special currency, they can continue to use the virtual currency of their virtual world. The exchange rates between virtual currencies depend on the rate of the available amount of each virtual currency within the payment system to each other. Depending on the available amount of money of each virtual currency, the exchange rate between the virtual currencies can be calculated.

The presented payment system faces the challenge to model different payment processes. A user can give money to another user in a virtual world environment, a user can buy a virtual object and a virtual world object can give money to a user. The payment system additionally has to make sure that the different communication partners interact with each other and thus arrange it that transactions can be completed. The payment system itself processes requests from virtual world objects and creates transactions for users. The payment system is also responsible for validating each input from the different communication partners and prevents offensives against the system. No matter if a user gives money to another user, a user wants to buy a virtual world object or if a user gets money from a virtual object, money must not leave the account of a user without his agreement.

IV. Architecture and Implementation of the Payment System

During each use case which is supported by the payment system, virtual world objects within 3D environments communicate with each other and users interact with the web application of the payment system. The challenge while designing the payment system was to find a way that allows 3D objects from a virtual world environment to communicate with the payment system and notify virtual world objects if, for example, a user authorized a transaction at the web site of the payment system. Thus, the information about transactions has to be available in the 3D environment and at the web

application of the payment system. Figure 3 gives an overview of the architecture of the presented payment system and illustrates which components have to communicate with each other in order to complete a transaction.

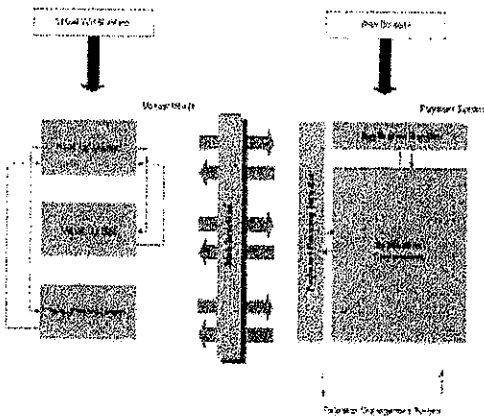

Fig. 3 Architecture of the Payment System

The payment system for virtual worlds faces the challenge to handle requests from different contexts. A user interacts with the payment system through a web application and virtual world objects also have to interact with the payment system in order to complete transactions. The payment system has to handle the information of both contexts in order to be able to successfully conclude transactions.

A user interacts with the web application of the payment system in order to authorize transactions. As already mentioned in the last section, only the secured environment of the web application of the payment system can guarantee that the authorization process of a payment cannot be eavesdropped. The user logs into the web application with his username and password and immediately gets all details of a transaction displayed. By authorizing the transaction, money will be transferred from one account to another. The payment system application has to ensure that this information gets stored. Furthermore, the web application of the payment system also gives the user the possibility to display all transaction details of completed payments. The payment system stores all information about completed transactions within a database management system and provides functionalities which are responsible for displaying the relevant data. Moreover, the application components of the system are also responsible for ensuring that all data which is sent during a transaction process is correct. These components control the information which is sent during each step of the payment process.

Within the virtual world environment, a user is able to purchase products, give money to other users or receive money from virtual world objects. Thus, the virtual world objects have to be able to communicate with each other. When a user registers at the payment system, he receives two objects which should help him to spend money within the virtual 3D environment.

The head up display and the virtual tip box are objects which are provided by the payment system. These objects are uniquely assigned to a user of the payment system. A user is not able to change this objects. With this objects, a user is able to give money to another user who is also registered at the payment system. With the virtual tip box, a user is able to receive money from other users. Thus, the virtual tip box has to be able to react if a user touches this object within the virtual environment. Additionally, the virtual tip box has to be able to send requests to the payment system in order to create new transactions for other users who want to give money to the owner of the object. The head up display is able to display the actual account information of a user and also displays information if, for example, a user has to authorize a transaction at the web site of the payment system. Thus, the head up display has to be able to send a request to the payment system in order to determine actual information about a user's transactions. Additionally, the payment system has to know which head up display belongs to which user. Just the head up display of its owner is allowed to request information concerning the status of its owner's transactions.

A user is also able to create virtual world objects and can offer these objects for sale to other users. These user-created virtual world objects have to be able to recognize if a user wants to buy them or give money to them and they also have to be able to send requests to the payment system in order to create transactions. The payment system has to be able to identify which objects belong to which user and which user wants to give money to them.

In order to offer virtual world objects the possibility to send requests to the payment system, an application programming interface has been developed. A web service [2] interface gives the virtual world objects the possibility to access certain functionalities of the payment system in order to, for example, create new transactions, get information if a user has authorized a certain transaction or get information about the actual account status of a user. The payment system provides a central component which receives all messages that arrive from virtual world objects. This component is responsible for handling these messages and calling the appropriate functions of the application components. It is the task of this component to provide the essential transaction data for the virtual world components. The virtual world components interact with each other during a payment process and exchange transaction data. The data gets validated during each process step by the payment system. Just one process step in the process chain of completing a transaction within a virtual world environment is taken out of the virtual world environment. Money gets first transferred from one account to another if a user authorized the payment within the web application of the payment system. A virtual world environment is not considered to be secure

enough the handle the task of authorizing a transaction.

In order to be able to give users of the payment system the possibility to sell products by using the payment system or to receive money within the virtual world environment, the application programming interface of the system offers the following application programming interface functions:

1) Give money to a user
2) Check if a user has paid for a transaction
3) Buy- function with a fixed price
4) Buy- function with no fixed price

Since the payment system for virtual worlds offers a web service interface for virtual world objects, requests have to be send to the payment system in order to get information from the payment system. The payment system will respond a XML [1] document to the virtual world object. The virtual world object has to parse this document in order to get the requested information. Figure 4 displays a scene where a user gives money to another user by using the virtual tip box.

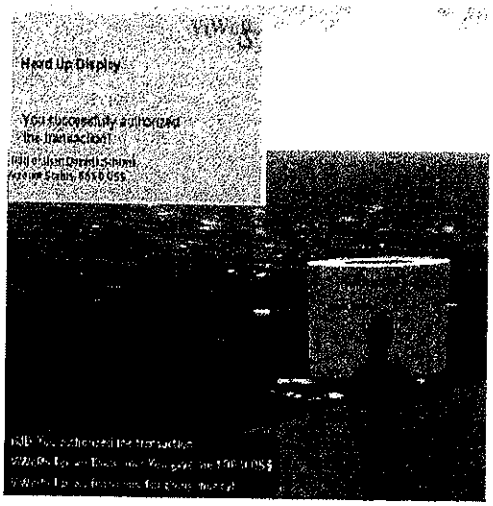

Fig. 4 Image of the Use Case "Avatar gives money to other avatar"

The figure displays the head up display of the user who wants to give money and the virtual tip box of the user who receives money within the virtual world environment. The head up display indicates that the transaction process has been completed successfully and also displays the actual account status of the user. The virtual tip box has already recognized that the user authorized the payment and displays a message for the user. Within the use case from the figure above, the application programming interface function "Buy- function with no fixed price" is used. The difference to the function "Buy- function with fixed price" is, that this method creates a transaction with no specified amount of money which will be transferred to another user if the transaction gets authorized. The virtual tip box sends a request to this method in order to create a new transaction for the user who wants to give money. The user who wants to give money to the owner of the virtual tip box can specify an amount of money which he wants to spend. The payment system receives the request from the virtual tip box and validates the given information. If the system validated the data successfully, a new transaction has been created for the user. The "Check if a user has paid for a transaction"-method is used by the head up display of the user who wants to give money. The head up display sends this request to the payment system in order to be notified when the user has authorized the payment.

Figure 5 displays a scene from the use case "Object gives money to avatar". Within this use case, a virtual object gives money to a user.

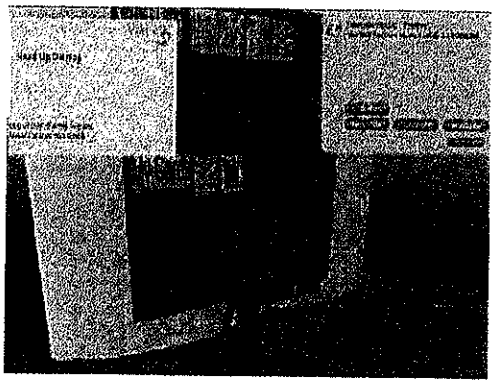

Fig. 5 Image of the Use Case "Object gives money to avatar"

The function "Give money to a user" is used to automatically create a transaction from a virtual world object. A new transaction will be created, but money is first transferred from one account to another if the owner of the virtual object, which gives money to a user, authorizes the transaction at the web site of the payment system.

V. Conclusion And Future Work

Virtual worlds are defined as 3D environments which can be accessed by multiple users at the same time. These virtual worlds offer users the possibility to communicate with each other in real time, create content within the virtual world and even carry out a business within a virtual world environment [2]. In future, several virtual worlds could exist and users would be able to easily switch from one virtual world to another [18]. This fact and the circumstance that virtual worlds are very often based on trading virtual objects which were created by its users, makes it an important functionality for these environments to be able to use money [8].

Identification, authentication, authorization, confidentiality, integrity, non-repudiation and availability are the main requirements for a secure transaction. Users and virtual world objects are identified by the payment system using their unique keys within virtual worlds. A user who wants to authorize a transaction at the web site of the payment system gets authenticated by entering his username and password at the web application. A valid username/password combination enables a user to authorize transactions. First if this authorization step is completed and a user has authorized a transaction at the web site of the payment system, money gets transferred from one account to another.

Confidentiality is hard to achieve within a virtual world environment, since this feature depends on the owner of a virtual world. Technologies which enable a secure communication within a virtual world do not exist yet. For that reason it was decided during designing the protocol of the payment process that events that trigger a transfer of money from one account to another can just be called within the web application of the payment system.

Integrity is achieved by strictly controlling each step of a payment process. The data of a transaction gets controlled within each step to determine its integrity. By authorizing a transaction at the web site of the payment system, a user confirms that the data was not modified during the payment process.

Non-reputation is achieved by ensuring with mechanisms within the payment system that a transaction can just be authorized once. A multiple authorization of a transaction is not able. The payment system ensures that just the owner of an account from which money gets transferred to another account can authorize payments. A user is able to immediately see which amount of money he has spent and which amount of money he has received. The payment system ensures this requirement by providing a functionality at the web application of the system that always displays the actual account activity of a user. The user is also able to immediately see for what purpose a certain transaction was and to whom he gave or from whom he received money.

Securing a payment system is not a trivial task and means that all different components of the system have to be secured. Communication-security between virtual world objects within a payment process is heavily dependent on the virtual world where this communication takes place. This fact made the design of the payment process more complex. It was decided to take some steps of the payment processes out of the virtual world environment. Some steps have to be completed within the web application of the payment system in order to ensure that money is not transferred from one account to another without the knowledge of the involved parties.

According to [5], [11] and [20], virtual worlds will change the way we use the Internet and thus will change the way, for example, we interact with each other or purchase products online. [2] mentions that virtual worlds do have the potential to be the future of e-commerce and perhaps of the Internet itself. The presented payment system for virtual worlds in this paper is an example for the new possibilities these environments offer and proposes an innovative system that enables users of these environments to carry on money transactions.

Future work will include the adoption of the concept of the payment system on different virtual world platforms. Especially an integration of the concept of the payment system for virtual worlds which are based on the Sun Wonderland platform would be a great feature for this environment. Furthermore, testing of the payment system under different environments will be another important future activity in order to provide a stable and secure system. Generally, based on the basic functionalities which are supported by the payment system, it is also thought to provide more features which should help users to model complex payment processes within the virtual world with little effort.

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