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# CONNECTING VIDEO GAMES AS A SOLUTION FOR THE GROWING VIDEO GAME MARKETS

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# Abstract

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The growth and development of the video game industry has led to fierce competition for customers' attention. Video game companies are using increasing amounts of money in advertising to gain visibility in the markets. In addition, the owners of digital distribution stores tend to favor the most successful video games when showcasing and suggesting new games for the players. Both these tendencies make it hard for small and new video game companies to compete in the same video game markets with the larger and well-known companies.

The goal of this thesis is to develop a general technical solution which would enable video games to exchange knowledge and allow video game developers to create games that can be connected to each other, for example by sharing common characters or items. This solution approaches the problem of visibility and discoverability on the video game markets from the viewpoint of enabling co-operation between video game companies. This is done by using semantic technologies to create a general model of video game information, allowing the video games to exchange semantically enriched knowledge about their game contents, instead of raw data.

The research has been conducted by following the principles of Design Science Research. The research started by performing a literature study to find out the current state of the art in the research of connecting video games. In addition, video game developers were interviewed to gather requirements and opinions on the possibility of connecting video games with each other. Based on the interview results, an ontology for modeling video game information was created. This model was then used as the basis for creating a platform to enable connecting separate video games. Also, a survey among Counter-Strike players was carried out to find out if players could be motivated to perform physical exercises in order to gain digital rewards in their favorite video games.

The ontology model was shown to be able to model and capture video game information in a general manner. The ontology, combined with the developed platform, allows video game developers to connect separate video game products with each other and to create new models for interaction between the games. The performed survey suggested that players are willing to do physical exercises in order to gain bonuses in video games.

Keywords: connecting video games, interoperability, video game ontology, video game developer interview, player interview

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Joensuu, November, 2016
Janne Parkkila

# List of publications

1. Where is the research on connecting game worlds? - A systematic mapping study. Parkkila, J., Ikonen, J., & Porras, J. (2015). Computer Science Review, 18(C), 46-58.

2. Towards Interoperability in Video Games. Parkkila, J., Hynninen, T., Ikonen, J., Porras, J., & Radulovic, F. (2015, September). In Proceedings of the 11th Biannual Conference on Italian SIGCHI Chapter (pp. 26-29). ACM.

3. An ontology for videogame interoperability. Parkkila, J., Radulovic, F., Garijo, D., Poveda-Villalón, M., Ikonen, J., Porras, J., & Gómez-Pérez, A. (2016). Multimedia Tools and Applications, 1-20.

4. Linking physical activities and video games. Ikonen, J., Ryhänen, P., Parkkila, J., & Knutas, A. (2015, June). In Proceedings of the 16th International Conference on Computer Systems and Technologies (pp. 120-127). ACM.

5. Gamecloud - A platform for Connecting Video Games. Parkkila, J., Järvi, K., Hynninen, T., Ikonen, J., & Porras, J. (2016). Journal of Virtual Worlds Research, 9(1).

In this thesis, these publications are referred to as *Publication I, Publication II, Publication III, Publication IV,* and *Publication V*

## Contribution of the author to the publications

1. Made the research plan, carried out the actual mapping study, analyzed the results, and wrote a major part of the article.
2. Made the research plan, led the research process and wrote most of the article.
3. Participated in the research plan, carried out the research, participated in the analysis and evaluation of the results, wrote most of the article.
4. Participated in designing the research, carrying out the research, and writing the article.
5. Made the research plan, carried out most of the research process, led the development of the research artifact, and wrote most of the article.

# Nomenclature

| | |
|---|---|
| CEO | Chief Executive Officer |
| F2P | Free to Play |
| IP | Intellectual Property |
| NPC | Non-player Character (also non-playable character) |
| PC | Personal Computer |
| WoW | World of Warcraft (a video game) |
| FPS | First-Person Shooter |
| MMO | Massive Multiplayer Online |
| MMORPG | Massive Multiplayer Online Role-Playing Game |
| RTS | Real-Time Strategy |
| VGO | Video Game Ontology |

# Contents

# 1 Introduction

During the last decade, the video game industry has grown to be a significant part of the entertainment industry. It has surpassed in size both the music and movie industries [56, 53, 55]. The video game industry in the USA alone is worth 23.5 billion US dollars, which has more than doubled during the last ten years [7]. Worldwide, the estimate for the size of the whole video game industry is 84 billion euros, of which the Finnish video game industry is worth around 2.4 billion euros, being the third biggest representative of video game industry in Europe [49].

Playing video games has become widely popular and accepted among all audiences [7]. The growth of mobile device sales, such as smartphones and tablets, has led to a situation where almost everyone is an owner of a portable gaming device. The popularity of video games has increased also because of new business models, such as Free to Play (F2P) and new styles of play, for example with the introduction of casual games [27] that can be played only for a few minutes at a time.

The growth and development of the video game markets have led to problems of visibility and discoverability. The mobile application stores only show a small portion of video game products at a time, due to for example limited screen size and the desire of marketplace owners to promote the best-selling products. This behavior tends to guide customers towards a few successful video games, making it hard for new games to be discovered by the players. One way to gain visibility is the marketing of video game products. This requires significant amounts of money, which smaller developers usually do not have. In addition, the Free to Play model has caused video game companies to spend money in order to gain new players. On average, companies use 2.73 US dollars to acquire one customer on a mobile platform, while an average player is only willing to spend 1.96 US dollars per month [62]. Taking into consideration the fact that only 10% of players spend more than six weeks playing a mobile game, the companies need to either encourage players to spend more money in the game or to lower the acquisition costs.

The big question lies in the problem of how to lower the marketing costs and how to enable visibility for smaller developers to reach their customers better. This thesis approaches the problem by presenting a solution for connecting video games with each other, by allowing the games to exchange semantically enriched knowledge with each other. Connecting video games to exchange information could improve the marketing efforts, as well as player immersion and gaming experience. If games could be connected to each other in the proposed manner, they could promote each other through cross-promotions, in-game links, and visiting characters from other games, and by transferring items or players' decisions from one game to another. These hyperlinks of games could allow players to experience a virtual universe of video games, where each game is a part

of a great continuum of games. Thus, the statement of this dissertation is that *Video Games should be connected with each other with a general, semantically enriched technical solution that can also bring contributions to both the developers and players*.

This thesis follows the methods of design science research [42] in the process of proving the thesis statement presented above. The chosen research approach connects the current research to previous research in the field of connecting video games. The approach also requires the researcher to develop an artifact or artifacts which are evaluated within the problem domain. The validity and quality of the research is then evaluated according to the possibility of the artifact(s) to improve the problem domain in the scope of the newly gained knowledge.

To respond to the requirements of design science research rigorously, the overall research question of this thesis is "*How can video games be connected in a general manner?*". The expression video games in this research refers to all digital games, such as computer games, current generation console games (e.g. Microsoft Xbox One, Sony Playstation 4) and games made for mobile phones and tablets. A connection between videos games means the possibility to enable interoperability, which allows current and future video games to exchange information with each other, regardless the programming language or platform where the game is targeted at. In order to answer the overall research question, the research has been split into smaller subquestions, which are:

1. What technologies could be used in connecting video games with each other, and do any general approaches exist? (Publication I)
2. What are the requirements of video game developers and players in connecting video games? (Publication II, Publication V)
3. How to create a general ontology model for exchanging video game knowledge between multiple games? (Publication III)
4. How can physical activities and physical world events be connected to video games and how would this be beneficial to players? (Publication IV)
5. How to create a platform to help developers to take advantage of the general model for information exchange between video games? (Publication V)

The results of this study are manifold. A semantic model for connecting video games in a general manner has been created and evaluated. The semantic model has then been used in the creation of a platform that lowers the usage barrier for video game developers to connect games with each other. The possibility of connecting video games is demonstrated with example games. In addition, a step has been taken even further, by evaluating whether physical world actions could be connected with existing video games, and whether that would bring benefits to the players. The goal of evaluating physical activity has not been

done to find out whether games could be created around physical activities, but whether recognizing physical effort and giving digital rewards in already existing video games would be considered worthwhile by the players. This has been done in the form of connecting physical exercising with video games, suggesting that connections between the physical and virtual worlds can also be created and could offer new market opportunities for different stakeholders. The stakeholders within the spectrum of this research are mainly video game developers, publishers of video games, and players of video games.

As with all scientific research, this thesis is not an exception and comes with limitations. The thesis does not discuss how to design and create video games that take advantage of the connection between games. The evaluation of how the technological solution would boost the marketing of video games has been left out due to the physical world constraint of finding video game companies that would be willing to test their commercial products with the research artifact in question. Also, the security and privacy issues are not considered in depth here. This is a significant issue that has been mentioned in the research articles, yet it is not within the scope of this thesis. Some research on the privacy issues of the solution proposed in this thesis can be found for example in [33, 32].

This thesis is divided into two parts: Introduction, divided into six chapters, and Appendices, including five scientific publications. The Introduction continues as follows: Chapter 2 introduces the background related to the video game business, giving a motivation for this thesis, and an overview on the underlying development and concepts. Chapter 3 describes the research goal and the chosen research methods in detail. Chapter 4 presents a summary of the publications, giving a short description and explaining their relation to the whole. The publications are included in the Appendix. Chapter 5 combines the results and discusses the theoretical and practical implications of the study. Finally, chapter 6 draws a conclusion of the thesis, summarizing the results and presenting some future research directions.

# 2 Video Games as Business

This chapter presents an overall look at the background for the research and introduces the key concepts. The chapter concentrates on giving a description of the video game industry and its growth, as well as the current situation of the market and existing trends. The main goal of this introduction is to explain the motivation behind the research and to help in understanding the research and technology decisions made in this thesis. A previous study related to connecting video games is part of the systematic literature mapping study, which is presented in detail in Publication I.

The chapter starts by giving a short history of the video game industry and the markets. It then continues by taking a look at the paradigm shift of marketing in the video game market and the problem of gaining visibility in the bloated market. Finally, it introduces the approach of connecting video games with each other to enhance visibility and playing experience, which is also the technology research target of this study.

## 2.1 A Short History of the Video Game Industry

The video game industry is a relatively new field of business, even though the first video games were made in the end the 1950s [29]. The first commercially success- full game was created in 1972, an arcade game called Pong by Atari, which sold more than 8,000 arcade units (cabinets) during the first two years [28]. From those times, the video game industry has seen significant growth, first in the 1980s in the form of gaming computers, such as Commodore 64 (which, according to Guinness Book of World Records is the best-selling computer in history [20]), Sinclair ZX Spectrum, and a few years later with Atari ST and Commodore Amiga. Around the same time, in the mid-1980s, home entertainment systems made by Nintendo and Sega started their march to peoples' homes. The popularity of home gaming computers and home entertainment systems introduced video games to large audiences, making way for a professional video game business.

1990s was the decade of innovation in video games. During the 1990s, video games saw a transition from raster graphics to 3D graphics, as well as the introduction of new video game genres like first-person shooters (FPS), real-time strategies (RTS) and the massive multiplayer online (MMO) games. Also, handheld gaming became popular with the introduction of Nintendo's Game Boy [64], preparing the way for mobile gaming. Personal computers also became more common in households, growing the video game markets even larger [64].

Finally, the 2000s saw the rise of mobile gaming, mainly due to the new touch screen smartphones. Even though Nokia had already started the first mobile gaming in the end of the 1990s by having the game of Snake preinstalled in their

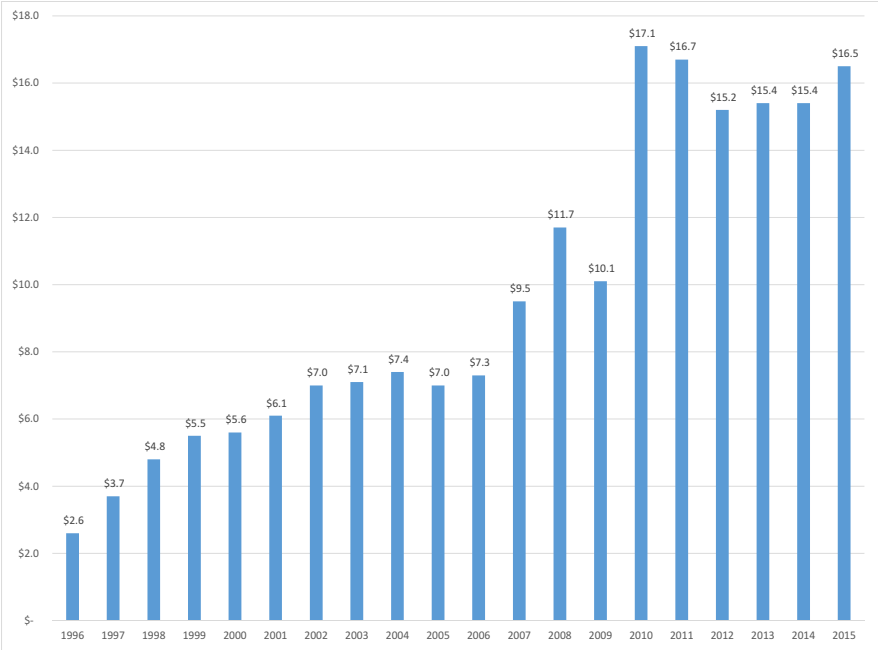


Figure 1: U.S. Computer and video game sales (in billions USD) [5, 7]

mobile phones, the real change happened with the introduction of Apple's iPhone in 2007 [61]. The possibility of downloading low-cost games from mobile phone marketplaces changed the video game business significantly. Previously, video games had been expensive, a new video game costing 50 euros or more. Now, the mobile games had a price tag of only a couple of euros. One of the first and most successful mobile games of this period was Angry Birds by Rovio (released on 2009), which reached 12 million paid downloads by 2010 [41].

By 2016, the whole video game industry has changed remarkably since the early days. The industry has gone through massive changes and seen significant growth [51]. During the last twenty years, the industry sales in US alone grew from 2.6 billion USD of 1996 to 16.5 billion USD in 2015, as can be seen in 1. Playing video games was previously considered as something meant for teenaged boys only. However, the demography of video game players has since changed, and currently the average gamer is a 35-year-old male, and 44% of the gamers in the US are female [6].

## 2.2 Distribution of video game markets

The video game industry is a large field of business, and the value chain of a video game contains multiple different stakeholders. Mainly, it consists of the actual video game developers and the players, but also of the platform owners, production tool developers, publishers, marketers, distributors, and sellers. The video game developers are the ones in charge of creating games to the end users, the players. However, the value chain contains many other important actors.

The platform owners, especially in console gaming, control the rights for creating video games on their platforms. Previously, the video game developers had to negotiate a separate development license that allowed the creation of games for the console in question. Only by negotiating a development license were the developers given access to development tools for the console in question. However, this has changed with the introduction of the new generation of production tools, such as Unity3D and Unreal game engines that also provide the tools to develop games for multiple platforms at the same time. Production tool developers are companies that either produce complete game engines or specialize in certain aspects of video game development; for example in physics or audio engines. The tools are usually an important part of video game development, as many video game developers do not want to build all their development tools themselves.

The publishers of video games were traditionally the ones who were in charge of the manufacturing and marketing of video games, e.g. their mission was to take the video game to the markets and to ensure that the game would sell. This has later dramatically changed with the introduction of digital distribution of video games. Publishers often purchase a video game concept of developers on the basis of an idea or a short playable demonstration, and then hire the developer to finish the product. The publisher carries the risk of taking the future video game product successfully to the market, but they also take a significant part of the earnings if the game sells well. Even though publishers sometimes work as marketers and distributors, these services can be purchased also separately, as hired work either by the publisher or the video game developer.

Before 2000, developing video games for distribution was an expensive and rather slow process. A game developer had to negotiate with the game console company for a development license, find a publisher to support the development, and have a distribution deal to get the video game product to the store shelves [64], just to name a few steps of the process. Until the beginning of the 2000s, the main distribution channel for video games was the shelves of video game stores and supermarkets. Once faster Internet connections became available, the distribution moved into the faster and cheaper digital channels. Instead of manufacturing physical video game DVD boxes and shipping them slowly around the world, the video game companies were able to produce an unlimited number of copies of their games and to instantly sold games to their customers on demand. This

also cut a part of the distribution costs, changing the way how revenue was shared among the developers and producers.

With the introduction of digital marketplaces, getting games to markets became considerably easier, as the developers no longer needed to coordinate and maintain complex production lines or logistic chains. The digital marketplaces also changed the revenue share of video game sales. As the digital channel has lower distribution costs and requires fewer middlemen, the digital marketplaces only take around 30% of the revenue, leaving the game company with 70% of the total sales [3]. The digital distribution has been adopted by all parts of the industry, from home game consoles (Sony Playstation, Microsoft Xbox) to PCs (Valve's Steam, GOG) and mobile phones (Apple's AppStore, Google Play). Also, the owners of digital distribution stores have started allowing outside game developers to their marketplaces, opening the doors for rapid growth in the number of game developers.

At the same time, the tools for developing video games have evolved in a significant manner. Companies have brought developer-friendly video game development tools to the markets. The professional-level development tools and game engines used by large video game companies, such as Unity3D and Unreal Engine, have become accessible for all, thanks to their free or low-cost pricing models. This has led into the democratization of video game development, making it possible for virtually anyone with a PC or laptop to develop their own video games.

The advancement of the digital distribution channels and the availability of development tools has brought a massive number of new game companies and single-person studios to the video game markets. This has led to fierce competition on the growing markets. To give an idea of the situation, the Nintendo 64 game console, which was sold between 1996-2003, had "only" a game catalogue of 388 games [37] during its complete lifespan. For comparison, in 2015, an average of 500 new mobile games were published every day in Apple's AppStore [19]. In addition, the count kept by [17] shows that in August 2016 Apple's AppStore had 644,090 different games in the United States alone.

## 2.3 Shift of video game marketing paradigms

The growth of the video game markets has led to a discovery and visibility problem. Even though hundreds of new games are released every month, only a small portion of video games bring profit to their creators [57, 1]. During its existence, the video game market has been under consistent change, and there has been confusion on how to best compete in the markets [16]. One of the big challenges for video game companies is to tackle the problem of visibility – how players can discover the game when it has to compete for player attention

with a large number of other video games [45]. In other fields of businesses, marketing professionals have recognized co-branding [63] and cross-promotion [58] as feasible approaches to solve the problem of large-scale markets.In addition to co-operation between the video game developers, a new paradigm of gaining players through free-to-play (F2P) has become widely popular, especially in mobile phone application stores. In order to understand the current situation in the video game markets, short explanations of co-branding, cross-promotion and free-to-play are given below.

### 2.3.1 Co-branding

Co-branding [63] comes from the idea of two or more companies forming a partnership to work together, gaining marketing synergy in the process. Co-branding can take multiple forms, varying from combining resources or leveraging individual core competencies to using one company's resources to promote multiple products at once. As an example, many retailers offer store credit cards that are co-branded with Visa, and local car dealers promote themselves with certain car manufacturers, such as being the official Volvo or Mercedes Benz dealerships. Another example of co-branding partnership is found in airlines, where multiple companies have joined together to form partnerships, such as Star Alliance (e.g. Lufthansa, Scandinavian Airlines, Avianca) and Oneworld (e.g. American Airlines, British Airways, Finnair). The airlines market themselves under the alliance name and also enable other members to sell flight tickets to their partnering airlines. This results in better customer experience, as the customer can purchase all the flights needed for the journey from one partner, without the need to buy the flights separately.

A good example of co-branding in video games is Square-Enix and Disney creating a game called Kingdom Hearts. The two companies joined a number of their franchises to create a successful product, which combined two different story universes into a single game. In Kingdom Hearts, famous Disney characters like Mickey Mouse, Donald Duck and Goofy meet Square-Enix's Final Fantasy characters. The companies were able to market the game with familiar characters from both companies, reaching a wide audience of fans of the franchises. Kingdom Hearts was received warmly by the players and sold well, and has received multiple sequels since [52].

### 2.3.2 Cross-promotion

Cross-promotion [46] is another form of marketing promotion where the customer of one product or service is targeted with promotion of a related product. For example, a mobile phone network may promote video or music streaming services with their mobile data plans, or a music artist can promote his or her biography

book during a rock concert.

Video games have also seen their share of cross-promotion. Games have been made of famous books, comics and movies, which can be considered as a certain form of cross-promotion. Even though movies and video games are separate products, the video game can boost the sales of the movie and vice versa. However, licensed video games are infamous of their poor quality and failures to sell. In 1982, Atari's E.T. the Extra-Terrestrial was deemed so bad that it was actually blamed to be one cause of the video game industry crash in the 1980s [40]. This is not always the case, as some licensed video games, such as Walking Dead [38], Batman: Arkham City [34] and South Park: Stick of Truth [14], have managed to rise above the rest and be considered as successful and good video games. Movie adaptations have been made of video games as well, although they have been less successful than the video game adaptations. Summer 2016 saw the yet most successful video game movie, Warcraft, to appear on the big screen. Even though the movie was the most successful video game movie of all time, it was considered to be a financial disappointment [35].

Cross-promotion often takes place as cross-media marketing, where one media (e.g. a movie) promotes another one (e.g. a book). However, in video games this is not always the case, and video games have been promoted through cross-promotion. Creating new video game brands and recognizable characters, as well as introducing them to new audiences is a difficult task, which requires skills and a significant marketing budget. However, leveraging an already known video game brand through cross-promotion, for example by connecting video games with each other, can be a valuable boost to the marketing efforts. Currently, game developers are exploring new opportunities to connect video games with each other in order to gain business benefits. A good example of such efforts is the cross-promotion of Supercell's Clash of Clans and GungHo's Puzzle & Dragons [21], which, among other benefits, have enabled Supercell to expand its market reach to the Japanese markets [22].

### 2.3.3 Free-to-play (F2P)

Free-to-play (F2P) as a term appeared in the 2010s to refer to a certain business model of video games. The idea of F2P is to give the video game to players for free and to ask for the players to pay small amounts of money (microtransactions) for additional game content or faster advancement in the game. Sometimes free-to-play is divided into shareware games and freemium games. Shareware games can be considered more like game demos, where the functionality of the game is severely limited for example to only one stage of the game. By purchasing the full version, the rest of the game is unlocked for the player. Shareware was a popular form of distributing and selling games in the 1980s and 1990s, having mostly disappeared in the 2010s.

Table 1: Number of free and paid mobile app store downloads worldwide in 2011-2017 (in billions) [54]

| Downloads | 2011 | 2012 | 2013 | 2014 | 2015 | 2016* | 2017* |
|---|---|---|---|---|---|---|---|
| Free | 22 | 57.33 | 92.88 | 127.7 | 167.05 | 211.31 | 253.91 |
| Paid | 2.9 | 6.65 | 9.19 | 11.11 | 12.57 | 13.49 | 14.78 |
| Total | 24.9 | 63.98 | 102.07 | 138.81 | 179.62 | 224.8 | 268.69 |

*estimate

The other form of F2P is the freemium model, and in the 2010s they are usually considered to be one and the same concept. In freemium games the players are given the full game for free. However, the player can use money to gain time-limited bonuses (known as consumables) or permanent things, such as new characters, weapons, cars, visual additions, or levels. The bonuses gained from the consumable items only last for a certain amount of time, making it possible for players to spend virtually unlimited amount of money in the game. A clever monetization logic is usually the backbone of F2P video games, as this is the way to gain profits from the games. Another possible way to gain profits from F2P video games is to show in-game advertisements during gameplay, in a similar manner as popular Internet news sites and blogs gain their money.

Even though free-to-play refers to a certain business model of video games, it is also closely related to the change of video game markets. The F2P business model is a common approach to designing video games in the mobile markets, where the players have grown accustomed to low prices of games (usually ranging from less than one euro to a couple of euros per game [44]). Freemium games lower the barrier of trying out new games and do not limit the maximum amount of money a player can spend on one game. This has led to a rather surprising development in video game marketing, where game companies are spending money to gain new players. The advancement of technology has enabled advertisers to follow the installations done on the basis of advertisements seen on Internet pages and inside video games.

Advertisers sell advertisements based on installations on a device, in- stead of the previous way of billing based on the amount of times an advertisement has been seen. On average, the cost for game companies on acquiring new customers (installing the game on their device) was between 1.78 USD to 2.51 USD per player in February 2016 [12]. This has caused free-to-play companies to spend significant amounts of money just on marketing and in trying to get as much money as possible from each player.

Table 1 showsthe number of free and paid mobile application store downloads worldwide from 2011 to 2015, and estimates for years 2016 and 2017. The numbers clearly show that the number of free applications has greatly surpassed the number of applications that need to be purchased upfront. Even though the table contains also the downloads of non-game applications, the numbers clearly

show that the application developers (and video game developers) believe in the F2P business model.

## 2.4 Towards business opportunities and interoperability of video games

All the developments in the video game sector mentioned above, such as the fact of video games becoming more accepted among the general public, the availability of low cost development tools, digital distribution, and the marketing of free-to-play games (F2P) have caused a problem of visibility for video game developers. Discovering new games is difficult, as new games are flooding to the markets, and especially the small screens of mobile devices allow only a few products to be shown simultaneously. In addition, the digital marketplace owners tend to promote the larger and more successful brands [8], as they tend to produce more income, bringing more money to the digital distributors as well. This tends to discriminate the smaller and less known video game developers, which has caused the developers to demand removal of top lists in mobile application stores [4]. Also, advertising video games requires a large marketing budget, which is usually available only to the biggest and most successful companies.

Gaining visibility and making a breakthrough requires a lot of developer effort. One possible approach would be for companies to team up with other video game developers and create common marketing efforts. Rovio, for example, has created a co-branding solution of marketing games of smaller companies under the umbrella term Rovio Stars [65]. The Finnish Supercell has teamed up with the Japanese GungHo to cross-promote their games to gain foothold in new markets [26]. All these arrangements are related purely to marketing, instead of taking a step further into sharing contents of one game with another one. Also, the current method of advertising inside games with pop-up banners is rather disrupting [50], breaking the playing immersion and taking away the focus from the actual gameplay [36]. What if the co-operation between video game companies could be taken a step further?

This thesis takes a look at the possibility of enabling transfer of video game information between separate game products. Enabling video games to exchange information between each other would allow player decisions, items, achievements, and even game characters to be transferred from one game to another. Instead of showing pop-up banners, an Angry Bird character could visit a Mario game, acting as a playable cross-promotion inside the other game. The decisions made by players in one game could carry on to other games, creating completely new gaming experiences.

Video games have been connected with other video games previously. A good example of linking games together is that of CCP linking games with their own


Figure 2: Barack Obama's presidential campaign advertisement inside Burnout Paradise [11]

products. Two of their games, the MMORPG (Massive Multiplayer Online Role-Playing Game) Eve Online and the FPS (First-Person Shooter) Dust 514 share the same universe, exchanging data with each other. Even though the games are of different genre and made for different platforms (Dust 514 for PlayStation 3 and Eve Online for PC), the two games manage to exchange information in a meaningful manner. A study by Carter & Gibbs [10] shows that Eve Online and Dust 514 players have found the connection between the two games to be meaningful, bringing more feeling and immersion to the game. Also, the connection between the two games can be considered valuable to the developer, as happy players spread the good word and are more willing to pay for satisfying experiences.

The connections between games have, however, been limited to products of a single producer or to single agreements between two companies. A general solution for enabling video games to exchange information between each other has not surfaced yet (Publication I). One of the main goals of this thesis is to create a general interoperability solution for exchanging information between video games.

Video games can also be connected with real-world events, blurring the difference between the physical and the virtual. Some examples have appeared in video game history, for example during Barack Obama's presidential campaign in Burnout Paradise (Figure 2) [11] and Nissan advertising their electric cars in the game of SimCity (Figure 3) [47]. A MMORPG called Everquest even allowed players to order pizza inside the game, making sure that the players would not need to stop playing the game in order to get some food [66].

This thesis approaches the visibility problem from the viewpoint of enabling new


Figure 3: Nissan advertisement of their electric cars inside SimCity [47]

collaboration possibilities for video game developers through a new technology. A technological solution, which allows video games to exchange information between each other and to connect games to create new playing experiences could allow game developers to form new ways of cooperation. Lowering the technical barriers for cooperation is a vital advancement, especially for smaller companies that do not have large resource pools available. Also, no general technical solution for enabling cross-promotion inside video games or between video games and the physical world exist currently (Publication I).

# 3 Research goal and methods

This chapter introduces the research goal and the research methods used in this thesis. A short description of the research problem and the main research question, together with the research subquestions are presented. The research approach of design science research and how it applies to the study is explained in detail. Additionally, the process of collecting research data and how the actual research process took place is explained.

## 3.1 The research problem

The main research question of this thesis concerns investigating how to connect video games with each other in a general manner. The question is further divided into five subquestions, which are presented in Table 2. The steps include the mapping of existing solutions and approaches for connecting video games, understanding the requirements of players and video game developers, designing a model for video game information sharing, and the creation of a platform that supports exchange of data between multiple video games.

The first subquestion (*What technologies could be used in connecting video games with each other and do any general approaches exist?*) is related to the background study of the research area and to understanding the current state-of-the-art research in the field of connecting video games. This is to ensure that the most recent knowledge is used when making research decisions and also to understand what has already been done in the field.

Table 2: The research subquestions and the publications they are addressed in

| | Subquestion | I | II | III | IV | V |
|---|---|---|---|---|---|---|
| 1 | What technologies could be used in connecting video games with each other and do any general approaches exist? | X | | | | |
| 2 | What are the requirements of video game developers and players for connecting games? | | X | | | X |
| 3 | How to create a general ontology model for exchanging video game knowledge between multiple games? (How to model video game -related information and knowledge?) | | | X | | |
| 4 | How can physical activities and physical world events be connected to video games and how would this be beneficial to players? | | | | X | |
| 5 | How to create a platform to help developers to take advantage of the general model for information exchange between video games? | | | | | X |

The second subquestion (*What are the requirements of video game developers and players for connecting games?)* and the third subquestion *(How to create a general ontology model for exchanging video game knowledge between multiple games?*) address the problem of what requirements video game developers and play- ers have for connecting games with each other. In order to create a general solution for exchanging video game knowledge, the requirements and restrictions from the business side must be gathered. Also, to reduce researcher bias in the research process, the conceptualization of video game contents and modeling of video game information is covered by these questions.

The fourth subquestion (*How can physical activities and physical world events be connected to video games and how would this be beneficial to players?*) is related to the possibility of connecting physical world events with existing video games. It focuses on evaluating player opinions on connecting video games with physical activities, and whether such an approach would be interesting for the players. The goal of this question is not to study exergames (where video games are built on top of physical activities) or augmented reality games, but to see if connecting existing games with physical activities would be worthwhile for gamers. In addition, it addresses the question of whether the model for video game information exchange could be used with tracking physical exercising.

The fifth subquestion (*How to create a platform to help developers to take advantage of the general model for information exchange between video games?*) is related to the creation of a platform that enables a low-barrier entry to video game developers for exchanging video game information between multiple games. In order to create video games that share information, the developers need to have a simple service which does not require a large amount of learning from the developers. The question takes a look at creating an intermediary service platform, which abstracts the requirement for learning semantic technologies, in order to take advantage of the knowledge exchange.

## 3.2 Research philosophy: Design Science Research

The practice and contribution of this thesis is in the field of information technology, although the systematic mapping study (Publication I) shows that the research on connecting video games is closely related to many other disciplines as well. The chosen research approach for this thesis is Design Science Research. This approach fits quite well with engineering sciences, where the goal is to create new solutions to existing problems. Hevner [23] defines design science research in the following manner: *"Design science research is a research paradigm in which a designer answers questions relevant to human problems via the creation of innovative artifacts, thereby contributing new knowledge to the body of scientific evidence. The designed artifacts are both useful and fundamental in understanding that problem.*".

Design science is fundamentally a problem-solving paradigm where the end goal is to produce an artifact which must be built and then be evaluated [23]. The evaluated target in design science is called an artifact, which can be broadly defined to be one of the following:

- Constructs (vocabulary and symbols)
- Models (abstractions and representations)
- Methods (algorithms and practices)
- Instantiations (implemented and prototype systems)
- Better design theories

The goal of this thesis is to evaluate how a technological solution for video game interoperability could be implemented and whether it would serve the requirements of both video game developers and players. Within the spectrum of this research, the presented and evaluated artifacts fall into the categories of constructs, models and instantiations. In the study, a common vocabulary of video games (Publication II) was gathered, which was then further developed into an ontological model, the Video Game Ontology (Publication III). The ontology was further used to create an instantiation of a technology platform to enable transfer of video game information between multiple video games (Publication V). Thus, the result of this thesis is not only a created and evaluated platform for enabling transfer of video game information, but also new knowledge in the form of a general model for defining content and player behavior in video games.

### 3.2.1 Routine design and design science research

Before going into details of the actual research, a short explanation on the difference between routine design practice and the discipline of design science research needs to be stated. The distinction between the two is not always straightforward. Hevner [23] notes that for example a design of faster or more lightweight mobile phones might or might not fall under the definition of design science research. If new knowledge is produced in the design process, for example by evaluating and comparing the created artifact rigorously with existing ones, the result can be considered a result of design science research. However, if no new knowledge is produced in the process, and the newly created artifact can be profitable and better from the pure business perspective, it does not count as being design science research, but application of best practices and conducting routine design.

When evaluating this thesis with the definition presented above, the research can be considered as design science research. New knowledge is produced, as only

little previous research has been done in the field of connecting video games (Publication I), and especially as the created Video Game Ontology (Publication III) definitely contributes to the knowledge base of video game and information systems research.

### 3.2.2 Guidelines for design science research

Implementing design science research itself is a complex process, with multiple steps and guidelines. A conceptual framework of how design science research should be carried out is presented by [23] and is shown in Table 3. These guidelines help to evaluate good design science research, and this thesis follows the given guidelines.

First, design science research must produce a new artifact or artifacts (the Video Game Ontology in Publication III, the Gamecloud platform in Publication V), which are then evaluated throughout the research process. Second, the problem must be relevant, being a technology-based solution to a business problem (problem of visibility in video game markets). Third, the design needs to be evaluated and its usability in the problem context demonstrated (Gamecloud platform in Publication V, connecting physical exercising with video games in Publication IV). Fourth, the research itself must follow good research practices, be verifiable and communicated forwards to the community (Publications I - V).

### 3.2.3 Design science research cycle

Design science research can be divided into three research cycles, which all have to be assessed during the research process. The Figure 4 presents the framework for design science research, showing how the focus of the research should be divided into three different research cycles: the relevance cycle, the rigor cycle and the design cycle [24].

Table 3: Design science research guidelines and how they are manifest in the present research

| Guideline | Description | Manifestation in the research |
|---|---|---|
| Guideline 1: Design as an artifact | Design science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation | An ontology for video games (Publication II, Publication III); A platform for connecting video games (Publication V) |
| Guideline 2: Problem relevance | The objective of design science research is to develop technology-based solutions to important and relevant business problem | The problem of visibility and discoverability in marketplaces; Interviews with video game developers (Publication V) |
| Guideline 3: Design evaluation | The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods | Demonstration video games to test the connections between video games (Publication III, Publication V); Video game developer and player interviews (Publication II, Publication IV, Publication V) |
| Guideline 4: Research contributions | Effective design science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies | Published research results in academic forums; Open-sourced ontology for modeling video game knowledge (Publication III); Open-sourced demonstration video games to evaluate the artifacts (Publication V) |
| Guideline 5: Research rigor | Design science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact | Use of scientific research methods; Evaluation of the ontology and platform with demonstration games (Publication III, Publication IV, Publication V); Scientific peer reviews of articles |
| Guideline 6: Design as a search process | The search for an effective artifact requires utilizing available means to reach the desired ends while satisfying the laws in the problem environment | Iterative process of development; Searching for proper directions in academic background literature and expert interviews (Publication I, Publication V) |
| Guideline 7: Communication about the research | Design science research must be presented effectively to both technology-oriented and management-oriented audiences | Publishing in academic forums; The thesis |

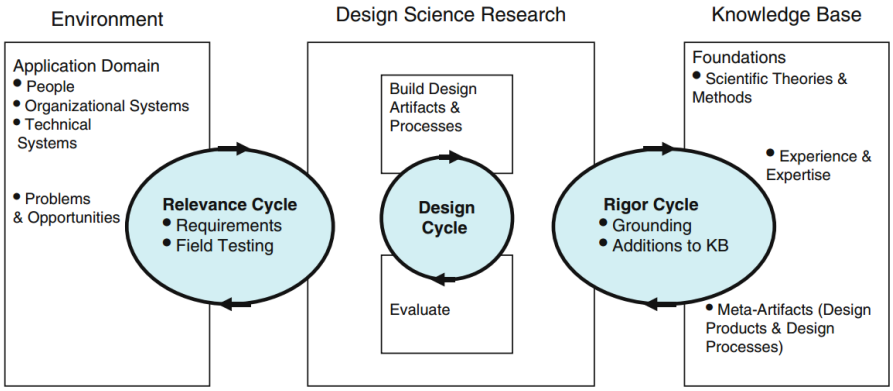


Figure 4: Design Science Research Cycle [24]

The relevance cycle connects design science activities with the environment in which the research is carried out. Good design science research must be done by identifying the application domain; the people, organizations and technical systems, as well as the problems and opportunities related to the actual environment. When the research artifact is designed and evaluated, the researcher needs to remember the designated usage environment for the solution. The rigor cycle connects the design science activities with the knowledge base of scientific foundations, experiences and expertise related to the project at hand. The research should draw from the existing knowledge base of scientific methods, which provide the foundations for rigorous design science research [24]. The central design cycle iterates between the core activities of building and evaluating the artifact(s) during the complete research project. Together, these three research cycles form the basis for carrying out design science research projects, and must always be present in design science research.

## 3.3 Research process

The research process of this thesis follows the design science research methodology, answering the research requirements listed above as well as possible, within the limitations of available resources. The research process started out with a systematic mapping study, which was used to map out the current state of the art in the field of connecting video games (Publication I). At the same time, interviews were carried out with video game players and video game developers to gather their opinions, expectations and restrictions for the approach of connecting video games (Publication II, Publication V). Based on the results of these two identification steps, a Video Game Ontology (VGO) was developed as an iterative process in order to answer all the gathered requirements. Once the Video Game Ontology was done, a platform using it to exchange video game information

between separate games was created (Publication V). The goal of the platform was to lower the entry barrier for developers to connect video games with each other. All the created artifacts were then evaluated with example video games, to demonstrate the possibility of connecting video games and the opportunities offered by the created platform (Publication III, Publication IV, Publication V).

Before presenting an overview of the publications related to this thesis, a short description of the study methods is presented.

### 3.3.1 Systematic mapping study

To tap into the knowledge base of existing research and to map out the current state of the art in the field of connecting video games, a systematic mapping study was chosen as the method for carrying out the background research. In order to carry out the study in a rigorous and repeatable manner, a decision was made to use systematic mapping study [9] [30] as the research method. As a method, systematic mapping study provides a good framework for creating a research strategy that can be followed systematically to perform a literature study, and all the taken steps can be followed.

Systematic mapping study is a good approach to be used when searching for literature in a field with little research or when the research goal is to draw a bigger picture of the field in question [30]. This leads to a mapping study having usually multiple research questions that need to be answered in order to map out the wanted research area. In addition to mapping out the publications related to the research field, the goal of a systematic mapping study is also to classify the existing research, to conduct thematic analysis, and to identify the publication forums [43] related to the research area. As the starting point of design science research is to build the research on existing scientific foundations, mapping out the current state of the art in the field of connecting games was a suitable approach for starting the overall research of this thesis.

### 3.3.2 Mixed methods: Survey and case study

Survey study refers to a group of methods that emphasize quantitative analysis of data. Methods such as mail questionnaires, telephone interviews and published statistics are used to collect information of a large number of organizations. The gathered data is then analyzed by using statistical techniques [15]. Surveys are often used to measure public opinion for newspaper and magazine articles, political opinions for elections, and in market research to understand consumer interests and preferences[13].

The survey approach seeks to discover relationships that are common across

organizations by studying a representative sample of them. The aim is to provide generalizable statements about the object of the study [15]. However, the survey often provides only information at a certain point in time and does not reveal a lot of information about the underlying meaning of the data. Thus, the study can be combined with other methods to gain a deeper understanding of the subject. In this research, questionnaire surveys were carried out in order to understand how the video game developers and players feel about the designed artifact and about the idea of connecting video games with each other.

Case study refers to a group of methods which emphasize qualitative analysis [15]. Methods such as participant observation, in-depth interviews and longitudinal studies are used to gather data from a small number of organizations. The main goal of case study is to understand the problem that is being investigated. In this approach the researchers try to ask penetrating questions and to capture organizational behavior, even though the conclusions drawn may be specific only to a particular organization and cannot be generalized [15].

To discover new ideas and gather requirements for the artifact to be developed, the mixed-method approach was used in multiple situations. This included combining survey and case study to attain more reliable results. Both video game players and video game developers were interviewed in different brainstorming sessions [60], with semi-structured interviews and with structured surveys. As an example for requirements gathering with semi-structured interviews, eight semi- structured face-to-face expert interviews with video game developers were carried out between the years 2013 and 2014 (Publication IV). The respondents were representatives of video game development companies, including CEOs, technology directors, and producers. The collected data was analyzed with thematic analysis to identify the requirements for the development of the technological platform.

# 4 Overview of the publications

This chapter presents an overview of the publications included in this thesis. The actual publications are enclosed in the Appendix. This chapter discusses the findings of the publications and their relation to the whole.

## 4.1 Publication I - Where is the research on connecting game worlds?

Publication details: Parkkila, J., Ikonen, J., & Porras, J. (2015). Where is the research on connecting game worlds? - A systematic mapping study. Computer Science Review, 18(C), 46-58.

### 4.1.1 Author's contribution

The present author made the research plan, carried out the actual mapping study, analyzed the results, and wrote a major part of the article.

### 4.1.2 Research objectives and results

In this publication, a background literature study on connecting video games was carried out. The goal of the study was to find out the current state of the art in the field of connecting video games. The background literature research was done in the form of a systematic mapping study [30]. In design science, all research must be based upon existing knowledge [24], thus justifying the need for the literature study. Also, the goal was to find out whether the existing technical solutions had been created for connecting video games and what suggestions had been presented in the topic.

The systematic mapping study followed the guidelines presented by Kitchenham [30]. The research process started by contacting experts in the field of the study, in order to gain a good understanding of possible academic publication forums to do the search in, and to assess possible keywords to use in the search. In the beginning, a smaller test study was carried out with some test keywords and in limited academic forums to see initial results. Based on the results of the initial search and the articles found, the search terms were adjusted accordingly. The final search terms used in the study were the following:

- connecting virtual worlds
- games AND (unifying OR connecting) AND (virtual worlds OR game worlds OR game universes)
- unifying games
- games AND unifying AND "virtual worlds"

The full-scale literature search was carried out in June 2014 and later updated in February 2015 to include new articles that had been released since. The results of the mapping study can be seen in Table 4. Even though a large number of different publication forums were searched, the literature search resulted only in 23 accepted articles. The accepted articles varied considerably from each other, focusing mostly on presenting technological approaches and discussing about connecting virtual worlds. The technology presentations featured articles such as how to teleport items between virtual worlds [39] and how to handle enable messaging between multiple virtual worlds and the physical world [25]. The more theoretical articles criticized for example the deterministic approach in the creation of standards [18].

The study revealed that only little research had been done in the field of connecting games, and the research varied a lot. There was some previous research on how to exchange information between virtual worlds, and even the creation of an MPEG-V standard for virtual worlds. However, a majority of the connectivity research focused on virtual worlds such as Second Life, and not much focus had been given to video games. However, ontologies were presented as a solution for aiding video game developers to create more realistic virtual worlds and to allow better interaction between objects in virtual worlds, for example by modeling weather and climate properties and relationships between elements [59].

The study did not find any general solution for enabling interoperability between video games. The results of the study actually pointed out that there was so far little research in the field of connecting video games. The research area is not solely technological, but overlaps with virtual reality studies, semantic technology studies, game studies, computer science, and with media studies in general. Connecting video games is not only a question of how to implement interoperability between video games technically, but also about how it affects the players, virtual worlds (in the end, games are also virtual worlds) and the culture around the video games.

In addition, the results of the study showed that researchers did not share a common vocabulary when discussing virtual worlds and the connecting of video games. A majority of the researchers seemed to use the term "virtual world", although the terminology did vary from "metaverse" to "social virtual worlds" and "multi-user virtual environment". The extent of different terms causes difficulties in carrying out research in the field. Literature studies are needed to map out

Table 4: Publications included in the systematic mapping study (Publication I)

| Topic/units of analysis | Research questions | Research approach | Publication type |
|---|---|---|---|
| Realism, ubiquity, interoperability and scalability of 3D virtual space technologies | What is the current status of computing in 3D virtual spaces and what is needed to move from a set of independent virtual worlds to a metaverse? | Literature survey | Journal |
| MPEG-V standardization; real world to virtual world adaptation | - | Technology presentation | Journal |
| Virtual institution execution environment; virtual world interoperability | - | Technology presentation | Journal |
| Connecting virtual worlds | Not clearly stated, but "How to construct a mechanism for navigation in complex virtual environments" | Technology presentation | Journal |
| Game ontology | "Identify important structural elements of games and their relationships, organizing them hierarchically" | Technology presentation | Conference |
| Semantics in games and virtual worlds | Not clear, but "How do semantics contribute to virtual worlds?" | Literature study, technology mapping | Journal |
| Conceptual modeling in Virtual Reality | Not clear, but "How semantically rich virtual reality applications can be done with conceptual modeling" | Technology presentation | Conference |
| Metadata schema for describing video games | Not clear, but "How to expand existing metadata schema" | Player interviews, domain analysis of catalog systems and popular game websites | Conference |
| Virtual currency unifcation | Not clear, but "How virtual currency unifcation could be implemented? | Questionnaire study, Idea presentation | Conference |
| Integrating virtual and physical objects | - | Technology presentation | Conference |
| Networking between virtual worlds | - | Technology presentation | Conference |

| Topic/units of analysis | Research questions | Research approach | Publication type |
|---|---|---|---|
| Internet Messaging between virtual worlds | - | Technology presentation | Conference |
| Service-oriented architecture for modeling affect awareness in games | Not clear, but "How to reduce the burden of incorporating affect into games? | Technology presentation | Journal |
| Modeling affect awareness in games | How to share user's affective information cross-games | Technology presentation | Journal |
| Constructing web service for modeling virtual scenes | - | Technology presentation | Conference |
| Interaction between virtual world and home automation | - | Technology presentation | Conference |
| Blending of virtual world and real world | - | Discussion | Journal |
| Player behavior after virtual world is closed | What happens when a cyberworld ends? | Multi-sited cyberethnography | Conference |
| Mobile features for improving meaningful gameplay | How can the current MMORPG support pervasiveness by enabling certain parts of the game played by mobile | Focus group study | Conference |
| Exchanging objects between virtual worlds, Connecting real-life bicycle to virtual world | Not clear, but "How to bridge the gap between virtual worlds and the real world?" | Focus group study, Technology presentation | Journal |
| Semantic technologies in Virtual Worlds | - | Discussion on the topic | Journal |
| Enabling hybrid telecommunications in virtual worlds | How to connect people who are potentially located in heterogeneous environments? | Technology presentation | Journal |
| Standardization of information for exchange of information between virtual worlds | - | Case study | Journal |

existing research for researchers to be able to base their research on previous knowledge. Also, an agreement upon terminology is needed within the research community.

### 4.1.3 Relation to the whole

The results of Publication I showed that there was a research gap in creating a general solution for connecting video games (and virtual worlds). Only little research had been previously done in the field, and none of it had more than experimental results in information exchange between separate virtual worlds. Also, no general solution was found, giving a strong validation for the creation of one.

In the results of the mapping study, semantic technologies were suggested as a promising approach for implementing interoperability between virtual worlds. If they could be used to explain the relations between items inside one game, why not the relations and meanings of items in different games. Semantic technologies could be used in modeling the domain knowledge of video games in order to enable the exchange of information between video games. This result led into further studying of semantic technologies and choosing them as the tool for implementing information exchange between multiple video games.

All in all, the small number of accepted articles, the variety of the articles, the colorful use of terminology among the researchers, and the previously done studies encouraged to continue with the chosen research path.

## 4.2 Publication II - Towards interoperability in video games

Publication details: Parkkila, J., Hynninen, T., Ikonen, J., Porras, J., & Radulovic, F. (2015, September). Towards interoperability in video games. In Proceedings of the 11th Biannual Conference on Italian SIGCHI Chapter (pp. 26-29). ACM.

### 4.2.1 Author's contribution

The present author made the research plan, led the research process and wrote most of the article.

### 4.2.2 Research objectives and results

The first step in the creation of a general solution for connecting video games was to gather knowledge about the problem domain and how the domain knowledge could be modeled into an ontology of video games. This research activity fits as a part of the design science research cycle [24] (see Table 4), which defines that the researcher must have proper understanding of the environment in order to attain a satisfiable research goal. To gather the domain knowledge of video games for the creation of the ontology, a study on collecting video game concepts was done.

The purpose of the study was to investigate the possibility of enabling the transfer of video game information between separate games. The goal was to identify the core concepts of video games and to justify the use of ontologies in enabling the transfer of information between video games. The gathering of core video game concepts was done by carrying out a group interview study among local video game developers. The group interviews followed the methods of mixed methods of combining survey and case study, as presented above in section 3.3.2 Mixed methods: Survey and case study.

During the group interviews, the video game developers were asked to brainstorm possible descriptive use cases and stories of video games that could be connected to each other. In addition, the developers were asked to write a short scenario on how they would imagine connecting video games would take place in practice. The interviews and brainstorming resulted in 83 different descriptive examples and stories, which could be used later in the creation process of the general data model for video game knowledge exchange.

The resulting video game developer stories were then analyzed further to extract concepts (nouns) that appeared in the stories. This resulted in 120 different concepts describing different aspects of video games, such as items, locations and characters. These concepts were then categorized according to their overall

meaning within the domain of video games. This led finally to eight different categories that served as the starting point for creating an initial ontology of video games. The resulting categories are shown in Table 5.

The results were then finally used to create an initial ontology that described the relations between the categories. The actual initial ontology is shown in Publication II (see Figure 1of the publication). This initial ontology could then be used as the starting point for iterating the actual ontology for modeling video game data.

### 4.2.3 Relation to the whole

For the whole research process of the thesis, this study served as a requirements gathering and domain knowledge definition step. The research resulted in gathering the core concepts of video games based on group interviews of video game developers. These stories and the extracted core concepts were used in the further development of the ontology for video games and in the design of a technological platform for enabling information exchange between multiple games.

The development of the initial ontology for video games and the classification of the concepts from the video game developer stories would later be used in the iterative generation process of the actual ontology model for video game knowledge.

Table 5: List of game concepts categorized from interviews with developers (Publication II)

| Category | Explanation | Example | Count (N=120) |
|---|---|---|---|
| Media | Methods of communication, residing outside the game. Places for discussing and changing opinions. | YouTube video, Twitter | 7 |
| Money-related | Things related to the use of money. The use of money or real-world equivalents of money. Also marketing-related information. | Credit Card, In-app Purchase, Advertisement | 7 |
| Location | Locations that often serve as the scene for game events to happen. | an island, a school, a sport event | 16 |
| Game | The actual games played by people. | Eve Online, Pac Man, WoW (World of Warcraft) | 8 |
| Item | Items are things found in games. These can be either functional things that are used or purely decorative for creating a believable setting for a game. | a gun, a sword, a photograph | 20 |
| Character | Characters are the actors through whom stories are told and events take place in games. There is no distinction between player and non-player characters | NPC (non-player character), a police, a friend | 9 |
| Game Type | Different types of games and their genres. | Car simulator, FPS, Genre | 5 |
| Abstract | Abstract things that possess multiple meanings and are difficult to describe in one word | social interaction, weather condition, love | 15 |
| Game Mechanics | Mechanics related to games. These concepts exist in multiple games but do not manifest in similar ways | a mission, stamina, infinite ammo, game interface | 16 |
| Event | Events that happen in games. An event happens at a certain moment of time and has often consequences | Advancing in game, making a decision, gaining an achievement | 10 |
| Ranking | Different means to rank players, characters or their advancement in games. | Karma, reputation, high score | 7 |

## 4.3 Publication III - An Ontology for Videogame Interoperability

Publication details: Parkkila, J., Radulovic, F., Garijo, D., Poveda-Villalón, M., Ikonen, J., Porras, J., & Gómez-Pérez, A. (2016). An ontology for videogame interoperability. Multimedia Tools and Applications, 1-20.

### 4.3.1 Author's contribution

The present author participated in making the research plan, carried out the research, participated in the analysis and evaluation of the results, and wrote most of the article.

### 4.3.2 Research objectives and results

This study continued the previous study of creating the ontology model for video game knowledge exchange (Publication II) by creating and evaluating an ontological model for capturing knowledge of video games and how they are played. As a result of the research, a Video Game Ontology (VGO) was created, which allows video games to exchange information between each other. Ad hoc examples for achieving exchange of video game information between two games existed, but a prior solution for exchanging video game information in a general manner was not found (Publication I). The problem of ad hoc solutions is that they do not scale to a large variety of games and require efforts from developers to negotiate the formats for data exchange. A true interoperability solution should be able to scale across different games that have been implemented on different platforms.

The creation process of the Video Game Ontology followed an iterative process as stated in the design science research cycle [24] and is common in development of engineering solutions. The interview results of previous research (Publication II) were used to formulate competency questions, which the ontology must be able to answer. These competency questions, in combination with the previous initial ontology and the video game developer interview concepts were then evaluated against each iteration of the ontology.

The created ontology, VGO, presented in Figure 5, enables video game developers to annotate information of video games, to exchange information between multiple games, and to gather statistical knowledge of a player's gameplay behavior. This includes defining the contents of video games, such as characters, items or events, and also the metadata related to the video game itself. As seen in 5, the same core concepts as were extracted from the video game developers

interviews stayed the same, yet a lot of additional relations and some concepts, such as gameplay session, were added.

The ontology has a few main concepts to which the rest are connected. The game itself (vgo:Game) is in the middle, as the idea is to model video game information. The game can have items, characters and achievements. In addition, the game can have metadata, such as belonging to a certain video game genre, being created by a company or an individual, and be a purchasable product for a certain price. Video game information published according to this ontology model can be also indexed by search engines and thus ranked higher in the search results, for example by Yahoo! and Google [2].

The other main concepts in the VGO are the player (vgo:Player) and the events taking place in the games (vgo:InstantaneousEvent). The player and his/her relations are used to describe knowledge about an individual player. A player can own achievements, characters and items. The player can play certain games and make in-app purchases. The events taking place in games refer for example to a player unlocking an achievement, completing a certain level, or even to the pressing of a button or a change of settings in a video game. Most video game event knowledge can be used to analyze player behavior and to help video game developers to see how their games are played and by what kind of demographies. All these relationships are captured by the created ontology.

The Video Game Ontology enables capturing deeper knowledge of player behavior in video games than what is currently gathered with more traditional approaches. Also, it allows representing relevant metadata and statistics of different video games by using the same semantic model. Additionally, it also serves as an enabler for user-friendly and unified experience in the exchange of data between video games.

The ontology was further evaluated by modeling video game data of three example video games. The example games were implemented to demonstrate the interoperability between video games. An example of this is a scenario where a player is rewarded with a special item in one game, after gaining several achievements in another game. Furthermore, the study showed an example on how to integrate an advertisement in one game into the gameplay of another. One of the demonstration games contained a non-player character which, when interacted with, mentioned a link to another video game. When a player interacts with the link shown inside the game, a reward is automatically granted to the player in the game where the link leads to.

On top of the demonstration of in-game usage inside video games, the created Video Game Ontology can be used to query information about players or video games. The manner in which the ontology was modeled enables the creation of ontology queries that can be used to retrieve similar information from different games. This allows for example the developers to gather gameplay information

of different games, or even the creation of general tools for analyzing video game data.

### 4.3.3 Relation to the whole

The study resulted in a research artifact (model for video game information), which should be the end goal of design science research [23]. This artifact was created in an iterative manner and evaluated by constructing three example video games and modeling them by using the created Video Game Ontology (VGO). The example video games demonstrated different benefits of the VGO, showing that it can be used to model the gameplay knowledge of players, to construct links to connect different kinds of games with each other, and to create in-game advertisements to encourage players to discover new video games.

The ontology proved to be a valid tool for modeling the knowledge of video games and player behavior in video games. The created ontology also served as the main model for exchanging information in the following research, where physical activities were linked with video games (Publication IV), and in the creation and evaluation of the video game interoperability platform (Publication V).

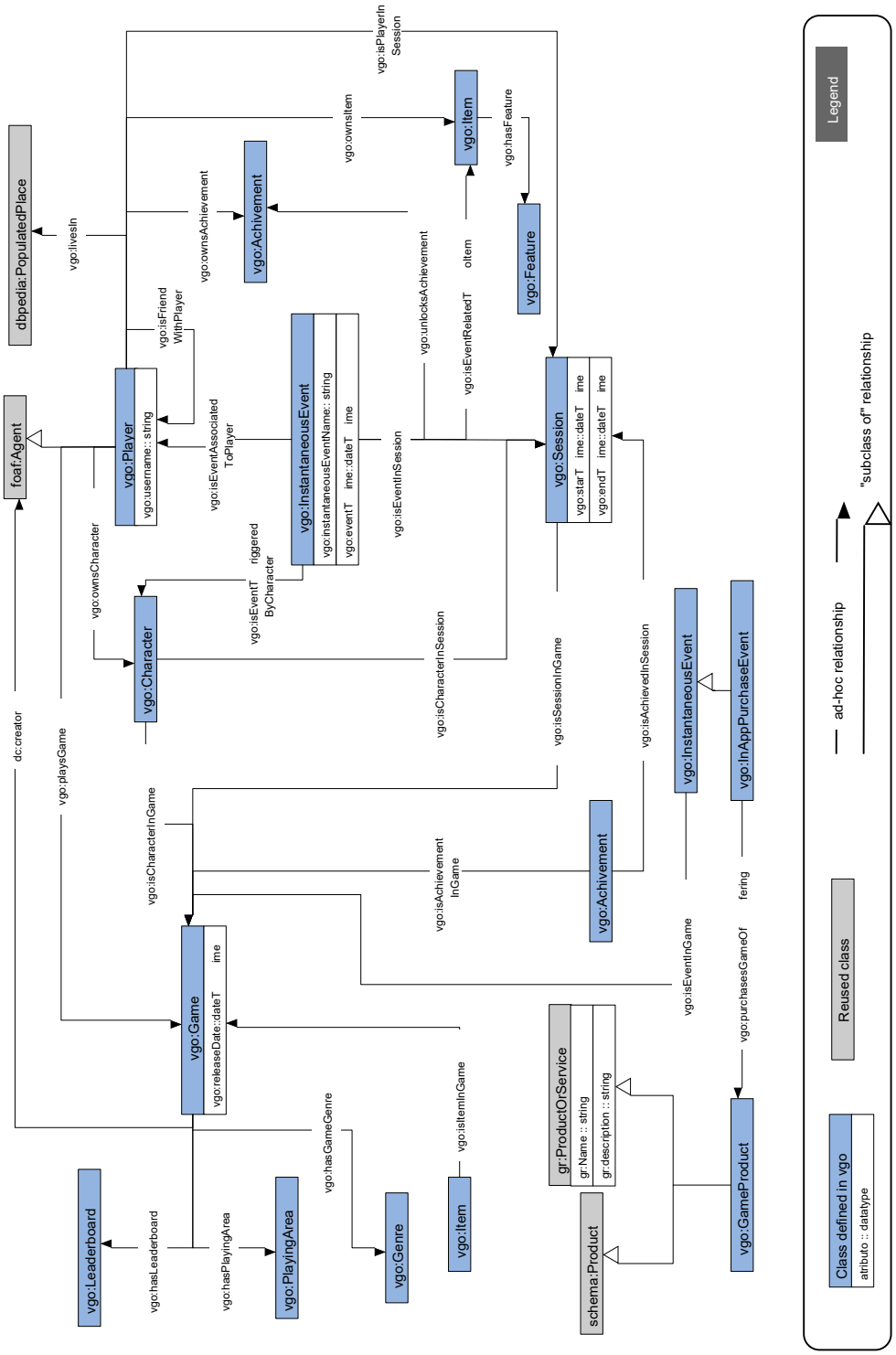


Figure 5: Overview of the Video Game Ontology (Publication III)

## 4.4 Publication IV - Linking physical activities and video games

Publication details: Ikonen, J., Ryhänen, P., Parkkila, J., & Knutas, A. (2015, June). Linking physical activities and video games. In Proceedings of the 16th International Conference on Computer Systems and Technologies (pp. 120-127). ACM.

### 4.4.1 Author's contribution

The present author participated in designing the research, carrying out the research, and writing the article.

### 4.4.2 Research objectives and results

The objective of this research was to find out if players of video games could be motivated to do physical exercising by connecting the physical world with video games. This research followed the survey methods briefly explained in Section 3.3.2 Mixed methods: Survey and case study. For the research purposes, a survey on players' opinions on physical exercise as a tool to earn in-game rewards was carried out. The survey was targeted to players of the Counter-Strike video game in order to have a specific group to evaluate. The questionnaire was openly available on the Internet for anyone to answer.

The questionnaire received 47 answers, where the majority of the respondents were males (93.6 %) and of the age between 19 and 30 (60%). Of the respondents, 87% had used money to buy in-app purchases in a video game. 53% of the respondents said that they would be willing to do some tasks if that would result in a virtual reward in a game. Changing the question to "Would you do physical exercise (e.g. run for an hour) to unlock exclusive skin or a special weapon in the game?", 47% of the respondents answered yes and 35% answered no. For a reminder, it has to be stated that the research of this publication was done in 2014, two years prior to the release of Pokemon GO. The question was aimed at understanding whether players would be willing to exercise for video game bonuses, which Pokemon GO later managed to turn into an important gameplay mechanism. Thus, it may be argued that the Counter-Strike players answering the questionnaire were more negative than the general public.

Continuing on the same path, we asked "Do you think that physical exercise (like running) could be used as currency in some other games which you play?" 60% of the respondents felt that physical exercising could be used as in-game currency. If the respondent was to be given in-game currency in their favorite game, 26% would

definitely take advantage of this option, and 30% would likely take advantage of this option. Some even responded that they would even buy a tracking device to collect exercise data to receive in-game rewards.

A correlation analysis was performed on the questionnaire variables. A weak inverse correlation was found between people interested in doing a physical task to unlock a weapon and the amount of exercise the respondent was doing (R=-0.31; p=0.04). This means that the respondents who exercised a lot were not willing to do extra task for in-game rewards, but conversely respondents who exercised little could be motivated to exercise more with in-game rewards. The respondents who currently exercised between one to seven hours weekly were the most motivated to exercise for in-game rewards, and the respondents who exercised 8 to 14 hours weekly were the least motivated to exercise for in-game rewards.

In addition to the questionnaire, a game was developed to demonstrate the possibility of connecting physical exercising with a video game. The demonstration game called Bugbear Wars allowed players who had previously done physical exercises to gain bonuses in the game. The connection between the video game and the exercising was implemented by using the previously created Video Game Ontology (Publication IV) and the Gamecloud platform (Publication V), to demonstrate the feasibility of transferring physical activities to video games.

### 4.4.3 Relation to the whole

The results of this study showed that there are people who would like to receive in-game rewards from doing physical activities outside video games. This differs from the idea of exergaming, by rewarding players from exercising, instead of making a game out of physical exercising. The goal of exergaming is similar, with the idea to encourage people into exercising by adding a video game layer on top of the actual exercising. Usually this is done by building the whole video game around a physical activity, such as walking on a treadmill. In our approach, physical activity was not required to play a game. Instead, digital benefits were given to players who performed physical exercises in a traditional manner, but this was not required to play any video games.

Some of the respondents were also willing to spend money to buy a physical activity tracker in order to take advantage of such rewards. In comparison, there seemed to be a group of people who definitely did not want to perform physical activities to gain in-game rewards.

The results of the study pointed out that combining games and physical activity trackers is technologically feasible, and there is an audience who would be willing to exercise in order to receive rewards in their favorite games. In addition, using physical exercises to grant players in-game currency could actually encourage those players who do some physical exercising to exercise even more.

The created video game demonstrated the technological possibility of connecting video games and physical exercising with the help of the Video Game Ontology. The player survey results suggested that connecting video games and the physical world contributes value to the players. Even third parties, such as activity tracker manufacturers and sellers could benefit from the connections. Thus, connecting physical exercises with video games is possible, and it can bring additional value to the players of video games.

## 4.5 Publication V - Gamecloud - A platform for connecting video games

Publication details: Parkkila, J., Järvi, K., Hynninen, T., Ikonen, J., & Porras, J. (2016). Gamecloud-A Platform for Connecting Video Games. Journal of Virtual Worlds Research, 9(1).

### 4.5.1 Author's contribution

The present author made the research plan, carried out a majority of the research process, led the development of the research artifact, and wrote most of the article.

### 4.5.2 Research objectives and results

This research explored the possibility of creating a generic platform to connect multiple video games with each other. The research contained video game developer interviews for understanding and gathering requirements for a technology platform that would enable connecting video games with each other. The interviews were done by using the mixed method approach described in Section 3.3.2 Mixed methods: Survey and case study. No generic technological solution existed at the time to enable the transfer of video game content, such as characters, items, player-made decisions, or game events, between separate game products. The claim of the paper was that video games can be connected with a technological platform and that in addition to cross-promotion, the connections between video games could be more profound, and that these connections can be created with a small developer effort.

Following the framework for carrying design science research [23], a platform (artifact) was created to enable developer-friendly use of the previously created Video Game Ontology (Publication III), and its use was evaluated from the viewpoint of connecting different games with each other. In addition, the design of the platform architecture and the reasoning behind it were presented.

In order to discover the requirements for the technological platform, eight semi-structured face-to-face expert interviews were conducted. The respondents represented different video game development companies, including s, technology directors and producers. The respondents were purposefully selected from different size and type video game companies to capture different perspectives in the issue. All respondents had published video games, and including games for PCs, video game consoles, mobile phones, and tablets. The results of the interviews are shown in Table 6, which lists all the major requirements and comments the video game developers had for connecting video games. The

Table 6: Results of the analysis of the video game developer interview data (Publication V)

| | Game-to-game or reality-to-game linkages |
|---|---|
| Description | A game that is linked to another game, sharing knowledge of game content (characters, items, player-made decisions, and game events) between games A game that is related to reality, sharing knowledge of real world content (items, decisions, and events) with a game |
| Benefits | Brand extension<br>Customer retention<br>Market expansion<br>User acquisition |
| Nature of the connection | Sharing achievements<br>Sharing statistics |
| Technological solution | Support for multiple platforms |
| Boundary conditions | Coordination<br>No requirements for the player<br>Recognizability |
| Challenges | Asymmetry in development partnerships<br>Fragmentation of technological platforms<br>Loss of control over brand<br>Loss of performance<br>Intellectual property (IP) rights and game publishers<br>Security |

respondents saw that connecting games would bring benefits to brand extension, customer retention, market expansion, and user acquisition. The view of the respondents matches with the efforts made previously by some video game companies, such as Supercell and GungHo [21].

The respondents also discussed the challenges in connecting video games. In collaboration between game developers, asymmetry challenges were mentioned as an issue that might create difficulties in developing game-to-game linkages. Asymmetry will be caused by the difference in size of the game developers, for example when a small indie developer collaborates with a large game development company, and also by asymmetric distribution of the received business benefits. In general, the respondents also expressed concern over the fragmentation of technological platforms, loss of control over the brand, loss of performance, game publishers' rights over (Intellectual Property) and security. As games are developed for many different kinds of technological platforms (mobile, tablet, PC, and console), ensuring interoperability for games that have been developed for different technological platforms was mentioned as a challenge.

One challenge, especially for larger game development companies, was the desire to retain control over their brands, which in the context of video games means the actual game and the characters in it. As many businesses collaborate with publishers to take their games to the market, some companies may not even hold IP rights in their possession, making it extremely difficult to allow the game characters to be used by other games, even though the developers might wish to do so.

Connecting games with each other and with the physical world requires the collection of player information. Physical world connections require collection of personal data of the players, which should be stored and utilized in a secure manner. The secure storage of privacy-related data and the protection of player privacy were mentioned as an important boundary condition for technological development as well.

### 4.5.3 Relation to the whole

The research presented an overall view of the opinions of video game developers on connecting video games and the opportunities and challenges that were seen in the approach. Requirements for creating a platform for connecting video games were gathered and then used as the basis for designing and implementing the actual platform (the design science research artifact).

The platform itself was evaluated against example video games, as should be done according to the principles of design science research [23]. The results of the evaluation verified that connecting video games with each other is possible with a small effort by game developers. However, testing the technology platform with commercial games that have active player-bases turned out to be difficult to arrange. The game companies were hesitant to test the research platform with their existing commercial products in the market. This is quite understandable, as testing new technology with published products is always risky.

The interviewed video game developers saw the connecting of video games as a promising venture, although some obstacles need to be cleared. For one, collaboration with other video game developers was seen as a challenge. Many of the developers felt that releasing data of their video games to their competitors could pose a risk to their brands. In addition, the video game developers stated that even though connections between video games could be created, the games themselves should be playable without the need to take advantage of these connections. Thus, the connections, even though beneficial, should always be optional to use.

# 5 Contributions and Limitations of the Thesis

The purpose of this chapter is to draw a bigger picture based on the results of the different publications and to present their implications as a conclusive summary. The research problem and the objectives stayed the same throughout the research, although some difficulties and limitations surfaced during the research process. This chapter also recognizes and discusses these limitations.

The overall research problem of this thesis was "*How can video games be connected in a general manner?*" This question was divided into several subquestions, which were answered in the publications included in this thesis. The objective of the thesis was to study the technological possibility to create a general solution to connecting multiple video games with each other in a developer-friendly manner. This approach could then enable new marketing methods for video game companies to gain better visibility in the competed and crowded video game markets. In addition, new forms of interactivity and continuity across separate video game products could be created by connecting video games. The research was carried out by following the design science research [24] methods, where both theoretical and practical research was carried out.

The research produced several results. First, a literature survey was carried out in the area of connecting video games, mapping a bigger picture of what had been previously done in the research of connecting video games, as well as what kind of vocabulary was used by different overlapping fields of academic study. Second, a semantic model for representing video game information and player behavior was created - one which did not exist previously. This model enables the exchange of video game information between separate video games, by using a common vocabulary that is also understandable for machines. Third, a platform for connecting video games was created, demonstrating the possibility of connecting separate games with each other by using example games. The platform also demonstrated how semantic knowledge can be abstracted so that video game developers are not required to learn new technologies in order to take advantage of the semantic technologies. Fourth, the results of the player survey showed that the physical world activities of video game players can be connected with video games. The results of the survey pointed out that the players of Counter-Strike were willing to perform physical activities (such as to go jogging) in order to gain digital rewards in video games.

## 5.1 Contributions to theory

Only little research has been done previously on connecting video games or transferring gameplay information between separate video game products (Publication I). The literature study showed that there had been suggestions within

the academic community to use ontologies in connecting video games, yet no general solution had been introduced so far. The complete research of this thesis proves that different video games can indeed be connected with each other with the use of ontologies.

The research provided a general solution video game ontology for sharing gameplay information with separate video game products (Publication III). The created Video Game Ontology (VGO) was evaluated with example games, demonstrating that it works as a solution for the problem of exchanging information between separate video games (Publication III, Publication V). The Video Game Ontology was made publicly available for the research community to evaluate it, for video game developers to use it, and to further the development of general information exchange between video games.

In addition to using the Video Game Ontology to connect video games, it was used to connect physical exercising with a video game (Publication IV). Players who did physical exercises were able to gain bonuses in an example video game, Bugbear Wars. Even though it was a purely technical demonstration, it showed that ontologies can also be used to connect physical and virtual worlds.

An interesting discovery was made when surveying the players of Counter-Strike and their willingness to perform physical activities in order to gain digital rewards in video games (Publication IV). Almost half of the respondents of the survey said that they would be willing to do physical exercising to receive digital rewards, and a little over half of the players felt that physical exercising could be used as in-game currency in video games. This suggests that digital rewards in video games can be used to motivate players to perform physical exercising.

## 5.2 Contributions to practice

The research resulted in many findings and presented new questions and research directions. To begin with, a practical problem discovered was the low knowledge of semantic technologies or what they even meant. Ontologies and semantics were indeed quite an unknown topic for all the participants of the interviews. Thus, a big problem is related to getting video game developers to use semantic technologies. In this study, the problem was solved by creating an abstraction layer which allowed the developers to take advantage of the video game ontology without the need to actually know the underlying technical details (Publication V).

Another issue that came up several times was related to protecting player privacy and gameplay data (Publication V). Even though solving this was out of the scope of this thesis, the finding should be noted. The video game developers felt that protecting the privacy and trust of their customers was quite important. This is a very good sign that companies feel responsible to maintain high standards for

privacy. However, many of the developers had rather vague explanation of their privacy and security requirements, hinting that more knowledge is required in this area.

One of the surprising findings that surfaced in the interviews with video game developers was the lack of trust (Publication V) - lack of trust towards other developers and lack of trust towards the players of video games. Even though the video game industry is often seen as a competitive, yet collaborative field, the results of the interviews did not support the statement. The video game companies were hesitant to share information with other parties, and were quite worried about the possible ill-use of their intellectual property in cases of sharing the content of their video games with other video game developers. This is quite similar to the situation in the more traditional fields of business, where they believe that sharing information leads into cannibalization and loss of customers [46].

The interviewed video game developers were also worried about the terms of video game publishers or digital marketplaces, such as Valve's Steam and Apple's AppStore (Publication V). Some terms of agreements may contain clauses that prohibit the use of external tools for storing gameplay data, sharing this data with other games, or even from using tools that are not in the list of the publisher's accepted list. This is an understandable restriction, one to which little can be done outside publisher terms negotiations. The digital marketplaces do not currently limit the transferring of gameplay information, as presented in this thesis. However, if large amounts of money started to move in a way that the digital distributors would not get any income, some limitations or changes might likely happen.

## 5.3 Limitations of the thesis and threats to its validity

No study exists without some limitations and boundary conditions to its applicability, and this thesis is not an exception. The interpretive nature of the thesis in carrying out the literature research, as well as the developer interviews and the gathering of ontology requirements are all possible sources for researcher bias [31]. This bias is shared in all qualitative studies. To prevent such problems, we consulted a variety of other researchers (in the literature study, Publication I), and interviewed video game developers from companies of different sizes and types (Publication II, Publication V). It can be argued that having only Finnish video game companies would give a rather limited view from the industry side. This was a problem caused by the available and limited resources. However, the interviewed companies had various backgrounds in and views about the game industry, drawing a positively varying picture of the research problem and the field of research.

Another issue was getting the video game companies to actually try the developed platform in practice. The video game companies turned out to be rather protective

about their commercially released games and intellectual property rights, and thus quite hesitant on trying out technology still in the research stage. Because of this, we were not able to gather short- or long-term experiences and feedback on how the research results would affect the practical sales of video games. Nonetheless, Pokemon Go was released in the final moments of finishing this thesis. In Japan, McDonald's restaurants are important physical locations (Pokemon gyms) for playing the game, which led to a huge increase in the sales of Pokemon-themed hamburgers and the growth of McDonald's shares [48]. This gives a strong signal towards the proposition that digital gameplay can be used to advance the sales of physical products.

## 5.4 Implications for further research

Taking into account the findings of this thesis, multiple further research directions arise. The privacy and security issues, which were left out of the thesis are important matters. When multiple games share information with each other, preventing leakage of personal data is an important issue. How to make sure that information stays anonymized, yet allowing video games to share knowledge with each other and video game developers to use gameplay information for improving the playing experience? Also, studying how developers' understanding of privacy and security risks and legal requirements actually meet in reality would be worth studying.

This thesis proved that transferring video game knowledge is possible with the use of semantic technologies. However, transferring 2D or 3D objects between video games is another issue. Perhaps video games using similar game engines can exchange graphical assets, but to be able to transfer the graphical assets between completely different video games requires further studies. Some research has been done in the area (Publication I), but there is a clear research gap for more studies here.

The developed technology allows connecting video games in a manner that can be used to create links from one game to another. These links can encourage players to try out new games, which they might not have tried out without the in-game advertisements. A problem with this lies in the asymmetry of the linkage; while one game receives new players, another one may be losing them. Understanding the long- and short-term effects of such links to both parties involved is an interesting research direction. However, this requires connecting video games with active player bases to gain large enough mass for the analysis. In addition, evaluating how the player exchange from large companies' games to small game developers' video games could be done in a fair manner that could benefit both the parties would be worth studying.

# 6 Conclusions

The study of video games as an academic field is rather new, even though it is gaining popularity among scholars. Connecting video games, which is the topic of this thesis, has been explored even less. Although some research has been done in the field previously (Publication I), there is still much more to be studied. The current growth of the video game industry and the adoption of new technologies, such as augmented reality and virtual reality are quite likely to increase the amount of research in all related areas. The results of this thesis serve as a proof that technology for connecting video games can be created, yet business restrictions and political issues still exist for the wider adoption of the paradigm of connecting video games with each other.

Based on the results of the presented research, connecting video games in a general manner is possible and can be implemented with only a little developer effort (Publication V). The games can share players' past experiences, decisions and gameplay history and use that knowledge to create personalized playing experiences. These hyperlinks between video games can work as in-game advertisements that are less intrusive than flashy pop-up banners and fit better to the overall immersion of the game in question. The players can also experience a sense of continuity between different video games, and video game publishers can use these connections to promote other game products in their catalogues.

Video games can also be connected with the physical world in a meaningful manner. Players are even willing to perform physical activities to gain digital rewards in their favorite games, or even to buy activity trackers to unlock such features (Publication IV). This can be seen in action in the successful Pokemon Go, which has motivated a huge number of players to walk tens of kilometers per day to find and catch new Pokemons. With the use of ontologies and semantic technologies, many video games could connect to the physical world and create similar or even more innovative gaming concepts based on the world around us.

Linking video games with each other will quite likely grow in popularity in the near future. Games have already been used as a platform for promoting presidential campaigns in the United States, as well as to market food and beverages. However, game companies are waking up to recognize the benefits of co-branding and co-marketing of games within games, for example to gain foothold in video game markets on different continents. The interoperability platform presented in this thesis was created for research purposes, but large digital store owners and video game publishers, such as Valve, Ubisoft, Google, Apple and Microsoft already own widely used platforms that could be extended to enable connecting video games as presented in this thesis.

The process for connecting video games has already started in a small scale among video game products that have been created by the same company (a good example

of this development are the games created by Icelandic CCP Games) or among the games of one publisher. This will help to avoid difficult competition situations and problems of asymmetry, where one video game would benefit from the success of another. The physical world will also start to connect with video games, as is happening for example with Pokemon Go. The well-known video game brands will be the most likely to lead this change, but as the practice becomes more common, less-known brands and smaller developers will get their share as well.

The cross-section of the digital and physical worlds has a huge potential for new business ventures and new paradigms for interaction. Even though more work in these areas is needed, all the players, video game companies, publishers and physical world actors have much to gain from the coming changes.

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# Appendix I: Publications

# Publication I

Parkkila, J., Ikonen, J., & Porras, J.

**Where is the research on connecting game worlds? – A systematic mapping study**

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*Computer Science Review*
18(C), pp. 46-58, 2015

# Publication II

Parkkila, J., Hynninen, T., Ikonen, J., Porras, J., & Radulovic, F.

**Towards Interoperability in Video Games**

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*Proceedings of the 11th Biannual Conference on Italian SIGCHI Chapter*
pp. 26-29, 2015, ACM

# Publication III

Parkkila, J., Radulovic, F., Garijo, D., Poveda-Villalón, M.,
Ikonen, J., Porras, J., & Gómez-Pérez, A.
**An ontology for videogame interoperability**

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*Multimedia Tools and Applications*
pp. 1-20, 2016

# Publication IV

Ikonen, J., Ryhänen, P., Parkkila, J., & Knutas, A.
**Linking physical activities and video games**

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*Proceedings of the 16th International Conference on Computer Systems and Technologies*
pp. 120-127, 2015, ACM

# Publication V

Parkkila, J., Järvi, K., Hynninen, T., Ikonen, J., & Porras, J.

**Gamecloud - A platform for Connecting Video Games**

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*Journal of Virtual Worlds Research*
Vol. 9, No 1, 2016

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