Serious Gaming Coming of Age: Implementing a European Innovation Policy to Amplify Serious Game Development

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ABSTRACT

This paper presents the "gamecomponents" portal, which was funded by the European Commission to support and amplify the field of serious game development. The portal system provides a central point of access for the exchange of advanced game software and knowledge resources. Different from existing game asset stores, the portal is dedicated to serious games rather than leisure games. Its initial offerings include over 40 advanced "pluggable" services. Different from existing asset stores, the software is platform-independent and thus avoids any risks of vendor lock-in. The paper provides a quick overview of the key characteristics of the portal and discusses the measures and options to procure its sustainable exploitation and growth.

Author Keywords

Game software; online marketplace; serious games; game development; software reuse; software components; game ecosystem

ACM Classification Keywords

• Applied computing~Computer games
• Software and its engineering~Interactive games
• Software and its engineering~Reusability
• General and reference~Empirical studies
• Networks~Cloud computing

INTRODUCTION

The benefits of applying games for serious purposes have been well recognised. Over the last decade, the European Commission (EC) has spent over hundred million Euros to research and innovation of serious gaming through its Horizon 2020 Programme and its predecessors. The support from the EC is grounded in the ambition of making Europe the most competitive and dynamic knowledge-based economy in the world, of creating of new jobs and growth by raising the level of investments (the Juncker plan) and of making the transition to a digital, single market that meets the requirements of the digital age (the Lisbon Agenda [3] and the Europe 2020 strategy [4]). Among the many EC-funded initiatives is the RAGE European flagship project, which has recently launched a game development marketplace portal to amplify knowledge exchange and networking across multiple players in the field. The main goal is to establish a European "innovation ecosystem" [2] in serious gaming, capable of interconnecting multiple innovation actors from R&D networks and networks of commercial parties across the entire value chain to generate commercial value. The innovation ecosystem concept is particularly applicable to advanced technologies (such as gaming), because high-tech industries are knowledge-driven, offer higher growth potential and thereby spur job creation and economic development. The RAGE marketplace portal is readily positioned as an instrument to promote ecosystem formation and the associated mechanisms of technology transfer and branch development.

This paper provides a quick overview of the arguments to launch the marketplace portal, its design considerations and initial offerings, its role to connect serious game stakeholders and an outlook on its potential growth.

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PROBLEM ANALYSIS

The field of serious gaming suffers from a variety of problems. Major issues are summarised below.

Fragmentation

Notwithstanding its potential, the serious game landscape is highly fragmented. Relevant research groups are scattered over a diversity of contributing disciplines, ranging from computer science to psychology and cultural science, as well as different application areas: health, military, education, cultural heritage. Likewise, the serious game industry is scattered over a large number of small independent players (SME's) and displays many features of an emerging, immature branch of business: weak interconnectedness, limited knowledge exchange, absence of harmonising standards, limited specialisations, limited division of labour and insufficient evidence of the products' efficacies [5]. As a consequence, the overall field of serious gaming is likely to suffer from missed opportunities, limited adoption, and a lack of success cases to open up new areas and markets (e.g. schools, business, governments).

Inherent complexity of games

Serious games are among the most complex ICTs because of their inherent dynamics requiring high degrees of user interaction, data processing and adaptation mechanisms, the high audio-visual demands (sounds, animations, videos), and the specific pedagogical requirements to be included in the games' design.

Comparison with triple A leisure games

In many cases serious games are typically "low budget, low tech" often referred to as being no more than "the poor cousins of the computer game industry" [5]. Product quality tends to be well below leisure games standards and the products' effectiveness for learning is often questioned [5].

Limited research-industry collaborations

Although the positive impact of R&D spending on the industry's competitiveness and innovation power is beyond dispute, the small SME's often lack the resources to invest in R&D. Moreover, there are some fundamental differences, if not barriers, between game research and the game industry with respect to time horizon (typically years versus months or even weeks), finance (government funded versus commercial operation), and overall attitude (fundamental versus pragmatic).

Technological diversity

Progress is hampered by the wide variety of programming languages, game development systems and delivery platforms that game studios have in use, all of which go with specific technical constraints and incompatibilities that pose severe barriers to growth.

High development costs

Serious games require high upfront investments. This is partly due to the complexity of games. It can likewise be attributed to a lack of knowledge exchange in the networks, leaving single parties to frequently re-invent the wheel, which is inefficient as such. For large take-up in the market, development costs and time-to-market should go down, which could be procured by enhanced knowledge exchange and the reuse of software for game development.

CONTRIBUTIONS TO THE FIELD

In 2015, the EC decided to fund the RAGE project to address these problems. The RAGE consortium was composed of 19 partners from 10 European countries, including game studios, game researchers, educators and business innovators. The overall budget of 9 million Euro signifies the urgency and significance of the problems identified. The main assignments to the RAGE consortium were:

- Reduce interoperability issues between different technical platforms
- Provide cutting-edge game technology examples that can be easily reused
- Provide scientific and practical evidence through real-world application cases
- Create a repository for the exchange of game software
- Provide a model for sustainable exploitation

The outcomes of the project are summarized below.

The RAGE component-based software architecture

RAGE has prepared a component-based architecture to accommodate the easy integration and reuse of software in the wide diversity of development platforms, target platforms and programming languages that are being used in practice [7,8]. The RAGE architecture is essentially lightweight and does not demand substantial overheads from developers. The simple case would be the remote communications of server-side components with centralised applications: these are based on a service-oriented architecture (SOA) using the HTTP-protocol (e.g. REST), which offers platform-independence and interoperability among heterogeneous technologies. Web services offer several advantages such as decoupling from implementation details and a high degree of reusability of services, but may also affect system performance due to frequent network calls and they impede off-line gaming. Client-side components, which all need to be integrated into client-machine applications (viz. game engines), bypass these problems, but they are more sensible to system incompatibilities. Regarding the client-side, the RAGE component architecture overcomes many of potential incompatibilities as it avoids dependencies of external software frameworks by not relying on game application code. Instead, it uses a limited set of well-established software patterns (Bridge, Singleton, Publish/Subscribe) and coding practices aimed at decoupling abstraction from its implementation. This decoupling facilitates reusability of a component across different game engines and other client environments with minimal integration effort. The architecture was validated for multiple programming languages (C#, C++, Java, JavaScript) and many proof cases have been established with real games [7,8].

Reusable software components

The research parties in RAGE have created a diverse set of game components, all of which offer pedagogically-oriented functionality to be used or integrated in serious games. They provide unique, enabling technologies for game developers empowering them and their studios to create better games at lower costs and in less time. As game components should extend rather than restrict the creative space of developers, the components work under the hood only: they do not directly address the game's user-interface, thus respecting any look and feel deemed appropriate for the game. The set of components include software for massive learning analytics (tracker, storage, authentication and analytics fully decoupled from e.g. Google), affective tools (e.g. arousal detection, emotion detection, motivation assessment), adaptation and balancing tools (based on e.g. game difficulty, competences, motivation), modelling tools for believable Non-Playing Characters (e.g. dynamic mood modelling, appraisal modelling), procedural animation of non-verbal behaviours, a social gamification suite (enabling

multi-player features, e.g. tournaments, teams, group challenges, award systems), competence-based adaptation, dialogue builder and reasoned software, natural language processing (topic mining, sentiment analysis, essay grading, summary evaluation, comprehension prediction, text-to-speech vice versa, lipsync) and many other functions. So far, all these components use the Apache 2.0 license (white label software), which allows for reuse by third parties both for commercial and non-commercial purposes, either under open source or closed source conditions. To promote the adoption and reuse of the software products exposed, they have all been enriched with user guides, instructional materials, demonstrators and proof cases.

Component usage in real-world games

For the validation of the approach, professional game studios have created 7 games based on the various components. The games focus on various 21st-century soft skills and address diverse educational and training contexts: leadership and management skills for recreational sports leaders, customer helpdesk skills and collaboration skills for vocational IT students, conflict management skills and creative entrepreneurial skills for art and design students, job application skills for corporate candidates, and interrogation skills for police officers. Over 2,000 participants were involved in the game sessions. For all games a dedicated evaluation was carried out with the purpose to, on the one hand, collect scientific evidence for the effectiveness of this game-based training, and on the other hand, to substantiate the practicability of component-based game development [1]. With respect to the latter, an extensive assessment was carried out of the usability and practicability of the available components as well as the RAGE architectural elements among developers. The developers are generally positive about the components and the architecture and claim that these help them to do a better job in less time. The costs/benefits ratios of components are highly favourable: while all components, including their design, development and empirical validation, are based on extensive long-term research (multiple years), the integration of a component in a game is merely a matter of days or even hours. A case-based costs-benefits analysis has confirmed the impact of reusing software components, reporting costs/benefits ratios up to 1 over 100 (a succinct version of the costs-benefits analysis can be found at https://www.gamecomponents.eu/page/case-studies).

The Marketplace Portal

RAGE contributes to the objective of an innovation ecosystem by its community platform at gamecomponents.eu, that offers centralised access to the collection of reusable game software components. It differs substantially from existing gaming marketplaces, such as the Unity Asset Store, the Unreal Engine marketplace and the Cry Engine marketplace, which are all driven by commercial game platform vendors. The existing stores do not specifically focus on serious games: most objects are media objects (e.g. terrains, audio, buildings, weapons, user-interface objects, and templates) rather than software objects, and they readily lead to vendor vendor lock-in, because the scarce game software objects can only be used in the vendor's game platform. In contrast, the gamecomponents.eu portal is domain-driven instead of platform-driven: it has a clear focus on serious games, which are no longer positioned as a by-product of leisure games, and its software offerings can be used across multiple development platforms.

At the core of the gamecomponents.eu portal is a digital repository of software objects and associated knowledge resources [6]. Figure 1 shows a screenshot of the software catalogue page.

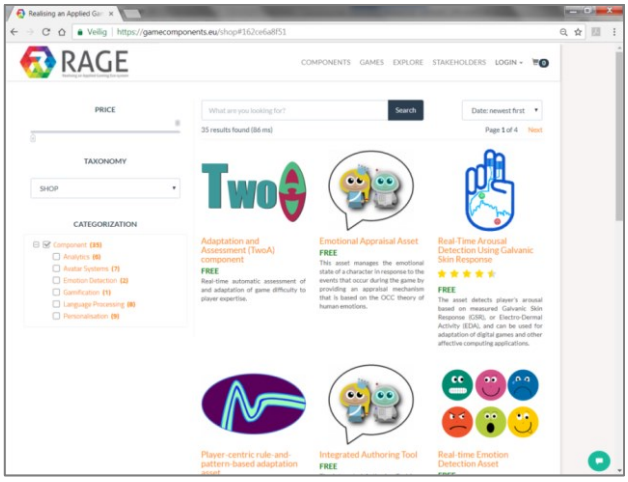

Fig. 1. A screenshot of the software catalogue at the marketplace portal (gamecomponents.eu).

The look and feel of the portal largely complies to what is common at existing marketplaces, while offering various search and filter options. Providers of game software can use the submission tools to specify the relevant metadata and to upload the associated software and artefacts such as manuals, tutorials, videos, demos, design documents, testimonials, training courses, empirical proof cases, etc. The software can either be uploaded as a separate zip archive or included as a reference to an external archive (e.g., Github, Bitbucket). Integration with social media platforms such as Mendeley and Slideshare allow for easy import of existing resources [6]. Also, the portal is supported by a full e-commerce suite, which allows parties to sell and buy artefacts. It allows parties to go beyond current free and open source offerings, and expose proprietary materials requiring licence fees and service costs. It helps to transform the marketplace into a true trading place.

After its launch in the course of 2018, the number of monthly visits to the portal gradually grew to over 8000 in January 2019. By then, the number of direct downloads from the

portal was 40 per month. Additional downloads from existing software management portals such as Github or Bitbucket are not included.

DISCUSSION

With its gamecomponents.eu portal and the initial collection of reusable game software, the RAGE project has created a starting point for establishing a serious gaming innovation ecosystem. However, solely the launch of a portal, even if it exposes high quality technologies and resources, does not make an innovation ecosystem. The ecosystem would essentially be a social system that links together diverse stakeholders across the value chain: individuals from universities, industries, education and government, using the portal as a vehicle. A key question will be to what extent the portal will be embraced by serious gaming stakeholders, either from academia or from the industry, to benefit from the opportunities for collaboration and the exchange of knowledge and resources. Evidently, the portal will need to grow in terms of contents and in terms of users. A steady influx of new software components, tools and resources is deemed essential, along with a growing number of users and associated application cases demonstrating the successful deployment of component-based serious games.

To preserve the results of the RAGE project after its recent ending, parties have established the RAGE Foundation as the legal entity acting as the custodian of the RAGE legacy. Currently, the RAGE Foundation has been focussing on the following priorities. First, the Foundation will arrange and participate in stakeholder events to enthuse and encourage the various target groups. This should help to establish further growth both on the supply side of game software and on the demand side. Second, the Foundation will elaborate the details of the hybrid multi-sided business model that has been devised for sustainable exploitation of the portal. Based on extensive stakeholder consultations, this model was selected as the best option, providing the flexibility and ability to eventually accommodate multiple revenue streams, such as subscription fees, e-commerce services, and premium services, and to adapt quickly to changing market conditions in the fluid and fractured serious gaming development landscape [7]. Third, the Foundation is actively engaged in exploring opportunities for funding and financing. As a first success the Foundation together with the Dutch Gaming Association (DGA) has launched a gaming fieldlab (https://dutchgamesassociation.nl/service/dga-gaming-fieldlab/) that provides funding to public-private research collaborations targeting reusable game software.

Successful future exploitation of the marketplace may truly advance synergy and coherence in the domain of serious gaming.

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