**Introduction**

A newly established company approached to get a professional guidance on how to start mobile game development. The company wanted to understand the relative software and hardware analysis in relation to the different environmental set-ups such as on-premise architecture or cloud computing. The company aims to start with smaller scale and asked to provide the recommendation according to following user categories:

1. Developers

* Programming
* Testing

2. Designers

* Animating
* Modeling

3. Managers

* Project managing
* Marketing

In the beginning stage of the business, the company decided not to create a separate position for testing and assigned it to developers instead. In addition, the company asked to make a recommendation by adopting the TCQ (Time, Cost Quality) triangle as the base determiner.

Accordingly, the primary focus of the following report is guiding the new company into highly competitive but at the same time very profitable and on demand industry, mobile game development. The report covers hardware, software and server analyses in according to the company`s status and requirements.

**Review of hardware and recommendations**

The process of mobile game development includes highly demanding workflows with different type of hardware components. Smart way of handling hardware barriers will be to apply different solutions to above-mentioned user categories (developers, designers, managers).

Table 1. Hardware specifications in relation to different user categories

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Categories | Computer type | CPU (Central Processing Unit) | GPU (Graphics Processing Unit) | RAM (Random Access Memory) | Recommended model |
| Developers | Laptop or desktop computer | Intel i5 or better | AMD Radeon 520 | 8GB and above | HP envy 17T  Price: $1,199 |
| Designers | Desktop computer *(all in one preferred)* | AMD Ryzen 7 3800X or Intel i9 9700K | *(Buy the best you can afford)*  NVidia GeForce RTX 2080 | 16 GB and above | Microsoft Surface Studio 2  Price: $3,999 |
| Managers | Laptop | Intel Core i3 or above | AMD Radeon 520 | 4GB and above | Acer Aspire 5  Price: $320 |

I neeed pictures for above computers in a table

The set of hardware for the development branch requires medium type of computers that satisfies the needs of programmers and testers. The recommended CPU starts with Intel i5 as the developers might need a reasonable CPU while testing and running the game in the coding process. For example, instead of deploying the game whenever there is a need to test the codes, programmers usually rely on their CPUs to take multiple screenshots of the game and send back to the developer as the preview. The power of the GPUs for development branch is not a difference maker, however, programmers need the RAM with minimum of 8 GB to run various software such as Unity, Visual Studio and Google chrome at the same time. The recommended model is HP envy 17T which comes with touchscreen, up to 1TB memory and outstanding graphics.

Traditionally creating video games were mostly about programming, however, the industry turned into multi billion worth business where companies now started to consider graphic details like character design, cut scenes, level design, puzzles and animations (Study.com, 2020). As it is easy to notice from above table, the designers require the most powerful hardware systems among all user categories. The main reason is a process called rendering which converts the art model from designer’s viewport into realistic images or animations (Pixar, no date). The more powerful the CPU and the GPU of the computers, the faster is rendering time which helps to finish the games a lot more faster instead of waiting for a single video to render in couple of weeks. The recommended computer model is all in one Microsoft Surface Studio 2, which is built for designing purposes. Even though the hefty price of $3,999 might be violating the cost rule of the TCQ triangle, it is better to invest once in the beginning instead waiting the render-time for several weeks or even months.

The managers user category has no specific limitations or recommendations in relation to hardware systems. The recommended type of computer would be laptops as business meetings and special events might require the transportable computers, however an Ultrabooks or Chromebooks can easily meet the same requirements as well. The proposed advice is to buy a laptop with the average configuration that does not costs much money such as Acer Aspire 5.

**Review of software**

In comparison to hardware systems, finding the most suitable software might be little more challenging task. In the era of Digital Revolution, hundreds of software were built to satisfy the needs of game developers regardless of their knowledge, experience or expertise (gamedesigning, 2019). However, the difficult part is deciding the type of computing services that runs the infrastructure of the organizations. Here are three tables that demonstrates the set of software options in according to cloud, on-premise and hybrid based infrastructures:

**Cloud based software options:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Users | Name and price | Browsers support | Short description | Benefits | Limitations |
| Design | **Adobe Creative Cloud**  Price: $69.99 per month, team;  *SaaS[[1]](#footnote-1)* | Google Chrome, Firefox, Microsoft Edge, Safari | Adobe offers best range of software from drawing sketches to even making a short movies | + 20+ apps  + Up to 100GB storage + Contains enormous library and great community | - Fluctuated price  - Some apps don`t get enough attention and upgrade |
| **Gravit Designer**  Price: Free;  *SaaS* | Chrome, Firefox, Safari | Vector graphics designer for product, graphic and website designing | + Easy interface  + Fast rendering  + Completely free | - Range for saving format is limited |
| **Vectr**  Price: free;  *SaaS* | Chrome, Firefox, Safari | Graphics software for 2d Art | + Supports collaboration  + Beginner friendly  + Completely free | - Up to 100 edits only without internet |
| Development | **AWS Cloud9**  Price: Depends on the CPU usage and storage (around $40-50), per team;  *PaaS[[2]](#footnote-2)* | Mozilla Firefox, Chrome, Microsoft Edge, Safari | Cloud-based platform that helps to write, run and debug the code | + Text chat support  + Integrated Debugger  + Supports libraries, plug-ins and SDKs  + Comes with AWS special command line | - Sometimes slows down  - No shortcuts (e.g. to run)  - Code highlighting is very poor |
| **Codenvy**  Price: Free;  *PaaS* | portable with any browser`s latest version | A cloud based workspace for coding purposes | + Easy interface  + Git support  +support for JAVA and SQL  + Great team workspace  + No need to install | - Low community  - Keyboard shortcuts are way different to any similar software |
| **Heroku**  Starting Price (professional): $7 per month, team;  *PaaS* | Chrome, Firefox or Safari | Cloud based programming platform | + Comes with notification and alerts  + Open source  + Supports all new programming languages as well | - Local installation  - Concerns about security |
| Production | **Workflow Max**  Price: $99 per month, 10 users;  *SaaS* | Google Chrome, Microsoft Edge, Mozilla Firefox,  Safari 8 (or later) | Project management platform which helps to control the flow of the business | + Great analysis and reporting system  + Helps to control staff  + Tracks expenses | - Difficulty in configuration  - Pricing is per user |
| **QuickBooks**  Price: $70 per month, 5 users;  *SaaS* | Mozilla Firefox, Google Chrome, Safari and Microsoft Edge | Accounting software which helps to work with financial side of the business | +500 integrations  +User friendly  +Supports 3rd part applications | - Number of the user is limited  - No support for very complex accountant usage |
| **Google Team Drive**  Price: $12 per month, team;  *SaaS* | Microsoft Edge, Internet Explorer, Chrome, Safari, Firefox | Tool that provides to edit, share and collaborate on different type of documents | + Unlimited storage  + Very good support and great community  + Accessible from phones and tablets  + Team-based file ownership | - Slow download or upload |

**On-premise based software options:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Users | Name and price | OS/browsers support | Short description | Benefits | Limitations |
| Design | **Adobe creative suite**  Price: $79.99 per month, team | Mac OS X,  Windows | Similar to Adobe Creative Cloud, but on-premise based | + Tech Support  + Every Adobe creative app  + Console for managing License  + Great community | - Fluctuated price  - Does not supported or updated anymore |
| **Blender**  Price: free | Mac OS X,  Windows, Linux, Haiku, FreeBSD, NetBSD | Blender is open source, computer graphics software used to 3d modelling, animation and visual effects. It is one of greatest software in design industries if not best after update 2.8 | + Supportive community  + Vast major of online tutorials  + Includes separate sculpting, shading, tracking, rigging interfaces  + Has tons of add-ons (create yours with Python) | - Slows down while working with high-poly objects  - Sometimes new updates changes the whole software and requires to relearn the UI |
| **Autodesk Maya**  Price: $4170 per year, tem | Mac OS X,  Windows, Linux, | Autodesk Maya is the computer graphics software which is used by every big gaming and animation companies (even Pixar uses it) | + Animation is easier and more realistic than Blender or 3DS MAX  + Free form 3D modeling  + Being use by almost all gaming industries provided a lot of plugins | - Very costly  - Rarely provides updates (so new additions comes late to Maya) |
| Development | **Visual Studio 2019**  Price: free (Community version) | Windows, Mac OS X, Linux | It is an integrated development environment to build software, apps, websites, services and more | + Project collaboration  + Works best with Unity  + Growing community  + Do not requires much coding for UI and Front End | - Sometimes crashes(so save more often)  -Additional packages are very heavy (takes too much space) |
| **Unity**  Price: Free | Windows, Mac OS X, Linux | Game engine to create cross-platform games | + Supports almost all gaming platforms (25 including PS4, Xbox, Switch)  + Any possible problem is probably has solution in the internet  + Supports built-in monetizing  + Supports both 2d and 3D  + Now supports deploying ***VR*** games  + Has own asset store | - Design and modelling is almost unhelpful  - Depends on Mouse (very hard to control with stylus or touchscreen)  - Because of the new version 5.0 most of the documentation and books are outdated |
| **Unreal engine**  Price: Royalty fee (5% of your gross revenue) | Windows, Mac OS X, Linux | Mobile app creator for IOS, Android, Widows and BlackBerry platforms | + Promises best graphics  + Faster rendering  + Blueprint visual scripting allows to work with nodes instead of hardcoding everything | - Negotiating custom license after game deployment  - Not as much plugin as other engines  - Size of the game is heavily influenced by the built-in data |
| Production | **Odoo**  Price: $37.50 per month, 5 users | Linux, Unix-like, Mac OS X, Windows, iOS, Android | All in one business management software that includes billing, manufacturing and project management | + Daily backups  + Email integration  + Very safe  + Supports phone and tablets | - Lack of customer support  - Difficult to maintain |
| **Tryton**  Price: free | Windows | A software that monitors the project management by three tier architectures: client, server, database | + Reporting and Analytics  + Tech support  + Can easily switch to cloud based app | - Only supports Widows  - Lack of documentation |
| **Microsoft Office 2019** Price: $249.99 (one-time purchase) | Windows, Mac OS X | A list of packages that contains all the office applications that helps to share, edit, create and manage projects | + Supports 17 different languages  + Black theme  + Speech feature (text-to-speech)  + Works offline | - Not as supported as Office 365 (which is cloud based)  - There will be no updates |

**Hybrid based software options**

*(Note! The Hybrid table is achieved by combining above two table sets, so the detailed information of the given software can be found in relation to the corresponding (*🗸) *tick symbol)*

|  |  |  |  |
| --- | --- | --- | --- |
| Users | Software name and price | Cloud-based | On-premise based |
| Design | **Adobe Creative Cloud**  Price: $69.99 per month, team;  *SaaS* | 🗸  *(e.g. the tick symbol is in cloud based column, so go to cloud-based software table to see the detailed information of the software)* | 🗴 |
| **Blender**  Price: free | 🗴 | 🗸 |
| **Gravit Designer**  Price: Free;  *SaaS* | 🗸 | 🗴 |
| Development | **Visual Studio 2019**  Price: Free(Community version) | 🗴 | 🗸 |
| **Unity**  Price: Free | 🗴 | 🗸 |
| **AWS Cloud9**  Price: Depends on AWS CPU usage and storage (around $40-50)  SaaS | 🗸 | 🗴 |
| Production | **Google Team Drive**  Price: $12 per month, team;  *SaaS* | 🗸 | 🗴 |
| **Workflow Max**  Price: $99 per month, 10 users;  *SaaS* | 🗸 | 🗴 |
| **QuickBooks**  Price: $70 per month, 5 users;  *SaaS* | 🗸 | 🗴 |

**Recommendations**

One of the crucial factors of selecting the most suitable software is the type of computing services. Building an organization based on cloud computing is currently accepted as good management practice, however the infrastructure is still not capable of delivering powerful and integrated software that serves the mobile app development. For instance, current cloud based infrastructure has no any set of software that is capable of creating complex animations, visual effects or 3D models. However, absence of powerful software cannot lead the companies to stick with on-premise based structure as well. Simple management tasks or team projects are too slow to share and collaborate with members. Therefore, recommended approach is to rely on hybrid infrastructure. As a result, only software from hybrid-based table will be discussed in the following section.

Referring to the hybrid based table, for developers two on-premise based and one cloud based software were selected: Unity, Visual Studio 2019, AWS cloud9. Previously mobile game development required to build a custom game engine with complex theories such as Physics, Computational Geometry algorithms and linear Algebra (Serrano, 2017). However, open-source and cross-platform game engine developed by Unity Technologies require no prior math or physics for creating mobile games. With the programming language C #alone (no more support for JavaScript), developers gets following benefits from Unity:

* Deploying games into 25 different platforms including modern VR Tech.
* Using Unity Asset Store that includes hundreds of Level designs, polygons, skyboxes and many more
* Access to Unity Community where almost any problem has multiple solutions

As the company assigned testing part of the development to programmers, developers might be required to spend few hours with copying and installing the game into different mobile phones. However, Unity provided with mobile app called Unity Remote 5 that helps to live test games through USB cables without installations (Unity, 2019). As for the selection of Visual Studio, Unity Technologies recommends the software, which includes C# support, Git support and clear debugging as well. AWS cloud9 is alternate cloud-based text editor that allows to share code with team members in real-time.

During the Microsoft`s Unity tutorial, famous game designer Matt Newman suggested to split the game designing software types into 3 categories: Sketching, Graphics and Editing (2018). A cloud based Gravit Designer was selected as sketching software that is completely free of charge and helps to create outstanding Vectors with smart SVG editor and accurate knife precision. With regard to graphics software there are currently two best options Blender and Maya, as Autodesk 3ds Max is falling behind and a little bit outdated. To stick with company`s cost factor of TCQ triangle, Blender was selected as the primary graphics software which is completely free and open source. The latest update 2.8 completely changed the software with creating user-friendly interface, sharp workbench and real-time Rendering called EEVEE (Blender, 2019). The free software is overtaking $4,170 worth Maya in each field, as there are even rumors of Pixar switching from Maya to Blender. The last recommended software is adobe creative cloud, which has essential apps like Illustrator and Premier Pro to speed up the editing and designing processes.

The last category, management is recommended to use completely cloud-based software as the daily tasks of the department can easily achieved by lightweight applications. Google Team drive is highly recommended as a central station for the whole team to share the projects and documents. Workflow max and Quick tools are both all in one project management software that allows to analyze and keep track of business status.

**Server related recommendations**

Game servers are server side structure that allows storing the user data and maintaining the online mechanism of the mobile games (Bynum, 2020). As games grow in size, using a dedicated game server helps to maintain large player traffic, safe transactions (in-app purchases), secure environment and player backups. The best option would be subscribing to the Power Server plan of HostGator. Just for $249 per month (which is currently at 50% discount) subscribers get 99.9% uptime guarantee, 8 core / 16 Thread Intel Xeon-D (a type of CPU), 16 GB RAM and unlimited data transfer (HostGator, 2020).

**Conclusion**

In conclusion, modern technological advancements created a simple environment that facilitates developers into game development, however, companies have to carefully consider the relevant hardware, software and sever types. In general, about average hardware set is recommended for mobile game developers, however because of the process called rendering, the designers need a powerful computers as Microsoft Surface Studio 2 with a powerful CPU and GPU. The recommended approach for software is to rely on hybrid infrastructure since powerful software such as Blender and Unity are not available in cloud computing. Finally, companies should subscribe to the dedicated server hosting called HostGator, which provides reliable and powerful server model.

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1. SaaS – Software as a Service, type of cloud based service that offers subscription based software to the users [↑](#footnote-ref-1)
2. PaaS – Platform as a Service, supplies with environment for coding, testing and developing software [↑](#footnote-ref-2)