

The IMD Project

# VR/AR Market Report

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## 1. EXECUTIVE SUMMARY

Virtual Reality (VR) and Augmented Reality (AR) markets are expected to grow fast during the next few years. The growth derives first from consumer uptake of VR gear and content. This is mainly based on games. Later on the major growth comes from the industrial uptake of AR technology and services.

The development of the VR/AR gear market so far has been a disappointment compared with the earlier expectations. The main obstacles for quicker consumer uptake have been high prices, requirements of the computing devices, cyber sickness, and the chicken-and-egg-situation with the development of gear and content.

The basic workflow in VR as in all media includes content production, distribution, and consumption. There are multiple parties involved in the VR workflow. The production of 360 videos differs from the traditional production of 2D videos in several ways in terms of narrative, filming, sound, and postproduction. The challenges of delivering the video and providing a seamless end-user experience are even bigger.

There are no established business models for 360 videos or other kind of VR/AR content yet. Companies are still doing mainly pilots and PR-oriented try-outs in order to learn the new technologies, and to understand their commercial potential and requirements concerning skills and resources. The main ways to finance productions are sponsoring, subcontracting, branded content, and public subsidies. Advertising is also becoming a relevant model.

Currently it is challenging to get VC funding for VR/AR companies, as the expectations of the early hype have not been fulfilled. The companies developing technology, software and tools are in a stronger position to get VC funding than the content production companies.

There are no established VR/AR platforms for mass distribution or broadcasting yet. Social media services are primary channels for reaching larger audiences. Media houses have also created their own standalone applications. For more immersive content gear platforms are important but limited from consumers' point of view. For VR games there are already established digital distribution platforms.

We analysed the current Finnish VR/AR industry landscape, and categorised companies' products and services into three areas: tools and platforms, production, and applications/content. We identified more than 60 companies in Finland working on VR. In addition to these companies, there are also a remarkable number of VR utilizer companies, which represent any industry or branch.

The SWOT analysis revealed that the Finnish companies have some clear strengths especially in technical skills, support systems, and co-operation networks. However, the companies are, at the same time, suffering to survive due to lack of funding, work opportunities, and in some cases business skills.

The international VR/AR market is developing very fast. Therefore it would be essential to develop the companies and their skills swiftly so that the fast movers could exploit the opportunities and gain market shares in selected business areas. The biggest challenges are ensuring financing, and keeping and acquiring sufficient talent in Finland. In both the B2B and B2C market, VR/AR requires more promotion to speed up VR/AR uptake, which would then enable scaling up the Finnish VR/AR companies.

In order to exploit the potential of the emerging markets **we recommend the following action points:**

- Invest in the industrial uptake of VR/AR, especially the successful mid-scale companies in basic industries
- Invest in exploiting the potential of VR/AR in the most potential business areas such as security, education, health care, construction, and maintenance
- Add VR/AR into the education programs in all levels and create specialized programs
- Support co-operation between SME companies and academic research institutions.
- Amplify the resources for VR/AR research
- Target more Tekes support and funds for VR/AR
- Support international networking and exports of the VR/AR companies
- Subsidize various kinds of pilot projects and further development of the best ideas
- Use the success and reputation of Finnish gaming industry in promoting Finnish VR/AR companies and products both in Finland and abroad
- Improve the understanding of consumers' habits and values

**The main advices for the VR/AR start-up companies** are the following:

- Join the VR/AR associations and create networks with other companies and relevant academic institutions working in the field of VR/AR
- Find out about the various public support systems such as Tekes and Ely
- If you need support for starting, developing and/or establishing your business, consider joining a specialized incubator program such as Nordic VR Startups, Yle Beta, and Mediapolis Accelerator
- In order to get VC funding, make sure that your business model and plan is viable enough
- Secure a sufficient funding basis as both the industrial and consumer uptake of VR/AR can take longer than predicted

- Start working on exports as soon as possible, and invest enough time and resources in the regular presence and networking in your target territories
- Find a clear and narrow enough focus for your business without trying to do too many things simultaneously
- Rely as much as possible on already existing ready-made technical or other solutions instead of developing your own solutions (unless it is your business area)
- If you have problems in finding local talent and skills, rely on a distributed network or recruit team members, who can be located in any part of the world
- Educate your potential customers, who are not aware of the possibilities of VR/AR
- Start creating an IPR portfolio of your own as soon as possible, and learn to exploit it

## 2. INTRODUCTION

### 2.1. Background

Virtual Reality (VR) is now a timely topic in consumer technology. After decades of research, products are coming to market that allow fully immersive VR experiences with games and media. An important subclass of VR media is immersive video and audio. It offers a profound sense of virtual presence (especially when combined with spatial audio), can be enhanced with interactive features and computer generated graphic and audio, and is compatible with many media production tools.

However, so far the production has required specialized setups and expertise, which has been rare among media companies. Traditional media industry has been observing the development in the field, but trials with immersive media have been quite rare so far. The industry will soon have to adopt this technology, as the new generation of consumers will expect similar immersive media experiences they already know from gaming.

The problem of production of immersive media is still a black art. Building the needed camera setups and using them has so far required extensive expertise. Crucially, immersive media calls for new conventions in storytelling and production planning.

Immersive Media Disruption project aims to provide the following concrete outcomes:

1. Tested models of immersive production processes
2. Models, guidelines and tools to support storytelling (instead of technology)
3. Evaluated case studies in different areas
4. The best practice recommendations
5. Software tools to support the production process.

Project partners have been Aito Media, Nokia Technologies, YLE, University of Tampere and Tampere University of Technology.

This report was commissioned by Nokia Technologies in order to provide the partners and other interested parties with basic information on the current state of VR/AR market and to present suggestion show the Finnish companies could enter the international VR/AR market and grow.

## 2.2. Aims

The main aims of this report are:

- To provide basic information on the current state and the future trends of the VR/AR market
- To study, which areas of the VR/AR business are most potential for Finnish VR/AR companies
- To analyse, which are the critical success factors for Finnish VR/AR companies
- To propose action points for Finnish VR/AR companies for entering the international market and creating growth

## 2.3. Methods

The report was produced by Digital Media Finland, which is a leading consulting company in the field of media, creative industries, and technologies related to these areas. Consultants Jari Muikku and Seppo Kalli did the study during August-November 2017. Some market data of the chapter four was updated in January 2018.

The study was done mainly as a desk study using various freely available information sources. In addition to this, we did 16 interviews<sup>1</sup> with representatives of Finnish companies and research institutes working in various sectors of VR/AR. Furthermore, the consultants used material, which was collected from various events and seminars during 2017 such as Laval VR and IBC in Amsterdam.

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<sup>1</sup> The list of the interviews is presented in Appendix.

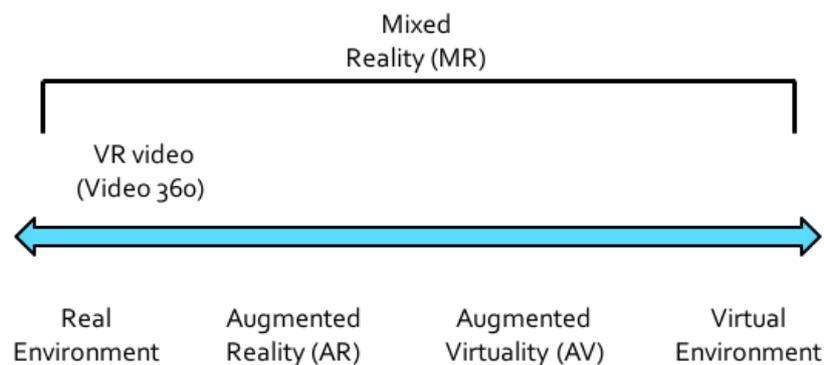
### 3. BACKGROUND

In this chapter we discuss the basic concepts of virtual and augmented reality.

#### 3.1. What Is Virtual Reality?

Virtual reality (VR) is a powerful technology that promises to change our lives unlike any other. By artificially stimulating our senses, our bodies become tricked into accepting another version of reality.<sup>2</sup>

In general virtual reality can take many forms and can be considered to range on a virtuality continuum from the real environment to fully virtual environment. The following diagram shows various forms along that continuum:



The real environment is the real world that we live in. Augmented virtuality (AV) is the result of capturing real-world content and bringing that content into VR. Augmented reality (AR) refers to systems in which most of the visual stimuli are propagated directly through glass or cameras to the eyes, and some additional structures appear to be superimposed onto the user's world.

True virtual environments are artificially created without capturing any content from the real world. Augmented reality (AR) and virtual reality (VR) have many differences, but there are also many similarities, although the experiences may still be very different. VR is transporting the consumer to a different world whereas augmented reality adds virtual reality elements to the local real world. In practice the same hardware might be used for both while consuming or experiencing the content.

The term mixed reality (MR) is used to refer to an entire spectrum that encompasses VR, AR, and normal reality. In some cases MR refers to bringing 3D virtual objects such as holograms into the

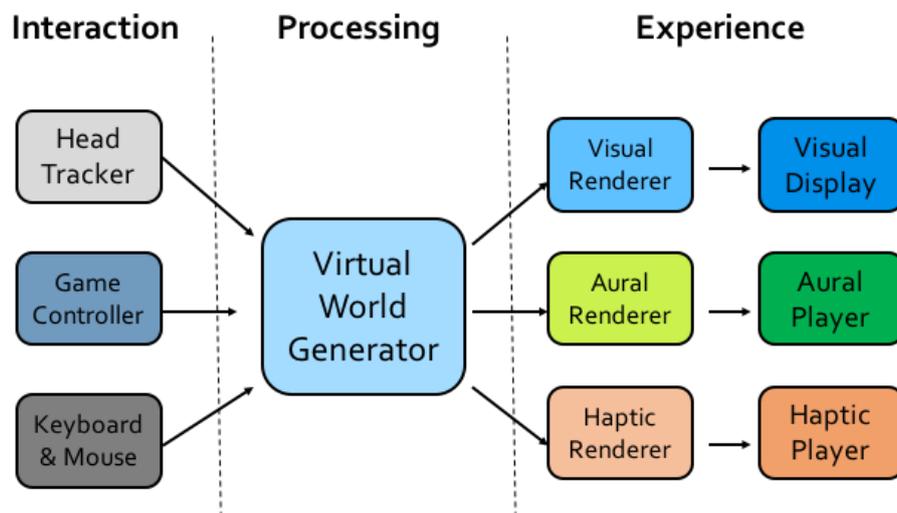
<sup>2</sup> "Virtual Reality" by Steven M. LaValle (2017), <http://vr.cs.uiuc.edu/>

real world without the need to use any headset for watching. More recently, the term XR has also been used to refer to the all fore-mentioned forms.

VR video (video 360 degrees) includes experience that allows users to turn in any direction to view the content. However, the viewer lacks the ability to interact, move around, and can be considered a passenger, watching as the content plays out. Live events such as festivals have seen remarkable uptake for this type of VR because of the low technical overhead associated with delivering such experiences to smartphones.

Immersion is the objective degree to which a VR system and application projects stimuli onto the sensory receptors of users. Presence, in short, is a sense of “being there” inside a space, even when physically located in a different location.

Visual rendering specifies what the visual display should show through an interface to the virtual world generator (VWG). Similarly aural rendering involves aural processing and haptic rendering haptic representation related to virtual world generator as presented in the following picture:



One of the essential novelties of VR is that the user is free to change his/her viewing gaze at will, allowing individual immersive experiences in any viewing direction at any given moment. Consequently, the methods of audio creation, transmission and reproduction applied for VR should be able to accompany the dynamically changing visual perspective. This means that audio is reproduced equally well in all directions.

Today, low-cost consumer VR technology is surpassing professional head mounted device (HMD) systems. The latest technological components, mainly arising from the smartphone industry,

have enabled high-resolution, low-cost, portable VR headsets to provide compelling VR experiences.

### 3.2. Comfort and VR Sickness

Compared with the traditional media, where the content presented in the display is mostly independent from user actions, content presented using VR devices react (at least in part) to user actions. This interactivity has strong implication for the creation of the content to grant an enjoyable and comfortable user experience.

However, every unintended, uncomfortable side effect of using a VR system means some form of VR sickness. Experiencing discomfort as a side effect of using VR systems has been the largest threat to widespread adoption of VR.

Motion sickness resulting from motion (also known as cybersickness) is the most common negative health effect resulting from VR usage and its unstable scenes due to latency. Latency is the time a system takes to respond to a user's action, the true time from the start of movement to the time a pixel resulting from that movement responds.

Physical fatigue is another cause of discomfort related to VR. It can be a function of multiple causes including the weight of worn/held equipment, holding unnatural poses, and navigation techniques that require physical motion over an extended period of time.

As a result of these causes most currently available VR content products have a limited duration or they have been designed to be used only for shorter periods of time.

## 4. MARKET SITUATION

In this chapter we describe briefly the current VR/AR market situation on global level. This presentation is based mainly on the various international research companies' forecasts, which were available at the time of writing this report.

### 4.1. Overview of the VR/AR Market

According to the various forecasts VR/AR market will grow fast during the next few years. The general trend presented in all forecasts is that the growth derives first from consumer uptake of VR gear and content. This is mainly based on games. Later on the growth comes mainly from the industrial uptake of AR technology and services.

The following predictions concern either VR/AR market as a whole or its individual segments. The forecasts concerning the VR/AR gear are presented in the chapter 4.2.

International Data Corporation (IDC) predicts that the VR/AR market will grow during the period of 2017-2021 by around 100% annually<sup>3</sup>. Total spending on VR/AR products and services is expected to grow from USD 17.8 billion of 2018 to USD 215 billion by 2021.

The biggest territories in 2018 are USA (\$6.4 billion), Asia/Pacific excluding Japan (\$5.1 billion) and Western Europe (\$3.0 billion). By the end of the forecast period USA will hold its leading position but Western Europe will pass Asia/Pacific excluding Japan area.

According to IDC the largest source of VR/AR revenues in 2017 is consumers. However, during the following years other segments such as process manufacturing, government, retail, construction, transportation, and professional services will pass the consumer segment.

IDC sees that the industry cases that will attract the largest investments are expected to be retail showcasing (\$442 million), on-site assembly and safety (\$362 million), and process manufacturing training (\$309 million). By the end of the forecast period, the largest industry use cases will be industrial maintenance (\$5.2 billion), public infrastructure maintenance (\$3.6 billion), and retail showcasing (\$3.2 billion).

The consumer segment spending will mainly consist of games with total spending growing to forecasted \$9.5 billion by 2021.

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<sup>3</sup> <https://www.idc.com/getdoc.jsp?containerId=prUS42959717> and <https://www.idc.com/getdoc.jsp?containerId=prUS43248817>

All in all, IDC predicts that spending on VR systems (including gear, software, consulting services, and systems integration services) will be greater than AR-related spending in 2017 and 2018, largely due to consumer uptake of hardware, games, and paid content. After 2018, AR spending will pass VR spending due to the industrial AR uptake.

Digi-Capital's prediction is more moderate as its forecast for VR/AR revenue in 2021 is around USD 120 billion even if the VR/AR industry would outperform<sup>4</sup>. In case of underperforming the revenue in 2021 would be around USD 90 billion.

Out of the other research companies ABI Research predicts<sup>5</sup> that the value of all kinds of VR content (360, interactive and immersive video) will generate USD 6 billion by 2022. PwC's prediction<sup>6</sup> is more positive than ABI's as it forecasts that VR video revenue will exceed interactive application and gaming revenue by 2019. SuperData Research expect<sup>7</sup> that VR revenue (excluding AR) will total USD 30 billion by 2020.

All in all, the fore-mentioned forecasts predict the same trends: the VR/AR market will grow fast during the next few years, but the "hockey stick" growth will not be seen until the 2020's.

However, as the market is in its infancy and the level of uncertainty of predicting many essential factors is high, the current forecasts are varied in terms of the actual value. Furthermore, the bases of the various calculations are not necessarily the same.

## 4.2. Gear and Consumers

The currently available VR gear can be divided into three main categories:

1. PC-based immersive VR headsets such as HTC Vive, Oculus Rift, Samsung Odyssey, and Playstation VR plus various additional control devices
2. Smartphones (mainly Samsung and Google top-line products and ecosystems)

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<sup>4</sup> <https://www.digi-capital.com/news/2017/01/after-mixed-year-mobile-ar-to-drive-108-billion-vrar-market-by-2021/#more-1617>

<sup>5</sup> <https://www.abiresearch.com/market-research/product/1028277-360-degree-interactive-and-immersive-video/>

<sup>6</sup> <https://www.pwc.com/gx/en/industries/entertainment-media/outlook/segment-insights/virtual-reality.html>

<sup>7</sup> <https://www.superdataresearch.com/market-data/virtual-reality-industry-report/>

3. Standalone VR headsets, which do not require a separate computing device such as Daydream VR, Oculus Go<sup>8</sup>, HTC Vive Focus<sup>9</sup> and Samsung Gear VR

Compared to VR there are less AR headsets available. The most important manufacturers, at the time of writing this, were Microsoft (HoloLens), Vuzix, Daqri, ODG, and Epson. The industry has high hopes for the fore coming products such as Magic Leap and Snapchat (Snap Spectacles 2.0).

Another future trend will be headsets, which can be used for both VR and AR content.

The development of the VR/AR gear market so far has been a disappointment compared with the earlier expectations especially in the field of immersive VR headsets. Some of the main obstacles for quicker consumer uptake have been high prices, requirements of the computing devices, cybersickness, and the chicken-and-egg-situation with the development of gear and content.

Therefore the main gear used for the consumption of VR content has been smartphone. However, VR/AR features have been available so far mainly in the top-line devices, which has slowed down the uptake.

IDC forecasts that the shipments of the VR and AR headsets will go up from 9.6 million of 2017 to 59.2 of 2021<sup>10</sup>.

The market has been propped up by low-cost VR screenless viewers such as the Samsung Gear VR. Google Cardboard passed 10 million shipped pieces by early 2017 according to Google. In addition to this, Sony PlayStation VR sales surpassed one million<sup>11</sup> in mid-2017.

IDC anticipates that VR screenless viewers will account only for 14.8% of the entire market in 2021, down from 58.8% in 2017. Over the course of the next few years, tethered headsets from the likes of Sony or Meta will account for the majority of shipments and in 2021 standalone headsets like the Oculus Go or HoloLens will take center stage and account for almost half of the AR/VR headset market. Consumers are very likely to have their first AR experience via a mobile phone or tablet rather than a dedicated headset.

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<sup>8</sup> <https://www.oculus.com/blog/oc4-day-1-recap-the-path-to-a-billion-people-in-vr/>;  
<https://www.ft.com/content/9459c9c2-aebb-11e7-aab9-abaa44b1e130?desktop=true&conceptId=fdfea8b2-e7b2-33c2-83dd-ac0175d72e51&segmentId=7c8f09b9-9b61-4fbb-9430-9208a9e233c8#myft:notification:daily-email:content:headline:html>

<sup>9</sup> <https://www.theverge.com/2017/11/14/16648112/htc-vive-focus-standalone-headset-announced-daydream-cancelled>

<sup>10</sup> <https://www.idc.com/getdoc.jsp?containerId=prUS43388417>

<sup>11</sup> <https://www.theverge.com/2017/6/5/15719382/playstation-vr-sony-sales-one-million>

The market shares of the manufacturers were during Q2/2017 as follows according to IDC<sup>12</sup>:

COMPANY	Q2/2017 SHIPMENTS VOLUME (IN THOUSANDS)	Q2/2017 MARKET SHARES
1. Samsung	568.0	26.7%
2. Sony	519.4	24.4%
3. Facebook	246.9	11.6%
4. TCL	106.4	5.0%
5. HTC	94.5	4.4%
Others	594.8	27.9%
<b>TOTAL</b>	<b>2130.0</b>	<b>100%</b>

IDC believes that VR headsets will continue to lead in terms of volume throughout the forecast, but AR in general will have a much bigger overall impact on the industry.

CCS Insight predicts that the value of AR headset sales will be USD 3.6 billion in 2018. Greenlight Insights' forecast expects the value of AR headset and content sales to be USD 12.9 billion by 2020. Out of this sum \$7.1 billion would be from devices and \$5.8 from content.<sup>13</sup>

IDC believes the best opportunity for dedicated AR headsets exists in the commercial segment. A huge level of interest and investment is happening around vertical markets such as healthcare, manufacturing, field service workers, and design.

Consumers' usage of AR is expected to happen mainly by smartphones. According to eMarketer there are currently 2.4 billion people in the world using smartphones, and Android and iOS account for 99.7% out of the new shipments. Both Google (ARCore) and Apple (ARKit) are investing a lot on the new mobile AR platforms and applications. They both believe that the mobile AR market will be significant in the long run. For example, Google is expecting 100 million downloads at the end of their current preview period of ARCore for developers.

The number of the US citizens who have engaged with AR in some form in 2017 is 40 million (12.4% of the entire population) according to the estimation by eMarketer. Tractica expects that there will be 1.9 billion mobile AR users by 2022.

Ericsson<sup>14</sup> predicts that 30% of consumers will use VR for TV and video watching in five years' time. The main driver is the new dimension VR watching offers to consumers. Of those people

<sup>12</sup> <https://www.idc.com/getdoc.jsp?containerId=prUS43021317>

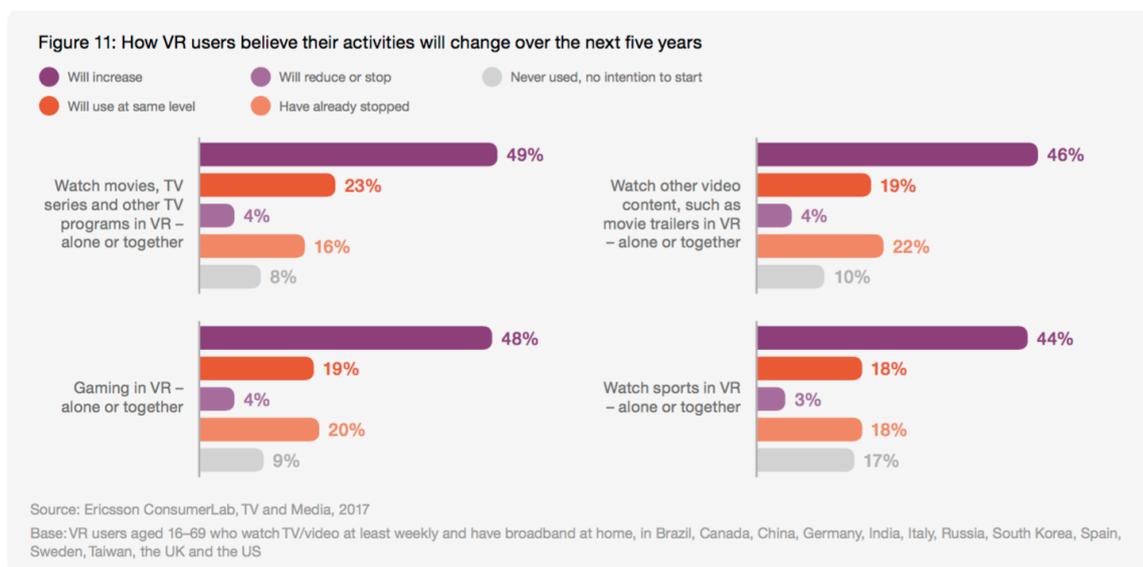
<sup>13</sup> MusicAlly AR Report 18.10.2017

<sup>14</sup> [https://www.ericsson.com/assets/local/networked-society/consumerlab/reports/ericsson\\_consumerlab\\_tv\\_media\\_report.pdf](https://www.ericsson.com/assets/local/networked-society/consumerlab/reports/ericsson_consumerlab_tv_media_report.pdf)

who are interested in VR but not using it yet, over 40% say that they will use VR to watch immersive and interactive movies regularly, and more than a third live sports events and concerts. Another important driver is the future possibility of watching UHD/4K content without big screens.

The Ericsson study claims that 10% of consumers are already using a VR device, with more than 25% planning to get one. This would mean that every one in three consumers would be using VR by 2020.

According to the results of the study, a third of people planning to get VR headsets say they will start using the technology in less than one year, and over half believe that VR headsets will be mainstream in less than three years. However, these results of the Ericsson study have been criticized for being way too optimistic.



Big Internet companies believe that social aspect of VR will be important as well. For example, Facebook has built in social VR features into its Spaces service, and Microsoft bought social VR platform start-up company AltspaceVR in October 2017<sup>15</sup>.

### 4.3. VR Industry Guidelines

The market development has brought along also the need to seek after common industry standards and guidelines. Virtual Reality Industry Forum started an open feedback and consultation process in September 2017 to create guidelines for the whole industry<sup>16</sup>. The first full version is expected to be ready in early 2018.

<sup>15</sup> <http://time.com/4967092/microsoft-altspacevr-virtual-reality/>

<sup>16</sup> <http://www.vr-if.org/guidelines/>

The guidelines cover all aspects of the distribution ecosystems, including compression, storage and delivery, in order to ensure high quality and comfortable consumer VR experiences. These guidelines are aimed at addressing best practices for VR content distribution as well as advocating interoperability and deployment guidelines based on common technical standards for VR content distribution, including promoting the use of common profiles across the industry.

The targeted audience for the guidelines includes content distributors, service providers, broadcasters, mobile operators, consumer electronics manufacturers, professional equipment manufacturers, software developers and technology companies who aim to enable deployment of VR content distribution services.

## 5. VR/AR ECOSYSTEM AND LANDSCAPE

In this chapter we describe the current structure of VR/AR industry in Finland, and the structure of the industry by terms of workflow, business models, publishing, distribution, and competencies.

### 5.1. VR/AR Landscape in Finland

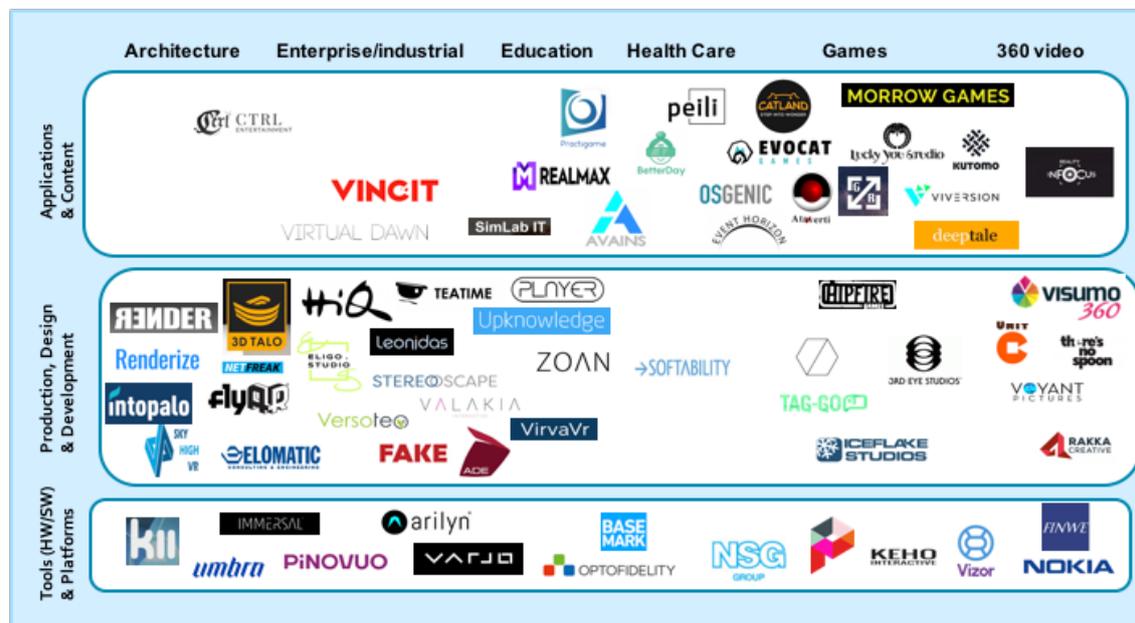
We have presented the current Finnish VR/AR landscape in a nutshell in the following diagram. The landscape categorises companies' products and services into three areas:

- Tools and platforms
- Production
- Applications/content

The VR landscape diagram is based on our extensive research and information gathered during the project. The VR ecosystem is developing and evolving very quickly, and therefore the described landscape can be seen only as a momentary snapshot of the situation. For example, during the project some new companies were established and at least three VR/AR companies ended their life due to bankrupt or some other reason. During the project period also Nokia announced that it ceases investments in developing its Ozo camera. Support and sales of the existing generation will continue.

There were, at the time of writing the report, more than 60 companies in Finland identified to work on VR/AR. In addition to these companies, there are also a remarkable number of VR/AR utilizer companies, which are not shown in the picture. These companies can basically represent any industry or branch.

## VR and AR industry landscape in Finland 2017



Most of the companies that work in the production category are producing VR content for industrial and enterprise applications. Game production is another large business area. So far the established media companies have not been active in producing VR/AR content.

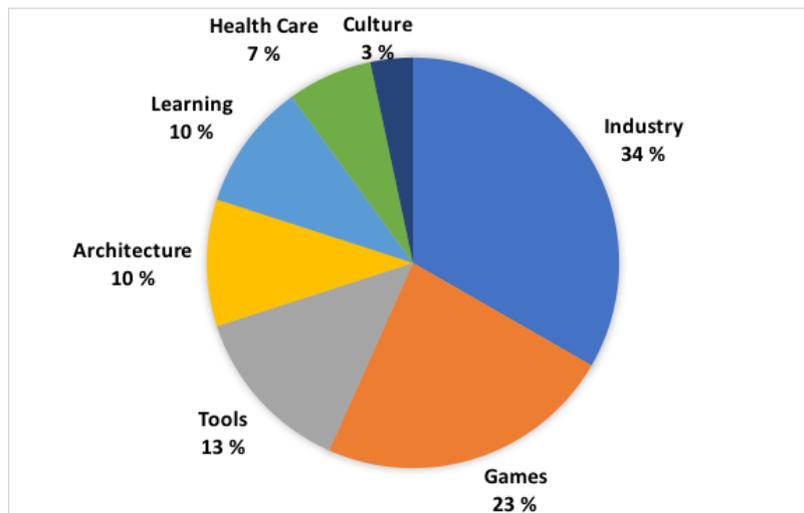
About half of the companies expressed that they concentrate on VR, one fourth of the companies did both AR and VR, six companies focus purely on AR, and similarly six companies are working on 360 video.

The VR landscape covers also companies which make VR tools and platforms. These include companies, which concentrate on VR and its enabling technologies. An example of this is Vizor, which is developing VR creation and hosting platform to allow users effortlessly to produce 360-degree tours, stories and Web VR experiences by simply dragging and dropping media components.

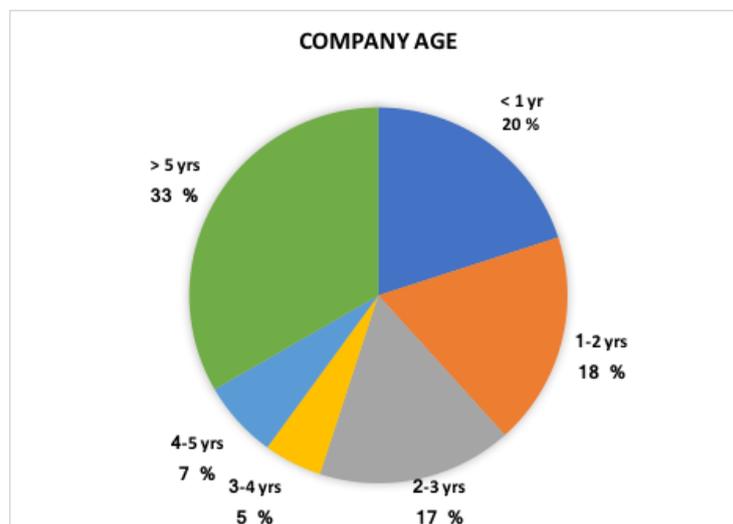
We made a closer analysis of 60 Finnish VR/AR companies, which represent very well the whole spectrum of the Finnish VR/AR landscape. The analysis shows that about one third of the companies (20/60) are working in general industrial applications including marketing, and no single application area can be identified. Another popular area is gaming, where about one fourth (14/60) of the companies are working. Architectural and learning applications are both the

key application areas of six companies (10%). Health Care is the focus area of four companies and two companies are targeting on cultural applications. In addition to these, eight companies provide enabling software and hardware tools.

The following diagram shows the distribution of the companies according to their focus application areas:



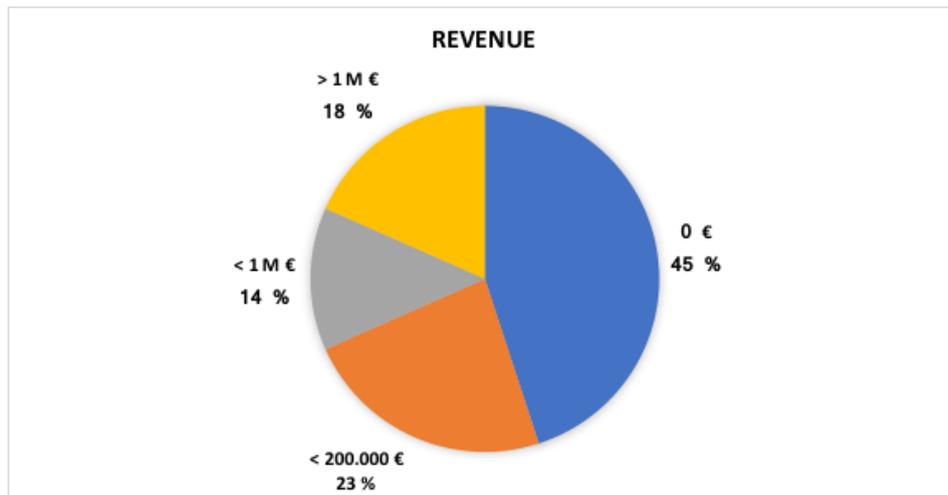
VR/AR is a relatively new area. Therefore most of the companies are also very young. The following diagram shows the age division of the VR/AR companies:



Two thirds of the companies are younger than five years old. This means that 40 out of the identified 60 companies can be categorized as start-ups. During the past three years several new companies have been established. In 2017, already 12 companies were established, 11 companies in 2016, and 10 in 2015. The older companies are mostly SME companies established

typically between 2000-2012. These are companies, whose main working area is either general software design and development, visualization or animation. They have typically established a separate unit or taken an auxiliary business name, under which they are working on VR/AR.

The revenue of a young start-up is typically very small. The next diagram shows the distribution of the companies according to their revenues. The revenue figures are typically from 2016, depending on the companies' fiscal year.

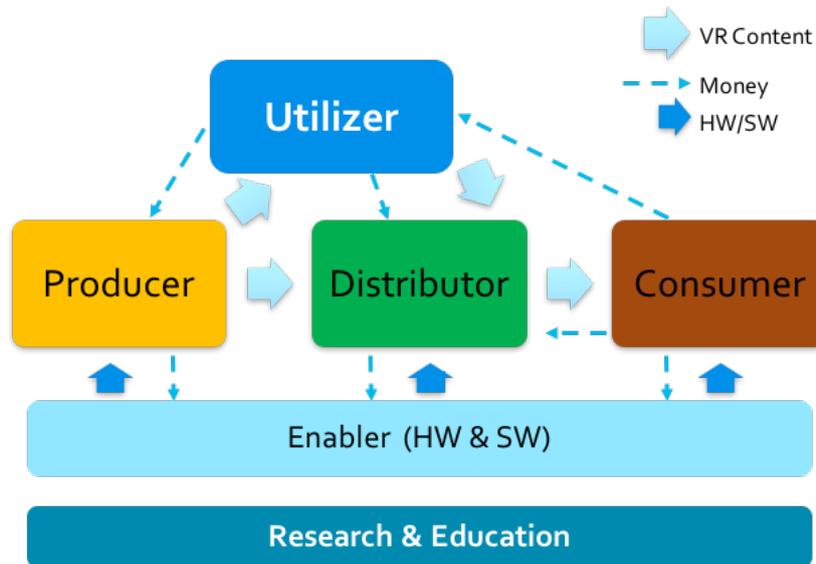


Nearly half of the companies, i.e. 27 companies, didn't have any revenue at all. Fourteen companies had revenue less than €200,000, eight companies had revenue between €200,000 and €1 million, and eleven companies' revenue exceeded €1 million. From the reported activities of the companies we can assume that the companies, who had revenue over €200,000, are working mostly in other areas than VR/AR. The VR/AR business in those companies seem to be rather marginal compared to the other business. However, the companies did not reveal any detailed sources of their revenue.

## 5.2. VR/AR Ecosystem and Workflow

The basic workflow in VR/AR as in all media includes content production, its distribution, and finally its consumption by the consumer. There are multiple parties involved in the VR workflow.

The following diagram describes different parties in VR production and consumption. It shows also content and material flows between parties and depicts principal money flows between parties in order to emphasize business relationships between them.



**Producer** is the party, who is actually preparing the content. The technical workflow is covering capturing from various sensors with real-time stitching of the material, and content producing including data conversion, post-production with stitching, 3D graphics and mapping.

**Utilizer** is the party, who is, on the other hand, ordering the content from Producer and, on the other hand, has some kind of contact with Consumer. Typically Utilizer is the body, which is using VR content, for example, as a part of its product and service marketing.

**Distributor** is the party, who takes care of the content delivery. The technical workflow covers storage, CDN, and streaming, download or broadcast.

**Consumer** is the party, who is using the VR content. The technical workflow in this phase covers decoding the content, using DRM license verification and decryption, rendering, interaction and finally experiencing of VR content.

**Enabler** is the party whose task is to enable other parties to carry out their processes. Enabler provides software and/or hardware tools or techniques for other parties.

**Research and Education** is the party, who is working in the field by developing new VR innovations or raising VR competencies.

### 5.3. Production of 360 Video

When we take a closer look at the process of making 360 videos<sup>17</sup>, we can notice that it differs from the traditional production of 2D videos in several ways.

**Firstly**, *the narrative* is different because, for example, it is not possible to use pictures of different sizes, the narrative is more theatre- than film-like and requires large movements and requires less shootings, getting in and out of scenes has to be made in a more peaceful way than in 2D films, and sounds and gestures direct what the viewers look at. Also the role of viewers has to be decided or if they are spectators or active participants. Furthermore, the intensity cannot be created with editing effects but by different means bearing in mind the VR nausea of watchers, and the possible challenges and benefits of taking watchers to places they have never been or which do not exist in real world.

**Secondly**, *filming* 360 videos causes some practical challenges such as hiding the crew either by using them as assisting actors, behind natural barriers such as trees, or by digital masking. Another challenge is moving the camera, on the other hand, according to the story, and, on the other hand, moving in the space where the filming takes place. Scriptwriter has to decide what happens simultaneously in which part of the space, and this affects, among other things, lighting.

**Thirdly**, *sound* is still often recorded as stereo, as binaural solutions are only entering the market. Binaural sound requires that the audience use headphones.

**Forthly**, the *postproduction* phase is burdensome, even though there are more and more ready-made solutions available, as different steps of the process are multiplied. The “stitching” process of 360 video consists of three steps:

- Raw frame image processing
- Calibration (to avoid the vertical parallax while aligning the overlapping portions of the images)
- Optical flow (this process fills in the gaps between cameras virtually)

The challenges of delivering the video and providing a seamless end-user experience are even bigger, especially on mobile devices. The four main challenges to the audience are<sup>18</sup>:

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<sup>17</sup> Further information on the production of 360 live video:

<http://www.streamingmedia.com/Producer/Articles/ReadArticle.aspx?ArticleID=120540&PageNum=1>

<sup>18</sup> <http://www.streamingmedia.com/Articles/Editorial/Featured-Articles/SME-17-4-Challenges-of-Virtual-Reality-118294.aspx>

*Challenge 1: Motion-to-photon latency on mobile*

*Solution:* Single rendering and scanline racing help in coping with the latency inherent in mobile VR experiences.

*Challenge 2: 360° support in Safari on mobile web*

*Solution:* Player can be embedded in an iframe on the same domain as the CDN, and also employ a reverse proxy for mobile web traffic.

*Challenge 3: Enormous amount of data*

*Solution:* Cube mapping can achieve 30% bandwidth reduction over equirectangular. Alternatively, it is possible to achieve a 40% reduction with HEVC, VP9 vs H.264.

*Challenge 4: Achieving 6 DoF (Degrees of Freedom)*

*Solution:* There currently is no solution to this problem. However, there are emerging Adobe solutions that say they can enhance existing monoscopic 360 videos with 6 DoF by inferring the camera path and 3D scene geometry using structure-from-motion techniques. Additionally, it uses a novel warping algorithm to synthesize views on the fly by warping original content.

## 5.4. Business Models and VC Funding

At the time of writing this report it was evident that there are no established business models for 360 videos or other kind of VR/AR content yet. For example, it is not clear yet in which point of the process and how consumer pays for VR content: one-off payment for downloads, subscription fee, ad- or data-funded services, in-app-purchase or otherwise.

The business models vary also according to the business area. There are, at least, three main categories:

- VR/AR content and applications
- VR/AR technologies
- Production and professional services

Current and future business models can vary if the products and services are mainly aimed at B2B or B2C markets. Furthermore, the needs for funding are also different in these categories as, for example, production service companies do not need as much outside funding as development of technology.

Companies are still doing mainly pilots and PR-oriented try-outs in order to learn the new technologies, and to understand their commercial potential and requirements concerning skills and resources. For example, more than half of the Forbes 50 most valuable brands have engaged in some form of VR promotion to date<sup>19</sup>. According to the interviews, many VR/AR companies have had to consult or educate their potential customers before being able to sell services or products.

The main ways to finance productions are, both in Finland and on international market:

- Sponsoring
- Subcontracting
- Branded content
- Public subsidies

Advertising is also becoming a relevant model for financing VR/AR productions. The first steps in this field are, in addition to the fore-mentioned options, pre- and post-roll ads and virally spreading branded contents. Bigger challenges lie ahead for advertising, which is embedded into 360 videos or other VR/AR content. These forms can be, for example, embedded 2D pictures, videos or ads, virtual product placement, interactive hotspots and various game-like ad solutions.

Programmatic buying is also starting to make its way to VR/AR advertising, even though its financial value is now, and will be for some time, marginal. Some early stage pioneers of this field are, for example, Advrty and Advir who are competing with players like Google and Unity Ads<sup>20</sup>.

More traditional advertising methods can be applied in live 360 video streams. There are several examples how this kind of material has attracted and enhanced large audiences as a part of large music or sports event, and brought along real additional value<sup>21</sup>.

All in all, as the VR/AR gear base among consumers is still limited in numbers and as there are no established and widely used distribution channels for VR/AR content yet, there are no real scaling factors available for VR/AR content business yet. The main problem is that neither B2C nor B2B market has not taken off yet as the egg-and-chicken situation continues between gear and content. Investors do not believe that large audiences would be willing to buy €600 headsets just in order to use them for 20 minutes now and then.

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<sup>19</sup> <https://www.juniperresearch.com/document-library/white-papers/how-oculus-killed-vr-development-how-to-fix-it>

<sup>20</sup> <http://www.marmai.fi/uutiset/mainos-ei-saa-hairita-kuluttajaa-vr-maailmassa-mainosalustan-kehittanyt-ruotsalaisyritys-tuo-ohjelmallisen-ostamisen-vr-markkinointiin-6681664>;  
<https://www.juniperresearch.com/document-library/white-papers/how-oculus-killed-vr-development-how-to-fix-it>

<sup>21</sup> Some examples are presented in chapter 6.2

This situation is reflected also in the field of VC funding of the VR/AR companies. Currently it is difficult to get funding for VR companies, as the expectations of the early hype have not been fulfilled. However, AR companies find the situation easier as all parties expect the size of AR market to pass VR market during the next few years. In both fields it also looks like, at the moment, that the companies developing technology, software and tools are in a stronger position to get VC funding than the content production companies.

During 2017 the VR/AR start-up companies raised over USD three billion across various categories<sup>22</sup>. However, the investments were divided between companies unevenly as some individual companies such as Magic Leap took major parts of the whole sum.

As a result of this situation it is expected that there will be a lot of merger and acquisition (M&A) cases as the big companies acquire scarce talent, skills, teams and technology by buying or consolidating promising start-up companies like in the case of Google and Owlchemy<sup>23</sup>.

Another challenge for scaling the VR/AR business in the future is the limits set by the technical capacity of Internet<sup>24</sup>. The increasingly high resolution and refresh rates necessary for VR content means that the data requirements for VR will be comparable with, if not higher than, 4K content streaming. This limits effective use of VR to those areas where such data speeds reliably exist. This means that countries that have an average speed of less than 6Mbps on mobile or fixed-line broadband are far less likely to have a viable VR market.

## 5.5. Publishing and Distribution

So far games has been the focus area of the VR content industry. The goal has been to create captivating immersive gaming experiences. However, the games have typically been limited to a single VR platform, although some cross-platform sales are starting to emerge. Furthermore, there are only very limited number of titles of premium quality available on the market. Further investments require large user and gear base.

In the field of film and TV production several companies are producing various kind of content. Most of the material is consumed either through various streaming services or standalone apps. At this phase, even large media companies have to adapt to this in order to gain larger audience.

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<sup>22</sup> <http://www.digi-capital.com/news/2018/01/record-over-3b-ar-vr-investment-in-2017-1-5b-in-q4/#.WIMqUSNDzoz>

<sup>23</sup> <https://seekingalpha.com/article/4072751-google-acquires-owlchemy-labs-vr-content>

<sup>24</sup> <http://www.streamingmediaglobal.com/Articles/News/Featured-News/Virtual-Reality-Causing-an-Additional-21000-PB-of-Traffic-by-21-119771.aspx>

Currently there are still no established VR/AR platforms for mass distribution or broadcasting. For 360 videos social media services such as YouTube, Snap, Instagram and Facebook are primary channels to reach larger audiences.

Media houses have also created their own standalone applications (e.g. Arte 360, Sky and MTG<sup>25</sup>). This has to be seen as an intermediate stage of development as the apps will not work in larger scale in the future in the B2C market.

For more immersive content gear platforms such as Oculus Store are important but limited from consumers' point of view. VR games are an easier case as established digital platforms such as Steam are viable also for VR products.

One should also bear in mind that the distribution of VR/AR content is not limited only to digital platforms. VR arcades, cafes and movie theatres are gaining popularity all over the world as they can offer, compared to home usage, more versatile content, technically better presentations, and offer a social context for enjoying the content<sup>26</sup>.

The development brings along also new kind of concepts and products to markets. A good example is EDM music producer Tokimonsta's album "Lune Rouge", which was released in October 2017 and was distributed via VR platforms instead of the established music distribution channels<sup>27</sup>.

## 5.6. Competencies

VR is very different than any other form of media. VR is extremely cross-disciplinary and there is a clear paradigm shift from traditional development to VR development.

For VR, the user experience is more important than for any other medium. A bad VR design and execution will make users sick. The experience must be extremely compelling and engaging to convince people.

VR by its nature is cross-disciplinary, and communication between team mates is essential for VR development. Producers need to take a clear paradigm shift from traditional development to VR development as described in the previous chapters.

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<sup>25</sup> <http://www.broadbandtvnews.com/2017/05/30/mtg-launches-vr-app/#more-146500>

<sup>26</sup> <https://www.ft.com/content/da0ed140-a260-11e7-9e4f-7f5e6a7c98a2?desktop=true&conceptId=23629959-5137-384a-a8af-3f7d9cb16912&segmentId=7c8f09b9-9b61-4fbb-9430-9208a9e233c8#myft:notification:daily-email:content:headline:html>

<sup>27</sup> MusicAlly 28.9.2017

## 5.7. VR/AR Research, Education, and Development in Finland

In this chapter we present some of the key VR/AR-related academic research institutions and initiatives in Finland.

### 5.7.1. VR/AR Research and Education

#### Aalto University

**Department of Signal Processing and Acoustics**<sup>28</sup> utilises existing techniques to develop 360-degree sound for virtual reality environments. The goal is to create 3D audio for virtual reality environments that is as realistic as possible. For this, the technology must meet two criteria: It must have the ability to replicate real, recorded sonic environments and to synthesise non-existing ones. The technique must also succeed in creating these audio experiences through both headphones and loudspeakers in a way that results in the perception of natural sound from any and all directions.

#### Tampere University of Applied Sciences, TAMK

**TAMK Media and Art Sector**<sup>29</sup> is providing education in international media and arts sector. The study modules aim to lead to high professional competences in the following areas: game design and production, emerging media production (VR/AR/MR/XR), motion graphics design, production and content design, animation, music production and music business, song writing, sound design, event production, cultural export, and entrepreneurship.

#### Tampere University of Technology, TUT

**Research Centre for Immersive Visual Technologies, CIVIT**<sup>30</sup> is a joint undertaking between the Department of Signal Processing and the Department of Pervasive Computing. Its main purpose is to provide expertise and facilities for studying and utilizing emerging visual technologies and the related new user experience with the aim to enhance the existing and to develop new scientific and industrial applications where advanced visualization is a must.

**Virtual reality and Graphics Architectures (VGA)**<sup>31</sup> group's research areas are computer graphics hardware architectures and virtual reality. The aims are to enable virtual reality in mobile devices with restrictive power and energy budgets by exploring new graphics hardware architectures and software systems.

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<sup>28</sup> <http://www.aalto.fi/en/current/news/2016-11-22-004/>

<sup>29</sup> <http://www.tamk.fi/fi/web/tamk/media-and-arts>

<sup>30</sup> [www.tut.fi/en/civit/](http://www.tut.fi/en/civit/)

<sup>31</sup> [www.tut.fi/vga](http://www.tut.fi/vga)

**Novi Research Center**<sup>32</sup> operates as a part of the Industrial and Information Management Unit. Novi's research areas cover VR/AR business models and value creation. In general the research center aims to understand phenomena that relate to knowledge economy and knowledge-based value creation.

### University of Helsinki

**Visual Cognition Research Group**<sup>33</sup> focus in visual cognition, especially in virtual reality, perception of natural images and applying vision science to advanced display technologies. The team has a long history of studying head-mounted displays and virtual reality. It has studied sickness symptoms with various consumer head-mounted displays and how well head-mounted displays can be used in everyday environment. As the virtual reality and 360-videos are now making a breakthrough in various domains, the group is focusing its research efforts to this area.

### University of Oulu

**Center for Machine Vision and Signal Analysis (CMVS)**<sup>34</sup> is combining the expertise of University of Oulu computer vision and biosignal analysis scientists. The Center for Machine Vision and Signal analysis is making research results in many areas, including texture analysis, facial image analysis, 3D computer vision, energy-efficient architectures for embedded systems, and biomedical engineering. Among the highlights of its research are the Local Binary Pattern (LBP) methodology, LBP-based face descriptors, and methods for geometric camera calibration. The areas of application for CMVS's current research include affective computing, perceptual interfaces for human-computer interaction, biometrics, augmented reality, and biosignal analysis.

### University of Tampere, UTA

**Tampere Unit for Computer-Human Interaction (TAUCHI)**<sup>35</sup> is focusing on human–technology interaction. It carries out a wide range of multidisciplinary research into technology-mediated novel ways of multimodal interaction with devices, environments and people. The aims are to develop better and more intuitive user interfaces for the future utilizing gestural interfaces, gaze tracking, haptics, mixed reality, computer vision, and virtual avatars.

### University of Turku, UTU

**Department of Future Technologies**<sup>36</sup> is a scientific research and education unit covering the ICT field. The aim of the research, especially in MIRACLE<sup>37</sup> project, is to find cost-

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<sup>32</sup> [http://www.tut.fi/novi/?page\\_id=1973](http://www.tut.fi/novi/?page_id=1973)

<sup>33</sup> <http://www.helsinki.fi/psychology/groups/visualcognition/>

<sup>34</sup> <http://www.oulu.fi/cmvs/>

<sup>35</sup> <http://www.uta.fi/sis/tauchi/index.html>

<sup>36</sup> <https://tt.utu.fi/en/>

<sup>37</sup> <https://tt.utu.fi/ar/research/miracle/>

efficient ways to create attractive mixed reality applications for cultural travel and out-of-classroom learning, by multi-disciplinary teams and in co-operation with local businesses. The research covers development of cost-efficient tools and processes, studying learning experiences by AR applications and seamless connection with social media.

## VTT

**VTT Augmented Reality Research**<sup>38</sup> is developing Augmented Reality (AR), which is the technique of superimposing virtual objects in the user's view of the real world, providing a novel visualisation technology for a wide range of application. Mixed Reality (MR) is a more general term for visualizations and/or environments where physical and virtual elements can co-exist and interact. VTT started working in the AR field in 2000 with the development of virtual advertisements for live TV broadcast. In the following years VTT expanded its expertise to game and entertainment applications.

### 5.7.2. *Tekes Support for VR/AR Development*

Tekes<sup>39</sup> has launched a Mixed Reality campaign, that offers funding for development and utilisation of virtual reality (VR) and augmented reality (AR) solutions in business.

The objectives of the campaign are:

- Finland will establish the world's leading companies producing VR/AR technology and content.
- Finnish companies will become global forerunners in developing and utilising VR/AR technology. Health care, for example, and all key industrial sectors will come on board in addition to games and entertainment.
- The Finnish VR/AR ecosystem will be closely connected to the other major corresponding ecosystems around the world.

Through this campaign Tekes can fund companies that develop solutions and utilise virtual and augmented reality in their business operations, and to build expertise in this area in Finland.

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<sup>38</sup> <http://virtual.vtt.fi/virtual/proj2/multimedia/>

<sup>39</sup> <https://www.tekes.fi/en/programmes-and-services/campaigns/team-finland-mixed-reality/>

## 6. MARKET FEATURES

In this chapter we present some current market features, which are relevant to the focus area of the IMD project, 360 videos.

### 6.1. Media Incumbents and VR

Established media incumbents such as national public broadcasting companies are currently in the process of defining their relationship with VR and AR. On the other hand, they need to learn and experiment the possibilities the new technologies offer them. On the other hand, as their goal is to reach mass audiences, they cannot justify big investments based on the wishes and habits of the small early adaptor segments of their audiences unless it is important enough for the long-term customer engagement and other strategic goals.

For commercial media companies this is even more evident as there are hardly any significant and profitable business opportunities available within a short timespan. Therefore they have to create long-term VR/AR strategies with adjusted investment plans.

### 6.2. 360 Video Cases

In this chapter we present some international 360 video cases, which are interesting from the point of view of the IMD project.

#### 6.2.1. Case 1: BBC's Audience Research Project

Among the European public broadcasters the British BBC has traditionally been a forerunner in testing and applying new technologies. In the case of VR/AR, BBC has done basic research work to define their role in this emerging area<sup>40</sup>.

BBC studied what their audiences want out of the various kinds of VR experiences. The key takeaways of the results of the research project were:

- The industry has difficulty communicating what VR experiences are actually like
- The appeal of VR can go far beyond the novel and extreme
- Participants loved VR which allowed you to:
  - Walk in someone else's shoes to better understand the world (e.g. experiencing what it's like to lose your sight – Notes on Blindness)
  - Experience something you wouldn't normally do (e.g. sky-diving – although the novelty factor wore off quickly so it's likely you'd watch these sorts of things a small number of times)

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<sup>40</sup> <http://www.bbc.co.uk/blogs/internet/entries/c438a2cd-fcd4-42f3-ab69-244d3c579011>

- Learn effectively (e.g. become microscopic and travel through the body to learn about anatomy – like The Body VR)
- Remove all distraction, enabling focus on activities like relaxation
- Headsets provide audiences with a rare opportunity to engage with content utterly free from distraction

BBC itself wanted to learn how to tell stories in a new way by using these technologies. The key takeaways of the results regarding this issue were:

- Experiences without a narrative or goal tended to fall flat
- Make the most of the unique possibilities of VR
  - Playing with scale
  - Presence and embodiment: the viewer must feel ‘there’ to be immersed
- Recognising the risk of cognitive overload
  - Audiences need time to process and understand what is happening around them before being able to follow a narrative
  - When and where to draw their attention is also fundamentally important

### **6.2.2. Case 2: 360 Video in News Production**

The relation between 360 video and immersive VR in news production is two-sided<sup>41</sup>. On the other hand, 360 video is not a gateway to immersive VR for consumers as the ecosystem lacks interesting enough content, and there are only too few and too expensive equipment available.

On the other hand, 360 videos can be seen as a gateway to immersive VR in production. It is quite easy to produce 360 videos quickly and cheaply as there are more and more affordable “prosumer” 360 cameras available making it useful in fast-pace news material production.

However, transferring the material from one platform to another is still quite difficult. Furthermore, there are requirements such as consumers should wear headphones in order to make most of the binaural sound tracks.

As the commercial potential of 360 videos is still quite limited, it is usual that technology companies sponsor the media companies, who are producing them. For example, New York Times’ 360 videos are sponsored by Samsung, and The Guardian’s by Google. There is an evident reliability risk in sponsored news content, but as long as there is no monetisable market, the media companies will most probably continue the collaboration in form of pilot projects in order to find the best ways to produce, distribute, and monetize 360 video content.

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<sup>41</sup> <http://www.streamingmediaglobal.com/Articles/Editorial/Featured-Articles/360°-Video-Is-No-Gateway-to-VR-says-BBC-119364.aspx>

TV news broadcasters have a choice to opt for quality or reach. Currently, the documentary type of content with high production values that run up to 20 minutes long, and is delivered via apps to headsets is the quality route. Very short or sub-two-minute clips intended for the magic window or browser viewing on smartphones and distributed on social channels is the other. The danger in going for quality is that media companies do not build a big enough audience to justify investment, and the danger of reach is that content is not distinctive enough to be special and it might be better shooting with regular video.

### **6.2.3. Case 3: European Broadcasters**

Most European public broadcasters are studying the possibilities of 360 videos and VR content. The main goal for most companies is to test different technologies and learn of their potential and possibilities.

However, the broadcasters do not see themselves as the main drivers of the market but catalysts for the development, which is reflected in their limited budgets for VR/AR development work. Some big commercial broadcasters such as Sky<sup>42</sup> in the UK are also investing into VR and 360 video content.

For example, Yle in Finland runs a VR/AR incubator Yle Beta. Yle does not develop hardware but wants to find ways to tell stories with new means via iteration and pivoting. They also want to find hypotheses for the next generation media experiences for testing.

So far many broadcasters have mainly produced VR or 360 video promos or trailers of high-profile TV shows such as Galapagos and Great Barrier Reef (David Attenborough/BBC), Mr Robot (USA Networks), Westworld (HBO), and 600<sup>th</sup> episode of The Simpsons. Sports and branded content are usually seen as the first steps towards financially viable VR or 360 video productions. For example, many VR production companies expressed at MIPCOM trade fair in October 2017 in Cannes that there is a lot of demand for information on VR and 360 videos from TV industry.

On the other hand, production companies see that VR should not just be a complement but a unique proposition too. On the other hand, broadcasters see VR and 360 videos as complements to what they are doing. This is an obvious bottleneck for the growth of the production of new kind of content. For broadcasters the biggest challenge is to find working ways to distribute new kind of VR/AR content to large enough audiences.

From the point of view of independent production companies 360 videos are currently in most cases the only option, as immersive VR would require such financial and other resources, which are not in most cases available for them.

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<sup>42</sup> <https://www.sky.com/help/articles/sky-vr-app>

#### 6.2.4. Case 4: Publishing Houses

Newspaper and magazine publishing houses are also studying the possibilities of VR and 360 videos to enhance their offerings<sup>43</sup>. The most well known example is The New York Times with their Daily 360 covering breaking news around the world. Publications as diverse as USA Today, Euronews, and Germany's Bild have all made significant experiments.

As VR is conducive to immersive storytelling, short-form 360-degree shorts, movies, and documentaries are a natural fit for publishers. Many news and entertainment publishers now post an increasing array of feature stories, interactive tours, and vignettes in the form of VR videos. Another method has been to encourage citizen journalists to upload and post 360-degree videos to sites. Many publishers are building their own VR/AR mobile apps.

VR advertisements and brand-promoting videos are another possibility. According to a Nielsen and YuMe report, VR prompted a 27% higher reaction in users and kept them engaged for 34% longer than traditional ads<sup>44</sup>.

Publishers can earn money from 360 videos in many ways such as<sup>45</sup>:

- Branded content: As with 2D video, there is money in distributing branded 360 videos
- Pre-roll: As the volume of 360 content grows on YouTube, we will likely see a rise in demand for and supply of 360 pre-roll
- "Sponsored by": Messages and logos around the content on the page or on a Google Cardboard viewer

#### 6.2.5. Case 5: 360 Live Streaming

In addition to recorded content, 360 live streaming has already opened new kind of business opportunities. These can be, for example, enhancing a physical event, creating dedicated events, or launching platforms.

For example, Oculus Venues<sup>46</sup> will be launched in 2018. It will offer possibilities to watch concerts, and catch premieres of new movies and TV shows with up to 1,000 people.

Samsung launched the VR Live Pass in June 2017. It streams live sports events and concerts to owners of its mobile-VR headset. The offering has included so far, for example, a UFC fighting

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<sup>43</sup> <http://www.econtentmag.com/Articles/Editorial/Feature/Virtual-Augmented-and-Mixed-Reality-Opens-Up-a-World-of-Possibilities-for-Publishers-117723.htm?PageNum=2>

<sup>44</sup> <http://www.onlinevideo.net/2017/10/vr-ads-show-huge-product-recall-numbers-finds-yume-study/>

<sup>45</sup> <https://blog.wan-iffra.org/2017/09/08/project-ponders-ways-to-make-money-from-360-video>

<sup>46</sup> <https://www.oculus.com/blog/oc4-day-1-recap-the-path-to-a-billion-people-in-vr/>

show, extreme-sports event, and Coldplay's concert. Samsung won't be charging Gear VR owners for the Live Pass at this point.<sup>47</sup>

Sponsoring is the main way to finance these kinds of services for the time being. For example, Global Citizen Festival in New York in September 2017, which presented some high-profile artists, was streamed for free, and was sponsored by Citi.<sup>48</sup>

The case of Goodwood Festival of Speed is a good demonstration of the potential of 360 live streaming<sup>49</sup>. This three-day motor sports show, which takes place annually in Goodwood, UK, has a cap of 150,000 attendees per day. This means that many fans, which would come to the event from all over the world, will not be able to participate the event.

In order to extend the reach of the festival, the organizers produced a 360 live stream via Facebook Live sponsored by Renault. The stream offered exclusive content such as celebrity interviews, backstage events, and drivers' helmet and dashcamera feeds. During the three days 1.5 million people watched these live 360 streams, and the streams were also shared actively. This extended the reach and created real additional value both to the festival and the sponsors.

## 7. FINNISH VR/AR COMPANIES: SWOT ANALYSIS

We have presented in the following table the SWOT analysis of the Finnish VR/AR companies and the domestic market situation.

These points are based on the interviews of the representatives of various kinds of VR/AR companies, and the other research work we have done around this subject. Strengths and weaknesses are internal attributes whereas opportunities and threats are external market features.

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<sup>47</sup> MusicAlly 31.5.2017

<sup>48</sup> MusicAlly 20.9.2017

<sup>49</sup> <http://www.streamingmediaglobal.com/Articles/Editorial/Featured-Articles/Extending-Access-to-Goodwood-Festival-of-Speed-using-360-Live-Video-119824.aspx>

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> <li>• Technical skills in certain areas: optics, machine learning, graphics, coding, mobile technologies, user interface design</li> <li>• Commercial skills that have been developed in mobile, game and software businesses</li> <li>• Co-operation in VR/AR associations and other networks</li> <li>• Support systems (Tekes, networks, incubators etc.)</li> <li>• Easy to facilitate functionally non-overlapping ecosystems between companies</li> <li>• Good possibilities to test various kinds of ideas in business and content production</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of co-operation between tech and content companies</li> <li>• Lack of co-operation between SME companies and academic research institutions</li> <li>• Scarcity of skilled individuals and teams</li> <li>• Lack of funding and/or viable business ideas</li> <li>• Variable business and export skills in start-up companies</li> <li>• Domestic market is too small for sustainable business</li> <li>• Location of Finland: long distance for direct and regular face-to-face contacts in exports</li> <li>• Lack of mass distribution or broadcasting channels</li> <li>• Emerging market: difficult to create volume in business and experience for product development</li> <li>• Difficult to specialize: companies have to work on too broad basis in order to survive</li> <li>• Difficult to create own IPR catalogues</li> </ul>
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> <li>• There is a lot of room for growth and scaling:                         <ul style="list-style-type: none"> <li>○ Many big companies are only starting to experiment with VR/AR</li> <li>○ Increasing demand for work-for-hire B2B subcontracting</li> <li>○ Big companies need help both from tech and content companies</li> <li>○ Increasing demand for tools and ready-made solutions</li> <li>○ Fast-growing Asian markets (e.g. VR arcades)</li> </ul> </li> <li>• Low threshold to start production as more and more ready-made elements and affordable technology become available</li> <li>• Development of new kind of production methods and processes</li> <li>• Apple's and Google's mobile AR tool kits open up possibilities also for small companies to develop products for global markets</li> <li>• VC funding is available                         <ul style="list-style-type: none"> <li>○ Many VCs are still waiting for the maturation of the market</li> <li>○ VCs are especially interested in opportunities of AR</li> </ul> </li> <li>• All companies have equal opportunities as none of them have a long track record</li> <li>• Growth of the consumer market with the new generation of headsets</li> </ul>	<ul style="list-style-type: none"> <li>• Industrial uptake takes longer time than expected</li> <li>• Content production budgets remain too small for developing sustainable business</li> <li>• It can take a long time before VR/AR businesses can run on cash flow</li> <li>• Fierce competition                         <ul style="list-style-type: none"> <li>○ Big Internet companies have huge resources in competition</li> <li>○ Scarcity of skilled persons and teams</li> </ul> </li> <li>• Main development takes place in North America and Asia instead of Europe</li> <li>• VC funding slows down                         <ul style="list-style-type: none"> <li>○ VCs are disappointed at VR market's development</li> <li>○ Investors are wary of the bubble as the company valuations have risen</li> <li>○ Big companies are waiting for ready-made or tested solutions before making further investments</li> </ul> </li> <li>• Consumer gear basis remains fragmented and too small</li> <li>• Consumers do not understand the value of VR/AR for them</li> </ul>

These lists reveal that, on the other hand, the Finnish companies have some clear strengths especially in technical skills, support systems, and co-operation networks. However, on the other hand, the companies are, within a shorter time span, suffering to survive due to lack of funding, work opportunities, and in some cases business skills.

So far we have not seen any real business success stories in Finland as the VR/AR market is only emerging. Some companies have managed to get substantial amount of funding. At the same time, we have already seen some companies either quitting the business or being bankrupted either due to lack of funding or viable market, or failed or premature products or services.

The international VR/AR market is developing very fast. Therefore it would be essential to seize the day and invest in developing the companies and their skills swiftly so that the fast movers could exploit the opportunities and gain market shares in selected business areas.

The following enhanced SWOT table lists proposals for action points:

<b>STRENGTHS/OPPORTUNITIES: INVEST IN</b>	<b>STRENGTHS/THREATS: DEVELOP</b>
<ul style="list-style-type: none"> <li>• Industrial applications in different business areas: medical, shipbuilding, construction, machinery etc.</li> <li>• Co-operation with gear manufacturers</li> <li>• Developing current narrow-scale strengths in order to be forerunners on global level</li> <li>• Flagship projects with important global companies (e.g. cars, film studios) for obtaining benchmark value</li> <li>• Creating own IPR catalogues for licensing business</li> <li>• Consulting potential buyers in order to make them understand the potential of VR/AR and to close deals</li> <li>• Quality of content, that will be crucial advantage in competition at some point of market development</li> <li>• Starting with focused products</li> <li>• Exploiting in full the already existing platforms such as Facebook and Steam</li> <li>• Flexible support systems, which can adapt to swiftly-changing market conditions</li> <li>• Recruiting people with commercial experience in working in game, software and mobile industries</li> </ul>	<ul style="list-style-type: none"> <li>• Skills in distribution, presentation and sound</li> <li>• Participation in international events and trade fairs</li> <li>• International business contacts systematically, public support for trips</li> <li>• Understanding the features of each territories' markets and business cultures</li> <li>• Communication and co-operation between companies and academic research institutions</li> <li>• Co-operation between different VR/AR associations</li> <li>• More world-class tech companies (such as Varjo)</li> <li>• Sales activities, both individual and joint</li> <li>• Understanding better the requirements of the new kind of narration and exploiting them</li> <li>• Adding VR/AR to media education programs; applying e.g. medialab methods</li> <li>• Co-operation with local international events such as Slush</li> </ul>
<b>WEAKNESSES/OPPORTUNITIES: PREPARE FOR</b>	<b>WEAKNESSES/THREATS: AVOID</b>
<ul style="list-style-type: none"> <li>• Slower than expected development of both industrial and consumer uptake of VR/AR</li> <li>• Hard international competition in all areas of VR/AR</li> <li>• Facing competition from companies, which are heavily state-funded in their home countries</li> <li>• Difficulties in getting VC funding</li> <li>• Bankrupts, mergers and acquisitions during the next few years</li> <li>• Pivoting and quick changes in the strategy of the company according to the development of the market</li> <li>• Shortage and fierce competition on scarce top-level talent/teams and skills</li> <li>• Quick changes of price levels both in B2B and B2C businesses</li> </ul>	<ul style="list-style-type: none"> <li>• Competing in areas, which require long-term development processes and large investments</li> <li>• Competing in areas, which are not the core strengths of the company and its partners</li> <li>• Concentrating too much on domestic market</li> <li>• Scattering the focus of the company</li> </ul>

Based on these tables the **critical success factors** of Finnish VR/AR companies are:

- Relying on the already existing strengths and concentrating on developing them to the world-class level
- Being able to concentrate on narrow-scale products in individual companies
- Creating business models that attract funding
- Securing support for developing products and establishing businesses
- Being able to produce world-class flagship products for obtaining benchmark value
- Creating substantial IPR catalogues, which enable long-term licensing business
- Keeping the best local skills, talent and teams in Finnish companies, and attracting international talent to come to work in Finland
- Getting VR/AR into the education programs in all levels
- Developing the co-operation between the companies, and between companies and academic research institutions
- Creating and maintaining international network for exports
- Educating the local big companies so that they would start ordering VR/AR products and services from local companies in a large scale
- Promoting VR/AR technologies and services to consumers

From the point of view of individual VR/AR companies, who have started their activities only recently, the market situation is challenging. Based on the research work, the previous SWOT lists, and the interviews we did, our **main advices** for them are the following:

- Join the VR/AR associations and create networks with other companies and relevant academic institutions working in the field of VR/AR
- Find out about the various public support systems such as Tekes and Ely
- If you need support for starting, developing and/or establishing your business, consider joining a specialized incubator program such as Nordic VR Startups<sup>50</sup>, Yle Beta<sup>51</sup>, and Mediapolis Accelerator<sup>52</sup>
- In order to get VC funding, make sure that your business model and plan is viable enough
- Secure a sufficient funding basis as both the industrial and consumer uptake of VR/AR can take longer than predicted
- Start working on exports as soon as possible, and invest enough time and resources in the regular presence and networking in your target territories
- Find a clear and narrow enough focus for your business without trying to do too many things simultaneously

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<sup>50</sup> <http://nordicvrstartups.com>

<sup>51</sup> <https://yle.fi/aihe/termi/yle/18-238569>

<sup>52</sup> <https://maccelerator.fi>

- Rely as much as possible on already existing ready-made technical or other solutions instead of developing your own solutions (unless it is your business area)
- If you have problems in finding local talent and skills, rely on a distributed network or recruit team members, who can be located in any part of the world
- Educate your potential customers, who are not aware of the possibilities of VR/AR
- Start creating an IPR portfolio of your own as soon as possible, and learn to exploit it

## 8. CONCLUSIONS AND RECOMMENDATIONS

The VR/AR market is developing fast both in Finland and on global level. In order to run successful business Finnish companies have to establish themselves swiftly both in Finland and in global markets. The strategies of Finnish companies have to be based on the already strong skills and develop them further. This requires more co-operations between the companies and also with academic research institutions.

The biggest challenges are ensuring financing, and keeping and acquiring scarce talent in Finland. The next few years are challenging especially for the start-ups to survive before the market starts growing substantially. In both the B2B and B2C market VR/AR requires a lot of promotion in order to speed up the uptake, which would enable scaling up the volume of Finnish VR/AR companies.

In order to exploit the potential of the emerging markets we would recommend the following action points:

- Invest in the industrial uptake of VR/AR, especially the successful companies in basic industries
- Invest in exploiting the potential of VR/AR in the most potential business areas such as security, education, health care, construction, and maintenance
- Add VR/AR into the education programs in all levels and create specialized programs
- Support co-operation between SME companies and academic research institutions
- Amplify the resources for VR/AR research
- Target more Tekes support and funds for VR/AR
- Support international networking and exports of the VR/AR companies
- Subsidize various kinds of pilot projects and further development of the best ideas
- Use the success and reputation of Finnish gaming industry in promoting Finnish VR/AR companies and products both in Finland and abroad
- Improve the understanding of consumers' habits and values

Most of the fore-mentioned action points would require further analysis, which would include action plans for all parties in business. These plans should be executed without further delays in order to move fast in international markets and gain competitive advantages in the growing market.

## 9. APPENDIX: INTERVIEWS

COMPANY	PERSON	DATE/2017
3rd Eye Studios	Koivistoinen, Kari	25.10.
Aito Media	Hynninen, Ilkka	27.10.
Deeptale	Pänkäläinen, Tero	17.10.
Doorstories / Mediapolis Accelerator	Tuovinen, Timoteus	12.10.
Fake	Parikka, Santtu	17.10.
Freelance film director	Pietiläinen, Tommi	17.10.
Keho Interactive	Karsisto, Mikko	11.10.
Leonidas / VR Finland	Peltola, Kari	14.11.
Media Deals, Berlin	Baujard, Thierry	19.10.
Rakka Creative	Huttu-Hiltunen, Ilmari	23.10.
Tekes	Parviainen, Aki Rajahalme, Petri	3.10. 6.10.
TUT	Helander, Nina	15.11.
UTA	Raisamo, Roope Turunen, Markku	23.10.
Vizor	Jäderholm, Antti Kananen, Kaarlo	2.11.
Yle	Komulainen, Anssi	23.10.