When it is reported that Apple has set about assembling a large team of specialists in virtual and augmented reality (VR/AR) to look at building prototypes of headsets to rival the Oculus Rift or the Microsoft's Hololens, it would seem to suggest that the world of augmented reality (AR) is beginning to witness a moving of the tectonic plates, as a growing number of companies adjust their focus from trials and test projects to real commercial deployments.

AR, when combined with wearable technology, can offer a hands-free computing environment that gives users greater levels of interaction with information and their surroundings.

According to Saverio Romeo, principal analyst with Beecham Research: "We expect to see the rapid evolution of smart glasses with more miniaturisation, better field of view and battery life. There will also be increasing attention on AR's convergence with VR technology and the Internet of Things."

AR is forecast to become a widely pervasive technology and this nascent 'revolution' is expected to go well beyond 'Google Glass', fitness tracking and health monitoring. However, increased collaboration between AR/VR and IoT developers is seen by many as crucial to the successful future development of the technology.

According to David Harold, senior director of marketing communications with Imagination Technologies: "With continued refinement of AR technologies in areas such as contextual awareness, together with improvements in real time analytics, ever more ubiquitous connectivity and the decreasing cost of wearable devices, there is a great opportunity for AR to make a huge impact across a range of different industries." He lists manufacturing, logistics, healthcare and retail; all of which are expected to be among the most dynamic markets, with AR offering users a new way to interact with information as well as providing a greater depth of control and access to knowledge.

"AR has the potential to not only create new markets, but also to disrupt existing ones," says Adam Kerin, Qualcomm's senior manager of marketing. "It has the potential to have a broad impact and will aid in day-to-day tasks as a hands-free device."

According to Harold: "Most of the apps built to date around AR technology have been focused on retail environments, but we expect the use cases to develop rapidly as AR makes its way into new types of devices."

Among them is sharing the point of view of the AR wearer, which is throwing up a number of innovative applications, according to Harry Zervos, principal analyst at IDTechEx.

"An interesting space is in insurance claims and similar sectors. A person can see from their office what another person deployed to the scene in question can see, directly and with no noticeable time lag, allowing remote support, the identification of key elements and real time cross referencing with databases that are not always available at hand to an investigator dispatched to the scene."

A report published earlier this year by Beecham Research highlighted a number of recent corporate acquisitions that, it said, reflected a growing level of market activity and consolidation in the AR sector.

According to the report, the AR market is beginning to accelerate as companies recognise the benefits of the technology and the achievable returns on their investment – according to Beecham, the AR market could be worth around $800million by 2020.

Moment

Has the moment finally arrived? Will augmented and virtual reality become the next big computing application, creating new and disrupting existing markets? By **Neil Tyler**.

Smartphones

Smartphones will have a critical role to play in the AR ecosystem as they will be the primary viewing device. The challenge, therefore, will be to equip the smartphone with the optimum number of sensors and processors while addressing higher power requirements and cost.

"Faster processing will come at a price," explains Radhika Arora, ON Semiconductor's IoT product line manager. "Adding more sensors (cameras and others) could mean larger form factors, which will hamper the user experience. And all this will need to happen without disrupting the existing smartphone world."

The ecosystem that supports AR and VR is large and varied and includes head-mounted devices, memory, cameras, haptics, audio and graphics.

"On Qualcomm's Snapdragon processors we're continually adding more functionality to better support AR use cases," Kerin explains. "It is very challenging to implement because of the processing complexity and latency issues, along with requirements for improved sensors and new display technologies.

"A lot of the technologies that are relevant for smartphones are applicable for AR, whether it is computer vision, graphics, image processing, audio processing, latency optimisation or low power processing," he

"Most of the apps built to date around AR technology have been focused on retail environments, we expect the use cases to develop rapidly as AR makes its way into new types of devices."
David Harold

# of truth?

continues. "We are making great strides on computer vision, since it is such an essential component for contextual awareness and making our devices smarter."

As AR expands from mobile phones and tablets into wearables, it's crucial that advanced and compute capable feature sets are retained whilst silicon area and development costs are reduced.

"Imagination's technologies are already deployed in a range of glasses with some AR features and new technologies like our PowerVR GPUs will enable more usable and efficient future generations of wearable AR devices," says Harold. "Beyond multimedia, another important consideration is connectivity. A lot of AR devices will incorporate Wi-Fi and companies can reduce BoM costs and power consumption by integrating this functionality onto a SoC, rather than a chipset."

Sensors and processor will also need to be able to effectively process complex AR functions such as predictive head motion tracking and reduce 'motion to photon' latency.

"Tools like the FastCV SDK, Symphony SDK and the Hexagon SDK are available to developers and OEMs so they can maximise performance, reduce power and reduce development time," says Kerin.

Market opportunities
It is not the first time that virtual and, to a lesser extent, augmented reality have been touted as the 'next big thing'. There was a similar boom in the 1990s, with gaming companies introducing 3D games, while the concept of immersive worlds was discussed extensively in books and on film.

"AR has the potential to not only create new markets, but also to disrupt existing ones"
Adam Kerin

Perhaps it was this portrayal in the media that raised AR and VR expectations beyond what was possible at the time – graphics were poor, devices very expensive and computing power low, leaving consumers dissatisfied.

Research from Goldman Sachs suggests there have been more than 225 VC investments in AR/VR companies since the latest cycle of activity was kicked off by Facebook's acquisition of Oculus in 2014. This time, howver, the technology is ready to deliver on the promise and the list of companies involved includes Qualcomm, Sony, HP, Google, Intel, Disney and Microsoft, not to mention Apple.

Augmented reality and virtual reality have different use cases, technologies and market opportunities. VR is completely immersive – the user enters into a virtual world via a headset which cannot be seen through. By contrast, AR overlays digital imagery onto the real world. Examples include the HoloLens from Microsoft and the less than well received Google Glass.

Surprisingly, business has been one of the strongest adopters of AR, leading not only to the rise of strong trade bodies for AR in industry, but also the reconsideration of product plans from some technology businesses who were expecting the weighting of interest to be more towards consumer use, suggests Harold.

In fact, more and more businesses are expected to place smart glasses at the core of their IoT systems, as they look to make workers more productive and to streamline their back end operations

According to Valerie Riffaud-Cangelosi, new markets development manager at Epson, the AR market is set for strong growth. "Deploying AR will enable more efficient processes and by enhancing reality the user will be able, for example, to maintain an engine or a complex electrical board in an intuitive and easy way – they will be able to see inside the device and act on the information there and then.

"Epson unveiled its first AR product – the Moverio BT-100 – five years ago. Today, its BT-300 smart glasses offer video and access to new augmented reality experiences for a variety of commercial and vertical market applications."

The Moverio BT-300, unveiled at this year's Mobile World Congress in Barcelona, employs a variety of technologies and can project in-line digital content into the wearer's field of view.

According to Riffaud-Cangelosi, the most significant advance with the BT-300 is a proprietary micro display projection system called Si-OLED (silicon organic light emitting diode) which can produce deeper and truer black tones. That is important because a true black projected onto the lenses of these smart glasses equates to the

"For a true mobile AR system, there is still not enough computing power to create stereo 3D augmented reality graphics"
Radika Arora

absence of colour and therefore total transparency. The latest Si-OLED displays can blend projected digital content more realistically with the real world the user sees while wearing these glasses.

The glasses weigh just 60g and use an Intel Atom 5, 1.44GHz Quad core chip. The use of Android 5.1 has expanded the complexity of the apps that can be written for the glasses.

AR headsets are expected to evolve from the current type of eyewear to much sleeker devices. Possibilities range from fashionable glasses to contact lenses and, in the distant future, it could be possible to make AR implantable with apps having direct access to the nervous system.

One key technological challenge, especially for mobile AR, is packaging the components into a compact, sleek and lightweight format that people can wear comfortably all day. Additionally, AR headsets touch the face, so they have to remain cool to the touch, which brings additional power and thermal constraints.

"For a true mobile AR system, there is still not enough computing power to create stereo 3D augmented reality graphics," Arora argues. "Laptops are just about starting to be equipped with the necessary graphics processing units and both sensors (to a large extent image sensors) and haptics will play a critical role in the future adoption of AR.

"For image sensors, getting the form factor more compact will be key as well as improving their performance in varying light conditions."

Consumers will want a mobile experience where they are untethered and free to use their AR headset throughout the day, so extended battery life will be essential.

Addressing all of these challenges will be critical in the development of AR devices that consumers will be excited to purchase and – at least in the consumer market – headsets will need to be fashionable.

But while the future may witness fashionable eyewear – even bionic eyes with immersive 3D displays – AR developers will need to focus on a common interface that integrates with the gadgets/wearables in use today, whether that's a smartphone or a pair of glasses.

"AR is still very new, with limited market penetration," says Qualcomm's Kerin, "but as the technology advances and the form factor decreases, we can expect to see it evolving into a seamless experience that users will interact with daily."

> **More and more businesses are expected to place smart glasses at the core of their IoT systems as they look to make workers more productive and to streamline their back end operations**