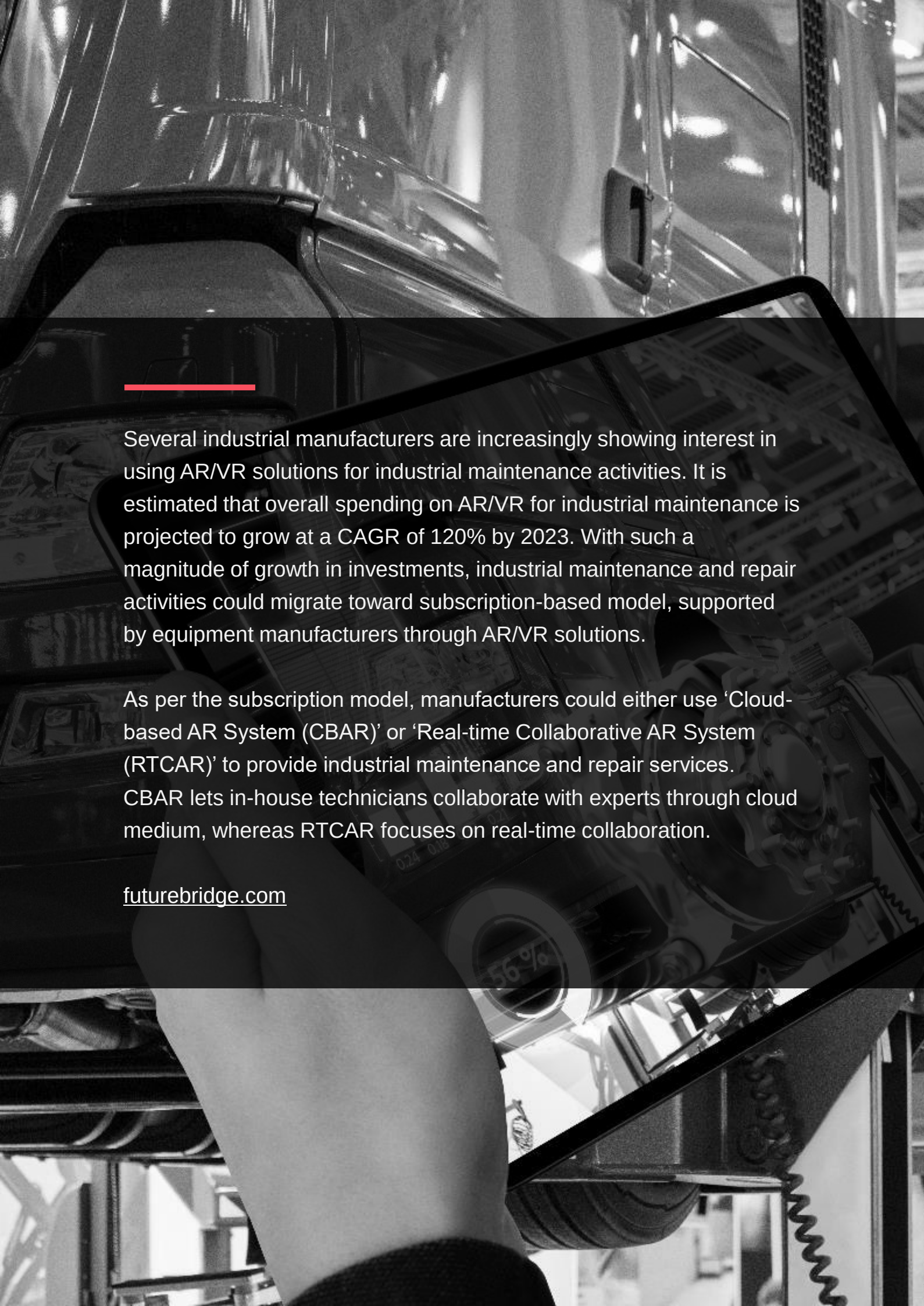
WHITE PAPER

July 2019

Augmented Reality – Prospects for Subscription-based Model for Industrial Maintenance

FutureBridge



Several industrial manufacturers are increasingly showing interest in using AR/VR solutions for industrial maintenance activities. It is estimated that overall spending on AR/VR for industrial maintenance is projected to grow at a CAGR of 120% by 2023. With such a magnitude of growth in investments, industrial maintenance and repair activities could migrate toward subscription-based model, supported by equipment manufacturers through AR/VR solutions.

As per the subscription model, manufacturers could either use ‘Cloud-based AR System (CBAR)’ or ‘Real-time Collaborative AR System (RTCAR)’ to provide industrial maintenance and repair services. CBAR lets in-house technicians collaborate with experts through cloud medium, whereas RTCAR focuses on real-time collaboration.

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Key Messages

1. The adoption of augmented reality (AR) solutions by firms across several sectors is increasing at a rapid pace. The overall spending on global AR/VR market (including both consumer and commercial sector) is expected to reach around $20 billion in 2019. The use cases anticipated to witness spending growth include AR for lab and field education, AR for public infrastructure maintenance, and AR for anatomy diagnostic. Spending on AR/VR for industrial maintenance is expected to equal AR/VR gaming by 2023, growing at a CAGR of around 120%. **Electrolux, Alstom, Elay Group,** and **Xerox** are some of the few companies that have already adopted AR solutions for maintenance activities.

2. This led us to foresee the possibilities of using a subscription-based model for industrial repair and maintenance services using AR solutions. The two possible models that will enable subscription services of industrial maintenance are – (1) Cloud-based AR System (CBAR) and (2) Real-time Collaborative AR System (RTCAR). CBAR lets the in-house technician collaborate with an expert through cloud medium, whereas RTCAR focuses on real-time collaboration.

3. A major disruption that could be witnessed in the value chain is the increase in coherence and collaboration among AR manufacturers and OEMs. OEMs will look to partner or collaborate or even acquire device manufacturers/content providers to offer AR-based remote maintenance services with a subscription model.

4. Major drivers for this model are time and cost benefits, for instance, cost reduction of 89% and time reduction of 78% was achieved while using augmented reality solutions for remote maintenance in the robotics industry. Other major drivers are minimal equipment downtime and addressing the lack of a skilled workforce.

5. Despite several benefits, the model also has few challenges which might put this reality into the future. Some of the major challenges this model might face are model development, acceptance, data transfer, and content creation. However, FutureBridge foresees the adoption of subscription-based maintenance model through AR solutions increasing in the next 3-5 years.

AR Introduction

Augmented Reality (AR) enhances the real-world environment by overlaying virtual objects, images, or information that is real-time based. Other forms of virtual enhancements, including text, graphics, audio, video, and GPS data, can also be used in enhancing the real-world environment. Thus, a multitude of data available with the businesses is put to use by AR, which enhances the internal productivity of the business. The virtual enhancements in AR are interactive and digitally responsive with advanced AR technology.

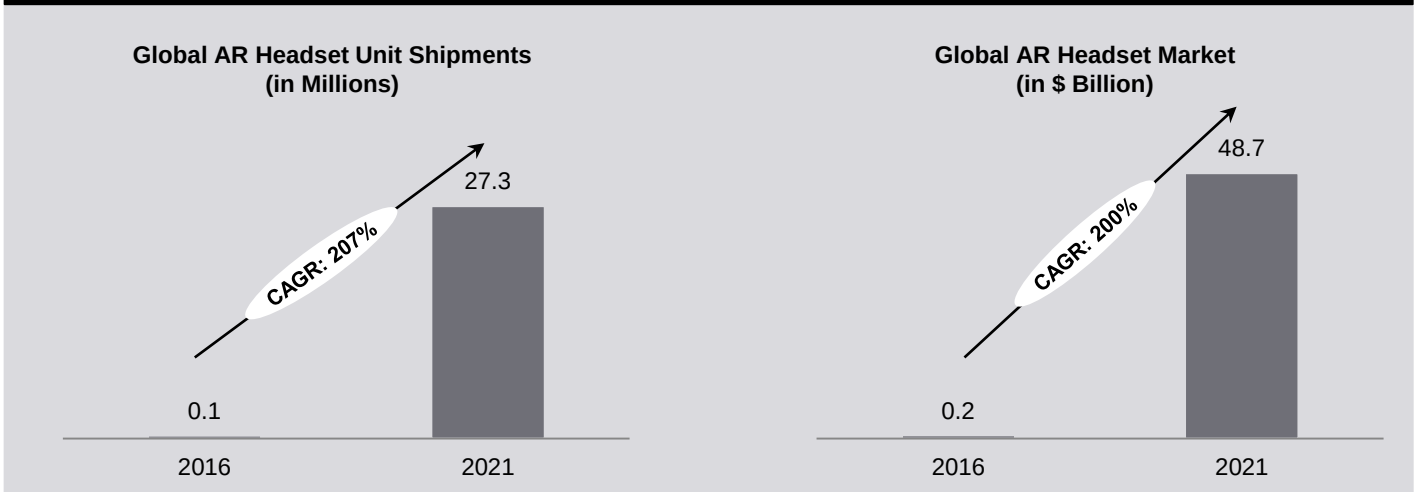
A typical AR system includes the following systems:

- A computer system to run the AR application
- A digital camera to capture the real world scene
- A tracking system to track the position of users and objects and synchronize it with real world scene
- A display (handheld devices or head-mounted displays)
- A data acquisition system to interact with the AR application

AR Market Growth

The AR market is predicted to witness huge growth in the coming years, as per the research report from IDC. The unit shipments of AR Headset is estimated to grow at a CAGR of around 207%, while the AR headset value market is expected to witness a growth of approximately 200% during the forecast period 2016–2021.

EXHIBIT 1: Global AR Commercial Headsets Unit Shipments and Global AR Commercial Headset Value Market



Source: IDC and FutureBridge Analysis

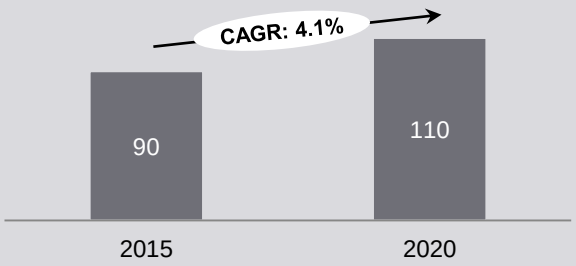
The overall spending on global AR/VR market (including both consumer and commercial sector) was around $14 billion in 2017 and is expected to reach around $20 billion in 2019, as per the initial assessment of FutureBridge. The worldwide spending on AR/VR is expected to be led by the consumer sector that includes VR games, AR games, video/feature viewing apps, and etc.

However, the commercial sector including retail, discrete manufacturing, process manufacturing, transportation, lab and field, anatomy diagnostics, internal videography, and etc. are expected to witness increased spending over the next five years. It is also estimated that the overall AR/VR spending in process manufacturing and discrete manufacturing industries will surpass the AR/VR consumer spending segment by 2021.

Currently, the most significant industrial use cases of AR solutions are training, retail showcasing and on-site assembly and safety, and this trend is expected to witness some changes, as more and more industrial spending on AR solutions will be made for industrial maintenance. The overall spending on AR/VR for industrial maintenance is expected to grow at a CAGR of around 120% until 2023. By 2023, the spending on AR/VR for industrial maintenance will reach the level of spending in the AR/VR gaming sector. Overall, the industrial expenditure on AR/VR by the end of 2021 will primarily be driven by the need for AR/VR solutions in industrial maintenance. The importance of industrial maintenance highlights the key aspect of IIoT, Industry 4.0, and so on.

IIoT is one of the key enablers for AR based industrial maintenance services and would play a significant role in moving the maintenance services to a subscription-based model. This is because predictive maintenance, which is being adopted by a large number of industrial customers, is best served by this model using IIoT. IIoT plays a key role in data collection and storage from a myriad of devices in the industrial setup. Hence, the growth of IIoT in the industrial sector plays a key role in helping the industrial maintenance, transition from normal maintenance to subscription-based maintenance with AR solution, in the future.

EXHIBIT 2: Global IIoT Market (US$ Billion)



Source: Morgan Stanley and FutureBridge Analysis

AR in Maintenance and A Futuristic Thought

Maintenance is an imperative and the most common service across various industries, accounting for almost 30% of the operating costs and about 60–70% of product lifecycle costs. Therefore, maintenance planning has become a vital parameter to reduce equipment downtime and increase productivity. Therefore, manufacturing companies are increasingly focusing on “Products – Service Systems” (PSS), which is a combined ecosystem of both products and services, and AR is making quick inroads in this field of thought.

The ever advancing technologies with respect to AR, connected devices, sensor devices, 3D cameras and etc. has made it entirely possible for remote service personnel to assist in-house technicians on the repair and maintenance services. Several enabling technologies, such as magnetic navigation technology, low-power wireless machinery condition sensors, low-power wireless Bluetooth communications, other sensor devices, IoT, and cloud computing access, are clubbed with AR technology to overlay the virtual image of the equipment with all the necessary information (including working condition of equipment, maintenance history and equipment location in the plant.) over the real world equipment. This assists the in-house technician with required repair or maintenance information on the specific equipment or component. With this thought, our whitepaper analyses the opportunities of a new subscription-based service model enabled by the remote assistance feature of AR technology.

The Future of Industrial Maintenance

The possibility of industrial repair and maintenance services to move into a subscription-based model in the future is on the cards with AR making quick inroads in the manufacturing sector lately. The remote assistance technology with AR could bring an entirely different aspect of repair and maintenance services in the future, which could be subscription based repair and maintenance services.

In this model, end-users utilize the technical knowledge/expertise in repair and maintenance services from OEM and carry out the physical repair and maintenance activity themselves with the help of in-house technicians. The subscription model can be used for any type of maintenance, be it breakdown or preventive or predictive. The future will belong to subscription services of industrial maintenance that will be provided by OEMs as a part of *‘Products Services Systems’* of ‘Servitization,’ a booming business model for manufacturers. End-users can subscribe for maintenance services either on an annual or hourly basis, as provided by the OEMs.

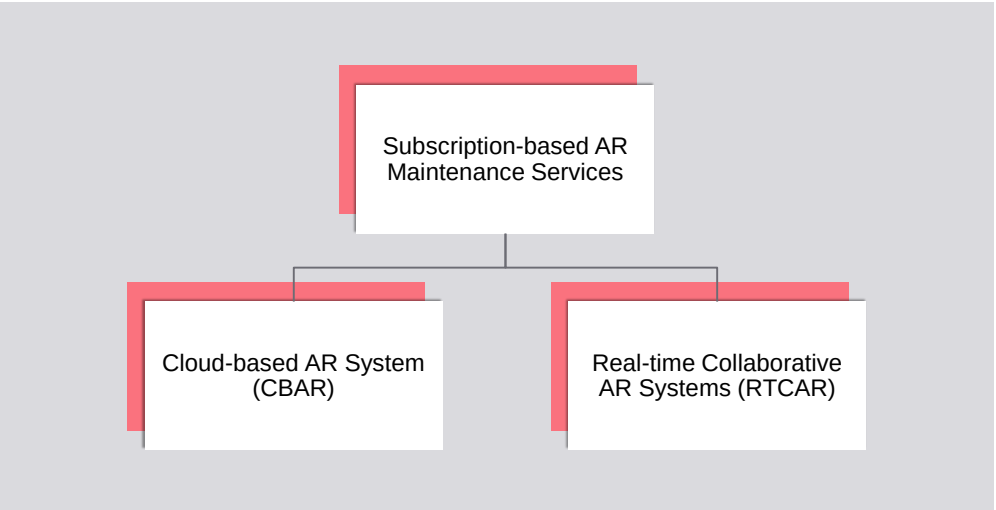
In our whitepaper, we have analyzed the possibilities of two types of model, which can be made available to the end-users. In the first model, end-users will rely on cloud-based communication with the expert. In this model, OEMs will provide the end-users with login credentials to a dedicated service portal in the cloud. The service portal will house various automation applications, AR content, feedback documents, malfunction documents, and etc. The application in the cloud platform will perform a checking function and act accordingly. An expert will be notified only if necessary, and when notified, the communication between the expert and in-house technician will be through the cloud platform.

In the second model, a collaboration between the in-house technician and the expert happens in real-time. The in-house technician uses an input device to capture the condition of the equipment, which will be analyzed by the expert. Post analysis, respective AR visualization scenes will be pushed to the in-house technician's device with step-by-step guidance on the service requirement. The second model is expected to be expensive than the first one.

Model Development

The aim of this whitepaper is to understand the opportunities in providing a subscription-based service model using connectivity solutions such as the internet that combines cloud-based systems and expertise at a remote location. In this model, AR technology enables tele-maintenance of equipment by collaborating the end-user and the manufacturer. AR-based maintenance and repair operations can be categorized into two major models; they are:

- Cloud-based AR Systems (CBAR)
- Real-time Collaborative AR Systems (RTCAR)

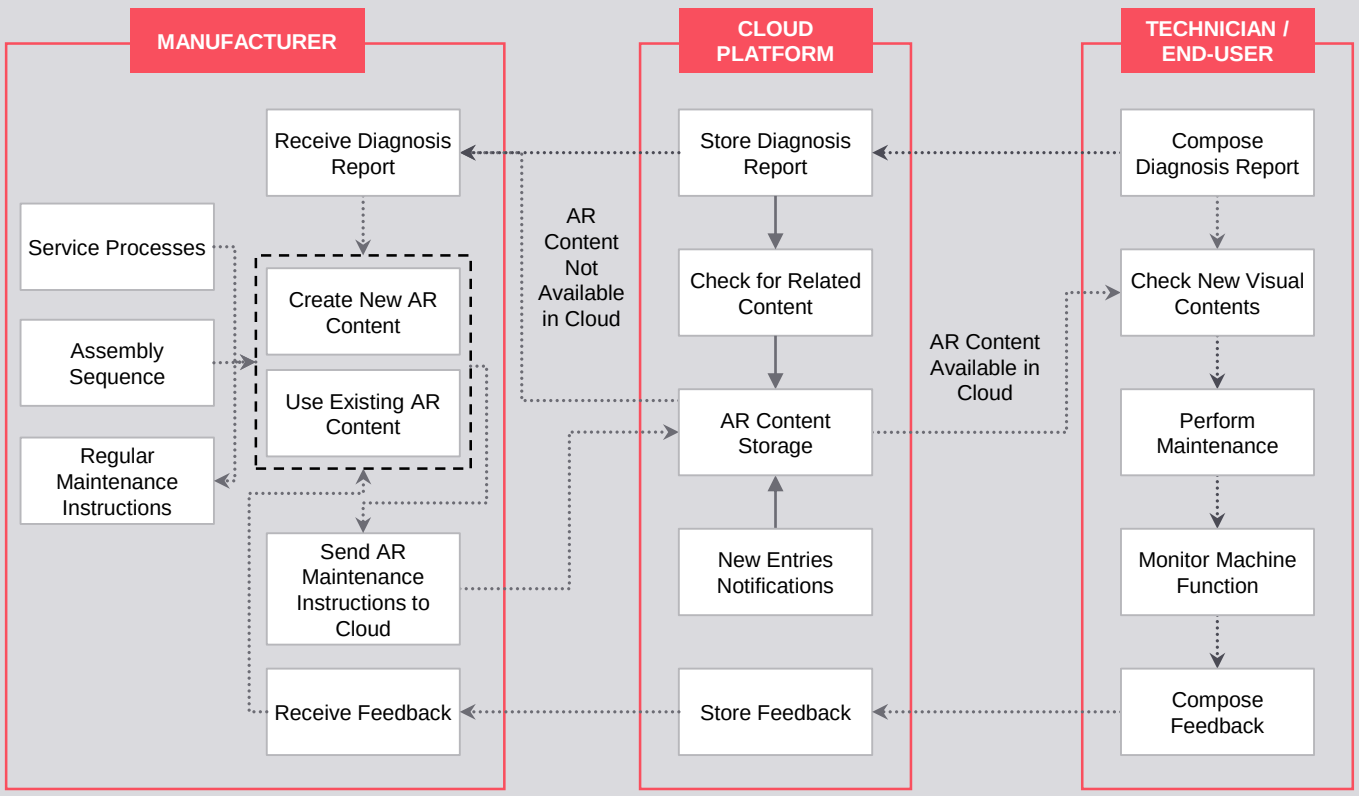


Cloud-based AR Systems (CBAR)

In this model, all the useful information required by the technician is stored in the cloud, which can already be converted into visual models or being authored or converted in real-time on demand. This allows the technician to act independently with the help of the AR system, to perform repair or maintenance activity, without the need of having the service expert present at the location. This model is developed by combining cloud-based platform with a remote maintenance system that enables cloud-based communication between the technician (end-user) and the service expert (manufacturer).

All the AR maintenance visualization scenes are stored in the cloud database for future uses, as the same malfunction can occur with several other end-users. This ensures quick response time to the similar maintenance service need that might arise in the future. Especially, in case of preventive maintenance operations, where some activities tend to occur several times for industrial equipment, storing AR visualization sequence would drastically reduce the maintenance response time as the user could use previously created AR visualization sequence.

EXHIBIT 3: Processes Involved in CBAR



Source: FutureBridge Analysis

This model requires the following steps to be performed.

- Composition of Service / Malfunction Report
- Search for Related Content
  - Diagnosis and AR Maintenance Instruction Generation
- Maintenance and Evaluation

Composition of Service/Malfunction Report
Whenever a maintenance service is required, be it scheduled maintenance or breakdown maintenance, the technician needs to develop 'the service report' or 'the malfunction report' and store it in the cloud. The report includes various points describing the service requirement or issues or machine data, such as sensor data, image of the malfunctioning equipment/part, and sound recording of the equipment.

Search for Related Content
The service report or the malfunction report will be checked for keywords, and those keywords would be used for determining or understanding the service requirement. Post understanding the service requirement, the application will check for related AR content from the cloud storage. The in-house technician will be notified on the availability of related AR content. In case of non-availability, an expert from the OEM will be notified to provide assistance on the created malfunction report.

Diagnosis and AR Maintenance Instruction Generation: The service/malfunction report provides the expert with necessary features of the equipment that is essential for failure diagnosis. Identification of the reason for malfunction is carried out by the expert post receiving notification about the report. AR instructions are generated and stored in the cloud for the technician's perusal after successful identification of the malfunction cause. In some cases, an expert might need more information about the malfunction, which will be gathered by to-and-fro feedback sharing between the in-house technician and the expert.

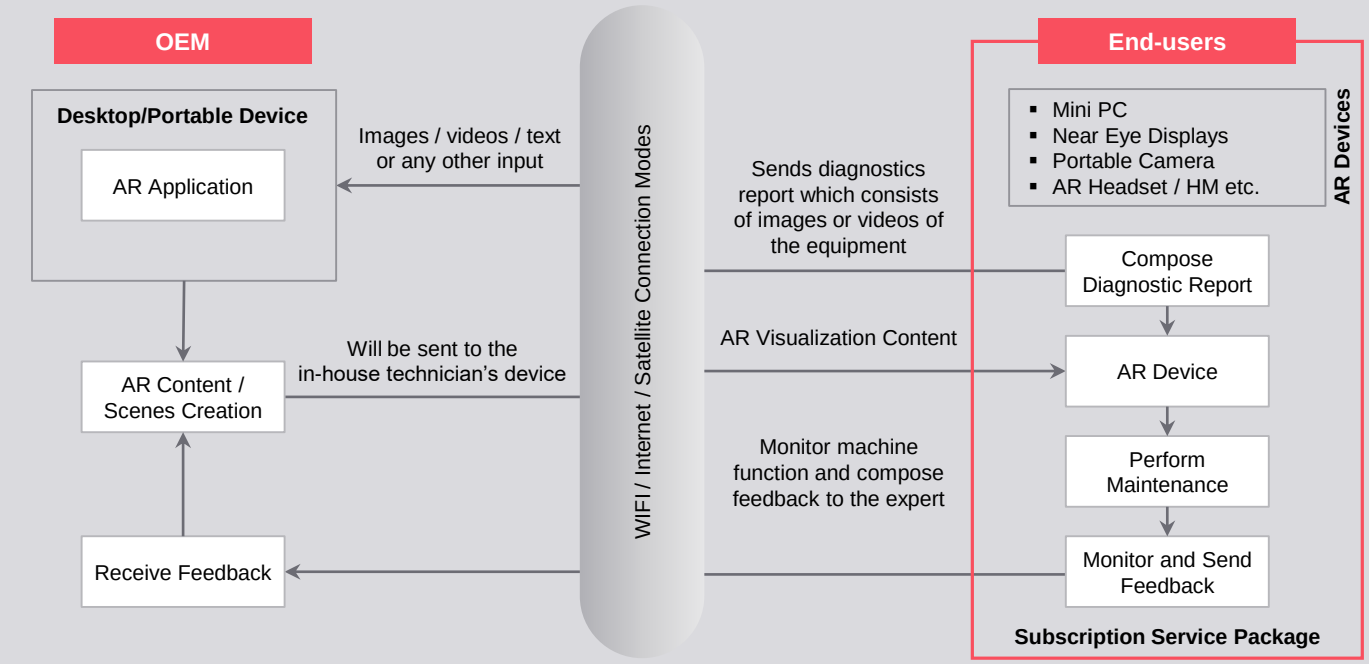
Maintenance and Evaluation
AR instructions generated by the expert has visualization models of the equipment and the repair steps to be performed. The expert quickly creates AR instructions with the help of an automated algorithm, which automates scene creation in the assembly and disassembly processes. This ensures minimal downtime of the equipment.

Real-time Collaborative AR Systems (RTCAR)

More than one user is involved in this model, and it is essential when complex maintenance/repair procedures are carried out. While carrying out complex procedures, in-house technicians look for intervention and assistance from experts for troubleshooting the issues. In this mode, in-house technicians connect with the

expert on a real-time basis through AR devices. The expert at OEMs end can see and visualize the equipment through the view of an in-house technician at the equipment end.

EXHIBIT 4: Processes Involved in RTCAR



Source: FutureBridge analysis

Impact of Model on Industrial Maintenance

Industrial maintenance based on a subscription model with AR solutions plays a significant role in all types of maintenance. The major types of maintenance in focus are:

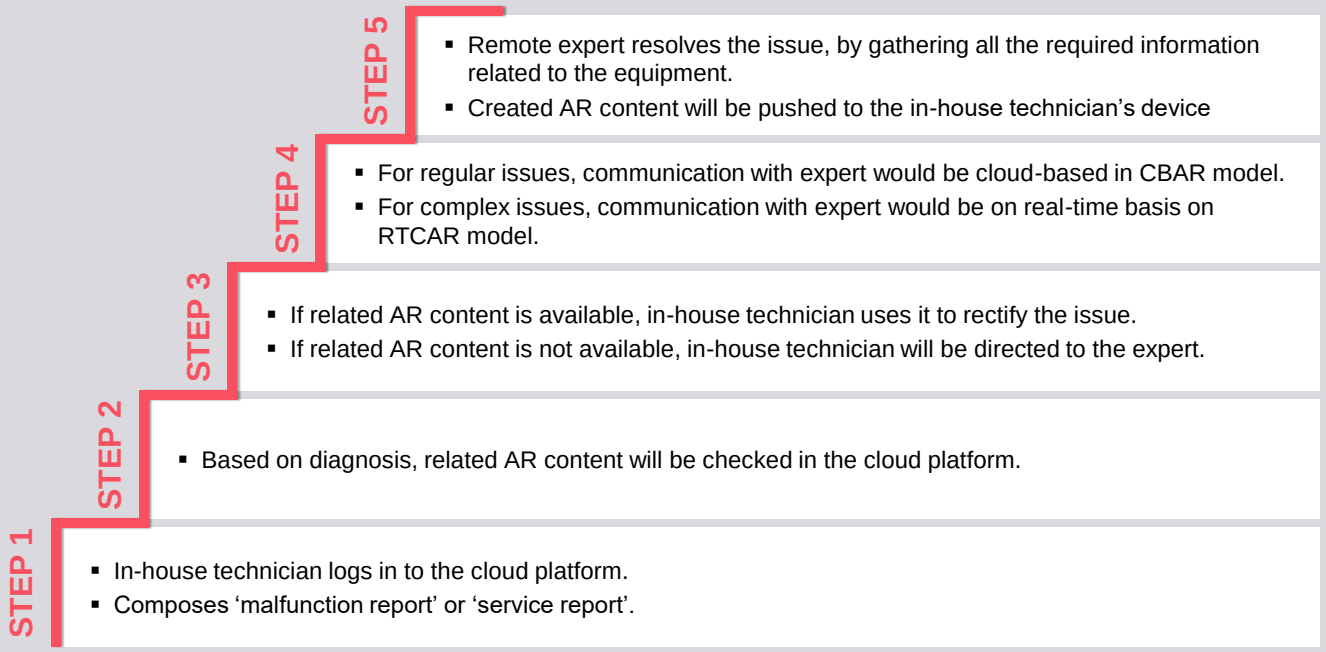
- Reactive Maintenance
- Preventive Maintenance
- Predictive Maintenance

Reactive Maintenance

Reactive maintenance takes place when there is a breakdown of the equipment/part. When such events occur, in-house technicians look for readily available AR content stored in the cloud platform. If AR content is readily available, necessary steps will

be taken to rectify the issue. This can be achieved by the CBAR model, where cloud-based storage is available with ready AR visualization scenes. If AR content is not available in the cloud, immediate assistance will be provided by the expert to resolve the issue. The collaboration with the expert can be either by CBAR or RTCAR model.

EXHIBIT 5: Future of Industrial Maintenance



Source: FutureBridge analysis

Preventive Maintenance

Preventive maintenance is the regular checks or maintenance activities done for equipment to prevent or minimize its downtime. This type of maintenance activity can be done mostly through CBAR model, but as the complexity of the equipment increases, in-house technicians might require real-time assistance of an expert, thus moving to RTCAR model. In-house technicians use head-mounted display or smart handheld device and perform several diagnostic tests on the equipment, including thermal imaging, vibrational analysis and etc., with the help of wireless sensors and compose the 'service report.' The service report contains required information on equipment which can help to find relevant AR content from the cloud platform. Based on the complexity involved in the maintenance activity, either cloud platform retrieves the AR content, or communication link will be established with the expert who can help to develop and to store new content to the cloud platform. Upon receiving the content, the AR device can assist an in-house technician with detailed equipment-specific maintenance information processes to be followed.

Predictive Maintenance

In predictive maintenance, an expert from the OEM maintains a regular check on the health and functioning of the equipment, its parts, and accessories. This is done with the help of enabling technologies such as connected devices and IoT. Diagnostic intelligence is the major enabling factor for predictive maintenance, and it is achieved by the cloud computing network, which is a repository of historical measurement specific to equipment and its parts. Diagnostic intelligence analyses stored values in the cloud network and transform them into insightful information, thus enabling the technician to make effective and quicker decisions. Based on the insights from the analysis of diagnostics intelligence, specific maintenance activities will be performed on the equipment. This type of maintenance can be done by both the CBAR and RTCAR model. End-users subscribed for CBAR predictive maintenance model receive regular notification from the expert or the cloud informing about the maintenance activity to be performed. This model minimizes machine downtime to a near zero level.

For instance, while performing predictive maintenance for compressors, the following parameters need to be monitored on a regular basis:

- Motor Temperature
- Vibration
- Motor Current

These parameters are monitored at regular work intervals by temperature sensors, vibration sensors, and current transformers, and the measured values are stored in the repository (cloud network). The MEMS (microelectromechanical) sensors are capable of identifying and analyzing elastic waves created by the vibration related stress in any material. It can be used to identify several measurements, including acoustic measurement, light emissions, humidity, pressure, and magnetic and gyroscopic fluctuations. These values get transformed to insightful information and appear on the smart glass or handheld device when the specific equipment or component is looked via an AR device.

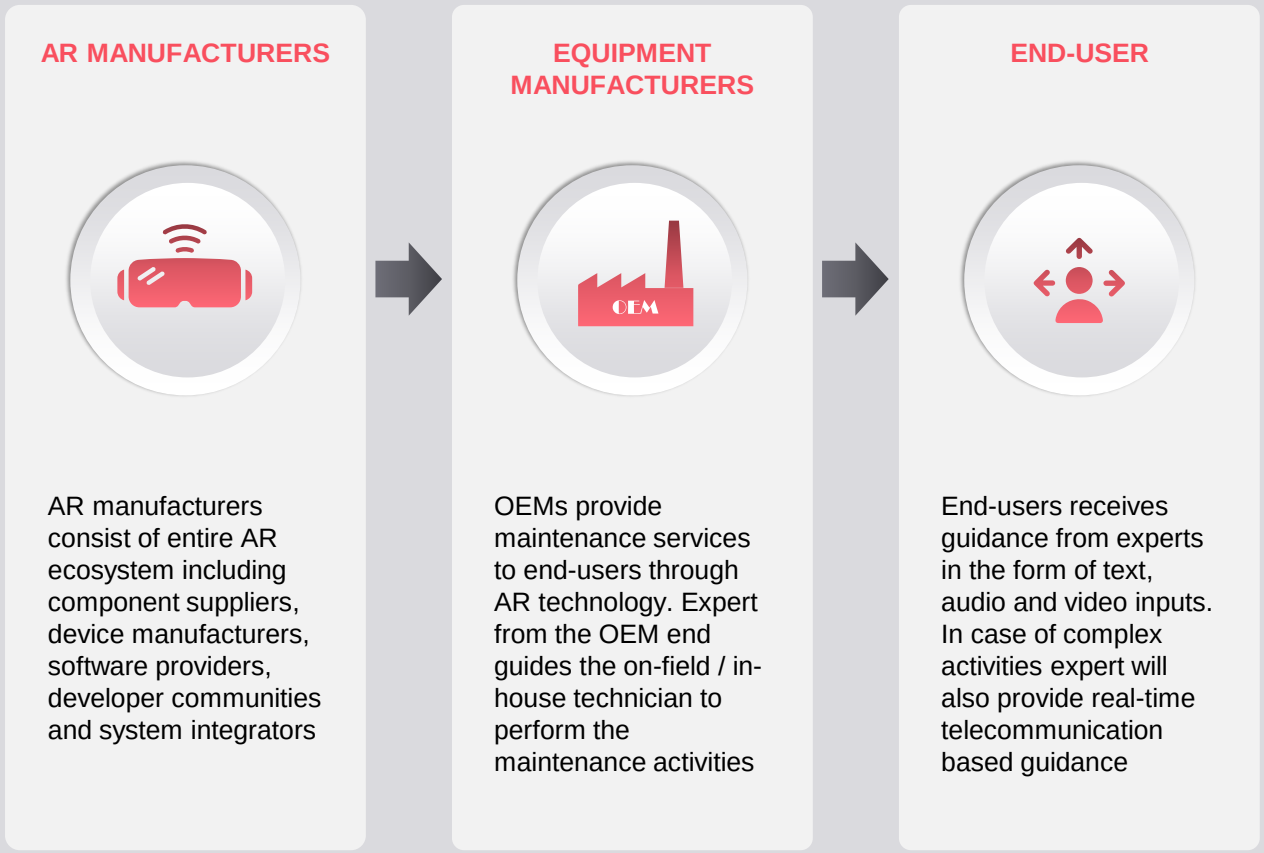
The device also displays recent maintenance activities carried out along with the health of the equipment, thus reducing the time required for making corrective decisions. Based on the corrective measures needed, maintenance activities will be carried out by the in-house technician, with the help of AR content from the cloud or with the help from the expert via AR device.

Value Chain Analysis

Role in the Current Value Chain

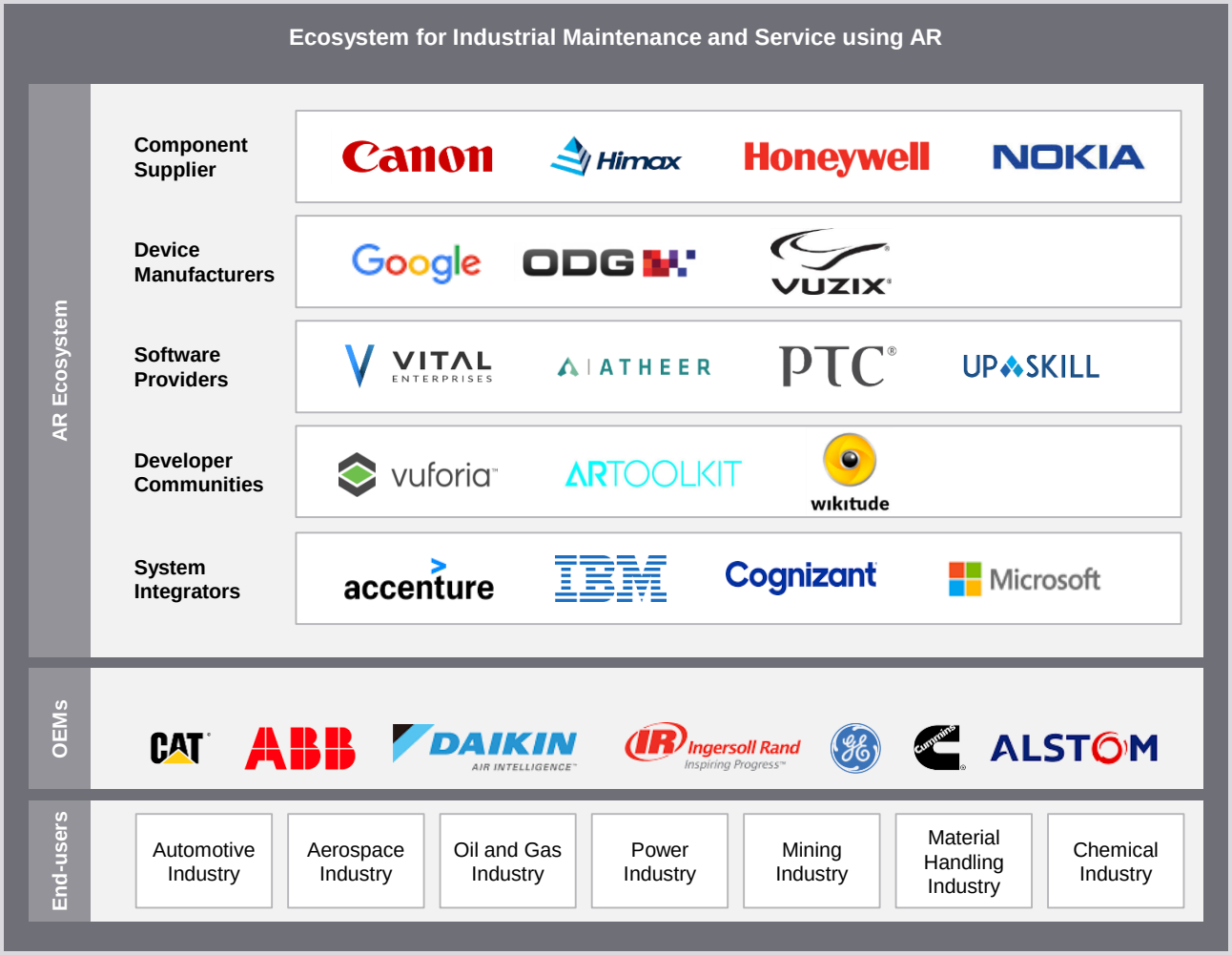
The current value chain for industrial remote maintenance services with AR technology includes AR manufacturers, OEMs, and end-users. In the current model, the OEMs provide remote maintenance and assistance services in resolving the maintenance issues of the end-user. However, currently, none of the equipment manufacturers provide industrial maintenance services on a subscription basis using AR solutions.

EXHIBIT 6: Value Chain of Industrial Repair and Maintenance Services using AR



Source: FutureBridge analysis

EXHIBIT 7: Ecosystem for Industrial Repair and Maintenance Services using AR Technology

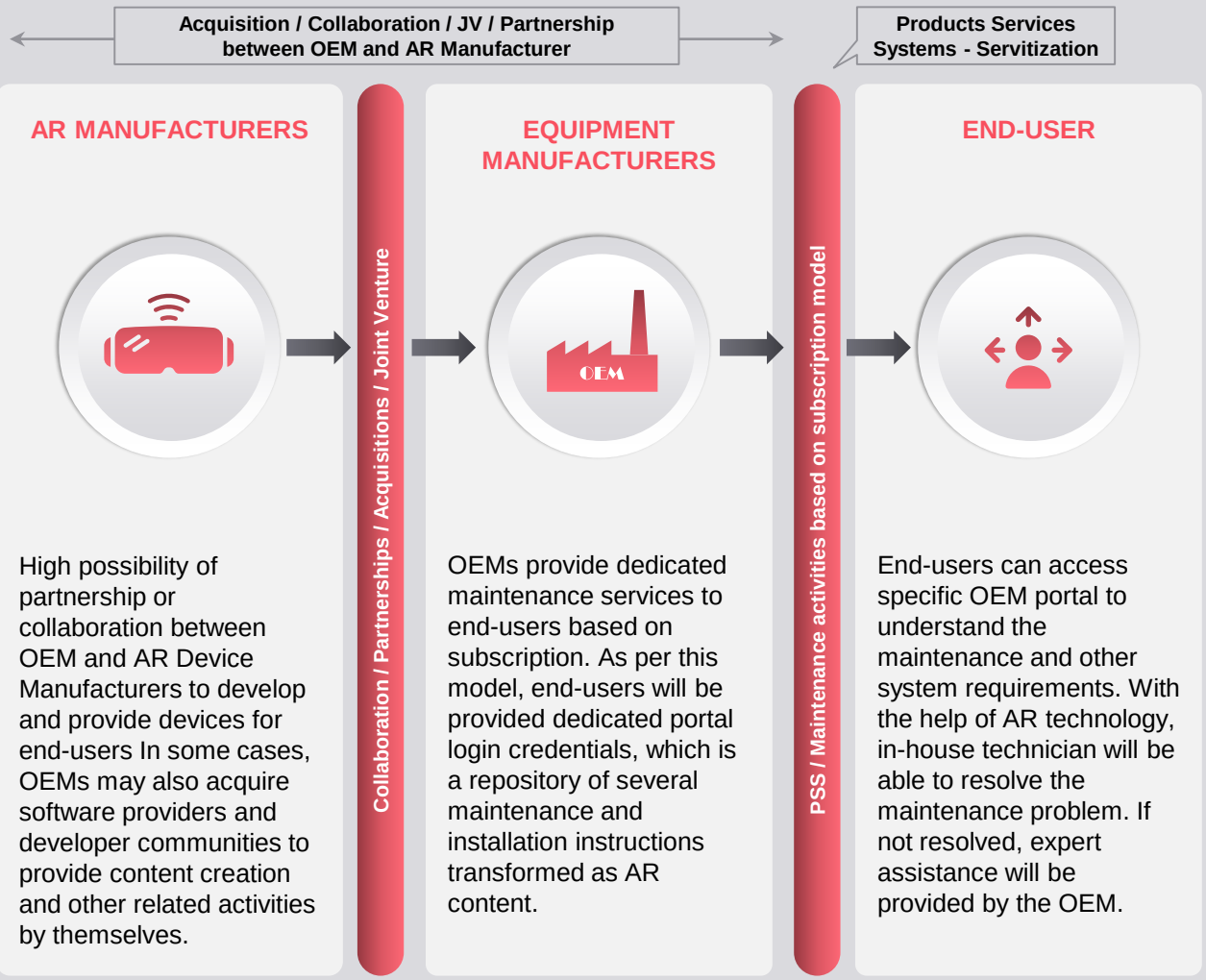


Source: FutureBridge analysis

Potential Disruptions Expected in the Future Value Chain

The future value chain for industrial remote maintenance services with AR technology is based on the subscription model. This model includes AR manufacturers, OEMs, and end-users, where OEMs not only provide product but services package as well, bundled with the product. This model is the basis for "Products Services Systems," which is a feature of "Servitization" model. In the future model, the OEMs provide remote maintenance and assistance services in resolving the maintenance issues and based on the subscription model; they also provide predictive maintenance of the equipment thus reducing the downtime of the equipment drastically.

EXHIBIT 8: Value Chain of Industrial Repair and Maintenance Services by Subscription-based Model using AR



Source: FutureBridge analysis

Other major disruption that can be witnessed in the value chain is the increase in coherence among AR manufacturers and OEMs. OEMs will look to partner or collaborate with the device manufactures to provide AR devices along with the subscription model. However, the need of the hour will arise from content developers and software providers, as they play a significant role in providing software for developing required AR content for various maintenance and repair activities. Due to this necessity, there is a high possibility of OEMs acquiring software providers and developer communities in the future. Thus, the increasing adoption of subscription-based industrial repair and maintenance services through AR solutions is expected to bring in some disruptions in the value chain.

Impact of Subscription Model on Players in Value Chain

The major stakeholders in the move (transitioning to a subscription-based industrial maintenance model by AR) are AR manufacturers, OEMs, and end-users. The move will happen only if it benefits all of the stakeholders in the value chain. Let us look at some of the benefits applicable to the stakeholders and assess them with the current situation.

Minimal downtime, 24x7 service, predictive maintenance offered are the major benefits that end-users get through AR subscription for their industrial repair and maintenance services.

TABLE 1: End-user Benefit Comparison

Stake Holders	End-users (As a service receiver)		
Parameters	**Without AR**	**With AR**	**With AR Subscription**
Minimal Downtime (Almost Zero)	×	✓	✓✓
24*7 Service	×	×	✓✓
First Time Fix Rates	×	✓	✓✓
No Queue / Waiting	×	×	✓✓
Predictive Maintenance	×	×	✓✓
Empower In-house Technicians	×	✓	✓✓

The expert from the OEM is benefitted by increased visibility and prior knowledge on equipment health, thus saving time and effort to diagnose the issue.

TABLE 2: OEM Benefit Comparison

Stake Holders	OEMs (As a service provider)		
Parameters	**Without AR**	**With AR**	**With AR Subscription**
Cost Effectiveness / Reduction	×	✓	✓✓
Increased Visibility	×	×	✓✓
Tackling Geographical Spread	×	✓	✓✓
Prior Knowledge on Equipment Health	×	×	✓✓
Long Term Relation with End-user	✓	✓	✓✓

AR players can effectively leverage the collaboration with OEM by increasing their sales among industrial end-users around the world with the help of OEM channel. They also get constant business through OEMs.

TABLE 3: AR Technology Players Benefit Comparison

Stake Holders	AR Technology Players	
Parameters	**As Standalone Players**	**In JV with OEMs for Subscription Services**
Increased Sales to Industrial End-users	×	✓✓
Increased Brand Recognition	✓	✓✓
Constant Business through OEMs	×	✓✓
Around the World Sales through OEM Channel	×	✓✓

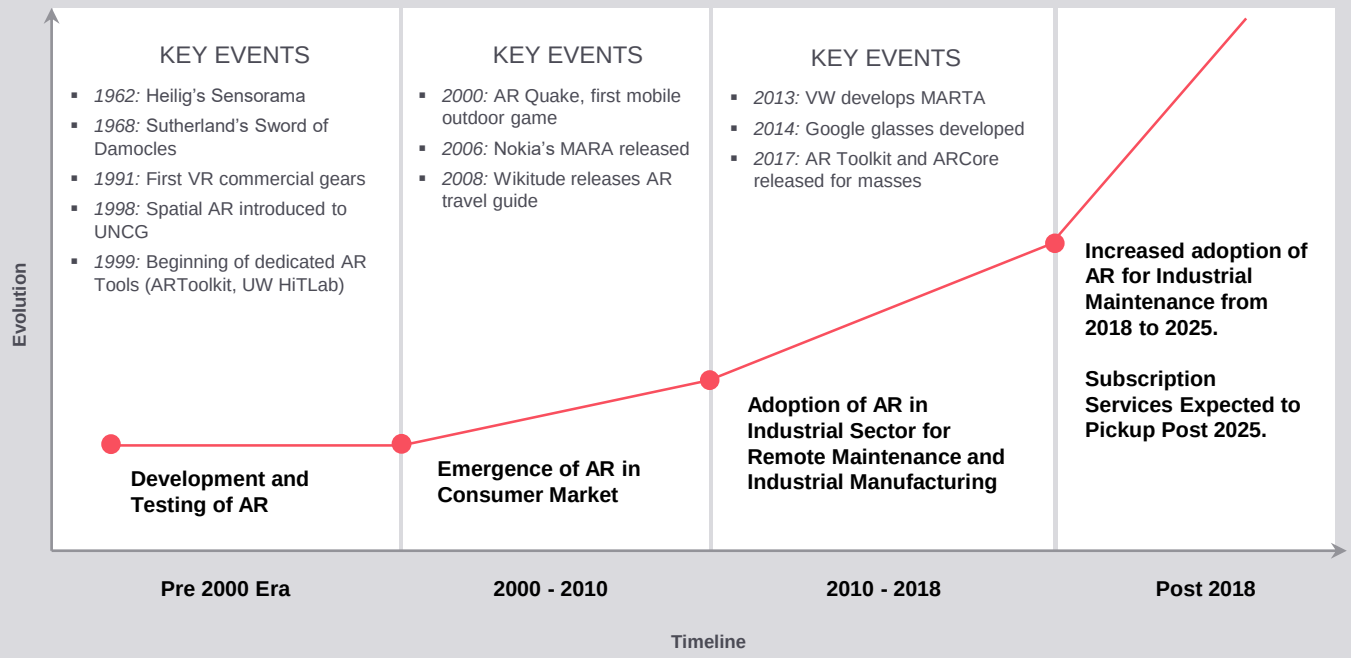
Source: FutureBridge analysis

Timelines of Major Events in AR

The adoption of AR in industrial maintenance services is expected to witness strong growth, and by 2025, almost 20–40% of maintenance services will be offered through AR solutions. Once the AR solution has deepened its roots in the industrial maintenance sector, players will start establishing subscription services for the industrial maintenance sector.

The below timelines explains the major events in the past and future predictions.

EXHIBIT 9: Timelines and Major Events for AR



Source: FutureBridge analysis

Industrial Remote Maintenance – Sample Use Cases

Electrolux implements AR technology for remote maintenance

Electrolux is introducing AR technology for 16 of its factories in the EMEA (Europe, the Middle East, and Africa) region for its maintenance activities. This enables speedy maintenance process, thereby minimizing production downtime.

> Digitization is changing fast our working environment in operations and is starting to add value and competitive advantages for the company. Using this technology means the onsite technician can work hands-free, and the problem can be identified quickly and easily, without misunderstanding. It cuts costs and traveling, saves time and reduces the failure rate and gets equipment faster back to work,
>
> **– Carsten Franke,**
> *SVP Industrial Operations, Major Appliances EMEA.*

Alstom uses JoinPad's AR remote support for train maintenance

Alstom chose JoinPad as a technology partner to help the company improve communications between its on-field operators and the remote experts providing guidance. Using JoinPad's Smart Assistance application, it was possible for the expert to view the field of the user in real time and share virtual objects to guide the on-field technician. Smart Assistance is a cross-platform product and can be used with smart glasses, tablets, and web. The company has also integrated the AR system with other typical features of industry 4.0, such as big data and artificial intelligence.

Elay Group uses Virtualware AR solution for maintenance and remote support

Elay group operating out of Gipuzkoa has over 50 years of experience in developing high-quality automotive components. The firm collaborated with Virtualware to develop a solution that can provide support and management to maintenance employees in its Chinese plant, from its headquarters in Spain. Virtualware provided remote assistance application that connects the specialized staff from Spain to its new staffs in China. The application uses text and video streaming services through an AR interface, which can be used to send and receive information via mobile device or tablets. The solution has improved overall plant productivity by reducing the cost and time required for maintenance activities.

Xerox uses Fieldbit AR solution to empower its field-service force

Xerox, one of the major players in the global printing industry, faced a severe crisis of labor shortage to address maintenance and repair services arising from its

customers. The option of increasing headcount to sort the issue was left out, as it had huge impact on the operating margin of the company. Customers demanded quick response and immediate resolution for all the maintenance related issues, be it a hardware problem or an application error. Fieldbit offered a solution to Xerox, according to which an experienced technician would use Fieldbit Hero and provide assistance to both the customers and the field engineers. The product helped the expert to observe and understand customers' issues on a real-time basis and provide instructions in the form of AR content.

Upon using Fieldbit solution, Xerox Israel realized the following benefits:

- ↑ **76%** — **Remote resolution rate increased by 76% within first four months of Fieldbit implementation**
- ↑ **67%** — **First-time fix rates of a service request increased by 67%**
- ↑ **20%** — **Field engineers utilization increased by 20%**
- ↓ **2hrs** — **Total elapsed time to resolve a service request decreased by 2 hours**

Major Drivers

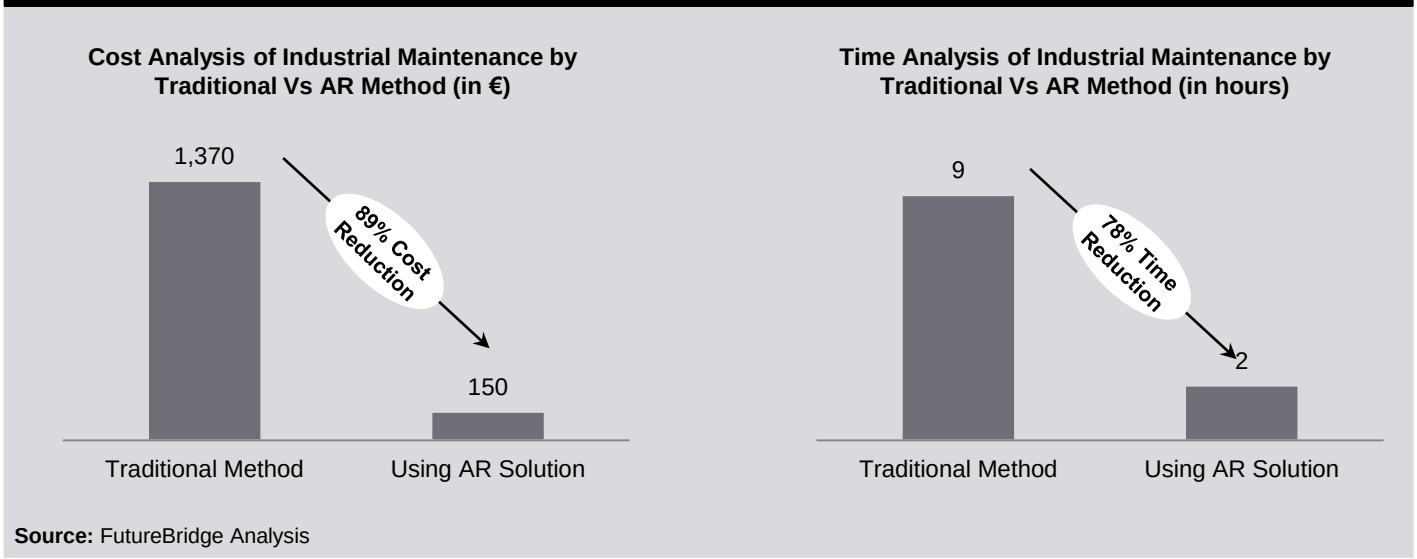
The AR-supported maintenance service model has the following enabling factors, which is expected to push an increase in the future. The major drivers for the shift are:

- Time and Cost Benefit
- Enabling Focus on Core Competency
- Addressing Issues of Lack of Skilled Workforce
- Minimizing equipment downtime

Time and Cost Benefit

The major advantage of AR solution is the time and cost-benefit realized by the end-user in the long run. The following case is related to the maintenance of an industrial robot, specific to replacement of a battery pack for an industrial robot, which is usually performed by an expert deployed by the manufacturer. The activity is important for the continuous functioning of the robot. The manufacturer, in this case, is around 11,000Km away from the end-user and hence incurs huge costs in performing the maintenance activity. However, by using AR technology and cloud-based assistance from the expert, the expenses and time taken for the maintenance activity are decreased drastically. The research conducted by performing the maintenance activity using AR technology provided the following result. The results are specific to the study conducted, which may or may not be the same in real case industrial scenarios.

EXHIBIT 10: Cost and Time Analysis of Industrial Maintenance by Traditional Vs. AR Method



Source: FutureBridge Analysis

The case study is referred from "Augmented reality application to support remote maintenance as a service in the Robotics industry" conducted by D. Mourtzisa, V. Zogopoulosa, and E. Vlachoua in 2017.

Enabling Focus on Core Competency

Subscription based model of repair and maintenance services would enable end-user companies to focus on their core competencies, rather than spending time and investment in training and developing the expertise in maintaining their equipment. The company can focus on improving productivity, enhancing the output instead of worrying about technical expertise in maintaining the production machinery. Hence, focusing on core competency is a major advantage for the end-user in adopting subscription-based maintenances services with the help of AR, as the repair and maintenance services issues are taken care by experts from OEM without losing valuable time.

The following box with facts explains the impact of AR solutions on an in-house technician's efficiency.

20% **The efficiency of an engineer increased by 20% when service instruction manual was replaced by AR/VR**

30-50% **According to McKinsey, a company's machine downtime will decrease by 30 – 50% when they invest in AR technology**

Addressing Issues of Lack of Skilled Workforce

Aging workforce combined with low-level of interest in the field work by the new workforce joining various industries is posing a new challenge to the developed economies in field service related businesses. This has resulted in a severe shortage of skilled workers, especially in service-related sectors. It is predicted that around two million jobs pertaining to technical requirements will remain vacant due to the lack of a skilled workforce.

AR plays an important role in bridging the skill gap existing among the technical personnel. AR technology overlays a computer-generated 3D image over the real-world image and assists the technical personnel in understanding the complete installation of the system, working of the equipment, etc., thus providing required knowledge and direction, for non-technical personnel to complete a technical job. When subscription services are added to this, the problem of lack of skilled labor can be addressed easily, as the in-house technician queries will be resolved by the expert in real time by semi-skilled or even by an unskilled worker.

40% **Use of AR/VR technology has increased technicians productivity by 40%**

Minimizing Equipment Downtime

In the subscription-based, AR-supported maintenance service model, in case of any equipment breakdown, the customer will not have to wait for an expert from OEM to come down to their location and repair the equipment. Instead, they can take help from an expert at a remote location, and with the help of AR, the in-house technician can perform the repair and maintenance activity. In most cases, the experts would try to maintain a higher first-time fix rate percentage.

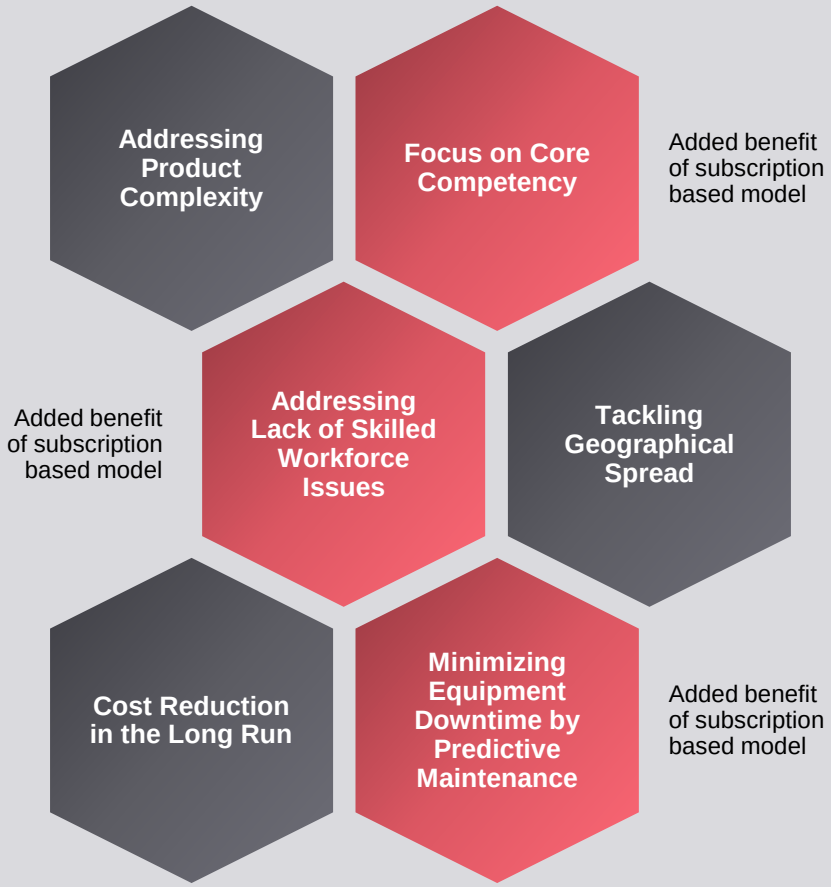
In the case of predictive maintenance, experts from OEM constantly monitor the performance and functioning of equipment and its parts, thus ensuring minimal downtime. Tools and technologies related to predictive maintenance enable the expert to predict any future breakdowns or outages, thus taking prior actions to prevent the same. Expert gets notified on several issues such as scheduled part replacement, over-heating of a part, decreasing performance of a part and etc., helping him to take necessary actions.

67%

First-time fix rates of a service request increased by 67% when a global technology products manufacturer replaced service instruction manual by AR/VR, thus providing remote assistance to the engineers

Some of the common drivers for AR solutions are given below:

EXHIBIT 11: Benefits of Subscription-based Remote Maintenance through AR Solution



Source: FutureBridge Analysis

Key Challenges

Despite several benefits, the model also has few challenges. Some of the major challenges this model might face are as follows:

Model Development

The most challenging part is developing a subscription model, which will benefit all the stakeholders in the value chain. There are several ways in which a subscription-based model can be devised; identification of ways to monetize the subscription play an important role in the model to succeed.

Acceptance

Acceptance of industrial repair and maintenance as a subscription-based model using AR is little far-fetched currently. When it comes to industrial repair and maintenance services, end-users don't want to take risks that might impact their business operations. Until and unless proved efficient, this model has to wait to be accepted. However, with advancing technologies, remote experts are already able to solve complex technical issues and assist in-house technicians. Therefore, with a first-mover making inroads, there will be several followers for this model.

Apart from these, there are some technical issues that are perceived in the industry; they are:

- Data Transfer and
- Content Generation

Data Transfer

Remote maintenance through AR systems requires the transfer of complex data between the expert and in-house technician. Some devices might not have the computing power to process such heavy data files. However, these issues can be overcome by the use of high-end devices, which might increase the cost of investment. Security issues of data files transferred is also a major concern for both the OEMs and end-users involved in the ecosystem.

Content Generation

Concerns related to obtaining data, information, and documents in their original format might hamper the speed and quality of content generation. For instance, obtaining data log from a SCADA system or drawing from a CAD repository plays a crucial role in developing content that can be transformed into AR visualization scenes, which can be overlayed on the real world image. The absence of such critical data files or CAD images could prove as a setback in implementing AR solutions for maintenance services.

Conclusion

The popularity gained by AR technology over the last few years is commendable; it overcame several challenges and has finally started to take off. The major advantage of AR technology is remote assistance, which with further advances, will transit toward subscription-based maintenance model. It is exactly similar to remote assistance feature with experts assisting the in-house technician in solving a breakdown or maintenance issue but with pre-signed maintenance agreement. However, with the presence of growth inhibitors, the adoption of subscription-based remote maintenance will need some more time in the future. Initial adopters of this model might face some challenges because of which several players in the industrial sector might be reluctant to adopt a new model for their maintenance services until the model is tested and proved successful. To conclude, FutureBridge foresees the adoption of subscription-based maintenance model through AR solutions increasing in the next three to five years.

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