

A close-up photograph of a man's face wearing a pair of blue AR glasses. The glasses display various futuristic data visualizations, including a world map, a bar chart, and a circular interface with a hand cursor. The background is dark with faint, glowing circular patterns.

# Metaverse for Smart Manufacturing

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# What is Metaverse



Experiential

Persistent

Decentralized



Virtual and Physical world overlaps

Creator economies

**The Metaverse is the next generation of the internet providing connected, immersive experiences, facilitated by the intersection of various technologies**

# Benefits of Metaverse in Manufacturing



Improves **Retention & Recall**



**Assessment Module** to measure the performance



Easy **Maintenance** functions with **step by step guide**



**Dial an Expert** with annotations for easy understanding

## Training Solutions



- ▶ Virtual Reality : Operator Training made simple
- ▶ Augmented Reality: Explains complex components in a realistic and simple manner.
- ▶ DIY Training Platform & Authoring Tool

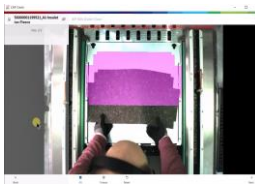
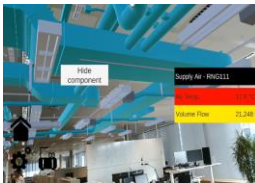
## Operation and Maintenance



- ▶ Maintenance Service Manual
- ▶ Maintenance & Repair
- ▶ Dial an Expert – Step by step guidance from an expert to fix a complex machinery

# Metaverse Relevance at Bosch

## (Different Domains – Different Solutions)



Automotive Service, Training, Demo of Safety Solutions

Assembly Trainings, Ergonomic analysis, AR assisted Assembly, Remote Telepresence

AR BIM, AR GIS (utilities), Digital twin (buildings), AR Indoor Navigation

AR visualization of products, Virtual Reality experiences (Dish washers)



Mobility Solutions



Industrial Technology



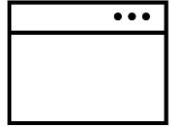
Energy and Building Technology



Consumer Goods

# Metaverse Applications in Manufacturing

## Building Blocks of a Metaverse/AR/VR application



Browser/Desktop apps (2D screens)



Virtual Reality Gear  
(Head Gear + Hand Controllers)



Mixed Reality Gear



Mobile Devices

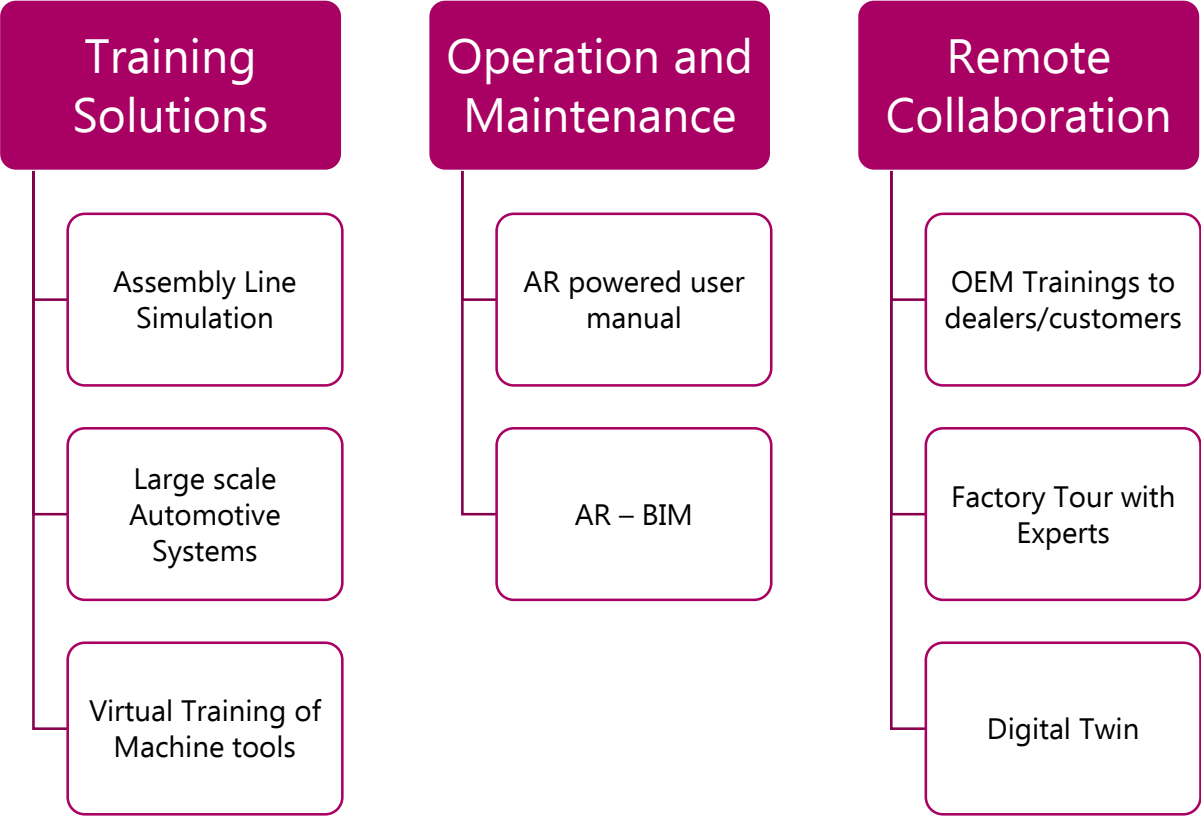
Virtual Worlds (Gaming Engine) + API services (to talk with other systems)



Compute Infrastructure (Cloud /PC/Decentralized Infra)

# Metaverse Applications in Manufacturing

## Deep dive into Case studies



# ***Case studies : Training Solutions***

# Metaverse Applications in Manufacturing

## Digital Transformation in Enterprise Training



### BENEFITS

- ▶ **No Production Stoppage** for Operator training
- ▶ **75% reduction** in Experts dependency for training
- ▶ **Increase 50%** retention of Training content
- ▶ **Consistent Training Content** across all employees



# Metaverse Applications in Manufacturing

## Immersive Virtual Reality powered hands on learning



VR platforms enabled high fidelity immersion into Virtual worlds.

### NaP Virtual Reality Training Simulator for Station.4

#### Customer Benefits



Hands on experience (similar to a real world)

No need to halt the production line

No need to tamper process for

Troubleshooting

Expert dependency is reduced

# ASC - Immersive Learning

## Key Figures and devices

5

Types of Vehicle

12

Modules

100+

Devices deployed during the curriculum



Mixed Reality



Virtual Reality



360 Videos



Augmented Reality  
+  
Guided Interactive

# ASC - Immersive Learning Virtual Reality (HTC-Vive)



ALS MK IV

Tata 2.5

Maruti Gypsy

Quit

# Metaverse Applications in Manufacturing

## Virtual Reality powered training tool

**HOMAG EDGE - VR EXPERIENCE**

**movavi**

THIS VIDEO WAS MADE WITH  
MOVAVI VIDEO EDITOR TRIAL

*- Bosch -*

# ***Case studies : Operation and Maintenance***

# Metaverse Applications in Manufacturing

## Key Challenges for Maintenance & Repair



Expert Cost

High Travelling cost of Experts



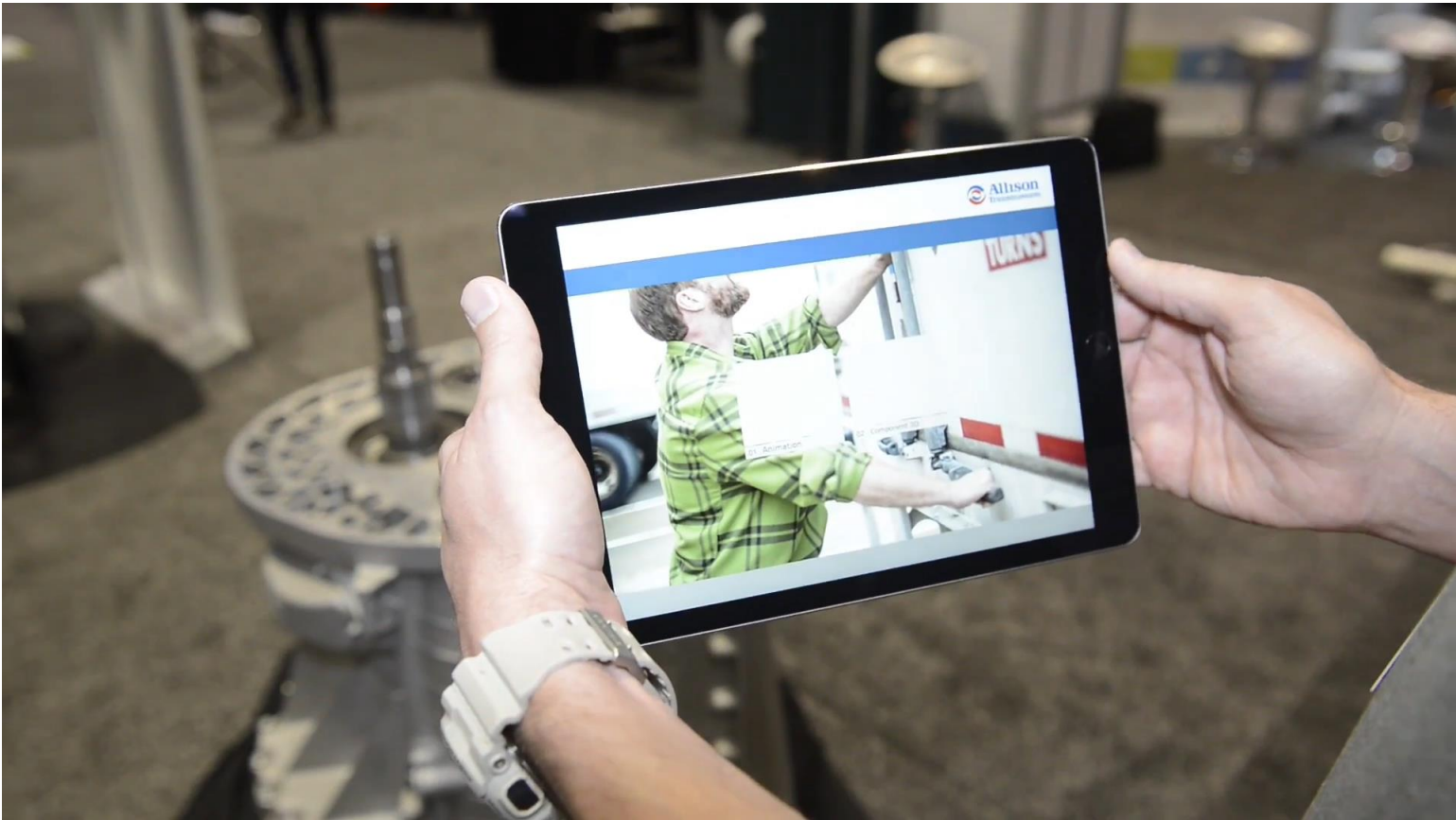
Machine Downtime

Downtime of Machinery impacting production



Effective Maintenance

Skilled experts not available for efficient maintenance



# Metaverse Applications in Manufacturing

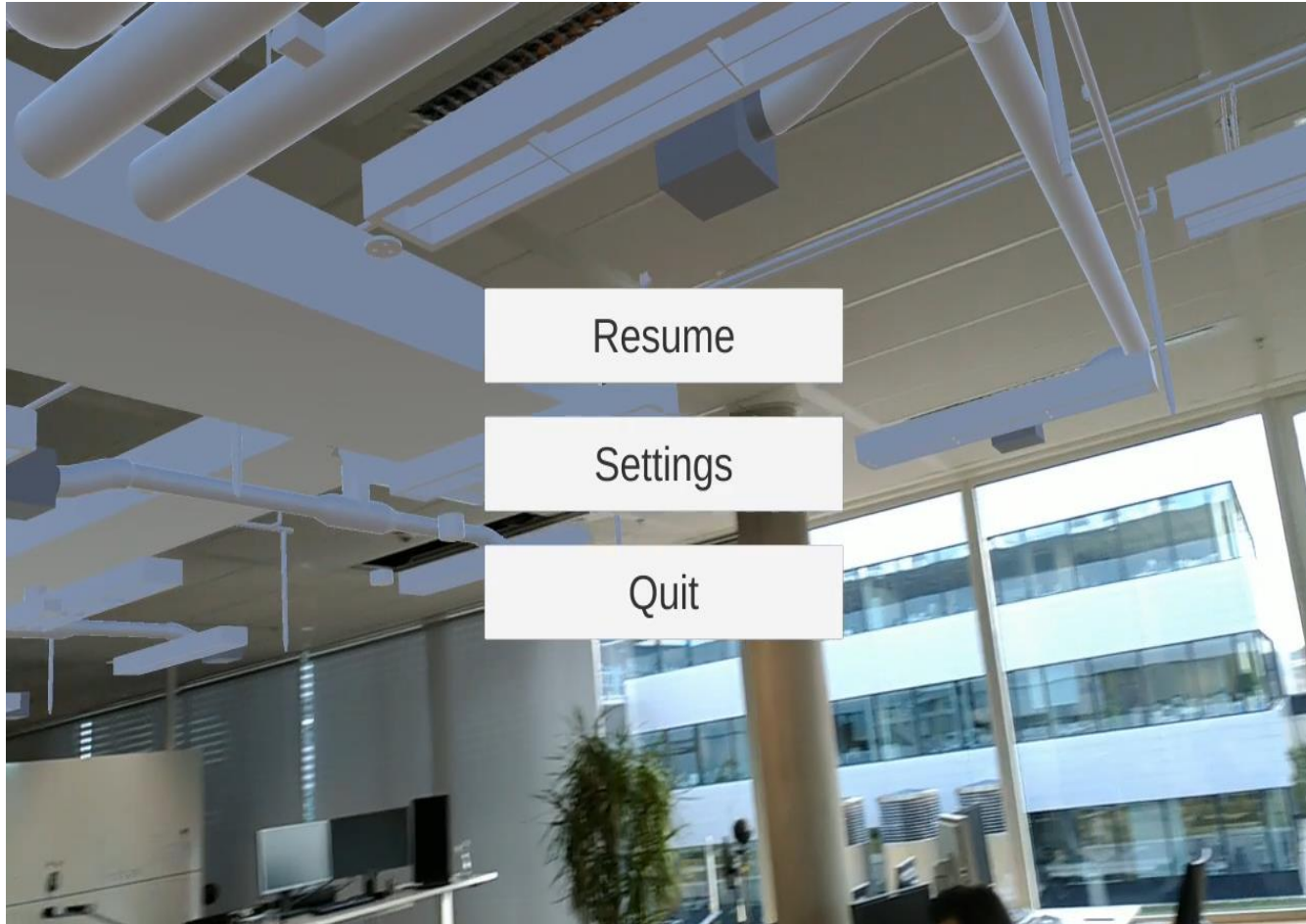
## AR powered Service Manual



- ▶ Dependency on expert reduced
- ▶ 24/7 Availability
- ▶ Ease of Maintenance operations

# AR/VR Solutions for Enterprise

## AR powered Building Information Model



### **Building Maintenance :**

Overlay of Virtual BIM data directly in real world enables efficient maintenance and reduce expert dependency.

### **Renovations :**

Placement of hidden (beams, structural members, ducts, conduits, and pipes) can be viewed easily using an AR wearable.

This helps in renovations. AR also enables the clients to visualize redesigns and identify any issues early in the planning, thus making renovation an easier task.

***BGSW (former RBEI) ported AR-BIM solution from Google Tango to IOS (using ARKit )***



# ***Case Studies : Remote Collaboration***

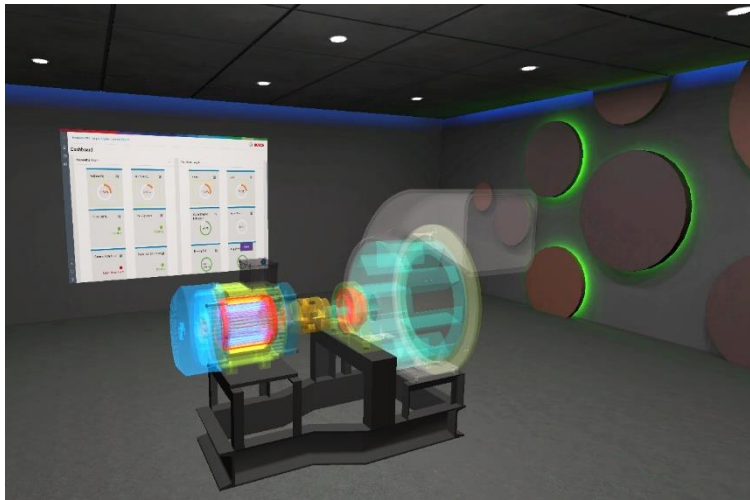
# Extensions to Metaverse

Explaining Product Trainings Remotely



# Extensions to Metaverse

## Factory tour with experts



Concept: Guided walkthrough of a manufacturing line

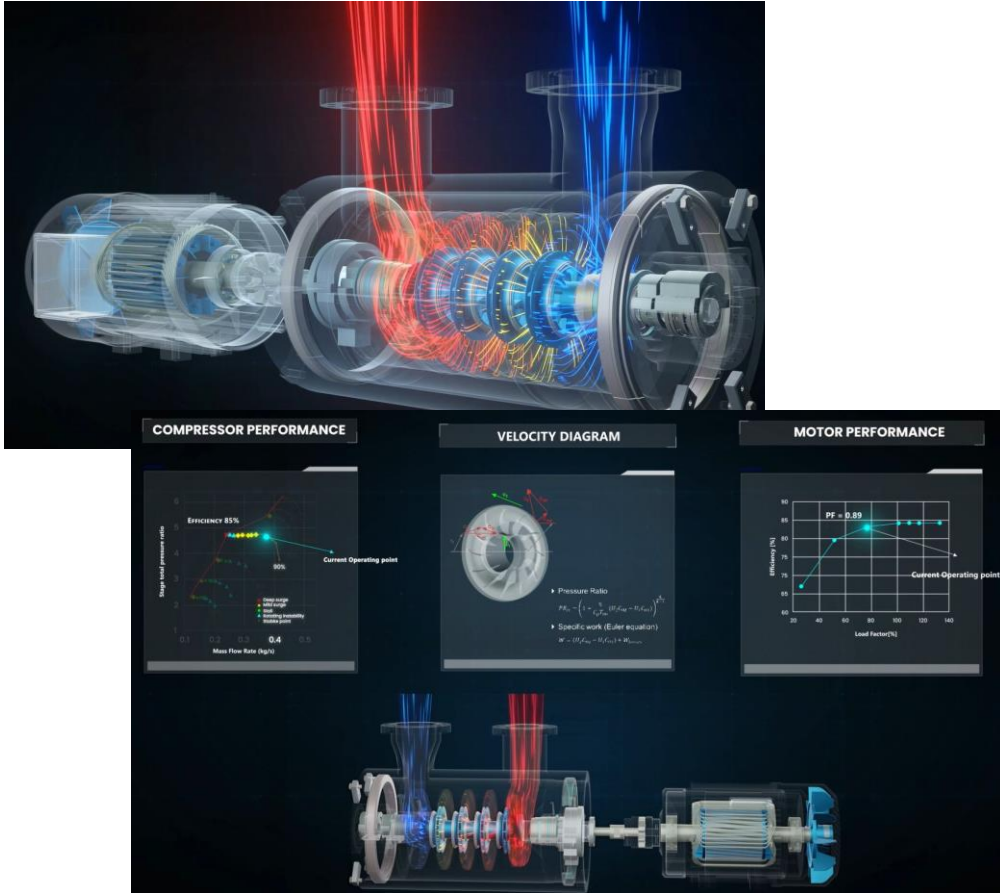
Features:

- Multiuser experience of a factory
- Experience Visual quality inspection and Digital Twin
- Realtime discussions with expert and among visitors

Metaverse elements:

- Avatars and Interactions
- Persistence
- Spatial Audio
- Multiple worlds and Teleportation

# Extensions to Metaverse Digital Twin



Concept: Live visualization of critical infrastructure status through Digital Twin

Key benefits:

- Reduced down-time with quick problem localization and resolution
- Remote expert availability

Features:

- Immersive 3D experience and interactions
- Maintenance trainings, Remote asset monitoring
- Remote maintenance assistance between expert and field assistant

Metaverse elements:

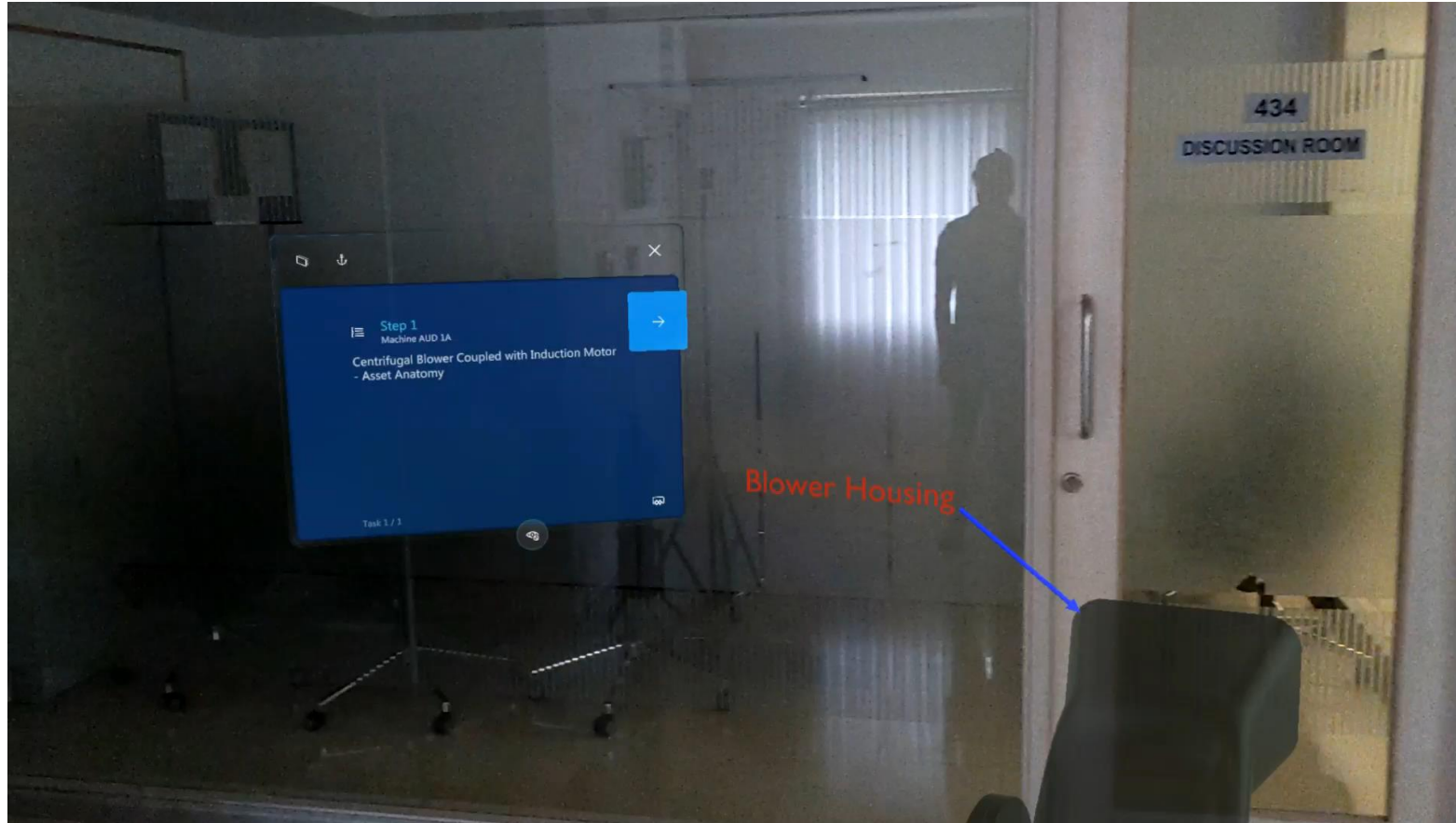
- Real-time interaction, Spatial mapping
- Gesture recognition, Shared experiences

Technology

- Dynamic 365 – Guides, Remote assist, HoloLens 2 (Industrial edition)

# Metaverse Applications in Manufacturing

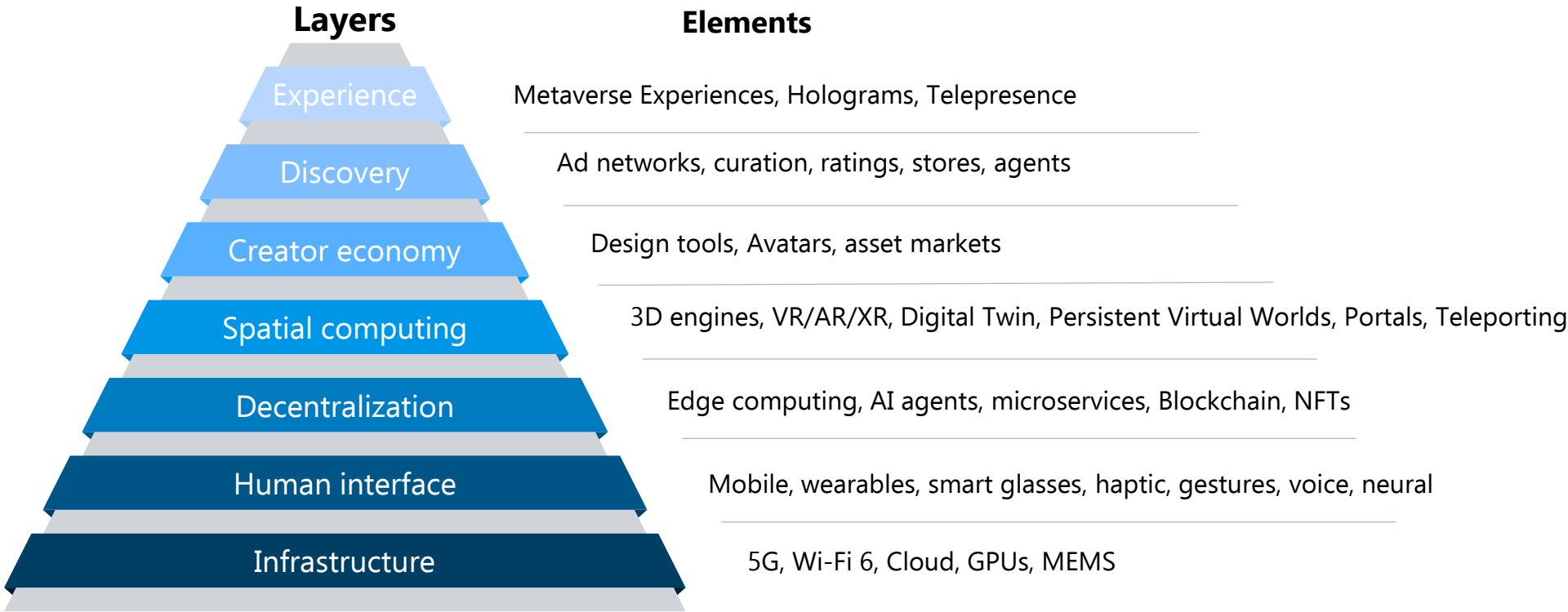
## XR interfaces for Digital Twin



# ***Overview of Tech Stack : Building a Metaverse Application***

# Metaverse

## Layers of Metaverse



# Metaverse Tech Stack

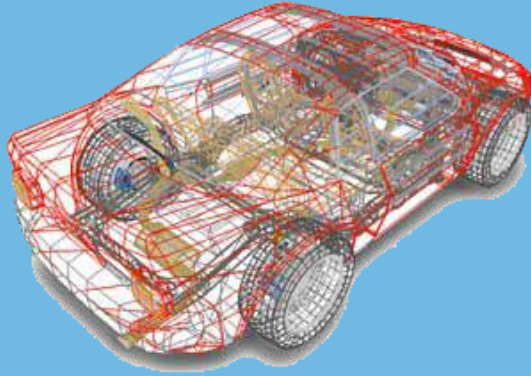
## Building blocks of an XR Solution



User Experience (UX)



3D Vision Pipeline



3D Graphics Pipeline



# Metaverse Tech Stack

## User Experience



Understanding Requirements



Questionnaire Session



Explaining Product



Experiencing Product



UX is very important to improve the longevity of the offering

# Metaverse Tech Stack

## Different tracking approach:

### **Marker Based:**

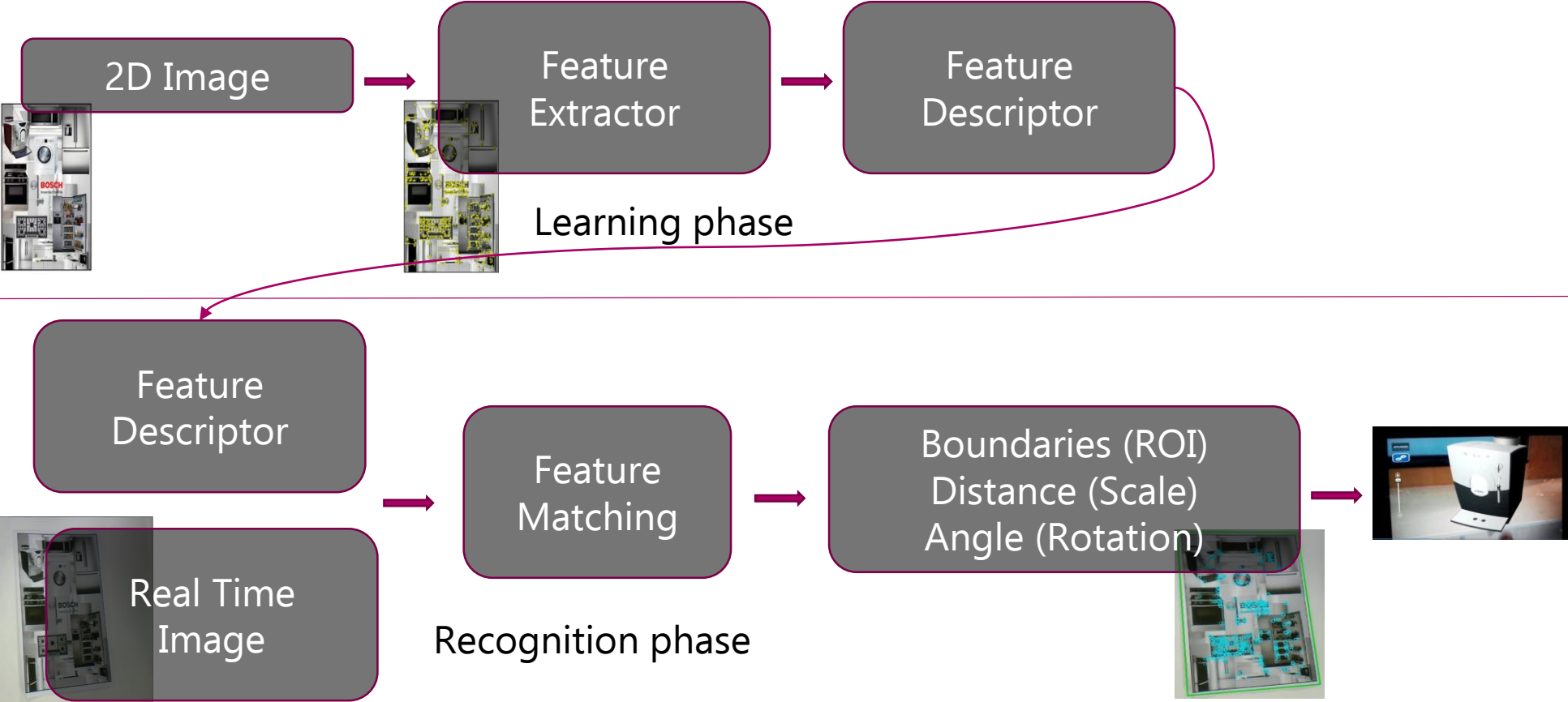
- 1) Different Image marker
- 2) QR Code based marker

### **Marker-less Based:**

- 1) CAD based tracking – This technique required CAD files for creation of targets
- 2) SLAM Based approach – This we need to pre learn the area and superimpose 3D on the 3D generated map

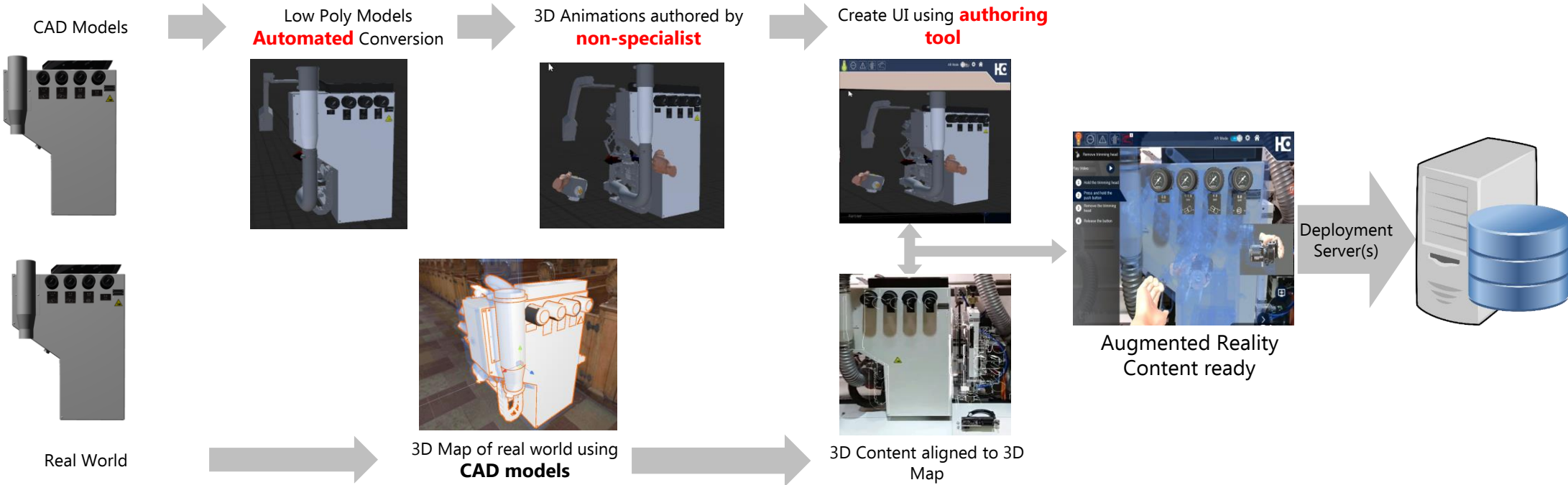
# Metaverse Tech Stack

## Marker based tracking



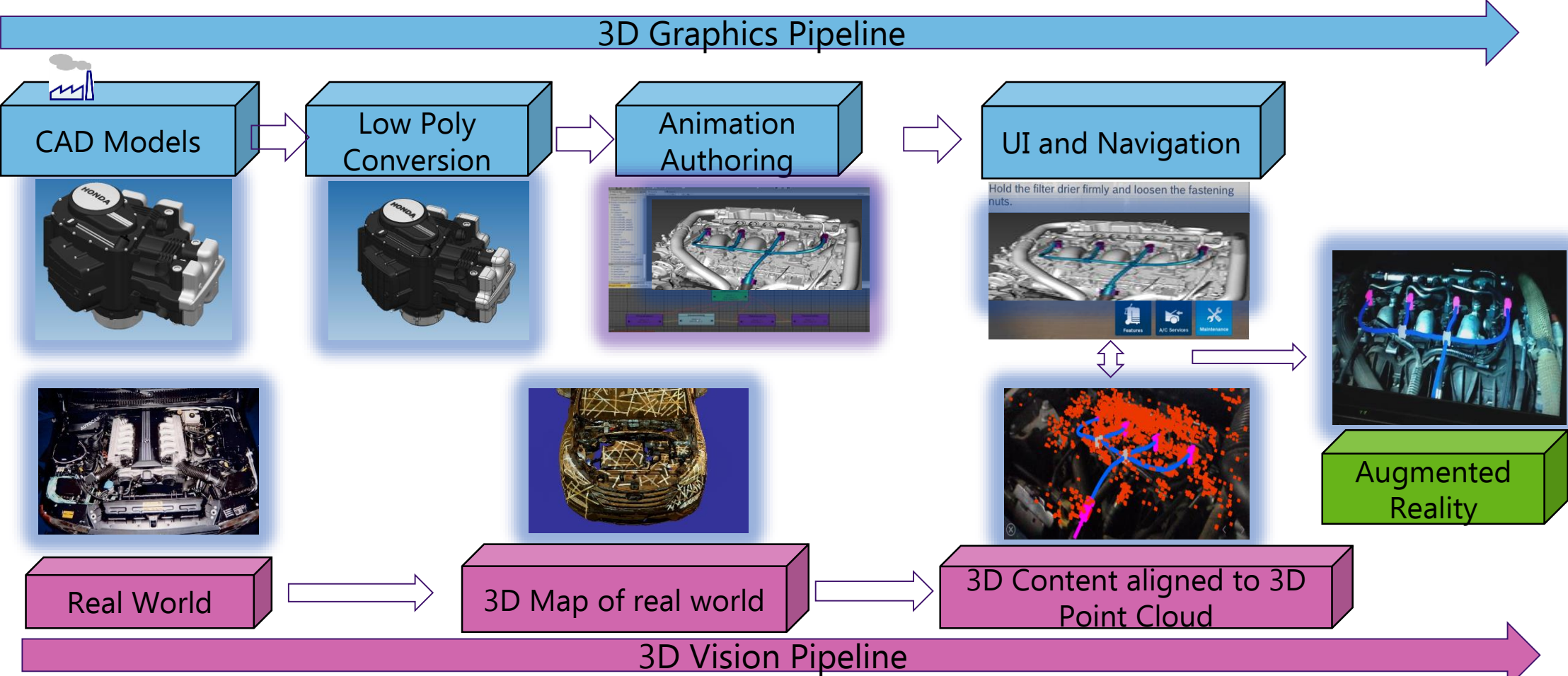
# Metaverse Tech Stack

## CAD based tracking



# Metaverse Tech Stack

## SLAM Based approach



3D Tracking Demo  
(RBEI internal project only)

3D Data Courtesy : AA-AS (Juergen Lumera)

# Metaverse Tech Stack

## Marker versus Markerless Technologies

Factor	Marker based Technique	3D Markerless
Detection type	2D	3D
Robustness of tracking	High	High
Industrial applications	Limited usage	Highly usable
Hostile environments (high temperature, dusty environments)	Not useful	Highly usable
Target applications	Sales, eCommerce	Maintenance , Field support, Sales events
DIY Consumer AR App	Needs physical markers placed on the consumer product	No markers required

# THANK YOU

Special thanks to Smart Device, AI (vision) & 3D Graphics researchers and practitioners around the world whose efforts brought ***Niche Technology like AR to Consumers***



# Metaverse Applications in Manufacturing

## Enabling Safe workplaces with Full Body Tracking

Work Station XYZ

Disconnect Start Capture

Calibrate Suit

Analysis Parameters:

Arm Preference: Right

Load(Arms): 0-2Kgs (Intermittent)

Load(Trunk): 0-2Kgs (Intermittent)

Physical Work(Arms): Static


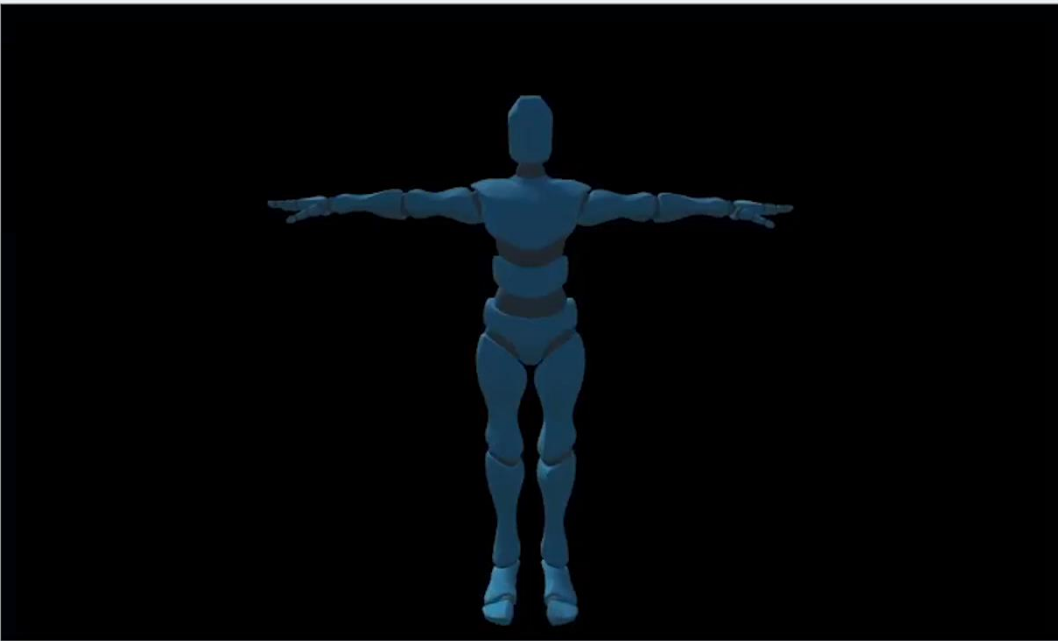
Physical Work(Trunk): Static

Support:

Left Arm

Right Arm

Legs



Results	
Score :	5
Neck Score :	1
Trunk Score :	1
Right Arm	5
Individual Scores	▼
Left Arm	5
Individual Scores	▼

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