WORKGROUP 2
IMMERSIVE MEDIA & ADVANCED INTERFACES

SERVICES AND DIGITAL ECONOMY
TECHNOLOGY
ROADMAP

SG:D
EMPOWERING POSSIBILITIES

IMDA
INFOCOMM MEDIA DEVELOPMENT AUTHORITY

OUTLINE

- **A MARKET STUDY**
  - 1 Market Potential
  - 2 Key Drivers
  - 3 Others
- **B TECHNOLOGY STUDY**
  - 1 Technology Readiness Map
  - 2 Technology Capabilities
  - 3 Application Use cases
- **C CONCLUSIONS**
  - 1 SWOT Analysis
  - 2 Recommendations

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GLOBAL MARKET POTENTIAL

Market Potential for IMAI technologies

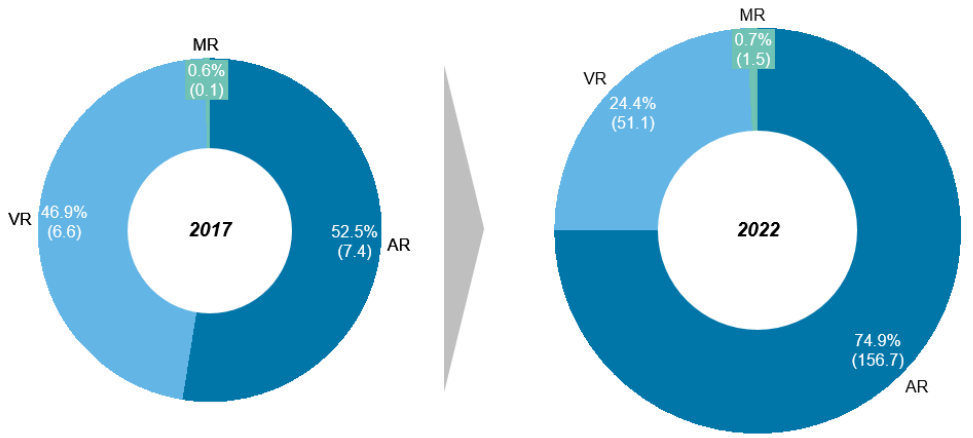
	Vision	Tactile	Auditory	Olfaction	Gustation
Global Market Spending in 2022 (17-22 CAGR) *(USD Billion)*	209.2 (71.6%)	19.6 (16.2%)	17.8 (16.6%)	1.2 (30.4%)	Emerging Technology
APAC Market Spending in 2022 (17-22 CAGR) *(USD Billion)*	62.5[1] (68.5%)	8.4 (15.5%)	7.5 (18.0%)	0.3 (30.7%)	
APAC Market Share *(%)*	29.9%	42.9%	41.9%	22.9%	

Note: The estimated market sizes of each technology are reflected by the market sizes of key sub-technology components: Vision – AR/VR technology, Tactile – Haptic technology, Auditory – 3D Audio & Speech Recognition technology, Olfaction – Digital Scent technology; (1) APAC excluding Japan;
Source: International Data Corporation (IDC); Markets and Markets; InkWood Research; Global Market Insights; Transparency Market Research; Coherent Market Insights; Newzoo Market Research; Monitor Deloitte Analysis

Market Potential for Vision technologies

Global Market Potential Breakdown by AR/VR/MR

(%; US$ Billion, 2017-2022)



Source: Technavio; Deloitte Insights; Monitor Deloitte Analysis

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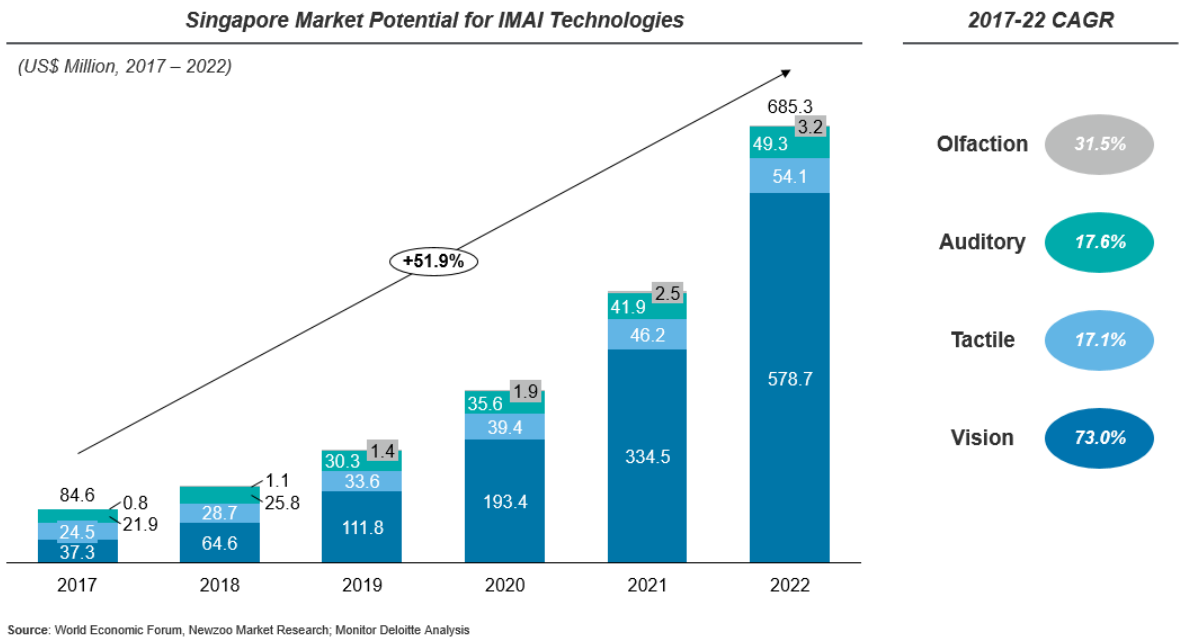
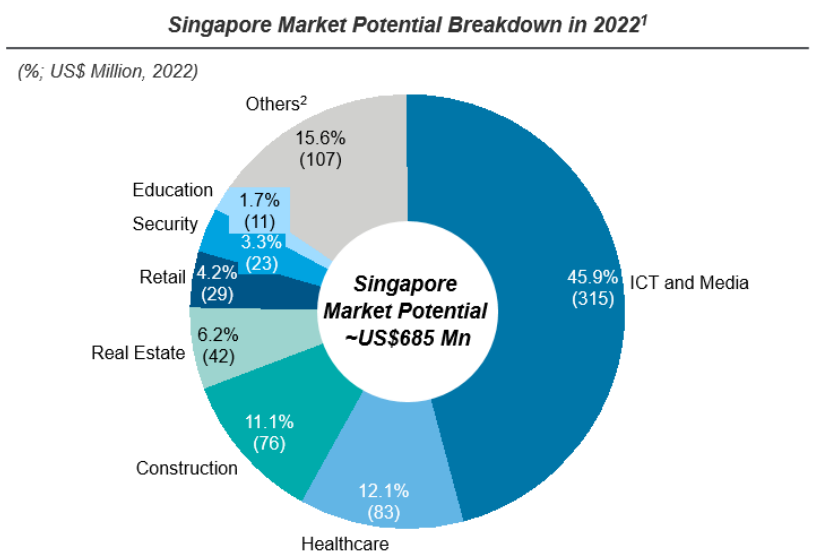
SINGAPORE MARKET POTENTIAL

Singapore Market Potential for IMAI technologies



Source: World Economic Forum, Newzoo Market Research; Monitor Deloitte Analysis

Singapore Market Sector Potential



Note: (1) Estimation based on the Global market values for the Visual (AR/VR) technology; (2) Sectors for Tactile, Auditory and Olfaction technologies – Tactile technology accounts for ~8% of the total IMAI market, of which Electronics sector accounts for 30% of the market and other sectors includes ICT and Media (video games), Automotive, Healthcare, and Security; Auditory technology accounts for ~7% of the total IMAI market, of which Electronics sector accounts for 37%, Healthcare accounts for 25%, Finance accounts for 11% of the market (based on Speech Recognition technology market - ~75% of Auditory technology market); Olfaction technology accounts for ~0.5% of the total IMAI market and sectors include Healthcare, Food & Beverage and Environment monitoring
Source: World Economic Forum; Goldman Sachs; Monitor Deloitte Analysis

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- AMONGST THE IMAI TECHNOLOGIES, THE SECTOR FOR VISION SHOWS THE MOST GROWTH POTENTIAL (WITH HIGHEST PROJECTED MARKET SPEND OF US$209.2 BILLION AND CAGR OF 71.6%.

- WITHIN THE VISION SECTOR, AR CURRENTLY HAS THE LARGEST MARKET SHARE

- DUE TO GREATER MARKET POTENTIAL FOR VISION SECTOR, IT IS PROPOSED TO FOCUS ON IMAI TECHNOLOGIES PERTAINING TO VISION (I.E. VR AND AR/MR)

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TECHNICAL WRITE-UP SUMMARY

Initial Focus

1 Clusters and industry verticals

BUILT ENVIRONMENT
- Construction
- Security
- Real Estate & Smart FM
- Environmental Services

TRADE & CONNECTIVITY
- Wholesale Trade
- Land Transport
- Sea Transport
- Air Transport
- Logistics

MODERN SVCS
- Financial Services
- Professional Services
- ICT and Media

LIFESTYLE
- Food Manufacturing
- Food Services
- Hotels
- Retail

2 Experience enablers*

Consumers
- Product Simulation
- Information Retrieval
- Customer Engagement
- Marketing
- ...

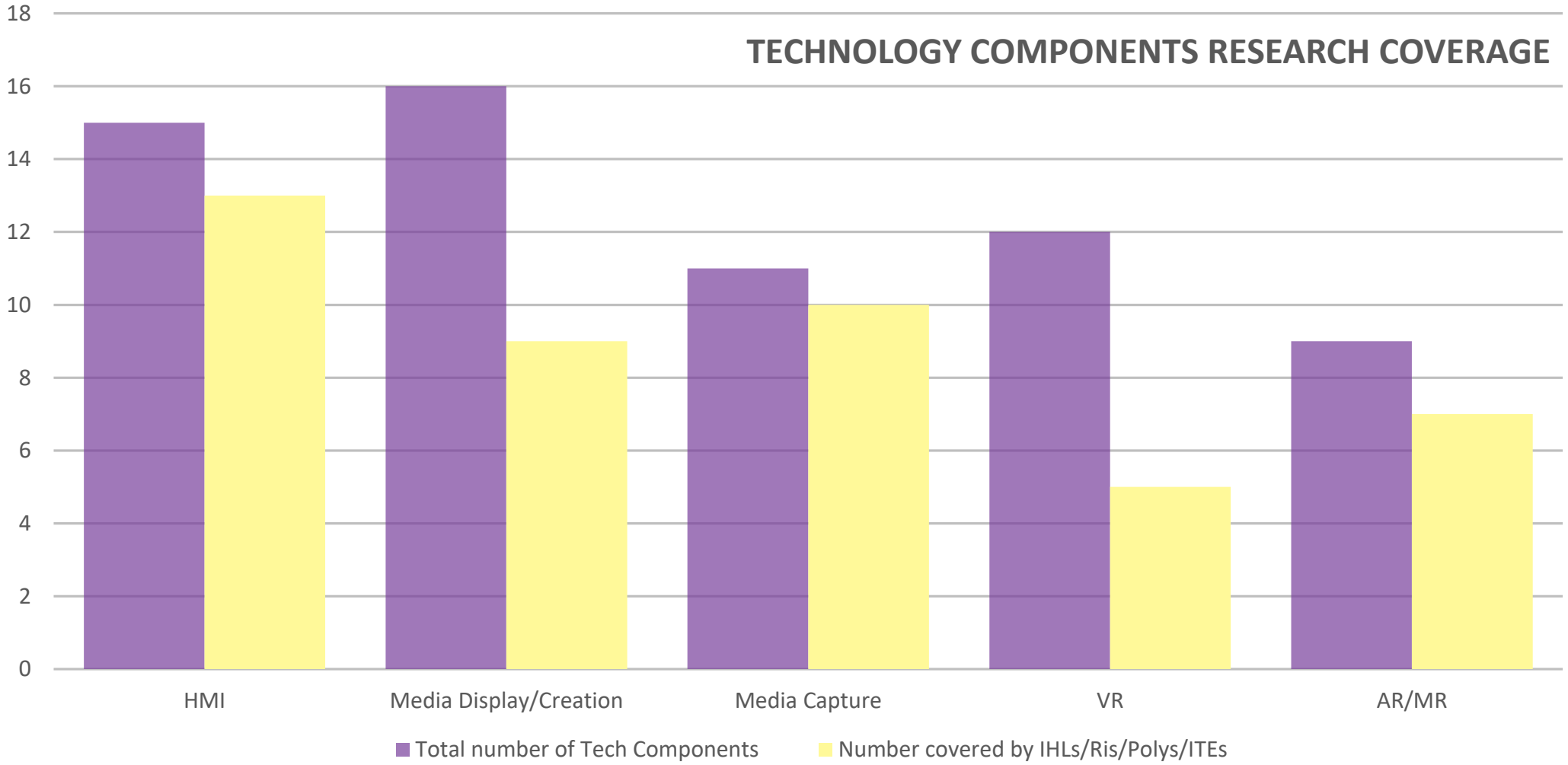
Enterprise Users
- Maintenance
- Quality Control
- Telepresence
- Training
- System Simulation
- Layout Simulation
- Market Expansion
- Data Collection
- ....

* Non-exhaustive list

3 IMAI technology components

- Human-Machine Interaction
- Media Creation/Display
- Media Capture
- Virtual Reality
- Augmented / Mixed Reality

Source: IMDA



Polytechnics and ITE

1. Singapore Polytechnic
2. Temasek Polytechnic
3. Institute of Technical Education

Universities

A. Nanyang Technological University
B. National University of Singapore

Research Institutes

a) Fraunhofer Singapore
b) Institute for Infocomm Research

Source: IMDA

TECHNOLOGY READINESS MAP

	Categories	Now~2 Years	3~5 years	>5 years
Human-Machine Interaction	**Capabilities**	-Process and digitally encode basic to complex forms of human input and generate basic to complex forms of sensory feedback		

	Technologies	• Body pose recognition/tracking
		• Hand gesture recognition/tracking
		• Voice enabled interface
		  ◦ Speech recognition/synthesis
		  ◦ Voice profile recognition
		  ◦ Voice profile generation
		• Eye tracking
		• Haptics rendering
		• Multi-user touch interface
			• Tangible haptic devices
			• Voice enabled interface
			  ◦ Conversable AI
			  ◦ Task/chat oriented spoken dialogue
			• Iris recognition
			• Gaze control
			• Face gesture recognition
			• Emotion recognition
				• Advanced haptic devices
				• Brain-computer interface
				• Haptic feedback recognition
				• Learning from observation

	Application Scenarios/Use Cases	Large crowd surveillance, voice purchasing/booking, feature based verification		
Media Creation/Display	**Capabilities**	-Generate media output for human consumption via human senses		
	Technologies	• Holograms (waveguide displays) • 4K UHD TV (3840 x 2160 pixels) • Micro LED displays • Smart mirrors • 360 degree films • HD video streaming • AR enhanced displays	• 8K UHD TV (7680 x 4320 pixels) • Glasses-free 3D HDTV • Natural focus adjustable displays • 360 degree video streams • Taste creation	• 3D volumetric image creation • 16k UHD TV (15360 x 8640 pixels) • Electronic lenses • 360 degree film theatres
	Application Scenarios/Use Cases	Large 360 theatres, advertising displays, exhibits.		

Source: IMDA

TECHNOLOGY READINESS MAP

	Categories	Now~2 Years	3~5 years	>5 years
Media Capture	**Capabilities**	-Digitally encode non-digital information		

	Technologies	• Stereoscopic image/video capture
		• Multi lens camera
		• 360 degree image/video capture
		• Volumetric image/video capture
		• 3D audio capture
		• 3D reconstruction from image
		• 3D object scanning
		  ◦ Portable scanners
		  ◦ Stationary scanners
		• Drone assisted image/video capture
			• Taste encoding
			• 3D object scanning
			  ◦ Automated 3D model cleaning
				• Light field image/video capture

	Application Scenarios/Use Cases	HD cameras, filming of VR media, automated 3D model generation for goods.		
Virtual Reality	**Capabilities**	-Immerse a user in a digital environment		

	Technologies	• Untethered head mounted displays (HMD)
		  ◦ WiGig connectivity
		• Standalone HMDs
		• Eye tracking
		• Multi-user VR
		• WebXR, OpenXR, OSVR, OpenVR
		• 3D audio
		  ◦ Spatial audio
			• 3D camera on HMD
			• Volumetric VR
			• Smell modules
			• VR content sharing
			• IEEE P2048 standards (VR/AR)
			• 3D audio
			  ◦ Individualised binaural synthesis
			  ◦ Dynamic binaural synthesis
				• Improved and integrated haptic feedback
				• Improved hardware performance

	Application Scenarios/Use Cases	Training, simulation and psychological treatments.		

Source: IMDA

TECHNOLOGY READINESS MAP

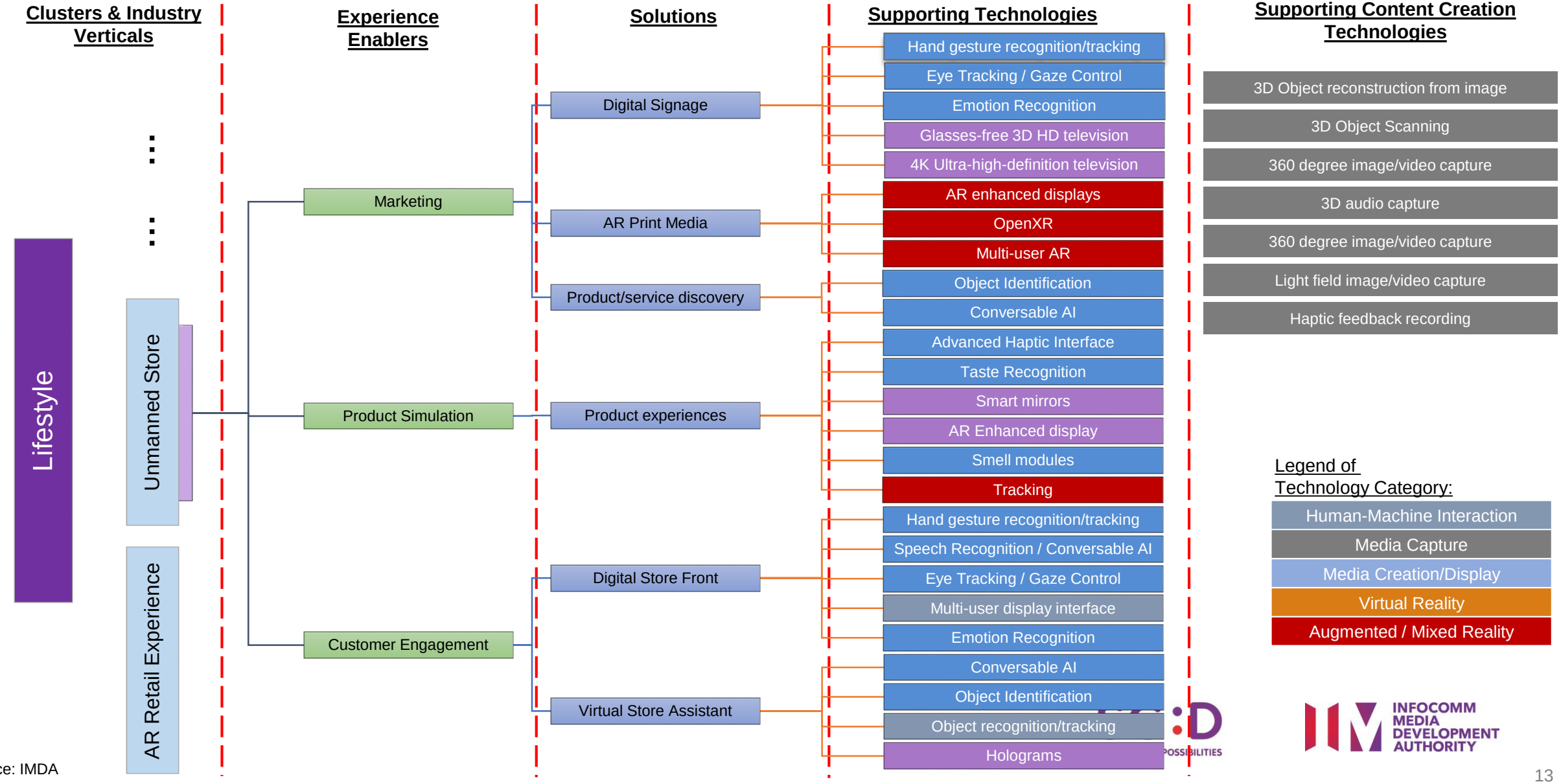
	Categories	Now~2 Years	3~5 years	>5 years
Augmented Reality	**Capabilities**	-Overlay digital imagery on top of real image streams -Interaction between digital objects and real objects/environment		

	Technologies	• Simultaneous localisation and mapping (SLAM)
		• Computer vision
		  • Object recognition/tracking
		  • Orientation/World tracking
		  • Plane detection
		  • Motion tracking
		• Multi-user AR
		• 3D audio
		  • Spatial audio
		• OpenXR, ARKit, ARCore, Vuforia
			• Persistent AR content
			• AR content sharing
			• 3D audio
			  • Individualised binaural synthesis
			  • Dynamic binaural synthesis
			• IEEE P2048 standards (VR/AR)
			• Unity AR Foundation
			• Computer vision
			  • Occlusion
				• AR contact lenses
				• Computer vision
				  • High precision measurement
				  • High precision object tracking

	Application Scenarios/Use Cases	Training for component assembly, medical education of human anatomy, entertainment, high precision measurement in build sites.		

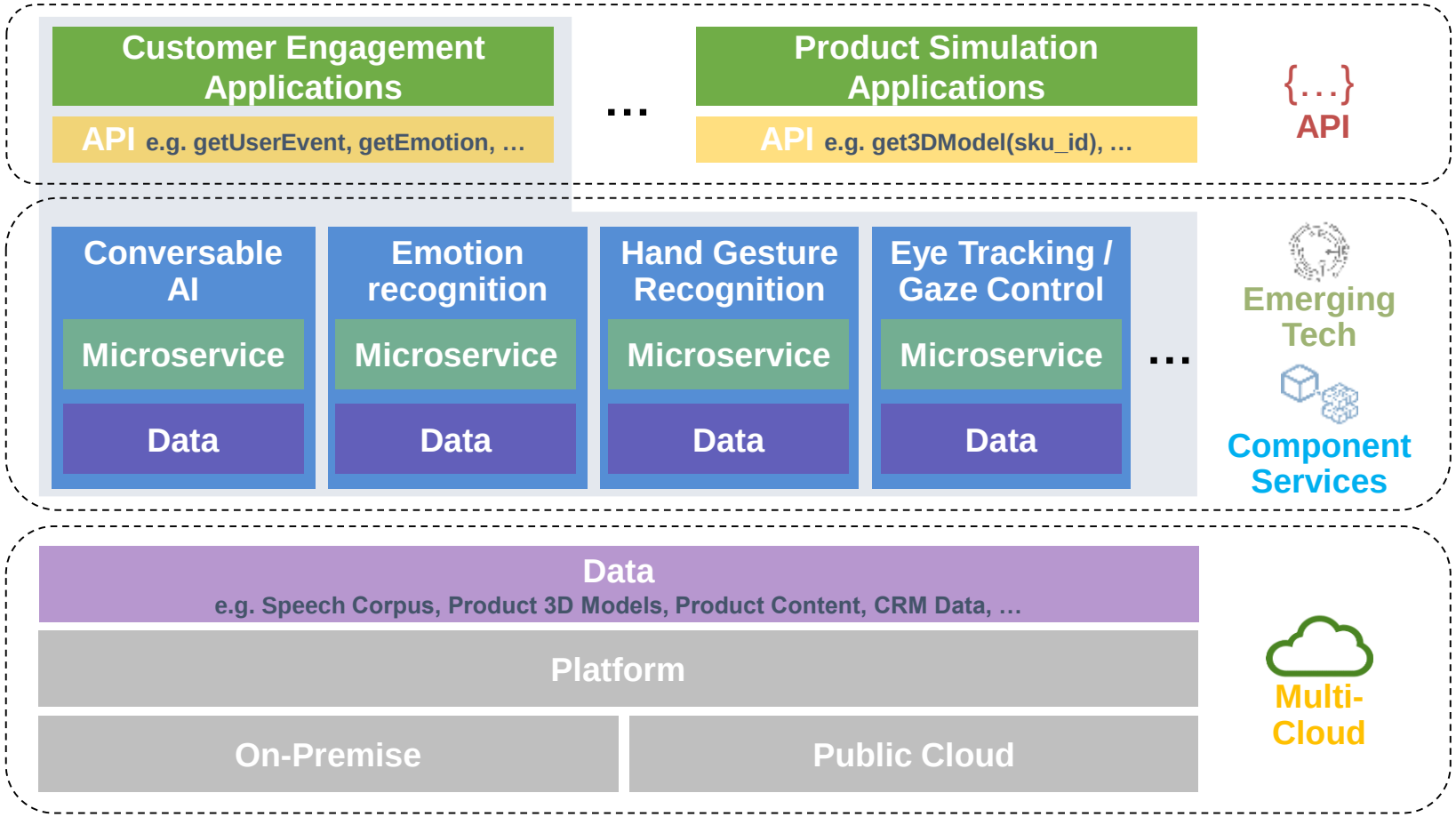
Source: IMDA

USE CASES



Source: IMDA

WG2
Immersive Media & Adv. Interfaces



1 Human Machine Interaction
- 1.1 Multi-user display interfaces
- 1.2 Emotion recognition
- 1.3 Conversable AI

2 Media Creation/Display
- 2.1 4K UHD TV (3840x2160 pixels)
- 2.2 Natural focus adjustable displays
- 2.3 360-degree film theatres

3 Media Capture
- 3.1 Stereoscopic image/video capture
- 3.2 3D object reconstruction from image
- 3.3 3D object scanning

4 Virtual Reality
- 4.1 Untethered head-mounted display (HMD)
- 4.2 Volumetric VR
- 4.3 VR Content Sharing

5 Augmented/Mixed Reality (AR)
- 5.1 AR Content Sharing
- 5.2 Persistence AR
- 5.3 Multi-user AR

Source: IMDA

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SWOT ANALYSIS – WG2

STRENGTHS

1. Presence of international IMAI players (tech & media giants) in Singapore
2. Strong innovation hubs (e.g. IMDA's PIXEL) and global reputation of local research institutes & universities
3. Active R&D efforts by research institutes & universities, IHLs and local corporate labs in the IMAI space (e.g. Fraunhofer, CUTE, LiveLabs, ARTC, etc.)
4. Strong communication infrastructure such as mobile and network connectivity (e.g. piloting of 5G)
5. Government willingness to support promising local companies
6. Strong regulatory & legal framework (e.g. IP protection laws)

WEAKNESSES

1. Small domestic market and lack of scale
2. Low risk-appetite amongst enterprises to invest in new technologies like IMAI
3. Lack of talents for R&D and tech development
4. Core IMAI technologies dominated by international players – lack of local tech developers
5. Inconsistent level of IMAI adoption and digital capabilities amongst local enterprises (e.g. local tech providers need to upskill; local solution providers lack expertise / knowledge to quickly adopt IMAI tech)

OPPORTUNITIES

1. Existing Smart Nation initiative to be leveraged – make Singapore as a hub for experimental & innovative use of technology
2. Strong export market opportunities leveraging high growth potential in APAC
3. Strongly service-oriented country – sectors with high potential to adopt IMAI tech such as retail, healthcare

THREATS

1. Need for Singapore to constantly keep abreast with fast moving tech advancement, in order to fully realise market opportunities from IMAI R&D projects
2. Increasing competition in the region due to their lower cost (e.g. Thailand, Philippines), increasing competitiveness (e.g. Malaysia's EFTZ) and large investments and capital (e.g. China, Korea)

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Source: IMDA

ALIGNMENT OF IMAI TO DE FRAMEWORK

DIGITALISING INDUSTRIES

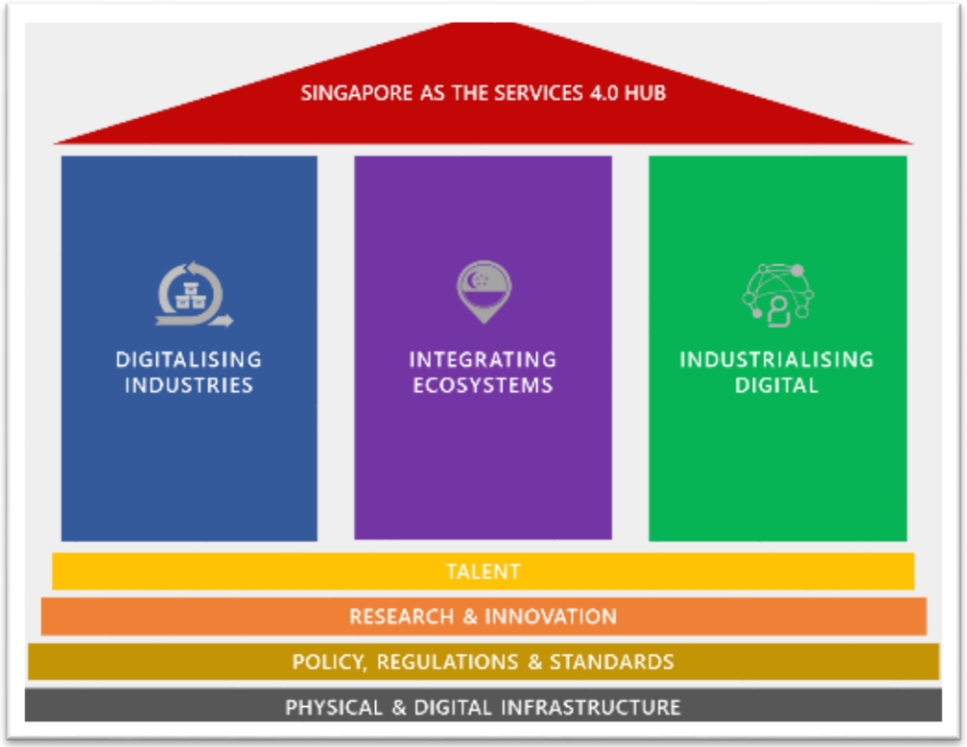
MID Immersive Media (IM) strategy
- Advocacy for IM adoption – Raise awareness on potential applications of IM
- Build Innovation Capacity – Promote IM adoption in enterprises, with innovative POCs.

INTEGRATING ECOSYSTEMS

IMAI Micro-Services Platform
- Quality control
- Telepresence
- Maintenance
- Marketing
- Product simulation etc…

TALENT

MID Immersive Media (IM) strategy
- Talent Development – Groom IM industry-ready professionals



RESEARCH & INNOVATION

Translation Engineering Centre
- Microservices translation
- Technical consultancy
- IP
- GTM support

Research Productisation workshops
- For tech providers to learn about local R&D work that have the potential for commercialization / productisation
- Showcasing & profiling

PHYSICAL & DIGITAL INFRA

5G mobile networks
- Higher bandwidth and lower latency for input / output data transfer

4k / 8k live streaming and displays
- Higher capacity for visual feedback data output

New recommendation

Existing strategy

Source: IMDA

RECOMMENDATION (1/2)

Recommendations		Descriptions
INTEGRATING ECOSYSTEMS	• **IMAI Micro-Services Platform**	• To catalyse the growth of the local IMAI ecosystem, it is crucial to democratise access to IMAI technologies. This can be achieved by adopting a Cloud Native Architecture approach, which offers the potential to improve ease of use, provide more flexibility, ensure scalability and reduce cost. In turn this will reduce friction in adoption of IMAI amongst users, and empower them to create more innovative IMAI products and solutions. • This platform should also have differentiating factor(s) from the current platforms in the market, to have a unique selling point. Through such a platform, the local enterprises can benefit from better economies of scale and can tap onto the other micro-services available on the platform (e.g. data analytics, Cyber Security, etc.) to augment and complement their own offerings.
PHYSICAL & DIGITAL INFRA	• **Supporting technologies to invest in**	**4k/8k displays** and **5G mobile networks** have been identified as potentially critical elements for the future success of IMAI technologies. • **4k/8k displays** – This refers to the underlying infrastructure to support delivery of 4k/8k content. High display resolution allows for higher graphical fidelity, thus facilitating enhancements in the creation and visualisation of IMAI contents. • **5G mobile networks** – Higher quality IMAI content may have larger file sizes; while this is not a concern for contents that are installed on the devices, it may create performance issues when real-time streaming. Advanced 5G mobile networks can improve connectivity and latency, becoming increasingly important for the lag-free streaming of the high quality IMAI contents.

Source: IMDA

RECOMMENDATION (2/2)

Recommendations		Descriptions
RESEARCH & INNOVATION	• **IMAI technologies to invest in**	• After conducting market studies, technology studies, and industry engagements, the findings reveal that Singapore should prioritise investments in technologies which drive **Augmented Reality (AR), Virtual Reality (VR)** and **Mixed Reality (MR)** applications.
	• **IMAI Translation Engineering Centre**	• This is a proposed collective approach where public and private sector organizations combine resources and know-how to identify and develop solutions/products on the most critical areas of IMAI. Such a lab has the potential for: 1. Micro-services translation for Alpha/Beta trials 2. Venue for ideation/innovation 3. Provider of consultancy/experimentation services 4. Commercialization opportunities for R&D projects 5. Networking/business match-making
	• **Research Productisation workshops**	• To augment the efforts by the IMAI Translation Engineering Centre, roadshows and engagement sessions could be organized to put local technology providers in touch with RIs and IHLs to understand more on the R&D work. From such engagements, the technology providers can have a better understanding on the potential R&D work that they can leverage on to develop into commercial products and solutions.

Source: IMDA

THANK YOU

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APPENDIX

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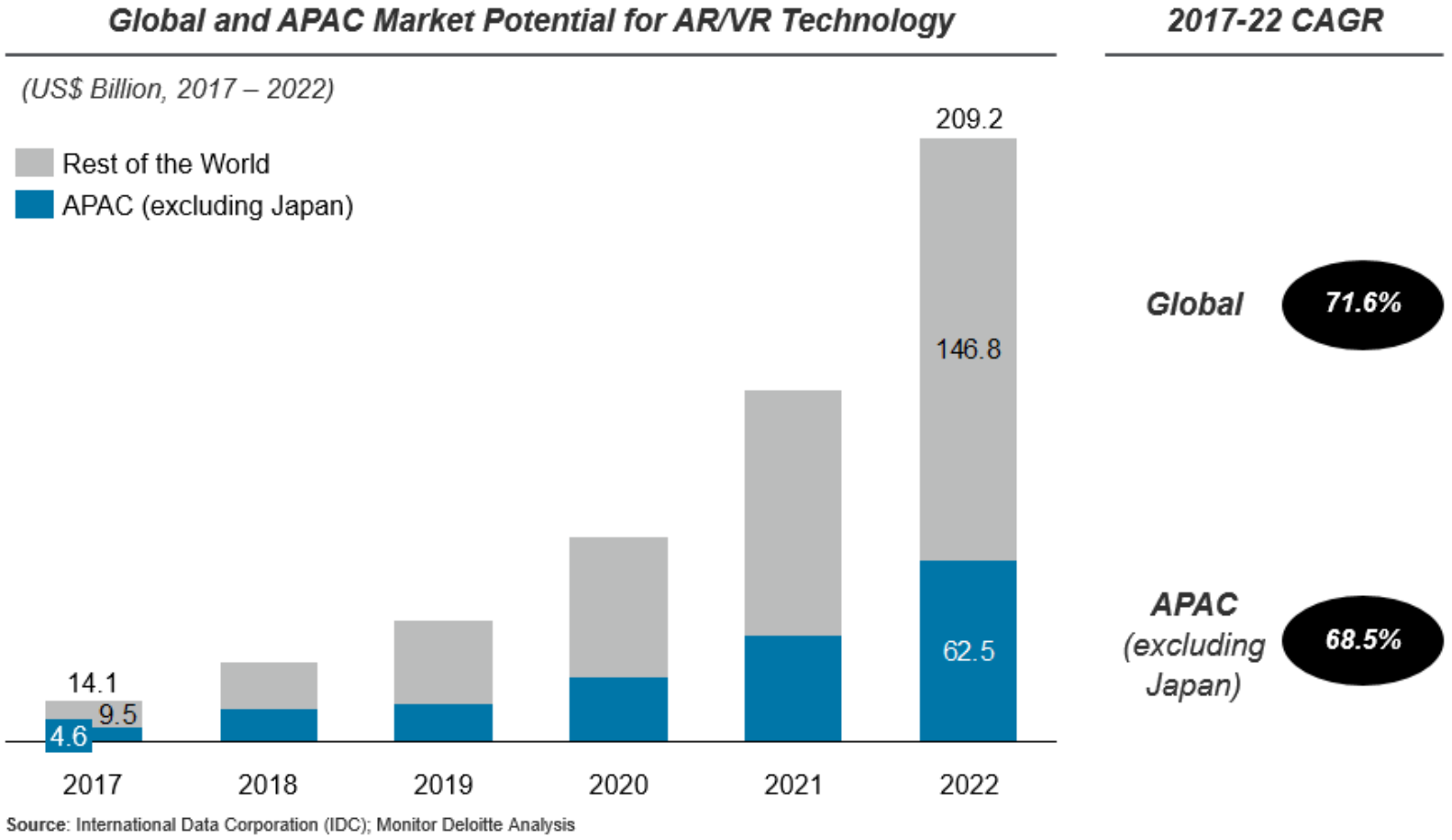
IMAI MARKET - VISION



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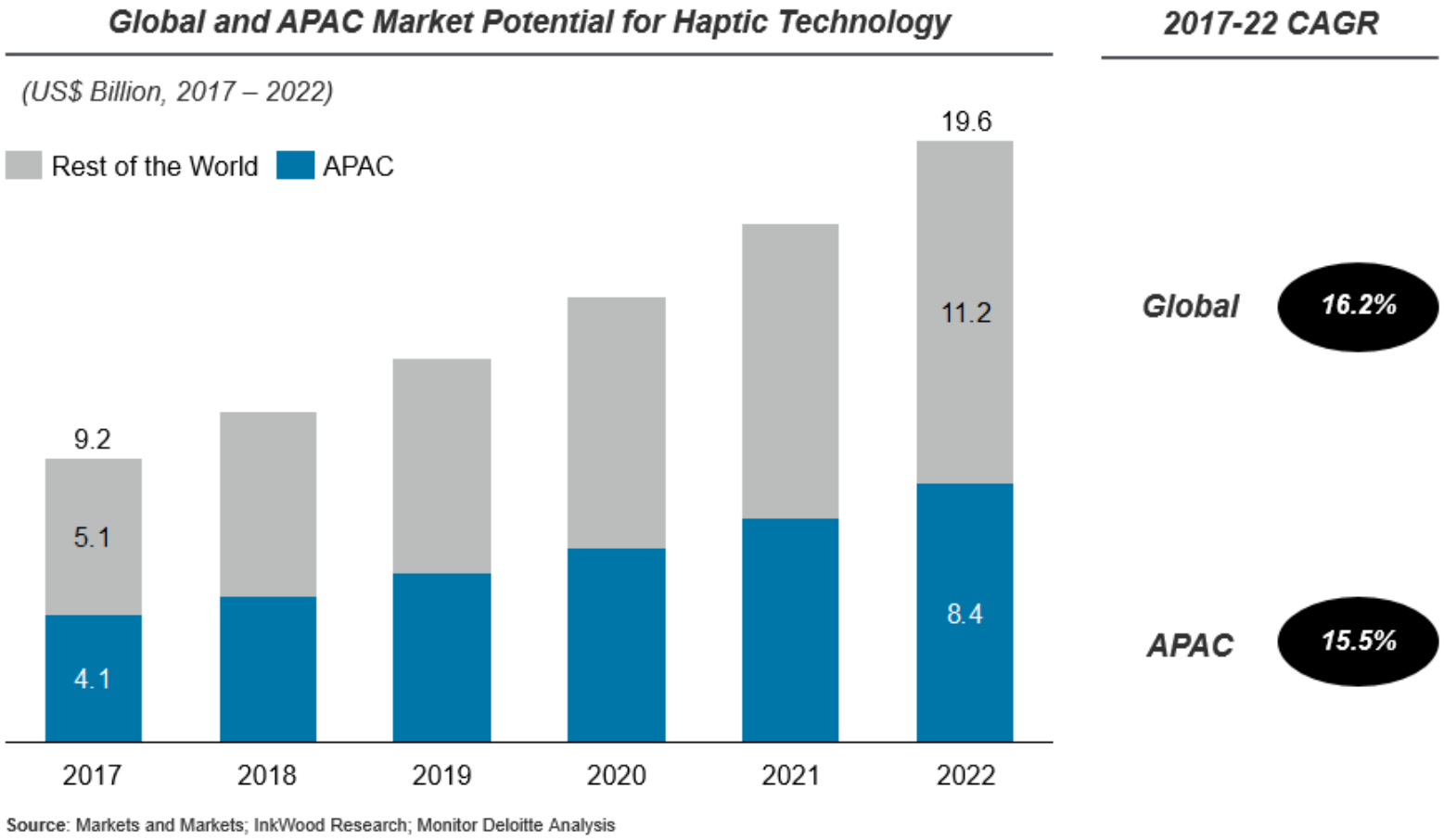
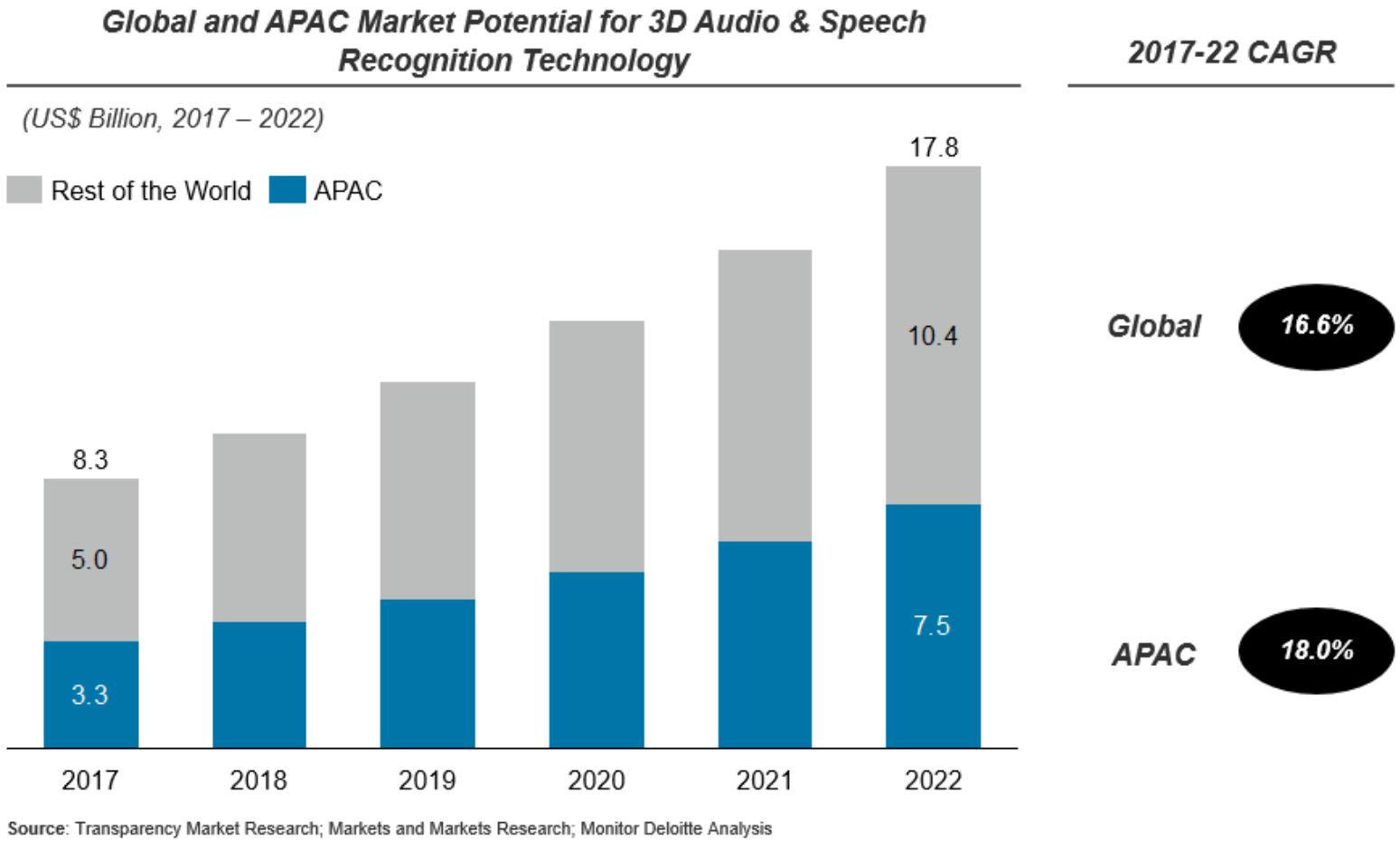
IMAI MARKET - TACTILE



Source: Markets and Markets; InkWood Research; Monitor Deloitte Analysis

IMAI MARKET - AUDITORY



Source: Transparency Market Research; Markets and Markets Research; Monitor Deloitte Analysis

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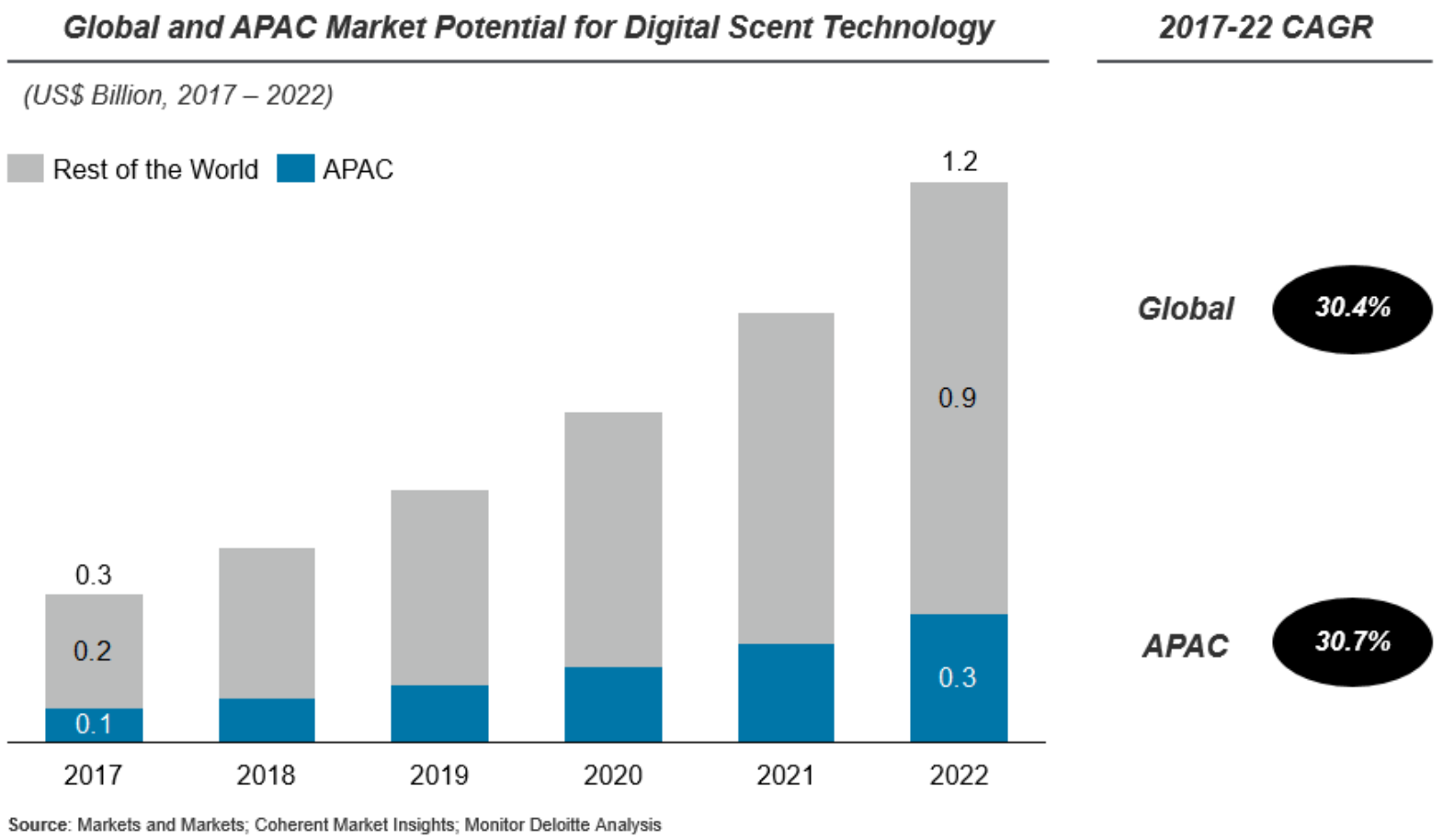
IMAI MARKET - OLFACTION



SWOT ANALYSIS FOR RESEARCH INSTITUTES (RI)

Strengths

- Competent and credible researchers
- Robust frameworks / methodologies available for research and validation of research findings
- Open mind set to explore new research areas, instead of following the convention (i.e. technologies with higher Technology Adoption Readiness Level)
- Strong international networks and connections with other researchers / Research Institutes
- Strong global reputation

Weaknesses

- Insufficient research staffs to cope with demands
- Disconnect between research areas and areas with actual tangible value for enterprises / industries
- Low risk appetite for new unexplored research areas, which may have lower possibilities of immediate returns but larger potential upside in the future (i.e. technologies with lower Technology Adoption Readiness Level)
- Challenges in hiring foreign workforce (i.e. more justifications required from employers)

Opportunities

- Leverage on Smart Nation initiative, and differentiate ourselves as a hub that is receptive to research of new, cutting-edge technologies
- Leverage on improved rankings of our local universities, as well as Singapore's reputation for quality education and high standard of living, to attract top students and researchers
- Closer opportunities for working with industry (proof of concept)

Threats

- Brain drain i.e. preference of top research talents to work in more lucrative sectors such as finance, and major IT firms
- Industry needs moving faster than research outcomes

Source: IMDA

SWOT ANALYSIS FOR START-UPS (SU)

Strengths

- Willingness to experiment with new / ground-breaking ideas and business models
- More agile and nimble in execution (i.e. able to pivot quickly)
- Able to operate with lean resources
- Attractive working environment to top talent who are looking for equity and autonomy

Weaknesses

- Lack of established processes, funds and business models, leading to a fragile and unstable working environment
- Greater physical / emotional / finance hardship involved in working at a start-up, possibly leading to a high turnover rate
- Difficulty in penetrating overseas markets, due to entrenched local start-ups who have a stronger / more loyal community

Opportunities

- Potential for unlimited upside, if a new market is created (e.g. sharing economy (AirBnB, Uber), social networks (Facebook))
- Accelerated learning opportunities, as founders will fail, learn and iterate in multiple roles at a rapid pace
- Partnering with larger international companies in Singapore, for localised content (require proactive approach to engaging with the larger international companies)

Threats

- Patent trolls, who issue frivolous lawsuits to take advantage the new products / services
- Competition from entrenched incumbents who have more resources to develop similar products / services and overtake the market share

Source: IMDA

SWOT ANALYSIS FOR LARGE LOCAL ENTERPRISES (LLE)

Strengths

- Strong global / regional reputation for being trustworthy and capable to do business with
- Workforce in company has strong command of English (international language for businesses)
- Strong database of customers' information (e.g. shopping history, spending habits etc.) for marketing and outreach purposes

Weaknesses

- Rising labour costs, due to higher standard of living in Singapore and restrictions on hiring foreign workers
- Over-emphasis on legacy / bread and butter issues, leading to inadequate focus on developing new products / solutions that could grow the business
- Lack of talents who can create innovative / transformative business models and products
- Reliance on global MNCs for core technologies

Opportunities

- Leverage on Singapore's global / regional reputation and brand name, and expand into other markets
- Leverage on Singapore government's extensive range of grants / schemes to further expand the business, try out emerging technologies and train workforce
- Leverage on R&D activities by research institutes (e.g. A*Star) instead of building in-house R&D capabilities

Threats

- Competition from overseas companies who may have greater resources, better products or more brand power to attract work force talents / customers
- Small domestic market, which does not offer scale
- Aging workforce
- Lack of collaborative efforts within the industry (e.g. to expand to other markets)

Source: IMDA

SWOT ANALYSIS FOR LARGE LOCAL ENTERPRISES (LLE) TECH PROVIDER

Strengths

- Strong local reputation / brand recognition
- Strong organisational / management structure
- Diverse line of products / services

Weaknesses

- Lack of reputation / brand recognition beyond Singapore
- Over-reliance on a small number of major local clients (e.g. public sector agencies)

Opportunities

- Create “add-ons” to existing products / services, to further broaden the scope of company’s offerings and tap on existing customer base
- Displace higher-priced competition with new technologies
- OEM opportunities (e.g. white label solutions)

Threats

- May not be able to adopt latest technologies quickly enough, to continue providing value to customers and maintain competitiveness

Source: IMDA

SWOT ANALYSIS FOR MULTINATIONAL CORPORATION (MNC)

Strengths

- Strong, well established brand name that brings credibility and is attractive for business connections
- Loyal customer base that is familiar with and reliant on the company's products / services
- Sufficient financial / workforce resources to invest in new ventures

Weaknesses

- Greater administrative and financial overheads, due to larger workforce and scope of operations
- Less agile and nimble in reacting to new market trends and experimenting on new ideas
- May not be as knowledgeable as the smaller local / regional competitors, on the preferences & requirements of local / regional market
- May be perceived as a less attractive place to work (due to bureaucracy, lack of autonomy, slow pace of progress, etc.)

Opportunities

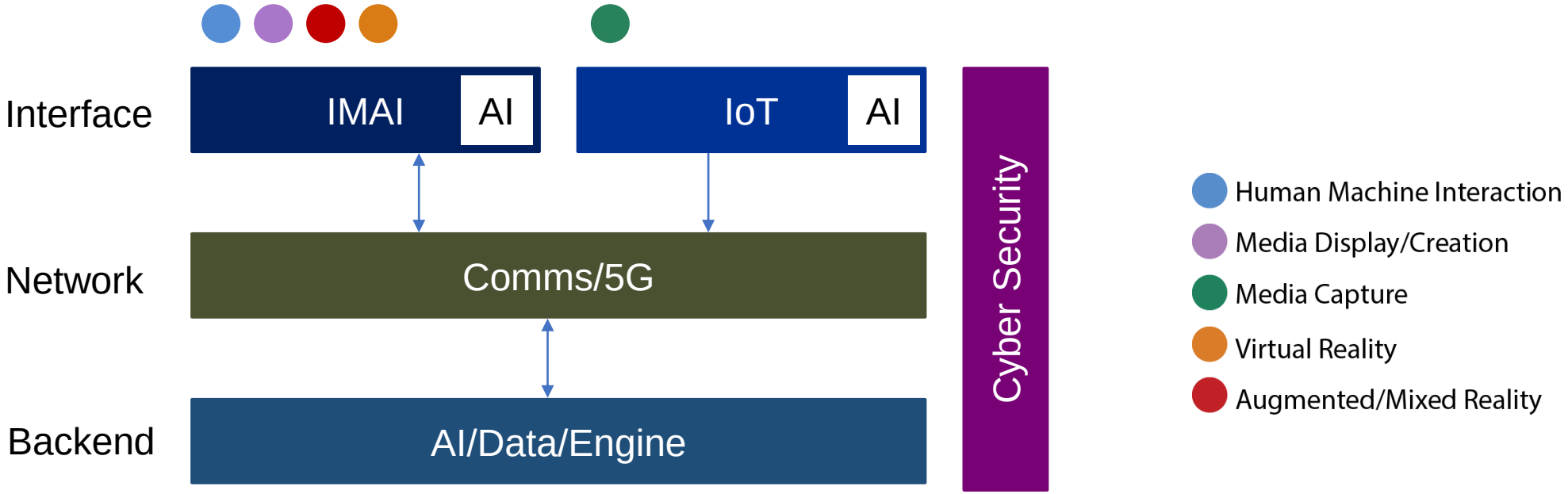
- Leverage on the established business processes and brand name, to expand overseas and capture new markets
- Potential to expand existing IP into other complementary product lines
- Acquire other companies / patents, to accelerate acquisition of new customer bases or products

Threats

- Intense competition from other MNCs and start-ups who are targeting the same market
- Slowing rate of growth, as the company's pace of innovation and expansion plateaus

Source: IMDA

IMAI AND OTHER TECHNOLOGIES



Source: IMDA

HUMAN-MACHINE INTERACTION TECHNOLOGY ROADMAP

Less than 2 years	3-5 years	More than 5 years
Body pose recognition/tracking[1,2,3,A,a,b]	Tangible haptic devices[3,A]	Advanced haptic devices[A,B]
Hand gesture recognition/tracking[1,2,3,A,a,b]		Brain-computer interface[a,A]
Voice enabled interface[3,A,b] • Speech recognition/synthesis[2] • Voice profile recognition • Voice profile generation	Voice enabled interface[A,b] • Conversable AI • Task/chat oriented spoken dialogue	Haptic feedback recognition
Eye tracking[2,3,a,b]	Iris recognition Gaze control[1,3]	Learning from observation[b]
Haptics rendering[a]	Face gesture recognition[A,B,a,b] Emotion recognition[A,B,a,b]	
Multi-user display interfaces[2]		

Polytechnics and ITE
1. Singapore Polytechnic
2. Temasek Polytechnic
3. Institute of Technical Education

Universities
A. Nanyang Technological University
B. National University of Singapore

Research Institutes
a) Fraunhofer Singapore
b) Institute for Infocomm Research

Source: IMDA

MEDIA CREATION/DISPLAY TECHNOLOGY ROADMAP

Less than 2 years	3-5 years	More than 5 years
Holograms (waveguide displays)[3]		3D volumetric image creation[A]
4K UHD TV (3840x2160 pixels)[3] Micro LED displays	8K UHD TV (7680x4320 pixels) Glasses-free 3D HD TV[A]	16K UHD TV (15360x8640p)
Smart mirrors	Natural focus adjustable displays[A]	Electronic lenses
360 degree films[2,3,A]	360 degree video streams[3]	360 degree film theatres
HD video streaming[3,A]	Taste creation	
AR enhanced displays[3,A]		

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1. Singapore Polytechnic
2. Temasek Polytechnic
3. Institute of Technical Education

Universities
A. Nanyang Technological University
B. National University of Singapore

Research Institutes
a) Fraunhofer Singapore
b) Institute for Infocomm Research

Source: IMDA

MEDIA CAPTURE TECHNOLOGY ROADMAP

Less than 2 years	3-5 years	More than 5 years
Stereoscopic image/video capture[1,A] Multi lens cameras[1,A] 360 degree image/video capture[1,3,A] Volumetric image/video capture[1,A]		Light field image/video capture[3,A]
3D audio capture[A]	Taste encoding	
3D object reconstruction from image[3,A,a]		
3D object scanning[1,3,A,a] • Portable scanners • Stationary scanners	3D object scanning[A] • Automated 3D model cleaning	
Drone assisted image/video capture[3,A,a]		

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Source: IMDA

VIRTUAL REALITY (VR) TECHNOLOGY ROADMAP

Less than 2 years	3-5 years	More than 5 years
Untethered head-mounted display (HMD) • WiGig connectivity Standalone HMDs	3D camera on HMD Volumetric VR Smell modules	Improved and integrated haptic feedback[a] • Force[3] • Sensation
Eye tracking[3,a]		
Multi-user VR[3,a]	VR content sharing[3]	
3D audio[b] • Spatial audio	3D audio[b] • Individualised binaural rendering • Dynamic binaural synthesis	
WebXR, OpenXR, OSVR, OpenVR	IEEE P2048 standards (VR/AR)	
		Improved hardware performance[3]

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AUGMENTED REALITY (AR) TECHNOLOGY ROADMAP

Less than 2 years	3-5 years	More than 5 years
Simultaneous Mapping And Localisation (SLAM)[3,A,b]	Persistent AR content	AR Contact lenses[A]
Computer Vision[1,A,a] • Object recognition/tracking[3,b] • Orientation/World tracking[b] • Plane detection • Motion tracking[3,b]	Computer Vision • Occlusion	Computer Vision[A,b] • High precision measurement • High precision object tracking
Multi-user AR[1,2,A,a]	AR content sharing[b]	
3D audio[b] • Spatial audio	3D audio[b] • Individualised binaural rendering • Dynamic binaural synthesis	
OpenXR[1], ARKit[1,3], ARCore[1,3] Vuforia[1,2,3]	IEEE P2048 standards (VR/AR) Unity AR Foundation[2,A]	

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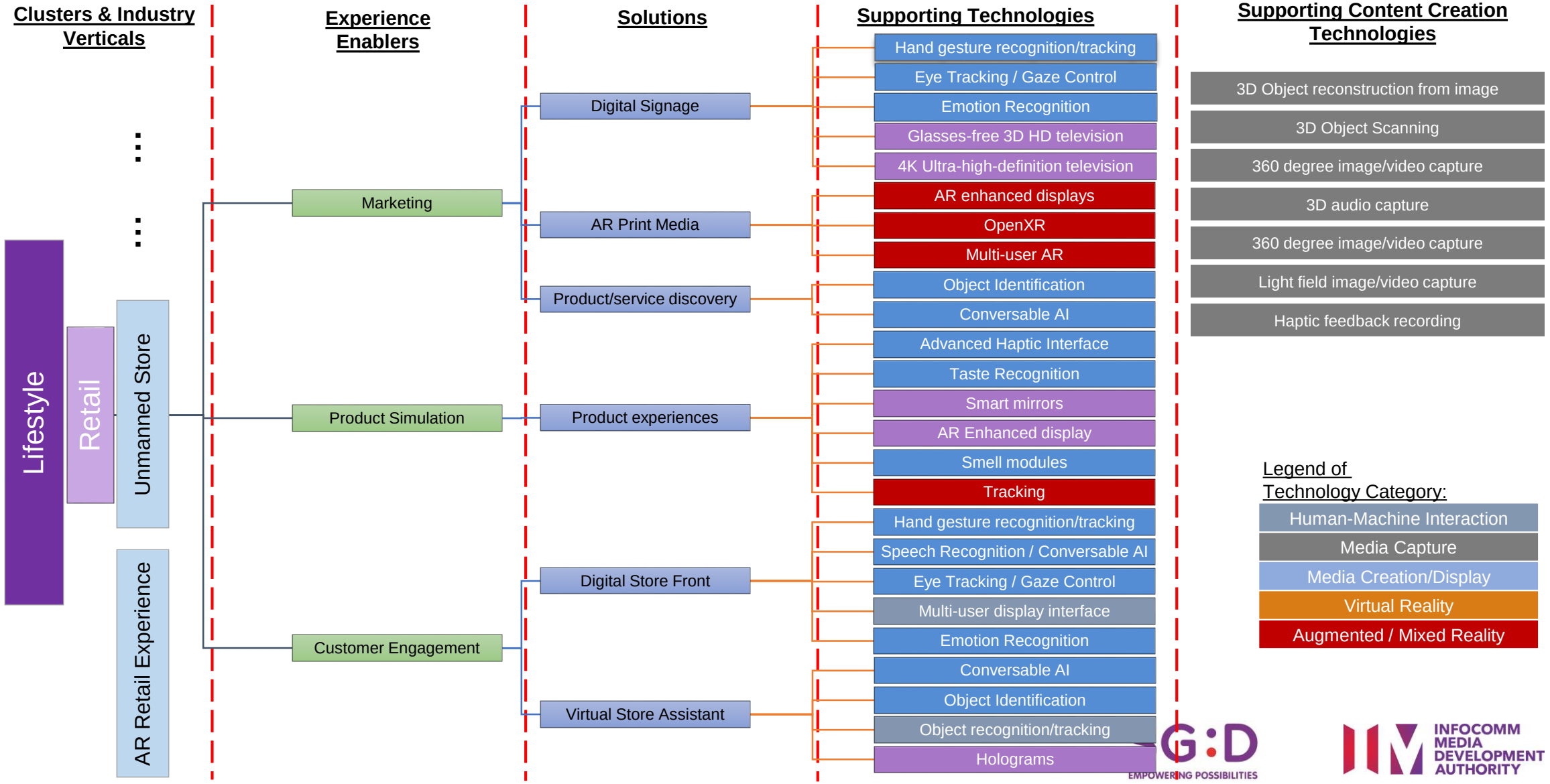
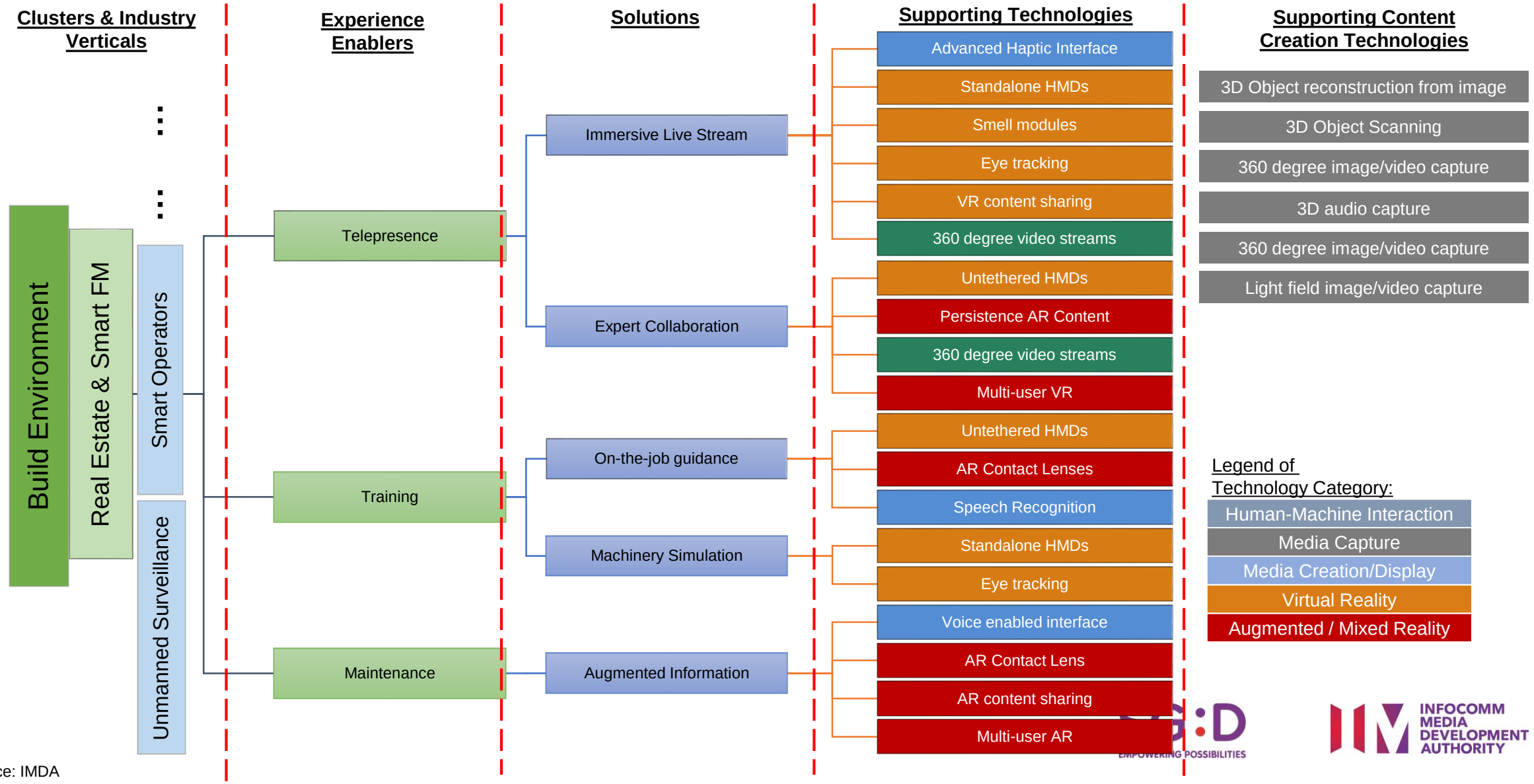
Source: IMDA

USE CASES IN RETAIL SECTOR



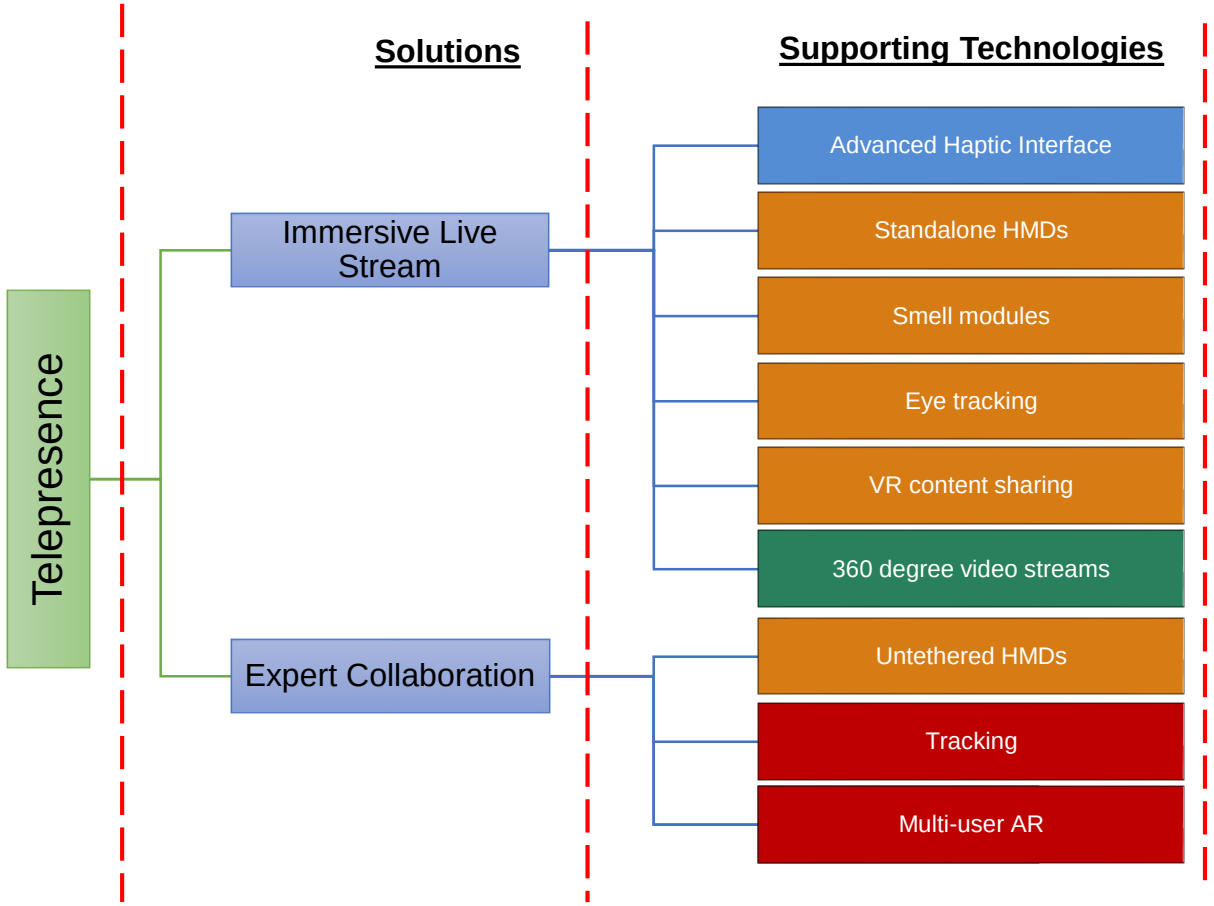
Source: IMDA

USE CASES IN REAL ESTATE & SMART FM SECTOR



Source: IMDA

EXPERIENCE ENABLERS: TELEPRESENCE (SMART FM)

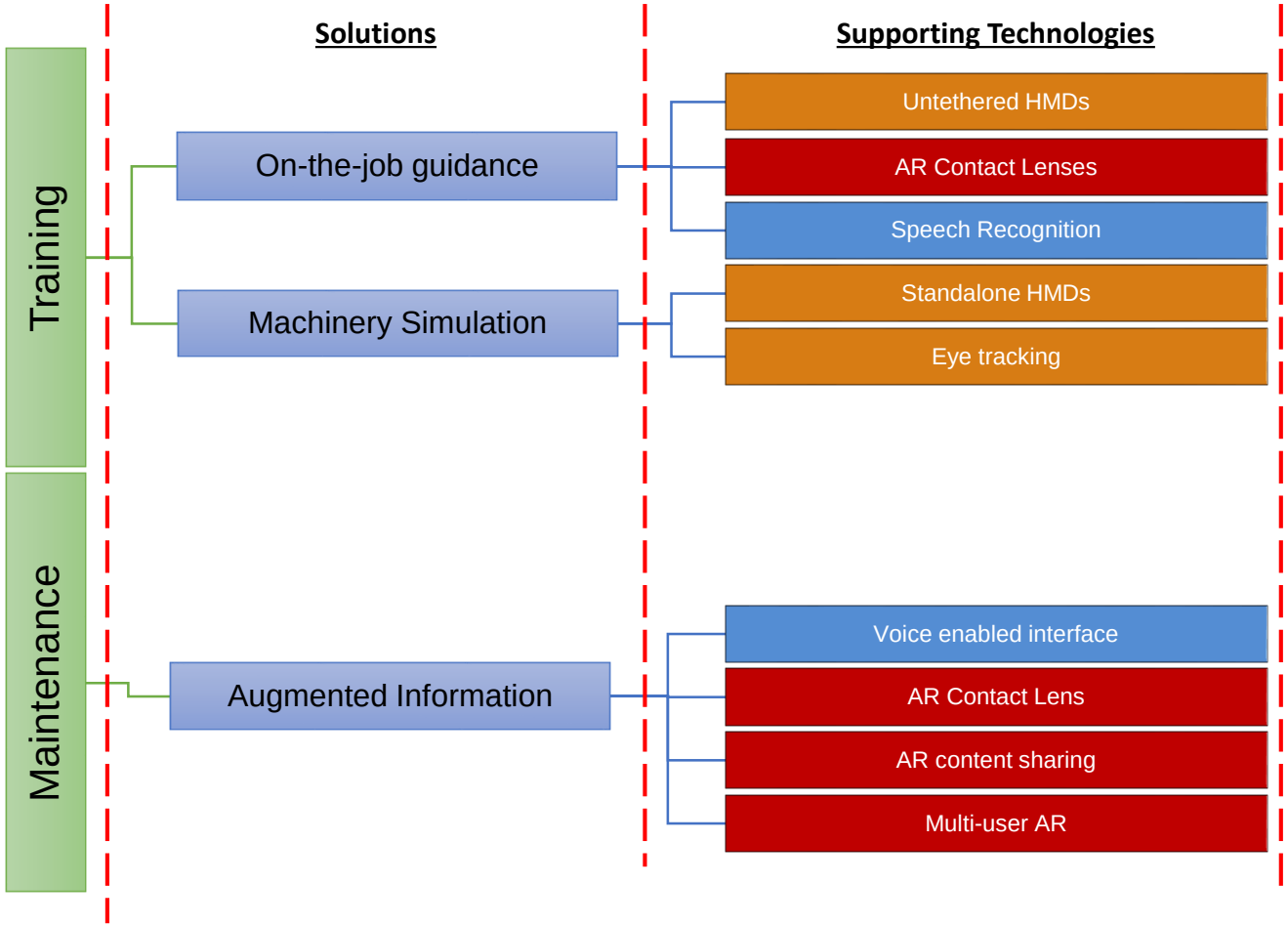


Legend of Technology Category:

- Human-Machine Interaction
- Media Capture
- Media Creation/Display
- Virtual Reality
- Augmented / Mixed Reality

Source: IMDA

EXPERIENCE ENABLERS: TRAINING & MAINTENANCE (SMART FM)

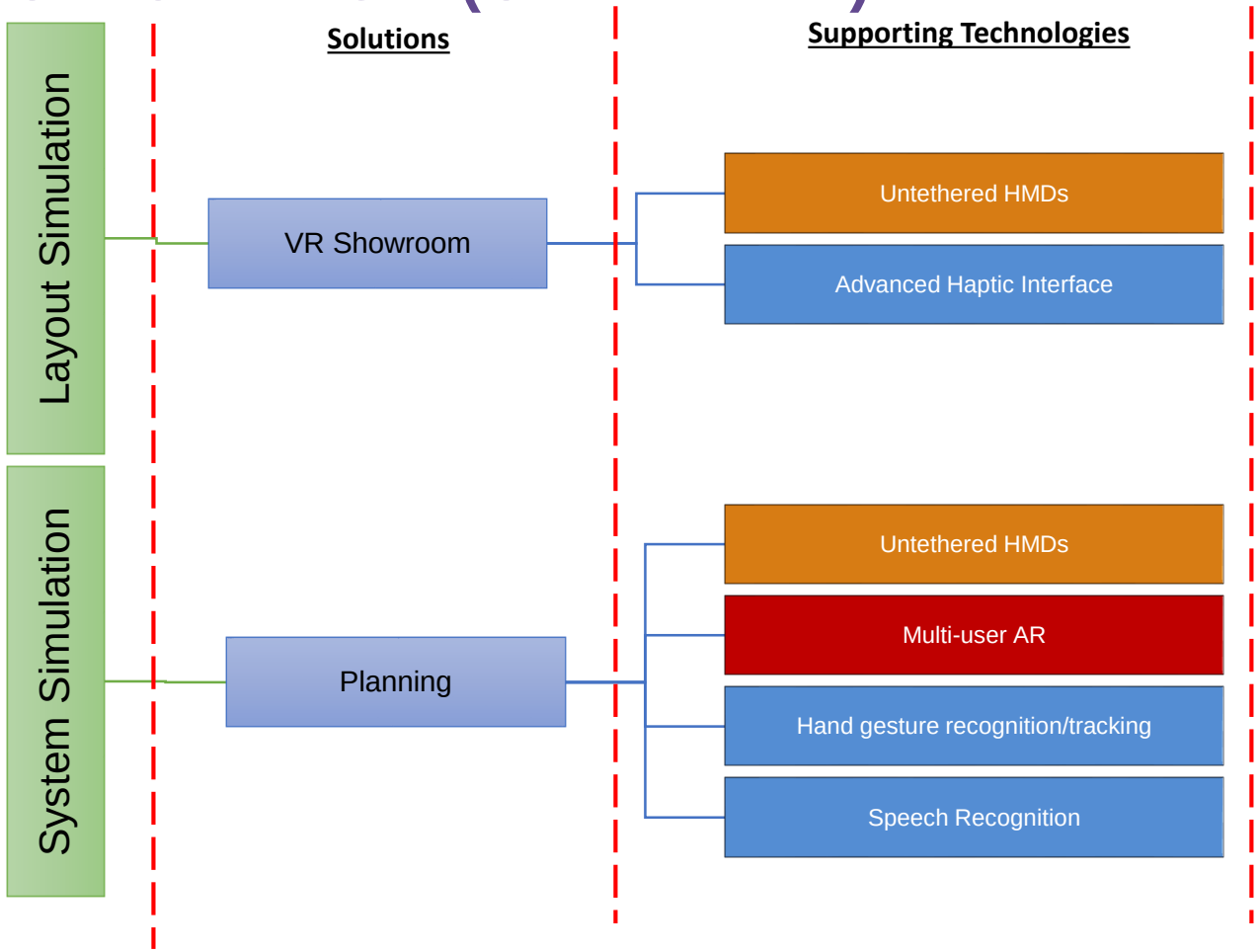


Legend of Technology Category:

- Human-Machine Interaction
- Media Capture
- Media Creation/Display
- Virtual Reality
- Augmented / Mixed Reality

Source: IMDA

EXPERIENCE ENABLERS: LAYOUT SIMULATION & SYSTEM SIMULATION (SMART FM)

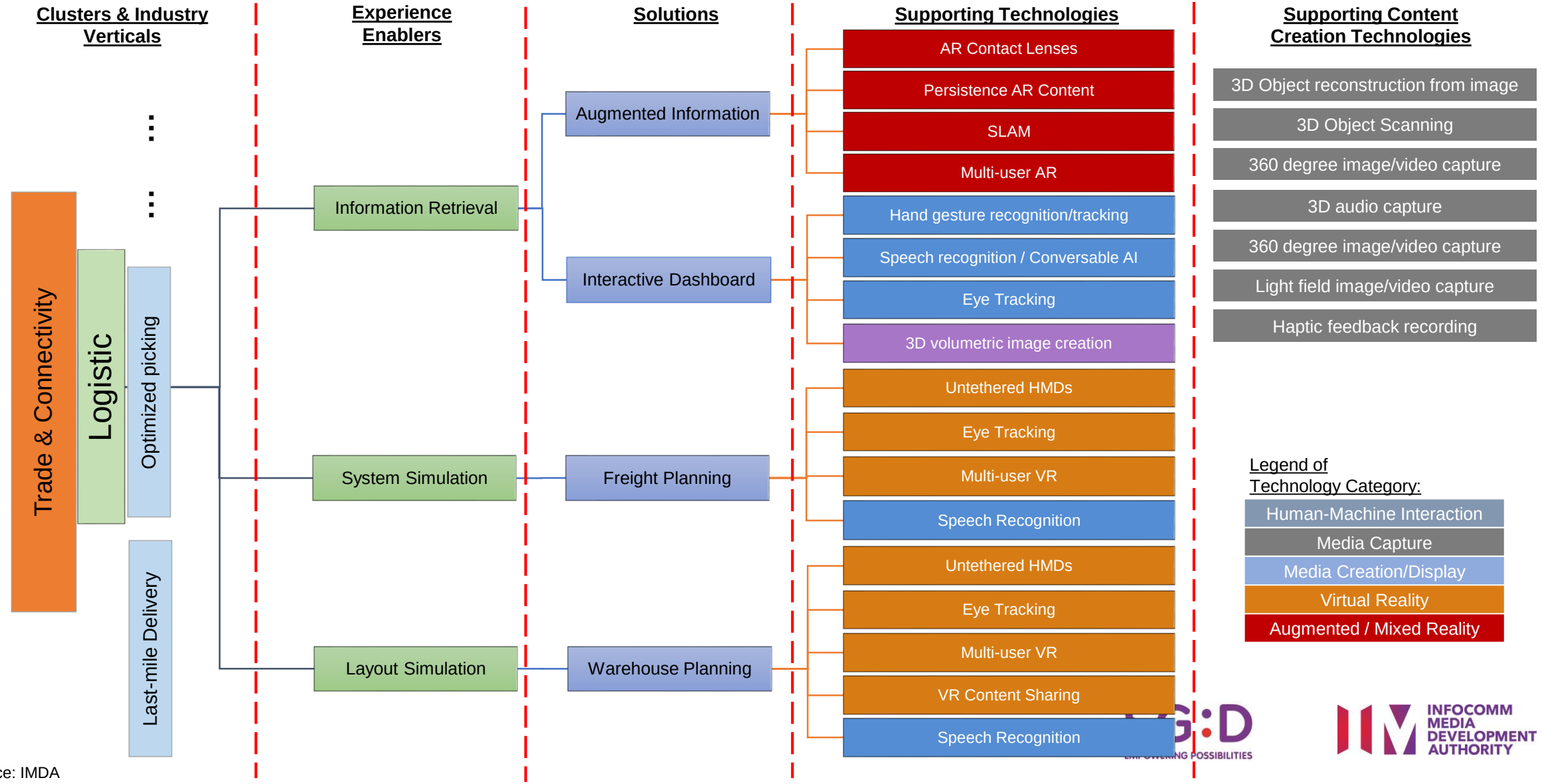


Legend of Technology Category:

- Human-Machine Interaction
- Media Capture
- Media Creation/Display
- Virtual Reality
- Augmented / Mixed Reality

Source: IMDA

Use Cases in Logistics



Source: IMDA

IM TECHNOLOGY – REFERENCE MATERIALS

- Bank of America Merrill Lynch Future Reality: Virtual, Augmented & Mixed Reality (VR, AR & MR) Primer 2016
- Goldman Sachs Profiles in Innovation Virtual Reality & Augmented Reality 2016
- IDC AR/VR Point of View and Analysis 2017
- Deloitte Insights Tech Trends 2018
- Mindshare Trends 2017
- ABI Research CES 2018 for Visionaries
- Accenture Digital Fjord Trends 2017
- EIT Digital Innovation Radar 2015 Annual Trend Report
- Qualcomm paper Making Immersive Virtual Reality Possible in Mobile 2016
- PWC An Introduction to Enterprise Virtual Reality May 2017
- Google Research
- Gartner hype cycle for semiconductors and Electronics Technologies 2017
- Gartner hype cycle for Drones and Mobile Robots 2017
- Gartner hype cycle for Emerging Technologies 2017
- Gartner hype cycle for Consumer Devices 2017
- Gartner hype cycle for Mobile Device Technologies 2017
- Gartner hype cycle for Personal Technologies 2017
- Gartner hype cycle for Wearable Devices 2017

SG:D EMPOWERING POSSIBILITIES

INFOCOMM MEDIA DEVELOPMENT AUTHORITY

GUIDING PRINCIPLES

1. Limit of number of slides, excluding ToCs and page breaker,
   - Not more than 20 slides

2. WGs are flexible to use different formats to communicate the messages
   - Please refer to sample based on WG 5

3. Be consistent in presenting throughout different workgroups such as
   - Technology and Capability Readiness Map Table
   - Definition of timeframe to be defined clearly as “Now-2 Years”, “3-5 Years” and “> 5 Years”

4. Recommendations Must BE mapped across the DE house

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