WORKGROUP 1 FUTURE COMMUNICATIONS & INTERNET-OF-THINGS

SERVICES AND DIGITAL ECONOMY
TECHNOLOGY
ROADMAP

19 NOVEMBER 2018

SG:D
EMPOWERING POSSIBILITIES

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OUTLINE

A	**MARKET STUDY**	1 **Global Trends**	2 **Market Potential**
B	**TECHNOLOGY STUDY**	1 **Technology Readiness Map**	2 **Application Use cases**
C	**CONCLUSIONS**	1 **SWOT Analysis**	2 **Recommendations**

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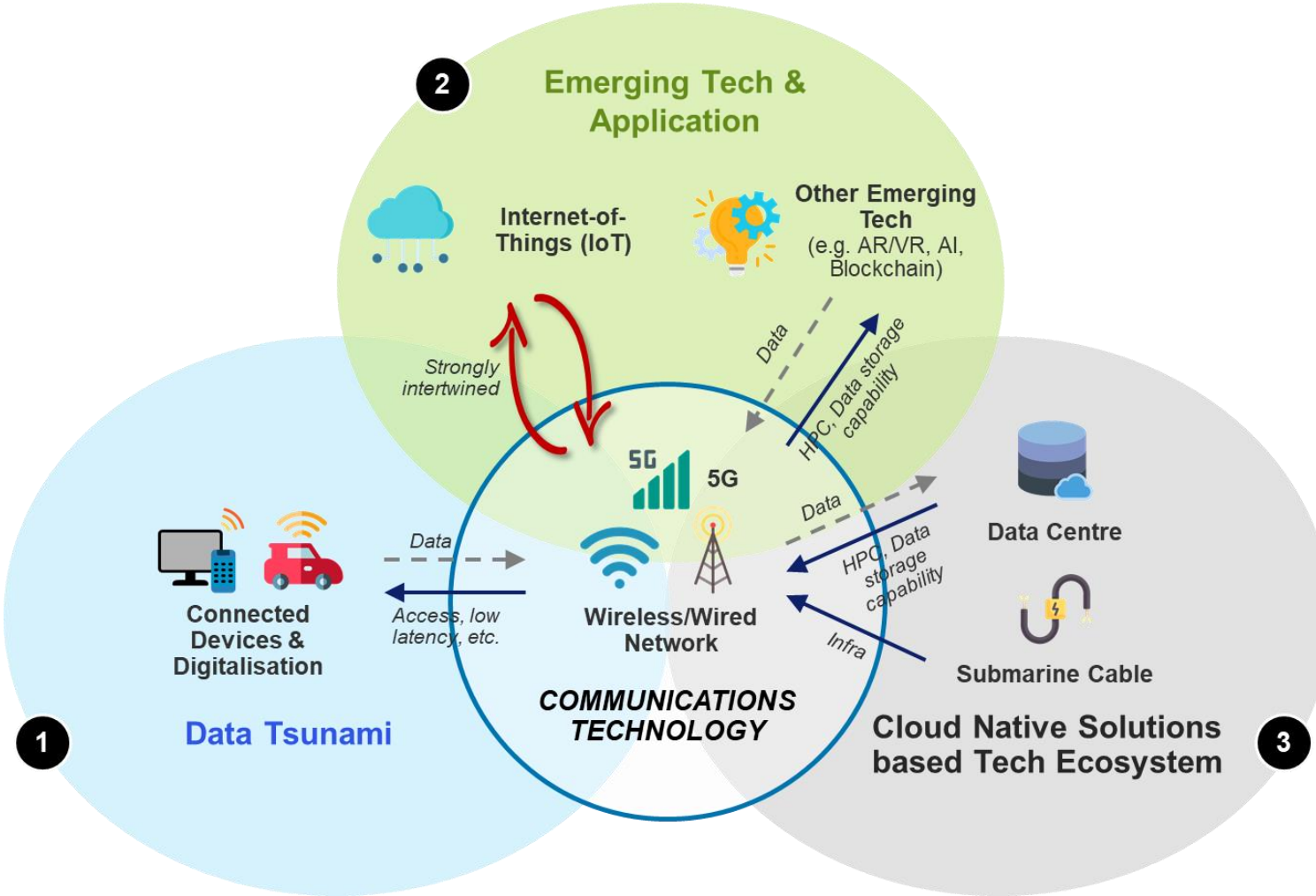
GLOBAL TRENDS

Three paradigms of Services 4.0 enabled by *Communication Technology*

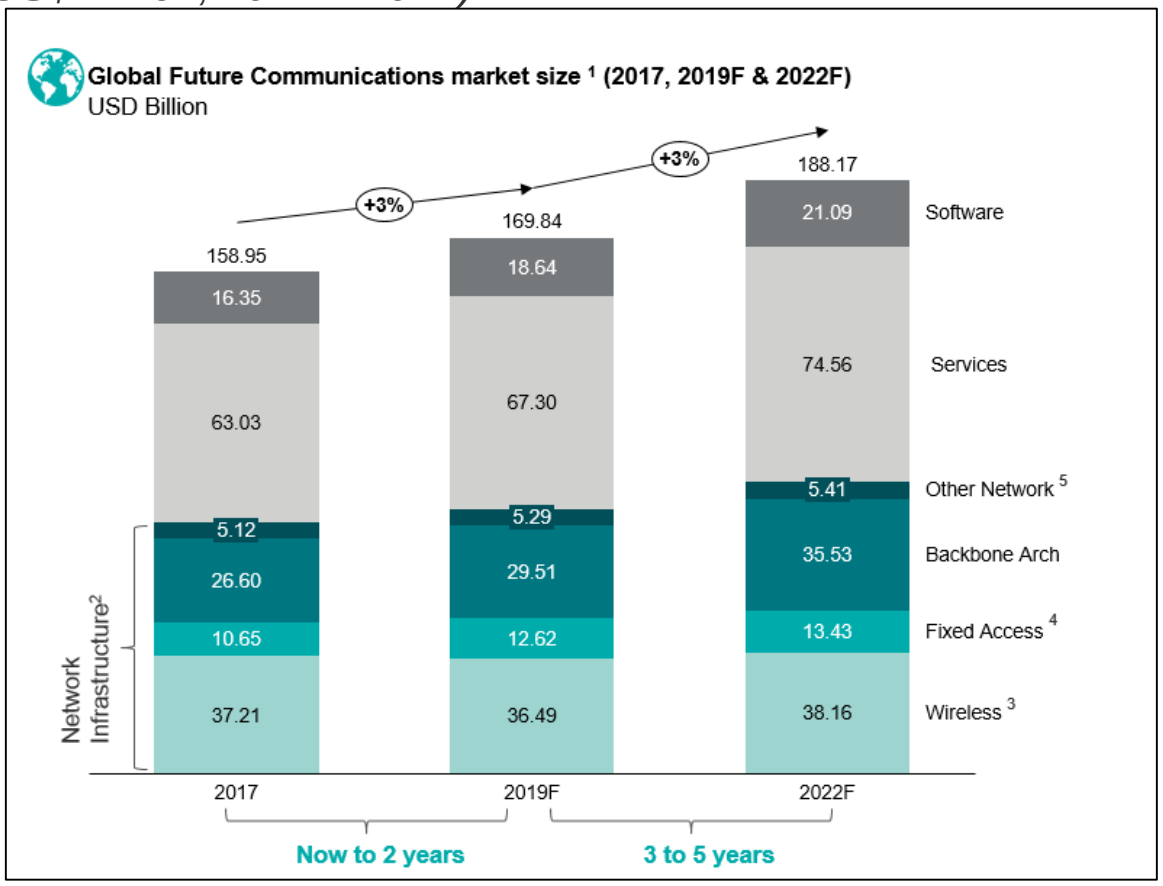


Source: Monitor Deloitte Analyses

MARKET POTENTIAL - GLOBAL

Market Potential for Future Communications

(US$ Billion, 2017 – 2022)



Key drivers

Wireless Infrastructure - investments in 5G are already underway and are expected to grow exponentially over the 2019-2022

Fixed Access - driven by investments in FTTx (deep fibre), fixed wireless for 4G and some G.fast deployments

Backbone Architecture - driven by significant investments in optical fibre backhaul and virtualized switches and routers

Note: 1. Future Communications market size is calculated as the spending on the different technology categories – Network Infra, Software and Services by CSPs 2. Network Infrastructure includes N/W software such as Virtual Network Functions (VNFs) for packet core 3 Wireless Infra does not include Satellite, 4. Fixed access does not include end user devices 5. Other Network includes voice and data switching and application infrastructure

Source: Gartner - Forecast: Communications Service Provider Operational Technology Worldwide, 2017; Monitor Deloitte Analyses

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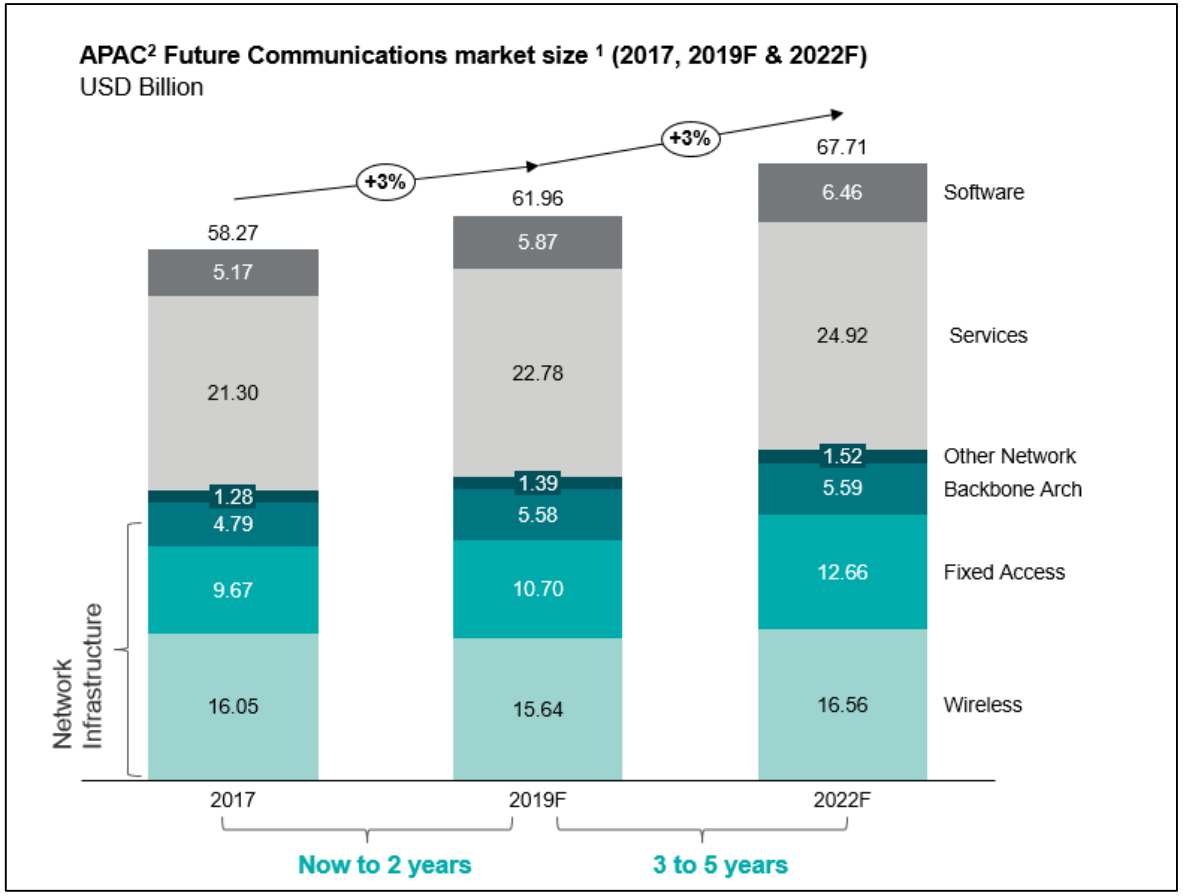
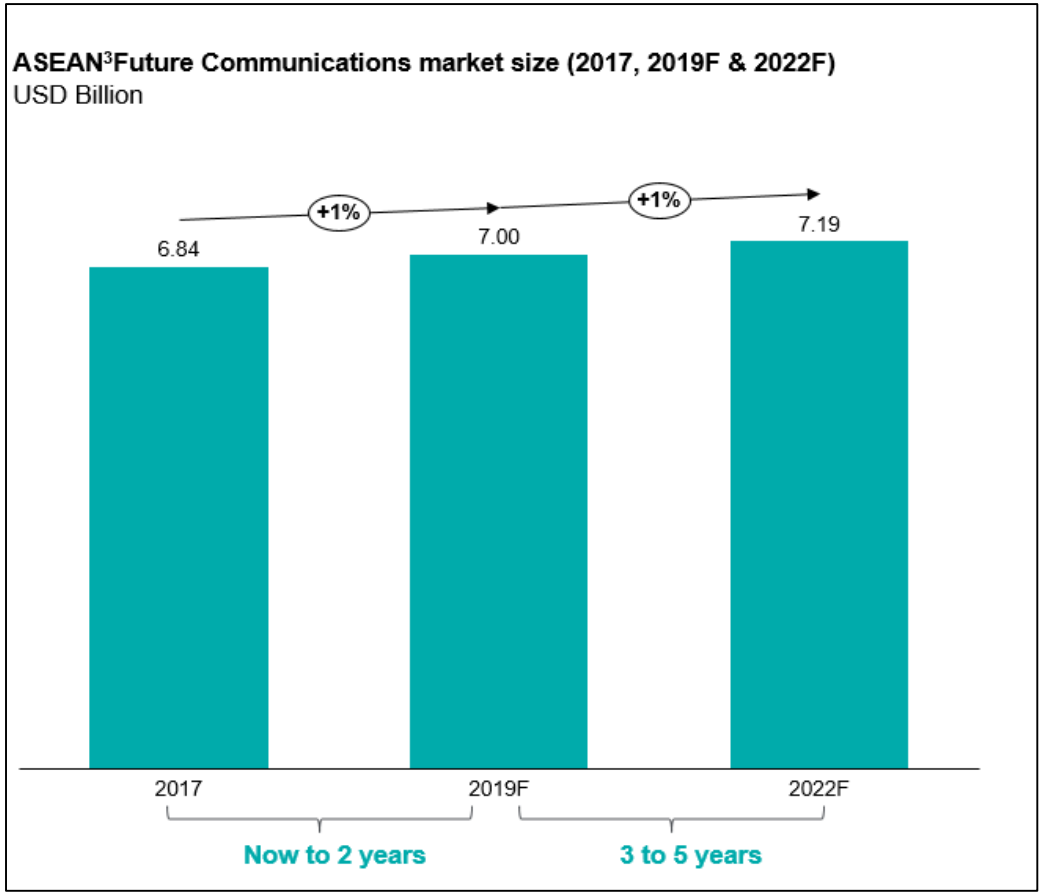
MARKET POTENTIAL – APAC & ASEAN

Market Potential for Future Communications

(US$ Billion, 2017 – 2022)





Note: 1. Future Communications market size is calculated as the spending on the different technology categories.2 APAC Includes Greater China and Japan 3. Includes all ASEAN countries except Singapore
Source: Gartner - Forecast: Communications Service Provider Operational Technology Worldwide, 2017 Gartner, ASEAN Secretariat Database, Asian Development Outlook 2018; Monitor Deloitte Analyses

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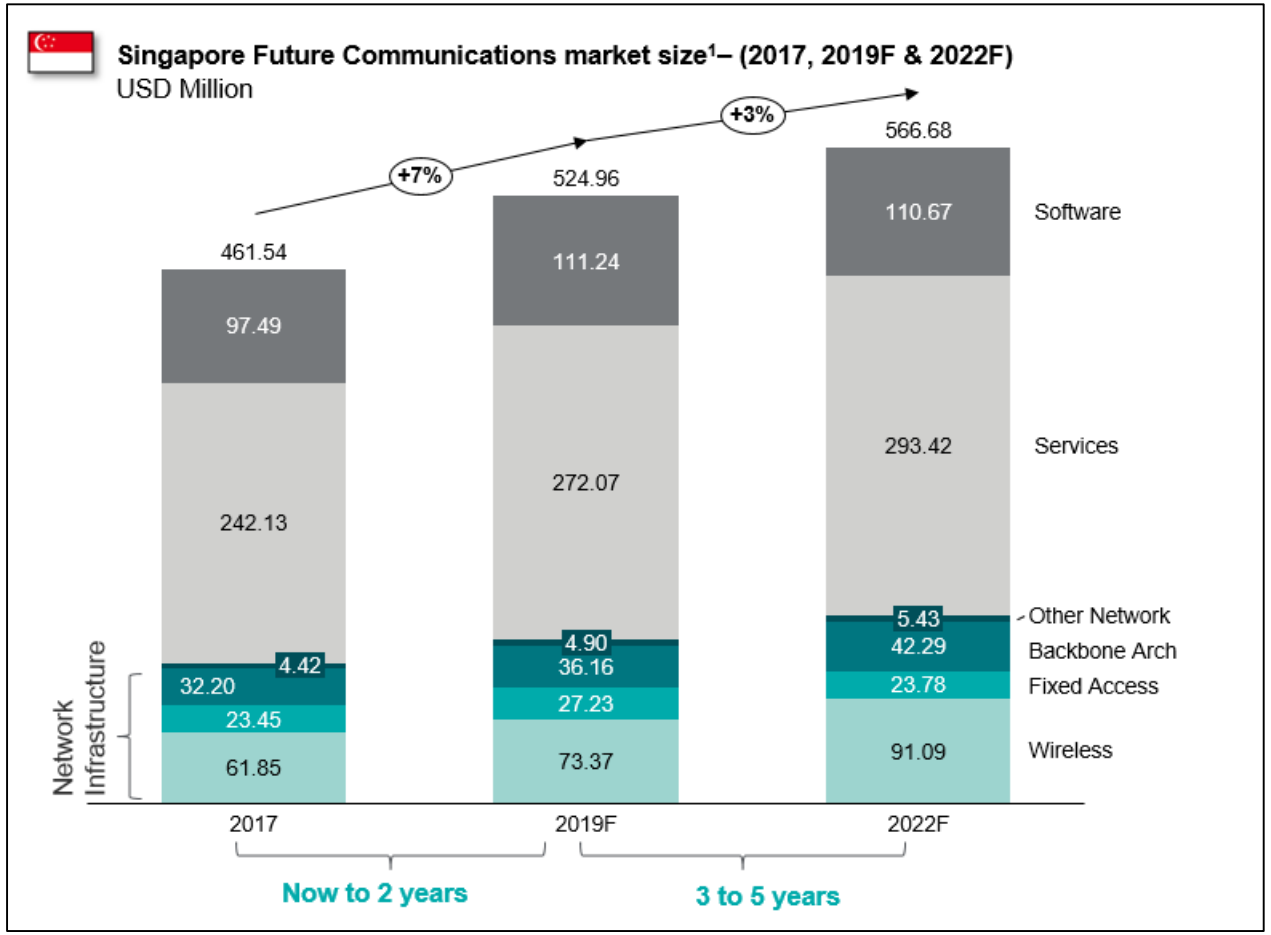
MARKET POTENTIAL - SINGAPORE

Singapore Market Potential for Future Communications

(US$ Million, 2017 – 2022)



Key drivers

Wireless Infrastructure – driven by investments in 5G and small cells, as well as continued investments in 4G by Singapore operators.

Backbone Architecture – continuous grow driven by significant investments in optical fibre backhaul and virtualized switches and routers

Services – driven by increased investments in ICT, managed services and cloud services for enterprise use, as well as network planning and optimization by operators to get maximum capacity and coverage

Note: 1. Future Communications market size is calculated as the spending on the different technology categories – Network Infra, Software and Services by CSPs

Source: Gartner - Forecast: Communications Service Provider Operational Technology Worldwide, 2017; Monitor Deloitte Analyses

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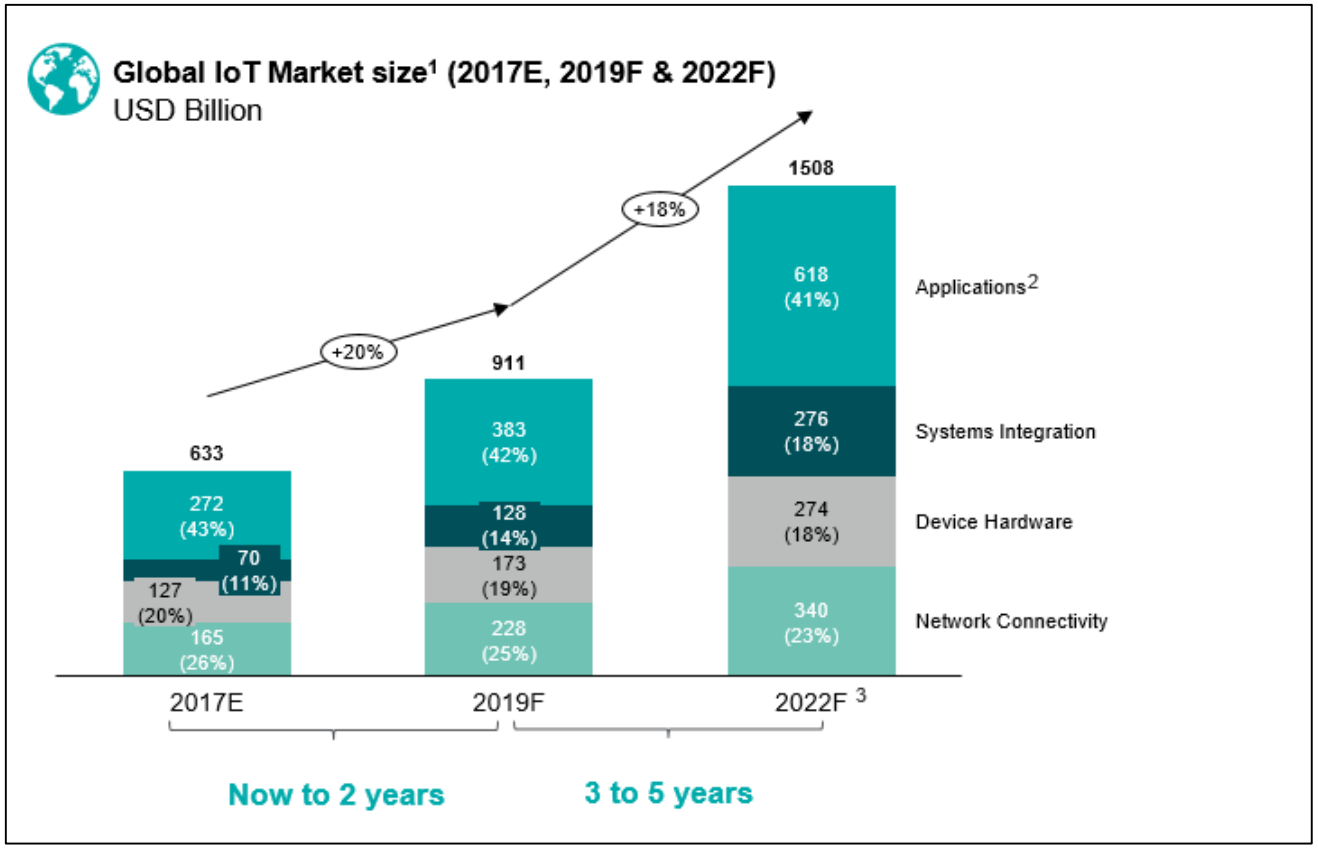
MARKET POTENTIAL - GLOBAL

Market Potential for IoT

(US$ Billion, 2017 – 2022)



Key drivers

Systems Integrations - highest growth of 5-year CAGR pf 32% driven by proliferation of platforms

Devices & Hardware – driven by expected exponential growth of the number of endpoints or devices for IoT due to diminishing costs of sensors and devices

Network Connectivity – driven by telecom operators and other network providers investing in 5G, NB-IoT and other technologies in order to meet the specific needs of IoT networks.

Applications – driven by the growth in advanced data analytics tools and IoT platforms increasingly offering more applications

Note: 1. IoT market size refers to spending defined as the total spending on each element in the IoT network – Network Connectivity, Device Hardware, Systems Integration & Applications 2. Applications include Data Analytics, 3. 2021-23 Global values forecasted using CAGR from 2017-2020,
Source: HSBC Global Research, Monitor Deloitte Analyses

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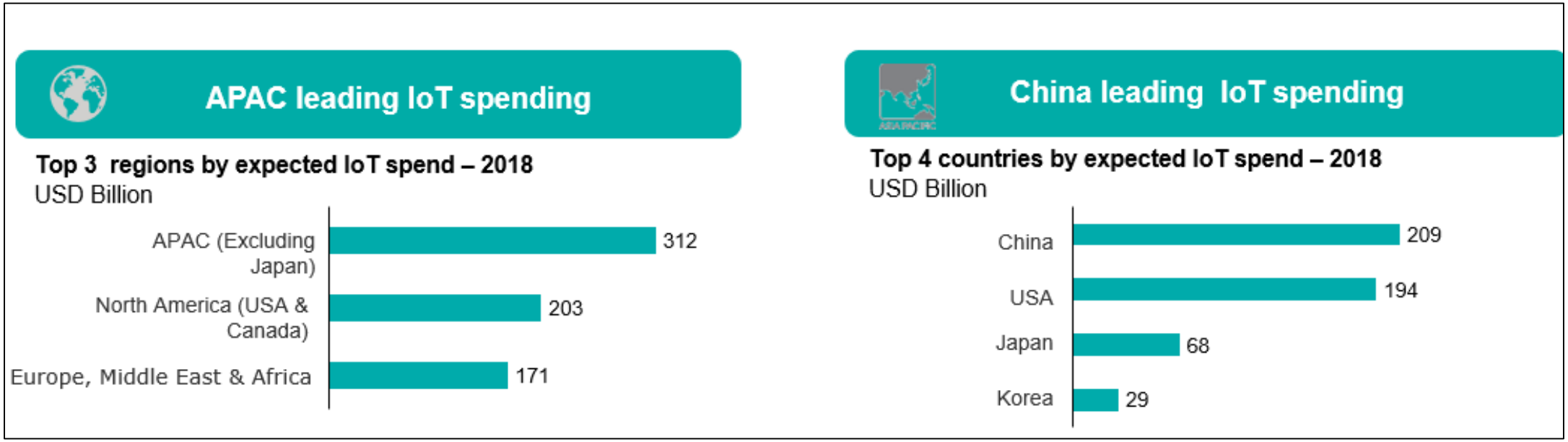
MARKET POTENTIAL – APAC

APAC Market Potential for IoT[1]

(US$ Billion, 2017 – 2022)



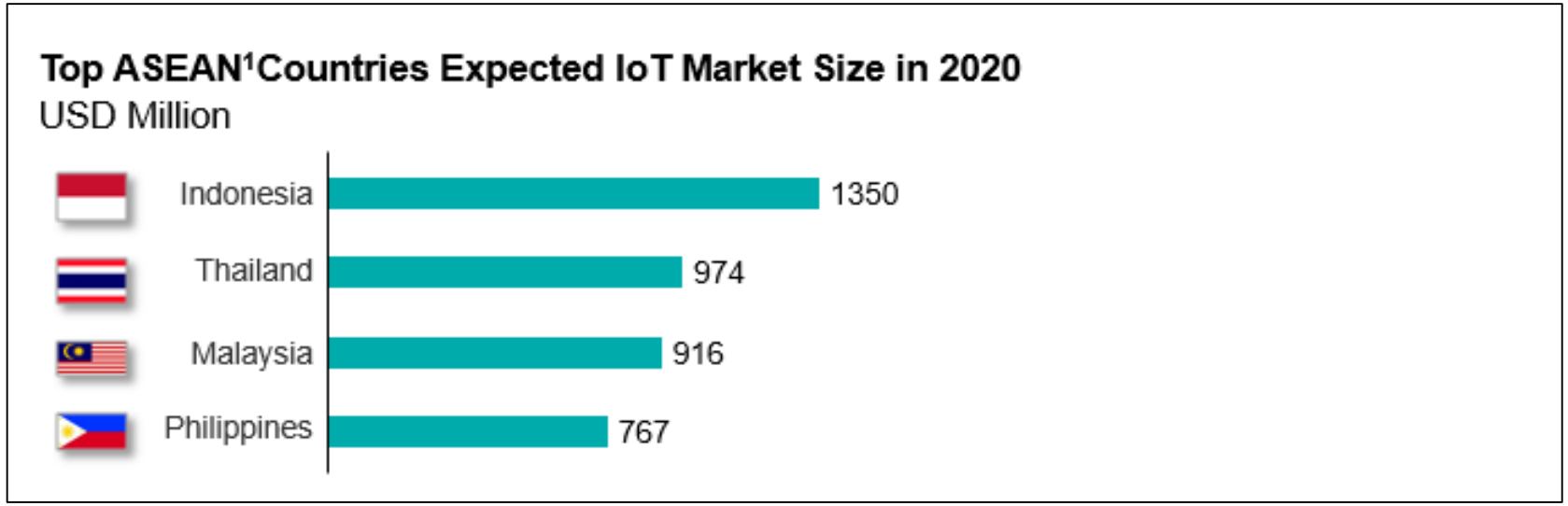
Note: 1. IoT market size defined as total spending on the each element in the IoT network – Network Connectivity, Device Hardware, Systems Integration and Applications.
Source: IDC Worldwide IoT spending 2018; Monitor Deloitte Analyses

MARKET POTENTIAL – ASEAN

ASEAN Market Potential for IoT

(US$ Million 2020)

The overall market size[3] for IoT for in ASEAN (all countries except Singapore) is estimated to grow to **4.6 Billion** in 2020[2]. The chart below highlights the expected IoT spending by the top 4 countries in ASEAN (excluding Singapore) in 2020.



Note: 1. This chart includes only the top 4 ASEAN includes Indonesia, Thailand, Malaysia & Philippines. Does not include Singapore 2. Expected to grow from a small base of 280 Million in 2014. 3. IoT market size defined as total spending on the each element in the IoT network – Network Connectivity, Device Hardware, Systems Integration and Applications.
Source: Frost & Sullivan, ASEAN Secretariat Database, Asian Development Outlook 2018; Monitor Deloitte Analyses

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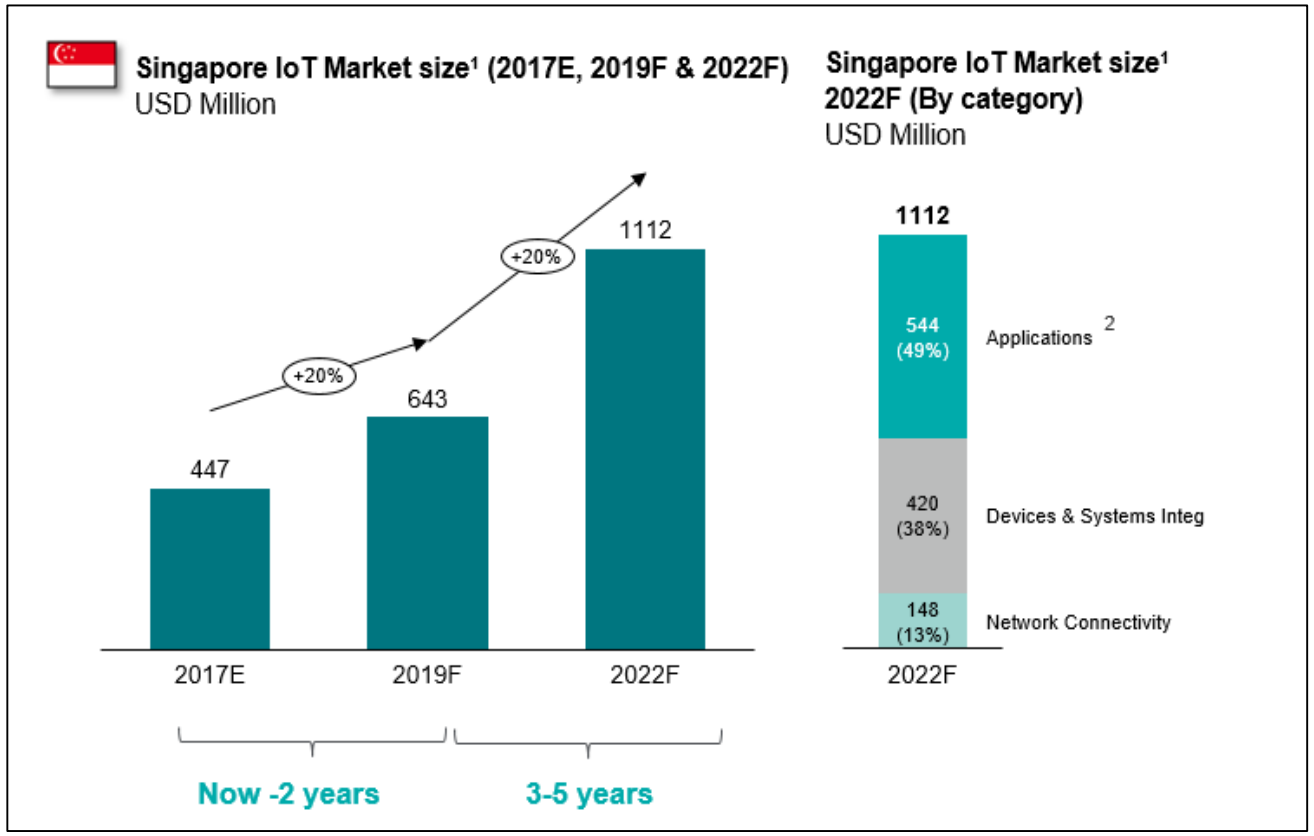
MARKET POTENTIAL - SINGAPORE

Singapore Market Potential for IoT

(US$ Million, 2017 – 2022)



Key drivers

Industry 4.0 – significant investments in the manufacturing sector to drive technology adoption. Strong focus on integration of sensors with machines and products to improve customer service, optimize asset utilization and conduct predictive maintenance

The Smart Nation - the Government has also been a key driver in driving adoption of IoT as the Government has been increasingly looking to launch initiatives that incorporate IoT as part of its strategy to digitize and enhance its public services

Infrastructure - Investments in low power networks to support IoT solutions such as the launch of the NB-IoT and Sigfox networks in Singapore. Mobile operators are also making investments in 5G solutions for IoT applications.

Note: 1.IoT market size defined as total spending on the each element in the IoT network – Network Connectivity, Device Hardware, Systems Integration and Applications. 2. Applications include Data Analytics
Source: IDC, Machina, Nokia, Research & Markets, Analysys Mason Research, Monitor Deloitte Analyses

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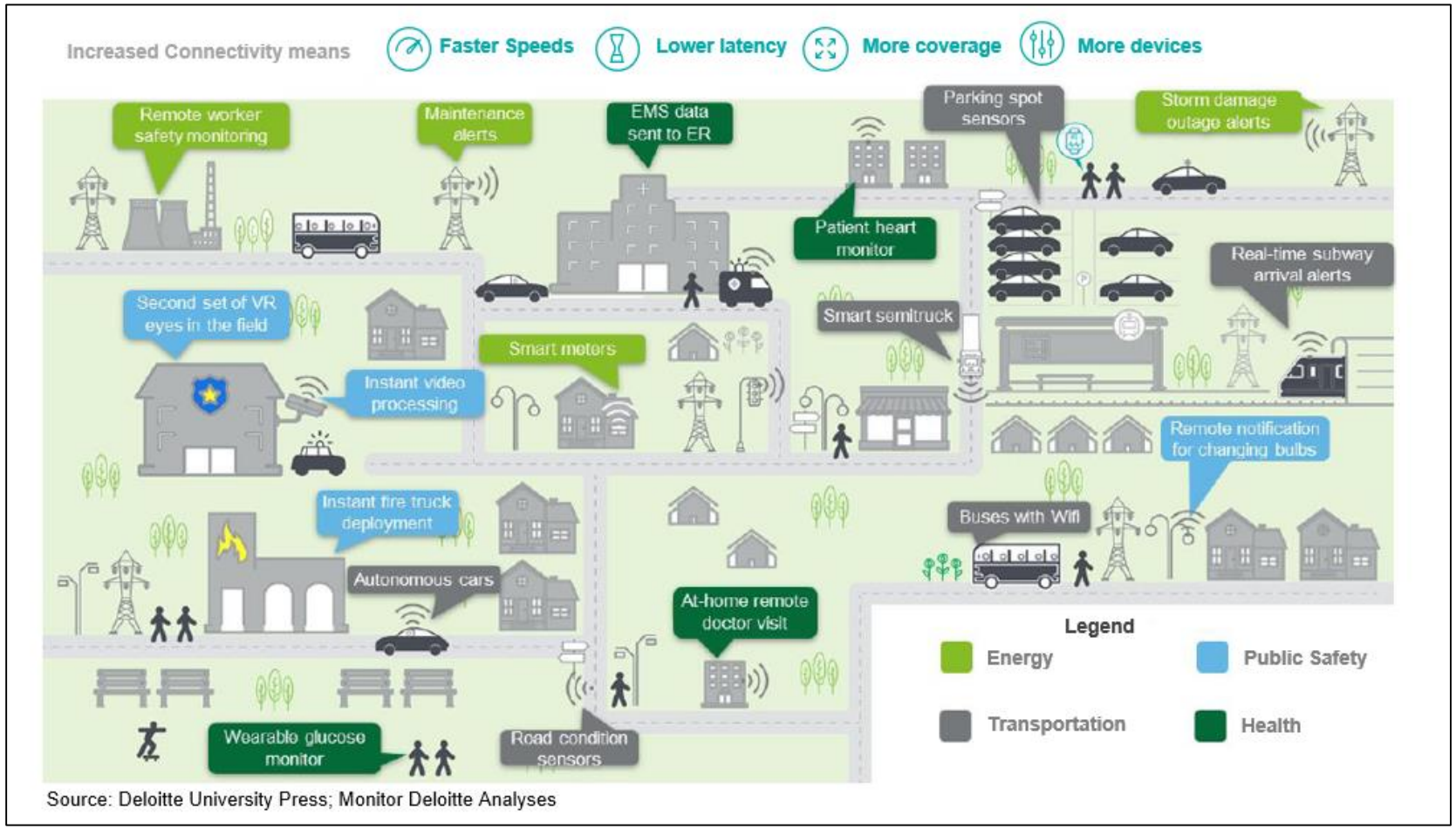
FUTURE COMMUNICATIONS & INTERNET-OF-THINGS ARE KEY FOUNDATIONAL TECHNOLOGIES FOR SERVICES 4.0



5G & the Eco-system of Connectivity

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TECHNOLOGY CAPABILITIES

KEY IDENTIFIED CAPABILITIES TO FUEL GROWTH

INTERNET-OF-THINGS

PLATFORMIZATION
Availability of pre-integrated technologies and standardised features/solutions enabling interoperability, scalability, modularity and thus reducing time to market

INTELLIGENCE
Support for AI and analytics capabilities and where these are located (increasingly at the network “edge”)

SECURITY
Support for embedded security solutions for IoT (including authentication, network security, encryption, API security and security analytics amongst others)

MOBILITY
Support for mobility in instances where parts of the system are expected to change their location

COMMUNICATIONS

SPEED - WIRELESS
Measure of how fast of information delivery over wireless air interface

SPEED - OPTICAL
Measure of how fast of information delivery over optical fibres

LATENCY
Measure of how much time it takes for a packet of data to get from one designated point to another (i.e. delay in the system)

RELIABILITY
Measure of the ability of the network to be able to transfer information as per specification with limited loss

POWER EFFICIENCY
Measure of how much energy the network consumes in order to be able to transfer information

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TECHNOLOGY ADOPTION READINESS MAP – FUTURE COMMUNICATIONS

NOW - 2 YEARS	3 - 5 YEARS	> 5 YEARS
SPEED - WIRELESS		
MOBILITY • LTE Advanced/ Advanced Pro • LTE Enhanced License Assisted Access (eLAA) • LTE-WLAN Aggregation (LWA) • LTE WLAN Radio Level Integration with IPsec Tunnel (LWIP) • 5G eMBB (NSA) **NON-MOBILITY** • Fixed Wireless Access • 802.11ac Wave 1/ 2 (Wi-Fi 5) • Bluetooth 4.2/5 Basic Rate/ Enhanced Data Rate (BR/EDR) • 802.11ax (Wi-Fi 6), 802.11 ad	**MOBILITY** • 5G eMBB (SA) **NON-MOBILITY** • 802.11 ay	**MOBILITY** • 5G eMBB enhancements **NON-MOBILITY** • Li-Fi
SPEED – WIRED		
FTTx • G-PON • XG-PON (10G-PON) • XGS-PON • NG-PON2 (4 wavelengths) **TRANSMISSION** • 400G/ 800G WDM • 10/40/100 Gigabit Ethernet	**FTTx** • NG-PON2 (8 wavelengths) • 25G PON • DWDM **TRANSMISSION** • Multi-Terabit WDM	**FTTx** • 50G PON • NG-PON2+ (TWDM-PON, OFDM-PON) • XG(S)-PON+ **TRANSMISSION** • Optical OFDM (OFDM for optical) • 100G PON (100Gbps downstream) • WDM PON (Dedicated wavelength per user) • 200/400 Gb/s electrical interfaces
LATENCY		
• LTE Mission Critical (MC) services • Dedicated Short Range Communications (DSRC)	• LTE-V2X/C-V2X • 5G uRLLC	• 5G uRLLC enhancements
POWER EFFICIENCY		
WIDE AREA • LTE-M/ eMTC (Cat M1) • NB-IoT (Cat NB1) • LoRaWAN • Sigfox **SHORT RANGE** • Bluetooth 4.2/ 5 Low Energy (LE) • Z-Wave • Zigbee • Near field communication (NFC) • Low-power Wi-Fi	**WIDE AREA** • LTE-M/eMTC (Cat M2) • NB-IoT (Cat NB2)	**WIDE AREA** • 5G mMTC
LOW PACKET LOSS (WIRELESS)		
	• 5G uRLLC	• 5G uRLLC enhancements

TECHNOLOGY ADOPTION READINESS MAP – INTERNET-OF-THINGS

NOW - 2 YEARS	3 - 5 YEARS	> 5 YEARS
PLATFORMIZATION		
• Message Queue Telemetry Transport (MQTT) • Constrained Application Protocol (CoAP) • Advanced Message Queuing Protocol • Data Distribution Service (DDS) • eSIM • Device Management - (OMA-DM, OMA-CP)	• IPv6, 6LoWPAN • Device Management Open Mobile Alliance Lightweight Machine-to-Machine (OMA LWM2M)	• Enterprise taxonomy and ontology management
INTELLIGENCE		
• Speech recognition • Machine Learning (including Ensemble learning methods) • Natural language understanding • Predictive analytics • Video Surveillance	• Deep learning • Edge computing technologies (multi-access computing, fog computing, cloudlet, micro-data centre) • Natural language generation • Predictive analytics	• Cognitive computing • Deep reinforcement learning • Conversational user interfaces • Natural language processing • Prescriptive analytics
SECURITY		
• Application Security as a Service • Identity-proofing services • Disaster Recovery as a Service • IaaS container encryption • Tokenization • End point protection – Identity & Access Management • FIDO Authentication protocol • IoT network security • IoT security for data encryption • IoT API security • IoT PKI & Digital certificates	• Secure processing unit • Trusted Environment • Software-defined security • Secure web gateways • Identity management as a service • Security analytics • Secure by design • Secure Web Gateway • Cloud-access security brokers • Cloud service brokerage	• Hardware Security • Blockchain • Digital security • Key management as a service
MOBILITY		
• LTE-M/eMTC (Cat M1) • NB-IoT (Cat NB1) • LoRaWAN • Sigfox	• LTE-M/eMTC (Cat M2) • NB-IoT (Cat NB2)	• 5G mMTC

USE CASES – FUTURE COMMUNICATIONS

High-Speed Wired Technologies

- Data centre interconnects (DCI)
- Wired networks to residential, commercial and other spaces as backhaul
  - edge computing deployments
  - wireless gateways and access points
  - ultra-high-definition end-points

High-Speed Wireless Technologies (Non-mobility)

- Ultra-high definition streaming applications
- AR, VR, MR streaming applications
- Instant replays during live matches
- Fixed wireless access networks
- High quality video conferencing
- Instant cloud access
- Large file transfers
- Cloud computing

High-Speed Wireless Technologies (Mobility)

- Ultra-high definition streaming applications
- AR, VR, MR streaming applications
- High quality live video sharing
- Instant cloud access
- Large file transfers
- Cloud computing

Low Latency and High Reliability Wireless Technologies

- Industrial automation
- Remote and tele operations e.g. remote surgery, tele-driving
- Tactile internet
- Collision avoidance of automated guided/autonomous vehicle to vehicle, vehicle to infrastructure and vehicle to human
- Unmanned Aerial Vehicles/ Drones
- AR/VR/MR cloud applications
- Cloud and interactive gaming
- Public safety e.g. emergency services

Power Efficient Wireless Technologies

- Temperature and humidity sensors
- Door/windows sensors
- Motion sensors
- Light sensors
- Smoke detection sensors
- Alarms
- Smart locks
- Wearables
- Asset and fleet trackers
- Smart electricity, water and gas meters
- Waste management
- Other battery-powered smart monitoring devices e.g. environmental monitoring sensors, parking detection, outdoor parking detection

USE CASES – INTERNET-OF-THINGS

MANUFACTURING

- Digital twins
- Smart and digital factories
- Fault detection and resolutions
- Predictive and preventive maintenance
- Traceability and trackability
- Asset management
- RFID tagging

TRANSPORTATION & LOGISTICS

- Capacity sensing
- Route planning and optimization
- Real-time traceability
- Threat detection and prevention
- Environment monitoring and management
- Energy management
- Fault detection and resolutions
- Predictive and preventive maintenance
- Autonomous truck platooning

CONNECTED VEHICLES

- Remote operations
- Autonomous vehicles
- Real-time traceability
- Threat detection and prevention
- Fault detection and resolutions
- Predictive and preventive maintenance
- Autonomous truck platooning

SMART BUILDINGS

- Threat detection and prevention
- Fault detection and resolutions
- Predictive and preventive maintenance
- Security and emergency response
- Comfort optimization
- Utilisation and building performance tracking

INFOCOMM MEDIA

- Authentication of Individualized Content Access

UTILITIES

- Remote monitoring and operations
- Massive smart metering
- Integration of distributed energy resources

CONSUMER IoT – HOME SECURITY/HOME AUTOMATION

- Smart homes
- Personalisation and customization of individual profiles
- Real-time monitoring
- Safety and security
- Automatic management and predictive maintenance

RETAIL

- Location and proximity advertising
- Contextualised personalized advertising
- Virtual smart mirrors
- Inventory management and replenishment
- Customer recognition and location positioning
- Automated checkout

HEALTH

- Remote monitoring of patients
- Telemedicine
- Personalised diagnostics and treatment

INSURANCE

- Usage-based insurance for automobiles
- Tailored and personalised insurance for consumers based on their environment, lifestyle and medical records
- Manufacturing-specialty insurance for extended warranty

CONSTRUCTION

- Worksite safety
- Preventive and predictive maintenance
- Construction optimisation
- Business information modelling

Source: IMDA

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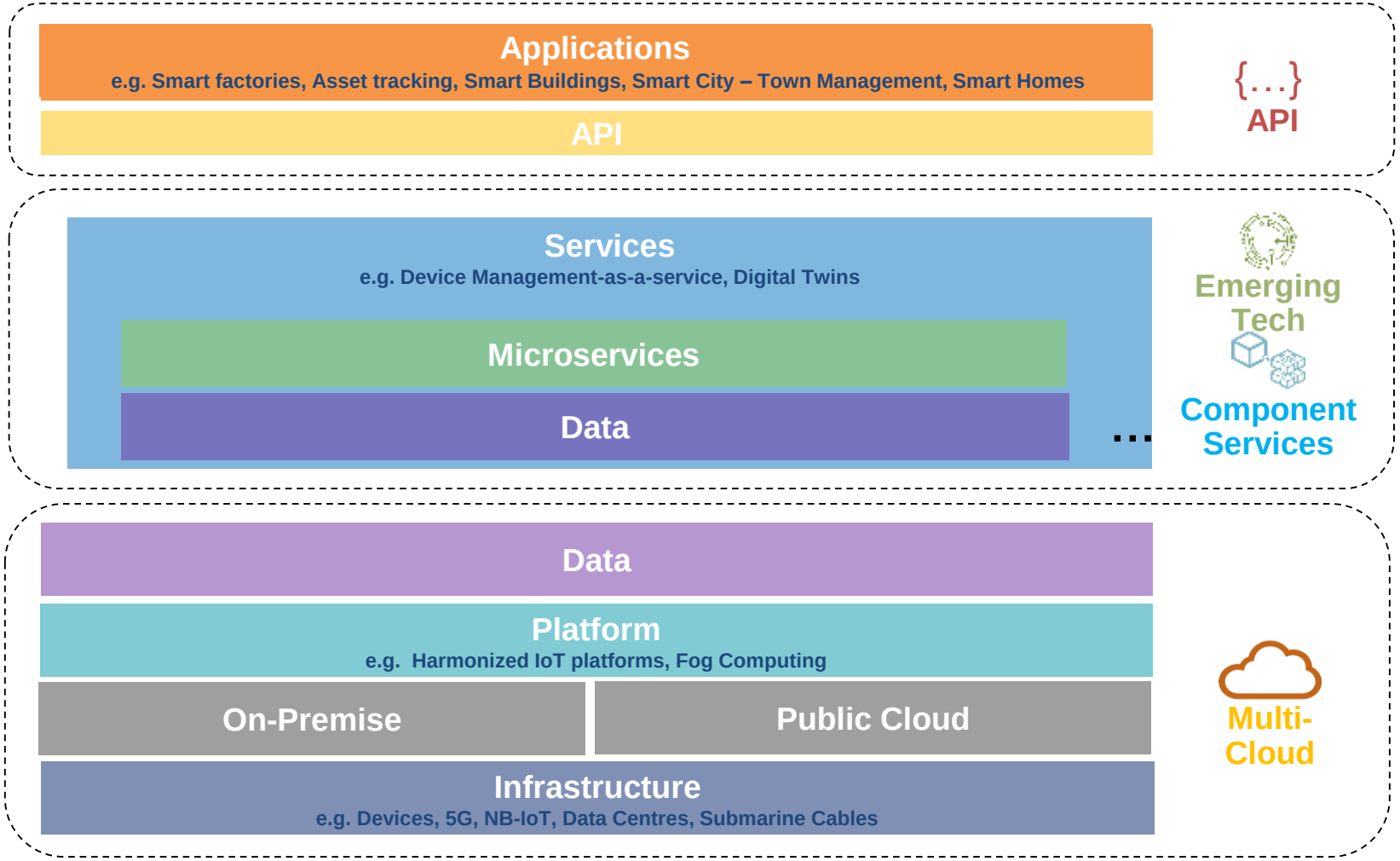
ALIGNMENT TO CLOUD NATIVE ARCHITECTURE



1 Future communications (All)

1.1	Speed (wired) – PON, WDM etc.
1.2	Speed (wireless) – LTE, 5G eMBB, Wi-Fi 5/6 etc.
1.3	Latency (wireless) – LTE-V2X/C-V2X, 5G uRLLC
1.4	Reliability (wireless) – 5G uRLLC
1.5	Power Efficiency (wireless) – NB-IoT, 5G mMTC
etc.	

Future communications as the fundamental enabler to connect massive, high bandwidth, and low latency devices.

2 Internet-of-Things - Platformisation

2.1	Messaging – DDS, MQTT, CoAP etc.
2.2	Device management – LWM2M etc.
2.3	e-SIM

Platformisation of IoT technologies will allow interoperability, scalability and modularity.

3 Internet-of-Things - Intelligence

3.1	Machine & deep learning, cognitive computing
3.2	Language – Recognition, generation, processing
3.3	Edge computing – Multi-access, fog, cloudlet etc.

Increasing intelligence for broader, faster and smarter services

4 Internet-of-Things – Mobility

4.1	LTE-M/eMTC (Cat M2)
4.2	NB-IoT (Cat NB2)

Advances in mobility for IoT technologies will allow the system to react to changes in location

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SWOT ANALYSIS

STRENGTHS

1. **Pervasive** and **high-speed** wireless and wired networks
2. Strong **Government support** and progressive initiatives
3. Hot **regional testbed** and **innovation hub** anchor
4. Strong **data centre presence** and **international connectivity**

WEAKNESSES

1. **Adoption inertia** and low IoT take off
2. **Fragmentation** of IoT ecosystem
3. **Small** market size
4. Limited **talent pool**
5. Loss of opportunities in **diversified use cases**

OPPORTUNITIES

1. High **tech readiness**
2. High global **growth** in IoT
3. **Smart city** use cases

THREATS

1. **Aggressive** overseas markets
2. Limited availability of **new spectrum**
3. Vulnerable to **cyber attacks**

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ALIGNMENT OF FUTURE READY SYSTEMS TO DE FRAMEWORK

DIGITALISING INDUSTRIES

- Government agencies and organisations to shed legacy processes
- Leverage IoT and other innovation hubs to raise awareness, match technologies to problem statements and test business models
- Participate in 5G trials to be better poised to use it to address challenges in todays' wireless networks such as higher latency and a lack of priority for critical communications

TALENT

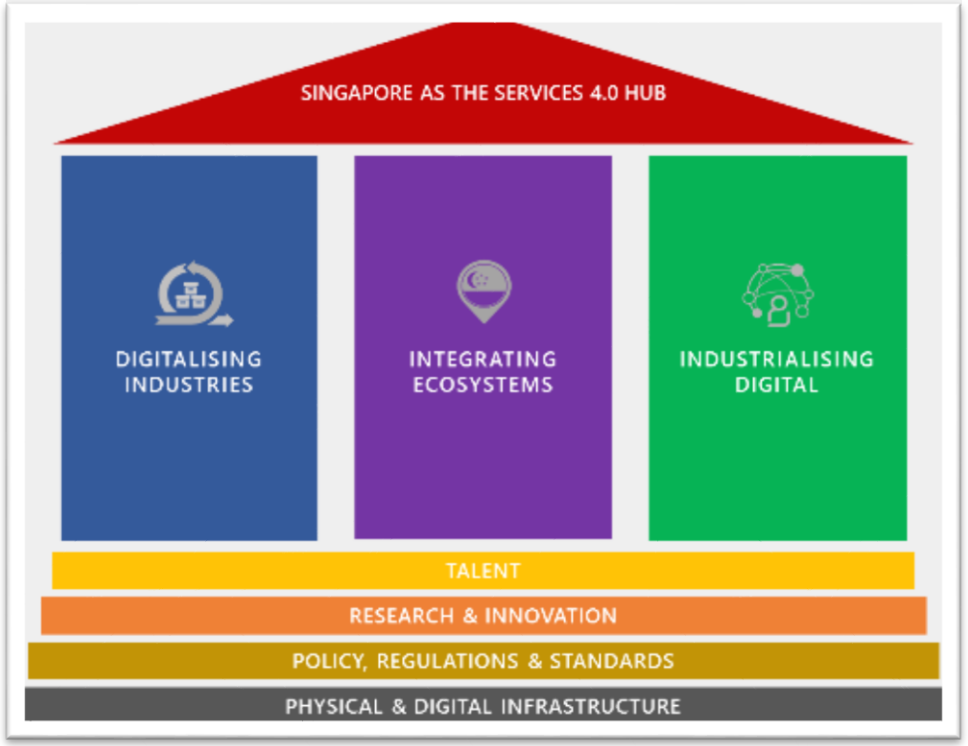
- Workforce retraining on communication technologies, IoT and other related skills for the mid and senior generation

POLICY, REGULATION & STDS

- Set Security standards for IoT and drive certification of IoT devices
- Regulatory policies for wireless technologies should be revisited and amended as necessary

INTEGRATING ECOSYSTEMS

- Adopt technologies that are standards-based for interoperability and faster implementation



INDUSTRIALISING DIGITAL

- Government to continue bolstering support and lead demand in IoT use cases
- Adopt technologies that are standards-based and enable interoperability such as eSIM
- Companies to use cloud platforms to develop component services and leverage other cloud-based services, solutions and emerging tech to augment or complement their offerings

RESEARCH & INNOVATION

- Invest in developing technologies and solutions such as green technologies

PHYSICAL & DIGITAL INFRA

- Build upon and enhance Singapore's strong infrastructure in existing wired and wireless networks, while investing in the next generation of networks

Source: IMDA

RECOMMENDATION

Recommendations	Descriptions
CONTINUED GOVERNMENT DRIVE FOR A BRIGHTER DIGITAL FUTURE	• Ensure the Relevant Policies and Regulations for IoT and Future Communications are in place
	• On a national level, there needs to be collaboration among Government agencies in the IoT discussion in order to formulate corresponding national policy and strategy, conceptualise key projects and identify key challenges to be addressed. In addition, given that Cyber Security is a key component of IoT and data privacy is a national concern, the Government should consider drawing up a national security policy for IoT including setting security standards and drive certification of IoT devices.
	• Lead Demand in IoT in Smart Cities and other Public Sectors Projects
	• Singapore can look to integrate IoT further in the Smart Nation initiative to be able to derive further benefit from IoT and set a framework in place for private sectors to follow suit. The Government should also focus on ensuring that IoT is integrated into new infrastructure projects such as Terminal 5 airport and the construction of the mega port in Tuas. Thus, this will lead to encouraging local enterprises to build innovative solutions (e.g. facilities management) which can then be replicable to other airports and seaports.
	• Lead the Efforts to ensuring the Requisite Infrastructure is in Place
	• The Government will need to work with the private sector to build upon and enhance Singapore's strong infrastructure in existing wired and wireless networks. One key enabler in this category will be ensuring fibre connectivity and backbone by making enhancements and expansion of the nationwide fibre network. The Government should work with the telecommunication providers and other key stakeholders to ensure that technologies such as DWDM are used to increase capacity over existing fibre networks and enable scalability. There will be a pressing need for more sophisticated data centres. A DC-to-DC backbone fabric will be required to provide a low-latency and high-bandwidth communication between data centres to meet these requirements.
	• Lead Efforts in Investing in Developing Technologies and Solutions
	• The Government should consider setting up programmes that provide funding for R&D in green technologies for both academia and industries to work together to develop solutions. The benefits can be leveraged beyond the domestic market as Singapore as can consider exporting these technologies to other regional and global markets.

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RECOMMENDATION

Recommendations	Descriptions
STANDARDS, PLATFORMS AND CLOUD-BASED SERVICES	• Encourage Industry to Adopt Standards-based Technologies including eSIM
	• It is imperative to adopt technologies that are standards-based. There are several standards and bodies including IEEE, 3GPP, Wi-Fi Alliance, Bluetooth Special Interest Group (SIG), Open Mobile Alliance (OMA). Standards enable interoperability, prevents vendor lock-in and encourage rapid adoption of technologies. • One such technology and standard that could enable this interoperability for IoT is eSIM. It is envisaged that M2M IoT devices are likely to benefit from eSIM, as these devices could be located across very diverse, unsupervised and inaccessible locations rendering the replacement of physical SIM cards impractical and expensive. , Thus, the Government should work with the telecom operators and IoT device manufacturers to accelerate the widespread adoption of eSIM.
	• Establish a Common Standards-based framework for Harmonized Platforms
	• Adoption of IoT can be accelerated with a harmonised platform where a common standards-based framework and architecture can be established to harmonise and connect the different hardware and software solutions. Well defined technical specifications can be developed with the technology providers for standardised protocols, APIs and interfaces for the collection, management and access to services and data. Component services can be exposed and discovered within the harmonised platform to enable different IoT applications.
	• Establish a Services 4.0 Ecosystem for Companies to Embrace a Cloud Native Architecture to Build and Leverage Component Services
	• As the Services 4.0 vision is built on a Cloud Native Architecture, the Government should organise programmes that encourage and facilitate enterprises to participate in this ecosystem. Thus, enterprises will need to be supported to migrate their infrastructure to a Cloud Native Architecture. Technology solution providers will need to be encouraged to develop cloud based component services and leverage other cloud-based services, solutions and emerging technologies to augment or complement their development. Telecommunication companies should also be encouraged to lead this transformation by creating new services via platforms, cloud and component services, especially for enterprise customers.

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RECOMMENDATION

Recommendations	Descriptions
SHIFTING GEARS FOR GREATER INDUSTRY ADOPTION	
• Shed Legacy Processes, Increase Digitalisation and Enable Access to Data legacy processes	• The Government will need to be role model by changing legacy processes, adopting greater digitalisation and allowing access to certain relevant data. Government agencies and organisations will need to shed legacy processes and systems and adopt a more agile way of working. The Government also has plans to adopt a Cloud Native Architecture and to build component services on this Cloud Native Architecture. Government can consider enabling access to anonymised data obtained through the Smart Sensor Network and other Smart City devices for companies in the private sectors to be able to use to build innovative solutions.
• Enable Industry to Leverage Innovation Hubs	• The Government should enable industry to leverage innovation hubs focused on IoT and relevant communication technologies by bringing together key stakeholders to collaborate. As part of these innovation hubs, industry, academia and government will need to collaborate to enhance R&D in IoT and Future Communications by identifying and investing in developing technologies and solutions and enabling rapid and innovative commercialisation and implementation of these technologies. SMEs in Singapore can leverage Government initiatives such as the IMDA SMEs Go Digital Programme.
• Enable Next Generation Wireless 5G Networks	• The performance and capabilities of 5G needs to be better understood, and should be investigated and validated through the conduct of early 5G field trials. • The Government should work with telecommunication providers to set up 5G field test beds where all relevant stakeholders including companies in other sectors can participate. • The Government should also work with the telecommunication providers and encourage infrastructure sharing. This is likely to be more prevalent in 5G to mitigate the business risks and high investment costs. • The Government can also work with the industry to ease early adoption such as reviewing the QoS requirements for coverage.

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RECOMMENDATION

Recommendations		Descriptions
CONTINUOUS LEARNING FOR DIGITAL TRANSFORMATION	• Re-skill Workforce in Relevant Technology Areas	• Given Singapore's aging workforce, programmes that focus on workforce retraining for the mid and senior generation are a key imperative. There will be a need for a large number of technical skilled workers with domain knowledge in specific areas of communication technologies such as optical fibre networks, 5G, low power networks and Wi-Fi technologies. The Government should work with universities and private sectors to be able to establish programs, courses and projects that the workforce can register. Experts from other countries can also be leveraged by enabling them to come on special immigration visas to set up special programs in Future Communications and IoT.
	• Developing Cross Functional Talent	• Cross functional understanding of how these technologies can be capitalised on to generate value is also critical. Broader technical knowledge and skills in software and hardware engineering, network design and optimisation, data analytics and management will be required. Understanding the technical implications on communication technologies of launching Services 4.0 and the Cloud Native Architecture will be important. Thus, cross-domain knowledge will be key. The Government should establish competency centres for Future Communications and IoT along with key private sectors players that will provide access to tools and technologies for workers across different sectors.
	• Develop Talent Programmes for Related Technologies focused on Schools and Colleges	• It is also critical to establish programmes that encourage schools and colleges to build relevant skills in students early on to equip our future generations with relevant digital skills. Singapore should be considering incorporating relevant skills such as programming and basic understanding of software engineering, communication technologies and IoT into the mainstream school curriculum. The Government should work with universities to establish more degree programs and courses related to software engineering, communication technologies and IoT. Programs that offer scholarships, internships and job opportunities should be established to encourage students to pursue these degrees and courses related to software engineering, communication technologies and IoT.

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