

Annex A-1: Future Communications and Internet-of-Things

1 Brief Introduction

Annex A-1: The technologies classified under Future Communications and Internet-of-Things (IoT) would enable the transformation of enterprises into digital businesses and the creation of value by facilitating new business models, new products and solutions by providing access to high-speed networks and enabling ambient connectivity across devices, people and businesses. Future Communications and IoT form the foundations for the growth of Digital Economy and help realise Singapore's vision of becoming the Hub for Services 4.0.

2 Market Study

Global and Regional Trends

A wide range of wired and wireless communication technologies are covered and categorised under the Future Communications technology area. These technologies have and will continue to enable ubiquitous connectivity resulting in a 'Data Tsunami'. An increasing number of innovations are expected to be fuelled through the use of wireless networks. Further, it is envisioned that 5G networks will enable enhanced capabilities such as increased data rates and volumes, significantly reduced network latency, support for large number of devices and network agility through network slicing. Thus 5G is expected to be transformational to existing wireless applications. In addition, 5G (along with other technologies such as optical fibre, data centres and submarine cables) is expected to be a key factor in driving adoption of emerging technologies and cloud computing as these require higher bandwidth, greater capacity, security, and lower latency. The global Future Communications market size is estimated to grow to US\$188 billion in 2022, at a CAGR of 3% from 2017 to 2022. The Future Communications market in APAC is expected to witness similar growth at 3% from 2017 to 2022 and is estimated to be US\$67.7 billion in 2022.

Technologies classified under the IoT are expected to provide benefits through new ways of capturing information and creating value from data obtained from connected devices. Factors such as the proliferation of platforms, increasing augmentation of IoT networks and devices with intelligence and security capabilities and the rapid growth of lower power networks will be key growth drivers of IoT. The global IoT market size is estimated to be US\$1.5 trillion in 2022, at a CAGR of 19% from 2017 to 2022. The IoT market in APAC was the highest in 2018 at US\$312 billion and is expected to grow to US\$516 billion in 2022, at a CAGR of 13% from 2018 to 2022. The IoT market has been driven by industrial sectors such as manufacturing and logistics but consumer driven applications and services such as Home Automation and Appliances, Insurance, and Healthcare are expected to grow faster and drive further IoT adoption.

Singapore Trends

The Future Communications market size in Singapore is estimated to be US\$567 million in 2022, at a 4% CAGR from 2017 to 2022. From 2017 to 2019, the Future Communications market in Singapore grew at 7%, which was faster than the global market which grew at 3%. This was due to the increased demand for

services enabled by 4G and FTTx and the associated infrastructure investments. Operators in Singapore are participating in 5G trials to explore 5G capabilities in specific applications and use cases. From 2019 onwards, proliferation of IoT, increased adoption of emerging technologies and increased demand for Ultra-high definition video streaming applications are expected to require the capabilities provided by 5G networks. Thus, these are expected to drive further adoption of 5G. Also, as adoption of cloud computing by enterprises grows in Singapore, demand for enabling Future Communications technologies such as optical fibre, data centres and submarine cables are also expected to grow further.

The Singapore IoT market size is estimated to be US\$1.1 billion in 2022 at a CAGR of 20% from 2017 to 2022. Some of the key factors for this growth include the Smart Nation initiatives driven by the Government and the current Industry 4.0 drive in the Manufacturing and Logistics sectors. Favourable infrastructure such as high fibre connectivity, data centres and submarine cables and investments in low power networks and 5G networks by operators are likely to drive adoption of IoT further.

3 Technology Study

Contributions of Future Communications and IoT to Cloud Native Architecture

As a part of the overall technology roadmap recommendation, Singapore needs to establish a Cloud Native Architecture to improve access to emerging technologies amongst the stakeholders and enable the Services 4.0 ecosystem envisioned. We believe that Future Communications and IoT technologies will play an important part in executing the Cloud Native Architecture as highlighted by the exhibit below. Exhibit 1 below shows in more detail how Future Communications and IoT will contribute to various aspects of Cloud Native Architecture. Future Communication technologies such as 5G, NB-IoT, data centres etc. are expected to provide the foundational infrastructure required to support this architecture. IoT on the other hand will contribute to all aspects of Cloud Native Architecture from providing infrastructure (devices) to platforms (e.g. Harmonised IoT platforms, Fog Computing), Microservices (e.g. Device-Management-as-a-service) and applications (e.g. Smart Factories).

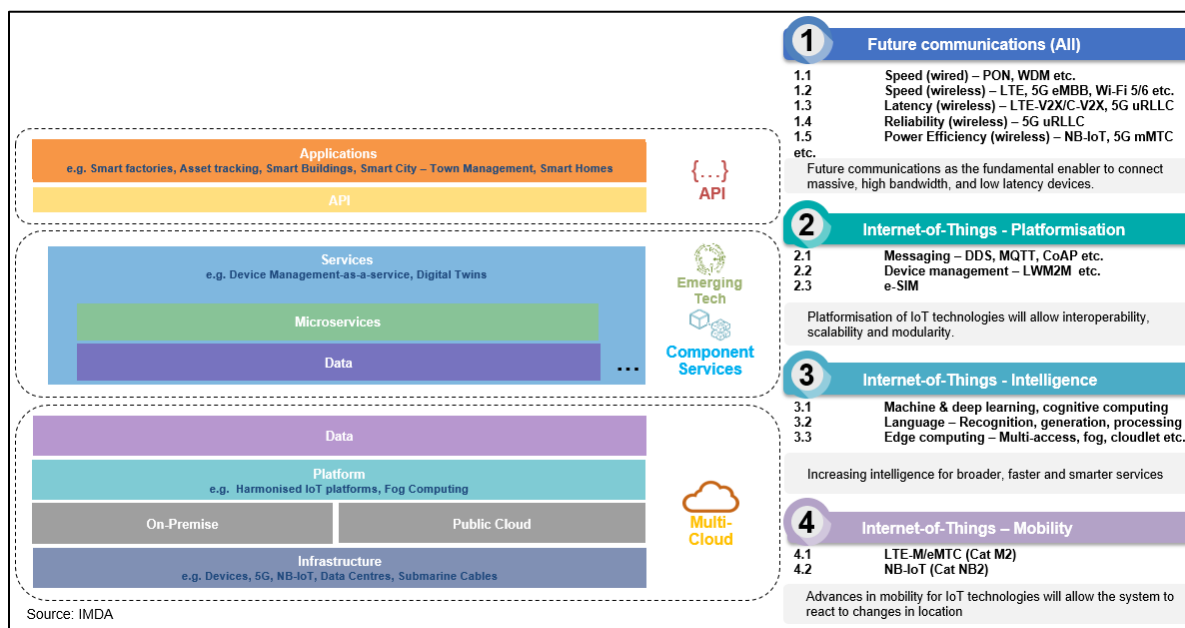


Exhibit 1: Contributions of Future Communications and IoT to Cloud Native Architecture

4 SWOT Analysis

Our study of the Singaporean landscape and the global market for Future Communications and IoT reveals specific strengths, weaknesses, opportunities and threats as discussed in the exhibit below. Building capabilities in Future Communications and IoT technologies requires a focused set of strategies, with Singapore's unique strengths and weaknesses in mind. Singapore has a strong infrastructure in place, is a strong innovation hub, is backed by a strong Government and has a very vibrant Communications industry. However, it will be crucial to continue to build on the existing capabilities to develop a favourable ecosystem for both IoT and Future of Communications to tap into the regional and global market.

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| <p style="text-align: center;">STRENGTHS</p> <ol style="list-style-type: none"> 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 | <p style="text-align: center;">WEAKNESSES</p> <ol style="list-style-type: none"> 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 |
| <p style="text-align: center;">OPPORTUNITIES</p> <ol style="list-style-type: none"> 1. High tech readiness 2. High global growth in IoT 3. Smart city use cases <p>Source: IMDA</p> | <p style="text-align: center;">THREATS</p> <ol style="list-style-type: none"> 1. Aggressive overseas markets 2. Limited availability of new spectrum 3. Vulnerable to cyber attacks |

Exhibit 2: SWOT for Future Communications and IoT

5 Recommendations

Based on the several guidelines developed from the SWOT analysis of Singapore Landscape, four main recommendations have been identified:

1. The Singapore Government should lead the efforts for Digitisation by playing several pivotal roles: as a policy maker and regulator (ensuring that the relevant policies and regulations for IoT and Future Communications are in place), adopter (leading demand in IoT in Smart Cities and other public sector projects), educator (highlighting successful case studies and promoting IoT programmes) and infrastructure enabler and builder (leading the efforts to ensure that the requisite infrastructure is in place and investing in developing technologies and solutions).
2. The Singapore Government should work with industry players by encouraging adoption of standards-based technologies such as eSIM, establishing a common standards-based framework to develop and adopt harmonised platforms to enable rapid adoption of IoT and contributing to the Cloud Native Architecture ecosystem and scaling up of Services 4.0.
3. The Singapore Government will need to facilitate greater industry adoption by acting as a role model by changing legacy processes and adopting greater digitalisation, encouraging industry to leverage on the many Innovation Hubs and enabling next generation wireless 5G networks by bringing together industry players to participate in 5G pilot tests.
4. The Singapore Government should enable continuous learning for digital transformation by establishing programmes towards re-skilling and continuous learning of existing workforce, developing cross-functional talent as well as ensuring that Singapore's future generations of workers are equipped adequately.