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Assessing the Readiness of Future Network Cyber Infrastructure in Malaysia– Part-1: Survey Data Analysis

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1.BACKGROUND

Good national communication networks infrastructure (NCI) provides Malaysians with the facilities they need to participate fully in the global digital society and benefit from the digital economy and opportunities it brings in terms of employment, innovation, creative expression and social inclusion. From the technological perspective, artificial intelligence (AI), 5G, internet of things (IoT) and big data are some of the components of future network that will usher Malaysia towards becoming a smart digital nation. In light of this, the MCMC invited this independent study to determine the current state of communication and multimedia infrastructure in Malaysia and review the future network readiness of our country.

1.1. SCOPE

There are 4 main objectives of the project:

Assess readiness – propose methodology(s) that could assess the future readiness of our current networks platform in supporting the ubiquitous digital and electronics services.

Identify challenges and opportunities – gather information from relevant stakeholders to identify where are the gaps and challenges and as well as new opportunities, that arises in deploying emerging technologies for the future network.

Establish future network requirements – determine the necessary elements to make Malaysia future ready towards becoming a smart digital nation.

Facilitate stakeholders – analyze how MCMC can assist the stakeholders in achieving the communication and multimedia objectives of the 11th Malaysia Plan as well as our National Policy Objectives.

1.2. OBJECTIVE

It is envisaged that the project will promote strategic assessment of networks planning, development and monitoring and enhance MCMC's Communications and Digital Ecosystem Sector's opportunities for engagement and collaboration with key stakeholders to provide greater impetus for the movement towards developing a national strategy to balance investments in technology and infrastructure with investments in the skills and knowledge Malaysian need to use ICTs to improve the quality of their lives, increase productivity throughout the private and public sectors and develop innovative products and services.

The outcome from the project is intended to form part of the collective body of knowledge and information resources needed to support the Technology Development Department' s advocacy role on emerging and future networks specifically, as well as MCMC's role in handling the many complex challenges in regulating and managing the ICT impacts of on society.

2.STUDY INTRODUCTION

The study was commissioned in the summer of 2017. The study benefits from an extensive an extensive on the ground fact finding effort. A suggested study team was formed with officers from MCMC's Technology Development Department and lead by the author. The author also suggested that fact finding consultation with a national telecommunication focus group. MCMC contacted the key stakeholders. The proposed focus group included five communication provider organizations. These providers are deemed by MCMC as the main players in Malaysia's telecommunication industry. Together these companies represent 80% of Malaysia's current telecommunication industry by revenue and they also manages 80% of commercial radio spectrum. It was also participated by a national research organizations MIMOS and the University Putra Malaysia's (UPM) next generation telecommunication systems research groups. The study team

took a three pronged approach. First are the discussion and knowledge. Half day meetings were conducted with the focus group organizations. The author also met area specialist from MCMC. More than 50 Malaysia experts- including executives, planners and engineers, from the regulatory experts, academics, and researchers made presentations, provided both issue specific presentations, and participated in open format intensive discussion sessions. Each group provided their insight into the issues through discussion on topics including the a) current state of telecommunication infrastructure, b) about their vision, plan and activities on 5G, b) services for smart community, c) Internet of Things (IoT), d) network virtualization, and e) data centers and cloud services. Secondly, a national seminar on Future Network for Smart Digital Malaysia was conducted. It was participated by 200 experts from all the stakeholder organizations from industry, academia, and government. Third a written survey instrument was designed and distributed to the focus group organizations. This document summarizes the findings of the written survey and also insights received from the surveys. A second associated document to provide the technical assessment and recommendations. The authors would like to thank the companies and in particulars their expert groups for their input. Below is a short profile of the organizations.

2.1. CELCOM

Celcom reported to be Malaysia's leading data network provider, with the largest mobile broadband and corporate services provider. With almost 10 million customers, Celcom is part of the Axiata Group of Companies, one of the world's largest telecommunications company with close to 300 million customers across 10 Asian markets.

Celcom's Head of Network Surveillance Mr. Zaharuddin Aman was the key presenter at the Knowledge Sharing Session, with other participants including personnel from Network, Corporate Strategy and Regulatory Divisions. The Future Network Focus Group Team comprises of personnel from Network, Corporate Strategy and Regulatory Divisions, with Mr. Low Kien Yap as the team contact.

2.2. DIGI TELECOMMUNICATIONS

Digi Telecommunications is a mobile communication company engaged in the establishment, maintenance and provision of telecommunication and related services. Digi reported to be the first telecommunication industry to launch and operate a fully digital cellular network in Malaysia. Digi has provided a variety of mobile communication services including voice under prepaid and postpaid plans, SMS, data plans and services, international roaming, international calling card, WAP services and so on. Digi mission is to provide customer specific solutions to meet individual needs for communications, connectivity and access to information and security.

Siti Fauziah of Regulatory, Adam Azlam of Sustainability, and Soam Chin Choon of Core Network Technology were presenters at the knowledge sharing session. The rest of the participants includes the regulatory team, technology team, and corporate team, with Fami Abdul Hamid, Regulatory Corporate Affairs, as team contact.

2.3. MAXIS BROADBAND

Maxis reported to have the widest LTE coverage of 88% population coverage nationwide, fastest LTE speed of average 30 Mbps and best mobile streaming experience which they received a 4 star rating national wide including Sabah and Sarawak according to a YouTube video checkup. Maxis reported that its customers enjoy a superior experience when making voice calls and text, and immerse themselves in an ever expanding universe of connected applications on the most advanced cellular network, encompassing 3G and 4G LTE technologies.

Lam Leong Kien, Senior Specialist, Regulatory, Tan Cheng Peng, Head of Technology, Strategy and Planning, and Chai Ming Ching, Head of IoT were presenters during the knowledge sharing session. Other participants included Mohd Edymainoe Mohd Noh, and Siti Noraini Abd Rahman. The Future Network Focus Group Team consists of Mariappan Chanachayai, Chai Ming Ching, Mohd Edymainoe Mohd Noh, Lam Leong Kien, and Siti Noraini Abd Rahman as the team contact.

2.4. TELEKOM MALAYSIA

Telekom Malaysia Berhad (TM) is Malaysia's reported to be the convergence champion and number one converged communications services provider, which offers a comprehensive range of communication services and solutions in broadband, data and fixed-line. TM have 2.36 million broadband customers, 2.7 million HSBB ports nationwide, and 1 million UniFi customers.

Mr. Mohd Fakruzzaki Hanafi, AGM SDN Development and Integration, Teh Keng Hoe, Director Solution Planning, Mohd Zafir, Manager RF Planning, and Chu Chin Huei, Manager Business Analyst were presenters during Knowledge Sharing session. Other participants were Arief Khalid Supian, and Amiza Zainol Abidin. Telekom Malaysia did not have a Focus Network Group team.

2.5. U MOBILE

UMobile reported to be one of the newer mobile telecommunications service providers, with its vision focused on simplifying and improving lives while delivering best in class customer experience. It is currently operating with frequencies in the 2100 and 2600 bands, providing 3G and LTE services, and as a result of the spectrum re-farming process, is also progressively expanding its network on the 1800 and 900 bands. UMobile's active subscribers grew from 540,000 in 2012 to 5 million in 2017.

Mr. Tai Koon Sun, Khoo Poh Hean, and Mohd Fuad Romelli of UMobile were presenters during the knowledge sharing session. Other participants were Liew Wai Ming, and Noor Wahida Abu Bakar.

2.6. MIMOS

MIMOS is a leader in ICT innovations, pioneering new market creations for partners through patentable technologies for economic growth. With firm government support, MIMOS has been focusing on market-driven R&D areas to ensure our technologies are commercially available for sustained growth. To date, they have contributed to the ICT landscape through development of more than 20 technology prototypes and transfer of 19 technology platforms to 23 technology recipients.

Dr. Hafizal Mohamad, Senior Staff Researcher is the presenter during knowledge sharing session, with Dr. Nordin Ramli as the other participant. The Future Network Focus group consists of Drs. Nordin Ramli, Mohd Ariff Abdullah, Ahmad Zaki Abu Bakar, Azrulmukmin Azmi, and Hafizal Mohamad as the team contact.

2.7. UNIVERSITI PUTRA MALAYSIA (UPM)/WIPNET

Associate Professor Dr. Shaiful Jahari Hasim, WiPNet member is the presenter at knowledge sharing session, with Associate Professor Ir Dr. Aduwati Sali, Associate Professor Dr. Raja Syamsul Azmir Raja Abdullah, Associate Professor Dr. Sharifah Mumtazah, Dr. Makhfudzah

Mohktar, and research officer Aziz Md Ali as participants. The Future Network Focus Group consists of Dr. Mohd Hanif Yaacob, Associate Professor Ir Dr Aduwati Sali, Professor Dr Mohd Adzir Mahdi, Professor Borhanuddin Mohd Ali, Professor Dr Nor Kamariah Noordin, Associate Professor Dr Mohd Fadlee A Rasid, Associate Professor Dr Raja Syamsul Azmir Raja Abdullah, Associate Professor Alyani Ismail, Associate Professor Dr Siti Barirah Ahmad Anas, Associate Professor Ir Dr Mohd Syamsuri Yaacob, Dr Makhfudzah Mokhtar, Dr Zuraidah Zan, Dr Nurul Adilah Abdul Latif, and Associate Professor Dr. Shaiful Jahari Hasim. Dr. Mohd Hanif Yaacob is the team contact.

As part of the research center under Universiti Putra Malaysia Faculty of Engineering, Wireless and Photonics Network Research Center (WiPNET) was appointed as the National Center of Excellence for Sensor Technology (NEST) by the Malaysia government. WiPNET focuses on the end-to-end communication network solutions deployed in critical fields of telecommunications, agriculture, food analysis, biomedical and environmental monitoring. The group makes significant scientific findings in functional nanomaterials, optical fiber and wireless devices, broadband communication networks and satellite systems. WiPNET vision is to be a world class research center with high impact community contributions in communication technologies.

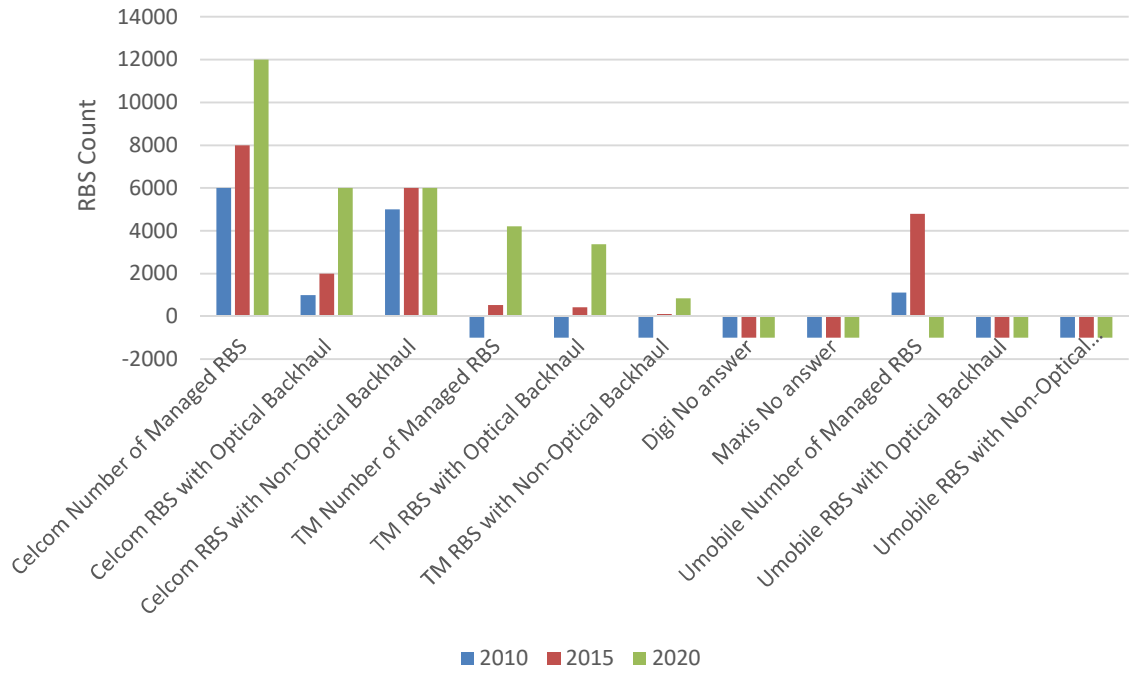
3.NETWORK

To understand the extent of each provider's telecommunication network infrastructure we requested information about the number of managed RBS points deployed nationwide and how many of those have optical and non-optical backhaul data connection. To estimate the trend we also requested data for the years 2010 and 2015 data and projected data for the year 2020. Figure 1 provides a snapshot.

Among the respondents, Celcom stands out to be the distinct leader with 8000+ RBS deployed. It is followed by U-Mobile. The 2020 projection indicates both have aggressive expansion plan. Telekom Malaysia (TM) did not have data for 2010, but is also projected to have significant growth based on their 2015 to 2020 projection. UMobile only provided the total managed RBS number, and have substantial growth between 2010 and 2015, but did not provide their 2020 projection. Digi and Maxis did not provide RBS data. Overall, it seems that the volume the expansion lead by Celcom will be felt nationwide. MCMC will gain working closely with Celcom and U-Mobile.

Regarding the quality/capacity of RBS it seems vast majority of the reported RBS does not currently have optical-backhaul. It seems more that 75% of RBS backhaul-capacity is limited by non-optical backhaul. Celcom shows that it has plan. It expects to move aggressively bringing about half of their RBS with optical back-haul by 2020. From reported data (or the lack of reporting) seems to indicate that there might not be any clear planned investment to improve the back-haul for the rest and MCMC should probe further.

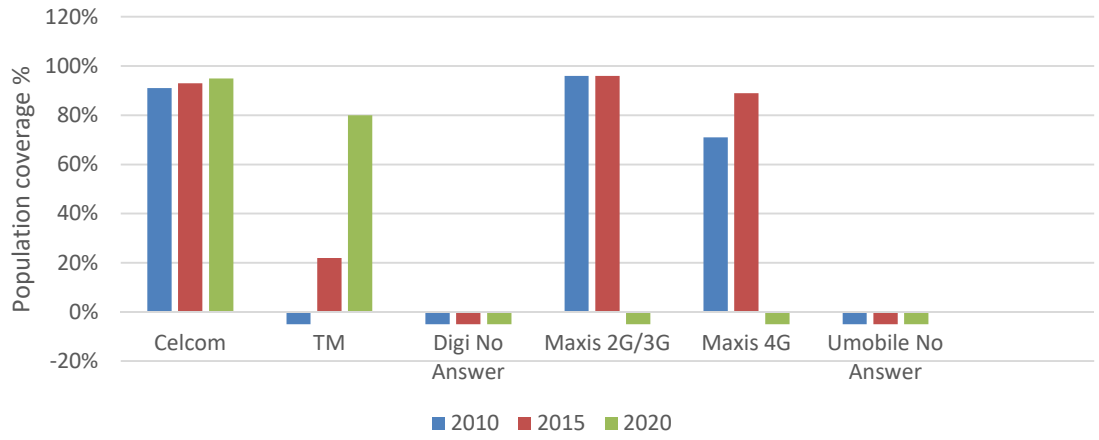
Figure 1. Radio Network



To understand the extent of network infrastructure coverage in Malaysia, we also asked two types of coverage data - population coverage and geo-graphics coverage. Population coverage from the providers were requested for the years 2010 and 2015, and a 2020 projection, and is shown in Figure 2.

Maxis provided coverage data for 2010 and 2015, showing steady numbers with very minimal increase for 2G and 3G, but a higher % increase for 4G. Celcom's population coverage showed steady with some growth. Telekom Malaysia did not have data in 2010, with a minimal coverage in 2015 but shows significant increase for the year 2020. It will be interesting to investigate the reasons of the last of the 'dark pockets' in population coverage in further depth.

Figure 2. Population Coverage %



Geographic coverage growth for 2010 and 2015 were requested and a projection for 2020, but only Digi provided their current Geographic Coverage. Digi's have less than 50% current geographic coverage on 3G, 4G, and 4G LTE on the following Malaysia states: Johor, Kedah, Kelantan, Kuala Lumpur, Melaka, N Sembilan, Pahang, Penang, Perak, Perlis, Sabah, Sarawak, Selangor and Terengganu. There is certainly much room for geographic coverage improvement. There are large swatch of uncovered areas. For comparison, Figure 3.2 shows geographic coverage of USA's Verizon Wireless.

Figure 3.1. Geographic coverage – Digi

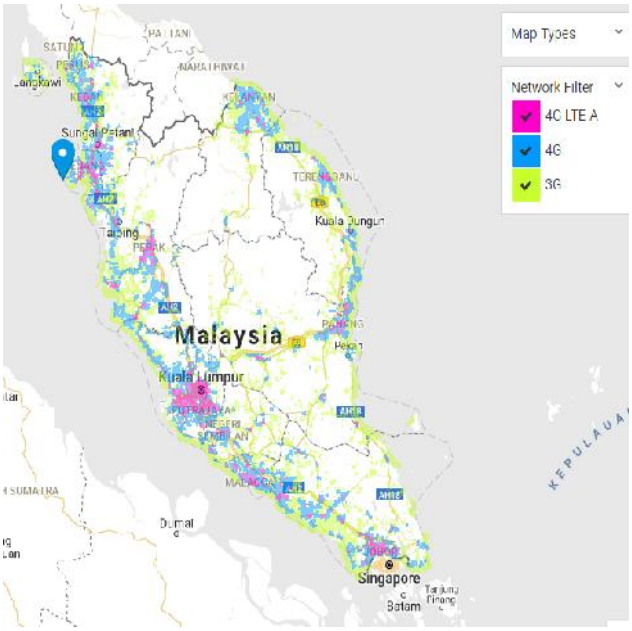
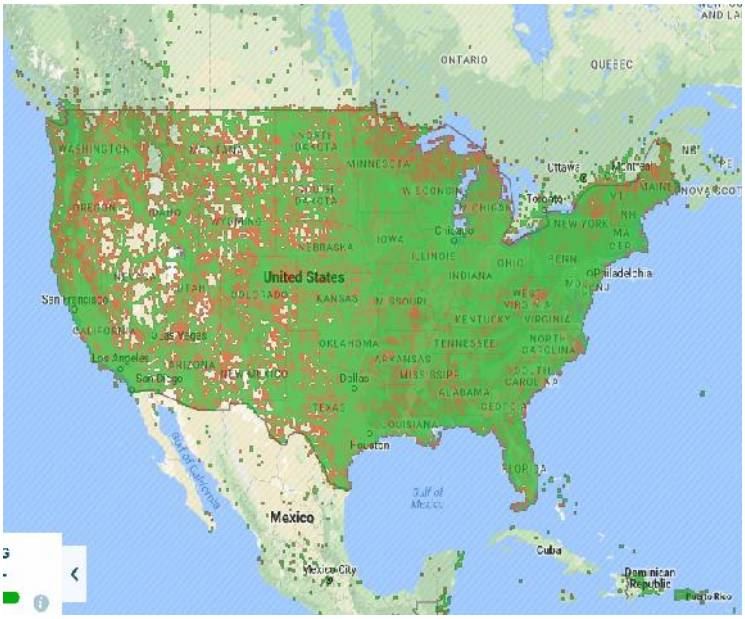


Figure 3.2. Geographic coverage – Verizon Wireless, USA



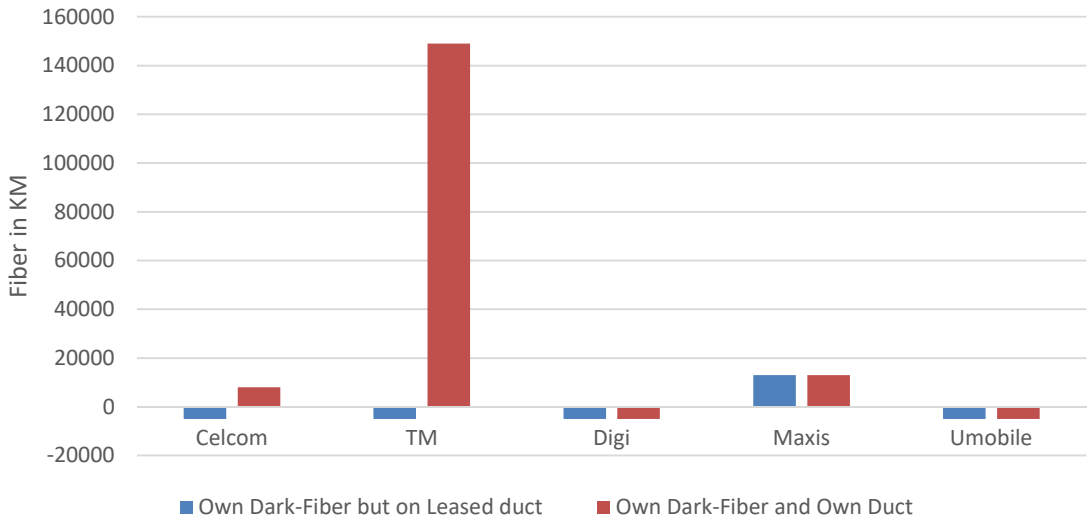
4.LEVEL OF SHARING IN NCI INFRASTRUCTURE

4.1. INFRASTRUCTURE USED FROM MARKET

To understand the level of sharing in each infrastructure, the respondents were requested to help us with data on their fiber and radio related infrastructure sharing. In Fiber Sharing, they were asked to provide length in km for following sharing models: a) own dark-fiber inside own duct/conduit, b) own dark fiber but is on a leased duct/conduit, c) leased lambda on fiber, d) and leased bandwidth on fiber.

Telekom Malaysia reported having the longest owned dark fiber in their own duct with over 149,000 km. However, they do not report having any of their own dark fiber on a leased duct/ conduit, nor leased lambda on fiber. Their leased bandwidth on fiber goes to a distance of up to 240km, and is only used for transmission. This indicates TM backhaul infrastructure mostly built on fully owned asset. Celcom have over 8,000 km of their own fiber on their own duct, no additional data was provided. Only Maxis reported having shared infrastructure where 13,000 km is on combination owned and leased fiber, and no other data was provided. UMobile did not any provide data. Figure 4 provides a visualization of the data.

Figure 4. Fiber Sharing Model

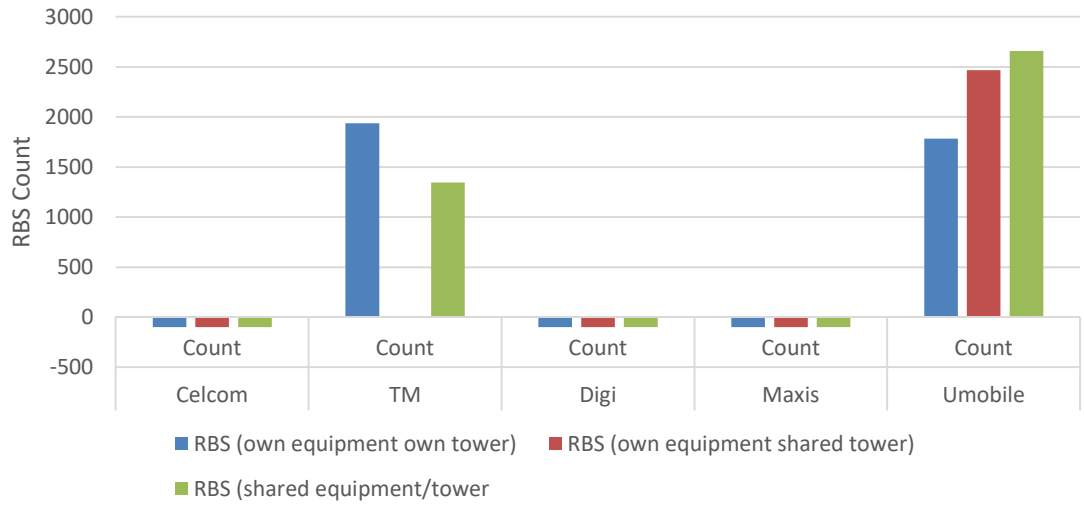


In Radio Network Sharing, the providers were requested to provide data for RBS count on their own equipment on their own tower, RBS count on their own equipment on a shared tower, and RBS count on shared equipment on a shared tower.

UMobile have the most numbers of RBS, 1785 with their own equipment in their own tower, 2466 with their own equipment on a shared tower, and 2660 RanShare with Maxis, shared equipment on a shared tower. Telekom Malaysia have 1347 RBS with their own equipment in their own tower consisting of mainly private WiMax rooftop and TM orange structures. 1938 RBS in their own equipment on a shared tower, and 3 RBS shared equipment on a shared tower in TM CRAN Putrajaya.

Maxis only noted a 3G RAN share on their radio network sharing model, while Celcom did not provide any data.

Figure 5. Radio Network Sharing Model



4.2. LEVEL OF INFRASTRUCTURE WE CONTRIBUTED TO THE MARKET

We also asked question to understand how much of owned asset each company is opening up for sharing. Reported data apparently shown Telekom Malaysia does not lease dark fiber to others. Telekom Malaysia does not lease lambda to others. As per survey, it appears Telekom Malaysia have leased bulk bandwidth over fiber asset up to 240 km for transmission only. This is the only reporting of asset sharing.

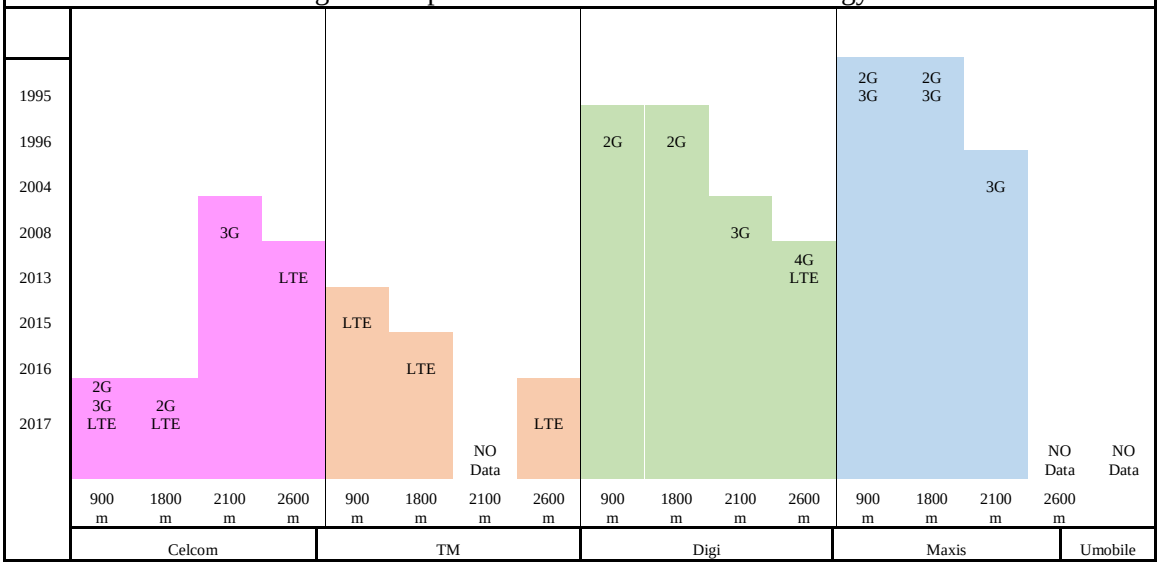
No one else provided data for this.

5.SPECTRUM BANDS

To understand how much Malaysian organizations have invested into various generation of technology and current usage. The providers were requested to provide bands each are operating and provide some data about the history of traffic in those bands[1].

[1] MCMC has the fuller picture of spectrum allocation.

Figure 6. Spectrum Band Width and Technology

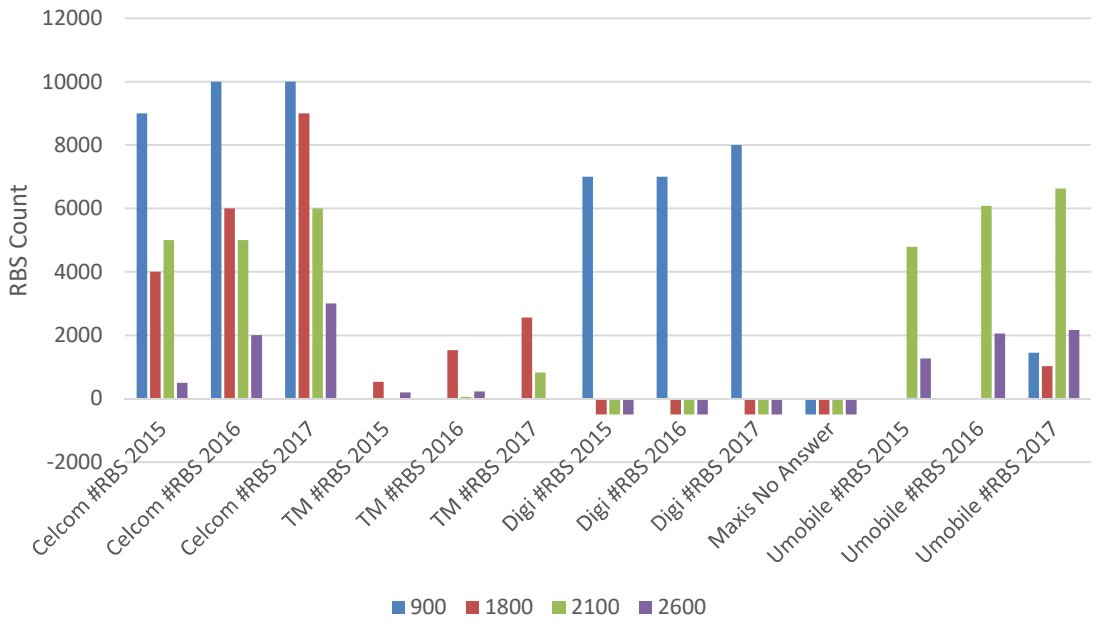


Maxis and Digi established 2G and 3G earlier than their counterpart Celcom and Telekom Malaysia. Digi have direct ownership. Celcom have Spectrum assignment ownership for Bands 900m, 1800, and 2100m and apparatus assignment ownership for 2600m band range. All four providers reached 4G LTE in the 2600m band range by the year 2016-2017.

5.1. SPECTRUM BANDS AND ESTIMATED RBS COUNT AND ESTIMATED TRAFFIC TB

To understand the rollout status of the technology generations we also requested data on the amount of estimated RBS in various spectrum-bands and estimated traffic in terabyte per month for the years 2015, 2016, and 2017.

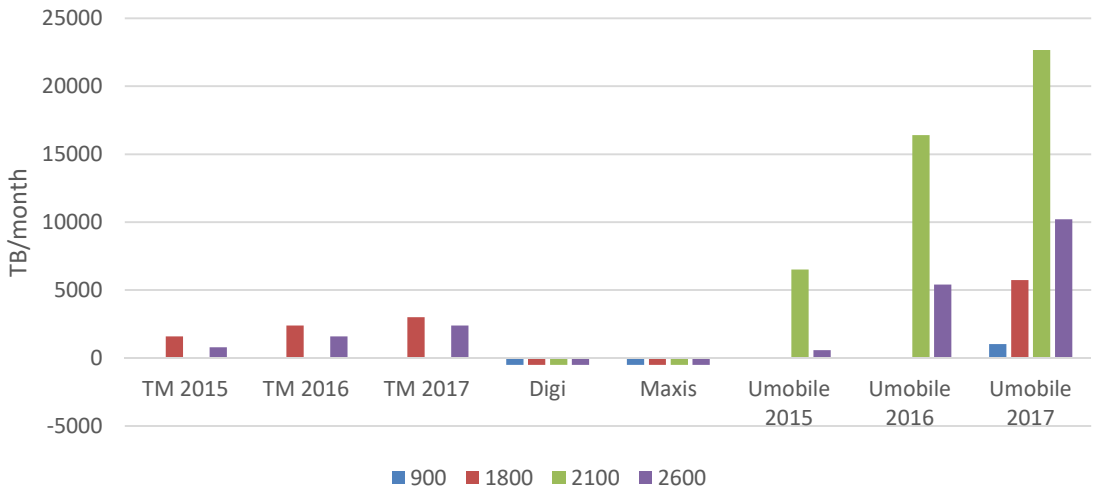
Figure 7. Spectrum Bands and Estimated RBS Count



Celcom allocated their 900 and 1800 bands in the 1990s, the 2100 band in 2008 and 2600 band in 2013 with a consistent drop in RBS count from 2015 to 2017. Digi allocated spectrum band in 1996 with increase RBS from 2015 to 2017. Telekom Malaysia allocated 3 bands within 2015 and 2016, UMobile allocated a 2100 band in 2008, followed by 2600 band in 2013 and later added 900 and 1800 band in 2017. It seems much of RBS (like Celcom) is in 2G/3G, currently the providers are invested into aggressively rolling out 4G-LTE.

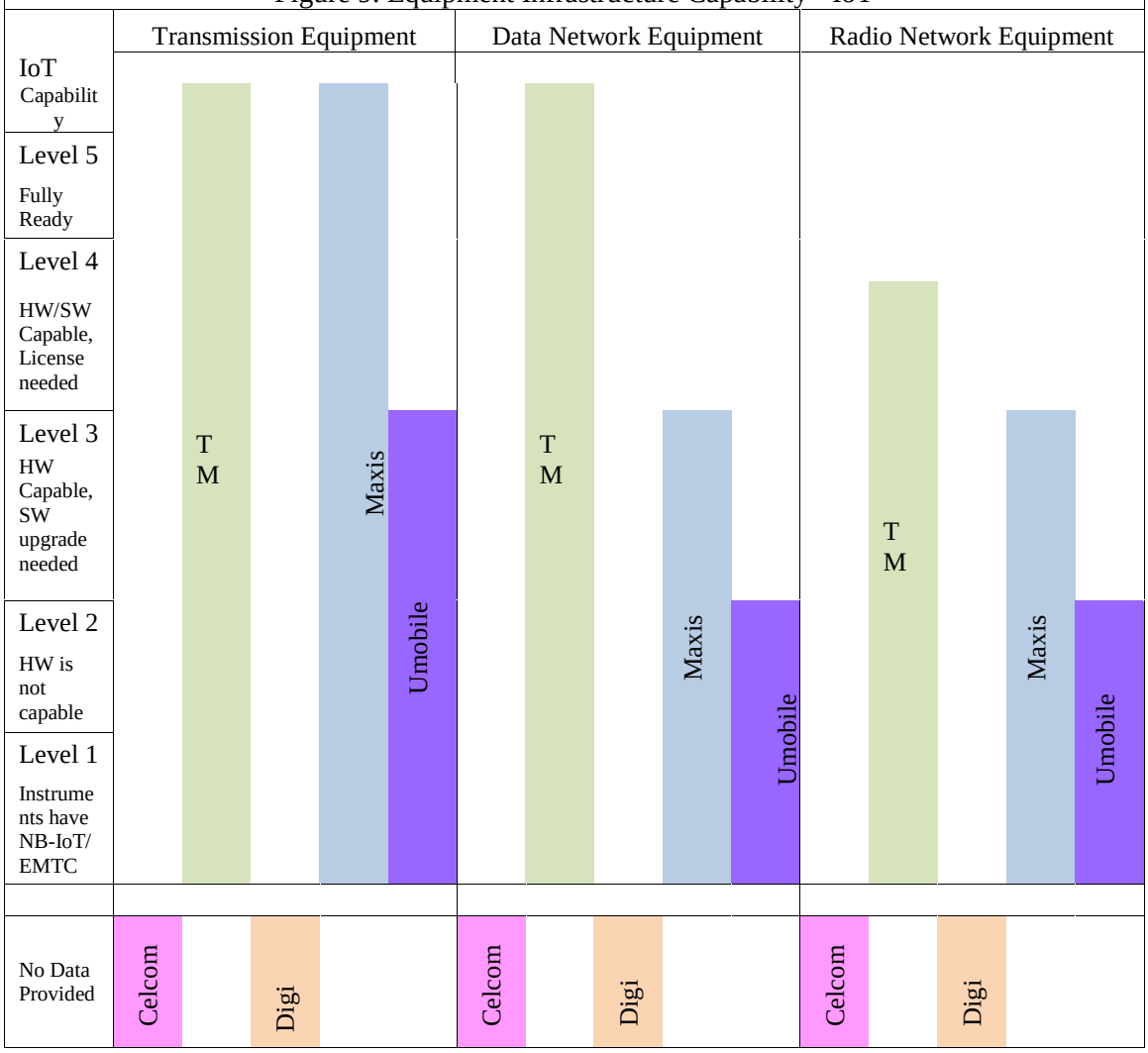
For estimated traffic TM and Umobile provided data. We encourage working with the companies to obtain more traffic data in future cycles.

Figure 8. Estimated TB Traffic/month



5.2. EQUIPMENT INFRASTRUCTURE CAPABILITY

Figure 9. Equipment Infrastructure Capability - IoT

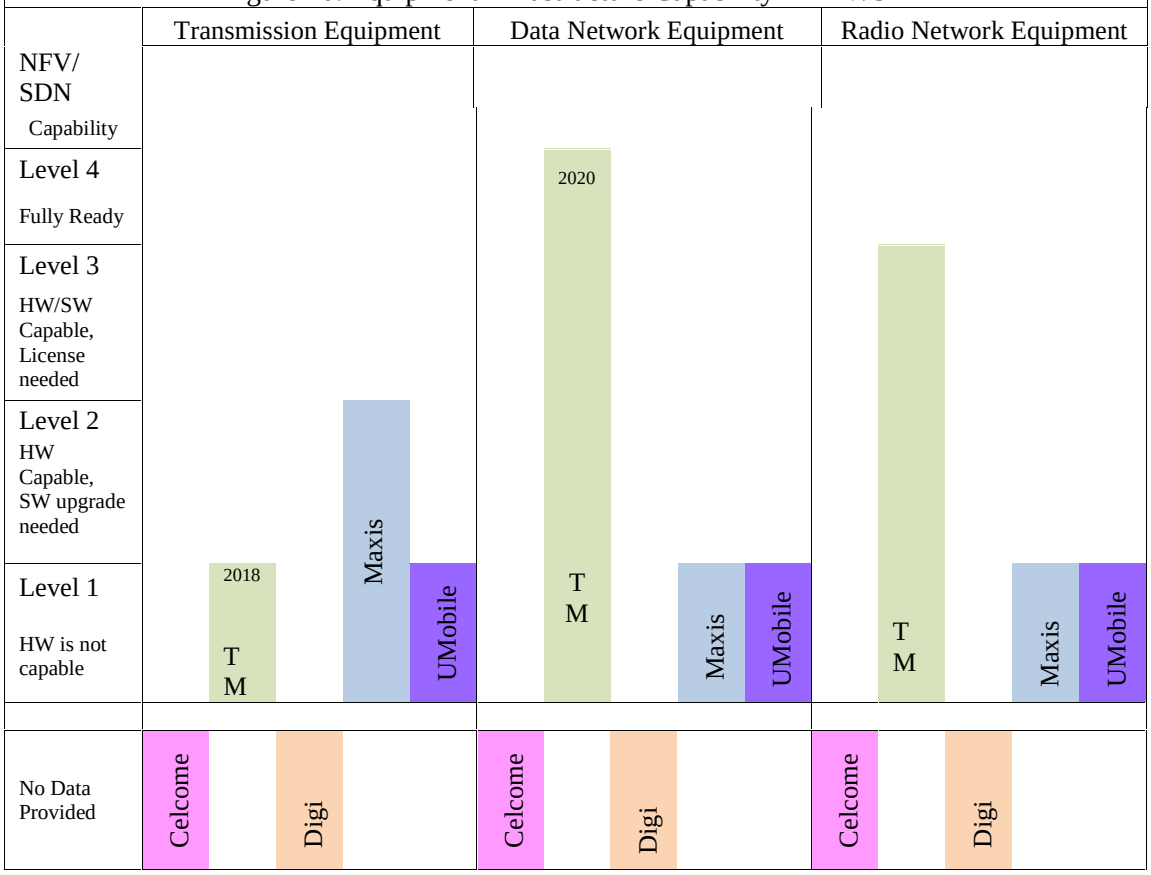


Almost all respondents demonstrated awareness about the impending Internet-of-Things and Network Virtualization. We requested to indicate the readiness of their infrastructure to support rollout IoT services. UMobile reported currently conducting trial, with a target in 2018/2019 for NFV and 2020 for NFV and SDN. The hardware is 100% capable for transmission equipment, data network equipment, and radio network equipment. For IoT capability, transmission equipment hardware is capable but needs software upgrade, and data network equipment and radio network equipment are also hardware capable. Digi did not want to disclose this information.

Maxis is offering IoT services currently on 2G/3G/4G as these equipment can use their data capabilities. NB-IoT/eMTC is still at the early stage with few pilot and commercial deployments worldwide and emerging ecosystem. Their network is NB-IoT/eMTC hardware ready but requires software upgrade, and they are continually evaluating such technology. The core network of their

Data Network Equipment infrastructure is hardware ready. Some Radio network equipment sites require new and additional base band card.

Figure 10. Equipment Infrastructure Capability – NFV/SDN



Telekom Malaysia (TM) is at the testing stage on virtual EPC (NFV). Transmission network is 70% hardware capable, with on-going upgrade in process and is planned to be HW/SW capable for new deployment in 2018. TM's Data Network Equipment is hardware capable, requiring software upgrade and will be fully ready for vEPC and vCPE in estimated 3 years' time. Their radio network equipment are hardware and software capable, needing a license.

Maxis Transmission equipment for NFV/SDN capability is currently at 50% capable, IP core and microwave, and SDN capable, but require software upgrade. Maxis is planning to deploy NFV based core network elements in 2017 and moving forward will be extended to other components of the network. Maxis is also assessing Transport SDN capability which is currently in the tender stage.

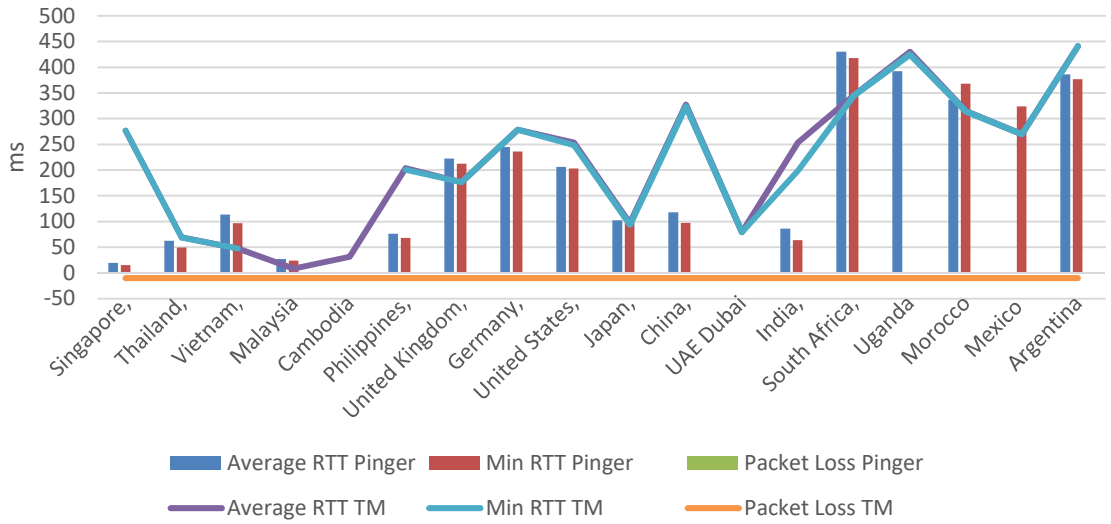
6.NETWORK PERFORMANCE

To understand the technical data carriage characteristics at user level we requested a range of network performance parameters that is experienced by the mobile users from the providers, both for inter Malaysia between its regions (broken down by inter-state delays) and international - Malaysia to different parts of the world. The parameters includes average round trip delay, minimum round trip delay, packet loss experienced by the network.

6.1. A.9 NETWORK HEALTH WITHIN MALAYSIA

No one provided data for delays experienced within Malaysia. A Pinger site delay is available to provide an alternate estimate of the delays- though it is not reflective of any single provider's network. For international network performance, Telekom Malaysia provided partial data on Average RTT and Minimum RTT, none for Jitter IPDV and TCP. No data for Packet Loss from Telekom Malaysia. Figure-11 provides a comparison of this data with Pinger data.

Figure 11. Network Health Malaysia-International



	Average RTT Pinger	Min RTT Pinger	Packet Loss Pinger	Average RTT TM	Min RTT TM	Packet Loss TM
Singapore,	19.6	15.16	0.19	277	277	0
Thailand,	62.39	49.55	0.47	70	69	0
Vietnam,	113.58	96.75	0.6	48	48	0
Malaysia	27.21	23.95	0.36	9		
Cambodia				32		
Philippines,	76.04	68.11	0.28	204	201	0
United Kingdom,	222.49	212.41	0.23	177	177	0
Germany,	244.54	235.91	0.25	279	279	0
United States,	206.42	203.25	0.2	254	249	0

Japan,	102.55	99.47	0.18	97	94	0
China,	117.86	97.12	0.35	327	324	0
UAE Dubai				80	80	
India,	86	63.84	1.05	254	199	0
South Africa,	430.01	417.72	0.28	346	345	0
Uganda	392.53		0.88	430	425	
Morocco	336.73	368.14	0.37	315	314	
Mexico		323.98		270	270	
Argentina	386.17	376.63	0.35	441	441	

7. NATURE OF DATA AND GROWTH

To understand and learn about the provider's experience and projection on data growth. The providers were requested to provide net volume traffic that the backhaul network has carried per data type such as voice, voice or video over data, internet of things, sensor data or machine to machine data, and other forms of data, reported in zettabytes per year. Observed data for the years 2014-2016 were requested, and projections for the years 2017-202.

Telekom Malaysia stated that they do not monitor data according to data type as requested above. No one provided any answers to the requested information as shown in the three tables below.

7.1. TOTAL DATA OF OUR CUSTOMER WE CARRIED OVER BACKHAUL NETWORK (ZB/YEAR)

TOTAL DATA OF OUR CUSTOMER WE CARRIED OVER BACKHAUL NETWORK (ZB/YEAR)							
Type	2014	2015	2016	2017	2018	2019	2020
Voice							
VVDATA							
IOTMD							
IOTDATA							
Aggregate							

7.2. TOTAL DATA OF OUR CUSTOMER WE MOVED IN/OUT INTERNATIONALLY (ZB/YEAR)

TOTAL DATA OF OUR CUSTOMER WE MOVED IN/OUT INTERNATIONALLY (ZB/YEAR)							
Type	2014	2015	2016	2017	2018	2019	2020
Voice							
VVDATA							
IOTMD							
IOTDATA							
Aggregate							

7.3. DATA USAGE PER YEAR – TOTAL DATA OF OUR CUSTOMER WE CARRIED

DATA USAGE PER YEAR – TOTAL DATA OF OUR CUSTOMER WE CARRIED							
Type	2014	2015	2016	2017	2018	2019	2020
Voice							
VVDATA							
IOTMD							
IOTDATA							
Aggregate							

7.4. PUBLIC DATA CENTER RAW STORAGE

Data centers and public clouds (DC & PC) are becoming increasingly important part of traffic contributor on national communication infrastructure. To understand the growth phenomena of the provider's established data centers and cloud infrastructure, the following were requested. Data about storage capacity and traffic volume of the backhaul network has carried for the public data center and/or cloud. Observed data for the years 2014-2017 were requested, and projection for the years 2017-2020. Each virtual machine requested is considered as one work load. Workload density is the ration of workload processed and the number of actual physical core.

Only Telekom Malaysia provided data for this.

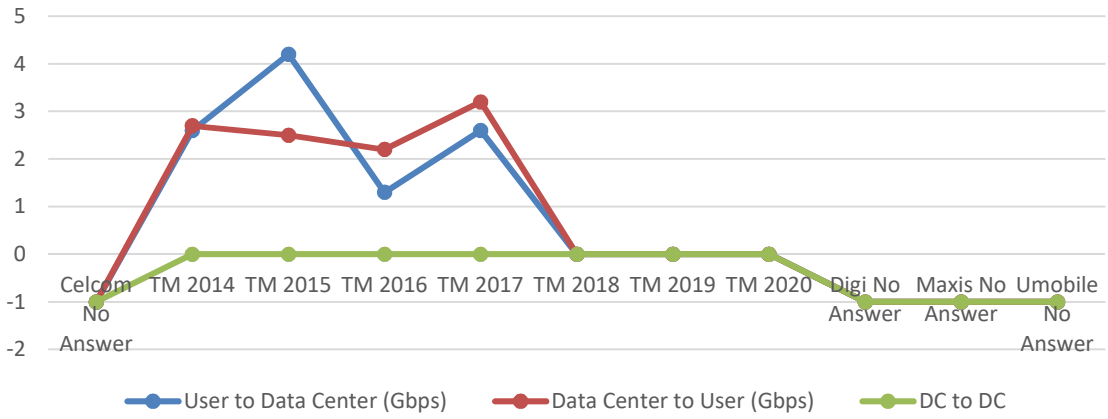
Telekom Malaysia							
Type	2014	2015	2016	2017	2018	2019	2020
# Data Centers	13	12	11	10	9	NA	NA
# Public Data Centers	13	12	11	10	9	NA	NA
# Hyper scale DC & PC	0	1	2	2	2	NA	NA
Workloads processed	0	NA	NA	NA	NA	NA	NA
Workload density	0	NA	NA	NA	NA	NA	NA
Total Storage Capacity	0	130 TB	264 TB	461 TB	NA	NA	NA
Storage Used by tenants	0	40 TB	80 TB	160 TB	NA	NA	NA
Storage used by IAAS	0	NA	NA	NA	NA	NA	NA
Storage used by PAAS	0	NA	NA	NA	NA	NA	NA
Storage used by SAAS	0	NA	NA	NA	NA	NA	NA

The number of data centers and public data centers have decreased through the years, possibly caused by the increase in the number of hyper scale DC and PC. Storage capacity have increased in parallel with the increase of data centers. Storage used have also increased parallel with total storage capacity. There is no other data provided

7.5. DATA CENTER TRAFFIC (EB)

Telekom Malaysia							
Type	2014	2015	2016	2017	2018	2019	2020
User to Data Center	2.6 Gbps	4.2 Gbps	1.3 Gbps	2.6 Gbps	NA	NA	NA
Data Center to User	2.7 Gbps	2.5 Gbps	2.2 Gbps	3.2 Gbps	NA	NA	NA
DC to DC	NA	NA	NA	NA	NA	NA	NA

Figure 12. Data Center Traffic (EB)



8. EFFORTS IN FUTURE NETWORK

8.1. PLANS AND EXPECTED TIMELINE FOR FUTURE NETWORK

To better understand each provider's plan for Future Network, the companies were asked to share their current plans and future projects in preparation for Future Network. They were requested to share any pioneering experiences in the implementation of the elements of Future Network in Malaysia. Overview of teams and plans, and description of pilot projects that have been launched were requested.

Celcom is exploring projects for Smart Community efforts, and is the only one that answered.

8.2. TO USE 5G SPECTRUM

Figure 13.1 Efforts in Future Network – 5G

	No Data Provided	Exploring Projects	Actively Planning	Laboratory Experiment	Setting partnerships	Limited scale field piloting	Seeking sustainability	Business viability set	System Operational
5G									
Celcom									
TM									
Digi									
Maxis									
UMobile									

The survey found that almost all mobile operators are indeed aware of the development in 5G. Celcom, Maxis, Telekom Malaysia, and UMobile are all exploring what is 5G in preparations to use 5G Spectrum for Future Network. Few also reported that initial study on 5G high level architecture are being considered and potential vendors has been identified, for a possible trial in 2018 or 2019. Given the lack of specificity in 5G's definitions (which are themselves not well defined yet internationally until early 2017) the operators are exploring what their vendor's are proposing as the 5G architecture. The following diagrams (read left to right progressively) will provide an understanding of the stage they are in for each element of the FN namely Data Center integration, NFV and SDN and IoT support. Left means low preparation and right means advanced stage.

8.3. TO EXPAND DATA CENTER AND ENGAGE PUBLIC CLOUD

Figure 13.2 Efforts in Future Network – Data center/Public cloud

	No Data Provided	Exploring Projects	Actively Planning	Laboratory Experiment	Setting partnerships	Limited scale field piloting	Seeking sustainability	Business viability set	System Operational
DC PC									
Celcom									
TM									
Digi									
Maxis									
UMobile									

Maxis offers public cloud for enterprise customers only, and delivers cloud computing solution via the internet. Celcom plans to expand their Data Center and Public Cloud, while Telekom Malaysia will depend on overall corporate group strategy on Telco cloud. UMobile have no plans to expand their Data Center and/or Public Cloud at the moment.

8.4. TO DEPLOY/ ENHANCE NFV/SDN

Figure 13.3 Efforts in Future Network – NFV/SDN

	No Data	Exploring Projects	Actively Planning	Laboratory Experiment	Setting partnerships	Limited scale field piloting	Seeking sustainability	Business viability set	System Operational
NFV SDN									
Celcom									
TM									
Digi									
Maxis									
UMobile									

Celcom is working on deploying Network Function Virtualization and Software defined Networking while Maxis is planning to deploy NFV based core network elements in 2017 and moving forward will be extended to other components of the network. They are also assessing Transport SDN capability which is currently under tender stage.

8.5. TO SUPPORT IOT DEVICE

Figure 13.4 Efforts in Future Network – IoT and Low delay communication

	No Data	Exploring Projects	Actively Planning	Laboratory Experiment	Setting partnerships	Limited scale field piloting	Seeking sustainability	Business viability set	System Operational
IoT									
Celcom									
TM									
Digi									
Maxis						Trial 2018			
UMobile									

While Celcom is working on supporting IoT services, Maxis is already offering IoT service using 2G/3G/4G technologies, and will trial Narrow Band IoT in 2018. Like other matter, Telekom Malaysia's plans will depend on overall group strategy on Telco cloud which is currently under study. mMTC services is one of the main use case of 5G network and to support this is highly dependent on business case and ecosystem maturity.

9. CHALLENGES AND SUGGESTIONS

To better understand and learn about issues and challenges each provider is facing, the providers were requested to share candidly in the areas of 5G, Data center/Public cloud, NFV/SDN deployment and IoT Support services. We also requested them to provide insights on how MCMC can help alleviate these difficulties.

9.1. TO USE 5G SPECTRUM AND ROLL OUT 5G

Respondents' noted spectrum availability as one of the biggest challenge. They also noted sustainability, market readiness, device ecosystem readiness and pricing all affect the use of the 5G Spectrum. Some of the road blocks for rolling out 5G Spectrum are high regulatory cost of site acquisition, fiber trenching, fiber leasing, and spectrum acquisition, monopoly by state-backed company, slow land approval and high approval fees by state authorities. Suggestions are made for allowing mobile operators to build telecommunications infrastructure and regulate fees and prices for fiber leasing, eliminate monopoly and anti-competition behaviors. There are also concerns that about a guideline plan how 5G will be rolled out. In Malaysia 5G spectrums have not been assigned. Many operators noted following challenges and road blocks for 5G: a) spectrum availability, insufficient bandwidth (of spectrums??), and high regulatory cost of spectrum acquisition b) sustainability, market readiness, device ecosystem readiness and pricing; c) high regulatory cost of site acquisition, d) cost of fiber trenching, fiber leasing, e) monopoly by state-backed company, f) slow land approval and high approval fees by state authorities.

9.2. TO EXPAND DATA CENTER AND ENGAGE PUBLIC CLOUD

A challenge for Maxis to expand their Data Center and/or Public Cloud is the limited geographical reach as a domestic player, and competition from other Telco-Over the Top players.

9.3. TO DEPLOY/ ENHANCE NFV/SDN

Besides the high cost of investment to deploy NFV/SDN, maturity and limitation on applications for NFV/SDN solution from the vendors is also a key challenge. Carrier grade performance is also a challenge for Maxis in their plans to deploy and/or enhance NFV/SDN. There is however, much less responses received for network virtualization. Celcom reported working on deploying Network Function Virtualization and Software defined Networking while Maxis is planning to deploy NFV based core network elements in 2017 and moving forward will be extended to other components of the network. They are also assessing Transport SDN capability which is currently under tender stage. The reported anxieties are: a) the high cost of investment to deploy NFV/SDN; b) maturity and limitation on applications for NFV/SDN solution from the vendors is also a key challenge; and c) Carrier grade performance is also a challenge for Maxis in their plans to deploy and/or enhance NFV/SDN.

9.4. TO SUPPORT IOT DEVICES

Currently, there are no specific guidelines for IoT devices in terms of technology implementation. There are limited sensors available for testing, interoperability for multi-vendor

environment, initial module and licensing costs are high thus making it difficult to justify the business strategy. Organization readiness to create new skill sets and processes is also a challenge.

9.5. COLLABORATION

The survey also probed collaboration efforts taken by the players both locally and internationally particularly related to Future network. Telekom Malaysia and Digi did not respond to this question.

UMobile is in collaboration with other providers such as Maxis being their DR (Disaster Recovery?) provider. UMobile is exploring the possibility for alliance with universities. Celcom is in collaboration with government organizations, and Huawei and Ericcson. Maxis reported a partnership with Vodafone since July 2016, to offer IoT solutions to Malaysia business across industries. The solution is about connecting devices over the internet, allows objects to be sensed and controlled remotely across existing data networks, to improve efficiency, enhance customer experience, create new revenue stream, as well as automate processes. eKelas is another Maxis collaboration initiative to facilitate technology-enabled teaching, and making remote learning a reality for these students. It is an engaging after-school supplement, done via highly-interactive digital content, in line with Malaysian School Syllabus. The eKelas programme at Pusat Internet 1 Malaysia (PI1M) centres are managed by Maxis. As a member to Bridge Alliance of leading Asia Pacific mobile operators, Maxis expressed their ability to extend their reach and scale in areas such as M2M/IoT, enterprise mobility, roaming and optimization, drawing on the collective experience and their high-performance networks to address customer needs. The group has also transformed the experience of travelers when it comes to roaming by designing innovative offers to drive adoption and revenue. As part of the group, Maxis expressed confidence to leverage on the alliance's scale and scope to negotiate for cost savings.

10. SUMMARY OF FINDINGS AND RECOMMENDATIONS

The MCMC team also conducted other analysis besides the survey. An in-depth analysis of the status and subsequent recommendation documents is to be into technical documents part-II [1] and Part-III [3].

Future network is a rapidly evolving technology participated by many diverse players. Unlike 4G where mobile communication and broad-band companies played key roles- the Future Network ecosystem will see expanded eco-system with major players including CKD (content-knowledge-and-data) organization, as well as public-entities-as-service-and-infrastructure-providers.

One of the implicit goals of this survey was to raise awareness about the importance of data-driven policy mechanism for any organization. The current survey can be used as a template. It can be expanded and stake holders should be encouraged to continue to provide the more baseline data towards formulation of an effective national policy.

11. REFERENCES:

1. TR2018-12-02: A Roadmap for the Readiness of Future Network Cyber Infrastructure in Malaysia: Part-3: Recommendations, Javed I Khan, Study Commissioned by Malaysian Communications and Multimedia Commission (MCMC), Government of Malaysia, and Supported by Fulbright Senior Specialist Program, Fulbright Commission, US Department of State, 2017-2018, December 2018.
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