

Contents

1	Introduction	1
1.1	Background	1
1.2	Objectives of the ICT sector roadmap	1
1.3	Content of this report	2
2	Current state of the ICT sector in PNG	4
2.1	The transformative potential of ICT in PNG	4
2.2	Internet in PNG	5
2.3	Recent and ongoing developments in PNG	7
2.4	Current priorities of the PNG government	9
3	ICT sector roadmap	11
3.1	Mission statement and objectives	11
3.2	Digital framework	11
3.3	Roadmap activities	14
3.4	Short term	16
3.5	Medium term	22
3.6	Long term	25
4	Implementation of the ICT sector roadmap	27
4.1	Implementation approach	27
4.2	Current state assessment	29

Annex A	Case studies	
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1 Introduction

1.1 Background

Papua New Guinea (PNG) is a diverse country with rich natural resources. Its economy is primarily driven by two sectors: the agriculture, forestry and fishing sector; and the minerals and energy extraction sector.¹ Future economic growth will rely on unlocking the potential of other sectors and developing a modern economy through the effective use of information and communication technology (ICT). Improved use of ICT can also drive efficiencies across government and enable the delivery of better services to the citizens of PNG.

The Department of Communication and Information (DCI) is responsible for developing government policy on ICT to drive development of the digital economy. A 2013 report commissioned by the DCI and the World Bank found that the DCI's policy-making unit was under-resourced and lacked sufficient capacity for the development and implementation of effective ICT policies.² These capacity constraints, combined with significant resource limitations, have limited the ability of the DCI to perform its statutory functions, and to provide effective policy advice and communications strategies to the government is highly restricted.

Consultancy firm Analysys Mason has been engaged to support the institutional strengthening of the DCI. Analysys Mason has worked with the DCI to support its capacity building, including developing a policy-making framework and a monitoring evaluation framework, undertaking study tours with ICT policy-making departments in Singapore and South Korea, and developing an approach for formalising the DCI's status within the Government of PNG (GoPNG).

1.2 Objectives of the ICT sector roadmap

The ICT sector in PNG is fragmented and, due to resource limitations, ICT policy and programmes across government are currently developed on an ad-hoc basis, without a structured plan to guide activities. The DCI and stakeholders within GoPNG have highlighted the need for enhanced oversight of the ICT sector, and for a structured plan to guide policy development. This ICT sector roadmap ("ICT roadmap") has been developed to provide the DCI with the basis for formulating an overarching ICT sector policy to guide the development of the sector.

The ICT roadmap has been developed through consultation with the DCI, the World Bank, ICT sector stakeholders including telecommunications operators and government departments, and is in line with international best practice. It builds on the policy objectives of the GoPNG, as outlined in:

¹ See <http://www.worldbank.org/en/country/png/overview>

² Capacity building for policy making, M Babatunde Fafunwa for the DCI, October 2013

- the National ICT Policy Phase 1 (2008) and Phase 2 (2009)
- the National ICT Act 2009
- the National Broadband Policy (2013)

The ICT roadmap details key activities to be targeted in the short, medium and long term, so that the DCI can develop the relevant policy accordingly. It should be noted that the ICT roadmap is not an exhaustive list of activities, nor is it designed to be future proof in the face of a rapidly evolving ICT market. The roadmap should be considered as a live document and will be regularly reviewed by the DCI to monitor progress and updated to ensure the roadmap activities remain relevant and up to date.

The DCI is expected to explore areas of focus as they become priorities and develop policies or programmes in collaboration with stakeholders in government, industry and the public. The ability for the DCI to develop appropriate policies, and to deliver the activities outlined in the ICT roadmap, is dependent on the department receiving greater levels of funding to alleviate current resource constraints. Implementation considerations for the ICT roadmap are discussed in Section 3, and this should be read in conjunction with the capacity building plan prepared for the DCI.³

1.3 Content of this report

This report presents the output from Task 2 of Analysys Mason's engagement, as summarised in Figure 1.1 below.

³ A capacity building plan was provided to the DCI by Analysys Mason on 29 March 2018 – *Capacity-building plan* (ref. no. 2009803-124)

Figure 1.1: Summary of Task 2 [Source: Analysys Mason inception report, 2017]

Task	Task title	Summary description of task
T2	Framework to improve the availability of ICT services	<ul style="list-style-type: none"> The aim of this task is to provide guidance to the DCI on how to improve the availability of ICT services, access to ICT and to improve usage and take-up of ICT We will consult with the DCI to understand what activities it is currently pursuing against the following areas of the digital framework: <ul style="list-style-type: none"> Digital infrastructure (e.g. availability of telecoms networks, data centres, IXPs, payment systems) Digital government (eGovernment to increase the efficiency and effectiveness of government services) Digital services (availability and affordability of digital services, and development of local online content) Digital skills (ICT literacy to promote take-up of digital services, and support ICT employment) Digital business environment (support for innovation and R&D, start-ups, and access to finance) Digital safety (cybersecurity, fraud prevention, consumer rights and data protection for digital services) We will make recommendations for the DCI against each of these areas, supported by case studies of approaches taken in other countries

Through discussions with the DCI, it has been agreed that the output from this task should be an overarching ICT roadmap containing suggested policies and activities to guide the development of the ICT sector and the growth of a digital economy in PNG.

This report outlines the proposed ICT roadmap and provides a set of suggested policies and activities to be developed by the DCI to improve availability of, access to, and take-up of ICT services. The remainder of this document is structured as follows:

- **Section 2** contains an assessment of the current state of the ICT sector in PNG
- **Section 3** contains the objectives, digital framework and detailed activities of the ICT roadmap
- **Section 4** discusses the implementation of the ICT sector roadmap
- **Annex A** contains case studies related to the digital framework areas

2 Current state of the ICT sector in PNG

2.1 The transformative potential of ICT in PNG

The ICT environment in PNG is currently less developed than in many of its peers in Asia-Pacific, and this has constrained the development of all sectors of the economy. This can be partly attributed to a historical lack of government focus on ICT development, with insufficient resources committed to the formulation and implementation of effective ICT policy.

ICT has the potential to drive significant economic growth in PNG, deliver great benefits to citizens, and transform the delivery of government services:

- **ICT can become a major source of employment** as illustrated by Singapore, where the ICT sector employs 5% of the national workforce and contributes over 10% of the country's gross domestic product (GDP).
- Beyond the direct economic contribution of the ICT sector, **ICT can deliver benefits across the economy by making all industries more productive and efficient**. Studies suggest that a 10% increase in broadband penetration in developing countries is correlated with a 1.35% increase in GDP.⁴
- **ICT has the power to deliver significant social and economic benefits to citizens**, providing greater economic opportunities, reducing poverty and hunger, and improving access to healthcare and education services.⁵ Increased adoption of digital technologies can increase innovation, efficiency and inclusion, as well as achieving economic growth and job creation. The World Bank has forecast that the contribution of ICT to PNG's economy could grow from USD465 million in 2014 to USD2.4 billion by 2040.⁶
- Finally, effective government **use of ICT for e-government can improve the delivery of public services and improve citizen satisfaction**, while also driving efficiencies and cost savings across the public sector. Central co-ordination across ministries is essential, and the government of the Republic of Korea (South Korea) estimates it has achieved savings of USD700 million per annum by implementing interoperability standards for all government ICT systems.

⁴ See <http://bit.ly/2GQbgJh> for further details

⁵ World Bank, *World Development Report 2016: Digital Dividends*; see <http://bit.ly/1lhG3Yo>

⁶ World Bank, *Pacific Possible*, 2017; see <http://bit.ly/2xYBUvJ>

2.2 Internet in PNG

Mobile internet penetration (3G and 4G) in PNG has grown rapidly over the last 10 years but had only reached 10% in 2016 (see Figure 2.1), and total mobile penetration (including 2G) has only reached 30%.⁷ Until 2013, internet access grew in line with household computer access. Since 2013, the growth of internet access has strongly outpaced growth in computer access – reflecting the fact that growth in internet access is now being driven primarily by mobile internet (3G services), rather than fixed internet access via computers – as shown in Figure 2.2 below.

Figure 2.1: Mobile service penetration in PNG

[Source: Source: GSMA Intelligence, Q4 2017]

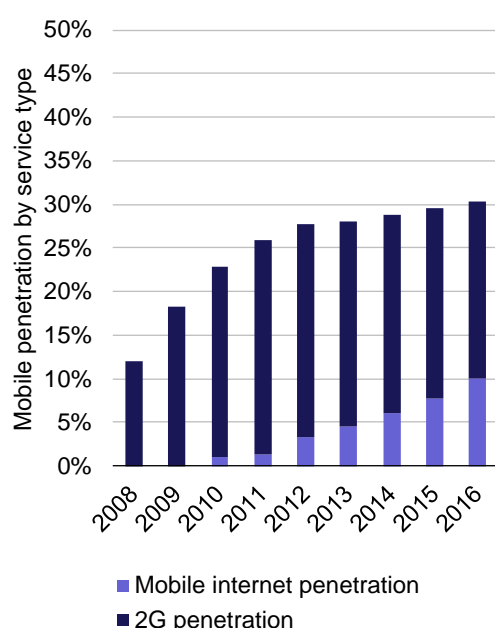
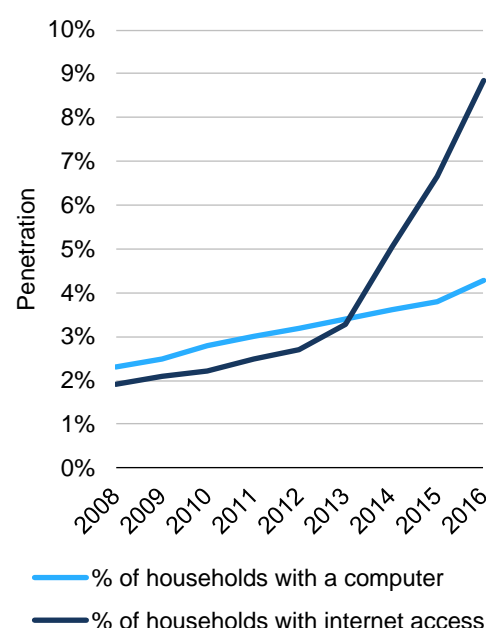


Figure 2.2: Computer and internet access in PNG

[Source: ITU, December 2017]



To place PNG in an international context, we have benchmarked various metrics in PNG against 15 countries in the Asia-Pacific region – with a mix of developed, developing nations. Mobile internet penetration (unique users out of total population) has been taken as a proxy for internet access in PNG, with overall penetration at 10% as of Q4 2017. However, PNG has significantly lower internet penetration than comparable Pacific island nations such as Vanuatu (24%) and Fiji (49%) – as shown in Figure 2.3.

⁷ It should be noted that, due to the challenges with data collection in PNG, there is a significant level of uncertainty in the reported values for ICT sector related indicators

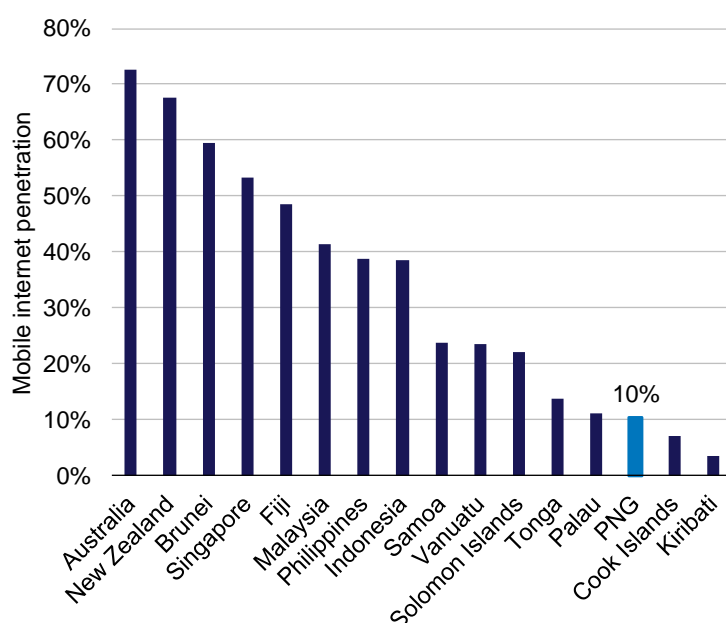


Figure 2.3: Mobile internet penetration
 [Source: GSMA Intelligence, Q4 2017]

These low levels of penetration are likely to be constrained by two supply-side factors, in addition to demand-side factors such as digital literacy and the perceived relevance of online services:

- **Availability:** 3G coverage in PNG has rapidly grown since 2012, from 12% to 74% at the end of 2017. However, coverage in PNG still lags behind benchmark countries – limiting access to services (see Figure 2.4). Around one quarter of the population do not have access to mobile internet services, with significant challenges in further network rollouts due to the challenging geography of PNG.
- **Affordability:** Service pricing in PNG is significantly higher than international comparisons – based on the cheapest monthly data package of each country’s largest mobile operator (see Figure 2.5). In PNG, this package costs USD22 (PGK68), equivalent to almost 10% of monthly GDP per capita. These high costs limit the affordability of mobile internet services for much of the population.

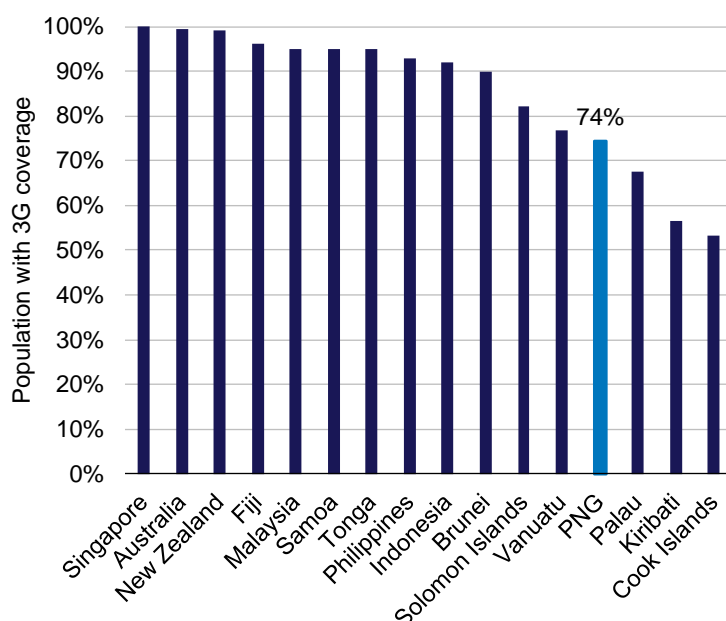


Figure 2.4: 3G coverage in PNG
[Source: GSMA Intelligence, Q4 2017]

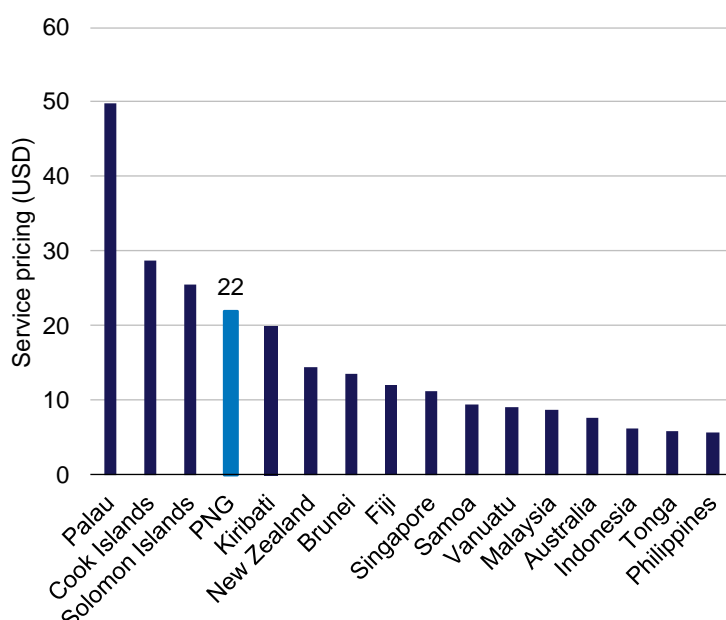


Figure 2.5: Service pricing⁸ [Source: Operator websites, March 2018]

2.3 Recent and ongoing developments in PNG

To provide a baseline against which to develop a future roadmap for the ICT sector, we performed a review of the current state of the sector and identified key recent and ongoing developments. This review was based on consultation with industry stakeholders, supported by desk research.

Selected key developments are shown in Figure 2.6 below, categorised against the digital framework used to frame the ICT sector roadmap (see Figure 3.1 below). Many of these activities

⁸ Service pricing based on the cheapest monthly pre-paid data package of each country's largest operator in March 2018.

are expected to result in significant improvements in the digital economy in PNG, and have shaped the activities recommended in the roadmap in Section 3 below.

Figure 2.6: Selected developments in the ICT sector in PNG [Source: Analysys Mason, 2018]

Framework area	Development	Details
Digital infrastructure	Internet Exchange Point	<ul style="list-style-type: none"> A neutral Internet Exchange Point (IXP) was formed in Port Moresby in 2017 after three years of development As of December 2017, 18 companies in PNG signed up to IXP including BeMobile and Digicel The IXP is expected to lower cost of services, and reduce the reliance on expensive international transit, by keeping more traffic on local networks
Digital infrastructure	New submarine cables	<ul style="list-style-type: none"> A new international submarine cable between Port Moresby and Sydney is currently in the scoping stage, and is expected to significantly improve international connectivity in PNG A domestic submarine cable linking Port Moresby to 11 cities in PNG, with an interconnection to Indonesia, is in the planning stage and is expected to improve connectivity and backhaul availability around PNG
Digital government	Digitising data collection	<ul style="list-style-type: none"> The Department of Education (DoE) worked with a local firm in PNG to develop a data collection app for schools The MyPNGSchool app can be used to provide data on student enrolment and teacher numbers directly to the DoE, simplifying data collection and improving accuracy
Digital government	E-government policy	<ul style="list-style-type: none"> The DCI is in the process of developing an overarching e-government policy to develop a secure system for shared services, manage the underlying infrastructure and promote usage and best practices
Digital government	National ID Programme	<ul style="list-style-type: none"> A National ID Programme is currently in progress in PNG aiming to provide all 8 million citizens with an ID card by 2021 As of February 2018, a total of 357 000 ID cards had been issued with a target of 1.5 million additional ID card by the end of 2018
Digital services	Mobile cash	<ul style="list-style-type: none"> MiBank, a microfinance project co-funded by the Asian Development Bank, Australian Aid and GoPNG, has launched mobile cash and micro-insurance products in PNG
Digital services	Mobile banking	<ul style="list-style-type: none"> Many banks in PNG currently offer mobile banking, including by 'short codes',⁹ but features are often limited to Digicel's mobile network Kina Bank, a local PNG bank, launched two smartphone enabled mobile banking apps in 2017 focussed on the retail and enterprise markets
Digital skills	ICT in universities	<ul style="list-style-type: none"> The DoE is providing support to universities to develop an online presence and use digital technologies as part of their teaching Divine Word University is developing online learning programmes planned to launch in 2018

⁹ Short codes are short sequences of numbers and characters used by telecommunications operators and service providers to enable automated services based on SMS messages

Framework area	Development	Details
Digital skills	ICT in schools	<ul style="list-style-type: none"> E-libraries containing ~500 000 books and 37 million articles are currently being rolled out to schools in PNG This programme was developed as a partnership between the DoE and a local PNG company, with the application designed specifically for offline use in schools without internet connectivity
Digital business environment	Financial inclusion	<ul style="list-style-type: none"> The Bank of PNG (BPNG), in partnership with the Centre for Excellence in Financial Inclusion (CEFI) is currently undertaking a digital mapping exercise to map financial infrastructure, for example ATMs, bank branches and card payment terminals The project is expected to produce a dashboard map, allowing areas lacking financial infrastructure to be identified Other work being undertaken by CEFI working groups includes; financial literacy in the national curriculum, consumer protection, and improving access to finance for SMEs and agricultural enterprises
Digital business environment	PNG ICT clusters	<ul style="list-style-type: none"> A PNG ICT cluster, formed in 2014 with funding from the European Commission, aims to provide a forum linking ICT start-ups, universities and the government A PNG cluster was recently reported to be fund-raising and providing training for ICT start-ups pitching for investor funding
Digital safety	Cyber-crime and cyber-security	<ul style="list-style-type: none"> The cyber-crime policy was approved in 2014 and the cyber-crime code act was passed by parliament in 2016, creating new offences related to cyber-crime and providing capacity for enforcement A cyber-security policy is currently under development by NICTA and the DCI in consultation with the International Telecommunications Union (ITU) A cyber-security forum has recently been launched with support from the BPNG
Digital safety	PNG CERT	<ul style="list-style-type: none"> A Computer Emergency Response Team (CERT) for PNG was established in November 2017 to respond to cyber-security incidents and provide support to the ICT sector Over the next 12 months, PNGCERT aims to develop its basic infrastructure and start providing support for incident response

2.4 Current priorities of the PNG government

The government of PNG has published several strategy documents outlining development priorities for the country, with the aim of developing PNG into a “*smart, fair, wise, healthy and happy nation*”.¹⁰ However, there is a lack of explicit focus on the role that ICT can play in driving economic development and transforming other sectors of the economy. ICT policy in PNG is

¹⁰ For further details, see Annex C of the report provided to the DCI by Analysys Mason on 12 October 2017 – *Policy framework and monitoring and evaluation framework* (ref. no. 2009803-184)

currently set by the National ICT Policy 2008 and the National ICT Act 2009, but these have not been updated since their approval 10 years ago.¹¹

The Alotau Accord II¹² identifies priorities for the development of PNG over the next five years, including economic growth, infrastructure, law and order, education and health. ICT can play a key role in realising these priorities, however just 2 of the 85 priorities specifically relate to the role of ICT:

- completion of the national fibre-optic cable infrastructure¹³
- delivering e-commerce, e-health, e-agriculture and e-government

From discussions with the DCI, Analysys Mason understands that, as part of its wider strategy, the government of PNG would like to focus on:

- using ICT to drive economic growth
- increasing the affordability of internet access
- preparing for the APEC summit

These priorities are reflected in the activities identified in the ICT roadmap below.

¹¹ A review of the National ICT Policy 2008 and the National ICT Act 2009 was provided to the DCI in an Analysys Mason deliverable on 29 March 2018 - *Review of the DCI's status with the Government of Papua New Guinea, and ICT sector policies* (ref. no. 2009803-123).

¹² The Alotau Accord II is the coalition government agreement, as provided to Analysys Mason by the DCI in October 2017.

¹³ This infrastructure includes the national transmission network and the national submarine fibre-optic cable deployments.

3 ICT sector roadmap

3.1 Mission statement and objectives

The limited capacity of the DCI means there has been a lack of clear direction for policy making. The ICT roadmap presented in this document aims to provide strategic direction for the DCI's future activities, and this requires a clear definition of the department's overall mission. Based on consultation with the DCI, a new mission statement for the department has been developed as follows:

“Enabling the use of appropriate and affordable digital technologies in Papua New Guinea, for the benefit of all”

The DCI will use the mission statement to guide its activities and policy formulation, and to help shape the development of the digital economy in PNG. All activities outlined in the ICT roadmap are designed to support the overall mission statement.

3.2 Digital framework

To support the development of a clear and comprehensive ICT roadmap, activities have been classified within a digital framework. This framework comprises six focus areas, which have been identified as key elements in supporting the DCI's mission. These six digital framework areas are linked, and many activities in the ICT roadmap will address more than one area. The six framework areas are shown in Figure 3.1 below.

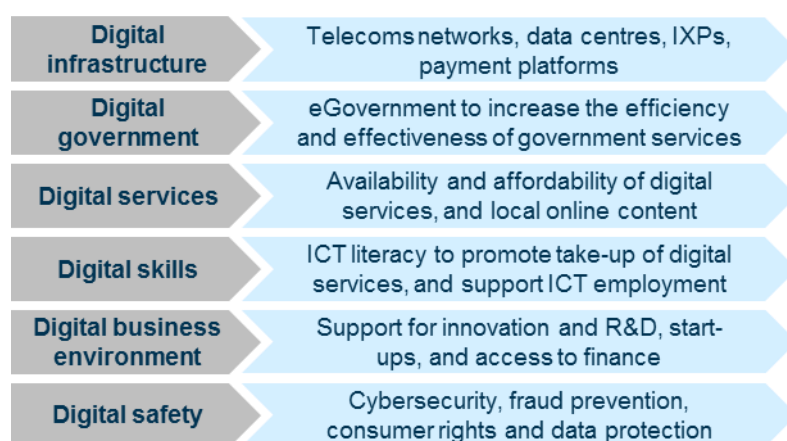


Figure 3.1: Framework areas in the ICT roadmap [Source: Analysys Mason and DCI, 2017]

This framework enables a clear, structured approach to promoting development. The areas of the framework are linked but allow for activities to be clearly categorised, and similar frameworks are used by other policy makers around the world. The framework areas are discussed in turn in the following subsections. International case studies in each of these areas are provided in Annex A.

Digital infrastructure

Digital infrastructure underpins the delivery of digital services. Rolling out widespread, modern and resilient infrastructure with sufficient capacity is key to development of the ICT sector in PNG. Activities within this framework area are focused on developing the availability and quality of telecoms networks, and supporting infrastructure such as data centres, internet exchange points (IXPs), international gateways and payment platforms. Initiatives should also aim to ensure that infrastructure is deployed in a way that encourages effective competition and supports the provision of affordable services.

Case studies

- The impact of international gateway liberalisation (Section A.1.1)
 - National broadband infrastructure in Malaysia (Section A.1.2)
 - Free Wi-Fi in the Philippines (Section A.1.3)
-

Digital government

Delivering government services digitally can drive take-up and use of digital services, both inside government and across the wider PNG public. The digitisation of services can bring significant cost savings for governments, and the infrastructure deployed to support e-government can promote wider access to digital services. Short-term activities within this framework focus on digitising high-volume transactions (such as tax payments or birth registrations) to promote the use of ICT for citizen-to-government interactions and building awareness and take-up of ICT.

Case studies

- Modernising the Argentinian civil service (Section A.2.1)
 - Delivering e-Government in Singapore (Section A.2.2)
-

Digital services

Digital infrastructure is important in enabling connectivity, but it is the adoption of online services that use this connectivity which will create value for PNG. Citizens and businesses can benefit from access to information, tools to improve productivity and efficiency, and improved access to services such as health and education. Activities within this framework are focused on promoting the provision and take-up of affordable, relevant digital services, and supporting the development of local content.

Case studies

- Promoting online service delivery in local languages (Section A.3.1)
 - E-health in the Philippines (Section A.3.2)
-

Digital skills¹⁴

For citizens in PNG to use digital services, they must have the necessary skills, and promoting digital literacy among citizens and businesses will be a key component of developing a strong ICT ecosystem. Providing practical ICT skills training to targeted segments of the population can increase demand for digital services and grow the digital economy. In the longer term, the development of an ICT curriculum for educational institutions will help to create a skilled ICT workforce and thus support the development of a vibrant local ICT sector.

Case studies

- Developing ICT skills in Rwanda (Section A.4.1)
- Promoting e-literacy in South Korea (Section A.4.2)

Digital business environment

A supportive business environment can drive the creation and growth of new and innovative locally developed digital services. The government of PNG can assist the provision of a stable business environment that promotes innovation by supporting technology hubs, and related policies on taxation, financial support and business incubation. The adoption of appropriate digital technologies by businesses should be encouraged, along with support for the growth of start-ups and small and medium-sized enterprises (SMEs) in priority sectors.

Case studies

- Supporting entrepreneurs in Chile (Section A.5.1)
- Supporting start-ups in Thailand (Section A.5.2)

Digital safety

The take-up of digital services can be promoted by providing a safe, secure digital environment. A key step in developing a thriving ICT ecosystem is to provide PNG consumers and businesses with the confidence they need to undertake transactions online. Tools to prevent fraud and promote trust should be developed and provided to consumers and businesses. Equally, ensuring the cyber security of critical ICT infrastructure in PNG and preventing cyber-attacks will help to create a stable environment and promote the use of digital services. Finally, the development of legislation on consumer rights and data protection can help give consumers confidence to trust online services.

Case studies

- Supporting digital payments in Thailand (Section A.6.1)
- Managing cyber security in South Korea (Section A.6.2)

¹⁴ It should be noted that there is limited evidence of the success of large scale digital skills programmes due to challenges in measuring meaningful outputs, however a lack of digital skills has been shown to be a major barrier to the adoption of digital services

3.3 Roadmap activities

A summary of activities suggested in the ICT roadmap to support development of the digital economy in PNG is provided in Figure 3.2 below. Each activity is designed to contribute to the objectives and mission statement of the ICT roadmap. The activities have been developed after consultations with the DCI and stakeholders to understand the current state of the sector, and a gap analysis against international best practice.

Activities are grouped according to the suggested timeframe for implementation:

- **Short-term** activities should be targeted within the **next two years**
- **Medium-term** activities should be targeted within the next **three to five years**
- **Long-term** activities should be targeted within the next **five to ten years**.

The individual activities in these four categories are described in more detail in Sections 3.4 to 3.6 below. In each case, suggested actions are provided, as well as verifiable indicators and outcomes. These indicators and outcomes should be used as the basis for developing monitoring and evaluation strategies for each activity.¹⁵

The activities identified as short-term priorities are likely to remain relevant over the next two years, however medium-term and long-term activities are more likely to be subject to change as the ICT market develops. The roadmap should be considered as a live document and it should be regularly reviewed to monitor progress, and updated to ensure the roadmap activities remain relevant in the face of a rapidly evolving market.

¹⁵ A monitoring and evaluation framework was provided to the DCI by Analysys Mason on 12 October 2017 in the report *Policy framework and monitoring and evaluation framework* (ref. no. 2009803-184).

Figure 3.2: Summary of the ICT roadmap [Source: Analysys Mason, 2017]

	Short term	Medium term	Long term
Digital infrastructure	<ul style="list-style-type: none"> ▪ Liberalisation of the IGX ▪ NTN and wholesale access ▪ International connectivity ▪ Land rights ▪ Preparation for APEC summit 	<ul style="list-style-type: none"> ▪ Mobile market review ▪ Connectivity for education ▪ Connectivity for healthcare 	<ul style="list-style-type: none"> ▪ Promotion of high-speed networks ▪ Government-owned satellite
Digital government	<ul style="list-style-type: none"> ▪ Management and use of IGIS ▪ Digitisation of the civil service ▪ Data collection ▪ Government ICT procurement ▪ Formalise the DCI's status 	<ul style="list-style-type: none"> ▪ Phase 2 of IGIS ▪ Single digital identity (ID) ▪ Unified government data portal ▪ Online e-government services 	<ul style="list-style-type: none"> ▪ Provision of all government services online
Digital services	<ul style="list-style-type: none"> ▪ Registration of mobile SIMs ▪ DTT switchover ▪ Mobile money ▪ Media and broadcasting review ▪ Digital agriculture 	<ul style="list-style-type: none"> ▪ Local traffic caching ▪ Promoting local content ▪ E-commerce stimulation 	
Digital skills	<ul style="list-style-type: none"> ▪ Training for civil servants ▪ Digital hubs ▪ Essential digital skills programme 	<ul style="list-style-type: none"> ▪ Sector-focused digital skills programmes ▪ Digital education curriculum 	<ul style="list-style-type: none"> ▪ Remote community outreach ▪ Advanced ICT training programmes
Digital business environment	<ul style="list-style-type: none"> ▪ Lowering barriers for ICT start-ups 	<ul style="list-style-type: none"> ▪ Innovation hubs ▪ Review of environmental impact 	<ul style="list-style-type: none"> ▪ Regional collaboration ▪ Business growth support
Digital safety	<ul style="list-style-type: none"> ▪ Raising cyber-security and cyber-crime awareness ▪ Cyber-security and incident response 	<ul style="list-style-type: none"> ▪ Update data protection and privacy legislation 	

3.4 Short term

Figure 3.3: Short-term activities suggested for the DCI [Source: Analysys Mason]

Activity	Framework area	Actions	Outcomes & benefits for PNG	Suggested partner agencies
Liberalisation of International Gateways (IGX)	Digital infrastructure	<ul style="list-style-type: none"> Liberalise access to data IGX's by requiring wholesale access for all operators Develop a policy governing licensing of new data IGX operators 	<ul style="list-style-type: none"> Policy on licensing data IGXs approved by National Executive Council (NEC) Number of operators with access to IGX increases Lower retail cost of internet access and international connectivity (IP transit) 	<ul style="list-style-type: none"> NICTA
NTN and wholesale access	Digital infrastructure	<ul style="list-style-type: none"> Review strategic options for wholesale infrastructure access requirements, including mandated infrastructure sharing DCI to obtain oversight of the deployment and operational status of the national transmission network (NTN) Increase the number of rural breakout points Develop interconnection agreements with Indonesia 	<ul style="list-style-type: none"> Increased retail competition Take-up of wholesale services by operators Reduction in cost of ICT services DCI to obtain regular updates on the status of the NTN Increased national and international connectivity (km of fibre and capacity available) Increased redundancy in international connectivity 	<ul style="list-style-type: none"> NICTA Telikom PNG DataCo
International connectivity	Digital infrastructure	<ul style="list-style-type: none"> Review and finalise plans for proposed APNGG-3 cable, including possible collaboration with Australia Review legal and licensing requirements for establishing submarine cable landing stations and assess barriers to increased international connectivity Develop policy to promote international connectivity 	<ul style="list-style-type: none"> Policy on international connectivity approved by the NEC Increased capacity for transit of international IP traffic Increased number of suppliers of international IP transit Lower wholesale and retail prices 	<ul style="list-style-type: none"> NICTA

Activity	Framework area	Actions	Outcomes & benefits for PNG	Suggested partner agencies
Land rights	Digital infrastructure	<ul style="list-style-type: none"> Review legislation on rights of way and wayleaves for infrastructure deployment (e.g. fibre and mobile towers) Publish document clarifying requirements, rights and responsibilities for landowners and infrastructure owners Provide a document highlighting challenges and areas for policy development in the context of telecoms infrastructure Develop an approach to digitising land records 	<ul style="list-style-type: none"> Guidelines on land access and infrastructure deployment published Increased infrastructure deployment via simplified process Digitised land ownership records, simplifying process of identifying land owners 	<ul style="list-style-type: none"> Department of Lands & Physical Planning
Preparation for APEC summit	Digital infrastructure	<ul style="list-style-type: none"> Work with APEC organising committee to identify ICT infrastructure needs Identify delivery partners to provide suitable infrastructure in time for summit 	<ul style="list-style-type: none"> APEC summit provided with suitable connectivity and ICT infrastructure PNG is able to showcase its abilities and ICT infrastructure on a global scale 	<ul style="list-style-type: none"> APEC planning committee
Management and use of Integrated Government Information System (IGIS)¹⁶	Digital government	<ul style="list-style-type: none"> Establish a high-level whole-of-government committee to oversee IGIS and implementation of e-government agenda Both infrastructure (e.g. fibre-optic backbone networks) and services (e.g. the national data centre, internet and email) should be considered Draft IGIS and e-government policy, including interoperability requirements Assess potential transfer of IGIS infrastructure to DataCo under appropriate terms (including service-level agreements, access pricing, and ownership of concessional loan) 	<ul style="list-style-type: none"> High-level government committee established, with reporting lines to Ministry of Energy, Communication, and Information Technology, and the Prime Minister Increased service levels and availability of IGIS Cost savings for government use of IGIS network and facilities Increased use of IGIS network and facilities 	<ul style="list-style-type: none"> NEC

¹⁶ Analysys Mason understands that on 27 September 2017 the DCI released terms of reference for development of a broader e-government policy covering IGIS, the Internet & Email policy, securing government data, the development of common government ICT platforms, and the promotion of ICT within government.

Activity	Framework area	Actions	Outcomes & benefits for PNG	Suggested partner agencies
Digitisation of the civil service¹⁷	Digital government	<ul style="list-style-type: none"> • Create online system for submission of policies and legislation to the NEC • Develop and implement a Data and Information Access and Exchange policy, for approval by the NEC • Finalise broader e-government policy, including Internet & Email policy, for approval by the NEC 	<ul style="list-style-type: none"> • Full online management of the NEC submission process • Implementation of a standardised approach to data management, internet and email across government, approved by the NEC and mandated by law • Increased use of government email facilities • Reduced printing expenditure by government 	<ul style="list-style-type: none"> • NEC • Department of Personnel Management
Data collection	Digital government	<ul style="list-style-type: none"> • Develop and implement a policy for collection and management of ICT sector statistics • Submit an amendment to the NICT Act to provide the DCI with appropriate data collection powers • Procure an integrated data management and open-data platform¹⁸ 	<ul style="list-style-type: none"> • Policy on data collection and management approved by the NEC • DCI provided with the required data-collection powers • Increased levels of market and industry data held by the DCI 	<ul style="list-style-type: none"> • NEC
Government ICT procurement	Digital government	<ul style="list-style-type: none"> • Develop a policy for centralised procurement, or mandated procurement standards, for government ICT hardware and software, and gain approval from the NEC • This policy should reflect the balance required between cost-savings and providing small enterprises with the ability to tender for government contracts • Central oversight and approval of ICT procurements over a threshold (e.g. PGK1 million) should be considered 	<ul style="list-style-type: none"> • Policy approved by the NEC and implemented • Increased value for money from government ICT spending • Improved standardisation across departments 	<ul style="list-style-type: none"> • NICTA • DOPM?

¹⁷ Suggested monitoring and evaluation criteria for the Internet & Email policy were provided to the DCI by Analysys Mason on 12 October 2017 – *Policy framework and monitoring and evaluation framework* (ref. no. 2009803-184).

¹⁸ An approach to data collection, data management and data-sharing was provided to the DCI by Analysys Mason on 29 March 2018 – *Strategic approach to the collection and management of ICT sector statistics* (ref. no. 2009803-133).

Activity	Framework area	Actions	Outcomes & benefits for PNG	Suggested partner agencies
Formalise the DCI's status	Digital government	<ul style="list-style-type: none"> Formalise the DCI's status via an NEC amendment and an amendment to the NICT Act 2009¹⁹ Explore the potential of providing the DCI with central agency status within GoPNG 	<ul style="list-style-type: none"> Establishment of new DCI powers approved by the NEC, including detailed roles and responsibilities Increased ability of DCI to deliver effective policies, programmes and advice to other government departments 	<ul style="list-style-type: none"> NEC
Registration of mobile SIMs	Digital services	<ul style="list-style-type: none"> Complete registration of SIMs Implement approach to manage deactivation of non-registered SIMs, including communication and enforcement plan 	<ul style="list-style-type: none"> All SIMs in PNG registered by deadline Any non-registered SIMs deactivated after appropriate warning period Potential increase in secure e-commerce through digital ID's linked to sim cards 	<ul style="list-style-type: none"> NICTA
Digital terrestrial television (DTT) switchover	Digital services	<ul style="list-style-type: none"> Implement the DTT switchover, building on the ITU DTT roadmap for PNG²⁰ Consider appropriate support to state and private operators to ensure successful switchover 	<ul style="list-style-type: none"> DTT switchover completed 700 MHz spectrum repurposed 	<ul style="list-style-type: none"> NICTA NBC
Mobile money	Digital services	<ul style="list-style-type: none"> Review legal requirements for mobile money systems and services Develop a policy to promote the development and take-up of mobile money systems and services 	<ul style="list-style-type: none"> Policy approved and implemented, including guidelines on legal requirements and security standards Increased usage of mobile money in PNG Greater financial inclusion of citizens 	<ul style="list-style-type: none"> Bank of PNG

¹⁹ A strategy for formalising the DCI's status was provided to the DCI in an Analysys Mason deliverable on 29 March 2018 - *Review of the DCI's status with the Government of Papua New Guinea, and ICT sector policies* (ref. no. 2009803-123).

²⁰ See <http://bit.ly/2otaw5R> for further details

Activity	Framework area	Actions	Outcomes & benefits for PNG	Suggested partner agencies
Media and broadcasting review	Digital services	<ul style="list-style-type: none"> Evaluate the current state of the media market in PNG, including cross-media ownership, convergence, policy and legislation Benchmark relevant policy approaches in developed nation Develop updated media and broadcasting policy for approval by the NEC 	<ul style="list-style-type: none"> New media and broadcasting policy approved and implemented 	<ul style="list-style-type: none"> NICTA NBC
Digital agriculture	Digital services	<ul style="list-style-type: none"> Collaborate with the Department of Agriculture & Livestock to develop a policy framework promoting the adoption of e-agriculture solutions Develop partnerships with appropriate organisations to deliver services 	<ul style="list-style-type: none"> Policy on e-agriculture approved by the NEC E-agriculture services delivered in PNG Take-up of services within pilot communities Increased ease of access to relevant information and trading markets 	<ul style="list-style-type: none"> Department of Agriculture & Livestock
Training for civil servants	Digital skills	<ul style="list-style-type: none"> Develop a training programme for civil servants to promote the use of government ICT facilities provided through IGIS e.g. email, data hosting service etc. 	<ul style="list-style-type: none"> Number of civil servants participating in programme Increased use of IGIS facilities Reduction in travel and ICT costs for government 	<ul style="list-style-type: none"> Department of Personnel Management
Digital hubs²¹	Digital skills	<ul style="list-style-type: none"> Identify target settlements for digital hubs Assess operating models and partnership requirements for digital hubs Establish a network of digital hubs in major settlements in collaboration with the Department for Provincial and Local Level Government 	<ul style="list-style-type: none"> Digital hubs established in target settlements Increased access to ICT facilities, connectivity, and digital skills training to promote adoption 	<ul style="list-style-type: none"> Department for Provincial and Local Level Government
Essential digital skills programme	Digital skills	<ul style="list-style-type: none"> Develop a training programme on essential digital skills to be delivered at digital hubs in collaboration with the Department of Education Identify suitable organisations to deliver training programme 	<ul style="list-style-type: none"> Training programme delivered at digital hubs Increased ICT literacy and use of digital hubs 	<ul style="list-style-type: none"> Department of Education

²¹ Analysys Mason understands that the establishment of digital hubs is included within the Rural Communications Project; see <http://bit.ly/2FxWvva> for further details

Activity	Framework area	Actions	Outcomes & benefits for PNG	Suggested partner agencies
Lowering barriers for ICT start-ups	Digital business environment	<ul style="list-style-type: none"> Consult local ICT start-ups and the PNG ICT cluster to identify key barriers and recommend potential solutions Dedicated support for SMEs should be considered Develop associated policy, and recommendations for other government departments 	<ul style="list-style-type: none"> Increased number of ICT start-ups Simplified process for starting an ICT business 	<ul style="list-style-type: none"> Department of Treasury
Raising cyber-security and cyber-crime awareness	Digital safety	<ul style="list-style-type: none"> Develop communication plan to raise awareness of cyber-crime and cyber-security Develop guidelines for the role of the police and NICTA in investigating cyber crime 	<ul style="list-style-type: none"> Increased reporting of cyber-crime incidents Increased investigation and effective responses to incidents Guidelines on the role of NICTA and the police during cyber-crime investigations published 	<ul style="list-style-type: none"> NICTA Department of the Attorney General
Cyber-security and incident response²²	Digital safety	<ul style="list-style-type: none"> Finalise draft cybersecurity policy and pass into legislation Establish Computer Incident Response Team (CERT) Conduct national cybersecurity audit including critical government and industry ICT assets 	<ul style="list-style-type: none"> List of critical infrastructure assets with protection plans and recovery policies 	<ul style="list-style-type: none"> NICTA Department of the Attorney General

²² Analysys Mason understands that a CERT was established in PNG in November 2017, see <http://bit.ly/2CL6o5y> for further details

3.5 Medium term

Figure 3.4: Medium-term activities suggested for the DCI [Source: Analysys Mason, 2017]

Activity	Framework area	Actions	Outcomes & benefits for PNG	Suggested partner agencies
Mobile market review	Digital infrastructure	<ul style="list-style-type: none"> Review mobile market dynamics Consider options for enhancing retail competition Develop policy on improving competition in the mobile market for approval by NEC 	<ul style="list-style-type: none"> Policy approved by the NEC Increased level of competition in the mobile market Lower retail prices 	<ul style="list-style-type: none"> NICTA
Connectivity for education	Digital infrastructure	<ul style="list-style-type: none"> Identify target educational establishments for connection Conduct options analysis for connecting target educational establishments to the internet including sustainability of the potential connectivity model Develop an implementation plan to connect educational establishments, for approval by the NEC 	<ul style="list-style-type: none"> Implementation plan approved Target establishments connected PNG universities connected to TIEN3²³ and worldwide academic networks Increased use of internet and e-education services in connected establishments 	<ul style="list-style-type: none"> Department of Education
Connectivity for healthcare	Digital infrastructure	<ul style="list-style-type: none"> Identify target medical establishments for connection Conduct options analysis for connecting targeted medical establishments to the internet Develop an implementation plan to connect health establishments, for approval by the NEC 	<ul style="list-style-type: none"> Implementation plan approved Target establishments connected Increased use of internet and e-health services in connected establishments 	<ul style="list-style-type: none"> Department of Health
Phase 2 of IGIS	Digital government	<ul style="list-style-type: none"> Update the planned second phase of the IGIS network as appropriate Develop an implementation plan for Phase 2 of the IGIS network, in line with e-government policy 	<ul style="list-style-type: none"> Policy approved by the NEC and IGIS Phase 2 implemented All government sites connected to IGIS Increased usage of IGIS by civil servants 	<ul style="list-style-type: none"> NICTA

²³ TIEN3 is the research and education network for Asia-Pacific; see <http://bit.ly/2F9nqzK> for further details

Activity	Framework area	Actions	Outcomes & benefits for PNG	Suggested partner agencies
Unified government data portal	Digital government	<ul style="list-style-type: none"> • Provide a single platform for online access to government data and services • Develop policy for data-sharing between government departments and open-data for citizens 	<ul style="list-style-type: none"> • Policy on internal and external data sharing approved by NEC and implemented • Unified government platform launched with communications plan to drive usage 	<ul style="list-style-type: none"> • NICTA
Online e-government services	Digital government	<ul style="list-style-type: none"> • Develop guidelines for service delivery and development of a common platforms • Consult department Chief Information Officers (CIOs) to develop departmental e-government roadmaps, prioritising key 'pain points' and meeting government-wide standards 	<ul style="list-style-type: none"> • Guidelines for service delivery and development of a common platform published • Every government department has a published departmental e-government strategy 	<ul style="list-style-type: none"> • Departmental Chief Information Officers
Single digital identity (ID)²⁴	Digital government	<ul style="list-style-type: none"> • Build on the National ID programme to develop a single digital ID for login and interactions with government and businesses online 	<ul style="list-style-type: none"> • Implementation of a single ID for authentication across all government services 	<ul style="list-style-type: none"> • Department for National Planning
Promoting local content	Digital services	<ul style="list-style-type: none"> • Develop an approach to promote development of the local content and online services sector 	<ul style="list-style-type: none"> • Increased proportion of top-100 websites to be locally hosted or in local languages • Increased number of online content and services companies in PNG 	
E-commerce stimulation	Digital services	<ul style="list-style-type: none"> • Identify programmes to support the development of e-commerce markets and solutions • Identify suitable partners for delivery of programmes • Review requirements for e-commerce legal framework (e.g. consumer protection, e-transaction laws) • Prepare e-commerce policy for approval by the 	<ul style="list-style-type: none"> • E-commerce policy approved and published • Required legal frameworks developed and passed into law • Increased provision and adoption of e-commerce services 	<ul style="list-style-type: none"> • Department of Treasury • Bank of PNG

²⁴ Currently, an individual account is required for each digital service. A single digital ID provides a unified account across all government services, and approved services from businesses. See SingPass (the digital ID for government services) and the proposed National Digital ID programme in Singapore for further details, <https://www.singpass.gov.sg>

Activity	Framework area	Actions	Outcomes & benefits for PNG	Suggested partner agencies
NEC				
Sector-focused digital skills programmes	Digital skills	<ul style="list-style-type: none"> Develop ICT training programmes for key sectors (e.g. education, healthcare, finance) Identify suitable partners for delivery of training programmes 	<ul style="list-style-type: none"> Training programmes delivered to target sectors Increased take-up and effective use of ICT within targeted sectors 	<ul style="list-style-type: none"> Appropriate sector responsible departments
Digital education curriculum	Digital skills	<ul style="list-style-type: none"> Liaise with the Department of Education to develop an ICT curriculum for schools, focused on developing age-appropriate digital skills 	<ul style="list-style-type: none"> ICT curriculum published All schools providing ICT education Increased ICT literacy among pupils 	<ul style="list-style-type: none"> Department of Education
Innovation hubs	Digital business environment	<ul style="list-style-type: none"> Identify target cities, and establish innovation hubs Identify suitable partners to provide support to start-ups and SMEs in innovation hubs Develop policy to promote an ICT start-up environment within innovation hubs 	<ul style="list-style-type: none"> Innovation hubs established with suitable partner organisations Increased number of ICT start-ups Increased utilisation of ICT in start-ups 	<ul style="list-style-type: none"> Department of Implementation and Rural Development
Review of environmental impact	Digital business environment	<ul style="list-style-type: none"> Identify current environmental impact of ICT industry Review relevant legislation Consult industry on potential approaches Develop a policy for environmentally friendly growth of the ICT industry, for approval by the NEC Provide guidelines on the use of ICT to reduce the environmental impact of businesses 	<ul style="list-style-type: none"> Policy managing environmentally friendly growth of ICT industry approved and implemented Reduced environmental impact of digital economy Increased recycling of ICT assets / e-waste Increased use of teleconferencing and remote working reported by businesses 	<ul style="list-style-type: none"> Department of Environment and Conservation
Update information and data protection	Digital safety	<ul style="list-style-type: none"> Review and update data-protection legislation, reflecting requirements for digital services 	<ul style="list-style-type: none"> New data-protection policy and legislation passed by the NEC and parliament 	<ul style="list-style-type: none"> Department of Attorney-General

Activity	Framework area	Actions	Outcomes & benefits for PNG	Suggested partner agencies
legislation		<ul style="list-style-type: none"> Review need for data sovereignty legislation, including benchmark of international experiences²⁵ 	<ul style="list-style-type: none"> Report on data sovereignty passed to minister and NEC 	

3.6 Long term

Figure 3.5: Long-term activities suggested for the DCI [Source: Analysys Mason, 2017]

Activity	Framework area	Actions	Outcomes & benefits for PNG	Suggested delivery partners
Promote high-speed fixed and mobile networks	Digital infrastructure	<ul style="list-style-type: none"> Review options for increasing network speeds Promote roll-out of fibre and other appropriate technologies 	<ul style="list-style-type: none"> Recommendations provided to NICTA/NEC on preferred approach to driving network upgrades Increased availability of high-speed internet services 	<ul style="list-style-type: none"> NICTA
Government-owned satellite	Digital infrastructure	<ul style="list-style-type: none"> Review of previous studies on a PNG-owned satellite (or purchased capacity on a transponder) 	<ul style="list-style-type: none"> Paper provided to the NEC with options analysis and preferred model 	<ul style="list-style-type: none"> NICTA
Provision of all government services online	Digital government	<ul style="list-style-type: none"> Liaise with government departments to migrate remaining citizen-facing services to online platforms 	<ul style="list-style-type: none"> All relevant government services digitised and available for public access online 	<ul style="list-style-type: none"> Appropriate government departments
Remote community outreach	Digital skills	<ul style="list-style-type: none"> Develop an ICT skills programme to build ICT literacy in remote communities 	<ul style="list-style-type: none"> Increased take-up and use of ICT and Internet access in remote communities 	<ul style="list-style-type: none"> Department of Education
Advanced ICT training programmes	Digital services	<ul style="list-style-type: none"> Develop ICT training and accreditation curriculum for higher education institutes Consultation with industry to identify skills gaps and provide targeted training 	<ul style="list-style-type: none"> Increased number of ICT graduates Skills gaps identified and targeted 	<ul style="list-style-type: none"> Department of Education
Regional	Digital	<ul style="list-style-type: none"> Promote development of regional digital 	<ul style="list-style-type: none"> Simplification of the regional ICT environment 	<ul style="list-style-type: none"> Department of

²⁵ It should be noted that care should be taken in developing new legislation, as data localisation laws have been shown to significantly reduce investment in the ICT sector and restrict development, see <http://bit.ly/2hCtfK9> or <http://bit.ly/2G40aAl> for further information

Activity	Framework area	Actions	Outcomes & benefits for PNG	Suggested delivery partners
collaboration	business environment	economy with neighbouring countries by removing barriers to collaboration and trade	<ul style="list-style-type: none"> Increased cross-border ICT trade 	Commerce & Industry
Business growth support	Digital skills	<ul style="list-style-type: none"> Evaluate policies, legislation, and regulation related to supporting the growth of digital business including; visas for skilled workers, taxation of digital businesses, ease of starting a business, and the ease of obtaining capital financing Develop updated policies, legislation, and regulations to support the growth of digital businesses 	<ul style="list-style-type: none"> Updated policies, legislation, and regulation approved by the NEC and enacted Increased value of ICT sector in PNG 	<ul style="list-style-type: none"> Appropriate government departments

4 Implementation of the ICT sector roadmap

The ICT roadmap details a range of short, medium and long-term activities to further the development of the ICT sector in PNG. It sets out an ambitious vision for PNG, and its implementation will require significant resources for the DCI. This in turn will require commitment from the top levels of PNG's government, in recognition of the transformative impact ICT can have on PNG's economy.

4.1 Implementation approach

We recommend four key focus areas to support the implementation of the ICT sector roadmap:

- Growing DCI's internal capacity
- Obtaining buy-in from senior politicians
- Collaborative approach with delivery partners
- Encouraging stakeholder engagement

Growing DCI's internal capacity

The DCI is chronically under-funded, receiving less than 0.1% of total government expenditure, compared to the governments of Fiji and Malaysia which provide 0.7% of government expenditure to their respective ministries with responsibility for ICT policy. The developed digital economies of Singapore and South Korea each spend more than 4% of their total government expenditure on their ministries with responsibility for ICT policy, reflecting the high levels of commitment to ICT.

If the DCI is to successfully deliver the activities outlined in this roadmap, it is essential that the government of PNG increases the human and financial resources available to the department. This investment in the DCI can in turn deliver significant economic benefits to PNG, by supporting the widespread availability, affordability and effective use of ICT. Analysys Mason has worked with the DCI to develop a capacity building plan to support the DCI's case for increased support from the GoPNG, and the implementation of this capacity building plan is a critical step in supporting the implementation of this ICT roadmap.²⁶

Obtaining buy-in from senior politicians

The DCI should work closely with the Minister for Information, Communication and Energy to ensure that the National Executive Committee (NEC) is aware of the importance of ICT and the potential impacts both on government and the economy. The NEC should be provided with regular

²⁶ A capacity building plan was provided to the DCI by Analysys Mason on 29 March 2018 – *Capacity-building plan* (ref. no. 2009803-124)

briefings on the process of ICT-related initiatives such as the rollout of IGIS and e-government. These briefings should be tailored to the NEC, focussing only on the high-level impacts of policies and programmes.

Collaborative approach with delivery partners

The DCI currently has limited capacity to support large-scale policy development. We suggest that the DCI identifies suitable delivery partners within GoPNG and collaborates with them during both the policy development and policy implementation stages. This would allow the DCI to leverage the experience of delivery partners and drive successful policy interventions. As part of the policy development process, the DCI should ensure that the roles and responsibilities of both the DCI and the delivery partners are clearly defined to provide clarity on the expectations of all parties involved.

Stakeholders commented that a cross-government committee should be formed to drive implementation of the roadmap, drive collaboration and promote development of the required policies. We suggest that two committees should be formed:

- A **high-level committee** consisting of officers at a departmental head or ministerial level. This committee should focus on driving collaboration across government and providing political support for the development and implementation of ICT policies.
- An **operational committee** consisting of ICT managers and policy officers across government. This committee should focus on ensuring a coherent approach to policy-development and implementation across government. This committee can be formed by re-activating the Information and Technology Board (ITB), a currently dormant committee under the remit of the DCI.

As the body with responsibility for oversight and future planning for the ICT sector, the DCI should have an appropriate representative on both committees.

Encouraging stakeholder engagement

A key issue highlighted during the stakeholder consultations was a lack of awareness of government ICT policies and initiatives. The DCI should work with the delivery partners for each policy area to develop a marketing and communications plan and encourage a high level of stakeholder engagement. An increased awareness of policies and programmes is likely to increase their effectiveness, leading to a multiplier effect, higher uptake of services and a larger market to support the development of new and innovative ICT services in PNG.²⁷

²⁷ A marketing and communications strategy was provided to the DCI in an Analysys Mason deliverable on 29 March 2018 – *Marketing and communications strategy* (ref. no. 2009803-121)

4.2 Current state assessment

A high-level assessment has been performed as part of the development of this roadmap, but we recommend that the DCI should urgently undertake a detailed current state assessment of ICT policies and activities in PNG. The DCI should conduct a consultation across all government departments and agencies in GoPNG to identify policies, legislation and activities related to the ICT sector that are in progress or have already be enacted.

We suggest that this assessment be performed using the digital framework provided in Section 3.2 above. This will provide the DCI with a simple visual tool for tracking policy development across all six framework areas, and this can be updated as part of the DCI's monitoring and oversight of the ICT sector.

Annex A Case studies

Analysys Mason has identified case studies for each of the digital framework areas, to provide the DCI with examples of the impacts government intervention can have in the ICT sector and support the implementation of the ICT roadmap. Each case study provides an overview of the policy, the impact (or expected impact), and key learnings for the DCI.

A summary of the case studies provided in Annex A is shown in Figure A.1 below.

Figure A.1: Summary of case studies [Source: Analysys Mason, 2017]

Framework area	Case studies
Digital infrastructure	<ul style="list-style-type: none"> • The impact of international gateway liberalisation (Section A.1.1) • National broadband infrastructure in Malaysia (Section A.1.2) • Free Wi-Fi in the Philippines (Section A.1.3)
Digital government	<ul style="list-style-type: none"> • Modernising the Argentinian civil service (Section A.2.1) • Delivering e-Government in Singapore (Section A.2.2)
Digital services	<ul style="list-style-type: none"> • Promoting online service delivery in local languages (Section A.3.1) • E-health in the Philippines (Section A.3.2)
Digital skills	<ul style="list-style-type: none"> • Developing ICT skills in Rwanda (Section A.4.1) • Promoting e-literacy in South Korea (Section A.4.2)
Digital business environment	<ul style="list-style-type: none"> • Supporting entrepreneurs in Chile (Section A.5.1) • Supporting start-ups in Thailand (Section A.5.2)
Digital safety	<ul style="list-style-type: none"> • Supporting digital payments in Thailand (Section A.6.1) • Managing cyber security in South Korea (Section A.6.2)

A.1 Digital infrastructure case studies

A.1.1 The impact of international gateway liberalisation

Liberalisation of international gateway (IGX) access has supported the arrival of numerous new submarine cables in West Africa over the last 15 years. Organisations such as the World Bank, the Economic Community of West African States and the ITU have supported the development of public-private partnerships (PPPs) to fund submarine cable investment, with open-access regulations to cable landing stations a requirement of funding.²⁸

Figure A.2 below illustrates the impact that liberalisation of IGXs had on data traffic in Thailand, Kenya and Singapore. Many countries liberalised their international gateways in the last decade, with assessment of the impact of liberalisation possible within a few years. Overall, liberalisation

²⁸ *Lifting barriers to Internet development in Africa: suggestions for improving connectivity*, The Internet Society, 2013; see <https://bit.ly/2pPdCB5>

has led to increased international connectivity, reduced costs for domestic and international internet connections, and higher internet penetration.

Figure A.2: Impact of internet gateway liberalisation in selected countries [Source: ITU, 2009]^{29,30}

Country	Date of IGX liberalisation	Impacts
Thailand	2007	<ul style="list-style-type: none"> International bandwidth increased by 250% Internet subscribers doubled
Kenya	2005	<ul style="list-style-type: none"> International bandwidth increased by almost 700% within one year Reduction in cost of international connectivity
Singapore	2000	<ul style="list-style-type: none"> Cost of international connectivity dropped by 95% over a seven-year period Increased number of internet service providers and lower internet prices

Liberalisation of data IGX's can dramatically reduce the cost of international connectivity, as well as generating revenue for the government through licence sales.

A.1.2 National broadband infrastructure in Malaysia

Malaysia embarked on a USD3.4 billion project to build a backhaul and access network between 2008 and 2012. The project was a PPP, with the Malaysian government contributing USD0.7 billion and the private sector contributing the remaining funding of USD2.7 billion. The project was a private-sector design, build and operate (DBO) venture – meaning that an operator led the implementation and retained ownership of the infrastructure.³¹

The operator and the government agreed a revenue-sharing scheme, through which the government received fixed payments of USD16 million per year for the first four years, followed by variable annual payments depending on the number of subscribers. The project resulted in the deployment of 51 343km of fibre, and almost 1.5 million premises passed by the fibre access network.

PPPs can be used to extend backbone and access networks further or faster than the private sector would do alone. PPP models in which operators retain ownership of the infrastructure can typically maximise the private-sector share of investment and encourage efficient network operations.

A.1.3 Free Wi-Fi in the Philippines

The Philippines is currently implementing an internet access programme, *Pipol Konek*, which provides free Wi-Fi service in public areas and state institutions. *Pipol Konek* aims to provide free,

²⁹ See <https://bit.ly/2lYt9aq> for further details

³⁰ See <https://bit.ly/2GALHPC> for further details

³¹ *Developing successful public-private partnerships to foster investment in universal broadband networks*, The ITU, 2013; see <https://bit.ly/2pLKhIx>

reliable and ubiquitous internet access to all Filipinos, by leveraging a combination of private-sector investment and USD28 million of public funding. Its focus is on increasing digital inclusion, digital service take-up, and promoting a digitally literate population.³²

The Filipino parliament has passed legislation requiring free internet service of at least 2Mbit/s per connection to be provided to the public in all state institutions within the coverage area, including government offices, hospitals, public transport terminals, parks and plazas. The programme is targeting points of presence in 31 cities and 967 municipalities.³³

Infrastructure used to connect public-sector institutions to the internet can be used to support affordable internet access to help connect the unconnected.

A.2 Digital government case studies

A.2.1 Modernising the Argentinian civil service

Since 2015, the Argentinian government has been implementing a programme to modernise all aspects of the Argentinian civil service. The programme was initially provided with funding of USD100 million (approximately 0.3% of the national government budget) and implementation is being led at national level by the newly created Ministry of Modernisation and at a local level by provincial officials. The programme is focused on four workstreams:

- modernisation of human resources management
- digitisation of department processes
- delivering an e-government agenda
- open government and public information.

In less than two years, the programme has resulted in measurable impacts in a wide range of areas. Almost 70% of provinces in Argentina have signed up to the Federal Commitment for the Modernisation of the State. Argentina has improved from 107th to 95th in the Corruption Perception Index, 46th to 41st in the UN's E-Government Development Index, and from 51st to 17th in the Global Open Data Index.³⁴

A political programme with strong leadership, clear objectives and sufficient budget allocation can have a transformative impact on public services in a short period of time.

³² *The Free Wi-Fi internet Access in Public Places Project*, Department of Science and Technology, 2015; see <https://bit.ly/2pRxAvh>

³³ *Free Wi-Fi internet Access in Public Places Terms of Reference*, The Department of ICT, 2015; see <https://bit.ly/2J0KqQg>

³⁴ *The modernisation of Argentina's public administration*, The Centre for Public Impact, 2017; see <https://bit.ly/2GAvURc>

A.2.2 Delivering e-Government in Singapore

Over the last 35 years, Singapore has implemented a series of e-government visions and strategies, and created a world-leading e-government programme. In the early 2000s, interactions identified as ‘pain points’ by citizens (high-volume transactional services such as tax payments) were initially targeted for digitisation as pilot programmes and to achieve stakeholder buy-in.³⁵

Singapore’s current e-government strategy is defined in the *Smart Nation Vision*, with implementation being led by GovTech, an agency within the Prime Minister’s Office. Singapore now delivers almost 2000 services online or over mobile and ranks 4th in the UN’s E-Government Development Index.³⁶

PNG’s e-government development should initially focus on services that can have the highest impact and should be driven by leadership from the top levels of government.

A.3 Digital services case studies

A.3.1 Promoting online service delivery in local languages

Over the last 15 years, The World Economic Forum, UNESCO and the World Bank have implemented programmes promoting internet content in local languages. Almost 50% of global internet content is in English, with 80% of all content in one of just ten languages. A lack of local content has been identified as a key barrier to take-up of digital services, especially where English is not widely spoken.

In Gabon, the government is promoting the development of services and internet content in local vernacular languages. This includes the development of an e-learning platform using three Gabonese languages, and the development of online dictionaries for local languages to support app development. In a workshop involving the Gabonese government, service providers and users, the World Bank found that developing local language content created “*a sense of pride and equality with other countries to see one’s language on the Internet*”.³⁷

Promoting relevant content in local languages can help drive the take-up of digital services; this will be especially important in PNG, given its linguistic diversity.

A.3.2 E-health in the Philippines

To overcome the challenge of delivering healthcare in remote communities, and a chronic shortage of healthcare professionals, the government of the Philippines launched the Philippines eHealth

³⁵ Study Tour Findings, Analysys Mason, September 2017 (ref. no. 2009803-371).

³⁶ *Building a digital government in Singapore*, The Centre for Public Impact, 2016; see <https://bit.ly/2i9RC2n>

³⁷ See <https://bit.ly/1o6MKT8> for details

Strategic Framework and Plan 2014–2020.³⁸ The strategy oversees the development of e-health solutions in the Philippines, including standards and interoperability, the government's investment strategy, supporting infrastructure, and suggested e-health solutions.

Under this strategy, the healthcare sector has adopted a Community Health Information Tracking System (CHITS), implementing electronic medical records in over 1500 medical institutions, including 200 rural institutions. The CHITS programme was recently extended to allow mobile devices to be used to view and update medical records via the Wireless Access for Health (WAH) programme. The WAH programme also allows healthcare professionals to send alerts to patients via SMS, and for data to be accessed and transmitted over wireless 3G networks.³⁹

Government-led e-health programmes can help provide healthcare in remote environments and promote modernisation of the health service.

A.4 Digital skills case studies

A.4.1 Developing ICT skills in Rwanda

To support the development of a digitally literate population and increase the penetration of ICT, the Rwandan government approved the inclusion of ICT in Rwanda's education policy in 2016.⁴⁰ The ICT in Education policy has four strategic objectives:

- To develop a competent and relevant ICT professional base to meet industry needs
- To increase ICT penetration and usage at all educational levels
- To develop education leadership and teachers' capacity and capability in and through ICT
- To enhance teaching, learning and research through ICT integration in higher learning institutes.

The government is providing USD42 million of funding between 2016 and 2020 to support the policy, including delivering smart classrooms (with grid, solar or generator power) to 100% of schools, a new ICT-based curriculum for all school grades, an awareness campaign, and financing for students to purchase devices. As part of this policy, a partnership with Microsoft is due to deliver 500 smart classrooms in Rwanda by the end of 2017.⁴¹

Providing ICT facilities in schools, combined with an ICT-based curriculum, can be used to increase ICT skills levels and drive take-up of services.

³⁸ *Philippines eHealth Strategic Framework and Plan 2014–2020*, the Government of the Philippines, 2014; see <https://bit.ly/2pNZ3xP>

³⁹ See <https://bit.ly/2urT2YC> for further details

⁴⁰ See <https://bit.ly/2lce1VE> for further details

⁴¹ See <https://bit.ly/2pxY3MZ> for further details

A.4.2 Promoting e-literacy in South Korea

Between 1998 and 2004, the Ministry of Communication and Information in South Korea led the implementation of a large-scale ICT skills training programme, organised in two phases. After consultations involving ten government ministries, a comprehensive national programme was formulated, to target citizens who lacked basic ICT literacy skills (around 60% of the Korean population). Skills training was targeted at those segments of the population which were most likely to benefit from skills training and those most likely to be digitally excluded.⁴²

Implementation was led by the appropriate government departments, with funding from both local and central government agencies. Phase 1 of the programme reached almost 14 million Koreans, although only 37% of attendees reported that the programme had equipped them with sufficient skills to incorporate ICT into their daily lives. Phase 2 aimed to build on Phase 1 by providing further ICT training, and over 9 million Koreans took part.⁴³

Mass e-literacy programmes can have a significant impact but require a coordinated approach across government and discussions with participants to evaluate their impact.

A.5 Digital business environment case studies

A.5.1 Supporting entrepreneurs in Chile

As part of an effort to diversify Chile's economy away from commodities, the government began supporting digital start-ups and entrepreneurs in 2010. A new government agency (InnovaChile) and an incubator programme (Start-up Chile) were created to help attract and support digital start-ups, and drive long-term economic growth. Start-ups are provided with a six-month programme of support, tailored to their stage of development (proof of concept, commercialisation, or growth support).⁴⁴

Around 200 to 250 companies a year are accepted onto the support programme. Between 2010 and 2015, 1200 start-ups and over 3000 entrepreneurs were supported. Over USD135 million in private investment was raised by start-ups in the incubator programme, more than six times the government's initial investment.⁴⁵

A targeted programme supporting the development of technology start-ups can attract innovators, promote inward investment and drive economic growth.

⁴² *Korea's Informatization Policy to Deliver ICT use in everyday life*, Korea Agency for Digital Opportunity and Promotion, 2007; see <https://bit.ly/2lbvGwK>

⁴³ *Abu Dhabi's ICT Policy Priority Areas and Korea's Best Practices*, Korea Development Institute, 2012; see <https://bit.ly/2usGAwb>

⁴⁴ *Bringing innovative entrepreneurs and start-ups to Chile*, The Centre for Public Impact, 2016; see <https://bit.ly/2Ghuho0>

⁴⁵ See <http://www.startupchile.org/> for further details

A.5.2 Supporting start-ups in Thailand

In 2017, the government of Thailand announced a Digital Economy fund to support the development of new digital start-ups. The USD150 million fund aims to promote research and development by start-ups and support the establishment and growth of new businesses.⁴⁶ Thailand has announced a waiver on taxes for venture-capital investments in digital start-ups, and is simplifying the visa process for foreign entrepreneurs and digital specialists to work in Thailand.

Thailand's national innovation agency has also partnered with an investment firm to develop SPARK, an accelerator programme. SPARK will provide qualified start-ups with two months of training in areas such as software development and graphic design, followed by the opportunity to bid for venture capital funding at the end of the programme.⁴⁷

Targeted government interventions, combined with a favourable legislative framework, can be used to provide a supporting digital business environment.

A.6 Digital safety case studies

A.6.1 Supporting digital payments in Thailand

The Bank of Thailand oversees the financial sector in Thailand, including payment systems. It has published three payment systems roadmaps, including the most recent (for 2012–2016). As part of its role, the Bank of Thailand aims to promote a safe environment for digital payments, including mandating the encryption of consumer data and strict requirements on consumer authentication.⁴⁸

AirPay is a provider of digital payment services in Thailand, including e-wallet functionality, peer-to-peer transfers and e-payments. As well as linking to bank accounts and credit cards, AirPay also caters to the substantial 'unbanked' population who can use cash to top up accounts at over 90 000 physical service points across Thailand. Since its launch in 2015, AirPay has gained over 1 million users in Thailand and Vietnam and plans to expand to Indonesia and the Philippines.⁴⁹

AirPay has invested in fraud detection and provides higher protection than most online banking services in Thailand. It also uses features such as two-factor authentication and encrypts all communications with its customers and partners. AirPay has suggested that it would not be able to function without strong encryption protection.

Promoting digital safety can enable consumer trust and promote the growth of digital services such as electronic payments.

⁴⁶ See <https://bit.ly/2GgvvE7> for further details

⁴⁷ See <https://bit.ly/2GfzqRF> for further details

⁴⁸ Bank of Thailand guidelines; see <https://bit.ly/2pLDpLi> for further details

⁴⁹ *How strong encryption supports the development of a safe and secure internet: an Asia–pacific perspective*, Analysys Mason, 2017; see <https://bit.ly/2GhXldK> for further details

A.6.2 Managing cyber security in South Korea

South Korea considers cyber security as a top priority for development of the digital economy. The Korean Internet & Security Agency (KISA) is dedicated to managing cyber threats at a sector level, with around 600 employees focused on governance, laws & regulation, protection measures, and promotion of the cyber-security industry.⁵⁰

Between 2011 and 2014, two major security breaches resulted in the theft of unencrypted personal information on almost 55 million Koreans. Following these incidents, a new framework was introduced to manage cyber security, including financial penalties for non-compliance and data breaches. To promote early disclosure and allow investigations, firms are eligible for a 30% reduction in fines if they voluntarily disclose a data breach.⁵¹

Development of a secure digital economy requires collaboration between government and industry, with incentives to adopt best practice and report incidents.

⁵⁰ Key learnings from the study tours were delivered to the DCI in an Analysys Mason report on 29 September 2017 – *Study Tour Findings* (ref. no. 2009803-731).

⁵¹ *How strong encryption supports the development of a safe and secure internet: an Asia–pacific perspective*, Analysys Mason, 2017; see <https://bit.ly/2GhXldK> for further details