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Maximising availability of international connectivity in the Pacific

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1 Introduction

1.1 Background

The World Conference on International Telecommunications (WCIT-12) identified that the international connectivity of small island developing states (SIDS) remains key to their economic development and creation of their own information society.[1] WCIT-12 instructed that further study be undertaken of the special situation of telecommunication/ICT services in SIDS, with particular consideration being given to the importance of access to international optical fibre networks at reasonable cost. It also undertook to assist SIDS with planning and guidance to promote regional and multilateral projects that will provide them with greater access to international optical fibre networks.

The World Telecommunication Development Conference (WTDC) 2014 gave particular emphasis to the need to improve ICT connectivity in the Pacific in the Asia-Pacific Regional Initiative 1 (see Table 1.1.1)

Table 1.1.1: WTDC-14 Asia-Pacific Regional Initiatives

ASP RI 1: Addressing special needs of least developed countries, small island developing states, including Pacific island countries, and landlocked developing countries.

Objective: To provide special assistance to least developed countries (LDCs), small island developing states (SIDS), including Pacific island countries, and landlocked developing countries (LLDCs) in order to meet their priority ICT requirements.

Expected results:

1) Improved infrastructure and enhanced access to affordable ICT services.
2) Improved enabling environment to facilitate ICT development.
3) Appropriate national, sub-regional and regional frameworks for cybersecurity.
4) Enhanced skills of relevant human resources.
5) Addressing specific issues and challenges in the Pacific island countries.

ASP RI 3: Harnessing the benefits of new technologies.

Objective: To assist ITU Member States in utilizing new technologies and address human and technical capacity challenges related to issues such as those identified in the expected results, among others.

Expected results:

1) (p) Assistance in the development of frameworks for new and emerging technical issues as well as for utilizing new technologies in, but not limited to, … Cable landing stations …

ASP RI 4: Development of broadband access and adoption of broadband

Objective: To assist Member States in the development of broadband access in urban and rural areas and to support system construction to resolve social issues leveraging the benefits of telecommunication/ICT applications.

Expected results

9) Studies and assistance on effective utilization and optimization of optical fibre cable networks, especially submarine cable network.

The need for universal broadband connectivity for the Asia-Pacific region was re-emphasized during WTDC-17 (Table 1.1.2). Access to international optical fibre networks at reasonable costs, including submarine cable capacity, is central to the realisation of universal broadband access policy goals especially in many Pacific island countries.

[1] International Telecommunication Union (2012), *Final Acts of the World Conference on International Telecommunications* (Dubai, 2012), available at www.itu.int/en/wcit-12/Documents/final-acts-wcit-12.pdf

Table 1.1.2: WTDC-17 Asia-Pacific Regional Initiatives

ASP RI 1: Special consideration for least developed countries, small island developing states, including Pacific island countries, and landlocked developing countries.

Objective: To provide special assistance to least developed countries (LDCs), small island developing states (SIDS), including Pacific island countries, and landlocked developing countries (LLDCs) in order to meet their priority telecommunication/ICT requirements.

Expected results:

1) Development of policy and regulatory frameworks for broadband infrastructure, ICT applications and cybersecurity, taking into account the special needs of LDCs, SIDS and LLDCs, and strengthening of human capacity to address future policy and regulatory challenges.
2) Universal access to telecommunication/ICTs promoted in LDCs, SIDS, and LLDCs.
3) Assistance to LDCs, SIDS and LLDCs in adopting telecommunication/ICT applications in disaster management, relating to disaster prediction, preparedness, adaptation, monitoring, mitigation, response, rehabilitation and recovery of telecommunication/ICT networks based on their priority needs.
4) Assistance to LDCs, SIDS and LLDCs in their efforts to achieve internationally agreed goals, such as the 2030 Agenda for Sustainable Development, the Sendai Framework for Disaster Risk Reduction, the Istanbul Plan of Action for LDCs, the Samoa Pathway for SIDS and the Vienna Programme of Action for LLDCs.

In line with the expected results of these initiatives, ITU published in 2017 *Maximising availability of international connectivity in developing countries: Strategies to ensure global digital inclusion,*[2] which among other things gave special consideration to the challenges faced by Pacific islands.

Together with the Pacific Islands Telecommunications Association (PITA), which had also expressed the need to support a study on connectivity, ITU conducted a workshop[3] *Enhancing access to submarine cables for Pacific island countries* with support from the Department of Communications and the Arts, Government of Australia, and the Department of Communications, Government of Fiji.

This report primarily draws on the discussions during the workshop and extends the global study by undertaking a stocktake of the existing and planned submarine cables connecting the Pacific islands and providing some illustrative case studies. It has been updated with information until March 2018.

This report is focused on the following Pacific islands: American Samoa, the Commonwealth of the Northern Mariana Islands, Cook Islands, the Federated States of Micronesia, Fiji, French Polynesia, Guam, Kiribati, Nauru, New Caledonia, Niue, Palau, Papua New Guinea, the Republic of the Marshall Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, and Wallis and Futuna.

1.2 International connectivity in the Pacific: The changing situation

International connectivity to the Pacific islands has improved significantly over the last decade. In 2007, only four Pacific islands were connected to an international submarine cable: CNMI, Guam, Fiji, and PNG. In the subsequent ten years another ten international cables were constructed, bringing fibre-optic connectivity for the first time to a further eight Pacific islands. This are a further ten international cables currently in various stages of development that would provide inaugural connections for the remaining seven Pacific Islands. If most of those proposals are carried through to fruition then all Pacific islands – at, least, the main island of each of the Pacific island countries – will have direct access to fibre-optic internet capacity. This is a remarkable turn of events in a relatively short period.

This is a remarkable development since the first Trans-Pacific (telegraph) cable landed in Fiji in 1901. Since then the two analogue systems COMPAC constructed in 1961 and subsequently replaced by

[2] www.itu.int/pub/D-PREF-BB.GDI_01
[3] www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/Pages/Events/2017/Submarine%20Cable/submarine-cables-for-Pacific-Islands-Countries.aspx

ANZCAN in 1984 were full service cable systems interconnecting Australia, New Zealand, Norfolk Island, Fiji and Hawaii to Canada. ANZCAN was replaced by SOUTHERN CROSS in 2000 interconnecting Australia and New Zealand to the United States of America mainland through Fiji and Hawaii. APNG was an analogue coaxial copper cable connecting Australia with Papua New Guinea, which started operation in 1976 and has been replaced by the APNG-2 cable. The PPC-1 network[4] was another important step that connected Sydney (Australia) with Guam with branching unit to Madang (Papua New Guinea).

Table 1.2.1: Number of international submarine cables connected to each Pacific island

Pacific Islands	Currently active	Proposed additional#	Pacific Islands	Currently active	Proposed additional#
American Samoa	2	1	Palau	1	0
Northern Mariana Islands	2	0	Papua New Guinea	2	2*
Cook Islands	0	1	Marshall Islands	1	0
Federated States of Micronesia	2	1	Samoa	2	2
Fiji	4	2	Solomon Islands	0	2
French Polynesia	1	1	Tokelau	0	2
Guam	12	2	Tonga	1	1
Kiribati	0	2	Tuvalu	0	1
Nauru	0	1	Vanuatu	1	0
New Caledonia	1	1	Wallis and Futuna	1	0
Niue	0	1			

Source: ITU

* As a replacement for an existing cable.

Includes cables currently under construction and proposed/planned cables, including dormant branching units.

1.3 Need for speed: demand drivers

The investment in submarine cables to the Pacific islands is being driven by the need to improve access to low cost, high bandwidth international connectivity. The geography of the region, the small scale of the island economies, and the high capital costs of submarine cables have meant that most Pacific islands have relied solely on geostationary satellites for Internet access. As a consequence international bandwidth has remained expensive and restricted (See Table 1.3.1). For example, prior to the landing of their first submarine cables, total contracted international capacity in Papua New Guinea was just 22 Mbit/s per month in 2006, and 80 Mbit/s per month in Tonga in 2013. (See Table 1.5.1)

Such limitations have kept retail broadband prices unduly high, deterred investment in mobile broadband infrastructure, and dampened ICT diffusion. This in turn compounds many of the longstanding economic challenges faced by Pacific islands generally, such as isolation and an increased risk of marginalisation, limited economic activity and economic integration, high transaction costs, limited skilled labour and high unemployment, and vulnerability to economic and environmental shocks.

[4] www.pipenetworks.com/ppc1-network.php

The lack of affordable, good quality Internet access thus came to be identified as the principal constraint to further ICT diffusion and long term economic and social development more generally. This coincided with the recognition that greater integration of the island economies, both nationally and with the larger neighbouring economies, was essential to the sustainable development of the Pacific islands and overcoming the economic costs of distance. Towards these ends official development assistance, in particular from the World Bank and the Asian Development Bank, has in recent years been directed towards the construction of submarine cables to the Pacific islands and, once landed, economic reforms to ensure the potential economic benefits are realized.

Table 1.3.1: Contracted international bandwidth in selected Pacific islands (Mbit/s)

Pacific Islands	International submarine cables		Satellite bandwidth (duplex)
	Lit capacity	Committed capacity	
American Samoa	1 000	700	300
Cook Islands			400
Fiji		20 000	
Federated States of Micronesia	4 000	250	
Kiribati			200
Marshall Islands	20 000	2 500	
Niue			24
Papua New Guinea	10 000	1 618	200
Samoa		300	200
Solomon Islands			400
Tokelau			32.5
Tonga	10 000	1 210	
Tuvalu			95
Vanuatu	10 000	1 618	200

Source: Maui Sanford (Data current as of December 2017).

1.4 Overview of submarine cables in the Pacific: Current situation and upcoming projects

Table 1.4.1 provides a summary of the 21 submarine cables currently connected to one or more Pacific islands. Six of these have been commissioned within the last five years.

Having established a first cable connection, a number of Pacific islands have turned their attention to the construction of a second or even third cable. Samoa wishes to establish itself as a regional cable hub – like Fiji is for the South Pacific region and Guam is in the North Pacific. In the cases of Papua New Guinea (with respect to APNG-2), Samoa and American Samoa, a second cable has proven necessary because their first cables were of particularly low capacity – around 1 Gbit/s – as they were recycled sections of an earlier generation of submarine cable. In the case of Northern Mariana

Islands, a second cable system is sought to provide route diversity after having experienced the effects of disconnection due to cable breaks caused by typhoons in 2015 and 2016.

Further on, Table 1.4.2 summarizes nine planned cables that are proposed to include a landing in a Pacific island. These proposals are at different stages of development – some are currently under construction while some others are still very much at the planning stage. Five of those listed are proposed to use development assistance from the World Bank and Asian Development Bank. Some of the proposals – such as Tui-Samoa, Manatua, and the East Micronesian Cable – are examples of regional cooperation initiatives. If all of the proposed cables eventuate, every Pacific island will have a connection to at least one international submarine cable by around 2020. (Some of the proposals however, ultimately may not proceed or may do so with a revised route that does not include a landing in a Pacific island.)

International backhaul options continue to remain limited to either Fiji (which links to Australia and the United States) and Guam (which has three separate landing stations and links to many hubs, including Hong Kong (China), Japan, Philippines, and the United States). Although the ASH cable in American Samoa links to Hawaii, the cable is of insufficient capacity to be a backhaul option for other countries in the region. Two new cable projects – Hawaiki (RFS June 2018) and Southern Cross NEXT (RFS 2020) – have potential to improve direct onward international connectivity by extending branches to American Samoa, Fiji, Kiribati, and Tokelau.

Table 1.4.1: International submarine cables currently serving Pacific islands

Cable	Route	Cable length (km)	Ready for service	Owners
TPC-5 Cable Network (TPC-5 CN)	United States – Guam – Japan	22 560	Dec 1996	Consortium of 78 members including AT&T (US), MCI (US), KDD (JP), IDC (JP), DGT (CN), BT (UK).
Mariana – Guam Cable	Northern Mariana Islands – Guam		1997	IT&E (MP)
Guam – Philippines Cable	Guam – Philippines	3 600	March 1999	Kanematsu Corporation (JP), KDD-SCS (JP), PLDT (PH)
China – United States Cable Network (CUCN)	United States – Japan – China – Republic of Korea – Guam	30 000	Jan 2000	Consortium including AT&T (US), China Telecom (CN), Chungwa Telecom (CN, Hong Kong Telecom (CN), KDD (JP), Korea Telecom, MCI (US), NTT, SBC (US), SingTel (SG), Sprint (US), Telekom Malaysia, Teleglobe (US), Telstra (AU).
Southern Cross Cable Network (SCCN)	United States – Fiji – Australia – New Zealand	30 500	Nov 2000	Spark (NZ) Singtel Optus (AU) Verizon (US)
Australia – Japan Cable (AJC)	Australia – Guam – Japan	12 700	Dec 2001	Softbank Telecom (JP) Telstra (AU) Verizon (US) AT&T (US)

Cable	Route	Cable length (km)	Ready for service	Owners
Tata TGN-Pacific	Guam – Japan – United States	22 300	Dec 2002	Tata (IN)
APNG-2	Papua New Guinea – Australia	1 800	2006	Telikom (PG) Telstra (AU)
Gondwana-1	Australia – New Caledonia	2 151	Sep 2008	OPT (NC)
American Samoa – Hawaii (ASH)	United States – American Samoa	4 250	May 2009	Government (AS) Elandia (AS)
Samoa – American Samoa (SAS)	Samoa – American Samoa	250	May 2009	Government (AS) Elandia (AS)
PIPE Pacific Cable 1 (PPC-1)	Australia – Papua New Guinea – Guam	7 185	Oct 2009	TPG (AU)
Asia-America Gateway (AAG) Cable System	Singapore – Malaysia Thailand – Brunei – Viet Nam – China – Philippines – Guam – United States	20 000	Nov 2009	Consortium including Telekom (MY), AT&T (US), Starhub (SG), PLDT (PH), CAT (TH), Airtel (Bharti), Telstra (AU), Telkom Indonesia (ID), BT (BI), Eastern Telecom (PH), PT (ID), Spark (NZ), Viettel (VN), Saigon Postel Corporation (VN), Vietnam Telecom International (VN), BIG (BI) , BayanTel (PH), Ezecom (KH)
HANTRU-1	Guam – Marshall Islands – Federated States of Micronesia	2 917	Mar 2010	Hannon Armstrong (FM) FSMTC (FM) MINTA (MH)
Honotua	United States – French Polynesia	4 805	Sep 2010	OPT (PF)
Tonga Cable	Tonga – Fiji	827	Aug 2013	Government (TO) TCC (TO) Digicel (TO)
Guam – Okinawa Kyusu Incheon (GOKI)	Japan – Guam	4 244	Dec 2013	AT&T (US)
Interchange Cable Network 1 (ICN1)	Vanuatu – Fiji	1 238	Jan 2014	Interchange (VU)
Atisa	Guam – Northern Mariana Islands	279	June 2017	Docomo Pacific (GU)

Cable	Route	Cable length (km)	Ready for service	Owners
SEA-US	Indonesia – Guam – Philippines – United States, with BUs to Palau and Federated States of Micronesia	14 500	Aug 2017	RTI, Inc., Globe Telecom (US) Hawaiian Telcom (US) GTA TeleGuam (GU) Telin (ID) Balau Submarine Cable Co (PW) FSMTC (FM)
Tui-Samoa	Samoa – Wallis and Futuna – Fiji	1 470	Feb 2018	Samoa Submarine Cable Company (WS)

Sources: Telegeography, Submarinenetworks.com, Submarine Telecoms Forum.

Table 1.4.2: Proposed international submarine cables that will serve Pacific islands

Cable	Routing	Cable length (km) (approx.)	Proposed RFS date	Owners
Hawaiki	Australia – New Zealand – United States with BUs to American Samoa and available to New Caledonia, Fiji, Tonga	10 200	June 2018	Hawaiki Cable Co (NZ)
Hong Kong – Guam (HK-G)	Guam – China	3 900	2019	RTI Connectivity (SG)
Japan – Guam – Australia (JGA)	Japan – Guam – Australia	9 500	2019	Consortium including RTI Connectivity (SG) AARNET (AU) Google (US)
Coral Sea Cable System	Australia – Papua New Guinea – Solomon Islands	4 500	2019	Government (AU) Kumul Telikom Holdings (PG) Solomon Islands Cable Co (SI)
East Micronesian Cable	Federated States of Micronesia – Nauru – Kiribati	>2 000	2019	Government (FM) Government (KI) Government (NR)
Manatua	Samoa – French Polynesia – with BUs to Cook Islands and Niue	>4 500	2019	Government (CK) Government (NU) Government (WS) OPT (PF)
Southern Cross NEXT	Australia – United States with BUs to New Zealand, Fiji, Kiribati, and Tokelau	12 500	2020	Spark (NZ) Singtel Optus (AU) Verizon (US)
National Submarine Fibre Cable Network*	Papua New Guinea – Indonesia	5 457	2019	Kumul Telikom Holdings (PG)

Cable	Routing	Cable length (km) (approx.)	Proposed RFS date	Owners
Samoa – Tokelau – Tuvalu	Samoa – Tokelau – Tuvalu	>1 500	Proposal only	Proposal only

Sources: Asian Development Bank, Submarinenetworks.com, Telegeography, World Bank. Current as of 31 March 2018.

* The proposed national festoon linking 14 population centres is to include an international link to Jayapura in Indonesia.

Many Pacific island states are actually archipelagoes. Even with a connection to an international submarine cable they may still remain dependent on satellite for domestic backhaul because the distances between islands are too great for microwave links.[5] Accordingly many Pacific islands are turning their attention to addressing their national connectivity needs through the deployment of inter-island submarine cable links, often in tandem with an international deployment. Table 1.4.3 summarizes these current proposals together with existing systems.

Table 1.4.3: Existing and planned national submarine cable systems

Country	Islands being connected	Cable length (km)	RFS Date
Cook Islands*	Rarotonga – Aitutaki	264	2019
Northern Mariana Islands *	Saipan – Tinian – Rota	281	June 2017
Federated States of Micronesia	Pohnpei – Yap* Chuuk – Pohnpei Pohnpei – Kosrae	2 236 741 550	2018
Fiji*	Suva – Savusavu	95	Dec 2017
French Polynesia*	Tahiti – Moorea – Huahune – Raiatea – Bora Bora		2010
French Polynesia	Tahiti – Rangiroa – Manihi – Takaroa – Kaukura – Arutua – Fakarava archipelago – Makemo – Hao – Hiva Oa – Nuku Hiva	2 500	2019
New Caledonia	Grand Terre – Mouli – Lifou	>200	2008
Palau	Babeldaob (festoon) – Koror – Peleliu	183	1996
Papua New Guinea	Festoon linking 14 population centres#	5 457	2019
Marshall Islands *	Majuro – Kwajalein	>470	2010
Samoa*	Apia – Savaii	76	Dec 2017
Solomon Islands*	Honiara – Auki – Noro	333	2019
Tokelau*	Atafu – Nukunonu – Fakaofu	165	Proposal only
Tonga	Tongatapu – Ha'apai – Vava'u	310	2018
Vanuatu*	Efate – Espiritu Santo Espiritu Santo – Malo	>250 >40	Dec 2019 Dec 2019 (trial)

[5] In 2016, Digicel installed a 189 km microwave link between two Tonga islands. This is understood to be the longest microwave link in a mobile telecommunication network established to date.

Country	Islands being connected	Cable length (km)	RFS Date
Wallis and Futuna*	Wallis – Futuna	260	Dec 2017

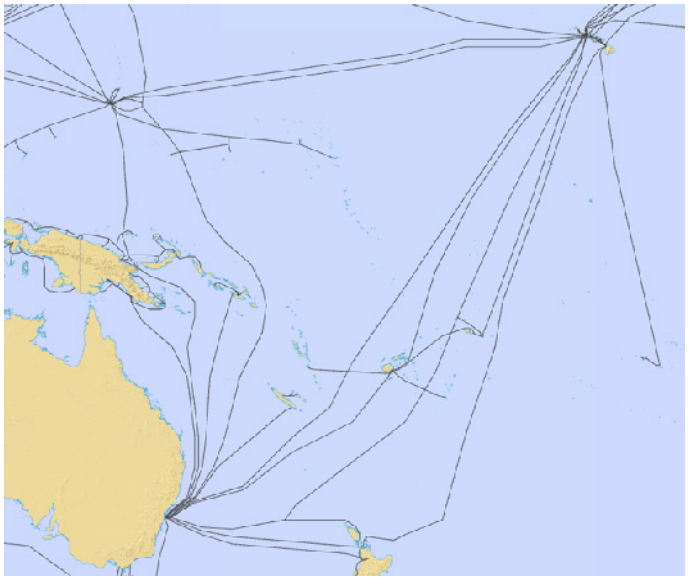
Source: Operator websites. Current as of 31 March 2018.

* In tandem with the construction of an international submarine cable.

Will also include an international link to Jayapura, Indonesia.

Figure 1.4.1 shows existing and selected proposed submarine cables in the Pacific islands region. It includes both international and national cables and provides an indication of the potential reach of submarine cables into the region by 2020. The ITU Interactive Terrestrial Maps has been developed in collaboration with UNESCAP and ECOSOC. The submarine cable maps are from Telegeography.

Figure 1.4.1: Map of existing and selected proposed international and national submarine cables



Source: ITU (https://www.itu.int/en/ITU-D/Technology/Pages/InteractiveTransmissionMaps.aspx)

1.5 Common features of submarine cables in the Pacific

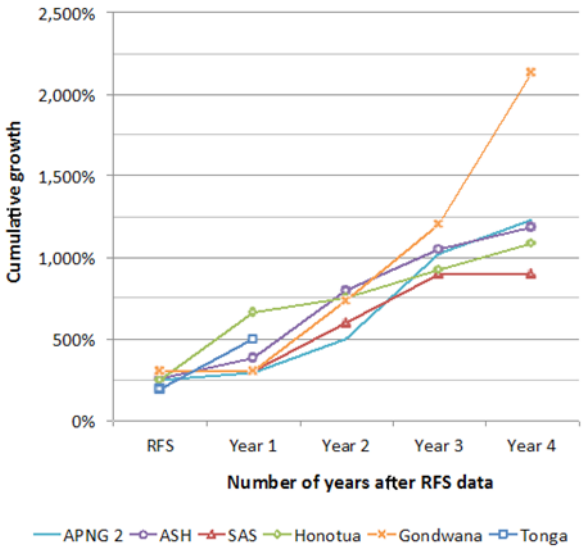
The extension of submarine cables to the Pacific islands leads to substantial reductions in the price of international connectivity and significant increases in international bandwidth. However, there are limits. Pricing gets reduced from thousands of dollars per Mbit/s (via satellite) to something in the hundreds of dollars per Mbit/s (via cable), but achieving unit pricing in the tens of dollars as exists in more developed economies is rare. Prior to the commissioning of the cable in Tonga in 2013, the wholesale price was around USD 3 800[6] per Mbit/s per month and total international bandwidth purchases were just 65 Mbit/s. By May 2016, the average price had reduced to around USD 250 per Mbit/s per month and total bandwidth had increased to 710 Mbit/s. (Subsequent regulatory intervention lowered prices further so that by July 2017 the average price was around USD 150 per Mbit/s per month and total bandwidth was 1 000 Mbit/s.)

The price reductions enabled by a submarine cable see wholesale demand for international bandwidth grow significantly and consistently. Typically demand has increased by about 1 000 per cent on the pre-cable volumes within three years of the commissioning of the cable. (See Figure 1.5.1) However, in absolute terms the total deployed bandwidth still tends to remain low, both relative to the amount that is available and to broader international standards (Table 1.5.1).

6 Asian Development Bank, *Pacific Economic Monitor*, December 2016, p.27.

The exceptions both in terms of price and utilisation are Guam and its near neighbour, Northern Mariana Islands; and the French overseas territories of New Caledonia and French Polynesia. These four countries have each had access to an international submarine cable for around ten years, have domestic inter-island submarine cable links (with the exception of Guam which comprises a single island), and enjoy among the highest rates of GDP per capita in the region.

Figure 1.5.1: Cumulative rates of growth in wholesale demand for international connectivity following the commissioning the first international submarine cable



Source: Hibbard Consulting.

Table 1.5.1: Changes in wholesale demand for international connectivity following the commissioning the first international submarine cable

Pacific Islands	Cable	Wholesale demand for international connectivity (Mbit/s per month)		
		Prior to commissioning	As of RFS + 1 month	As of 2017 (years since RFS)
Papua New Guinea	APNG-2	22	45*	700* (11)
New Caledonia	Gondwana	150	450	16 000 (9)
American Samoa	ASH	35	90	850 (9)
Samoa	SAS-ASH	15	45	250 (9)
French Polynesia	Honotua	600	1 500	16 000 (7)
Tonga	Tonga Cable	80	310	1 000 (4)
Vanuatu	ICN1	150	450	1 250 (4)

Source: Hibbard Consulting.

* On the APNG-2 cable only.

All submarine cables in the Pacific islands share some common characteristics that make the financial feasibility of cable projects in the region particularly challenging and tend to necessitate development aid and assistance, potentially on an ongoing basis. Pacific island cables tend to:

- involve very long cable lengths, which adds to the costs of construction and repair contingency costs;
- have few buyers of capacity as a result of the small size of national telecommunication markets, which can make it difficult to cover operating expenditure;
- have very low utilisation, which keeps unit costs and pricing high – and in turn dampens utilisation;
- face difficulty sourcing and retaining skilled labour, which encourages outsourcing of operations.

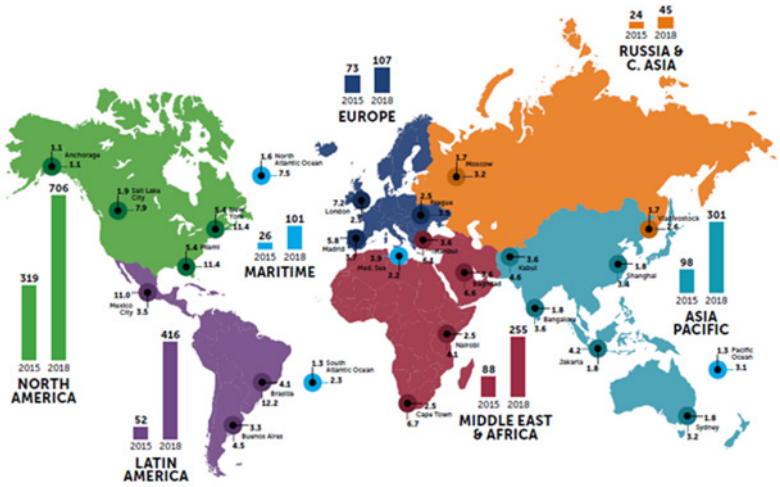
These characteristics are a consequence of the general economic challenges faced by all small island developing states.

1.6 Future role of satellite connectivity

The Pacific islands have long been dependent on satellites as their only source of international connectivity. For many of them this will remain the case for some time. Fortunately the availability of transponder capacity in the region has increased significantly in recent years, with further supply due to be commissioned in 2018-19, which has seen some price reductions (see Table 1.6.1 below). Although there is potential for cost-sharing arrangements to be established between different Pacific islands through dynamic spectrum assignment – which split transponder paths with beams to cover islands in different geographic location – such opportunities have not been well exploited to date.

Submarine cables remain the preferred technology for their technical superiority in terms of bandwidth and latency, and their operating cost effectiveness. Satellite signals are also prone to interference from climatic conditions of the tropical Pacific islands. Nonetheless satellite communications will likely continue to play a major role in the national and international connectivity of many Pacific islands. Papua New Guinea, for example, continues to rely heavily on satellite services for multipoint broadband requirements for private VSAT network and mobile networks coverage expansion, as do French Polynesia, Fiji and the Federated States of Micronesia. Satellite capacity will also continue to have an important role to play in providing redundancy for submarine cables and inter-island connectivity, particularly as many Pacific islands will only ever have one connection to an international submarine cable. Satellite will likely also remain the only means of providing domestic and/or international connectivity for some remote islands. By way of example, in the Federated States of Micronesia access to public telephony services are provided in some outer islands via village phones that use Iridium satellites.

Figure 1.6.1: World map of HTS supply (in Gbit/s) for 2015 and 2018



Source: Euroconsult, HTS – Vertical Market Analysis & Forecasts (2016).

Another recent application of resilience was seen in Cook Islands when, during a disaster (fire) the mobile core of Cook Islands was destroyed. The satellite connectivity from Samoa greatly helped in mitigating the impact on services. With the rise of applications and enhanced opportunity to share services across islands, the role of resilience and universal access will be even higher.

Table 1.6.1: Geostationary satellites providing broadband connectivity to Pacific islands

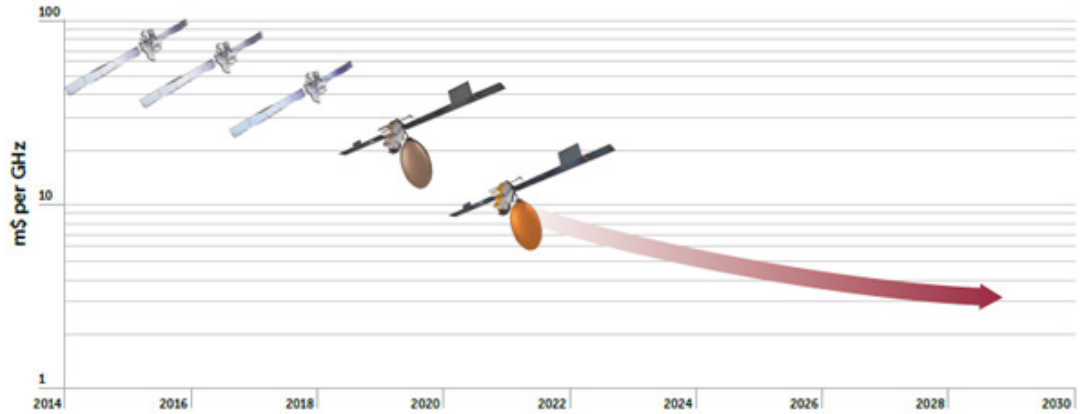
Operator (Satellite)	Launch date	Position	Transponder capacity	Pacific Islands with contracted capacity or interest
SKY Perfect JSAT (JCSat 2B)	May 2016	154° E	26 C-band and 18-Ku-band transponders. Will replace JCSat 2A.	
ABS (ABS-6)	Sep 1999	159° E	28 C-band and 16 Ku-band transponders	Kiribati, Samoa, Tuvalu
Intelsat (Intelsat 19)	May 2012	166° E	24 C-Band and 34 Ku-Band transponders	Fiji, Federated States of Micronesia, New Caledonia
Eutelsat 172B	June 2017	172° E	14C-band & 36 KU HTS transponders	Fiji
SES (NSS-9)	Feb 2009	177° W	44 C-band transponders	Fiji, Papua New Guinea, Solomon Islands
Intelsat IS 18	6 Oct 2011	180° E	24C-band & 12 KU transponders	French Polynesia
JCSat 18 (Kacific-1)	Planned (launching Dec 2019)		Ku and Ka-band HTS (56 narrow beams)	Tuvalu, Vanuatu

Sources: Operator websites, Satbeams SPRL.

The new high throughput satellite (HTS) technology, which use multi-spot beams and frequency reuse to achieve greater throughput from a given orbital location, has the potential to substantially increase the available capacity in the region. Eutelsat has been serving the Pacific with its new HTS

172B satellite since November 2017, with its first major customer being the Fiji Government. And Intelsat will launch its new EPIC HTS Satellite over the Pacific by 2019. Kacific Broadband Satellites is planning to deploy a HTS in a geostationary orbit to provide broadband access direct-to-buildings using concentrated beams in the Ka-band with a footprint that will cover the Pacific islands and also New Zealand, Indonesia and the Philippines. Forecasts suggest that HTS capacity will grow from >700 Gbit/s in 2015 to around 3 000 Gbit/s in 2020, while capacity will grow beyond expected demand by 2020[7]. According to Broadband Commission Working Group on Technologies in Space and the Upper-Atmosphere, Identifying the potential of new communications technologies for sustainable development, "By 2020-2025 there will be over 100 HTS systems in orbit delivering terabytes of connectivity across the world using the Ku- and Ka- bands, reducing unit bandwidth costs and bringing satellite services to parity with terrestrial solutions".

Figure 1.6.2: Impact of HTS technology development on cost per GHz



Source: Broadband Commission Working Group on Technologies in Space and the Upper-Atmosphere, Identifying the potential of new communications technologies for sustainable development, September 2017.

Medium earth orbit (MEO) satellite connectivity is also becoming particularly significant in the region. This provides lower bandwidth costs compared to many GEO satellite systems as well as reduced propagation delay. For example, the O3b satellite system – the acronym stands for the "other three billion" of unconnected people – consists of 12 High Throughput Satellite (HTS) in an MEO, which enables each of its beams in the Ka-band to deliver up to 1.6 Gbit/s of throughput at a lower latency (<150ms) than geostationary satellite connectivity. It is able to supply capacity at about USD 400 per Mbit/s. By using two earth station terminals, the capacity available on a single link is up to 800 Mbit/s downlink and 650 Mbit/s uplink.[8] As a result, O3b services have been adopted in many Pacific islands, including American Samoa, Cook Islands, Federated States of Micronesia, Nauru, Palau, Papua New Guinea, Samoa, and Vanuatu. However, the current total capacity of the O3b constellation is 192 Gbit/s, which is less than two wave lengths of a single optical fibre. Accordingly it seems likely that even the use of this system in the Pacific long term will principally be for national thin routes and to provide international links for very small island nations that do not have the scale to justify the cost of a submarine cable connection.

1.7 ITU project on satellite

In partnership with the International Telecommunications Satellite Organization (ITSO), Kacific Broadband Satellites, Inmarsat, and Intelsat, ITU is currently implementing a project that aims to utilize unused satellite capacity to make available low cost, reliable, diverse satellite communications

[7] Euroconsult, HTS – Vertical Market Analysis & Forecasts (2016).

[8] www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/Pages/Events/2017/Submarine%20Cable/submarine-cables-for-Pacific-Islands-Countries.aspx

capacity for the Pacific islands region, specifically Fiji, Kiribati, Federated States of Micronesia, Nauru, Papua New Guinea, Samoa, Tonga, Tuvalu, and Vanuatu. The project is titled 'Development of satellite communications capacity and emergency communications solutions for Small Islands Developing States of the Pacific'. The key performance indicators and expected results of the project are shown in Table 1.7.1.[9]

Table 1.7.1: KPIs and expected results of the Development of satellite communications capacity and emergency communications solutions for Small Islands Developing States of the Pacific project

No.	Key performance indicator	Expected results
1	Number of Pacific islands countries benefiting from the satellite communications capacity	11 ITU Member States (beneficiary countries) – subject to such countries signing bilateral cooperation agreements with ITU
2	Number of rural/remote community e-centres	Up to 55 e-centres
3	Number of rural/remote communities	Up to 100 communities
4	Number of persons (operator of community e-centres) trained	Up to 100 people
5	Network management system	Capable of monitoring (remote access) of no less than 80% of the total e-centres established
6	Number of services and applications	Availability of ICT services and applications at least in Health, Education, and Agriculture sectors
7	Percentage of sustainable sites after two years	Not less than 80%

2 Building the enabling environment

2.1 Financing and ownership

With the exception of the major trans-Pacific cables that have a landing in Guam or (in the case of SCCN) Fiji, the submarine cables to the Pacific islands tend to be structured as private cables rather than consortium models. The small scale of the islands' markets, and operators' limited access to capital, do not tend to be consortium projects. Thus the inaugural cables to American Samoa, French Polynesia, New Caledonia, Samoa, Palau, Tonga, and Vanuatu have all been structured as private cables, which has enabled the participation of governments, provident funds and local investors, and the utilisation of debt finance and grant funding. However, the proposed East Micronesian and Manatua cables may prove to be the exceptions as the potential to structure these particular projects as consortium models is currently being explored.

Variations of these models are possible, such as under a public-private partnership (PPP), but none has yet been adopted in the Pacific islands.

The financial structure of the cable can have a significant influence on the pricing of capacity. Under a consortium model, the members of the consortium will bear the capital costs of cable construction and in return be allocated units of capacity on the cable according to the level of its financial contribution. Capacity is thus exchanged for funding. Each consortium member also contributes to the

[9] www.itu.int/net4/ITU-D/CDS/projects/display.asp?ProjectNo=7RAS14050

operations and maintenance expenses, at cost, in proportion to its financial contribution. In contrast, capacity and ownership are not linked under a private cable model and the equity participants will seek to achieve a reasonable return on their investment in the cable project.

The contribution of subsidized loans and grant funding from multilateral development banks tends to substantially reduce the cost of capital and thereby directly reduce the pricing of capacity. Subsidized loans require a return on capital that is lower than the market rate of return; grant funding requires neither interest payments nor a return of capital. Given the huge capital costs of submarine cable projects in the region – in the order of USD 20-50 million – these types of development aid will tend to substantially improve the availability and affordability of retail broadband services. However, the development banks tend only to fund capital costs and not the ongoing operating expenditure, which must therefore be covered by the revenues from sales of capacity leases or indefeasible rights of use (IRUs). Further, the development banks principally provide financing to governments, not companies or state-owned enterprises. Beneficiary governments therefore must determine how to pass the funding support through to the cable project, for example by way of its own grant or equity participation (and if the latter, what ROI expectations may be attached to it).

2.2 Licensing and rights of way

As the landing of submarine cables in the Pacific islands is still a relatively recent and infrequent phenomenon, most jurisdictions do not have cable-specific licensing or authorization regimes. The exceptions are the foreign territories of the United States. Landing a cable in Guam, for example, requires a specific cable landing licence to be granted by the United States Federal Communications Commission acting under the *Cable Landing License Act of 1921* and an Executive Order of the United States President. Samoa has in the past issued an individual licence called a Submarine Cable Landing Station Licence but is currently revising its telecommunication licensing regime and may remove such categorization.

Those countries that have adopted some form of unified licensing regime for telecommunications generally issue a standard network operation licence to authorize the installation and operation of a submarine cable within territorial waters and the facilities in the cable landing station. In Papua New Guinea, this has included the creation of a special 'international gateway' licence category. In some other cases, these standard licences have been subject to special licence conditions; for example, in Tonga and Samoa the licensee has been restricted to wholesale operations only.

2.3 Equal access and pricing

Most of the submarine cables serving the Pacific islands are subject to some form of regulation to ensure equality of access to the (landed) cable capacity. Generally this has not been controversial as the cables in question are not consortium models were the capacity is reserved for the consortium members. The exceptions are those states that maintain national telecommunication monopolies: New Caledonia, Federated States of Micronesia, and the Marshall Islands. Vanuatu is also a notable exception as it is also provides the only example in the region of a regulator making an official finding of anti-competitive behaviour in a submarine cable capacity market.[10]

As shown in Table 2.3.1, there are three common means of imposing ex ante access obligations in this context: via legislation, licence condition, or access regulation. However, these options are not mutually exclusive. It is also increasingly common for open access principles to be imposed as a condition of project finance, particularly in the case of development aid funding. Such commitments may be reflected in a licence condition and also in the legal documents establishing the landing company (e.g. articles of association or company constitution).

[10] *Determination and findings relating to the wholesale international Internet services market and the Speedcast complaint against Interchange Limited*, issued by the Telecommunications and Radiocommunications Regulator on 1 June 2016.

Various forms of price regulation are increasingly being introduced to force reductions in the pricing of wholesale bandwidth and, in turn, retail broadband services. Tonga's approach stands out as a creative intervention in a complex area. As uncertainty about wholesale demand makes it risky to impose aggressive price reductions, the Tonga Ministry of Information and Communications – the sector regulator – specified that the regulated cost-based prices that it had determined would only be available if both of the two main customers committed to buying a specified minimum amount of bandwidth each year for a five year period. The specified minimum increased each year. This commitment is then locked in by way of a take-or-pay contract that requires the purchaser to pay for the additional capacity each year regardless of whether it is taken and put into service. In this way the regulator has been able to reduce the uncertainty around future demand and achieve price reductions sooner than they would otherwise have been introduced. The cable landing station operator also has revenue certainty for five years.

Table 2.3.1: Regulation of access to and pricing of submarine cable capacity in the Pacific islands

	General open access obligation			Specific regulation of access pricing	
	Under law	Under licence	Regulation	Reference offer	Regulation
American Samoa	No	Yes*	No	No	No
Northern Mariana Islands	No	Yes*	No	No	No
Federated States of Micronesia	Yes#	No	No	No	No
Fiji	No	No	No	No	Yes. Price cap.
French Polynesia	No	No	Yes	Yes	Yes. Annual pricing review.
Guam	No	Yes*	No	No	No
New Caledonia	No	No	No	Yes	Yes. Annual pricing review.
Palau	Yes	No	No	Yes	No
Papua New Guinea	Yes	No	No	No	No
Marshall Islands	No	No	No	No	No
Samoa	Yes	No	No	Yes	Yes. Price approval.
Tonga	Yes	Yes	Yes	Yes	Yes. Price setting.
Vanuatu	No	No	No	No	Yes. Price approval.

Sources: Operator and regulator websites, enhancing access to submarine cables for Pacific island countries workshop delegates.

* Only if the cable system is licensed on a common carrier basis. Cable systems may also be licensed and operated on a non-common carrier basis under the FCC's private submarine cable policy if the FCC concludes that the operator will be unable to exercise market power because of existence of sufficient alternatives in the form of other landed cables.

Potentially. Section 389 of the Federated States of Micronesia Telecommunications Act of 2014 provides for the establishment of an open access entity.

2.4 Human and institutional capacity

To exploit fully the opportunities for economic and social development that are created by the landing of a submarine cable, Pacific islands typically need to develop the technical capacity of their institutions and human resources in a number of key areas. This is distinct from and in addition to the need for the proposed cable landing station operator to develop the technical capacity to manage and operate the landing station and supply wholesale capacity services.

A project to commission the construction of a cable will require the skills and capacity to build a business case, analyse and compare investment options and structures, negotiate with sophisticated commercial parties, and manage and administer complex projects and procurements. To then realize the potential for significant ICT-led development that is created by the cable, Pacific islands need to develop the institutional, policy, and human resource capacity to design and administer policy and programmes that foster a modern ICT sector and a broadband-enabled economy. The development and implementation of appropriate ICT legislative and regulatory frameworks is a common early priority and will often comprise part of any development aid. Also important is the development of institutional knowledge and capacity for the development of ICT-enabled policies and programmes across the entire economy, in particular in areas of education, health, and governments services.

These various capabilities need to be developed concurrently and the need for capacity development is often ongoing. They all have a bearing on the ultimate success of a cable project.

2.5 Issues and challenges

In the ITU and Pacific Islands Telecommunications Association workshop on enhancing access to submarine cables for Pacific island countries held in August 2017, delegates identified the following issues as they common challenges faced by the Pacific islands in relation to the installation and operation of submarine cables.

Table 2.5.1: Common challenges for submarine cable projects in the Pacific islands

Financing: • How best to use grant funding? • How to cover annual operational expenses?	Limited resources and technical capabilities: • human resources; • power.
Policy and regulation: • political risk/interventions; • permits and licences; • underdeveloped regulatory frameworks.	Wholesale pricing: • small market size; • low utilisation; • retail affordability.
National optical fibre distribution: • aging infrastructure; • inter-island connectivity; • financing.	Location of the cable landing station: • land ownership/custom title; • distance from beach manhole.
Maintenance and repairs	Technology upgrades
Environmental factors	

Source: Enhancing access to submarine cables for Pacific island countries workshop delegates.

3 Case studies from the Pacific

3.1 Fiji

Figure 3.1.1: Map showing existing and planned cables

Source: ITU (https://www.itu.int/en/ITU-D/Technology/Pages/InteractiveTransmissionMaps.aspx)

Key data

Land area (sq.km.) (as proportion of total area)	18 270 (71%)
Population 2016	898 760
GDP 2016 (current USD in millions)	4 631
GNI per capita, Atlas method, 2016 (current USD)	4 840
Major telecommunication operators	• Digicel (Fiji) Ltd • Vodafone Fiji Ltd • Telecom Fiji Ltd • Fiji International Telecommunications Ltd (Fintel)
International submarine cables (ready for service, design capacity, lit capacity)	• Southern Cross Cable Network (2000, 22 Tbit/s, 30 Gbit/s) • Interchange Cable Network 1 (ICN1) (2014, 320 Gbit/s, n/a) • Tonga Cable (2013, 320 Gbit/s, 20 Gbit/s) • Tui-Samoa Cable (2018, 8 Tbit/s, (n/a)) • Southern Cross NEXT (2020, 60 Tbit/s, n/a) • Hawaiki (potential, 43.8 Tbit/s, n/a)
Cable landing station operator (no. of international landing stations)	Fiji International Telecommunications Ltd (Fintel) (1)

Sources: ITU, World Bank Group, United States Department of State, operator websites

	2010	2017
Mobile subscriptions per 100 inhabitants	81.1	114.2
Fixed (wired) broadband subscriptions per 100 inhabitants	2.7	1.4

	2010	2017
Mobile broadband subscriptions per 100 inhabitants	0.82	55.7
Households with a computer	26.8%	44.6%
Households with Internet access at home	18.8%	35.9%
Individuals using the Internet	20.0%	50%

Source: ITU (https://www.itu.int/net4/itu-d/icteye/CountryProfile.aspx)

Existing cables

- Fiji is a well-established submarine cable hub with connections to major traffic origination and destination hubs, including Australia, New Zealand, and the United States. There are currently four submarine cables landed in Suva, with a fifth planned for 2020.
- The principal connection is to the Southern Cross Cable Network (SCCN), which directly connects Fiji to Australia, New Zealand, through Hawaii to the United States mainland. It currently provides Fiji with access to 30 Gbit/s of capacity. SCCN is operated by New Zealand-based Southern Cross Cables Limited (SCCL), ownership of which is shared by Spark (New Zealand), (50%), SingTel Optus (40%) and Verizon (10%).
- The other cables that are landed in Fiji do so for the purpose of interconnecting with the SCCN.

Access and price regulation

- The Fijian Competition and Consumer Commission (the Commission) regulates the pricing of interconnection services pursuant to a Ministerial price control order made under the Commerce Commission Decree 2010.
- In 2010, the Commission determined Fintel to have substantial market power arising from its control of access to the SCCN and imposed price caps on certain IP transit products, as shown in Table 3.1.1. Maximum prices for other wholesale services were also imposed, including for co-location services and facilities interconnect services.

Table 3.1.1: Price caps for IP transit via Fintel

Product	Price per Mbit/s per month (FJD)		Price per Mbit/s per month (USD)	
	2010	Current	2010	Current
IP Transit (Australia)	832	258	434	127
IP Transit Plus (Australia)	998	310	521	153
IP Transit (United States)	1 300	221	679	109
IP Transit Plus (United States)	1 560	265	814	131
IP Transit – Premium	843	338	440	167
IP Transit Plus – Premium	1 012	436	828	215

Source: Fiji Competition and Consumer Commission, Final Determination on Prices and Access for Southern Cross Capacity and Network (November 2013).

Affordability of retail broadband services

- The price of entry-level broadband services has reduced significantly and is now well under the 5 per cent benchmark set by the Broadband Commission (Table 3.1.2).

Table 3.1.2: Pricing of entry-level mobile broadband services as a proportion of GNI per capita per month

	2016
Handset-based mobile broadband, 500 MB/month, prepaid	2.84%
Computer-based mobile broadband, 1 GB/month, post-paid	2.81%

Source: ITU

Future plans

- The proposed Southern Cross NEXT Cable linking Australia, New Zealand to the United States and planned to be in service by 2020, plans to have a BU to Fiji. Fiji should also benefit from diverse routes transiting in Samoa: by June 2018 via American Samoa to Hawaiki cable using the SAS Cable; by 2019 via Tahiti combining Manatua (Samoa – Tahiti) and existing Honotua (Tahiti – Hawaii).

3.2 Papua New Guinea

Figure 3.2.1: Map showing existing and proposed cables

Source: ITU (https://www.itu.int/en/ITU-D/Technology/Pages/InteractiveTransmissionMaps.aspx)

Key data

Land area (sq.km.) (as proportion of total area)	452 860 (45%)
Population 2016	8 084 991
GDP 2014 (current USD in millions)	16 928
GNI per capita, Atlas method, 2014 (current USD)	2 160
Major telecommunication operators	• Digicel (Papua New Guinea) Ltd • bmobile Ltd • PNG DataCo Ltd • Telikom PNG
International submarine cables (ready for service, design capacity, lit capacity)	• APNG-2 (2006, 1.136 Gbit/s, 1.136 Gbit/s) • PPC-1 (2009, 2.56 Tbit/s, 40 Gbit/s (spur) • Coral Sea Cable System (2019, 20 Gbit/s, n/a) • PNG National Submarine Fibre Cable Network (proposed, 8 Tbit/s, n/a)

Cable landing station operator (no. of international landing stations)	Telikom (2)

Sources: ITU, World Bank Group, United States Department of State, operator websites.

	2010	2017
Mobile subscriptions per 100 inhabitants	27.8	48.7
Fixed (wired) broadband subscriptions per 100 inhabitants	0.1	0.2
Mobile broadband subscriptions per 100 inhabitants	0.2	11.1
Households with a computer	2.8%	4.7%
Households with Internet access at home	2.2%	11%
Individuals using the Internet	1.3%	11.2%

Source: ITU (https://www.itu.int/net4/itu-d/icteye/CountryProfile.aspx)

Existing cables

- Two international submarine cables have been landed in Papua New Guinea. Access to both is controlled by Telikom PNG Ltd (Kumul Telikom Holdings Ltd).
- The Australia – Papua New Guinea 2 (APNG-2) cable is landed in Port Moresby. It is a recycled cable based on recovered sections of the former PACRIM West submarine cable between Sydney and Guam. Approximately 700 Mbit/s of its 1.136 Gbit/s of capacity is currently utilized, of which 300 Mbit/s is for redundancy.
- The PIPE Pacific Cable (PPC-1) is landed in Madang. It currently provides access to 10 Gbit/s of capacity however, this is under-utilized (at about 2.5 Gbit/s) as the national transmission backbone between Madang and Port Moresby (the capital) is not entirely optical fibre and depends in part on microwave due to the topography of the region. PPC-1 is owned and operated by the Australian based company PIPE Networks Pty Ltd, a subsidiary of TPG Telecom Limited.

Access and price regulation

- In 2013, the 'international submarine cable transmission capacity service' and the 'international submarine cable gateway access service' were made 'declared services' by the Minister responsible for telecommunications, on the recommendation of the National Information and Communications Technology Authority (NICTA). As a consequence those wholesale services are subject to statutory principles requiring cost-based pricing and non-discriminatory supply. Further, in the event of a dispute regarding the terms of access, the parties at dispute may request NICTA to resolve the dispute through arbitration.
- To date, no disputes regarding access to either submarine cable have been referred to NICTA for arbitration.

Affordability of retail broadband services

- The price of entry-level broadband services as a proposition of GNI per capita per month remains high relative to the 5 per cent benchmark set by the Broadband Commission, suggesting that mobile broadband services generally are unaffordable to many people. This is reflected in the number of active mobile broadband subscriptions per 100 inhabitants (6.1), which remains very low by regional standards.

Table 3.2.1: Pricing of entry-level mobile broadband services as a proportion of GNI per capita per month

	2016
Handset-based mobile broadband, 500 MB/month, prepaid	9.73%
Computer-based mobile broadband, 1 GB/month, post-paid	14.17%

Sources: ITU

Future plans

- A new cable – the Coral Sea Cable System – is to be constructed with development aid and assistance from the Australian Government to provide replacement submarine cable capacity into Port Moresby.
- A domestic submarine cable network to provide broadband transmission capacity into 14 of the Papua New Guinea major coastal centres and islands, plus international connectivity via a link into neighbouring Jayapura in Indonesia, is also planned.

3.3 Samoa

Figure 3.3.1: Map showing existing and planned cables

Source: ITU (https://www.itu.int/en/ITU-D/Technology/Pages/InteractiveTransmissionMaps.aspx)

Map also shows American Samoa.

Key data

Land area (sq.km)	2 830
Population 2016	195 125
GDP 2016 (current USD in millions)	785
GNI per capita, Atlas method, 2016 (current USD)	4 100
Major telecommunication operators	• Bluesky Samoa Ltd • Digicel (Samoa) Ltd
International submarine cables (ready for service, design capacity, lit capacity)	• Samoa – American Samoa (SAS) cable via American Samoa – Hawaii (ASH) cable (2009, 1.2 Gbit/s, 1.2 Gbit/s) • Tui-Samoa Cable (2018, 8 Tbit/s, n/a)

Cable landing station operator (no. of international landing stations)	• ASH Cable LLC (1) • Samoa Submarine Cable Company Ltd (1)

Source: ITU, World Bank Group, operator websites.

	2010	2017
Mobile subscriptions per 100 inhabitants	48.4	63.2
Fixed (wired) broadband subscriptions per 100 inhabitants	0.1	1
Mobile broadband subscriptions per 100 inhabitants		29.8
Households with a computer	13.0%	24%
Households with Internet access at home	10.0%	32.7%
Individuals using the Internet	7.0%	33.6%

Source: ITU (https://www.itu.int/net4/itu-d/icteye/CountryProfile.aspx)

Existing cables

- The Samoa-American Samoa (SAS) cable is landed in Apia. It is a recycled cable based on recovered sections of the former PACRIM East submarine cable between New Zealand and Hawaii. Its design capacity is only 1.136 Gbit/s, however, new optical transmission technologies could potentially expand its capacity to a few 100 Gbit/s wavelengths. Access is controlled by Bluesky Samoa Ltd.
- A new submarine cable – the Tui-Samoa Cable – connecting Samoa's two main islands (Upolu and Savai'i) via Fiji to the existing Southern Cross Cable Network between Australian and the United States was put into service in February 2018. The estimated cost of USD 40 million was financed with developmental aid and private sector equity investment. A special purpose vehicle – the Samoa Submarine Cable Company (SSCC) – was established to own and operate the new submarine cable.

Access and price regulation

- Under the Telecommunications Act, a service provider found to be dominant in a relevant market is required to maintain a reference interconnection offer (RIO) with respect to the services it supplies in that market.
- In 2015, the Regulator determined that American Samoa Hawaii Cable LLC, (ASH Cable LLC) was dominant in the market for the supply of wholesale submarine cable capacity to Samoa, based on the fact that ASH Cable LLC was the only supplier of international connectivity to Samoa via its SAS Cable. That connectivity is supplied within Samoa by Bluesky Samoa Ltd as local delivery agent for ASH Cable LLC. Bluesky is therefore required to maintain a RIO for a range of wholesale access services relating to international bandwidth on the SAS Cable.
- In April 2016 ASH Cable LLC submitted a revised RIO to the Regulator for its approval. The approved prices are shown in Table 3.3.1.
- In 2017, acting pursuant to an undertaking to the regulator, SSCC filed its own RIO with the regulator. SSCC approved prices for capacity lease commitments made before the RFS date were USD 107/Mbit/s per month for 1 000 Mbit/s and USD 71/Mbit/s per month for 2 000 Mbit/s. A 15-year IRU of 10 Gbit/s was also offered for USD 15.12 million (plus O&M at 3%).

Table 3.3.1: Lease capacity pricing on the SAS cable

Transmission capacity of the service (Mbit/s per month) (half circuit)	Price per month (USD)	Implied price per Mbit/s per month of a full circuit (USD)
1.544 (T1)	200	259
2.048 (E1)	250	244
44.736 (DS3)	3 650	163

Source: Bluesky Samoa Ltd Reference Interconnection Offer (2016).

Affordability of retail broadband services

- The price of entry-level broadband services as a proposition of GNI per capita per month has substantially reduced since Samoa first gained access to international cable capacity via the SAS/ASH cables (Table 3.3.2).

Table 3.3.2: Pricing of entry-level mobile broadband services as a proportion of GNI per capita per month

	2016
Handset-based mobile broadband, 500 MB/month, prepaid	4.76%
Computer-based mobile broadband, 1 GB/month, post-paid	5.36%

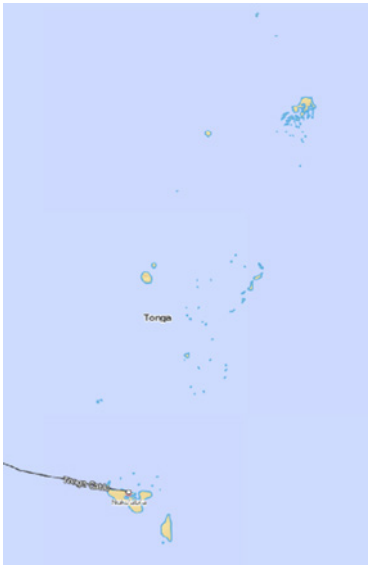
Source: ITU

Future plans

- A proposal for a new submarine cable linking Samoa, Tokelau, and Tuvalu is being studied.

3.4 Tonga

Figure 3.4.1: Map showing the existing cable



Source: ITU (https://www.itu.int/en/ITU-D/Technology/Pages/InteractiveTransmissionMaps.aspx)

Key data

Land area (sq km)	720
Population 2016	107 122
GDP 2016 (current USD in millions)	395
GNI per capita, Atlas method, 2016 (current USD)	4 020
Major telecommunication operators	• Digicel (Tonga) Ltd • Tonga Communications Corporation Ltd
International submarine cables (ready for service, design capacity, lit capacity)	• Tonga Cable (2013, 320 Gbit/s, 20 Gbit/s) • Hawaiki (potential, 43.8 Tbit/s, n/a)
Cable landing station operator (no. of international landing stations)	• Tonga Cable Ltd (1)

Source: ITU, World Bank Group, operator websites.

	2010	2017
Mobile subscriptions per 100 inhabitants	52.2	80.5
Fixed (wired) broadband subscriptions per 100 inhabitants	1.1	1.7
Active mobile broadband subscriptions per 100 inhabitants		59.2
Households with a computer	10.1%	40.5%
Households with Internet access at home	7.8%	47.2%
Individuals using the Internet	16.0%	41.2%

Source: ITU (https://www.itu.int/net4/itu-d/icteye/CountryProfile.aspx)

Existing cables

- Tonga's first submarine cable was landed in Nuku'alofa in 2013. It connects Tonga to Fiji and provides access to 10 Gbit/s of capacity. Access is controlled by Tonga Cable Limited (TCL).

Access and price regulation

- The telecommunications laws were reviewed in 2014. The *Communications Act 2015* requires the following wholesale services to offered on terms and conditions that are subject to regulatory oversight: access to and interconnection with international cable capacity; co-location space within an international cable landing station; and wholesale carriage over backhaul optical fibre from a international cable landing station to an exchange at which interconnection is offered.
- The *Interconnection and Access (Submarine Cable Services) Rules 2017* regulate the pricing of capacity leases under a take-or-pay arrangement. In return for making minimum annual purchase commitments wholesale customers are able to access cheaper (cost-based) pricing that would otherwise not have been able to been offered (or imposed) in the absence of such certainty. This arrangement also gives TCL revenue certainty for five years. The minimum annual purchases increase from 300 Mbit/s per month in year one to 1 000 Mbit/s per month in year five. To avoid the risk of freeriding, in practice both of the major telecommunication operators must commit to these minimum annual purchases before either can access the regulated prices. The regulated prices, which are fixed for the five year period ending June 2021, are shown in Table 3.4.1

Table 3.4.1: Regulated lease capacity pricing

Transmission capacity of the service (Mbit/s per month)	Price per Mbit/s per month (USD)
≥1,000	100
600-999	125
500-599	150
400-499	175
300-399	200
200-299	225
155-199	250
100-154	275
<100	300

Source: Interconnection and Access (Submarine Cable Services) Rules 2017.

Affordability of retail broadband services

- The retail mobile broadband services are below the 5 per cent benchmark set by the Broadband Commission (Table 3.4.2).

Table 3.4.2: Pricing of entry-level mobile broadband services as a proportion of GNI per capita per month

	2016
Handset-based mobile broadband, 500 MB/month, prepaid	2.19%
Computer-based mobile broadband, 1 GB/month, post-paid	3.50%

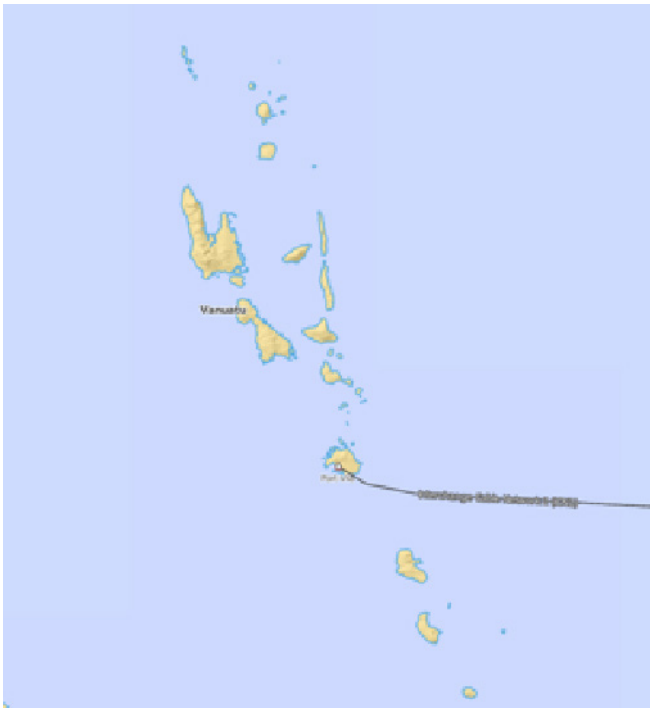
Source: ITU

Future plans

- A domestic cable is currently being constructed to link the outer island groups of Vava'u and Ha'apai to the island of Tongatapu, where the international cable landing station is located.
- TCL has contracted a dormant Branching Unit on the Hawaiki Cable for potential future use.

3.5 Vanuatu

Figure 3.5.1: Map showing the existing cable



Source: ITU (https://www.itu.int/en/ITU-D/Technology/Pages/InteractiveTransmissionMaps.aspx)

Key data

Land area (sq km): (as proportion of total area)	12 190 (15%)
Population 2016	270 402
GDP 2016 (current USD in millions)	773
GNI per capita, Atlas method, 2014 (current USD)	3 170
Major telecommunication operators	• Digicel (Vanuatu) Ltd • Telecom Vanuatu Ltd
International submarine cables (ready for service, design capacity, lit capacity)	• Interchange Cable Network 1 (ICN1) (2014, 1 280 Gbit/s, 20 Gbit/s)
Cable landing station operator (no. of international landing stations)	• Interchange (1)

Source: ITU, World Bank Group, operator websites.

	2010	2017
Mobile subscriptions per 100 inhabitants	71.9	82.5
Fixed (wired) broadband subscriptions per 100 inhabitants	0.2	1.8
Mobile broadband subscriptions per 100 inhabitants		45.4
Households with a computer	8.7%	22.4%

	2010	2017
Households with Internet access at home	5.4%	29.4%
Individuals using the Internet	8.0%	25.7%

Source: ITU (https://www.itu.int/net4/itu-d/icteye/CountryProfile.aspx)

Existing cables

- Vanuatu's first submarine cable, ICN-1, was ready for service in early 2014. It connects Vanuatu via Fiji to the Southern Cross Cable Network (SCCN). ICN-1 currently provides 20 Gbit/s of capacity into Vanuatu. It is owned and operated by Interchange Ltd.

Access and price regulation

- For the first four years following commissioning, Interchange offered only Indefeasible Rights of Use (IRUs). Shorter-term capacity leases were offered by a wholesaler, Fidelity Communications Corporation (FCC), which had purchased a number of IRUs from Interchange. There was a regulatory investigation carried out by TRR for anti-competitive conduct and complaints received from service providers including the Government that it was too expensive to purchase Internet capacity at the wholesale price. Interchange commenced offering capacity leases in October 2017.
- Since 2016, the Telecommunications and Radiocommunications Regulator (TRR) has required all proposed price and non-price terms and conditions of supply to be filed for the TRR review and pre-approval to ensure prices are cost-based and not discriminatory.[11]
- In October 2017, the TRR approved the Interchange capacity lease price of USD 285 per Mbit/s per month.[12]

Affordability of retail broadband services

- The price of handset based mobile broadband (prepaid) is below the 5 per cent benchmark set by the Broadband Commission, while that of computer based mobile broadband (postpaid) is well above the benchmark.

Table 3.5.1: Pricing of entry-level mobile broadband services as a proportion of GNI per capita per month

	2010	2016
Handset-based mobile broadband, 500 MB/month, prepaid	n/a	3.29%
Computer-based mobile broadband, 1 GB/month, post-paid	n/a	16.47%

Source: ITU

Future plans

- There is no public confirmation on any formal plans for additional submarine cables at the moment.

[11] *Order No.3 of 2016: Orders relating to the wholesale international Internet services market and Speedcast complaint against ICL,* issued by the Telecommunications and Radiocommunications Regulator on 1 June 2016.

[12] *TRR Decision on ICL request for approval of ICL proposed pricing for sale of leased capacity*, issued by the Telecommunications and Radiocommunications Regulator on 10 November 2017.

4 Recommendations

Based on the collective recent experience of the Pacific islands in the construction, regulation and exploitation of submarine cables there are many initiatives that can be taken to maximize the availability of international connectivity in the region.

- **Financial structure**. The lower the cost of capital, the cheaper the wholesale pricing of capacity will be. Governments should take advantage of the special advantages provided by development aid in this context and use it strategically with a view to achieving long-term broadband-enabled economic and social development.
- **Regional collaborations**. Partnering to construct and operate point-to-point cable links can improve the feasibility and timeliness of such projects, enable more islands to be connected directly, foster the development of additional hubs, share the burden of repair contingency costs, promote greater integration, and better utilize the limited skills and capital available in the region.
- **Connections of opportunity**. The opportunity to gain access to a larger trans-Pacific cable during its planning stage should be exploited if and when they arise. This may be increasingly important for the establishment of connections to outer islands and inter-island links in the future.
- **Telecommunication licensing**. As the telecommunication legal and regulatory frameworks of many Pacific islands may not have anticipated the landing of a submarine cable, it may be necessary to review, update and complete these laws and regulations. Key areas for attention will tend to be licensing and access regulation (including price regulation). Consideration should be given to whether a new type or special category of licence is necessary to fit the circumstances of the landing station operator. Fixed licence periods, where they exist, should be longer than 15 years and ideally matched to the design life of the cable to enable the licensee to continue selling (or at least offering) long-term IRUs during the term of the licence.
- **One-stop-shop**. In addition to some form of telecommunication licence, there may be a range of other licences and authorisations required to lay and land a submarine cable. For example, approval of the cable route and cable laying activity by a maritime authority; authorisations to construct beach manholes, bury terrestrial cables, or construct and power landing stations on public or customary land. This process could be simplified and sped up by establishing a one-stop-shop with all the necessary authorities, or alternatively by appointing a coordinating authority.
- **Access regulation**. Regulatory oversight of price and non-price terms and conditions of access to (landed) capacity and also co-location space in cable landing stations will tend to be necessary given the absence of competition in these markets in this region. Innovative regulatory interventions in wholesale pricing may be necessary, particularly during the early years of the cable, to help reduce risk and demand uncertainty, encourage greater utilisation, and help the landing station operator achieve lower unit costs. At regional hubs, this oversight may need to extend to the pricing of cross-connects.
- **Cable protection and maintenance**. Once landed, submarine cables may need some form of protective regulatory regime to minimize the risks of damage to the cable, which can cause a loss of connectivity and are costly to repair. This is particularly important for the private cables, which do not have the ability to spread repair costs across many consortium members.
- **Hubs**. The development of regional traffic consolidation points may, over time, help to create sufficient traffic to encourage the large international carriers to build out their own infrastructure further into the region.
- **Institutional capacity development**. Further development of the technical knowledge and skills in the key areas of policy, legislation and regulatory frameworks will better enable Pacific island countries to analyse the costs and benefits of available options for international connectivity,

make informed decisions; negotiate with partners; manage complex projects; and realize the socio-economic development potential of enhanced access to ICT.

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