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INTRODUCTION

The Pacific subregion is the world's most dynamic geographic region, encountering huge daily challenges due to the small size of the islands in terms of area and population, their remoteness as they are spread widely across the vast Pacific Ocean, and their vulnerability to natural disasters and climate change threats. In this context, improving connectivity of the Pacific subregion with other parts of the world using submarine cable and satellite technologies is being considered as the most crucial enabler for economic and social well-being.

The benefits of submarine cables to the Pacific subregion are significant because they not only bring high bandwidth capacity, but also considerably lower costs. The submarine cables have connected Fiji, French Polynesia, Guam, the Marshall Islands, the Federated States of Micronesia, New Caledonia, Palau, Papua New Guinea, Samoa, Tonga, Vanuatu, and Wallis and Futuna. However, inter-island (domestic) connectivity remains seriously constrained with a high proportion of outer islands and remote areas that are not yet connected. Thus, it is important for the Pacific subregion to continue working together with satellite service providers to address the digital gaps in the region.

The working paper on "Satellite Communications in Pacific Island Countries" examines how the Pacific Island countries respond to the challenges and opportunities of submarine cable connectivity through the use of satellite technology to enhance the availability, affordability and resilience of broadband connectivity.

The Dynamic of Submarine and Satellite Communication Development in the Pacific

The deployment of submarine fiber-optic cables to countries in the Pacific subregion in the last decade has transformed the connectivity landscape. Today, 15 countries and territories in the subregion already have a submarine fiber-optic cable connection and it is planned that all islands will be connected by the end of 2020 (Table 1).

Table 1: Submarine fiber-optic cables in the Pacific

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.

Source: International Telecommunication Union, *Maximizing Availability of International Connectivity in the Pacific* (Geneva, 2018). Available at https://www.itu.int/en/ITU-D/Regulatory-Market/Documents/Infrastructure_portal/Maximising-availability-of-int-connectivity-in-the-pacific.pdf.

While most Pacific Island countries are moving towards submarine fiber-optic connections as the primary means for communications, satellite technology is being retained for redundancy. Seven of 19 Pacific Island countries are using satellite technology primarily for international and/or domestic connectivity, while 11 are using satellite technology for redundancy (Table 2).

Table 2: Satellite technology usage and purpose in the Pacific (as of 19 November 2018)

Countries	Current Usage of Satellite	Purpose	Plan for Future
American Samoa	Yes	Redundancy	Redundancy
Cook Islands	Yes	International /Domestic connection	Redundancy
Fiji	Yes	Redundancy	Redundancy (reviewing)
French Polynesia	Yes	Redundancy	Redundancy
Federated States of Micronesia	Yes	Redundancy	Redundancy
Guam	*Not available*	*Not available*	Redundancy
Kiribati	Yes	International /Domestic connection	Redundancy
Marshall Islands	Yes	Redundancy	Redundancy
Nauru	Yes	International connection	Redundancy
New Caledonia	Yes	Redundancy	Redundancy
Niue	Yes	International connection	Redundancy
Palau	Yes	Redundancy	Redundancy
Papua New Guinea	Yes	Redundancy	Redundancy
Samoa	Yes	Redundancy	Redundancy
Solomon Islands	Yes	International /Domestic connection	Redundancy
Tokelau	Yes	International connection	Redundancy
Tonga	Yes	Redundancy	Redundancy
Tuvalu	Yes	International /Domestic connection	Redundancy
Vanuatu	Yes	Redundancy	Redundancy

Source: Authors' consolidation based on various governments/regional sources.

In the deployment of submarine fiber-optic cables in several Pacific Island countries, landing stations have been established mainly on the main islands. Second domestic landing stations are connected between the main island and most often, the second most populous island. However, connections to the outer islands are still mostly covered by satellite and microwave technologies (Table 3). Therefore, satellite/microwave technologies are seen as complementary services to the submarine fiber-optic cables in most Pacific Island countries.

Table 3: The number of islands connected by submarine cables, satellite and microwave

Pacific Island Country	Number of Islands Inhabited	Number of Islands Connected by Submarine Cables	Number of Islands Dependent on Satellite or Microwave
American Samoa	1	1	1
Cook Islands	15	0	15
Federated States of Micronesia	4 States	4	0
Fiji	106	2	104
French Polynesia	1	1	129
Guam	1	1	0
Kiribati	32	0	32
Marshall Islands	29	2	27
Nauru	1	0	1
New Caledonia	1	1	0
Niue	1	0	1
Palau	8 States	3	5
Papua New Guinea	3	1	2
Samoa	4	2	2
Solomon Islands	1000 +	0	1000
Tokelau	3	0	3
Tonga	36	3	33
Tuvalu	3	0	3
Vanuatu	80	1	79

Source: Authors' consolidation based on various governments/regional sources.

Satellite service providers, therefore, need to consider adjusting their business model to suit these new conditions in the Pacific subregion. While most of them are primarily providing backhaul services, they could consider diversifying their services to include a full set of services ranging from Internet access, telephony, backup services to payment systems. These services are required in rural and remote islands. An integrated market in the region may facilitate this in order to increase market size.

Advantages and Disadvantages of Satellite Technology

One of the main advantages of satellite technology in the Pacific is the ability to cover large areas. As thousands of isolated islands are spread across 33 million square kilometers, satellite technology has been the ideal connectivity solution because of the easy installation of the antenna. Besides, satellite technology is inherently a broadcast medium with an ability to transmit simultaneously from one point to an arbitrary number of other points within its coverage area.

However, satellite communications is very costly, has high maintenance costs and is not always reliable, especially during heavy rain.

New Players and New Developments in Satellite Technology

Over the years, there have been some new satellite players and technologies in the Pacific subregion, including JCSAT-2B, Eutelsat 172B, Intelsat, Horizons-3e, among others. With these new satellite services, Pacific Island countries now have more choices, and the intense competition could help lower prices.

At the same time, satellite services provided to Pacific Island countries have been evolving, with greater emphasis placed on providing broadband connectivity with 4G mobile network technology through new satellite systems such as Eutelsat and Intelsat Horizons-3e.

Cases Using Satellite Technology in the Pacific

The University of the South Pacific (USP) is using satellite technology extensively for its education network—USPNet. However, as countries in the Pacific are being connected by submarine cables, including the Marshall Islands, Samoa, Tonga and Vanuatu, USP is reviewing its strategies to connect USP campuses to submarine cables because of their greater bandwidth capacity and affordability. Nevertheless, USP's current plan for the next five years is to continue using satellite technology. But this may change as submarine

cable development in the region has made significant leaps and bounds recently.[1]

The Forum Fisheries Agency (FFA) has deployed a number of very-small-aperture terminal (VSAT) units to support its members' fisheries operation in the area of vessel monitoring. The FFA has deployed VSATs each for the Cook Islands, Kiribati, Solomon Islands and Tuvalu, and will continue to provide technical assistance and services to members from these four countries since it is still uncertain whether they will have access to submarine fiber-optic connections. Should the members in these countries gain access to submarine fiber-optic connections in future, FFA plans to continue offering satellite services as backup for fisheries operations.[2]

Policy Recommendations

In light of the findings from this study, the following policy recommendations could be considered by Pacific Island countries including regional/international stakeholders working in this area:

The University of the South Pacific, in collaboration with the Council of Regional Organizations in the Pacific ICT Working Group, should continue to lead and coordinate ICT initiatives and strategies for the Pacific;

Conduct a feasibility study to identify the challenges and opportunities for satellite service providers to provide full ICT services in the Pacific;

Create an ecosystem to ensure that satellite technology continues to be an important complement to submarine fiber-optic cables in connecting remote and distanced islands; and

Emphasize that satellite technology provides a reliable redundancy service and is critical for emergency communications and disaster recovery.

[1] See McMaster JC, and Duncan RC, *Impact of ICT on university education in small Island states: the case of the University of the South Pacific. In: Small States, Smart Solutions*. The World Bank, Washington DC, (2008), pp. 193-211; and Duncan R, and McMaster J, The Role of USPNet in Capacity Development in the South Pacific subregion, Pacific Choice, Capacity Development Series, Asian Development Bank, 2008. Available from: https://think-asia.org/bitstream/handle/11540/2581/uspnet-capacity-development.pdf?sequence=1

[2] See Forum Fisheries Agency, Pacific fisheries officials step up vessel monitoring skills, Public Announcement. Available from: https://www.ffa.int/node/762

Launched by the ESCAP resolution 73/6 in 2017, the Asia-Pacific Information Superhighway (AP-IS) initiative aims to increase the availability and affordability of broadband connectivity across Asia and the Pacific through four pillars: (1) physical infrastructure development; (2) Internet traffic and network management; (3) promoting e-resilience and (4) broadband for all. The AP-IS Policy Brief Series is designed to deliver key messages emanating from the analytical research conducted by the ESCAP secretariat and AP-IS partners for member countries' informed decision making.

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