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A Study on the Costing, Operational Principles and Modalities of a Proposed South Pacific Internet Exchange

August 2020

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Contact:
It has been prepared by **Andrew Khoo** of **Edgeconnect Pty Ltd**, and can be contacted:

- via email at **andrew@edgeconnect.io**
- via postal mail at **PO Box 1083, Ryde NSW 1680. Australia.**

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Abbreviations and Acronyms

AP-IS	Asia-Pacific Information Superhighway
APE	Auckland Peering Exchange
APNIC	Asia Pacific Network Information Centre
CDN	Content Distribution Network
DNS	Domain Name System
ESCAP	Economic and Social Commission for Asia and the Pacific
FINTEL	Fiji International Telecommunications
IP	Internet Protocol
IX/IXP	Internet Exchange Point
KW	Kilowatt
NAT	Network Address Translation
NUS	National University of Samoa
NZ	New Zealand
NZIX	New Zealand Internet Exchange
RPKI	Resource Public Key Information
USA	United States of America
USP	University of South Pacific

1. Background

1.1 Introduction

This report is the results of a study on the costing, operational principles and possible modalities of a Pacific Internet Exchange Point (IXP).

The study follows an initial report - *Pacific-IX Desktop Feasibility Study* by *Dr Paul Brooks* – that was completed in December 2019.

The scope of that study reads:

> *As part of the development of the Asia-Pacific Information Superhighway (AP-IS) initiative, UN ESCAP and the Internet Society (ISOC) initiated a feasibility study to establish whether a regional 'Pacific IXP' was feasible, to which multiple member nations could connect, and if it was thought to be feasible, where the physical infrastructure should be installed for best effect.*

1.2 Summary of Conclusions of Initial Desktop Study

The conclusions from the initial study *Pacific-IX Desktop Feasibility Study* states:

This study found that the collection of Pacific island member and associate members states of ESCAP (hereinafter referred to as Pacific Islands) are generally well connected by subsea cables, with many nations connected by at least one cable, and many particularly in the southern section connected (or soon to be connected) by two cables and in some cases more than two. While there are still some countries reliant on satellite connectivity and not connected by any subsea cable (notably Tuvalu, and Nauru), these are in the minority.

This study determined that the Pacific Islands were split into two distinct zones – a northern zone surrounding the island of Guam, and a southern zone clustered loosely between Australia, New Zealand and Hawaii.

These two zones are significantly far apart, and no subsea cable connects the two zones together. Any traffic between a northern zone country and a southern zone country must pass through either Australia, or the USA either in Hawaii or the west coast of the USA mainland. As there are already very large, well-connected IXPs near the cable landings in Australia and USA, these IXPs will always be closer and provide more benefit to a Pacific island than any IXP located within the other Pacific zone.

These characteristics make it infeasible for a single IXP to serve all Pacific islands, however each zone has a recommended IXP solution that should provide significant performance and efficiency benefits for each Pacific island.

1.3 Proposed Physical Topology of the South Pacific Internet Exchange

This figure from the initial desktop study represents the physical topology identified in the report as the best suited for deployment of the South Pacific IXP spanning the countries of Fiji, Samoa and New Zealand.

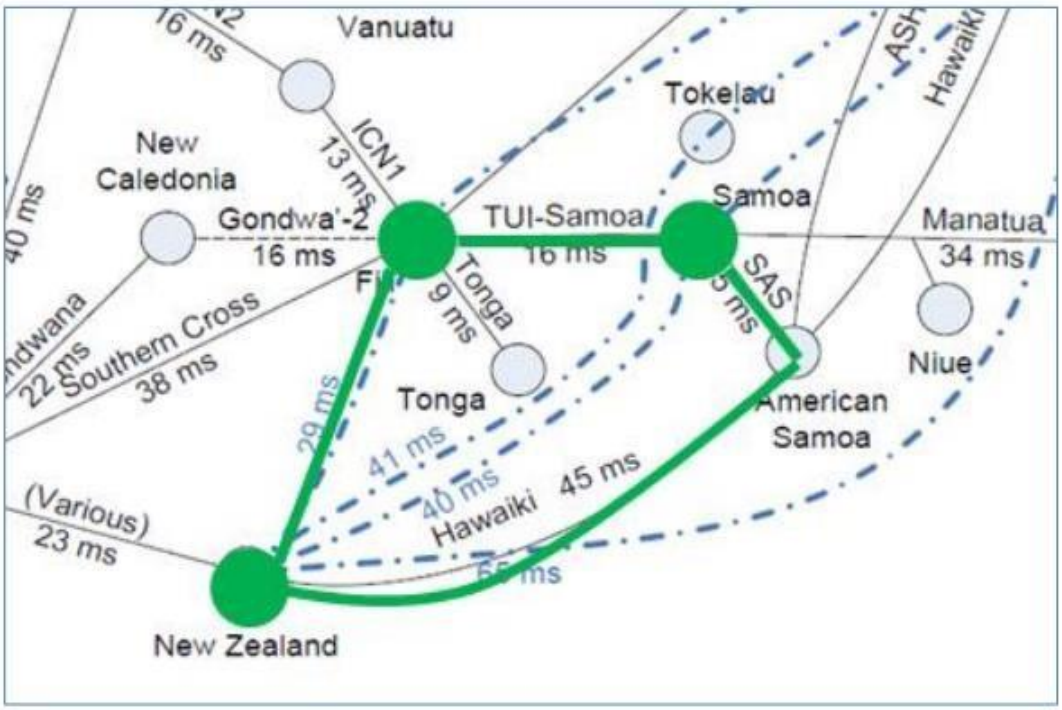

Figure 1. Best suited physical topology for deployment of the South Pacific IXP

1.4 Stakeholder Engagement and Workshop for Study

As part of the process for obtaining a suitable actionable result for this study, an online workshop was held on 5th August, 2020. This workshop was co-hosted by ESCAP and the Internet Society in support of the implementation of the Asia-Pacific Information Superhighway initiative in the Pacific.

This workshop presented initial findings, and included extensive Q&A sessions from the participants regarding possible implementation steps and potential challenges of implementing a South Pacific IXP.

The discussions from the workshop were incorporated into this report.

1.5 Recommendations

The recommendations in this study are based on investigations on current best practice in the operation of IXPs and are formulated based on the results of an online workshop held on 5th August, 2020.

During the workshop, it was determined that the best outcome for success of the **South Pacific Internet Exchange (SP-IX)** would be:

- the primary beneficiaries of the South Pacific IX will be the countries of Fiji and Samoa - the New Zealand leg of the South Pacific IX should be used to effect efficiencies and economic benefit to the primary beneficiaries, and

- a "hybrid IXP" model should be established - this uses route servers at each location to "peer" with the existing IXPs.

2. Corporate Structure

It is recommended that the South Pacific IX be operated by two members - Fiji-IX and the proposed Samoa-IX - either in a joint-venture corporate arrangement, or as a not-for-profit organization.

This arrangement will allow the South Pacific IX to avoid some of the more complicated political and regulatory considerations as ascertained, yet allow autonomy of operation of each IXP with regards to the South Pacific Internet Exchange.

It has been determined that there is no impediment to the proposed South Pacific Internet Exchange from participating in IX related activities in New Zealand.

However, participation in peering activity on the New Zealand Internet Exchange (NZIX) requires that the corporate entity that incorporates the South Pacific IX be a member of the NZIX.

3. Existing Infrastructure

This section presents the existing Internet Exchange (IX) in Fiji, Samoa and New Zealand, current projects being implemented and other relevant information for the present study.

3.1 Fiji

Fiji has an IX situated in Suva, Fiji, known as Fiji-IX, and was established in November 2017. It is situated in one the premises of FINTEL (Fiji International Telecommunications) in Vatuwaqa, Suva. The decision was made to situate the exchange point here instead of a more neutral government facility due to the lack of 24x7x365 access at the latter.

There are presently seven members on the IX switch (as at August 2020), these being:

- all four major Internet Service Providers (ISPs) in Fiji
- University of South Pacific (USP)
- Fiji National University (FNU)
- Walesi - an OTT video provider

Fiji-IX is run as a not-for-profit organisation, with the operational costs equally divided amongst all members. An expansion of Fiji-IX (referred to as Fiji-IX Phase 2) was planned for April 2020. This has been delayed due to the global health situation at that time. As part of Phase 2, Asia Pacific Network Information Centre (APNIC) has allocated an Autonomous System (AS) number and public address range for the use of Fiji-IX.

It has also provided assistance with this project and has provided two Cisco Nexus 9,000 network switches and a Domain Name System (DNS) root server (F-root) instance to be established at USP.

3.2 Samoa

Samoa has a proposed IX to be situated at Apia, Samoa; from which APNIC has allocated an AS number and public address range for use at this IX. These resources are held by Computer Services Limited (CSL). Two Cisco Nexus 3,064 switches were delivered to the National University of Samoa (NUS) in 2016.

The IX is not yet functional at the time of this study (August 2020), but it was advised that this will be actively worked on and is expected to be online at the beginning of 2021.

3.3 New Zealand

New Zealand has two major national IXs and a few smaller that are city-based. The two primary IXs are the New Zealand Internet Exchange (NZIX) and NZIX ExchangeNET.

- **New Zealand Internet Exchange (NZIX)**

The New Zealand Internet Exchange (NZIX) is established as a non-for-profit society. Any participants intending to connect to the IX must join the society as members. It is located at three locations in Auckland, NZ (also known as AKL-IX, in the North Island), and two locations in Christchurch, NZ (also known as CHC-IX, in the South Island). AKL-IX has 80 active peers on its peering fabric, and CHC-IX has 7 active peers on its peering fabric. Both locations offer port speeds of 1Gbps, 10Gbps, 40Gbps and 100Gbps.

- **NZIX ExchangeNet**

NZIX ExchangeNet is a commercial IX operated by Citilink Ltd. It is located in Auckland and Wellington (in the North Island) and Christchurch (in the South Island). The Auckland peering fabric, known as APE, is present at 13 locations in Auckland; the Christchurch peering fabric, known as CHIX-NZ, is accessible at 2 locations, and has five peers presently active. Finally, the Wellington peering fabric, known as WIX,- is accessible at 11 datacenters and over 500 buildings in Wellington.

There are currently plans for peering fabrics in Hamilton and Dunedin.

4. South Pacific Internet Exchange Locations

This section suggests the ideal locations of the IX nodes in the three countries of Fiji, Samoa and New Zealand.

4.1 Fiji - Suva

The location for the Fijian node of the South Pacific IX should be co-located with the existing Fiji-IX at Suva FJ. This is physically located at FINTEL in Suva, Fiji.

4.2 Samoa - Apia

The location for the Samoan node of the South Pacific IX should be co-located with the newly proposed Samoa-IX. We understand this will be physically located at the National University of Samoa (NUS) campus.

4.3 New Zealand - Auckland

In the initial draft of this report, there were a few locations identified in New Zealand that could be good candidates for the New Zealand location of the South Pacific IX.

Subsequent to the workshop held on 5th August, 2020, an evaluation of requirements due to the revised focus indicates that the most ideal location to situate the New Zealand leg of the South Pacific IX would be in Auckland at *DataCentre220* - a facility at 220 Queen Street, Auckland operated commercially by Data Centre Limited. This location has access to both AKL-IX (NZIX) and Auckland Peering Exchange (APE operated by NZIX ExchangeNet), as well as to Megaport's MegaIX service. Additionally, it has infrastructure for caches and content associated with Akamai, Amazon, Cloudflare, Fastly, Microsoft and Netflix amongst others.

5. Design

5.1 Physical Topology

One of the determinations from the workshop held on 5th August, 2020 was that the best design for the South Pacific IX would be a "hybrid IXP" as an adjunct to the present IXPs.

A possible design for this would be as follows:

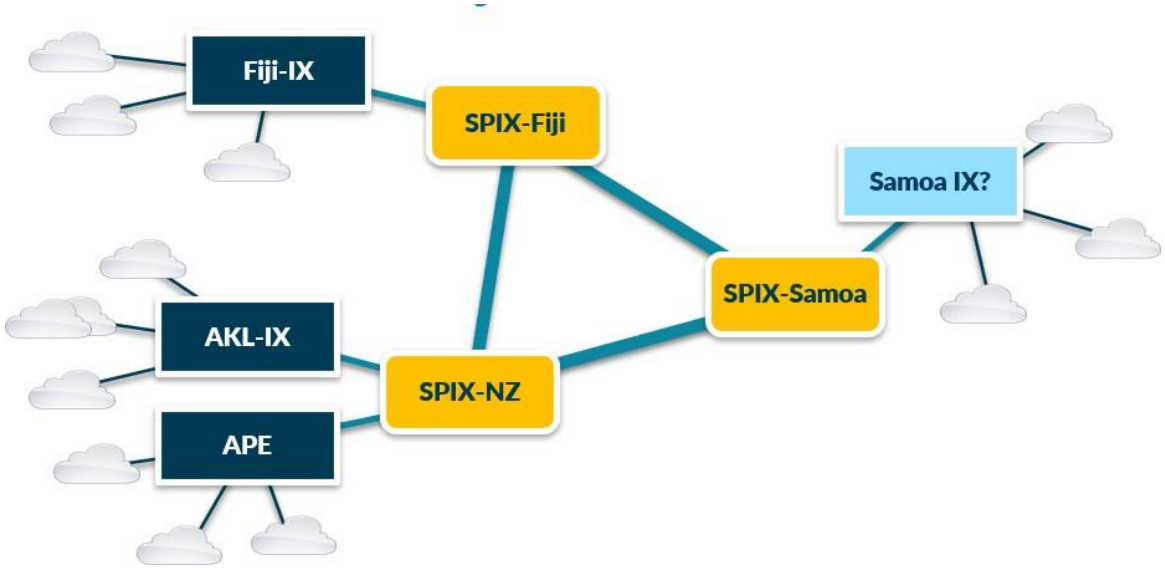

Figure 2. Suggested hybrid IXP design for the South Pacific Internet Exchange

This design leverages the existing IXPs in each economy, and allows a seamless connection on an opt-in basis to other services available over the South Pacific IX fabric.

This design also minimises the requirement for participants in Fiji and Samoa to have more than one circuit into their respective IXPs locations, thus possibly encouraging greater participation from future peers.

5.2 Route Servers

The function of a route server is to enable participants at a peering exchange to exchange route prefixes with other participants by a single peering session to the route server - or two for redundancy purposes.

The alternative to this design is for each participant to connect to every other participant on a 1:1 basis, increasing the complexity and management of Border Gateway Protocol (BGP) peering sessions as the number of participants increase, as shown in Figure 3.

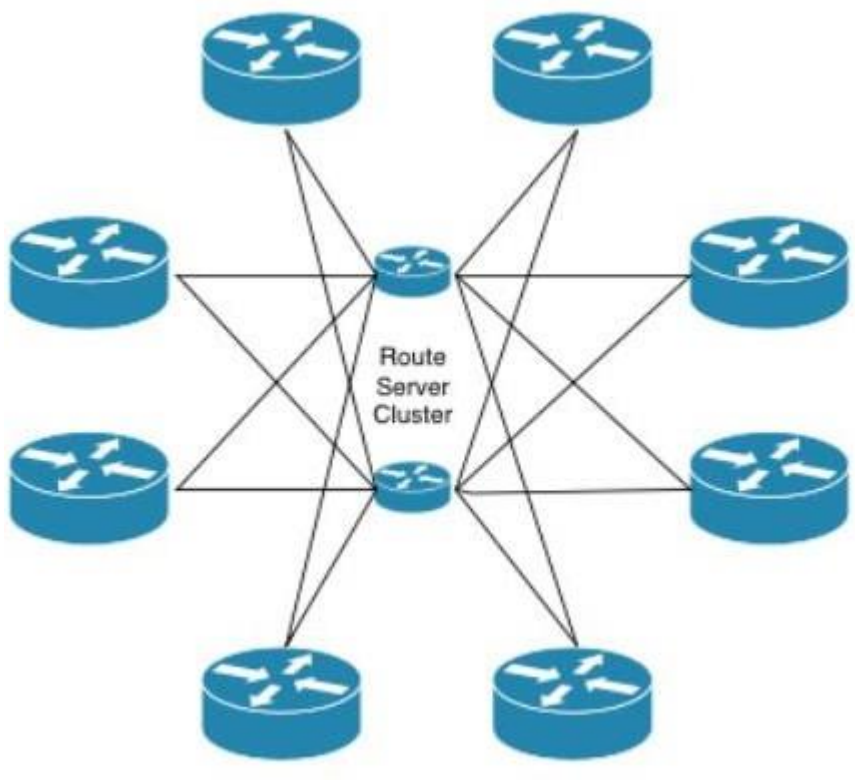

Figure 3. Route Server Cluster design

It is recommended that the router server be implemented using the BIRD Internet routing daemon *(https://bird.network.cz/)*. This piece of software is provided under the GNU General Public Licence. A common deployment of this software is on a server running Ubuntu 20.04-LTS, in which two separate physical servers should be deployed with two instances of this software for route server redundancy purposes. An example implementation of BIRD acting as a route server can be found at
https://gitlab.nic.cz/labs/bird/-/wikis/Route_server_with_community_based_filtering_and_multiple_RIBs.

There is a high level of community support for the installation and operation of the BIRD software.

5.3 Supporting Services

In addition to the route servers, there are various other software tools and services that will either be useful for the operation of the IXP, or for extra functionality that can be provided to participants. They are:

- **IXP Manager**

IXP Manager is a management platform for IXPs to assist in the administration and operation of an IXP *(https://www.ixpmanager.org/)*. This software is presently in operation at over 145 IXPs globally, and is offered at no cost to utilise thanks to various sponsors of its development. It can be deployed on a server running Ubuntu 20.04-LTS.

It integrates with the BIRD software when used as a route server by providing automatic configuration of participant sessions and assists in maintaining best practices in Internet routing "hygiene" by supporting Resource Public Key Infrastructure (RPKI) and bogon/MANRS-compliant configurations.

- **Looking Glass**

A "looking glass" server provides a view of routing information for participants. It assists participants in diagnosing Internet routing issues, and also provides a good indicator of connectivity between different participants. The IXP Manager software described in the previous section contains a robust and stable implementation of a looking glass server, and is automatically integrated with its other functions as configured.

- **RPKI Infrastructure Support**

RPKI is a way to secure the Internet against IPv4/IPv6 prefix hijacks and leaks. When RPKI is adopted by a service provider, it protects the provider from rogue advertisements of their IPv4/IPv6 prefixes, thus ensuring the safety and security of the provider's resources and downstream customers. A validation suite can be run at each IXP location to perform this testing and verification. An example of this software suite can run on another server installed with Ubuntu 18.04- LTS with the following software:

- RIPE Validator Server
- ARIN RPKI data
- RTR Server

- **DNS Root Servers**

A Domain Name Server (DNS) root name server is responsible for translating domain names into IP addresses - it answers client requests in the DNS's "root"/apex zone and is an absolute reference as to which downstream name server is required to perform the translation of domain name into IP address.

An anycast instance of the F-root server is intended to be deployed into the National University of Samoa (NUS) campus. This will allow participants to access locally due to the

nature of anycast.

- **Software Mirrors**

Software mirrors maintain mirror copies of popular or common open source software that can be accessed by participants "locally", thus providing better performance to the users, and reduced transit cost for the participants. Most commonly, used open source software can be mirrored. The only cost to the IXP is the initial population and update of the software sources. Subsequent requests by participants' users are served from the mirrors. Examples of open source software that can be mirrored are: Ubuntu, Fedora, Centos, CPAN/Perl, FreeBSD and MacPorts, among others. Sufficient disk storage space is required for this resource to be properly deployed.

5.4 Special/Additional Services

In addition to the core services that can be delivered to participants as described in the previous section, there are a few additional services that can be optionally provided and can allow participants to further leverage the connection to the peering fabric at the South Pacific IX.

Two of such services are:

- **Proxy Cache**

A proxy cache server stores internet content (HTTP, FTP, etc.) as requested from users, and serves this same content to subsequent requests for the content from other users. The content is managed on a Least-Recently-Used discard basis, so only "fresh" content is stored on the storage systems. Due to this automatic purging mechanism, there is no ongoing operational requirement to manage a proxy cache server's efficiency. An example of a proxy cache server system is Squid.

The size of the proxy cache is dependent on the amount of memory and disk storage space available to the server. Participants at the IXP can transparently forward requests by users to the proxy cache server system, thus lowering effectively the need for Internet transit to serve the requests of the users.

- **NAT64/DNS64**

There is a migration to IPv6 services due to the exhaustion of IPv4 address space available to be obtained by providers. Unfortunately, there are some services which can only be accessed on IPv4.

By deploying NAT64 instances (in conjunction with a DNS64 service), the IXP can assist participants to access IPv4 resources whilst allowing providers to provide a single-stack IPv6 solution to their users. An example of implementation of NAT64 is Jool *(https://www.jool.mx/*), which can be deployed on a server installed with Ubuntu 20.04-LTS.

Google offers public DNS64 servers that can be used. This server can be used by all

participants at the IXP based on a common NAT64/DNS64 IPv6 Well-Known-Prefix (WKP).

6. Organisational Structure

This section presents the organizational structure that should be in place when establishing the South Pacific IX.

6.1 Administrative

The administrative functions related to the South Pacific IX would be primarily focused on onboarding new participants and managing the finances corresponding to the entity. There is also a need for the corporate entity to be able to establish bank accounts and related accounts services to enter into arrangements for services required, as well as to invoice members for services rendered.

Depending on the corporate structure, there may also be a need for the provision of audited figures and related for each jurisdiction, provided that the corporate entity exists.

As the administrative functions are relatively light initially, it is recommended that each member (Fiji-IX and Samoa-IX) undertakes some of the administrative work that needs to be performed.

6.2 Operational

There are two aspects of operational support required for the South Pacific IX.

- Proactive - Routine operations
    - turn up services - connect new participants to the IX
    - manage and update infrastructure - security, updates, features

- Reactive - Outage & "event" management ("NOC")
    - diagnose and mitigate issues as they arise (e.g. DDoS attacks, etc.)
    - respond to regulatory requests (e.g. LEA/LI, etc.)

It is recommended that each member (Fiji-IX and Samoa-IX) undertakes part of the functions as required in an on-demand basis. In this working model, all members should nominate a key person for escalation purposes in the event of reactive support.

6.3 "Marketing" and Evangelism

To maximise the functionality and utility of the IX fabric, there must be an effort to add additional participants to either of the member IXPs (Fiji-IX and Samoa-IX).

Due to the recommendations of a hybrid functioning model, this effort will be in common with encouraging additional participants to the respective member IXPs in each economy.

7. Financial considerations

7.1 Establishment Costs

APNIC makes available to entities in its coverage area an *IXP Development Package*. This "package" consists on various items that can be provided to assist in the establishment of new IXPs. The establishment costs for the initial constructions of the South Pacific IX can be minimised if APNIC's *IXP Development Package* is leveraged. Based on APNIC's documentation, minimum training and technical assistance can be provided with regard to the establishment of the peering switch fabric, the settlement of route servers and the configuration of other software components that might be included in the package (e.g. root server anycast instance, IXP manager and ROV/IPv6 deployment support, among others).

APNIC has indicated their support for this initiative.

7.2 Operating Budget

The proposed operating budget for the South Pacific IX has three primary components. These are described in the following sub-sections.

7.2.1 Infrastructure

The primary cost involved in infrastructure on an ongoing basis is the co-location costs and the associated cost of power and cooling. The ongoing costs for the "hybrid IXP" model in both Fiji and Samoa can be absorbed into the operating costs of Fiji-IX and Samoa-IX respectively. The co-location space requirements should not exceed 14RU (1/3 rack).

On the other hand, the co-location cost in Auckland, New Zealand, at the DataCentre220 (220 Queen Street, Auckland NZ) has two components:

- the monthly cost for half rack is NZ$475 (US$312), and
- the estimated monthly cost for power is approximately NZ$292 (US$192) for 1KW (Kilowatt) consumption.

An estimated monthly cost of NZ$767 (US$502) should be budgeted for 1.5KW power use, with a variance of up to NZ$914 (US$600).

7.2.2 Operational Staffing

As indicated in section 6 of this study, it is proposed that the initial costs associated with operational staffing be absorbed by the members, at least for an initial fixed period of six to twelve months.

A subsequent review can be performed later in this period as to whether a variation to the arrangements would be necessary, at which time a decision can be undertaken on cost recovery on an equal proportional basis or otherwise.

7.2.3 Capacity Costs

The capacity costs associated with the South Pacific IX can be broken down to:

1. Fiji-to-Samoa and Samoa-to-Fiji inter-IX costs: the cost associated with this will generally be constrained as there is little content hosted in either economy that is accessed by the other (as at August 2020)

2. Fiji-to-NZ and Samoa-to-NZ: the capacity required for this will be associated with various cache-fill and content retrieval costs that will come from content caches and related situation at the New Zealand leg of the South Pacific IX.

Note: *there is no expectation of a decrease in the volume of internet traffic sourced internationally by the participants, but rather a pivot of traffic volumes from internet transit, to that from the New Zealand leg of the South Pacific IX. This is due to no local content distribution network (CDN) or content caching performed at the local IXP locations.*

There are two primary methods for allocating costs for this capacity:

- equal apportionment of costs between all participants at each member (Fiji-IX and Samoa-IX) or

- allocating costs as a proportion of traffic used - this will required additional builds of traffic flow collectors and aggregators.

It is recommended that an equal apportionment of costs be adopted initially for a fixed period of time, perhaps six or twelve months, since this will reduce the administrative and operational burden of the South Pacific IX to start.

During this initial fixed period, systems can be put in place to determine whether an equal apportionment of costs should be applicable, or further investigations are required as to how to fairly allocate costs on a per-member's participant's basis.

As an alternative, one or multiple subsea cable providers can be approached for assistance for provision of capacity on a subsidised, or free, basis. When this has happened in previous undertakings similar to the South Pacific IX, it has been due to the providers' nullifying costs by associating it as part of a discretionary marketing budget, or as part of a budget for development purposes.

8. Summary

The initial desktop study completed in December 2019 explores two possibilities for a Pacific IXP, and concludes that a South Pacific IX can be feasible.

As a result of the discussions during the online workshop held on 5th August, 2020, it was determined that due to internet traffic patterns dominantly flowing from global content providers, the primary use of the South Pacific IX would be to provide to participants in Fiji and Samoa better access to CDN and other content caches present in New Zealand.

This report provides details of a possible design and implementation strategies to establish the South Pacific IX with a minimum expenditure and/or risk, whilst providing growth as the South Pacific IX matures.

Most of the recommendations are suitable for immediate implementation, and will also allow the proposed South Pacific IX to adopt best practices to assist internet development in the region.