Pacific Regional Internet Exchange Feasibility Study

For UN-ESCAP Asia-Pacific Information Superhighway (AP-IS) initiative

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“Internet exchange points (IXPs) are a vital part of the Internet ecosystem in that they enable two users in different networks to most efficiently exchange information in the broad Internet network system. In this way, they are analogous to regional airport hubs—airlines exchange passengers between their flights in much the same way that networks exchange traffic across an IXP.”

Internet Society
## Key Considerations

| Technical Aspects | Network operators seek **interconnection points that create the most efficient traffic flows to and from their users**, thereby providing robust data flows and positive end-user satisfaction.  
|                  | Network Operators sometimes focus on Products and Traffic - rather than end user experience. |
| Business Considerations | Network operators seek the **most reliable traffic exchange at the lowest feasible cost** – seeking to **minimise product unit costs** and **operational expenditure**. |
| Legal and Regulatory Factors | Legal, regulatory and often competitive conflict factors influence the **desirability** of a market as a place for interconnection.  
|                  | Impact of network operator decisions on price/cost considerations may affect end-user experience. |
Types of Interconnection

Transit
The transit network agrees to provide its customers with connectivity to the rest of the Internet for a fee.

Peering
Two networks agree to a mutual exchange of traffic to and from users on their own networks (but not via their transit links) on a no-cost basis.
An IXP reduces latency, reduces transit costs......
Reduced latency improves performance, speed, and reliability

– Upgrading ‘bandwidth’ per user from 5Mbps to 10Mbps results in a mere 5% improvement in page loading times! In other words, an average consumer...would not benefit much from upgrading their connection when it comes to browsing the web.

– However, the latency graph tells an entirely different story. For every 20ms improvement in latency, we have a linear improvement in page loading times.

(Source: Ilya Grigorik, www.igvita.com)
One website ‘element’ requires many (~5) RTTs
Every website has many many elements and ‘Round-Trip-Times’
Every website has many many ‘Round-Trip-Times’

‘simple’ website for AirBNB has:

• 13 DNS lookups (13 RTTs)
• ~260 ‘elements’ to retrieve
• Each element might need 4 RTTs for ‘TCP handshake’ and ‘Security’ encryption setup, and then data of element
• Around 1100 ‘Round-Trip-Times’ to retrieve all these elements to display the web-page
Subsea Cables – Two Pacific Zones

North Pacific Islands Group

South Pacific Islands Group
Northern Group – All can connect to Guam, and GU-IX/MARIX

- Palau
- Mariana Islands
- Federated States of Micronesia
- Marshall Islands
- PNG (also peer in IXP in Sydney)
Two IXPs in Guam

GU-IX

- https://www.gu-ix.net
- Established 2010
- (May not still be operating)

Mariana Islands Internet Exchange (MARIIX)

- MARIIX is a project operated at and partially funded by the University of Guam’s Office of Information Technology (OIT).
- https://mariix.net
Add cables (to 2020) to form topology graph with round-trip latency per segment
Subsea cable maps can be deceiving

Map shows

- Main trunk cable joins USA, Hawaii, Sydney, New Zealand
- Branch Units and spurs to American Samoa
- Unused Branch Units offshore Fiji, Tonga, New Caledonia for future use
- Easy to assume spurs (American Samoa) can connect to Sydney, NZ, Hawaii and Fiji/Tonga/NC if short stubs are built – can connect any-to-any
But ‘Straight Line Diagram’ shows American Samoa (and the other BUs) cannot connect to Sydney – wrong fibre pair.

The ‘branches’ fibre-pair only connects to NZ, not Sydney.

But Tafuna spur is connected to only one fibre-pair.

Same fibre-pair as Tonga/Fiji/New Caledonia BUs.

NETWORK DESIGN
But – each spur is allocated on a different ‘wavelength’ – spurs can only see New Zealand and Hawaii – American Samoa and new ‘Tomoo’ New Caledonia cannot connect directly

**SX-NEXT is same design**
Southern Cross NEXT (RFS 2022)

Kiribati, Tokelau, Fiji will not connect directly, only to New Zealand or USA under this design
Add Southern Cross NEXT...Fiji, Samoa, Tokelau, Kiribati cannot connect directly, only hairpin through NZ or USA.
Optimising location of South Pacific Region IXP
Selection Criteria – IXP Location

Diversity/Redundancy for Reliability

• Location should have at least two, ideally more, cable paths using different cable systems

Minimise Latency for best performance

• Location should minimise aggregate latency from the collection of all Pacific Island Members

Low Cost Backhaul

• Abundant and low cost to connect from Landing Stations to the IXP datacentre (terrestrial fibre), ideally with infrastructure-based competition
## Consider NZ, Fiji, Samoa as possible IXP locations

- Find lowest-latency path from each country to target location
- Calculate ‘Weighted Average Latency’ - Weighting by ‘Internet Users’ per country
- Identify location for IXP that minimises average latency across all paths

<table>
<thead>
<tr>
<th>Country</th>
<th>Population</th>
<th>Internet Users</th>
<th>Latency to NZ</th>
<th>Weighted Latency</th>
<th>Latency to Fiji</th>
<th>Weighted Latency</th>
<th>Latency to Samoa</th>
<th>Weighted Latency</th>
<th>Latency to closest</th>
<th>Weighted Latency</th>
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<tbody>
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<td>926276</td>
<td>425680</td>
<td>29</td>
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<td>16</td>
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<td>201000</td>
<td>45</td>
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<td>13.16</td>
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<td><strong>54.08</strong></td>
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<td><strong>15.99</strong></td>
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</table>

Average Latency ~ 42 milliseconds  
Weighted Average Latency ~ 26 milliseconds  
Almost identical benefit, whether IXP is in Fiji or Samoa
Consider Distributed IXP – linked switches in Fiji, Samoa, New Zealand, forming a diverse loop using diverse cables...
Benefits of Distributed IXP

- Fairness – reduced costs for those countries not directly hosting a node
- Economies-of-scale through aggregation of trunks between nodes
- Optimised latency reduction: in-country traffic stays in-country as well as in-region
- Loop provides diversity even if a cable breaks
- NZ is a major node with existing global transit backbones, Akamai/Cloudfront/AWS caches for ‘quickstart’ performance benefits

Next Steps

- ESCAP secretariat to set up an intergovernmental Working Group to discuss and agree on the operational principles and modalities of the Pacific IXP
- Build Detailed Not-For-Profit Break-even Financial Model
  - Estimate Cable Capacity Required between nodes
  - Determine Capacity Costs between nodes
  - Cost Recovery Options – sharing costs equitably - Flat membership charges??
- Agree Detailed Design
• Pacific IXP is feasible – sufficient countries have sufficient cables and sufficient independent ISPs to interconnect on multiple paths

• Establish country IXPs to keep internal traffic internal

• Interconnect country IXP switches to form a pan-Pacific IXP mesh/ring

• If Pacific IXP is set up in either Fiji or Samoa:
  Average Latency between members $\sim 42$ ms
  Weighted Average Latency between members $\sim 26$ ms

• If Pacific IXP is set up in Fiji, Samoa AND New Zealand:
  Average Latency to IXP node $\sim 27$ ms
  Weighted Average Latency between members $\sim 16$ ms

• North Pacific members should consider joining IXPs in Guam
Thank you.

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