Let's Measure

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In 2014, discussions began among the APNIC Executive Council (EC) when it set out to expand the APNIC Development Program. The EC wanted to do this by raising funds, independent from APNIC membership contributions, to support regional Internet development efforts in the future. Those discussions led to the establishment of APNIC Foundation in September 2016. It became operational in early 2017.



ISIF Asia is the Foundation's grant fund. It was officially launched in 2008, as a partnership between APNIC, the Internet Society (ISOC) and the International Development Research Centre (IDRC). Various other sponsors have supported the fund since. ISIF Asia provides grant and award funding for Internet development projects supporting Infrastructure, Inclusion and Knowledge in the Asia Pacific.

ISIF Asia was administered by APNIC from 2008 until 2016. As APNIC established the APNIC Foundation in 2016, ISIF Asia was transferred to the Foundation from 2017.



The School on Internet Asia (SOI Asia) is led by Keio University. It was launched in 2001 as a platform for interuniversity education and research programs among institutions throughout Asia, focused on science and Internetrelated domains. SOI Asia has several major programs, in particular the Asia Pacific Internet Engineers Program (APIE), the Evidence Based Approach (EBA) and Community Based Research (CBR).

In 2021, SOI Asia and the Foundation began working together and the Foundation has a staff member based out of Keio University.



IPv6 Adoption

IPv6 adoption varies significantly around the world and across different types of networks. Some regions and countries have significantly higher adoption rates. Major content delivery networks have been at the forefront.





APNIC Labs

https://stats.labs.apnic.net/ipv6/TH



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Cloudflare Radar

https://radar.cloudflare.com/adoption-and-usage/th?dateRange=52w

Google IPv6

https://www.google.com/intl/en/ipv6/statistics.html#tab=per-country-ipv6-adoption

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APNIC Labs: **51.28%** Cloudflare: **46%** Google IPv6: **45.89%**

Which number is correct?





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Measurement is hard!!!

Bias Type	What it is
Selection Bias	You choose vantage points (e.g. RIPE Atlas probes) or target lists (e.g. Tranco Top 1K websites) that aren't representative.
Sampling Bias	Measurement frequency or timing favours certain networks or times of day.
Confirmation Bias	You design tests to prove a hypothesis (e.g. "IPv6 is faster than IPv4").
Interpretation Bias	When an analyst draws conclusions not directly supported by the dataset.
Presentation Bias	When data is shown without context, caveats or clear interpretation guidance.









ÎPv6 Adoption Statistics in Thailand – Top 10 ASN

ASN	AS Description	IPv6 Capable	Pop Coverage (RADAR) Millions	Net Coverage IHR	Samples	Wt.Avg
AS131445	AIS3G-2100-AS-AP Advance Wireless Network	95.19%	9.50	21.50%	72,645	95.19%
AS17552	TRUEONLINE-AS-AP True Online	71.06%	7.40	15.90%	62,074	71.06%
AS133481	AIS-FIBRE-AS-AP AIS Fibre	66.94%	6.80	14.20%	56,797	66.94%
AS45758	TTBP-AS-AP Triple T Broadband Public Company Limited	71.72%	5.60	12.20%	48,038	71.72%
AS24378	ENGTAC-AS-TH-AP Total Access Communication PLC.	0.07%	4.10	9.20%	31,760	0.07%
AS23969	TOT-NET TOT Public Company Limited	0.25%	3.70	7.90%	29,648	0.25%
AS132618	REALFUTURE-AS-AP Real Future Company Limited	0.11%	3.00	7.00%	23,950	0.11%
AS132061	REALMOVE-AS-AP Realmove Company Limited	0.06%	2.70	6.70%	20,399	0.06%
AS131090	CAT-IDC-4BYTENET-AS-AP CAT TELECOM Public Company Ltd,CAT	0.17%	0.50	1.10%	2,877	0.17%
AS9931	CAT-AP The Communication Authoity of Thailand, CAT	0.32%	0.50	1.10%	2,486	0.32%
	https://stats.labs.apnic.net/ipv6/TH					53.01%



https://rex.apnic.net/resources?economy=TH



How should we measure?

It depends what do you want to measure

 Do you want to measure what percentage of population using Internet have IPv6?

		IPv6	Pop Coverage	Net Coverage	Complete	
ASN	AS Description	Capable	(RADAR)	IHK	Samples	w.Avg
AS131445	AIS3G-2100-AS-AP Advance Wireless Network	95.19%	9.50	21.50%	72,645	95.19%
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	TTBP-AS-AP Triple T Broadband Public Company					
AS45758	Limited	71.72%	5.60	12.20%	48,038	71.72%
			29.30			77.53%

 Around 24 Million Internet users have IPv6 access which is roughly 35% of total Internet Users in Thailand



How should we measure?

 Do you want to measure how many networks in the country providing IPv6 to their end users?
 IPv6 Delegations in TH

Total IPv6 Delegations	208	
In Routing Table	123	
Not in Routing Table	85	



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Take aways

• Measurements are Indicative, Not Absolutes

IPv6 probe-success rates and BGP statistics give you a snapshot of "what's out there," but they can't capture every nuance. Treat the numbers as directional guides rather than the final answer.

• Large Operators Drive the Numbers

A handful of tier-1 and large consumer ISPs account for the lion's share of IPv6 announcements and probe-success samples. We should laud their engineering teams for building robust IPv6 backbones and customer-facing rollouts.

• Smaller Networks Lag Behind FOCUS HERE Many regional carriers, enterprise networks still either don't advertise IPv6 at all or only do so for the sake of it.



Internet Exchange Points

How it works? Why do we need them?





Internet Exchange Points

• Internet Exchange Point (IXP)

An Internet Exchange Point (IXP) is a physical location where Internet Service Providers (ISPs) of various sizes, Enterprise Networks, and Content Delivery Networks (CDNs) connect and exchange Internet traffic locally. The primary purpose of an IXP is to reduce the cost, latency, and complexity of Internet traffic exchange by **keeping local traffic local, resulting in faster, more reliable service for end users**. [Internet Society]

 An Internet eXchange Point (IXP) is a dedicated physical infrastructure typically a set of Ethernet switches in one or more data-centre facilities through which Internet service providers (ISPs) and content delivery networks (CDNs) exchange traffic directly between their autonomous systems (ASes). [CAIDA]





Internet Exchange Point

- In Summary "An Internet Exchange Point (IXP) is a physical interconnection facility where domestic and international networks exchange traffic locally to reduce latency, lower transit costs, and improve overall performance."
- BUT local networks must peer directly with each other using the IXP fabric or use the IXP's route server to fully leverage the Internet exchange and share traffic locally.
- Failing to join the IXP harms small local operators far more than it does the larger ones.





Internet Exchange Point

- For any country to maintain a robust and resilient infrastructure, it needs a healthy local peering ecosystem which is made possible by a handful of wellplaced IXPs.
- To understand the local ecosystem, we collaborated with the Internet Health Report (ihr.live) to build a country level dataset on peering and interconnection.

		Thaila	and		
		Weekly r	eport		
OVERVIEW	MONITORING	ROUTING	PEERING	RANKINGS	CUSTOM

https://www.ihr.live/en/country/TH





Internet Exchange Points

What are we trying to achieve with this measurement?

- Our goal is to provide an indicative view of local peering and interconnection, drawing on publicly available data from PeeringDB, CAIDA, and ALICE Looking Glass.
- While these sources offer valuable insights, the results are inherently imprecise some networks choose private bilateral peering arrangements rather than using IXPs so the figures should be interpreted as directional rather than definitive.
- Also, the data in PeeringDB is not verifiable and at times not complete.
- Shout out to Internet Health Report (IIJ) team for developing and publishing to dataset.





IXP outlook in Thailand

Thailand

BKNIX	CS Loxinfo Public Company Limi	ited	NATIONAL TELECOM PLC	BBIX, Inc.	International gateway co., Ltd	Jastel Network (Tharland)
BKNIX (Thailand)	CSL Thai-IX Singapore	CSL The-Di Melaysia	THAILAND IX (TH-IX)	BBIX Thailand	AMS-IX Bangkok	JTIX (Thailand)
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	CEL Thai IV Bangkok				TRUE-IX	
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						BGP Exchange
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 It's common and not inherently wrong to judge an IXP by its "member count" and "aggregate traffic", but do these metrics overlook its core mission which is enabling efficient "local" interconnection, reducing latency, and bolstering network resilience.



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IXP outlook in Thailand



- Which Internet Exchange Points do local Thai networks peer at?
- Majority connects to IXPs in Thailand, but many Thai networks see value connecting to neighbouring or to regional IXPs



IXP outlook in Thailand

IXP Membership for ASes Registered in Thailand

- Top 5 IXPs in terms of local networks
 - BKNIX
 - Thailand-IX
 - BBIX-Thailand
 - Equinix-Singapore
 - CSL-Thai-IX
- As per the records, there are 9 exchanges in Bangkok.

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IXP outlook in Thailand



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- Which Internet Exchange Points do International networks peer at?
- Majority of networks are originated from US, Hong Kong and Cambodia.



IXP outlook in Thailand

IXP Membership for ASes Registered outside Thailand

- Top 5 IXPs in terms of Intl networks
 - BKNIX
 - Thailand-IX
 - BBIX-Thailand
- Majority of International networks rely on top 3 local IXPs otherwise they connect to foreign commercial IXes.

bknix (thailand) - TH-	27	8	11	2	0	4	0	1	3	3	2	0	0
thailand ix (th-ix) - TH-	8	25	9	1	0	4	1	0	3	3	0	0	0
bbix thailand - TH -	11	9	19	1	2	4	0	1	2	2	2	0	0
csl thai-ix bangkok - TH -	2	1	1	5	0	0	0	3	3	3	0	0	0
true-ix - TH -	0	0	2	0	5	1	0	1	0	0	0	0	0
ams-ix bangkok - TH -	4	4	4	0	1	7	1	0	2	2	0	0	0
jtix (thailand) - TH -	0	1	0	0	0	1	4	0	0	0	0	0	0
csl thai-ix singapore - TH -	1	0	1	3	1	0	0	14	3	3	0	0	0
thai-ix - TH -	3	3	2	3	0	2	0	3	7	7	0	0	0
csl thai-ix malaysia - TH-	3	3	2	3	0	2	0	3	7	7	0	0	0
bknix chiang mai (thailand) - TH -	2	0	2	0	0	0	0	0	0	0	2	0	0
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### Take aways

#### How many are too many?

- When networks are spread across many exchanges, each IXP may lack enough peers to enable efficient multilateral peering.
- A country with 5+ small IXPs in a city/metro might struggle to consolidate traffic, reducing the benefits of a strong exchange.

#### **Higher Infrastructure Costs**

- Small, under-utilized IXPs face sustainability issues due to operational overheads such as switching gear, power, cooling and cross-connects.
- Operators connecting to several exchanges face multiple membership fees and port charges, eroding the cost-savings that IXPs are meant to deliver.





### **Internet Exchange - Issues**

- If a country has too many IXPs, network interconnection becomes fragmented, leading to inefficiencies.
- Smaller IXPs may lack enough participants, leading to low efficiency.
- Increased costs for ISPs that must connect to multiple IXPs to reach all local peers.
- A country with 5+ small IXPs might struggle to consolidate traffic, reducing the benefits of a strong exchange.



### Take aways

- Despite over 430 active networks in the country, fewer than 25 percent peer at IXPs.
- While additional exchange points help to restrict monopolies and provide infrastructure resiliency and could help small operators but excessive number of IXPs risks splintering the peering fabric into isolated 'islands.'
- Lower the technical barrier by offering an easy to understand peering experience such as pre-configured BGP templates.
- In markets where local traffic constitutes the majority of an ISP's volume, peering savings can reach up to 20 percent of operating costs compared to using upstream transit links.



# Peering is complex topic!

**Bridging Gap Protocol – Skynews** 

Thank You!



