



IPv6 journey of a growing provider

SAFNOG 2019

Greg Antic

Network Engineer

Find us on - [SmartTechnologyCentre](#)





History of SMART Technology Centre

- Established in 2006
- Quickly evolving into specialised ISP with MSP solutions
- National Footprint
- ECN/ECS ICASA licence issued in 2009
- ISPA membership since 2010
- Registered as (PTY) LTD in 2011
- Received first ASN 37670 and first /21 IPv4 prefix in 2011 from Afrinic
- Received first /32 IPv6 prefix in 2012 from Afrinic
- First FTTH deployment in August 2014
- Core network powered by Cisco and Mellanox



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IPv6? Email hoarder...

-----Original Message-----

From: members-bounces@afrinic.net <members-bounces@afrinic.net> On Behalf Of AfriNIC (Billing)
Sent: Friday, 03 February 2012 3:07 PM
To: rs@afrinic.net
Subject: 2012 Billing Cycle

Dear Member,

....

HAVE YOU REQUESTED YOUR IPV6 PREFIX YET?

There is no extra cost if you get your IPv6 prefix now. You can do so from the portal in FOUR easy steps:-

- Log into <https://my.afrinic.net>
- Go to Resources -> IPv6 Resources
- click on 'Request IPv6 resource'
- Fill in the form and submit

We thank you for your continued support and collaboration.

The AfriNIC Billing Team

AfriNIC - The internet numbers registry for Africa



Our Network

- ASN 37670 - Tier 2 multi-homed operator



- Present in 3 regions, Cape Town, Durban and Johannesburg



- Private data centre facility in Bedfordview, South Africa
- Open peering policy at Nap Africa and JINX
- PeeringDB members



- MANRS – Network Operator Participant (L1-L4)



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The beginning of our IPv6 Journey



>>>



- Attended the inaugural SAFNOG at the Hilton Hotel back in 2014
- Great inspiration taken from the programs, audience and fellow colleagues most notably was a program on IPv6 Deployment for Broadband Internet by Azura Mat Salim - Telekom Malaysia
- As it does in IT – a number of years went by while we grew the business and kept the lights burning. It was not until 2016 when we were in a position to begin exploring IPv6 and having it deployed in some fashion on our network
- First real encounter with IPv6 was at the Afrinic INRM & IPV6 training session in Johannesburg in July 2016
- Leading up to the training we decided to configure our /32 prefix on a loopback interface and advertise it over our only IPv6 enabled IP Transit provider at the time, Seacom. According to RIPE Stats, our IPv6 prefix was first seen on 28 June 2016
- Unfortunately, one network engineer with IPv6 training didn't make a big enough business case for us to begin deploying IPv6
- The following year we were lucky again to send a second network engineer on the Afrinic INRM & IPV6 training session in Johannesburg and our IPv6 business case started developing
- We believed it was time to do something with our skills and deploy IPv6...



State of Global IPv6 adoption

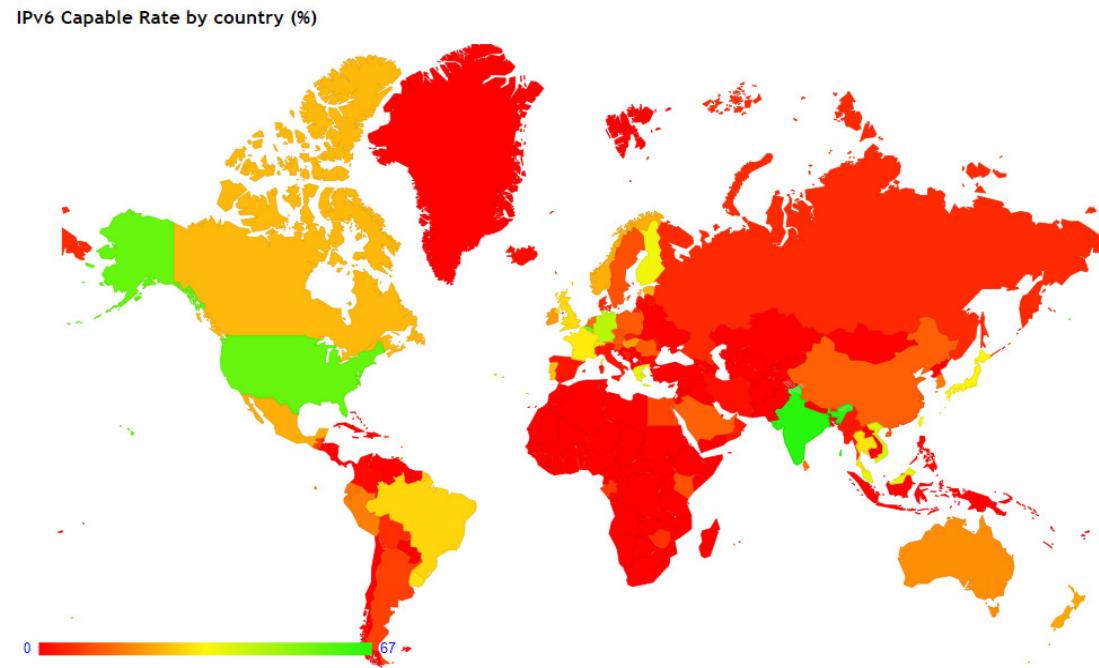
- South Africa and Africa are far behind in the IPv6 global adoption rankings
 - Africa - 1.80%*
 - Americas – 30.52%*
 - Asia – 25.13%*
 - Australia – 19.70%*
 - Europe – 17.56%*
 - South Africa - 0.22%*
- Lack of IPv6 roadmaps from FNO's and MNO's in South Africa
- APNIC has a statistics tool which shows the adoption of IPv6 per country/continent down to ASN
 - I reached out to APNIC a few months back to understand how they collect this data:



**mart
TECHNOLOGY**

“How this works is we purchase advertising all around the world based on a set of very common key words that will show our ad to end users as they are browsing the internet.

Based on this our advert checks the hosts ipv6 capability based on two factors. The first being can this host do ipv6 and the next to check given the choice between taking an ipv4 or ipv6 route does the host choose the v6 path.”



*Based on the average percent from APNIC



State of Global IPv6 adoption

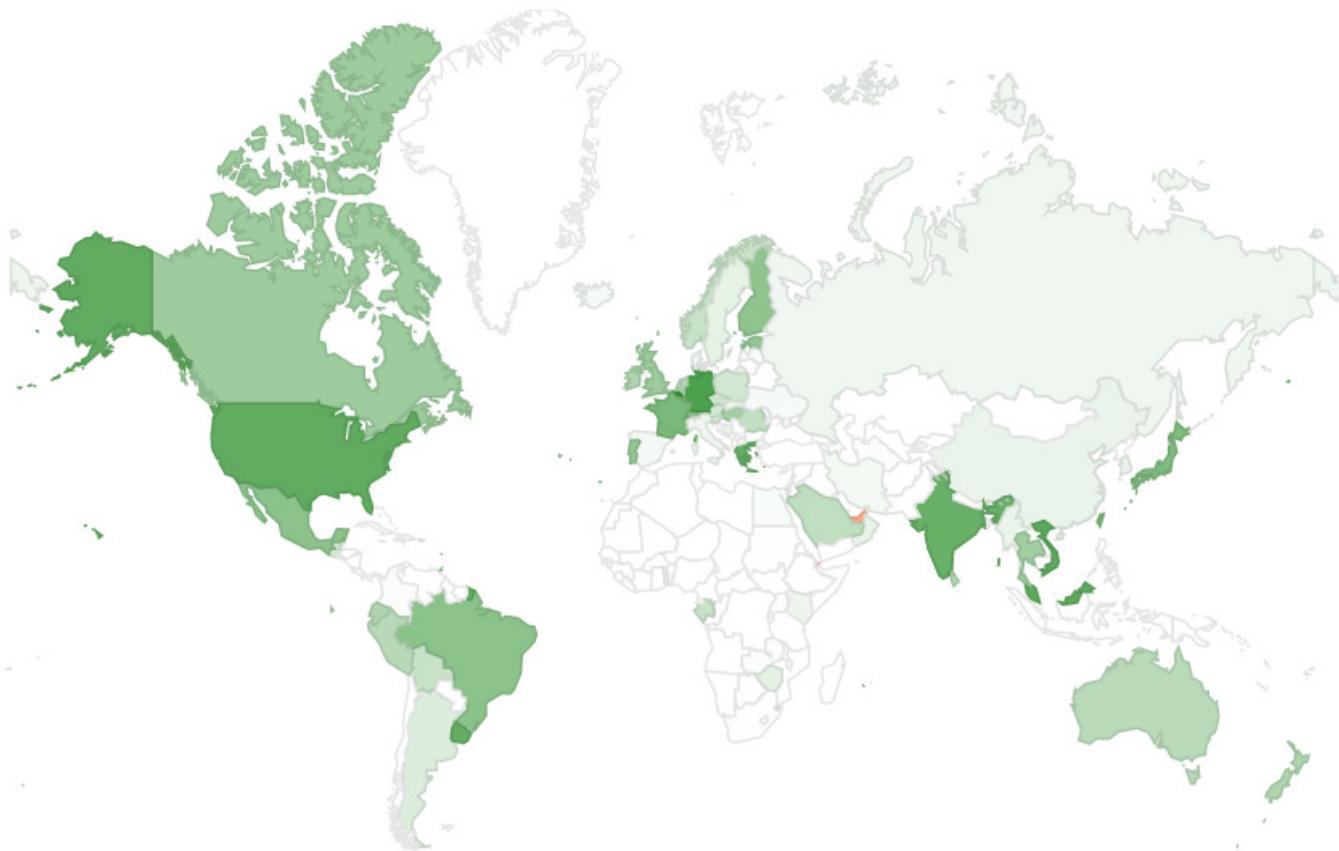
CC	Country	IPv6 Capable	IPv6 Preferred ▾	Samples	Weight	Weighted Samples
YT	Mayotte, Eastern Africa, Africa	55.39%	55.06%	8,679	0	0
RE	Reunion, Eastern Africa, Africa	19.29%	18.83%	88,635	0	0
KE	Kenya, Eastern Africa, Africa	12.86%	12.74%	768,631	2.62	2,011,093
EG	Egypt, Northern Africa, Africa	10.02%	9.95%	2,152,325	1.33	2,862,137
GA	Gabon, Middle Africa, Africa	8.79%	8.73%	128,297	0.15	18,618
ZW	Zimbabwe, Eastern Africa, Africa	5.97%	5.88%	190,161	1.64	311,065
TG	Togo, Western Africa, Africa	3.09%	3.05%	117,950	0.43	51,151
CG	Congo, Middle Africa, Africa	0.28%	0.28%	43,938	0.81	35,558
ZA	South Africa, Southern Africa, Africa	0.25%	0.22%	640,225	4.05	2,591,518
ZM	Zambia, Eastern Africa, Africa	0.13%	0.13%	293,470	1	294,587
UG	Uganda, Eastern Africa, Africa	0.10%	0.09%	168,404	4.41	742,147
RW	Rwanda, Eastern Africa, Africa	0.09%	0.07%	133,895	1.01	135,844
SD	Sudan, Northern Africa, Africa	0.05%	0.05%	184,627	5.2	960,493
MV	Malawi, Eastern Africa, Africa	0.05%	0.05%	43,837	2.5	109,599
MU	Mauritius, Eastern Africa, Africa	0.03%	0.02%	177,467	0.26	46,456
BF	Burkina Faso, Western Africa, Africa	0.01%	0.01%	54,348	3.26	177,246
TZ	United Republic of Tanzania, Eastern Africa, Africa	0.01%	0.01%	707,042	0.39	275,954
CI	Cote d'Ivoire, Western Africa, Africa	0.01%	0.01%	200,300	2.4	480,601
CM	Cameroon, Middle Africa, Africa	0.01%	0.01%	332,365	1.17	389,868
TN	Tunisia, Northern Africa, Africa	0.01%	0.01%	594,939	0.82	486,549
BW	Botswana, Southern Africa, Africa	0.01%	0.01%	39,904	1.09	43,558
NG	Nigeria, Western Africa, Africa	0.01%	0.01%	1,294,188	6.12	7,926,304
MZ	Mozambique, Eastern Africa, Africa	0.01%	0.01%	165,233	1.04	171,880
SC	Seychelles, Eastern Africa, Africa	0.03%	0.00%	27,503	0.17	4,762
SZ	Swaziland, Southern Africa, Africa	0.01%	0.00%	17,237	1.96	33,731
CD	Democratic Republic of the Congo, Middle Africa, Africa	0.00%	0.00%	86,470	3.34	289,045
MG	Madagascar, Eastern Africa, Africa	0.00%	0.00%	47,129	2.1	99,199
SN	Senegal, Western Africa, Africa	0.00%	0.00%	574,801	0.58	335,165
DZ	Algeria, Northern Africa, Africa	0.00%	0.00%	3,917,985	0.18	721,153
SL	Sierra Leone, Western Africa, Africa	0.00%	0.00%	49,625	0.33	16,205
MA	Morocco, Northern Africa, Africa	0.00%	0.00%	2,252,614	0.8	1,810,923
GM	Gambia, Western Africa, Africa	0.00%	0.00%	51,623	0.62	32,196
GH	Ghana, Western Africa, Africa	0.00%	0.00%	906,666	0.81	732,087
LY	Libya, Northern Africa, Africa	0.00%	0.00%	369,482	0.32	118,835
GN	Guinea, Western Africa, Africa	0.00%	0.00%	82,272	0.25	20,627
SO	Somalia, Eastern Africa, Africa	0.00%	0.00%	312,048	0.07	22,718
CV	Cape Verde, Western Africa, Africa	0.00%	0.00%	31,723	0.64	20,429
DJ	Djibouti, Eastern Africa, Africa	0.00%	0.00%	36,781	0.27	9,891
NE	Niger, Western Africa, Africa	0.00%	0.00%	76,258	0.54	41,529
BJ	Benin, Western Africa, Africa	0.00%	0.00%	234,709	0.24	56,528
AO	Angola, Middle Africa, Africa	0.00%	0.00%	120,353	5.19	624,695
BI	Burundi, Eastern Africa, Africa	0.00%	0.00%	45,282	0.33	14,839
LR	Liberia, Western Africa, Africa	0.00%	0.00%	98,904	0.37	36,626
ET	Ethiopia, Eastern Africa, Africa	0.00%	0.00%	122,022	3.25	395,969
NA	Namibia, Southern Africa, Africa	0.00%	0.00%	72,534	0.49	35,304
ML	Mali, Western Africa, Africa	0.00%	0.00%	164,239	1.25	205,312
ST	Sao Tome and Principe, Middle Africa, Africa	0.00%	0.00%	3,844	1.22	4,677
QQ	Equatorial Guinea, Middle Africa, Africa	0.00%	0.00%	15,351	1.58	24,295
SS	South Sudan, Northern Africa, Africa	0.00%	0.00%	3,197	60.71	194,091
KM	Comoros, Eastern Africa, Africa	0.00%	0.00%	3,275	1.62	5,319
GW	Guinea-Bissau, Western Africa, Africa	0.00%	0.00%	10,159	0.58	5,853
TD	Chad, Middle Africa, Africa	0.00%	0.00%	3,446	10.59	36,507
CF	Central African Republic, Middle Africa, Africa	0.00%	0.00%	5,594	3.32	18,578
SH	Saint Helena, Ascension, and Tristan da Cunha, Western Africa, Africa	0.00%	0.00%	101	0	0
ER	Eritrea, Eastern Africa, Africa	0.00%	0.00%	333	15.01	4,999
LS	Lesotho, Southern Africa, Africa	0.00%	0.00%	17,874	2.27	40,516
MR	Mauritania, Western Africa, Africa	0.00%	0.00%	96,483	0.71	68,198
EH	Western Sahara, Northern Africa, Africa	0	0	68	0	0





Google

Per-Country IPv6 adoption

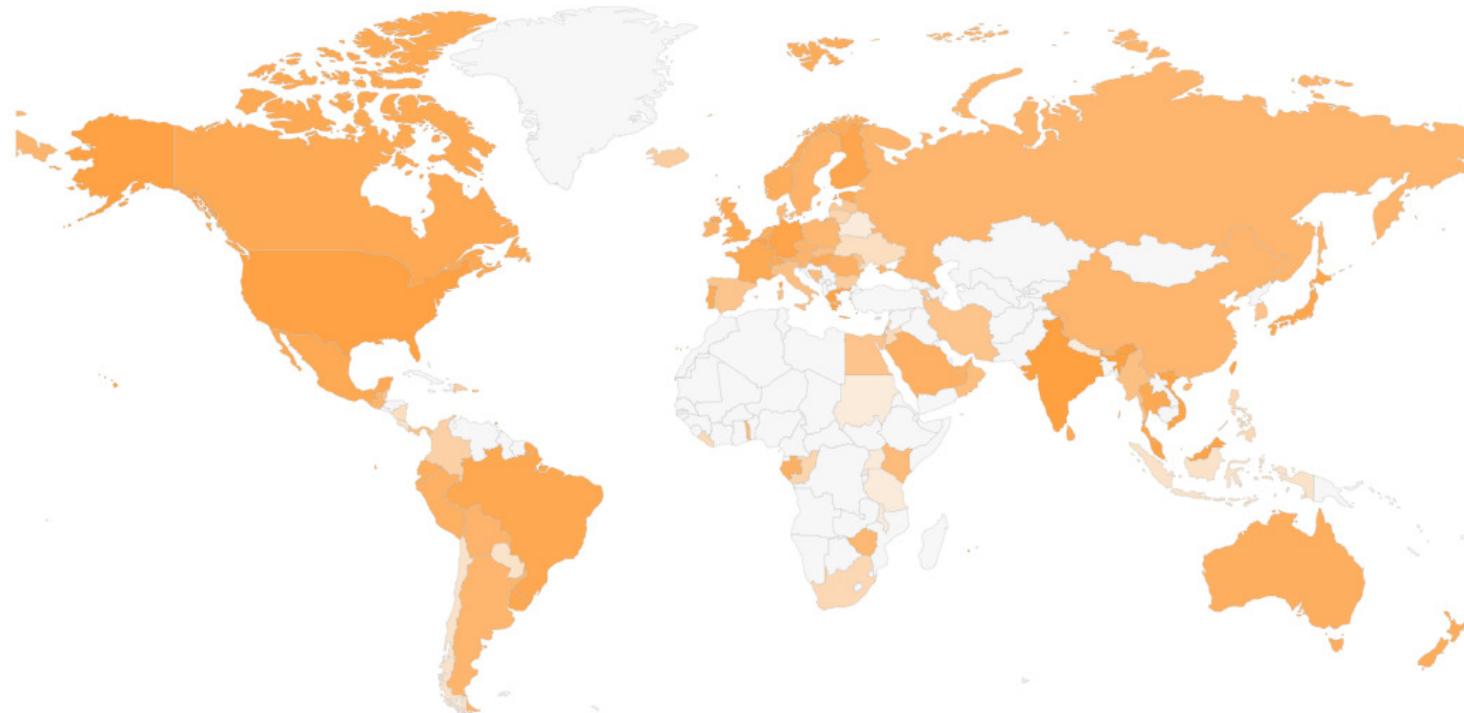


Source: Google.

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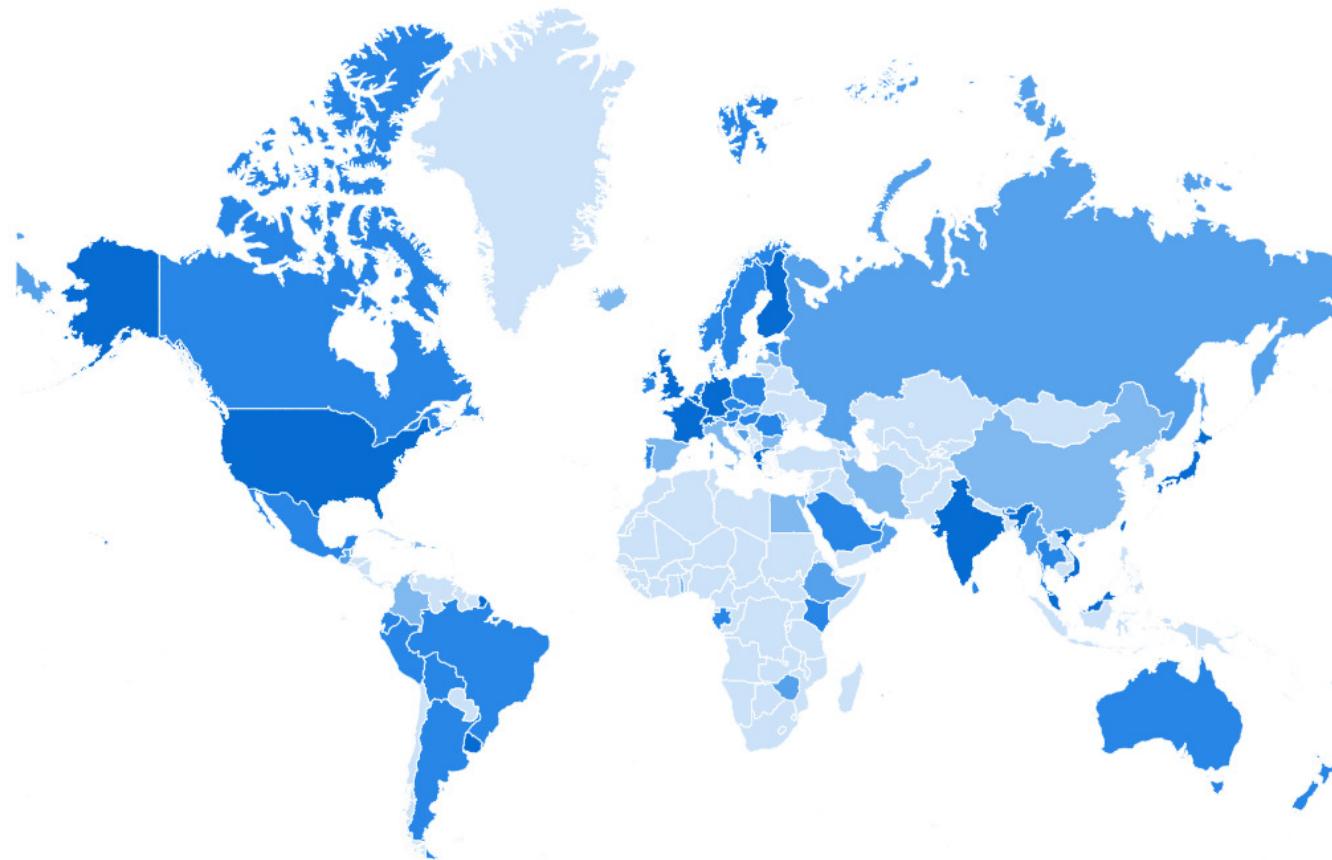
IPv6 Adoption By Country



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PER-COUNTRY ADOPTION MAP



A large graphic element on the right side of the map, consisting of three concentric circles. The innermost circle is teal, the middle is light blue, and the outermost is medium blue. Below this graphic, the word "smart" is written in a large, bold, black sans-serif font.



Possible reasons for low IPv6 adoption

- Skills shortage
- No benefit to business or end users
- Equipment support
- Management approval
- Busy work schedules
- Afrinic still has IPv4 space available
- Nobody talking about IPv6 in the business
- Customers not requesting IPv6
- Tech companies not talking about IPv6
- Complexity

Our Goal...

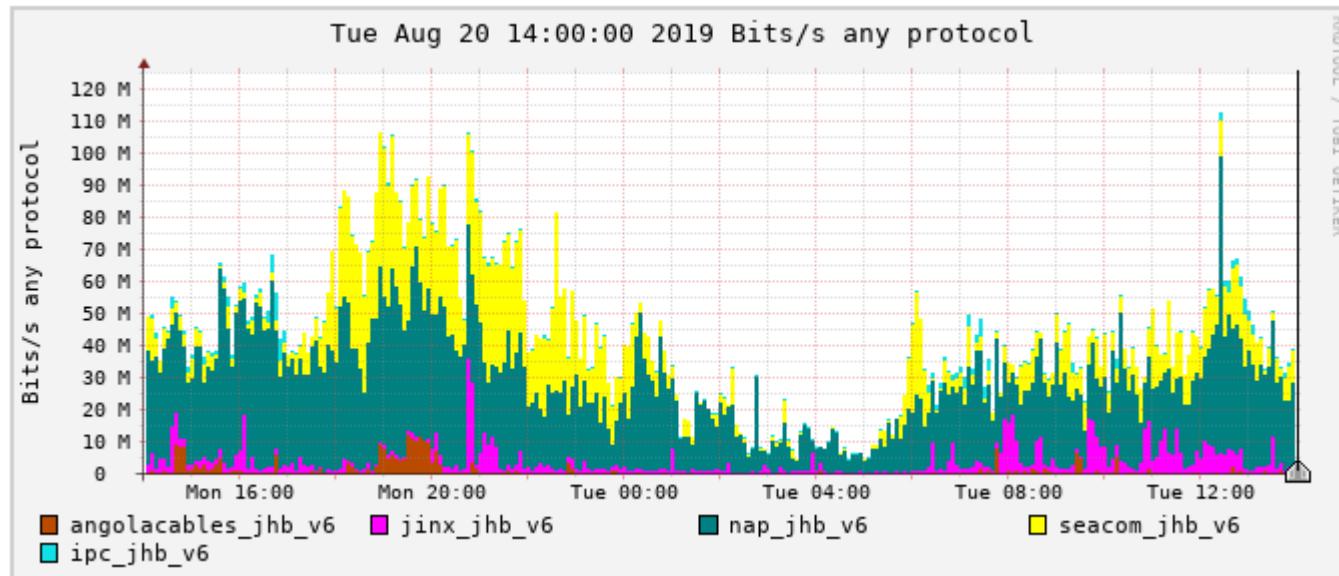
We wanted to prove to ourselves IPv6 is not impossible/difficult to deploy in South Africa

We wanted to give back to the community by way of implementing IPv6

We didn't just want to turn on IPv6, we wanted our customers to use it

And that's what we did!

IPv6 traffic for 1 day



Where we started

- Reviewed network equipment and upgraded network equipment software
- Reviewed and updated Afrinic registry records
 - ROA/RPKI
 - Route6
- Spoke to our transit providers about enabling IPv6, of our 2 transit providers at the time only 1 was IPv6 ready
- Designed our IPv6 addressing plan
 - This actually took quite a while as we couldn't agree on the subnetting schema
 - It also took a while to get it into our IPAM
- Dual-stacked core network segments
- Reviewed our IPv4 peering to find peers peering on IPv6 and established peering
 - This took a while as a lot of peers showed they were IPv6 peering but were not ready
- Established IPv6 peering with CDN providers and the big guys
- Implemented a Ripe Atlas Probe on 1 October 2016 - thanks Nishal for motivating and encouraging us
 - This qualified as our first proper IPv6 enabled device



What we did

- Enabled native IPv6 on all customer facing production services
- Enabled native IPv6 on our internal network
- Cisco 6VPE - IPv6 over IPv4 MPLS VPN
- Deployed dual stack to all our managed FTTH customers
- Deployed dual stack to all our managed FTTB customers
- Updated network security to follow MANRS principles



Getting IPv6 into production environment

- Required buy-in from other technical teams and management
- Adjusted all edge firewall rules to the correct respective protocol IPv4/IPv6
- Dual stacked edge firewalls
- Dual stacked authoritative and recursive DNS servers
 - Updated DNS records
 - Updated AfriNIC DNS Reverse Delegation
 - Root hints
- Dual stacked edge mail gateways
 - Required provider to make these changes...



Getting IPv6 into production environment

- Dual stacked web servers and enabled IPv6 on our website
- Updated IPAM software to provide better IPv6 support and IPv6 bug fixes
- Updated Radius Servers to record IPv6 attributes
- Afrinic RIR objects – Route6
- Afrinic ROA (RPKI validation)
- MANRS
- BCP
 - Secure VTY/remote access
 - SNMP
 - CoPP
 - ACL's from any any to any4 and any6



How we tested

- Looking glass servers
- Hurricane Electric IPv6 Certification
- test-ipv6.com and ipv6-test.com
- We were surprised to find no local IPv6 speedtest servers
 - We reached out to a popular IT forum regarding adding IPv6 support – on the road map
- We hosted an HTML5 IPv6 speedtest server
 - We do not benchmark any of our FTTX services based on web based speedtests
 - iPerf
 - Mikrotik Bandwidth Test



How we tested

- APNIC IPv6 Measurements
- RIPE IPv6 Measurements
- Running IPv6 at home using tunnel techniques
- Netflow
- SNMP

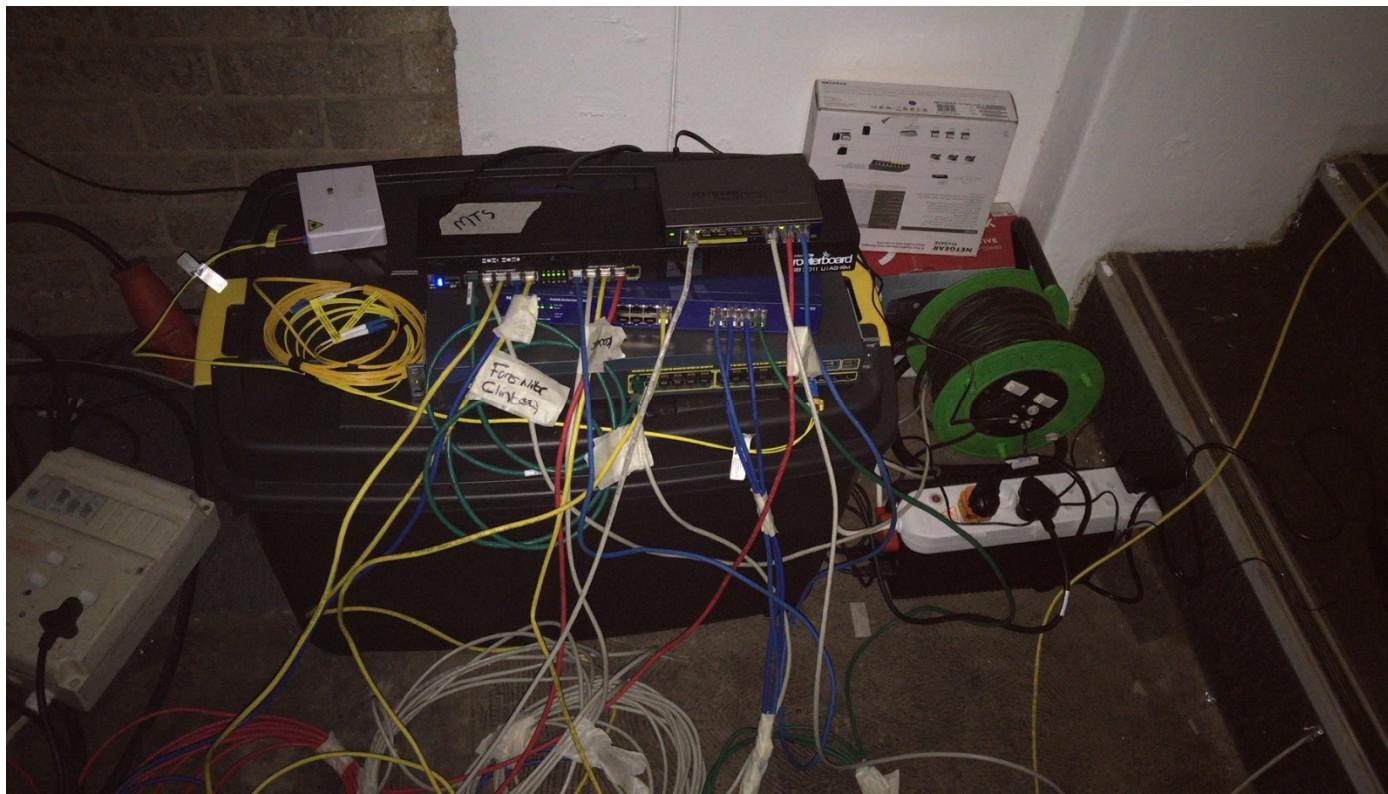


Taking IPv6 to the customer

- Updated provisioning portal to support IPv6 prefixes and IPv6 radius attributes for BNG
- Tested various methods of deploying IPv6 to end customers, SLAAC, DHCP-PD, Static, Pools
- Largely manual process of taking IPv6 to the end customer
- We standardized on /56 for home customer and /48 for business customer
- Older ONT/CPE inability to dual stack and continue to function efficiently
- On our Mikrotik BNG routers we use a variety of techniques to deploy IPv6
 - Radius attributes **framed-ipv6-prefix** and **delegated-ipv6-prefix** to generate a route toward the customer over their PPP session and manually configured static IPv6 on customer ONT/CPE LAN side as /64
 - PPP DHCPv6 PD Pool to delegate /56 to customer, also required **framed-ipv6-pool** attribute for ONT/CPE to complete SLAAC
 - Static IPv6 on the WAN and LAN

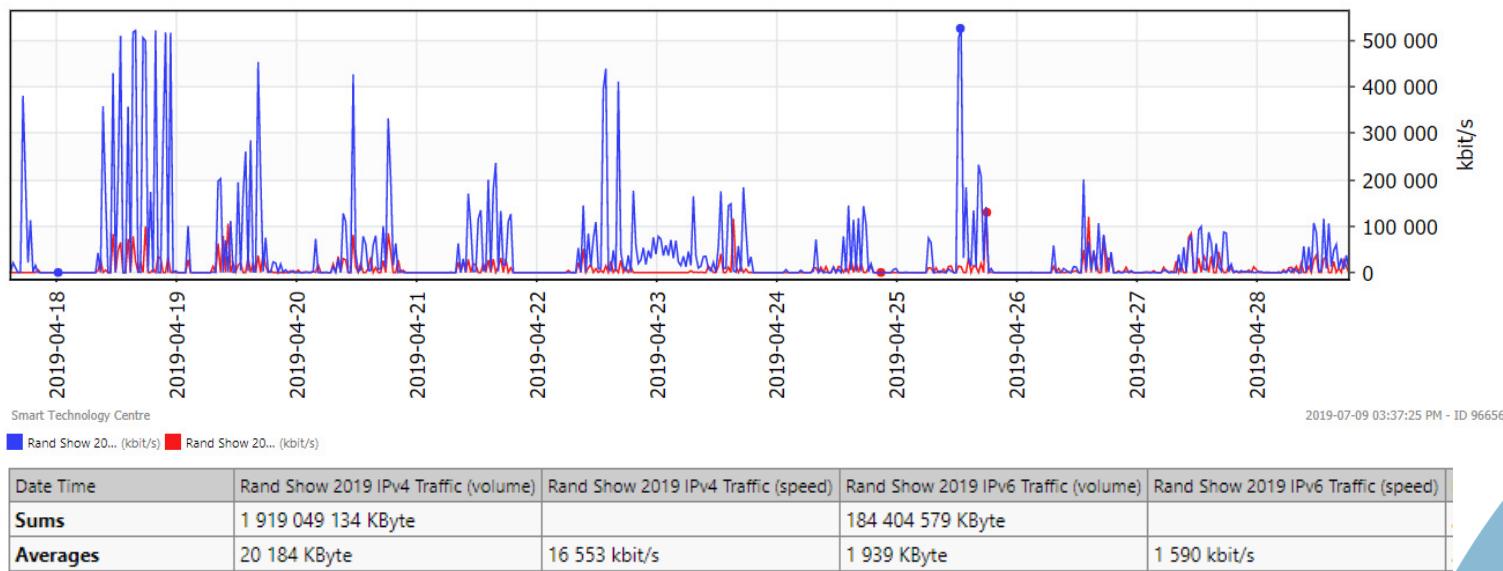
Taking IPv6 to a public event

- We sponsored a 500Mbps link for the Rand Show Gaming Exhibition for 2 weeks in April 2019
- Thankfully, we didn't have a hand in this cabling... but it worked! Ours was the Cisco ☺



Taking IPv6 to a public event

- Our goal was to deliver a dual stacked native IPv6 network to gauge the amount of IPv6 traffic from a gaming event
- We made a lot of assumptions about gaming devices
- We were impressed with the results but really anticipated more IPv6 traffic
- The results – Blue IPv4, Red IPv6





SMART and IPv6 in the media

Technology & business for development



EE Publishers Home Articles: EngineerIT IPv6 rolled out in South Africa



IPv6 rolled out in South Africa

March 5th, 2019, Published in [Articles: EngineerIT](#)



Smart Technology Centre (STC) is one of the first Internet service providers (ISPs) in South Africa to roll out a full production Internet Protocol version 6 (IPv6) connectivity to its client infrastructure and cloud services platform. In essence, an IP address provides a unique location system for computers and devices connected to the internet or on networks and then routes this traffic across the internet. A basic analogy is to compare it to a number plate, which identifies where your computer is from and where it is going across the internet roadways and what information needs to be sent to and from it.

IPv4, the de facto protocol used by most electronic devices in South Africa to connect to the internet, has been around for many years and is essentially running out of IP addresses. Things have changed rapidly, and the explosion in the number of devices connected to the internet – from cellphones, laptops, tablets, smart TVs, watches, routers, right down to smart fridges and home automation systems – has created a need for a robust communication protocol to manage the connectivity of these devices.

SELECT COUNTRY ZA

ABOUT OUR NETWORK CONTACT

STC offers IPv6 to its client infrastructure and cloud services

29 Apr 2019

Smart Technology Centre (STC) is one of the first Internet Service Providers (ISPs) in South Africa to roll out a full production Internet Protocol version 6 (IPv6) connectivity to its client infrastructure and cloud services platform.

"In essence, an IP address provides a unique location system for computers and devices connected to the internet or on networks and then routes this traffic across the internet. A basic analogy is to compare it to a number plate, which identifies where your computer is from and where it is going across the internet roadways and what information needs to be sent to and from it. We've invested heavily into innovation, best of breed equipment and training to enable us to deploy IPv6 well ahead of many other ISPs in the country. Currently, those networks that have been connected using IPv6 and dual-stacked with IPv4 are performing well, roughly 10% or a quarter of our current internet traffic to be exact."

IPv4, the de facto standard version that most electronic devices in South Africa still use to connect to the internet, has been around for many years and is essentially running out of IP addresses – the unique identifier that every device connected to the internet has.



Africa Company News Industry Areas Technology Areas Press Offices

STC rolls out IPv6

Nov 28, 2018

Smart Technology Centre (STC) is one of the first Internet Service Providers (ISPs) in South Africa to roll out a full production Internet Protocol version 6 (IPv6) connectivity to its client's infrastructure and cloud services.

"In essence, an IP address provides a location system for computers and devices connected to the internet or on network and then routes this traffic across the internet," explains Richard Morris, MD of Smart Technology Centre. "A basic analog is to compare it to a number plate, which identifies where your computer is from and where it is going across the internet roadways and what information needs to be sent to and from it.

"We've invested heavily into innovation, best of breed equipment and training to enable us to deploy IPv6 well ahead of many other ISPs in the country. Currently, those networks that have been connected using IPv6 and dual-stacked with IPv4 are performing well, roughly 10% or a quarter of our current internet traffic to be exact."

IPv4, the de facto standard version that most electronic devices in South Africa still use to connect to the internet, has been around for many years and is essentially running out of IP addresses – the unique identifier that every device connected to the internet has.



Home / IOT / STC offers IPv6 to clients and cloud services

STC offers IPv6 to clients and cloud services

Through supplier Seacom, STC is one of the first in SA to invest in the equipment and training needed to deploy IPv6.

ISSUED BY SEACOM
Johannesburg, 14 Jun 2019

Read time 6min 10sec



Smart Technology Centre (STC) is one of the first Internet service providers (ISPs) in SA to roll out a full production Internet Protocol version 6 (IPv6) connectivity to its client infrastructure and cloud services platform.

VISIT OUR PRESS OFFICE
SEACOM





Challenges encountered on our IPv6 journey

- Our biggest challenge was on our private GPON FTTX network
- Lab field tested IPv6 for a few weeks and did not identify any issues
- Gradually manually deployed native IPv6 dual stack to several hundred ONT's over a 4 week period
 - Vendor OLT was not fully IPv6 ready with provisioning commands but did however support IPv6
 - Vendor initially supplied new OLT software but quickly withdrew the release due to issues
 - We chose to proceed as there was no road map provided
- 2 weeks later we started hearing complaints and were puzzled as we thought everything was great
- Symptoms were most prevalent on audio streaming, gaming and lack of throughput
- We had no choice but to manually roll back IPv6 on several hundred ONT's and engaged the vendor for help
- After many weeks of testing and debugging we determined the problem was on the older ONT models running dual stack



Challenges encountered on our IPv6 journey

- Over a 6 month period we tested countless software releases with various changes and fixes by the vendor engineering team
- Engineering identified the problem to be related to flow cache with the way IPv6 packets were handled on the ONT
- The fix was to process IPv6 packets differently to IPv4 packets which may increase the ONT CPU utilization
- The OLT software was updated to support IPv6 provisioning; we tried to automate the IPv6 provisioning instead of manual...
- We were dealt a hard blow when the older ONT's began crashing due to kernel panic which required manual intervention
- We engaged the vendor for help again and the kernel panic cause was identified and fixed
- We didn't take any chances, we manually reconfigured IPv6 dual stack on all the ONT's again
- Eventually we lost count how many thousands of times we enabled and disabled IPv6 on the ONT's
- Through perseverance and amazing support from the vendor we came out with a WIN, we refused to give up!

Challenges encountered on our IPv6 journey

- Transit providers not being ready for IPv6 in 2019...
- Content still being preferred over IPv4
 - Netflix
- Hardware vendors not supporting features, ie: IPv6 over PPPoE
 - Sophos XG, TPLINK
- Vendors appeared to not follow RFC or out-dated software on devices
 - ONT/CPE devices would not accept DHCP-PD or SLAAC
- Lack of full IPv6 support from vendors
 - Missing provisioning commands
 - Inability to dual stack OOB Management
 - Inability to manage ONT over IPv6
- Security of end device behind ONT/CPE
- Unusual terminology by different vendors
- Static IPv6 prefix or Dynamic IPv6 prefix
- Slow to no uptake of IPv6 by local tech companies
- What is the standard for informing customers when migrating to IPV6

Looking ahead

The South African ISP and IPv6 landscape is changing...

- Openserve announced on 28 May 2019 they would be launching IPv6 on their IPC network amongst others
 - We were the **first** ISP in South Africa to deploy IPv6 on the Openserve IPC network!
 - Openserve require a minimum of a /36 IPv6 prefix, Openserve further subnet this /36 into /44 for their BNG's
 - Openserve configure an address pool much like IPv4 however this time DHCP-PD and allocate /56 prefix to the end customer
 - Radius attributes
 - Framed-IPv6-Pool
 - Delegated-IPv6-Prefix-Pool
- Voice over IPv6
- NAGLAN at Rage Expo 2019
 - We are encouraging native dual-stack for the gaming event this year hosting 2500 gamers
- Open Access FNO's providing IPv6
- MNO or MVNO providing IPv6
- Wireless Hotspot providers deploying IPv6
- Look forward to see more IPv6 success stories from all sized providers
- **IPv6 can be done, with little effort and a great feeling of satisfaction as reward!**



We encourage the other providers on OpenServe IPC to activate IPv6 and dual stack customers



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Thanks

We would like to thank the organizations and people who have empowered us through training and mentoring and believing in us over the last 5 years.



Mark Tinka
Nishal Goburdhan
Mukom Akong Tamon





Q&A



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