HKIX IPv4 Address Renumbering from /23 to /21 – Experience Sharing

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20th Anniversary of HKIX

- HKIX started with thin coaxial cables **in Apr 1995**
  - *Gradually changed to UTP cables / fibers with switch(es)*
    - *low-end -> high-end*
    - *One switch -> multiple switches*
- Participants had to put co-located routers at HKIX sites in order to connect
  - *Until Metro Ethernet became popular*
- It was a free service
  - *Now a fully chargeable service for long-term sustainability*

HKIX Today

- Supports both MLPA (Multilateral Peering) and BLPA (Bilateral Peering) over layer 2

- Supports IPv4/IPv6 dual-stack

- <u>Neutral among ISPs / telcos / local loop providers / data centers / content providers / cloud services providers</u>

- More and more non-HK participants

- >230 AS'es connected

- >420 connections in total
  - 2 x 100GE + **>190 x 10GE** + >220 x GE

- ~485Gbps (5-min) total traffic at peak

- Annual Traffic Growth = 30% to 40%

Yearly Traffic Statistics

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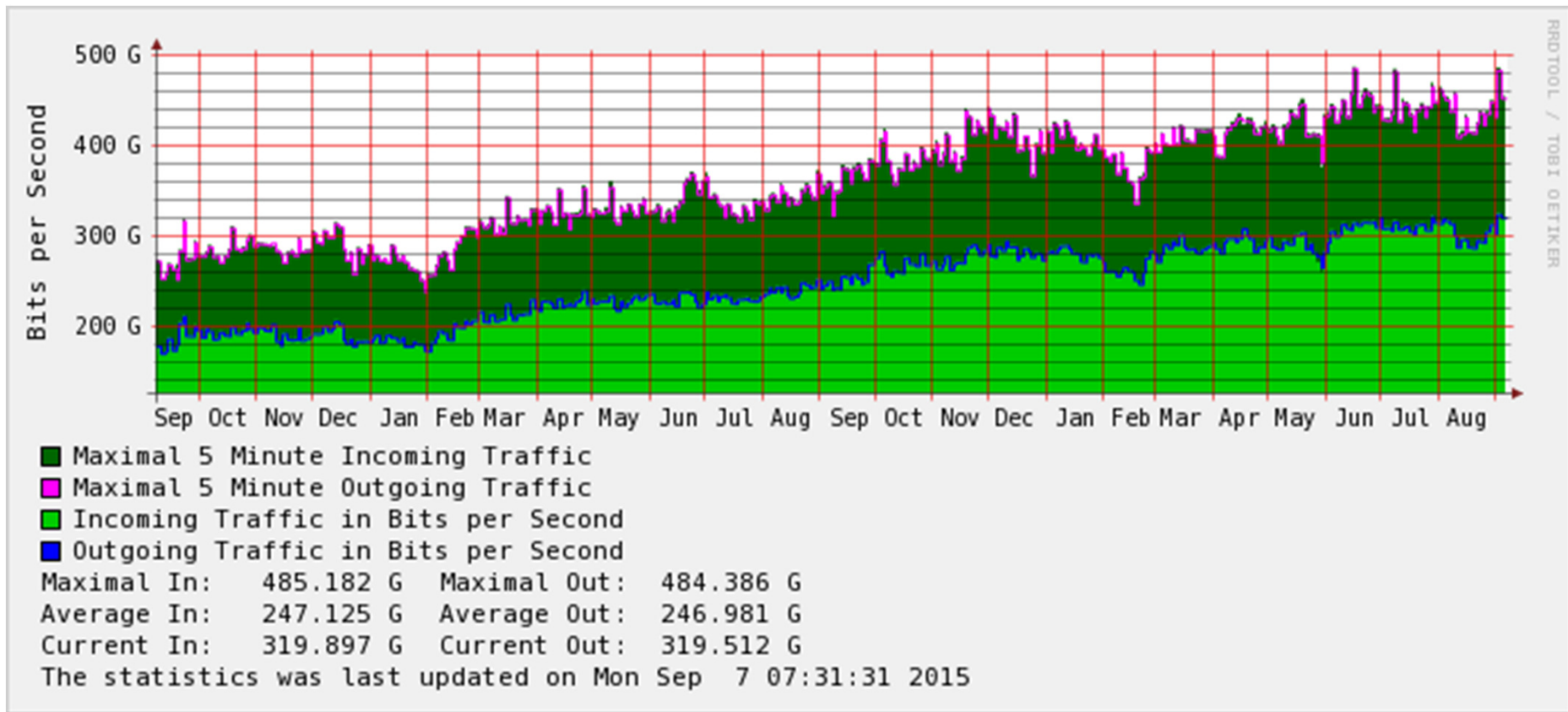
The Recent Upgrade
Done in 2014

- A new highly-scalable two-tier dual-core spine-and-leaf architecture within CUHK by taking advantage of the new data center inside CUHK Campus
  - HKIX1 site + HKIX1b site as <u>Core Sites</u>
    - Fiber distance between 2 Core Sites: <2km
  - Provide site/chassis/card resilience
  - Support 100GE connections
  - Scalable to support >6.4Tbps total traffic using 100GE backbone links primarily and FabricPath
- **Ready to support HKIX2/3/4/5/6/etc as <u>Satellite Sites</u>**
  - **<u>Satellite Sites</u> have Access Switches only, which connect to Core Switches at both <u>Core Sites</u>**

The Design

- Dual-Core Two-Tier Spine-and-Leaf Design for high scalability
  - Have to sustain the growth in the next 5+ years (to support >6.4Tbps traffic level)
  - Core Switches at 2 <u>Core Sites (HKIX1 & HKIX1b)</u> only
    - No interconnections among core switches
  - Access Switches to serve connections from participants at HKIX1 & HKIX1b
    - Also at <u>Satellite Sites</u> HKIX2/3/4/5/6/etc
    - Little over-subscription between each access switch and the core switches
  - FabricPath (TRILL-like) used among the switches for resilience and load balancing
- Card/Chassis/Site Resilience
  - LACP not supported across chassis though (card resilience only)
- 100GE optics support
  - LR4 for <=10km and ER4-lite for <=25km (4Q2015)
  - Support by local loop providers is key
- Port Security still maintained (over LACP too)
  - Only allows one MAC address / one IPv4 address / one IPv6 address per port (physical or virtual)
- Have better control of Unknown-Unicast-Flooding traffic and other storm control
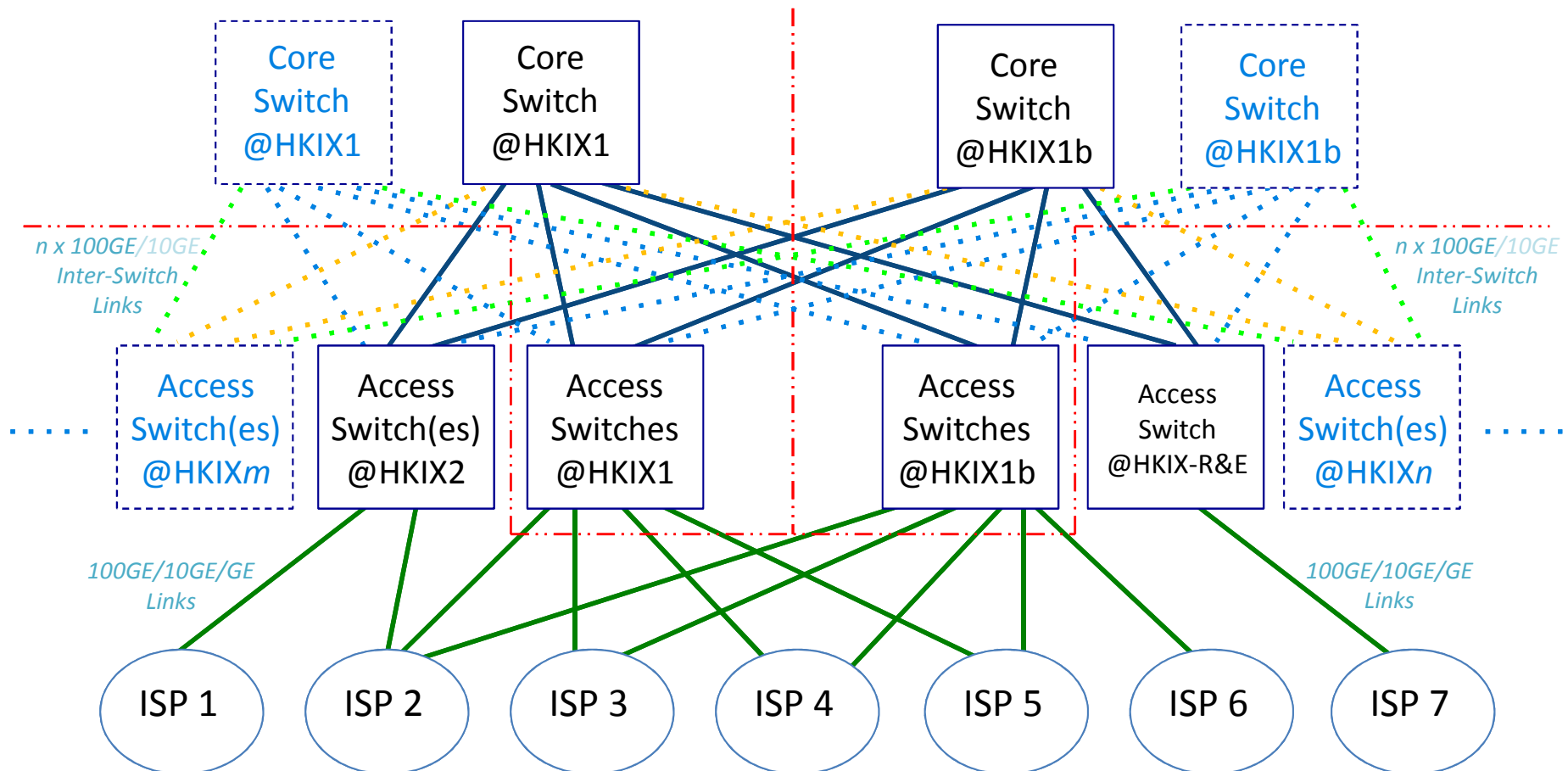
New HKIX Dual-Core Two-Tier Spine-and-Leaf Architecture For 2014 and Beyond

HKIX1 Core Site @CUHK ------(<2km)------ HKIX1b Core Site @CUHK

Core Switch @HKIX1

Core Switch @HKIX1

Core Switch @HKIX1b

Core Switch @HKIX1b

n x 100GE/10GE Inter-Switch Links

n x 100GE/10GE Inter-Switch Links

Access Switch(es) @HKIXm

Access Switch(es) @HKIX2

Access Switches @HKIX1

Access Switches @HKIX1b

Access Switch @HKIX-R&E

Access Switch(es) @HKIXn

100GE/10GE/GE Links

100GE/10GE/GE Links

ISP 1

ISP 2

ISP 3

ISP 4

ISP 5

ISP 6

ISP 7

FabricPath
Being Used in New Architecture

- We adopt spine-and-leaf architecture for high scalability
  - Avoid connecting participant ports on core switches
- The Spanning Tree Protocol (STP) domains do not cross into the FabricPath network
  - Layer 2 gateway switches, which are on the edge between the CE and the FabricPath network, must be the root for all STP domains that are connected to a FabricPath network
- Load balancing is working fine
  - Even with odd number of links
- Transparent to participants (i.e. no BGP down) when adding/removing inter-switch links

IPv4 Address Renumbering and Route Servers Upgrade

Migration Date: 12-15 Jun 2015 (Fri-Mon)

IPv4 Address Renumbering

- Network mask was changed to /21 from /23, for accommodating future growth

- ALL participants had to change to **NEW 123.255.88/21**, away from *OLD 202.40.160/23*

- **Parallel run of old and new IPv4 addresses only during the 4-day migration period, having learnt from experience of other IXPs**

- MLPA: New route servers support new IPv4 addresses while old route servers supported old addresses, but IPv6 was handled separately

- BLPA: Individual participants had to coordinate with their peering partners directly

- *No change to IPv6 addresses*

Route Servers Upgrade

- The two old route servers were decommissioned at the end of the period

- Two new route servers had been installed at HKIX1 and HKIX1b (the two HKIX core sites)

- More route server features will be supported later

IPv4 Address Renumbering and Route Servers Upgrade

Considerations beforehand:

- Peak traffic level: ~450Gbps (5-min average)

- # of prefixes on MLPA route servers: ~80K IPv4 prefixes & ~12K IPv6 prefixes

- Complexity of migration: participants from many different time zones & 330+ BGP sessions

- Have to minimize topology changes and configuration changes to participants

- Also need to care about bilateral peering – both old and new networks on the same VLAN

- Have to take care of capacity requirements and routing performance if transit is to be provided between old and new networks

Three options had been looked into:

- **Big Bang Approach** – Pros: Minimum effort to HKIX / Cons: Need coordination with ALL participants for aligning the maintenance window which is extremely difficult

- **Parallel Run with Transit** – Pros: Easier for participants / Cons: Transit routers would need to handle huge traffic of up to 300Gbps and would not be able to support BLPA across old and new networks

- **Parallel Run with Secondary Address** – Pros: Flexible changing time as secondary address can be configured before migration / Cons: Participants need to configure 2nd address on all the router interfaces connecting to HKIX

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IPv4 Address Renumbering and Route Servers Upgrade

After careful studies and making reference to other IXPs around the world, we finally decided to take the approach of **Parallel Run with Secondary Address** + **Transit Router** (for backup and contingency) and do the renumbering within **4-day period** (Fri to Mon)

IPv4 Address Renumbering and Route Servers Upgrade

Communication Part:

Before Migration

- 3-4 months – Announced the address renumbering at APRICOT-APAN 2015 and then HKNOG 1.1
- 3 months – Made the announcement by emails to all HKIX participants without detailed info and requested them to provide their contact points for the IPv4 renumbering tasks
- 2-3 months – Replied acknowledged participants and let them know that a migration webpage had been established and the latest information would be published there
- 2 months – Sent reminders to participants who had not respond through all contact points (i.e. contractual / billing / technical contacts) as their commitment to the address renumbering would be very important to the whole project
- 5 weeks – Provided the information of new IP addresses and published the mapping of old address to new address on the migration webpage
- 4 weeks – Published final schedule, migration details, sample configurations and FAQs
- 3 weeks – Sent individual emails to participants and asked them to confirm and specify the intended migration time within the 4-day period
- 1-2 weeks – Followed up again if reply was still not received from the participants
- 1 week – Set up the Command and Control Center (CCC) and ensure that all email templates were ready in place
- 1 day – CCC in operations, 24-hour technical team standby

IPv4 Address Renumbering and Route Servers Upgrade

Communication Part:

<u>During Migration</u>

- Closely monitored the migration progress and escalated the cases to technical team in case problem reported by HKIX participants
- Provided the latest renumbering status on migration webpage and let participants know the up-to-date progress

<u>After Migration</u>

- Followed up with participants and requested them to remove the old addresses from their router interfaces

IPv4 Address Renumbering and Route Servers Upgrade

Technical Part:

Before Migration

- 2 months – Tested the equipment in lab and did simulation with different scenarios
- 1 month – Equipment trial run and final acceptance test
- 3 weeks – Installed the new route servers & backup transit router
- 2 weeks – Replaced RS2 with new route server using OLD address
- 1 week – Deployed new RS1 and invited some participants for pilot testing

During Migration

- Start of Day 1 – Re-configured RS2 to use NEW address; Set up new RS1 with NEW address; old RS1 still in production
- Day 1-4 – Set up BGP sessions with participants on new RS1 & RS2; Parallel run of new and old Route Servers
- Day 1-4 – Monitored the traffic and the overall progress with the migration schedule provided by participants
- Day 1-4 – Provided instant technical assistance (including trouble-shooting) to participants in case they had difficulties in setting up the BGP sessions
- Day 1-4 – No observable traffic drop during the period
- End of Day 4 – Shut down and decommissioned old RS1 & RS2

IPv4 Address Renumbering and Route Servers Upgrade
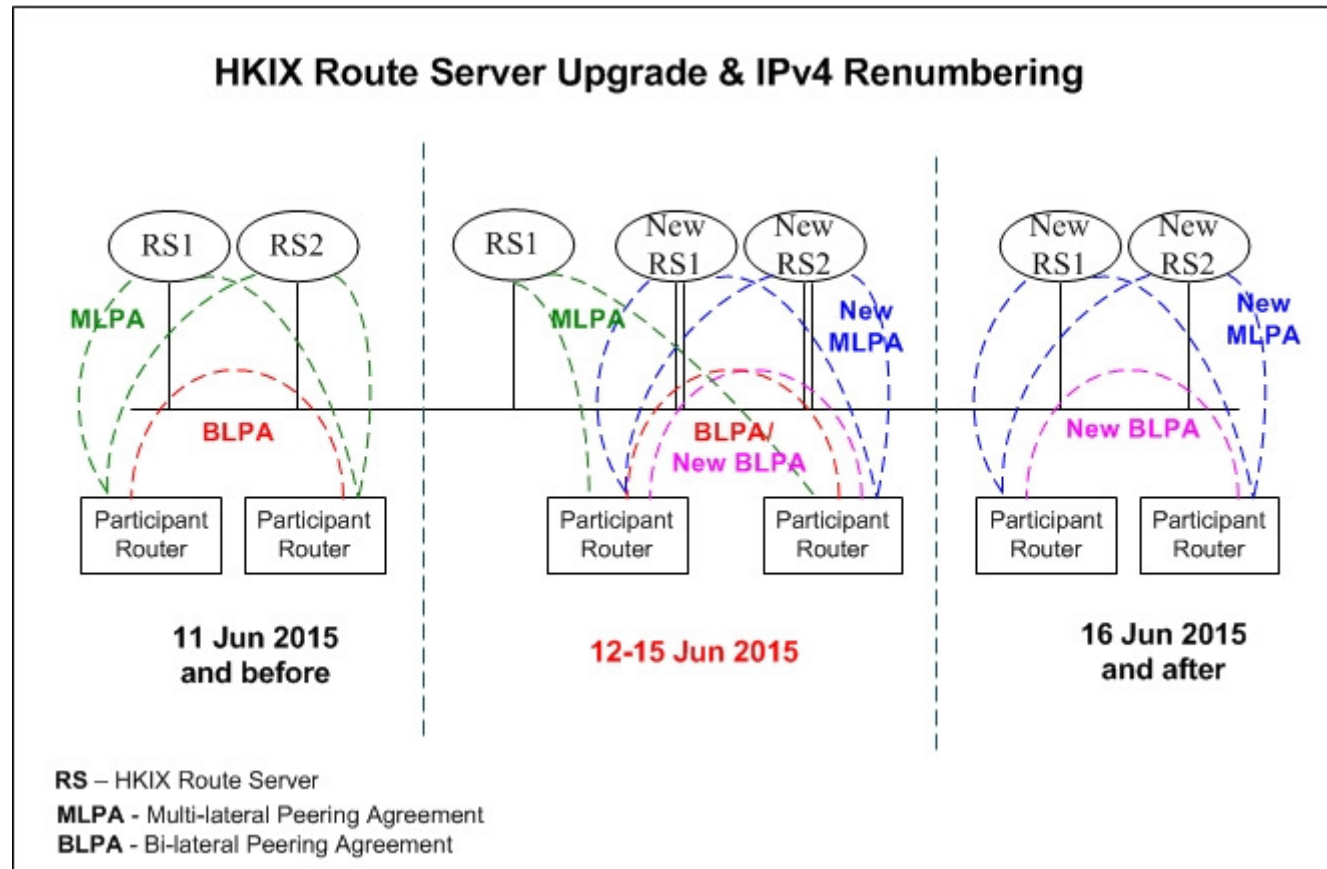
IPv4 Address Renumbering and Route Servers Upgrade

Lessons Learnt:

- The Key to Success is <u>Good Planning and Good Communication</u>

- Parallel run for migration is a must but there is no need to do parallel run for too long

- Making contact with all the participants is most time-consuming but is also most important

<u>Many thanks to the whole HKIX Team and all the HKIX participants involved</u>

Setting up
Multiple HKIX Satellite Sites

- Allow participants to **connect to HKIX more easily at lower cost** from those satellite sites in Hong Kong
- Open to all commercial data centres in HK which fulfil minimum requirements so as to maintain neutrality which is the key success factor of HKIX
  - ISO27001 requirement
  - Minimum size requirements
  - Requirements on circuits connecting back to the two HKIX core sites
  - Non-exclusive
- Intend to create win-win situation with satellite site collaborators
- To be named HKIX2/3/4/5/6/etc
- **Contact us if you are interested in this**
- *NOTE: HKIX1 and HKIX1b (the two HKIX core sites) will continue to serve participants directly*

Planned Work in 2015-2016

- **Introduce advanced Route Server functions**
- Better Control of Proxy ARP
- Better support for DDoS Mitigation
- More L2 ACL on HKIX peering LAN
- Portal for HKIX participants
  - Port info and traffic statistics
  - Self-service port security update
  - Network maintenance schedule
- Improve after-hour support
- ISO27001

Thank you!