

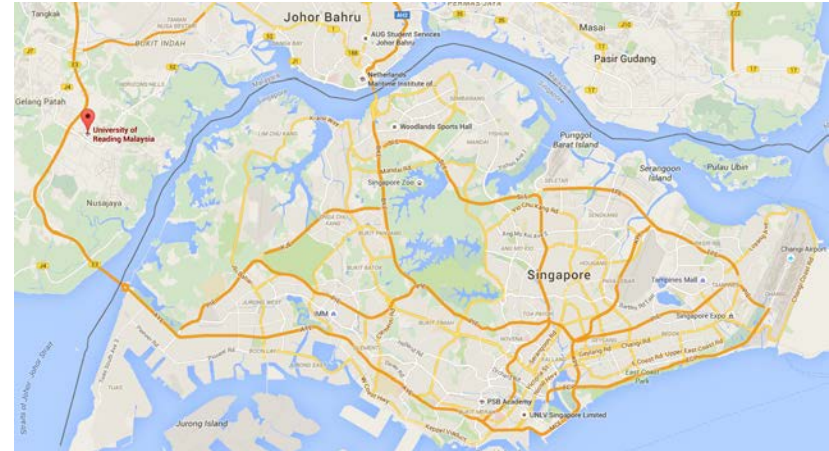
GREENFIELD IPV6



CAMPUS AND LOCATION

Educity Iskandar, Malaysia

- 40 minutes from Singapore
- Other HE institutions:
 - Newcastle University Medicine
 - University of Southampton
 - NMIT
 - Raffles University Iskandar
 - MDIS



CAMPUS AND LOCATION

Facilities include:

- Four lecture theatres
- Teaching and research labs
- Building Information Modelling lounge
- Dealing room
- Moot court

NETWORK DESIGN

- 4,500 access ports
- 124 x 11ac Wi-Fi APs
- Two data centres
- 14 comms rooms
- VoIP everywhere
- Four video conference facilities
- Building services on IP
- Assigned AS number
- /48 of IPv6 PI address space
- /23 of IPv4 PI address space
- Single IGP for both IPv6 and IPv4
- BGP to two commercial ISPs
- Fabric-based network
- IPv6 first, IPv4 overlaid





NETWORK DESIGN

- Single IGP covering IPv6 and IPv4

Benefits	Risks
Lower overhead	Bugs could affect both stacks
Consistent topology	Training for staff
Improved convergence	Remembering to look at 'v6' protocol for v4 diagnostics
Simpler configuration	Remember to enable IPv6 on all interfaces

OSPFV3 FOR IPV4

Uses realms to handle address families

- IPv6 unicast (default)
- IPv6 multicast
- IPv4 unicast
- IPv4 multicast

```
protocols {  
  ospf3 {  
    realm ipv4-unicast {  
      area 0.0.0.0 {  
        interface lo0.0;  
        interface irb.53;  
        ...  
      }  
    }  
    area 0.0.0.0 {  
      interface lo0.0;  
      interface irb.53;  
      ...  
    }  
  }  
}
```


IPV6 ADDRESSING

End-user hosts using SLAAC, with plans to migrate to DHCPv6

- Group policy to disable privacy extensions
- Predictable addresses based on MAC address allows for DNS registration
- Waiting for vendor support for RFC6939 (option 79, DHCPv6 client link-layer address)

Servers have static addresses, with per-service prefixes

- 2001:db8:abc:123::**<svc>**:**<inst>**:**<id>**
- Examples:
 - Authoritative DNS servers are 2001:df0:2bf:1::**53**:**1** and :**2**
 - Video conferencing MCU / gateway on 2001:df0:2bf:1::**5060**:**1**:**1** and :**2**

IPV6 SITE-TO-SITE VPN

Campuses connected via IPSEC VPN over the Internet

- Private peering between Telekom Malaysia and Janet
- ~190ms RTT
- IPv4 outer encapsulation with IPv6 and IPv4 inner tunnel
 - Not using GRE, as not required
 - IPv6 using ULA addresses (/126)
 - IPv4 using RFC1918 (/30)

IPV6 SITE-TO-SITE VPN

traceroute to ntp.reading.edu.my (2001:df0:2bf::24) from 2001:630:53:fa::e4, 30 hops max, 24 byte packets

```
1  vlan-250.net.rdg.ac.uk (2001:630:53:fa::fe)  1.202 ms  0.988 ms  0.893 ms
2  xe-5-0-7.core-wk.net.rdg.ac.uk (2001:630:53:8898::39)  0.281 ms  0.3 ms  0.267 ms
3  campus-bb.fw-ext.net.rdg.ac.uk (2001:630:53:8971::41)  0.441 ms  0.497 ms  0.403 ms
4  fd0c:8da8:1839::2 (fd0c:8da8:1839::2)  197.07 ms  196.866 ms  196.909 ms
5  irb-3920.core-ec.net.reading.edu.my (2001:df0:2bf::16)  205.513 ms  200.181 ms  203.947 ms
6  tick.reading.edu.my (2001:df0:2bf::24)  196.883 ms  197.283 ms  197.334 ms
```

Recommended to opt in to unofficial ULA registry at
<https://www.sixxs.net/tools/grh/ula/>

IPv6 SERVICES

DNS

- Uses IPv6 only for zone transfers, combined with TSIG.
- Not all registrars support IPv6 glue, so choose carefully.
- Client-facing DNS using Anycast, more on this in a moment...

NTP

- We run Stratum 1 NTP servers, using GPS + PPS as references.
- Peering between the two servers over IPv6 only.
- Peering with outside servers as backup reference done via IPv6.

IPV6 SERVICES

File and Print

- Windows 2016 Technical Preview
- Stretched cluster with synchronous replication (over 40GbE)
- IPv6 cluster endpoint addresses
- Print management software does not support IPv6 ☹
 - Printers, IIS, databases do support IPv6

IPV6 SERVICES

Email / calendaring / voicemail

- Unix MTA using Exim. Fully IPv6 compliant.
- Mail storage using Exchange 2013, delivery to Exchange over IPv6.

Web

- External web hosting provider doesn't support IPv6 (Amazon AWS)
- Used CloudFlare services as CDN in front of web hosting to enable IPv6 and provide DDoS protection

IPV6 SERVICES

Unified Comms (Skype for Business)

- Fully IPv6 enabled, uses IPv6 by default wherever possible.
- Handsets support IPv6 correctly
 - Polycom VVX500, firmware 5.4.0
- Video conferencing endpoints support IPv6 transport
 - Polycom RealPresence Group 500 and Group 700
 - Some functionality lost over IPv6, but nothing we use.
- Internal SIP trunks using IPv6, TLS and SRTP.
- Using Pexip for video conference MCU and technology bridging, has IPv6 support out the box.

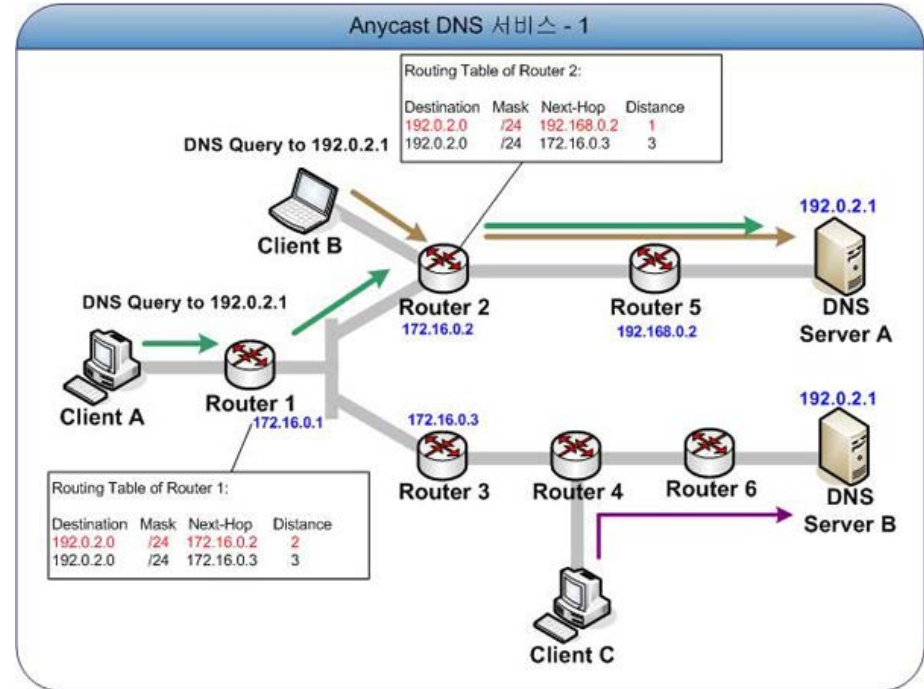
DNS ANYCAST

Client-facing resolvers

- Linux servers running Ubuntu 14.04 LTS
- BIND 9.9.5 + patches
- RPZ implemented for Malaysian regulatory compliance
- Quagga to provide BGP stack
 - OSPFv3 stack is unstable and doesn't support realms

DNS ANYCAST

- Provides rapid failover between DNS servers
- Can provide load balancing between DNS servers
- Server talks BGP (or another routing protocol) to network
- Uses loopback address(es) on server



DNS ANYCAST

Quagga BGP configuration for Anycast addresses 2001:db8:53:: and 10.53.53.53:

```
router bgp 65535
  bgp router-id 10.0.53.1
  bgp log-neighbor-changes
  redistribute connected
  timers bgp 3 10
  neighbor 10.1.0.1 remote-as 198723
  neighbor 10.1.0.1 update-source lo
  neighbor 10.1.0.1 next-hop-self
  neighbor 10.1.0.1 prefix-list anycast-dns-v4 out
  neighbor 2001:db8::1 remote-as 198723
  neighbor 2001:db8::1 update-source lo
  no neighbor 2001:db8::1 activate
```

```
address-family ipv6
  redistribute connected
  neighbor 2001:db8::1 activate
  neighbor 2001:db8::1 next-hop-self
  neighbor 2001:db8::1 prefix-list anycast-dns-v6 out
  exit-address-family
!
ip prefix-list anycast-dns-v4 permit 10.53.53.53/32
ipv6 prefix-list anycast-dns-v6 permit 2001:db8:53::/128
```

IPv4 LEGACY STUFF

- Door access and intruder alarm systems
- CCTV
- SIP trunks to ITSP
 - SBC (Audiocodes) does support IPv6, but not reliable.
 - ITSP does not support IPv6 and most likely will never do so.
- Printer management
- Library catalogue
 - Cloud hosted, IPv6 on committed roadmap for within 12 months.

QUESTIONS?

