IT Operation (3)

IPv6 Operation (and Transition)

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NTT Communications

Topics

- about myself
- IPv4 and IPv6 difference
  - Addressing
- Transition
  - How to migrate IPv6 into IPv4 network
- Practical issues
  - in transition
  - in daily operation

about myself

- IPv6 operator / researcher (?)
  - working on IPv6 (as an operator) since 1997
  - worked to deploy WIDE 6Bone
- backbone ISP engineer
  - operating NTT Communications Global IP Network (aka “ntt.net”)
  - “ntt.net” is a backbone ISP rather than domestic ISP providing Internet services for other ISPs
  - doing BGP configuration mostly
  - “ntt.net” is fully IPv4/IPv6 dual stack network

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IPv4 and IPv6 difference (1)

- no significant difference between IPv4 and IPv6
  - especially from backbone ISP point of view
- major change for IPv6 is “IP Address”
  - address space is expanded from 32bit to 128bit
  - text representation is fully changed
    - decimal expression to hex-decimal expression
      - IPv4: 192.168.128.254
      - IPv6: 2001:db8:0:d802:2d0:b7ff:fe88:eb8a
    - for more detail, see RFC3513 “IPv6 Addressing Architecture”

IPv4 and IPv6 difference (2)

- IPv6 address space
  - currently, 2 types of IPv6 address space
    - pTLA (pseudo TLA)
      - experimental address space for “6Bone”
      - won’t be used in the near future (no further allocation)
    - **sTLA** (sub TLA)
      - production address space (/20-/35)
      - most ISPs are using this block for their network
      - around 700 prefixes are allocated
  - routing table size
    - IPv4: around 130,000 routes
    - IPv6: around 600 routes (including pTLA, sTLA, others)

IPv4 and IPv6 difference (3)

- thanks to its large address space, we can assign IPv6 address in more tidy way
  - IPv4
    - we cannot get large address block from RIR (Regional Internet Registry)
    - difficult to follow physical network design
  - IPv6
    - we CAN get one large address block
    - easy to follow physical network design
  - talk about this later again

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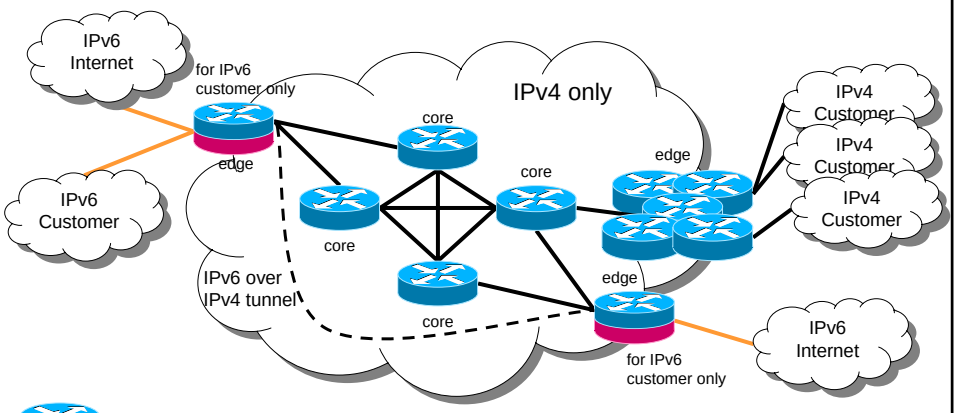
Transition / Migration

- How to migrate
  - Schedule: gradually, all at once, ...
  - Technique: from scratch, tunnel, various translation mechanisms, MPLS, dual stack, ...
  - But, there is no ideal way. need to customize to some extent.
- What we did
  - We had 3 steps over 3 years
    - made IPv6 “backbone” using IPv6 over IPv4 tunnel
    - made core routers dual stack
    - made edge routers dual stack

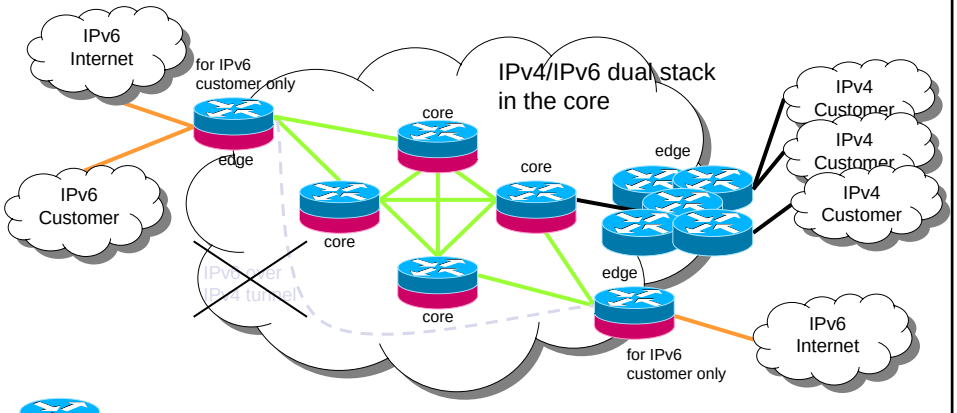
Principles (for ourselves)

- Keep It Simple, Stupid
  - try to make all routers / services dual stack
- Keep IPv6 same as IPv4
  - do not introduce strange configuration for IPv6 only
  - follow the same physical design as IPv4
    - do not use logical overlay (ex. tunnel, VLAN, MPLS)

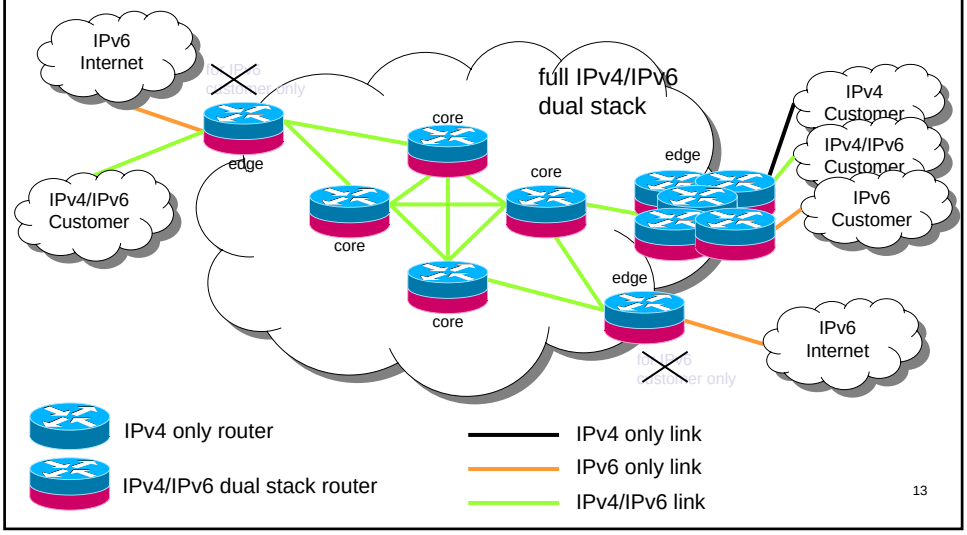
Transition example (1)



Transition example (2)



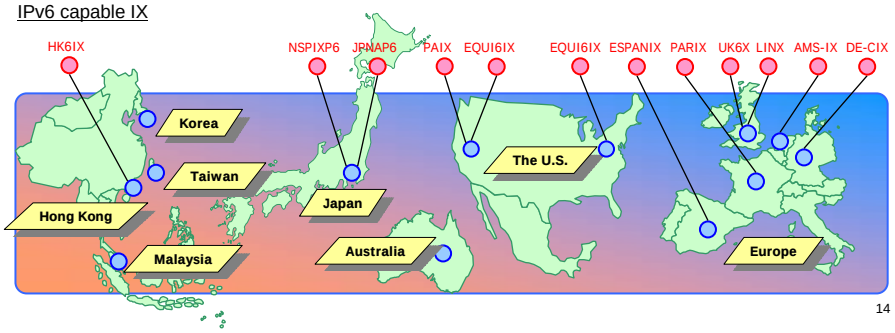
Transition example (3)



Transition example (4)

- all routers (> 300) are fully dual stack
  - connected to both IPv4 and IPv6 IXes
  - provide IPv4, IPv6, IPv4/IPv6 services
- some servers also provide IPv6 service

IPv6 capable IX



Thoughts on what we did

- Pros for dual stack approach
  - no additional hardware cost
  - able to operate IPv6 just like IPv4 (small educational cost)
- Cons for dual stack approach
  - software maturity still vary
  - (IS-IS case) Require “X-day”
    - have to implement dual stack all at once
    - will discuss later

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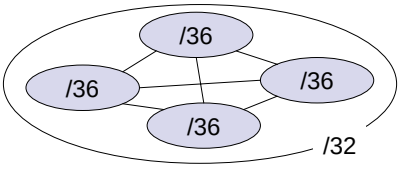
Issues in transition

- Addressing design
- Tunnel
- Routing Protocol
  - BGP
  - OSPF / IS-IS
- Access network
  - ex. ADSL
- Others ...

Addressing design (1)

- unlike IPv4, we can use large address block
  - we can design IPv6 addressing on our free will
- Assign enough address block per POP basis (ex. /36)



you can assign /36 for 16 POPs
(/36 - /32 = 4bit → 16)

- use the same addressing in each POP (within /36)
  - ex. /48 for router loopback, /48 for router p-t-p, ...
  - easy to make packet filtering rules (ACL)
  - easy to understand how addresses are assigned

Addressing design (2)

- point to point address prefix length

  - **/64** will be good, some use **/126** (just like IPv4)

- Let's use "easy to remember" service address
  - 2001:db8:0:d802::80 for HTTP server
  - you don't have to assign Interface-ID ×
    - 2001:db8:0:d802:2d0:b7ff:fe88:eb8a

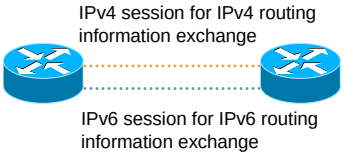
Tunnel technology

- There are 2 types of major tunnel technology
  - IP-in-IP, GRE (Generic Routing Encapsulation)
  - you need to use the same type in each tunnel end
- MTU
  - be careful about encapsulation overhead

- Encapsulation / Decapsulation
  - needs some time and CPU power
- Hard to solve problems
  - tunnel depends on IPv4 infrastructure
- Does not scale

Routing Protocol (1)

- BGP
  - Separate IPv6 routing from IPv4 routing
    - you can use IPv4 for IPv6 routing information exchange
    - BUT you have to separate



  - You can setup IPv6 peering not affecting IPv4
    - able to deploy IPv6 gradually
  - Again, try to use the same routing policy for both

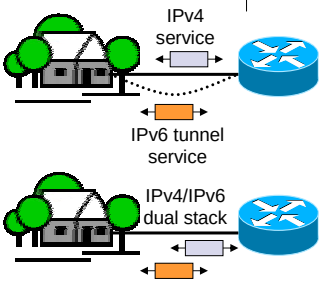
Routing Protocol (2)

- OSPFv2 (for IPv4) and OSPFv3 (for IPv6)
  - completely different protocol
  - able to co-exist
    - does not affect each other
    - easy to deploy IPv6 (OSPFv3) gradually
- IS-IS
  - single topology for IPv4 and IPv6
    - to tell the truth, there is multi-topology extension
  - to enable IPv6, all IS-IS nodes have to enable IPv6 all at once. difficult for gradual deployment.

needs X-day !

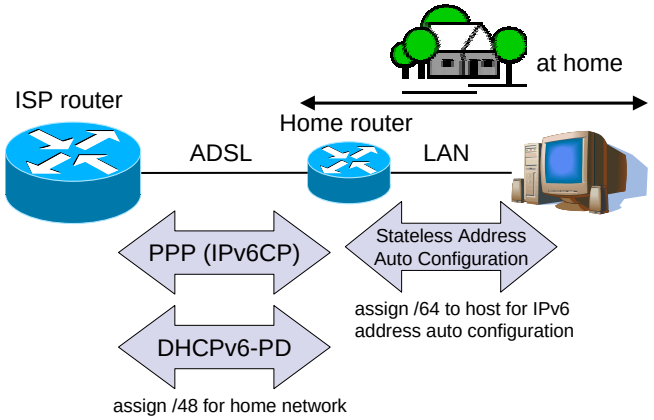
Access Network (1)

- IPv6 over IPv4 Tunneling
  - easy to deploy
  - hard to support edge devices
- IPv4/IPv6 dual stack
  - in IPv4, /32 is assigned to users, in IPv6, /48 is assigned to users
  - this means “new function” for auto address configuration
    - Prefix Delegation protocol



Access Network (2)

- Protocols for IPv4/IPv6 dual stack service



Access Network (3)

- This service works well since 2002 Summer
- No impact on existing IPv4 only services
  - IPv6CP is initiated from home router side
- Nation wide service via L2TP
- Most ISPs in Japan are using this spec
- Issues
  - DNS discovery in home network
  - Multicast ... ?

Others ...

- Layer3 switches
  - some Layer3 switches doesn't fully support IPv6
  - no need to worry about Layer2 switches
    - can use the same one as of today
- Multicast
  - IPv4 multicast is gradually deploying
  - IPv6 multicast needs more tests
    - however, PIM-SM has been used in various experiments
    - some standards are still under discussion

Issues in daily operation

- Router operation
- Server operation
- Monitoring
  - NMS (Network Management Systems)
- Accounting

Router Operation

- When enabled IPv6, router commands output may slightly change
  - ex. Juniper – “show bgp summary”
- IPv6 related commands hierarchy differs from vendors
  - Juniper – “show route table inet.6”
  - Cisco – “show ipv6 route”
  - you can see how vendors treat IPv6 ☺
- Default protocol for some commands become IPv6
  - ping / traceroute will be sent to IPv6 address if a destination have IPv6 address (and DNS entry)
  - you have to explicitly specify IPv4 to send IPv4 packet
    - ex. “ping inet www.6bone.net”

Server Operation

- Again, default protocol for various commands become IPv6
  - ex. Solaris : “ping –A inet www.6bon.net” for IPv4
  - telnet / ssh will try to connect via IPv6. so, even if IPv4 is fine, you’re sometime unable to connect to servers / routers
  - think about using literal IPv4 address
    - ex. “telnet 192.168.128.10”
- Need to setup packet filter for IPv4 and IPv6
  - major filters already support IPv6

Monitoring

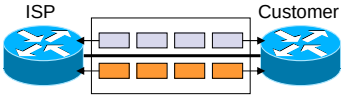
- currently, most ISP use SNMP (Simple Network Management Protocol) for monitoring nodes
  - only a few router supports IPv6 SNMP transport
  - routers still have to have IPv4 connectivity
- NMS (ex. HP OpenView) doesn’t fully support IPv6
  - NMS support IPv6 to some extent, but operators have to learn IPv6 special operations

Accounting

- ISP use interface byte counter to measure how much traffic send/receive to/from customers
  - based on this, ISP charge their customers

- most router cannot count IPv6 packets only
  - so, cannot charge IPv4 and IPv6 separately

IPv4/IPv6 dual stack



able to count sum of packets

Today's Assignment

(for this assignment, http://www.sixxs.net/main/ will help you)

1. Try to do "traceroute" from IPv6 looking glass to one IPv6 site and send its result
2. How many IPv6 prefixes are allocated for you country's organizations ?
3. What kind of applications are now IPv6 capable on Windows, MacOS, UNIX ? (you don't have to pick them all)
4. What makes IPv6 popular and what prevents IPv6 from being popular right now ?
5. Give 1-2 lines of feedback