



IPv6 from 50 thousand feet

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Bargain

- No diagrams of header formats
- No slides reading "Drivers for IPv6"
- No marketing
 - Well, maybe just a little bit
 - But only of IPv6
- In return, your attention and suspended disbelief before dinner



What I'm going to talk about

- Why?
 - Not the usual reasons
 - Running out of address space
 - "It's, like, cool"
 - Savings: Money & Time
 - Useful features



What I'm going to talk about

- How?
 - Deployment or experimentation
 - Existing deployments
 - With a nod to our hosts
- When?
 - Recommendations



Why?

- The usual reasons
 - IPv4 has problems
 - Some of these will get worse over time
 - Address space exhaustion
 - Management scalability
 - Do it **now** because it's the latest and greatest thing



Why?

- My reasons
 - IPv6 saves money and time
 - Key features increase
 - Simplicity
 - Manageability
 - IPv6 has other features worth having
 - Security
 - QoS



Problems with IPv4

- Address space exhaustion
 - Prior to CIDR (~93) extremely inefficient address allocation
 - Better now, but the writing is on the wall
 - 36% of address space left (RIPE 43)
 - We have till 2004-2018 depending on whose curves you believe



Problems with IPv4

- Address space exhaustion
 - This is an ultimate deadline
 - Eventually you will need more and there won't be any there
 - More a problem for commercial ISPs than university end-sites
 - But it's still a problem for the people you are trying to reach, if not for you



Problems with IPv4

- Address space exhaustion
 - Key concept:
 - You will need to look at this for your network eventually
 - It might be within your tenure or might not, but why not be nice to your successor?



Problems with IPv4

- Management
 - "Man in a van" problem
 - Address management,
- Security
 - Not designed in
- Complexity
 - End-to-end philosophy is broken
 - Subtle capabilities have been lost



Problems with IPv4

- Management
 - Address management needs human oversight
 - Renumbering handled badly
 - Manual configuration generally required



Address allocation

- Address management is necessary
 - Automatic address assignment is broken
 - DHCP is deficient
 - DHCP servers require management
 - Prevent address collision
 - Security implications
 - Many deployments are statically addressed
 - Need staff to do this



Renumbering

- Renumbering doesn't happen often...
- But when it does
 - It's a network down-time event
 - It's very costly in terms of time and staff



Hands on configuration – why?

- Key concepts
 - Address management is broken
 - Renumbering requires manual attention
 - Nodes generally require some element of administrator attention



Problems with IPv4

- Security
 - Spoofing
 - Address spoofing
 - Packet synthesis
 - Plaintext authentication
 - Etc...
 - No built-in authentication/encryption



Problems with v4

- Complexity
 - IPv4 has been around a long long time
 - Feature creep
 - Philosophy of simplicity has been undermined
 - NATs
 - Firewalls, etc
 - We need to start again, taking into account lessons learned



IPv6 solves IPv4 problems

- Address space exhaustion
 - Solves it twice
 - By being bigger (128 bits)
 - By being cleverer about using address space(s)
 - Site- and link- locals
- Management
 - If it can be done automatically, it is
 - Stateless (and stateful) autoconfiguration
 - Router advertisement and solicitation



IPv6 solves IPv4 problems

- Security
 - IPSEC **mandatory**
 - Secures everything...
 - DNS, router solicitations, HTTP, everything
 - As long as the end-point supports it
- Complexity
 - Simplification of standards, header formats
 - No requirement for workarounds like NAT



Another way to put this

- IPv6 saves you money and time
 - Less hands-on management required
 - Management moved to routers and infrastructure servers rather than end hosts
- This directly translates to smaller staff costs
 - Less time is less money



Key IPv6 features to achieve this

- Stateless autoconfiguration
- Router solicitation and discovery
- Prefix deprecation
- Automatic key negotiation
- 6-to-4 transition mechanism



Stateless autoconfiguration

- Nodes generate addresses automatically
 - Combine network prefixes with MAC addresses
 - Network prefixes include "well-known" prefixes that mean
 - local link only
 - local network only
 - and any others you choose to provide
 - Routers provide prefix information



Router solicitation/discovery

- Nodes can automatically discover routing tables
 - Send "router solicitation" messages
 - Receive prefixes, MTU, TTL etc
 - Routers can deprecate prefixes for renumbering purposes



Key negotiation

- Inbuilt (IPsec) security has a notion of automatic keying
 - Nodes can transmit periodically (re)generated cryptographic keys automatically
 - Communication can be automatically secured without administrator intervention



6-to-4 transition mechanism

- An address space has been reserved for this interoperability method
- Embeds the IPv4 address in the IPv6 address
- Communicate via encapsulation
- All works automatically
- Downside: latency



How do I start understanding this?

- Decide whether to run trial production services or experiment
- You need a plan
- Recommendations
 - Start small
 - Very easy to incrementally add and change
 - Very easy to run in parallel



Do I do this quickly?

- There won't be an flag-day
 - Don't worry about having to synchronise deployment
 - Don't worry about having to solve all the problems in one go
 - Go for phased, gradual ushering-in



Production or experimentation?

- I'm not talking about moving your network over to IPv6 tomorrow
- I'm talking about the ease of running the two in parallel
 - It is surprisingly easy
- Question is whether you introduce in production environment or not



Production services

- Running production services
 - Most if not all IP protocol services can be run over IPv6
 - HTTP, DNS, SMTP...
 - All the core ones, most of the rest (including IM and other frivolities)
 - IPv6 can in many cases be introduced without affecting the stability of the service
 - Particularly using 6-to-4



Production services

- Gotchas
 - Apache 2 should be used for IPv6
 - Does not currently support mod_php or other important modules
 - Can run the two in parallel as necessary
 - BIND (for DNS) listens on all available IPv6 interfaces
 - Can't restrict it to (say) internal interfaces
 - There are other DNS servers



Production services

- Gotchas
 - Hosts require dual stacks
 - Older hosts will require patching/OS updates
 - Commercial products in many cases fall behind the free ones in implementing IPv6



Experimentation

- Minimal deployment of IPv6
 - One host and a tunnel
- Minimal useful deployment of IPv6
 - Several hosts, one router, and a tunnel
 - Allows you to experiment with the network management features
- Recommendation
 - Get addresses from upstream now
 - But don't let it delay you



Start Small

- Tunnel Brokers
- 6-to-4 transition mechanism
- Get addresses from upstream(s)



Tunnel Brokers

- A way to get address space to an end-node quickly and easily
 - HEAnet will be offering this shortly



6-to-4 transition mechanism

- Makes it very easy to start offering a few services
 - You don't even need an allocation from your upstream
 - You can embed the AAAA records in the DNS and see how this affects production networks



Grow when necessary

- New shipments of hosts will have v6 stacks pre-supplied
 - XP has it installed but you have to enable it
 - Next version of Windows will have it pre-enabled (fear!)
- You don't need to do anything for new equipment



Grow when necessary

- IPv6 stacks will learn most of what they have to know from their environment
 - Once you have a router announcing network policy, the clients will keep in line
 - Services can be offered locally and remotely as you wish



Grow when necessary

- Commercial support available
 - Consulting
 - Usual vendors
 - Products
 - Usual vendors
 - Your own staff may know more than you think
 - In-house support only may be viable



When to start?

- What are your production services?
 - If they are easy to switch, why not do that now?
 - You'll have to do it eventually, and the more experience you have at the time of switch, the better
 - It can be done at very low cost



When do I benefit?

- The more of a server farm which has IPv6 the better
 - The sooner you will feel the management benefits
 - Ultimately it will begin to be more cost-effective to offer services over IPv6 when the clients want it
 - Overhead you pay in software/training etc amortized over lifetime of protocol



When to finish?

- The IPv4 Internet will be with us for a long(++) time
 - This is a process with no flag-day
- A salutary thought:
 - 80% of everything is HTTP
 - 80% of HTTP is top 20 websites
 - Only the top 20 websites have to be reachable by IPv6 for over 50% of your traffic to be V6



Who else is doing this?

- Difficult to measure
 - Internal deployment only
 - Worldwide organisations with allocations may not be offering service here
- Methods
 - 6Bone
 - DNS
 - HEAnet MRTG



Irish deployment

- Our hosts...
 - <http://mrtg.heanet.net/mrtg/ip6/>
 - ~250kbps at TCD, for example
 - Services offered over both protocols
 - [ftp.heanet.ie](ftp://ftp.heanet.ie) for example
 - <http://www.sixxs.net/> will be using some HEAnet space
- IPv6 assignments to most Irish ISPs



Irish deployment

- Plans afoot for
 - Eircom 6to4 router
 - INEX IPv6 traffic exchange
 - IEDR recently began testing AAAA DNS records
- Important to note
 - You aren't alone
 - There is community and upstream support



Worldwide deployment

- Commercial services in
 - America
 - Japan



References

- <http://aso.icann.org/meetings/ga-2/presentations/mylotte/sld019.html>



Thank you!

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