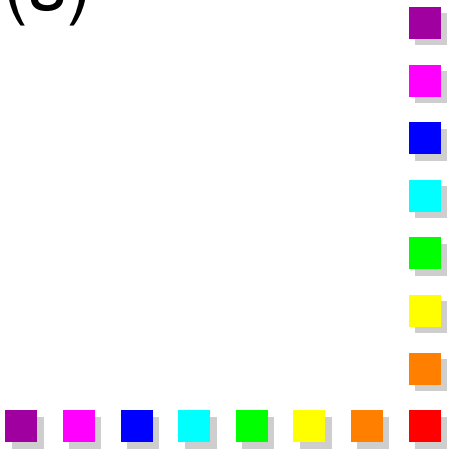
# IPv6 Update

## The Great Compromise(s)

Matt Crawford

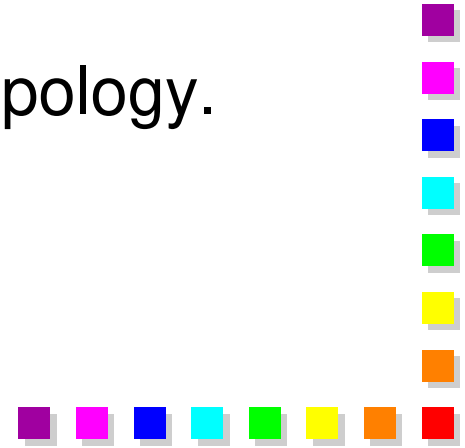


# Current Phenomena

- An explosion of terminology, as authors try to avoid the connotations of all previously-used words.
- Communities of interest bringing late-breaking requirements.
- An atmosphere of “last chance to get it right” before an installed base freezes ...
  - ... Class, Priority & Flow Label
  - ... Address architecture
  - ... Even the forwarding rules!

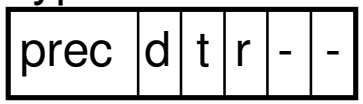
# What's the Payoff?

- For Users
  - New features on a clean base.
- For Sites
  - Large address space per site.
  - Plug and play!
- For ISPs
  - Addressing which can follow topology.
- For the Internet
  - Room for all.



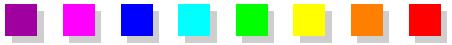
# Header Comparison

Type of service:



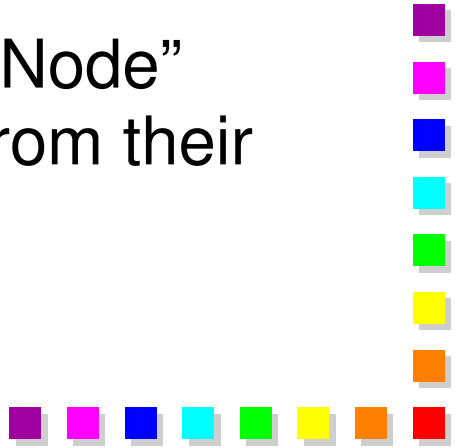

Priority:
0-7=congestion ctl
8-15=uncontrolled

Class: 3 bits defined,
5 bits reserved

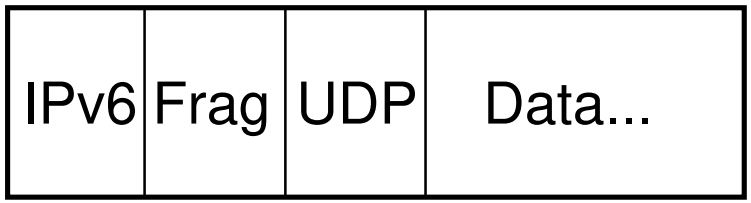


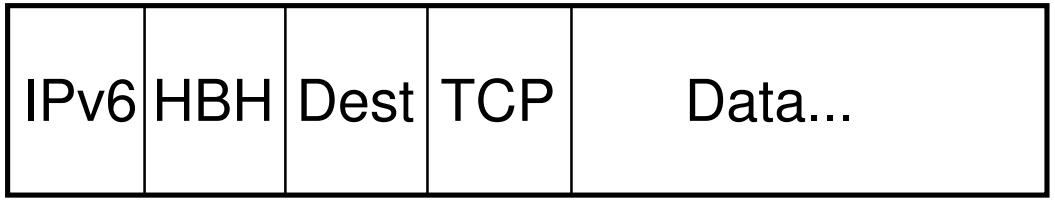
# Neighbor Discovery

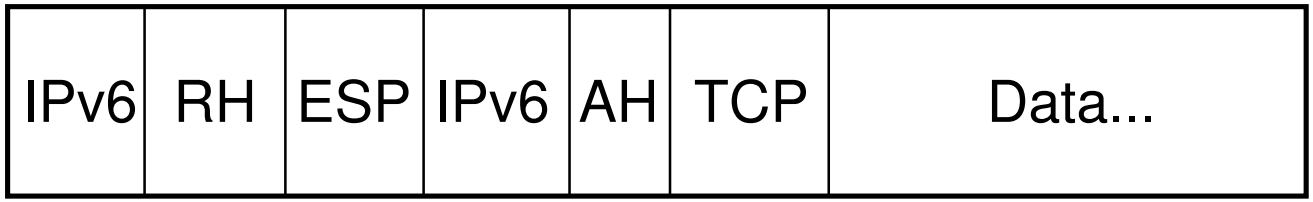
- Routers advertise local network configuration
  - Including auto-configuration details.
- No ARP (and no broadcasts).
  - ICMPv6 messages instead of a separate protocol.
  - Nodes send/listen to “Solicited-Node” multicast address(es) derived from their unicast address(es).



# Extension Headers



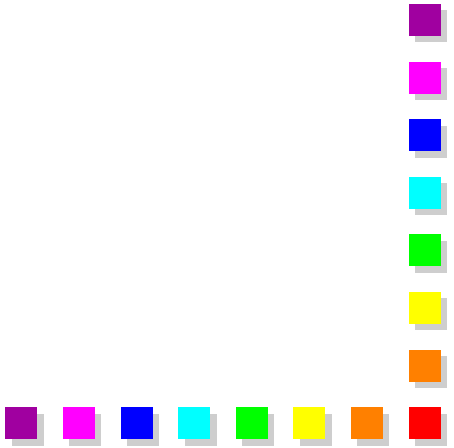



# Recent Changes

- Increase the minimum allowed MTU?
- Priority bits undefined, more “Class” bits added.
  - Due to recent work (and recent agreement) among end2end researchers on explicit congestion notification.
    - Relies on active queue management in routers.
- Removal of “strict” source routing.
  - Original purpose unachievable.
    - And semi-obsolete.

# Recent Changes (cont.)

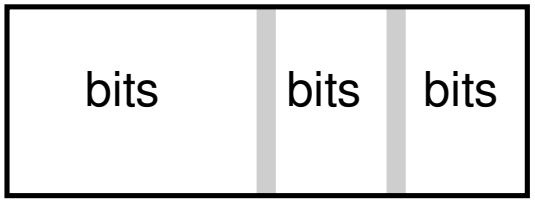
- New dest. option for mobile nodes.
  - Because of ingress filtering.
- Reassign multicast addresses so high-rate multimedia strem never lands on a solicited-node address.
  - That might save your toaster.
- Bridged Ethernet/FDDI MTU determination is dead.
  - A casualty of IEEE 802.1p.
- Addressing!



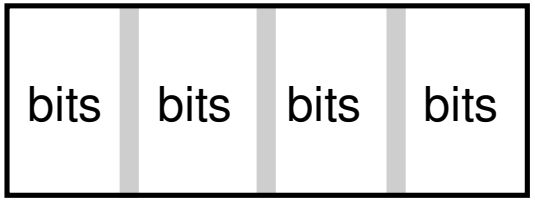
# Addressing Objectives

- Enormous deployment scaling
  - Demands large address space/efficient use.
- Packet forwarding speed
  - Demands that routing decisions be made on a short, aligned field.
- **Autoconfiguration**
  - **Demands a large “interface token.”**
- Routing computation
  - Demands good aggregation of routes.

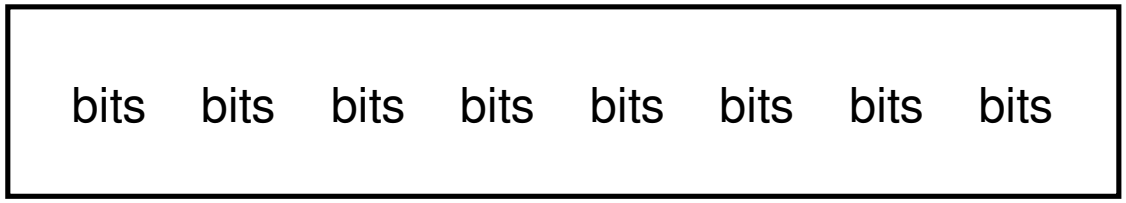
# What's in an Address?




Site-within-world
Subnet-within-site
Node-on-subnet




ISP-within-world
Site-within-ISP




???

# Forwarding Speed

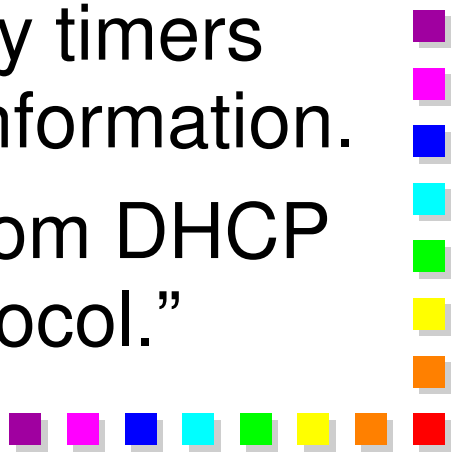
- The party line of router builders is that doing all forwarding based on 64 bits would be a big win.
  - This leaves a lot of space for interface tokens, but puts the squeeze on the topological portion of the address.
    - The more so given the decision that every “site” gets the same amount of address space.

# Autoconfiguration

- Serverless auto-configuration must generate an address unique on the link using only built-in information.
  - Random and hashing methods are subject to failure when partitions are healed.
  - Therefore, use a built-in MAC address when one exists.
    - 16 to 64 bits.
    - Not perfectly unique, but ‘supposedly unique.’
      - Local clashes can be detected and resolved locally.

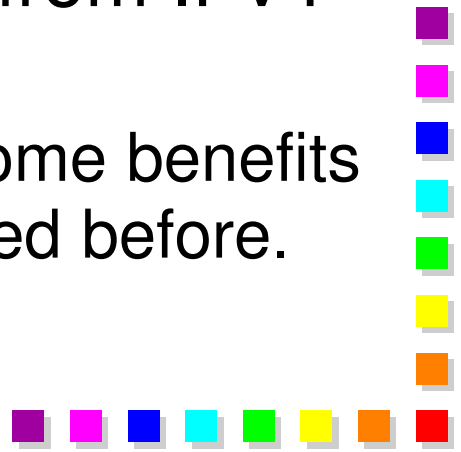
# IPv6 Host Autoconfiguration

- Host creates “Link-Local” address using built-in information.
  - Perform “Duplicate Address Detection.”
- Host Solicits Router Advertisements.
- Routers advertise valid prefixes, MTU, Hop Limit, Neighbor Discovery timers and other autoconfiguration information.
- Other information available from DHCP and/or “Service Location Protocol.”



# Routing Computation

- Concern for aggressively preserved aggregation led to “8+8” proposal.
  - **One of the underpinnings was a globally unique 64-bit “End System Designator.”**
- Full separation of Identity and Location proved too great a departure from IPv4 architecture.
  - Tying identity to location has some benefits that weren’t generally recognized before.

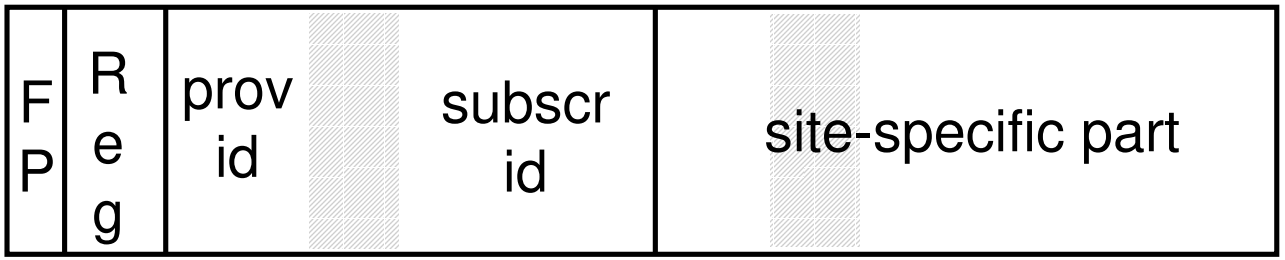


# Ideas Retained From 8+8

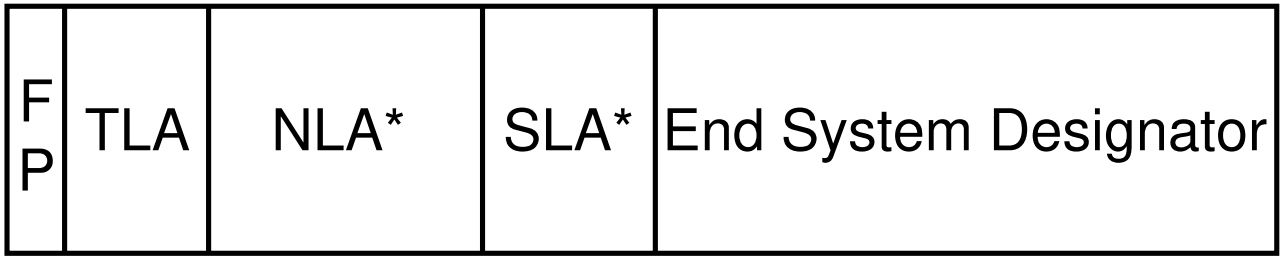
- Global address structure which is less ‘flat at the top’ than previous provider-based scheme.
- Possible DNS changes to aid renumbering.
- Emphasis on site-local addresses.
- **End-System Designator of 64 bits replaces the interface token of medium-dependent length.**

# IPv6 Address Format

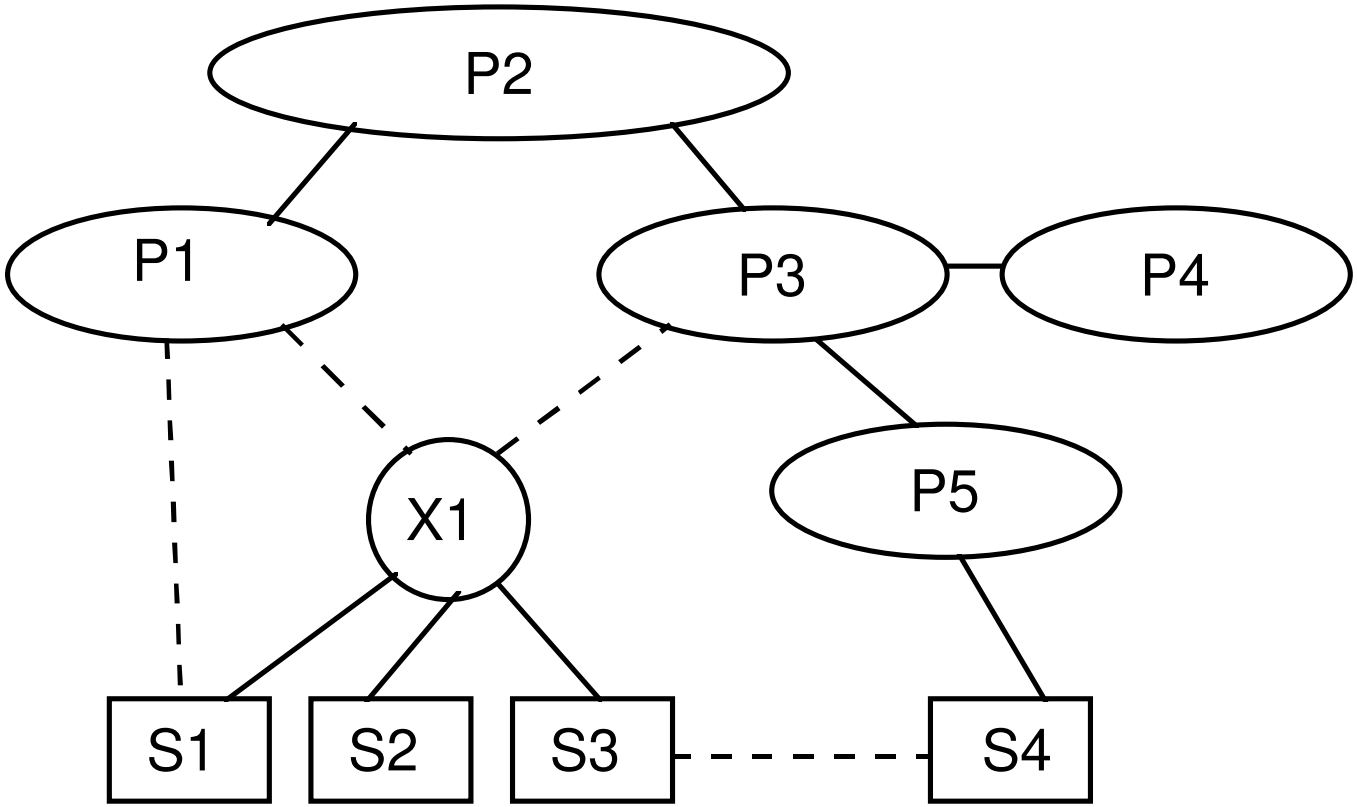
*Old*




*New*

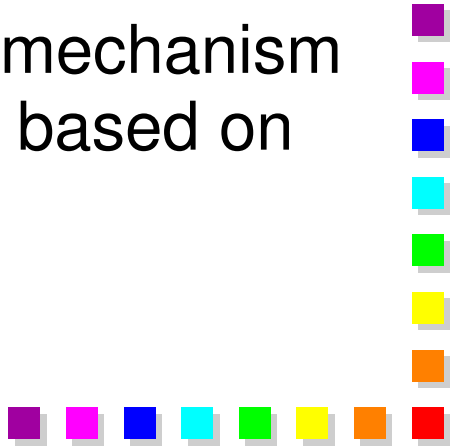


# Address Assignment



# End System Designators

- Guaranteed global uniqueness requires a (distributed) enumeration of all assigned values.
  - Which implies registries, delegations, records ...
    - which will lead to things like net 10 again.
  - On the other hand, you'd get a mechanism for lookups and key distribution based on ESD almost for free...
    - but it's worth very little.

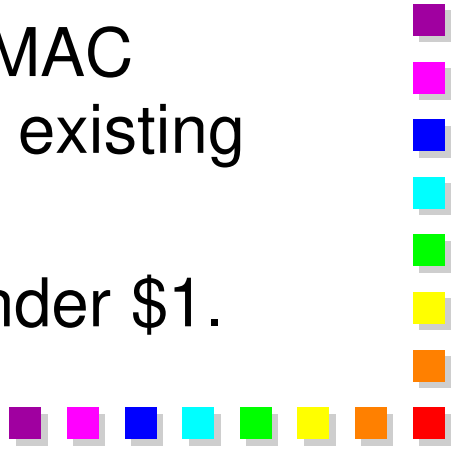


# Global Uniqueness?

- Perfect global uniqueness of End System Designators cannot be achieved.
- Almost-perfect could be achieved, but at a large administrative cost.
- Is it worth the price? With no tie to location, ESDs are eminently spoofable.
- But perhaps future protocols could still benefit from unique ESDs.

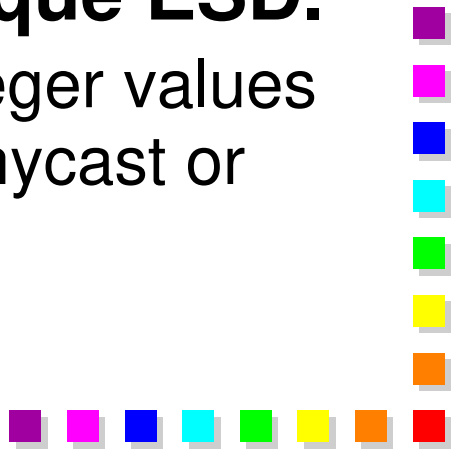
# Uniqueness (continued)

- Settle for pretty good uniqueness, courtesy of IEEE and interface vendors.
  - EUI-64: 24 bits of company_id and 40 bits chosen by manufacturer.
    - minus 2 special bits leaves 4 million company_id's to assign.
  - A defined embedding of 48 bit MAC addresses exists, so millions of existing nodes are already covered.
  - Assignment through chips at under $1.



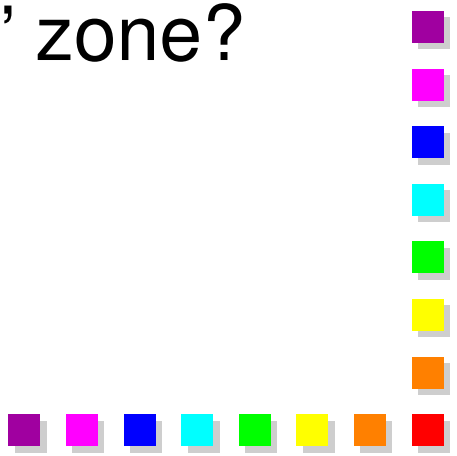
# But Sometimes...

- Sometimes one has no built-in identifier, or has no particular piece of hardware to be associated with a certain address.
- **One of the two special bits in the company_id is the Universal/ Local bit. Set this to flag non-unique ESD.**
  - One might rather use *small* integer values (especially 0) for well-known anycast or made-up identifiers.
    - So complement this bit.



# Deployment at FNAL

- A few IPv6 nodes have been on-line for over a year.
- Until router vendors move IPv6 into main-line, support will be through a host acting as IPv6 router, or an additional small router.
- Currently accessible by IPv6:
  - CD, CDF, D0, Fixed Target.
- To join: http://www-dcg/Net/ipv6-testing.

# The Wavefront

- Instantly reconfiguring all routers in a site to add, change or remove prefixes.
- Storing addresses in DNS as separate parts, to simplify renumbering.
- Involving routers in DNS?
- Eliminating the DNS “reverse” zone?
- Mobility vs. renumbering.
- Service Location
  - Finder / Browser / more