Address Assignment

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Routing

- To route packets to a destination, need a mechanism to name the destinations
  - IPv4 – IP address
  - 802.11 – MAC address

- Routable network layer (IP) address must be unique network-wide

- Link layer address need only be unique on the link
IP Address Auto-configuration

- Unique key needed for each host
IP Address Auto-configuration

- Key may be too large to fit in the IP address:

  IPv4 address: 32 bits
  802.11 address: 48 bits
Address Auto-Configuration

- Random address selection

![Graph showing the probability that a pair of hosts picks the same address against the number of hosts (n). The graph illustrates that the probability increases as the number of hosts increases, with curves for different bit sizes (16 bits and 32 bits).]
Dynamic Host Configuration Protocol (DHCP)
DHCP in Multi-Hop Wireless Networks

- DHCP may be used so long as each host is reachable from a DHCP server.
DHCP in Multi-Hop Wireless Networks

- If a host cannot reach a DHCP server, it cannot get an IP address
Auto-Configuration in Ad Hoc Networks

- How to assign unique addresses?

- DHCP server may not be available, or may become partitioned from other hosts

- If loss of connectivity to DHCP server acceptable, DHCP can be extended for use in ad hoc networks
  
  * Turn each host that has an IP address into a DHCP relay
Auto-Configuration in Ad Hoc Networks

- Can we assign unique addresses when no DHCP server present?

- Random address selection
  ➔ Potential for duplication
Duplicate Address Detection (DAD)
in Ad Hoc Networks

DAD in conjunction with reactive routing:

- Host picks an address randomly
- Host performs route discovery for the chosen address
- If a route reply is received, address duplication is detected
- If no route reply received within a timeout interval, assign the address
Duplicate Address Detection (DAD) in Ad Hoc Networks

DAD in conjunction with reactive routing:

- Host picks an address randomly
- Host performs route discovery for the chosen address
- If a route reply is received, address duplication is detected
- If no route reply received within a timeout interval, assign the address

How to pick the timeout interval?
DAD in Ad Hoc Networks

- When upper bound on message delays not known, difficult to pick a timeout interval
  
  Too small $\Rightarrow$ Address duplication may occur
  
  Too large $\Rightarrow$ Time wasted

- If partitions can occur for unbounded intervals of time, timeout mechanism ineffective
Example:
Initially Partitioned Network

IP address = a

D’s packets for address a routed to A
Merged Network

- Duplicate address detection (DAD) important To avoid misrouting

![Diagram of a network with nodes labeled A, B, C, D, E, F, G, H, K, and an IP address a. The network shows connections between nodes, indicating communication paths.]
Potential Solution: Detect Merger of Partitions

Assign largest key in a partition as partition identifies

(a) Two partitions
Potential Solution:
Detect Merger of Partitions

Different keys for two end of a new link detects a merge

(b) Merged network
Potential Solution:
Detect Merger of Partitions

Search for duplicate addresses in the newly merged partition → Overhead

(b) Merged network
Potential Solution:
Detect Merger of Partitions

- Need to manage partition identifiers

- Detection when a partition divides into two partitions
  
  - Need to update partition identifiers
  - Involves delays
  - Window of vulnerability to address duplication
Alternative Approach

- If you cannot solve a problem

  Change the problem!

- Weak duplicate address detection
Weak DAD Requirement

Packets from a given host to a given address should be routed to the same destination, despite duplication of the address.
Example:
Initially Partitioned Network

IP address = $a$

D’s packets for address $a$ routed to A
Merged Network:
Acceptable Behavior
with Weak DAD

IP address = a

Packets from D to address $a$ still routed to host A
Merged Network: Unacceptable behavior

Packets from D to address $a$ routed to host K instead of A
Weak DAD: Implementation

- Integrate duplicate address detection with route maintenance
Weak DAD with Link State Routing

- Each host has a unique key

- In all routing-related packets (link state updates) IP addresses tagged by keys
  - (IP, key) pair
Weak DAD with Dynamic Source Routing

- Address duplication not always detected
- Duplication detected before misrouting can occur

- Weak
  - Reliable, but potentially delayed, DAD
Weak DAD with Dynamic Source Routing

![Network Diagram]

Nodes: A, B, C, D, E, F, G, S

Connections:
- A to D
- B to F, S
- C to E
- E to S
- F to B, S
- G to F

- (IPs, Ks)
- (IPs, Ks), (IP_B, K_B)
Adverse Higher Layer Interaction

- Higher layers interaction may result in undesirable behavior with weak DAD

- IP addresses, which are network layer addresses, are often also used at higher layers
Higher Layer Interaction

IP address = a

M -- F

D -- P

IP address = b

A

Q -- E -- R

IP address = a

Q discovers service Foo at address a
Example: Networks merge

Node A performs service discovery for *Foo*, and learns from Q that *Foo* is available at address *a*
Example: Networks merge

Node A’s packets to a are delivered to M

R provides service Foo not M

IP address = a

IP address = b