AERO DHCPv6 Control Messaging

IETF91 – Honolulu, HI

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AERO History

- Developed in the 2008 – 2014 timeframe
- Based on earlier works published as Independent Submission RFCs (RANGER, VET, SEAL, IRON)
- First Edition published as IETF RFC 6706
- Second Edition now an Internet draft (draft-templin-aerolink)

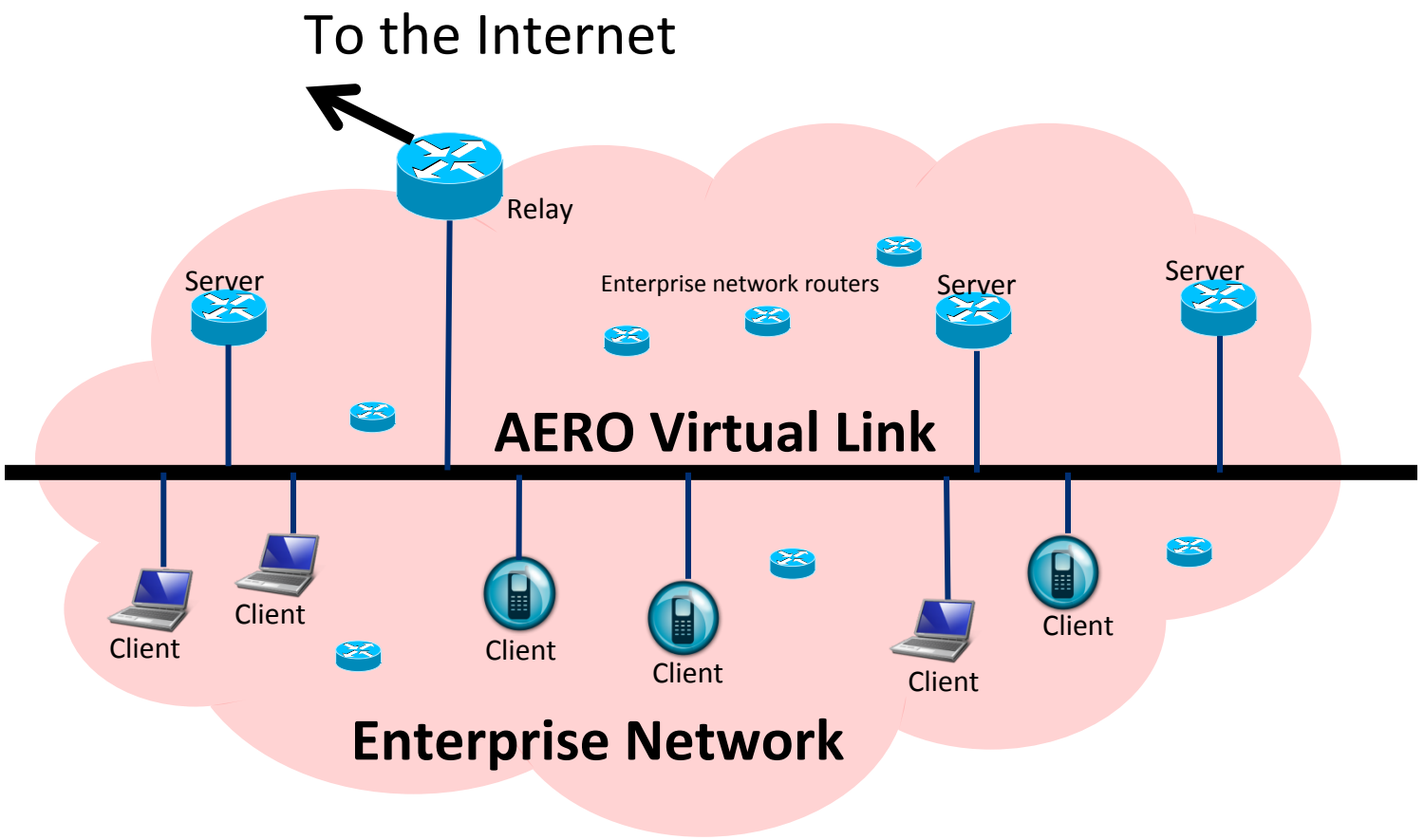
AERO Overview (1)

- A new routing and addressing system for IP Internetworks (e.g., enterprise networks, operator networks, campus networks, etc.)
- Tunnel virtual overlay over existing Internetworks
- End user devices as mobile routers:
  - cellphones, tables, laptops, airplanes, etc.
- Mobiles maintain stable IP address/prefix even as they move between access network points of attachment
- Supports Intra-network and Internet mobility
- Integration platform for security, traffic engineering, multiple interfaces, etc.

AERO Overview (2)

- Non-Broadcast, Multiple Access (NBMA) tunnel virtual link model
  - Virtual link configured over "home" network
  - Clients, Servers and Relays as "neighbors" on the link
  - Mobile Clients; fixed-infrastructure Servers and Relays
- IPv6 ND for Route Optimization, NUD
- Relays track Client/Server associations via BGP
- **DHCPv6 PD establishes and manages Client/ Server associations**

AERO LINK Reference Model

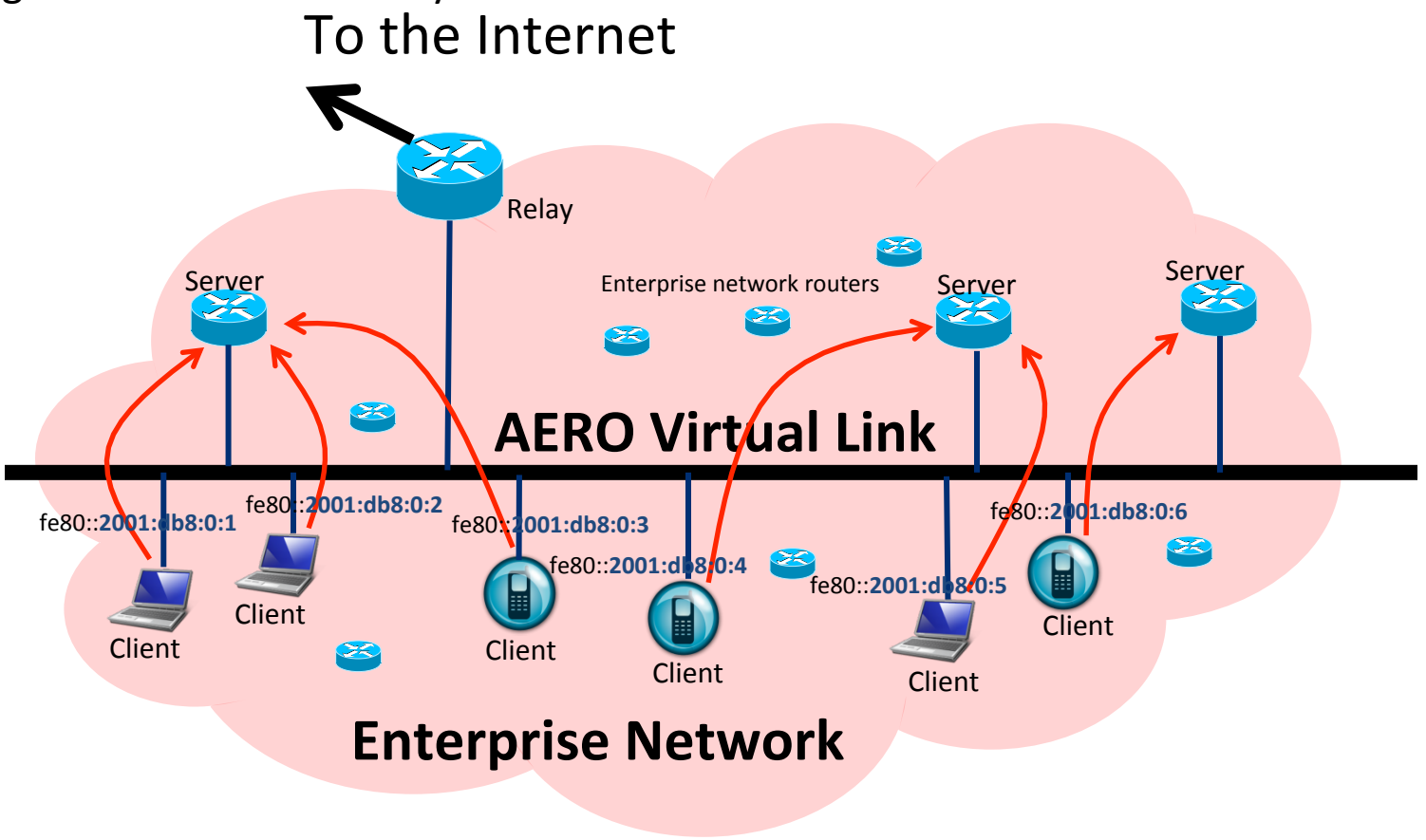


AERO DHCPv6 Service Model

- All AERO Servers are also DHCPv6 Servers
- All AERO Servers have common table of Client ID to AERO Client Prefix (ACP) mappings
- AERO Clients get ACP delegations through DHCPv6 PD via a “nearby” Server
- AERO Clients get the *same* ACP regardless of which Server they associate with
- AERO Clients can Request the same ACP via multiple Servers
- Prefix Delegation adds Neighbor Cache Entry for Client<->ACP binding

AERO DHCPv6 PD

- All AERO Servers are DHCPv6 servers
- AERO Clients Request ACP Delegations via DHCPv6
- Clients get same ACPs from any Server

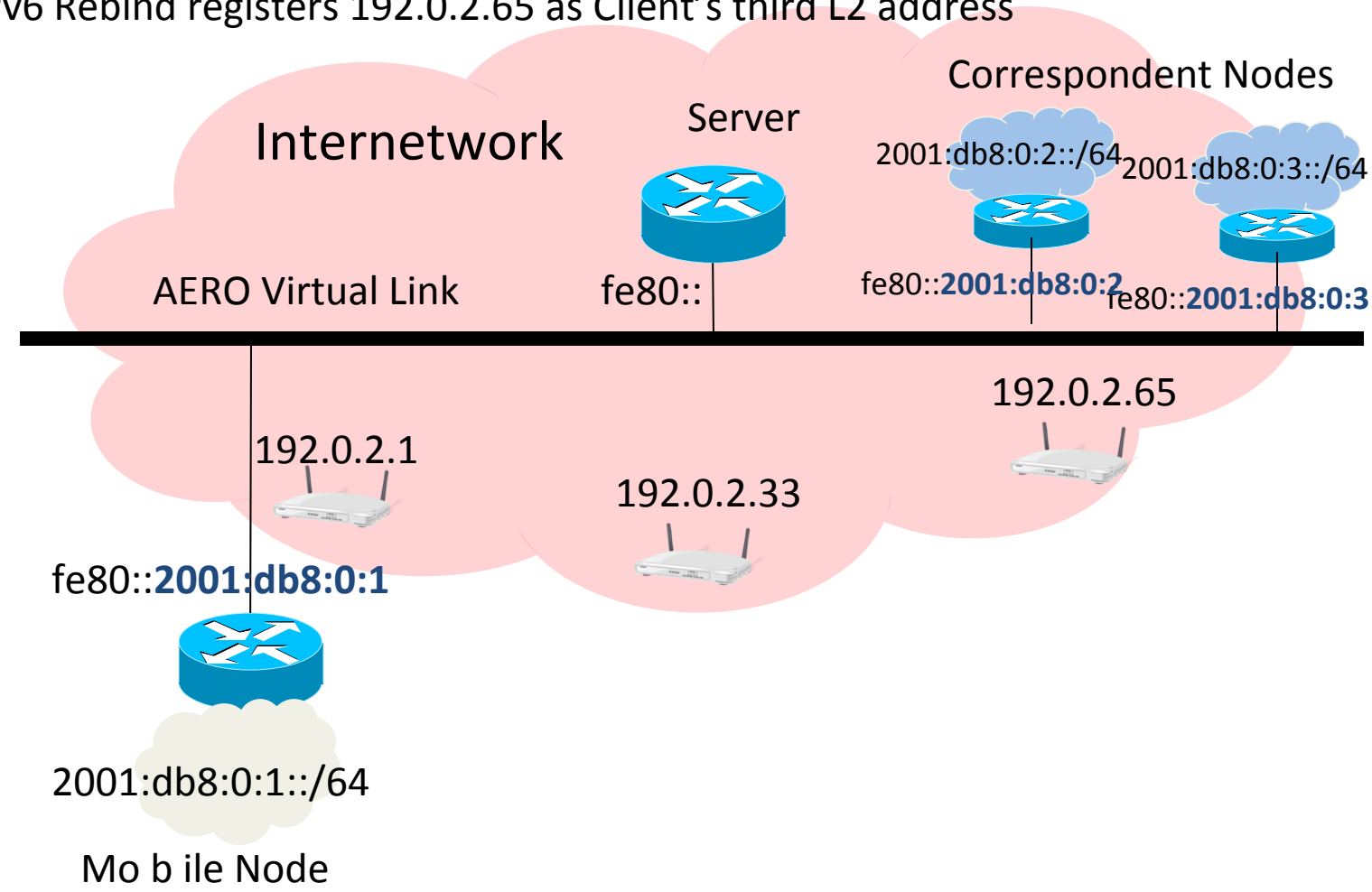


AERO Node Mobility

- AERO Server keeps IPv6 neighbor cache entry for AERO Client
  - Client AERO address is network-layer address
  - Client's encapsulation IP address is link-layer address
- If Client's link-layer address changes, inform Server with DHCPv6 Rebind
- Server updates the link-layer address in the neighbor cache entry if Rebind succeeds

AERO Node Mobility

- DHCPv6 Request registers 192.0.2.1 as Client's first L2 address
- DHCPv6 Rebind registers 192.0.2.33 as Client's second L2 address
- DHCPv6 Rebind registers 192.0.2.65 as Client's third L2 address



DHCPv6 Security

- AERO Server critical infrastructure trust anchor for AERO Client; Servers authenticate Clients
- AERO Client authenticates itself to the access network (e.g., IEEE 802.1x) then issues DHCPv6 Request to get Prefix Delegation
- AERO Server needs some way to know Client is authorized to use its claimed Client ID (DUID)
- DHCPv6 Auth? – not widely used; weak
- Secure DHCPv6? – looks promising

Backups

AERO Advanced Topics

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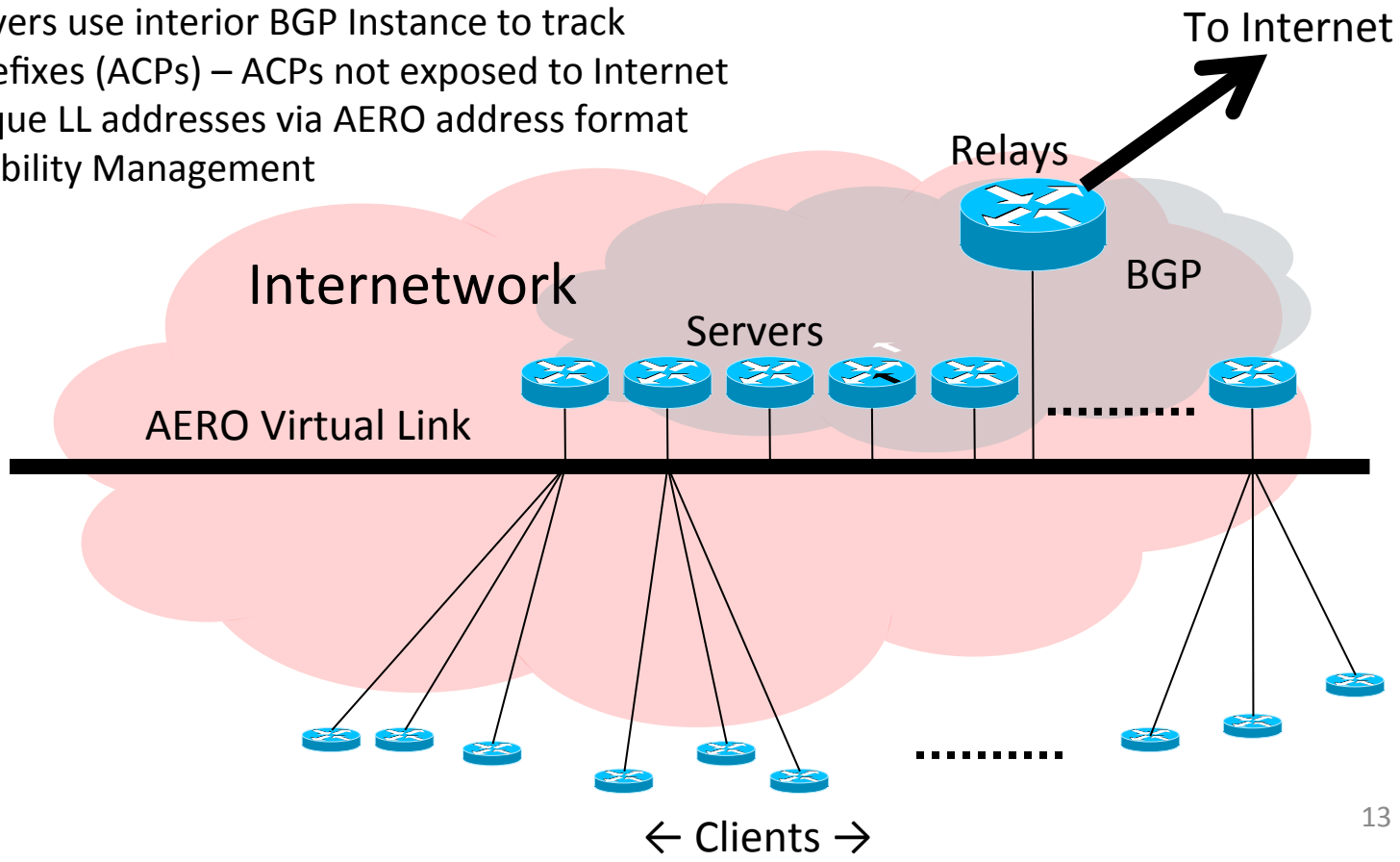
AERO Overview

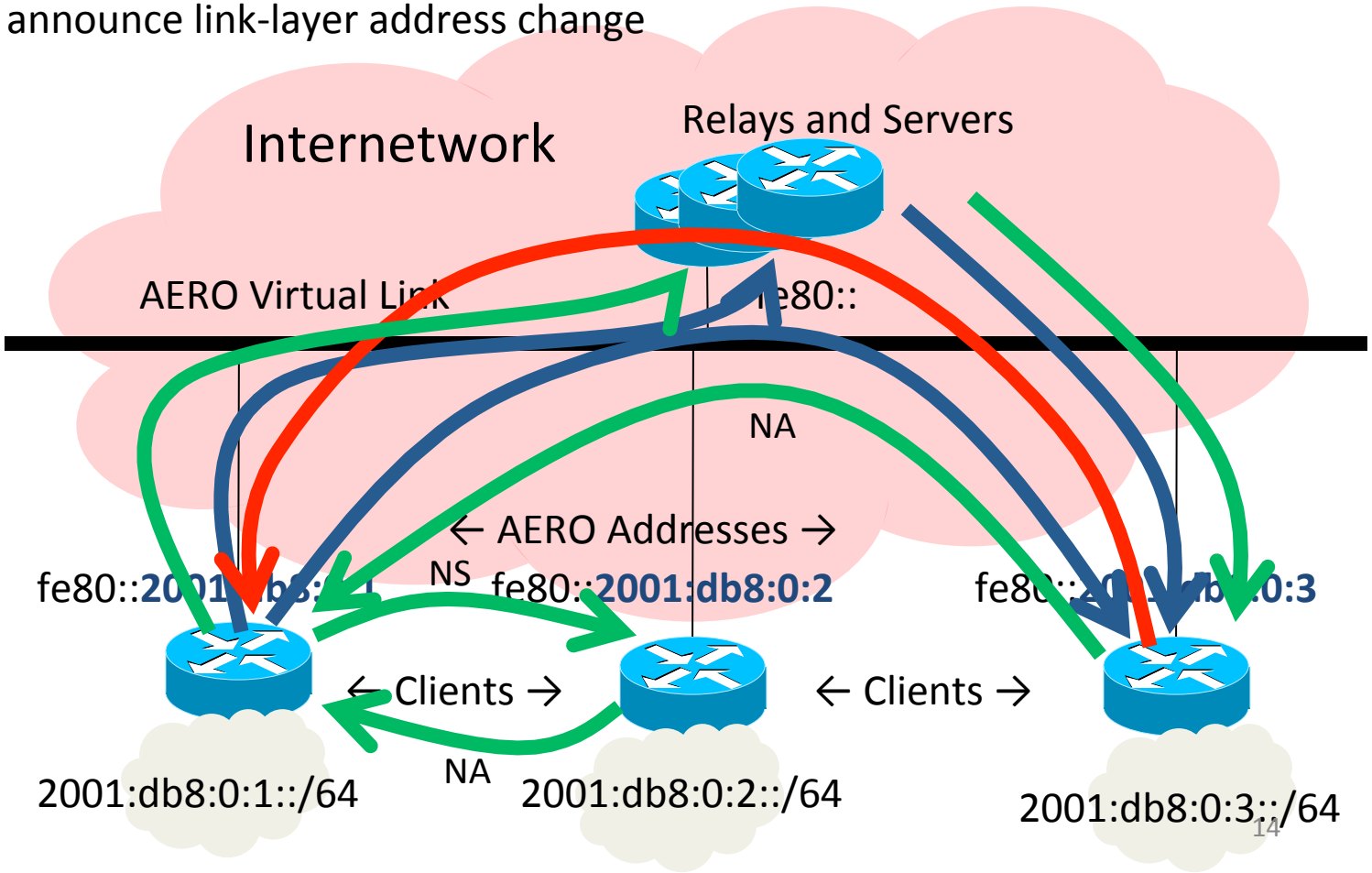
- Non-Broadcast Multiple Access (NBMA) tunnel virtual link configured over Enterprise or other Internetwork
- All nodes on the link are single-hop neighbors
- IPv6 ND works the same as for any link
- Clients associate with Servers via DHCPv6 PD
- Relays and Servers use interior BGP Instance to track AERO Client Prefixes (ACPs) – ACPs not exposed to Internet
- Clients get unique LL addresses via AERO address format
- Distributed Mobility Management

- Archetype for MIP/PMIP is a **mobile host** associated with a **home link**
- Archetype for AERO is a **mobile router** associated with a **home network**



AERO IPv6 Neighbor Discovery

- First packet and IPv6 ND “Predirect” to Server
- Server forwards “Predirect”; triggers IPv6 ND Redirect
- Subsequent packets go directly to target
- Standard IPv6 ND NUD to test reachability
- Unsolicited NA to announce link-layer address change

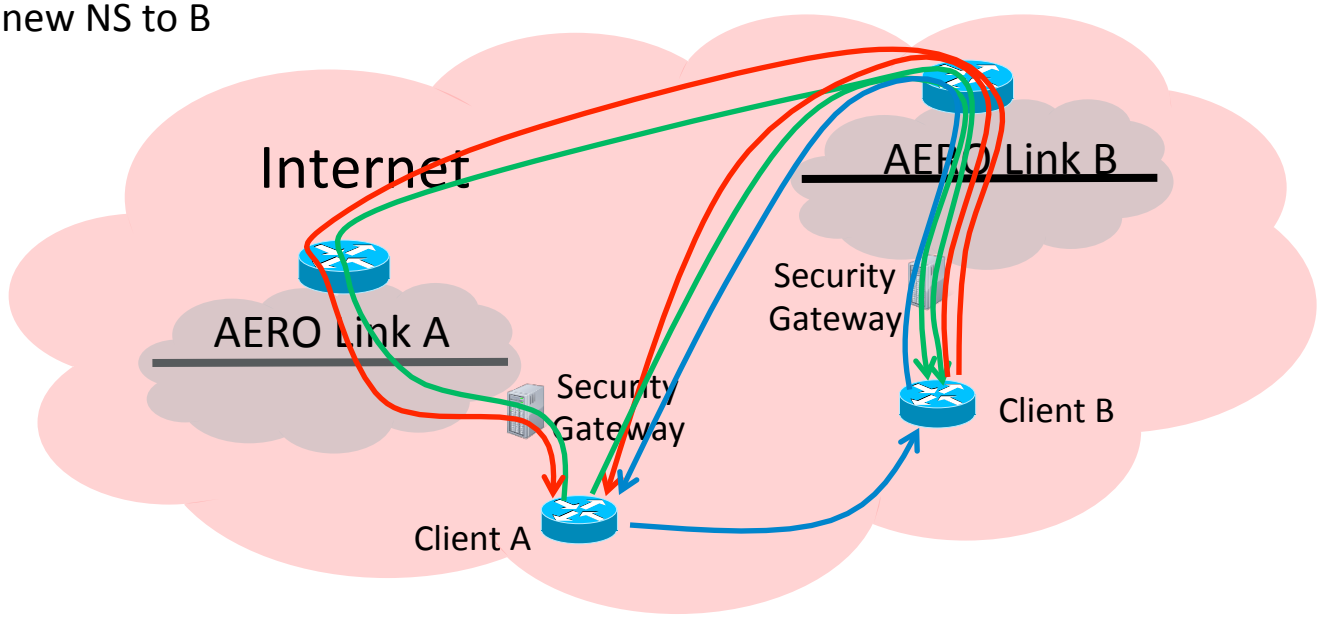


AERO Intra-Network Mobility

- Client C1 moves from access link A1 to access link A2 within the same Internetwork
- C1 sends unsolicited NA to Client C2 with new link-layer address from A2
- C2 updates ncache entry for C1 the same as for link-layer address change on any IPv6 link
  - **This is a "micro-mobility" event – no BGP updates**
- If C1 moves "far" from its current Server S1, it sends DHCPv6 PD Request to new Server S2 and DHCPv6 PD Release to old Server S1
  - **A "macro-mobility" event – S1; S2 send BGP updates**

AERO Internet-Wide Mobility

- Client A sends Predirect message through home network (similar to MIP “Home Test Init”) and sends Predirect through Internet (similar to MIP “Care-of Test Init”)
- Client B sends Redirect messages to Client A’s home address and Internet address (similar to Home Test / Care-of Test)
- Client A sends NS to Client B (similar to Binding Update)
- Client B sends NA to Client A (similar to Binding Ack)
- Route optimization in forward direction A->B (asymmetric)
- If A moves, sends new NS to B



Proxy AERO

- AERO Clients become fixed infrastructure the same as for AERO Servers, Relays
- Clients analogous to PMIP MAG; Servers analogous to PMIP LMA
- Mobile nodes associate with Clients via IPv6 ND; link-layer join/leave (same as for PMIP)
- When a MN comes on a Client's access link, Client issues new DHCPv6 PD
- Client will have many ACPs and many AERO addresses; one for each mobile
- Fast handovers coordinated roughly the same as for Fast PMIP, but simpler (see draft)

AERO Capability Discovery

- If correspondent node uses same AERO Service Prefix (ASP), Internetwork and Internet-wide Route Optimization supported
- If candidate correspondent node has the ACP 2001:db8:2::/64, perform DNS lookup for:

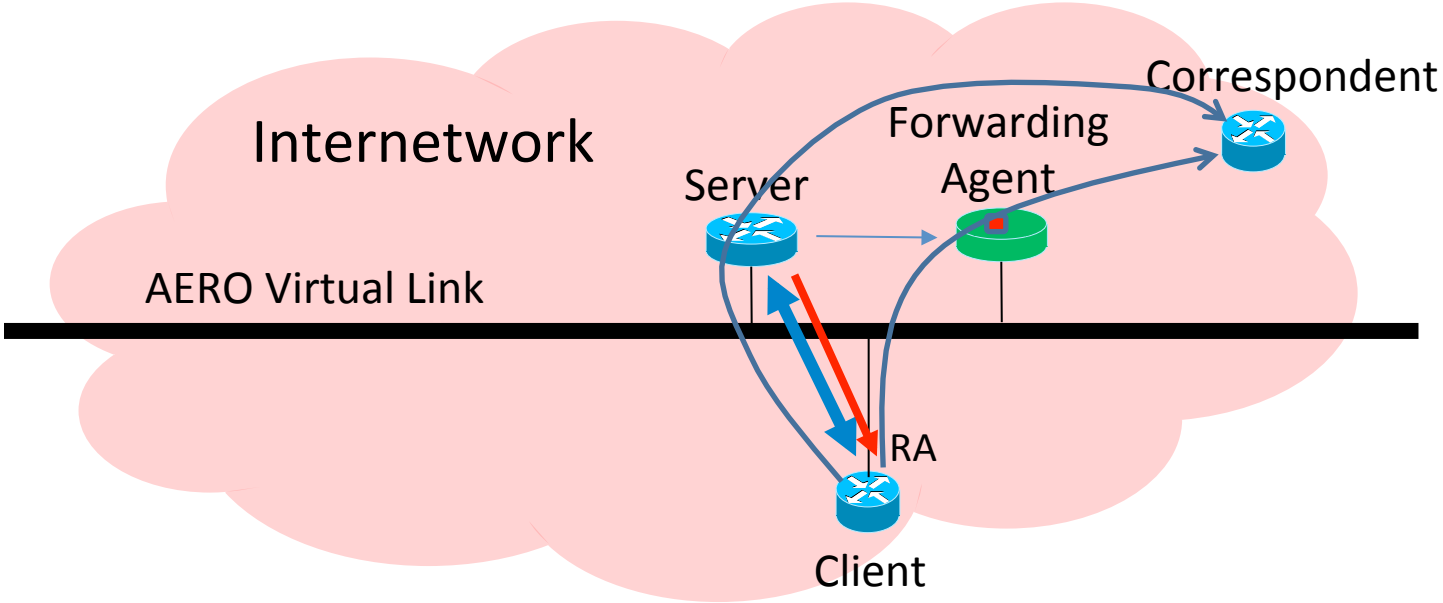
  0.0.0.0.2.0.0.0.8.b.d.0.1.0.0.2.aero.linkupnetworks.net

- If DNS lookup succeeds, correspondent is an AERO node in a different home network

  - **How to detect whether node is in a Proxy AERO domain?**

AERO Control/Forwarding Plane Separation

- Client associates with Server via DHCPv6 PD as usual
- Server updates Forwarding Agent (NETCONF, BGP, etc.)
- Client sends initial packets through Server
- Server returns IPv6 ND RA message with SLLAO containing link-layer address of Forwarding Agent
- Client sends subsequent packets through Forwarding Agent



Backups

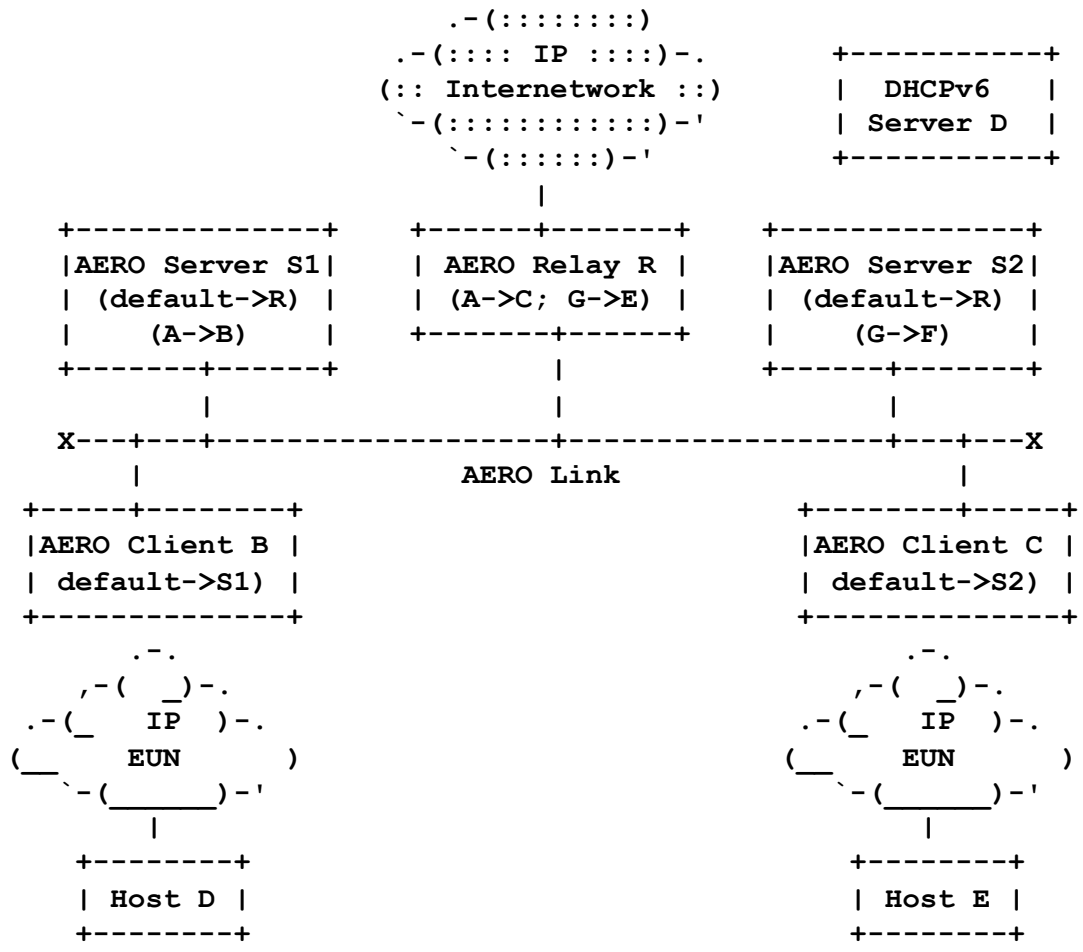
AERO Use Cases

- AERO for enterprise mobile device users
  - iPad, iPhone, Android, Windows mobiles
  - Goal: place AERO handsets with corporate users
- AERO for civil aviation:
  - Airplane as mobile router for its attached networks
  - On-board device addresses remain stable as aircraft travels
  - Goal: effective Air Traffic Management
- AERO for other uses:
  - numerous other use cases under investigation

AERO Innovations

- New IPv6 link-local Address Format (the AERO Address)
  - IPv6 delegated prefix is 2001:db8:1:2::/64
  - AERO link-local address is fe80::2001:db8:1:2
  - Address and prefix do not change as node moves
- AERO route optimization
  - Uses network trust anchors as intermediaries
  - Fully supports mobility (mobile networks and routers)
  - Works over any IPv4 or IPv6 access technologies (e.g., Ethernet, 3G/4G, WiFi, aeronautical links, MANET links, etc.)
- AERO Routing System
  - Servers manage collections of mobile Clients
  - BGP routing between Servers and Relays
  - Relays connect AERO link to rest of Internetwork

AERO LINK Reference Model

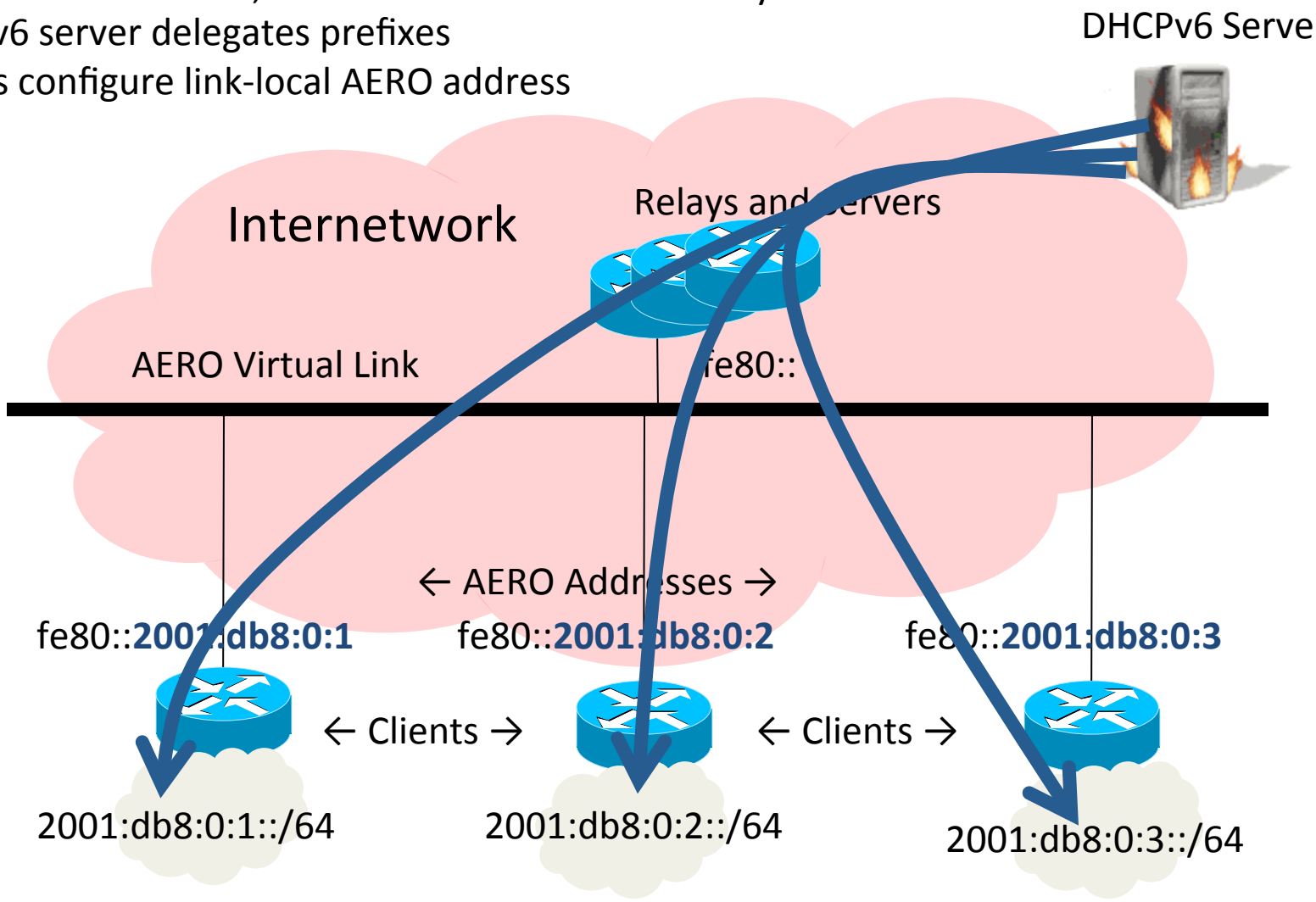


Old AERO DHCPv6 Service Model (deprecated)

- All AERO Servers are also DHCPv6 relays
- AERO Servers pass Client DHCPv6 PD requests to a centralized DHCPv6 server
- DHCPv6 server delegates AERO Client Prefix (ACP)
- AERO Server "snoops" PD and caches Client<->ACP binding (similar to old DHCPv6 "RAAN" option)
- Problematic if Client needs to move to a new AERO Server (no way of telling old Server "goodbye")
- Does not allow Client to associate with multiple Servers

Old AERO DHCPv6 PD (deprecated)

- Single DHCPv6 Server; AERO Servers as DHCPv6 relays
- DHCPv6 server delegates prefixes
- Clients configure link-local AERO address



AERO Advanced Topics

- DHCPv6 Service Model and IPv6 link-local address forming
- IPv6 Neighbor Discovery mobility signaling
- AERO mobility scenarios (intra-network, Internet-wide, proxy AERO)
- AERO correspondent node capability discovery
- AERO Control/Forwarding Plane Separation