IPv6 WiFi in HD: getting beyond 10K.

Andrew Yourtchenko

Technical Leader (IPv6 transition), CCIE#5323

@ayourtch

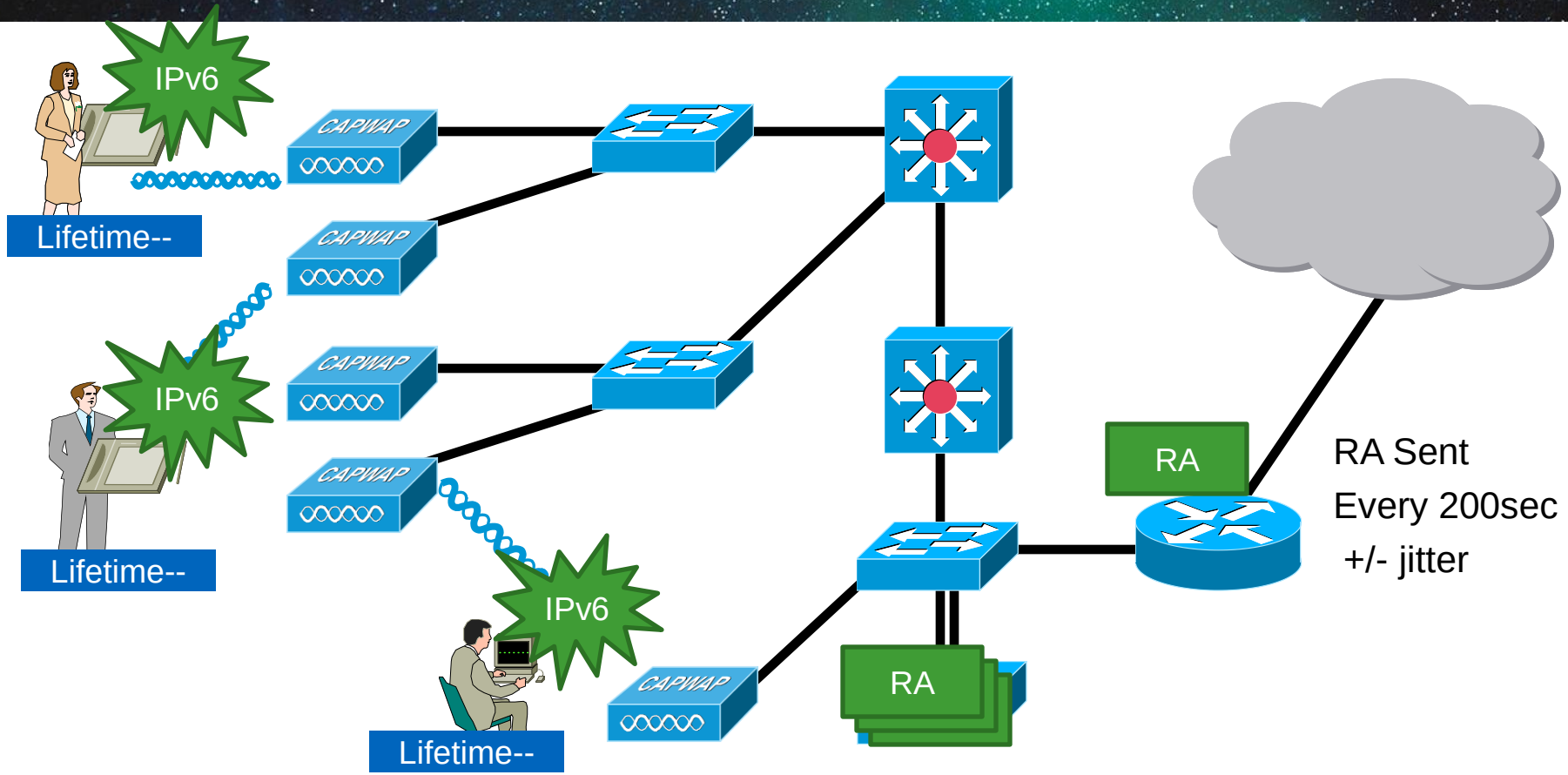
Agenda

- Avoiding Extra Router Advertisements
- Neighbor Discovery Tuning
- Managing Multicast

© 2014 Cisco and/or its affiliates. All rights reserved.

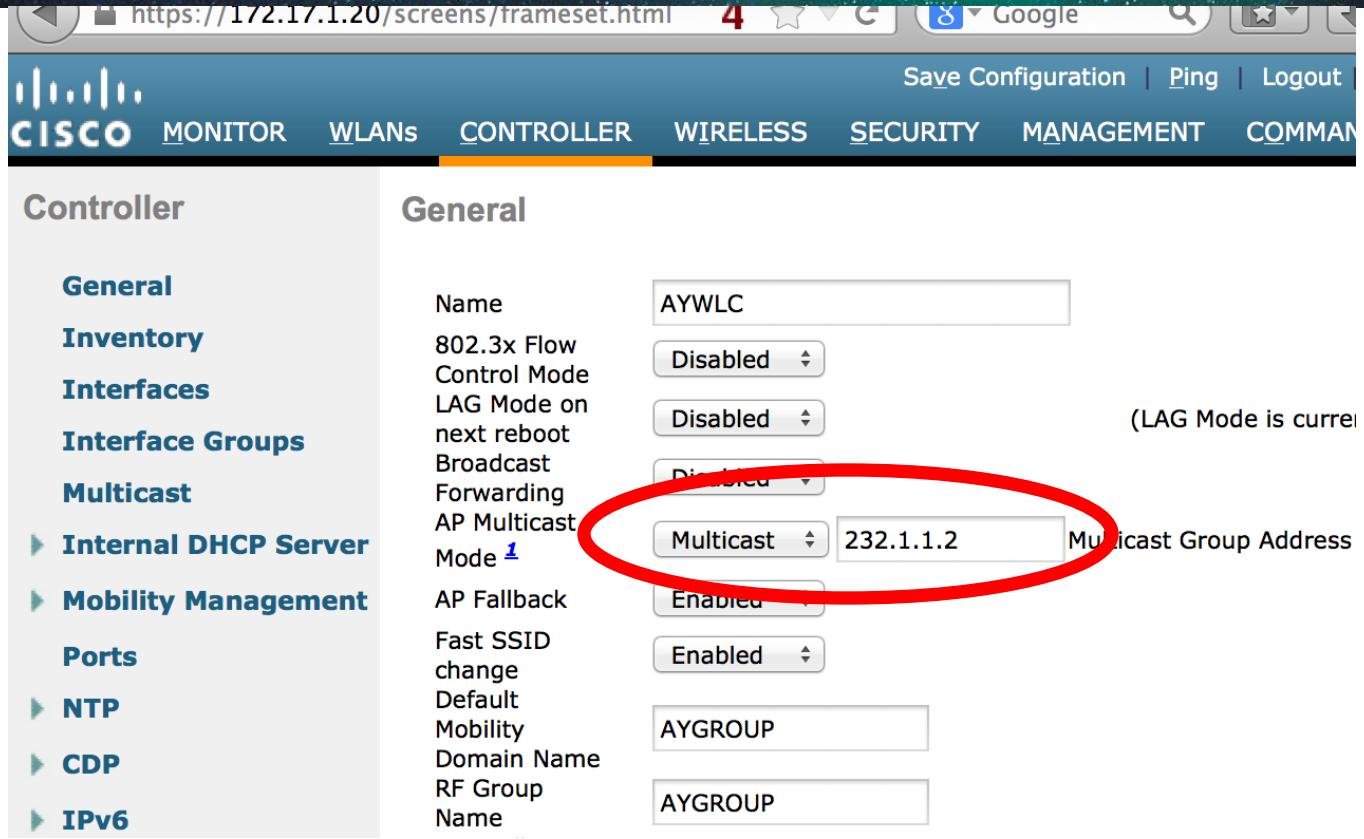
Avoiding Extra Router Advertisements

ND: Router Maintenance



© 2014 Cisco and/or its affiliates. All rights reserved.

Multicast multicast mode



© 2014 Cisco and/or its affiliates. All rights reserved.

Multicast CAPWAP packet

```
264 8.387238   fe80::5054:ff:fe12:3457   ff02::1   ICMPv6   218 Router Advertisem
```

```
▷ Frame 264: 218 bytes on wire (1744 bits), 218 bytes captured (1744 bits)
▷ Ethernet II, Src: Cisco_e0:5f:64 (d0:c2:82:e0:5f:64), Dst: IPv4mcast_01:01:02 (01:00:5e:01:0
▷ Internet Protocol Version 4, Src: 172.17.1.20 (172.17.1.20), Dst: 232.1.1.2 (232.1.1.2)
▷ User Datagram Protocol, Src Port: capwap-data (5247), Dst Port: 12224 (12224)
▷ Control And Provisioning of Wireless Access Points
▽ IEEE 802.11 Data, Flags: ......F.
    Type/Subtype: Data (0x20)
  ▷ Frame Control Field: 0x0800(Swapped)
    .000 0000 0000 0000 = Duration: 0 microseconds
    Receiver address: IPv6mcast_00:00:00:01 (33:33:00:00:00:01)
    Destination address: IPv6mcast_00:00:00:01 (33:33:00:00:00:01)
    Transmitter address: 00:00:00_00:00:00 (00:00:00:00:00:00)
    BSS Id: 00:00:00_00:00:00 (00:00:00:00:00:00)
    Source address: RealtekU_12:34:57 (52:54:00:12:34:57)
    Fragment number: 0
    Sequence number: 0
▷ Logical-Link Control
▷ Internet Protocol Version 6, Src: fe80::5054:ff:fe12:3457 (fe80::5054:ff:fe12:3457), Dst: ff
▷ Internet Control Message Protocol v6
```


© 2014 Cisco and/or its affiliates. All rights reserved.

PIM SSM configuration

```
ip pim rp-address 172.16.10.50
ip pim ssm default

interface GigabitEthernet1
 ip address 172.17.1.1 255.255.255.0
 ip pim sparse mode
 ip igmp version 3
```


© 2014 Cisco and/or its affiliates. All rights reserved.

Output “show ip mroute” on the router

```
Outgoing interface flags: H - Hardware switched, A – Assert
Timers: Uptime/Expires
 Interface state: Interface, Next-Hop or VCD, State/Mode

(172.17.1.20, 232.1.1.2), 00:12:36/00:02:23, flags: sTI
  Incoming interface: GigabitEthernet1, RPF nbr 0.0.0.0
  Outgoing interface list:
    GigabitEthernet1.118, Forward/Sparse, 00:12:36/00:02:23

(*, 224.0.1.40), 00:24:39/00:02:53, RP 172.16.10.50, flags: SJCL
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    GigabitEthernet1, Forward/Sparse, 00:24:39/00:02:53
```

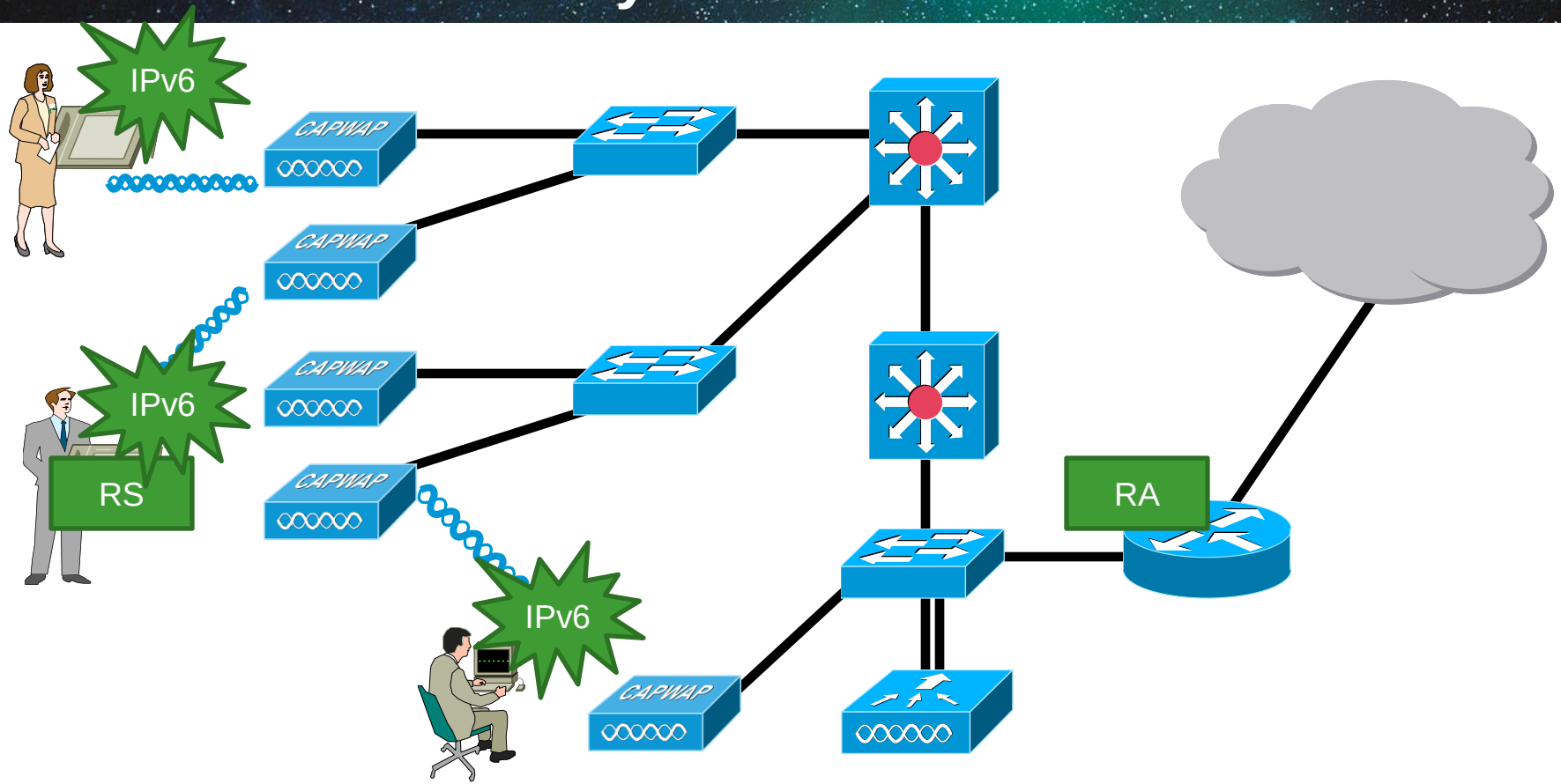

© 2014 Cisco and/or its affiliates. All rights reserved.

Multicast at a glance on the AP

```
APc47a.fe34.1cc9#show capwap mcast
CAPWAP MULTICAST
         Multicast Group: 232.1.1.2, Source: 172.17.1.20
V1 Rpt Sent:                    0;   V2 Rpt Sent:                2
V3 Rpt Sent:                  189;   Leave Sent:                 1
V1 Query Rcvd:                  0;   V2 Query Rcvd:              0
V3 Query Rcvd:                188;   V1 Rpt Rcvd:                0
V2 Rpt Rcvd:                    0;   V3 Rpt Rcvd:                0
APc47a.fe34.1cc9#
```


© 2014 Cisco and/or its affiliates. All rights reserved.

ND: Router Discovery



© 2014 Cisco and/or its affiliates. All rights reserved.

The Devil’s in the details…

RFC4861, 6.2.6. Processing Router Solicitations

In addition to sending periodic, unsolicited advertisements, a router sends advertisements in response to valid solicitations received on an advertising interface. A router **MAY choose to unicast** the response directly to the soliciting host's address (if the solicitation's source address is not the unspecified address), but the **usual case is to multicast the response to the all-nodes group**.

© 2014 Cisco and/or its affiliates. All rights reserved.

Tcpdump on a host in a large WiFi network

```
22:15:25.308623 IP6 fe80::217:dfff:fe76:fc40 > ff02::1: ICMP6, router advertisement, length 64
22:15:25.309215 IP6 fe80::217:dfff:fe76:fc40 > 2a02:88fe:de30:501:5fe:13a0:afad:c700: ICMP6, neighbor
01:5fe:13a0:afad:c700, length 32
22:15:32.724207 IP6 fe80::217:dfff:fe76:fc40 > ff02::1: ICMP6, router advertisement, length 64
22:15:35.650625 IP6 fe80::217:dfff:fe76:fc40 > ff02::1: ICMP6, router advertisement, length 64
22:15:38.783752 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:15:42.437960 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:16:01.238144 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:16:15.442989 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:16:19.520928 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:16:23.903221 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:16:26.932310 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:16:29.961204 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:16:33.030970 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:18:26.253591 IP6 fe80::217:dfff:fe76:fc40 > ff02::1: ICMP6, router advertisement, length 64
22:18:27.485346 IP6 andrews-macbook-air.local > ff02::2: ICMP6, router solicitation, length 8
22:18:28.406047 IP6 andrews-macbook-air.local > ff02::2: ICMP6, router solicitation, length 8
22:18:29.344763 IP6 fe80::217:dfff:fe76:fc40 > ff02::1: ICMP6, router advertisement, length 64
22:18:29.357259 IP6 andrews-macbook-air.local > ff02::2: ICMP6, router solicitation, length 8
```


© 2014 Cisco and/or its affiliates. All rights reserved.

USB battery vendors, rejoice !

www.amazon.com/s/ref=nb_sb_noss?url=search-alias%3Daps&field-keywords=high+capacity+smartphone+bat

phil mayers reachable time

hide | Link to this page | Add to Widget | Add to aStore | Share | Your Earnings Summary | What's New | Discussion Boards | Settings

amazon Try Prime | Recommendations | Today's Deals | Gift Cards | Sell | Help | Electronics Gift Guide | A new deal every | Shop now

Shop by Department | Search All | high capacity smartphone battery charger | Go | Hello, Andrew Your Account | Try Prime | Cart | Wish List

Departments

Cell Phones & Accessories
- External Cell Phone Battery Packs
- Cell Phone Travel Chargers
- + See more...

Computers & Accessories
- Touch Screen Tablet Chargers & Adapters
- Touch Screen Tablet Accessories

Electronics
- MP3 Player Batteries
- GPS System Accessories
- + See All 15 Departments

Eligible for Free Shipping (What's this?)
- Free Shipping by Amazon

Brand
- EZOPower
- Bravolink
- Orei
- ROMOSS
- Poweradd™
- SHARKK
- Generic
- Tecknet

Tools & Home Improvement
Check out top deals in the Tools & Home Improvement Countdown to Black Friday Deals store Shop Now

"high capacity smartphone battery charger"

Showing 1 - 16 of 24,471 Results | Choose a Department to enable sor

LEPOW - U-STONE 12000 High Capacity Multi-Voltage External Battery Charger Power Pack f Smart Phones - Compatible... by Lepow

~~$119.99~~ **$101.99** Prime
Order in the next **34 hours** and get it by **Monday, Nov 18.**
More Buying Choices
$79.99 new (3 offers)
$70.00 used (2 offers)

(11)
FREE Shipping
Product Features
... 12000mAh of *Capacity*! ~ 7 full ... External *Battery* Pack - Take it ...
Electronics: See all 10,726 items

Anker® Astro E4 13000mAh Portable High Capacity Dual-Port External Battery Pack Power Bank Backup Charger for... by Anker

~~$119.99~~ **$43.99** Prime
Order in the next **34 hours** and get it by **Monday, Nov 18.**
More Buying Choices
$43.99 new (2 offers)

(893)
FREE Shipping
Product Features
... Huge *capacity* (13000mAh) delivers 6+ charges to most *smartphones* or an ...

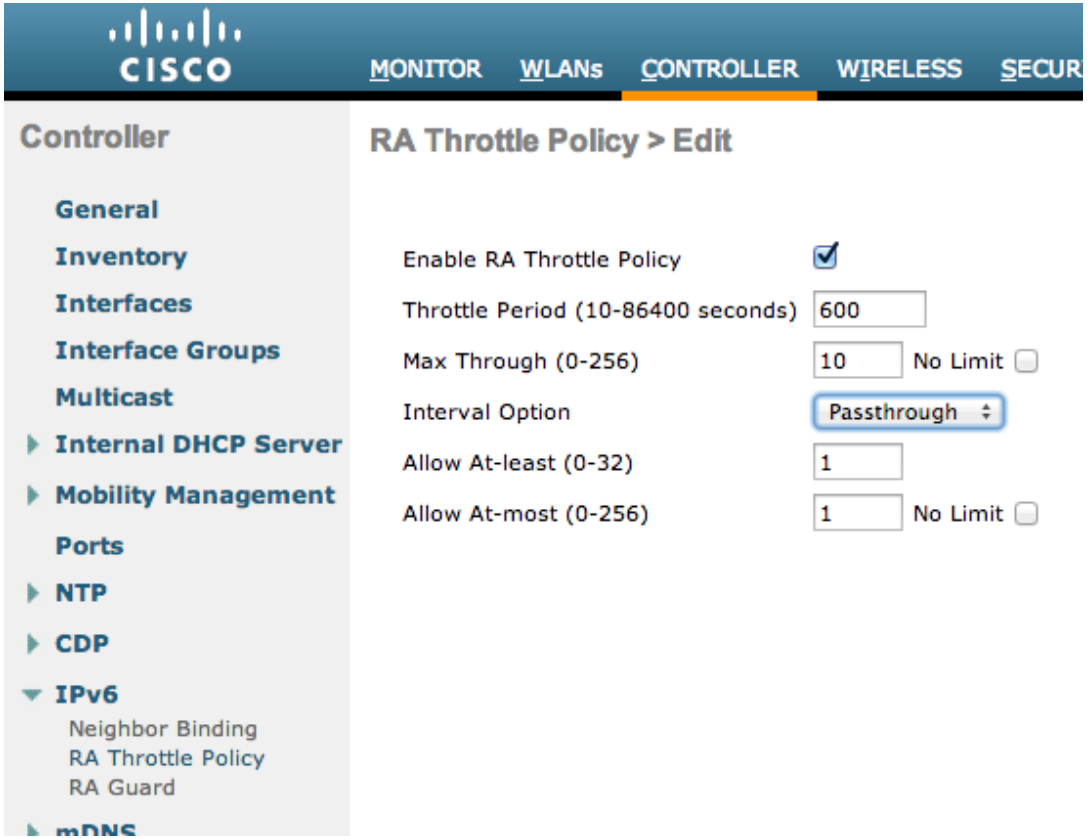
© 2014 Cisco and/or its affiliates. All rights reserved.

One more reason to manage the multicast RAs …

```
APc47a.fe34.1cc9#show capwap mcast mgid all | begin RA MGID
RA MGID Information
  MGID = 8341
    IPv6 mc2uc Clients = 1
  MGID = 8343
    IPv6 mc2uc Clients = 1
APc47a.fe34.1cc9#show capwap mcast mgid id 8343
Normal Mcast Clients:
Reliable Mcast Clients:
 Client: 14cf.929d.740c    ---   Qos User Priority: 3 State:
ADMITTED
     History - Retry Pct: 0 0 0 0   Rate )500Kbps): 0 65535
65535
APc47a.fe34.1cc9#
```


© 2014 Cisco and/or its affiliates. All rights reserved.

A different approach: RA throttle



© 2014 Cisco and/or its affiliates. All rights reserved.

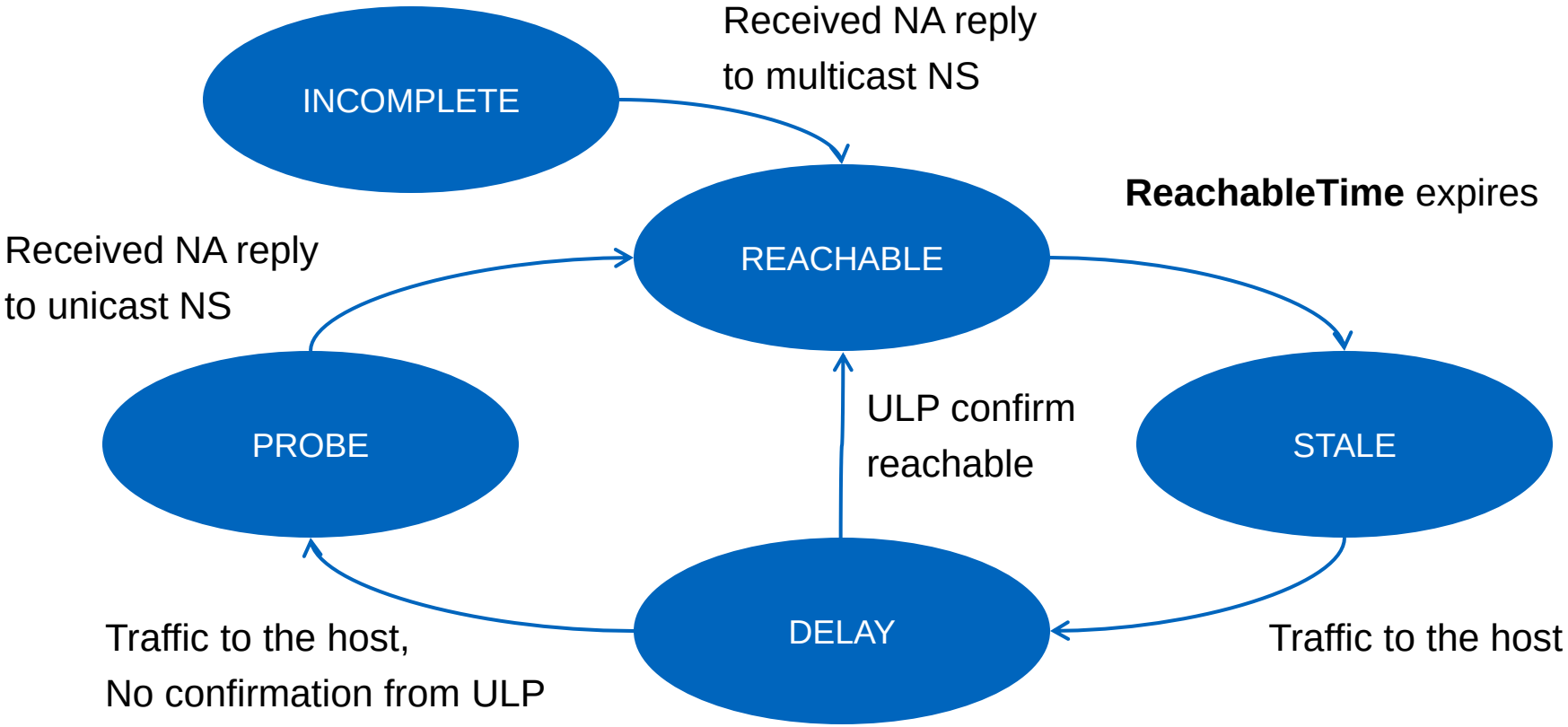
IOS vs. NX-OS solicited RA behavior

- NX-OS sends unicast solicited RA packets
- Periodic RA still sent multicast as expected
- Easy (Less need for RA-throttle), but may be harder to debug (ucast vs. mcast)

© 2014 Cisco and/or its affiliates. All rights reserved.

Neighbor Discovery Tuning

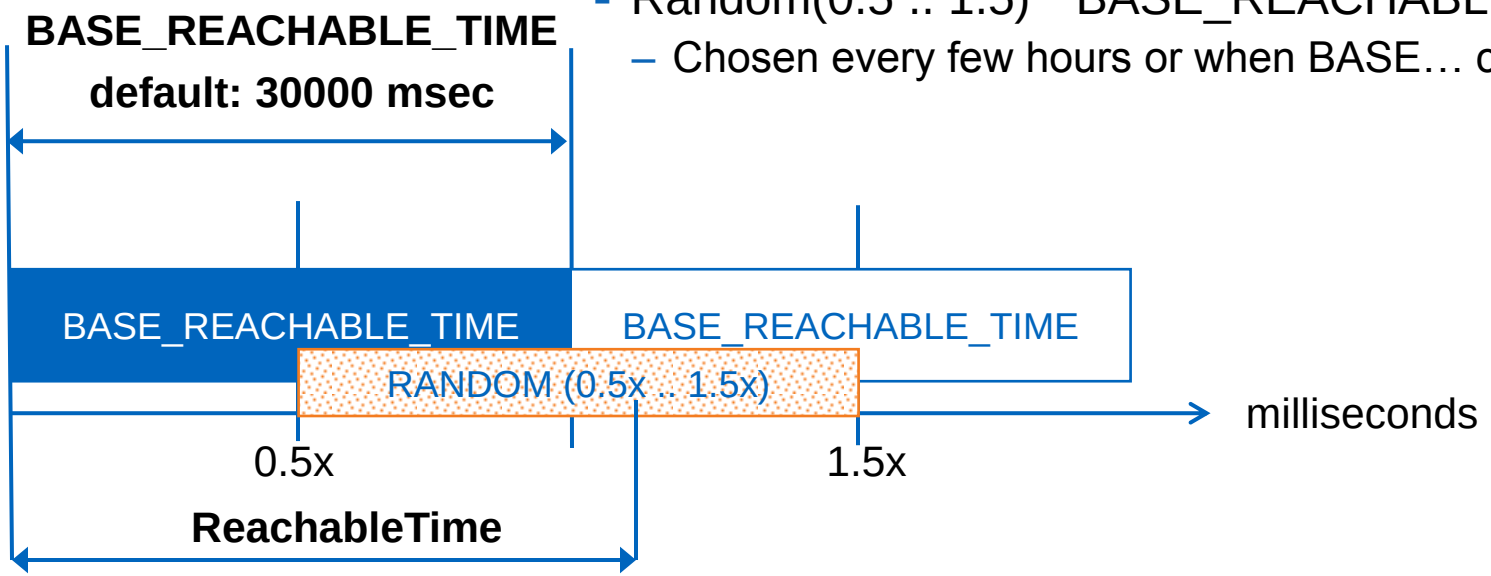
Neighbor Discovery State Diagram



© 2014 Cisco and/or its affiliates. All rights reserved.

ReachableTime: How Long Is It ?

- BASE_REACHABLE_TIME
  - Sent in RA or taken from default
  - Value in **milliseconds**
- Random(0.5 .. 1.5) * BASE_REACHABLE_TIME
  - Chosen every few hours or when BASE… changes



© 2014 Cisco and/or its affiliates. All rights reserved.

Increase the reachable time on the IPv6 Router

```
csr1k-ayhome(config)#interface gig1.103
csr1k-ayhome(config-subif)# ipv6 nd reachable-time ?
  <0-3600000>  Reachability time in milliseconds


csr1k-ayhome(config-subif)# ipv6 nd reachable-time 600000
csr1k-ayhome(config-subif)#^Z
csr1k-ayhome#
```

- Less load on the media + first hop router packet processing
- Postponing NUD = bigger neighbor table on the first hop router
- NUD triggered after RAND(0.5 .. 1.5 * reachable-time)

© 2014 Cisco and/or its affiliates. All rights reserved.

Impact of ND reachable timers on first hop router

- Long timers cause accumulation of the entries
  - Hardware forwarding tables may overflow

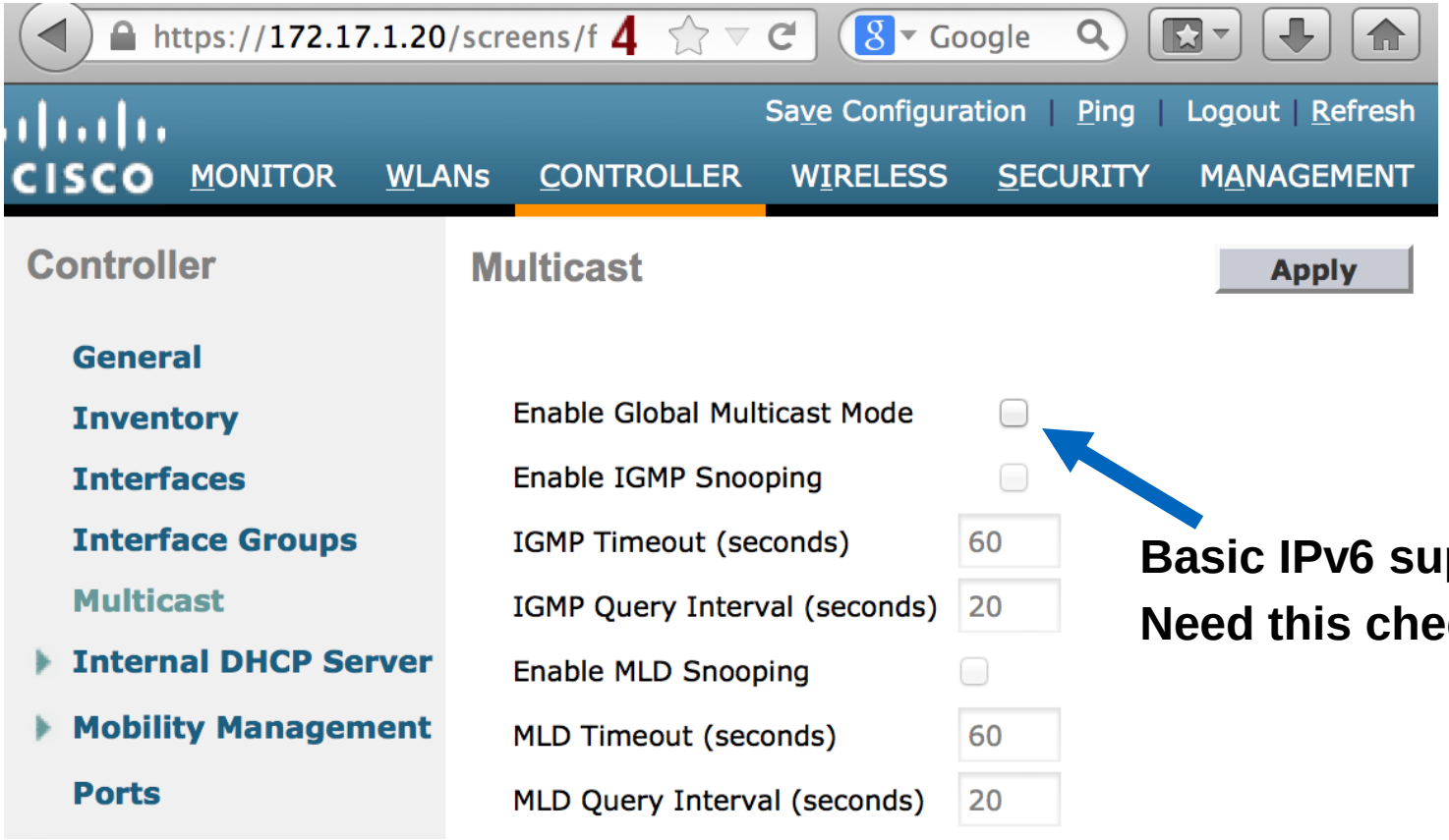
```
csr1k-ayhome#sh ipv6 neighbors
IPv6 Address                              Age Link-layer Addr State Interface
2001:470:73CD:DF01:55C1:5C08:2AAF:30        0 1410.9fe7.c1de  REACH Gi1.101
2001:470:73CD:DF01:DD08:31D2:21C0:590F    146 1410.9fe7.c1de  STALE Gi1.101
FE80::1610:9FFF:FEE7:C1DE                   0 1410.9fe7.c1de  REACH Gi1.101
FE80::16CF:92FF:FEA0:E64C                 206 14cf.92a0.e64c  STALE Gi1.101
2001:470:73CD:DF03:1610:9FFF:FEE7:C1DE    164 1410.9fe7.c1de  STALE Gi1.103
FE80::123                                  36 14cf.929d.740c  STALE Gi1.103
FE80::2323                                 32 14cf.929d.740c  STALE Gi1.103
FE80::1610:9FFF:FEE7:C1DE                 157 1410.9fe7.c1de  STALE Gi1.103
FE80::16CF:92FF:FE9D:740C                  95 14cf.929d.740c  STALE Gi1.103

csr1k-ayhome#
```

```
ipv6 nd cache expire <14400?> refresh
```


© 2014 Cisco and/or its affiliates. All rights reserved.

Managing Multicast

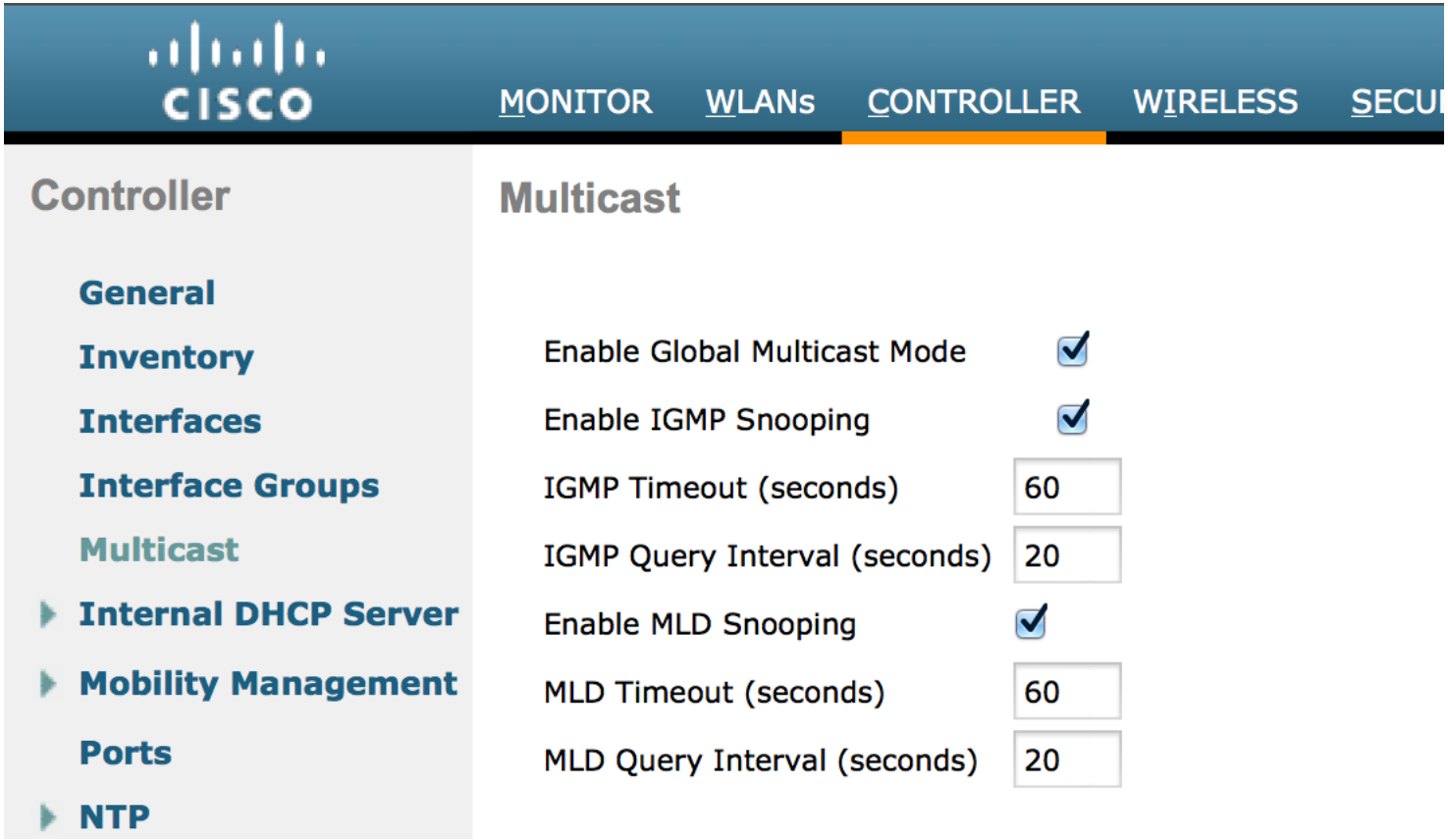
Global multicast enable/disable



Basic IPv6 support does NOT Need this checkbox checked

© 2014 Cisco and/or its affiliates. All rights reserved.

Turning global multicast on …



© 2014 Cisco and/or its affiliates. All rights reserved.

Turned Multicast On ? Meet mDNS !

```
QU)? AY-iPad.local. (182)
19:55:46.941123 IP 169.254.135.253.5353 > 224.0.0.251.5353: 0 [4q] [4n] [1au] ANY (QM)? AY iPad._ipp._tcp.local. ANY (QM)? AY-iPad.local. ANY (QM)? AY-iPad.local. ANY (QM)? AY
-iPad.local. (182)
19:55:46.941187 IPv6 fe80::4a8:185c:d78f:1034.5353 > ff02::fb.5353: 0 [4q] [4n] [1au] ANY (QM)? AY iPad._ipp._tcp.local. ANY (QM)? AY-iPad.local. ANY (QM)? AY-iPad.local. ANY (
QM)? AY-iPad.local. (182)
19:55:47.463462 IP 169.254.135.253.5353 > 224.0.0.251.5353: 0*- [0q] 13/0/6 (Cache flush) TXT "txtvers=1" "qtotal=1" "rp=ipp" "note=iPad Zap" "ty=iPad Zap Print Server" "produ
ct=(Zap)" "printer-state=3" "printer-type=0xf04d" "Transparent=F" "Binary=T" "Duplex=F" "Copies=F" "pdl=image/urf,application/pdf,image/jpeg,image/png" "URF=none", PTR _ipp._t
cp.local., PTR AY iPad._ipp._tcp.local., PTR AY iPad._ipp._tcp.local., PTR AY iPad._ipp._tcp.local., PTR AY iPad._ipp._tcp.local., TXT "model=K94AP", (Cache flush) SRV AY-iPad.local.:631 0 0, (Cache
flush) PTR AY-iPad.local., (Cache flush) PTR AY-iPad.local., (Cache flush) PTR AY-iPad.local., (Cache flush) AAAA fe80::4a8:185c:d78f:1034, (Cache flush) AAAA 2001:470:73cd:d
f03:896:a5a6:1926:b108, (Cache flush) A 169.254.135.253 (829)
19:55:48.401349 IP 169.254.135.253.5353 > 224.0.0.251.5353: 0*- [0q] 13/0/6 (Cache flush) TXT "txtvers=1" "qtotal=1" "rp=ipp" "note=iPad Zap" "ty=iPad Zap Print Server" "produ
ct=(Zap)" "printer-state=3" "printer-type=0xf04d" "Transparent=F" "Binary=T" "Duplex=F" "Copies=F" "pdl=image/urf,application/pdf,image/jpeg,image/png" "URF=none", PTR _ipp._t
cp.local., PTR AY iPad._ipp._tcp.local., PTR AY iPad._ipp._tcp.local., PTR AY iPad._ipp._tcp.local., PTR AY iPad._ipp._tcp.local., TXT "model=K94AP", (Cache flush) SRV AY-iPad.local.:631 0 0, (Cache
flush) PTR AY-iPad.local., (Cache flush) PTR AY-iPad.local., (Cache flush) PTR AY-iPad.local., (Cache flush) AAAA fe80::4a8:185c:d78f:1034, (Cache flush) AAAA 2001:470:73cd:d
f03:896:a5a6:1926:b108, (Cache flush) A 169.254.135.253 (829)
19:55:50.487545 IP 169.254.135.253.5353 > 224.0.0.251.5353: 0*- [0q] 13/0/6 (Cache flush) TXT "txtvers=1" "qtotal=1" "rp=ipp" "note=iPad Zap" "ty=iPad Zap Print Server" "produ
ct=(Zap)" "printer-state=3" "printer-type=0xf04d" "Transparent=F" "Binary=T" "Duplex=F" "Copies=F" "pdl=image/urf,application/pdf,image/jpeg,image/png" "URF=none", PTR _ipp._t
cp.local., PTR AY iPad._ipp._tcp.local., PTR AY iPad._ipp._tcp.local., PTR AY iPad._ipp._tcp.local., PTR AY iPad._ipp._tcp.local., TXT "model=K94AP", (Cache flush) SRV AY-iPad.local.:631 0 0, (Cache
flush) PTR AY-iPad.local., (Cache flush) PTR AY-iPad.local., (Cache flush) PTR AY-iPad.local., (Cache flush) AAAA fe80::4a8:185c:d78f:1034, (Cache flush) AAAA 2001:470:73cd:d
f03:896:a5a6:1926:b108, (Cache flush) A 169.254.135.253 (829)
19:55:54.456686 IP 169.254.135.253.5353 > 224.0.0.251.5353: 0*- [0q] 13/0/6 (Cache flush) TXT "txtvers=1" "qtotal=1" "rp=ipp" "note=iPad Zap" "ty=iPad Zap Print Server" "produ
ct=(Zap)" "printer-state=3" "printer-type=0xf04d" "Transparent=F" "Binary=T" "Duplex=F" "Copies=F" "pdl=image/urf,application/pdf,image/jpeg,image/png" "URF=none", PTR _ipp._t
```

Total Packet quantity ~ NumAdvertisers * NumListeners * k

Brute-force approach to mDNS overload: create ACL…

CISCO MONITOR WLANs CONTROLLER WIRELESS SECURITY MANAGEMENT COMMANDS

Security

- AAA
  - General
  - RADIUS
    - Authentication
    - Accounting
    - Fallback
  - TACACS+
  - LDAP
  - Local Net Users
  - MAC Filtering
  - Disabled Clients
  - User Login Policies
  - AP Policies
  - Password Policies
- Local EAP
- Priority Order
- Certificate
- Access Control Lists
  - Access Control Lists
  - CPU Access Control Lists
  - FlexConnect ACLs

Access Control Lists

New...

Enable Counters ☐

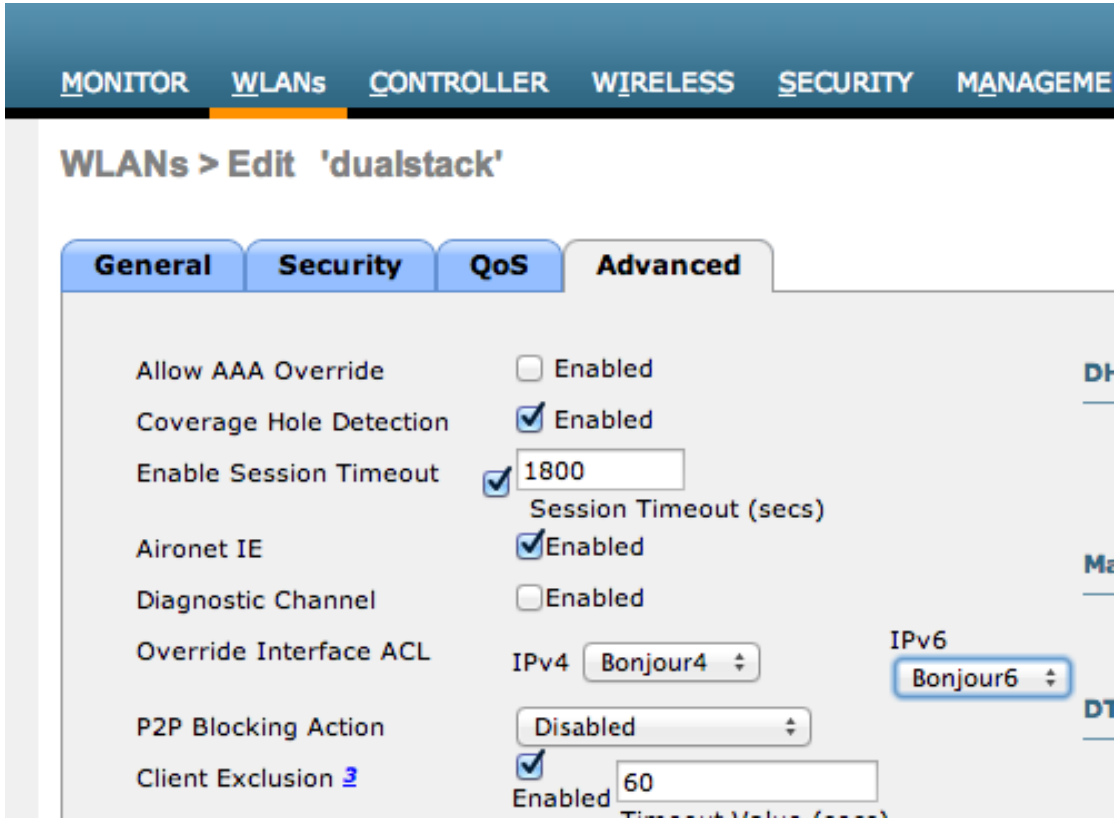
Name	Type
Bonjour4	IPv4
Bonjour6	IPv6

Seq	Action	Source IPv6/Prefix Length	Destination IPv6/Prefix Length	Protocol	Source Port	Dest Port
1	Deny	:: / 0	:: / 0	UDP	Any	5353
2	Permit	:: / 0	:: / 0	Any	Any	Any

Seq	Action	Source IP/Mask	Destination IP/Mask	Protocol	Source Port	Dest Port	DSCP	Direction
1	Deny	0.0.0.0 / 0.0.0.0	0.0.0.0 / 0.0.0.0	UDP	Any	5353	Any	Any
2	Permit	0.0.0.0 / 0.0.0.0	0.0.0.0 / 0.0.0.0	Any	Any	Any	Any	Any

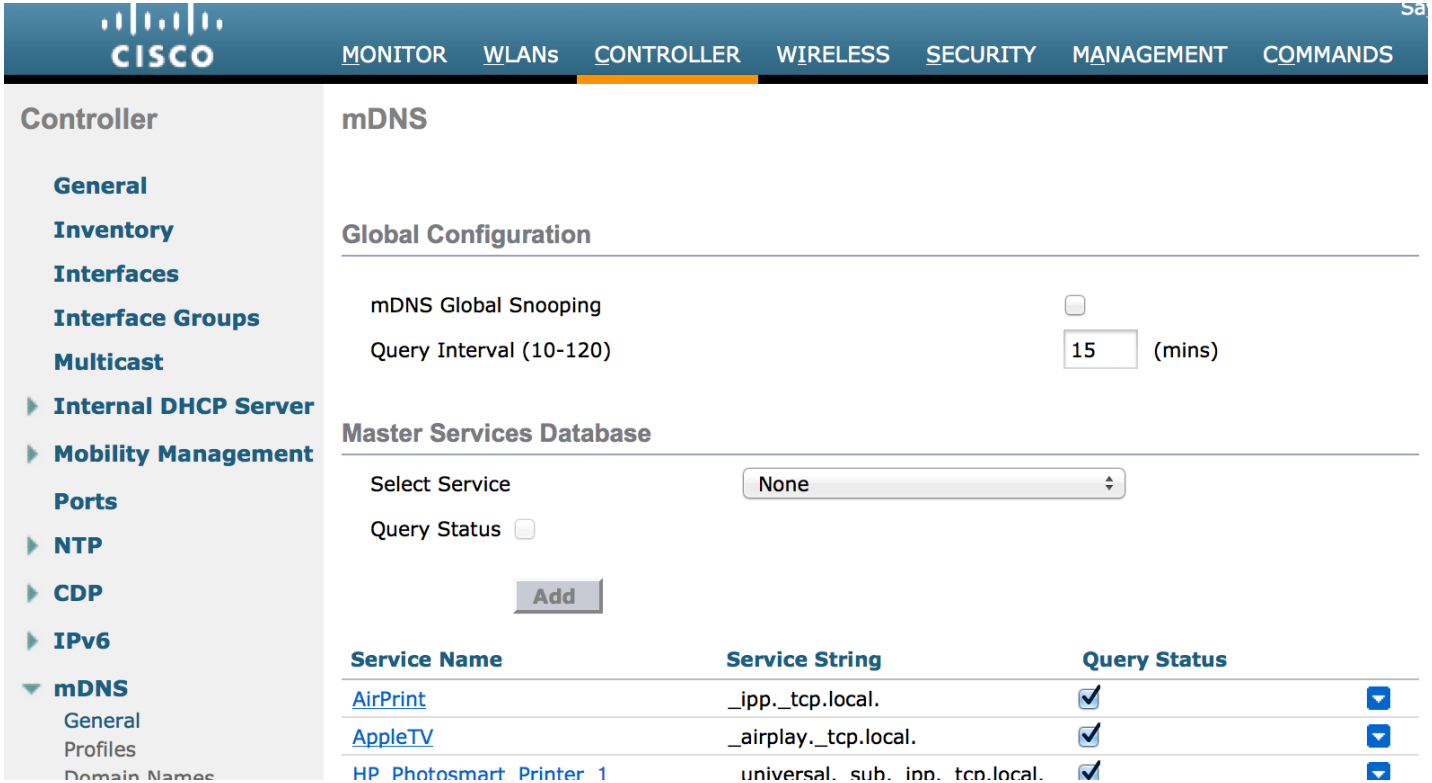
© 2014 Cisco and/or its affiliates. All rights reserved.

Brute-force approach to mDNS overload: …and apply it!



© 2014 Cisco and/or its affiliates. All rights reserved.

Bonjour Gateway: a kinder, gentler, flexible way



© 2014 Cisco and/or its affiliates. All rights reserved.

What about LLMR ?

- **Link-local Multicast Name Resolution**
  - Used to resolve the names of hosts on the local link
- Defined in RFC4795
- Used by Windows Vista, Windows Server 2008, Windows 7 and Windows 8
- Run over multicast UDP to port 5355
- Practical experience: Mostly harmless

© 2014 Cisco and/or its affiliates. All rights reserved.

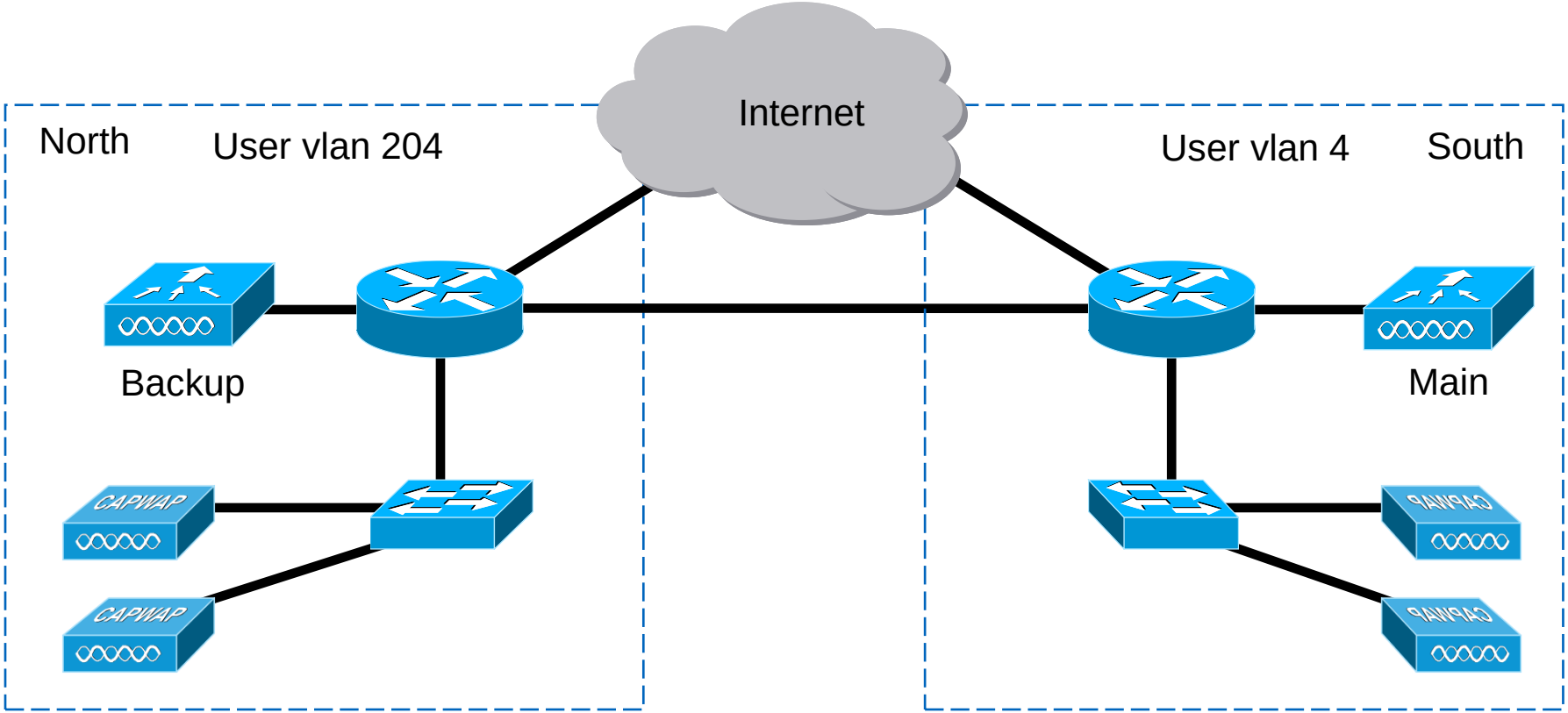
Conclusions

- You can control IPv6 chattiness quite well
- Use the WLC features
- Complement with IPv6 protocol tuning

© 2014 Cisco and/or its affiliates. All rights reserved.

CiscoLive2014 wireless LAN considerations

CiscoLive 2014 dualstack SSID config (high level)



© 2014 Cisco and/or its affiliates. All rights reserved.

Configuration design goals

- Must allow any distribution of access points between the two controllers
  - All access points on North, all access points on South, split between the two
- L3 roaming of clients while between North and South, on IPv4 and IPv6
  - The client keeps their original link, the data is sent in/out the anchor controller
- Minimize the amount of chatter – save batteries
  - Use RA Throttler on WLC with 30 minute timer.
- Minimize the size of the neighbor caches on the devices
  - Very large link, many small devices
- Allow for possible full reassociation vs of L3 roaming
  - Prefix does change but the connectivity must be recovered quickly

© 2014 Cisco and/or its affiliates. All rights reserved.

South SVI configuration

```
interface Vlan4
 description !!! WIRELESS CLIENTS !!! CiscoLive2014 !!!
 .. IPv4 configuration omitted ..
 ipv6 address FE80::1 link-local
 ipv6 address 2001:4D38:A:400::1/64
 ipv6 nd reachable-time 1800000
 ipv6 nd prefix default 86400 9000 off-link no-autoconfig
 ipv6 nd prefix 2001:4D38:A:400::/64 604800 86400 off-link
 ipv6 nd prefix 2001:4D38:A:6800::/64 604800 0 off-link
 ipv6 nd router-preference High
 ipv6 nd ra lifetime 9000
 no ipv6 redirects
 no ipv6 unreachables
 ipv6 verify unicast source reachable-via rx
 ipv6 ospf network point-to-point
 ipv6 ospf flood-reduction
 ipv6 ospf 1 area 0
End
ipv6 route 2001:4D38:A:400::/64 vlan4
```


© 2014 Cisco and/or its affiliates. All rights reserved.

North SVI configuration

```
interface Vlan204
 description !!! WIRELESS CLIENTS !!! CiscoLive2014 !!! DO NOT USE VLAN4 on NORTH !!!
 .. IPv4 configuration omitted ..
 ipv6 address FE80::1 link-local
 ipv6 address 2001:4D38:A:6800::1/64
 ipv6 nd reachable-time 1800000
 ipv6 nd prefix default 86400 9000 off-link no-autoconfig
 ipv6 nd prefix 2001:4D38:A:400::/64 604800 0 off-link
 ipv6 nd prefix 2001:4D38:A:6800::/64 604800 86400 off-link
 ipv6 nd router-preference High
 ipv6 nd ra lifetime 9000
 no ipv6 redirects
 no ipv6 unreachables
 ipv6 verify unicast source reachable-via rx
 ipv6 ospf network point-to-point
 ipv6 ospf flood-reduction
 ipv6 ospf 1 area 0
End
Ipv6 route 2001:4D38:A:6800::/64 Vlan204
```


© 2014 Cisco and/or its affiliates. All rights reserved.

CISCO™