Early experiences with IPv6-only WiFi

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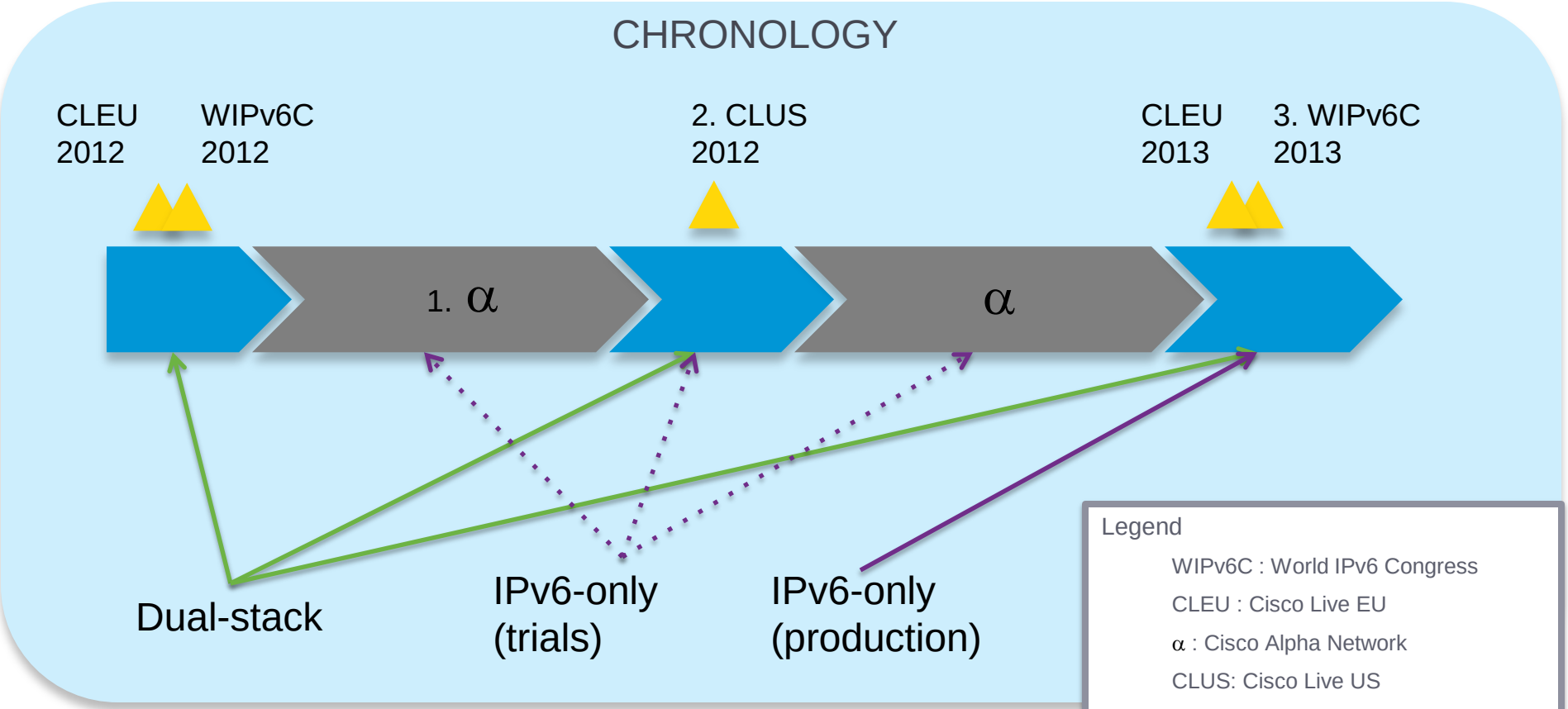
Informal experiments with IPv6-only Wi-Fi

TL;DR version

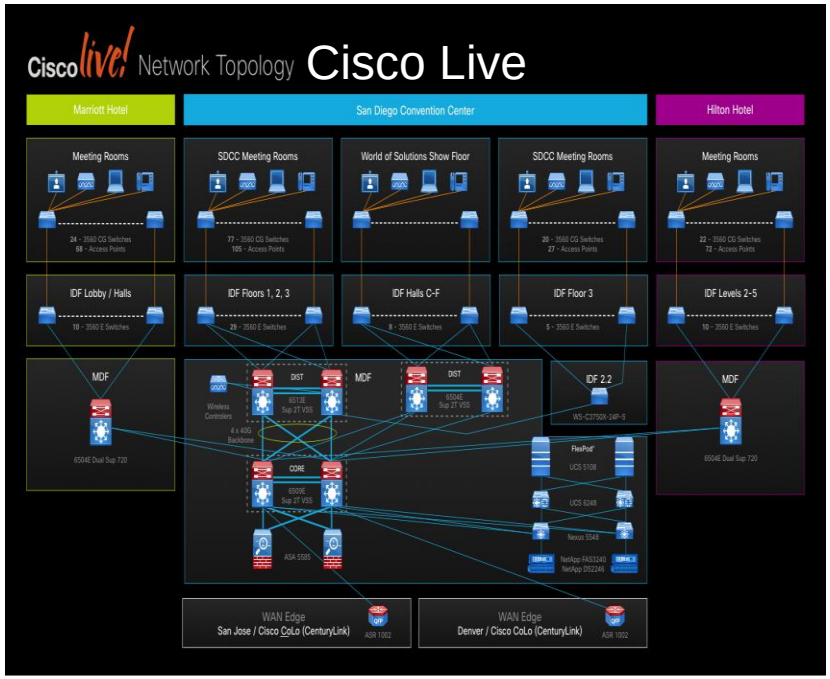
- Scope
  - Series of experiments inside Cisco and at Public Conferences (e.g. Cisco Live) with IPv6-only Wi-Fi
- Network
  - Core network dual-stacked
  - Access to ‘legacy’ Internet through a NAT64
  - Tried both dedicated and shared Access Points with a “try me” IPv6 SSID
- Logistics
  - Volunteer based support – Red T-shirts offered as incentive
  - Each event was contained within a (very large) conference room, floor or campus building
  - Email alias and wiki for support and report issues, findings – limited publicity
  - Kept list of applications that worked/didn’t work (user-reported)
  - Kept traffic statistics
- Results
  - Things went from strange to better

How did we get into this?

Volunteer to help with network access at some public events

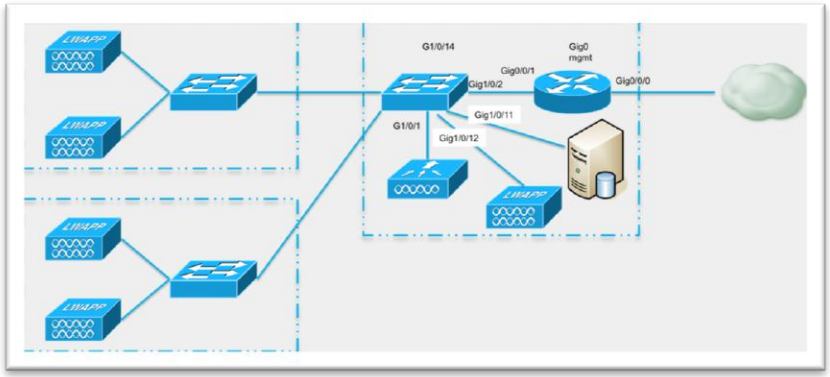


Background on these events



- Series of world wide Cisco events
- Mix of technical education and product show case
- Over 17,000 attendees expected in US in 2013
- Network connectivity for attendees, booths, on-site services (registration …), conference traffic (video), NOC

World IPv6 Congress 2013

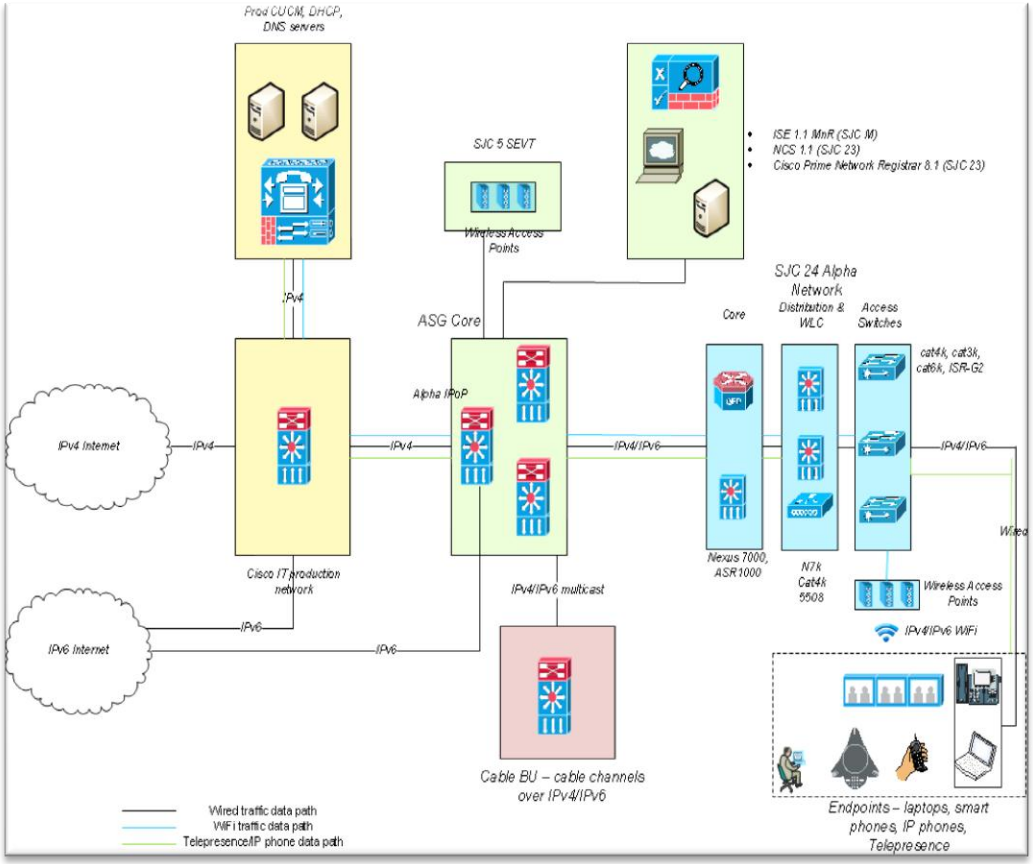


- IPv6 focused event in Paris
- Targeted ~500 attendees in 2013
- Co-located with World MPLS Congress and SDN congress
- Network connectivity for attendees, booths, on-site

1. Cisco α Network

A private, small-scale BYOD experiment

- Goals
  - Saw some “surprises” on a public dual-stack network, wanted to investigate internally
    - **Discovered clients aggressively creating new temporary IPv6 address - used temporary**
    - **Workaround : set short first-hop lifetimes for binding table**
    - Most surprises were related to RF environment
  - Wanted to investigate client/network/behavior off-line
  - Also decided to try IPv6-only Wi-Fi to test application behavior
- Deploy IPv6-only SSID during Cisco systems engineer training events and engineering plug-fests



Cisco Alpha Network Findings

- Network and client issues
  - **Different OS policies generate new privacy addresses at different times**
  - DHCPv6 not supported on some OS [versions]
  - Some mobile OS' don't support IPv6-only at all – at best workaround with IPv4 + ACL
  - Network devices still need IPv4 too
  - **Happy Eyeballs implementation varies across platforms/browsers**
  - Subtle First Hop/RA timer interactions
  - Certain devices have a high sensitivity to SSID switching (with dual stack too)
  - **Very few mobile clients support IPv6 on radio interfaces**
- Our network setup
  - **An old IPv4 multicast filter impacted [tunneled] RA distribution ☹**
  - An over-engineered network had too many switches sending RAs: some reached clients, some didn't
  - Our DNS server address is not easy to remember (next time use eg. 2001:DB8::53)
- User Experience
  - **Many users couldn't tell if they were using IPv6 or not**
    - Test-ipv6.com, IPvFOO, IPv6 toolkit app etc are very useful – thank you!
  - Different device configurations (IT-installed, self-installed) meant different out of the box behavior (e.g. IPv6 on/off)
  - Poor user experience == frequent disconnects and long wait to associate (IPv4 multicast issue)
  - Recorded 160 applications tried by users (at internal events)
  - **Generally collaboration applications broke through NAT64**

Repeating "Turn It On" events at local sales offices through 2013

2. Cisco Live US 2012

A discreet public BYOD experiment

- The event network was fully dual-stacked
- Again volunteer-staffed, decided to try a larger experiment
- Semi-private IPv6-only Wi-Fi
  - IPv6 servers go native, IPv4 servers go through NAT64 and DNS64, using SLAAC + stateless DHCP
  - Rest of network is dual-stacked
  - SSID: **ciscov6**, password: **ciscolive2012**
  - SSID is not broadcasted (you have to type it in), not available everywhere
  - Special hack to enable certain devices to function
    - Giving all devices 100.64.0.0/16 address
    - IPv4 traffic is blocked
    - Happy Eyeballs and IPv6 preference provides IPv6-only-like service
- Also had IPv6-only Wi-Fi in the “World of Solutions” demo area
- Network settings – first hop timer setting
  - Access devices care about IP/MAC bindings – for forwarding and to avoid various forms of spoofing attacks
  - First hop binding tables have limited space
  - First hop binding entries are flushed periodically to make sure there are free entries for new clients or addresses, which creates sensitivity to client prefix lifetimes with SLAAC
  - **Short timers are good if there is client volatility on SSID; long timers are good to reduce ND chatter, allow for long device sleep** …
  - Experimental value for conference environment ~ 30 minutes. => 30 minutes prefix lifetime ……

Cisco Live US 2012 findings

- Client issues
  - Need special hack for some devices to work , hence IPv4 on the IPv6 network
  - Some devices couldn't reach DNS64 server
  - Intermittent cases of IPv4 preferred over IPv6 at demo station – maybe due to crowded RF or maybe because of client/browser AF selection
  - Some problems seen at previous events fixed in new versions of software, but also saw new problems on IPv6-only network
  - Saw a disparity of client software versions (expected), so some "fixed problems" were still out there
- Network design issues
  - **Address allocation conundrum – SLAAC is easy, but requires timer tuning. DHCPv6 avoids a lot of the tuning exercises, but not supported on all platforms**
  - Choice of first hop timers means clients shouldn't switch/flap SSIDs quickly and repeatedly
  - **FHS binding table management logic changes to accommodate clients' behavior**
- Changed First Hop default settings in WLC code
- To know more

  http://blogs.cisco.com/borderless/ipv6-at-ciscolive-san-diego/ (US, 2012)

  http://www.cisco.com/en/US/prod/collateral/iosswrel/ps6537/ps6553/whitepaper_C11-721661.html (US, 2012)

  http://blogs.cisco.com/borderless/ipv6-just-works-cisco-live-london-dual-stack-network (Europe, 2013)

3. World IPv6 Congress 2013

Officially supported, BYOD IPv6-only WiFi

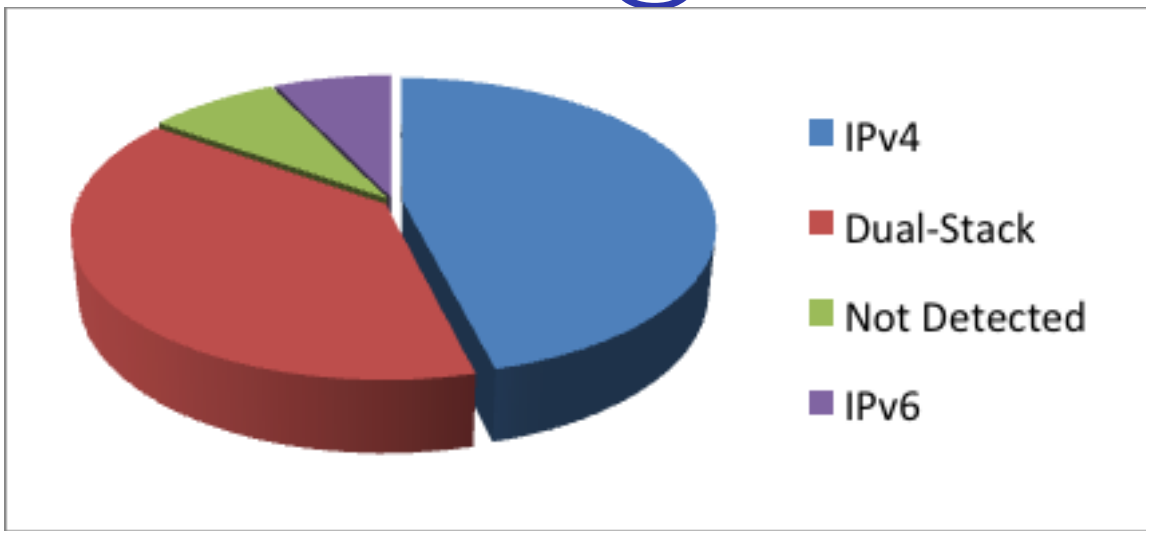
- Event featured 3 SSIDs : Open dual-stack, Open demo (NAT64), WPK2 IPv6 only
- Used an “IPv5 Cookbook”
  - Allocate IPv4 & drop any IPv4 traffic at first L3 hop
  - Used DHCPv6
  - Use WLC 7.3 (on Cisco Wireless LAN Controllers)
  - **Enable first hop security, default timers work**
  - Run IPv6 multicast over multicast CAPWAP (multicast-multicast mode)
  - Enable multicast suppression on the IPv4 network to limit excess multicast solicited RAs
  - Use v4/v6 ACLs to drop Bonjour traffic
  - Use NAT64 to reach “legacy Internet”
- Progress with some major client OS’ but inconsistent behaviors persist
  - Cache time-outs for privacy addresses can result in device trying to use a privacy address after sleep that is blocked by the first hop
  - Certain devices/applications use IPv4-only reachability tests
- Decreed the experiment a success
- Next year, IPv4 access will only be provided on request

What we learned

- Before IPv6 turn on
  - A fair amount of selling is still required to overcome fear of the unknown
  - Knowledge of IPv6 outside core group(s)/enthusiasts can be superficial
- Support
  - No shortage of volunteers (T-shirt effect?) and lots of enthusiasm but actual support provided by small groups of usual suspects
  - Real debug/troubleshooting skills are poorly distributed
- Dual stack
  - Worked well
- IPv6-only works, but …
  - See subtle network / client interactions
  - And not so subtle stack differences
  - And unsubtle end-point behavioral differences
  - Also uncover old design “short-cuts”
  - And need design changes e.g. security and management planes
- There are things to fix

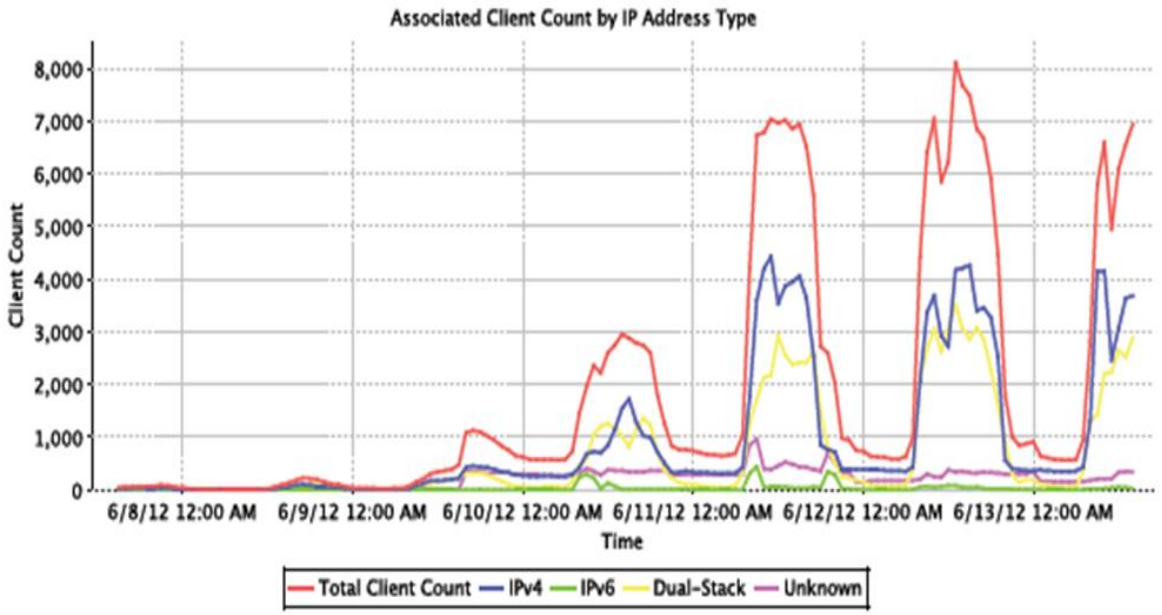
Some Measurements

IPv6 Statistics @ Cisco Live US 2012



Measure: Unique MACs with
- IPv6 LL address
- IPv6 global address
- IPv6 with global EUI address
- IPv4 global address

Measurements de-duplicate privacy addresses



In 6 months *:

Dual stack-capable devices increased from 47.5% to 77.5%

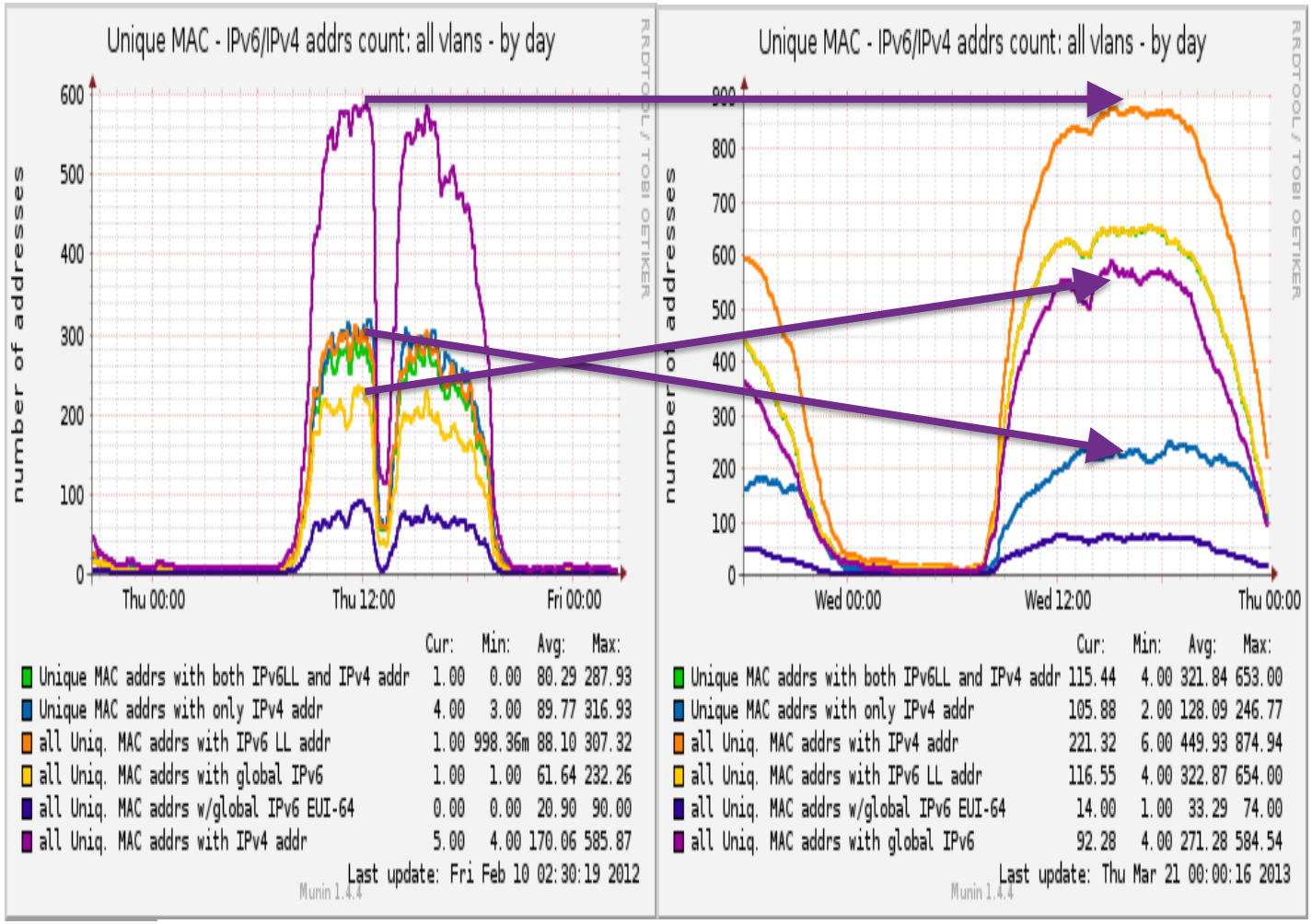
IPv6-using devices increased by 87.3%

** Between IPv6 World Congress, Jan 2012 And Cisco Live US: June 2012*
Dual stack capable : IPv4 global + IPv6 LL
IPv6 using : IPv6 global

Data from dual-stack production network

World IPv6 Congress

Client stats: 2012 vs 2013



Max clients: 586 → 875

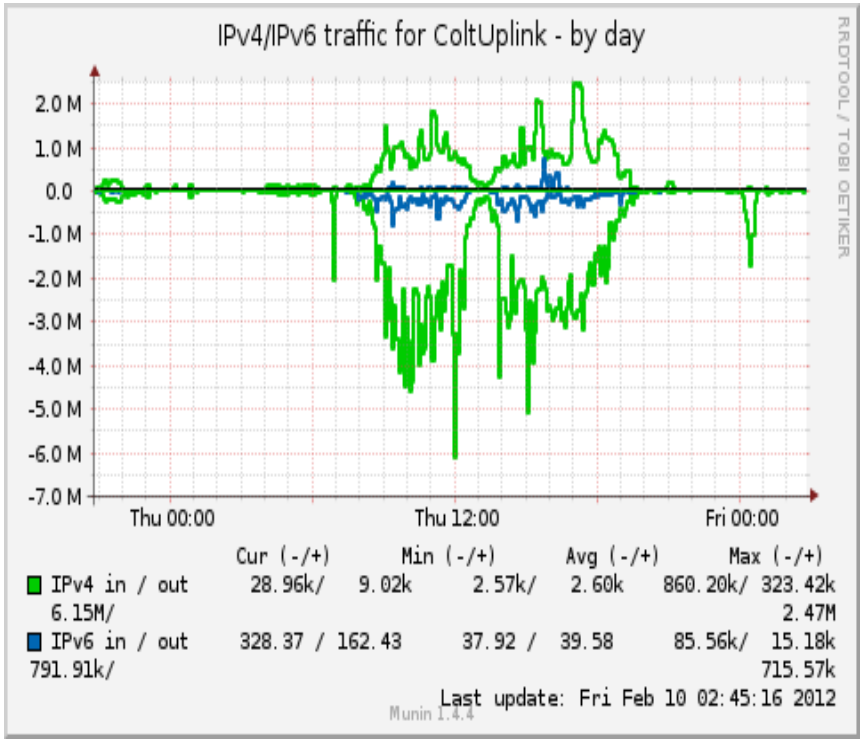
Using IPv6: 232 → 584

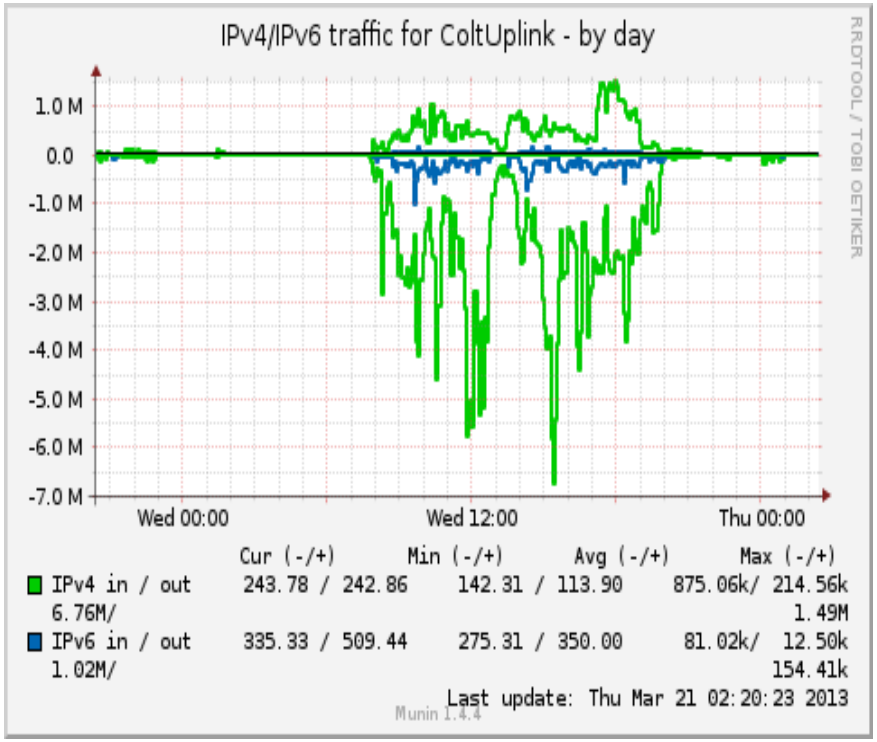
IPv4-only: 317 → 246

Number of clients using IPv6 39% → 66%

World IPv6 Congress

IPv4 / IPv6 Traffic stats 2012 vs 2013





IPv4: 6.15Mb → 6.76Mb = 109% of 2012

IPv6: 792Kb → 1020Kb = 129% of 2012

World IPv6 Congress 2013

High-level results from our “almost IPv6-only” experiment

- 96 hosts: with IPv4 address (baseline total clients on network)
- 85 hosts: have IPv6 link-local address
- 60 hosts: have global IPv6 address
- 11 hosts: no IPv6 ?
- 25 hosts: blocked??

Summary

Thank You