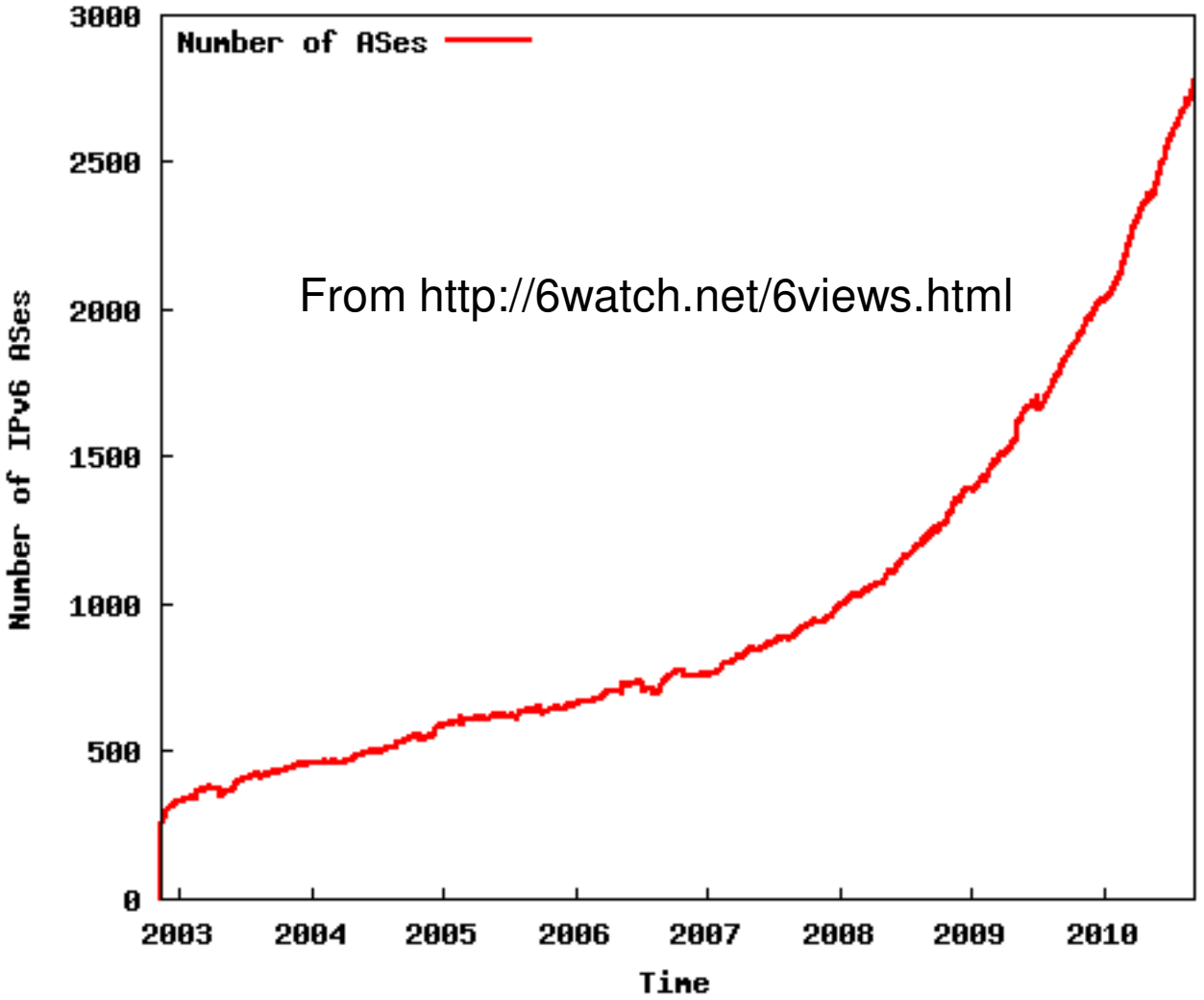
6 Watch: Monitoring IPv6 Deployment and Connectivity

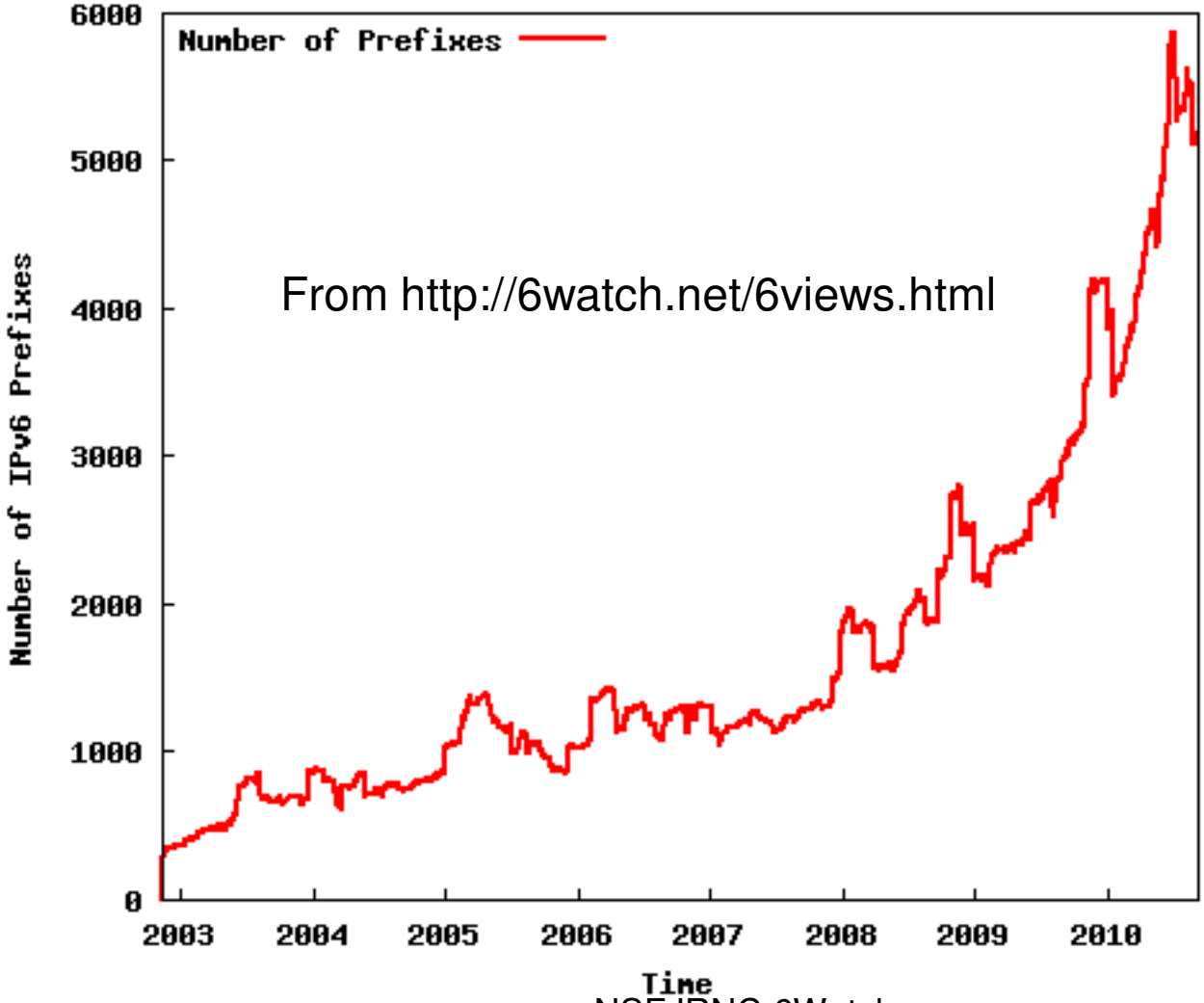
Dan Massey Colorado State University

Many Positive Trends For IPv6

Growth in IPv6 ASNs



Growth in IPv6 Prefixes



And Many More IPv6 Activities

- DNS Requests for IPv6 Records
  - AAAA records 2nd most popular type at top level DNS servers
    - Above MX/NS/etc and behind only A records
  - A6 records are the 4th most popular type!
    - Proves nothing is ever obsolete in the Internet ☺
- IPv6 growing in importance with IPv4 exhaustion issues, World IPv6 Day, etc.
  - Hopefully don't need to convince this group

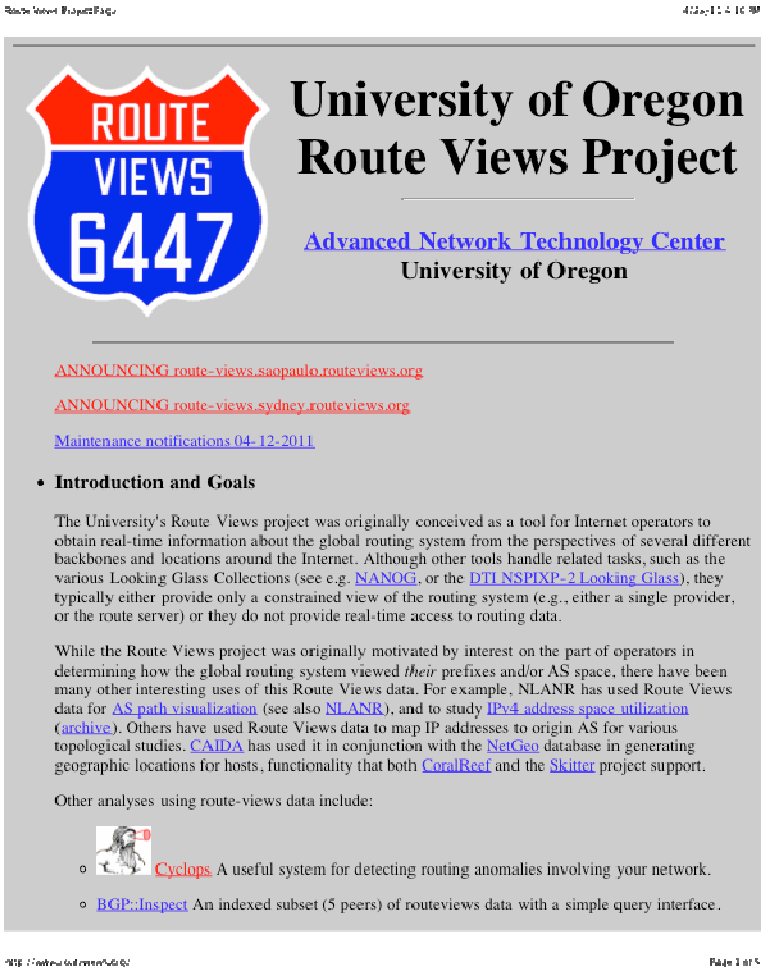
Objectives For This Talk

- Introduce the 6Watch Monitoring System
  - Understand how the numbers are generated
  - BGP Data From Oregon RouteViews
  - DNS Data From SecSpider
  - New Data and Control Plane Integration
- Show How 6Watch Could Help You
- Request Your Help In Data Collection

The 6Watch Team

- University of Oregon/Oregon RouteViews
  - Dave Meyer
  - John Kemp
- UCLA
  - Lixia Zhang
- Colorado State
  - Dan Massey

6Views BGP Monitoring



University of Oregon
Route Views Project

Advanced Network Technology Center
University of Oregon

ANNOUNCING route-views.saopaulo.routeviews.org

ANNOUNCING route-views.sydney.routeviews.org

Maintenance notifications 04-12-2011

- **Introduction and Goals**

The University's Route Views project was originally conceived as a tool for Internet operators to obtain real-time information about the global routing system from the perspectives of several different backbones and locations around the Internet. Although other tools handle related tasks, such as the various Looking Glass Collections (see e.g. NANOG, or the DTI NSPIXP-2 Looking Glass), they typically either provide only a constrained view of the routing system (e.g., either a single provider, or the route server) or they do not provide real-time access to routing data.

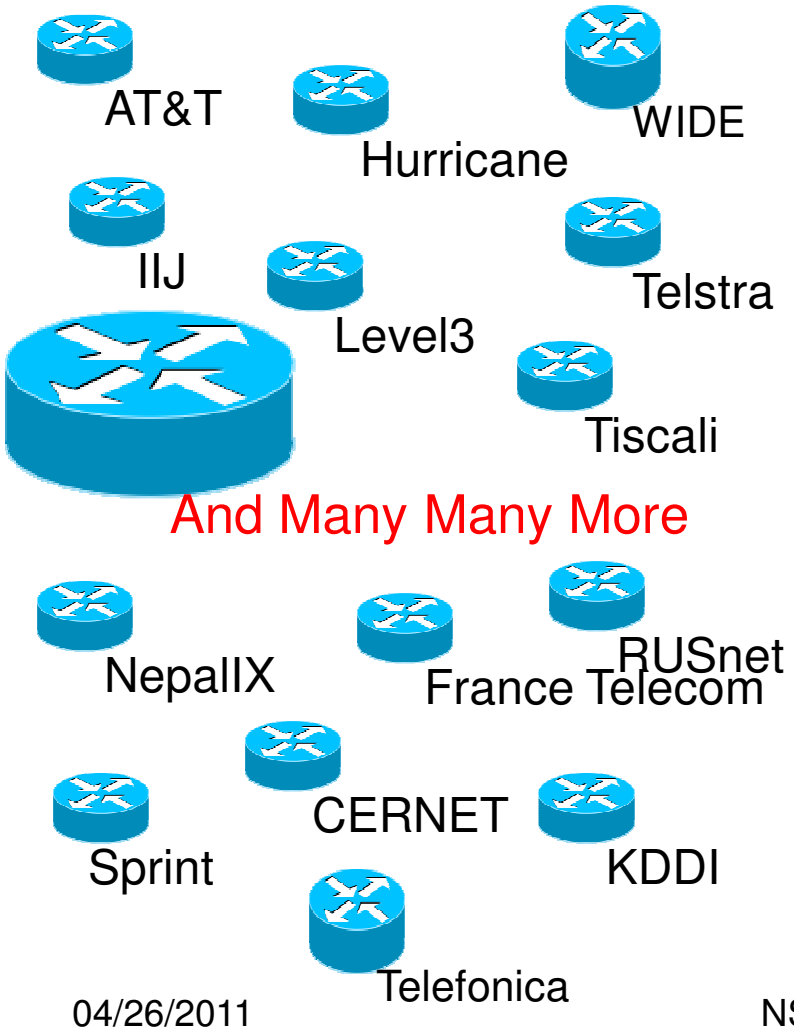
While the Route Views project was originally motivated by interest on the part of operators in determining how the global routing system viewed *their* prefixes and/or AS space, there have been many other interesting uses of this Route Views data. For example, NLANR has used Route Views data for AS path visualization (see also NLANR), and to study IPv4 address space utilization (archive). Others have used Route Views data to map IP addresses to origin AS for various topological studies. CAIDA has used it in conjunction with the NetGeo database in generating geographic locations for hosts, functionality that both CoralReef and the Skitter project support.

Other analyses using route-views data include:

- Cyclops A useful system for detecting routing anomalies involving your network.
- BGP::Inspect An indexed subset (5 peers) of routeviews data with a simple query interface.

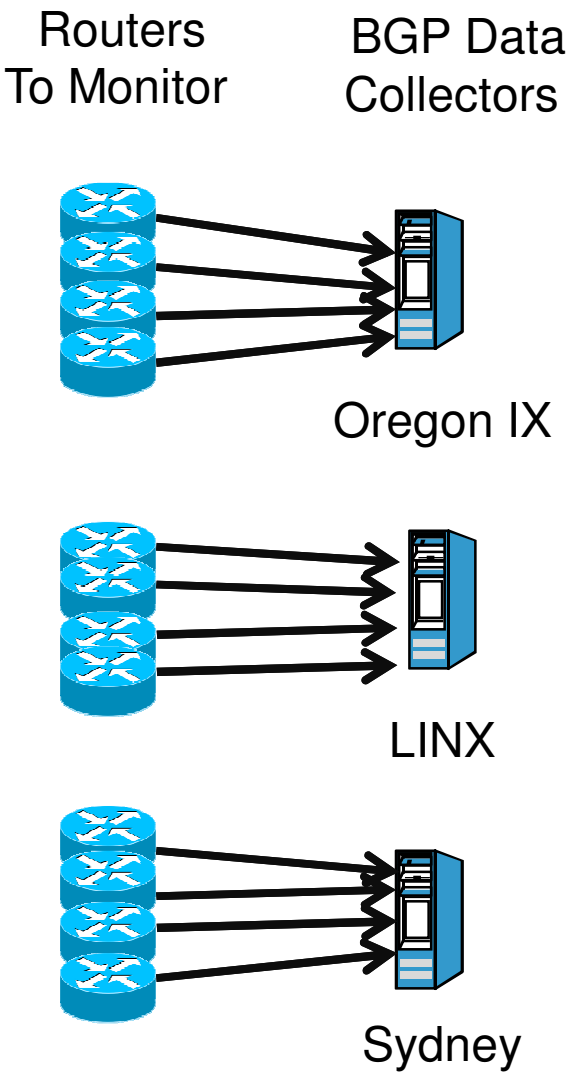
- Shows IPv6 Routing Table Growth
- Shows Growth in IPv6 Origin ASNs
- Allows One to infer IPv6 Connectivity and AS Level Topologies

How BGP Data Collection Works (1/3)



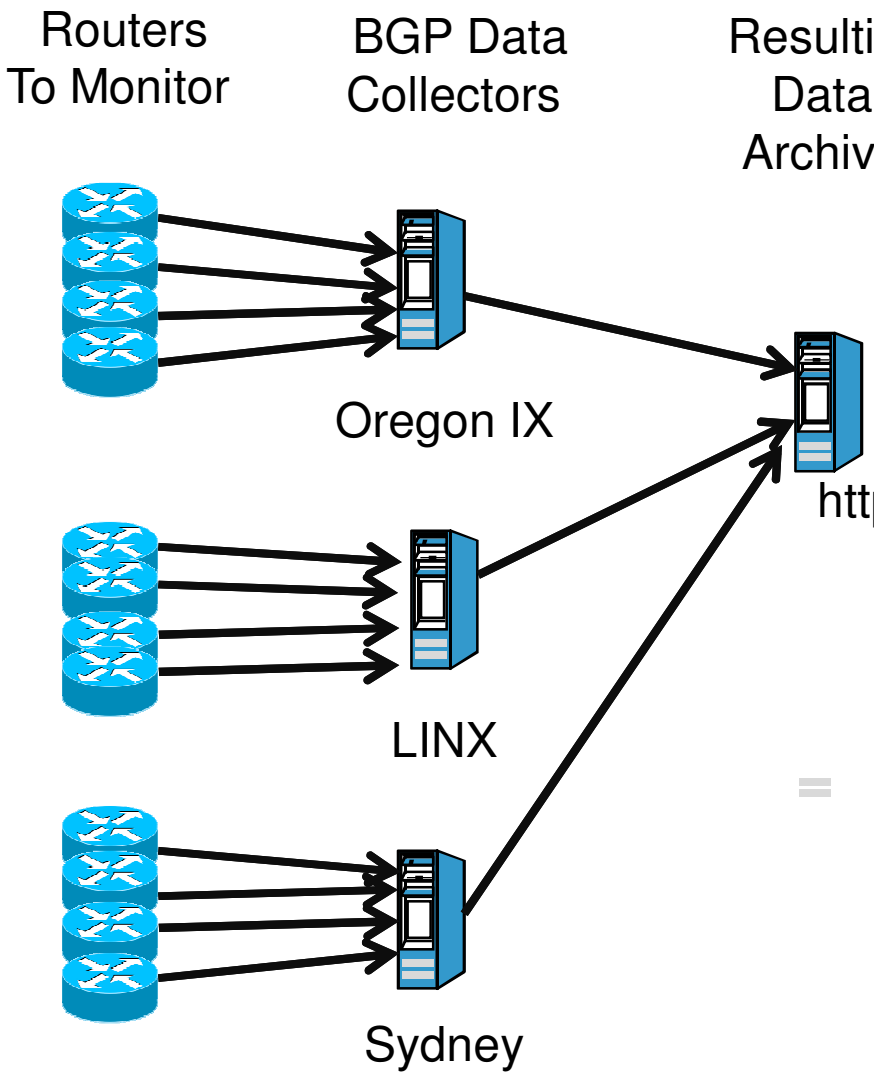
- ISPs around the world offer to provide BGP data
- Agree data can be made publically available to any operator or researcher

How BGP Data Collection Works (2/3)



- Monitoring projects deploy collectors at exchange points
- ISP routers peer with collectors
- To the ISP router, the collector is just another BGP peer (e.g. router)
  - Only the collector never announces any routes!

How BGP Data Collection Works (3/3)



- All Route Updates Are Logged
  - 15 minute intervals

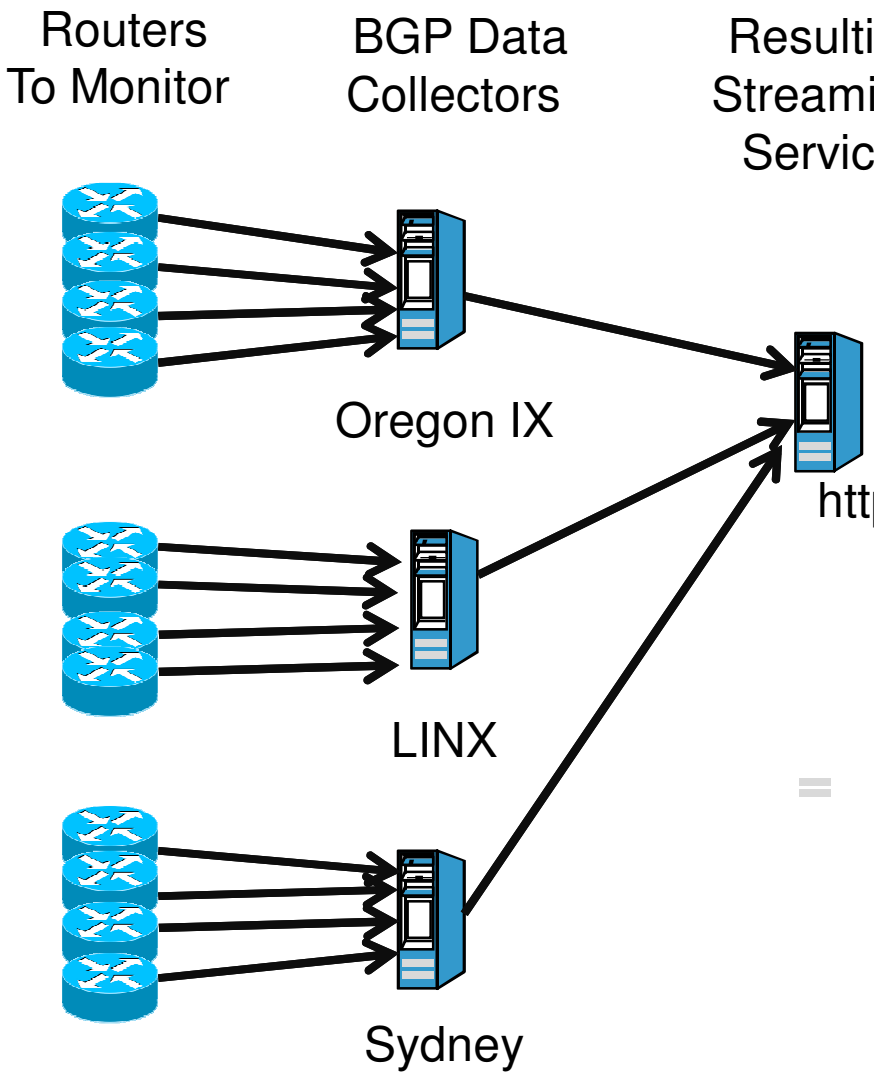
http://archive.routeviews.org/bgpdata/

- Collector also archives routing table of each peer router
  - 2 hour intervals

BGP Data Collection and IPv6

- IPv6 Peering With Routers
  - 80+ Routers Peer Using IPv6
- IPv6 Tables Reported By Routers
  - Updates and routing tables list IPv6 Prefixes
- Allows One To Count IPv6 Prefixes, Size of v6 BGP table, Deduce v6 connectivity from AS Path in updates, etc.

New Feature: Real-Time Data

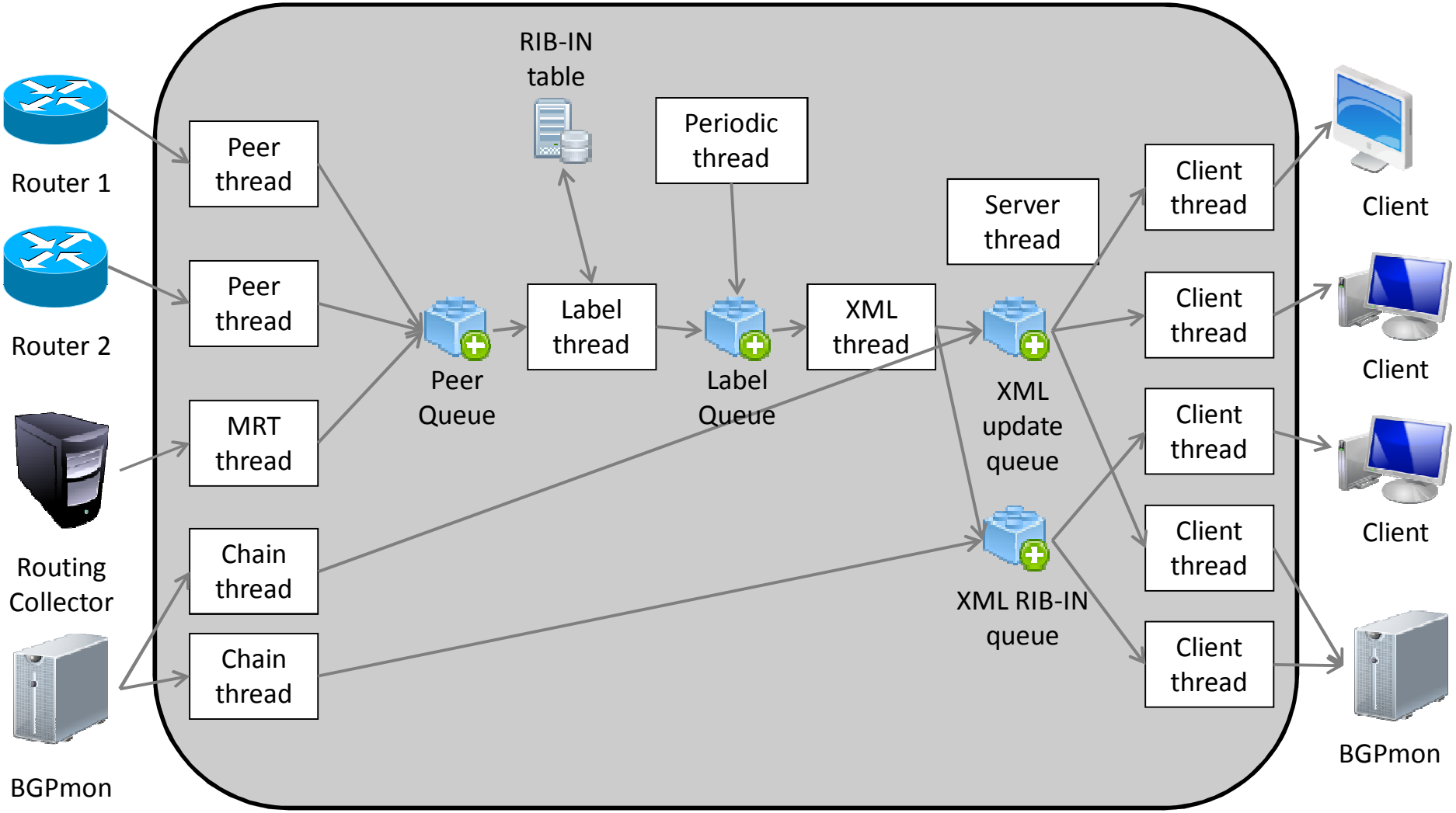


- Developed new BGP monitoring software (BGPmon)

http://bgpmon.netsec.colostate.edu/

- Improves how collectors work
  - Can support more peers
  - Create collection meshes
- Can Now Get Data in Real-Time (both v4 and v6)!

BGPmon Architecture



BGP Message Example

- “Bits off the wire” between two BGP speakers:
  - 4001010040020C020536D900D10D1C10866E0F4 00304C02BD98D18BD5533
    - Not easy to analyze. RFC 4271 has all details.
- How we can represent BGP message in human readable format?
  - Extensible Markup Language (XML)
    - Extensible and easy to use data format.
    - It is widely used for the representation of arbitrary data structures.
    - It is common for XML to be used in interchanging data over the Internet (RFC 3023).

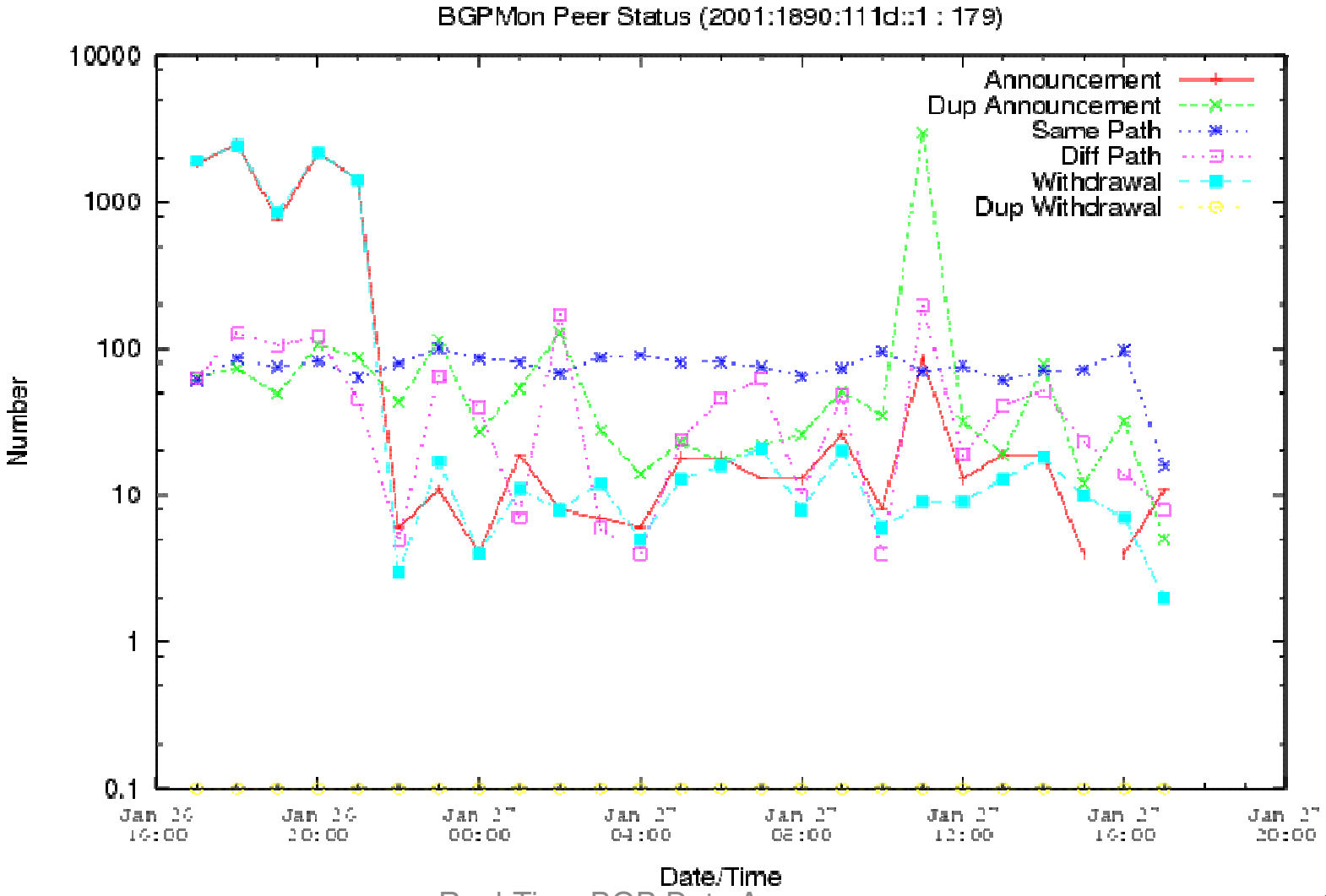
XML-Based Format for Representing BGP Messages (XFB)

```
<ASCII_MSG>
        <LENGTH>53</LENGTH>                          ← BGP message total length
        <TYPE value="2">UPDATE</TYPE>                ← BGP message type, according to RFC 4271
        <UPDATE>
            <ATTRIBUTE>
                <LENGTH>12</LENGTH>
                <TYPE value="2">AS_PATH</TYPE>
                <AS_PATH>
                    <AS_SEG type="AS_SEQUENCE" length="5">
                        <AS>14041</AS><AS>209</AS>
<AS>3356</AS>   BGP AS Path data →
                        <AS>4230</AS><AS>28175</AS>

                    </AS_SEG>
                </AS_PATH>
            </ATTRIBUTE>
            <ATTRIBUTE>
Multi-protocol Support for v6 →
                <LENGTH>28</LENGTH>
                <TYPE value="14"> MP_REACH_NLRI</TYPE>
                <MP_REACH_NLRI>
                .....
Announced Prefix →
                <PREFIX label="DPATH" afi="IPV6" afi_value="2"
                safi="UNICAST" safi_value="1"> 2001:468:d01:33/96  </PREFIX>
            </ATTRIBUTE>
    </UPDATE>
```

Not difficult, right?

XML Data from one v6 Peer



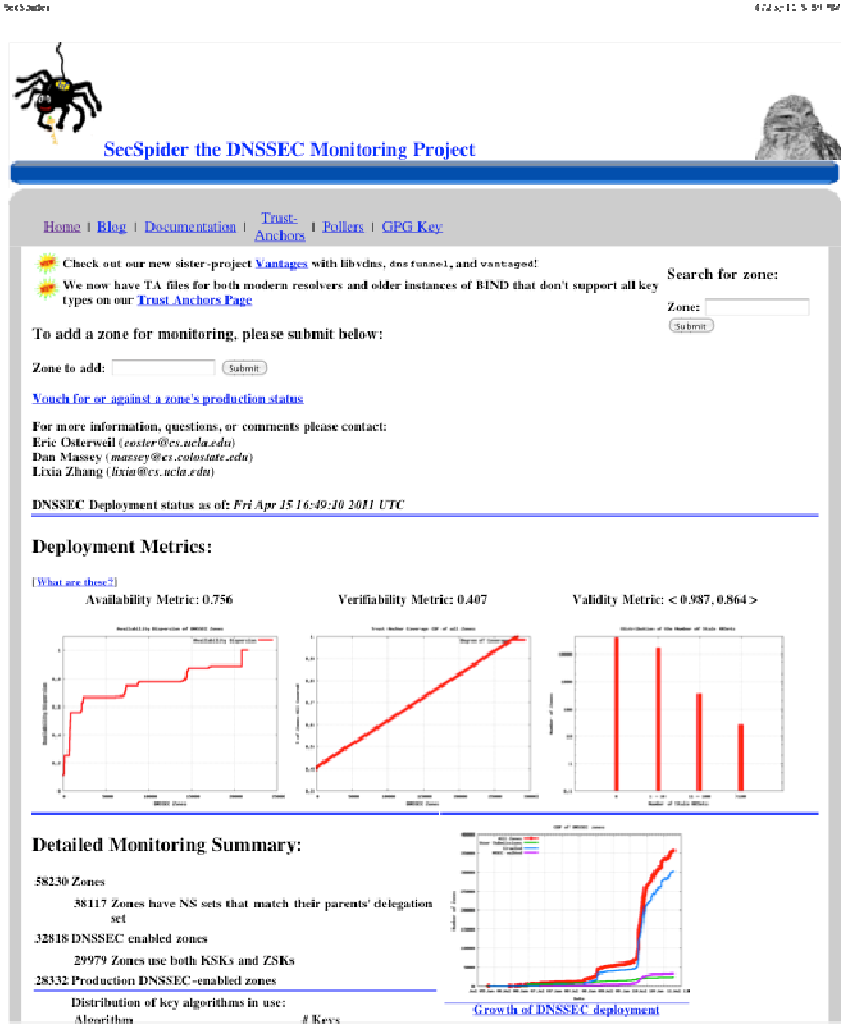
But BGP Is Not Sufficient…

- BGP Data Only Shows Control Plane
  - Do all announced routes work?
  - Can they be reached from v4 and/or reach v4?
- 6Views Enhances BGP with Data Plane
  - But how to test? Ping? Look for websites?
  - Our solution: DNS!

DNS IPv6 Monitoring

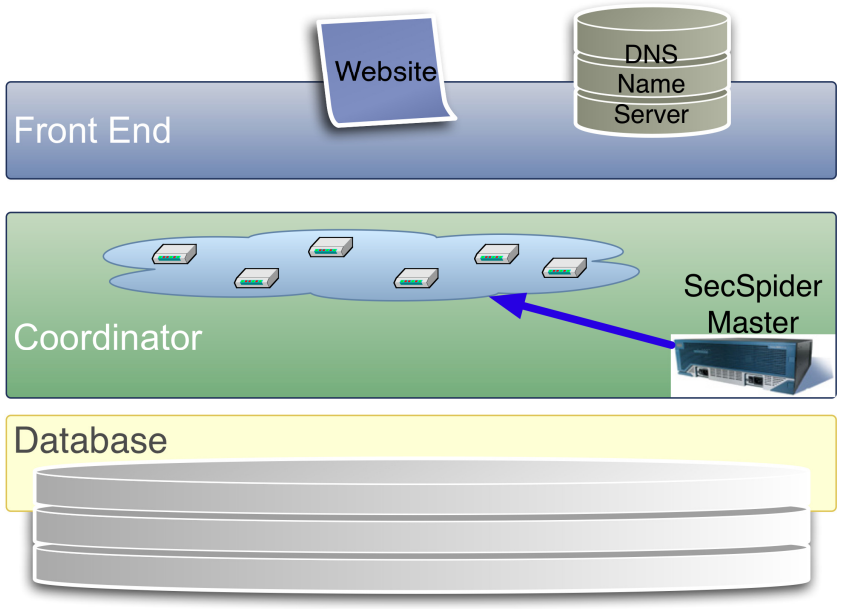
- Network doesn't work unless DNS works!
- Can v6 DNS resolver reach v6 DNS server?
- Can v4 DNS resolver reach v6 DNS server?
- Can v6 DNS resolver reach v4 DNS server?

SecSpider DNS Monitoring



- Developed by Eric Osterweil (now at Verisign)
- Designed to Track DNSSEC Deployment
- Monitors secure DNS zones from multiple locations

How DNS Data Collection Works (1/3)



- Sites around globe agree to host DNS pollers
- Master coordinator with redundancy directs pollers
- Back-end DB tracks all data collected

How DNS Data Collection Works (2/3)

- Master decides what to query
  - Ex: poller in China, query for www.rmv6tf.org AAAA
  - Coordinator specifies exact query to send, including all header bits, OPT RRs, etc.
- Master decides who to query
  - Ex: poller in China, send that query to 2a01:e0b:1:64:240:63ff:fee8:6155
- Poller only sends query and relays back response

How DNS Data Collection Works (3/3)

- Master Communicates with Poller over DNS
  - Master creates exact query to send
  - Adds a DNS OPT RR that specifies the desired DNS server
  - Sends Query (with OPT RR) to Poller
- Poller Listens For Queries
  - Strips off OPT RR to find server
  - Sends Query to Server
  - Forwards Reply to Master
- Master/Poller Channel Secured With TSIG
  - Ensures only master can direct poller

DNS Data Collection and IPv6

- Instruct v6 Pollers to Query v6 DNS Servers
  - Test both DNS functionality and connectivity between v6 networks
- Instruct v6 Pollers to Query v4 DNS Servers
  - Test both DNS functionality and v6 to v4 connectivity
- Instruct v4 Pollers to Query v6 DNS Servers
  - Test both DNS functionality and v6 reachability from v4

Why Might All This Matter to You?

- RouteViews BGP Data Already Widely Used in Many IPv6 Numbers You See Now
  - New real-time data enables new types of measurements
  - New IPv6 specific data archives makes analyzing IPv6 data easier
    - (don't have to sift out lots of IPv4 cruft)
  - DNS Data (release in summer) will add data plane results (and DNS results1)

Why Might All This Matter to You?

- Can provide your site real-time IPv6 connectivity monitoring
  - 6Cyclops will track your IPv6 connectivity and notify you of routing incidents that impact your prefix
  - 6Spider can track your IPv6 DNS service and notify you of DNS and data plane connectivity issues
- Interested in free monitoring services?
  - Contact bgpmon@netsec.colostate.edu

A Request For Your Help

- Help Finding Your IPv6 DNS Servers
  - 6Spider Pollers Query IPv6 DNS Servers
  - Load is on order of 1-2 queries per day
  - Standard DNS query, as from any resolver
  - Requires nothing at the server…
- But we need to find the server to query it
  - Crawling DNS is slow…
  - If you run a v6 DNS authoritative server, could you point us at the address?
  - Contact bgpmon@netsec.colostate.edu

Even More Generous Help

- Hosting a 6Spider Poller
  - More IPv6 6Spider DNS Pollers Needed
  - Involves installing Poller software (RDNSD)
  - Configure TSIG key to ensure only master can control poller
  - Only sends and receives (UDP) DNS queries
  - Contact bgpmon@netsec.colostate.edu

Even More Generous Help

- Additional Peering For IPv6 Data Collection
  - If you are already peering with RouteViews, Thank You!
  - If not, could you consider peering with a BGPmon data collector?
  - More data provides the community with a better picture of IPv6 rollout
  - Contact bgpmon@netsec.colostate.edu

Questions?

bgpmon@netsec.colostate.edu