

Link-Rank: A Tool for Visualizing BGP Routing Dynamics

Mohit Lad
UCLA

Tim Ma
UCLA

Dan Massey
Colorado State
University

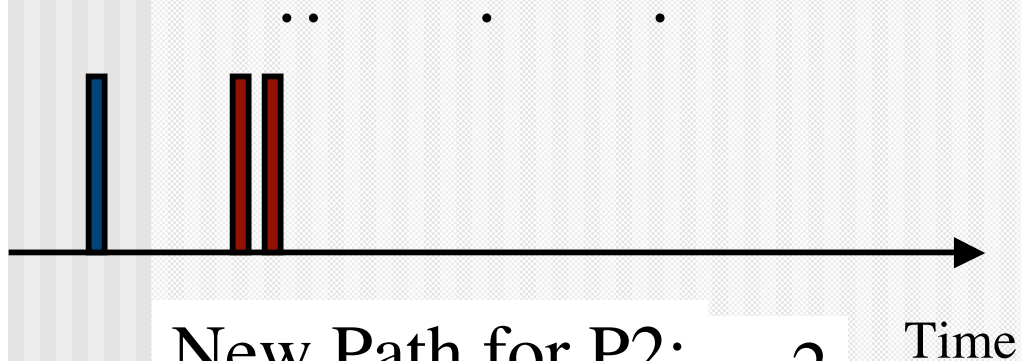
Lixia Zhang
UCLA

Purpose of BGP Visualization

- ISP Perspective:
 - Which AS-AS links are most used by my routes?
 - On any given day, are there any major routing events affecting my routes?
 - How am I affected by instability more than one hop away?
 - For the dynamics observed, is the problem global or local?

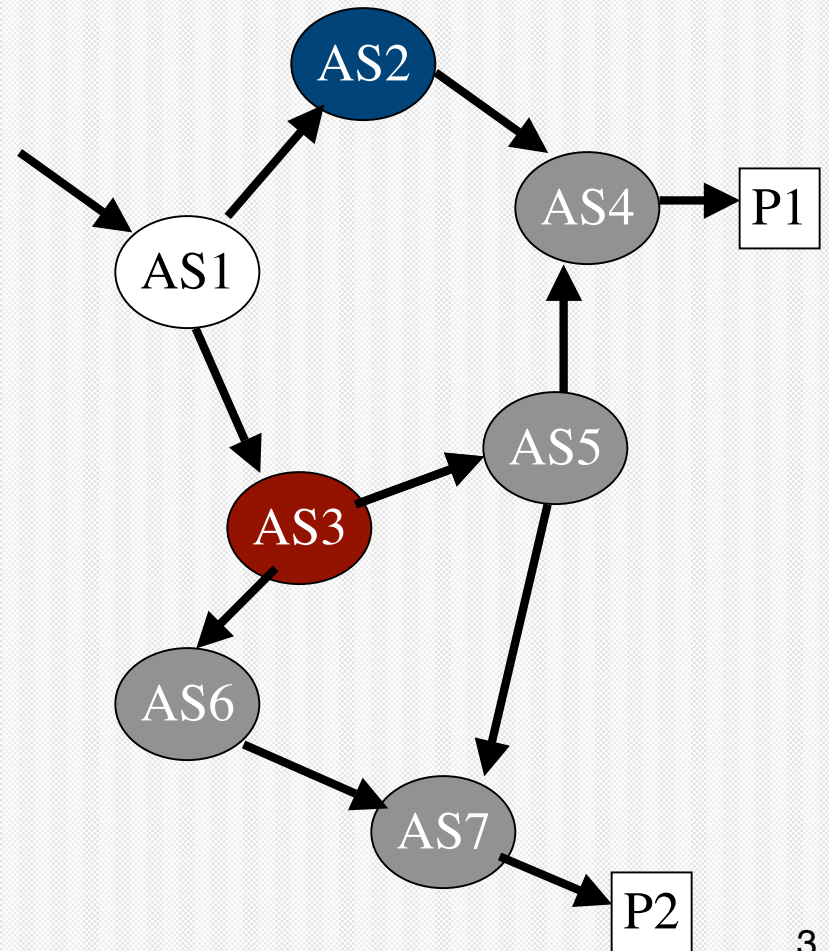
Background on BGP Visualization

BGP Updates



New Path for P2:
AS3-AS6-AS7

2



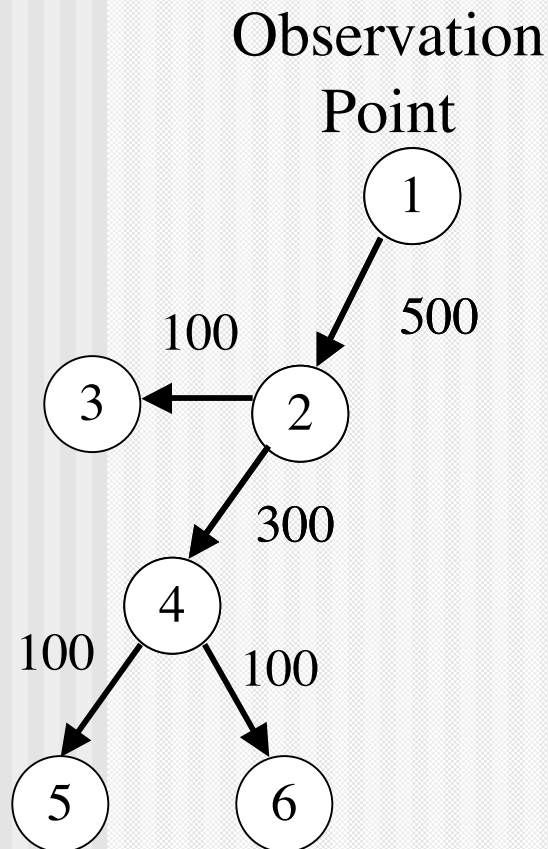
Challenges in Visualization

- Topological Granularity
 - Updates for various prefixes.
 - Which AS-AS links should one visualize?
- Time:
 - Updates arrive on a continuous basis.
 - What time interval should one look at?
- View:
 - More than one observation points.
 - How to combine views from different observation points?

First Step

- Topological Granularity:
 - View all possible links above a threshold
- Time:
 - Assume a particular time instant 't'
- View:
 - Assume a single monitoring point.

Link-Rank Graph at time t from Single View



- Link-Rank of a link (weight) is the number of prefixes reached by the observation point using that link.
- Link-Rank graph too big with all the links.
- Filter: Apply threshold to see only links above a certain usage.

Applying threshold of 200

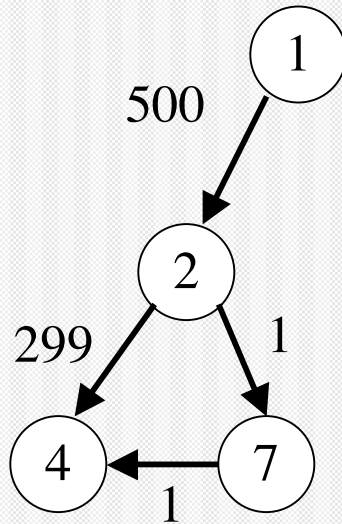
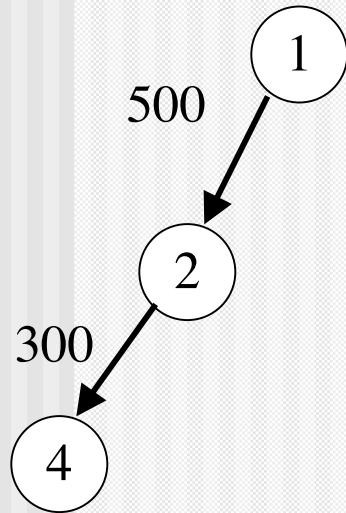
Using Threshold for Snapshot

Node 4 advertises
Prefixes P_1 to P_{100}

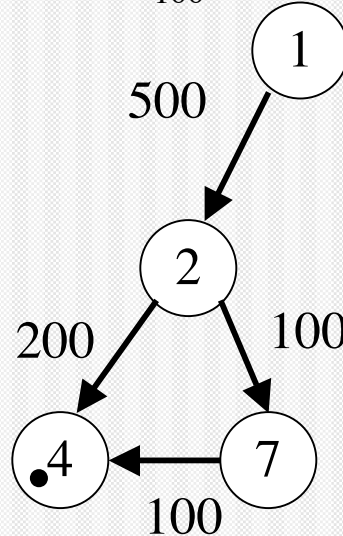
Time

Path P_1 $\langle 1, 2, 7, 4 \rangle$

Path P_{100} $\langle 1, 2, 7, 4 \rangle$



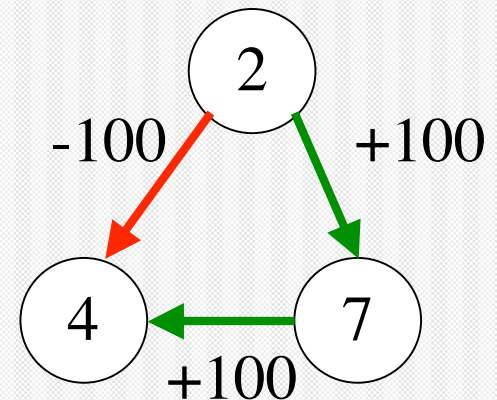
...



Take snapshot when
running total of rank
of any link changes by
more than $w=100$

Rank-Change Graph

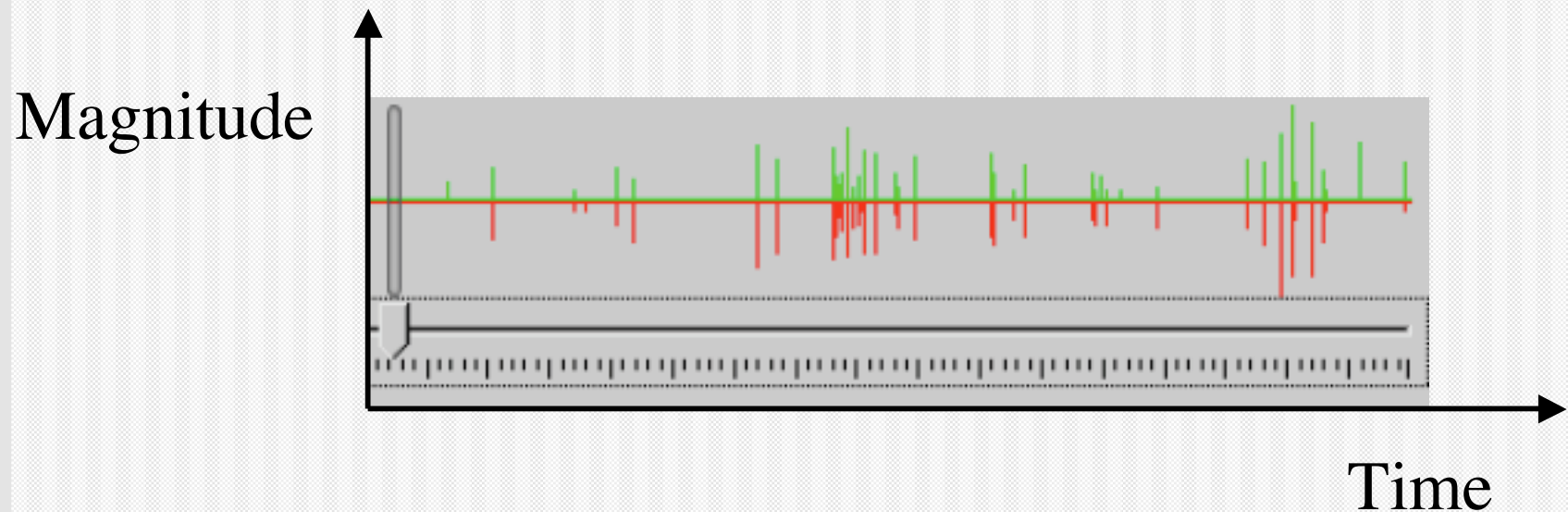
- Show which links have changed in the given time interval.
- Red lines indicate loss of LinkRank, while green lines indicate gain of LinkRank.



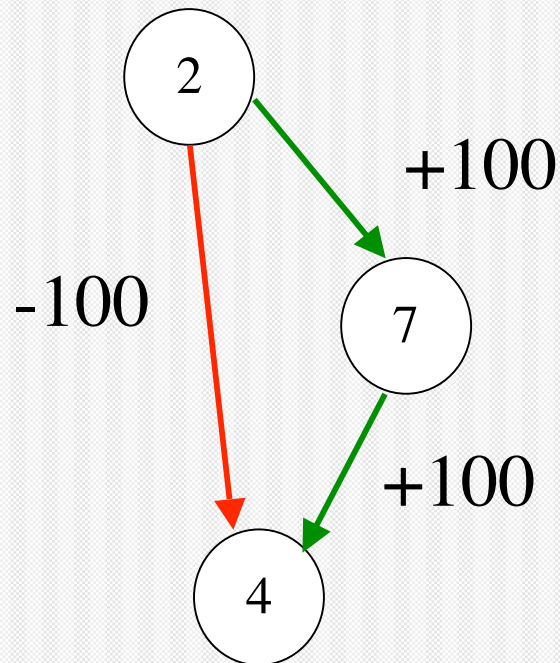
Rank-Change
in time-interval
(t_0, t_1)

Activity Plot

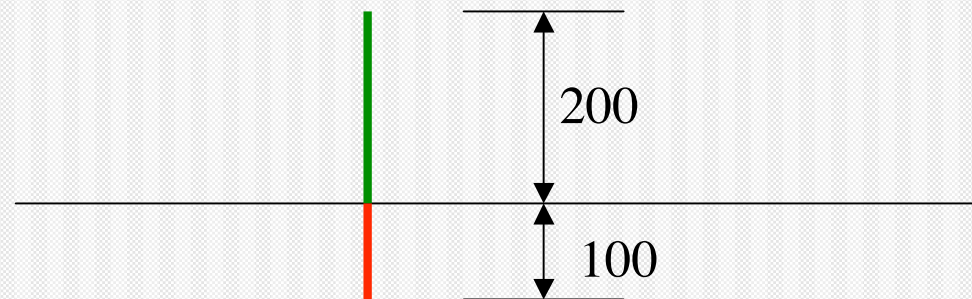
- Challenge is to know when major events happen on a time scale.
- Activity Plot presents a high level picture of routing change events by time.



Plotting Activity Bar

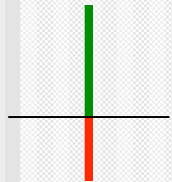


Sum of all the gains = 200
Sum of all the losses = -100



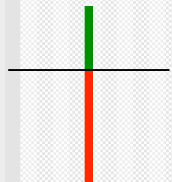
At any time, the activity bars indicate the total rank gains and the total rank losses.

Implications of Activity Plot



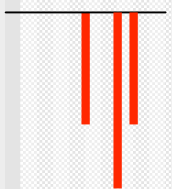
Gain Larger than loss. Due to combination of

1. Longer new paths.
2. Gain in number of routes or threshold filter.



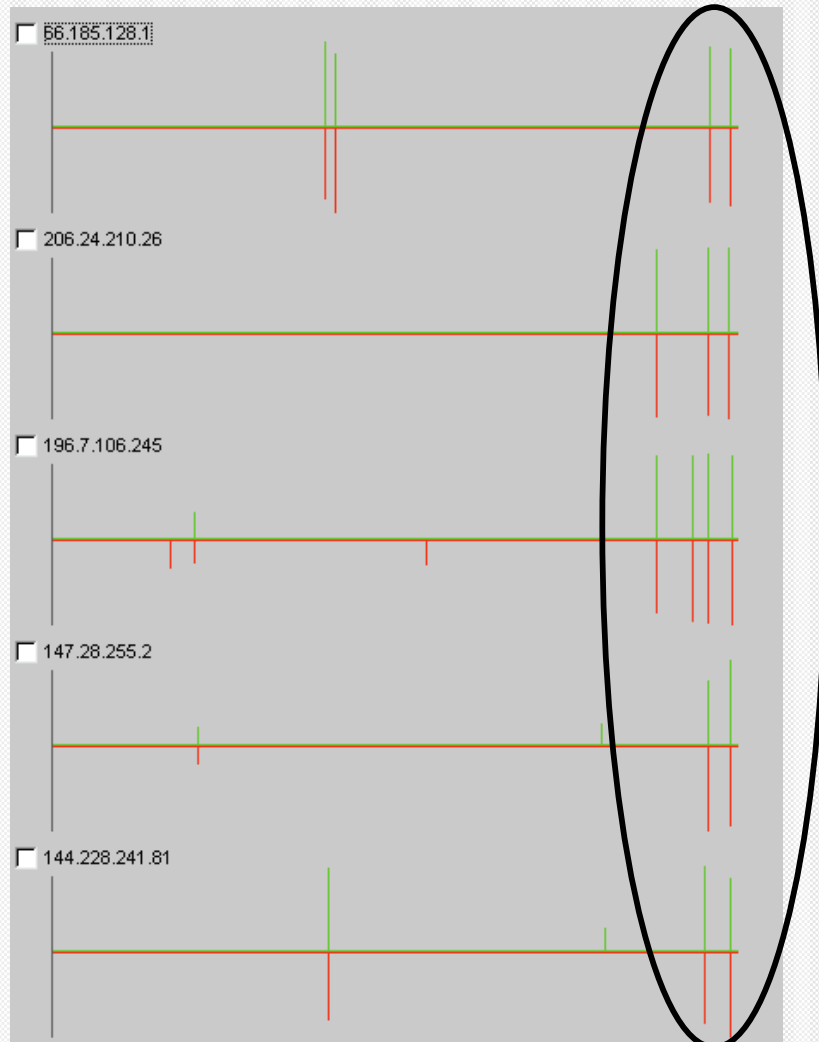
Gain smaller than loss. Due to Combination of

1. Shorter new paths.
2. Loss in number of routes or threshold filter.



No compensating gain for losses
Most likely indicates loss of routes

Using Activity Graphs



- Multiple peers show routing dynamics at the same time.
- Activity Graphs help identify “active time” periods from one view.
- Activity Graphs also help identify possible “overlapping activity” from multiple points of view.

Case-study I

Understanding Routing Dynamics from Single View Point

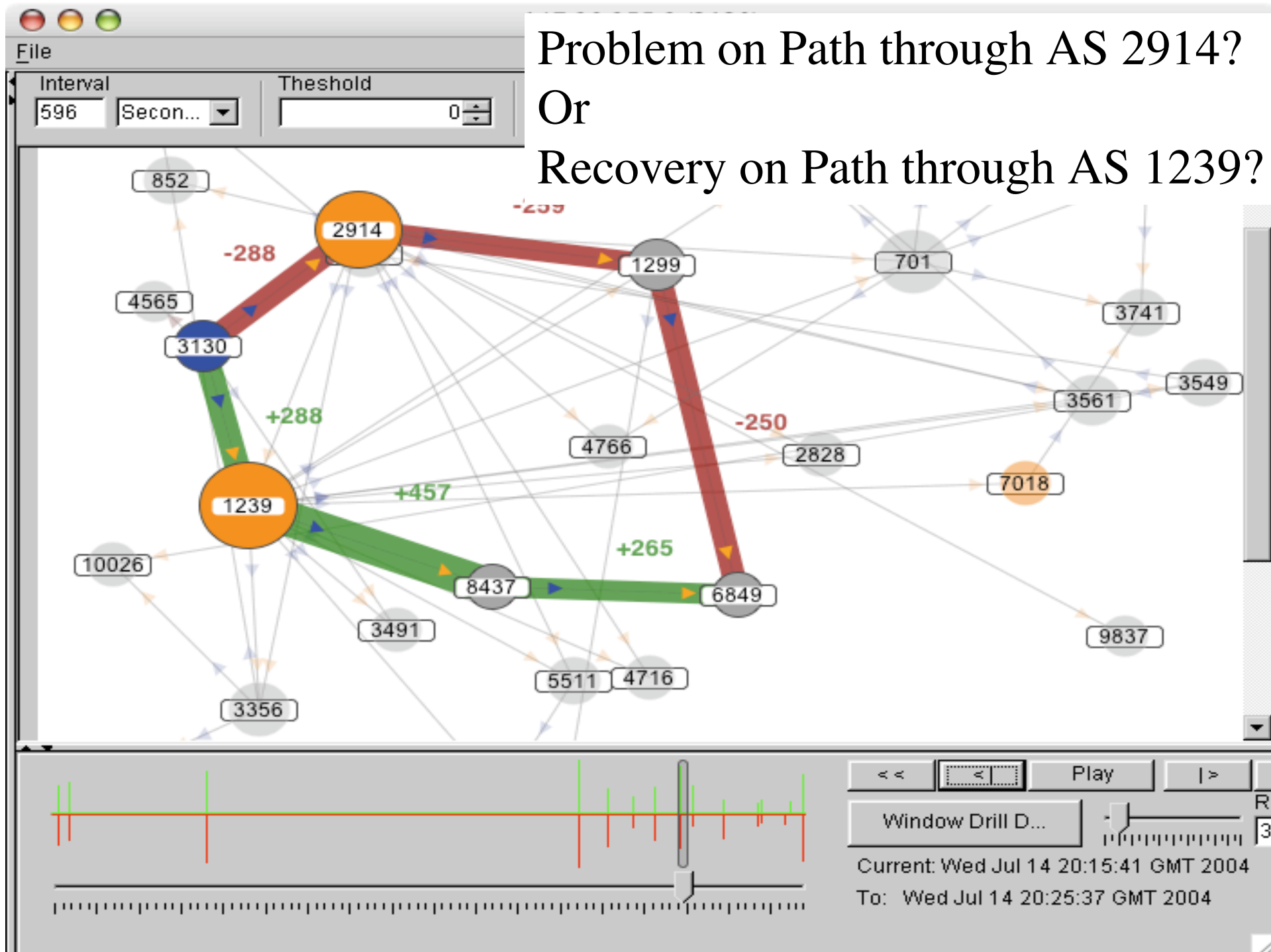
Case-study II

Inference by Choosing Relevant Views

Problem on Path through AS 2914?

Or

Recovery on Path through AS 1239?



File

Interval

596

Secon... ▾

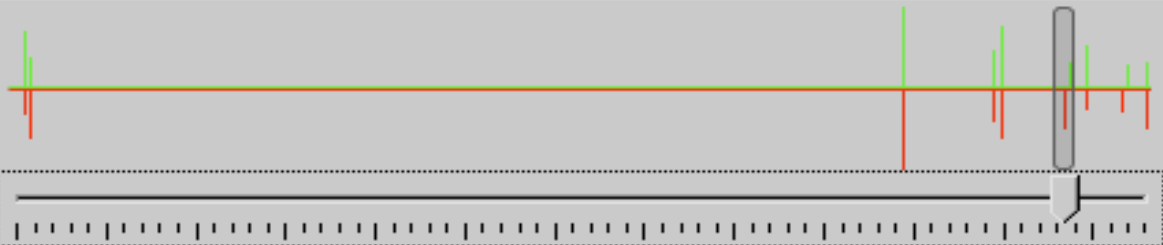
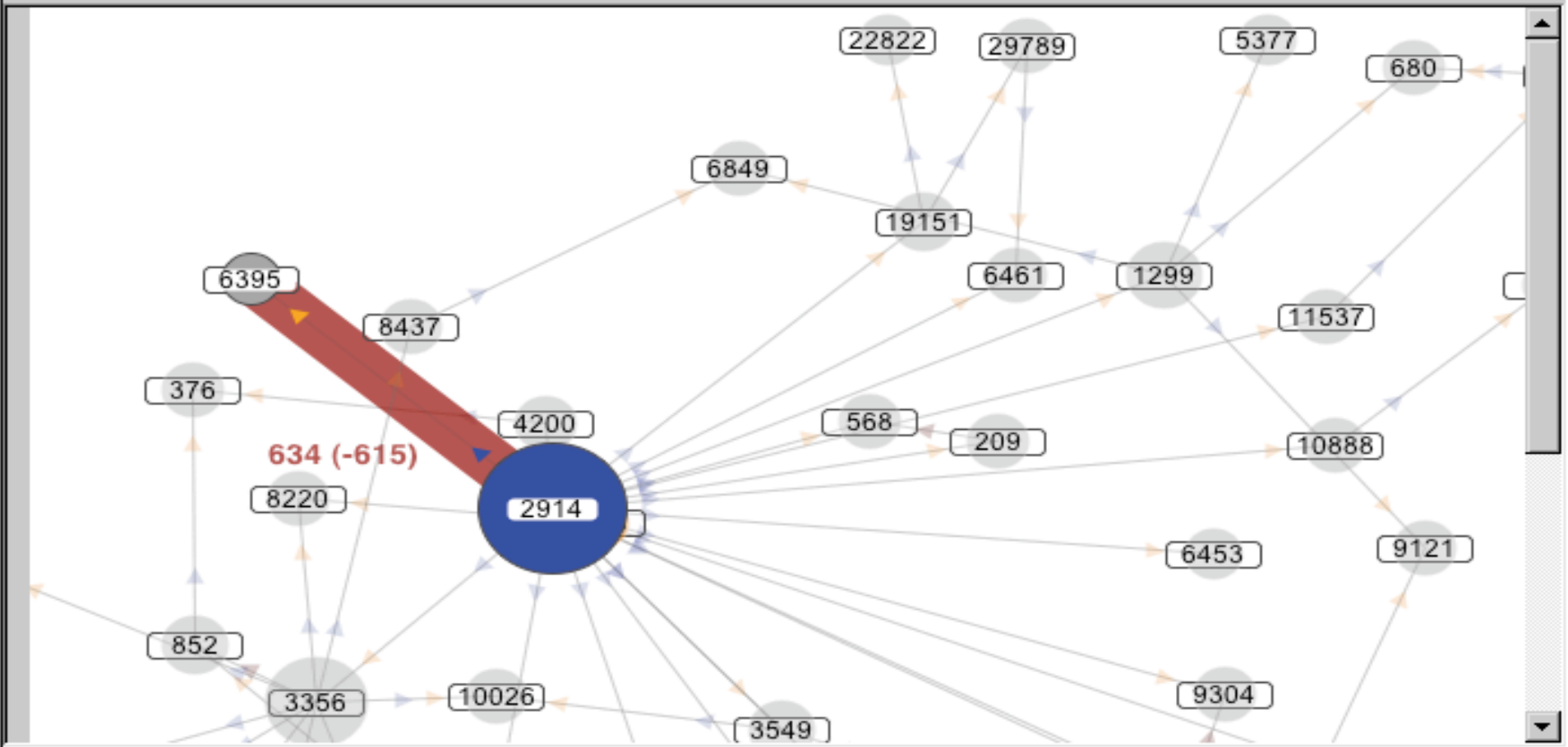
Theshold

0

Show Aggregate

Link Label

Rank and Ran... ▾



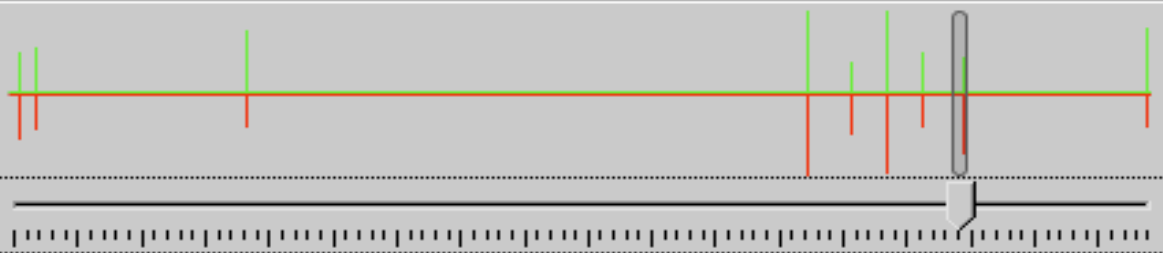
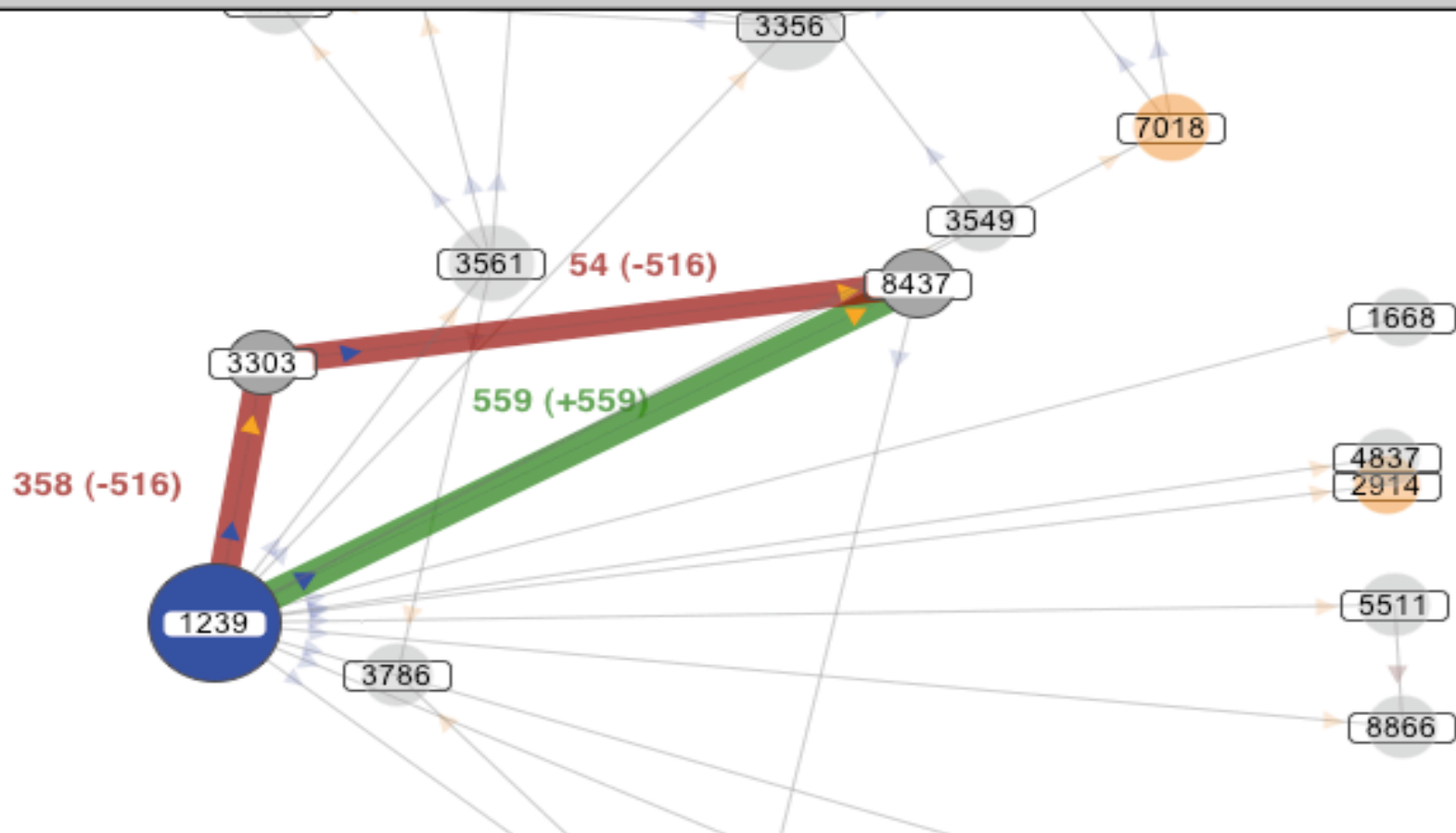
<< <| Play |>

Window Drill D... 3

Current: Wed Jul 14 20:16:29 GMT 2004
To: Wed Jul 14 20:26:25 GMT 2004

File

Interval: 596 Theshold: 0 Show Aggregate Link Label: Rank and Ran...



<< <| Play |> >>
Window Drill D... [Slider]
Current: Wed Jul 14 20:11:43 GMT 2004
To: Wed Jul 14 20:21:39 GMT 2004

LinkRank and BGPlay

- BGPlay shows how the routes to a specific prefix changed during a time interval.
- LinkRank provides broader view of overall routing stability/dynamics.
- LinkRank and BGPlay complement each other

Case-study III

Using LinkRank with BGPlay

October 18, 2004

File

Interval

546 Secon...

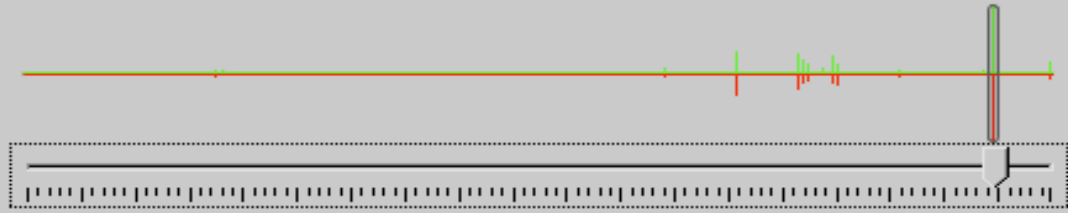
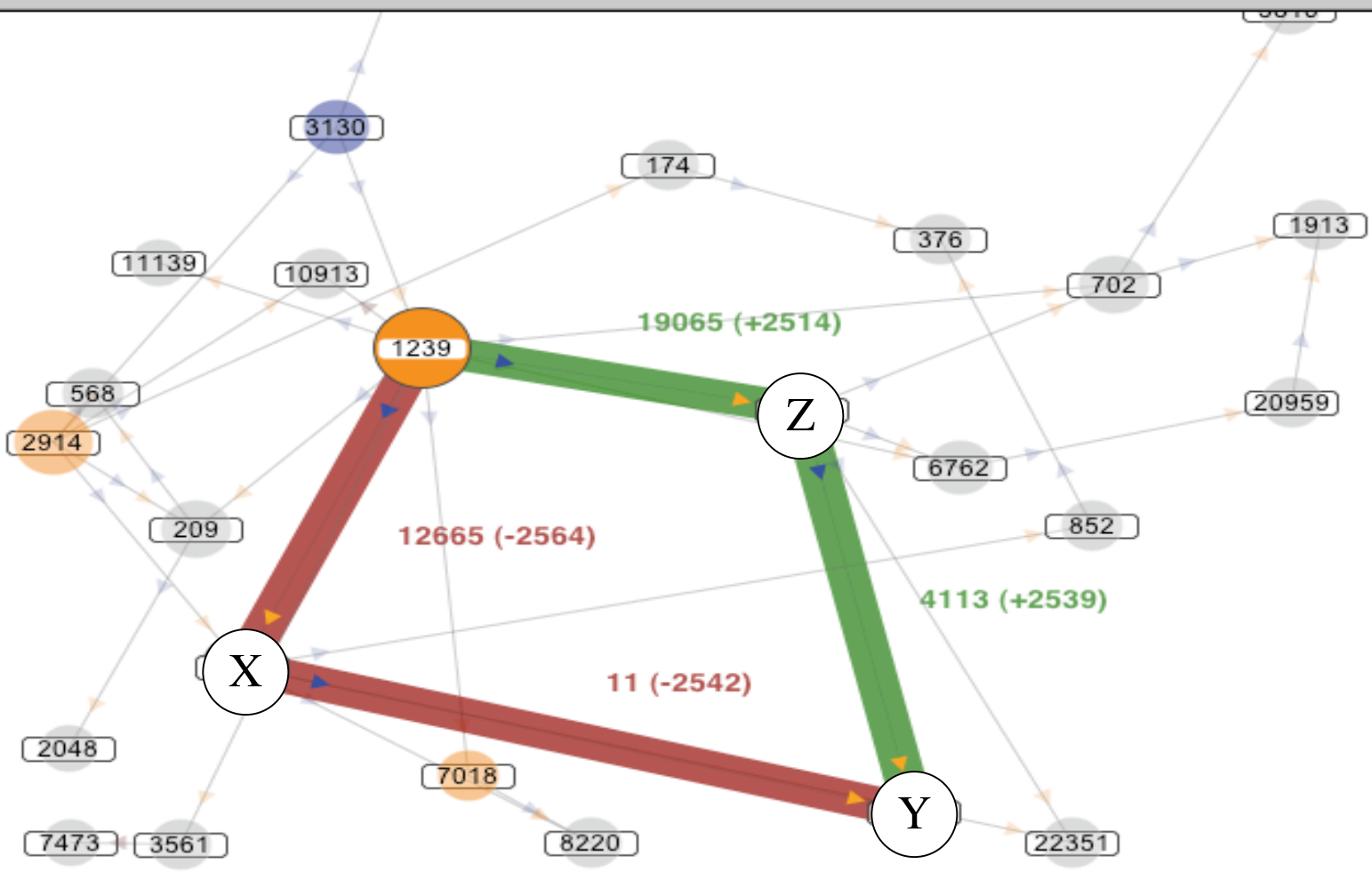
Theshold

0

Show Aggregate

Link Label

Rank and Ran...



<< <| Play |> >>

Window Drill D... Rate (ms) 300

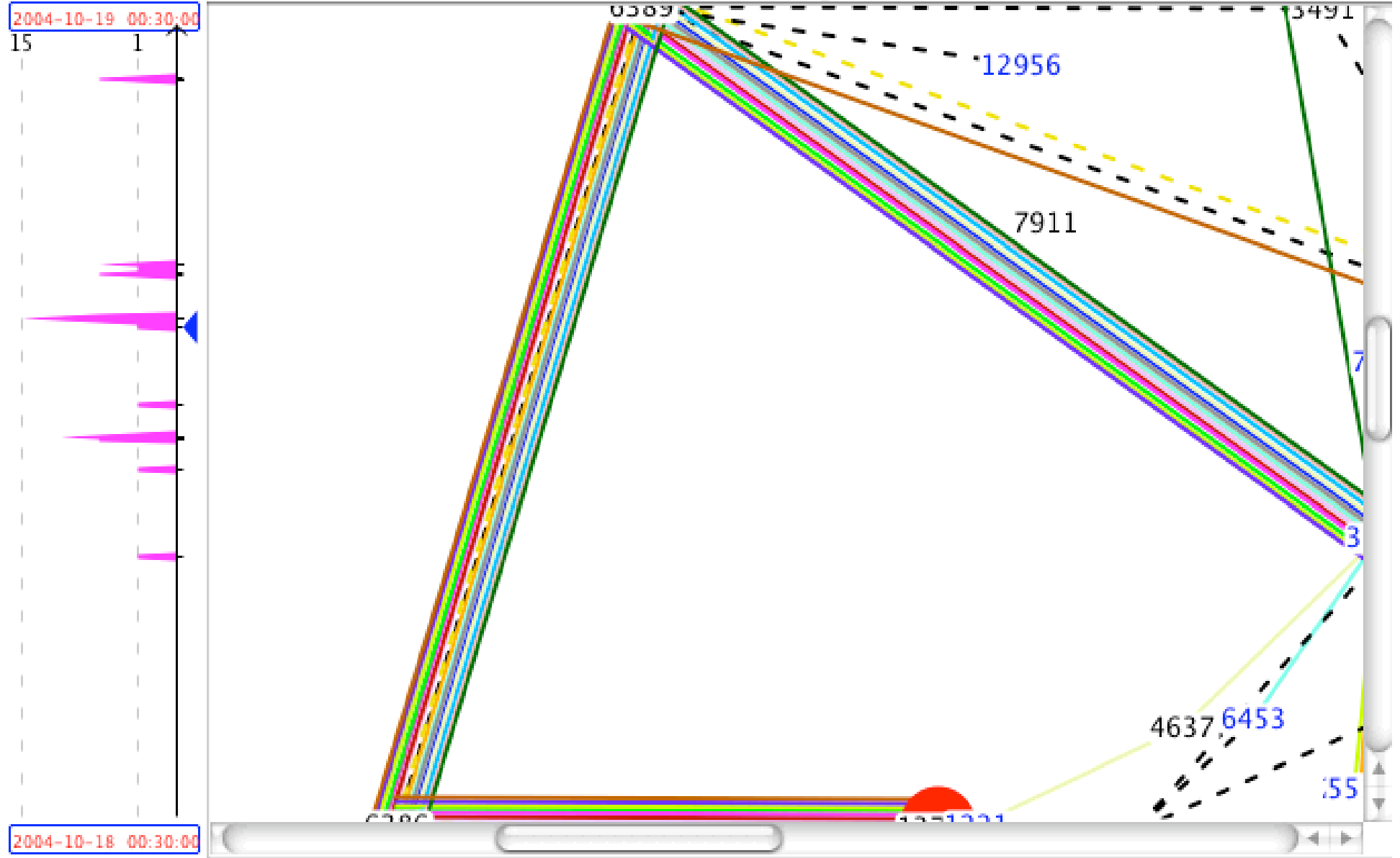
Current: Mon Oct 18 15:37:28 GMT 2004

To: Mon Oct 18 15:46:34 GMT 2004

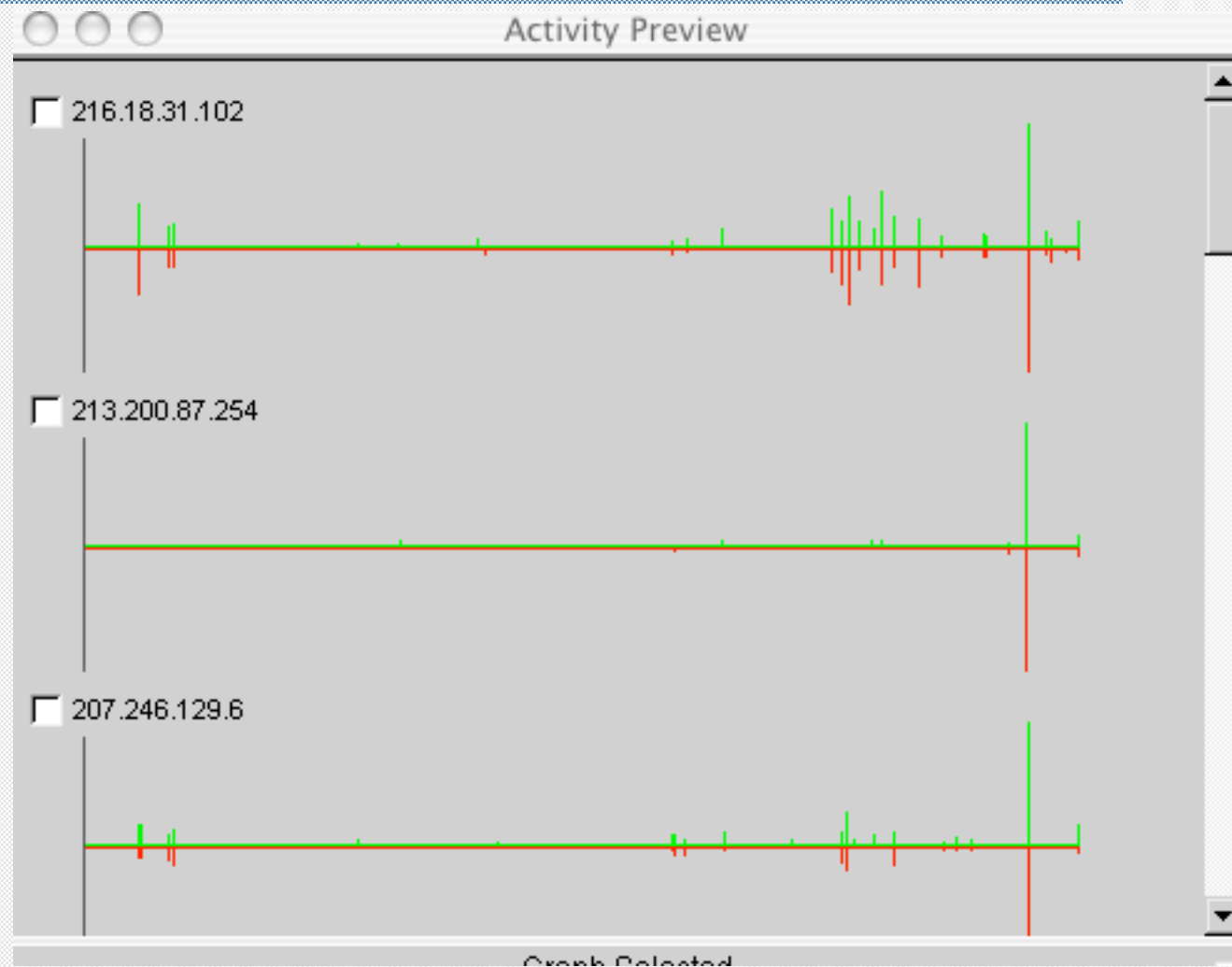
BGPlay: changes to prefix 216.206.128.0/24 from 2004-10-18 00:30:00 to 2004-10-19 00:30:00

9/31 2004-10-18 15:22:38 Route Re-announcement 16150 8434 325
RV 217.75.96.60

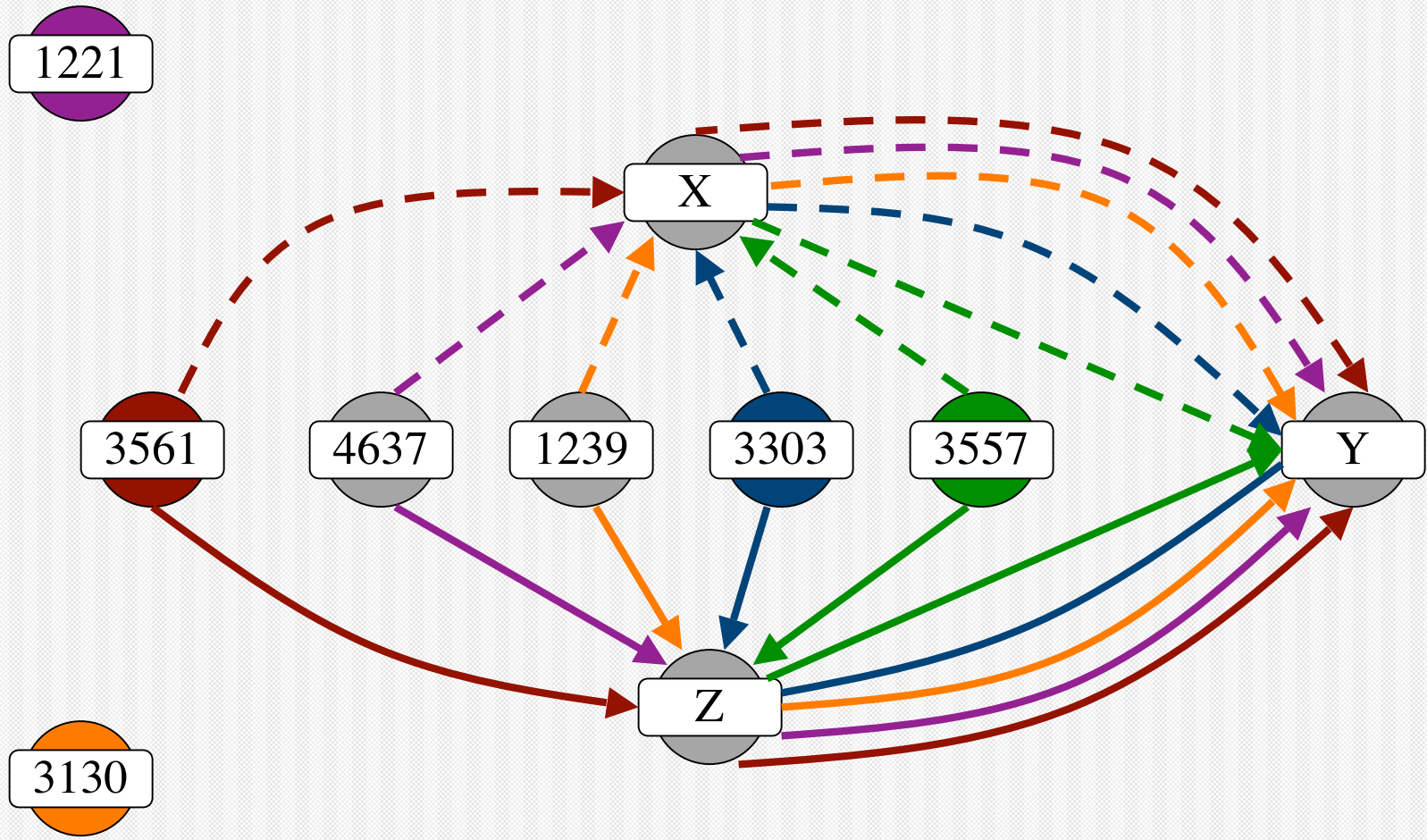
AS2152 CSU-53 California State University



Overlapping Activity across Different Views



Combining Views with LinkRank



LinkRank and RouteExplorer

- LinkRank monitors global routing and can combine views from multiple observation points in different ASes.
 - LinkRank complements RouteExplorer (which combines views within an AS)
- LinkRank does not perform any inference
 - Ongoing work on graph theoretic fault inference.

Summary

- LinkRank used to “make sense” of huge amounts of BGP logs.
- LinkRank can combine graphs from various observation points to give a more complete picture.
- Thresholds and “Drill down” feature can control the level of detail desired.
- Activity graphs ensure dynamics will not be missed easily.

Testing and Release

- Seeking Input For Features/Functionalities
 - Will be incorporated into Link-Rank code
- LinkRank will be packaged for public release
 - Beta release planned December 2004.
- If interested in being a part of our initial testing, please contact
mohit@cs.ucla.edu
- More information and updates at
<http://linkrank.cs.ucla.edu>