BGP Link Reputation Evaluator

An Algorithm based tool to identify *legitimate* or *malicious/hijack* BGP link

Alfred Arouna[1] Lionel Metongnon[2] Pr. Marc Lobelle[3]

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AfPIF 2017 - 22,23,24 August 2017 - Abidjan, Côte D'Ivoire

Disclamer

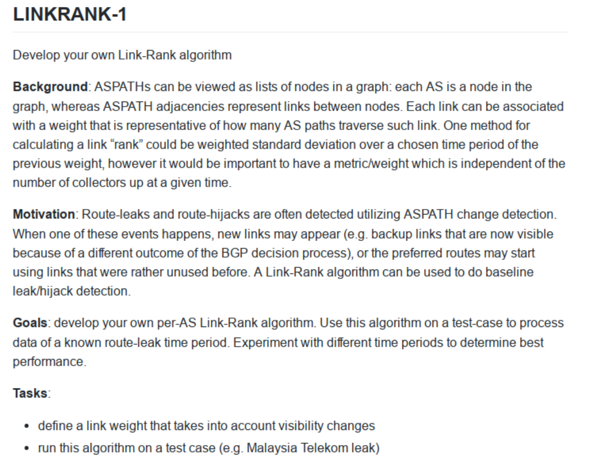
- Ongoing study...
- Community input to improve current result.
- Code not yet ready for production (alpha release).
- Code available at: `https://bitbucket.org/alfredarouna/bgplink`

Outline

1. Base Idea
2. Tools
3. Our proposal
4. Hypothesis & verification
5. Malaysia Telecom test cases results
6. Other tests cases results
7. Improvement (proposals)

Base Idea

Linkrank Challenge from CAIDA BGP Hackathon



LINKRANK-1

Develop your own Link-Rank algorithm

Background: ASPATHs can be viewed as lists of nodes in a graph: each AS is a node in the graph, whereas ASPATH adjacencies represent links between nodes. Each link can be associated with a weight that is representative of how many AS paths traverse such link. One method for calculating a link "rank" could be weighted standard deviation over a chosen time period of the previous weight, however it would be important to have a metric/weight which is independent of the number of collectors up at a given time.

Motivation: Route-leaks and route-hijacks are often detected utilizing ASPATH change detection. When one of these events happens, new links may appear (e.g. backup links that are now visible because of a different outcome of the BGP decision process), or the preferred routes may start using links that were rather unused before. A Link-Rank algorithm can be used to do baseline leak/hijack detection.

Goals: develop your own per-AS Link-Rank algorithm. Use this algorithm on a test-case to process data of a known route-leak time period. Experiment with different time periods to determine best performance.

Tasks:

- define a link weight that takes into account visibility changes
- run this algorithm on a test case (e.g. Malaysia Telekom leak)

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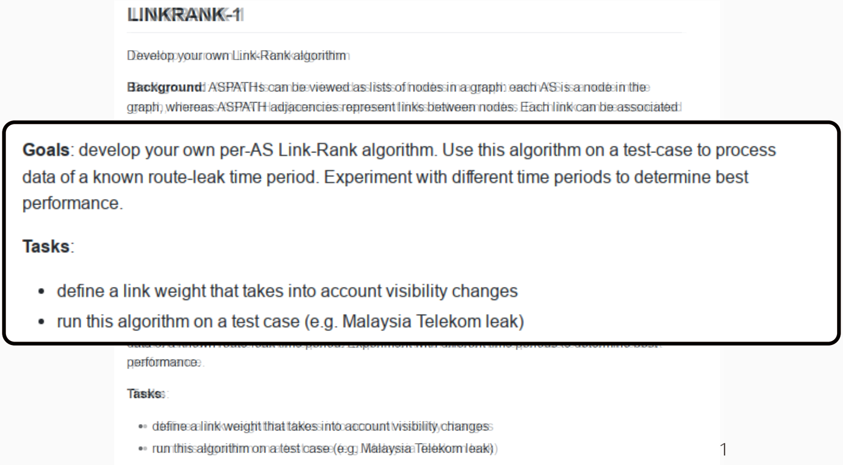

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[1] https://github.com/CAIDA/bgp-hackathon/wiki/List-of-Challenges#linkrank-1

Tools

Tools available and missing components

Tools available:

[2] https://bgpstream.caida.org/

[3] https://bgplayjs.com/?section=bgplay

[4] https://www.team-cymru.org/Services/Bogons/fullbogons-ipv4.txt

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- Test case: Telekom Malaysia leak.
- Metric: link weight.

Will be interesting to have:

- New metrics: link bogon degree and link stability.
- Rename: link weight to link rank.
- New Objective:
    - Algorithm to easily identify link with good/bad reputation.
    - Graphical view with intuitive color code: green to red.

Hypothesis & verification

Our approach (1/2)

Hypothesis

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Links with *good reputation*:

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Links with *good reputation*:

- does not carry bogon,
- have positive stability,
- are used by many AS.

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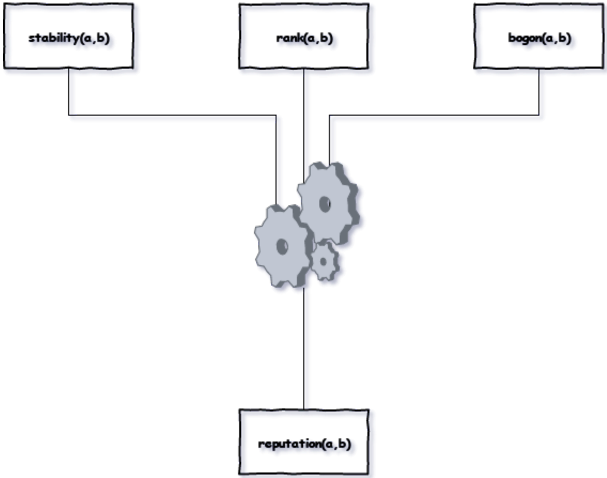
- have positive stability,
- are used by many AS.

Verification (1/2)

Developed an algorithm based on the hypothesis metrics:

- bogon degree - $bogons_t(\langle A, B \rangle)$,
- link stability - $stability_t(\langle A, B \rangle)$,
- link rank - $rank_t(\langle A, B \rangle)$.

Our algorithm...



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[6] https://www.ripe.net/publications/news/industry-developments/youtube-hijacking-a-ripe-ncc-ris-case-study

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Tested on three cases:

- Routes leak with Telekom Malaysia [5].
- Censorship with Youtube hijack by Pakistan Telecom [6].
- Malicious activities with Link Telecom incident[7].

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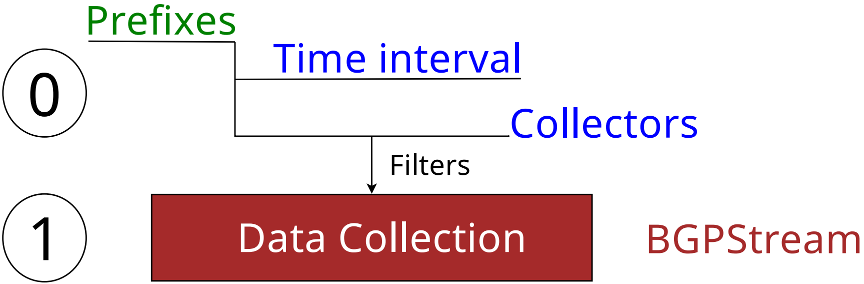
Three phases (1/3)



0

Prefixes

Time interval

Collectors

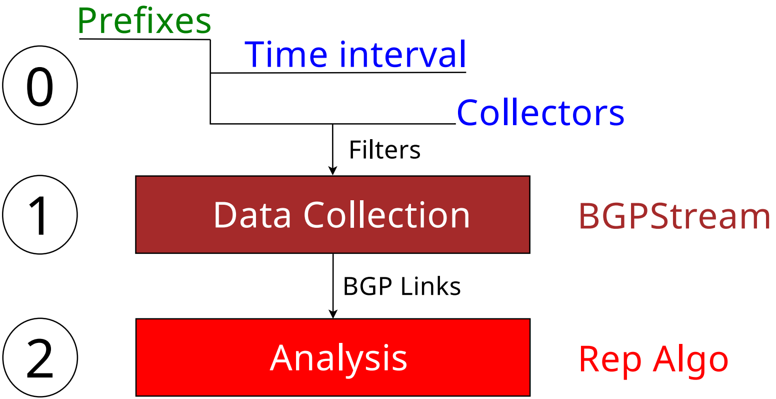
Filters

1

Data Collection

BGPStream

Three phases (2/3)



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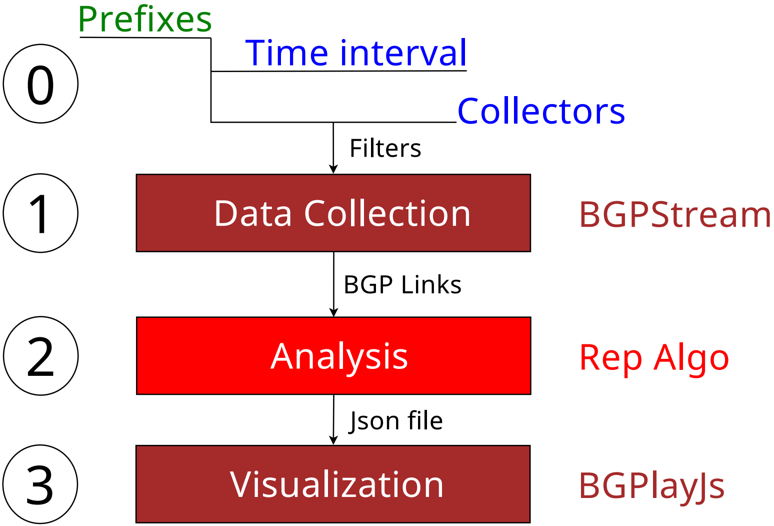

Malaysia Telecom test cases results

Test: Leak case (Telekom Malaysia)

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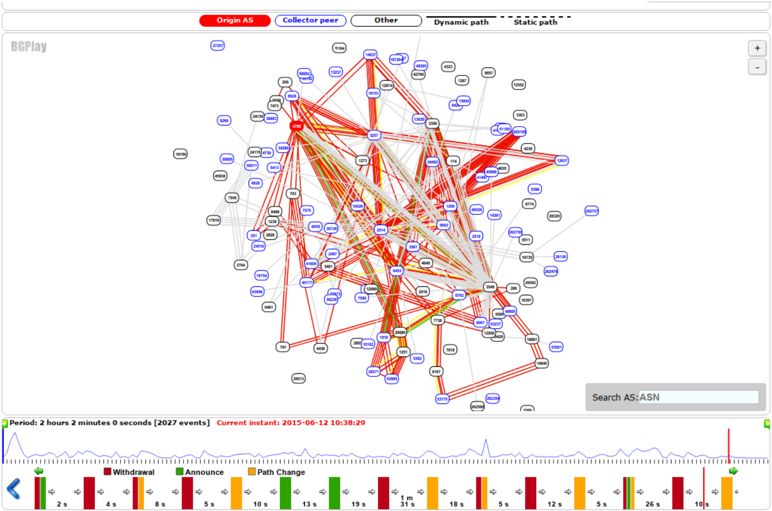

Period: 2 hours 2 minutes 0 seconds [2027 events] Current instant: 2015-06-12 10:38:29

Search AS: ASN

Test: Control case (Telekom Malaysia)

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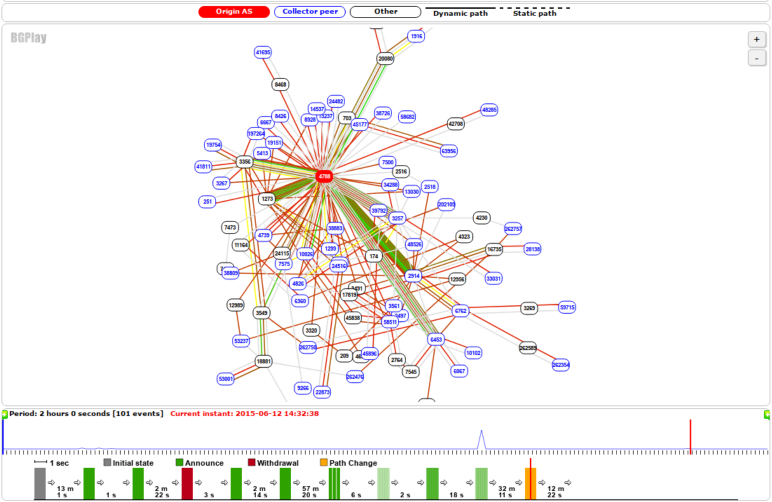

Period: 2 hours 0 seconds [101 events] Current instant: 2015-06-12 14:32:38

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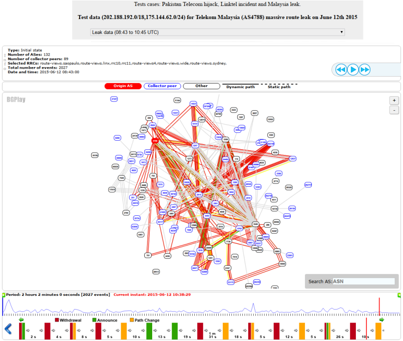

Tests cases: Pakistan Telecom hijack, Linktel incident and Malaysia leak.

Test data (202.188.192.0/18,175.144.62.0/24) for Telekom Malaysia (AS4788) massive route leak on June 12th 2015

Leak data (08:43 to 10:45 UTC) ▾

Type: Initial state
Number of ASes: 132
Number of collector peers: 89
Selected RRCs: route-views.saopaulo,route-views.linx,rrc10,rrc11,route-views4,route-views.wide,route-views.sydney,
Total number of events: 2027
Date and time: 2015-06-12 08:43:00

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Figure 1: Leak case reputation

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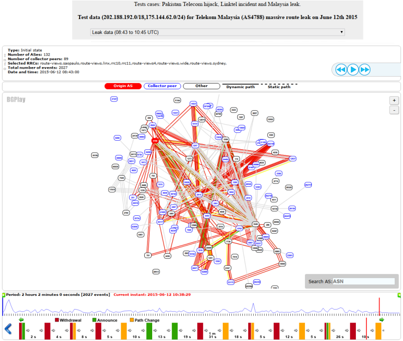

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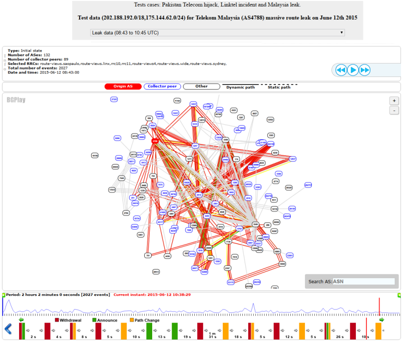

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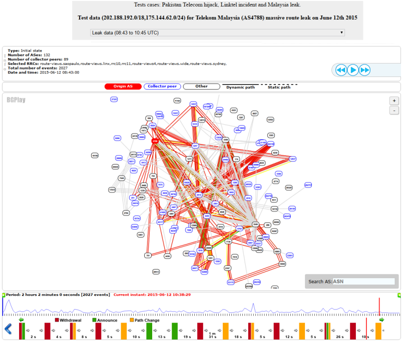

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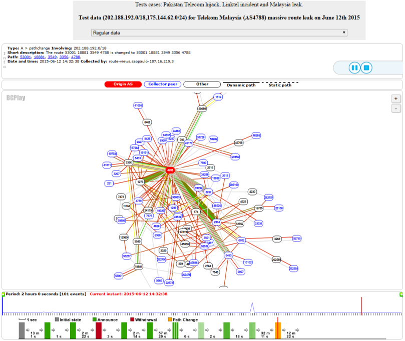

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Regular data ▾

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Date and time: 2015-06-12 14:32:38 **Collected by:** route-views.saopaulo-187.16.219.3

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Figure 2: Control case reputation

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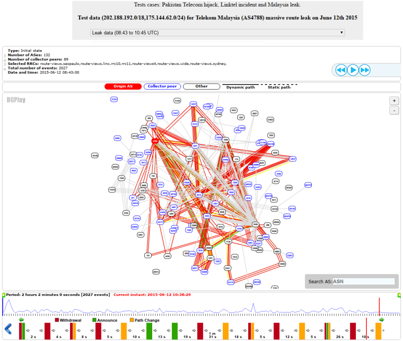
- Most links have *bad reputation*.

Leak and Control cases (Telekom Malaysia)



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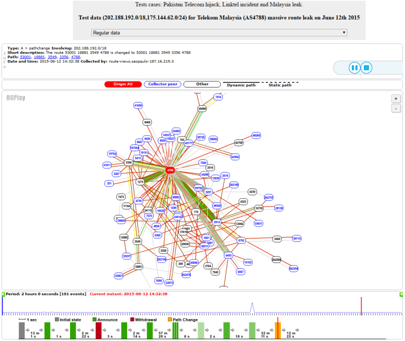

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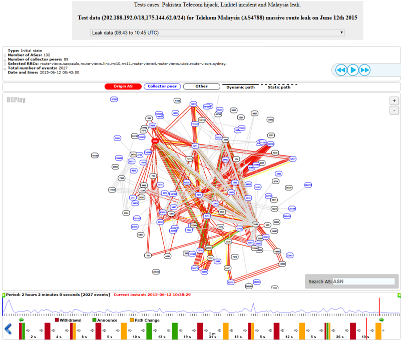

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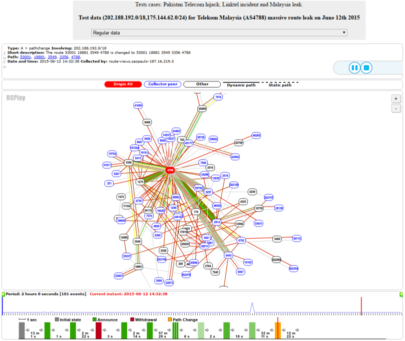

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Figure 2: Control case reputation

- 08:43 to 10:45 UTC.
- Most links have *bad reputation*.

- 12:45 to 14:45 UTC.
- Mix of *good* and *bad reputation*.

Other tests cases results

Censorship test case (YouTube Hijack)

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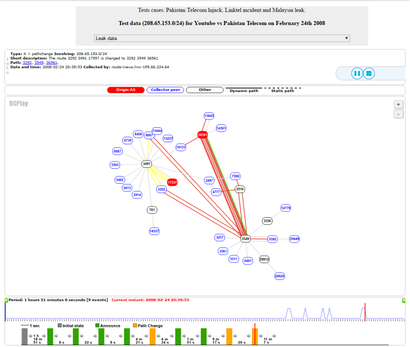

Tests cases: Pakistan Telecom hijack, Linktel incident and Malaysia leak.

Test data (208.65.153.0/24) for Youtube vs Pakistan Telecom on February 24th 2008

Leak data ▾

Type: A > pathchange **Involving:** 208.65.153.0/24
Short description: The route 3292 3491 17557 is changed to 3292 3549 36561
Path: 3292, 3549, 36561,
Date and time: 2008-02-24 20:39:53 **Collected by:** route-views.linx-195.66.224.64

Period: 1 hours 51 minutes 0 seconds [9 events] **Current instant: 2008-02-24 20:39:53**

Figure 3: Hijack case reputation

Censorship test case (YouTube Hijack)

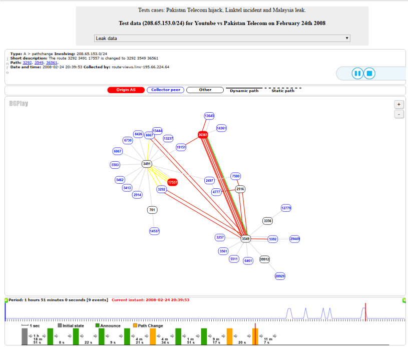

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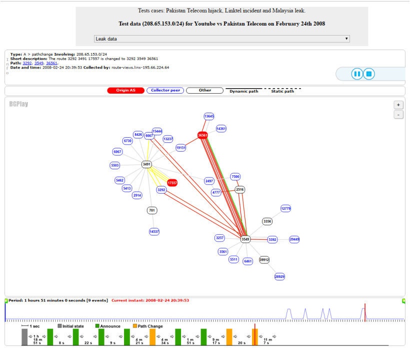
Figure 3: Hijack case reputation

- 19:00 to 20:51 UTC.
-

Censorship test case (YouTube Hijack)



Tests cases: Pakistan Telecom hijack, Linktel incident and Malaysia leak.

Test data (208.65.153.0/24) for Youtube vs Pakistan Telecom on February 24th 2008

Leak data ▾

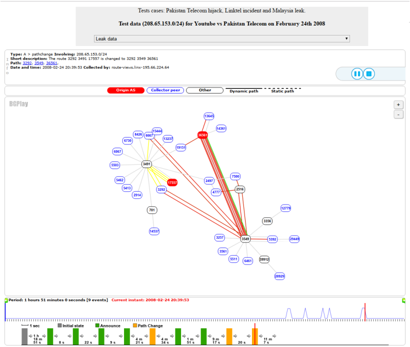
Type: A > pathchange **Involving:** 208.65.153.0/24
Short description: The route 3292 3491 17557 is changed to 3292 3549 36561
Path: 3292, 3549, 36561,
Date and time: 2008-02-24 20:39:53 **Collected by:** route-views.linx-195.66.224.64

Period: 1 hours 51 minutes 0 seconds [9 events] Current instant: 2008-02-24 20:39:53

Figure 3: Hijack case reputation

- 19:00 to 20:51 UTC.
- Youtube links have *bad reputation*.

Censorship test case (YouTube Hijack)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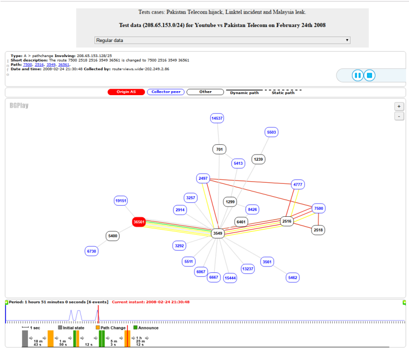

Tests cases: Pakistan Telecom hijack, Linktel incident and Malaysia leak.

Test data (208.65.153.0/24) for Youtube vs Pakistan Telecom on February 24th 2008

Regular data

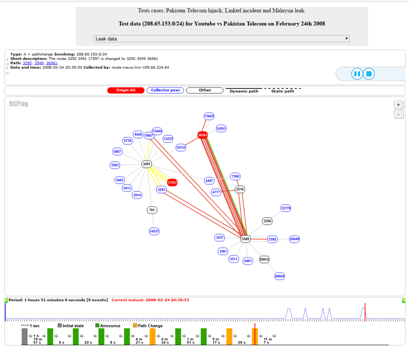
Type: A > pathchange **Involving:** 208.65.153.128/25
Short description: The route 7500 2518 2516 3549 36561 is changed to 7500 2516 3549 36561
Path: 7500, 2516, 3549, 36561,
Date and time: 2008-02-24 21:30:48 **Collected by:** route-views.wide-202.249.2.86

Period: 1 hours 51 minutes 0 seconds [6 events] Current instant: 2008-02-24 21:30:48

Figure 4: Control case reputation

- 19:00 to 20:51 UTC.
- Youtube links have *bad reputation*.

Censorship test case (YouTube Hijack)



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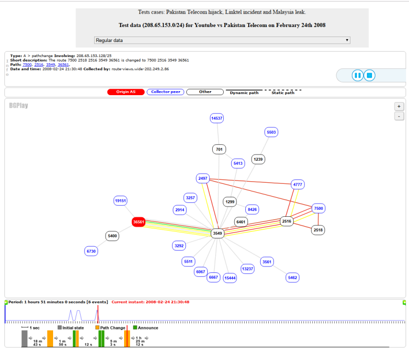

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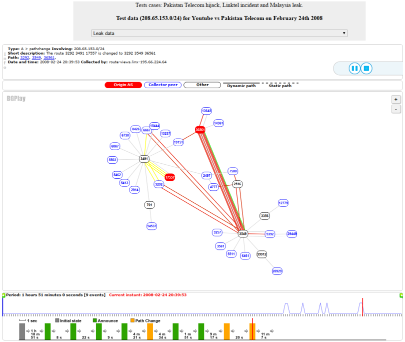
Period: 1 hours 51 minutes 0 seconds [6 events] Current instant: 2008-02-24 21:30:48

Figure 4: Control case reputation

- 21:05 to 22:56 UTC.
-

Censorship test case (YouTube Hijack)



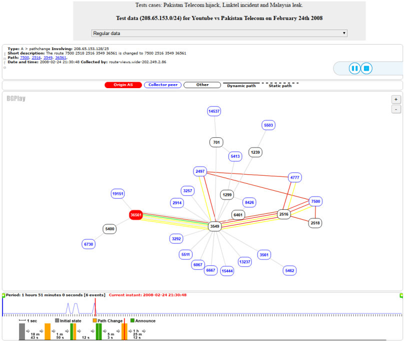
Tests cases: Pakistan Telecom hijack, Linktel incident and Malaysia leak.

Test data (208.65.153.0/24) for Youtube vs Pakistan Telecom on February 24th 2008

Leak data

Type: A > pathchange **Involving:** 208.65.153.0/24
Short description: The route 3292 3491 17557 is changed to 3292 3549 36561
Path: 3292, 3549, 36561,
Date and time: 2008-02-24 20:39:53 **Collected by:** route-views.linx-195.66.224.64

Period: 1 hours 51 minutes 0 seconds [9 events] Current instant: 2008-02-24 20:39:53



Tests cases: Pakistan Telecom hijack, Linktel incident and Malaysia leak.

Test data (208.65.153.0/24) for Youtube vs Pakistan Telecom on February 24th 2008

Regular data

Type: A > pathchange **Involving:** 208.65.153.128/25
Short description: The route 7500 2518 2516 3549 36561 is changed to 7500 2516 3549 36561
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Figure 3: Hijack case reputation

Figure 4: Control case reputation

- 19:00 to 20:51 UTC.
- Youtube links have *bad reputation*.

- 21:05 to 22:56 UTC.
- Mix of *good reputation* and *bad reputation*.

Malicious activities test case (Link Telecom Hijack)

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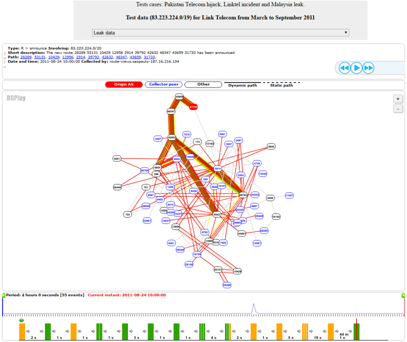

Tests cases: Pakistan Telecom hijack, Linktel incident and Malaysia leak.

Test data (83.223.224.0/19) for Link Telecom from March to September 2011

Leak data ▾

Type: R > announce **Involving:** 83.223.224.0/20
Short description: The new route 28289 53131 10429 12956 2914 39792 42632 48347 43659 31733 has been announced
Path: 28289, 53131, 10429, 12956, 2914, 39792, 42632, 48347, 43659, 31733,
Date and time: 2011-08-24 10:00:00 **Collected by:** route-views.saopaulo-187.16.216.104

Period: 2 hours 0 seconds [55 events] Current instant: 2011-08-24 10:00:00

Figure 5: Leak case reputation

Malicious activities test case (Link Telecom Hijack)

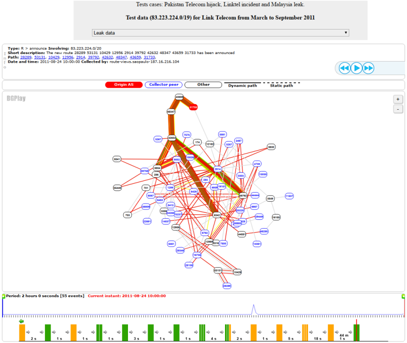

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Figure 5: Leak case reputation

- 08:00 to 10:00 UTC (August 24, 2011).
-

Malicious activities test case (Link Telecom Hijack)

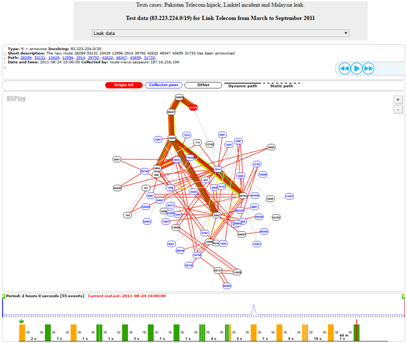

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Figure 5: Leak case reputation

- 08:00 to 10:00 UTC (August 24, 2011).
- Most links have *bad reputation*.

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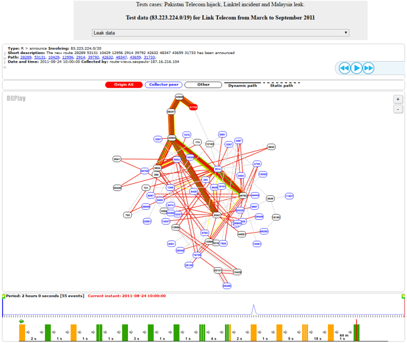

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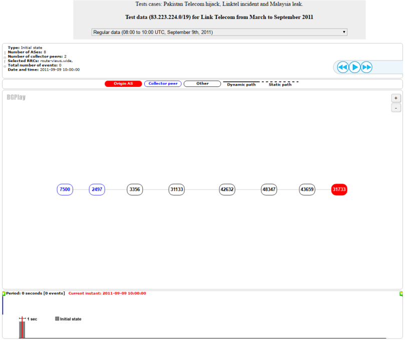

Tests cases: Pakistan Telecom hijack, Linktel incident and Malaysia leak.

Test data (83.223.224.0/19) for Link Telecom from March to September 2011

Regular data (08:00 to 10:00 UTC, September 9th, 2011) ▾

Type: Initial state
Number of ASes: 8
Number of collector peers: 2
Selected RRCs: route-views.wide,
Total number of events: 0
Date and time: 2011-09-09 10:00:00

Period: 0 seconds [0 events] Current instant: 2011-09-09 10:00:00

Figure 6: Control case reputation

- 08:00 to 10:00 UTC (August 24, 2011).
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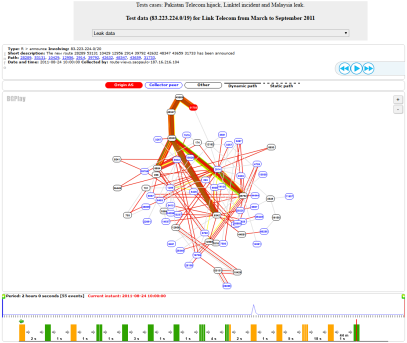
Malicious activities test case (Link Telecom Hijack)



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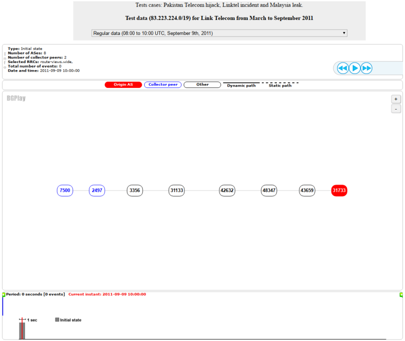

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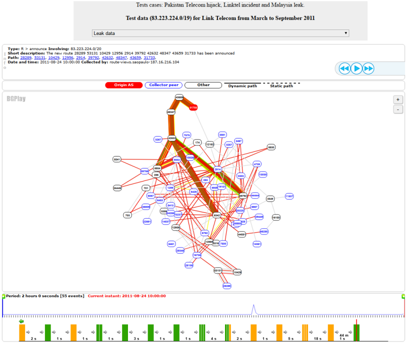

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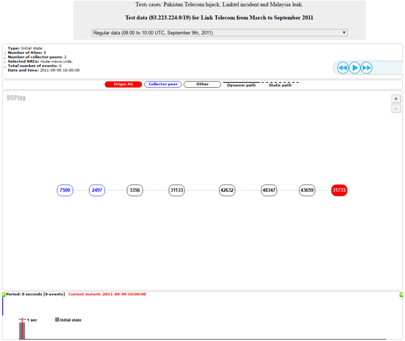

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Figure 6: Control case reputation

- 08:00 to 10:00 UTC (September 9, 2011).
- No event.

Improvement (proposals)

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- Better view

Improvement (proposals)

- Better view
    - [Problem] Unclear view with BGPlayJS.
    -

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  - [Proposal] Draw **One** line between links (using netJSON ?).

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- More testing
    - [Problem] Only three test cases.
    -

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  - [Problem] Only three test cases.
  - [Proposal] Add more (well-known) BGP incidents.
- Large scale algorithm
  - [Problem] BGP is large scale protocol vs limited resources.
  - [Proposal] Use Massive Data/AI tools for link classification.

Thanks

Thanks

Corrections / updates / comments

would be appreciated