Measuring and Monitoring BGP

Alberto Dainotti,
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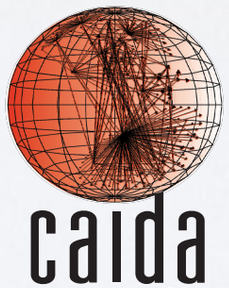

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MEASURING BGP

Why?

BGP is the central nervous system of the Internet

BGP's design is known to contribute to issues in:

- **Availability**
  - -Labovitz et al. *"Delayed Internet Routing Convergence"*, IEEE/ACM Trans. Netw., 2001.
  - -Varadhan et al. *"Persistent Route Oscillations in Inter-domain Routing"*. Computer Networks, 2000.
  - -Katz-Bassett et al. "*LIFEGUARD: Practical Repair of Persistent Route Failures*", SIGCOMM, 2012.
- **Performance**
  - -Spring et al. *"The Causes of Path Inflation"*. SIGCOMM, 2003.
- **Security**
  - -Zheng et al. *"A Light-Weight Distributed Scheme for Detecting IP Prefix Hijacks in Realtime"*. SIGCOMM, 2007.

Need to *engineer* protocol evolution!

MEASURING BGP

Why?

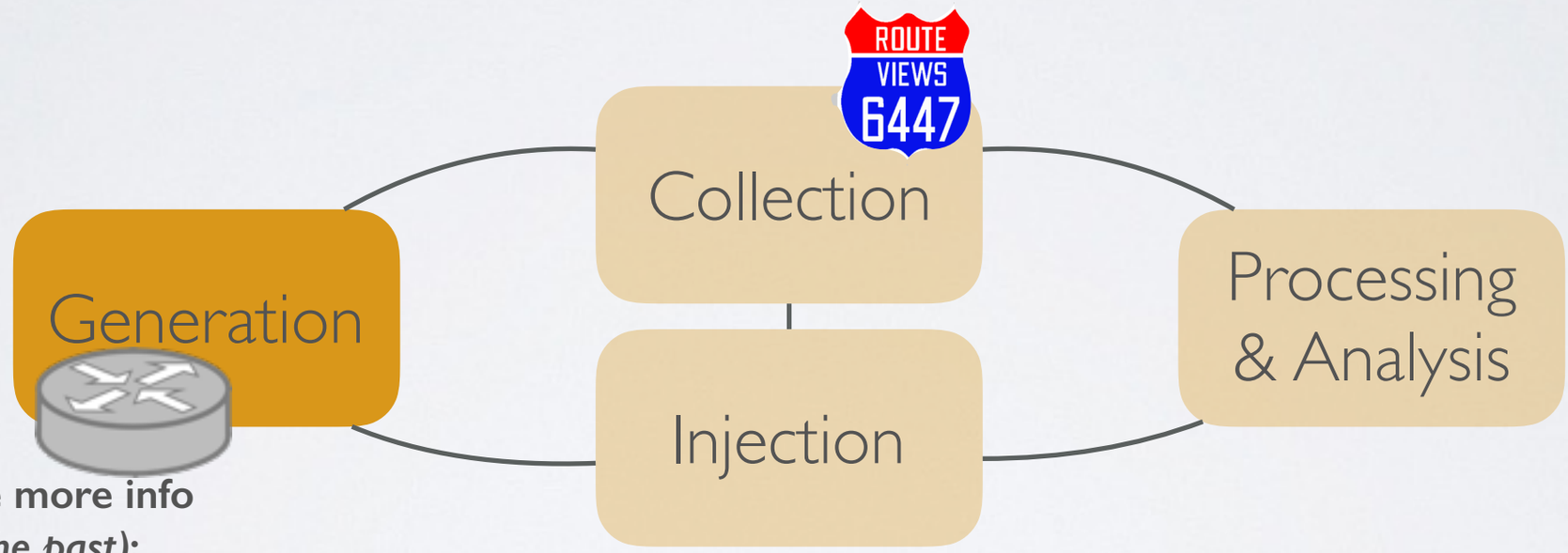
Defining problems and make ***protocol engineering*** decisions through realistic evaluations is difficult also because **we know little about the <u>structure</u> and <u>dynamics</u> of the BGP ecosystem!**

- AS-level topology
  -Gregori et al. *"On the incompleteness of the AS-level graph: a novel methodology for BGP route collector placement"*, IMC 2012
- AS relationships
  -Giotsas et al. *"Inferring Complex AS Relationships"*, IMC 2014
- AS interactions: driven by relationships, policies, network conditions, operator updates
  -Anwar et al. *"Investigating Interdomain Routing Policies in the Wild "*, IMC 2015
  -Lychev et al. *"BGP Security in Partial Deployment: Is the Juice Worth the Squeeze?"*, SIGCOMM 2013

MEASURING BGP

two issues - somehow related

1. Literature shows that **we need more/better data**
   - more info from the protocol/routers



Attempts to generate more info
***(not much traction in the past)*:**

- **`RFC 4384 BGP Communities for Data Collection`**
- **`draft-ymbk-grow-bgp-collector-communities`**

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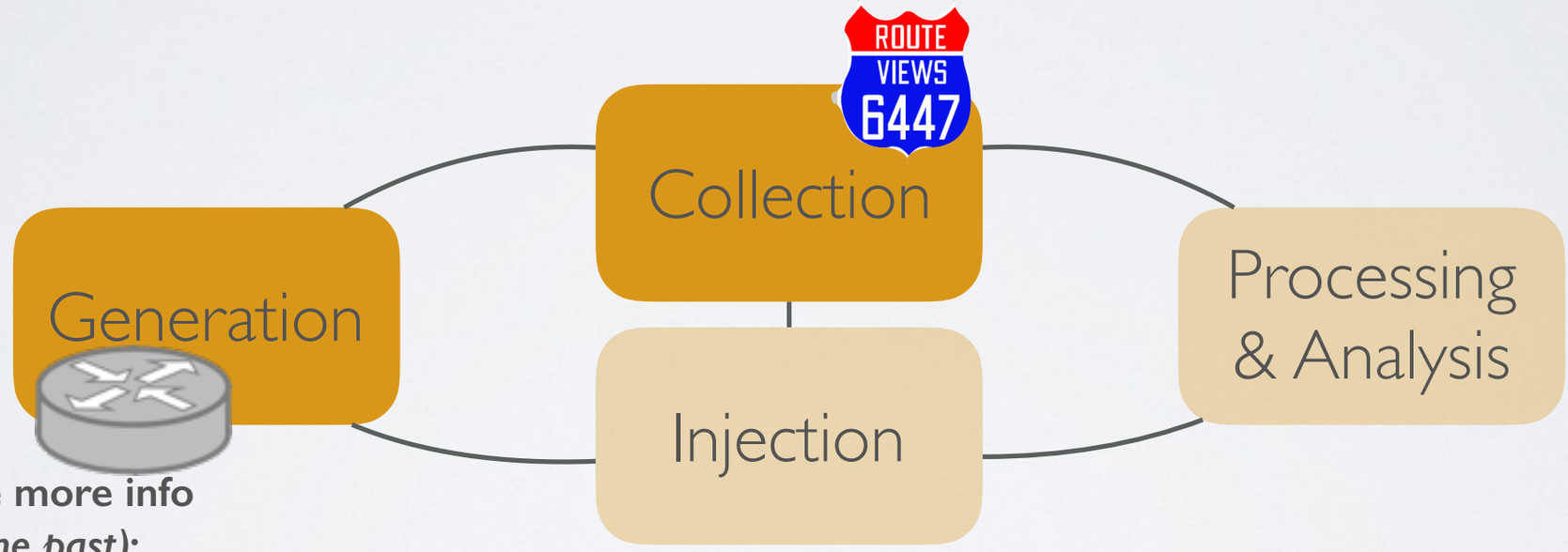

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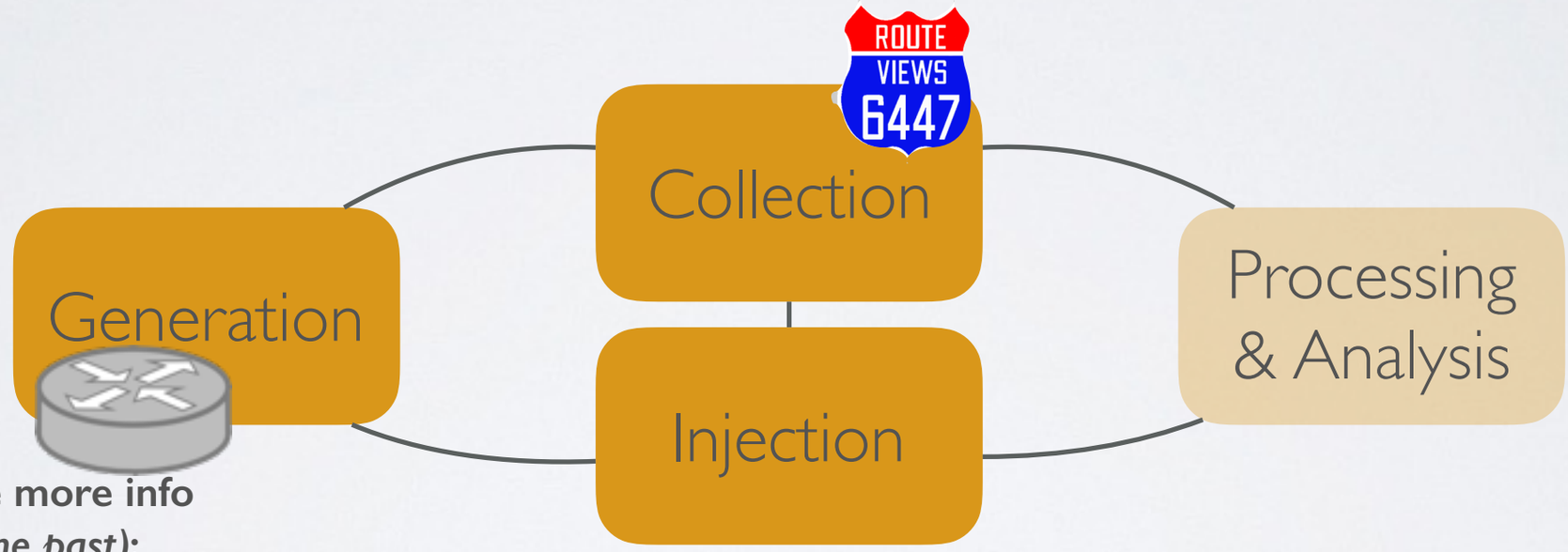

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Inject/Receive Routes & Traffic.
PEERING - http://peering.usc.edu
Schlinker et al. *"PEERING: An AS for Us"*, HotNets 2014

MEASURING BGP

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1. Literature shows that **we need more/better data**
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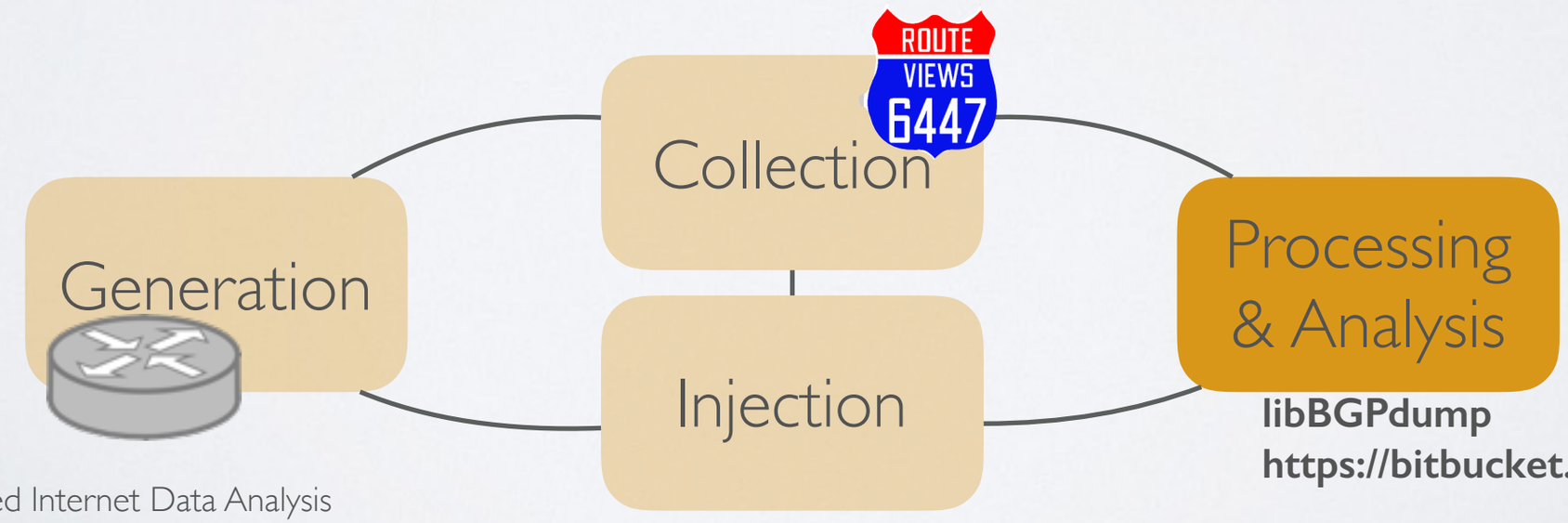
2. But we also **need better tools to learn from the data**
   - to make data analysis: *easier, faster, able to cope with BIG and heterogeneous data*
   - to monitor BGP in near-realtime
   - tightening data collection, processing, visualization, …



libBGPdump
https://bitbucket.org/ripencc/bgpdump

BGP EVENTS & DYNAMICS

IODA: Detection and Analysis of Internet Outages

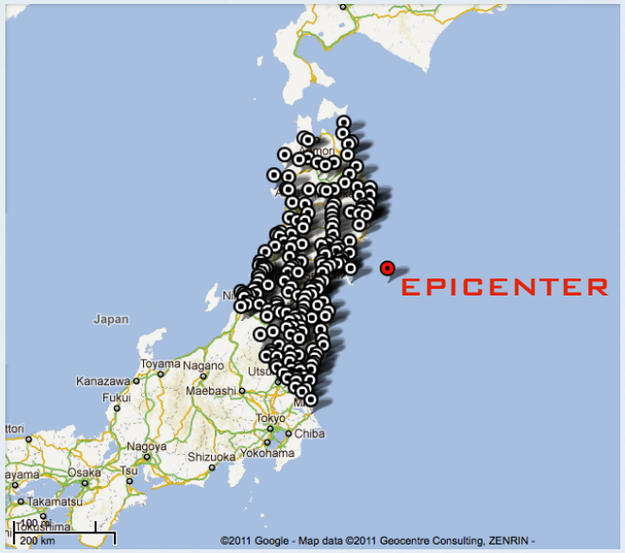
- Country-level Internet Blackouts during the Arab Spring

Dainotti et al. "Analysis of Country-wide Internet Outages Caused by Censorship" IMC 2011

Egypt, Jan 2011
Government orders to shut down the Internet

- Natural disasters affecting the infrastructure

Dainotti et al. "Extracting Benefit from Harm: Using Malware Pollution to Analyze the Impact of Political and Geophysical Events on the Internet" SIGCOMM CCR 2012

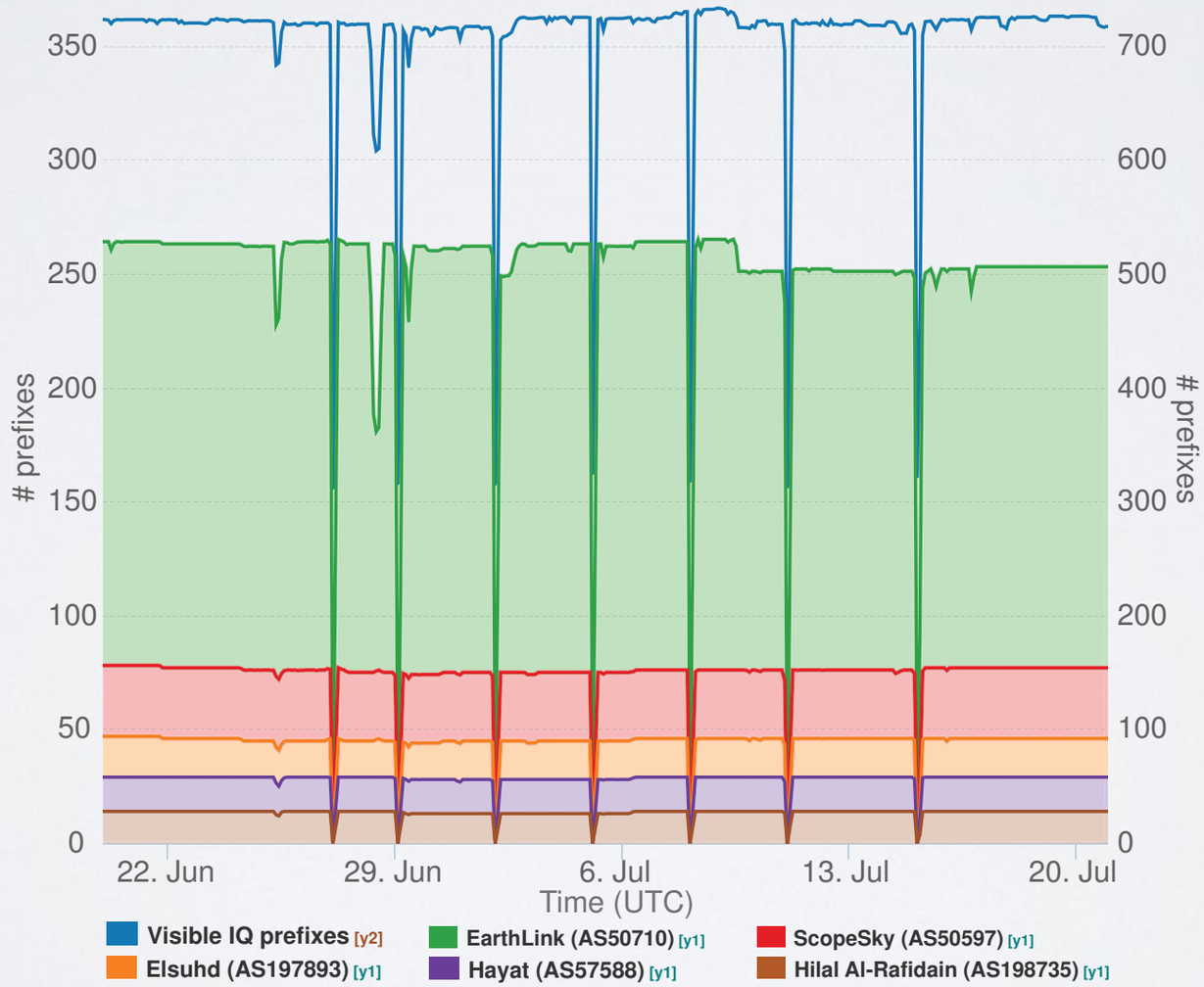


Japan, Mar 2011
Earthquake of Magnitude 9.0

BGP EVENTS & DYNAMICS

IODA: Detection and Analysis of Internet Outages

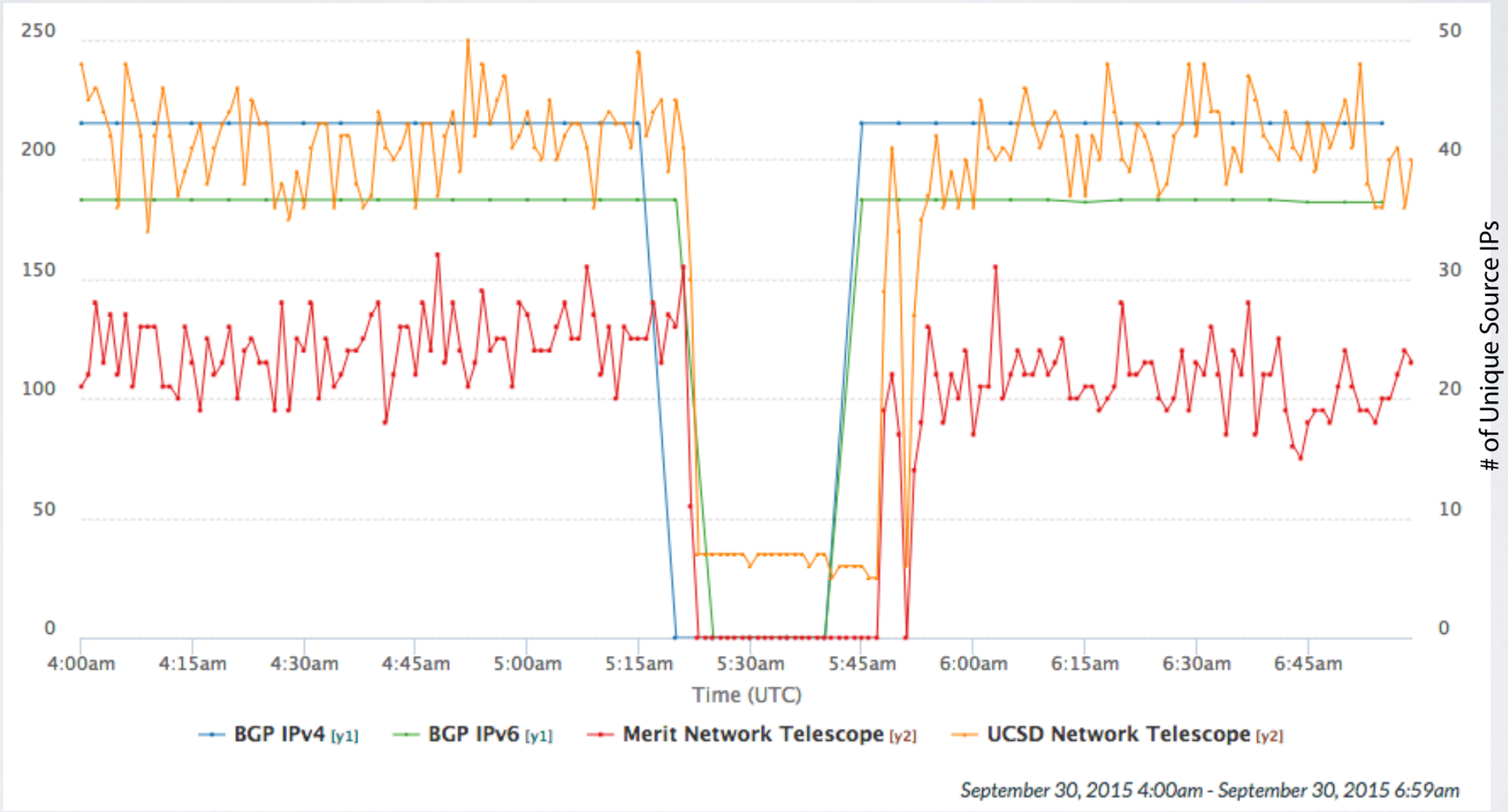
Country-wide Internet outages in Iraq that the government ordered in conjunction with the ministerial preparatory exams - Jul 2015



BGP EVENTS & DYNAMICS

IODA: Detection and Analysis of Internet Outages

Outage of AS11351(Time Warner Cable LLC)
September 30, 2015

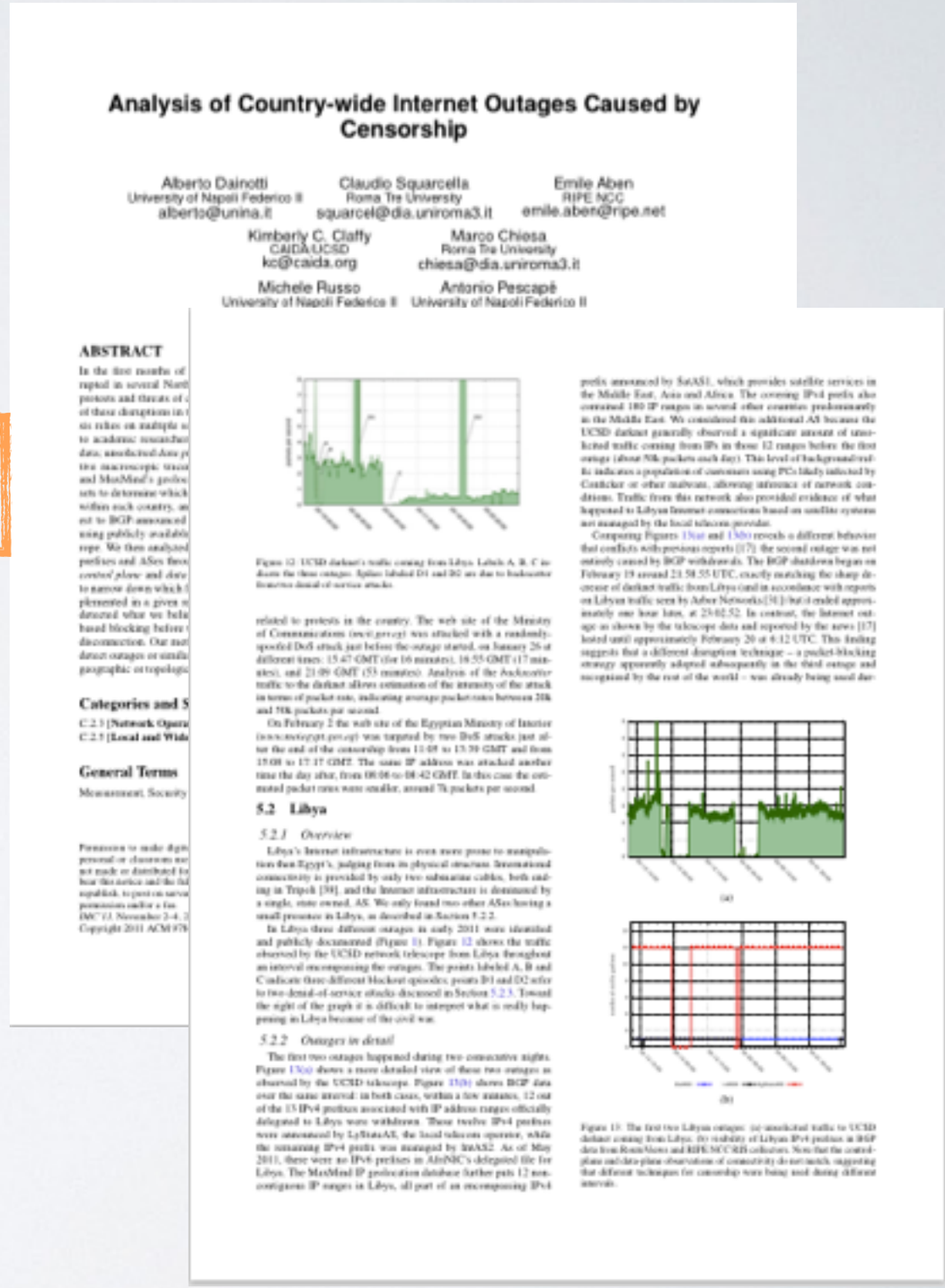


BEFORE IODA

post-event manual analysis

Egypt, Jan 2011
Government orders to shut down the Internet

4 months of work



Analysis of Country-wide Internet Outages Caused by Censorship

Alberto Dainotti, University of Napoli Federico II, alberto@unina.it
Claudio Squarcella, Roma Tre University, squarcel@dia.uniroma3.it
Emile Aben, RIPE NCC, emile.aben@ripe.net
Kimberly C. Claffy, CAIDA/UCSD, kc@caida.org
Marco Chiesa, Roma Tre University, chiesa@dia.uniroma3.it
Michele Russo, University of Napoli Federico II
Antonio Pescapé, University of Napoli Federico II

ABSTRACT

Dainotti et al. "Analysis of Country-wide Internet Outages Caused by Censorship" IMC 2011

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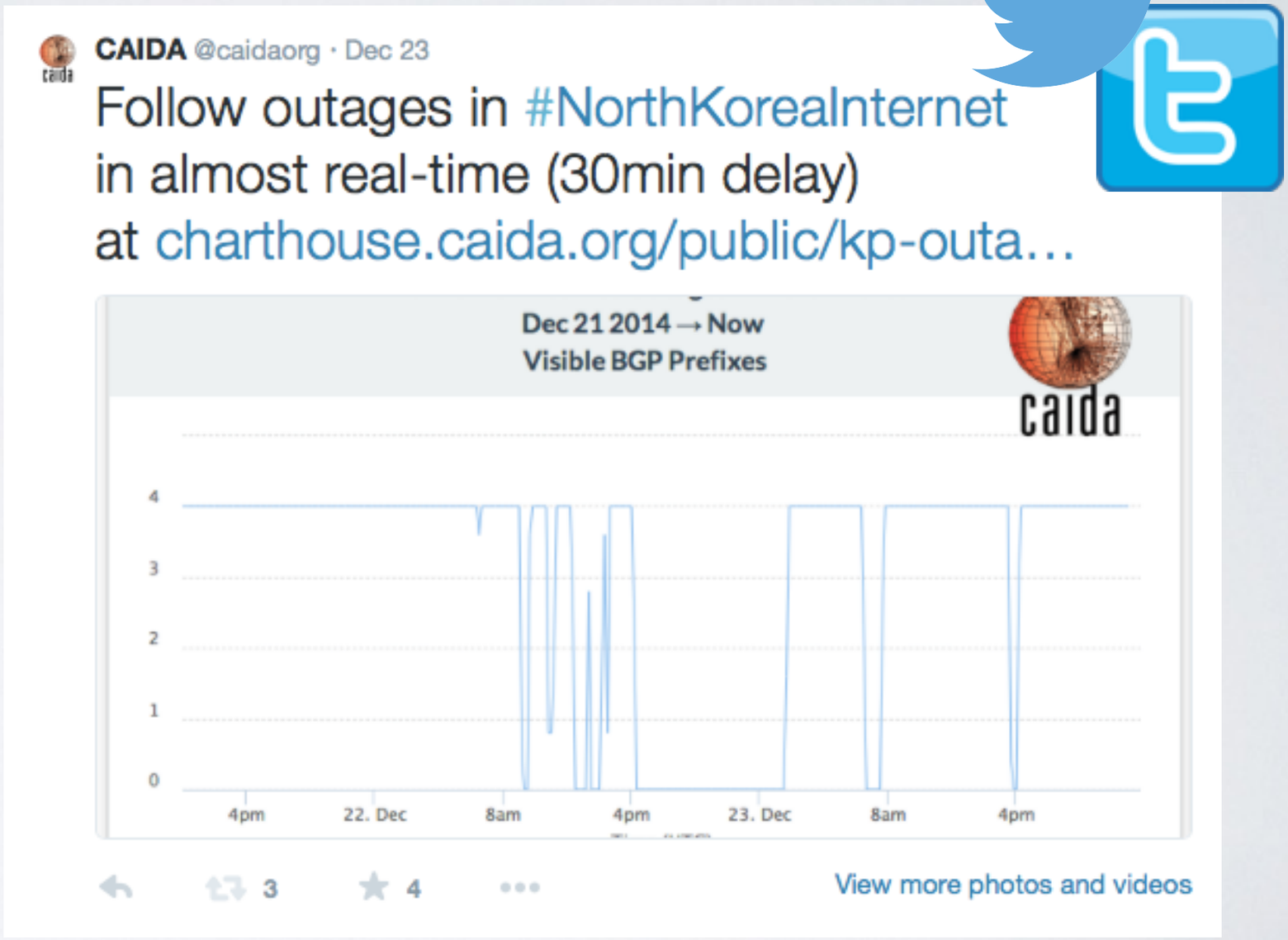
IODA TODAY

live Internet monitoring

Last Christmas we made it possible for anybody to follow the North Korean disconnection almost live



MEASURING BGP

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   - more info from the protocol/routers, more collectors, more experimental testbeds, …

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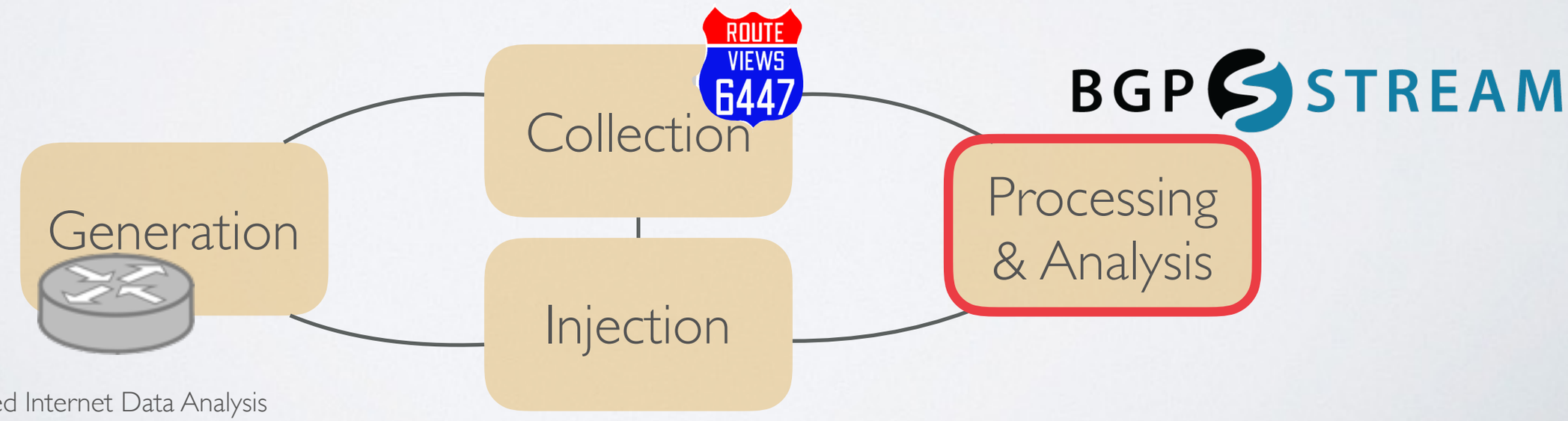
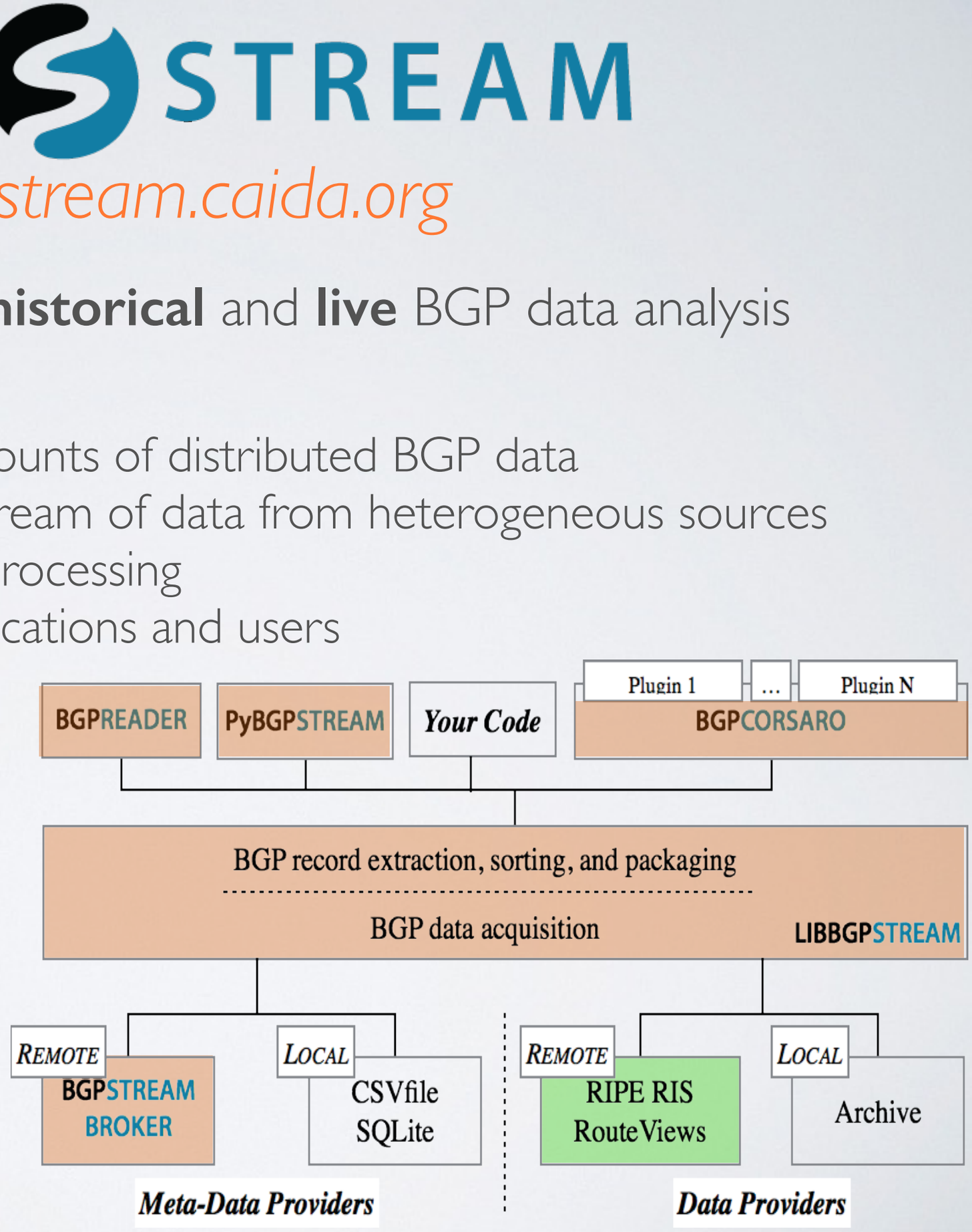


BGPSTREAM

bgpstream.caida.org

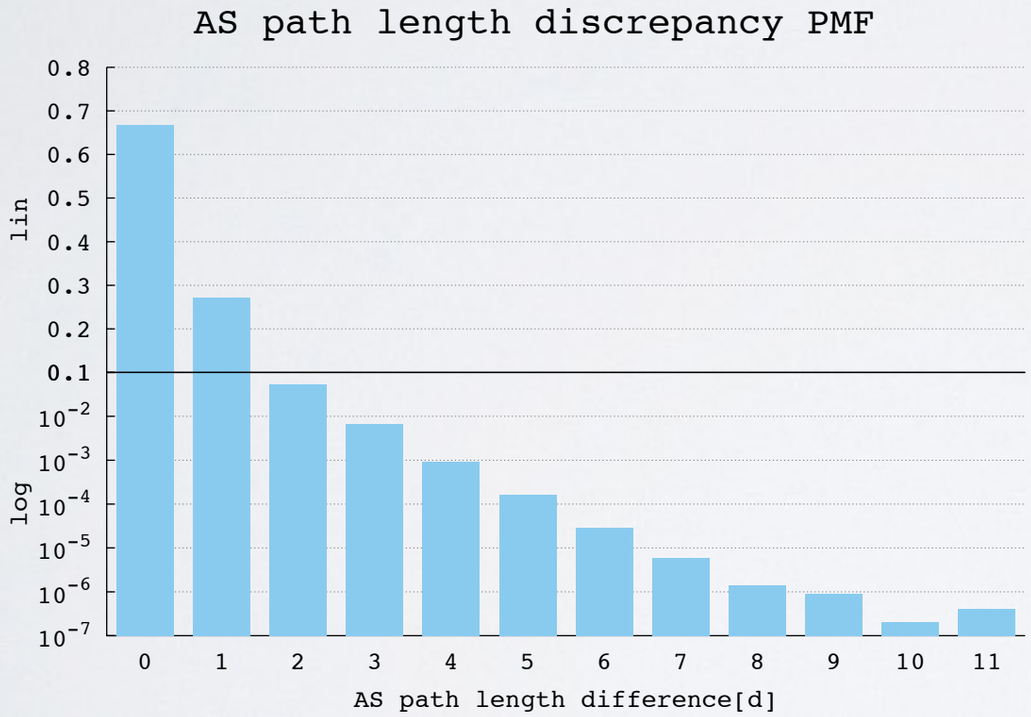
- A software framework for **historical** and **live** BGP data analysis
- Design goals:
  - -Efficiently deal with large amounts of distributed BGP data
  - -Offer a time-ordered data stream of data from heterogeneous sources
  - -Support near-realtime data processing
  - -Target a broad range of applications and users
  - -Scalable
  - -Easily extensible



PYBGPSTREAM

Example: studying AS path inflation

How many AS paths are longer than the shortest path between two ASes due to routing policies? (directly correlates to the increase in BGP convergence time)




```python
from _pybgpstream import BGPStream, BGPRecord, BGPElem
from collections import defaultdict
from itertools import groupby
import networkx as nx

stream = BGPStream()
as_graph = nx.Graph()
rec = BGPRecord()
bgp_lens = defaultdict(lambda: defaultdict(lambda: None))
stream.add_filter('record-type','ribs')
stream.add_interval_filter(1438415400,1438416600)
stream.start()

while(stream.get_next_record(rec)):
    elem = rec.get_next_elem()
    while(elem):
        monitor = str(elem.peer_asn)
        hops = [k for k, g in groupby(elem.fields['as-path'].split(" "))]
        if len(hops) > 1 and hops[0] == monitor:
            origin = hops[-1]
            for i in range(0,len(hops)-1):
                as_graph.add_edge(hops[i],hops[i+1])
            bgp_lens[monitor][origin] = \
                min(filter(bool,[bgp_lens[monitor][origin],len(hops)]))
        elem = rec.get_next_elem()
for monitor in bgp_lens:
    for origin in bgp_lens[monitor]:
        nxlen = len(nx.shortest_path(as_graph, monitor, origin))
        print monitor, origin, bgp_lens[monitor][origin], nxlen
```

30 LINES OF PYTHON CODE

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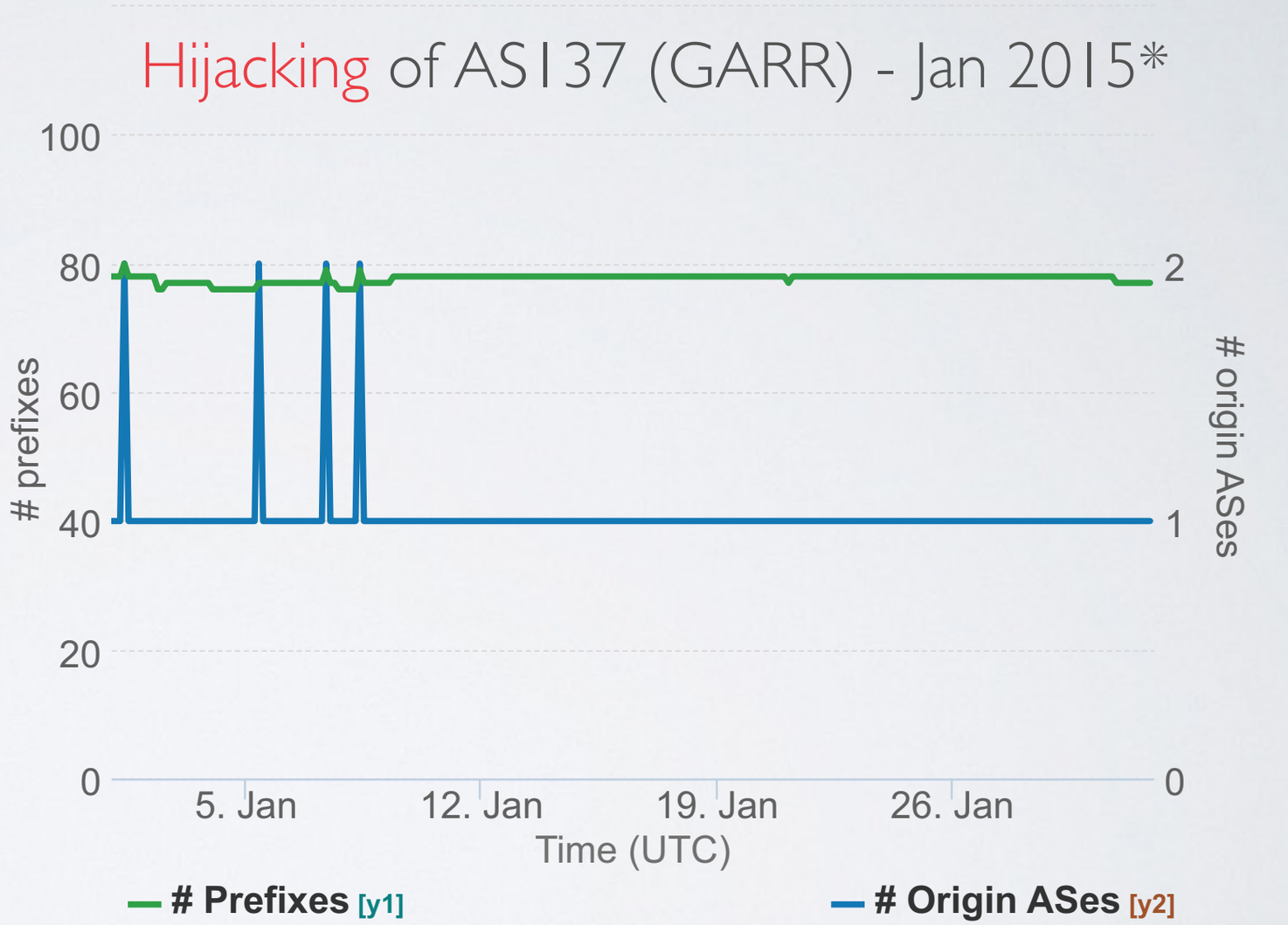
BGPCORSARO

Example: monitor your own address space on BGP

*The "**prefix-monitor**" plugin (distributed with source) monitors a set of IP ranges as they are seen from BGP monitors distributed worldwide:*

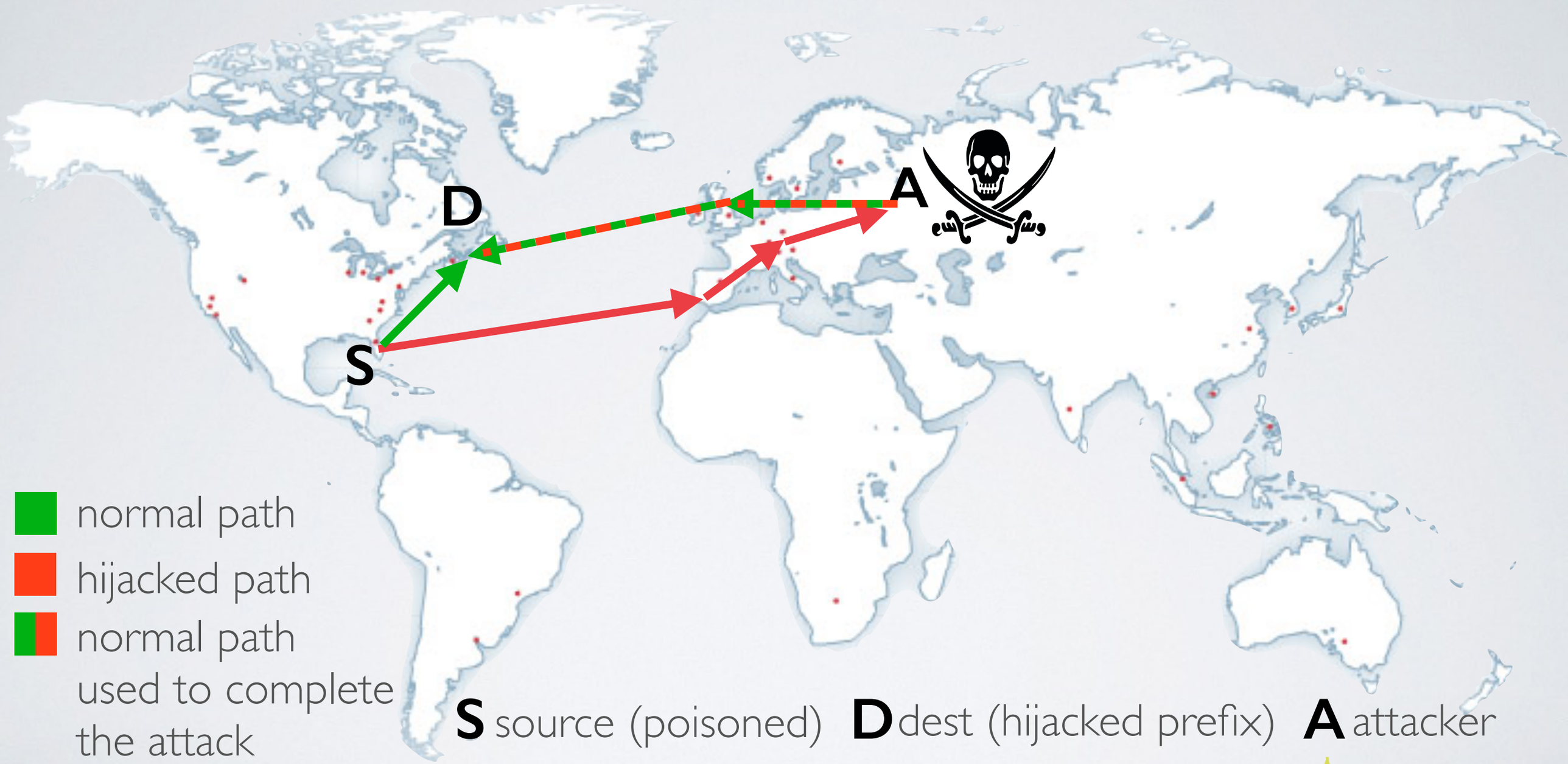
- *how many prefixes reachable*
- *how many origin ASes*
- *generates detailed logs*



**Originally discovered by Dyn: http://research.dyn.com/2015/01/vast-world-of-fraudulent-routing/*

ANOTHER SUPPORTED PROJECT

Hijacks: detection of MITM BGP attacks



normal path

hijacked path

normal path used to complete the attack

S source (poisoned) **D** dest (hijacked prefix) **A** attacker

caida

Stony Brook University

www.caida.org/funding/hijacks/

COMCAST

NSF

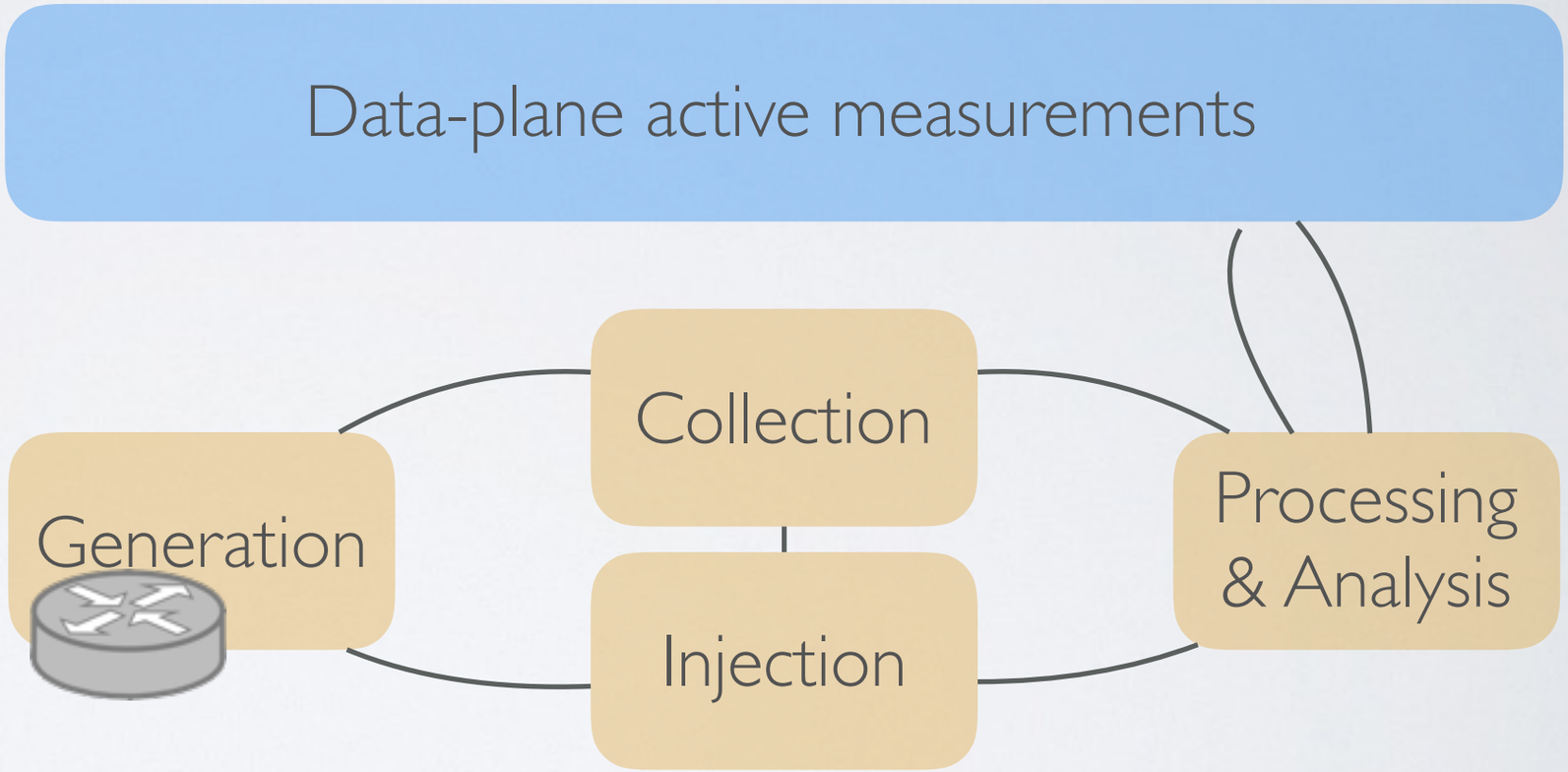
U.S. DEPARTMENT OF HOMELAND SECURITY

ANOTHER SUPPORTED PROJECT

Hijacks: detection of MITM BGP attacks

Research informed by (and tested with) ***data in the wild***

Live BGP measurements trigger on-demand dataplane measurements (e.g., traceroutes) ***during*** *a suspicious event.*



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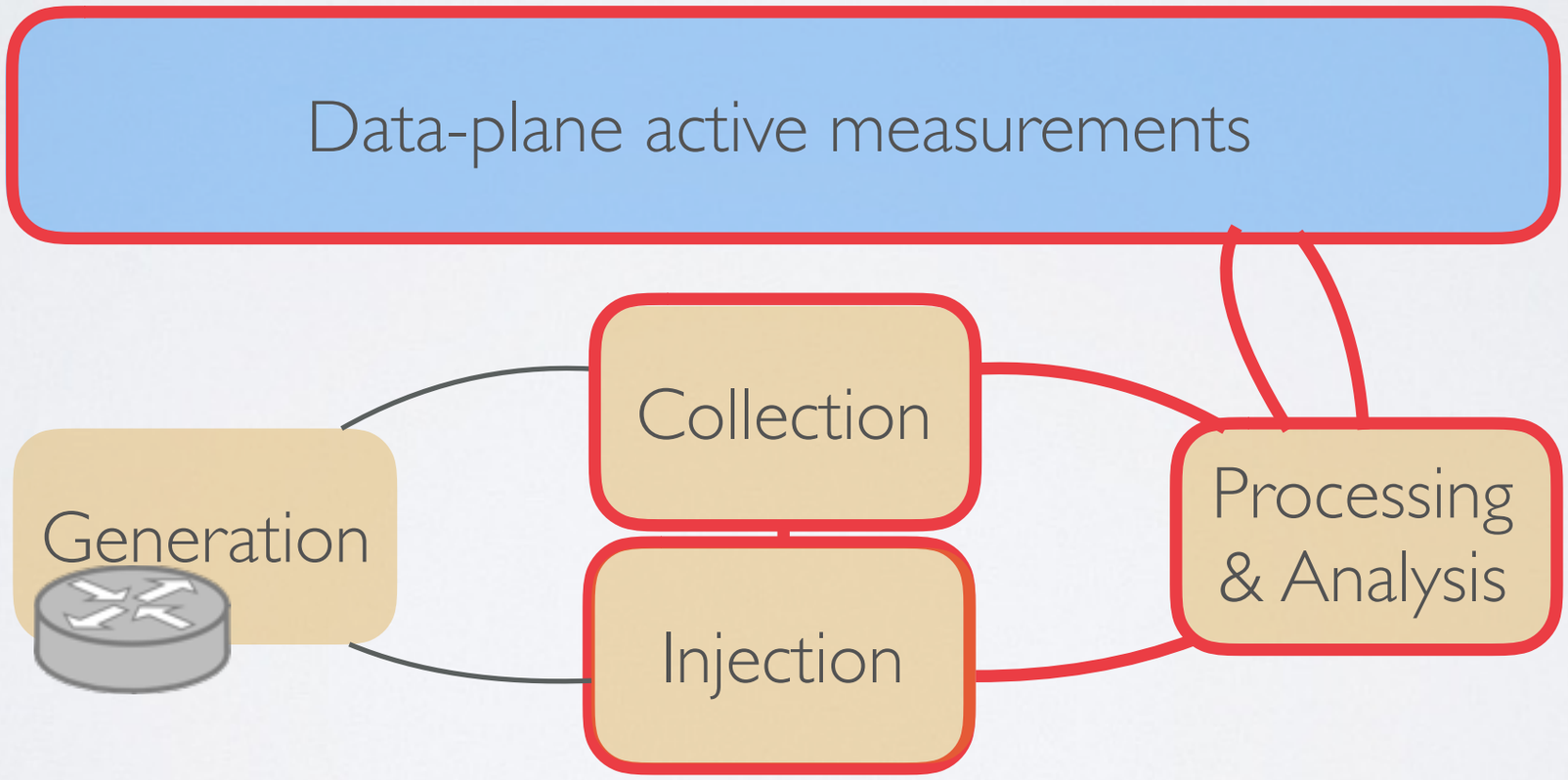
BGP HACKATHON - FEB 2016

*theme: "**live** BGP measurements & monitoring"*

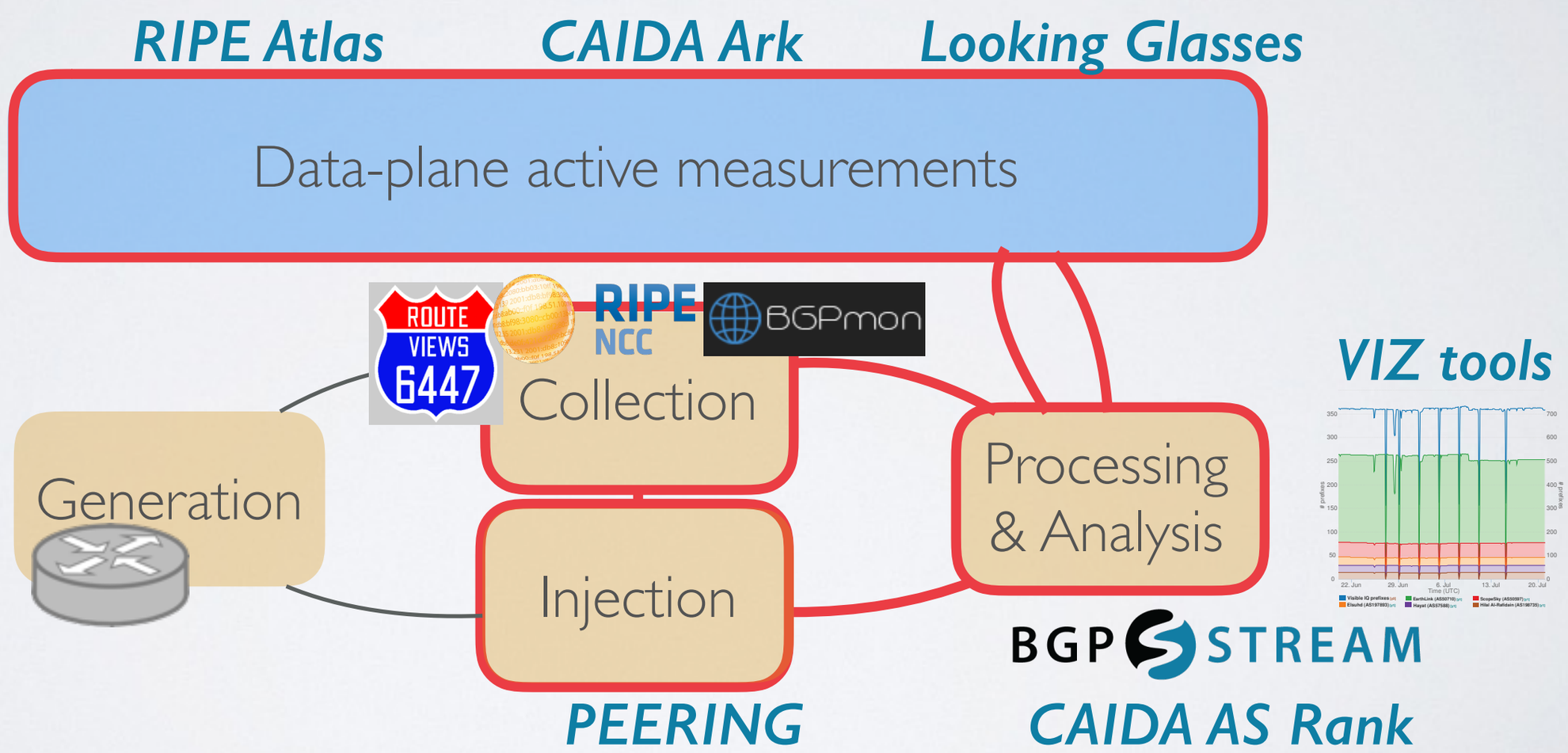
Improve/Integrate tools to study the BGP eco-system. Target practical problems: topology, hijacks, outages, RPKI deployment, path inflation, circuitous paths, policies, relationships, visualize dynamics, …



BGP HACKATHON - FEB 2016

*theme: "**live** BGP measurements & monitoring"*

We will provide a rich toolbox and "live" data access:



BGP HACKATHON

http://github.com/CAIDA/bgp-hackathon/wiki

- **6-7 February 2016** (weekend before NANOG 66)
- **San Diego** Supercomputer Center, UC San Diego
- **Theme**: **live BGP measurements** and monitoring
- Toolbox: *BGPMon, RIPE RIS, PEERING, BGPStream, RIPE Atlas, CAIDA Archipelago, Route Views, looking glasses, AS relationships, AS Rank, Visualization tools, …*

- How to **contribute**:
  - *join us and come over to hack!*
  - *help teams as a domain expert*
  - *propose projects that hacking teams may pick*
  - *offer to join the jury that will assign awards*

>>> bgp-hackathon-info@caida.org <<<

THANKS

bgpstream.caida.org

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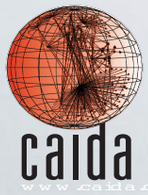

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