# Path Transparency Observatory
## Demo of the Web User Interface

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mami
measurement and architecture for a middleboxed internet

measurement | architecture | experimentation

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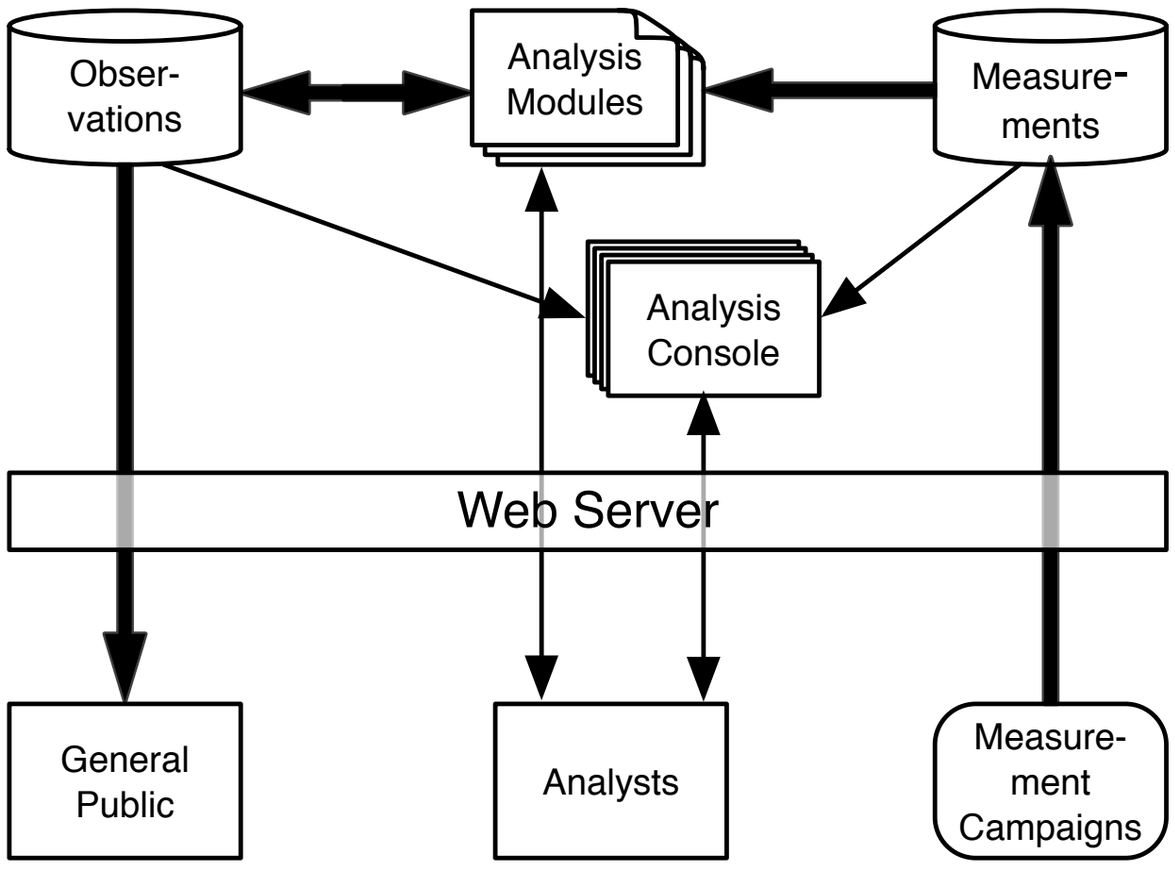
# Path Transparency Observatory - PTO

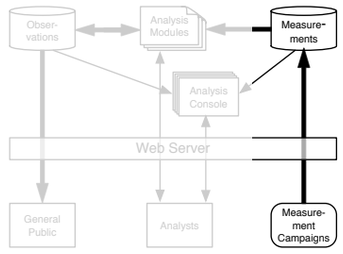
- Store
  - raw data and
  - computed conditions
- that relate to path transparency, enabling
  - exploration and
  - analysis
- with a special focus on
  - easing replication and
  - providing insights to the general public

# PTO - Architecture



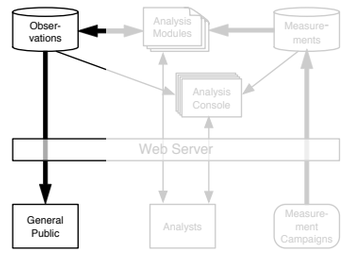

- **Raw measurement storage**
  - manual or automated upload per measurement campaign
- **Analyzers**
  - generate *observations* from measurements
  - Jupyterhub for interactive analysis and analysis development
- **Web UI for general public**
  - access to selected observations from vetted analysis modules

# PTO - Measurements




- Raw data stored from measurement campaigns
- Data format most appropriate to the tool/campaign
  - IPFIX, tracebox, json, mPlane results …
- Stored in HDFS for easy clustering
  - metadata stored in MongoDB

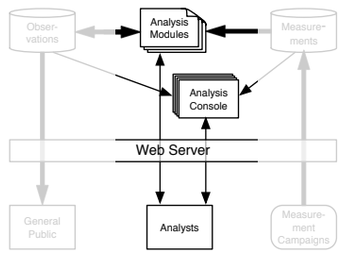
# PTO - Observations




- **Path Transparency Observation {P, t, c, v}**
  - *path designator* **P*:*** sequence of identifiers for path along which the observation was taken (initiator, target, and other point on along path between them, as e.g. network-layer addresses, prefixes, or AS numbers)
  - *temporal scope* **t*:*** when a observation was taken and is considered valid
  - *condition* **c:** condition observed along the path (e.g. whether ECN causes connectivity failure, whether a TFO cookie request succeeds); inherently boolean, but may contain associated values **v**.

- Conditions have symbolic names, arranged in hierarchy, e.g.,
  - **`ecn.connectivity.works`**
  - **`ecn.negotiation_attempt.succeeded`**
- Stored in MongoDB for ease of clustering and querying

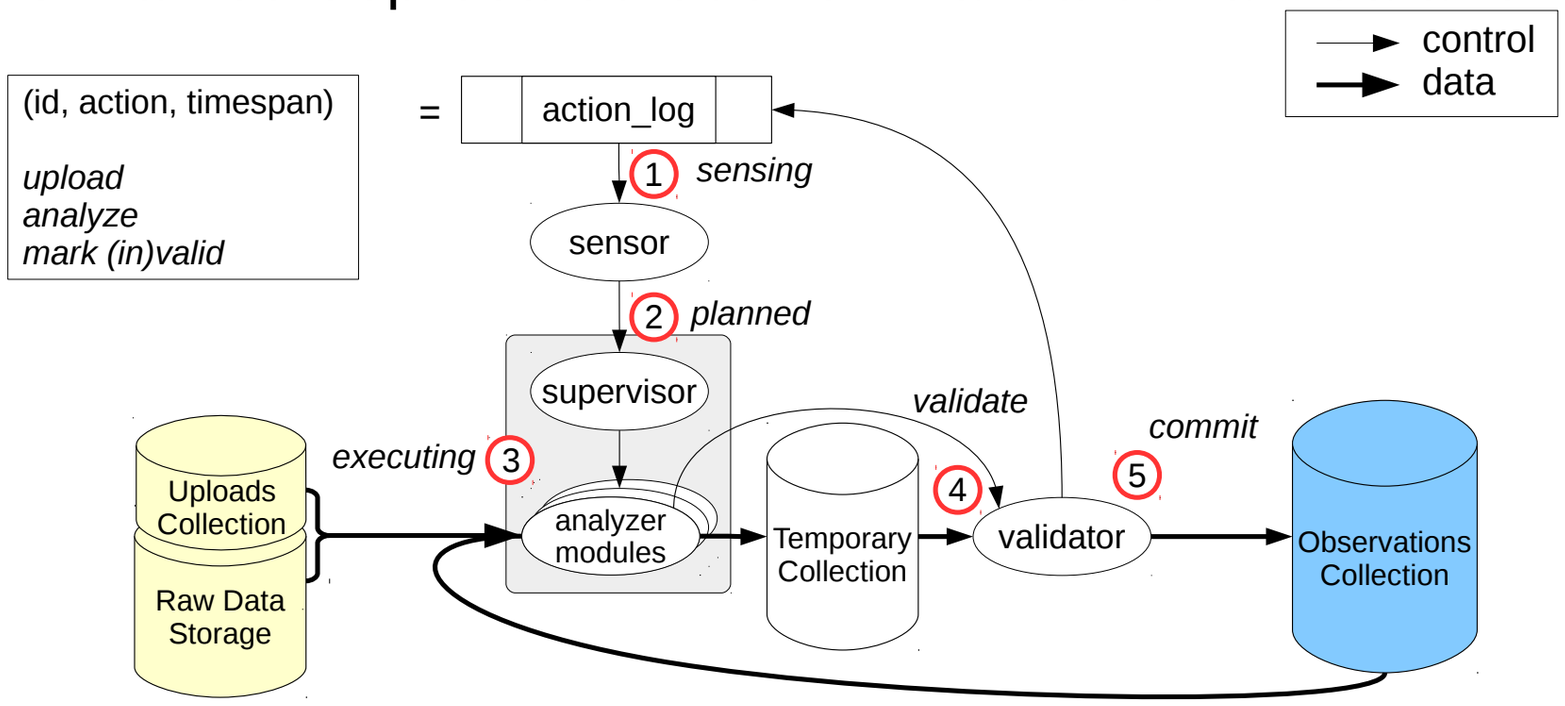
# PTO - Analyzers




- Analyzers produce Observations
  - based on measurements in the raw data or other Observations
- Observations contain the name of the analyzer…
  - …and the commit identifier of the exact analyzer version
- This enables reproducibility and also easier filtering:
  - “Give me all observations from analyser x, excluding (buggy) commit 1a2b3c4d”
- Analysis console is Jupyterhub, enables easy exploratory analysis of measurements and observations

# Automatic Analysis and Reanalysis

- Research is inherently exploratory, but
  requires immutable raw data for repeatability.
- Observations contain all information required to regenerate them.
- Sensors trigger on new data uploads, rerun analysis on data replacement.
- Observations marked deprecated due to invalidated raw data remain available.

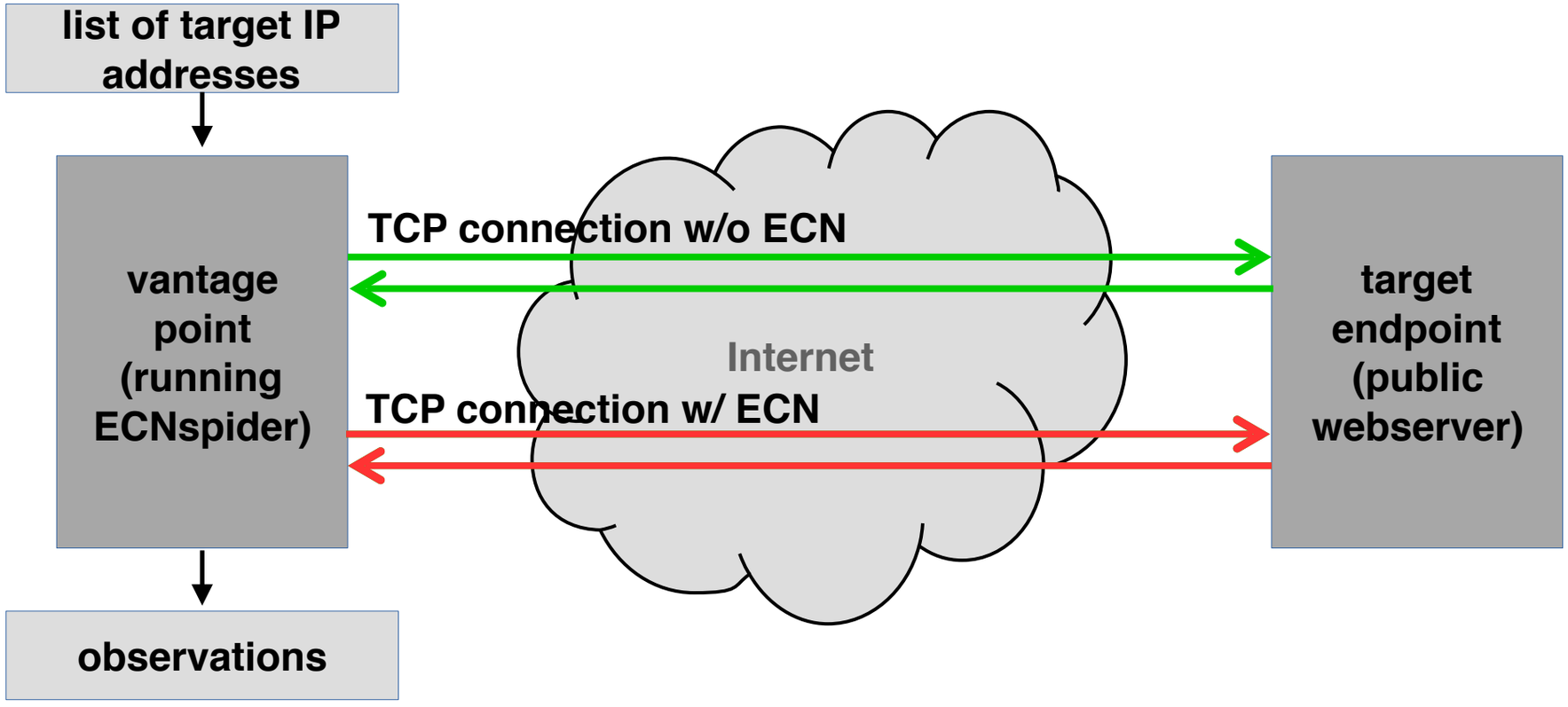


# PTO - State of Development

- PTO backend infrastructure up since ***~March***
- PTO measurement upload software since ***~April***
- PTO condition-querying REST service since ***~May***
- PTO query API working since ***~June***
  - …but being constantly optimised
- PTO Web UI in active development since ***~July***
  - …now in Beta testing inside MAMI
  - …about to go live in December

# Example measurement study (1): ECN connectivity testing

- **Explicit Congestion Notification (ECN):** TCP extension to signal congestion before dropping packets
  - Negotiation between both endpoints and network support needed
- **ECNspider:** A/B testing using PATHspider for ECN connectivity testing:

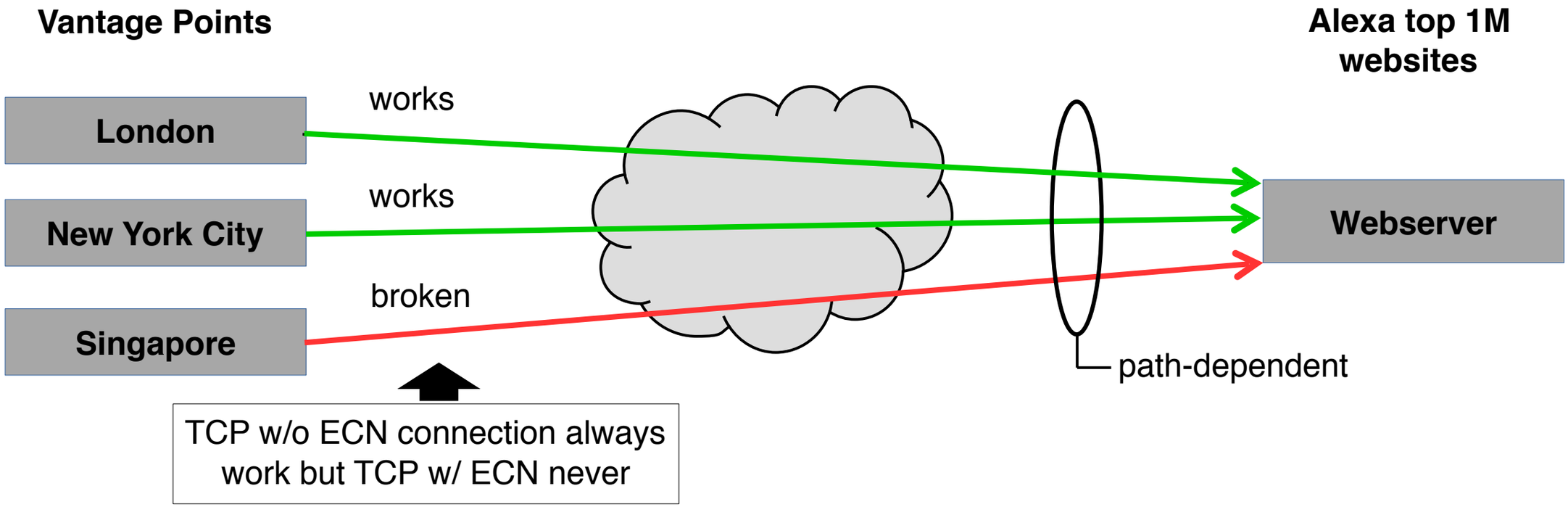


# Example measurement study (1): ECN observations

- **`ECN.connectivity.{works, broken, transient, offline}`**
  - **works:** all TCP w/o ECN connections and all TCP connections w/ ECN worked
  - **broken:** all TCP w/o ECN connections and no TCP connections w/ ECN worked
  - **transient:** TCP connections w/ ECN did not work
  - **offline:** no TCP connections could be established at all
- **`ECN.negotiation_attempt.{succeeded, failed}`**
  - **succeeded:** ECN was successfully negotiated
  - **failed:** target host did not support ECN

# Example measurement study (3): ECN path transparency

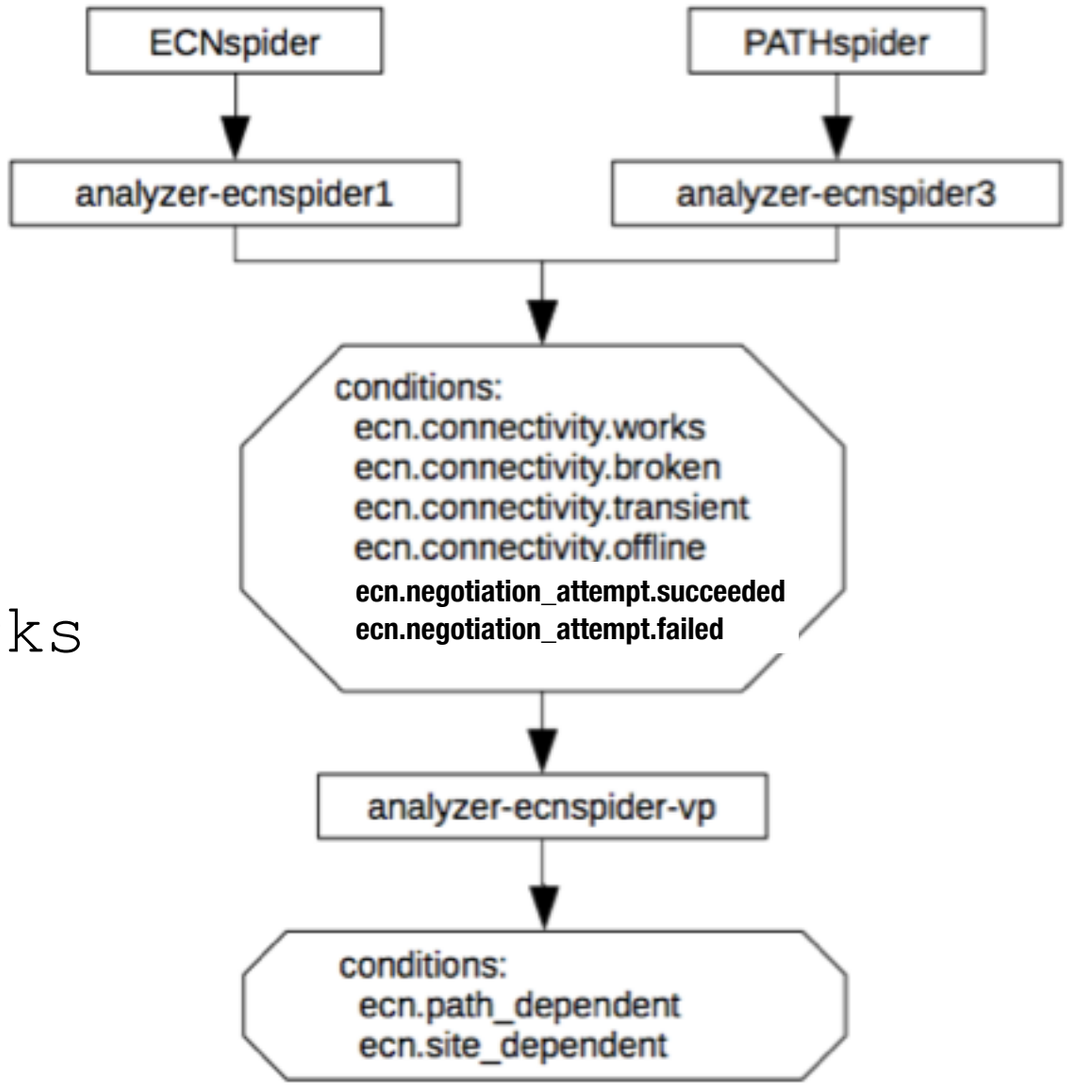
- Measuring path-dependency based on different vantage points



# Example measurement study (4): ECN path transparency analyses

Additional analysis tool in PTO (analyzer-ecnspider-vp) compares observations from different vantage points and derived a path-dependent observation:

- **`ecn.path_dependent`**: from some vantage points `ecn.connectivity.works` and some `ecn.connectivity.broken`
- **`ecn.site_dependent`**: from all vantage points `ecn.connectivity.broken`



# PTO Web UI: Query Parameters

## Observatory

Path Criteria `( empty ) - * - ( empty ) | Thu, 01 Jan 1970 00:00:00 GMT - Fri, 30 Aug 2019 22:35:29 GMT`

Conditions `ecn.connectivity.transient OR ecn.connectivity.broken`

*Specify observation conditions.*

Name

ecn.connectivity.transient

Select a condition.

Operator

OR

Select a logical operator.

Name

ecn.connectivity.broken

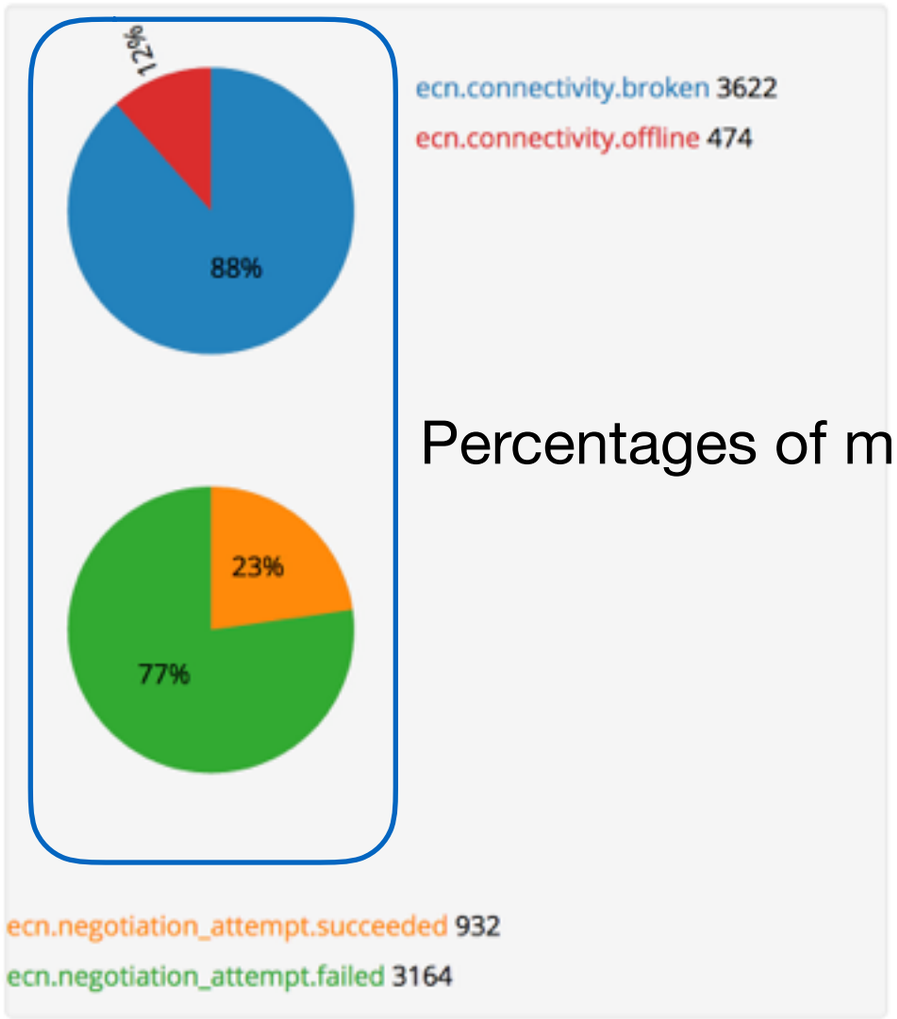
Select a condition.

+ −

# PTO Web UI

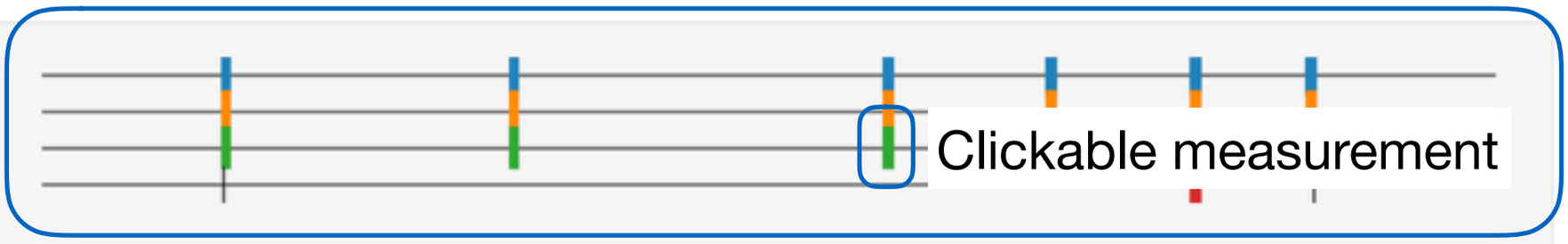
- User selects criteria in PTO UI:
  - Date and time
  - Path
  - Condition(s)
- Submits query to PTO
- PTO queries mongo database according to submission
- PTO returns JSON to PTO UI
- PTO UI renders JSON

# PTO Web UI: Rendering Results (1)




Percentages of mutually exclusive conditions

| | |
|---|---|
| **Path:** | - * - |
| **Observations:** | 4096 |
| **From:** | Sun, 12 Jun 2016 16:49:59 GMT |
| **To:** | Wed, 10 Aug 2016 19:09:41 GMT |




Timeline

# PTO Web UI: Rendering Results (2)

« 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 »

| Analyzer | Path IP Src | Path IP Dst | Conditions |
|---|---|---|---|
| analyzer-ecnspider1 | 188.166.3.245 | 85.26.148.161 | ecn.connectivity.broken, ecn.negotiation_attempt.failed |
| analyzer-ecnspider1 | 188.166.3.245 | 119.10.36.27 | ecn.connectivity.broken, ecn.negotiation_attempt.failed |
| analyzer-ecnspider1 | 188.166.3.245 | 114.80.207.205 | ecn.connectivity.broken, ecn.negotiation_attempt.failed |
| analyzer-ecnspider1 | 188.166.3.245 | 14.63.164.41 | ecn.connectivity.broken, ecn.negotiation_attempt.failed |
| analyzer-ecnspider1 | 188.166.3.245 | 149.202.112.33 | ecn.connectivity.broken, ecn.negotiation_attempt.succeeded |
| analyzer-ecnspider1 | 188.166.3.245 | 103.35.151.41 | ecn.connectivity.broken, ecn.negotiation_attempt.failed |
| analyzer-ecnspider1 | 188.166.3.245 | 204.141.11.38 | ecn.connectivity.broken, ecn.negotiation_attempt.failed |
| analyzer-ecnspider1 | 188.166.3.245 | 69.87.205.26 | ecn.connectivity.broken, ecn.negotiation_attempt.succeeded |
| analyzer-ecnspider1 | 188.166.3.245 | 192.187.111.202 | ecn.connectivity.broken, ecn.negotiation_attempt.succeeded |
| analyzer-ecnspider1 | 188.166.3.245 | 63.141.224.83 | ecn.connectivity.broken, ecn.negotiation_attempt.succeeded |
| analyzer-ecnspider1 | 188.166.3.245 | 61.91.120.146 | ecn.connectivity.broken, ecn.negotiation_attempt.failed |
| analyzer-ecnspider1 | 188.166.3.245 | 185.22.234.105 | ecn.connectivity.broken, ecn.negotiation_attempt.succeeded |
| analyzer-ecnspider1 | 188.166.3.245 | 119.254.65.178 | ecn.connectivity.broken, ecn.negotiation_attempt.failed |
| analyzer-ecnspider1 | 188.166.3.245 | 219.163.33.35 | ecn.connectivity.broken, ecn.negotiation_attempt.failed |
| analyzer-ecnspider1 | 188.166.3.245 | 14.49.24.71 | ecn.connectivity.broken, ecn.negotiation_attempt.failed |
| analyzer-ecnspider1 | 188.166.3.245 | 208.110.70.75 | ecn.connectivity.broken, ecn.negotiation_attempt.failed |

Clickable row

Table View

# PTO Web UI: Rendering Results (3)

## Observation Details `5790f2a3fed8f54132e425ab`

### JSON Raw

{"sources":{"upl":[0]},"_id":{"$oid":"5790f2a3fed8f54132e425ab"},"action_ids

### Properties

| | |
|---|---|
| **Time From** | Sun, 12 Jun 2016 16:49:59 GMT |
| **Time To** | Sun, 12 Jun 2016 16:50:04 GMT |
| **Analyzer** | analyzer-ecnspider1 |
| **Value** | ( empty ) |
| **Sources** | |
| **Action IDs** | 67:true |
| **Conditions** | ecn.connectivity.broken, ecn.negotiation_attempt.failed |
| **Path** | 188.166.3.245, *, 85.26.148.161 |

### Uploads

| Measurement Campaign | Start Time | Stop Time | Sequence | Format |
|---|---|---|---|---|
| ecn-june16 | Sun, 12 Jun 2016 00:00:00 GMT | Mon, 13 Jun 2016 00:00:00 GMT | 0000 | ecnspider1-zip-csv-ipfix |

# PTO on the web

- Path Transparency Observatory web UI:
  - https://observatory.mami-project.eu/#/observatory
- All sources on GitHub!
  - data upload: https://github.com/mami-project/observatory-upload
  - core: https://github.com/mami-project/pto-core
  - web interface: https://github.com/mami-project/pto-web