Internet Path Transparency Research and the mPlane Platform

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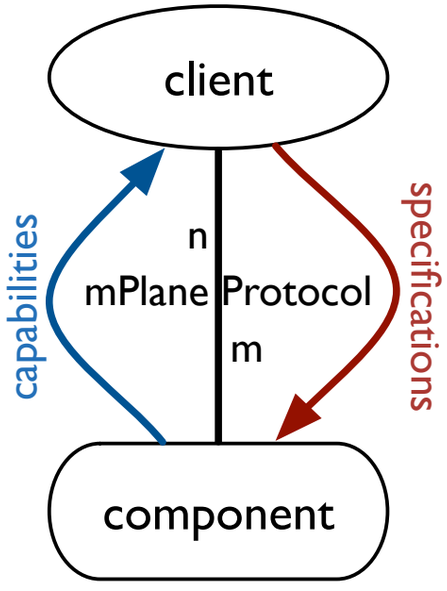
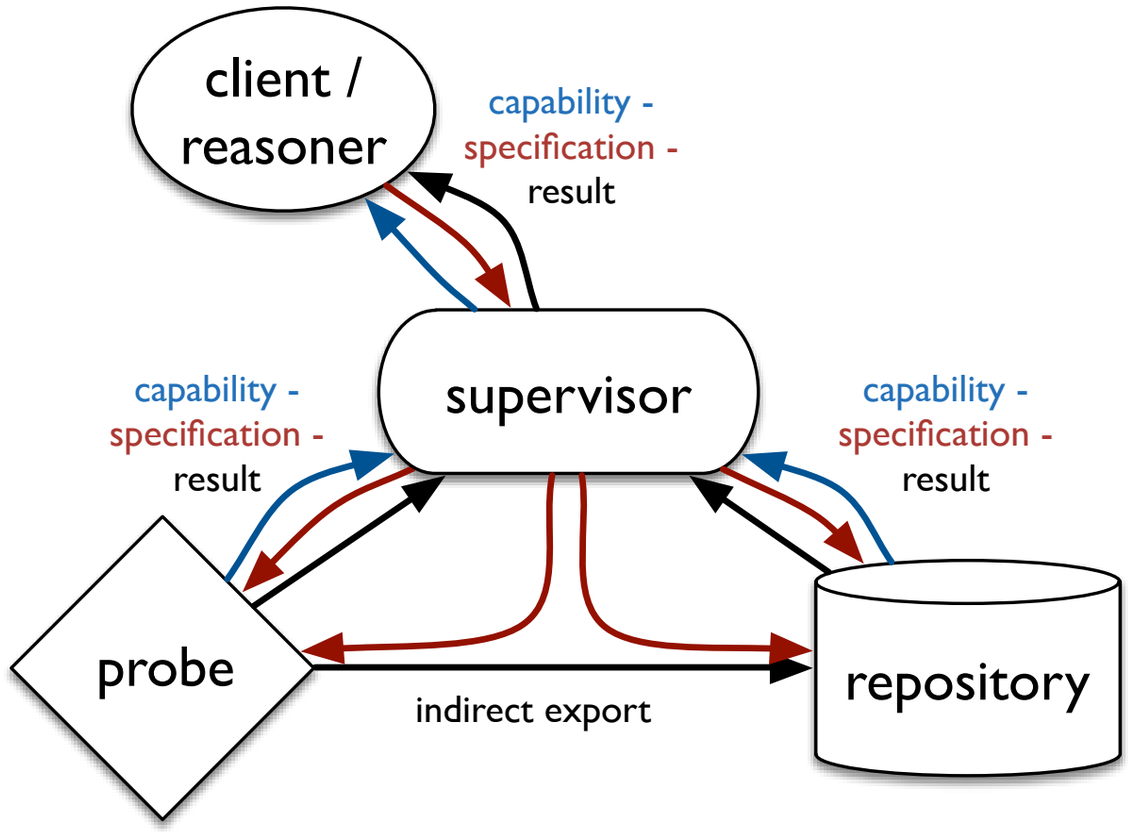
mPlane

(in one slide)

- Self-descriptive, error-tolerant RPC protocol connecting *clients* with *components* to cooperatively perform network measurements and analysis using heterogeneous tools.
- Measurements and analyses described using *capabilities* containing measurement *schemas* defined in terms of a registry of *elements*.
- Schema defines the measurement to perform.
- Weak imperativeness: responsibility follows the message flow.
- *Supervisors* knit larger infrastructures of heterogeneous components together.

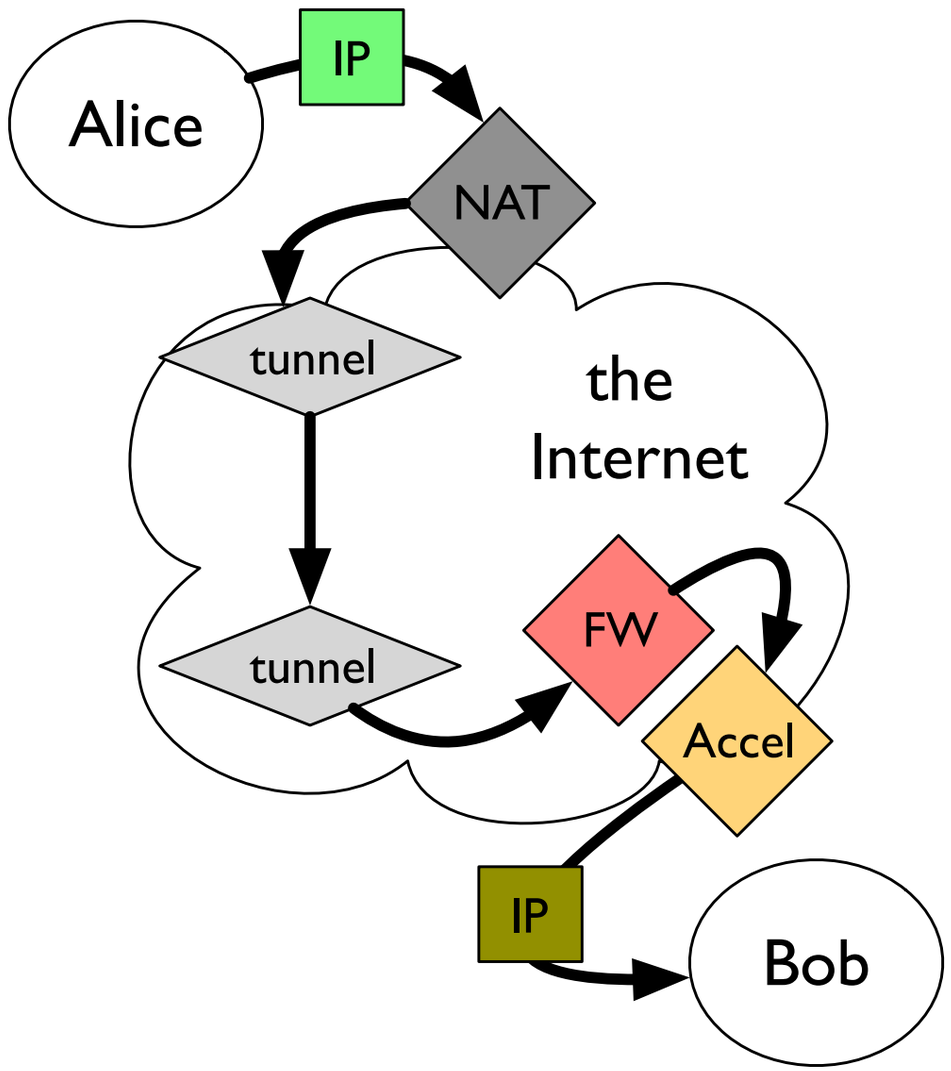




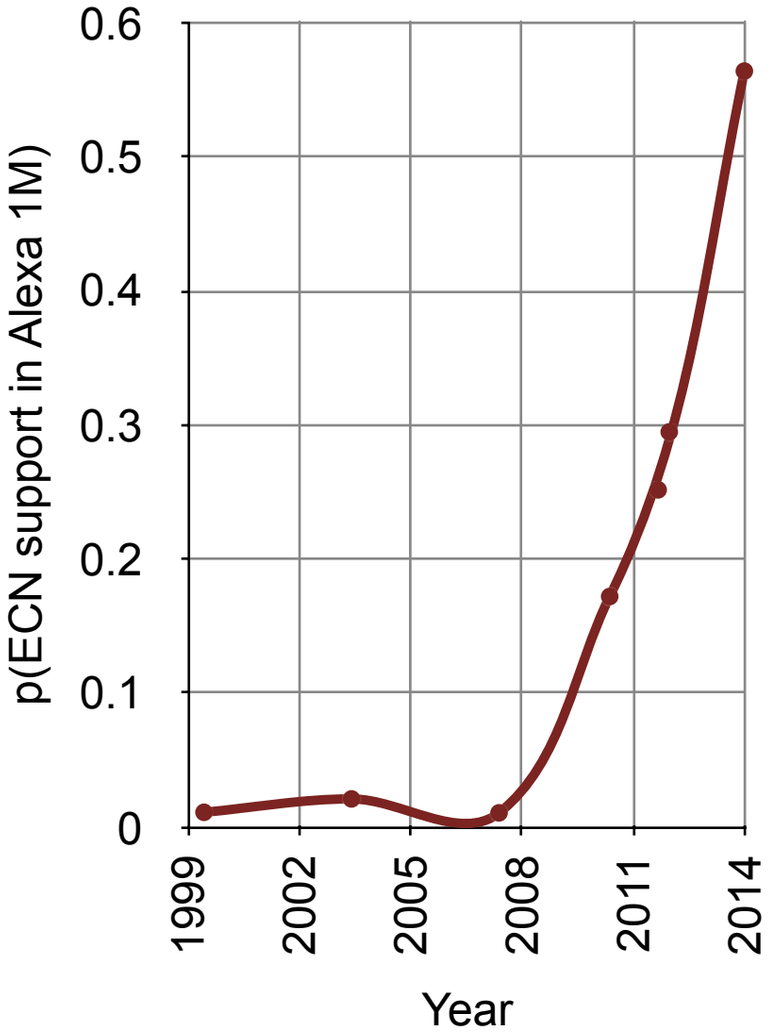
path transparency

(in one slide)

- The Internet is not end-to-end...
  - some of this is policy, but a lot of it is accident
  - deployment of new protocols over IP, transport extensions difficult or impossible
- ...but some paths are worse than others.
  - Goal: data on "how bad" and "where" to guide future protocol design
  - In operations: another tool for troubleshooting connectivity dependency for unusual traffic



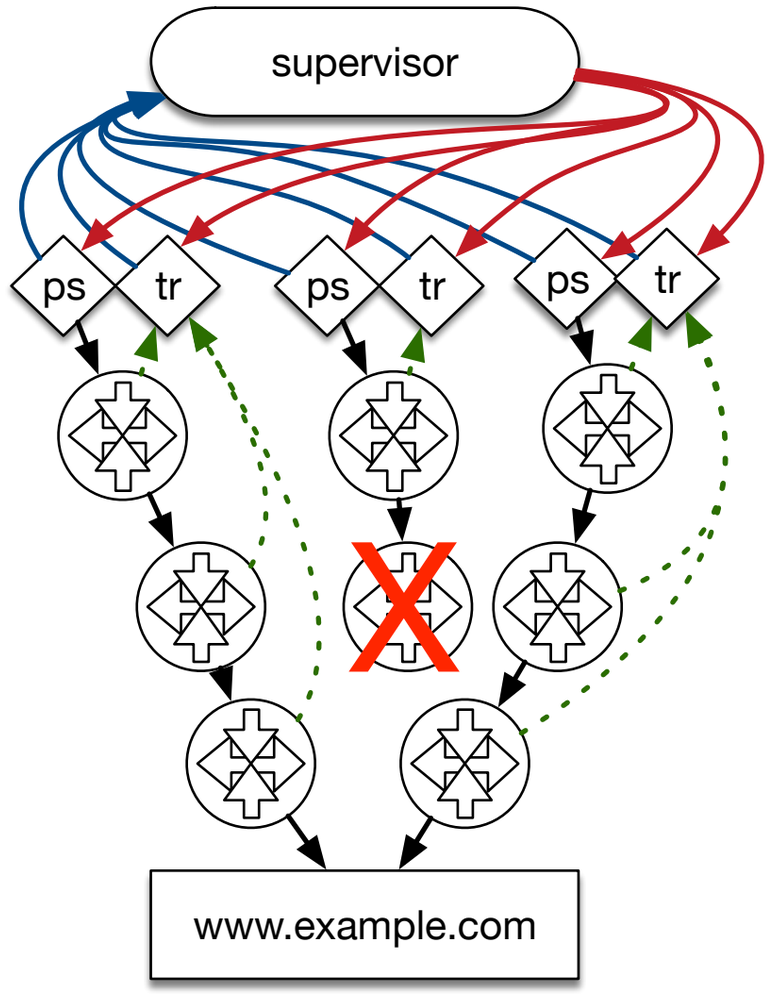
use case: ECN



- replaces loss as a congestion control signal
- Deployment in 00's failed
  - Router reboots, broken middleboxes, use of TOS
  - Linux kernel defaults have since led to server-side deployment
- Question: is it safe to turn on by default in client OSs?

applying mPlane to path transparency

- mPlane-based `pathspider` tool connects to set of targets with feature enabled and disabled.
- `pathspiders` at multiple vantage points find path dependency.
- Triggers `tracebox` to localize impairment.
- mPlane enabled easy integration.



path transparency on the web

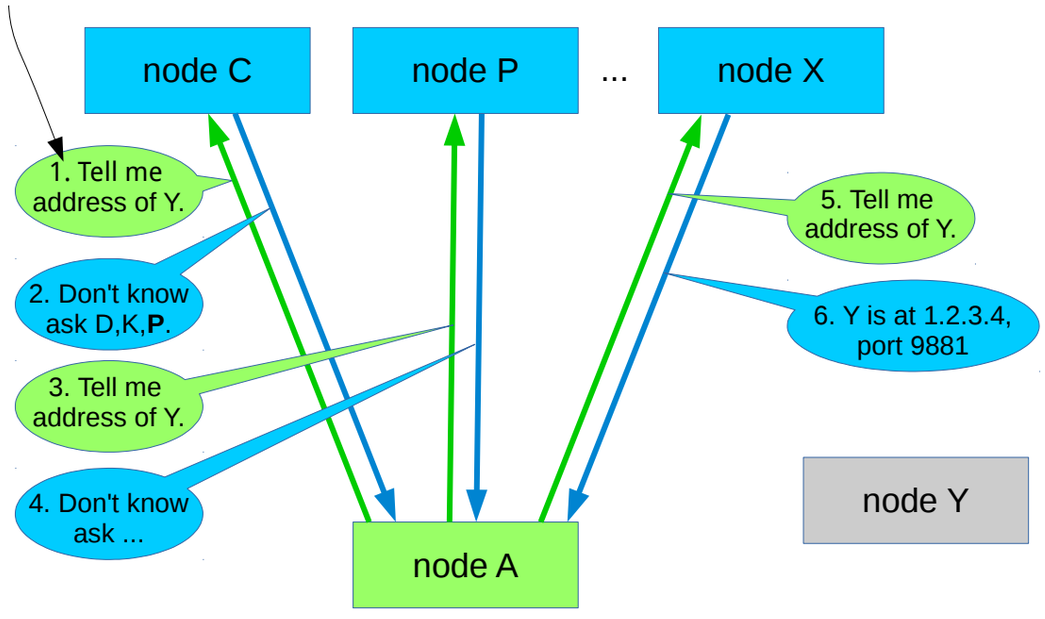
Result[1] *(Trammell et al, PAM 2015)*

- 0.5% of Alexa 1M refuse to connect with ECN, but fallback saves these. 0.04% of sites may have more interesting impairments.
- **Safe to use client defaults to drive ECN deployment.**
- Apple currently testing this result in developer betas of iOS and OSX[2]
  - terrestrial Internet basically OK, mobile Internet less OK
  - impairments primarily access-network dependent: runtime per-connection fallback is a valid strategy.

[1] B. Trammell et. al. “Enabling Internet-Wide Deployment of ECN”, Passive and Active Measurement, March 2015, Brooklyn.
[2] T. Pauly, “Results from wide testing of ECN”, IRTF HOPSRG at IETF 94, November 2015, Yokohama.

path transparency beyond the web

- What about client machines?
- **Ideal approach:** lots of probes on client networks (Atlas, Netalyzr, Chrome, etc.)
- **Stopgap approach:** harvest client IPs from BitTorrent DHT
  - Simply replace the web resolver component with a DHT resolver component.
- **Results**: of 687k machines, 0.21% unambiguously have a problem when ECN negotiated: comparable to web.



I’m sold, tell me more

- mPlane SDK: https://github.com/fp7mplane/protocol-ri
  - Or just `$ pip3 install mplane-sdk`
    - (Note: pathspider needs the `sdk-multival` branch)
- ECN-Spider/pathspider: https://github.com/britram/pathtools
  - ECN now.
    A/B testing of arbitrary protocol features soon.

Backup

mPlane in detail:

Capability

- Each component advertises its willingness to perform ECN measurements in a capability
- Results are intermediate: for each target, return connectivity and ECN TCP/IP flags information both with and without ECN enabled.

```
{
    "capability" : "measure",
    "version":     1,
    "registry":    “http://mplane.corvid.ch/ecnspider.json”,
    "label":       "ecnspider-ip4",
    "when":        "now ... future",
    "parameters" : {
        "source.ip4": “192.0.2.33”,
        "destination.ip4": "[*]",
    },
    "results": [
        "destination.ip4",
        "ecnspider.ecnstate",
        "connectivity.ip",
        "octets.layer5",
        "ecnspider.initflags.fwd",
        "ecnspider.synflags.fwd",
        "ecnspider.unionflags.fwd",
        "ecnspider.initflags.rev",
        "ecnspider.synflags.rev",
        "ecnspider.unionflags.rev"
    ]
}
```

mPlane in detail:

Capability Schema

- The verb and set of parameters and results together define the measurement's *schema.*
- The schema is equivalent to the name of the RPC entry point.

```
{
    "capability" : "measure",
    "version":     1,
    "registry":    “http://mplane.corvid.ch/ecnspider.json”,
    "label":       "ecnspider-ip4",
    "when":        "now ... future",
    "parameters" : {
        "source.ip4": “192.0.2.33”,
        "destination.ip4": "[*]",
    },
    "results": [
        "destination.ip4",
        "ecnspider.ecnstate",
        "connectivity.ip",
        "octets.layer5",
        "ecnspider.initflags.fwd",
        "ecnspider.synflags.fwd",
        "ecnspider.unionflags.fwd",
        "ecnspider.initflags.rev",
        "ecnspider.synflags.rev",
        "ecnspider.unionflags.rev"
    ]
}
```

mPlane in detail:

Registry Extensibility

- Each measurement is bound to a registry of elements.
- Registries inherit elements from the base registry.
- Here, ECN-specific elements have been added to the base registry.

```
{
    "capability" : "measure",
    "version":     1,
    "registry":    “http://mplane.corvid.ch/ecnspider.json”,
    "label":       "ecnspider-ip4",
    "when":        "now ... future",
    "parameters" : {
        "source.ip4": “192.0.2.33”,
        "destination.ip4": "[*]",
    },
    "results": [
        "destination.ip4",
        "ecnspider.ecnstate",
        "connectivity.ip",
        "octets.layer5",
        "ecnspider.initflags.fwd",
        "ecnspider.synflags.fwd",
        "ecnspider.unionflags.fwd",
        "ecnspider.initflags.rev",
        "ecnspider.synflags.rev",
        "ecnspider.unionflags.rev"
    ]
}
```

mPlane in detail:

Specification

- Specification completely defines the measurement to be performed
- Controller sends a list of targets to each vantage point.
- Vantage point returns a single *result* per specification.

```
{
    "specification" : "measure",
    "version":     1,
    "registry":    “http://mplane.corvid.ch/ecnspider.json",
    "label":       "ecnspider-ip4",
    "when":        "now”,
    “token”:       “d41d8cd98f00b204e9800998ecf8427e”,
    "parameters" : {
        "source.ip4": “192.0.2.33”,
        "destination.ip4": [
            “192.0.2.67”,
            “192.0.2.89”,
            “192.0.2.123”]
    },
    "results": [
        "destination.ip4",
        "ecnspider.ecnstate",
        "connectivity.ip",
        "octets.layer5",
        "ecnspider.initflags.fwd",
        "ecnspider.synflags.fwd",
        "ecnspider.unionflags.fwd",
        "ecnspider.initflags.rev",
        "ecnspider.synflags.rev",
        "ecnspider.unionflags.rev"
    ]
}
```

path transparency beyond mPlane

- mPlane vision: heterogeneous measurement tools declare their capabilities in terms of a common vocabulary of elements, and you get plug and play measurements.
- messy realities of path transparency measurement:
  - lots of data (e.g. application/OS error logs) available that may not fit into a clean observation schema
  - we need to get more detailed about the definition of path transparency elements in the registry in order to ensure comparability
- next step: a path transparency observatory

future work:
a path transparency observatory

- What we really want is a way to analyze path transparency source data in detail and in aggregate…
  - … from multiple sources of varying resolution
  - … where we may not have much detail at all about the paths (full traceroute, IP pairs, prefix pairs, AS pairs, pseudonymous IDs…)
    - … but where we can verify that the same test was used for the same transparency condition
    - … and (as a bonus) such that we can repeat studies in time and space (yay, science!)
- Insight: transparency conditions can be completely and repeatably described in terms of cleverly expressed patterns of packets.
- Integration: define mPlane elements for tests in terms of these patterns.
- Observatory to be build in the framework of the upcoming (2016-2018) H2020 MAMI project; watch this space!