A Platform for Measurement Iteration and Automation

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What is mPlane?

• 3-year EU FP7-funded research project, consortium of 16.
• **Goal**: build a measurement platform for intra- and inter-domain network performance troubleshooting support.
  • Support automated and automation-assisted iterative measurement for root cause analysis.
  • Research new techniques in passive and active network measurement and data analysis relevant to performance.
• **Insight**: three years is not long enough to build and integrate a bunch of working measurement tools.
• **Plan**: Leverage existing tools through a simple, easy-to-implement, “standard” interface that covers applicable metrics.
Everything’s a a component

- A *component* implements the mPlane control interfaces:
  - can advertise its *capabilities*,
  - accepts measurement *specifications*,
  - provides *results* (or *receipts* therefor), and
  - may participate in brokered asynchronous data export.
- *Clients* direct components to perform measurements via interfaces
- *Supervisor*: component + client
  - maps higher-level to lower-level specifications,
  - consolidates results from lower-level components.
- *Reasoner*: client supporting automated measurement iteration.
Statements

capabilities → specification

client

result

supervisor

components

capabilities → specification
Capabilities

- What can a component do?
  - Produce measurements (of a given type, directly or via a given protocol)
  - Consume measurements (of a given type, via a given protocol)
  - Other stuff (free-form, matched by name)
- Capabilities have parameters.
  - Must be given in a specification to use the capability
  - Parameters have constraints (i.e., acceptable values)
Specifications, Results, and Receipts

- A specification is an order to a component to perform a measurement or analysis.
  - Essentially a “filled-in” capability.
- A result may be returned immediately...
  - in the same format as the specification, with all parameters intact.
  - ...or later by presenting a receipt.
- Specifications for asynchronous export coordinate the exchange of data among components.
Iterative measurement

• Iterative measurement uses the results of one measurement to influence inputs or choice of a subsequent measurement.

• ...natural pattern in “drill-down” during troubleshooting

• Reasoner automates iteration by learning which subsequent measurements are most likely to result in a determination of cause.
Flexible Data Model and Transport

- Statement (capability, specification, result) data model defined separate from serialization format.
  - Reference implementation: JSON
  - Examples (for readability): YAML
- Multiple app-layer protocols for moving statements among components, supporting both push and pull for each statement type
  - Default: HTTP over TLS w/mutual auth
  - Easier key management: raw messages over SSH
Yay! We’ve (re-)invented middleware!

• Less ugly than the W3C Web Services stack, but basically just measurement-aware RESTful RPC with timing, delay tolerance, asynchronicity.

• How does this get us any closer to measurement interoperation?
Types

- Network measurement produces rows in databases.

- Analysis munges rows into other rows.

- The measurement or analysis performed is completely described by the schema...
  - ...if you’ve designed the schema right.

- Operations of common measurement tools can be fully described by the data types involved.
Type Interoperability

• Schema = table, template
• Element = column, info element
• Primitive = storage representation
• Two schemas are compatible if one is a subset of the other.
• Interoperability becomes a matter of ensuring elements have equivalent meanings.
Type Registry

- Structured namespace of Elements
  - [value].[modifiers].[units].[function]: [primitive]
  - e.g. delay.twoway.icmp.ms.mean: natural
- Mappings to IPFIX Information Elements when appropriate.
- Current registry covers network flow, common active measurements, and QoS use cases.
Example: ping

- capability: measure
  parameters:
    start.ms: now...+inf
    end.ms: now...+inf
    source.ip4: 10.2.3.4
    destination.ip4: *
    period.s: 1...60
  results:
    - delay.twoway.icmp.ms.min
    - delay.twoway.icmp.ms.mean
    - delay.twoway.icmp.ms.max
Example: ping

- **specification**: measure parameters:
  - start.ms: **2013-09-13 11:30:00**
  - end.ms: **2013-09-13 11:31:00**
  - source.ip4: **10.2.3.4**
  - destination.ip4: **10.4.5.6**
  - period.s: **1**

- results:
  - delay.twoway.icmp.ms.min
  - delay.twoway.icmp.ms.mean
  - delay.twoway.icmp.ms.max
Example: ping

- **results**: measure
  - parameters:
    - start.ms: 2013-09-13 11:30:01.045
    - end.ms: 2013-09-13 11:31:01.044
    - source.ip4: 10.2.3.4
    - destination.ip4: 10.4.5.6
    - period.s: 1
  - results:
    - delay.twoway.icmp.ms.min
    - delay.twoway.icmp.ms.mean
    - delay.twoway.icmp.ms.max
  - resultvalues:
    - 41
    - 47
    - 53
Example: traceroute6

- capability: measure
  link: mplane-https://supervisor.example.com/traceroute
  parameters:
    start.ms: now...+inf
    end.ms: now...+inf
    source.ip6: 2001:618:1:102::2
    destination.ip6: *
    hops.ip6.max: 1...255
    delay.twoway.udp.ms.count: 1...3
  results:
    - intermediate.ip6
    - hops.ip6
    - delay.twoway.udp.ms
Example: traceroute6

- **specification**: measure
  - parameters:
    - start.ms: **now**
    - end.ms: **now**
    - source.ip6: `2001:618:1:102::2`
    - destination.ip6: `2001:470:26:9c2::3`
    - hops.ip6.max: **32**
    - delay.twoway.udp.ms.count: **1**
  - results:
    - intermediate.ip6
    - hops.ip6
    - delay.twoway.udp.ms
Example: traceroute6

- results: measure
  parameters:
    start.ms: now
    end.ms: now
    source.ip6: 2001:618:1:102::2
    destination.ip6: 2001:470:26:9c2::3
    hops.ip6.max: 32
    delay.twoway.udp.ms.count: 1
  results:
    - intermediate.ip6
    - hops.ip6
    - delay.twoway.udp.ms
  resultvalues:
    - - 2001:618:ffff:1::1036:1
      - 1
      - 4
    - - 2001:618:ffff:1::1035:2
      - 2
      - 7
    - - 2001:7f8:24::aa
      - 3
      - 9
comparing mPlane and RIPE Atlas

- RIPE Atlas: ~4k small active hardware probes provide traceroute, ping, DNS.
  - Protocol + implementation + instantiation
- Centralized set of RIPE-operated controllers running Atlas-specific control and reporting protocols.
  - REST API for data access.
  - Control subject to credit availability.
- Atlas’ tests are mostly covered by the mPlane reference implementation.
  - Interop experiment: mPlane interface proxy to Atlas API, allow retrieval of results by Atlas participants.