Large Scale Measurement Machinery
ArkQueue and Scamper Tools

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Outline

Introduction

ArkQueue

Scamper

Wishlist
Ark Background
  ▶ what is Ark?
  ▶ user’s perspective
  ▶ how do we tell it what to do?
  ▶ how do we get useful data?

ArkQueue
  ▶ python module for interfacing with Ark
  ▶ (i.e. what commonly goes wrong, and how we fixed it)

Scamper Tools
  ▶ probing with Scamper
  ▶ Scamper data collection

Ark wishlist
Archipelago (Ark) is CAIDA’s next-generation active measurement infrastructure and represents an evolution of the skitter infrastructure

- Practically speaking?
  - many geographically distributed vantage points, contributed or hosted by volunteers
  - supporting infrastructure

- Usage:
  - CAIDA uses ark to systematically collect topology data (e.g. ITDK)
  - CAIDA grants access to other researchers to conduct measurements via Topology on Demand (ToD)
  - performance is non-deterministic due to shared resources and distributed host institutions
Ark Monitors

106 (and growing) Ark Monitor Locations

Figure: http://www.caida.org/data/monitors/monitor-map-ark.xml
A User’s Perspective

CAIDA’s Ark:

- We have all (at least) heard of CAIDA’s Archipelago...
- And maybe even used it?
We’ve been using Ark for several years, e.g.

- **Spoofer project:** receive/coordinating spoofed probes from clients [IMC09]
- **Net mapping:** efficient primitives [IMC10], ingress point spreading [PAM14]
- **TCP HICCUPS:** ascertain path-mangling within TCP to cooperate with middleboxes [SIGCOMM14]
- **Router geolocation:** via landmark active probing
- **IPv6 mapping:** exhaustive probing of all /48’s in all /32’s to understand IPv6 subnetting, IPv6 probing heuristics
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I can talk about these more later...
A User’s Perspective

We’ve been using Ark for several years...

- It’s powerful and useful for measurement research
- Have run into most issues others are likely to encounter
- (Issues either of the system, or the user’s perception of how it’s supposed to work)
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- It’s powerful and useful for measurement research
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To ease our own pain, we created some tools that may be of use to the community
1. Provide host where probes will be initiated and get it authenticated by CAIDA
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2. Use `tod-client` command-line interactive application on host to submit probe requests and get results

   **Probe request**  "<probeID> <monitor> <cmnd> <target>"
1. Provide host where probes will be initiated and get it authenticated by CAIDA

2. Use `tod-client` command-line interactive application on host to submit probe requests and get results

   **Probe request** "<probeID> <monitor> <cmnd> <target>"

   **Probe result** e.g.  
   
   <probeID> data <target> 2001:470:1f06:ee1::2 0 1 1424475896 R 78.375 7  
   2001:7f8:1::a500:6939:1,12.839,1 2001:470:0:2d0::1,6.412,1  
   2001:470:0:2cf::2,72.077,1 2001:470:0:5d::2,75.762,1

3. Parse results

   Simple, right?
Ark Background

**ToD/tod-client usage issues**

- results arrive asynchronously after seconds, minutes, or never...
- typical (small) experiment requires >100,000 probes
- and submitting *too many* requests at once may break Ark
- and may require requests to be a function of prior results

**During any given experiment some subset of Ark monitors down or too slow**

- subset changes over time
- Ark/ToD does not expose monitor status
- causes head-of-line blocking
Scenarios we kept experiencing
Students, ourselves, and general ToD-newbies
Scenarios we kept experiencing

Students, ourselves, and general ToD-newbies

Student: “Which vantage points should I use...”

- How to select randomly? How to select up/responsive monitors? How to know what are the monitors in the first place?
Scenarios we kept experiencing

- Students, ourselves, and general ToD-newbies
- Student: “Which vantage points should I use...”
  - How to select randomly? How to select up/responsive monitors? How to know what are the monitors in the first place?
- Student: “Which VP did this result come from...”
  - ToD responses only include (potentially private IP) of source
Student: “My experiment stopped running...”
- typically caused by waiting for results from downed monitor
- limited number of probes can be “in-flight” (≈ 100)
- even when choosing monitors at random, eventually all in-flight probes waiting on downed monitor
Ark Background
ToD/tod-client usage issues

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▶ Student: “Ark is b0rken...”
  ▶ by multiple tod-client processes using same session ID
  ▶ ...or a downed monitor
  ▶ ...or a non-existent monitor
  ▶ ...or a monitor busy doing other things
  ▶ ...or a monitor that doesn’t support the command (e.g. IPv6)
Student: “Ark is b0rken (again)…”

- submitting millions of requests to monitor X
- program wrapping tod-client died/crashed
- requests at monitor X still pending
- new requests seemingly unresponsive (monitor still busy with old/stale requests that will never be fetched)
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Student: “I got more results than probes submitted...”
- old/stale results arriving from an earlier experiment
- when a monitor “wakes up” all the previously queued probe requests are executed
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▶ Student: “How do I make tod-client do X...”
  ▶ tod-client written in Ruby
  ▶ limits accessibility for those willing to customize/tweak/deploy
Outline

Introduction

ArkQueue

Scamper

Wishlist
ArkQueue
Python module for interfacing with Ark

- Designed to finesse the submission of probe-requests to ToD
- Removes the need for every user to handle common scenarios in their own code
- Changing subset of down or slow Ark monitors
  - ArkQueue sorts and queues user probe requests by VP
  - runs separate instance of `tod-client` for each VP
  - tracks VP response time and stops submitting if unresponsive
  - reports unresponsive VPs to user for future reference
- Submitting “too many” requests may break Ark
  - ArkQueue maintains “just enough” requests outstanding
ArkQueue
Python module cont.

- Results arrive asynchronously
  - ArkQueue assigns unique session- and probe-IDs
  - maps responses to requests and returns both
  - uses callback hook to process replies on arrival
- Results stay in system even after `tod-client` terminates
  - ArkQueue cleans up outstanding requests using `tod-debug`
- ArkQueue facilitate intelligent probing patterns, where future probes depend of feedback from earlier probes
- Along with ArkQueue, python module is provided for parsing `tod-client` output
from arkqueue import ArkQueue

def submit(x):
    sys.stdout.write('+')

def finish(out, request):
    sys.stdout.write('^')

ark = ArkQueue(monitorfile="monitors.yaml",
                sessionid="ArkQueueSample", yaml=True, verbose=False,
                submit_hook=submit, finish_hook=finish, idle_hook=None,
                concurrency=10, timeout=60, monitor_blacklist=list())
vps = ark.getMonitors()
targets = ['128.61.2.1', '130.207.244.244', '2607:f8b0:4005:802:',
          '2001:470:1f06:ee1::2']
ard.start()
for i in range(0, 100):
    vp = vps[i % len(vps)]
    target = targets[i % len(targets)]
    ark.addProbe(targets=[vp + ' ' + target], priority=3)
ArkQueue

[rbeverly@bob ~/research/direct/ark/arkqueue]$ ./arkqueue_sample.py

[ arkqueue_sample.py ] Interacting with Ark ToD, will maintain 1 traces in flight per vantage point.

Exiting Ark
2015-03-31 04:57:15,614 - [ArkQueue]:INFO: Thread asked to exit.

ArkQueue Probing Summary:
Total number of probes submitted: 100
Number of probes completed: 86
Average probe completion time: 7.28698908488 s
Number of probes not completed: 14
Number of Ark vantage points used: 72
Number of Ark vantage points not responding: 12
Scamper is CAIDA’s software daemon that runs on each Ark monitor to create probes and collect data.

Why do we care?

- Scamper can do much more than the probe type allowed by tod-client
- may have vantage points outside of Ark on which to run Scamper

How do we use it?

- run Scamper interactively, or as a daemon
- CAIDA-provided sc_attach utility submits commands to a Scamper daemon, and writes the results to a warts file
- other stand-alone utilities and a c-library are available from CAIDA to parse the warts files into human-readable formats
Most of our (and our students) probing and analysis is performed using Python programs

<table>
<thead>
<tr>
<th><strong>sc_attach.py</strong></th>
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<tbody>
<tr>
<td>Native Python module for issuing commands to a Scamper instance. Receives results and writes to a binary warts file.</td>
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<tr>
<th><strong>sc_wartsdump.py / sc_analysis_dump.py</strong></th>
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<tbody>
<tr>
<td>Native Python module for parsing a binary warts file to text for further analysis</td>
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- `sc_wartsdump` also used for parsing warts data collected by CAIDA
- ArkQueue and Scamper Tools publicly available to facilitate wider adoption and use of Ark/ToD
Outline

- Introduction
- ArkQueue
- Scamper
- Wishlist
Ark Wishlist

Ark Wishlist (not in order):

- Expose list of available monitors (and tell user of new monitors put into production)
- Warts output (ToD produces tab delimited partial output)
- Ability to clear large numbers of tuples in a timely manner (takes very long time)
- Full control over scamper options/flags (can only use what Ark exposes)
- Fix marinda memory leak
- Visibility into outstanding request tuples
- Visibility into individual monitor queue/status
Thanks!

- http://www.cmand.org/direct
- https://github.com/cmand/arkqueue
- https://github.com/cmand/scamper