Effective Diagnostic Strategies for Wide Area Networks
aka
Network Path and Application Diagnosis (NPAD)

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NSF STI Award

• 3 year PSC & NCAR project
  – Matt Mathis (PSC) & Peter O’Neil (NCAR) Co-PI’s
  – Senior Personnel
    • John Heffner & Raghu Reddy from PSC
    • Pete Siemsen & David Mitchell from NCAR

• Builds on Web100 and Net100 projects

• Continues focus on e2e performance issues
  – where previous efforts dealt with end systems, we now turn our attention to application flows across the path
Observed Behavior

- Symptoms appear to scale with increasing RTT path delay
  - Servers and Local Clients throughput good, but for remote client, throughput performance is poor
  - Reflective of most types of flaws
  - Impacts are multiplicative as backbone path magnifies symptoms of an existing flaw
Example Impacts

- Chat application (e.g., 50 RTT per user request)
  - On 1ms LAN, 50ms total time
  - On 100ms WAN, 5s total time

- Fixed TCP buffer space (e.g., 32kBytes)
  - On a 1ms LAN, 200Mb/s throughput limit
  - On a 100ms WAN, 2Mb/s throughput limit

- Packet Loss (e.g., 1% with 9kB MTU packets)
  - On a 1ms LAN, 500 Mb/s throughput limit
  - On a 100ms WAN, 5Mb/s throughput limit
Symptoms Present Diagnostic Quandaries

• False reassurance on short path flows
  – Obscures actual local bugs/problems
  – Incorrectly points elsewhere

• Stymies e2e diagnosis and thus improvements

• Promotes diagnosis as “one off workarounds”
  – Unscalable time sync
NPAD Approach

• Web100 based diagnostic server
  – Simple TCP test to a test target
  – Use MIB and model to rescale results
• TCP discard server for test target
  – Believe (hope) would be trivial to widely deploy
  – C or Java
• Provide good estimates of results for long paths
e2e Diagnosis

- Approximately 1 diagnostic server per campus/backbone/GigaPoP
- Test targets at lots of PoPs/hubs or LANs (or WS/clusters)
- Allows for isolating a flaw (slowdown) across each element of a long path
End User Tool

• Web/Java client
  – With built in test target
  – Invokes test on Diagnostic Server back to self
Combine with Other Approaches

- Bench test applications and end-systems (stacks)
- Use long ideal (virtual) paths
  - Dummynet style of emulated delay
  - Tunnel or VPN style of “scenic” routing
Project Goals

• Develop and learn from tool extensions which compensate for results that scale with RTT
• Study effects of various delay times
• Test the effects of these diagnostic tools with network users and operators using actual high performance applications
NPAD Summary Rationale

• Single point failures are (relatively) easy to find and fix
• Remaining failures are interactive & complex
  – RTT, packet loss, and MTU size
  – RTT and application design
  – Packet rate limit and MTU
  – Queue size buffers in routers and burstyness due to
    • ACK compression and cross traffic or
    • Application design