NetPrints
Diagnosing Home Network Misconfigurations using Shared Knowledge

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Typical Home Network

No network admin!
## Examples of Problems

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
</tr>
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<tbody>
<tr>
<td>VPN client does not connect from home</td>
<td>Turn on PPTP passthrough on router, use a subnet that is either 192.168.0.x or 192.168.1.x</td>
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<td>XBOX doesn’t connect to the Live service</td>
<td>Turn up your MTU above 1355, change NAT settings to full-cone, turn on UPnP.</td>
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<td>File sharing doesn’t seem to work at home</td>
<td>Make sure you and the file server are on the same domain/workgroup.</td>
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<tr>
<td>Printing doesn’t work from my laptop</td>
<td>Turn on correct firewall rules on the print server machine</td>
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<td>Cannot send large emails</td>
<td>Turn down MTU on your router</td>
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Diversity $\Rightarrow$ home network troubleshooting is hard
What Do Users Do Today?

Source: Managing the Digital Home, a survey of 6,116 U.S. and Canadian home Internet users © 2007 Parks Associates

Avg time to resolve solutions: 2 hours
NetPrints

NetPrints = Network Problem Fingerprinting
Automate problem diagnosis using “shared knowledge”
Putting NetPrints in Context

NetPrints

- Distributed configuration information
- Unstructured, heterogeneous environment
- Problems caused due to interaction of multiple configurations

Windows Diagnostics Framework
- Rule-based techniques
- Tracing
- Learning-based

Network Magic
- Strider+PeerPressure
- SVM-based performance debugger

Apple’s Diagnostics
- Autobash

Resolve basic connectivity issues
Resolve local configuration issues
(Application specific: too many rules)
Assumptions

• Current design requires basic connectivity
  – Looking at application-specific problems
  – Not inherent, Knowledgebase can be shipped offline

• Not dealing with performance
  – “good” and “bad” are the only two states considered
NetPrints in Action

Fixed the problem by setting pptp_pass=1. Please try IT Connection Manager again.

Knowledgebase for VPN client

NetPrints server

Suggest.xml
... pptp_pass=1
pppt_pass=0
...
Diagnosis Strategies

• Snapshot-based
  – Collect config snapshots from different users

• Change-based
  – Collect config changes that a user makes

• Symptom-based
  – Collect signatures of problems from network traffic
System Design

NetPrints Client

- Config Scraper (End-host & Router)
- Network Feature Extractor
- GUI

Local-Area Network

Internet Gateway Device

NetPrints Server

- Server Knowledgebase
  - Config trees
  - Change trees
  - Signatures
- Diagnosis engine

Internet
Normal Mode

NetPrints Client

1. Config Scraper (End-host & Router)
2. Network Feature Extractor
3. GUI

Local-Area Network

Internet Gateway Device

4. Send data to server

NetPrints Server

5. Server Knowledgebase

Config trees
Change trees
Signature
diagnosis engine

Internet
Diagnose Mode

1. GUI
2. Config Scraper (End-host & Router)
3. Network Feature Extractor
4. Send data to server
5. Diagnosis engine uses configuration mutation

Server Knowledgebase
- Config trees
- Change trees
- Signatures

Local-Area Network
Internet Gateway Device
Internet
#1: Configuration Scraper

- **Router scraper**
  - UPnP
  - Web Interface (HTTP Request Hijacking)

- **End-host scraper**
  - Interface-specific parameters
  - Patches and software versions
  - Firewall rules

- **Remote scraper**
  - Composition of local and remote configs
## Composing Local & Remote Configs

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Sometimes it is the *combination* of local and remote configs that is the problem.
#2: Server Knowledgebase

- Per-application decision trees constructed using labeled configuration snapshots
  - decision trees aid interpretability
  - C4.5 decision tree learning algorithm

- Configuration tree, Change trees and network signatures
Methodology

• Testbed comprising 7 different routers
  – various makes: Netgear, Linksys, D-Link, Belkin

• Clients running the VPN sent configurations to the NetPrints service
  – Roughly 6000 config parameters per snapshot

• Service learned configuration trees using C4.5 algorithm
Example of Configuration Tree

Simplified Config Tree for VPN Client
#3: Configuration Mutation

- Preference for mutations involving frequently changing parameters
- Assumption: higher the frequency, less disruptive the change
Shortcoming of Configuration Trees

• Some config info may not be learned
• So traversal of config tree may end in a “good” leaf even if config is problematic
• Reasons:
  – Insufficient data
    • e.g., a new router enters the market
  – Hidden configurations
    • e.g., application-specific parameters
### Summary of Diagnosis Procedure

#### Configuration tree

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<th>Change trees</th>
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<td>1XXXXXXX</td>
<td></td>
</tr>
<tr>
<td>0XXX X1X</td>
<td></td>
</tr>
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Experimental Evaluation

• Testbed comprising 7 different routers
  – various makes: Netgear, Linksys, D-Link, Belkin
Findings

• Intuitive inferences
  – VPN: If `pptp_pass==1` then GOOD

• Surprising inferences
  – VPN: If `stateful==off` and `pptp_pass==0` and `ipsec_pass==0` and `l2tp_pass==0` then GOOD
Tolerance to Mislabeled

13-17% mislabeling $\Rightarrow$ 1% error in diagnosis
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13-17% mislabeling $\Rightarrow$ 1% error in diagnosis
Summary

• Home network diagnostics is challenging
  – diversity of apps and configs
  – absence of an admin

• NetPrints leverages community info to perform *automated* diagnosis
  – decision tree based learning
  – configuration trees, network traffic signatures and change trees
Thank you

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http://research.microsoft.com/netprints