Analyzing Network Configuration Changes
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Problem Statement
• Networks are difficult to configure
  • Thousands of lines of configuration commands
  • Functionality distributed across many devices
  • Many different protocols and standards to configure
  • Manual and time-consuming
• Difficult to design suitable tools
  • Limited knowledge of how networks are configured
  • Limited understanding of how operators interact with the network

Objective
• Understand properties of configuration changes
  • How the network changes over time
  • How the operators interact with different devices
• Use observations to motivate the design of new tools

Commonly Performed Tasks
A small number of tasks account for most changes in the network

<table>
<thead>
<tr>
<th>Frequently Configuration Changed</th>
<th>Goal</th>
<th>Percent Of changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface, Routing Protocol</td>
<td>Adding a Department</td>
<td>60%</td>
</tr>
<tr>
<td>Interface, Routing, Prefix-list (control plane filter)</td>
<td>Adding a Department with security controls</td>
<td>10%</td>
</tr>
<tr>
<td>ACL (data plane filter), Interface, Routing Protocol</td>
<td>Adding a Department with security controls</td>
<td>6%</td>
</tr>
<tr>
<td>Route-map, Prefix-list</td>
<td>Changing Control plane</td>
<td>5%</td>
</tr>
<tr>
<td>Interface, Prefix-list (control plane filter)</td>
<td>Changing the address for a department</td>
<td>4%</td>
</tr>
</tbody>
</table>

Configuration Changes

![Graph showing number of lines changed vs. device type]

Data and Observations
• Archived configuration files from 2 enterprises
  • 5 years worth of configuration changes
    • Campus 1: 28 routers, 416 firewalls and 1316 switches
    • Campus 2: 51 routers, 1248 switches, 347 firewalls

Future Work
• Automating configuration management
  • Utilize observations to generate
    • Automatically create configuration templates
    • Automatically detect common misconfiguration
• Synthesizing configuration from a high-level language
  • Develop high-level policy language
  • Design algorithms to create low-level configuration commands

![Graph showing CDF of number of changes]

![Graph showing number of changes vs. time of day]

Most prevalent configuration aren’t the most frequently changed
Operators interact differently with different devices