Impact of the 2003 Blackouts on Internet Communications

CpE 6510 – Resilient Networks

Presented By
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Outline

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• Edge customer ASes
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Introduction

• This report is an analysis of the reliability of Internet connectivity to customer networks during the severe failure of the electric power grid in Northeastern US and Canada on 14–16 August, 2003.

• Connectivity outages longer than four hours and twelve hours

• 3,175 networks suffered from abnormal connectivity outages
Background

• Within two minutes, the outage was complete across the region of Northeastern US and Ontario, Canada on August 14 2003

• Power Restoration was slow and incremental

Figure 1: Blacked out areas are within the dotted line[1]
Background

- Basis for analysis of the Impact
  - What is globally advertised networks?
  - Customers connect to one or more Network Service Providers (NSP).
  - Some customers choose their networks to be Autonomous addressed as Autonomous systems (AS).
Background

• Autonomous systems use BGP to communicate with other Ases.

• What is BGP?

• The approach for the analysis depends on the routing information of the BGP.
Network Outage statistics

- This report presents a list of all networks inside the blackout area.
- ARIN database.

Metrics To characterize impact of blackouts on Internet Customers:
1. Number and duration of network outages.
2. Number of ASes located in the blackout area.
3. Number of business entities and other institutions.
Figure 2: Black – number of ongoing outages
- Base line noise – MS blast worm
Network Outage Distributions in Organizations

Figure 3: Number of Autonomous Systems versus the percentage of their networks that had outages longer than 4 hours [1]

MS Blast Worm - Network outage < 4hrs
Network Outage Distributions in Organizations

• Impact can be characterized by different approaches.

• Renesys approach – percentage of networks in Ases that had 4 or more hours longer outages.

• The previous graph shows striking shape.
Network outage Distributions in Organizations

Networks in Ases at 0% peak is 4,735. Networks in Ases at 100% peak is 997.

<table>
<thead>
<tr>
<th>AS Number</th>
<th>Provider AS</th>
<th>est. # networks in blackout area</th>
<th>% network outages ≥ 4 hr</th>
<th>average outage duration (hours)</th>
<th>comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>209</td>
<td>Qwest</td>
<td>109</td>
<td>6%</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>237</td>
<td>Merit</td>
<td>94</td>
<td>35%</td>
<td>24</td>
<td>Michigan</td>
</tr>
<tr>
<td>577</td>
<td>Bell Adv. Comm</td>
<td>160</td>
<td>11%</td>
<td>17</td>
<td>Ontario</td>
</tr>
<tr>
<td>701</td>
<td>UUNET</td>
<td>266</td>
<td>41%</td>
<td>22</td>
<td></td>
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<tr>
<td>813</td>
<td>UUNET</td>
<td>50</td>
<td>40%</td>
<td>13</td>
<td>Ontario</td>
</tr>
<tr>
<td>852</td>
<td>Telus</td>
<td>64</td>
<td>14%</td>
<td>16</td>
<td>Canada</td>
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<tr>
<td>1239</td>
<td>Sprint</td>
<td>61</td>
<td>29%</td>
<td>22</td>
<td></td>
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<tr>
<td>1785</td>
<td>FASTNET</td>
<td>97</td>
<td>18%</td>
<td>12</td>
<td>NY, PA</td>
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<tr>
<td>2386</td>
<td>ATT Data Comm</td>
<td>136</td>
<td>7%</td>
<td>20</td>
<td></td>
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<tr>
<td>3602</td>
<td>Sprint Canada</td>
<td>66</td>
<td>20%</td>
<td>30</td>
<td></td>
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<tr>
<td>4471</td>
<td>MICA</td>
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<td>87%</td>
<td>22</td>
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<td>Electric Lightwave</td>
<td>57</td>
<td>2%</td>
<td>13</td>
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<tr>
<td>7018</td>
<td>AT&amp;T Worldnet</td>
<td>328</td>
<td>35%</td>
<td>15</td>
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<tr>
<td>7046</td>
<td>UUNET</td>
<td>66</td>
<td>24%</td>
<td>33</td>
<td></td>
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<td>12021</td>
<td>Hamilton Hydro</td>
<td>55</td>
<td>27%</td>
<td>16</td>
<td>Fibrewired, ON</td>
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<tr>
<td>14456</td>
<td>Peterborough Util</td>
<td>52</td>
<td>0%</td>
<td>—</td>
<td>Ontario</td>
</tr>
<tr>
<td>15290</td>
<td>Allstream</td>
<td>115</td>
<td>15%</td>
<td>18</td>
<td>was AT&amp;T Canada</td>
</tr>
</tbody>
</table>

Table 1: Ases with 50 or more customer networks in the blackout area.[1]
Edge Customer ASes

- Customer ASes that do not transit externally originated traffic.
- These plots are based on the 2\textsuperscript{nd} and 3\textsuperscript{rd} metrics.

Figure 4: Left: Autonomous Systems versus the number of their originated networks. Right: Business entities or organizations versus the number of their networks. [1]
Conclusions

• The very largest provider networks unaffected by the blackout.

• The report considered only networks that are individually advertised worldwide.

• No evidence showing affects on global internet stability.

• Fare survivability of organizations advertising large number of networks and multihomed organizations.
Methodology

Data sources and Methodology:

• BGP routing messages from approximately 30 BGP routers.
• BGP sessions from Asia, South Africa, Europe and North America maintained for months used for analysis.
• Routing messages are timestamped and archived in Renesys databases.
• Two datasets of the networks located in the geographic blackout areas (US/Canada and Italy).
• Further datasets of networks advertised by 5 or more routers were considered same as Italian Blackout.
• The outage accounted only if the withdrawal signals continue to come from 5 or more routers within the range of 30 seconds.
• Outages longer than 5 minutes are counted.
Errors in the Methodology :- Routing register contained errors, Round off error and BGP routers remaining on backup power.

Differences between US/Canada and Italian blackout

- The number of globally advertised networks is over 14 times larger in the North American blackout area than in all of Italy.

- The number of Autonomous Systems that are either fully or partially inside the North American blackout area is over 7 times larger than the number of ASes in all of Italy.

- The degrees of route aggregation (distributions of routable network sizes) are qualitatively significantly different.
Reference:


• www.renesys.com
Thank You
Questions?