Monitoring the ATLAS TDAQ Network at CERN

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Brasov, 15/01/2009

Large Scale

3000 nodes, 200 edge switches, 5 core routers 6000 ports
Plus physicists!

- Network dimensioned to meet 'requirements'
- Maximum average link occupancy = 60%
- *Should* mean peace of mind for Network Support
- *Actually* seen as a challenge by physicists
  - 40% for free! Turn up the wick until something breaks!
- Continuous running out of spec!
- Must distinguish between 'real' and 'self inflicted' problems

Commissioning

Basic question:
Does any of it work????
Monitor everything!

**ICMP:**
Internet Control Message Protocol

**SNMP:**
Simple Network Management Protocol

**SPECTRUM**
Tells you it's alive
Tells you if it dies
Fetches status info..
- and hides it!
Commercial versus Proprietary

• Special needs:
  – Multiple networks per processor
  – Want to see whole picture for system analysis
  – Want to see all detail for component analysis
  – Want to see traffic volume visually
  – Want traffic/errors qualified
• Spectrum CORBA API clumsy
• Multiple requests hits the CPU hard
Network Browser: Miniplots

Click on switch folder for miniplots of all ports.

Dynamic pages with real time traffic

Real-time global top
Most active connections
in real time.

Current ATLAS
applications running in
the network.

Connections and traffic
per switch port.
Network browser: port stats

Click on port instance for traffic and error plots.

Affiliated mini-plots

<table>
<thead>
<tr>
<th>#Connection</th>
<th>IP address</th>
<th>Switch Port</th>
<th>Traffic (%)</th>
<th>Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>pc-tdg-sfo-01.dr0</td>
<td>10.152.32.253</td>
<td>SW-data-sfo-01</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>pc-tdg-sfo-02.dr0</td>
<td>10.152.32.252</td>
<td>SW-data-sfo-01</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>pc-tdg-sfo-03.dr0</td>
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<td>SW-data-sfo-01</td>
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<td></td>
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<tr>
<td>pc-tdg-sfo-06.dr0</td>
<td>10.152.32.250</td>
<td>SW-data-sfo-01</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>pc-tdg-sfo-07.dr0</td>
<td>10.152.32.249</td>
<td>SW-data-sfo-01</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>
Searching and Aggregation

Scaling and aggregated plots
System Diagnostics

We have prior detailed measurements of losses and latencies against loads. System dimensioned for a nominal operating maximum of 60% load on any port.

Naïve world view:
Flag Loads with high thresholds, above, say 85% throughput
Flag Errors with low thresholds, above, say, 0.05% or about 10pkts/sec at 1Gbps

Unfortunately it’s not so simple

Where is the real error?

TCP

<table>
<thead>
<tr>
<th>Traffic</th>
<th>Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>80%</td>
<td>5K pkts/s</td>
</tr>
</tbody>
</table>

UDP

<table>
<thead>
<tr>
<th>Traffic</th>
<th>Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2%</td>
<td>10 pkts/s</td>
</tr>
</tbody>
</table>
Anomalous traffic

...and from here to rules based expert systems

Transition to displays

- So far have concentrated on low level port and switch monitoring and diagnostics.
- Identified scaling issues
- Want to have a display with a system view
- Want to retain architectural model
- Want to exploit real time stats
GUESS 2D Visualisation

- Traffic overlaid onto connectivity.
- No hosts, only switches
- Only 1 data core
- Autoplacement different for each discovery

Can zoom and pan

GUESS: Guided Placement
For operators we provide a summary of status per application set.

2D Display Limitations

2D Display is very good for switch to switch traffic visualisation
No ‘level of detail’ feature as you zoom in or out
Can’t incorporate host details - - -would overwhelm the plot

BUT..

I want all the detail when something goes wrong
I want neighbouring views when examining individual behaviour
I want the system wide view for visual correlation
I want different levels of detail depending on my viewpoint
I want fly-through, and navigation and easily visible errors
I want … I want …

I want GOOGLE Earth for my network.
3D Display

Google earth as inspiration
Variable detail as a function of viewing distance
Variable viewing angles
Intuitive navigation
Unfortunately Google doesn’t cope with our dynamic update requirements
So we went looking for display software that does.

X3D (enhanced VRML)
Octaga Player

3D Top Level View
3D Top Level View

Detail of processor farm
Diagnostic Tools: 1

- YATG (Yet Another Traffic Grapher)
  - High speed SNMP-based traffic monitoring (the switch is the limiting factor)
  - Fine time granularity statistics for selected device interfaces

- ATLAS-like traffic bandwidth measurements
  - Distributed applications replicate the transactional request-response transfer protocol
  - Demonstrate maximum achievable bandwidth
Diagnostic tools :2

- Dynamic queue growth measurement

Diagnostic tools :3  SFLOW (1)

- sFlow is the standard for statistical packet sampling
  - Each network port → sampling system
  - All packet samples → central location (software)
  - Analysis → information about the content of the traffic

- By collecting packet samples, the packets can be classified into flows
  - A flow → network conversation between two applications
  - The bandwidth occupancy for each flow can be estimated

- We developed an sFlow analysis application in order to study the technology
Diagnostic tools: 3 SFLOW (2)

For one switch port
Using SNMP: “bandwidth usage on port B1 is 89%”
Using sFlow: Pie chart with traffic distribution

For the entire network
Traffic matrix with all senders and receivers

Summary

• large scale network
• monitor, diagnose
  – commercial tools
  – “in-house” built software
  – plots for 6000 ports
  – different levels of visual abstraction
• 24/7 operation
• errors not welcome