Enterprise Network Test Strategies for Network Availability and Performance

A Sitaramaiah
Director
Fluke Networks India
Why is Enterprise Network Testing becoming increasingly important?

- IT is increasingly deployed by enterprises
  - Becoming a key competitive differentiator
  - Being deployed as Customer satisfaction is means to customer retention
- Applications are becoming more and more Web and IP enabled
- Convergence of Voice, data and Video on Network is enabling collaboration to ensure faster and better response to customer needs
- ROI on investment in IT is being more demanded by Business Managers
  - alignment of business and IT objectives is more imperative like never before
Three Laws of Networking

#1 - Networks *Never* Go Slower
   • *Plan for higher speeds, increased throughput, reduced response time*

#2 - Networks *Never* Get Smaller
   • *Plan for more users, more traffic, more capacity,*
   • *Integrate customers, supply chain*

#3 - Networks *Never* Stay the Same
   • *Plan for flexibility, reconfiguration, manageability*
A Simple framework for Enterprise Network Test

- **Troubleshooting approach**
  - Aimed at front-end network engineers responsible for network troubleshooting and auditing to help recover from problems
  - A reactive approach to network management
  - Need to equip network engineers with tools to troubleshoot physical layer (copper, optical fiber and wireless) as well as logical (Data link and Network layer) layer issues

- **Network Analysis and Monitoring approach**
  - Aimed at Network Managers who plan and provide for Network performance
  - A proactive approach to Network management
  - Aims to “prove it is not the network”

- **SLA focused approach to Enterprise Performance Management**
  - Aimed at CIOs and Network Managers to ensure availability and delivery of applications over enterprise networks
  - Service / SLA focused approach
  - Goes beyond traditional practice of ensuring network availability / uptime
A simple framework for Enterprise Network Test

- Service Level Management
  - Monitor & Baseline
    - Troubleshoot

Traditional Focus of Enterprise Network Test

Network + Application

Network
Enterprise Customers want to know

- How can I make informed decisions on upgrades?
- What is normal on my network?
- Is it a network or server or application problem?
- Where is the traffic and Who is causing it?
- What do I need to Qualify when I deploy new technologies?
  + POE, 1G at desktop or 10G Ethernet in backbone, MPLS

Traditional DCI / SI focus in India on Enterprise testing

- LAN Cabling Certification driven by Cabling OEM Warranty
- Cable Plant and Test result documentation
- Network Turn-up is a thankless job
- No prevalent LAN Acceptance testing practices
- AMC focus on reacting to and fixing breaks

Availability Vs. Performance
## Enterprise Network Test

### Enterprise Network Test: How does it stack up

<table>
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<th>Scope</th>
<th>LAN Cabling Integration</th>
<th>Network Integration</th>
<th>Systems Integration</th>
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<td>Switching</td>
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<td>Routing</td>
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<td><strong>Availability</strong></td>
<td>Verification &amp; troubleshooting</td>
<td>Network Turn-up Test</td>
<td>Networking Monitoring &amp; Troubleshooting</td>
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<td>Performance</td>
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<td>Network Acceptance Test</td>
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<td>WAN Traffic Analysis</td>
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## LAN Media test strategies

<table>
<thead>
<tr>
<th>Media</th>
<th>Availability</th>
<th>Performance</th>
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<tr>
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<td>Continuity</td>
<td>Attenuation</td>
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<td>Crosstalk</td>
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<td>Wire Map</td>
<td>PP/PS</td>
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<td>NEXT, FEXT and ELFEXT</td>
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<tr>
<td></td>
<td>Length</td>
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<tr>
<td>Optical Fiber</td>
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<td></td>
<td>Fiber Continuity</td>
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<tr>
<td>Wireless</td>
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<td></td>
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<tr>
<td></td>
<td>Network Coverage</td>
<td>Throughput</td>
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</table>

Test Result Documentation as well as Cable Plant Documentation is Key to assuring end customer Network Availability and Performance.
Levels of Field Testing – Assuring Copper Cabling Systems Performance

Verification

– The installed link meets basic continuity requirements
– Does not imply any bandwidth or transmission quality measure

Qualification

– The installed cabling link successfully transmits data using a specific network technology (i.e. 10GBASE-TX)
– Does not imply compliance with technologies other than the one used in the test

These levels do not deliver the assurance and confidence of the certification test
Levels of Field Testing – Assuring Copper Cabling Systems Performance Certification

- The definition of performance and the level ("category") of performance is defined by industry standards
  - TIA-568-B defines Cat 5e, Cat 6
  - ISO 11801 and ISO/IEC 61935 define Class C, D , E, EA and F
- The installed cabling link meets the transmission performance criteria as defined by the applicable industry standard
- The tests are conducted and test results are documented and reported in compliance with the standard
## Network Technology and Certification Category

<table>
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<tr>
<th>Network Technology</th>
<th>Data Rate</th>
<th>Minimum required link category</th>
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<tbody>
<tr>
<td>10BASE-T</td>
<td>10 Mb/s Ethernet</td>
<td>Cat 3 / Class C</td>
</tr>
<tr>
<td>100BASE-T4</td>
<td>100 Mb/s Ethernet (4-wire)</td>
<td>Cat 3 / Class C</td>
</tr>
<tr>
<td>100VG-AnyLan</td>
<td>100 Mb/s</td>
<td>Cat 3 / Class C</td>
</tr>
<tr>
<td>Token Ring</td>
<td>4 Mb/s</td>
<td>Cat 3 / Class C</td>
</tr>
<tr>
<td>100BASE-TX</td>
<td>100 Mb/s Ethernet (2-wire)</td>
<td>Cat 5 / Class D:2000</td>
</tr>
<tr>
<td>ATM-155</td>
<td>155 Mb/s</td>
<td>Cat 5 / Class D:2000</td>
</tr>
<tr>
<td>Token Ring</td>
<td>16 Mb/s</td>
<td>Cat 5 / Class D:2000</td>
</tr>
<tr>
<td>1000BASE-T</td>
<td>1 Gb/s Ethernet</td>
<td>Cat 5e / Class D:2002</td>
</tr>
<tr>
<td>10GBASE-T</td>
<td>10 Gb/s Ethernet</td>
<td>Cat 6 / Class E or Cat 6A / Class EA</td>
</tr>
</tbody>
</table>

*Note: The table lists various network technologies along with their corresponding data rates and minimum required link categories.*
Cabling Requirements for 10GBASE-T

- The signal-to-noise analysis is complex and consists of two types of disturbances:
  - ‘In-channel’ disturbances – Initially set to ISO/IEC 11801 Class E limits extended to 500 MHz
    *(Class E/Cat 6 defined from 1 to 250 MHz)*
  - ‘Between-Channel’ disturbances for Crosstalk referred to as “Alien Crosstalk”
- Proposed cabling specifications:
  - TIA-TSB-155
  - Standard for “Augmented Cat 6” (Cat 6A) TIA-568-B.2-10
Alien Crosstalk

- Crosstalk between wire-pairs in adjacent cables
- General rules:
  - The effect is due in first instance by proximity
  - This crosstalk is worst between wire-pairs with the same twist rate
  - The effect is greater for pairs with a lower twist rate
  - Impact increases with the distance over which the cables run in parallel
  - Impact increases with the frequency of the transmitted signals
Alien Crosstalk Is An External Noise Source

- Signal strength: measured by “Insertion Loss”
- Alien Crosstalk: An external source to NEXT, FEXT and RL
Two-Tier Testing for Optical Fiber Cabling Systems

Per TSB-140 Additional Guidelines For Field-Testing Length, Loss And Polarity Of Optical Fiber Cabling Systems
(Approved by TR-42 in February 2004)

• **Tier 1: OLTS (Optical Loss Test Set)**
  – Conforms to TIA-526-14A and TIA-526-7
  – Most closely simulates system
  – Measures the total loss of a fiber channel
  – Verify polarity using OLTS or VFL

• **Tier 2: OTDR Trace**
  – Can show segment lengths, connector locations & losses, and losses not at a connector
  – Provides evidence that cable is installed without degrading events (e.g., bends, connection, splice)
  – Can do single-ended testing
Test Example: Tier 1 (OLTS)

- 50/125 μm cabling (laser optimized)
- 130 m backbone cable
- 7 m patch cord
- 80 m to the wall outlet

2.15 dB - Pass

Standard Limits
2.6 dB max attenuation
300m max distance
Test Example: Tier 2

130 m 7 m 80 m
Event Table from OTDR

Location (m) | 850nm (dB) | Event | Pass/Fail
--- | --- | --- | ---
0 | .18 | Reflect | Pass
130 | .14 | Reflect | Pass
137 | .88 | Reflect | Fail
217 | .19 | Reflect | Pass

1.39 + 0.76 (for cable) = 2.15 dB
Assuring Optical Fiber cabling Performance with Tier II testing

ChannelMap

Endface Inspection and SAVE

OTDR Trace & Analysis

Loss/Length Certification

Records Management & Documentation
Wireless LAN - What is the objective?

Design and Test for Coverage

Design and Test for Performance

- Desired applications drive specifications
  - “Normal” client use (How might it change?)
  - VoWLAN
  - Specialized applications (healthcare patient telemetry, etc.)

- Clear specifications must be agreed upon
  - Desired data rate
  - AP coverage/count - % of facility, # of Users – Plan for growth!
  - Signal strength
  - Signal to Noise Ratio
## Network Test Strategies

### Network Integration: Test Strategies for Availability and Performance

<table>
<thead>
<tr>
<th>Availability</th>
<th>Performance</th>
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<tr>
<td>Network Turn Up</td>
<td>LAN Acceptance Test</td>
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### Connectivity from TO

<table>
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<th>LAN Discovery</th>
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<tr>
<td>Speed</td>
<td>Network Throughput Test</td>
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<tr>
<td>Duplex</td>
<td>(IETF RFC 2544)</td>
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<tr>
<td>PoE Voltages</td>
<td>Throughput</td>
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<thead>
<tr>
<th>Network Resources</th>
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<tbody>
<tr>
<td>Servers</td>
<td>Latency</td>
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<td>Gateway</td>
<td>Packet Loss</td>
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<td>Printers</td>
<td>Baseline Response Time</td>
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</table>

### Link utilization

<table>
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<th>% utilization</th>
<th>Errors</th>
<th>Broadcasts</th>
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<tr>
<td>Network</td>
<td>Application</td>
<td>Application</td>
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</table>
The switch port performs the basic auto-negotiation function.

- No DHCP server has been found. No static address has been entered.

- Checking the Traffic on this port we learn that the switch port is not “active”.
- Can be due to a defective switch port, or a mis-configured port or a disabled port.
LAN Acceptance Test – Device Discovery

Device Discovery

Network Discovery

VLAN Discovery

IP Subnets

Networks

Device Discovery - All Devices
LAN Acceptance Test - RFC 2544 testing

• IETF RFC 2544 “discusses and defines a number of tests that may be used to describe the performance characteristics of a network interconnecting device.”
• The RFC 2544 guidelines provide a standard testing methodology
• RFC 2544 is optimized for testing single routing devices in a laboratory environment
• Not all the tests are applicable for providers installing or troubleshooting Ethernet-based IP on active WAN links
• 3 of the 6 tests specified by RFC 2544 are really necessary to characterize performance in an Internet environment
  – Throughput
  – Latency
  – Frame Loss Rate
LAN Acceptance Test - RFC 2544

Throughput Device Results

EtherScope-TAC
Remote Device
IP: 610.248.001.142
Speed: 160Mb
Duplex: Full
Local Device
802.1Q: Enabled
Accur.: 95%
Complete
Estimated time: 00:01:50

RFC 2544 Throughput Results

Frame Size (bytes)
Rate (FPS)
0 150000
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0 60 128 256 512 1024 1522

Display Mode
- BPS
- FPS

View Mode
- Table
- Graph

100Mb Configure Graphs Start Report
## Systems Test Strategies

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<td>Trending what makes up the WAN link utilization</td>
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<td>Trouble assignment</td>
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</tbody>
</table>
System Availability Vs. System Performance?

- **Network**
  - **Network Availability**
    - Ex: Network interfaces should be available 99.9999% of the time.
  - **Network Performance**
    - Ex: Latency on the Houston to Singapore interface should be less than 300 ms.

- **Application**
  - **Application Availability**
    - Ex: Oracle application should be available 98% of business hours.
  - **Application Performance**
    - Ex: 90% of Oracle users should have response time less than 2 seconds.

- Which one more accurately reflects user problems?
WAN Traffic Analysis - Top N Applications, Talkers, Destinations …
Adopting Enterprise Network Strategies
Can be a WIN-WIN situation for DCI / SI & Customers communities

Thank you.