Stress Testing to Validate Router Readiness for Deployment

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Agenda

- Background on IETF's Benchmarking Methodology Working Group
- Accelerated Stress Testing Model
  - Terminology
  - Benchmarks
  - Methodology
- Test tool requirements
- Summary & Recommendations

IETF's Benchmarking Methodology WG

- BMWG falls under the Operations and Management Area
- BMWG makes a series of recommendations for the measurement of the performance characteristics of various internetworking technologies
- Benchmarks devices in the network, not live networks
- Benchmarks Performance, not Conformance
- http://www.ietf.org/html.charters/bmwg-charter.html

BMWG's Stress Test Work Item

- draft-ietf-bmwg-acc-bench-term-01.txt
  - Terminology for Benchmarking Router Accelerated Life Testing
- draft-ietf-bmwg-acc-bench-meth-00.txt
  - Methodology for Benchmarking Router Accelerated Life Testing

- IETF BMWG's Stress Testing work item is to provide framework, terminology, guidelines, and procedures for network providers and device vendors to perform Stress Testing

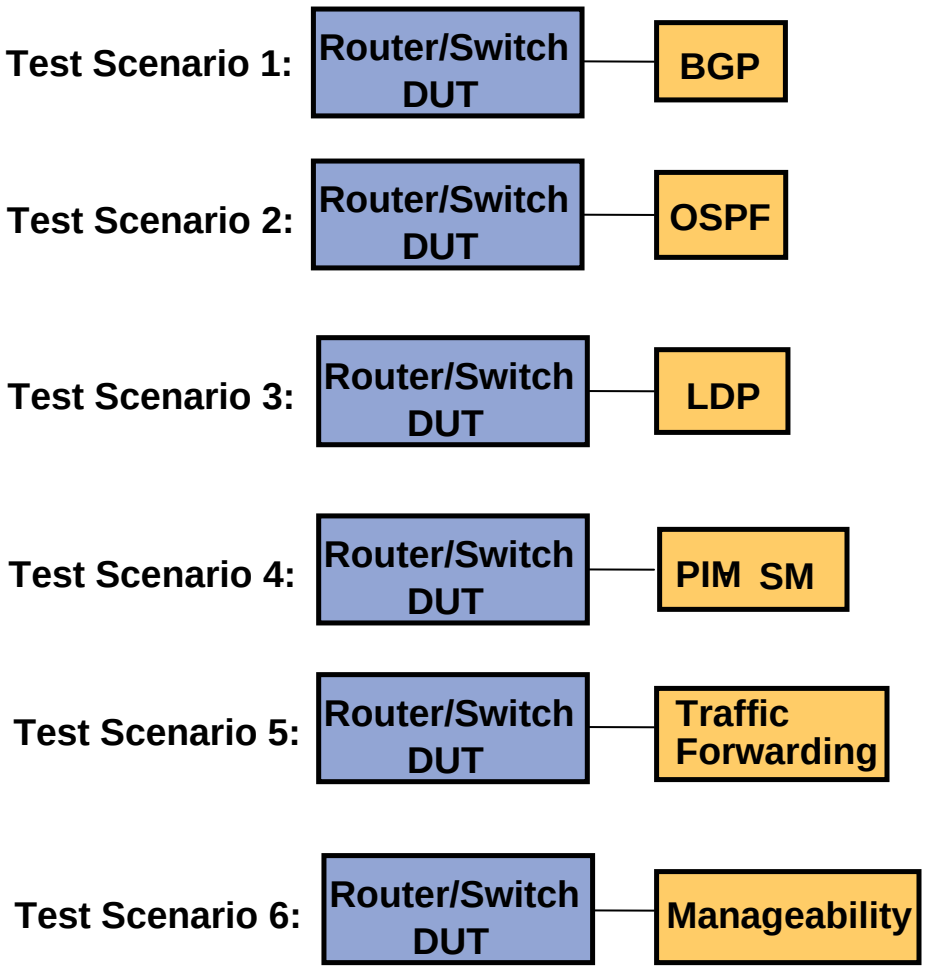
Stress testing terminology

- DUT
- White box versus Black box testing
- Stress Testing
- Instability Conditions
- Data, Control, Security and Management Planes
- Configuration Sets
- Evaluation Benchmarks

Importance of Stress Testing

- Router/Switch Test Engineers typically perform only ISOLATED testing
- Isolated testing is necessary to validate functionality
- Deficiency = Service Provider networks have numerous functions simultaneously operational in a dynamic environment
- Stress Testing resolves this test deficiency by validating router/switch readiness for deployment
- Router/Switch vendors and ISPs should both perform Stress testing in addition to isolated feature testing

Isolated Testing Model



Protocol Test Coverage:

Conformance
Scalability
Convergence

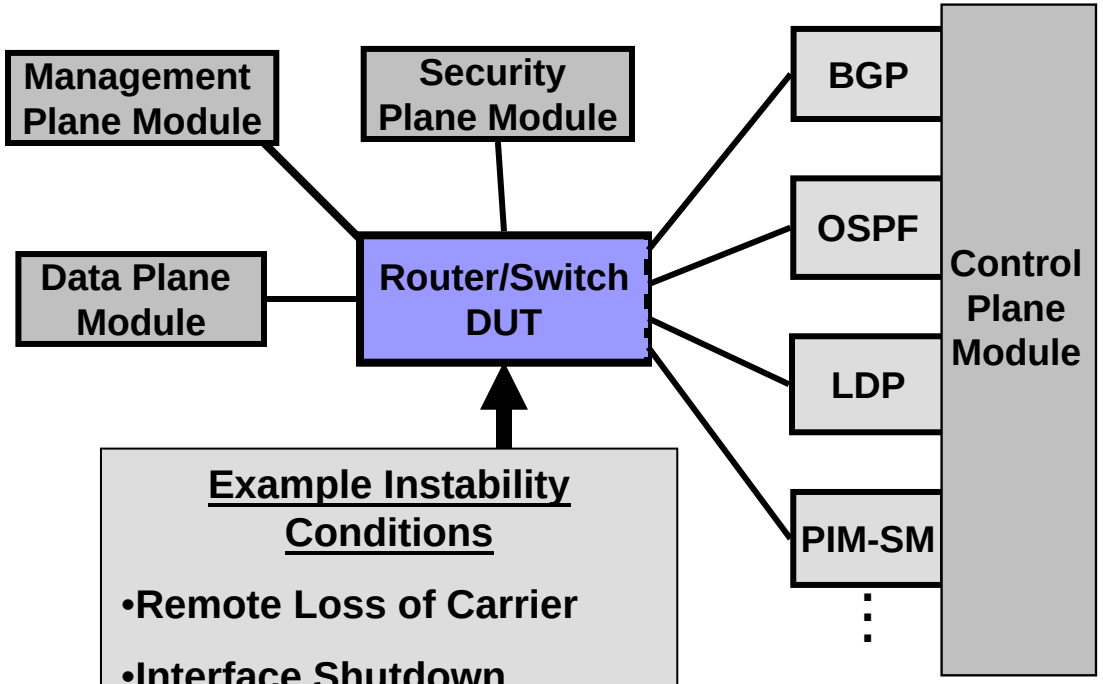
Traffic Forwarding Test Coverage:

Forwarding Rate/Throughput
Delay/Jitter

Manageability Test Coverage:

SNMP, User Access, etc.

Stress Test Model



Example Instability Conditions

- Remote Loss of Carrier
- Interface Shutdown Cycling Rate
- BGP Route Flap Rate
- IGP Route Flap Rate
- Better Next-Hop
- LSP Reroute Rate
- >100% link utilization

Note: All Instability Conditions produce a Convergence Event

Example Router Configuration

- Data Plane
  - Line Cards/Interfaces
- Security Plane
  - Traffic Forwarding with and without filters
- Control Plane
  - Routing
    - BGP
    - IGP
  - MPLS
    - TE
    - L2/L3 VPNs
- Management Plane
  - User Access
  - SNMP
  - Logging/Debug
  - Packet Statistics Collection

Stress Test Measurements

- Identify difficult to detect Software Coding bugs such as:
  - Memory Leaks
  - Sub-optimal CPU Utilization
  - Incorrect Multi-Protocol coding logic
- Verify Manageability
  - Ability to open and close SSH sessions
  - Enter stressful and invalid commands
  - Perform MIB Walk
  - Enable Logging and Debug
- Evaluate Convergence Under Stress:
  - Instability Conditions force Convergence Events
  - Data Plane is monitored for routing errors during Convergence Events

Stress Test Benchmarks

- Maximum CPU Utilization
  - Identifies Resource Exhaustion, most common cause for Denial of Service of a router.
- Available Memory
  - Identify large memory leaks
  - Identify slow memory leaks
    - Constant route changes accelerate slow memory leaks to make them identifiable in a single test
- Run-Time without Control Plane Error
- Run-Time without Data Plane Error
- Run-Time without Management Plane Error
- Run-Time without Security Plane Error

Stress Test Methodology

- Drive Control, Management, and Security Planes
- Monitor Data Plane, Available Memory, Max CPU
- Accelerate stress on Control Plane using *Instability Conditions*
- Failure when:
  - Control Plane – Session Lost
  - Data Plane – Misrouted, lost, or reordered packet
  - Management Plane – Access Denial or gross error from object value
  - Security Plane – Incorrect permit/deny
- Pass when:
  - *Success Threshold* reached and no failures observed

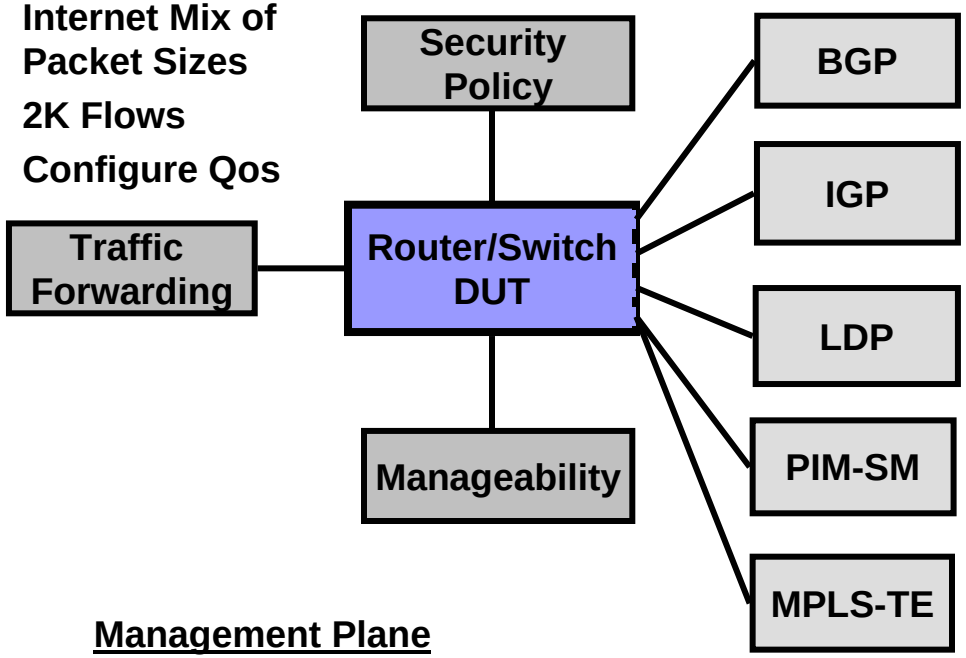
Example Stress Test

Data Plane

- Line Rate on 100% of interfaces
- Internet Mix of Packet Sizes
- 2K Flows
- Configure Qos

Security Plane

- 200 ACLs
- 200 ACEs



Control Plane

- 100 Sessions (20 EBGP, 80 IBGP)
- 300K selected routes, 2M Route Instances
- 80 Adjacencies
- 5K routes (2500 inter-area, 2500 intra-area)
- 20 Adjacencies
- 1K FECs
- 5K Groups joined
- 1.5K tunnels (250 ingress tunnels, 250 egress tunnels, and 1K mid-point tunnels)
- Transit node for 100 targeted peers (LDP over RSVP)
- FRR enabled for local link protection of LDP sessions

Management Plane

- 1K SNMP GETs per minute
- 1 telnet session open every 10 minutes
- 1 telnet session closed every 10 minutes
- Enable Debug and Logging

Instability

- 200K BGP route flaps every 10 minutes
- 1K IGP route flaps every minute
- 100 MPLS-TE reroutes every minute
- Cycle interfaces - 1 Link Loss every minute
- >100% offered load to 5 outbound interfaces

DUT Behavior During Stress

- Route Convergence due to BGP flaps
- Route and FEC Convergence due to IGP flaps
  - Common cause of slow memory leak
- Flap link to force nested-Convergence Events
  - Common cause of high CPU utilization -> exacerbated when scaling protocols and routes
  - FRR protection may cause failover to backup path
- Data traffic switches outbound interfaces
- Logging and Debug continues
  - Common cause of high CPU utilization when router is not under stress

Test Tool Requirements

- Software Requirements:
  - Emulate multiple protocols simultaneously on the same interface
  - Send and measure traffic to emulated routes and LSPs
  - Perform SNMP testing and validate results against externally observed measurements
  - Initiate and repeat Instability Conditions
- System Requirements:
  - Support protocol emulation on all interfaces types
  - High Port Density
  - Stability over many hours/days of operation - "Must work under stress to evaluate stress"

Current Limitations of Commercial Test Equipment

- Commercially available IP test tools do not meet most Stress Test requirements
- In-House test tools must be developed
- Common Limitations:
  - Establish multiple protocols on same interface
  - Direct traffic to emulated routes/LSPs
  - Induce Instability Conditions at configurable rates.
  - Perform SNMP MIB Walk and value validation
  - Stable while supporting traffic generation, multiple emulated protocol, flapping, and measurement - for continuous hours

Summary

- Stress Test enhances router test and evaluation:
  - Verifies operation in deployed environment
  - Ensures System and Software stability
  - Validates correct routing under stress
  - Evaluates manageability under stress
  - Identifies difficult to detect software bugs
- Ultimate Benefits
  - Better release criteria for network deployment
  - Higher router availability in production networks
  - Identification of ability to withstand potential DoS attacks

Recommendations

- Router vendors
  - Develop deterministic measures of scaling an operational router running multiple protocols
  - Understand interactions among multiple operational protocols and the implications on router stability and scalability
- Test equipment vendors
  - Develop integrated test tools for stress testing of Control, Data, Management and Security Planes
- Service Providers
  - Employ certification testing methodology that allows for early detection of system failures
  - Aid in developing standardized testing terminology and methodology by participating in the BMWG mailing list (bmwg@ietf.org)

Comments?