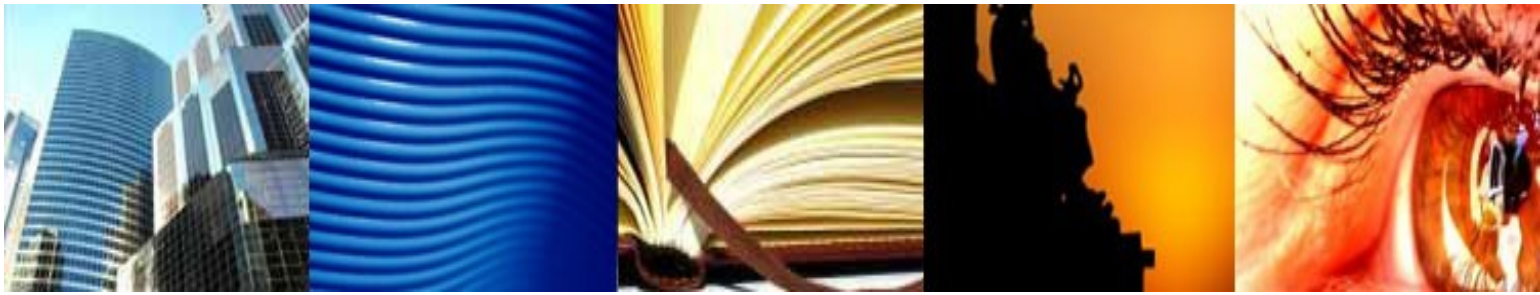
albedo Net.Storm emulator



High Performance Generator of IP packet impairments

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Triple Play QoS Requirements

- Convergence is moving **all applications to IP**
- However routers, and IP networks were designed **to transport Data**
- Video, Voice, TV, Internet, Data, etc.: all have **specific QoS** needs
- Can any network **support next gen** services?
- Are applications **tolerant enough** to real networks?
- Are routers, devices appropriate?

QoS	ITU-T Y.1541 - Applications	Delay	Jitter	Loss	Error	Order
Class 0	Real-Time, Jitter Sensitive, High Interaction (VoIP, VConf)	100 ms	50 ms	$1x10^{-3}$	$1x10^{-4}$	U
Class 1	Jitter Sensitive, Interactive (VoIP, Audio Streaming)	400 ms	50 ms	$1x10^{-3}$	$1x10^{-4}$	U
Class 2	Transaction Data, Interactive (Signalling)	100 ms	U	$1x10^{-3}$	$1x10^{-4}$	U
Class 3	Transaction Data, Interactive (Enterprise critical data)	400 ms	U	$1x10^{-3}$	$1x10^{-4}$	U
Class 4	Low Loss (Bulk Data, Video Streaming, VoD on local disk)	1 s	U	$1x10^{-3}$	$1x10^{-4}$	U
Class 5	Best Effort IP Networks (Traditional IP applications, www)	U	U	U	U	U
Class 6	Real-Time, Jitter Sensitive, High Interaction (IPTV, VConf)	100 ms	50 ms	$1x10^{-5}$	$1x10^{-6}$	$1x10^{-4}$
Class 7	Jitter Sensitive, Interactive, Low error (HDTV, IPTV, VTC, VoD)	400 ms	50 ms	$1x10^{-5}$	$1x10^{-6}$	$1x10^{-4}$

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Requirements to verify Networks and Applications

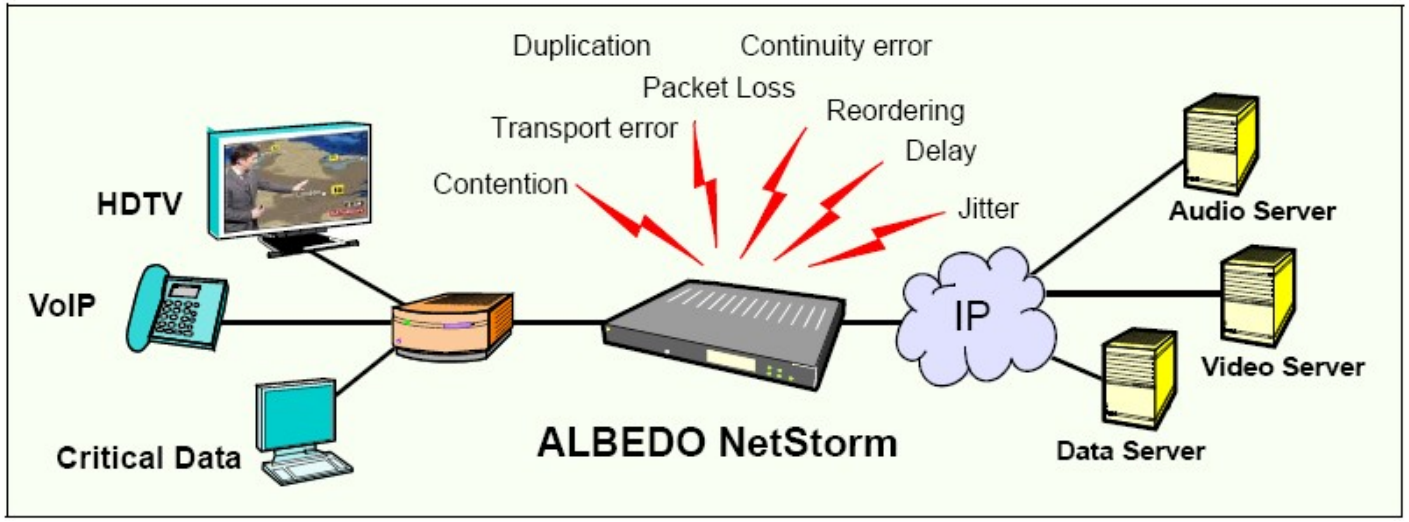
- **Realistic traffic**
  - IPTV, Streaming Video, Video on Demand,
  - VoIP, Audio Streaming
  - Web Browsing, Email, FTP
  - Not synthesized traffic
  - Line Rate Video 1G and 10G

- **Realistic Network Impairments**
  - Using ALBEDO NetStorm
  - Generation of real network conditiions
  - Modifies QoS real traffic

End-to-end Real Traffic Conditions

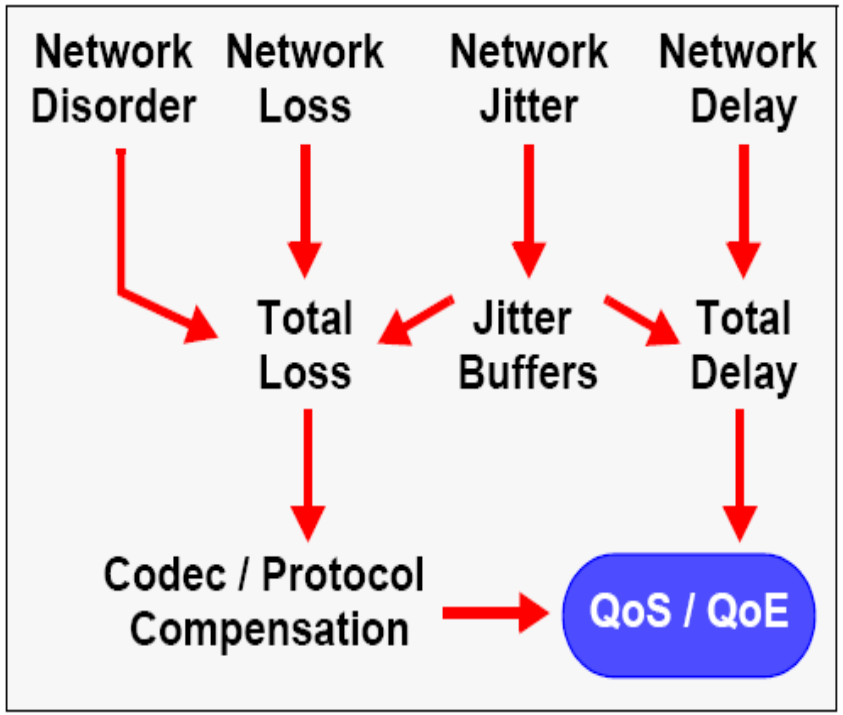
ALBEDO NetStorm emulates real IP actual network conditions

- **Managed**, **Partially Managed, Unmanaged**
- **Real traffic pass-through** then
  - Packet Loss, Error, Duplication, Reordering,
  - Packet Delay, Jitter, Bandwidth shaping, and Throttling
- Control per **traffic flow and filters**



Testing requirements

- **Quality of Service** (min bandwidth, max latency) are harder to test, compare than simple best-effort delivery
- **Nodes, Terminals, Protocols, and Applications** are harder to "pin down" and test thoroughly
- **Some features** such as multicast delivery require larger, more complex test environments
- **Access technologies** (HFC, xDSL, FTTH, WiMax, PLC, WiFi) can be highly asymmetric and expensive to test



Three Methods for testing IP applictions

(1) Simulation

- Can be cheap and quick to prepare
- Given sufficient resources, can do large-scale tests
- Tests are controlled, reproducible
- *Simulation implementation may differ considerably*
- *Synthetic environment may also poorly represent real one*

(2) Live testing

- Real code in real environment
- *May only be possible very late in development cycle*
- *Difficult or expensive to create a real test environment*
- *Tests not reproducible, it's difficult to analyze found issues*

(3) ALBEDO Network Emulation

- A controlled, reproducible environment for running live code
- Emulates any *real-world badness* in a small, laboratory
- Provides a means for simulations to interact with a live network
- Implemented via "hooks" into a real, networking implementation

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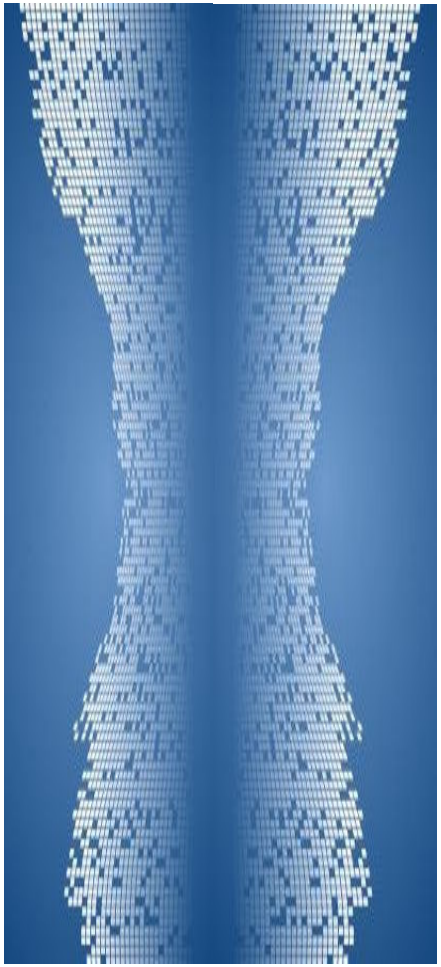
Net Storm Features

- **Simple user entry of network parameters (packet loss, delay)**
  - Allow record/playback of network conditions
  - Suitable for testing multicast, high-bandwidth applications
  - Emulate a wide range of network types with a small lab set-up
  - Emulate asymmetric networks over symmetric ones

- **Appropriate for Triple Play Design + Planning + Deployment**
  - Excellent for VoIP verification
  - Appropriate for IPTV applications (MPEG4, MPEG2, VC1)
  - Suitable to test protocols including SIP, H323,
  - Accurate enough to test Router, Switches, CPE

Network conditions emulated (I)

- **Packet delay**
  - Fixed
  - Variable (probability distribution, settable mean/variance)
- **Packet jitter**
  - Fixed
  - Variable (probability distribution, settable mean/variance)
- **Packet reordering**
  - Through large delay variances
- **Packet loss**
  - Uniform probability
  - Congestion-dependent (Gilbert Elliot algorithm)
- **Packet duplication**
  - Uniform probability
- **Bandwidth limitation**
  - Use in conjunction with congestion-dependent packet loss



Testing Market

ALBEDO NetStorm tool can:

- **Scalability Check**
  - Tolerance to Network Impairments
  - Response time, stream integrity, and video quality
  - Accuracy and response time of error correction
  - Control plane performance and scalability
- **Unicast and multicast performance**
  - Quality of video transport, control and content
  - Client transaction fulfillment, through transaction tracing

the 35% users abandon IPTV after a bad quality experience

only 55% of users are satified with the new VoIP service

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That's all

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