Net.Storm a LAN/WAN emulator

Real traffic conditions

Net.Storm simulates links and networks in terms of bandwidth and quality of service. Traffic is separated by user-defined filters into independent flows that receive specific treatment to replicate real-world traffic conditions through impairments and bandwidth limitations.

Net.Storm allows you to model network dynamics using arbitrary impairments and throughput management to verify how tolerant your designs are to degradations in the parameters that define the quality and capacity of your transmission network. The goal is to better understand the behavior of new devices and systems or to identify what is causing problems.

Define Streams

You can separate traffic into streams using any of the sixteen filters available in each direction (Tx+Rx), and then each stream will receive specific treatment. Filters can be MAC addresses, TCP ports, GOOSE protocol... whatever you can identify in the headers of the packets.

Set Bandwidth

The channel capacity of each flow can now be characterized using traffic shaping or traffic policy algorithms, just as a gateway, router, or pseudowire would do to limit and prioritize available bandwidth.

Select Quality

Each flow is now conducted to the impairment engines, which are a set of perturbations such as delay, jitter, packets, errors, duplications, etc. that can be programmed to occur with statistical periodicity.

“Ideal for IEC 61850, Telcos, Datacenters, Internet labs”

The result is a system that exactly replicates network conditions in a 100% controlled manner because all operations are performed by FPGA hardware-like engines with microsecond accuracy and, most importantly, with zero virtual delay for the rest of the traffic that is not affected by the emulation. Forget about cheap software-based emulations because the CPU can't handle medium or higher bit rates and will only work when the traffic is below a few kbps.

Think of Net.Storm as a real network, configurable with the characteristics you need in your lab to verify how it all works under network stress.

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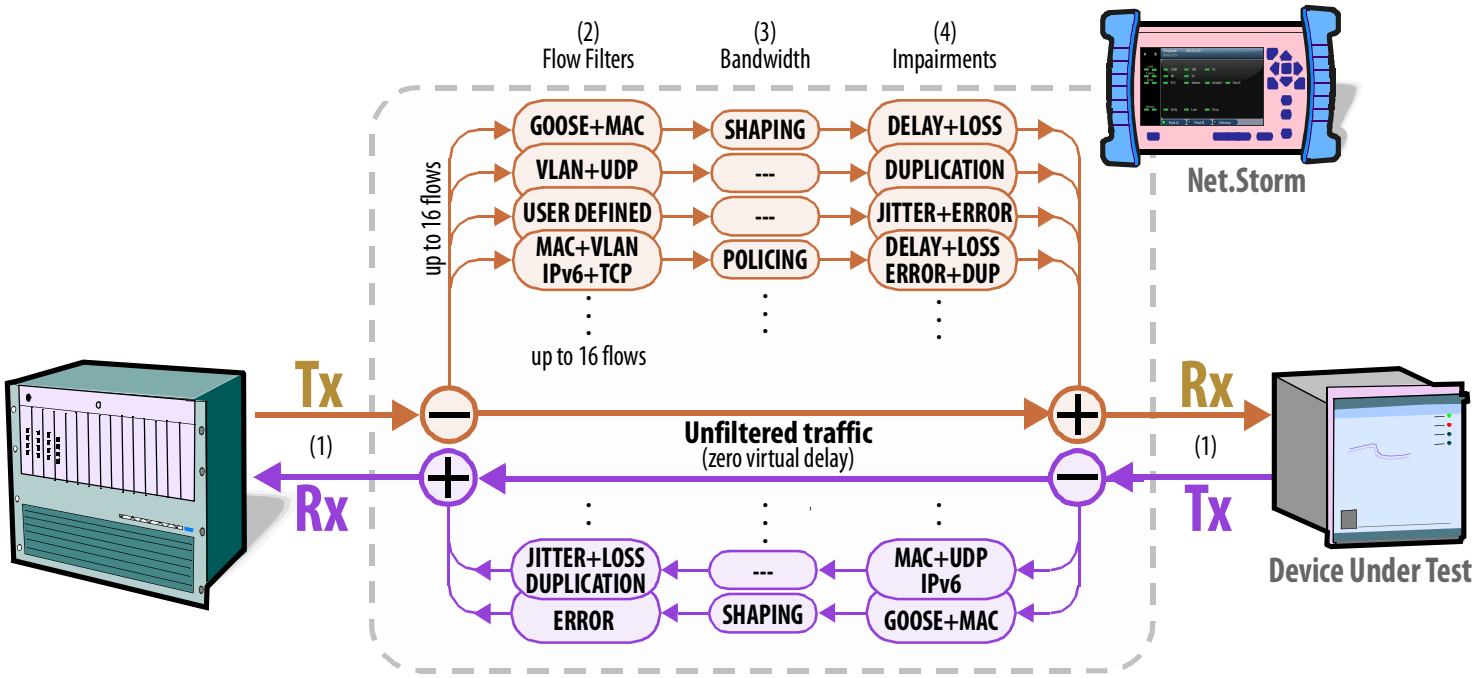


Net.Storm in operation: (1) connect in through mode, (2) program flow filters, (3) characterize bandwidth, (4) select impairments.

Unique choice

This is the only choice on the market for a portable network emulator, i.e. a self-contained appliance with keyboard, display, with 4 x opt / ele ports from 10Mbps to 1Gbps, and optional PoE.

To run, Net.Storm is connected in pass-through mode between two devices, then the user defines N filters to separate the traffic into N streams that receive a specific bandwidth and set of impairments, resulting in a realistic yet controlled simulation.

Split traffic

To separate traffic into flows, the user has up to 16 filters to identify each stream using any field of the headers:

- **MAC**: source address & mask, destination address & mask, ethertype & mask.
- **VLAN**: VID, priority bits, etc
- **IP**: IPv4 / IPv6, source address & mask, destination address & mask, protocol, DSCP, etc
- **TCP**: Source/Destination Port, Min/Max Source/Destination Port, etc
- **UDP**: Source/Destination Port, Min/Max Source/Destination Port, etc
- **User filter**: Protocols such as GOOSE, SV, VoIP can be identified by frame start, offset, match code, mask, etc

Once programmed, those packets that are part of a stream are redirected to the appropriate engines. The rest of the traffic continues without any content or timing disruption.

Bandwidth control

This engine is a replica of routers and gateways that limit the bandwidth of data flows to prioritize traffic to ensure that it does not exceed the capacity. If the traffic is too high packets can be dropped or delayed to maintain the limit using a traditional token bucket algorithm:

1. **Traffic Policing**: This strategy preserves the timing of the data stream, but non-conforming packets are lost.
2. **Traffic Shaping**: In this case, nonconforming packets are held in a buffer that, if not overloaded, is simply delayed.

Generate Impairments

Ethernet is a best-effort technology, which means that it is difficult to maintain quality of service despite the engineering applied because traffic is subject to congestion, access bottlenecks, priorities, etc. that ultimately degrade quality. Net.Storm is able to replicate the exact same impairments that degrade quality, using both deterministic and random modes:

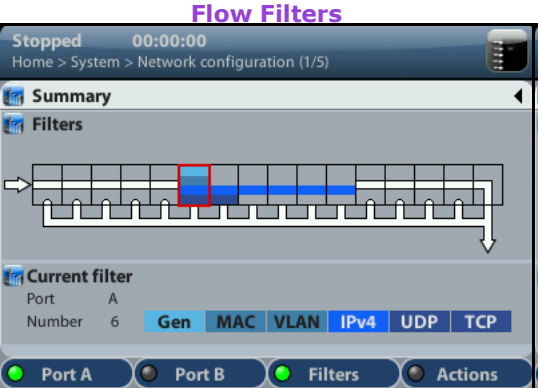
- **Loss**: in multiple modes such as single, statistical, burst, etc.
- **Delay**: according to deterministic or random distributions
- **Jitter**: according to deterministic or random distributions.
- **Reordering** function associated to the delays
- **Duplication** in simple, random and as probability in percent.
- **Error** in simple, random and probability in percent.

Indoors - outdoor

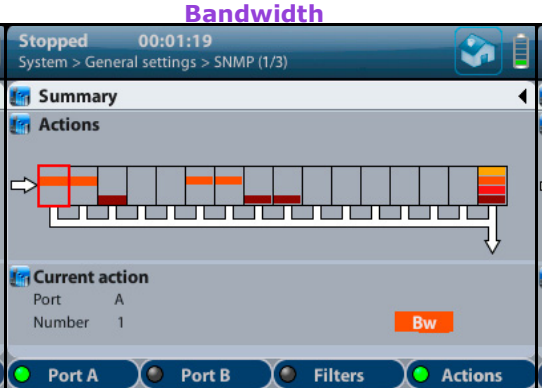
Net.Storm is an extremely flexible can be used in several ways:

- **Stand-alone** with touch screen display and batteries, ideal for outdoor use
- **Desktop device** with mouse, keyboard to be managed in the permanent labs
- **Remote unit** with a laptop running the VNC application.

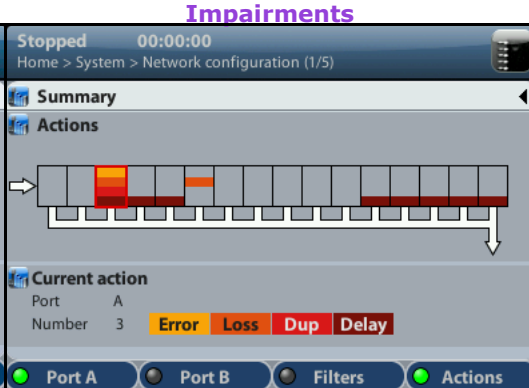
Flow Filters

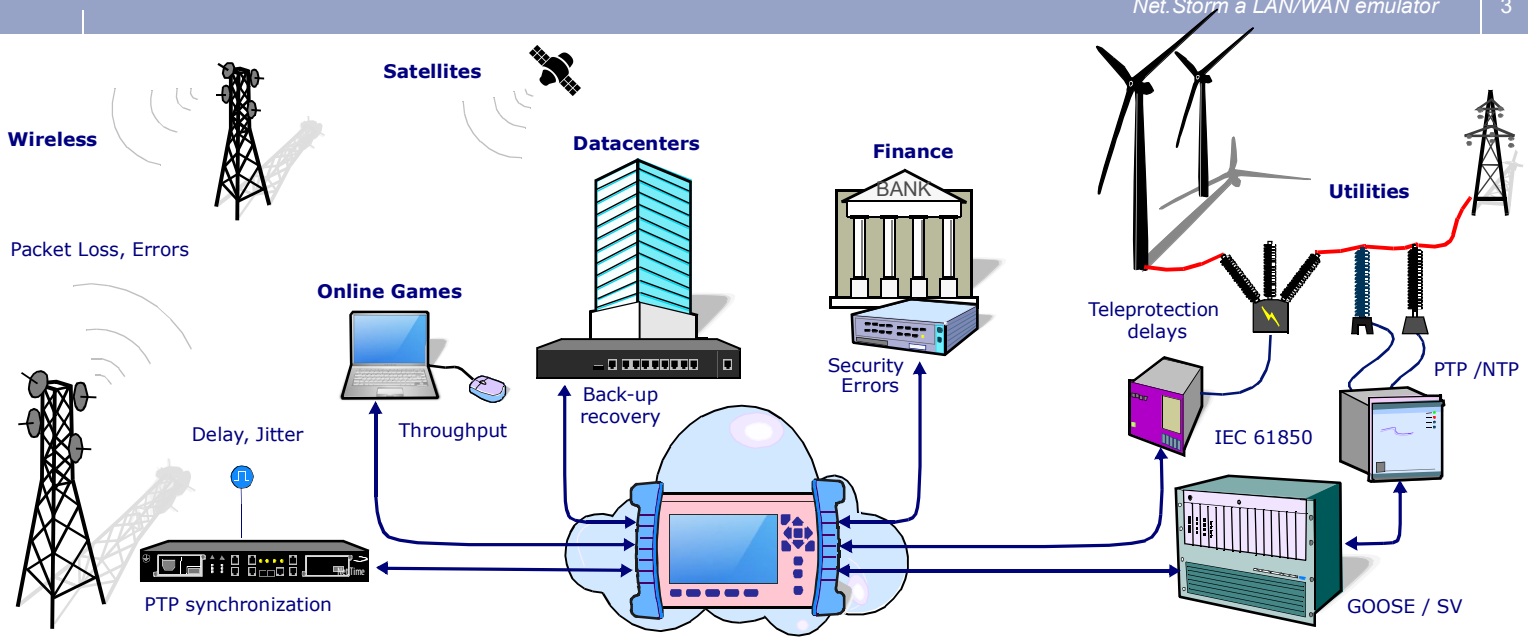


Bandwidth



Impairments





Applications

Universal Network Emulation

It makes sense to gain insight and discover network tolerances before they become problematic because predictable performance is required in all systems, especially those that operate critical infrastructures in a lot of industries as diverse as energy, telecommunications, finance, and data centers. For all of these, engineers will be able to simulate exactly the same conditions they will find on the Internet/substation/microwave/satellite/submarine links, which can always suffer from throughput limitations and quality degradation.

Users & Applications

Net.Storm is a tool for engineers who are designing, debugging, or integrating new devices and systems:

- **Network design**. Validation: performance and interoperability testing.
- **Approval and acceptance testing**: Stress systems with controlled bit errors and frame drops.

"100% FPGA design: Accuracy < 1?s"

- **Substations**: IED, MU and RTU product acceptance.
- **Data centers**: for backup failure simulation and security access.
- **PTP/NTP timing**: to generate interference to test synchronization quality.
- **Laboratories**: to create a tool to test fatal errors and recovery functions.
- **Universities**: to teach about quality and performance in links, LAN, WAN.
- **IEC 61850 rollout**: in utilities and protocol testing such as GOOSE, SV.
- **Security**: certain malware such as interception and identity replacement adds latency to be used to identify the thread.

Benefits

Net.Storm covers a wide range of concepts, but simulating these mission-critical systems interacting with devices is the essential concept: replicating the final network with real traffic to better understand the behavior of new designs and connections.

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BENEFITS

- Cost effective to market
- Reproduces and identifies problems in the field
- Verify 100% of network node and endpoint stability
- Easily identifies sources of degradation
- Handheld battery operated
- Zero virtual delay
- Indoor / Outdoor

APPLICATIONS

- Data Center backup Recovery Simulation
- IEC 61850 Deployments
- Teleprotection Simulations
- GOOSE acceptance testing
- PTP/NTP clock rollout
- Wireless delays and failures
- Traffic priority assurance
- Satellite delay emulation
- Online game development
- Internet streaming audio and video applications

KEY FEATURES

- Throughput Management
- 100% FPGA performance
- Accuracy < ?s
- Full duplex (Rx+Tx)
- 2 x 16 different streams: MAC, VLAN, IP, TCP, UDP, MPLS, GOOSE... Filters
- Touch screen, mouse, keyboard, VNC remote control
- Battery powered handheld
- SNMP / MIB support

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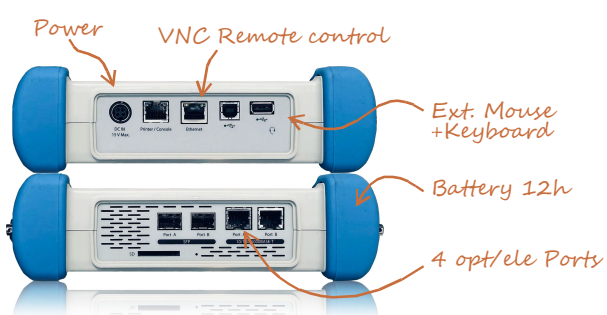
Flows or Streams (up to 8 filters to deffine the flow)	
Filters	• Traffic impairments can be defined over max. 32 traffic flows (16Tx, 16Rx) defined by means of filters • User-defined filters at IP, UDP and TCP headers including agnostic filters defined by 16-bit masks and user defined offset • Independent filtering criteria at each flow; Independent statistics for each configured filter
Ethernet Filters	• Ethernet flow: MAC origin, destination, group of address based on defined masks • Ethernet type and selection mask • VLAN and selection mask; CoS and selection mask
IP Filters	• IP address origin, destination, and masks. • Protocol encapsulated in the IP packet (TCP, UDP, Telnet, FTP, etc.) • Traffic flow selection based on DSCP with optional DSCP filters • Field contents at TCP/UDP layer port with optional port filters

Bandwidth impairments (up to 1 x stream)	
Traffic Shaping	• Shaping filter for bandwidth control. Based on token bucket algorithm (a) sustainable rate (frames/s), (b) depth (frames) • Not conforming frames are delayed.
Traffic Policing	• Policing filter for bandwidth control. Based on token bucket algorithm (a) sustainable rate (frames/s), (b) depth (frames) • Not conforming frames are dropped

Event Insertion (up to 6 events per stream)	
Events Insertion	• Independent event insertion in every single flow identified in the main stream. • Events: Frame loss, delay, frame duplication, errored frames. • Maximum process time caused by event insertion: 10 µs
Delay	• Single delay insertion [0ms - 60s] • Uniform distribution: minimum delay (Tmin) and maximum delay (Tmax) [0ms - 60s] • Random delays with exponential distribution: defined with a Mean (ms) and a Minimum delay (ms)
Jitter	• Deterministic or random jitter using uniform and exponential distribution • Uniform distribution: minimum delay (Tmin) and maximum delay (Tmax) • Exponential distribution: minimum delay (Tmin) and average delay (Tavg)
Loss	• Deterministic loss: unique, burst, periodical burst • Single loss insertion:; Constant loss defined by a probability • Burst Loss defined by time start / duration [0 - 30min], or first frame / number of loss packets [0 - 32,737 packets] • Periodic Burst Loss defined by time start / duration, or first frame / number of loss packets / separation between bursts [0 - 30min] • Random loss defined by a probability [0.00% - 99.99%] • Random loss defined by the two-state model of Gilbert-Elliot
Duplication	• Traffic duplication defined by deterministic and random events • Deterministic duplication defined by time or frame number • Random duplication defined by event probability [0.00% - 99.99%]
Error	• Single error insertion • Constant error insertion defined by a probability [0.00% - 99.99%]
Traffic Shaping	• Shaping filter for bandwidth control. Based on token bucket algorithm (a) sustainable rate (frames/s), (b) depth (frames) • Not conforming frames are delayed.
Traffic Policing	• Policing filter for bandwidth control. Based on token bucket algorithm (a) sustainable rate (frames/s), (b) depth (frames) • Not conforming frames are dropped

Operation and Management	
Results	• Auto-negotiation results including current bit rate, duplex mode, Ethernet interface • SFP presence, vendor, and part number • Frame counts: Ethernet, and IEEE 802.1Q (VLAN), control frames; Unicast, Multicast and Broadcast • Basic error analysis: FCS errors, undersized frames, oversized frames, fragments, jabbers • Frame size counts: 64, 65-127, 128-255, 256-511, 512-1023, 1024-1518 bytes; Byte counts: Port A (Tx / Rx) and Port B (Tx / Rx)
Performance	• Full Duplex operation at 1 Gbit/s or 1,5 Mframes/s in each direction • Accuracy better than 10^{-6} secs. at 1 Gbit/s • Performance and accuracy 100% independent of the line bit rate

Platform	
Interfaces	• 2 x RJ-45 port for electrical connection 10/100/1000BASE-T; PoE detection and PoE transparency • 2 x SFPs ports: 10BASE-T, 100BASE-TX, 100BASE-FX, 1000BASE-T, 1000BASE-SX, 1000BASE-LX, 1000BASE-ZX and 1000BASE-BX • Autonegotiation: Bit rate at 10, 100, and 1000 Mbit/s, Disable autonegotiation and direct set up • IPv4 and IPv6 support
Instrument	• Touchscreen 480 x 272 TFT • Mouse, keyboard & Ethernet ports • 1.0 kg, 223 x 144 x 65mm; IP-54 • Rechargeable Batteries continuous working up to 12 hours continuous operation • AC Power Adapter Input: 100 ~ 240 V AC, 50/60 Hz • Operating Temperature 0°C ~ 50° C, Storage Temperature -20°C ~ 70°C, Humidity 5% ~ 95%; IP rating 54 • SNMP, MIB support and VNC remote control



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