Company & LANforge WiFIRE Product Overview

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Company Overview

- Established in 2000 by Ben Greear, CEO, author of Linux VLAN code.

- Address a niche of affordable real world network traffic generation equipment: LANforge FIRE, LANforge WiFIRE (WiFi)

- Architecture facilitated development of LANforge ICE network emulator.

- First LANforge WiFIRE 802.11a/b/g traffic generator sold in 2006.

- First LANforge WiFIRE 802.11n traffic generator sold in 2010.

- First LANforge WiFIRE 802.11ac traffic generator sold in 2014Q2.

Sales Process

- Winning sales:
    - LANforge is typically the most affordable option.

    - Feature set is near the top of the industry – multi-tool.

    - Small company means excellent tech & pre-sales support. There is only top-tier support, no bottom-tier out-sourced support staff to waste customer's time.

    - Flexible licensing that does not restrict deployment topologies, i.e. move LANforge from lab testing to field testing is not restricted.

    - Able to add reasonable customer requests in timely manner, independent of road map.

    - Rapid custom management interface development.

LANforge
WiFIRE Customers

Network Test and Emulation

LANforge WiFIRE Platforms

Model CT520
- Single Radio
- Max. 128 virtual STAs

Model CT521
- Dual Radio
- Max. 400 virtual STAs

Model CT523
- Triple Radio
- Max. 600 virtual STAs

Model CT525
- Hex Radio
- Max. 1200 /n virtual STAs

* Virtual STA – A virtual WiFi client with unique MAC and IP routing table.

LANforge WiFIRE Comparison

	CT520	CT521	CT523	CT525
Max. /n STAs	128	400	600	1200
WiFi NIC	Atheros	Atheros	Atheros	Atheros
ABGN 3x3 Radios	1	2	3	6
Antennas	3 x Omni	6 x Omni	9 x Omni	18 x Omni
Antenna Gain	5/3 dBi @ 2.4/5 GHz	5/3 dBi @ 2.4/5 GHz	5/3 dBi @ 2.4/5 GHz	5/3 dBi @ 2.4/5 GHz
Max. Virtual APs	8	16	24	48
Ethernet Ports	2	2	2	6
AC 3x3 radios	No Support	2	3	6
Max. /ac STAs	NA	64	128	192
CPU	Intel Atom @ 1.6 GHz	Intel i7-620M @ 2.7 GHz	Intel i7-2655LE @ 2.2 GHz	Intel E5v3 3.7 GHz
Dimensions	11 x 7.5 x 2.5 inches 268 x 190 x 65 mm	11 x 8 x 2.6 inches 277 x 194 x 67 mm	11 x 8 x 2.6 inches 277 x 194 x 67 mm	Front access short 2U chassis
Weight	5.7 lbs/2.6 kg	8 lbs/3.6 kg	8 lbs/3.6 kg	20.4 lbs/9.3 kg

LANforge
WiFIRE Comparison

Model **CT522**
- Single Radio
- Max. 128 virtual STAs

|	**CT522**
Max. Virtual STAs	128
WiFi NIC	Atheros
ABGN 3x3 Radios	1
Antennas/Channels	3 x Patch
Antenna Gain	
Max. Virtual APs	4
Wired Ethernet Interfaces	1 + USB WiFi for management
Max. Unencrypted Throughput OTA	320 Mbps
802.11ac when available	No/Limited
CPU	Intel Celeron @ 1.3 GHz
Dimensions	11.3 x 8.3 x 0.7 inches 292 x 216 x 21 mm
Weight	3.1 lbs/1.4 kg

LANforge
WiFIRE Auxilliary Components

Model **CT703**
- 3 Channel Attenuator
- Controlled via LANforge or Manually
- Rate vs Attenuation Scripting

Model **CT704**
- 4 Channel Attenuator

	CT703/4
Impedance	50 Ω
Frequency Range	0.7 – 6.0 GHz
Attenuation Range	0 – 95.5 dB
Attenuation Steps	0.5 dB increments
Insertion Loss	8 dB nominal, 10 dB max
Attenuation Accuracy	1-15 dB: ±1dB, 16+ dB: ±1.5dB or 4%
Maximum VSWR	2:1
Operating Temperature	0 ~ 40° C
Operating Humidity	10 ~ 90%
Certification	RoHS
Dimensions	9 x 9.5 x 3 inches 240 x 230 x 80 mm.
Weight	3.1 lbs/1.4 kg

LANforge
WiFIRE Auxilliary Components
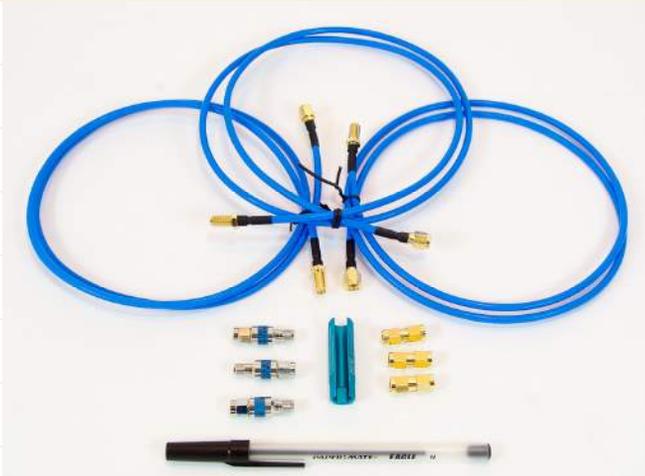
Item **CT540**
- Provides improved RF isolation.
- Connects WiFIRE to antenna device like an AP
- 30 dB attenuators included to avoid overdriving SUT

	CT540
Cable Type	670-141 semi-rigid
Length	1 m, 3 m available
Cable Quantity	3
Fixed Attenuation	30 dB
Attenuator Quantity	3
SMA Adapter Quantity	3
SMA Tool Quantity	1
Weight	1 lb/0.45 kg

LANforge
WiFIRE Comparison

- CT520
    - Lowest cost for widely distributed spatial deployment, e.g. WiFi deployment services.
    - Able to attain practical maximum throughput on 802.11n 3x3 unencrypted.
    - 355 Mbps of UDP throughput at the Ethernet frame level using 9K PDU with ideal antenna alignment.

- CT522
    - Portable standalone operation.

- CT521/CT523
    - Dual/Triple radio for simultaneous frequency use.
    - High virtual STA density .
    - Best encrypted/secure WiFi throughput performance.
    - 345 Mbps of UDP throughput at the Ethernet frame level using 9K PDU with ideal antenna alignment.

- CT52x
    - Custom form factors available to address wired and WiFi Ethernet needs:
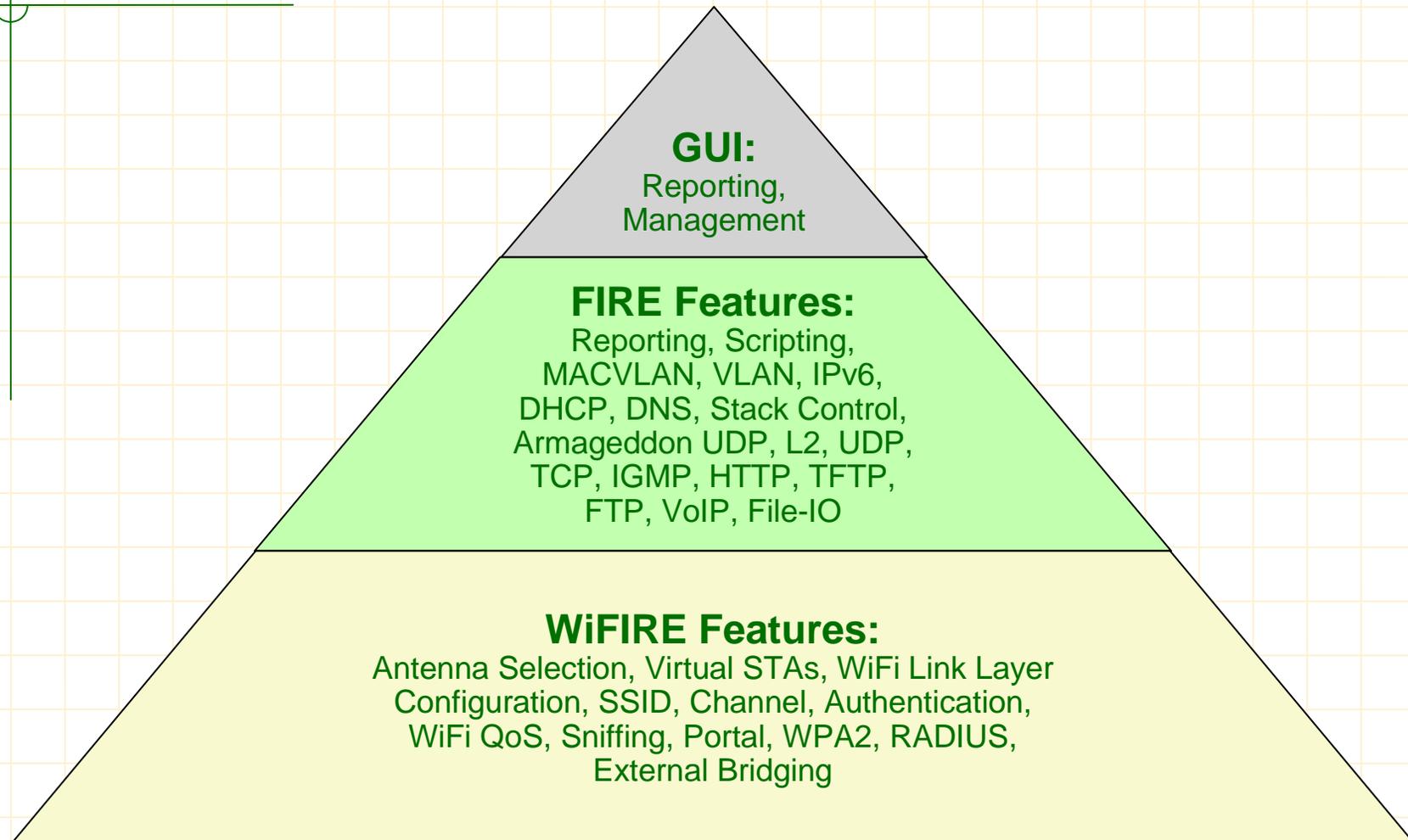
LANforge
WiFIRE Applications

- WiFi client functional testing.
  - Channel
  - Access
  - Authentication
  - DHCP
  - Migration (Code-17)

- Multiple traffic flows across WiFi clients.
- QoS verification at WiFi and flow layers.
- WiFi client capacity testing.
- Portal access (needs customization, China Mobile example).
- Mobility Roaming [802.11r/u/Hotspot 2.0(HS2.0)/802.1X FT]
- 802.11w Management Frame Protection.
- Emulated message loss in AP mode (probe, assoc, auth, reauth) and corrupt GTK Rekey MIC packets to test station's error handling code.

LANforge
Feature Hierarchy

GUI:
Reporting,
Management

FIRE Features:
Reporting, Scripting,
MACVLAN, VLAN, IPv6,
DHCP, DNS, Stack Control,
Armageddon UDP, L2, UDP,
TCP, IGMP, HTTP, TFTP,
FTP, VoIP, File-IO

WiFIRE Features:
Antenna Selection, Virtual STAs, WiFi Link Layer
Configuration, SSID, Channel, Authentication,
WiFi QoS, Sniffing, Portal, WPA2, RADIUS,
External Bridging

LANforge
WiFIRE Features

- Reported Statistics:
    - Rate, Link Status, Channel Utilisation, RSSI/Signal Strength, Noise, Decrypt Failures, WiFi Dropped, WiFi Retry, Missed Beacons, SSID, IP Address, Regular Packet Statistics.

- WiFi radio settings:
    - Country, Frequency, Sensitivity, RTS, Channel, Antenna configuration.

- Virtual STA creates realistic endpoints each with their own MAC address and routing table.

- Virtual STA settings:
    - SSID, Authentication, AMPDU, AMSDU, AP MAC, abgn Mode, MCS rates, WiFi Bridge, HT40, Guard Interval (SGI)

LANforge WiFIRE Features

- Rate vs. Attenuation Scripting (RFC 2544 script combined with automated attenuation scripting):

  http://www.candelatech.com/lf_wifi_examples.php#atten-udp

  http://www.candelatech.com/examples/udp-wifi-atten/script-report/index.html

Included GUI Plugins (http://www.candelatech.com/lfgui_ug.php#plugins)**:**

- Automated maximum WiFi client capacity testing:

  http://www.candelatech.com/examples/wifi_capacity-ChrUbuntu-3x3-tcp/index.html

- WiFi Port Reset emulates restart of stations associated to your WiFi network:

  http://www.candelatech.com/examples/wifi_capacity-ChrUbuntu-3x3-tcp/index.html

- Automated "Ensure Fairness" capacity testing:

  http://www.candelatech.com/examples/ensure_fairness_results/index.html

- Auxiliary wireless management interface.

- WiFi monitor interface for sniffing with Wireshark.

- Station migration across LANforge cluster.

LANforge
WiFIRE Road Map

- **Current AC status:** Wave 2 hardware acquired, no firmware yet.

- Release 5.3.2 Q3, 2015:
  - Basic support for WiFi Hotspot 2.0 Release 2.
  - Attenuation mobility script.
  - Support for multiple traffic type in WiFi Capacity script.
  - DHCP Options for emulating various third-party devices such as iPad.

- Future Releases:
  - 802.11ac Wave 2.
  - Expand support for Hotspot 2.0 Release 2.
  - 802.11v RTLS (Real Time Location Services).
  - 802.11k Assisted Roaming (Radio Resource Management/RRM)
  - GUI Monitoring of WiFi Access Classes (QoS).
  - CoovaChilli hotspot portal support.
  - WiFi RF Delay Line/Phase Shifter.
  - WiFi RF In-Phase Power Divider/Combiner.
  - Overlapping Channel Interference Scripting.
  - Channel Interference Scripting.

LANforge WiFIRE Links

- LANforge WiFi Testing Resources:
  http://www.candelatech.com/lf_wifi.php

  - LANforge 802.11AC Information

  - Improving WiFi Performance

  - Using WiFi Access Classes (QoS)

  - Generating WiFi Channel Interference

  - Configuring LANforge WiFIRE with RADIUS

  - Diagnosing LANforge WiFi Problems

  - Testing WiFi Fairness with LANforge

  - AP Testing Results with LANforge WiFIRE

  - LANforge WiFIRE cookbook examples

LANforge
WiFIRE Links

- LANforge WiFIRE Cookbooks:
  http://www.candelatech.com/lfgui_wifire_cookbook.php

  - Simple WiFi Testing

  - Channel Jamming

  - Bridged VAP

  - Hotspot 2.0, EAP-TLS, EAP-TTLS

  - Hotspot 2.0, EAP-AKA & Configure AP, RADIUS and STA

  - 802.11r (FT-EAP) Roaming

  - Hotspot 2.0 Roaming

  - Rate vs Range

  - And many more…

LANforge WiFIRE Links

- WiFIRE Architecture:
  http://www.candelatech.com/images/diagrams/fire_wifire.png
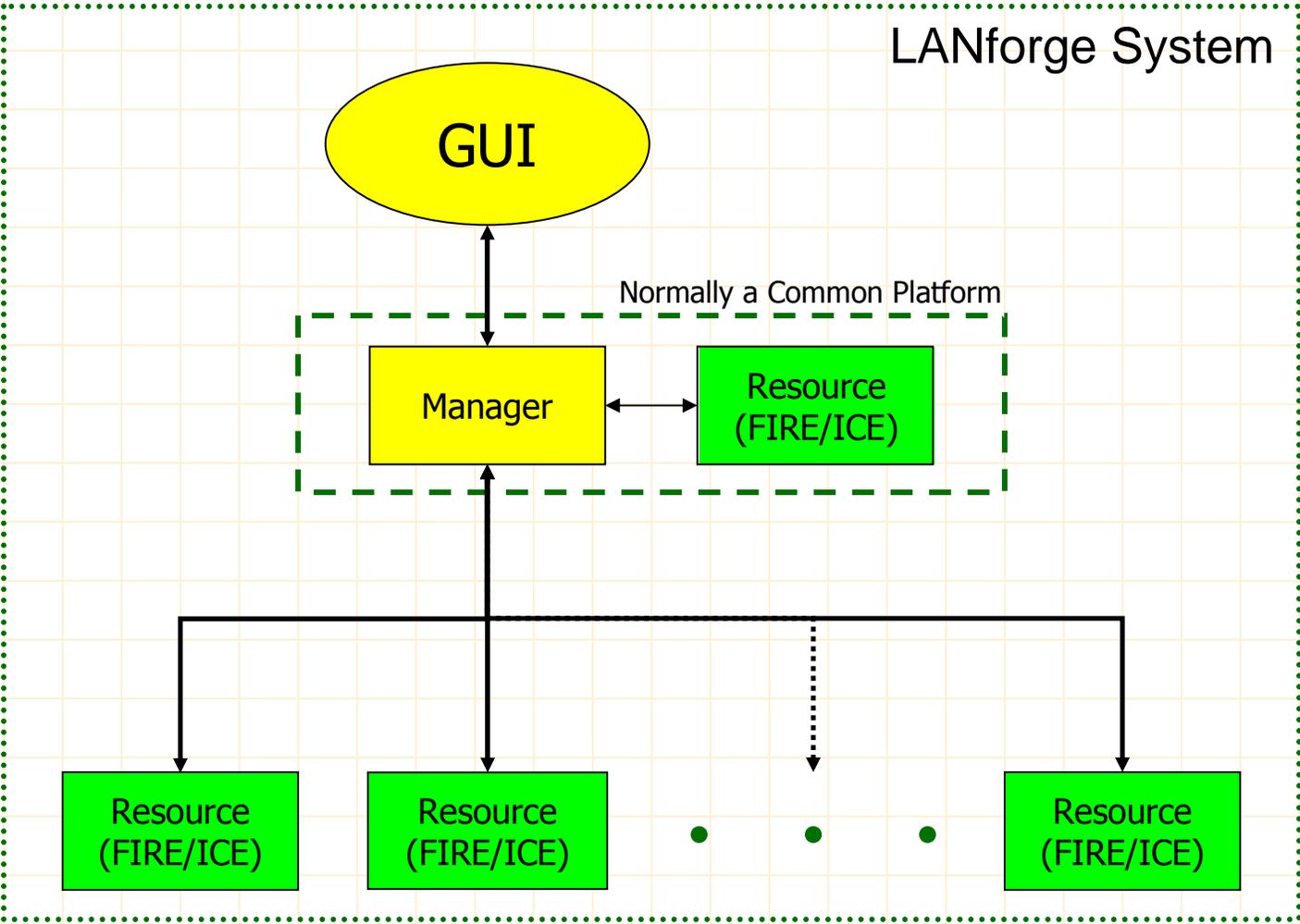
- Download Presentations and Datasheets:
  http://www.candelatech.com/pdfs

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  Candela Technologies Sales: sales@candelatech.com

  Thank You!

LANForge
System Architecture

LANforge System

GUI

Normally a Common Platform

Manager ↔ Resource (FIRE/ICE)

Resource (FIRE/ICE)

Resource (FIRE/ICE)

Resource (FIRE/ICE)

LANforge System Elements

- The **System**: GUI, Manager and Resources

- The **GUI**: Displays and records data reported by the Resource Manager. Generates control and configuration requests to the Resource Manager. May run on appliance or separate PC.

- A **Manager**: Only one in a system that performs data collection, configuration, control, licensing and can also be a Resource.

- A **Resource**: Network Traffic Generator (LANforge FIRE or WiFIRE) and/or Network Emulator (LANforge ICE). More Resources = More Capacity.

LANforge
GUI Features

- GPL'd enables localization and customization.

- Responsive native platform installation.

- Dynamic Graphing and Reporting.

- HTML reporting:
  http://www.candelatech.com/oss/fail-over-test/index.html

- CSV report generation.

- Netsmith Virtual Network Builder.

- Browser/Web Start option.

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LANforge
FIRE Automation Features

- CLI scriptable interface helps automate testing. Perl scripts provided free.

- Automated DB backup to preserve previous test configurations.

- Multiple users can share a LANforge system thereby leveraging investment. User administration feature prevents friendly fire.

- Scripting:
    - RFC 2544 – Iterate through a matrix of rates and payload sizes.
    - Hunt Script – Determine maximum throughput for various payloads based on constraints of packet loss, round trip delay and jitter within target thresholds. Zero Loss Throughput done right!

LANforge
FIRE Reporting Features

- Abundance of simultaneously reported packet statistics, e.g. Tx Rate, Rx Rate, Rx Drop, Tx Bytes, Rx Bytes, Latency, Jitter, Ethernet Driver Counters, etc...

- Maximum configurable MAC-VLANs = Unlimited, Maximum 802.1q VLANs per Interface = 4094. Minimum of 400 simultaneous traffic passing VLANs.

- Multiprotocol support without additional licensing. Standard licensing includes L2, L3 and L4. Additional licensing required for VoIP, PESQ, Armageddon, Resources and Ports.

- Easily increase system capacity by adding more Resources. Maximum number of Resources is 144 per system.

LANforge
FIRE Features

- 802.1q VLAN trunking support allows LANforge to be shared lab resource through network architecture.

- Over 70,000 connections per Resource make LANforge FIRE suitable for testing high multiple traffic flows e.g. Firewall or SBC testing.

- IP ToS (QoS) supported per RFCs: 1349, 2474 and 2481.

- Standard networking stacks provide realistic traffic generation.

- Endpoints can be quiesced with variable timers for graceful termination of packet flow.

continued…

LANforge
FIRE Features

- Ports can be configured via DHCP for ease of configuration of test scenario.

- LANforge Manager persistent CSV data gathering, i.e. does not need GUI.

- Test grouping for user profiles and user group profiles.

- .

LANforge
FIRE VoIP

- SIP supported.

- VoIP Endpoint can call a phone/UA or receive a call and record various statistics.

- Call setup via gateway/proxy possible. Known to operate with Asterisk, SER, Broadsoft, Sonus and Lucent IMS.

continued…

LANforge
FIRE VoIP

- VAD/Silence Suppression configurable for delay and keep alive.

- Fixed Jitter Buffer depth configurable upwards of 20ms in 20ms increments.

- Jitter buffer reports: Silence Fill, Underrun, Overrun and Current Size.

- Signalling and RTP port configurable.

LANforge
FIRE VoIP

- Voice Quality scoring by Opticom PESQ API via GUI. Additional quality statistics such as MOS-LQO, delay, attenuation, G.107, and others reported via CSV file.

- All RTCP statistics reported.

- Current maximum simultaneous call density with RTP per resource is 500 calls or 1000 VoIP endpoints. Each endpoint is unique with it's own MAC address, IP address and routing table.

- Basic call scripting: Multi Call, Continuous Call, Number of Calls, Call Duration, Ring Time, Inter-Call Gap, Start Delay, Auto Generated URIs/Phone Numbers.

LANforge
FIRE VoIP

- Call statistics reported: Attempts, Answers, Completes, Cancels, Busy and Fails.

- SIP call failures reported with reason codes.

- Endpoints can perform signalling only and hence increase the number of simultaneous calls/VoIP endpoints/BHCA.

- Endpoints can replay custom audio files and record audio to file and play audio to speaker.

- Individual call log available for each endpoint.

LANforge
FIRE Layer-4

- Feature allows http:// and ftp:// URLs to be accessed with multiple sessions and reporting.

- Support for four HTTP Authentication types (Basic, Digest, GSS, NTLM).

- Support for Proxy and three Proxy Authentication types (Basic, Digest, NTLM).

- SSL/HTTPS certification supported.

- Files can be uploaded or downloaded by an endpoint.

- LANforge can act as its own HTTP or FTP server for standalone traffic generation.

continued…

LANforge
FIRE Layer-4

- Single URL or list of URLs can be accessed by an endpoint.

- Connections can reuse TCP/IP ports or use new TCP/IP ports to cause additional stress.

- TCP sessions can use Secondary IP address linearly or randomly for nailed or temporary connections.

- Support for caching proxies such as Squid.

- Over 28,000 URLs per second per Resource when reusing TCP/IP ports. Over 13,000 URLs/sec/Resource without TCP/IP port reuse.

- Over 3000 HTTP simultaneous connections each with unique MAC and IP address per Resource.

LANforge
FIRE Layer-4

- Maximum aggregate download speed over 980 Mbps on GigE.

- Maximum aggregate download speed 9.74 Gbps on 10GE.

- HTTP and FTP failures reported with reason code.

- Layer 4 stateful traffic types supported:

  HTTP, HTTPS, FTP, FTPS, TFTP, SMTP, SMTPS, POP3, POP3S, IMAP, IMAPS, SCP, SFTP and SMTP

LANforge
Generic (L4-7)

- Generic endpoints allow command line tools (CLI) to be managed, executed and reported.

- Built in CLI tools: ping, traceroute, DNS, SMTP, Telnet, Netcat and NMAP.

- Custom in-house CLI tools can be integrated into the LANforge FIRE Generic endpoint and reporting framework.

- YouTube® video download using "clive".

LANforge
File I/O (L4-7)

- LANforge filesystem testing feature.

- Tests: NFS, iSCSI or SMB (SAMBA)

- Configurable for: RW Rate, RW Size, File Creation, File Sync, CRC Calculation and Custom Payloads.

- 2000 NFS endpoints/clients per resource.

LANforge Armageddon UDP

- Accelerated UDP traffic generation feature that allows LANforge FIRE to generate traffic at 2 x 10 Gbps (4 ports total) or more depending on HW.

- Packets can have rotating source and destination MAC addresses, IP ports and UDP ports. The combination of rotating ports and high speed significantly stresses network devices.

- Packets can have variable size and a set amount of packets can be sent at configured rate (PPS).

- Latency is reported with microsecond (μ S) precision.

- Current maximum speed 2 x 10 Gbps bidirectional (FDX) sending to self (20 Gbps total aggregate on high-end appliance). Or 2 x 20 Gbps bidirectional sending between two LANforge FIRE resources.

- MPPS FDX (1.6 MPPS Unidirectional) sending to self with 60 byte packets.