Company &
LANforge WiFIRE Product
Overview

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Company Overview

- Established in 2000 by Ben Greear, CEO.
- 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. moving 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

PANASONIC AVIONICS
INNOTECH-EXCEAIRE AVIATION GROUP
National Chiao Tung University
Honeywell
EMS TECHNOLOGIES
Telefónica
SEQUANS COMMUNICATIONS
FORTINET
The Communications Security Establishment of the Government of Canada
Bell
ROGERS
JUNGO
BROCADE
arcadyan
VT Miltope
A company of VT Systems
cradlepoint
CSR
ruckus WIRELESS
alvarion
WATERLOO
nfm systems
compex
iRobot
VIDEOTRON
qa cafe
ip test solutions
DASAN NANO
motorola SOLUTIONS
EDGEMONTECH SOLUTIONS
ABB
HUAWEI
ATKINS
AeroMexico
Tellar
ATLAS
SANGAMO BIOTECH
Brinsea
Lambrecht
MADISON
MACH II
tektronix
Bright House Networks
constant
edgeware
altair semiconductor
appareo
TOTAL
TELUS
JET AVIATION
A GENERAL DYNAMICS COMPANY

Jul 12, 2018
Network Testing
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 virtual STAs

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

<table>
<thead>
<tr>
<th></th>
<th>CT520</th>
<th>CT521</th>
<th>CT523</th>
<th>CT525</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. In STAs</td>
<td>128</td>
<td>400</td>
<td>600</td>
<td>1200</td>
</tr>
<tr>
<td>WiFi NIC</td>
<td>Atheros</td>
<td>Atheros</td>
<td>Atheros</td>
<td>Atheros</td>
</tr>
<tr>
<td>ABGN 3x3 Radios</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Antennas</td>
<td>3 x Omni</td>
<td>6 x Omni</td>
<td>9 x Omni</td>
<td>18 x Omni</td>
</tr>
<tr>
<td>Antenna Gain</td>
<td>5/3 dBi @ 2.4/5 GHz</td>
<td>5/3 dBi @ 2.4/5 GHz</td>
<td>5/3 dBi @ 2.4/5 GHz</td>
<td>5/3 dBi @ 2.4/5 GHz</td>
</tr>
<tr>
<td>Max. Virtual APs</td>
<td>8</td>
<td>16</td>
<td>24</td>
<td>48</td>
</tr>
<tr>
<td>Ethernet Ports</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>AC 3x3/4x4 radios</td>
<td>No Support</td>
<td>2</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Max. /ac STAs</td>
<td>NA</td>
<td>128</td>
<td>192</td>
<td>384</td>
</tr>
<tr>
<td>CPU</td>
<td>Intel Atom @ 1.6 GHz</td>
<td>Intel i7-620M @ 2.7 GHz</td>
<td>Intel i7-2655LE @ 2.2 GHz</td>
<td>Intel E5v3 3.7 GHz</td>
</tr>
<tr>
<td>Dimensions</td>
<td>11 x 7.5 x 2.5 inches, 268 x 190 x 65 mm</td>
<td>11 x 8 x 2.6 inches, 277 x 194 x 67 mm</td>
<td>11 x 8 x 2.6 inches, 277 x 194 x 67 mm</td>
<td>Front access short 2U chassis</td>
</tr>
<tr>
<td>Weight</td>
<td>5.7 lbs/2.6 kg</td>
<td>8 lbs/3.6 kg</td>
<td>8 lbs/3.6 kg</td>
<td>20.4 lbs/9.3 kg</td>
</tr>
</tbody>
</table>
LANforge
WiFIRE Auxilliary Components

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

Model **CT704**
- 4 Channel Attenuator

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

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

<table>
<thead>
<tr>
<th>CT540</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable Type</td>
<td>670-141 semi-rigid</td>
</tr>
<tr>
<td>Length</td>
<td>1 m, 3 m available</td>
</tr>
<tr>
<td>Cable Quantity</td>
<td>4</td>
</tr>
<tr>
<td>Fixed Attenuation</td>
<td>30 dB</td>
</tr>
<tr>
<td>Attenuator Quantity</td>
<td>4</td>
</tr>
<tr>
<td>SMA Adapter Quantity</td>
<td>4</td>
</tr>
<tr>
<td>SMA Tool Quantity</td>
<td>1</td>
</tr>
<tr>
<td>Weight</td>
<td>1 lb/0.45 kg</td>
</tr>
</tbody>
</table>
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.

- **CT521/CT523**
  - Dual/Triple radio for simultaneous frequency use.
  - High virtual STA density.
  - Best encrypted/secure WiFi throughput performance.
  - 900+ Mbps of UDP throughput at the Ethernet frame level with ideal RF environment.

- **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/CLI

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, VHT80, VHT160, Guard Interval (SGI)

Continued…
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

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

- 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 MU-MIMO supported.

- Stable Release 5.3.7:
  - Wave-2 160 support.
  - Allow corrupting WiFi management frames on purpose.

- Future Releases:
  - 2.5 and 5Gbps Ethernet NIC support.
  - REST API for automation is being implemented for 5.3.8.
  - VHT 80+80 support.
  - Customer requests
LANforge WiFiRE Links

  - 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:

- 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
Pricing

• Please contact your Distributor:

OR

Candela Technologies Sales: sales@candelatech.com

Thank You!

Jul 12, 2018
LANForge System Architecture

Normally a Common Platform

LANforge System

GUI

CLI

Manager

Resource (WiFIRE/ICE)

Resource (WiFIRE/ICE)

Resource (WiFIRE/ICE)

Resource (WiFIRE/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.
- CSV report generation.
- Netsmith Virtual Network Builder.
- Browser/Web Start option.

continued...
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.


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

continued...
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.

continued…
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 its 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.

continued...
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.

- Individual call log available for each endpoint.
LANforge FIRE Layer-4

- Feature allows http, https, ftp, scp and other protocols 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, SCP, SFTP
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 (μS) 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.