

TeraVM at Cisco

What is TeraVM?

TeraVM is a software based L2–7 test tool running on Cisco UCS since 2005, in the Cloud (Amazon, Azure, Google Cloud, Oracle OCI, Openstack) and as a container, delivering a fully virtualized application emulation and security validation solution to test and secure devices, networks and their services.

Why TeraVM?

- **Cisco custom-specific test capabilities**
- **Flow based tool with realism:**
 - Provides per-flow statistics in real time
 - Statefully emulates and measures individual endpoint and application performance for data, voice, video and security services
 - Easily pinpoint and isolate problem flows and bottlenecks
- **Adaptive engine:**
 - Dynamically and Automatically find the maximum capacity of Devices Under Test
 - Same test profile can be used for multiple platforms
- **Centralized License Server/Elastic Test Bed:**
 - Scale with realism and grow on demand with license sharing across geographical locations
 - Flexibility to run anywhere... lab, datacenter and the cloud, with consistent performance coverage
 - Sharing test resources and methodologies delivering the most cost-effective solution
 - Shareable Cybersecurity threat database, maximizing resource utilization and total cost of ownership
 - Auto License Check-In on test completion
- **Wireless Mobility (5G, 4G, 3G, 2G) validation with realism:**
 - Highly scalable user and control plane traffic. Scale beyond 100 Gbps of traffic

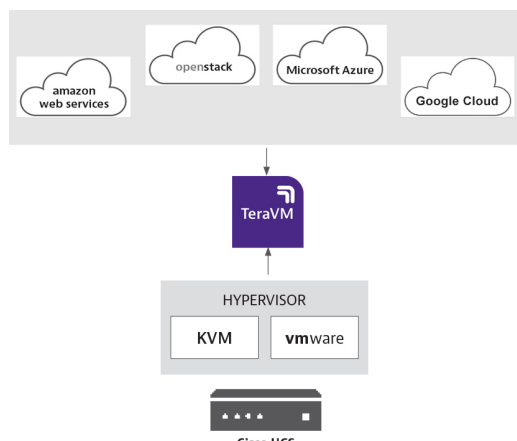


Figure 1: System Under Test

Key Facts

TeraVM is 100% virtual

- Tests physical solutions and/or virtual solutions
- Supports all major hypervisors - ESXi, KVM
- Supports all major cloud platforms - OpenStack, AWS, MS-Azure, Google Cloud, Oracle OCI, Containerization
- Supports 1 GbE, 10 GbE, 40 and 100 GbE NICs

Automation and Orchestration

- REST, CLI, Perl, TCL, XML, Java API, Python, Jython
- Cisco LaasNG, Cisco pyATS, Qualisystems (CloudShell)

L2-7 Stateful Traffic Application Emulation

- Voice: CUCM, CUBE, VoIP, WebEx, VoLTE, SIP & RTP, MOS
- Video: CMTS, CDN, Multicast, AMT, ABR, IPTV, VoD, OTT streaming, Video conferencing, WebEx, TelePresence, HTTP Video
- Data: TCP/UDP, Teraflow, Ookla speed test, HTTP/HTTPS, SMTP/SMTSP, POP3/POP3S, FTP/FTPS, P2P, DNS, Quick UDP Internet Connections (QUIC)

Secure Access Firewall/VPN (ASA Firewall, FirePOWER)

- Secure TCP/UDP Protocols (SSL, TLS, DTLS, IPSec IKE)
- Client and Clientless VPNs (Cisco AnyConnect SSL and IPsec)
- 802.1x EAP-MD5, EAP & PEAP with MS CHAPv2 Authentication
- Mobile Secure Gateway validation (S1-U over IPsec)

Cybersecurity Threat and Malware Penetration

- 40,000+ attacks (Spam, Viruses, DDoS, Malware), updated monthly
- DDoS attack applications:
 - Flood: SYN, Reflective SYN, Reset, UDP, Ping, ARP
 - Attacks: Teardrop; UDP Fragmentation; Configurable Rates, Start and Stop
 - Spoof Mac addressing
- Mixed application flows: Good, the Bad and your Own

Wireless RAN and Core Emulation

- vRAN: 5G, 4G, AMF, UPF, SMF wraparound
- vCORE: 5G (NSA & SA), 4G, Mobility, SecGW, MEC, Network Slicing – Millions of UEs and Bearers
- CloT: IPDD over NAS, NIDD over SCEF at Scale
- WiFi ePDG offload (EoGRE)

Wireless Core Interface Testing

- Support testing across multiple key Core interfaces
- Error Injection over 5G-N2 (AMF)
- Error Injection over 4G-S1 (MME)

Cisco Test Coverage

TeraVM includes Cisco specific endpoint emulation and real time measurements

- Dynamic IPv6 Assignment for AnyConnect VPN Client
- Cisco AnyConnect SSL VPN Client
- Cisco AnyConnect IPSec IKEv1/IKEv2 VPN Client
- Cisco NetFlow Records, NetFlow Exporter Emulation
- Cisco Identity Services Engine (ISE) with 802.1X client
- Cisco Umbrella
- Captive Portal testing
- Cisco TelePresence
- Cisco WebEx

Application Support

General

- System utilization reports (Location, User, Testbed, Licenses in use, Usage stats)
- License check-in default timer

Adaptive Engine

- Dynamically and Automatically find the maximum capacity of Devices Under Test
- Same test profile can be used for multiple platforms
- Faster setup, faster testing, faster results

Network Interface Support

- Support for 1/10/40/100 Gbps I/O

Data

- Jumbo Frame support with max MTU/Segment configurable
- TeraFlowUDP Out-of-Sequence Statistics
- TCP / UDP, Teraflow, Ookla speed test
- HTTP / HTTPS
- HTTP 2.0
- SMTP / POP3 (incl. file attachments)
- FTP (Passive/Active), P2P applications, DNS
- FTP client session count limit
- DNS client (w/ HTTP/S applications, incl. IP address resolution)
- DNS Server

Address Assignment

- Configurable MAC
- DHCP, PPPoE (IPv4 & IPv6)
- Dual Stack (6RD, DS Lite)

Ethernet Switch

- VLAN Tagging (up to 8 concurrent tags)
- ACL, 802.1p, DSCP
- Enable path MTU discovery

Data Center

- VxLAN, GRE, SR-IOV

Automation

- REST, CLI, Perl, TCL, XML, Java API
- Python, Jython
- Cisco LaasNG, Qualisystems (CloudShell), Luxoft Software Defined Lab (SDL), Openstack, Cisco pyATS

Replay Application Repository

- Intelligent UDP & stateful TCP Replay: Ability to dynamically change content
- Replay large PCAP files: TCP, UDP and raw data playback
- IP Replay (w/ DHCP): multiple TCP/UDP streams
- Amplify and dynamically substitute data into PCAP files

Video

- CMTS, CDN, Multicast: IGMP v1/v2/v3 & MLD v1/v2
- Automatic Multicast Tunneling (AMT)

- Video on Demand (VoD)
- Adaptive Bit Rate (HLS, HDS, MPEG-DASH, Smooth)
- Video conferencing, WebEx, Telepresence
- HTTP based video
- H.265 codec support

Voice

- Secure VoIP & WebEx calls in HTML5 UI
- Dual-Stack VoIP Gateway emulation
- Cisco CUCM, CUBE
- VoIP: SIP & RTP (secure & unsecure), SMS
- VoIP client scaling with auto generated unique
- VoIP with EVS (Enhanced Voice Services)
- AKA authentication request per client
- VoLTE Emergency calls support
- Dual Hosted UACs, SIP Trunking
- Voice & Video quality metric (MOS simultaneously supported)
- EVS codec support, various bit rates, silence suppression
- G.711 Support for SID – RFC3889
- SIP Updates for IMS including PANI information
- MCPTT group calls (including KPI support)

Secure Access / VPN

- SSLv2/3, TLSv1.0/1/2/3 and DTLSv1.0/2
- TLS Client-side Cipher Suite Selection
- Dynamic IPv6 Assignment for AnyConnect VPN Client
- Clientless VPN (SSL/TLS/DTLS), IPSec (IKEv1/ v2 (DH groups 31 & 32)), Generic remote access, CSFR support
- Cisco AnyConnect SSL & Cisco AnyConnect IPSec VPN Clients
- Cisco Umbrella
- SAML, SSO, Active Directory based login
- 802.1x EAP-MD5, EAP & PEAP with MS CHAPv2 Authentication
- RADIUS client support with configurable custom AVPs.
- 802.1X Accounting Start and Stop Records
- Site to Site VPN - IPV6/V4
- Additional security to limit access to public IP address assigned to TeraVM in public cloud environments
- Cisco AnyConnect SSL and IKE certificate based authentication with multiple user provided ECDSA EdDSA certificates
- PPTP VPN Client and Server supported
- Cisco AnyConnect emulation with SAML based authentication
- Cisco AnyConnect STRAP (Session Token Re-Use Anchor Protocol)

Security

- 40,000+ Malware attacks & Cybersecurity threats, updated monthly
- Spam / Viruses / DDoS / Malware
- Malware Application Profiles
- TCP CUBIC congestion control
- DDoS attack applications:
 - Flood: SYN, Reflective SYN, Reset, UDP, Ping, ARP
 - Attacks: Teardrop; UDP Fragmentation; Configurable Rates, Start and Stop

- Cisco Phones
- Cisco Video Clients
- Cisco DNA Center
- Mobile phones for Security Gateway
- IoT Device
 - Spoof Mac addressing
- Good and Bad mixed traffic flows
- Statefully scale Cisco specific threats
- Ability to use 3rd party threat libraries
- Ability to turn on/off Extended Master Secret (RFC 7627) support flag to test Cisco FTD, ASA and other security solutions
- Support for TLS 1.3, TLS 1.2 simultaneously on Client and Server
- Configurable TLS record size
- TCP delayed ack (timer based)
- HTTP Strict Transport Security (HSTS) header support
- TLS SNI support incl. unique certificate per FQDN

SLA Monitoring

- TWAMP-RFC 5357, PING-RFC 792
- Cisco Netflow Records/Exporter emulation at scale

Mobility - 5G, 4G, 3G, 2G

- Core and RAN: 3GPP Rel.8, 10, 11, 13, 15
- vRAN emulation:
 - 5G-NR, 4G-EUTRAN, 3G-UTRAN, 2G-GERAN at 1,000s of RANs
- Core Emulation:
 - 5G (NSA & SA), 4G-LTE, 3G, 2G with Mobility at millions of UEs and Bearers
- 5G, 4G, 3G, 2G Core interface testing
- Error Injection over 5G-N2 (AMF), 4G-S1 (MME)
- Encrypted RAN load for SecGW
- GTP tunnel support; GTPv2 (4G) S11/S5; GTPv1 (3G) Gn (4G) S1-U
- VoLTE (secure/unsecure), ViLTE
- ePDG Wifi Offload (EoGRE)
- VoWiFi (functional testing)

Internet of Things (IoT)

- Client emulation
- CoAP-RFC 7252
- NIDD over SCEF, S11-U, S1-U
- SCEF Emulation Including Protocol Relay

Cloud Platform Support

- Amazon AWS
- Google Cloud (GCP)
- Oracle Cloud (OCI)
- Microsoft Azure

Hypervisors

- VMware ESXi
- KVM Ubuntu
- KVM Redhat
- Citrix XenServer
- Hyper-V
- Openstack

Kubernetes Cloud Platforms (Containerized TeraVM)

- Google GKE
- Amazon EKS

NetSecOPEN Tests

- NetSecOPEN Test Suite



Contact Us: cisco@viavisolutions.com

To reach the VIAVI office nearest you, visit viavisolutions.com/contact

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teravmatcisco-ds-wir-nse-ae
30187436 904 1020