Routing performance LCOS 10.94

Table of contents

Routing performance LCOS 10.94

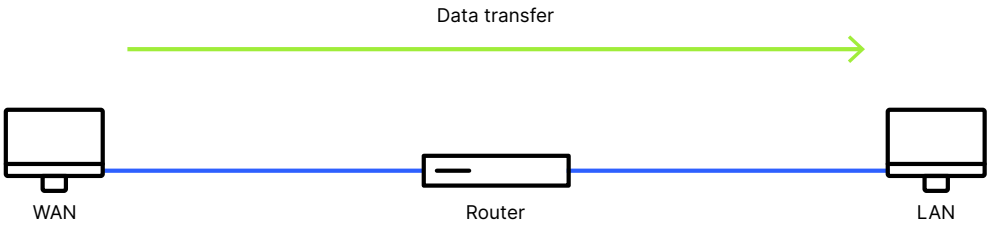
This tech paper provides a performance overview of the LANCOM routers. The routers, which are typically used as CPE or branch office devices, and the VPN gateways of the ISG series, which are typically used as central devices, are presented in terms of routing and VPN/IPSec performance.

For a clear presentation of the test results and thus better comparability of performance, devices are grouped into categories with similar hardware equipment.

The performance values shown are particularly suitable for comparing the different device categories with each other. They also allow conclusions to be drawn about the performance that can be expected in a real application. However, this may differ from the tech paper, e.g. because the device configuration, network environment or the measurement itself are different.

Definition of performance and associated measurement setups

Performance UDP



With UDP, IP datagrams are sent without a connection - sometimes as a continuous data stream. In contrast to TCP, there are no internal protocol mechanisms that guarantee or confirm the successful transmission of individual datagrams. There is also no adaptation of the transmission rate to the characteristics of the transmission path (e.g. lines or devices).

For the measurement of UDP performance, this means that it is not the reliable transmission itself, but the measurement method that must reflect its behavior. This is usually done using a search method that determines the highest possible transmission rate (in constant packets per second) at which the packet losses on the receiving side remain below a defined threshold. In the measurements presented in the tech paper, this target threshold is generally 1%.

With manual simulation, you start with a low transmission rate and gradually increase it until the losses observed on the receiving end exceed the defined threshold. Important: It is not permissible to simply select a transmission rate that is clearly too high and then only evaluate what is still arriving on the receiving end.

It should be noted that not only the device itself, but also the interfaces and lines used can limit the measurable performance. This is particularly evident in the UDP measurements: While the measurement results for smaller frames or packets still differ significantly between the various device categories, they largely converge for larger ones.

The following requirements must be observed when using UDP packet generators:

→ Uniform transmission: All packets must be sent evenly at the packet or frame rate to be examined - not in bursts.

→ Adapted packet size: The packet size should match the MTU (Maximum Transfer Unit) of the route so that the device to be examined does not have to perform any additional fragmentation. Important: The MTU can vary depending on the tunnel type. This is often less important for TCP measurements, as a negotiated

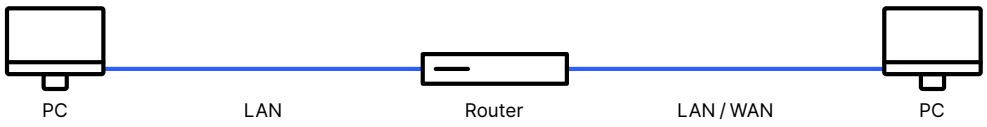
MSS (Maximum Segment Size) is usually reduced by mechanisms such as MSS clamping on the router.

→ No fragmentation: Only non-fragmented packets or frames should be generated. Fragments can - depending on the router settings - trigger complex reassembly.

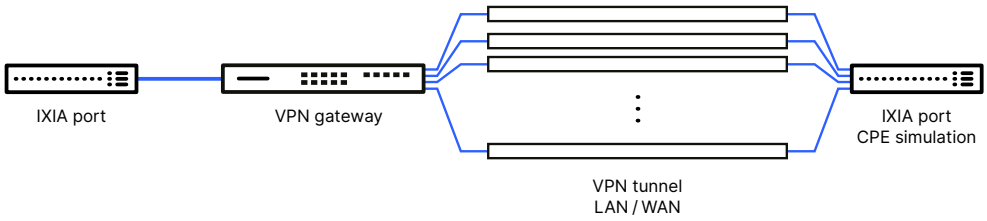
Measurement setup UDP

Various packet generators and search algorithms are used to measure UDP performance:

→ Routing performance: TRex is used as a packet generator for pure routing performance. This runs under Linux on a standard PC.



→ IPSec performance: For IPSec measurements, IxLoad from Keysight/IXIA is used on a PerfectStorm One appliance. This simulates one side of the VPN tunnel at a time, while the other side is taken over by the LANCOM device under test. This also allows tests to be carried out with a larger number of VPN tunnels that are terminated together on a LANCOM VPN gateway.



Definition measured values UDP

UDP measurements typically determine how many packets or Ethernet frames are successfully transmitted per second. A throughput value in Mbps is calculated by multiplying this by the total size of the respective IP packet or Ethernet frame.

These values are specified for a range of different packet sizes in the UDP measurement tables. The maximum possible packet size depends on whether it is an IPSec or a pure routing measurement, as the MTU in an IPSec tunnel is lower than on an unencrypted route due to the additional overhead.

In addition, some IMIX profiles are also taken into account in the measurements - i.e. mixtures of different packet sizes. Such “Internet mixes” simulate typical size distributions in real data traffic.

There is no binding standard for the selection of the frame sizes used. Therefore, in addition to the default setting of the IXIA test system (IMIX 0), two other common patterns are used: IMIX 1 and IMIX 2.

→ IMIX 0:
64 bytes (45 %)
128 bytes (20 %)
256 bytes (5 %)
512 bytes (3 %)
1024 bytes (2 %)
1280 bytes (1 %)
1418 bytes (24 %) for IPSec resp.
1518 bytes (24 %) for routing

→ IMIX 1:
64 bytes (58.4 %)
570 bytes (33.3 %)
1418 bytes (8.3 %) for IPSec resp.
1518 bytes (8.3 %) for routing

→ IMIX 2:
90 bytes (58 %)
92 bytes (2 %)
594 bytes (24 %)
1418 bytes (16 %) for IPSec resp.
1518 bytes (16 %) for routing

For the measurement, only a single tunnel is set up over the WAN link. However, the LANCOM ISG-5000 and ISG-8000 devices achieve higher total throughputs when several tunnels are used simultaneously.

Performance TCP

With TCP, the transmission of each data segment is already monitored by the protocol itself. TCP dynamically adjusts the transmission rate on this basis, among other things. This automatically sets the maximum possible performance that can be achieved via the devices and lines involved.

However, TCP measurements are highly dependent on the specific endpoints used - for example, the PC or mobile device, the network adapter (NIC) and its TCP offloading capabilities, the TCP stack of the respective operating system, the browser used, etc. These components influence both the internal control of TCP behavior and the overhead caused by TCP.

The properties of the underlying WAN route also have an impact on TCP performance. Delay/latency, jitter and packet loss are particularly important factors here. The relationship between the latency time (RTT, round-trip time) and the TCP window parameters plays a central role here. These buffer sizes must be sufficiently dimensioned to compensate for the delay on the connection. The required size results from the so-called BDP (Bandwidth-Delay Product) of the route.

To ensure that the measured performance is not artificially limited, the TCP implementation or generator used must actually be able to utilize this BDP.

Measurement setup TCP

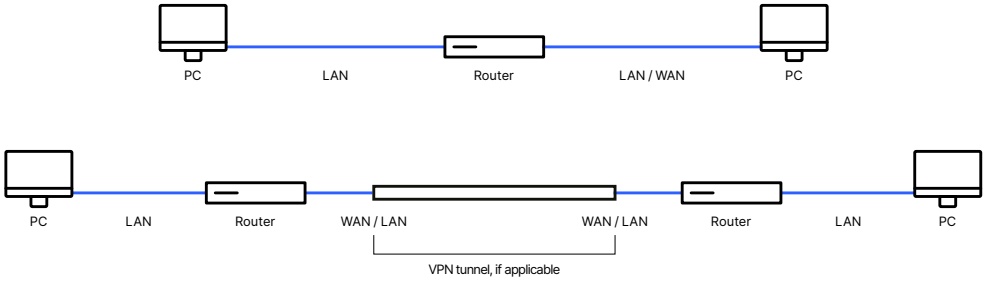
The measurements shown are intended to provide an orientation with regard to the performance of different routing and tunnel variants. Two scenarios are considered in each case:

→ Single system: A single device under test.

→ Two-point scenario: Two devices of the same type that are connected to each other via a WAN link. Different tunnel types are configured and compared on this route.

Linux-based PCs are used to measure TCP performance. A distinction is made between two types of measurement:

→ TCP measurement with iperf3: The iperf3 tool is used here to carry out targeted TCP throughput measurements.



→ HTTP measurement with nginx and siege: In this scenario, data is transferred between an nginx web server and the siege tool, which serves as an HTTP load generator.

Definition measurement values TCP

The information relates exclusively to the transported user data - for example, the transfer of larger files or complete HTTP pages.

General information vRouter

For the UDP-IPSec measurements, a vRouter was operated on a Xeon E-2176G @ 3.7 GHz under an ESXi hypervisor. Intel X710 adapters via VMXNET3 were used as network interfaces.

For the TCP/HTTP measurements, a vRouter was used on a Xeon E3-1230v5 @ 3.4 GHz, also under ESXi, was used for the TCP/HTTP measurements. Intel X710 interfaces with VMXNET3 were also used here.

The performance of a vRouter depends heavily on the host system used - in particular on its hardware, configuration and parallel use by other virtual machines.

The measured values shown in the tech paper therefore only provide a rough guide for vRouters. In contrast, hardware-based devices offer a much higher degree of practical relevance due to their fixed system environment.

Category assignment of the devices under test (DUT) for a better overview of the measurement results

In the left-hand column of the following table you will find the name of your LANCOM device. The corresponding device category is shown in the right-hand column. Using this category, you can clearly assign the corresponding performance values for your device in the tables on the following pages.

LANCOM device name	Device category
1650E	A
1800EF, 1800EF-4G, 1800EF-5G, 1800EFW	B
1800VA 1800VA-4G 1800VAW 1800VAW-4G 1803VA 1803VA-4G 1803VAW 750-5G IAP-5G OAP-5G	C
1800EFW-5G 1800VA-5G 1803VA-5G 1803VAW-5G 1930EF 1930EF-5G 1936VAG 1936VAG-5G	D
1926VAG-4G	E
2100EF ISG-5000	G
ISG-8000	H
vRouter	I

UDP measurement values for all devices

Note: When using large frames, the measured performance may not be limited by the device performance itself, but by the bandwidth of the Ethernet interfaces used (1G or 10G).

Table 01 - WAN-LAN routing

			Throughput [Mbps] @ frame size [bytes] and frame rate [fps]							
Device category	**Reference device**	**LCOS**	**64**	**128**	**256**	**512**	**1,024**	**1,280**	**1,518**	
A	1650E	10.94	**83** 162,000	**166** 162,000	**332** 162,000	**665** 162,000	**972** 118,000	**972** 95,000	**986** 81,200	**Mbps** Frames/s
B	1800EF	10.94	**94** 185,000	**183** 178,000	**345** 168,000	**670** 163,000	**972** 118,000	**972** 95,000	**986** 81,200	**Mbps** Frames/s
C	1800VAW-4G	10.94	**78** 153,000	**157** 153,000	**313** 153,000	**630** 153,000	**972** 118,000	**976** 95,300	**977** 80,400	**Mbps** Frames/s
D	1800VA-5G	10.94	**98** 192,000	**197** 192,000	**395** 192,000	**787** 192,000	**972** 118,000	**976** 95,300	**977** 80,400	**Mbps** Frames/s
E	1926VAG	10.94	**79** 154,000	**157** 153,000	**315** 153,000	**630** 153,000	**972** 118,000	**976** 95,300	**977** 80,400	**Mbps** Frames/s
G	ISG-5000	10.94	**371** 725,000	**740** 722,000	**1,470** 720,000	**2,810** 686,000	**5,800** 708,000	**7,200** 703,000	**8,470** 697,000	**Mbps** Frames/s
H	ISG-8000	10.94	**758** 1,480,000	**1,510** 1,470,000	**3,020** 1,470,000	**6,060** 1,480,000	**9,720** 1,180,000	**9,790** 956,000	**9,860** 812,000	**Mbps** Frames/s
I	vRouter	10.94	**572** 1,110,000	**1,100** 1,070,000	**2,160** 1,050,000	**4,350** 1,060,000	**7,880** 962,000	**9,720** 950,000	**9,860** 812,000	**Mbps** Frames/s

Table 02 - LAN-WAN routing

			Throughput [Mbps] @ frame size [bytes] and frame rate [fps]							
Device category	**Reference device**	**LCOS**	**64**	**128**	**256**	**512**	**1,024**	**1,280**	**1,518**	
A	1650E	10.94	**76** 150,000	**154** 151,000	**309** 151,000	**624** 152,000	**972** 118,000	**972** 95,000	**986** 81,200	**Mbps** Frames/s
B	1800EF	10.94	**90** 176,000	**174** 170,000	**327** 160,000	**645** 157,000	**972** 118,000	**972** 95,000	**986** 81,200	**Mbps** Frames/s
C	1800VAW-4G	10.94	**62** 122,000	**123** 120,000	**249** 121,000	**499** 121,000	**972** 118,000	**976** 95,300	**977** 80,400	**Mbps** Frames/s
D	1800VA-5G	10.94	**70** 137,000	**141** 138,000	**281** 137,000	**563** 137,000	**972** 118,000	**976** 95,300	**977** 80,400	**Mbps** Frames/s
E	1926VAG	10.94	**64** 125,000	**128** 125,000	**257** 125,000	**515** 125,000	**972** 118,000	**976** 95,300	**977** 80,400	**Mbps** Frames/s
G	ISG-5000	10.94	**264** 517,000	**538** 525,000	**1,080** 531,000	**2,160** 528,000	**4,760** 582,000	**5,320** 520,000	**6,550** 539,000	**Mbps** Frames/s
H	ISG-8000	10.94	**745** 1,450,000	**1,500** 1,460,000	**2,890** 1,410,000	**5,880** 1,430,000	**9,720** 1,180,000	**9,790** 956,000	**9,860** 812,000	**Mbps** Frames/s
I	vRouter	10.94	**473** 925,000	**979** 956,000	**1,880** 918,000	**3,680** 900,000	**7,520** 918,000	**8,890** 868,000	**9,630** 793,000	**Mbps** Frames/s

Table 03 - LAN-LAN routing

			Throughput [Mbps] @ frame size [bytes] and frame rate [fps]							
Device category	**Reference device**	**LCOS**	**64**	**128**	**256**	**512**	**1,024**	**1,280**	**1,518**	
A	1650E	10.94	**98** 192,000	**197** 192,000	**394** 192,000	**788** 192,000	**972** 118,000	**972** 95,000	**986** 81,200	**Mbps** Frames/s
B	1800EF	10.94	**115** 225,000	**222** 217,000	**409** 200,000	**798** 195,000	**972** 118,000	**972** 95,000	**986** 81,200	**Mbps** Frames/s
C	1800VAW-4G	10.94	**112** 219,000	**224** 219,000	**449** 219,000	**896** 218,000	**972** 118,000	**976** 95,300	**977** 80,400	**Mbps** Frames/s
D	1800VA-5G	10.94	**90** 175,000	**179** 175,000	**358** 175,000	**713** 174,000	**972** 118,000	**976** 95,300	**977** 80,400	**Mbps** Frames/s
E	1926VAG	10.94	**92** 179,000	**184** 179,000	**368** 179,000	**732** 178,000	**972** 118,000	**976** 95,300	**977** 80,400	**Mbps** Frames/s
G	ISG-5000	10.94	**388** 759,000	**771** 753,000	**1,540** 753,000	**3,040** 742,000	**6,080** 742,000	**7,600** 742,000	**8,980** 739,000	**Mbps** Frames/s
H	ISG-8000	10.94	**809** 1,580,000	**1,600** 1,560,000	**3,210** 1,560,000	**6,420** 1,560,000	**9,720** 1,180,000	**9,790** 956,000	**9,860** 812,000	**Mbps** Frames/s
I	vRouter	10.94	**521** 1,010,000	**1,010** 993,000	**2,030** 993,000	**3,940** 962,000	**7,680** 937,000	**9,340** 912,000	**9,860** 812,000	**Mbps** Frames/s

Table 04 - IPSec 1 tunnel AES-GCM via WAN - decryption

			Throughput [Mbps] @ frame size [bytes] and frame rate [frames/s]							
Device category	**Reference device**	**LCOS**	**64**	**128**	**256**	**512**	**1.024**	**1.280**	**1.418**	
A	1650E	10.94	**48.8** 95,400	**99.8** 97,400	**192** 93,700	**378** 92,200	**728** 88,800	**906** 88,400	**941** 82,900	**Mbps** Frames/s
B	1800EF	10.94	**77.7** 151,000	**153** 149,000	**292** 142,000	**549** 134,000	**931** 113,000	**943** 92,000	**948** 83,600	**Mbps** Frames/s
C	1800VAW-4G	10.94	**46.2** 90,200	**92.5** 90,300	**185** 90,500	**375** 91,500	**747** 91,200	**911** 88,900	**947** 83,400	**Mbps** Frames/s
D	1800VA-5G	10.94	**68.9** 134,000	**141** 137,000	**291** 141,000	**583** 142,000	**930** 113,000	**943** 92,100	**948** 83,600	**Mbps** Frames/s
E	1926VAG	10.94	**44.4** 86,600	**91.5** 89,300	**183** 89,100	**369** 90,000	**727** 88,700	**904** 88,300	**941** 82,900	**Mbps** Frames/s
G	ISG-5000	10.94	**237** 463,000	**467** 456,000	**900** 439,000	**1,750** 429,000	**3,330** 406,000	**4,120** 403,000	**4,570** 403,000	**Mbps** Frames/s
H	ISG-8000	10.94	**447** 873,000	**790** 771,000	**1,450** 711,000	**2,880** 703,000	**4,440** 543,000	**5,140** 502,000	**5,160** 455,000	**Mbps** Frames/s
I	vRouter	10.94	**389** 760,000	**759** 741,000	**1,440** 704,000	**2,710** 662,000	**4,600** 561,000	**5,180** 506,000	**5,160** 455,000	**Mbps** Frames/s

Table 05 - IPSec 1 tunnel AES-GCM via WAN - encryption

			Throughput [Mbps] @ frame size [bytes] and frame rate [frames/s]							
Device category	**Reference device**	**LCOS**	**64**	**128**	**256**	**512**	**1,024**	**1,280**	**1,418**	
A	1650E	10.94	**40.6** 74,600	**107** 101,000	**232** 111,000	**454** 109,000	**881** 106,000	**944** 91,700	**940** 82,600	**Mbps** Frames/s
B	1800EF	10.94	**112** 205,000	**219** 207,000	**429** 206,000	**858** 206,000	**928** 112,000	**948** 92,000	**944** 83,000	**Mbps** Frames/s
C	1800VAW-4G	10.94	**54.8** 100,000	**105** 99,700	**214** 102,000	**422** 101,000	**831** 100,000	**948** 91,300	**952** 82,900	**Mbps** Frames/s
D	1800VA-5G	10.94	**90.5** 166,000	**178** 168,000	**350** 167,000	**698** 167,000	**935** 112,000	**948** 91,700	**952** 83,100	**Mbps** Frames/s
E	1926VAG	10.94	**52.9** 97,300	**107** 100,000	**210** 100,000	**408** 98,000	**797** 96,500	**940** 91,100	**952** 82,900	**Mbps** Frames/s
G	ISG-5000	10.94	**291** 533,000	**560** 525,000	**1,050** 507,000	**1,920** 463,000	**3,250** 396,000	**3,890** 379,000	**4,290** 376,000	**Mbps** Frames/s
H	ISG-8000	10.94	**578** 1,050,000	**1,070** 1,000,000	**2,530** 1,210,000	**4,130** 1,000,000	**5,250** 639,000	**5,200** 506,000	**5,180** 455,000	**Mbps** Frames/s
I	vRouter	10.94	**427** 783,000	**824** 774,000	**1,550** 748,000	**2,770** 668,000	**4,590** 557,000	**5,200** 506,000	**5,180** 455,000	**Mbps** Frames/s

Table 06 - IPSec 1 tunnel AES-GCM via WAN - decryption / encryption IMIX

			Throughpput [Mbps] and frame rate [Frames/s]						
Device category	**Reference device**	**LCOS**	**Decryption**			**Encryption**			
			IMIX 0	**IMIX 1**	**IMIX 2**	**IMIX 0**	**IMIX 1**	**IMIX 2**	
A	1650E	10.94	**310** 84,100	**213** 77,200	**221** 65,100	**270** 72,000	**218** 78,000	**249** 72,800	**Mbps** Frames/s
B	1800EF	10.94	**446** 120,000	**308** 111,000	**300** 87,800	**334** 88,800	**259** 92,000	**243** 71,100	**Mbps** Frames/s
C	1800VAW-4G	10.94	**333** 90,200	**252** 91,100	**306** 90,200	**379** 101,000	**293** 104,000	**349** 101,000	**Mbps** Frames/s
D	1800VA-5G	10.94	**513** 139,000	**380** 137,000	**472** 139,000	**607** 162,000	**455** 161,000	**550** 160,000	**Mbps** Frames/s
E	1926VAG	10.94	**321** 87,200	**247** 89,500	**293** 86,900	**364** 97,300	**277** 98,400	**334** 97,600	**Mbps** Frames/s
G	ISG-5000	10.94	**1,550** 421,000	**1,170** 427,000	**1,360** 402,000	**1,660** 446,000	**1,260** 452,000	**1,520** 444,000	**Mbps** Frames/s
H	ISG-8000	10.94	**2,390** 649,000	**1,860** 674,000	**2,310** 684,000	**4,010** 1,070,000	**3,110** 1,110,000	**3,670** 1,070,000	**Mbps** Frames/s
I	vRouter	10.94	**2,500** 680,000	**1,910** 692,000	**2,290** 676,000	**2,490** 669,000	**2,020** 722,000	**2,300** 672,000	**Mbps** Frames/s

UDP measurement values for devices with 10G interfaces

Note: For large frames or TCP, the measured performance may not be determined by the performance of the device, but is limited by the Ethernet interfaces (1G or 10G).

Table 07 - IPSec 10 tunnel AES-GCM via LAN - decryption

Throughput [Mbps] @ frame size [bytes] and frame rate [frames/s]

Device category	Reference device	LCOS	64	128	256	512	1,024	1,280	1,418	
G	ISG-5000	10.94	**221** 431,000	**449** 438,000	**1,020** 500,000	**1,760** 430,000	**3,480** 425,000	**4,080** 398,000	**4,400** 388,000	**Mbps** Frames/s
H	ISG-8000	10.94	**406** 1,180,000	**1,210** 1,180,000	**2,470** 1,200,000	**4,830** 1,180,000	**9,320** 1,130,000	**9,450** 923,000	**9,480** 835,000	**Mbps** Frames/s
I	vRouter	10.94	**342** 667,000	**674** 658,000	**1,310** 640,000	**2,430** 594,000	**4,120** 503,000	**5,100** 498,000	**5,530** 488,000	**Mbps** Frames/s

Table 08 - IPSec 10 tunnel AES-GCM via LAN - encryption

Throughput [Mbps] @ frame size [bytes] and frame rate [frames/s]

Device category	Reference device	LCOS	64	128	256	512	1,024	1,280	1,418	
G	ISG-5000	10.94	**255** 466,000	**453** 428,000	**698** 335,000	**1,950** 468,000	**3,470** 419,000	**4,080** 397,000	**4,540** 396,000	**Mbps** Frames/s
H	ISG-8000	10.94	**788** 1,430,000	**1,400** 1,330,000	**2,910** 1,390,000	**5,660** 1,350,000	**9,430** 1,130,000	**9,540** 923,000	**9,500** 835,000	**Mbps** Frames/s
I	vRouter	10.94	**372** 683,000	**602** 570,000	**1,370** 659,000	**2,630** 635,000	**4,430** 539,000	**4,830** 466,000	**4,660** 409,000	**Mbps** Frames/s

Table 09 - IPSec 10 tunnel AES-GCM via LAN - decryption / encryption IMIX

Throughput [Mbps] and frame rate [Frames/s]

Device category	Reference device	LCOS	Decryption			Encryption			
			IMIX 0	IMIX 1	IMIX 2	IMIX 0	IMIX 1	IMIX 2	
G	ISG-5000	10.94	**1,630** 444,000	**1,290** 468,000	**1,050** 309,000	**1,210** 324,000	**992** 354,000	**1,110** 325,000	**Mbps** Frames/s
H	ISG-8000	10.94	**4,380** 1,190,000	**3,230** 1,170,000	**3,970** 1,170,000	**5,120** 1,360,000	**3,810** 1,360,000	**4,680** 1,350,000	**Mbps** Frames/s
I	vRouter	10.94	**2,130** 578,000	**1,750** 632,000	**1,670** 495,000	**1,970** 528,000	**1,290** 457,000	**2,140** 622,000	**Mbps** Frames/s

Table 10 - IPSec 10 tunnel AES-GCM via WAN - decryption

			Throughput [Mbps] @ frame size [bytes] and frame rate [frames/s]							
Device category	**Reference device**	**LCOS**	**64**	**128**	**256**	**512**	**1,024**	**1,280**	**1,418**	
G	ISG-5000	10.94	**213** 416,000	**460** 448,000	**942** 459,000	**1,690** 414,000	**3,210** 392,000	**4,010** 392,000	**4,420** 390,000	**Mbps** Frames/s
H	ISG-8000	10.94	**552** 1,070,000	**1,060** 1,040,000	**2,170** 1,060,000	**4,280** 1,040,000	**8,590** 1,040,000	**9,450** 923,000	**9,470** 835,000	**Mbps** Frames/s
I	vRouter	10.94	**390** 761,000	**755** 737,000	**1,410** 692,000	**2,620** 641,000	**4,590** 560,000	**5,390** 527,000	**5,850** 516,000	**Mbps** Frames/s

Table 11 - IPSec 10 tunnel AES-GCM via WAN - encryption

			Throughput [Mbps] @ frame size [bytes] and frame rate [frames/s]							
Device category	**Reference device**	**LCOS**	**64**	**128**	**256**	**512**	**1,024**	**1,280**	**1,418**	
G	ISG-5000	10.94	**272** 497,000	**524** 493,000	**1,050** 504,000	**2,030** 491,000	**3,320** 401,000	**4,120** 400,000	**4,220** 371,000	**Mbps** Frames/s
H	ISG-8000	10.94	**751** 1,370,000	**1,430** 1,340,000	**2,860** 1,360,000	**5,390** 1,300,000	**9,390** 1,130,000	**9,540** 923,000	**9,500** 835,000	**Mbps** Frames/s
I	vRouter	10.94	**412** 757,000	**802** 755,000	**1,510** 720,000	**2,590** 628,000	**4,590** 557,000	**5,460** 531,000	**5,720** 503,000	**Mbps** Frames/s

Table 12 - IPSec 10 tunnel AES-GCM via WAN - decryption / encryption IMIX

			Throughput [Mbps] and frame rate [frames/s]						
Device cetegory	**Reference device**	**LCOS**	**Decryption**			**Encryption**			
			IMIX 0	**IMIX 1**	**IMIX 2**	**IMIX 0**	**IMIX 1**	**IMIX 2**	
G	ISG-5000	10.94	**1,390** 377,000	**1,040** 379,000	**1,030** 304,000	**1,500** 401,000	**1,100** 395,000	**978** 283,000	**Mbps** Frames/s
H	ISG-8000	10.94	**3,930** 1,060,000	**2,920** 1,050,000	**3,560** 1,050,000	**5,040** 1,340,000	**3,780** 1,340,000	**4,570** 1,330,000	**Mbps** Frames/s
I	vRouter	10.94	**2,340** 636,000	**1,850** 670,000	**1,920** 571,000	**2,120** 567,000	**1,870** 668,000	**1,680** 490,000	**Mbps** Frames/s

TCP measurement values for all devices

Note: When using large frames or TCP transfers, the measured performance may not be limited by the device performance itself, but by the bandwidth of the Ethernet interfaces used (1G or 10G).

Table 13 - iPerf single DUT routing

			Throughput [Mbps] for 5 parallel transfers		
Device category	**Reference device**	**LCOS**	**LAN download / upload**	**WAN download**	**WAN upload**
A	1650E	10.94	**926**	**926**	**926**
B	1800EF	10.94	**938**	**938**	**938**
C	1800VAW-4G	10.94	**940**	**940**	**936**
D	1800VA-5G	10.94	**940**	**940**	**937**
E	1926VAG	10.94	**926**	**925**	**925**
G	ISG-5000	10.94	**8.030**	**6.240**	**5.740**
H	ISG-8000	10.94	**9.400**	**9.400**	**9.400**
I	vRouter	10.94	**9.400**	**9.400**	**9.400**

Table 14 - HTTP single DUT routing

			Throughput [Mbps] for 5 parallel transfers		
Device category	**Reference device**	**LCOS**	**LAN download / upload**	**WAN download**	**WAN upload**
A	1650E	10.94	**909**	**907**	**907**
B	1800EF	10.94	**928**	**931**	**932**
C	1800VAW-4G	10.94	**931**	**921**	**931**
D	1800VA-5G	10.94	**933**	**929**	**928**
E	1926VAG	10.94	**912**	**909**	**911**
G	ISG-5000	10.94	**4.680**	**4.640**	**4.700**
H	ISG-8000	10.94	**9.400**	**9.400**	**9.400**
I	vRouter	10.94	**9.400**	**9.400**	**9.400**

Table 15 - iPerf DUT2DUT WAN routing

Throughput [Mbps] for 5 parallel transfers

Device category	Reference device	LCOS	IPv4	PPP NAT	L2TP	EOGRE tunnel	L2TPv3 tunnel over LAN Bridge
A	1650E	10.94	915	903	795	894	880
B	1800EF	10.94	940	935	747	916	908
C	1800VAW-4G	10.94	931	927	771	701	735
D	1800VA-5G	10.94	934	928	781	780	814
E	1926VAG	10.94	907	904	796	751	799
G	ISG-5000	10.94	5,330	5,040	2,580	2,960	3,120
H	ISG-8000	10.94	9,400	7,690	7,310	5,980	5,530
I	vRouter	10.94	9,120	8,970	6,080	5,760	4,860

Table 16 - iPerf DUT2DUT WAN routing over VPN

Throughput [Mbps] for 5 parallel transfers

Device category	Reference device	LCOS	IPSec tunnel AES-CBC	IPSec tunnel AES-GCM	L2TPv3 tunnel in IPSec tunnel AES-GCM	WireGuard
A	1650E	10.94	756	806	530	496
B	1800EF	10.94	891	903	775	517
C	1800VAW-4G	10.94	777	820	473	310
D	1800VA-5G	10.94	883	896	600	314
E	1926VAG	10.94	812	811	469	304
G	ISG-5000	10.94	796	3,950	2,170	2,970
H	ISG-8000	10.94	1,620	4,930	5,010	7,420
I	vRouter	10.94	1,400	4,230	2,580	2,500

Table 17 - HTTP DUT2DUT WAN routing

Throughput [Mbps] for 5 parallel transfers

Device category	Reference device	LCOS	IPv4	PPP NAT	L2TP	EOGRE tunnel	L2TPv3 tunnel over LAN Bridge
A	1650E	10.94	905	902	878	893	884
B	1800EF	10.94	930	926	905	903	895
C	1800VAW-4G	10.94	921	922	883	812	844
D	1800VA-5G	10.94	921	921	877	897	889
E	1926VAG	10.94	905	900	879	868	874
G	ISG-5000	10.94	3,660	3,640	2,520	2,850	2,890
H	ISG-8000	10.94	9,310	7,580	7,500	7,060	6,000
I	vRouter	10.94	8,920	8,790	5,920	5,730	4,920

Table 18 - HTTP DUT2DUT WAN routing over VPN

Throughput [Mbps] for 5 parallel transfers

Device category	Reference device	LCOS	IPSec tunnel AES-CBC	IPSec tunnel AES-GCM	L2TPv3 tunnel in IPSec tunnel AES-GCM	WireGuard
A	1650E	10.94	855	860	598	496
B	1800EF	10.94	880	893	857	517
C	1800VAW-4G	10.94	864	883	527	310
D	1800VA-5G	10.94	870	886	713	314
E	1926VAG	10.94	860	876	514	304
G	ISG-5000	10.94	778	3,400	2,170	2,970
H	ISG-8000	10.94	1,620	5,080	4,760	7,420
I	vRouter	10.94	1,410	4,150	2,590	2,500

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