White Paper

Why Real Testing Requires Emulation, Not Just Simulation for Layer 4-7

Are You Testing for the Real World?

Testing for the real world is about emulating the entire network, not just individual switches and routers. This includes controlling variables related to Quality of Service (QoS) including latency and packet loss. Real network testing at Layer 4-7 involves emulating the behaviors of the TCP/IP stack as well as security protocols such as IPsec. It also includes controlling variables related to Quality of Experience (QoE) such as response time and video quality.

On paper, test solutions often look quite similar. To ensure you've found the right test solution, consider a bake-off or an in-depth trial before making your final selection. By proactively and continually hardening the networked products and services against attacks you can plan for the unexpected, and ensure your testing is unique to your environment.

The importance of realistic testing to produce meaningful test results

Test equipment should enable traffic generation across the full TCP/IP stack; Layers 4-7, as well as Layers 2. As such, organizations invest significant resources in building and protecting their networks. Performance and security testing is critical to maintain integrity and continuity across operations and within an infrastructure.

To ensure the ability to handle continually-increasing traffic loads, some may over purchase and/or over-provision in terms of hardware and software to stay on the safe side. Proper investment in the right testing solution can prevent over-spending caused by over-provisioning.

To truly test stateful application-aware security devices, realism is a must. Effective testing also requires another important element: proper test solutions. The challenge is selecting test solutions that enable the highest levels of testing realism, which is essential for producing meaningful test results.

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Executive Summary

Our always-on, connected world sets expectations that businesses and organizations need to provide a secure, seamless, and hassle-free online experience. In many instances, they are required via compliance and service-level agreements to meet and/or exceed those expectations. In the absence of real security and performance testing, one might encounter end-user dissatisfaction, delays in product development, or service delivery, loss of revenue, and other financial ramifications such as stiff fines. Real and proper testing helps avoid these types of significant risks to your networks, operations, and increasinglly to your reputation.

Test equipment that supports the highest levels of realism help ensure true testing that sufficiently achieves the desired levels of performance, availability, security and scalability. This is precisely why a vital part of achieving realism in testing is selecting test solutions that require emulation, not just simulation.

A variety of different test solution types are available including freeware, homegrown, and commercial options. Each type of solution has a place within the complex world of network testing, yet when it comes to having confidence, your testing needs to be based on your unique test needs and environment. Tests should generate realistic and stateful end-user traffic otherwise lightweight and somewhat superficial testing (without proper load under test) can potentially create a false sense of security.

Best practices for realistic network testing

- Validating network devices, discovering performance limitations
- Performing due diligence through proof-of-concept (PoC) for network designs and upgrades
- Planning for headroom and growth as requirements change, supporting proper provisioning of network resources
- Know that you are testing real-world behaviors of your network
- Test both pre-production and production, to have confidence in behaviors of your live systems
- Understand production traffic patterns and how to test to them
- Make sure your security solutions hold up under load

Emulation versus simulation

Test Emulation and Test Simulation are often used interchangeably. However, they are not the same. Test Emulation is to imitate, replicate or reproduce the exact scenario such that it recreates a snapshot in time, whereas, Test Simulation is a fabrication of a network scenario with the goal to resemble such a scenario that it could be passable or plausible if not evaluated closely. While seemingly subtle, these differences are crucial when it comes to ensuring realistic testing.

For a better understanding, consider these examples:

Test emulation: A test solution that also has emulation capability can generate legitimate and realistic payloads. This way additional features and capabilities of the target system can be tested. Emulation also drives indirect behaviors such as placing higher demand on the target system CPU. This is an important level of realism, particularly when running performance or scalability tests.

Test simulation: A test solution with simulation capability may generate a variety of TCP/IP traffic, but without meaningful payloads. This not only stops the target system from processing the payload, it prevents it from exercising the corresponding features and capabilities that a real payload would enable. The benefits of emulation are even clearer when considering more detailed, real-world testing scenarios in L4-7.

As shown in these simple examples, test emulation provides far greater value than simulation. At the same time, emulation has been growing in importance for several reasons:

- Device intelligence is growing. Network devices from firewalls and load balancers to switches and routers have increasingly complex logic and state management. Emulation is the only way to generate the many different device states and exercise all the corresponding logic.
- Decisions are being made further up the OSI model. For example, in order to test devices that support deep packet inspection (DPI), realistic payloads must be used at all layers in the OSI model. Proper emulation must also ensure that the right sequences of traffic are exchanged between the test system and the system under test (SUT.)
- Devices are taking on multiple roles. As devices do more, there is a greater possibility for one activity on a device to impact other activities on the same device. For example, virtual switches often run on servers that are also running other applications. This creates competition for shared resources such as the CPU. Emulation enables testing for indirect impacts such as increased CPU consumption by the virtual switch.
- The cost of downtime, outages and failures is on the rise. A single problem with a production network can creates costs across a number of categories, including business disruption, lost revenue, end-user productivity, IT productivity, detection, recovery and more. Yet, what "appeared to work" in the lab often fails in the real world simply because realistic emulation testing was not achieved.

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High Performance Layer 4-7 Devices

An increasing number of sophisticated, high-performance security and content-aware devices are at layers 4 through 7. This calls for, among other things, even greater sophistication of network emulation from test equipment. When Layer 4-7 devices are not properly tested, they face a greater risk for failure within production networks.
Failure of these devices opens the network to the threats they were made to protect against.

As with lower layers in the stack, realistic traffic is also critical for DPI and content- aware devices. In this case, the requirement includes a variety of application protocols and traffic. While HTTP is a common protocol, it is important to realize that a robust test solution for Layers 4-7 should go well beyond HTTP support. For example, SSL and IPsec traffic should both be supported since that is a better reflection of the real world.

Since the most important network traffic is encrypted, proper network emulation requires test equipment that can generate encrypted data exchanges. Additionally, devices that terminate SSL and IPsec traditionally have lower performance since these operations are CPU intensive. If your business uses secure communications, then you should test as close as possible to how the equipment will be used.

Different organizations have different types of applications, including custom applications. Test solutions must provide mechanisms to drive all the different traffic associated with these applications—even the custom applications. Some test solutions are limited to simple traffic capture and playback, leaving out the ability to drive stateful application exchanges. To properly emulate custom application traffic, test engineers need to use a test solution that provides the ability to build exact custom traffic profiles and drive them at an extreme scale.

In terms of performance, the industry conversation has moved from QoS at Layer 2-3 to QoE at Layer 4-7. This is an important distinction since the network can simultaneously deliver high performance and low customer experience. Latency of IP traffic simply does not tell the full story of what the end-user's experience is.

In order to accurately test QoE, test equipment needs the capability to generate realistic end-user traffic. In this case, the test traffic must reflect variations, both obvious and subtle, in the subjective perceptions of end-users. To achieve this, test engineers should have the ability to precisely control and adjust variables such as response time, voice quality, video quality, and more.

Selecting the Right Equipment

Finding the right test solution can be a challenge, particularly if "simulation" is misrepresented as "emulation." Don't choose a test solution simply because it describes itself as "supporting emulation." Look deeper to verify that it actually replicates, with precision, both the internal and external behaviors of the most important applications, devices and protocols in the network. The depth, breadth and realism of emulation is what matters for accurate testing.

Sophisticated test emulation means replicating the exact behaviors and traffic between devices based on stateful interactions. You do not achieve realism if stateful devices simply receive random traffic with dummy payloads; they must carry on a conversation that has specific meaning from beginning to end.

One of the most important elements needed for a test solution, in order to achieve realism, is a custom TCP/IP stack that enables test engineers control over the many variables and fields within the stack. Unfortunately, some solutions just sit above the operating system and make calls to the sockets' API. While a variety of TCP/IP traffic can be sent using sockets, fine-grained control is lost. Direct access to any layer in the TCP/IP stack enables control over malformed packets, lost packets, retransmissions and more.

Ease of use and flexible user options is another important selection criterion. Test solutions need to have robust testing options, however testing teams have varied responsibilities and level of experience. Due to this your testing solutions need the flexibility to provision visibility as well as provide a user interface that is intuitive to all users based on their role.

About Spirent Communications

Spirent Communications (LSE: SPT) is a global leader with deep expertise and decades of experience in testing, assurance, analytics and security, serving developers, service providers, and enterprise networks.

We help bring clarity to increasingly complex technological and business challenges.

Spirent's customers have made a promise to their customers to deliver superior performance. Spirent assures that those promises are fulfilled.

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Conclusion

Consumers in today's app-aware world have increasingly growing QoE and QoS expectations. On-demand solutions are expected to be fast and secure. Any failure to meet consumer expectations can have a big ripple effect in your business. Not only is there the immediate impact to business when you are down but as customers lose confidence in your business which effects their buying patterns with you long term.

In order to have confidence in your systems, you need to continually test and monitor them with realistic testing scenarios. This requires testing with emulation and not settling for just simulated scenarios that resemble, but do not replicate, your real world environment.

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