NE1ONE
By Calnex

The Final Frontier - Solving The Problem of Modeling Satellite Networks in Controlled Test Facilities

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SATELLITE NETWORKS IN THE 21ST CENTURY

As bandwidth continues to increase and services become cheaper over time, more businesses are making the reach to satellite networks to support and expand their operations and communications - and for good reason.

Satellite networks provide crucial connectivity to locations all across the globe, many of which cannot be accessed by WANs, or are so temporary that installing physical network infrastructure is entirely cost and time prohibitive. Combined with the huge expansion of satellite technology in recent years, with projects such as OneWeb & StarLink making SATCOMs more accessible than ever, more and more organizations are incorporating some form of satellite communications into their operational networks.

As a consequence, these space-age networks are becoming irreplaceable in many communications chains, and as Satellite Networks become more accessible than ever before, their importance will only increase throughout the next decade.

However, this connectivity comes at a cost.

Satellites communicate on a number of different wavebands (L, S, C, X, Ku, K, Ka, etc.) with the relatively high frequencies typically used to communicate with geostationary (GEO) satellites and relatively low frequencies used to communicate with low earth orbit (LEO) satellites.

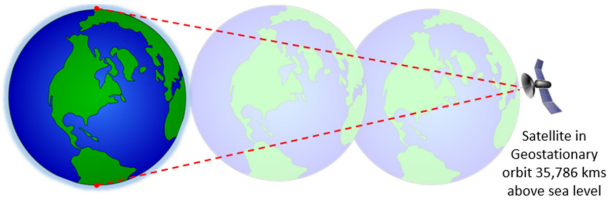
All of these frequencies have unique network characteristics which are nothing like those seen on Earth-based WAN networks, and all of these networks can very easily prevent applications from working due to their unique, extreme, network-based stresses.

But why is it difficult to prepare applications for Satellite Networks? Why do applications, which work perfectly fine over WAN Networks, face issues when operated over SATCOMs?

WHY SATELLITE NETWORKS IMPACT APPLICATION PERFORMANCE

Satellite networks have characteristics that are unlike any other network in modern communication chains, and subsequently can cause issues that do not appear anywhere else, and that can be very difficult to pre-empt in test labs as a result. Let's look more into what these characteristics are, and what challenges they pose to our applications and products.

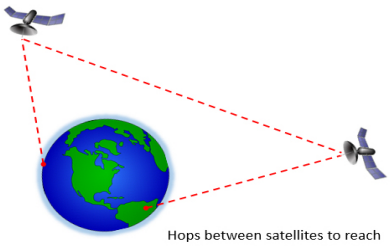
Latency
The most obvious cause of performance issues for applications operating over Satellite Networks stem from the latency (delay) in the application traffic traversing the SATCOM, and it's unavoidable; the further the distance information has to travel the greater the latency.



In satellite communications, especially when compared with global wired circuits, the distances can be enormous. A wired connection between two closely located cities can average somewhere between 10-30ms of latency. By contrast, a GEO Satellite Connection between two cities will average between 600-700ms of latency!

This means that every request an application receives or makes will be massively delayed, leading to severe timeout errors which will cause unprepared applications to suffer and fail in crucial live environments.

Latency (Continued)
In addition to this, if you need to communicate with a station or user on the other side of the globe, one GEO satellite jump won't be enough- you'll need two! This will naturally double that already large latency, meaning that every request an application sends or receives would be experiencing between 1200-1400ms of latency, which is more than enough to provoke an unprepared product to fail.



Hops between satellites to reach locations on the other side of the Earth greatly increase latencies

Wavebands
There are a wide variety of wavebands available in Satellite Networks, all designed to support different bandwidth requirements. However, these different wavebands will have unique characteristics leading to an impact on the networks that will support your application's performance in live environments. In particular, the highest frequency wavebands provide some very excellent throughputs and speeds, but these wavebands are typically very susceptible to being degraded by rain fades and cloud coverage, which results in a large amount of data loss. This data loss results in retransmissions of application requests, or a reduction of net bandwidth, which naturally leads to application performance issues.

Intermittent Connectivity & Jitter
MEO (Medium Earth Orbit) and incomplete LEO (Low Earth Orbit) constellations of satellites travel at a different speed to the earth's rotation, meaning that their range of coverage on the Earth is constantly moving, and these satellites can move out of range for the stations or users that need to utilize them.

This leads to applications experiencing long periods of time where connectivity may not be available, or they may experience instances where connectivity is lost during communications. If not prepared for the consequences of lost or intermittent connectivity, applications may fail to operate at a high level once in a live environment.

Complete LEO constellations try to mitigate this by always having the next satellite available. However, LEO satellites travel at enormously fast speeds, relative to the ground, which creates an erratic network environment that can lead to delay and jitter during ground to satellite and satellite to satellite handover, which can place further stress on applications.

The Ground Segment
In addition to all of the stresses that latency, jitter, and intermittent connectivity can have on an application, the ground based environments that applications will operate in can cause them to already be degraded (typically by bandwidth and latency) before making the SATCOM jump, reducing the application's chance to continue to work over the SATCOM link before failing.

In another example, we can look to the defense industry. Often, soldiers in the field will communicate wirelessly to a VSAT terminal, which can then directly link to a Satellite Network which will pass communications across the globe. The VSAT satellite link will have all the stresses we've detailed already, but the wireless segment that the soldiers are using could also be heavily degraded, with weather, jamming, and line of sight issues causing the application to lose information over that stressful first link. This means that when the application then goes to operate over the combined VSAT-wireless link, it will be doing so in an already stressed state, and has a higher chance of failing.

In addition to this, applications will often then have to traverse at least one WAN link on the other side of this SATCOM, which can provide just enough stress to make communications unintelligible if the application's information has already suffered stress over the SATCOM.

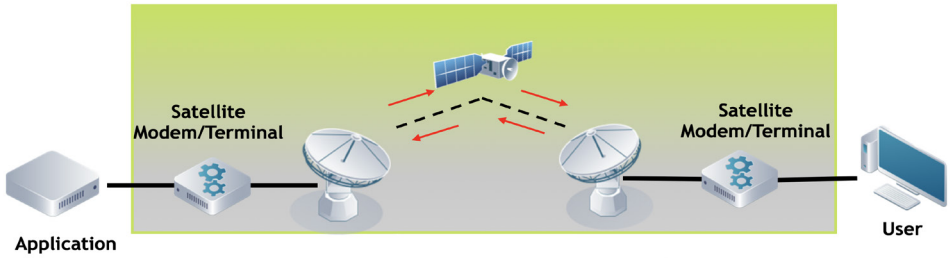
THE TROUBLE OF APPLICATION TESTING IN SATELLITE NETWORKS

The high commercial cost of satellite network bandwidth and associated resources (e.g. modems) has posed a significant challenge to validating application performance and optimization before release. Utilizing real, live satellite networks is not a cost-effective approach to preparing an application for the realities of SATCOMs- it's just too expensive to be a feasible long-term solution.

In addition to this, these live networks, despite being real, often bear little resemblance to actual operational environments. In contrast to the heavily loaded, international, potentially intermittent connections of a potentially degraded ground segment, these private 'live' networks are often connected straight to a test lab and nowhere else, meaning that they offer very different conditions to those that would be experienced in an operational environment, which further means they cannot effectively function as a test bed for application development.

These connections also fail to incorporate the impact of the ground (or wireless) segment, meaning that while applications may successfully operate over Satellite Networks in their perfect state, they could still fail to operate once deployed into a live environment if they have never experienced the impact of satellite networks after they have been damaged by a poor quality ground environment. This is a major oversight that many organizations fall victim to when using live networks for testing.

Organizations have, therefore, looked for alternative solutions including the use of Satellite Simulators (SatSims).



These eliminate the need for dishes and the satellites, (but not the modems, which still incur a large cost and add unneeded complexity), and provide a live satellite connection that can be used for test purposes. However, SatSims still don't offer an environment that can be used to make a truly robust product, as the connections that these SatSims often do not reflect real world conditions.

In operational environments, satellite networks will be supporting other traffic over connections between sites across the globe, meaning that the links will have varied latencies and bandwidth availabilities as a result. When using SatSims, the connections you have will, more often than not, be private unloaded connections, which are not equatable to the conditions experienced in live environments.

In addition to this, SatSim solutions don't emulate the impact of the ground segment, which can cause applications to be degraded before a SATCOM jump, and will only predict the impact of poor weather if the poor weather is present when tests are being conducted, which could be impossible if weather hazards such as heavy rain or dust/sand storms don't occur in your region. This means that applications that are verified by using SatSims could still face massive issues in operational environments due to these unavoidable variables that weren't considered in any pre-deployment SatSim tests.

Over time, the blind spots present in SatSim test setups are becoming more and more apparent for test organizers, as they come to the conclusion that using SatSims still fails to provide a suitable long-term solution for testing against satellite networks.

Subsequently, many organizations involved with satellite communications are turning towards a new solution- the Software Defined Test Network.

MODELING THE ENTIRE NETWORK COMMUNICATIONS CHAIN - THE NE-ONE ENTERPRISE

The NE-ONE Enterprise provides developers, testers and network specialists with a Software Defined Test Network that enables them to test the effects of satellite network conditions in a controlled and repeatable environment. Through the Software Defined Test Network, a user can create a live, working model of any satellite network they may have to operate over, including GEO and VSAT links, MEO and LEO Satellite Constellations, and the entire end-to-end network communications chain surrounding those satellite networks, to verify applications will preserve performance once they have endured every stress of their operational environment.

The NE-ONE Enterprise Network Emulator can easily model any satellite network topology, including full Satellite Constellations with Ground Segments included.

Unlike SatSims, there is no need for satellite modems or terminals to be included in the configuration. Instead the NE-ONE Enterprise presents standard Ethernet ports which enables the user to easily connect their equipment. When network packets pass through the NE-ONE, they are impaired to mimic the real-world network- for example, packets can be subjected to delay (latency/jitter), bit errors, loss, queuing, QoS, etc. to the extent that the impact of environmental factors such as rain fade can be mimicked, so that the effects on application performance can be observed, all from the control of a test lab, with no other test equipment required.

As a result, developers, testers and network specialists can use the NE-ONE to test and optimize the application code and verify that any modifications have worked using exactly the same conditions as previously used, in a cost-effective environment that accelerates application development and improves product quality.

By modeling your operational environments in the NE-ONE, you provide yourself with a test bed that can represent any network topology, from end to end, and expose your applications, devices, products, and services to a range of different, dynamic network scenarios that could cause your product to fail, all within a controlled test environment. In addition to this, the NE-ONE Enterprise comes equipped with a range of analytical tools and report capabilities, to give you everything you need to understand the causes of any application/product failures and fix them to ensure a successful deployment, and a large range of NE-ONE models is available to meet all budgets and all requirements, making it the ideal short & long-term solution for application testing over satellite networks.

VIRTUAL APPLIANCES

The NE-ONE Family is also available as part of our Flex virtual appliances range, certified to run on VMware's ESXi Server and OpenStack.

SUMMARY

Using satellite networks for application delivery provides huge benefits, but they also carry additional application failure risks that are not present in other types of networks, which will cause unprepared products to fail. Organizations that are developing, testing, evaluating or supporting products that run over satellite networks can quickly benefit from using Software Defined Test Networks to identify and mitigate the risk of application performance issues or failure. This includes the ability to delay any live satellite network testing until much later in the project lifecycle, leading to significant cost savings.

The Software Defined Test Network is the ultimate long-term solution for organizations needing to test over SATCOMs, and enables any customer to accelerate product timescales, ensure successful deployments, and re-create customer errors on both current and past projects.

ABOUT THE NE-ONE

Every industry from finance to tech, defense to games, retail to healthcare is undertaking some degree of digital transformation. Success in the digital age is all about application delivery and performance but guaranteeing this isn't easy, especially when it comes to distributed networks that span countries or continents.

NE-ONE Software Defined Test Networks technology provides organizations a way to create real-world network conditions in which to analyze, predict and verify application performance before deploying applications into potentially challenging network environments. The insight it provides allows businesses to effectively manage their digital products and brand, reducing deployment costs and risk, mitigating remediation expense and impact to resources at the same time as improving quality.

In an environment where the risk of a failed application launch or migration could cost revenue, brand reputation, jobs, or even lives, the effective assessment, and management of this risk should be an integral part of any development, deployment or migration process.

DISCLAIMER

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