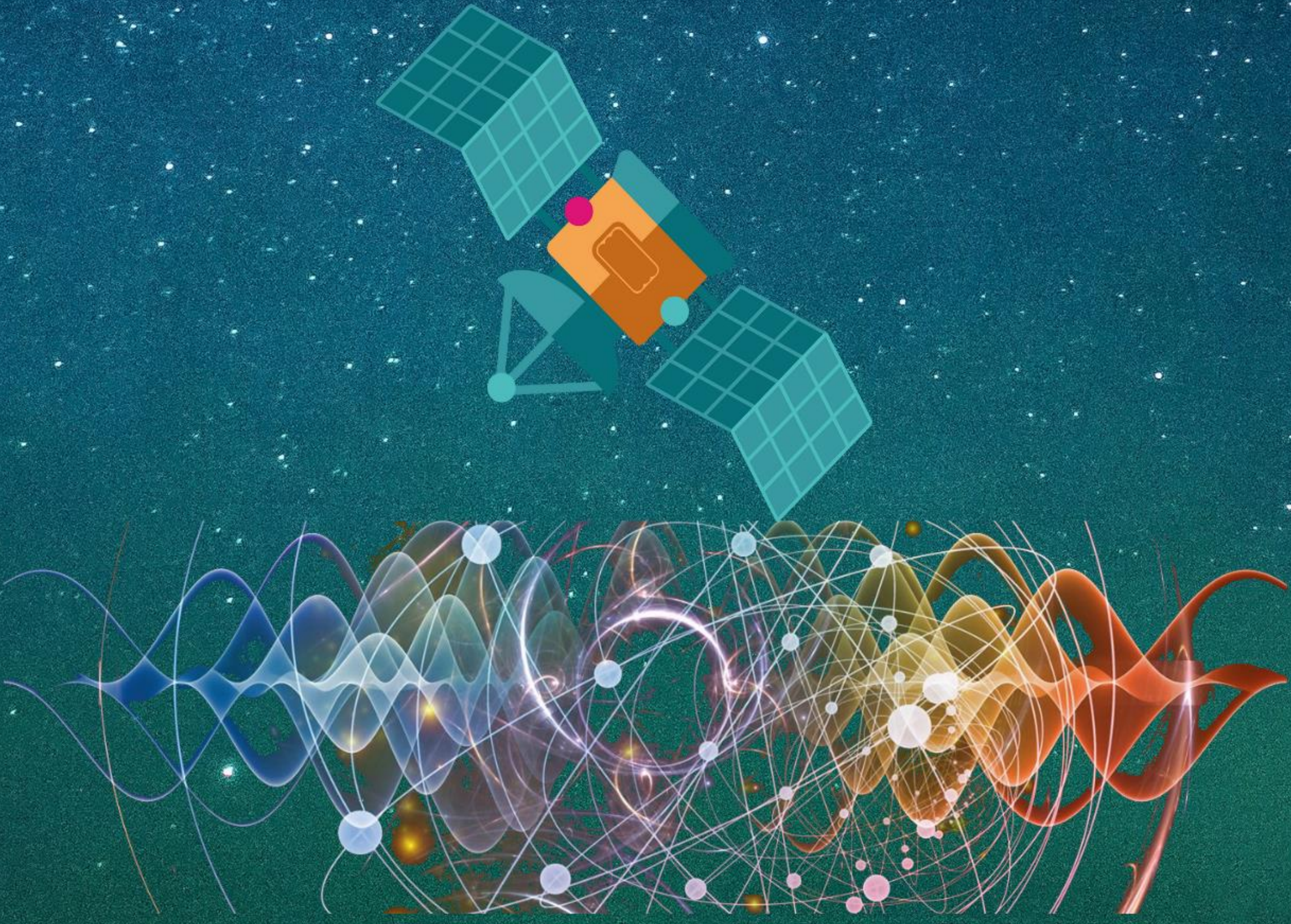
DIPL.ING.(FH)KLAUS ROCK

HTTP-QuSS

HTTP - QUANTUM SPEED AND SECURITY Ψ

February 14, 2022

GEO | MEO | LEO | FSO SATELLITE SEGMENTS



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Latency and Performance the biggest Challenge using Satellites

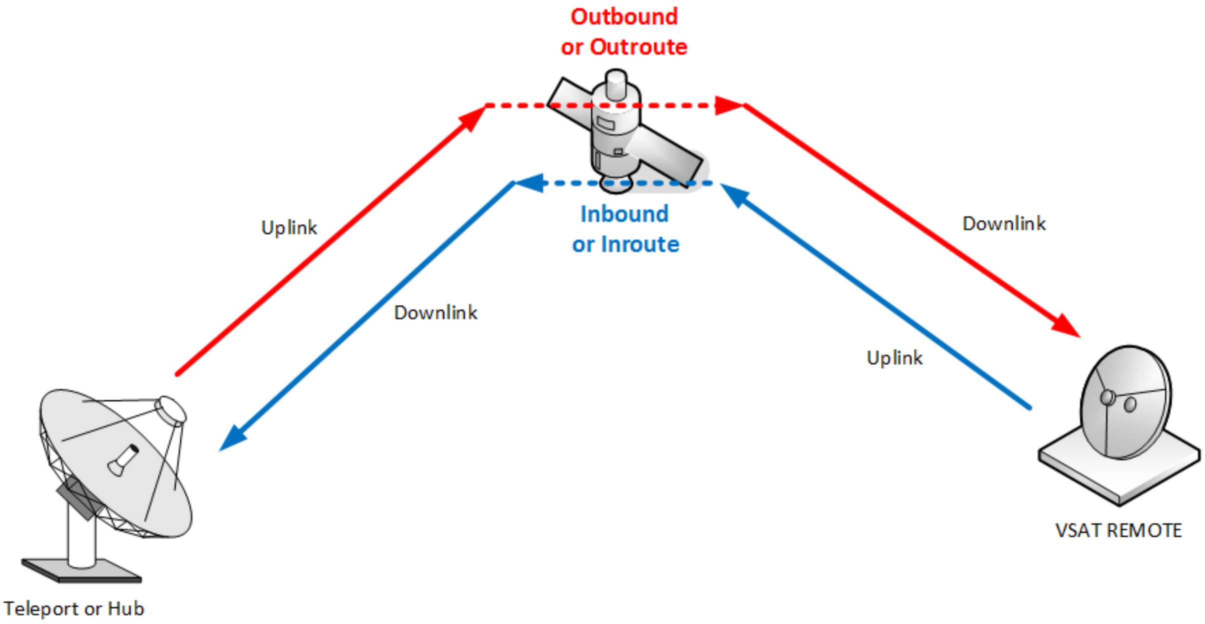
GEO | MEO | LEO Satellite - Latency

Latency (commonly referred to as "ping time") is the delay between requesting data and the receipt of a response, or in the case of one-way communication, between the actual moment of a signal's broadcast and the time it is received at its destination.

A radio signal takes about 250 milliseconds to reach a geostationary satellite and then 250 milliseconds to reach the ground station, so nearly 1/2 of a second overall. Typically, during perfect conditions, the physics involved in satellite communications account for approximately 550 milliseconds of latency round-trip time.

The longer latency is the primary difference between a standard terrestrial-based network and a geostationary satellite-based network. The round-trip latency of a geostationary satellite communications network can be more than 12 times that of a terrestrial based network.

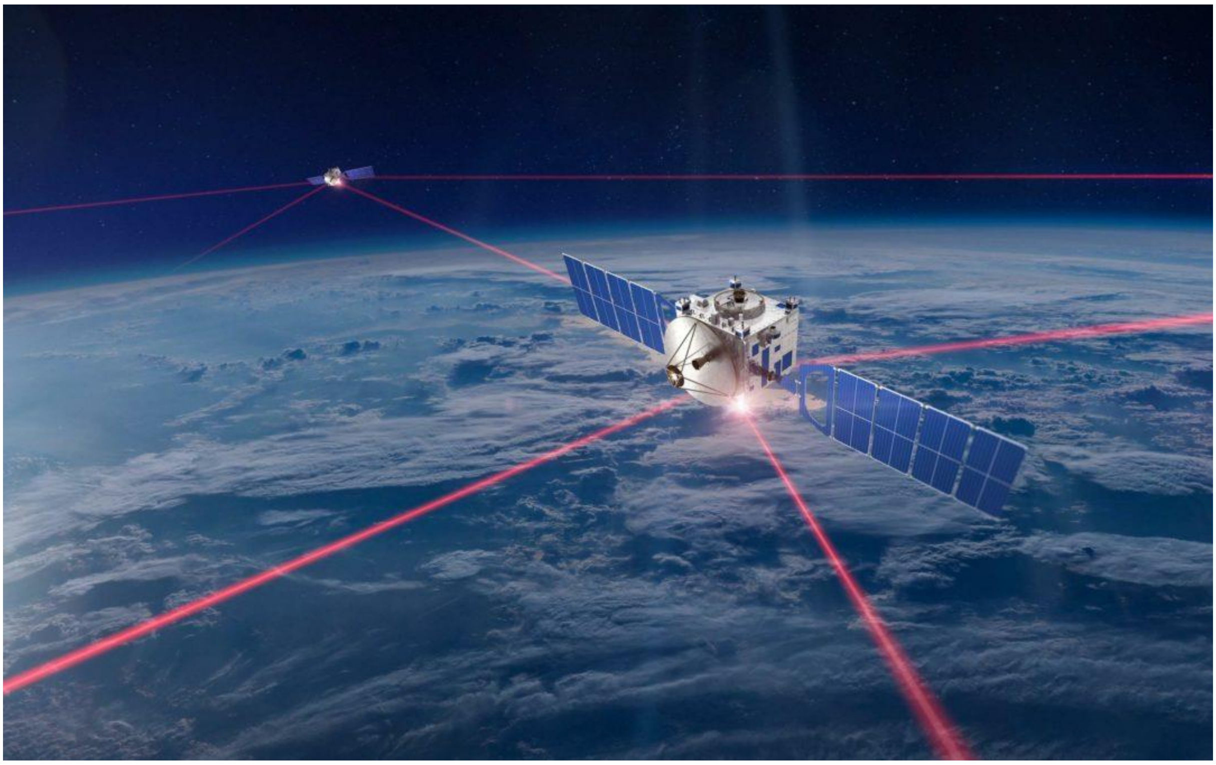
Geostationary Orbits	= 500 ms	Orbit	35,786 km
Medium Earth Orbits	= 125 ms	Orbit	8,062 km
Low Earth Orbits	= 40 ms	Orbit	1,420 km



Latency also caused by:

- Interference
- Line of Sight
- Fresnel Zone
- Network Saturation

FSO | Laser Optic Satellite - Latency

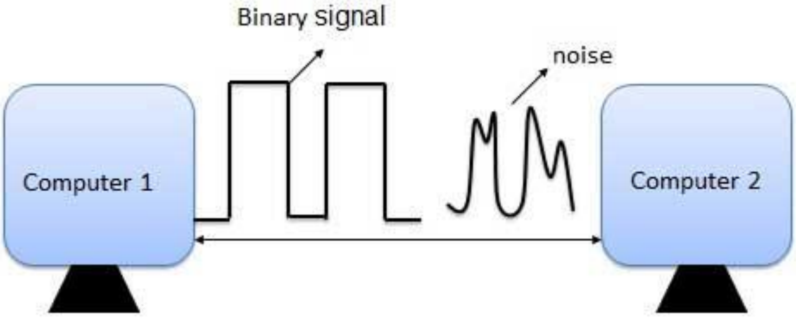


FSO (**F**ree **S**pace **O**ptic) is a line-of-sight technology that uses invisible beams of light to provide optical Bandwidth Connections capable of sending up to 1.25 Gbps full duplex of voice, video, and data information's.

Nevertheless, the FSO systems have some drawbacks due to their susceptibility to the atmospheric turbulence and local weather conditions. The effects of these can cause beam wandering, as well as scintillation, which in due course results in the received optical intensity fluctuation. Consequently, the system reliability and availability can be determined by the extent of these effects.

As a result, FSO technology is relatively unreliable like the normal optical fiber technology. Therefore, apart from the fact that these can limit the system performance, its employment for WEB applications might also be limited as well. Consequently, the drawbacks hinder the FSO scheme as an effective standalone solution.

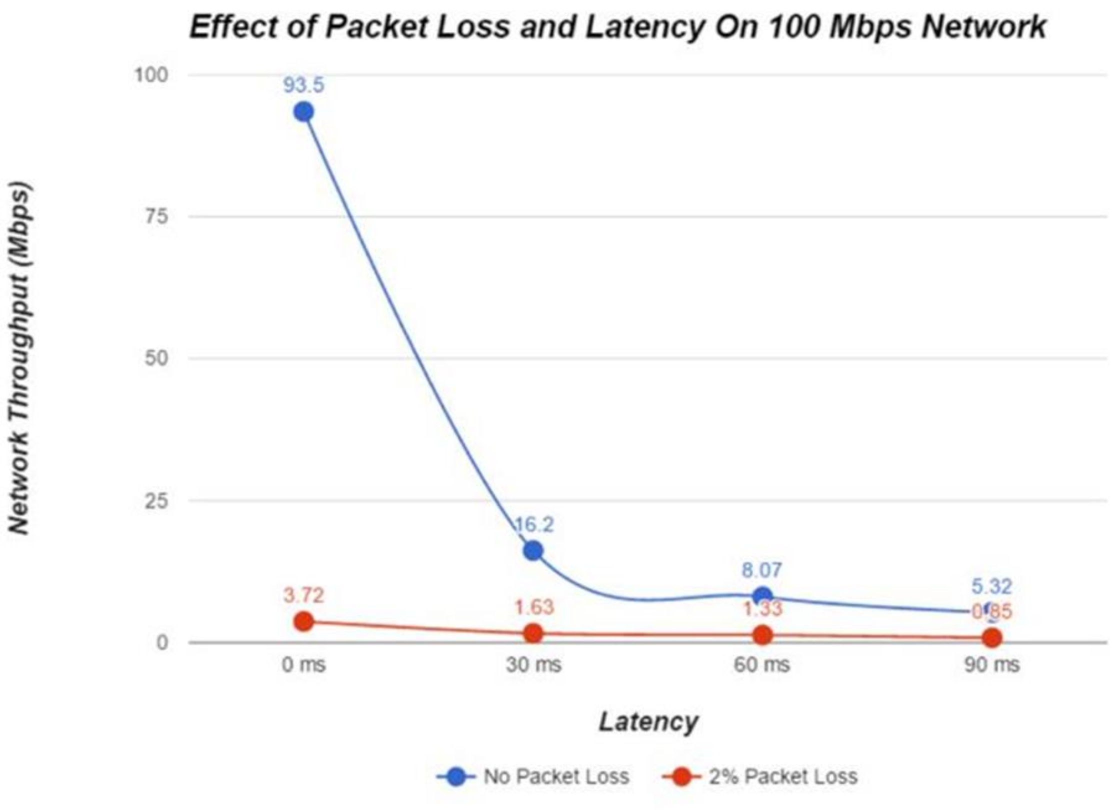
These drawbacks cause huge loss of data that must be reconstructed by the receiver side using complex data recovery Codes and thereby lead to significant Latencies.



Latency together with TCP Package Losses and his huge Impact on Data Throughput

When latency is high, it means that the sender spends more time idle (not sending any new packets), which reduces how fast throughput grows.

The TCP congestion window mechanism deals with missing acknowledgment packets as follows: if an acknowledgement packet is missing after a period of time, the packet is considered as lost and the TCP congestion window is reduced by half (hence the throughput too – which corresponds to the perception of limited capacity on the route by the sender); the TCP window size can then restart increasing if acknowledgment packets are received properly.



Packet loss will have two effects on the speed of transmission of data:

- Packets will have to be retransmitted (even if only the acknowledgment packet got lost and the packets got delivered)
- The TCP congestion window size will not allow an optimal throughput

There are much more Challenges which would exceed this short introduction.

How the Satellite Industry tries to overcome these Problems

For a two-way satellite service to perform properly in conjunction with traditional terrestrial networks (Internet, Intranet), satellite data networks must employ special techniques to deal with the extra 44,600- mile space segment of the connection. Without those steps, the increased latency, the time required to traverse the extra distance, means that TCP severely limits performance.

The Internet relies on the Transmission Control Protocol (TCP) to ensure packet delivery without errors. TCP works by sending a certain amount of data, the "window size," then waiting for the receiver to send an acknowledgment of receipt. With TCP, the sender cannot transmit more data until it has received an acknowledgment. If an acknowledgment does not arrive in a timely manner, TCP assumes the packet was lost (discarded due to network congestion) and resends it. When packets go unacknowledged, TCP also slows the transmission rate to reduce congestion and to minimize the need for retransmissions.

TCP/IP sessions start out sending data slowly. Speed builds as the rate of the acknowledgments increases which verifies the network's capacity to carry more traffic. This is known as slow-start, followed by a ramp-up in speed. The speed of the connection builds until the sender detects packet loss from a lack of an acknowledgment. This allows TCP to achieve the fastest practical data transfer rate for the conditions present on the network.

The standard TCP/IP protocol does not understand that a satellite is involved and operates as if the satellite latency was caused by congestion whereas the true reason is the distance involved. If uncorrected, this effect causes all packets over a satellite network to be sent at the slow-start rate.

Current satellite data networks employ a technique referred to as TCP acceleration or IP spoofing to compensate for the extra time required to transit the space segment. Special equipment at the carrier's main satellite hub appears to terminate the TCP session, so it appears to the sender as the remote location. In actuality, the device at the satellite hub acts as a relay or forwarder between the originating terrestrial location and the remote satellite unit.

When the spoofing equipment receives Internet, traffic destined for a remote satellite location, it immediately acknowledges receipt of the packet to the sender so more data packets will follow promptly. This way, the sender never experiences the actual latency to the remote site because acknowledgments return rapidly.

As a result, TCP moves out of slow-start mode quickly and builds to the highest practical speed. To prevent packets from being acknowledged twice, the spoofing equipment suppresses acknowledgments from the remote site. In this way, computers behind a satellite link communicate seamlessly and efficiently with servers on the terrestrial Internet. Despite of acceleration techniques, some applications are very latency sensitive.

Please Note: That most of all these Acceleration Methods based upon Spoofing Equipment will not work or not work well with modern TLS encrypted WEB Applications.

To overcome this Latency Issue LEO Satellites are just launched

Main Advantages

- Less power (about 1 watt) is needed for transmission.
- It has least propagation delay (about 10ms) compare to other orbits due to closeness to the Earth. Due to lower latency, it can be used for real-time time critical applications.
- It eliminates the need for small size antennas and low consumption amplifiers (BUC's) receiver equipment's due to higher C/N signal ratio.
- Low price satellite equipment's are enough for ground stations.
- Better frequency reuse can be achieved due to smaller footprints.
- It provides high elevation for polar regions of the Earth.
  Hence better global coverage can be achieved.

Main Disadvantages

- As it is at lesser distance above the Earth, it covers less region of the earth. Hence large number of satellites are needed to cover the entire region of the Earth. Hence the installation of such LEO based system is costly.
- As LEO satellites move constantly and hence service is being handed off by each satellite to the next one in the constellation. Hence beam transition techniques of satellites is required to cover any region on the Earth.
- Atmospheric effects are more and hence will cause gradual orbital dis-orientation of the satellites. This requires regular maintenance of satellites to keep them on track in the LEO orbit.
- It is only visible for 15 to 20 minutes from particular area of the Earth. Hence there is less time available for testing and troubleshooting activities.
- Efficiency to serve populated region is less compare to GEO satellites.
- Ground station is very complex as it requires to handle frequent handoffs between LEO satellites.
- The complete deployment of LEO constellation is essential to start the service to the customers. Hence it requires more time to provide the satellite service & mass adoption by the users compare to GEO.
- LEO satellites have shorter life span (about 5 to 8 years) compare to GEO satellites (about 10 years).

Cybersecurity for Satellite connected Devices and Cars?

Just like any other connected computer-enabled device, however, satellite links are prone to cybercrimes. Criminals might be motivated to hack into operating systems and steal important user data, or else disrupt its operation and jeopardize the passenger's safety. Some of the possible cyber-precipitated scenarios that you can expect with the full adoption of driverless cars include:

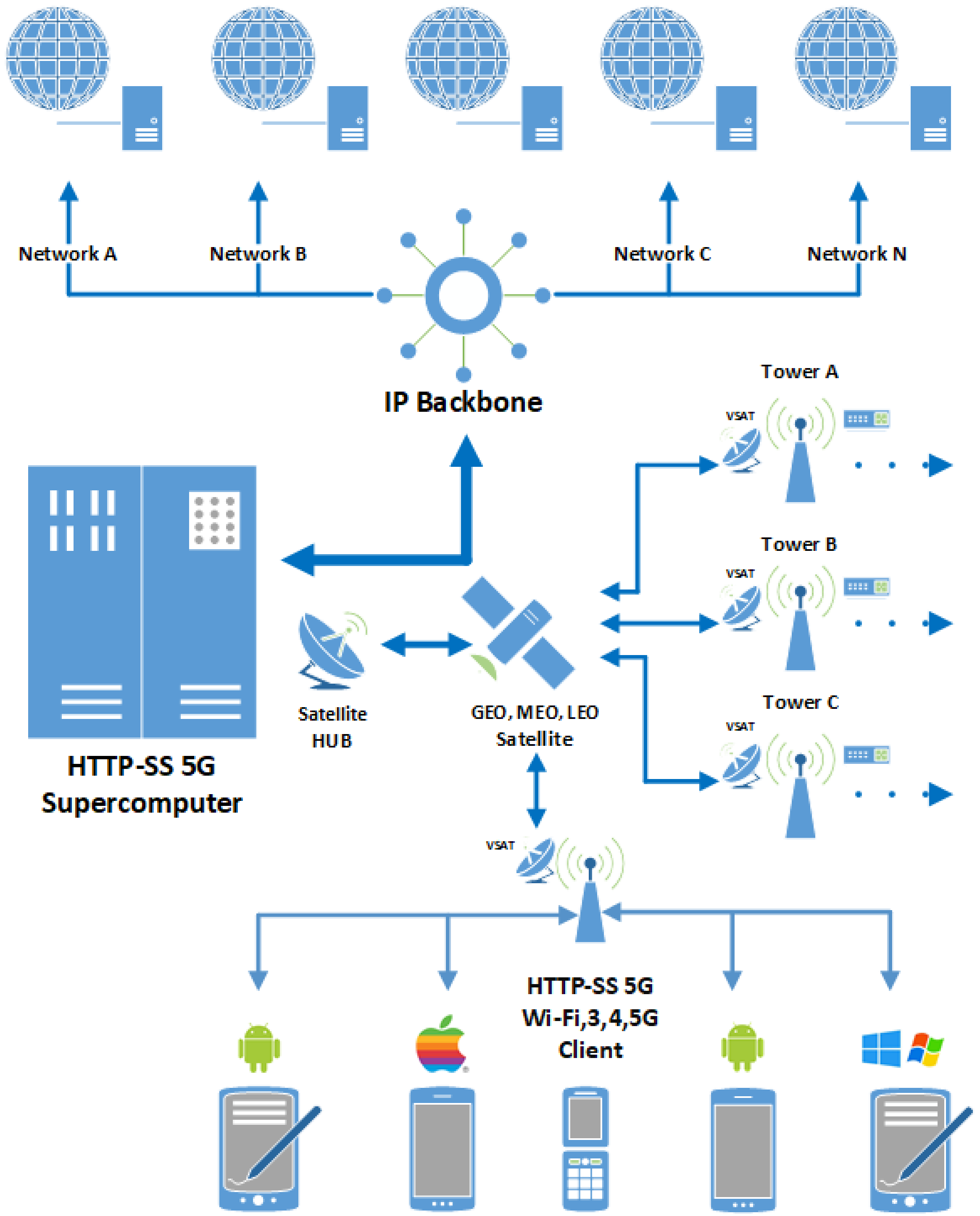
- Criminals hacking satellite links for self-driving cars to force extort ransom.
- Terrorists hijacking the network and taking control over a transport system in each area. Hacking a network can cause major crashes by disabling the light-detecting and ranging sensors, leading to endless confusion.
- Hacking server operating systems remotely to destroy it could harm the user financially.
- As with any other hacking scenario, hacking into satellite connected self-driving cars could expose a great deal of your personal data—including your destination. With this information, someone could potentially track the user with an aim toward robbery or assault. If hackers can gain access to the controls of the vehicle, it could also be possible to redirect the vehicle to a more convenient location for either of those scenarios.
- As the technology evolves, satellite connected driverless cars will be able to turn on any smart device in your home, be it the TV, heater, garage door, or front gate, and everything programmable in the home. Hackers could use these features to gain access to your home.

The threats and benefits of satellite connected autonomous cars will not be entirely clear until the technology is fully rolled out. The good thing is that even with the many probable cybersecurity threats the **HTTP-QuSS Supercomputer** has an integrated Active Cybersecurity which eliminates all these threads before reaching the car data backbone vie the HTTP-QuSS Client

What is HTTP-QuSS

HTTP-QuSS consists of an **Embedded Supercomputer** of the newest Generation stationed at an IP Backbone Site or Satellite Ground Station and an **AI Edge Server** for **Satellite VSAT Terminals.**

The **HTTP-QuSS Supercomputer** eliminates the Bandwidth destroying Latency Issue caused by Long Round Trip Times, Protocol Handshakes, Data Losses, congested Networks by many Users etc. and therefore existing GEO, MEO, LEO Satellite Networks are able to fulfil 5G Requirements like low Latencies and Gbit/s Bandwidths.



Unique Selling Proposition

- **Total Elimination of the TCP Latency Problem and related Bandwidth Losses Within GEO, MEO, LEO Satellite Communication Networks**
  - ✓ Through a new **HTTP 5G S**ingle **S**tream Architecture and Technology
  - ✓ By using the next Generation of Embedded Server Supercomputer Hardware
  - ✓ By Artificial Intelligence supported Data Transmission and highly Parallelized Process Chains
  - ✓ Integrated Dynamic Bandwidth Shaping and Slicing for max Bandwidth Usage
- **Highly reduced Data Transmission for all WEB Objects and Files**
  - ✓ By AI supported WEB Object Push and File Descriptor Delta Data Algorithm
  - ✓ And 1 Round Trip Protocol Handshake
  - ✓ and therefore 90 % reduced secure Data Transmission
  - ✓ All WEB- and TCP Applications are supported
- **5G Bandwidth and Real-Time Performance for existing Satellite Networks**
  - ✓ With its own AI Supercomputer and patented Architecture
  - ✓ Integrated automatic transparent parallel Processing Refactoring
  - ✓ Smart parallel Process Chains with highly efficient Inter Communication
  - ✓ And much more …
- **Quantum Secure Cyber Security**
  - ✓ Through keyless 2 Level Data Encryption
- **Pure Client Software Solution for legacy Devices**
  - ✓ No need of special Hardware on Client Site
  - ✓ No need of special Browser or Proxy Settings on Client Site
- **Fast and transparent Satellite Network Installation and Integration**
  - ✓ No need of Reconfigurations in existing Infrastructure
  - ✓ Fully transparent for User
  - ✓ Supports all Devices PC''s, Laptops, Smartphones (Android, iOS), DSL- and VSAT Routers etc.etc.

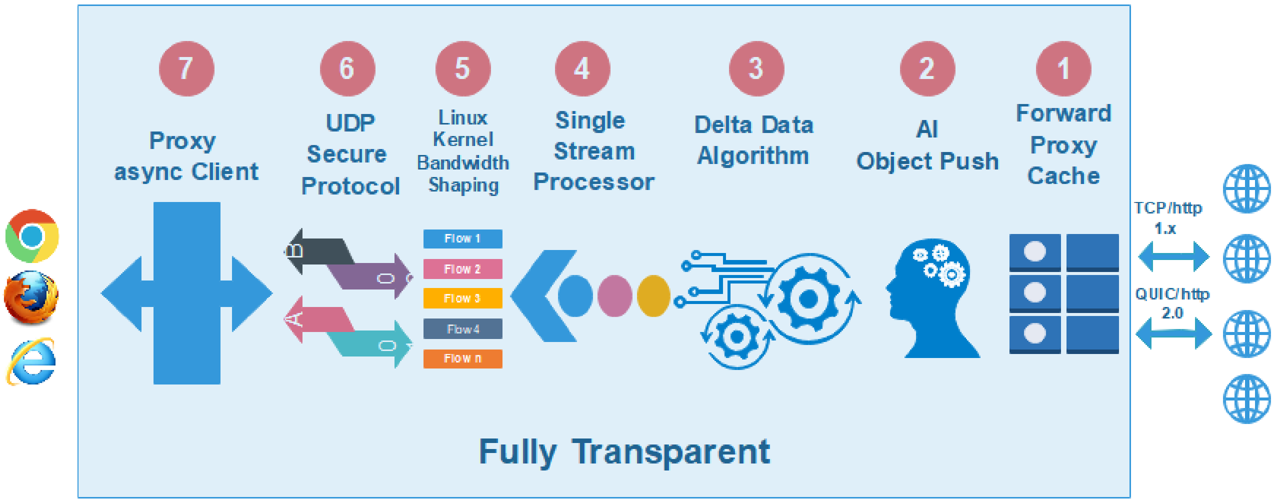
Major Advantages for Satellite GEO, MEO, LEO Satellite Links

- Best use of limited and expensive Resources (Bandwidths)
- No Bandwidth Losses through TCP Latency Issue
- Fulfils Realtime and Bandwidth 5G Automotive Requirements
- More efficient and faster Data Transmission
    - ✓ Faster WEB Page Loading
    - ✓ Significantly better Performance
    - ✓ All TCP/UDP TLS encrypted WEB Apps are supported
- Transparent and fast Integration into existing 5G Infrastructure for self-driving Cars
    - ✓ Part of Car Automotive Operating System
    - ✓ No need of extra Hardware
- No need of 5G Contract
- Can reduce his monthly Costs dramatically because Data Volume will be reduced by **90 %**
- No upgrade of existing Provider Contracts

- Gbit/s Bandwidth Speed available in Satellite Links because eliminating the TCP Latency Bandwidth Killer
- Much better Performance for Cloud Applications
- Fast Cloud Data Backup
- Broadband Availability, even in rural Areas
- Supports upcoming Low Earth Orbit Satellite Networks by avoiding heavy 1 Gbit/s Bandwidth Losses caused by Round Trip Times > 30 ms

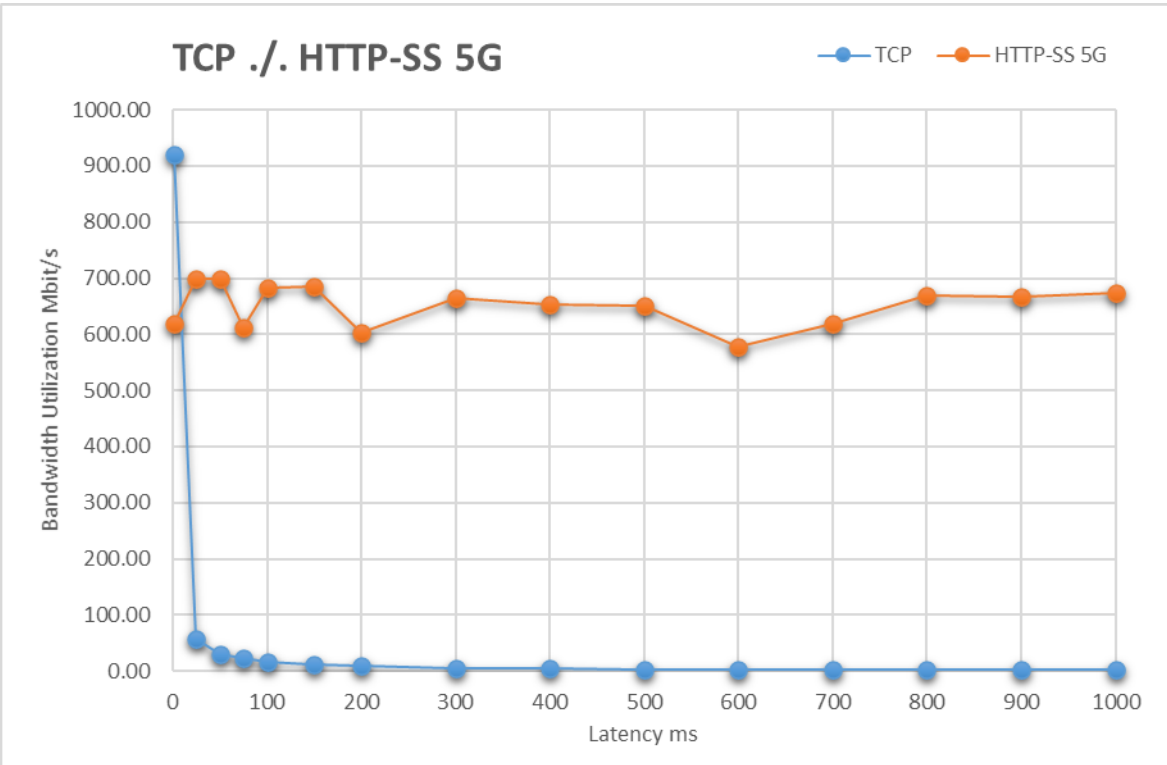
Transparent GEO, MEO, LEO Satellite Network Integration

- No need to change Infrastructure by fully **transparent Network Integration**
- Supports **all common Browsers** and **TCP Application**

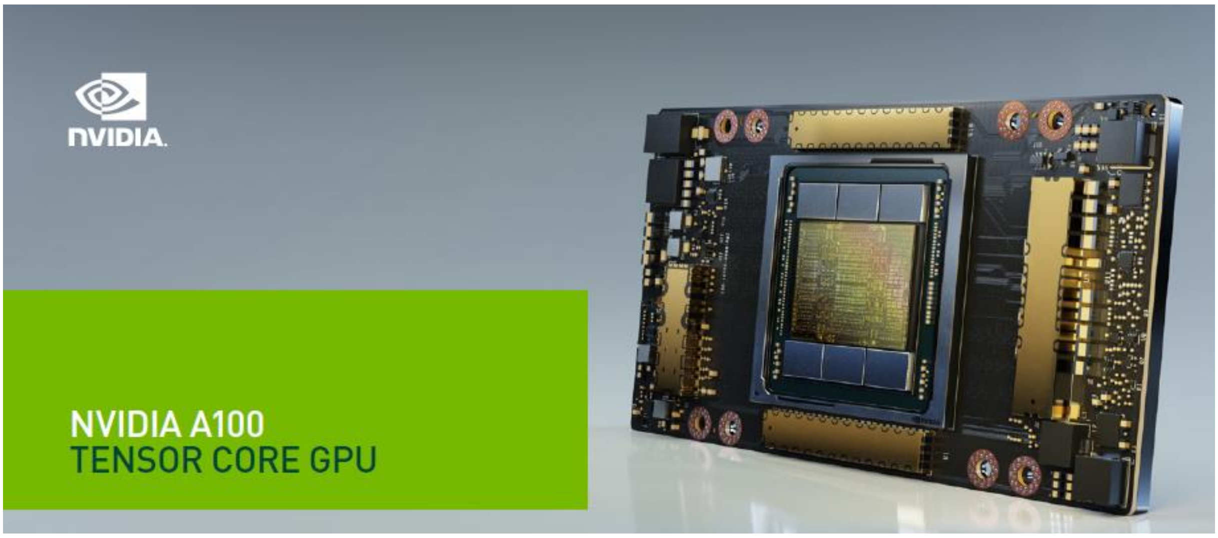


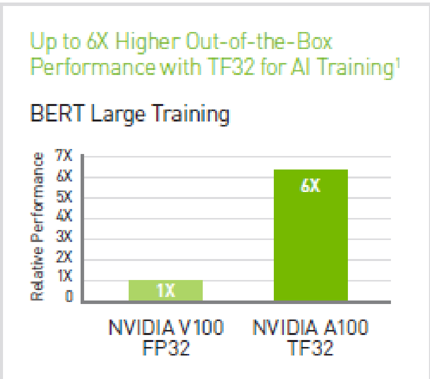
No Latency to Bandwidth Dependency

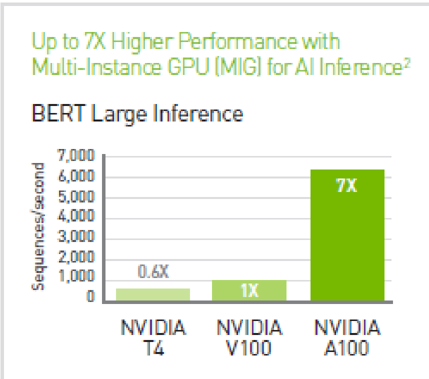
- **No Dependency** between **R**ound **T**rip **T**ime and **TCP Bandwidth**
- **Breakthrough** in higher bandwidths Regions even at very long Round Trips

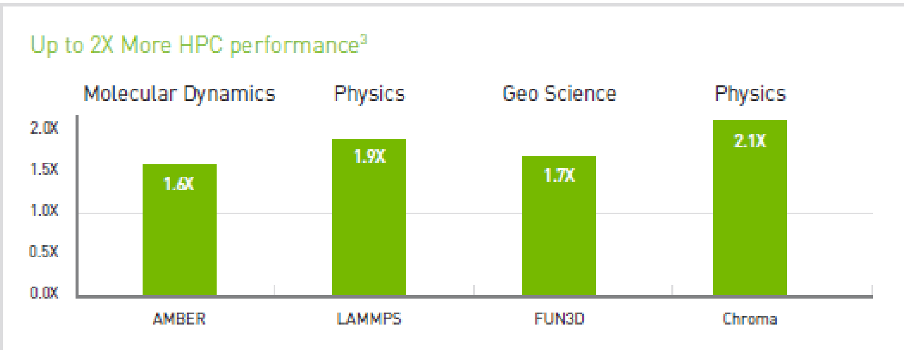


NVIDIA A-100 as HTTP-QuSS Satellite HUB Supercomputer









SYSTEM SPECIFICATIONS (PEAK PERFORMANCE)

	NVIDIA A100 for NVIDIA HGX™	NVIDIA A100 for PCIe
GPU Architecture	NVIDIA Ampere	
Double-Precision Performance	FP64: 9.7 TFLOPS FP64 Tensor Core: 19.5 TFLOPS	
Single-Precision Performance	FP32: 19.5 TFLOPS Tensor Float 32 (TF32): 156 TFLOPS | 312 TFLOPS*	
Half-Precision Performance	312 TFLOPS | 624 TFLOPS*	
Bfloat16	312 TFLOPS | 624 TFLOPS*	
Integer Performance	INT8: 624 TOPS | 1,248 TOPS* INT4: 1,248 TOPS | 2,496 TOPS*	
GPU Memory	40 GB HBM2	
Memory Bandwidth	1.6 TB/sec	
Error-Correcting Code	Yes	
Interconnect Interface	PCIe Gen4: 64 GB/sec Third generation NVIDIA® NVLink®: 600 GB/sec**	PCIe Gen4: 64 GB/sec Third generation NVIDIA® NVLink®: 600 GB/sec**
Form Factor	4/8 SXM GPUs in NVIDIA HGX™ A100	PCIe
Multi-Instance GPU (MIG)	Up to 7 GPU instances	
Max Power Consumption	400 W	250 W
Delivered Performance for Top Apps	100%	90%
Thermal Solution	Passive	
Compute APIs	CUDA®, DirectCompute, OpenCL™, OpenACC®	

* Structural sparsity enabled

** SXM GPUs via HGX A100 server boards; PCIe GPUs via NVLink Bridge for up to 2 GPUs

GROUNDBREAKING INNOVATIONS

NVIDIA AMPERE ARCHITECTURE

A100 accelerates workloads big and small. Whether using MIG to partition an A100 GPU into smaller instances, or NVLink to connect multiple GPUs to accelerate large-scale workloads, A100 can readily handle different-sized acceleration needs, from the smallest job to the biggest multi-node workload. A100's versatility means IT managers can maximize the utility of every GPU in their data center around the clock.

THIRD-GENERATION TENSOR CORES

A100 delivers 312 teraFLOPS (TFLOPS) of deep learning performance. That's 20X Tensor FLOPS for deep learning training and 20X Tensor TOPS for deep learning inference compared to NVIDIA Volta™ GPUs.

NEXT-GENERATION NVLINK

NVIDIA NVLink in A100 delivers 2X higher throughput compared to the previous generation. When combined with NVIDIA NVSwitch™, up to 16 A100 GPUs can be interconnected at up to 600 gigabytes per second (GB/sec) to unleash the highest application performance possible on a single server. NVLink is available in A100 SXM GPUs via HGX A100 server boards and in PCIe GPUs via an NVLink Bridge for up to 2 GPUs.

MULTI-INSTANCE GPU (MIG)

An A100 GPU can be partitioned into as many as seven GPU instances, fully isolated at the hardware level with their own high-bandwidth memory, cache, and compute cores. MIG gives developers access to breakthrough acceleration for all their applications, and IT administrators can offer right-sized GPU acceleration for every job, optimizing utilization and expanding access to every user and application.

HBM2

With 40 gigabytes (GB) of high-bandwidth memory (HBM2), A100 delivers improved raw bandwidth of 1.6TB/sec, as well as higher dynamic random-access memory (DRAM) utilization efficiency at 95 percent. A100 delivers 1.7X higher memory bandwidth over the previous generation.

STRUCTURAL SPARSITY

AI networks are big, having millions to billions of parameters. Not all these parameters are needed for accurate predictions, and some can be converted to zeros to make the models "sparse" without compromising accuracy. Tensor Cores in A100 can provide up to 2X higher performance for sparse models. While the sparsity feature more readily benefits AI inference, it can also improve the performance of model training.

The NVIDIA A100 Tensor Core GPU is the flagship product of the NVIDIA data center platform for deep learning, HPC, and data analytics. The platform accelerates over 700 HPC applications and every major deep learning framework. It's available everywhere, from desktops to servers to cloud services, delivering both dramatic performance gains and cost-saving opportunities.