Real-Time Latency:

Rethinking Remote Networks

TELESAT™

"You can buy your way out of bandwidth problems.

But latency is divine"

Executive summary

▲ **Latency is the time delay over a communications link**, and is primarily determined by the distance data must travel between a user and the server

▲ **Low earth orbits (LEO) are 35 times closer to Earth** than traditional geostationary orbit (GEO) used for satellite communications. Due to the closeness and shorter data paths, LEO-based networks have **latency similar to terrestrial networks**[1]

▲ LEO's low latency enables **fiber quality connectivity**, benefiting users and service providers by

- Loading webpages as fast as Fiber and ~8 times faster than a traditional satellite system

- Simplifying networks by removing need for performance accelerators

- Improving management of secure and encrypted traffic

- Allowing real-time applications from remote areas (e.g., VoIP, telemedicine, remote-control machines)

▲ **Telesat Lightspeed not only offers low latency but also provides**

- High throughput and flexible capacity

- Transformational economics

- Highly resilient and secure global network

- Plug and play, standard-based Ethernet service

30 – 50 milliseconds Round Trip Time (RTT)

Questions answered

▲ What is Latency?

▲ How does it vary for different technologies?

How does lower latency improve **user experience**?

What **business outcomes** can lower latency enable?

Telesat Lightspeed - what is the overall value proposition?

What is latency?

Latency is time delay over a communications link, often measured as round trip time in milliseconds

On the Internet, user devices request data and servers respond to these requests

Latency determines how quickly the user begins to get a response from the server

Latency is determined primarily by the distance these requests and responses must travel, plus any processing time along the way

For high speed Internet services, it is often latency rather than bandwidth that determines the user experience

What is latency?

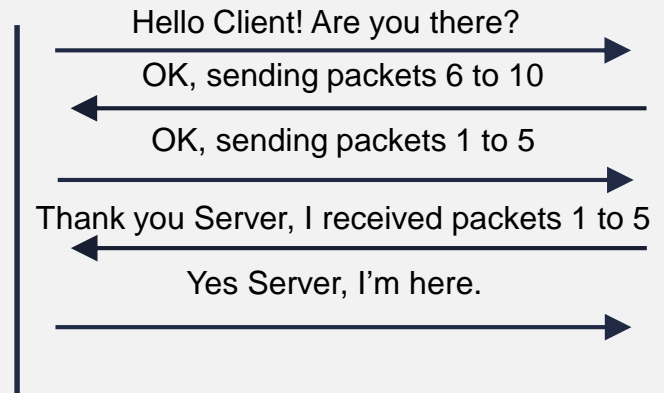## Understanding latency via an airplane analogy

	Goal		**Drivers**		
✈	Maximum **passengers** flown in a month	⟷	**Short route**	*and*	Big plane
Internet	Maximum **data packets** moved in an Internet session[1]	⟷	**Low Latency**	*and*	High bandwidth

Only having high bandwidth (big plane) is not enough, low latency (shortest route) is critical to maximize output

An Internet session has multiple requests and responses, similar to multiple to and fro trips made by a plane over a month; Network latency is dependent on multiple factors beyond length of data transport link (e.g., congestion) but this paper focuses on round-trip length since it is a primary determinant of latency

Why latency matters on the internet

Internet protocols require low latency to run at speed

Hello Client! Are you there?

OK, sending packets 6 to 10

OK, sending packets 1 to 5

Thank you Server, I received packets 1 to 5

Yes Server, I'm here.

Data packets flow quickly when latency is low

SERVER

Send more packets

Wait to receive reply

Send more packets

Insert High Latency

Wait to receive

Reply

Wait to receive

Reply

CLIENT
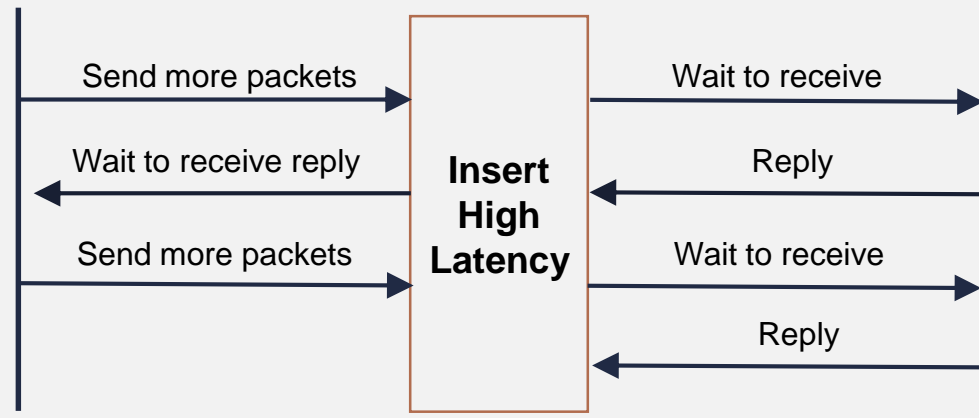
Latency slows the process dramatically regardless of data rate

Satellite latency

The further a satellite is from earth, higher the latency (round trip time)
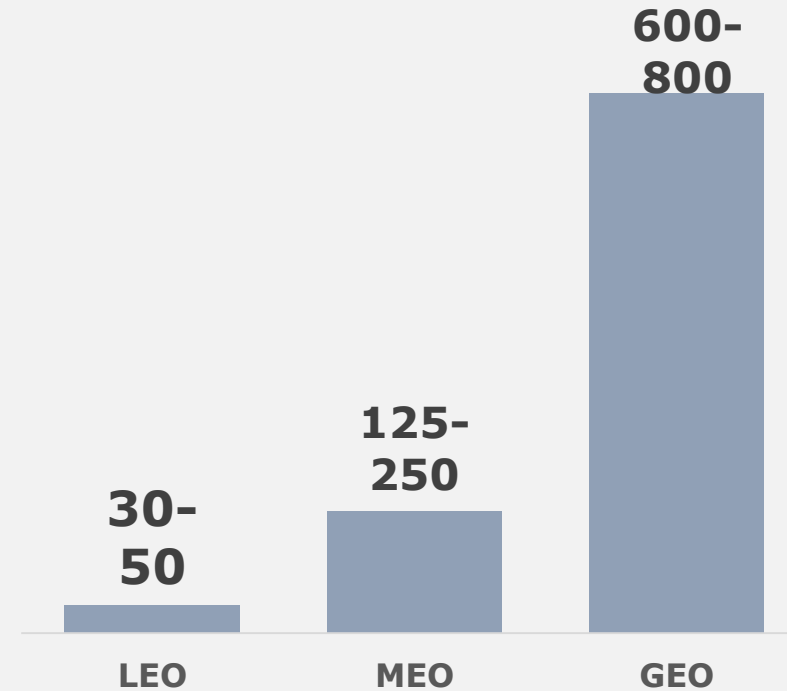
Relative distance of satellites from Earth
1x = 1,000 km

GEO: 35x

MEO: 8x

LEO: 1x
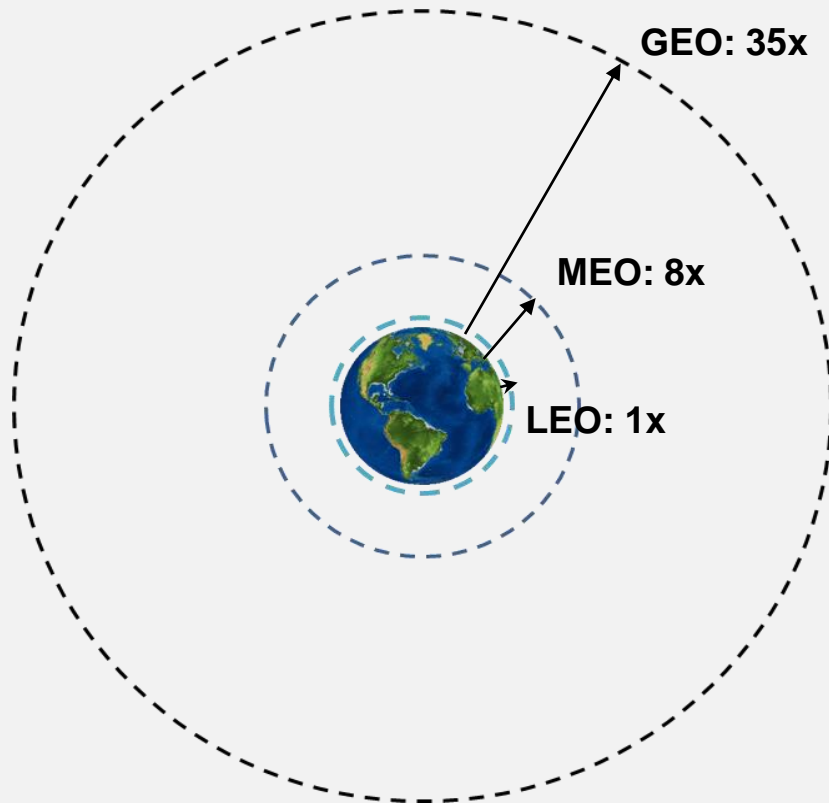
Round Trip Time
Milliseconds

600-800

125-250

30-50

LEO   MEO   GEO

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How does lower latency improve **user experience**?

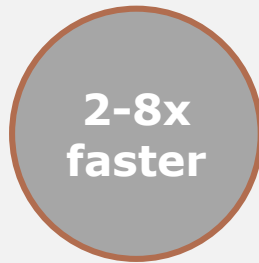What **business outcomes** can lower latency enable?

Telesat Lightspeed - what is the overall value proposition?

Better user experience

LEO's low latency enables a superior Internet experience vs GEO/MEO

Faster web pages

Real-time comms and control

Faster than fiber over long distance

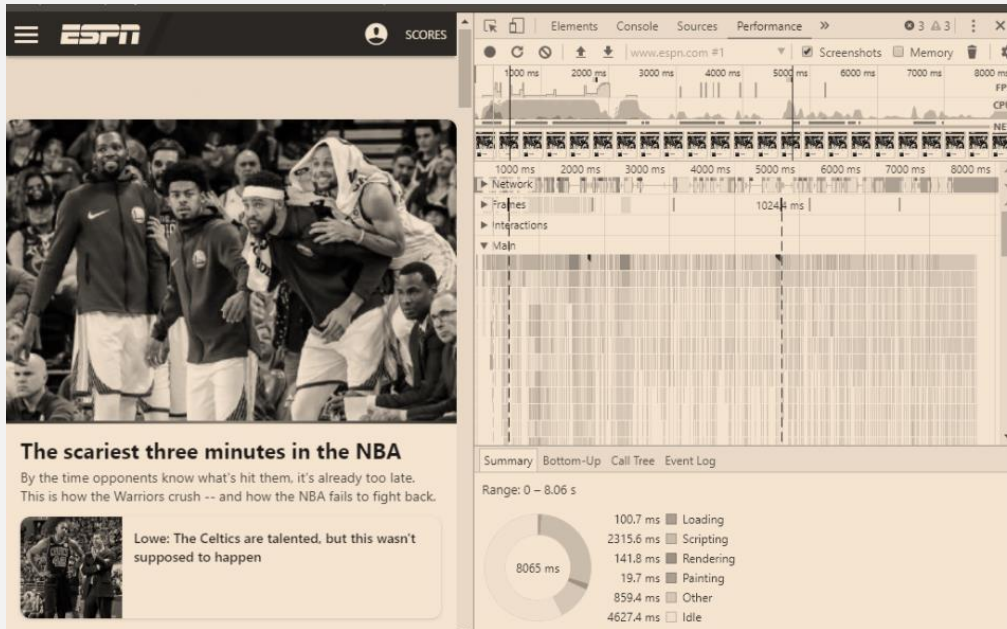*Seamless experience with encrypted traffic*

2-8x faster

Web and digital media

## LEO's low latency enables fiber quality web experience

Faster web pages

Tests conducted in Telesat simulation lab with latency setup based on a Caribbean location to Miami: LEO=28-32 ms, MEO=150 ms, GEO=700 ms (no acceleration)
Each test repeated 5 times to record average results

Relative time to load website
Ratio vs Fiber load time

Telesat Lightspeed loads webpages:
- **Similar to Fiber**
- **2x faster vs MEO**
- **6-8x faster vs GEO**

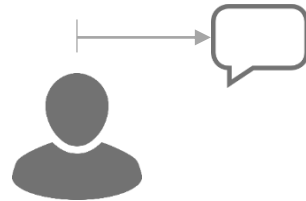| Fiber	LEO	MEO	GEO
1	1.1	2	6-8
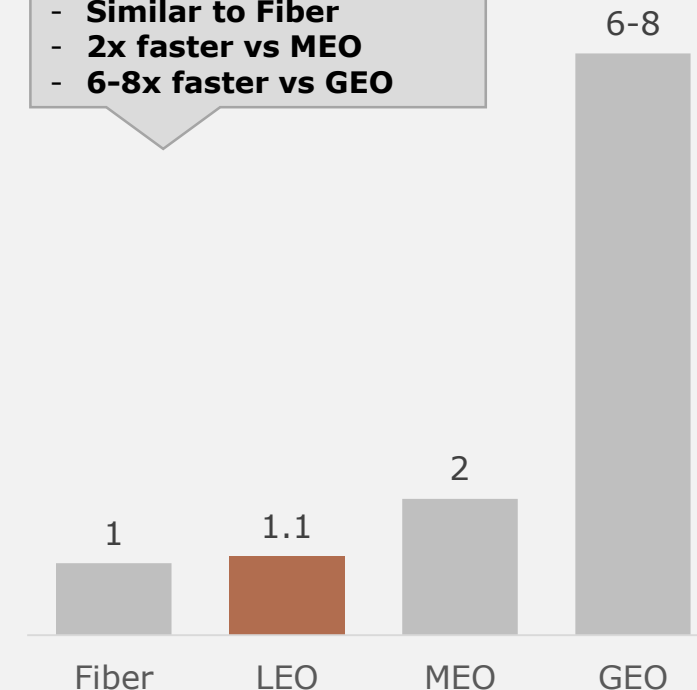
Real-time comms and control

LEO's low latency enables real-time communication and control

Real-time communication

Traditional Satellites

High latency causes **buffering** before making a connection

Video and voice also become **out of sync**

LEO Satellites

Video and voice are **delivered in real-time** in low latency LEO systems
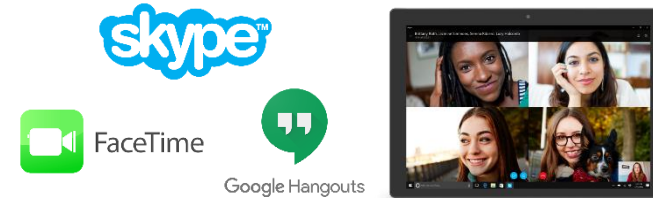
Real-time control

The low latency of the LEO system removes the delay between the sending and receiving of a signal

The LEO system enables real-time control of **latency sensitive applications**

Real-time consumer applications

Video Chat

skype™
FaceTime
Google Hangouts

Interactive Social Media

Periscope

f LIVE
LIVE

Real-time enterprise applications

Video Conferencing

Cisco webex
slack
Skype for Business

Remote control

UAV

Telemedicine

VoIP

LEO latency delivers a good VoIP user experience

Impact of latency on VoIP
MOS[1,2]

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Source: Netbeez
1. MOS = Mean Opinion Score: higher score indicates higher user satisfaction with streaming video start time and quality
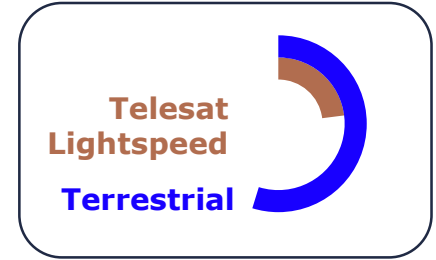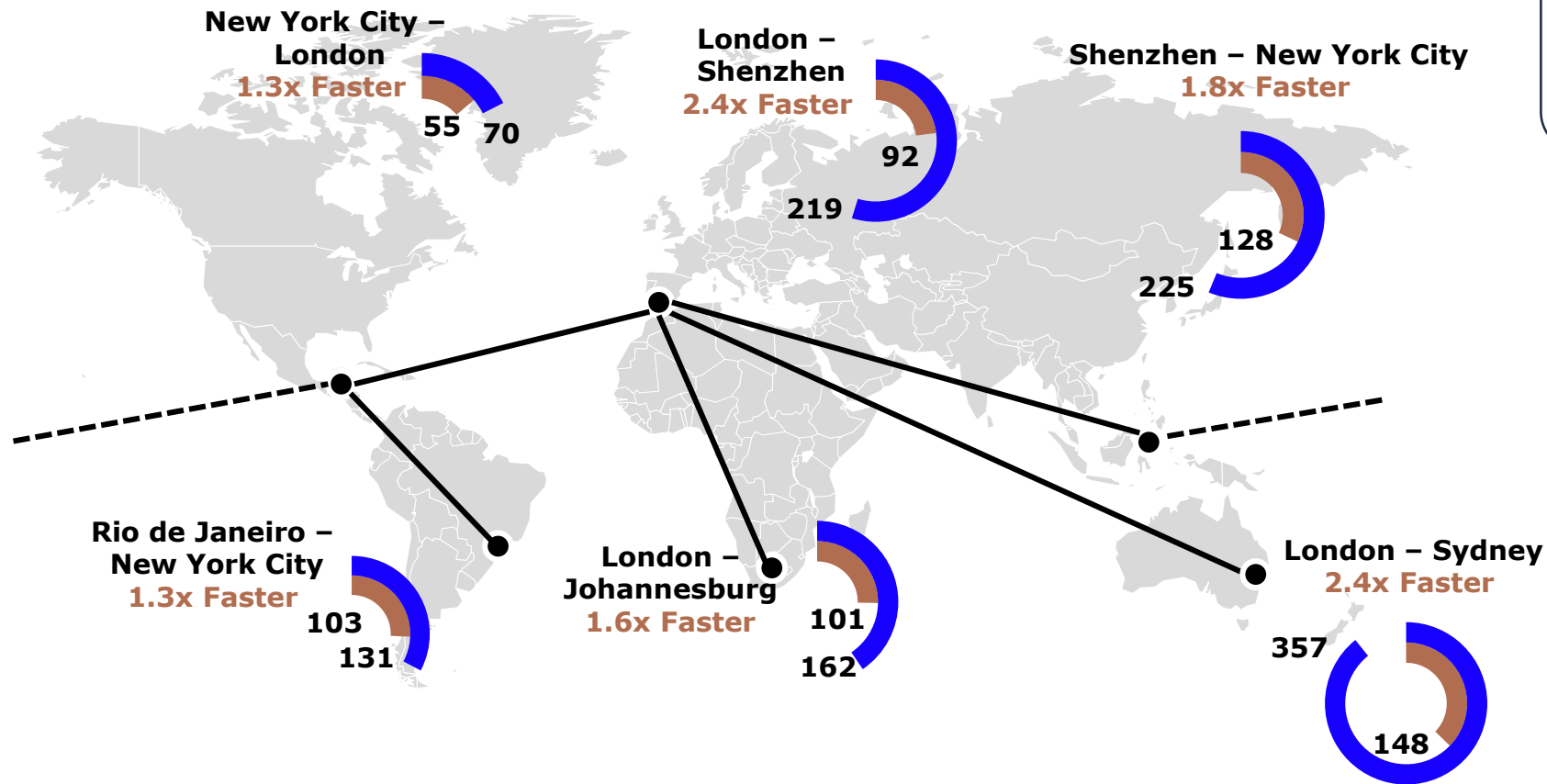2. Packet loss 0%
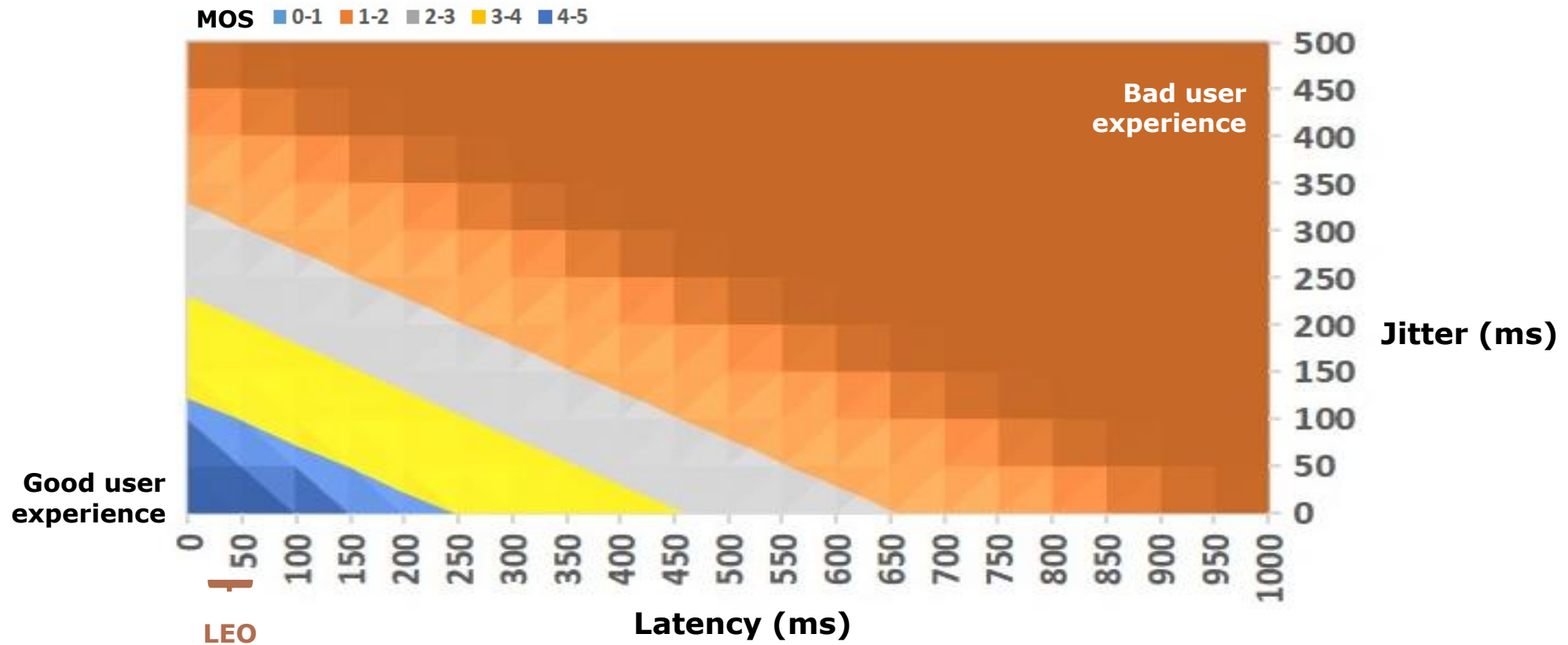
Long distance latency

Leveraging inter-satellite links, Telesat Lightspeed can offer lower latency across long distances vs terrestrial networks

Round Trip Time – Telesat Lightspeed Latency vs Terrestrial Latency
Milliseconds

New York City – London
1.3x Faster
55 70

London – Shenzhen
2.4x Faster
92
219

Shenzhen – New York City
1.8x Faster
128
225

Telesat Lightspeed
Terrestrial

LEO Latency based on Telesat Lightspeed simulations of traffic moving over only inter-satellite links, Telesat Lightspeed latency (round-trip time) is at network layer including processing latency for system and Inter-satellite links Terrestrial data from https://wondernetwork.com/pings

Rio de Janeiro – New York City
1.3x Faster
103
131

London – Johannesburg
1.6x Faster
101
162

London – Sydney
2.4x Faster
357
148

Encrypted Traffic

LEO improves performance of unencrypted as well as encrypted traffic

In 2017 50% of internet traffic was encrypted – by 2019 it will be 75%[1]
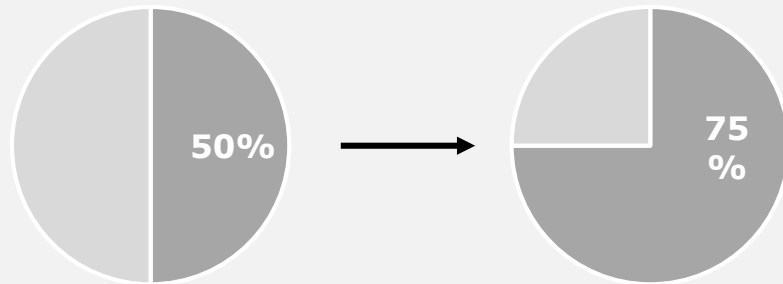
GEO systems use modified Internet protocols to accelerate unencrypted traffic to partially mitigate the impact of high latency

But encrypted traffic cannot be accelerated

As share of encrypted traffic on the Internet grows, benefits of GEO acceleration will decline

50% → 75%

LEO does not need acceleration thereby ensuring high performance even with encrypted traffic

Encrypted traffic

Consumer application traffic is mostly encrypted

90+% of Google traffic is encrypted[1]
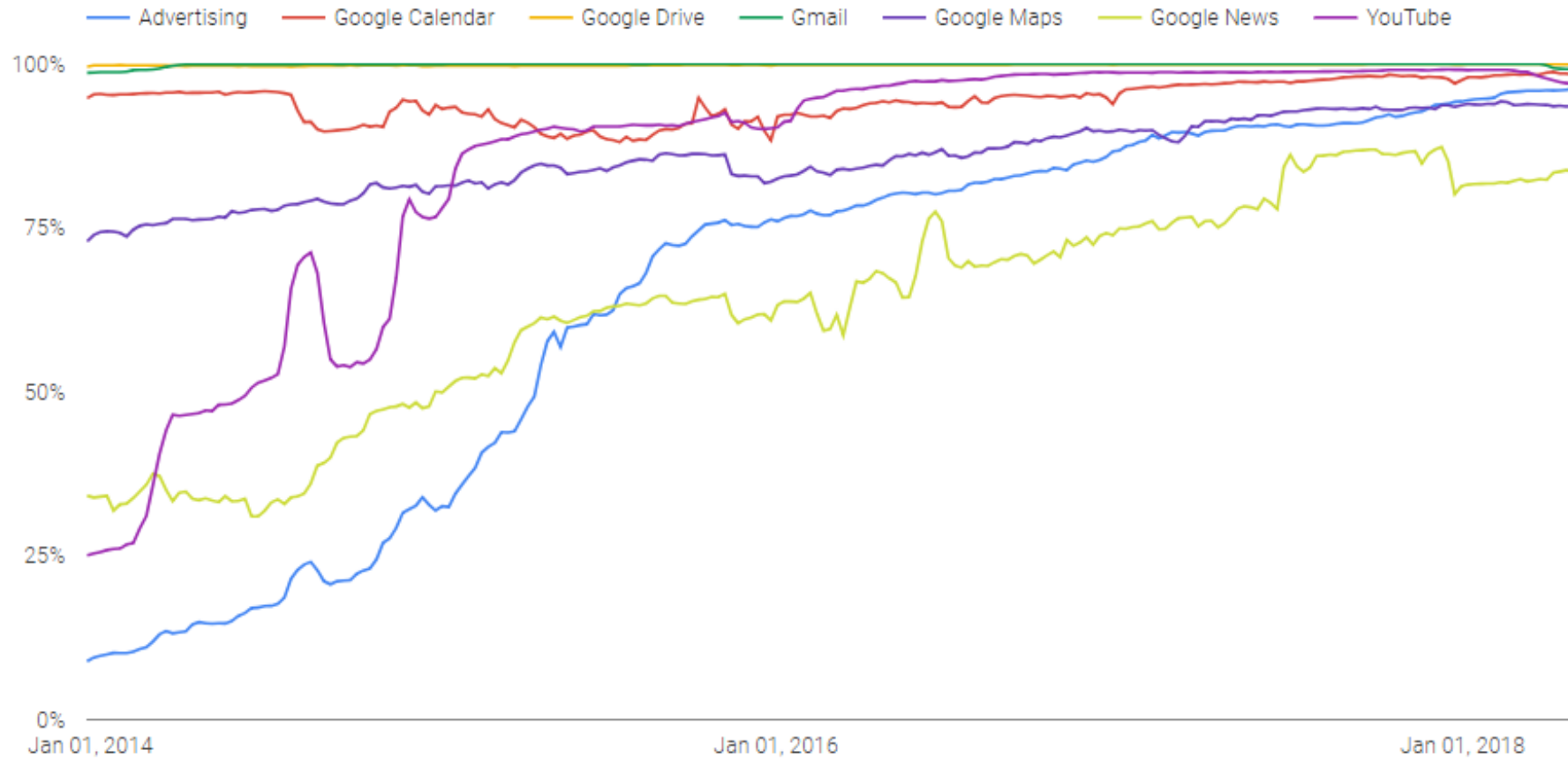
Encrypted traffic

Enterprise application traffic is increasingly being encrypted

Percentage of Application WAN traffic, 2015 vs. 2016[1]
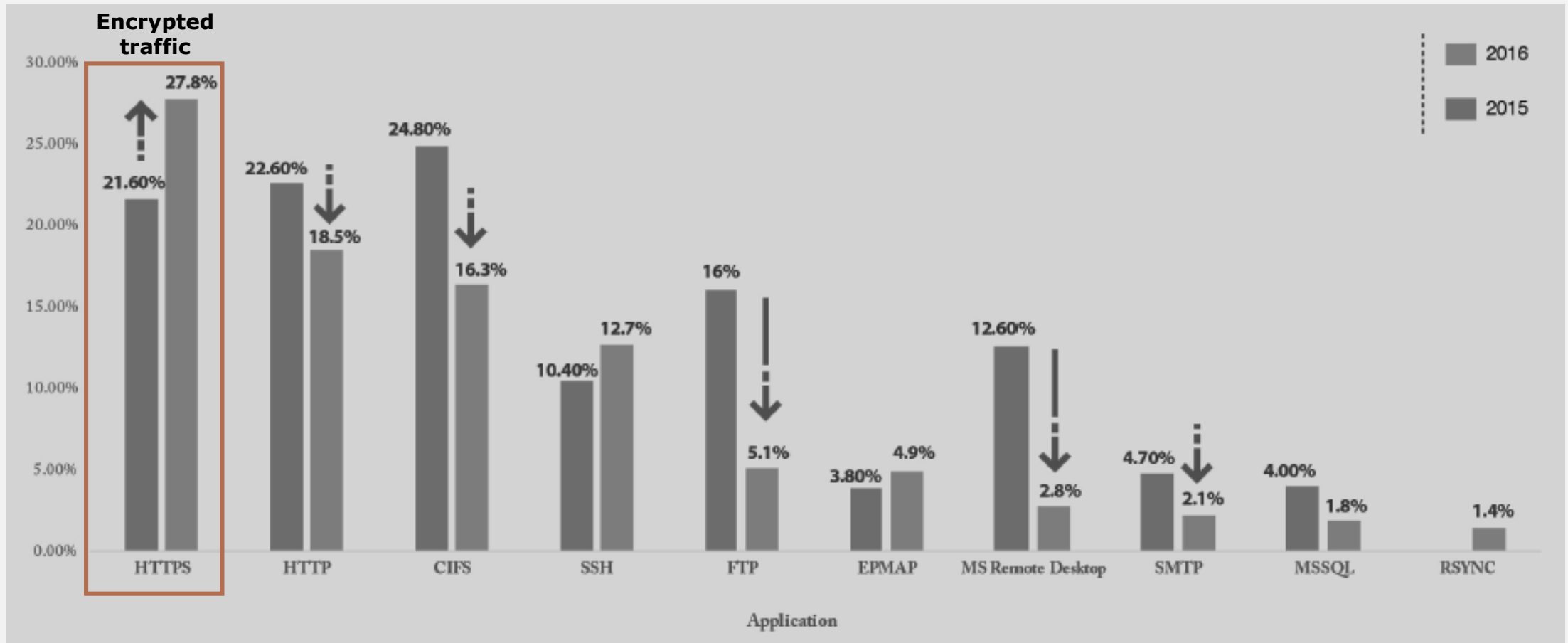
1. Aryaka – "State of the WAN" - percentage

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Telesat Lightspeed - what is the overall value proposition?

Business benefits of LEO's low latency

Higher user satisfaction; improved efficiencies via real-time control

CELLULAR BACKHAUL

Lower churn and simplified network with no requirement for GEO accelerators

AVIATION

Terrestrial-like in-flight passenger connectivity and real-time applications for crew

MARINE

Responsive passenger Internet and better real-time vessel optimization (fuel savings)

REMOTE COMMUNITIES

Effective e-learning and telemedicine, urban broadband experience in remote and rural areas

GOVERNMENT

Highly responsive airborne ISR and better video/VoIP chats of personnel with family

ENERGY

Real-time management of production; improved crew welfare with responsive Internet

Cellular Backhaul - benefits of LEO latency

Increased end-user satisfaction and improved operational efficiency

End User

- No lag video chat, instant use of social media
- Improved user experience

Network

- Simplified network with no requirement for performance accelerators
- Fully compatible with true end-to-end encryption. No need for split encryption tunnels

User Satisfaction

Increased Revenues

Improved Efficiency & decreased costs

Aviation - benefits of LEO latency

Browse the web at 35,000 feet like both feet are on the ground

Passenger

- No lag video chat and quickly load webpages
- Improves customer loyalty and bookings

Crew

- Real-time weather and navigation for pilots
- Enables use of satellite for operational communications

Aircraft

- Real-time engine monitoring and preparation for maintenance issues
- Lowers maintenance costs and increases aircraft uptime

👍 User Satisfaction

$ Increased Revenues

📈 Improved Efficiency & decreased costs

Remote Communities - benefits of LEO latency

Enabling broadband experience in rural and remote communities

Home / Business

- Compelling Internet experience to consumers and small businesses

Hospital

- Real-time telemedicine and imaging
- Improved patient experience, reduced wait times and lower medical costs

Schools

- Remote teachers, quick loading web content for in-class applications
- Reduced digital divide from urban schools

User Satisfaction   Increased Revenues   Improved Efficiency & decreased costs

Marine - benefits of LEO latency

At-home like connectivity for passengers; improved ship-shore collaboration

Passenger

- No lag video chat and quickly load webpages
- Quickly upload photos and video to social media
- Improves customer loyalty and bookings

Crew

- Real-time weather and navigation for crew
- VoIP and other latency sensitive communications

Ship

- Real-time engine monitoring and reaction to maintenance issues
- Fuel optimization
- Reduces maintenance costs and improves operational efficiency

User Satisfaction

Increased Revenues

Improved Efficiency & decreased costs

Government - benefits of LEO latency

Highly responsive airborne ISR applications

Unmanned Platforms

- Accurate control and navigation
- Real time remote control for immediate response to steer, shoot, avoid collision, etc.

Morale, Welfare & Recreation

- Quickly load webpages
- VoIP applications without lag
- Improved personnel morale

User Satisfaction   Increased Revenues   Improved Efficiency & decreased costs

Energy - benefits of LEO latency

Transforming remote operations with real-time applications

Operational Systems

- Real-time data between automated platforms and on shore control centers
- Automation of platforms increasing safety and reducing labor costs
- Improved production

Crew

- Communications with family on shore
- Remote learning
- Better crew satisfaction and retention

User Satisfaction

Increased Revenues

Improved Efficiency & decreased costs

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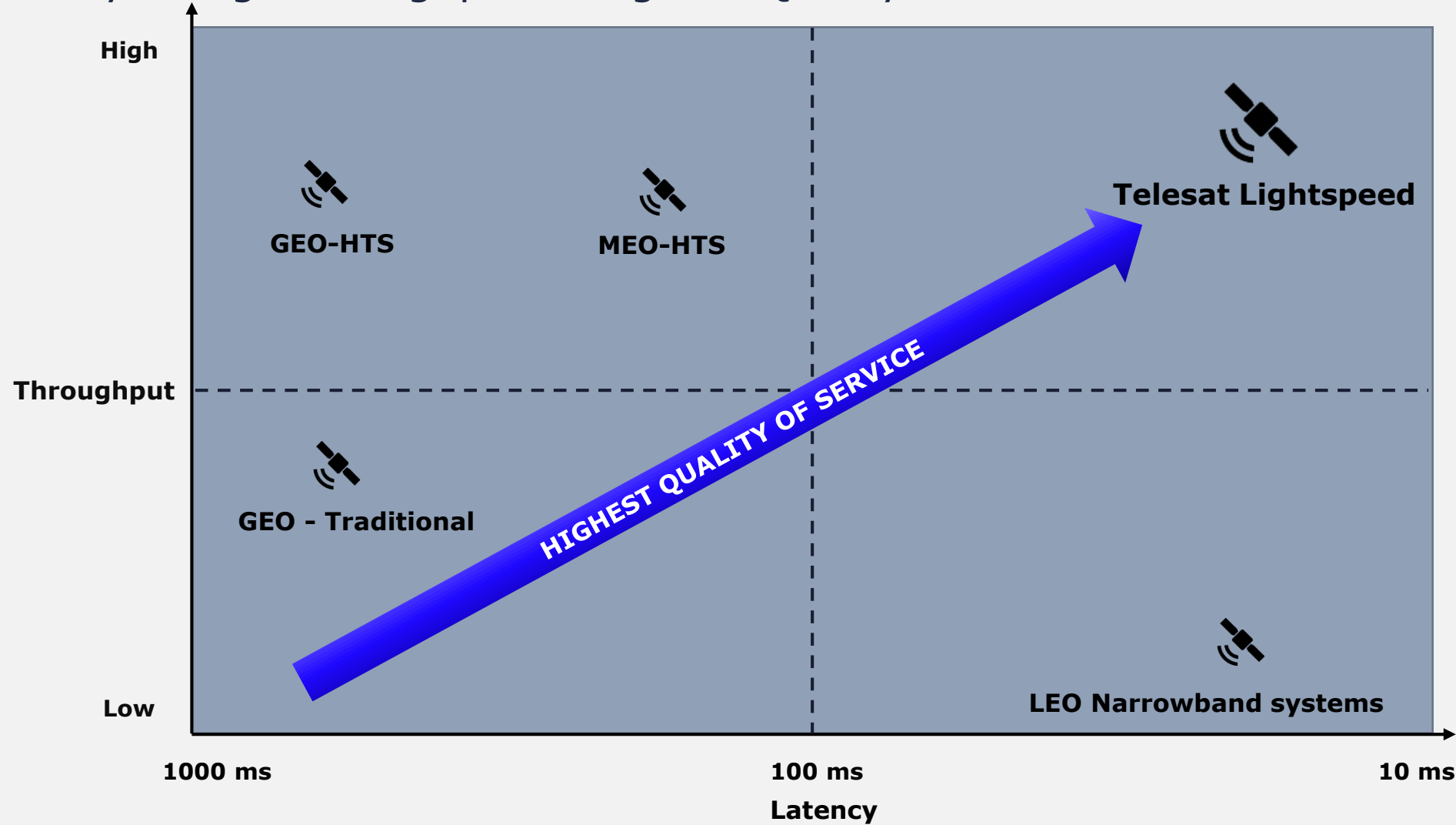What **business outcomes** can lower latency enable?

Telesat Lightspeed - what is the overall value proposition?

Telesat Lightspeed: more than low latency

High Throughput
Gbps links, Tbps sellable capacity

Low Cost
Transformational economics

Global
'Anywhere, Anytime'

Plug & Play
Quick service deployments

Low Latency
sub-50 msec RTT (space only)
sub-100 msec RTT (space & ground)

Flexible & Focused Capacity
100s of Gbps in concentrated area

Unmatched Resilience
Unmatched Resilience, Interference resistance, Inter satellite links

Telesat Lightspeed

Low latency + High throughput = Highest Quality of Service

GEO = Geostationary orbit; MEO = Medium Earth Orbit, HTS = High Throughput Satellite, LEO = Low Earth Orbit

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