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TCP Optimization

Network Optimization Use Case

Taking Control of TCP

August 2018 (Updated)

TCP Optimization

Use Case Overview

- Network speeds are increasing but that does not result in desired QoE for the network users due to TCP protocol challenges
- TCP performance on today's mobile and fixed networks is sub-optimal costing network operators a huge sums of business due to inefficient use of expensive resources (for e.g. RAN and Spectrum in mobile networks), growing capacity challenges, and poor subscriber experience
- Managing video streams, heavy users and bandwidth-intensive background applications tackle congestion only
- Subscribers increasing reliance on digital devices mandates that critical applications of transactional nature use reliable data transports like TCP
- Optimizing transport layer (TCP) introduces an entirely new and independent class of network optimization that can complement other congestion mitigation techniques
- TCP uses flow and congestion control that is most suitable for fixed networks as flow and congestion issues are more predictable
- Sandvine's solution for TCP Optimization 'takes control' of TCP connection in the network and makes TCP 'access-aware', optimizing it for the unique characteristics of a mobile operator's mobile network

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TCP Protocol in Internet Network

TCP is the engine of the Internet

85-90% of fixed and 96% of mobile Internet traffic is TCP

TCP behaves very poorly on mobile, satellite and WAN networks where higher latencies and lost packets are normal

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TCP Protocol Challenges

- TCP, being endpoints protocol, makes no assumptions about underlying network and remains conservative to overcome uncertainty
- No guarantee that different TCP endpoint devices use same algorithms and TCP options for congestion control
- TCP congestion control mechanism lack direct knowledge of the underlying network and call model characteristics of the network
- Lacking end-to-end control and visibility, inflight data rates fluctuates on both sides of the BDP*
- TCP's behavior to "starve" and "overwhelms" the network resources has major negative impact on subscribers QoE

*__Bandwidth Delay Product__ (BDP) is the mathematical product of instantaneously available bandwidth and latency

TCP is built in 1974

Overreact to packet drops

Don't act on flows in aggregate

Designed for fixed access networks

Left on its own, TCP stops network from reaching its potential

TCP may be fast when bandwidth is scarce

When bandwidth is available, TCP is not fast enough

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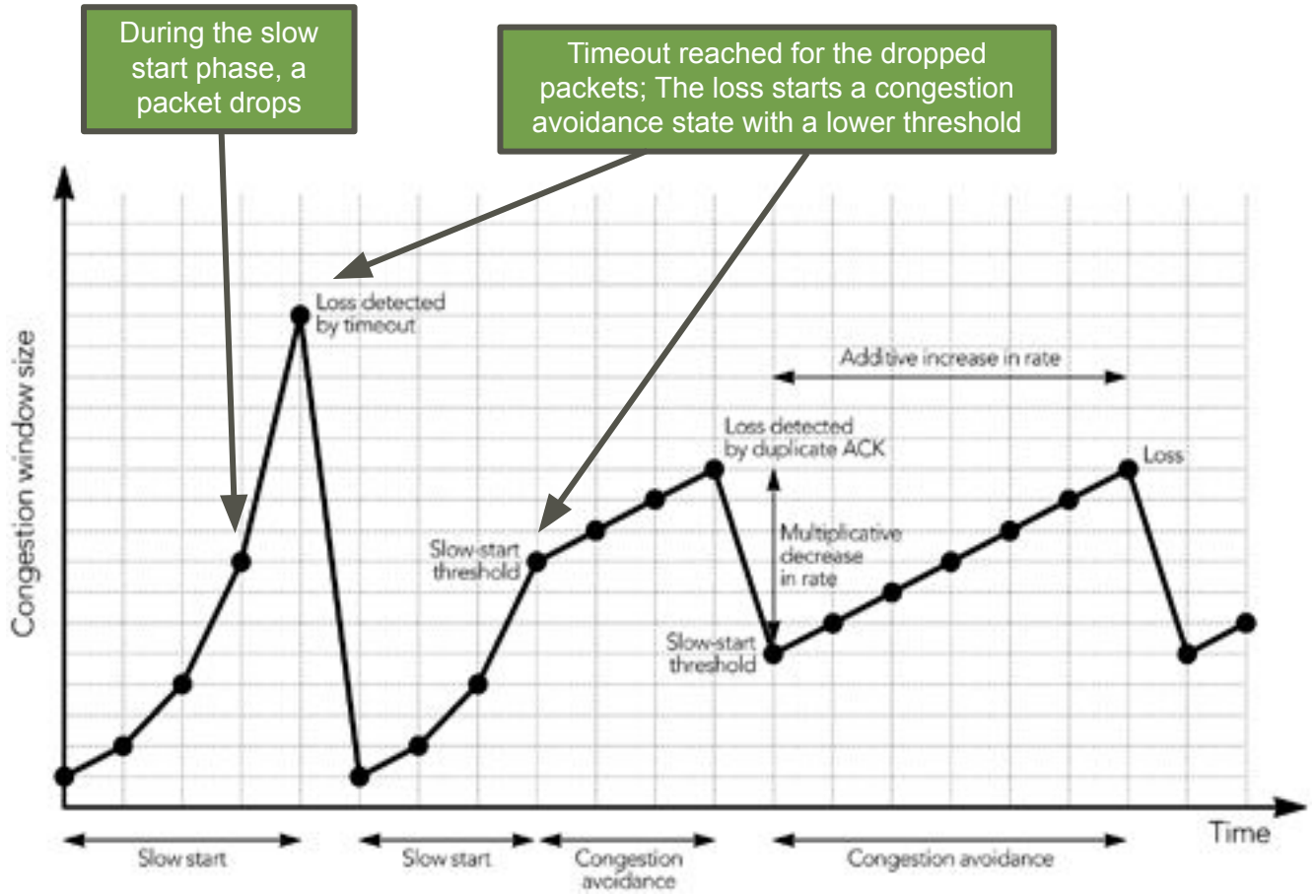
TCP Protocol Challenges – Slow Start at Work



A few dropped packets (for e.g. from interference in a wireless network) cause TCP to be much slower than the network performance demands can justify. The network can accommodate much more aggressive 'ramp-up', but TCP is too conservative to use the available capacity.

Misinterpreting network conditions make TCP itself a bottleneck for performance and efficiency.

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Problems with ’Transparent’ Proxy Solution

There is no ’Transparent’ Proxy Solution for TCP Acceleration

PROXY ISSUES	DESCRIPTION
Detected as man-in-the-middle	Proxies break the original TCP connection to control the traffic flow
Flows with no payload	Proxies see the SYN packet but nothing else. Around 30% of TCP flows have no data
TCP options mismatch	Data transfers can’t reach maximum performance because proxy guesses / chooses TCP options
Packet Fragmentation	Improperly set ‘don’t fragment’ flag in the setup. Firewalls drop fragmented packets
Multipath TCP	Proxies break multipath TCP

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Sandvine Solution – Value Proposition

Unique Approach
Creates a TCP “midpoint” which takes control of the TCP connection while remain end-to-end transparent

Designed for Today’s Networks
Account for all TCP connections as a collective whole while taking all TCP flows for an individual user for actions. Manages ”starving” and “bufferbloats” efficiently

Improved Subscriber QoE
Faster data transmissions and increased application performance

Increased Network Performance
Higher ratio of goodput to throughput, better resource utilization, reduced retransmissions, extended investments lifetime

Increase Revenue Opportunities
Faster and more reliable connections allow subscribers to do more data usage

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Better Congestion Control

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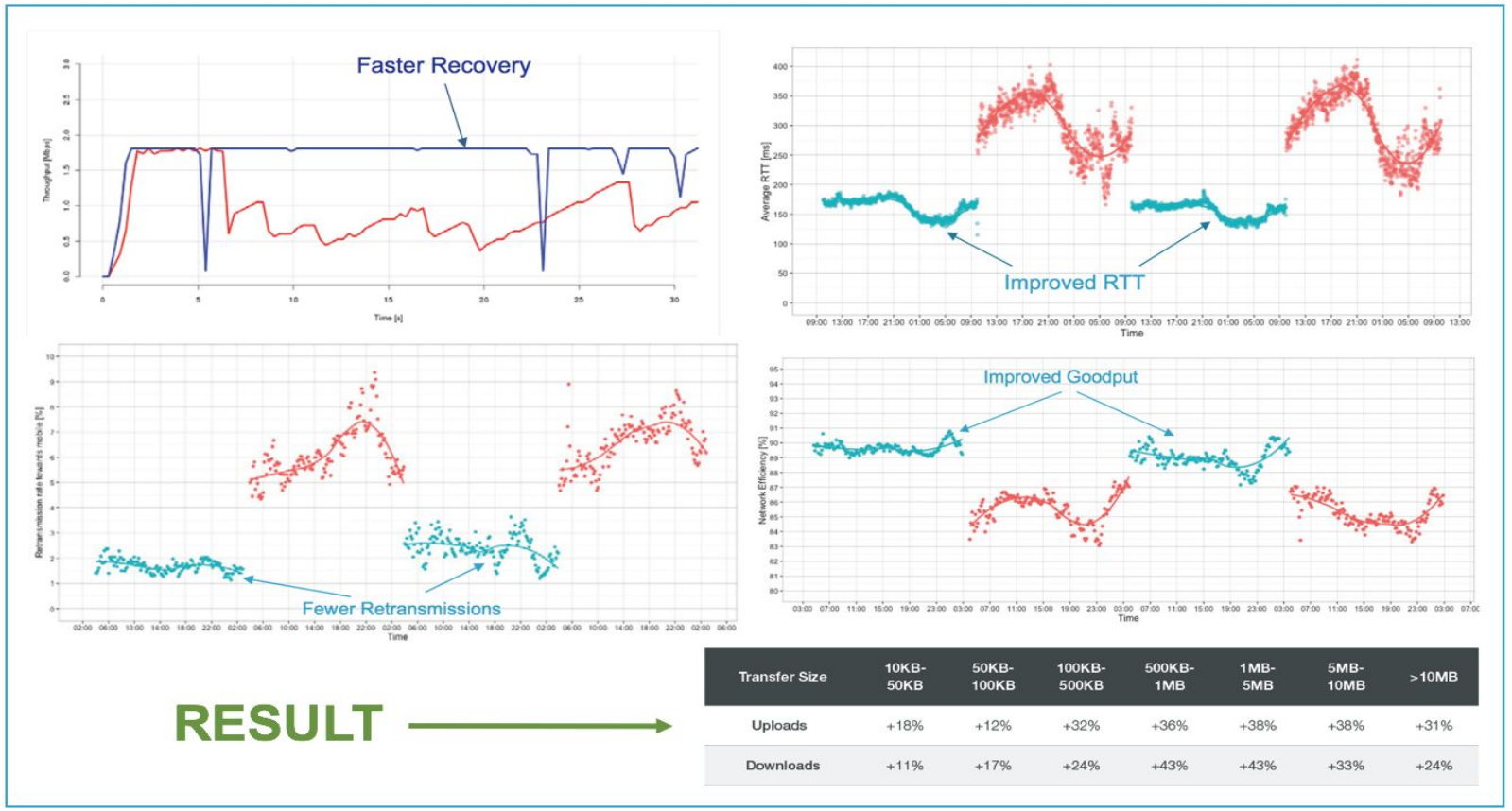
Sandvine Solution – Improvements

- ✔ Faster recovery from errors
- ✔ Faster and consistent RTT
- ✔ Consistently low retransmissions
- ✔ Higher and improved Goodput



Transfer Size	10KB-50KB	50KB-100KB	100KB-500KB	500KB-1MB	1MB-5MB	5MB-10MB	>10MB
Uploads	+18%	+12%	+32%	+36%	+38%	+38%	+31%
Downloads	+11%	+17%	+24%	+43%	+43%	+33%	+24%

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Sandvine Solution – Business Case / ROI

Capacity Expansion

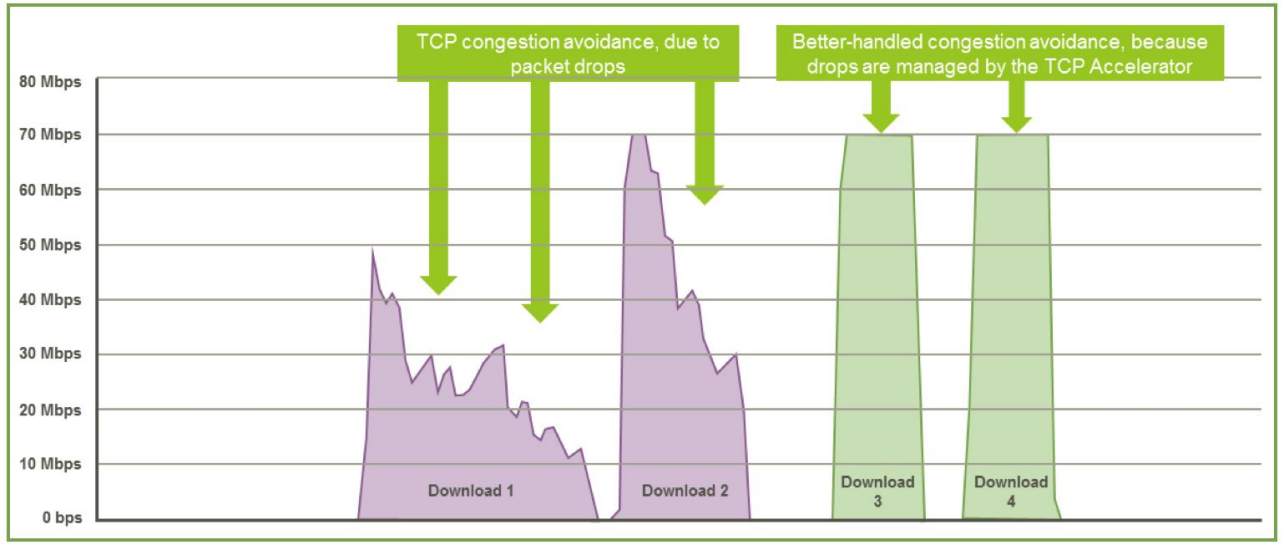
Maintain good latency at 95% utilization of the network – “hotter” utilization of investment by supporting more subscribers

Savings on Interconnect Fee

Fewer retransmissions allow savings on interconnect fee. Retransmissions can be reduced from 7-9% to 1-2%

Revenue Increase

Improving average RTT directly impact subscriber QoE resulting in more usage, satisfied customers and increased revenue



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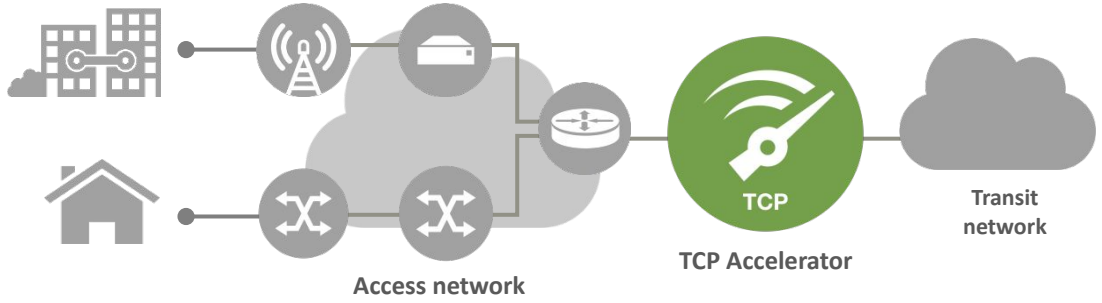
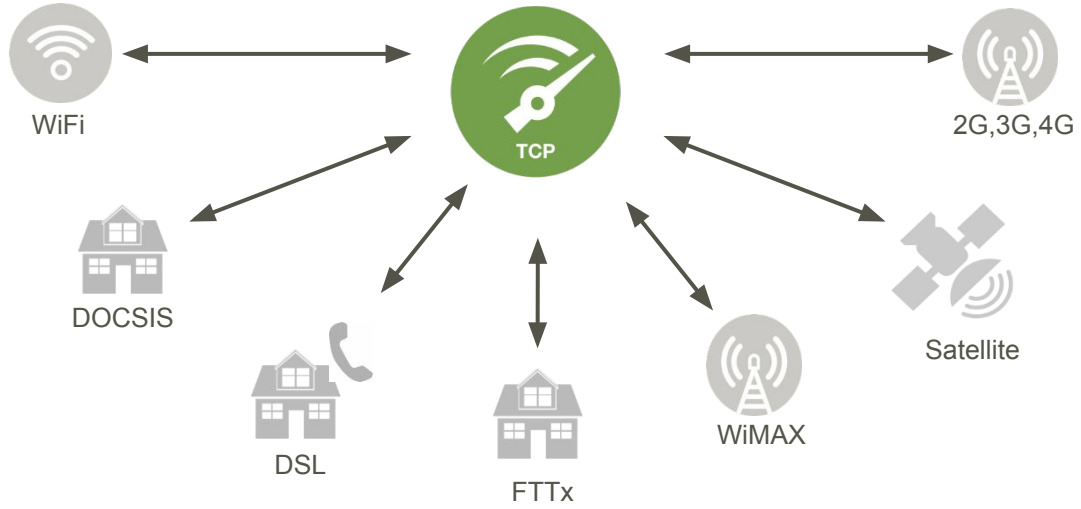
Use Case - Deployments

Typical TCP Accelerator Deployment



TCP Accelerator Solution is Access-Agnostic



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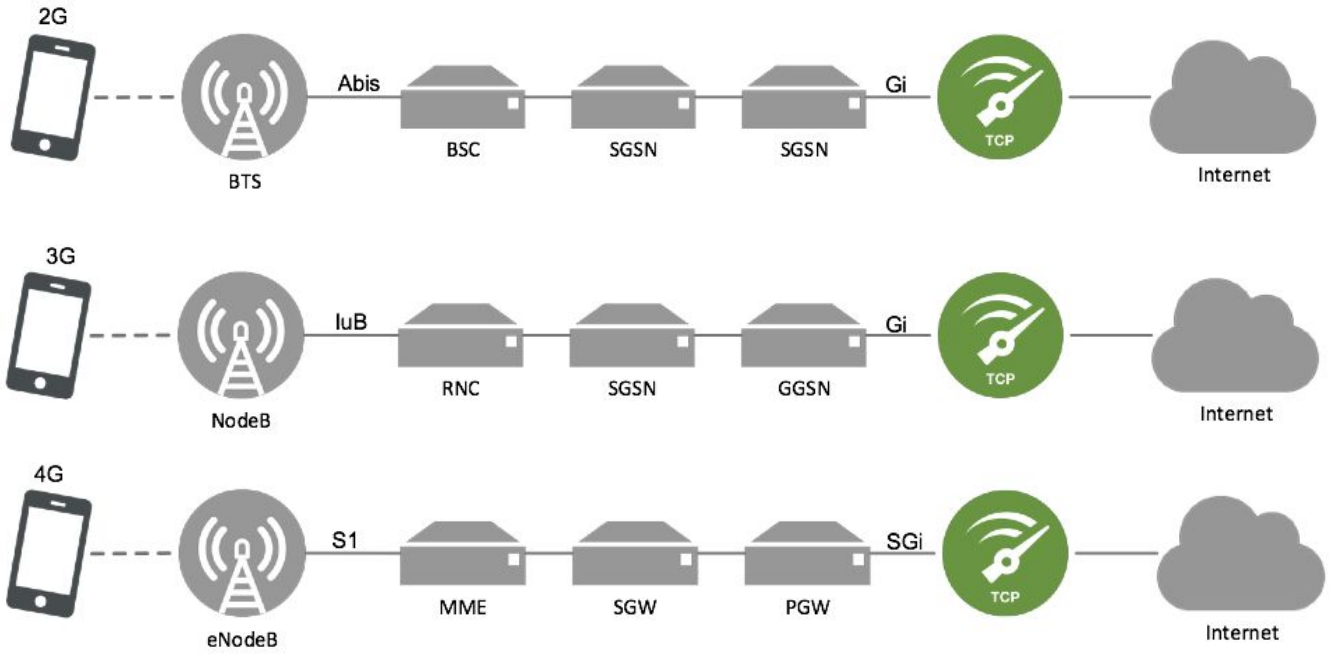
Use Case - Deployments

Mobile Access Technologies



DSL Access Technology

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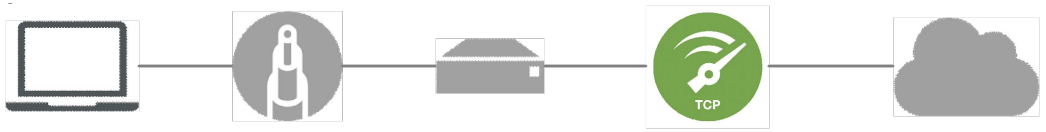
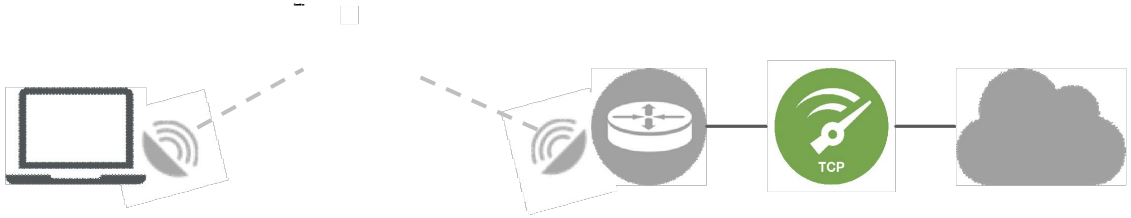
Use Case - Deployments

Cable Access Technology



WiMAX Access Technology

Satellite Access Technology



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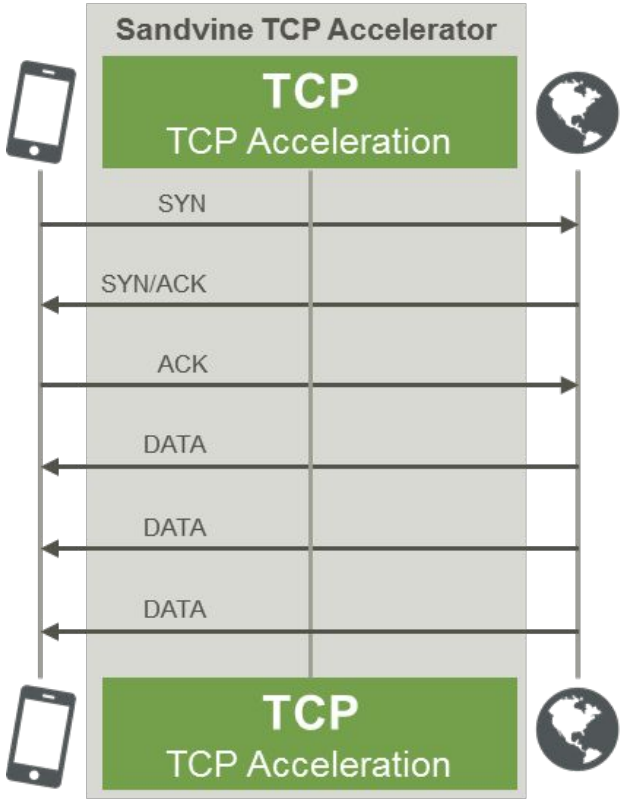
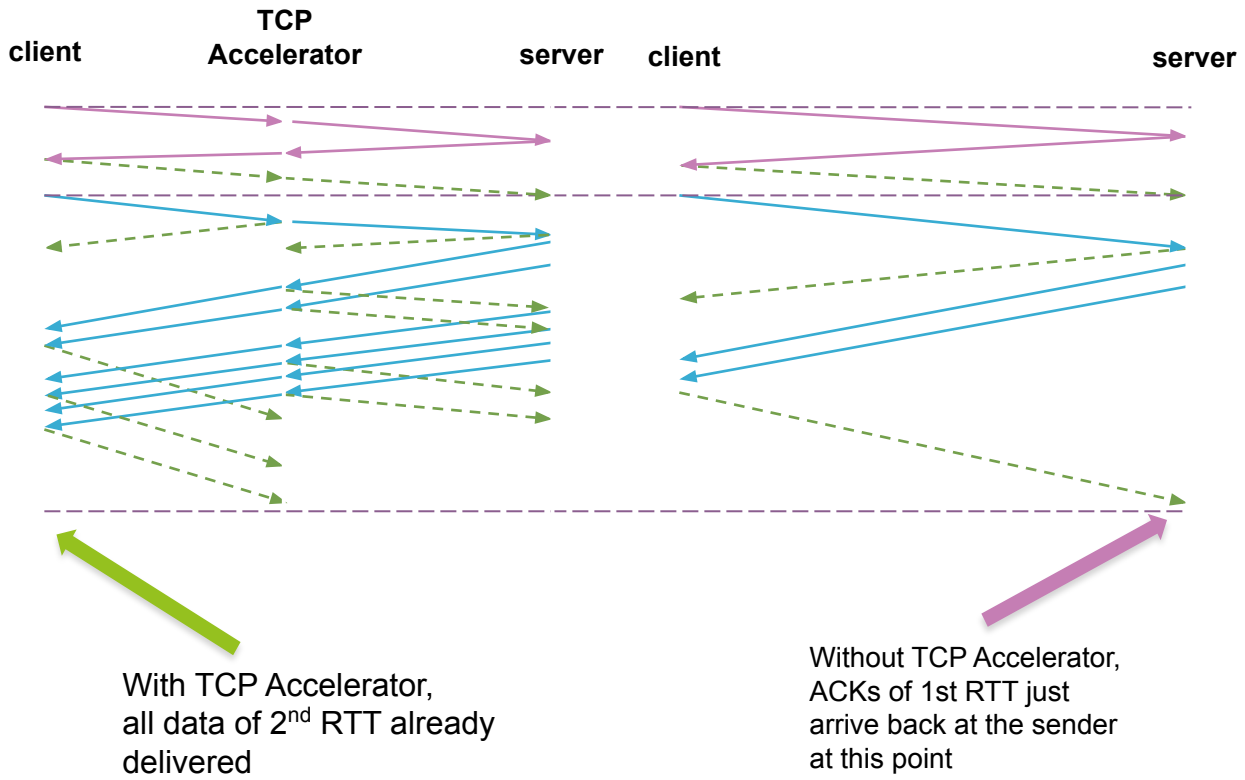
Use Case – Call Flows





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Sandvine Solution – Product Features

Transparency	Behaves as a bridge and doesn't terminate the TCP connection, so the acceleration is completely transparent to the endpoints
Powerful TCP Acceleration Techniques	Applies a variety of acceleration techniques: two-sided acceleration, reduced packet loss during TCP slow-start, congestion control, fast retransmit, and improved retransmission handling
TCP Buffer Management	Manages buffer queues by adjusting the sending rate to correspond to the level of buffered data in the access network
Egress Burst Control	Prevents buffer overflow during bursty transfers
Supported Traffic	Acceleration can be applied to all types of traffic including uploads, downloads, application that uses TCP (encrypted and HTTP2 also); Directional support for configuration variables
Multiple Operational Modes	Three operating modes (Shunt, Accelerate, Bypass) to simplify testing and upgrades, and to ensure traffic flow
Multiple Acceleration Profiles	Distinct acceleration profiles (consisting of tuning parameters) can be created and applied to specific traffic
Carrier-Grade Performance	TCP Accelerator scales to support the world's largest networks, so CSP can enjoy the benefits of TCP acceleration at every scale
Fairness	Prevents latency-insensitive application from being favored over latency-sensitive ones; treats all traffic fairly producing a positive impact on subscriber quality of experience
Audit Records and Historical Reporting	TCP performance measurements and statistics are logged and can be used for audit purposes or examined for business and operational intelligence

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Field References

Accelerated

Not Accelerated

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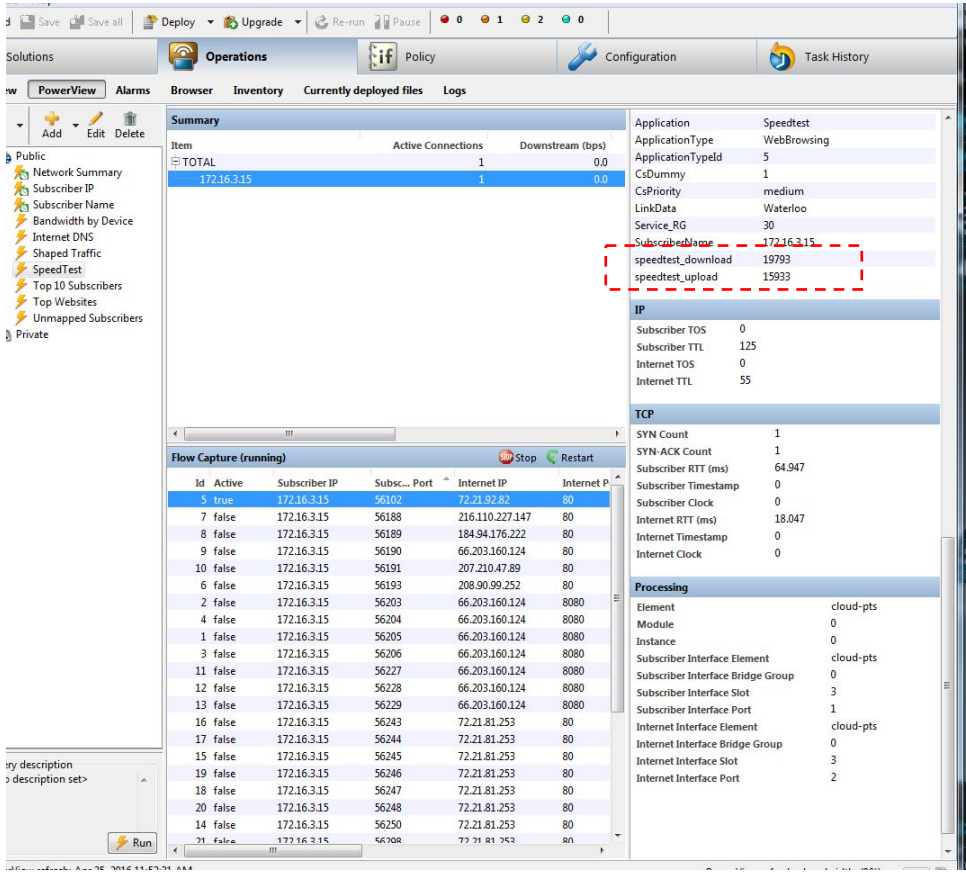
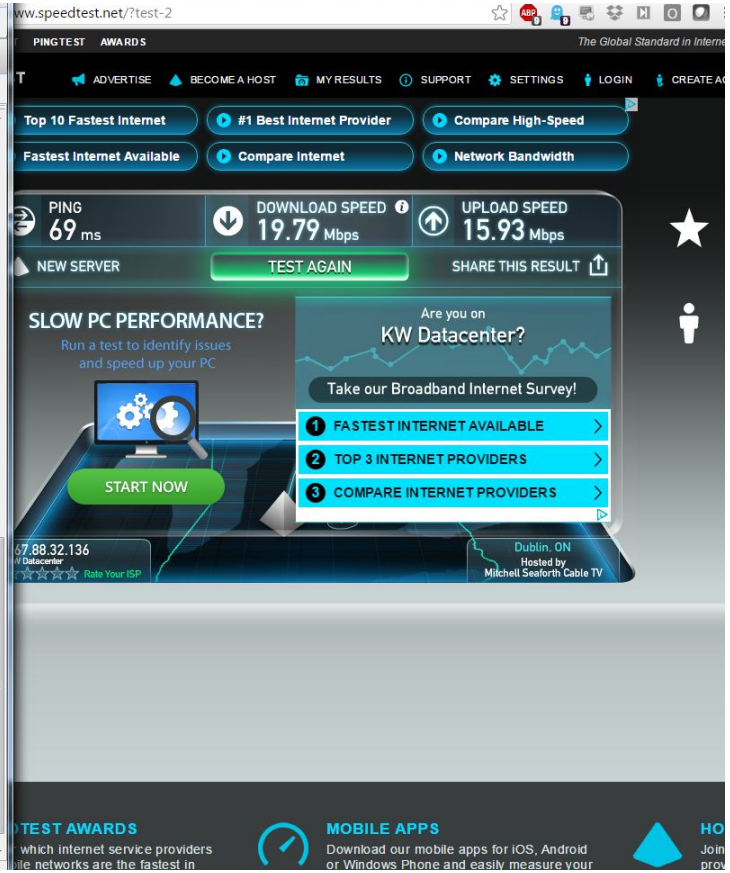
Field References

Comparing Speedtest with Sandvine Control Center results





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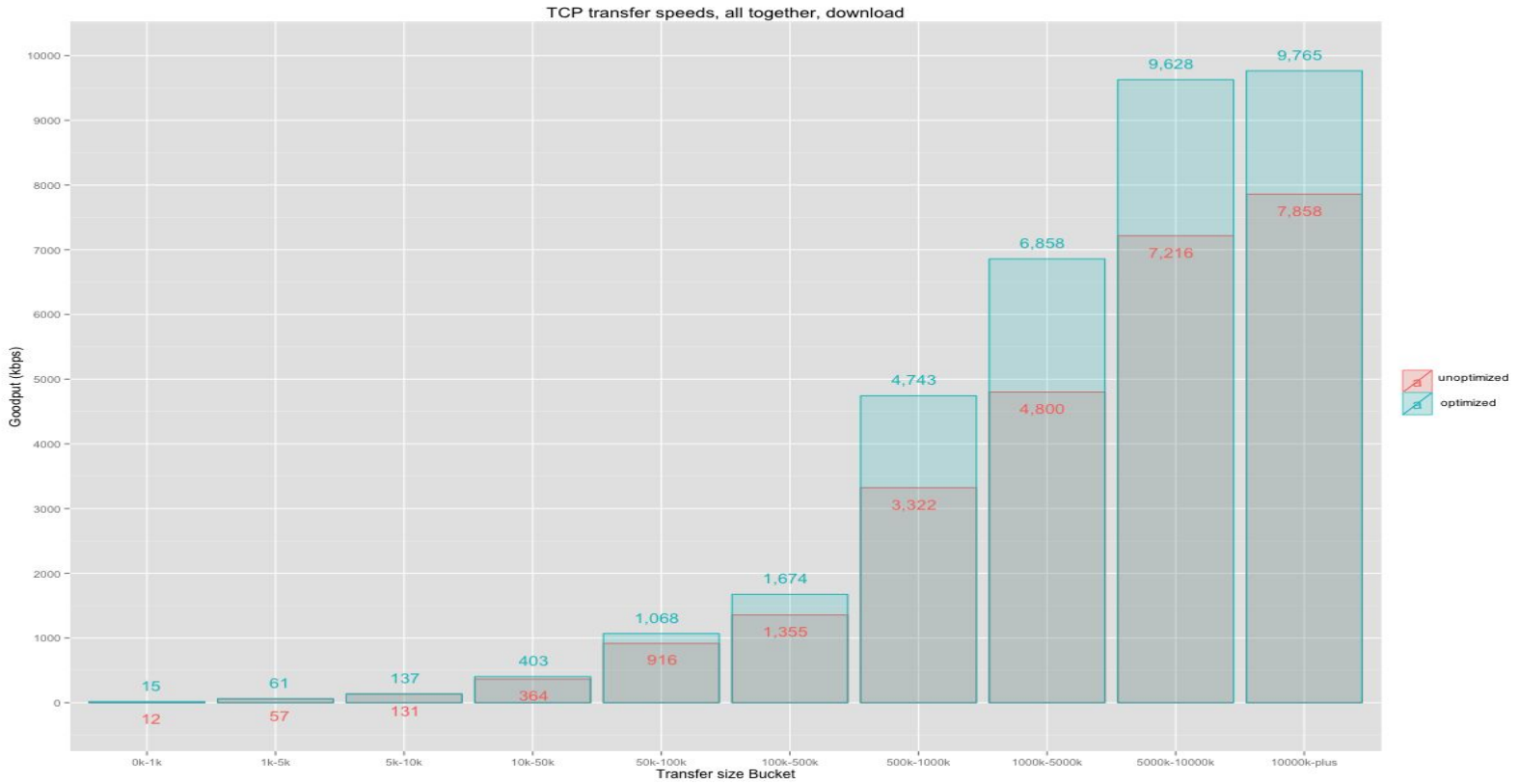
Field References

Improvement in goodput after applying TCP-A in a 3G/4G network in each transfer size bucket



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Recent tests conducted at a North American Operator shows significant improvement in subscriber throughput in different network conditions

Test Scenario: Speedtest
- Speedtest Android App
- North American Closest Speedtest Server
- 10x iterations of each test

Item	Avg Down (Mbps)	Avg Up (Mbps)	Peak Down	Peak Up
Baseline	36.57	8.87	47.6	9.9
Accelerated	49.73	11.46	62.6	13.8
Gain	+35.7%	+29.2%	+31.5%	+39.1%

Test Scenario: Download Impairment
- HTML5 Speedtest Web Page
- Server located in Amazon East Zone (Ohio)
- Impairment: 10-30 msec latency, 0.3% packet loss introduced

Item	Avg Down (Mbps)	Peak Down (Mbps)
Baseline	13.87	15.8
Accelerated	24.62	27.7
Gain	+77.5%	+75.3%

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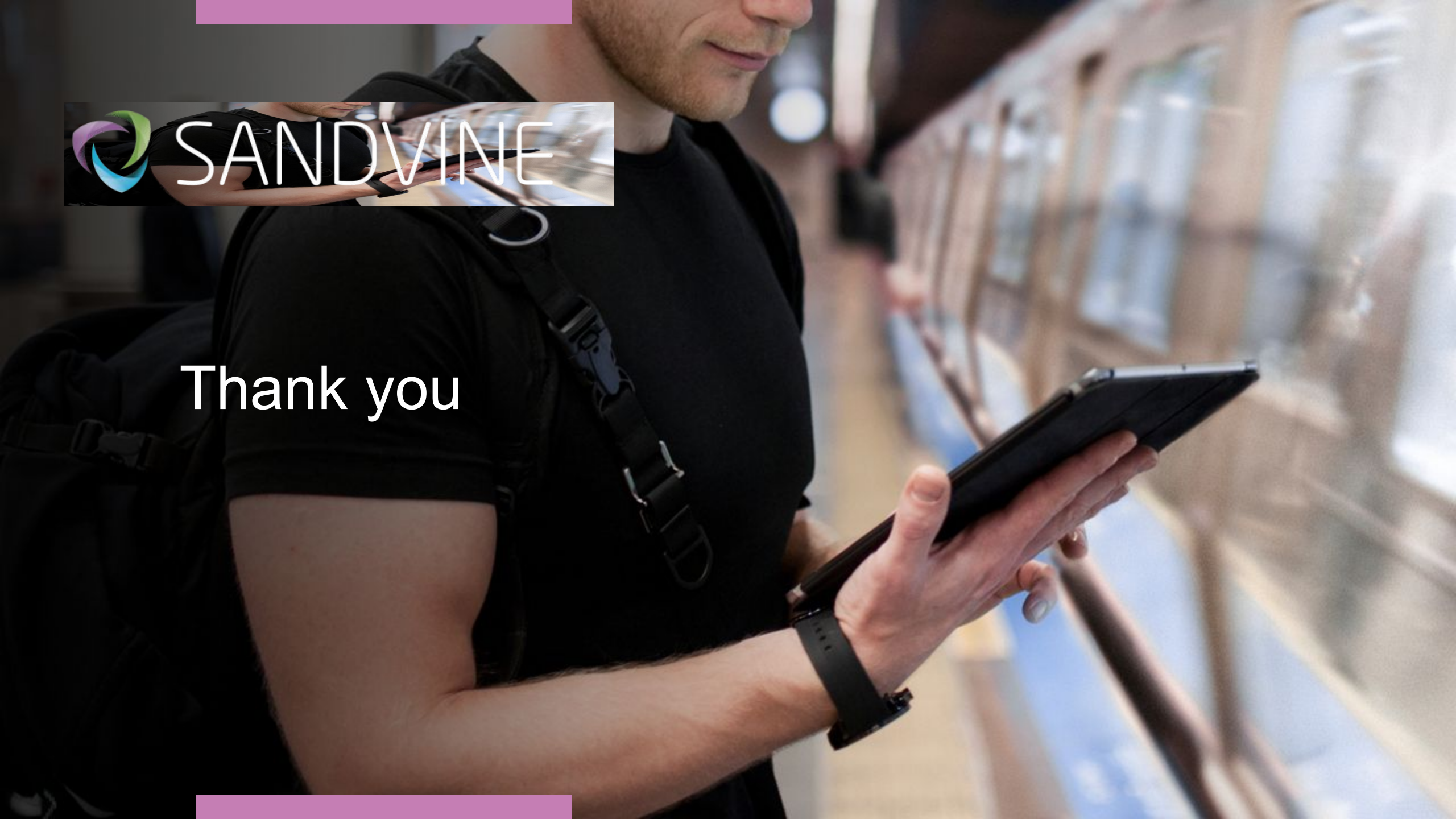

Thank you