



# TCP Optimization Network Optimization Use Case Taking Control of TCP

August 2018 (Updated)

# TCP Optimization

## Use Case Overview

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- 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
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# TCP Optimization

## TCP Protocol in Internet Network

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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

# TCP Optimization

## 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 maximum amount of data that can be simultaneously 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

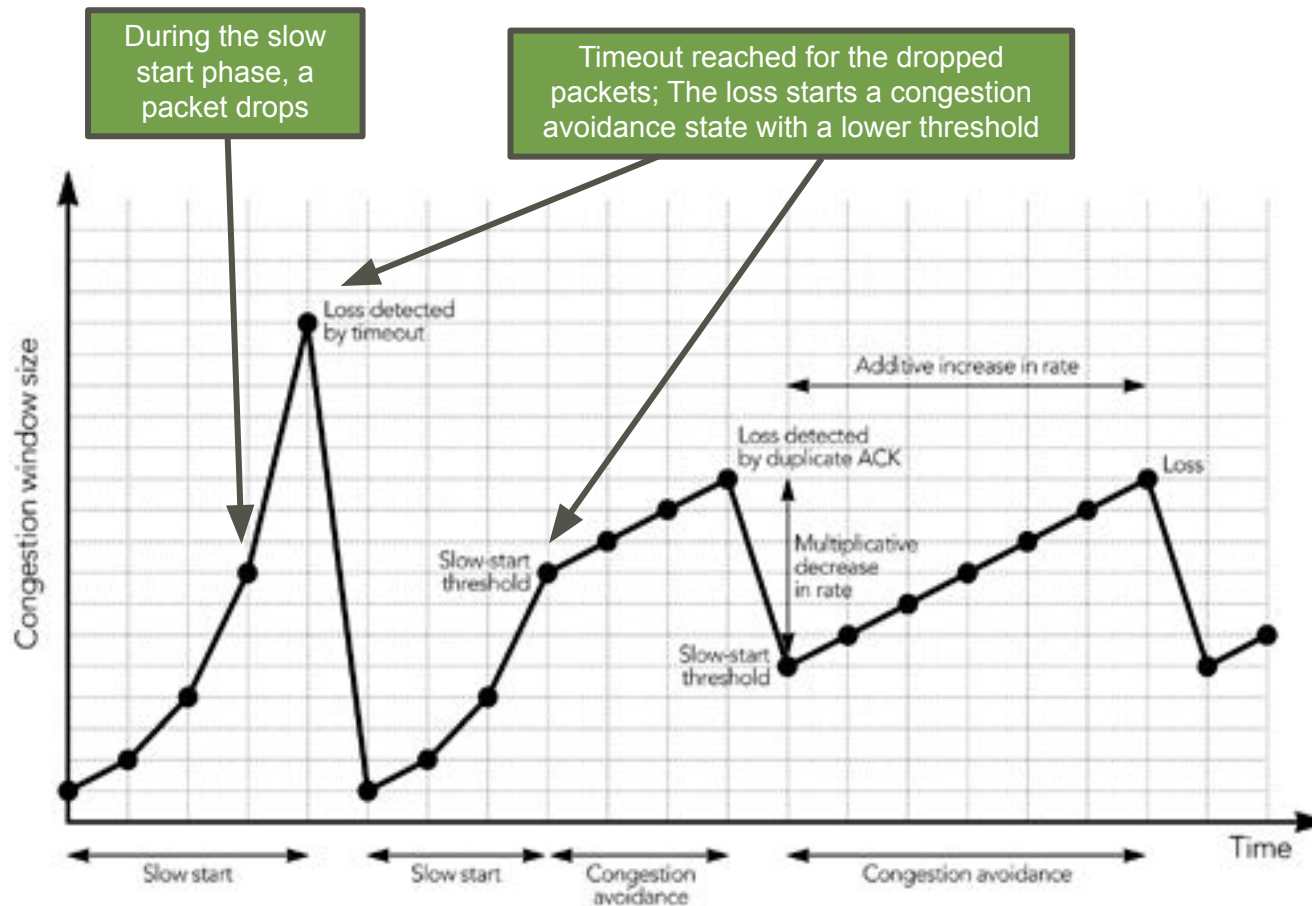
Left on its own, TCP stops network from reaching its potential

TCP may be fast when bandwidth is scarce

When bandwidth is available, TCP is not fast enough

# TCP Optimization

## 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.

# TCP Optimization

## Problems with 'Transparent' Proxy Solution

There is no 'Transparent' Proxy Solution for TCP Acceleration

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



# TCP Optimization

## Sandvine Solution – Value Proposition

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### 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

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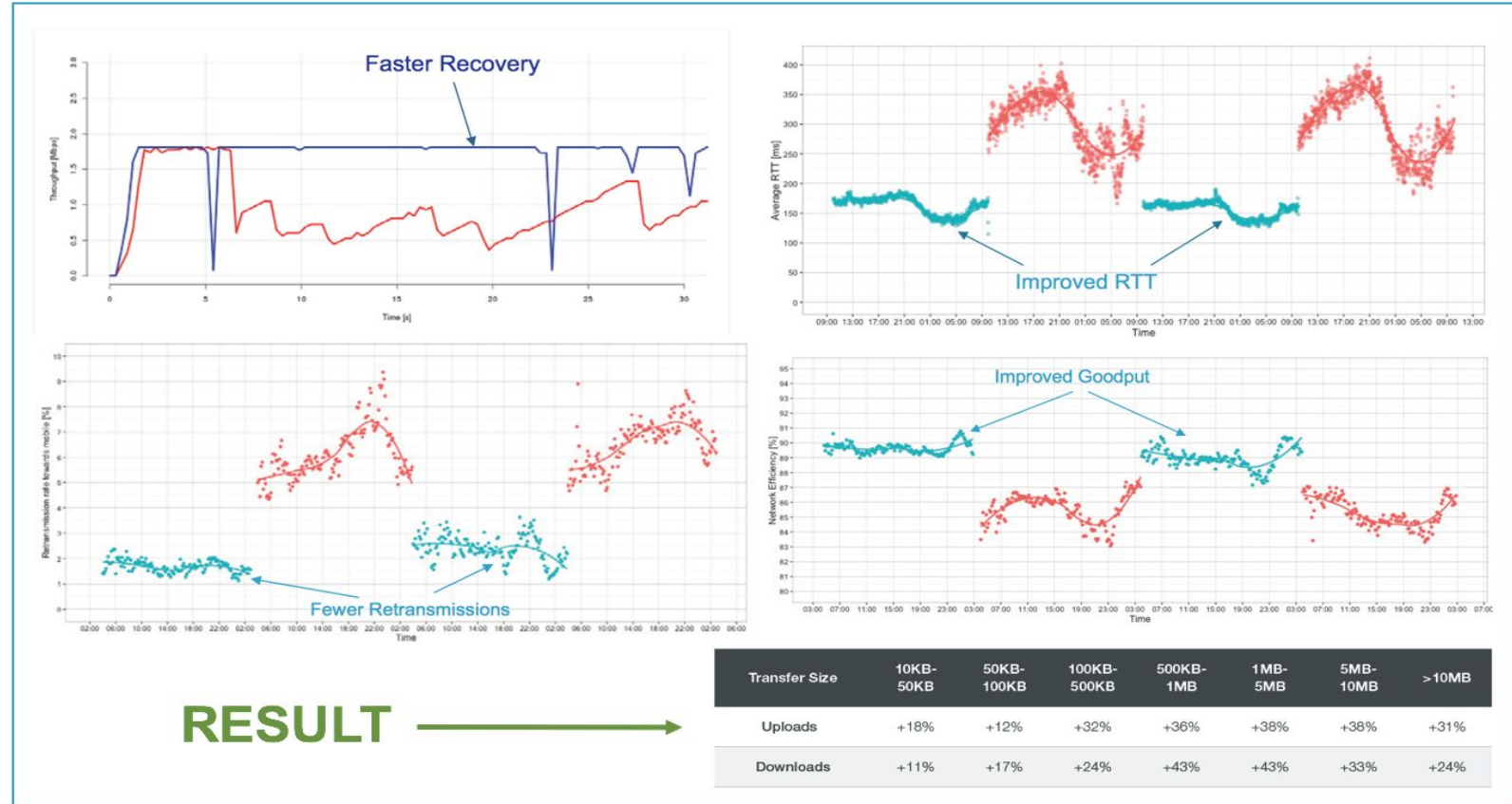
### Increase Revenue Opportunities

Faster and more reliable connections allow subscribers to do more data usage

# TCP Optimization

## Sandvine Solution – Improvements

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





# TCP Optimization

## Sandvine Solution – Business Case / ROI

### Capacity Expansion

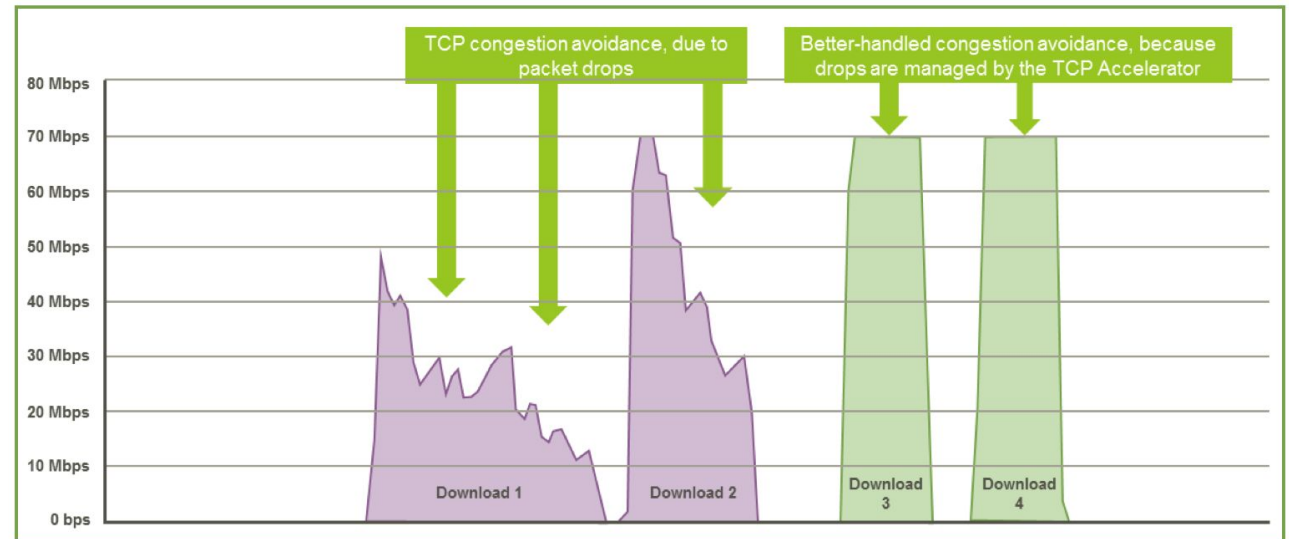
Maintain good latency at 95% utilization of the network – “hotter” utilization of investment by supporting more subscribers

### Savings on Interconnect Fee

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

### Revenue Increase

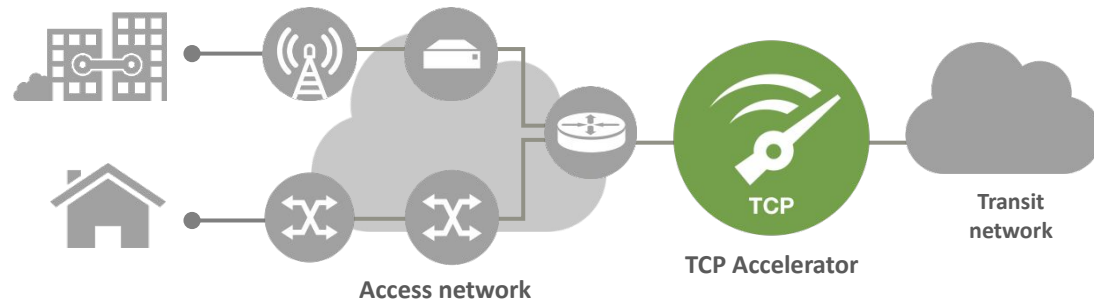
Improving average RTT directly impact subscriber QoE resulting in more usage, satisfied customers and increased revenue



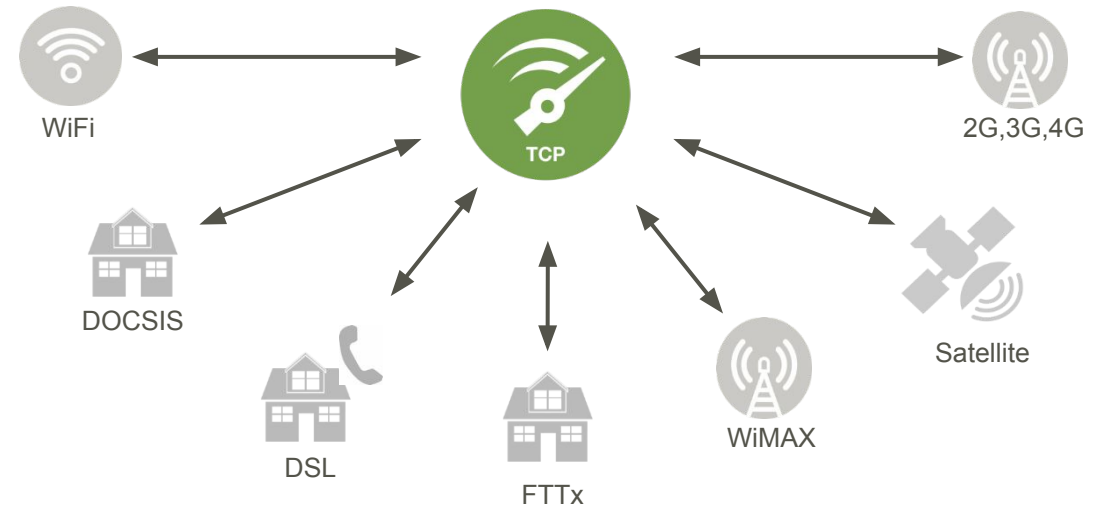
# TCP Optimization

## Use Case - Deployments

### Typical TCP Accelerator Deployment



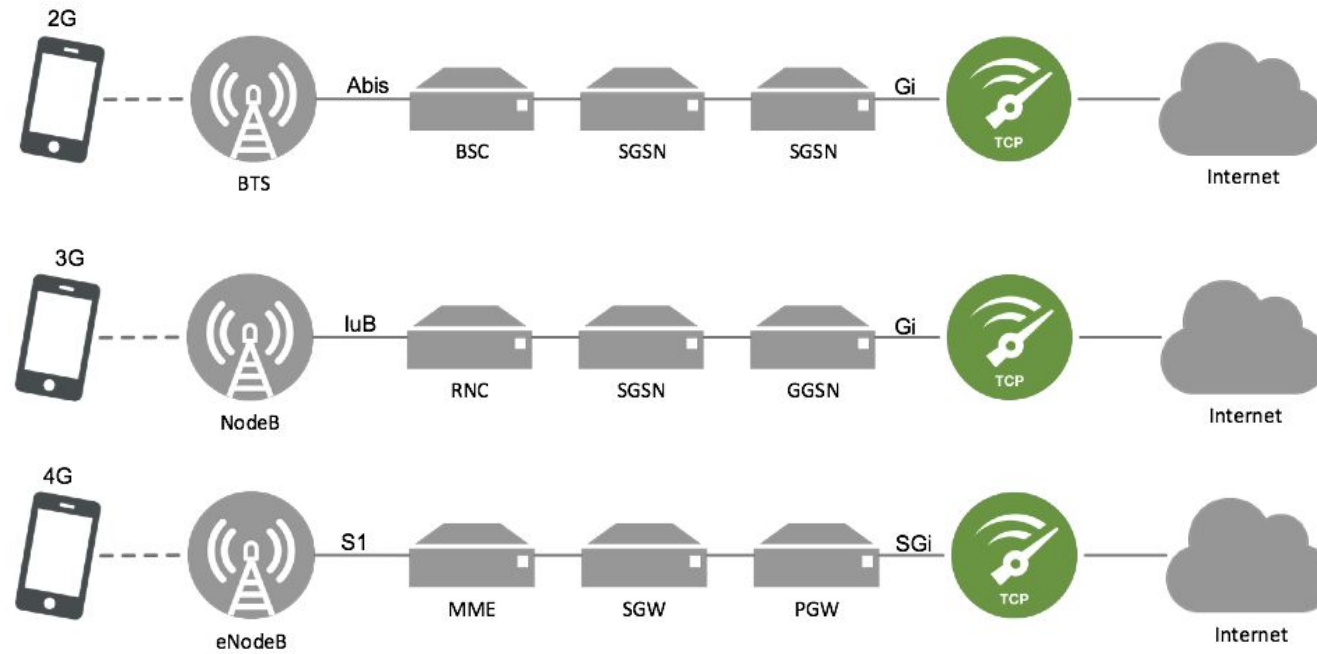
### TCP Accelerator Solution is Access-Agnostic



# TCP Optimization

## Use Case - Deployments

### Mobile Access Technologies



### DSL Access Technology

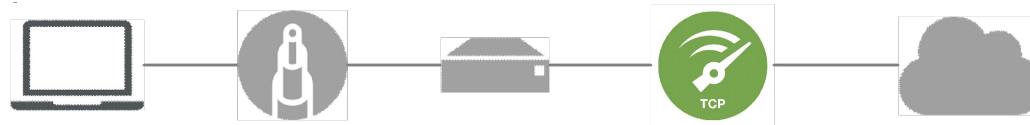


# TCP Optimization

## Use Case - Deployments

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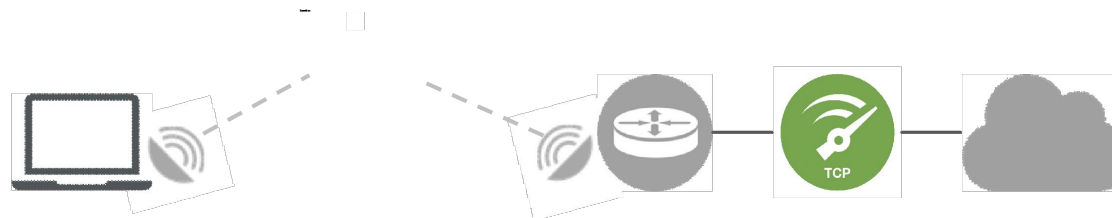
### Cable Access Technology



### WiMAX Access Technology

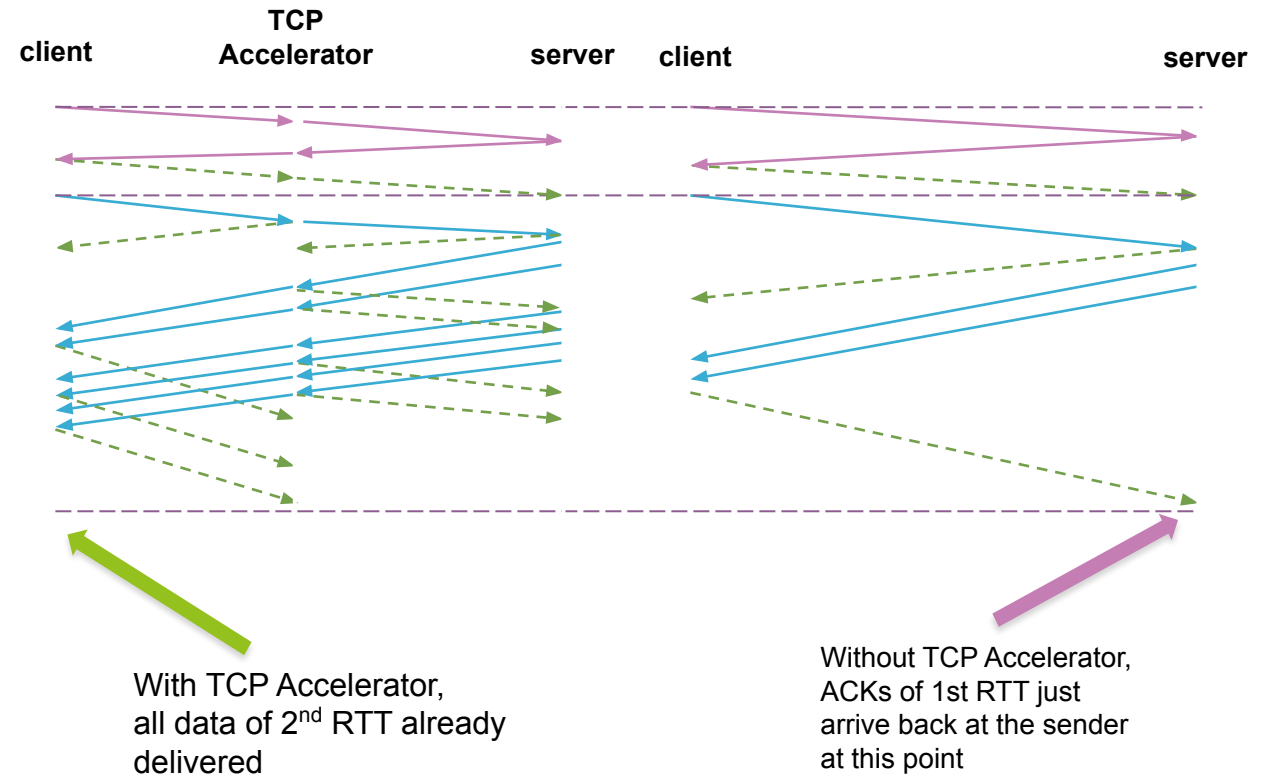
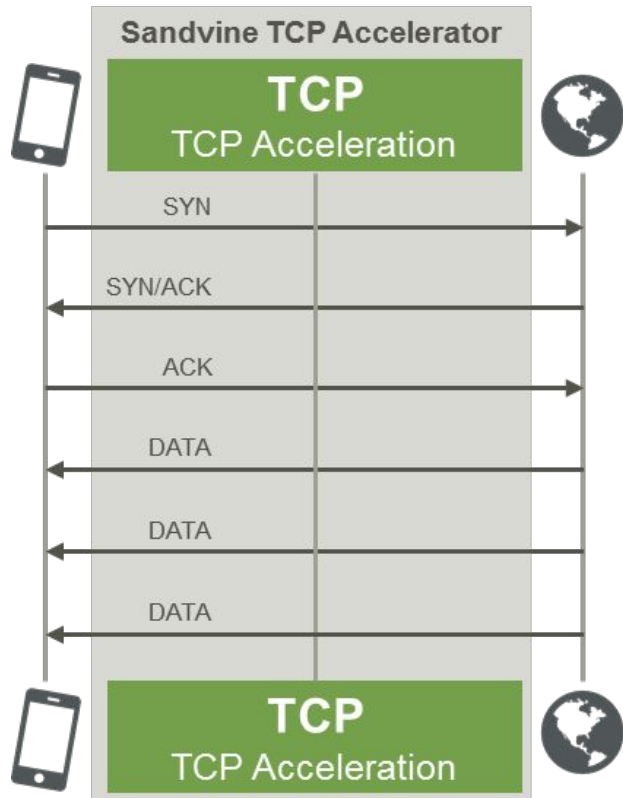


### Satellite Access Technology



# TCP Optimization

## Use Case – Call Flows



# TCP Optimization

## Sandvine Solution – Product Features

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



# TCP Optimization

## Field References



Accelerated

Not Accelerated



# TCP Optimization

## Field References

Comparing  
Speedtest with  
Sandvine Control  
Center results

The screenshot shows the Sandvine Control Center interface. The top navigation bar includes 'Solutions', 'Operations', 'Policy', 'Configuration', and 'Task History'. The left sidebar has 'PowerView', 'Alarms', 'Browser', 'Inventory', 'Currently deployed files', and 'Logs'. The main area is divided into 'Summary' and 'Flow Capture (running)'. The 'Summary' table shows active connections and downstream bandwidth. The 'Flow Capture' table lists individual flows with subscriber IP, port, and internet IP. The right pane shows detailed statistics for a selected subscriber, including application type, speedtest results, and TCP/IP parameters.

Item	Active Connections	Downstream (bps)
TOTAL	1	0.0
172.16.3.15	1	0.0

Id	Active	Subscriber IP	Subsc... Port	Internet IP	Internet P
5	true	172.16.3.15	56102	72.21.92.82	80
7	false	172.16.3.15	56188	216.110.227.147	80
8	false	172.16.3.15	56189	184.94.176.222	80
9	false	172.16.3.15	56190	66.203.160.124	80
10	false	172.16.3.15	56191	207.210.47.89	80
6	false	172.16.3.15	56193	208.90.99.252	80
2	false	172.16.3.15	56203	66.203.160.124	8080
4	false	172.16.3.15	56204	66.203.160.124	8080
1	false	172.16.3.15	56205	66.203.160.124	8080
3	false	172.16.3.15	56206	66.203.160.124	8080
11	false	172.16.3.15	56227	66.203.160.124	8080
12	false	172.16.3.15	56228	66.203.160.124	8080
13	false	172.16.3.15	56229	66.203.160.124	8080
16	false	172.16.3.15	56243	72.21.81.253	80
17	false	172.16.3.15	56244	72.21.81.253	80
15	false	172.16.3.15	56245	72.21.81.253	80
19	false	172.16.3.15	56246	72.21.81.253	80
18	false	172.16.3.15	56247	72.21.81.253	80
20	false	172.16.3.15	56248	72.21.81.253	80
14	false	172.16.3.15	56250	72.21.81.253	80
21	false	172.16.3.15	56208	72.21.81.253	80

Application	Speedtest
ApplicationType	WebBrowsing
ApplicationTypeId	5
CsDummy	1
CsPriority	medium
LinkData	Waterloo
Service_RG	30
SubscriberName	172.16.3.15
speedtest_download	19793
speedtest_upload	15933

TCP	
SYN Count	1
SYN-ACK Count	1
Subscriber RTT (ms)	64.947
Subscriber Timestamp	0
Subscriber Clock	0
Internet RTT (ms)	18.047
Internet Timestamp	0
Internet Clock	0

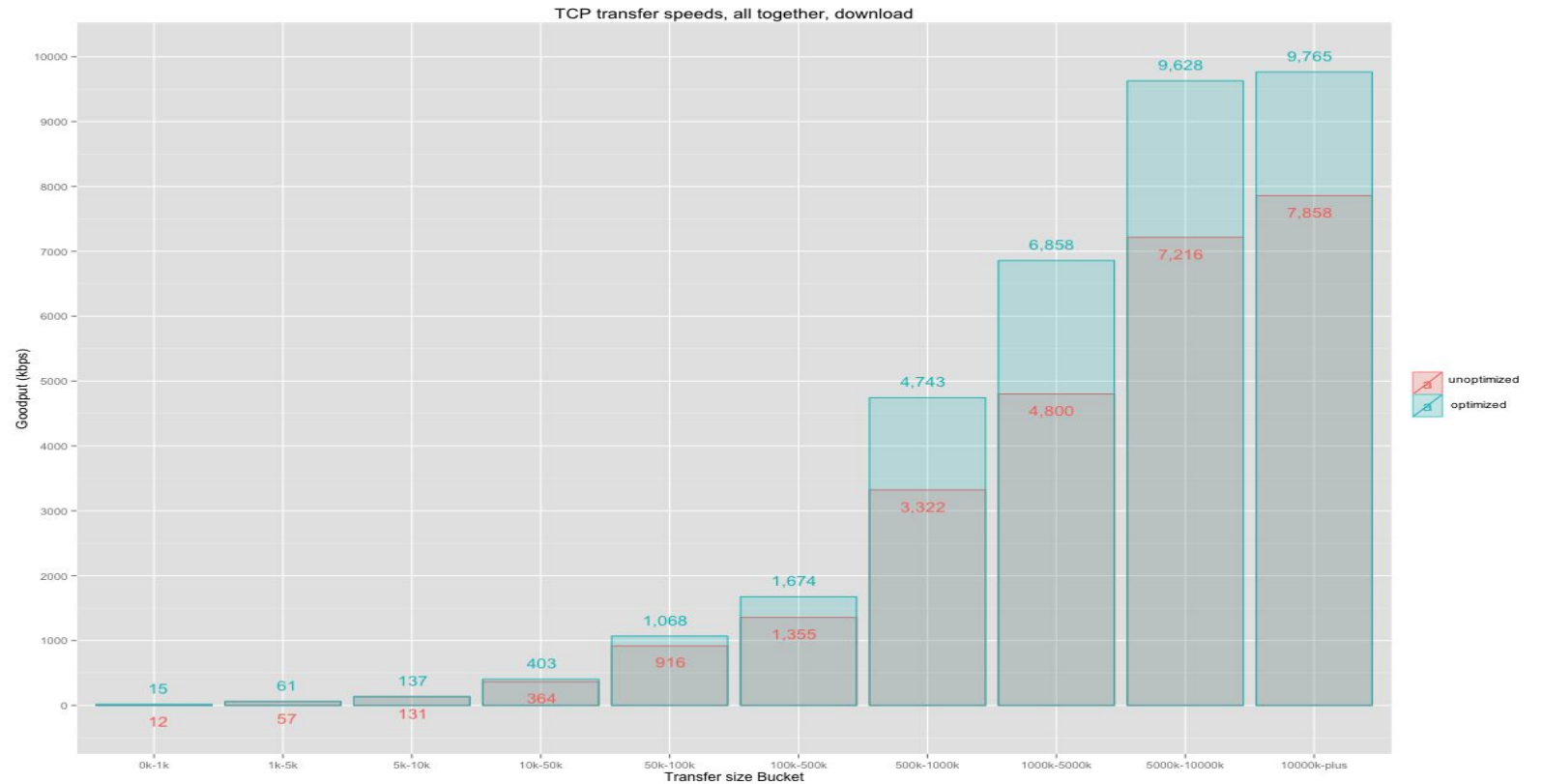
Processing	
Element	cloud-pts
Module	0
Instance	0
Subscriber Interface Element	cloud-pts
Subscriber Interface Bridge Group	0
Subscriber Interface Slot	3
Subscriber Interface Port	1
Internet Interface Element	cloud-pts
Internet Interface Bridge Group	0
Internet Interface Slot	3
Internet Interface Port	2

The screenshot shows the Speedtest.net website. The top navigation bar includes 'PING TEST', 'AWARDS', 'ADVERTISE', 'BECOME A HOST', 'MY RESULTS', 'SUPPORT', 'SETTINGS', 'LOGIN', and 'CREATE A'. The main content area displays test results for a specific location: 'Dublin, ON' hosted by 'Mitchell Seaforth Cable TV'. The results show a ping of 69 ms, a download speed of 19.79 Mbps, and an upload speed of 15.93 Mbps. Below the results, there are buttons for 'NEW SERVER', 'TEST AGAIN', and 'SHARE THIS RESULT'. A section titled 'SLOW PC PERFORMANCE?' encourages users to run a test to identify issues and speed up their PC. Another section titled 'Are you on KW Datacenter?' encourages users to take a broadband internet survey. The bottom of the page features a 'TEST AWARDS' section and a 'MOBILE APPS' section with download links for iOS, Android, and Windows Phone.

# TCP Optimization

## Field References

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



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## Field References

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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 <ul style="list-style-type: none"><li>Speedtest Android App</li><li>North American Closest Speedtest Server</li><li>10x iterations of each test</li></ul>				
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 <ul style="list-style-type: none"><li>HTML5 Speedtest Web Page</li><li>Server located in Amazon East Zone (Ohio)</li><li>Impairment: 10-30 msec latency, 0.3% packet loss introduced</li></ul>		
Item	Avg Down (Mbps)	Peak Down (Mbps)
Baseline	13.87	15.8
Accelerated	24.62	27.7
Gain	+77.5%	+75.3%





Thank you