Test Report

Tier-1 Equipment Vendor Technical Due Diligence of Mobidia's Transport Layer Optimization Technology

Functional & Performance Tests

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Abstract
This report describes the results of the detailed functional and performance testing of Mobidia's transport layer optimization technology for the purposes of assessing the suitability of integration with a Tier-1 Equipment Vendor's Core Platforms. Tests were designed in collaboration with and directed by a Tier-1 Equipment Vendor's engineering staff, and were performed on Verizon Mobile's EVDO network in May 2010.

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Table of Contents

List of Figures

List of Tables

Abbreviations

CR	Capacity Recovery is metric describing benefit of DMP compared to TCP sessions
DMP	Dynamic Multimedia Proxy
MAG	Mobidia Advanced Gateway
MIC	Mobidia Intelligent Client
TTC	Time to Completion of a TCP or DMP session
UE	User Equipment: Laptop with USB 3G modem

1 Executive Summary

Mobidia is a supplier of transport-layer optimization software that is deployed incrementally and transparently on existing mobile data network infrastructure to help mobile operators scale their networks to meet the ever-growing demand for mobile data.

At the recommendation of Tier-1, European Mobile Operator in 2009, Mobidia and a Tier-1 Equipment Vendor collaborated to execute a series of performance and functional testing of Mobidia's technology to confirm stated impact on mobile networks and their efficiency. The test took place on May 3-6, 2010 to satisfy technical due diligence requirements.

The identified objectives for the technology demonstration and testing were:

- To demonstrate to Tier-1 Equipment Vendor the functional and performance characteristics of Mobidia's technology on a public access network;
- To allow a Tier-1 Equipment Vendor the direction of, and hands-on participation in, the testing, and ownership of the test results;
- To characterize the benefits of Mobidia's technology, generally, and demonstrate the technology specifically on a CDMA2000/EVDO(Rev A) network. (Previously Mobidia has completed Operator-sponsored testing only on UMTS/HSPA networks.)

The trial was conducted as follows:

- Testing was performed in accordance with mutually-developed and agreed Test Plan. The benefits of Mobidia's transport-layer optimization technology, according to the plan, are assessed relative to identical TCP transfers under the same network conditions.
- Testing was performed on public access (live network) EVDO connections, using retail user equipment from Verizon Mobile.
- Testing was performed by Tier-1 Equipment Vendor personnel with the assistance of Mobidia technical staff.
- Testing was performed in multiple East Coast locations.

Throughout the tests, Mobidia's transport-layer optimization technology demonstrated significant and repeatable increases to radio utilization. The test results demonstrated Mobidia's ability to optimize network resource usage through acceleration of data sessions. The results were consistent with typical test results of 15-30% increases in network efficiency that Mobidia has demonstrated in multiple Tier-1 operator trials around the world. In addition, testing was performed in typical and weak radio signal strength conditions. Testing also demonstrated that Mobidia's session robustness is on par with TCP, and that optimization benefits extended to extremely weak signal levels.

During the testing a total of 544 test runs of eight (8) traffic profiles were completed in two locations. This report is a summary of all data collected during the test period extending across multiple days.

A summary of the key results of the tests are provided in Table 1, below.

Table 1 - Summary of Results

Traffic Type		Test Result, relative to same transfers under the same network conditions using TCP	
Single-UE Profiles (Represents lightly loaded sector with higher per user bandwidth rates)	Web	**42%**	higher realized data rate
	Download	**31%**	higher realized data rate
	Video	**24%**	higher realized data rate
	Upload	**68%**	higher realized data rate
Multi-UE Profile (Represents a loaded sector with lower per user bandwidth rates due to sharing)	Aggregate simultaneous data rate increase of representative traffic mix for multiple DMP users	**22%**	higher realized data rate
	Multi-UE aggregate Capacity Recovery (CR) for representative traffic mix .... * This value is directly comparable to results from previous testing performed on Tier-1 operator UMTS network (see Appendix F).	**20%***	Capacity Recovery (CR)

2 Associated Documents

Table 2 provides a list of the files associated with the testing. The test data spreadsheet includes all data collected in the test period, and calculations all summary values.

Table 2 – List of Files Associated with Testing

Document	Description	File Name
Test Report	This document. Description and discussion of test results.	**2010 05_Mobidia Technical Due Diligence Report _May 11 2010.pdf**
Test Plan	Detailed description of tests and test coverage, infrastructure, topology.	**Mobidia VZ Test Plan _Final_May 11 2010.pdf**
Results summary	Spreadsheet containing all data, calculations and a summary of results sheet.	**Mobidia VZ Test Data and Calculations _May 11 2010.xls**

3 Introduction

Mobidia Technology Inc. is a Vancouver, Canada based software vendor that provides a transport-layer optimization solution to make mobile data networks more efficient by accelerating data sessions. The technology is complimentary to other optimization solutions, such as compression, and deploys transparently to existing network infrastructure. Mobidia's technology will reduce network resource requirements (RAN and backhaul) required to deliver the same or better mobile broadband user experiences.

Over the last two years, Mobidia has been performing detailed testing on mobile networks around the world, characterizing the efficacy of Mobidia's transport optimization technology for various and varied deployed networks. Similar to most mobile network optimization solutions, its performance is sensitive to network topology and network conditions; a fact that motivates local testing.

Extensive testing in Europe and Asia on UMTS/HSPA networks has repeatedly demonstrated Mobidia's ability to increase network efficiency by 15-30%. During a recent and significant trial in collaboration with a Tier-1 operator, Mobidia demonstrated an overall optimization benefit of 22.4% in fully-loaded network scenarios. This substantive finding represents the value of Mobidia's technology during peak load and capacity constrained conditions. General network performance and user experience during these conditions are used to assess renewed or additional network investments. The benefits of Mobidia's optimization technology act to directly decrease or defer these CAPEX costs.

The testing and results described in this report are a detailed assessment of Mobidia's transport optimization performance on Verizon Mobile's EVDO RevA network. The optimization provides performance gains in mobile topologies and these gains are measured relative to TCP under the same conditions, at the same time, for the same data. The results are based on file transfers (runs) at fixed intervals, over many hours, on multiple days. To enable efficient testing, an automated framework was utilized to manage session initiation and to collate captured data. Laptops (Windows Vista) with retail Verizon EVDO USB modems and data plans were used in the tests.

The following sections present and discuss the results of the tests.

4 Optimization Benefits Considered in Testing

In collaboration with a Tier-1 Equipment Vendor, Mobidia established four primary optimization benefits to measure on the Verizon network during the testing.

4.1 Data Rate Consistency

During busy hours, the downlink backhaul often becomes congested, resulting in significantly slower TCP data rates. Mobidia's transport layer optimization technology deals with congestion more efficiently than TCP, as the data rate for Mobidia-enabled devices is less impacted by congested conditions. Based on testing on HSPA networks, Mobidia's downlink data rate will typically be 15% faster or more than the TCP downlink data rate when there is backhaul congestion. In cases of significant congestion, Mobidia's downlink data rate has been observed to reach levels 30% or greater than TCP.

4.2 Saving Network Time

In order to maximize network throughput and minimize network time consumption of each transfer, network resources must be fully utilized when they are available (unshared). Network resource sharing and congestion is reduced by completing sessions faster. With faster session completion times, the onset of congestion is delayed and the probability of sharing resources is lower. In typical mobile data networks, Mobidia completes sessions faster by realizing data rates 5-15% greater than TCP.

4.3 Enhanced Sector Capacity

Compared to TCP, Mobidia better utilizes the provided connection resources. The sector resources allocated to each UE (and the resulting connection rate) are defined by the Node B/BTS. Yet, there remains an opportunity to achieve higher (realized) throughput due to enhanced layer 4 efficiency from being tuned to mobile connections and topology. By more effectively utilizing these allocated resources, a higher aggregate throughput is achieved.

4.4 Faster Upstream Data Rates

TCP does not take maximum advantage of RAN scheduling algorithms. Mobidia's uplink data rate is typically 30-50% faster than TCP.

5 Test Strategy

The objective of the tests defined in the plan was to enable a direct comparison between session completion times for various traffic types when Mobidia transport layer optimization (DMP) is enabled, and when it is not (TCP). The testing is a comparison between DMP and TCP. The test has been designed to provide a clear and efficient comparison captured in real-world conditions, and hence, is representative of actual, real network benefits.

The test environment included the following characteristics:

- Public access ("live") Verizon EVDO network with connection using retail Verizon 3G USB dongles,
- A variety of traffic types (download, HTTP web, and video) representative of current mix of traffic on mobile networks,
- Variety of network conditions, all times of day were included in the testing,
- Two locations representing different radio signal strength scenarios, classified as typical and weak.

Testing consists of a succession of TCP and DMP transfers over extended periods for each of the traffic profiles. Transfers alternate between TCP and DMP to capture similar conditions that allow for direct comparison.

A test run is defined as having an identical traffic profile executed twice, back-to–back (once for TCP and once for DMP). Completing a single pass of all of the traffic profiles defined a test cycle, and the test cycle was repeated on scheduled intervals over the test period. A set of runs for each traffic profile over the test period is captured and reported. The results constitute a statistically-significant, averaged comparison that is fully representative of live network conditions.

The test period for the testing described in this report was 24 hours and this was repeated on successive days beginning on May 3, 2010 and ending on May 6, 2010. In this way the profile cycling over the test period included all traffic types and is highly representative of all conditions present on the network.

Testing was also considered under conditions of weak radio signal. This was accomplished by testing at two unique locations – one with typical signal strength, and the second known to experience weak signal strength. The following conditions as a result were tested:

- Typical > -75dBm, and
- Weak < -90dBm.

6 Network Topology of Testing

The network topology for the testing described in this document assumed servers installed in a collocation facility in the Boston area. This architecture is assumed to perform equivalently to a topology with the Mobidia optimization server deployed in the mobile core, or integrated within the GGSN.

The data paths for DMP and TCP are identical to ensure a fair comparison, as shown in Figure 1.

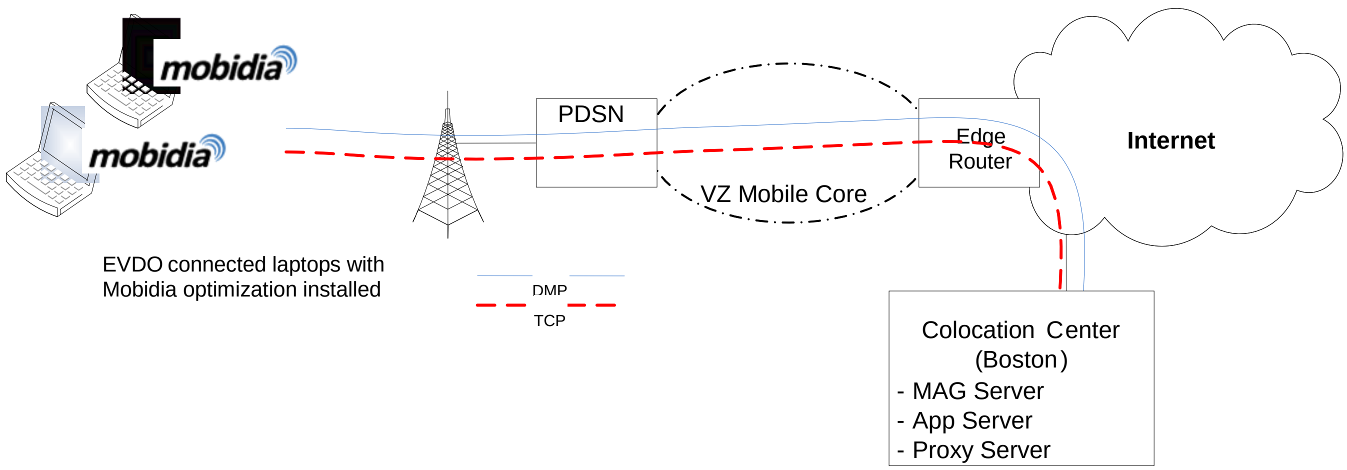

Figure 1 – Test Network Topology

7 Results and Analysis

Testing ran over successive days May 3-6, 2010, in two East Coast locations. One location represented typical radio signal conditions and was chosen randomly in an area that was known to satisfy typical signal strength requirements needed to facilitate reliable comparative testing. Another location provided the environment of weak radio signal strength.

7.1 Data Rate Consistency Benefit

Data rate consistency is measured as the realized data rate of DMP relative to TCP, and is a benefit associated with the capacity recovery (CR) benefit discussed in the next section. The perspective taken in the test plan is to identify how user experience is maintained during busy hours when network congestion contributes to limit the realized data rate below the available data rate. This benefit is measured as the realized data rate relative to TCP under the same conditions (testing is a comparison between alternate TCP and DMP transfers over the same time period for identical data). Under busy hour conditions Mobidia layer 4 optimization attempts to fully utilize the available radio resource.

Differentiating congested from typical conditions was not possible due to a lack of modulation in round-trip-time RTT (see Section 7.6.1) over the day. Identifying this trend would clearly isolate and differentiate busy hours from non-busy hours in the captured data. Nevertheless, the testing demonstrated significant increases in radio utilization and enhanced user experience as the typical state of the network provided conditions whereby optimization benefits were generated.

During testing on other operator's UMTS networks, busy hour behaviours of substantially or clearly increased RTT resulted in a marked difference between DMP and TCP performance during busy hours.

Without a clearly identified busy hour period and associated characteristic, the time of day contributions and source data presented here in Table 3 are identical to those described for the saving network time benefit in Section 7.2. This is instead of separating busy hours from non-busy hours and reporting the benefit separately.

Table 3 – Data Rate Consistency Result

Benefit: Data rate consistency

Location: East Coast Location 1

Observed Signal Strength: Average -72dBm, Peak -68dBm

Traffic type	Expected Result	Test Result, relative to same transfers under same conditions using TCP
Download	15 – 30%	**31%** higher data rate
Web		**42%** higher data rate
Video		**24%** higher data rate

7.2 Saving Network Time Benefit (Capacity Recovery)

The value of saving mobile network time is to reduce periods of time when radio resources are shared, and to delay the onset of congestion. This is achieved by completing sessions when resources are available and not missing an opportunity to send. A comparative assessment of time to complete sessions between DMP and TCP provides measure of optimization performance gain (see Appendix B for the details of this calculation). The capacity recovery metric takes the perspective of completing sessions faster and getting off of the network. Note, capacity recovery metric has been used in previous testing.

Table 4 summarizes the relative benefit in aggregate of DMP over TCP as capacity recovery for the testing during all three 24hr test periods for the three traffic types: download, web, and video.

Table 4 - Saving Network Time Result

Benefit: Saving network time (non-congested) **Location:** East Coast Location 1 **Observed Signal Strength:** Average -72dBm, Peak -68dBm		
Traffic type	**Expected Result**	**Test Result, relative to same transfers under same conditions using TCP**
Download	5-15%	23.4% capacity recovery
Web		29.8% capacity recovery
Video		19.2% capacity recovery

7.3 Faster Upload Data Rate

As mobile users increasingly utilize social network services and upload pictures and videos, the upload requirements on the mobile network logically increase. It then is important to utilize upstream resources as efficiently as possible. The same complete-sessions-faster logic assumed for download applies to upload.

The assessment used in this report was the relative realized data rate of DMP compared to TCP for identical transfers. As with all tests described in this report the comparison runs are successively completed over 24 hour periods. The results reported in Table 5 are an aggregation of all upload runs.

Table 5 - Faster Upload Result

Benefit: Faster upload data rates **Location:** East Coast Location 1 **Observed Signal Strength:** Average -72dBm, Peak -68dBm		
Traffic type	**Expected Result**	**Test Result, relative to same transfers under same conditions using TCP**
FTPSwpUp	40% to 100% faster	68% faster

7.4 Higher Aggregate Data Rate Benefit

This test is defined with multiple UEs performing simultaneous transfers. A mix of DMP and TCP users is included in the test to support the assessment of DMP impacts on non-DMP users, and also to assess the aggregate impact of DMP for the four UE group. The traffic transferred in this test is consistent with the 40%-30%-30% (web-download-video) traffic profile that is typical of North American mobile networks[1].

The impact of DMP on the TCP user in a mix of DMP/TCP users observed in location 1 was 95%. Previous testing in an urban East Coast location resulted in a significantly higher 99%. This difference is the result of relative signal strength differences between the UE within the location 1 group with the TCP user unfortunately

[1] Allot Mobile Trends, 2010 (http://www.allot.com/mobiletrends.html) which reports H2 2009 data.

having the lowest signal strength. In tests on other (UMTS) networks, values of 99% to 104% are typical for the relative impact of DMP on TCP users.

Table 6 - Higher Aggregate Data Rate Result

Benefit: Higher aggregate data rate (Multiple UE) **Location:** East Coast Location 1 **Observed Signal Strength:** Average -72dBm, Peak -68dBm		
Traffic type	**Expected Result**	**Test Result, relative to same transfers under same conditions using TCP**
Aggregate simultaneous data rate increase to multiple DMP users (UE2,3,4) 40/30/30 Traffic mix	Positive impact for DMP users and for aggregate	**122%** increased average realized data rate
Aggregate data rate increase to mix of users (all users, mix of DMP and TCP) 40/30/30 Traffic mix		**115%** increased average realized data rate
Impact of DMP on TCP user	Minimal impact to TCP users within test	**95%** of realized data rate compared to when multi-UE utilized only TCP.

7.5 Weak Signal Performance

Generally, Mobidia optimization technology is not sensitive to signal strength but weak signal strength does impact testing by introducing failed runs and greater variability between transfers. It is clear that the ability to optimize will diminish in conditions of failed sessions and data rates that do not support the functionality of applications. A key success criterion in weak signal conditions is therefore to not negatively impact session completion success.

In summary, optimization did not adversely affect session completion success under extreme signal conditions, and optimization benefits were still present at minimal radio signal strength and reduced connection rates.

Table 7 - Weak Signal Performance Result

<table>
<tr><td colspan="3">Benefit: Saving network time (non-congested)
Location: East Coast Location 2
Observed Signal Strength: Average -102dBm, Peak -96dBm</td></tr>
<tr><th>Traffic type</th><th>Expected Result</th><th>Test Result, relative to same transfers under same conditions using TCP</th></tr>
<tr><td>Download</td><td rowspan="4">Optimization performance typical of typical signal strength conditions will extend to low signal strength to point when connection resources are extremely scarce.
Additional runs would be required for reliable result due to increased transfer to transfer variability.
Failed session probability will be the same as observed for TCP sessions.</td><td>6.26% capacity recovery
5 runs; 1 tool failure
A failure to capture error was recorded.</td></tr>
<tr><td>Web</td><td>-22.0% capacity recovery
7 runs; 0 failures
A single extreme transfer time (3.5 times longer than average) was observed, and if removed the CR becomes +10.7%. This is a demonstration of increased transfer-to-transfer variability.</td></tr>
<tr><td>Video</td><td>NA%
YouTube sessions failed for TCP and for DMP in 5 of 6 runs. A comparative performance assessment was not possible.
6 runs; 5 failures for DMP, 5 failures for TCP</td></tr>
<tr><td>Upload</td><td>13.36% capacity recovery
6 runs; 1 DMP failure, 0 TCP failure</td></tr>
</table>

7.6 Additional Discussions

7.6.1 Time of Day Effects

The round-trip-time (RTT) of packets can be used as an indicator of network congestion as signal strength and sharing of radio sector resources do not contribute to the RTT value. The floor RTT (FRTT) – or minimum RTT – was found to be stable during testing on Verizon's network. This is in contrast to UMTS testing in EU where a marked increase in the FRTT demarcated the operator-identified busy hours.

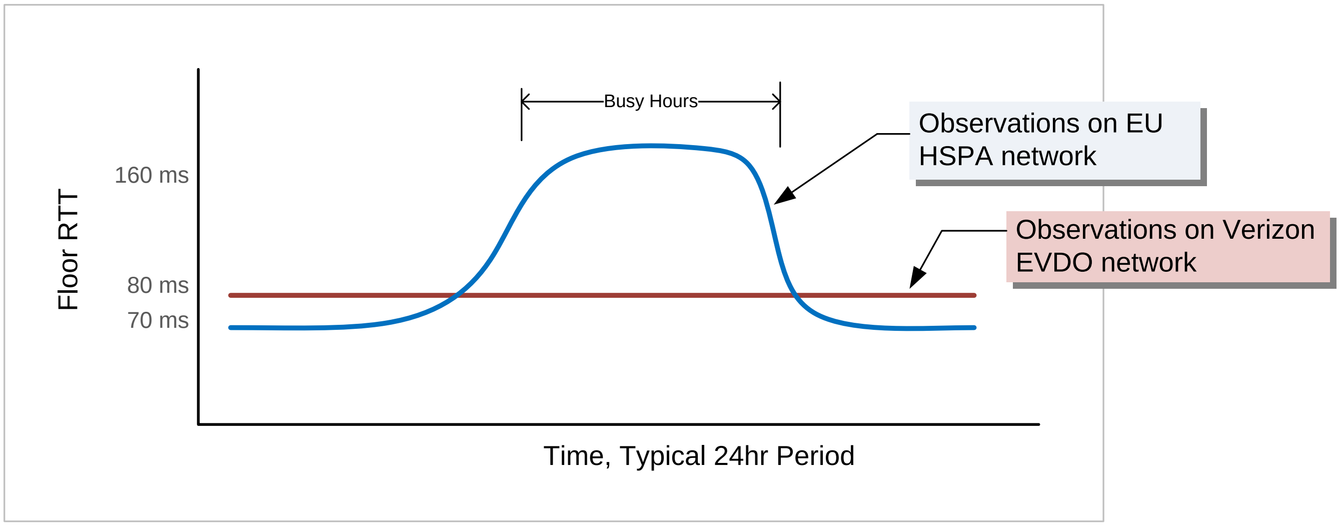

Figure 2 - Floor RTT Comparison Between Networks

7.6.2 1xRTT Performance

Testing on May 6 included a limited set of runs that appear to have used 1xRTT connections. This occurred in the early morning hours after 1 am. Considering the Web traffic profile, the average realized data rate of the five runs during this period dropped from a previous average of 600kbps to 75kbps. Transfers using DMP and TCP were both affected by the same rate drop to 1/8 of the previous average rate.

While 1xRTT was not a focus or objective of the testing, this unexpected condition provided data to assess DMP performance in 1xRTT mode and provided the data to confirm that DMP was fully operational in 1xRTT mode. For the limited data captured in 1xRTT mode, the capacity recovery was 34%. This value should not be extrapolated as a general 1xRTT result as it is based on limited data, and is based on a single profile. As a preliminary result, it can be concluded that an optimization benefit on 1xRTT is possible, and that in the cases when EVDO is unavailable and 1xRTT mode results, continued use of optimization would be recommended.

7.6.3 Packet Retransmission Comparison

As Mobidia optimization manages the in-flight packets relative to the realized connection rate, it is interesting to look at a comparison of retransmitted bytes between DMP and TCP. Figure 3 is a plot of retransmitted packets captured during the May 4 test period (24 hours); all test periods show similar results. While DMP can dramatically reduce retransmitted packets, note that retransmission bytes were approximately 1% of total bytes sent.

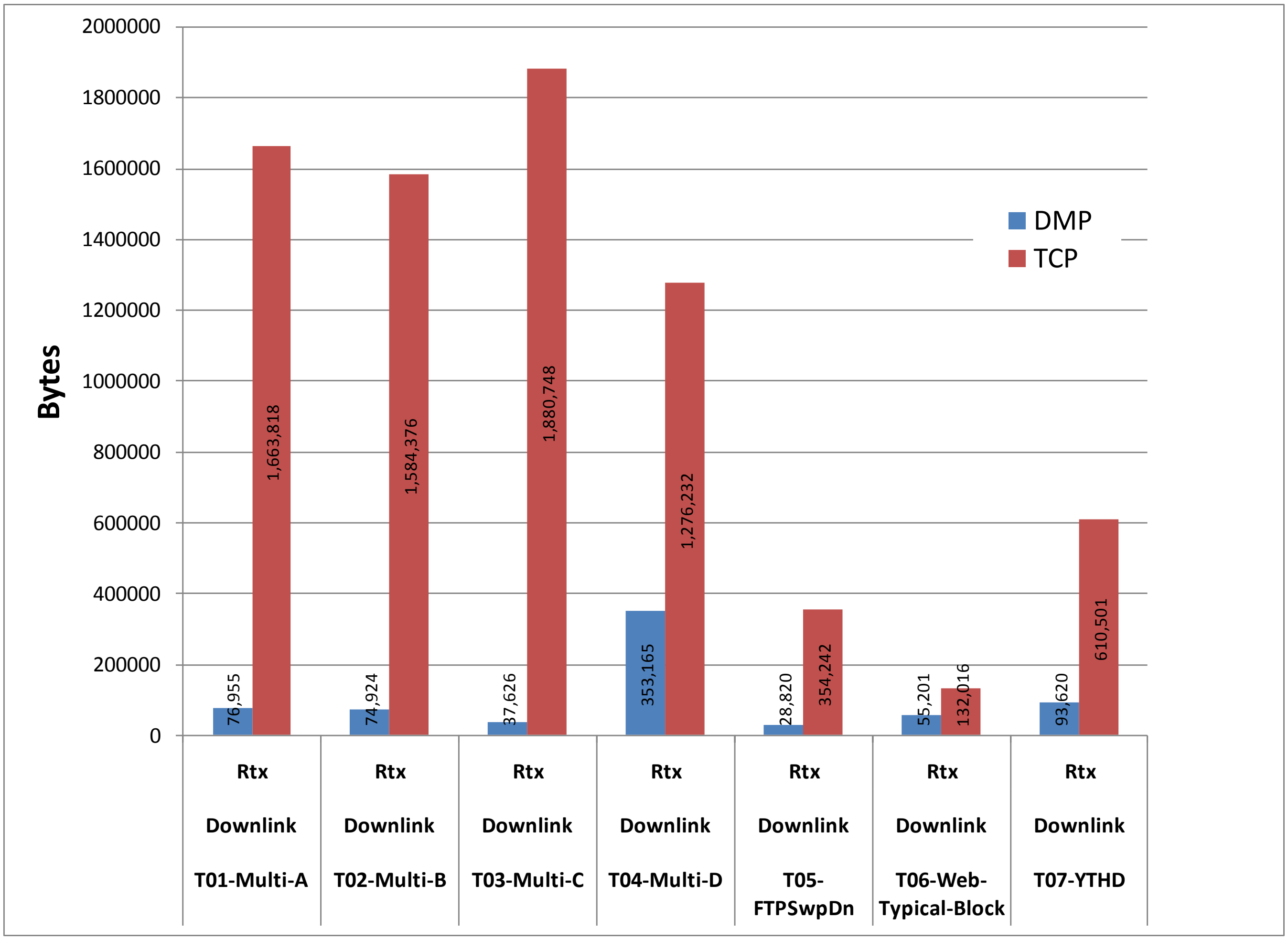

Figure 3 – Sum of Retransmission Bytes per Profile for May 4 Test Period

8 Conclusions

In collaboration with a Tier-1 Equipment Vendor, Mobidia designed and executed testing of the transport-layer optimization technology on Verizon Mobile's EVDO network. Substantial benefits of using Mobidia's transport layer technology were demonstrated through the course of the testing. These benefits shown on an EVDO network were demonstrated to be similar to previous testing on UMTS networks. Specifically, the testing showed that for a traffic mix representative of real user's traffic, network performance gains of 20% and higher can be realized using Mobidia's technology.

The findings in this report are highly representative of Mobidia technology benefits. Testing was conducted over extended periods, over multiple days, and utilized a comprehensive set of traffic profiles. The results in this report are consistent with detailed testing on a Tier-1 European operator's network. Therefore the results can be viewed positively and are sufficient to satisfy the technical due diligence process.

Further, weak signal performance and performance in 1xRTT mode proved satisfactory. While testing was not exhaustive in these operating scenarios, Mobidia optimization robustness and operating range was demonstrated to be appropriate and sufficient for real world application.

Results reported in this document represent a true and fair characterization of Mobidia's transport layer optimization technology.

Appendix A Testing on Verizon EVDO at Other Locations

Previous to testing in location 1, Mobidia completed similar optimization testing in a central, urban East Coast location. These results are presented in this section.

In summary, the results in central, urban East Coast during April 2010 were consistent with testing performed in May 2010 at location 1. This urban location was chosen to increase the likelihood of directly observing and identifying busy hour effects, and then assessing optimization performance in this network condition. A clearly identifiable busy hour was not identified in this location as was the case in location 1. The performance optimization in all locations is very consistent as can be observed in the data presented in this section.

Test Results from central, urban East Coast

Multiple UE testing at the central, urban East Coast location provided very similar results to those captured in location 1. This was somewhat of a surprise as it initially was predicted that due to greater mobile data use and density the urban location would more clearly demonstrate impacts for busy hour congestion. In general terms, rural locations are expected to experience coverage issues, while urban locations are expected to experience only capacity issues. As noted in Section 7.1, clearly discernable busy hours were not identified in the data collected (further and deeper analysis may provide new insights on this topic). Alternatively, there is strong evidence that Mobidia optimization performance is consistently delivered on Verizon EVDO network independent of location.

The impact of DMP on collocated TCP users observed in central, urban East Coast 99%) was significantly lower than observed in location 1 (95%). In tests on other (UMTS) networks, values of 99% to 102% are typical for the relative impact of DMP on TCP users.

Table 8 - Higher Aggregate Data Rate Result

<table>
<tr><td colspan="3">Benefit: Higher aggregate data rate (Multiple UE)
Location: central, urban East Coast
Dates: April 8/11/12/13, 2010</td></tr>
<tr><th>Traffic type</th><th>Expected Result</th><th>Test Result, relative to same transfers under same conditions using TCP</th></tr>
<tr><td>Impact of DMP users (UE2,3,4)
40/30/30 Traffic mix</td><td rowspan="2">Positive impact for DMP users and for aggregate</td><td>126% in average realized data rate</td></tr>
<tr><td>Aggregate (all users) data rate
40/30/30 Traffic mix</td><td>118% in average realized data rate</td></tr>
<tr><td>Impact of DMP on TCP user</td><td>Minimal impact to TCP users within test</td><td>99% of performance compared to when multi-UE utilized only TCP.</td></tr>
</table>

Appendix B Data Rate and Capacity Recovery Calculations

Time to completion (TTC) is the metric found to most conveniently measure transport layer efficiency. Based on guidance from operators, it is representative of network capacity consumption.

A test run is when an identical test profile is executed twice (and back-to-back), once for TCP and once for DMP. The corresponding two TTC values can be used to make a comparative value.

Data Rate Benefit

The calculation of how much faster the realized data rate achieved by DMP is than TCP is relatively simple. Assuming the same file is transferred or loaded which is defined in the test, the data rate benefit is the ratio of TTC of the respective TCP and DMP sessions in the test. Multiple test runs will be executed for a given test profile and a statistical average of the benefit is calculated across all runs is given by the following expression, in percent:

$$\text{Data rate benefit} = \sum(TTC_{TCP}[x]) \;/\; \sum(TTC_{DMP}[x]),$$

x = 1..N, where N is the number of runs of a specific profile.

Capacity Recovery Benefit

Another possible calculation to demonstrate the benefit is capacity recovery (CR). This is a measure of the network resources that are freed by having sessions complete faster using DMP.

Multiple test runs will be executed for a given test profile, and a statistical average of the CR values will be calculated across all runs. CR and is defined as follows:

$$\mathbf{CR}[\text{profile A}] = 1 - \sum(TTC_{DMP}[x]) \;/\; \sum(TTC_{TCP}[x]),$$

x = 1..N, where N is the number of runs of a specific profile.

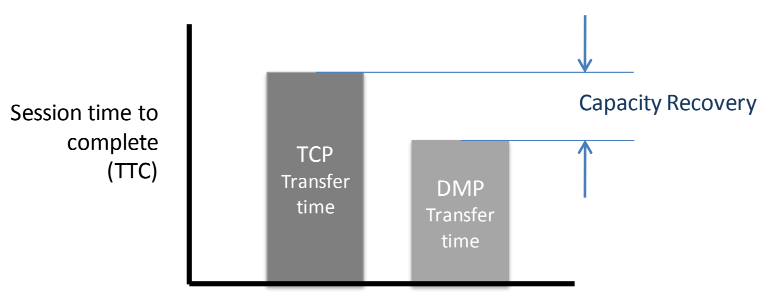

Figure 4 - Diagram of Capacity Recovery Calculation

Appendix C Configuration of Test Laptop

UE setup

Test laptops are instrumented with the following programs:

- UE Test Framework
- Mobidia Measurement Tool (MMT)
- Wireshark (v1.3.4)
- Microsoft Internet Explorer 8
- YouTube framework (Google/YouTube API set v2.0)

The Wireshark application enabled full packet capture of all traffic of the test laptops.

The Mobidia Measurement Tool (MMT) is a tool that launches the various applications replacing human (mouse click) commands. The MMT reports session start and stop times to the UE Test Framework.

Equipment Used in Testing

UE

- Microsoft Vista SP2 laptops
  - Default Windows settings and configuration
- USB 3G dongles (Verizon CDMA, retail purchased)

MAG Server

- HP blade server; Linux CentOS_5.2
- Installed in Axcelx colocation, Somerville, MA

Web and FTP Server

- HP blade server; Linux CentOS_5.2
- Installed in Axcelx colocation, Somerville, MA

Wireshark Server

- MS Server 2003
- Installed in Axcelx colocation, Somerville, MA

Appendix D Mobidia Technology & Corporate Overview

Mobidia's technology provides mobile operators with a revolutionary new software platform that enhances their mobile data networks by leveraging the distributed computing power of millions of connected laptops, netbooks, and smartphones. The software recovers capacity from the existing wireless network while speeding the delivery of data to subscribers to make networks more efficient and profitable. Mobidia's platform can also be deployed to enhance existing subscriber, and service, policy solutions.

Mobidia takes an innovative approach by using software that resides on the subscribers' smartphones or laptops and software that is installed in an operator's core network. Once deployed, it is fully transparent to subscribers' applications or services and the operators existing network infrastructure. The solution seamlessly interfaces with other optimization, DPI, and policy solutions.

Mobidia's transport layer optimization solution, the first commercially available component of its platform, has repeatedly demonstrated an ability to recover 15-30 percent of network capacity at peak times, and under peak loads. Mobidia is working closely with the world's leading mobile operators and solution providers to integrate this optimization into their mobile networks. In 2009, Mobidia conducted over 10 network trials, tests, and network characterizations in Europe, Asia, and North America. The results of these trials conclusively demonstrated:

- The solution's ability to recover network capacity in a number of different network topologies.
- The solution's compatibility with and additive benefits to existing content compression, transcoding, and other higher layer optimization technologies.
- The solution's positive impact on subscribers' experience by accelerating their data sessions and decreasing the variability of connected services.

Mobidia is a venture-funded corporation, located in British Columbia, Canada with a regional presence in the US, UK, Germany, and Singapore. Our staff has worked with Microsoft, Symbian, Motorola, Samsung, LG and PMC-Sierra creating optimized protocols stacks, developing radio modems, mobile operating systems and core network elements. We are a group of passionate mobile experts that understand the challenges of mobile networks at a protocol, RAN, and platform level.

Appendix E Mobidia's Transport Layer Optimization Technology Overview

Mobidia's transport optimization solution addresses the inefficiencies of TCP on mobile networks by implementing an innovative protocol that is an extension of the standard user datagram protocol (UDP) and optimized for wireless connections and a wireless environment. The solution is implemented at layer 4 and achieves compatibility and interworking with existing network elements and provides complete transparency to subscribers' applications and services. The solution is able to address and optimize TCP traffic without generating incompatibility or disruption to existing technology. As a result, efficiency is gained while maintaining the benefits from other investments and solutions.

At a high-level, Mobidia's solution decouples bandwidth rate from latency, increasing throughput and better utilizing available network resources. All TCP sessions across the radio access network (RAN) will be accelerated yielding higher data rates. Through enhanced management of resources across multiple sessions, resources are also conserved to further increase efficiencies and provide more stable connections. The net results of implementing the solution are that network capacity is recovered and subscribers' experiences are enhanced. Furthermore the greatest benefits of the Mobidia solution, and its highest performance relative to TCP, will occur when resources are needed most – during "busy hours" and under peak loads.

Optimization Mechanisms

There are a variety of mechanisms that Mobidia utilizes to optimize data traffic. Primary methods include:

Optimized Acknowledgement Algorithm Mobidia's transport optimization uses an algorithm that provides all the reliability of TCP but provides a couple of very important enhancements including less sensitivity to downstream and upstream variability.

Connect-rate Aware Ramp Mobidia's solution identifies available per user RAN resources and quickly moves to an optimal bandwidth rate.

Optimized Congestion Management Utilizing the fast ramp and optimized ACK algorithm, bandwidth rate thresholds are defined quickly and are based on physical resources and per user equipment (UE) allocation.

Improved Congestion Buffering Mobidia's proprietary buffering leverages software on the user equipment to intelligently manipulate buffer sizes.

Intelligent Multi-Session Resource Allocation Mobidia instantly allocates resources between multiple sessions while managing "fairness".

Enhancement	Primary Benefits
Optimized Acknowledgement Algorithm	• Higher data rate in high-latency conditions • Higher and more stable data rate during times of latency modulation (such as during "busy hours") • Decreased sensitivity to short-term increases in latency • Decoupling of downlink rate from uplink conditions
Fast Bandwidth Rate Ramp	• Higher data rate with faster completion times • Especially significant and noticeable with small files (such as web page downloads) • More bandwidth allocated per user equipment
Optimized Congestion Management	• Higher data rates and decrease susceptibility to latency • Recovered capacity typically "lost" from TCP inefficiencies during busy times
Improved Congestion Buffering	• Increased performance and stability of network connection • Realized data rate is decoupled from short term variations from receive rate of user equipment
Multi-Session Resource Allocation	• Reduction in backhaul congestion

Solution Differentiation

As demonstrated, Mobidia's impact to both the network and subscriber experience is considerable. Equally valuable to wireless operators is the solution's characteristics that speed deployment and enable interworking with existing network elements. These characteristics represent Mobidia's differentiation and unique approach.

Transparency Mobidia's core components of its transport optimization solution can be deployed transparently to existing technology. The technology is completely transparent to subscribers and does not degrade the subscribers' experience in any way. It is deployed and runs at layer 4, completely under the application layer. As a result, it is "invisible" to applications, services, and core network elements.

Complimentary The optimization occurs at the transport layer without any modification to packet's payloads. The solution does not aggregate sessions nor does it create "tunnelled" traffic. As a result, the solution runs transparently and limits any disruption to policy engines, deep packet inspection, quality of service (QoS) implementations, and other traffic management strategies. In multiple field tests and trials, the solution has been proven to show interworking with client/server-based optimization solutions (such as compression).

Additive Mobidia's solution has repeatedly demonstrated efficiency gains of 15-30% on networks with both server and client/server-based optimization solutions deployed. Mobidia's transport optimization compliments other optimization technologies and provides the foundational efficiency to complete a data traffic management strategy.

Appendix F Results from EU Tier-1 Operator Testing

Executive Summary

Under the sponsorship and supervision of a Tier-1 European mobile operator, Mobidia conducted a trial of its innovative transport layer optimization technology on the operator's network. The goal of the testing was to quantify expected reductions to CAPEX investment required to meet the demand of growing mobile data users and usage that this technology can provide. The testing was performed in October and November 2009.
The specific goal of the tests described in this report was to confirm efficiency performance of Mobidia's technology in the deployed network environment during fully-loaded (busy-hour) conditions.

The test setup was designed to demonstrate the capacity recovery benefits of Mobidia's technology in conditions as representative as possible of real network scenario. With focus on fully-loaded network conditions, the results indicate benefits of recovered (or increased) network capacity and of stabilized user experience during congested network conditions.

A further objective of the testing was to confirm whether the previously identified performance gain (capacity recovery) would be preserved as deployed with the latest generation network architecture which includes a content optimization solution.

The specific defined objectives of the trial were:

- To demonstrate acceptable or better performance (approximately 10% or greater Capacity Recovery) of Mobidia's transport layer optimization technology within the deployed mobile network with content-layer optimization enabled.

- The target network environment mirrored the currently deployed mobile network under fully-loaded conditions. Public Access 3G radio connections and approved, unmodified, retail user equipment were utilized for all testing.

The trial was conducted as follows:

- The trials were performed in accordance with the Test Plan, developed by Mobidia and approved by the sponsoring operator. The test topology, harness, and methodology were audited and approved. Tests were run in November 2009.

- Deployment strategies and technology was also studied within the scope of the trial, but this topic is not addressed within this report.

Result	**Description**	**Value**
Capacity Recovery (CR) Performance	Test that Mobidia technology will increase network capacity under fully-loaded, busy-hour conditions, in target network topology with existing content optimization elements enabled. Threshold performance: approx. ≥ 10%.	25.4%
Content optimization compatibility	Operator audit of the normal functional operation of the content optimization currently deployed while Mobidia's technology is enabled.	Interoperable
Capacity recovery weighted by traffic mix in network	Value is calculated based on operator provided traffic mix of 35% web, 35% YouTube, 20% FTP.	22.4%

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