DMP Product Line Overview

June 2014

Optimization Overview

- Mobile network optimization, monitoring and subscriber analytics software
- Two stand-alone product lines:
  - **Mobile Data Optimization**: network optimization solution accelerates mobile data services for subscribers and improves network efficiency for carriers
  - **Mobile Subscriber Analytics**: mobile applications that collect and analyze mobile device usage metrics and enable subscribers to manage mobile data plans
- Patented technology optimizes transport layer efficiency across wireless data networks
- Extensive RAN, mobile platform, network protocol and wireless core expertise

Mobidia DMP Value Proposition

Increases Mobile Network Capacity by 15%-30%

- Patented process for optimizing TCP efficiency across wireless data networks
- Proven, repeatable performance validated in 20 carrier networks
- Network improvements additive to performance enhancements from 3rd party traffic optimization solutions (e.g., caching, compression)
- Helps carriers decrease or defer network CapEx

Accelerates Subscriber Data Services by up to 150%

- Accelerates mobile data applications and services
- Higher realized data rates with faster download completion times:
  - Identifies available per-user RAN resources and quickly moves to an optimal bandwidth rate; fewer spurious retransmissions during peak times

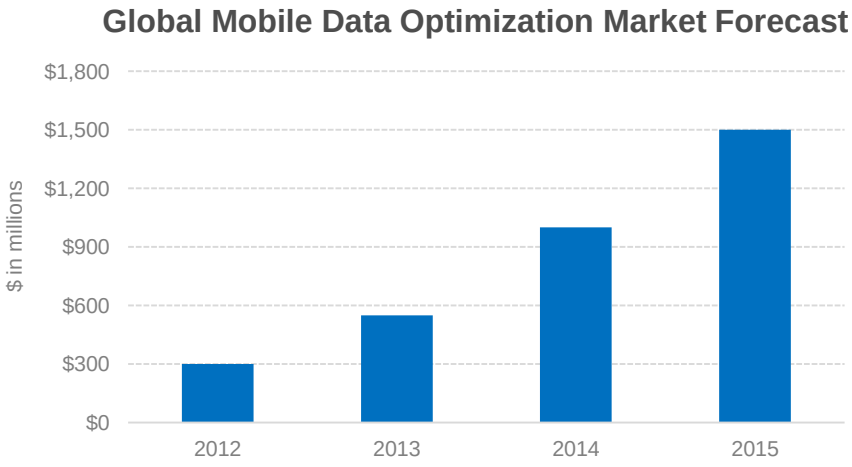
Enhances End-to-End Service Delivery

- Transparent interworking with subscriber, service and policy solutions
- Enables policy enforcement at the network edge (mobile devices):
  - Applies policy to upstream traffic (from the device) before data hits network
- Complements DPI by tagging data with application:
  - Distributes data classification to device; offloads DPI processing from core

Network and Service Analytics

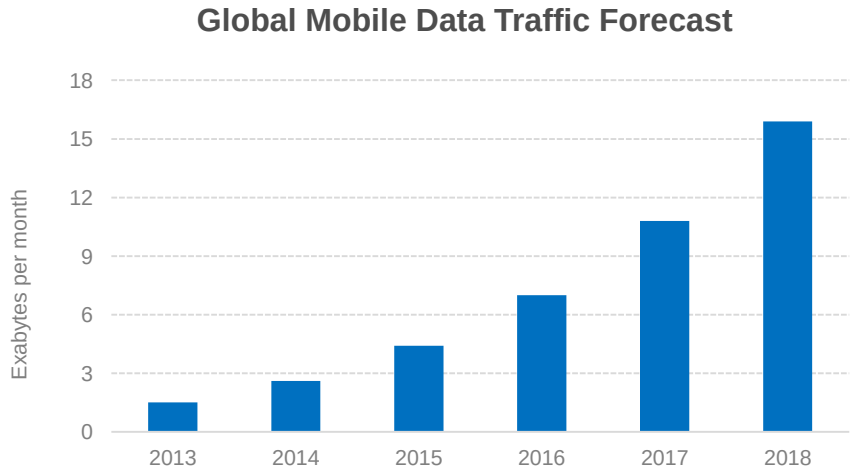
- Provides real-time network intelligence from mobile devices to network core
- Subscriber- and service-level intelligence and analysis
- Supports service and network capacity planning

Market Opportunity



Mobile data optimization market quadrupling from $350 million in 2012 to $1.5 billion in 2015:

- Spending on DPI, web and video optimization solutions to exceed $5 billion by 2019
- Carriers struggling to handle congestion amid rapid traffic growth and finite spectrum
- Mobile traffic growth not driving corresponding revenue growth; greater efficiency needed

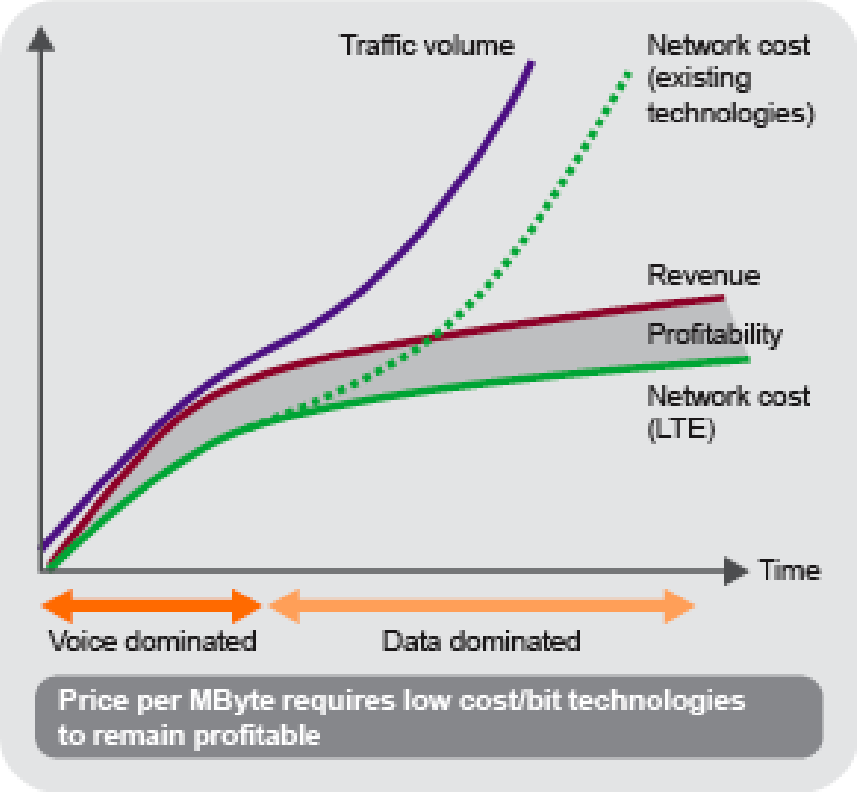


Mobile data traffic to grow from 1.5 EB/month in 2013 to 15.9 EB/month in 2018 (61% CAGR):

- Smartphone penetration – 21% of devices in 2013, but 88% of traffic (29X basic phone)
- Data usage – average smartphone user consumed 529 MB/month in 2013 (+50% YoY)
- High speed (3G/4G) networks drive rich media usage – video was 53% of mobile traffic in 2013

Sources: ABI Research and Cisco Visual Networking Index.

Data Traffic Growth Not Driving Revenue Growth

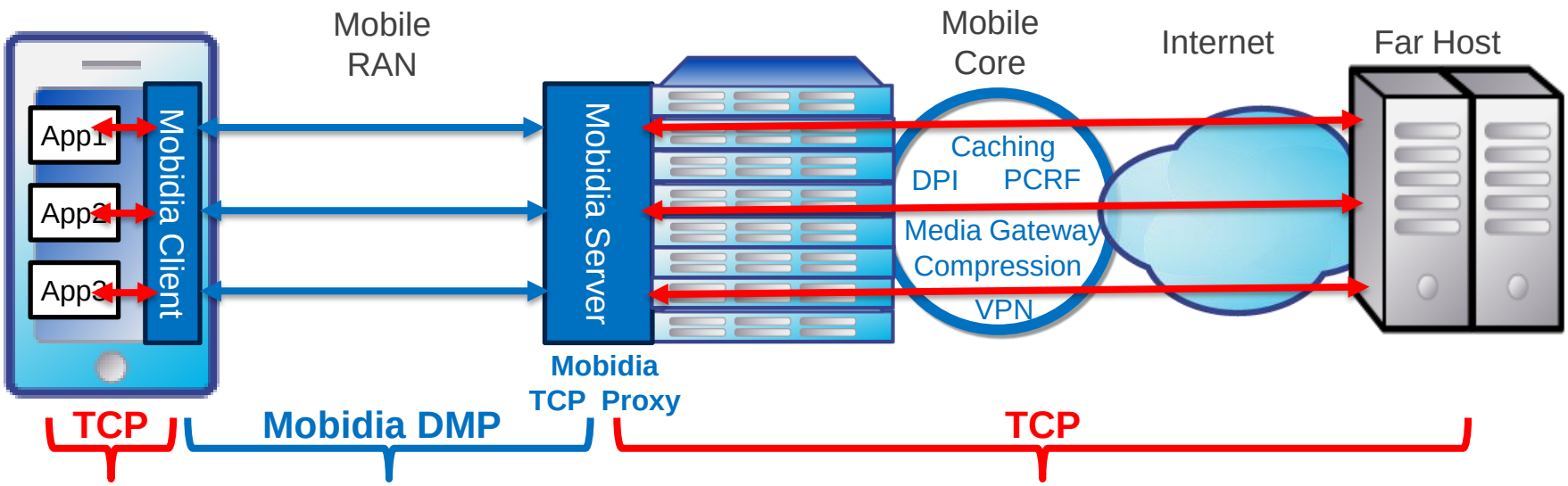


- Flat-rate data plans provide no way to curtail or monetize excessive use:
  - Revenues scale with subscriber growth, not traffic growth
- Cellular networks already highly congested in large markets
- Service quality is key differentiator between carriers
- Mobidia helps carriers improve network efficiency and performance:
  - 15%-30% capacity recovery during peak periods (when needed most)
  - Improves the performance of all data services for subscribers
  - Implements fair-use, QoS policies
- Mobidia helps carriers implement and enforce new charging models:
  - Usage-based billing, bandwidth caps, tiered pricing, etc.

TCP Shortcomings on Wireless Networks

- High round-trip time variation is often misinterpreted as congestion:
  - Results in TCP window collapse that reduces radio link efficiency
- No awareness of connection rate
- No awareness of competition for limited connection resources
- Over-contributes data into the network (especially multiple sessions from single user)
- Selective acknowledgement packets are highly limited and can be reneged

How Mobidia DMP Optimizes TCP



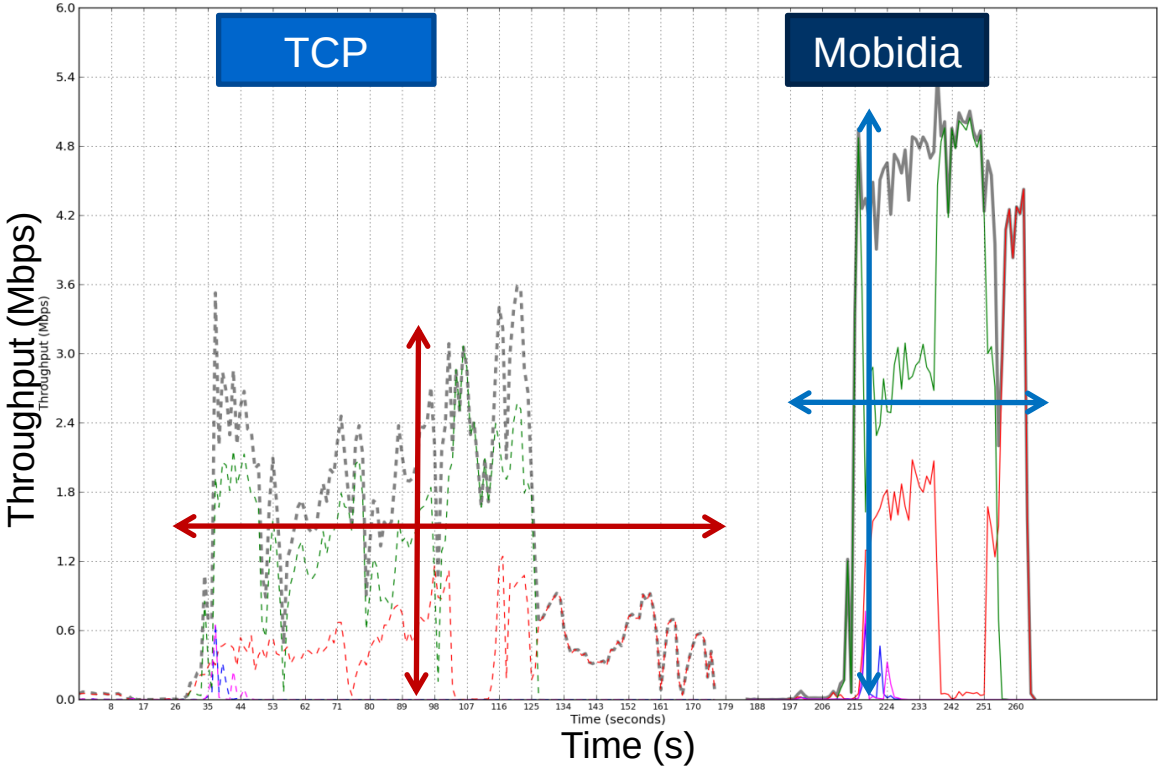
- Optimizes all mobile applications and services
- Eliminates inefficient TCP sessions in RAN
- Proprietary UDP-based protocol transports TCP payload
- 1:1 session mapping supports end-to-end policy management
- Transparent to applications and core infrastructure
- Complements and interoperates with 3rd party traffic management tools (DPI, caching/compression and QoS solutions)
- Mobidia server deployed in carrier network or externally in cloud

Key DMP Optimization Techniques and Benefits

Technology	Description	Primary Benefits
Optimized Acknowledgement Algorithm	Transport algorithm provides equivalent reliability to TCP, but less sensitive to network variability (upstream and downstream)	• Higher data rate in high latency conditions • Stable data rate during times of latency modulation, such as peak traffic periods • Less sensitive to short-term spikes in latency • Faster congestion epoch recovery
Connect-Rate Aware Rate Ramp	Identifies available per-user RAN resources and quickly moves to an optimal bandwidth rate	• Higher data rate with faster completion times (particularly noticeable with small files, web pages) • More bandwidth allocated per mobile device
Optimized Congestion Management	Utilizing fast “ramp” and optimized acknowledgement algorithm, defines bandwidth rate thresholds quickly and based on per-user allocations	• Higher data rates and less susceptibility to initial latency • Recovers capacity typically “lost” from TCP inefficiencies during peak traffic periods
Improved Congestion Buffering	Proprietary buffering leveraging software on the mobile device to intelligently manipulate buffer sizes	• Increases performance and improves stability of network connection • Realized data rate is decoupled from short-term variations from “receive” rate of user devices
Multi-Session Resource Allocation	Real-time allocation of resources between multiple sessions while managing fair access	• Reduces backhaul congestion, particularly owing to “unfair” subscriber bandwidth utilization

Subscriber Benefits of Transport Optimization

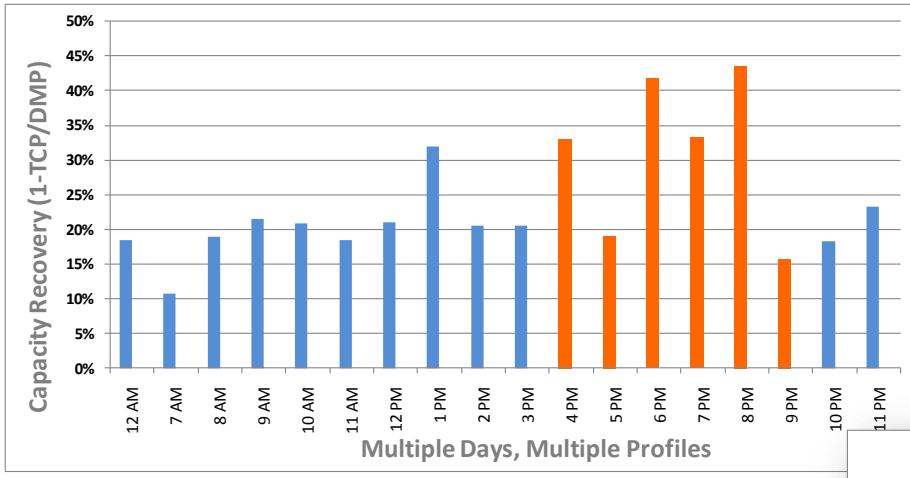
- Efficiency gains with acceleration
- 22.4% capacity recovery validated by operators
- All data sessions completed faster
- Improved subscriber experience during congested times
  - Higher bandwidth rates
  - Stable connections
  - Less perceived latency
  - Up to 30% faster experience



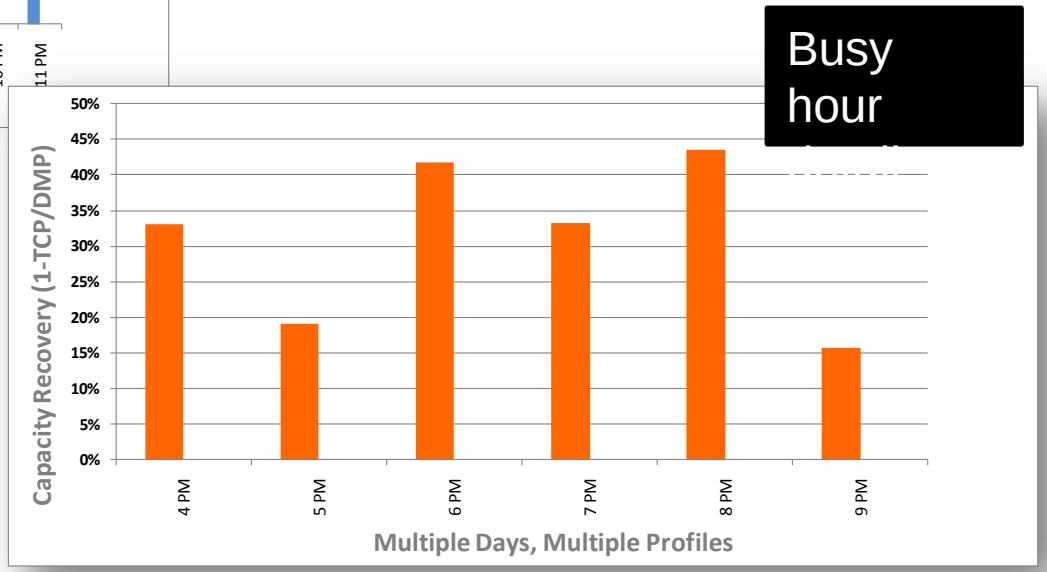
Example of an "A/B" comparison of TCP and Mobidia (multiple test profiles run consecutively)

Efficiency gains without the typical "trade-offs" of Optimization

DMP Accelerates During Busy Hours



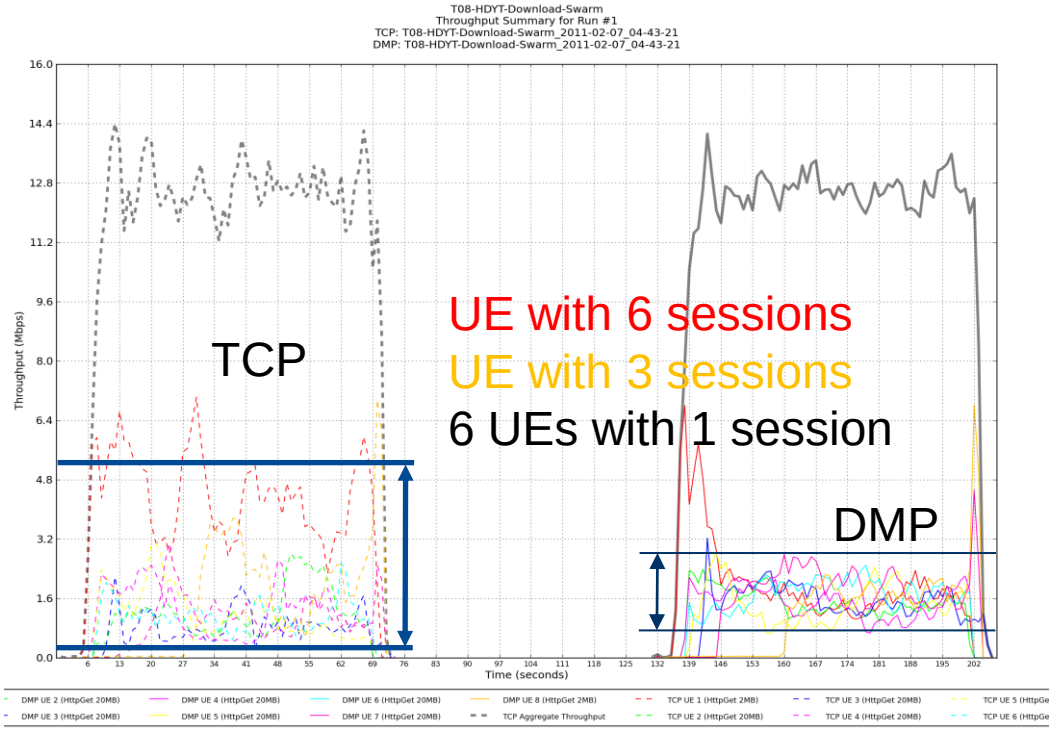
$$CR = 1 - \sum TTC_{DMP} / \sum TTC_{TCP}$$



- Testing showed consistent performance advantage using DMP over TCP in identical conditions

- DMP completes session faster and more consistently that TCP
- Consistently faster during all times of days with biggest results during busy hours
- Aggregate number of runs exceeded 400 (multiple days and profiles)

Nonintrusive Fairness (FUP)



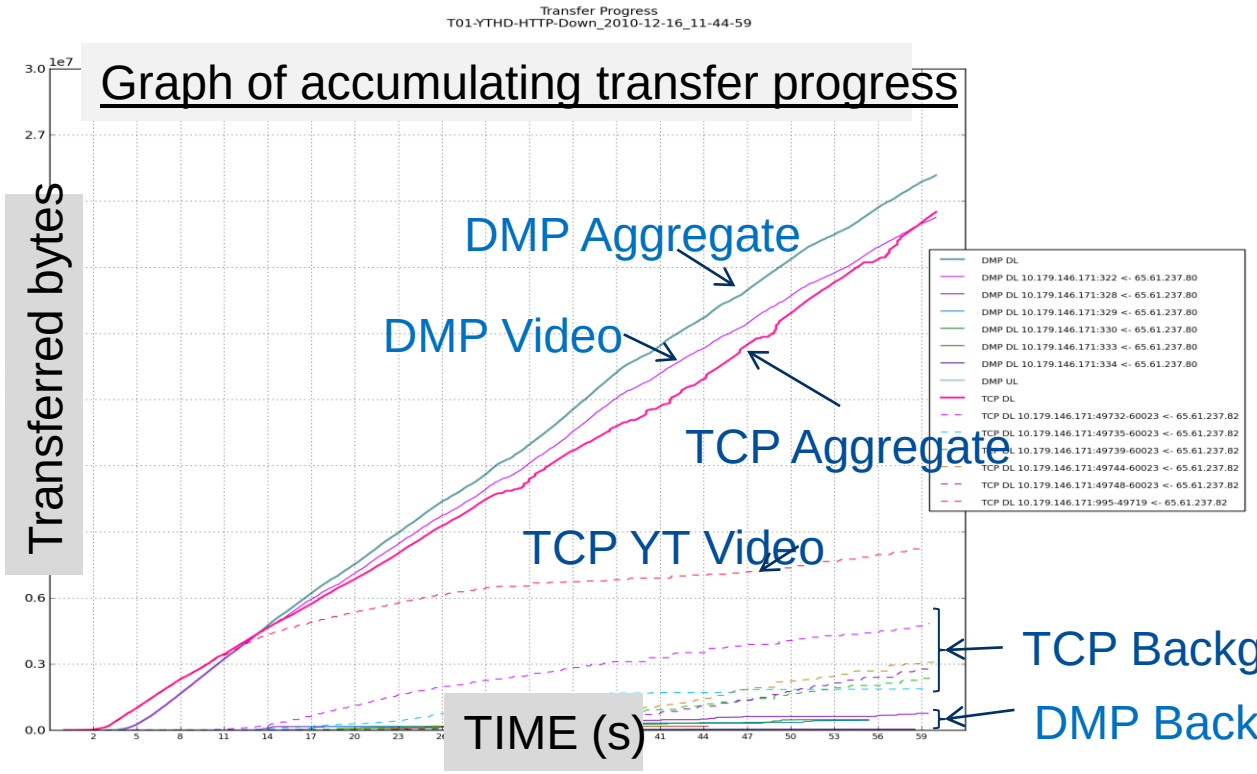
- 8 UE simultaneously transmitting/receiving on 3G connection (collocated)
  - 1 UE has 6 sessions
  - 1 UE has 3 sessions
  - 6 UE has 1 session

- In TCP scenario, sessions and not users are given fair treatment – each session realizes similar performance
- Users experience is dependent on number of active sessions, therefore is varied
  - Aggressive applications split across multiple sessions
  - Single session users suffer
  - Video stream performance suffers

- DMP – each user sees the same performance (this is due to ASM) independent of active session count
  - Avoids use of rate capping solutions

Real Time Policy Enforcement

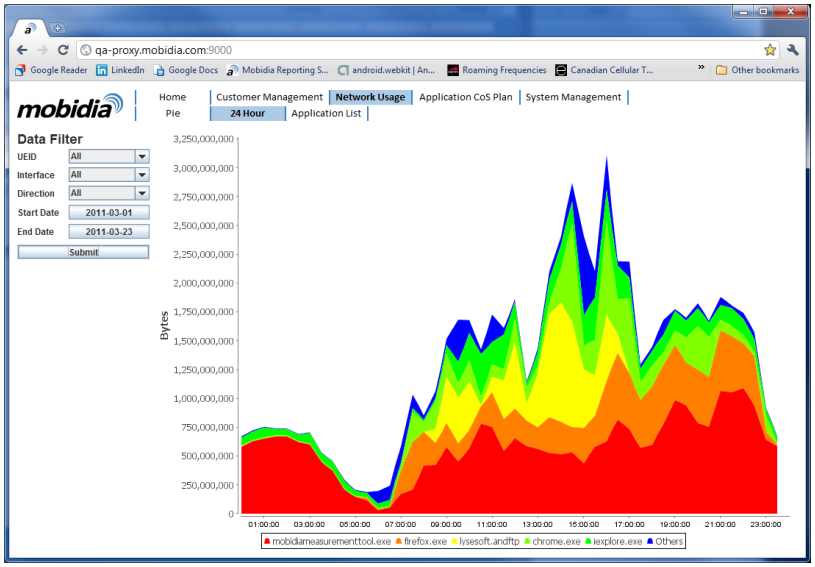
1. DMP guarantees video performance in multiservice environment
2. TCP video performance slows due to competing sessions

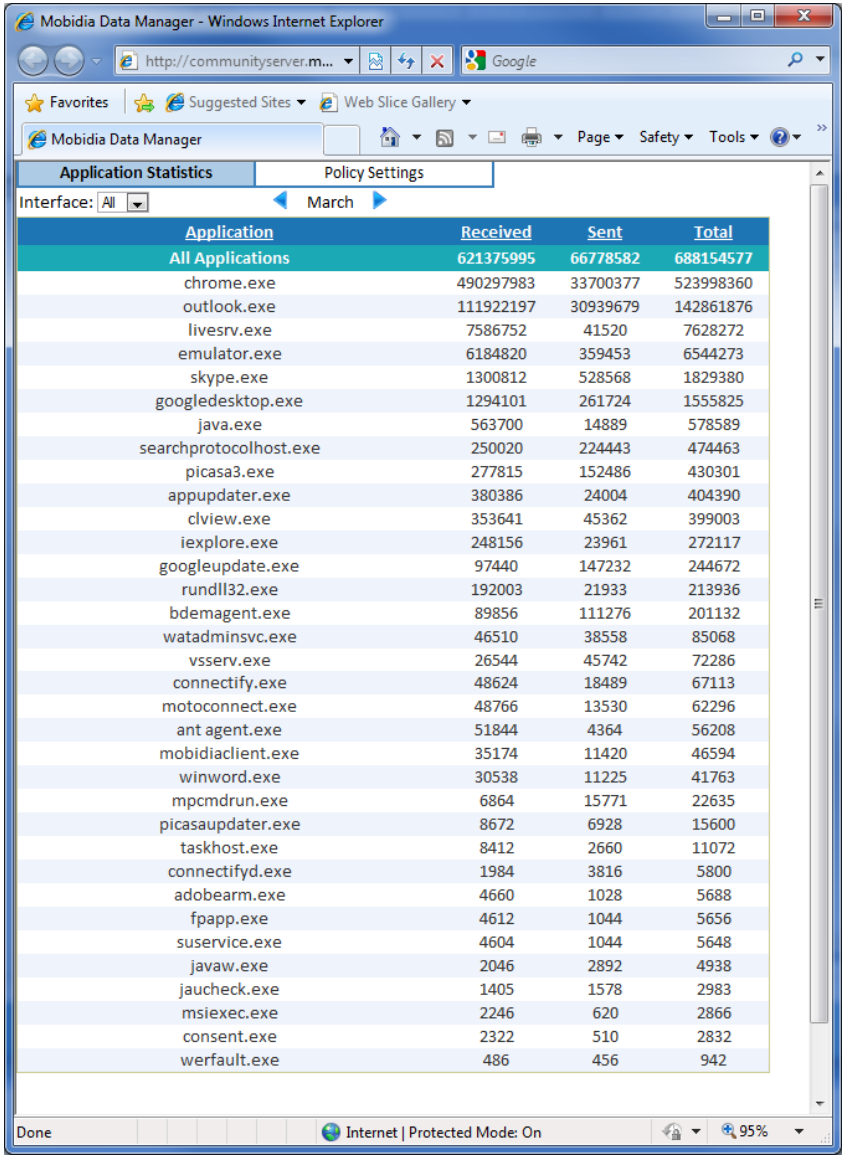


- Results achieved without any network QoS (e.g. DiffServ)
- Single point provisioning for End-to-End service assurance
- Combines congestion management with QoS mechanisms
  - Video session identified via "AppTag", not DPI
  - Allocation of background traffic can be adjusted if desired
- Future: provide low latency, low jitter performance to specific sessions

Detailed Usage Reporting per Subscriber

- Included in optimization or subscriber policy solution
- Automatic application identification and discovery
- Usage data
  - All interfaces (mobile, WiFi, Ethernet)
  - Per subscriber, per app
  - Per device/OS
  - Radio state
  - Time-stamped
- Query-able central database; XML/CSV data formats





Application	Received	Sent	Total
All Applications	621375995	66778582	688154577
chrome.exe	490297983	33700377	523998360
outlook.exe	111922197	30939679	142861876
livesrv.exe	7586752	41520	7628272
emulator.exe	6184820	359453	6544273
skype.exe	1300812	528568	1829380
googledesktop.exe	1294101	261724	1555825
java.exe	563700	14889	578589
searchprotocolhost.exe	250020	224443	474463
picasa3.exe	277815	152486	430301
appupdater.exe	380386	24004	404390
clview.exe	353641	45362	399003
iexplore.exe	248156	23961	272117
googleupdate.exe	97440	147232	244672
rundll32.exe	192003	21933	213936
bdemagent.exe	89856	111276	201132
watadminsvc.exe	46510	38558	85068
vsserv.exe	26544	45742	72286
connectify.exe	48624	18489	67113
motoconnect.exe	48766	13530	62296
ant agent.exe	51844	4364	56208
mobidiaclient.exe	35174	11420	46594
winword.exe	30538	11225	41763
mpcmdrun.exe	6864	15771	22635
picasaupdater.exe	8672	6928	15600
taskhost.exe	8412	2660	11072
connectifyd.exe	1984	3816	5800
adobearm.exe	4660	1028	5688
fpapp.exe	4612	1044	5656
suservice.exe	4604	1044	5648
javaw.exe	2046	2892	4938
jaucheck.exe	1405	1578	2983
msiexec.exe	2246	620	2866
consent.exe	2322	510	2832
werfault.exe	486	456	942

Repeatable Performance in 20 Carrier Networks

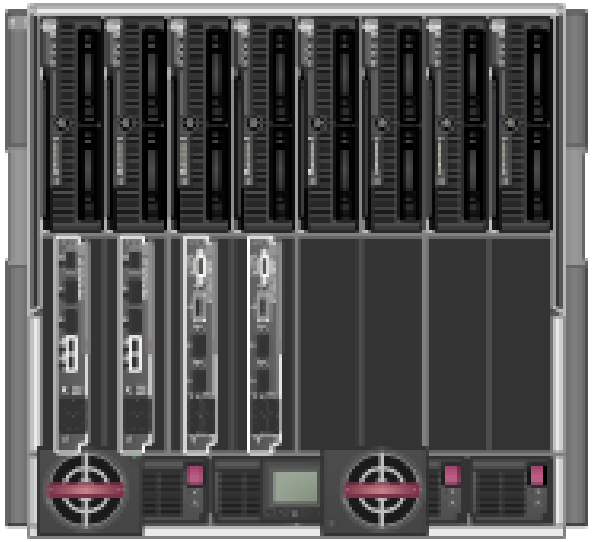
North America

EMEA

Asia Pacific

Product Components – Mobidia Server

Mobidia MS-1



- 10Gbps throughput Layer 4 Optimization
- Transparent proxy
- Linux Kernel
- ANSI C for all packet processing software
- GCC compiler
- Flexible deployment options: RAN, core network or hosted network co-location
- Standalone or integrated with GGSN, gateway or 3rd party optimization platform
- HP BLC7000 chassis:
  - 10U
  - 2x 10GE WAN, redundant
  - 8x Optimization Core blades (6 to 12 core)
  - Optimization redundancy N+1
  - Fully redundant fabric
  - NEBS compliant
- Scalability:
  - Nx10G supported using expansion platform

Product Components – Mobidia Mobile Client

*

- Works on smartphones, tablets and laptops
- Enhanced network (TCP) stack – extension of network infrastructure (not an application)
- Invisible to subscribers and applications:
  - No user interface or configuration
  - Automatically enables/disables without any user interaction
  - Content and packet payloads not modified
  - No degradation to user experience, battery life, processing load or radio functionality
- Transparent and complementary to 3rd party traffic optimization, DPI and QoS/policy tools
- Portability across mobile OS platforms
- OTA deployment supported

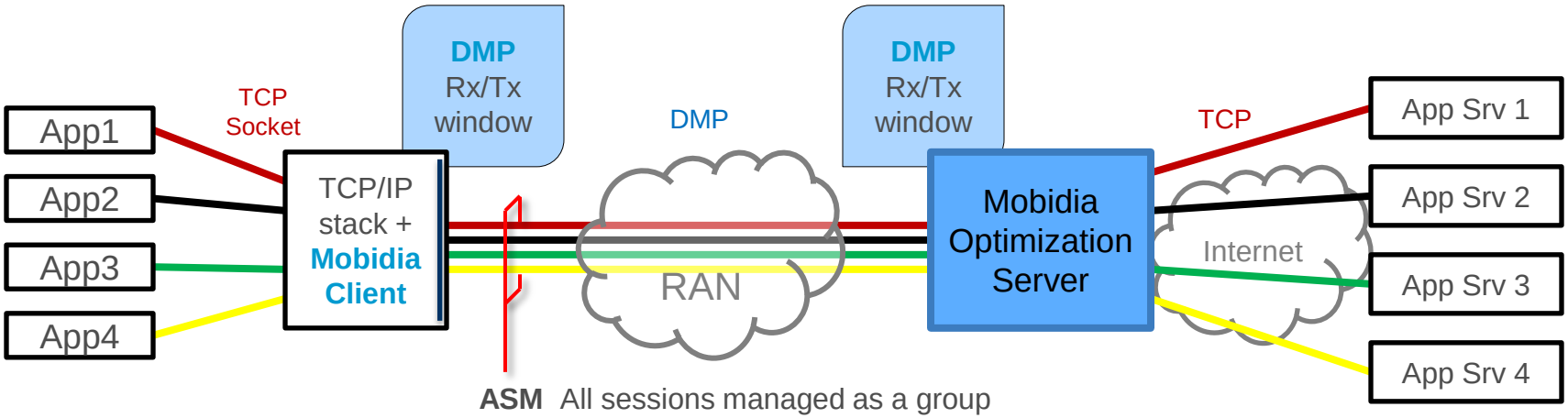
* Client embedded within iOS apps

Mobidia DMP Differentiation

	Mobidia	Allot	ByteMobile (Citrix)	Flash Networks	Sandvine	Vantrix
Primary Optimization Techniques	Protocol Optimization; QoS	Caching; Compression; QoS	Caching; Compression; Protocol Optimization	Caching; Compression; Protocol Optimization	QoS	Caching; Bit Rate
Deployment Model	Server + Mobile Client	Server	Server + Mobile Client	Server	Server	Server
Transparent to Applications/Services	●	◑	◑	◑	◑	◑
On-Device Policy Enforcement	●	○	◑	○	○	○
Subscriber-Level Service Intelligence	●	◑	●	◑	◑	◑

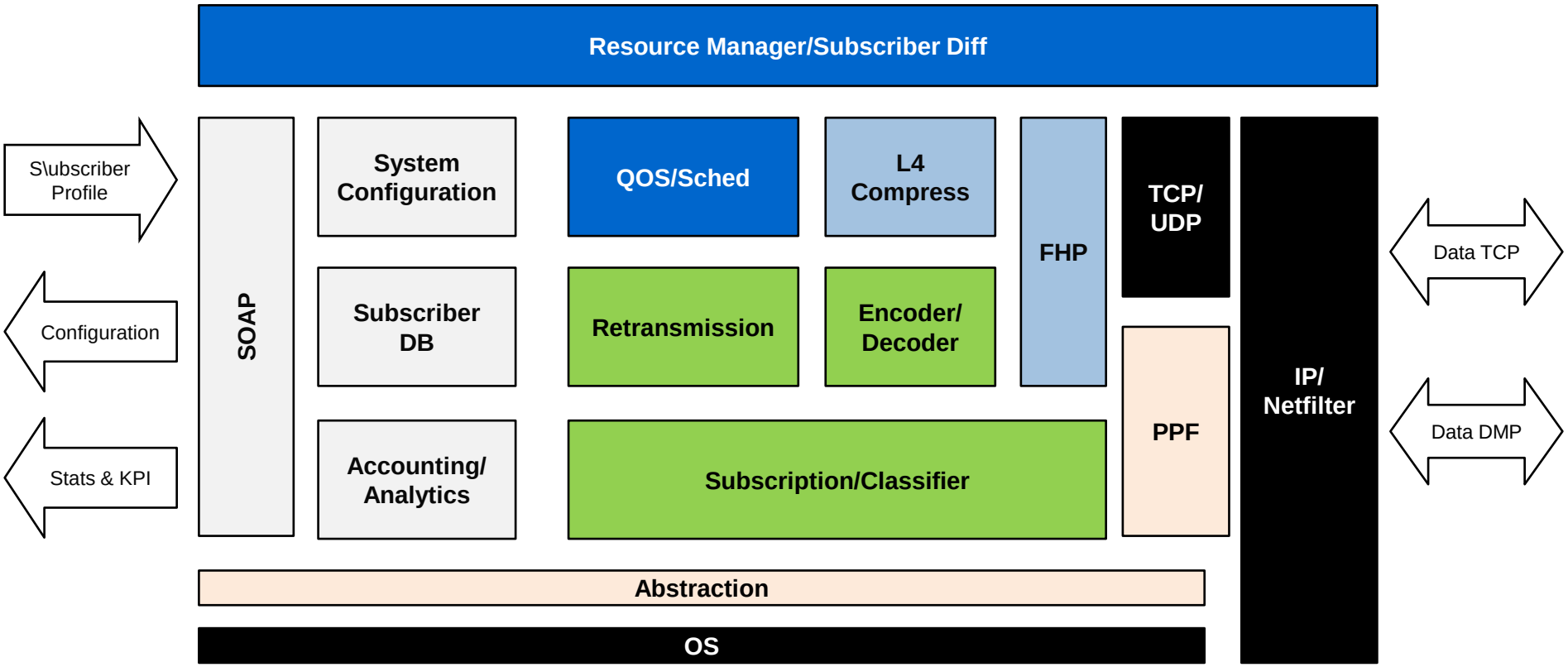
Appendix

DMP Mechanisms



- Aggregated session management (ASM) across RAN segment:
  - Replaces independently maintained Tx windows of TCP
  - Optimal congestion contribution and throughput are balanced
- Per UE managed data-in-flight (DIF):
  - DIF is dynamic to connection and conditions
  - Downstream and upstream shaped to realized connection rate
- Tightly managed resource allocation across active sessions of a user's equipment:
  - Conversely, enforcement is tightly coupled to congestion management and available connection rates in real-time

Server Architecture

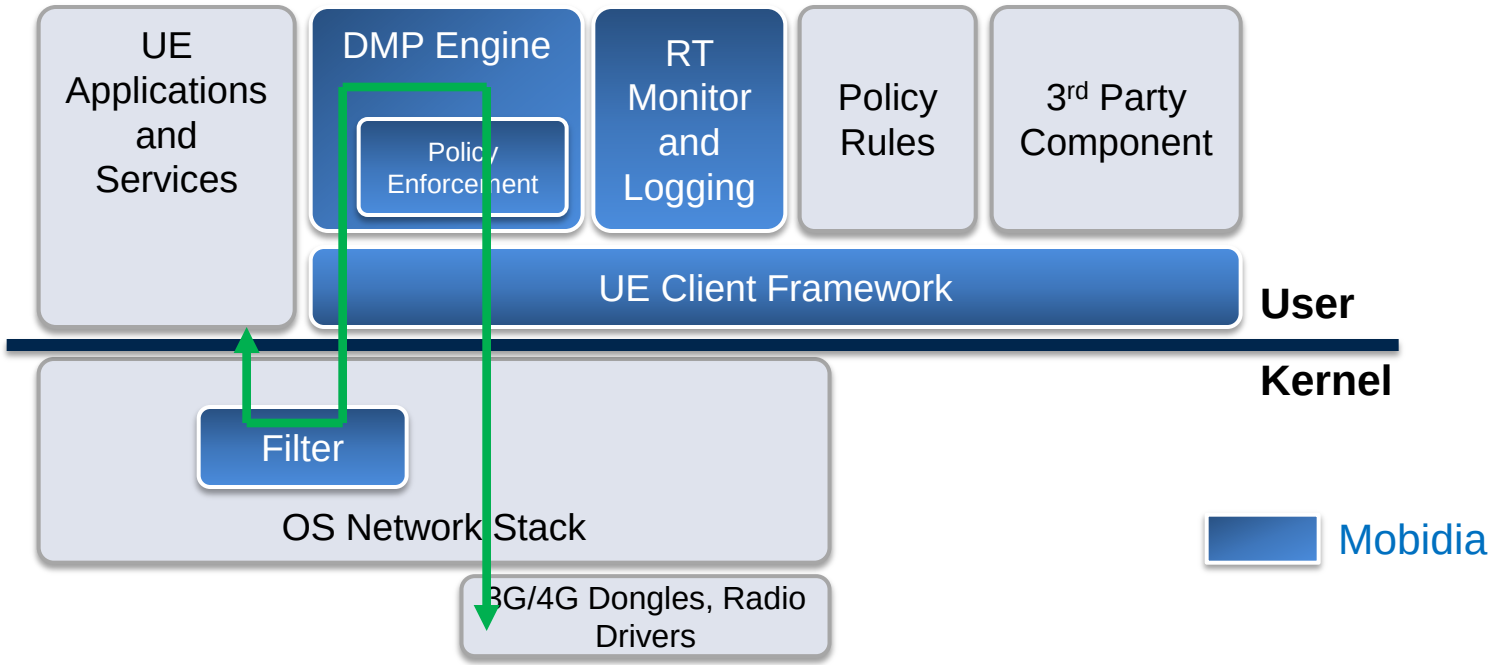


FHP – Far host proxy
PPF – Packet processing framework

Major Server Function Blocks

- Packet Processing Framework
  - Non-blocking event-based packet processing framework
  - Functional distribution and support for multiple cores:
    - Currently supports 4 cores; easily upgradable to new platforms
    - Thread pinning to optimize cache coherency
  - Control plane and data plane separation:
    - Supports three Ethernet interfaces for Control, Data-GGSN and Data-Internet
    - Optimized cache coherency with Ethernet card IRQ affinity
- DMP Core
  - Implemented inside Linux kernel as a loadable module:
    - Easily portable to user space at the API level
  - Framework supports multiple DMP versions running simultaneously
- FHP (TCP/UDP Translation Layer)
  - Implemented inside Linux kernel as a loadable module
  - TCP proxy uses Linux kernel native TCP stack:
    - Easy to integrate with other TCP stacks
  - Zero copy data transfer between TCP stack and DMP

Client Architecture



- Intercept point at L4
- Mobidia's client completely transparent to applications
- User space components common across multiple OS:
  - Windows 7/8, OS X, Linux (Android, MeeGo)
  - Key functionality in user space enables consistent behavior across all platforms
- Small kernel component customized for each platform:
  - Leverages defined intercept points provided by OS to anti-virus/firewall solutions