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# TLDK OVERVIEW

## TRANSPORT LAYER DEVELOPMENT KIT

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# Why TCP Performance matters?

## In the Cellular Network[1].

- TCP is 95.7% of downlink traffic, UDP is 4.1%.
  - HTTP/HTTPS account for 77.6% of all downstream bytes.
- Most TCP flows are small. On average 60.6% of the flows are smaller than 4 KB and only 9.5% of flows are larger than 32 KB.

## In the Wired Network [2].

- HTTP traffic dominates making up 60% of all traffic by bytes.
- Non-P2P lines pre-dominantly use HTTP, for which it contributes 72% of their traffic volume.

**TCP connection establishment rate is as important as throughput.**

# Evaluating TCP Stacks

| | |
|---|---|
| Performance | Connections setup/teardown rate<br>Throughput<br>RR Latency |
| Optimization | Core locality<br>Eliminating Mode Switching<br>Lock reduction<br>... |
| RFC Compliance | RFC 793 (TCP v4)<br>RFC 1948 (Defending Against Sequence Number Attacks)<br>RFC 2018 (TCP Selective Acknowledgment Options)<br>RFC 5681 (TCP Congestion Control)<br>... |
| API Compatibility | BSD Socks API |
| Maintenance | Total cost of ownership |

# What is TLDK (Transport Layer Development Kit)?

- TLDK is a high performance L4 protocol library with termination support for applications built using DPDK.
  - Support for UDP &TCP in client & server modes.
  - Support for common TCP options; MSS, timestamp, wnd scaling, s/ack.
  - Support for common TCP features; ddos protection, delayed ack, congestion control.
  - Support for common TCP HW offloads; TSO
  - Code examples demonstrating a number of use cases.
- TLDK implements core DPDK design concepts, such as
  - Bulk packet processing
  - Non-blocking API
  - No-mode switching
  - Cache optimization
  - Memory locality etc.

# What is TLDK (deeper dive)

- TDLK provides a socket-like API with familiar semantics (where possible).
- TLDK is application driven, protocols are driven by the application needing the data. Instead of data rx/tx events driving the application.

| Core TLDK Concepts | |
|---|---|
| Context (**tle_ctx**) | represents an 'independent copy of the stack‘, each owns set of <**tle_*_stream**> and <**dev**>. |
| Device (**tle_dev**) | abstracts the underlying device that RX/TX packets, understands the available transport protocols and hardware offloads. |
| Stream (**tle_*_stream**) | • represents an L4(UDP/TCP, etc.) endpoint address, and is an analogy to socket entity.<br>• belongs to particular <**tle_ctx**> but is visible globally across all threads (is multi-process safe). |

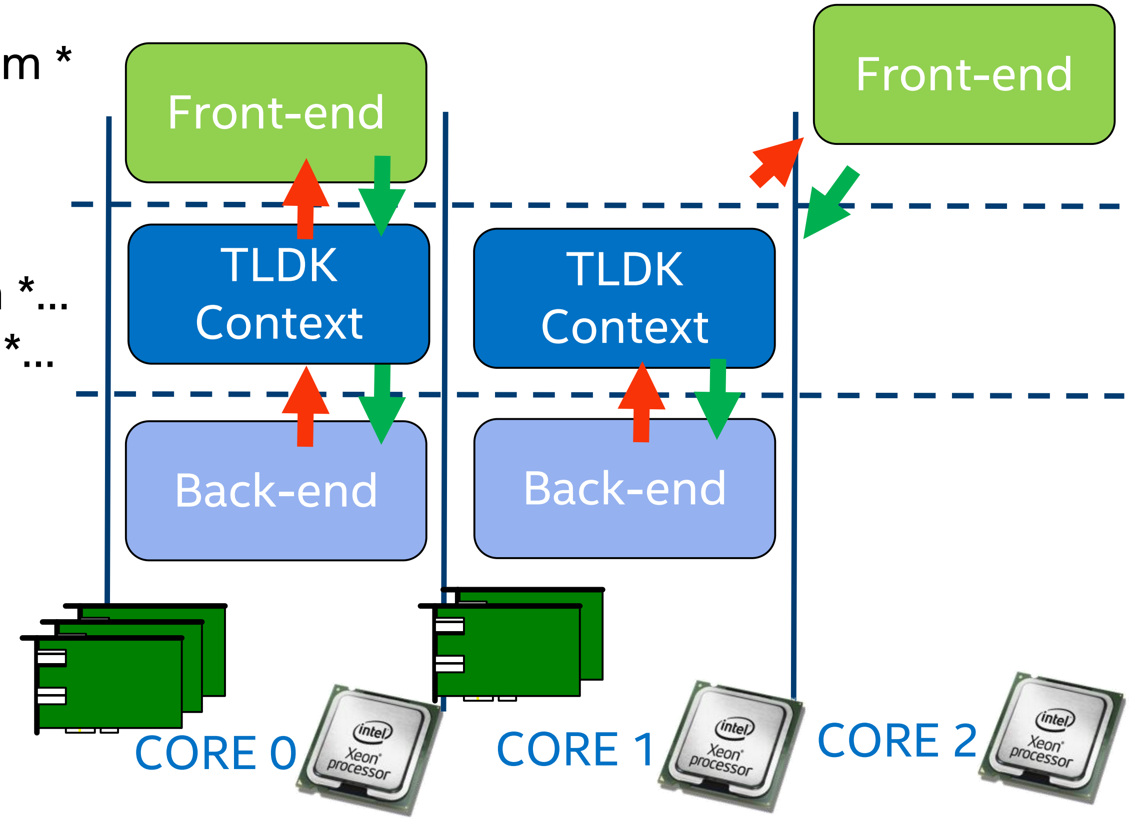
# How to write a TLDK TCP Application?

## TLDK Frontend

- tle_tcp_stream_accept(tle_stream *
- tle_tcp_reject(tle_stream *
- tle_tcp_stream_close_bulk(…
  tle_stream *ts[])
- tle_tcp_stream_send(tle_stream *…
- tle_tcp_stream_recv(tle_stream *…

## TLDK Backend

- tle_ctx_create
- tle_add_dev(tle_context* …
- tle_tcp_tx_bulk(tle_ctx *ctx
  ⇒ *rte_eth_rx_burst*
- tle_tcp_rx_bulk(tle_ctx *ctx
  ⇒rte_eth_tx_burst



# TLDK Performance (non-optimized code)

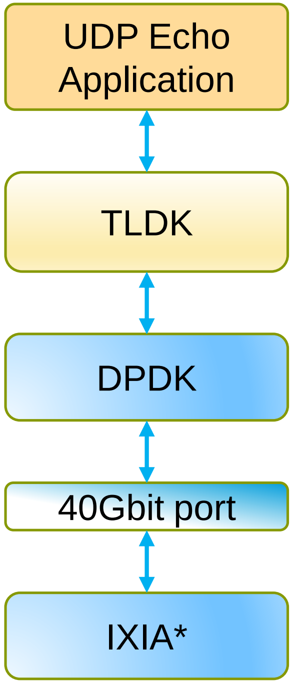
CPU: Intel® Xeon® Processor E5-2699 v3 @ 2.30GHz
64G Ram, Dual socket system, 2x400GB SSD, 2x1TB drives

NIC: Intel® Ethernet Controller XL710 for 40GbE QSFP+
Firmware: 5.04 0x80002505 0.0.0

DPDK: 16.07

Linux: Ubuntu* 15.10 (GNU/Linux 4.2.0-16-generic x86_64)

TLDK: Current release (2016-09-15)

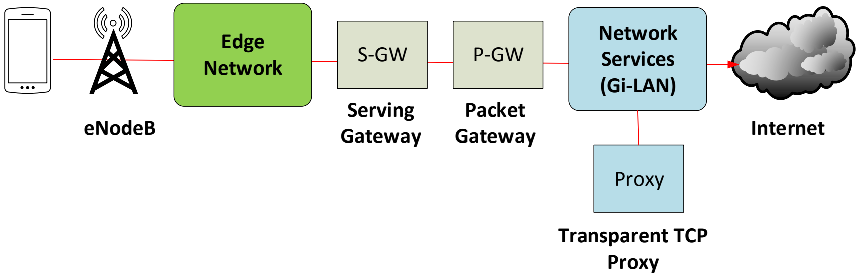



UDP Packet size used is 64 bytes, 5 cores we max out the PCI

| #Physical Cores | #Queues | Frame Rate Mpps |
|---|---|---|
| 1 | 1 | 7.4 |
| 2 | 2 | 14.8 |
| 3 | 3 | 22.2 |
| 4 | 4 | 29.5 |
| 5 | 5 | 36.4 (max for PCI) |

# Some possible use-cases for TLDK

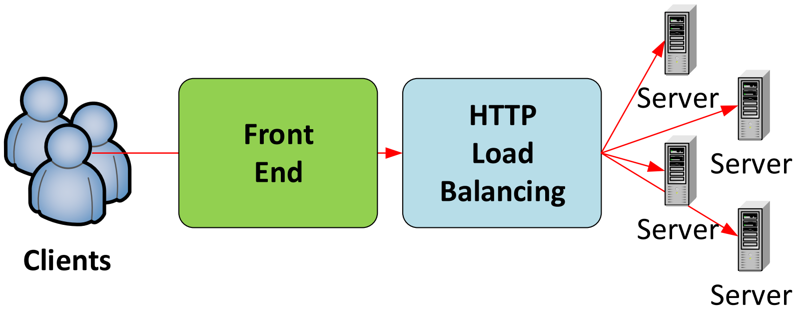
## TCP Transparent Proxy




- Common middle box in the cellular network, deployed in the Gi-LAN
- Observes & passes-through the 3-way hand-shake and setups a shadow flow.
- Sends ACK's on behalf of Client, caches TCP packets close to the network.
- Benefits are latency splitting, reduction in retransmission and buffer-bloat.

## Reverse Proxy & Load-balancer

- Common middle box in the data-centre, deployed between the Front-end (IDS/FW) and webservers.
- Typically supports features; server fault detection, session persistence.
- Typically supports distribution algorithms; round-robin, ip-hash and least-connected.
- Benefits are optimizing resource utilization, maximizing throughput, reducing latency, and ensuring fault-tolerant configurations.



# Summary

- Network operators, data centres are optimizing TCP workloads to reduce impedance mismatch, improve overall utilization, UX …
- Userspace TCP/UCP stack's are growing in popularity for reasons of performance and ease of upgrade.
- TLDK is a grounds up based on core DPDK design concepts designed to achieve ***Network Node*** performance requirements.

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Wiki: **wiki.fd.io/view/TLDK**

Call to action – ***we need feedback and contributions from fellow travellers to design, contribute code, optimizations, sample use cases etc!***

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# References


1. Comparison of Caching Strategies in Modern Cellular Backhaul Networks. S Woo et al., 2013
2. On Dominant Characteristics of Residential Broadband Internet Traffic, Maier et al., 2009

# Why TCP Performance matters?

## In the Cellular Network†

- TCP is 95.7% of downlink traffic, UDP is 4.1%.
  - HTTP/HTTPS account for 77.6% of all downstream bytes.
- Most TCP flows are small. On average 60.6% of the flows are smaller than 4 KB and only 9.5% of flows are larger than 32 KB.
- Median throughput is 21.1 Kpbs, the 90th %-tile is only 182.4 Kpbs. Most flows are short lived and never leave the TCP slow-start phase)

† Source: Comparison of Caching Strategies in Modern Cellular Backhaul Networks. S Woo et al., 2013

**TCP connection establishment rate is as important as throughput.**

# Why TCP Performance matters?

## In the Wired Network †

- HTTP traffic dominates making up 60% of all traffic by bytes.
- Roughly 3% of DSL-lines use P2P protocols and their traffic accounts for 30% of all volume.
- Non-P2P lines pre-dominantly use HTTP, for which it contributes 72% of their traffic volume.

† Source: On Dominant Characteristics of Residential Broadband Internet Traffic, Maier et al., 2009

TCP performance is an important part of UX

# Userspace TCP Implementations†

| | |
|---|---|
| NetBSD Based | Rump Kernel - github.com/rumpkernel |
| FreeBSD Based | Libplebnet - github.com/opendp<br>Libuinet - github.com/pkelsey/libuinet<br>DPDK_ANS - github.com/opendp/dpdk-ans |
| Linux Based | Linux Kernel Library - github.com/lkl/linux |
| Non-OS origin | VPP TCP - git.fd.io/vpp<br>OpenFastPath - www.openfastpath.org (is this based on FreedBSD).<br>mTCP - shader.kaist.edu/mtcp<br>Seastar - www.seastar-project.org |

† a non-comprehensive list.

# TLDK Design

| | |
|---|---|
| Performance | Connections setup/teardown rate<br>Throughput<br>RR Latency |
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Prioritize TCP performance, target TCP aggregation points in the network.