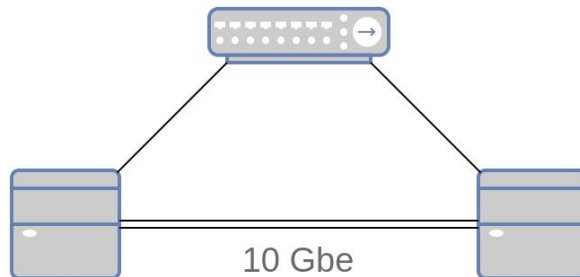# Performance Characteristics of the Interplanetary Overlay Network in 10 Gbps Networks

John Huff

Hardware

Dual socket Intel Xeon CPU E5-2697 v2 @ 3GHz

24 cores (48 virtual CPUs with hyperthreading)

Network interfaces: Intel Ethernet 10-Gigabit X540-AT2

iPerf 9.41 Gb/s

Testing methods

TCPCLA:
- Modified version of bpdriver/bpcounter
- Average instantaneous goodput on receiver over second half of test

CFDP:
- Time transfer of 1 GB file read from and written to ramdisk (tmpfs)

Testing Parameters

- Convergence layer adapters: TCPCLA
- Bundle size
- TCP buffer size
- Thread CPU affinity
- Memory vs File ZCO
- CFDP

NOTE: Unless otherwise noted, all tests were conducted running ION on a ramdisk, max heap is at least as large as bundle size, all threads locked to same CPU, rate limiting is turned off.
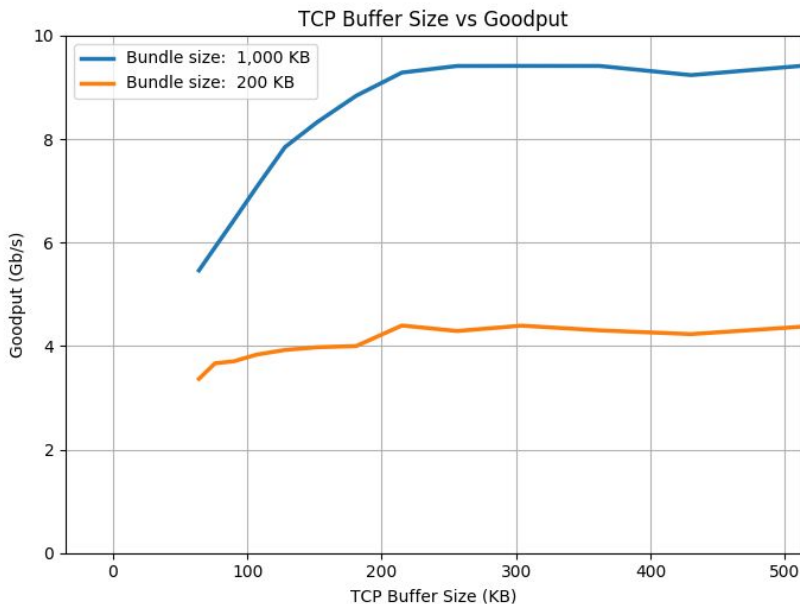
Bundle Size
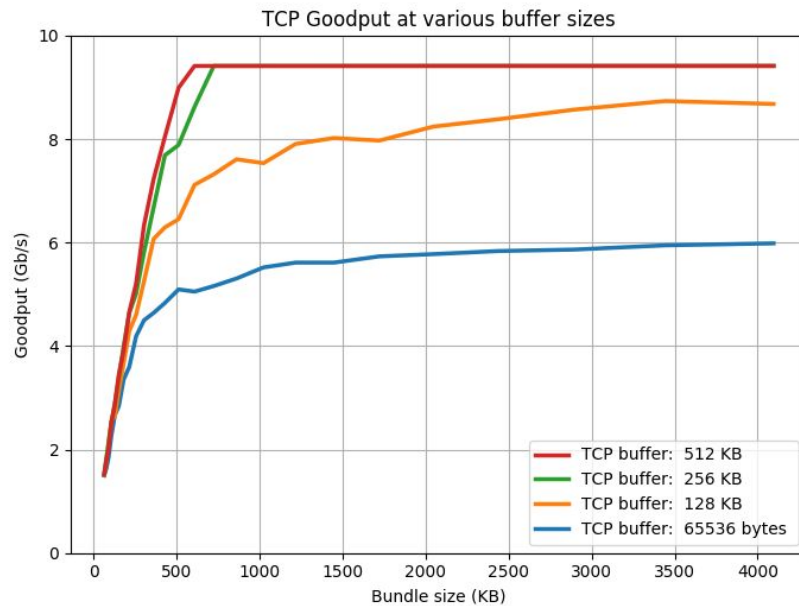
ION 3.7.0 stock
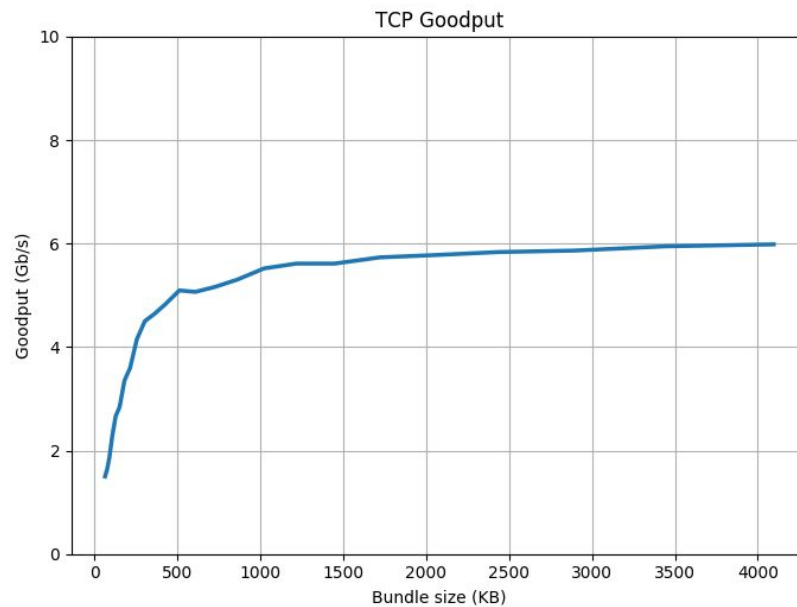
TCP buffer size

`bp/tcp/tcpcli.c`

`#define TCPCL_BUFSZ (64 * 1024)`

Buffer to read from socket into.

Data from buffer is stored in extent and appended to the bundle ZCO. Bundle is a ZCO consisting of a list of extents, each with max length of TCP buffer size.
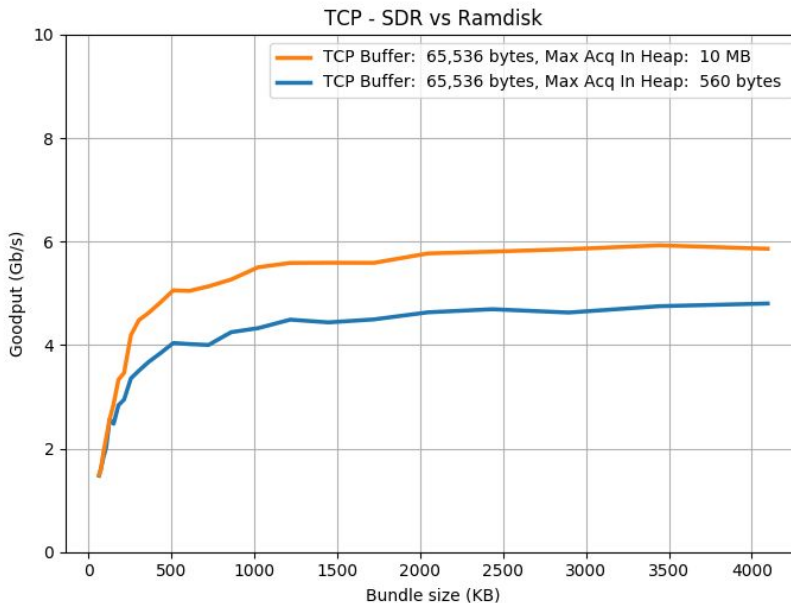
TCP buffer size

SDR vs Ramdisk

Using filesystem storage for ZCO decreased performance, even when using ramdisk.
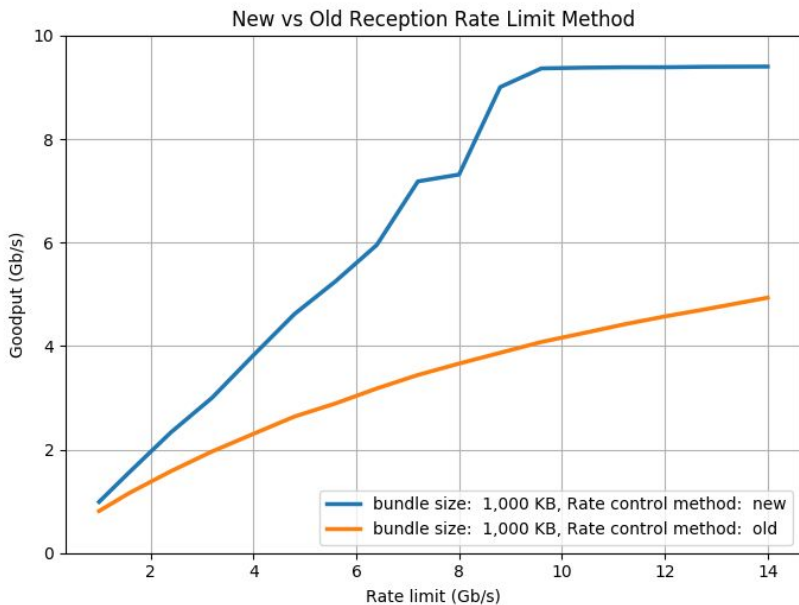
Rate limiting

Bug causing asymptotic behavior

Using xmit rate = 0 leaves rate limiting to TCP, but has undefined behavior in contact graph routing
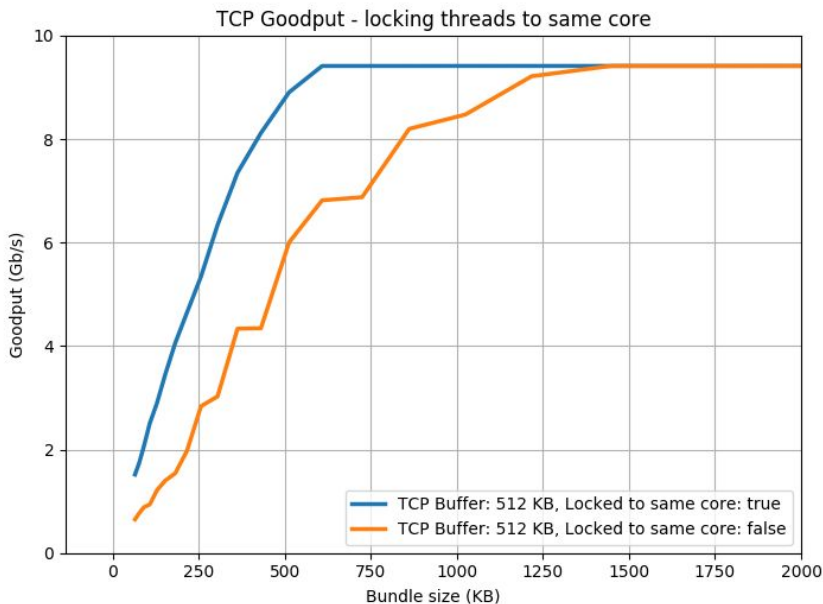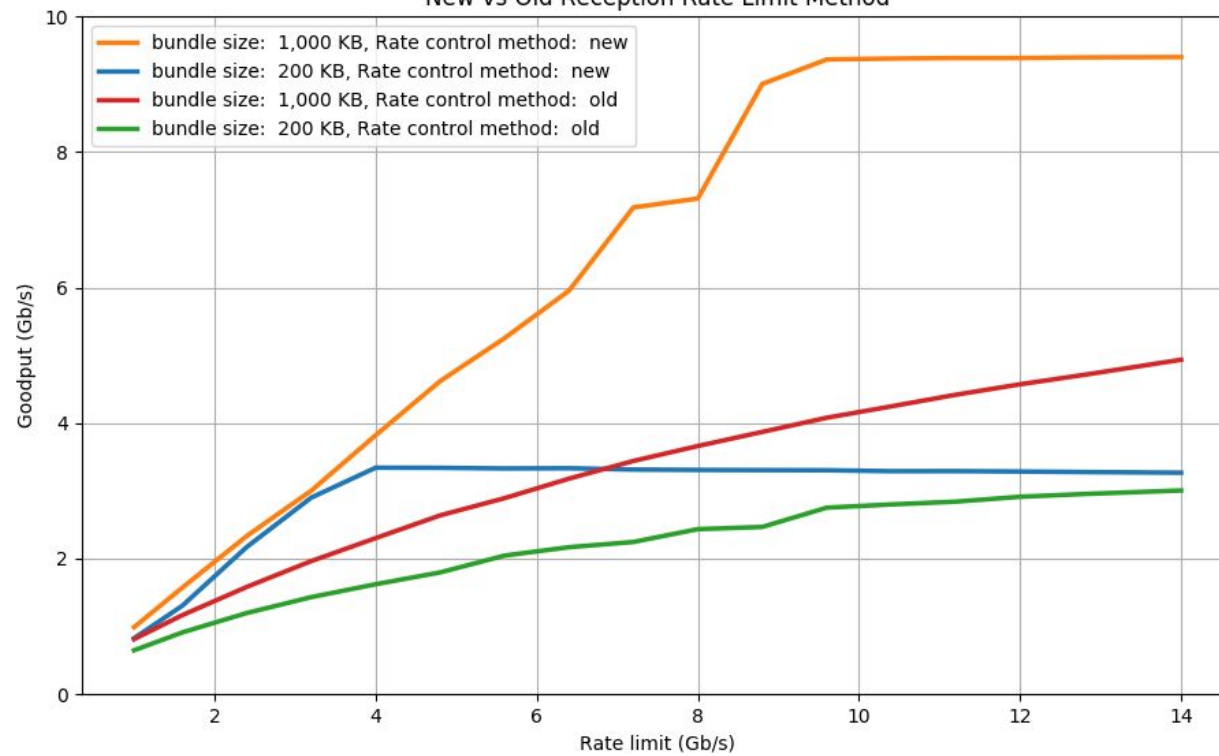
CPU Affinity

Locking all threads on all processes of an ION node greatly increases performance. (UNIX util: taskset)

Performance bump likely due to CPU caching. Same core = L1, L2 cache

Hardware dependent. Performance on hardware without caching would likely not be affected or be negatively affected.

TCP Goodput - locking threads to same core

TCP Buffer: 512 KB, Locked to same core: true
TCP Buffer: 512 KB, Locked to same core: false
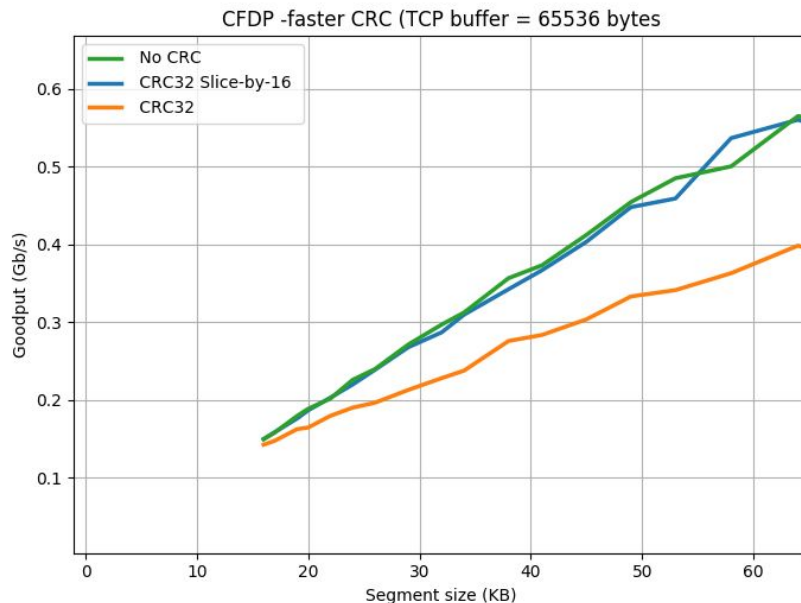
New vs Old Reception Rate Limit Method

CFDP

CCSDS File Delivery Protocol

Used in BPCP Utility

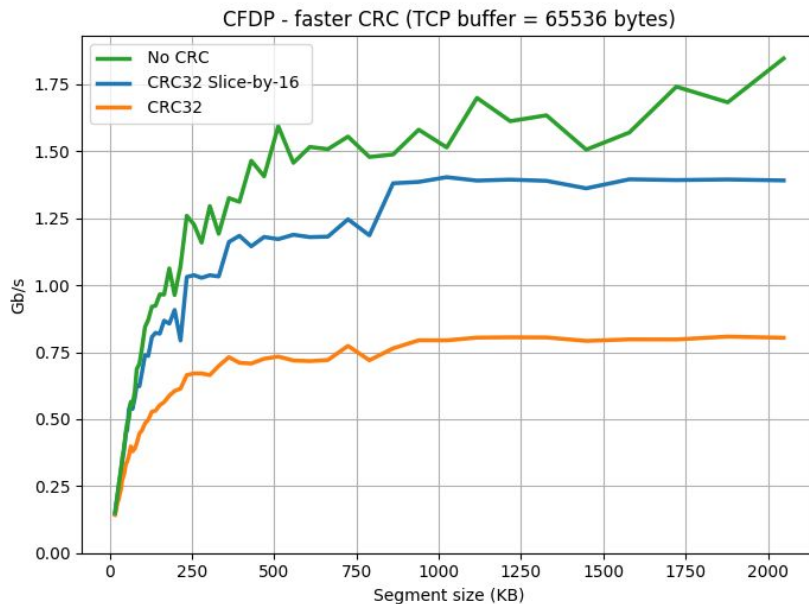Cyclic redundancy check (CRC) error-detecting code. Checksum for file.

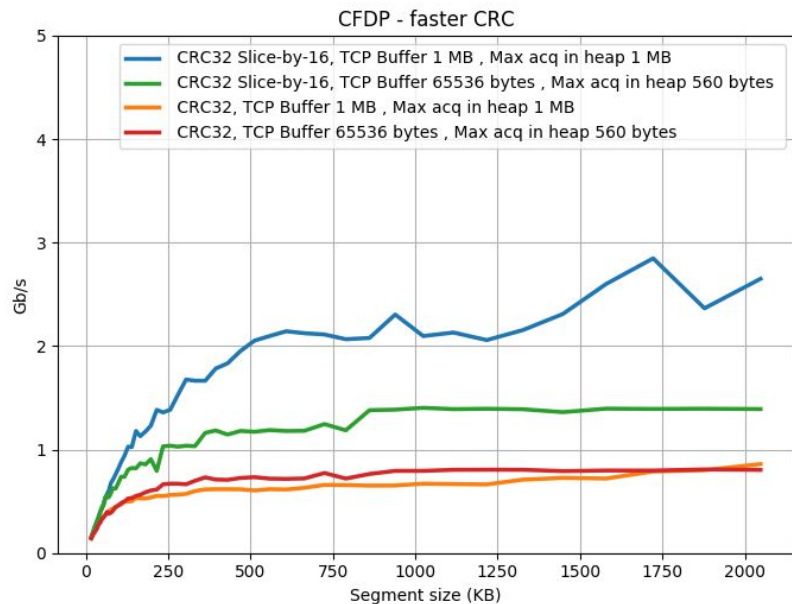Always calculated on sender, even if receiver doesn't request it

CFDP

Modified protocol to allow for segment sizes > 65536

Same result might be achieved using Delay-Tolerant Payload Conditioning (DTPC). New UT-layer adapter required.

CFDP - faster CRC (TCP buffer = 65536 bytes)

CFDP with larger TCP buffer

Summary & 10Gbps Deployment Recommendations

- Use bundle sizes >= 1M (or >= 512 KB if using large TCP buffer)
- Use TCP buffer size >= 512 KB (bpv*/tcp/tcpcli.c)
- Set heapmax >= maximum expected bundle size and >= TCP buffer size (bpadmin: m heapmax <max database heap for any single acquisition>)
- Lock all threads from all processes of same ION node to the same core. (taskset Unix util)
- CFDP: Use CRC32 slice-by-16

Repo branch: ion-4.0.0-high-speed. To compile use ./configure --enable-high-speed. Increases TCP buffer size to 512 KB, sets default CFDP checksum type to CRC slice-by-16. Addresses TCP rate limiting bug.

Future work

Test Licklider Transmission Protocol (LTP) over UDP, TCP

Test on slower hardware (Rockchip RK3399)