Integration and evaluation of QUIC and TCP-BBR in long-haul data transfers

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July 9, 2018

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2. TCP: BBR and Cubic
3. QUIC
4. Then... 100G
5. Acknowledgments

Initial disclaimer

- **First:** I am not a network man.
- PhD in Computational logic and parallel algorithms.
- Example: my previous submiissions to CHEP all related to Parallel Computing.
- Sysadmin at LT2 Brunel London.
- Half-time rented to Jisc (UK academic network) to help research institutions to improve performance in data transfers.

  Meaning... Transfer WLCG sysadmin experience?
- First task: Singaren...

First case

- A testbed
  - Singaren DTN: *filesender.singaren.net.sg:2811*
  - An old disk server at Brunel: *dc2-grid-e6-000.brunel.ac.uk*
    - Dual stack
    - RAM: 8 GB
    - Network: dual 10 gbps
    - CentOS 7 on kernel 4.16
  - 20 gbps link from Brunel to Jisc.
  - 10 gbps link from Singapore to Eurasia link.
  - A reference:
    DTN at CERN: *ftp://cern-dtn.es.net:2811/data1*
- Tools
  - The usual suspects: iperf3, traceroute, ping
  - globus-url-copy to serve disk-to-disk transfers
- Target: transfer files at 10 gbps

Framing the target

- How can we improve on

```
        [root@dc2-grid-e6-000 ~]#  globus-url-copy    -p 4 -vb \
        ftp://gridftp-user@filesender.singaren.net.sg:2811/data1/1G.file /dev/null
Source: ftp://gridftp-user@filesender.singaren.net.sg:2811/data1/
Dest:   file:///dev/
  1G.file  ->  null

   1071382528 bytes        42.57 MB/sec avg        78.00 MB/sec inst
```

- What is that saying?
  - 0.6 gbps on a 10 gbps link;
  - We are testing 100-200 gbps links at Jisc, 100 gbps to Australia.
  - Optical transmission speeds are approaching Terabit capacity;
  - yet, peak TCP session speeds are not keeping up.

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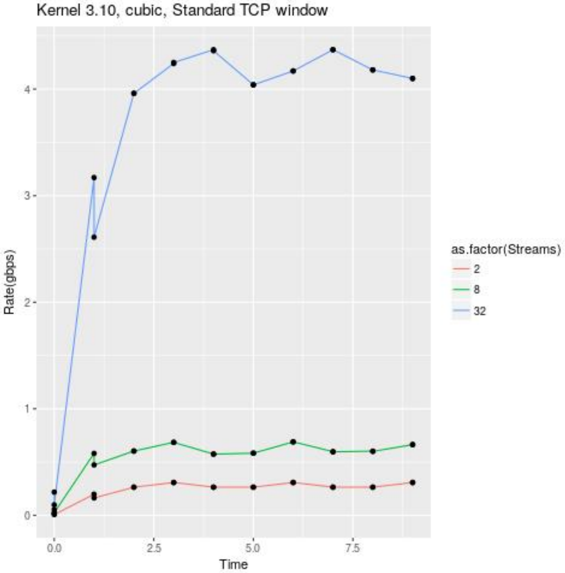
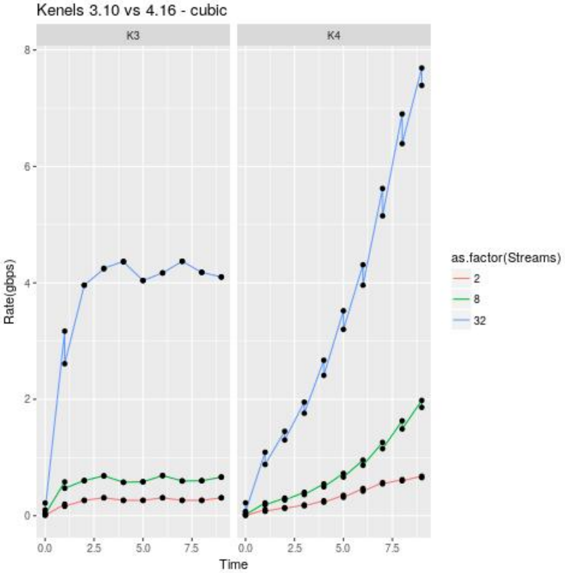
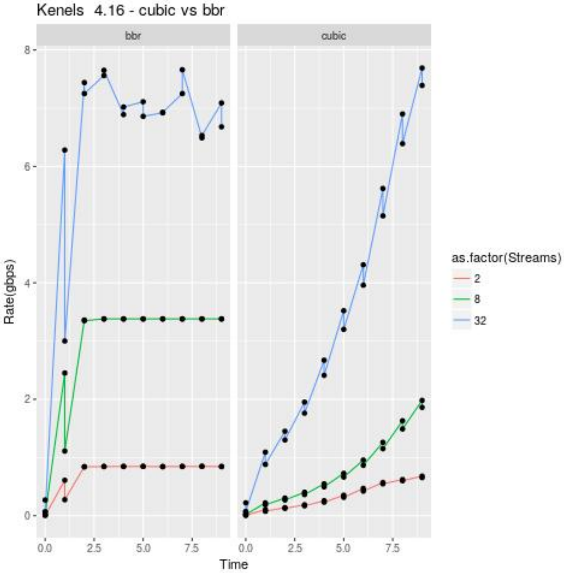
Status after link repair



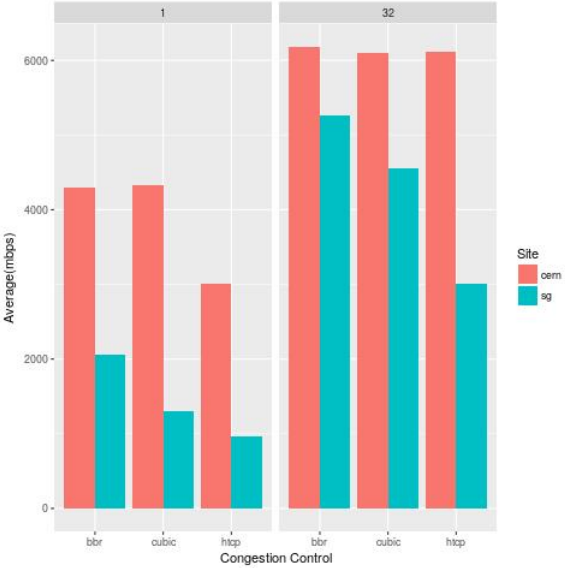
Move to kernel 4.16



BBR and Cubic in Kernel 4.16



BBR, Cubic and htcp



TCP protocol

- It's an ACK-pacing protocol: it reacts to past network states
  - An ACK signal shows the rate of data that left the network at the receiver that occurred at $\frac{1}{2}$ RTT back in time
  - if there is data loss, the ACK signal of that loss is already $\frac{1}{2}$ RTT old
  - If there is no data loss, that is also old news TCP should react conservatively to good news
- TCP control
  - Use ACK for $\frac{1}{2}$ RTT old event to increase/decrease the sending rate;
  - Minimise packet re-ordering;
  - Minimise packet loss.

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QUIC goodies

- QUIC is defined on top of UDP with user space implementation.
- Data sent directly on connection establishment.
  - 0-RTT connection establishment;
  - great in long haul transfer and in presence of packet loss.
- Flexibile to mix with a variety of congestion control approaches: Cubic available, BBR in use at Google(?).
- Encrypted connections by default.
  - It will make some UK biomed community happy.
  - It makes it harder for network middle boxes tampering with traffic. We end network people could be happy.
- Multi-streaming protocol

QUIC in test

- QUIC is used in Google services (claims of 7%) of traffic.
- IETF workgroup points to a dozen implementations.
- Most won't compile.
- Prototype built on top of: quicr, and ngtcp2.
- Debug stage
- Local 10 Gbps testbed
- Rates below 4 Gbps

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100G network

- Brunel HPC clusters
  - Omnipath and Infiniband
  - Kernels 3.10 and 4.16
  - TCP limits below 90 gbps
- Geant
  - Richard-Hughes Jones (Geant and SKA) testing 100 gbps link Europe to Australia.
  - Linux kernel 3.10
  - Lmited TCP rates below 90 gbps.
  - Using Cubic with varied TCP windows, but up to 40 MB
- Jisc testbed
  - 100 gbps, Melanox based
  - Hierarchy of NVMes, SSDs, HDDs targeting 100 gbps between persistent storage.
  - Based on Netflix architwecture: only 100 Gbps success?
  - First step: local tests only.
  - To be available for testing by research institutions.

On going work

- Brunel storage slowly moving Kernel 4.16
  - BBR to evaluated
  - Network performance counters under investigation.
- Half of Brunel compute nodes already on kernel 4.16 and using BBR.
- Brunel/Jisc QUIC tool (proof of concept) should be available soon (4 weeks?)
- Jisc new 100 Gbps testbed to be available in August

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On going work

Lopes, and Rand are members of the GridPP collaboration and wish to acknowledge funding from the Science and Technology Facilities Council, UK.