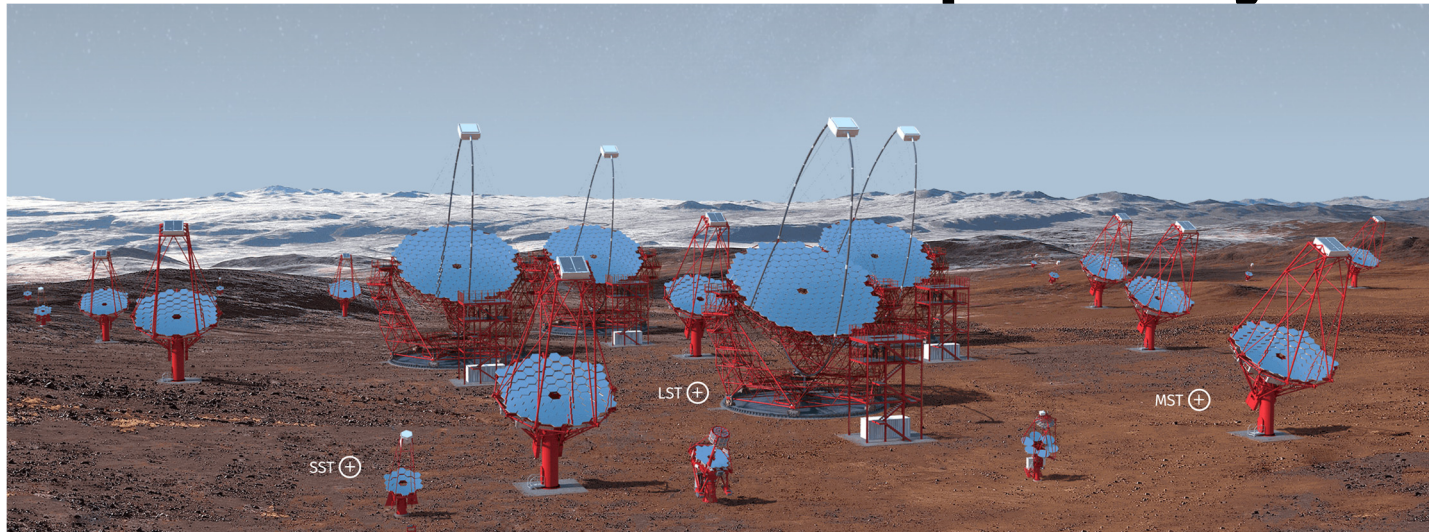


A New ACS Bulk Data Transfer Service for CTA

**Mauricio Araya, Leonardo Pizarro, Horst von Brand,
Marcelo Jara, Rodolfo Castillo, Igor Oya, Etienne Lyard**

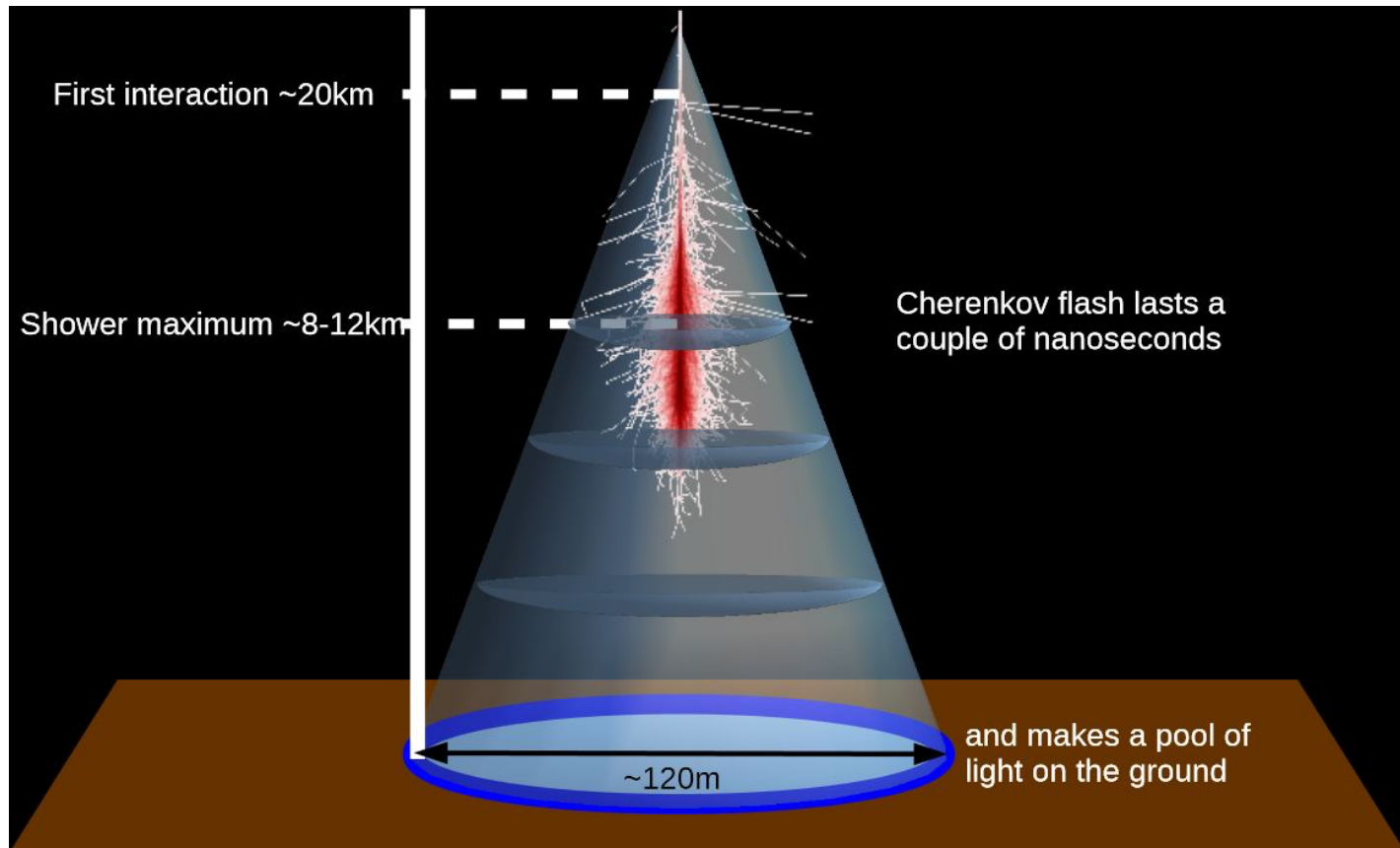
Cherenkov Telescope Array



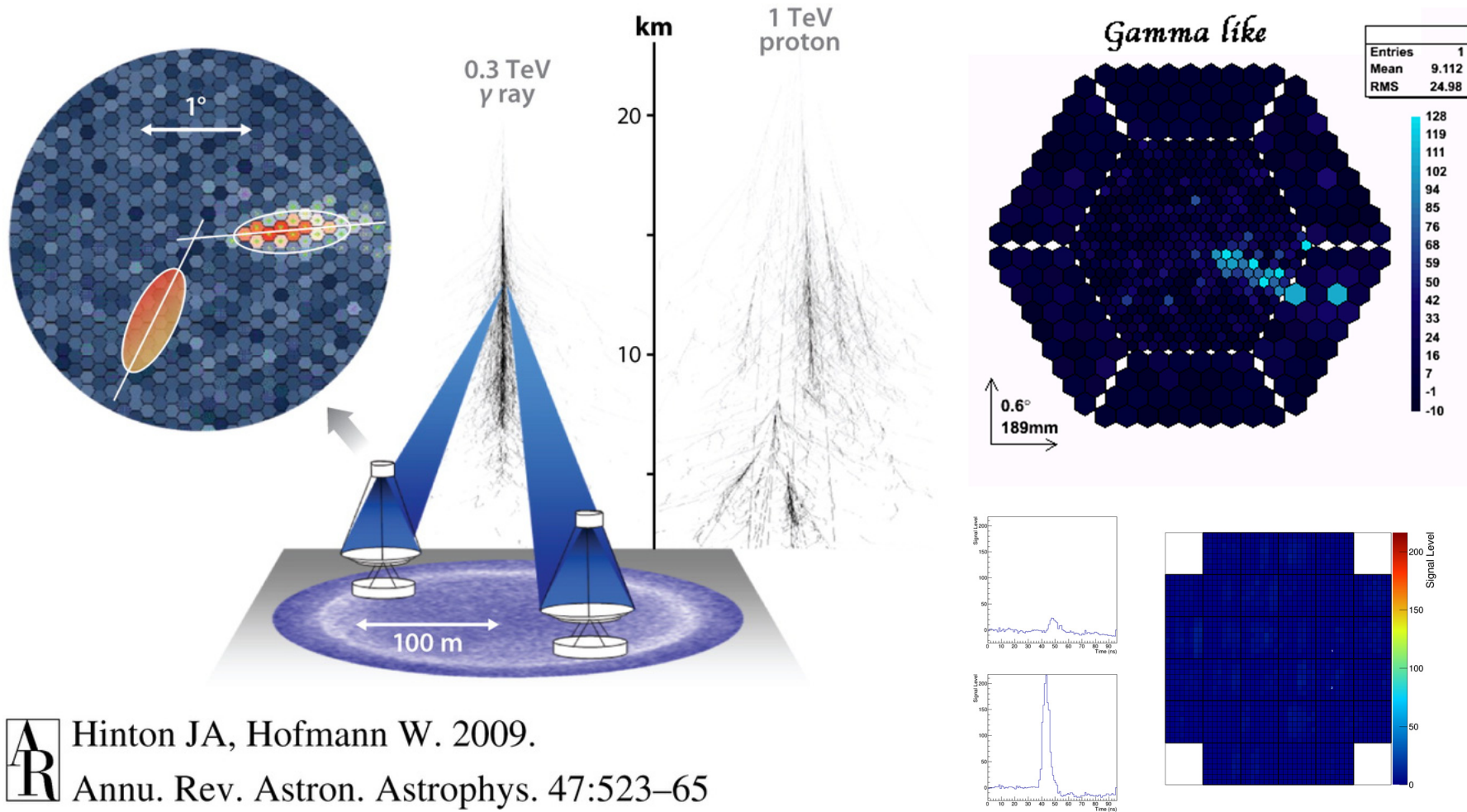
- Ground-based Gamma-Ray Observatory
 - Will be the largest
 - Will be the most sensitive
- More than 100 telescopes
 - Antofagasta
 - La Palma



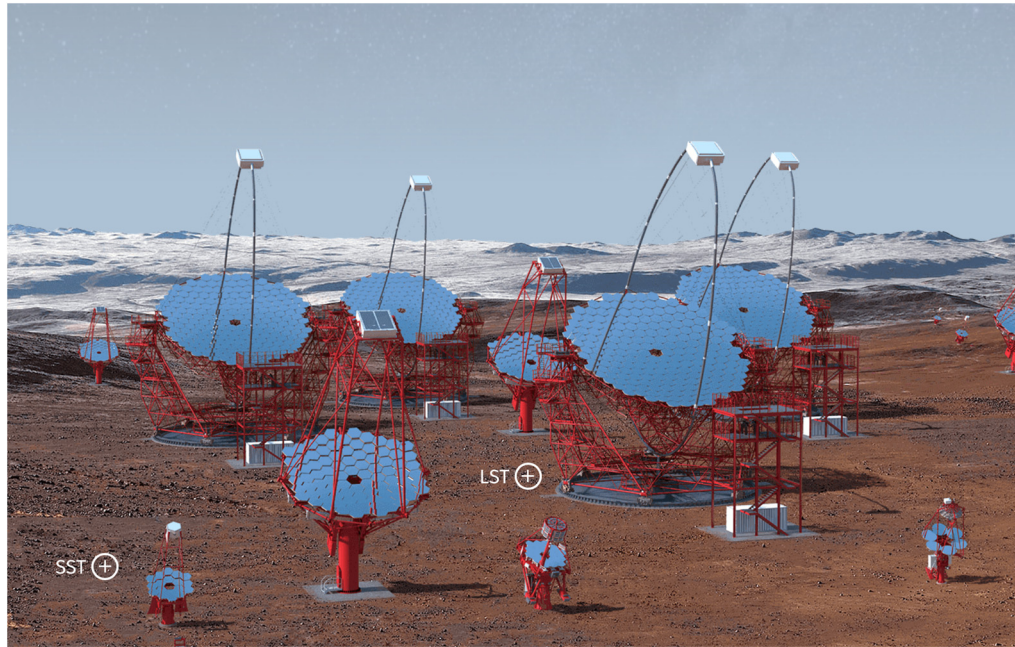
Imaging Atmospheric Cherenkov Technique



Imaging Atmospheric Cherenkov Technique




 Hinton JA, Hofmann W. 2009.
 Annu. Rev. Astron. Astrophys. 47:523–65



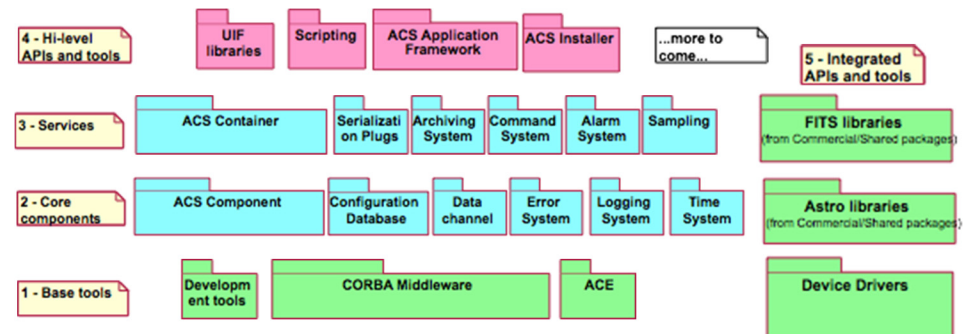
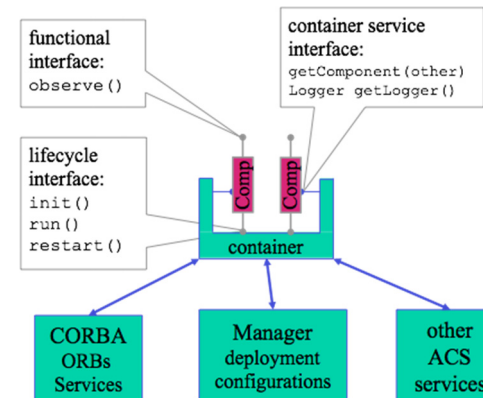
- An array of mounts
 - Very precise
 - Complex instruments
 - Distributed system



- ALMA provides that
 - **ALMA Common Software (ACS)**
 - DevIO Implementations

ALMA Common Software

- **Distributed Control Framework (Array Control)**
- Ideal for high-level CTA control
- Development 2000-2015
- Users: ALMA, APEX, GTC
- Currently under operations
- **Reusable**
 - But need to be adapted



Data Acquisition is Different

- Monte-Carlo Simulations
 - Maximum readout of 80 Gbps
- Approximately 5 Gbps x Camera (compression)
 - Need a highly-performant **bulk-data transfer service**

camera type	goal rate	data rate
LST	15.0 kHz	27.8 Gb/s
MST-NectarCAM	9.0 kHz	32.7 Gb/s
MST-FlashCAM	9.0 kHz	4.4 Gb/s
SST-2M-G	0.6 kHz	2.0 Gb/s
SST-2M-AS	0.6 kHz	0.07 Gb/s
SST-1M-DG	0.6 kHz	0.34 Gb/s
SCT	2.5 kHz	28.3 Gb/s

Site	Trigger Rate for Hadrons (Hz)	LST/event	MST/event	SST/event	SCT/event
CTA-South	39941	0.5421*	1.8260	0.6149	0.6523
CTA-North	17017	1.1895*	2.2048	-	-

Telescope type	Pixels per camera	Window (ns)	Samples (per ns)	Bytes/sample	Bytes for header	Bytes/pixel
LST	1855	30	1	4	5	125
MST-NectarCAM	1855	60	1	4	5	245
MST-FlashCAM	1764	60	0.25	2	5	35
SST-2M-G	2048	100	1	2	5	205
SST-2M-AS	2048	N/A	N/A	N/A	N/A	7
SST-1M-DG	1300	100	0.25	2	5	55
SCT	11328	60	1	2	5	125

Bulk-Data Transfer Service (BDT)

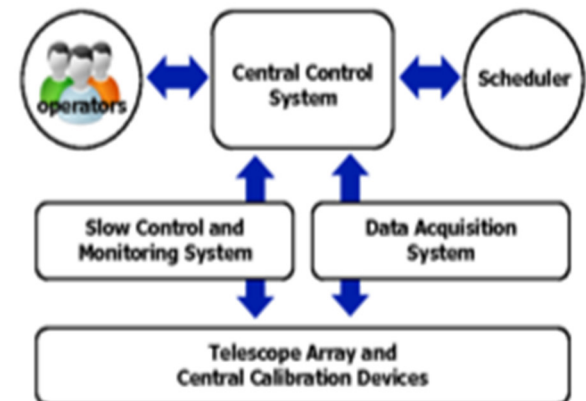
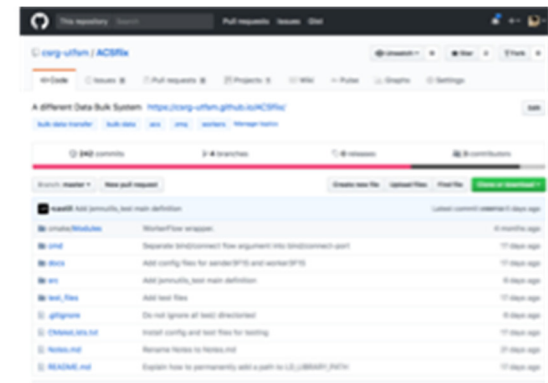
- ALMA's BDT-NG service
 - Based on DDS
 - Proprietary (RTI)
 - Tailored for ALMA
- ACS Community Branch
 - No Open Source Implementation
 - CORBA-based one is deprecated
 - But IDL is defined and agreed



Bulk-Data Transfer using 0MQ (BDT-Z)

- Highlights
 - Open-source alternative for CTA
 - Independent and ACS API
 - DAQ can focus on serialization
- Implemented in C++ using 0MQ
 - **Data Transfer:** Push-pull pattern
 - **Data Control:** Publisher-subscriber

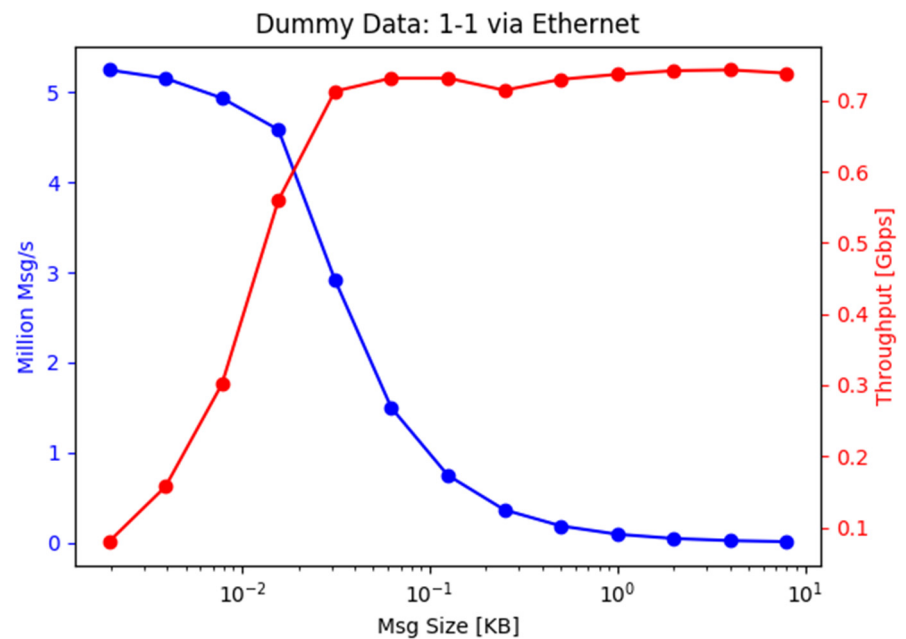
ØMQ



Performance

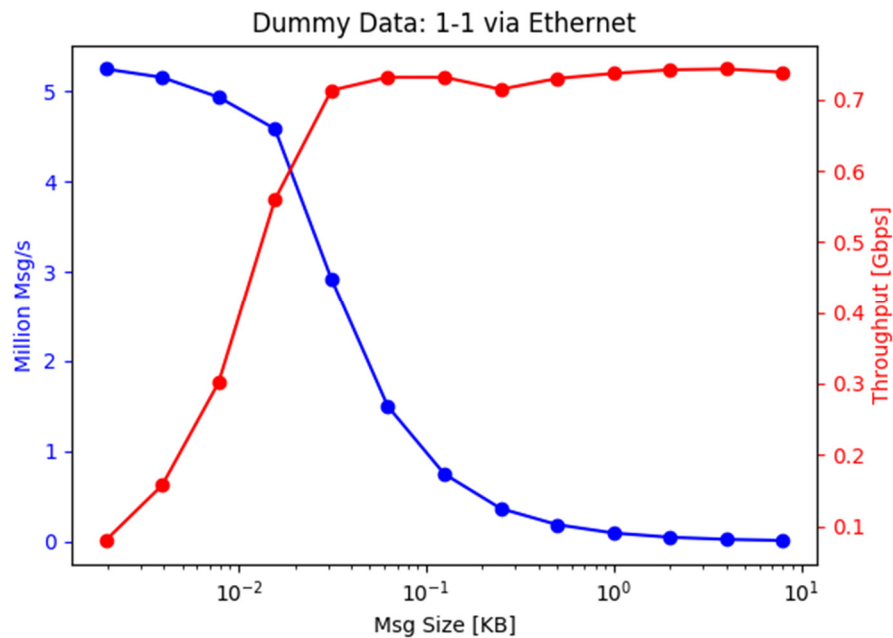
- Bulk Data Transfer
- **Throughput** (bps) is the key
- But not at all cost!
- We want CPU usage to be reasonable
- Load depends on generated **msg/s**
- We can vary the packet size

- Dummy data over Ethernet

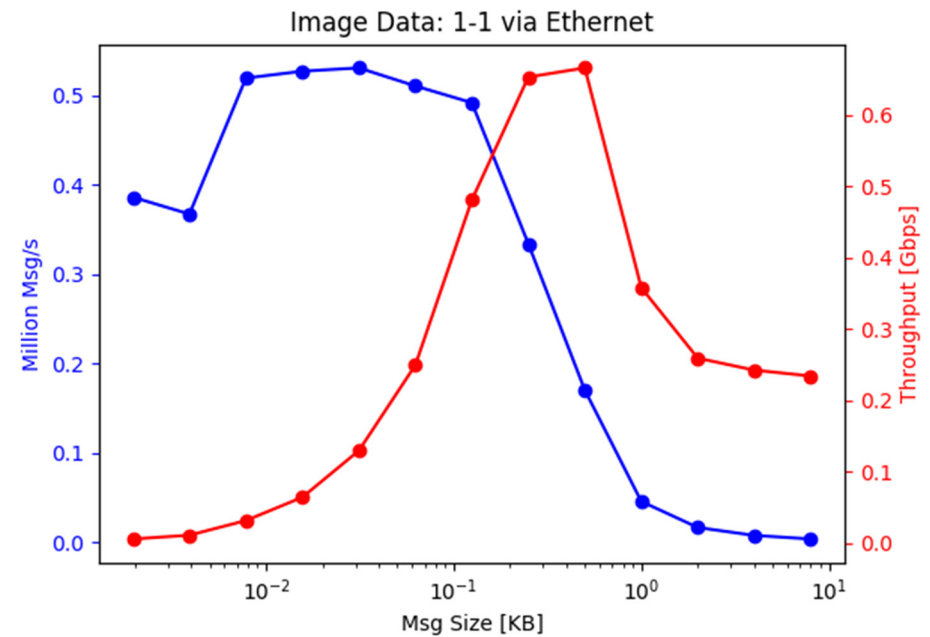


Performance

- Dummy data over Ethernet



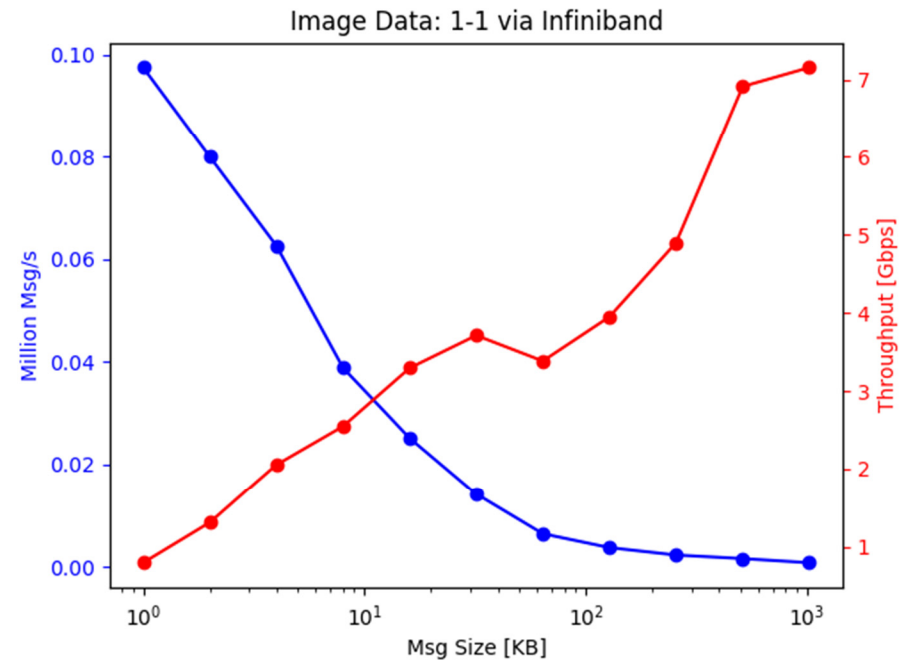
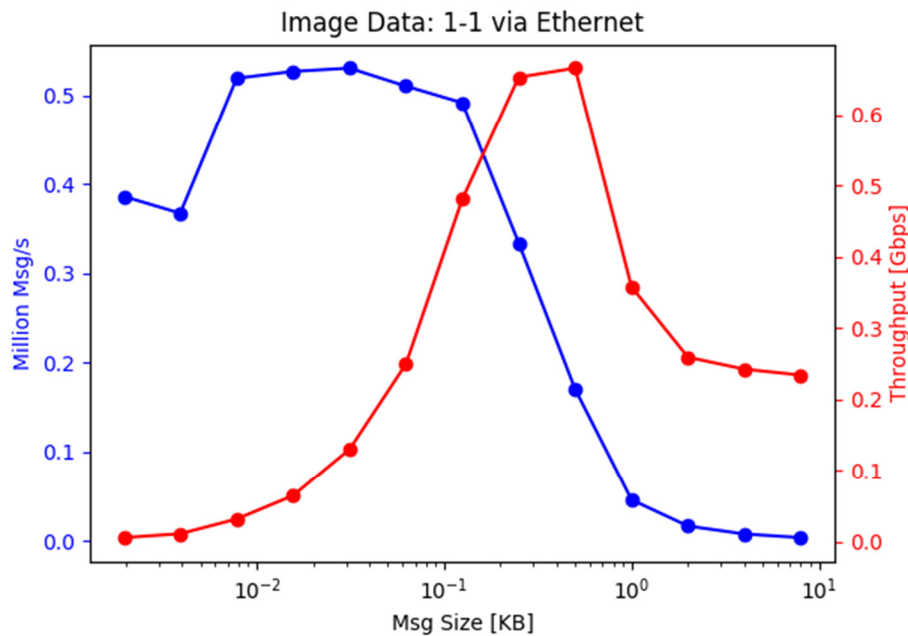
- Image data over Ethernet



Performance

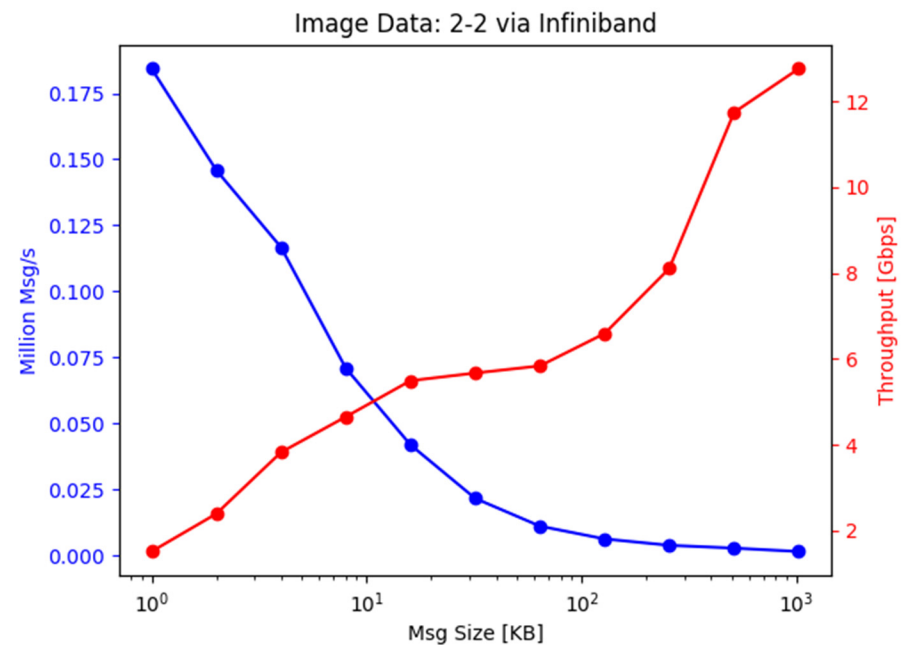
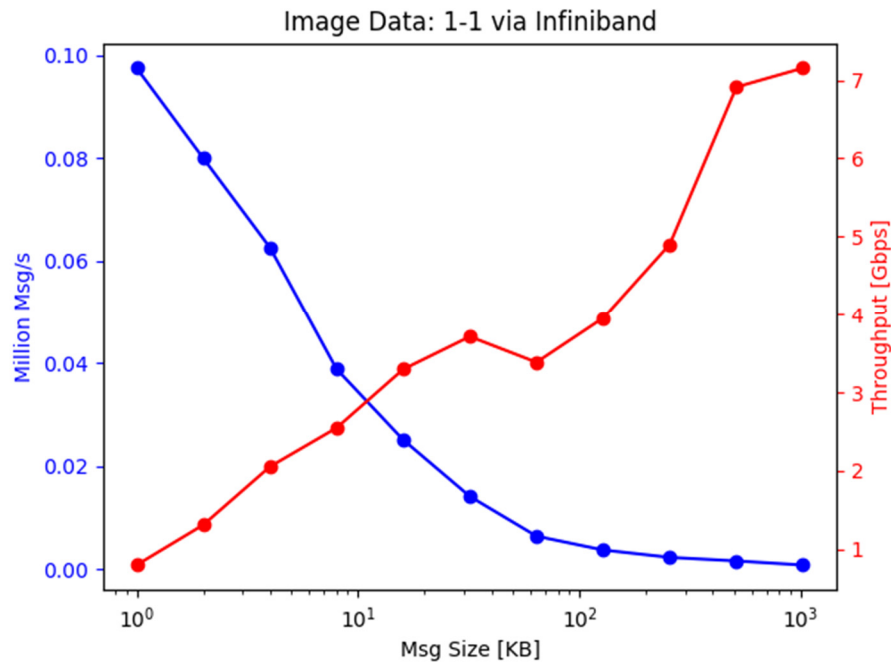
- Image data over Ethernet

- Image data over Infiniband (1)

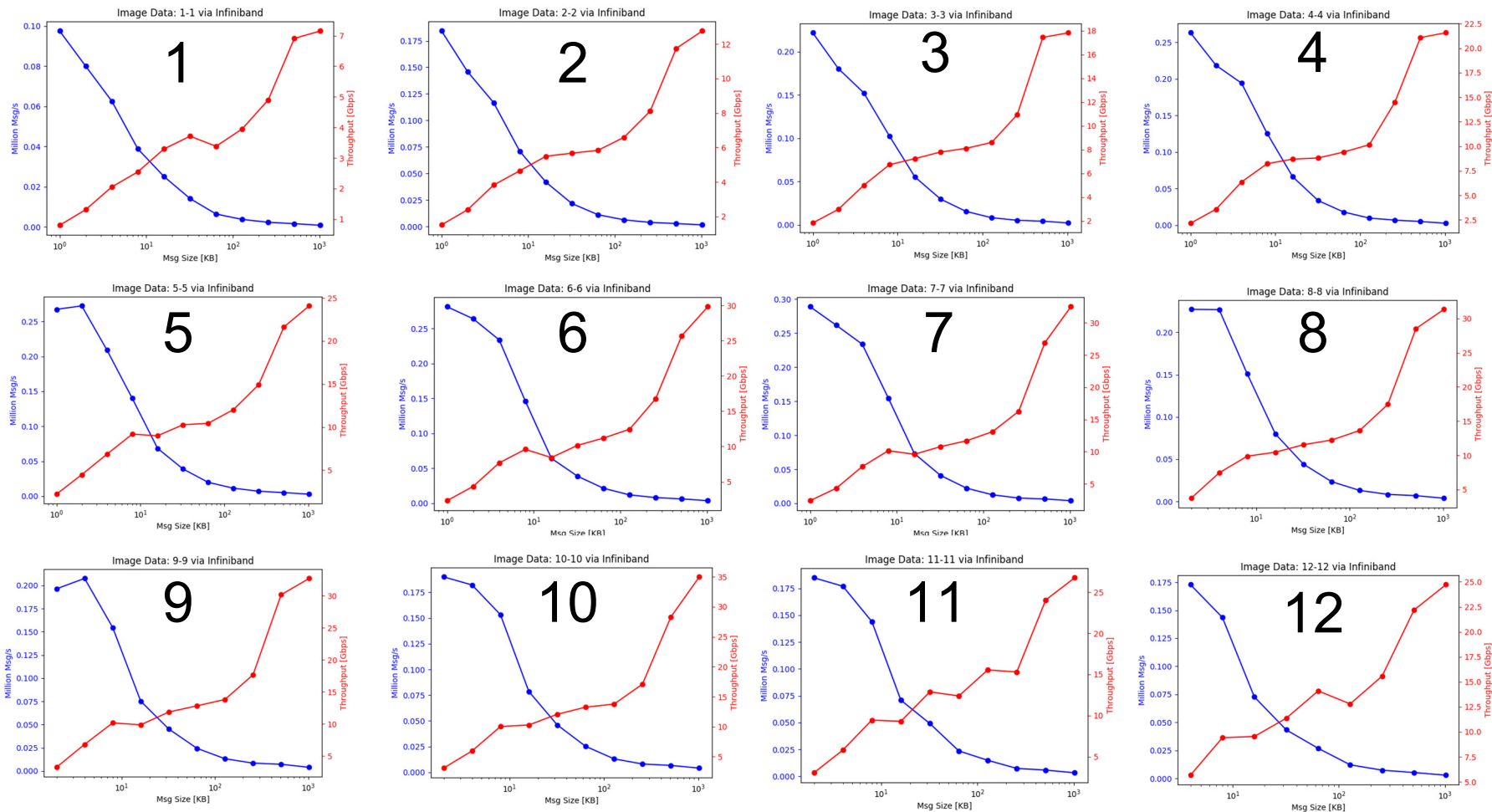


Performance

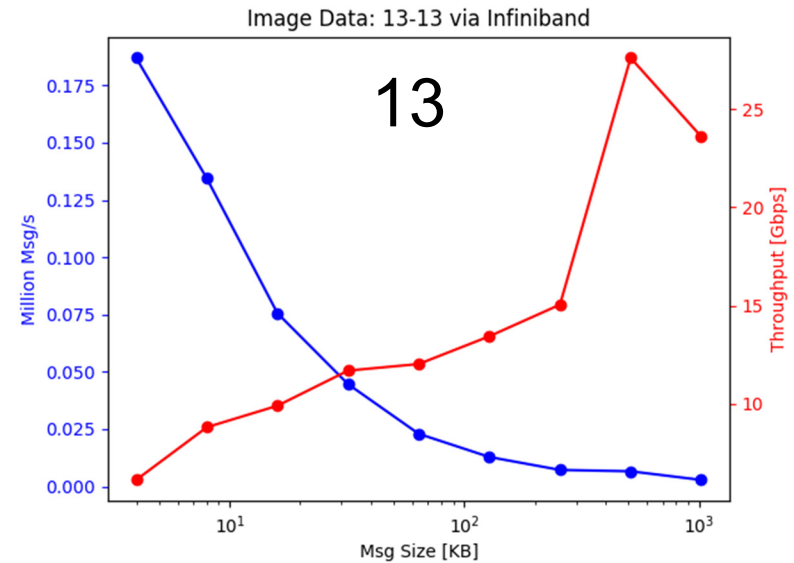
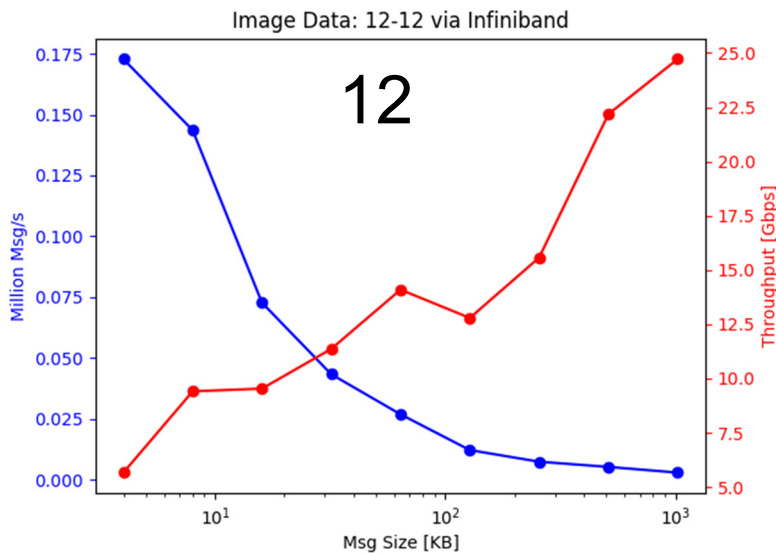
- Image data over Infiniband (1)
- Image data over Infiniband (2)



Performance



Performance



Oooops!

Performance

Image Data: 13-13 via Infiniband

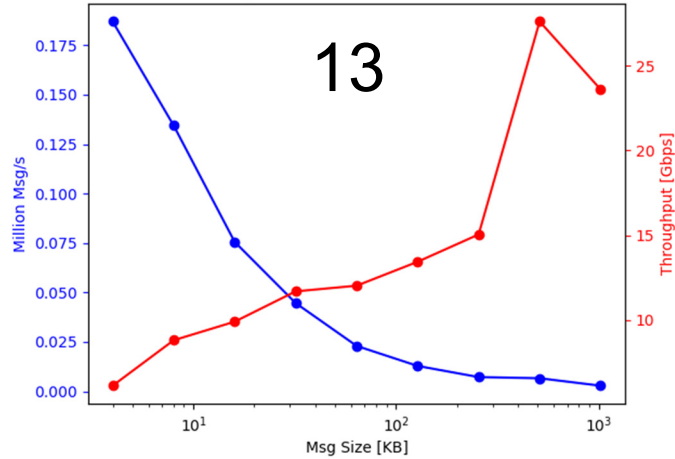


Image Data: 14-14 via Infiniband

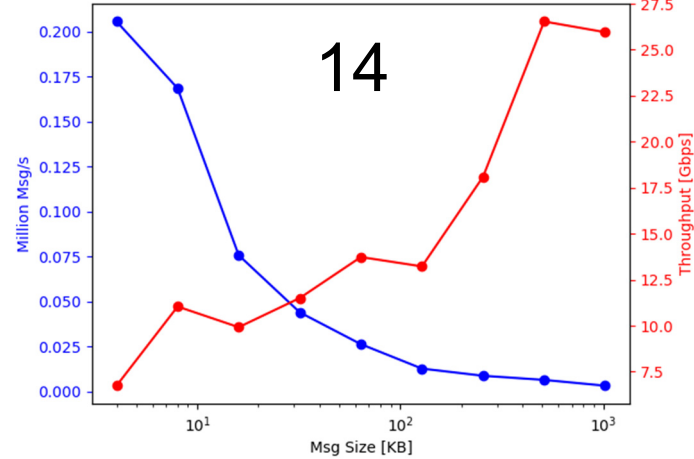


Image Data: 23-23 via Infiniband

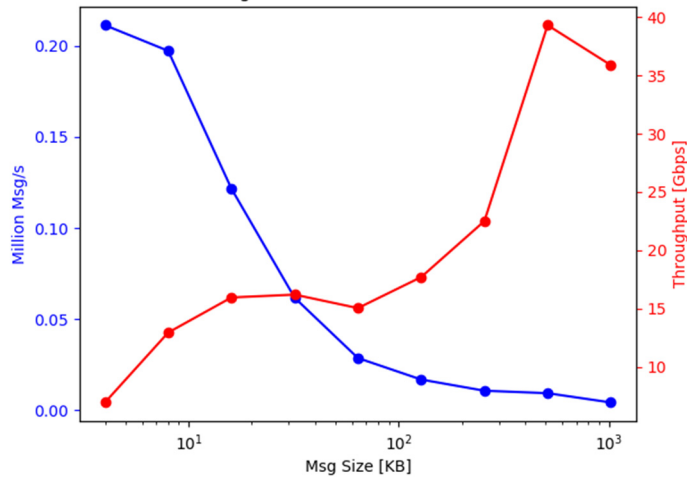
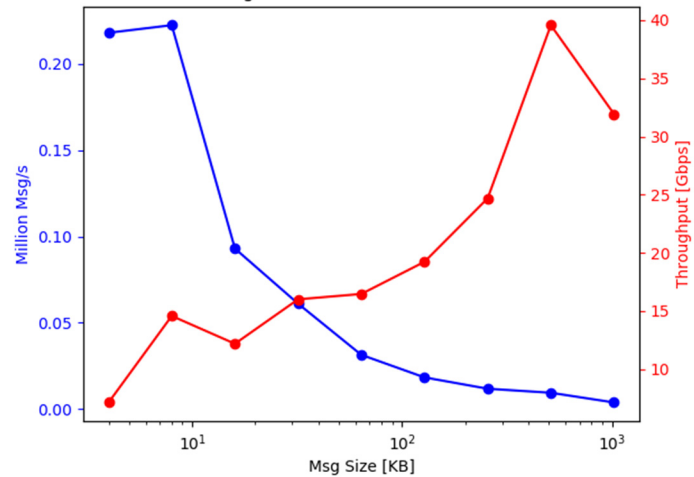
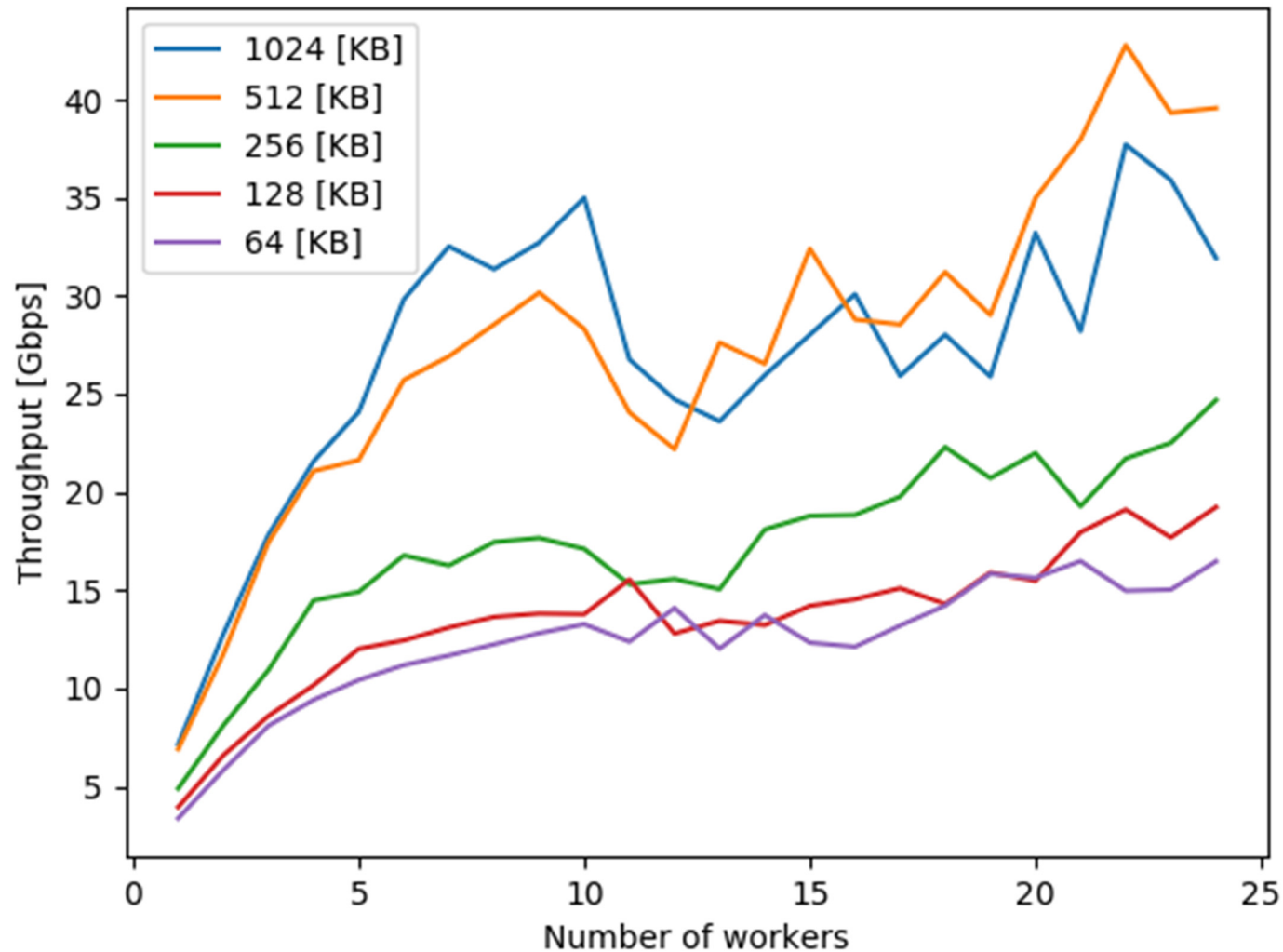


Image Data: 24-24 via Infiniband

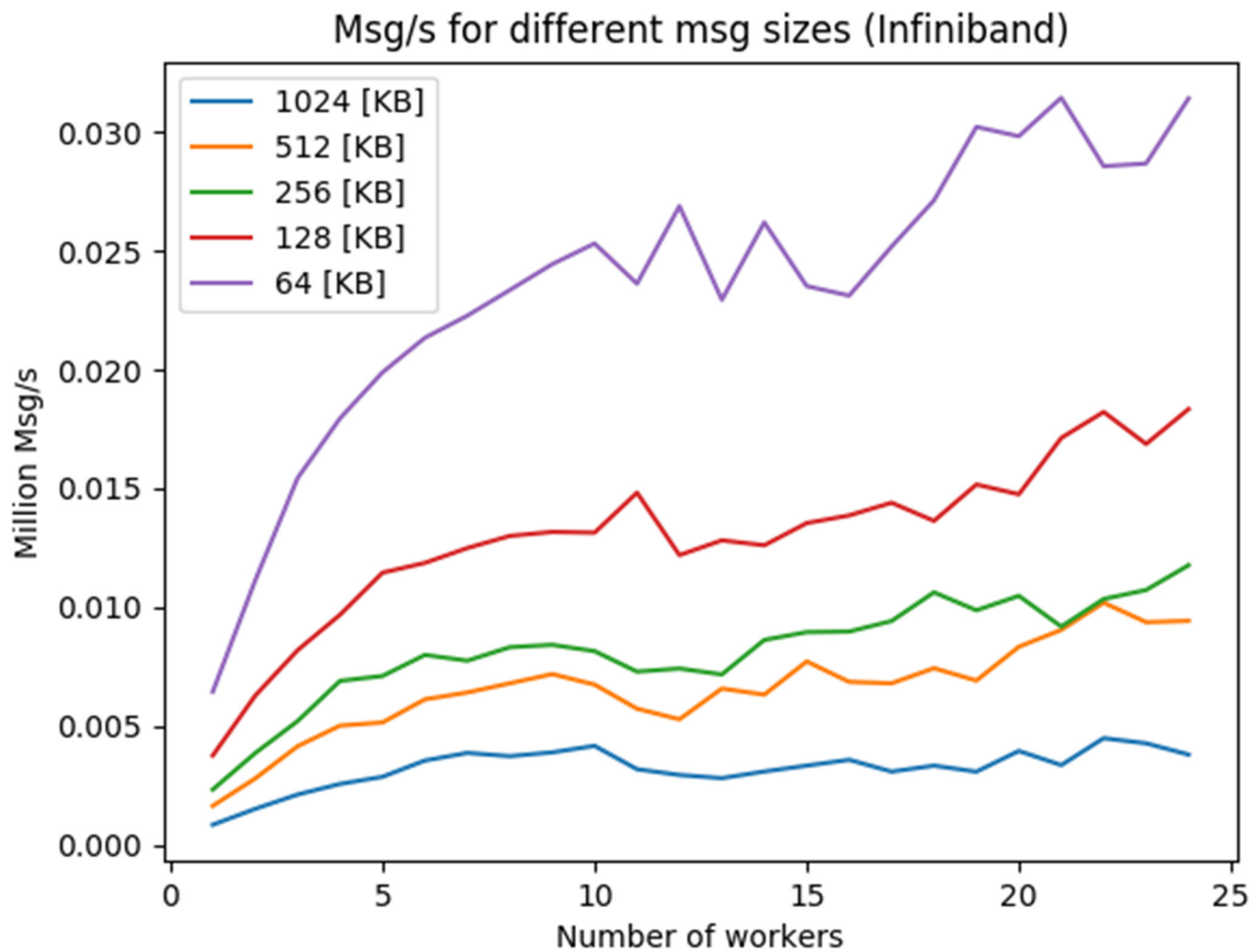


Performance

Throughput for different msg sizes (Infiniband)



Performance

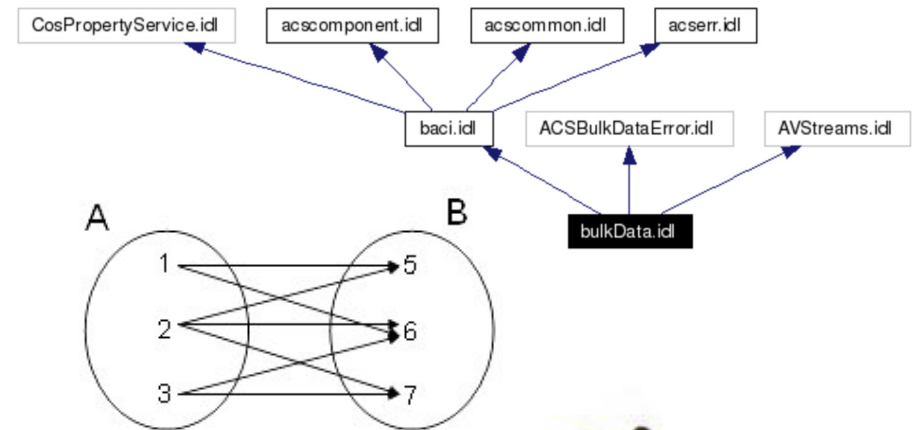


Next Steps

- Test ACS integration (CentOS 7)
 - Does initial CORBA comm affect?
 - Does a larger stack affect?



- Agree mods to BDT IDL
- Test non-symmetric simultaneous st
- Alternatives



- Apache Kafka
- HDF5 (hadoop)



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