Scalable and Reliable Data Broadcast with Kascade

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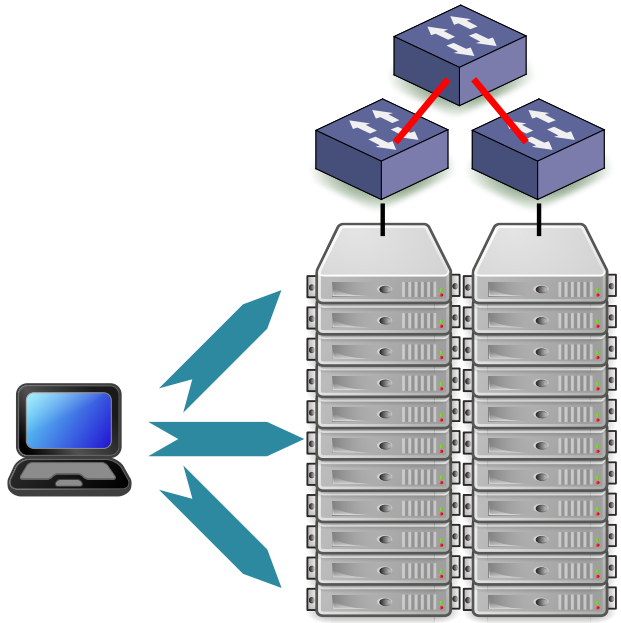
Context Big Data

Broadcast:

- Large amount of data
- From one storage
- To large number of nodes
- Fault tolerant

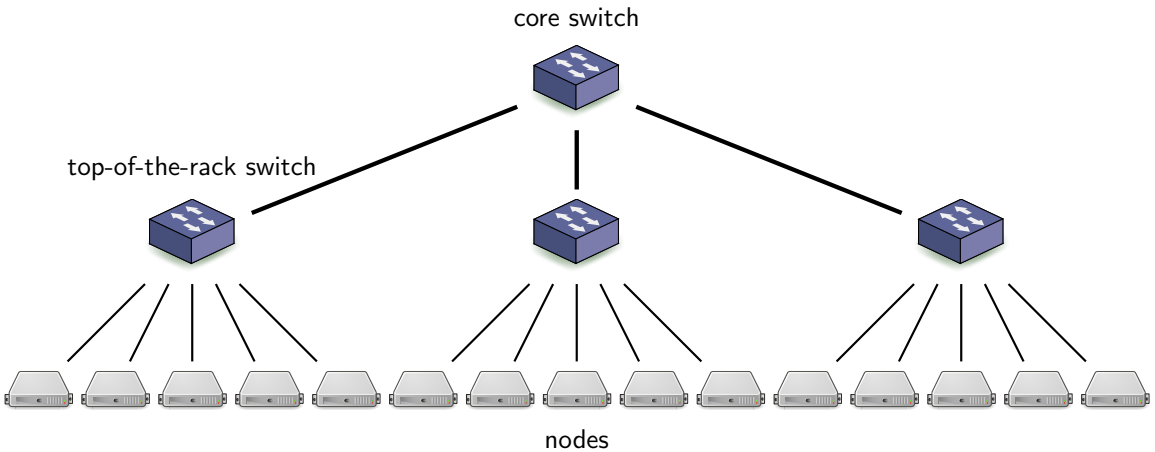
Useful to:

- Distribute big data before analysis
- System image deployment in HPC Cluster



Challenges

- Efficient use of fat tree network
  - Present in most cluster
  - Cost-efficient
- Fault-tolerance
  - One computer can have a problem
    $\rightarrow$ Many computers have problems
- Stream capability



Related work

- Network Layer multicast
- Binomial tree
- BitTorrent
- Pipelined Broadcast

Network Layer multicast

- IP multicast
  - Support is usually disabled in network equipment
  - Find a group address or method to share it
  - High-throughput protocol UDP is unfair to another protocols
  - Message delivering is not guaranteed !
    $\rightarrow$UDPCast provides:
    - Acknowledgment
      $\rightarrow$ Generate too many packets to the master, it's not scalable
    - Forward Error Correction (FEC)
      $\rightarrow$ Configuration depends of packets lost amount
- InfiniBand multicast
  - Not installed on all nodes (expensive)
  - Same problem

Conclusions

- Best in theory
- Not possible or efficient in practice

Protocols

Binomial tree

- Transfer random part of file (entire file is in memory or hard drive)

BitTorrent

- Verbose protocol
- Transfer random part of file

Conclusions

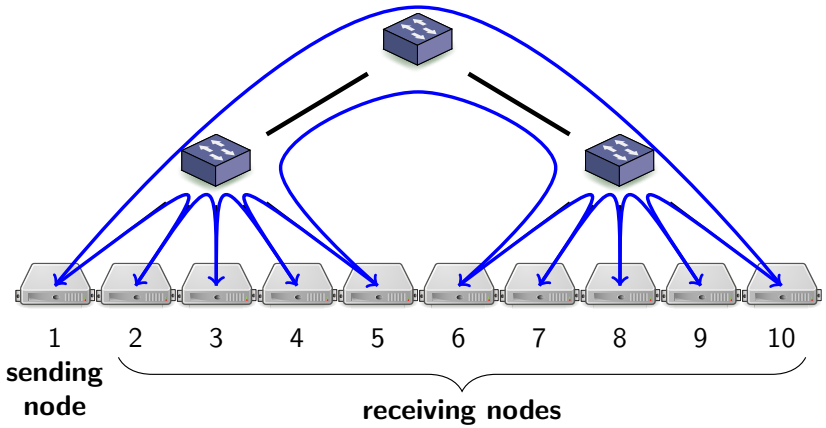
- Not suitable

Pipelined Broadcast

- One time on each direction
- Topology aware

Already existing projects:

- Not fault tolerant:
  - Ka
  - Dolly
  - part of MPI_Bcast primitive (Open MPI)
- Fault tolerant:
  - Dolly+
    $\rightarrow$ unmaintained and FT is not mentioned in their publication.



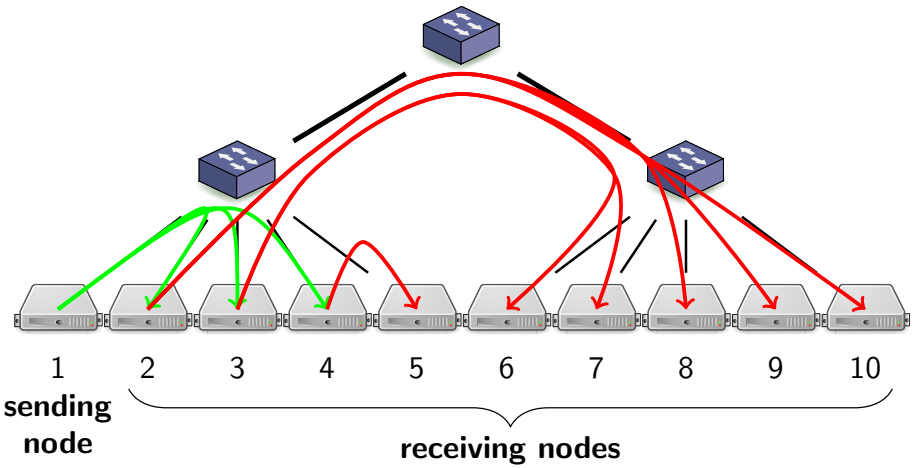
Our contributions: Kascade

How does it work ?

- Overview of pipeline establishment
- Fault detection
- Recovery
- Collecting information
- Protocol is needed

Overview of data transfer pipeline (Kascade)

1. Order the nodes
2. Deploy itself
   $\rightarrow$ Efficient help with Taktuk (Parallel launcher)
3. Establish the pipeline (open TCP/IP connections)
4. Transfer the data
5. Send report to the master



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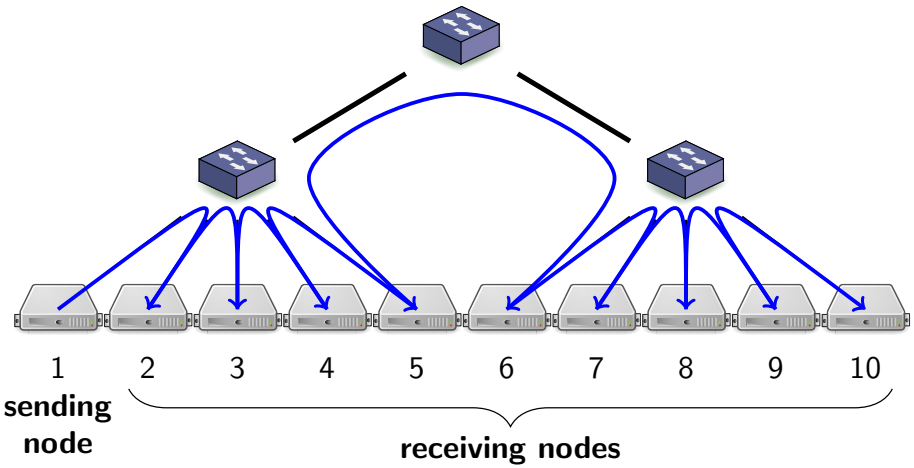

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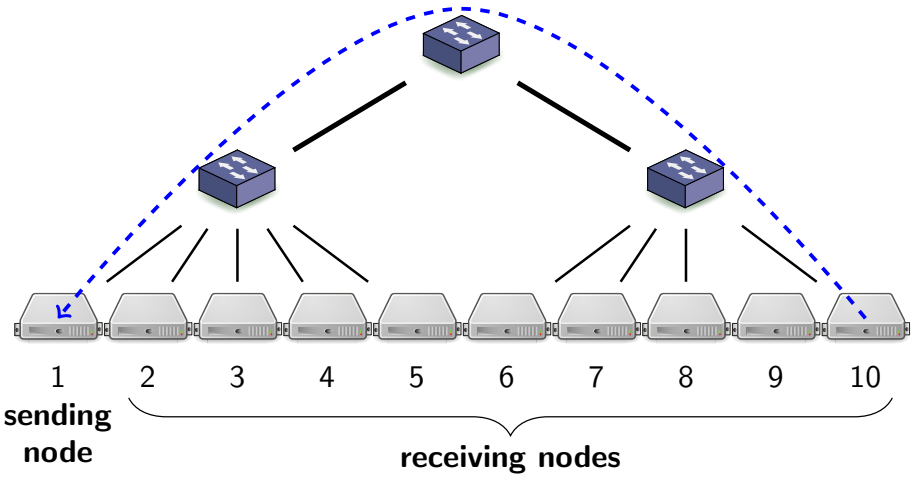


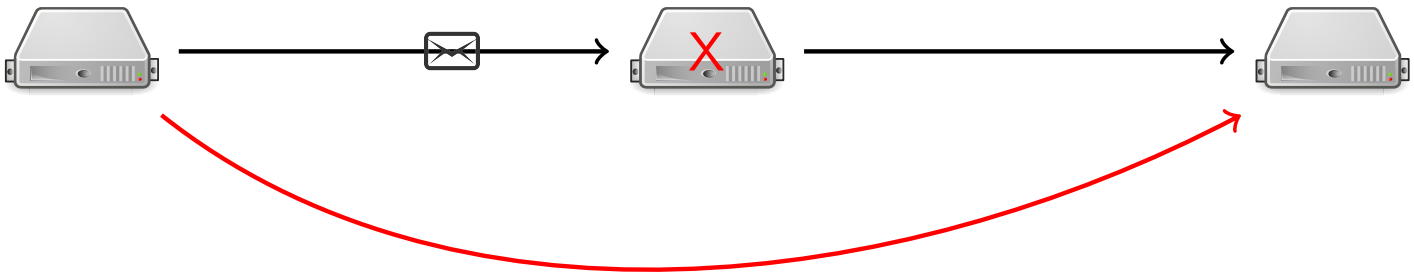
Fault detection

- Two case of faults:
  - Stream closed (error packet received)
  - Black hole (nothing comes back)

- The sender handles error
- When the next node stops to read the stream
  $\rightarrow$ ping the next node

Recovery

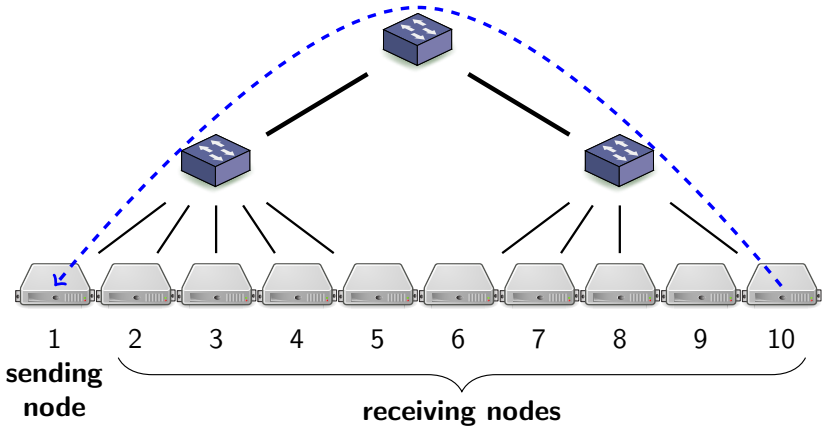
- Add error to the report
- Try to connect to the next node
- Replay the lost messages
  - Use buffer to resend lost message
  - Ask the missing part to the master in worst case



Collecting status at end of transfer

- Connecting to the master directly is not scalable or fault tolerant
- Using the pipeline to transmit a report is scalable and fault tolerant

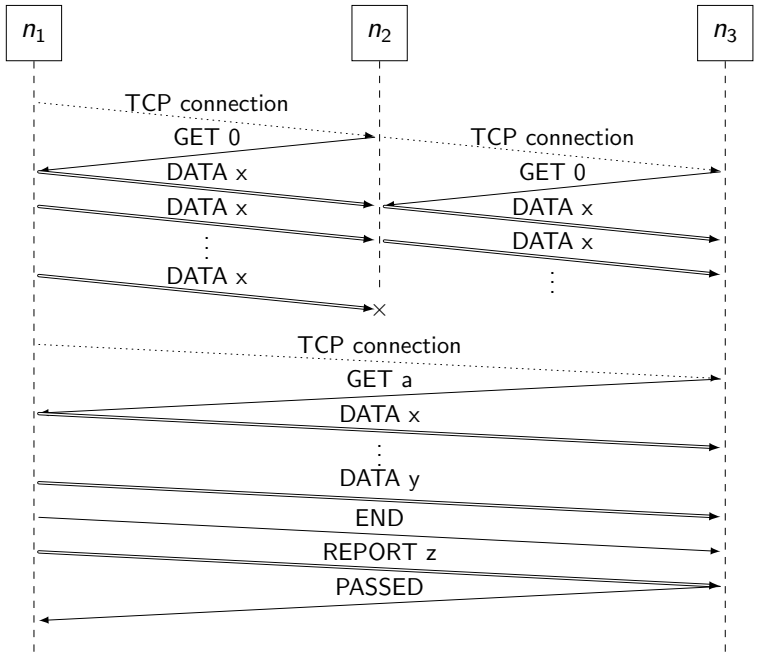
- The last node forwards the report to the master
- The report reception implies the end of transfer



Protocol is needed

The protocol

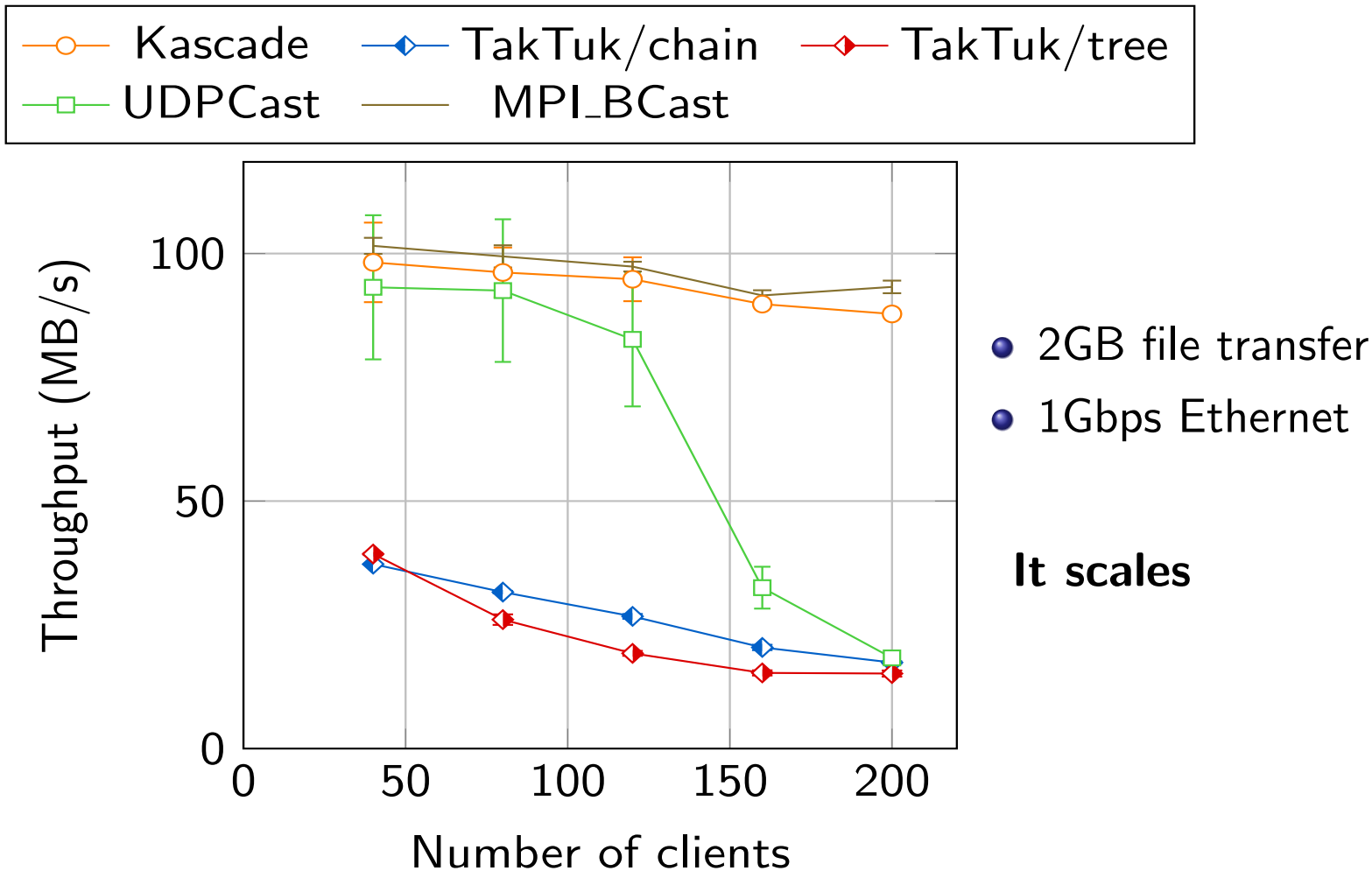
- avoids the data size knowledge (stream capability)
- permits prematurely end requested by user
- distinguishes the report than data
- improves the fault tolerance (correct ending despite failures)



Validation questions

- How do the various solutions perform and scale up to large number of nodes?
- How does Kascade perform on high-performance networks (10 Gbps Ethernet, IP over InfiniBand)?
- What is the impact of network topology and communication structure on performance?
- What it the impact of I/O performance on the overall performance?
- How does Kascade perform on large-scale (Internet-like) setups?
- How does Kascade perform on smaller files?
- How well does Kascade's fault tolerance mechanism perform?

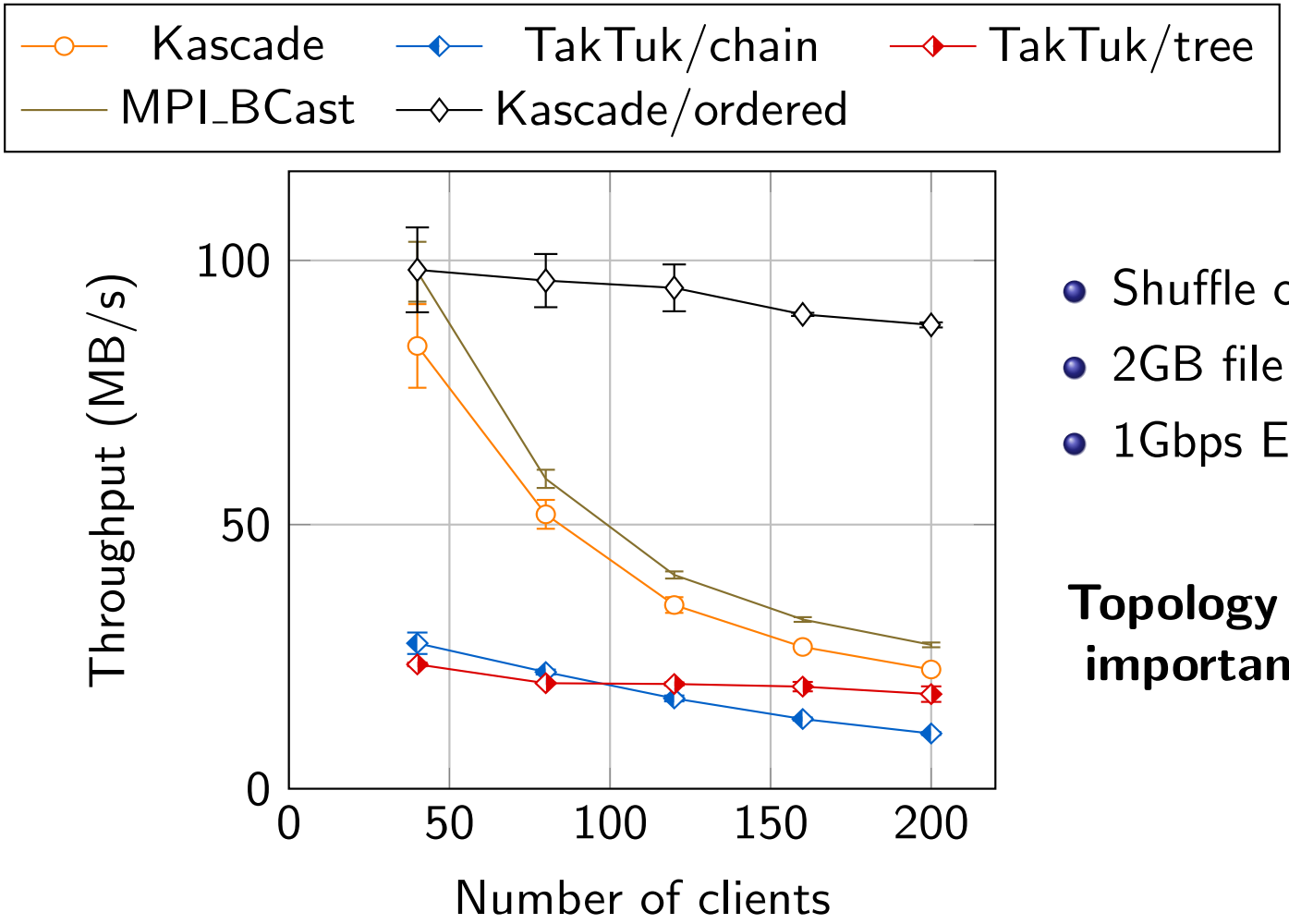
How do the various solutions perform and scale up to large number of nodes ?



- 2GB file transfer
- 1Gbps Ethernet

It scales

What is the impact of network topology and communication structure on performance ?



- Shuffle order of nodes
- 2GB file transfer
- 1Gbps Ethernet

Topology awareness is important

How well does Kascade's fault tolerance mechanism perform?

Simultaneous

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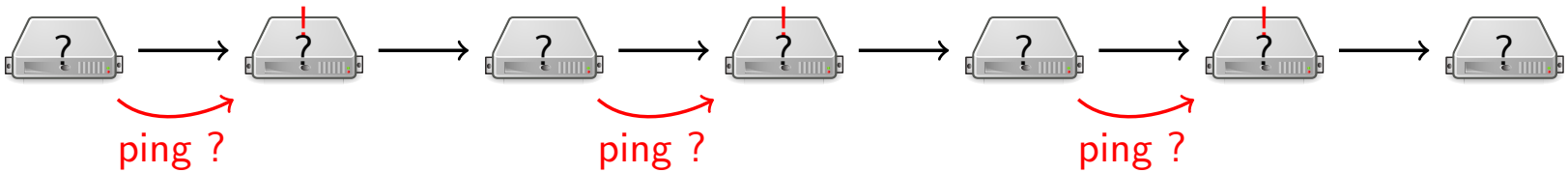

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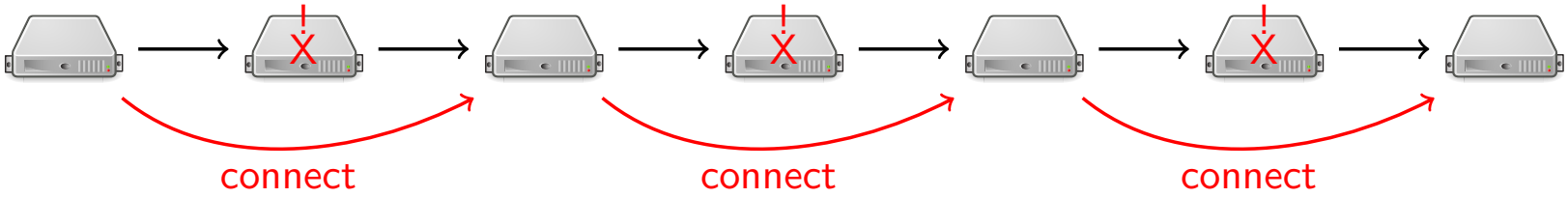

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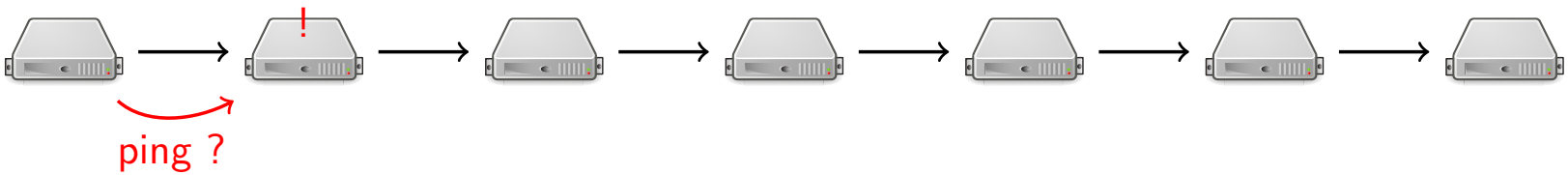

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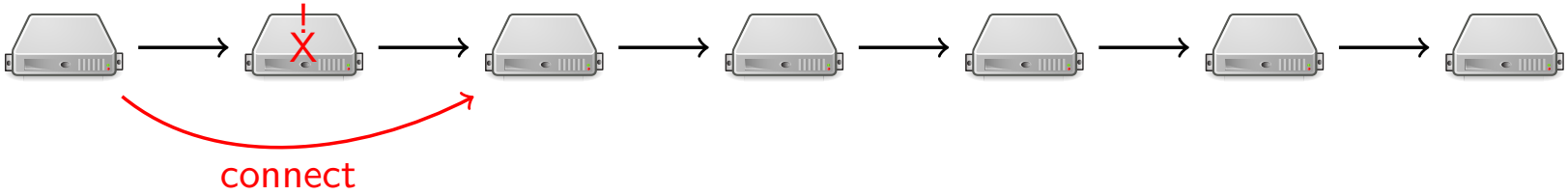

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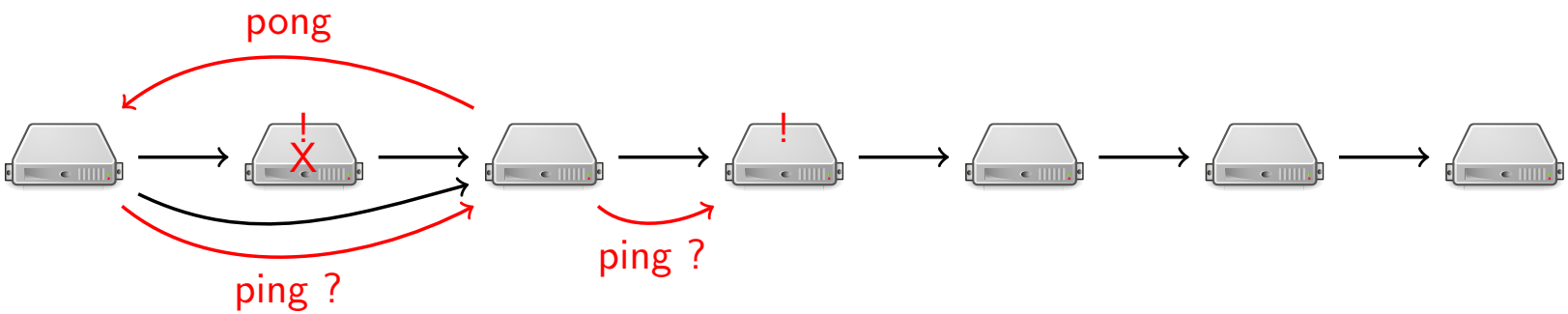

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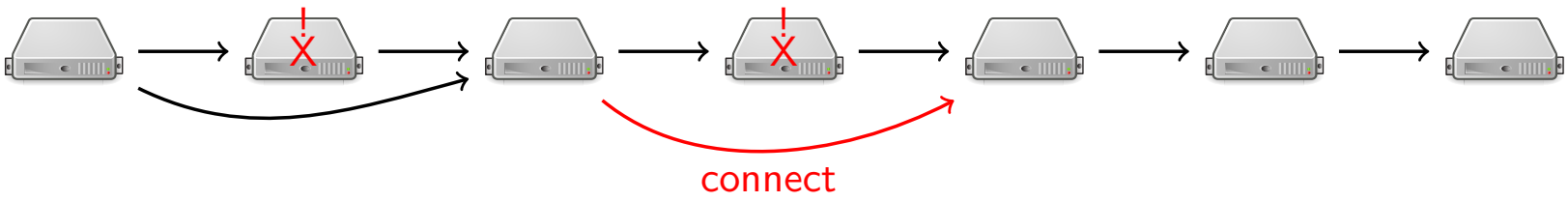

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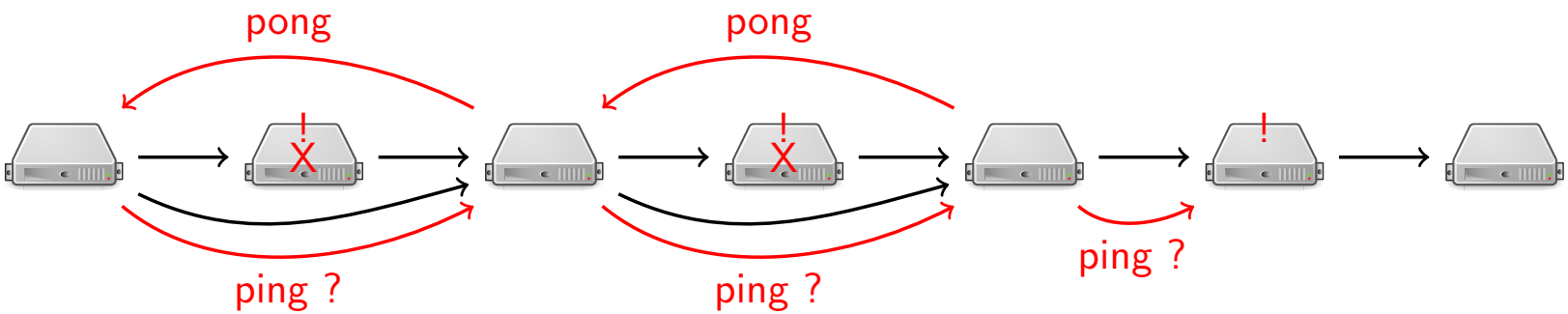

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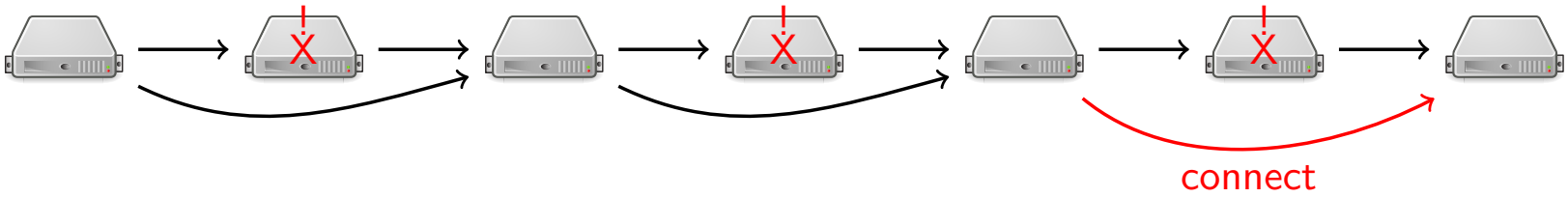

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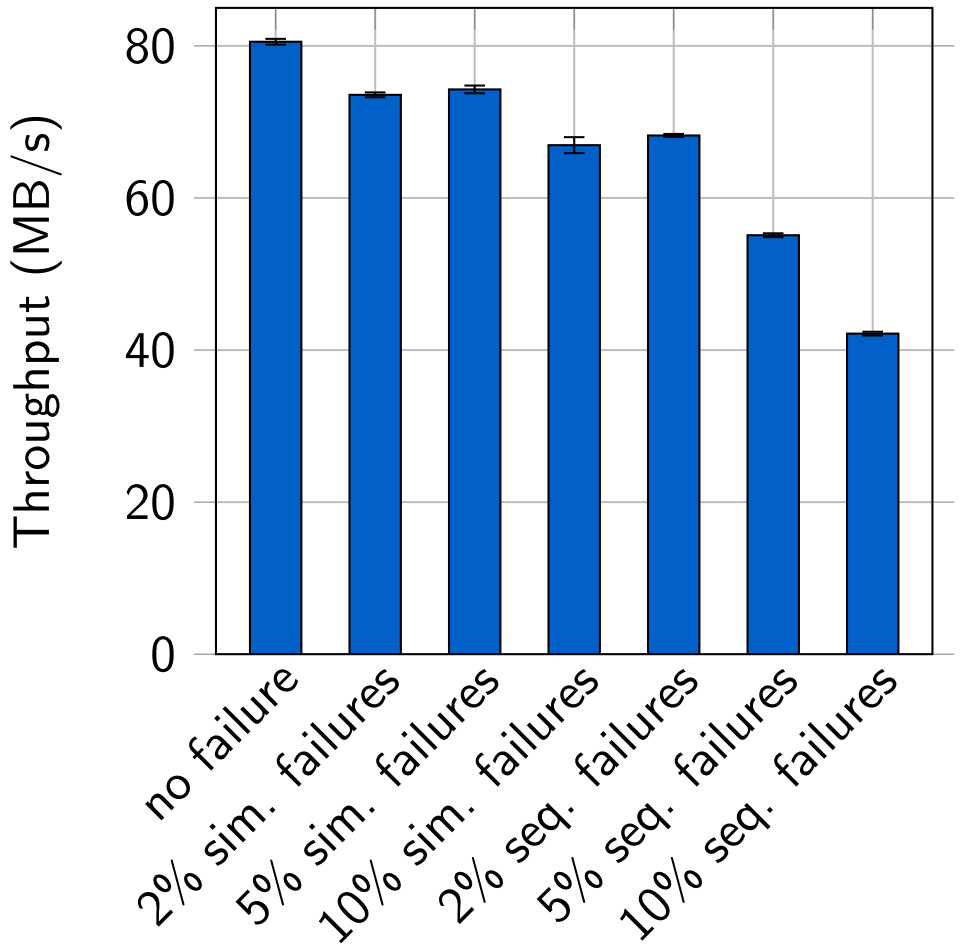

- 100 virtual nodes, fault injected with Distem
- 5GB file transfer
- 1Gbps Ethernet

Fault tolerant

Conclusions

- Efficient use of fat tree network
  - Saturate the 1Gbps network
- Fault-tolerance
  - Mechanisms works
  - Performance is acceptable in hostile environment
- Stream capability

Future work:

- Slow node elimination
  $\rightarrow$ when a node in the pipeline slows down the transfer rate because of a malfunction