Swarm-based Incast Congestion Control in a Datacenter Serving Web Applications

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Outline

- Introduction
- Approach description
- Evaluation
- Conclusion

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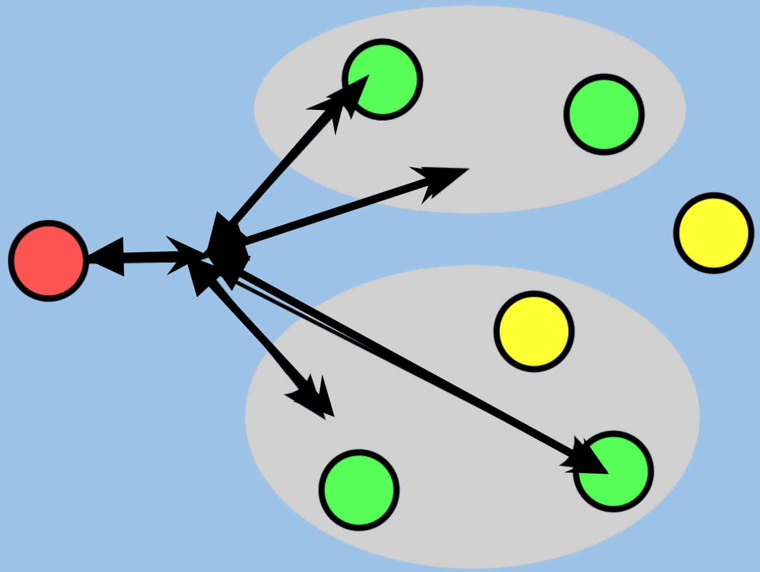
Incast congestion is a common problem in modern datacenters

1. TCP timeout and retransmission
2. Throughput loss
3. Increased latency
4. Application failure

Glenn from *Morgan Stanley*, *NSDI 2015*

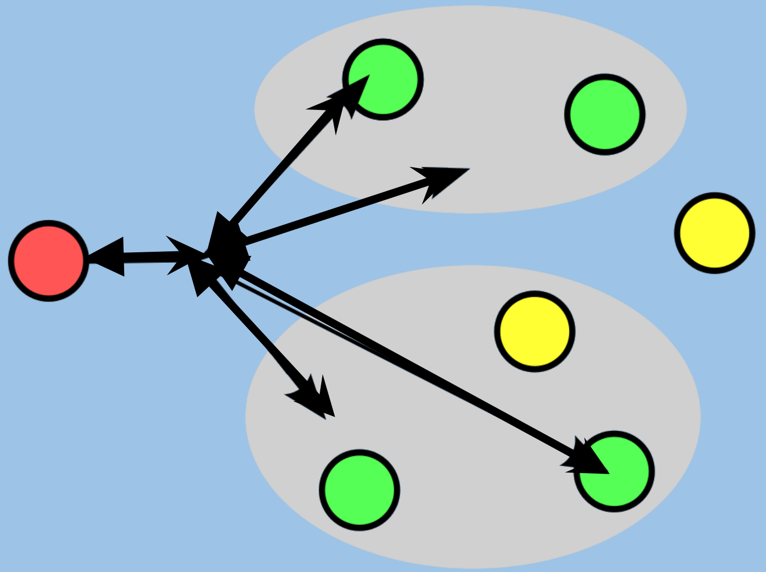
Incast congestion



Incast is a many-to-one communication pattern commonly found in cloud data centers. It begins when a singular parent server places a request for data objects to a large number of servers simultaneously.

The Nodes respond to the singular Parent. The result is a micro burst of many machines simultaneously sending TCP data streams to one machine

Incast congestion



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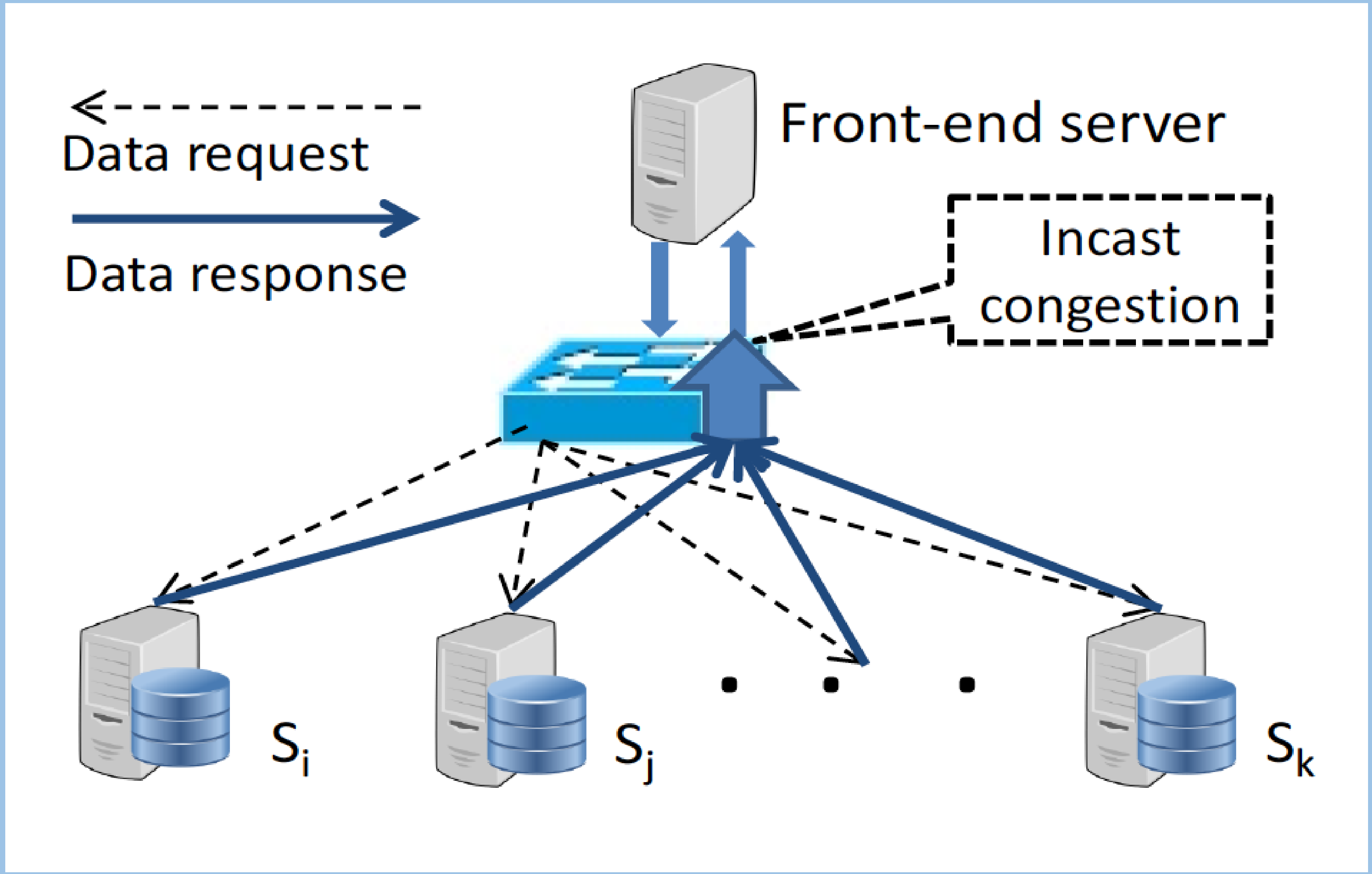
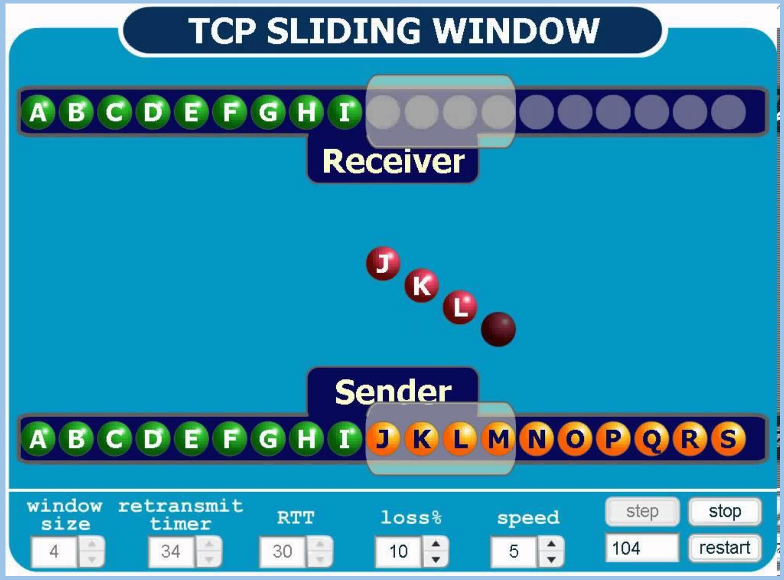
The servers respond to the singular parent, resulting a micro burst of many machines simultaneously sending TCP data streams to one machine

Introduction



Previous work

Sliding Window *MCN'95*

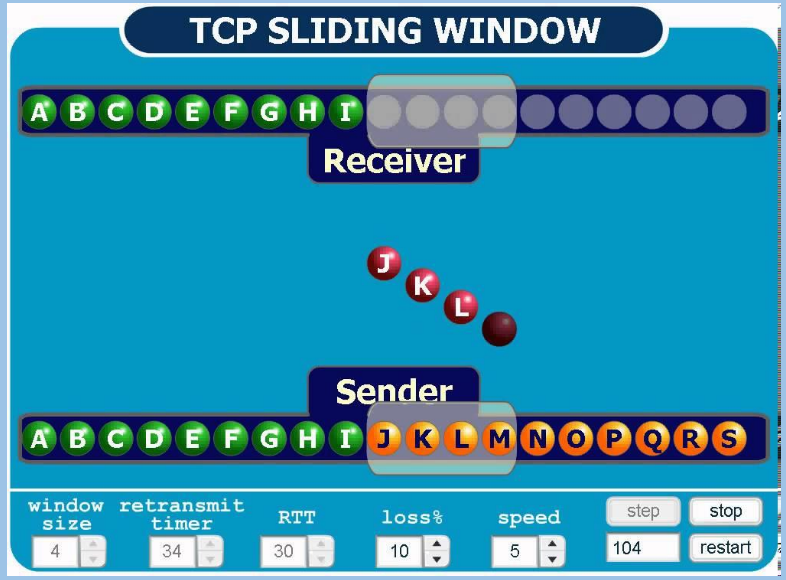


The window size changes after the congestion is detected

ICTCP (Improved sliding window protocol)

Staggered flow

Previous work



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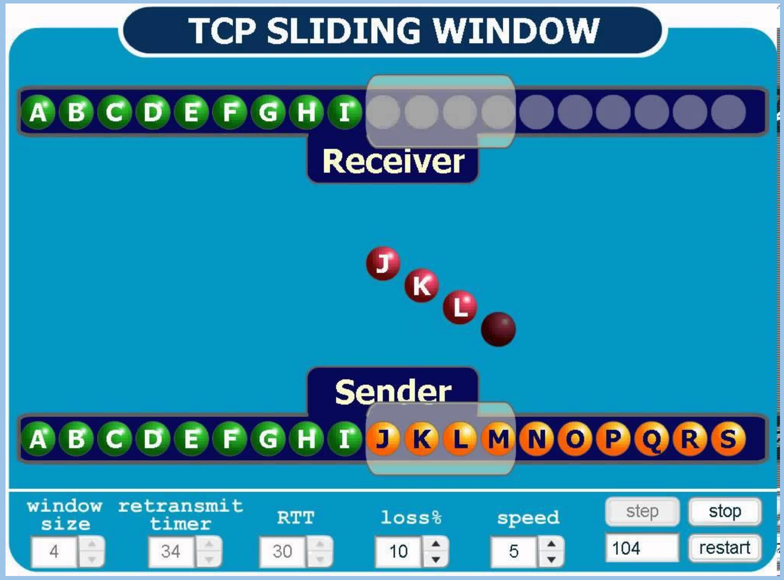

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Staggered flow *MASCOTS'12,* COMPSACW'13

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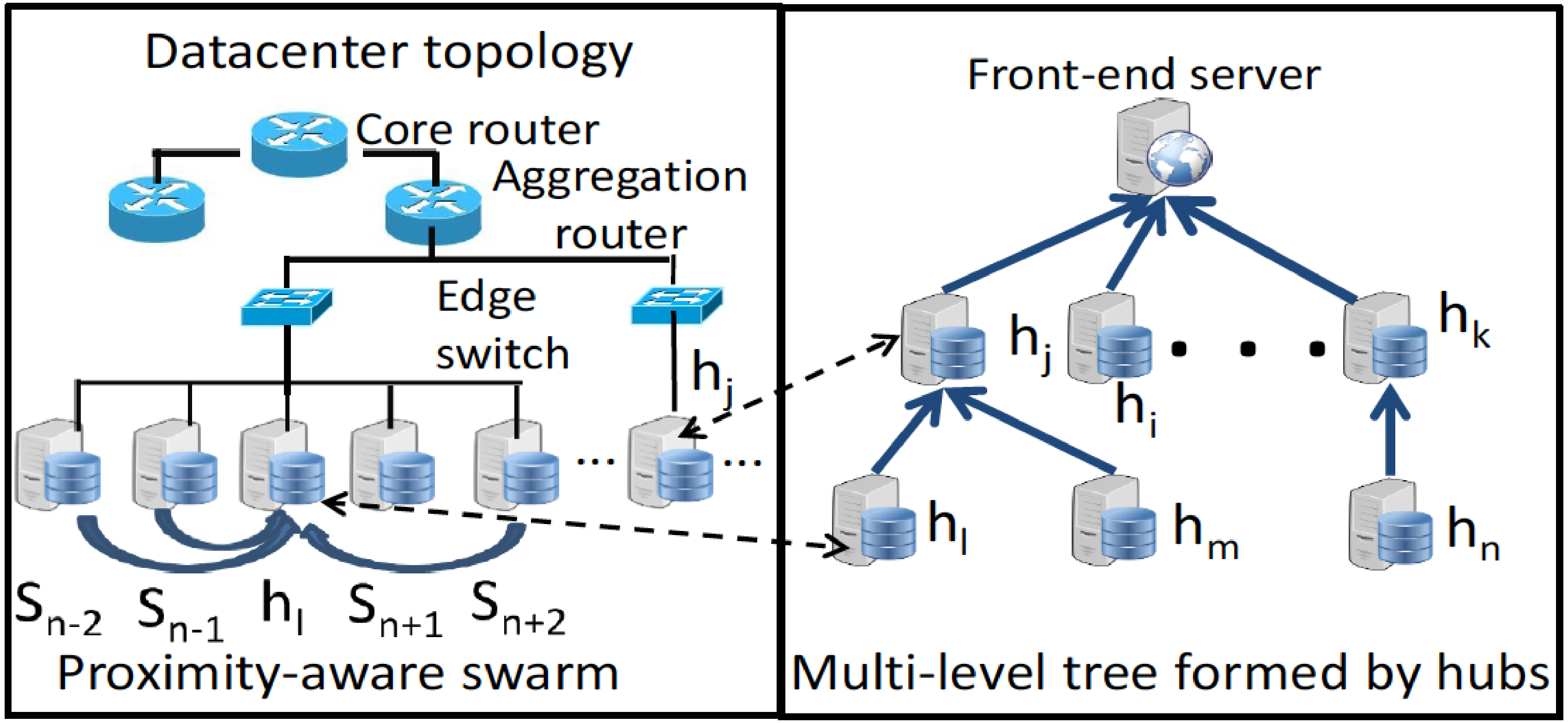

A multilevel tree with proximity-aware swarm

Hub: The server connecting with the font-end server and has the largest spare capacity to handle I/O among each rack

Approach Description

A swarm structure is formed only for one data request

1. The transient structure does not need to be maintained
2. Transmitting data through a much smaller structure greatly reduces the latency
3. Data servers without requested data objects do not need to participate in the structure

Determine a suitable number of hubs:

$$N = \frac{\frac{S_e}{B_d} * B_u}{\bar{s} * m}$$

Building multi-level tree of hubs:

1. The hubs under the same aggregation router are linked together in the tree
2. A hub's child always has a smaller number of requested data objects than its parent

Pseudocode of multi-level tree generation

1. Cluster target data servers in each rack into a swarm
2. /* Select a hub from each swarm*/
3. For each swarm do
4. Select the data server with the largest number of requested data objects as the hub; Enqueue the hub into queue Q_h
5. Sort the hubs in Q_h in ascending order of number of requested data objects

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Pseudocode of multi-level tree generation

1. /*Create multi-level tree from hubs*/
2. While Q_h>N do
3. Dequeue a hub $h_i$from Q_h
4. Select a hub h_j with the smallest number of data objects and under the same aggregation router as h_i; Link h_i as child to h_j
5. While h_j has less than children and h_i has children do
6. Transmit the last child from h_i to be a child of h_j

Two-level data transmission speed control

In order to avoid overloading the front-end server:

1. At the front-end server

The front-end server periodically adjusts the assigned bandwidth to each hub after each short time period

2. At the aggregation router

For multi front-end servers under the same router, we adjust the request transmission speed of each front-end server

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Evaluation

Simulation setup:

3000 data servers with fat tree structure

TCP retransmission timeout: 10ms

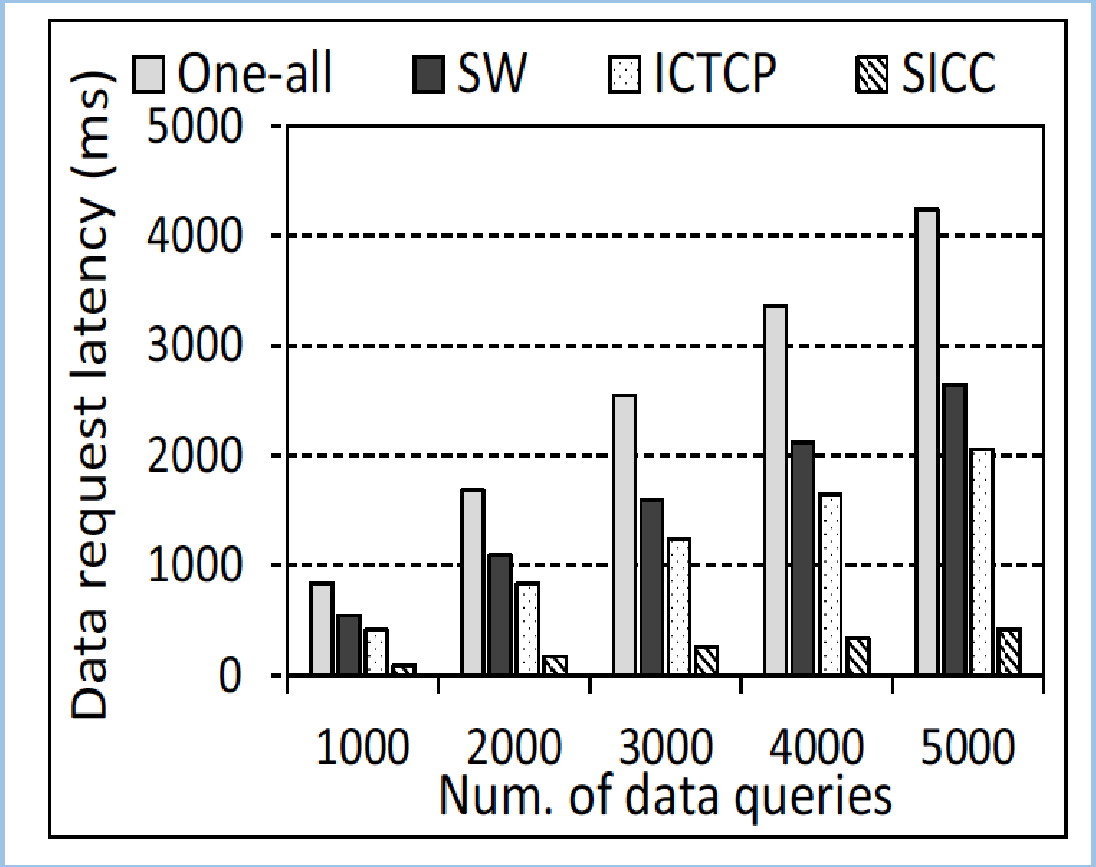
Comparison methods:

1. One-all

2. Sliding window protocol (SW) *MCN'95*

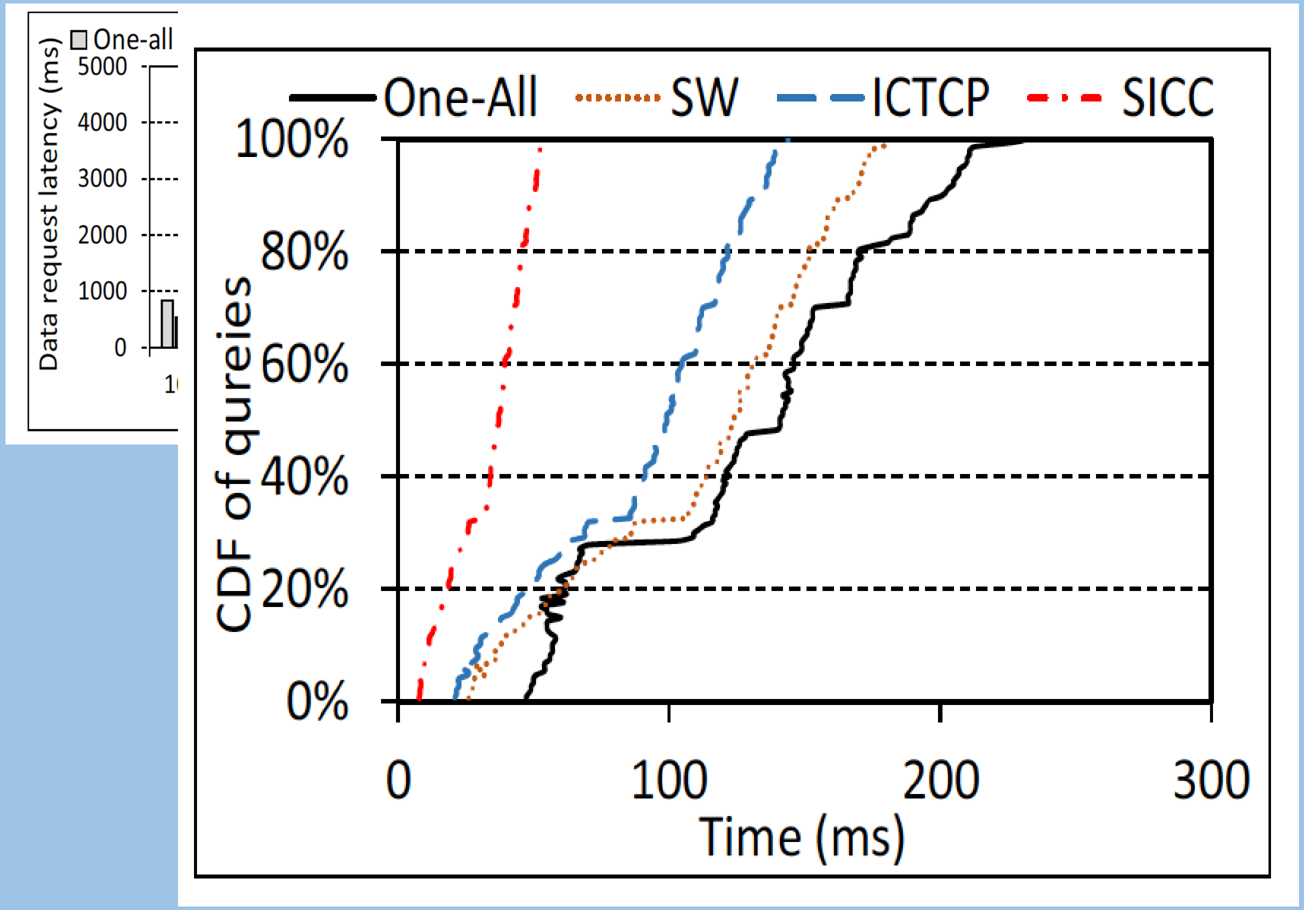
3. ICTCP *Conext'10*

Evaluation



Performance of SICC

Evaluation



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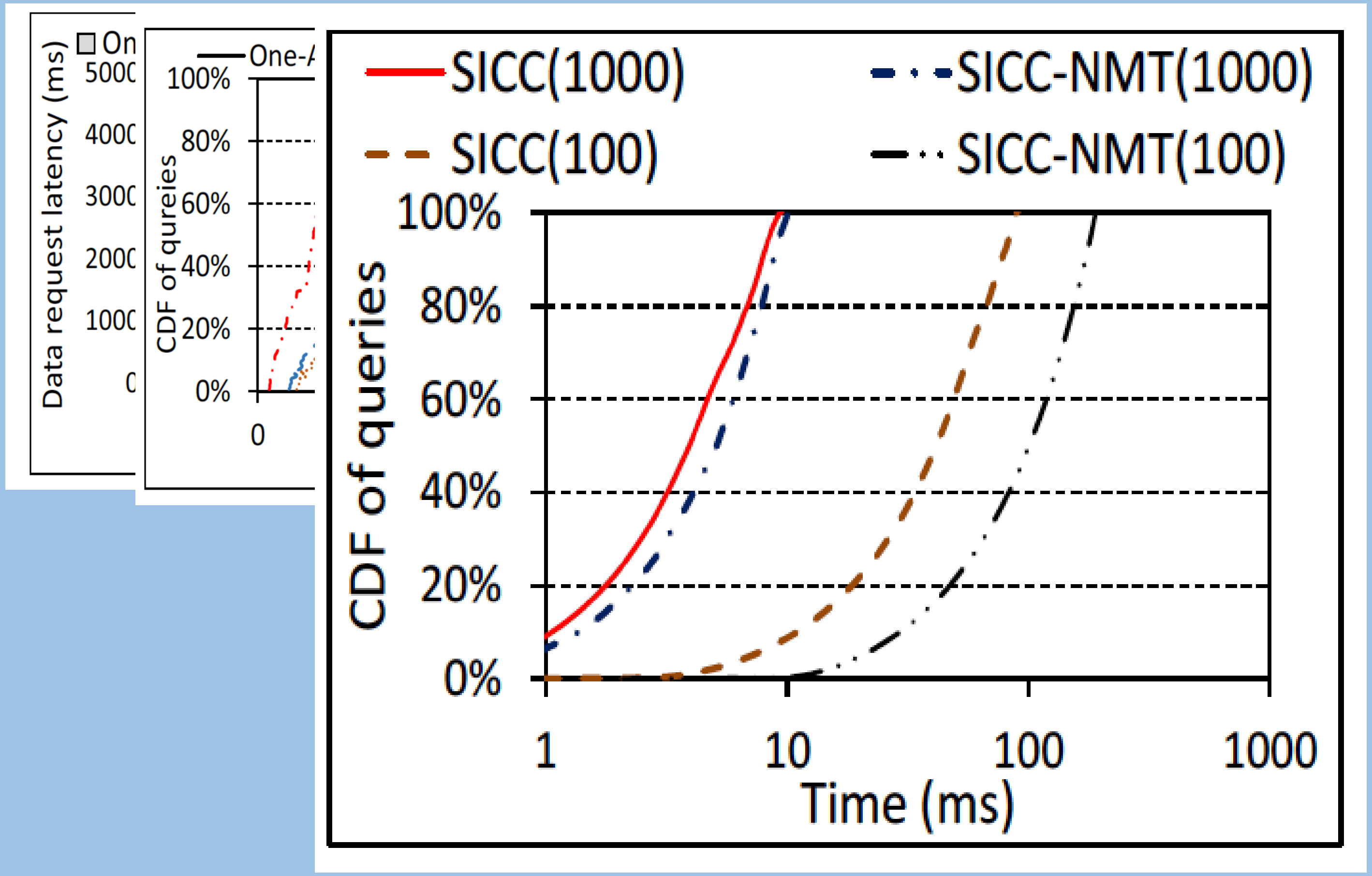
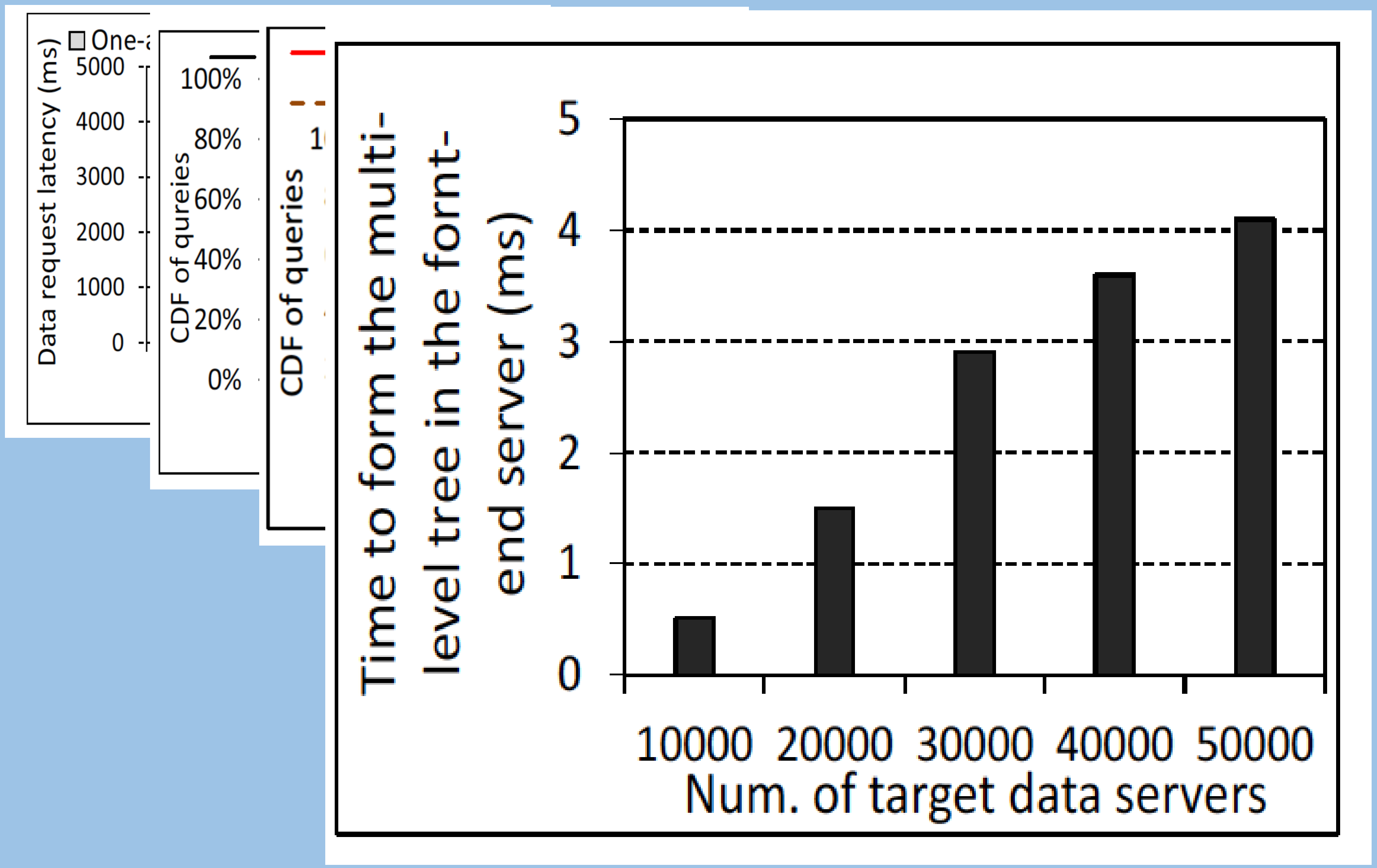


Performance of multi-level tree of hubs

Evaluation



Computing time of multi-level tree generation

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Conclusion

1. Incast congestion is a common problem in modern datacenters

2. We proposed Swarm-based Incast Congestion Control method (SICC)
    1. Proximity-aware swarm based data transmission
    2. Two-level data transmission speed control
    3. other enhancements

3. Experiments show that SICC achieves higher throughput and lower latency

Thank you!

Question