Distributed Algorithms - Paper presentation

18/12/2018

ByzCast: Byzantine Fault-Tolerant Atomic Multicast

Alessia Ruggeri & Francesco Saverio Zuppichini

1.
What questions does the paper answer?

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The paper present **ByzCast**, the first Byzantine Fault-Tolerant atomic multicast.

1. What questions does the paper answer?

Improve existing protocol for atomic multicast by integrating it with existing BTF abstractions

Improve the ability to handle malicious behaviours

Improve the scalability of performances

2.

What are the main contributions of the paper?

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Present a partially genuine atomic multicast protocol that builds on multiple instances of atomic broadcast

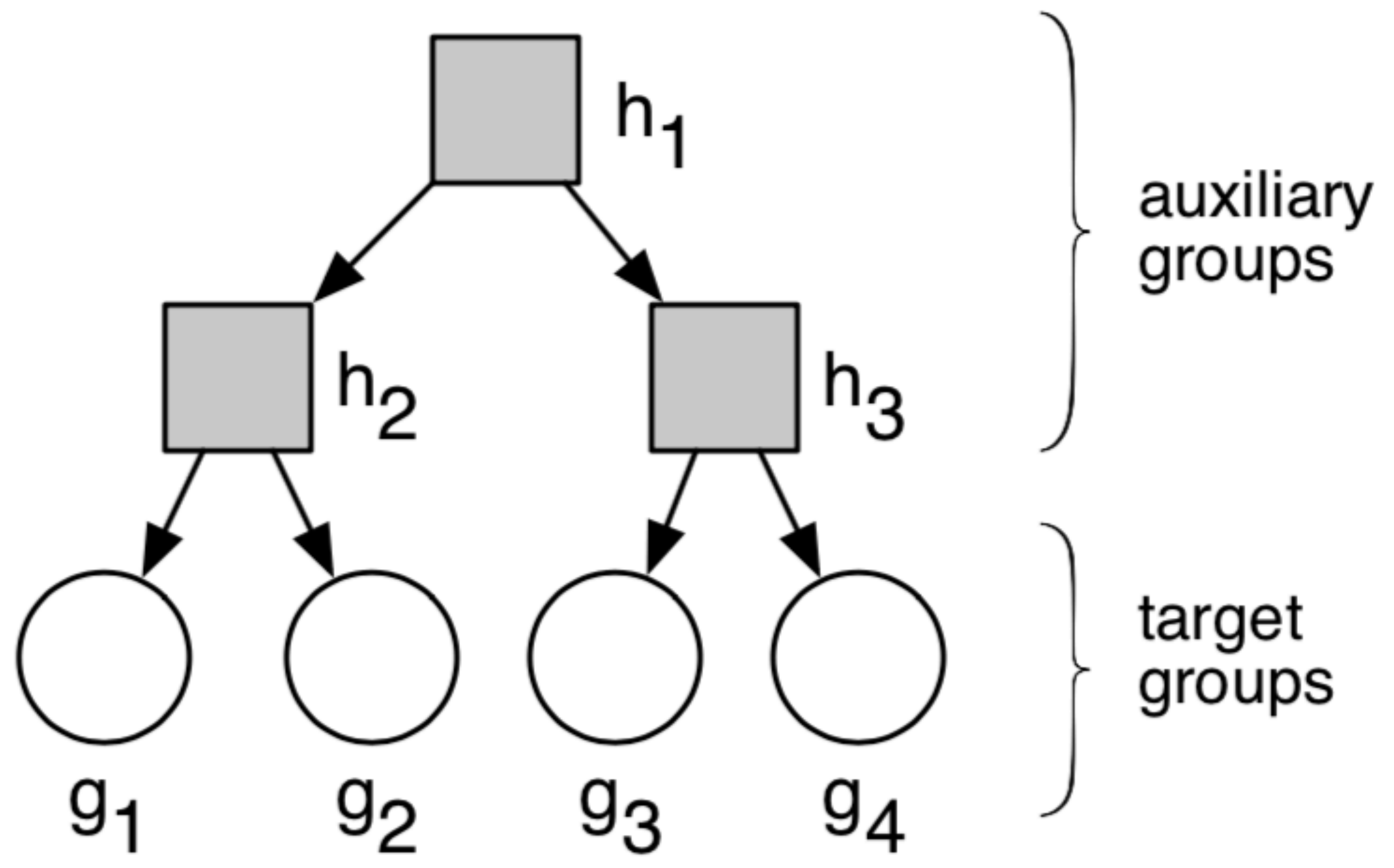
Define the problem of building an overlay tree as an optimisation problem

Describe a prototype of ByzCast

Provide an experimental evaluation of ByzCast

Partially genuine atomic multicast protocol

Protocol:



Target groups	$\Gamma = \{g_1, \ldots, g_m\}$
Auxiliary groups	$\Lambda = \{h_1, \ldots, h_n\}$

Each group *x* implements a **FIFO atomic broadcast**

reach(x)	set of target groups that can be reached from *x* by walking down the tree
lca(m.dst)	lowest common ancestor

Partially genuine atomic multicast protocol

Alg. 1 ByzCast

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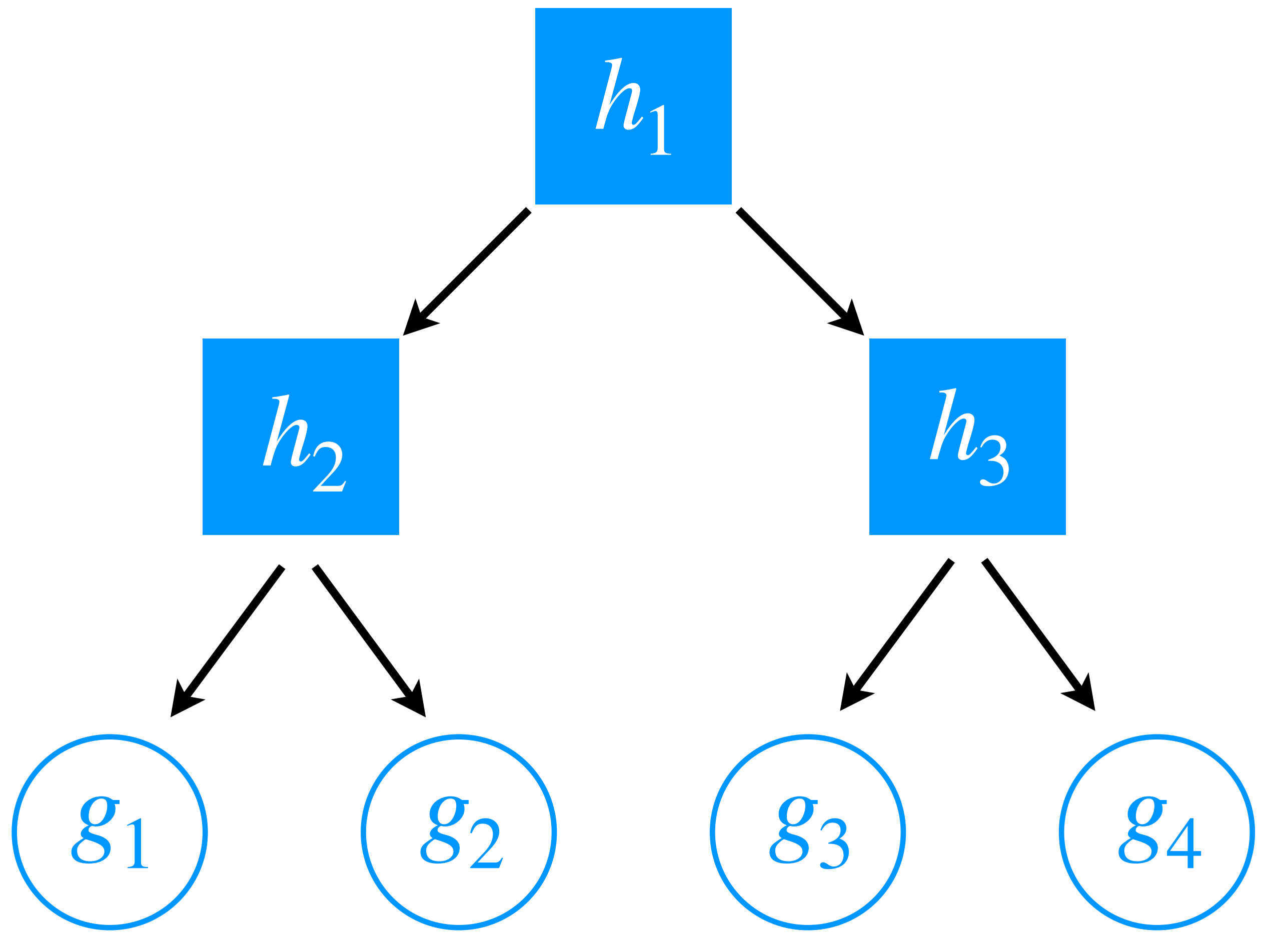

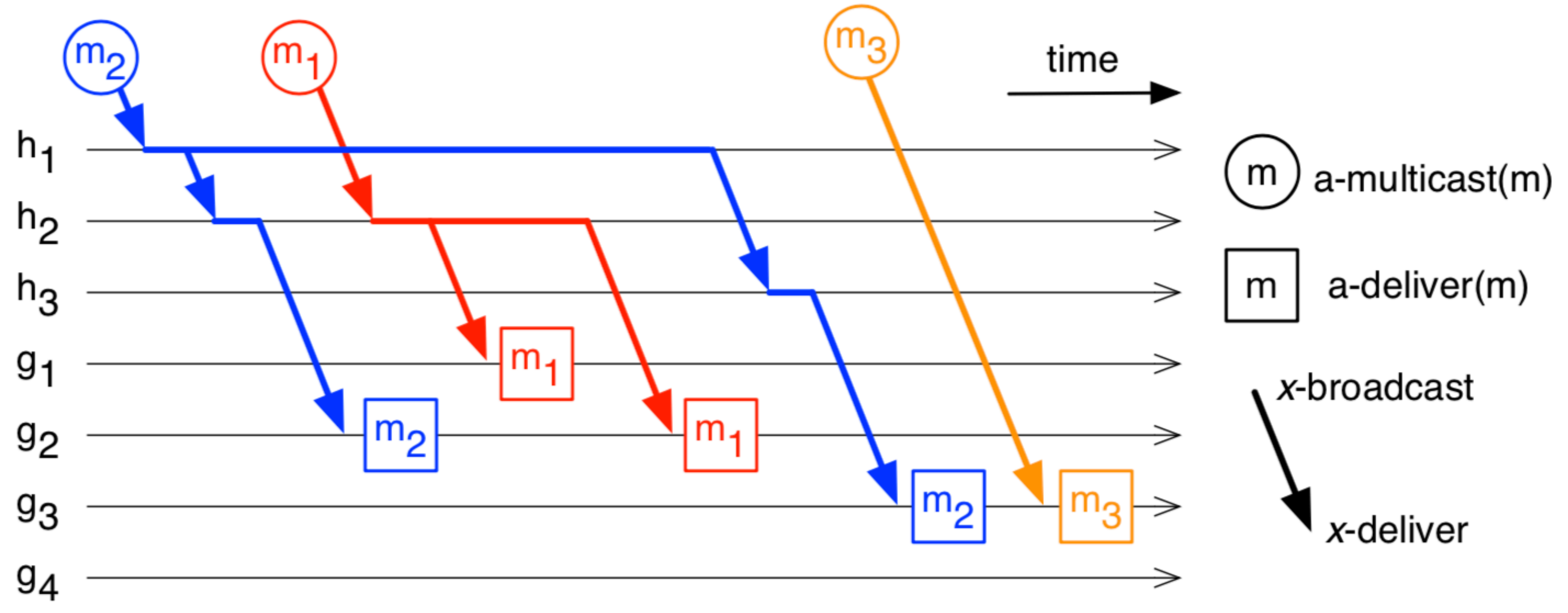

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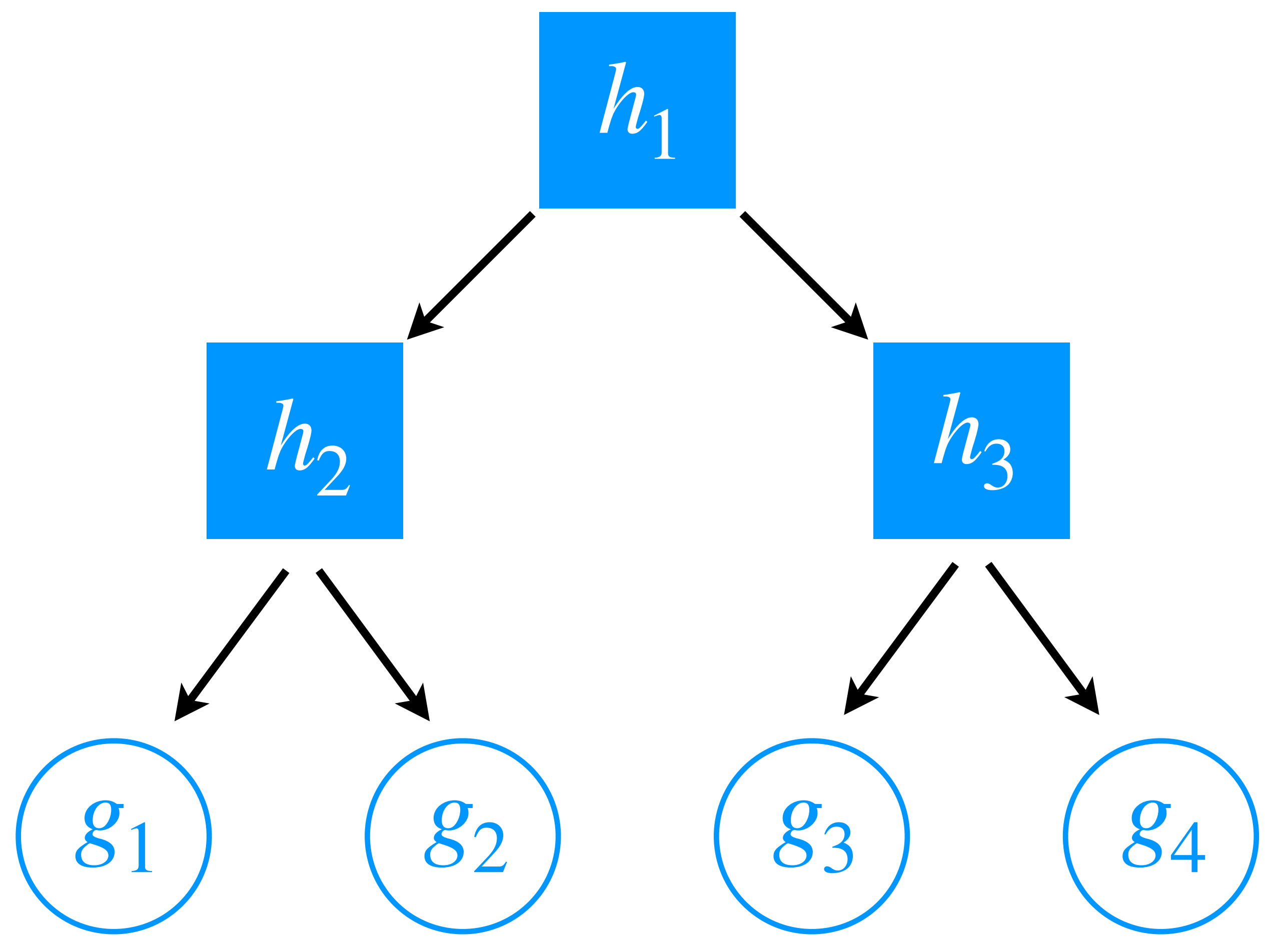

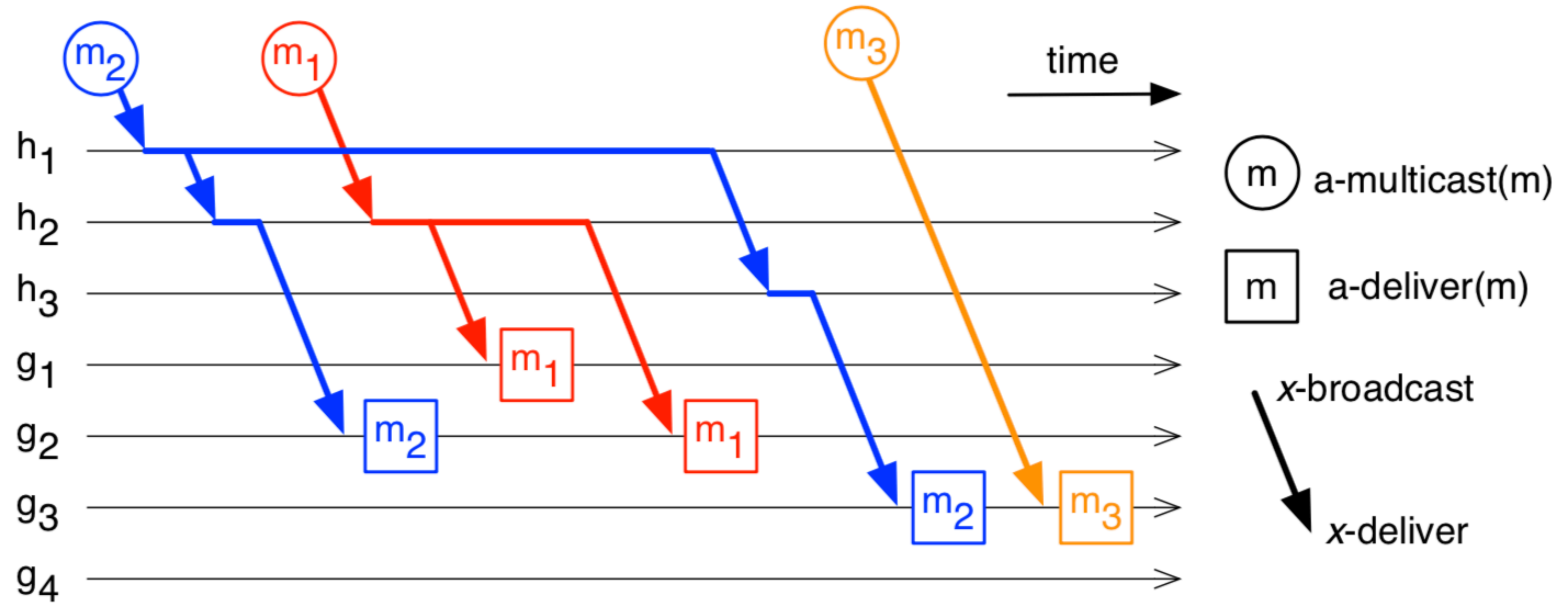

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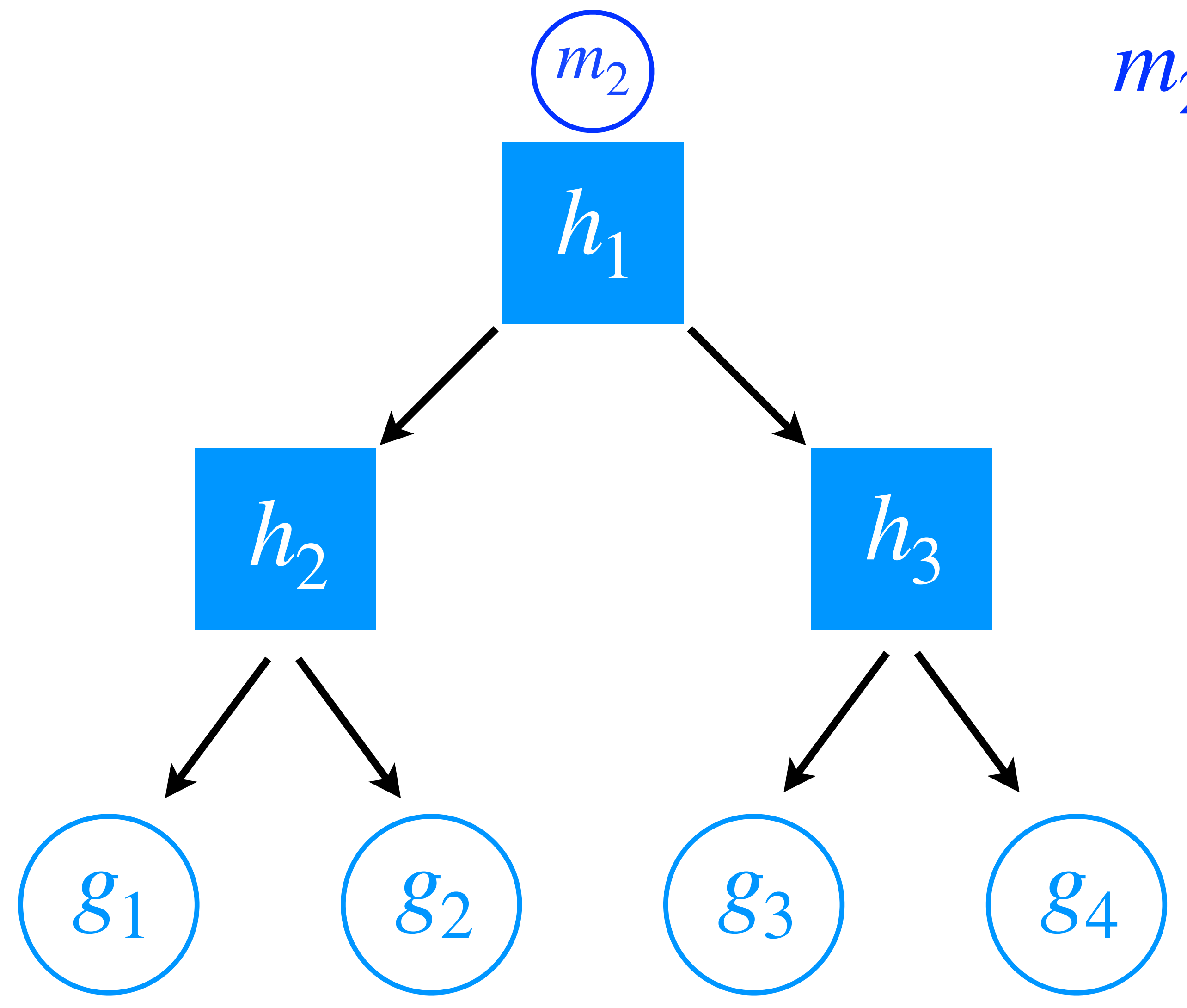

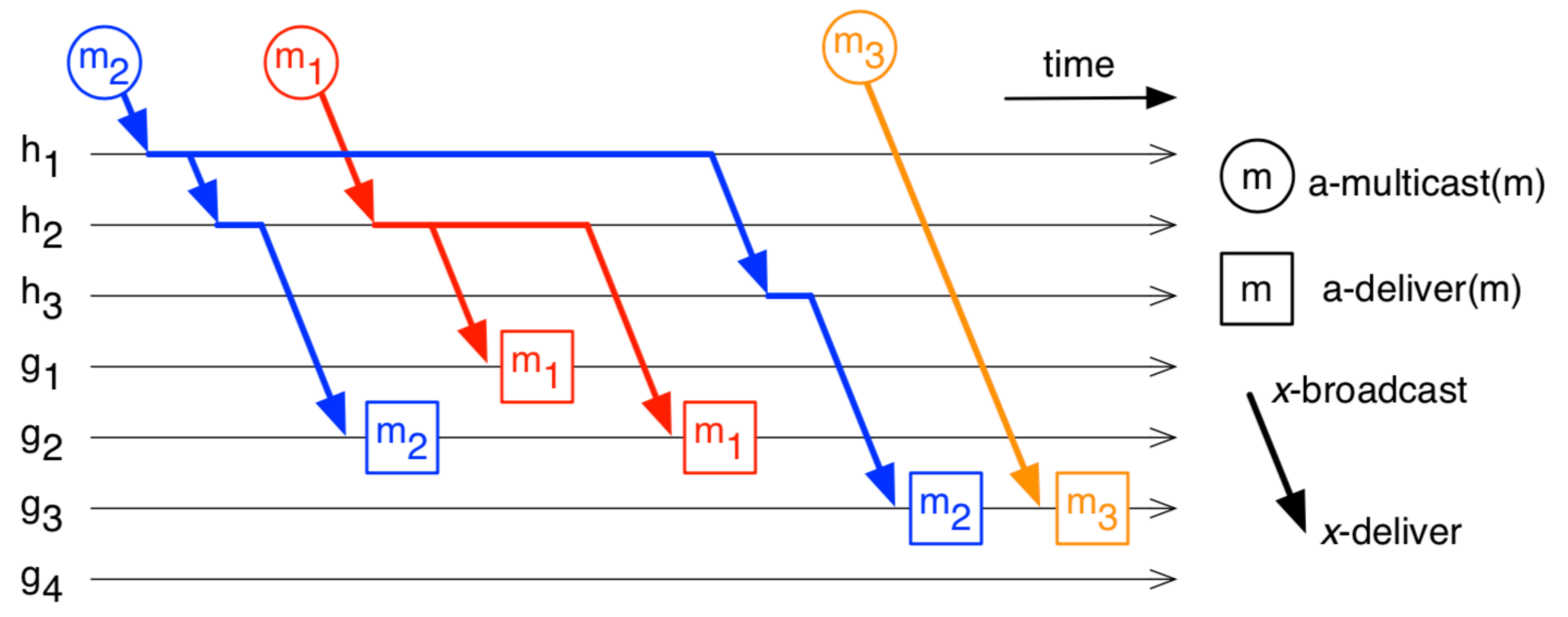

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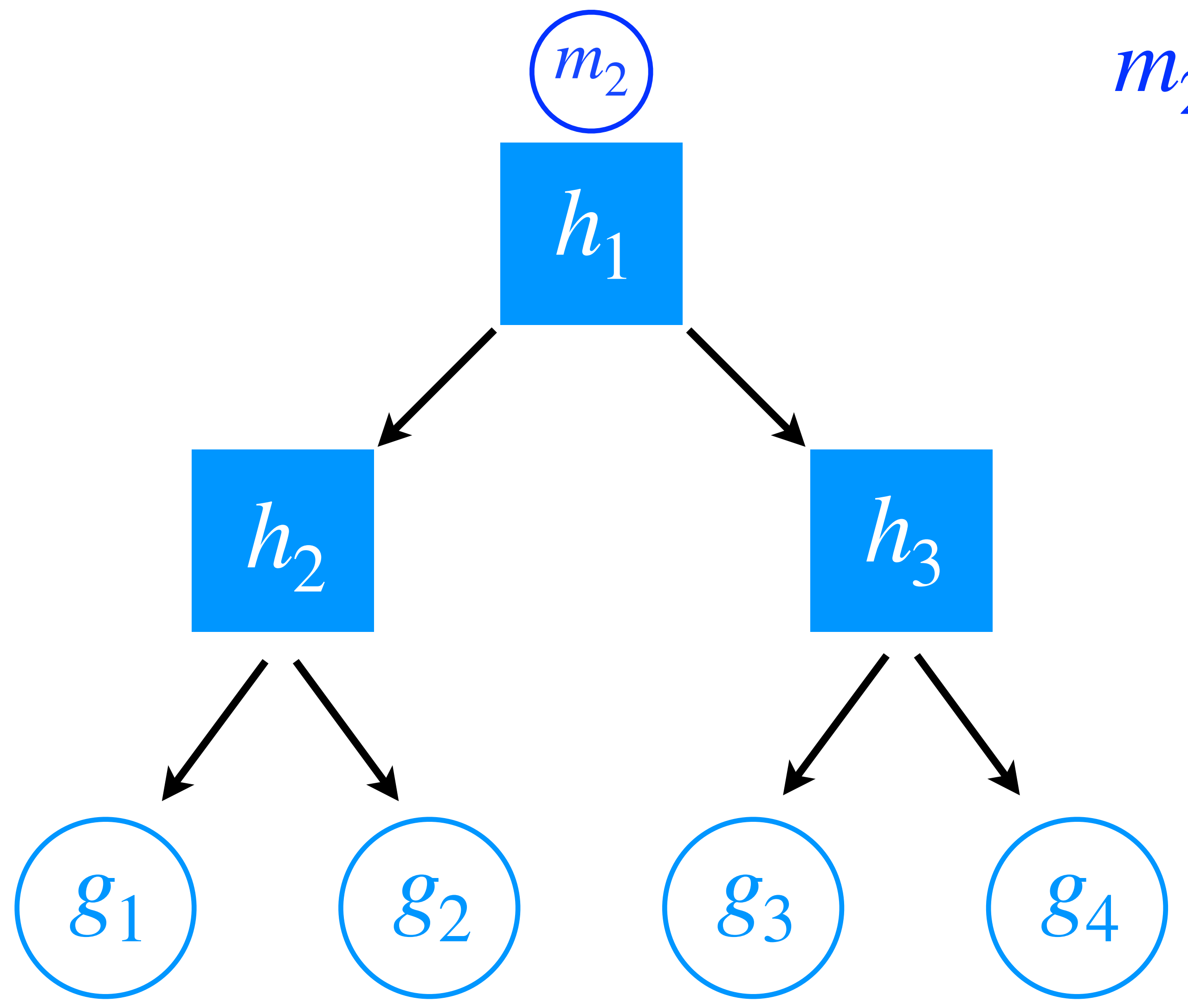

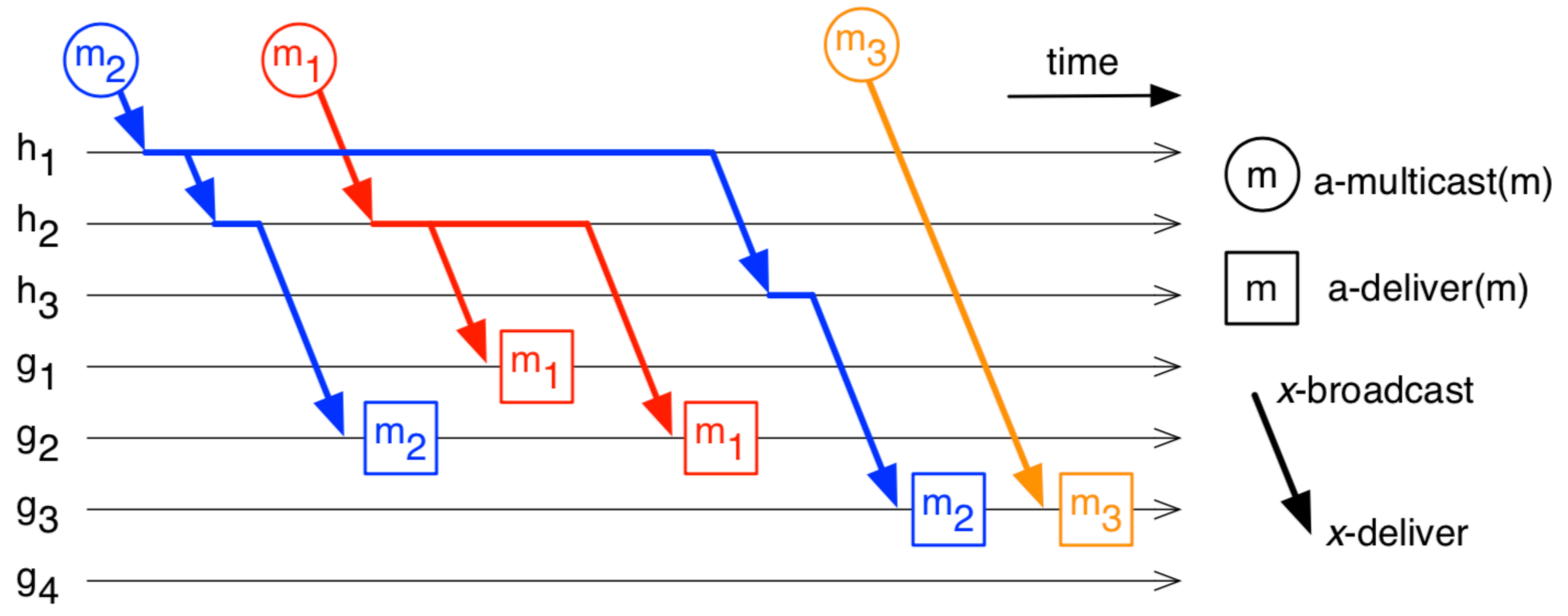

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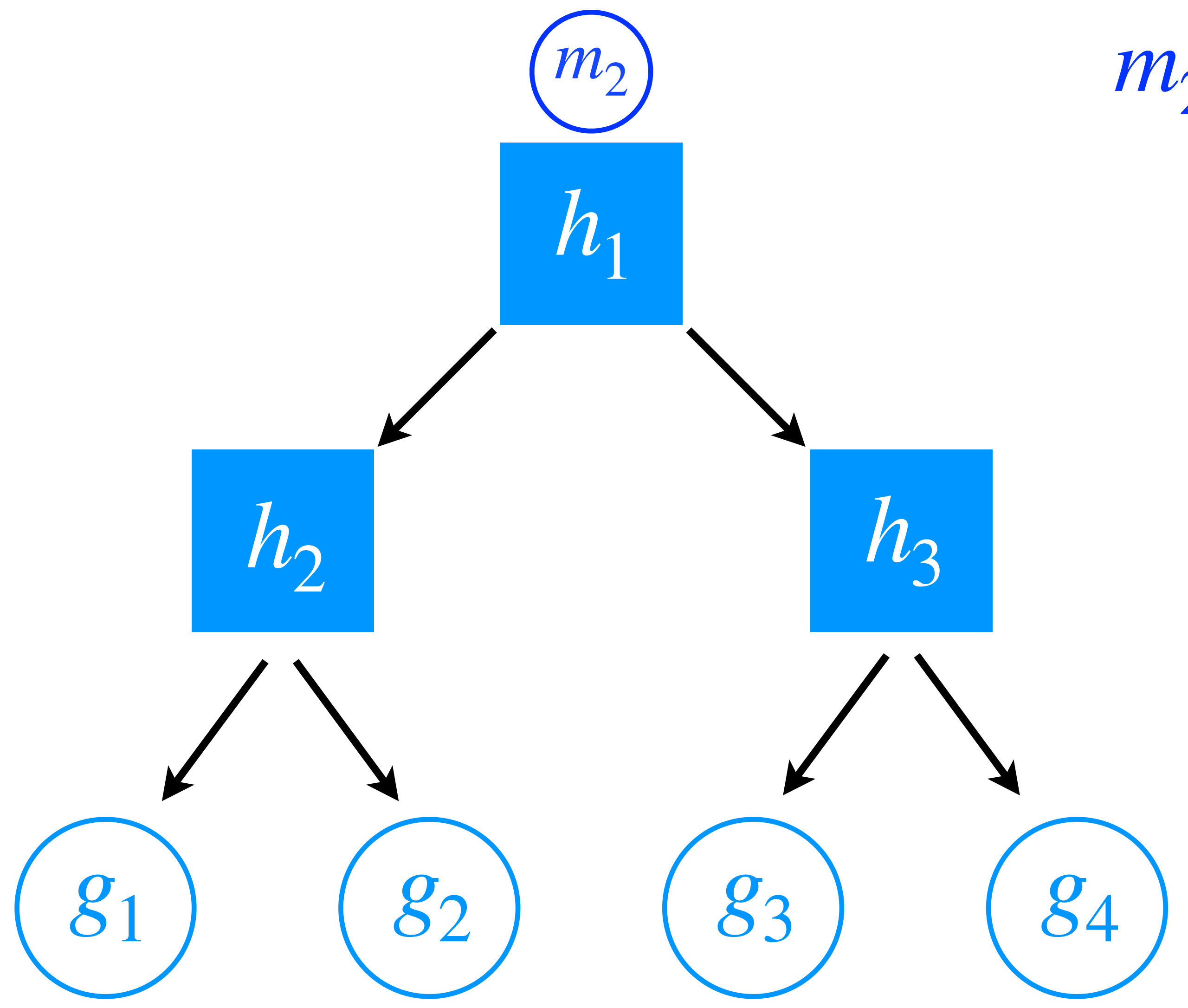

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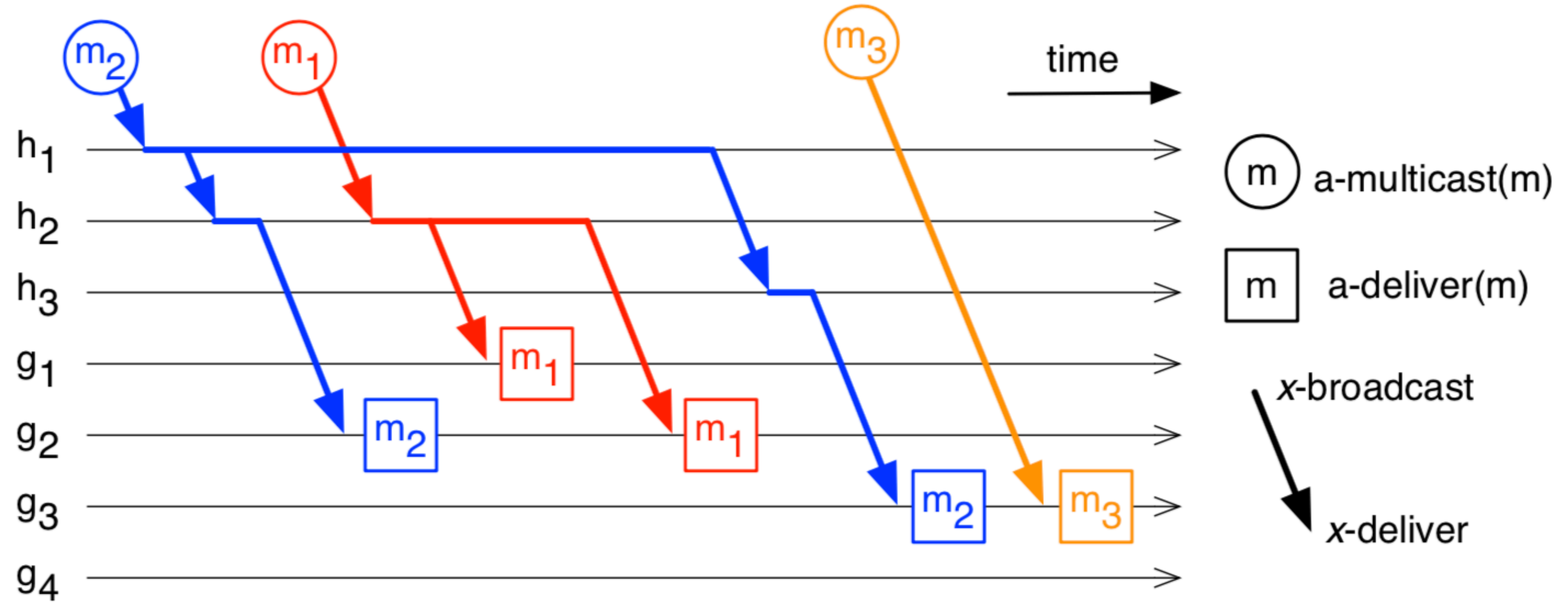

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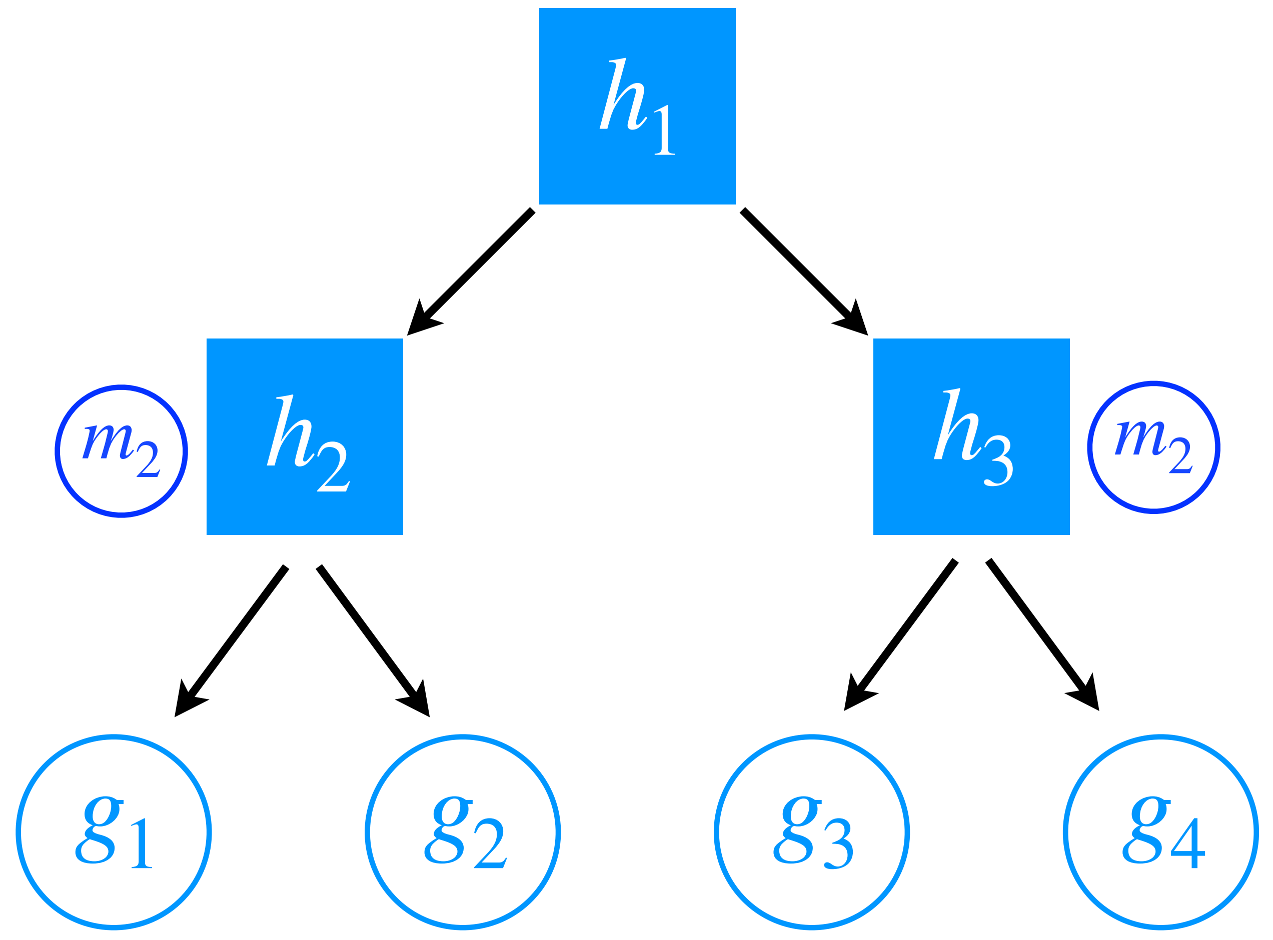

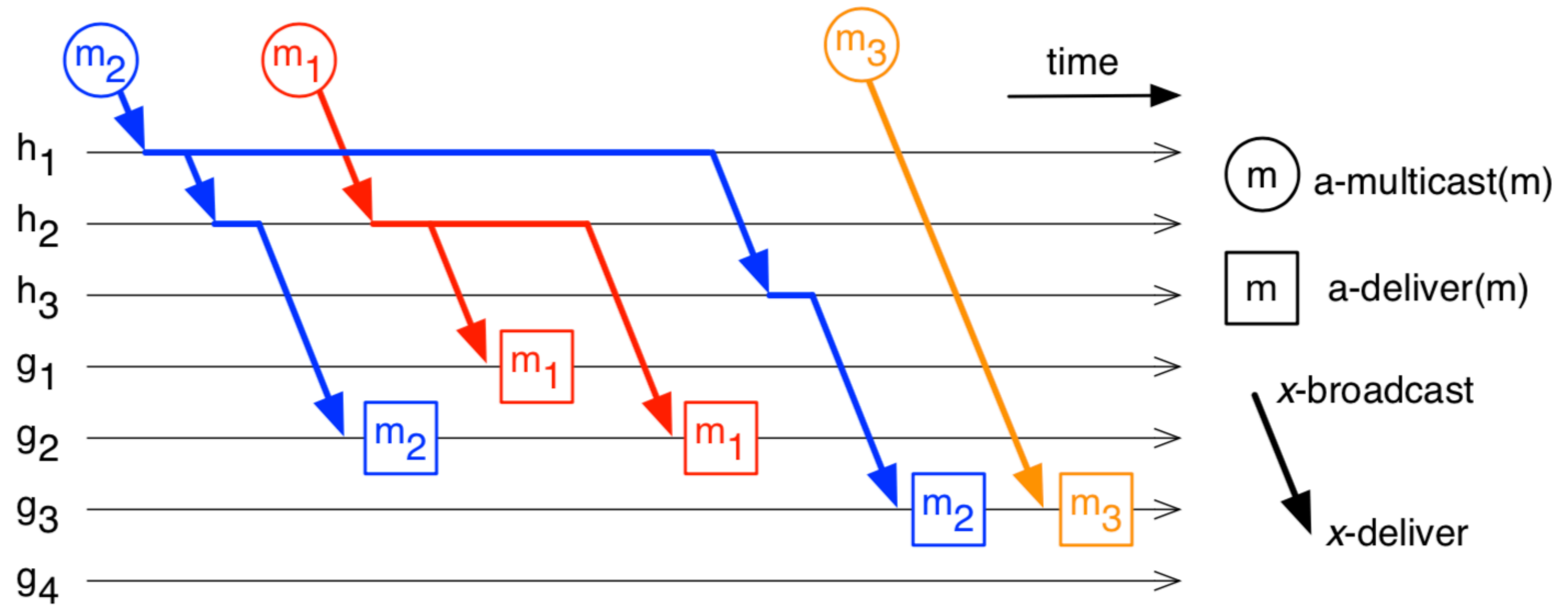

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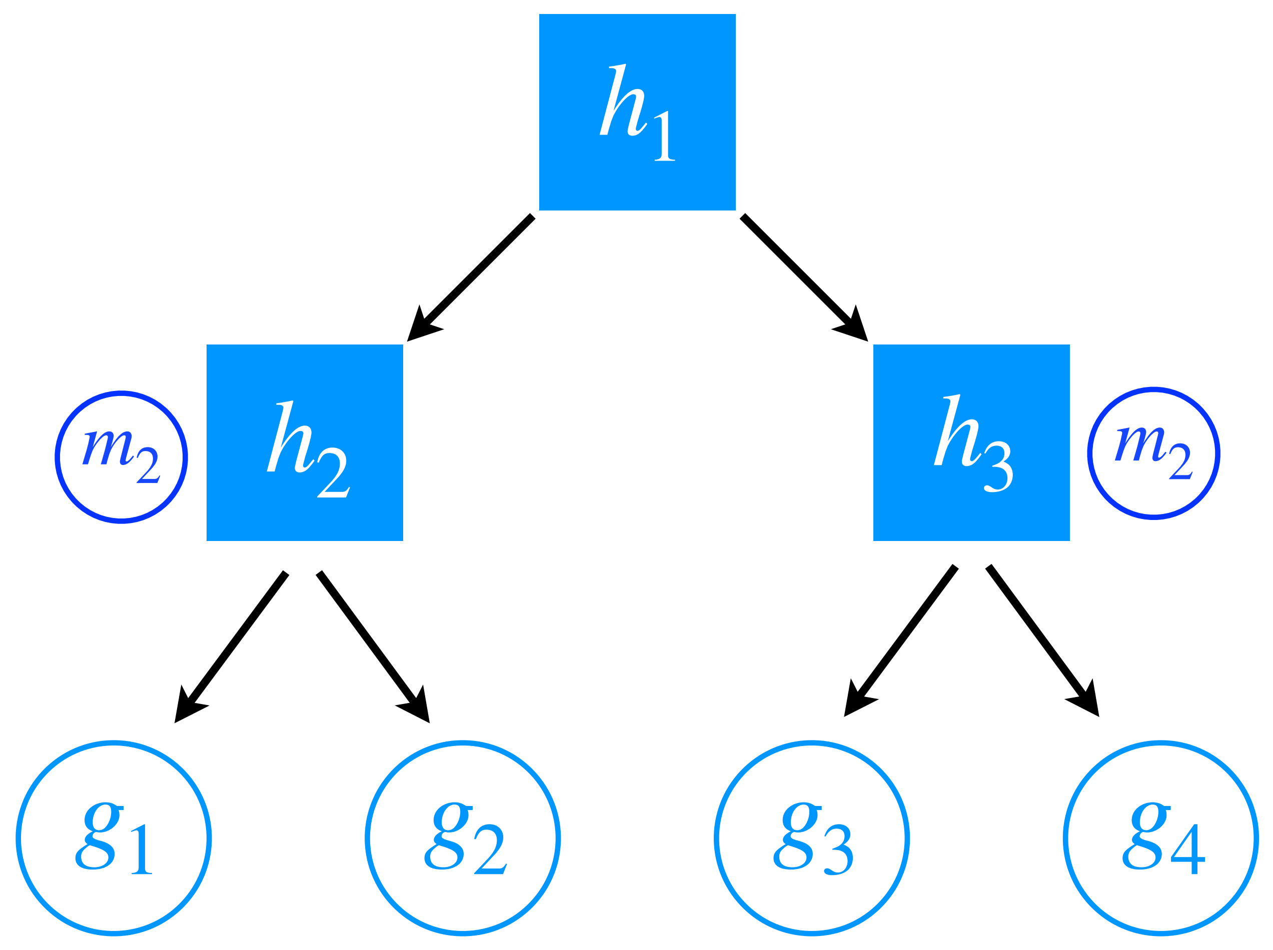

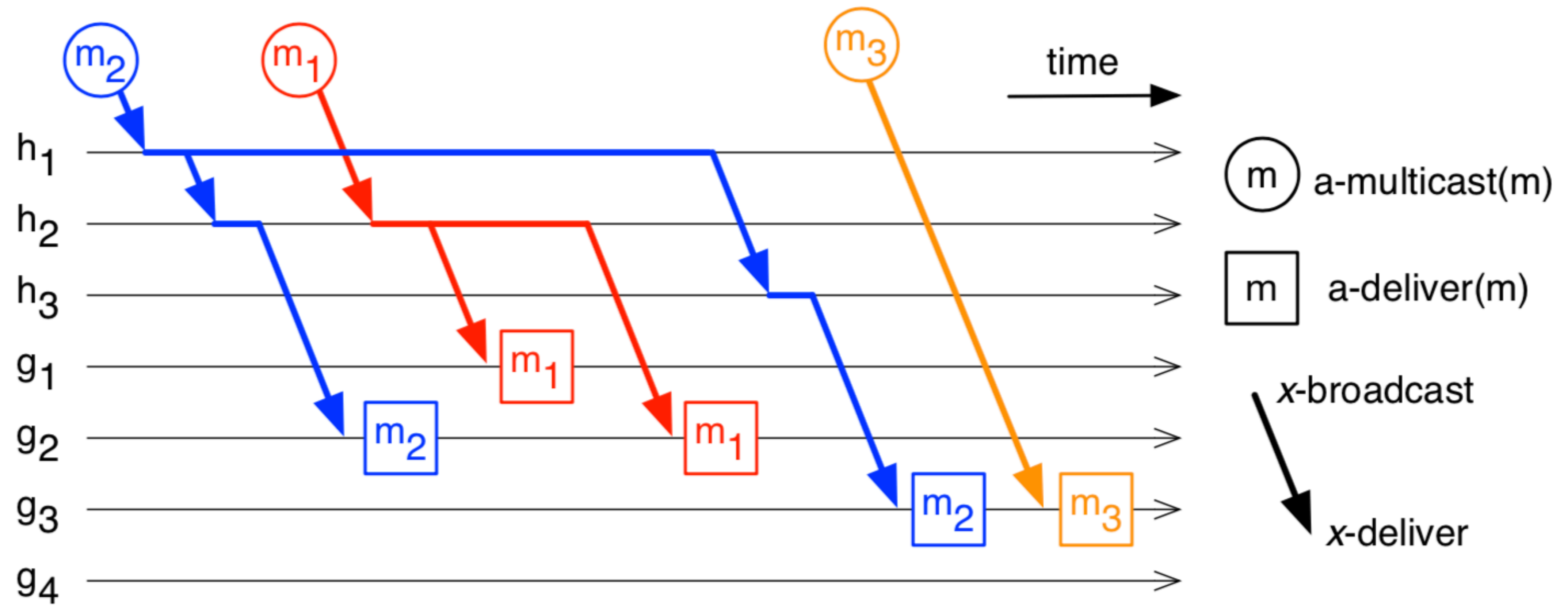

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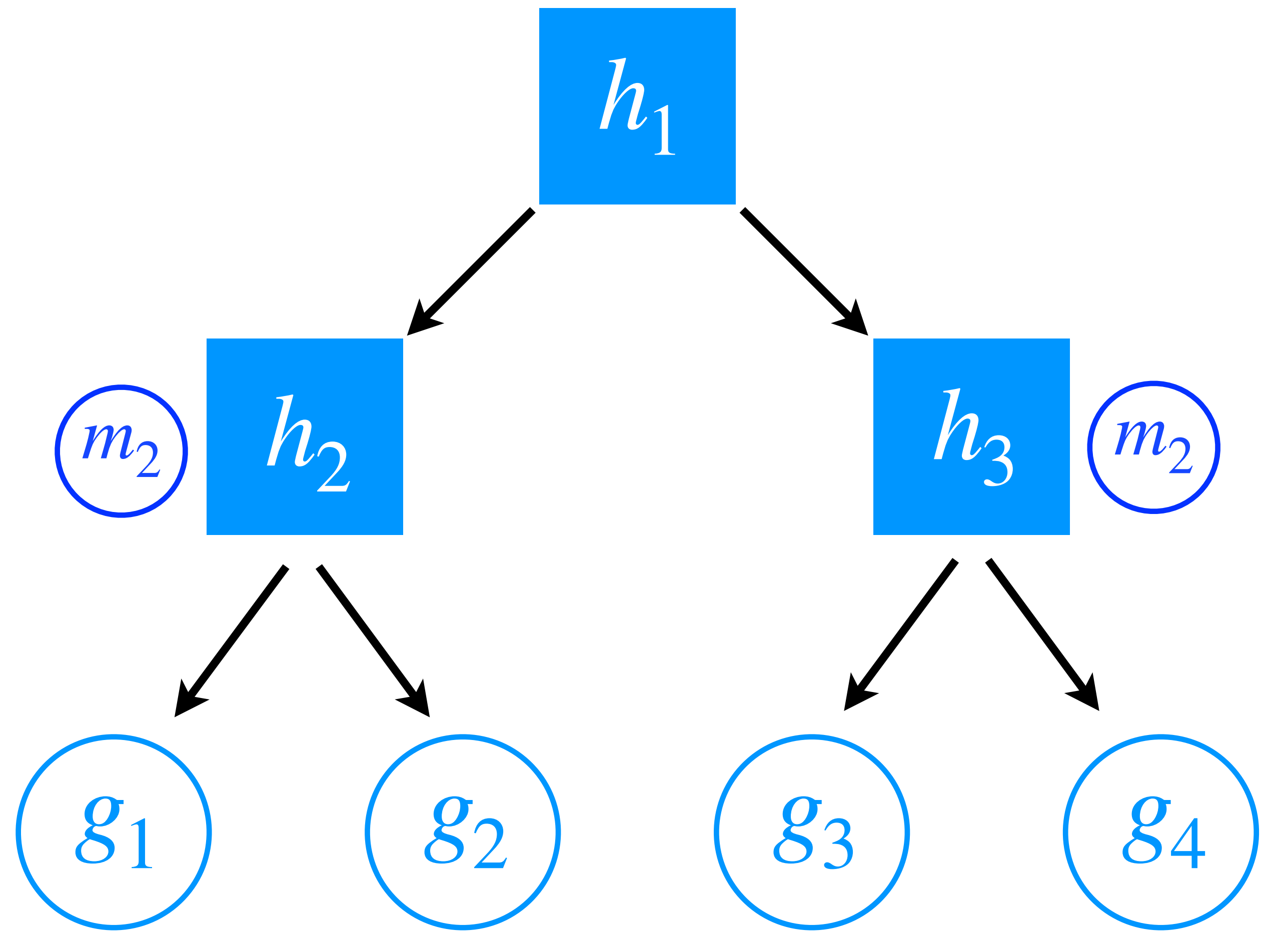

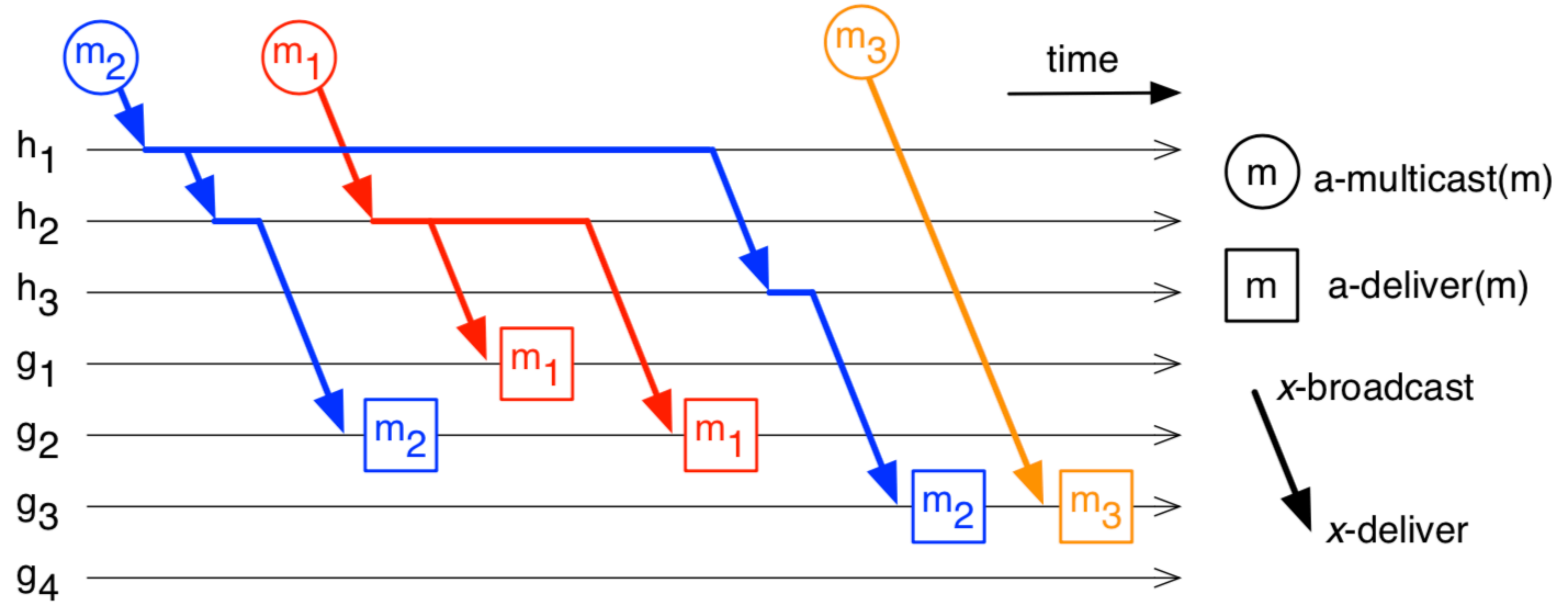

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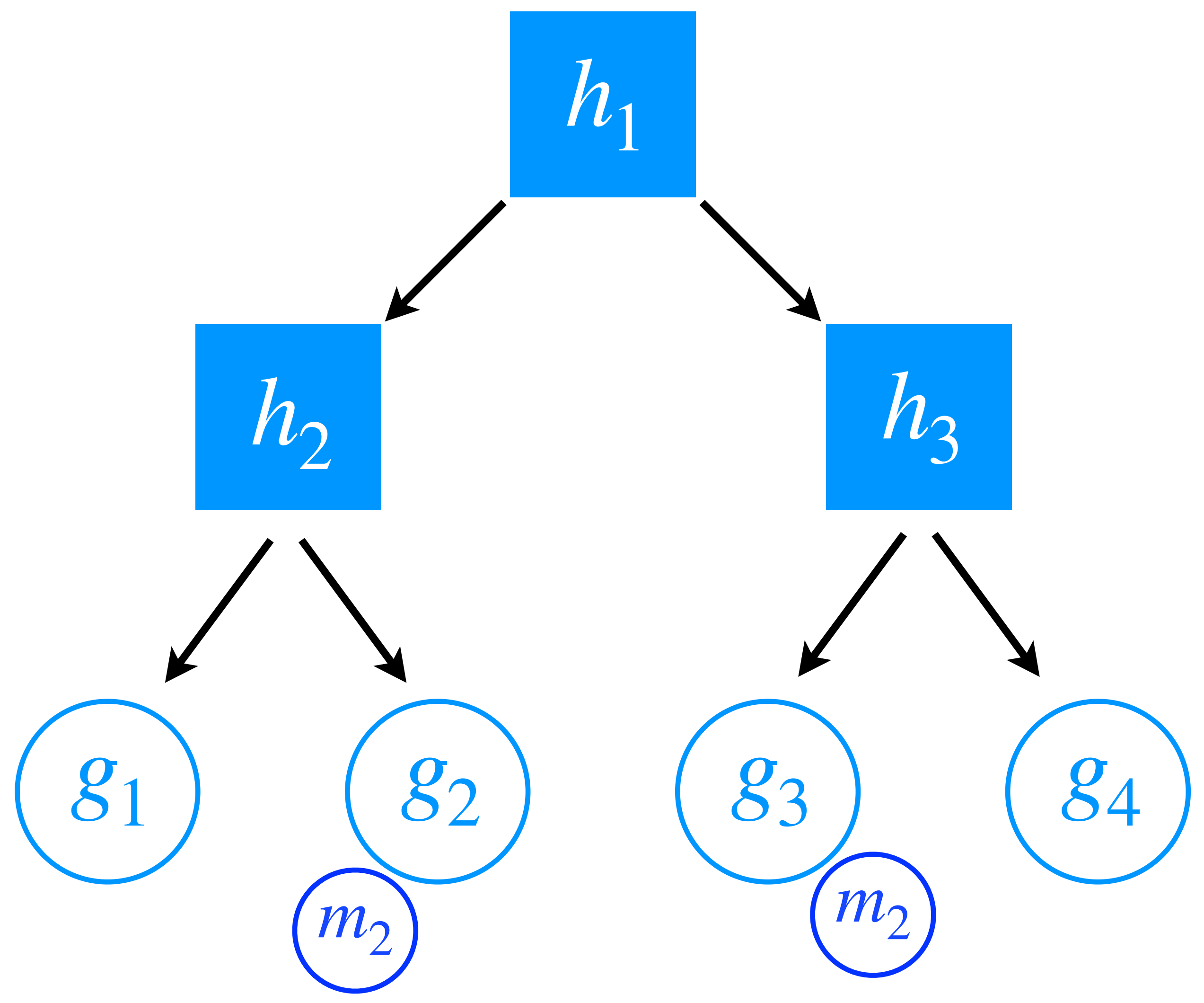

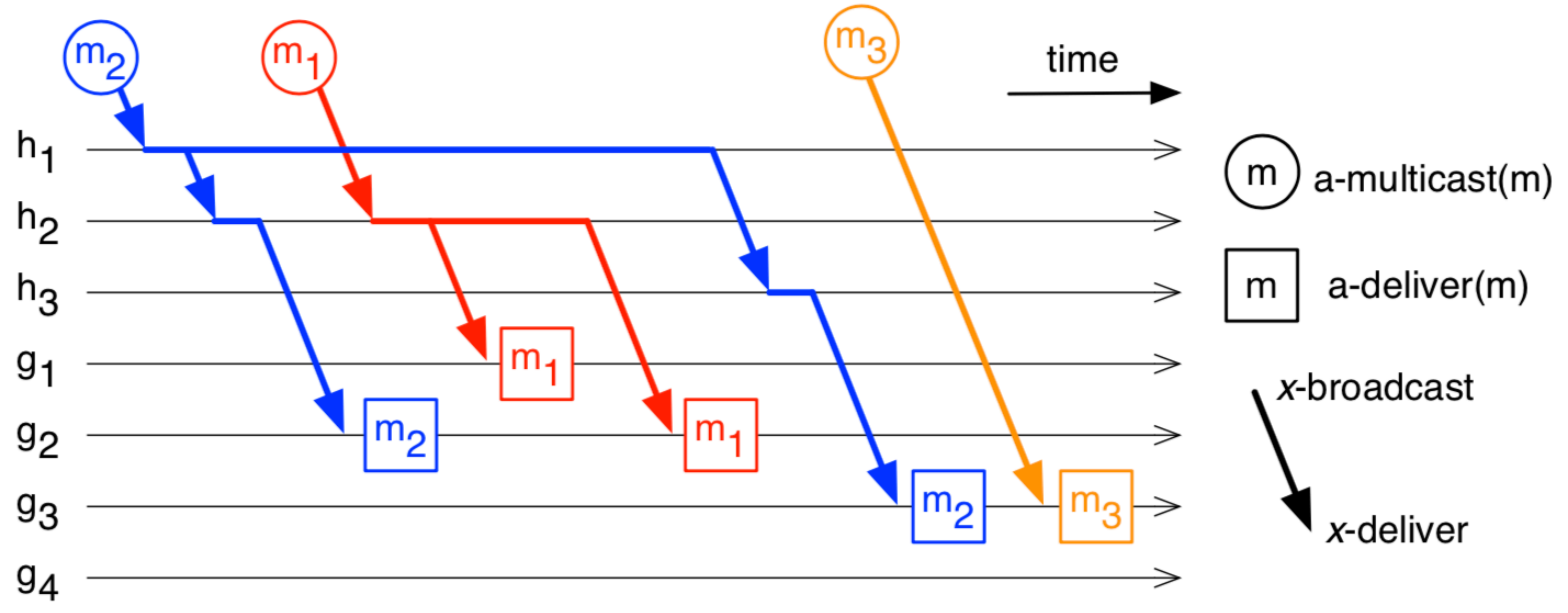

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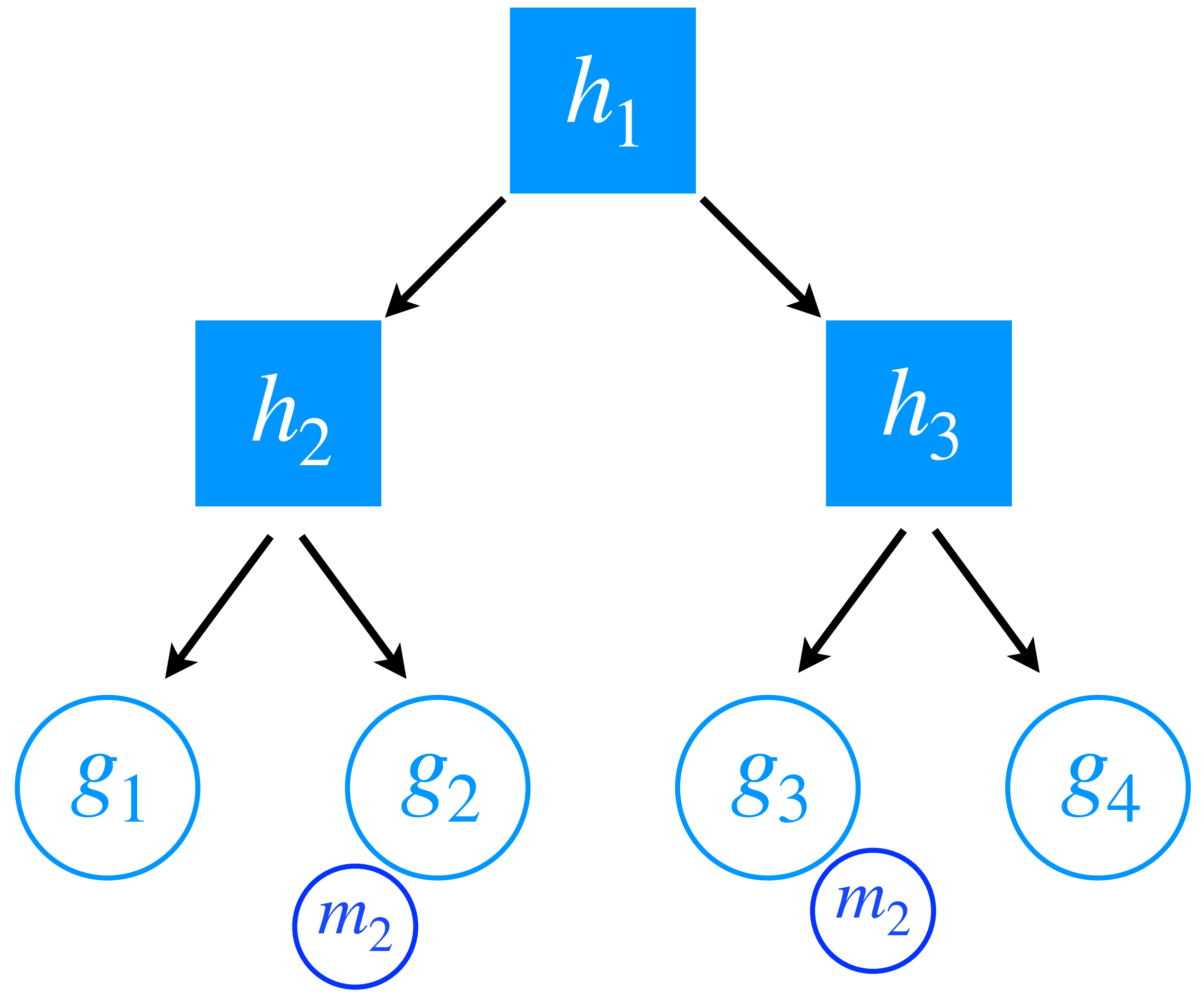

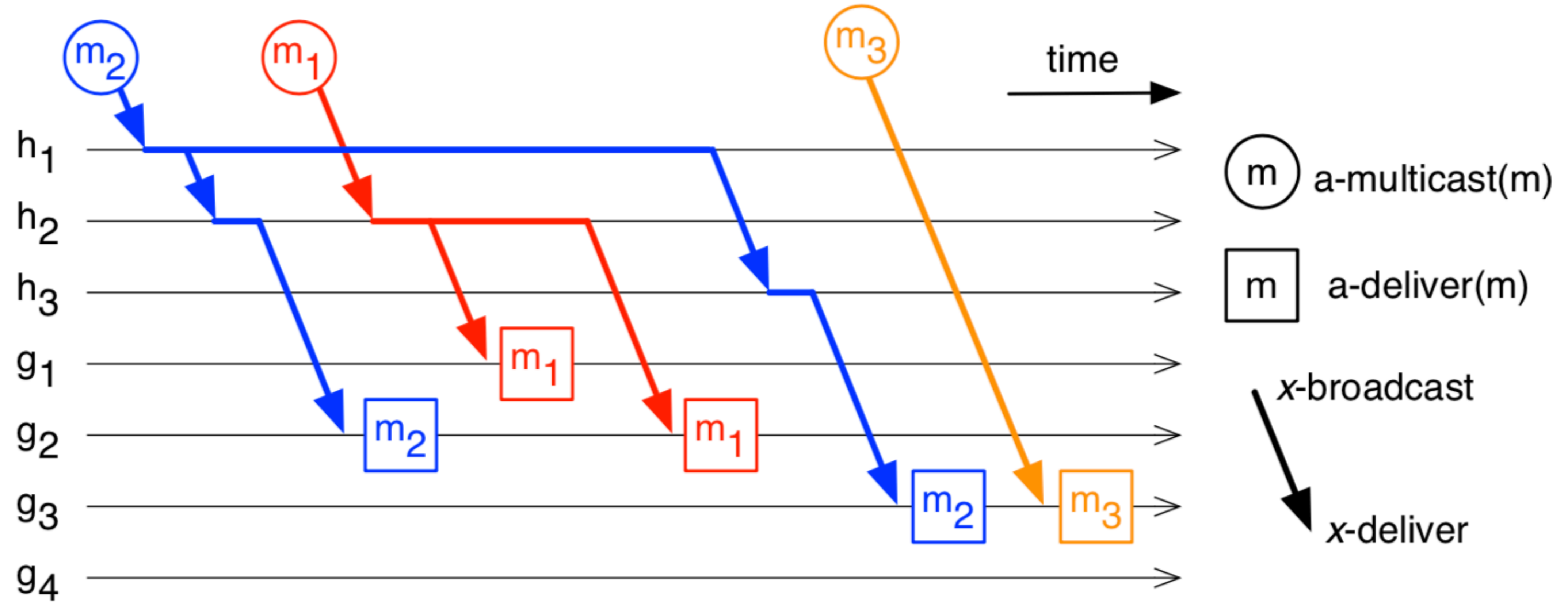

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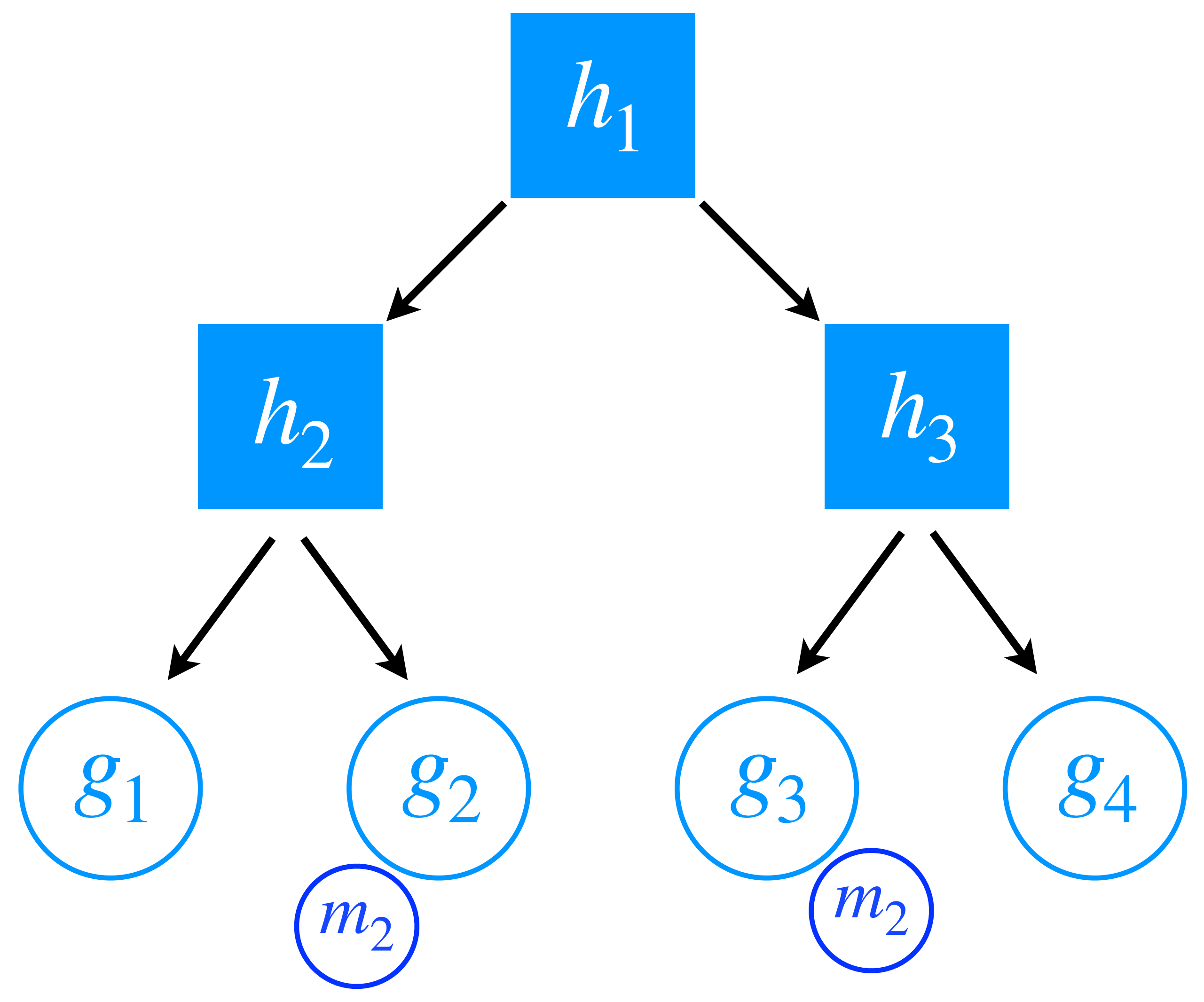

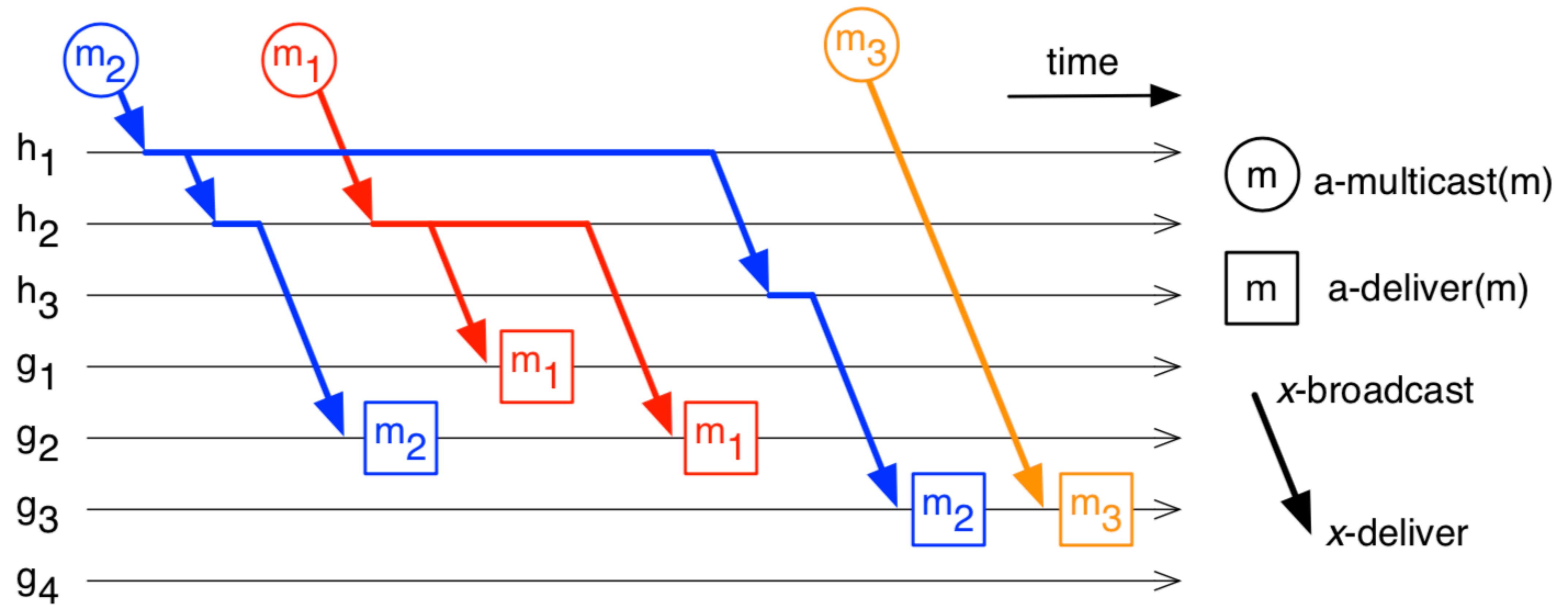

Optimisation problem of building an overlay tree

Optimisation problem:

Minimise the height of the various destination:

$$minimise \quad \sum_{d \in D} H(T,d)$$

where $H(T,d)$: height of the lowest common ancestor of groups in *d*

$$subject\ to \quad \forall(x) \ : \ L(T,d) \leq K(x)$$

where $L(T,d)$: load imposed on group *x*
$K(x)$: maximum performance in msg/s for group *x*

3.

What evidence supports the paper contributions?

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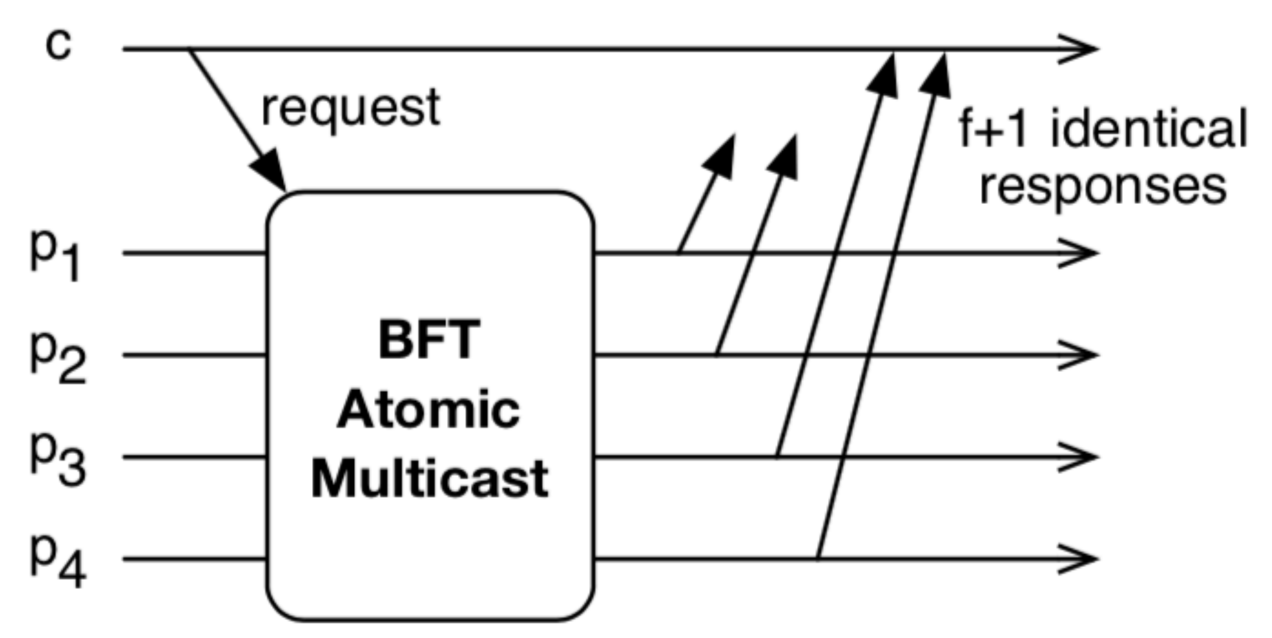
Prototype:

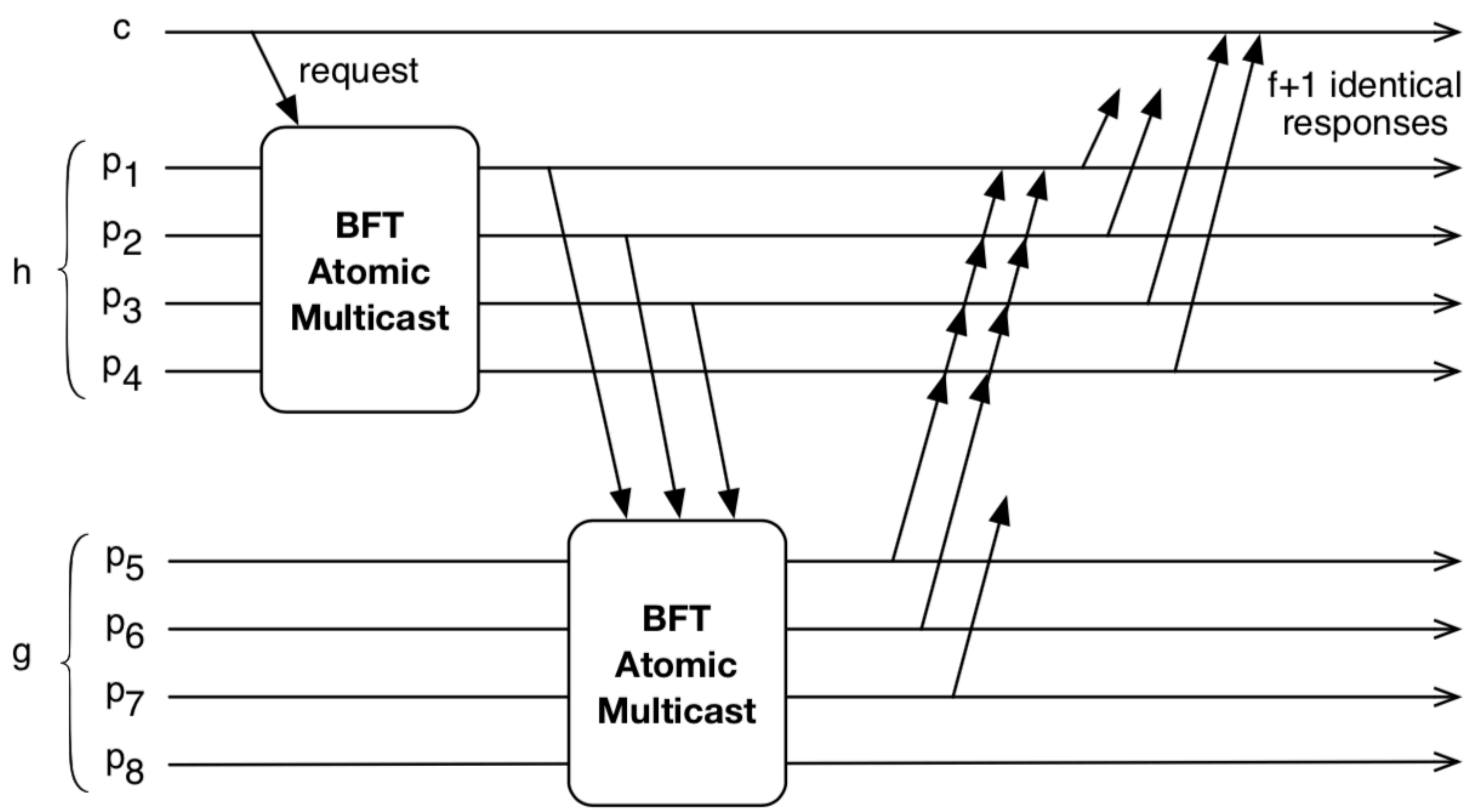
Implementation of ByzCast on top of BFT-SMaRt (Mod-SMaRt algorithm)

Each group $\longrightarrow$ BFT replicated state machine

Clients and auxiliary groups waits for $f+1$ correct replies

Implementation can be found here:
https://github.com/tarcisiocjr/byzcast





4.
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Performance evaluation:

Environment:

Four **targets group** and up to three **auxiliary groups**

Two workloads:

uniform workload $\longrightarrow$ all combination of two destination groups

skewed workload $\longrightarrow$ destination groups are either $\{g_1, g_2\}$ or $\{g_3, g_4\}$

$$K(h_i) = 9500 \ m/s$$

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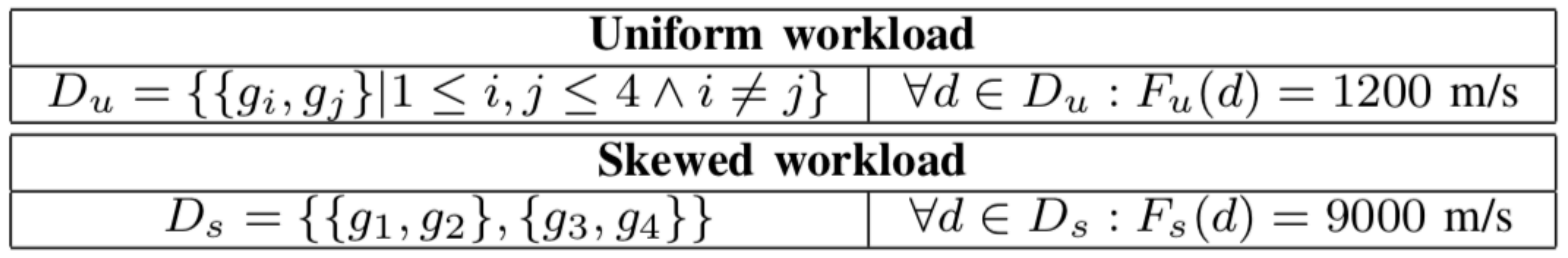


Uniform workload	
$D_u = \{\{g_i, g_j\} \mid 1 \leq i, j \leq 4 \wedge i \neq j\}$	$\forall d \in D_u : F_u(d) = 1200$ m/s
Skewed workload	
$D_s = \{\{g_1, g_2\}, \{g_3, g_4\}\}$	$\forall d \in D_s : F_s(d) = 9000$ m/s

TABLE II: Uniform and skewed workloads.

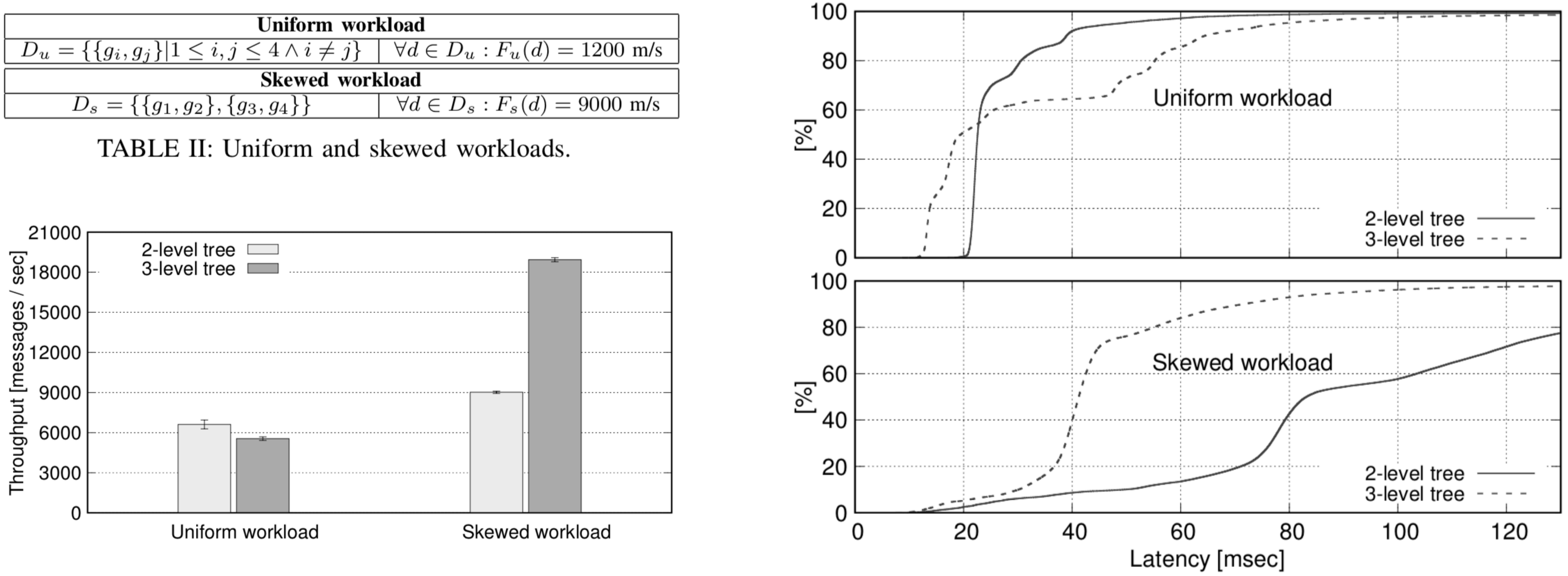
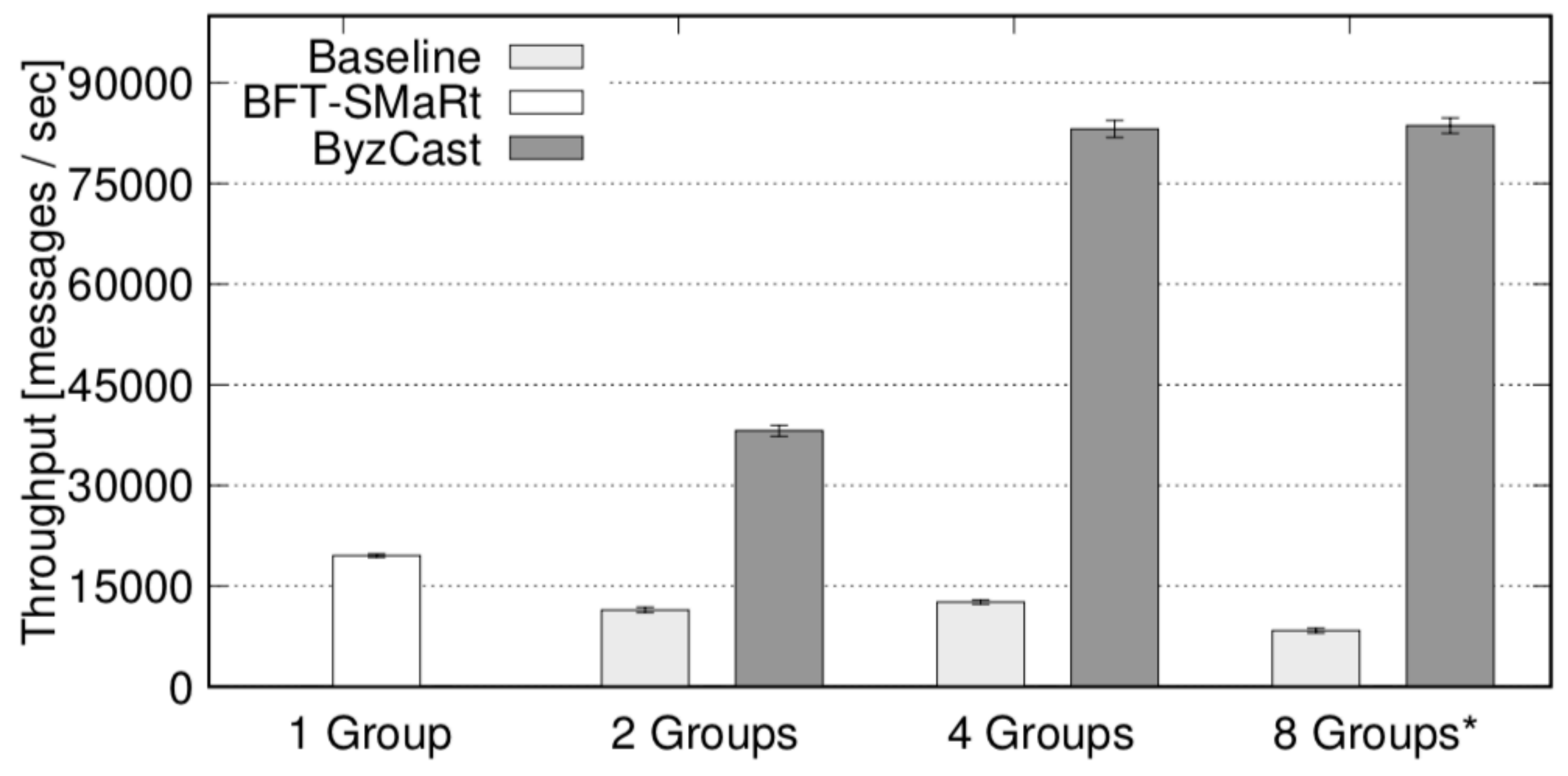


Fig. 3: ByzCast global messages throughput and latency CDF with 2-level and 3-level trees. Whiskers show 95% confidence interval.

4. Do the data actually support the conclusions?

200 clients per group multicast local messages only (100 for 8-groups)



(a) Local messages.

Genuineness of ByzCast with respect to local messages leads to better performances

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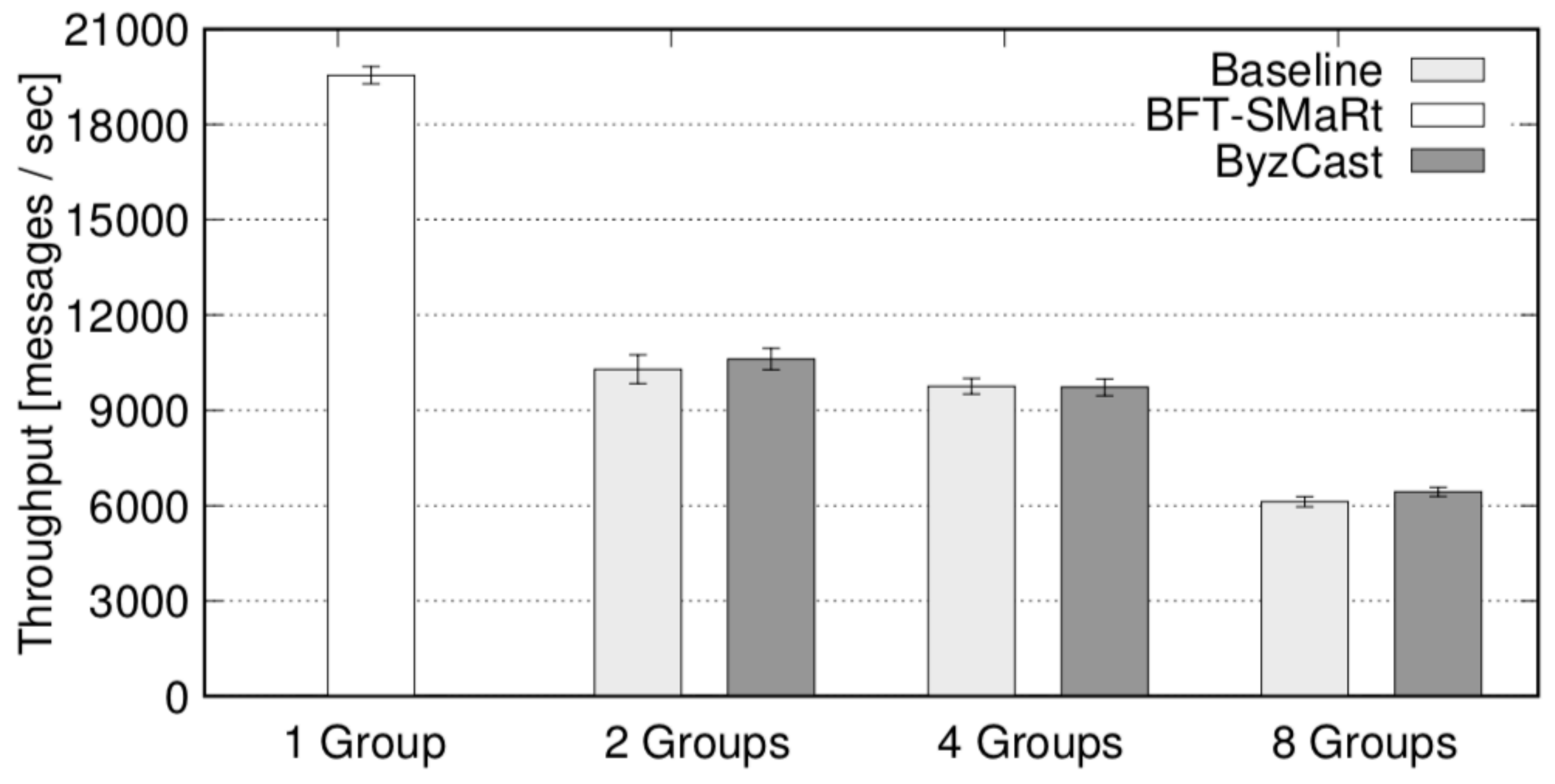

(b) Global messages.

Global messages in ByzCast have to be ordered by both the auxiliary group and the target groups

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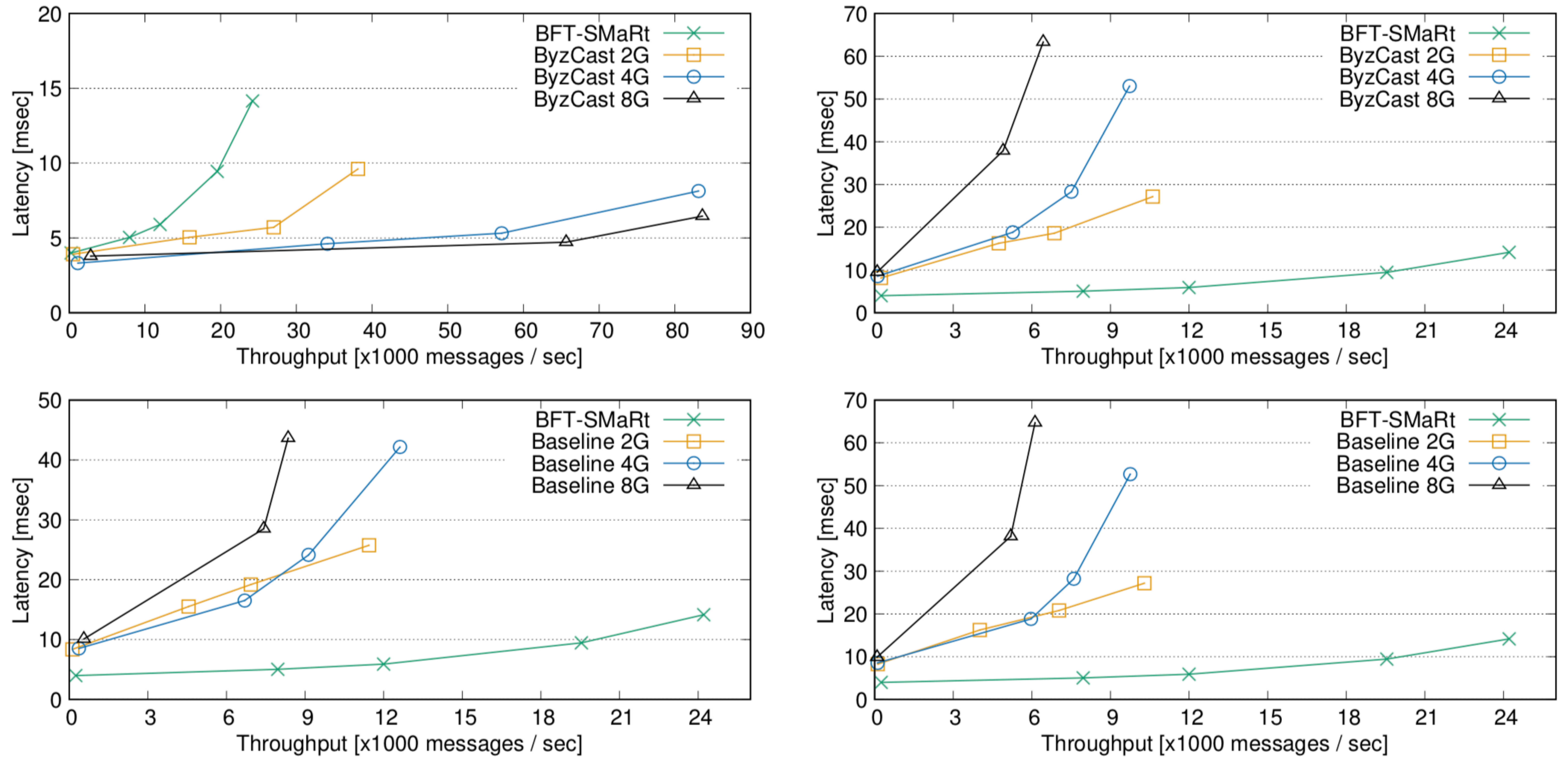

(a) Local messages: ByzCast (top) and Baseline (bottom).

(b) Global messages: ByzCast (top) and Baseline (bottom).

Fig. 5: Throughput vs. latency in a LAN.

5.
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The experiments results seem to be plausible thanks to the **partially genuineness** of ByzCast.

Other than being performed in a **controlled environment** as the LAN, corresponding experiments have been reproduced also in **WAN**, leading to similar performances and results.

5. What is the quality of that evidence?

Performance with mixed workload in WAN $\longrightarrow$ more realistic workload

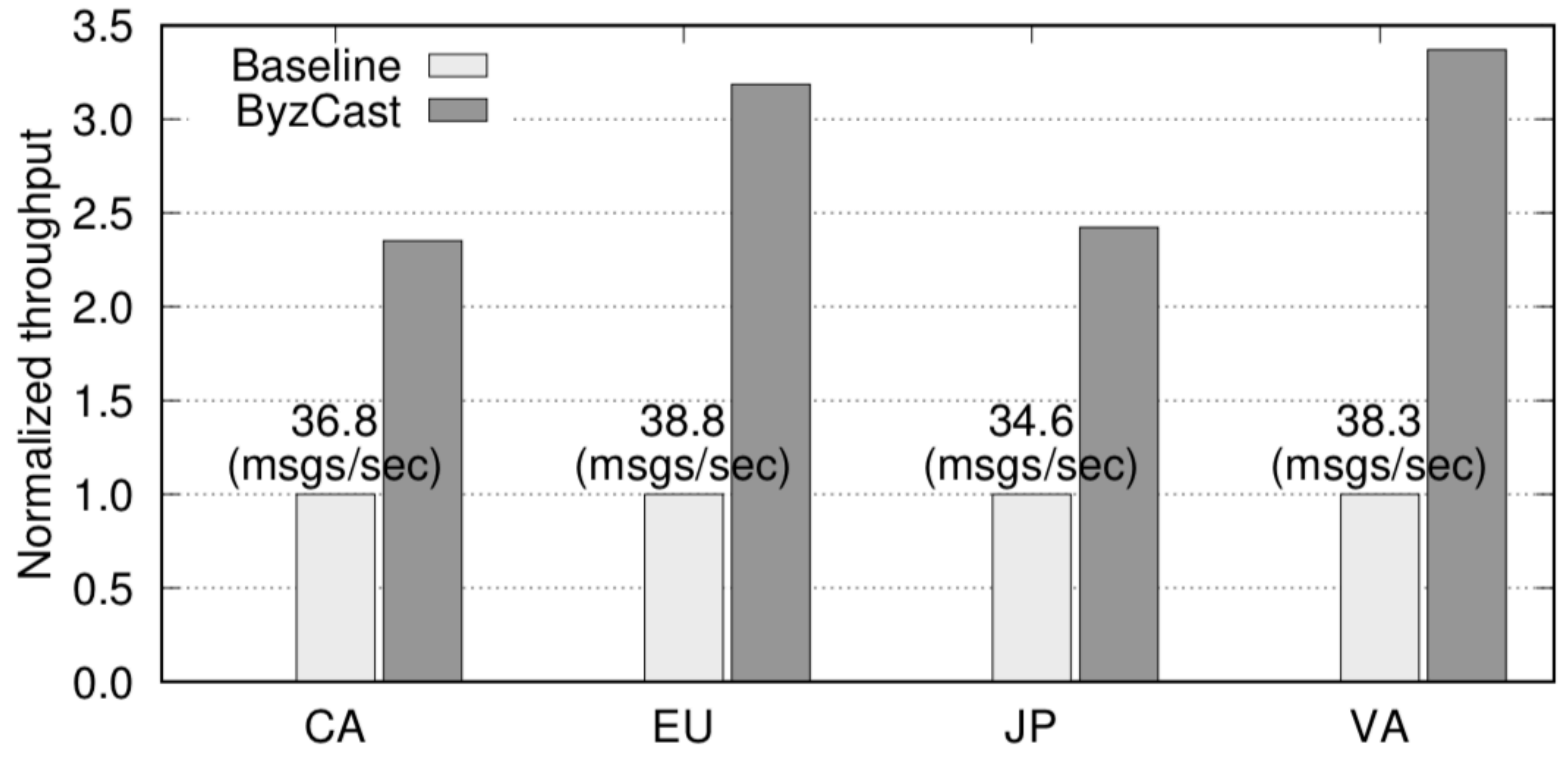

Fig. 9: Normalized throughput with mixed workload in a WAN.

ByzCast is 2x to 3x faster than the Baseline protocol in terms of throughput

6.
Why are the contributions important?

6. Why are the contributions important?

Introduction of a novel atomic multicast algorithm

Designing of a BFT and partially genuine protocol

Demonstration of performances in two different environments

Thank you for your attention

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