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 presents **ByzCast**, the first Byzantine Fault-Tolerant atomic multicast.

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

Improve the ability to handle malicious behaviours

Improve the scalability of performances

2.
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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

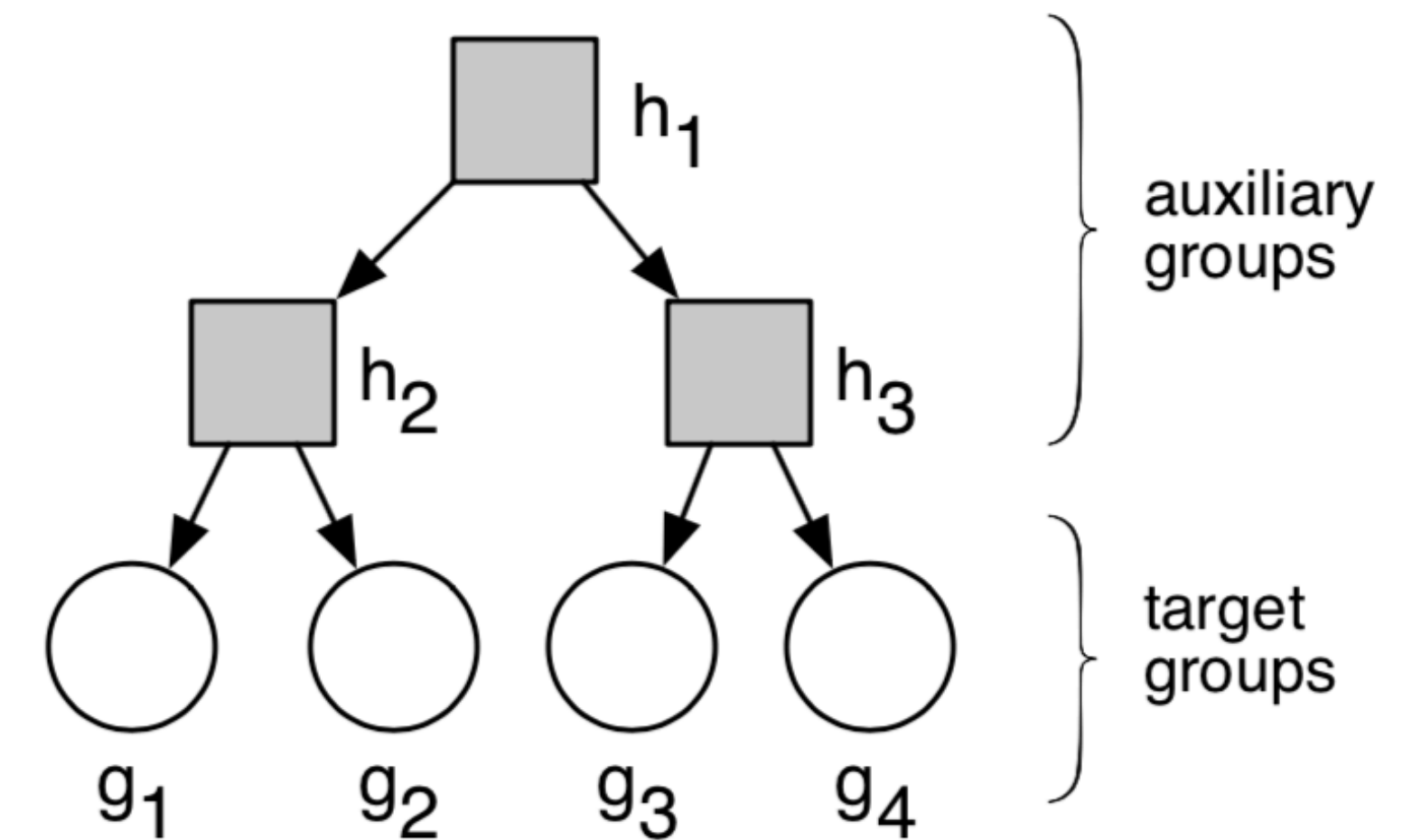## Partially genuine atomic multicast protocol

Protocol:

Target groups $\qquad \Gamma = \{g_1, \ldots, g_m\}$

Auxiliary groups $\qquad \Lambda = \{h_1, \ldots, h_n\}$

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

reach(x) $\qquad$ set of target groups that can be reached from *x* by walking down the tree

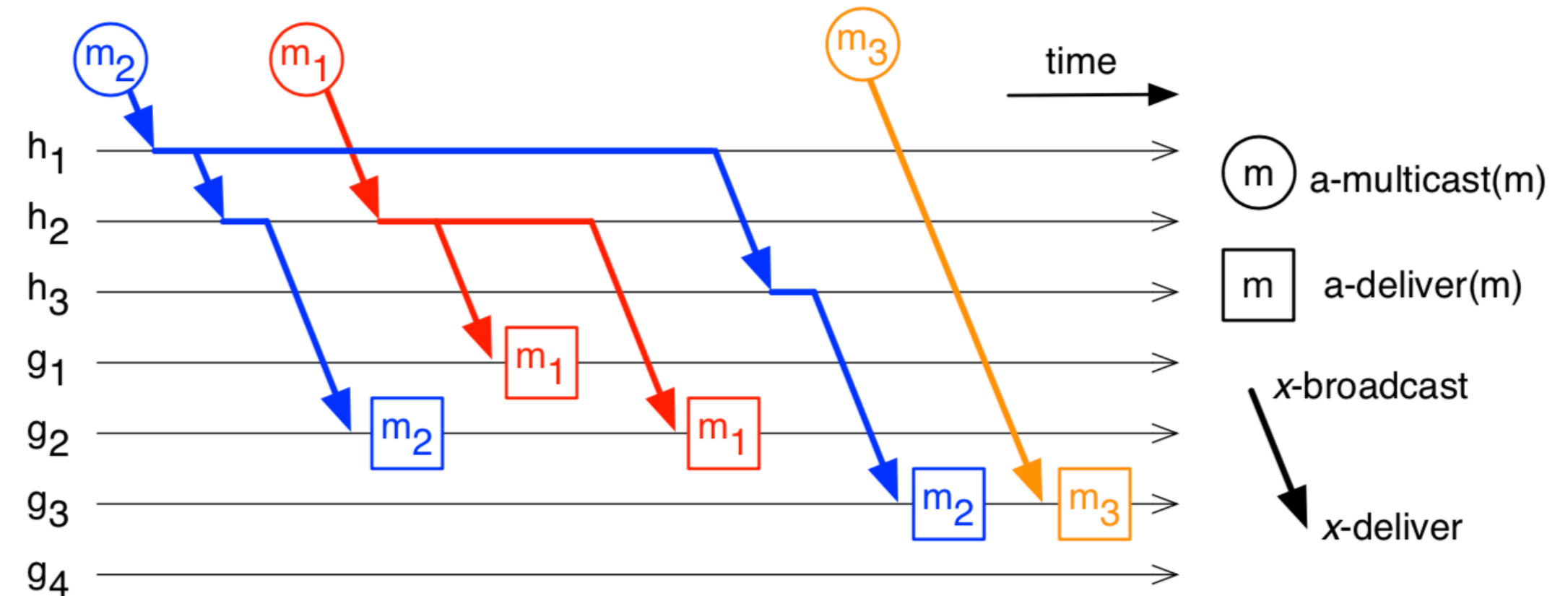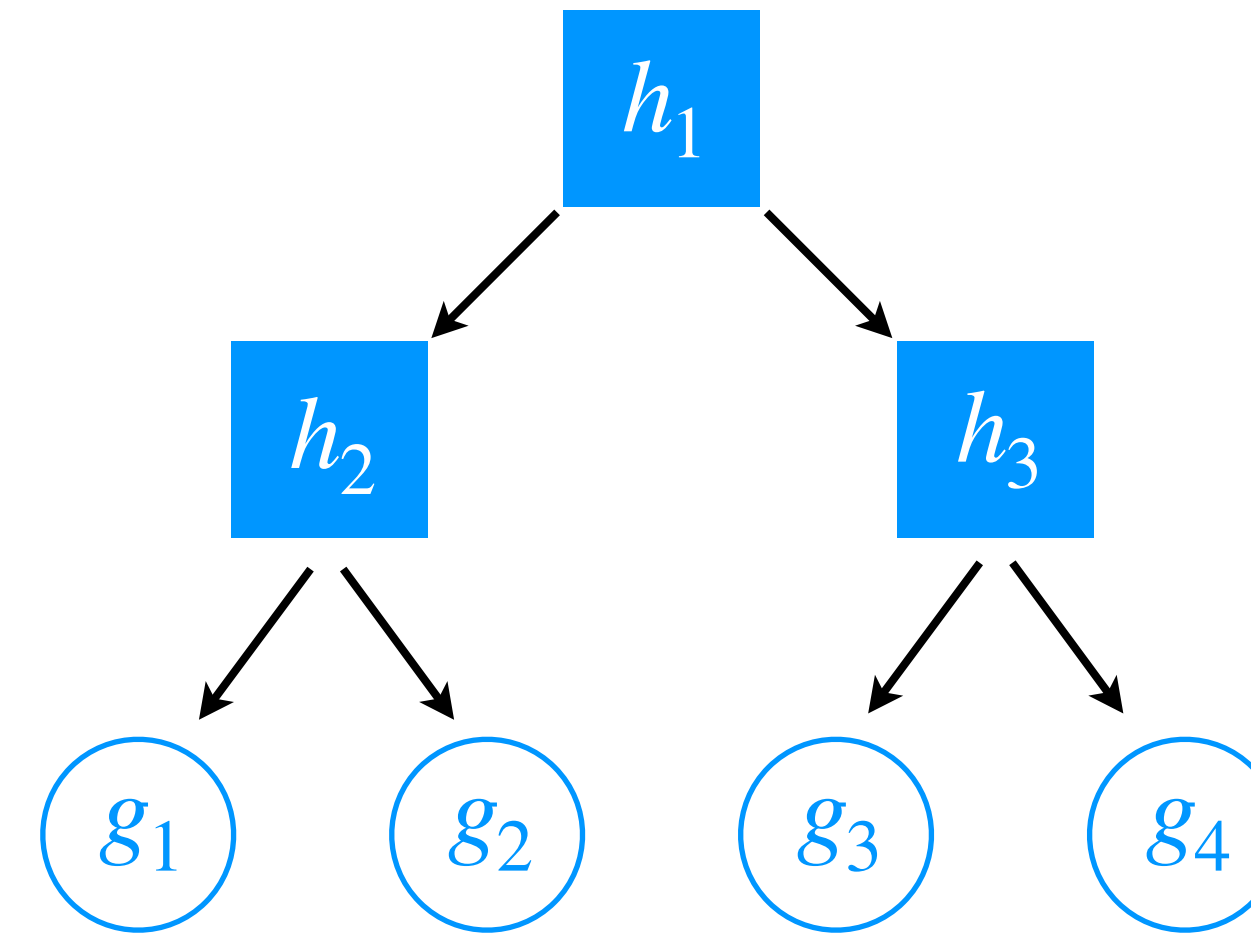*lca(m.dst)* $\qquad$ lowest common ancestor

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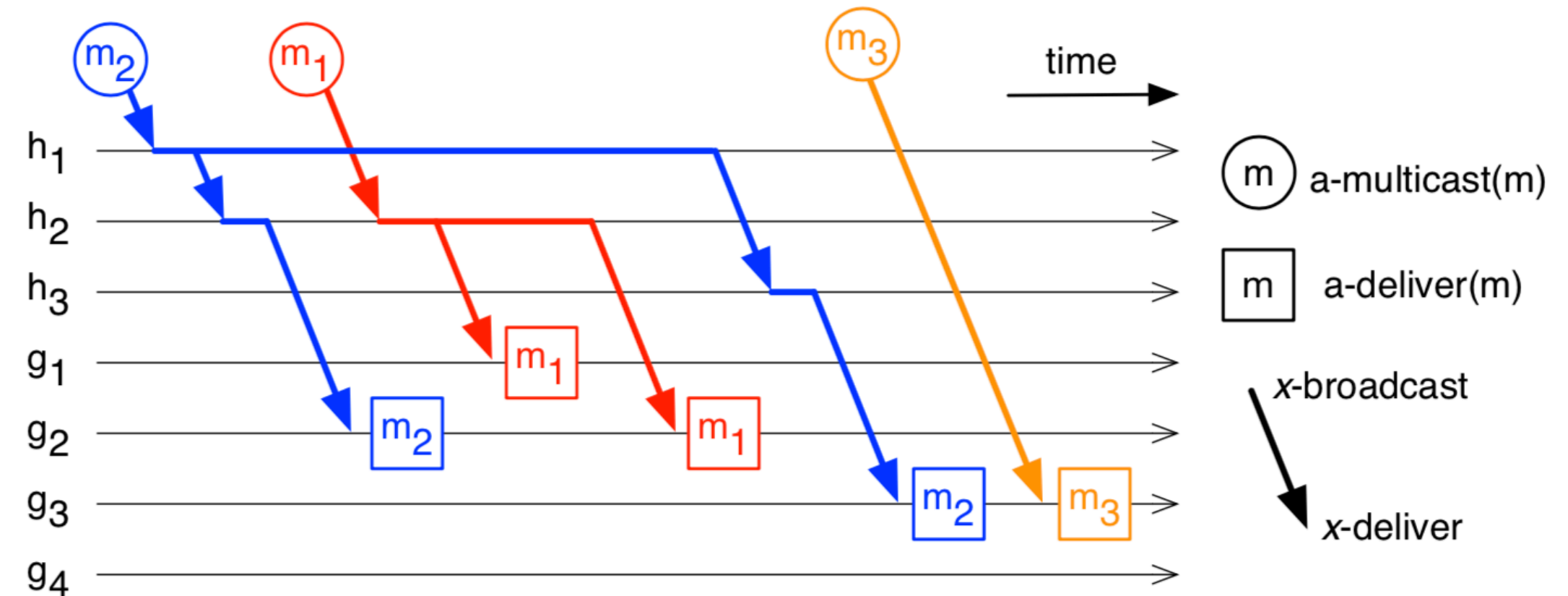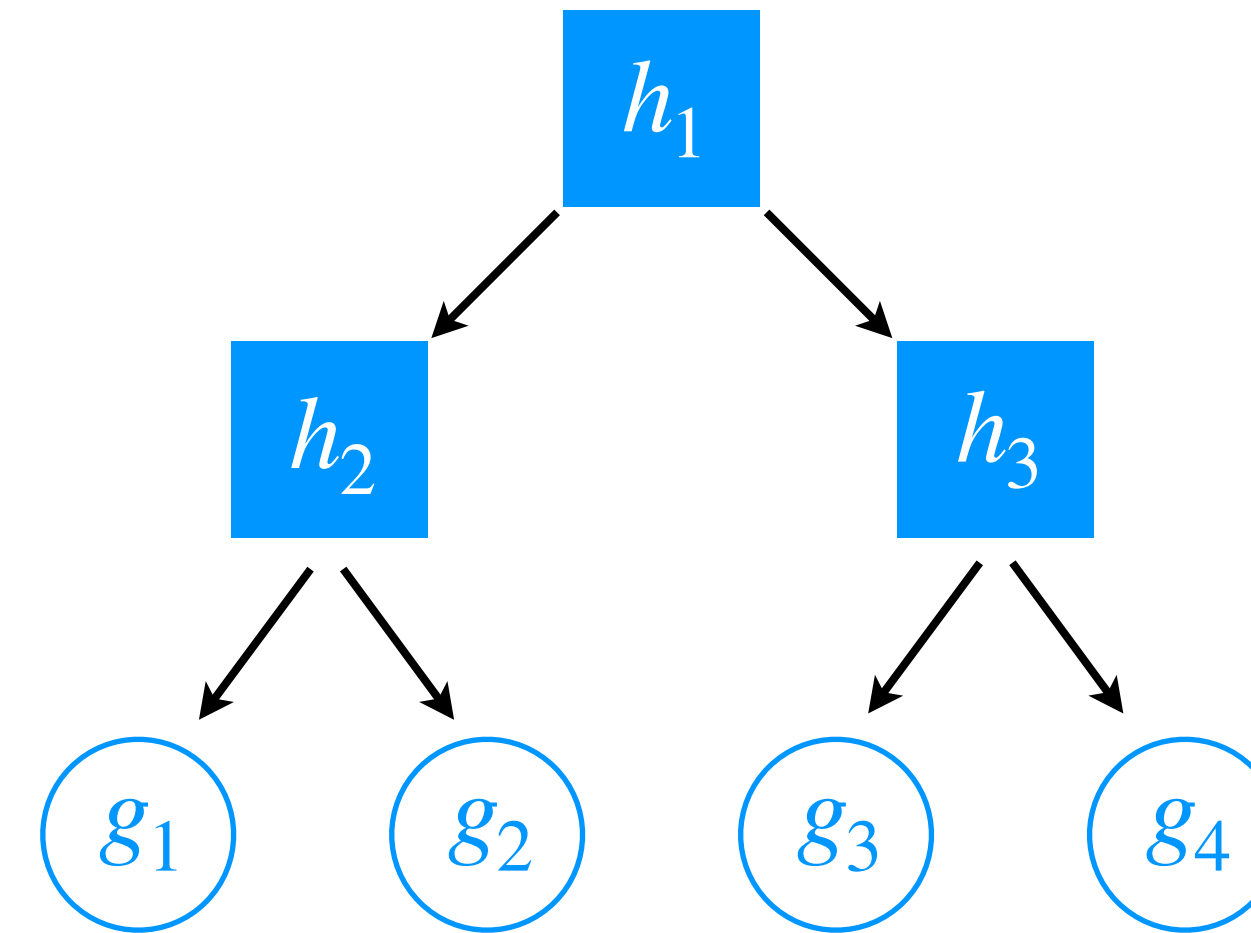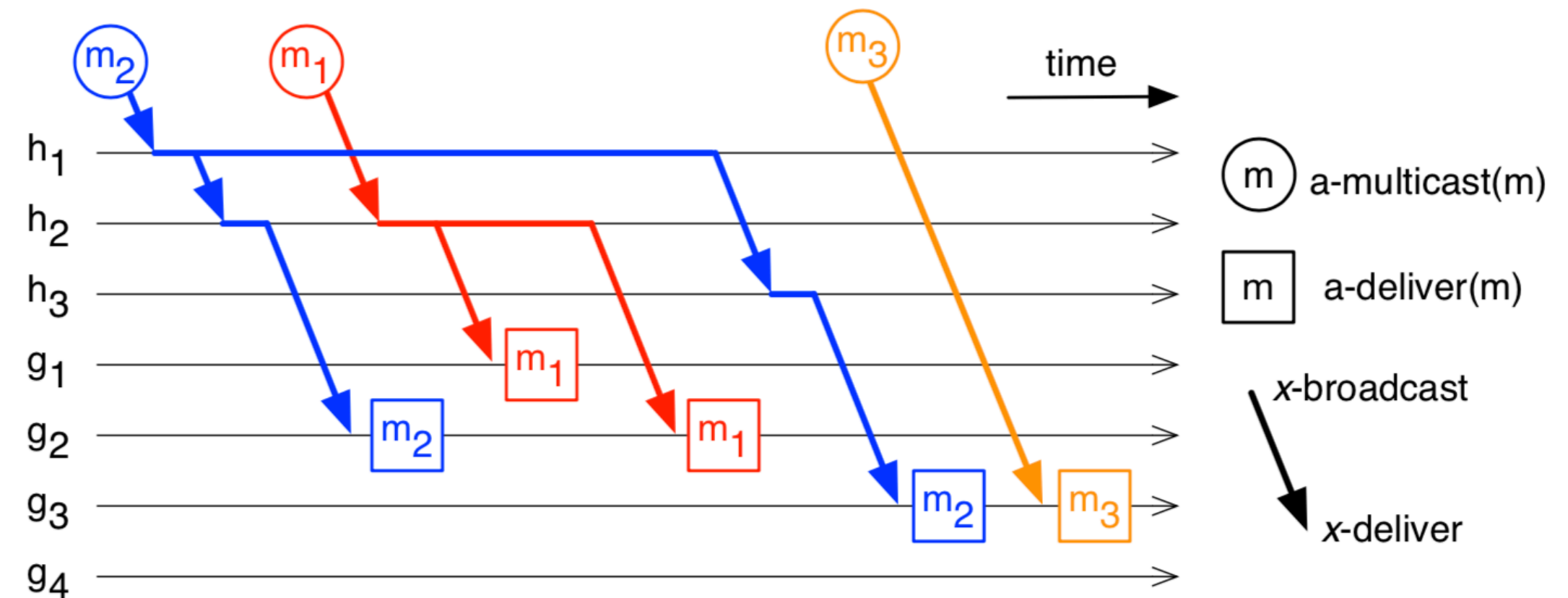
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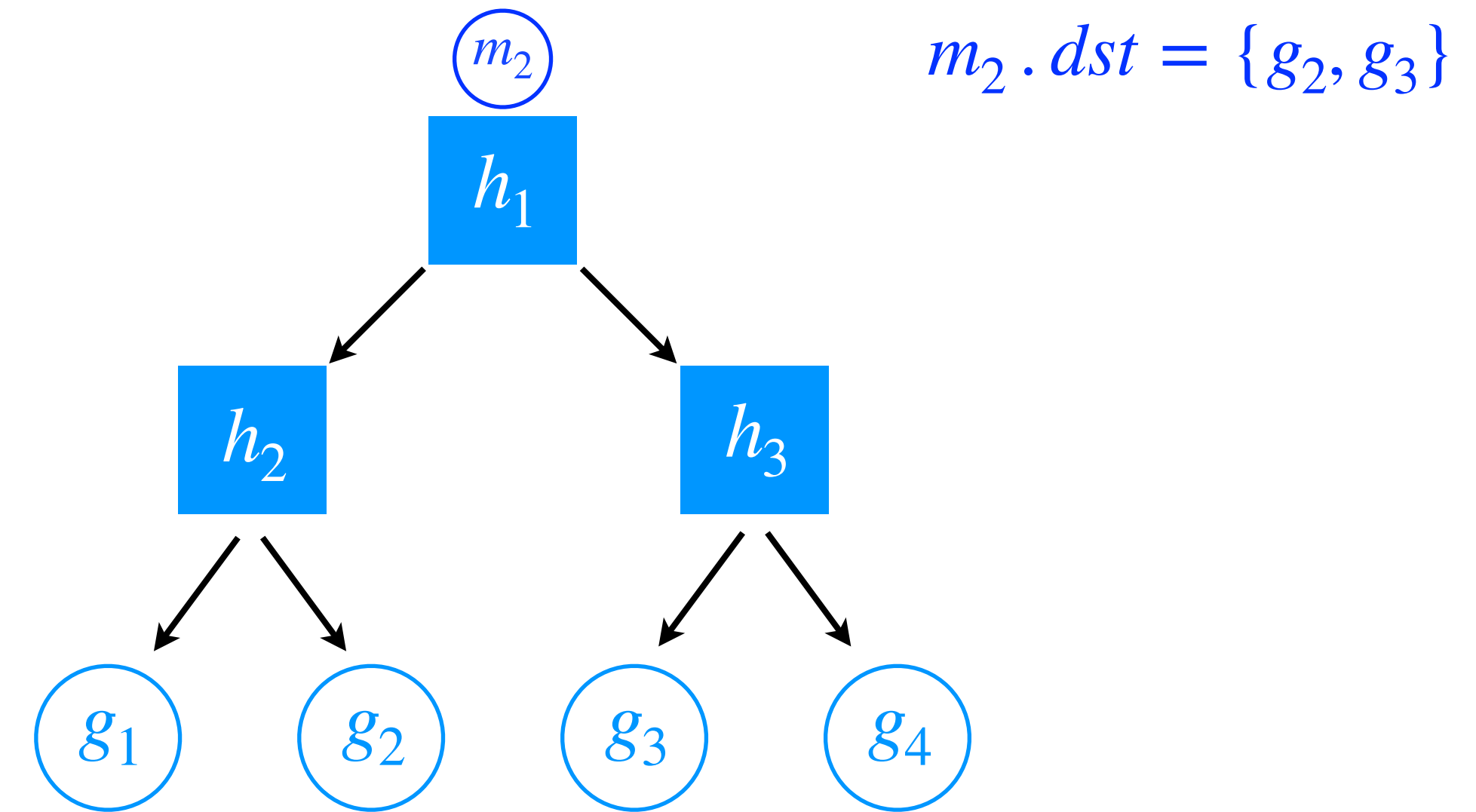
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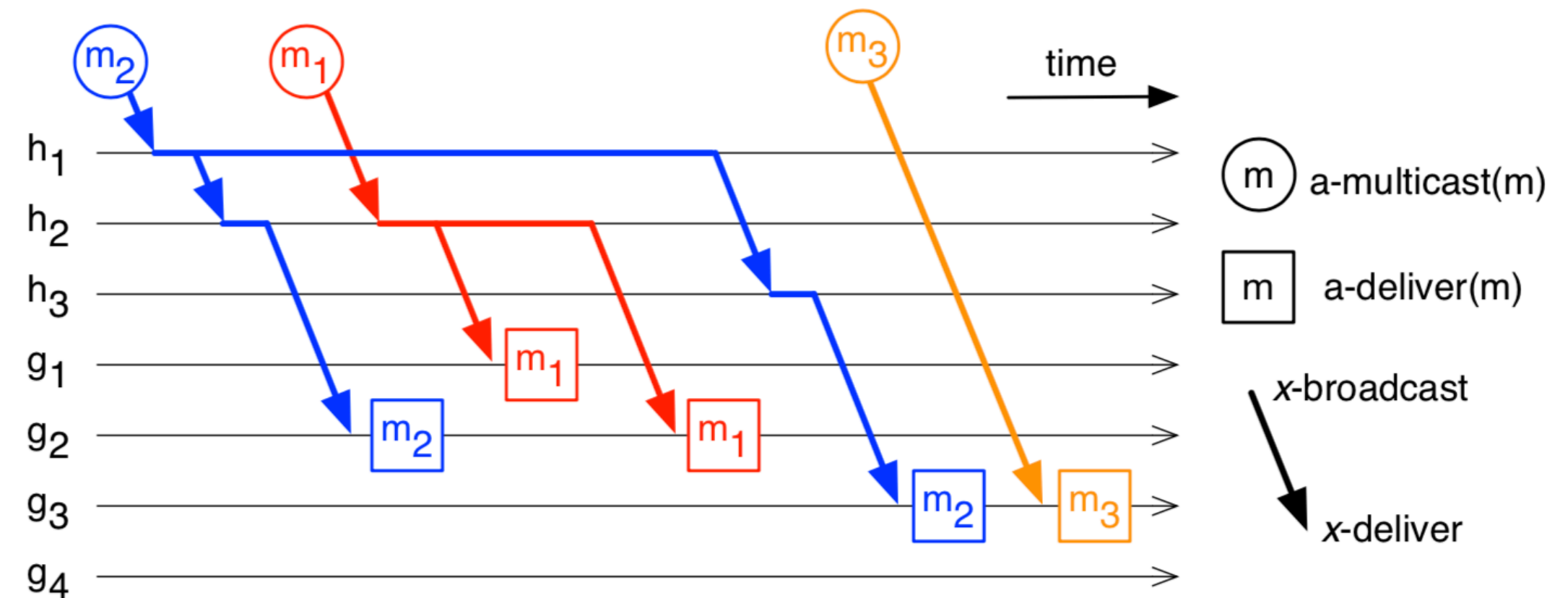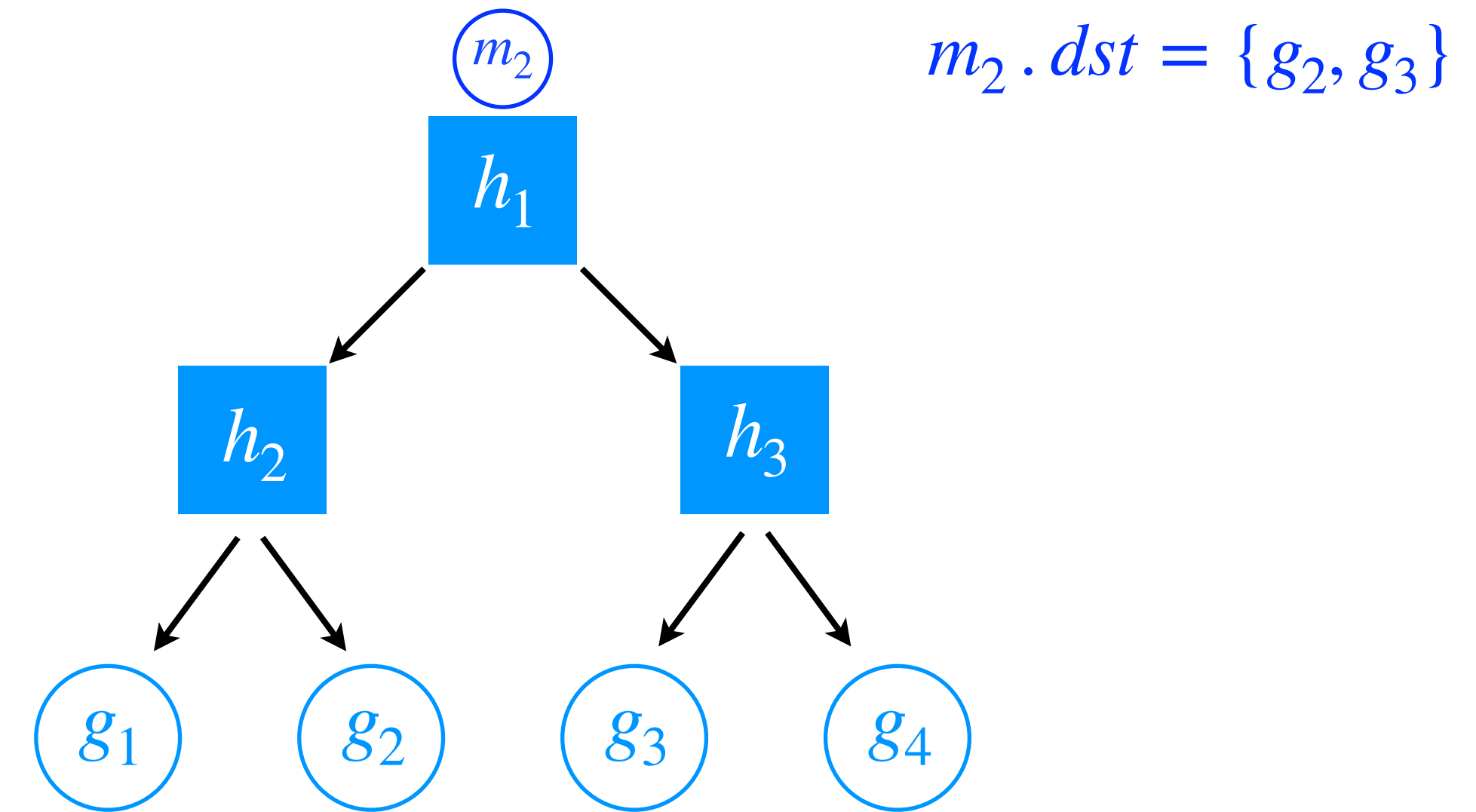14: $A\text{-}delivered \leftarrow A\text{-}delivered \cup \{m\}$

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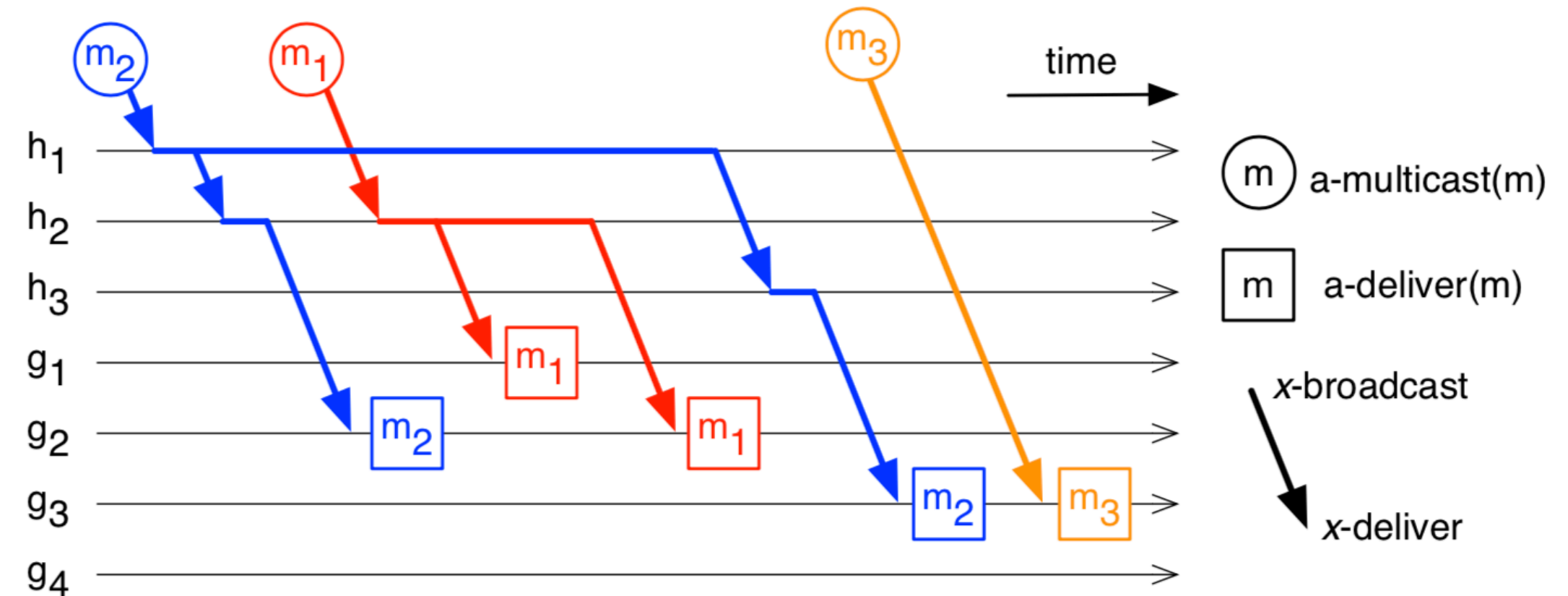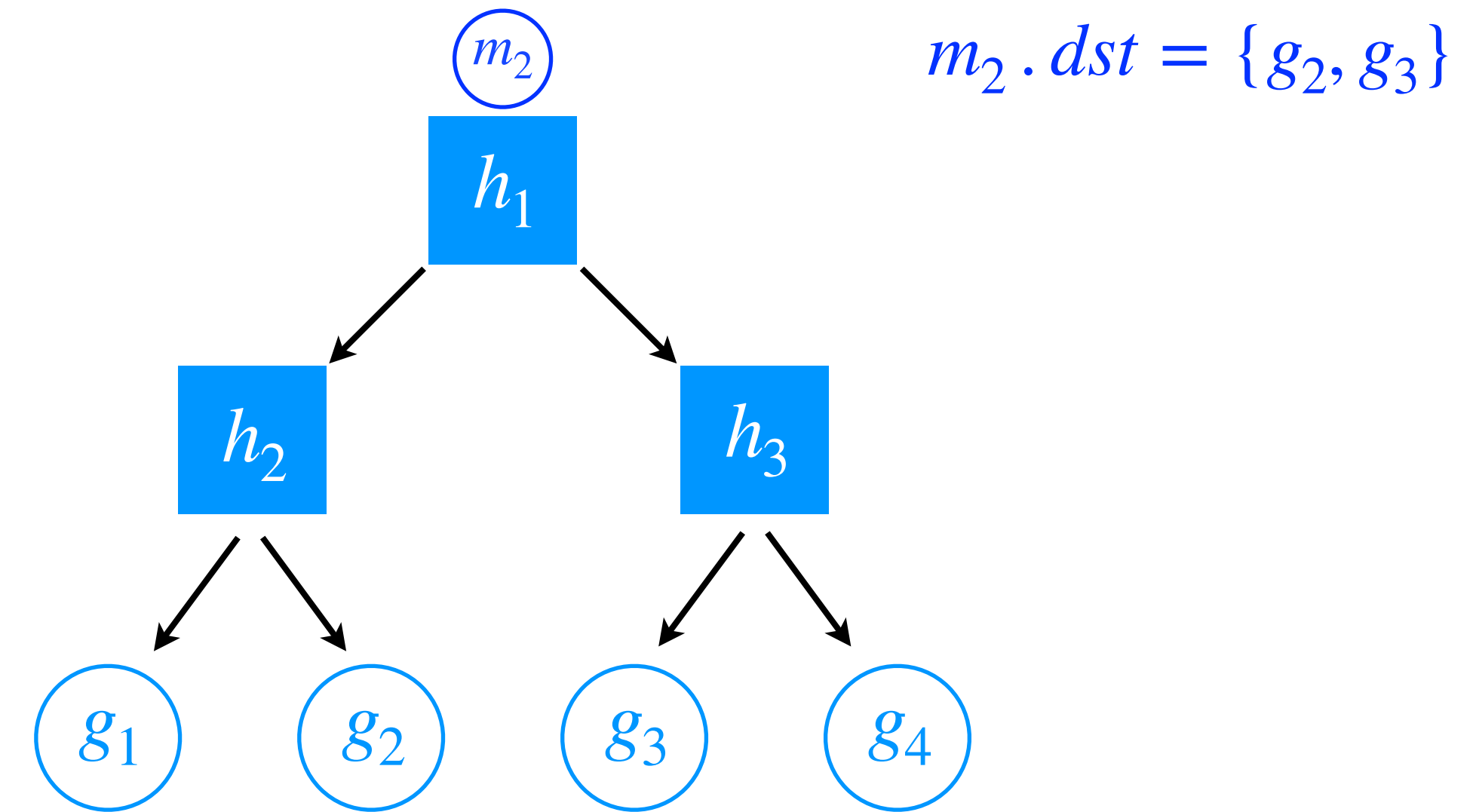$$m_2 . dst = \{g_2, g_3\}$$

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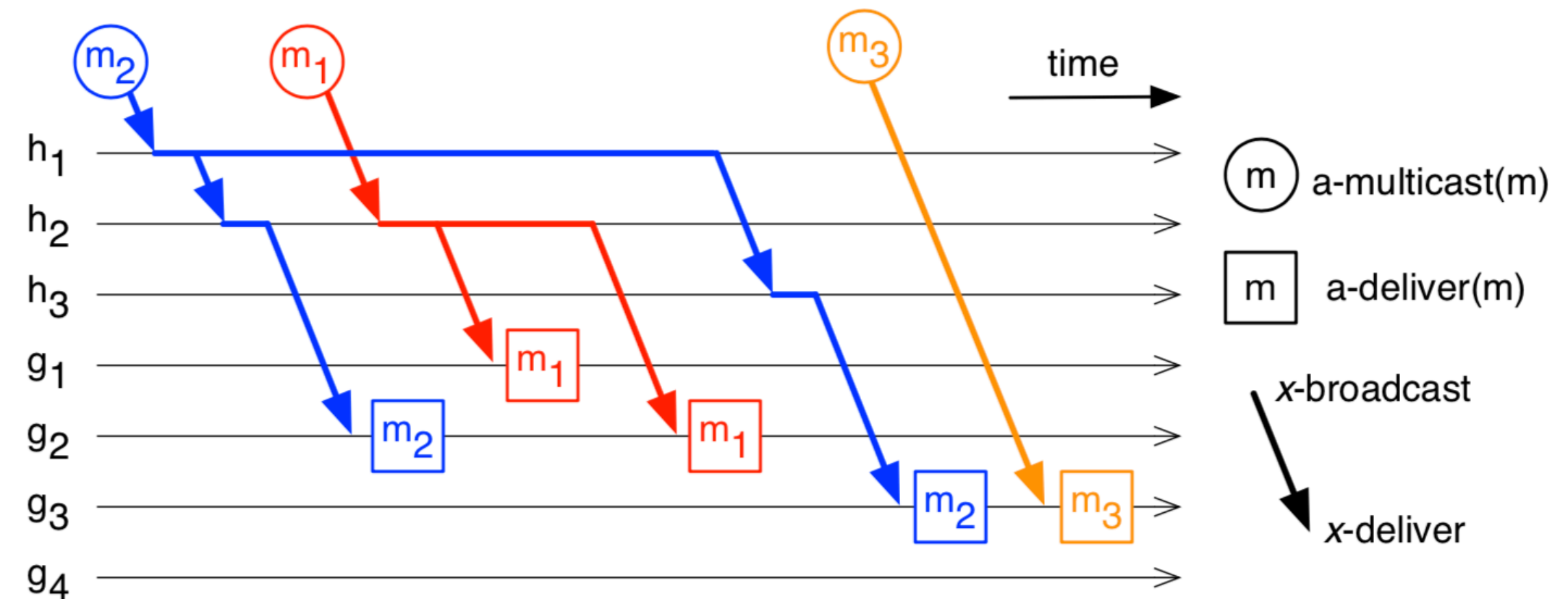14: $A\text{-}delivered \leftarrow A\text{-}delivered \cup \{m\}$
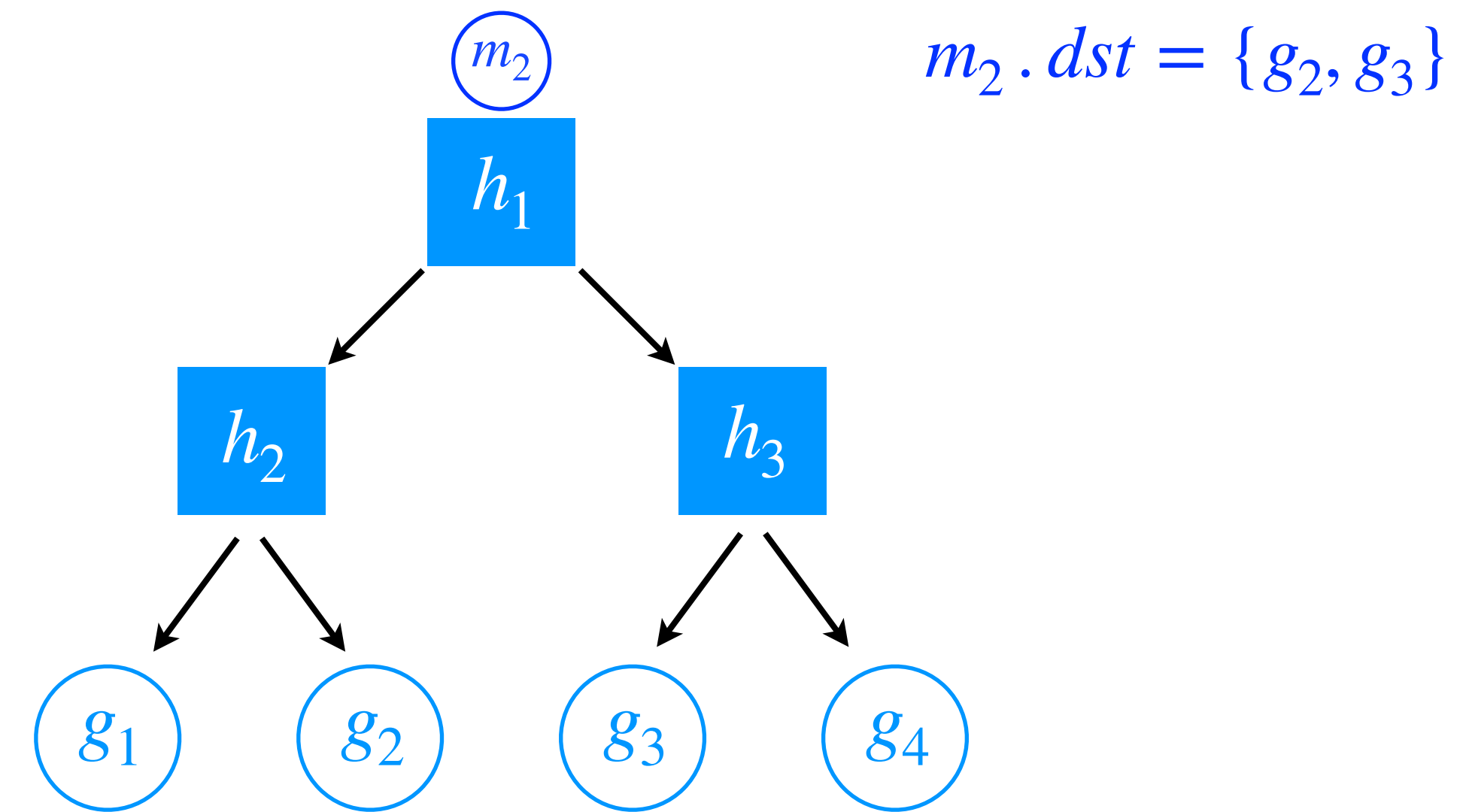
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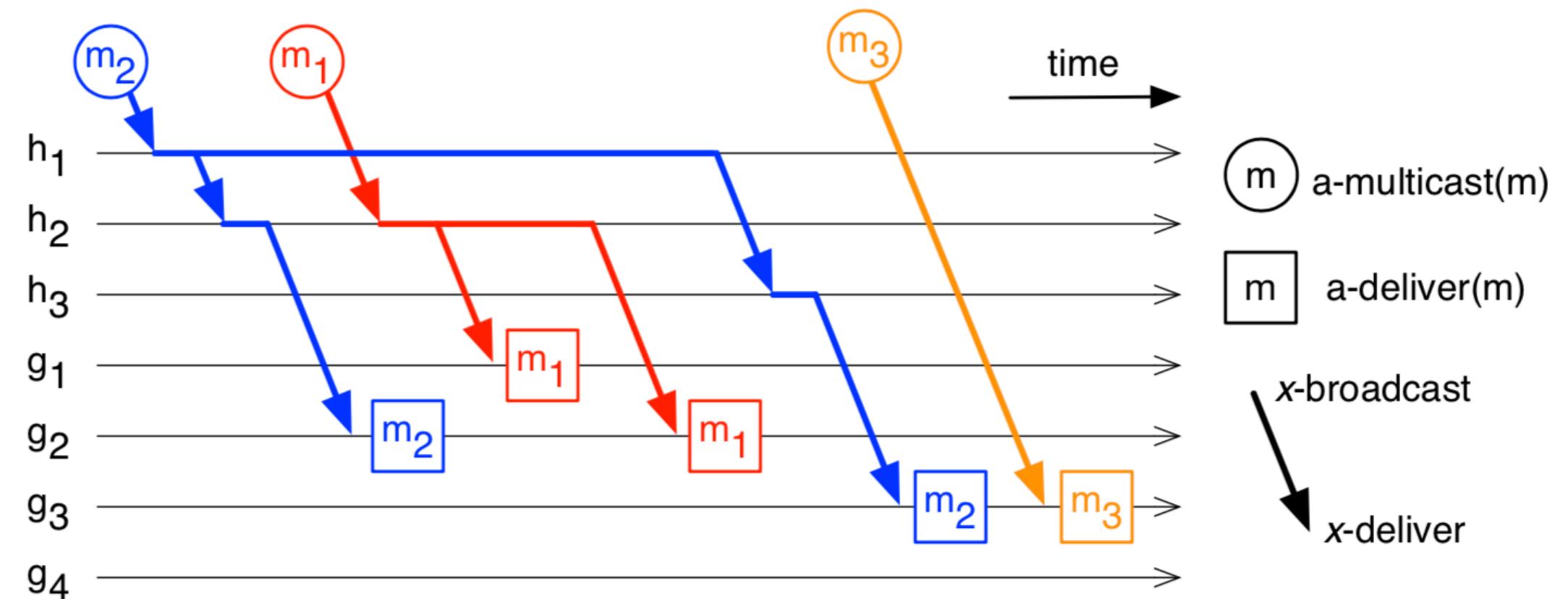14: $A\text{-}delivered \leftarrow A\text{-}delivered \cup \{m\}$
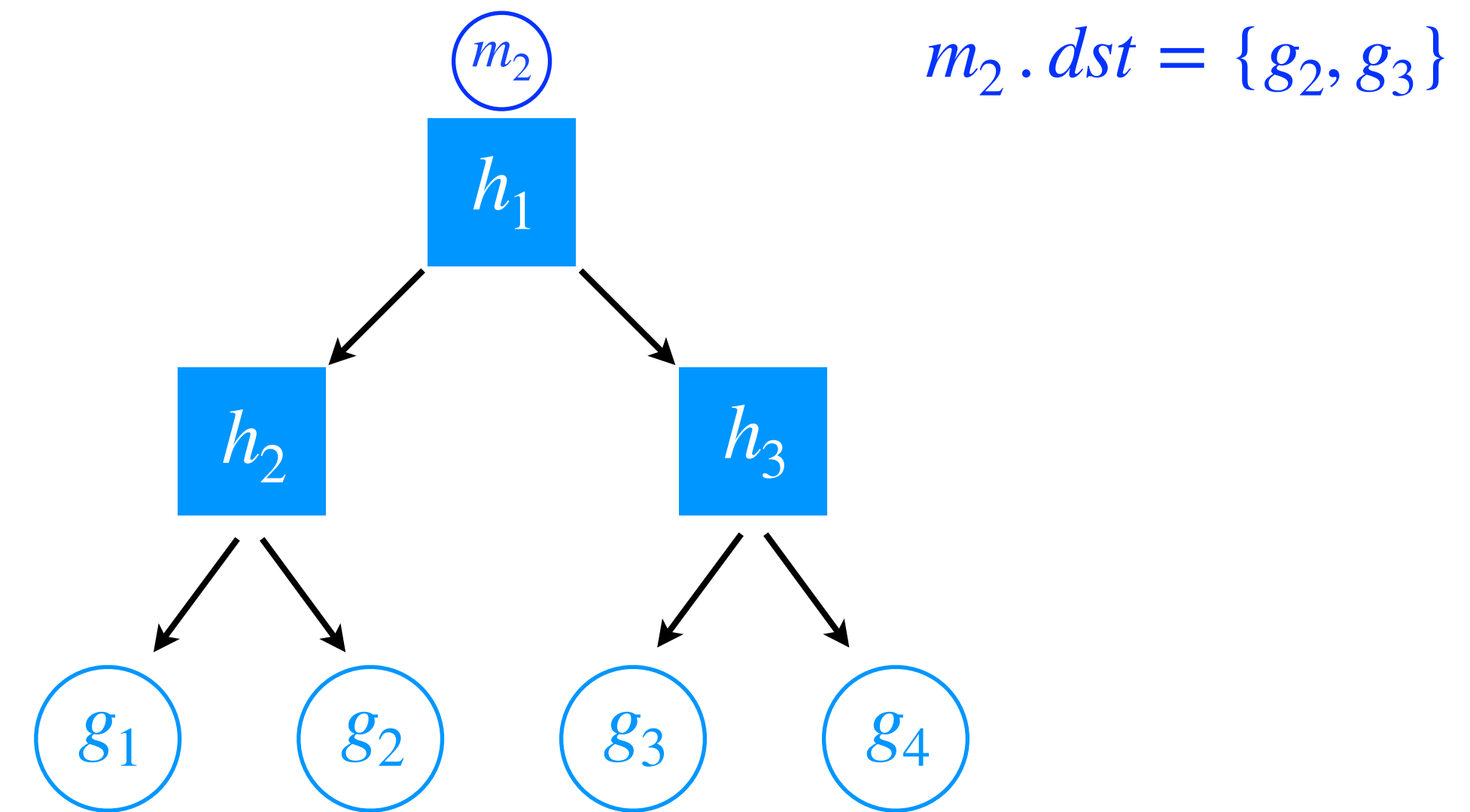
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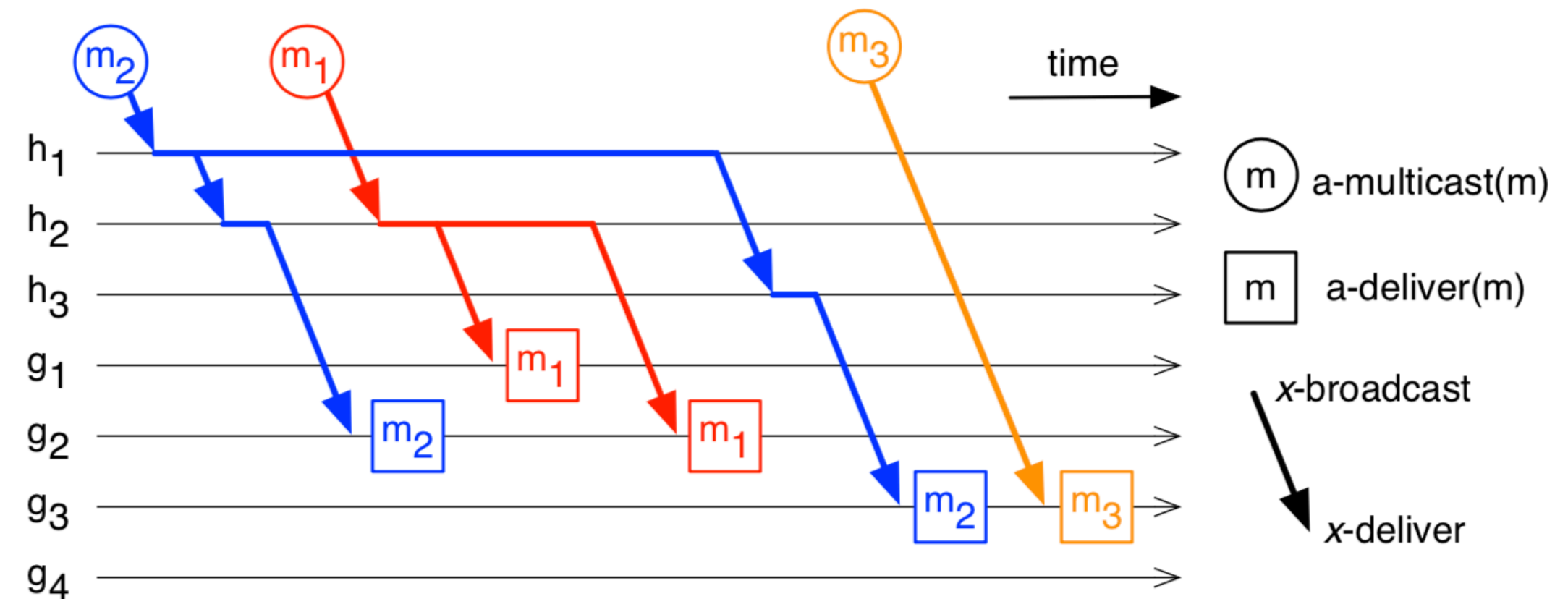
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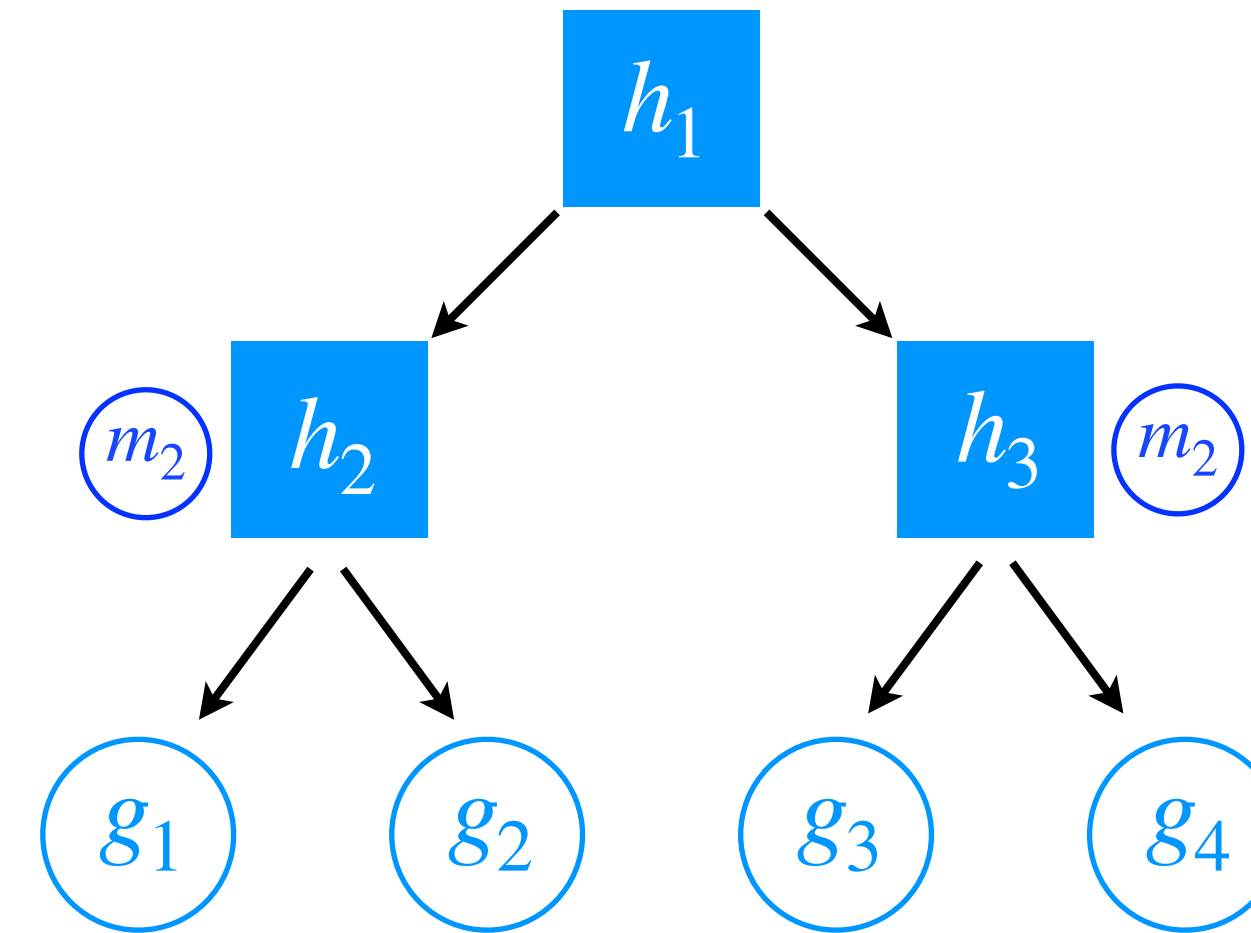**Alg. 1** ByzCast

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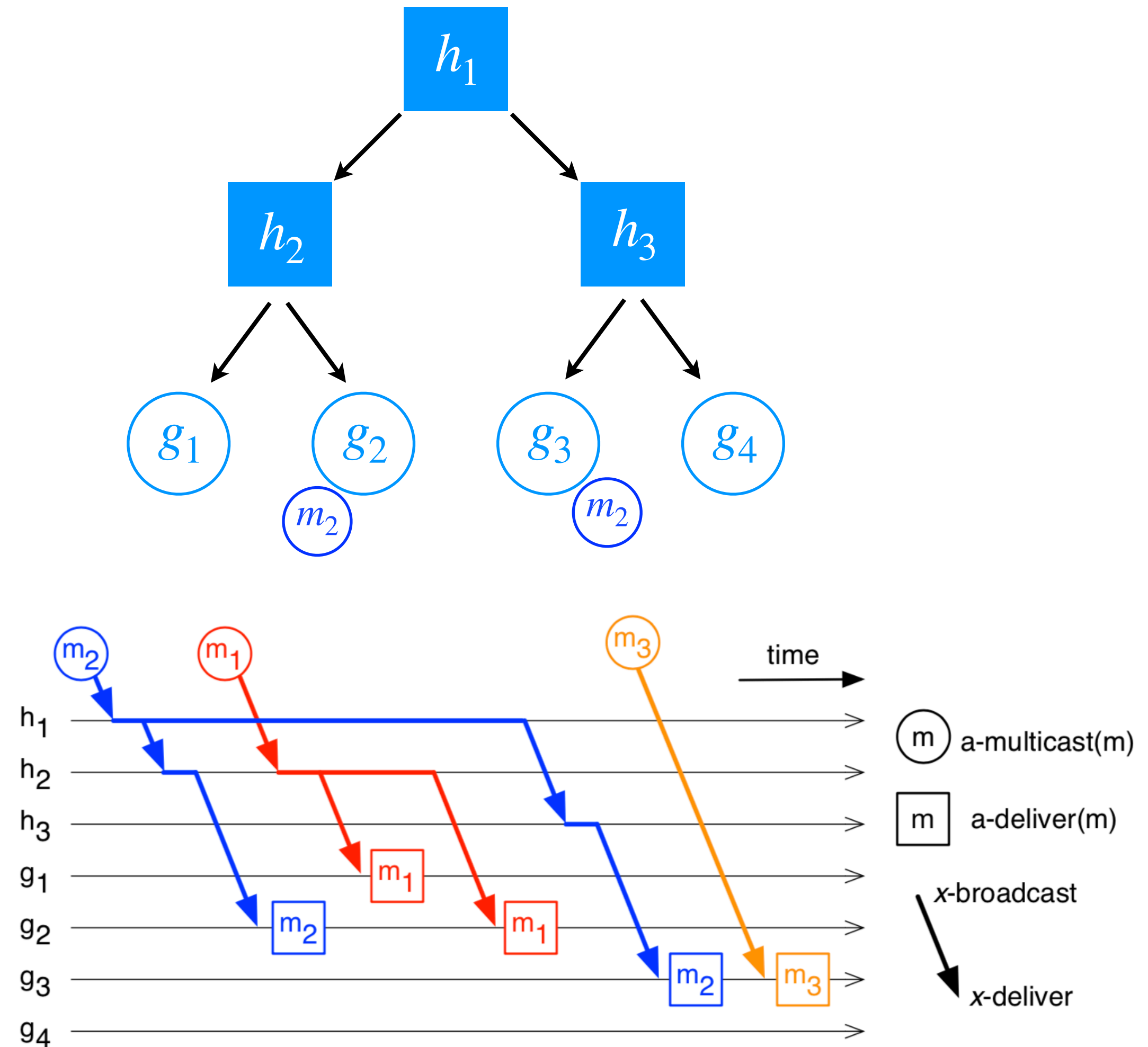**Alg. 1** ByzCast

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Optimisation problem of building an overlay tree

Optimisation problem:

Minimise the height of the various destinations:

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

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?
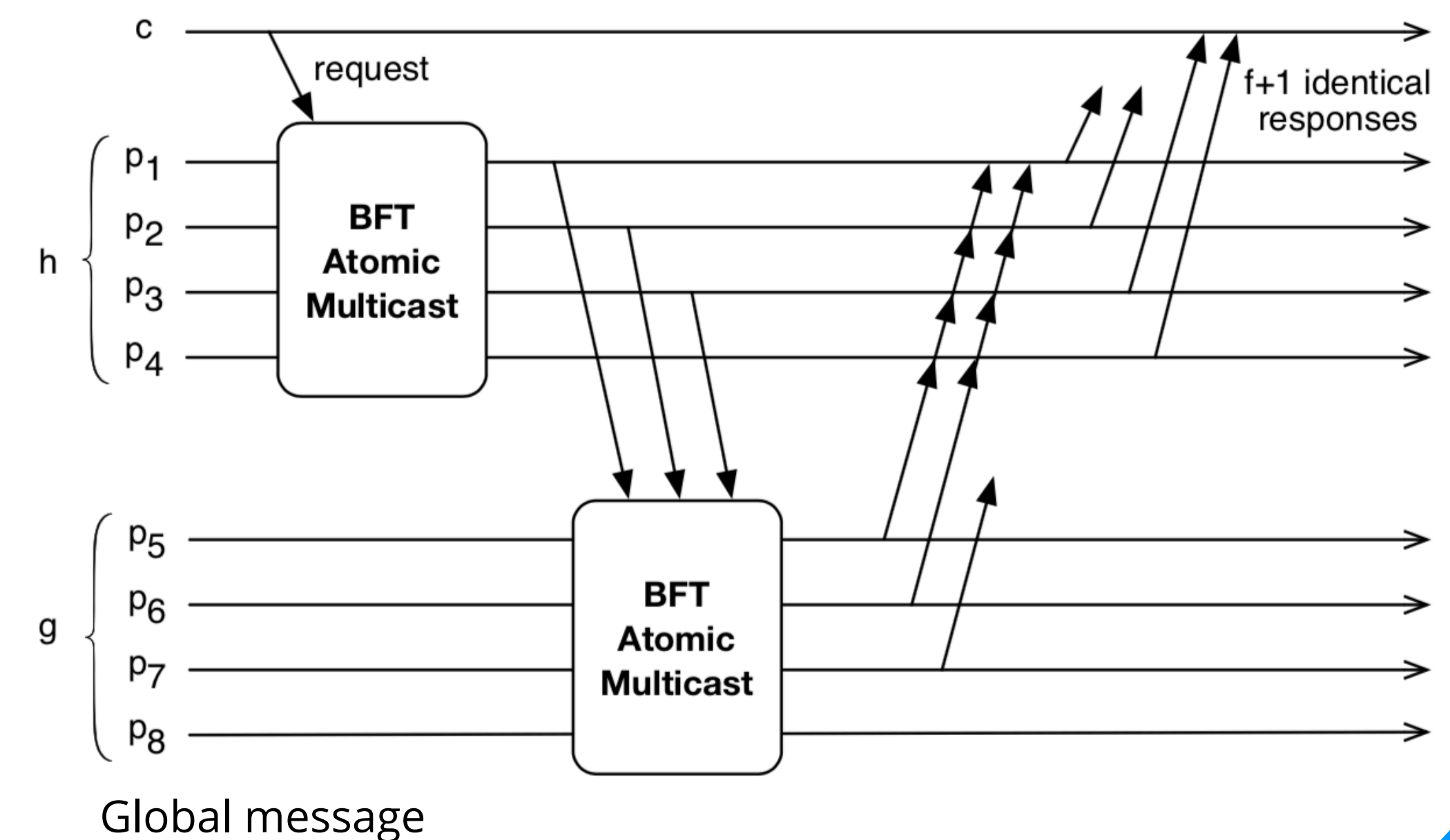
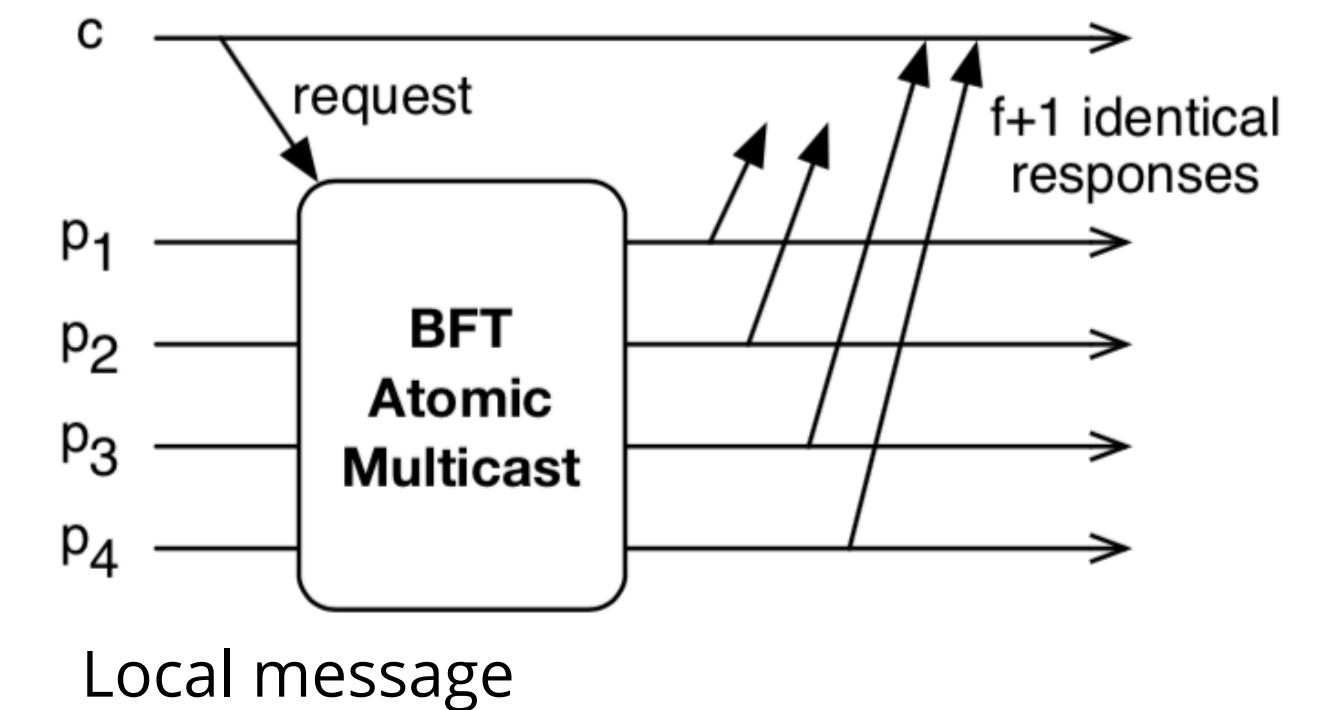## 3. What evidence supports the paper contributions?

Prototype:

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

Each group $\longrightarrow$ BFT replicated state machine

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

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

Local message

Global message

4.
Do the data actually support the conclusions?

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Performance evaluation:

Environment:

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

Two workloads:

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

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

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

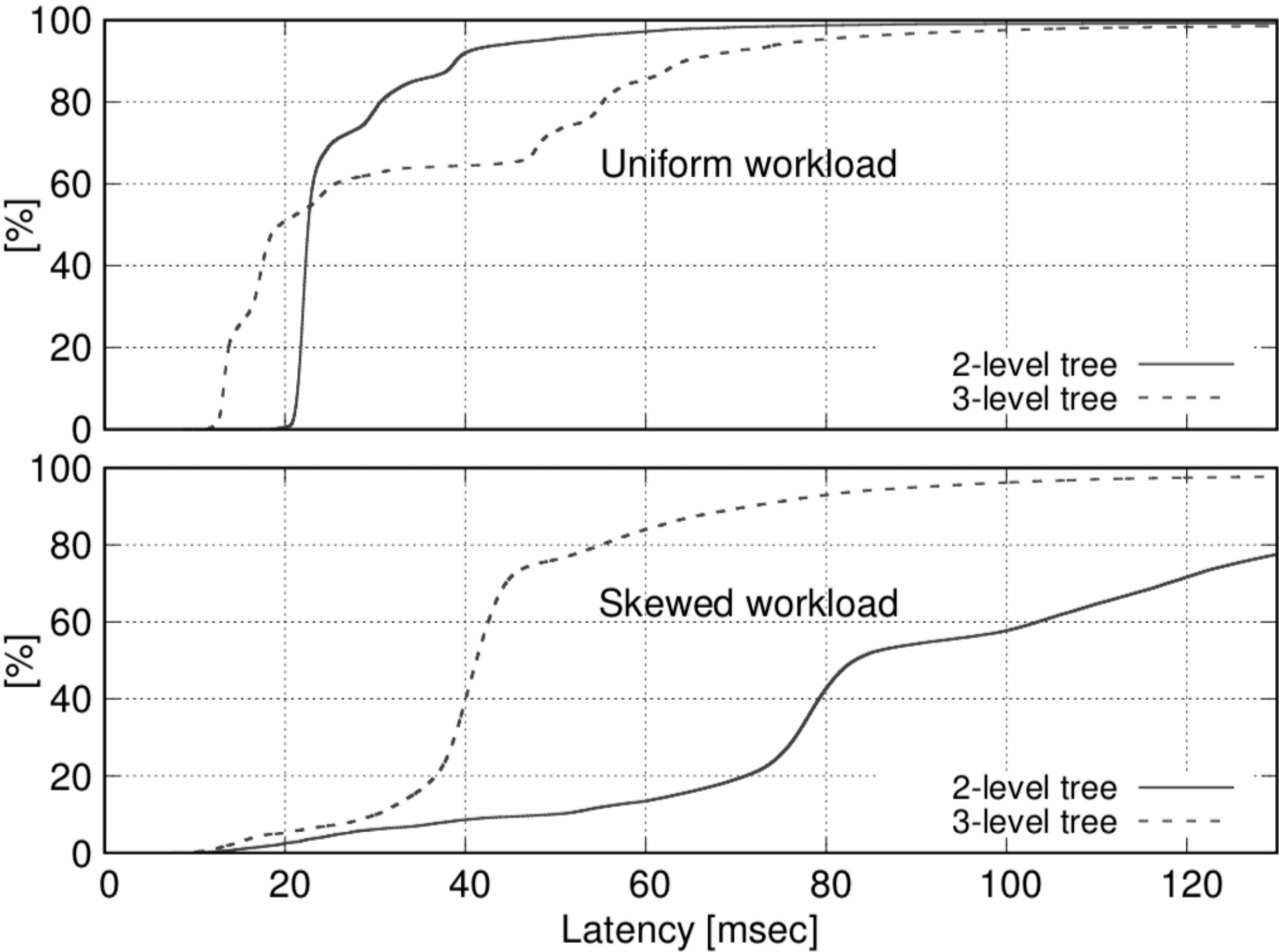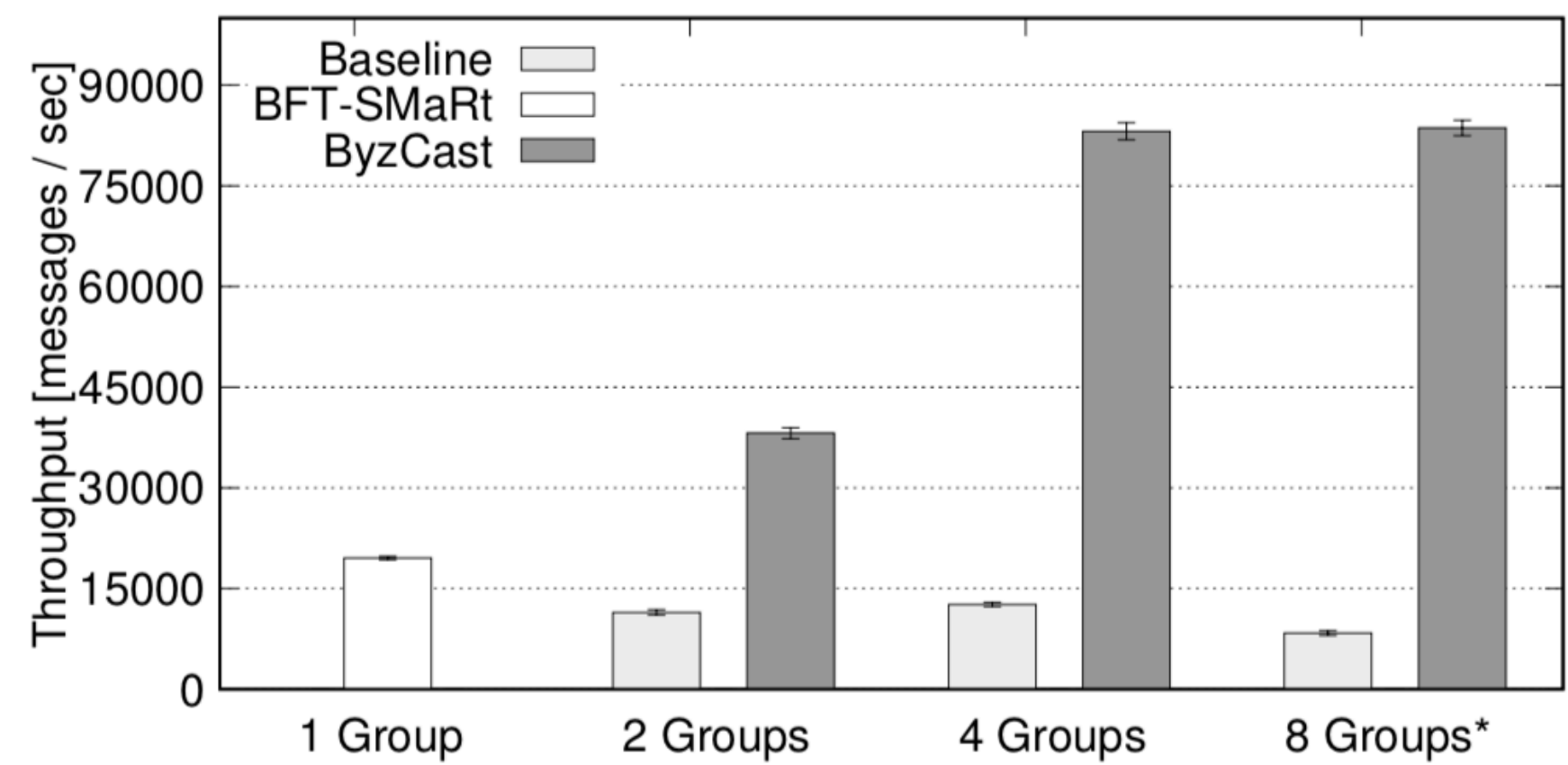## 4. Do the data actually support the conclusions?

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

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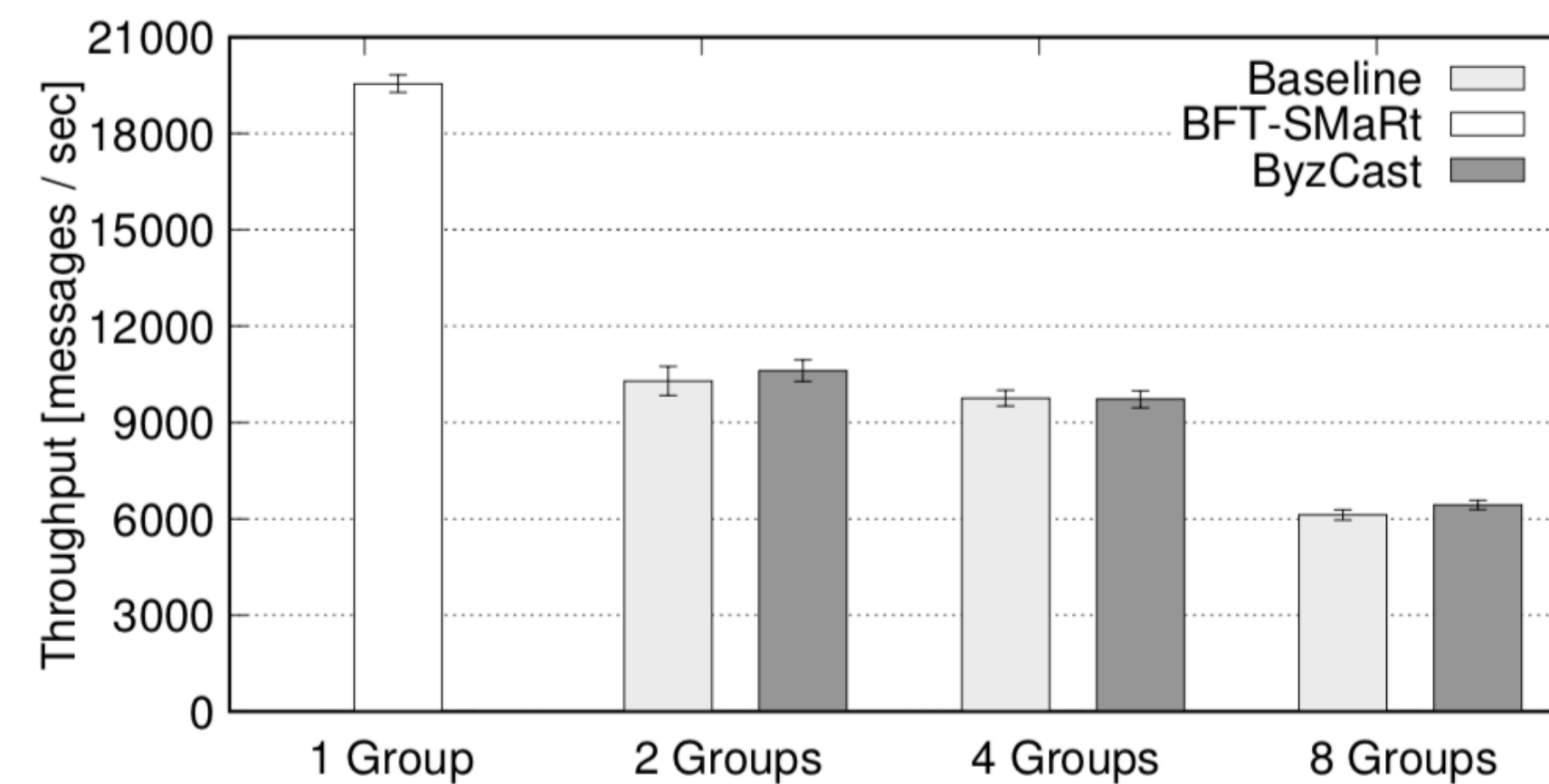200 clients per group multicast local messages only (100 for 8-groups)

(a) Local messages.

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

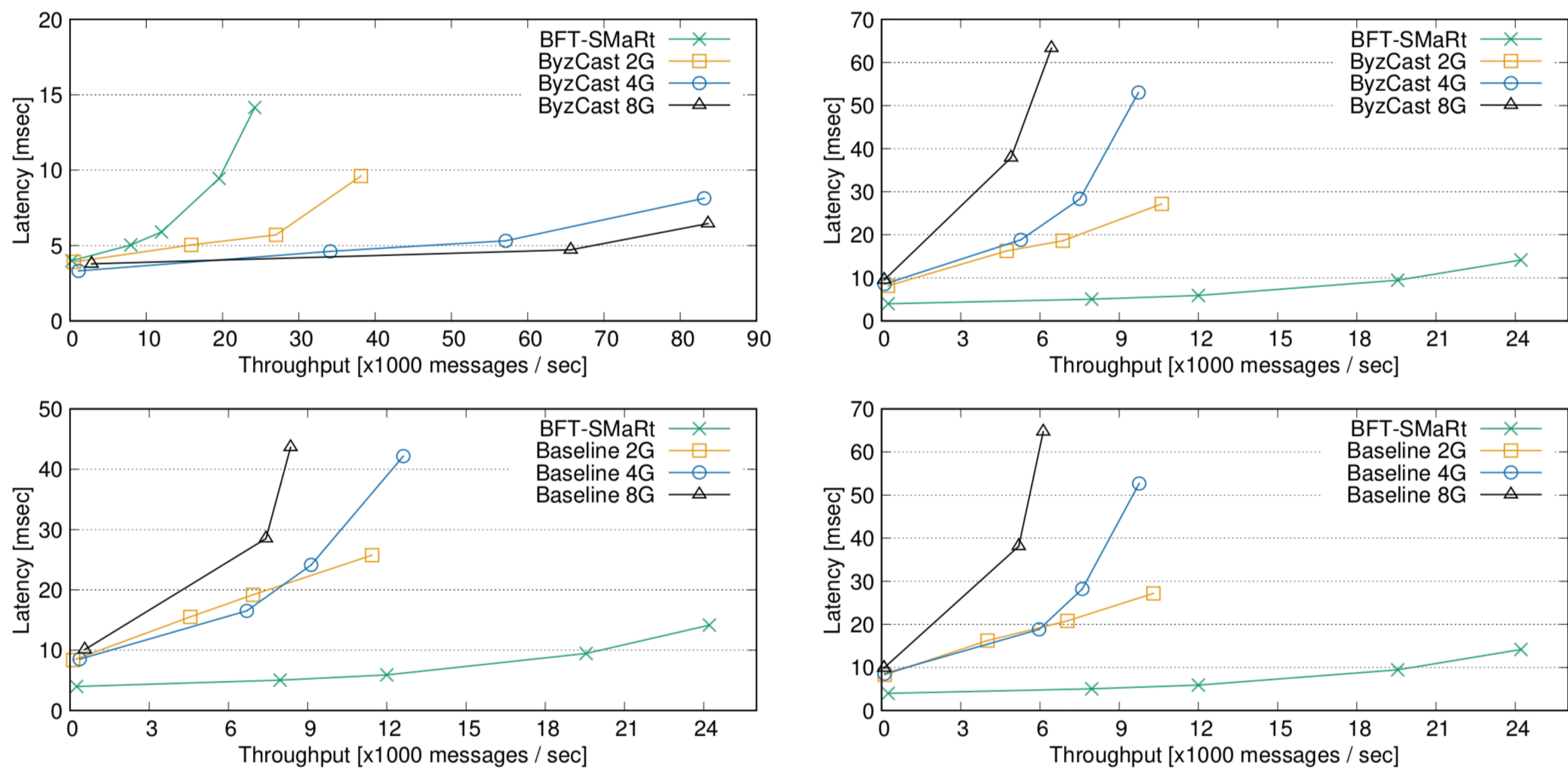## 4. Do the data actually support the conclusions?

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

(b) Global messages.

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

4. Do the data actually support the conclusions?

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

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

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

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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 ⟶ more realistic workload
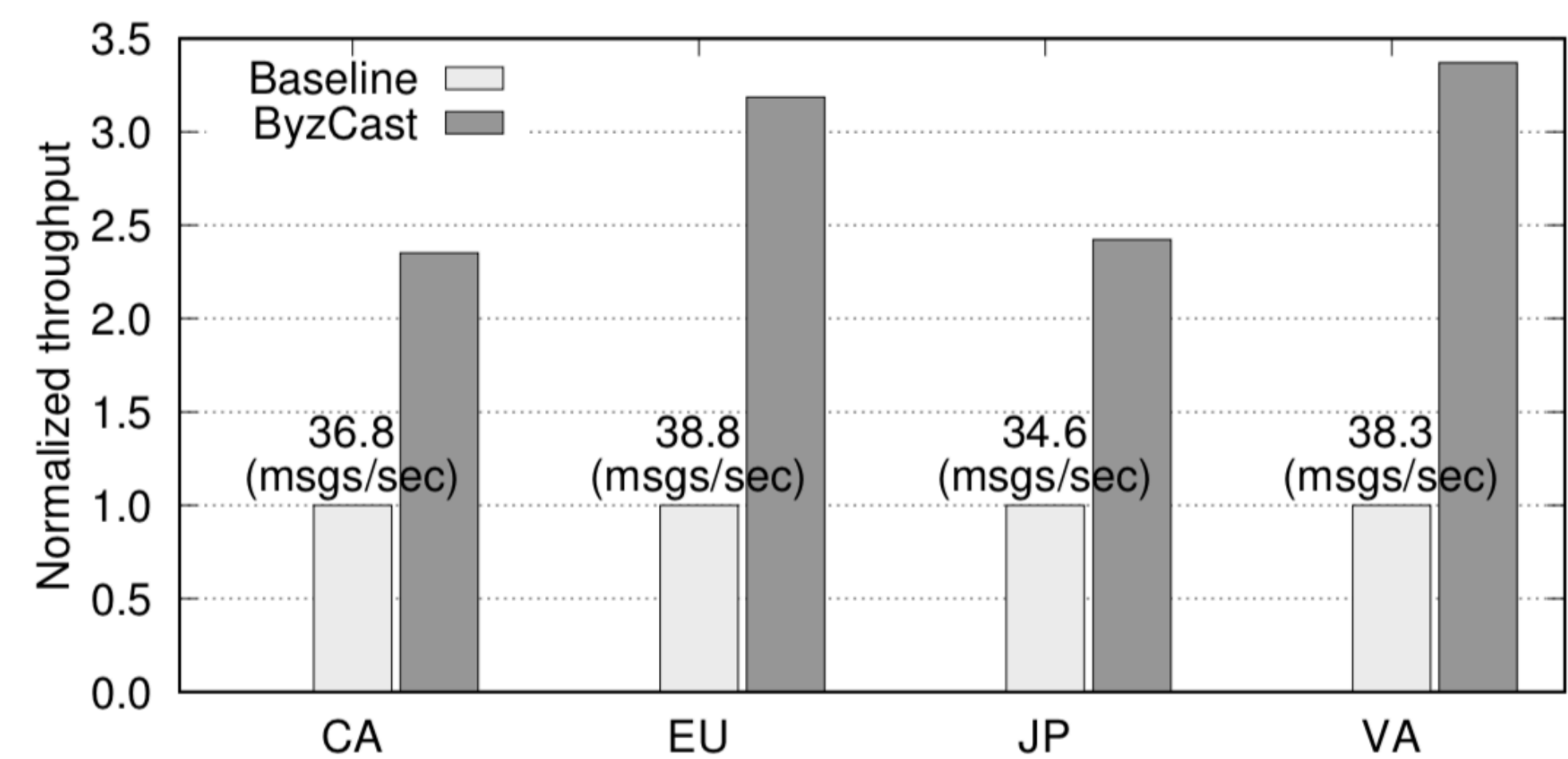

Fig. 9: Normalized throughput with mixed workload in a WAN.

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

6.
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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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