6.033 Spring 2018

Lecture #19

- **Distributed transactions**
  - **Availability**
  - **Replicated State Machines**

goal: build reliable systems from unreliable components

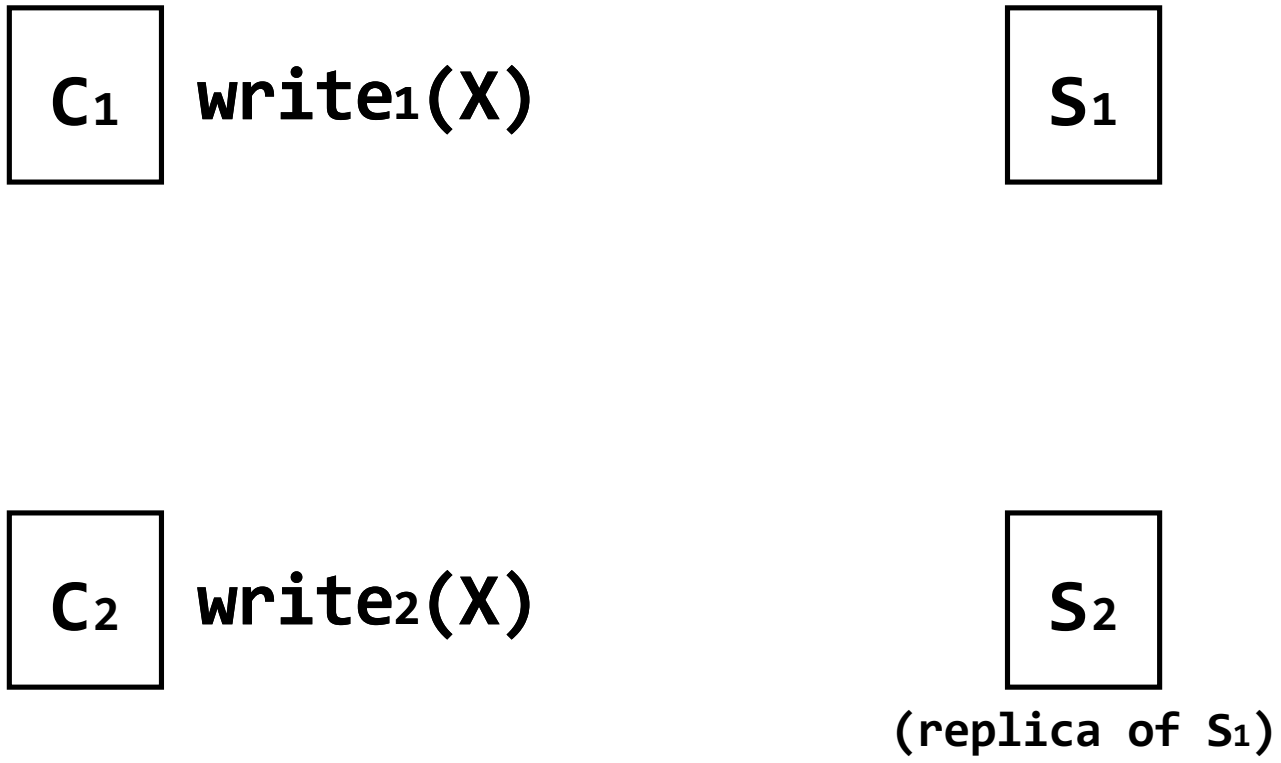
the abstraction that makes that easier is

transactions, which provide **atomicity** and **isolation**, while not hindering **performance**

atomicity → **shadow copies** (simple, poor performance) or **logs** (better performance, a bit more complex)

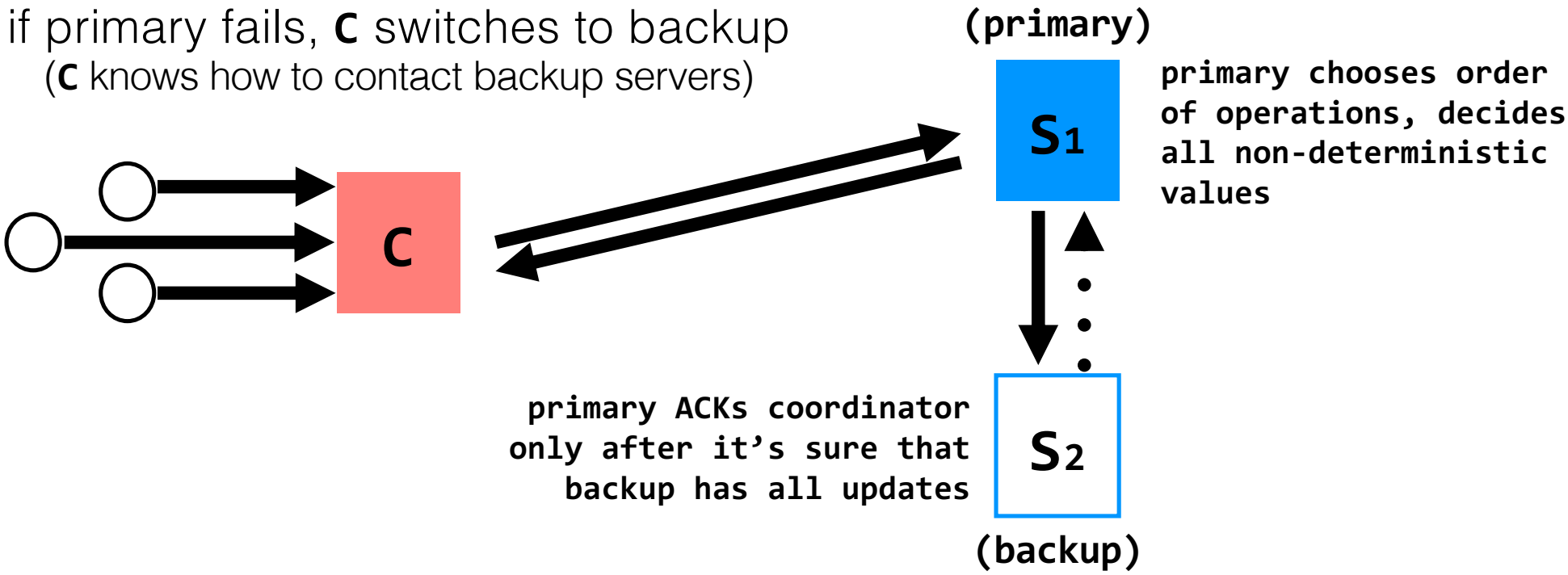
isolation → **two-phase locking**

we also want transaction-based systems to be **distributed** — to run across multiple machines — and to remain **available** even through failures



problem: replica servers can become inconsistent

if primary fails, **C** switches to backup
(**C** knows how to contact backup servers)



attempt: coordinators communicate with primary servers, who communicate with backup servers

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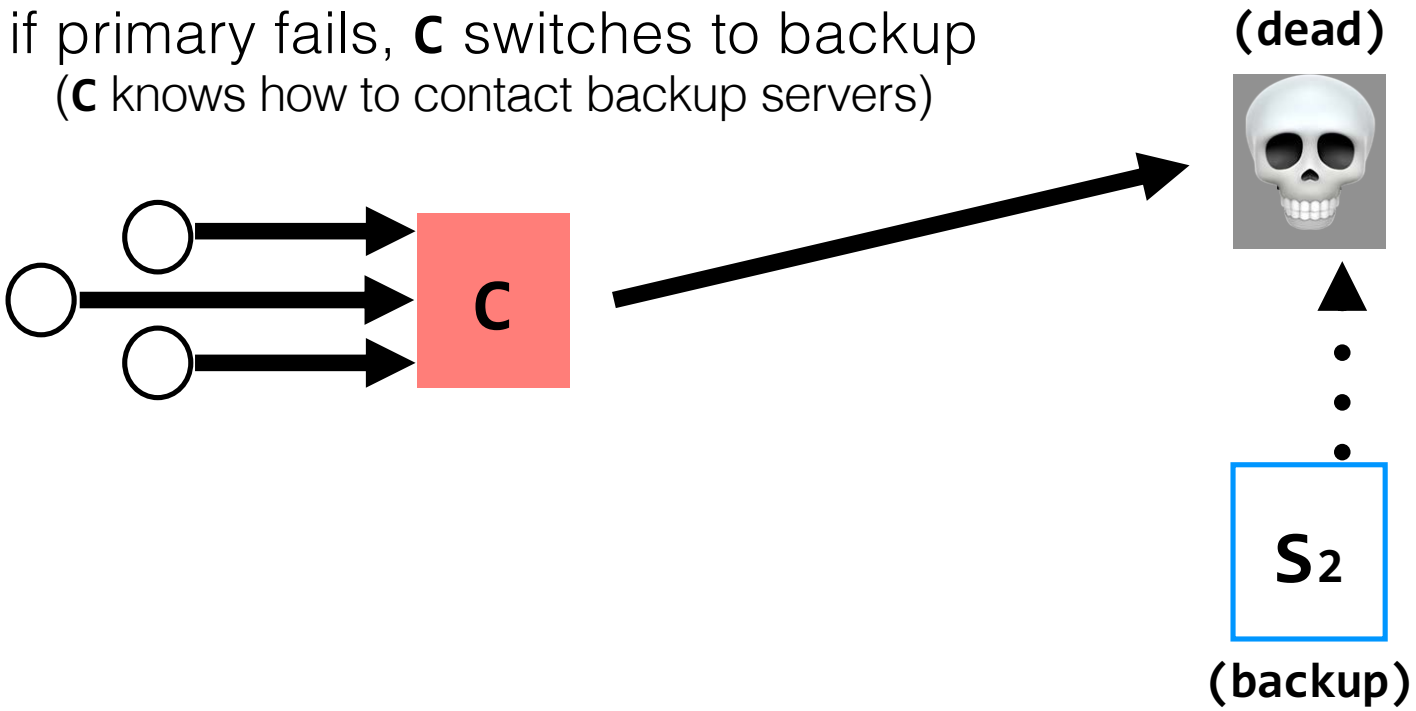

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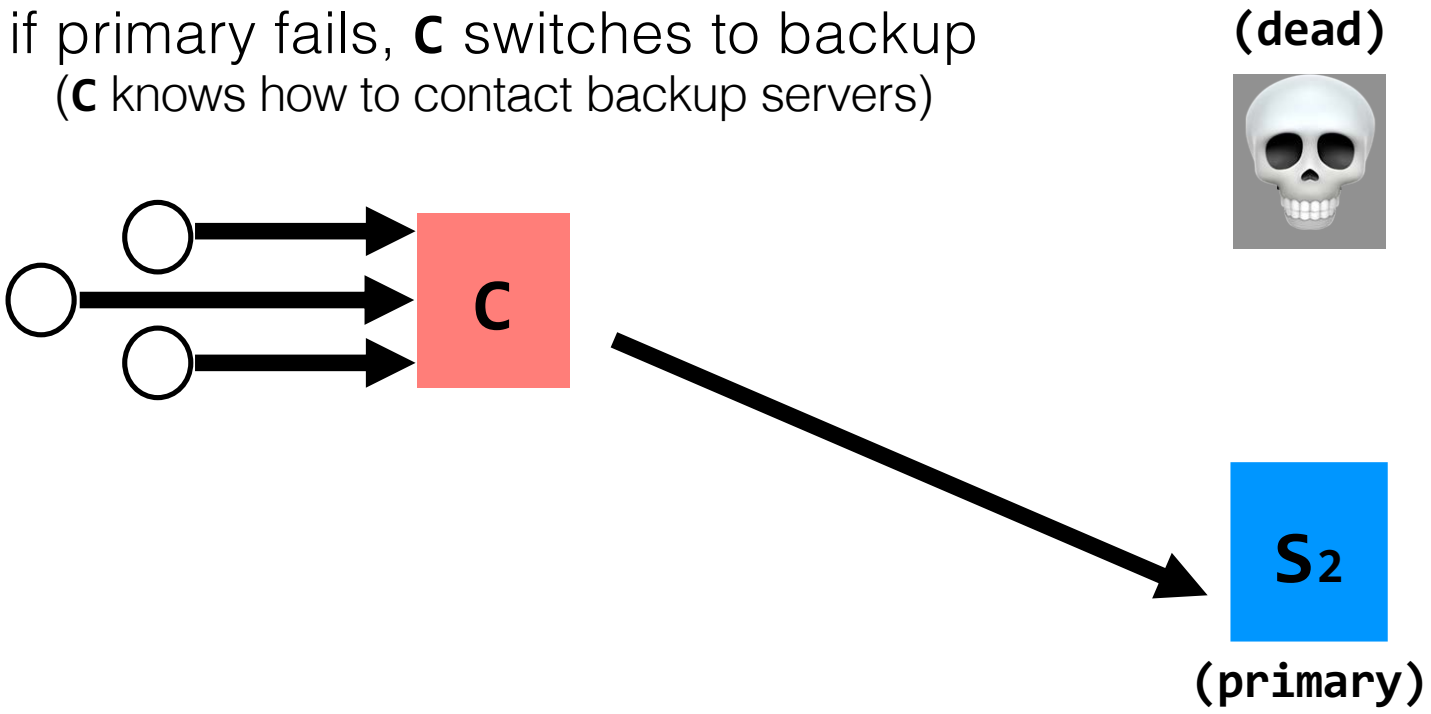
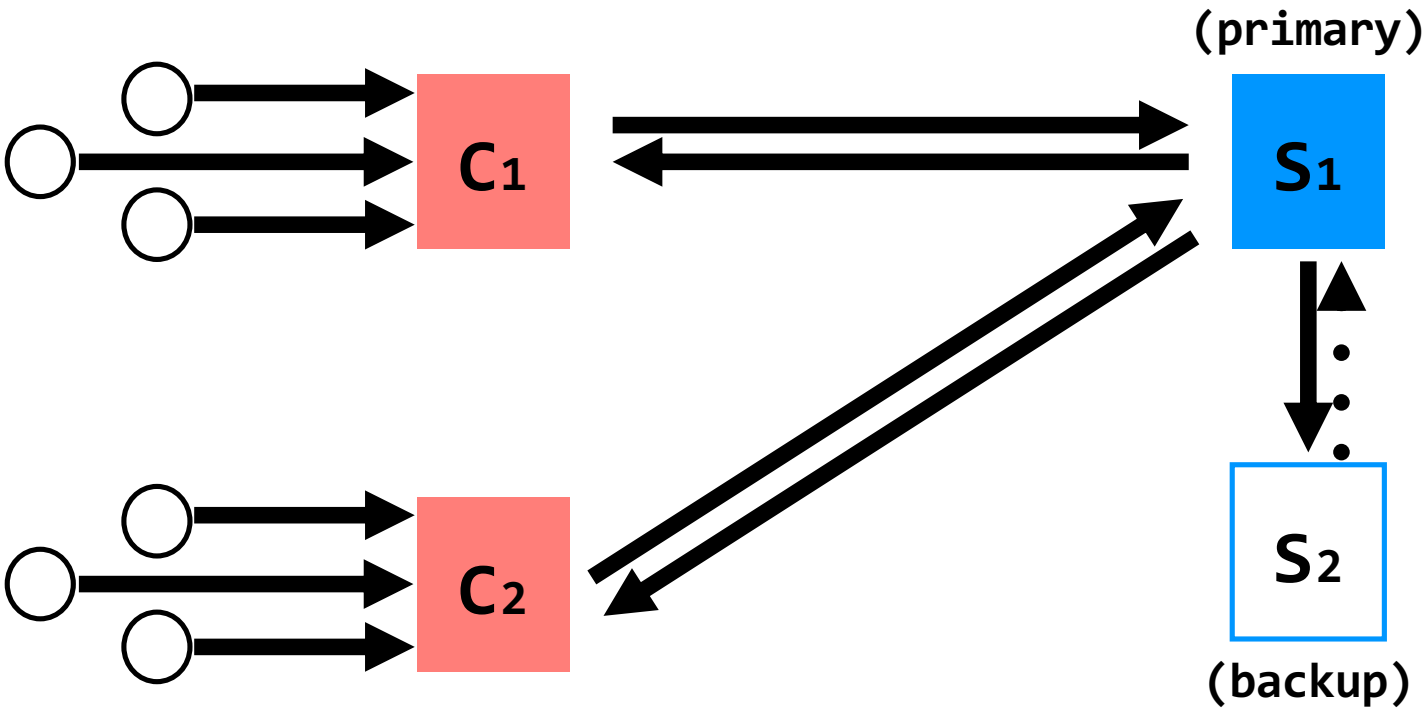


attempt: coordinators communicate with primary servers, who communicate with backup servers

multiple coordinators + the network = problems



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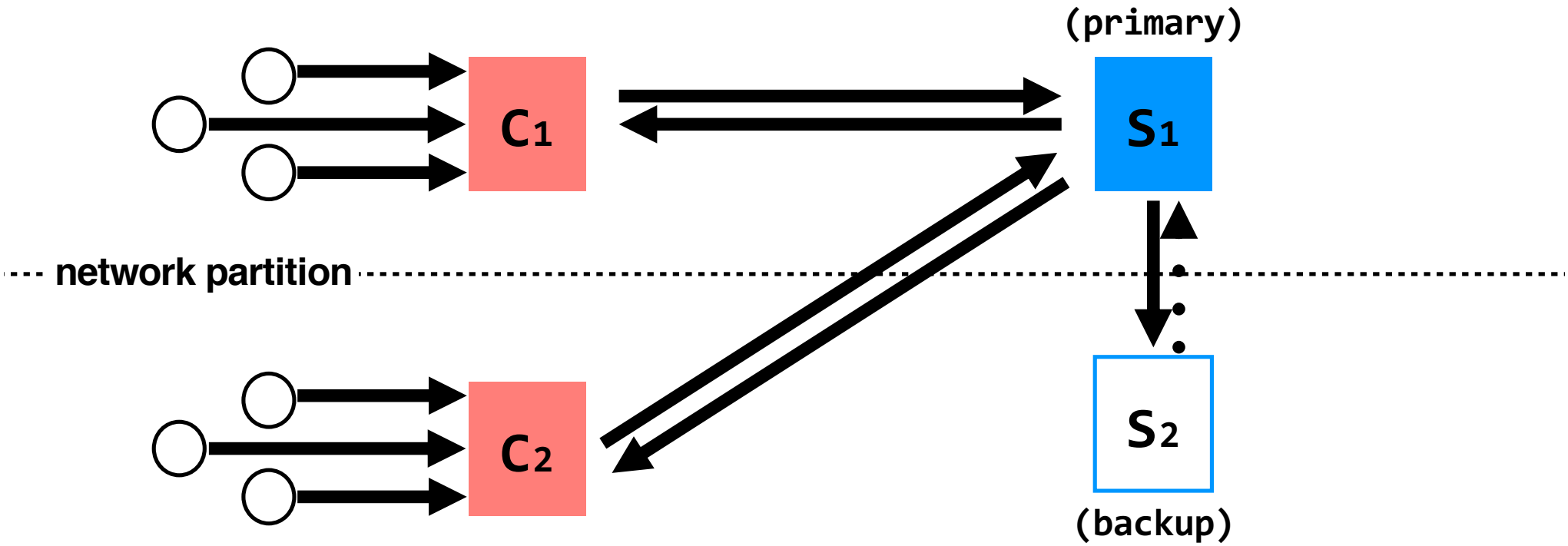

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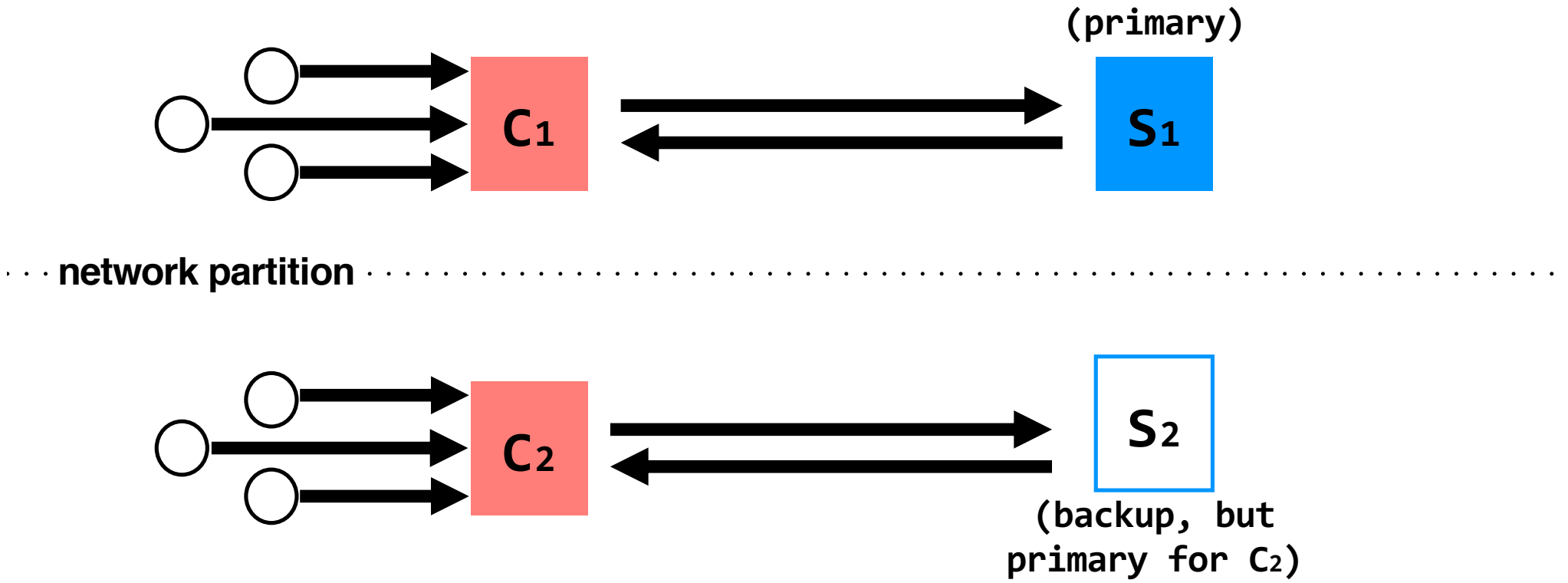

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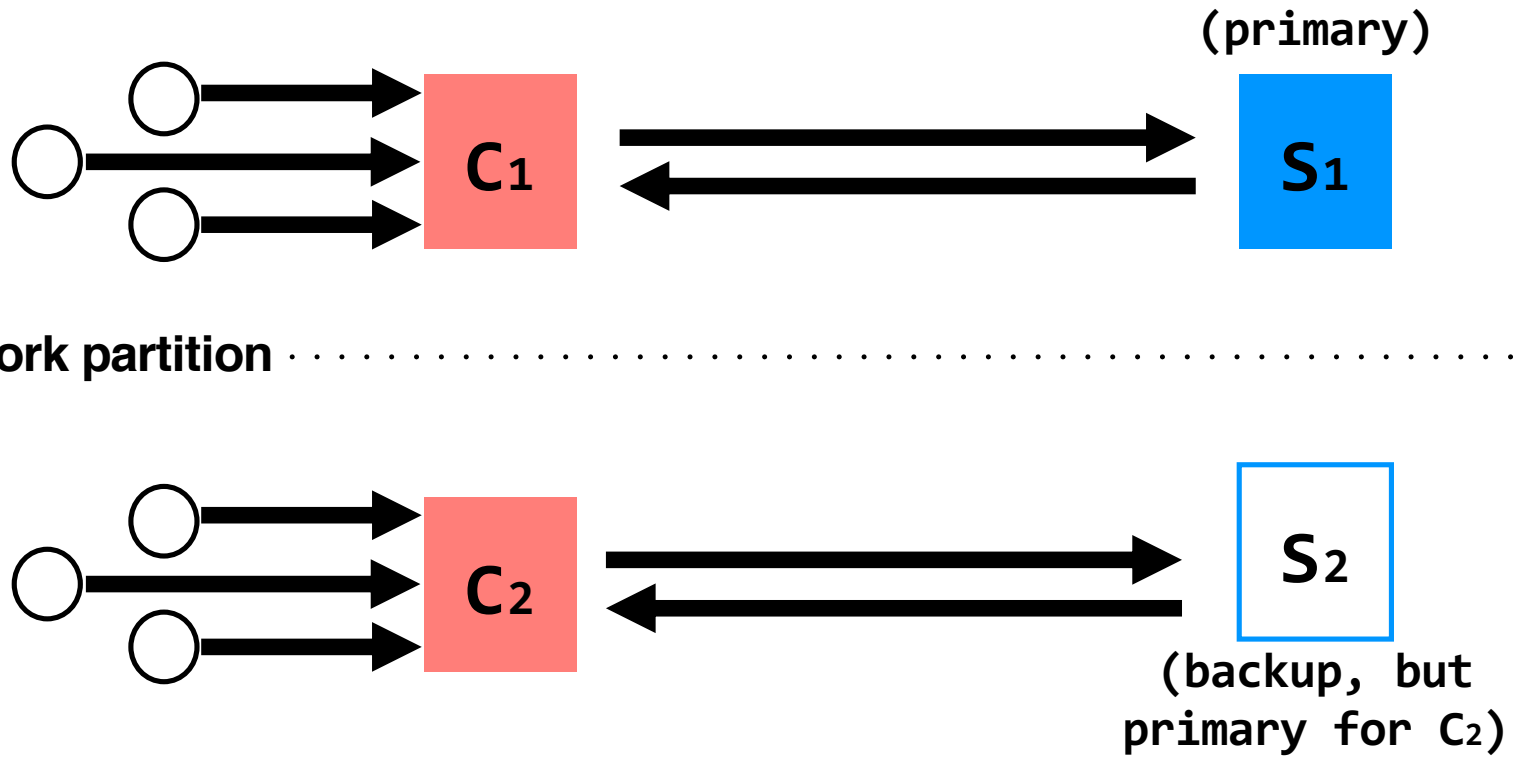
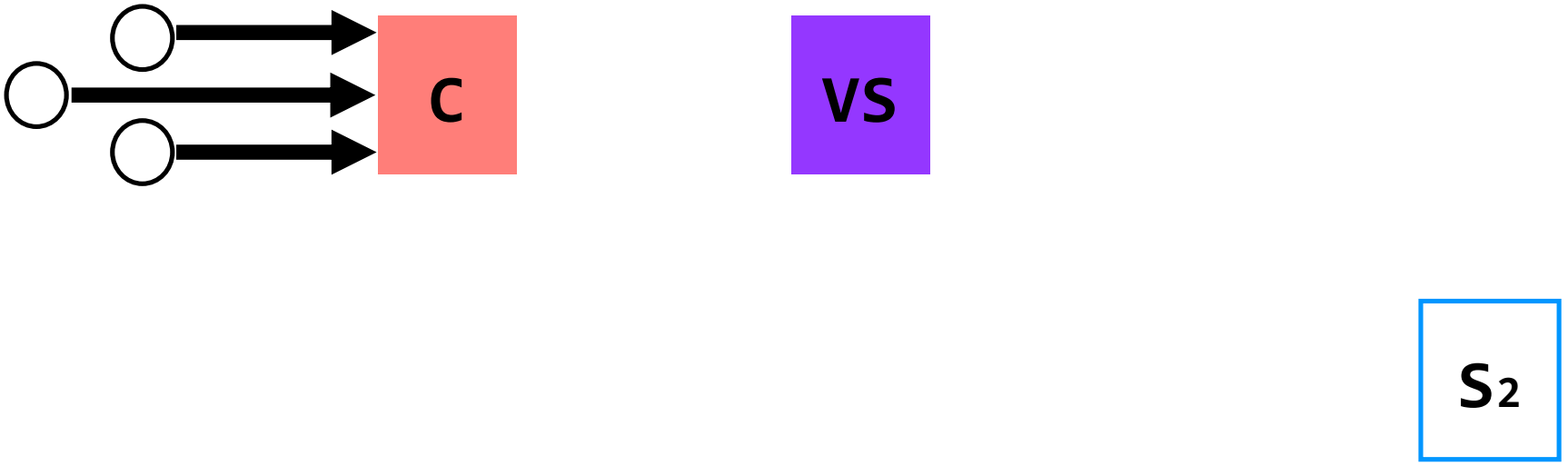
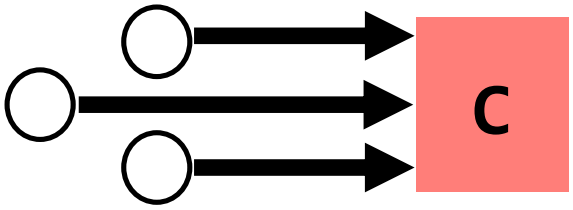


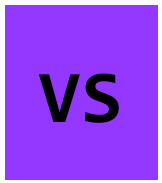
C1 and **C2** are using different primaries;
S1 and **S2** are no longer consistent

attempt: coordinators communicate with primary servers, who communicate with backup servers



use a **view server**, which determines which replica is the primary

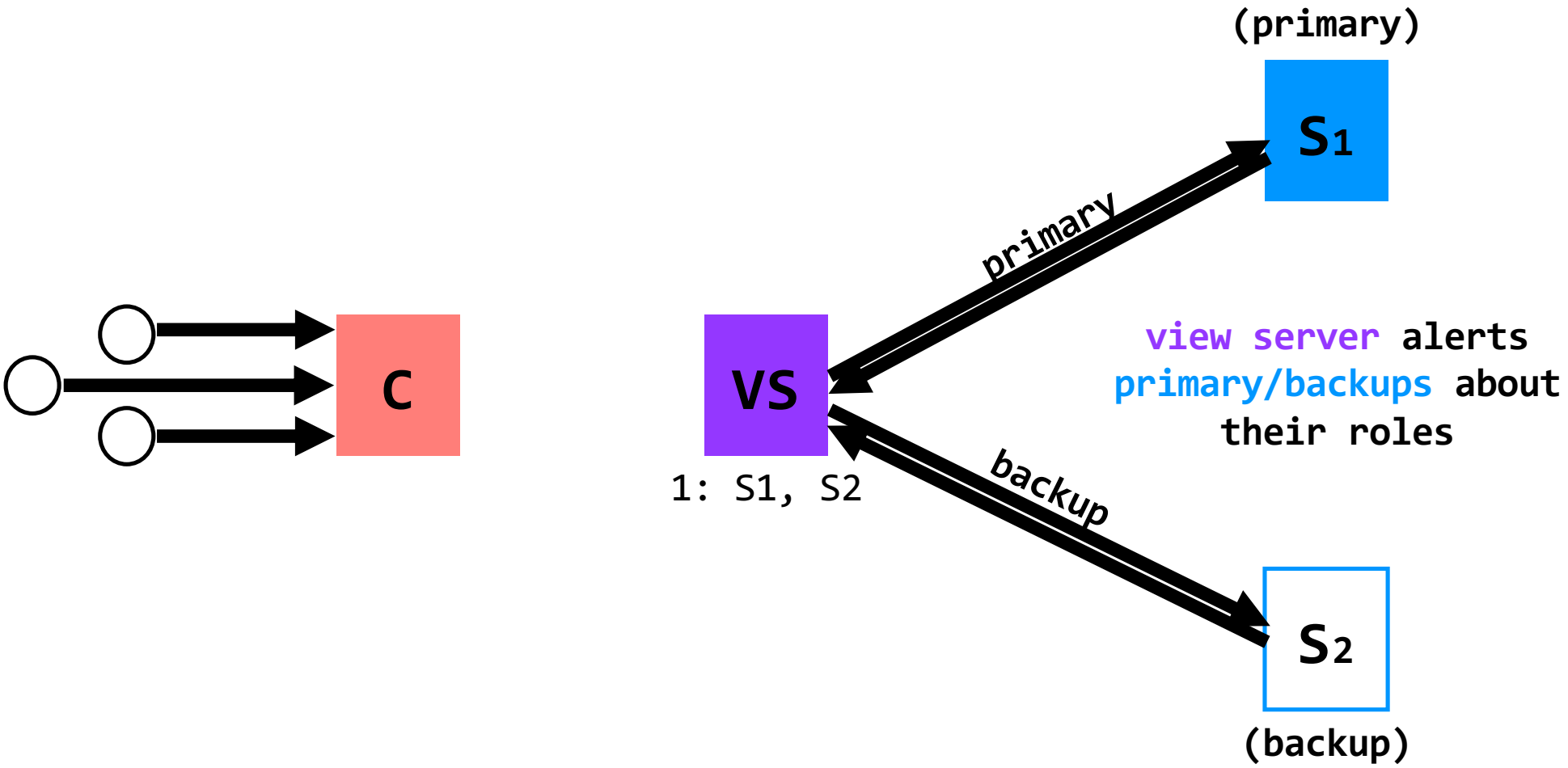




1: S1, S2

view server keeps a table that maintains a sequence of *views*

use a **view server**, which determines which replica is the primary



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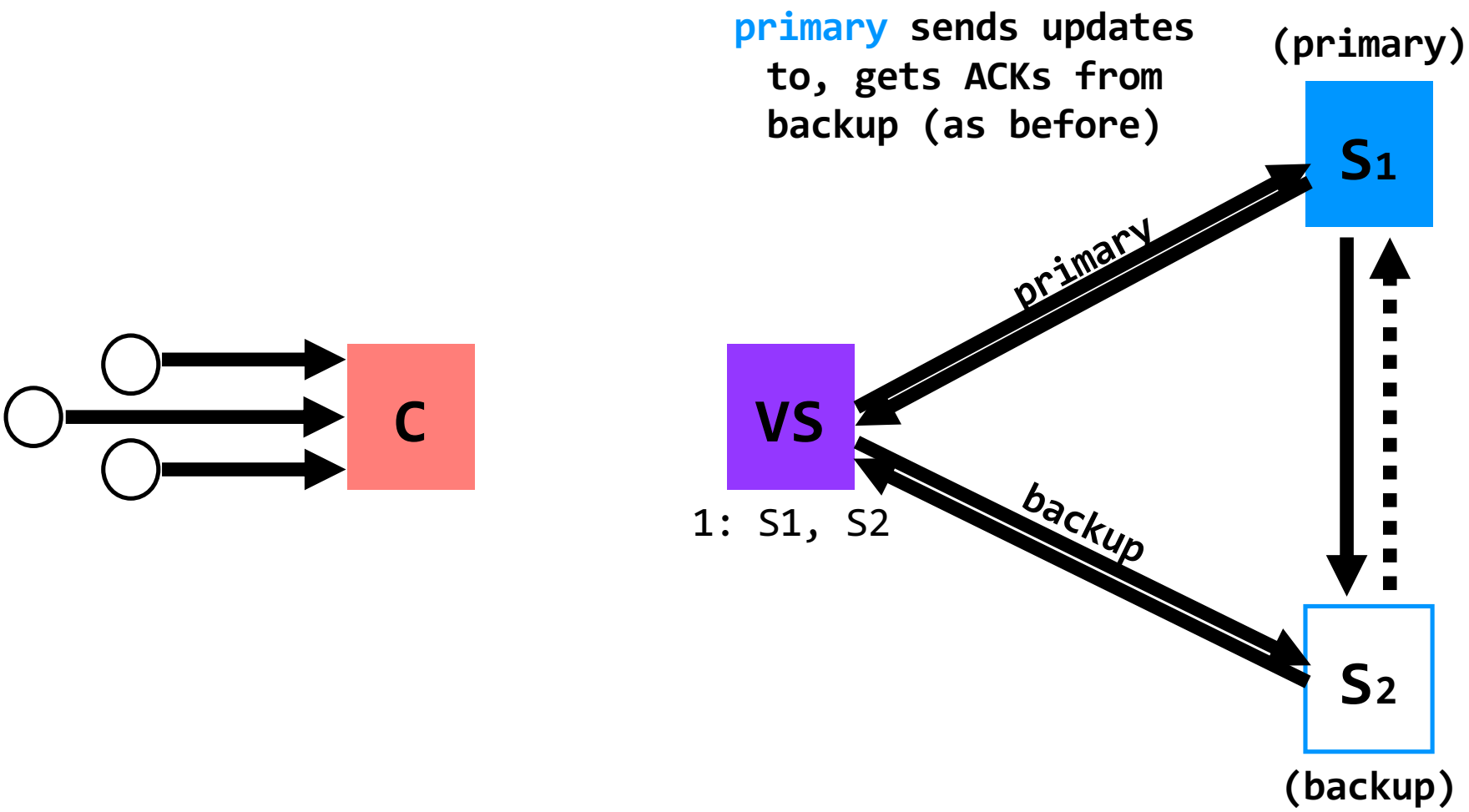

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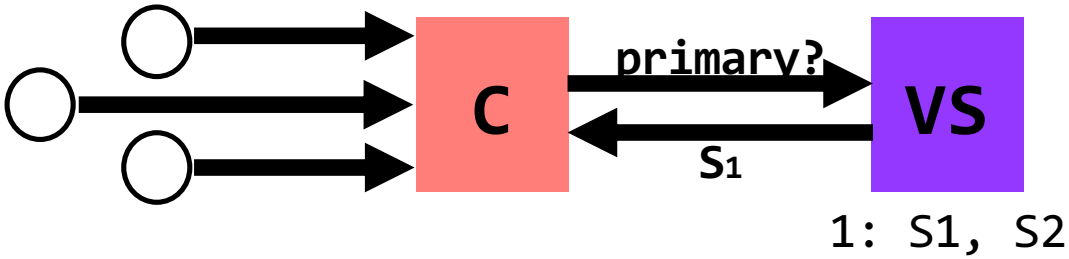
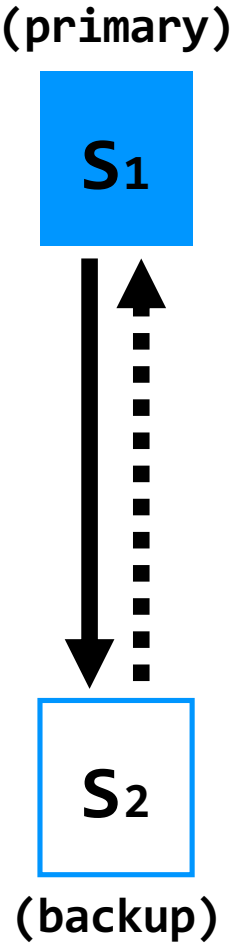


coordinators make requests to view server to find out who is primary



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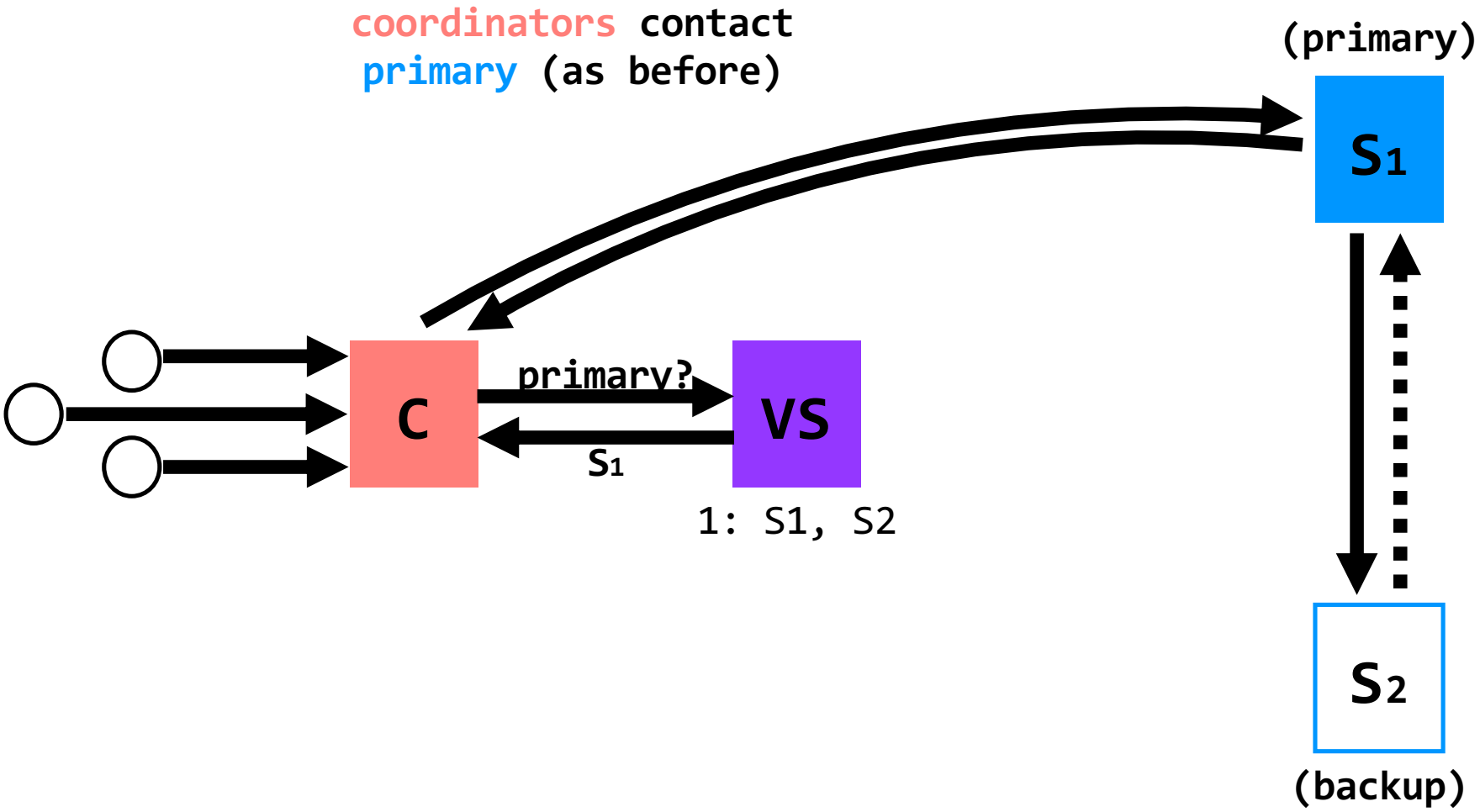

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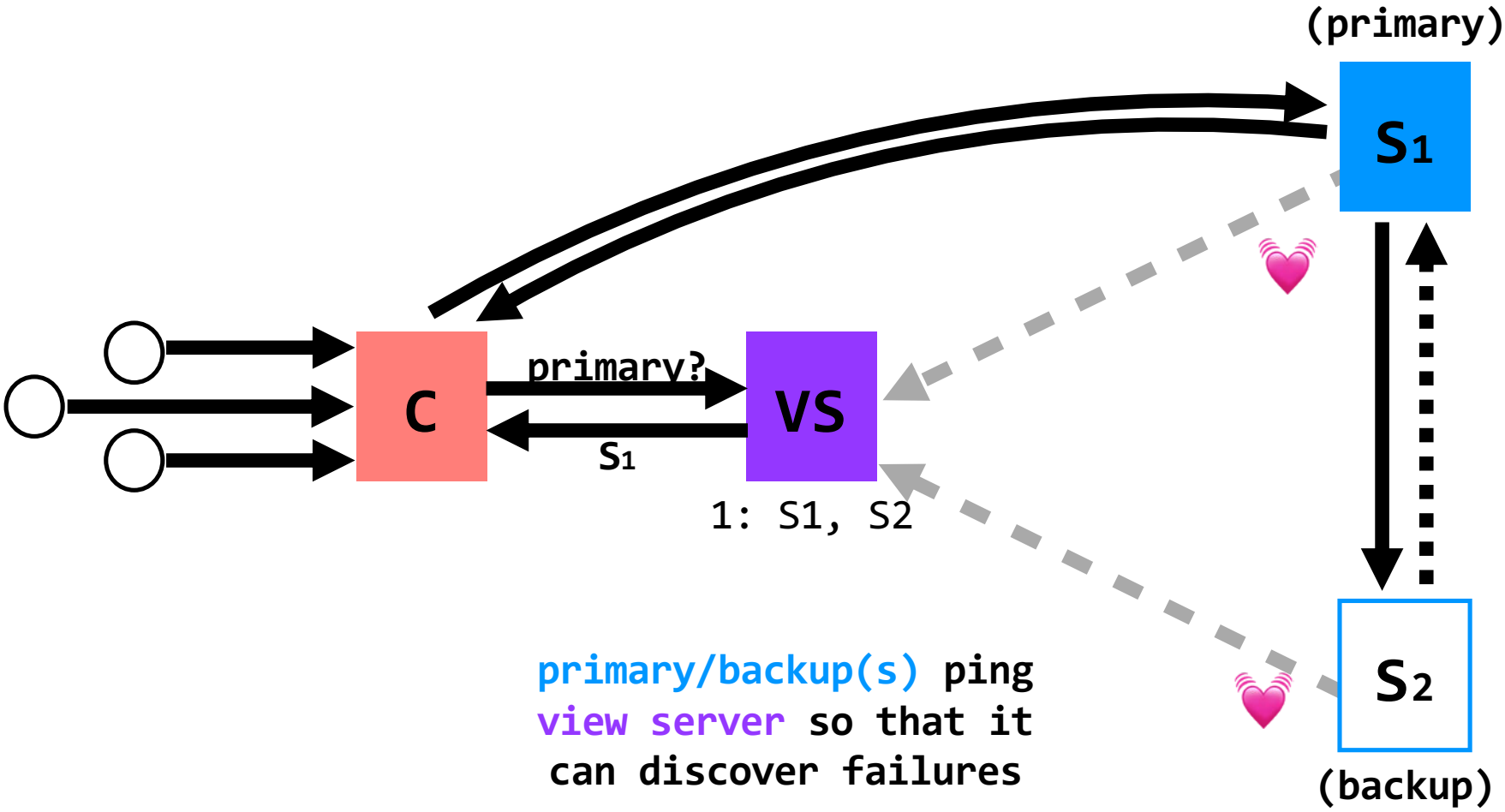
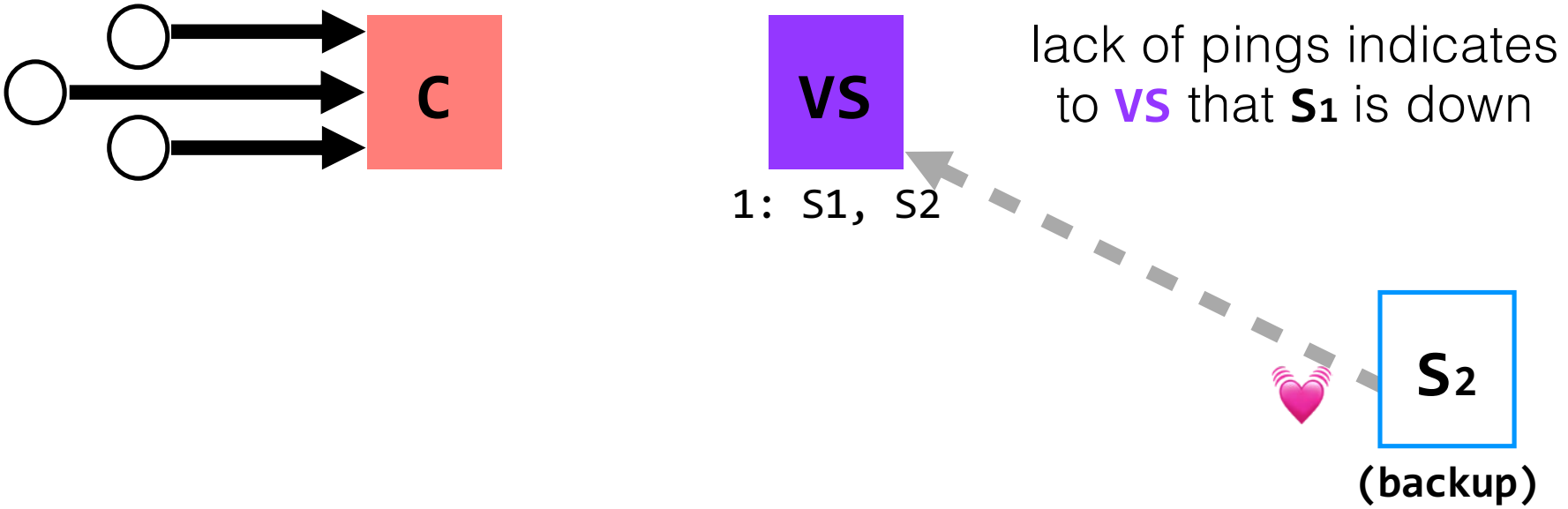


use a **view server**, which determines which replica is the primary

handling primary failure



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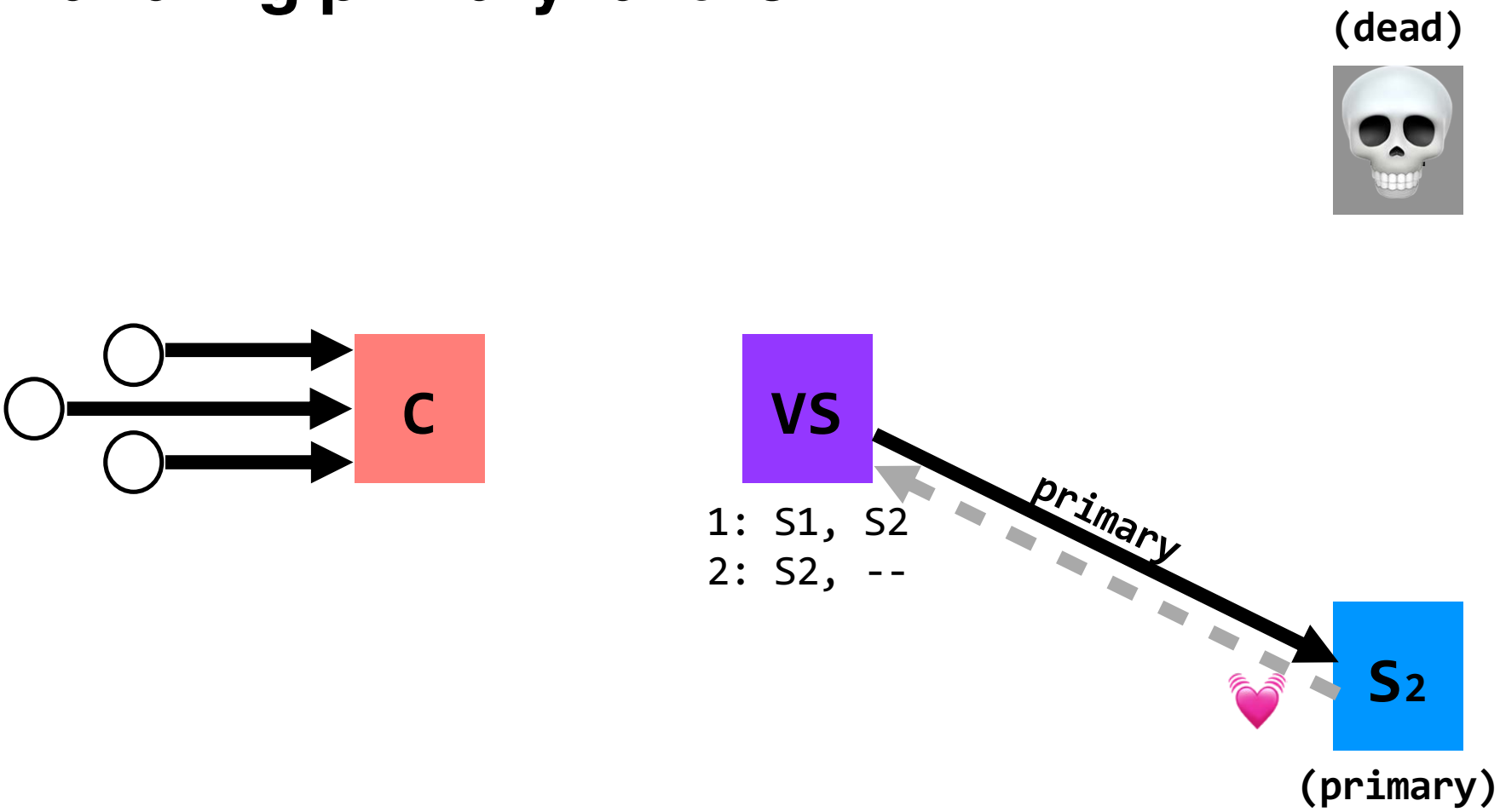

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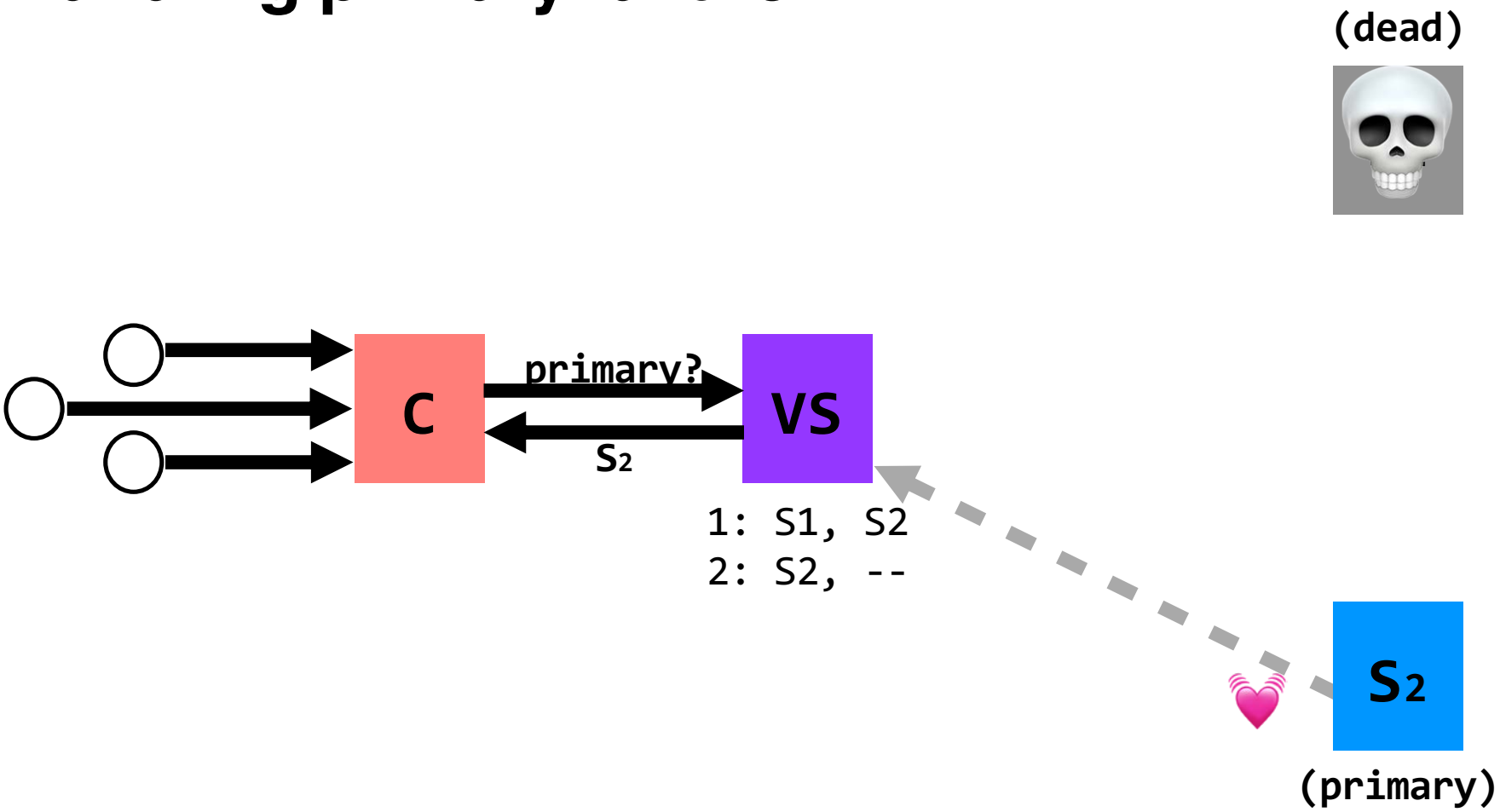

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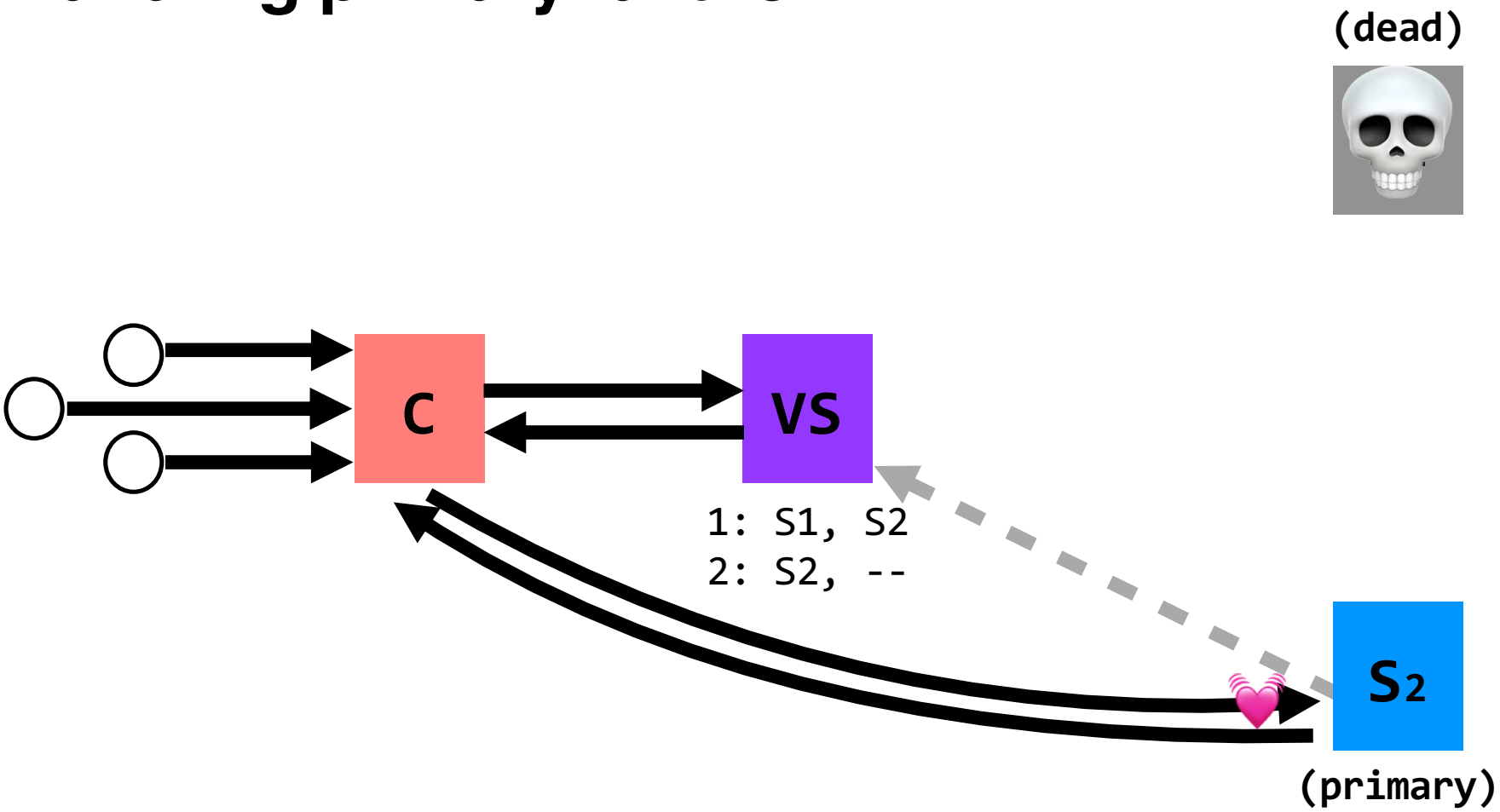
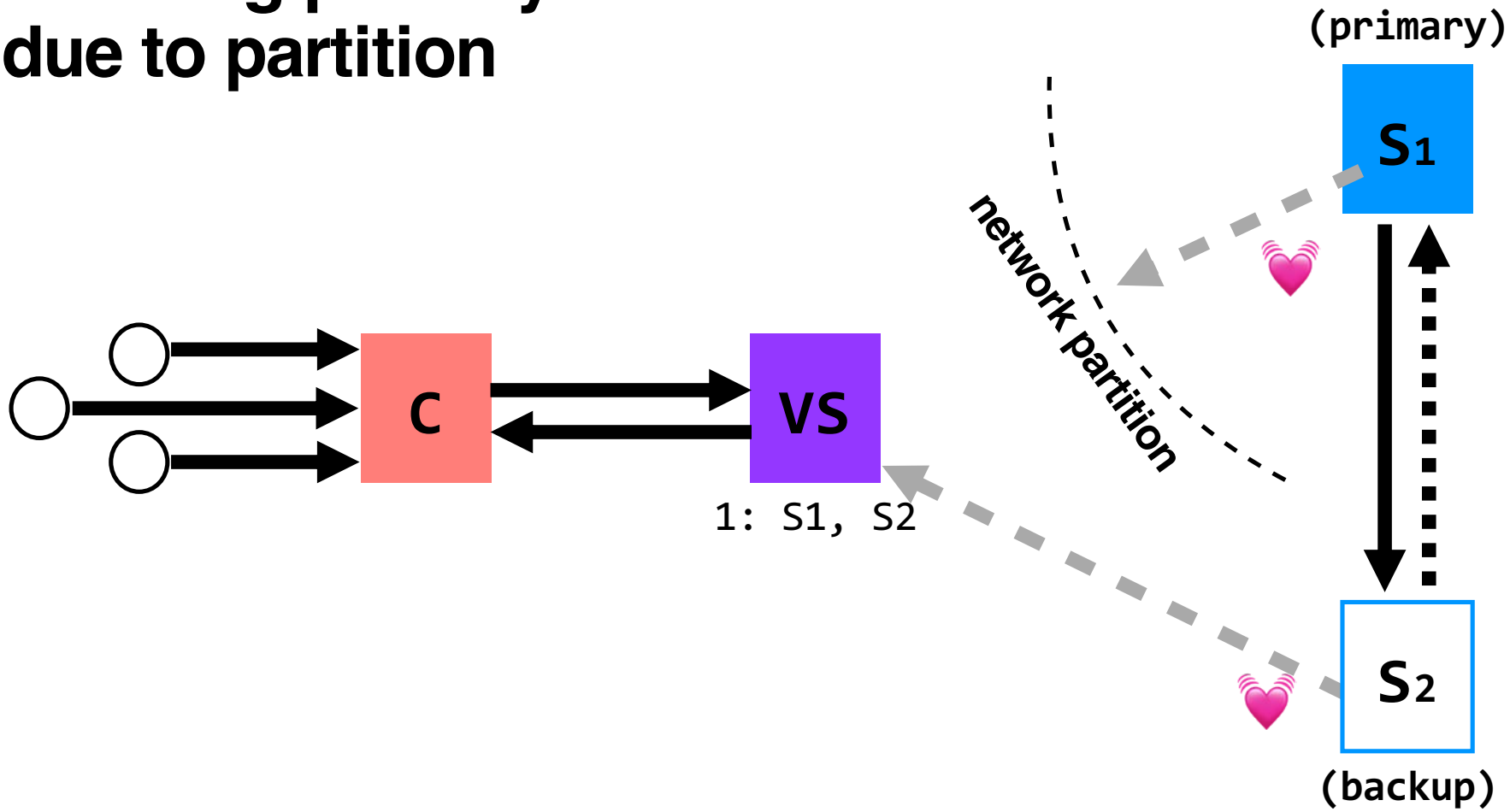
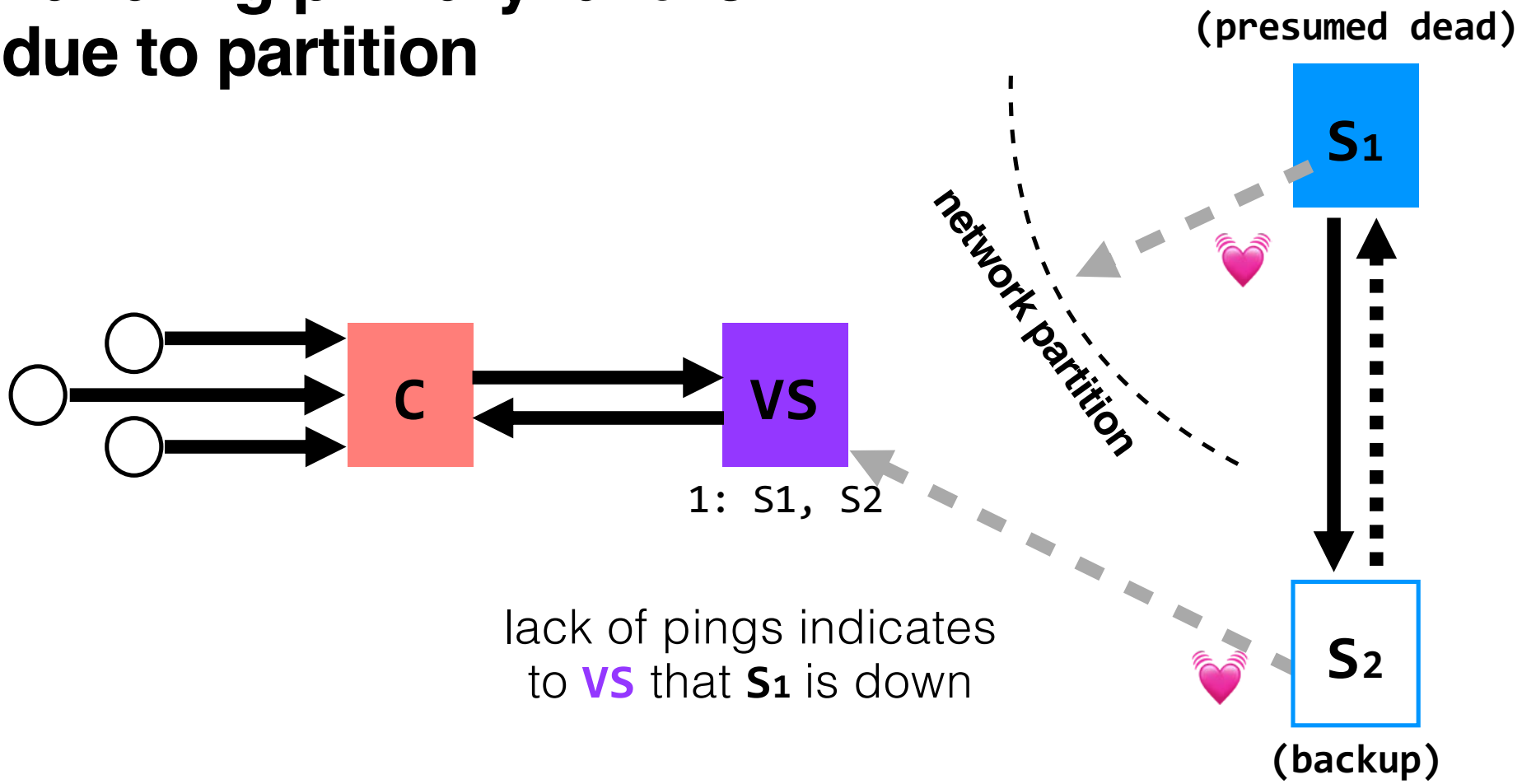


handling primary failure due to partition



pose a partition keeps S1 from communicating with the view se

handling primary failure due to partition



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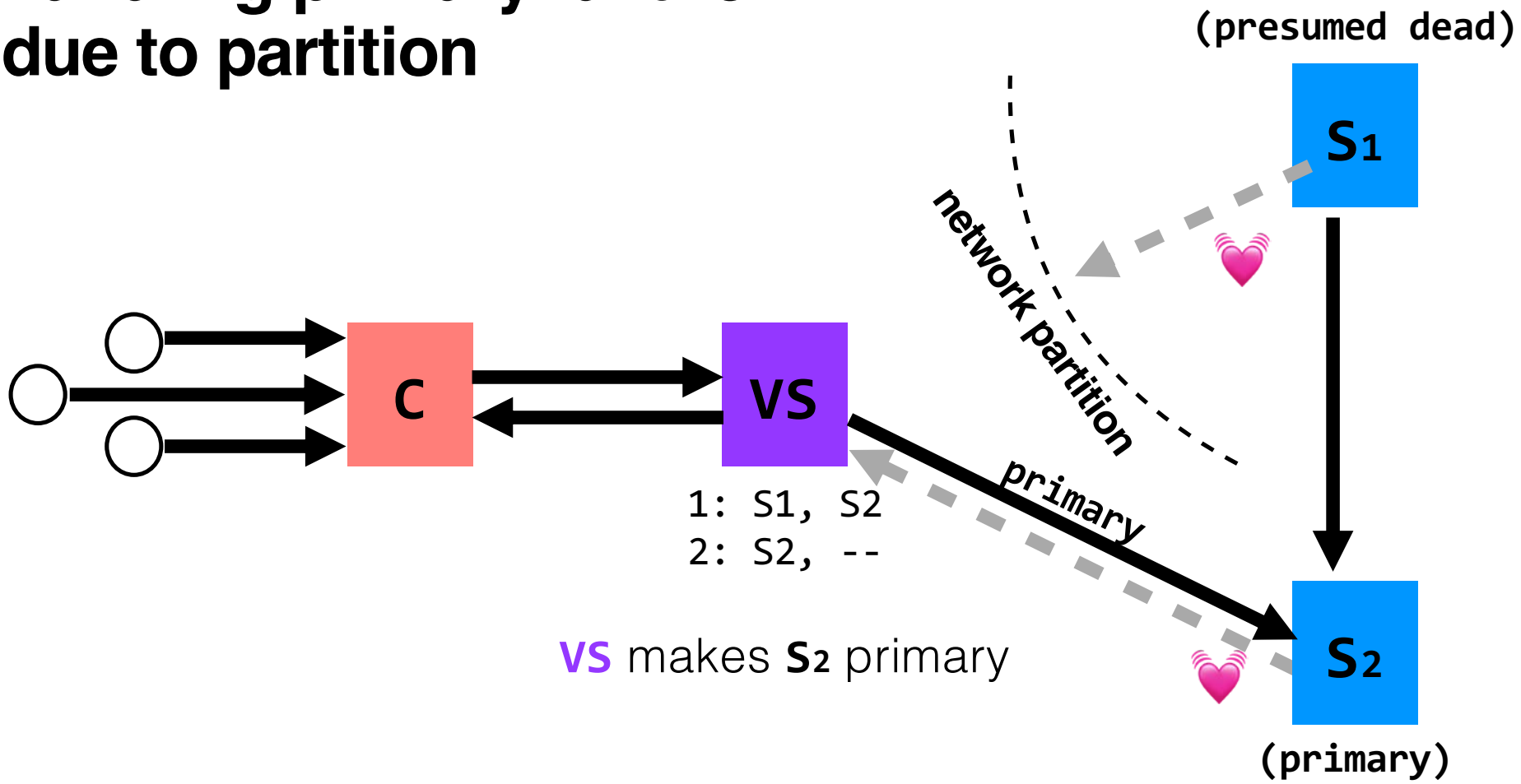

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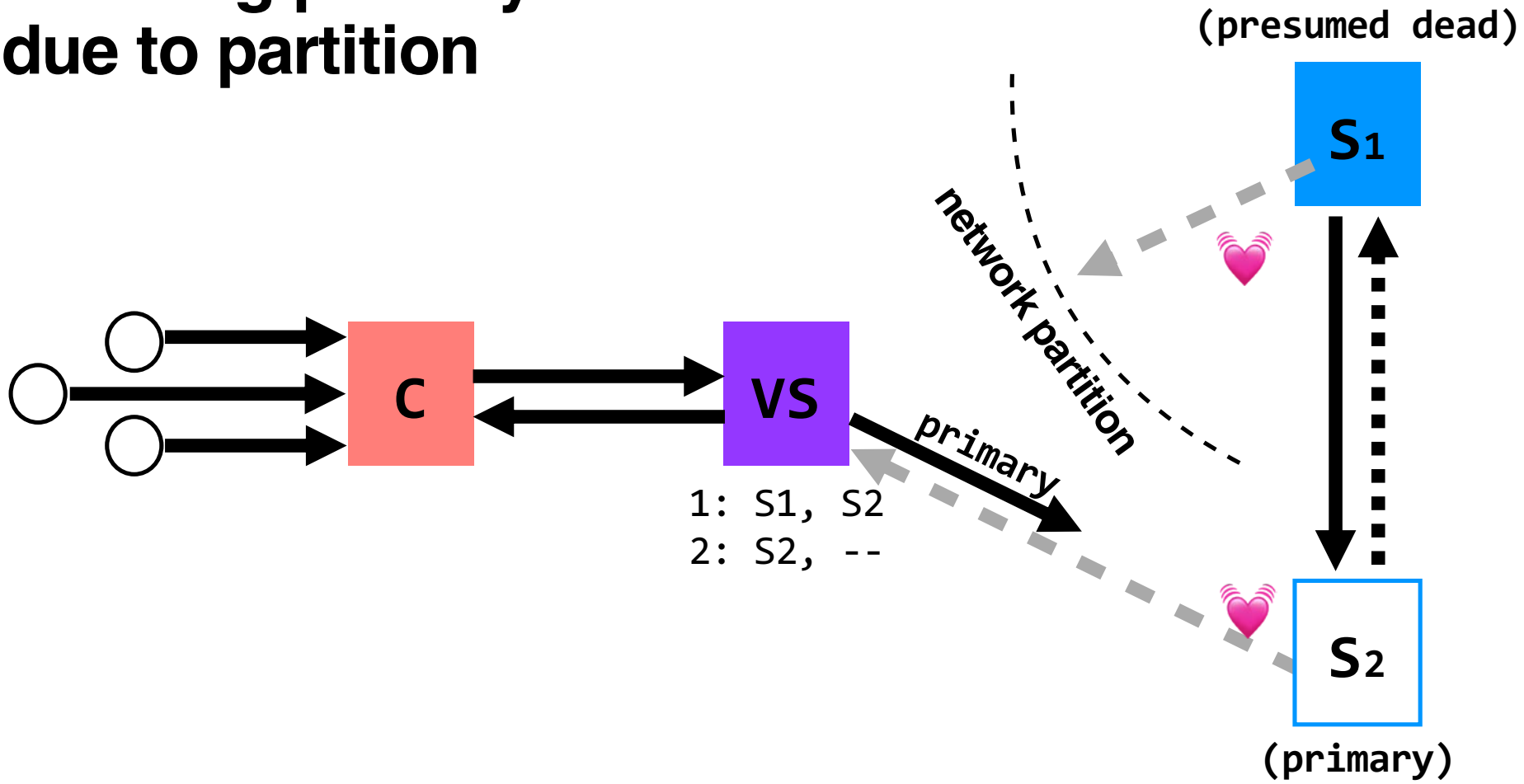
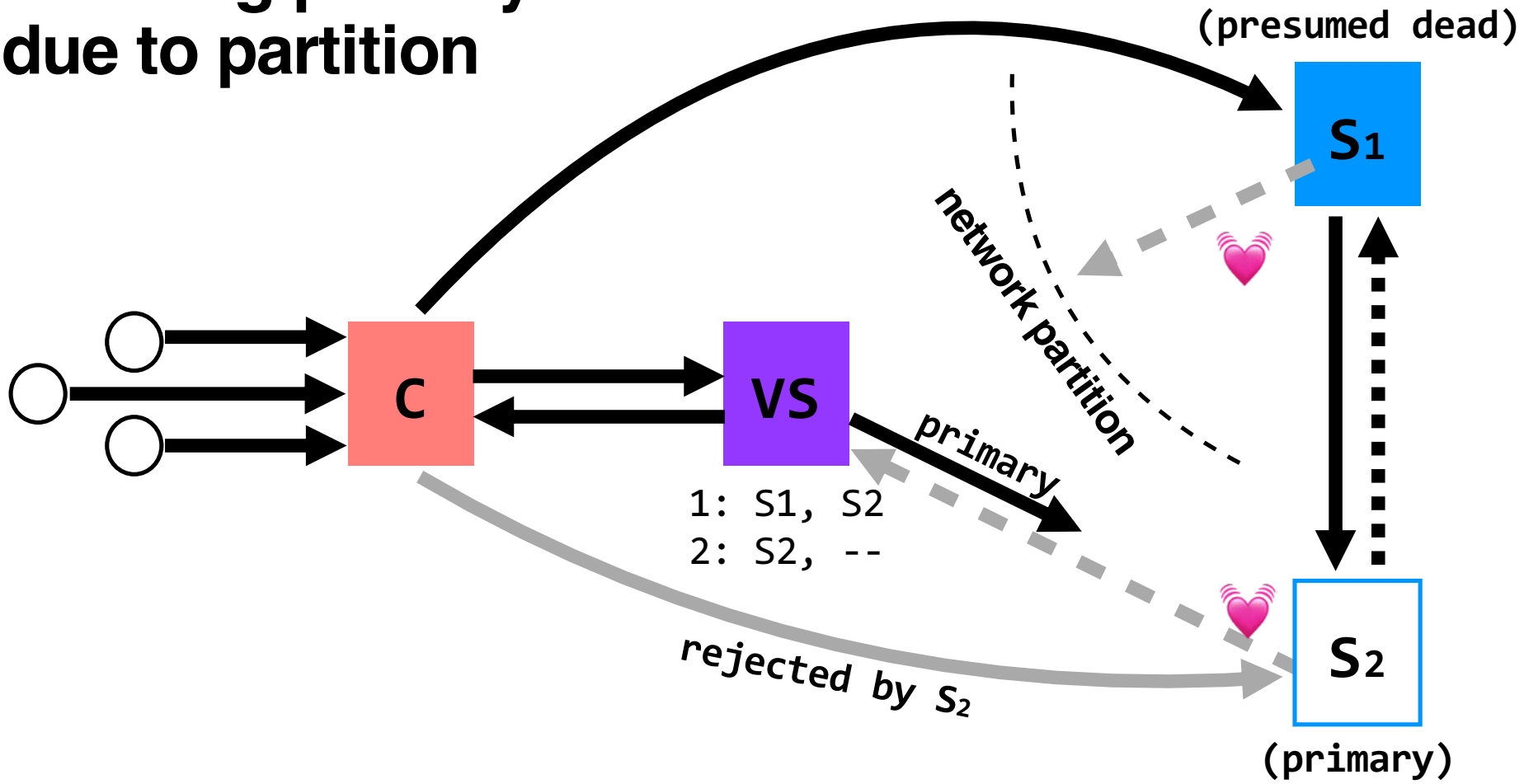


question: what happens before S_2 knows it's the primary?

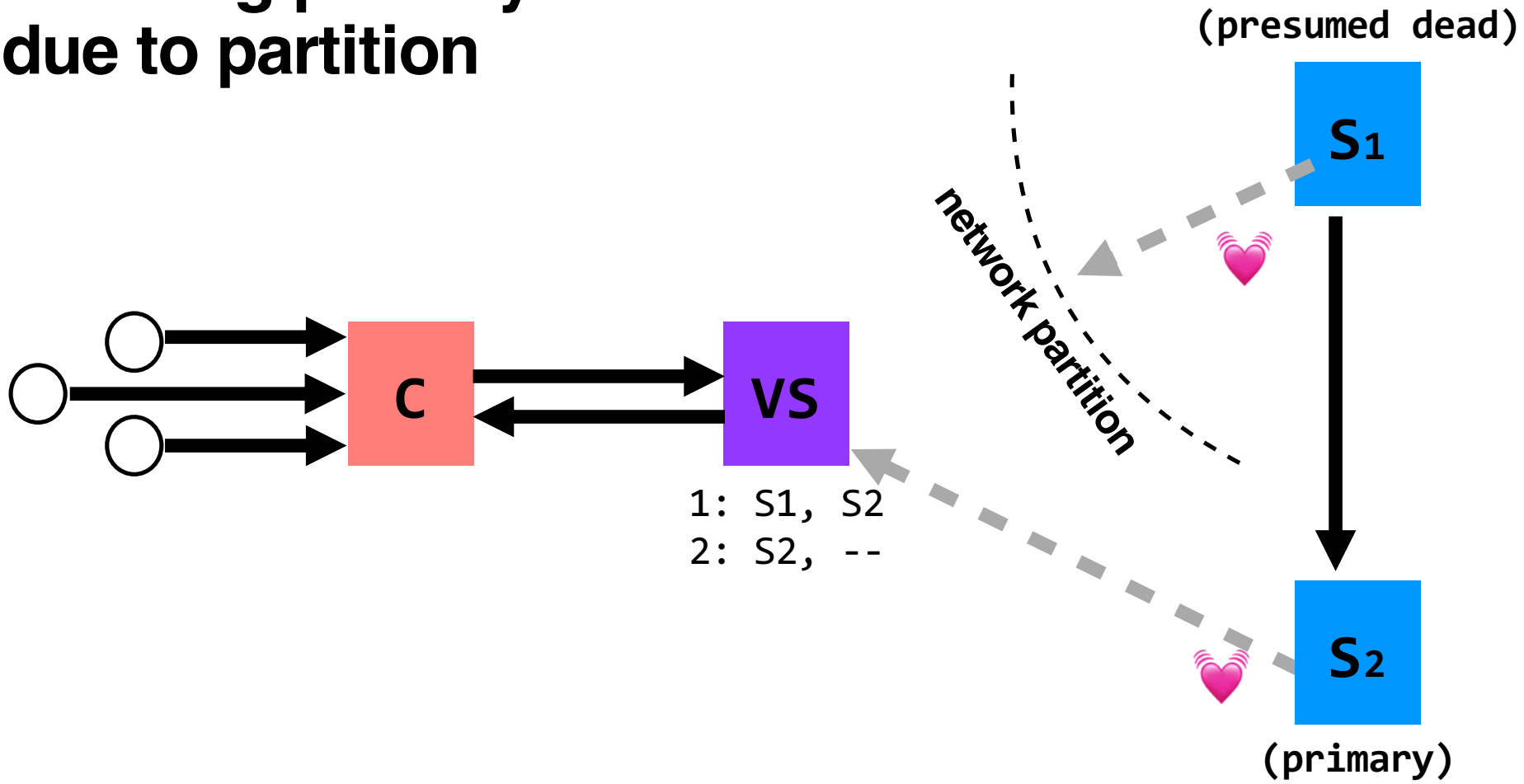
handling primary failure due to partition



S2 will act as backup

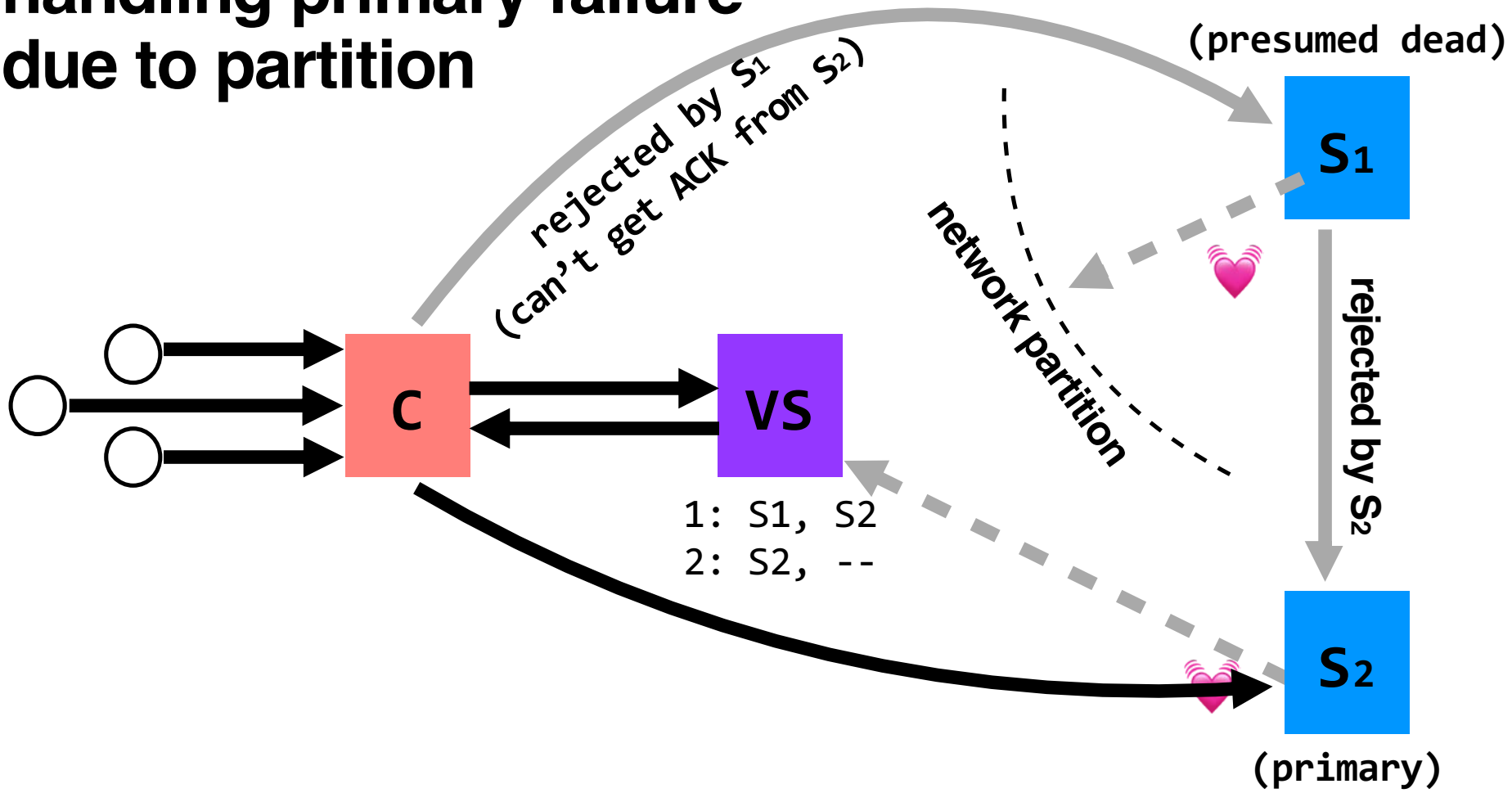
(accept updates from S1, reject coordinator requests)

handling primary failure due to partition



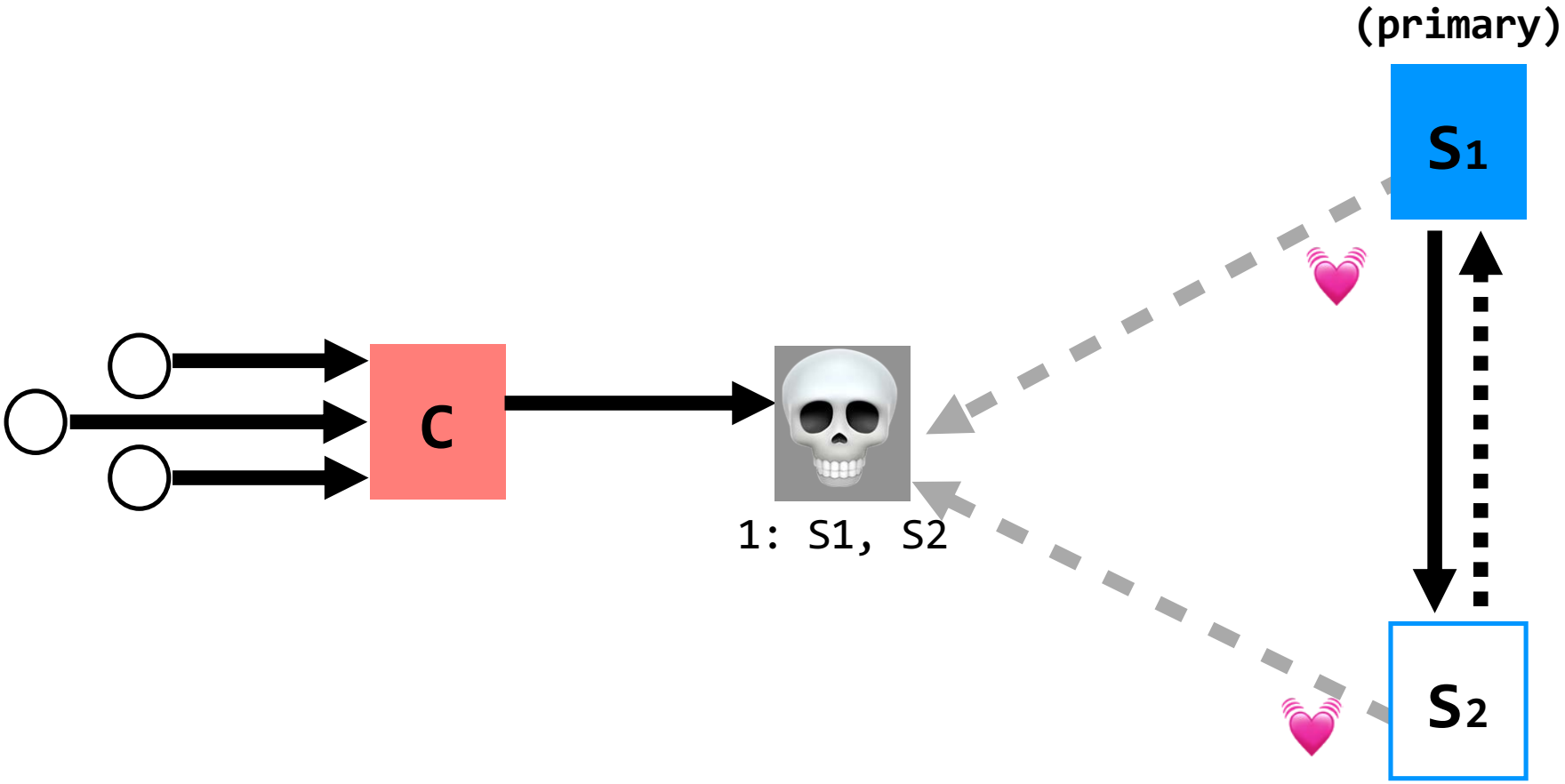
question: what happens after S_2 knows it's the primary, but S_1 also thinks it is?

handling primary failure due to partition

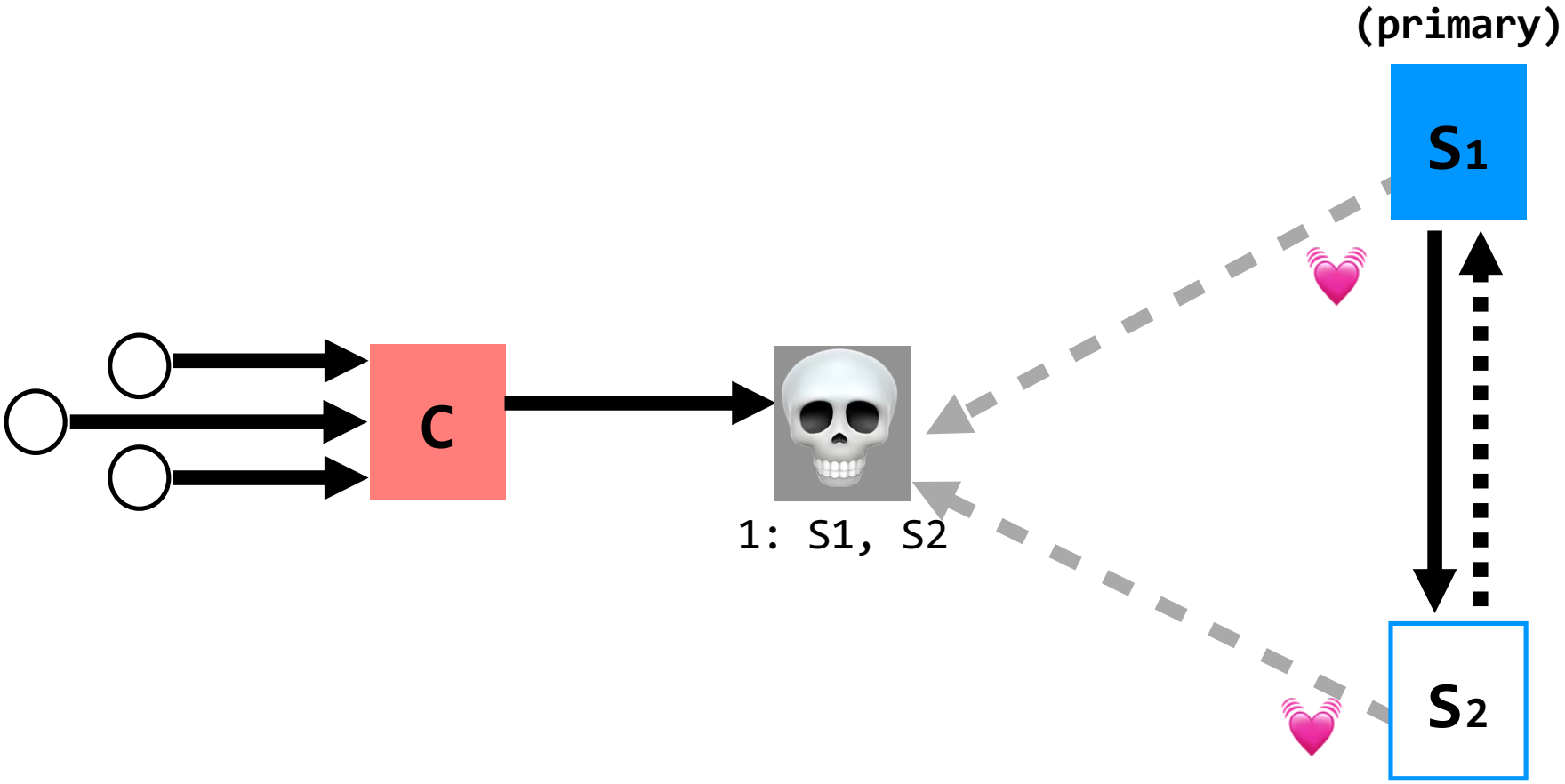


S_1 won't be able to act as primary

(can't accept client requests because it won't get ACKs from S_2)



problem: what if view server fails?



problem: what if view server fails?

go to recitation tomorrow and find out!

- **Replicated state machines (RSMs)** provide **single-copy consistency**: operations complete as if there is a single copy of the data, though internally there are replicas.

- RSMs use a **primary-backup** mechanism for replication. The **view server** ensures that only one replica acts as the primary. It can also recruit new backups after servers fail.

- To extend this model to handle view-server failures, we need a mechanism to provide **distributed consensus**; see tomorrow's recitation (on Raft).

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