# Distributed Snapshots

10/6/17

## A note on assignment 1...

Using channels is easy, debugging them is hard…

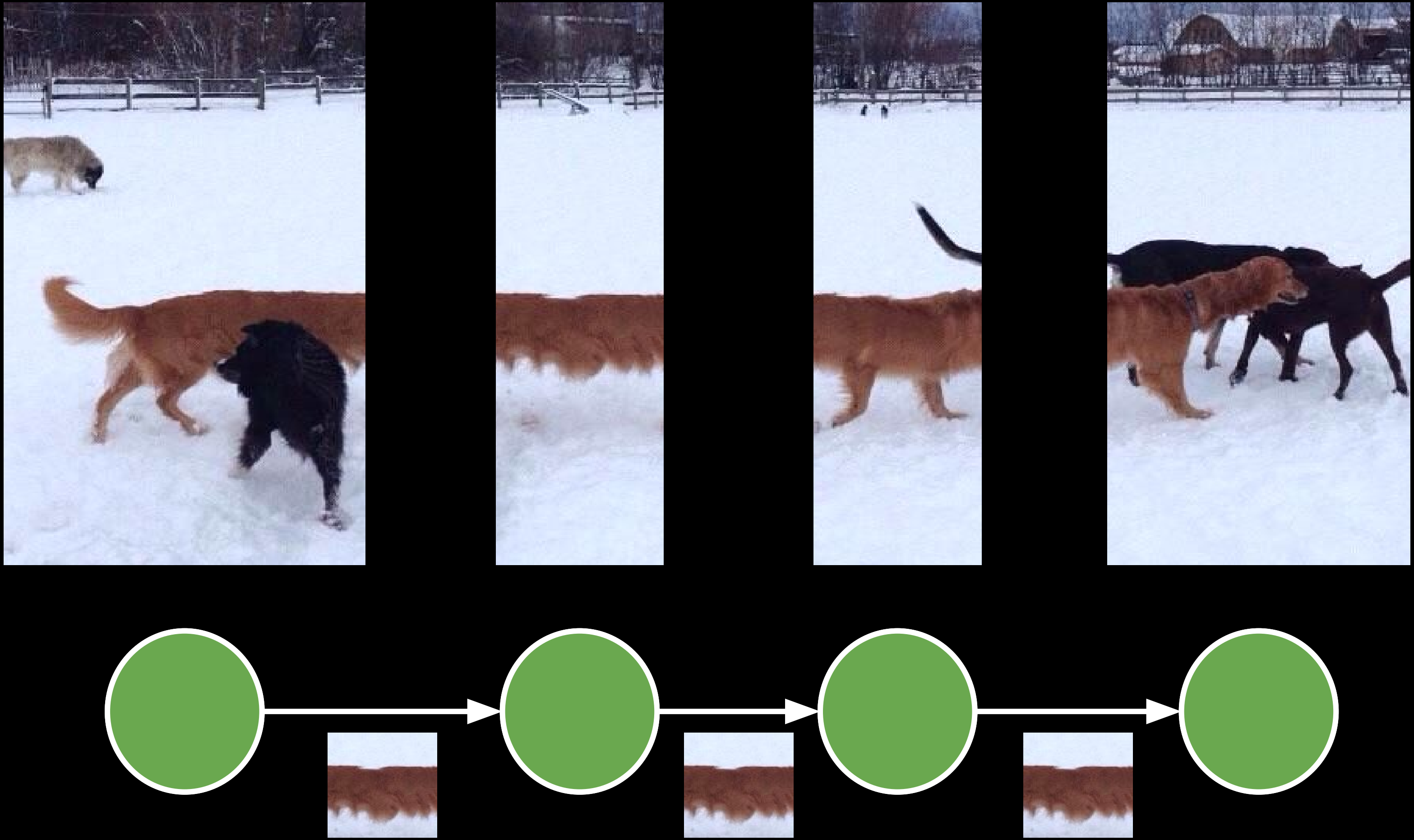
Bullet-proof way: Keep track of how many things go in and go out

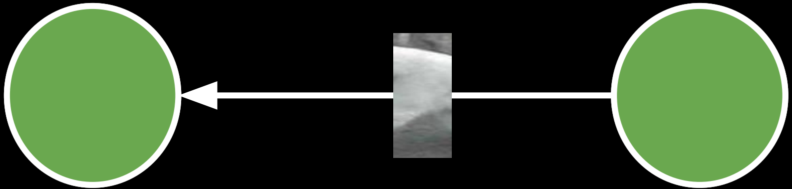
*Always* ask yourself: is this channel buffered?

In general, don’t use locks or atomic operations with channels (awkward)

Try not to nest goroutines (hard to reason about)

Need synchronization





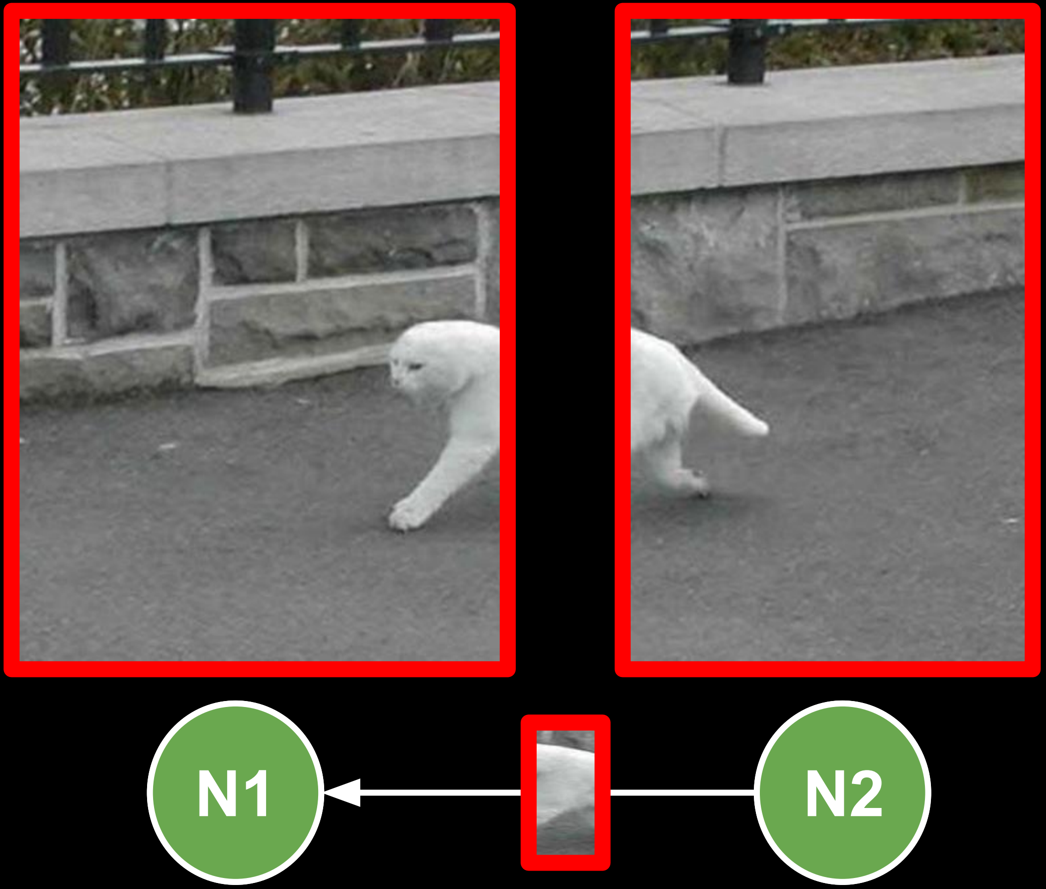
## Distributed snapshots are easy to screw up

Must ensure state is not duplicated across the cluster

Must ensure state is not lost across the cluster

Messages in flight must also be recorded

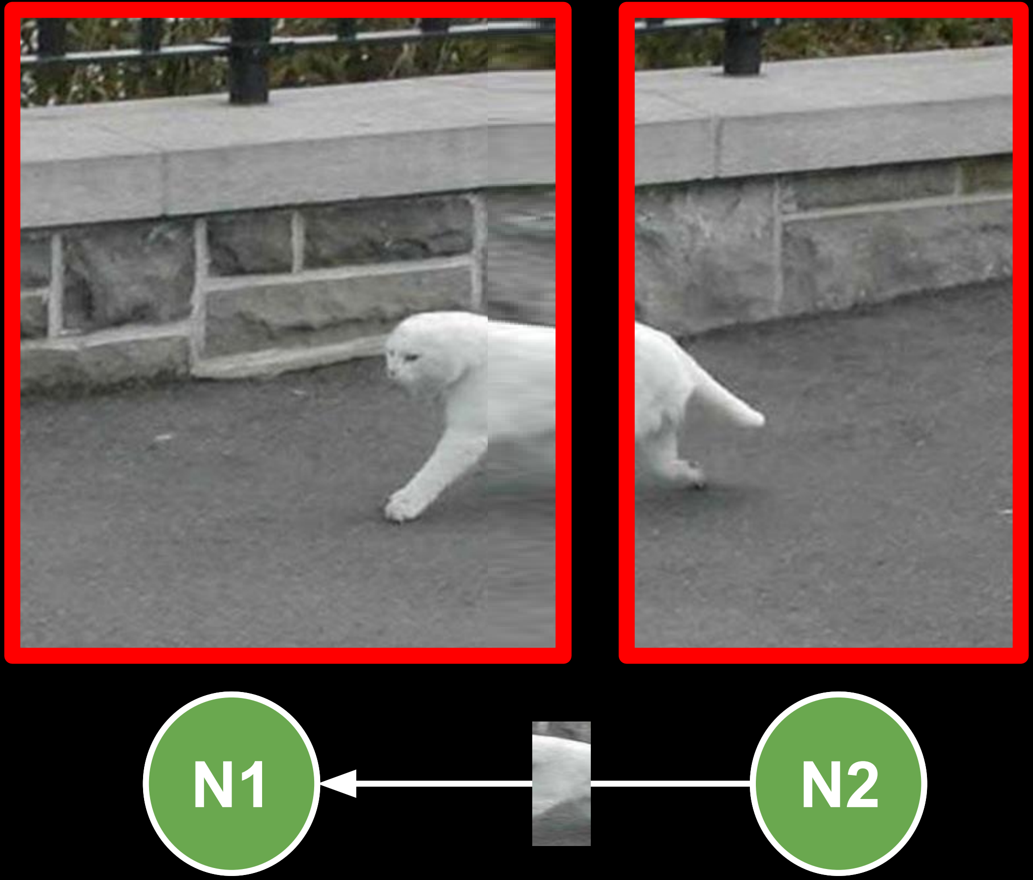
*But which ones?*



*Event order:*

1. Snap N1
2. N2 sends body
3. Snap N2
4. N1 receives body

**Should record message!**



*Event order:*

1. N2 sends body
2. Snap N2
3. N1 receives body
4. Snap N1

**N1 already received the body in step 3**

**Should NOT record message**

## Intuition

If you *haven't* snapshotted your local state yet, you should *NOT* record future messages you receive — *Why?*

After snapshotting your local state, you should record future messages you receive

*Which one guarantees zero loss?*
*Which one guarantees zero duplication?*

## Chandy-lamport snapshot algorithm

**Key idea:** Servers send marker messages to each other

Mark the beginning of the snapshot process on the server

Act as a barrier (stopper) for recording messages

## Chandy-lamport snapshot algorithm

Starting the snapshot process on a server:

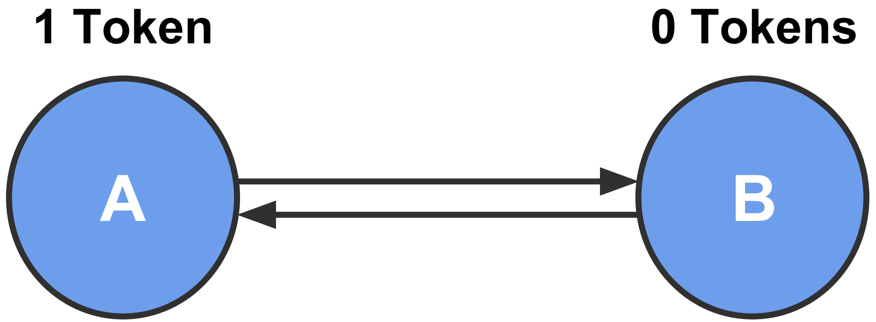
- Record its local state
- Send marker messages on all outbound interfaces

When you receive a marker message:

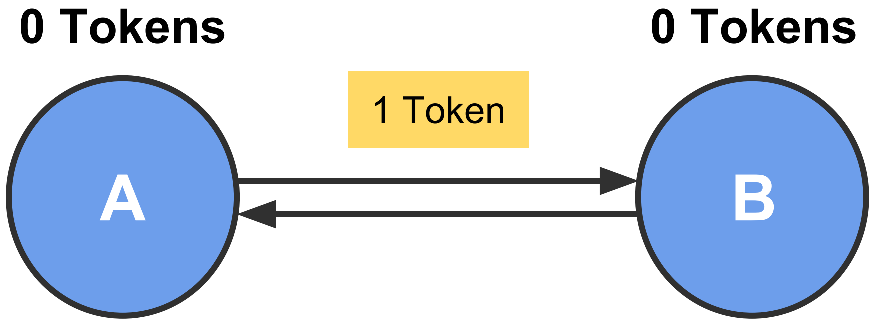
- If you haven't started the snapshot process yet, record your local state and send marker messages on all other interfaces
- Start recording messages you receive on all *other* interfaces
- Stop recording messages you receive on *this* interface

Terminate when all servers have received marker messages on all interfaces

# Token passing example 1



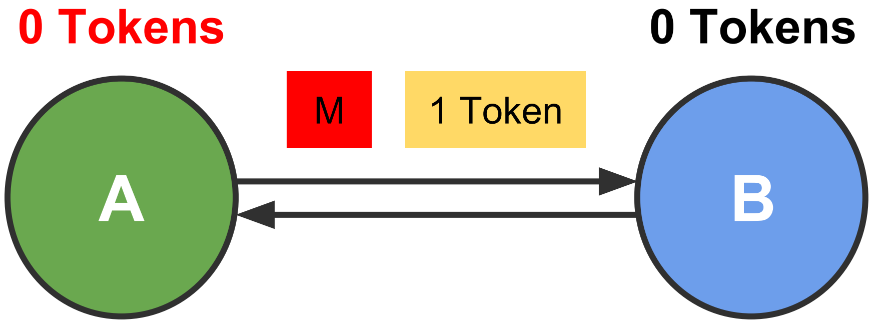
## Token passing example 1



*Event order:*

1. A sends 1 token

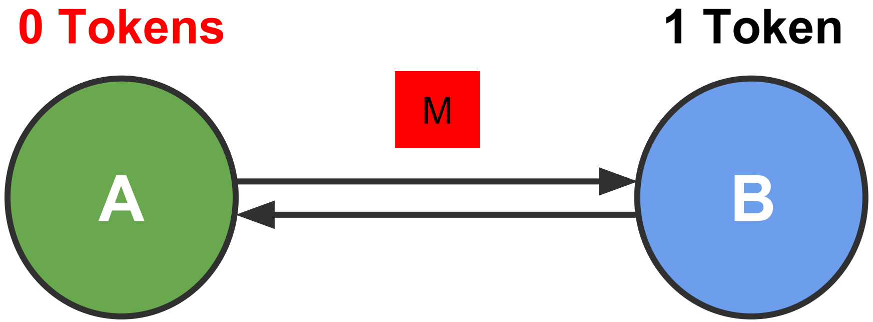
# Token passing example 1



*Event order:*

1. A sends 1 token
2. A starts snapshot, sends marker

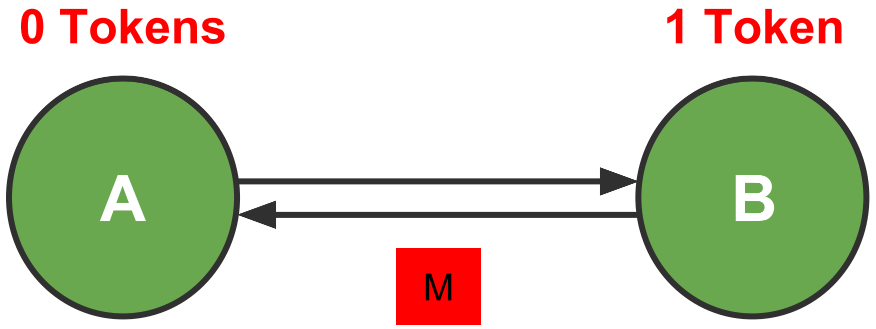
## Token passing example 1



*Event order:*

1. A sends 1 token
2. A starts snapshot, sends marker
3. B receives 1 token

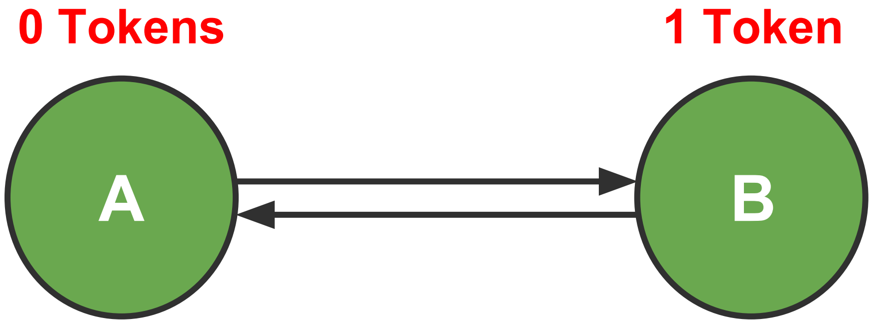
# Token passing example 1



*Event order:*

1. A sends 1 token
2. A starts snapshot, sends marker
3. B receives 1 token
4. B receives marker, starts snapshot

## Token passing example 1

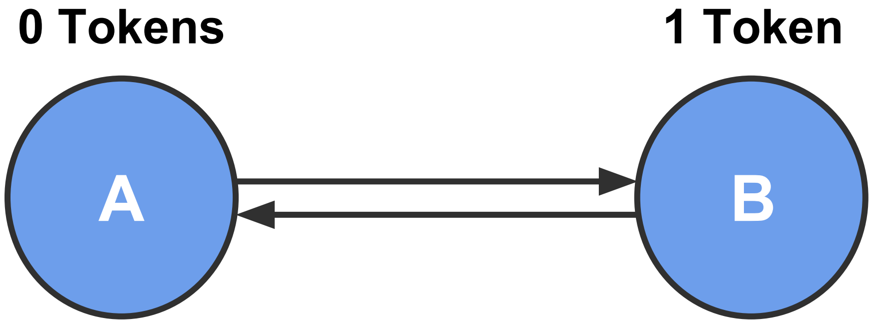


*Event order:*

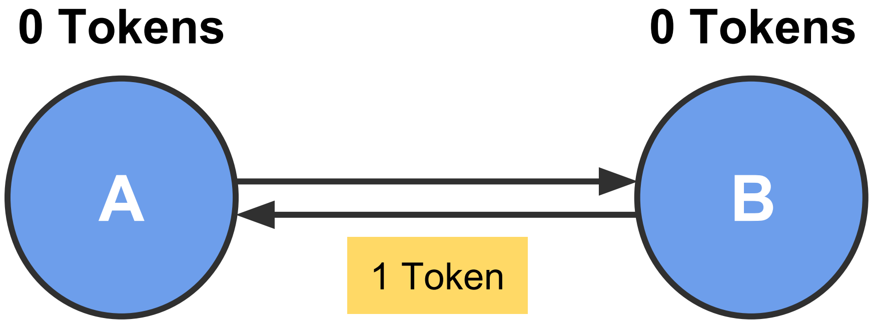
1. A sends 1 token
2. A starts snapshot, sends marker
3. B receives 1 token
4. B receives marker, starts snapshot
5. A receives marker

*We did not record the token message because B received it before B started the snapshot process*

## Token passing example 2



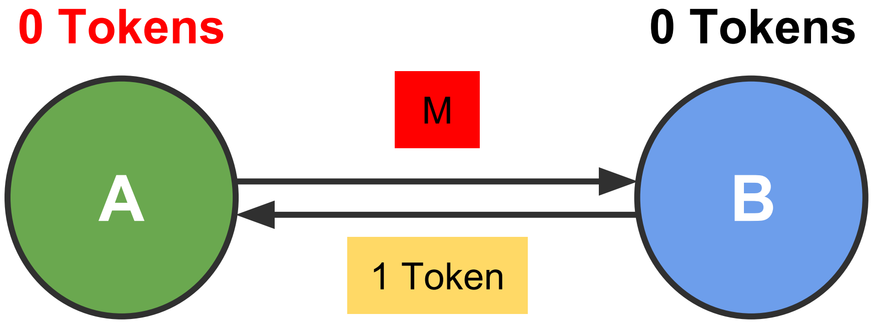
## Token passing example 2



*Event order:*

1. B sends 1 token

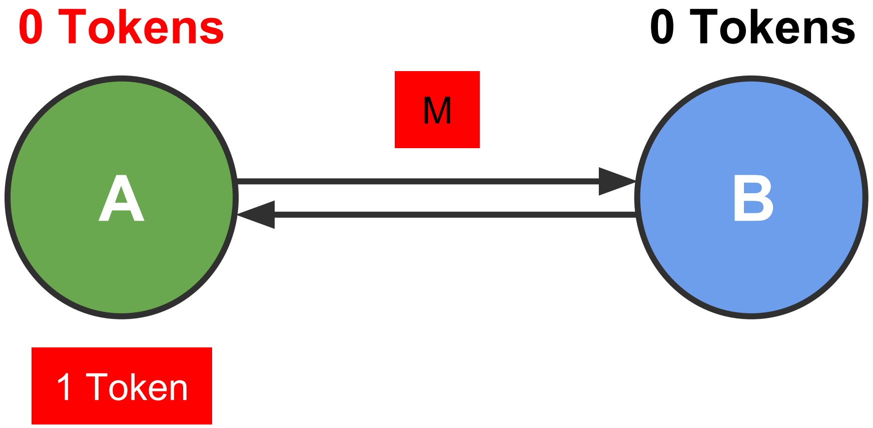
## Token passing example 2



*Event order:*

1. B sends 1 token
2. A starts snapshot, sends marker

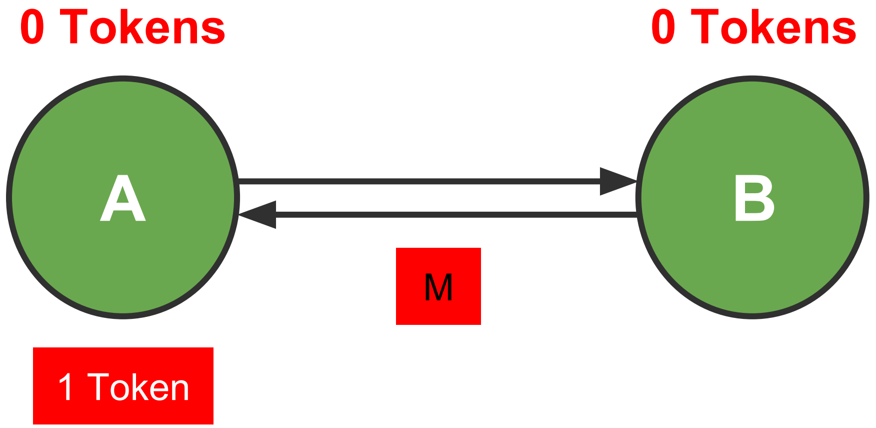
## Token passing example 2



*Event order:*

1. B sends 1 token
2. A starts snapshot, sends marker
3. A receives 1 token, records message

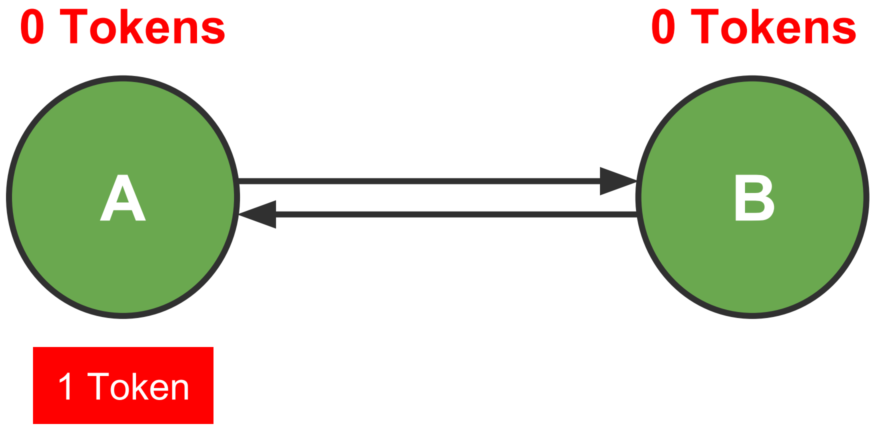
## Token passing example 2



*Event order:*

1. B sends 1 token
2. A starts snapshot, sends marker
3. A receives 1 token, records message
4. B receives marker, starts snapshot

# Token passing example 2

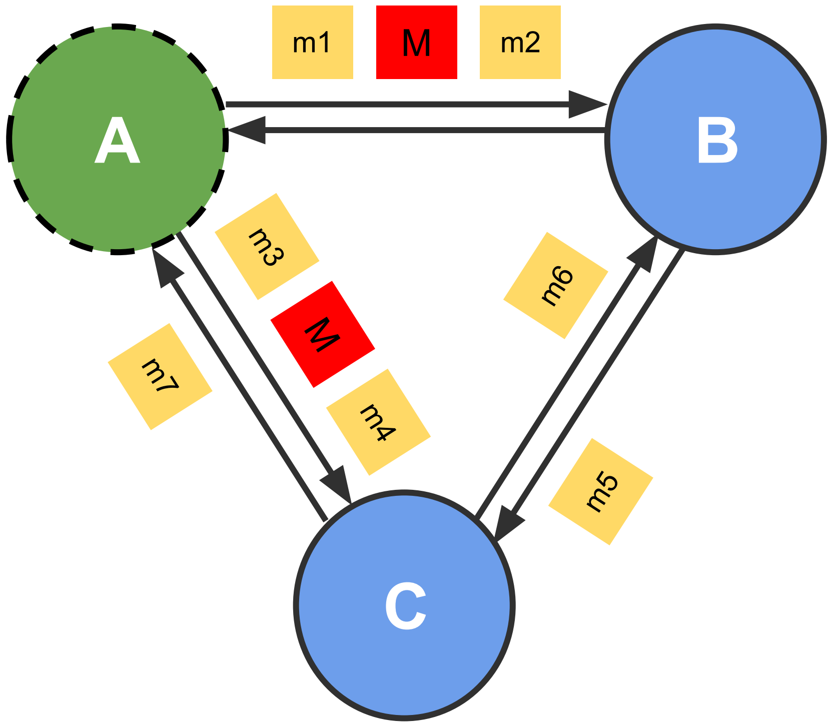


*Event order:*

1. B sends 1 token
2. A starts snapshot, sends marker
3. A receives 1 token, records message
4. B receives marker, starts snapshot
5. A receives marker

*We recorded the token message because A received it* ***after*** *it has already started the snapshot process*

# Token passing example 3



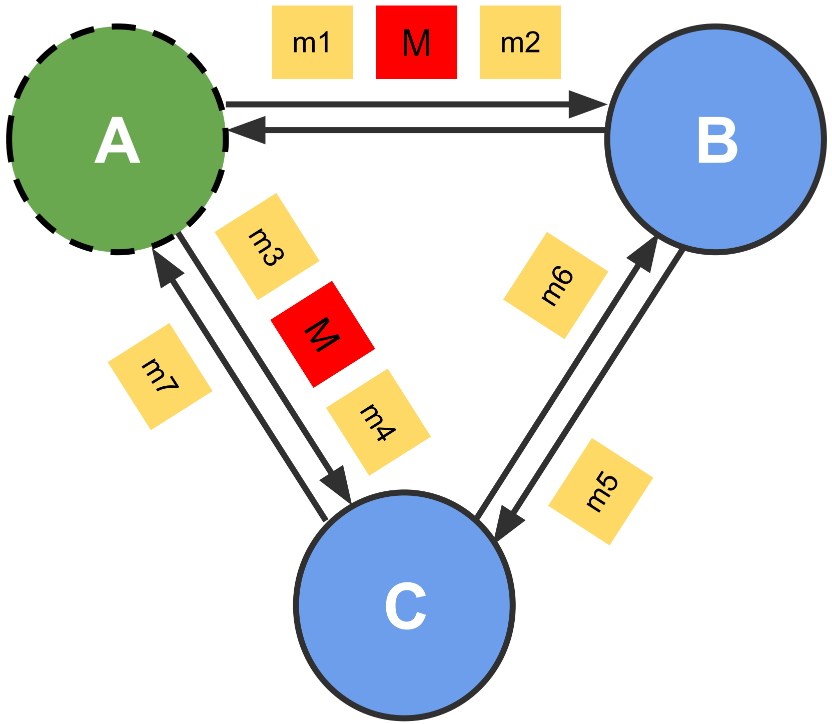
Which messages are definitely recorded*?

Which messages are definitely *not* recorded?

Which messages *might* be recorded?

*recorded as an in-flight message as part of the channel state

## Token passing example 3



Which messages are definitely recorded*?

m7

Which messages are definitely *not* recorded?

m1, m2, m3, m4

Which messages *might* be recorded?

m5, m6

*recorded as an in-flight message as part of the channel state

## Assignment 2

You will implement the Chandy-Lamport snapshot algorithm

Application is a token passing system

- Number of tokens must be preserved in your snapshots

Implementation uses *discrete time* simulator to order events

- `Simulator` manages servers and injects events into the system
- `Server` implements the snapshot algorithm

## Assignment 2 interfaces

```
func (sim *Simulator) Tick()

func (sim *Simulator) StartSnapshot(serverId string)

func (sim *Simulator) NotifySnapshotComplete(serverId string, snapshotId int)

func (sim *Simulator) CollectSnapshot(snapshotId int) *SnapshotState
```

*What kind of state does the simulator need to keep track of?*

Time, topology, channels to signal the completion of snapshots

## Assignment 2 interfaces

```
func (server *Server) SendToNeighbors(message interface{})

func (server *Server) SendTokens(numTokens int, dest string)

func (server *Server) HandlePacket(src string, message interface{})

func (server *Server) StartSnapshot(snapshotId int)
```

*What kind of state does the server need to keep track of?*

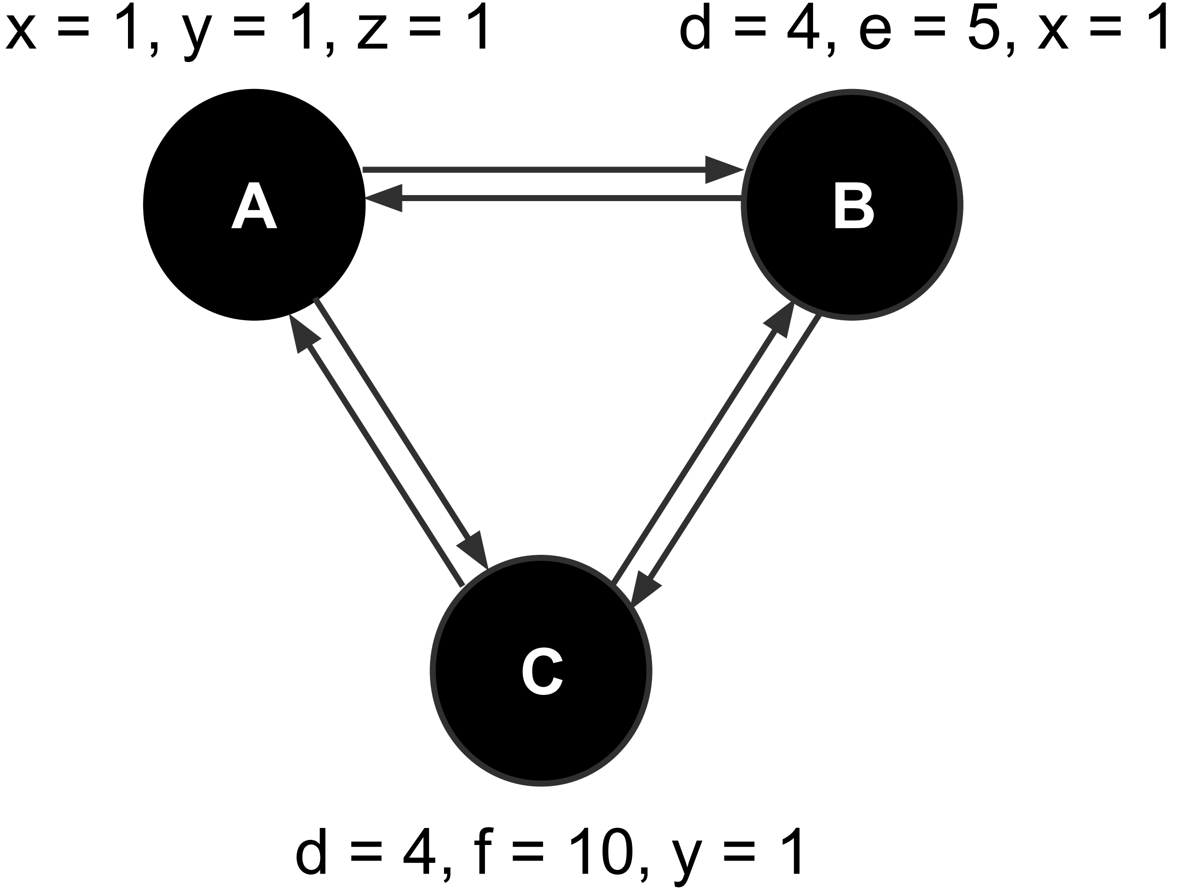
Local state, neighbors, which interfaces received markers, recorded messages

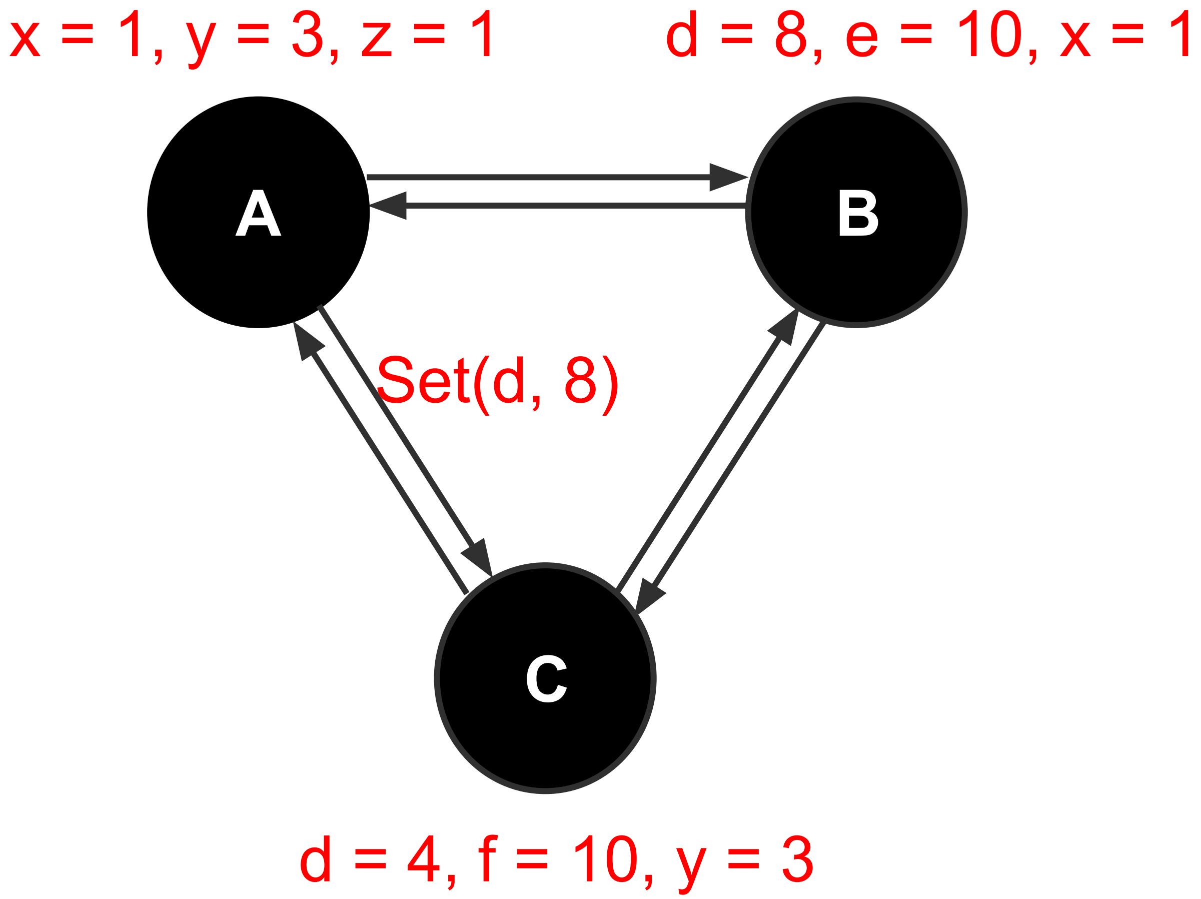
## Assignment 2

Out tonight, check piazza...

Due 10/20 (Fri) at 11:59pm!

## Distributed database exercise


x = 1, y = 1, z = 1
d = 4, e = 5, x = 1
A
B
C
d = 4, f = 10, y = 1


x = 1, y = 3, z = 1
d = 8, e = 10, x = 1
A
B
Set(d, 8)
C
d = 4, f = 10, y = 3