EECS 591
Distributed Systems

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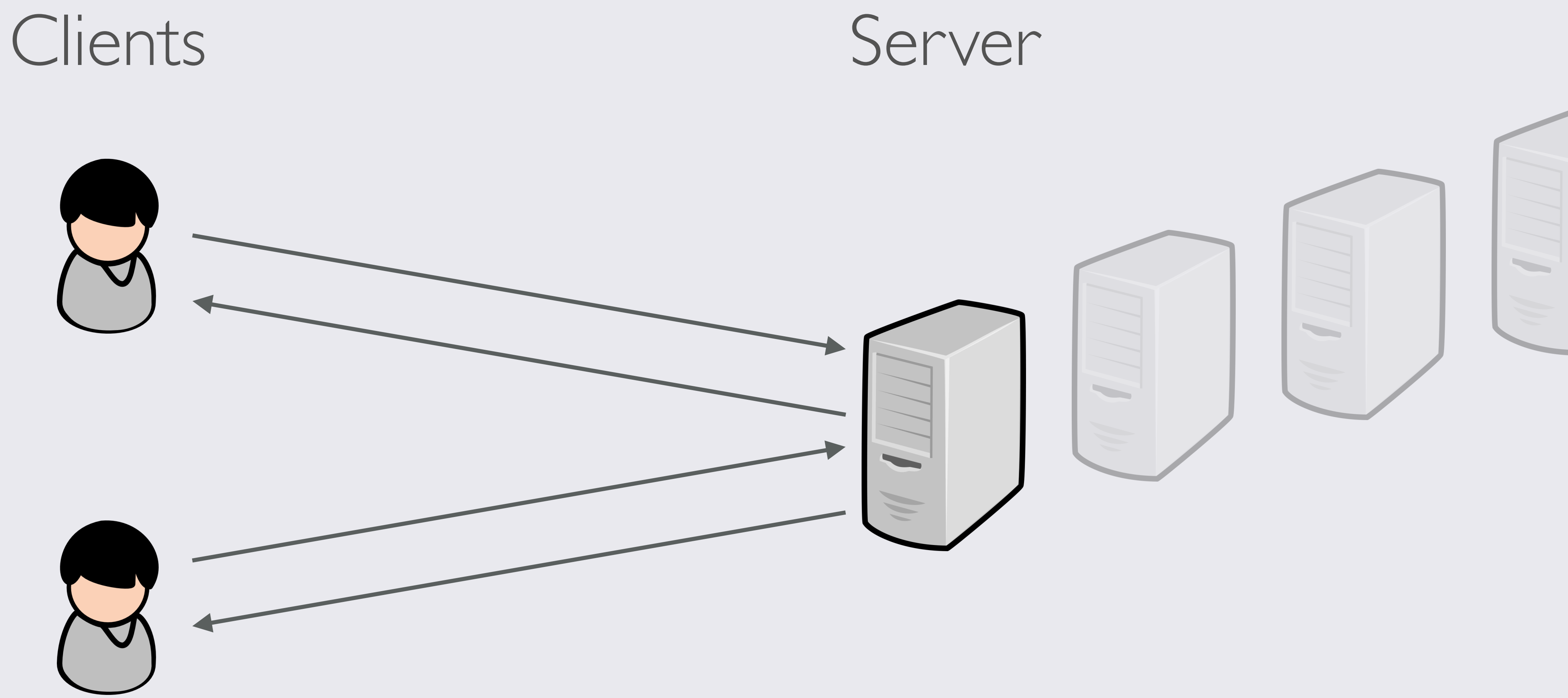
Fall 2021

CONSISTENCY

Is the server's response correct?

(are all the server's responses consistent with each other?)

Consistency



Consistency is a **property** of the execution; a constraint on the values of the reads and writes returned by the server

Causal consistency

All processes see causally related events in the same order.

A student removes advisor from friends list and then posts Spring Break photos

The advisor should not be able to see the pictures

SERIALIZABILITY

*A **concurrent** execution of transactions is equivalent to one that executes the transactions serially in **some sequential order**.*

Are these runs serializable?

1)

T_1: W(x,3)

T_2: W(x,5)

T_3: R(x)=3

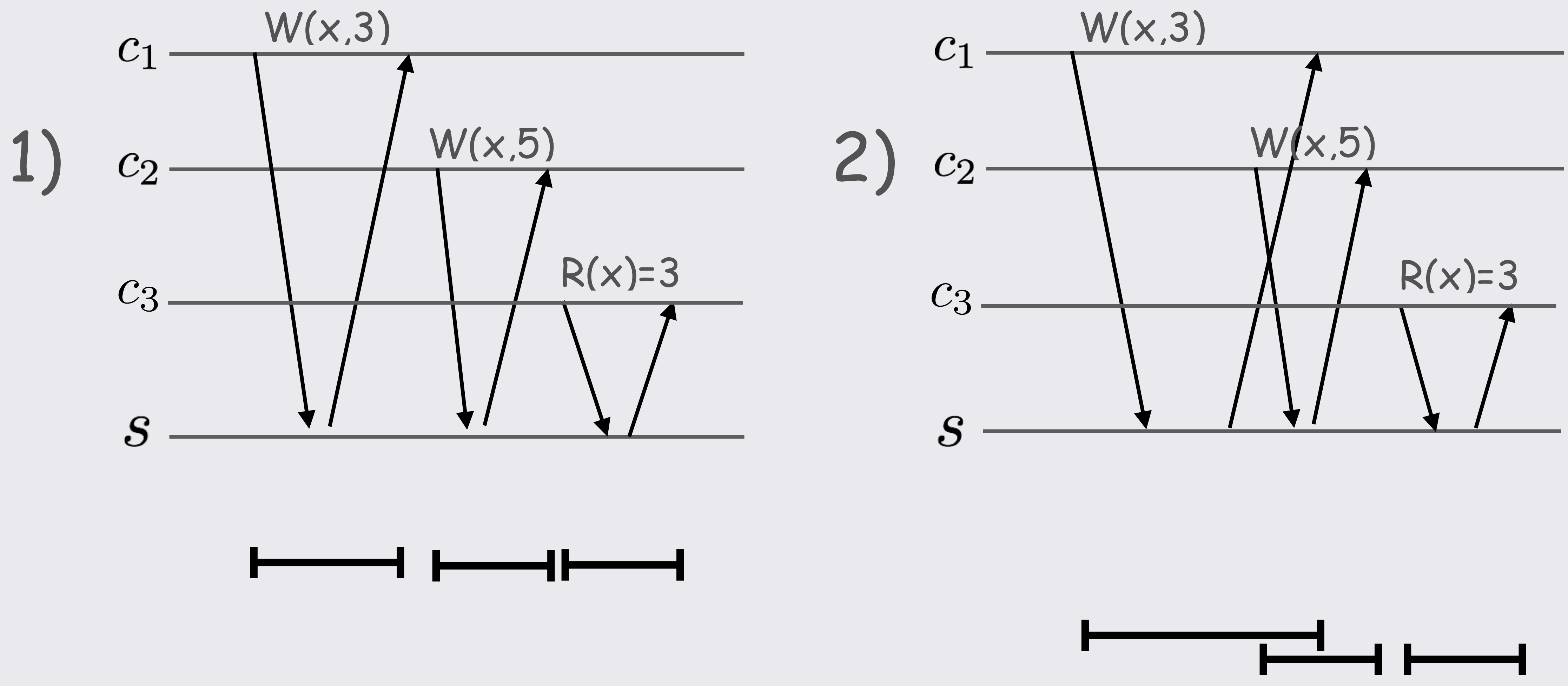
2)

T_1: W(x,3)

T_2: [W(x,5),R(x)=3]

LINEARIZABILITY

*Same as serializability, but the sequential order must preserve the **real-time** constraints of non-overlapping operations.*



Administrivia

Implementation project

- Going out after class
- Groups of 2 (no need to declare)

Deadlines for the coming month

- Declare project topic: 10/8
- Problem set #2: 10/11
- Midterm exam: **moved to 10/27**
- Implementation project: 10/25
- Presentation slides: 11/2

Consensus

Validity If all processes that propose a value propose v, then all correct processes eventually decide v

Agreement If a correct process decides v, then all correct processes eventually decide v

Integrity Every correct process decides at most one value, and if it decides v, then some process must have proposed v

Termination Every correct process eventually decides some value

THE ALGORITHM

Process p_i:

Initially $V = \{v_i\}$

To execute ***propose(*** v_i ***)***:

round $k, 1 \leq k \leq f+1$

1. Send $\{v \in V: p_i$ has not already sent $v\}$ to all
2. for all $j, 0 \leq j \leq n+1, j \neq i$, do
3. receive S_j from p_j
4. $V := V \cup S_j$

---

decide( ) occurs as follows:

5. if $k = f+1$
6. decide min(V)

Good news

Our algorithm implementing consensus in a synchronous setting is correct! That is, it is both safe and live.

Bad news

The FLP result:

There is no protocol that solves consensus in an asynchronous system where one process may crash

Fischer, Lynch, Paterson 1985

The intuition

In an asynchronous setting, a process ***cannot tell the difference*** between a crashed process and one whose messages take long to arrive

How long should the process wait before deciding?

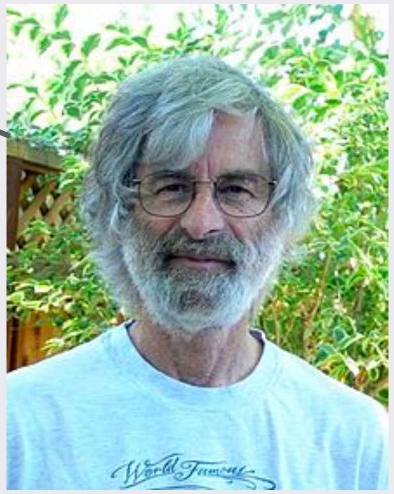
- It can't wait forever: that would violate liveness
- If it gives up on a process, but it turns out that process is just slow, that would violate safety

GETTING AROUND THE IMPOSSIBILITY RESULT OF FLP

You can't be both safe and live in the presence of asynchrony

The FLP result

Fine, then I'll just be safe! I will only be live when the network behaves synchronously



Enter Paxos


Paxos
Arkoudaki
Orkos
Lakos
Monodendri
Glyfada
Lakka
Loggos
Leverchio
Kipos
Marmari
Kipiadi
Gaios
Defteri
Ballos
Mogonisi
Ag Marina
Vrika
Voutoumi
Antipaxos

Abstract

The Paxos algorithm, when presented in plain English, is very simple.