

# CS4344

## Networked and Mobile Games

LECTURE



Introduction

# About CS4344

- To learn about technical issues and solutions in networked/mobile game development
- Complements CS4213 “Game Development”

**We are at the frontier of  
the topic**

**No perfect textbook for  
this class. But we will use**



# Networking and Online Games

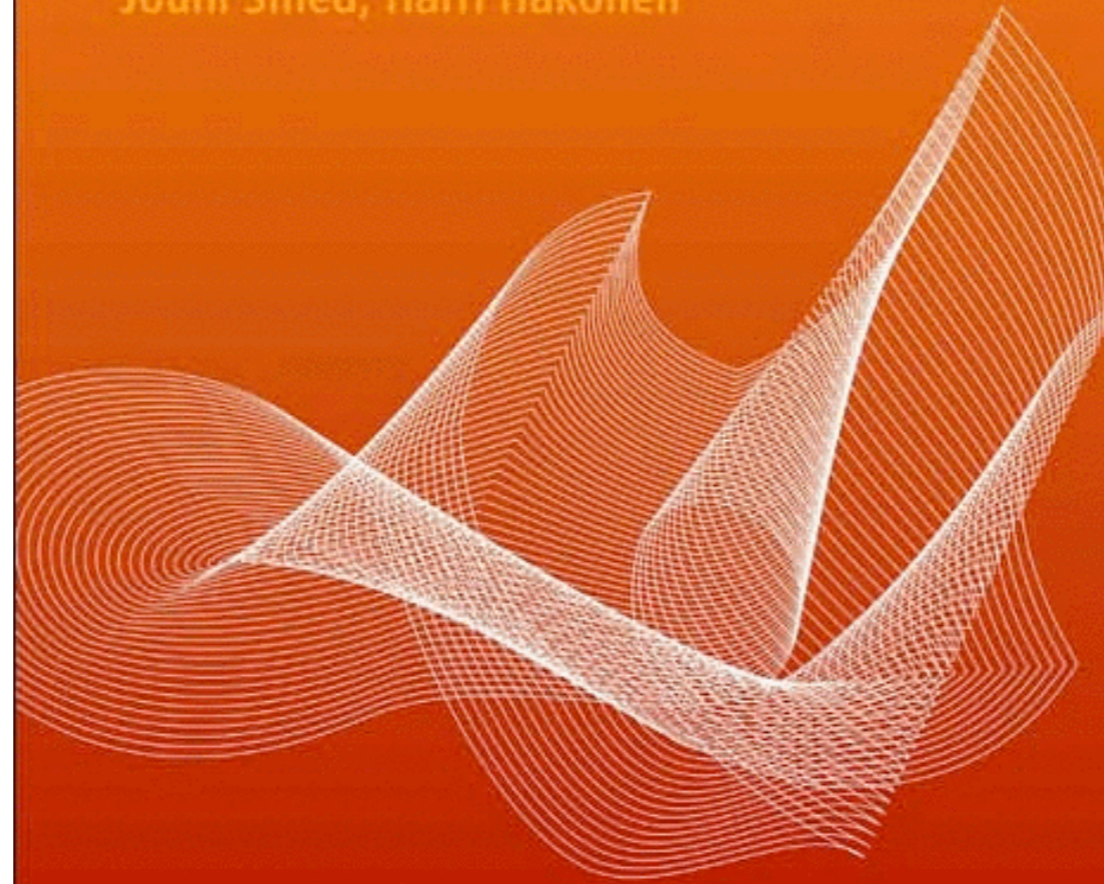
Understanding and Engineering  
Multiplayer Internet Games

Grenville Armitage  
Mark Claypool  
Philip Branch


 WILEY

# Algorithms and Networking for Computer Games

Jouni Smed, Harri Hakonen



 WILEY

 MITEA



[START OVER](#)[EXPORT](#)[LIMIT THIS SEARCH](#)[ANOTHER SEARCH](#)Record: [Prev](#) [Next](#)

Author [Armitage, Grenville.](#)  
 Title **Networking and online games : understanding and engineering multiplayer Internet games / Grenville Armitage, Mark Claypool, Philip Branch.**  
 Imprint Chichester, England ; Hoboken, NJ : John Wiley & Sons, c2006.

Click on the following to:

[View the electronic version \(full-text\) via Wiley-Interscience](#)

LOCATION	CALL #	STACK#	STATUS
<a href="#">CL Books</a>	<a href="#">QA76.76 Com.Ar 2006</a>		AVAILABLE

Descrip. ix, 218 p. : ill. ; 25 cm.  
 Bibliog. Includes bibliographical references and index.  
 Note Online version restricted to NUS staff and students only through NUSNET.  
 Also available in online version.  
 Subject [Computer games -- Programming.](#)  
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[TCP/IP \(Computer network protocol\)](#)  
[Internet games.](#)  
 Add corp aut [Wiley InterScience \(Online service\)](#)  
 Add author [Claypool, Mark.](#)  
               [Branch, Philip.](#)  
 Add title [Understanding and engineering multiplayer Internet games](#)  
               [Networking and online games \[electronic resource\]](#)

**Additional materials comes  
from online resources and  
research papers.**

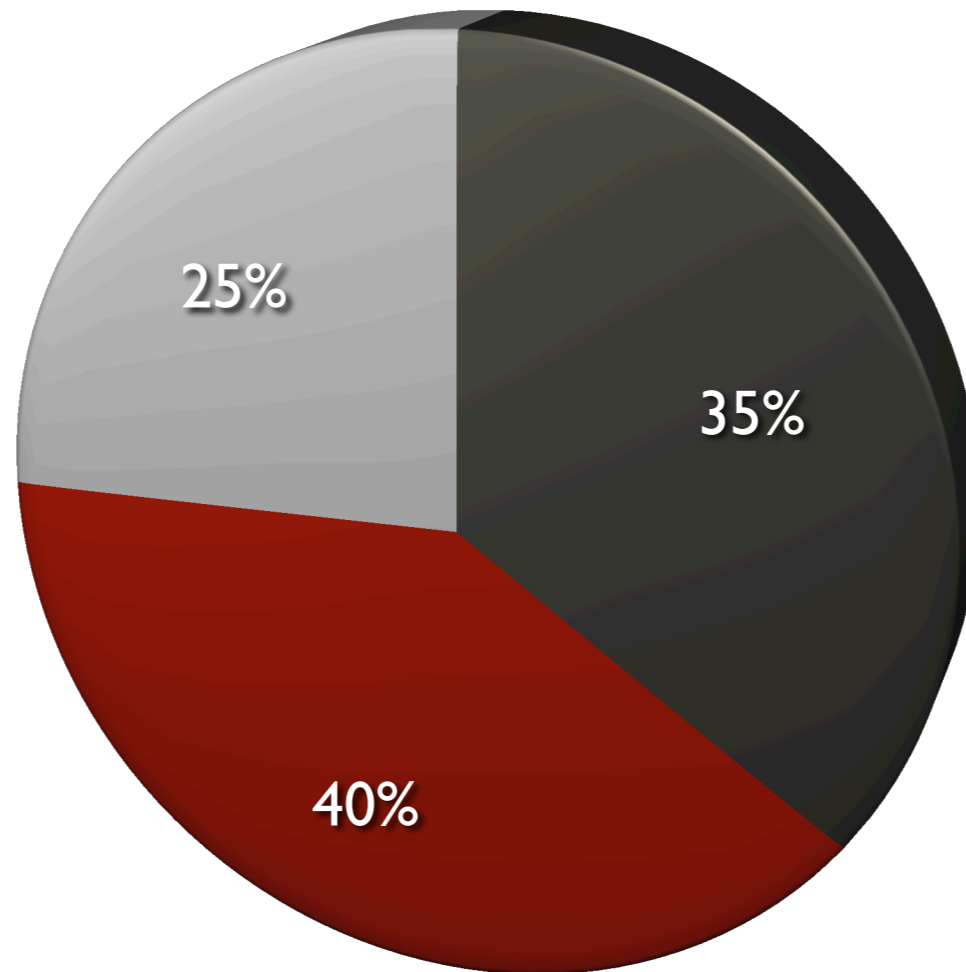
**“We don’t know what we  
are doing. That’s why it’s  
research”**

**So, don't swallow everything  
you read (and I say) without  
thinking.**

**I am learning about  
the area myself.**

# CS4344 Assessment

● Final Exam    ● Assignments    ● Quizzes/Midterm





# CS4344: Networked and Mobile Games

SEMESTER 1, 2007/08

About  
Reading List  
Assignments

## Calendar

**13 Aug:** first lecture  
**24 Sep:** no class (recess)  
**26 Nov:** final exam

### Aug 07

S	M	Tu	W	Th	F	S
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	1

### Sep 07

2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

## Archive

2006/7 Semester 1

## About CS4344

- **Who:** Ooi Wei Tsang (ooiwt)
- **Where:** SR2 (COM1 #02-04)
- **When:** Mon 1000-1200
- **Workload:** Lecture (2hr) Preparation (6hr) Homework (2hr) per week
- **CA:** Open Book Exam (35%) Assignments (40%) Quizzes/Midterm (25%)
- **Objective:** This module aims at providing students a deep understanding of various technical issues pertaining to the development of networked games and mobile games. Students will be exposed to concepts from distributed systems, operating systems, security and cryptography, networking and embedded systems. In particular, issues such as game server architectures (mirrored, centralised, peer-to-peer etc.), consistency management (bucket synchronisation, dead reckoning etc.), interest management, scalability to large number of clients (C10K problem), cheat prevention and detection, power management, will be discussed.

## Topics

- Communication architecture of networked games
- Synchronization protocols/consistency maintenance
- Interest management
- Scalability issues
- Cheat prevention and detection.
- Case studies

## Related Courses (Elsewhere)

- **COMP 521 Modern Computer Games** at McGill University
- **CSC337 Computer Games Development** at Newcastle University
- **CS5961 Networked Game Design** at University of Utah
- **CS679 Computer Game Technology** at University of Wisconsin

<http://www.comp.nus.edu.sg/~cs4344>

- **TKO 2252 Multimedia Computer Games** at University of Turku, Finland
- **CS638 Computer Game Technology** at University of Wisconsin
- **CS228E Networked Game Design** at University of Utah
- **CSC337 Computer Games Development** at Newcastle University

**Questions?**



**“Networked Games” ?**

**Games that involve more  
than one hosts  
communicating over the  
network**

## INTERACTIVE SUDOKU

# sudoku

07 31 ||

No 27 Tuesday, August 7th 2007

EASY

		9			8		4	
8			4			9		
	3	1			6	8		5
2		7	1		9	4	3	8
				5		2	7	1
	4		7		2	5	6	9
5		3	6			7	8	
		4			3			6
	7		8			1		

### ONLINE COMPETITION

Play Sudoku to win a laptop from **TOSHIBA**



### Today's Sudoku

Mon Aug 6  
Terms & Conditions

### ARCHIVE

#### EASY

Mon Aug 6  
Mon Jul 30  
Mon Jul 23

#### MILD

Tue Aug 7  
Wed Aug 1  
Tue Jul 31

#### DIFFICULT

Mon Aug 6  
Sat Aug 4  
Fri Aug 3

#### FIENDISH

Sun Aug 5  
Thu Aug 2  
Wed Aug 1

#### SUPER FIENDISH

Sun Aug 5  
Fri Aug 3  
Sun Jul 29

Submit

Print

Reset

Help



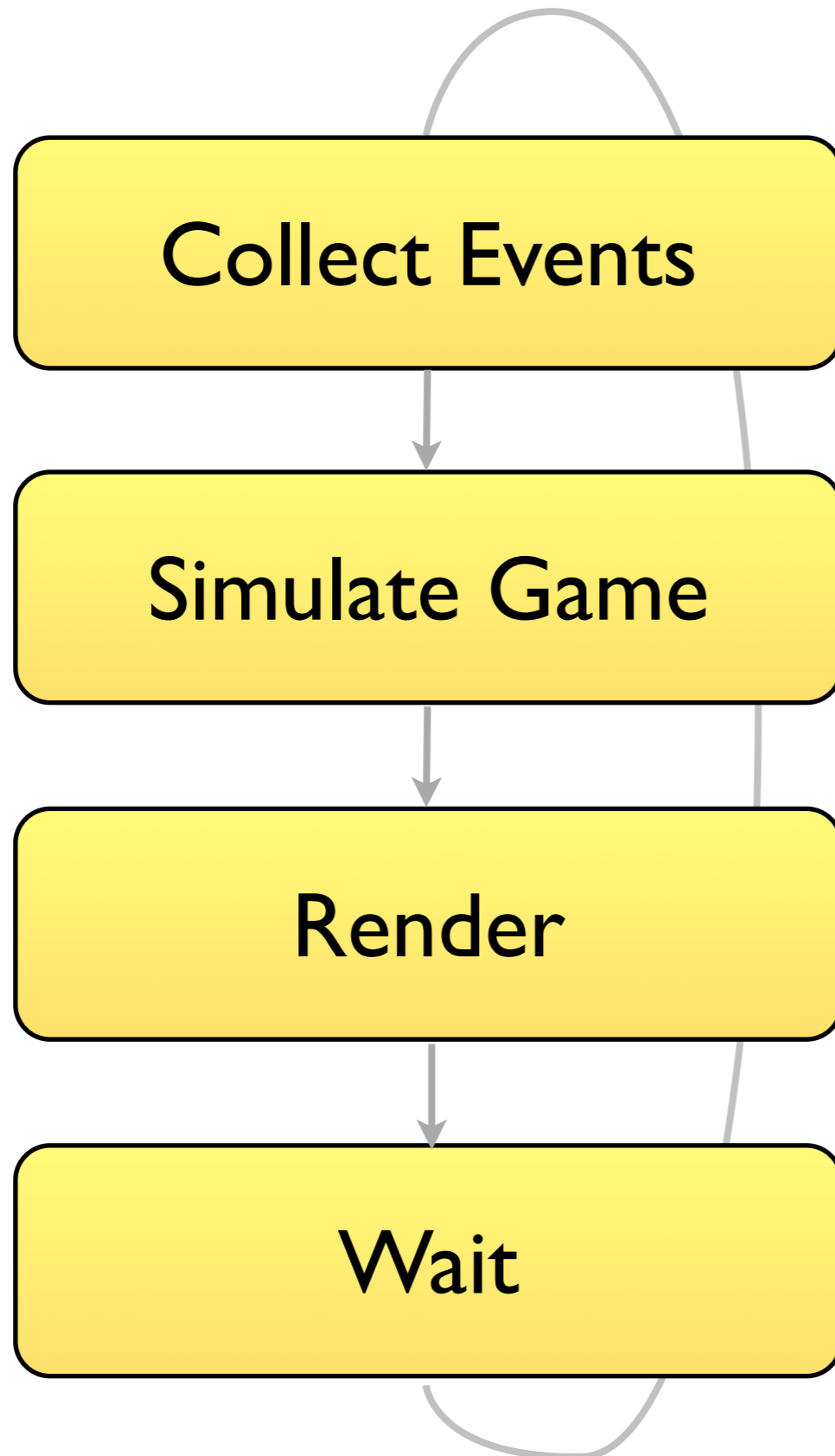
Games that involve more  
than one **player**  
communicating over the  
**Internet/LAN**

**We focus on real-time  
multi-player games in  
CS4344**

**and other similar  
applications**

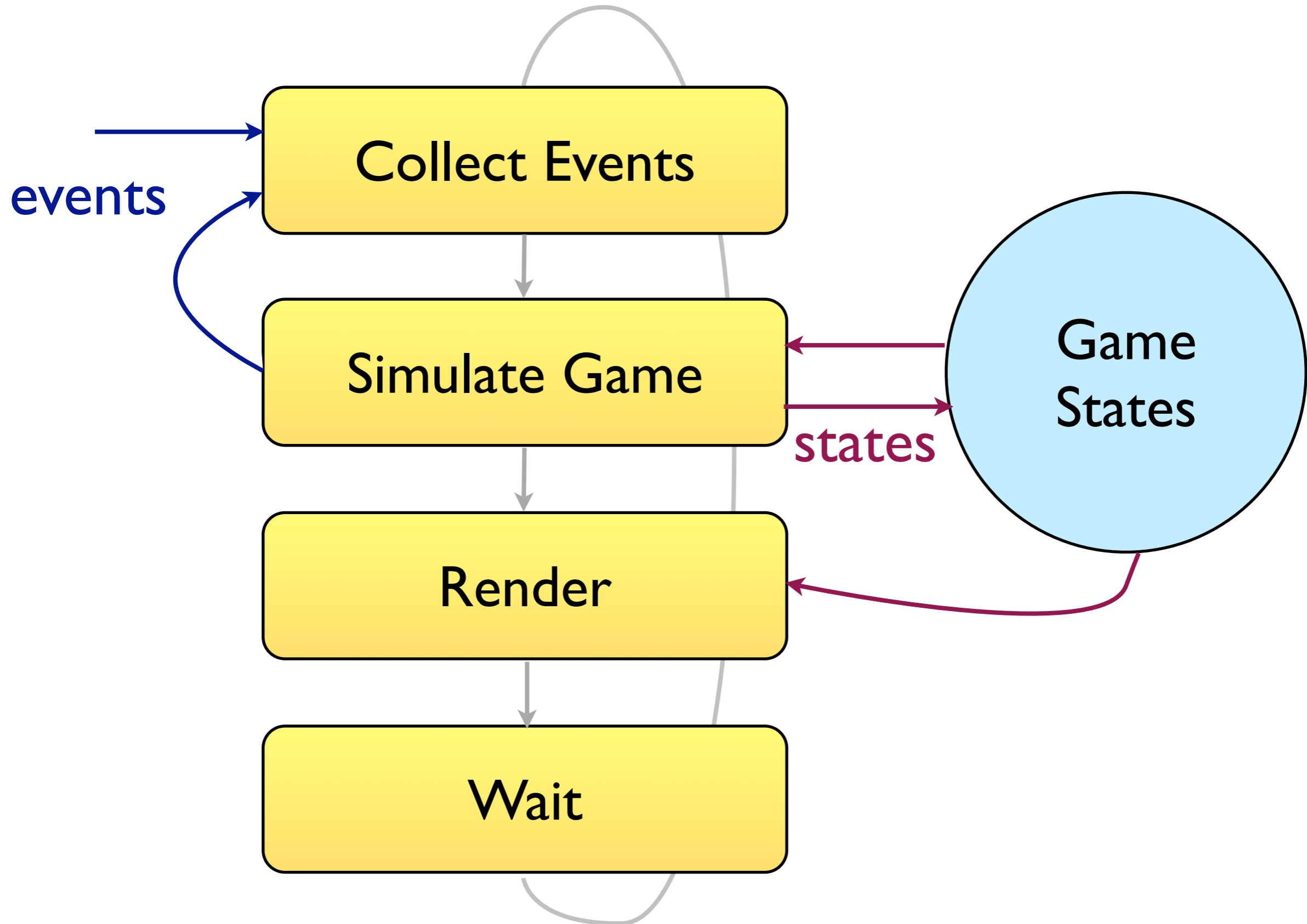
# An Abstract Model for Networked Games

# A generic loop for games

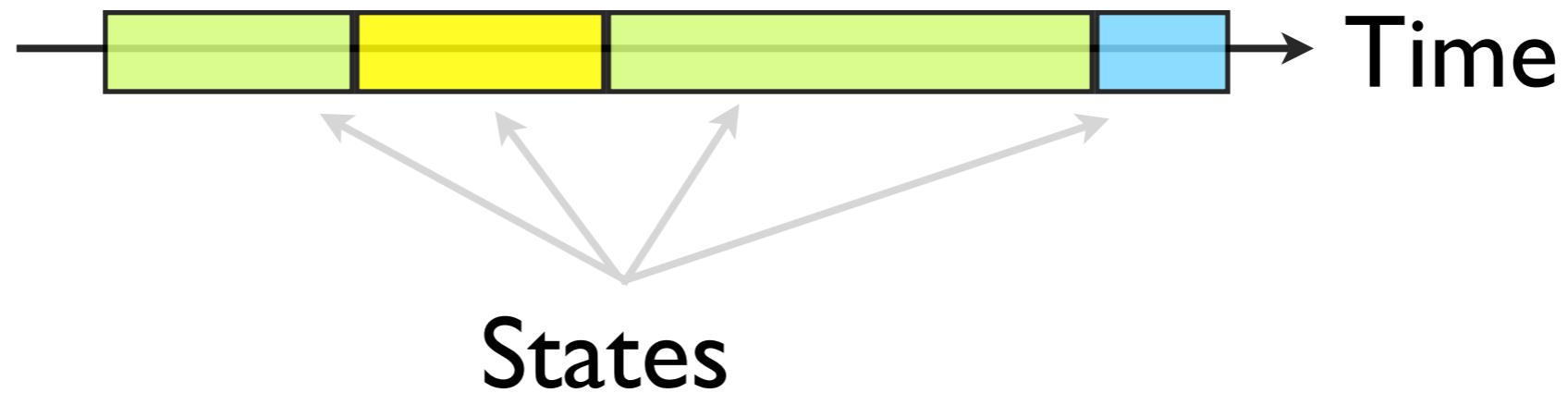




# A generic loop for games



Can be viewed as a sequence of states that changes over time, in reaction to events.

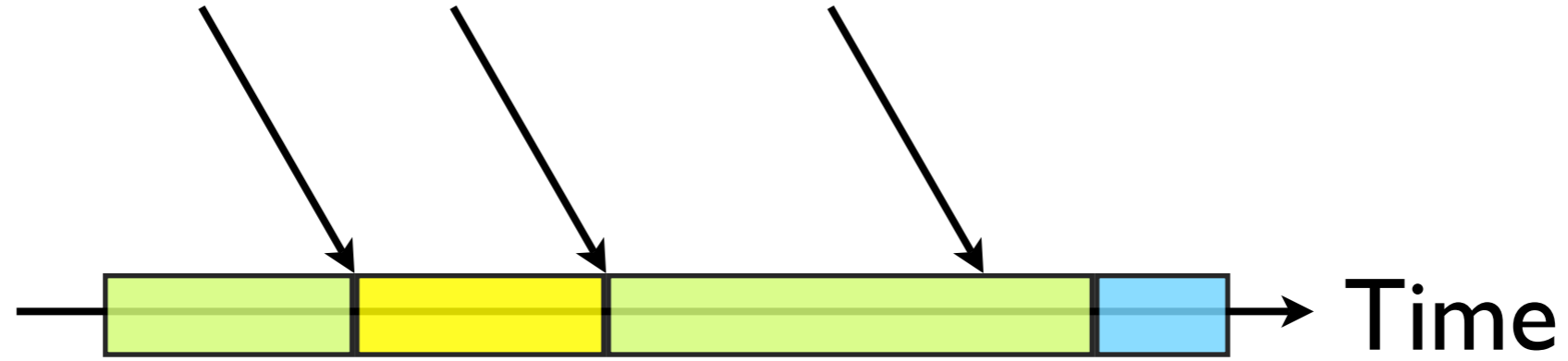


A state can be discrete or continuous.

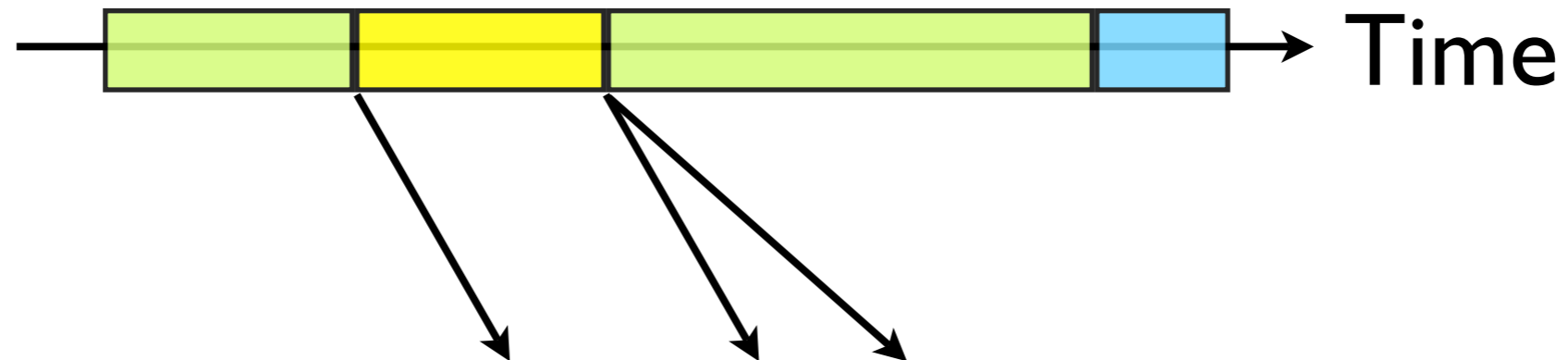


State changes over time

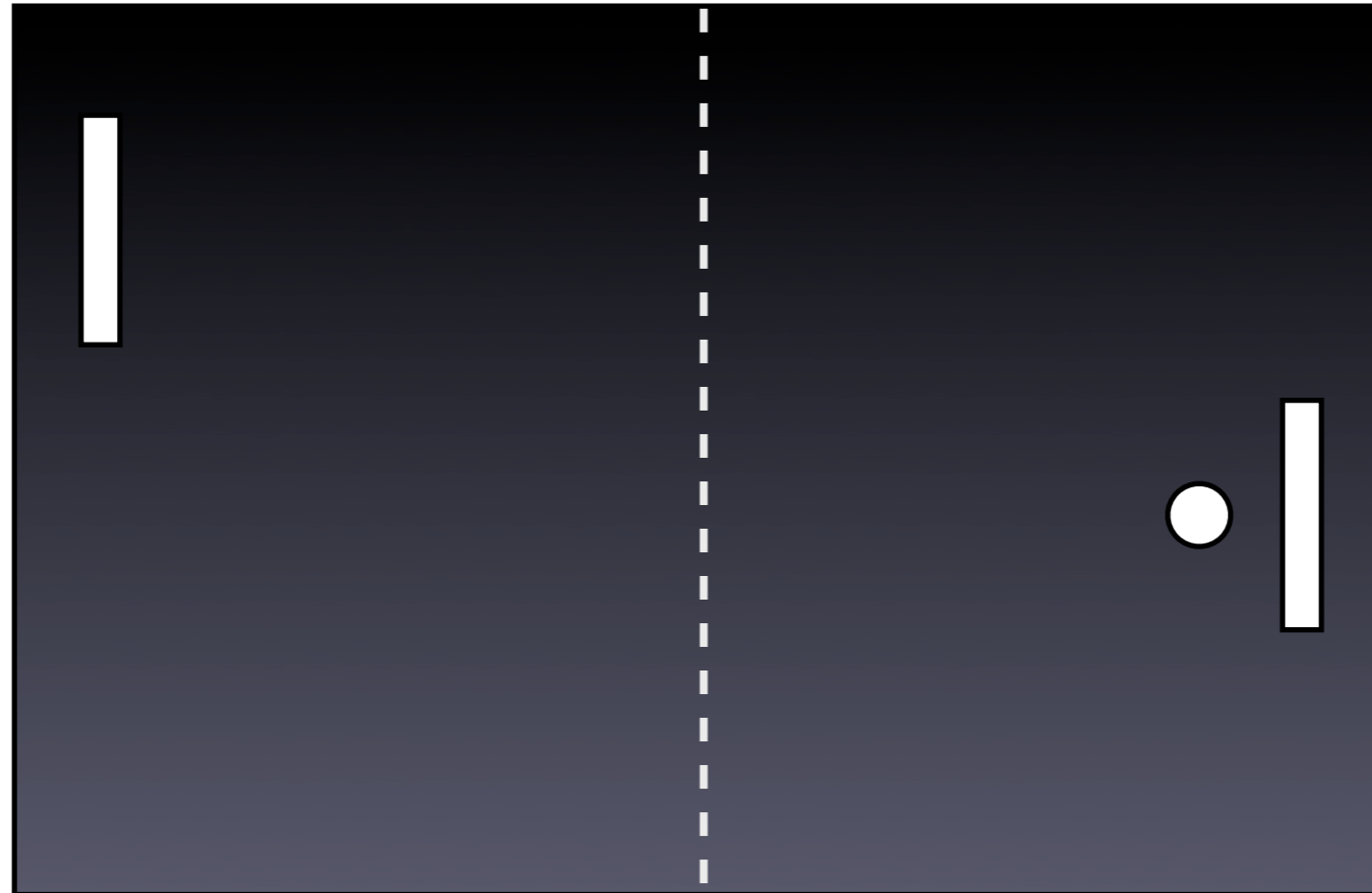
Example events: user input, timer, messages from other hosts.



A host may send messages to other hosts.  
Message can be state or event.



# Example: Two-player Pong



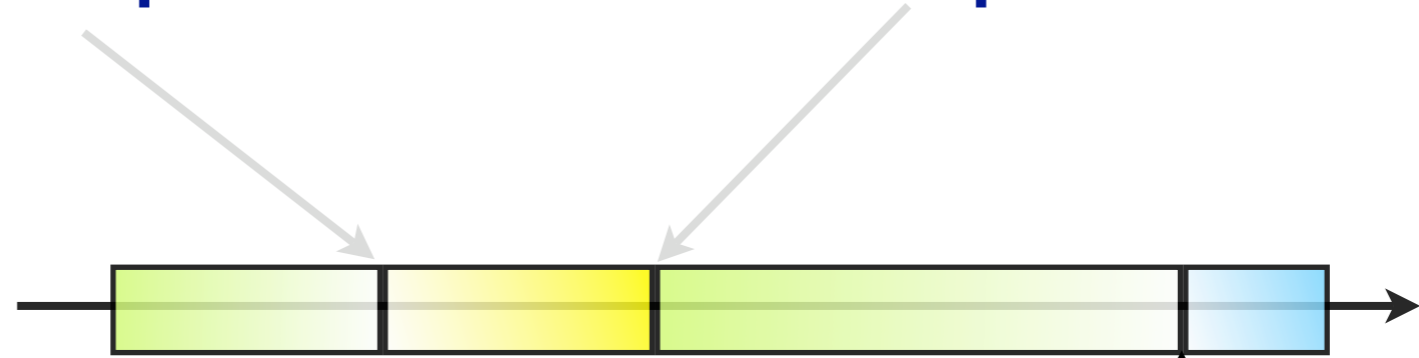
**States:** position of peddles and ball

**Events:** movement

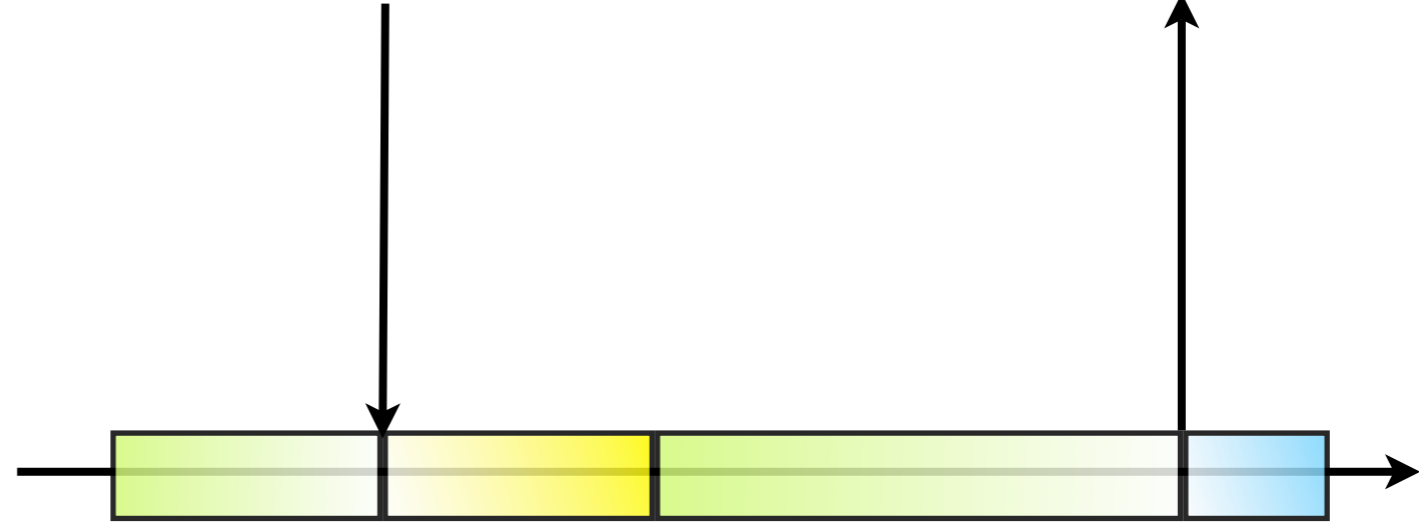
A moves peddle

Ball hits peddle

Player A



Player B

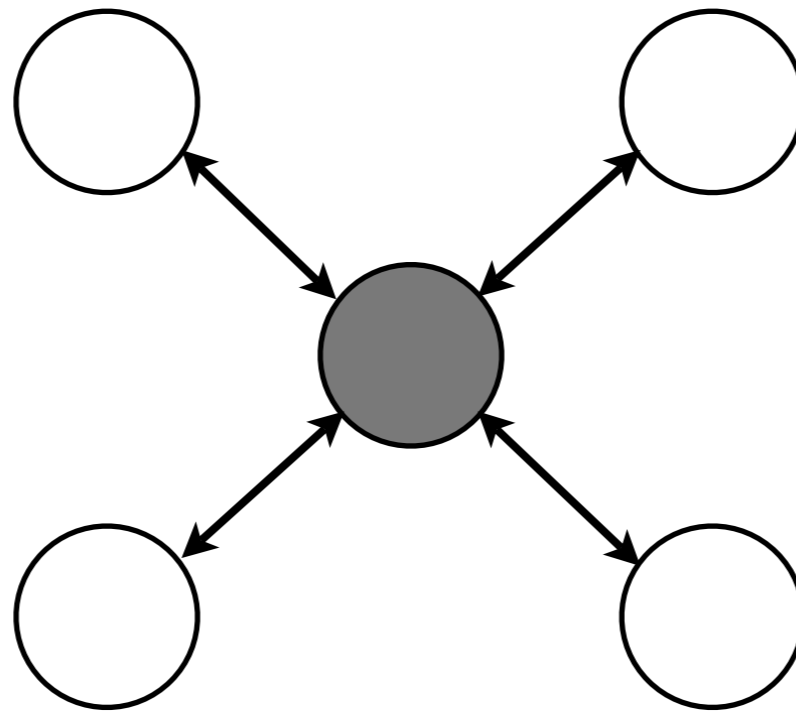


B moves peddle

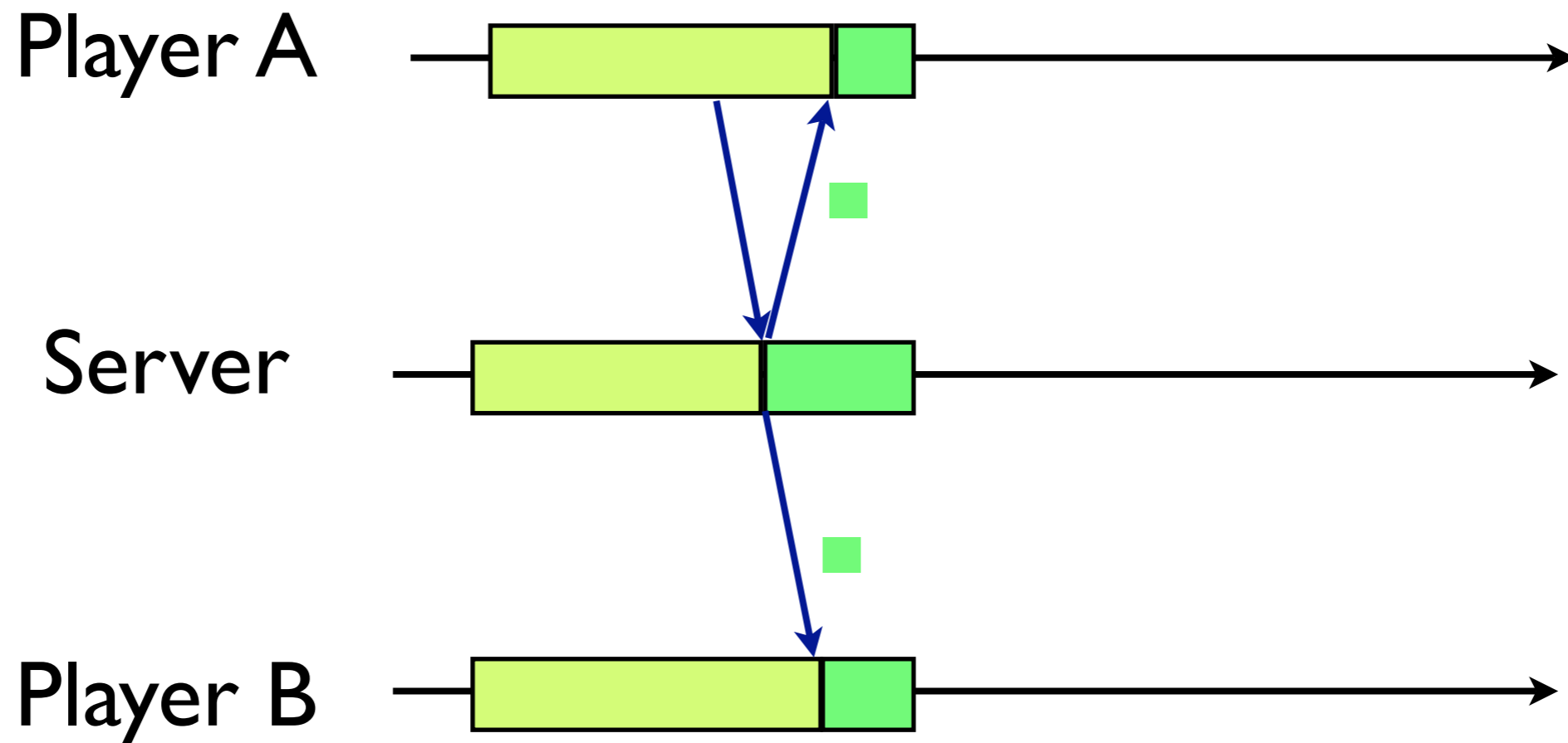
# Basic Communication Architectures



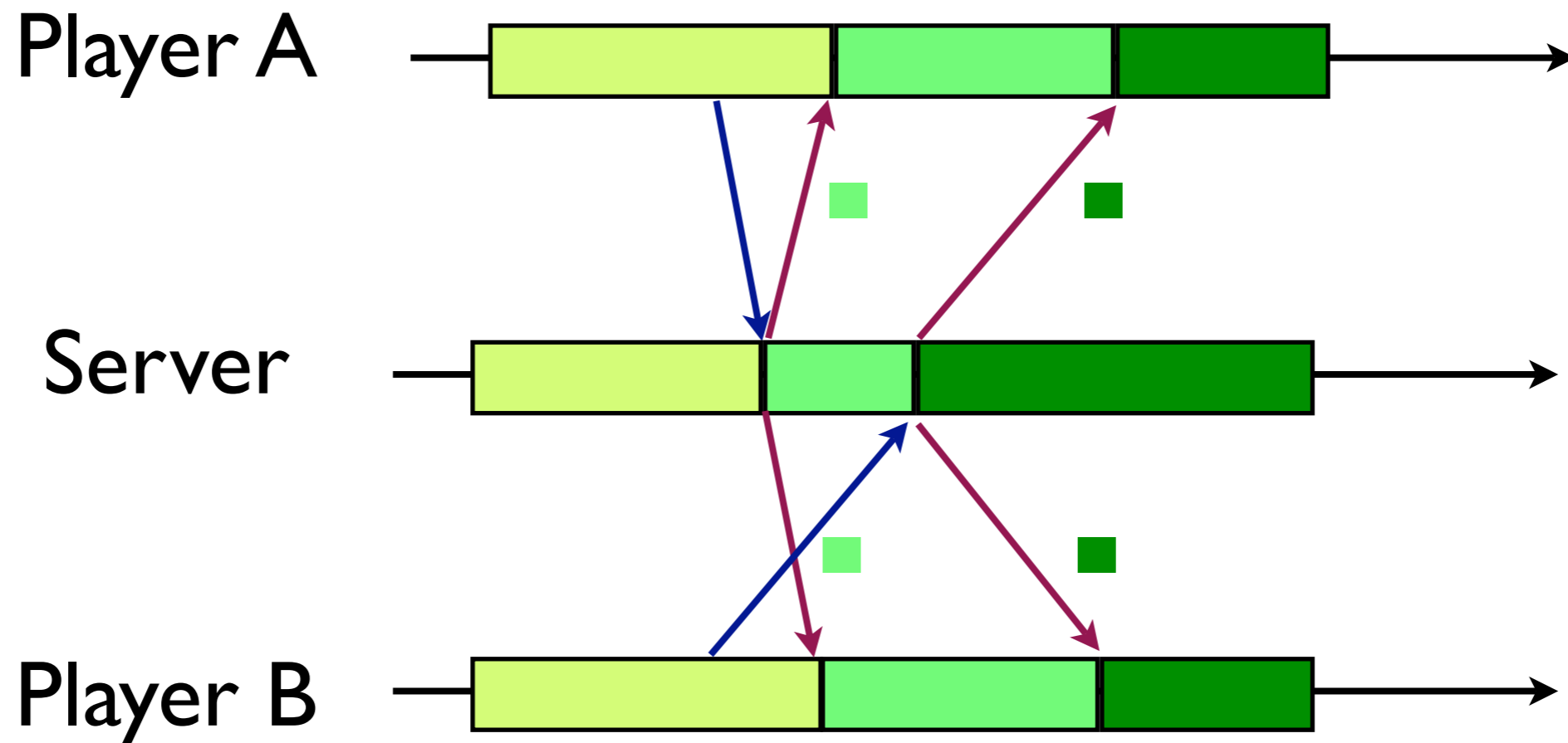
# Centralized Architecture

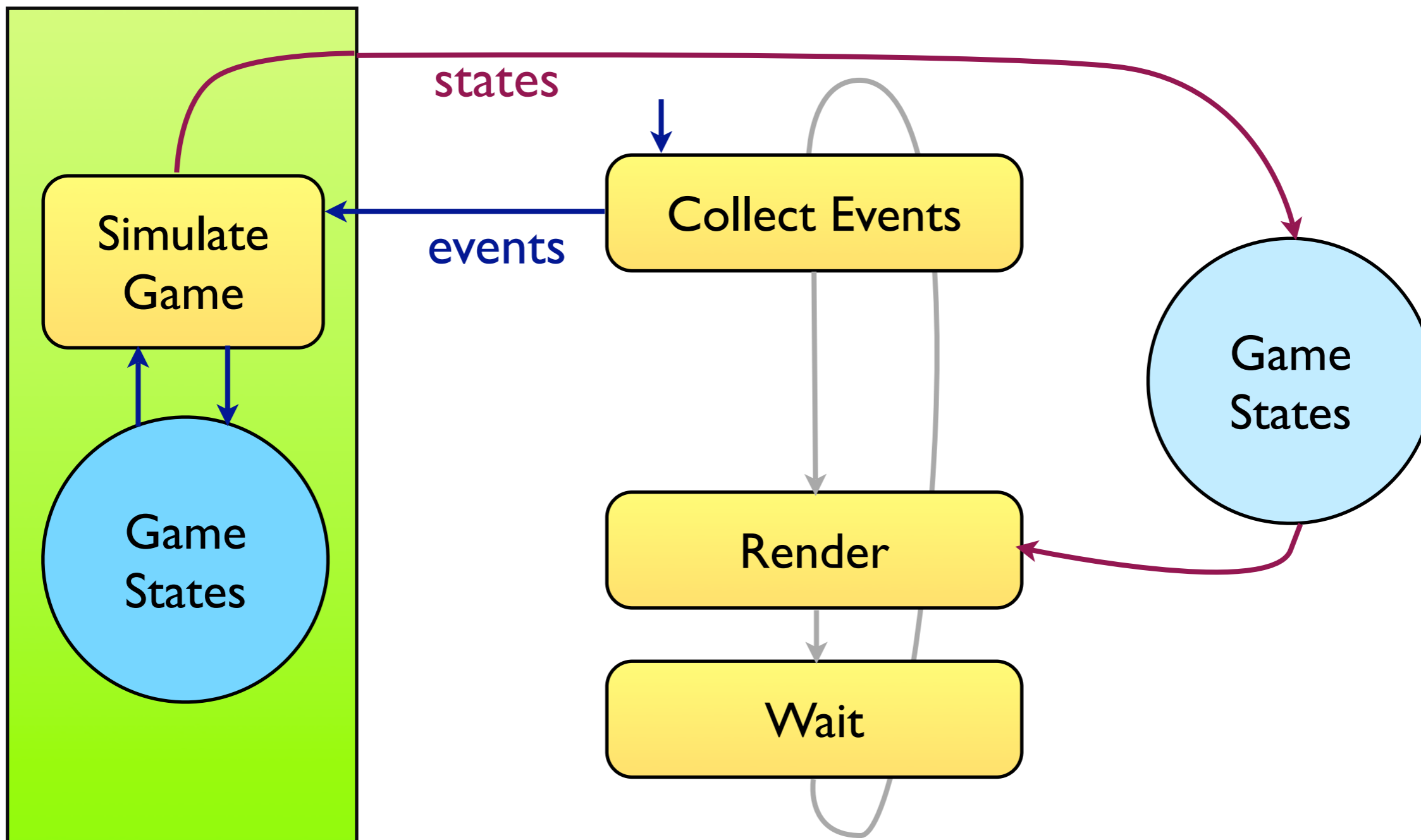


Client sends events to the server. Server computes new states and updates clients with new states.

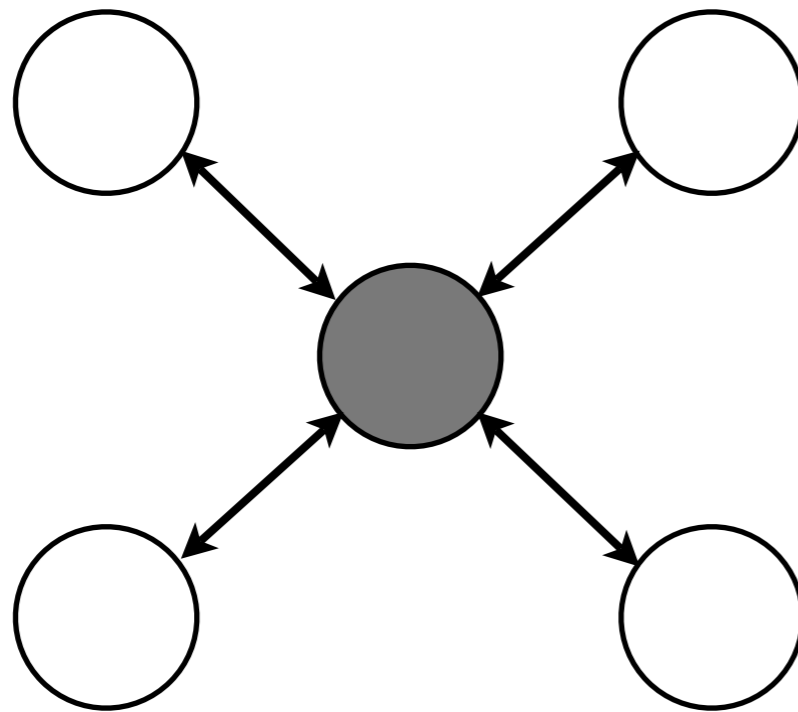


Client sends events to the server. Server computes new states and updates clients with new states.





# “Smart” server, dumb clients



## **Role of server**

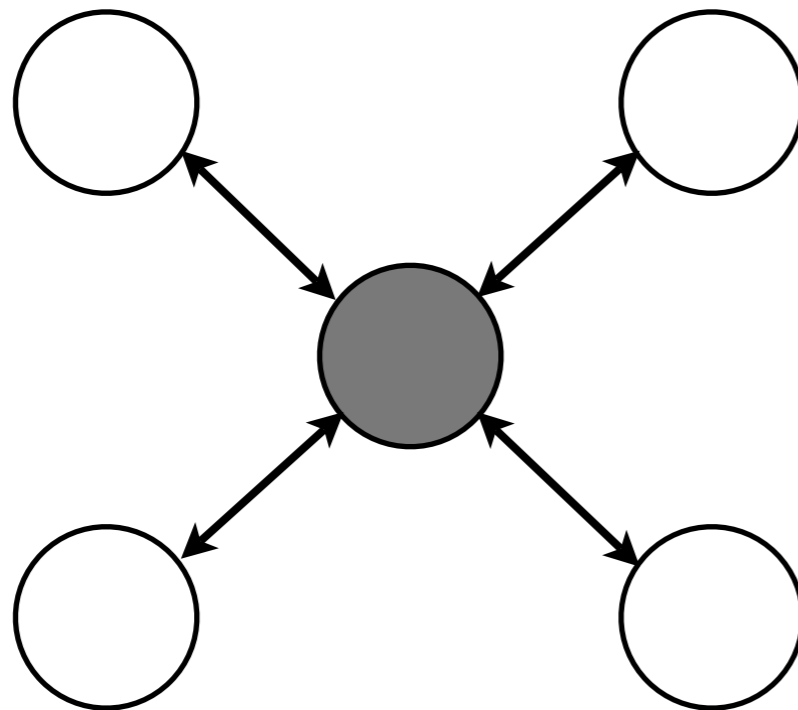
Maintain states

Simulate games

Notify clients

Resolve conflicts

# Dumb server, smart clients



## **Role of server**

Notify clients

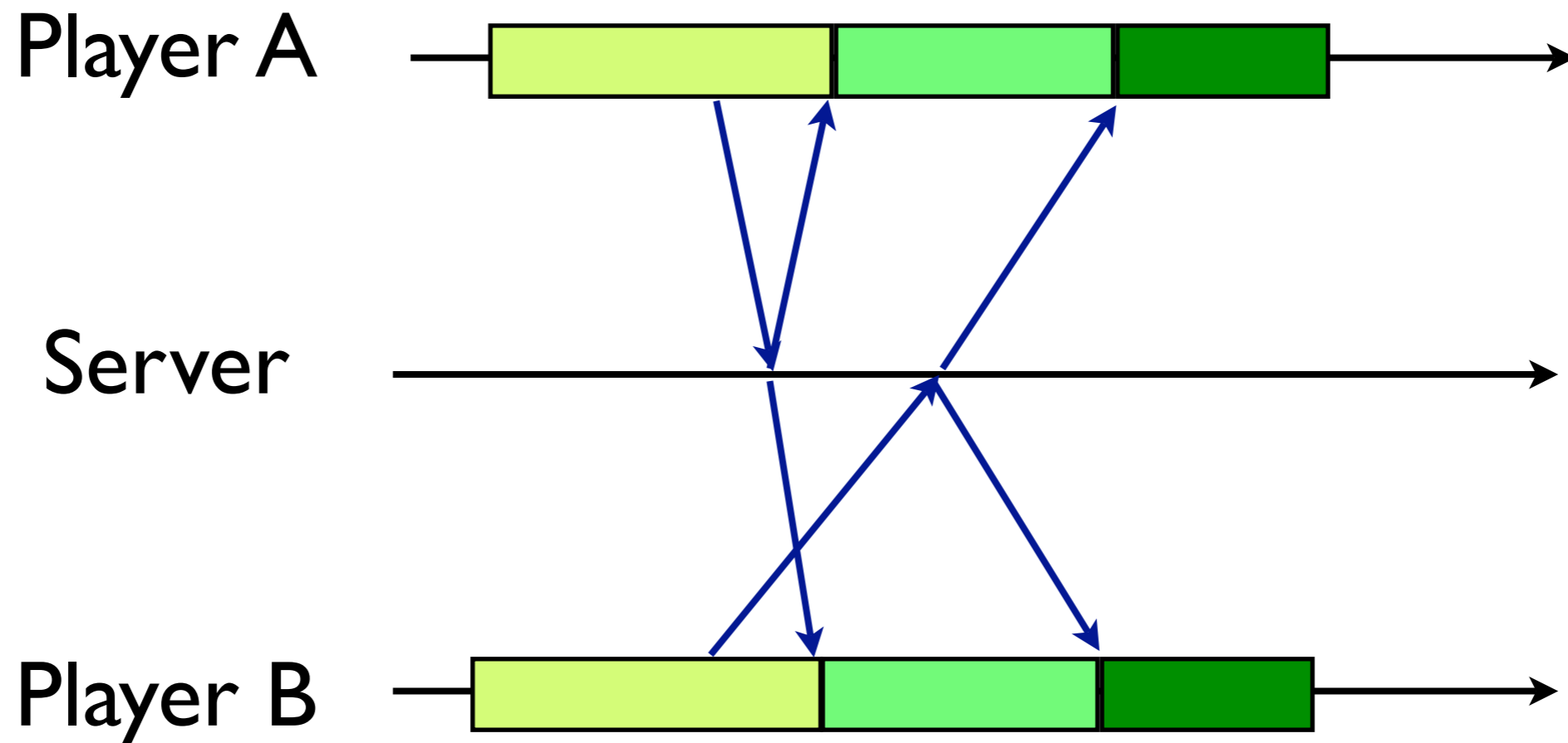
Resolve conflicts

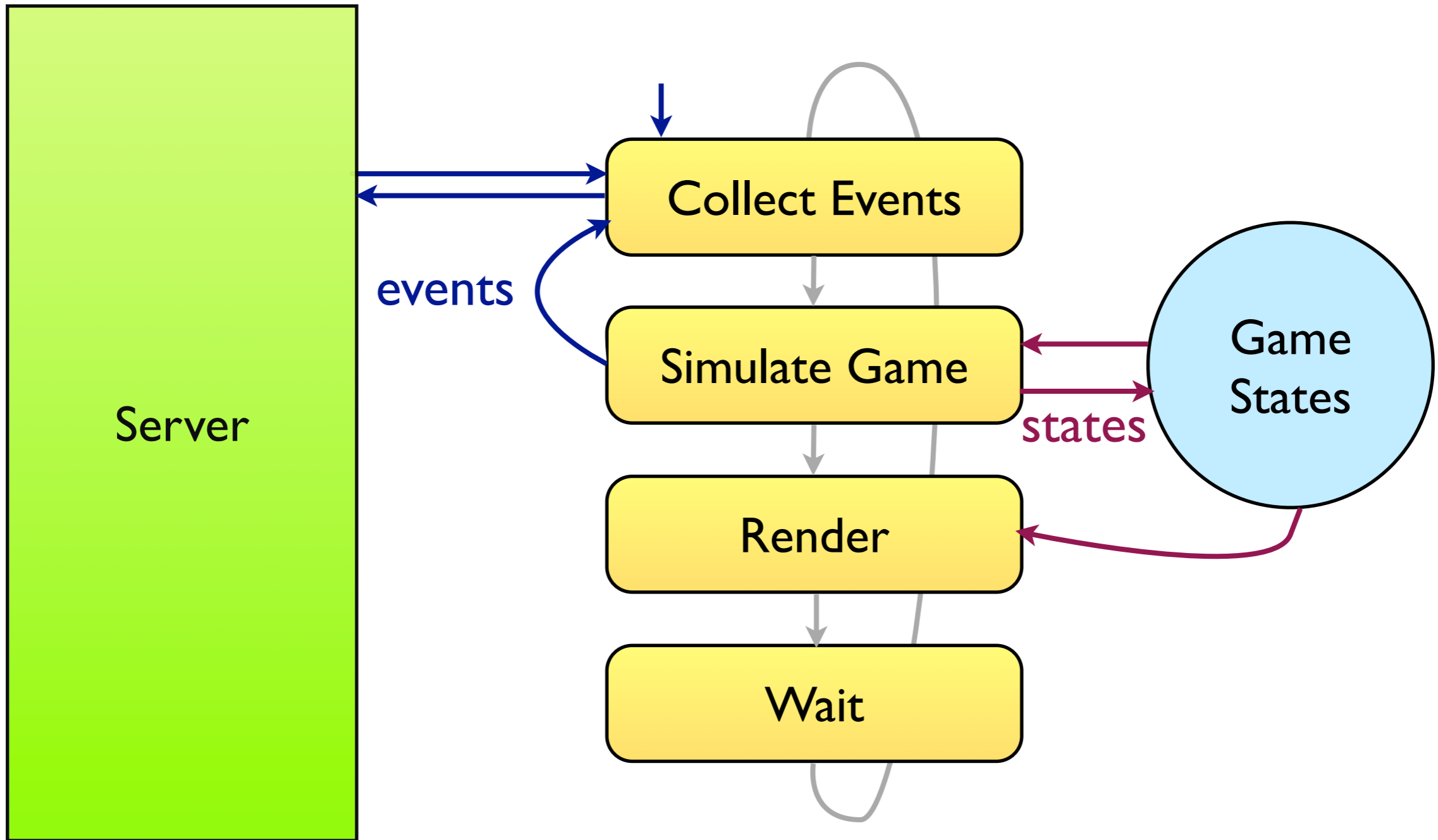
## **Role of clients**

Maintain states

Simulate games

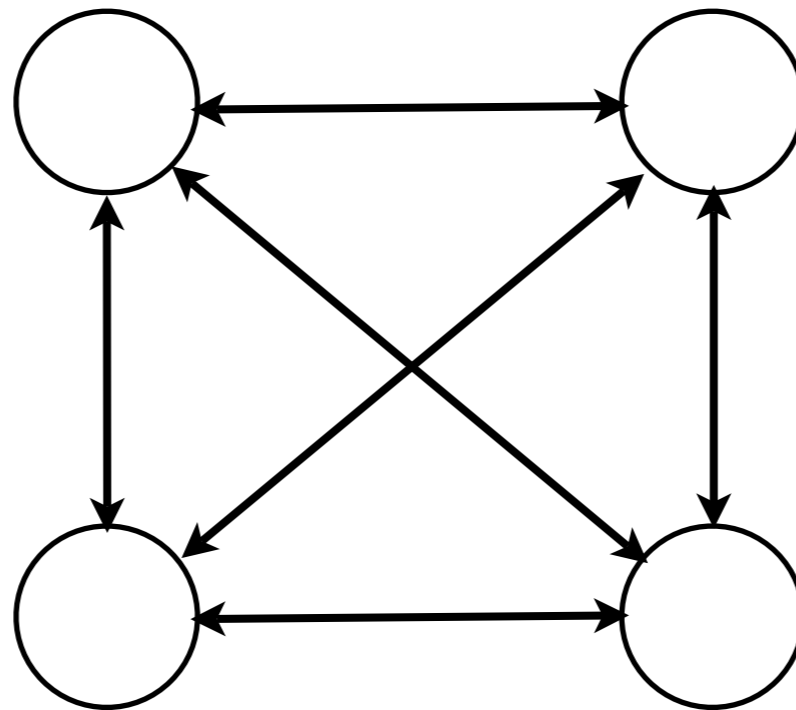
Clients simulate and maintain states. Server resolves conflicts and forwards events to clients.



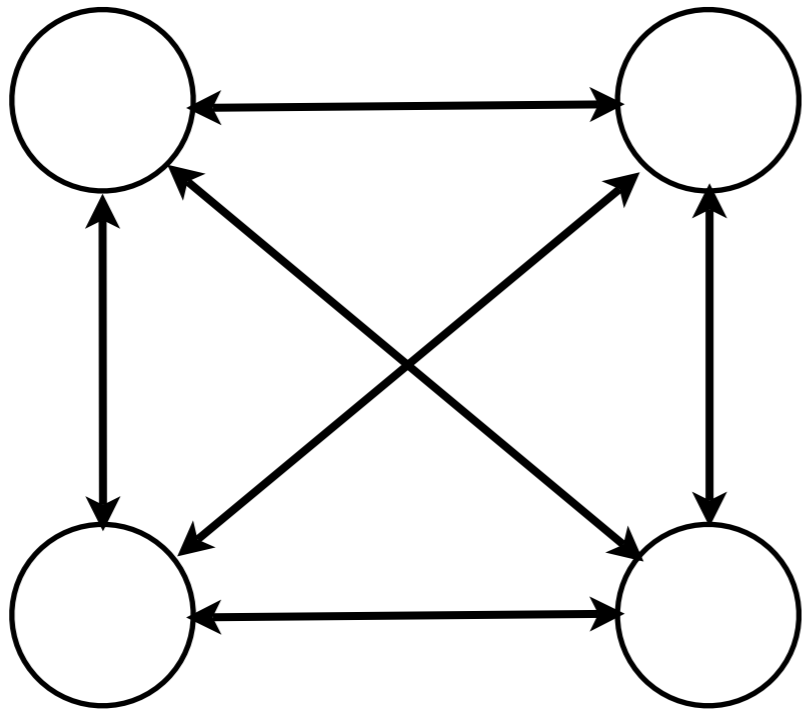




# Point-to-Point Architecture



# Point-to-Point Architecture



## **Role of clients**

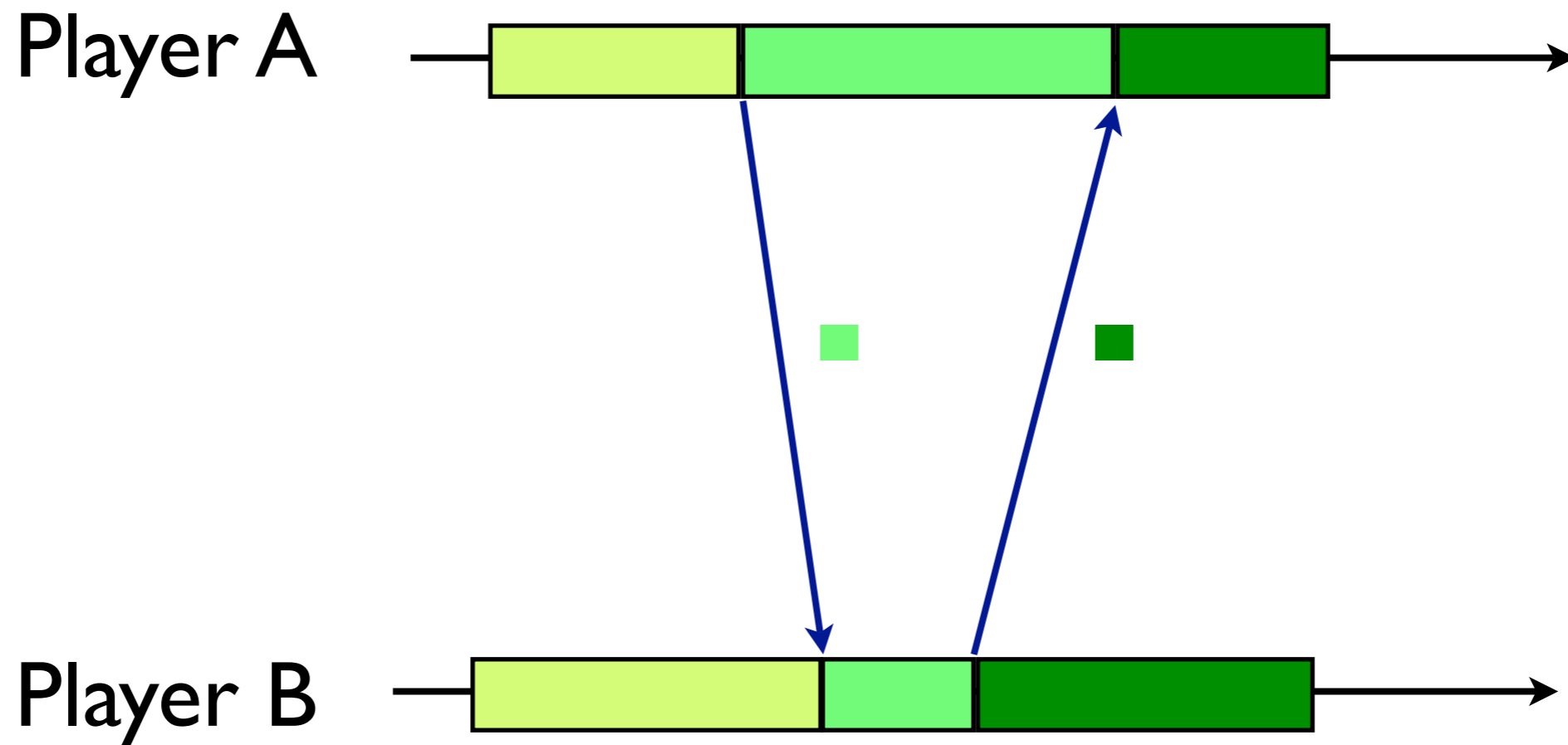
Notify clients

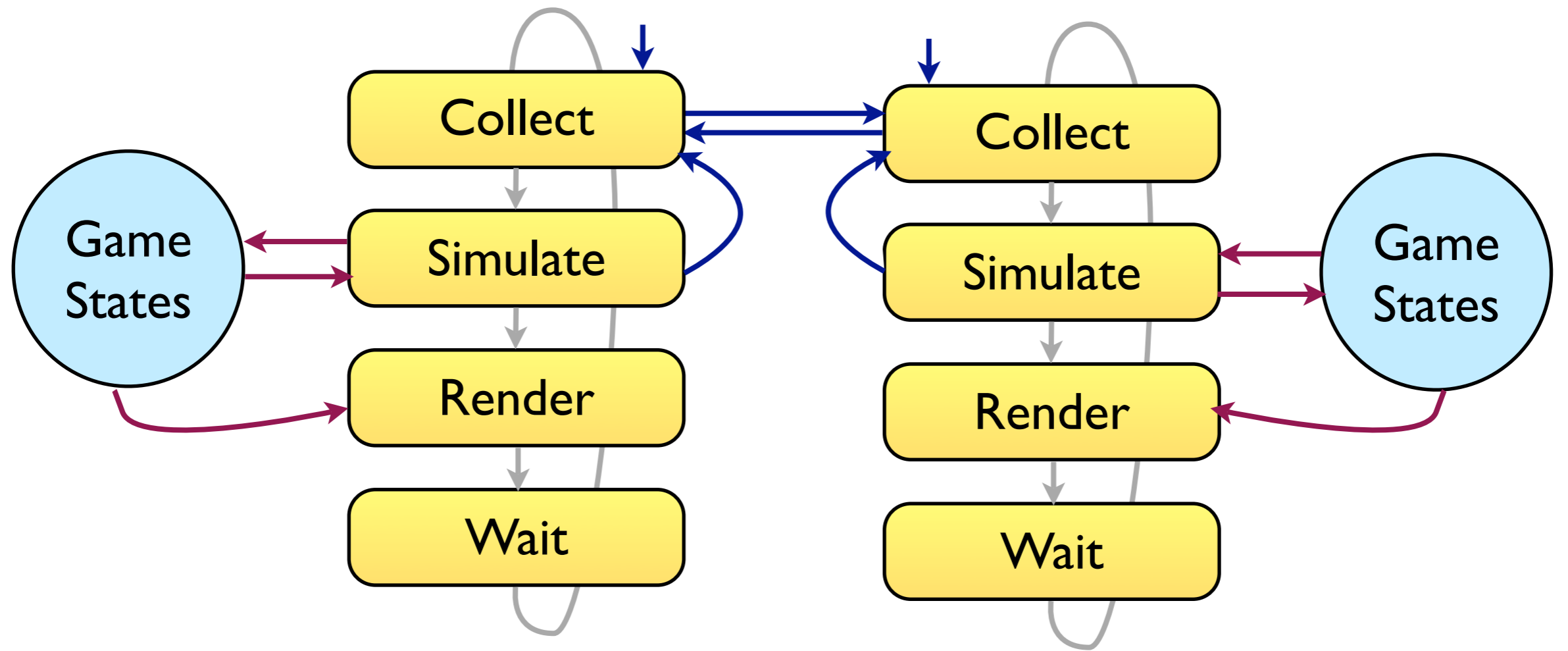
Resolve conflicts

Maintain states

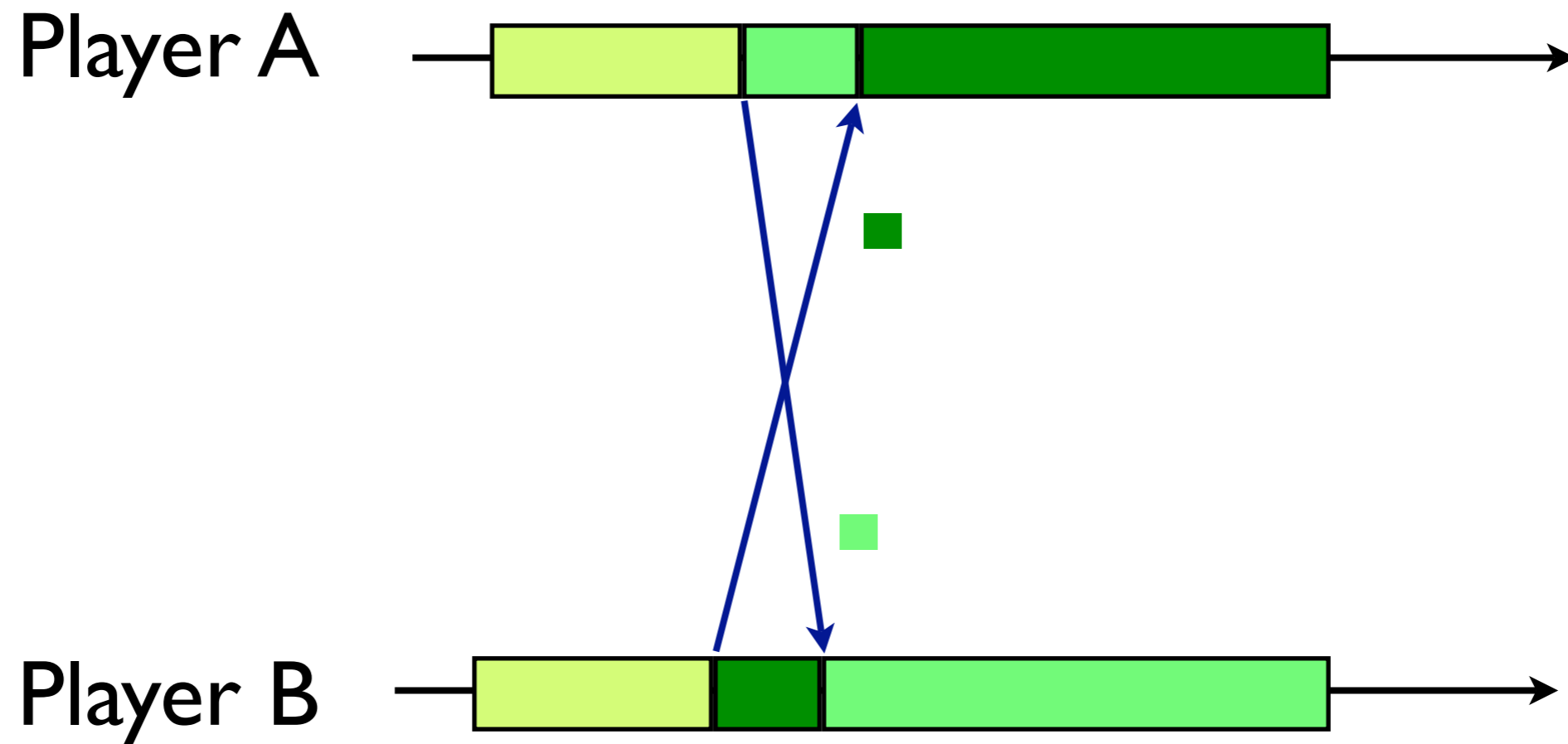
Simulate games

Clients simulate the game, maintain states, and forward message to each other.

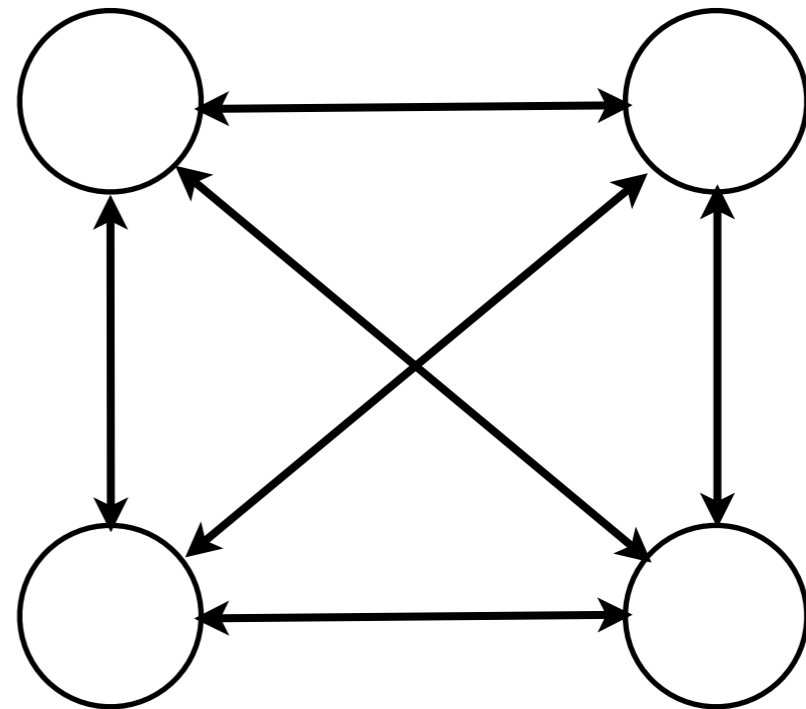
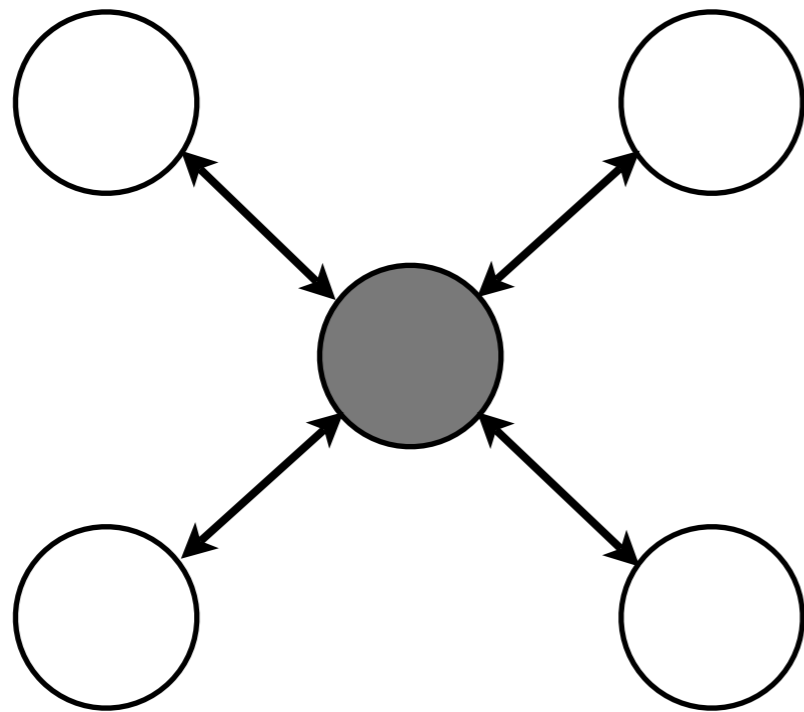




Maintaining consistency is not trivial.



# Centralized vs. Distributed



# Design Requirements

# Responsive

(reacts to player's action)



# Consistent

(players have the same view of  
the game state)

# Cheat Proof

(player cannot cheat)

# Fair

(should be fair to all players)

# Resource Efficient

(minimal amount of network traffic, CPU cycles, memory)

# Scalable

(able to handle large number  
of players)

# Robust

(able to handle failure  
gracefully)

# Simple

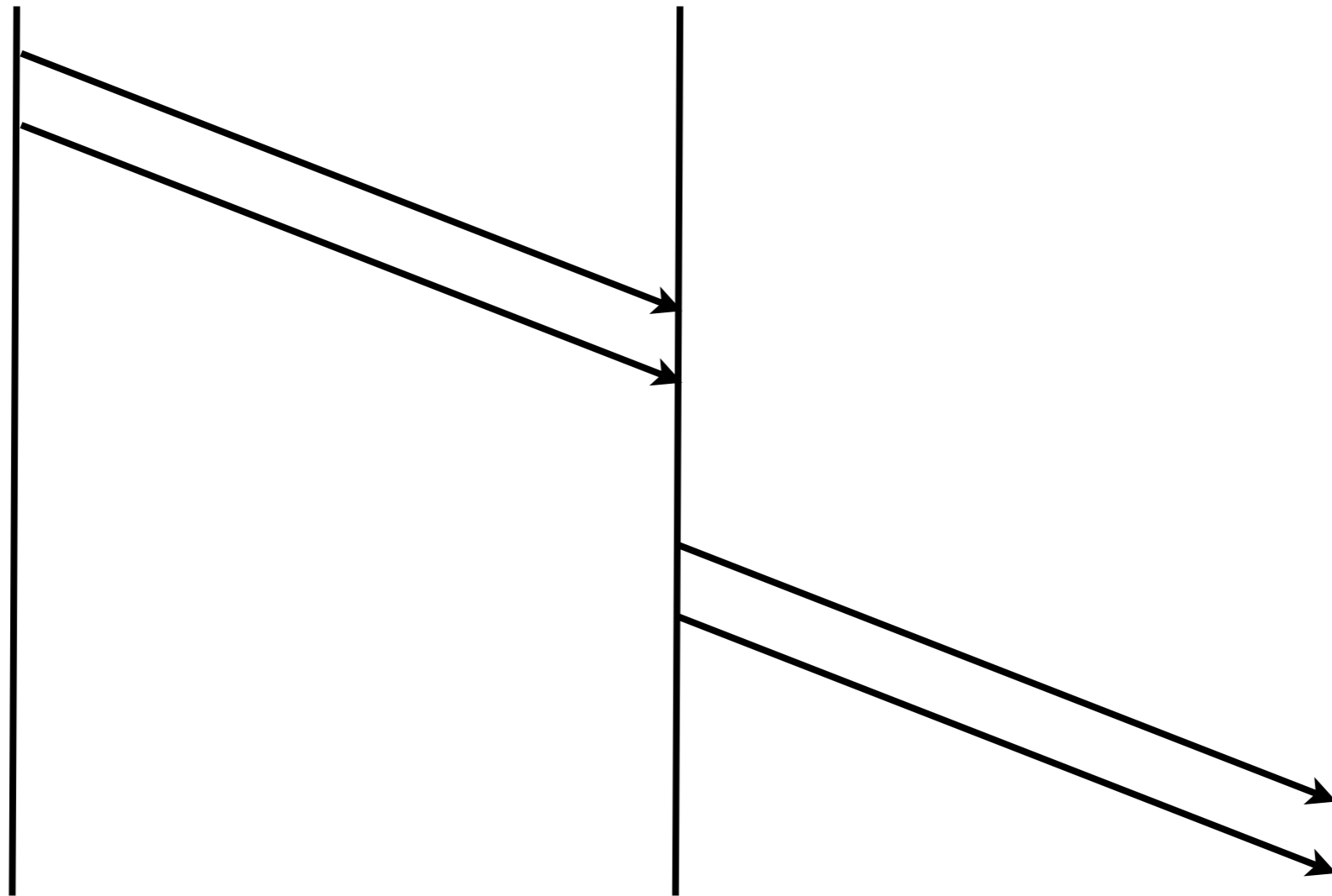
(easy to implement/maintain)

**Why Difficult?**

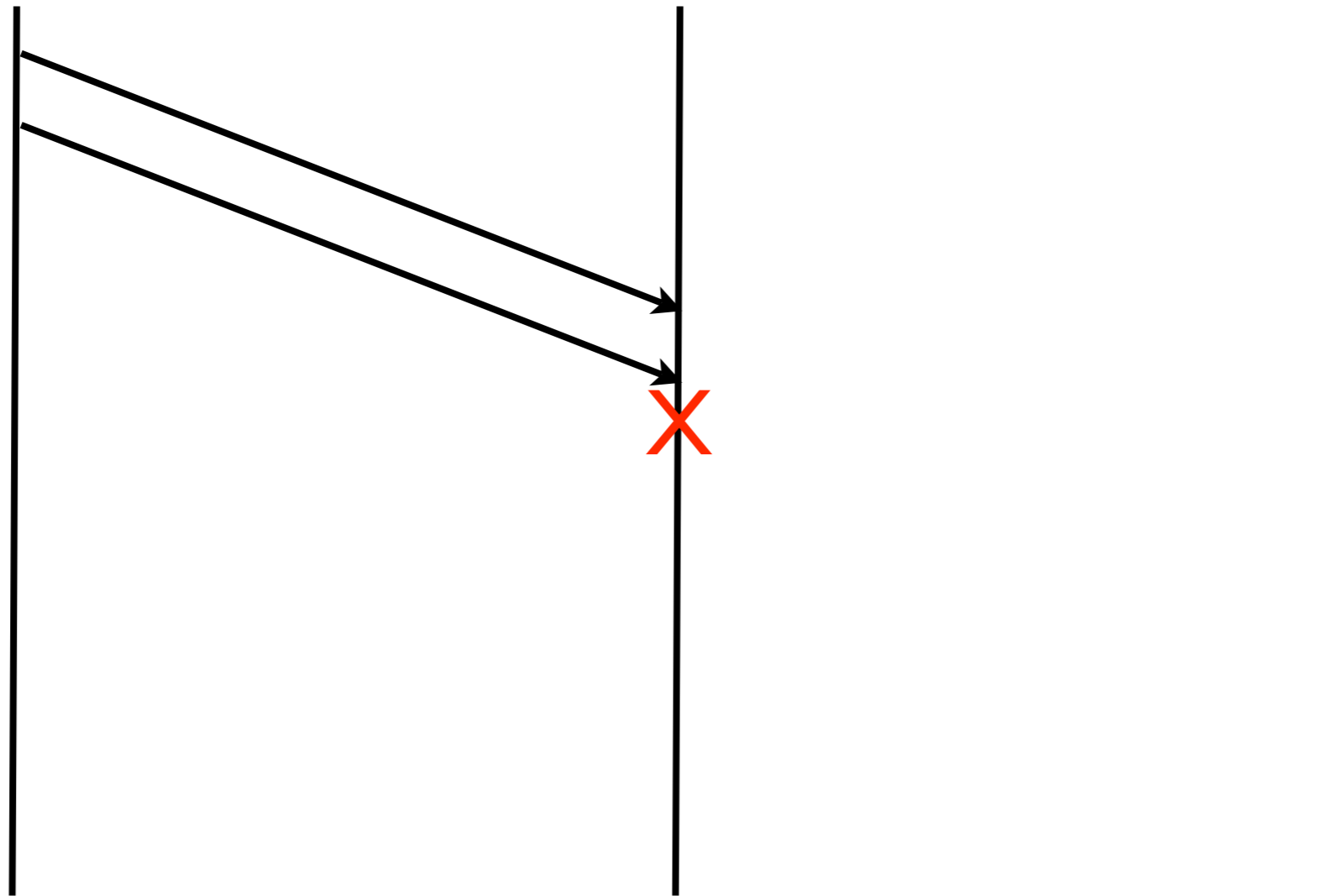


**Internet is a  
best-effort network**

Packets take time to travel.



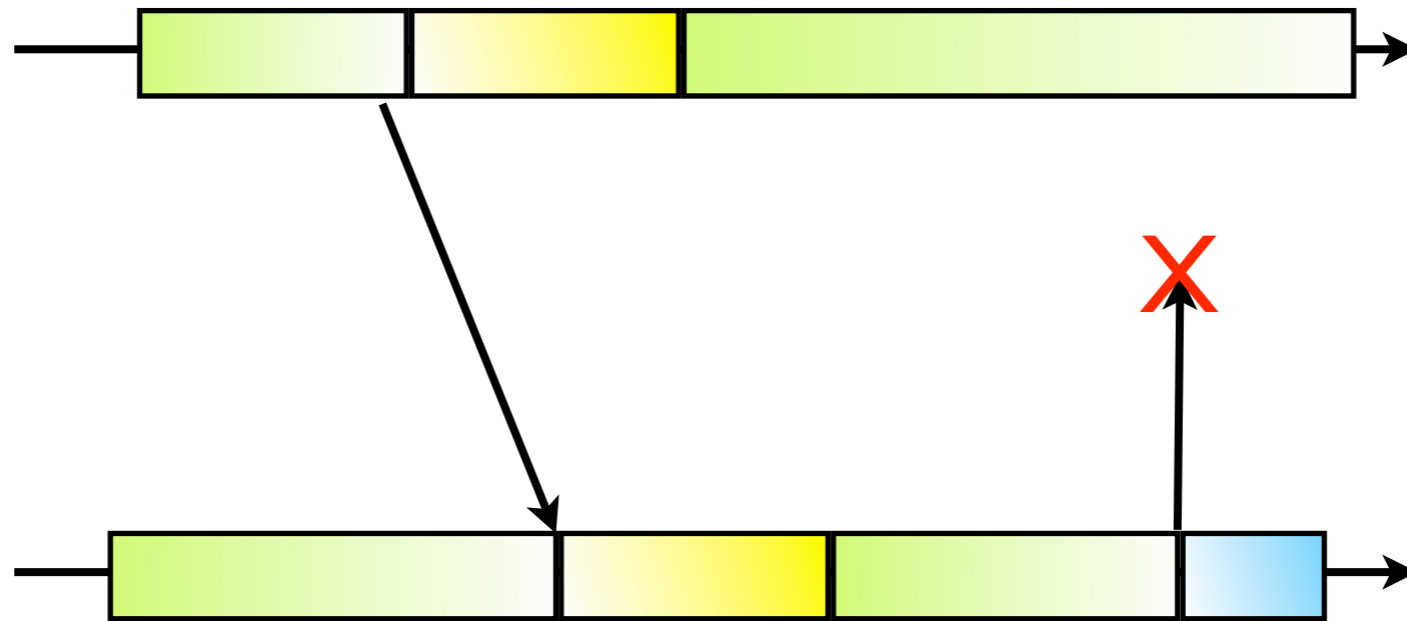
# Packets can be dropped or corrupted



Ideally, updates should reach other players immediately, so that states are consistent at all time.



Delay and loss lead to inconsistent states.



Number of players  
can be huge

## WORLD OF WARCRAFT® SURPASSES 9 MILLION SUBSCRIBERS WORLDWIDE

IRVINE, Calif. – July 24, 2007 – Blizzard Entertainment, Inc. announced today that World of Warcraft®, its award-winning massively multiplayer online role-playing game (MMORPG), has reached a new milestone, with a player base now totaling more than 9 million subscribers worldwide. The company is currently working with its partner for World of Warcraft in China, The9, to prepare the game's first expansion, World of Warcraft: The Burning Crusade™, for launch in mainland China and anticipates an influx of new and returning subscribers in conjunction with that event.

"We're thrilled that gamers around the world have continued to embrace World of Warcraft so enthusiastically," said Mike Morhaime, president and cofounder of Blizzard Entertainment®. "We've worked hard to provide a compelling experience for our players, and we plan to continue updating the game with exciting new content for them to enjoy for many years to come."

Since debuting in North America on November 23, 2004, World of Warcraft has become the most popular MMORPG around the world. It was the bestselling PC game of 2005 and 2006\* and has remained at or near the top of the weekly PC-game sales charts for much of 2007 as well. Blizzard's Burning Crusade expansion released to critical acclaim in several regions earlier this year and shattered PC-game sales records in North America and Europe, with nearly 2.4 million copies sold in its first 24 hours of release and approximately 3.5 million in its first month. World of Warcraft is available in seven different languages and, in addition to North America and Europe, is played in mainland China, Korea, Australia, New Zealand, Singapore, Thailand, Malaysia, and the regions of Taiwan, Hong Kong, and Macau.

For further information on World of Warcraft and The Burning Crusade, please visit the official website at [www.worldofwarcraft.com](http://www.worldofwarcraft.com). To keep pace with the continued growth of World of Warcraft as well as development on other Blizzard games, the company is currently hiring for numerous open positions -- more information on available career opportunities at Blizzard can be found at <http://jobs.blizzard.com>.

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Block

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home > PR > Press

## Press Releases | Official Press Releases from NCsoft

• Title | NCsoft's Lineage Franchise Continues Global Success

• No. | 18 • Referred by | NCsoft • Date | 2006-11-16 • Views | 888 • Attachment |

North America and Europe become latest territories to hit major milestone

AUSTIN, Texas, November 15, 2006 — NCsoft® today announced Lineage® II, with more than 14 million customers worldwide, has reached 100,000 active players in North America and Europe. The title started as a cult favorite of many massively multiplayer online (MMO) gamers in North America and Europe and continues its success as the premiere player-versus-player (PvP) online role playing game for the elite PvP player.

Lineage II was launched in North America in 2004 as a modest success. The game has since built itself into one of the top MMOs in the western markets, with a 25 percent growth rate in 2006. NCsoft credits the growth of the game to regular updates and free expansions to the product, and delivering features requested by players. Additionally, NCsoft has implemented aggressive policies to eliminate activities like "botting" and "farming" which give some players unfair advantages over legitimate players.

"This is a great franchise that has dominated Asia and now we are seeing very positive growth in North America and Europe," said Robert Garriott, CEO for NCsoft North America. "This game took a little time to find its audience because it is such a rich, tough and complex world. It is not a game for the feint of heart, but we worked to adjust the game to fit our customers and we're seeing more players view it as the pinnacle of MMO gaming. More and more players are



# EVE Online Tops 10.000 Simultaneous Players In The Same World

REYKJAVIK, Iceland, April 26

CCP announced today that EVE Online has broken through the 10.000 simultaneous users threshold, when 10.396 users played EVE Online at the same time in the same world. This confirms that a "one world" game design is not just a vision but a reality and breaks the boundaries a multi-world (shards) game design places on players.

*"The EVE 'one world' design has enabled CCP to create the single largest MMORPG world to date according to our information,"* said Hilmar Veigar Petursson, CTO at CCP. "There have often been times when we thought this would not be possible, but by working closely with our community we have been able to create a game platform that players seem to enjoy, and is capable to handle the current and future influx of new users."

In conjunction with the recently announced availability of online distribution and the availability of the Tech Level 2 Expansion Pack, EVE Online has emerged as on the fastest growing MMORPG with a prolific and multi-faceted player base from across the globe all connected to a single game world, something that is rarity in the MMORPG genre.

*"Although having more than 10.000 players in the same world is a technical and architectural feat,"* said PhD Kjartan Pierre Emilsson, CCP's Lead Game Designer. "The most important thing is what this means to the players. It is well known that the richness and variety of interaction available between people rises dramatically with the number of people that can actually interact. With ten thousand people you have over hundred million possible link options. If you are notorious in EVE you are so to the whole population of EVE, not just in your little 'shard' of the game."

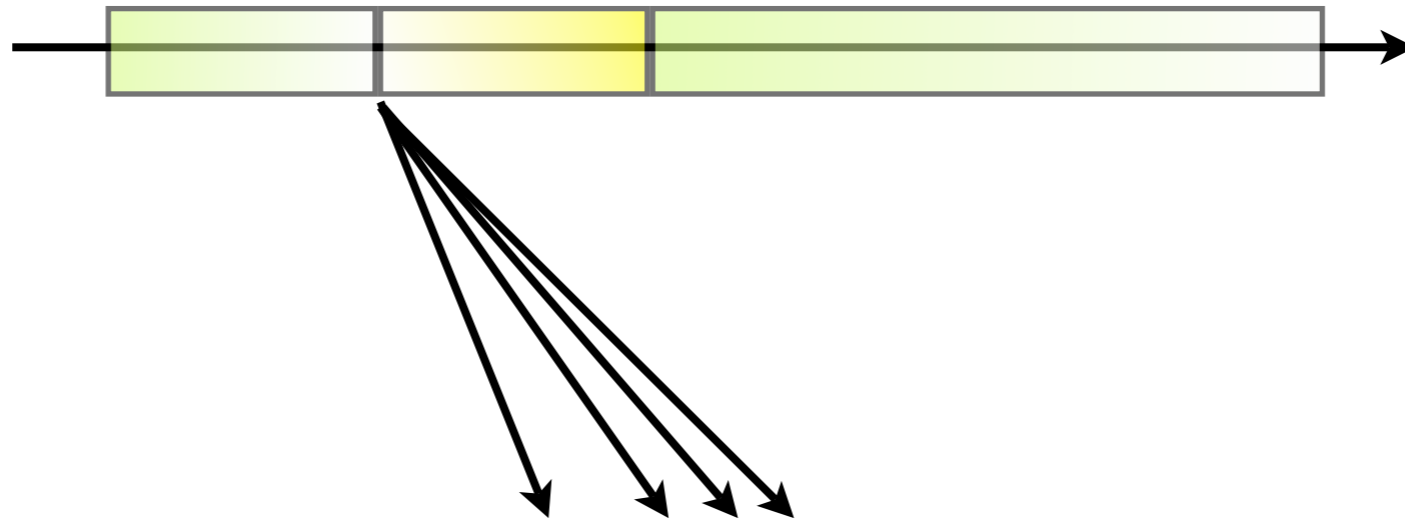
## About EVE Online

EVE Online is the next generation in massive multiplayer online games. Set in a world of galactic magnitude, governed by a hyper capitalistic economy. Your aim is to establish yourself as a major mover and shaker, trusted by your friends and respected by your enemies. Your main tools to accomplish this, apart from the whole panoply of sophisticated equipment, space ships and corporations will be your business acumen and social skills, Machiavellian thinking and cunning combat strategies.

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sophisticated equipment, space ships and corporations will be your business acumen and social skills, Machiavellian thinking and cunning combat strategies. Your main tools to accomplish this, apart from the whole panoply of sophisticated equipment, space ships and corporations will be your business acumen and social skills, Machiavellian thinking and cunning combat strategies.

# Huge cost in network/CPU resources



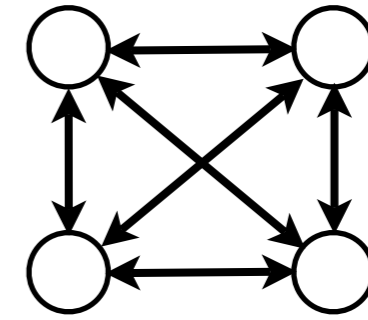
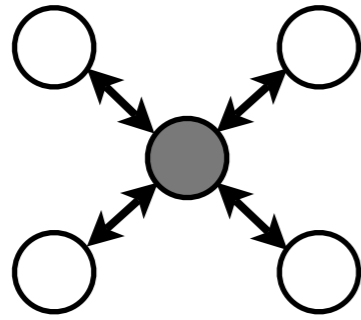
**Users are  
competitive**

**Games should be fair to all  
players**

network delay and losses

large number of users

cheating



**Latency**

**Robustness**

**Conflict/Cheating**

**Consistency**

**Accounting**

**Scalability**

**Complexity**