Lecture 10

Server Discovery and Player Matchmaking

Previously on CS4344

How to deal with latency?

This lecture:

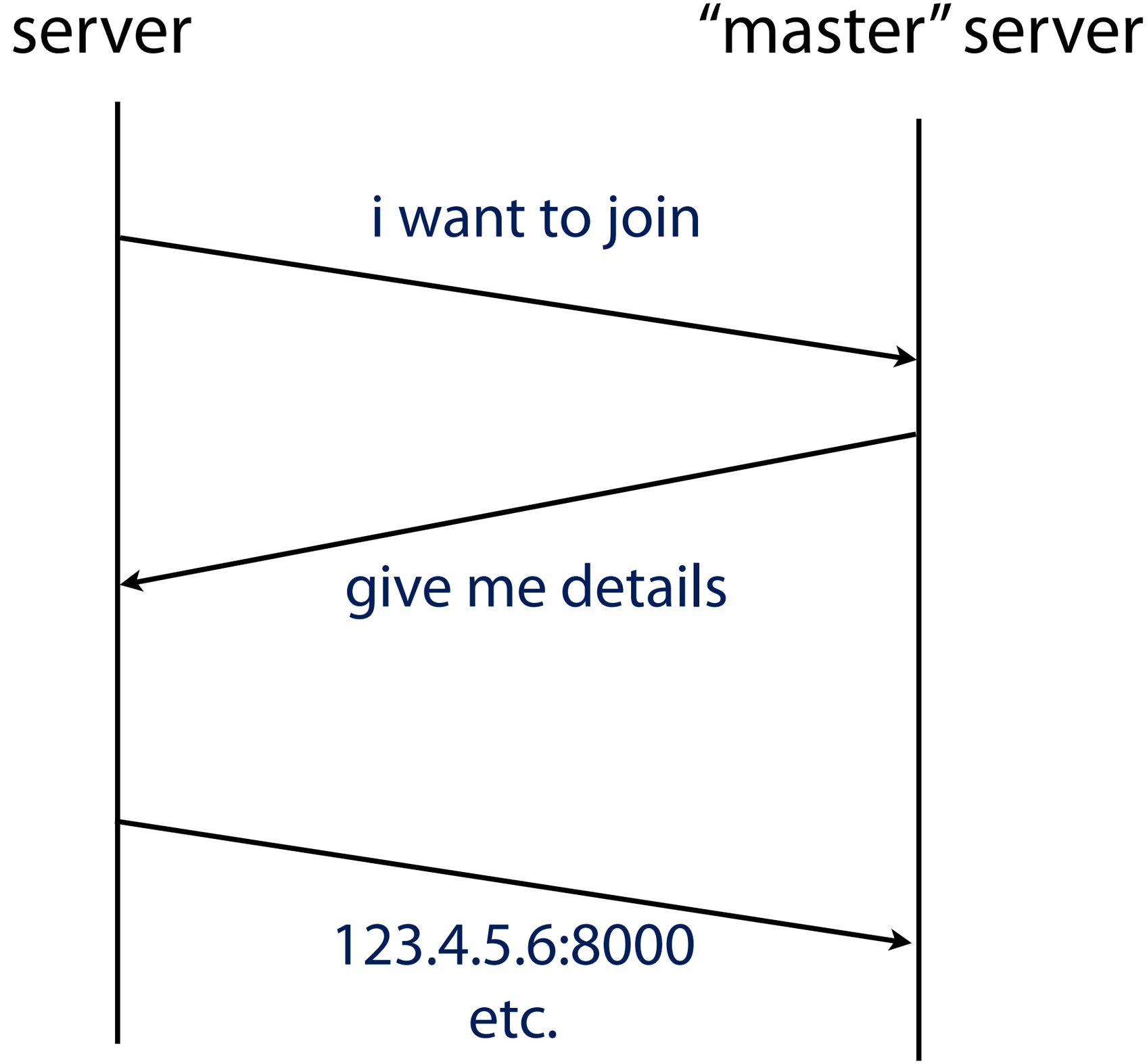
How to reduce latency?

Idea: pick the "closest" server to connect to

Game services (e.g., Garena) host multiple game servers for the same game.

Game console can host games
(i.e., become the server)

How does it work?
Using Valve's Steam Counter Strike: Source server discovery as an example.


server
“master” server
i want to join
give me details
123.4.5.6:8000
etc.

SEARCH BY | MATCHING | PLAYING | LOCATED IN

Server Name or IP | Counter Strike Source | All Locations | GO

ADVERTISEMENT

10000 of servers worldwide

SEARCH RESULTS — Searching: Counter Strike Source Servers

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Rank↓	Gm	Server Name		Players	Loc	IP:Port	Server Map
10205.		www.nighteam.com [US] | DUST 24/7	JOIN	28/64		67.219.107.106:27017	de_dust
10205.		- P O R T (ONLY) // [c2Play.de] -	JOIN	24/42		193.192.59.45:27400	de_port
10205.		www.nighteam.com [US] | AZTEC 24/7	JOIN	20/64		67.219.107.106:27116	de_aztec
10205.		http://www.saigns.com # Dust Only, NoFF, NoBl	JOIN	34/64		217.160.107.113:27015	de_dust
10205.		- N U K E (ONLY) // [c2Play.de] -	JOIN	24/42		193.192.59.45:27050	de_nuke
10205.		- H A V A N A (ONLY) // [c2Play.de] -	JOIN	24/64		193.192.58.150:27050	cs_havana
10205.		- C B B L E (ONLY) // [c2Play.de] -	JOIN	24/42		193.192.59.45:27000	de_cbble
10205.		www.nighteam.com [EU] | DUST2 24/7	JOIN	20/64		176.31.122.148:27016	de_dust2
10205.		- T I D E S (ONLY) // [c2Play.de] -	JOIN	23/42		193.192.59.135:27650	de_tides
10205.		- P R O D I G Y (ONLY) // [c2Play.de] -	JOIN	24/42		193.192.59.45:27100	de_prodigy
10205.		.: D U S T (ONLY) // 4played.de :.	JOIN	0/42		130.185.109.15:27300	de_dust
10205.		- I T A L Y (ONLY) // [c2Play.de] [Beta] -	JOIN	24/42		193.192.59.135:27350	cs_italy
10205.		Counter-Strike: Source	JOIN	0/20		91.191.158.244:27015	de_dust2
10205.		- I T A L Y (ONLY) // [c2Play.de] -	JOIN	24/42		193.192.59.120:27100	cs_italy
NR.		The Crunch Trust [Office|Ranked]	JOIN	0/16		27.50.71.185:27015	cs_office
NR.		UcK-Brod WarServer	JOIN	0/13		176.57.128.137:27015	de_dust2
NR.		[TurboDom SARATOV] STEAM #1 DM	JOIN	0/22		109.195.16.195:27015	de_dust2
NR.		ThaEpixMachine JEEPATHON 24/7 -Seattle-	JOIN	0/50		74.91.117.143:27016	mg_jeepathon2k
NR.		DEATHMATCH | HL Stats | ContraGaming.ru	JOIN	0/16		87.226.13.228:27015	de_dust2
NR.		E-Revo EPS server	JOIN	0/12		188.165.229.48:27961	de_train
NR.		[Ger]Ballerbude | 24/7 | Standartmaps	JOIN	0/20		46.228.194.216:27015	cs_office
NR.		PlayZeek: Dust 2 Only: Bellum	JOIN	0/16		80.242.138.186:24032	de_dust2
NR.		PlayZeek: AWP Maps only: Adept	JOIN	0/16		80.242.138.187:24608	awp_factiOn_v2

Rank↓ Gm Server Name Players Loc IP:Port Server Map

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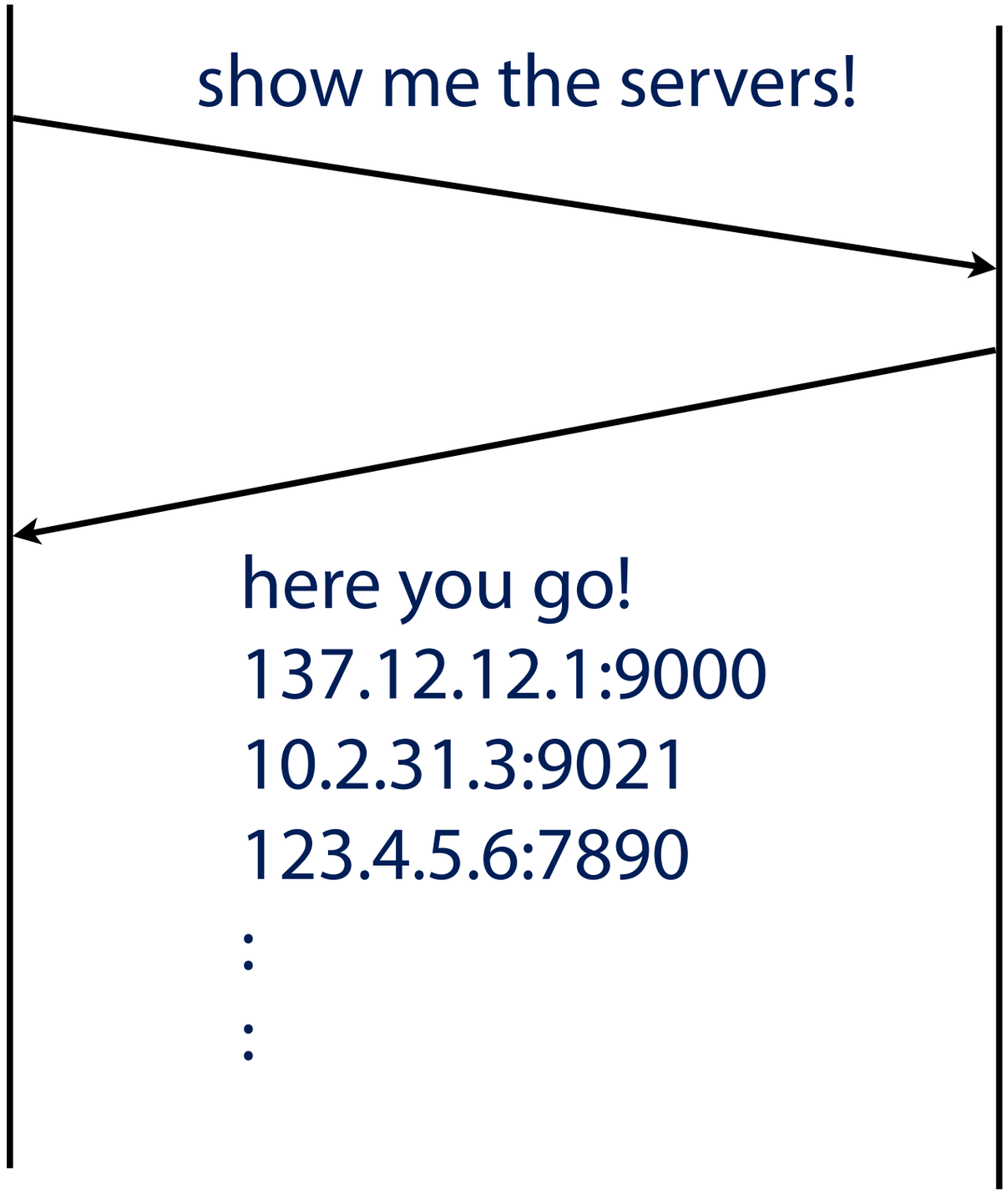
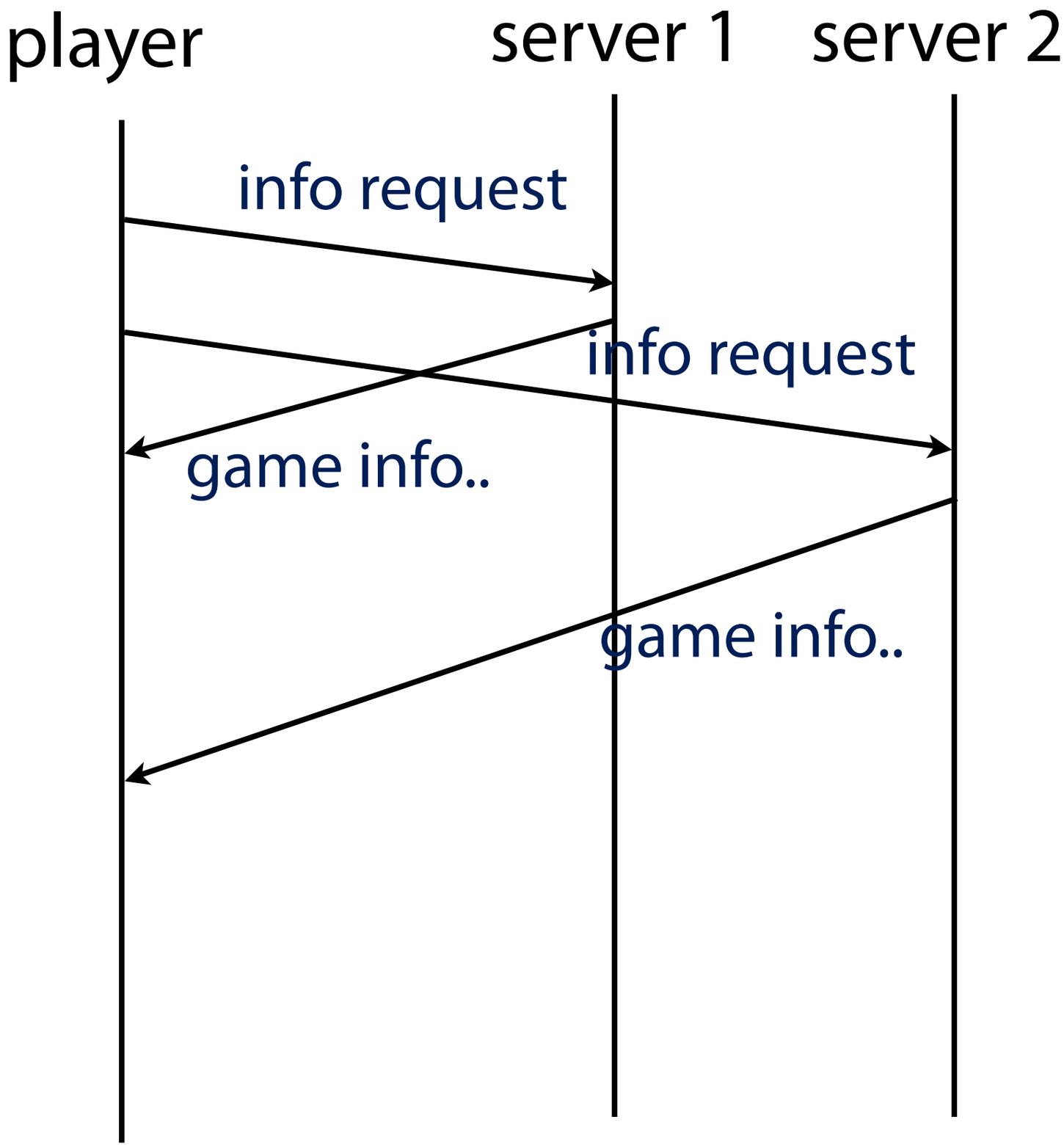
ADD A SERVER TO GAMETRACKER!

player

"master" server



in no particular order, up to 231 servers

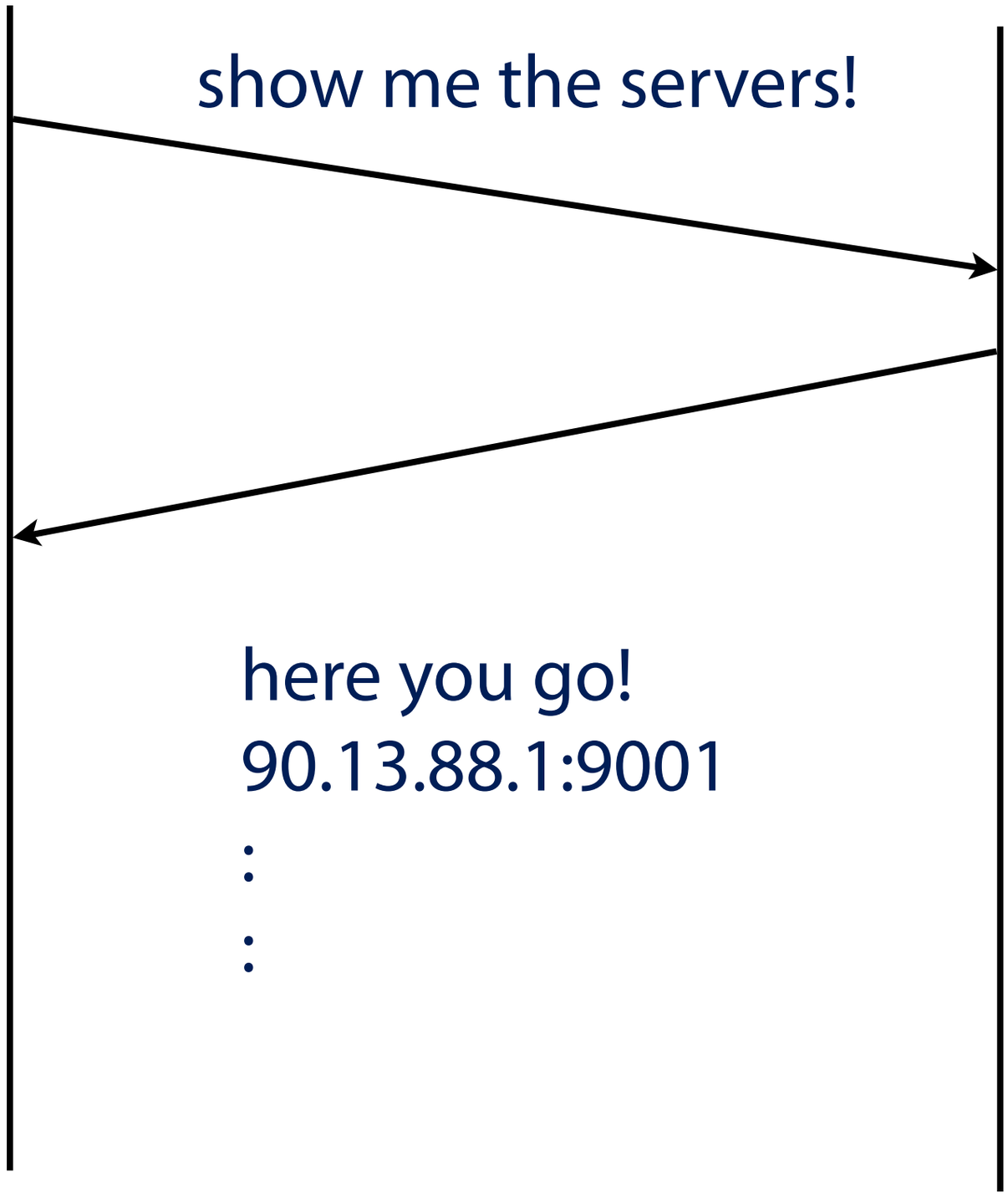


repeat for all 231 servers

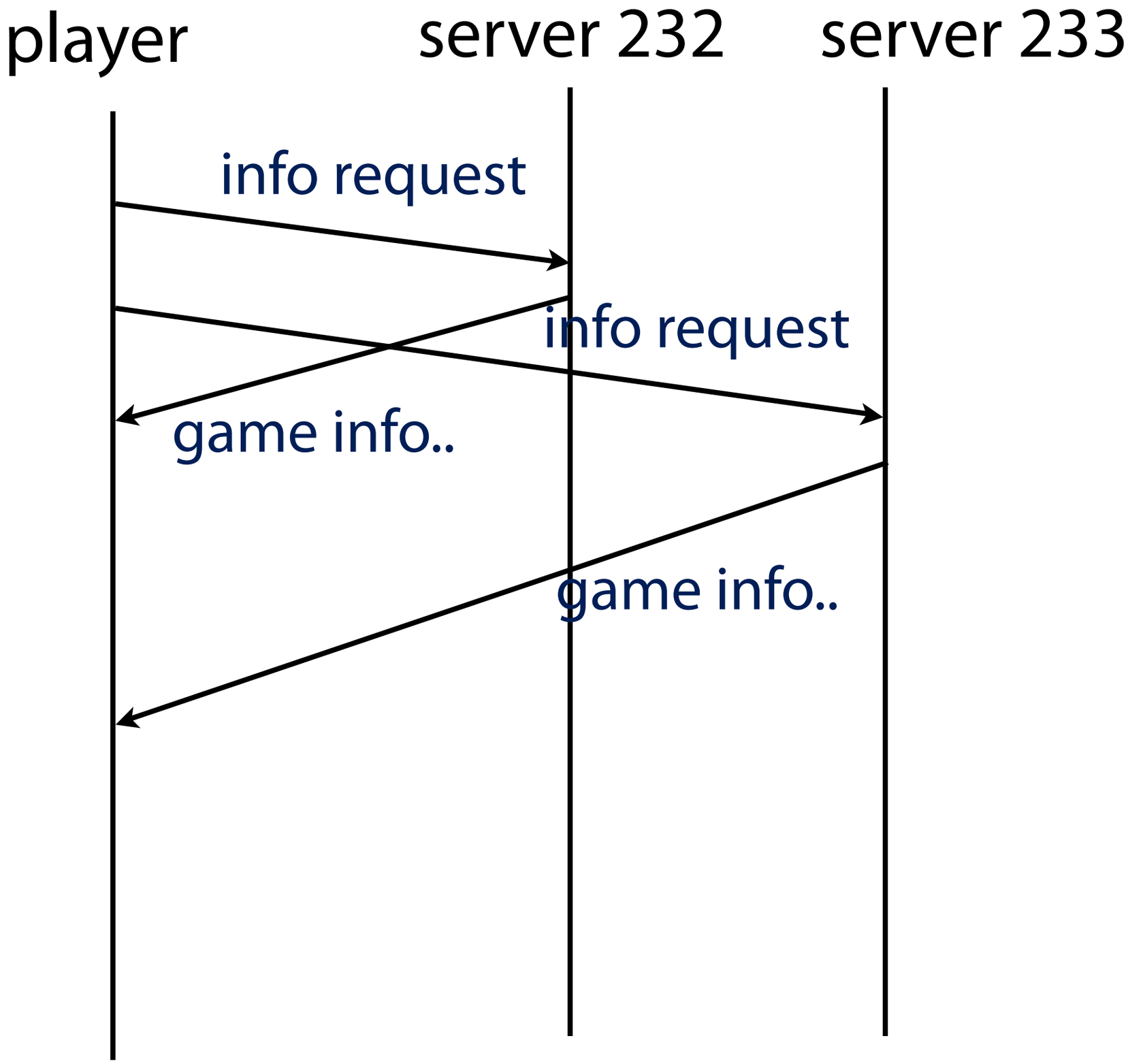
Meanwhile, probed servers are shown to player on the UI

player

“master” server



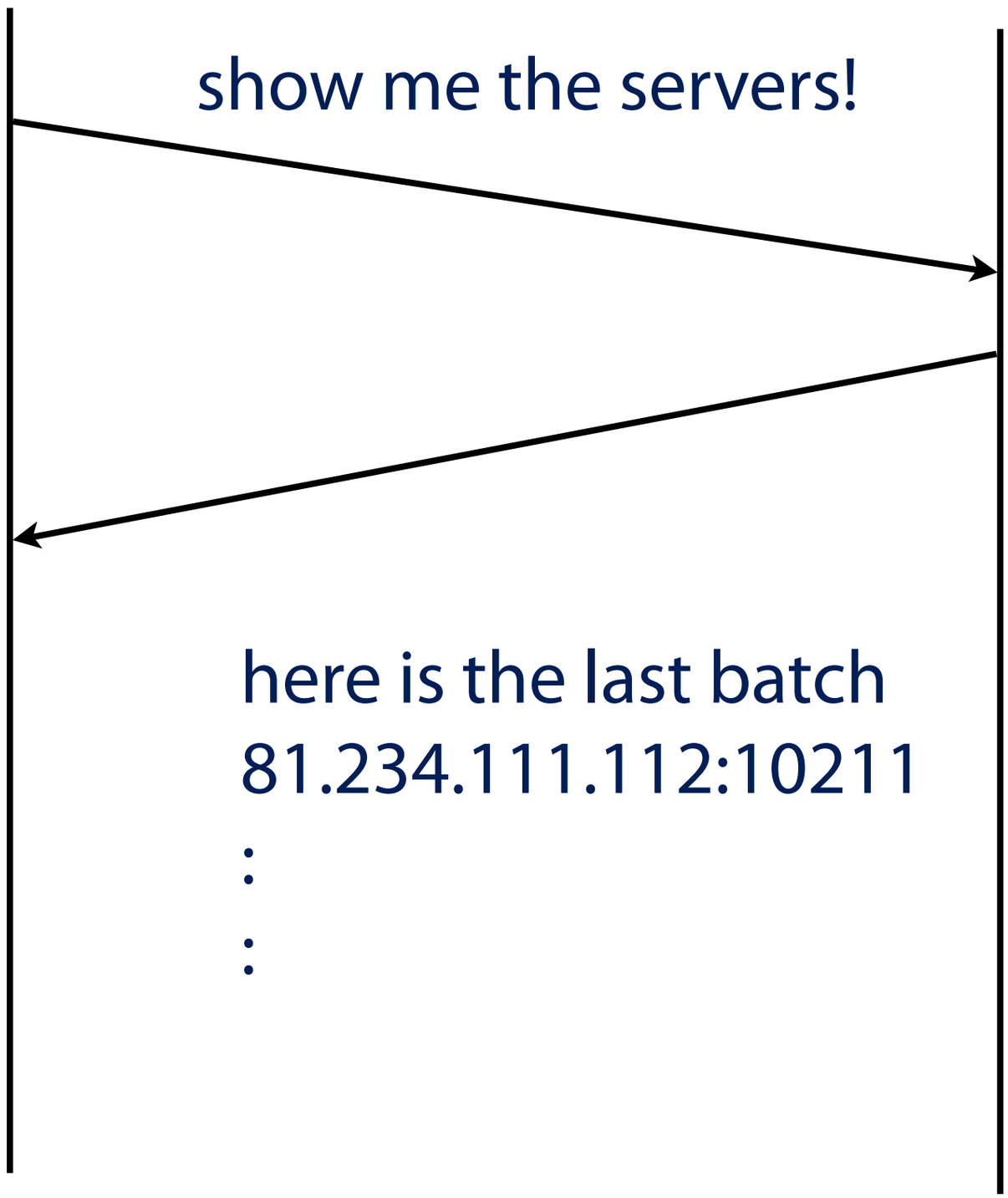
in no particular order, up to 231 servers



repeat for all 231 servers

player

"master" server



Slow

Steam limits the client to 140 probe/s for DSL 256kbps (minutes to go through all servers)

Inefficient

NAT maintains per-flow state.

Lots of new (but short) flow states to maintain!

Inefficient

Many irrelevant probes to a server (popular games easily have hundreds of thousands players worldwide)

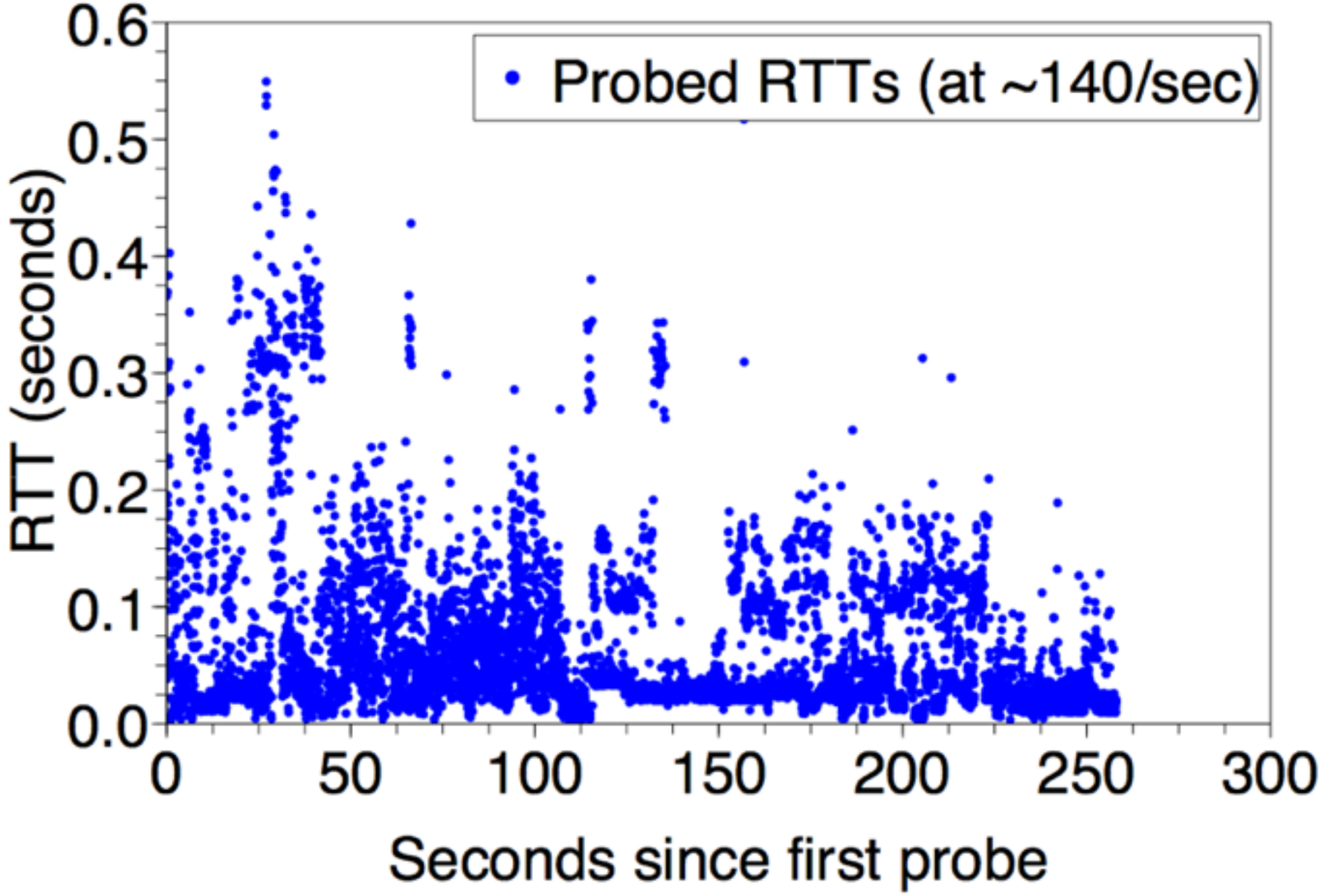


Fig. 2. RTTs observed by an English CS:S client probing 36K game servers (mid-2009). The probe sequence is unrelated to observed RTTs

Inefficient

Low RTT servers may not appear until later.

SEARCH BY | MATCHING | PLAYING | LOCATED IN

Server Name or IP | | Counter Strike Source | All Locations | GO

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SEARCH RESULTS

Searching: **Counter Strike Source** Servers

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Filter by location

Rank↓	Gm	Server Name		Players	Loc	IP:Port	Server Map
10205.		www.nighteam.com [US] | DUST 24/7	JOIN	24/42		67.219.107.106:27017	de_dust
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10205.		www.nighteam.com [US] | AZTEC 24/7	JOIN	20/64		67.219.107.106:27116	de_aztec
10205.		http://www.saigns.com # Dust Only, NoFF, NoBl	JOIN	34/64		217.160.107.113:27015	de_dust
10205.		- N U K E (ONLY) // [c2Play.de] -	JOIN	24/42		193.192.59.45:27050	de_nuke
10205.		- H A V A N A (ONLY) // [c2Play.de] -	JOIN	24/64		193.192.58.150:27050	cs_havana
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10205.		- P R O D I G Y (ONLY) // [c2Play.de] -	JOIN	24/42		193.192.59.45:27100	de_prodigy
10205.		.: D U S T (ONLY) // 4played.de :.	JOIN	0/42		130.185.109.15:27300	de_dust
10205.		- I T A L Y (ONLY) // [c2Play.de] [Beta] -	JOIN	24/42		193.192.59.135:27350	cs_italy
10205.		Counter-Strike: Source	JOIN	0/20		91.191.158.244:27015	de_dust2
10205.		- I T A L Y (ONLY) // [c2Play.de] -	JOIN	24/42		193.192.59.120:27100	cs_italy
NR.		The Crunch Trust [Office|Ranked]	JOIN	0/16		27.50.71.185:27015	cs_office
NR.		UcK-Brod WarServer	JOIN	0/13		176.57.128.137:27015	de_dust2
NR.		[TurboDom SARATOV] STEAM #1 DM	JOIN	0/22		109.195.16.195:27015	de_dust2
NR.		ThaEpixMachine JEEPATHON 24/7 -Seattle-	JOIN	0/50		74.91.117.143:27016	mg_jeepathon2k
NR.		DEATHMATCH | HL Stats | ContraGaming.ru	JOIN	0/16		87.226.13.228:27015	de_dust2
NR.		E-Revo EPS server	JOIN	0/12		188.165.229.48:27961	de_train
NR.		[Ger]Ballerbude | 24/7 | Standartmaps	JOIN	0/20		46.228.194.216:27015	cs_office
NR.		PlayZeek: Dust 2 Only: Bellum	JOIN	0/16		80.242.138.186:24032	de_dust2
NR.		PlayZeek: AWP Maps only: Adept	JOIN	0/16		80.242.138.187:24608	awp_factiOn_v2

Rank↓ | Gm | Server Name | Players | Loc | IP:Port | Server Map

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ADD A SERVER TO GAMETRACKER!

even if Steam filters the servers based on geographical location ("Asia") we may still have hundreds/thousands of servers to probe

Idea: probe servers in (roughly) increasing order of RTT

Question: how to estimate RTT before probing?

Solution 1:

GeoIP Location

Maps IP address to location

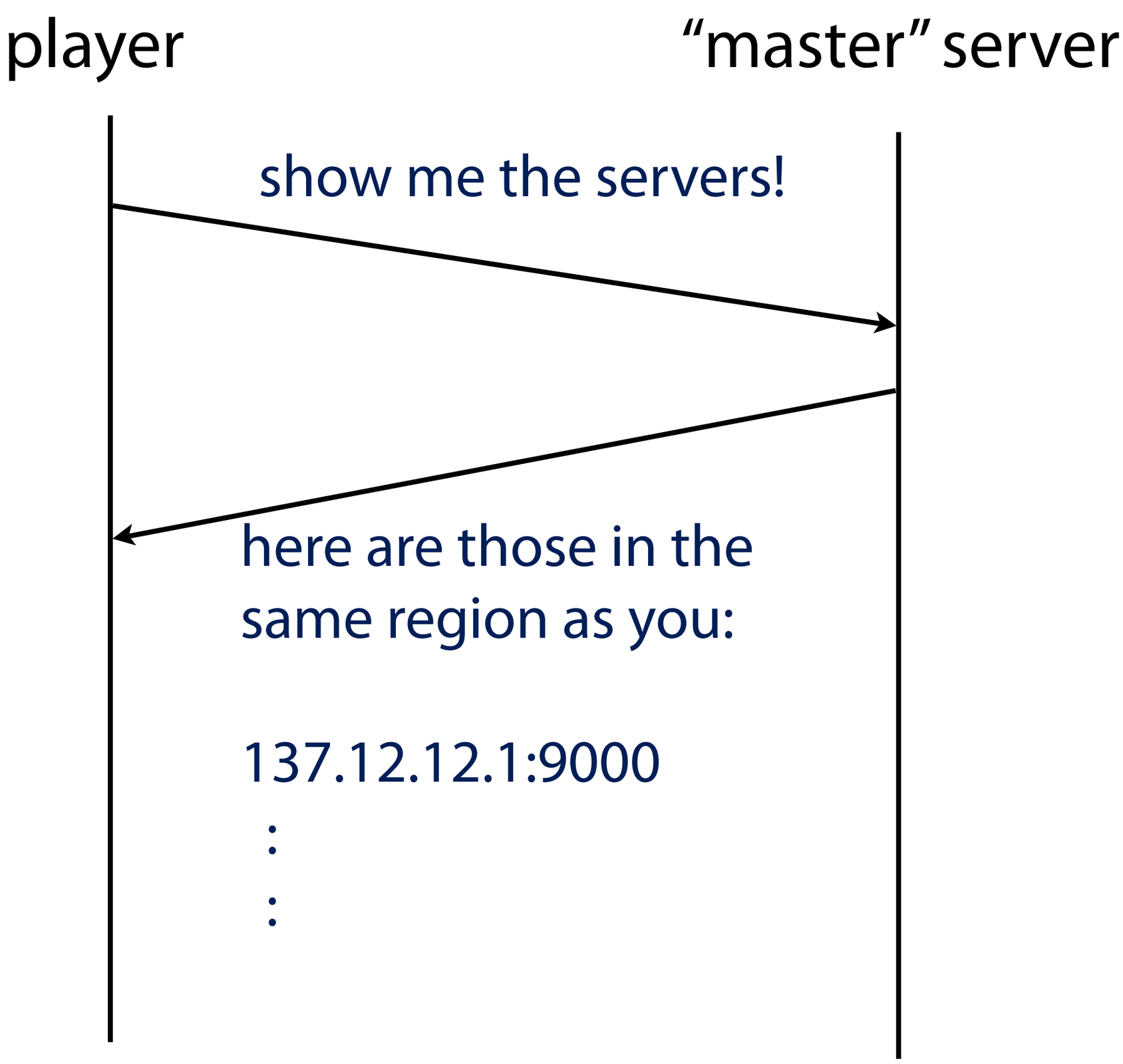
(demo: see http://www.maxmind.com/en/geoip_demo)

MaxMind GeoIP City/ISP/Organization Edition Results

IP Address	Country Code	Location	Postal Code	Coordinates	ISP	Organization	Domain	Metro Code
202.185.111.194	MY	Sungai Buloh, Selangor, Malaysia		3.2, 101.5833	JARING Communications Sdn Bhd	JARING Communications Sdn Bhd	um.edu.my	
173.194.38.179	US	Mountain View, California, United States	94043	37.4192, -122.0574	Google	Google	1e100.net	807
137.132.80.1	SG	Singapore, Singapore		1.2931, 103.8558	National University of Singapore	National University of Singapore	nus.edu.sg	

Results are generated with the Perl API and the commercial GeoIP City, GeoIP ISP, and GeoIP Organization databases. IPv6 results are generated with the GeoLite IPv6 City Database.

You can also test your own IP address.


player
"master" server
show me the servers!
here are those in the same region as you:
137.12.12.1:9000
:
:

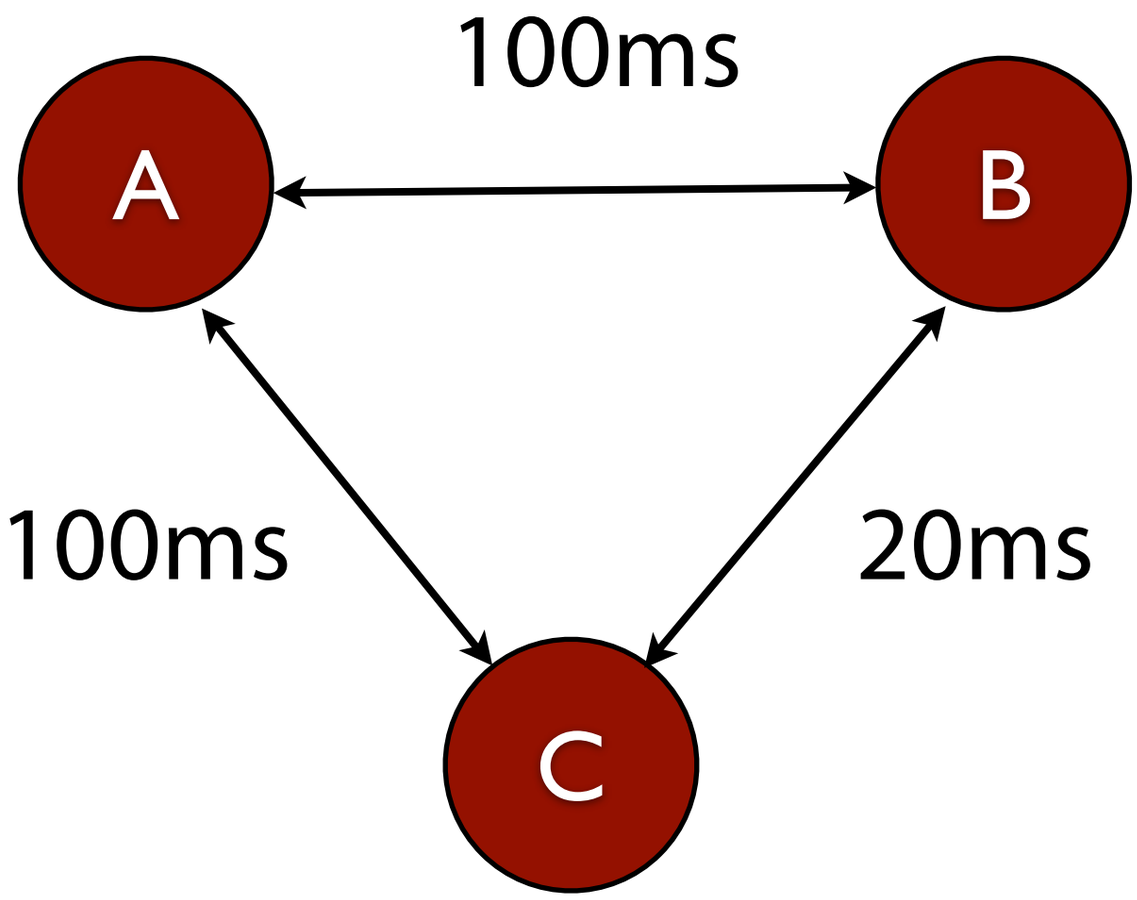
```
ooiMac:~ ooiwt$ ping www.google.com
PING www.google.com (173.194.38.179): 56 data bytes
64 bytes from 173.194.38.179: icmp_seq=0 ttl=52 time=12.890 ms
64 bytes from 173.194.38.179: icmp_seq=1 ttl=53 time=13.490 ms
64 bytes from 173.194.38.179: icmp_seq=2 ttl=53 time=13.027 ms
^C
--- www.google.com ping statistics ---
3 packets transmitted, 3 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 12.890/13.136/13.490/0.257 ms
ooiMac:~ ooiwt$ ping www.um.edu.my
PING www.um.edu.my (202.185.111.194): 56 data bytes
64 bytes from 202.185.111.194: icmp_seq=0 ttl=237 time=48.447 ms
64 bytes from 202.185.111.194: icmp_seq=1 ttl=237 time=51.332 ms
64 bytes from 202.185.111.194: icmp_seq=2 ttl=237 time=50.938 ms
^C
--- www.um.edu.my ping statistics ---
3 packets transmitted, 3 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 48.447/50.239/51.332/1.277 ms
```

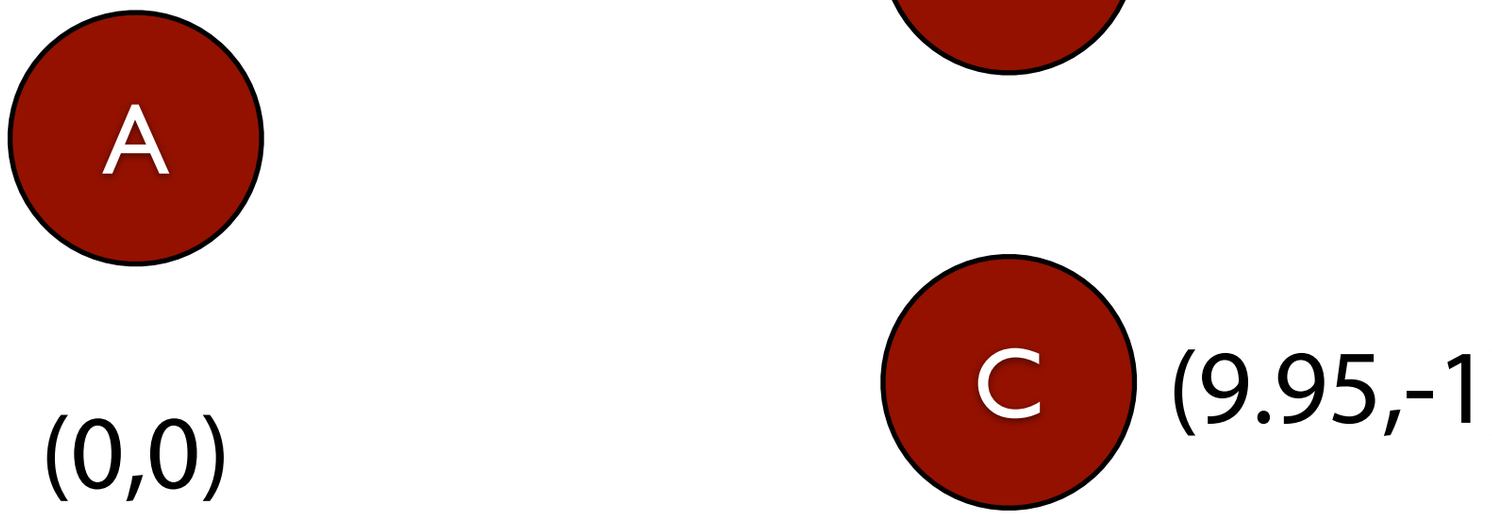
Problem: network latency not related to geographical location

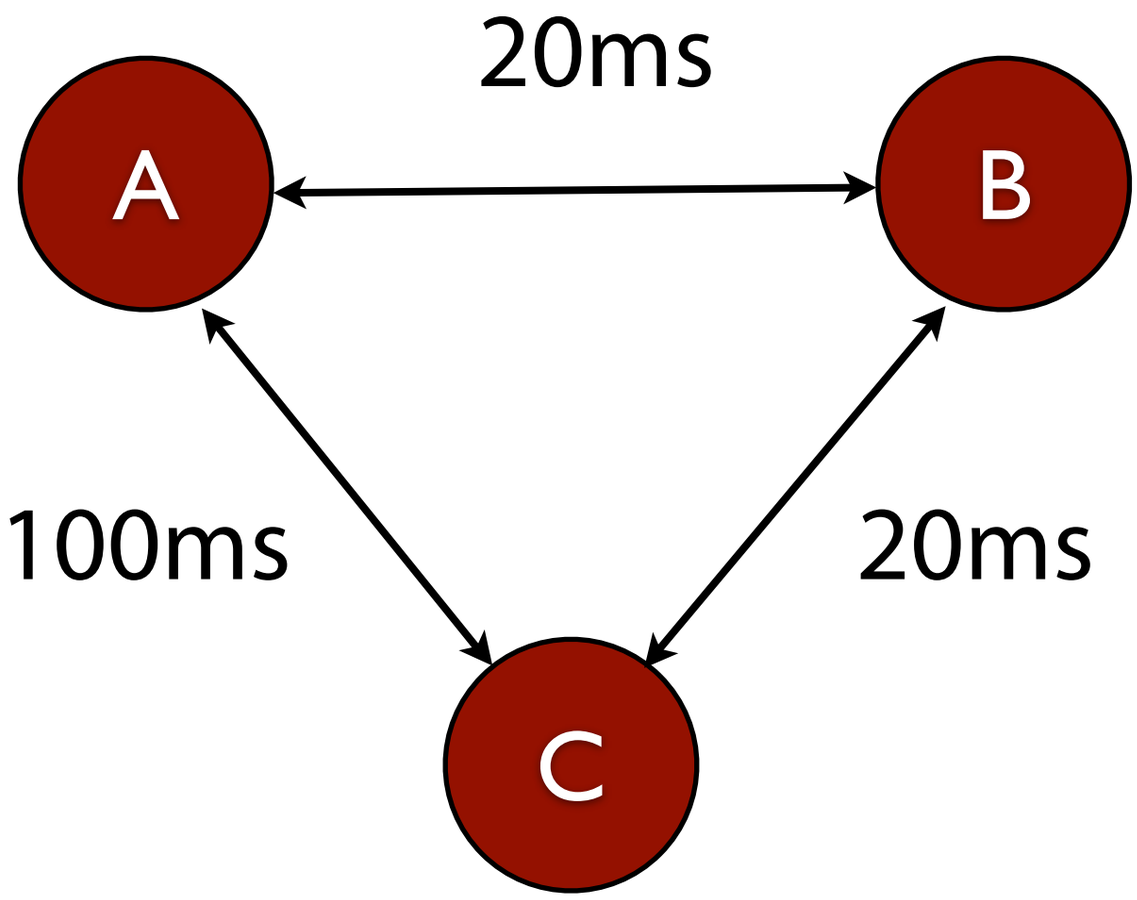
Solution 2:

Network Coordinates

Maps hosts to a coordinate in n-dimensional space, s.t. distance corresponds to latency


100ms
A
B
100ms
20ms
C

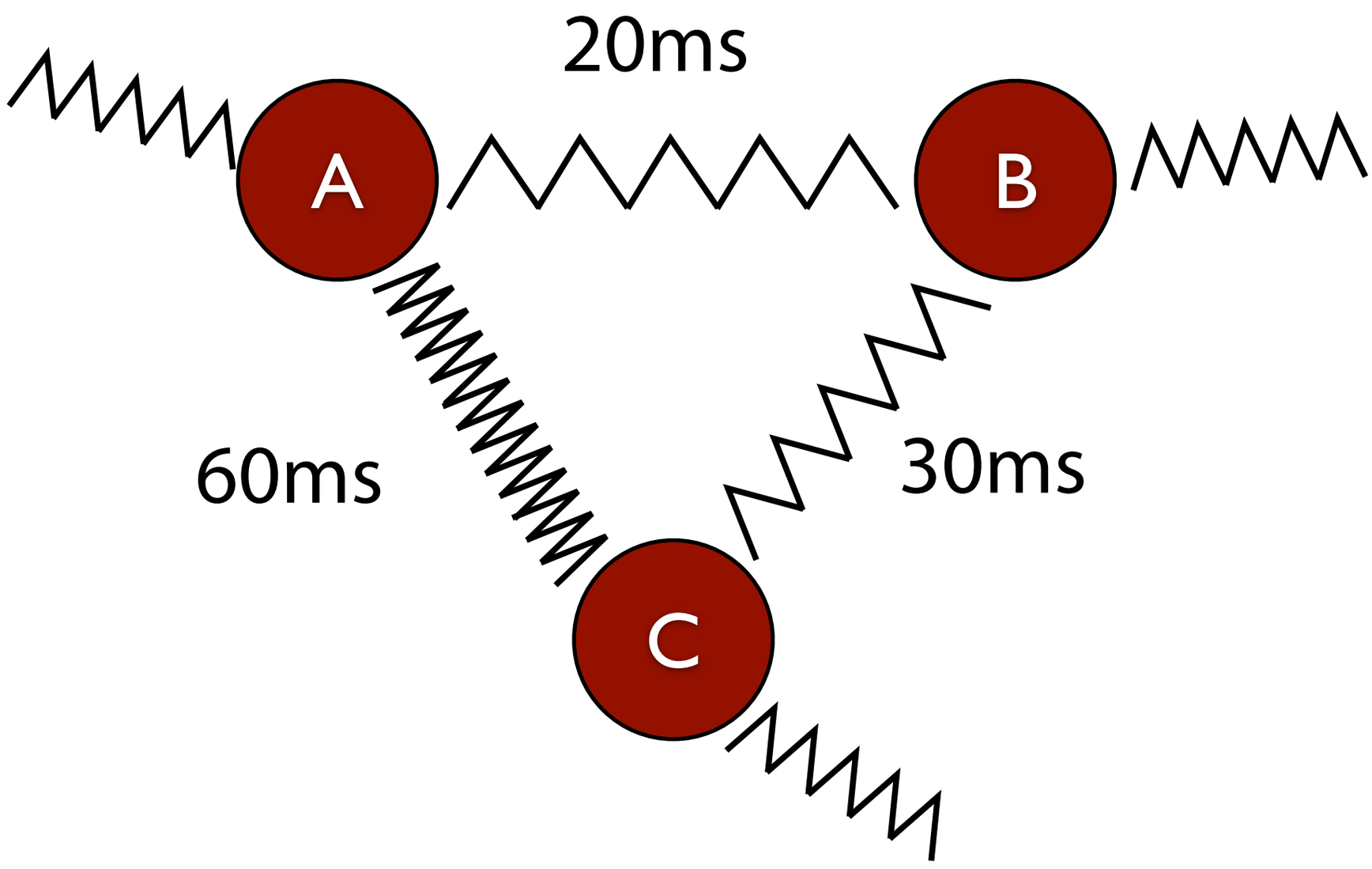

A
(0,0)
B
(9.95,1)
C
(9.95,-1)



Triangle inequality violated

No mapping is perfect.
We try to minimize error.

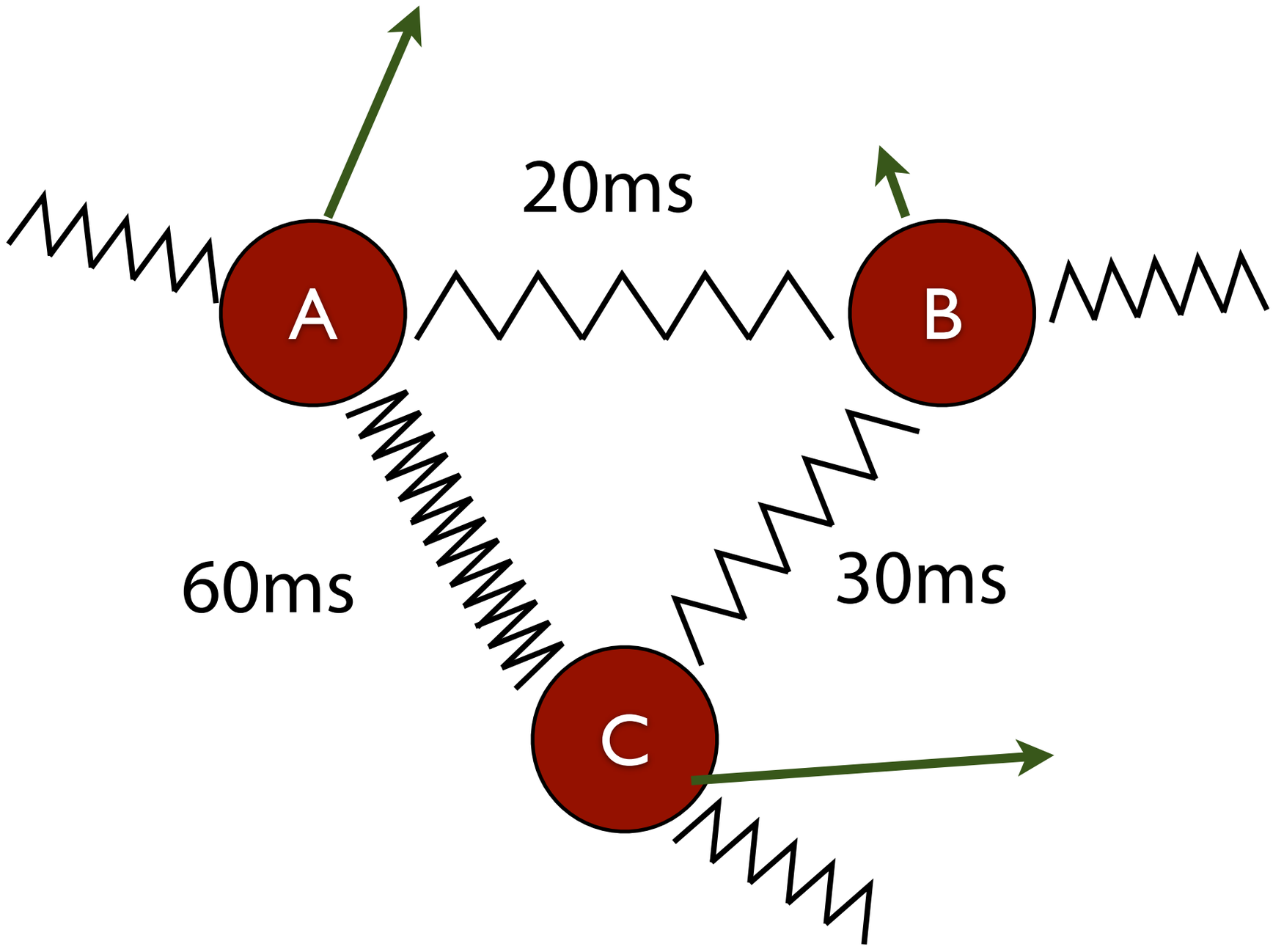
$$\sum_{i,j}(RTT(i,j) - DIST(i,j))^2$$

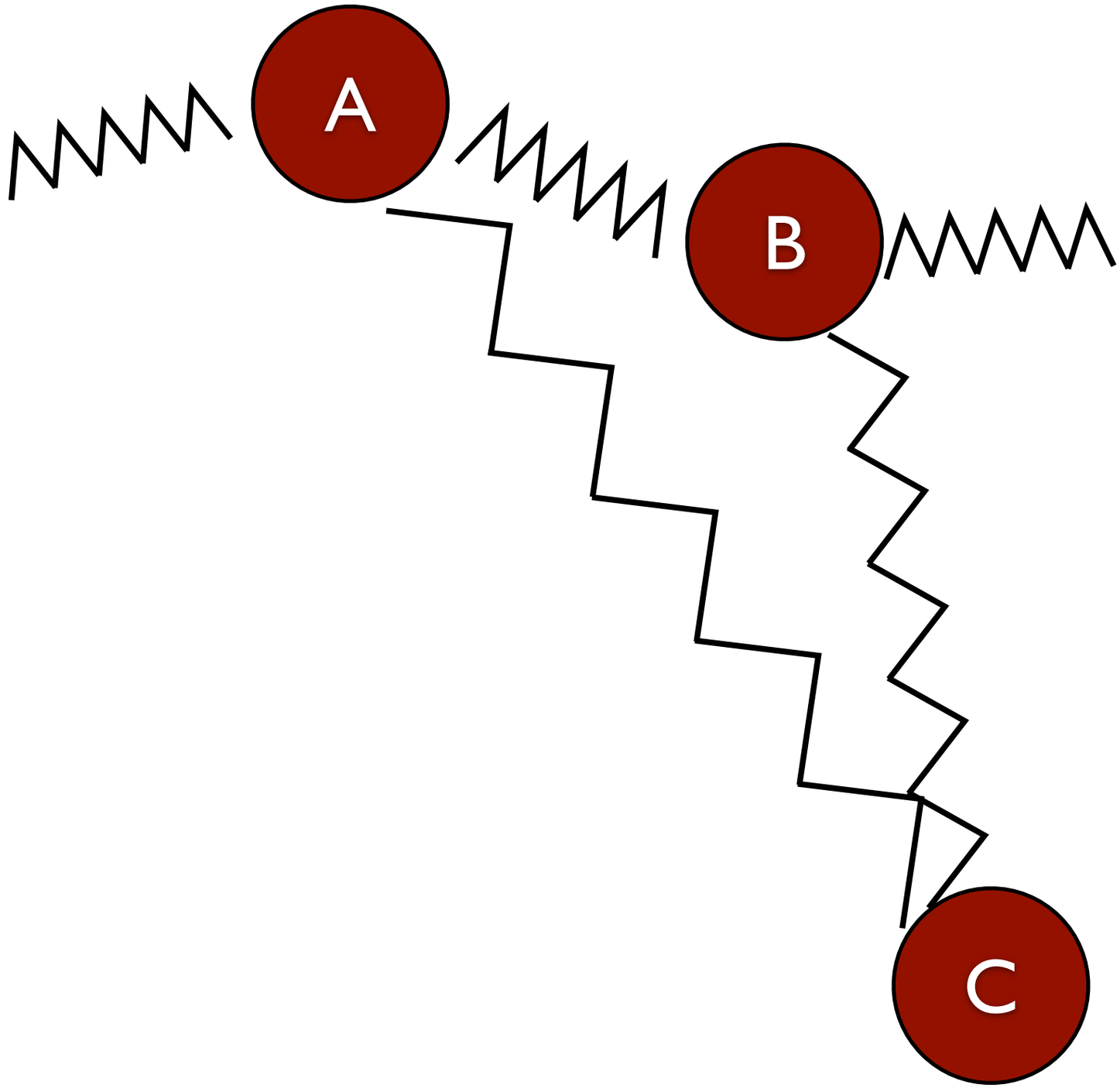

20ms
A
B
60ms
30ms
C

Hooke's Law

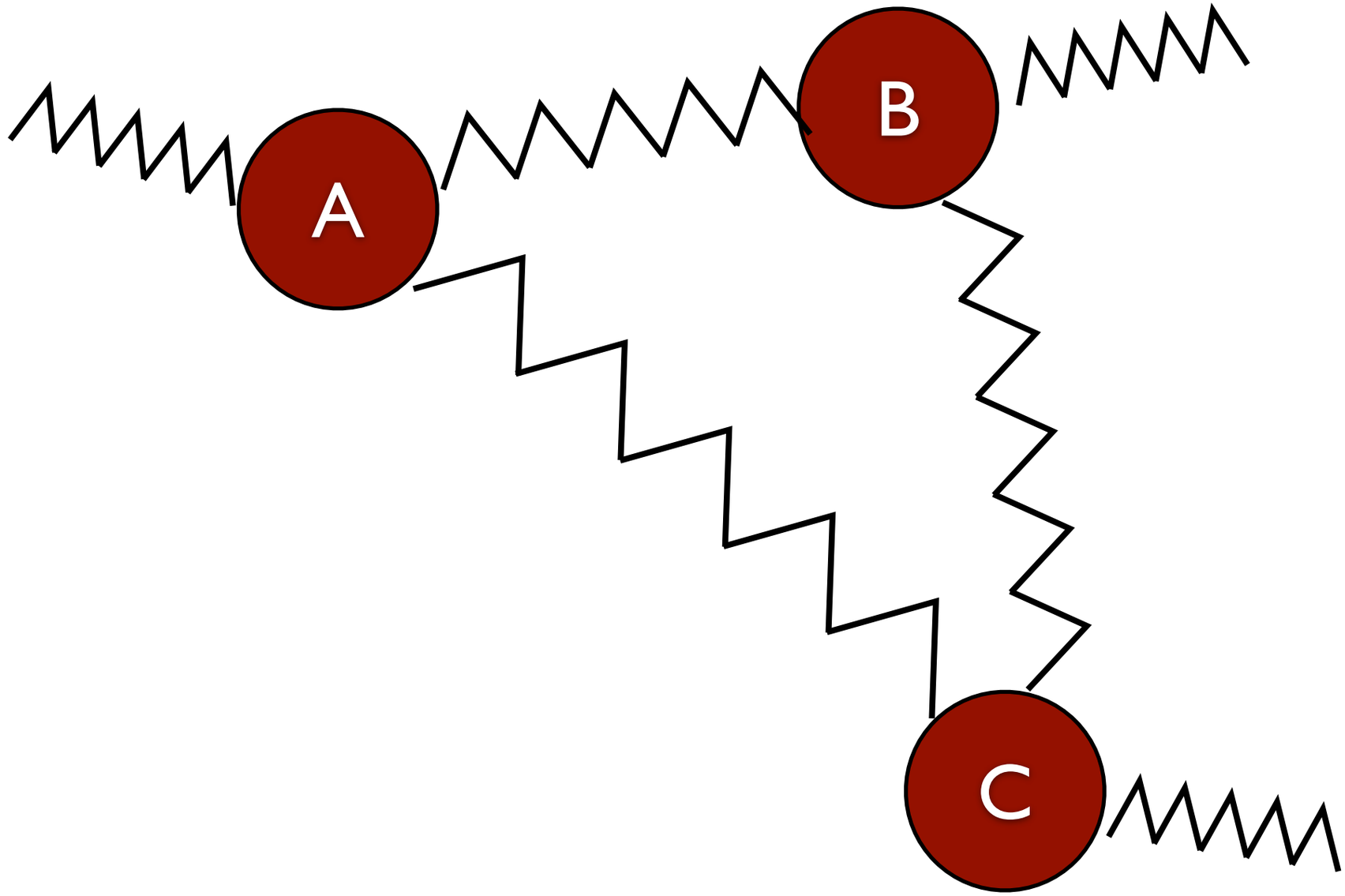
Force $\propto$ displacement

displacement = RTT(i,j) - DIST(i,j)


20ms
A
B
60ms
30ms
C



Move a small step in the direction of the force proportional to the magnitude of the force



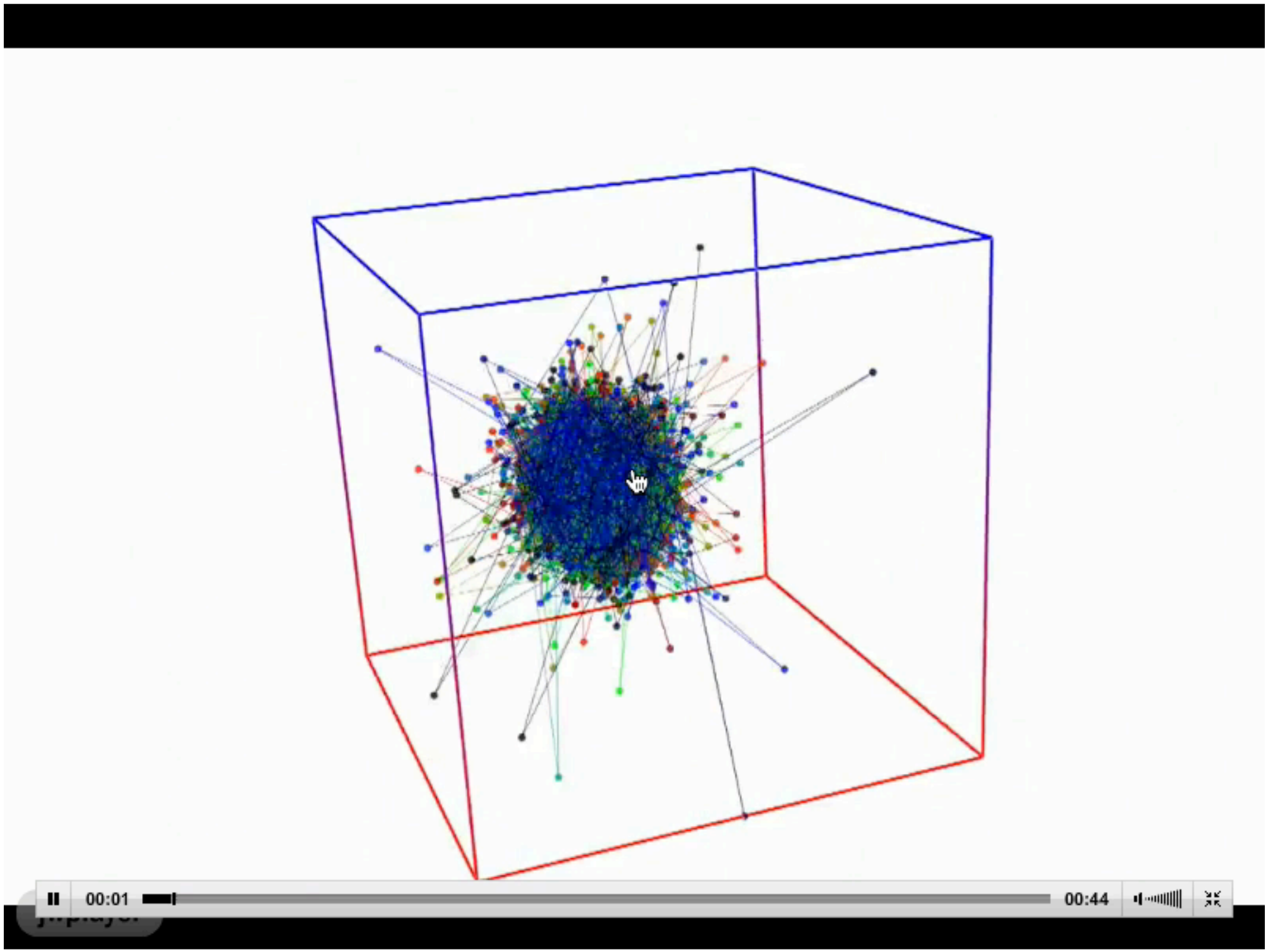
Repeat periodically

e.g,

Vivaldi Network Coordinates:

1. Fully Distributed
2. Used in Vuze/Azereus
3. Uses “2D + height” coordinate

http://wiki.vuze.com/w/Vivaldi_View



Video by Benedikt Fraunhofer (Taken from TUM SOS Group)

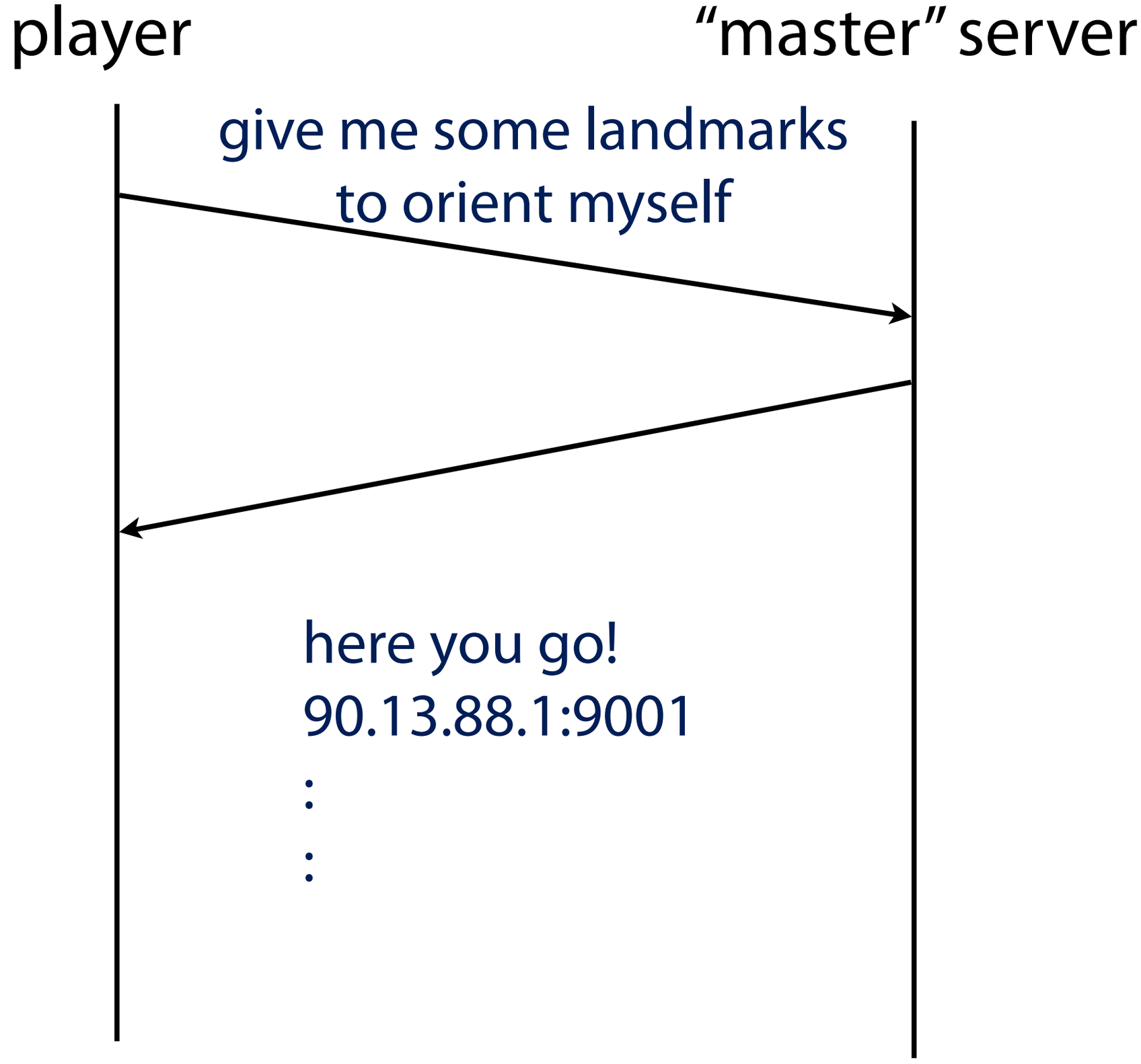
REED

Using Network Coordinates for FPS Server Discovery

Each game server measures RTT to a subset of other servers (and reports RTT measurement to master server.

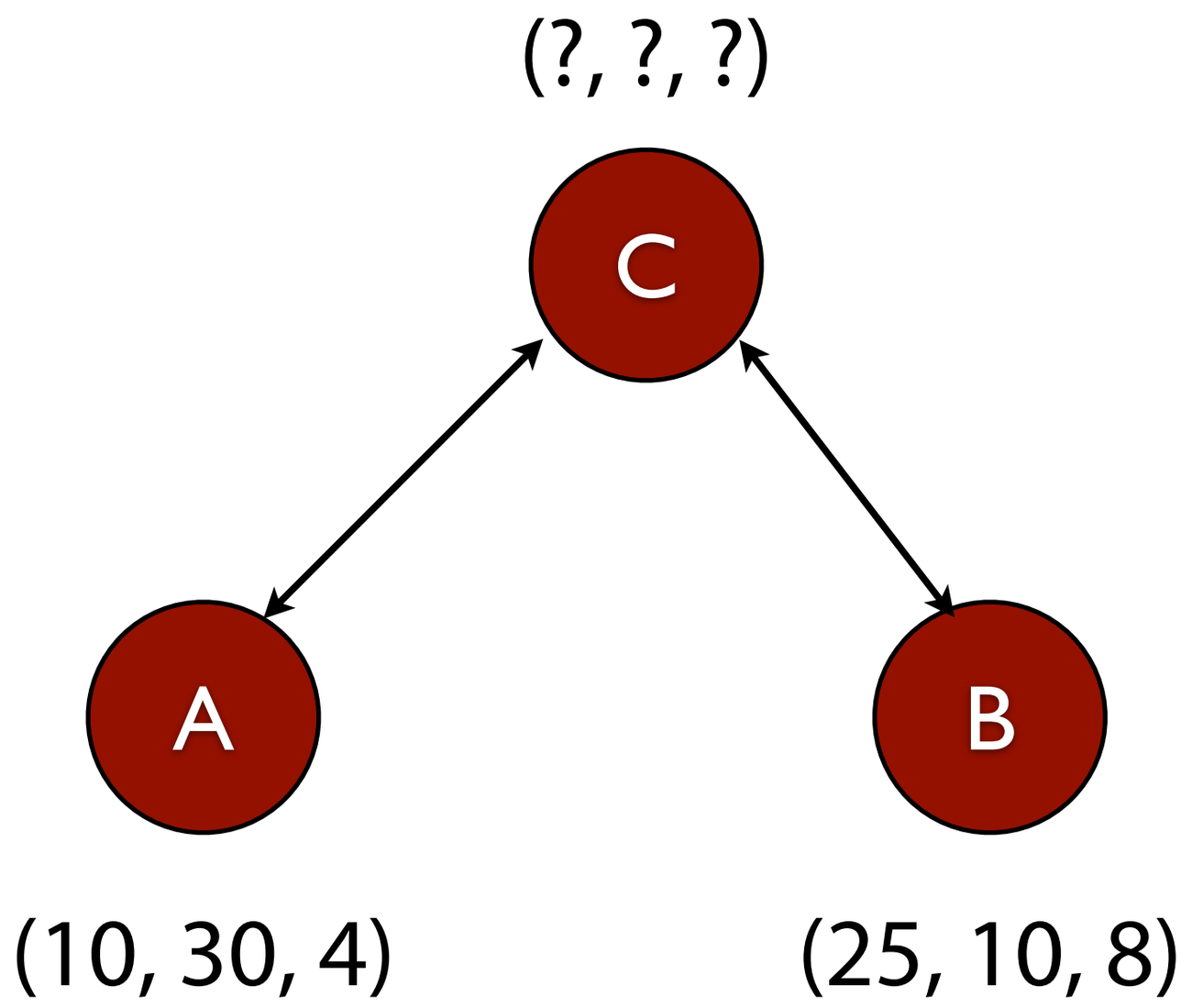
Master server computes network coordinates.

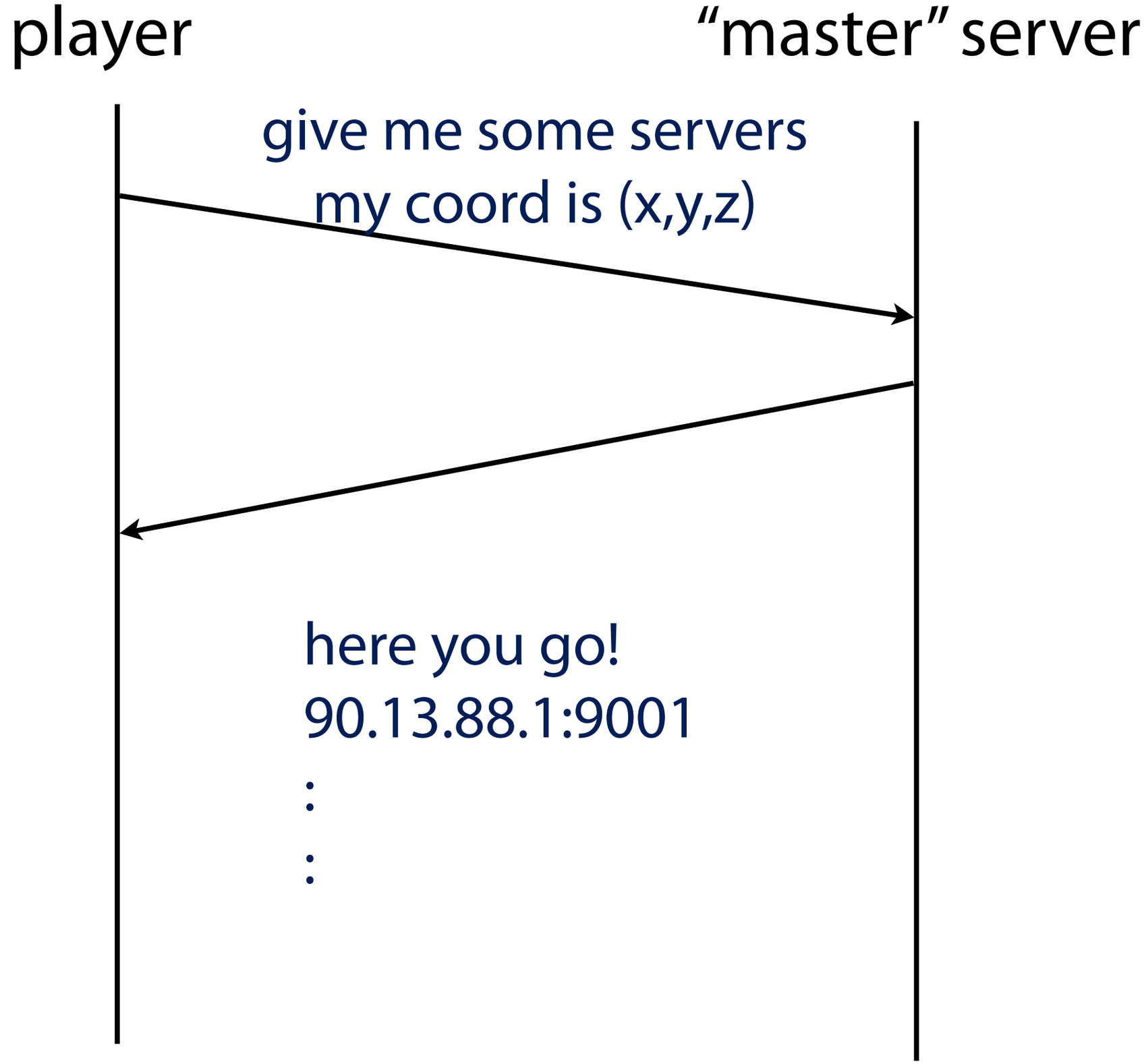
(unlike Vivaldi, REED is centralized)



small number (14) of game servers are returned

Client measures RTT to the landmarks and calibrates its own coordinates.





server returns game server in increasing order of distance from client.

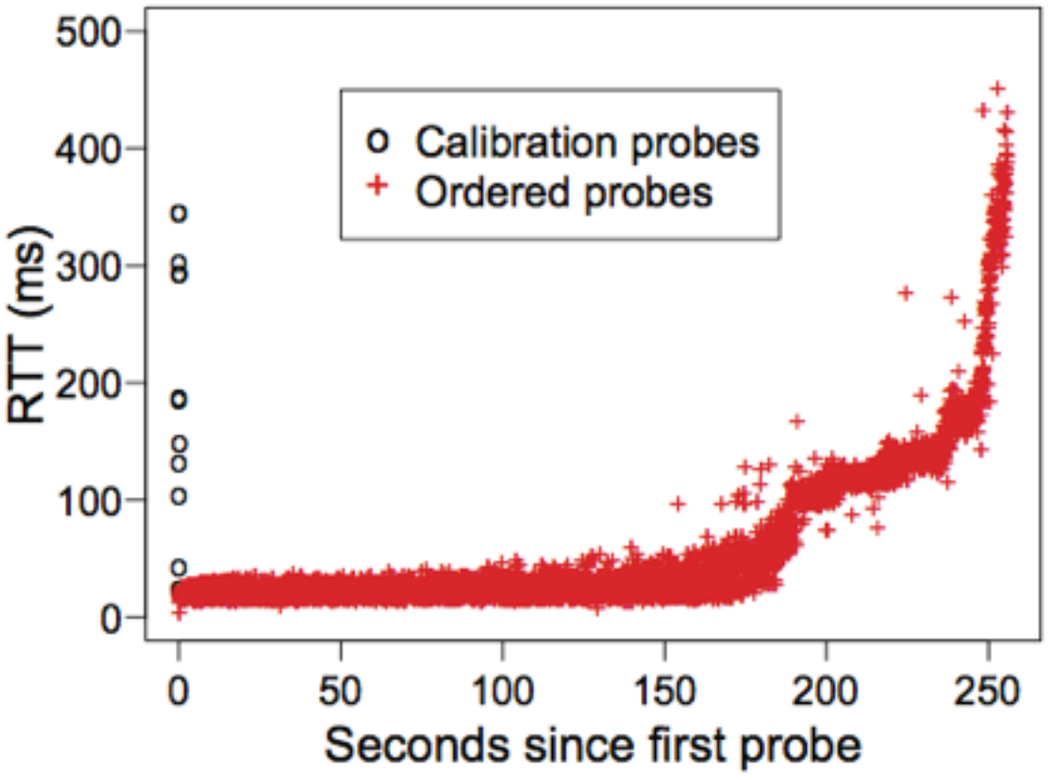


Fig. 7. Probed RTT versus time for European CS:S client using REED at 140 probes/second

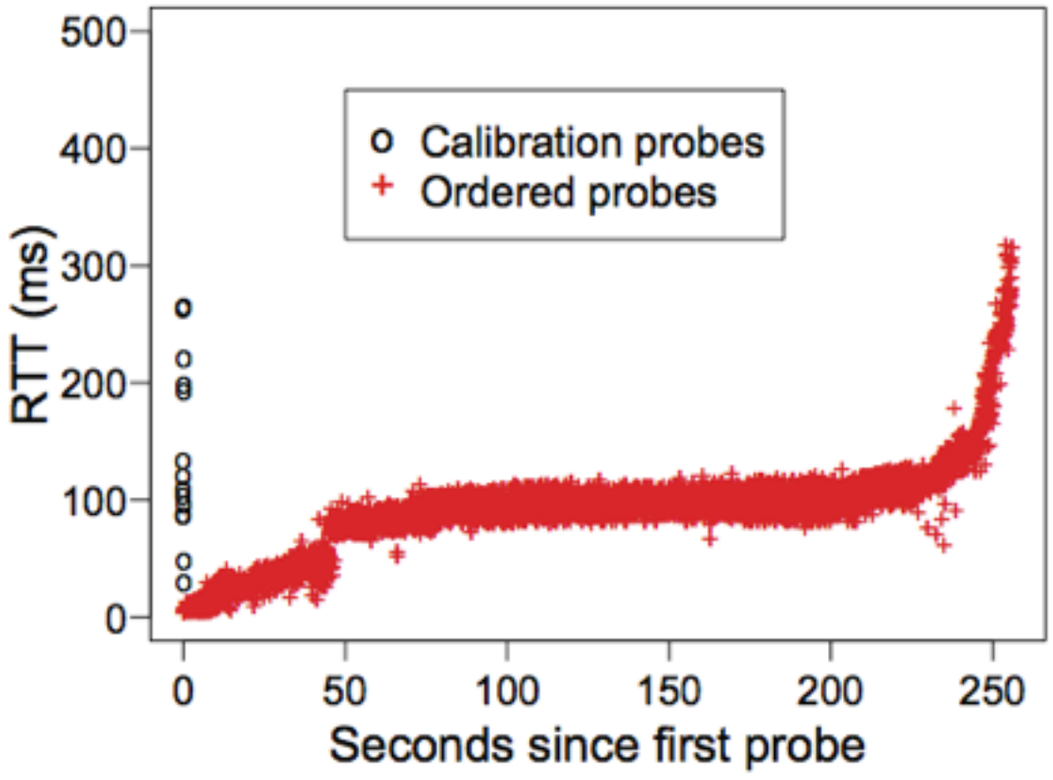
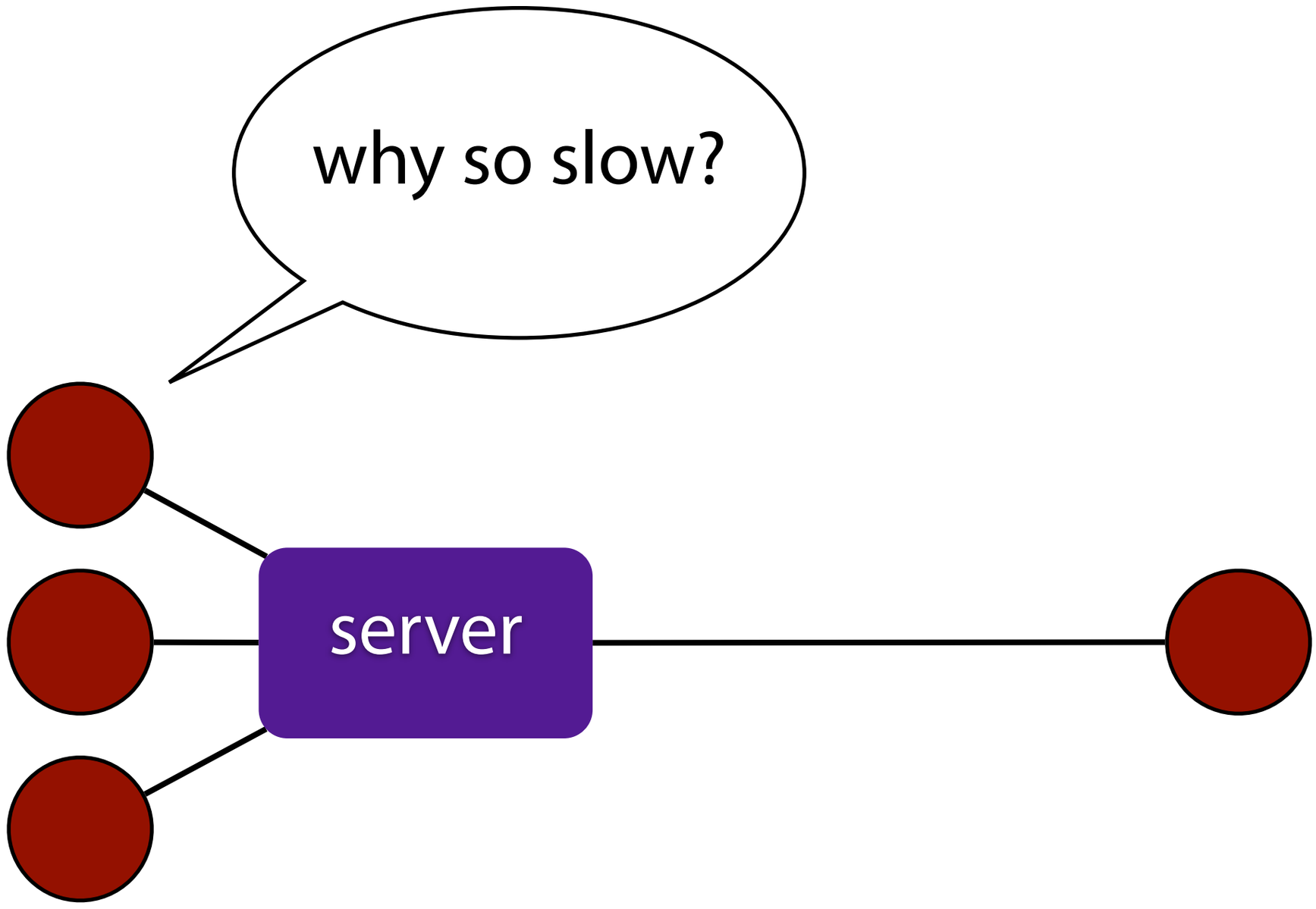


Fig. 8. Probed RTT versus time for American CS:S client using REED at 140 probes/second

Client can stop probing after measured RTTs to servers exceed a threshold.

as little as **1%** of probe time / traffic (compared to naive probing)

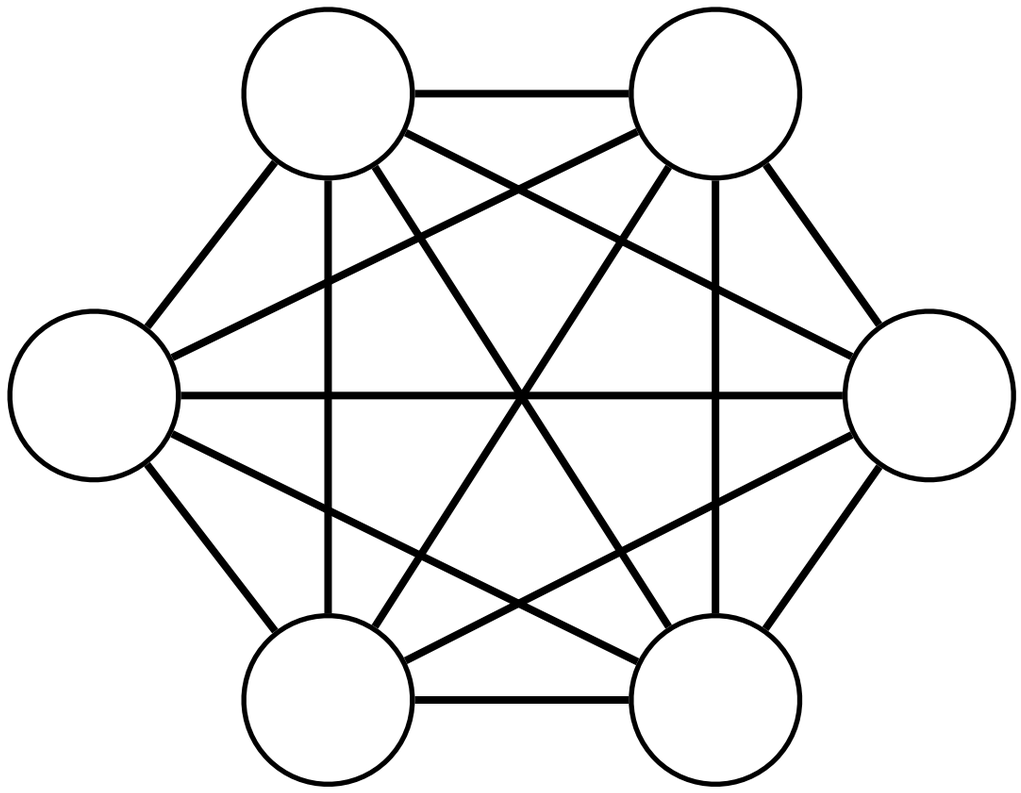
So far: assume player can choose server


why so slow?
server

P2P architecture:
needs to keep latency to
each other low.

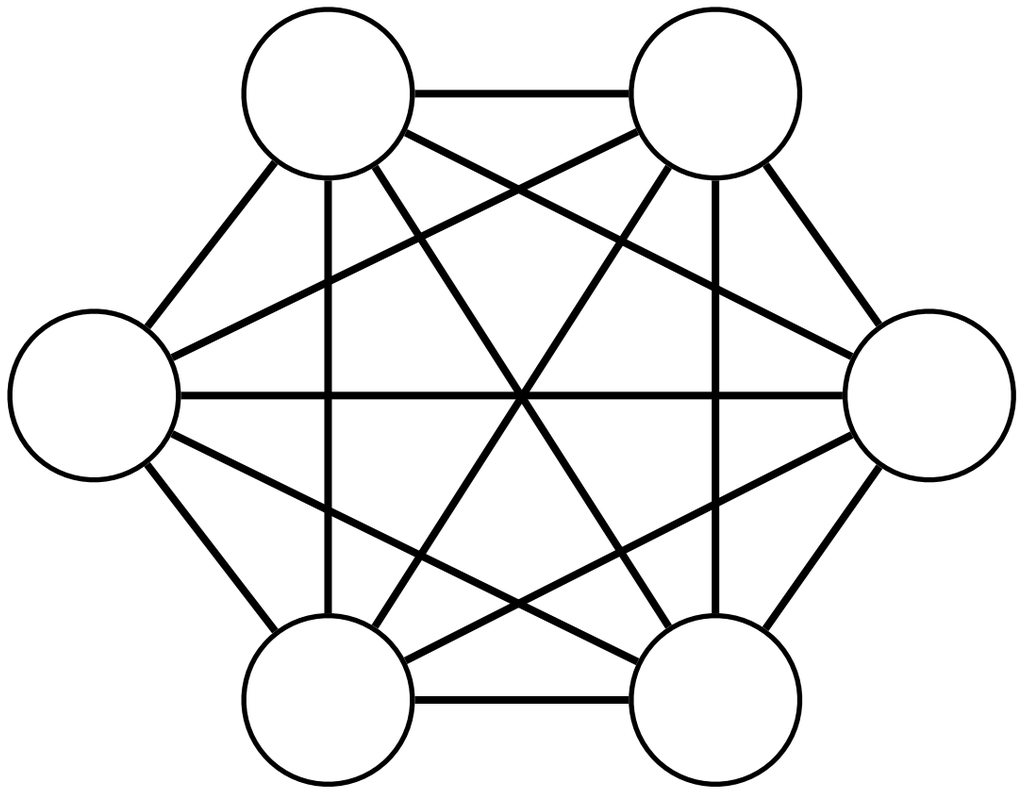
Solution: group players according to their latency to each other.

Players ping each other, report RTT to server



Model problem as a graph, with players as vertices and delay as edge cost.

A subset of players: a **sub-clique**
maximum latency between any pair: **diameter**

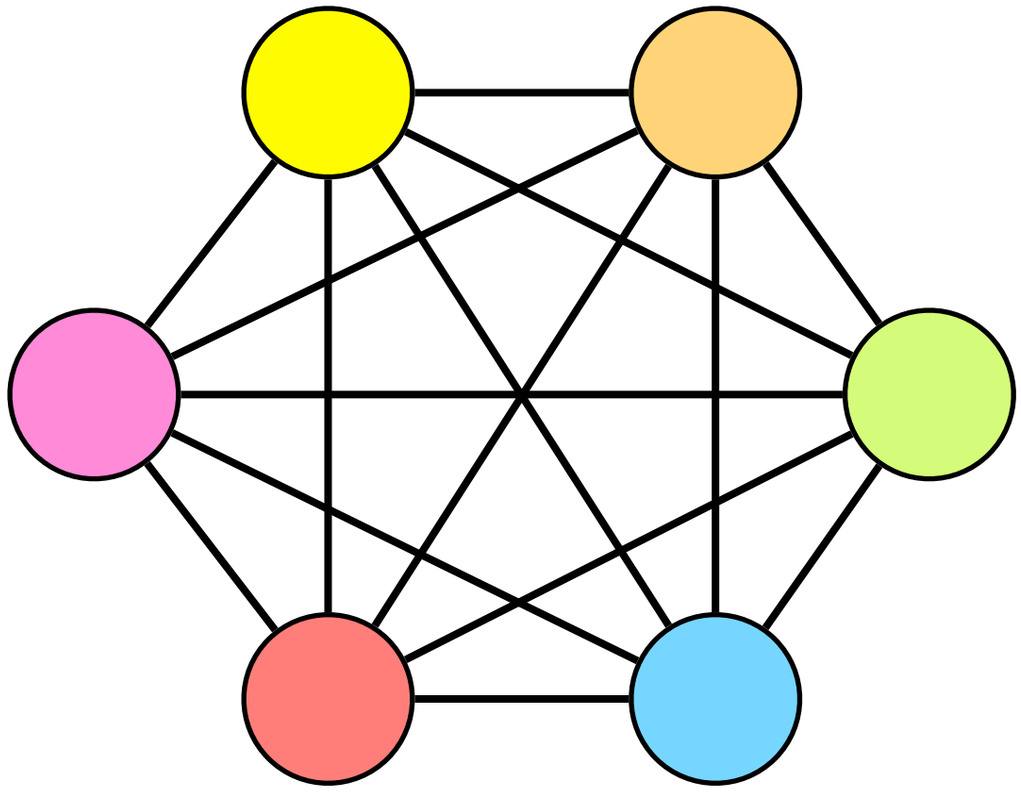


find a k-clique with minimum diameter

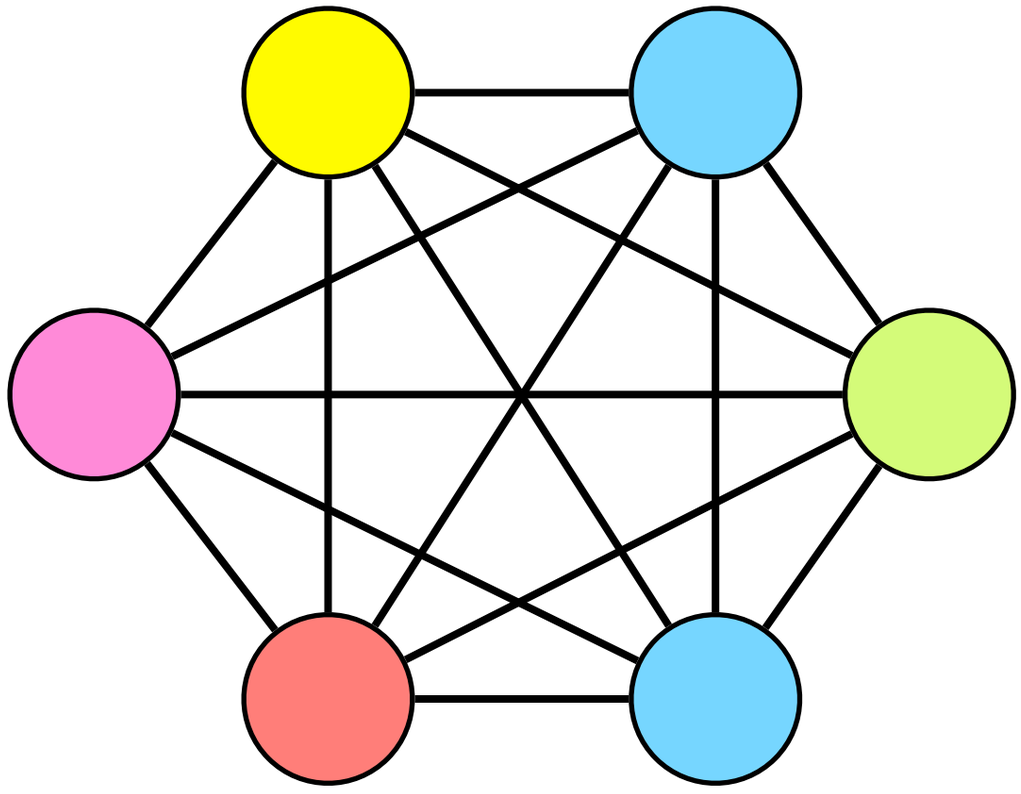
find a largest sub-clique with diameter below a threshold

a solution:

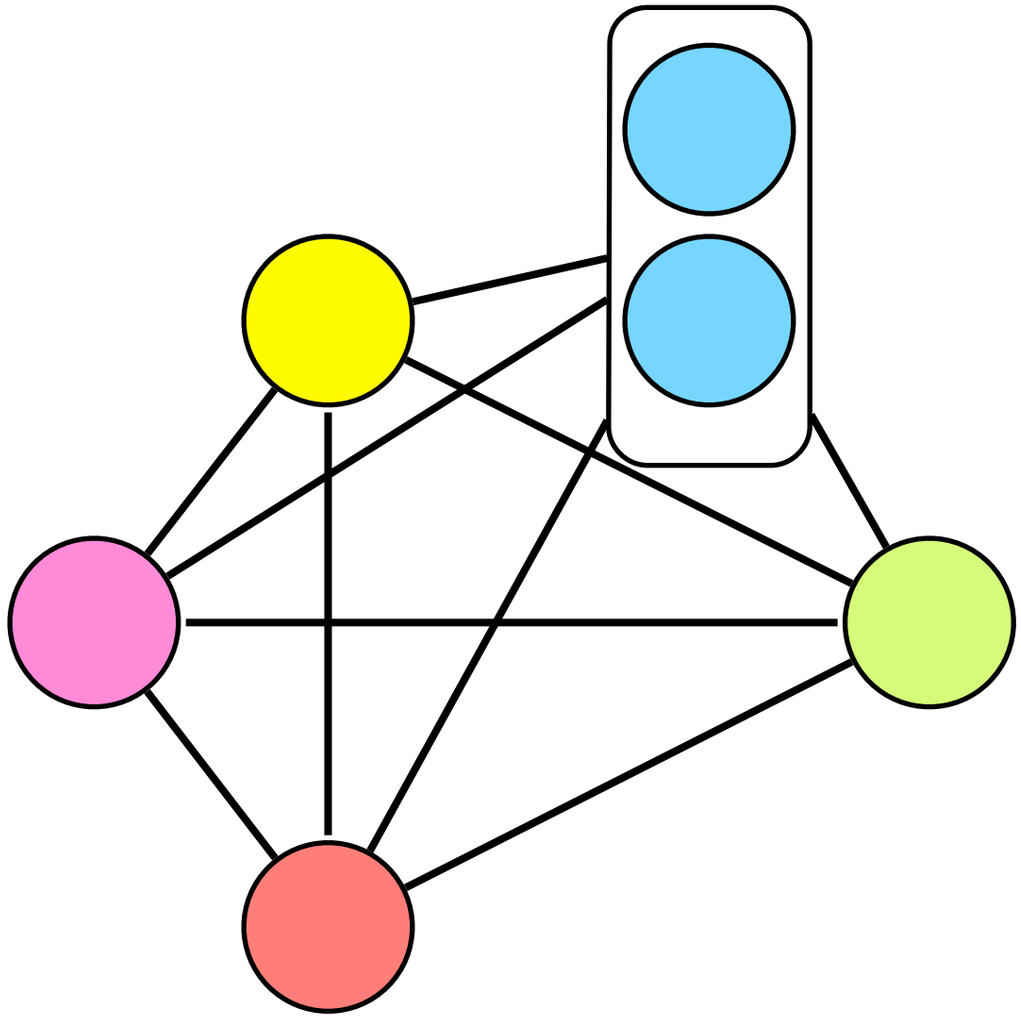
hierarchical clustering



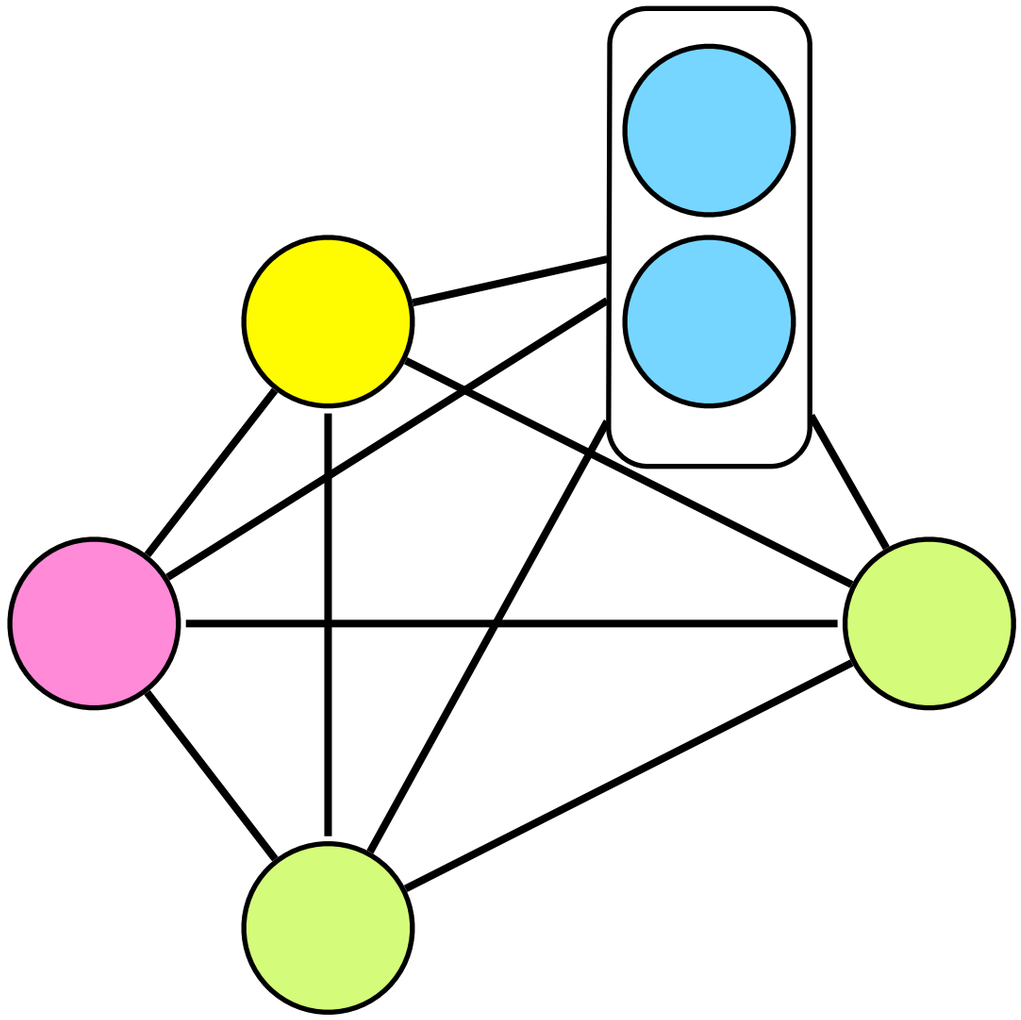
init: every player forms a cluster



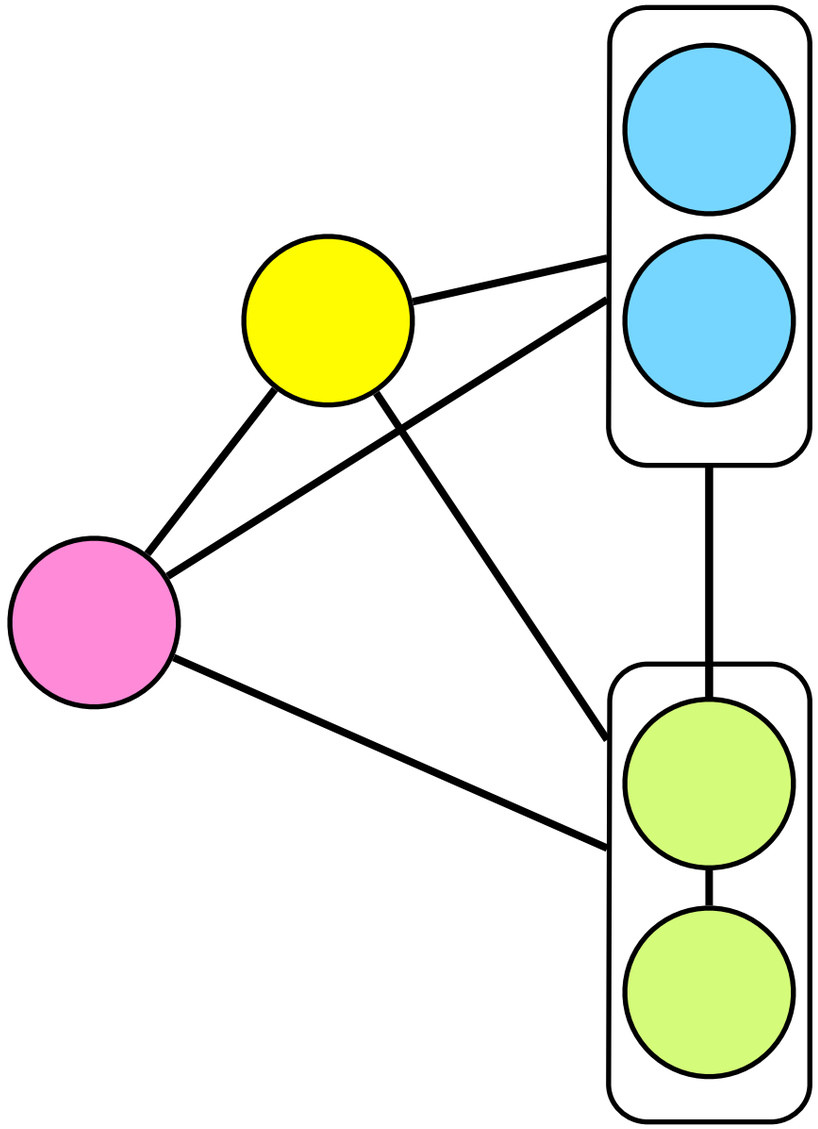
repeat: merge two closest clusters to form a larger cluster



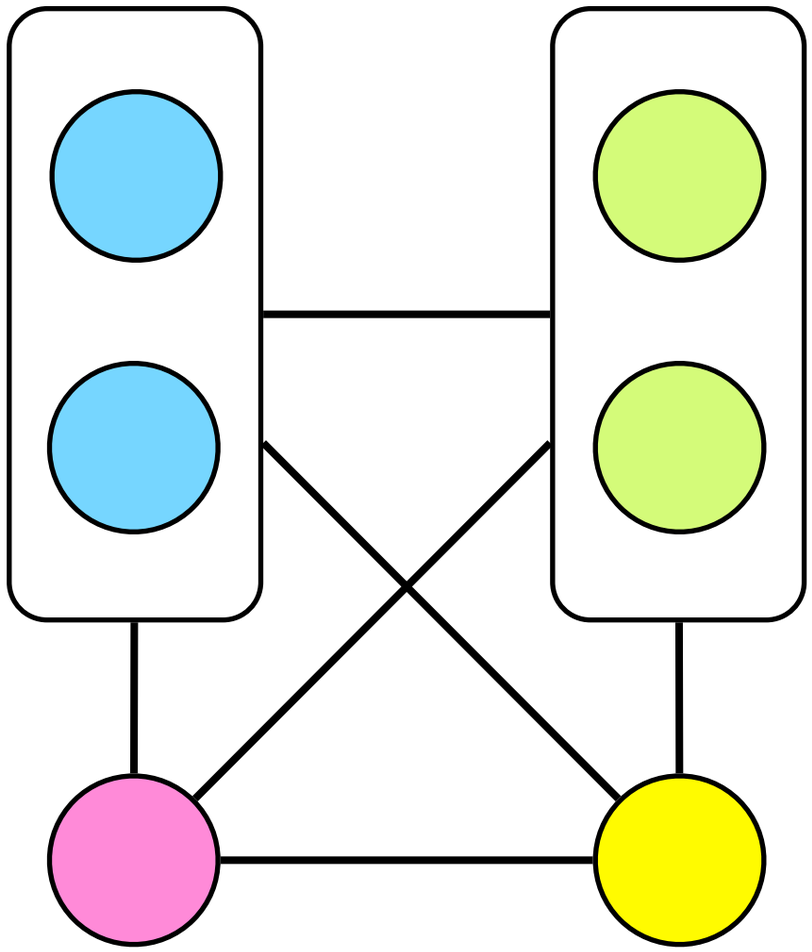
repeat: merge two closest clusters to form a larger cluster



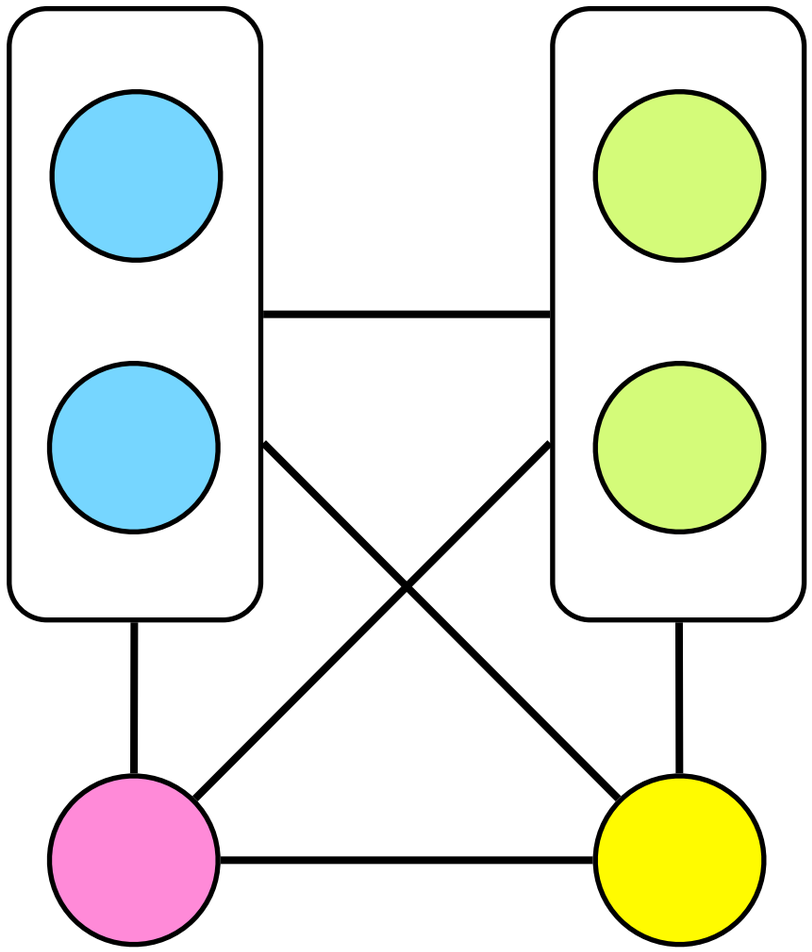
repeat: merge two closest clusters to form a larger cluster



repeat: merge two closest clusters to form a larger cluster



distance between two clusters: max delay between two players, one from each cluster.

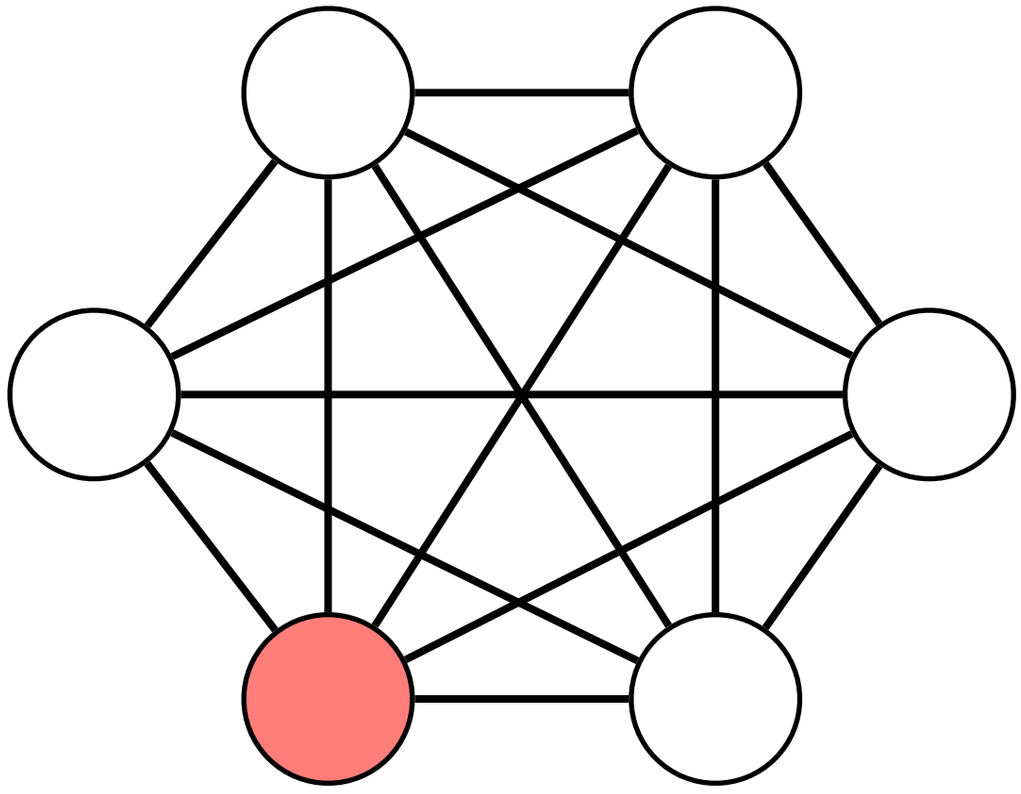


repeat until: diameter exceeds threshold or number of players is met.

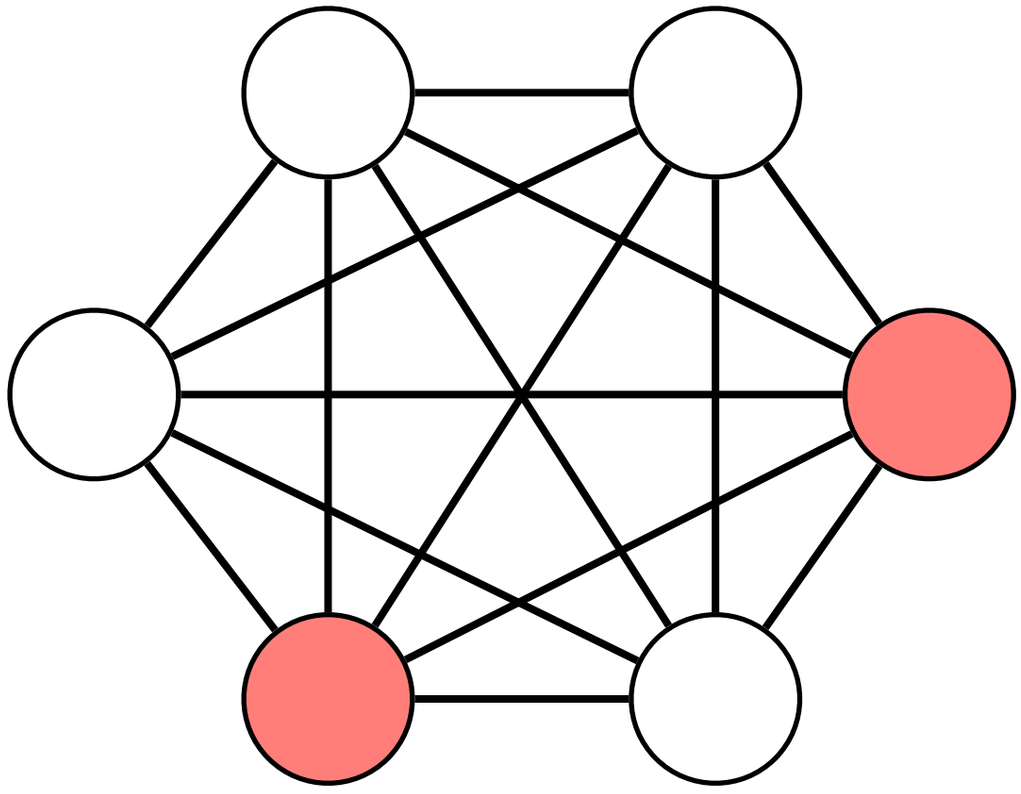
a solution:

QT clustering

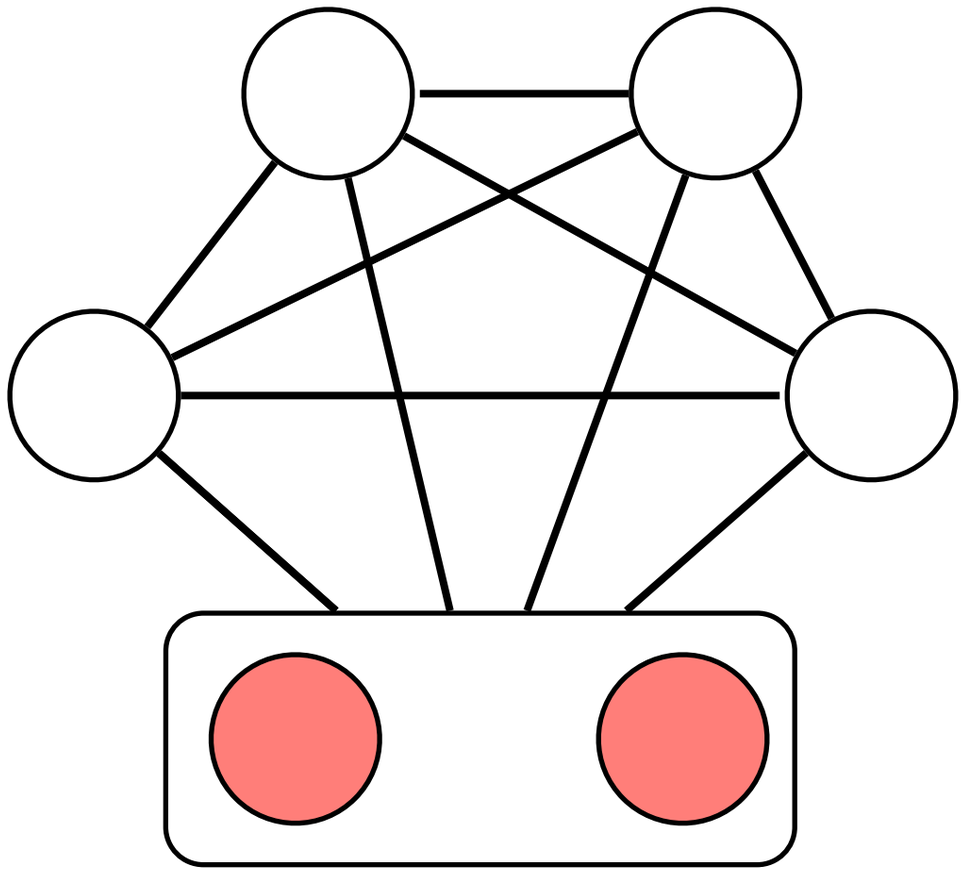
(quality threshold)



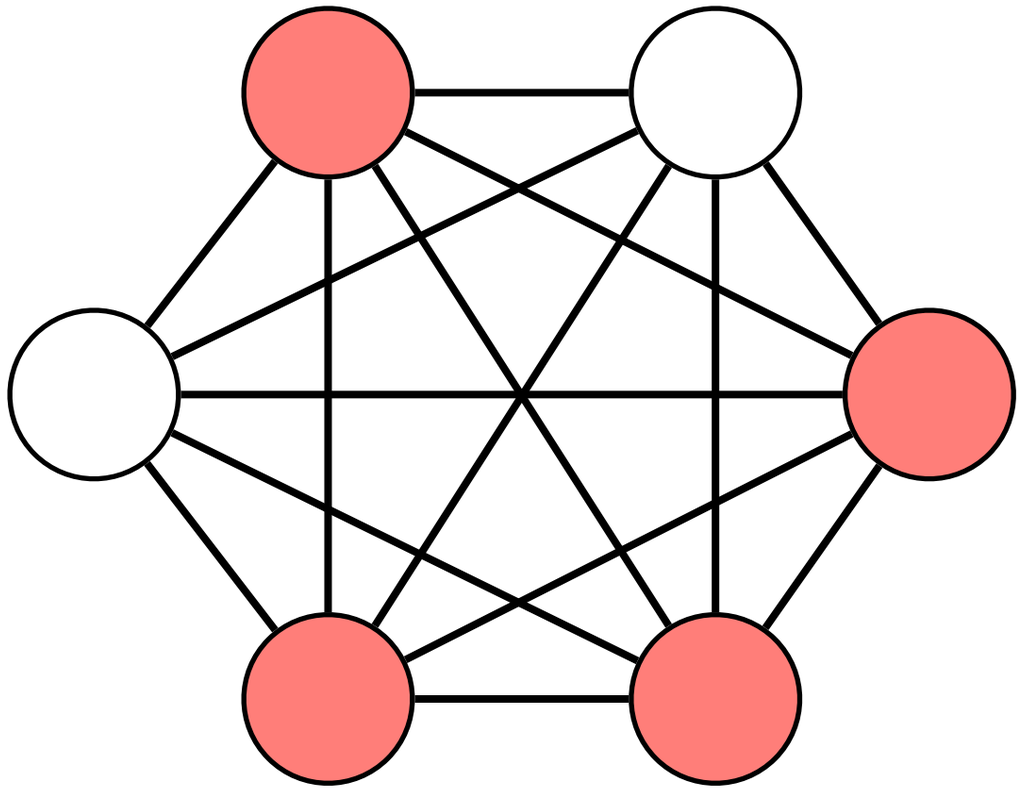
init: build a candidate cluster from one player



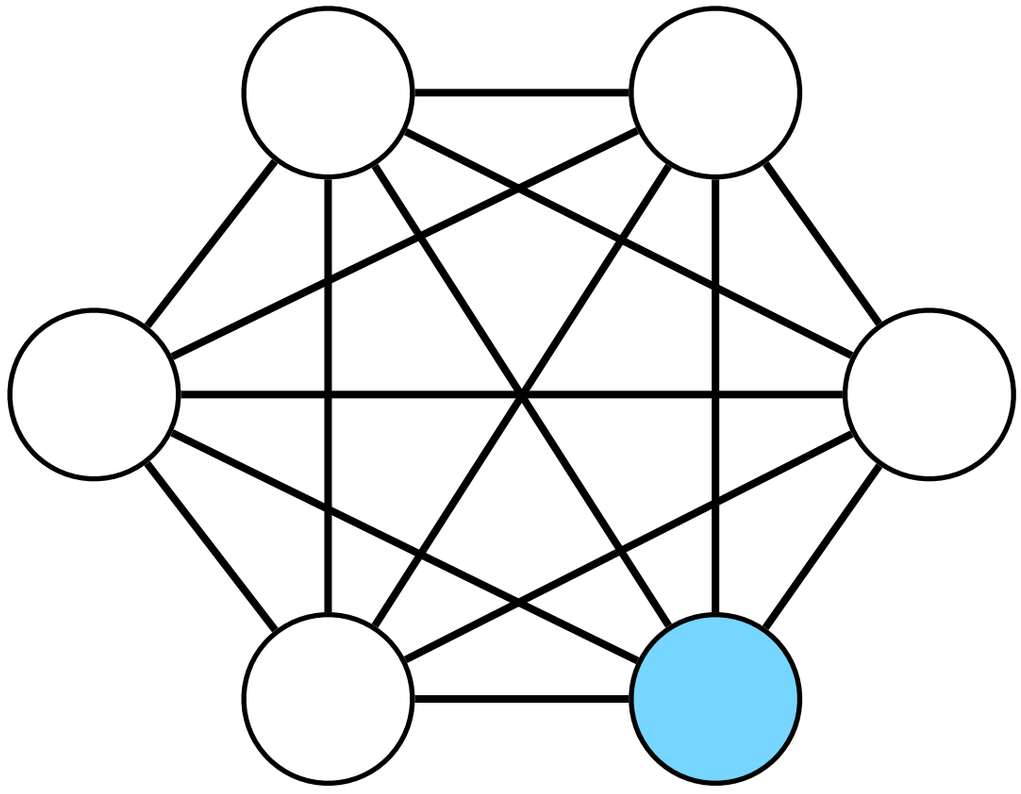
repeat: grow the cluster by adding one player with smallest distance



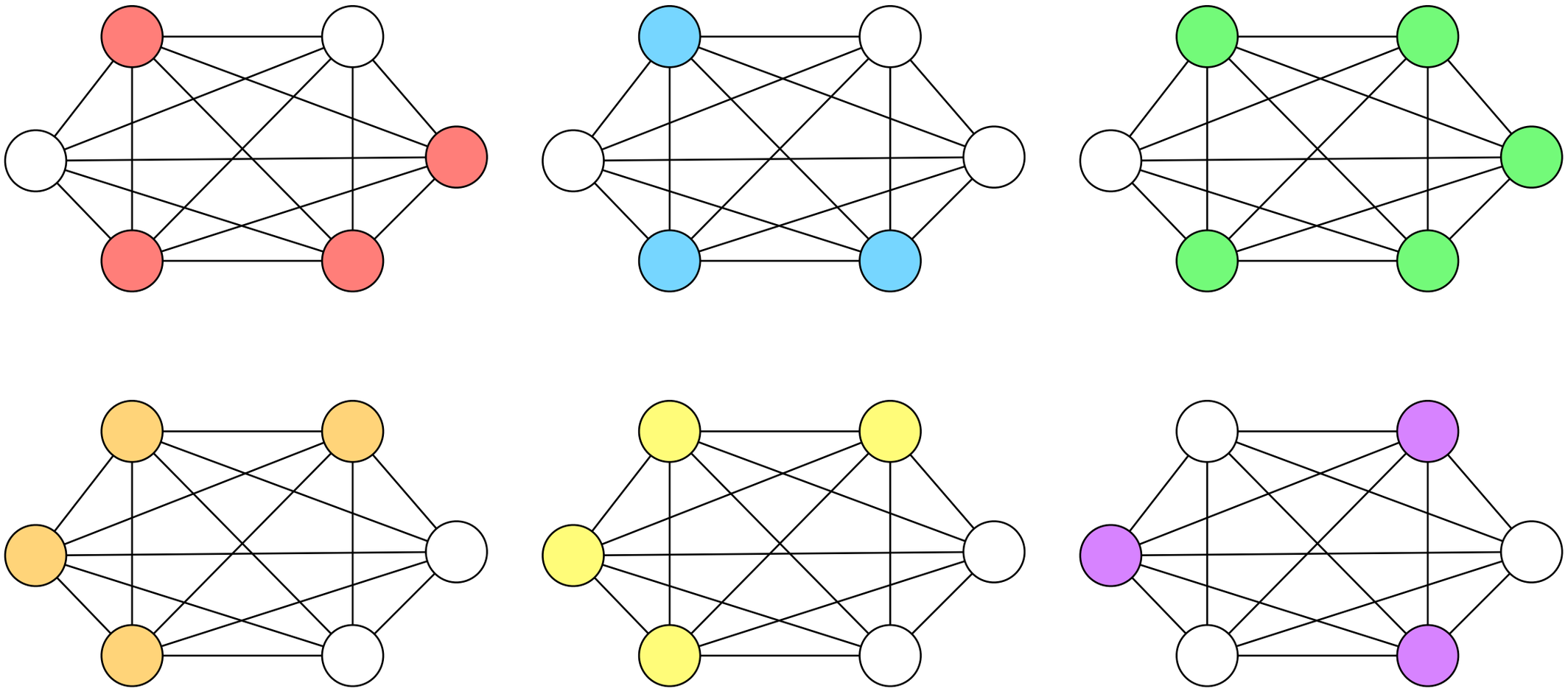
repeat: grow the cluster by adding one player with smallest distance



repeat until: diameter exceeds threshold or number of players is met.



re-init: now, try a candidate cluster from a different player



final step: output the best candidate cluster

Grouping players waiting in lobby according to their latency to each other.

New player: join the closest clusters without voilating size/diameter constraints.

Lecture 10

Server Discovery and Player Matchmaking