ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

inf | Informatik
Computer Science

Introduction to Assignment 3

Distributed Systems Lecture
HS 2011, ETH Zurich

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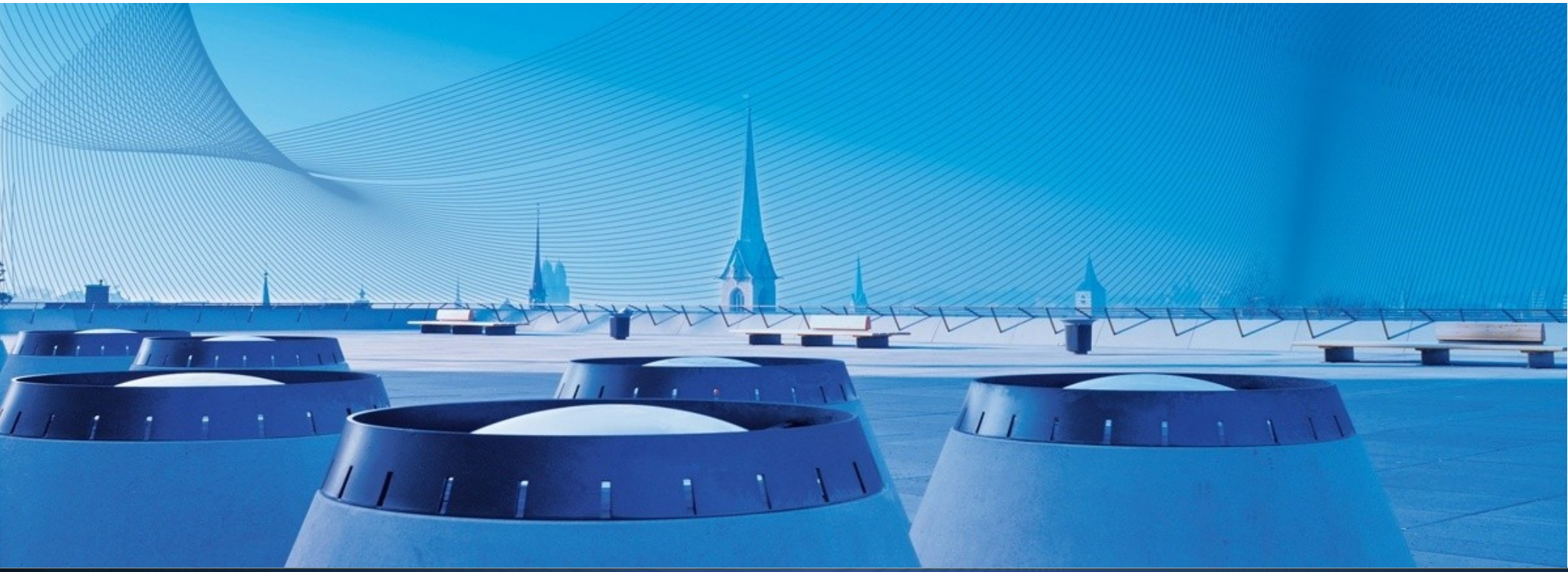


Today's Menu

- Repetition (lecture slides 189 – 195) + UDP
  - Causality
  - Lamport Time
  - Vector Time [new!]

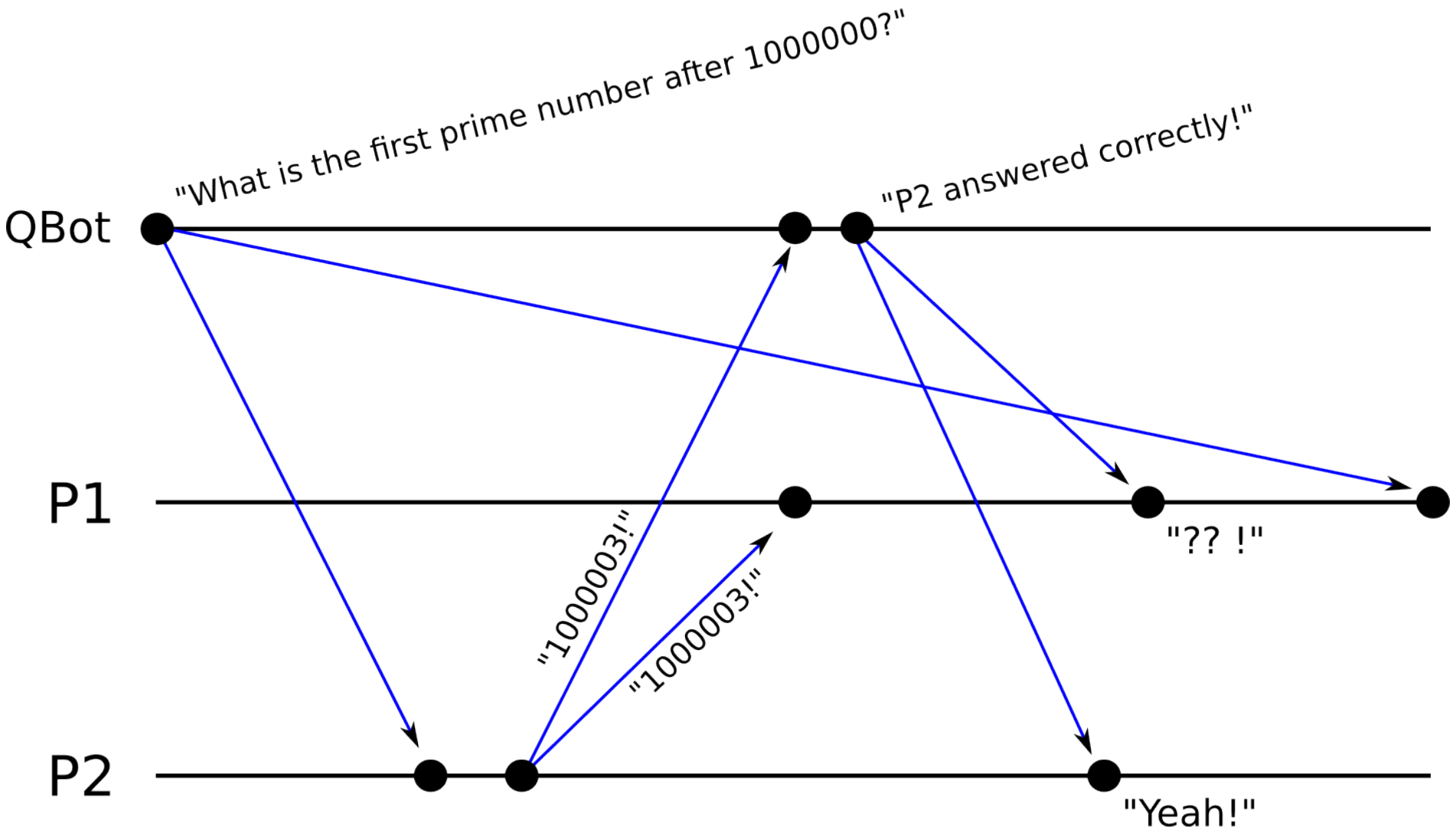
- Assignment 3
  - Task 1
  - Task 2
  - Task 3.1 and 3.2

Briefly: The User Datagram Protocol

- Simple transmission model
  - No hand-shakes, ordering, data integrity
  - Datagrams delayed (out of order), duplicate, missing

- Common applications
  - DNS (port 53)
  - Streaming
  - VoIP
  - Online gaming

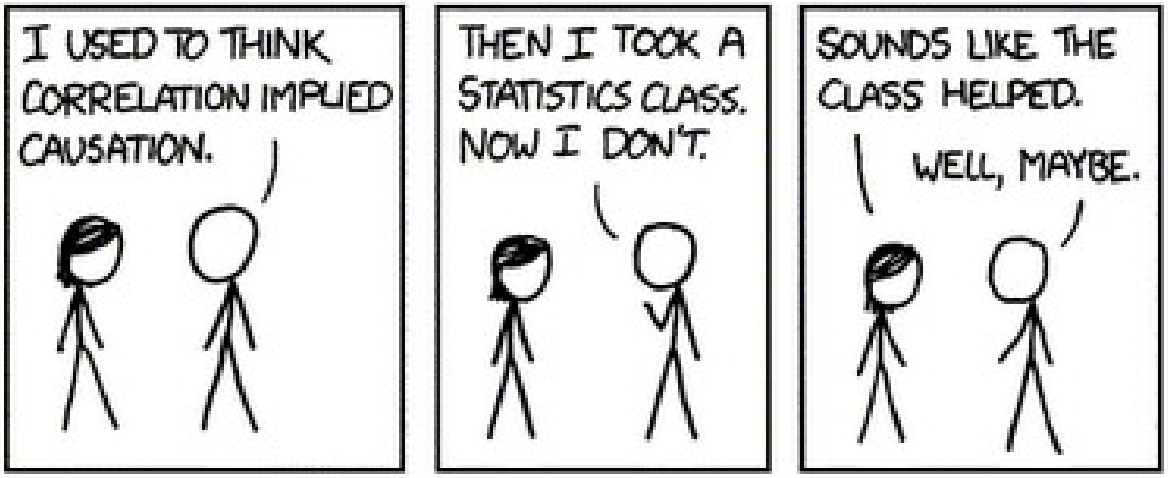
UDP Effects...


"What is the first prime number after 1000000?"
"P2 answered correctly!"
QBot
P1
P2
"1000003!"
"1000003!"
"?? !"
"Yeah!"

Causality

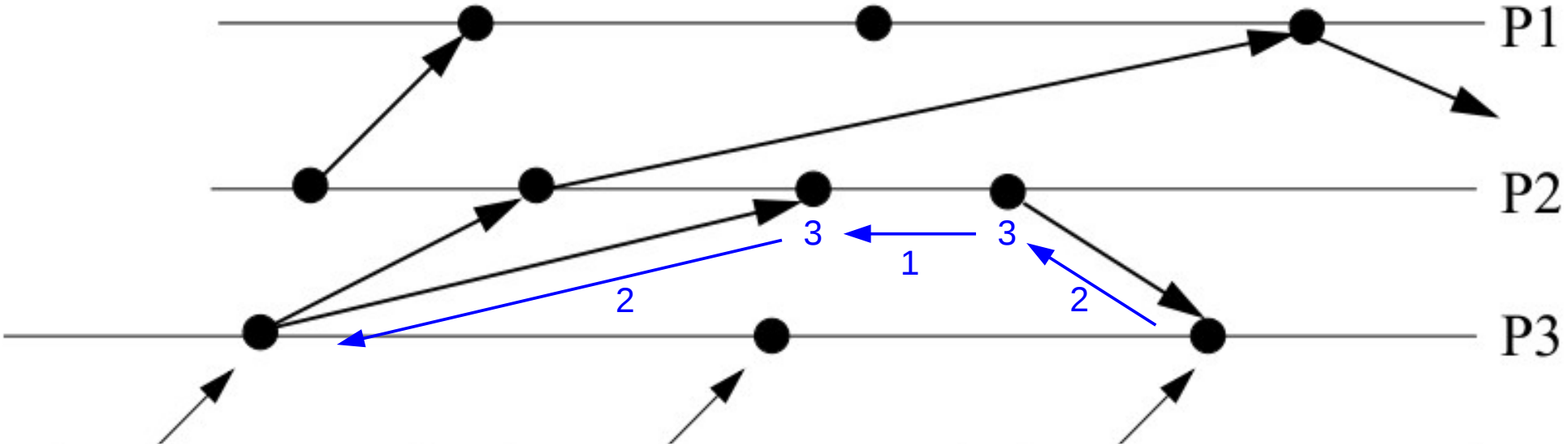
- Interesting property of distributed systems...
- Causal Relation '<' (“happened before”):

```
x < y iff (   (x, y on same process, x happens before y) or
              (x is send and y is corresponding receive) or
              (transitivity) )
```



Causality

```
x < y iff (   (x, y on same process, x happens before y) or   1
              (x is send and y is corresponding receive) or   2
              (transitivity) )                                3
```



Send event Internal event Receive event

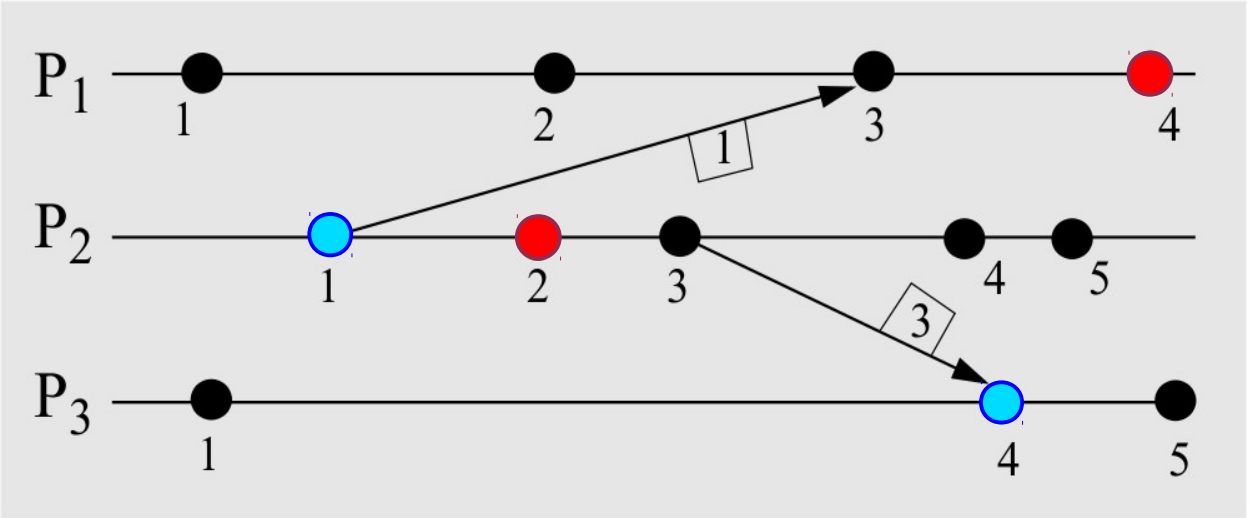
Software Clocks

- *Ideal Real Time:* *Transitive, dense, continuous,...*

- *Logical Time:* *Cheap version of real time*
  - ***Lamport Timestamps***
  - ***Vector Clocks***
  - *Matrix Clocks*

Lamport Time

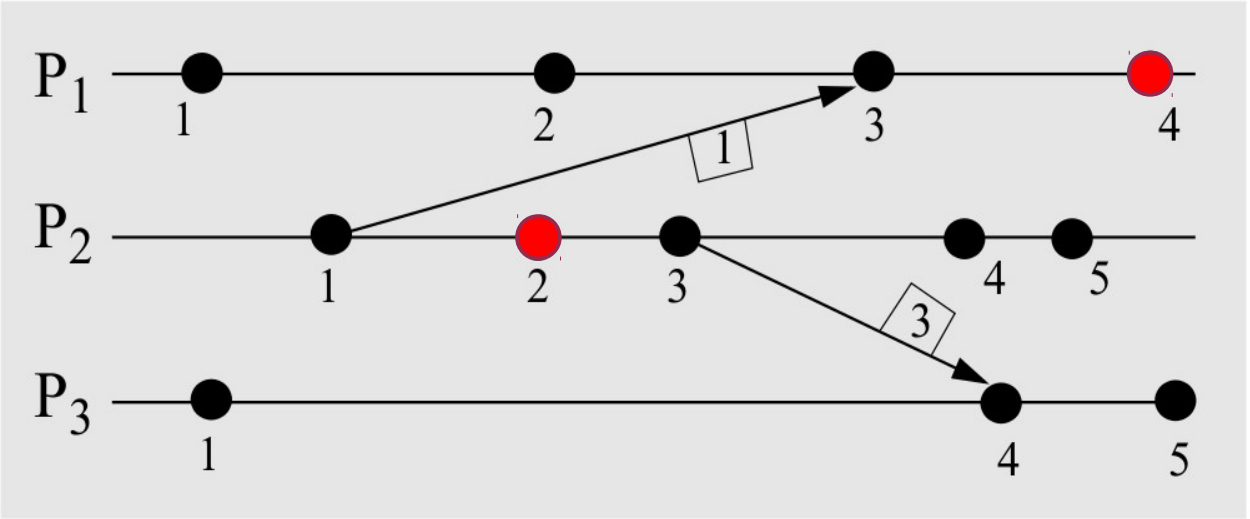
- Using a single clock value
  - Local Event: *Local clock tick*
  - Send Event: *Attach local clock value*
  - Receive Event: *max(local clock, message clock)*
- Satisfies clock consistency condition: $e < e' \rightarrow C(e) < C(e')$



Lamport Time

- Lamport Time does **not** satisfy ***strong clock consistency condition***

$$e < e' \leftrightarrow C(e) < C(e')$$



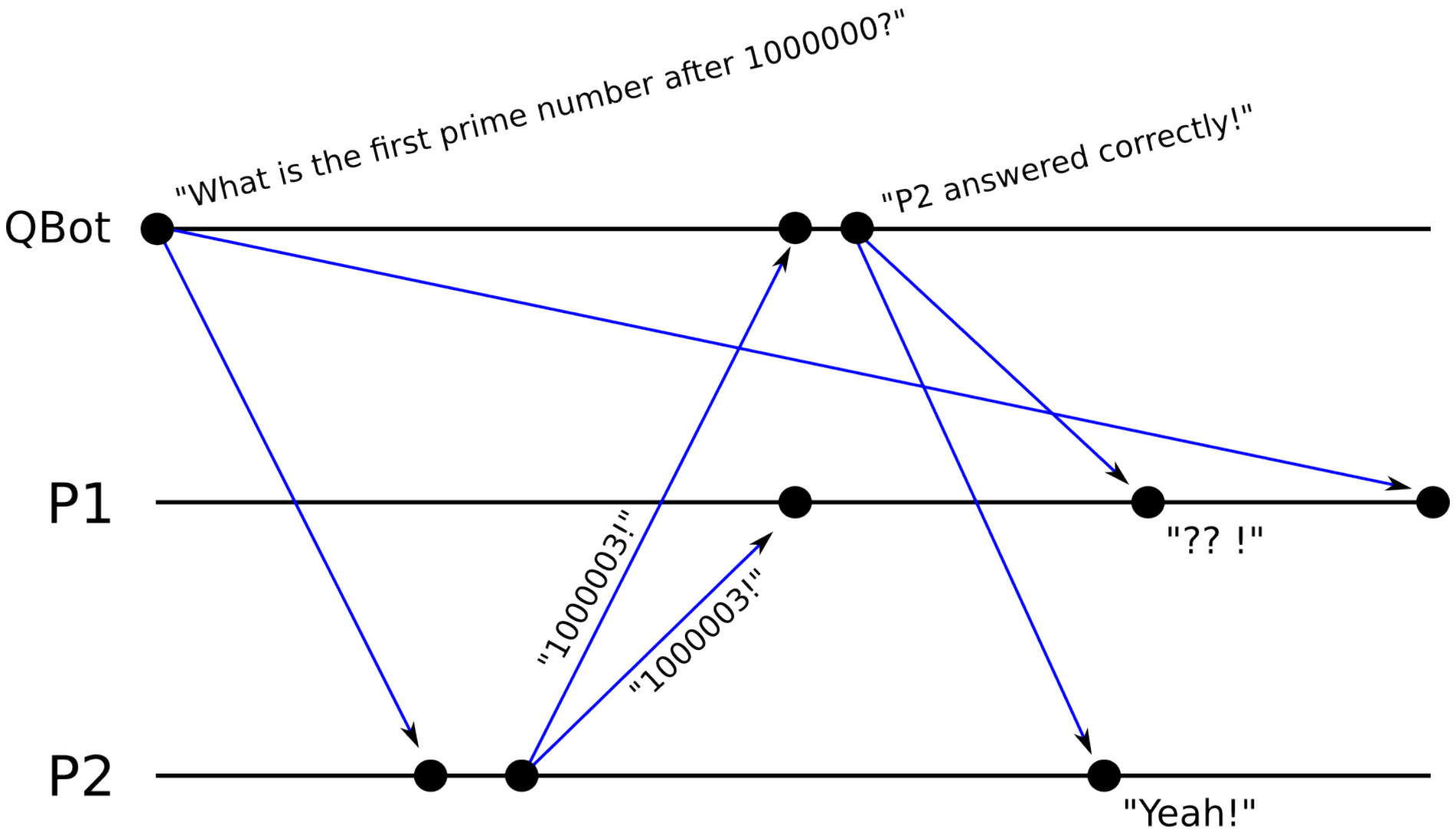
Vector Time

- Refining Lamport Time: Processes keep one counter per process

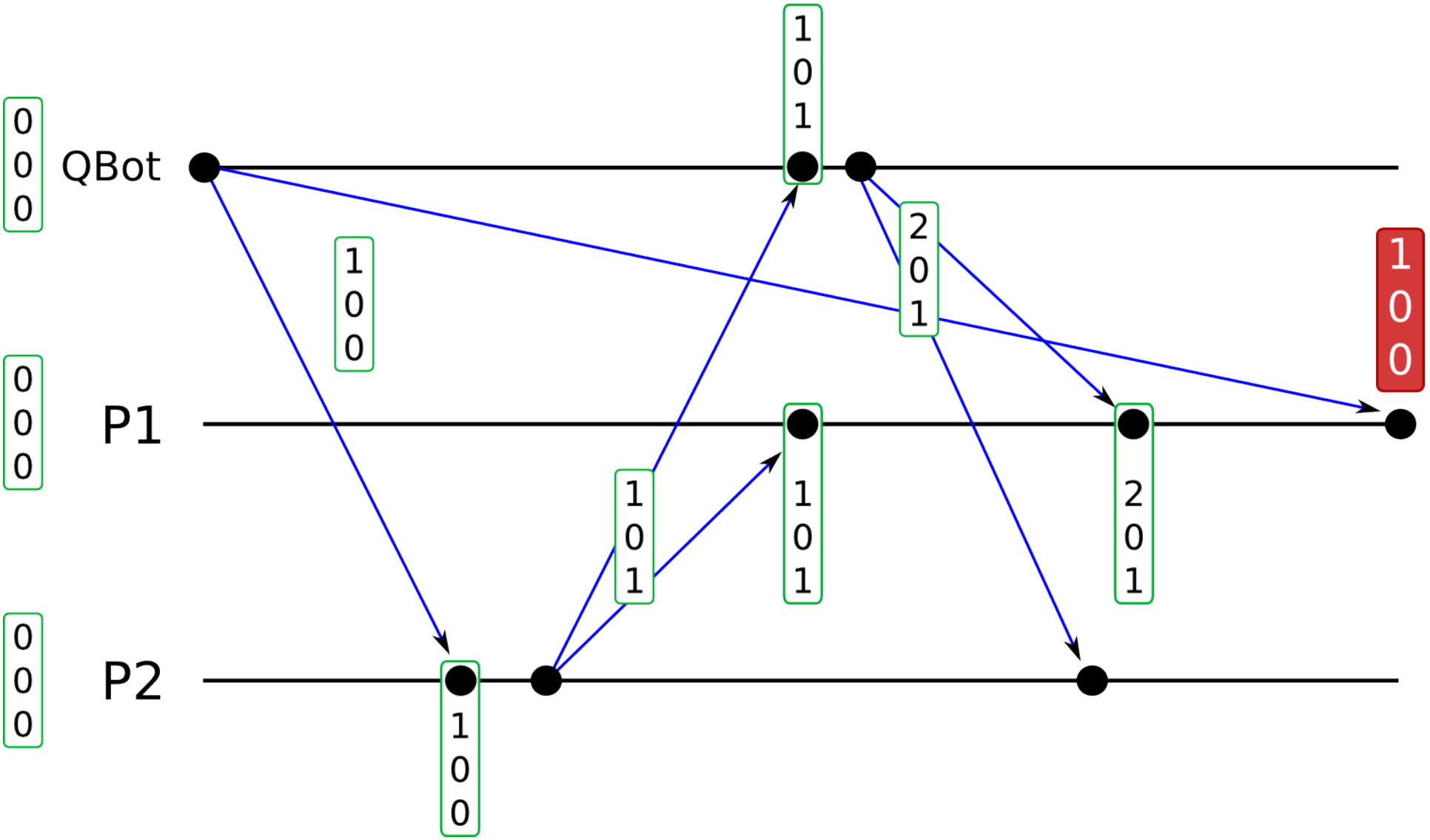
- Does satisfy strong clock consistency condition!

$$e < e' \leftrightarrow C(e) < C(e')$$

Vector Time [example]



Vector Time [example]



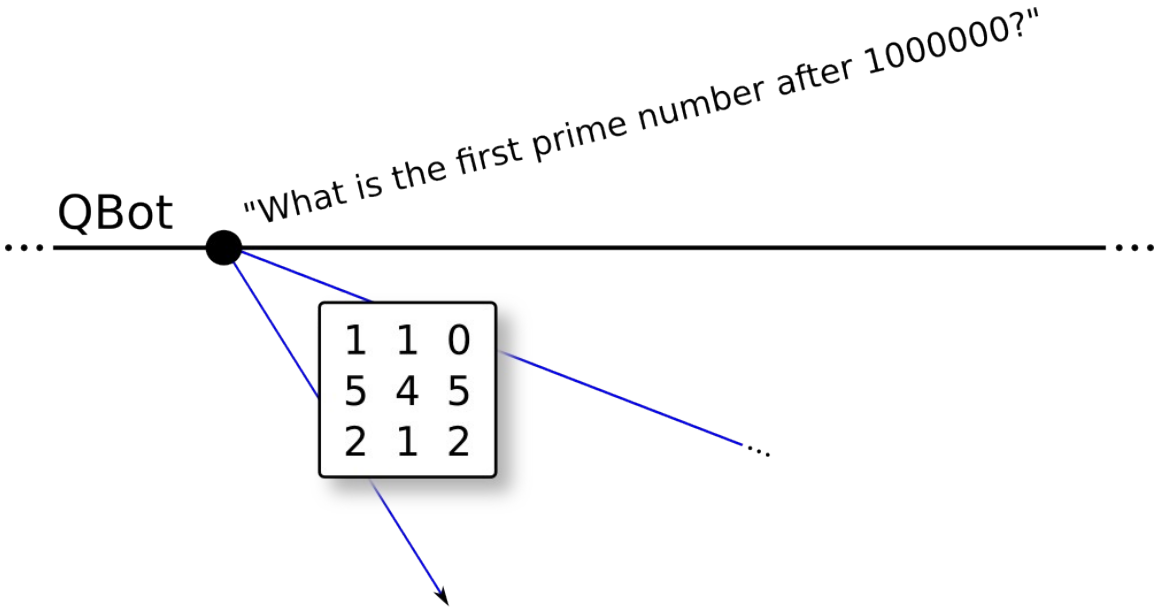
Vector Time

"Process *i stores information on what it thinks about the local time of processes (1,...,n)."*

Matrix Time [not in the assignment]

- Refining Vector Time: Processes keep n counters per process

"Process i *stores information on what it believes that processes (1,...,n) think about the local time of processes (1,...,n).*"



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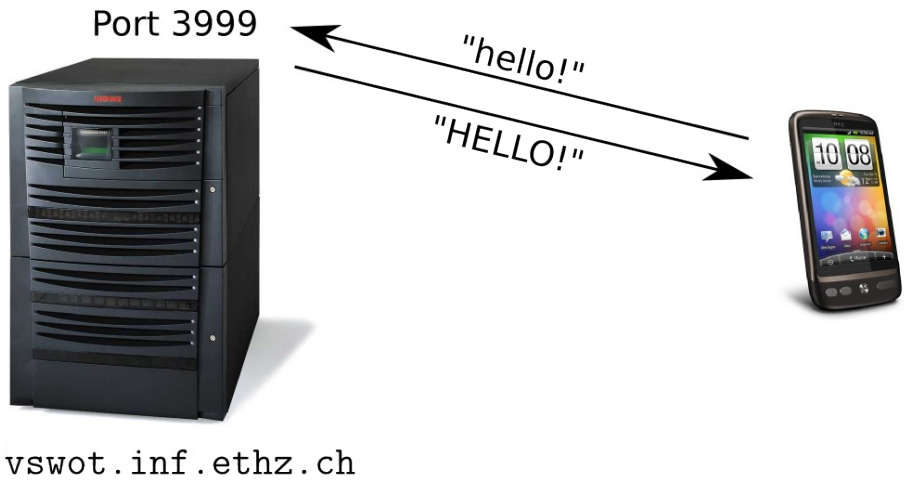
A Mobile, Causal, UDP-based Chat-Application

- Task 1: “Getting familiar with Datagrams”
- Task 2: “Starting the Conversation” + Lamport Timestamps
- Task 3: “Overcoming the Desequencer”
  - 3.1 Vector Clocks
  - 3.2 Additional questions (→Report)
- Report

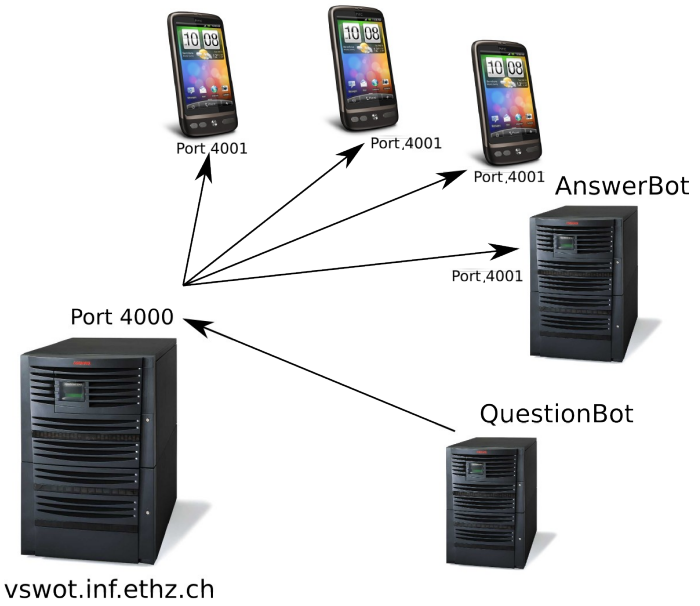
1. Getting familiar with Datagrams

- Communicate with server at vswot.inf.ethz.ch:3999 using UDP
- Provides “capitalization” service



Side Note: Encoding Time...

- Lamport Time: Need to encode single Timestamp
- Vector Time: Need to encode multiple Timestamps

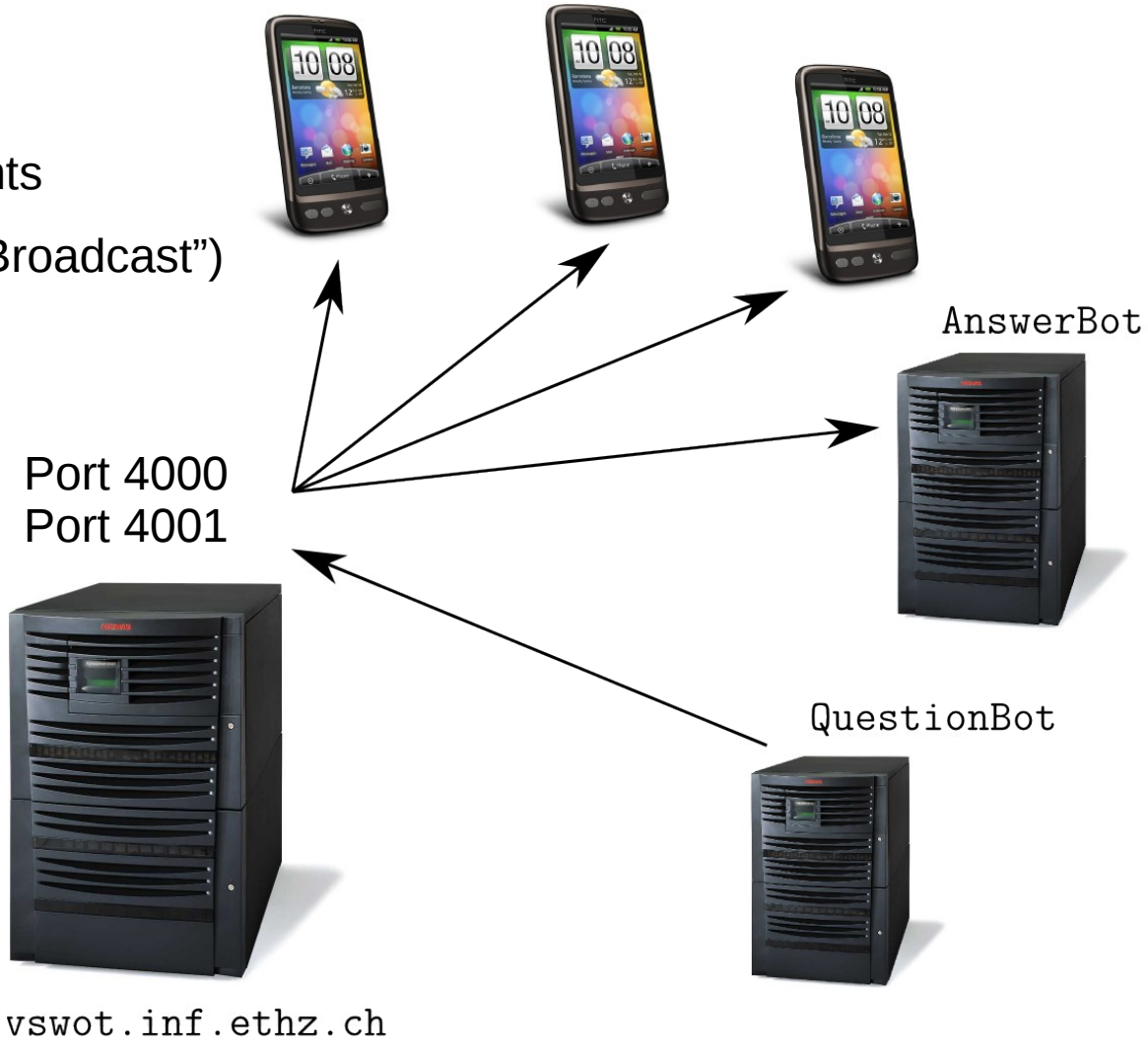


We use a Map<int, int> or dictionary to identify timestamps.

The key or index “0” always corresponds to Lamport time
Index i is associated to one of the clients and issued when registering!

Side Note: System Setup

- vswot Services
  - (De-)Registration of clients
  - Distributes messages (“Broadcast”)
  - De-sequencing “service”



The server *http://vswot.inf.ethz.ch:4000 JSON Protocol:*

--> {"cmd":"register","user":"willi"}

<-- {"index":3,"time_vector":{"3":0,"2":70,"1":71,"0":74},"success":"reg_ok"}

--> {"cmd":"get_clients"}

<-- {"clients":{"/129.132.75.130":"QuestionBot","/129.132.252.221":"AnswerBot","/77.58.228.17":"willi"}}

--> {"cmd":"info"}

<-- {"info":"I am an advanced UDP server that is running at port 4000 to provide a de-sequencing service for Android UDP chatting programs..."}

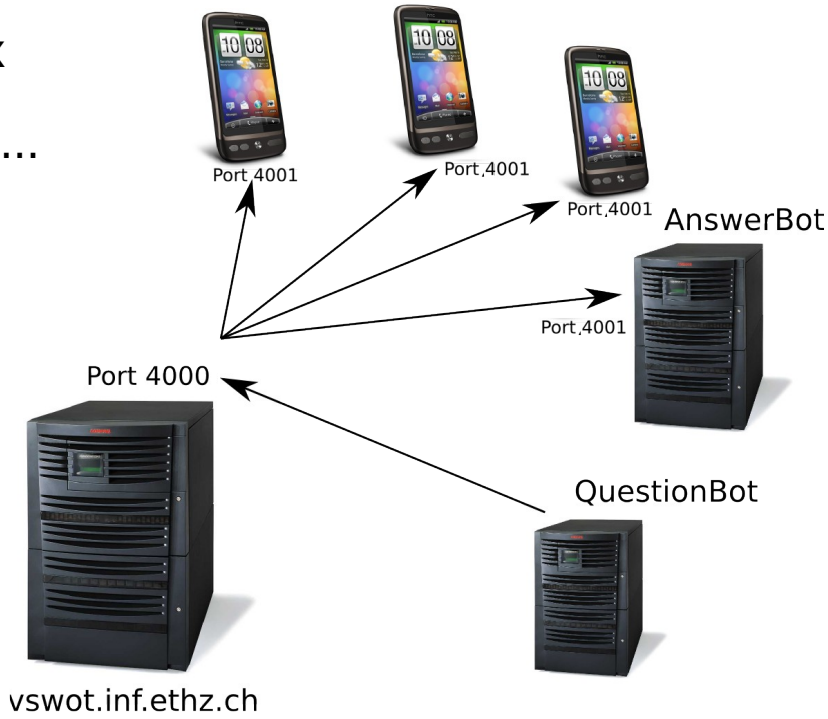
--> {"text":"hallo","cmd":"message","time_vector":{"3":1,"2":70,"1":71,"0":75}}

--> {"cmd":"deregister"}

<-- {"success":"dreg_ok"}

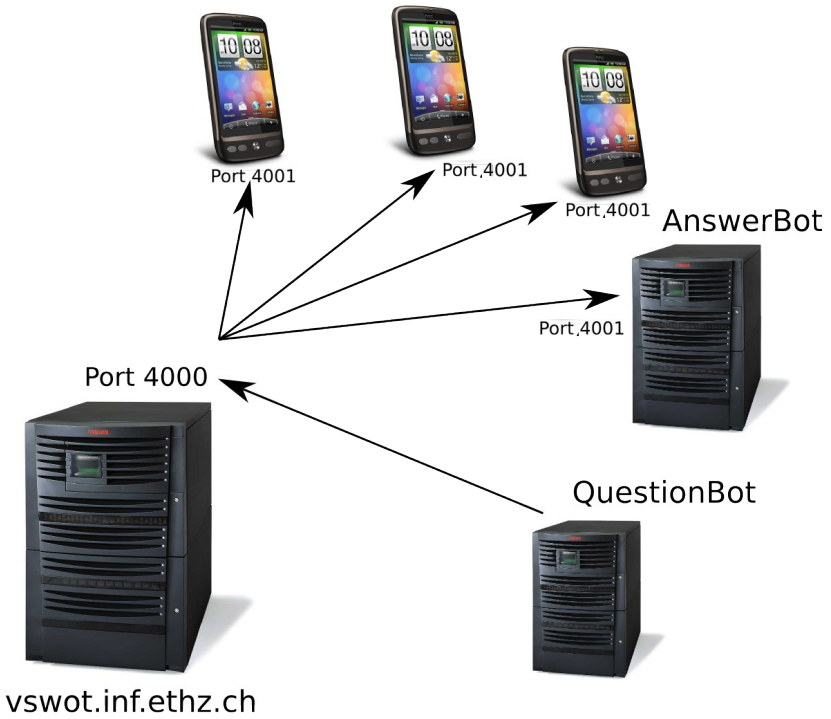
2. Starting the Conversation

- UDP chat with server (ports 4000/4001)
- Causality preservation via **Lamport Time**
- Lamport Timestamp stored **in 0th time vector index**
  - So: Only consider this index when doing task 2...



3.1 Overcoming the Desequencer

- UDP chat with server (ports 4000/4001)
- Causality preservation via **Vector Clocks**
- Own Timestamp **in ith time vector index**
  - i assigned by Server on registration



3.2 Overcoming the Desequencer

- When exactly are two Vector Clocks causally dependent?
  - Does your application allow “purely local” events? Do they trigger a clock tick?
  - Does a local clock tick happen before or after the sending of a message?
  - How are *receive* events handled? Do they trigger local clock ticks?

- Dynamically Joining / Leaving Clients
  - Read the paper “Dynamic Vector Clocks”
  - Describe the approach taken there

Cover this in your report!

Send / Receive / Tick policies

- Multiple ways to implement vector clock ticking
  - Tick only when sending, after sending [vs. before sending]
  - Tick when receiving and sending, after sending [vs. before sending]

- QuestionBot's and AnswerBot's policy:
  - Tick only when sending, before sending

    Example: Message from process 2 with timestamp *[4,5,1]* means:

    > "Before receiving me, you should already have received and delivered 4 messages from process 1, **4** (!) messages from process 2 and 1 message from process 3!"
    >
    > "If you did not receive these, wait before delivering me!"
  - What if a message is lost?

Issues / Considerations

- **Maybe try it in pure Java first...**
  - Better debugging... (e.g., Exceptions are actually displayed...)
  - Faster & More convenient

- **Use VPN when not in ETH network!**
- Lots of groups interact via the chat server
  - Potential Problem: Some groups non-compliant
  - Result could be: Everyone's code crashes...

  - Solution: Tag your messages (e.g., using your group number)
    Only consider own messages

That's it...