ETH zürich

Distributed Systems - HS 2013 Assignment 3

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Contact format

- If you need to contact me by email, please respect the following format:
  - Subject should be [VS HS2013] nethz – Description of your problem
  - Where nethz is the nethz of the group's leader
  - This way your email doesn't get lost in the flow of emails and if I need to check logs on the server, I can check your entries more efficiently.
- Please remember that if you contact me shortly before the deadline, a timely reply cannot be expected.

Outline

- Review of logical time and UDP
  - Causality
  - Lamport Timestamps
  - Vector Times
- Assignment 3
  - Task 1
  - Task 2
  - Task 3.1 and 3.2

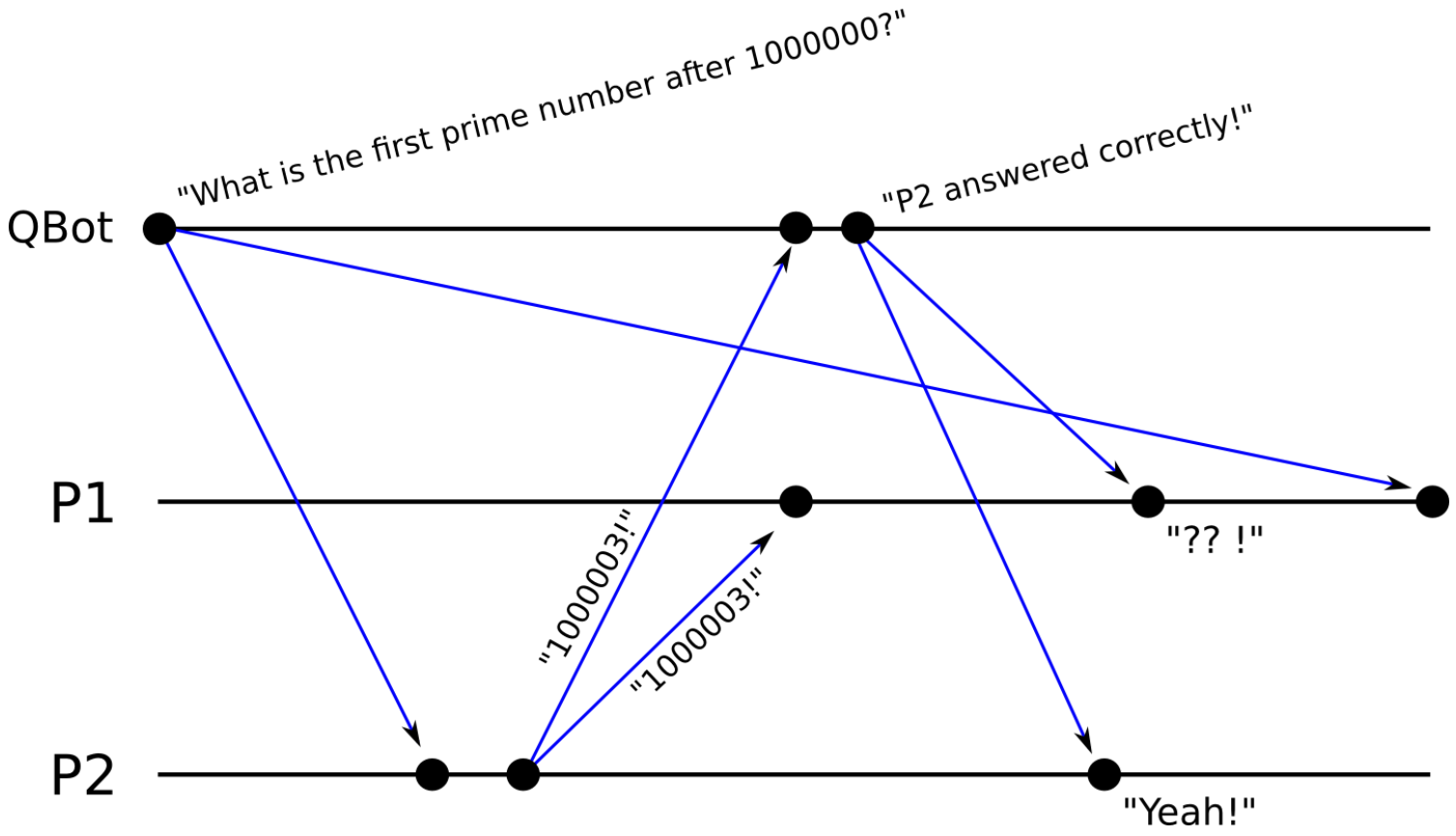
The User Datagram Protocol

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


```
    31 00:06:23.432149000 10.33.47.177     10.40.4.44      DNS       72 Standard query 0xb220  A www.ietf.org
    32 00:06:23.432569000 10.40.4.44       10.33.47.177    DNS       88 Standard query response 0xb220  A 12.22.58.30
    33 00:06:23.471947000 10.33.47.177     208.64.200.203  UDP      126 Source port: 51099  Destination port: 27018
    34 00:06:23.492935000 10.33.47.177     12.22.58.30     TCP       66 56033 > http [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=4 SA
    35 00:06:23.495665000 12.22.58.30      10.33.47.177    TCP       66 http > 56033 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=
    36 00:06:23.495708000 10.33.47.177     12.22.58.30     TCP       54 56033 > http [ACK] Seq=1 Ack=1 Win=65700 Len=0
    37 00:06:23.495808000 10.33.47.177     12.22.58.30     HTTP     428 GET / HTTP/1.1
```

```
Frame 31: 72 bytes on wire (576 bits), 72 bytes captured (576 bits) on interface 0
Ethernet II, Src: Micro-St_01:58:35 (8c:89:a5:01:58:35), Dst: Cisco_ec:e9:3f (28:94:0f:ec:e9:3f)
Internet Protocol Version 4, Src: 10.33.47.177 (10.33.47.177), Dst: 10.40.4.44 (10.40.4.44)
User Datagram Protocol, Src Port: 49927 (49927), Dst Port: domain (53)
    Source port: 49927 (49927)
    Destination port: domain (53)
    Length: 38
  Checksum: 0x485d [validation disabled]
Domain Name System (query)
```

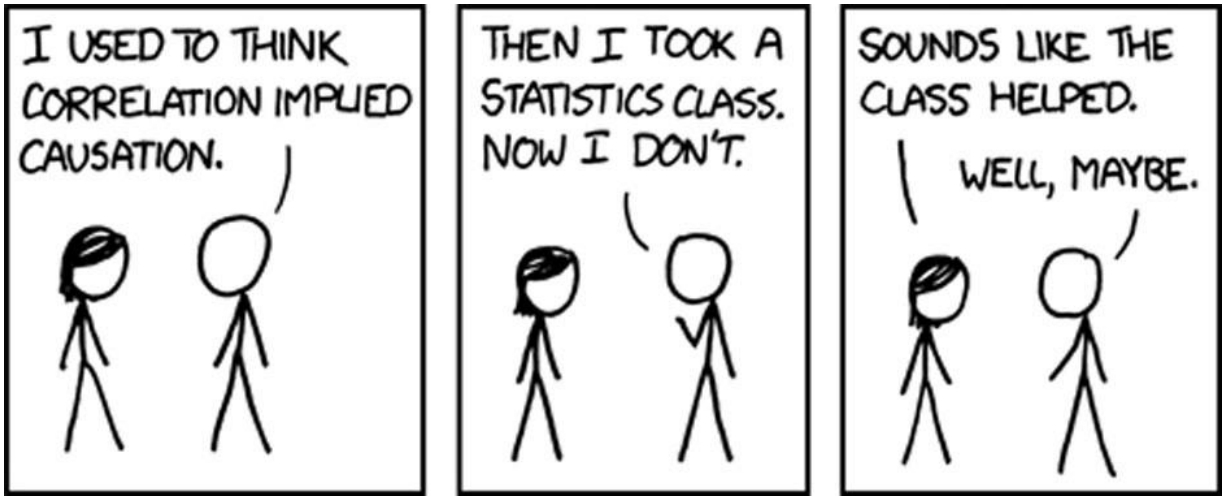
UDP Effects


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

Causality

- Interesting property of distributed systems
- Causal relationship **<** ("happened before")

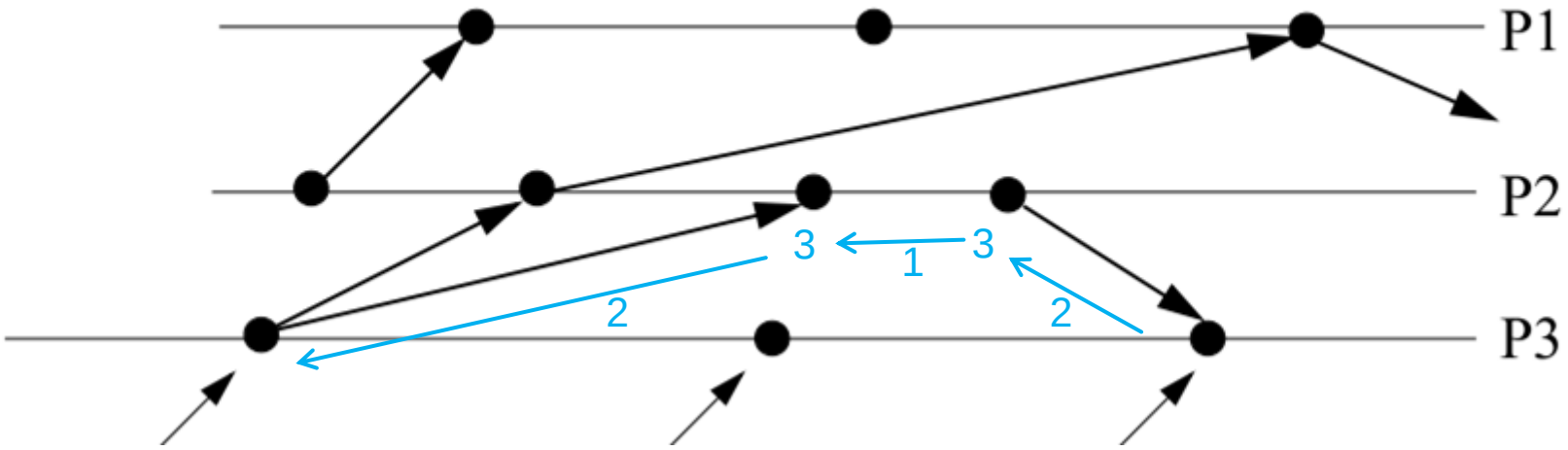
```
x < y iff (   (x, y on same process, x happens before y) or
              (x is send and y is correspondingly received) or
              (transitivity) )
```



Causality

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

1
2
3



Send event Internal event Receive event

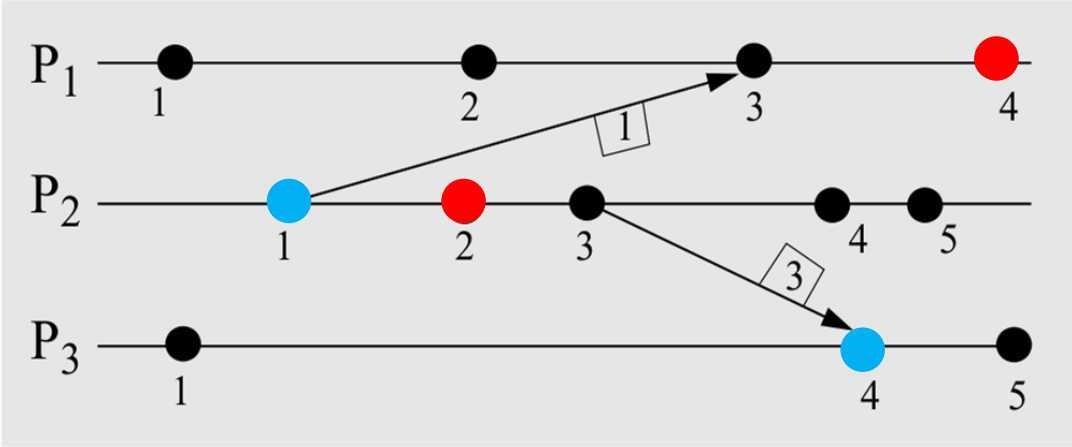
Software Clocks

- Ideal real time → Transitive, dense, continuous, etc.

- Logical time → Cheap version of real time
  - **Lamport Timestamps**
  - **Vector Clocks**
  - Matrix clocks

Lamport Time

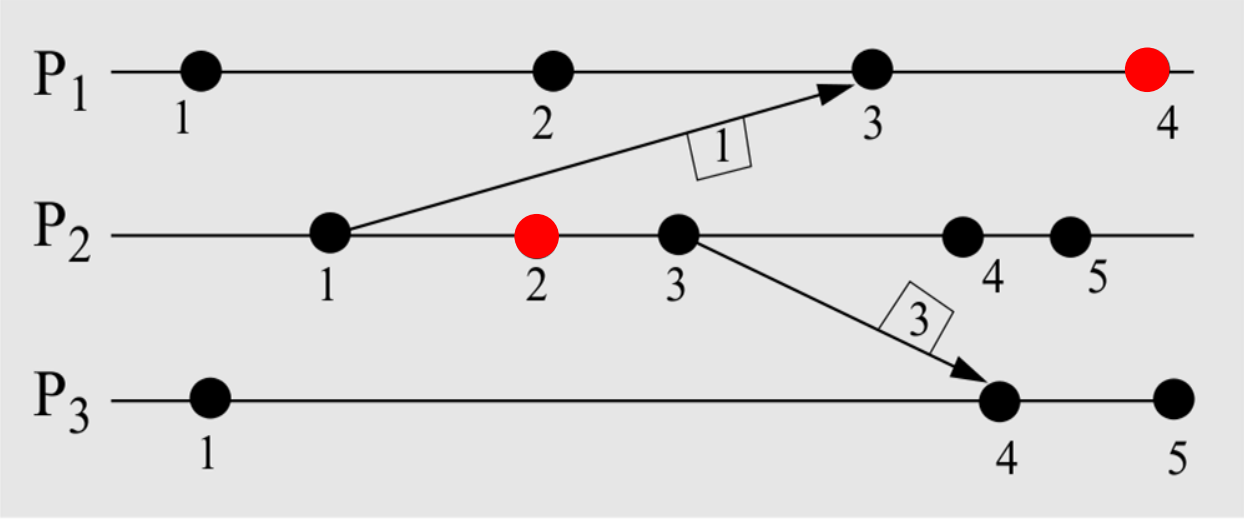
- Using a single clock value
  - Local Event: Local clock tick
  - Send Event: Attach local clock value
  - Receive Event: max(local clock, message clock)
- Satisfies clock consistency condition:
  $e < e' \rightarrow C(e) < C(e')$



Lamport Time

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

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

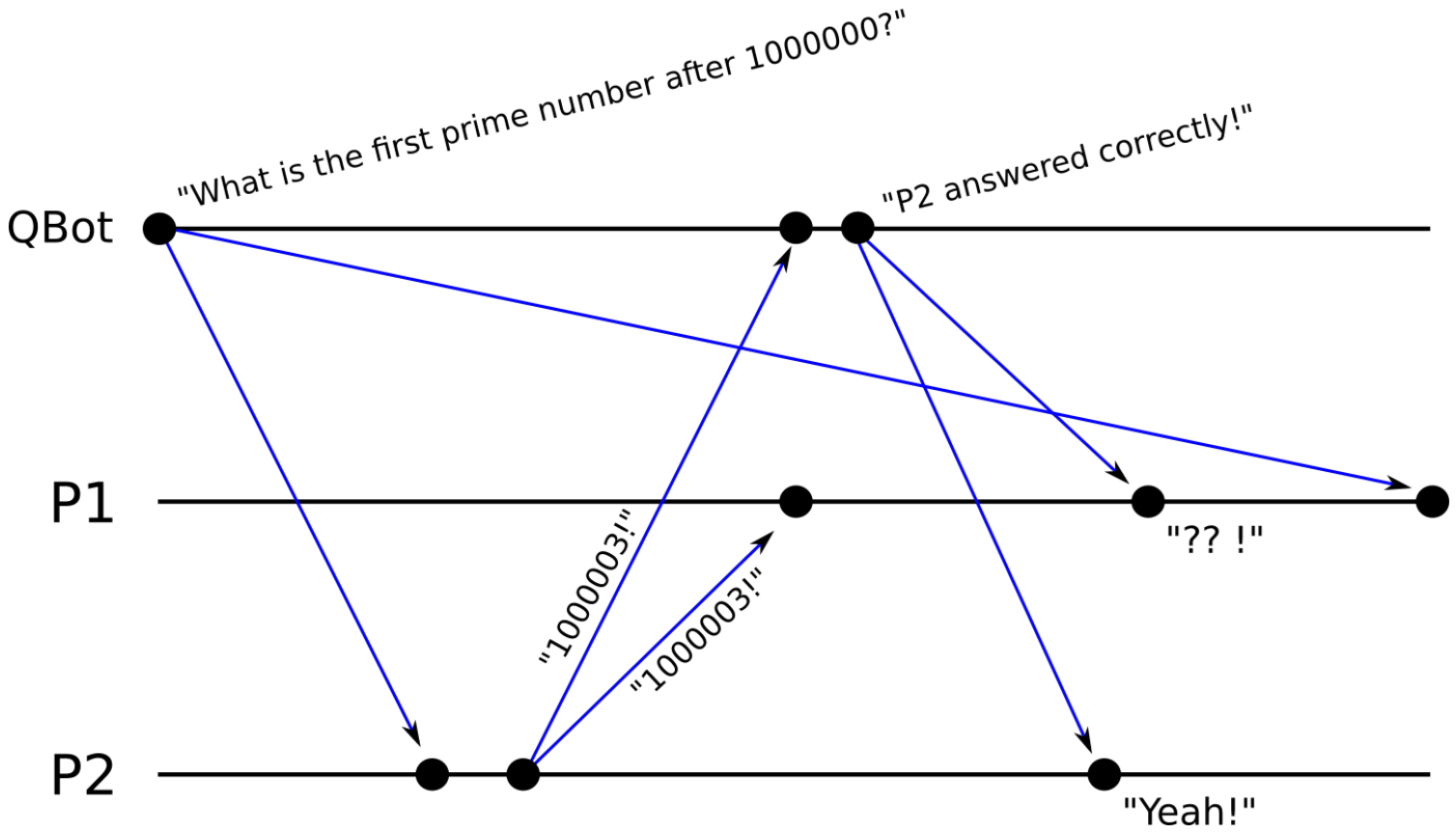


Vector Time

- Refining Lamport Time → Processes keep one counter per process
- Does satisfy strong clock consistency condition!

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

Vector Time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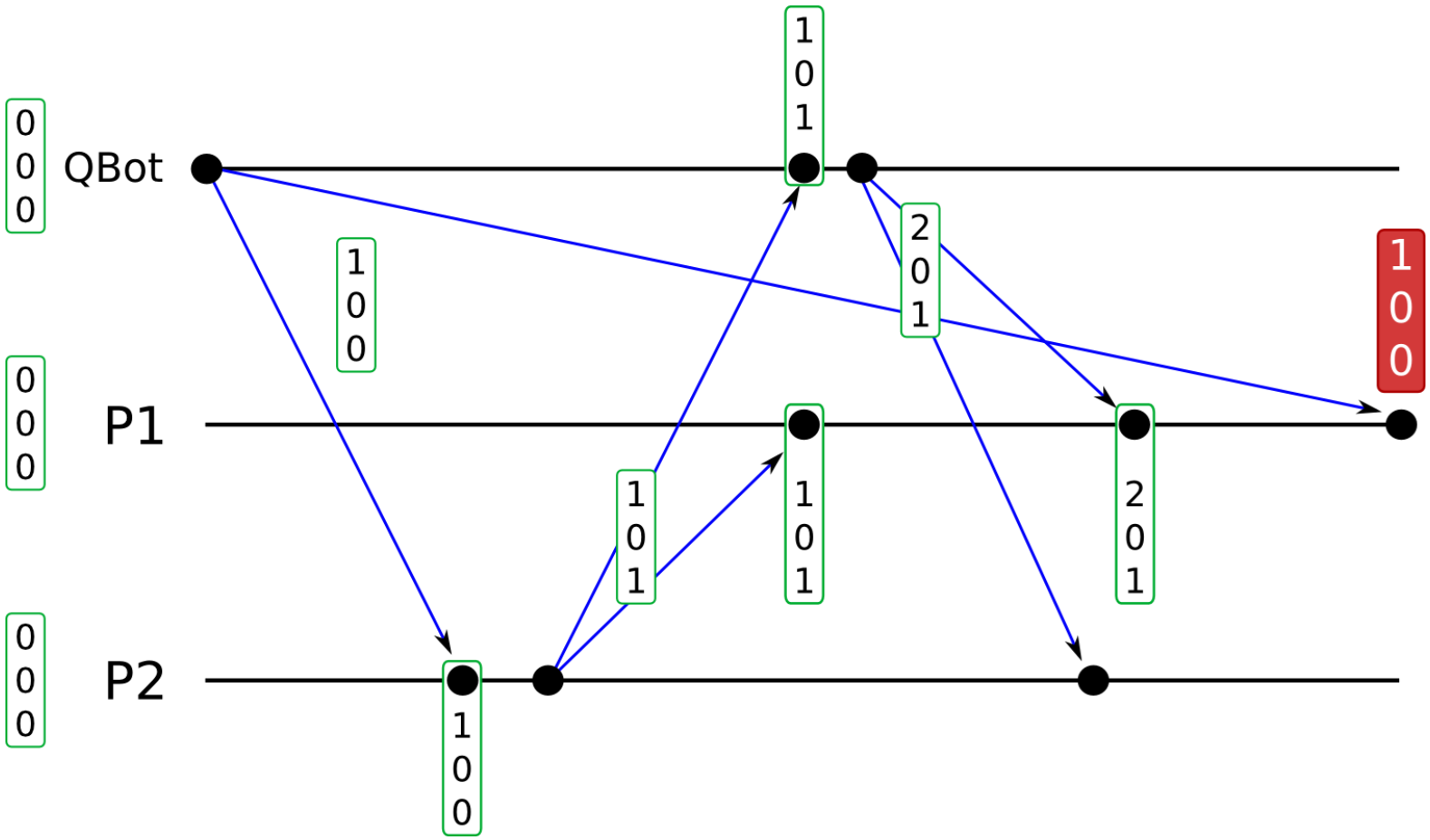
Vector Time

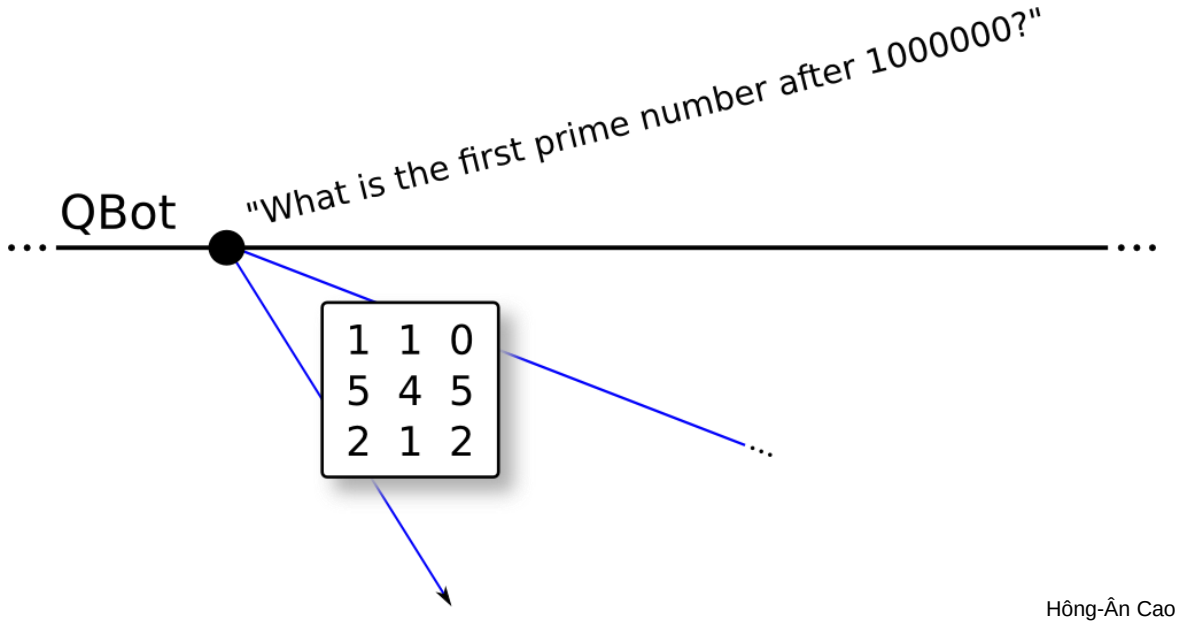


Vector Time

“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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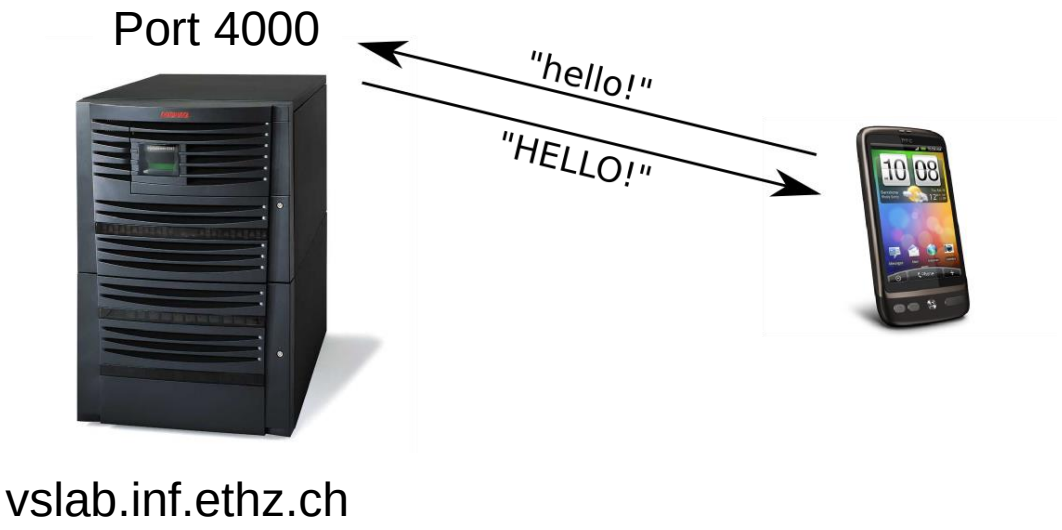
A Mobile, Causal, UDP-based Chat-Application

- 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

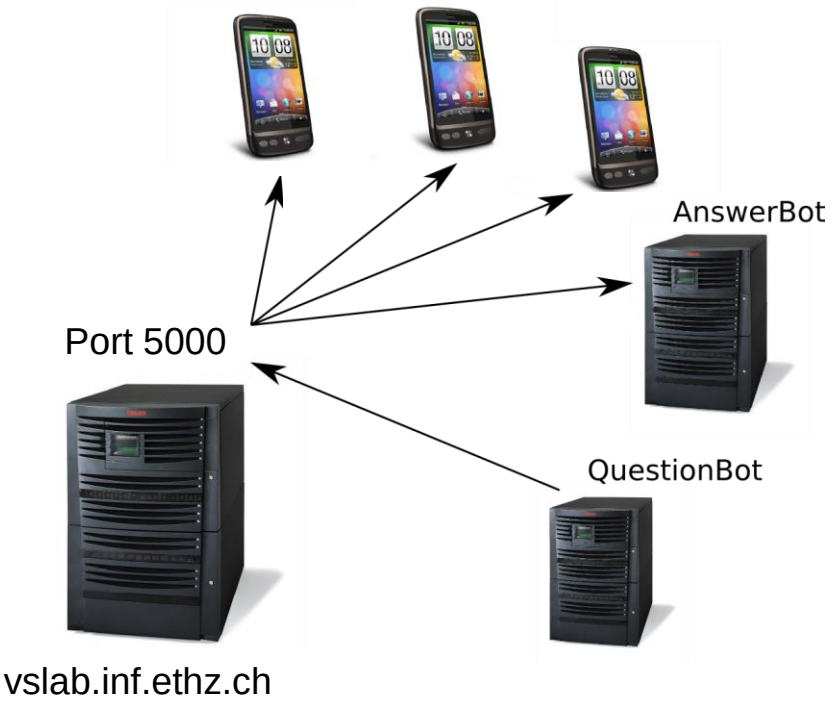
- Communicate with server at vslab.inf.ethz.ch:4000 using UDP
- Provides "capitalization" service



Side Note: Encoding Time

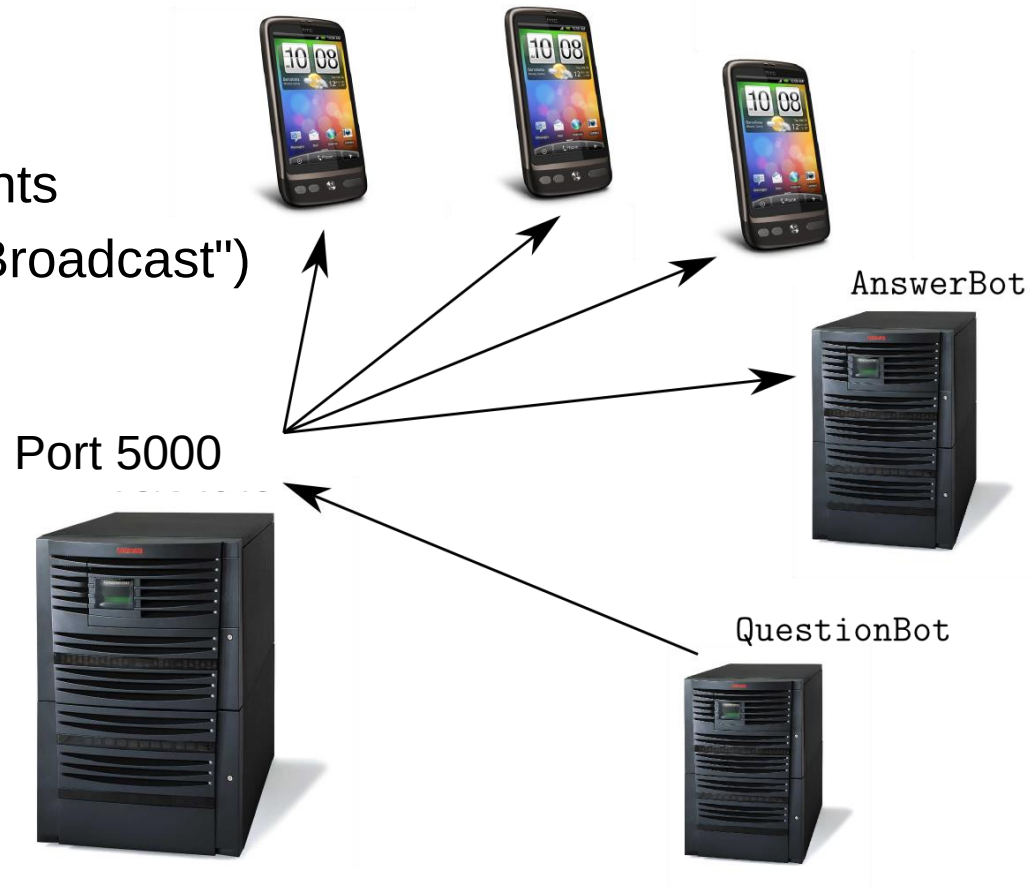
- Lamport Time → Need to encode single timestamp
- Vector Time → Need to encode multiple timestamps

- We use Map<int, int> or dictionary to identify vector times.
- An int is associated to the lamport time.



Side Note: System Setup

- vslab services:
  - (De-) Registration of clients
  - Distributes messages ("Broadcast")
  - De-sequencing "service"



JSON Protocol on vslab.inf.ethz.ch:5000

→ {"cmd": "register", "user": "caoh1"}

← {"index": 2, "init_time_vector": {"2": 0, "1": 70, "0": 71}, "init_lamport": 74,"success": "reg_ok"}

→ {"cmd": "get_clients"}

← {"clients": {"0": "questionbot", "1": "answerbot", "2": "caoh1"}}

→ {"cmd": "info"}

← {"info": "I am an advanced UDP server that is running at port 5000 to provide a de-sequencing service for Android UDP chatting programs..."}

→ {"text": "hallo","cmd": "message", "time_vector": {"2": 1, "1": 70, "0": 71}, "lamport": 75}}

→ {"cmd": "deregister"}

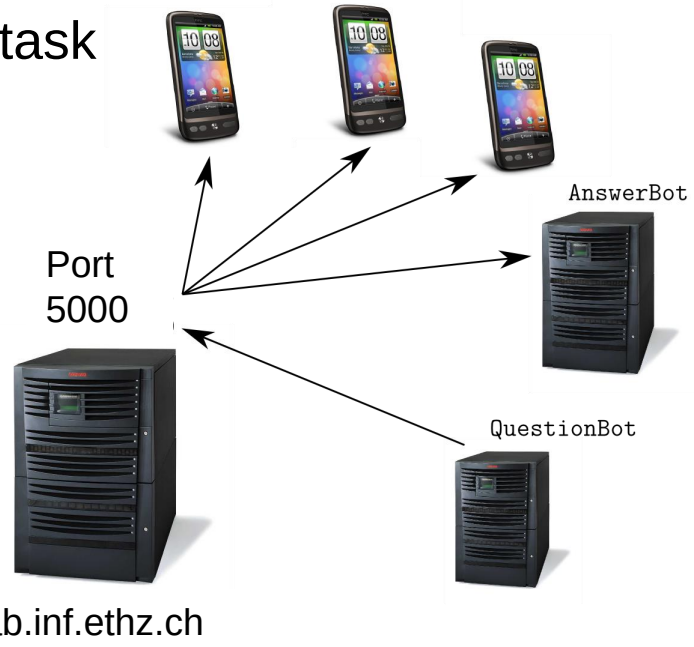
← {"success": "dreg_ok"}

Everyone else receives:

← {"cmd": "message", "text": "caoh1 has left (index 2)"}

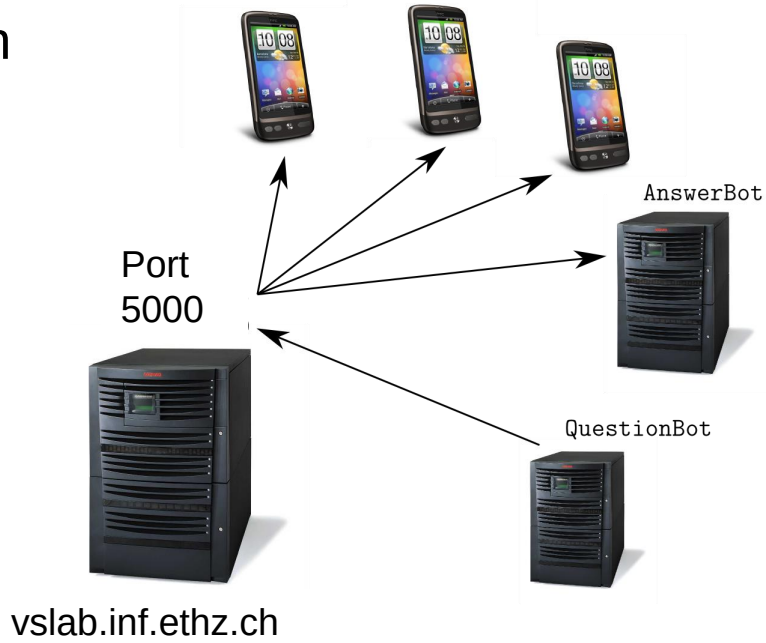
2. Starting the conversation

- UDP chat with server port 5000
- Causality preservation via Lamport Timestamps
- Lamport Timestamp stored in integer in field "Lamport"
  - So, only consider this value when doing task



3.1 Overcoming the desequencer

- UDP chat with server on port 5000
- Causality preservation via **Vector Clocks**
- Own timestamp in **i^{th} time vector index**
  - **i** assigned by server upon registration



3.2 Overcoming the desequencer

- When exactly are 2 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 sending 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

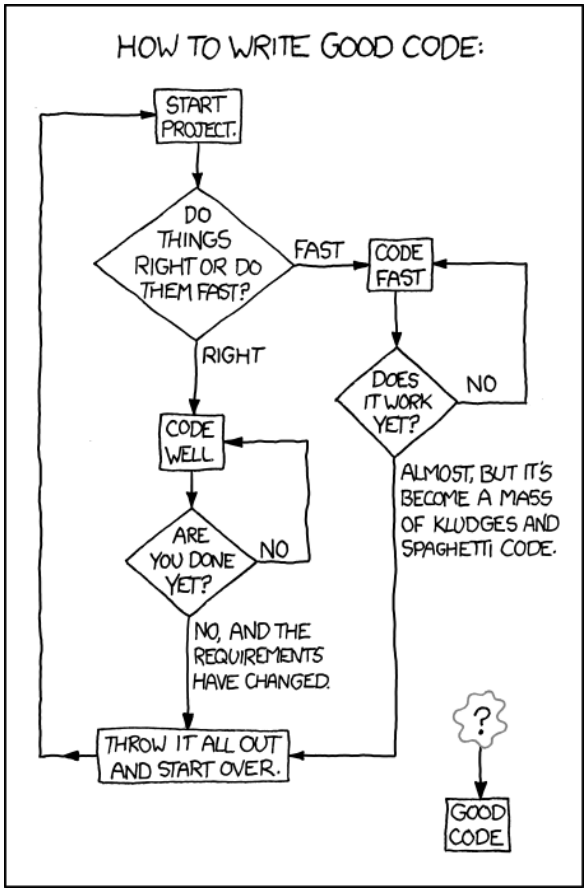
- Multiple ways to implement vector clock ticking
  - Tick only when sending, after sending [vs. before sending]
  - Tick when receiving and sending, after sending [vs. before sending]

- 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 (!) 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 and more convenient
- **Forward port to emulator**
  http://stackoverflow.com/questions/5064304/how-can-i-forward-my-localhost-ip-address-to-an-android-emulator
- **Use VPN when not in ETH network!**
- Lots of groups interact via the chat server
  - Potential problem → some groups non-compliant
  - Results could be → Everyone's code crashes…
  - Solution → Tag your messages (e.g. using your group's number) and/or only consider your own messages

The End


HOW TO WRITE GOOD CODE:
START PROJECT.
DO THINGS RIGHT OR DO THEM FAST?
FAST
CODE FAST
RIGHT
DOES IT WORK YET?
NO
CODE WELL
ARE YOU DONE YET?
NO
ALMOST, BUT IT'S BECOME A MASS OF KLUDGES AND SPAGHETTI CODE.
NO, AND THE REQUIREMENTS HAVE CHANGED.
?
THROW IT ALL OUT AND START OVER.
GOOD CODE