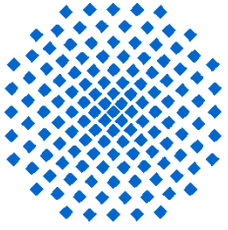

Universität Stuttgart

Institute of Parallel and
Distributed Systems (IPVS)

Universitätsstraße 38
D-70569 Stuttgart

Lab-course / Fachpraktikum

Computer Communication: Software-defined Networking

Winter Term 20/21

Assignment 4

Content-based Routing

January 12th, 2020

Sukanya Bhowmik, David Hellmanns

Overview

- **Task 4**
  - **Goals of this task**
  - 4.1 – Pub-Sub Routing **[6 points]**
  - 4.2 – Content-based Routing **[7 points]**
  - 4.3 – REST Interface for Content-based Routing **[7 points]**
- Deadline and Submission

Goals of this Task

Perform Content-based Routing for OpenFlow Networks:

- For static subscriptions via StaticEntryPusher (without & with in-network filtering)
- For dynamic subscriptions via own REST Interface

Overview

- **Task 4**
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  - **4.1 – Pub-Sub Routing**
  - 4.2 – Content-based Routing
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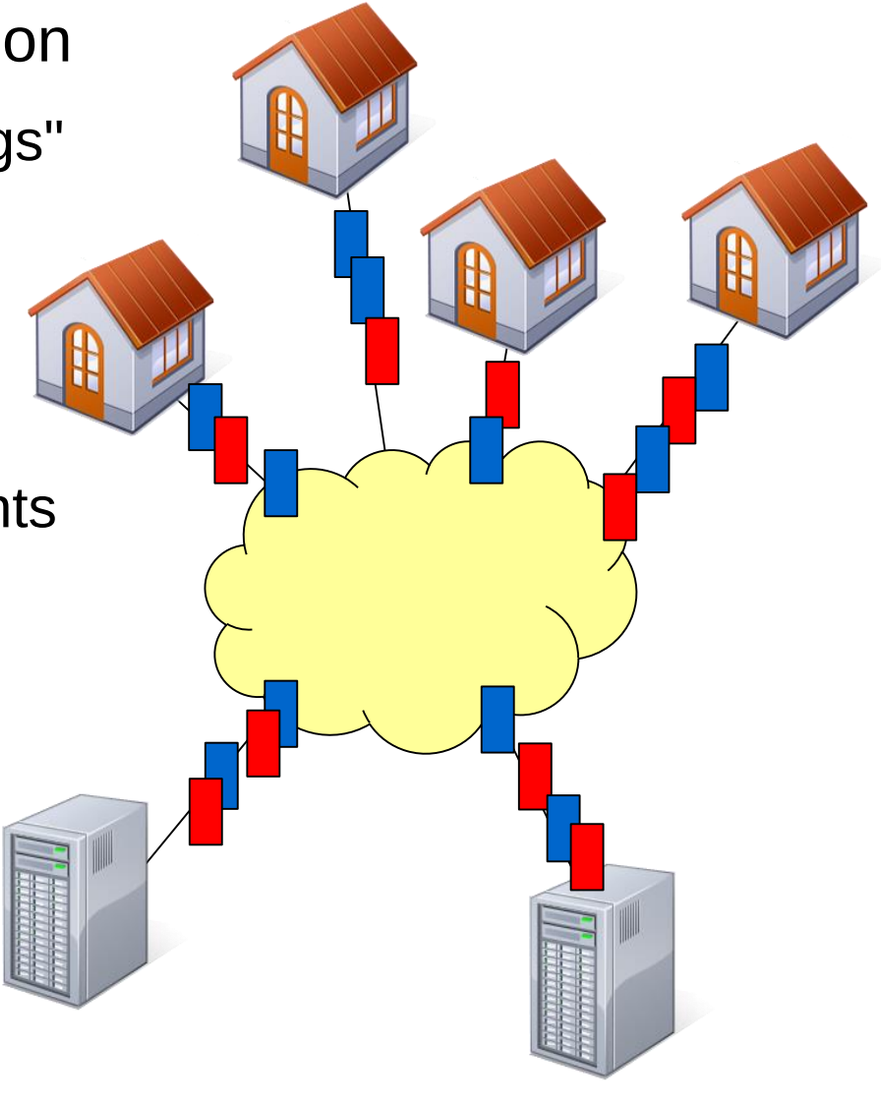
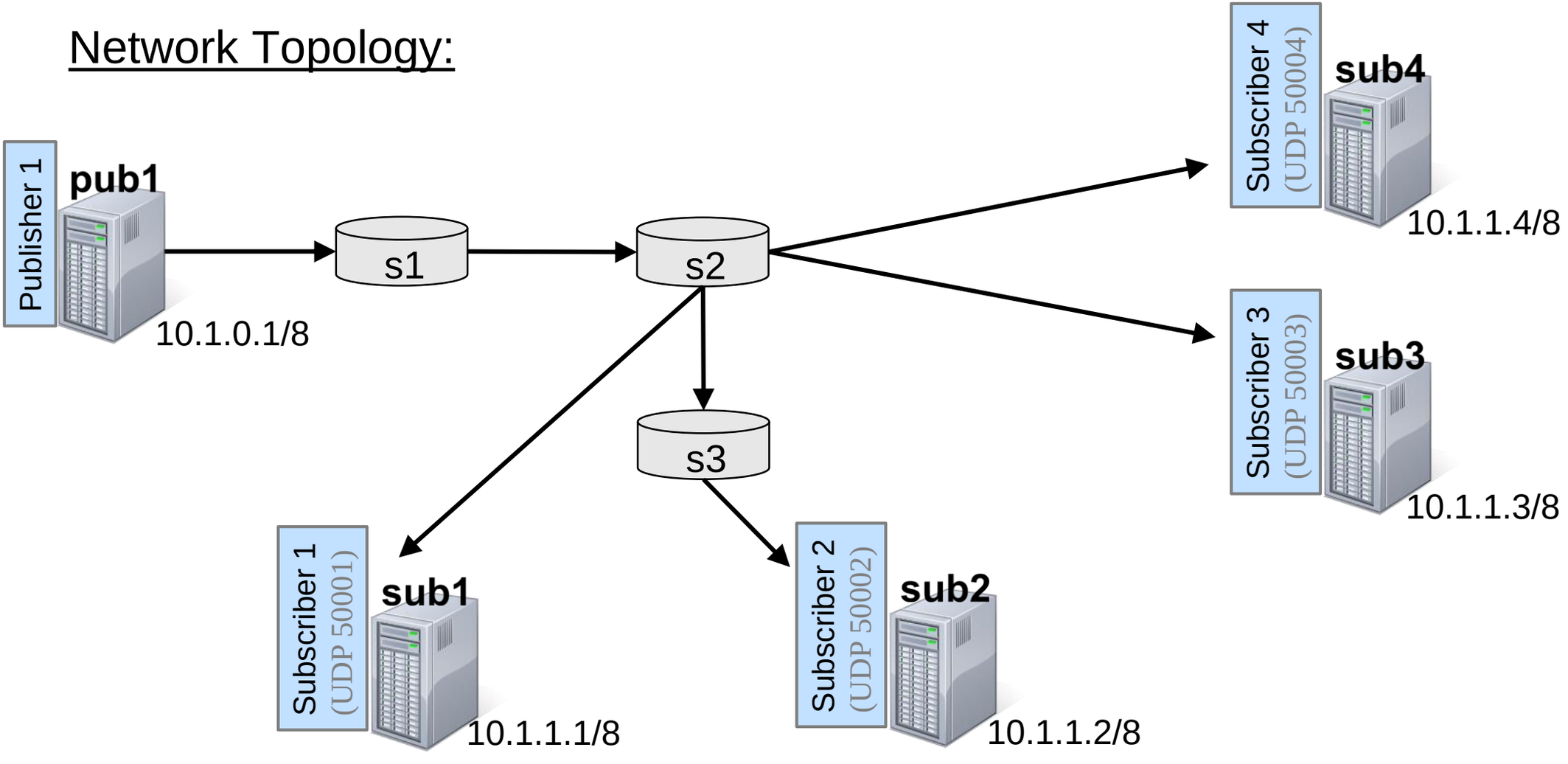
Task 4.1 – Pub-Sub Routing

- Measure residential energy consumption
  - Households equipped with "smart plugs"
  - Periodically "publish" energy and power measurements
  - "Subscribers" filter these measurements (e.g. by value, source, time, …) and perform some data analysis
  - *Naive networking:* forward all measurements to all subscribers



Task 4.1 – Pub-Sub Routing

Network Topology:



Task 4.1 – Pub-Sub Routing

- First, write a "subscriber" application (pref. Python or Java) which receives UDP datagrams containing measurement data and possibly filters them by measurement type (0 for energy and 1 for power) and value (greater, less or equal to a certain reference value). Write to **`stdout`**:
  - matching measurements as they arrive
  - a report of min/max values of all **received** measurements and min/max values of all **matching** measurements at exit
- Your application should take parameters to define
  - the listening UDP port
  - the type (0/1)
  - the reference value
  - whether to filter at all
  - the comparison operator (> or ≤)

Task 4.1 – Pub-Sub Routing

- Last, run two experiments with **`~/ex4/mininet4.py`**, which implements the previously shown topology, and **`/opt/floodlight/floodlight-noforwarding.sh`**
  1. All datagrams are forwarded to the subscribers and printed out, unfiltered by the application
  2. All datagrams are forwarded to the subscribers and filtered by the application

- To publish measurements, call **`~/ex4/publish`** on node **`pub1`**

Task 4.1 – Pub-Sub Routing

Run in total four subscribers:

1. On host sub1, collect power (type 1) values > 500 W (on port 50001)
2. On host sub2, collect power (type 1) values > 100 W (on port 50002)
3. On host sub3, collect energy (type 0) values ≤ 30 kWh (on port 50003)
4. On host sub4, collect energy (type 0) values > 136 kWh (on port 50004)

Task 4.1 – Pub-Sub Routing

We will use real data from the "DEBS Grand Challenge 2014"

- Measurement format (UDP **payload string**):

```
[ID],[Time],[Value],[Type],[PlugID],[HouseholdID],[HouseID]
```

16 bit measurement
- **energy [kWh]**
- **or power [W]**

depending on type

1 bit type flag
- **0 for energy**
- **1 for power**

- Write a script **`~/ex4/task41.sh`** which install flows for …
  - … ARP broadcast and IP forwarding in the 10.0.0.0/8 network
  - … forwarding of measurements (matched by the multicast IP 230.0.0.0/8) to all subscribers
- Compare the size of the unfiltered vs. filtered output

Overview

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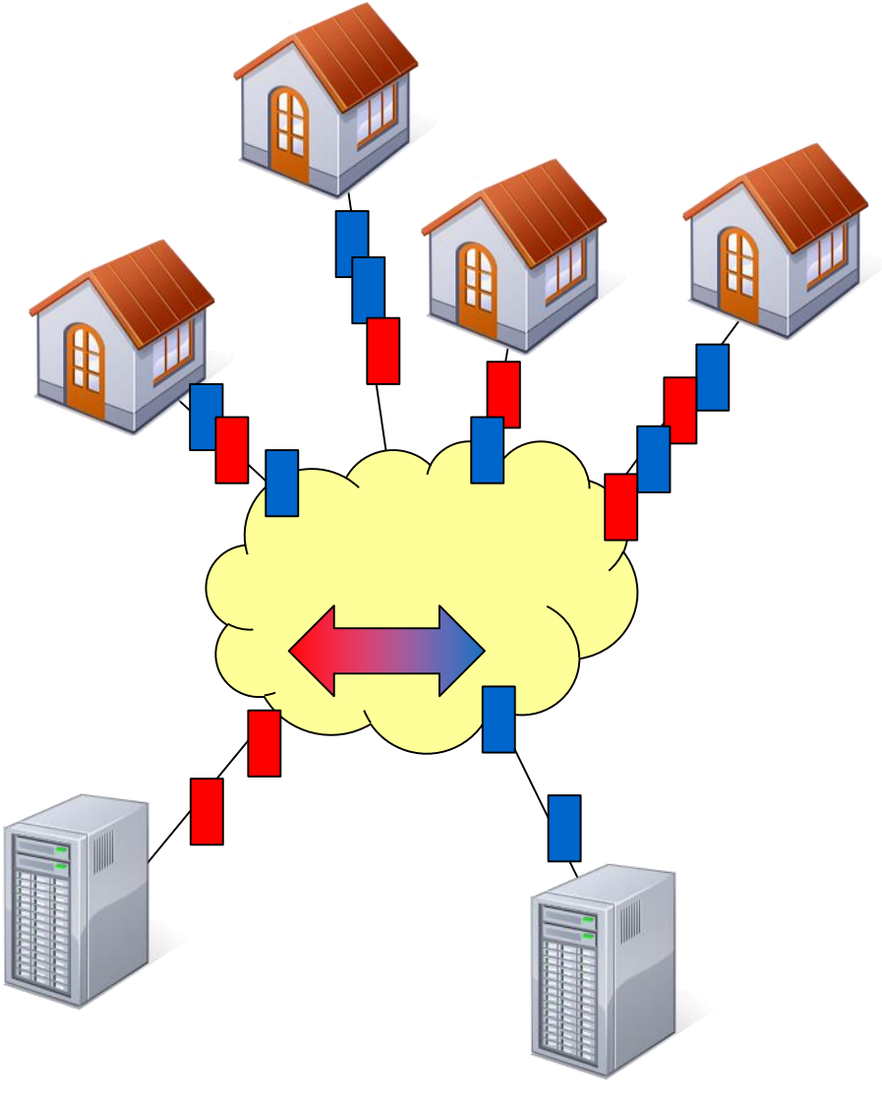
Task 4.2 – Content-based Routing

- Better:
  - (Pre-) filtering already in network
  - Reduce bandwidth in network and processing overhead at subscribers
  - **But:** measurements must be filtered *by content*!

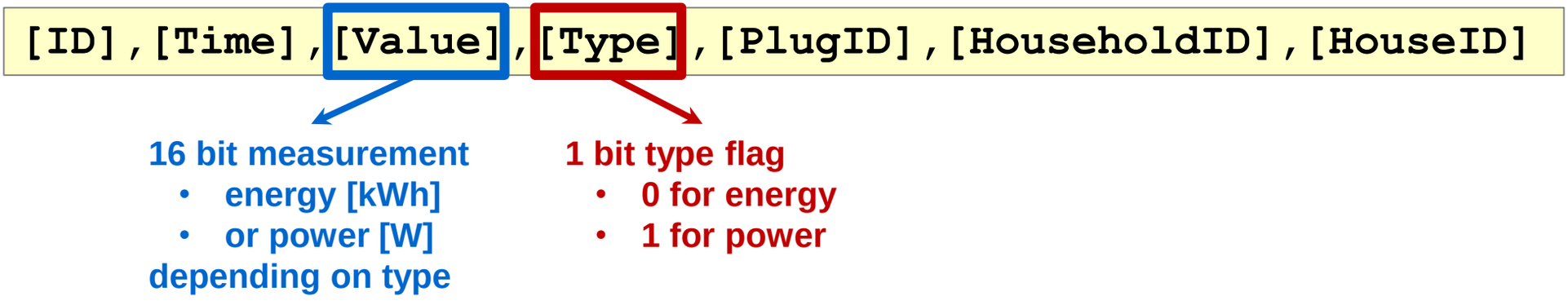


- Solution: encode (interesting parts of) content into IP address
- Express filters as OF matching rules

Task 4.2 – Content-based Routing

We will use real data from the "DEBS Grand Challenge 2014"

- Measurement format (UDP payload string):



We encode the type (**<T>**) and value (**<V>**) fields of the payload into the destination IP address: **230.<T>.<V-MSB>.<V-LSB>**

- Example: Payload: `3496,1377986403,285,1,0,6,0`
  Dst-IP: **230.1.1.29**

Task 4.2 – Content-based Routing

- Make a copy of your script from Task 4.1 (**`~/ex4/task42.sh`**) and add appropriate flow entries for content-based routing
- Implement content-based routing by forwarding only datagrams with values greater/less than the next lower/larger power of two
- On the data plane, comparisons have to be emulated using prefix matching. Simple example:
  - type=1 and value ≤ 3 ⟷ "eth_type=0x0800,ipv4_dst=230.1.0.0/30"

    (i.e. the network prefix [230], the type [1] and the 14 most significant bits of the value [0] are fixed, while the 2 least significant bits are wildcarded)
- Execute your modified script to install all necessary flow entries
- Exemplarily implement the rules from Slide 9

Task 4.2 – Content-based Routing

Important hints:

- Goal prioritization of the Content-based Routing approach
  1. Minimize total network traffic
     - Eliminate all unnecessary traffic (with a value filter granularity of power of twos)
  2. Reduce subscriber filtering effort
  3. *Minimize flow table consumption*
- Consider generic system properties (like scalability).

Overview

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Task 4.3 – REST Interface

- Create a package net.sdnlab.ex4.task43 for a Floodlight Module providing the following REST interface:
  - **POST** http://<controller>:8080/subscriptions/{name}/json
    to add a new subscription with {name} (define necessary filtering and subscriber parameters in the HTTP payload!)
  - **DELETE** http://<controller>:8080/subscriptions/{name}/json
    to delete the subscription with {name} again
  - **GET** http://<controller>:8080/subscriptions/json
    to return a list of all subscriptions in JSON format

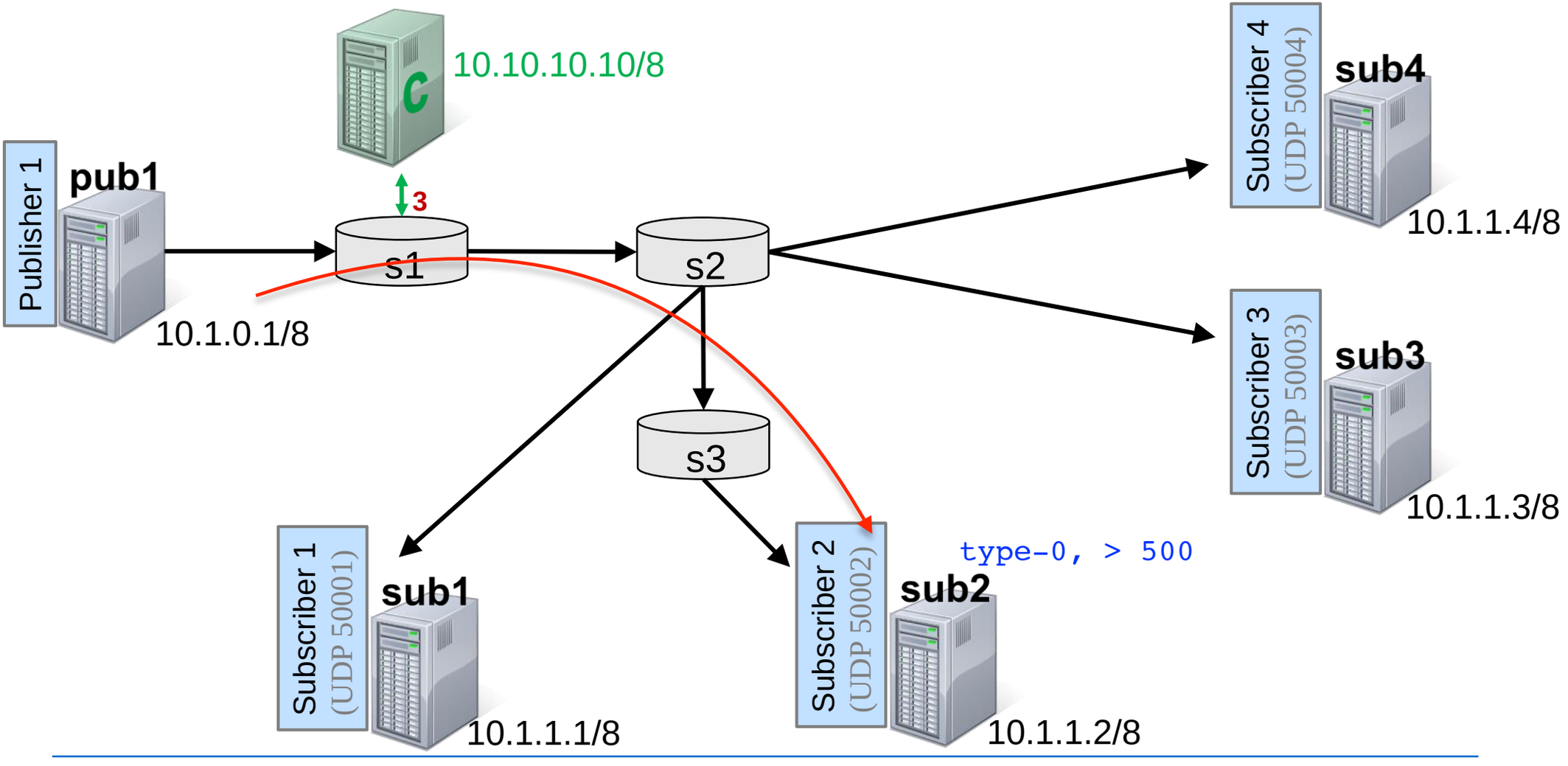
- You can find a module skeleton in **`~/ex4/java/task43`**

Task 4.3 – REST Interface

- Your module should
  - Implement the REST-interface described on the previous slide
  - Determine and install or delete the necessary flow entries upon handling incoming requests
- Also update your subscriber application to use this REST-interface to register subscriptions!
- Mininet hosts can reach the Floodlight controller's HTTP interface at http://10.10.10.10:8080/...
  - *Hint:* Make sure flows for communication with c are set up properly! (see next slide)

Task 4.3 – Pub-Sub Routing

Network Topology:



Task 4.3 – REST Interface

- Module skeleton in **`~/ex4/java/task43`**
  - ITask43Service.java – IFloodlightService interface for your module
  - Task43.java – your module
  - Task43WebRoutable.java – HTTP router
  - ListSubscriptionsResource.java – resource for **GET** requests
  - SubscriptionResource.java – resource for **POST/DELETE** requests
- You may of course add classes, e.g. to represent a subscription
- Read the tutorial "How to add a REST API to a Module" to understand project architecture (cf. ILIAS Wiki)

Overview

- Task 4
- **Deadline and Submission**

Deadline and Submission

- When (submission deadline): January 26th 2021 at 08:00
- How: Via ILIAS system
  - One submission per group
  1. One document (PDF)
     - Describing the commands you executed to solve the tasks
     - Showing the output
     - Explanation
  2. Your scripts
  3. Archive of source package net.sdnlab.ex4
- Be prepared to show a live demo to the supervisor during the next meeting