Introduction to OpenFlow

~With an example of customer service~

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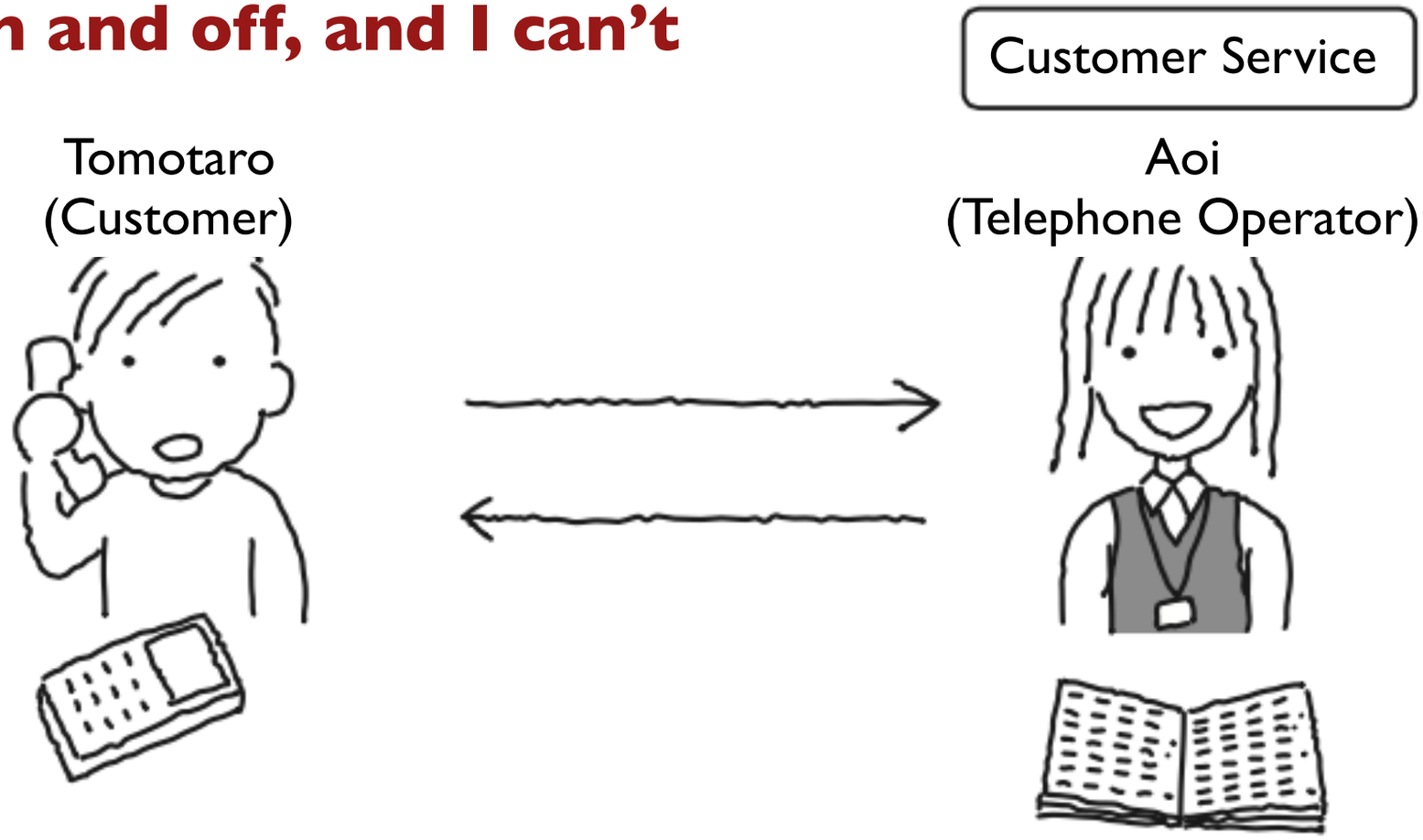
In the case of a customer service of an air conditioner

“A light on a remote control is flashing on and off, and I can’t stop it…”



1. Ms. Aoi, a tel operator, hears the customer’s trouble
2. She looks up the trouble in the instruction manual
3. She forwards the customer’s call to an engineer in charge depending on his trouble

Instruction Manual

Query	Response	Number of queries
Troubles with a remote control	**Forward the call to an engineer of peripheral equipment**	**8**
Troubles with an air conditioner	Forward the call to an engineer of air conditioners	6
Troubles with an outside unit	Forward the call to an engineer of peripheral equipment	4
Prank phone calls	Hung up the call	2

Instruction Manual

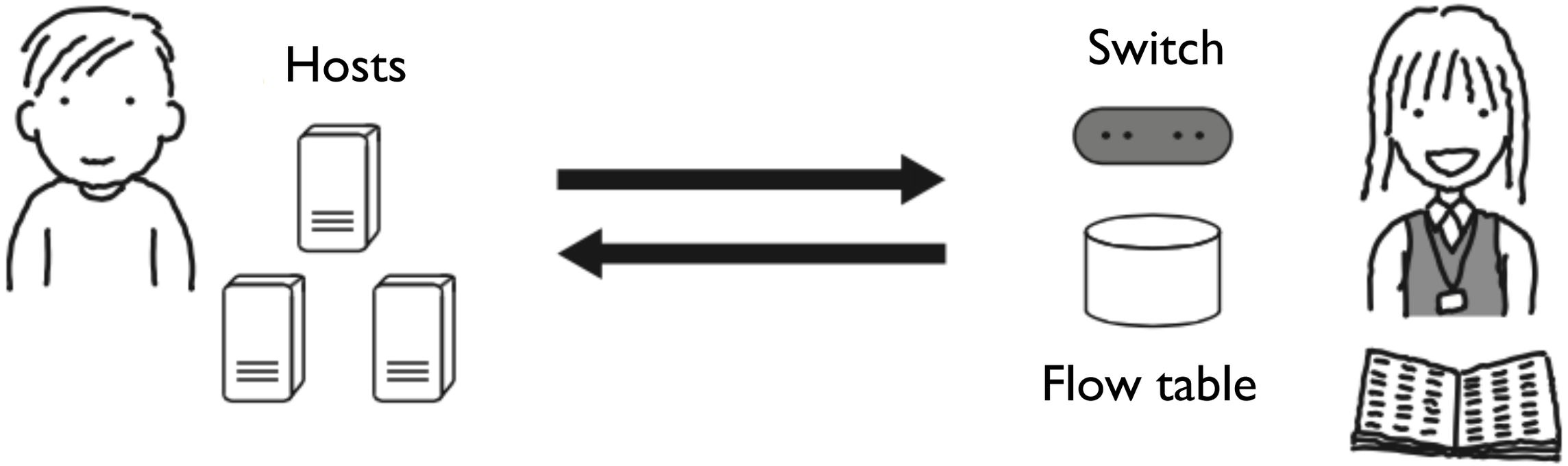
Record and update the number of queries

Query	Response	Number of queries
Troubles with a remote control	**Forward the call to an engineer of peripheral equipment**	**9**
Troubles with an air conditioner	Forward the call to an engineer of air conditioners	6
Troubles with an outside unit	Forward the call to an engineer of peripheral equipment	4
Prank phone calls	Hung up the call	2

Updating the Manual

- Telephone operators report the frequencies of troubles to their boss
- The boss can identify potential problems about the air conditioner and give engineers instructions:
  - Improve the remote control
  - Increase the number of engineers of peripherals

In the case of OpenFlow



1. A switch see the packet header
2. It looks up the information in the flow table
3. It determines the operation about the packet depending on the flow table

Rules=Flow Entries

Packet conditions **Transactions** **Number of Packets**

Match field	Action	Counter
Src IP address = 192.168.1.0	Forward packets to port 8	80
VLAN ID = 10	Forward packets to port 10	64
Src MAC address = 00:50:56:c0:00:08	Attach VLAN ID 2 to packets and forward them to port 8	24
Src IP address = 203.0.113.0/16	Discard packets	10

“Water leaks from the drain pipe of the air conditioner…”

Customer Service

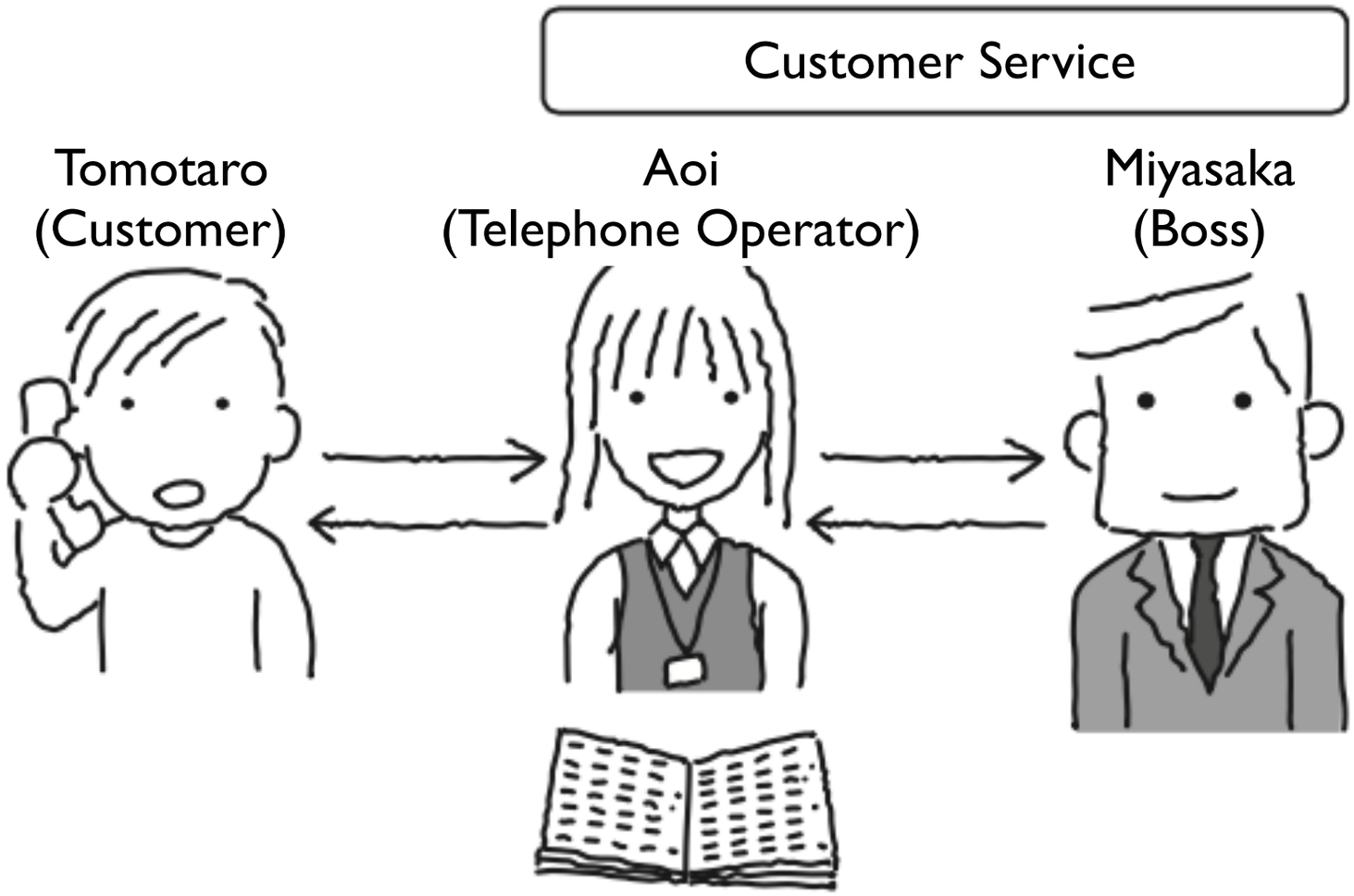
Tomotaro
(Customer)

Aoi
(Telephone Operator)

“How should I do…”

Instruction manual

1. In the case that the troubles of customers are not in the instruction manual…
2. “Just a moment”

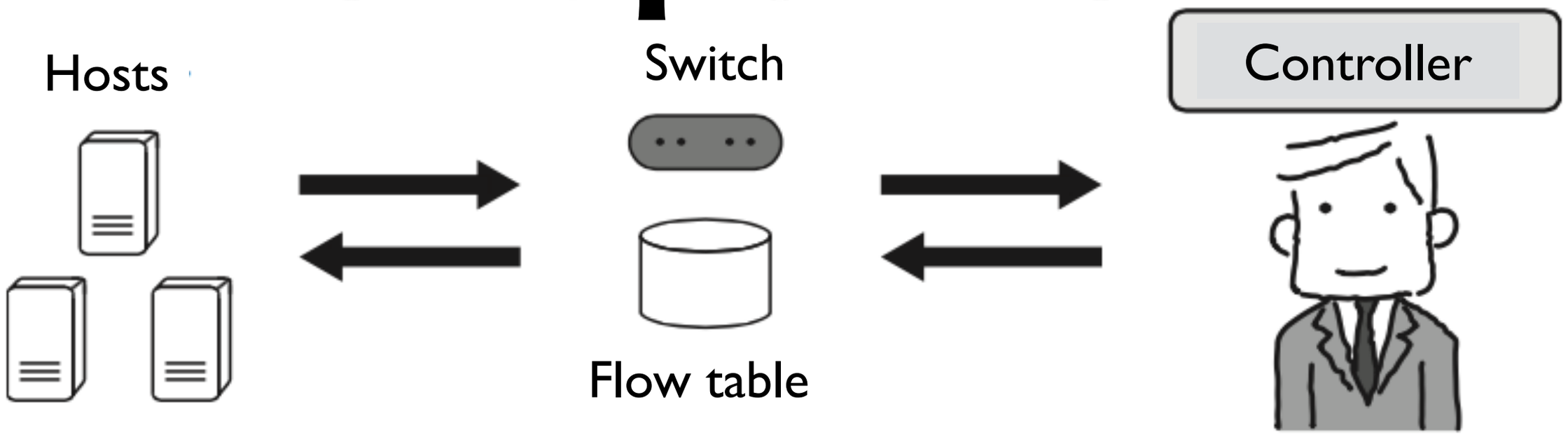


1. She asks her boss about the troubles.
2. The boss investigates the troubles and gives her instructions to resolve the trouble.
3. She writes the instructions to the instruction manual.

Updating the Instruction Manual

Query	Response	Number of queries
Troubles with a remote control	**Forward the call to an engineer of peripheral equipment**	**9**
Troubles with an air conditioner	Forward the call to an engineer of air conditioners	6
Troubles with an outside unit	Forward the call to an engineer of peripheral equipment	4
Prank phone calls	Hung up the call	2
Trouble with a drain pipe	Forward the call to an engineer of peripheral supplies	1

In the case of OpenFlow



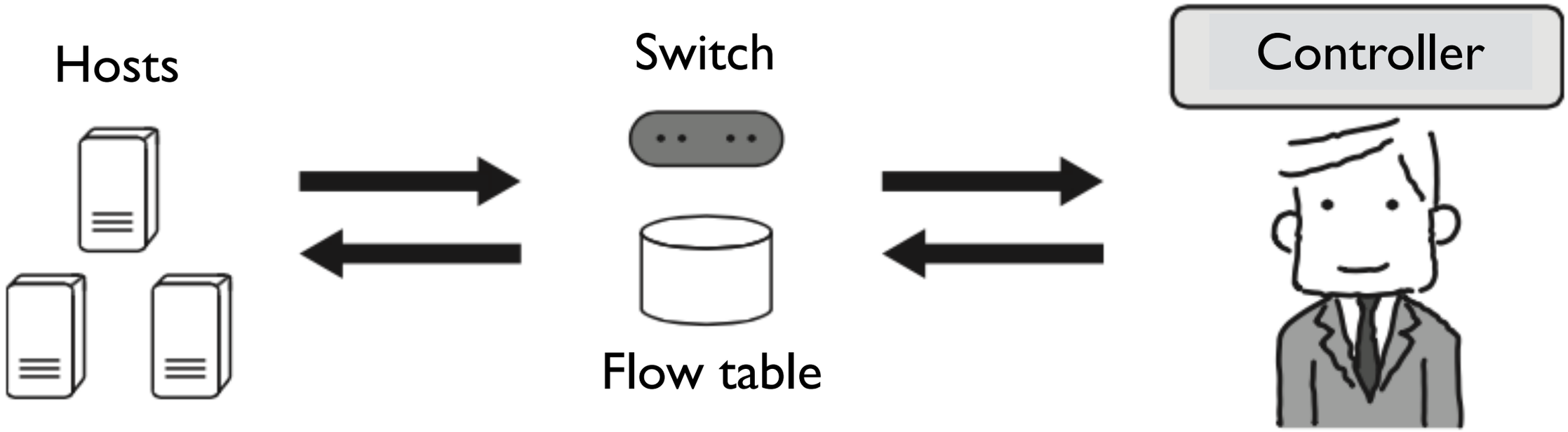
1.A switch asks the controller about actions about unknown packets.

2.The controller inspects the packets and determines actions for them.

3.The controller updates the flow table and process the packets according to the actions.

Fast (Hardware)

Very Slow (Software)

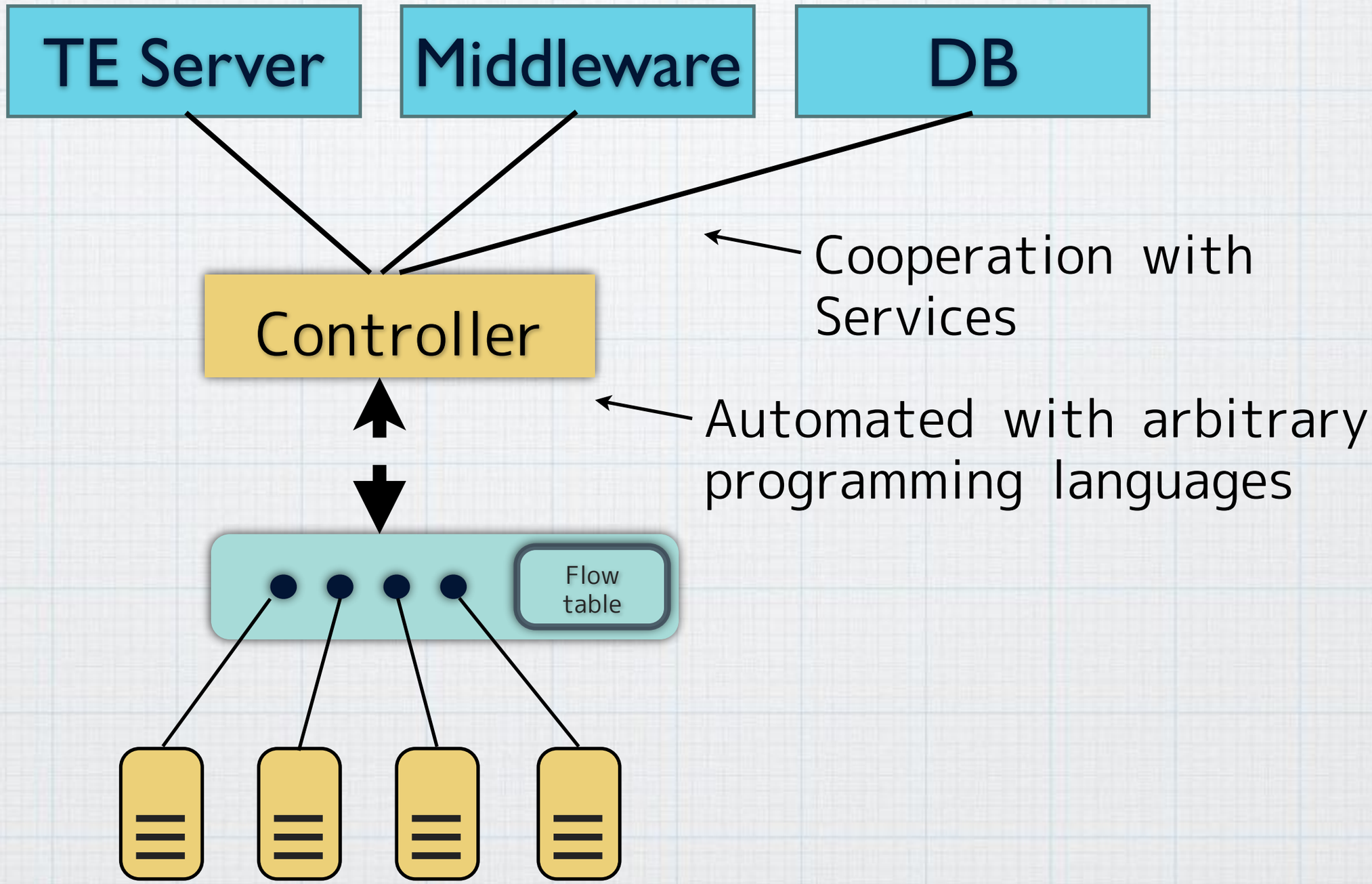


- Programming with OpenFlow is equivalent to designing a controller.
- If a boss (controller) is incompetent, forwarding at switches (customer service) does not work well.
- Asking the boss (controller), in general, consumes a lot of time, and instructions hence should be listed in an instruction manual (flow table) in advance.

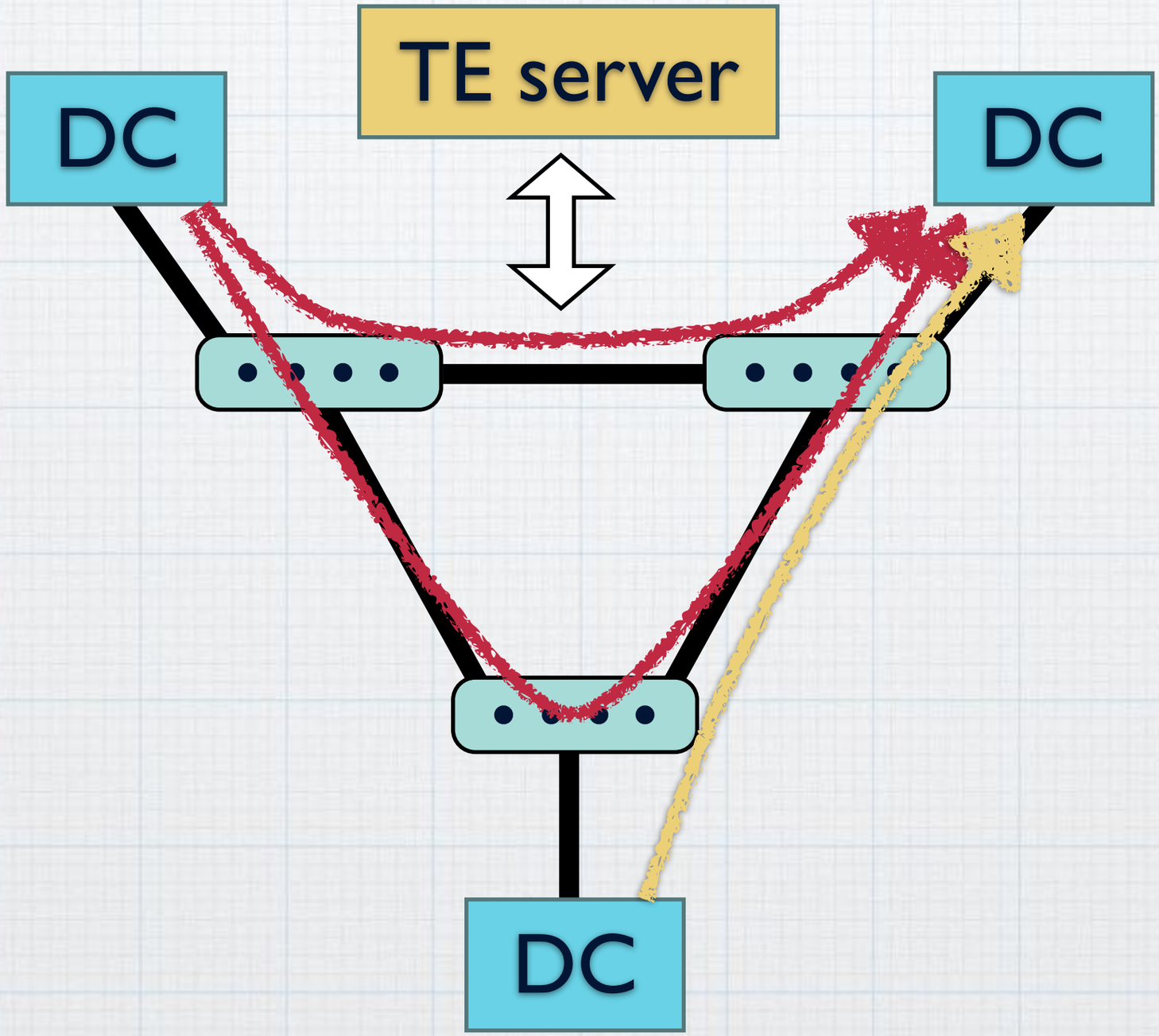
Lesson learned: Merits of OpenFlow

- Packet forwarding is automated by a controller, and the controller can cooperate with other services.
- A controller controls packet forwarding in a centralized manner.
- Existing methods for software development can be used for designing a controller

Cooperation and Automation



Centralized Control



Using Existing Software Deevelopment Methods

- Agile software development
- Network testing
- Version control (e.g., git)

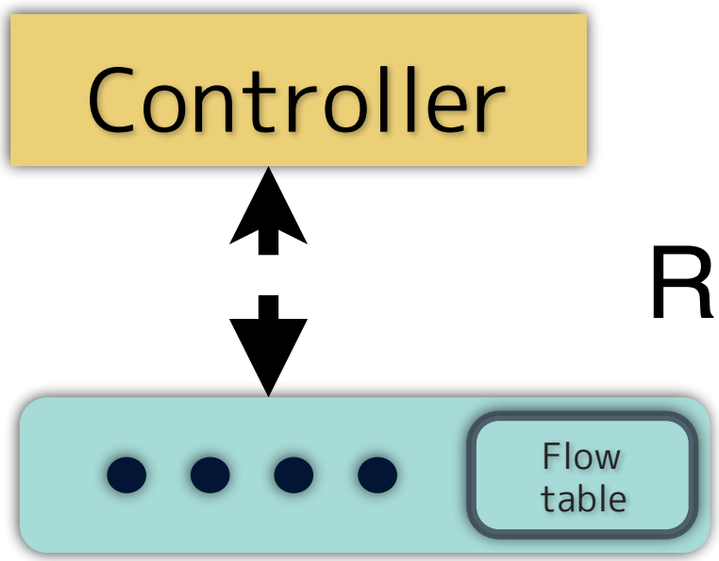
Increasing the Number of Ports

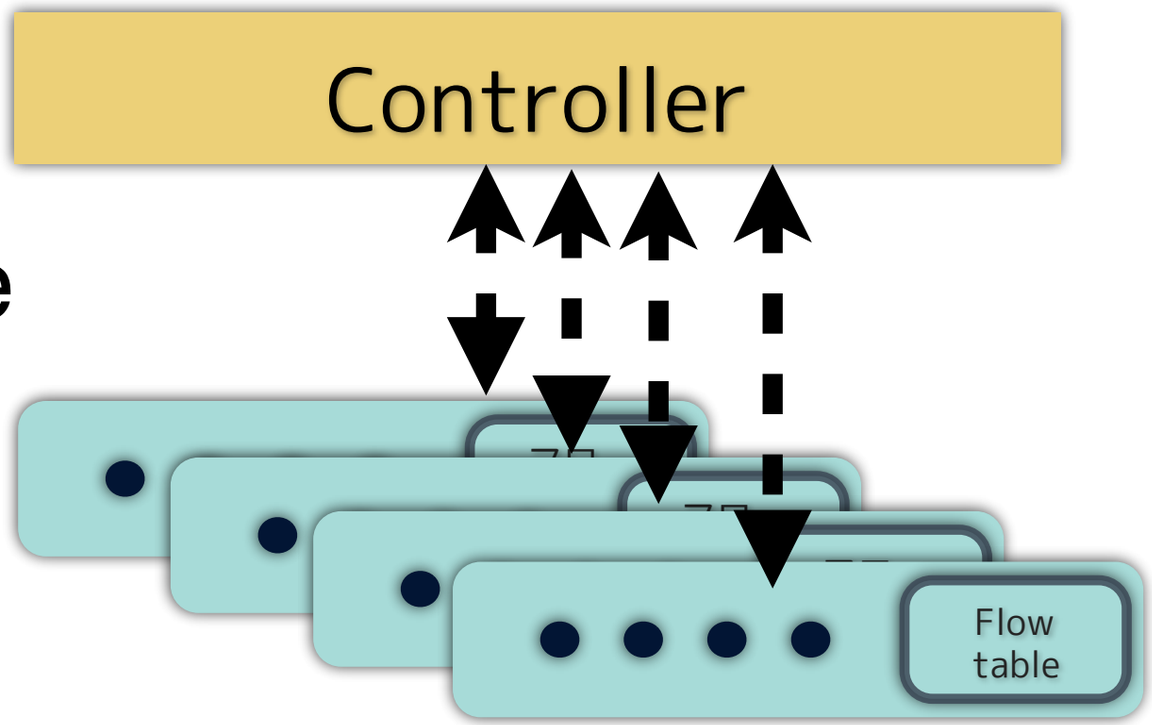
200,000 JPY

Expensive

1,000,000 JPY

Reasonable

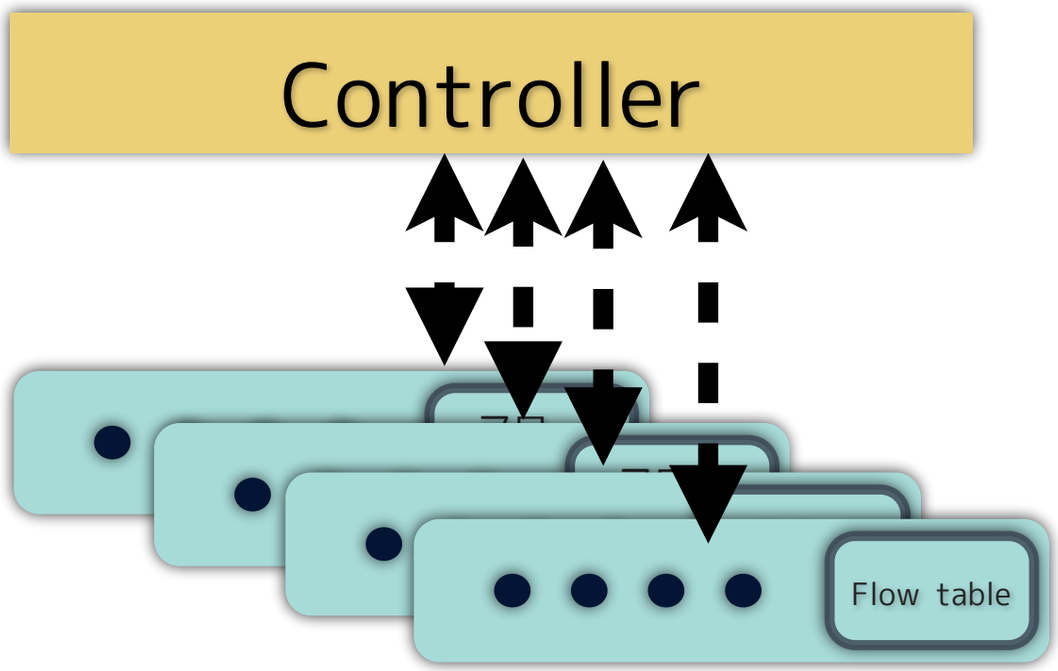




http://r.gnavi.co.jp/g045632/menu9/

VS

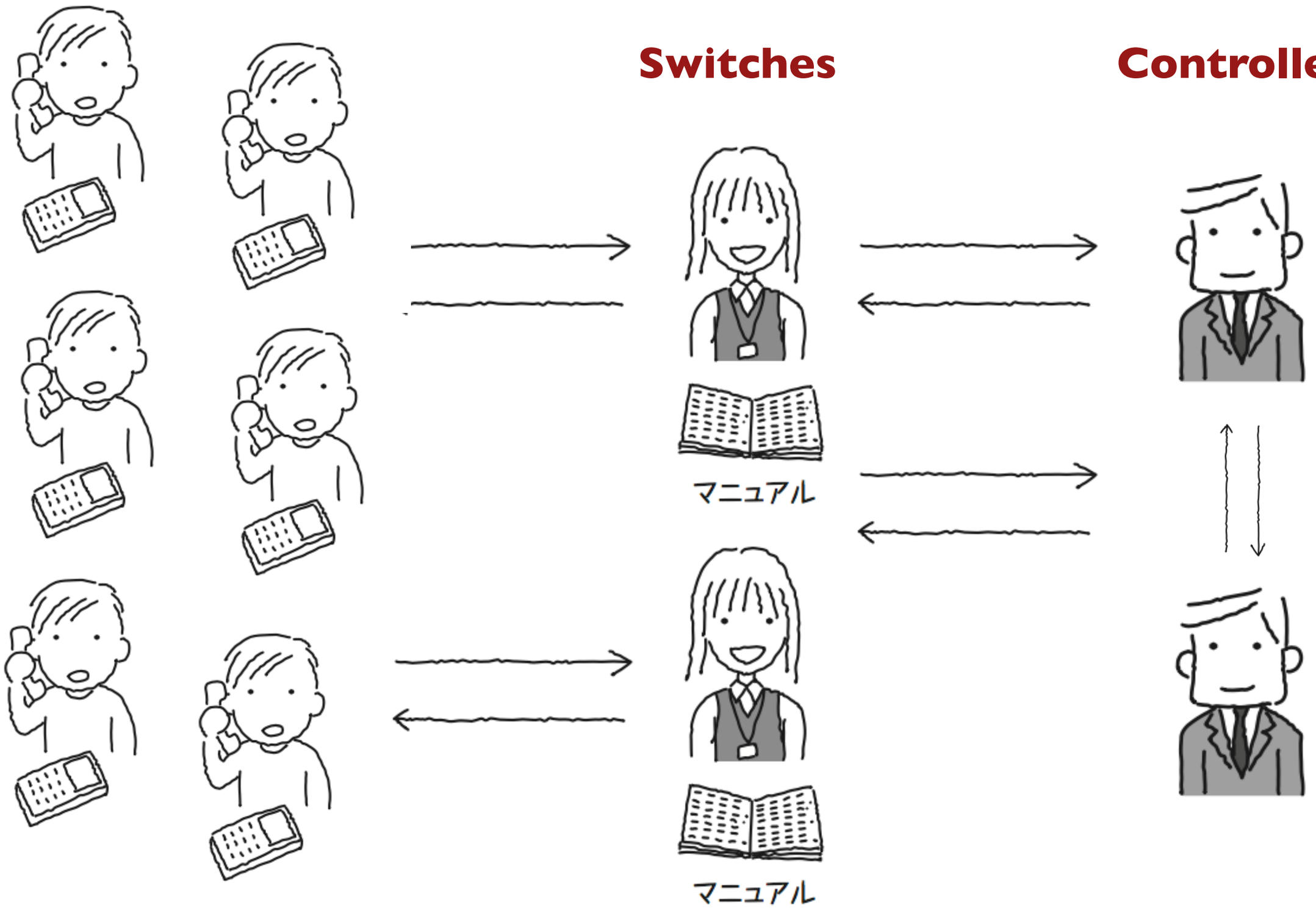
http://www.sk-aloha.jp/a/2016/08/post-1838.html



Hosts

Switches

Controllers



Conclusion: OpenFlow

- Flexible due to its software-oriented nature
  - Automation, Cooperation with applications and services, and centralized control
- Implementing a controller is not an easy task
  - Realizing functions that hardware routers/ switches cannot easily realize with OpenFlow!