# SDN-based Dynamic Traffic Shaping Method

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# AUTHOR

**Kuribayashi Shin-ichi** received the B.E., M.E., and D.E. degrees from Tohoku University, Japan, in 1978, 1980, and 1988 respectively. He joined NTT Electrical Communications Labs in 1980. He has been engaged in the design and development of ISDN packet switching, ATM, PHS, and IMT 2000 and IP-VPN systems. He researched distributed communication systems at Stanford University from December 1988 through December 1989. He participated in international standardization on ATM signaling and IMT2000 signaling protocols at ITU-T SG11 from 1990 through 2000. Since April 2004, he has been a Professor in the Department of Computer and Information Science, Faculty of Science and Technology, Seikei University. His research interests include resource management for NFV and SDN-based networks, QoS control, traffic control for cloud computing environments, IoT traffic management and green network. He is a member of IEEE and IEICE.

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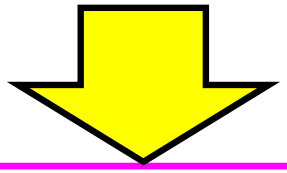
# (1) Motivation & Objective

# Motivation

-The conventional shaping method is often implemented in a congested part of the network, and need to place shaping functions at predetermined points in advance.
- If shaping can be performed near the sending side, it is expected that wasteful relay line bandwidth and relay transfer processing will be reduced, and resource efficiency will be improved.
- However, it is **difficult to achieve this with conventional networks**.



*Introduction of **SDN and NFV***

It will be easier than ever before to perform shaping dynamically when needed and near the sending side.

# Objective

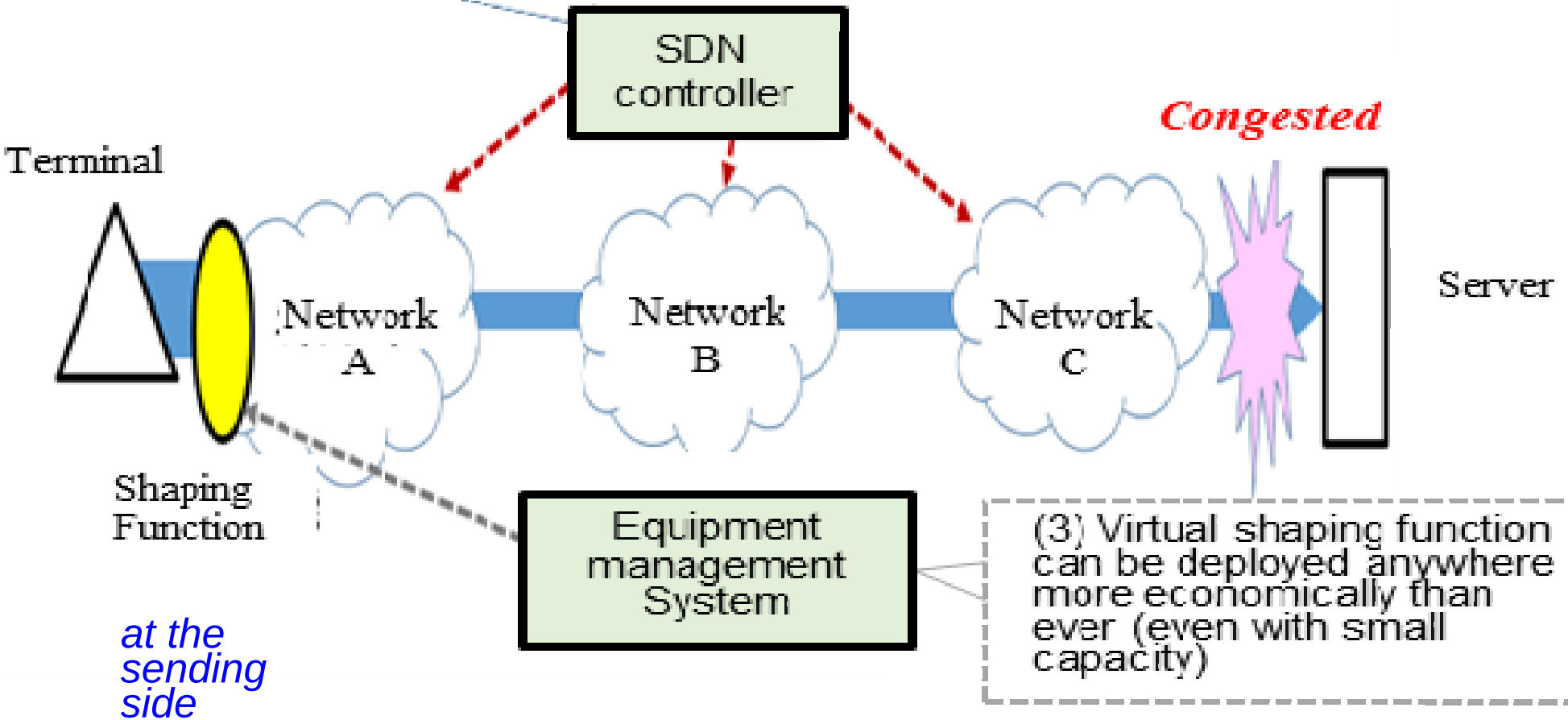
- *Propose "**Dynamic Traffic Shaping Method**" that dynamically selects the shaping position and the optimal communication flow for shaping and the optimal communication flow depending on the situation, with SDN- and NFV-based networks*

- *Clarify the system configuration to realize the proposed dynamic shaping method*

# (2) Proposed Dynamic Traffic Shaping method

# **Features of SDN and NFV** suitable for the proposed dynamic shaping method

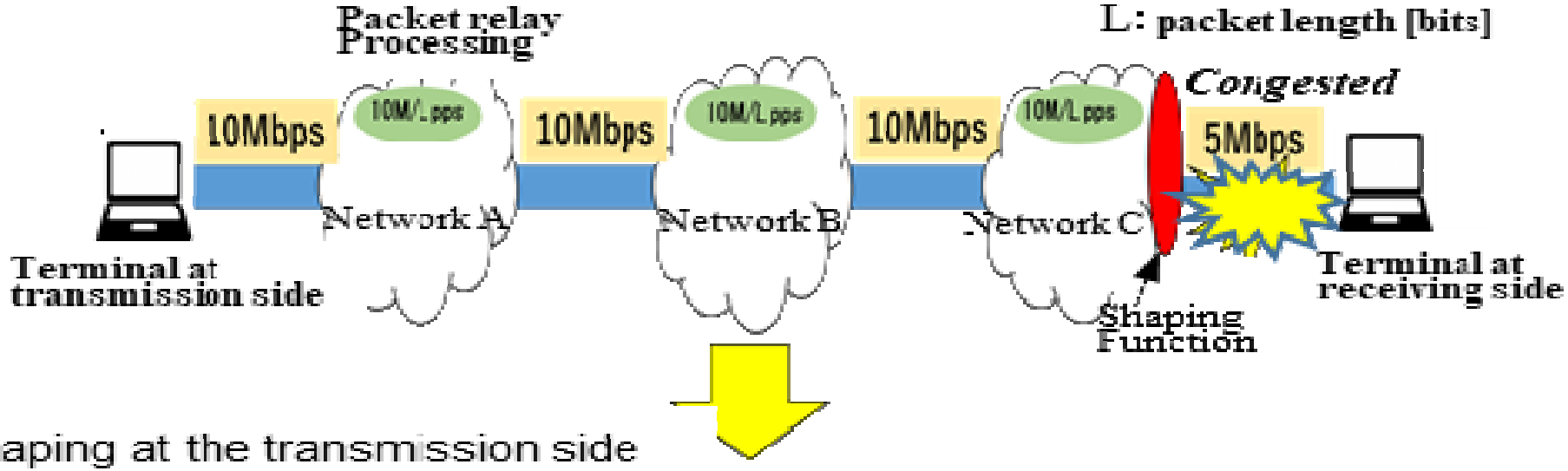
(1) Traffic data can be measured for each communication flow as a basic function, making it easy to select the communication flow to be shaped.
(2)The route for each communication flow can be grasped as a basic function, making it easy to select the optimal shaping location.



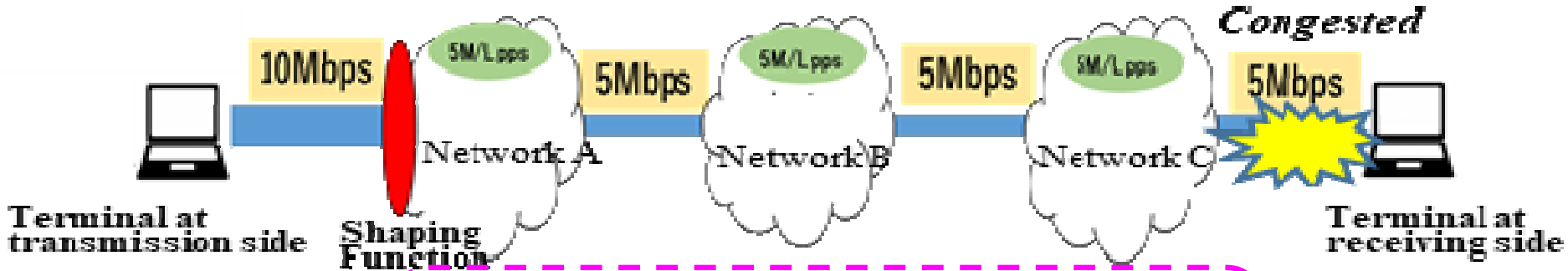
# Example of network resource reduction effect by shaping point

<1> Shaping near congested link (at the receiving side)

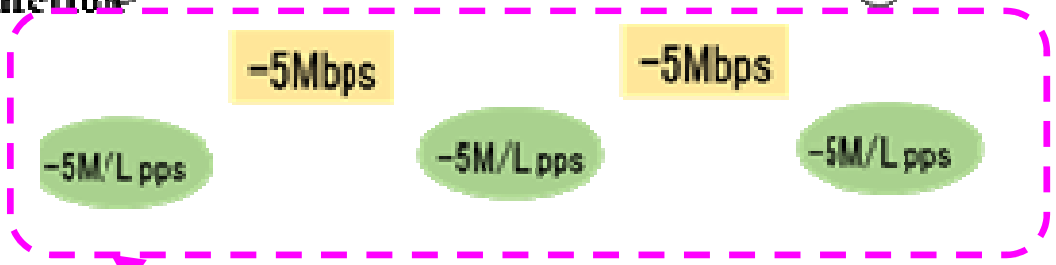
pps: packets/sec
L: packet length [bits]




<2> Shaping at the transmission side




Reducing resource
- Network bandwidth
- Packet relay processing capacity




*Network resource reduction*

# **Selection** of communication flow to be shaped

<Step 1> Among all the communication flows that pass through a link that is congested and requires traffic shaping, up to **N** (e.g., 10) fastest communication flows are selected as **candidates for shaping**.

<Step 2> The communication flow **with the largest x3 value (total reduced cost by shaping)** is selected to be shaped:

$$x3 = x1 * Cb + x2 * Cp$$

x1: the reduced Network bandwidth
x2: the reduced number of packets to be relayed.
Cb and Cp: cost-coefficient which are used to calculate the cost of two different units at the same level

$$x1 = \text{communication speed (V)} \times \text{number of hops (H)}$$

$$x2 = \frac{\text{communication speed (V)} \times \text{number of hops (H)}}{\text{packet length (P)}}$$

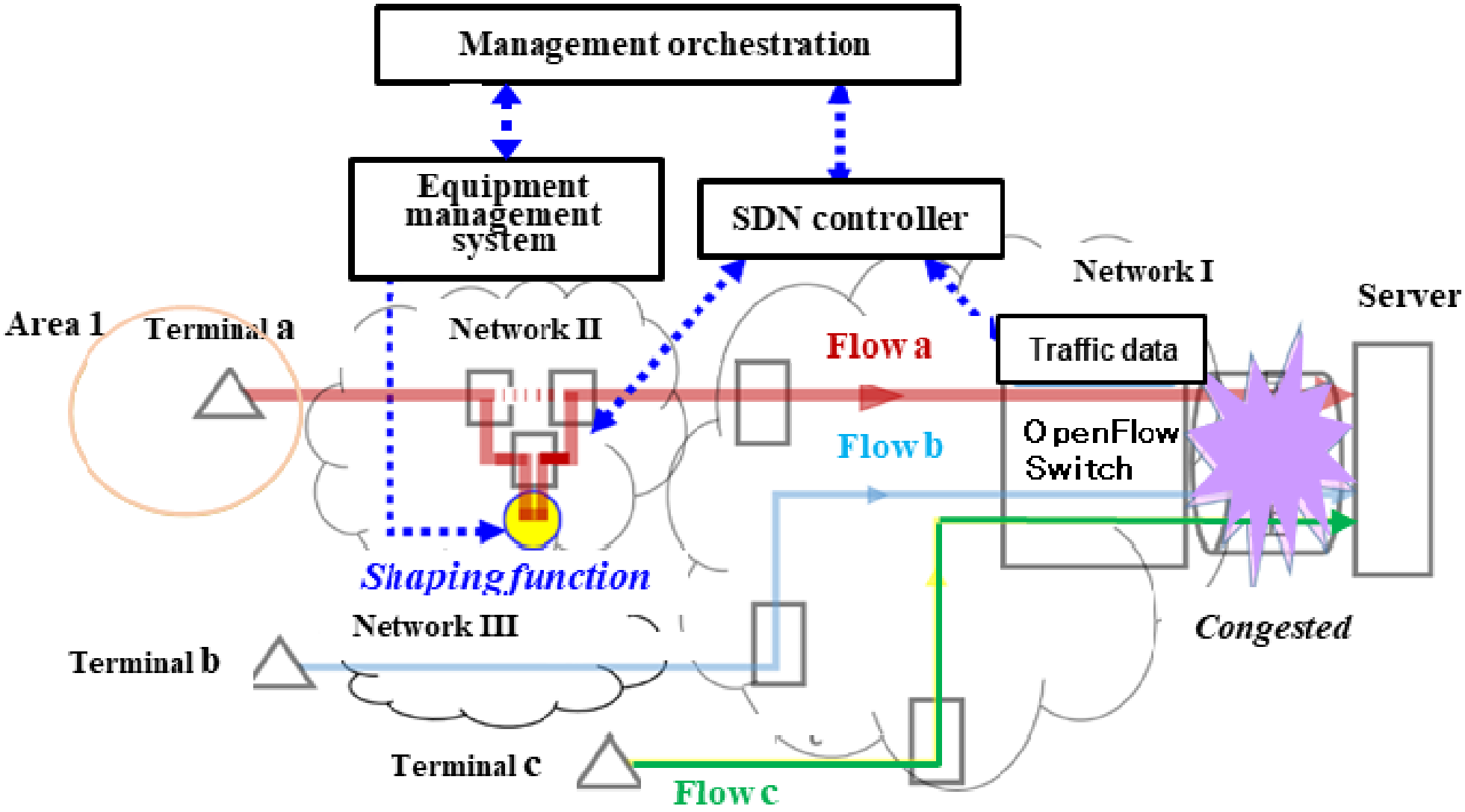
# Determination of shaping rate

○ The shaping speed of the selected communication flow for shaping is set so that the congestion of the line is eliminated. However, considering the quality of service, do not set the shaping speed for each communication flow to less than half of the original communication speed.

○ If the congestion cannot be resolved by shaping the first flow with the largest x3 value, the flow with the next largest x3 value will be subject for shaping. This is continued until the congestion is resolved.

# (3) System configuration and functions that realize the dynamic shaping method

# Proposed system configuration that automates dynamic shaping



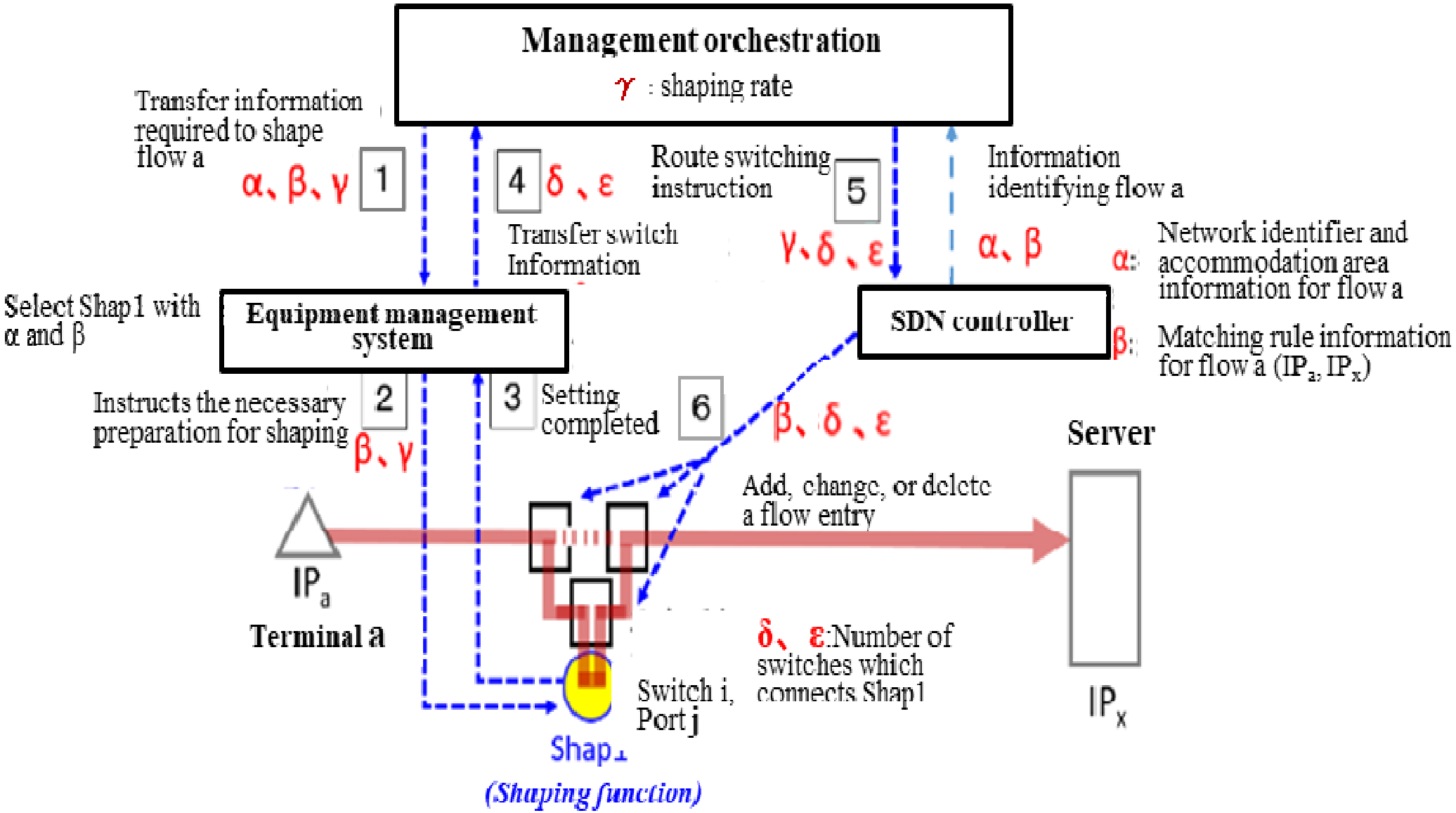

*OpenFlow protocol applied between OpenFlow controller and switch is required to be modified for the proposed system.

# MAIN FUNCTIONS OF MANAGEMENT ORCHESTRATION

・Summarize the flow of processing and controls other functions. Check the progress of each function and manage the processing order.

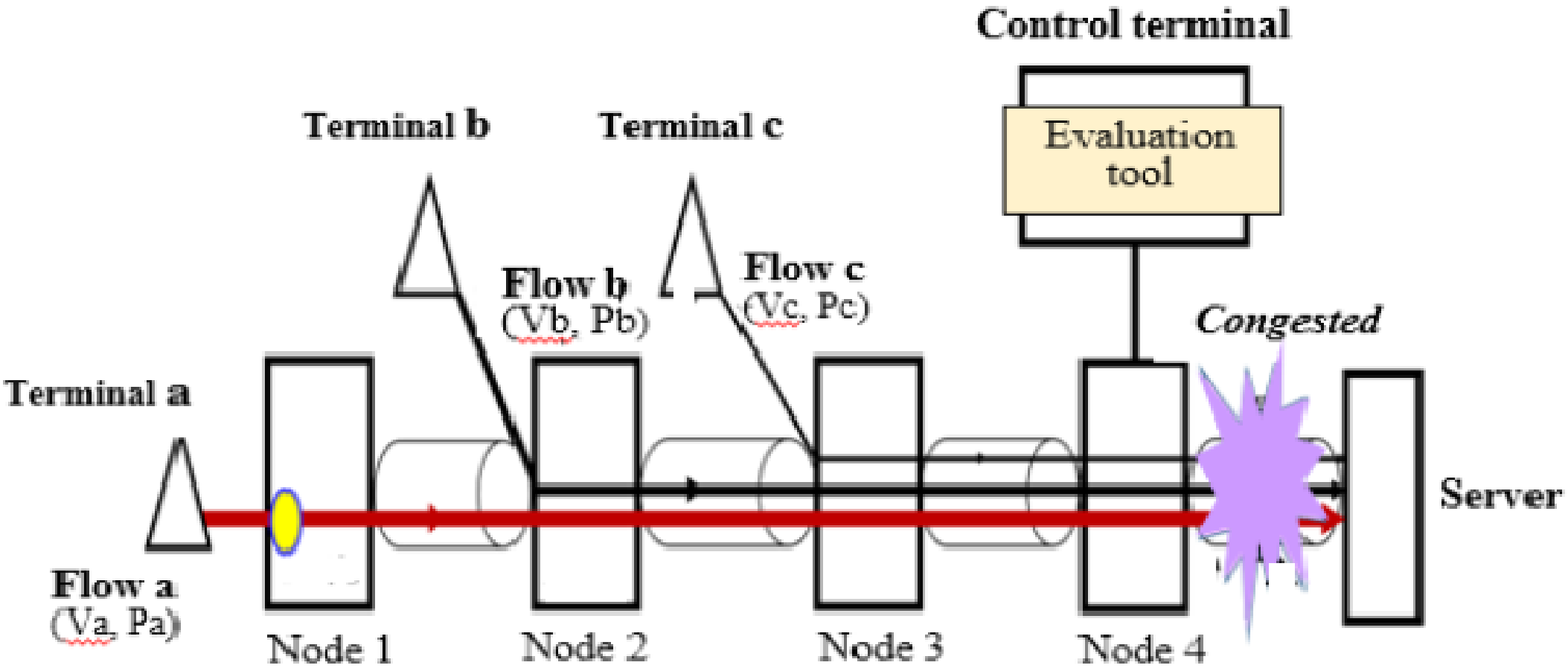
- Collect line usage rate
- Collect communication speed for each flow
- Collect hop count for each flow
- Select shaping target flow
  *Select the largest x3 value
- Determine shaping data for shaping target flow
- Decide shaping function (or create by NFV)
- Set shaping function parameter
- Route switching
- Link with SDN controller
- Link with equipment management system

# Cooperation method from selection of shaping function to route switching



# (4) Confirmation of the operation of the proposed dynamic shaping method

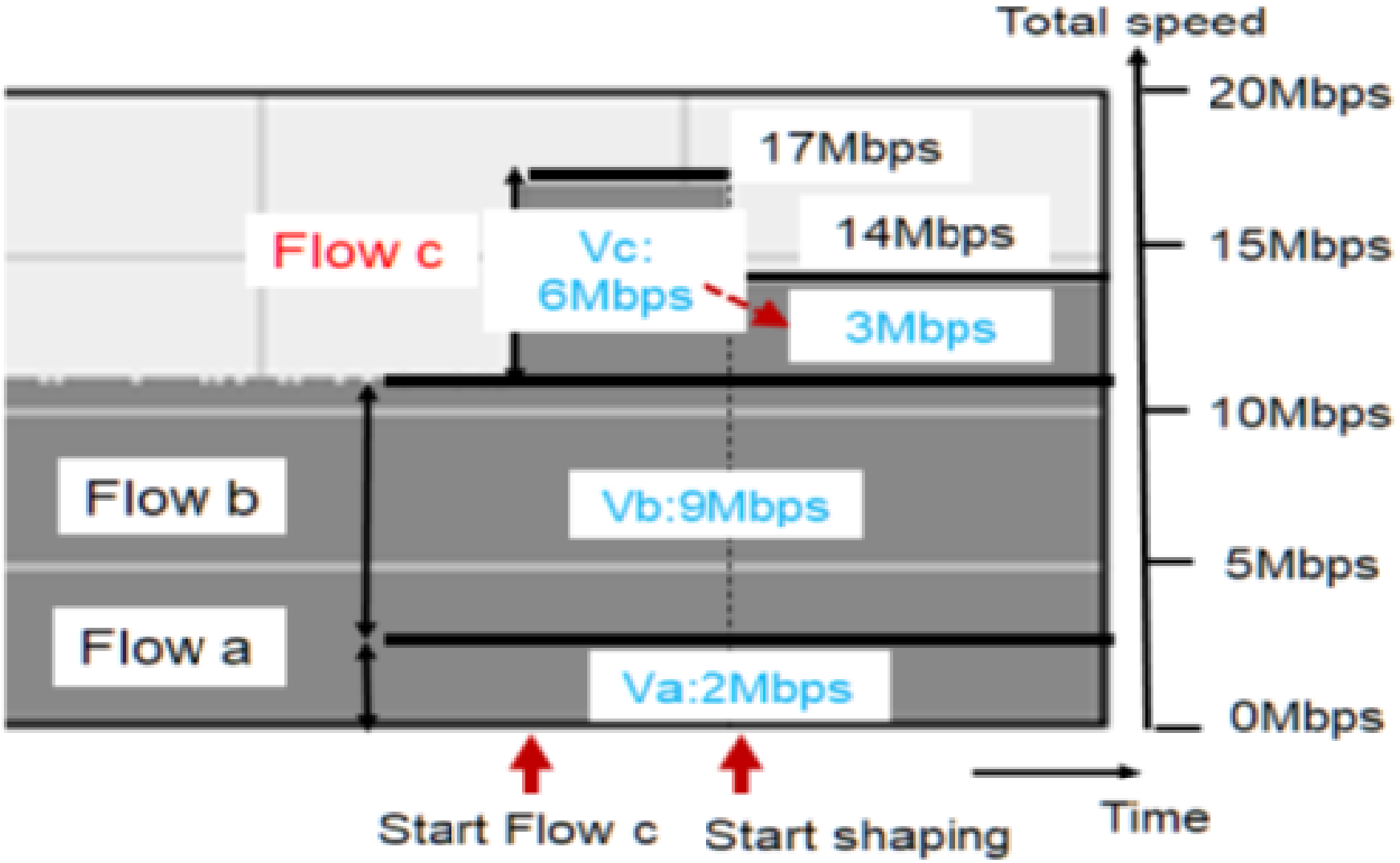
# Evaluation System




Terminal, server: Windows 10Pro (64-bit) laptop; Node: VyOS (1.1.4) desktop PC
Va,Vb,Vc: communication speed; Pa, Pb, Pc: packet length

# Measured communication speed from Node 4 to server

*The shaping is performed as expected in advance.*



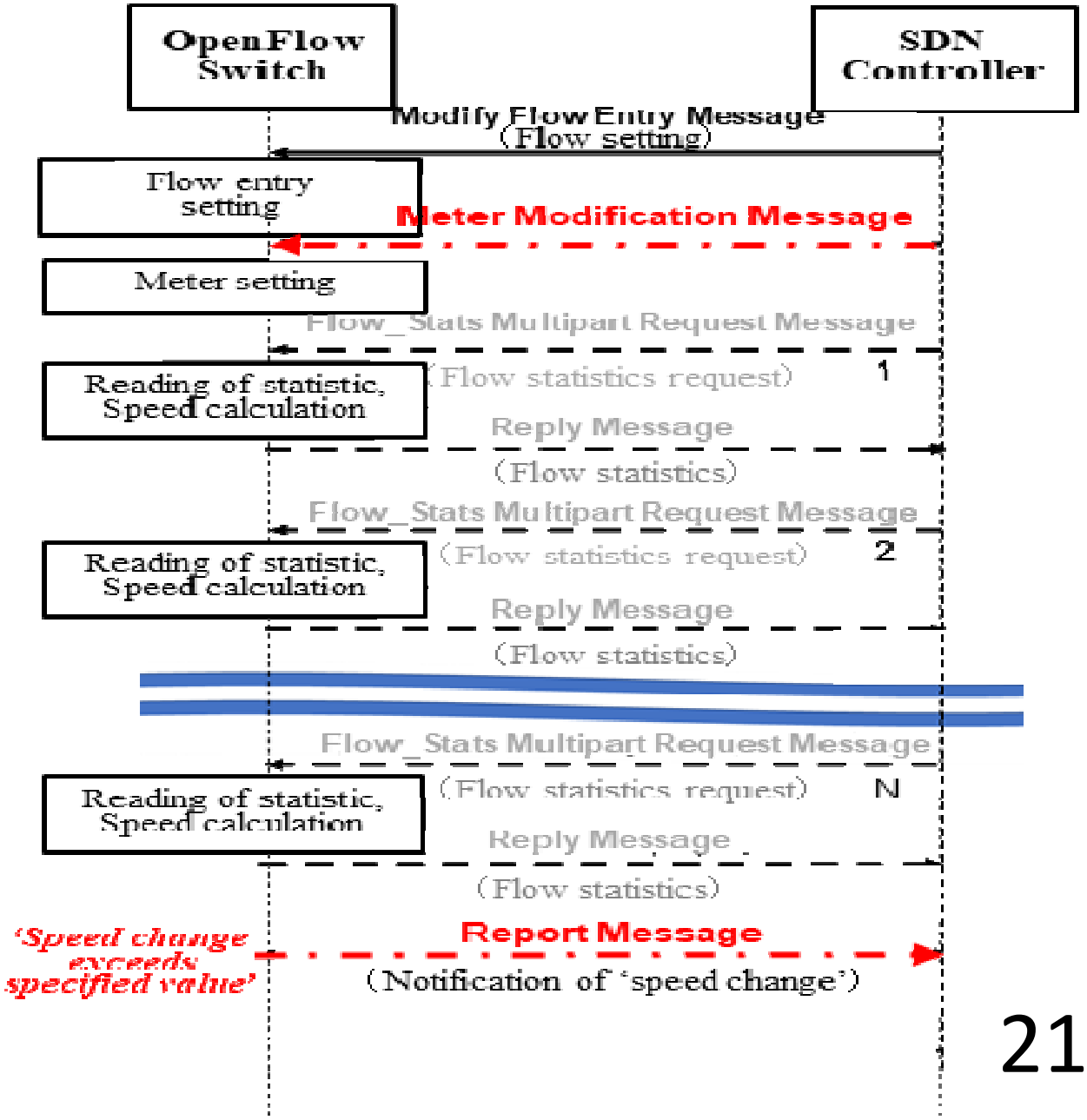
(5) Method to simplify the process of collecting **traffic data** of each communication flow

** In the dynamic shaping method, the traffic data (statistical information) collection by the SDN controller for each communication flow is a large processing load, so a simplified method is required!*

# Overview of the proposed method to simplify the process of collecting traffic data

-**The switch side** periodically collects traffic data of communication flows to be monitored and estimates the communication speed (**no inquiry from the SDN controller**).

- Then, only when the speed has increased or decreased significantly compared to the previous cycle, **the speed change is reported to the SDN controller**.



# (6) Summary

○ Proposal of “**Dynamic traffic shaping method**" that dynamically selects the optimum communication flow for shaping and its shaping position with SDN- and NFV-based networks

○ Operation verification of the proposed dynamic shaping method

○ Proposal for simplified method of speed measurement processing for each flow in SDN controller, which is a major issue in realization


Thank you