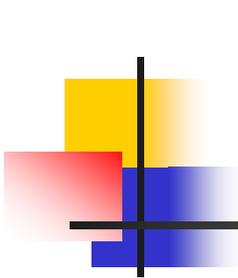# A Method of Constructing Personal Network for Ubiquitous Personal Services

Kazumasa Takami[1&2], Hajime Kusu[1] and Akira Ikeda[2]

[1]Graduate school of Engineering,

[2]Department of Engineering,

Soka University, JAPAN

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Outline

Introduction

Configuration of a Personal Network

Method of Building a PN
**   and Monitoring Protocol**

Touch&Select Method
    A Touch&Share method
    A Touch&Print method

Evaluation
    The monitoring protocol by simulation
   The Touch&Select method using prototyping

Conclusions and Future Works

Background and Goal

In a ubiquitous environment,
the connections of a variety of devices (including **electronic tags**) together with an advance in **Web services**,

are expected to give rise to

➤ a wide range of **personal area network services**,

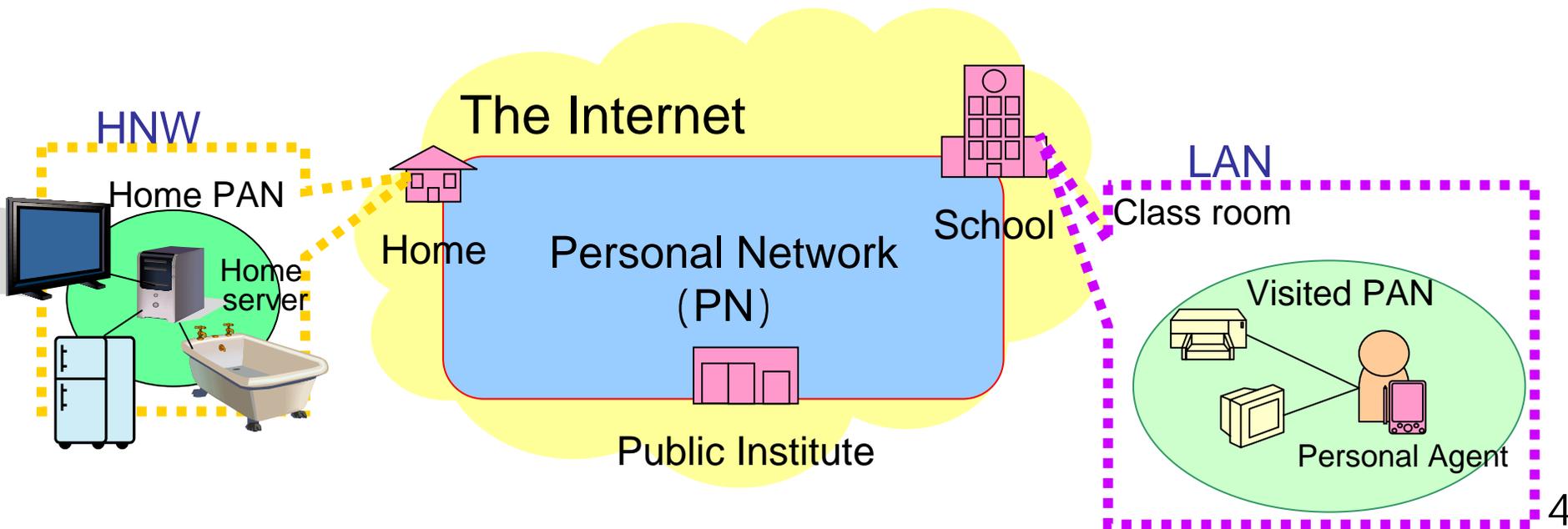➤ stimulating research into **smart space services incorporated with a sensing** environment.
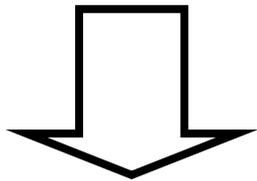
➤ PAN is not sufficient to provide a ubiquitous service **well tuned to individuals**.

➤ The advanced systems are becoming so complex as **to demand high skill of users**.

We proposes

- a method of building an Mobile IPv6-based **Personal Network** (PN) consisting of a personal agent (PA),

- a **Touch&Select method**, which uses RFID to enable the user to **intuitively** select a device.

Configuration of a Personal Network

Home PAN (**HPAN**): **mainly** used by the user.

Visited PAN (**VPAN**): built at a **temporarily** visited place.

Personal network (**PN**): a **logical network** consisting of an HPAN and **multiple** VPANs

A personal agent (**PA**): implemented on a mobile node carried by an individual.

HNW

The Internet

Home PAN

LAN

Home

Home server

Personal Network PN

School

Class room

Visited PAN

Public Institute

Personal Agent

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Example of a Ubiquitous Personal Service

The user integrates **the Web camera and the large display** in the classroom into his PAN, and establishes a **visual communication** with his friend in a café.

This friend has also integrated the Web camera and display in the café into her PAN.
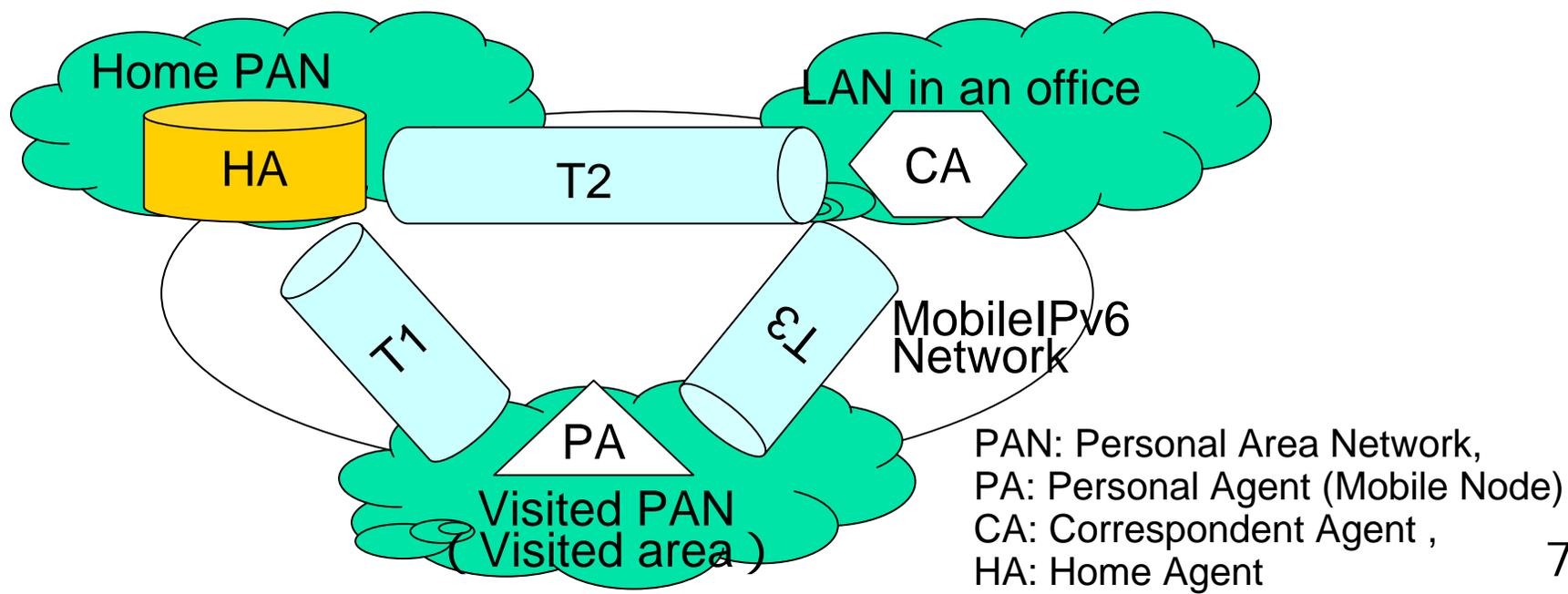
The user and his friend set up connections to their HPANs.
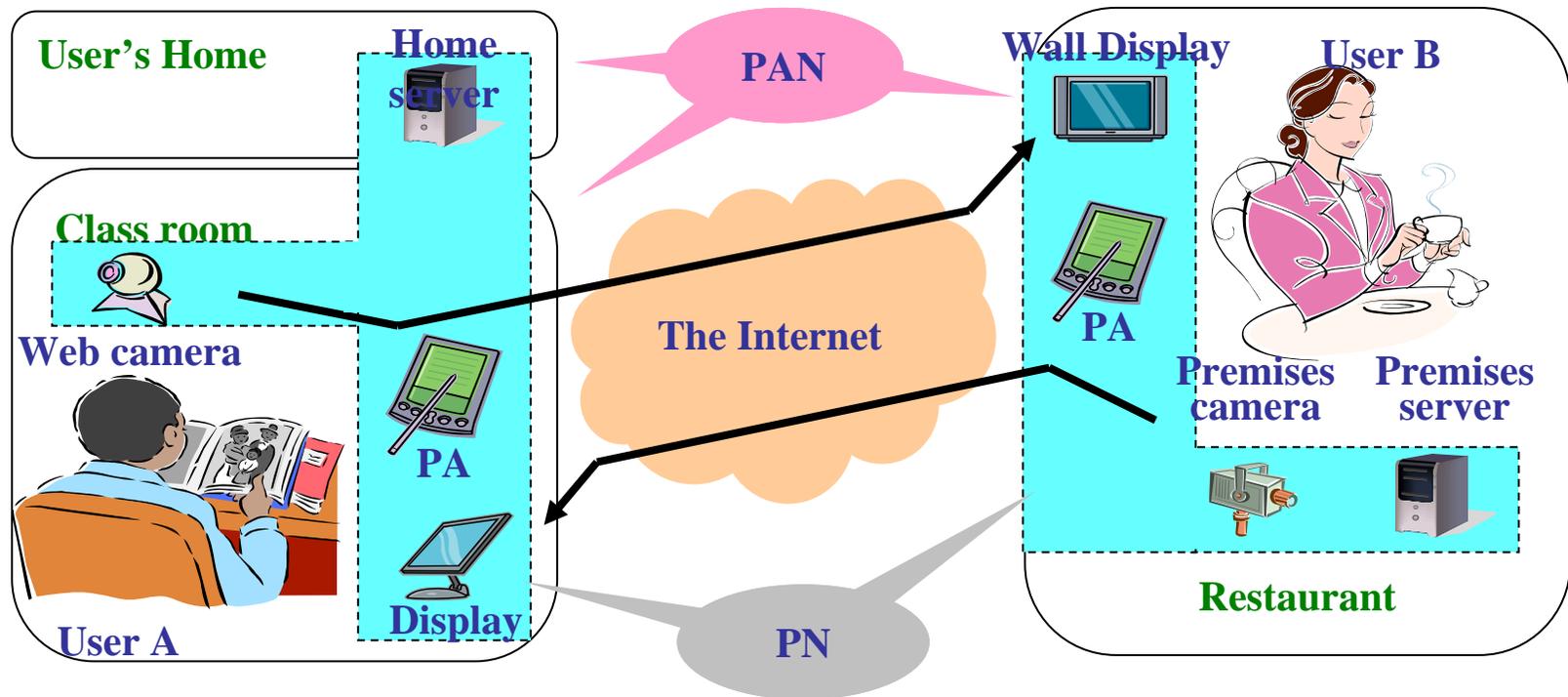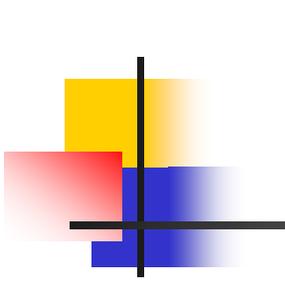
Requirements for a Method of Building a PN

(a) The **mobility** of the personal agent (PA), which plays the central part in the Visited PAN,

(b) **Dynamic establishment and release** of the PN,

(c) **Simultaneous establishment** of multiple PNs in different locations,

(d) **High security** in PNs.

Establishment of a PN through Dynamic Interconnections of Tunnels

The IPsec tunnels, T1-T2-T3, are managed as a **temporary ring network** over Mobile IPv6 wide-area network.

The T1-T2-T3 configuration is released when
- the use of the PN is **terminated**,
- the location of the PA is **unknown**,
- a **fault** is detected in the path.

Home PAN

LAN in an office

HA

T2

CA

T1

T3

MobileIPv6 Network

PA

Visited PAN
Visited area

PAN: Personal Area Network,
PA: Personal Agent (Mobile Node)
CA: Correspondent Agent ,
HA: Home Agent

Example of Establishing Multiple, Independent PNs

Multiple PNs in **different locations** can be established simultaneously.

This allows for independence and security of each communication location.

Sequence of the PN Monitoring Protocol

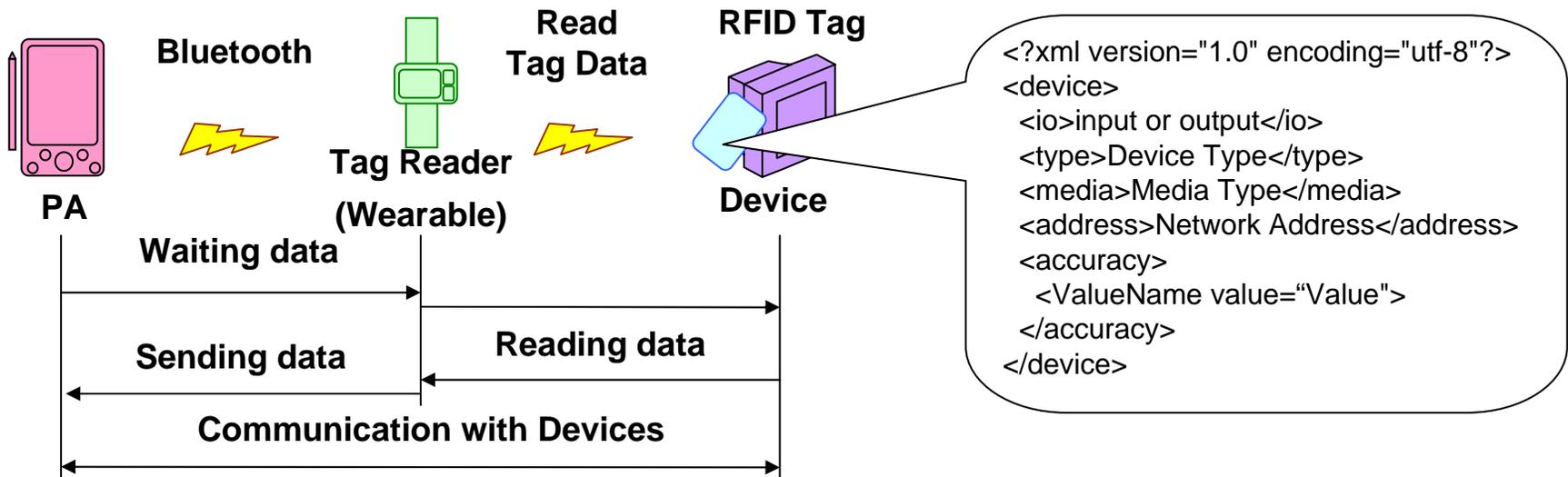The PN management mechanism **keeps track of the status of the tunnel** in each section and the PN.

It **circulates monitoring packets** in the PN, and when a node (PA, HA or CA) receives one of these packets, it sends an **acknowledgement packet to the upper node**.

HA   PA   CA

Interlink timeout

T.O.Link

Number of retransmissions M

Discard packets that have arrived after timeout

Ring timeout
T.O.Ring   T.O.Link1 × M
+T.O.Link2 × M
+T.O.Link3 × M

(note)
⟵ : Monitoring request message
⟵···· : Monitoring acknowledgement message
⟵·−·− : Failure reporting message

**Sends a failure reporting message towards the parent node in the direction opposite**

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Device Selection using the Touch&Select Method

Each device has an **RFID tag**, which **keeps data used for access** to that device.

When the tag is read by a tag reader, the user can **intuitively identify and select the device**.

Since the information about a device is attached to the device itself, the user can **easily obtain information about the communication environment**, such as network addresses, in an office he or she has temporarily visited.
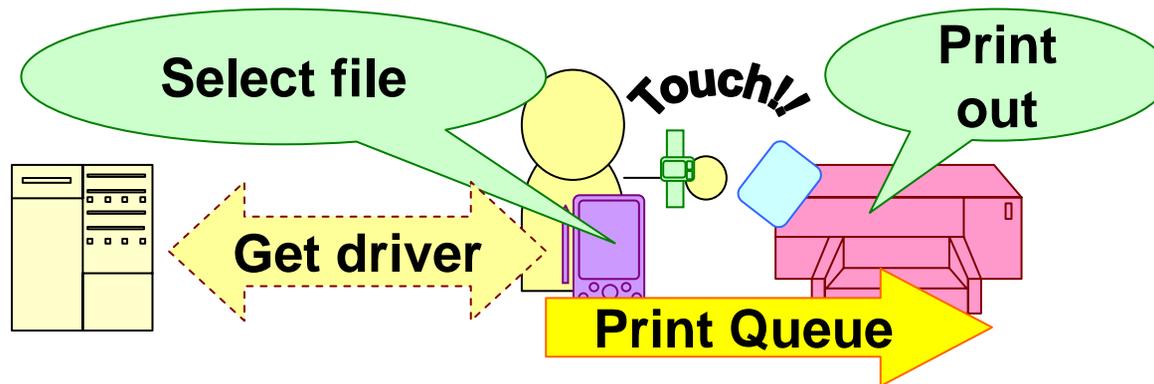
Bluetooth

Read Tag Data

RFID Tag

Tag Reader

(Wearable)

PA

Device

Waiting data

Sending data

Reading data

Communication with Devices

```xml
<?xml version="1.0" encoding="utf-8"?>
<device>
  <io>input or output</io>
  <type>Device Type</type>
  <media>Media Type</media>
  <address>Network Address</address>
  <accuracy>
    <ValueName value="Value">
  </accuracy>
</device>
```

Touch&Share Method

A user can specify the device to which **a file is to be transferred by simply touching it**.

The processing sequence is as follows:

Step1: PA1 **selects the file** to be sent. PA2 **selects the folder** in which the file is to be saved, and begins to wait.

Step2: PA1 **starts the wearable tag reader** and receives data read from the tag attached to the node of PA2.

Step3: PA1 sends a file summary data. PA2 receives the file summary data and decides whether to receive the file.

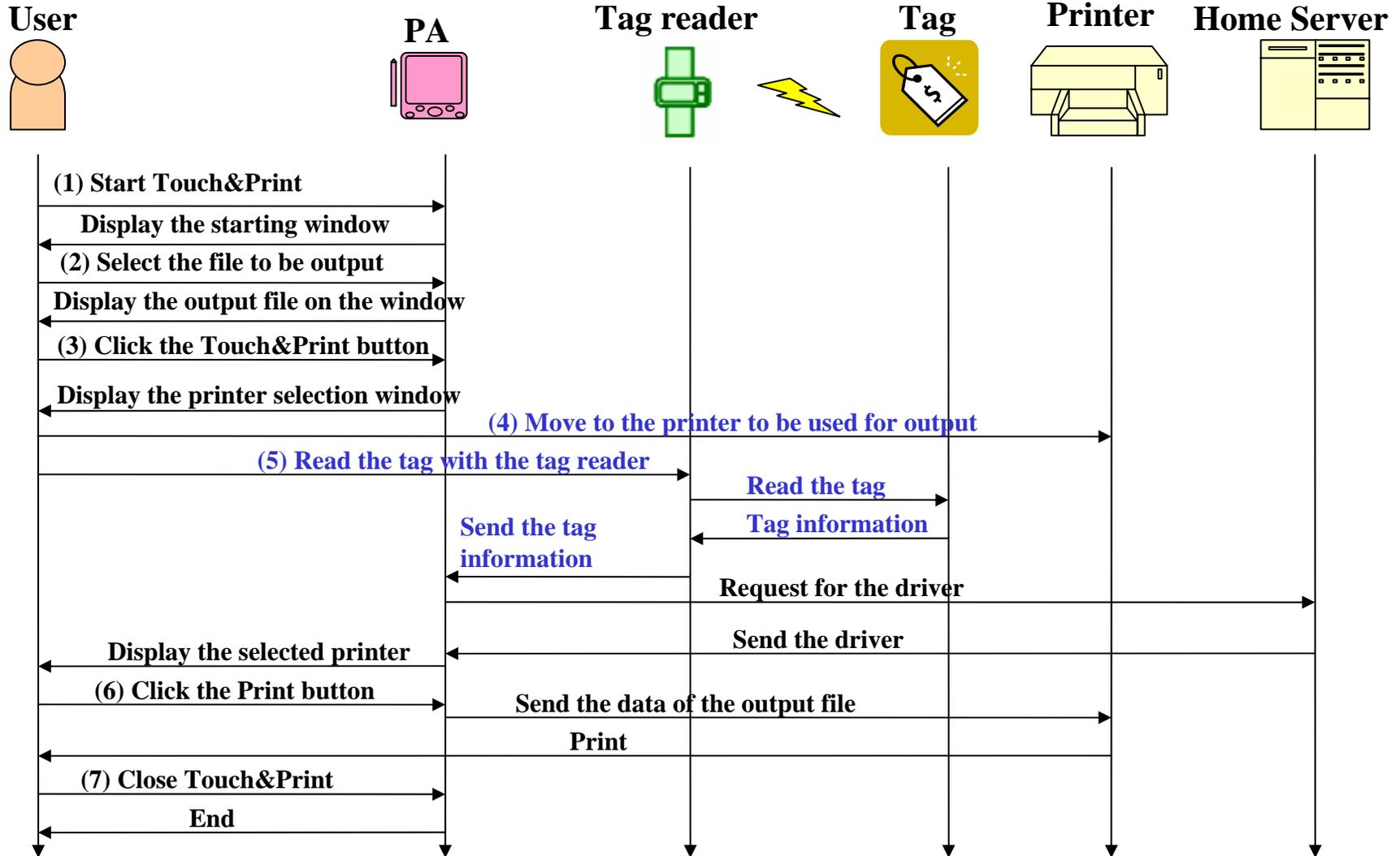Step4: **After receiving PA2's acceptance** to receive the file, PA1 sends the file.
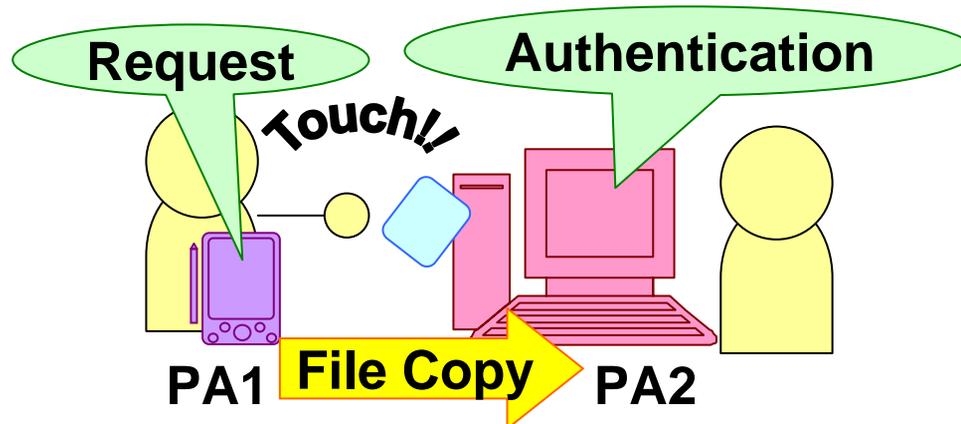
Touch&Print Method

  When a user **temporarily visits an office** new to him or her, he or she **cannot immediately understand the layout** and connections of printers and PCs.

  By touching the tag attached to the printer, the user can have his or her wearable RFID tag reader read data, and use the printer to output his or her file.
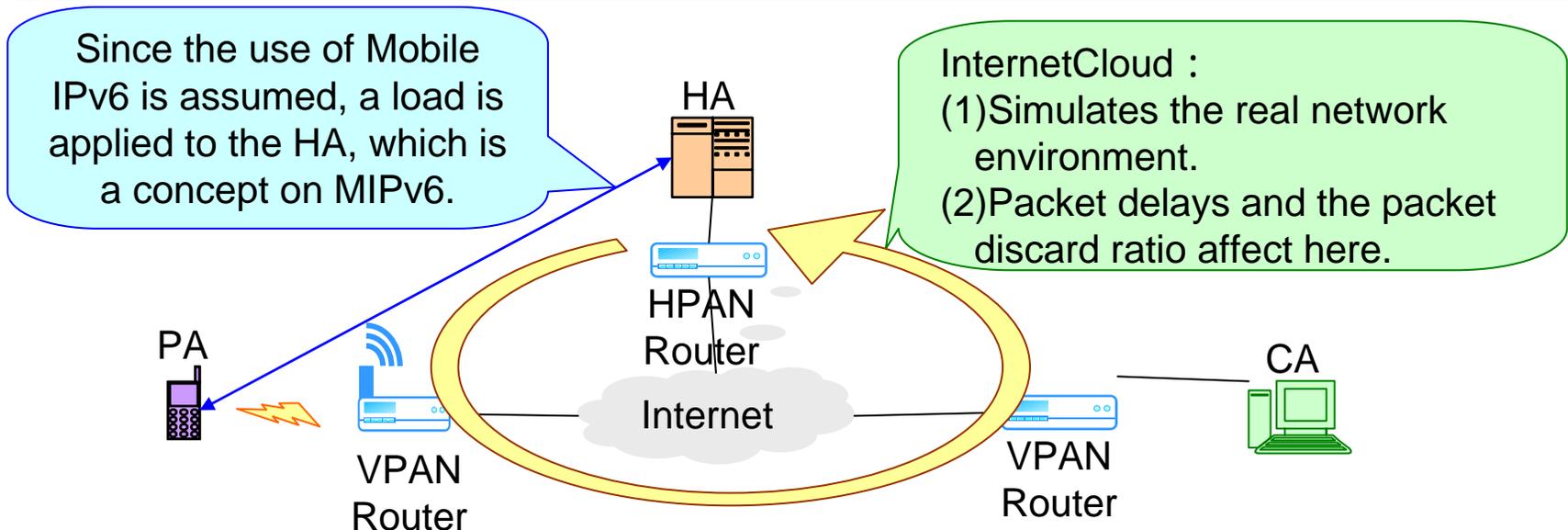
Sequence of using the Touch&Print method

User	PA	Tag reader	Tag	Printer	Home Server

(1) Start Touch&Print →

← **Display the starting window**

(2) Select the file to be output →

← **Display the output file on the window**

(3) Click the Touch&Print button →

← **Display the printer selection window**

(4) Move to the printer to be used for output →

(5) Read the tag with the tag reader →

Read the tag →

← **Tag information**

← **Send the tag information**

Request for the driver →

← **Send the driver**

← **Display the selected printer**

(6) Click the Print button →

Send the data of the output file →

Print →

← (to User)

(7) Close Touch&Print →

← **End**

Simulation Model
for PN Monitoring Protocol

We implemented the proposed protocol on a network simulator.

We examined **how the ring timeout detection time is affected** when the following conditions were changed.

- the interlink timeout T.O.Link,

- the maximum number of retransmissions,

- the packet discard ratio.

Since the use of Mobile IPv6 is assumed, a load is applied to the HA, which is a concept on MIPv6.

InternetCloud
(1) Simulates the real network environment.
(2) Packet delays and the packet discard ratio affect here.

HA

HPAN Router

PA

VPAN Router

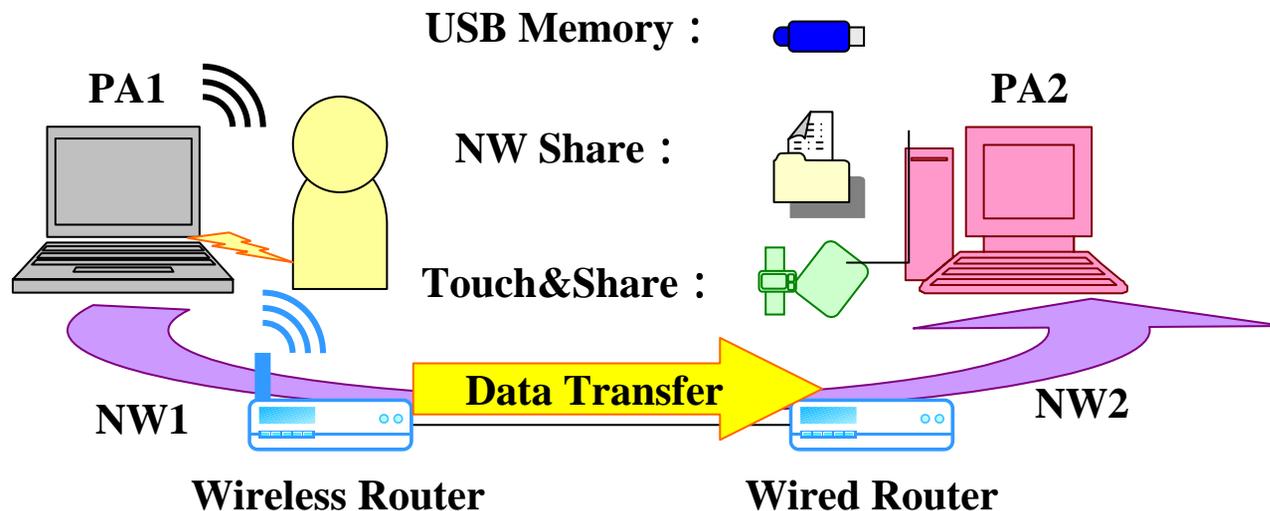Internet

VPAN Router

CA

Ring Delay of a Monitoring Packet

By selecting appropriate T.O.Link and M in the proposed protocol, it is possible to **achieve a wide range of PN fault detection** accuracy.

As the packet discard ratio increases, the link delay increases.

The **value of ring timeout** can be reduced,

- the packet discard ratio < 1%   about 1 sec.

- the packet discard ratio > 5,10%   about 2 sec.
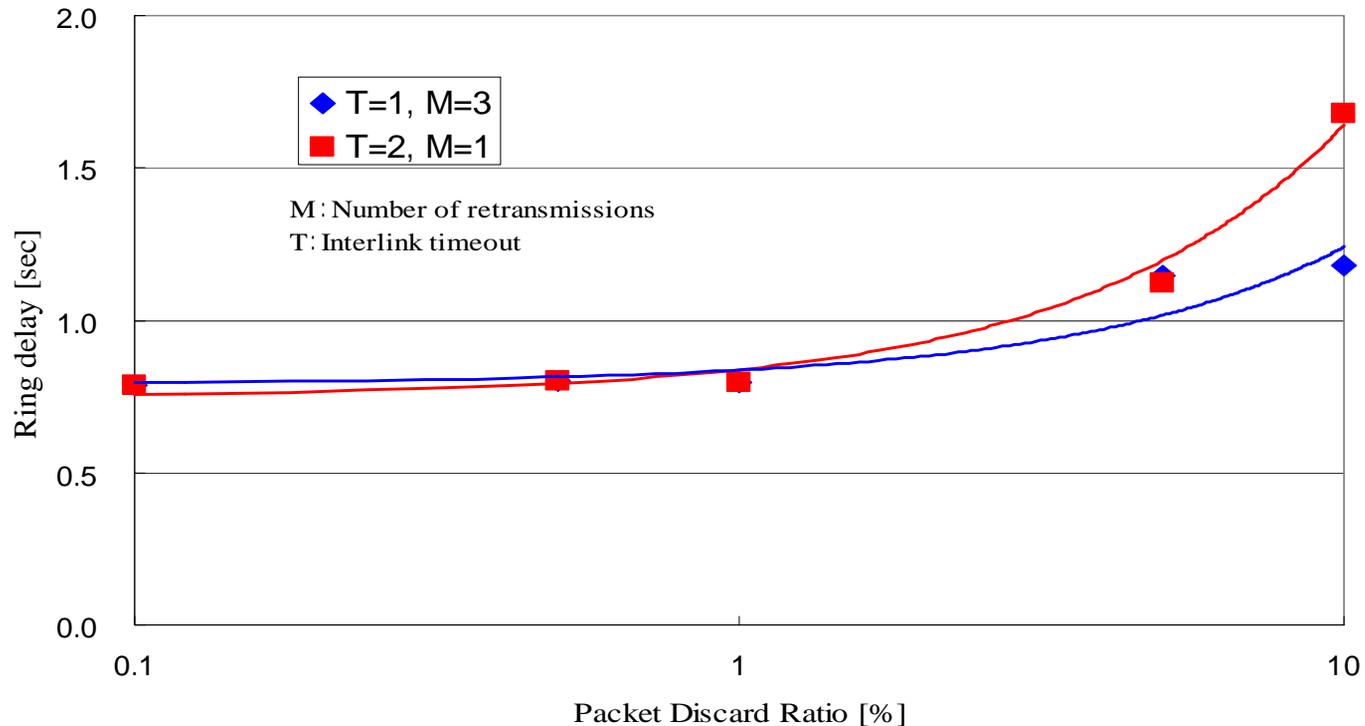
Experimental Environment for Comparing the Touch&Share Method

We experimented with **copying a file from one computer to another computer nearby** using three different methods:
- the proposed Touch&Share method,
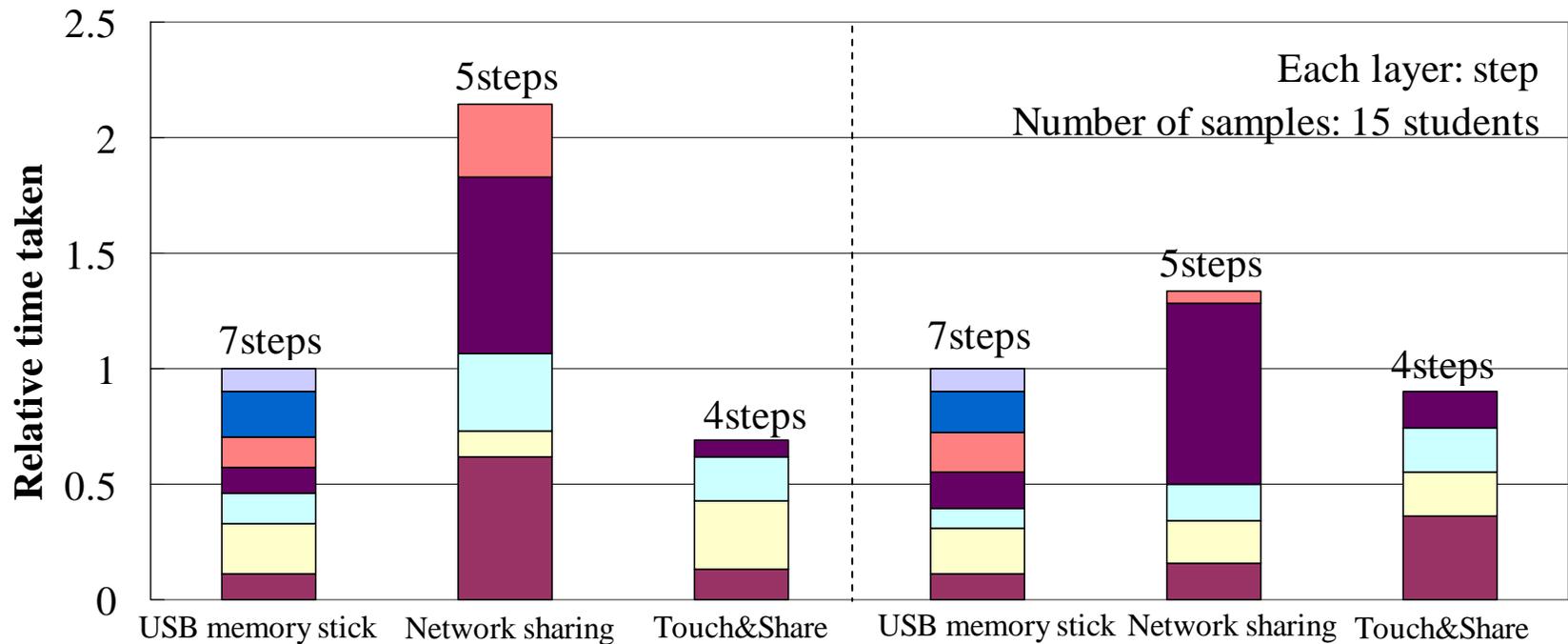- network sharing,
- the use of a USB memory stick.

The detail of the procedure

USB Memory

NW Share

Touch&Share

PA1

PA2

Data Transfer

NW1

NW2

Wireless Router

Wired Router

USB memory
1. Insert a USB memory stick to PC1.
2. Open the source folder.
3. Copy the file to the USB memory stick.
4. Withdraw the USB memory stick.
5. Insert the USB memory stick to PC2.
6. Open the destination folder.
7. Complete copying.

Network sharing
1. Open the source folder.
2. Open the destination parent folder.
3. Set file sharing.
4. Open the destination folder.
5. Complete copying.

| Touch&Share |
| --- |
| 1. Start the server. |
| 2. Open the source folder. |
| 3. Start the application. |
| 4. Complete copying. |

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Comparison of Copying Times Taken by Different Alternatives

The relative copying time is compared using the time taken by the USB memory stick as one.

The copying time was reduced
- by **10 to 30%** compared to the USB memory stick method,
- by **30 to 70%** compared to the network sharing method.

Each layer: step
Number of samples: 15 students

Relative time taken

USB memory stick   Network sharing   Touch&Share   USB memory stick   Network sharing   Touch&Share

Experiment using any appropriate   Experiments using the specified
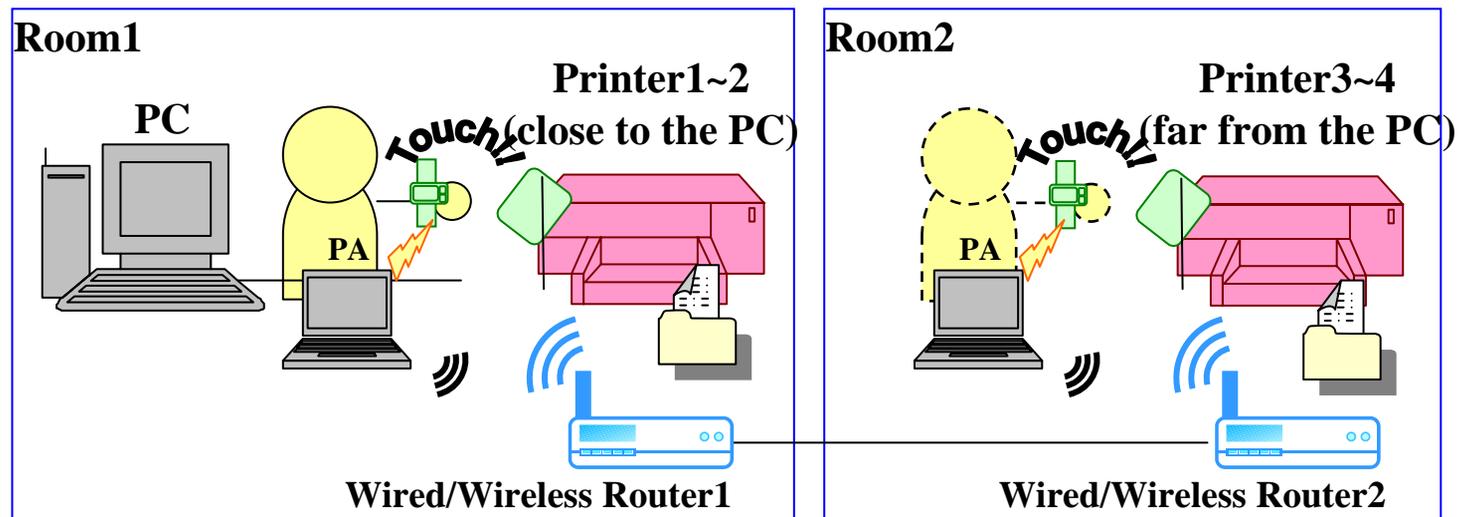
Comparison of Copying Times with AP and SP

As for the proposed method, there is **no significant difference** in the copying time between the two procedures.

This can be considered to indicate that the subjects were able to perform the copying operation **intuitively with simple questions**.
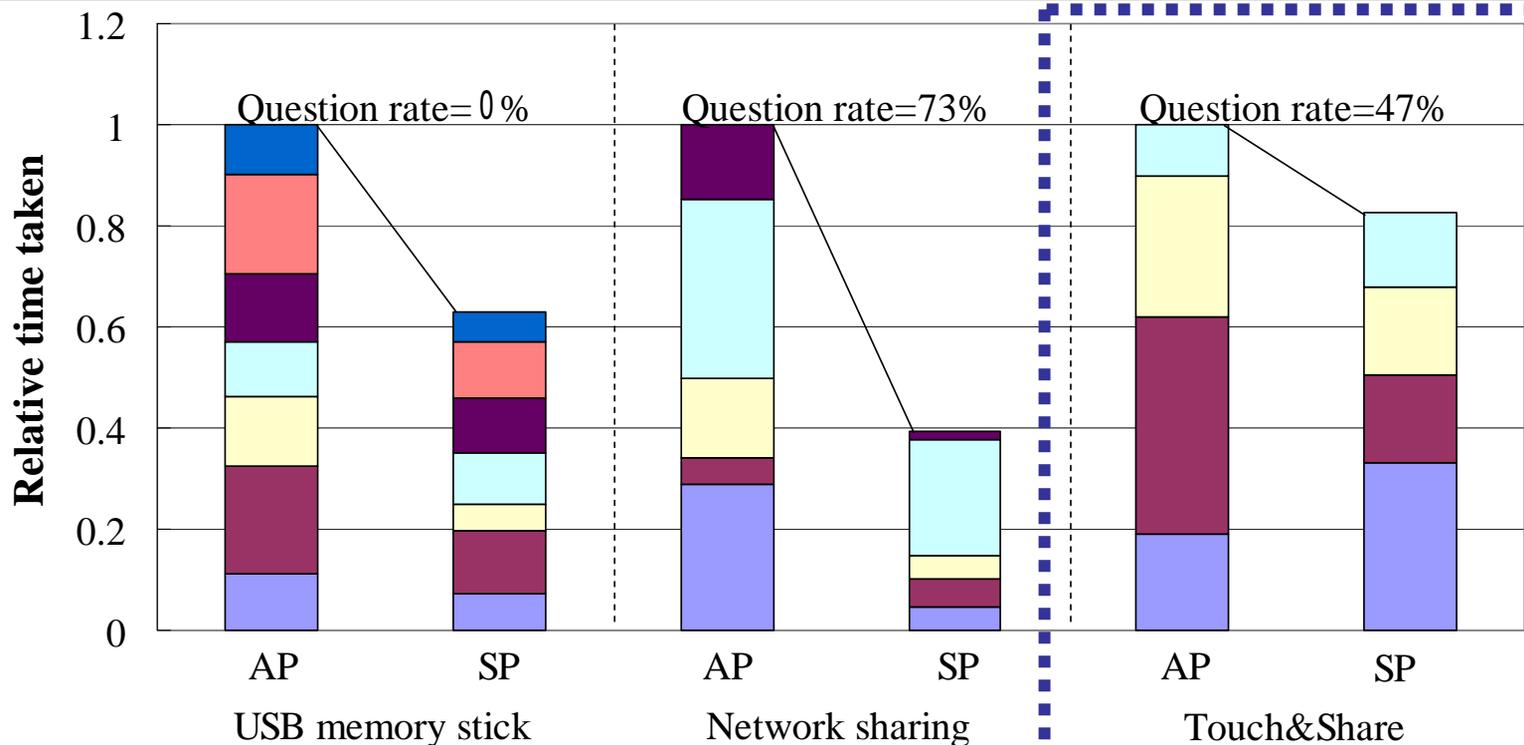
**(Note) AP: Any appropriate procedure, SP: Specified procedure**

Experimental Environment of the Touch&Print Method

We measured the length of time each of the 19 students spent.

We conducted two experiments:

Exp1: Print a file on **a default printer** and a printer touched by the student. These printers are **close to the PC**.

Exp2: Print a file on **an arbitrary printer** selected by using a conventional method and the Touch&Print method. These printers are **far from the PC**.


Room1 — PC — **Touch!!** — Printer1~2 (close to the PC) — PA — Wired/Wireless Router1

Room2 — **Touch!!** — Printer3~4 (far from the PC) — PA — Wired/Wireless Router2

Comparison of Time Spent

In Exp1, students spent **slightly shorter time** on average when using a default printer.

In Exp2, the **Touch&Print method took a shorter time** to print the file as compared with the conventional method.
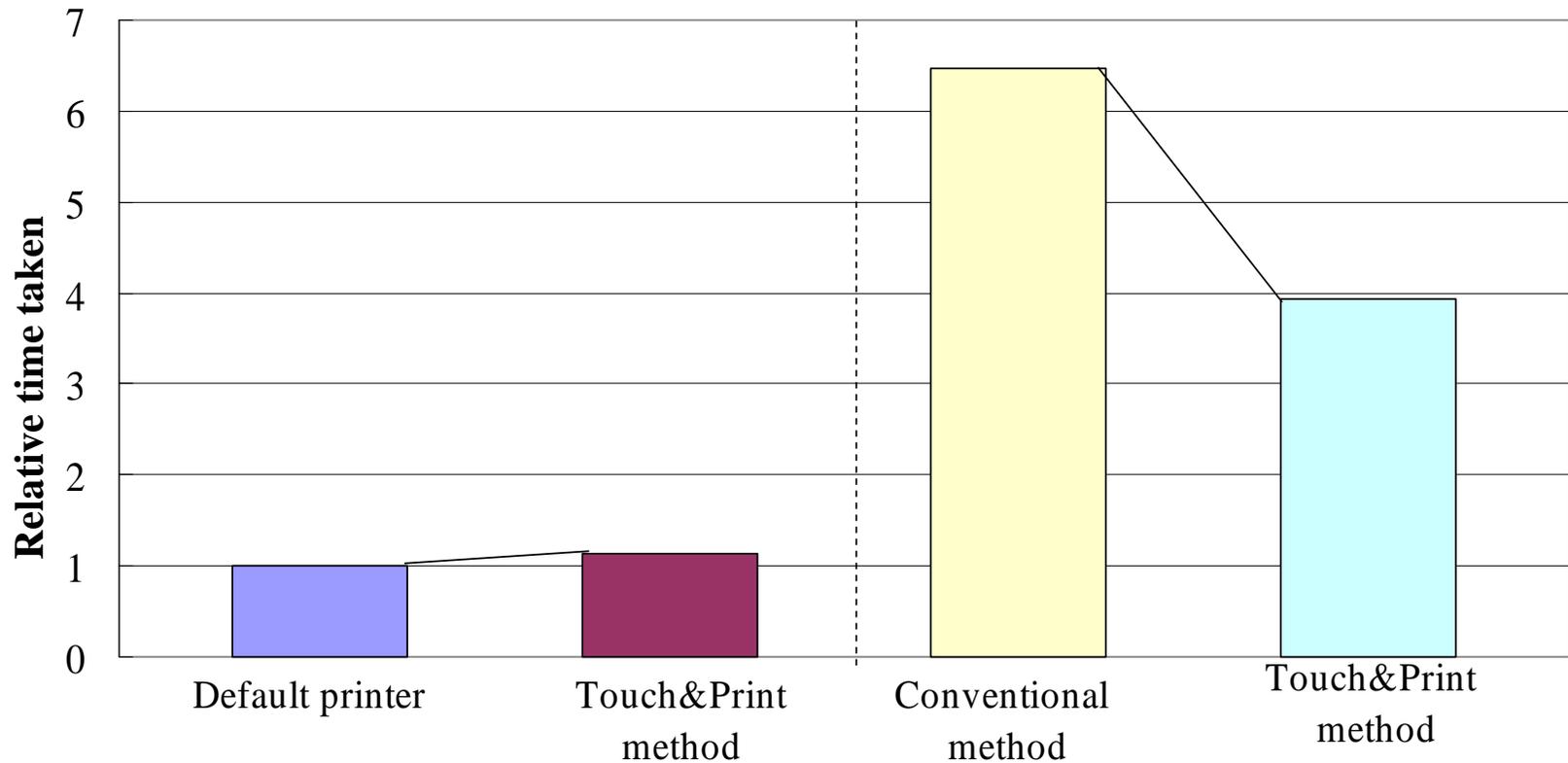
(a) Experiment 1   (b) Experiment 2
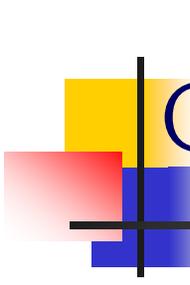
Conclusions and Future Works

Conclusions

- We have proposed
  - a method of **constructing a personal network** (PN),
  - a **Touch&Select method**.
- We evaluated a **PN monitoring protocol** and confirmed its effectiveness.
- We developed prototypes of a **Touch&Share method** and a **Touch&Print method** and verified them by experiments

Future Works

- How to monitor PNs when the user chooses to build **multiple PNs**.
- How to determine **whether to permit** interconnections at visited places.
- It is also necessary to explore a further range of **applications** of the Touch&Select method.