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Researches on Mobile Communications over a Private Address Area and a Global Address Area

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Abstract

IP addresses are classified to two types of addresses, those are global addresses used in the Internet and the private addresses used only in the home networks or enterprise networks. In ubiquitous networks, it is desired that mobile terminals can move freely during communications without being conscious of difference of the address types. We have been proposed the technology called Mobile PPC which realizes mobile transparency. In this paper, we have researched the realization of mobile transparency over a private address area and a global address area by extending Moible PPC.

1. INTRODUCTION

An Ubiquitous network, in that we can communicate anywhere anytime, is being expanded with the trend of the downsizing of communicaton terminals and the spread of wireless LANs. In such a network, there needs a mobile communication system that can keep the communication when an IP address changes with the location change of a terminal. There are some technologies which realize a mobile communication system, shuch as Mobile IP [1], LIN6, MAT, and Mobile PPC (Mobile Peer to Peer Communicaton) [2]. However, their technologies are only effective in the same type of address area. There is no research on a mobile communication system where a terminal can move over a private address area and a global address area. We will report, in this paper, a new technology that can realize a mobile communication system over a private address area and a global address area based on Mobile PPC.

2. Mobile PPC

Communication packets having different connection identifiers (source/destination IP addresses, port numbers, and protocol type) are considered to be different communication in transport layer in a communication terminal. Therefore, if a terminal moves to a different network during communication and an IP address changes, their communication breaks.

Mobile PPC is the protocol that can realize a mobile communication system only with end terminals. The communication terminals implementing Mobile PPC maintain so called "Connection ID Table (CIT)" that indicats the relationship between IP addresses before move and after move per connection identifier. When the terminal sends or receives a communication packet, the terminal executes address change to the packets according to the CIT records.

With this method, end terminals conceal changes of IP addresses to higher layer software and they can continue communication. CIT records are renewed every time when the terminal moves and an IP address changes.

A mobile communication system using Mobile PPC is shown in Fig.1. When communicaton starts between a mobile terminal (MN) and a correspondent terminal (CN), where both MN and CN have Mobile PPC functions, CIT records are generated based on the initial communication packet in both terminals. At the first stage, the field of IP ddress after move in CIT is empty, so address changes of the packets are not excuted. When MN moves and the IP address changes, MN sends a CN packet called "CIT UPDATE (CU)" which notifies IP addresses before move and after move. CN which receives CU searches CIT records by IP address of MN before move notified in the packet. If there is a corresponding record, CN renews the CIT record as information for the address change. After renewal of the CIT record, CN sends a CU reply packet to MN.

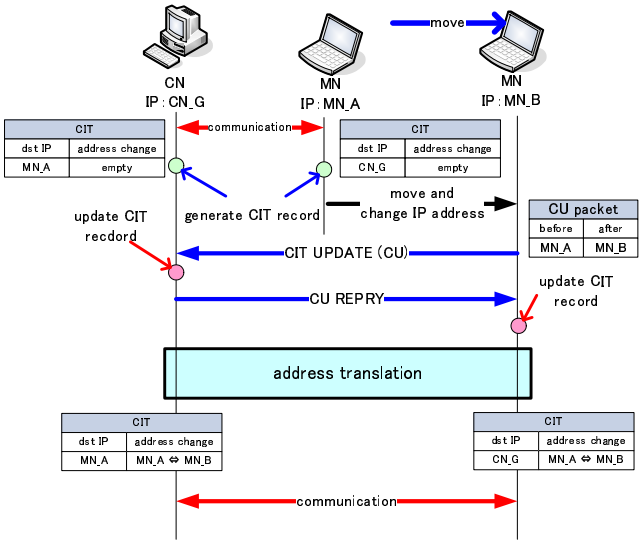

Fig. 1: A mobile communication system using Mobile PPC

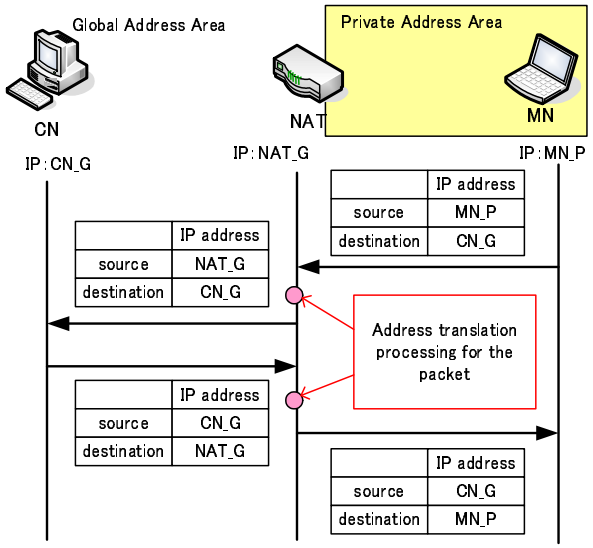

Fig. 2: Communication between CN in GA and MN in PA

When MN receives the CU reply packet, MN renews CIT of its own. Afterwards, both terminals execute IP address change to every communication packets according to the CIT records.

Mobile PPC can realize a mobile communication system well when both terminals are in the same type of address area, however, it is difficult to realize it when a terminal moves between a global address area (GA hereinafter) and a private address area (PA hereinafter).

Fig.2 shows communication between CN in GA and MN in PA. In such a system, there regulary exists NAT (Network Address Translator) between terminals. Communication has to begin from a terminal in PA side beause of NAT's property.

When the first packet reaches NAT, a source IP address of the packet is changed from a private address of MN (MN_P) into a global address of NAT (NAT_G), and the packet is relayed to CN. At the same time, a NAT table that relates MN_P and NAT_G is generated in NAT. The destination address of the reply packet of the first packet from CN becomes NAT_G, and the packet is destined to NAT.

When NAT recives the above reply packet, the destination address of the packet is changed into MN_P, according to the NAT table and is relayed to MN. If CN and MN have conventional Mobile PPC functions, CN generates improper CIT regarding a communicaton partner as NAT. With this reason, when MN moves from PA to GA, CN can not update a CIT record because CN can not find a CIT record of MN_P.

Next, we think in the case when MN moves from GA to PA. CN and MN are communicating in a global area at first and there does not exitst NAT between them. In this case, CN can find a CIT record from the information in CU reported from MN when it moves into PA, however, it is not possible for CN to continue the communication because the address change of the packet is not correctly executed.

3. Remodeling of Mobile PPC

In this paper, we assume that CN is always located in GA. In this condition, we have considered the next two cases. The first case is that MN moves from PA to GA, and the second case is that MN moves from GA to PA.

As a result of studies, it has become possible to realize a mobile comunication system that terminals can move from/to a different address area keeping their communications with the measures as follows. Fig.3 shows an example that MN starts communication from PA and moves to GA afterwards. The function is added to Mobile PPC that MN and CN have to exchange control packets between them before the communication. By this way, CN gets a global address of NAT and a private address of MN. This procedure is called "Extended DPRP (Dynamic Process Resolution Protocol).

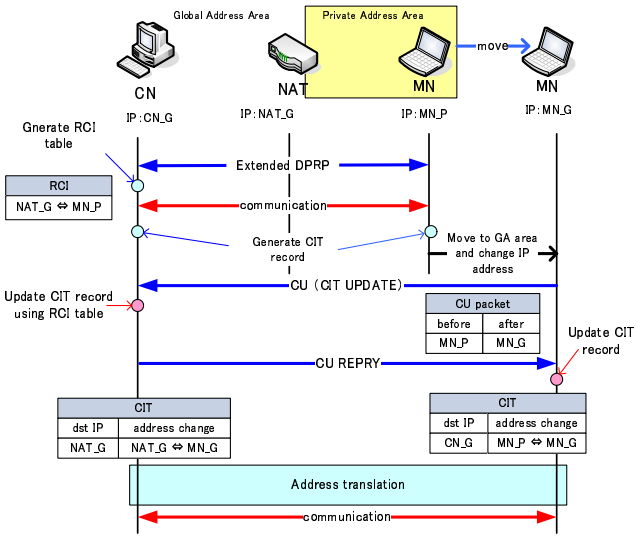

Fig. 3: An example MN moves from PA to GA

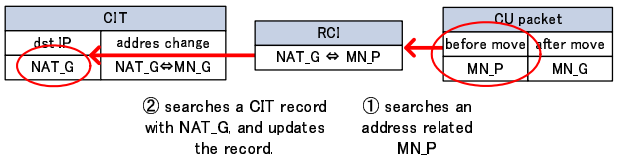

Fig. 4: Reffering RCI (PA → GA)

DPRP is well studied in [3]. CN generates a new table which relates a global address of NAT and a private address of MN in the execution of Extended DPRP. This table is called "Related Correspondence Information (RCI)".

When MN moves to GA, MN sends CU as usual. At the time of CIT update, CN reffers RCI shown in Fig.4 and finds NAT_G (the global address of NAT). Then, CN retrieves the CIT record with NAT_G. Thus, CN can get the new CIT record that indicates MN_G is a new IP address of MN.

Fig.5 shows an example that MN moves from GA to PA during communication. When MN moves into PA, MN executes Extended DPRP at this point in time, and CN generates RCI. When CN receives CU from MN, CN retrieves the CIT and updates its record using the RCI table as shown in Fig.6,and CN writes in NAT_G in CIT. With the measures described above, CIT can be updated properly, and a mobile communication system in that terminals can move between different address areas is realized.

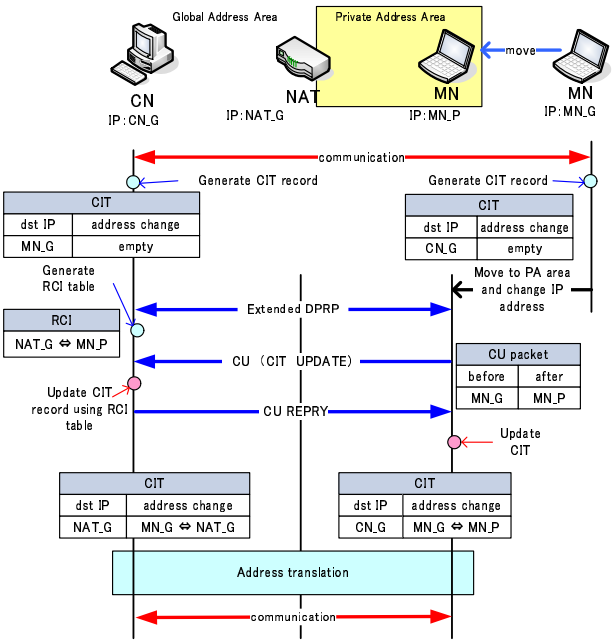

Fig. 5: An example MN moves from GA to PA

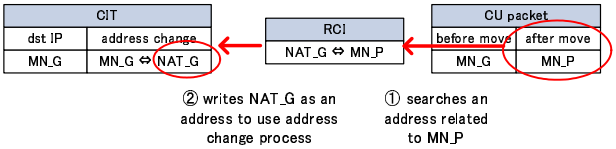

Fig. 6: Reffering RCI (GA → PA)

4. Conclusion

In this paper, we have studied the method to keep communication when MN moves from PA to GA and from GA to PA during communication. CN is always in GA this time. We will implement the new Mobile PPC described in this paper and evaluate the system.

References

[1] Perkin,C. : IP Mobility Suport for IPv4, RFC 3344,IETF,Aug.2002

[2] Motoki Takeuchi, Hidekazu Suzuki, Akira Watanabe : Implementation of Mobile PPC realizing the mobility of mobile terminals, IPSJ-UBI04007005,Vol.2005 No.28,PP.29-35(2005).

[3] Hidekazu Suzuki, Akira Watanabe: Implementation of Dynamic Process Resolution Protocol in Flexible Pribate Network, 2005-CSEC-28,PP.199-204, March.2005.

Researches on Mobile Communications over a Private Address Area and a Global Address Area

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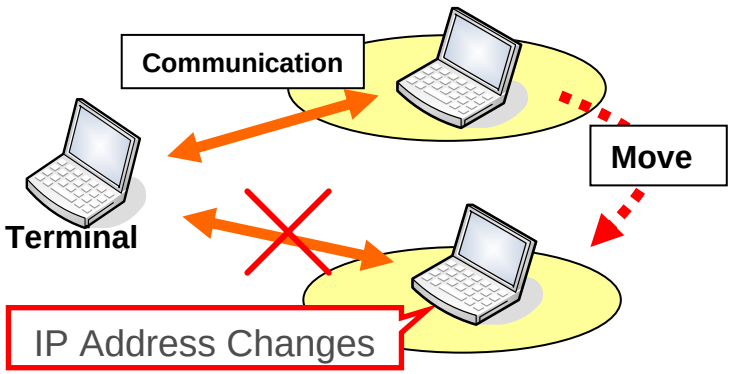
Background (1)

- An Ubiquitous network is expanding

⇒ It is desired that the terminals move during communications.

The problems of movement during communications



- When a terminal changes its location, a different IP address is assigned.
- Transport layer of the terminal regards that the communication is different if the IP address is different.

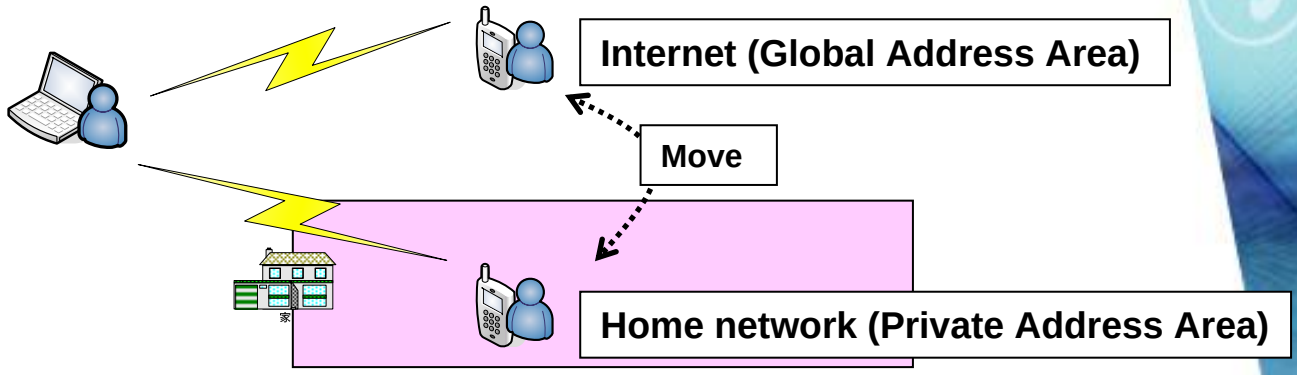
⇒ Communication is broken.

Mobility technology that realizes the continuation of communications is strongly desired.

There are some Mobility technologies such as Mobile IP, Mobile PPC, etc.

Background (2)

- In IPv4 network, there are two types of address areas, namely a global address area and private address areas.
  - ⇒ In previous works, most Mobility technologies are applicable to the either address areas.

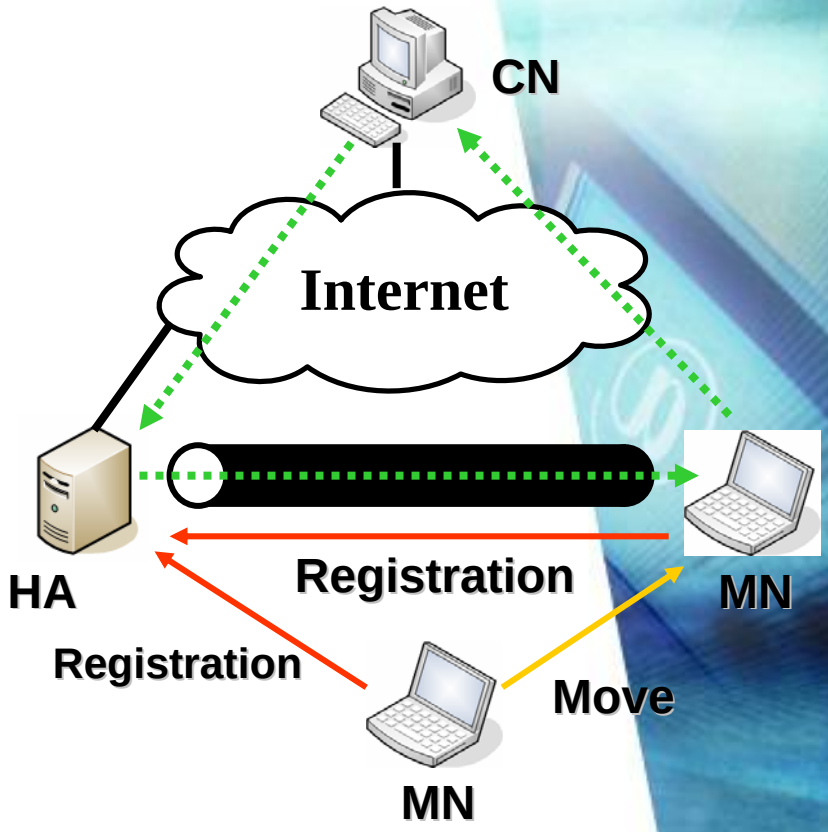


We will focus on the realization of the Mobility that terminals can move between a global address area and a private address area.

Mobile IP – Existing Technology –

The problems

- It requires an extra device such as HA (Home Agent) which manages locations of MN (Mobile Node).
- There is redundancy of the communication path.
- An extra header is added to the packets while tunnel transmission.



⇒ In order to solve the problems, we have been proposing a new technology called Mobile PPC.

Outline of Mobile PPC

Mobile PPC（Mobile Peer to Peer Communication）

It realizes mobility with only end terminals, with No extra devices

The functions of Mobile PPC are as follows.

- Function to notify a new and an old IP address

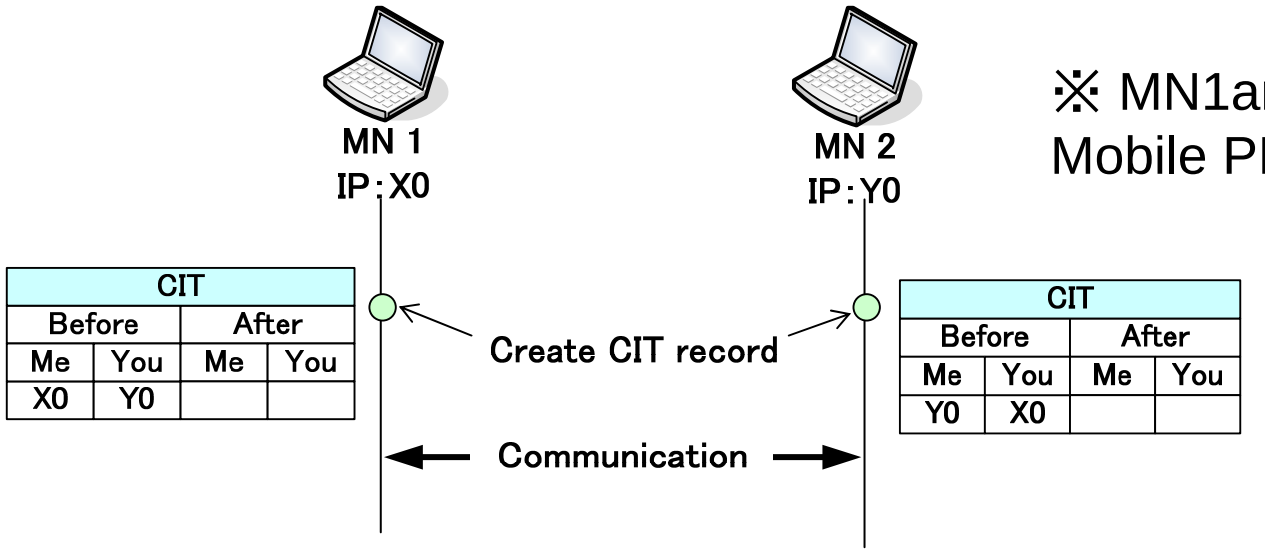
  When IP address of MN changes, MN notifies CN of the information which includes IP addresses of MN before and after the movement.

- Function to change the IP address

  After the movement, IP addresses in the packets are changed in the terminals.

These functions are implemented in IP layer in the terminals.

Behavior of Mobile PPC -At the initial phase-

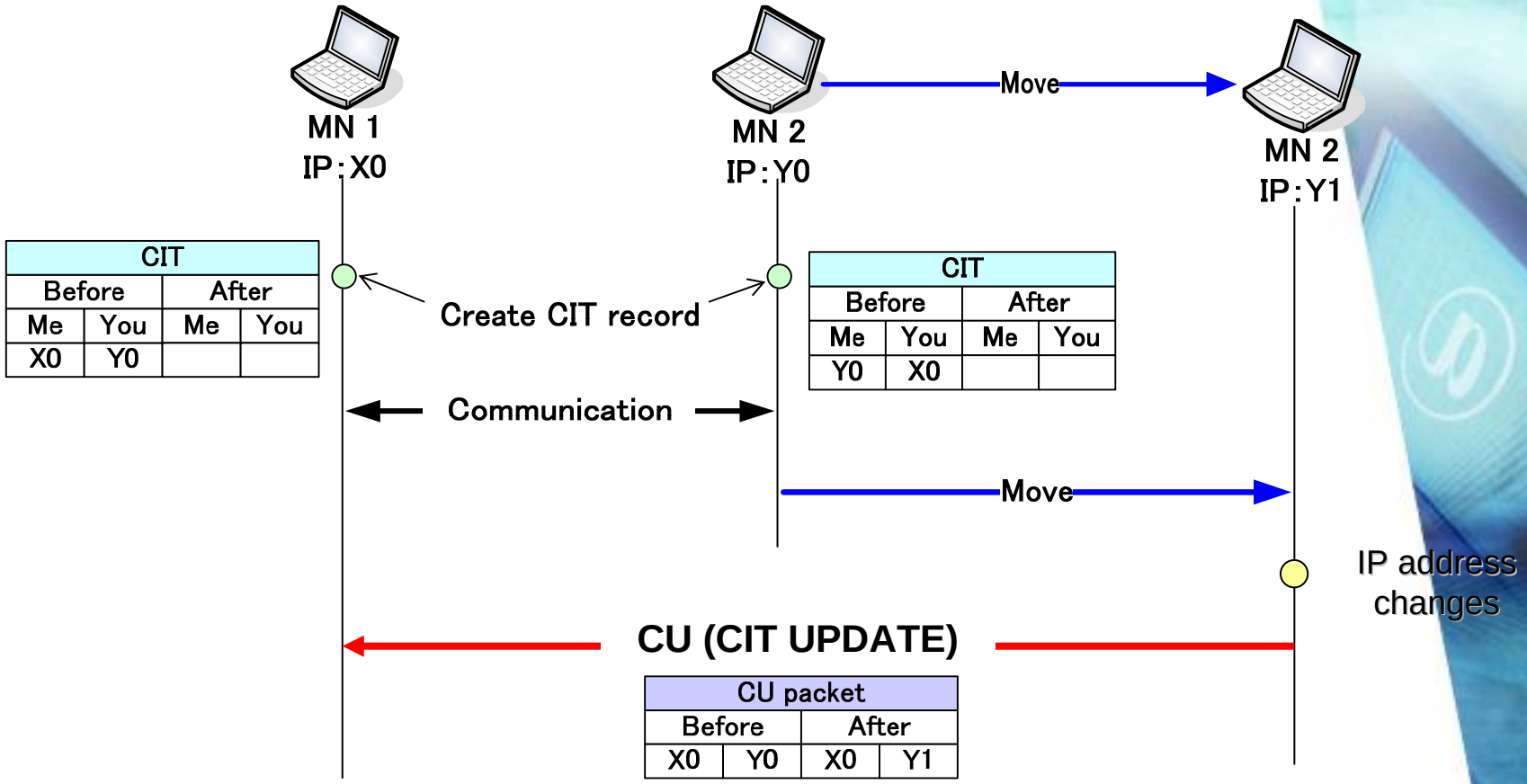


● CIT (Connection ID Table) is the table that indicates the relationship between the IP addresses before and after movement.

CIT			
Before		After	
Me	You	Me	You
X0	Y0	X0	Y1

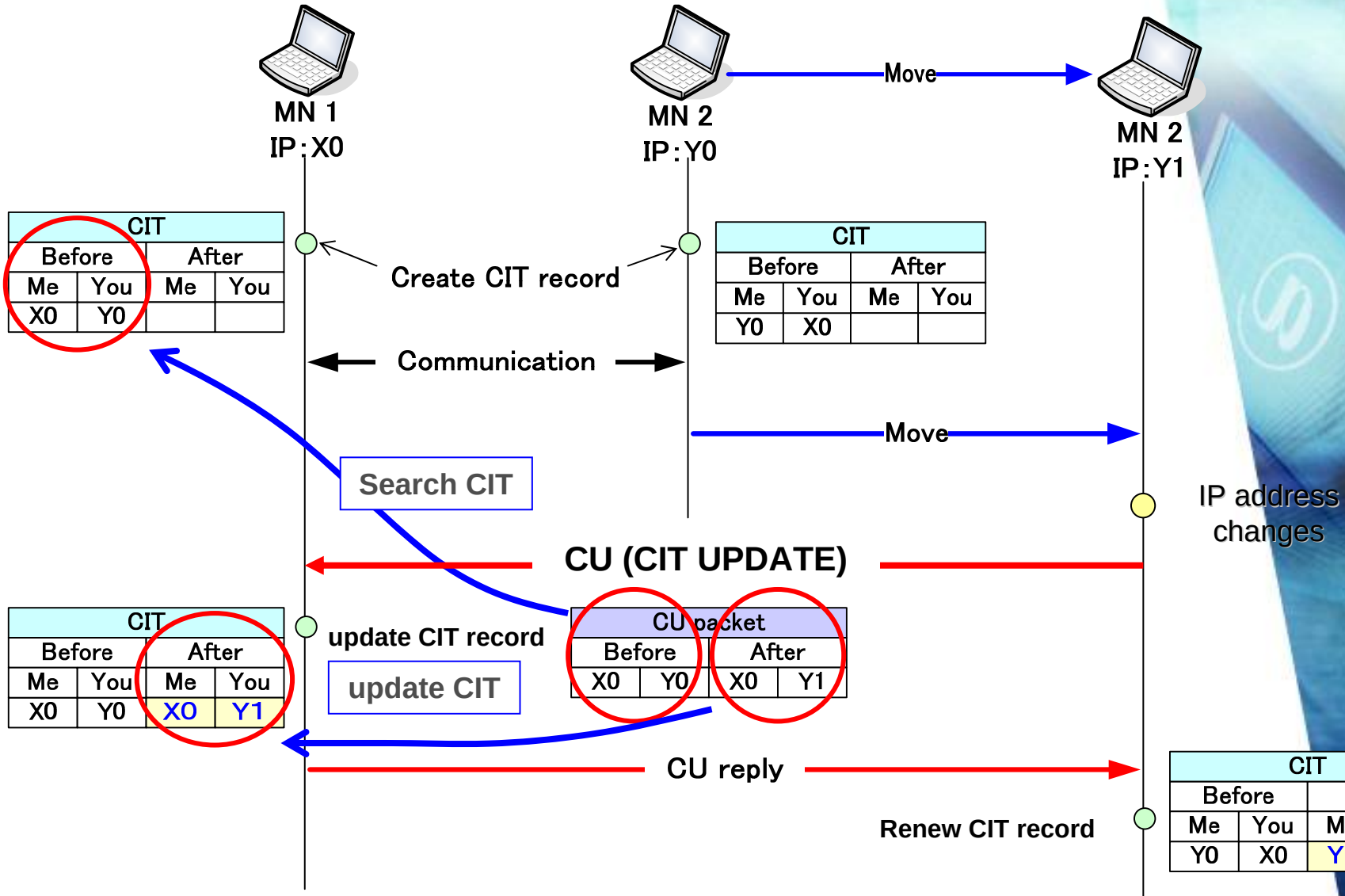
- Before — IP Addresses before movement
- After — IP Addresses after movement
- Me — IP Address of own
- You — IP Address of correspondent node

Behavior of Mobile PPC -Movement of the terminal-

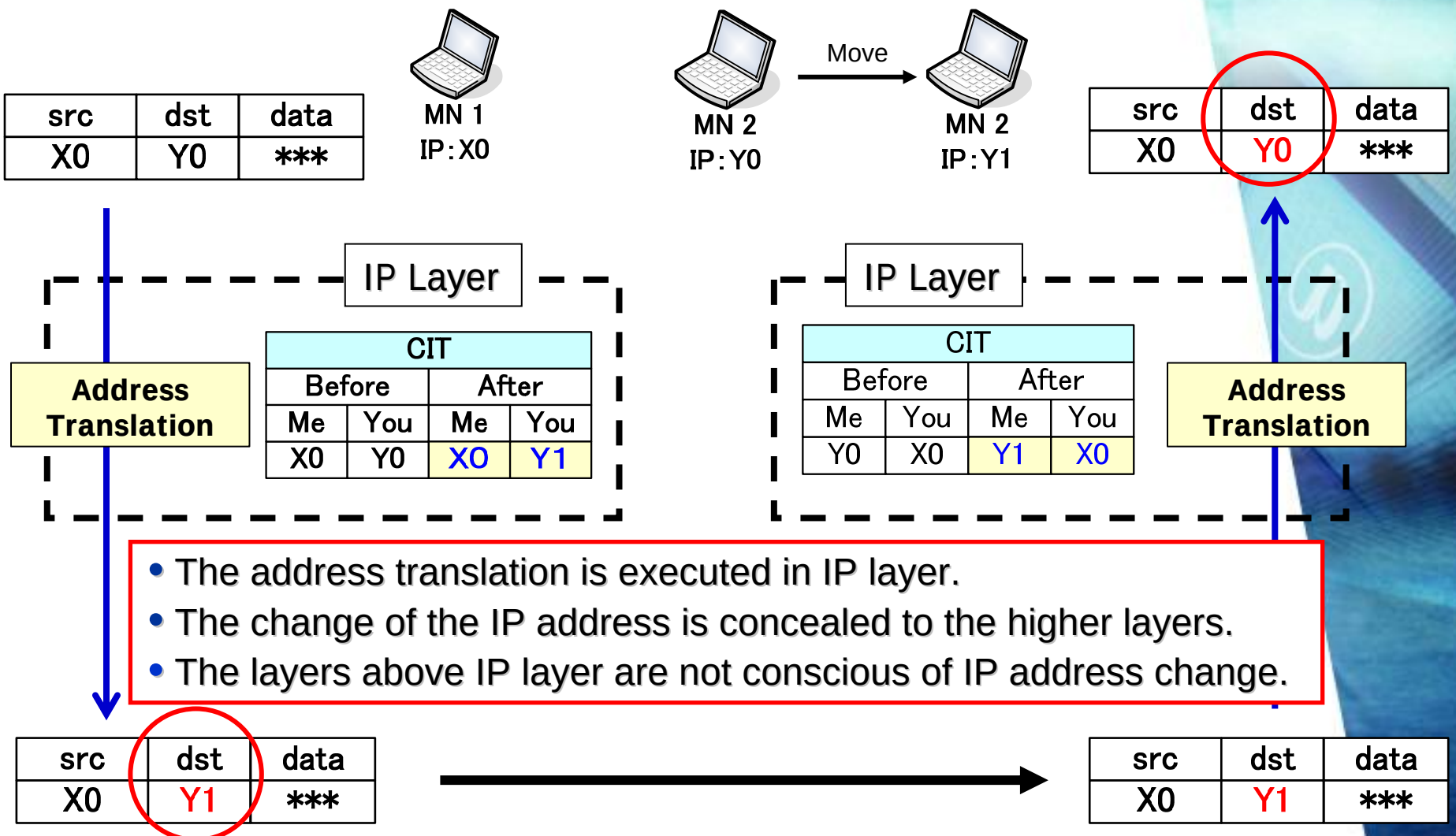


- When IP address of MN2 changes, MN2 generates CU which include the IP addresses before and after movement .
- MN2 sends CU to MN1.

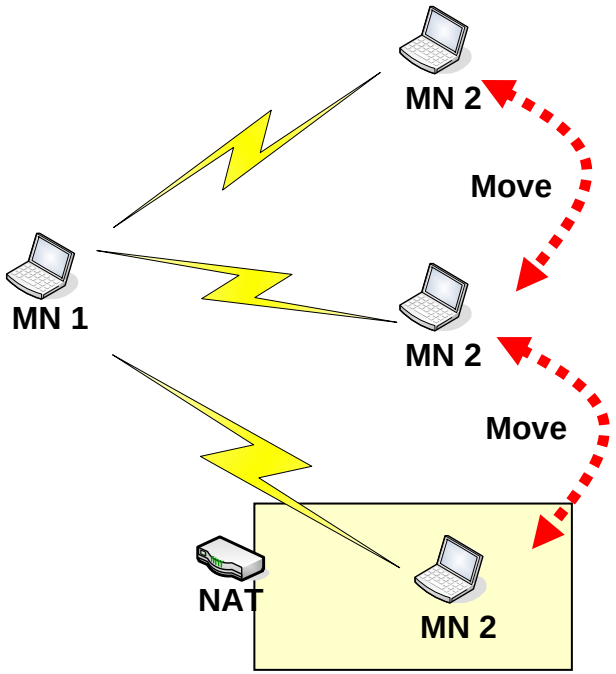
Behavior of Mobile PPC -CU negotiation-



Address Translation in Mobile PPC



- Mobile PPC works fairly well either in a global address area and a private address area.

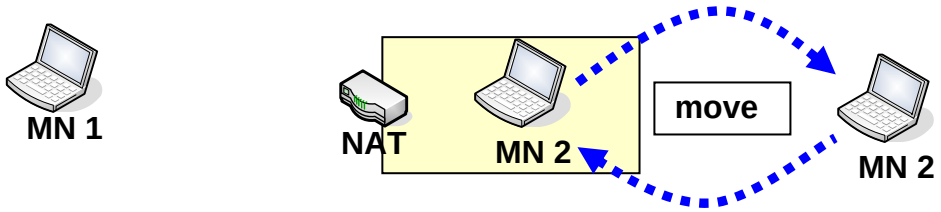


However, how is the Mobility over the both types of address area ?

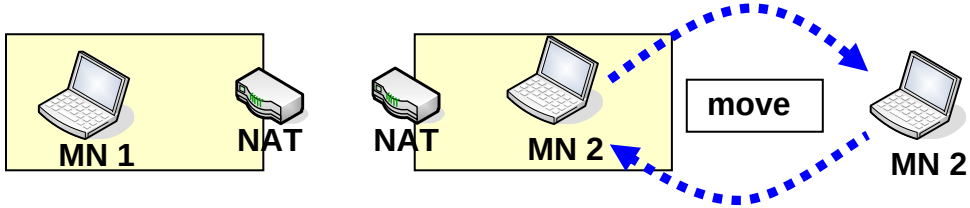
We will describe the Mobility of Mobile PPC over a global address area and a private address area.

Moving patterns

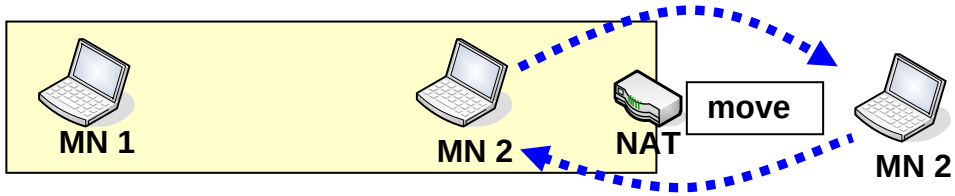
MN 1 : global
MN 2 : private ⇔ global



MN 1 : privateA
MN 2 : privateB ⇔ global



MN 1 : privateA
MN 2 : privateA ⇔ global



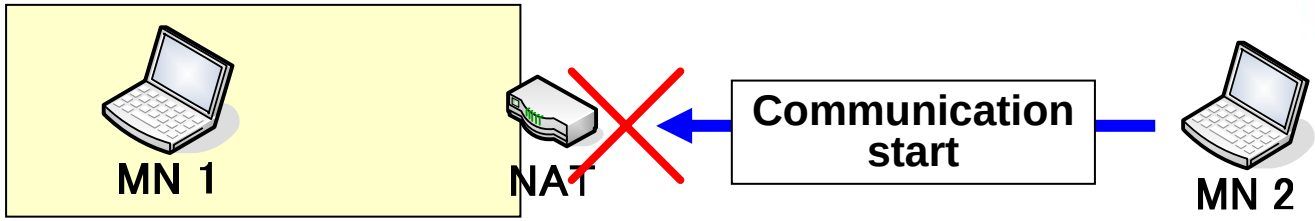
- There are various types of moving patterns over the different types of address area.

- In this presentation, We will describe the pattern, MN1 is in the global area and MN2 moves from a private area to a global area.

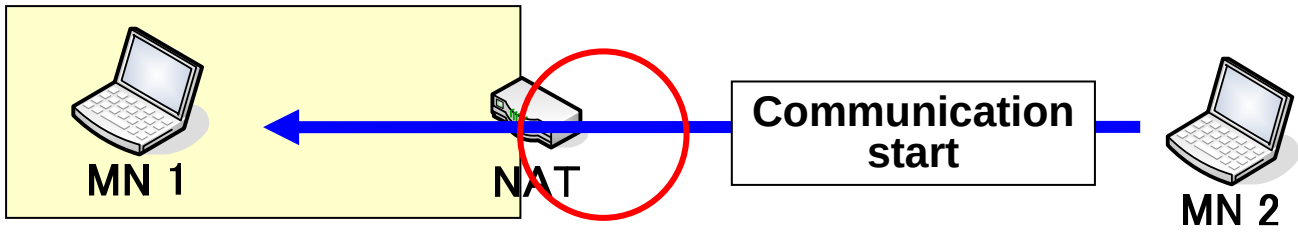
The problem of NAT traversal

The problem of NAT

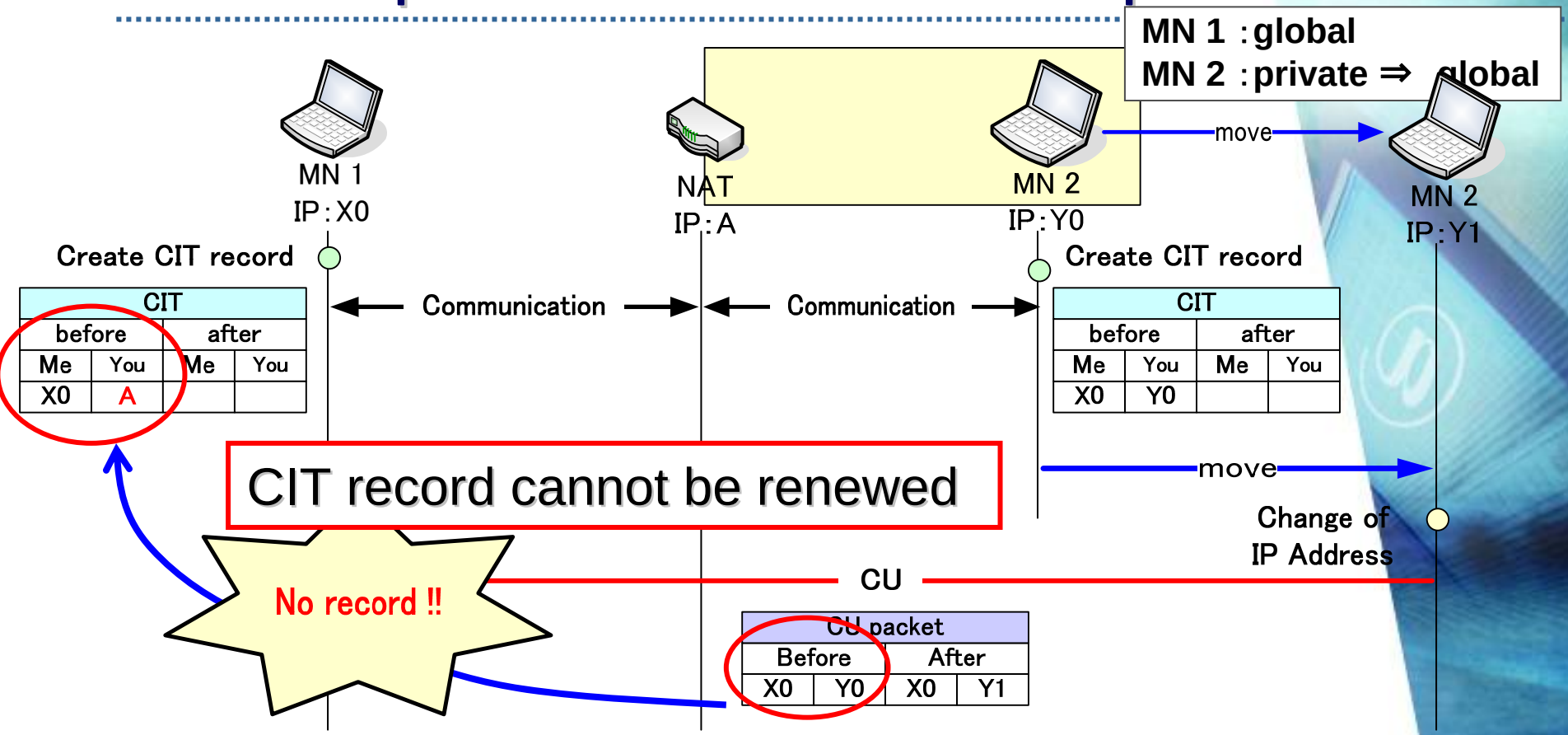
The external terminals cannot start a communication with the terminals behind NAT.



- We have been considering how to solve the problem of NAT traversal.
- We assume that the problem of NAT traversal is solved, and it is possible to start the communication from the both side.



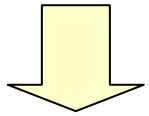
The sequence of the movement pattern



- MN1 cannot see MN2 because MN2 is behind NAT.
- MN1 creates the CIT record as NAT is the correspondent terminal.
- If MN2 moves to a global area and CU is sent from MN2 to MN1, there is no corresponding CIT record in MN1.

Prevention of communications by NAT

- The terminals cannot update CIT record correctly when NAT exists.



- Mobile PPC cannot realize the Mobility over a global and a private address area.

- **We think that if CIT is updated correctly, they can continue communication.**

The method of renewing CIT record correctly in the network where NAT exists

Outline of the proposed method

In the environment where NAT exists, MN1 needs to know the following information.

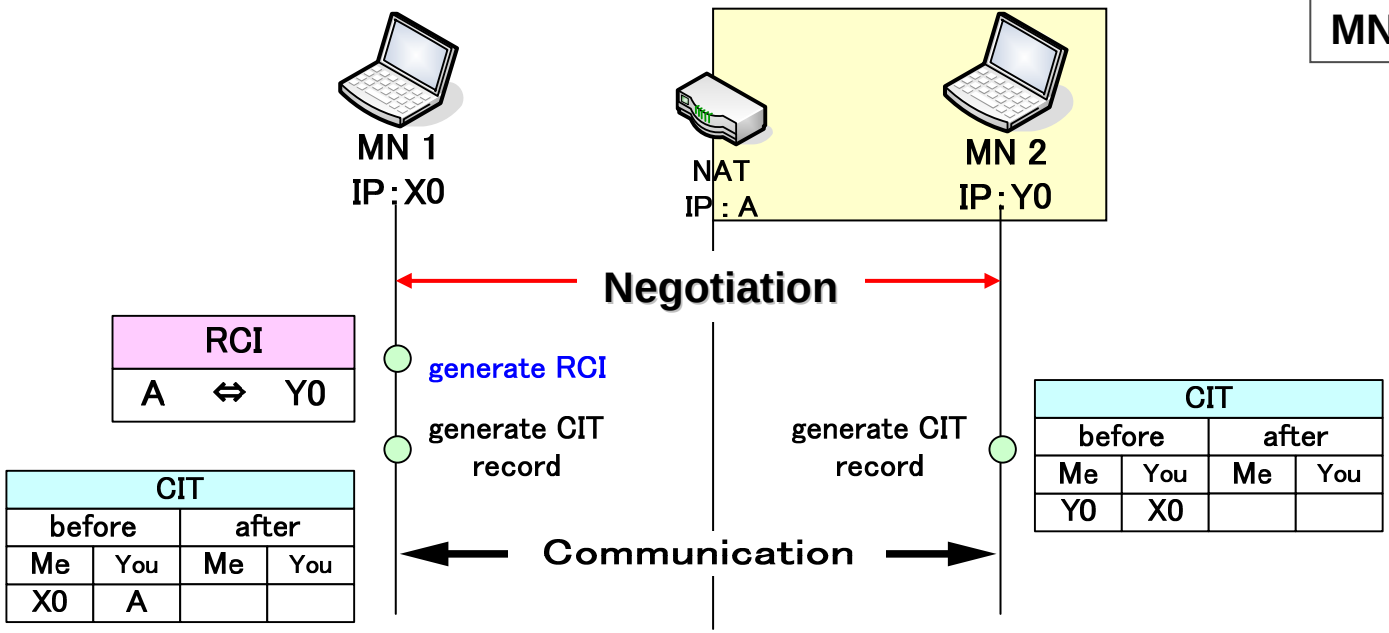
- a private IP address of MN2
  (When MN2 is in a private area)

In order to get the information, a negotiation process prior to the communication is introduced.

- The control packets are exchanged among the end terminals and NAT.
- MN1 gets the private IP address of the terminal behind NAT and the global IP address of NAT

The proposed method –At the initial phase–

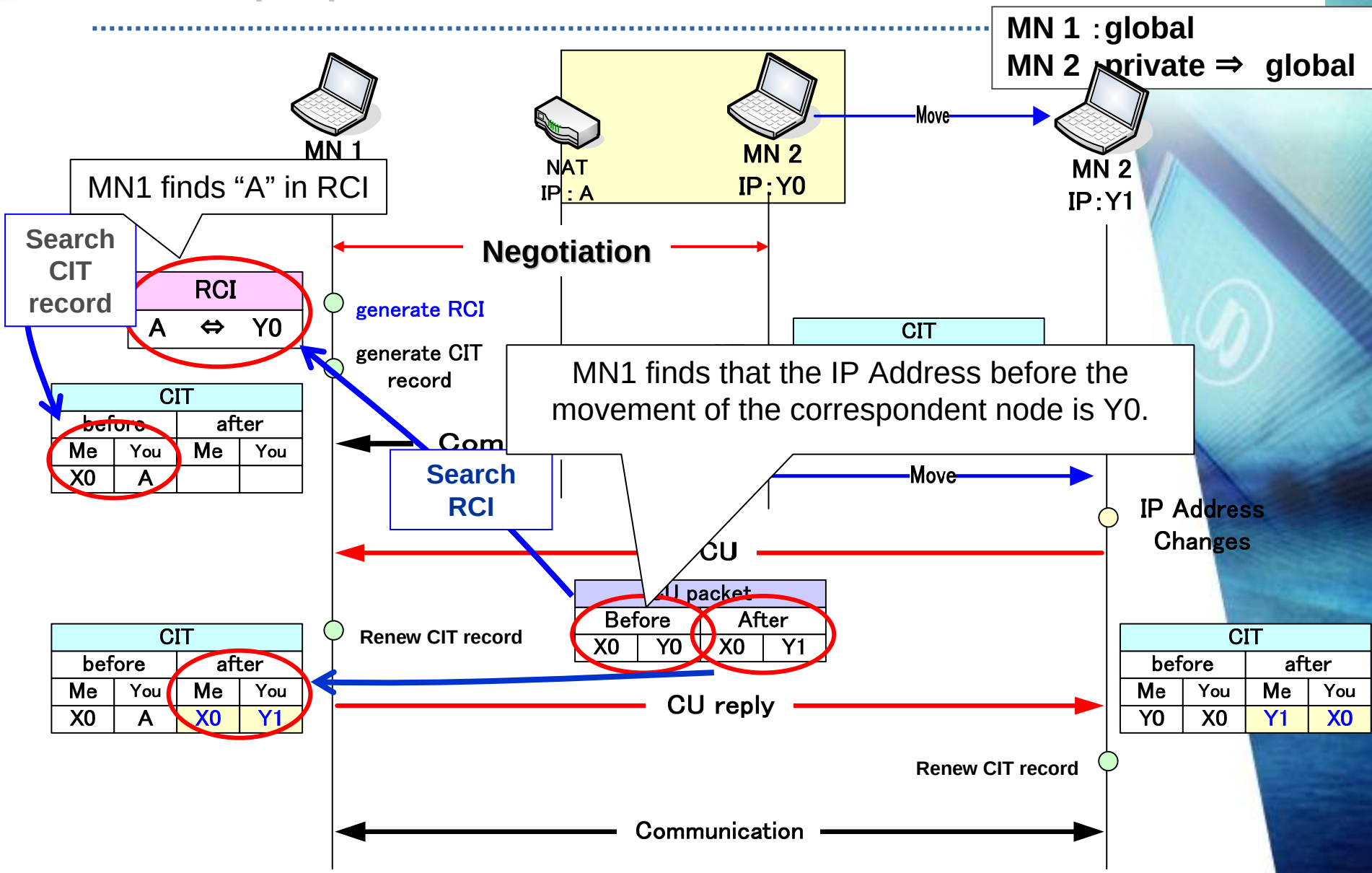
MN 1 : global
MN 2 : private ⇒ global



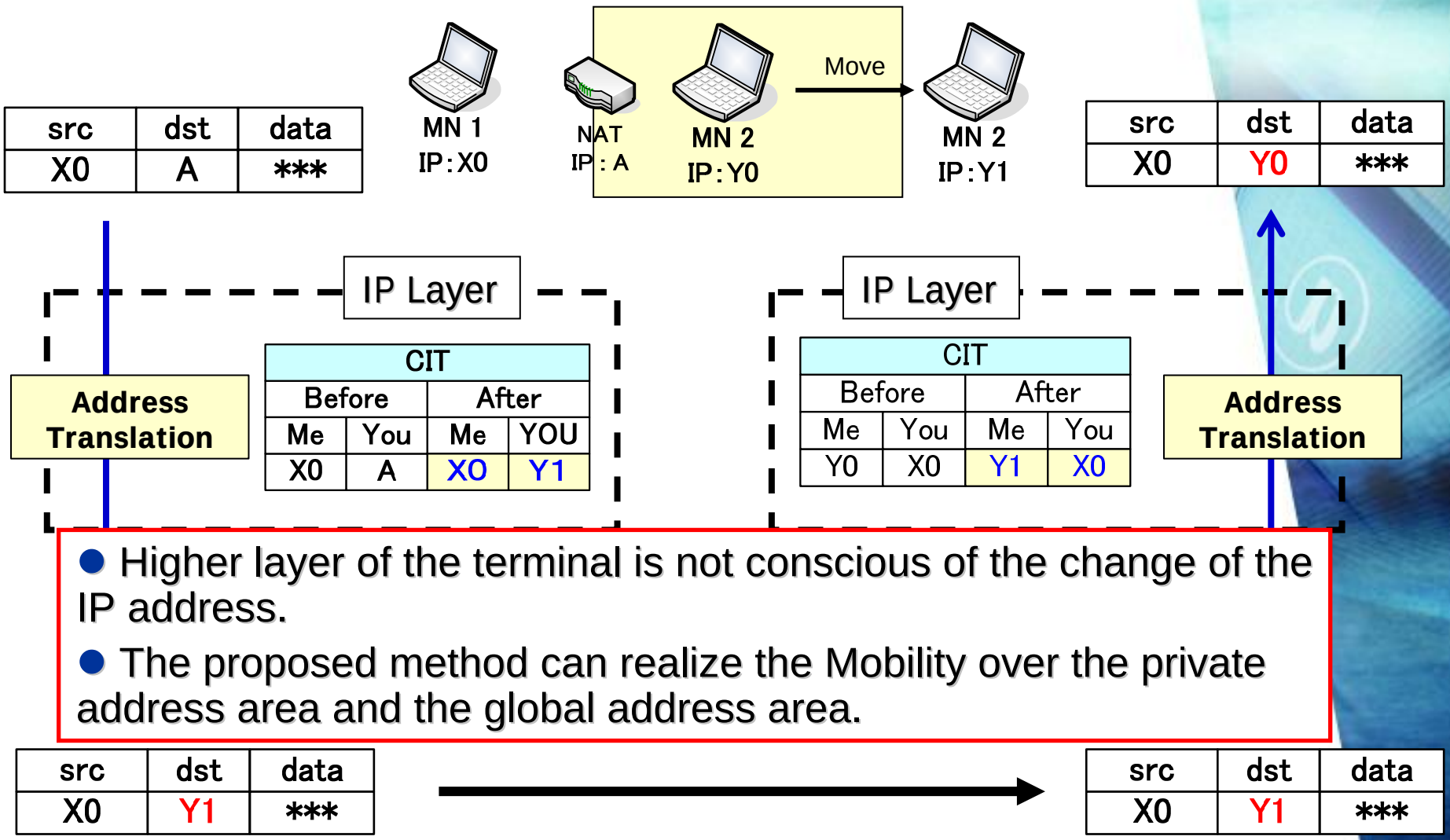
- The negotiation is executed before the communication.
- MN1 gets the private IP address of MN2.
- MN1 generates RCI (Related Correspondence Information) that memorizes the relationship between the global IP address of NAT and the private IP address of MN2.

RCI
IP Address of NAT ⇔ IP Address of MN2

The proposed method –Movement of the terminal–



Address translation in the proposed method



Summary and future plans

- **Summary**

  We have proposed the method realizing the Mobility over different types of address areas.

  → The negotiation prior to the communication is introduced and a new table RCI is defined.

And We have shown the prospects of the proposed method.

- **Future plans**

  Implementation and evaluation of the proposed method.

Mobile PPC

- In order to realize mobility in the Internet
  - An initial IP address resolution
    - A method of getting an initial IP address at the beginning the communication.
  - A continuous IP address resolution
    - A method of getting a new IP address when MN moves.

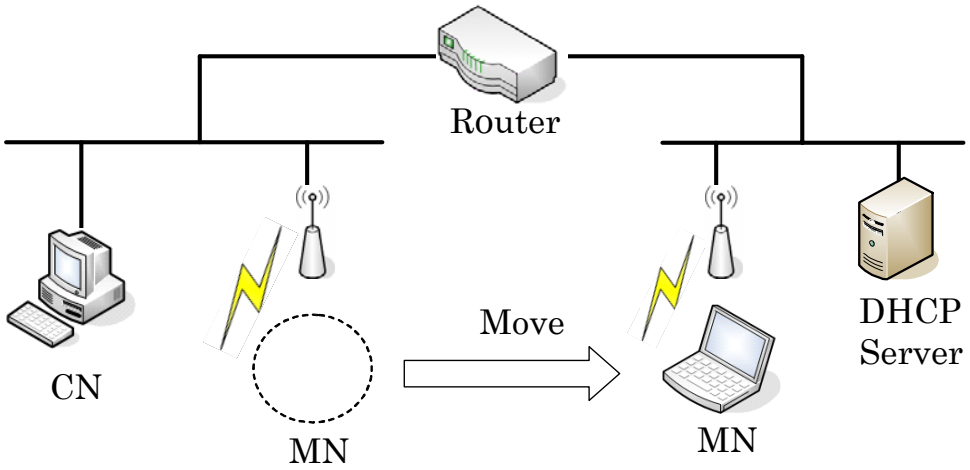
  ⇒These functions are Separated clearly.

- The initial IP address resolution
  DDNS (dynamic DNS)
  - DDNS dynamically manages the relationship between a host name and an IP address.
  - DDNS is already in a practical use.
- The continuous IP address resolution
  Mobile PPC (Mobile Peer to Peer Communication)

A trial system

- Mobile PPC is installed in MN and CN.
  - First, FTP file transmission is started from MN to CN, then MN moves to the other network during the transmission.
  - MN first acquires a new IP address from a DHCP server.
  - Then Mobile PPC begins, namely, the new address report, and the address change.

	MN	CN
CPU	Celeron 2GHz	Pentium 2.4GHz
Memory	256M	256M
NIC	IEEE802.11b	100BASE-T



We have confirmed that the FTP transmission continues

Communication breaking time

- **Communication breaking time is sum of ① and ②.**
  - ①An acquiring time of the new IP address from DHCP server.

Minimum	Average	Maximum
4.11 [sec]	6.33 [sec]	9.01 [sec]

  - ② A renewal time of CIT
    - CIT renewal in MN and CN
    - Packet transmission time of CU and CU reply
      - ➢ 4.61 [msec]

⇒The most of the communication breaking time is the IP address acquiring time.

Performance measurement

- **The degradation of performance**
  - The comparison of download time when 50MB files are down-loaded from MN to CN using FTP.

Mobile PPC	Download time
①Not Implemented	87.31[sec]
②Not Address Change	87.31[sec]
③Address Change	87.40[sec]

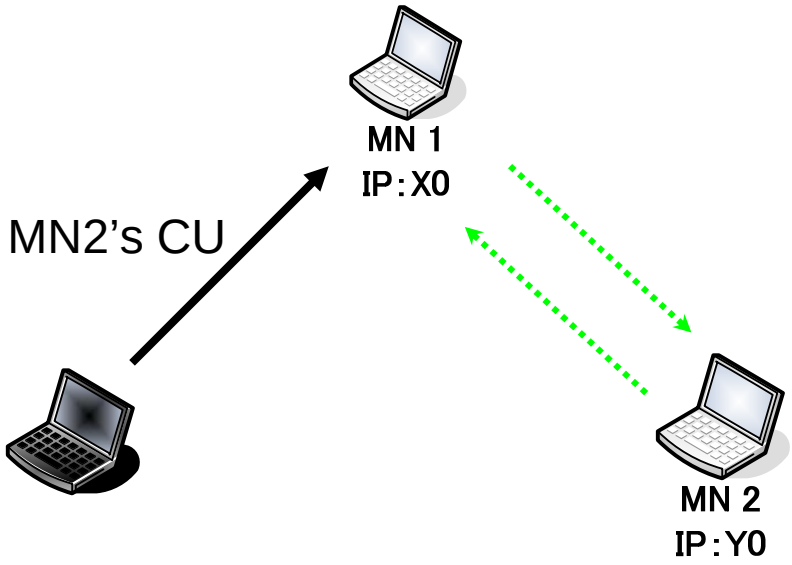
①Mobile PPC is not implemented in MN and CN.

②Mobile PPC is implemented in MN and CN, and address changes are not executed, namely before the movement)

③Mobile PPC is implemented in MN and CN and address changes are executed, namely after the movement of MN

- **A measurement result**
  - ① and ② takes just the same time, that shows there is no degradation with Mobile PPC.
  - ③ shows the degradation of about only 0.1%.

⇒ Almost no degradation in communication.



When anyone sends MN2's CU packet, it is possible that anyone pretend to be MN2.

We have been separately studying the authentication using Diffie-Hellman Key exchange.

↓

The terminals can exchange CU / CU reply safety

- If two terminals moves at the same time, it is possible to loss the packets and the communication is broken.

- We have been separately studying the method to solve the problem using two wireless LAN cards in a terminal.

- By using two wiremen LAN cards, when the terminal moves, it keep the IP addresses before and after the movement for a while.