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NTT EAST Recovery Operations at the East Japan Earthquake

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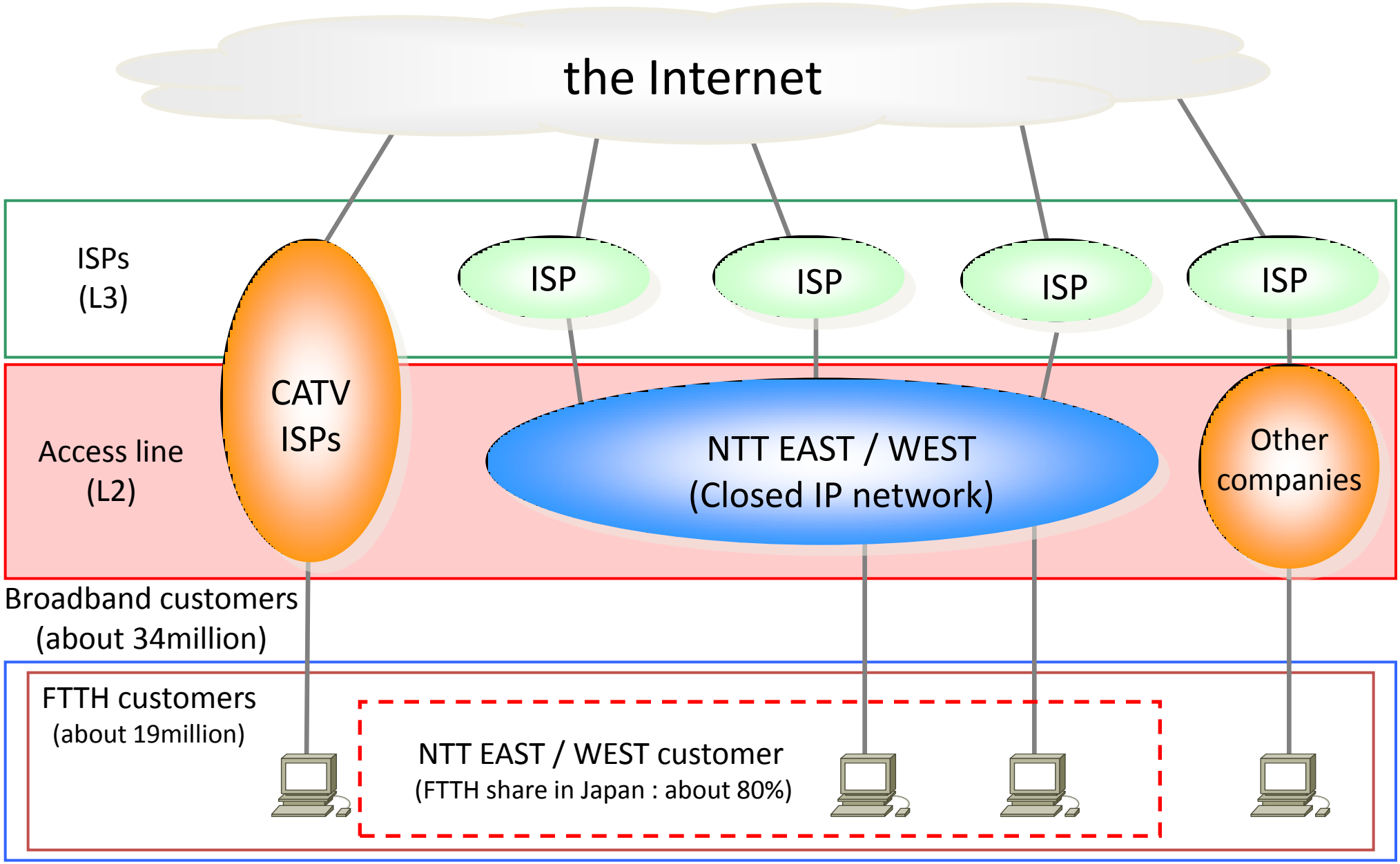
Overview

- Summary of the damage
- Robust network against a disaster
  - Construct physical network with robustness
  - Preparations against a disaster
  - What we should do after a disaster

Self Introduction

- AS 37901（NTT-NGN）
- Network (mainly layer 3 / IP) Operator
  - Design, Verification, Implementation, Operation, Troubleshoot, Experiment…
- Disaster Restoration Activities
  - Build up emergency network (L1 to L3)at damaged area
  - Remote support

Network Structure in Japan

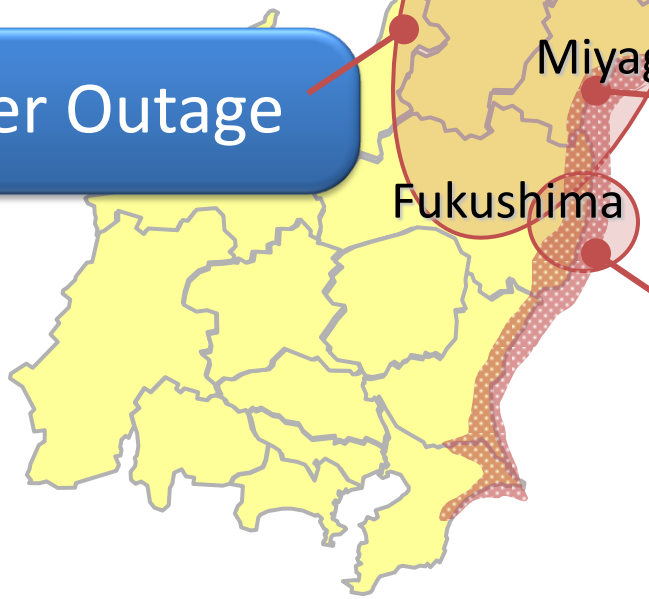


Incidents after the Earthquake

Collapse of buildings

Tsunami

Power Outage



Radiation

On-site recovery activity

after Tsunami

Temporarily rebuilt

Construct rack facilities

recovery work

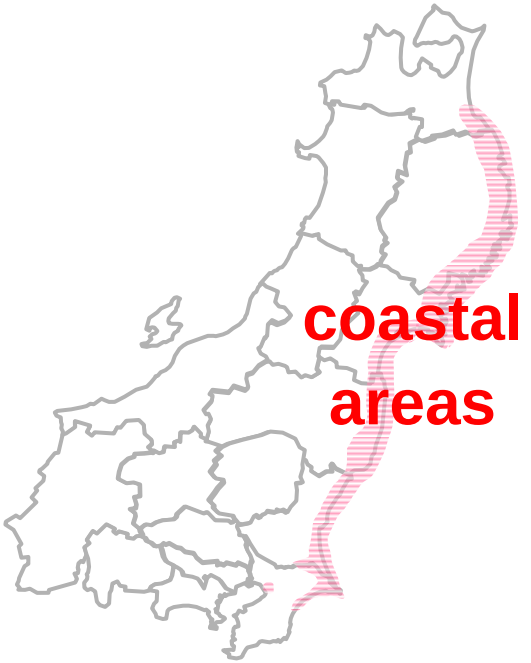
Damage of the Disaster

Item	Great East Japan Earthquake	Great Hanshin-Awaji (Kobe) Earthquake
Date and time	2:46 p.m., March 11, 2011	5:46 a.m., January 17, 1995
Epicenter	Pacific Ocean, near to Tohoku's Sanriku coast	Northern Awaji Island and the Akashi Channel
Magnitude	9.0	7.3
Death toll	15,835(1)	6,434
Missing persons	3,664(1)	3
Evacuees	approx. 470,000 max.(2)	approx. 320,000 max.
Households affected by power outages (excluding planned outages)	approx. 8,400,000 max.(3)	approx. 2,600,000 max.

1. National Police Agency (as of November 9, 2011)
2. Cabinet Office White Paper on Disaster Management 2011
3. Calculated from Ministry of Economy, Trade and Industry published data

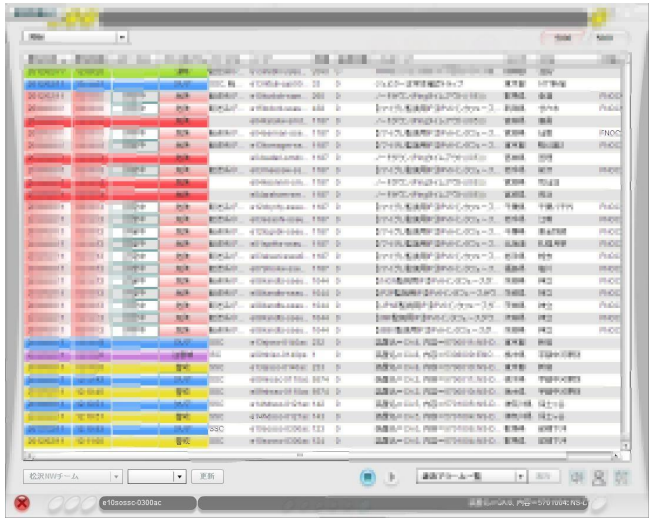
Damage to Access Networks

Item		Damage
Incapacitated buildings		385
Damaged lines		approx. 1.5 million
Time required to restore services		approx. 50 days
Equipment damage	Trunk lines	approx. 90 routes
	Communications buildings	16 completely destroyed 12 flooded
	Telephone Poles	28,000 （coastal areas）
	Aerial Cables	approx. 2,700 km （coastal areas）

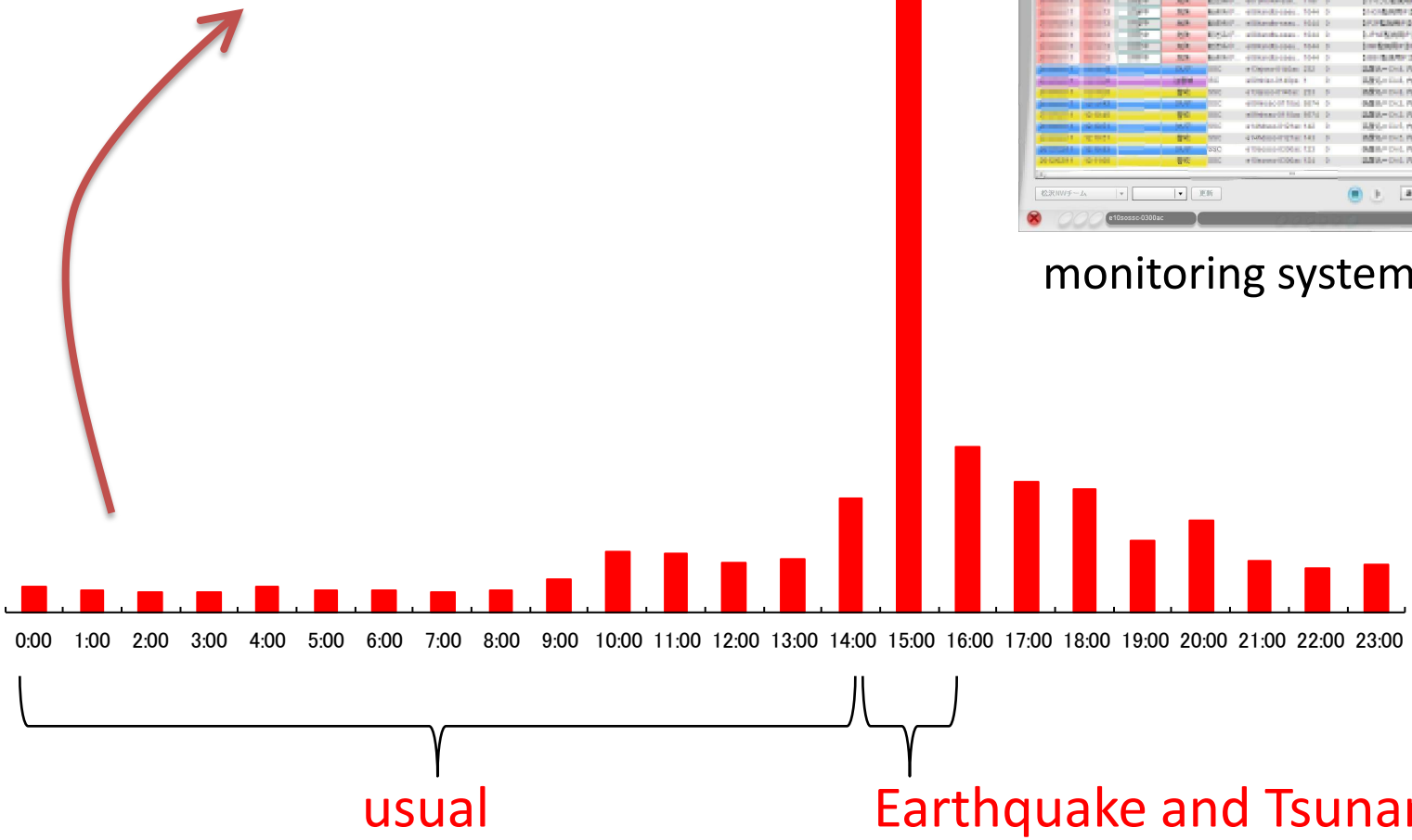


Network alarms @ 3.11

Uncountable ☹



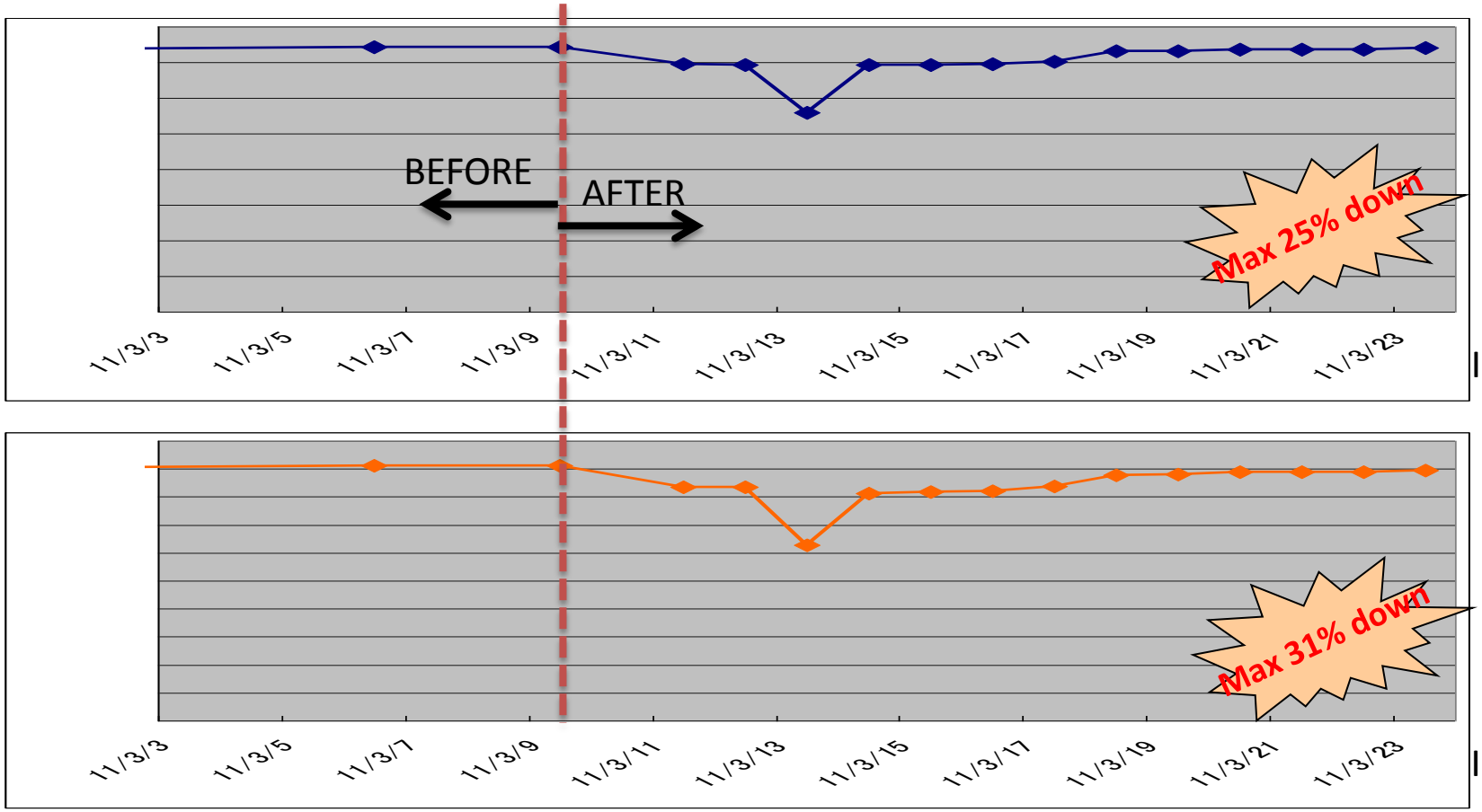
monitoring system window



3.11 NTT-NGN Routes information

- 25% IPv4 routes decreased
- 31% IPv6 routes decreased

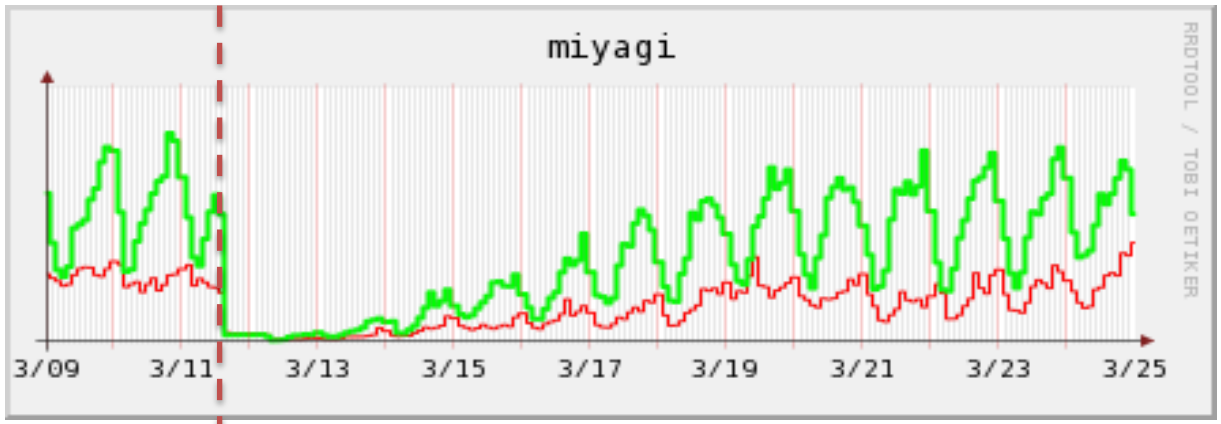
（note）this is closed NW information, not the Internet full routes



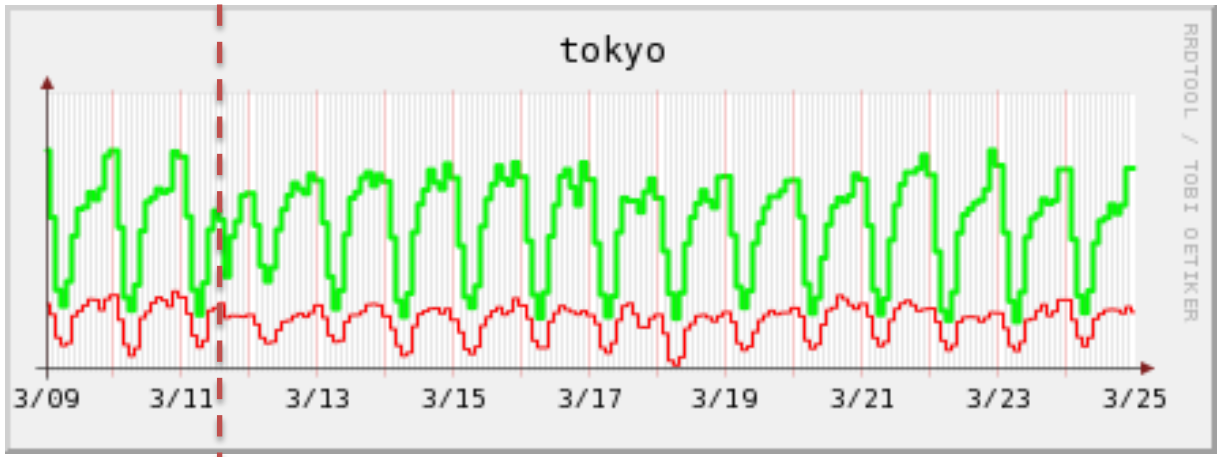
Traffic at damaged and non-damaged area

- network was disrupted widely in northern Japan
- Damages of remote area were almost negligible.

-Legend-
Download
Upload



Traffic @ Miyagi
(Damaged area)



Traffic @Tokyo
(Non-Damaged area)

14:46

Robust network against a disaster

- How do you keep on providing stable network ?
  1. Construct physical network with robustness
     - Fiber route redundancy, Cabling, Building, Maintenance NW, Virtual circuit redundancy, NOC
  2. Preparations against disaster
     - Formation, Priority
  3. What we should do after disaster
     - Investigation, Grasping, How to restore

- <u>Which way is more effective, more inexpensive and easier ?</u>

1. CONSTRUCT PHYSICAL NETWORK WITH ROBUSTNESS

2. PREPARATIONS AGAINST A DISASTER

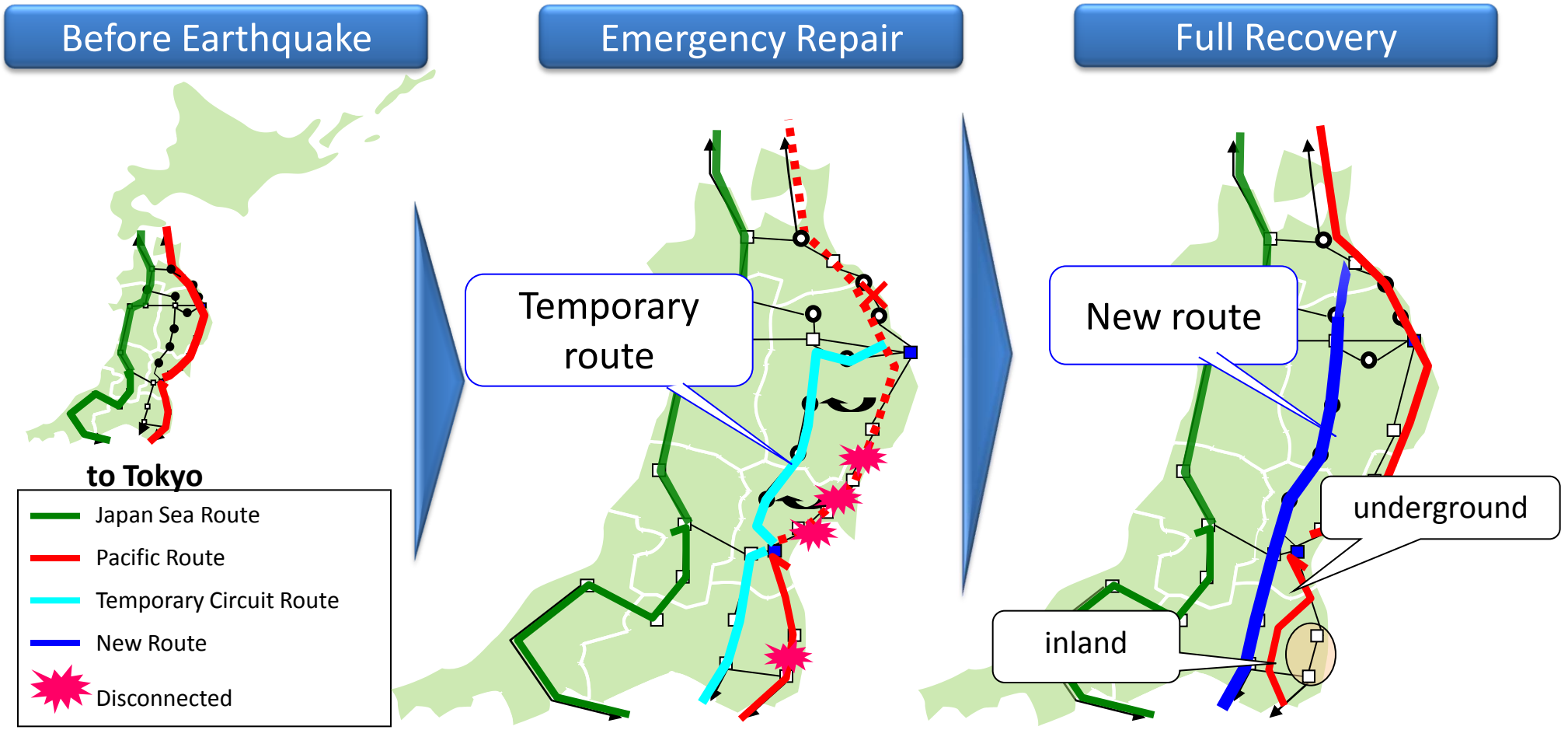
3. WHAT WE SHOULD DO AFTER A DISASTER

Robustness of Physical network

- Very effective
- It costs much money and long time
- 6 topics:
  - Fiber route redundancy
  - Cabling
  - Building
  - Maintenance Network
  - Virtual Circuit Redundancy
  - Network Operation Center

1-1. Fiber Route Redundancy

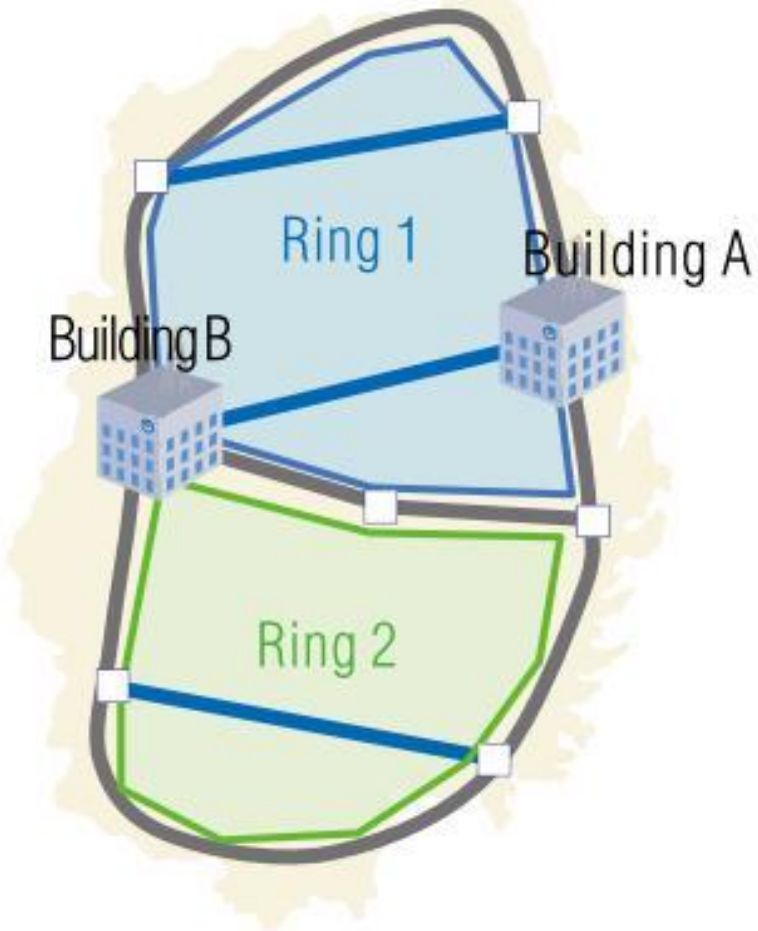
- A lot of fiber routes were severed
- New route added and new grand design installed



1-1. Fiber Route Redundancy

- It takes long time to repair large circuit.
- Mesh topology would be good ☺

- Multi path
  - More redundant
- Sub-dividing
  - Quick restoration
  - Minimize influence
- Grand design
  - Geographically safe route

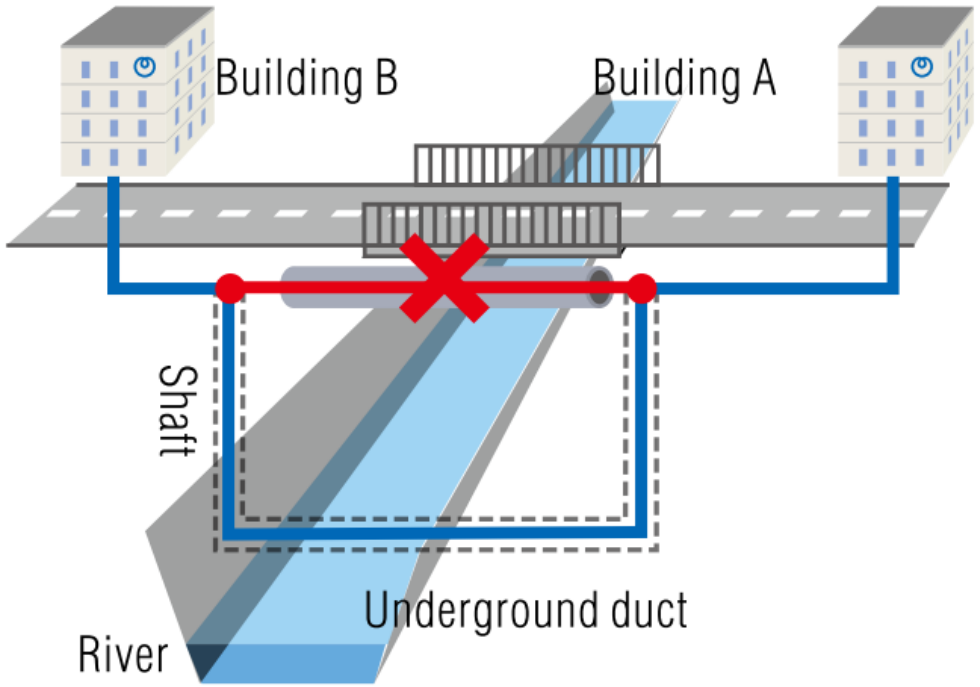


topology sub dividing

1-2. Cabling

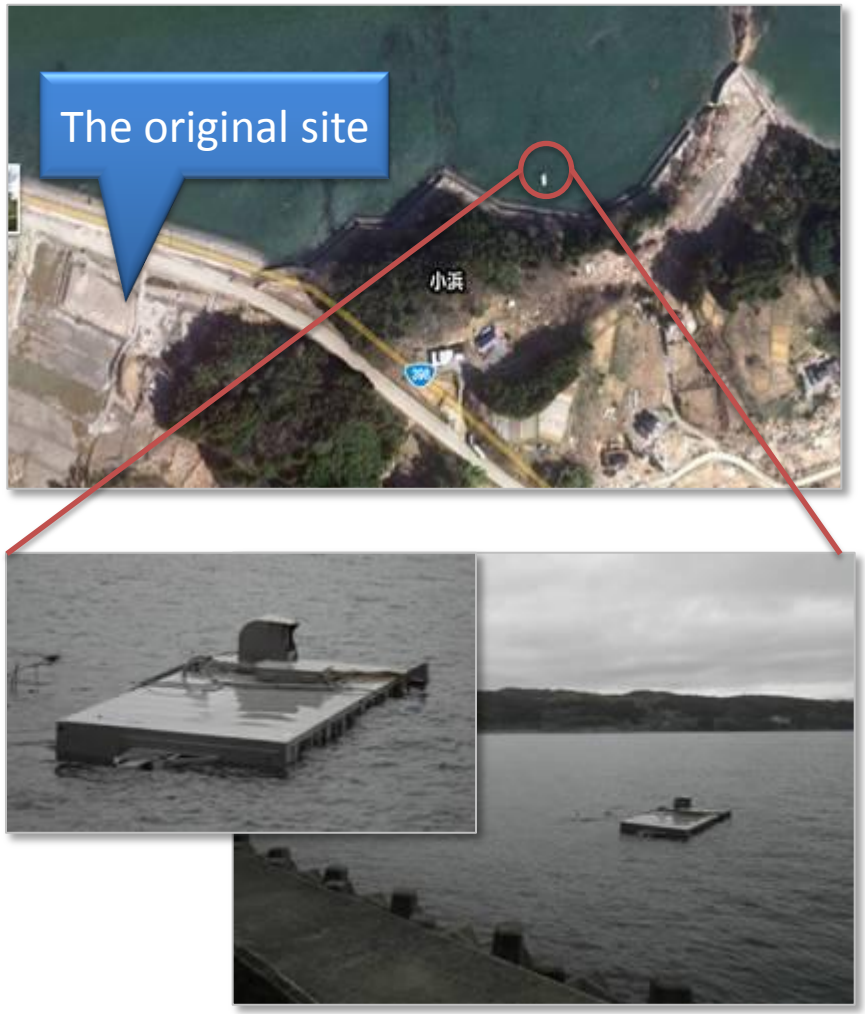
- Bridges, poles, cables and ducts were swept away on the ground
- Facilities under the ground withstood
- Lay underground especially important lines

In front of certain exchange building



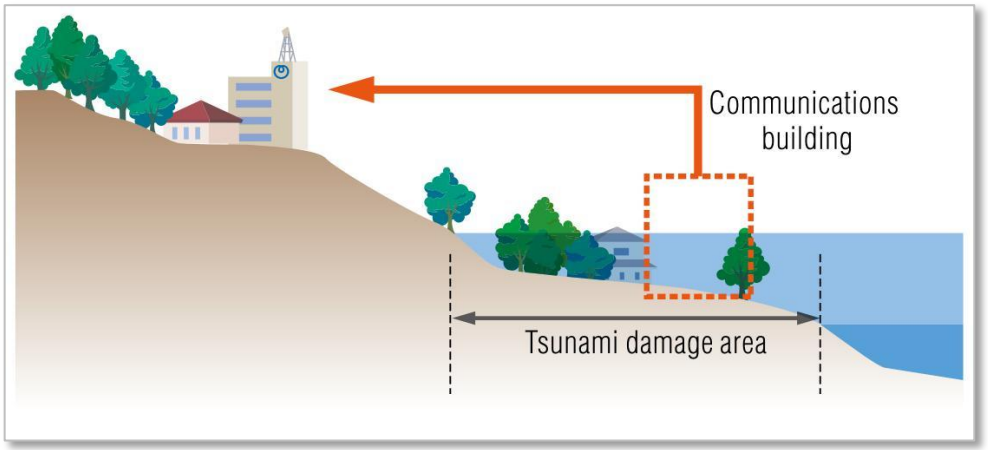
1-3. Buildings

- Buildings were carried away by Tsunami



building carried away

- Build on upper location
- Set facilities on upstairs
- Tsunami barriers

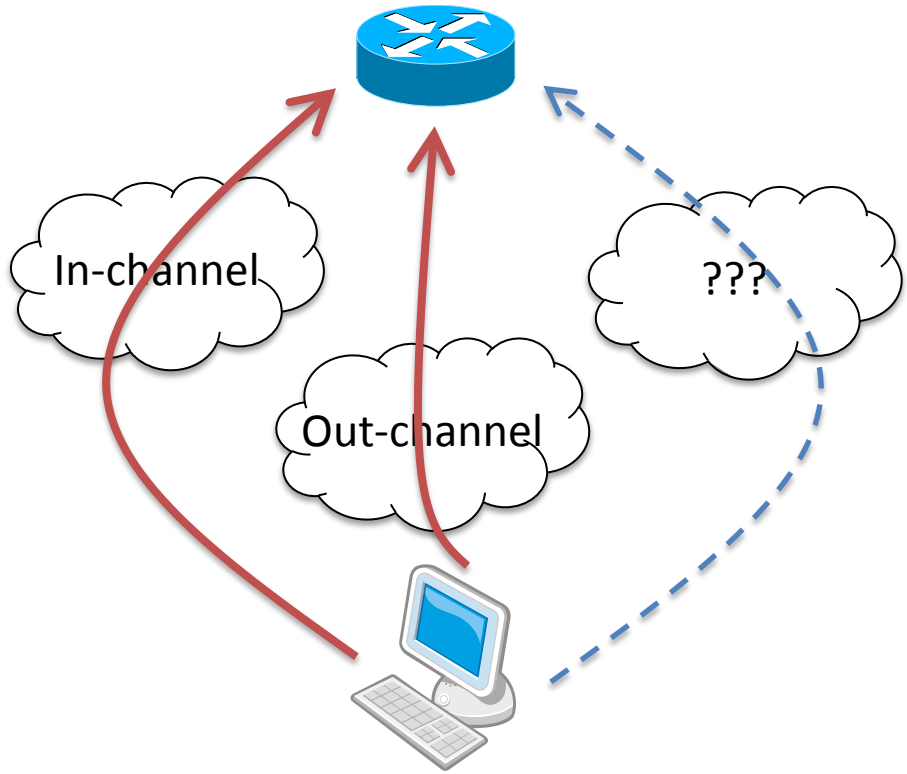


building up upper location

1-4. Maintenance Network

- Is divided from Data-plane physically
  - Confirm accessibility of all nodes
  - Affect quickness and accuracy of restoration
- Maintenance Network
  - In-channel
  - Out-channel
    - ISDN
    - 3G
    - Other carrier's network

>>> Divide physically



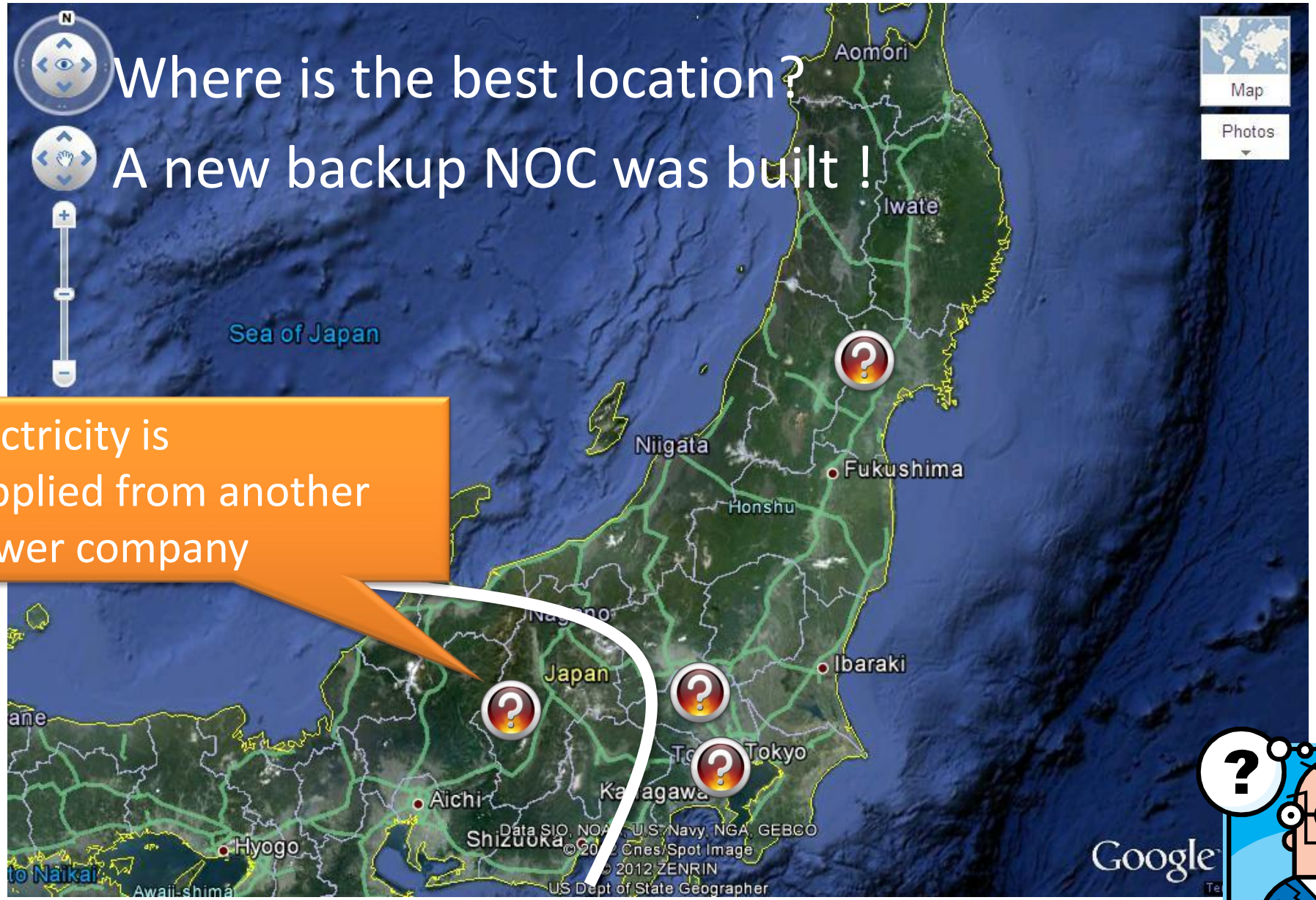
1-5. Virtual circuit redundancy (layer 3)

- Should be installed
  - Of course, layer3, IP
  - L3 redundancy is strongly depends on L1/L2
  - Enhance L1/L2 redundancy

>>> L3 Engineer should be careful of lower layer

Grasping all of network is difficult.
To know how to grasp is easy.

1-6. Network Operation Center



1-6. Network Operation Center

- NOC
  - is a control tower
  - Affect quickness and accuracy of restoration
- 6 points:
  - Building
  - Location
  - Keep communication lines
  - Human resources (operators, and related department)
  - Sustainability (power, transportation, logistics, food)

>>> Multi NOC operation

Section summary

- 6 topics:
  - fiber route redundancy
  - Cabling
  - Building
  - Maintenance Network
  - Virtual Circuit Redundancy
  - Network Operation Center

- More robust network will be achieved.
- More careful, quick, accurate trouble shooting and restoration will be held.

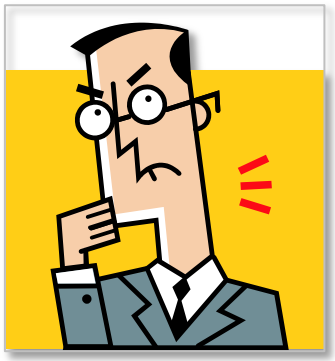
1. CONSTRUCT PHYSICAL NETWORK WITH ROBUSTNESS

2. PREPARATIONS AGAINST A DISASTER

3. WHAT WE SHOULD DO AFTER A DISASTER

Preparations against a disaster

- 2 points:
  - Formation
  - Make priority
- Situations are so complicated, critical and emergency.
- Hard to consider and decide these points after a disaster.
- Need much time & money to re-construct physical network.

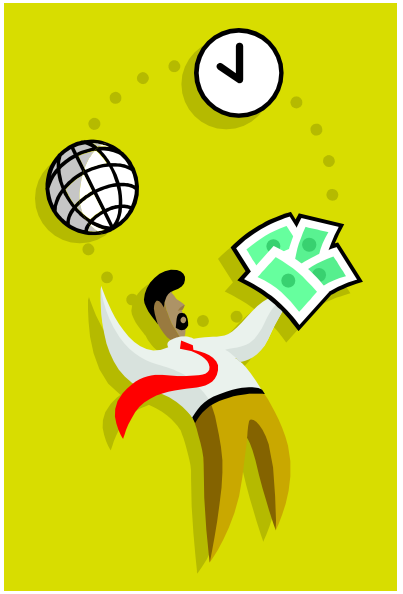


2-1. Formation

- We have trained periodically against disasters.
  - It worked very well.
- Viewpoints of the network operation division
  - Human resources are insufficient against a large scale disaster.
  - We need quick initial response.
  - The right man in the right place, if possible
  - We Should establish a formation system in advance of when a disaster occurs.

2-2. Priority

- What is the most important point for you ?
  - Services
    - Telephone, Internet, Video on Demand
  - Equipment
    - Fiber route, Core Routers, NMS
  - Customers
    - Important customers (government), traffic volume
- limitation
  - Various resources are limited
  - No time to consider
  - Less information of the network
- You can decide various rules in advance.
  - We discussed about lots of items
  - We rebuilt new priority policies.



Section summary

- 2 topics:
  - Formation
  - Priority
- It is so hard to consider and decide these points after a disaster occurred.
- You should consider in advance.
- They will help you about decision making and initial response.

1. CONSTRUCT PHYSICAL NETWORK WITH ROBUSTNESS
2. PREPARATIONS AGAINST A DISASTER
3. WHAT WE SHOULD DO AFTER A DISASTER

What we should do after a disaster ?

- Main mission is recover your own network
- Quickness and accuracy
- 2 points:
  - Investigation and Grasping
  - Rough Plan of Network Recovery

3-1. Investigation and grasping

- One of the most important mission for NW operator
- Measure impacts
  1. Nodes and Topology
     - L3, L2, L1, power
  2. Number of affected customers
  3. Important customers
     - Government, hospital, Self-Defense force(*1)

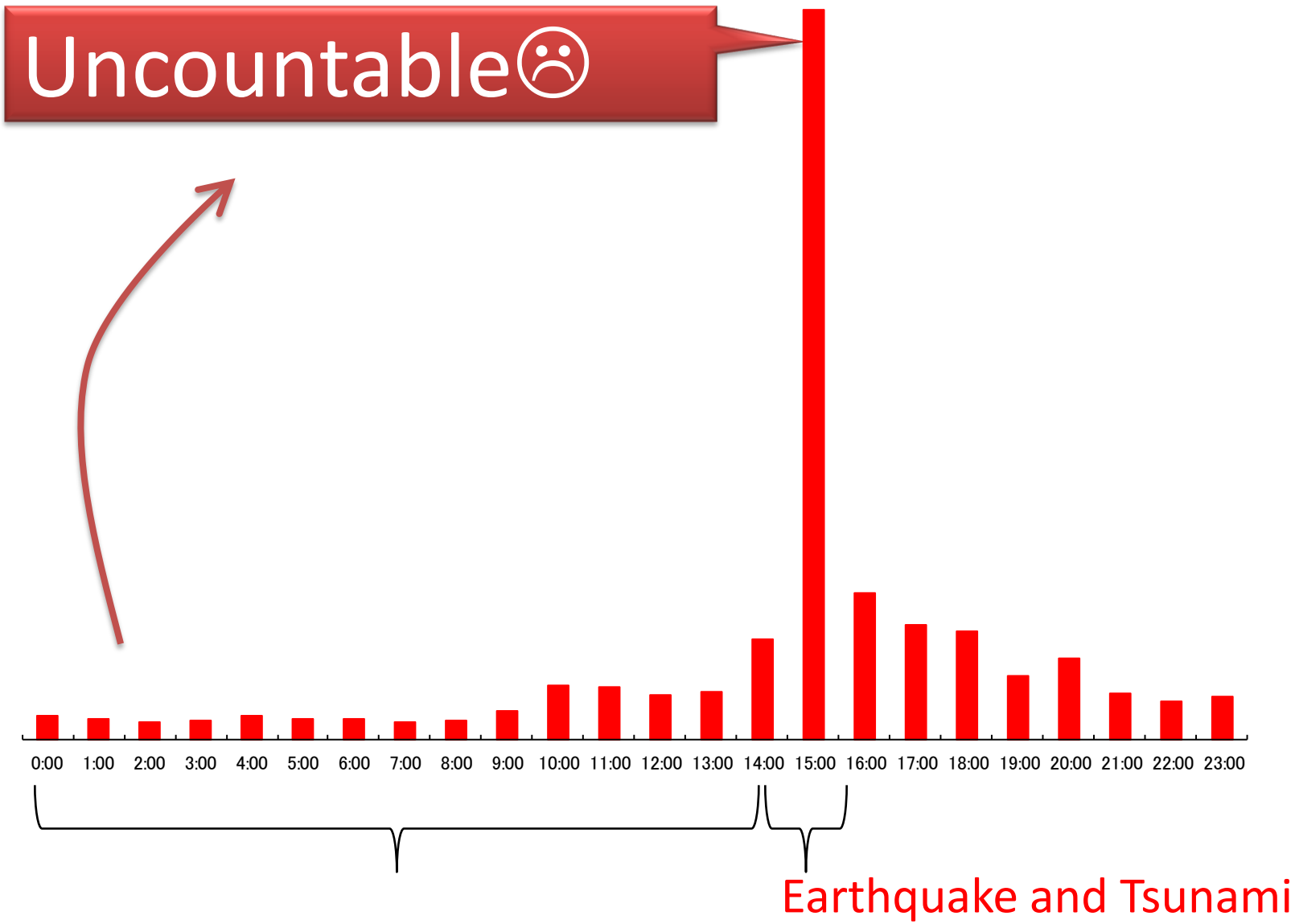
(*1) there are no army in Japan.
But there is a organization to defend our country.

Imagine.

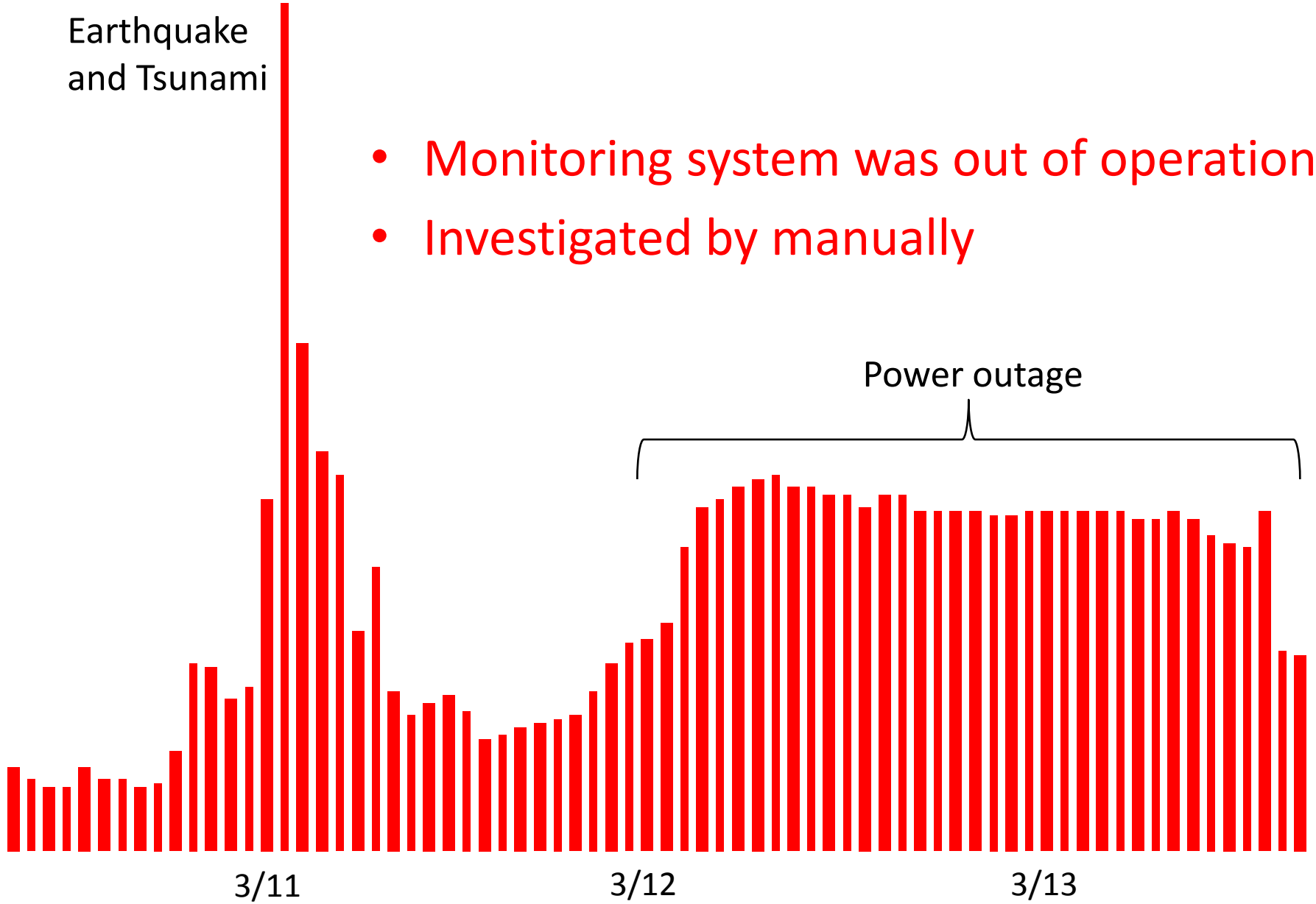
What do you do

when 10% nodes down?

Network alarms @ 3.11

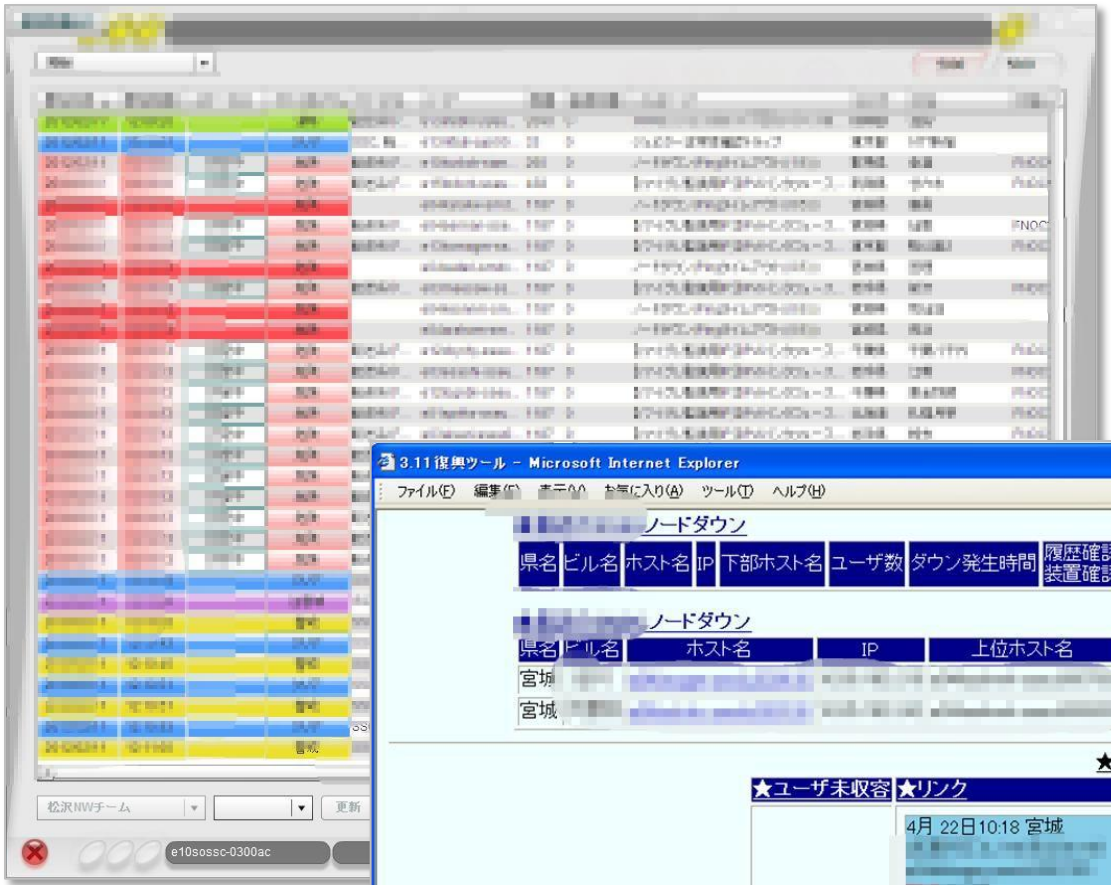


Network alarms @ 3.11-3.13

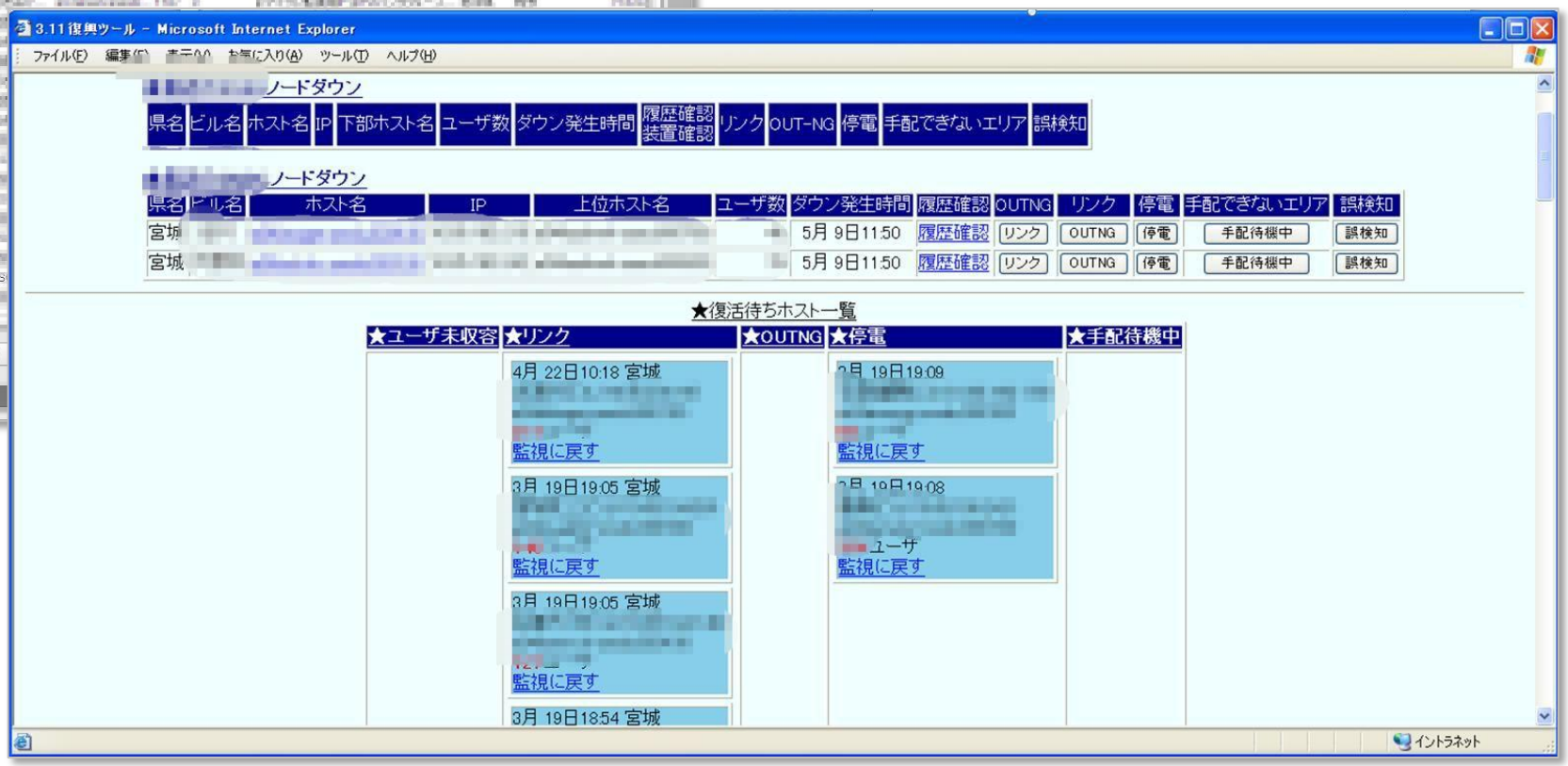


- Monitoring system was out of operational use
- Investigated by manually

Tools for disaster



- 3days later



Section summary

- Monitoring system
  - Is unavailable due to its high load, enormous alarms
  - Investigated manually and get statistics
    - Took 3 days to make tool
  - Usual
    - We need information in detail
  - Emergency
    - We need only summarized information

3-2. how to restore

- Recover to

	Original topology	Temporary topology
Facility shortage	Depends on equipment☹	☺
Response speed	☹	speedy☺
Design	One way☹	As we like☺
Operability	No worry to operate☺	Sometimes confuse us☹
Other	☺	Need re-construct to the original topology☹

- Schedule, cost, effect
- Flexibility, simple topology

Section summary

- 2 topics:
  - Investigation and Grasping
  - Rough plan of network recovery

SUMMARY

Robust network against a disaster

- How do you keep on providing stable network ?
  1. Construct physical network with robustness
     - fiber route redundancy, Cabling, Building, Maintenance NW, Virtual circuit redundancy, NOC
  2. Preparations against disaster
     - formation, Priority
  3. What we should do after disaster
     - Investigation, grasping, how to restore

- We have learnt a lot from disasters.

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明日へ。

THANK YOU.