

Dependable Cloud Computing:

Virtualization-Based Management
for Servers, Clients and Network

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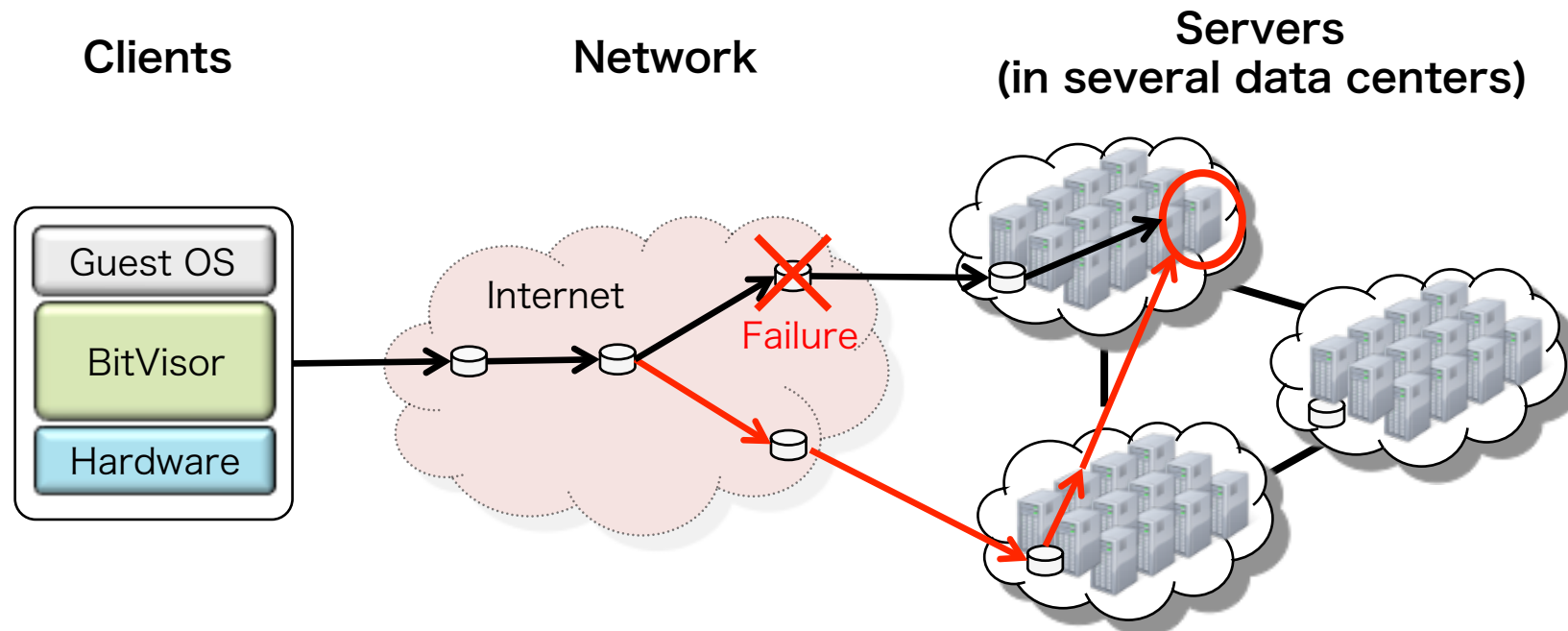
Yoshiaki Ishii, Kyohei Yano, Seiji Hirooka

Overview of Dependable Cloud computing

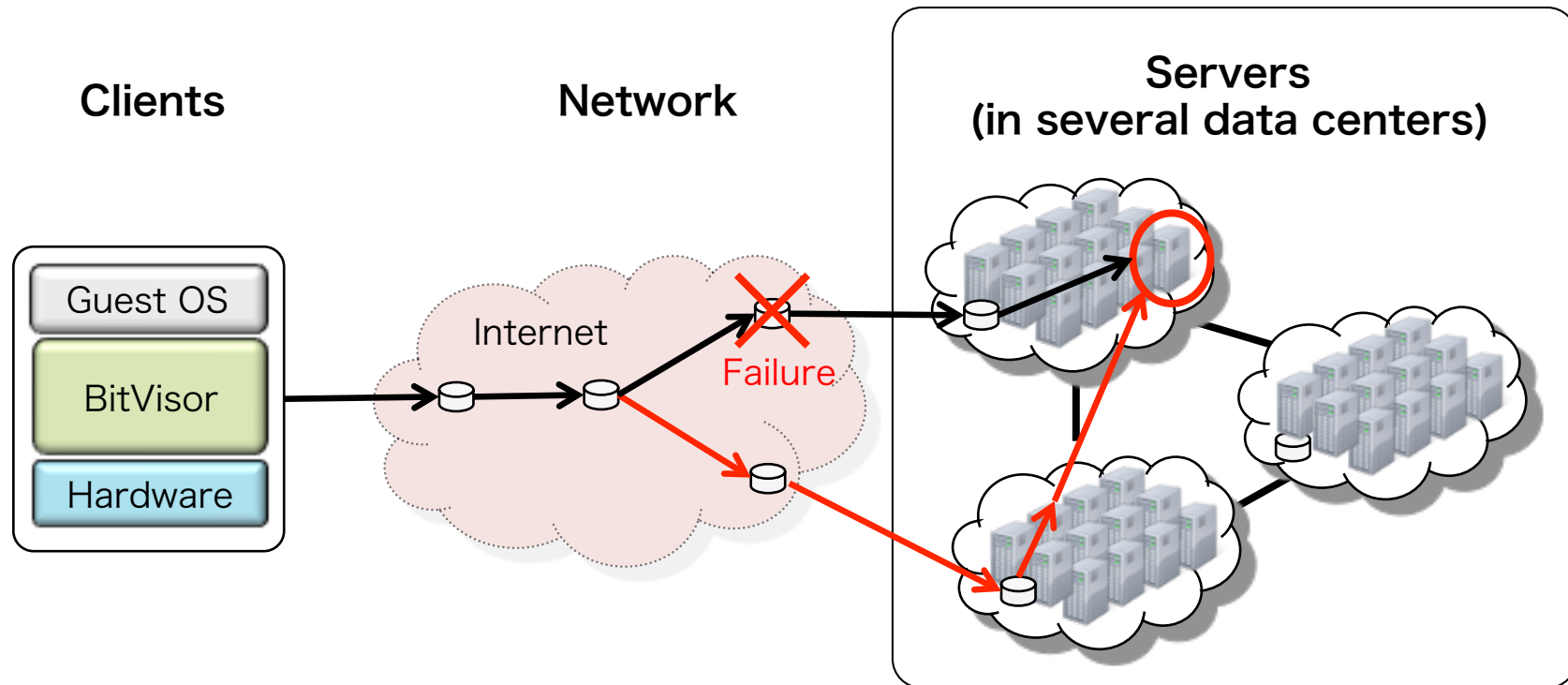
Developing infrastructural software for cloud computing with servers, client, and network.

Dependability :

Reliability, Availability, Response, Throughput, Security, Privacy



(I) Dependable Server Management



Kumoi (雲居) :

Middleware for Cloud Server Management

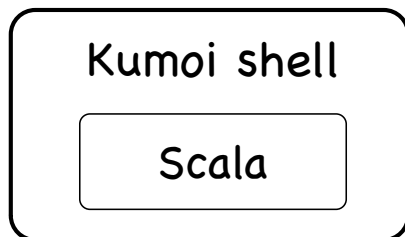
- Riding on the Scala programming language
 - ✓ OO & functional
 - ✓ "Scalable" coding (Java-to-Ruby level) with static type system
- Object/Resource mapping for data centers
 - ✓ Real/virtual machines and network are mapped to HW/SW objs. (Cf. O/R mapping in db software)
- Incorporated distributed algorithms such as gossip algorithms and Paxos.
- Available as open source software.

Kumoi Overview

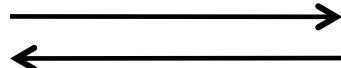
Manager/operator



Interactive/batch



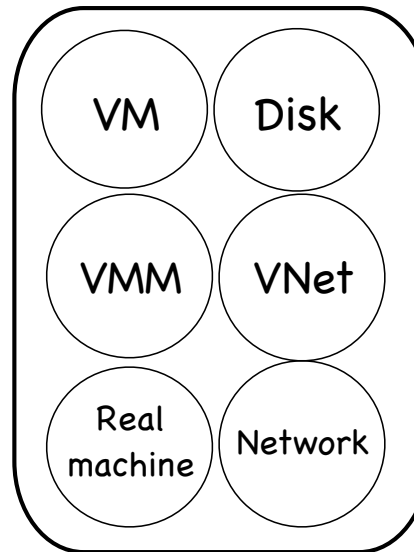
Method call



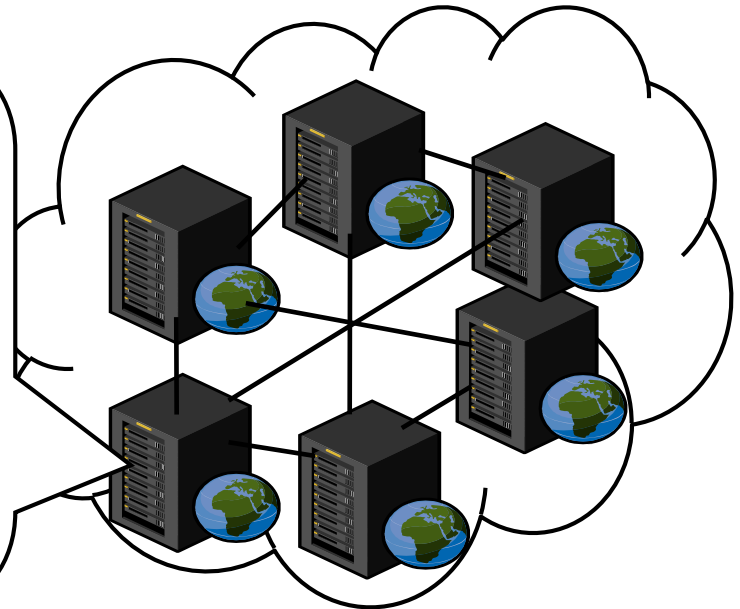
Result



Kumoi kernel



Data center



34K lines of Scala source code

Kumoi Scripting

(Cf. Unix scripting)

```
scala> pms.filter(_.cpuRatio > 0.9).map(_.name)
```

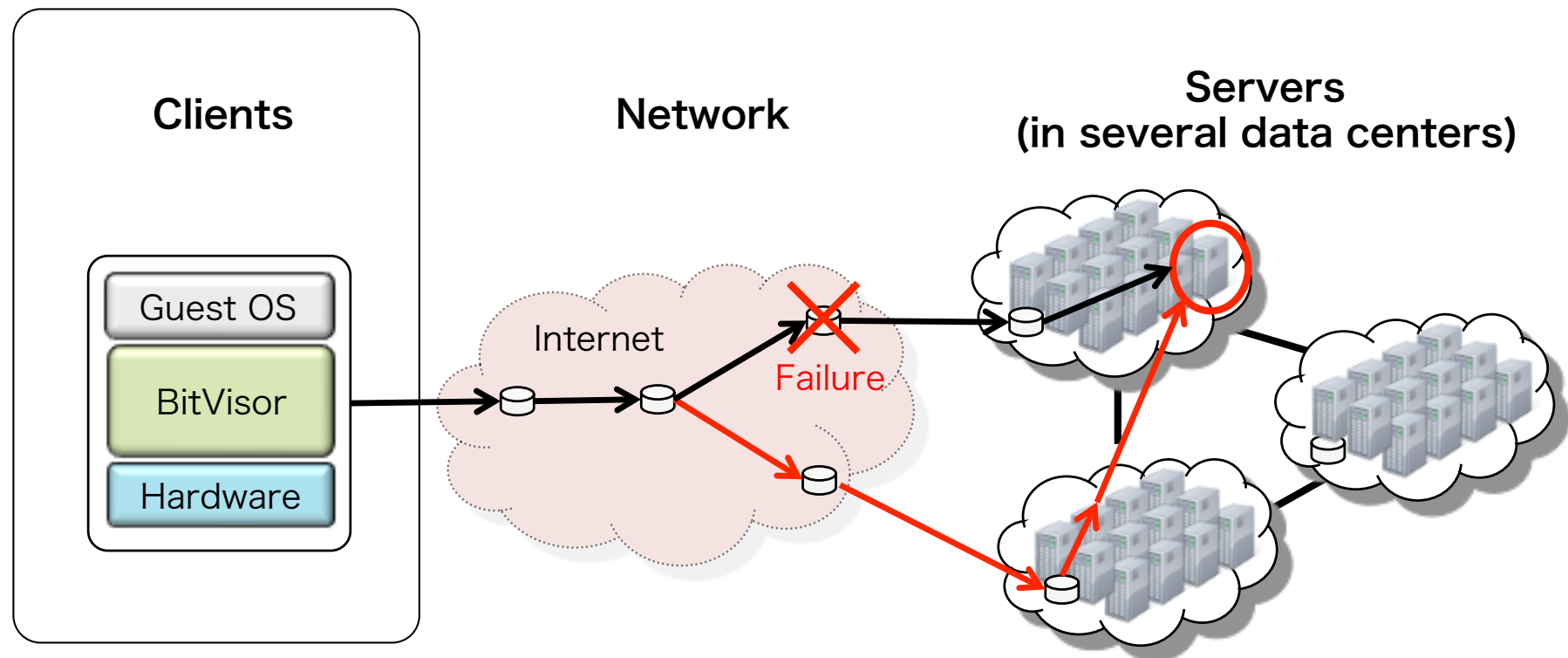
pms: List of available physical machines

_: Formal arguments for higher-order function

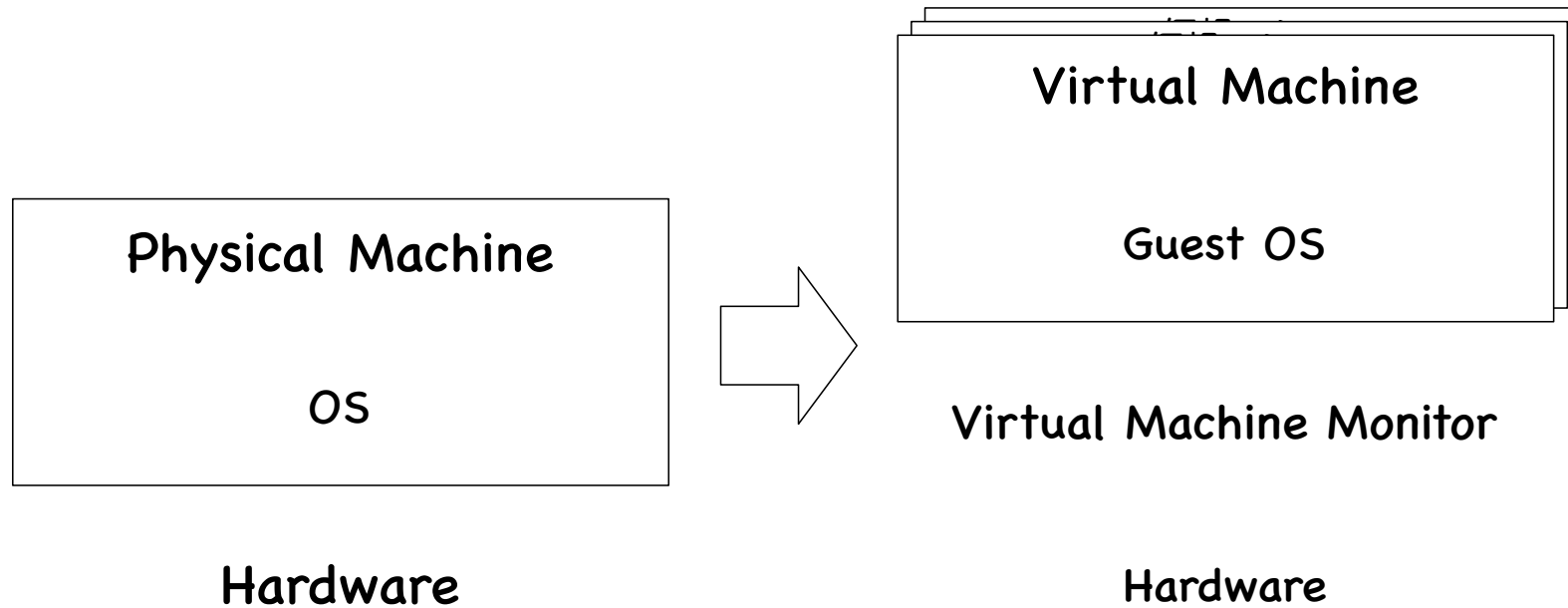
Kumoi System Programming: VM-Compaction

```
def compact(pms: List[VM]) {
  def firstFit(v: VM, rest: List[VM]) {
    rest match {
      case h :: rs if (h.cpuAvailable > v.cpuRatio) => v.migrateTo(h)
      case h :: rs => firstFit(v, rs)
      case List() =>
    }
  }
  def compacti(pms: List[VM]) {
    pms match {
      case h :: rest =>
        h.vms.foreach(v => firstFit(v, rest.reverse))
        compacti(rest)
      case List() =>
    }
  }
  compacti(pms.reverse)
}
```


(II) Dependable Client Management

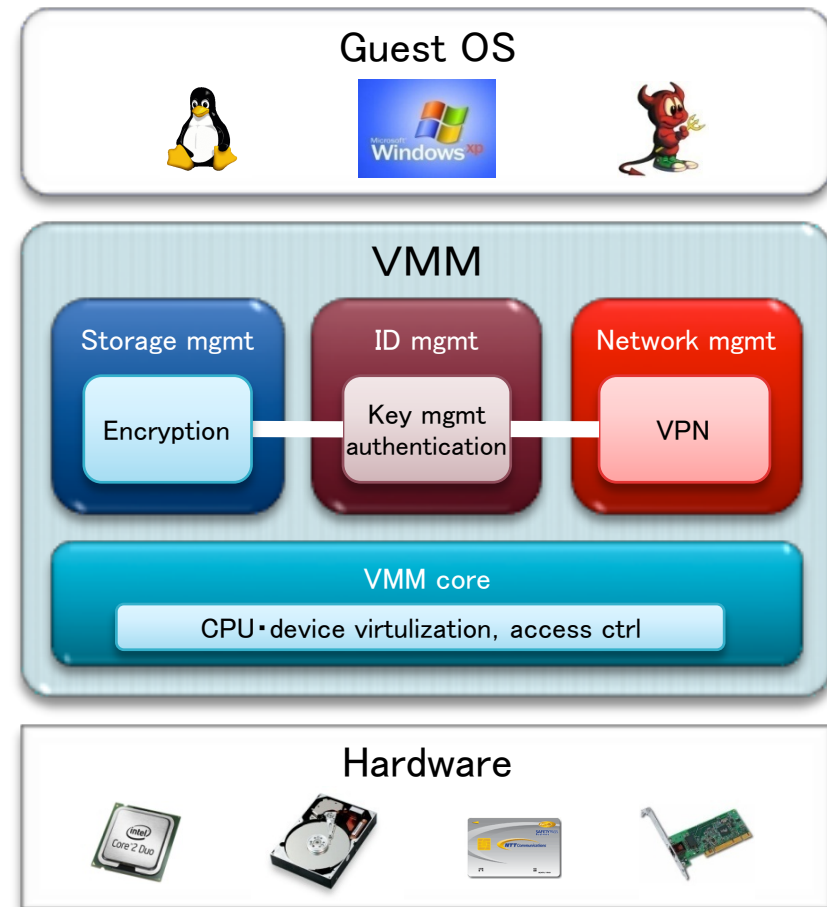


Virtual Machine Monitor



BitVisor: Secure VMM

- **Storage management**
 - ✓ Encrypting HDD, USB memory
- **Network management**
 - ✓ VPN (IPsec)
- **ID Management**
 - ✓ Key management/authentication with IC card
- **VMM Core**
 - ✓ Virtualization of CPU and memory



Utilization of BitVisor

- System file protection of guest OS
- Malware detection
 - ✓ IDS within VMM
- Transparent VPN switching (described in the next topic)

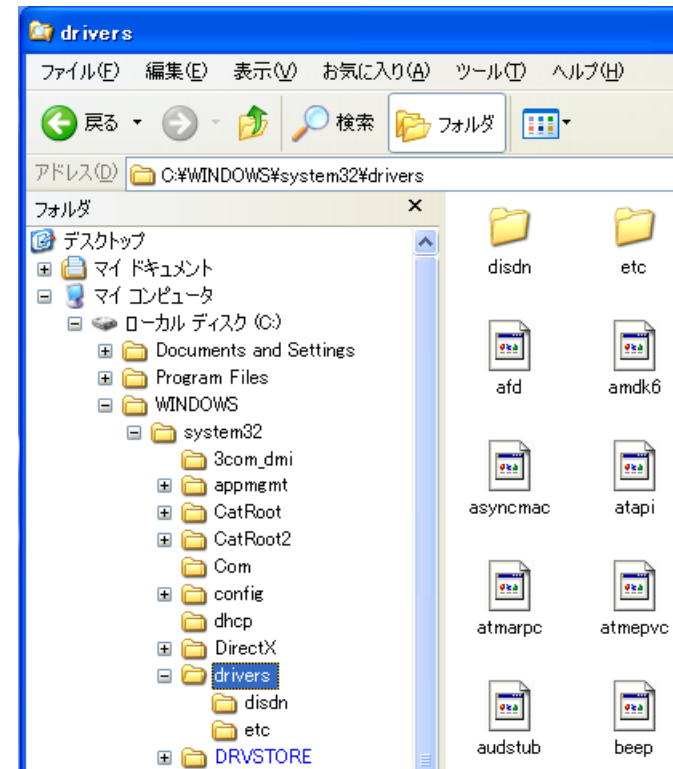
System File Protection of Guest OS

- Integrity (code cannot be modified undetectably)

- ✓ Kernel image

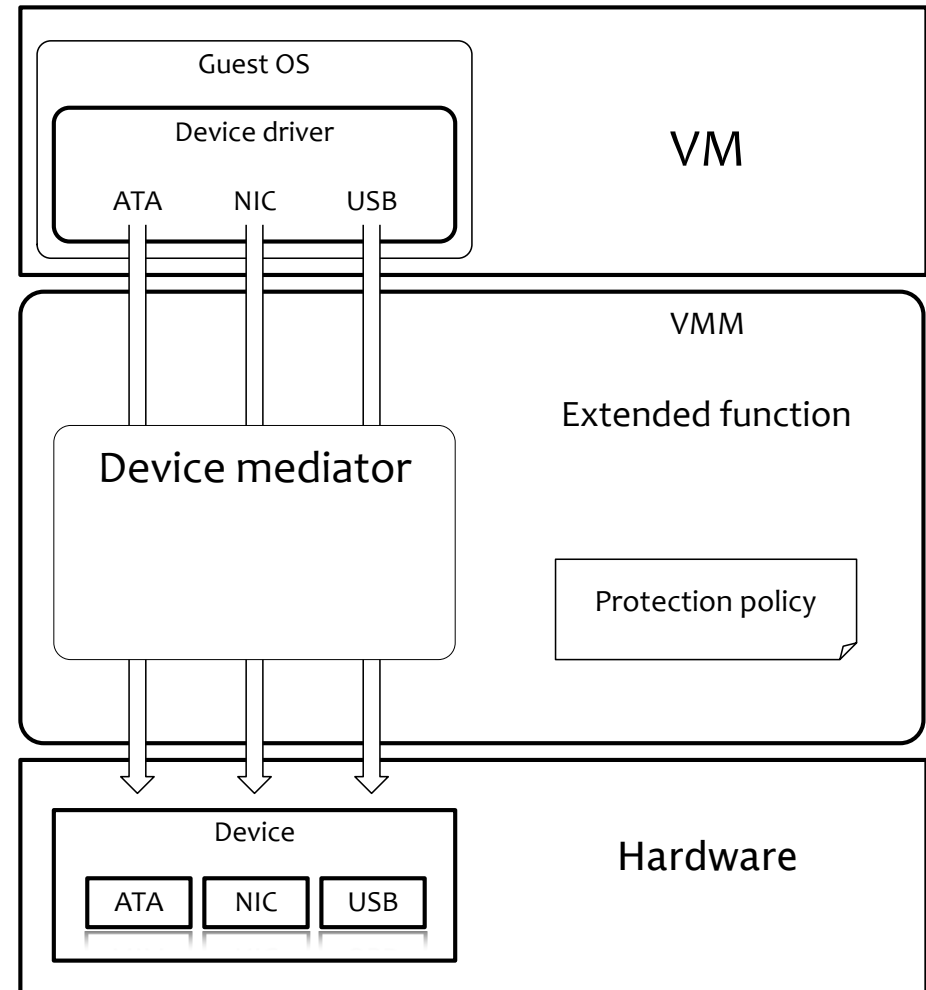
- ✓ Device driver

- ✓ etc.

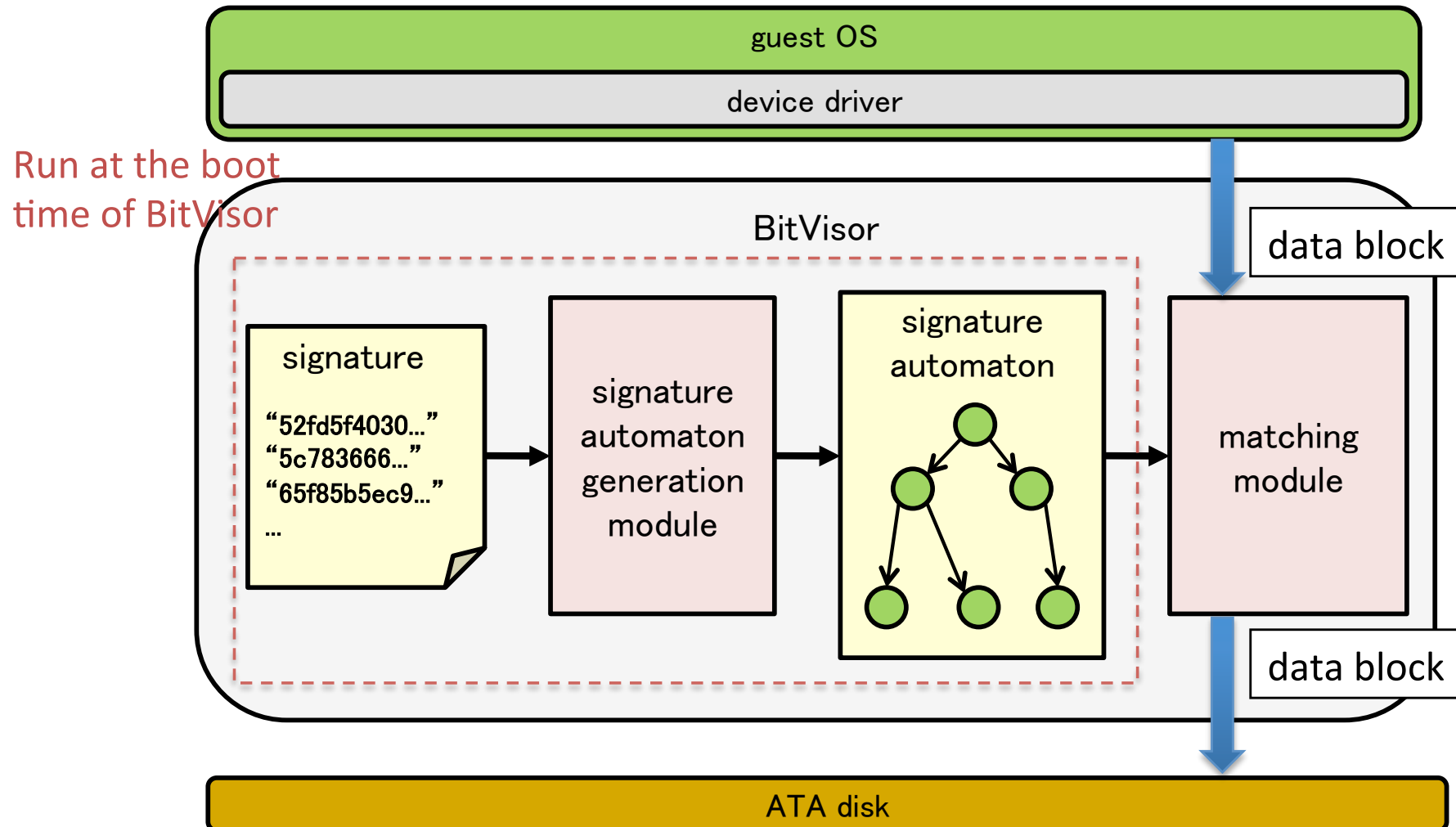


Implementation of System File Protection

- BitVisor monitors *every* storage access.
 - ✓ Detects system file modification.
- Mapping between files and sectors are managed.



Malware detection IDS within VMM



BitVisor as Research Platform

- HyperSafe [Wang et al., IEEE S&P '10]
 - ✓ Integrity of hypervisor itself, i.e., modification disabled.
- “Return-less” VMM [Li et al., EuroSys '10]
 - ✓ Against ROR (Return-Oriented Rootkit)
- TCVisor [Rezaei et al., ICITST '10]
 - ✓ Limited storage area can be seen by each user.



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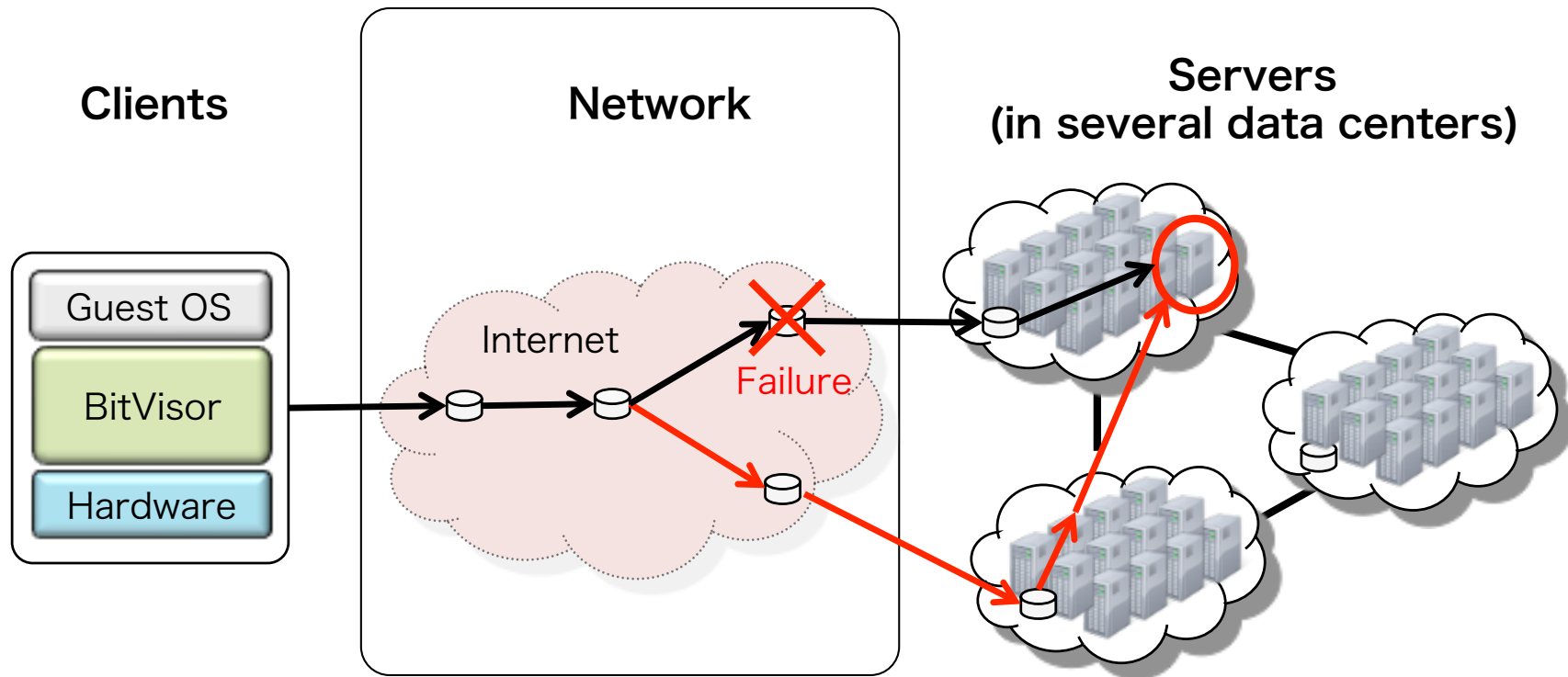
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コンピュータシステムシンポジウム
ComSys 2012

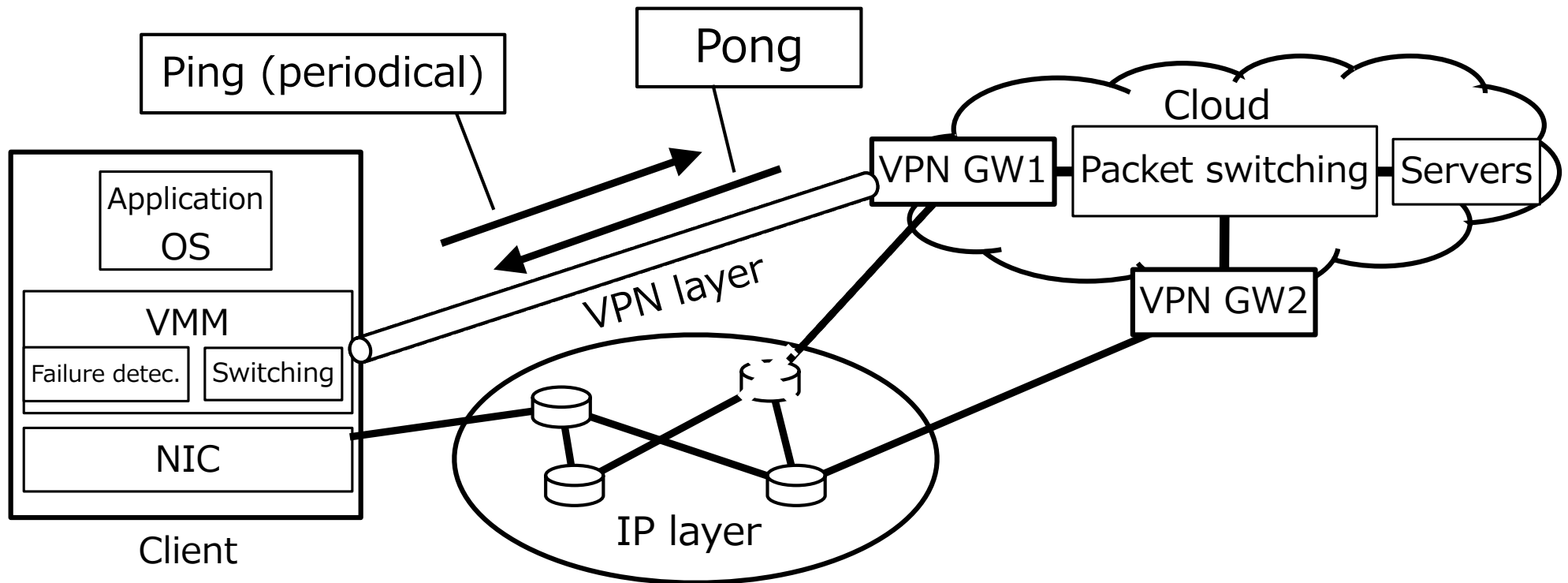
BitVisor Summit

2012年12月4日 (火)
筑波大学 東京キャンパス文京校舎

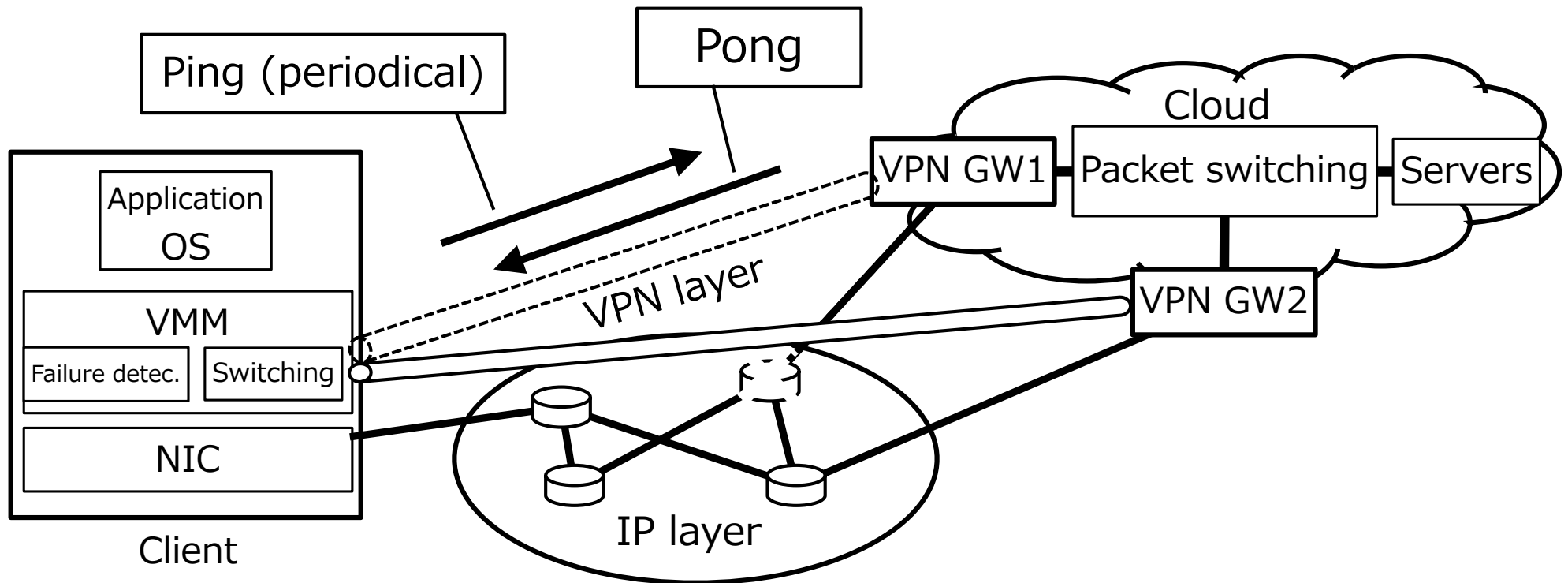
(III) Dependable Network



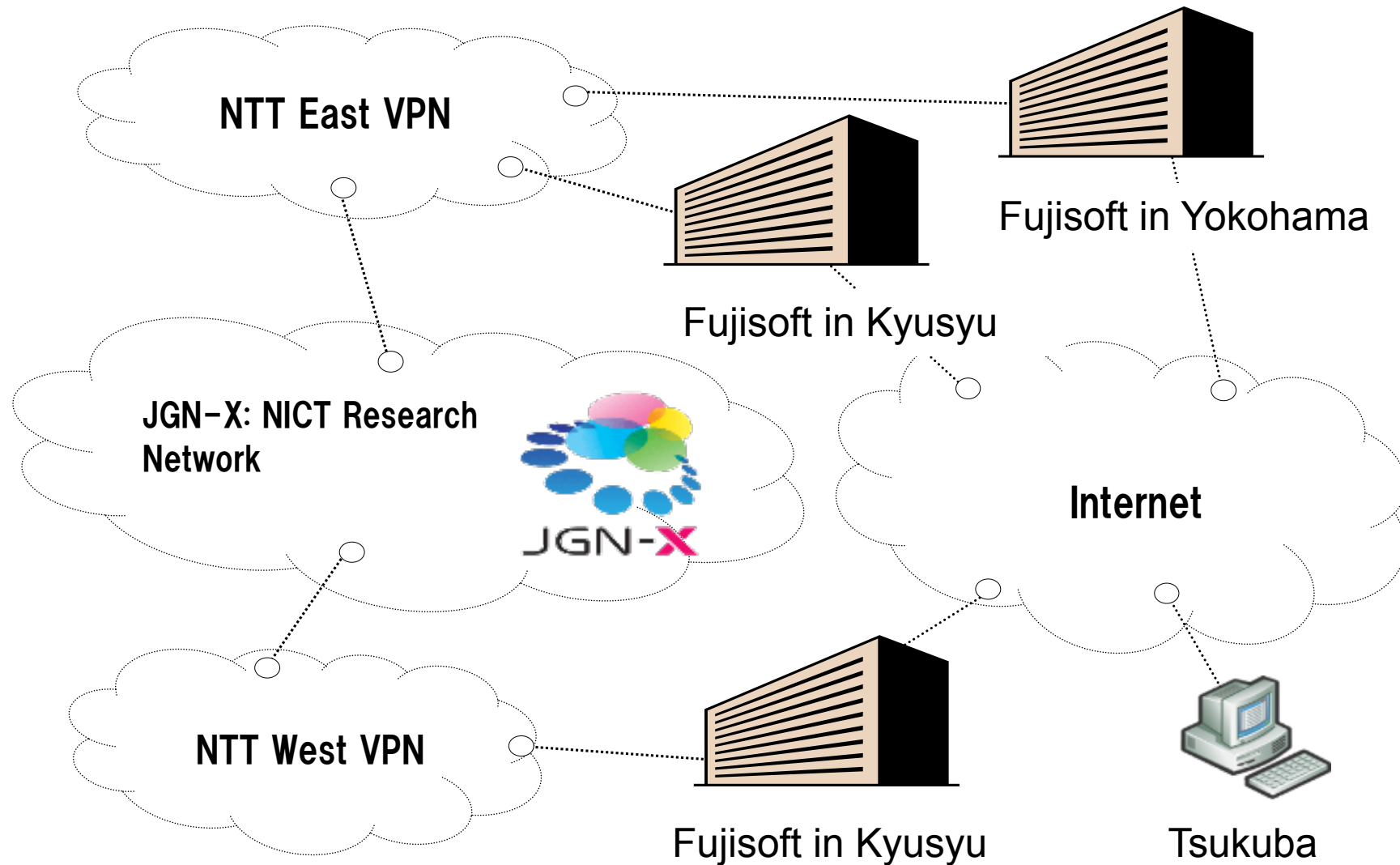
Failure Detection in VMM



VPN Switching in VMM



Experiments with Real Data Center



VPN Switching

Before: Tsukuba-Tokyo (56Km)

After: Tsukuba-Yokohama (84Km)

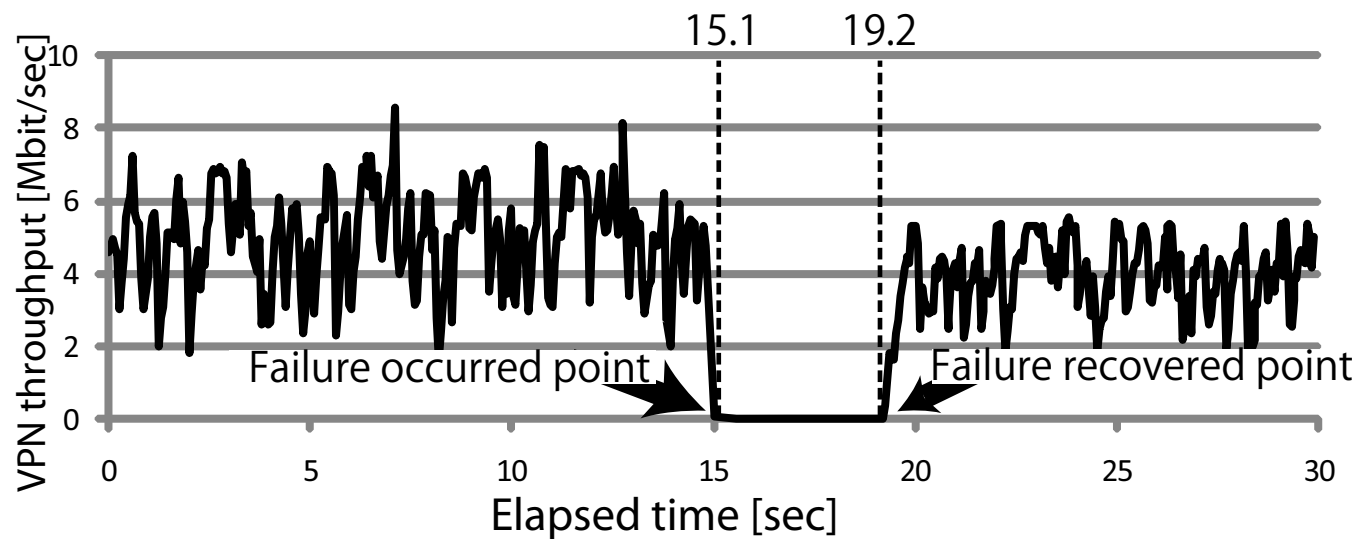
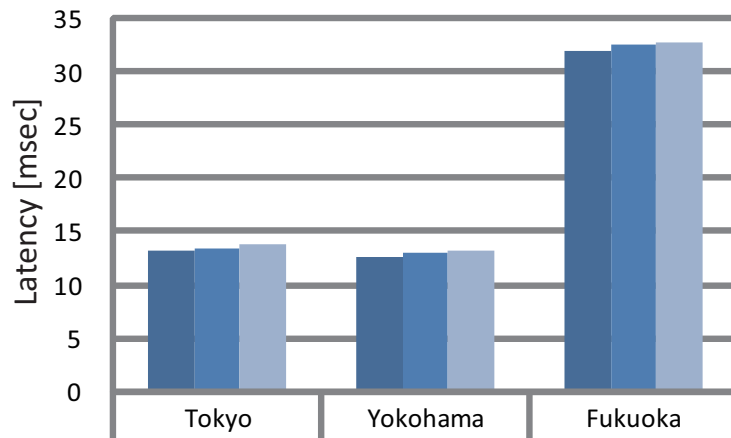


Figure 8. Throughput Transition over Failure

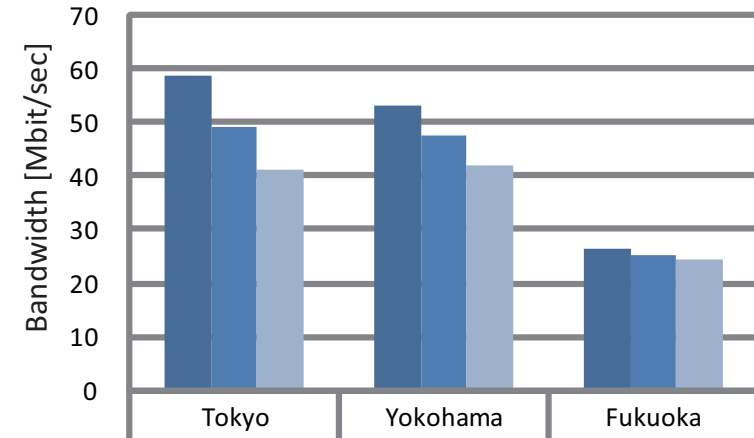
Newtork Latency and Throughput of VPN Switching

Tsukuba-Tokyo (56Km)
 Tsukuba-Yokohama (84Km)
 Tsukuba-Fukuoka (926Km)



	Tokyo	Yokohama	Fukuoka
VPN on OS	13.18	12.63	32.04
VPN on VMM	13.46	13.00	32.57
VPN on VMM with relay	13.71	13.23	32.80

Figure 9. Latency

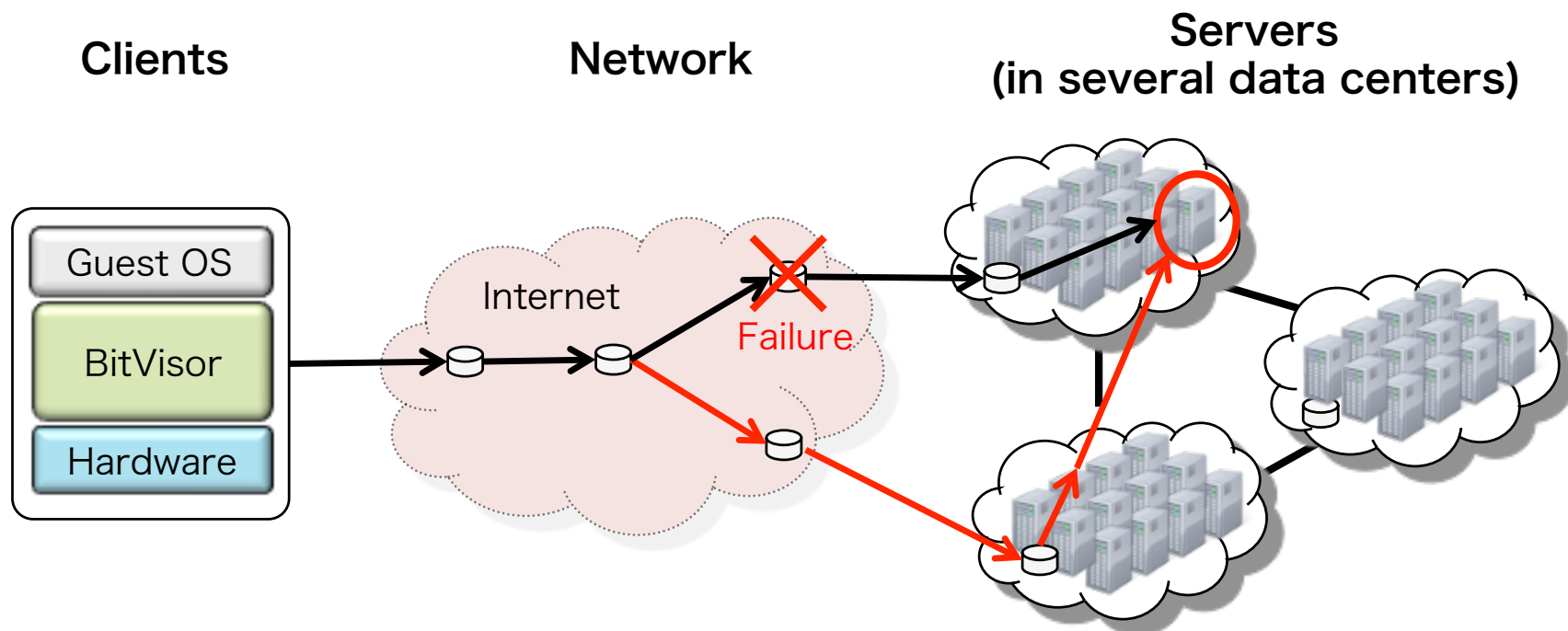


	Tokyo	Yokohama	Fukuoka
VPN on OS	58.88	52.98	26.43
VPN on VMM	49.31	47.45	25.27
VPN on VMM with relay	41.22	41.94	24.45

Figure 10. Throughput

Summary

Dependable cloud computing environment for servers, client and network, by using virtualization technologies.



Ongoing Work

- Extension and application of Kumoi
 - ✓ Virtual network control with OpenFlow
 - ✓ Failure-oblivious computing
 - ✓ Application: Parallel, distributed parameter tuning
- BitVisor application
 - ✓ Transparent network boot system
 - ✓ Acceleration of guest OS boot
 - ✓ Desktop grid with intra-VMM computation
- Energy-saving distributed storage system