

Credit-based Network Management

2009-01-06



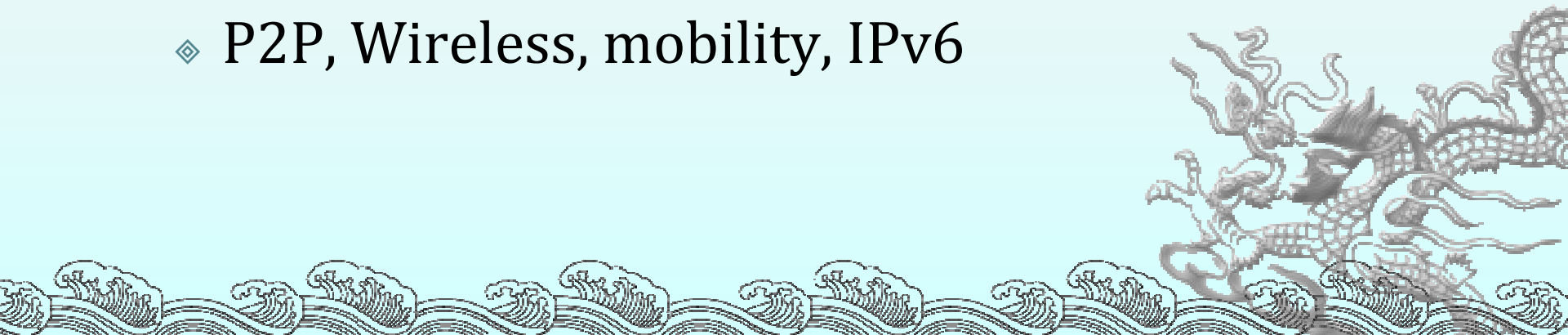
Outline

- ◆ The problem of Network Management
- ◆ The Idea of Credit-based Network Management
- ◆ An Implementation in Campus Network
- ◆ Conclusions

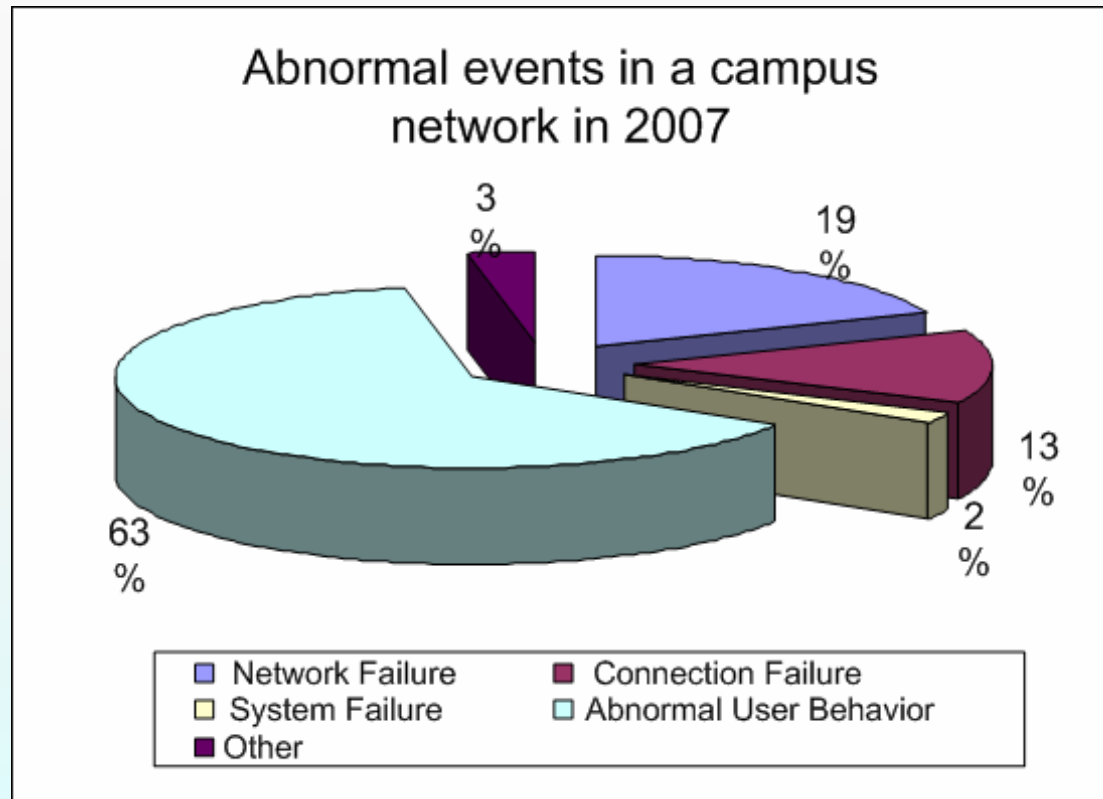


Network management headaches

- ◆ Widespread security problems
 - ◆ DDoS attacks
 - ◆ Address spoofing, misconfiguration
 - ◆ Unwanted traffic
- ◆ Poor QoS
- ◆ Problems brought up by new technologies
 - ◆ P2P, Wireless, mobility, IPv6



Physical vs behavioral problems



Behavioral problems

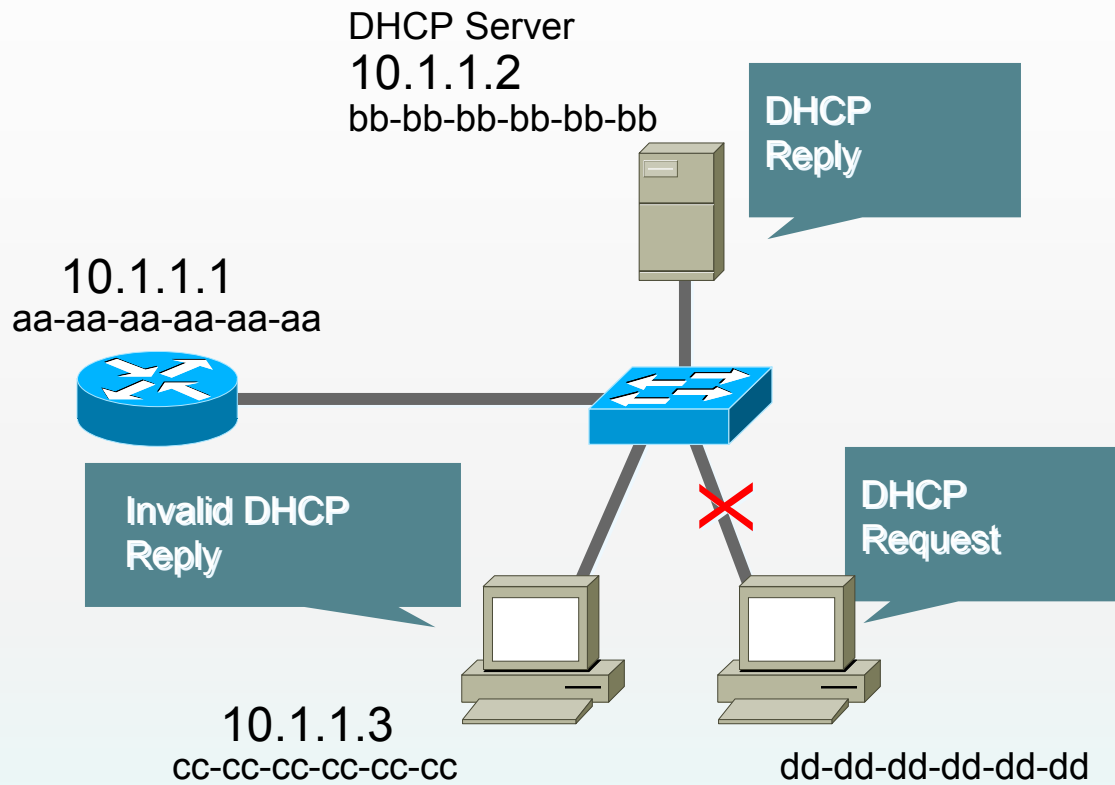
- ◆ Very few real malicious guys
- ◆ A few youngsters try to be hackers
- ◆ Most problems caused by carelessness, exploited by other hackers
- ◆ Let's consider a couple of common examples



DHCP Spoofing

- ◆ In many networks, users get IP addresses from a DHCP service
- ◆ An invalid DHCP server will cause problems to an entire LAN
- ◆ E.g. some WLAN router enables DHCP service, which causes problem to the LAN it is connected to

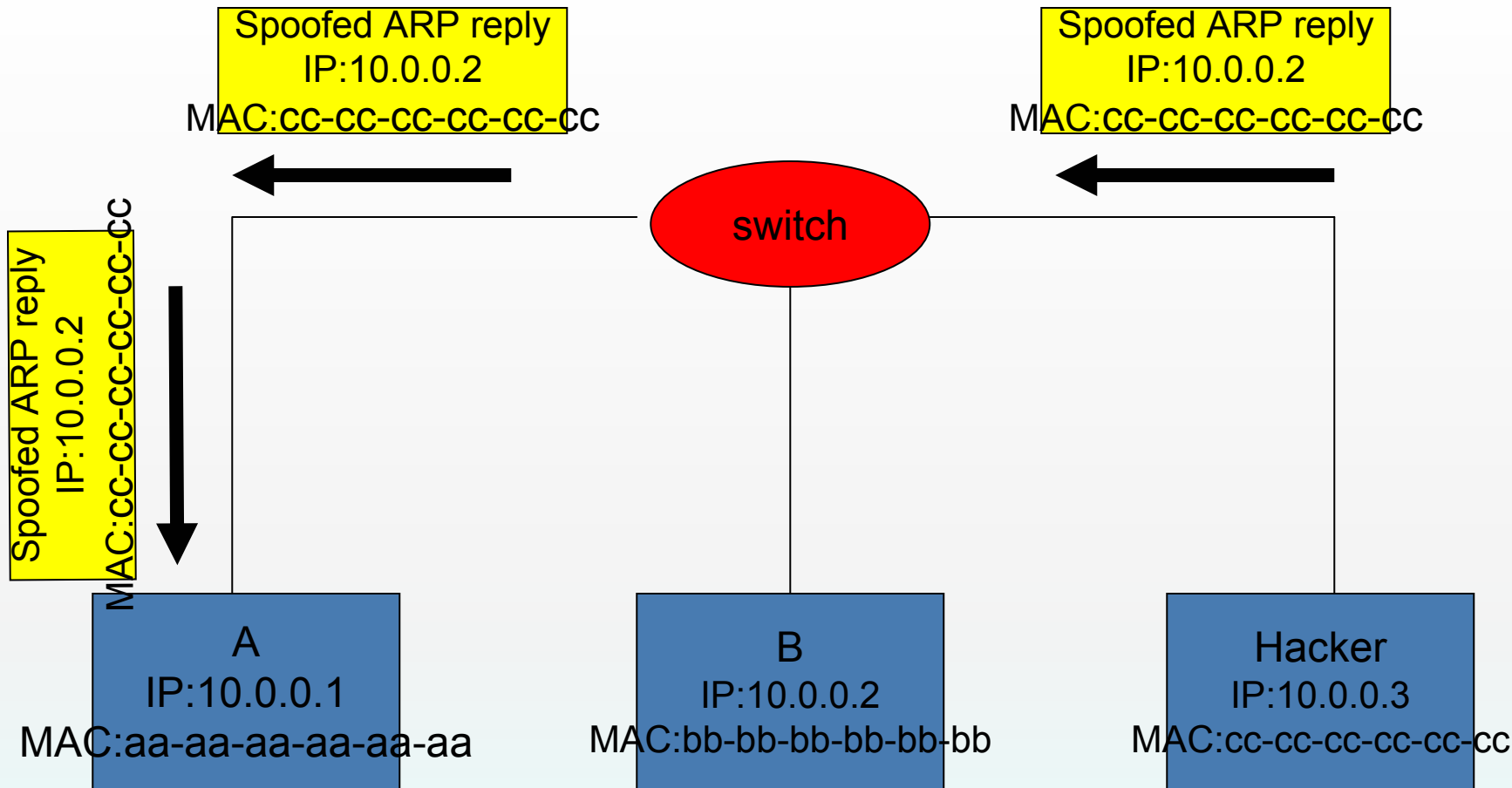




ARP Spoofing

- ◆ In an IP/Ethernet network, both hosts and routers use ARP protocol to map IP to physical addresses
- ◆ It is easy for someone to spoof ARP replies, causing problems to some hosts or the entire LAN.



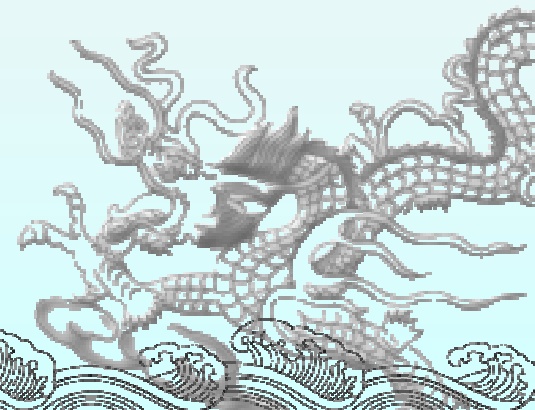


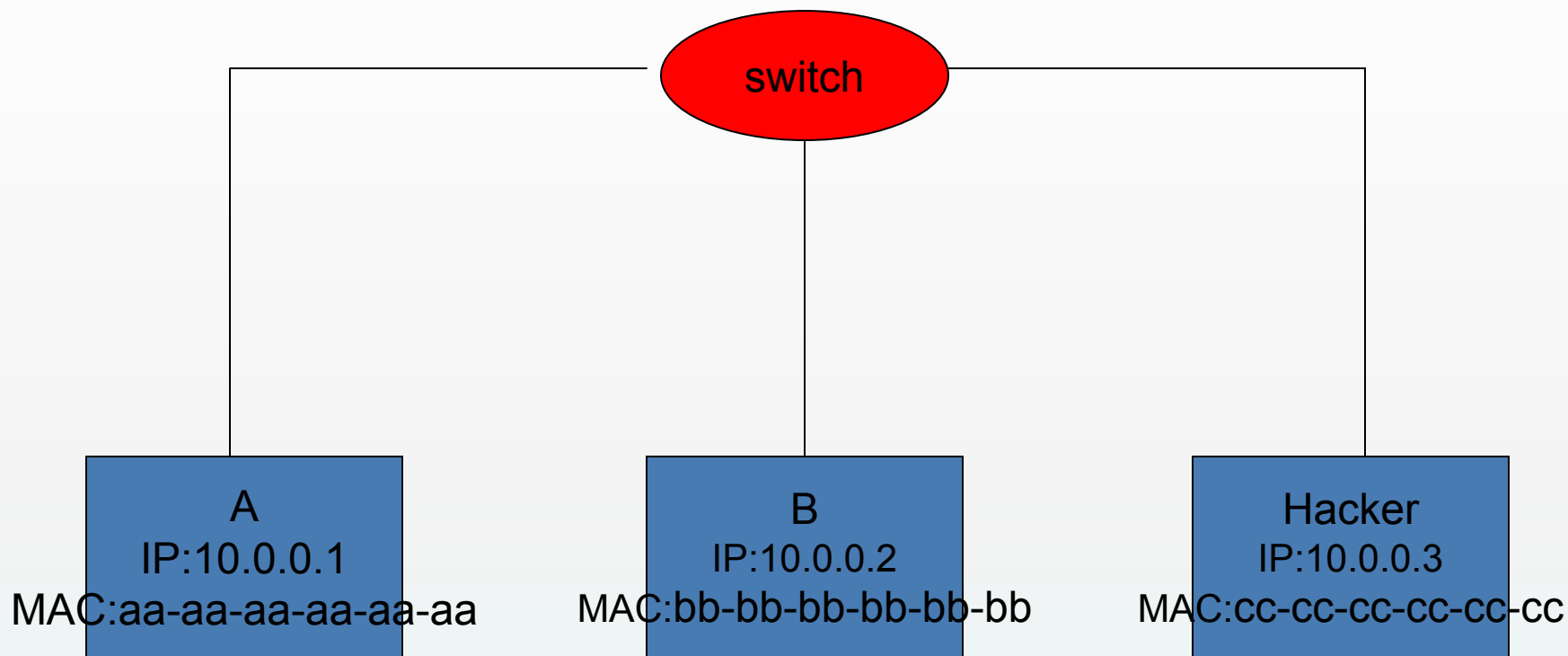
ARP cache

IP	MAC
10.0.0.2	bb-bb-bb-bb-bb-bb

ARP cache

IP	MAC
10.0.0.1	aa-aa-aa-aa-aa-aa





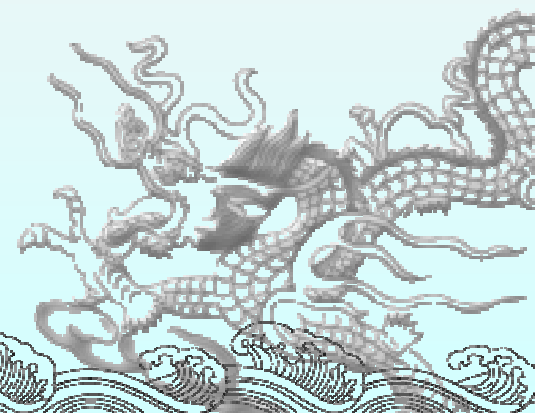
ARP cache

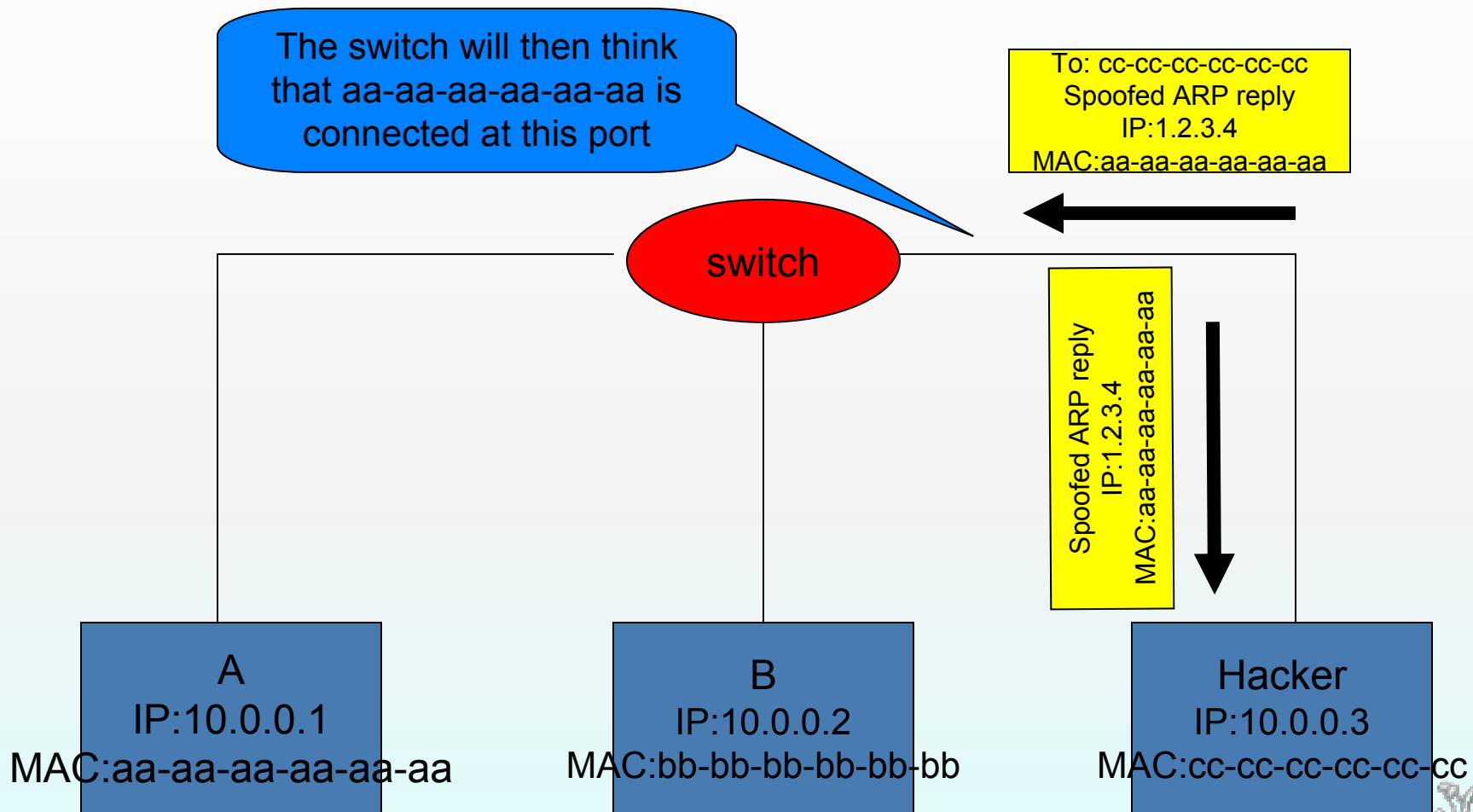
IP	MAC
10.0.0.2	cc-cc-cc-cc-cc-cc

A's cache is poisoned

ARP cache

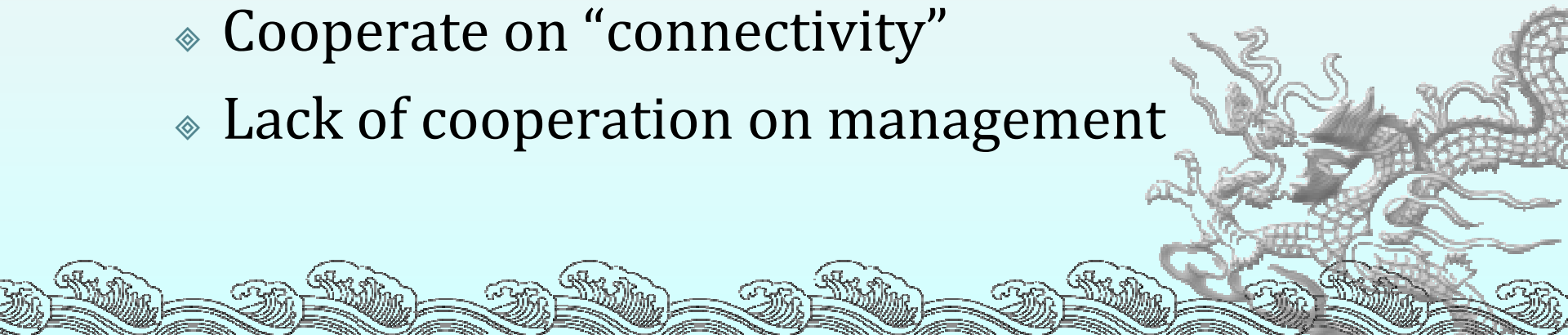
IP	MAC
10.0.0.1	aa-aa-aa-aa-aa-aa





Rooted in network architecture

- ◆ Open access
 - ◆ Favoring easy application development
 - ◆ Allow/support anonymous access (privacy)
 - ◆ Best-effort service
- ◆ Decentralized management for extensibility
 - ◆ Managed by many ISPs
 - ◆ Cooperate on “connectivity”
 - ◆ Lack of cooperation on management



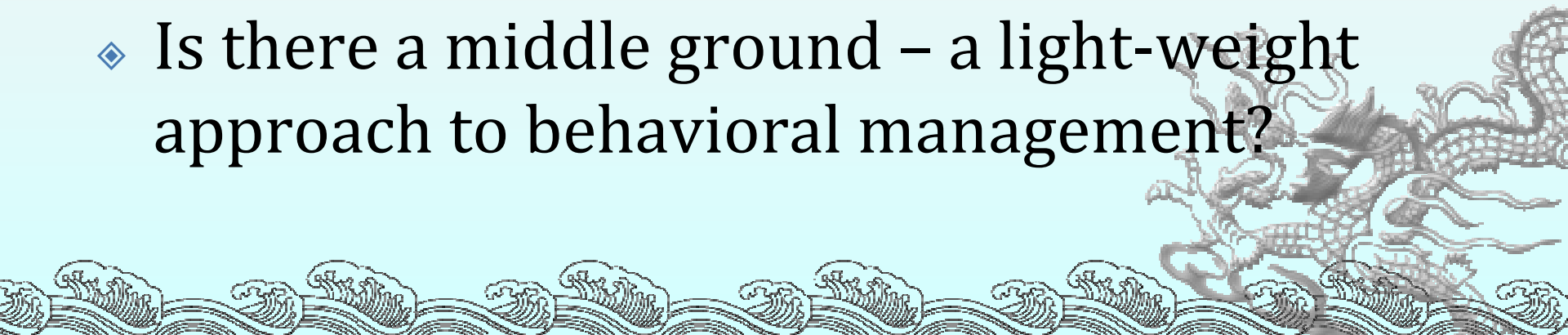
Current management practice

- ◆ Focus is on infrastructure management
 - ◆ Setting up routers, access points, name service, email, web servers, routing policies
 - ◆ Monitoring network resources for reliability
 - ◆ Setting up local security (e.g. user accounts) to protect usage of local resources
 - ◆ Responding to security problems



Behavioral management

- ◆ Internet is another human society
- ◆ Behavioral problems can be dealt with using law enforcement
 - ◆ Too heavy-weight for many scenarios
- ◆ Current practice is mostly passive
 - ◆ Filters, firewalls...
- ◆ Is there a middle ground – a light-weight approach to behavioral management?



What kind of mechanisms?

- ◆ Should be simple to implement
- ◆ Should have positive influence on user behavior, and effects should be cumulative
- ◆ Should not negatively impact normal operation
- ◆ Should benefit both the ISPs as well as users

⇒ Apply **credit ratings** to users and ISPs

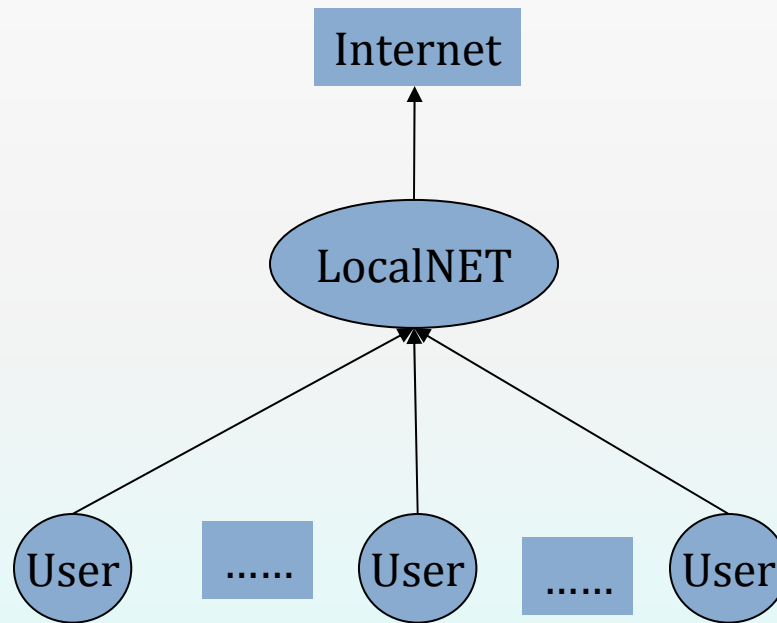


Concrete examples

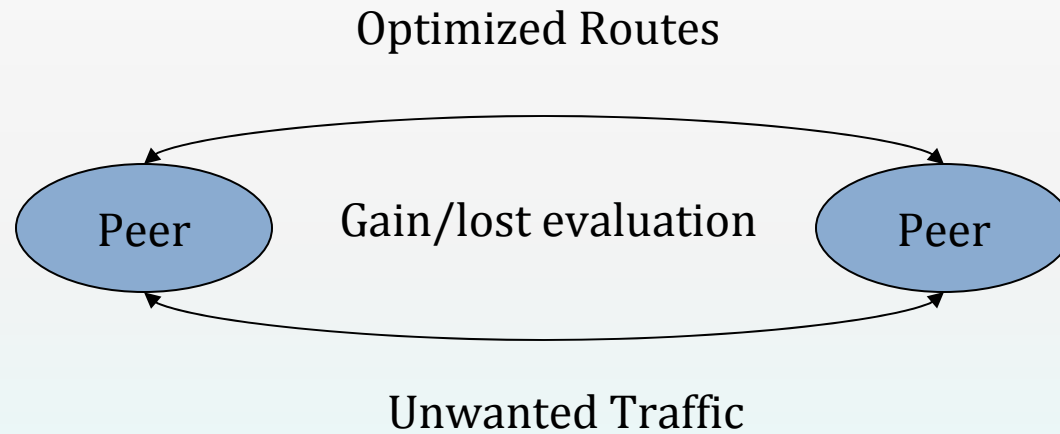
- ◆ Managing a campus network:
 - ◆ Allocate management resources according to user classification
 - ◆ Assign credit rating to users, and adjust service levels according to credit ratings
- ◆ Managing peering relationships
 - ◆ Monitor unwanted traffic
 - ◆ Monitor QoS



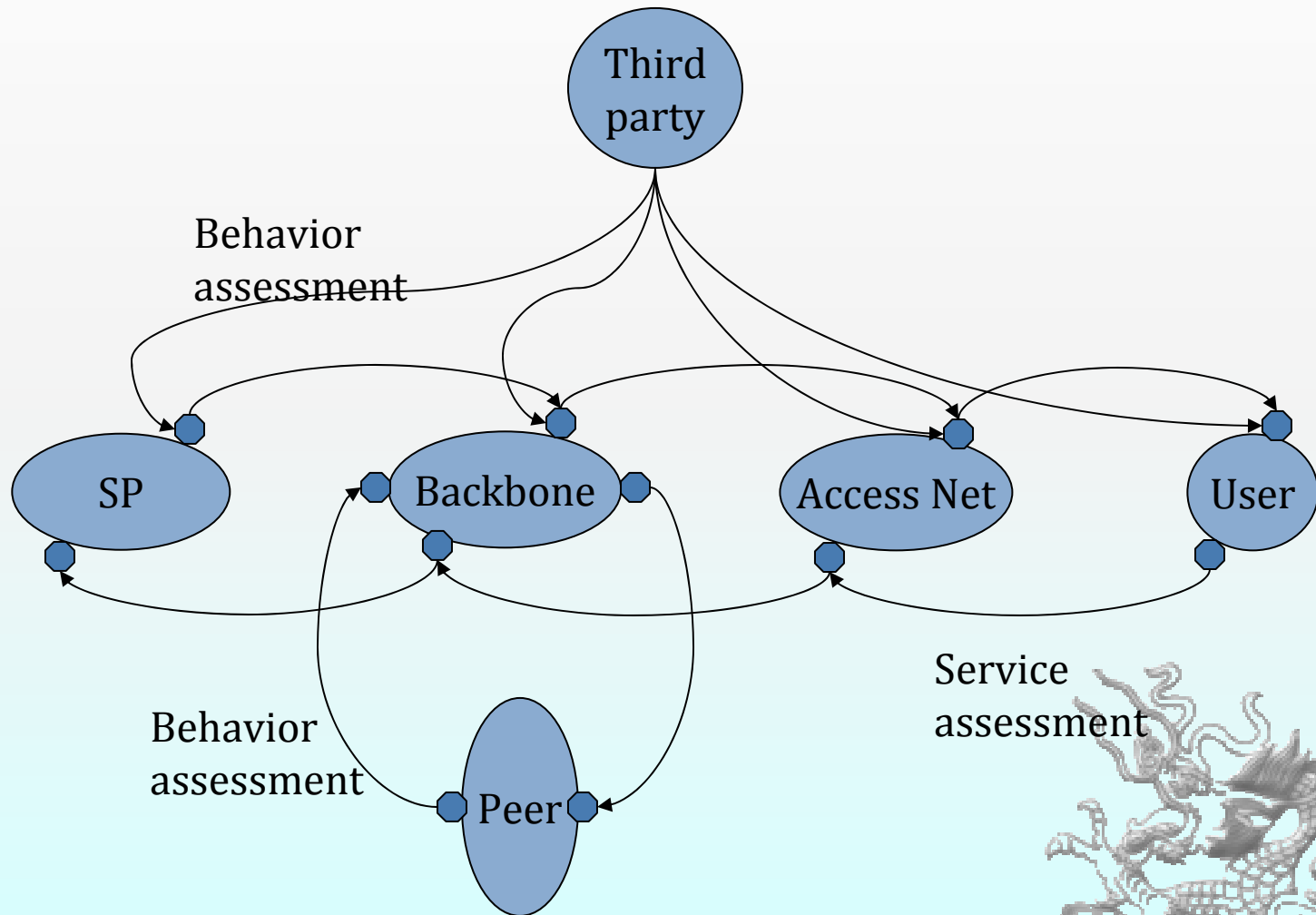
Access network scenario



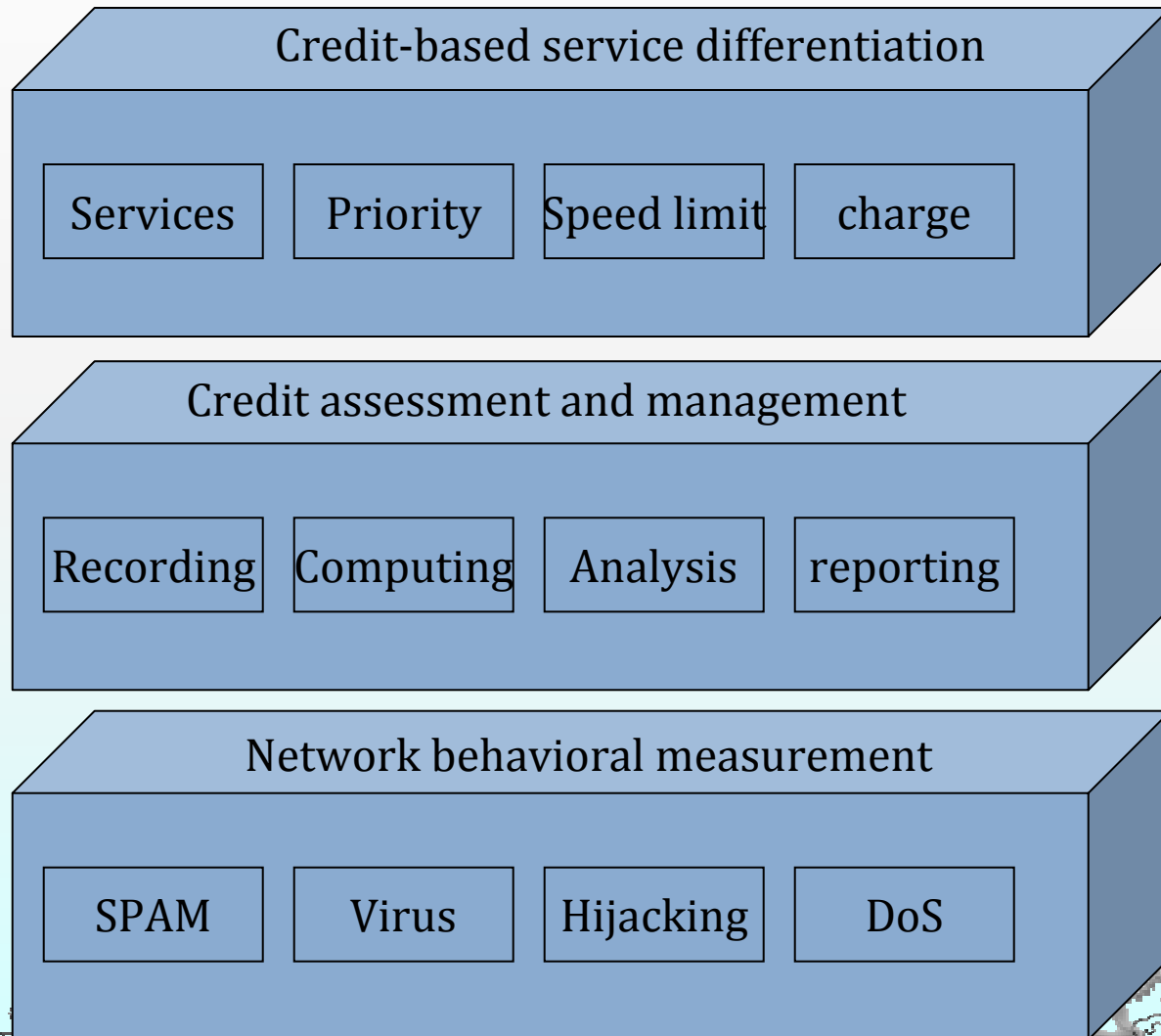
ISP peering scenario



General case – cascading effect



Framework



Methodology

- ◆ Credit rating methods in financial scenarios
- ◆ User classification methodologies based on machine learning
 - ◆ Need to consider structural/physical grouping, for ease of incentive application
- ◆ Reputation and incentive mechanisms in social networks



Other considerations

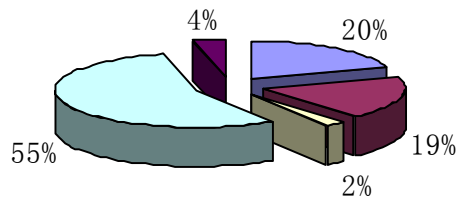
- ◆ Reward good behavior
- ◆ Punish bad behavior, but allow recovering
- ◆ Manual control (VIPs, over-rides)?
- ◆ Global cooperation, e.g.
 - ◆ Sharing of credit information
 - ◆ Standardized credit ratings



Case study – a campus network

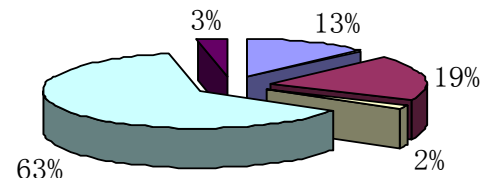
- Behavioral problems increasing
 - 2006 and 2007 data on campus

2006年处理案例分析图



Network Failure	Connection Failure
System Failure	User Problem
Other	

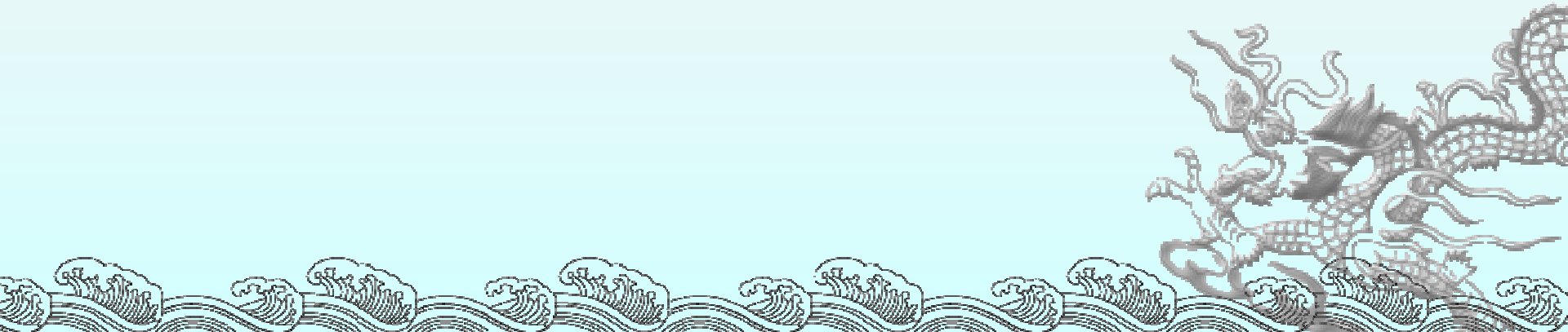
2007年度处理案例分析图



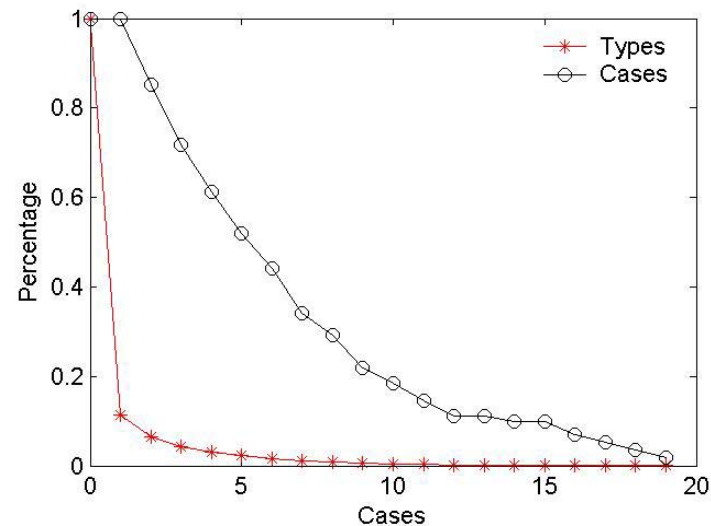
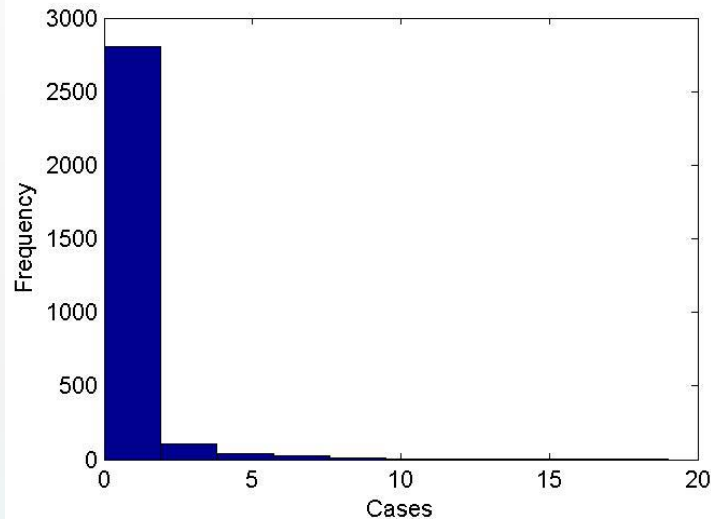
Network Failure	Connection Failure
System Failure	User Problem
Other	

Management difficulties

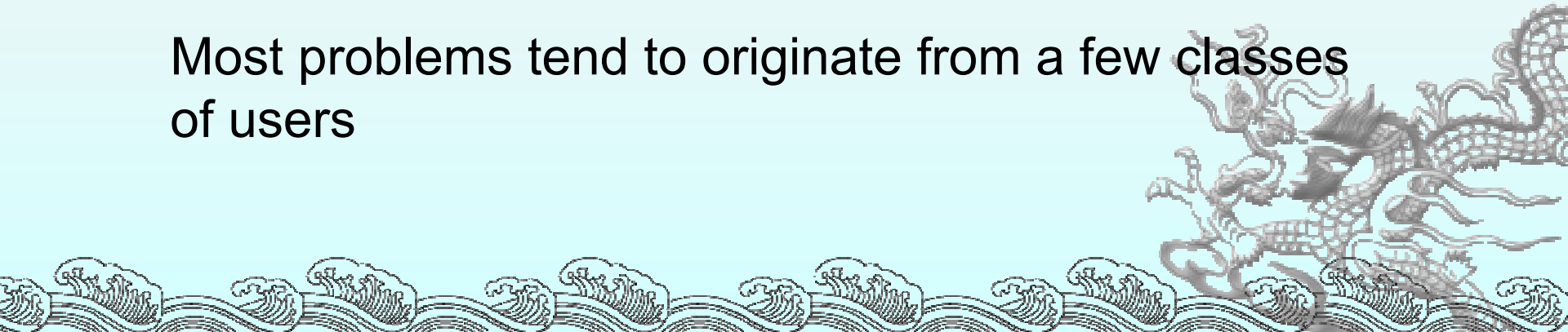
- ◆ Large user base (>50K), mobility
- ◆ Limited manpower for network admin
- ◆ New types of problems requirement more time and man power
- ◆ Cost for behavioral management is much higher than that of physical devices



Concentrated nature



Most problems tend to originate from a few classes of users



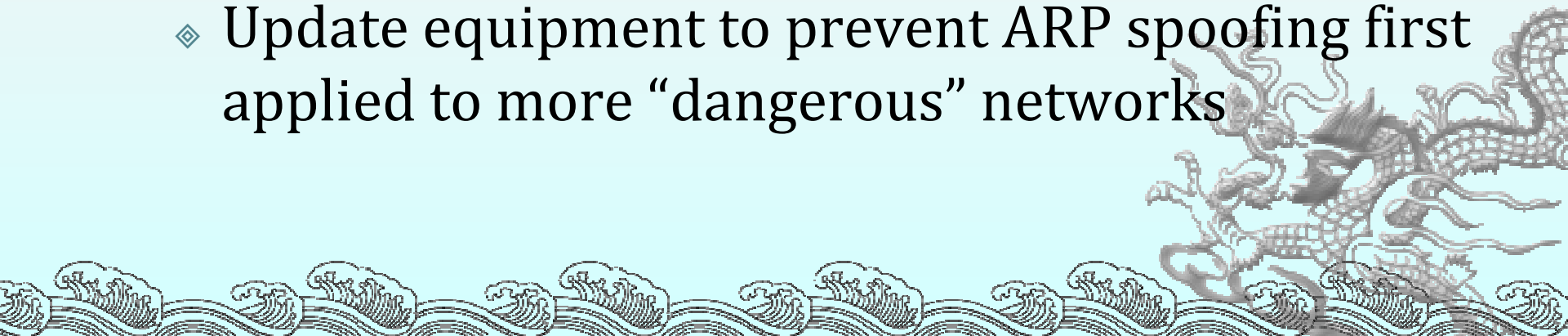
User classification

- ◆ After classification using selected attributes:
 - ◆ Male undergraduates (especially 1st yr, or 4th yr)
 - ◆ Specific departments
- ◆ Focused monitoring saves management resources



Physical attributes

- ◆ Physical grouping
 - ◆ Students can be grouped by dorm building
 - ◆ They belong to same subnets
 - ◆ Significant concentration with such grouping
- ◆ Ease of management based on physical grouping
 - ◆ Update equipment to prevent ARP spoofing first applied to more “dangerous” networks



Personal credit rating

- ◆ Repeat problematic users
 - ◆ 7.1% of problematic users are repeat users
 - ◆ They cause 14.3% of problems
 - ◆ The distribution of such users is random
- ◆ Need targeted treatment



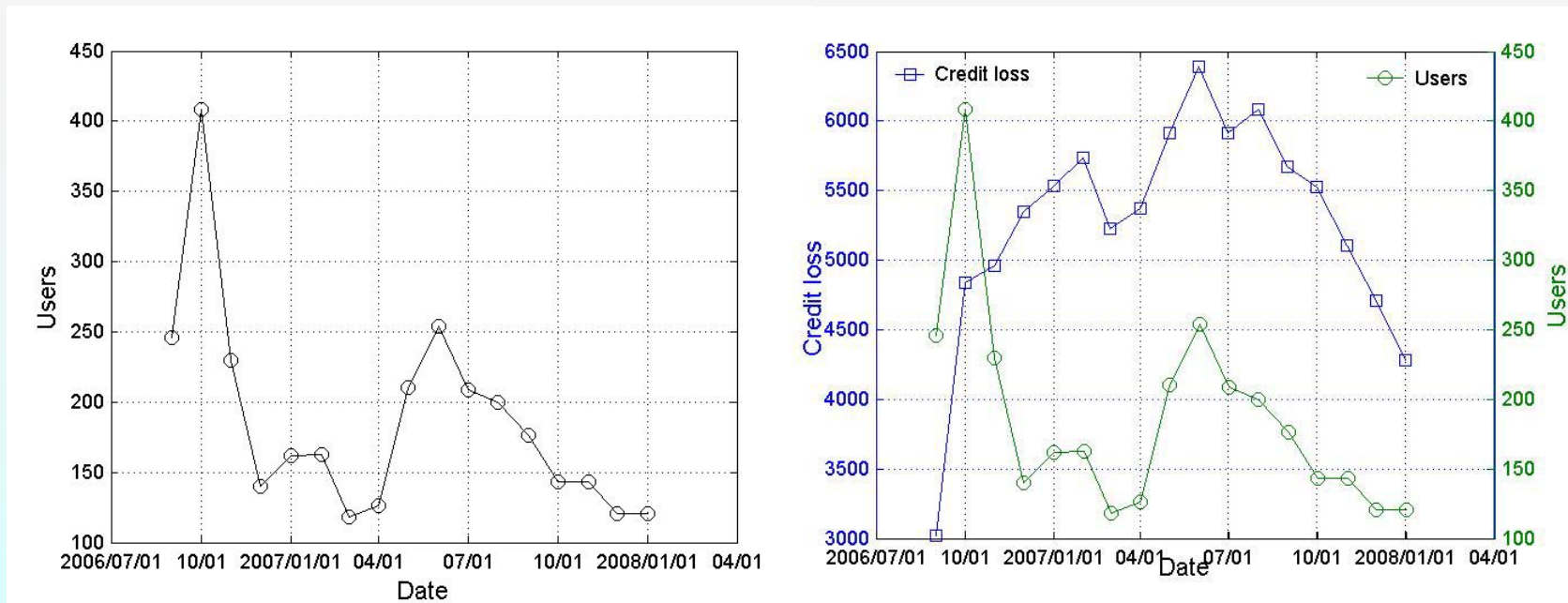
Experimental credit rating system

- ◆ Credit rating values
 - ◆ Minimum is 0; maximum is 100; >50 acceptable
- ◆ Initialization of credit rating
 - ◆ Generously initialize (almost) all to 60
- ◆ Rating adjustments
 - ◆ First offense: deduct $10*w$
 - ◆ Deduction for more offense = $\text{past} * 0.5 + 10*w$
 - ◆ Increment credit rating by 1 each month



Experimental results

Over span of 1.5 years, the fluctuation of problem users and credit adjustments:



Conclusion

- ◆ An important aspect of network management is user behavioral management
- ◆ Credit-based management:
 - ◆ Focus management on problem users
 - ◆ Apply incentive system to influence behavior
- ◆ Cascading effect (conjecture)
 - ◆ Help improve entire Internet

