Chap. 15) System Security

경희대학교 컴퓨터공학과

방 재 훈

Security Problem

- There is no perfectly secure system!
  - ✓ Protection can only increase the effort needed to do something bad. It cannot prevent it
  - ✓ Every system has holes, it just depends on what they look like
  - ✓ Even assuming a technically perfect system, there are always the four Bs:
    - Burglary: steal it
    - Bribery: find whoever has access to what you want and bribe them
    - Blackmail: or photograph them in a compromising position
    - Bludgeoning: or just beat them until they tell you

- Security service
  - ✓ CIA
    - Confidentiality
    - Integrity
    - Availability
  - ✓ Authentication, Authorization, Access control, Nonrepudiation

Cracker's Basic Steps

- Gather information
  - ✓ as much information about your site as possible
- Use port scanner
  - ✓ to gather information about what services are running on hosts
  - ✓ Search for weak security services
- Get a login account
  - ✓ Doesn't matter whose account
- Get root privilege
  - ✓ Bugs in programs or badly configured systems
- Keep root privilege
  - ✓ Leave some sort of backdoor for future access

Physical Security

- Hardware security
  - ✓ Restrict access to equipments
    - Smart card (ID card)
    - Bio-metric access control
- BIOS security
  - ✓ Set a boot password
  - ✓ Prevent booting from CD-ROM or floppy drives
- Session security
  - ✓ Some shells (e.g. tcsh) provide the automatic logout facility if there is no activity during the specified time period
  - ✓ vlock (for locking a virtual terminal) / xlock
  - ✓ Screen savers

Account Security

- Authentication
  - ✓ Make sure we know who we are talking to
  - ✓ Usually done with passwords
    - First line of defense and single biggest security hole
  - ✓ Problems in passwords:
    - Users who write their password on paper for all to see
    - Type password slowly that others can see
    - Dumb passwords like “password”
    - Passwords should be long and obscure – unfortunately easily forgotten and usually written down
  - ✓ Passwords should not be stored in a directly-readable form
    - Use some sort of one-way-transformation (a “secure hash”) and store that
  - ✓ *Cf) CHAP (Challenge Handshake Authentication Protocol)*

Account Security (Cont'd)

- Authentication alternatives
  - ✓ Some alternatives
    - Physical keys: badges, smart cards, …
    - Biometric keys: Fingerprints, iris prints, facial profiles, voice prints, hand geometry, signature analysis …
    - Passwords using images
  - ✓ Should not be forgeable or copiable
  - ✓ Can be stolen, but the owner should know if it is
    - Need to invalidate old one

Account Security (Cont'd)

- Authorization
  - ✓ Determine if x is allowed to do y
    - Can be represented as an "access matrix"
  - ✓ Access control lists (ACLs)
    - With each object, indicate which users are allowed to perform which operations
    - Simple and used in almost all file systems
  - ✓ Capabilities
    - With each users, indicate which resources may be accessed and in what ways
    - Frequently do both naming and protection: Can only "see" an object if you have a capability for it
    - Used in systems that need to be very secure

- Setuid/setgid programs
  - ✓ Badly written setuid programs may contain a security hole
    - Know of all setuid and setgid programs on your system
    - Setuid programs that are not needed should be deleted
    - Never allow setuid/setgid files in user's home directories
    - Use nosuid option in fstab file for home file system and for NFS-mounted file system
    - Maintain a check on any new setuid programs:
      find / -type f –perm 2000 –o perm 4000 –o perm 6000
    - Never write setuid/setgid shell programs

File System Security (Cont'd)

- Search paths
  - ✓ Many users include the current directory in their search path
  - ✓ A cracker could place programs with the same name as standard commands everywhere they have write access in directory hierarchy
    - The fake program may have malicious code, or capture data from the user pretending to be the real application
  - ✓ Place current directory last in the path
    - Alternatively use full path names (e.g. /bin/su)
  - ✓ Current directory SHOULD NOT be in the search path for root user

File System Security (Cont'd)

- Other countermeasures
  - ✓ Carefully specify default permissions: umask
  - ✓ Put a limitation on the file system usage: quota
  - ✓ Check file system integrity regularly: find, tripwire, …
    - Files without known owners may indicate unauthorized access: find / -nouser –o –nogroup
    - Files with "other" write permission (o+w) may indicate a problem: find / -type f –perm 2
  - ✓ Use encrypted file system
    - CFS (Cryptographic File System)
    - TCFS (Transparent CFS), etc.
  - ✓ Backup file system: tar, dd, …
  - ✓ Monitor system logs

- Use secure protocols
  - ✓ Don’t let the plain password float around the network
  - ✓ Secure shell (ssh) suite of programs encrypts the communications of many of protocols
    - ssh (telnet), slogin (rlogin), sftp (ftp)
  - ✓ Use secure http (https) for secure connection
  - ✓ Secure Socket Layer (SSL) provides data encryption of all data that passes between clients and server
  - ✓ IPsec protocol: encrypt every IP packet
    - Required for IPv6, optional for IPv4

Network Security (Cont'd)

- TCP wrappers
  - ✓ Monitors/filters Internet services such as telnet, ftp, finger, etc.
  - ✓ Similar to Internet super daemon, inetd
  - ✓ Before connecting the client to the service program, log the activity and check if it should be permitted
    - /etc/hosts.allow, /etc/hosts.deny
  - ✓ You should be able to detect cracking intention or activity from the log

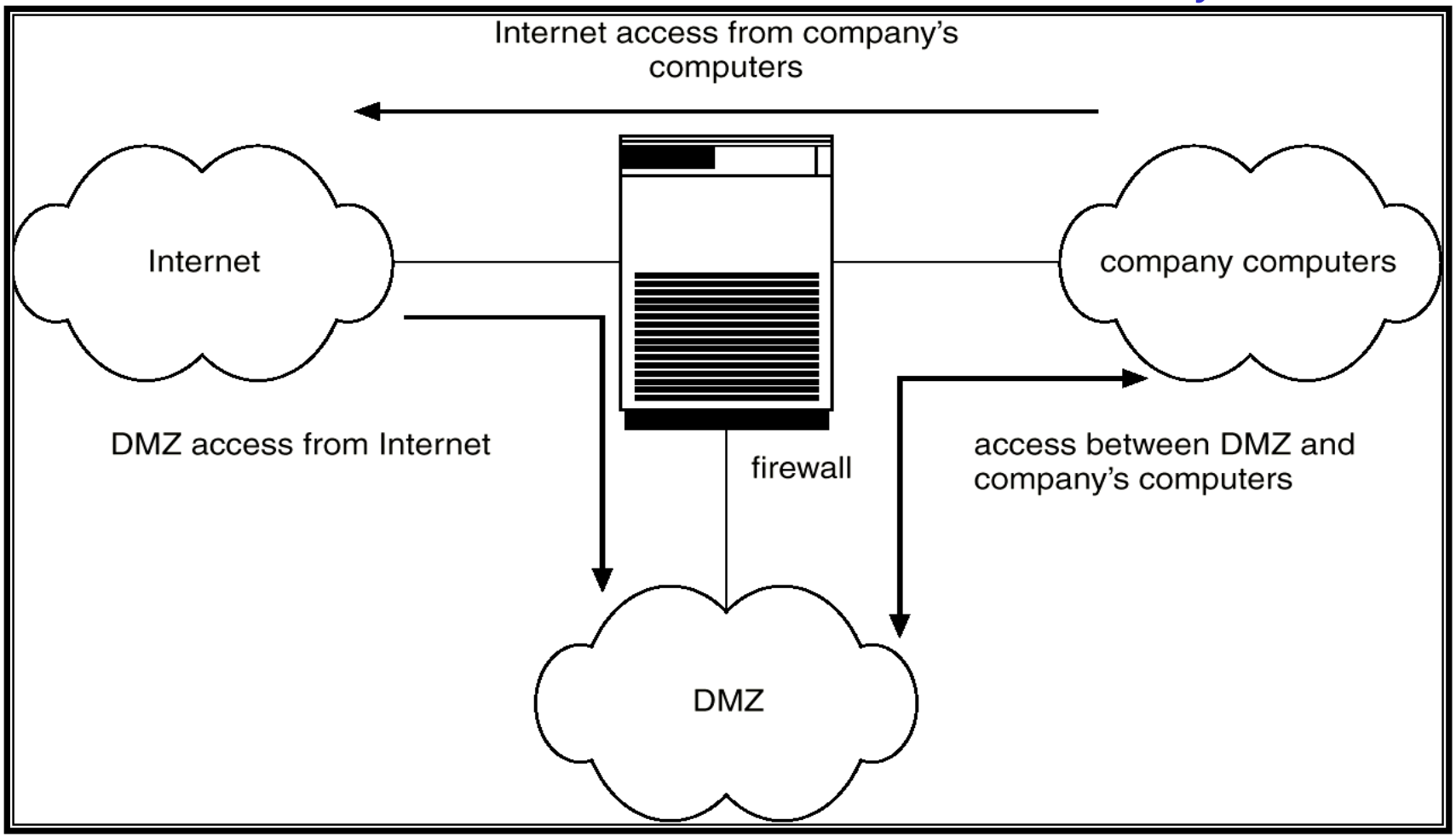
Network Security (Cont'd)

- Firewalls
  - ✓ Firewall
    - Creates a filter or protective layer between an organization's internal networks and any external networks to which they are connected
  - ✓ ipchain: packet filtering firewall
    - Examine each packet header to decide the action
    - e.g. block incoming ICMP echo requests:

      ipchains –A input –i eth0 –p icmp –s 0/0 –d 0/0 –l –j REJECT
  - ✓ Proxy firewall
    - Standard: require client-side configuration. Client connects to a special port
    - Transparent: similar to packet filter firewall, but controls traffic

Firewall

- A firewall is placed between trusted and untrusted hosts
- The firewall limits network access between these two security domains



Security Threats

- Physical threats
  - ✓ Acts of nature: floods, fire, earthquake, explosion, etc.
  - ✓ Intruder takes computers, dig up network cable, or access system consoles
- Logical threats
  - ✓ Caused by problems with computer software
    - Misuse by people (e.g. easy-to-guess passwords)
    - Bugs in programs or in their interaction with each other
- Operational threats
  - ✓ No security policy, incomplete enforcement
- Denial of service
  - ✓ Prevent computer from providing services through
    - wasting resources of computer
    - flooding services on your system, thus preventing them from providing service to legitimate clients

Attacks

- Dictionary attacks
  - ✓ crack, nutcrack, John the Ripper, etc.
  - ✓ *crack* program found 10-20% of passwords could be guessed, using a password list containing variations on login names, user's first and last names and a list of 1800 common first names

- Login spoofing
  - ✓ Simulate login process
  - ✓ Need to have the login sequence start with a key combination that user programs cannot catch
    - CTRL-ALT-DEL in Windows 2000.

Attacks (Cont'd)

- Trojan horses
  - ✓ A seemingly innocent program contains code to perform an unexpected and undesirable function
  - ✓ To have the Trojan horse run, the person planting it first has to get the program carrying it executed
    - Attract attention and encourage people to download and execute it
- Logic bomb
  - ✓ A piece of code written by one of a company's programmers and secretly inserted into the OS
  - ✓ OK as long as the programmer feeds it its daily password
  - ✓ If the programmer is suddenly fired, the logic bomb explodes
    - clear the disk, erase files at random, encrypt essential files, etc.

Attacks (Cont'd)

- Trap door
  - ✓ Created by the code inserted into the system by a system programmer to bypass some normal check
    - What happens if the programmer leaves the company?
    - Some special key sequences lead you to the "debug" mode in your mobile phone
  - ✓ Need to have code reviews as standard practice
  - ✓ Difficult to do in open-source software

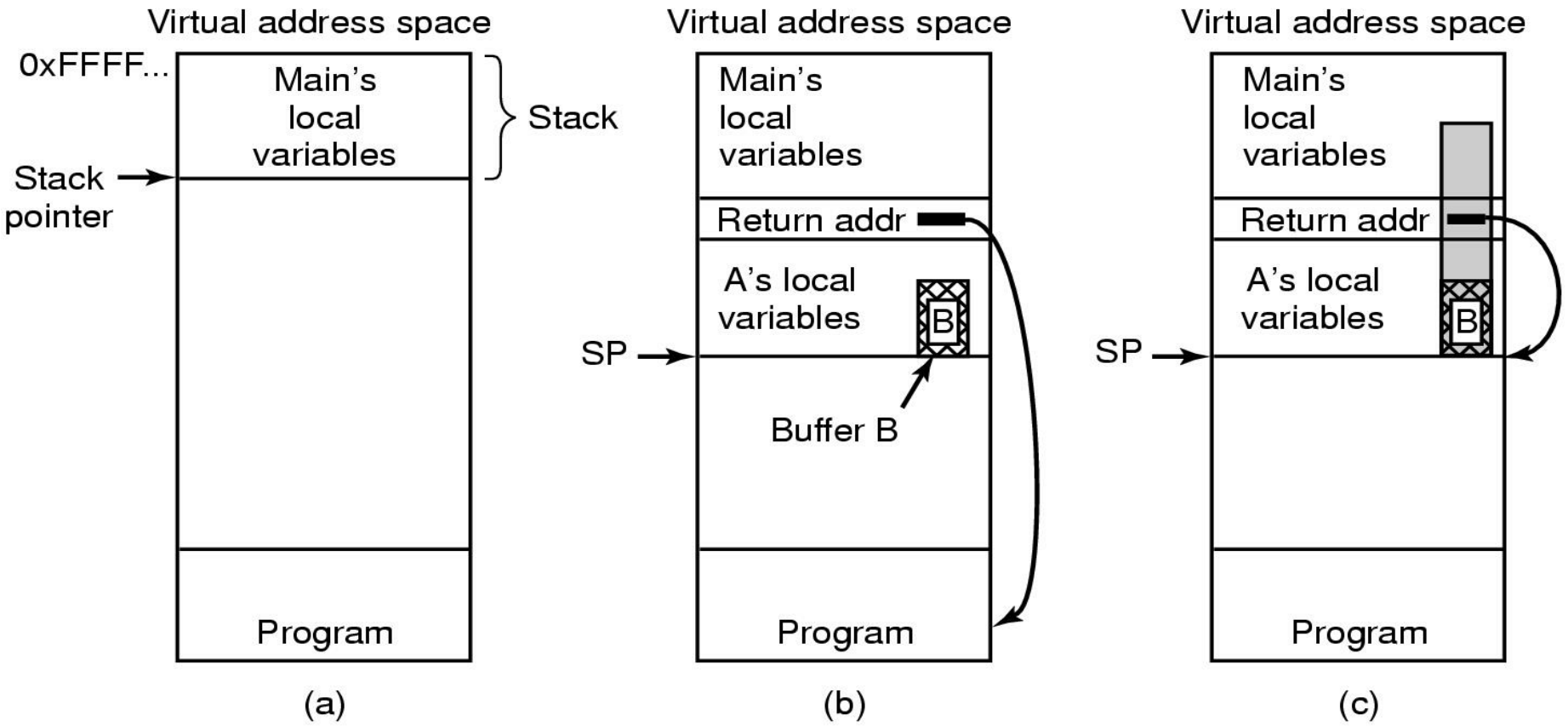
Attacks (Cont'd)

- Stack and Buffer overflow
  - ✓ What's the problem of the following codes?

```
void A(char *src)
{
    char B[1024];
    strcpy(B, src);
    printf(src); printf("\n");
}
int main(int argc, char *argv[])
{
    if (argc > 1)  {
        A(argv[1]);
    }
    return 0;
}
```

Attacks (Cont'd)

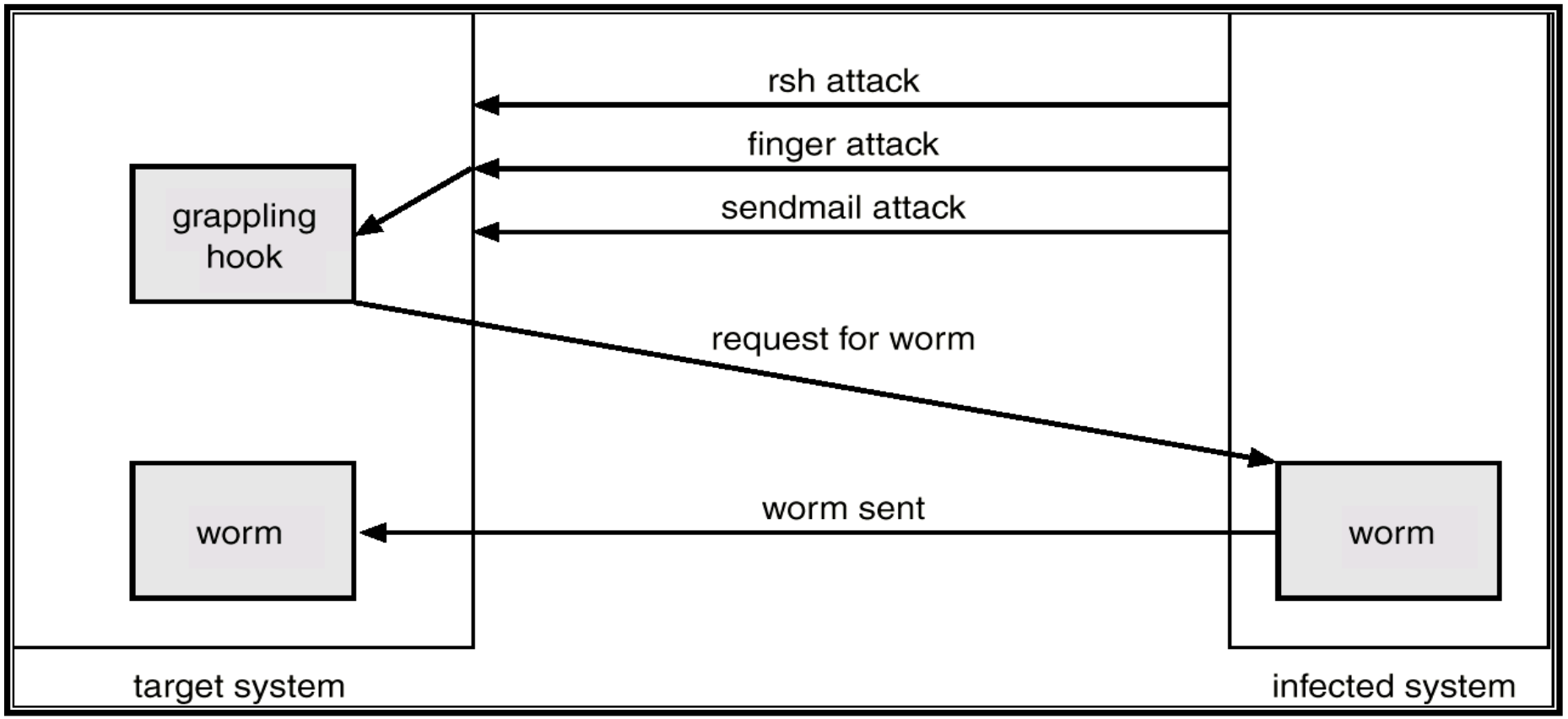
- Stack and Buffer overflow (Cont'd)
  - ✓ Do array bounds checking!



Attacks (Cont'd)

- Virus and worms
  - ✓ Virus is a program that can reproduce itself by attaching its code to another program
  - ✓ Worms are like viruses but are also capable of spreading itself from machine to machine via network
  - ✓ Types
    - memory resident viruses: e.g. intercept system call traps to infect other programs
    - boot sector viruses
    - device driver viruses: officially loaded at boot time
    - macro viruses: Microsoft Office
- Malware

The Morris Internet Worm

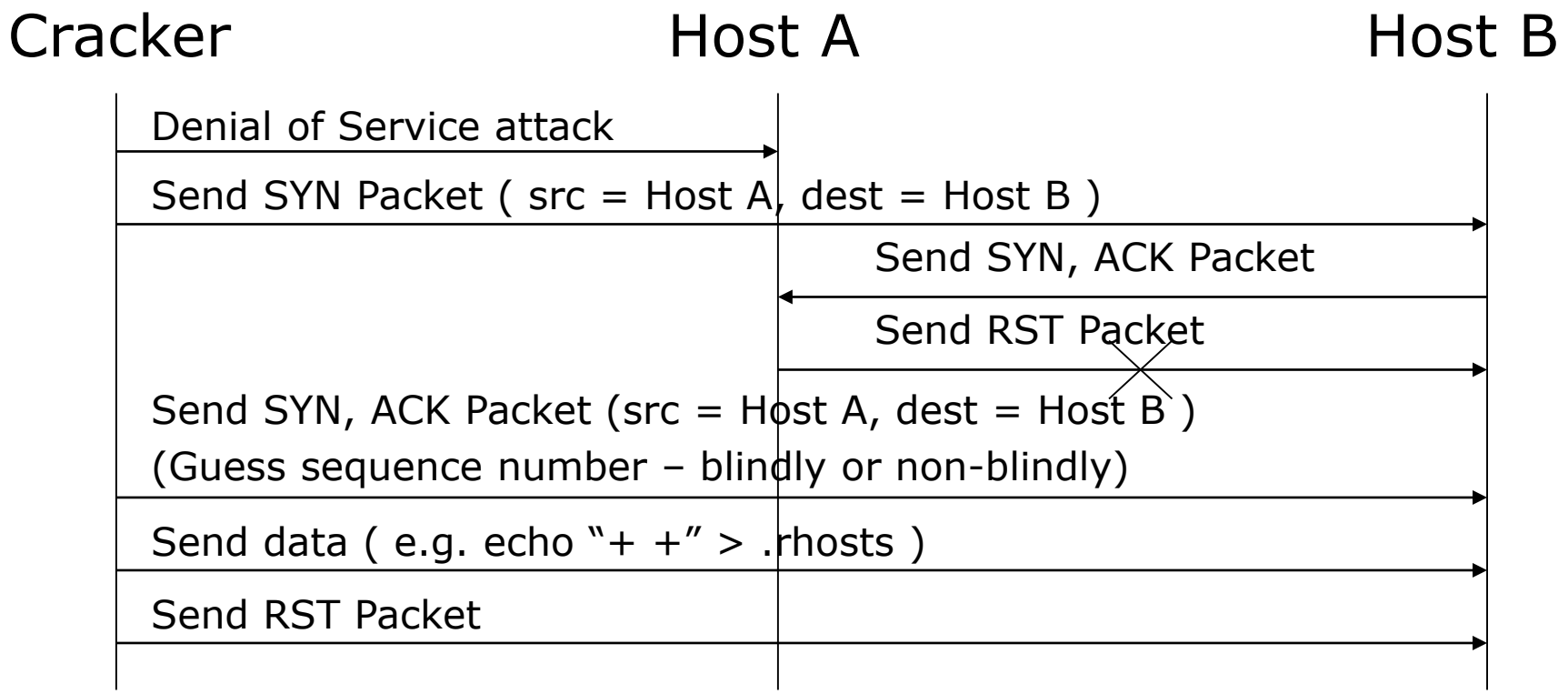


Attacks (Cont'd)

- Packet sniffing
  - ✓ Listens to ethernet traffic over LAN
  - ✓ Ethernet adapter in promiscuous mode
    - Need root privilege
  - ✓ Can see all data passing between hosts on the network
  - ✓ Can gather usernames and passwords
    - telnet, ftp, httpd, pop3, imap, etc.
  - ✓ tcpdump and sniffit are software sniffers

Attacks (Cont'd)

- IP spoofing
  - ✓ Steal an authorized IP and use it



Attacks (Cont'd)

- Denial of service: internal attacks
  - ✓ Use up all resources and make system crash
  - ✓ Attacking resources: disk, memory, process, …
  - ✓ Examples
    - Shell script: while (1) { mkdir foo; cd foo; }
    - C: while (1) { fork(); ((int *) malloc(100000))[40] = 1; }
  - ✓ Done by a local user, and in most cases by accident

Attacks (Cont'd)

- Denial of service: external attacks
  - ✓ Application level
    - Mail bombing
    - Buffer overflow
    - Java Applet attack
  - ✓ Protocol level
    - TCP SYN flooding
    - Ping flooding
  - ✓ Network level
    - UDP Storming

- Distributed DOS (DDOS)
  - ✓ Use multiple machines

Intrusion Detection

- Detect attempts to intrude into computer systems
- Detection methods:
  - ✓ Auditing and logging
  - ✓ Tripwire
    - UNIX software that checks if certain files and directories have been altered
    - I.e. password files
- System call monitoring

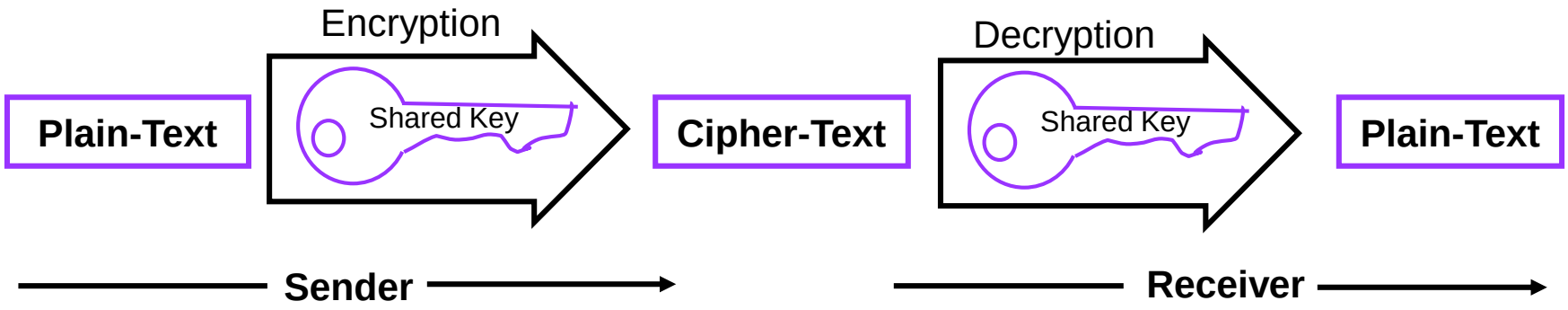
Basic Concept of Cryptography

- What is cryptography
  - ✓ The science of obfuscating data
  - ✓ Can provide authentication, confidentiality, data integrity and etc.
  - ✓ Cryptography algorithm is open, but key MUST be confidential

- Two kinds of cryptography
  - ✓ Shared key cryptography
  - ✓ Public key cryptography

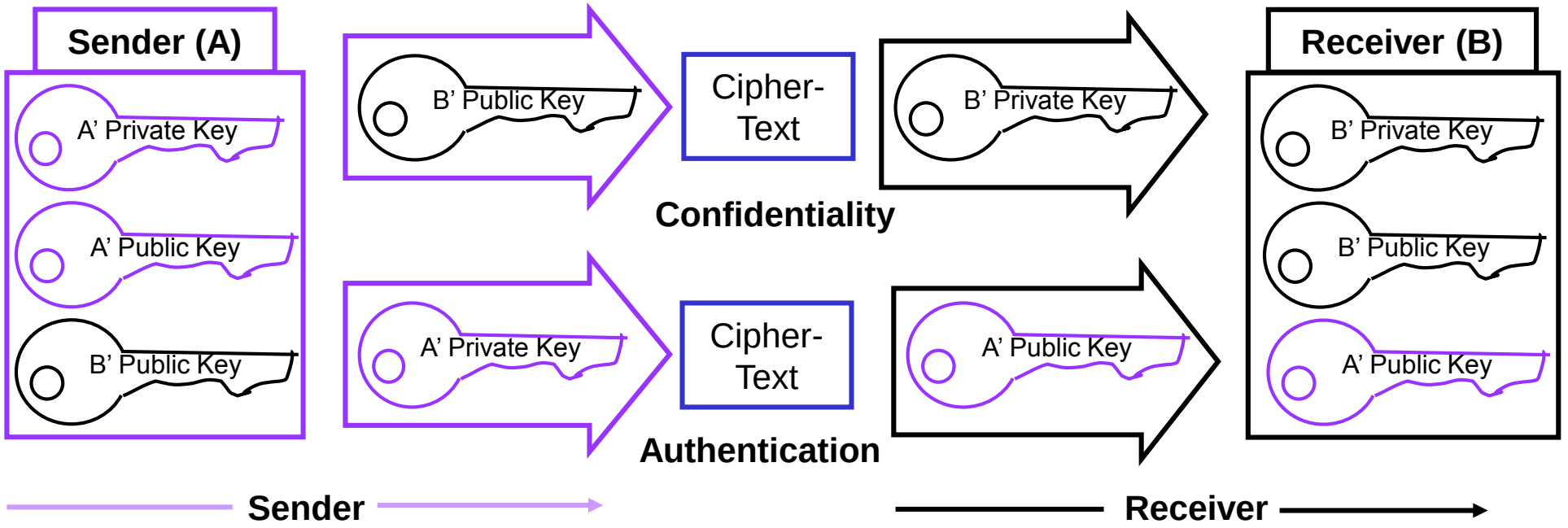
Basic Concept of Cryptography (Cont'd)

- Shared key cryptography
  - ✓ Both of peers share the same key
  - ✓ DES(Data Encryption Standard) (Cf. AES)
    - Bit operation (key size : 64bit, 128 bit)
    - Can provide authentication and confidentiality
    - ***How can distribute the shared key secret and keep it secret*** ?

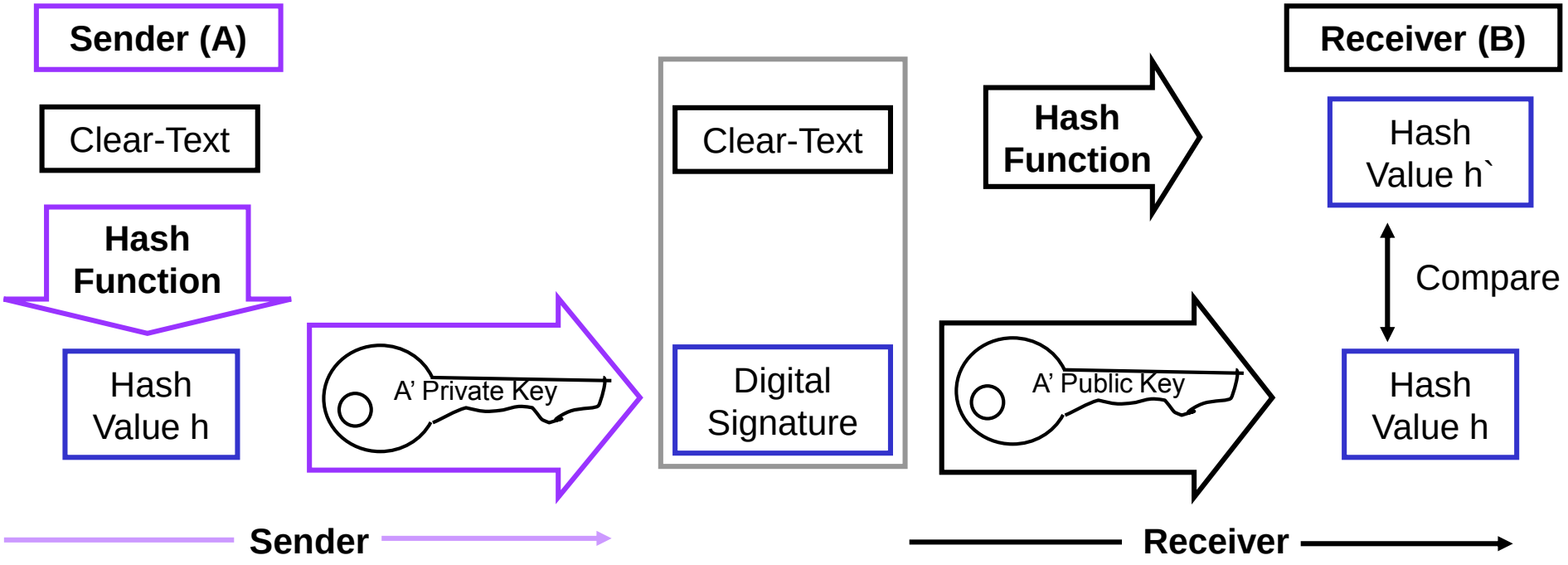


Basic Concept of Cryptography (Cont'd)

- Public key cryptography
  - ✓ Both of peers have its own private key and public keys
  - ✓ Key pair
    - well known 'Public Key' and secret 'Private Key'
  - ✓ Can provide confidentiality and authentication
  - ✓ RSA : well known algorithm (Cf. ECC)



- Digital Signature
  - ✓ minimize encryption processing
  - ✓ for authentication & integrity (not confidentiality)



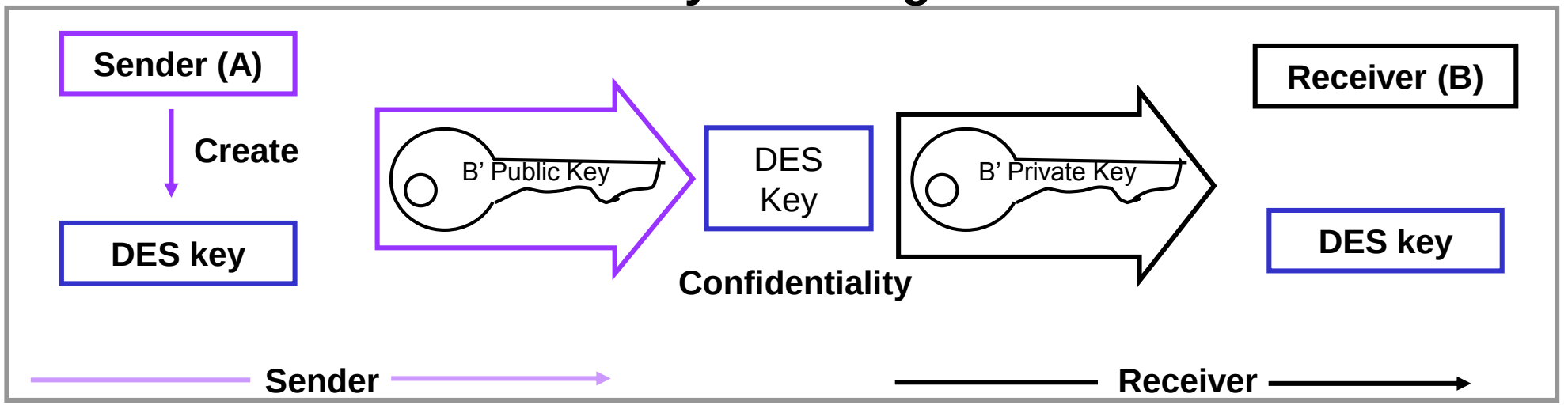
Applied Cryptography for Network (Cont'd)

- Validity of key
  - ✓ DES < several hours
  - ✓ RSA < several days
  - ✓ ***How can keep the connection secure?***

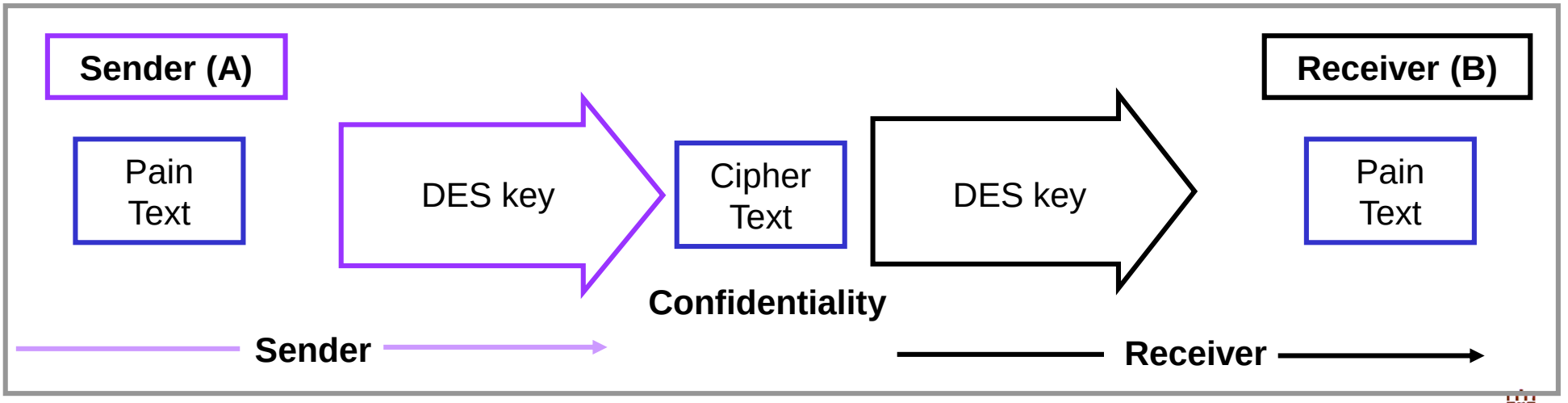
- Security
  - ✓ System security
    - Create DES key every session
    - Transfer DES key by RSA security
  - ✓ Connection (session) security
    - One time key created by DES
  - ✓ applied for SSL, TLS, IPsec and etc.

Applied Cryptography for Network (Cont'd)

Key exchange

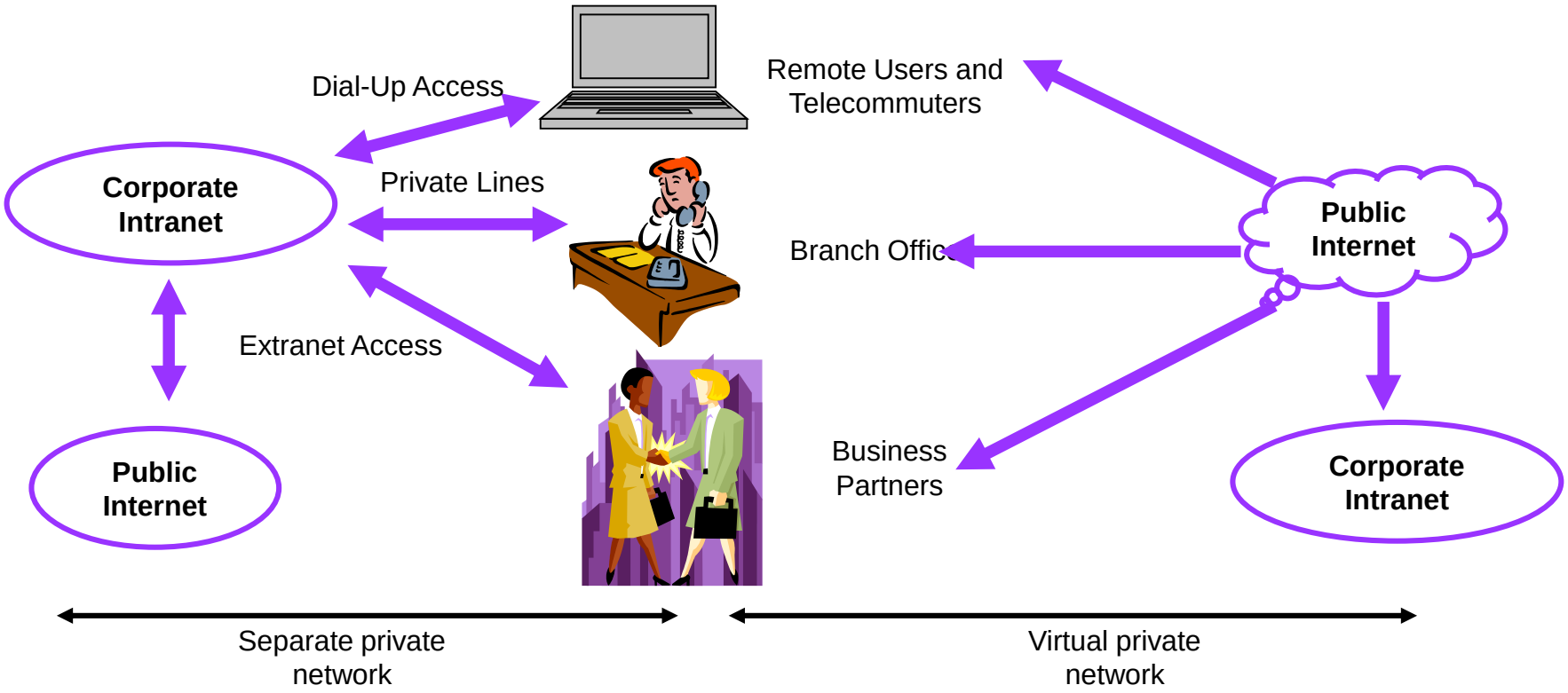


Data transfer

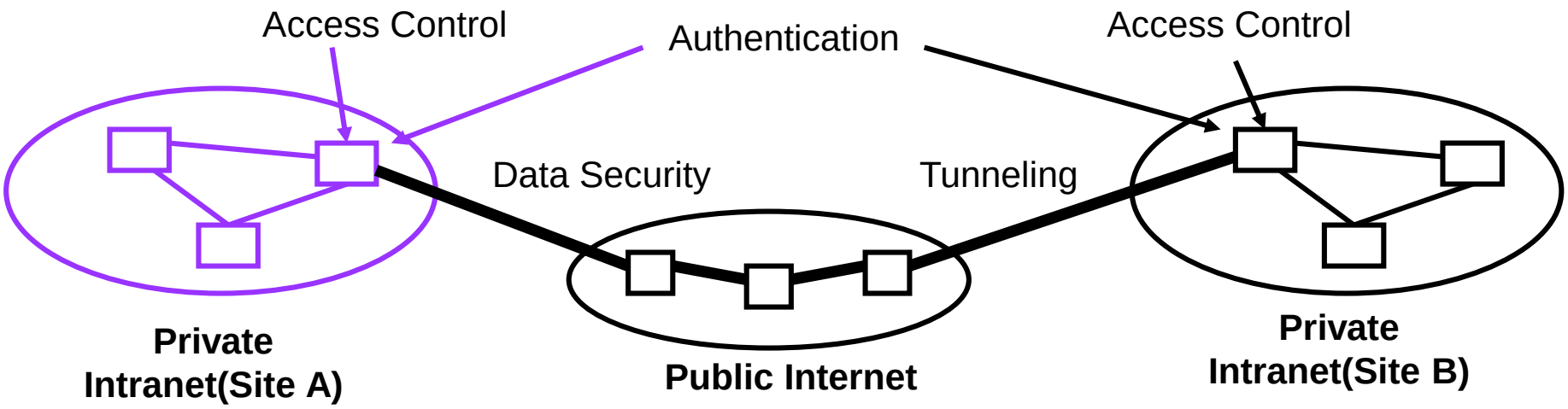


Virtual Private Network (VPN)

- Virtual
  - ✓ ***No*** physical infrastructure ***dedicated*** to the private network
- Private
  - ✓ Keep data confidential so that it can be received by an intended receiver



VPN Technologies



- Tunneling
  - ✓ PPTP, L2TP, L2F, MPLS , IPsec and etc.
- Authentication
  - ✓ Radius, CHAP, PKI and etc.
- Access Control
  - ✓ PKI and etc.
- Data Security
  - ✓ IPsec, PKI, SSL, TSL and etc.

Research topic: Mobile & Embedded System Security

- ✓ Security for Mobile Systems
  - Android/iOS/Tizen
  - Malware analysis
- ✓ Security for Embedded Systems
  - IoT device security
  - Hardware-assisted security
  - Embedded Linux security

Summary

- Security services
  - ✓ Integrity
  - ✓ Authentication
  - ✓ Authorization
  - ✓ Access control
  - ✓ Confidentiality (cryptography)
- Attacks
  - ✓ Dictionary attacks, login spoofing, Trojan horses, logic bomb, trap door, stack and buffer overflow, virus and worms, packet sniffing, IP spoofing, DoS (Denial of Service), DDoS (Distributed DoS)

Summary (Cont'd)

- Network security
  - ✓ Secure protocols
    - IP layer: IPsec
    - Transport layer: SSL (Secured Sockets Layer), TLS (Transport Layer Security)
    - Application layer: ssh, sftp, https
  - ✓ TCP wrappers
  - ✓ Firewall
  - ✓ IDS (Intrusion Detection System)
- Cryptography
  - ✓ Shared key cryptography
    - DES (Data Encryption Standard) algorithm
  - ✓ Public key cryptography
    - Well-known Public key vs. secret Private key
    - RSA algorithm
  - ✓ Digital signature