Systems Security Group | Lancaster University

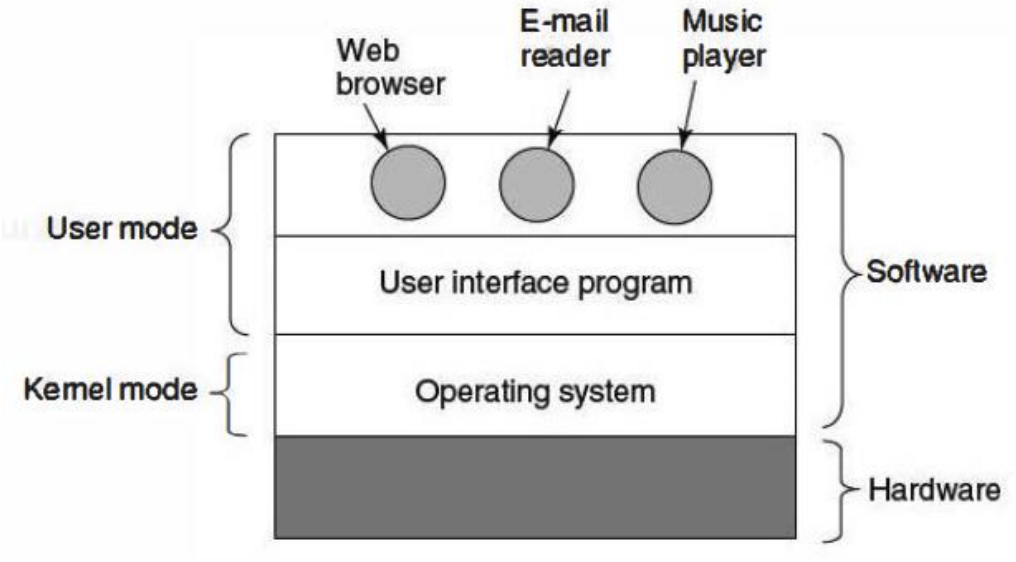
Operating Systems Security

Learning Objectives

- Understand about the security threats in operating systems
- Learn about ways to protect

What is an operating system?

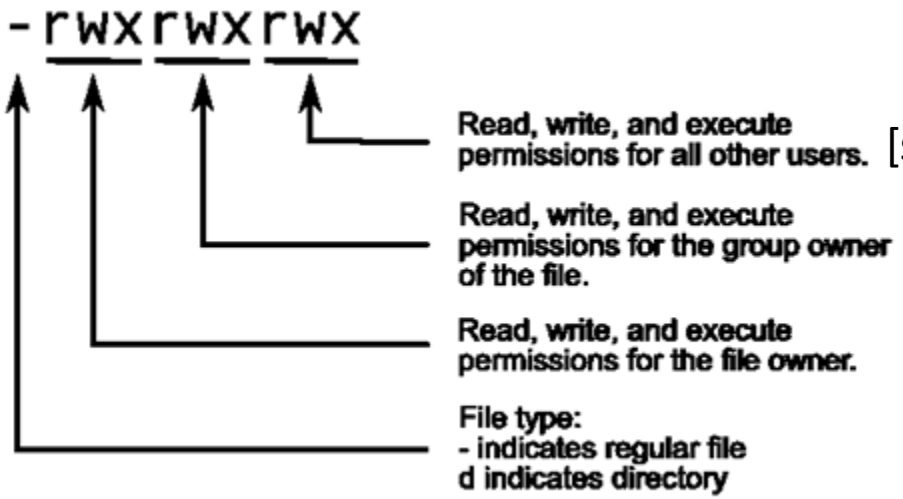
- A layer of software
  - Provide user programmes with a simpler model of a computer
  - Handle the managing of resources



[source: 1]

Why do we need protection?

- Confidentiality
  - Large amount of data is contained in systems
- Security issues
  - Human and nonhuman



[source: linuxcommand.org]

Threats

- Exposure of data
  - Threats data confidentiality
- Tampering of data
  - Threats data integrity
- Denial of service
  - Threats system's availability
- System infected by viruses
  - Threats the goal of excluding outsiders

Cryptography

- Cryptography may be used to ensure confidentiality and integrity
  - Symmetric cryptography
  - Asymmetric cryptography
  - Hash functions

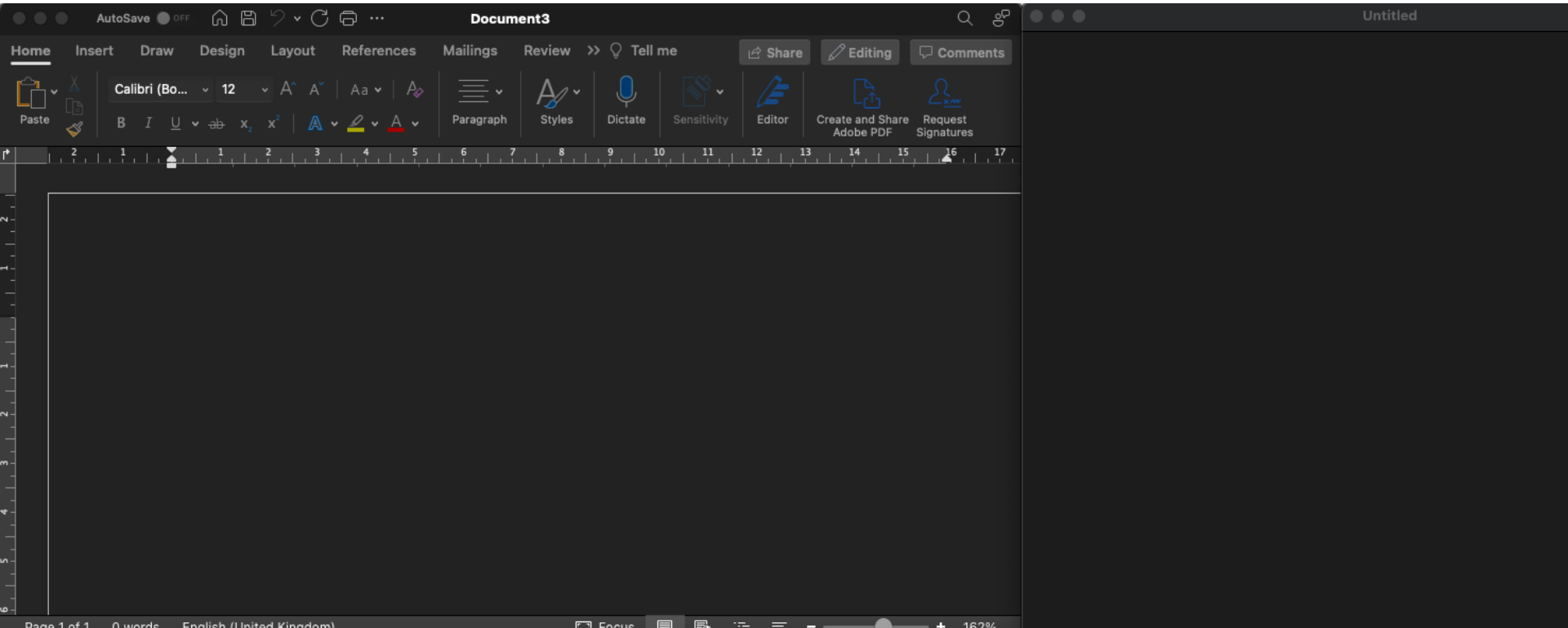
- What if the keys are compromised?

Trusted platform module (TPM)

- Cryptoprocessor with some non-volatile storage for the keys
- Can perform cryptographic operations in main memory
- Can verify digital signatures
- Since implemented in hardware, it's fast too

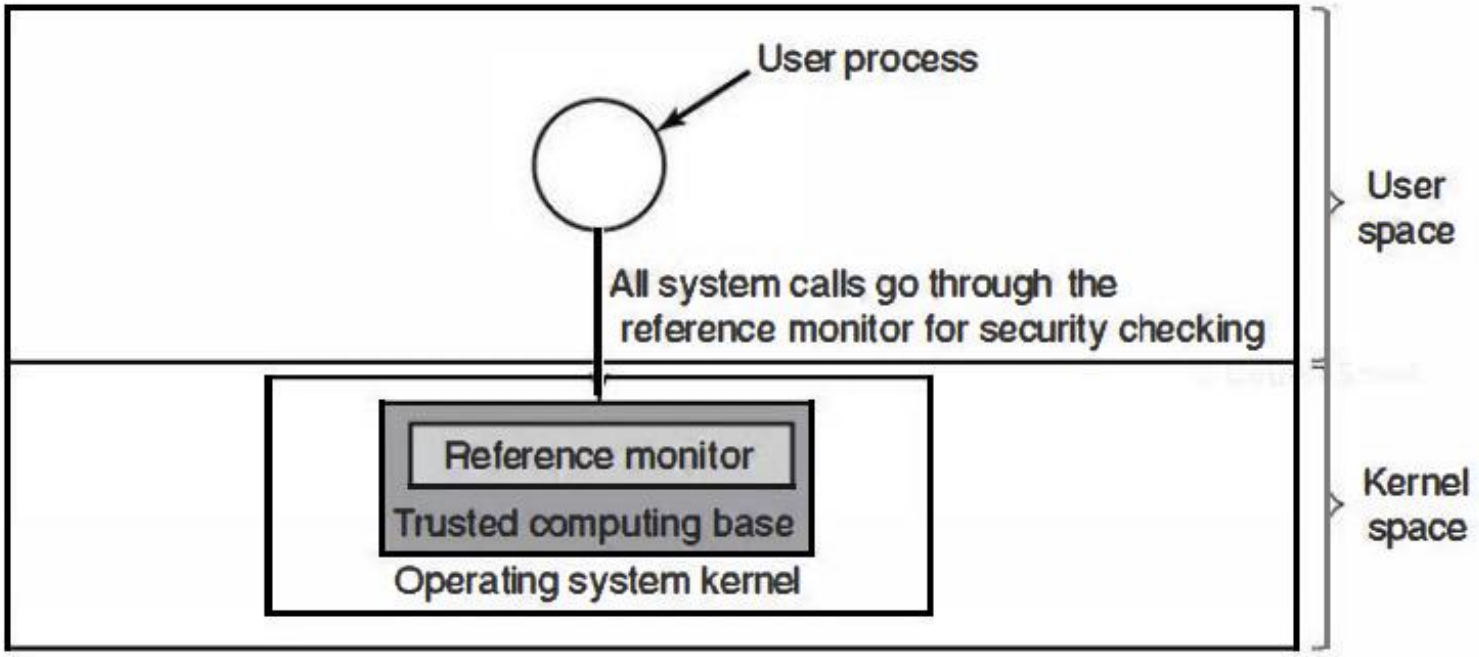
Trusted systems

- Can you build a secure computer system?
- Simplicity vs features



Trusted computing base

- Combination of hardware and software for enforcing security rules



[source: 1]

What else do we need?

Models to restrict access

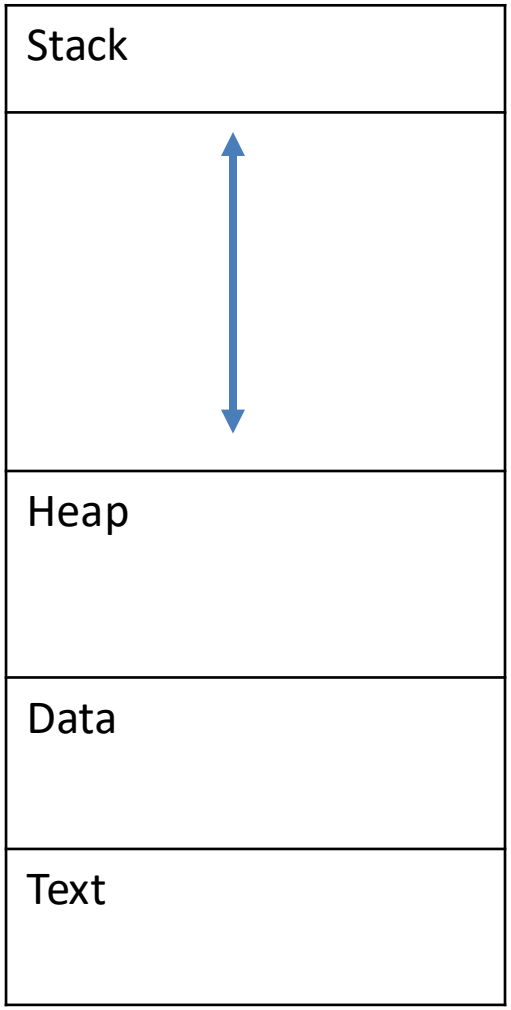
- Access matrix
- Multilevel security
  - Bell-La Padula model
  - Biba model

Are we secure now?

- Confinement problem [3]
  - Deals with preventing a process from transmitting information to any other program except its caller.
- Covert channels
  - Path of communication that was not designed to be used for communication.

Processes

- A program in execution
- **Stack**: temporal data e.g. local variables, return address
- **Heap**: dynamic allocated memory of the process at run time
- **Text**: current activity by the program counter and registers
- **Data**: contains global and static variables



Threads

- A process generates a thread when it requires to send something to the CPU for processing
- The thread includes an individual instruction set and data
- Generated dynamically
- Multithreaded applications are capable of running several different threads at the same time.
- Threads share the same resources of the process that created them

Memory leaks

- Every process is allocated with an amount of memory
- Memory should be released when the process finished with it
- Not the case for poorly written applications
- May be used for Denial of Service attacks and lead to memory starvation

Technical attacks

- Buffer overflow attacks
- String formatting attacks
- Integer overflow attacks
- Code injection attacks

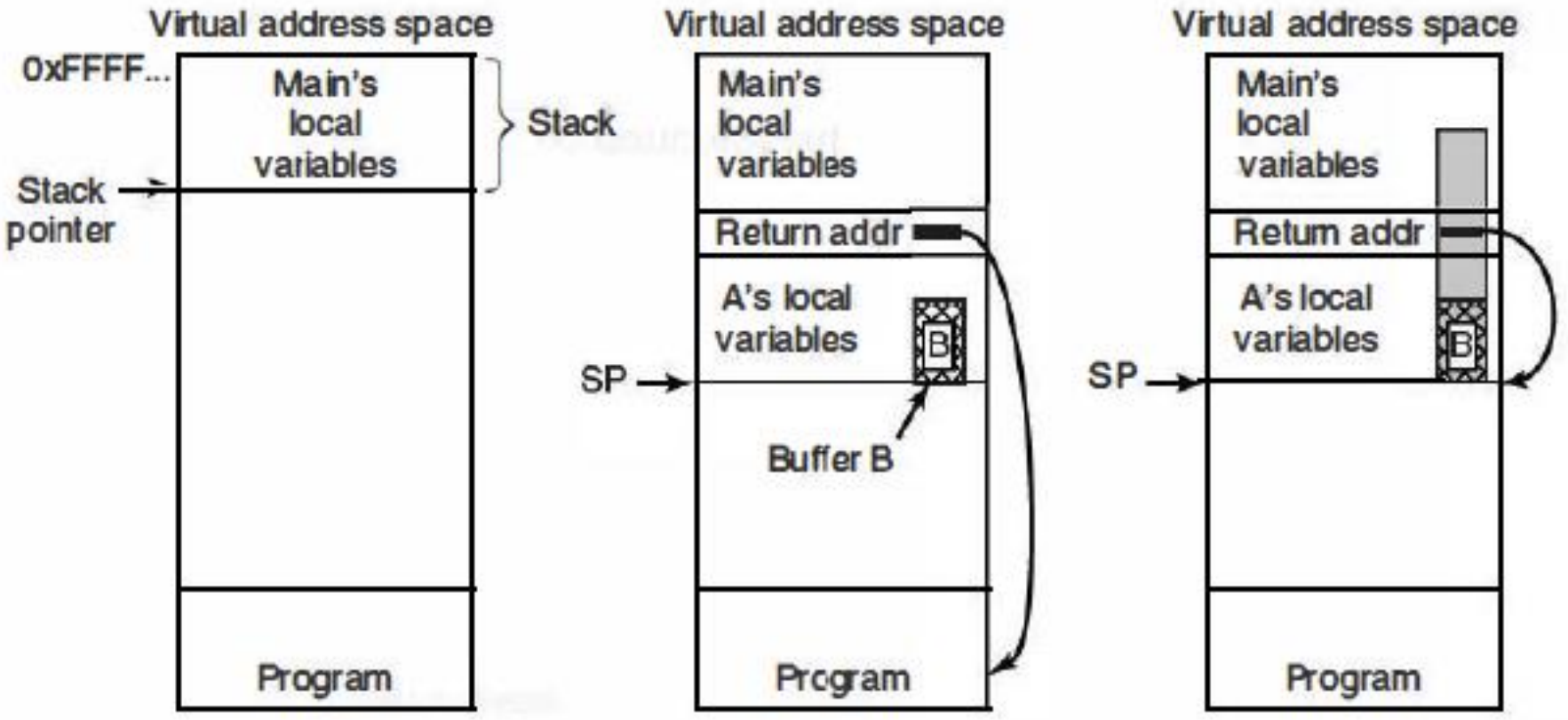
Buffer overflow

- C compiler does not do array bounds checking
- Suppose the following code

```
int i;
char ch[16];
i=32;
ch[i]=0;
```

Buffer overflow

[source: 1]



String formatting attacks

- Issues when valid formatting is not used with `printf`
- Statements such as `printf(buffer)` are still valid
- An attacker can pass a list of parameters that can be executed as a command
  - Execute code, read the stack, etc.

String formatting attacks

```
#include <stdio.h>
int main() {

char* s = "%x %x Hello World";
    printf("%s\n", s); //%x %x Hello World
    printf(s);//aedda000 aebb49e0 Hello World

    return 0;
}
```

Integer overflow

- Integer arithmetic operations are commonly done using modulo arithmetic
- Modulo arithmetic allows values to wrap if they go above a certain value
- 8-bit integer will hold values between 0 and 255
- What if a higher number has to be stored there?

Code injection attacks

- Gets a program to execute code without realising that
- Mainly due to poor implementations

```
int main(void) {
        char command[1024], src[500], dst[500];
        strcpy(command, "cp ");
        printf("Source: "); gets(src);
        printf("Destination: "); gets(dst);
        strcpy(command, src); strcpy(command, " ");
        strcpy(command, dst);
        system(command);
    return 0;}
```

Code injection attacks

- If a user adds
  - src = source.txt and dst = destination.txt
- It will execute
  - cp source.txt destination.txt
- How about
  - src = source.txt and
  - dst = destination.txt; rm –rf /
- It will execute
  - cp source.txt destination.txt; rm –rf /

References

[1] Andrew S. Tanenbaum, “Modern Operating systems”. Chapter 9
[2] Shon Harris, All in one CISSP, Chapter 5 on Security Architecture and Design.
[3] Lampson, B. W. (1973). A note on the confinement problem. *Communications of the ACM*, *16*(10), 613-615.