

Separation



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HISTORICAL BACKGROUND

BEFORE THE 1970s

- ▶ Computers only in physically secured environments
- ▶ Computers rebooted between each computation

ORIGIN OF SECURITY CONCERNS

- ▶ Time-sharing : organisations with different needs use a same computer for economical purposes (Multics, Unix)
- ▶ Security goal : Time-sharing should be as secure as non-Time-sharing systems

EXAMPLES

- ▶ University and DoE/DoD use the same super-computer for simulation
- ▶ Nowadays : exactly the same concern :
 - ▶ Avionics : RTCA DO-255
 - ▶ Cloud computing

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SEPARATION

SEPARATION INFORMAL STATEMENT

The execution of one program cannot influence in any way the execution of another program

EXTENSIVE DEFINITION

- ▶ A program in an infinite loop cannot preempt the processor
- ▶ A program with a memory leak cannot hold all the available memory
- ▶ In TS OS, the processor state has to be cleaned at each process change

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TRUSTED COMPUTING BASE (1/2)

ASSUME/GUARANTEE

When adding a new component to a system

- ▶ Except at the lowest level, use of other components based on assumptions
 - ▶ OS on the hardware
 - ▶ Applications/libraries on the OS and other applications/libraries
 - ▶ ...
- ▶ The new component guarantees (at some level of certainty) some properties :
 - ▶ no memory leaks,
 - ▶ bounds on execution time,
 - ▶ ...

TRUSTED COMPUTING BASE (2/2)

SECURITY IN CS

- ▶ Formalisms to state and prove the guarantees provided by a component based on some assumptions on other components
- ▶ Trusted computing base : parts of a system that are not analysed and just assumed to provide the stated guarantees
- ▶ Example : processor state reset :
 - ▶ register reset not in early version of Unix (unused registers were left as is)
 - ▶ cache never resetted after a context change (leading to lot of security attacks, *e.g.* Spectre)
- ▶ problem compounded in current processors by pipeline, speculative execution, and on-the-fly code optimisation

SECURITY SOLUTION : STATIC CONFIGURATION

PRINCIPLE

Ressources are statically allocated to consumers

SECURITY IMPLICATIONS : ACCESS CONTROL

- ▶ Access control policy : definition of the possible allocation of resources to consumers
- ▶ Must be defined before the start of the machine
- ▶ Cannot be changed while it is running

Static AC

- ▶ Example : bounds on execution time, memory available, etc.
- ▶ Unmutable policy :

Mandatory Access Control

- ▶ Allows for a thorough analysis of a system

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TIME SEPARATION

STATEMENT

The AC policy must specify the computation time allocated to each program

- ▶ Hard real-time systems
- ▶ Allocates a fraction of the processor cycles to each process
- ▶ In practice :
 - ▶ implemented in embedded and mission-critical systems for safety
the ABS functionality cannot be affected when you start a new Ariana Grande song

SPATIAL SEPARATION

STATEMENT

Memory available to each application has to be allocated statically and be disjoint

- ▶ *a.k.a.* **partitioning**
- ▶ Implies no direct communication between applications (IPC system V), communication through the OS still possible
- ▶ In practice
 - ▶ RAM, HDD, SSD are sets of pages, and that set is partitioned, and each application receives one subset
 - ▶ No malloc/mmap, or a secure variant
 - ▶ Bounded stack
 - ▶ No pointers unless the Processor/OS guarantees that pointers never access a wrong page
- ▶ Very hard in practice
 - ▶ Need for a specific language (e.g. Lustre) or compiler
 - ▶ Registers and cache still have to be shared on current processors

ACCESS CONTROL AND SPATIAL SEPARATION

- ▶ TL;DR : very hard, but with some tolerance, achieved by current systems like Linux CGroups
- ▶ Incidentally, development driven by Cloud-hosting companies
- ▶ Known tolerances :
 - ▶ shared libraries
 - ▶ bounds on max memory available, but no hard partition
 - ▶ root still can do whatever he wants

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PARTITIONING IN INFORMATION SYSTEMS

IN A COMPUTER NETWORK

- ▶ Tasks to be performed by a system are allocated to different computers based on their sensitivity
- ▶ The network is partitioned into **zones** for computers of similar security concerns
- ▶ Access Control on inter-zone exchanges (*a.k.a.* **firewall**)
- ▶ Example :
 - ▶ **DMZ** at the border between a **corporate network** and the **outside** (3 zones),
 - ▶ **Firewalls** to control packets between these zones

NOTE

- ▶ Outside of critical systems, there's no way to prove that all applications are secure
- ▶ First glimpse at **Layered Security/Defence-in-Depth**

GOOD AC SYSTEMS

NEAT SECURITY

- ▶ **Non-bypassable** : impossible to act outside of the bounds of the AC system
- ▶ **Evaluatable** : possible communications can be assessed before deployment
- ▶ **Always invoked** : no future rights, the AC system must always be queried
- ▶ **Tamperproof** : the AC system cannot be changed while the system is running
- ▶ These concerns are shared with safe systems
- ▶ Possible on systems dedicated to a task, not in general (e.g., no new file and no new user)
- ▶ The CS Security dilemma :
 - ▶ we know how to secure a system
 - ▶ we know how to have a usable system
 - ▶ we know how to build a cheap system

but no one has ever (or ever hopes to have) more than 2 out of 3

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