



Estonian Information
Technology College

Operating systems introduction

Operating systems 1800

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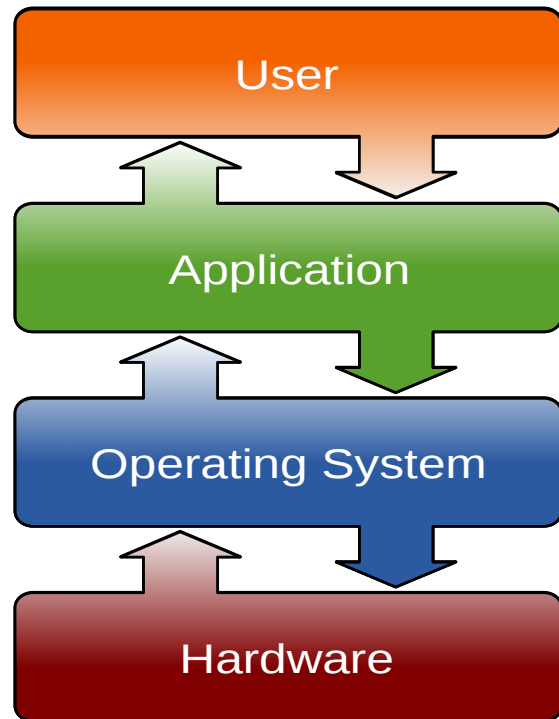
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Q/A

How many operating systems do you have
in your pocket right now?

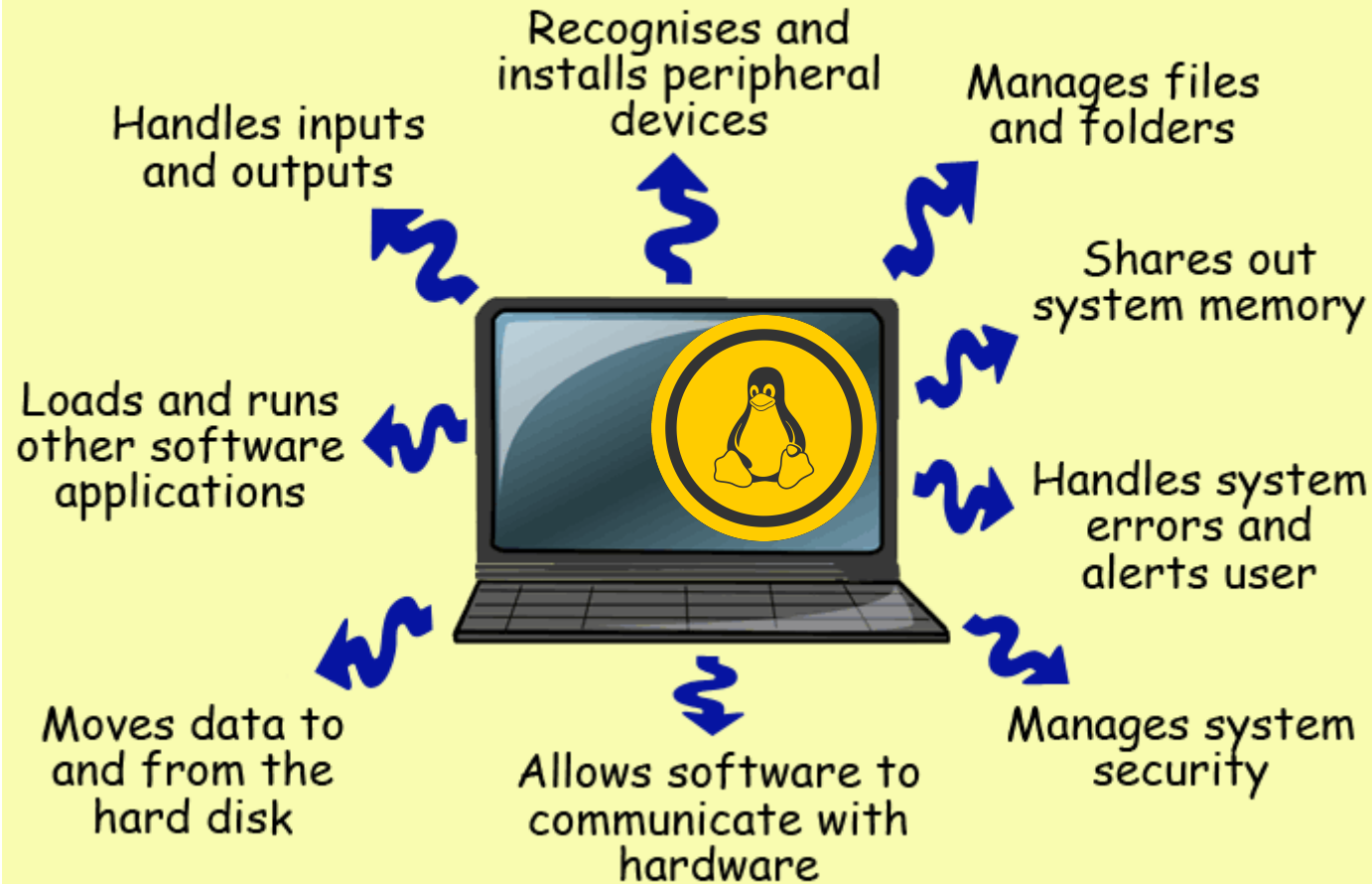


Computer system



Operating system is a vital component of the computer system

Tasks of the operating System



Definition of an OS

- An operating system (OS) is system software that manages computer hardware and software resources and provides common services for computer programs (API).

In the beginning...



- There were no operating systems
 - Apps were directly connected to devices and transition to another device was complicated
 - Specific purpose only
- Problems
 - Usage limitations
 - Migration and integration were limited and capacious
 - When needed to serve multiple programs or users then separate program were needed in order to keep an account

... and now

- There are operating systems everywhere
- Operating systems are working in small devices and also in cloud computing server rooms
- By equipment manufacturers are easier to use OS that fits onto device rather than create everything yourself again
- Security is much more important than earlier
- Modern OS offers solutions:
 - Multiuser multitasking OS
 - Application migration possible
 - User permissions applied
 - Better usage of resources

Types of OS

- Single mode
- Single mode and multitasking
- Multiuser mode and multitasking
- Real time
 - Robots, rockets
- Embedded
 - Smart devices
- Distributed
 - Servers

Operating system's tasks

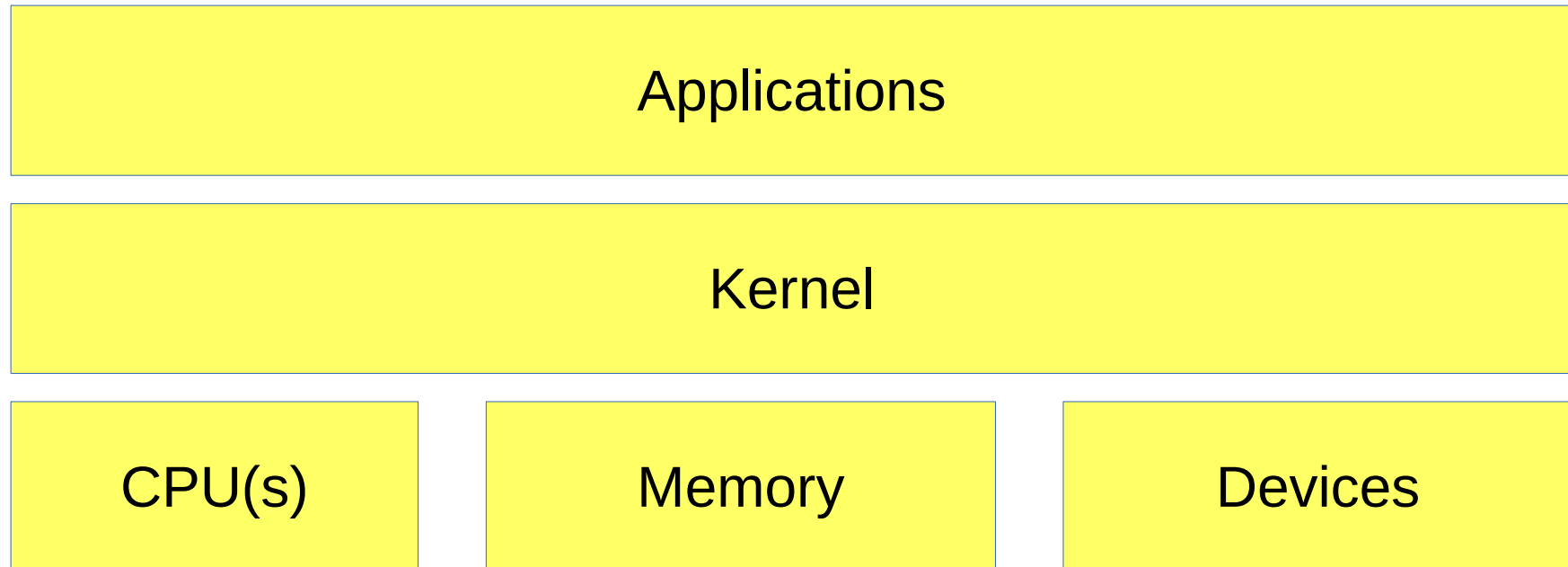
- Hardware management
 - CPU time
 - Memory management
 - Input/output management
 - Network management
- Computer system management
 - Application management
 - Input/output device management
 - User authentication and authorization
 - Data management between devices (also over network)

Command line interpretator

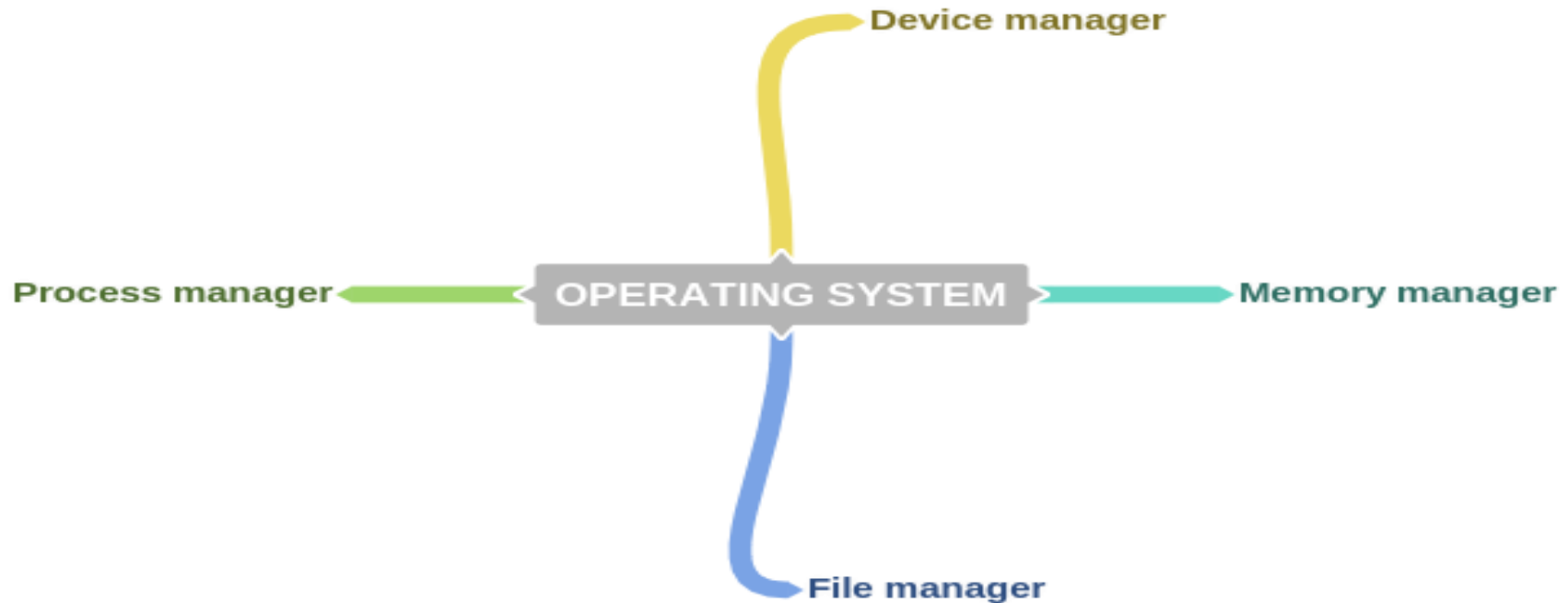
- CLI - Command Line Interface or command line interpretator
 - Bash shell, Bourne shell, cmd, PowerShell, zsh etc
 - sysadmin should know:
 - how to enter commands
 - redirect one command output into second command input
 - redirect or take input, output from file or another program
 - program and automate activities

Operating system's kernel

- Applications use the kernel to connect to computer system resources (CPU; memory and devices)



OS helpers -> managers



Operating system is the head of operations with 4 managers

Kernel tasks

- CPU time planning
 - Real time vs Package processing
 - Syncing
 - Multitasking with multiple CPUs
- Memory management
 - MMU - memory management unit
 - Cache and swap
- I/O management
 - Synchronous
 - Asynchronous
- File management
 - Permissions
 - File system hierarchy



CPU time planning

- CPU time needs to be planned while:
 - CPU usage efficiency
 - Reduce latency
 - Multitasking usage
- Algorithms for CPU time planning
 - FCFS *First Come First Served*
 - SJF *Shortest Job First*
 - Priorities for processes
 - Aim is to avoid starving
 - Round Robin

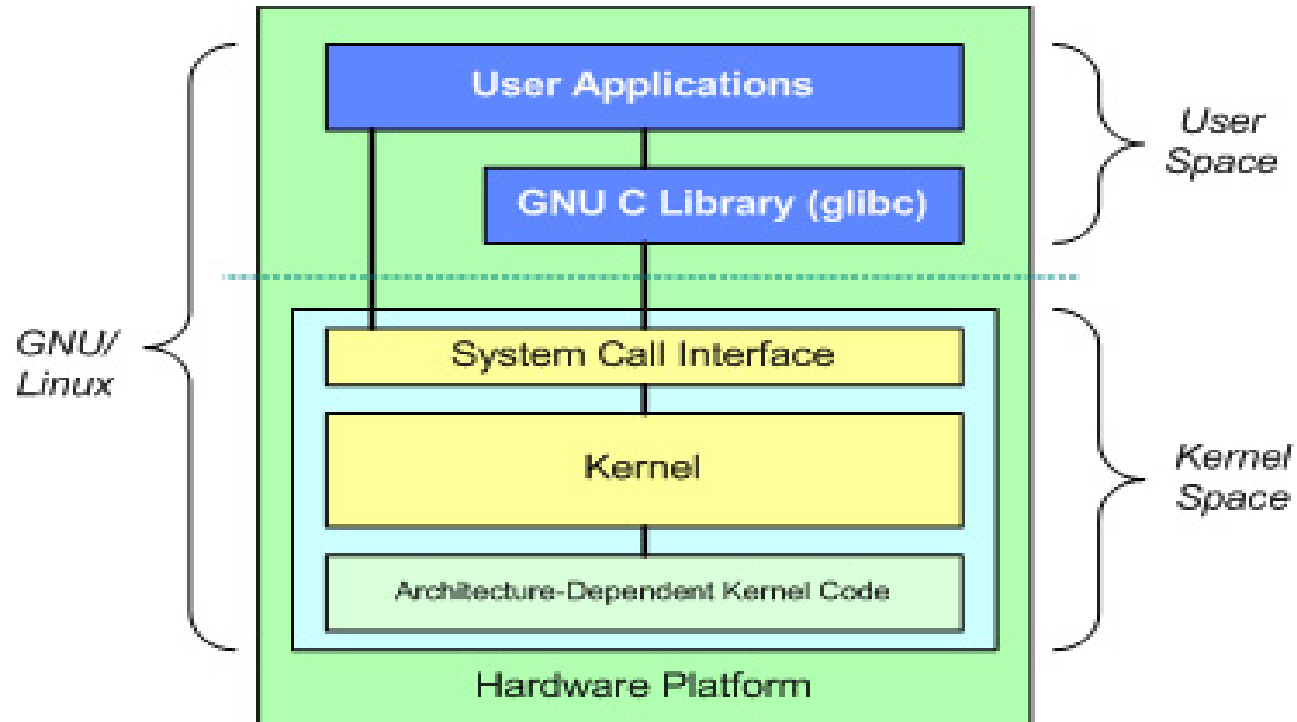
CPU interrupts

- Interrupts are central to operating systems, as they provide an efficient way for the operating system to interact with and react to its environment
- Interrupts are triggered by:
 - Hardware device
 - Software application
 - Timer and time planning

OS components

- kernel - mandatory
- user interface - optional
 - CLI command line interface
 - GUI graphical user interface

Simplified Linux kernel scheme



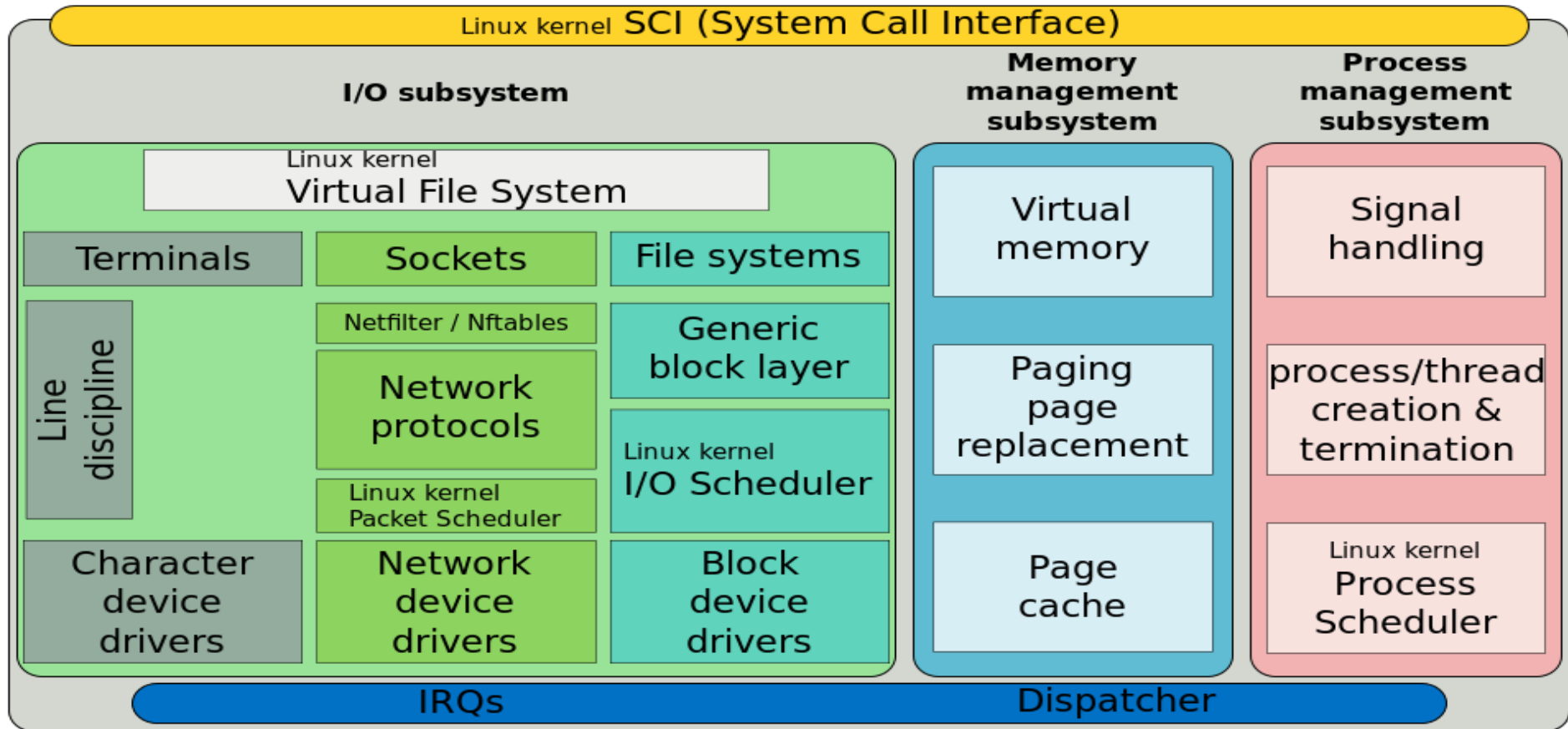
video: *How Linux is built?*

<https://www.youtube.com/watch?v=yVpbFMhOAwE>

<http://www.ibm.com/developerworks/linux/library/l-linux-kernel/figure2.jpg>
<http://www.ibm.com/developerworks/linux/library/l-linux-kernel/>

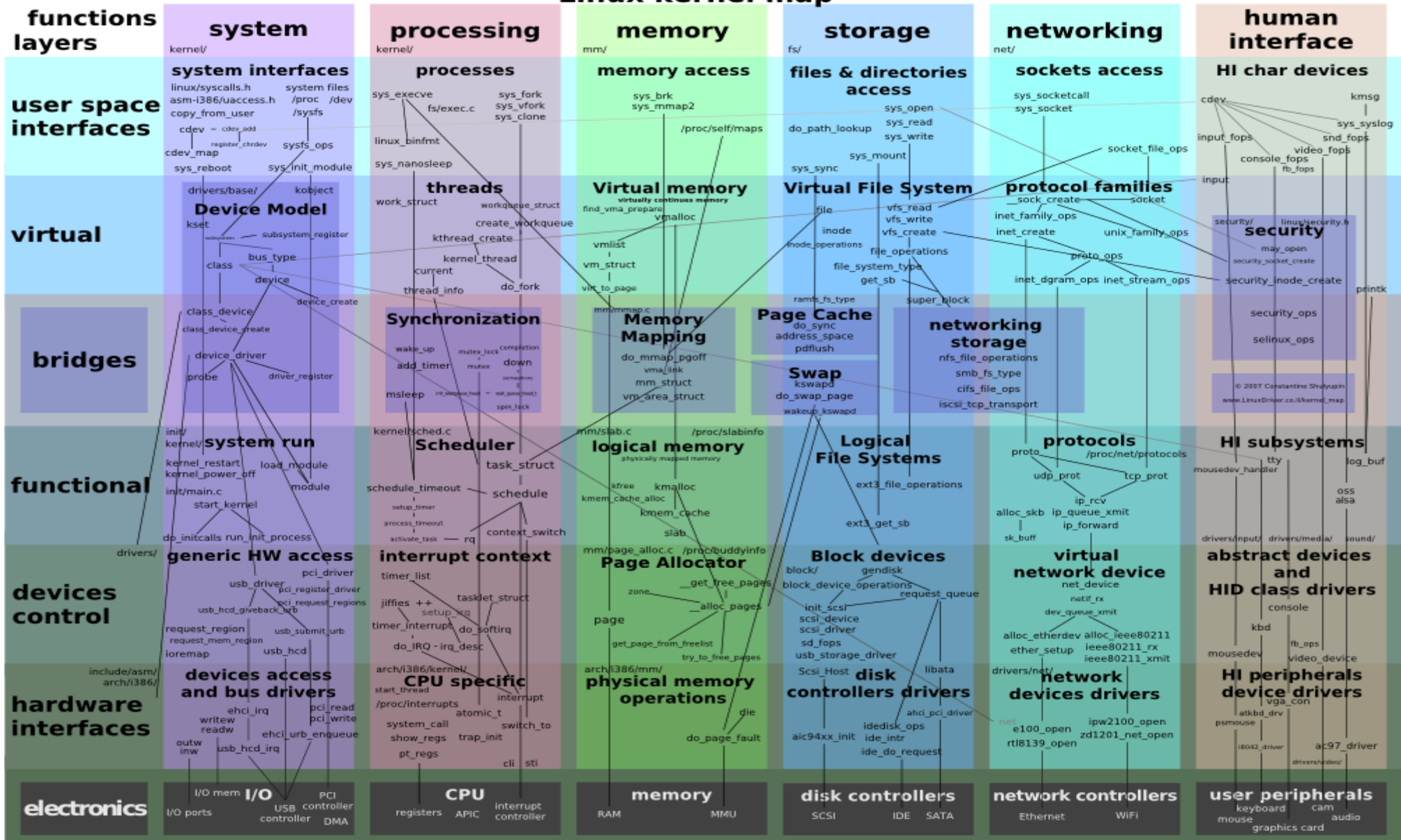
Linux kernel in more detail

- [https://en.wikipedia.org/wiki/Scheduling_\(computing\)](https://en.wikipedia.org/wiki/Scheduling_(computing))



on next slide: Linux kernel even more in detail

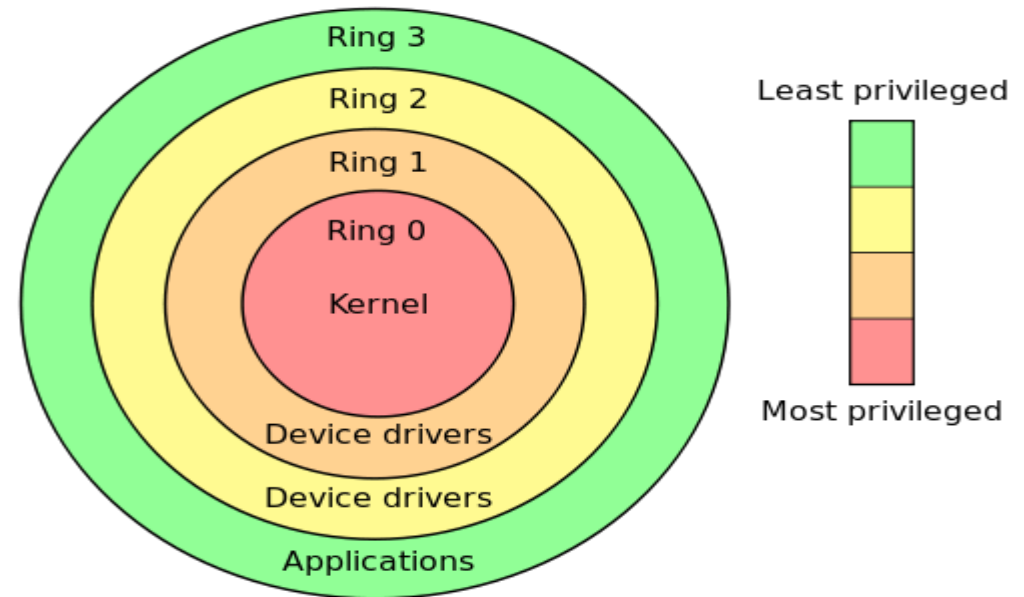
Linux kernel map



Kernel's supervisory and protected modes

- 0 - OS
- 1 - 2 - devices
- 3 - applications

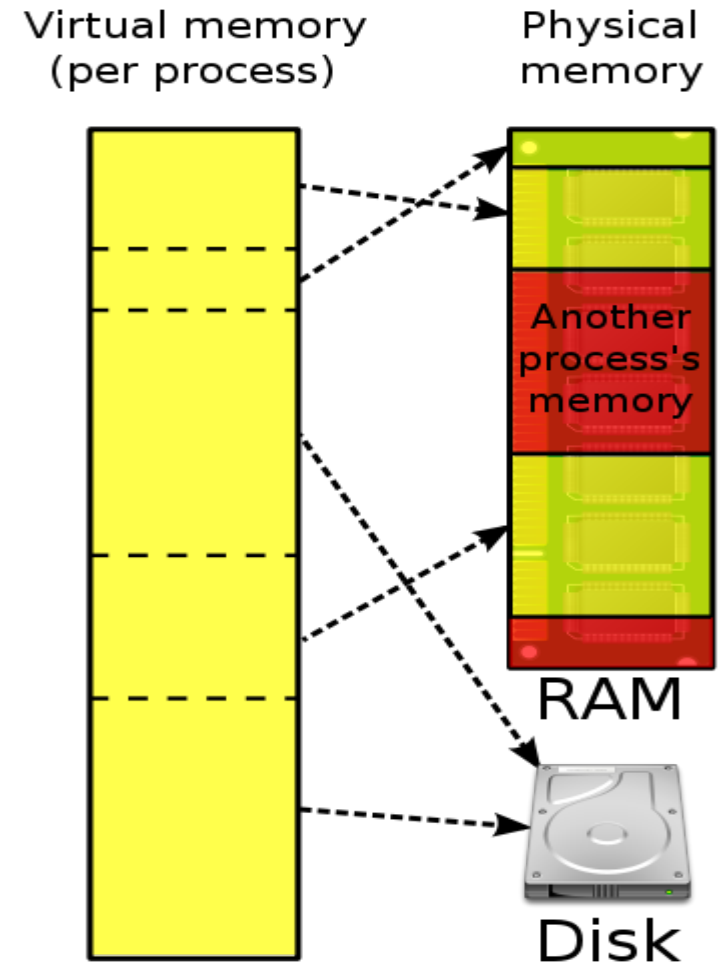
What for are such division of modes?



http://en.wikipedia.org/wiki/File:Priv_rings.svg

Memory manager (1)

- Virtual vs physical memory
- OS protects the memory
- Every process sees the allocated memory as interrupted virtual memory when at the same time MMU and OS convert it into the physical memory address



http://en.wikipedia.org/wiki/File:Virtual_memory.svg

Memory manager (2)

- Every process is handed virtual memory by the OS
- Virtual address is translated into a physical memory address by the MMU
- Swapping
 - Memory page is read into RAM only when asked
 - Memory pages not in use may be swapped out
 - Frees up RAM to disk
 - Slower
- Disk cache – most of the free cache is used for data buffering

Cache

- Cache is used to increase the performance of the whole system
- Processor cache
- Disk cache

What is the difference
between cache and buffer?

Cache vs buffer

- **cache** – software or hardware component, which holds the data for re-use them promptly. Reading data from cache is faster than the source data reading from random access memory (RAM) or a hard disk.
- **(data) buffer** – part of RAM for temporary data storage, which allows temporary recording through the exchange of data between two different transmission parameters of the unit. Most of the job is to maintain the buffer data to the processor to be processed prior to a device (such as a printer or hard drive) is sent.

Cache vs buffer 2

- If you are working on the text in a document processor, then it is stored in the office document software buffer and only then, if you give the *Save* command, the data will be sent from the software buffer to disk (storage medium).
- the data is deemed to central processor cache from main computer memory, disk caching data comes from the hard disk, the web browser cache comes from web, etc.
- **Buffer**
 - is something that has to be written to the disk (etc block device)
 - keeps metadata (permissions, location etc)
 - tracks which device memory is read/written
- **Cache**
 - is something that has to be read from disk and store for later use
 - keeps real file content

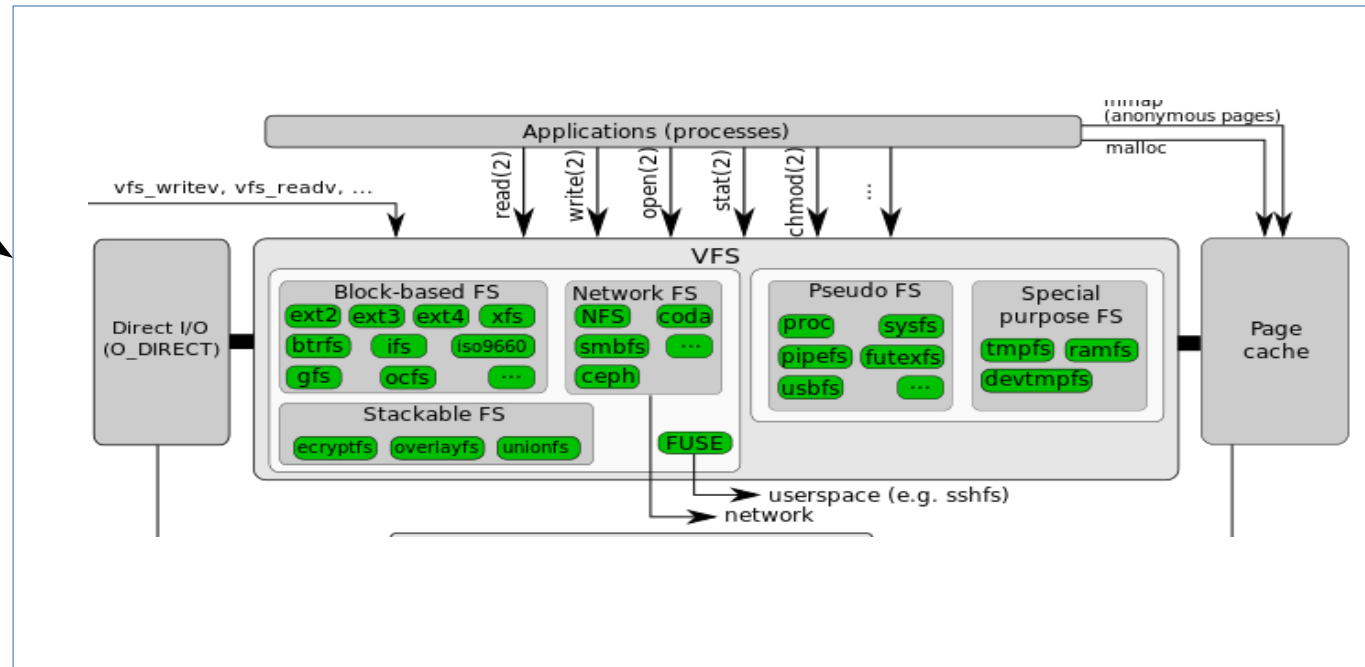
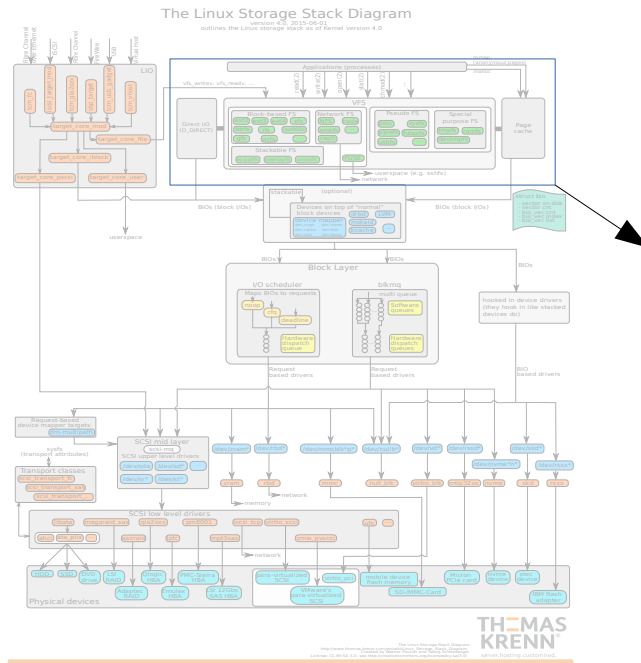
Device manager I/O

- Synchronous
 - Data is written to disk or storage and the application will continue its work
 - More reliable
- Asynchronous
 - Data is sent to the operating system (cache) and the application continues its work
 - Data is written to disk or storage
 - Less reliable

Partitions and file system

- MBR (DOS) type partition table can have:
 - 4 primary partitions, e.g. `/dev/sdx1...4` (replace “x” with a...z)
 - 3 primary (`/dev/sdx1...3`) + 1 extended (`/dev/sdx4`) with 1....128 logical volumes (`/dev/sdx5...132`)
- GPT type partition table can have 1...128 partitions
- Keeps the files in a structure
 - File System Hierarchy
 - https://en.wikipedia.org/wiki/Filesystem_Hierarchy_Standard
- Keeps a registry of every file
- Grants or revokes file permissions
 - Additional security with multiuser systems
- VFS – *virtual file system* – the software layer on top of a real file system, which allows different file systems appear as one unit for applications

Virtual file system



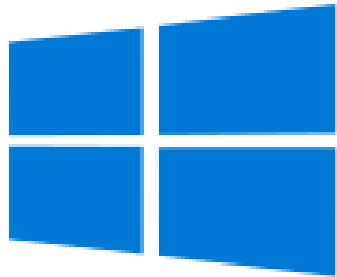
File systems

- are different:
 - may consider with file permissions
 - can have different understanding of allowed file names
 - may have with different limits and purposes
- e.g. EXT{2,3,4}, btrfs, NTFS, FAT{12,16,32}
- network file systems, distributed file systems

More reading:

- https://en.wikipedia.org/wiki/File_system

Examples of OS



https://en.wikipedia.org/wiki/Comparison_of_operating_systems

https://en.wikipedia.org/wiki/List_of_operating_systems

https://en.wikipedia.org/wiki/Timeline_of_operating_systems

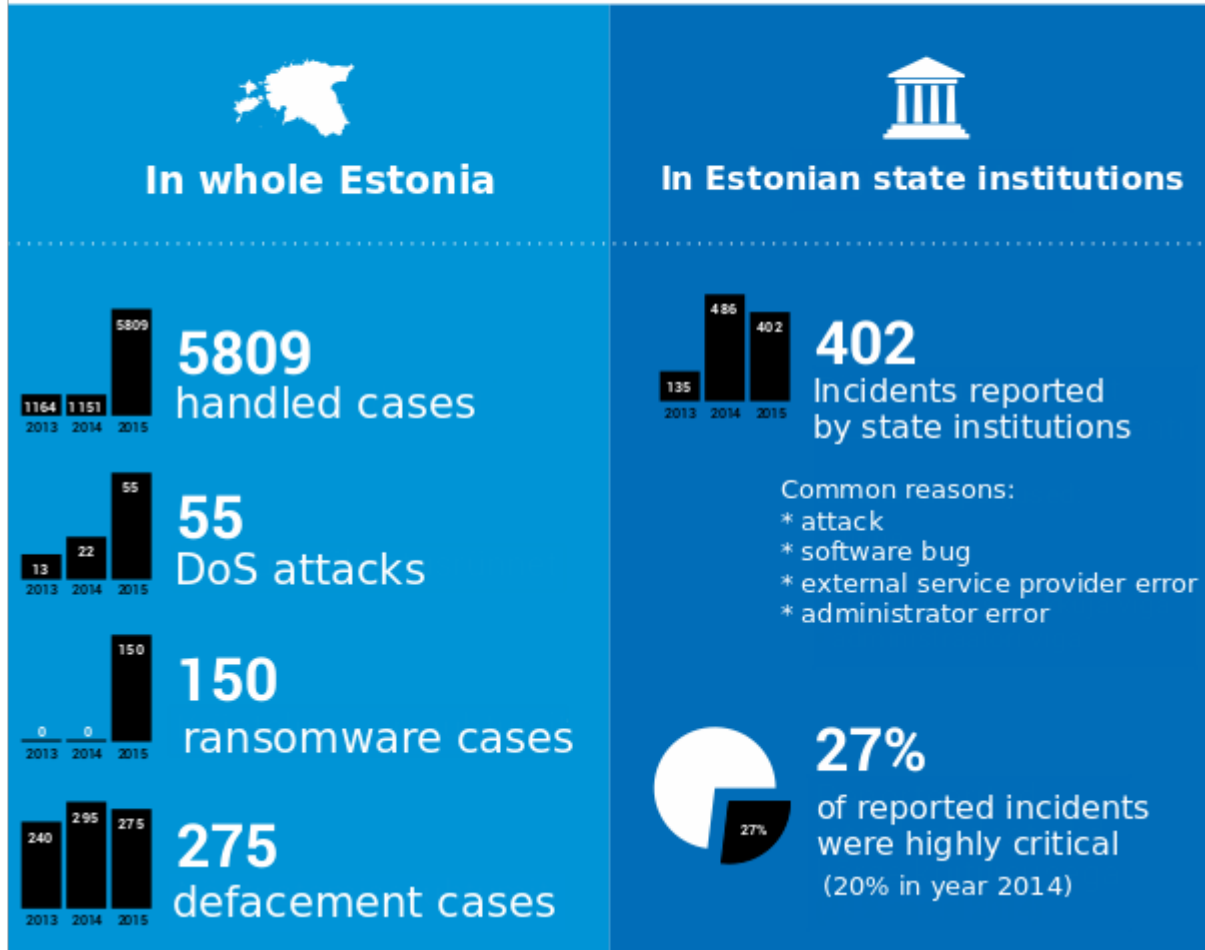
https://en.wikipedia.org/wiki/Category:Operating_systems

System performance

- *computer performance* shows the effectiveness of the computer system as a whole, including the data processing capability; measured by *benchmark*; some of the indicators characterizing:
 - short *response time*
 - high *throughput*
 - low utilization of *resources*
 - *high availability*
 - fast (or high density) *data compression*
 - high *bandwidth*
 - short *data transmission* time
 - *latency* – delay of system and its various components between referral and system response (check also *access time*)
 - *MIPS* – characterizing indicator of CPU, in Linux also *BogoMIPS*
 - file system performance, see *Linux filesystem performance test*, in case of NTFS

Security is important!

Year 2015 in cyber security of Estonia



- **420 000 ID-card needs new certificate** – needed to increase security
- **Cyber Hedgehog 2015** – the largest cyber exercise in Estonian history – CONEX, Locked Shields, Cyber Coalition, Cyber Europe
- **The probability to break SHA-1 is too large** – Google, Microsoft, Mozilla consider it unsecure
- **cyber security legal framework needs to be simplified** - cyber security management is now more than ten legal act in Estonia

statistics available only in Estonian

Administrator

- Administrator
 - System administrator
 - system installation
 - system management
 - system backup/restore
 - monitoring system load and volumes
 - developing system architecture
 - Application administrator
 - application, service specific management (e.g. economical software)

Systems management

- system administrators often have to deal with
 - conducting procurements
 - monitoring and planning system requirements
 - testing and documentation
 - computer network installation and management
 - simplifying the system
 - automating activities
 - the management of workplace computers (PC admin)
 - integrating software applications

Systems management 2

- continuing...
 - programming
 - searching and choosing of new software applications
 - supporting users
 - resolving cyber security incidents
 - increasing the performance
 - continuous self development and research in new technologies
 - **communication!**

Q/A?

What is a Linux distribution?



https://en.wikipedia.org/wiki/Linux_distribution

https://en.wikipedia.org/wiki/List_of_Linux_distributions

<https://distrowatch.com/>

Questions?

Thank you for your attention!

