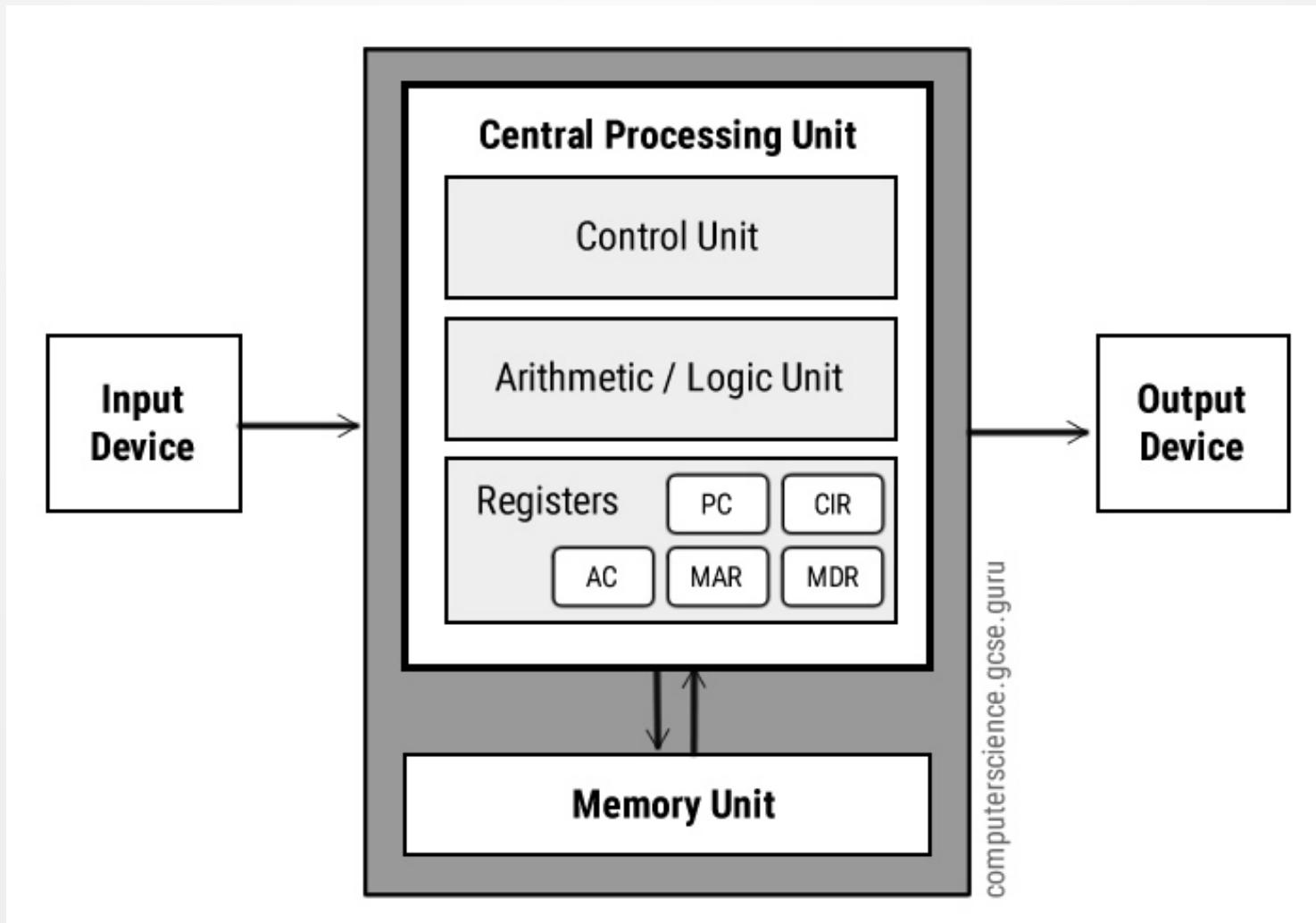


# Operačné systémy

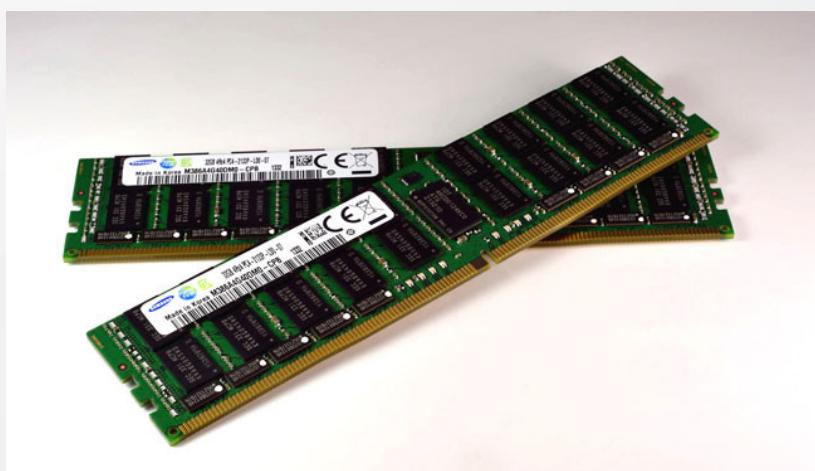
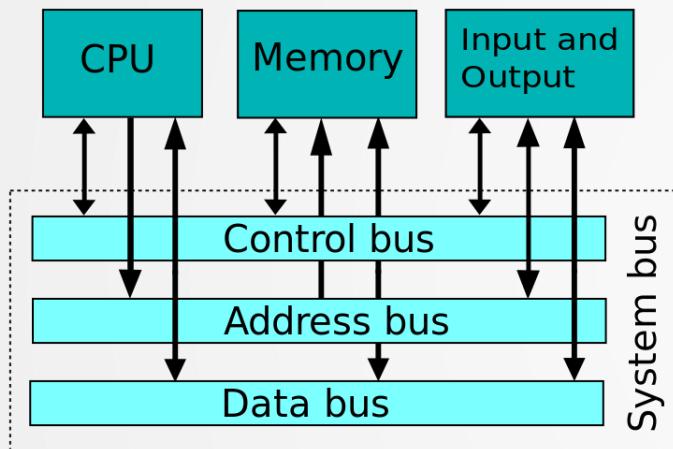
Miroslav Hájek

# Von Neumannova architektúra

- *John von Neumann - First Draft of a Report on the EDVAC*
- Dizajn elektronického digitálneho (binárny) programovateľného počítača



# Základný hardvér počítača

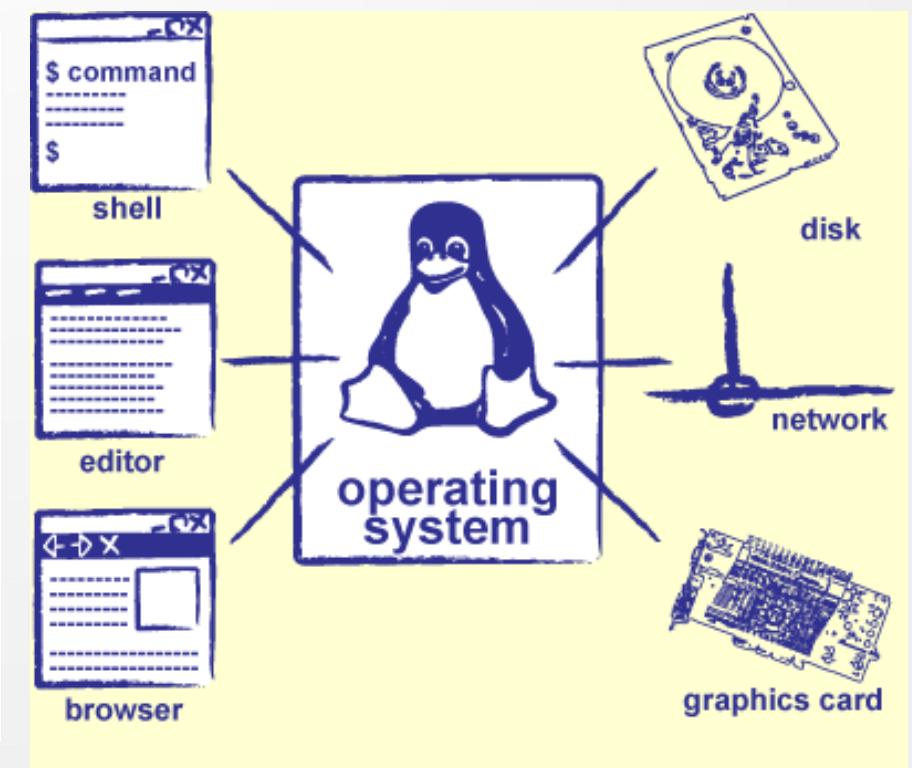
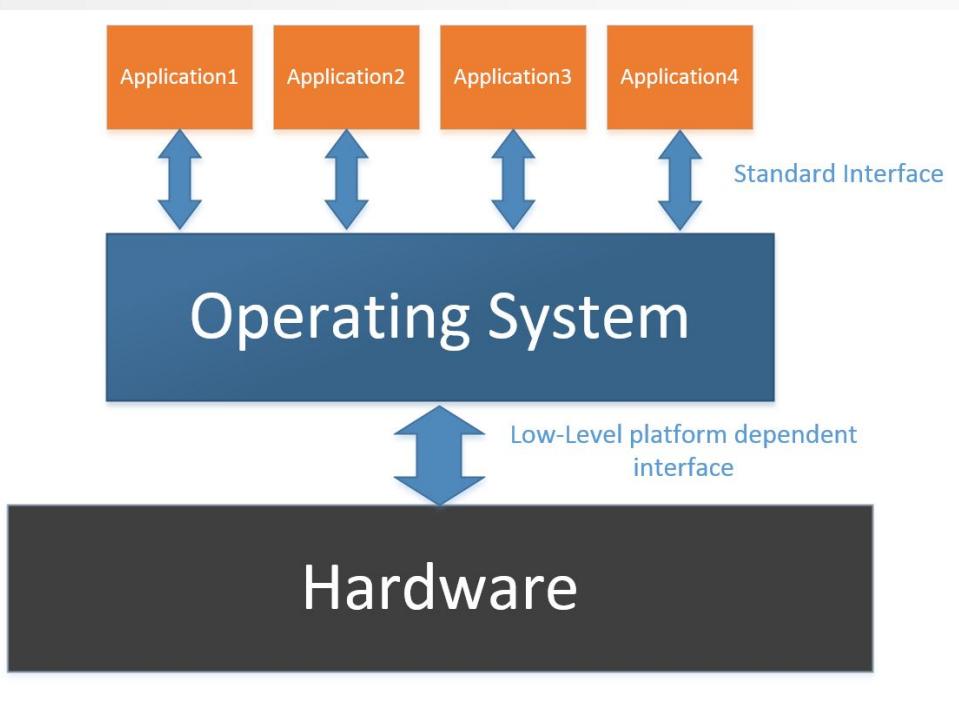


# Úlohy

- Definícia : „Základné programové vybavenie počítača“

Pohľady:

1. *Top-down*: jednotné a zjednodušené rozhranie – virtuálny stroj
2. *Bottom-up*: prerozdelenie a spravovanie hardvérových zdrojov



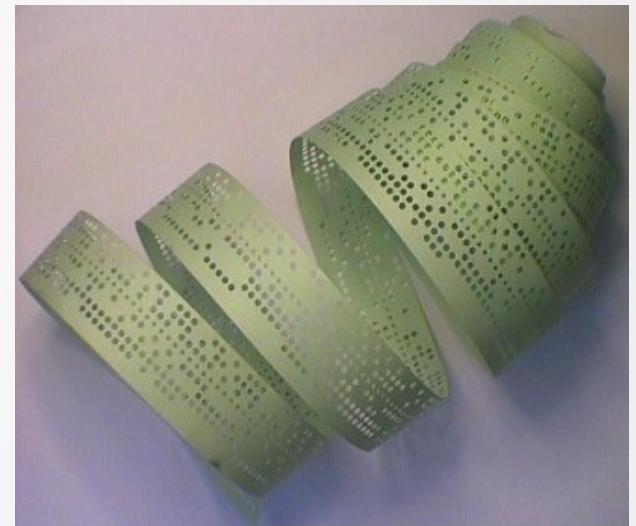
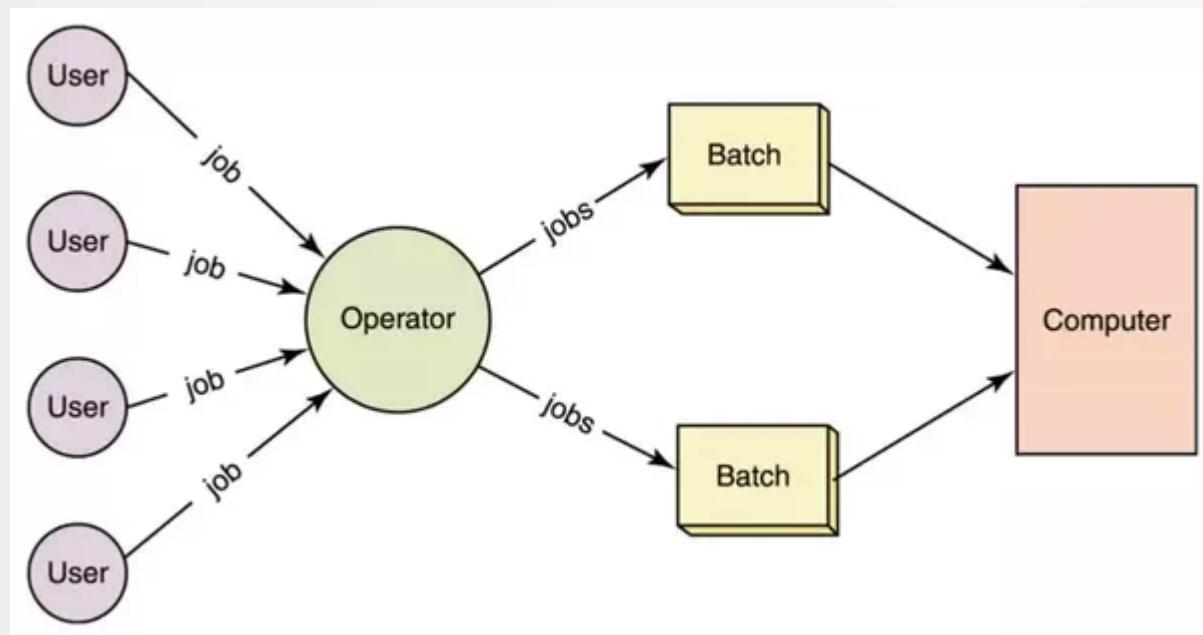
# História – dávkové spracovanie

- Nahrádza človeka manuálne spúšťajúceho programy
  - **Dávkové spracovanie úloh sálovými počítačmi (mainframe)**

1955 - GM-NAA I/O (General Motors, IBM704)

# 1960 – IBM 7090/94 IBSYS – dierne štítky

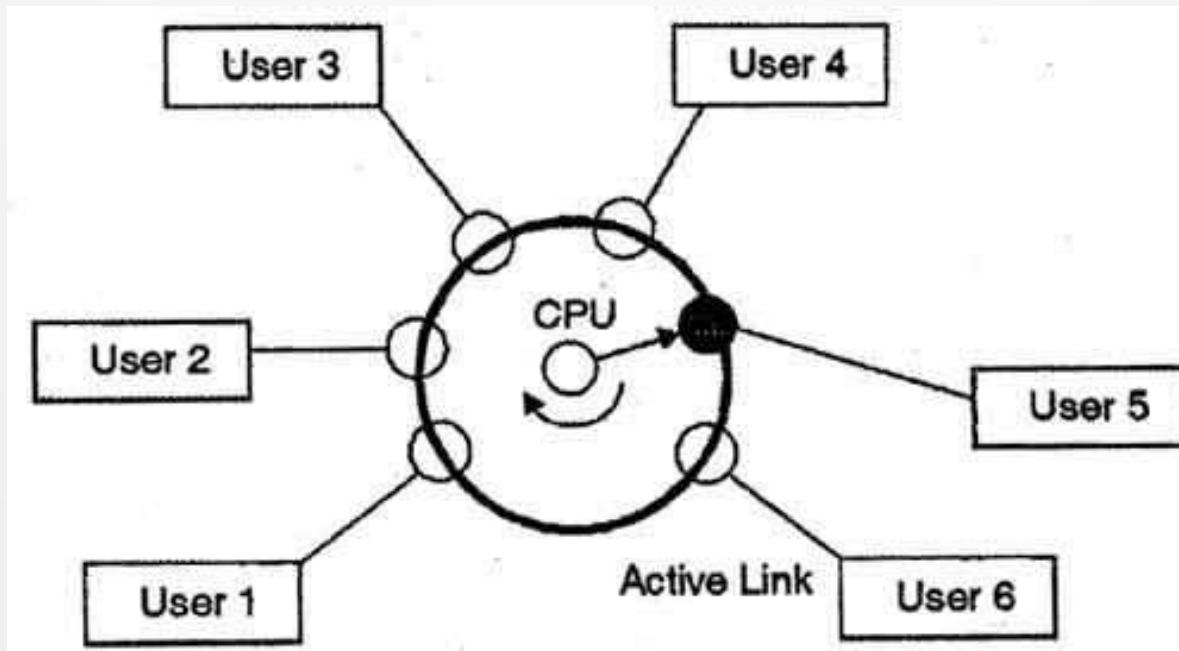
## 1966 – OS/360 (System/360)





# História – zdielanie času

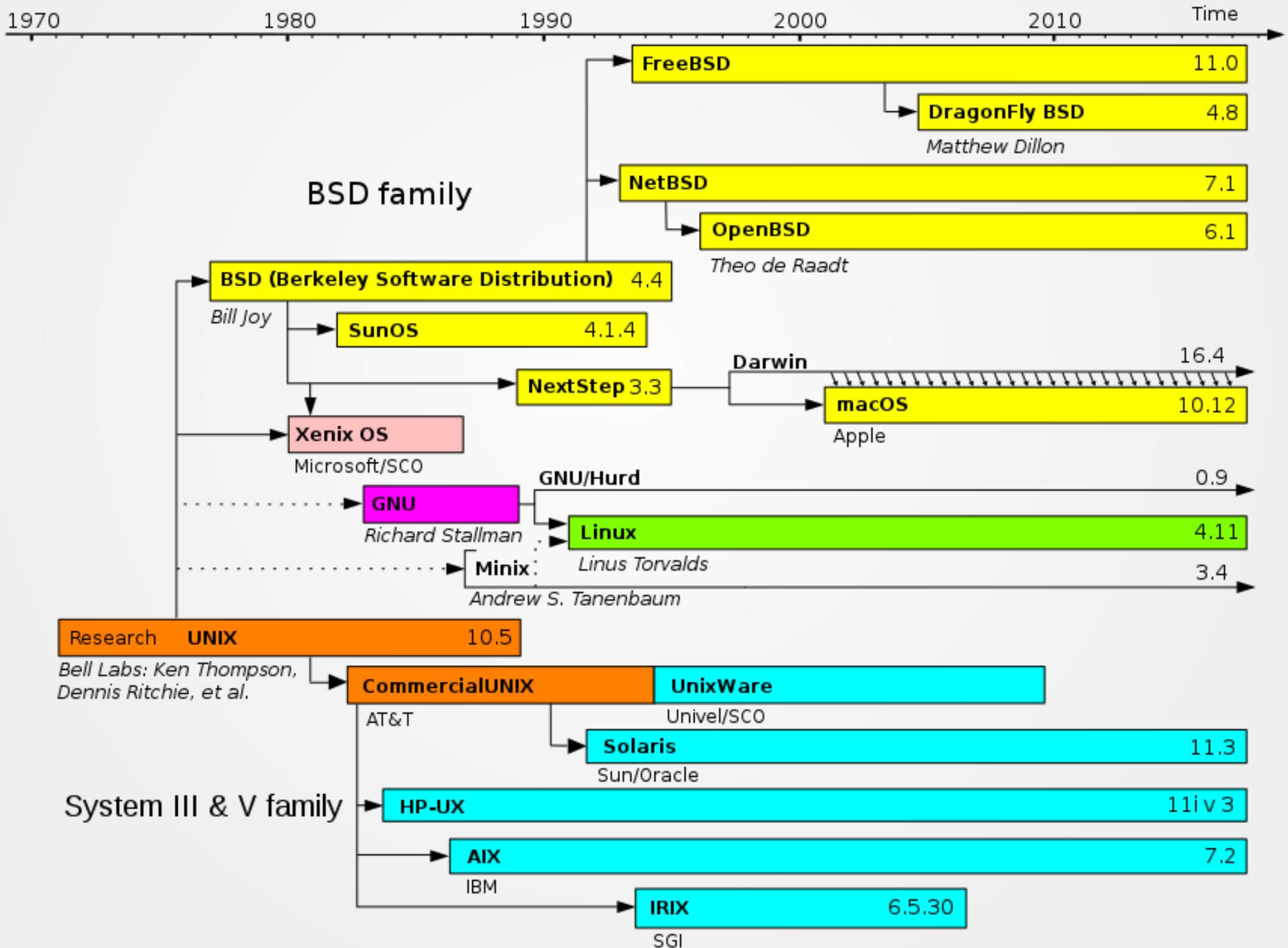
- Interaktívne zadávanie úloh cez terminály
- „*By time sharing, a big computer could be used as several small ones*“  
– John Backus
- 1961 – CTSS (*Compatible Time-Sharing System*)
  - Fernando J. Corbató, MIT (IBM 7090)
- 1969 – Multics (*Multiplexed Information and Computing Service*)
  - MIT, GE, AT&T Bell Labs



# História – UNIX

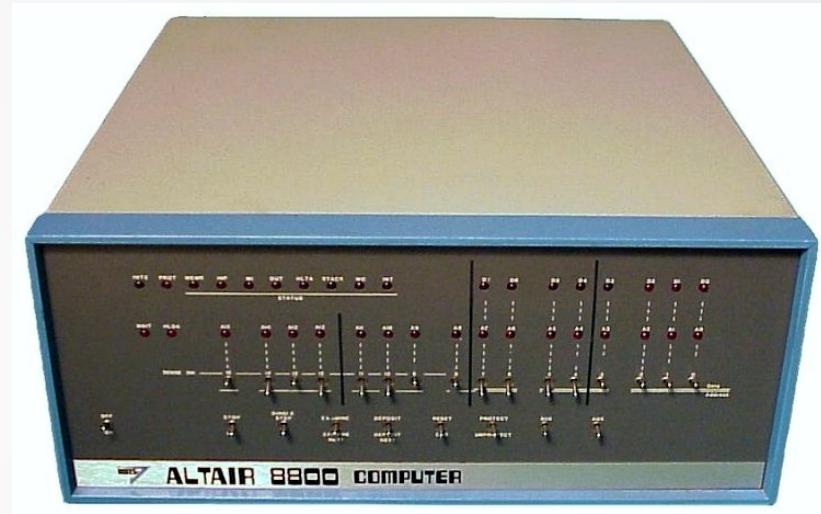
- 1969 (1973) – AT&T Bell Labs – skriňové počítače DEC PDP-7,11
- „*I think the major good idea in Unix was its clean and simple interface: open, close, read, and write.*“ – Ken Thomson





# História – Mikropočítače

- CP/M – 1974, Intel 8080 a Zilog Z80
- DOS (Disk Operating System) – 1980
  - Basic Input/Output System (BIOS)
  - Basic Disk Operating System (BDOS)
  - Console Command Processor (CCP)



```
Current date is Tue 1-01-1980
Enter new date:
Current time is 21:35:24.18
Enter new time:

The IBM Personal Computer DOS
Version 2.00 (C)Copyright IBM Corp 1981, 1982, 1983

A>dir

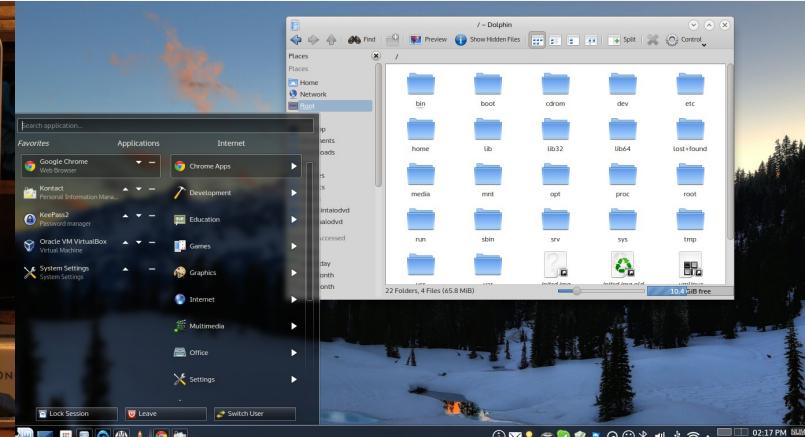
Volume in drive A has no label
Directory of A:\

COMMAND   COM    17664  3-08-83  12:00p
FORMAT     COM     6016   3-08-83  12:00p
CHKDSK    COM     6400   3-08-83  12:00p
SYS       COM     1408   3-08-83  12:00p
DEBUG      COM    11904   3-08-83  12:00p
SLOOP      32    1-01-80    7:44p
6 File(s)   292864 bytes free

A>_
```

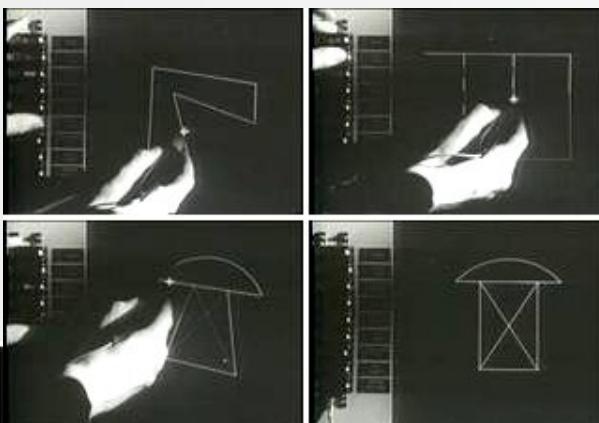


# Dnešné operačné systémy



# GUI – Grafické používateľské prostredie

- Jednoduché ovládanie cez interaktívne obrazové prvky
- Dôležité pre použitelnosť: ergonómia, dizajn, psychológia
- 1963 - Ivan Sutherland: sketchpad so svetelným perom
- 1970 - Douglas Engelbart, Xerox PARC : okná, tlačidlá, myš
- 1983 - Popularizácia s Apple Lisa a Macintosh



The image displays three screenshots of modern GUI toolkits:

- Button Demo**: A window showing various button types: Play (with icons), Stop, Pause, Next, Prev, Checkbox, Toggle buttons, and Radio buttons.
- Demo**: A window demonstrating form controls like Sliders, Progressbars, and Spinners, along with checkboxes, radio buttons, and dropdown menus.
- Control**: A window for styling and theme configuration, showing a sidebar with categories like Windows, Metrics, Properties, Rounding, and Color, and a main area for selecting colors and themes.

# CLI – Rozhranie cez príkazový riadok

- Textové rozhranie – preklad príkazov ako akcie pre systém

```
$ pwd  
/home/miroslav  
$ mkdir priecinok  
$ cd priecinok  
$ echo "Text zapisem do suboru" > zaznam.txt  
$ ls -la  
celkom 12  
drwxr-xr-x 2 miroslav miroslav 4096 jún 20 16:16 .  
drwxr-xr-x 91 miroslav miroslav 4096 jún 20 16:19 ..  
-rw-r--r-- 1 miroslav miroslav 23 jún 20 16:16 zaznam.txt  
$ makewords sentence | lowercase | sort | unique | mismatch  
$ grep -rnw '../Programy/Python/SEN' -e 'def'  
/home/miroslav/Programy/Python/SEN/sachovnica.py:4:def rgb():  
/home/miroslav/Programy/Python/SEN/strom.py:6:def strom(x, y, r, h, w):  
$ mv zaznam.txt pokus.txt  
$ rm pokus.txt  
$ _
```

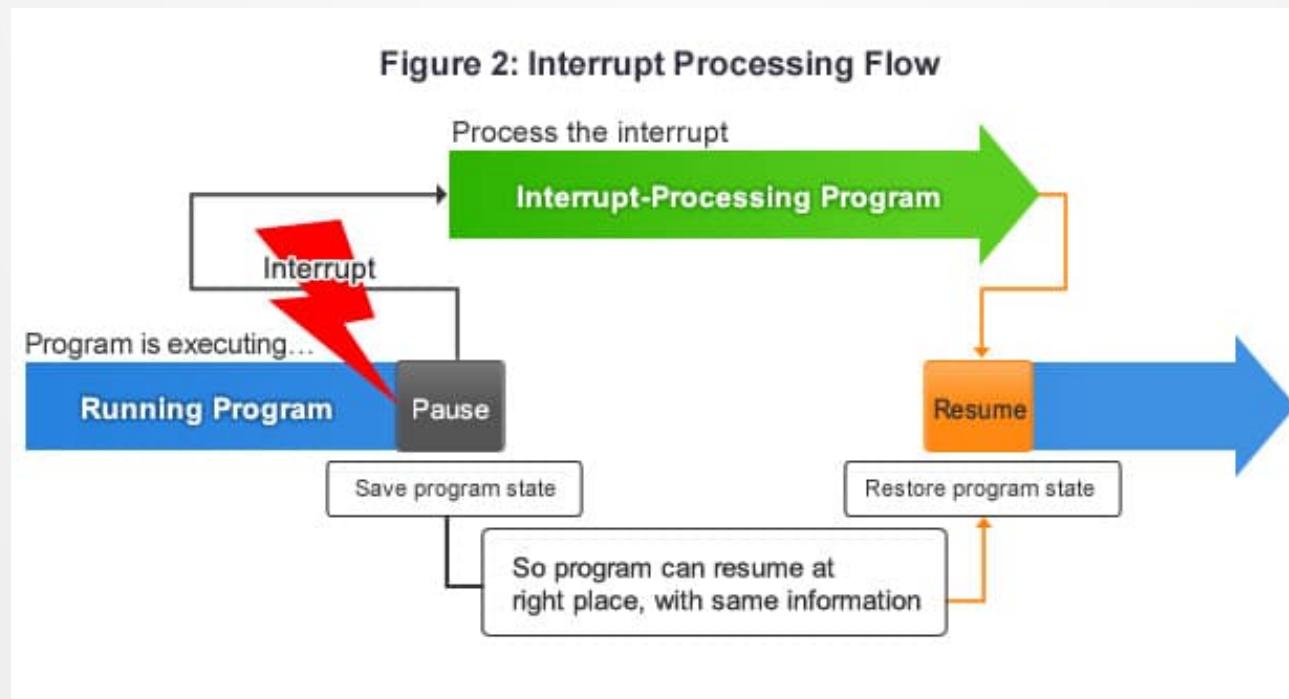


# Kedy beží OS?

## Prerušenie (IRQ)

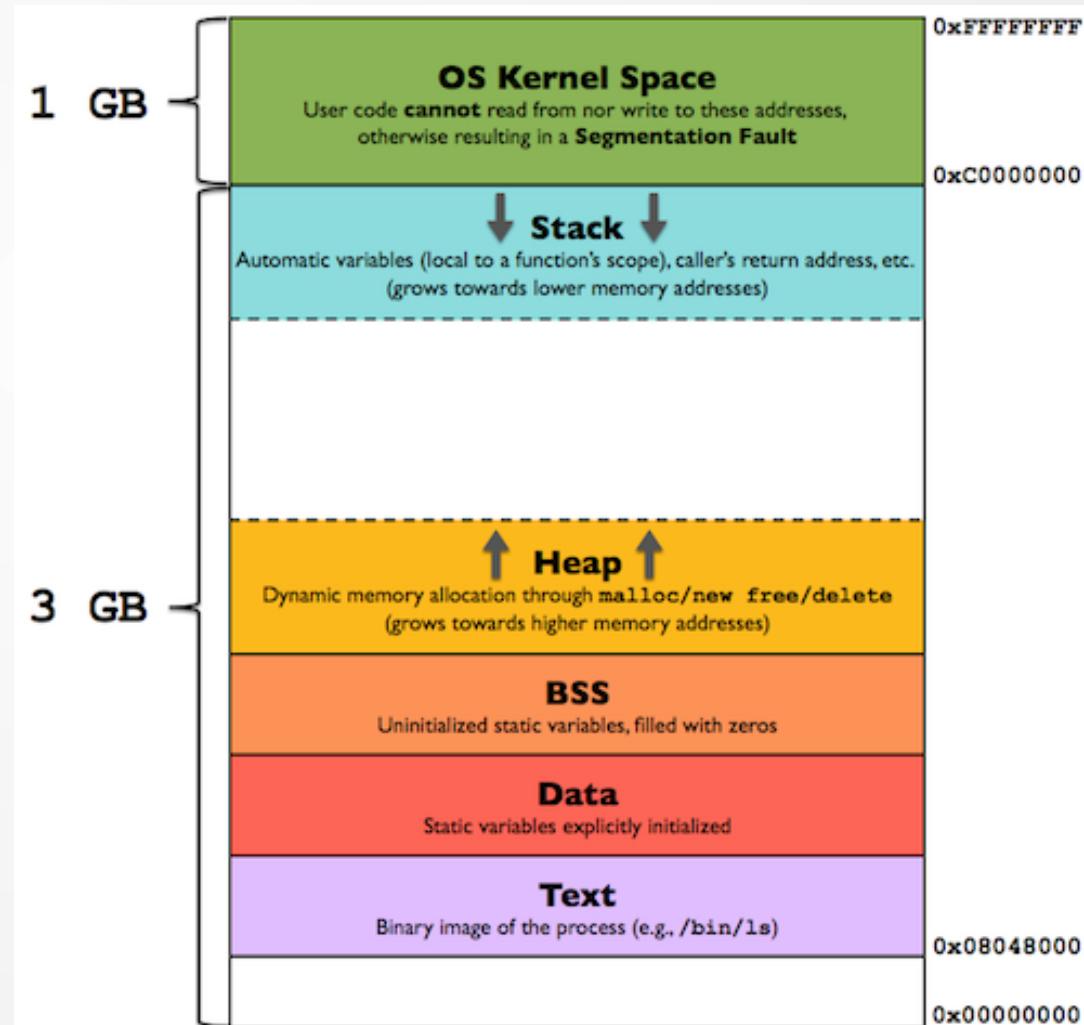
- Softvérové (syscall) – aplikácia potrebuje OS službu
- Hardvérové – elektrický signál od periférie pre procesor

*Analógia: čítanie knihy -- zvonček dverí*



# Procesy

- Program počas vykonávania vrátane dát a stavu (**kontext**):
  1. Adresný priestor (obr.)
  2. Registre (pc, sp, iný hardvér)
  3. Systémové zdroje (súbory, signály, metadáta, práva)



/include/linux/sched.h (struct task\_struct)

# Správa procesov (windows)

Správca úloh							Správca úloh								
Procesy		Výkon	História aplikácií	Spustenie	Používateľia	Podrobnosti	Služby	Procesy		Výkon	História aplikácií	Spustenie	Používateľia	Podrobnosti	Služby
Názov	Stav	37%	78%	29%	6%			Názov	Identifikátor PID	Stav	Meno používateľa	Proc...	Pamäť (súč...	Popis	
Applikácie (5)								chrome.exe	3892	Spustený	9	00	6 888 K	Google Chrome	
> Google Chrome (13)		27,0%	280,1 MB	12,5 MB/s	0 Mb/s			csrss.exe	572	Spustený	SYSTEM	00	584 K	Client Server Runtime	
> Kalkulačka (2)		0%	14,5 MB	0 MB/s	0 Mb/s			csrss.exe	4024	Spustený	SYSTEM	00	656 K	Client Server Runtime	
> Microsoft Word		0,9%	47,6 MB	0 MB/s	0 Mb/s			ctfmon.exe	1888	Spustený	9	00	2 588 K	CTF Loader	
> Prieskumník		0%	29,6 MB	0 MB/s	0 Mb/s			dllhost.exe	5272	Spustený	DWM-6	02	30 384 K	Desktop Window Man	
> Správca úloh		1,7%	12,9 MB	0 MB/s	0 Mb/s			dwm.exe	5140	Spustený					
Procesy na pozadí (24)								explorer.exe	3864	Spustený	9	01	30 788 K	Prieskumník	
> Antimalware Service Executable		0%	67,4 MB	0 MB/s	0 Mb/s			fontdrvhost.exe	912	Spustený	UMFD-0	00	0 K	Usermode Font Driver	
> Application Frame Host		0%	5,1 MB	0 MB/s	0 Mb/s			fontdrvhost.exe	488	Spustený	UMFD-6	00	1 212 K	Usermode Font Driver	
> COM Surrogate		0%	1,5 MB	0 MB/s	0 Mb/s			GoogleCrashHandler...	5112	Spustený	SYSTEM	00	176 K	Google Crash Handler	
> CTF Loader		0%	2,5 MB	0 MB/s	0 Mb/s			GoogleCrashHandler...	5104	Spustený	SYSTEM	00	0 K	Google Crash Handler	
> Google Crash Handler		0%	0 MB	0 MB/s	0 Mb/s			Isass.exe	716	Spustený	SYSTEM	00	3 520 K	Local Security Authorit	
> Google Crash Handler (32-bit.)		0%	0,2 MB	0 MB/s	0 Mb/s			MSASCuiL.exe	280	Spustený	9	00	508 K	Windows Defender no	
								MsMpEng.exe	2204	Spustený	SYSTEM	01	69 544 K	Antimalware Service E	
								NisSrv.exe	3624	Spustený	NETWORK SER...	00	1 232 K	Microsoft Network Rea	
								OfficeHubTaskHost.	7160	Odstavený	9	00	336 K	Office Hub Task Host	
								OneDrive.exe	2820	Spustený	9	00	1 764 K	Microsoft OneDrive	
								Prerušenia systému	-	Spustený	SYSTEM	01	0 K	Odložené volania proc	
								Procesy systémovej ...	0	Spustený	SYSTEM	58	8 K	Percento času, kedy je	
								Registry	88	Spustený	SYSTEM	00	2 500 K	NT Kernel & System	
								RPC Runtime Library	576	Spustený	0	00	1 100 K	RPC Runtime Library	

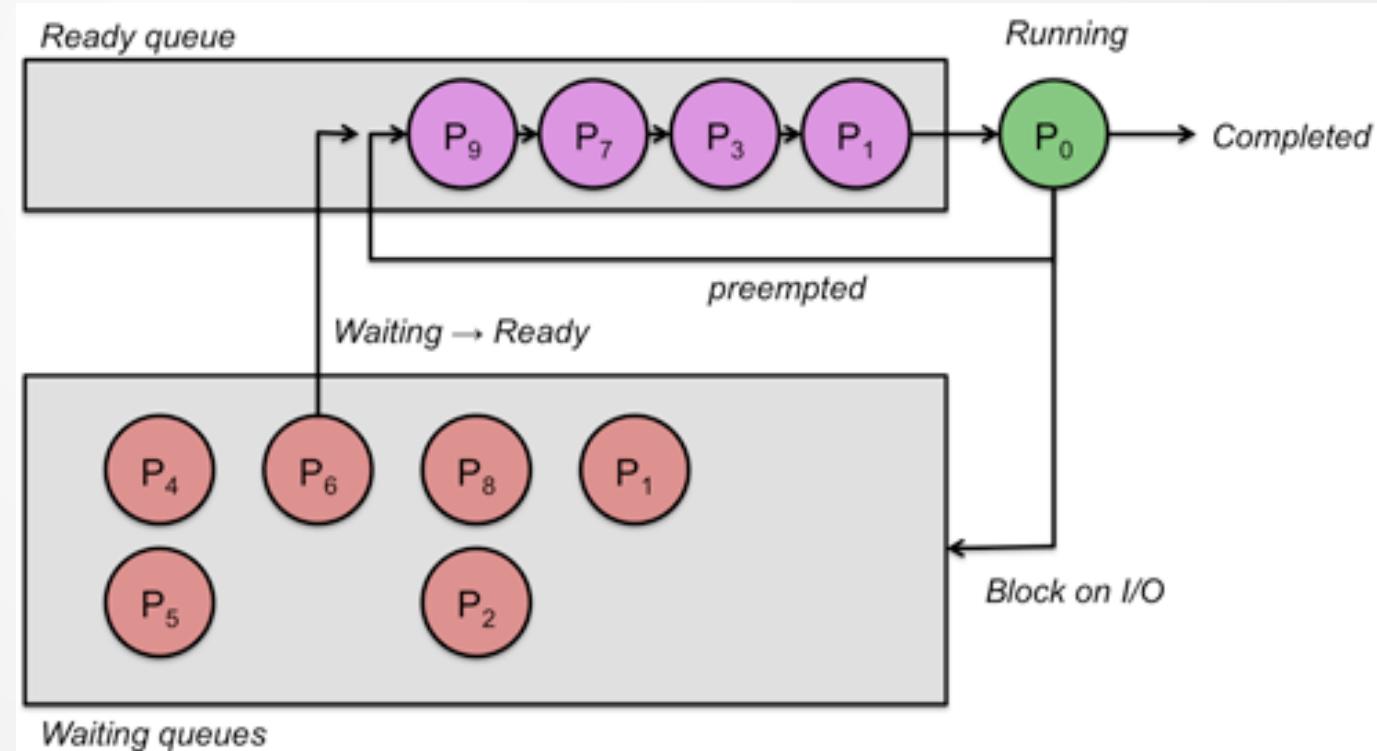
# Správa procesov (linux - htop)

1				0.7%]		Tasks: 57, 52 thr; 1 running													
2				2.0%]		Load average: 0.02 0.12 0.08													
3				0.0%]		Uptime: 00:08:04													
4				0.0%]															
Mem	[			107M/923M]															
Swp	[			0K/100.0M]															
PID	USER	PRI	NI	VIRT	RES	SHR	S	CPU%	MEM%	TIME+	Command								
1274	pi	20	0	200M	50412	29476	S	0.0	5.3	0:15.71	/usr/lib/xorg/Xorg -nolisten tcp :								
1492	pi	20	0	5508	3088	2464	R	2.0	0.3	0:12.53	htop								
1482	pi	20	0	49176	21668	17388	S	0.0	2.3	0:07.64	x-terminal-emulator								
1365	pi	20	0	135M	24000	19424	S	0.0	2.5	0:02.46	lxpanel --profile LXDE-pi								
1366	pi	20	0	141M	28196	23460	S	0.0	3.0	0:04.54	pcmanfm --desktop --profile LXDE-pi								
1359	pi	20	0	53504	14524	11728	S	0.0	1.5	0:01.80	openbox --config-file /home/pi/.co								
1284	pi	20	0	200M	50412	29476	S	0.0	5.3	0:00.56	/usr/lib/xorg/Xorg -nolisten tcp :								
1285	pi	20	0	52184	12412	11164	S	0.0	1.3	0:00.34	/usr/bin/lxsession -s LXDE-pi -e L								
433	root	20	0	10132	3348	2828	S	0.0	0.4	0:00.06	wpa_supplicant -B -c/etc/wpa_supp								
489	www-data	20	0	47220	2860	1596	S	0.0	0.3	0:00.04	nginx: worker process								
488	www-data	20	0	47220	2860	1596	S	0.0	0.3	0:00.04	nginx: worker process								
345	nobody	20	0	5288	2400	2160	S	0.0	0.3	0:00.08	/usr/sbin/thd --triggers /etc/trig								
1	root	20	0	27036	6060	4908	S	0.0	0.6	0:03.33	/sbin/init								
1410	root	20	0	59424	9392	7504	S	0.0	1.0	0:00.23	/usr/lib/udisks2/udisksd --no-debu								
1415	root	20	0	59424	9392	7504	S	0.0	1.0	0:00.00	/usr/lib/udisks2/udisksd --no-debu								
1414	root	20	0	59424	9392	7504	S	0.0	1.0	0:00.00	/usr/lib/udisks2/udisksd --no-debu								
1413	root	20	0	59424	9392	7504	S	0.0	1.0	0:00.01	/usr/lib/udisks2/udisksd --no-debu								
1411	root	20	0	59424	9392	7504	S	0.0	1.0	0:00.00	/usr/lib/udisks2/udisksd --no-debu								
1394	pi	20	0	28440	6272	5760	S	0.0	0.7	0:00.05	/usr/lib/menu-cache/menu-cached /r								
1397	pi	20	0	28440	6272	5760	S	0.0	0.7	0:00.00	/usr/lib/menu-cache/menu-cached /r								
1396	pi	20	0	28440	6272	5760	S	0.0	0.7	0:00.00	/usr/lib/menu-cache/menu-cached /r								
1	Help	F2	Setup	F3	Search	F4	Filter	F5	Tree	F6	SortBy	F7	Nice	-F8	Nice	+F9	Kill	F10	Quit

# Plánovanie behu procesov

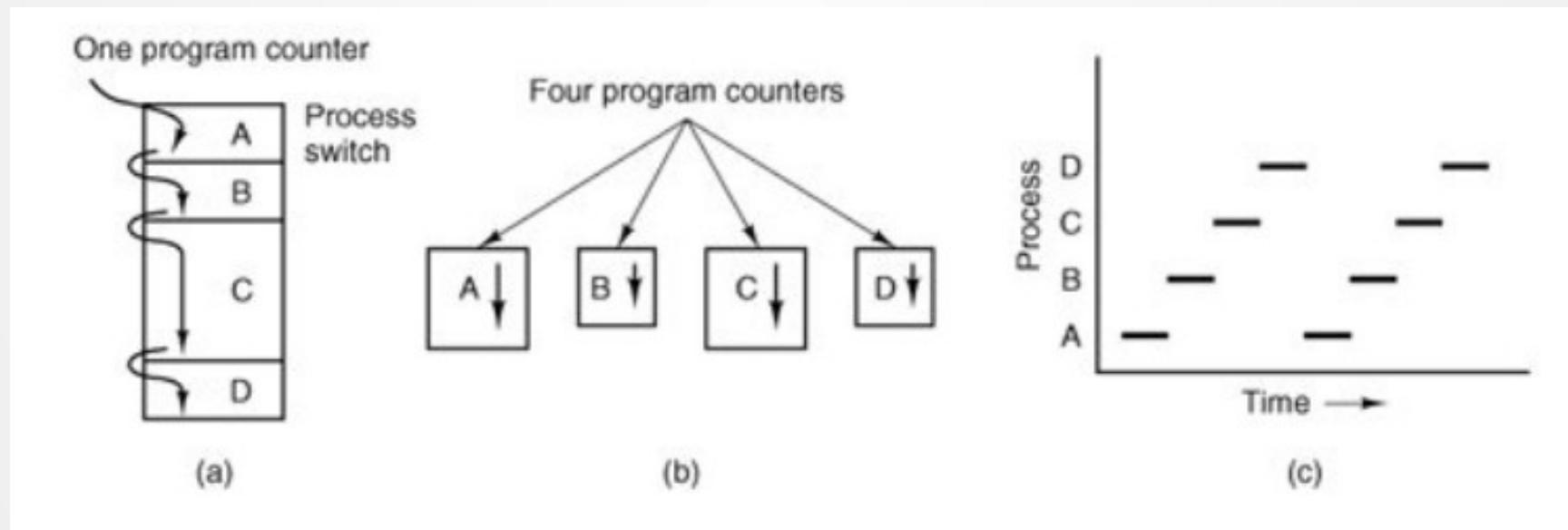
- Úloha plánovača: efektívne využiť výpočtové zdroje a byť fér

- Typy systémov:
  1. Dávkové (Batch)
  2. Interaktívne
  3. Real Time



# Zmena kontextu

- Uloženie stavu bežiaceho procesu a obnovenie iného efektívne
- Iniciácia: prerušenie



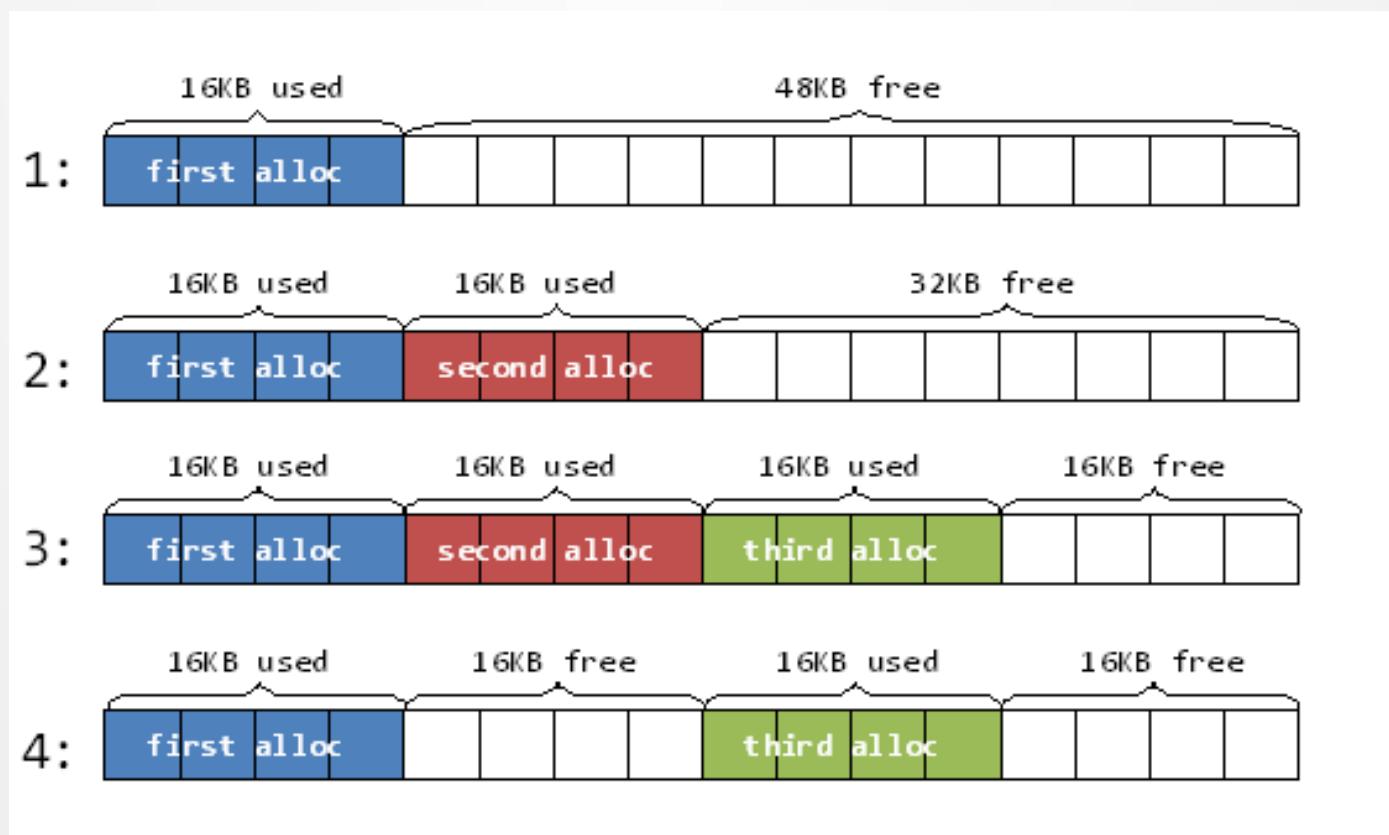
Pohľad OS

Pohľad aplikácie

Programy nebežia naraz

# Správa pamäti - Stránkovanie

- **Adresovateľosť** = dostupná pamäť ( $32\text{-bit} = 2^{32}\text{ B}$ )
- **Stránka** (4 kB) = najmenšia jednotka pre správu pamäti
- Proces má zoznam pridelených stránok - fragmentácia



# Virtuálny adresný priestor

- **Memory Management Unit** = Virtuálna adresa → Fyzická adresa
- Po zmene kontextu: **Page fault** → **Page tables** → **TLB**
  - Fragmentovaná fyzická pamäť je viruálne súvislá
  - Ochrana – oddelenie adres procesov
  - Copy-on-write – zdieľanie fyzických stránok
  - Swap – nepoužívané stránky na disk

Physical Memory		Process A		Process B	
		Page Table	Virtual Memory	Page Table	Virtual Memory
00x	H E L L	00x 00	00x H E L L	00x 03	00x H A V E
01x	R L D !	01x 02	01x O W O	01x 05	01x L O T
02x	O W O	02x 01	02x R L D !	02x 06	02x S O F
03x	H A V E	03x n.a.	03x #####	03x 04	03x F U N
04x	F U N	04x n.a.	04x #####	04x n.a.	04x #####
05x	L O T	05x 07	05x ; - )	05x 07	05x ; - )
06x	S O F				
07x	; - )				

# Vonkajšie pamäťové zariadenia

Magnetické



Optické



Flash



# Organizácia papierov



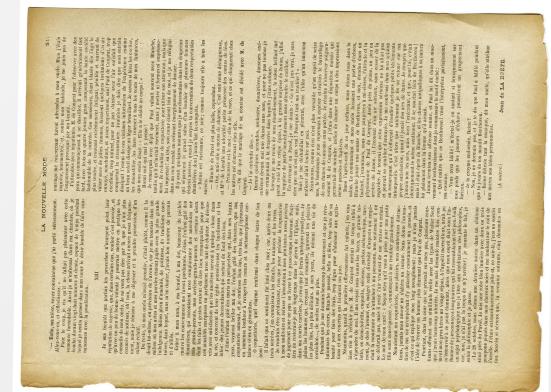
## 1. Kartotéka (File Cabinet)



## 2. Obal na spisy (File Folder)

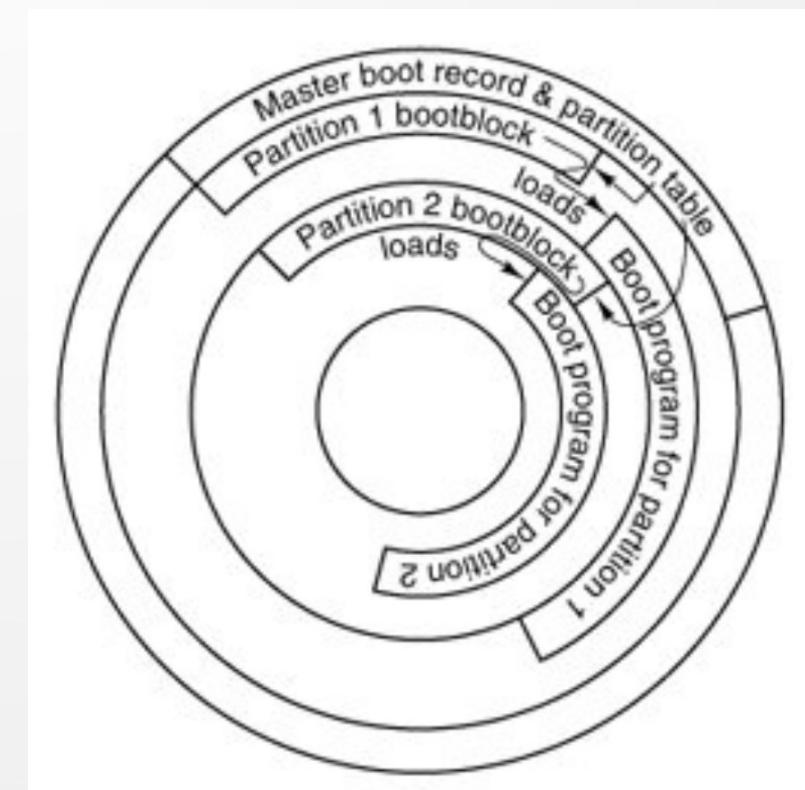
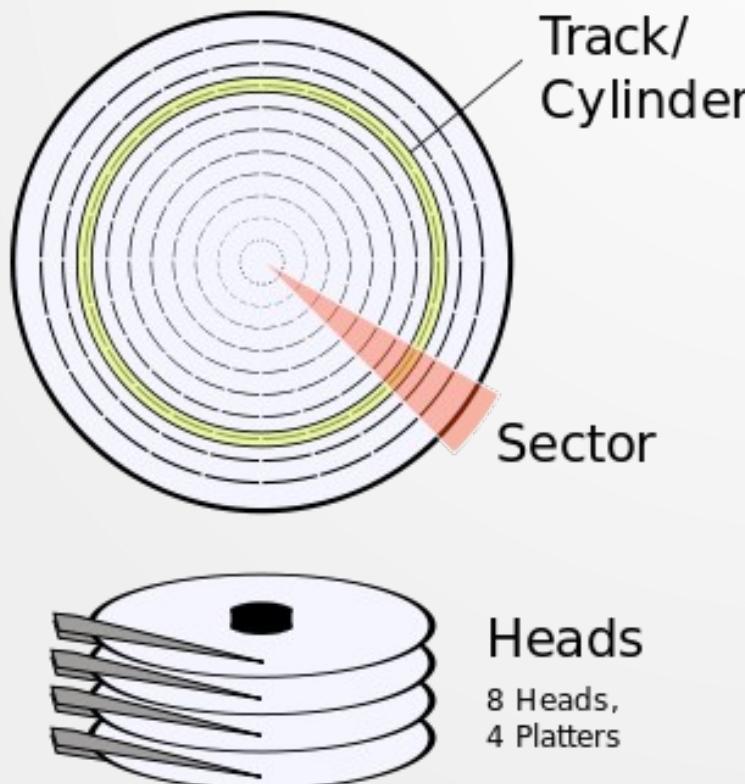


## 3. Úradný spis (File)



# Organizácia bytov na disku

- Fyzická:
  1. Cylinder-Head-Sector (geometria disku)
  2. Logical Block Adressing (lineárne)
- Virtálna
  1. Partition table (*tabuľka diskových oddielov* – MBR, GPT)
  2. Súborový systém (*formát* – FAT, NTFS, ext4, HFS+, ...)

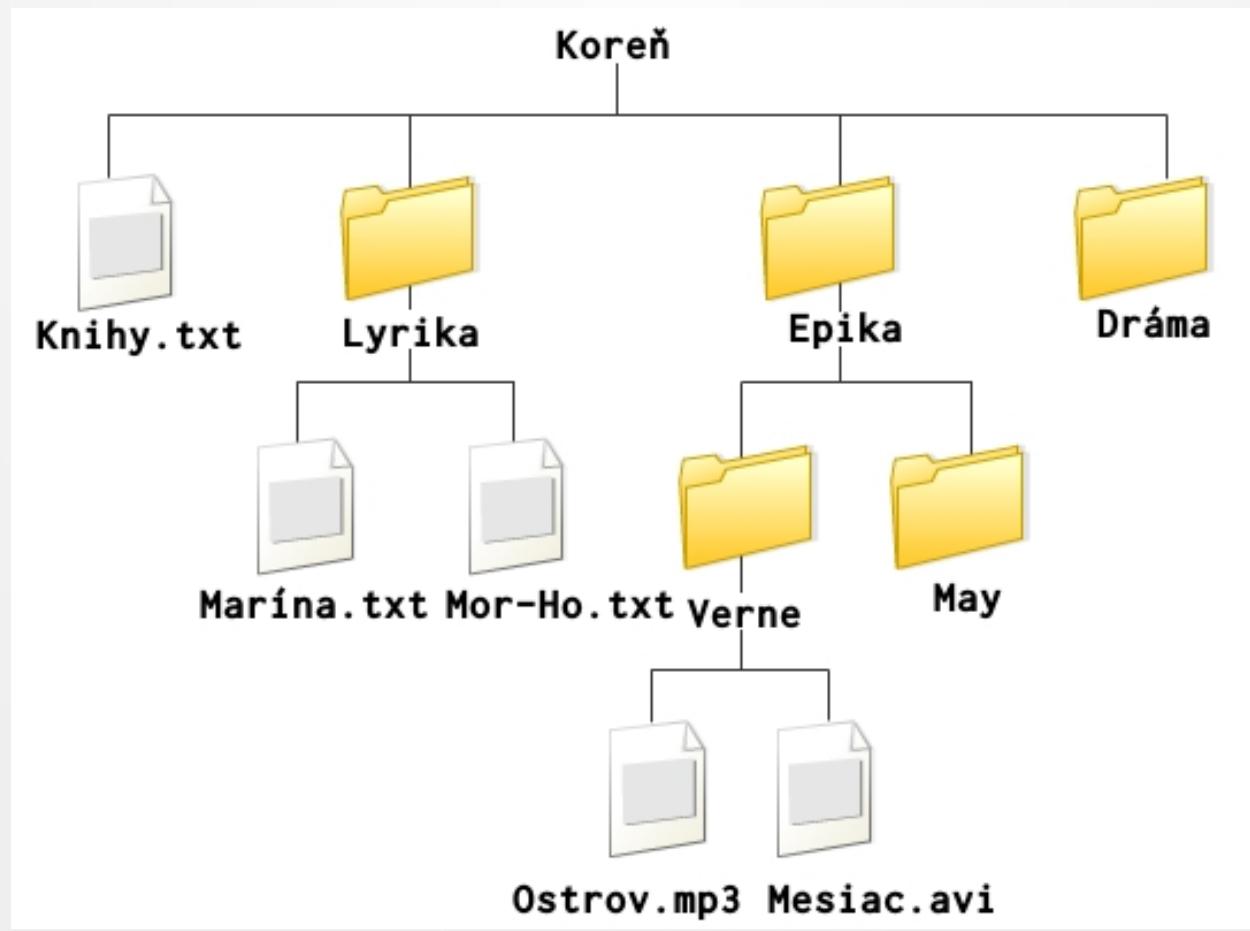


# File Allocation Table

00000050	20 20 46 41 54 33 32 20	20 20 0e 1f be 77 7c ac	FAT32	...w .
00004000	ff ff ff 0f ff ff ff 0f	ff ff ff 0f 04 00 00 00	.....	.....
00004010	05 00 00 00 06 00 00 00	ff ff ff 0f 0a 00 00 00	.....	.....
00004020	14 00 00 00 ff ff ff 0f	00 00 00 00 ff ff ff 0f	.....	.....
00004020	f7 ff ff 0f 1a 00 00 00	ff ff ff 0f 00 00 00 00	.....	.....
*				
003cb840	49 4e 46 4f 20 20 20 20	54 58 54 20 00 64 3c 80	INFO	TXT .d<.
003cb850	d7 4c d7 4c 00 00 3c 80	d7 4c 04 00 18 01 00 00	.L.L..<..L.....	.....
003cb860	53 55 42 44 49 52 20 20	20 20 20 10 00 64 61 80	SUBDIR	..da.
003cb870	d7 4c d7 4c 00 00 61 80	d7 4c 03 00 00 00 00 00	.L.L..a..L.....	.....
*				
003cd800	49 6e 66 6f 72 6d 61 74	69 6f 6e 20 69 73 20 61	Information is a	
003cd810	6e 79 20 65 6e 74 69 74	79 20 6f 72 20 66 6f 72	ny entity or for	
003cd820	6d 20 74 68 61 74 20 70	72 6f 76 69 64 65 73 20	m that provides	
003cd830	74 68 65 20 61 6e 73 77	65 72 20 74 6f 20 61 20	the answer to a	

# Stromová hierarchia

- Súborový systém
  - Adresáre (Directory, Folders)
  - Súbory (Files)
  - Odkazy (Links)
- Navigácia: cesty
  - absolútne */Epika/Verne/Ostrov.mp3*
  - relatívne *Verne/Ostrov.mp3*, *./*, *../*



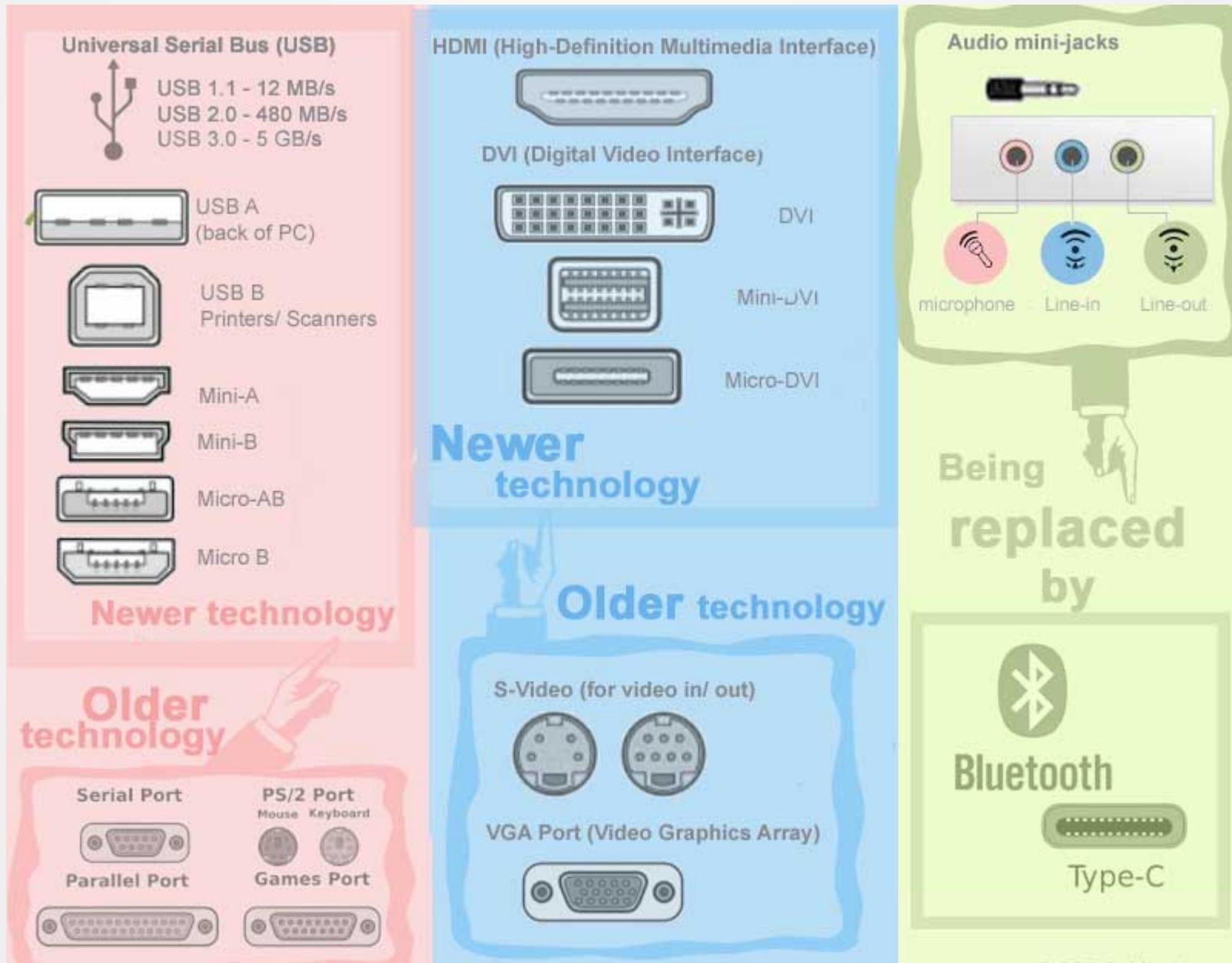
# Vlastnosti súboru (metadáta)

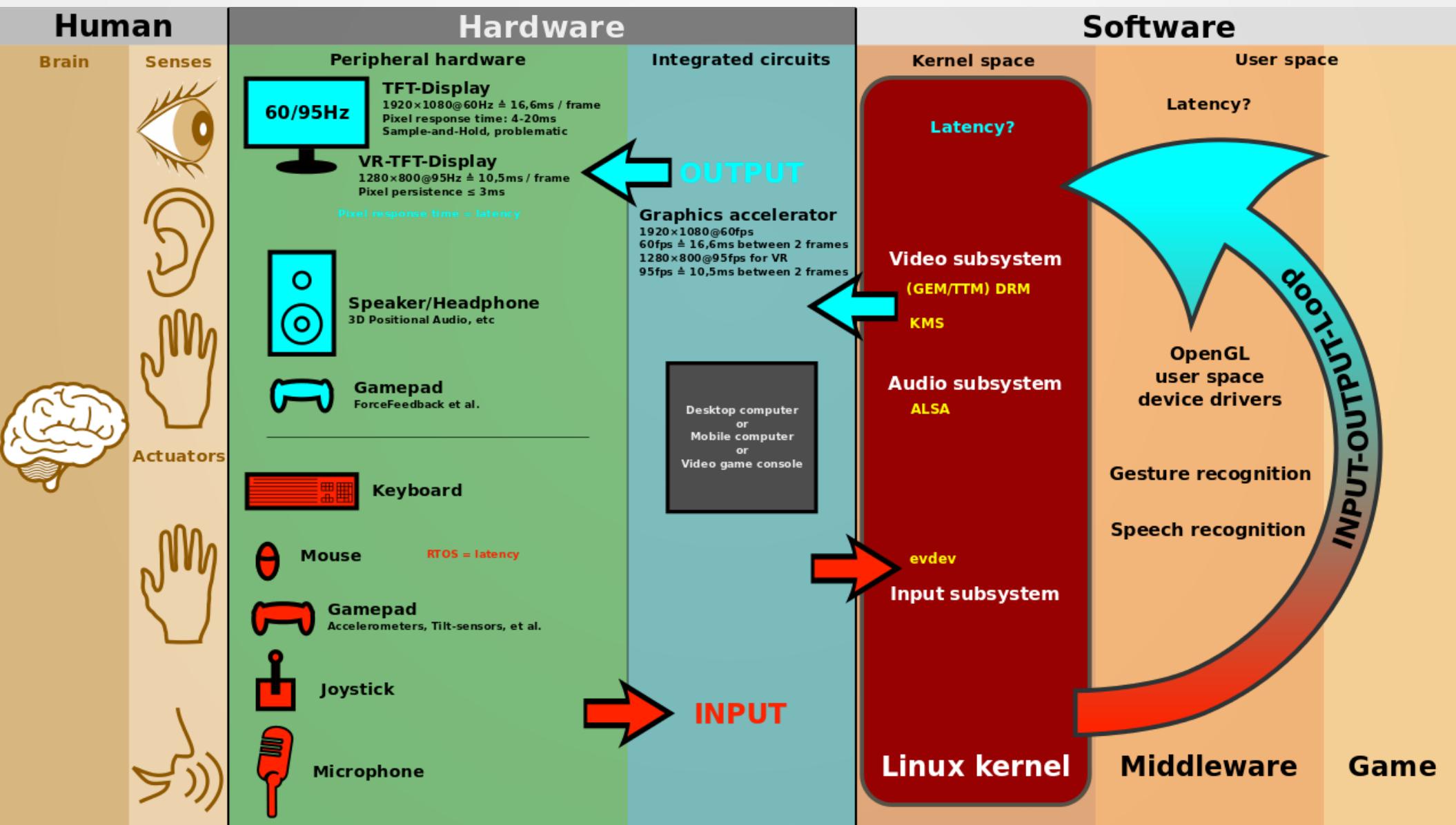
- Názov – subor.txt
- Formát – určený príponou / magickým číslom
- Veľkosť – v Bytoch
- Časové značky – vytvorenie, úprava
- Práva prístupu (rwx) – Užívateľ, Skupina, Ostatní

- Operácie so súbormi:
  - Vytvor – Vymaž
  - Otvor – Zatvor
  - Čítaj – Zapíš

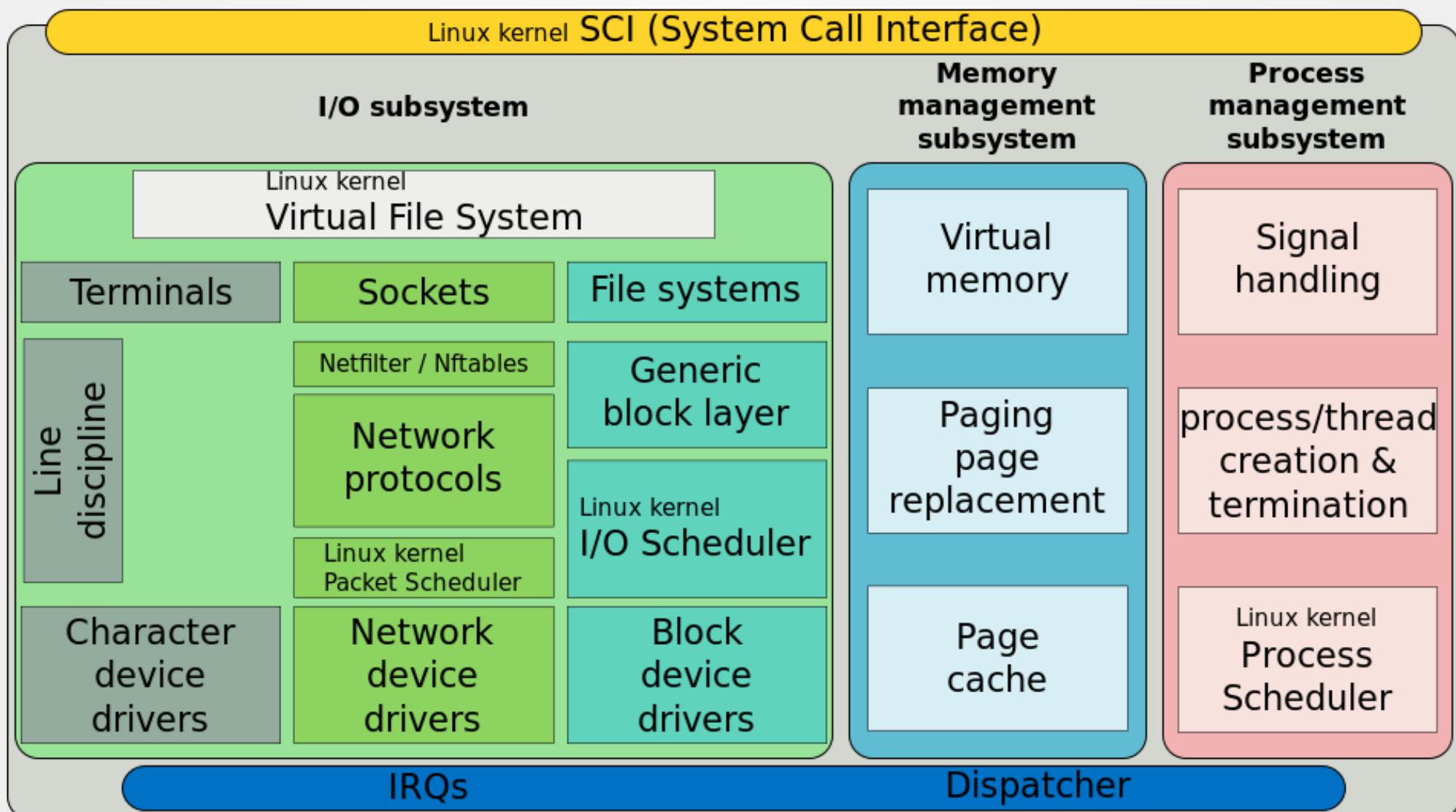
The screenshot shows a Windows desktop environment with several windows open. On the left, a File Explorer window displays a list of files in the 'Článok' folder, including 'Rozhovory', 'kniha.pdf', 'kvet.jpg', 'pocitace.txt', 'skladba.mp3', and 'text-clanku.doc'. The 'pocitace.txt' file is selected. To the right of this is a 'Properties' dialog box for 'pocitace.txt - vlastnosti'. The 'Všeobecné' tab shows the file is a 'Textový dokument (.txt)' located at 'C:\Users\9\Documents\Článok'. The 'Zabezpečenie' tab shows ownership by 'SYSTEM' and 'Administrators', and a list of permissions for 'SYSTEM'. The 'Podrobnosti' tab shows detailed file information like creation and modification dates. At the bottom of the properties window are buttons for 'OK', 'Zrušiť', and 'Použiť'. Below the properties window is another 'Properties' dialog box for 'pocitace.txt - vlastnosti', specifically for the 'SYSTEM' account. It lists various permissions like 'Upravy', 'Čitanie a vykonanie', and 'Zapisovať' with checkboxes indicating they are enabled.

# Ovládače periférnych zariadení





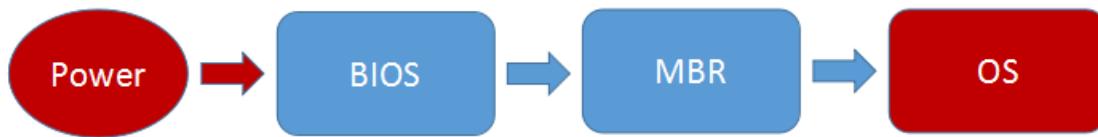
# Súčasti jadra OS (Linux)



<https://github.com/torvalds/linux>

<https://elixir.bootlin.com/linux/latest/source>

# Bootovanie (x86)



## 1) CPU (Reset Vector)

- EIP register: 0xFFFF FFFF (ROM)

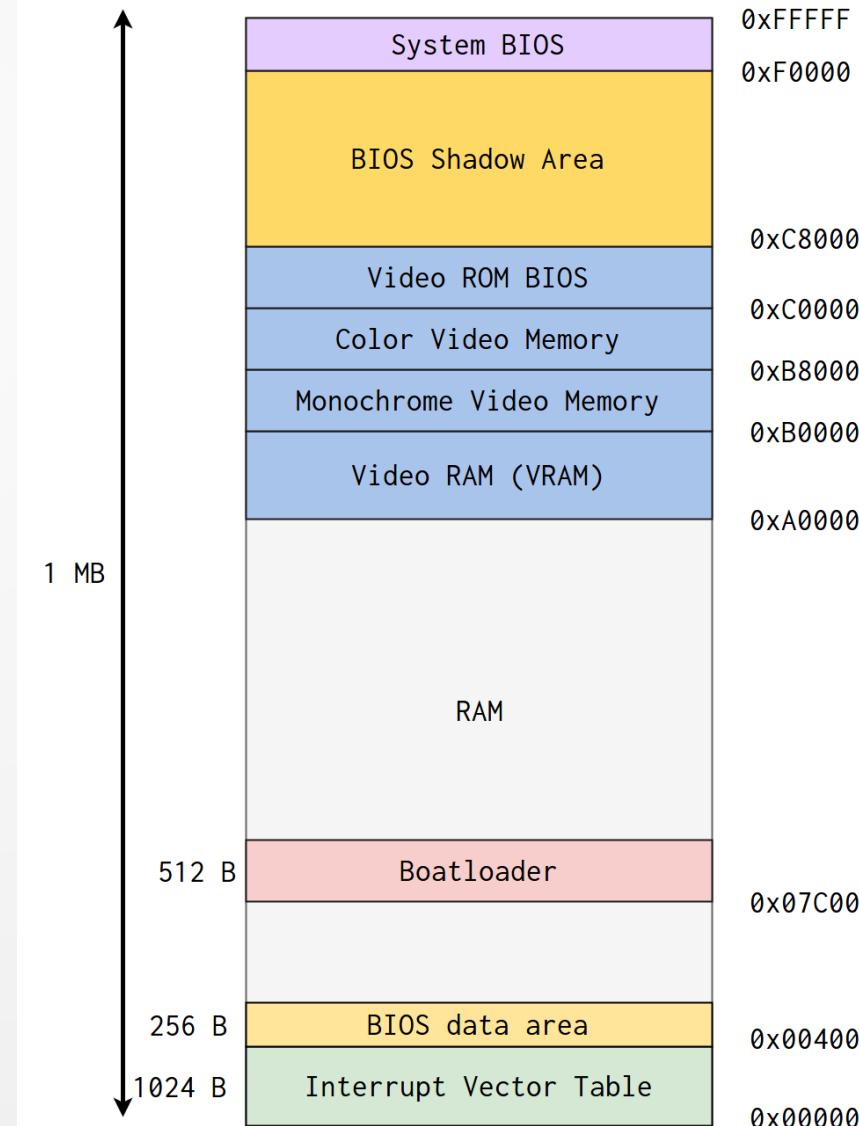
## 2) BIOS / UEFI

- POST (Power On Self Test) –  
Detekcia a nastavenie hardvéru

## 3) Bootovací sektor (0xAA55) skopíruje na 0x7C00 a vykoná kód

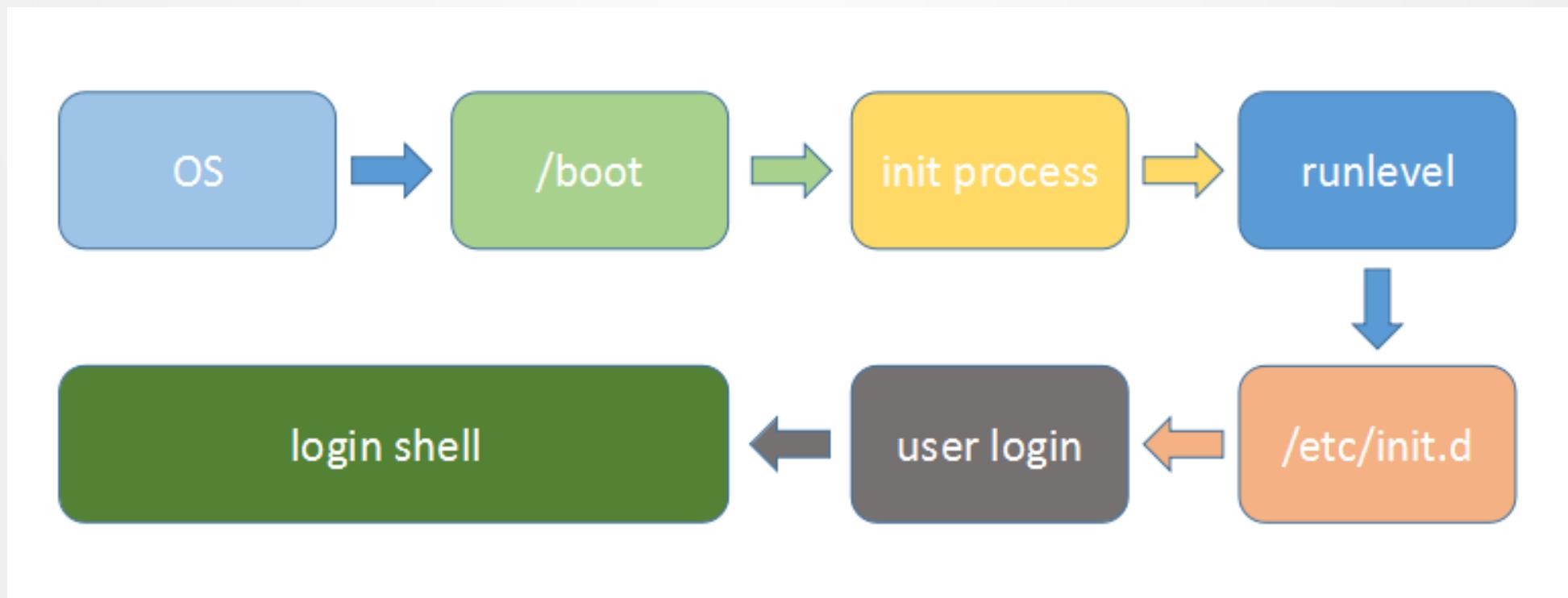
## 4) Bootloader (GRUB) zavedie OS na 0x100000

Low Memory (Real mode)



# Bootovanie (OS - Linux)

- Načítanie harvérových nastavení od BIOSu
- X86: Real mode (16b) -> Protected mode (32b) -> Long Mode (64b)
- Nastavenie OS (Prerušenia, Plánovač, MMU, SMP)
- Vytvorenie procesu: ***init (PID 1)***



# Ďakujem za pozornosť

*„Computer programs are the most intricate, delicately balanced and finely interwoven of all the products of human industry to date.“*

*- James Gleick*

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