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| Special Characters | |
| & | Background job |
| # | Comment |
| ~ | Home Directory |
| ! | Logical NOT |
| ‘ | Quote (Strong) |
| “ | Quote (Weak) |
| < | Redirect input |
| > | Redirect output |
| >> | Redirect output + append to file |
| | | Redirect (pipe) output to next command |
| / | Separator for pathname directories |
| ; | Separator for shell commands |
| [ ] | Start and end a character-set wildcard |
| { } | Start and end a command block |
| ( ) | Start and end a subshell |
| (( )) | Perform arithmetic |
| \* | Wildcard |
| ? | Wildcard – single character |
| $ | Variable expression |
| \ | Escape a special character |
| n>&m | Descriptor n is a copy of ouput file descriptor m |
| n<&m | Descriptor n is a copy of input file descriptor m |

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| String Operators | |
| ${varname:-word} | Returns word |
| ${varname:=word} | Sets and returns word |
| ${varname:?message} | Prints message and exits |
| ${varname:offset:length} | Returns substring |
| ${varname:+word} | If varname is defined, return word |

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| Pattern-matching operators | |
| ${varname#pattern} | Match first from the start |
| ${varname##pattern } | Match last from the start |
| ${varname%pattern} | Match first from the end |
| ${varname/pattern/replace} | Match longest and replace |
| ${varname//pattern/replace} | Match all and replace |

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| Variables | |
| $0, $1, $2, | Positional parameters |
| $@ | “$1” “$2” “$3” … |
| $\* | A string of positional params > 0 |
| $# | Number of positional params |
| $? | Exit status of last command run |

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| Functions | |
| define | function myfunction { … }  *or*  myfunction ( ) { … } |
| call | myfunction arg1 arg2 … |
| keywords | local – limit var scope |

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| If / else conditions | |
| x && y | If x runs, then run y |
| x || y | If x fails, then run y |
| x -a y | x AND y |
| x -o y | x OR y |
| -lt, -le, -eq, -gt, -ge, -ne | Integer comparisons |
| =, !=, <, > | String comparisons |
| -n str1 | str1 has length > 0 (nonzero) |
| -z str1 | str1 has length 0 (zero) |
| -d file | File exists and is a directory |
| -e file | File exists |
| -f file | File exists and is a regular file |
| -r file | User has read permission on file |
| -s file | File exists and is non empty |
| -w file | User has write permission on file |
| -x file | User has execute permission on file, or search if directory |
| -N file | File was modified since it was left read |
| -O file | User owns file |
| -G file | File’s group ID matches the user’s group ID |
| file1 -nt file2 | file1 has newer modification time than file2 |

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| Flow control sentences | |
| if | if *condition*; then  *commands*;  fi |
| for | for ((*init*; *condition*; *increment*)); do  *commands*;  done |
| for | for *var* in *array*; do  *commands*;  done |
| case | case *expression* in  *pattern1*) *commands* ;;  *pattern2*) *commands* ;;  \*) *commands* ;;  esac |
| while | while *condition*; do  *commands*;  done |
| until | until *condition*; do  *commands*;  done |

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| Arrays | |
| Arr\_name=(‘el1’ ‘ el2’ ‘el3’) | define |
| Arr\_name[index] | Element #index |
| Arr\_name[-1] | Last element |
| Arr\_name[@] | All elements, space-separated |
| #Arr\_name[@] | Array length |
| #Arr\_name[index] | String length of the Nth element |
| Arr\_name[@]:m:n | Range (from position m, length n |
| !Arr\_name[@] | Keys of all elements |
| Arr\_name=("${Arr\_name[@]}” “newElement”) | Push |
| Arr\_name+=('newElement’) | Also Push |
| unset Arr\_name[n] | Remove one item |

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| Dictionaries | |
| declare –A dict | Define |
| dict[key]=”value” | Define value of a key |
| dict[key] | Value of a key |
| dict[@a] | All values |
| !dict[@] | All keys |
| #dict[@] | Number of elements |
| unset dict[key] | Delete the key |

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| Useful Commands | |
| type <cmd> | Determine type of command:  -a ; displays all the locations |
| builtin <cmd> | Run builtin commands explicitly |
| which <cmd> | Locate the executable of a command:  -a ; show all locations |
| clear | Clear the terminal screen |
| echo “str1” | Print message to terminal screen:  -e ; uses escape sequences like (\n = newline, \t = tab)  -n ; supresses automatic newline after print |
| printf <format> <variables> | Print messages to terminal screen. Formatting be like:  %s – String  %-Xs – String wide X chars, left aligned  %Xs – String wide X chars, right aligned  %d – Integer (%-Xd, %Xd)  %f – Float  %.Xf - Round to X decimal spaces |
| date <options> <+format> | Will display date and time. Formats (“+%Y-%m-%d”):  %Y – Year, %m – month, %d – day, %H – hours, %M – minutes, %S – seconds, (%A uppercase for full name) %a – DayOfTheWeek, (%B) %b - Month  Options (-d “yesterday”):  “yesterday”, “next Monday”, |
| read <options>  <variable> | Read input from user or file and store into variable (read var1). Options:  -p “Text” : print before input  -a : store the input in array |
| history <options> | Display the command history for that session. Options:  -c : clear the history  -X : print the last X commands  -a : appends history to bash history file  -d X : deletes the command with index X from history |
| sleep <num\_time> | Delay the execution of a script. Num\_time:  Xs : delay for X second(s) (default)  Xm : delay for X minute(s)  Xh : delay for X hour(s) |
| man <command> | Opens the manual pages for the <command>. |
| ls <options> <path> | List the files and directories in the current working directory or given path. Options:  -l : list detailed view for files  -a : show all files, even hidden  -alp : ??? |
| pwd | Display the current working directory. |
| cd <directory> | Change the current working directory. <directory>:  ‘/path’ : changes directory to path  ‘..’ : changes to parent directory of the current one  ‘~username’ : changes to home directory for username  ‘-’ : changes to previous working directory used |
| mkdir <directory> | Creates new directory. <directory> can be:  ‘d1’ : creates new directory called d1  ‘d1’ ‘d2’ ‘d3’ : creates more directories in the current one  -p ‘d1/d2’ : creates d1 and another directory d2 as d1’s child |
| rmdir <directory> | Works the same as mkdir, but it deletes the directory if it is empty. |
| cat <file> | Display the contents of the file on the terminal. <file>:  ‘file.txt’ : displays file.txt  ‘f1.txt’ ‘f2.txt’ : displays files consecutively  -n ‘file.txt’ : displays file.txt with numbered lines |
| more, less, od, hexdump | More and less are both text viewers, od gives octal output and hexdump hexadecimal. |
| vi, vim, emacs, nano | File editors. Use ‘man file\_editor’ to learn how to use them. |
| cp <source> <destination> | Copy files or directories from source to destination.  cp file /path : copy file to path  cp –r directory /path : copy directory with all its contents to path |
| mv <source> <destination> | Moves files or directories from source to destination.  mv file /path : move file to path  mv directory /path : move directory to path  mv file.txt newfile.txt : renames file.txt to newfile.txt |
| rm <options> <file> | Remove or delete files from directories. Options:  -r: recursive  -f: force the removal |
| head <options> <file(s)> | Display the beginning of a text file.  -n X: specify the number of lines  -c X: displays X bytes and not lines |
| tail <options> <file(s)> | Display the last few lines of a text file. Counterpart to ‘head’.  -n X: specify the number of lines  -c X: displays X bytes, not lines |
| cut <options> <file> | -c X: specify positions to cut (1-5 file.txt wil extract first five from lines)  -f X: specify the fields to extract  -d X: specify the delimiter for cut |
| sort <options> <file> | Sort the lines of a text file al.  -r: reverse the lines order (Z-A)  -n: perform numerical sort instead  -u: outputs only the unique lines  -f: ignore cases |
| shuf <options> <file> | Generate random permutations.  -n X: Outputs at most X lines.  -o FILE: Writes the output to file  -r: allow repeated samples |
| nl <options> <file> | Add line numbers to a file or input stream. |
| uniq <options> <file> | Removes all consecutive lines. Options:  -c : also counts the amount of duplicates  -i : ignores the case  -d : outputs only duplicates  -u : outputs only the unique |
| rev <file> | Reverse the characters in each line of the input stream or file |
| tr <options> <set1> <set2> <file> | Translate or delete characters. Set1 is translated to Set2.  -d : removes the characters  -c : complement the Set1 |
| wc <options> <file> | Counts the number of lines, words, bytes. Options:  -l : only counts the lines  -w : only counts the words  -c : only counts the bytes |
| grep <options> <pattern> <file> | Search for specific pattern or regular expression. Options:  -i : ignore case  -v : invert the match (print only the lines not matching the pattern)  -w : match only whole words  -n : print the line numbers for each match  -r : search recursively through directories |
| shift <X> | Shift the positional parameters to the left. X is number of positions to shift. |
| jobs <options> | Display a list of jobs that are currently running in the background or are suspended. -l : also displays PID of a job  -p : displays only the PIDs  -r : displays the running jobs  -s : displays the stopped jobs |
| fg <JID> | Bring a job that is running in the background to the foreground. |
| bg <JID> | Start a suspended job in the background. |
| disown  %<JID> | Remove jobs from shell’s job control. (disown %2 : removes job with JID 2) |
| ulimit <options> | Display the resource limits of the current shell and its children.  -a : displas all current limits |

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| PROGRAMMING IN C | |
| syscall(x, …) | Make system calls in a program.  x: System call number  …: Arguments required for system call x |
| perror(char\* str) | Print a descriptive error message to stderr |
| open(path, flags, mode) | Open or create new files. Flags:  O\_RDONLY: read only  O\_WRONLY: write only  O\_RDWR: reading and writing  O\_CREAT: create file if not exist  O\_TRUNC: truncate file to 0 len |
| close(fd) | Close the file descriptor fd |
| read(fd, \*buffer, x) | Read data from a file or file descriptor fd. Stores read data to buffer and read x bytes. |
| write(fd, \*buffer, x) | Write x bytes from buffer to file descriptor fd. |
| printf(…) | Format and print data to stdout |
| dup(oldfd) | Duplicate an existing file descriptor oldfd to a new one |
| dup2(oldfd, newfd) | Duplicate an existing file descriptor oldfd to a specified file descriptor number newfd |
| rename(oldname, newname) | Change the name of an existing file or directory. |
| link(oldpath, newpath) | Create a new hard link to an existing file. |
| unlink(pathname) | Remove a specific file from the file system. |
| chmod(pathname, mode) | Change the permissions of a file or dir in the file system. |
| chown(pathname, owner, group) | Change ownership of a file or dir in the file system. |
| readdir(DIR \*dirp) | Used to read contents of a directory. |
| opendir(char\* dirname) | Open a directory. Returns DIR\* to directory system. |
| closedir(\*dirp) | Close a directory system. |
| chdir(path) | Change the current working directory of the process. |
| mkdir(path, mode) | Create new directory. |
| rmdir(path) | Remove or delete an empty dir |
| symlink(target, linkpath) | Create soft link / symbolic link. Linkpath references to target |
| readlink(path, buffer, buf\_size) | Read value of a symbolic link. |
| getuid(), setuid(), getgid(), setgid(),  geteuid(),getegid() | Get parameters:  UID – user ID, GID – group ID,  EUID – effective user ID |
| fork() | Create a new process by duplicating the existing process. Returns pid\_t -> 0 = child |
| exec() | Replace the current process with a new process.  execl(), execle(): take program name and a list of arguments  execv(), execvp(): take program name and an array of arguments  execve(): similar to execvp() but you can specify environment vars |
| wait(int\* status) | Make the parent process wait until one of its child processes terminates. |
| waitpid(pid, status) | Wait for specific process with pid to terminate. |
| exit(x) | Terminate the current process and return exit status x. |
| getpid(),  getppid() | Retrieve process ID,  retrieve parent process ID |
| sleep(x) | Suspend the execution of a program for x seconds. |
| pipe(int pipefd[2]) | Create an interprocess communication pipe.  pipefd[0]: file descriptor for read  pipefd[1]: file descriptor for write |
| kill(pid, sig) | Kill a signal to a specified process(es). |
| signal() | Specify the action to be taken when a particular signal is received by a process. |

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| USERS AND DOCUMENTS (Bash) | |
| whoami | Display the username of the current user |
| id | Display the user and group |
| groups <user> | Display the groups to which current user or <user> belongs |
| passwd <options>  <username> | Change or update the password of a user account |
| $UID | Variable, holds user id |
| $HOME | Variable, holds the absolute path to current user’s home dir |
| sudo <options> <command> | Execute commands with elevated privileges |
| su <options> <username> | Switch to user <username> |
| useradd, userdel, usermod | Create new user, delete an user, modify user account |
| groupadd, groupdel, groupmod | Create new group, delete a group, modify group |
| ln -s <target> <link\_name> | Create soft link with link\_name that refers to target file or dir |
| ln <target> <link\_name> | Create hard link or directory links. |
| readlink <link\_name> | Display the target of a symbolic link |
| chown <user><:group> <file(s)> | Change the ownership of files or dirs. <user> and <:group> represents new owners. |
| chgrp <group> <file(s)> | Change the group ownership of files or directories |

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| PROCESSES, SIGNALS, PIPES (Bash) | |
| ps | Display information about active processes running on system |
| pidof <program\_name> | Find the process ID (PID) of a running program based on name |
| pgrep <pattern> | Find PIDs by pattern |
| pstree | Display a tree-like representation of running processes |
| top | Monitor and manage system resources in real-time |
| kill <options> <pid(s)> | Send a signal to terminate to processes. Options:  -s sig: sig(SIGTERM, SIGKILL, SIGINT)  -a: send signal to all processes |
| trap <action> <signal(s)> | Define actions to be taken when specific signals are received.  action -> command to be executed when signal(s) received |
| <cmd> | <cmd> | Pipe (no explanation needed) |

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| THREADS (C) | |
| pthread\_t tx | Object that stores thread id |
| pthread\_createt(thread, attr, start\_routine, arg) | Create a new thread within multi-threaded program.  thread:pointer to pthread\_t  attr:attributes for a thread  start\_routine: pointer to the function that will be executed by the new thread  arg:optional arguments |
| pthread\_join(thread, \*\*value\_ptr) | Wait for a specific thread to terminate. Value\_ptr is optional for saving exit stat |
| pthread\_yield() | Voluntarily yield the processor by suspending the execution of the calling thread |
| pthread\_cancel(thread) | Request the cancellation of a specified thread. |

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| Teorija ½ polovica |
| strojna oprema (hw):  -fizična rač. oprema  -procesor,pomnilnik, I/O |
| software: brez fizične oblike podatki in programi SPO: OS, gonilniki, lupina, sistemski ukazi, upravljanje diska |
| Lupina: Uporabniski program, ki nudi osnovni uporabniski vmesnik za upravljanje racunalniskega sistema upravljanje z datotekami, procesi, napravami in s programi nadzor in konfiguracija OS |
| Graficna lupina preprosta za uporabo graficni uporabniski vmesnik (GUI) napredne vnosne naprave (tipkovnica, miska, …) |
| Arhitektura: Graficni vmesnik (graphical interface): desktop environment graficni elementi (okna, ikone, meniji, …) interaktivni elementi (kurzor, izbira, …) Prikazni streznik (display server): kominikacija z aplikacijami po protokolu posreduje dogodke I/O naprav upravlja izris oken (window manager) izris graficnih primitivov (crta, pravokotnik, …)  Upravitelj oken (window manager) program, ki nadzoruje postavitev in prikaz oken pogosto zdruzen s prikaznim streznikom nacini upravljanja oken (skladovni, ploscicni, kompozitni in dinamicni)  Operacijski sistem (video / GPU podsistem) Framebuffer naprava (/dev/fb0): dostop do video pomnilnika, upravljanje video naprave, …  Direct rendering manager (/dev/dri/card0): podsistem za upravljanje z GPU napravami  okna: skladovna, ploscicna, dinamicna, kompozitna |
| Ukazna lupina imenujemo jo tudi tekstovna tekstovni uporabniski vmesnik napredna uporaba (programiranje, preusmerjanje vhoda in izhoda) tezja za uporabo kot graficna REPL (read-evaluate-print loop) Tekstovni terminal (konzola): ukazna lupina tece v terminalu Psevdo terminal: program, ki emulira tekstovni terminal. Lahko tece v graficnem okolju |
| Lupina bash: avtomatko dopoljevanje ukazov in zgodovina preusmerjanje, cevovodi izvajanje v ozadju Vgrajeni ukazi: jih neposredno podpira lupina  Zunanji ukazi: nekje v /bin ali /usr/bin  type ukaz: tip ukaza  $PATH: pot, kjer so zunanji ukazi  which ukaz: pot do ukaza man ukaz prirocnik za zunanje ukaze |
| Sistemska orodja  Upravljanje datotecnega sistema: konsistentnos strukture, ciscenje, kompresija, etc.  Delo z datotekami: file manager, arhiverji, varnost, sinhronizacija, etc. Urejevalniki teksta: uproraba pri upravljanju sistema, hex urejevalniki, ukazni (premik po tekstu, etc.) in urejevalni (vstavljanje in brisanje) nacin Sistemska orodja: analiza delovanja sistema, konfiguracija, optimizacija, varnost, mrezna, etc. Razvojna orodja: programska oprema za razvoj programske opreme vrste: programerski, prevajalniki, povezovalniki, etc. |
| Operacijski sistem  nabor programske opreme nadzoruje izvajanje programov povezuje uporabnika s strojno opremo deluje kot vmesnik med programi in strojno opremo Vloge: sistemski vpogled upravljanje racunalniskih virov nadzor nad delovanjem ponudnik sistemskih storitev Sestavljen iz jedra, gonilnikov, lupine in sistemskih orodji  Storitve: upravljanje z uporabniki, procesi, pomnilnikom, datotecnimi sistemi in datotekami, I/O napravami, medprocesna komunikacija, …  Cilji: ease of use, security, reliability, performanceflexibility |
| Abstrakcija: posplositev in skrivanje podrobnosti poenotenje in zdruzevanje podobnih entitet v eno krovno (primer datoteka)  Virtualizacija mehanizem, ki nekaj ustvari navidezno (navidezna naprava, pomnilnik, procesor) preslikava navideznega v realno  Abstrakcija in virtualizacija: komplementarna koncepta. Primer: navidezni datotecni sistem VFS nudi enovit dostop do datotek, zdruzuje razlicne naprave in vkljucuje razlicne datotecne sisteme  Varnost: zaupanje v dobro delovanje sistema in jo dosezemo prek mehanizmov zascite sistema  Socasnost: obstoj vec procesov hkrati obcutek hkratnega izvajanja vec procesov  Persistenca: dolgorocni obstoj podatkov in informacij ucinkovitost hrambe omogoca medprocesno komunikacijo (npr datoteka) |
| Jedro programska koda, ki vsebuje bistveni del OS (npr upravljanje s procesi in pomnilnikom) izvaja se v priviligiranem nacinu delovanja procesorja (obvladuje celoten sistem)  Procesorki nivoji zascite:  Uporabniski prostor (zasciten nacin): omejena uporaba procesorja, napacna uporaba povzroci izjemo  Jedrni prostor (priviligiran nacin): neomejen dostop do pomnilnika in naprav, nekateri ukazi se lahko izvajajo samo v tem nacinu  Komunikacija med jedrom in strojno opremo: naprava: dejanska naprava (npr tipkovnica)  kontrolnik naprav: elektronska vezja, ki razumejo ukaze podane na vmesniku in jih posredujejo napravi (npr USB kontrolnik)  vmesnik strojne opreme: mehanizem programskega podajanja ukazov napravam (npr pomnilnisko preslikan I/O)  gonilniki naprav: programska koda, ki zna upravljati z napravo preko vmesnikov strojne opreme (niso del jedra) |
| Arhitektura jedra struktura in nacin povezovanja med posameznimi deli jedra  Monolitno jedro: velik kos strojne kode (vsebuje cel OS) deli OS lahko hitro komunicirajo preko klicev funkcij napaka v enem delu OS sesuje cel OS tezja obvladljivost programske kode sprememba izvorne kode -> ponovno prevajanje jedra DOS, FreeDOS, Windows 9x  Monolitno modularno jedro: modularna zasnova jedra (modul vsebuje gonilnik naprave) module je moc vloziti in izlociti iz jedra tekom izvajanja  Mikro jedro: vsebuje samo osnovne funkcionalnosti, ostale funkcionalnosti so izvedene preko procesov medprocesna komunikacija (odjemalec-streznik) medsebojni klici so casovno zahtevnejsi prilagodljivost, varnost, porazdeljenost in enostavnejsa implementacija Hibridno jedro: zasnova je mikro jedro, izvedba pa monolitna (npr Windows NT)  Nano jedro: manjse mikro jedro  Exokernel: manjse mikro jedro, omogoca le zascito in souporabo virov  Unikernel: specificno namensko jedro za izbrano aplikacijo |
| Sistemski klici mehanizem preko katerega uporabniski program zahteva jedrno storitev vsak klic ima svojo stevilko, prejme lahko tudi argumente stevilke in argumenti se prenasajo preko registrov in sklada  Tabela rokovalnikov sistemskih klicev: i-ti element tabele je naslov rokovnika  Preklop nivoja zascite procesorja: direkten klic podprograma v jedru sprozi izjemo zato s pomocjo strojne opreme izvedemo preklop v priviligiran nacin in klicemo podprogram  Sistemski vmesnik - preklop v jedro:  Namenski strojni ukaz: procesor naredi prekop in poklice namesceni rokovalnik sistemskih klicev v jedru Programska prekinitev: procesor naredi preklop in poklice namesceni rokovalnik prekinitve v jedru  Izvedba sistemskega klica:  priprava: podajanje st. sistemskega klica in arg  vstop v jedro: preko sistemskega vmesnika, preklopimo v priviligiran nacin in sprozimo rokovoalnik  izvedba rokovalnika sistemskega vmesnika: preverimo st klica in klic specificnega rokovalnika  izvedba rokovalnika sistemskega klica: navaden klic rutine znotraj jedra  izstop iz jedra: preklop nazaj v uporabniski nacin |
| sistemski klic vs klic funkcije: sistemski klic je pocasnejsi (preklop nivoja zascite) izvedba rokovalnika klica je zahtevnejsa podpora procesorja: funckijski (strojni ukaz), sistemski (poseben mehanizem) za funkcijske je OS kot programska knjiznica funkcijski klici so manj varni lunkja v sistemskem klicu lahko sesuje celoten os luknja v funkcijskem klicu sesuje lahko le program sistemski klic je tudi mehanizem zascite Ovojne funkcije sistemskih klicev: neposredna izvedba je zahtevna (assembly) saj je potrebno rokovanje z registri in vstop v jedro Ovojna funkcija je namenjena izvedbi sistemskega klica je v standardni kljiznici npr fork (unistd.h)  Izvedba sistemskega klica:  neposredno: nastavitev registrov in vstop v jedro v zbirniku  specificne ovojne funkcije: predpripravljena ovojna funkcija iz knjiznice  splosne ovojne funkcije: syscall() posredno preko ostalih funkcij: npr printf() |
| API: application programming interface. Vmesnik za uporabo programskih knjiznic. Temelji na simbolicni predstavitivi  ABI: application binary interface. Temelji na stevilski predstavitvi.  POSIX - standard IEEE 1003: prenosljiv vmesnik operacijskega sistema programski vmesnik med aplikacijami in OS predpisuje funkcije, ukazno lupino, … standard omogoca prenosljivost programov |
| Nacela nacrtovanja varnosti: ekonomičnost mehanizma, odprta zasnova, varne privzete nastavitve, sprotno preverjanje, najmanjši privilegiji, ločevanje privilegijev, uporabniško prijazna, najmanjši skupni mehanizem |
| Nadzorni seznam dostopa: Dat1(A,lastnik,R,W)(C,W) Seznam zmožnosti: A:(1,lastnik,R,W)(2,R,X) |
| VFS: uporabniku nudi enoten vmesnik do različnih fizičnih sistemov  superblock: predstavitev priklop. d.s., type, velikost, kazalec na root dir  inode: datoteka poljubnega tipa, podatki razen imena, lastnik, št trdih. povezav, velikost,kaz. na bloke z vsebino  dentry: ime, kazalec na pripadajoč inode, na starš. imenik,  file: dat. deskriptor, odprta datoteka nekega procesa, kazalec na ustrezen dentry, pozicija v datoteki, d.s., |
| medij hrani bite oz. bajte, uporabnik datoteke OS premošča vrzel med medijem in uporabnikom  gonilnik bn: napravo predstaiv kot zaporedje blokov gonilnik ds organizira bloke med seboj in jim doda pomen  fizični ds: diskovni(minix, reiser,linux), mrežn(nfs)i, posebni (proc, sysfs, udev)  Fragmentacija: neučinkovita raba pomn. prostora, zmanjša zmogljivost,  Defragmentacija: postopek prerazporejanja dodeljenega pomnilnika  Notranja frag: zaradi fiksne velikosti bloka je loh zadnji blok datoteke le delno izkoriščen, kontroliramo z velikostjo  Zunanja: pojav neuporabljenih področij, ki so vsak zase premajhna za nadaljne dodelitve  Podatkovna: bloki posamezne datoteke niso hranjeni blizu skupaj (bližje – hitrejši dostopi)  Razdelitev diska na več delov-ločeni logični diski(particija)  Načini:  MBR – glavni zagonski zapis, 1. sektor diska vsebuje MBR zapis, vsebuje tabelo particij(4 primarne ali 3 prim 1 razširjena), 32 bitni LBA, torej 2^32 max naslovov, 2TiB premalo  GPT-del UEFI, privzeta podpora za vsaj 128 particij, velikost particij do več ZiB, večja toleranca na napake -zaščiteni MBR, -primarno GPT zaglavje(podpis,različica,velikost,GUID, velikost tabele particij,vnosa) -vnosi (partition entries) – tip, GUID, začetni/končni LBA, zastavice, ime -> -particije -ponovljen partition entries, redundantnost |
| VBR, primarna FAT, kopija FAT, korenski imenik, ostalo imeniški zapis(ime,končnica,atribut,čas,prvi grozd, velikost datoteke)  FAT TABELA-zaporedje grozdov, ki tvorijo datoteko, enojno povezani seznam, namest kazalcev idx grozdov FAT12,16-12&16bitno naslavlanje grozdov, fixed root dir  FAT32-28bit, rootdir kjerkoli, dodatni sektor za metapodatke partici |