

## Programska podrška mjernih i procesnih sustava

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Zavod za elektroničke sustave i obradbu signala

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## Memory Management

upravljanje memorijskim prostorom

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## Kada nam treba MM ?

- dva osnovna razloga
  - kad nemamo dovoljno RAM-a
    - čak i za samo jedan proces
  - kad želimo "istovremeno" izvoditi više procesa
    - čak i ako ima dovoljno RAM-a
- dva osnovna posla
  - procesoru se prikazuje prividna slika RAM-a
  - dio RAM-a se privremeno prebacuje u neki drugi medij (tipično disk)

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## Znači, MM nam ne treba ako imamo dovoljno RAM-a ?

- teoretski i približno: DA, ali ...
- porast RAM-a tipičnog osobnog računala:

1975	1980	1985	1990	1995	2000
16K	64K	640K	2M	16M	256M

- memorije nikad nema dosta, jer:

“programi rastu koliko ima raspoložive memorije”

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## Monoprogramming

- samo jedan proces u memoriji
- uz korisnički proces trebamo i OS
- OS može biti
  - cijeli u RAMu
  - cijeli u ROMu
  - u RAMu a device driveri u ROMu




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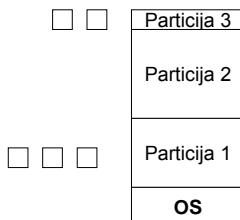
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## Multiprogramming s fiksnim particijama

više ulaznih redova čekanja



- particije su različitih veličina
- procese treba razvrstati u repove čekanja prema veličini
- neučinkovito kada manji procesi čekaju, dok je veća particija prazna

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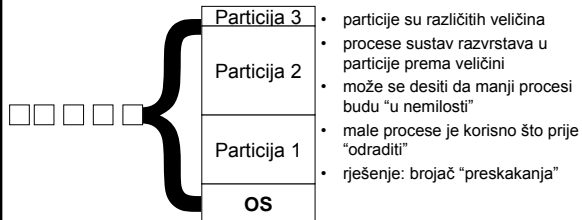
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## Multiprogramming s fiksnim particijama

jedan ulazni red čekanja




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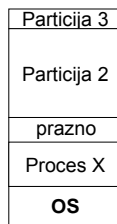
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## Multiprogramming s fiksnim particijama

internal fragmentation




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## Swapping

- "izmjena"
- procesi se iz memorije prebacuju u neki drugi medij (tipično na disk)
- potrebno uvijek kad ima manje memorije od procesa
- kod povrata procesa u RAM, slobodan prostor može biti raštrkan
- poseban je prostor na disku (swap area)
  - lagan pristup
  - u kontinuitetu
  - problem veličine

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## Praćenje korištenja memorije

- potrebno je voditi evidenciju koji dijelovi memorije su zauzeti, a koji su slobodni
  - bit mapa
  - povezane liste
- bit mapa
  - zauzima puno mjesta za veliku memoriju i mnogobrojne procese
- povezane liste
  - elegantno, ali ...
  - tipični problemi vezanih listi:
    - sporo traženje slobodnog mjesta

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## A što kad je jedan proces veći od RAMa ?

- očigledno se dijelovi procesa (program ili podaci) moraju bacati na disk i vraćati u RAM (swapping)
- podijelimo program u (relativno) nezavisne dijelove (overlays)
  - to mora učiniti čovjek: programer
  - problematično i naporno
  - ovisnost o konfiguraciji (memorije) računala
- automatski način: prividna memorija (virtual memory)
  - računalo radi samo
- najprikladnija organizacija memorije
  - u "stranicama" iste veličine
  - paging

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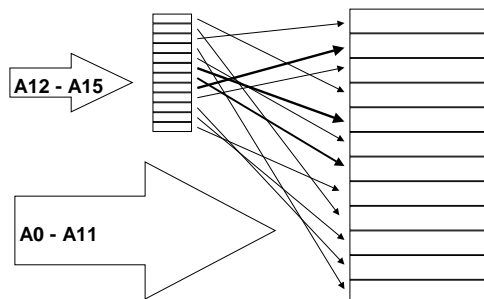
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## MMU




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## Virtual Memory LS&S

- kako memorijski prostor "vidi" procesor ?
  - kao paralelne memorijske ravnine
  - koje odabire stanje "context" registra
  - svaki proces u svojoj, odvojenoj ravnini

The diagram illustrates a processor labeled 'A0 - A15' with an arrow pointing towards a series of four vertical bars representing memory planes. Below these bars is a box labeled 'Context'. Arrows point from the 'Context' box to each of the four memory planes, indicating that the context register selects between different memory states for each plane.

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## Paging LS&S

- memorija podijeljena u fiksne "stranice"
- MMU vodi računa o fizičkom rasporedu
- MMU upozorava OS da treba napraviti razmjenu RAM-a s diskom
- ako su tablice prevelike:
  - multilevel paging
  - associative memory
- problem odluke o zamjeni stranica
  - paging algoritam

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## Višerazinski paging LS&S

- višerazinski paging
  - dvorazinski (VAX)
  - trofazinski (SPARC)
  - četverorazinski (Motorola 68030)

The diagram shows a 'context' box pointing to a 'context table'. From the context table, an arrow points to 'Index 1', which points to a box labeled '1. razina'. From '1. razina', an arrow points to 'Index 2', which points to a box labeled '2. razina'. From '2. razina', an arrow points to 'Index 3', which points to a box labeled '3. razina'. Finally, from '3. razina', an arrow points to a box labeled 'stranica' (page). A box labeled 'Offset' is also shown with an arrow pointing to the 'stranica' box.

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## Asocijativna memorija

LS&S

- sve tablice stranica (page tables) u RAMu
  - zauzima puno mjesta
- slabije korištene mogu biti na disku
  - sporo osvježavanje stanja i promjena konteksta
- rješenje: mali cache
  - s najčešće korištenim stranicama (i tablicama)
  - 32 do 64 podataka
- asocijativna memorija
  - ili translation lookaside buffer

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## Zero-level Paging

LS&S

- paging sveden na asocijativnu memoriju
- sam procesor ima tablicu od 64 elementa
- ako potrebna virtualna memorija nije u tablici
  - generira se prekid procesoru
  - dalje SW mora pronaci i ukrcati pravu tablicu za daljnji rad
- primjer: MIPS R2000
- motivi
  - ušteda prostora na CPU chipu
  - statistika potvrđuje učinkovitost

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## Paging algoritmi

LS&S

- optimalni
- Not-recently-used
- FIFO, First-In, First-Out
- Second Chance
- Clock
- Least Recently Used

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## Optimalni paging algoritam

- ovo bi bilo najbolje rješenje
- iz RAM-a vadi stranice koje će se najmanje ili u najkasnijoj fazi koristiti
- problem je što ne možemo znati koja će se stranica najmanje koristiti
- dakle, neostvarivo
- varijanta:
  - promatramo ponašanje sad
  - koristimo to kao pretpostavku u idućem prolazu

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## Programska podrška mjernih i procesnih sustava

[www.zesoi.fer.hr](http://www.zesoi.fer.hr)  
(<http://www.ZESOI.FER.hr/PPMPS>)

[ppmps@zesoi.fer.hr](mailto:ppmps@zesoi.fer.hr)

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