Process Migration - I

Models and Approaches

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Outline

- Introduction to Process Migration
- Models and Possibilities
- Load Balancing using Process Migration
- Migrating Resource Segment
- Challenges for creating Global Reference

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Definition

- Process migration is the mechanism to migrate code, data and state of execution from one node to another in a distributed systems.
- Moving a running process to a different machine is a costly and intricate task, and there has to be good reason(s) for doing so.

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Motivations

- Load balancing between nodes
- Minimize communication
- Due to the heterogeneity in the system, performance improvement through process migration is often based on qualitative reasoning
  - Migration of process to data location
  - Migration of data to process location

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Fugetta's Framework

- Code Segment:
  - contains the set of instructions that builds the program being executed.
- Resource segment:
  - stores external resources or references to those like files, devices, data, etc.
- Execution segment:
  - stores current execution state of a process.

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Migration Models

- Weak Mobility / Non pre-emptive:
  - In this model, it is possible to transfer only the code segment, along with perhaps some initialization data.
  - Migrated process restarts from its initial state.
  - The benefit of this approach is its simplicity.
  - Weak mobility only requires that the target machine executes the code - this essentially boils down to making the code portable.
  - *e.g., Java applets*

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Migration Models

- Strong Mobility / Pre-emptive:
  - Here, the execution segment can be transferred along with the code segment.
  - The characteristic feature of strong mobility is that a running process can be stopped, subsequently moved to another machine, and then resume execution where it left off.
  - More powerful than weak mobility and harder to implement.

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Migration Models

- Sender Initiated Migration:
  - Sender-initiated migration is initiated at the machine where the code currently resides or is being executed.
    - sending a search query across the system to find a compute server
    - uploading programs to the compute server

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Migration Models

- Receiver Initiated Migration:
  - The initiative for code migration is taken by the target machine.
  - Java applets are an example of this approach.
- Receiver-initiated migration is often simpler to implement than sender-initiated migration.

Uploading versus Downloading

- Securely uploading code to a server often initiated by sender requires that the client is previously registered and authenticated for the server.
- The client is expected to access the server's resources such as its disk, file system, etc.
- Protecting such resources is essential.

Uploading versus Downloading

- In contrast, downloading code at receiver initiation can be anonymous.
- The server is generally not interested in the client's resources.
- Code migration to the client is done for improving client-side performance.
- Thus only a few of the resources like memory are to be protected.

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Execution in Target Process

- In case of weak mobility, two things may happen:
  - the migrated code is executed in the target process
  - a separate process is created.
- e.g., Java applets are simply downloaded by a Web browser and are executed in the browser's address space.

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Execution in Target Process

- In this approach, there is no need to start a separate process – lower overhead for communication at the target machine.
- The main drawback is that the target process needs to be protected against malicious or inadvertent code executions.
- A simple solution is to let the operating system take care of that by creating a separate process to execute the migrated code.

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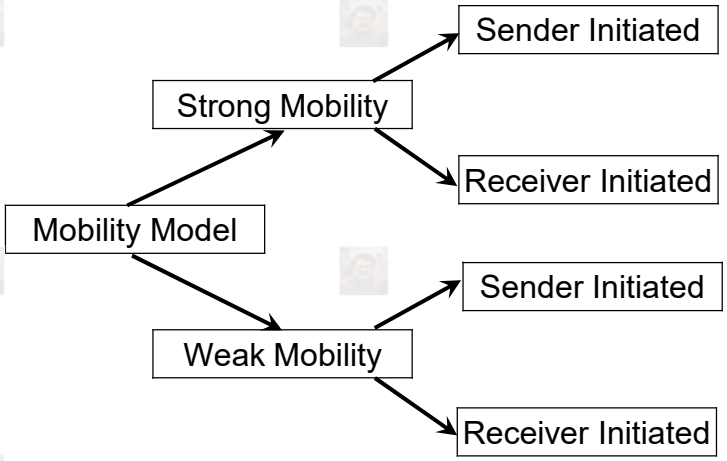
Process Migration Options



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Sender Initiated Migration

- A node having load higher than a pre-set upper threshold is referred as a Sender node
- Possible metrics could be, e.g.,
  - Number of jobs in ready queue
  - Throughput
  - Number of jobs in running, or blocked state
- Similarly, a node with load less than a pre-set lower threshold is called a Receiver node

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Sender Initiated Migration

- There should be an interval between the two thresholds, so that by releasing or accepting one, or two jobs a Sender does not become Receiver and vice versa
- A Sender node poles an arbitrary node and waits for response
- When the overall load of the system is low, this response time will be low as well
- Response time keeps on increasing with heavier loads; Sender poles another node

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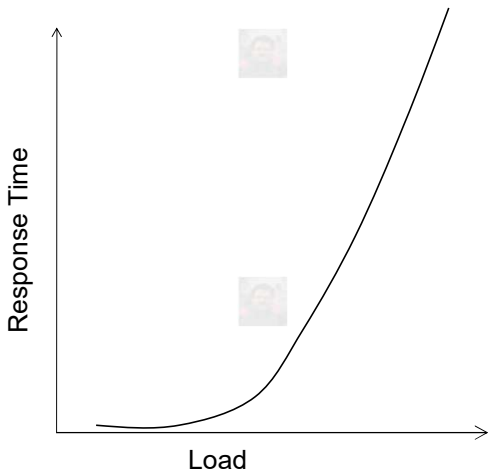
Sender Initiated Migration



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Sender Initiated Migration

- Excessive poling in a heavily loaded system adds to congestion and could worsen the performance of the system as a whole
- This is a type of thrashing
- In order to prevent this, a Sender node is allowed to pole a MAX number of times before it must wait for D interval to allow change of load in the system

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Receiver Initiated Migration

- A Receiver node poles an arbitrary node requesting job and waits for response
- When the overall load of the system is low, the response time will be high
- Response time keeps on decreasing for increase in system load
- Here too, excessive poling adds to congestion; but this happens when the system is having low average load

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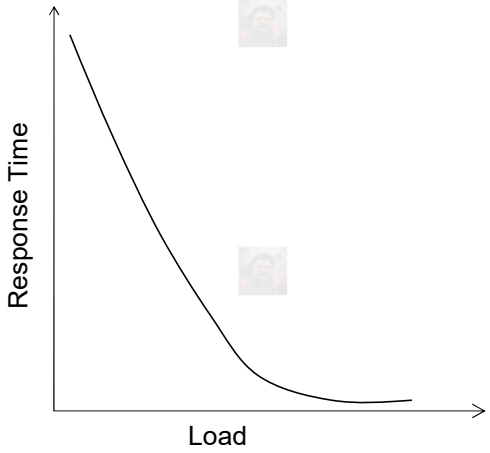
Receiver Initiated Migration



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Receiver Initiated Migration

- In order to prevent polling, a Receiver node is allowed to pole a MAX number of times in a single go
- Thus receiver-initiated migration ensures low response time in highly loaded system and appears to be a better option
- Is it necessarily so?

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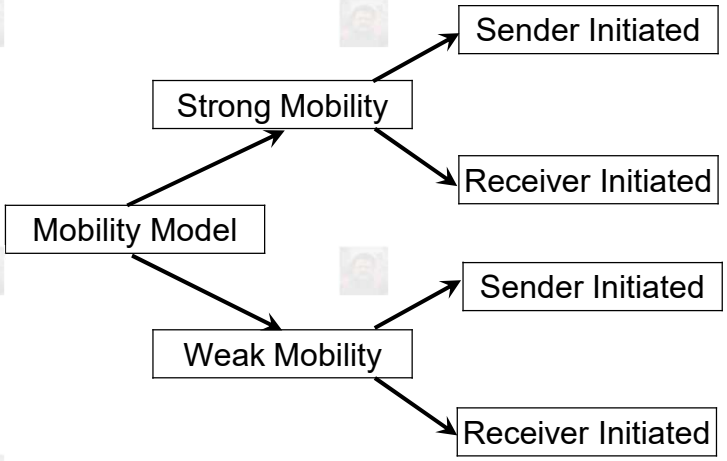
Process Migration Options



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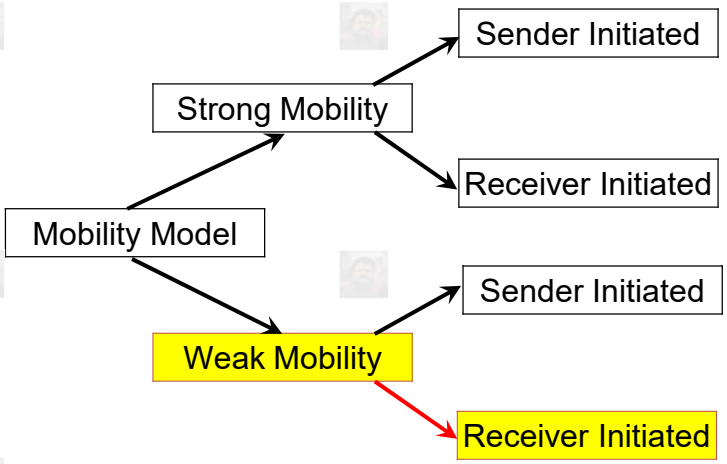

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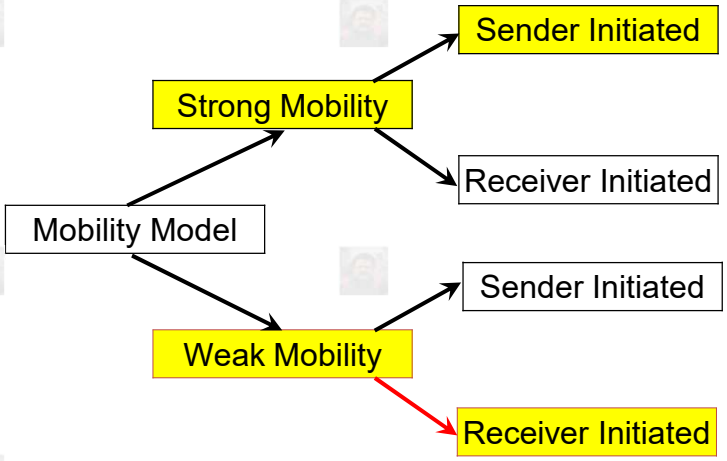

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Thanks for your kind attention

Questions??

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