Unit-IV

Distributed Shared Memory

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General Architecture of DSM Systems

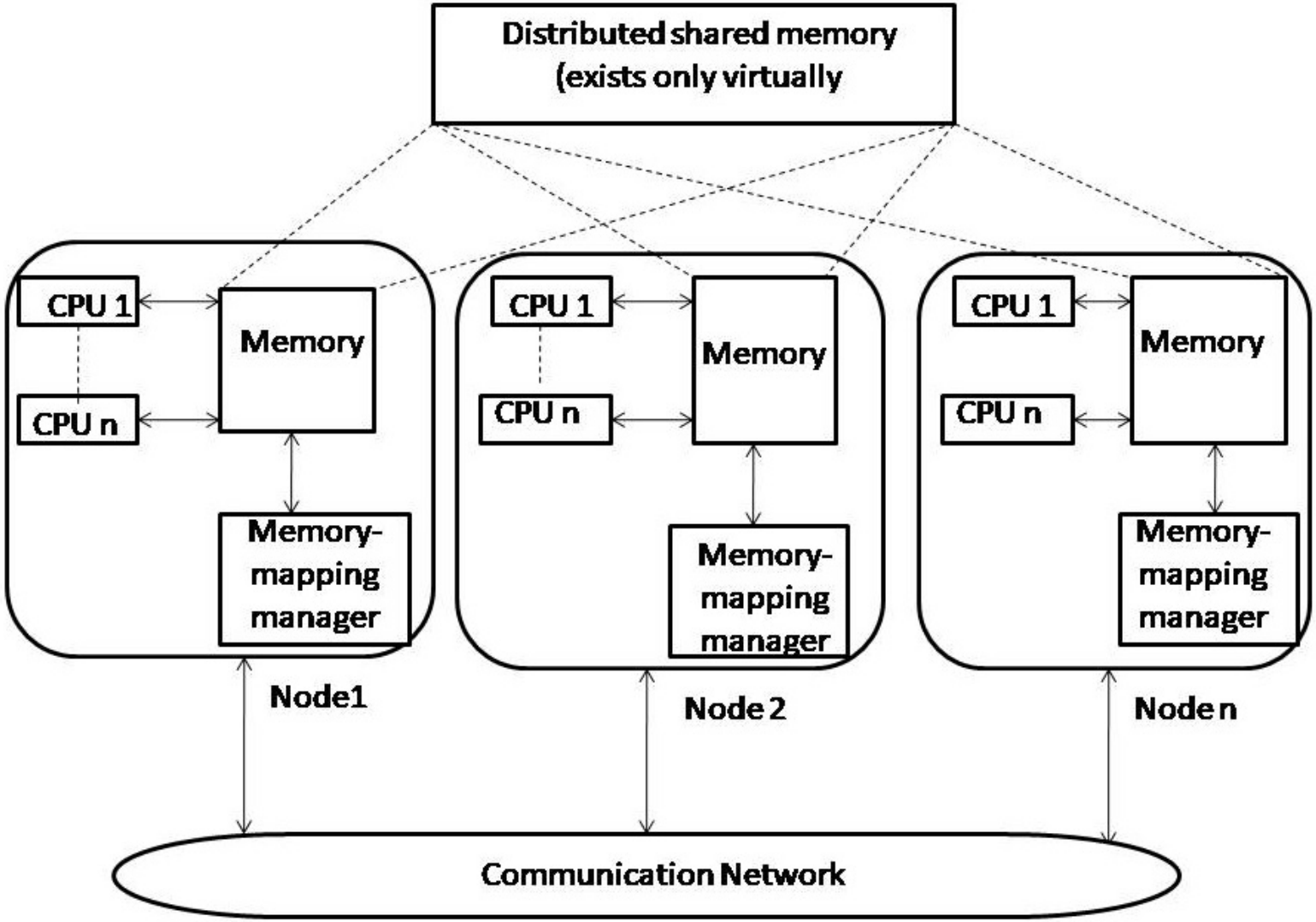


Figure: Distributer Shared Memory

Design and Implementation Issues of DSM

Important Issues involved in the design and implementation of DSM system are;

1. *Granularity*
2. *Structure and Shared Memory Space*
3. *Memory Coherence and Access Synchronization*
4. *Data Location and Access*
5. *Replacement Strategy*
6. *Trashing*
7. *Heterogeneity*

Granularity

One of the most visible parameters to be chosen in the design of a DSM system is the Block Size. Several criteria for choosing this granularity parameter are described as;

1. Factors Influencing Block Size Selection

Factors that influence the choice of block size are;

1. *Paging Overhead*
2. *Directory Size*
3. *Trashing*
4. *False Sharing*

Granularity...[Cntd...]

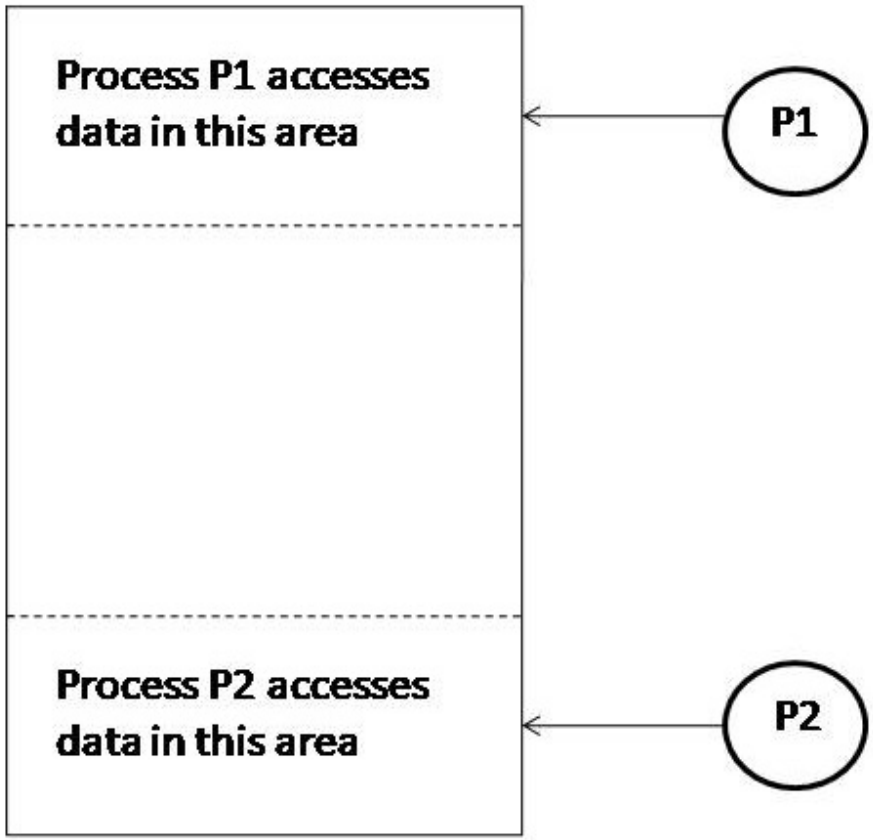


Figure: False Sharing

Granularity...[Cntd...]

2. Using Page Size as Block Size

Using page size as the block size of a DSM has the following advantages;

1. *Page Fault Handler*
2. *It allows the access right control to be readily integrated into functionality of the memory management unit of the system.*
3. *As long as a page can t into a packet, page size do not impose undue communication overhead at the time of network page fault.*
4. *Experiences has shown that a page size is a suitable data entity unit with respect to memory contention.*

Structure of Shared-Memory Space

The three commonly used approaches for structuring the shared memory space of a DSM are;

1. *No Structuring*
2. *Structuring by data type*
3. *Structuring as a database*

Consistency Models

1. *Strict Consistency Model*
2. *Sequential Consistency Model*
3. *Causal Consistency Model*
4. *Pipelined Random-Access Memory Consistency Model*
5. *Processor Consistency Model*
6. *Weak Consistency Model*
7. *Release Consistency Model*
8. *Discussion of Consistency Model*

Implementation of Sequential Consistency Model

The Designer of DSM system may choose from among the following replication and migration strategies

1. *Nonreplicated, Nonmigrating Block(NRNMBs)*
2. *Nonreplicated, Migrating Blocks(NRMBs)*
3. *Replicated, Migrating Blocks(RMBs)*
4. *Replicated, Nonmigrating Blocks(RNMBs)*

1.Nonreplicated, Nonmigrating Block(NRNMBs)

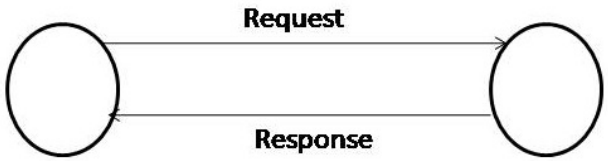


Figure: Nonreplicated, Nonmigrating Block(NRNMB) Strategy

Drawbacks

- *Serializing data access creates a bottleneck*
- *Parallelism, which is a major advantage of DSM, is not possible with this method*

Data Locating in NRNMB Strategy:

- *There is a single copy of each block in the entire system*
- *The location of a block never changes*

2.Nonreplicated,Migrating Block

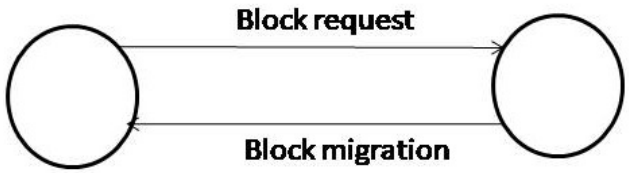


Figure: Nonreplicated, Migrating Block Strategy

Advantages

- *No communication costs are incurred when a process accesses data currently held locally.*
- *It allows the applications to take advantage of data access locally.*

Disadvantages:

- *It is prone to thrashing problem*
- *The advantage of parallelism cannot be availed in this method also.*

2.Nonreplicated,Migrating Block...[Cntd...]

Data Locating in the NRMB Strategy:

One of the following methods may be used in this strategy to locate a block

1. *Broadcasting*
2. *Centralized-Server Algorithm*
3. *Fixed Distributed-Server Algorithm*
4. *Dynamic Distributed-Server Algorithm*

2.Nonreplicated,Migrating Block...[Cntd...]

1. Broadcasting

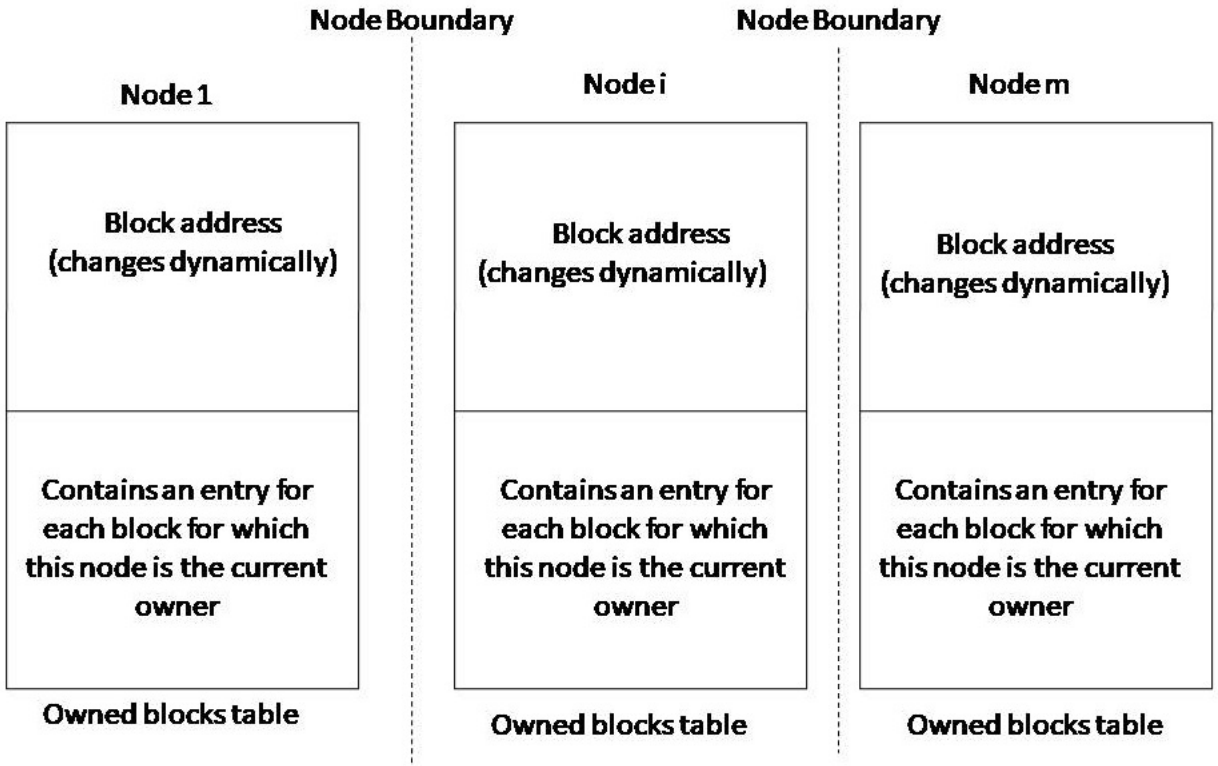


Figure: Structure and Location of owned blocks table in the Broadcasting Data Locating Mechanism for NRMB Strategy

2.Nonreplicated,Migrating Block...[Cntd...]

2. Centralized-Server Algorithm

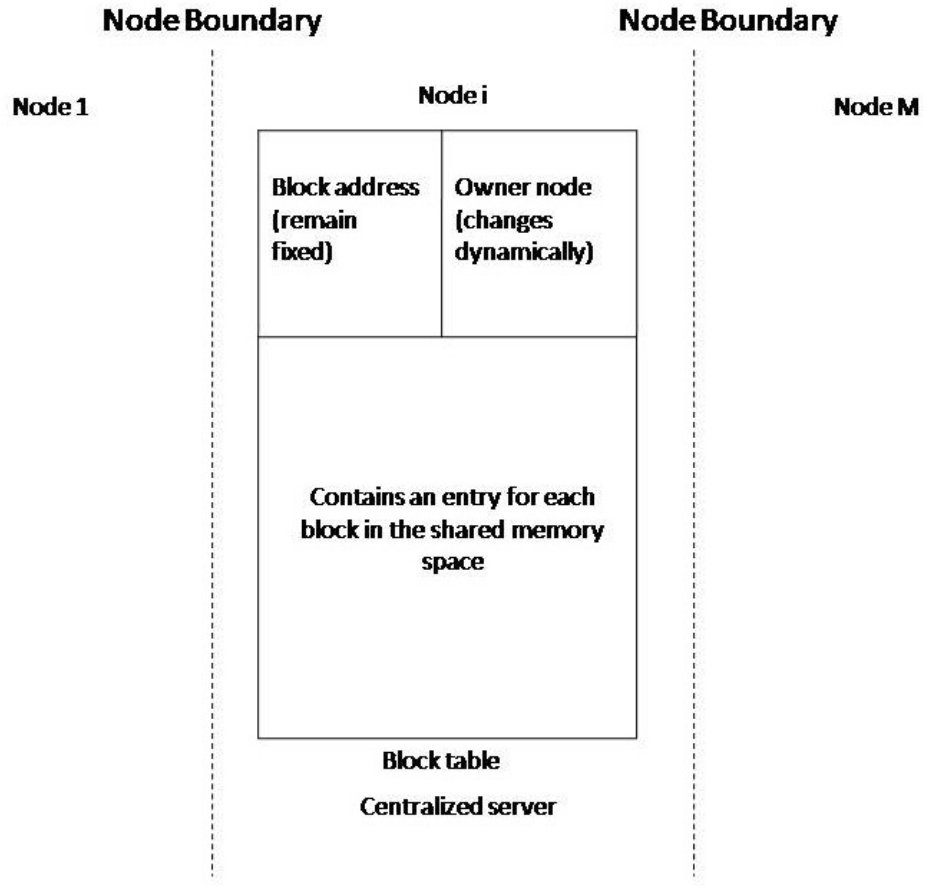


Figure: Structure and Location of block table in the Centralized-Server Data Locating Mechanism for NRMB Strategy

2.Nonreplicated,Migrating Block...[Cntd...]

3. Fixed Distributed-Server Algorithm

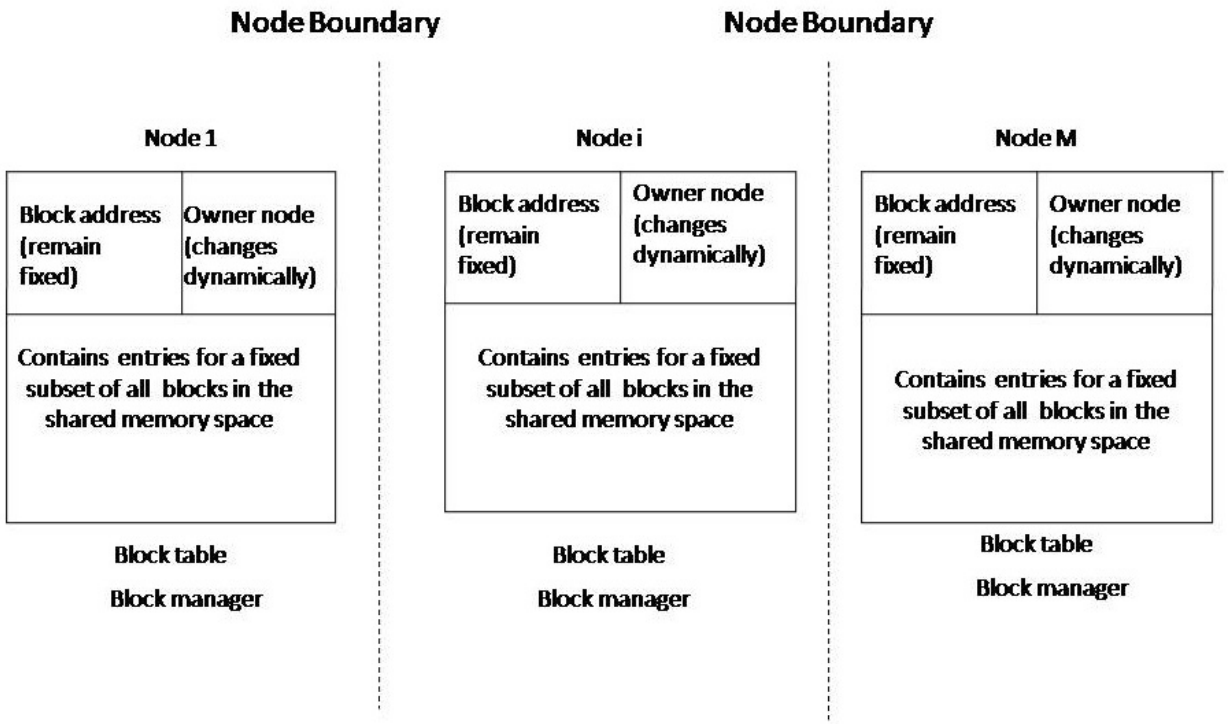


Figure: Structure and Location of owned blocks table in the Fixed Distributed-Server Data Locating Mechanism for NRMB Strategy

2.Nonreplicated,Migrating Block...[Cntd...]

4. Dynamic Distributed-Server Algorithm

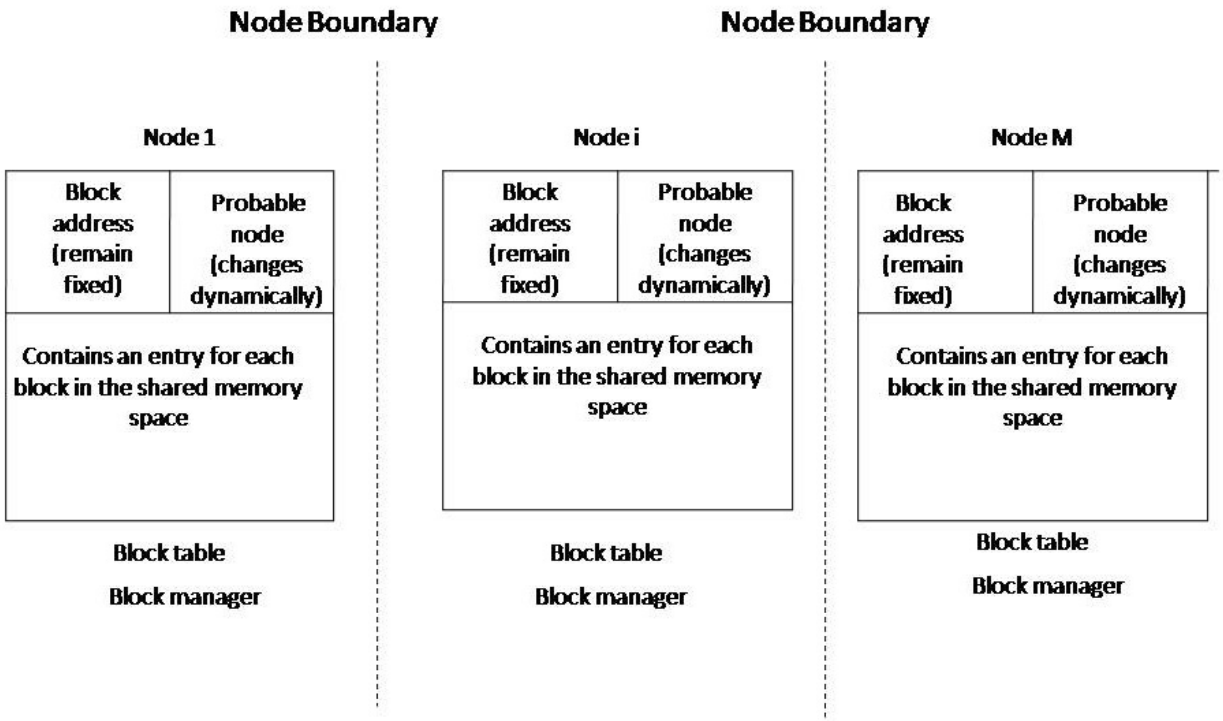


Figure: Structure and Location of owned blocks table in the Dynamic Distributed-Server Data Locating Mechanism for NRMB Strategy

3.Replicated, Migrating Blocks

The two basic protocols that may be used for ensuring sequential consistency

- Write-Invalidate

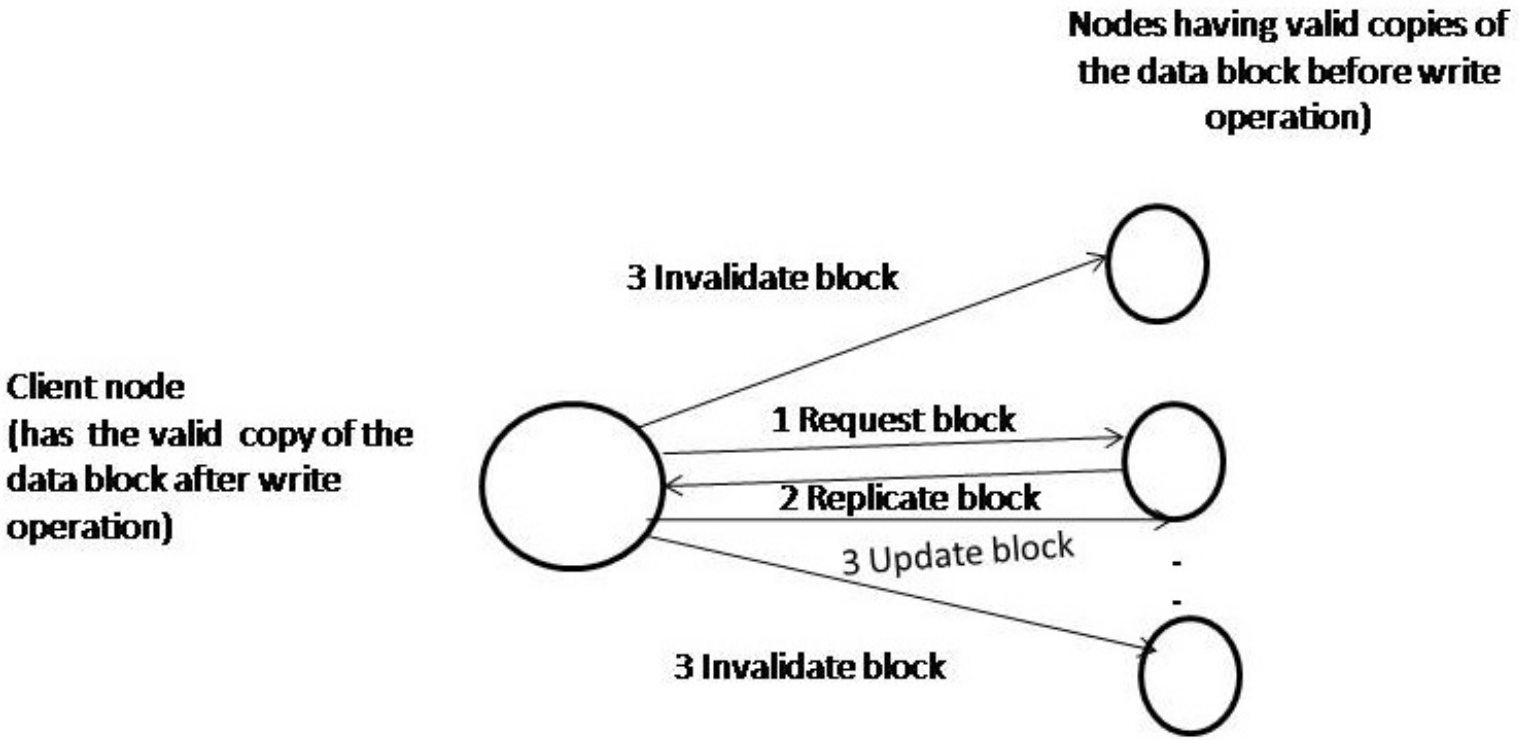


Figure: Write-Invalidate memory approach for RMB strategy

3.Replicated, Migrating Blocks...[Cntd...]

- Write-Update

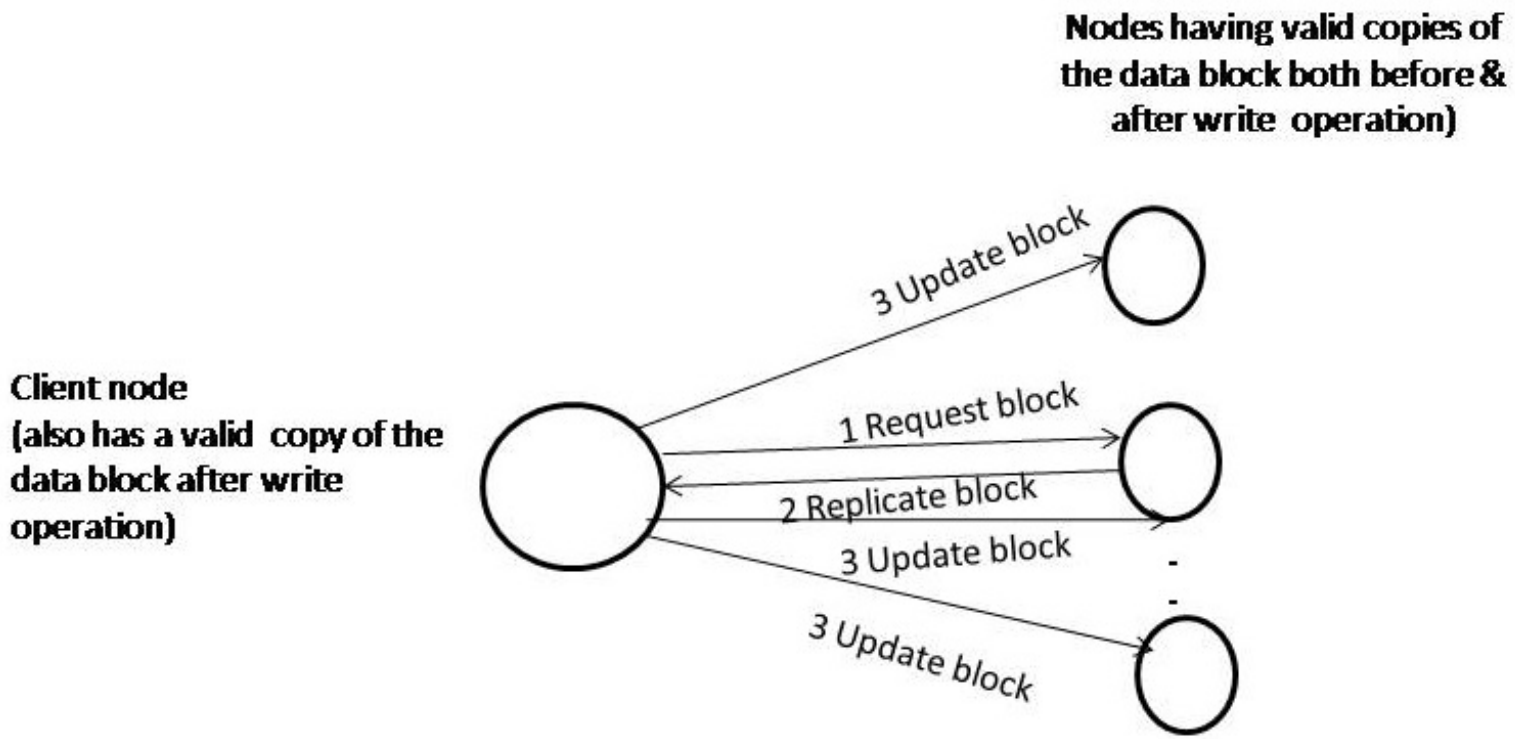


Figure: Write-Update memory approach for RMB strategy

3.Replicated, Migrating Blocks...[Cntd...]

Data Locating in RNM Strategy

The following data locating issues are involved in the Write-Invalidate protocol used with RMB strategy

- *Locating the owner of the block*
- *Keeping track of the node that currently have a valid copy of the block*

One of the following algorithms may be used to address these two issues

1. *Broadcasting*
2. *Centralized-Server Algorithm*
3. *Fixed Distributed-Server Algorithm*
4. *Dynamic Distributed-Server Algorithm*

3.Replicated, Migrating Blocks...[Cntd...]

1. Broadcasting

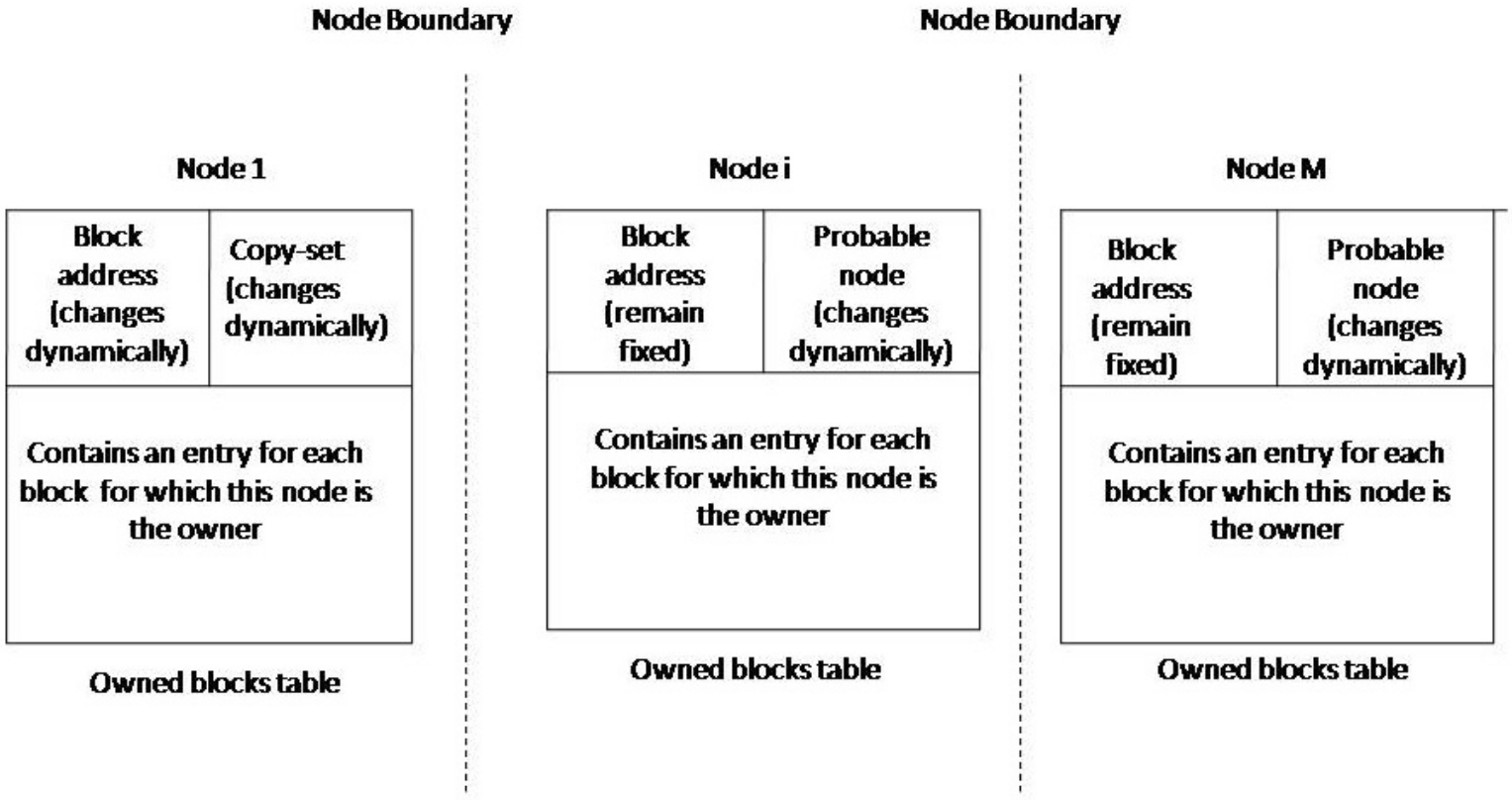


Figure: Structure and Location of owned blocks table in the broadcasting Data Locating Mechanism for RMB Strategy

3.Replicated, Migrating Blocks...[Cntd...]

2. Centralized-Server Algorithm

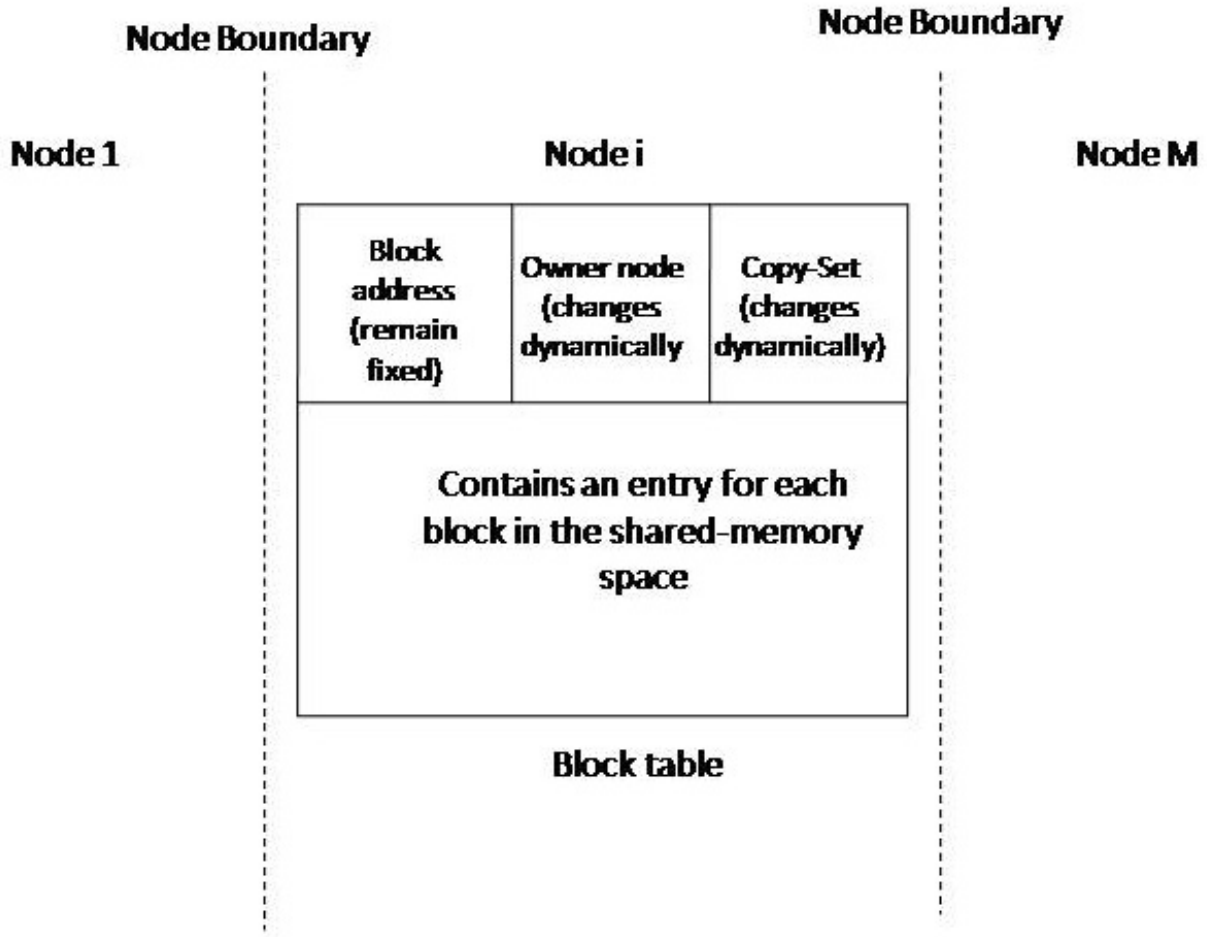


Figure: Structure and Location of owned blocks table in the Centralized-Server Data Locating Mechanism for RMB Strategy

3.Replicated, Migrating Blocks...[Cntd...]

3. Fixed Distributed-Server Algorithm

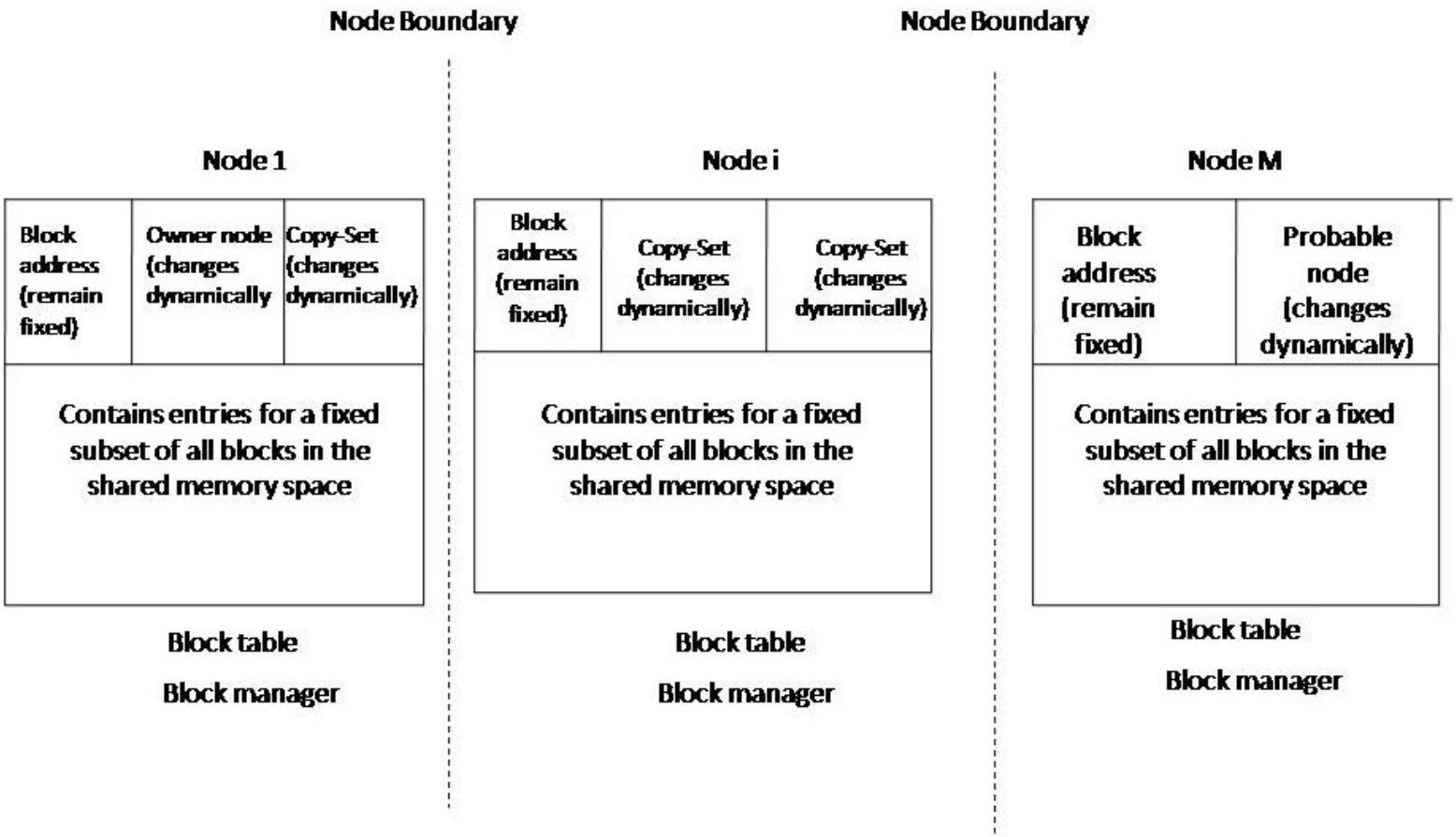


Figure: Structure and Location of blocks table in the fixed distributed Server Data Locating Mechanism for RMB Strategy

3.Replicated, Migrating Blocks...[Cntd...]

4. Dynamic Distributed-Server Algorithm

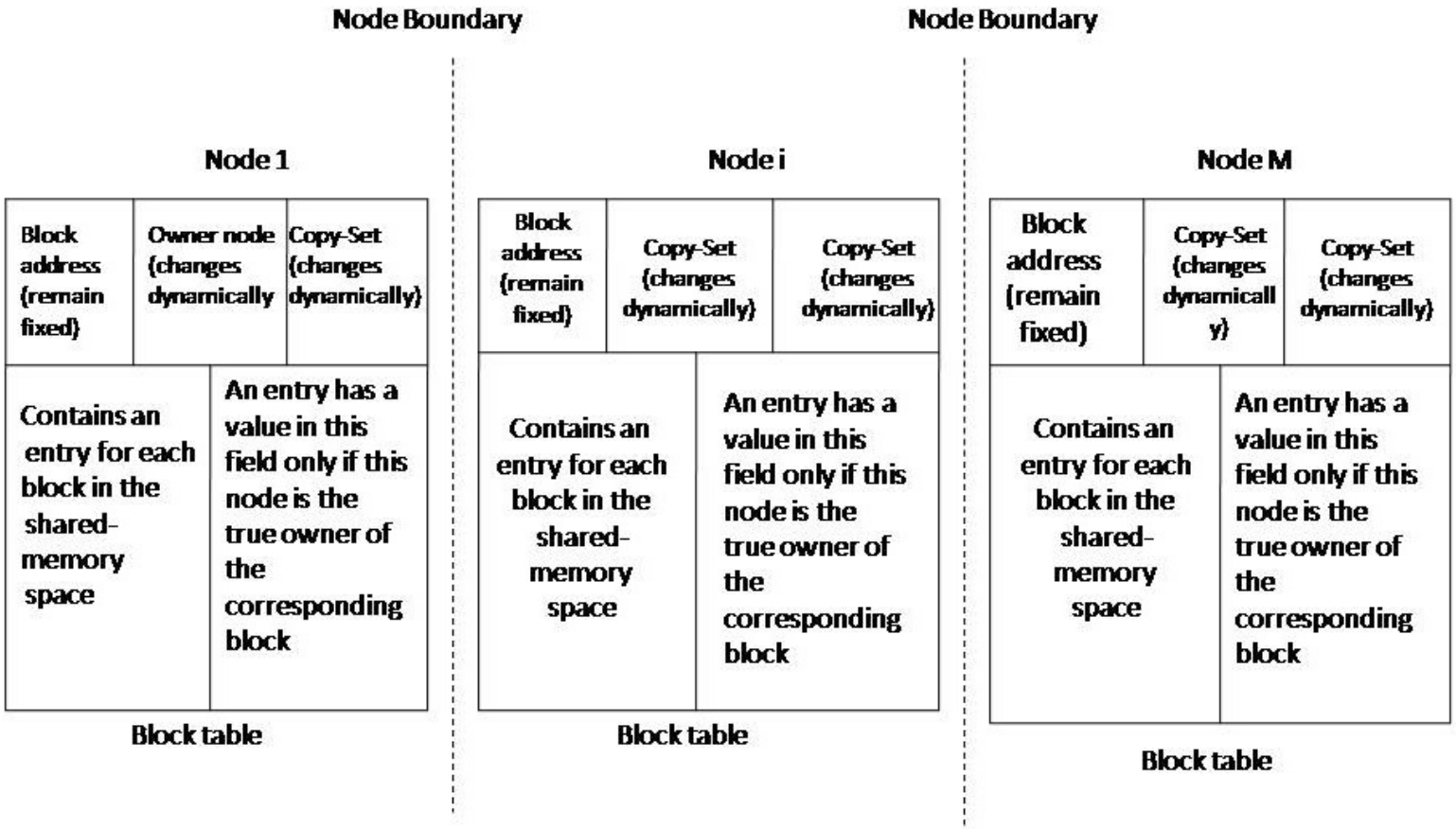


Figure: Structure and Location of blocks table in the Dynamic distributed Server Data Locating Mechanism for RMB Strategy

4.Replicated, Migrating Blocks

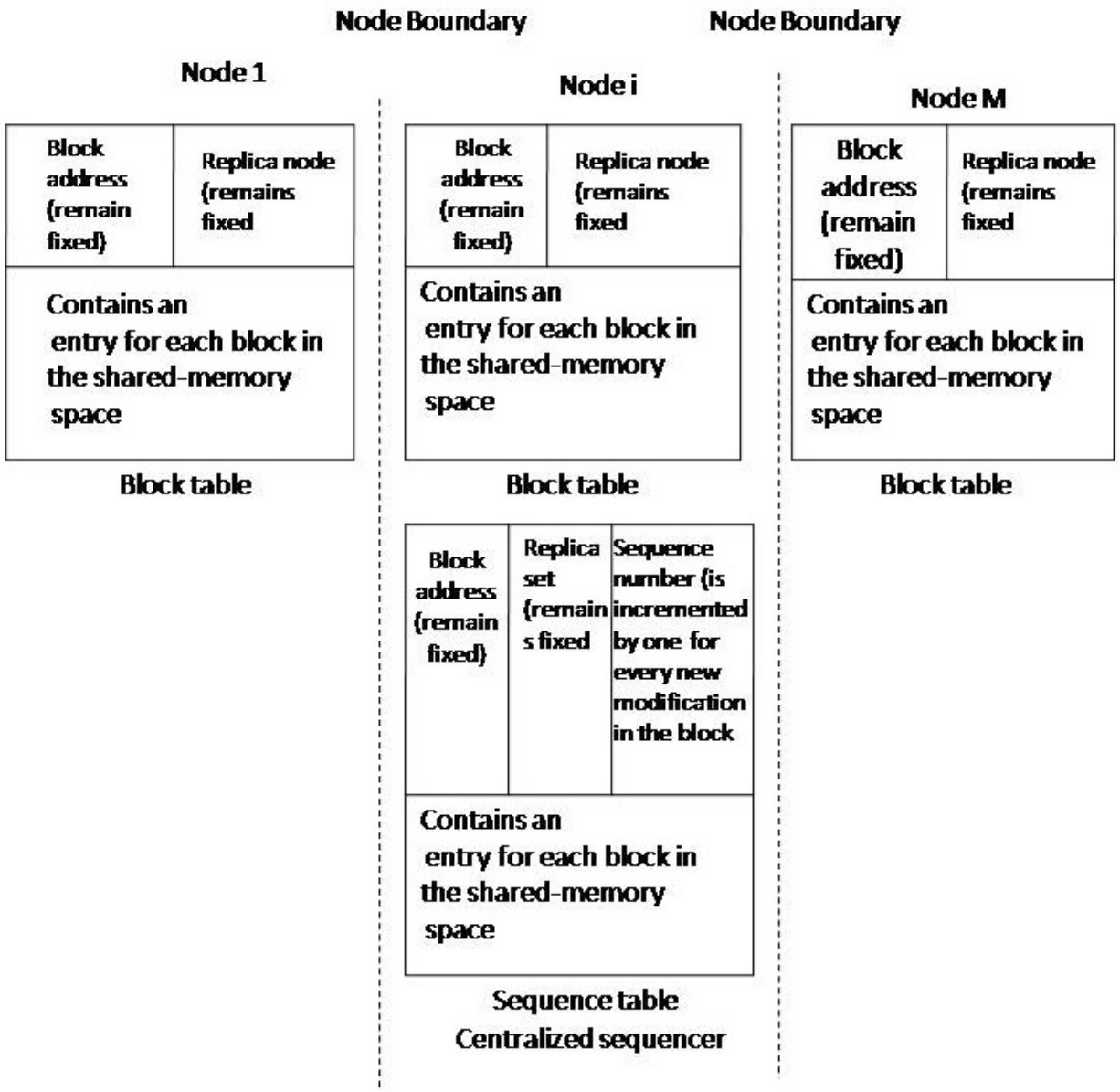
In this strategy, a shared memory block ma be replicated at multiple nodes of the system but the location of each replica is fi xed. A read or write access to a memory address is carried out by sending the process request to one of the nodes having replica of the block containing the memory address.

Data Locating in the RNMB Strategy

The RNMB strategy has following caracteristics

1. *The replica location of a block never change*
2. *All replica of a data blocks are kept consistent*
3. *Only a read request can be directly sent to one of the nodes having a replica of the blocks.*

4.Replicated, Migrating Blocks...[Cntd...]



Replacement Strategy

DSM system that allows shared memory blocks to be dynamically migrated/replicated. Following issues must be addressed when the available space for catching shared data fi
lls up at a node;.

- *Which Block to Replace*
- *Where to Place a Replaced Block*

Heterogeneous DSM

Two main issues in the building a DSM system on a network of heterogeneous machines are;.

- *Data Conversion*
- *Block Size Selection*

Advantages of DSM

- *Simple Abstraction*
- *Better Probability of Distributed Application Programs*
- *Better Performance of some Application*
- *Flexible Communication Environment*
- *Ease of Process Migration*