

Network-Based Cluster Computing

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Presentation Outline:

- **Cutting-Edge Technologies**
- **Network-based Cluster Computing**
- **Distributed Multi-Agent Computing**
- **Innovative Cluster Applications**

Information Technology: Today and The Future

■ What are hot today in 2000 ?

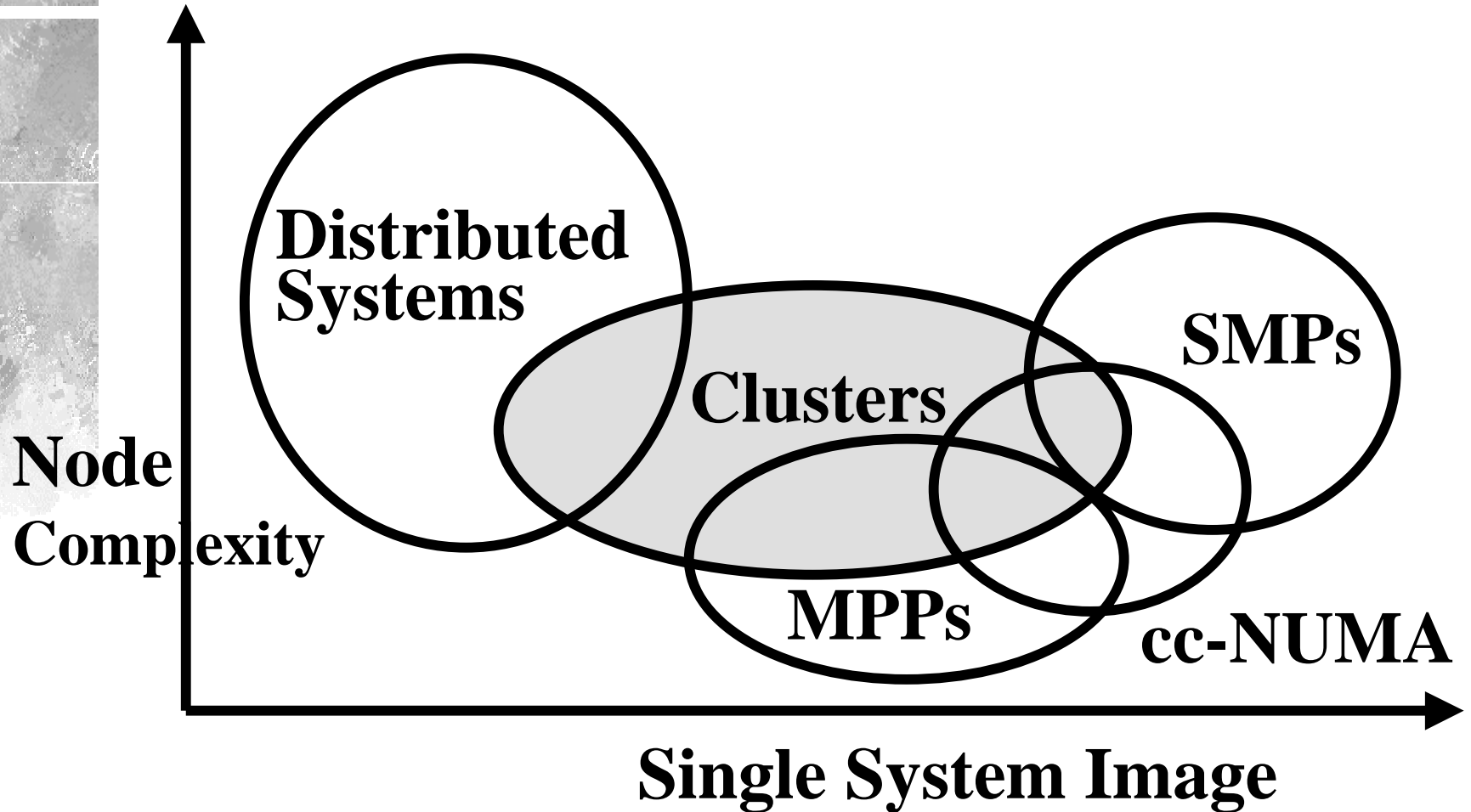
1 GHz microprocessors, 256 Mb RAM, Gigabit Ethernet, ATM switches, Unix/SMP, Windows NT, Java, Internet, digital TV, multimedia communications, etc.

■ How about beyond year 2000 ?

2 GHz microprocessors, 1-4 Gb RAM, NVSM (non-volatile semiconductor memory), 100 Gbps ~ 1 Tbps LANs, Satellite-based WWW, 3-30 Teraflops computers, cluster OS, Internet-based metacomputing, etc.



Competing Computer Architectures



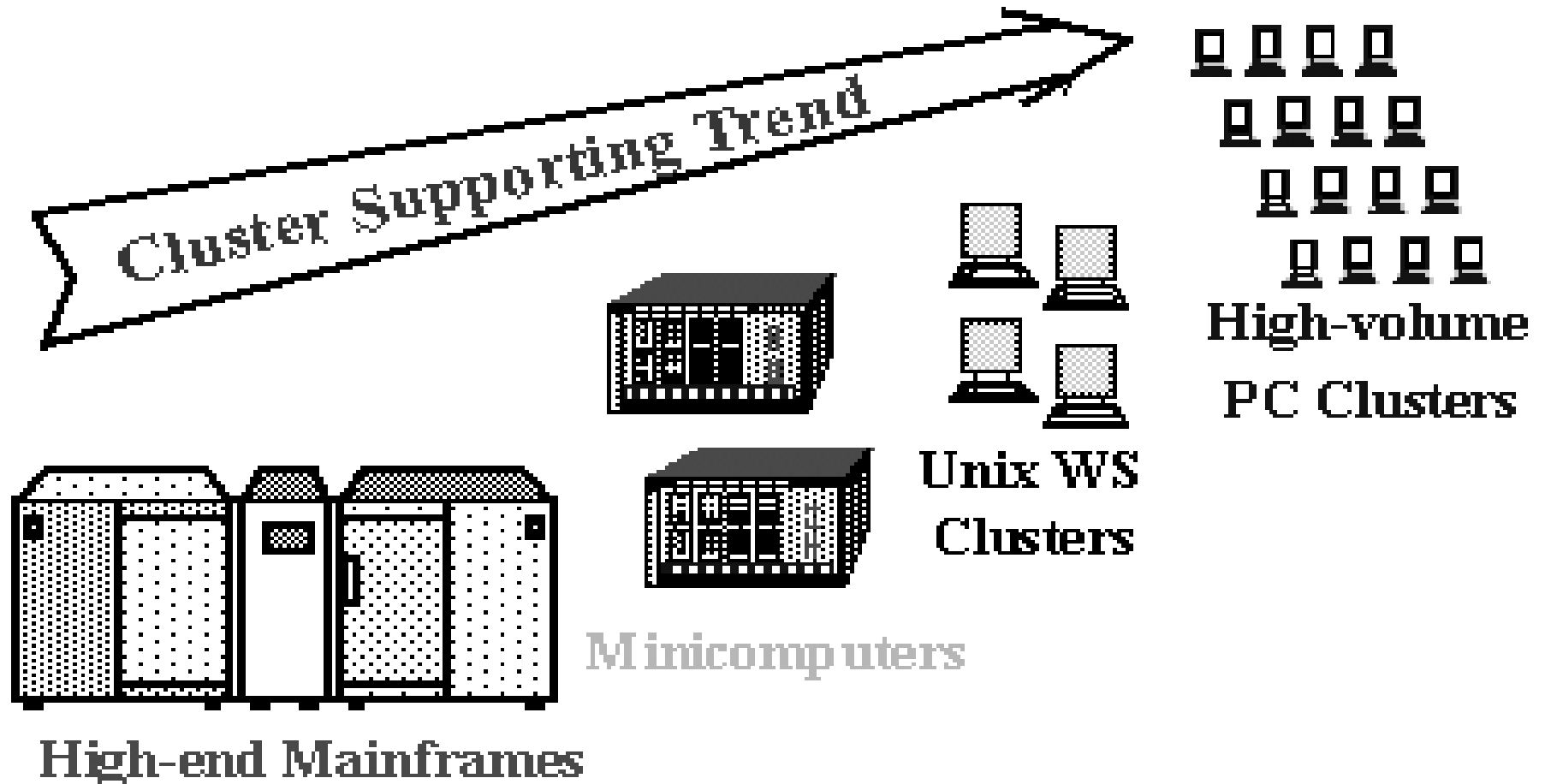
Comparison of Cluster with Other Scalable Parallel Architectures

Characteristic	MPP	SMP & CC-NUMA	Cluster	Distributed System
Number of Nodes	O(100)- O(1000)	O(10) – O(100)	O(100) or less	O(10)- O(1000)
Node Complexity	Fine or medium grain	Medium or Coarse grain	Medium grain	Wide range
Internode Communication	Message passing or DSM	Centralized or distributed shared memory	Message Passing	Shared files, RPC, message passing
Job Scheduling	Single run queue at host	Single run queue mostly	Multiple queues coordinated	Independent multiple Queues

Comparison of Cluster and Other Scalable Systems (cont'd)

System Characteristic	MPP	SMP & CC-NUMA	Cluster	Distributed System
SSI support	Partially	Always for SMP and some for NUMA	Desired	No
Node & Host OS	N microkernels 1 monolithic OS at host	One monolithic in SMP and multiple in CC- NUMA	N (Homogeneous or microkernel)	N (Heterogeneous)
Address Space	Multiple (Single for DSM)	Single	Multiple	Multiple
Internode Security	Unnecessary	Unnecessary	Required if exposed	Required

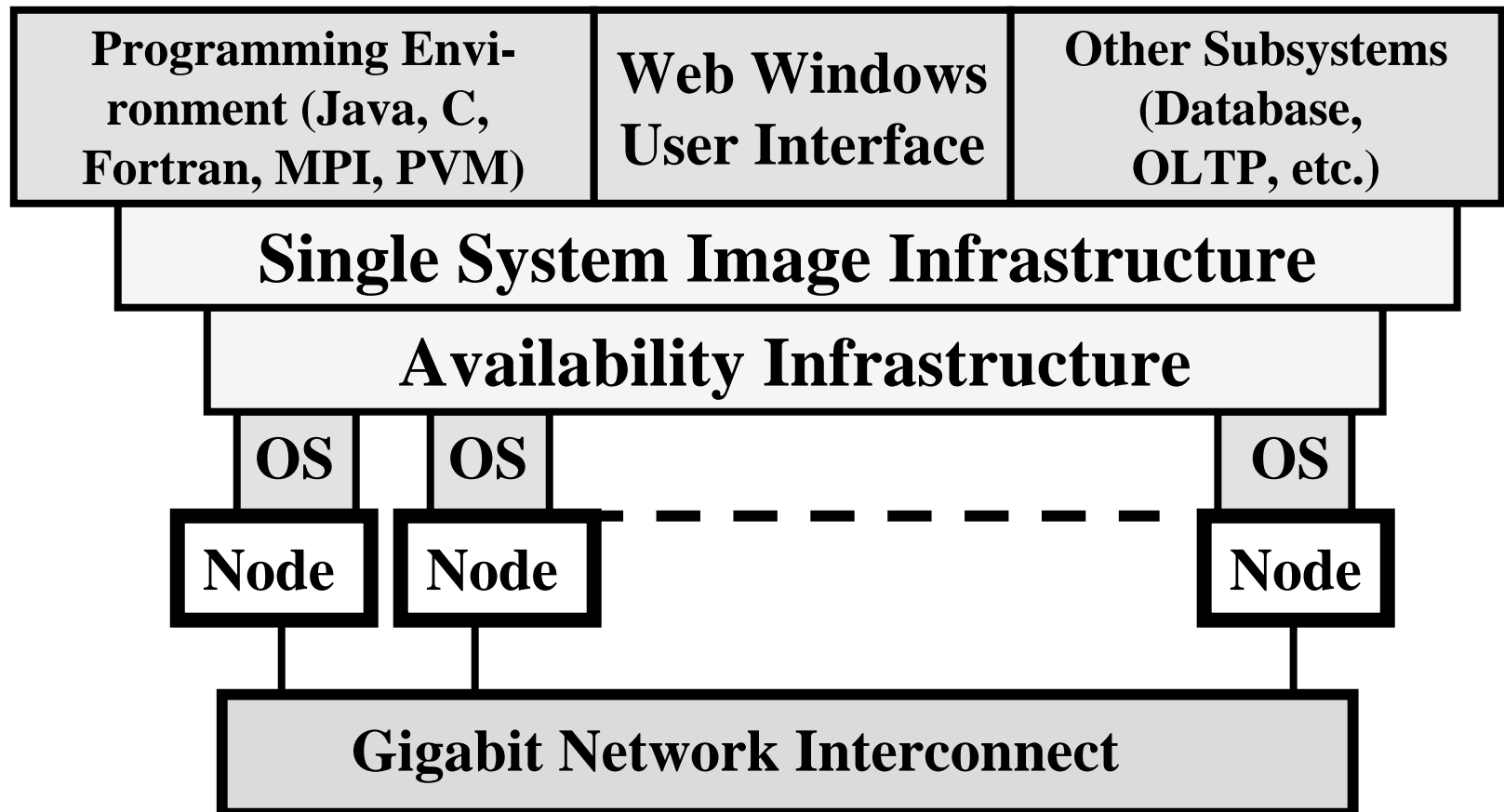
Clustering of Multiple Computers for Collective Applications



What is a Cluster of Computers?

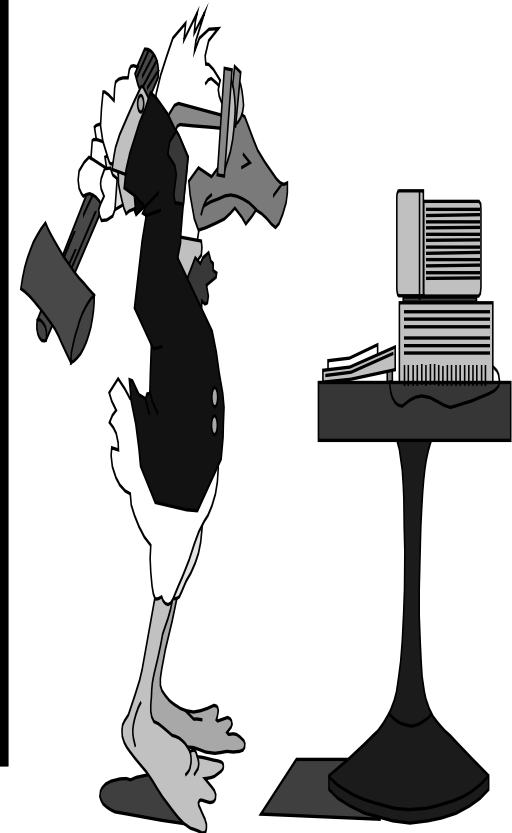
- ☐ **A collection of computer nodes, interconnected by a LAN and/or a high-speed switching network, all nodes can be used individually or collectively as a cluster.**
- ☐ **All computers in the cluster are glued together with middleware support for collective usage as a single computing resource, in addition to the traditional usage as individual computers.**

An SSI Cluster with Hardware, Software, and Middleware Support



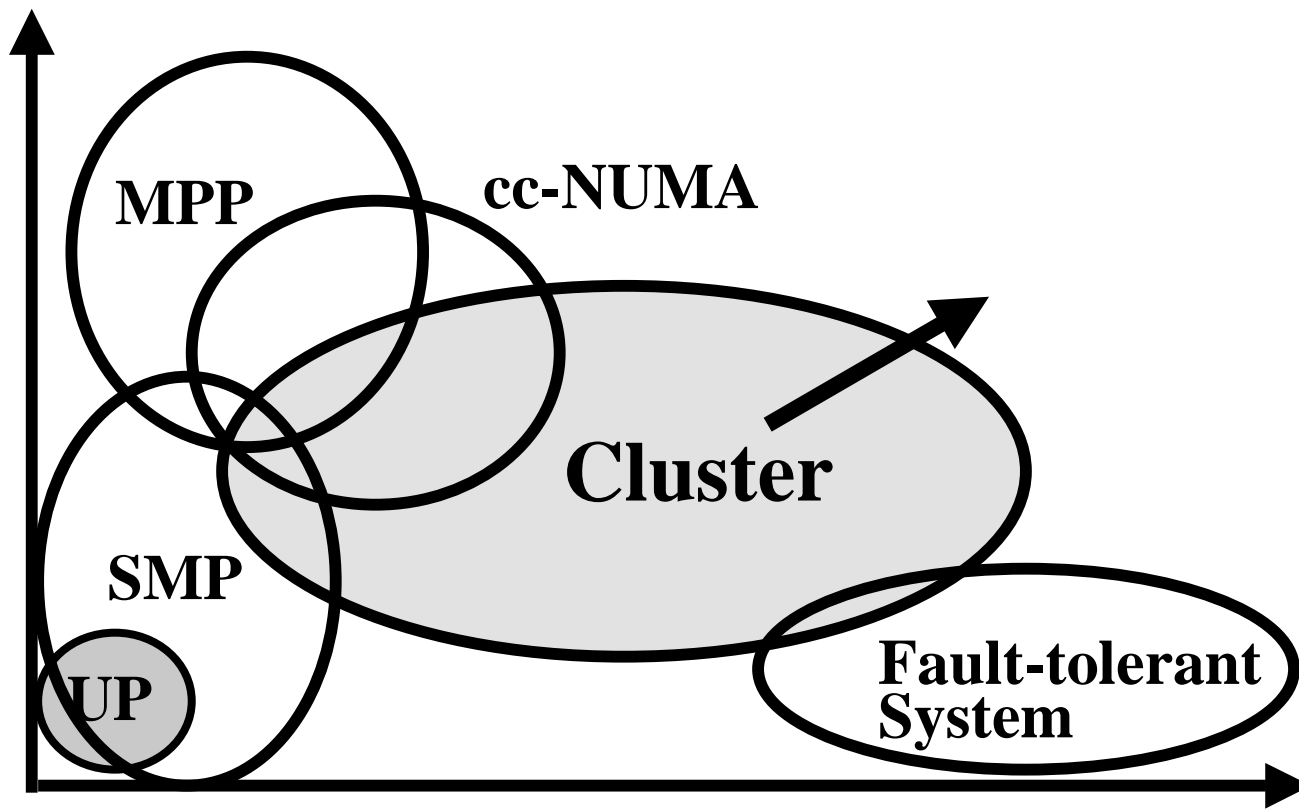
Major Cluster Design Issues

- **Size Scalability**
- **Enhanced Availability**
- **Single System Image**
- **System Manageability**
- **Fast Communication**
- **Security and Encryption**
- **Distributed Environment**



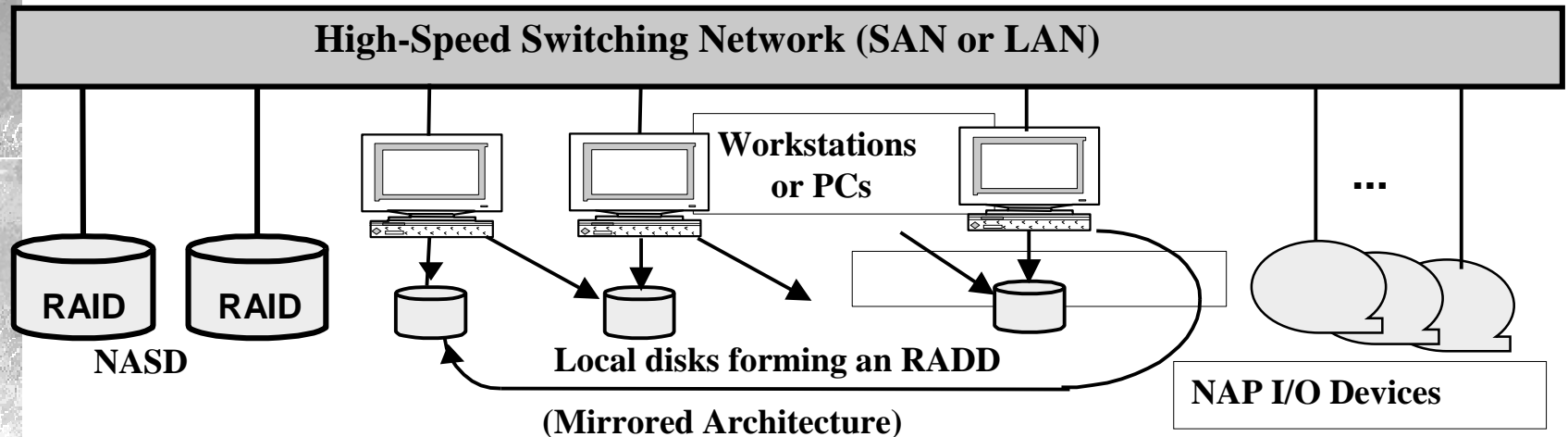
Performance vs. Availability

Scalable Performance

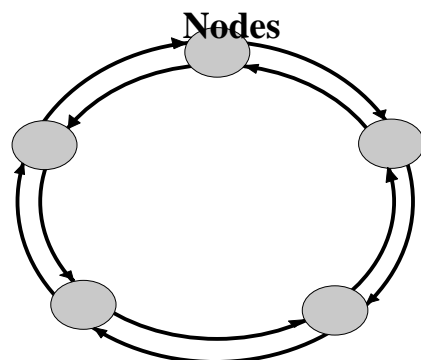


System Availability

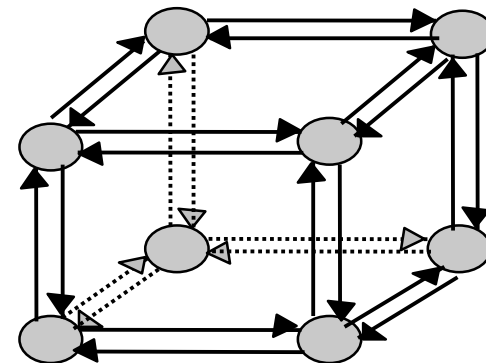
A PC/workstation Cluster with Distributed Disks, Network-Attached RAIDs, and I/O



(a) Unidirectional ring mirroring



(b) Bidirectional ring mirroring

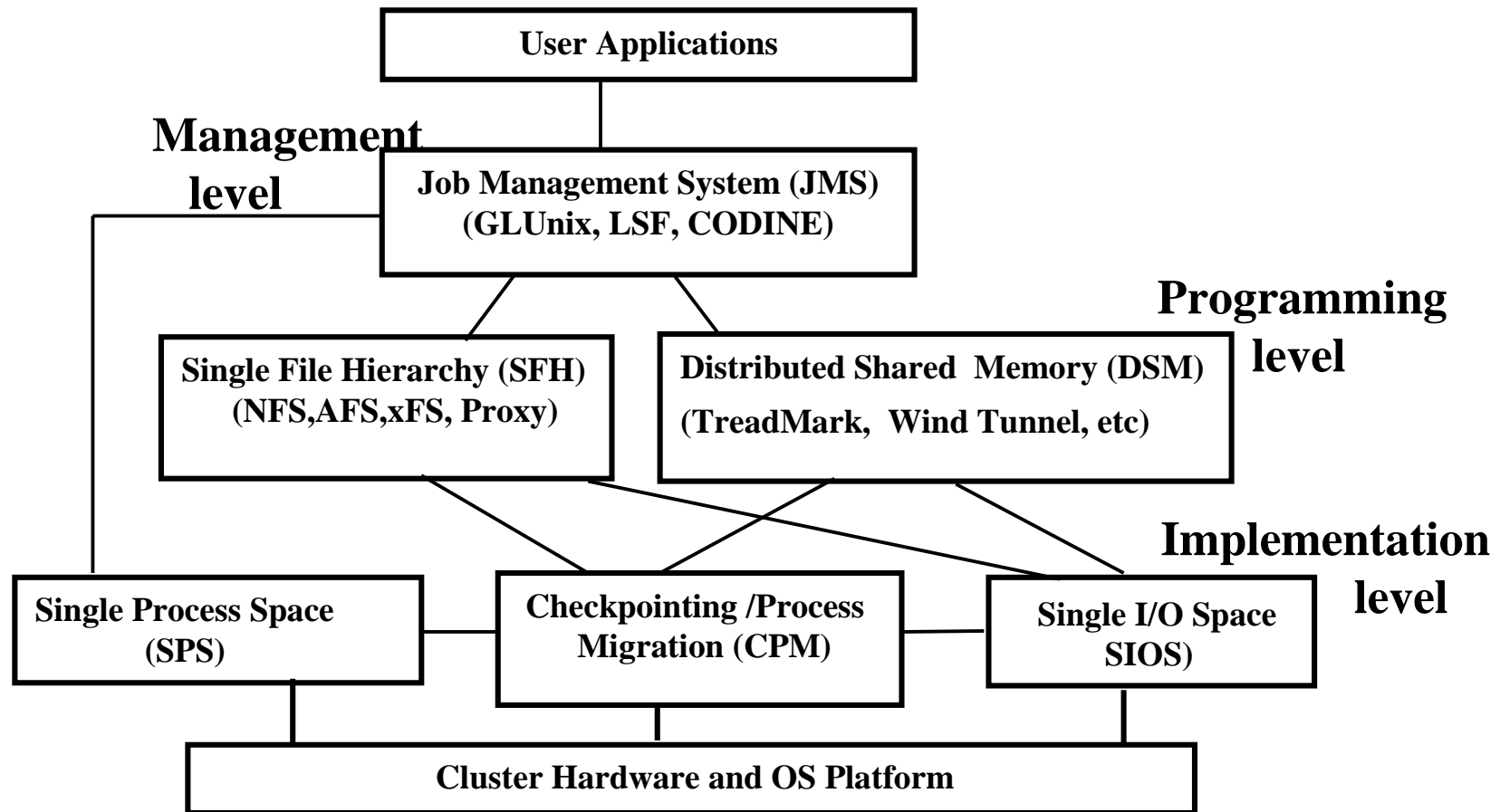


(c) Bidirectional mirroring on a 3-D torus

Existing Middleware Packages Supporting SSI Cluster Computing

SSI Features	GLUnix	TreadMarks	DQS/CODI NE	LSF
Single control point	Yes	no	yes	yes
Single entry point	Yes	no	no	no
Single file hierarchy	Yes	yes	yes	yes
Single memory space	No	yes	no	no
Single process space	Yes	no	no	no
Single I/O space	No	no	no	no
Single networking	No	no	no	no
Batch support	Yes	no	yes	yes
Interactive support	Yes	yes	yes	yes
Parallel support	Yes	yes	yes	yes
Load balancing	Yes	no	yes	yes
Process migration	Yes	no	no	no
Job monitoring	Yes	no	yes	yes
Suspend/Resume	No	no	yes	yes
Dynamic resource	Yes	no	yes	yes
User interface	cmd-line	cmd-line	GUI/cmd-line	GUI
Fault tolerance	Yes	no	yes	yes

Relationships among supporting middleware modules



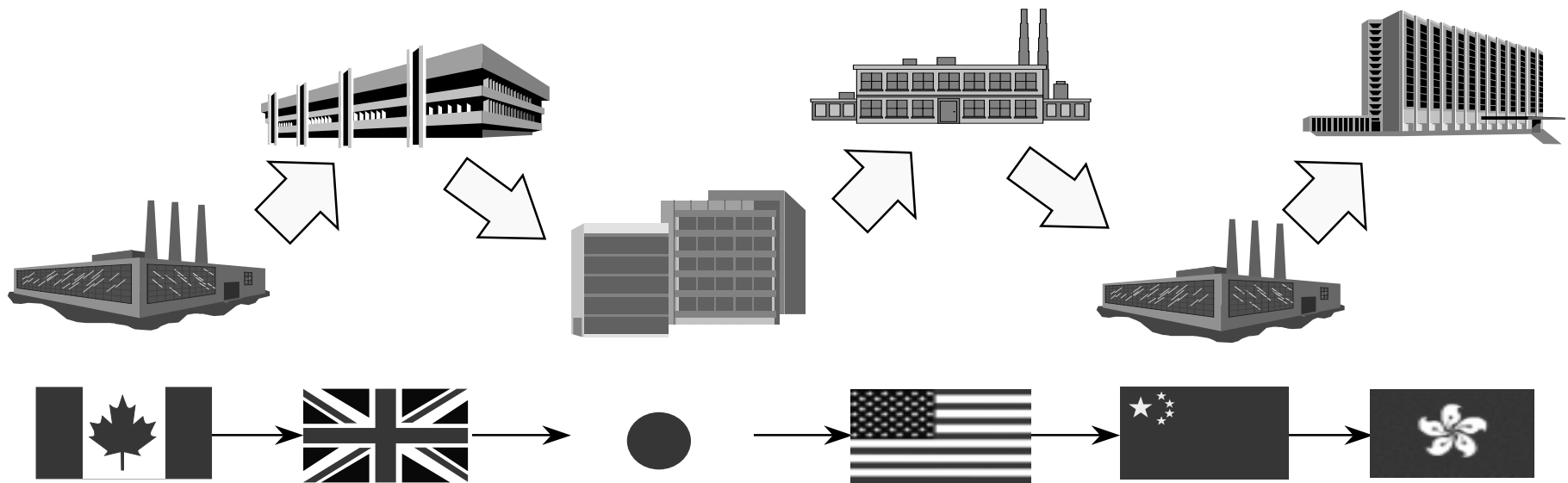
The Financial Digital Library (FDL) Project at HKU

- **An Java-coded, Internet-based, multi-agent system monitoring more than 30 economic indicators in Hong Kong**
- **An electronic disclosure system to improve the transparency and efficiency of financial information retrieval and processing**

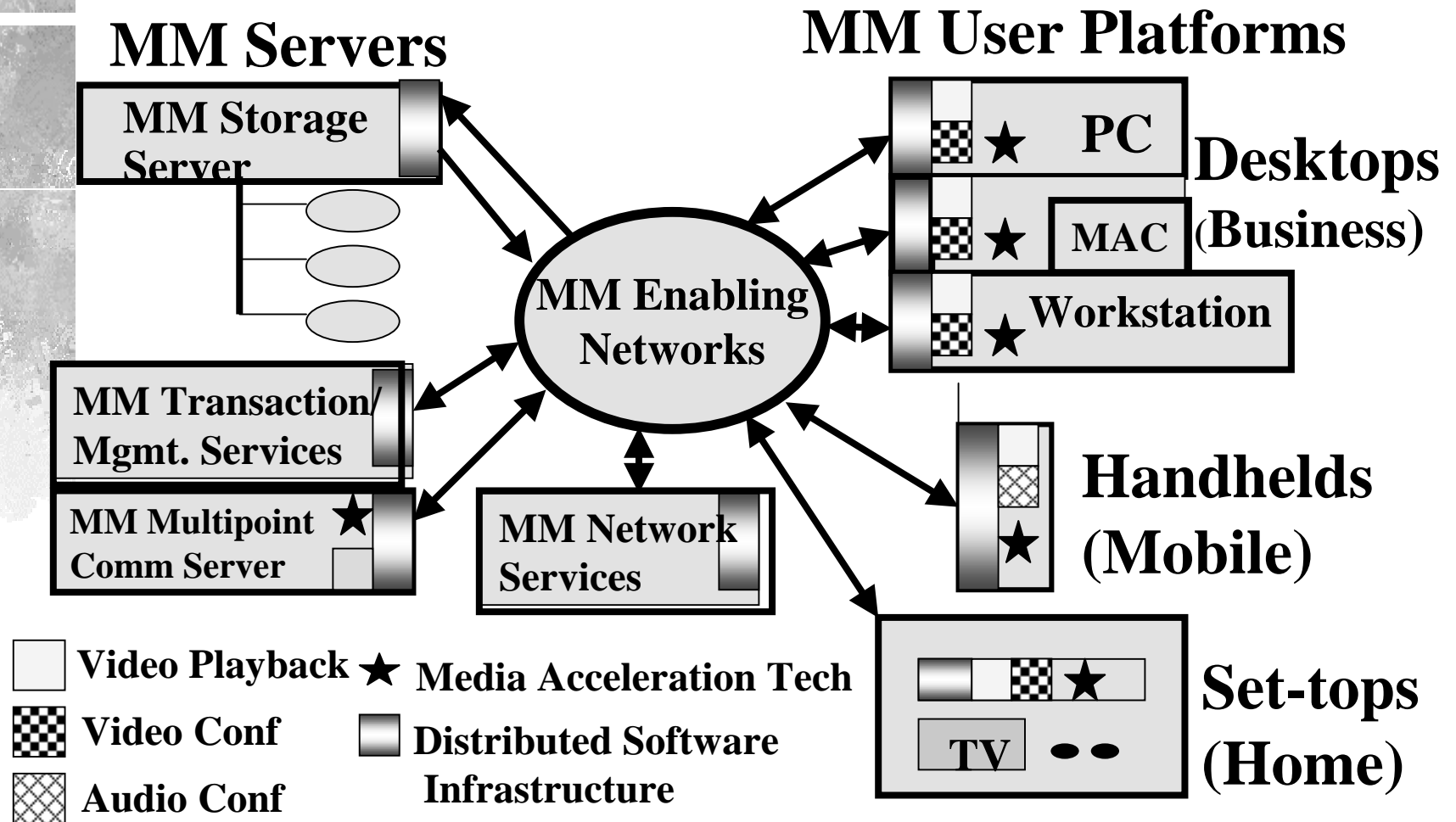


Information Technology for Business Globalization

- ◇ Business is managed globally, overcoming the barriers in time, distance, culture, and language
- ◇ Global supply chain management for multinational companies with headquarter, assembly plants, and distributors scattered all over the world



Distributed Multimedia Processing

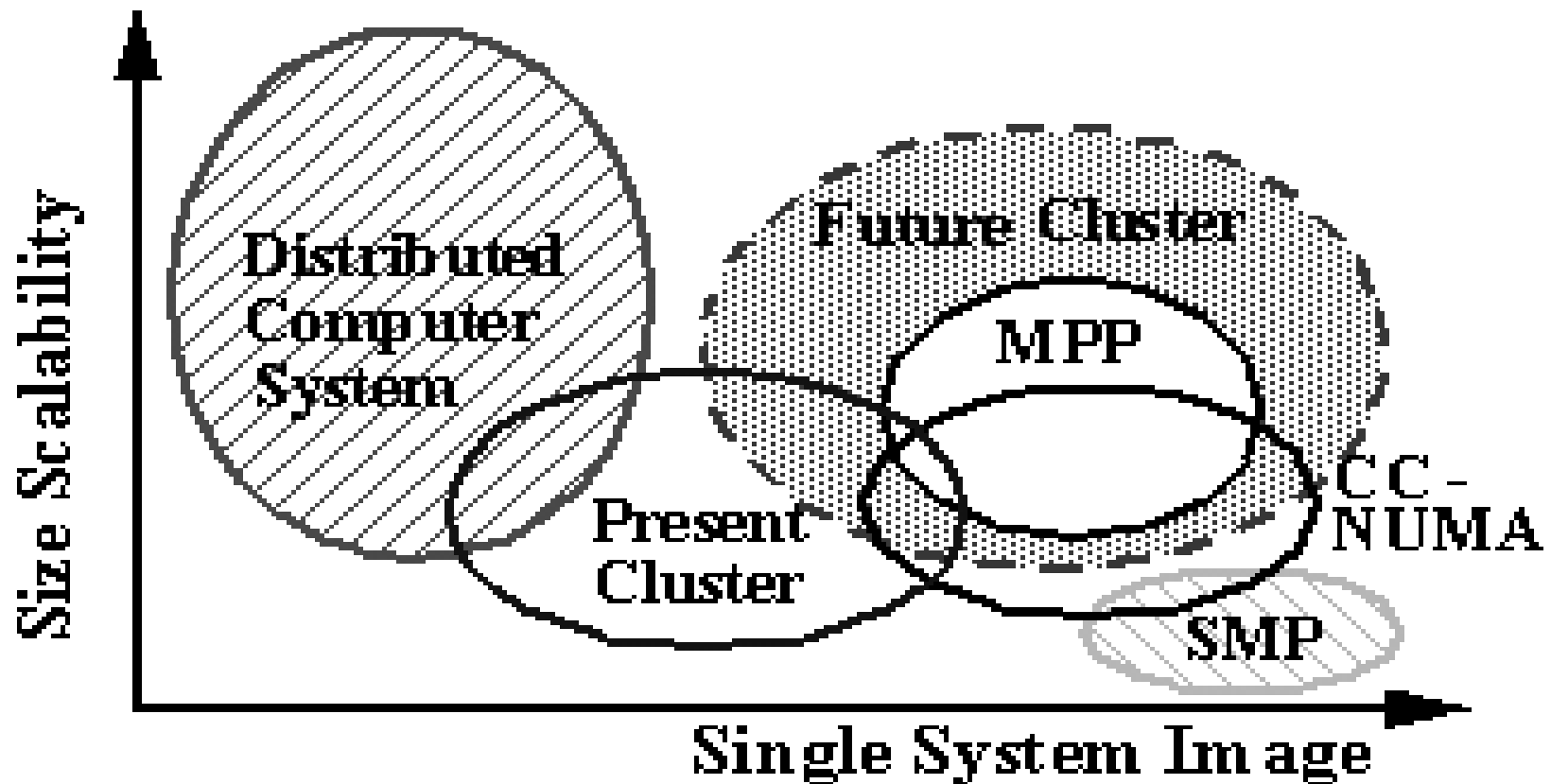


Bioinformatics : Computational Molecular Biology for Health Care

- ➔ Human genome research for health care, disease control, and new drug development
- ➔ Parallel processing in the search, sorting, and alignment of DNA/protein sequences
- ➔ Cluster of PCs/workstations for parallel and distributed genome research

Concluding Remarks:

1. Future clusters will be more scalable and providing many more SSI services.



Increasing demand of cluster, Java, and Internet-based applications:

- Distributed multimedia processing in electronic commerce, digital entertainment, and urban management.**
- Dedicated digital Libraries for distance education, bioinformatics for health-care, and economic crisis management**
- Innovative applications in remote services, telemedicine, collaborative designs, and environmental protection.**