Scalable Computing Over the Internet :-

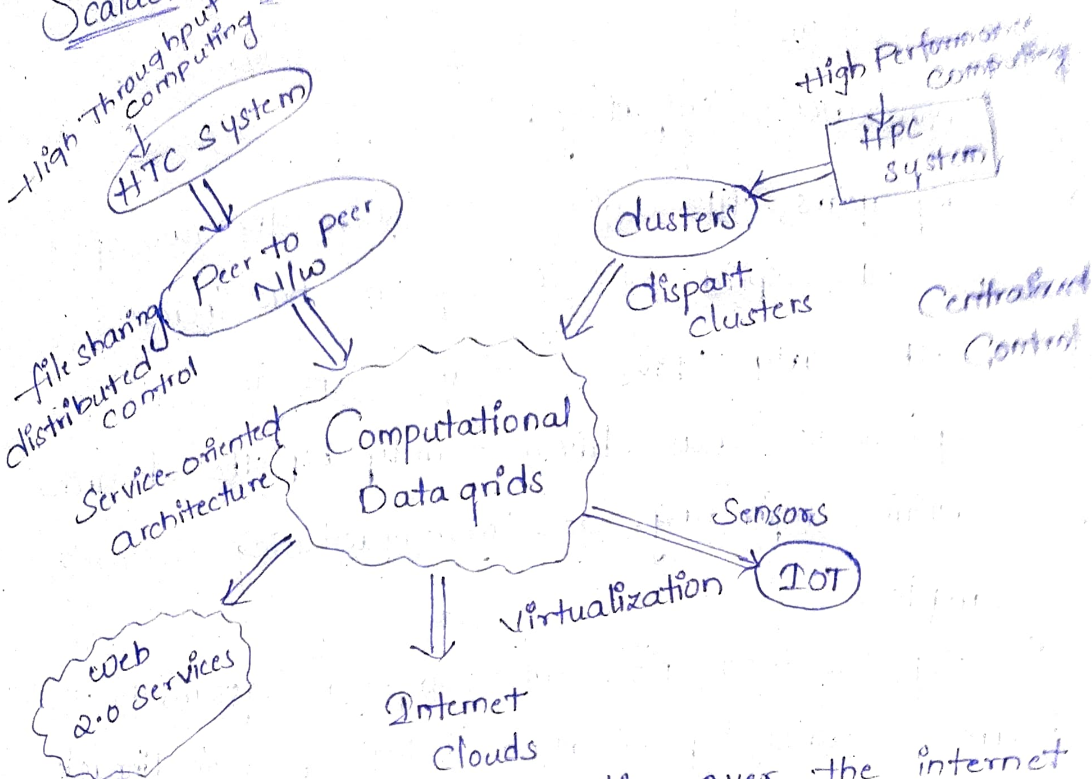


fig:- Scalable Computing over the internet

Over the past 60 years, computing technology has undergone a series of platform and environment changes. In this session, we assess evolutionary changes in machine architecture, Operating System platform, network connectivity, and application work-load.

The Age of Internet Computing :-

Billions of people uses the internet everyday. As a result, supercomputer sites and large data centers must provide high performance computing services to huge number of Internet uses concurrently. Because of this high demand, the Linpack Benchmark for high performance computing (HPC) applications is no longer optimal for measuring system performance.

the emergency of computing clouds instead demands High-throughput Computing (HTC) systems built with parallel and distributed computing technologies

High-Performance Computing:-

For many years, HPC systems emphasize the raw speed performance. the speed of HPC systems has increased from Gflops in the early 1990s to now pflops in 2010.

this improvment was driven mainly by the demands from scientific, engineering, and manufacturing companies.

for example:-

The top 500 most powerful computer systems in the world are measured by floating-point speed in Linpack benchmark results.

High Throughput Computing:-

the development of market-Oriented high-end computing System is undergoing a Strategic change from an HPC paradigm to an HTC paradigm.

This HTC paradigm pays more attention to high-flux Computing. The main application for high-flux computing is in Internet searches and web services by millions or more users simultaneously.

Peer to Peer Networks:-

A peer to peer N/w is a simple n/w of computers. It first came into existence in the late 1970's. Here each computer acts as a node for file sharing within the framed N/ws.

Computing Paradigms:-

There are 3 new computing paradigms. They are
1. Cloud Computing Paradigm
2. Distributted Computing paradigm
3. Parallel Computing Paradigm.

1. Cloud Computing Paradigm:-

Cloud is defined as the usage of someone else's server or host, process or store data. Cloud Computing is defined as the type of computing where it is the delivery of on-demand computing services over the internet on pay-as-you-go basis. It is widely distributed, n/w-based and used for storage.

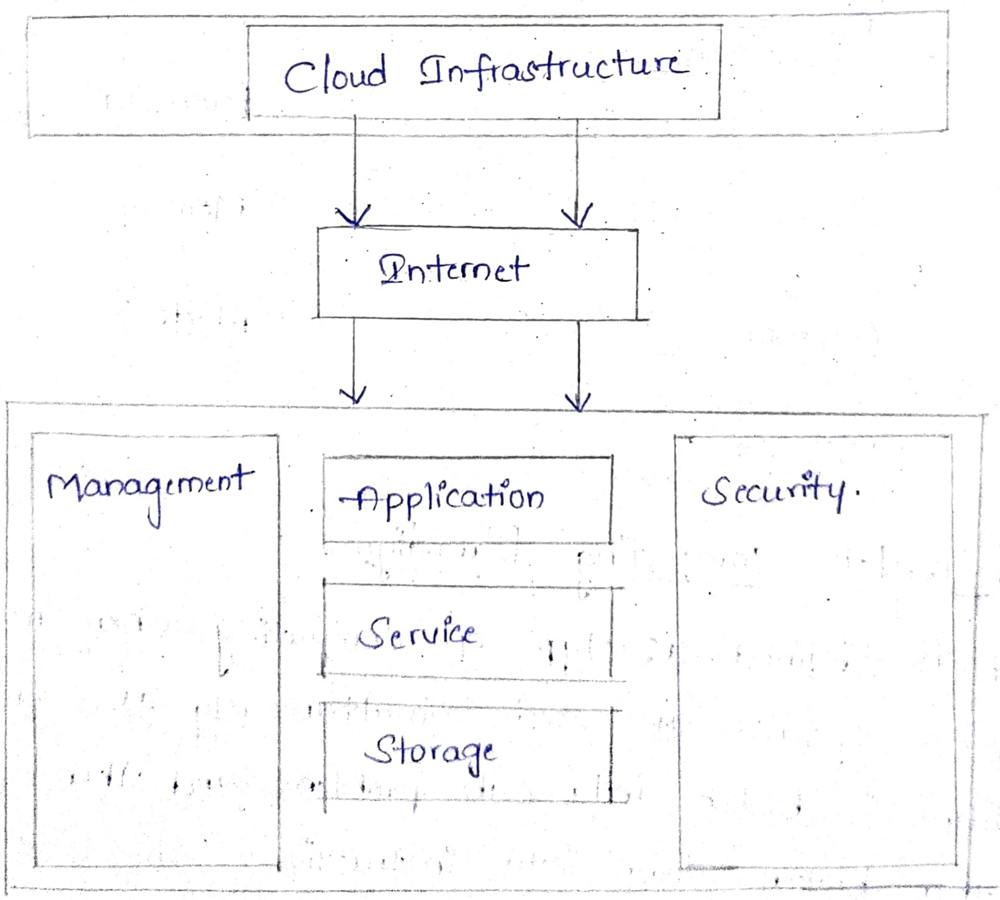
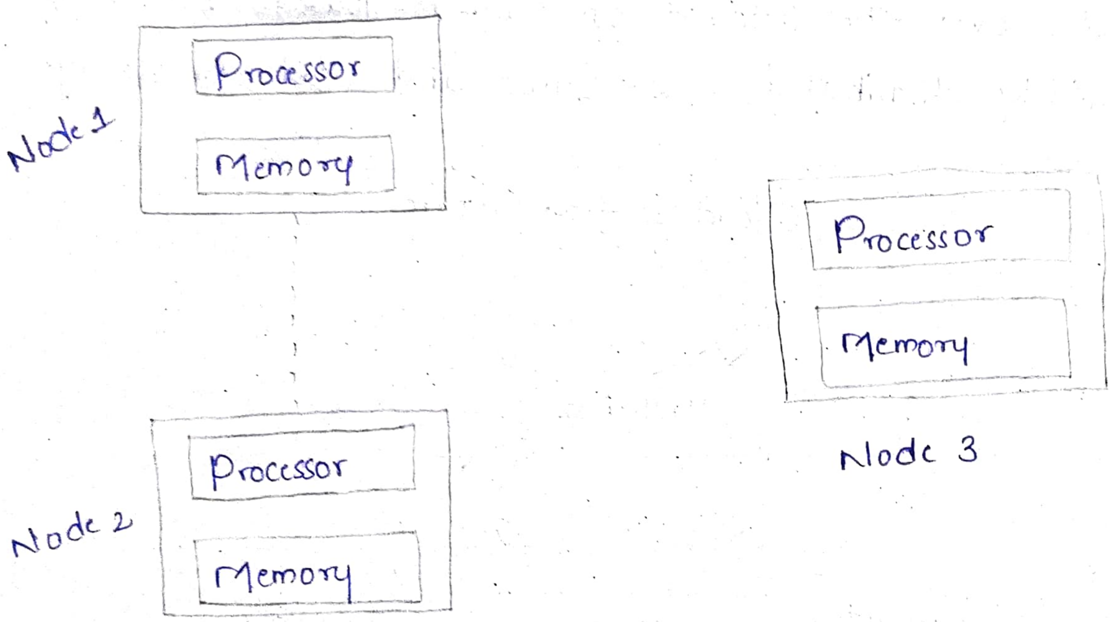


fig:- Cloud Computing Paradigm.

2. Distributed Computing Paradigm:-

Distributed computing is defined as a type of computing where multiple computer systems work on a single problem. Here all the computer systems are linked together and the problem is divided into sub-problems where each part is solved by different computer systems.

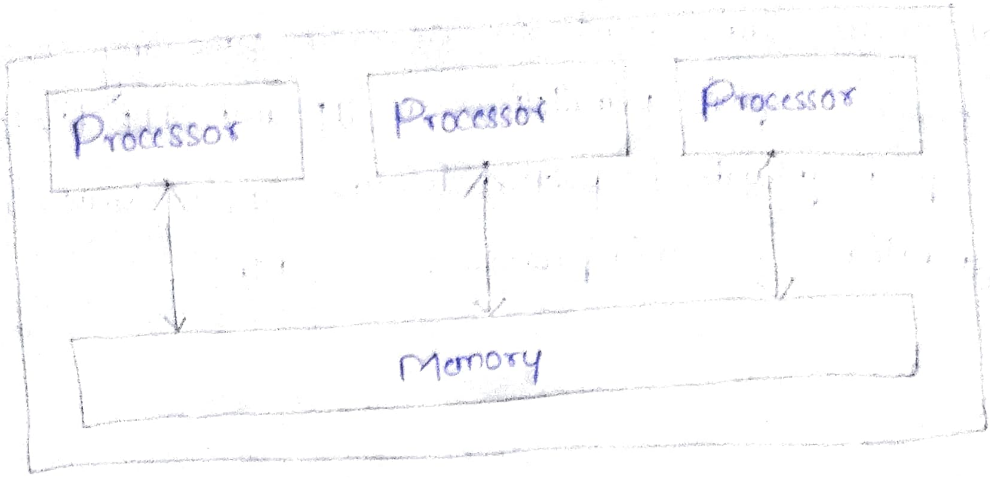
In the below diagram, each processor has its own local memory and all the processors communicate with each other over a n/w.



3. Parallel Computing Paradigm:-

It is defined as type of computing where multiple computer systems are used simultaneously. Here a problem is broken into sub-problems and then further broken down into instructions. These instructions from each subproblem are executed concurrently on different processors.

The goal of parallel computing is to save time and provide concurrency.



The Internet of Things:-

The concept of IOT was introduced in 1999 at MIT [40]. The IOT refers to the networked interconnection of everyday objects, tools, devices, or computers. One can view the IOT as a wireless n/w of sensors that interconnect all things in our daily life. These things can be large or small and they vary with respect to time and place. The idea is to tag every object using RFID or a related sensor or electronic technology such as GPS.

Technologies for Network-Based Systems:-

Multicore CPUs and Multithreading Technologies:-

Consider the growth of component and n/w technologies over the past 30 years. They are crucial to the development of HPC and HTC systems. Processor speed is measured in millions of instructions per second (MIPS) and N/w bandwidth is measured in megabits per second (Mbps) or gigabits per second (Gbps). The unit GE refers to 1 Gbps Ethernet Bandwidth

Advances in CPU processors:-

Advanced CPUs or microprocessors chips assume a multicore architecture with dual, quad, six, or more processing cores. These processors exploit parallelism at ILP and TLP levels. Processor speed growth is plotted in the upper curve in across generations of microprocessors or CMPs.

Multicore CPU and Many-Core GPU architectures:-

Multicore CPUs may increase from the tens of cores to hundreds or more in the future. But the CPU has reached its limit in terms of exploiting massive DLP due to the aforementioned memory wall problem. This has triggered the development of many-core GPU's with hundreds or more thin cores. Both IA-32 and IA-64 instructions set architectures are built into commercial CPUs.

n CPU Processors

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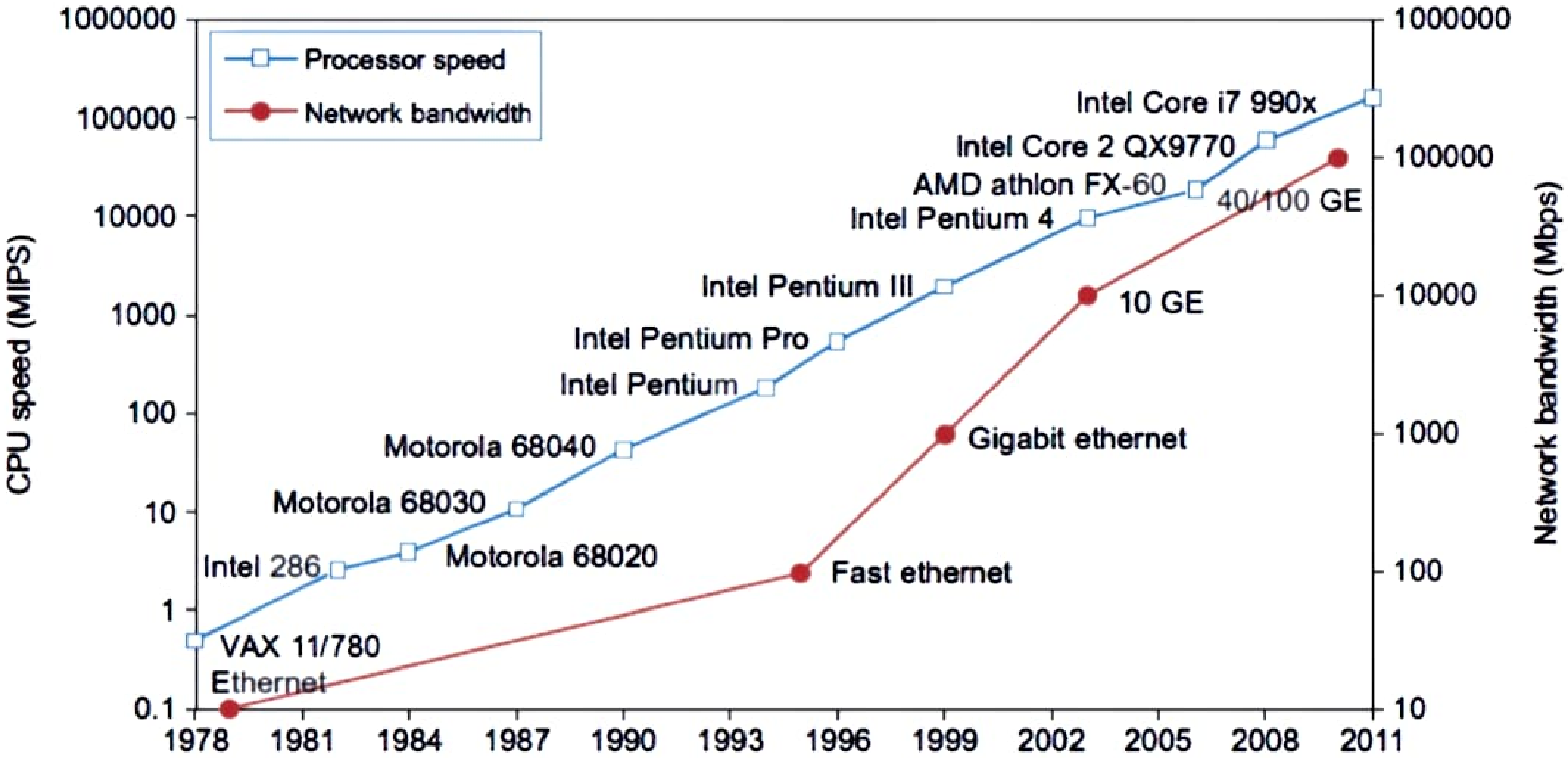


Multithreading Technology & How GPUs work Memory, Storage, and wide-area Networking Memory Technology

The growth of DRAM chip capacity from 16KB in 1976 to 64GB in 2011. This shows that memory chips have experienced a 4x increase in capacity every three years. Memory access time did not improve much in the past

Disks and Storage Technology:-

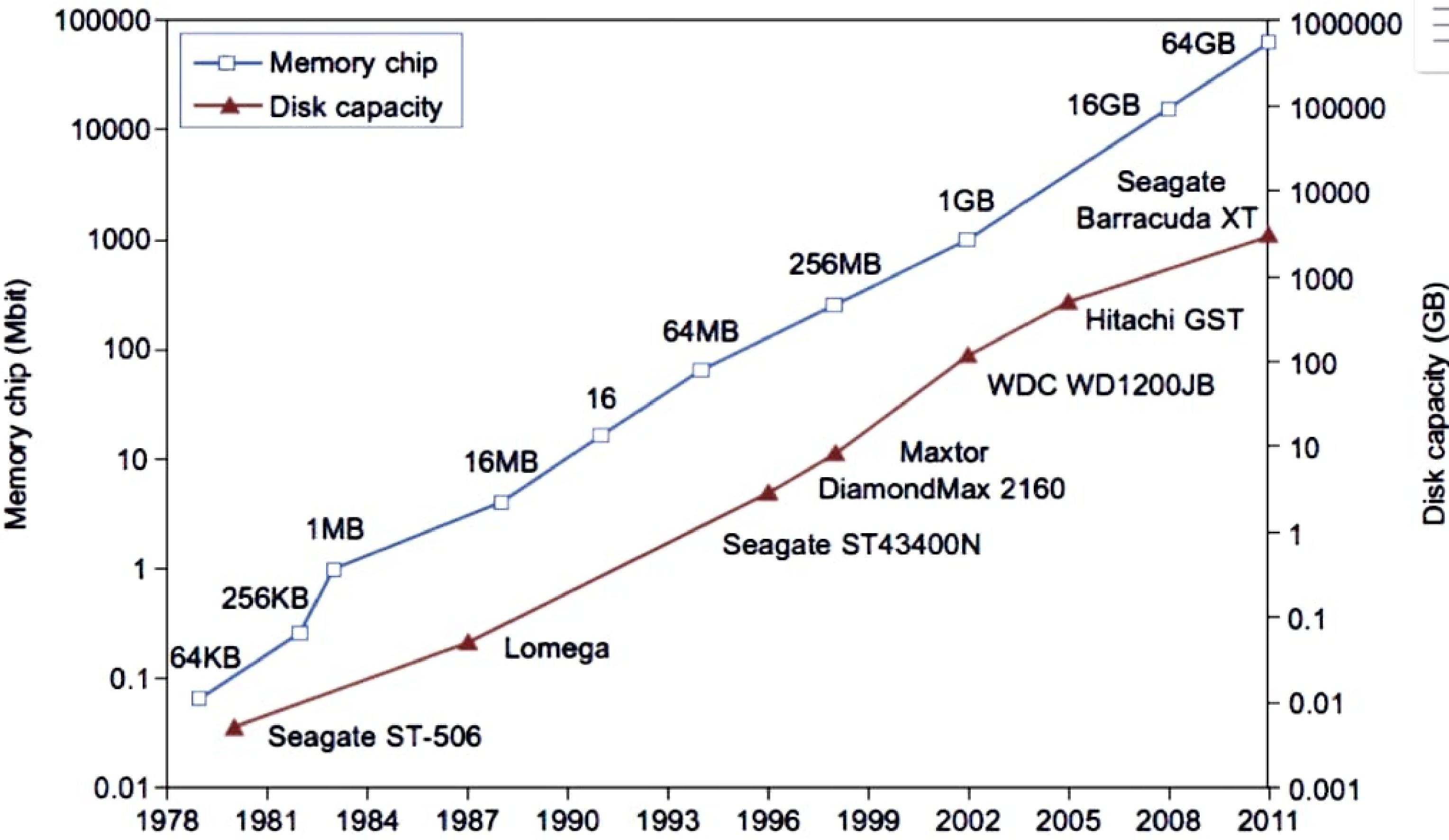
Beyond 2011, disks or disk arrays have exceeded 3TB in capacity. The lower curve in fig shows the disk storage growth in 7 orders of magnitude in 33 years. The rapid growth of flash memory and solid-state drives (SSDs) also impacts the future of HPC and HTC systems.

System Area Interconnects:-

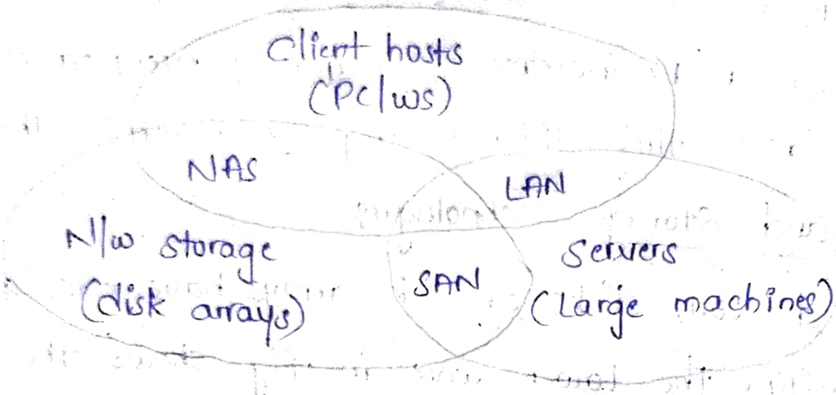
The nodes in small clusters are mostly interconnected by an ethernet switch or a local area network (LAN). As fig shows, a LAN typically is used to connect client hosts to big servers. A storage area N/w (SAN) connects servers to n/w storage such as disk arrays.

torage Technology

1, disks or disk arrays have exceeded 3 TB in capacity. The lower curve in Figur growth in 7 orders of magnitude in 33 years. The rapid growth of flash memory anc s) also impacts the future of HPC and HTC systems. The mortality rate of SSD i SSD can handle 300,000 to 1 million write cycles per block. So the SSD can last under conditions of heavy write usage. Flash and SSD will demonstrate impressiv lications.

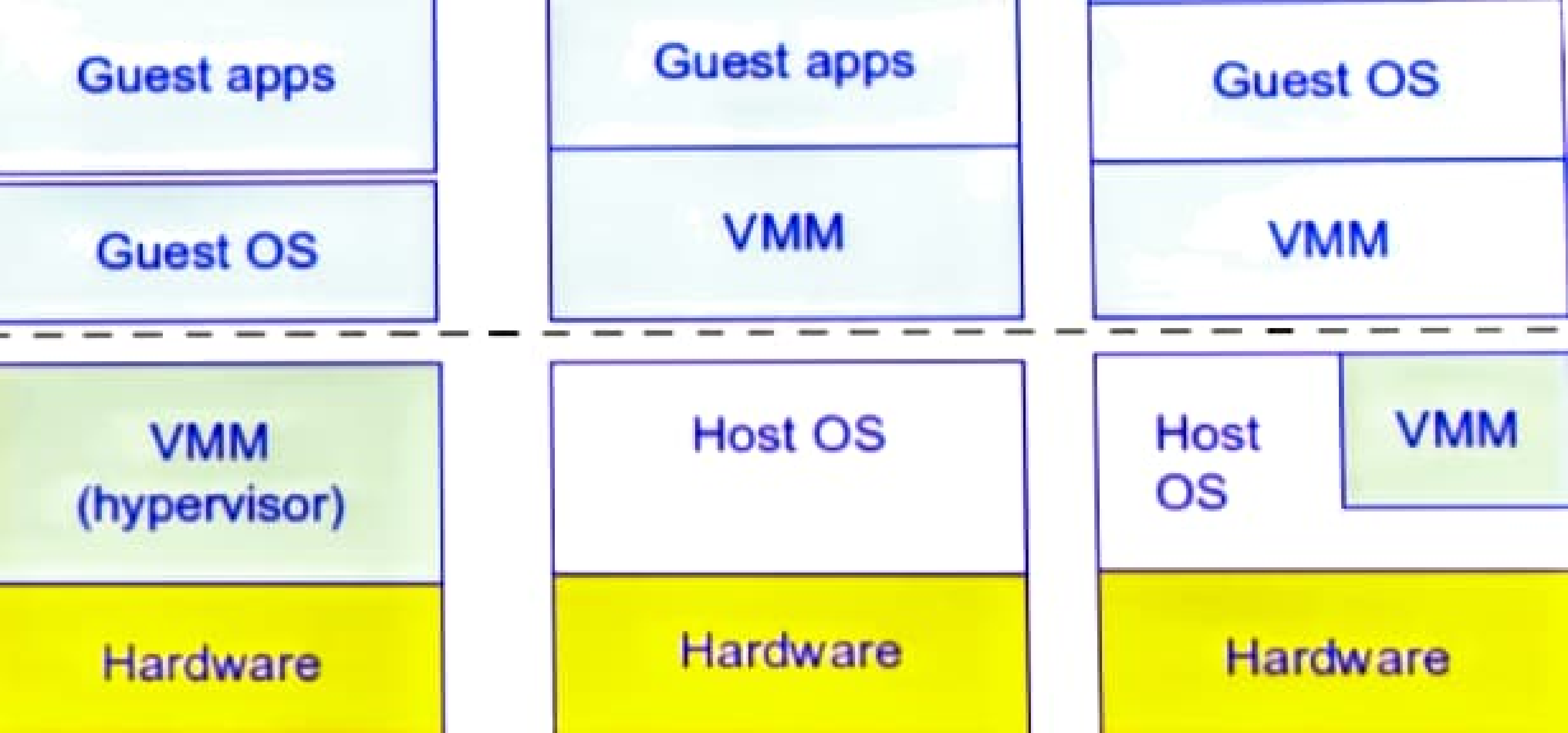


N/w attached Storage (NAS) Connects client hosts directly to the disk arrays. All three types of networks often appear in a large cluster built with commercial n/w Components.



Virtual Machines & Virtualization Middleware :-

A Conventional ~~middleware~~ computer has a single OS image. This offers a rigid architecture that tightly couples applications software to a specific hardware platform. Some software running well on one machine may not be executable on another platform with a different instructions set under a fixed OS. Virtual machines (VMs) offer novel solutions to underutilized resources, application inflexibility, Software manageability, and security concerns in existing physical Machines.


Guest apps
Guest OS
VMM
(hypervisor)
Hardware
Guest apps
VMM
Host OS
Hardware
Guest OS
VMM
Host
OS
VMM
Hardware

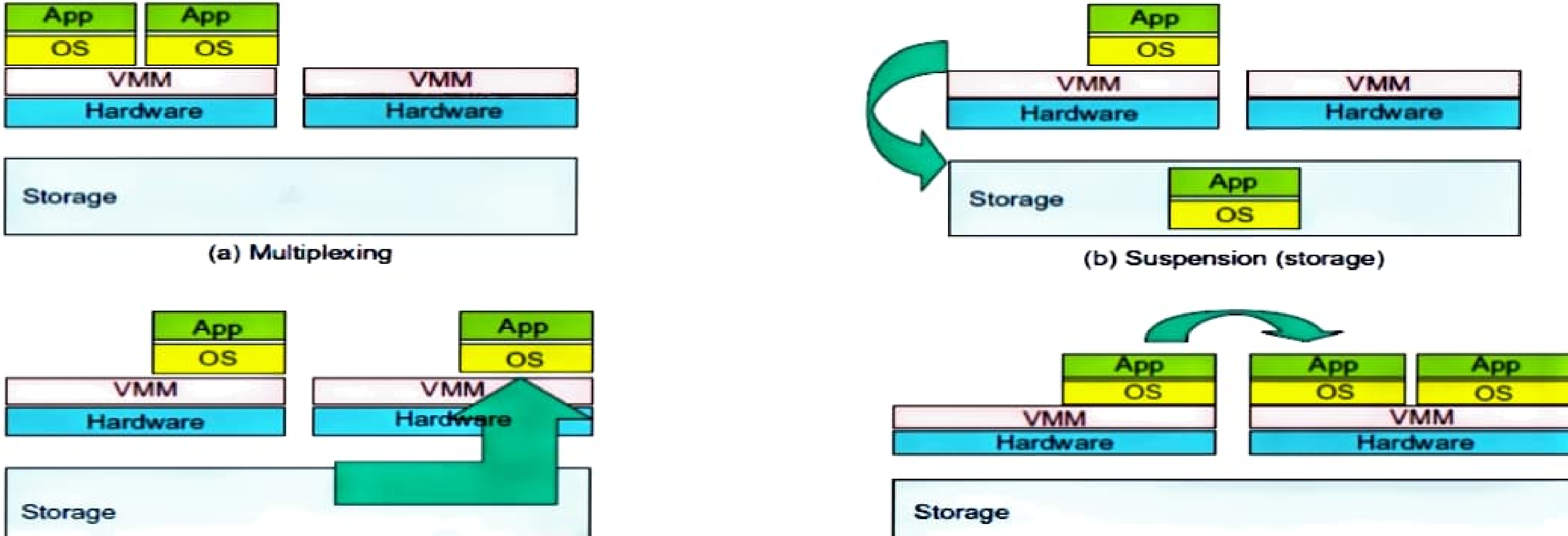
Virtual Machines :-

The host machine is equipped with the physical hardware, as shown at the bottom of fig. An example, is an x-86 architecture desktop running its installed windows Os, a shown in part (a) of the fig.

VM primitive Operations:-

The VMM provides the VM abstraction to the quest Os. with full virtualization, the VMM exports a VM abstraction identical to the physical machine so that a standard Os such as windows 2000 or Linux can run just as it would on the physical hardware. Low-Level VMM Operations are indicated by Mendel Rosenblum [41] & illustrated in fig 1.13.

Virtual infrastructures:- Physical resources for compute, storage, and networking at the bottom of figure are mapped to the needy applications embeeded in various VMs at the top. Hardware and Software are then separated Virtual infrastructure is what connects resources to distributed applications. It is a dynamic mapping of e VMM provides the VM abstraction to the guest OS. With full virtualization, the VMM exports a traction identical to the physical machine so that a standard OS such as Windows 2000 or Linux just as it would on the physical hardware. Low-level VMM operations are indicated by Men senblum [41] and illustrated in Figure 1.13.



(a) Multiplexing

(b) Suspension (storage)

system resources to specific applications. The result is decreased costs and increased efficiency and responsiveness. Virtualization for server consolidation and containment is a good example of this.

Data Centre Virtualization for Cloud Computing Data Centre Growth and cost Breakdown.

A large datacentre may be built with thousands of servers. Smaller data centers are typically built with hundreds of servers. The cost to build and maintain data center. servers has increased over the years. The cost of electricity and cooling did increase from 5 percent to 14 percent in 15 years.

System Models for distributed And Cloud Computing

Distributed and cloud computing systems are built over a large no. of autonomous computer nodes. These node machines are interconnected by SANs, LANs, or WANs in a hierarchical manner. with todays n/w technology, a few LAN switches can easily connects hundreds of machines as a working cluster. A WAN can connect many local clusters to form a very large cluster of clusters. In this sense, one can built a massive system with millions of computers connected to edge n/w's.

Massive systems are considered highly scalable, and can reach web- scale connectivity, either physically or logically.

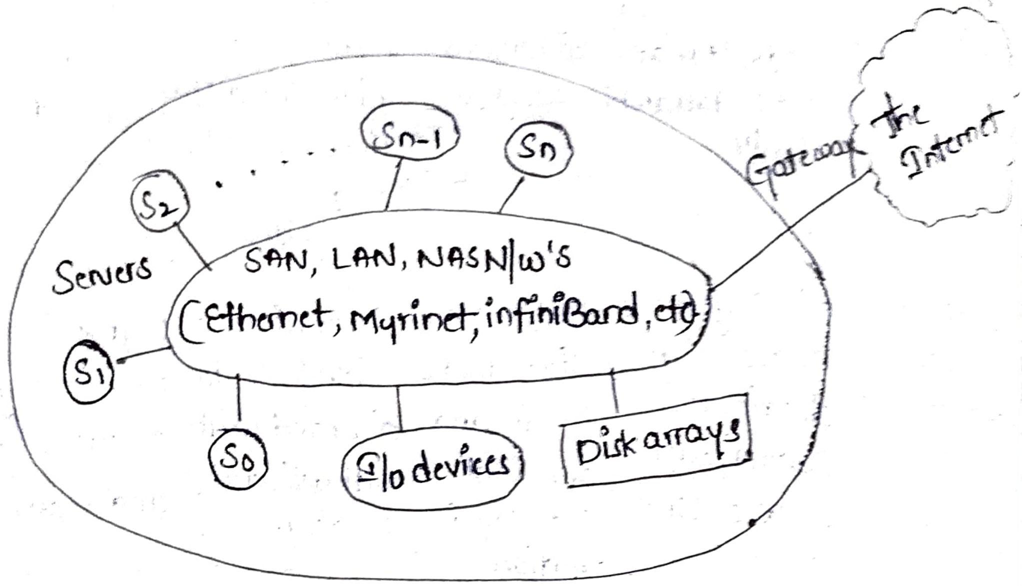
functionality, Applications	Computer cluster [10, 28, 38]	Peer-to-peer N/ws [34, 46]	Data/computational grids [6, 18, 51]	Cloud platforms [1, 9, 11, 12, 30]
Architecture, N/w connectivity & size	N/w of compute nodes interconnected by an SAN, LAN or WAN hierarchically	flexible n/w of client machines logically connected to an overlay n/w	Hetrogeneous clusters inter-connected by high-speed n/w links over selected resource sites	Virtualized cluster of servers over data centers via SLA
Control & Resources Management	Homogeneous nodes with distributed control, running UNIX or LINUX	Autonomous client nodes, free in and out, with self-organization	Centralized control, server-oriented with authenticated security.	Dynamic resource provisioning of servers, storage, and N/ws.
Applications & N/w centric services.	High performance computing search engines, & web services etc	Most appealing to business file sharing, content delivery, & social networking	Distributed super computing global problem solving, & data centre services	Upgrade web search, utility computing, & outsourced computing services
Representative Operational systems.	Google search engine, Sun Blade, IBM Road Runner, Cray XT4, etc...	Gnutella, eMule, BitTorrent, Napster, KaZaA, Skype, JXTA	TeraGrid, GriPhyN, UKEGEE, D-Grid, china Grid, etc	Google app Engine, IBM Bluecloud, AWS, and Microsoft Azure

Clusters of Cooperative Computers:-

A Computing cluster consists of interconnected stand-alone computers which work cooperatively as a single integrated, Computing resource. In the past, clustered computer systems have demonstrated impressive results in handling heavy workloads with large datasets.

Cluster Architecture :-

The below figure shows the architecture of a typical server cluster built around a low-latency, high bandwidth interconnection network. This network can be as simple as a SAN (E.g. Myrinet) or a LAN (E.g. Ethernet).



Single System Image :-

Greg Pfister [38] has indicated that an ideal cluster should merge multiple systems images into a single system image. Cluster designers design a cluster OS or some middleware to support SSI at various levels.

Hardware, Software and Middleware Support :-

Cluster exploring massive parallelism are commonly known as MPPs. Almost all HPC clusters in the Top 500 list are also MPPs. The building blocks are Computer nodes (PCs, workstations, servers, or SMP), Special Communication Software such as PVM, or MPI & a n/w interface card in each Computer node.

Grid Computing Infrastructures:-

Internet Services such as the Telnet Commands enables a local computer to connect to a remote computer. A web service such as HTTP enables remote access of remote ~~wef~~ web pages.

Computational Grids:-

Like an electric utility power grid, a computing grid offers an infrastructure that couples computers, Software/middleware, Special instruments, and people & sensors together. The grid is often constructed across LAN, WAN, or internet backbone n/w's at a regional, national, or global ~~Scope~~ Scale.

Grid families:-

Grid Technology demands new distributed Computing models, Software/Middleware Support, network protocols, and hardware infrastructures. National grid projects are followed by industrial grid platform development by IBM, Microsoft, Sun, HP, Dell, Cisco, EMC, Platform Computing and others.

Peer to Peer Network families:-

—An example of well established distributed System is the client-Server architecture, In this Scenario, client machines (PCs and workstations) are connected to a central server for compute, e-mail, file access, and database applications.

Overlay Networks:-

Data items or files are distributed in participating peers. Based on communication or file-sharing needs, the peer ID's form an overlay n/w at the logical level

Software Environments for Distributed Systems AND Clouds:

Service-Oriented Architecture:-

In grids/web services, java, and COBRA, an entity is, respectively, a service, a java object, and a COBRA distributed object in a variety of language. These architectures build on the traditional seven Open Systems Interconnection (OSI) layers provide the base networking abstractions.

Layered Architecture for Web Services & Grids:-

The entity Interfaces correspond to the web ~~page~~ Services Description Language (WSDL), Java method, and interfaces are linked with customized, high-level communication systems: SOAP, RMI, and IIOP in the three examples.

In this case of fault tolerance, the features in the web Services Reliable Messaging framework mimic the OSI layer capability modified to match the different abstractions at the entity levels.

Application Specific Services/grids
Generally useful services & grids
workflow
Service Management
Service discovery & information
Service internet transport → protocol
Service interfaces

Base hosting environment

Protocol HTTP, FTP, DNS ...
Presentation XDR ...
Session SSH ...
Transport TCP UDP ...
Network IP ...
Datalink/ physical

Higher level Services

Service Context

Service Internet

Bit level Internet

Web Services & Tools:-

Loose Coupling and Support of hetrogeneous implementations make services more attractive than distributed Objects. ~~the~~ Both web services and REST Systems have very distinct approaches to building reliable interoperable systems. This approach has mixed success as it has been hard to agree on key parts of the protocol and even harder to efficiently implement the protocol by Software such as Apache Axis

The Evolution of SOA:-

Service-Oriented Architecture (SOA) has evolved over the years. SOA applies to building grids, clouds, grids of clouds, clouds of grids, clouds of clouds, and systems of in general. A large no. of sensors provide data collection services.

Performance, Security, And Energy Efficiency:

Performance Metrics & Scalability Analysis:-

Performance metrics are needed to measure various distributed systems. In this section, we will discuss various dimensions of scalability and performance laws. ~~They~~ Then we will examine system scalability against OS images and the limiting factors encountered.

Performance Metrics:-

We discussed CPU speed in MIPS & n/w bandwidth in Mbps ~~in~~ to estimate pro-cessor and n/w performance.

→ An interconnection n/w that has low latency & high bandwidth is preffered.

→ Other Performance related metrics include the QoS for internet & Web Services; System availability & dependability; and Security resilience for System defense against n/w attacks.

Dimensions of Scalability:-

Users want to have a distributed system that can achieve scalable performance.

→ Size Scalability:- This refers to achieving higher performance or more functionality by increasing the machine size. The word "size" refers to adding processors, cache, memory, storage, or I/o channels. The most obvious way to determine size scalability is to simply count the no. of processors installed

→ Software Scalability:- This refers to upgrades in the OS or compilers, adding mathematical & engineering libraries, porting new application software, and installing more user-friendly programming environments. Some software ~~updates~~ upgrades may not work with large system configurations. Testing & fine-tuning of new software on larger systems is a nontrivial job

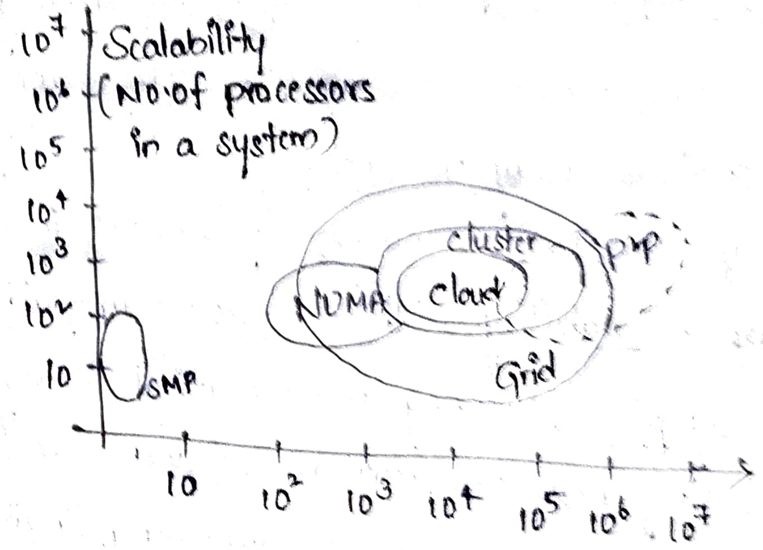
→ Application Scalability:- This refers to matching problem size scalability with machine size scalability. Problem size affects the size of the data set or the workload increase.

→ Technology Scalability:- This refers to a system that can adapt to changes in building technologies such as the component and networking technologies. When scaling a system design with new technology one must consider three aspects-

(1) Time refers to generation Scalability.

(2) Space is related to packaging and energy concerns.

(3) Hetrogeneity refers to the use of hardware components of Software packages from different vendors



Amdahl's Law:-

Consider the execution of a given program on a uniprocessor workstation with a total execution time of T minutes. Now, let's say the program has been parallelized or partitioned for parallel execution on a cluster of many processing nodes. Therefore, $(1-a)$ of the code ~~an~~ can be compiled for parallel execution by n processors. The total execution time ~~for~~ on a single processor is the $aT + (1-a)T/n$, where the first term is the sequential execution time on a single processor & the second term is parallel execution time on 'n' processing nodes.

$$\text{Speedup} = S = T/[aT + (1-a)T/n] = 1/[a + (1-a)/n]$$

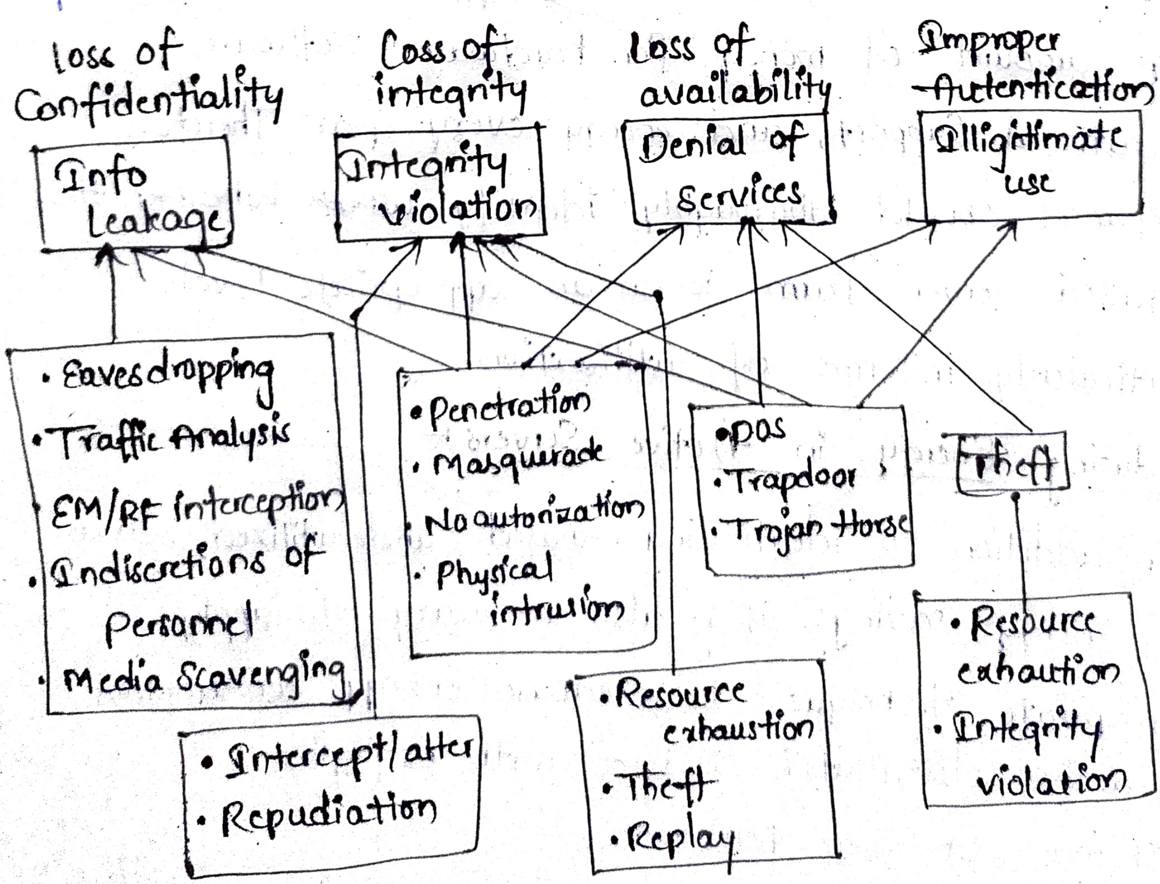
Fault Tolerance & System Availability :- - System Availability :-

HA (High Availability) is desired in all clusters, grids, P2P n/w's, and cloud systems. A system is highly available if it has a long mean time to failure (MTTF) & a short mean time to repair (MTTR). System availability is formally defined as follows:

System Availability = MTTF/(MTTF + MTTR)

N/w Threats & Data Integrity - Threats to systems & N/w :-

N/w viruses have threatened many users in widespread attacks. These ~~include indicates~~ incidents have created a worm epidemic by pulling down many routes and services, and are responsible for the loss of billions of dollars in business, govt, and services.



Copyright Protection:-

Collusive piracy is the main source of intellectual property violations within the boundary of P2P n/w. Paid clients may illegally share copyrighted content files with unpaid clients.

Energy Efficiency in Distributed Computing:-

Primary performance goals in conventional parallel & distributed computing systems are high performance & high throughput, considering some form of performance reliability. These emerging issues are crucial not only on their own, but also for the sustainability of Largescale computing systems in general.

Energy Consumption of Unused Servers:-

To run a server farm a company has to spend a huge amount of money for hardware, software, operational support, and energy every year. Therefore companies should thoroughly identify ~~whether~~ whether their installed server farm is at an appropriate level, particularly interms of utilization.

Reducing Energy in Active Servers:-

In addition to identifying unused / underutilized servers for energy savings, it is also necessary to apply appropriate techniques to decrease energy consumption in active distributed systems with negligible influence on their performance.

Energy in Active Servers

n to identifying unused/underutilized servers for energy savings, it is also nece e techniques to decrease energy consumption in active distributed systems w on their performance.