RAIN TECHNOLOGY

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ABSTARCT:

The massive jumps in technology led to the expansion of internet as the most accepted medium for communication. But one of the most prominent problems with this client server based technology is that of maintaining a regular connection. Even if a sole intermediate node breaks down, the entire system crumples. The solution to this problem can be the use of clustering. Clustering means linking together two or more systems to manage erratic workloads or to offer unremitting operation in the event one fails .Clustering technology suggests an approach to augment general reliability and performance. One implementation done for this was RAIN-Reliable Array Of Independent Nodes developed by the California Institute of Technology, in collaboration with NASA's Jet Propulsion Laboratory and the Defense Advanced Research Projects Agency (DARPA).The technology is implemented in a distributed computing architecture, built with inexpensive off-the-shelf components. The RAIN platform involves heterogeneous cluster of nodes linked using many interfaces to networks configured in fault-tolerant topologies. RAIN technology was capable of providing the solution by reducing the number of nodes in the chain linking the client and server in addition to making the current nodes more robust and more autonomous.

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1. RAIN TECHNOLOGY-RELIABLE ARRAY OF INDEPENDENT NODES:

RAIN Technology (Redundant/reliable array of inexpensive/independent nodes) is a heterogeneous collection of nodes called clusters linked through numerous interfaces to networks configured in fault-tolerant topologies. The RAIN technology concentrates on developing high - performance, fault-tolerant, portable clustering technology .RAIN technology was capable to proffer the solution by lessening the number of nodes in the chain connecting the client and server .apart from this it also facilitates in making the current nodes of client-server architecture more robust. The objective of the RAIN is to recognize and make key building blocks for reliable distributed systems built using reasonably priced off-the-shelf components .RAIN technology also offers the new feature of reinstating an out of order node by a new one thus keeping away from the break in information flow.

Rain technology is an open architecture approach to storage, which uses inexpensive computing hardware with extremely intelligent management software to make it reliable and efficient. The components of RAIN configuration run in parallel with operating system and network protocols. The fault tolerance is provided by the management software used which is similar to fault tolerance provided by expensive hardware devices.

2. BRIEF HISTORY OF RAIN:

The RAIN technology is actually the name of a research project that has its roots at the California Institute of Technology (Caltech), in association with NASA's Jet Propulsion Laboratory and the Defense Advanced Research Projects Agency (DARPA).It was started to develop a substitute to the costly, special-purpose computer systems used in space missions. The prime objective of the Caltech researchers was to put distributes processing across many economical commercial hardware and software components.

Later it was named as 'Rainfinity's technology' from the original research project name 'RAIN technology'. Rainfinity is a company that primarily deals with creating clustered solutions for enhancing the performance and availability of Internet data centers.

3. IMPORTANT CHARACTERISTICS OF RAIN:

Below listed are some of the distinguished characteristics of RAIN:

RAIN CHARACTERISTICS	RAIN BENEFITS	RAIN COMPONENTS

• Clustering
• Distributed
• Shared-Nothing
• Fault tolerant
• Reliance on software
• Use of inexpensive nodes
• Suitability for Network Applications
• Communication
• Scalability
• Group membership
• Data storage
	• Fault tolerance
	• Simple to deploy and manage
	• Open and portable
	• supports for heterogeneous environment
	• No distance limitation
	• Availability
	• Scalability
	• Load Balancing and Performance
		• RAIN nodes
		• IP-based internetworking
		• RAIN management software
		  • Storage component
		  • Communication component
		  • Computing component

Figure 1: Characteristics, benefits and components of RAIN

3.1. Clustering: Clustering means linking together two or more systems to handle variable workloads or to provide continued operation in the event one fails. Each computer may be a multiprocessor system itself, clustered computers behave like a single computer and are used for load balancing, fault tolerance, and parallel processing. Rainfinity provides clustering solutions that let Internet applications to run on a reliable, scalable cluster of computing nodes so that they do not become single points of failures.

3.2. Distributed: A distributed system is the one that contains many independent computers that communicate through a computer network. The computers communicate with each other in order to achieve a common goal. Software that runs in a distributed system is called a distributed program. RAIN uses loosely coupled architecture but, the distributed protocols interact closely with existing networking protocols so that a RAIN cluster is able to interact

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with the environment. Particularly, technological modules were developed to manage high-volume network-based transactions.

3.3. Shared-Nothing: Shared nothing architecture (SNA) is a distributed computing architecture that contains of multiple nodes such that each node consists of its own private memory, disks and input/output devices independent of any other node in the network. Each node is self sufficient and shares nothing across the network. Therefore, there is no disputation and no data sharing or system resources. In RAIN the most general share-nothing model is assumed. There is no shared storage accessible from all computing nodes. The only way for the computing nodes to share state is to communicate via a network.

3.4. Fault tolerant: RAIN achieves fault tolerance through software implementation. The system tolerates multiple node, link, and switch failures, with no single point of failure. But the concept has actually been derived from RAID (redundant array of independent disks) which is implementation on independent disk arrays. Disk-use techniques involve the use of multiple disks working cooperatively. It uses Disk striping uses a group of disks as one storage unit. RAID schemes improve performance and improve the reliability of the storage system by storing redundant data. RAID uses mirroring or shadowing (RAID 1) to keeps duplicate of each disk On the other hand RAIN is a novel, more advanced, way of protecting computer storage than RAID. A RAIN cluster is a proper distributed computing system that is tough to faults. It handles node, link and application failures or transient failures efficiently. When there are failures in the system, a RAIN cluster gracefully degrades to leave out the failed node continues to perform the operations.

3.5. Reliance on software: RAIN depends on software to systematize multiple separate computer servers to provide data reliability. In spite of storing multiple copies of the same data on physically separate hard disks on a server, data is replicated across multiple servers. The software organizing the cluster of RAIN servers knows the location of each copy and thus provides protection in case of failures by making duplicate copies as and when required.

3.6. Use of inexpensive nodes: RAIN uses loosely coupled computing clusters using inexpensive RAIN nodes, instead of using expensive hardware devices. It uses management software that transmits tasks to various computers and, in the event of a failure, will retry the

task until a node responds. Many of the loosely coupled computing projects make use of, to some degree, a RAIN strategy.

3.7. Suitability for Internet applications and Network Applications: RAIN technology is very apt for Internet and network applications. During the RAIN project, key components were put up to accomplished to achieve its suitability for network and internet applications. A patent was filed and granted for the RAIN technology. Rainfinity emerged as a byproduct, in 1998, and the company had exclusive intellectual property rights to the RAIN technology. After the formation of the company, the RAIN technology has been further augmented, and additional patents have been filed.

The architecture objectives for clustering data network applications are dissimilar to clustering data storage applications. Alike goals apply in the telecom environment that offer the Internet backbone infrastructure, owing to the nature of applications and services being clustered.

3.8. Scalability: The technology has the feature of scalability. Scalability is the ability of a computer application or product to continue to function well when it is changed in size or volume in order to meet a user need. RAIN has the characteristic wherein failed node is replaced by a new node. It focuses on recovery from unplanned and planned downtimes. This new-fangled type of cluster must also be able to make the most of I/O performance by load balancing across various computing nodes. Moreover with the help of RAIN connection between a client and server can be maintained despite all unplanned and planned downtimes.

3.9. Communication: Nodes communicate via interconnect topologies and reliable communication protocols. The nodes consist of multiple interface cards. For proper tracking and monitoring link state monitoring protocol is used and fault tolerant interconnect topologies are used.

3.10. Group membership: Group membership is done via protocols that keep track of all the nodes in the cluster. An elemental part of fault management is to recognize which nodes are working and contributing in the cluster as well as the nodes that are faulty.

3.11. Data storage: Fault tolerance in data storage across many disks is obtained using redundant storage schemes. The RAIN system proffers a loosely coupled storage system based on a class of error-control codes called array code.

Figure 2: RAIN Testbed

(Source: www.paradise.caltech.edu)

4. COMPONENTS OF RAIN:

The RAIN technology consists of following components:

4.1. RAIN nodes: These are the basic elements of RAIN, these hardware components use 1 terabyte of disk storage capacity comprising standard Ethernet networking and CPU processing power to run RAIN and data management software. Data is stored and secured reliably among multiple RAIN nodes.

4.2. IP-based internetworking: The physical interconnections amongst the RAIN nodes are established using standard IP-based LANs, metropolitan-area networks (MAN) and/or WANs. This allows administrators develop an integrated storage and protection grid of RAIN nodes across multiple data centers.
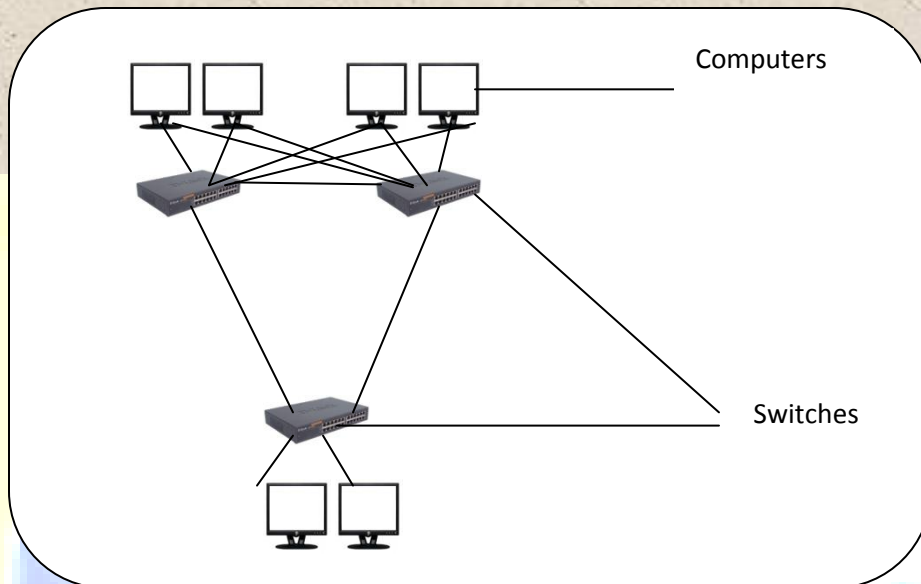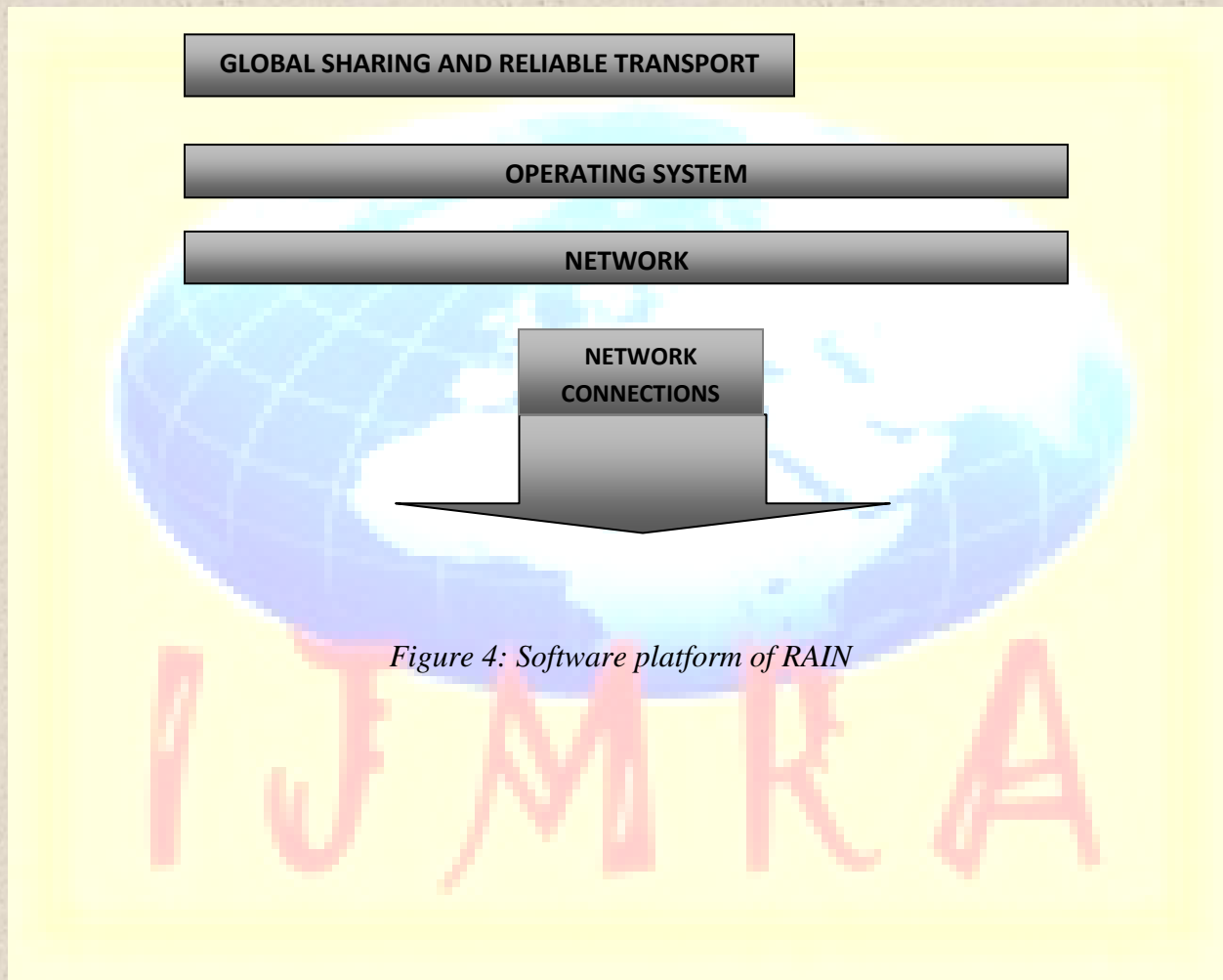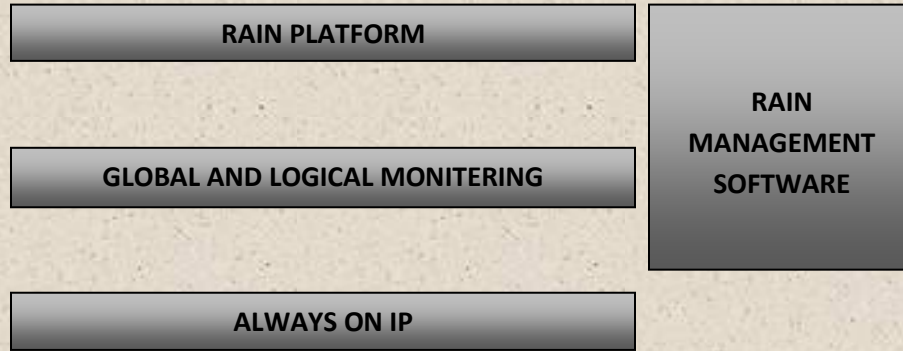

Figure 3: Hardware used in RAIN

4.3. RAIN management software: The RAIN management software is a vital component of the RAIN architecture and performs some significant tasks like letting RAIN nodes incessantly communicate their assets, capacity, performance and health among themselves, automatically detecting the presence of new RAIN nodes on a new network, recovery operations etc. RAIN software has three components:

- ♯ **Storage component**: The basic function of this component is to store and retrieve data across distributed processors

- ♯ **Communication component**: Communications component is used to create a redundant network between multiple for providing uniformity across the network.

- ♯ **Computing component**: A computing component is concerned with automatically recovering and restarting applications if there exist a malfunctioning processor.

APPLICATIONS

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RAIN PLATFORM

GLOBAL AND LOGICAL MONITERING

RAIN MANAGEMENT SOFTWARE

ALWAYS ON IP

GLOBAL SHARING AND RELIABLE TRANSPORT

OPERATING SYSTEM

NETWORK

NETWORK CONNECTIONS

Figure 4: Software platform of RAIN

5. ADVANTAGES OF RAIN:

RAIN technology offers various benefits as listed below:

- **Fault tolerance**: RAIN achieves fault tolerance through software implementation. The system tolerates multiple node, link, and switch failures, with no single point of failure .A

RAIN cluster is a true distributed computing system that is durable to faults, it works on the principle of graceful degradation.

- **Simple to deploy and manage:** It is very easy to deploy and administer a RAIN cluster. RAIN technology deals with the scalability problem on the layer where it is happening, without the need to create additional layers in the front. The management software allows the user to monitor and configure the entire cluster by connecting to any one of the nodes.

- **Open and portable:** The technology used is open and highly portable. It is compatible with a variety of   hardware and software environments. Currently it has been ported to Solaris, NT and Linux.

- **Supports for heterogeneous environment**: It supports a heterogeneous environment as well, where the cluster can consist of nodes of different operating systems with different configurations.

- **No distance limitation**: There is any distance restriction to RAIN technology. It allows clusters of geographically distributed nodes. It can work with many different Internet applications.

- **Availability:** Another advantage of RAIN is its incessant availability. Eg as in case of Rainwall ,it detects failures in software and hardware components in real time, shifting traffic from failing gateways to functioning ones without interrupting existing connections.

- **Scalability:** RAIN technology is scalable. There is no limit on the size of a RAIN cluster eg. Rainwall is scalable to any number of Internet firewall gateways and allows the addition of

  new gateways into the cluster without service interruption

- **Load Balancing and Performance**

  New nodes can be added into the cluster on the spot to take part in load sharing, without deteriorating the network performance as in case of Rainwall. Rainwall keeps track of the total traffic going into each node. When a disproportion is sensed, in the network traffic, it moves one or more of the virtual IPs on the more heavily-loaded node to the more lightly-loaded node. Also new nodes can be added into the cluster to participate in load sharing, without taking down the cluster.

6. APPLICATIONS:

Below listed are some of the applications of RAIN : video server (RAIN Video), a web server (SNOW), and a distributed check pointing system (RAIN Check) etc. These applications indicate quick failover response, little overhead and near-linear scalability of the Raincore protocols:

- **SNOW (Strong Network of Web servers)**: The first application, called SNOW, is a scalable Web server cluster that was developed as part of the RAIN project.

- **RAINVideo :** RAINVideo application is a collection of videos written and encoded to all n nodes in the system with distributed store operations.

- **RainWall**: RainWall is a commercial solution that provides the fault-tolerant and scalable firewall cluster.

- **RAINCheck :** Raincheck is a Distributed Check pointing Mechanism ,it implements a checkpoint and rollback/recovery mechanism on the RAIN platform based on the distributed store and retrieve operations.

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- **Distributed Check pointing Mechanism:** It is a checkpoint and rollback/recovery mechanism on the RAIN platform based on the distributed store and retrieve operations.

7. CONCLUSION:

RAIN technology has been exceedingly advantageous in facilitating resolution of high-availability and load-balancing problems. It is applicable to an extensive range of networking applications, such as firewalls, web servers, IP telephony gateways, application routers, etc. The purpose of the RAIN project has been to pave a way to fault-management, communication, and storage in a distributed environment. It integrates many significant exclusive innovations in its core elements, like unlimited scalability, built-in reliability; portability etc .It has very useful in the development of a fully functional distributed computing system.

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