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Wireless Network security and RAIN (Reliable Array of Independent Nodes) Technology

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ABSTRACT: Wireless networking is inherently insecure wireless data network use a variety of cryptographic technology such as encryption and authentication to provide barrier to such infiltration. Encryption algorithms play a main role in information security systems. On the other side, these algorithms consume a significant amount of computing resources such as CPU time, memory, and battery power. This paper illustrates the key concepts of security, wireless networks, and security over wireless networks. RAIN technology concentrates on developing high performance, fault-tolerant, portable clustering technology. The RAIN technology is a research collaboration between Caltech and NASA –JPL on distributed computing and data storage system for future space borne mission. The RAIN platform involves heterogeneous cluster of nodes linked using many interfaces. 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 node more robust and more autonomous.

Keywords: Wireless security; encryption technology; RAIN; NASA-JPL

INTRODUCTION

Wi-Fi is the name of the popular wireless networking technology that uses radio waves to provide wireless high-speed internet and network connection. The Wi-Fi alliance, the organization that owns the wi-fi (registered trade mark) term specifically defines Wi-Fi as any ―wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards." A common misconception is that the term Wi-Fi is short for "wireless fidelity," however this is not the case. Wi-Fi is simply a trademarked term meaning IEEE 802.11x. Initially, Wi-Fi was used in place of only the 2.4 GHz 802.11b standard, however the Wi-Fi Alliance has expanded the generic use of the Wi-Fi term to include any type of network or WLAN product based on any of the 802.11 standards, including 802.11b, 802.11a, dual-band, and so on, in an attempt to stop confusion about wireless LAN interoperability. Wi-Fi works with no physical wired connection between sender and receiver by using radio frequency (RF) technology, a frequency within the electromagnetic spectrum associated with radio wave propagation. When an RF current is supplied to an antenna, an electromagnetic field is created that then is able to propagate through space. The cornerstone of any wireless network is an access point (AP). The primary job of an access point is to broadcast a wireless signal that computers can detect and "tune" into. In order to connect to an access point and join a wireless network, computers and devices must be equipped with wireless network adapters. Wi-Fi is supported by many applications and devices including video game consoles, home networks, PDAs, mobile phones, major operating systems, and other types of consumer electronics. Any products that are tested and approved as "Wi-Fi Certified" (a registered trademark) by the Wi-Fi Alliance are certified as interoperable with each other, even if they are from different manufacturers. For example, a user with a Wi-Fi Certified product can use any brand of access point with any other brand of client hardware that also is also "Wi-Fi Certified". Products that pass this certification are required to carry an identifying seal on their packaging that states "Wi-Fi Certified" and indicates the radio frequency band used (2.5GHz for 802.11b, 802.11g, or 802.11n, and 5GHz for 802.11a).

Wireless Networks Challenges: Wireless Networks plays the most important role in the development of the information in between individual-to-individual, business-to-business, and individual-to-business. It changed completely the way of sharing of the information but still there are lot of challenges which are the hurdles in the wide adaptation of wireless network technology [1-2].we have to understand the main problems that not only Wi-Fi network faces but all the networks faces are –CIA that is confidentiality, integrity and authentication.

Confidentiality: Allow only the authorized person to read the encrypted messages or the information.

Integrity: It is defined as the information not being opened by third person and it should reach in the same format as it was sent by the sending party.

Authentication: The parties sending or receiving messages make sure that, who they say they are, and have right to undertake such actions. The main issue in the security of wireless signal is its mode of transmission .wireless signals are transmitted through the electromagnetic waves; these waves cannot be contained physically. In wireless networks the signals are

communicated via air, hence can be easily intercepted with the help of right transceiver equipment.

Wireless LANs: Wireless LANs supply high performance within andaround office buildings, factories, and homes [4].
Table1 provides some key characteristics at a glance.

Table 1. Key Characteristics of 802.11 Wireless LANs.

Characteristic	Description
Physical Layer	Direct Sequence Spread Spectrum (DSSS), Frequency Hopping Spread Spectrum (FHSS), Orthogonal Frequency Division Multiplexing (OFDM), infrared (IR).
Frequency Band	2.4 GHz (ISM band) and 5 GHz.
Data Rates	1 Mbps, 2 Mbps, 5.5 Mbps (11b), 11 Mbps(11b), 54 Mbps (11a)
Data & Network Security	RC4-based stream encryption algorithm for confidentiality, authentication, and integrity. Limited key management. (AES is being considered for IEEE 802.11i.)
Operating Range	Up to 150 feet indoors and 1500 feet outdoors
Negative Aspects	Poor security in native mode; throughput decrease with distance and load.

Wireless LANs Entities:
Clients or end-user devices and Access Points. Thebasic structure of a Wireless LAN is called infrastructure WLAN or BSS (Basic Service Set) shown in figure 1, in which the network consists of an access point and several wireless devices. When these devices try to communicate among themselves they propagate their data through the access point device.

Figure 1: Wireless LANs (BBS structure).

If the BSS did not have an access point device, andthe wireless devices were communicating with eachother directly, this BSS is called an Independent BS Sand works in mode called "ad hoc mode" (shown infigure2). Ad hoc networks are also commonly referredto as peer-to-peer networks [3].

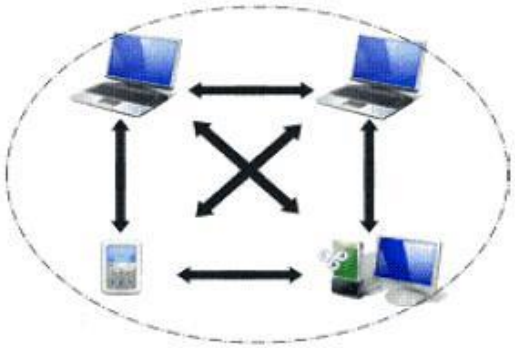

Figure 2:A dhoc Wireless LANs

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. [5].

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.

CHARACTERISTICS OF RAIN

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. Rain finity 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.

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

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.

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.

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.

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

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.

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.

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.

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 [6].

Components of RAIN: The RAIN technology consists of following components:

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.

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.

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 [7][8].

CONCLUSIONS

Wi-Fi security is not an easy task. Wireless network security is more difficult than wired network security. There are many protocols or standards or we can say technologies for wireless network security but every protocol has its demerits, until now there is no protocol which can provide security 100% or near about it. 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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