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Protocol Transparency in Heterogeneous Computer Networks

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Abstract-Many internet applications can be affected when end nodes are not are in the same address realm and seek the assistance of an IP Network Address Translator (NAT) enroute to bridge the realms. The NAT device alone cannot provide the necessary application/protocol transparency in all cases and seeks the assistance of Application Level Gateways (ALGs) where possible, to provide transparency. The purpose of this document is to identify the protocols and applications that break with NAT enroute. The document also attempts to identify any known workarounds. It is not possible to capture all applications that break with NAT in a single document. This documents attempts to capture as much information as possible, but is by no means a comprehensive coverage. We hope the coverage provides sufficient clues for applications not covered.

In networking all the devices (generally computers) are compatible with each other, but it may or may not be the case with internetworking. When two or more networks are connected together to form an internetwork, it is quite possible that the networks are incompatible to each other in many aspects. They may differ in terms of their topologies (set of rules for data transfer between two computers), signaling, addressing scheme and transmission mechanism as well as in the media (cables) used for transmission. There are two closely related problems which building up of a large network : **heterogeneity** and **Scale.** Thus any network may be homogeneous or heterogeneous depending on whether the network components are similar or dissimilar.

Internetworking is a highly sought-after feature whereby multiple distinct computer networks can be interconnected. This allows sharing of information and resources across physical boundaries. The goal of internetworking is to solve the various differences and create a seamless internet work. The internet is a network of computer networks which differ in their hardware and software characteristics, and yet they work seamlessly with each other. There has been an exponential increase in the nontraditional internet end systems connected together by communication links. In fact, this has been the most radical change in the field of networking. Another revolutionary aspect in the field of networking is the growth in the area of networking services and applications, as witnessed by the emergence of the web allows distributed applications like instant messaging, ubiquitous email use, peer to peer applications, internet telephony, audio and video streaming, etc including wireless access.

I. INTRODUCTION

The 20th century was dominated by the installation of the world wide telephone networks, the invention of radio and television, the birth and exponential growth of the computer industry, launching of communication satellites and so on. The rapid technological development in the communication systems was due to extensive research going on in the field of computer industry and networks systems. Information gathering, sophisticated methods of information processing and distributing are now built on top of a network. The network hardware and software provide a high degree of cohesiveness and transparency amongst the users. Users can share the software and hardware resources reliably, accurately, speedily saving a good amount of money. Computer Science mentors are confronted with the alarming task of not only trying to balance application and theory but also to keep up with the rapid advancement in technology. Our society is rapidly evolving into one that will continuously demand faster communication on a relatively slow expanding bandwidth. Though telecommunications system is a bare transporter of information by means of digital transmission and switching facilities but this concept can be expanded by enhancing network control and management capabilities for ubiquitous and seamless information utility of the future.During the past two decade, telecommunication has undergone an extraordinary acceleration due to the vast improvement in both the physical and logical structure of computer networks. The physical aspect of this improvement is characterized by the rapid deployment of fibre optic cables, high-frequency channels, infrared media, and ISDN lines. The improvement of the logical side is manifested by the ten-fold improvement of the widely used Ethernet protocol into Fast Ethernet and even by a hundred-folds increases as manifested by Gigabit Ethernet. Coupled with this is the introduction of new protocols such as those that integrate voice, data, and video.

Initial networks ware concentrated within a very small topological area, within an organization, hence homogeneous or similar networks were used that had the same technology with respect to topology, frame format, speed matching, protocols etc. Setting up of these networks is relatively easy and maintain with low cost. Maintaining the integrity and sequencing of packets is also easy and the fault detection and correction for the system could be done very easily.But with the alarming benefits obtained from the networking, it became necessary to connect multiple networks of one or more organizations into a large, uniform communication system i.e., there are many existing networks located at different places. It is desirable to connect them together for global communication and information exchange.Different networks may use different technology and methodology i.e., different transmission media, addressing scheme, packet format, and etc. No single network hardware can satisfy all constraints of different users/networks. Physically, two networks can only be connected by a computer that attaches to both of them. Routers (or gateways) are used to connect the he4terogeous networks which are enabled with large and complex software systems called protocols. Designing Protocols involve several steps including requirements formulation, specification, verification,

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implementation, conformance testing and documentation. In the design of distributed system, such as communication protocols in heterogeneous networks, protocol converters were used as the controllers for discrete event system. Initial attempt was made to determine whether a converter was required, for some protocol classes. Protocols in the form of communicating finite automata, a construction method for such a converter for those classes was proposed by Okumura, K that satisfied the conditions like the external equivalency, semantic equivalency, freedom from unexpected input and deadlock an upper bound of the computational complexity of the construction algorithm.Various formal methods for protocol conversion were then presented like Network Simulator, Tunneling, Header Translation etc. to enable convergence to a universal network for global communication by solving problems due to protocol mismatch as they occur at any layer in a multiple layer architecture. Simultaneously, some works were approached for transforming an instance of the protocol conversion problems into that of the protocol validation problems so that existing validation techniques could be applied to find a converter or to make sure that there exists no converter at al.

Later, research works were concentrated towards the verification of the correctness of communication protocols, both general properties and functional properties based on the state transition model using reachability analysis where they proposed a new strategy called the PROVAT and its effectiveness. As the communication systems were fast evolving to encompass a broad range of functions, the verification and validation techniques similarly evolved to adapt to the changed circumstances. The increasing complexity of the communication systems entailed the examination of all existing techniques towards a realistic assessment of the techniques like random walk validation which analyzes a small fraction of the reachable state space and detects a large fraction of the errors in a complex protocol provided the errors themselves have limited complexity.A top down method was proposed for synthesizing optimized protocol converters that explicitly used service specification of the internetworking for which the validation process could be waived and the constructed protocol was optimized. But, as it did not use message map set that was difficult to obtain and validate for complex protocols.

Later at IBM T.J. Research Center, a real time internal traffic shaping mechanism was designed for two classes of connections constant bit rat with deterministic guarantees and variable bit rate with statistical multiplexing. The mechanism did not require identifying and separating the network the packet flows of different real time session connections inside the network for which it achieves lower switching complexity as compared with other traffic shaping methods. As consequences of the time driven priority mechanisms it was revealed that the network QoS parameters were independent of the connection bandwidth and existing heterogeneous internetworking asynchronous data traffic.Large file transfers with existing internetworking data services introduced large periods of congestion inside the network and under some circumstances and overflow the receiver buffer at the host computer. These two adverse phenomena could be solved by setting up a CBR connection and using time-driven priority. Also, it was possible reduce the amount of buffering needed at the host receiver while transferring a video file we start playing the video before whole file has been transferred. The added timing information could enable traffic policing for securing the network QoS parameters.As the wireless communications grew up, it was found that the wireless communications results in lower cost and higher data transfer rate. In any self organized network, the mobile nodes acts as both host and router and can run independently and can connect to the existent information infrastructures such as X.25 network so that the users in different networks can share information and resources and collaborate in any time and in any locations. The protocol translation layer is the X.25 gateway core layer which performs the functions of users management, network address translation, packet formulation translation and flow control while utilizing the data transfer service offered by the two network.

As the Internet started growing and getting more commercial, consumer oriented and used for a wider set of purposes, networks professionals thought of redesigning the Internet to provided an end to end connectivity across the heterogeneous wireless networks. They of the opinion that has to be a strict set of principles to enable overall trustworthy operations amongst individual users. While the technological solutions were fixed and rigid, the openness, flexibility and generation had to be preserved by maintaining a balance of power play amongst the users. As the need for global communications was increasing, the changing networking scenario required interoperations among a set of autonomous heterogeneous networking environment and few researchers were of the opinion that though homogeneity results in improved interoperability and reduced costs, but practically homogeneity may serious vulnerability to the network as a whole.A homogeneity may pose serious vulnerable to a malicious attack that exploits weakness common to all of its components. So they were of the opinion that for a network to survive, it must be heterogeneous because heterogeneity increases a network's defense capabilities and makes it more resilient to orchestrated attacks. Further, Davide et al believed that for transparent mobility among various access technologies such as wireless LAN and 3G systems in a seamless way, QoS enabled networking, mobility support and adaptability building mechanisms are required and in this context BRENTE (Brain End Terminal Architecture) a comprehensive architecture was designed that brought predictable end to end QoS and mobility support towards applications and services and bridged the heterogeneity gap in seamless communication systems.

The applications use mobile information access, real time multimedia communications, networked games, immersion worlds, cooperative work, etc require better QoS mechanisms closely integrated with flexible mobility management in WLANs and providing QoS to mobile hosts is difficult due to varying performance of various radio channel access methods that share the channel equally between the hosts. Several parameters like limited geographical span to ensure the same high bit rate of the traffic sources to limit the use of channel function and the limited number of active hosts to keep the load sufficiently low etc are controlled to provide adequate QoS.Mapping QoS parameters is a key point to guarantee end QoS to the terminal users for effective interoperation. The bandwidth required is measured both by varying the packet length and by using different models to describe the traffic eg

Pareto model requires larger bandwidth than Markov Modulated Deterministic Process.The mobile node that is connected to the Internet using a wireless link, may have a lower bandwidth and higher error rate than wired networks which affect the size and number of messages transmitted over the link. Growth of users and networks in the Internet Network gives the impact to the performance of throughput and packet data dropped.To provide an end to end approach for transparent mobility a mobile host that has simultaneous access to the heterogeneous wireless networks like WLAN, GPRS (3G) systems needs to be empowered with different access technologies, different administrative domains and alternate network models. A multi-homed mobile host as it moves across the heterogeneous network may face the problems like reliance on infrastructure support, inability to leverage soft handoffs, lack of support for network specific congestion control schemes and no provisions for resource aggregation. These problems had to be addressed with an end to end approach for host mobility, provisions for seamless handoffs, support for multiple congestion control schemes and a flexible framework for bandwidth aggregation respectively.

Globally, the researchers were working on the challenges and implication of ubiquitous connectivity and computing as with time the networks were getting more heterogeneous and have predicted that wireless access coupled with user mobility would be the norm rather than the exception, allowing users to roam in a wide variety of geographically distributed environment is characterized by a number of challenges like the continuously available but varying network connectivity, characterized by high handoff rates exacerbated by the demands of spectrum reuse; the variability in client devices: impoverished devices need to push computation into the local infrastructure to allow for application-specific adaptation; and the variability in available services as the environment changes around the client each illustrating the need for adaptation.Works are in progress to create a framework of intelligent heterogeneous networks that can use context aware mobile nodes to collect data from sensor nodes efficiently by reducing transmission distance thereby increasing sensor network life. It can also make decisions on sensor data collection and deliver it to a sink which can accept multiple connections from the mobile nodes.

Designing and optimizing a protocol for single application or network was prone to many problems. In such a heterogeneous environment, the FLIP i.e., the Flexible interconnection Protocol, an interface between the network and data link layers that had the functionality all the way upto the application layer replaced the functionality of network and transport layer and could allow applications to employ diverse set of devices with varying power, processing and communication capabilities to coexist and interoperate.Researchers accepted that using optimized FLIP architecture, more than half the energy used by the power-anemic devices could be saved.

II. CONCLUSION & FUTURE WORK

One of the outcome of the present study is formulating a strategy for internetworking requirements. The study reveals the systematic compositions of various issues related to internetworking and the factors or design issues to be considered in internetworking, along with synthesizing optimized protocol converters.The heterogeneity of computer networks has been covered in details. The challenges of heterogeneous networks, the need for handling heterogeneity, and steps towards achieving seamless communication in such environment are formulated in a structured way.The next outcome is in the area of network transparency. The artile discussed the current trends of network transparency requirements, why the heterogeneity is inherent and how the heterogeneous traffic is handled with schemes of interoperability. It also dealt with methods to obtain the best possible transparent service for making the network interoperability feasible.

It is obvious that future networks will incorporate multiple protocols to meet diverse user requirements. Because of this, we are likely to find that a significant portion of the traffic in the Internet will not be from single-protocol communications. This will not just be true of near term, transitional networks but will remain as a reality for most of the Internet. As we pursue the selection of a set of protocols or one particular protocol scheme, we should always keep in mind the scalability and the eventual and special needs of multiprotocol networks.

In particular, every internetworking scheme should include mechanisms to handle mixed protocol traffic that includes tunneling, conversion, and multiprotocol end-systems. This will lead to seamless connectivity with more and more transparency effecting the decrease of interoperability problems in heterogeneous environments. The proposed artile entitled “Protocol Transparency in Heterogeneous Computer Networks” is basically an analysis of protocols of different environments such as TCP/IP and IPv6 etc. The proposed article deals in mapping from TCP/IP to IPv6 and vice versa. The mapping is done for frame formats and error detection. The other mappings such as baud rate, width, topology, IEEE standards are not discussed because of time constraint. Hence there is enough scope for future work as the mappings of baud rate, width, topology, IEEE standards from TCP/IP to IPv6 or any protocols can be implemented.

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