2010 Sixth International Conference on Networking and Services

Horizontal Addressing by Title in a Next Generation Internet

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***Abstract*—In this work in progress, a new proposal is introduced for Internet horizontal addressing through the unification of application, host, and user addresses in entity title. With this unification it is possible the host addressing in Internet without IP use, as well as the routing of applications without the use of TCP, UDP, or SCTP ports. For so, it is proposed to create one Domain Title Service in Internet architecture to enable the addresses unification and that the network structure can receive information about the entities' needs, and then meet them.**

Keywords-Computer Networks; Next Generation Internet; Post IP Technology; TCP/IP Architecture

I. INTRODUCTION

The Distributed Systems are widely used in many knowledge areas and several technologies were developed to support the networks communication, as the X.25, Frame Relay, ATM, and SS7, among others. However, nowadays in the world wide network the TCP/IP architecture presents a more expressive use.

Even though the principal protocols of network and transport layers of TCP/IP were specified around 30 years ago, they still support the intermediate layers of the Internet architecture [1]-[3]. Several studies for evolution of this architecture have been developed, however there are difficulties in large scale implementation due to the large installed base in use. Among these studies, there is the IRTF Routing Research Group (RRG) which works with ROFL (Routing on Flat Labels) and other related studies about flat routing, as the LFR studies (Landmark-based Flat Routing) [4]-[5].

The possibility of contributing to this architecture evolution, and consequently have a positive impact in the other knowledge areas that make use of distributed communication, encourages this study whose objective is propose the horizontal addressing (routing) in Internet architecture with the use of entity title in a DTS (Domain Title Service). This objective intends to contribute with the possibility to meet the new requirements in distributed communication through the unification of the applications, users and hosts addresses.

This paper is organized as follows: Section 2 shows the studies related to next generation Internet area; Section 3 presents a proposal for horizontal addressing by entity title; Section 4 presents the support to entity needs in a DTS and Section 5 shows the final considerations and suggestions for future work in this research area.

II. RELATED STUDY IN NEXT GENERATION INTERNET

Because of the importance of protocols of layers 3 and 4 in Internet architecture, its name is designated as TCP/IP architecture. Since the specifications of the principal protocols of these layers, several evolution attempts have been proposed, however, there is an enormous difficulty in a practical implementation due to the vastness, importance and use of this architecture.

Some researches related to Internet evolution propose the use of flat routing for communication among network elements. In this research there are studies of Landmark-based Flat Routing and flat routing over a binary identity space [4]-[5], where Pasquini presents developments over IBR (Identity Based Routing), VRR (Virtual Ring Routing), and ROFL developed by Caesar et al [6]-[8] in the IRTF Routing Research Group.

The origin of the word "landmark" comes from Tsuchiya's study over routing hierarchy for very large networks [9], and from Krioukov's study over compact routing also at the IRTF RRG [10], where are proposals for Future Domain Routing (FDR) and scalability problems, by the Scalability Research Subgroup (RR-FS). Pasquini also presents studies for domain identifiers in next generation Internet architecture, with studies over flat routing in this architecture [11]-[12].

Another line of studies is developed by Bryan Ford, who proposes evolutions for a new Internet in his studies over social network architecture, named by him as UIA (Unmanaged Internet Architecture). In his proposals, Ford specifies the UIP (Unmanaged Internet Protocol) and proposes solutions for scalable Internet routing by the use of node identities [13]-[14].

Others works ralated to scalable routing and addressing architecture for the Internet are conducted by the IETF Network Working Group, as the LISP (Locator Identifier Separation Protocol) with proposals to the scalability of the routing system.

In the area of next generation Internet for mobility support and multi-homing, Wong presents studies to decrease the IP semantics overload with the introduction of an identification layer placed between the network layer and the transport layer in the Internet architecture [15]-[16].

Some ontological deficiencies in the Internet architecture to support new communication requirements are also discussed in [17] and the studies for proposal of horizontal addressing in Internet architecture are introduced in [18].

As contribution to studies over next generation Internet, this paper presents a proposal for multiple address unification in Internet, in such a way that the hosts, users, and applications can

978-0-7695-3969-0/10 $26.00 © 2010 IEEE
DOI 10.1109/ICNS.2010.9

be localized by a unified way through horizontal addressing by entity title.

III. HORIZONTAL ADDRESSING PROPOSAL BY ENTITY TITLE

To reduce the complexity in routing in Internet architecture, which involves issues over the possibility of finding not only hosts, but also applications and users, among others, an alternative is unify the hierarchy structure used for finding hosts with the horizontal structure used for finding applications and users.

For so, this paper proposes the use of application titles, specified in ISO-9545/X.207 recommendation [19], be extended for use by hosts and users. According to the X.207 recommendation, the ASO-title (Application Service Object-title) that are used to identify the ASO without ambiguity, in an OSI environment, consist of the AP-title (Application Process title) which, by nature, address the applications horizontally.

Therefore, this paper seeks to broaden the use of title of applications for hosts and users with the address unification through the AP-title use.

Not to use a different nomenclature for "user title", "host title", and "application title", which would reduce the flexibility of its use in other addressing needs (for example, "grid title", "cluster title", and "sensor network title") it will be considered, from now on, the solely designation "entity title", or simply "title", whose objective is identify an entity no matter which one it is. Such title is used in this proposal to address entities in Internet in a horizontal manner.

A. Application, Host, and User Address Unification in Title

To unify the application, host, and user address, it is necessary to guarantee that the communication needs will continue being met by the distributed systems. One relevant point in this issue is that the application layer, in the OSI reference model, has an interface with the presentation layer and, in the Internet architecture, the application layer has a direct interface with the transport layer [20].

The address unification in title in Internet architecture needs to support the characteristics of this architecture, and a great conceptual challenge for this unified addressing is the change of hosts address paradigm, which uses hierarchy organization by IP use. Conceptually, to make the address unification possible, it is necessary a solution that will not make distinctions among hosts, users, and/or applications, in a way that they will be treated simply as communication entities.

For example, one entity user can invoke specific hardware information of one entity host, as disk partitions or processor temperature, and for this the user can invoke the host directly. Also, the user can change host's settings, as the processor speed, without the use of one application, or maybe, also without needing to connect with the operating system.

The difference in communication among these entities can happen not because of their intrinsic characteristics, but, naturally, in case they have distinct needs in different moments in time, which can also happen individually for a sole application, host, or user.

For distributed communication by titles to be possible, this study suggests that the entities be registered in a DTS (Domain Title Service), which is a register service of the entities and their needs. For the distributed communication, the network elements (NE) in the way between the entity up to the DTS identify and learn in which interfaces the entity reports. Also for wireless networks the NE's learn how are the entities connected to them.

This learning is timed and the titles without use in the learning table are cleared periodically. When one entity sends data to another one, the network elements in the way verify their local tables and, in case they do not find the destination title, they request information about it to the title server. A simplified illustration of DTS use is presented in Figure 1.

In the local area networks because of its characteristics, there is the possibility that the establishment of communication on them takes place without the DTS. For so, the mechanisms can be the previous configuration of the elements or the use of auto-discovery and auto-reconfiguration in the network, to have the information over the interfaces that an entity holding a title responds. One mechanism that can be used for that is the title broadcast, similar to ARP (Address Resolution Protocol) broadcast [21]. With the interface identification that responds to a title, the network elements learning table is updated and the communication is established.

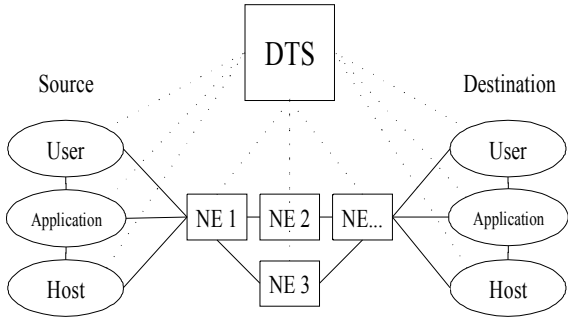

Figure 1. Basic Domain Title Service topology.

For entity localization that responds to a title in the worldwide network, it is suggested that the broadcast shall not be used due to performance and organization issues. In the worldwide network, it is necessary a better control as to avoid collapse of the auto-discovery mechanisms as well as the auto-reconfiguration ones. To make the control happen, one solution is the edge interface identification and organized sorting among access, distribution, and core structures, according to shown in Figure 2 [22].

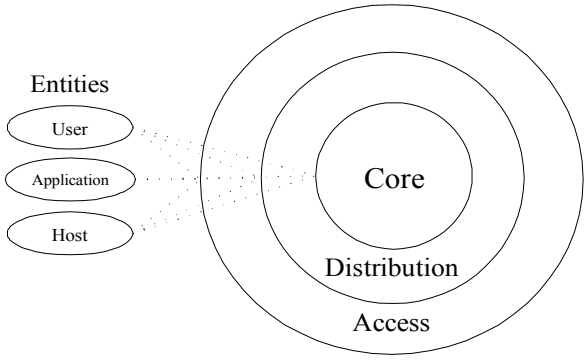

Figure 2. Worldwide network organization for the unified Title address.

It is important to stress that the current worldwide network has a similar structure for host connection, which enables applications and users to be connected. However, there is no direct support of intermediate layer protocols, which, according to the proposal of this study, will happen.

The addressing by title can be segmented in layers of restricted use, even though its nature is of low coupling between neighborhoods. Also there is no restriction that segments be used for specific tasks such, for example, for a better performance in some environments or throughout control. However, this horizontal title segmentation has practical and conceptual characteristics different from the current hierarchy addressing in Internet architecture because in this one there is low neighborhood coupling, and in the Internet, the addressing layers are determined by the networks and sub-networks through the use of masks for segmentation and routing.

The title addressing between source and destination creates an association between two or more entities that can be physically in the same host or in distinct ones. The hosts, in turn, are entities that have their own titles, even though they are not necessary for association establishment among entities, as applications, that use them to run.

To establish an association, one entity is invoked, according to specification recommended by X.207 that suggests the use of AEI (Application entity Invocation) [19]. This work also proposes the use expansion from AEI to EI (Entity Invocation), to support entities of different origins such as applications, hosts, and users, among others. Therefore, the horizontal addressing becomes possible in distributed systems by conceptual expansion of the use of entities in physically dispersed hosts.

To make it possible is suggested the use of functions of names and directories to organize the communication distribution among entities, to guarantee their association, which can be oriented toward connection, or not, according to specified in item 5.7 of X.207.

"*ASO-associations may be connection-mode or connectionless-mode communications. Within the Application Layer, there are no architectural restrictions on mappings between connectionless-mode and connection-mode ASO-associations.*"

The addressing by function of names and directories is described in X.207 recommendation, specified in ISO 7498-3, and recommended in X.650 [23]-[24]. In these recommendations/ specifications it is described the addressing used by the application layer and this study proposes that the described addressing be conceptually kept for application layer, and that the entities in Internet architecture use the same structure of horizontal addressing, which will make possible the Internet change to an entity with unified control of all entities. In this scenario, The Internet itself becomes one entity that will be able to have its own title registered in the DTS.

This way, the addressing of hosts, applications in hosts, and users done by the applications become a unique address, identified by title with organization and control unified in the distributed systems, through DTS with service function of names and directories. For example, the entity "helena miranda" registers in the DTS and informs its needs and characteristics, such as localization, for example, in icns.me.

Any existing entity, in any part of the world, to talk to "helena miranda" entity, requests the data of its localization to DTS, and any network element in the world starts sending the packages by the localization information supplied by the DTS to icns.me. When "helena miranda" moves its localization, it updates the DTS, which automatically makes the network elements start sending packages to the new localization, for example, to usp.br, cambridge.en or mit.us.

As registering its characteristics, one entity supplies, besides its localization, its needs in the time "t", which can be updated according to the change in the needs and characteristics along the time.

IV. SUPPORT TO ENTITY NEEDS IN DOMAIN TITLE SERVICE

The entities have different needs in distinct moments in time, according to the nature of its use and these needs demand distinct technological requirements to support them. For example, the entity E1, in moment t1, may need to establish a connection with entity E2 to send text messages with the need N1 of "Delivery Guarantee". For so, the entity E1 may need the technological requirements R1, R2, and R3. These requirements can change in time by the entity re-sending a request to the DTS. For this, the connection between the entity and DTS must be stable.

In a moment t2 this entity may have a second need N2, so the message transfer be done in a safe way. This need N2 may require technological requirements such as R1 and R4. This change in needs along the time and its impact in technological requirements to meet them occur according to shown in Figure 3.

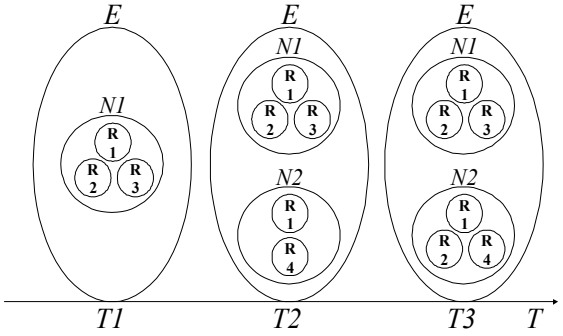

Figure 3. Timeline for the entities needs and its technological requests.

At the same instant of time, one entity may have distinct needs in communication with other entities. For example, the entity E1, in the time t3 may have the need N1 to guarantee the data delivery in communication with entity E3, for file transfer, with the requirements R1, R2, and R3. At the same time, this entity may have the need N2 of real time communication with the entity E4, to receive information from a sensor network, demanding the requirements R1, R2, and R4.

The DTS can be used to register these entity needs, in a way that the network elements have updated information over the needs among entities, at each instant of time. For so, the representation of communication needs among the entities, for register in the DTS, can be done by Leśniewski logic [25]. In this representation, the communication among entities in the previous example is expressed by the axioms:

E1E2t1 -> R1 ^ R2 ^ R3

E1E2t2 -> (R1 ^ R2 ^ R3) ^ (R1 ^ R4)

E1E3t3 -> R1 ^ R2 ^ R3

E1E4t3 -> R1 ^ R2 ^ R4

According to determination of semantic properties of propositional logic formulas in [26], the formula in t2 can be simplified as:

E1E2t2 -> R1 ^ R2 ^ R3 ^ R4

One need can be met by distinct technological requirements. For example, the need of "Delivery Guarantee" can be supported by the delivery confirmation of numbered packages, as it happens in the TCP and SCTP, or by the exclusive use of reliable means of transmission, for example, the ones used by ATM [4][22][27]-[28].

In this situation, suppose the technological requirement R1 is "Delivery Confirmation of Numbered Packages" and R3 the "Reliable Means of Transmission". In this scenario, the need "Delivery Guarantee" is met by "R1" or "R3", with no demanding of happening both. This situation permits changes in registered axioms in DTS to simplify the demands of technological requirements. In this simplification, the axioms can be represented by:

E1E2t1 -> R2 ^ (R1 v R3)

E1E2t2 -> R2 ^ R4 ^ (R1 v R3)

E1E3t3 -> R2 ^ (R1 v R3)

This logical representation of entity needs can facilitate the implementation in software and hardware of DTS operation, in a way to simplify the register, control, and meeting the needs of entities in a next generation Internet.

V. CONCLUSION AND FUTURE WORK

In the current Internet architecture, the applications only inform the operational system the need of TCP, UDP, and SCTP use, and do not have how to inform other requirements for network and transport layers, such as QoS, safety, low jitter, among others. In turn, the users and hosts do not have support of protocol from layers 3 and 4 either to inform their needs at each instant in time.

This study proposes that the addressing of applications, hosts, and users in the Internet architecture be unified in entity title, with the possibility of simplifying the complexity of address in Internet and that the network elements meet, in a more adequate way, the needs of the entities.

As a follow up to this study, the communication with the DTS will be implemented, without using IP, TCP, or SCTP in the worldwide network, and then will be compared its performance with the TCP/IP architecture. For so, our group is developing a C language library with the use of SOCKS-RAW, to the entities inform the network elements (including the operational system and DTS) their needs, in a given moment, with the use of Leśniewski logic.

Due to the importance of the scalability issues and to avoid overloading the DTS, a massive test will be made in this implementation to verify the performance and limits for critical environments.

As future studies, it is suggested to include mechanisms for neighborhood discovery procedure of network elements, without changing the low coupling of these horizontal addressing by titles. For so, it is suggested to use Landmark-based Flat routing techniques to have more efficiency in the worldwide addressing, once there are many network elements involved in distributed communication.

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