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Dynamics of Customized Internet Architecture: The Road Ahead

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Abstract— In most recent decade, the exponential growth of social media provides the internet users with new way to express themselves. The internet has become an integral part of everyday social life notably children and teenagers. As per the report released by "Internet World State" more than 1/3 of the world population now has access to the internet. The internet plays very important role in our daily lives and its impact will continue to grow. The current internet architecture designed 40 year ago is facing unprecedented challenges in many aspects, especially in the commercial context. So this is time to revisit the Internet architecture, to determine the changes and align better with current and future requirements. This paper is attempt to discuss the goal and directions for developing a next generation internet architecture that create greater functionality, adoptability and robustness in future internet architecture. The proposed next generation internet architecture is designed to meet the expected needs of businesses, organizations and governments. In Future internet architecture, networks are designed to enhance security, respond to emerging service challenges and also enabling the scalability of information infrastructure on which internet user are progressively confide.

Keywords— Internet Architecture, Future internet, Trust management, Manycast, Experimental Testbeds

I. INTRODUCTION

The emergence of internet is revolution of human communication. Currently we are moving in new era of computing and around 40% of the world population has an internet connection today. In 1995, it was less than 1% [1]. So there is no doubt internet has become a global communication infrastructure. The universal access of internet is the key issue that is currently being addressed globally. However many technical and non-technical challenges emerged during this process, that is the root cause to call potential new internet architecture. The current design of internet architecture was developed by in the late 1970 under the DARPA's internet research program. Billions of people all over the world use the Internet for finding, accessing and exchanging information, enjoying multimedia communications, taking advantage of advanced software services, buying and selling, keeping in touch with family and friends, to name a few So, Current reality and changing requirements are eating away at the viability of the original Internet architecture. The next generation internet architecture should enhance the security. It should allow the businesses to set their boundaries and implement policies inside the boundaries. It should allow governments to set that rule to protect their citizens on internet, also allow peoples to set their own policy for how and where they receive the information.

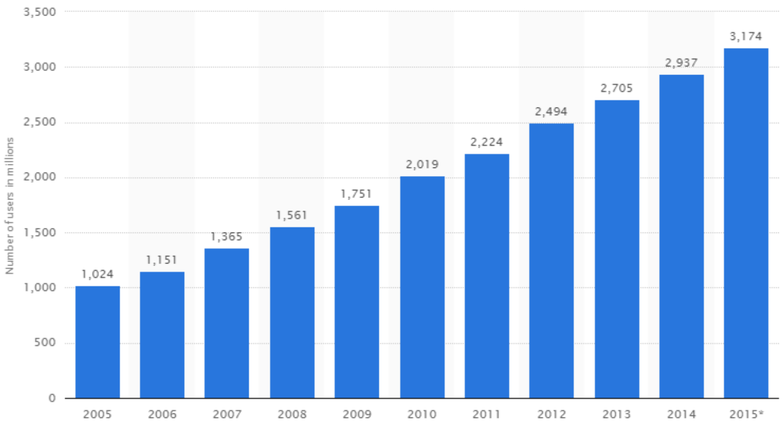


Fig.1 Number of worldwide internet users from 2000 to 2015 (in millions)
(Source: http://www.statista.com/statistics/273018/number-of-internet-users-worldwide/)

II. POLICY ISSUES AFFECTING ITS USES AND GROWTH

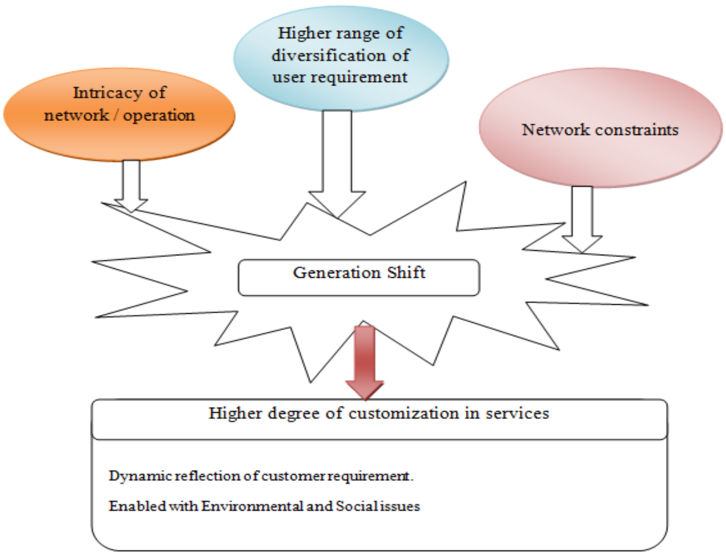
The exponential growth of internet for personal, government and business purpose may be affected by the policies. The cybercrime is also a growth industry with low risk and greater returns. Cybercrime may cause as much as $400 billion in losses annually, as per study of Intel's McAfee security unit in partnership with the Center for Strategic and International Studies (CSIS), a Washington, D.C.-based think tank. Even the smallest of these figures is more than the national income of most countries and governments and companies underestimate how much risk they face from cybercrime and how quickly this risk can grow . Currently the internet has been governed through a minimalistic, multistakeholder approach with private sector leadership. Today's Internet governance practice includes millions of Internet users, thousands of IT vendors, network providers and ISPs, hundreds of governments and dozens of intergovernmental organizations, standards bodies and international NGOs [2]. Theoretically, no limit to the kinds of applications or content users and developers could translate from imagination into existence [3]. It is as a result of this design and governance that the Internet has brought about unprecedented innovation in communications and exponentially increased global connectivity. The struggle for changes in governance mechanisms, more than any other, will determine the forces driving the future of the Internet.

III. RELATED WORK

The problem in current internet architecture and looking for improvement is not new one but most of the papers address only few aspect of the architecture. NFS has conducted several workshops on the research required in various important areas of networking such as Network research testbeds [4] , Mobility[5] [14], distributed system , and Virtualization[6]. Many problems still exist in current internet. By analyzing the challenges across the technical, economic and social domain in the current internet architecture. The continued success of internet is increasingly facing the issue of security attacks and lack of performance reliability of internet services. We can address the challenges by adding proper controllability and semantic aware property of internet architecture [7]. Firstly, the problems that users are facing in current internet architecture and some additional feature that need to considered in future internet architecture are introduced in next section.

IV. PROBLEMS WITH CURRENT INTERNET ARCHITECTURE

In this section, some features are listed that would help to remove the some of the problem faced by the current internet users.



A. Security

Security issues in current Internet are well known. So, future internet architecture should have some option for authentication of sources/destinations/intermediate systems, privacy of location, privacy of data, and data integrity guarantees. It should allow the businesses to set their boundaries and implement policies inside the boundaries.

B. Control, management, and data plane separation

In current internet architecture control, management and data planes are intermixed. No separate channel for control, manag0ement and data planes. Control massage (TCP connection) and management massage (SNMP massage) follow the same link as data massage. Control signals are also piggybacked on data packets. It's also cause of security risk on internet.

C. Mobility

The support of mobility is not primary goal of original design of internet architecture. Identification and location in one (IP Address) makes mobility complex. Among the limitations, the IP semantic overload seems to be a primary issue to be considered.

D. Energy

In current internet architecture, communication can happen only when both ends are awake. In this scenario, millions of devices switch on (365x24x7) for communication. All packets received and when destination is down are dropped. In wireless communication, this restriction is being relaxed by using base stations to store the packet when client device is not awake. So for efficient use of energy, this should be generalized in wired devices as well.

E. No explicit support for Client-Server traffic and distributed Service

A big share of current Internet traffic is client-server traffic. Web users are trying to reach search engine like "google.com" which is not a single system. "Google" is an example of distributed service with hundreds of systems in hundreds of location. The user is interested in the communicating with the nearest instance of this service. In current Internet, the name Google is resolved to a single IP address and so directing users to the right server is unnecessarily complex.

F. Person to Person communication

In present day, basic objective of communication is totally changed. Internet was designed for communication between computers but presently real target of communication is human being. A person may be reachable by using mobile, desktops, or laptops. So the goal of communication to reach the person not the desktops or any other system. Person does not have any IP address, we the users are forced to select one of these intermediate stops as the destination for our communication instead of the real destination the person. If each person had an address, the network could decide the right intermediate device or the person could dynamically change the device as appropriate.

G. Symmetric protocol

Most current internet protocols are symmetric since they are used between end systems with similar capabilities. The efficiency to discover and interact with devices over different technologies potentiates several scenarios which are currently neglected. The possibilities to identify devices across discovery protocols, devices are able to switch networks/protocols, re-discover the previous communicating devices and establishing new connection. Disable Wi-Fi to save power, and applications would be able to re-discover the devices they were communicating with and reconnect using Bluetooth [8]. So in some instances it is logical to allow asymmetric protocols.

H. Location independent addressing

IP Addresses are not related to the geographical location, So it's a strength of IP. The Internet uses an IP address to identify an interface as well as its network location. As a result, connections break when an endpoint changes network addresses, requiring application-layer workarounds to provide a semblance of seamless mobility [9]. Mobile devices also need to reflect their location. If any application requires large amount of data, it should to find nearest server .So future internet architecture should let the receiver decide about their location privacy.

V. ADDITIONAL FEATURE FOR NEW ARCHITECTURE

Based on the review of the past network architecture and its limitations, the new age architecture of the network process design have been studied. The summery of the benefits of the same have been described in the following paragraph in different perspective (Refer also fig.2)

A. Allocation of capacity

Currently ISP's are focused on offering services on top of the infrastructures they own and manage. The end user has no control over these services and the provider-consumer relationship is far from being automated [10]. Future internet architecture must facilitate user and network administrators the ability to allocate capacity among application and users. The today's internet, allocation occurs implicitly as result of congestion control. The goal has generally been some approximation of "fairness"; all slow down together, but this is not always the right model. For commercial activities, there is a desire to allocate capacity based on willingness to pay. For operational government activities, e.g., disaster response, there is a need to allocate capacity based on priority of task. It is not (always) the role of the network to tell the user how fast to go.

B. Global routing with local control of naming and addressing

IP address requires each system have a globally unique IP address. If user uses IPv4 then, he/she faces problem (distribute Unique IP address, IP address is limited so we can't give to everyone) of shortage of IP address. If IPv6, then it requires hardware level changes, so each of these having their own issue. For example, if nodes have private IP addresses, they are not easily reachable from outside. Future Internet Architecture should allow organizations the flexibility of deciding which of their local systems accessibility from outside and which are not.

C. Real time services

Today internet is use to run many of emergency and important protection services. These services requires real-time guarantee. The limited capacity of processing data on real-time poses limitation in the term of application deployment over internet. Often, separate dedicated/private networks are used to guarantee the required performance. The Future Internet should make this possible on the shared internet.

D. Cross-layer communication

The limitation of layered architecture is lower layers can't be communicated with higher layers. Cross layer communication provides bi-directional information exchange between layers. The cross layer communication improves broad range of network performance and application.

E. Receiver control

A communication involves three entities - sources, networks, and receivers. Most of control in the term of setting the rate and priority of packets are made by sources. So receiver need a way to indicate their preferences and policies for traffic coming through their link, which is currently not introduce in current internet architecture.

F. Manycast

The current internet architecture basically does not support manycast well. Many real time systems follows public-subscriber model. In this model data monitoring devices act as publisher and are subscribed by controller that gather and analyze the data to make control decision. For reliability reason, multiple redundant monitors and controllers are used. This requires n-by-m communication, where data can come to each of m subscribers from any one of n redundant publishers. Multicasts and anycasts are the special cases of manycast [11].

G. Support for Data aggregation and Transformation

The internet era is about having absolutely current and up-to-date information. Many sensor network applications requires for the intermediate system to summarize the data. So future internet architecture should provide facilities to aggregate consolidate and transform the data. This is necessary to adopt a variety of end systems. Traditionally organizations struggled to achieve this goal because their uses data was lying in multiple systems and different file formats (docs, images, charts, excel, PDF, scan, videos etc) current internet architecture has limited factor to integrate scattered and massive data to meet the goal. Video transcoding and compression are required to support a variety of video presentation standards (NTSC, PAL etc) on a variety of screen sizes (theatre screens, cell phones, palm devices etc).

H. Support for streaming data

As per the report of Cisco Visual Network Index (VNI) "In 2014, 88 percent of global mobile data traffic was smart traffic, with advanced computing/multi-media capabilities and a minimum of 3G connectivity, but that figure is expected to rise to 97 percent by 2019" [12][16].The availability of more affordable 3G and 4G handsets also fuelling growth in data traffic. The current internet is under huge pressure due to exponential growth in bandwidth demand. There have been emergence of popular video-streaming services that deliver internet video to IPTV, and from phone network to videoconferencing and video communication like Skype. The condition is further spoiled by the emerging trends to catch higher definition video streams that require more and more bandwidth [13]. Many of the real world application is stream oriented requires a fix or minimum throughput guarantee.

I. Virtualization

Future internet architecture use virtualization as the basis for an innovation-friendly, open architecture! It enables new protocols and architecture deployed independently without any disruptions. The virtualization of many types of resources (servers, links) is widely used today, so a generalized approach that allows to use a broad diversity of resources with higher security and flexibility [14]. L2 and L3 virtualization required to be able to move VMs from one cloud to another. The virtualization of resources plays a key role in future internet, enables coexistence of a mass of network in cost effective manner.

J. Experimental Testbeds

Evaluating and running newly developed software directly on internet is no longer an option, because they may impact on existing crucial services. In order to evaluate new software, it's popular to use simulators and small-scale testbeds based on actual nodes [15]. To explore the challenges related to large scale software, hardware, distributed system test and maintenance, security and robustness, co-ordination, openness and extensibility.

K. Trust Management

Due to the data theft issues user does not trust parties which they actually interact with. The major reason is that it is so assumed that the personal information might get leaked. Thus, the user avoids frequent communication. Less and less trust to the software developers.

The in-built feature within browsers to automate information gathering restricts the user to built-in trust with the provider of the software.

VI. CONCLUSIONS

The Future Internet architecture topics will address the limitations of an Internet not designed to support the very large set of requirements imposed by an ever more diversified usage. It also supports the advent of more efficient computational and data management models responding to the challenges posed by increased device / object connectivity and data-intensive applications. It should be designed for commerce and allow governments to protect their citizens in both the ways i.e. communication and transportation. The major challenge is how to manage the mobility and how to manage rapidly increasing data demand in future internet.

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