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Named Data Networking In Mobile Communication Network

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Abstract: ***This paper discusses the effect that Named Data Networking (NDN), a newly proposed Internet architecture, will have on the existing structure of mobile communication The recent years have witnessed a tremendous growth in the number of mobile internet users and the need for mobility support is indispensable for seamless Internet connectivity. The existing communication network architecture requires that the mobile devices should be aware of the location of other devices to make the connectivity possible, however with NDN there is a total paradigm shift, the application can make the connection even without knowing the location of other device. We will discuss how we can achieve this through NDN approach.***

Keywords: Named Data Network, Internet

1. Introduction

Mobile phones have become a necessity for most of the people throughout the world. The ability to keep in touch with family, business associates, and access to email are only a few of the reasons for the increasing importance of mobile phones. Its popularity increased tremendously with the advances in wireless technology. These mobile devices are capable of communicating with other devices through variety of wireless communication interfaces such as 3G/LTE, WiMAX, Wi-Fi, IEEE 1901(Power Line Communication), and 802.11p (DSRC/WAVE) among others. However any communication through this technology are host based and requires the sending and receiving devices to be aware of each other's location. This identification is based on IP address of the device and practically every mobile device relies on this IP address for identifying and routing the data across network. Named Data Network focuses on replacing this IP addresses with the name of the content. This means that instead of focusing on where to get the data we will focus on what data do we need to get.

In these age of cutting edge technologies data and information plays a crucial role. Having the right information at the right time can make all the difference in your business and experience with the technology. Thus users want the content as quickly as possible. However with the current network architecture the location of the content becomes the bottleneck in making seamless content distribution. With the NDN approach we aim in having a content centric distribution. This means that the content will be routed from the nearest available place without requiring us to reach out to the source every time. This concept is already implemented by many organizations like YouTube Netflix etcetera that are providing Content Centric Distribution. However this CDN approach works over the existing IP Architecture. When user demands a content, a DNS maps the content to the nearest content provider .This way it distributes the content from our nearest place rather than fetching it from one central system.

NDN works directly on network layer and CDN is the heart of its distribution system. In the subsequent section we will see what is NDN in more detail, following which we will discuss the shortcomings of today's mobile communication and how will implementation of NDN improve the current way in which mobile phones communicate and share data.

2. Mobile Communication over IP

Mobile IP enables routing of IP datagram's to mobile nodes. Every mobile node has an associated home address which is used for its identification. Even if the mobile device is not at a fixed location it still has a home address which is independent of its current point of attachment to the Internet or an organization. When the mobile node enters a new location it is given a care-of-address with a registration mechanism. This care-of-address associates the mobile node with its home address by providing the information about the mobile nodes current point of attachment to the Internet or organizations network.

Whenever a datagram arrives at the home agent, it redirects the packet from the home network to the care-of address by constructing a new IP header that contains the mobile node's care-of address as the destination IP address. This new header then encapsulates the original IP datagram, causing the mobile node's home address to have no effect on the encapsulated datagram's routing until it arrives at the care-of address. After arriving at the care-of address, each datagram is de-encapsulated and then delivered to the mobile node.

In this approach the delivery of the datagram has to pass through the home agent. Even when two devices are relatively close to each other they cannot communicate directly with each other. The datagram has to take a well defined path to send and receive the datagram packets. This places an overhead on the network to setup a communication path and then maintain the connection. Moreover there is no mechanism by which we can make use of all the available communication Interfaces. We can only rely on the ISP provided path to establish and maintain the connection. In the subsequent section we will see how NDN approach will completely enhance the way in which the forwarding mechanism takes place[1].The data distribution over IP is shown in Fig 1 below.

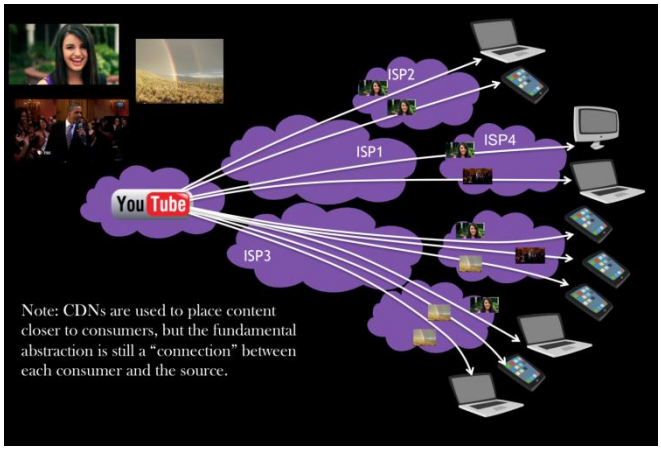

Figure 1: Content Distribution over IP. Image courtesy Van Jacobsen

3. Mobile Communication over NDN

3.1) NDN

In an NDN network, each application names the data it wants to fetch, and the network uses these application data names directly. Thus the names used in communication are independent from which interface one wants to use, or from whichever nodes the data may come from. Conceptually each NDN node maintains three major data structures: Content Store (CS), Pending Interest Table (PIT), and Forwarding Information Base (FIB). The CS is a temporary cache of Data packets that the node has received, which can potentially be used to satisfy future Interests. The PIT stores all Interests that have been forwarded but not satisfied yet. If a received Interest does not have a match in either the CS or the PIT, it will be forwarded toward the data producer(s) according to the FIB (presumably built by a routing protocol). When a Data packet arrives, the router finds the matching PIT entry and forwards the data to all downstream interfaces listed in the PIT entry. It then removes that PIT entry, and caches the Data in the CS. If a Data packet does not have a matching PIT entry, it is unsolicited and is dropped. Neither Interest nor Data packets carry IP addresses; Interest packets are routed toward data producers based on the names carried in them, and Data packets return based on thestate information set up by the Interests at each hop.

3.2) NDNs mobility approach

3.2.1) Introduction

Existing mobile network communication happen over IP address based framework, and thus location dependent. Also the data is passed to the network from a particular interface. We will see how we can eliminate this address dependency by making use of Named Data Networking.

Imagine a scenario where a mobile node wants to access a specific data from the network. This data could be physically located at any location on the web architecture. Whenever a user wants to access the data the request packet is forwarded to the source of the data and the content is then passed from the source station to the destination place on the network. This method of passing the data from the source to destination every time that piece of data is requested puts a significant amount of load on the provider of the data. One more issue with passing the data in this way is that whenever a user requests a piece of data on the network the user needs to ensure that the data is coming from valid source. And this verification is done based on the location of the data and not actually from the data received. Named Data Networking provides us with a viable solution to both this problem and also adds some more advantage in communication.

3.2.2) How Connection is established?

Mobile communication devices are equipped with many communication interfaces such as 3G/LTE, WiMAX, Wi-Fi, IEEE 1901(Power Line Communication), and 802.11p (DSRC/WAVE) among others. In Named Data Networking whenever a mobile node requests a piece of data from the network the Interest Packet is sent to the network from any of this available Interfaces connected to the device. At every subsequent node there are three types of data structures available. Content Store (CS), Pending Interest Table (PIT), and Forwarding Information Base (FIB). When a Data packet arrives, the router finds the matching PIT entry and forwards the data to all downstream interfaces listed in the PIT entry. It then removes that PIT entry, and caches the Data in the CS. Whenever an Interest packet arrive the content store are checked first. This way it ensures that the data is available from the nearest place from the source of requested data. Neither Interest nor Data packets carry IP addresses. Interest packets are routed toward data producers based on the names carried in them, and Data packets return based on the state information set up by the Interests at each hop [2].

The time taken for successful request and response is decreased as more and more devices are accessing the same content on the network. This also removes the overhead of establishing a communication path prior to communication like in case of TCP/IP. Since there are more than one interface connected to a device at any given time the communication will be successful even if some interfaces are down at the moment. This will ensure a reliable communication between the devices. Also two devices close to each other can directly communicate with each other without relying on the central point of communication which could provide a communication path between them. They could make use of any of the existing Interfaces and communicate conveniently. The distribution of content under NDN is shown in figure 2.

The security of the content is not dependent on the source address of the content provider. Each packet in itself would have the security mechanism. Thus it lays two responsibilities on the owner of the content. A content publisher must first determine the name by which it wants to refer to that content, which determines how that content will be found. Then it must generate a digital signature over that name and the corresponding content [3][4].

3.2.3) Caching

The nodes receiving the interest packet sends the Interest to all the connected Interfaces and maintains the PIT table. On successfully receiving the data from the network the node is expected to maintain a cache in the content store and delete the value from PIT. Thus every device is required to maintain the cache of the data for a particular amount of time. Mobile devices generally have less storage capability and different devices have different processing and storing capacity. The efficiency of the network thus relies heavily on the caching done by the devices.

Another challenge in maintaining the cache is the reliability of the data in the cache. The data maintained should be accurate and provides the latest version of the data. Although this problem is addressed by maintain the tree structure of the data with the rightmost branch of the tree providing the latest information, still it would add a significant load in maintain all the cache in the limited capability mobile node.[4][5].

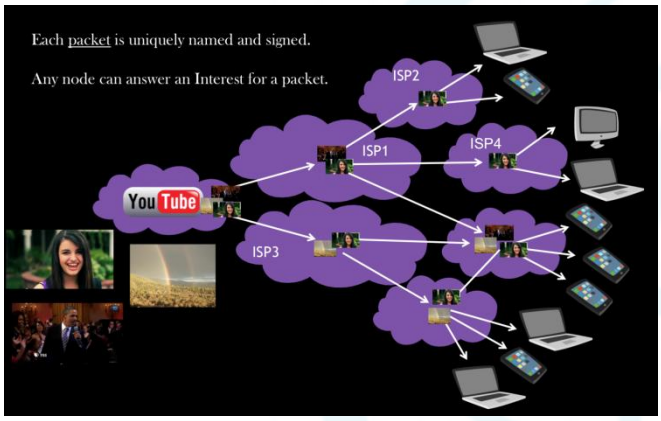

Figure 2: Content Distribution in Named Data Network. Image courtesy Van Jacobsen

3.2.4) Challenges

There are many challenges that need to be addressed as Named Data Networking is implemented in mobile Network communication. We already identified, how caching remains as a primary challenge in the limited capacity mobile devices. Other challenges in implementing NDN include Large forwarding Table. The size of FIB for name prefixes can be much larger than that of the IP address. Maintain this in the mobile node is yet another challenge. Throughput of the network is also a challenge as 100 Gbps Ethernet is approaching in practice. Name-based forwarding needs to be fast enough to keep up with the wire speed.

4. Conclusion

Future Internet will be heavily focused on replacing IP based structure with the Named Data Networking. Named-based forwarding possesses great capability to change how the networking works. Future mobile devices would need to be even more efficient in terms of storage and processing to reap maximum benefit from the named base forwarding concept.

References

[1] https://docs.oracle.com
[2] Van Jacobson, Diana K. Smetters, James D. Thornton, Michael F.Plass Nicholas H. Briggs and Rebecca L.Braynard “Networking Named Content” , CoNEXT’09, December 1-4, 2009, Rome Italy
[3] Diana Smetters and Van Jacobson , “Securing Network Content” , Palo Alto Research Center
[4] Cheng Yi, Jerald Abraham, Alexander Afanasyev, Lan Wang, Beichuan Zhang and Lixia Zhang, “On the Role of Routing in Named Data Networking”, ICN’14, September 24-26, 2014, Paris, France.
[5] Alexander Afanasyev, Junxiao Shi, Lan Wang, Beichuan Zhang and Lixia Zhang, “Packet Fragmentation in NDN: Why NDN Uses Hop-By-Hop Fragmentation” , NDN, NDN Memo, Technical Report NDN-0032, 2015