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NAMED DATA NETWORKING TECHNOLOGY AND ITS APPLICATIONS IN TODAY'S WORLD

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ABSTRACT

NAMED NAMED DATA NETWORKING also known as NDN, is a network architecture which depicts a new way to browse or design the Internet. Its main purpose is to shift the focus from the current host-centric network model, in which the communication is based on IP addresses and point-to-point communication, to a data-centric model. NDN is an alternative for the traditional host-centric networking architecture, which is based on "Internet Protocol" (IP). It is a useful networking model which allows content directly addressable and routable. IP addresses are replaced by specific names hierarchically for each content object. In addition to providing data security directly, which enables resilient communication in dynamic environments like mobile ad hoc networks and allows the content of each data packet to be verified, the consumer is able to request the data content using the application layer names, which is very beneficial for managing and optimizing the network traffic. Additionally, it offers built-in multicast, in-network caching, multipath forwarding, and direct data security, among other advantages for network communication. It also provides various benefits to network communication, which therefore includes built-in multicast, in-network caching, multipath forwarding, and secures data directly.

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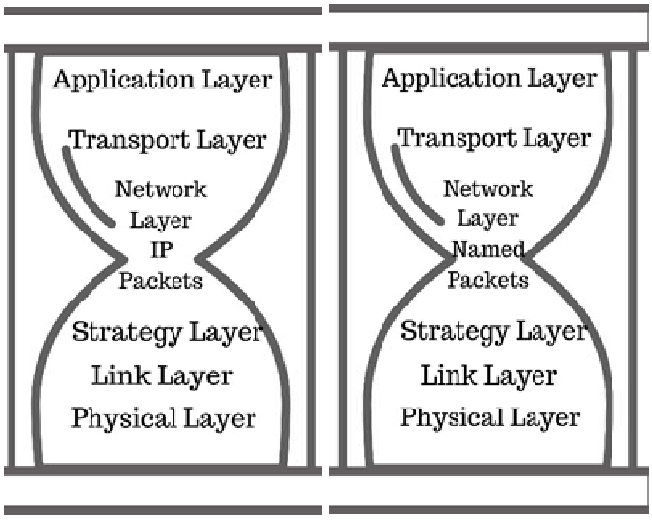
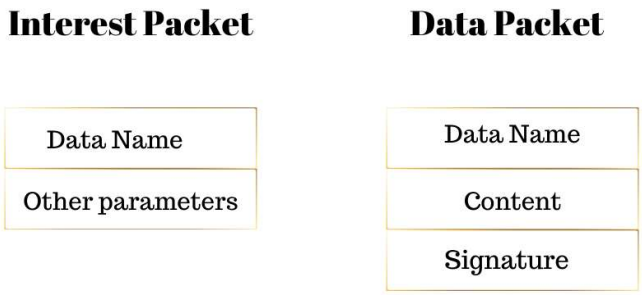
INTRODUCTION

In order to function and exchange data, all of the outdated architecture still in use today rely on Internet protocols, which facilitate interoperability among services and devices. However, with today's technology, we need innovations that may completely transform the conventional methods of data exchange and add new dimensions to this process. Naming data networking was created to fulfil the requirements of the present Internet architecture by supplying data by name rather than IP address, addressing the name rather than the address, and ignoring the storage location of the data. The outdated internet architecture's security mechanisms rely heavily on add-on features, which increases their reliance on the media and raises security-related issues. Add-on features like transport layer and security protocol create a scenario of overhead in maintaining and creating secure communication channels, which is inappropriate for wireless resource-constrained devices, as stated by A. Anjum et al. in article [3]. Naming Data Networking, or NDN, does not care where the data is located; instead, it requests the data by name. This design is more appropriate for the modern data delivery paradigm as it replaces the outdated practice of utilizing individual IP addresses and host addresses with merely a name. IoT sensors to cloud servers are all part of the universe of computing devices that NDN is meant to network. With this approach, everyone may directly safeguard their data and the network is typically empowered to recover identified data by any required methods; networking, storage, and computing resources are treated uniformly. NDN is a very promising network, but it is also limited in several ways, primarily because of its forwarding, caching, and signature features. Numerous researchers are trying to come up with fresh ideas on how to lessen these restrictions and boost NDN's effectiveness. The future of network technologies will be shaped in part by the increased efficiency, security, and scalability provided by the NDN architecture. Although it hasn't been embraced by many, its potential makes it a compelling option to deal with the problems that data-centric communication in the digital era will present. Additionally, NDN offers strong support for mobile devices, as stated by the fact that the devices may easily access the content even when their IP addresses and network locations change. In NDN, consumers confirm the integrity and validity of the received data, and data processes attempt to sign the content. Because it streamlines communication between users and apps, the content-centric paradigm is beneficial. utilizing three router components—"Forwarding information base (FIB)", "Content store (CS)", and "Pending interest table (PIT)" the network layer of NDN delivers routing functionalities utilizing content name framework rather than the outdated IP based method.



a)IP Hourglass architecture **b)NDN hourglass architecture**

NDN Architecture: NDN uses data names rather than IP addresses for delivering a new set of minimal functionalities, this change leads to various differences between NDN and IP addresses in their operation of data delivery. Data consumer is used for communication in NDN which is driven by the receiving end. For receiving data, an Interest packet is sent by the consumer that carries a name which identifies desired data. Interface via which requests come in is remembered by a router, and it forwards the Interest packet by seeing the name in its FIB(Forwarding Information Base). When the Interest packet is received by the node which has the requested data, then a Data packet is sent back, that carries the name and the content of the data, with a signature by procedure's key. The router stores the Interest waiting for returning Data packet in a Pending Interest Table(PIT). To retrieve the data which is dynamically generated, the consumers can build a piece of data's name deterministically without having seen the data or name beforehand. The Interest packets based on their name are routed towards data procedures. Reverse path is followed by the data packets to get back to the consumer.



NDN Router Overview:

The structure of an NDN router consists of 3 data structure

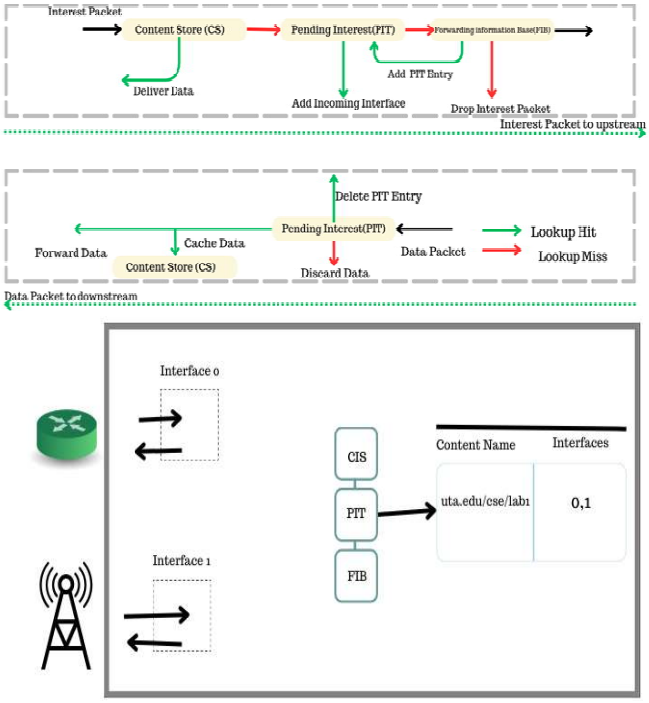
1. Pending Interest Table (PIT)
2. Content Store (CS)
3. Forwarding Information Base (FBI)

Pending Interest Table (PIT): It is one of the architectures of NDN which deals with maintaining a record for the interest packets who has not been assigned any of the corresponding Data packet. It has two essential functions one of them is to interest aggregation and another is to multicast forwarding. So whenever there is a request and the data name is not present in the PIT entry it makes a new entry in the table. If there is a match it just adds the incoming interface number to the already present one to avoid redundancy. PIT keeps track of all the interfaces which are requesting the same data. All the interfaces which have requested for the data will receive the data packet and will get multicast to all of them, once the Data packet arrives.

It is also responsible for better security as it detects unsatisfied interests.

Content Store (CS): It is like a cache memory for each router node. When consumers request for some data it is forwarded to its original producer. Each intermediary router cache and stores the data in the buffer when the packets of data are forwarded from producer to consumer. Next time the same data is requested instead of starting over it can directly access the data and transfer it. CS can treat the Interest packets as its own data if the data is already cached.

Forwarding Information Base (FIB): It is in charge of sending the Interest packets to the node that stores the data in "CS" or to the original producer. A list of hops and a name prefix are the two components of a FIB, which direct Interest packets to It is in charge of sending the Interest packets to the node that stores the data in "CS" or to the original producer. A list of hops and a name prefix are the two components of a FIB, which direct Interest packets to the nodes that are asking for data.



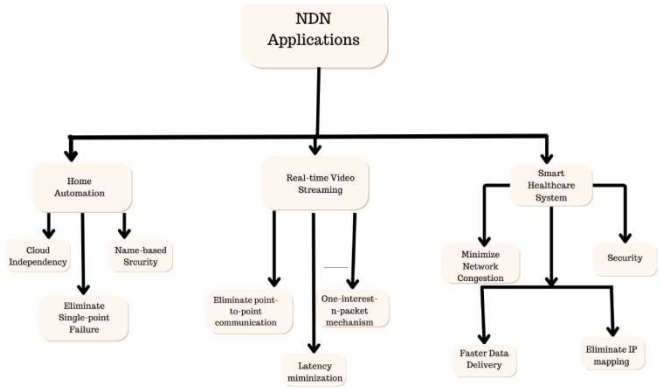
Internet aggregation

Related Work: The old way of using IP addresses has many shortcomings such as packet loss, less efficient, less security. Then CCN (Content Centric Network) was introduced which provided greater security than the IP network, it is much faster as well as more efficient. From the past few years "CCN" has gained high demand as a new networking architecture in many real-world scenarios whether it may be E-health application over 5G using CCN or Smart home based on CCN. The research [8] explains how E-health applications use CCN. Similarly [9] explains more about how IOT is nowadays used in Smart homes and how it uses CCN. The paper [7] explains about energy-delay trade off in CCN in caching strategy.

Application of NDN in Real world: This section will look into the applications of the NDN architecture and how it is getting implemented in the real-world scenario. Before IP protocols were used everywhere and this section will show us the loopholes in the IP host addressing system and how the NDN architecture is resolving all those issue and increasing the efficiency of it.

NDN in Smart homes: Smart homes are the houses which have automated devices connected to the internet. It uses sensors and actuators to communicate, process and react to the gathered data. Due to the high demands of tech gadgets such as laptops, smartphones, tablets, connected devices, device manufacturers have witnessed a

good economic growth. However, between all the networked devices in an home automation system is IP based communication which follows the old traditional approach of IP address hosting. Due to this the data must be tightly coupled with the device-to-device addresses and communication channel.



"Emerging applications of NDN along with the use cases"

In addition, the limited expressiveness of IP results in challenges for mobility support, multicast, and enormous access under the rigorous performance requirements of IOT. To overcome this issue "Named Data Networking (NDN)" is proposed by the researchers. By using NDN it decouples the home server and sensors, the user can directly request for a particular data from a particular area using Interest packet for information. Naming of sensors is also very important when you deal with NDN architecture, it should be named as it is well understood by both sensor humans as well as application specific names for sensors and actuators.

Real time video streaming using NDN: The ability to transmit live video has become very famous in the modern times. This is mostly due to live gaming community which is main reason behind it. The traditional real time video streaming follows "TCP/IP Networks", where the producer sends data to the consumers directly. However "TCP's" point to point connection give rise to issues when multiple clients wants to access the same data, therefore multiple redundant packets are formed that is being sent. Caching mechanism of "NDN" and interest aggregation can solve this problem. To get the most recent data the consumer requests an interest with timecode along with the name of the content that is requested. Once the initial data is received the user can request for consecutive segment data numbers for the videos. It helps users to overcome the loss of packet while streaming with the help of a caching mechanism which ensures uninterrupted playback. The paper [2] explains how the NDN real time video streaming works. The NDN way of video streaming approach can improve transmission delay, consistency for users, and can reduce bandwidth usage.

Smart Healthcare System using NDN: In modern times the technology is getting more advanced, the healthcare system is also getting modernised and is implemented by using IOT (Internet of Things). IOT is a collection of physical objects, different types of sensors and network connectivity which helps easy exchange of data remotely for interaction between the internet world and real life. The IOT in the field of healthcare has a significant part in treating, monitoring, analysing the disease, and improving care. The IOT system is based upon IP-based systems, which has some limitations to it. The paper [1] explains how healthcare uses IOT. IP-based systems use a transport layer to establish the end-to-end connection that is responsible for transportation of data and delivery of packets in both the medium i.e. wired and wireless medium. But the transport layer sometimes makes time sensitive data retrieval difficult. The mechanism responsible for congestion control assumes that packet loss is due to congestion, which decreases the congestion window by half. Due to this it can cause inaccurate output data, result, reading which can sometimes be the matter of life and death. IP also lacks inbuilt security which is not good as the health-related data is very sensitive, due to this there can be security breaches. The NDN router is responsible for controlling the forwarding rate of the interest on a hop-by-hop method to a specific node, thus managing congestion. Whenever there is a delay or congestion the caching mechanism uses the router's CS to identify the location where the packet has been lost in the hops. Due to this and storing data near to the user "NDN" reduces the delay time in delivery as well as ensures the security. When the mobile nodes change network using content naming, it reduces the risk of tracking the IP which results in reducing the overhead of mapping application names to IP addresses. In the article [6] by Saxena et al. shows how to Integrate NDN in healthcare. Another article [5] by Saxena et al. shows how Smart health can be used by integrating Internet of Things (IOT) and Named Data Networking.

CONCLUSION

The "NDN" design often provides answers to all of the problems that the "TCP/IP" conventional network poses and satisfies the needs of contemporary applications for communication. NDN applies the lessons learnt from previous protocols which were used before it which helps in improvising and increasing the efficiency of data synchronisation mechanism, security related issues, faster delivery. The NDN integration into existing applications of networks holds many promises, but typically it demands the continued innovation and exploration to realize its potential to the fullest. The NDN architecture is still in research stage and its use in solving the real-world problems will get mature just like the time when the IP was first roll out, with time it will become mature.

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