NAMED DATA NETWORKS

An awesome Network Architecture!

HOW DOES TODAY'S INTERNET ARCHITECTURE WORK?

LETS TAKE AN EXAMPLE

EXAMPLE!

- 1. You want to watch the movie "KGF" on amazon prime.
- 2. You type in the following URL:
 - a. URL: <u>www.primevideo.com/movie="KGF"</u>
- 3. And press Enter

WHAT HAPPENS NOW?

WHAT HAPPENS NOW?

1. First thing which happens is DNS Lookup!

DNS LOOKUP!

- 1. Send the URL to a DNS Server near to you.
- 2. Wait for some time :(
- 3. Get the IP Address of a amazon primevideo server

NOW YOU HAVE THE IP ADDRESS

THEN?

- 1. Your machine accesses the server using that IP Address.
- 2. It establishes a connection(assuming TCP) with the server.
- 3. Assuming the movie is divided into 1000 pieces, your machine starts asking piece by piece.
- 4. Let the URL of first piece be <u>www.primevideo.com/movie="KGF"/piece="1"</u>

THE NORMAL PROCESS.

1. As you finish watching a part, the next part is requested by the browser and it is loaded.

A QUICK ANALYSIS!

DNS LOOKUP IS COSTLY : (

It is of the order of milliseconds

DNS LOOKUP

- 1. It is of the order of milliseconds.
- 2. It is hidden latency.
- 3. And we know it there is a problem here.
- 4. We have a huge DNS Infrastructure built to reduce this hidden latency
- 5. But we certainly cannot reduce it to zero :(

QUICK ANALYSIS!

- We are spending time in terms of RTTs(Round Trip Time) to get data from prime servers to the host machine.
- 2. Is this really needed? Are we spending more?

CONSIDER THIS CASE

- 1. Suppose your friend is also watching KGF on amazon prime.
- 2. Can you do something about it?

CONSIDER THIS CASE

- 1. Suppose your friend is also watching KGF on amazon prime.
- 2. Can you do something about it?
- 3. Nope :(

IN THE CURRENT ARCHITECTURE, IF YOU Want Something, you directly talk to The server

Even if there is a source near you.

CAN YOU SEE ANY DIFFERENCE BETWEEN APPLICATION LAYER AND NETWORK LAYER?

DIFFERENCES BETWEEN APPLICATION LAYER AND NETWORK LAYER

- 1. Application Layer works solely on URLs.
- 2. Network Layer solely works on IP Addresses.

CAN YOU SEE THIS DISPARITY?

WHY WAS TCP/IP STACK BUILT IN THE FIRST PLACE?

WHY WAS TCP/IP STACK BUILT IN THE FIRST PLACE?

- 1. To replace Telephone Networks which used Circuit switching.
- 2. To use packet switching to transfer data from one machine to another machine.



- 1. TCP / IP Stack meant to replace a Machine-to-Machine Circuit switching technology.
- 2. Conclusions?

TCP/IP STACK IS ALSO A HOST-TO-HOST TECHNOLOGY.

But is uses packet switching

THEN WHAT HAPPENED?

WORLD WIDE WEB CAME, CONTENT DISTRIBUTION CAME.

AND THEY BECAME THE INTERNET WE KNOW TODAY

WHAT ABOUT APPLICATION Layer?

WHAT ABOUT APPLICATION LAYER?

- 1. A URL is at the heart of Application Layer.
- 2. This is where WWW, Content Distribution happens.

APPLICATION LAYER AND NETWORK LAYER

- Application Layer has NO CLUE about how Network Layer is working.
- 2. And Network Layer knows NOTHING about Application Layer.

APPLICATION LAYER KNOWS DATA, BUT Network Layer Knows Hosts.

DNS IS THE GLUE BETWEEN APPLICATION LAYER AND NETWORK LAYER.

And now we know why that hidden latency is a necessary evil

WHAT ABOUT IP SECURITY?

WHAT ABOUT IP SECURITY?

- 1. IPv4 has it's limitations.
- 2. Not secure
- 3. Very easy to spoof IP Addresses. This is an open problem even today. This is a source of a huge range of network attacks.
- 4. IP does not worry about integrity of a packet.
- 5. IPSec is an Add-On for IPv4 to make it secure

THIS IS NOT IMPRESSIVE

WHAT DID WE DISCUSS SO FAR?

- 1. Network Layer(IP) knows only Hosts / IP Addresses.
- 2. Application Layer knows only Data or URLs to locate that data.
- 3. They are working in 2 entirely different paradigms.
- There comes DNS the necessary evil unwanted, but needed.
- 5. IPv4 is not as secure as it has to be.
AND THERE COMES NDN!!

IT SOLVES ALL THESE PROBLEMS WITH IT'S DESIGN

Well, its designed to solve all these problems

WHAT IS NDN?

NDN: NAMED DATA NETWORKS

AN OVERVIEW

- 1. It works at the Network Layer.
- 2. Hosts are not identified here(No IP Addresses)
- 3. Only Data!
- 4. Data pieces are given UNIQUE names.

HOW DOES A NDN-PACKET LOOK LIKE?

There are 2 types of packets.

INTEREST PACKET AND DATA PACKET

TYPES OF NDN-PACKETS

Take the example where you want to watch "KGF" in amazon primevideo.

- You generate an Interest packet with the Data's name on it.
- 2. You need the first piece. Name of the first piece is www.primevideo.com/movie="KGF"/piece="1"

INTEREST PACKET

I need: "www.primevideo.com/movie="KGF" /piece="1"

THIS IS SENT TO NEAREST NDN Router

Unlike IP where DNS Lookup should happen first.

MAGIC HAPPENS, AND YOU GET A CORRESPONDING DATA PACKET.

DATA PACKET



TYPES OF NDN-MACHINES

HOST - WHICH

GENERATES INTEREST

PACKETS

SOURCE - WHICH

GIVES BACK THE DATA

PACKET WHEN IT GETS AN INTEREST PACKET

NDN ROUTER - AN OVERVIEW

It has multiple Network Interfaces.

And mainly,

There are 3 data structures in a NDN Router.

- 1. Content Store
- 2. Pending Interest Table
- 3. Forwarding Information Base

CONTENT STORE

- 1. This is a huge cache in the router.
- 2. It has Data and it's Name stored in it.
- 3. If it has the data piece that a certain Interest Packet needs, router takes it.
- 4. Data Packet is sent to you(host)
- 5. The Interest is said to be satisfied by a Data packet.

CONTENT STORE

Pointer to Data

QN: WHAT IF CONTENT STORE DOES NOT HAVE THAT DATA

PACKET?

PENDING INTEREST TABLE To the rescue!

PENDING INTEREST TABLE

- 1. Suppose the Data packet with
 name=www.primevideo.com/movie="KGF"/piece="1" is not in
 Content Store.
- 2. The name of data piece request in Interest Packet and Interface from which Interface came are noted!
- 3. The name says everything about the table :P

PENDING INTEREST TABLE

Data name	Interface from where it came
www.netflix.com/movie="sometre ndingmovie"/piece=1	10
www.primevideo.com/movie="KGF" /piece="987"	8

PENDING INTEREST TABLE

If there is already an entry of the data packet the host wants, no new entry is added.

JUST ADDING AN ENTRY IN SOME TABLE WON'T GET THE DATA PACKET RIGHT?

NOW COMES FORWARDING INFORMATION

BASE

FORWARDING INFORMATION BASE

- 1. That Interest Packet is then routed to several other NDN routers in contact with it.
- 2. Here, routing happens with the help of Data names

IDEA: AN INTEREST PACKET SHOULD Always routed towards the source

MAIN SOURCE = PRIMEVIDEO SERVER

Or can it be something else??

ROUTING!

Interest Packet is routed from one NDN router to another till it reaches the source.

ROUTING!

Or the interest packet can be sent to my friend who is also watching KGF!

INTEREST PACKETS HAVE TO ROUTED.

It has to be sent from requesting host to a source as fast as possible!

WHAT ABOUT DATA PACKET?

THEY DON'T HAVE TO BE ROUTED!

Some compute saved.

AN EXAMPLE: YOU WANT TO WATCH THE VERY FAMOUS "KGF" MOVIE!

ASSUME YOUR FRIEND IS ALSO WATCHING(FAMOUS MOVIE:P)

Requesting this: www.primevideo.com/movie="KGF"/piece="1"

TCP / IP

TCP / IP SCENARIO



REQUEST PACKET FROM HOST TO SERVER: 1, 2, 3, 4, 5


DATA PACKET FROM SERVER TO HOST: 6, 7, 8, 9, 10



QUICK ANALYSIS!

- 1. Host has to talk to the server every single time it wants something.
- 2. Practically, 25-30 hops per RTT.

LET US TAKE NDN

Multiple possibilities

NDN: INTEREST PACKET FROM HOST TO NEAREST NDN ROUTER AND THE FRIEND



MULTIPLE CASES



CASE2: DATA FOUND IN FRIEND'S CONTENT STORE



QUICK ANALYSIS

- 1. Took 2 hops 1 RTT
- 2. This is a practical case.
- 3. Condition: The content(here movie) should be present in the Content store.
- 4. Most popular, trending content is present in Content store!

CASE 3: NO DATA PACKET WITH ROUTER AND FRIEND = \rangle SEND INTEREST PACKETS TO OTHER ROUTERS



IIVILNEDI IAUNLIDANE NUUILUSENT TO SPECIFIC ROUTERS WHICH WILL HELP REACH SOURCE

QUICKLY

WHAT IF ROUTER 3 HAD THE DATA?



WORST CASE

 The interest packet goes to the main source(actual primevideo server)

QUICK ANALYSIS

1. Best case: Data is available in the first hop itself

QUICK ANALYSIS

Best case: Data is available in the first hop itself.
Worst case: Data available in main server.

Time taken: (in terms of hops)

- 1. Best case: 2 hops
- 2. Worst case: 25-30 hops

BEST CASE TIME OF IP IS COMPARABLE WITH WORST CASE OF NDN

WHAT ABOUT SECURITY?

- Data packets carry the hash of data it is carrying. So, data integrity is guaranteed.
- 2. IP does not have anything like that. It has a simple checksum for simple error detection.
- 3. An add-on called IP-Sec is designed for IPv4 security.
- 4. Increased privacy this comes by NDN's design!

IS THIS THE BEST THEN?

NOPE. EVERYTHING IN THIS WORLD COMES WITH A TRADE-OFF : (

FEW THINGS TO THINK ABOUT

- 1. How will a NDN device ensure freshness of data?
- 2. Does all this require sophisticated hardware?
- 3. Can it replace IP completely as a network layer?
- 4. And many more I don't know...

NDN CAN TECHNICALLY REPLACE CONTENT DISTRIBUTION NFTWORKS

CDNs are used to reduce transmission delay.

WILL NDN FIT INTO BUSINESS MODELS OF COMPANIES LIKE GOOGLE, AMAZON, NETFLIX ETC.,?

They all use Advertisement based models with extensive data-analytics and LEAST IMPORTANCE TO ONE'S PRIVACY

OPEN QUESTION: WILL NDN BE USED?

QUESTIONS?

SUGGESTIONS, FEEDBACK?

THANKYOU:-)