

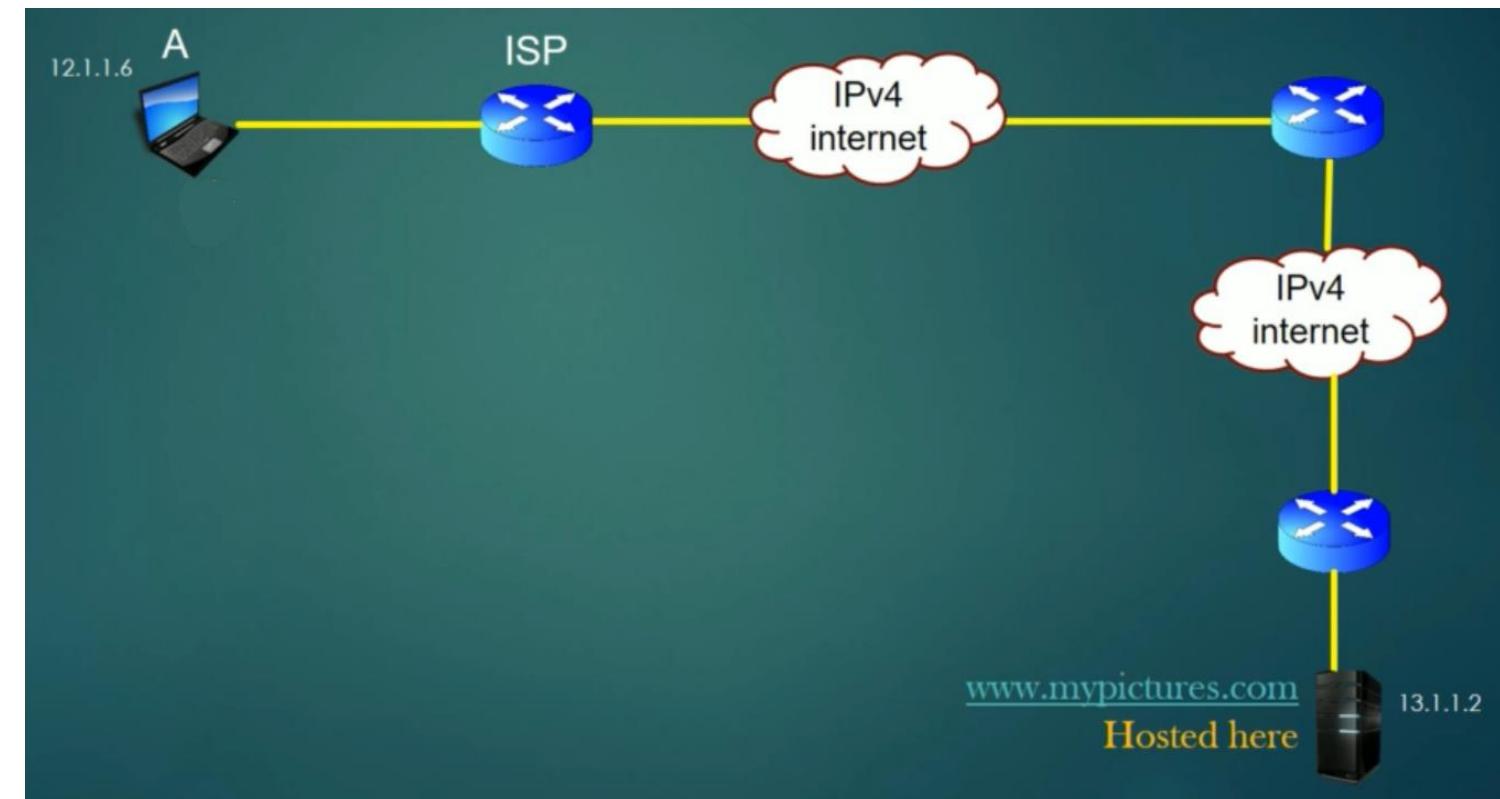
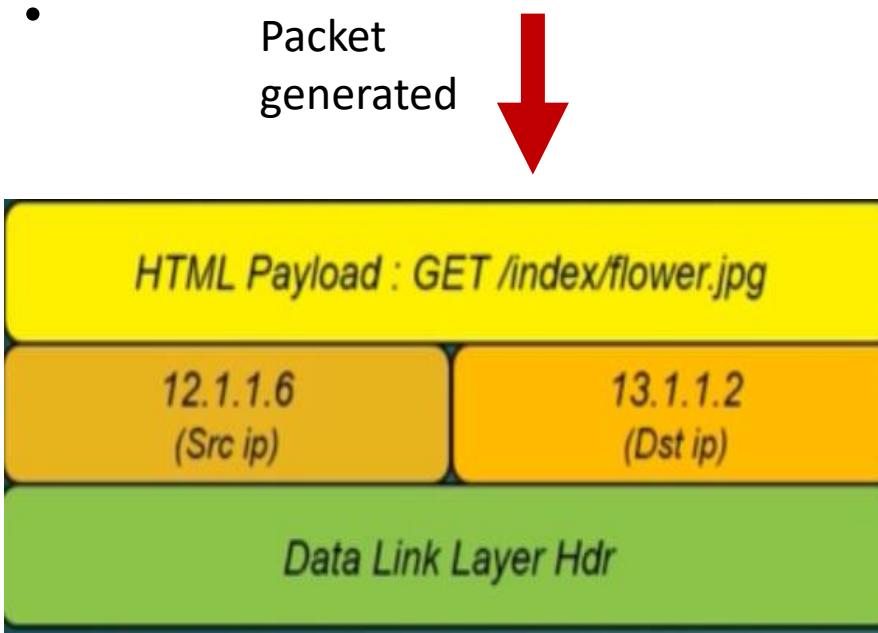
Domain Name Server (DNS)

Domain Name Server (DNS)

1. Domain Name Server is popularly known as DNS
2. DNS technology facilitates the mapping of website name to IP-address and IP-address to website name.
 - a) Website Domain Name → IP address of machine which hosts the website.
 - This is functionality of DNS
 - We do this all the time
 - Example : www.google.com is the website hosted on server whose IP is 8.8.8.8
 - b) IP-Address → Website Domain Name
 - This is functionality of Reverse DNS
 - Example: web host server corresponding to 8.8.8.8 is www.google.com
 - Can be checked using nslookup command.
3. DNS is like a phone book for the Internet!!
4. DNS plays its role whenever you visit some website or sending an email.

Domain Name Server (DNS)

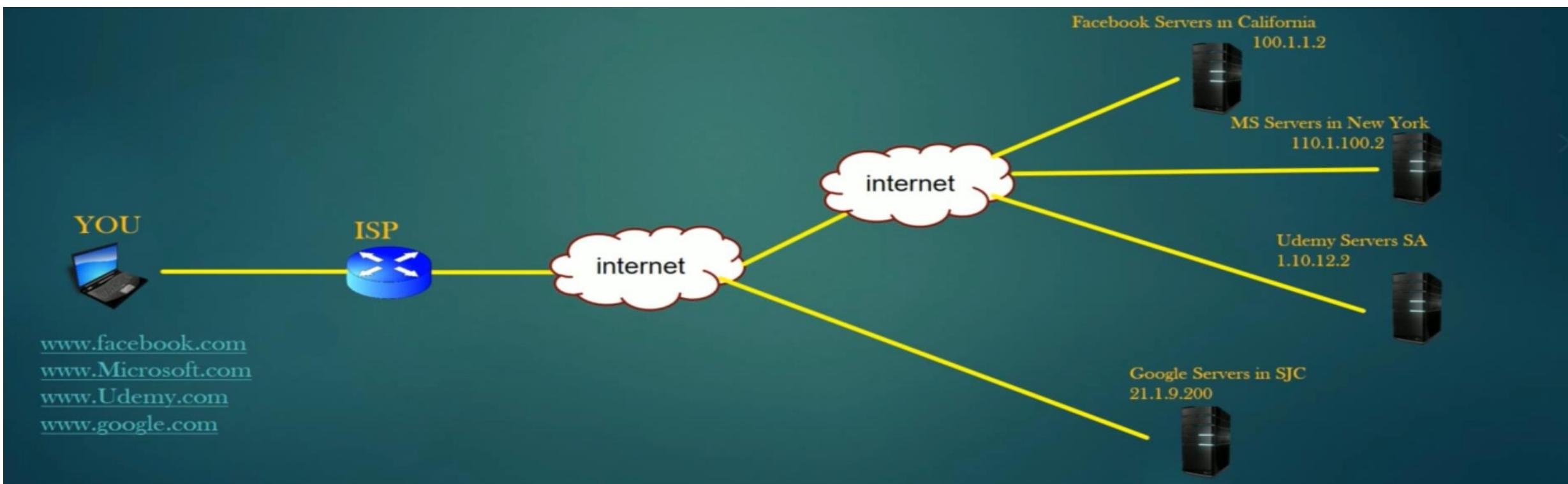
- Whenever you type out the name of any website in your browser, you are trying to access that particular website which is hosted somewhere on the network.
- The packet that is generated by your browser will look like this if you type out the following:
www.mypictures.com/index/flower.jpg



- Question:
- How your machine knows destination IP address 13.1.1.2? Where from it came?
- ANS: DNS

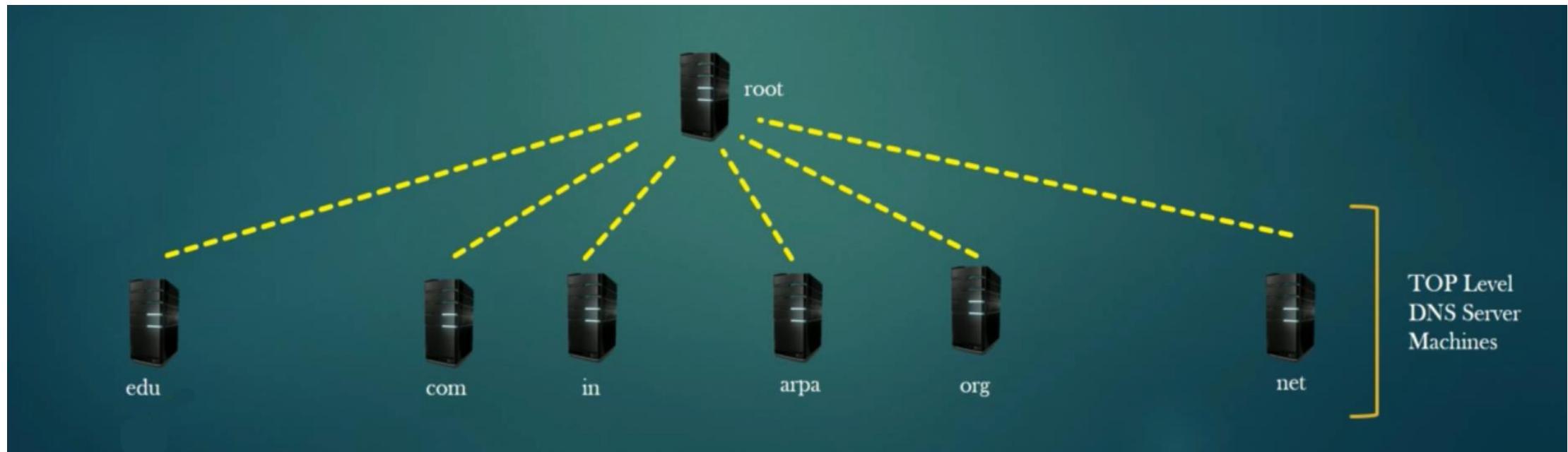
Domain Name Server (DNS)

- DNS is application layer protocol, and it works completely transparent to the end user.
- As an end user, you never need to learn which website is hosted on which server in the world, and it is not possible either.
- We always access the various websites through their names (called Domain Names), Human cant remember several IP addresses
- DNS allows you to access any public website hosted else where in the world through its domain name!



DNS System Architecture

- DNS system is a group of servers called DNS servers which works in collaboration with each other to implement DNS functionality
- These DNS server machines are distributed all across the globe with sufficient redundancy
- DNS machines are monitored & managed by, central authority
- Global DNS Server Machines (which comes under central authority) works at two levels:
 - ROOT LEVEL – Servers which work at root level are called root DNS servers
 - TOP LEVEL – servers which work at TOP Level are called TOP Level DNS Servers (TLDs)



DNS Server Geographical Distribution

- DNS Servers (root and TLD) are distributed across the globe
- Redundancy
 - Fault tolerance
 - Load balancing

Map of the Root Servers



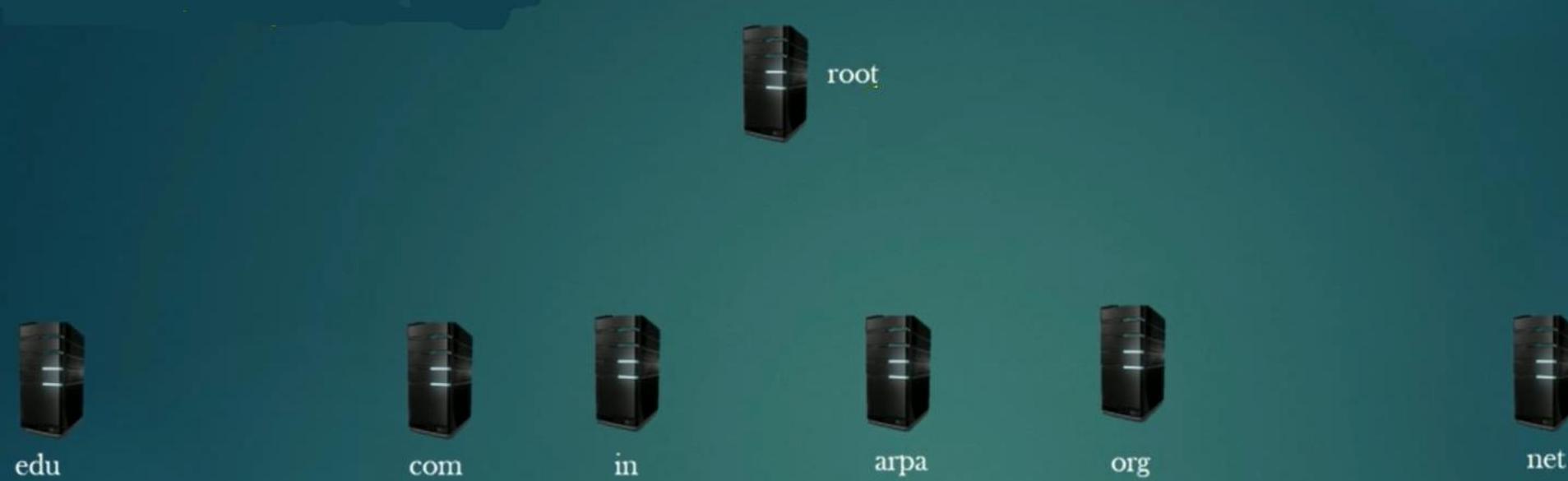
DNS – A Hierarchical and Decentralized System

- DNS is a Hierarchical System.



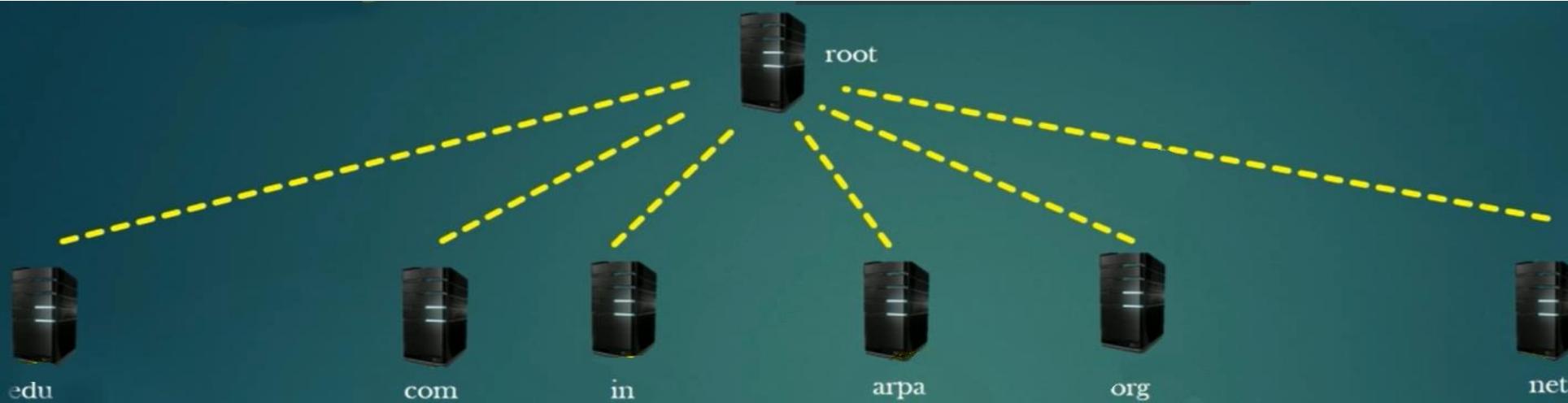
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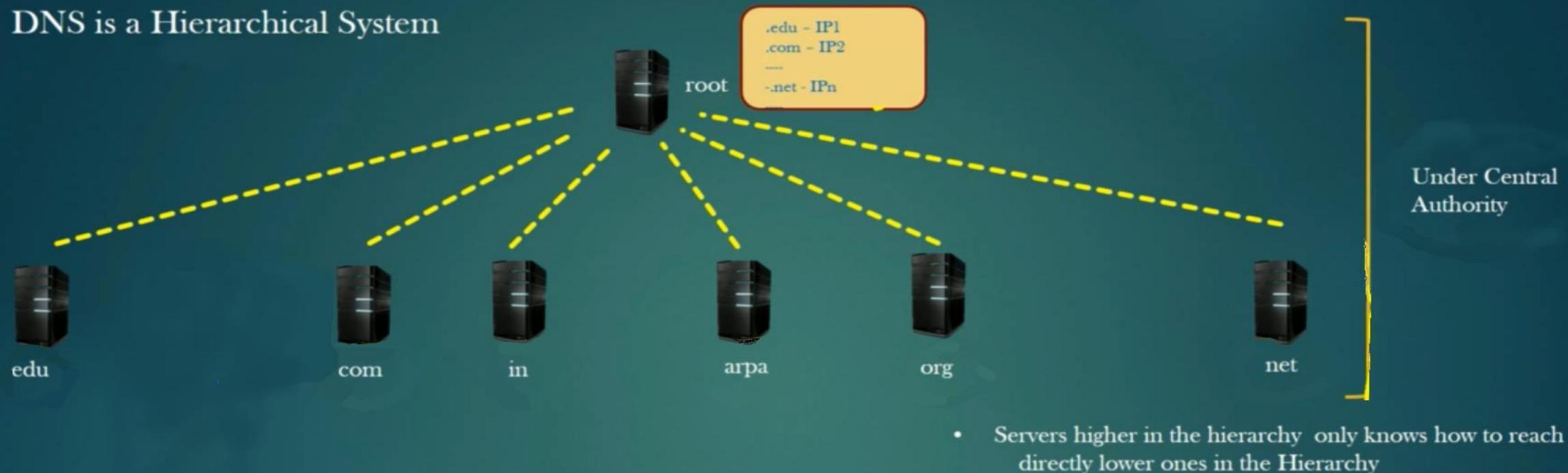
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DNS – A Hierarchical and Decentralized System

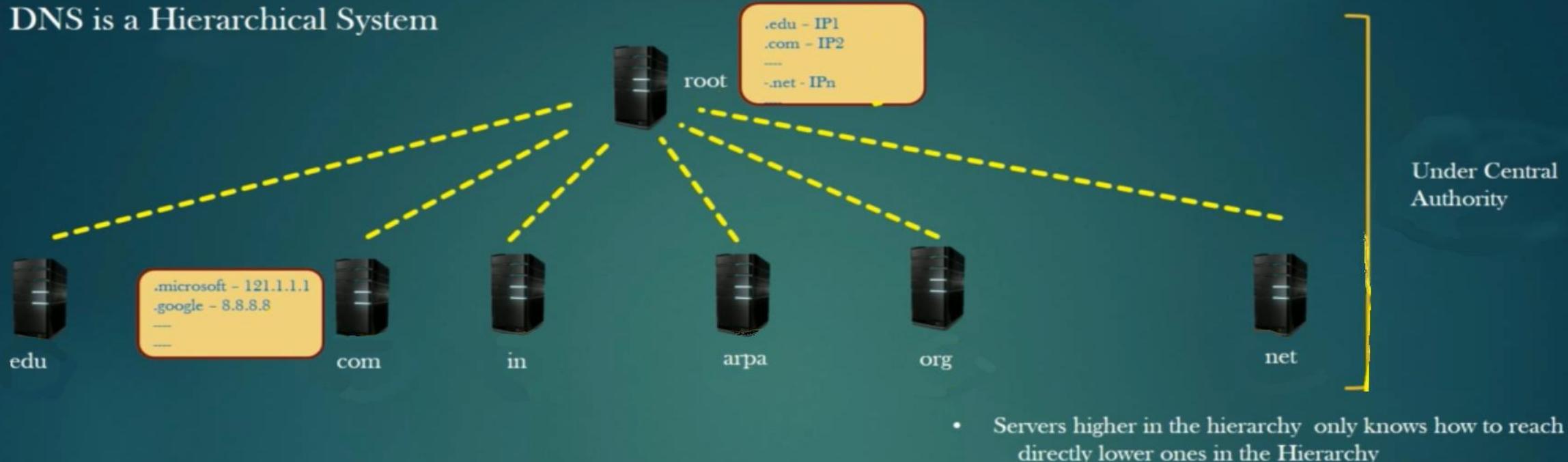
DNS is a Hierarchical System



- Servers higher in the hierarchy only knows how to reach directly lower ones in the Hierarchy

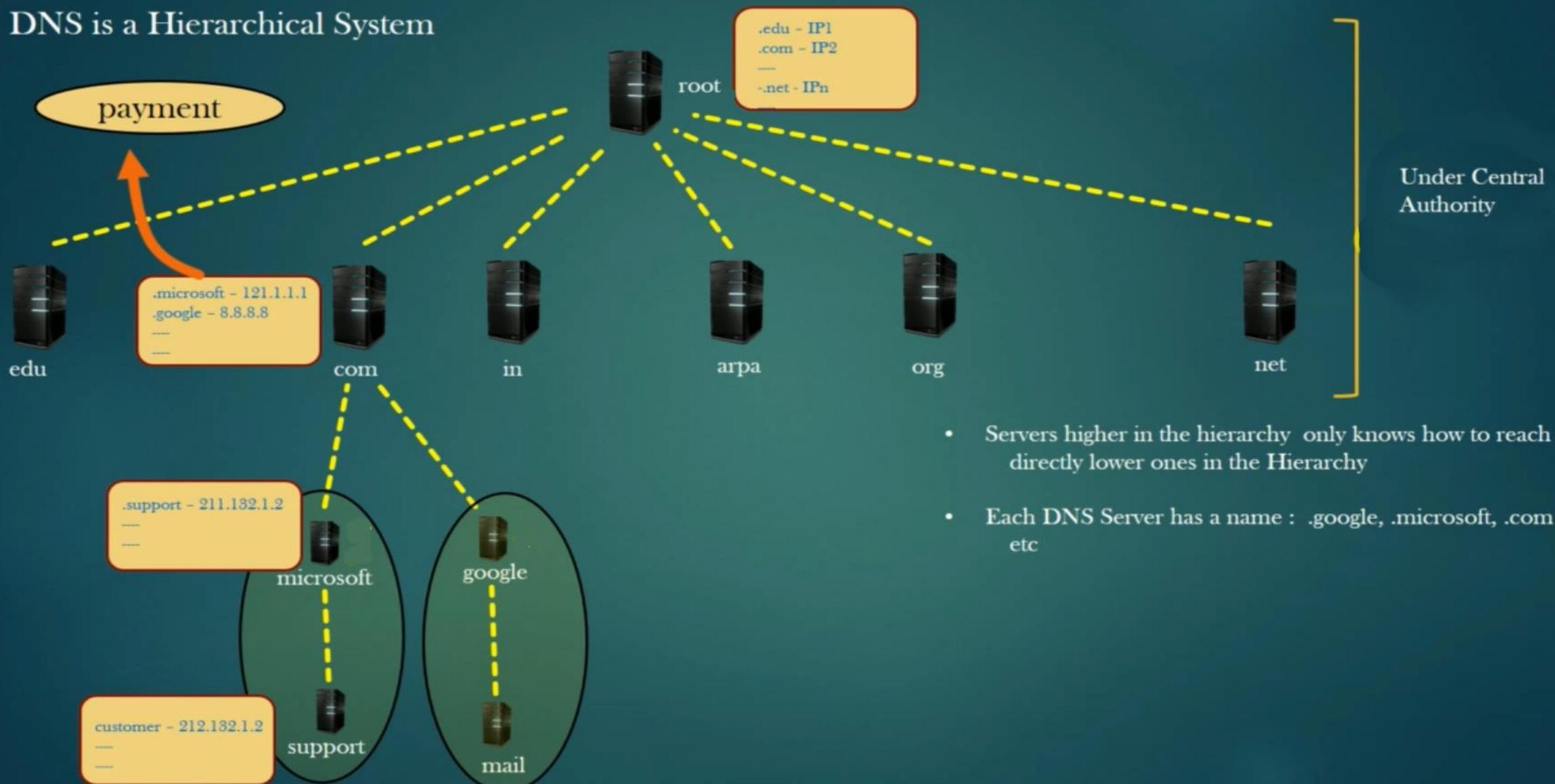
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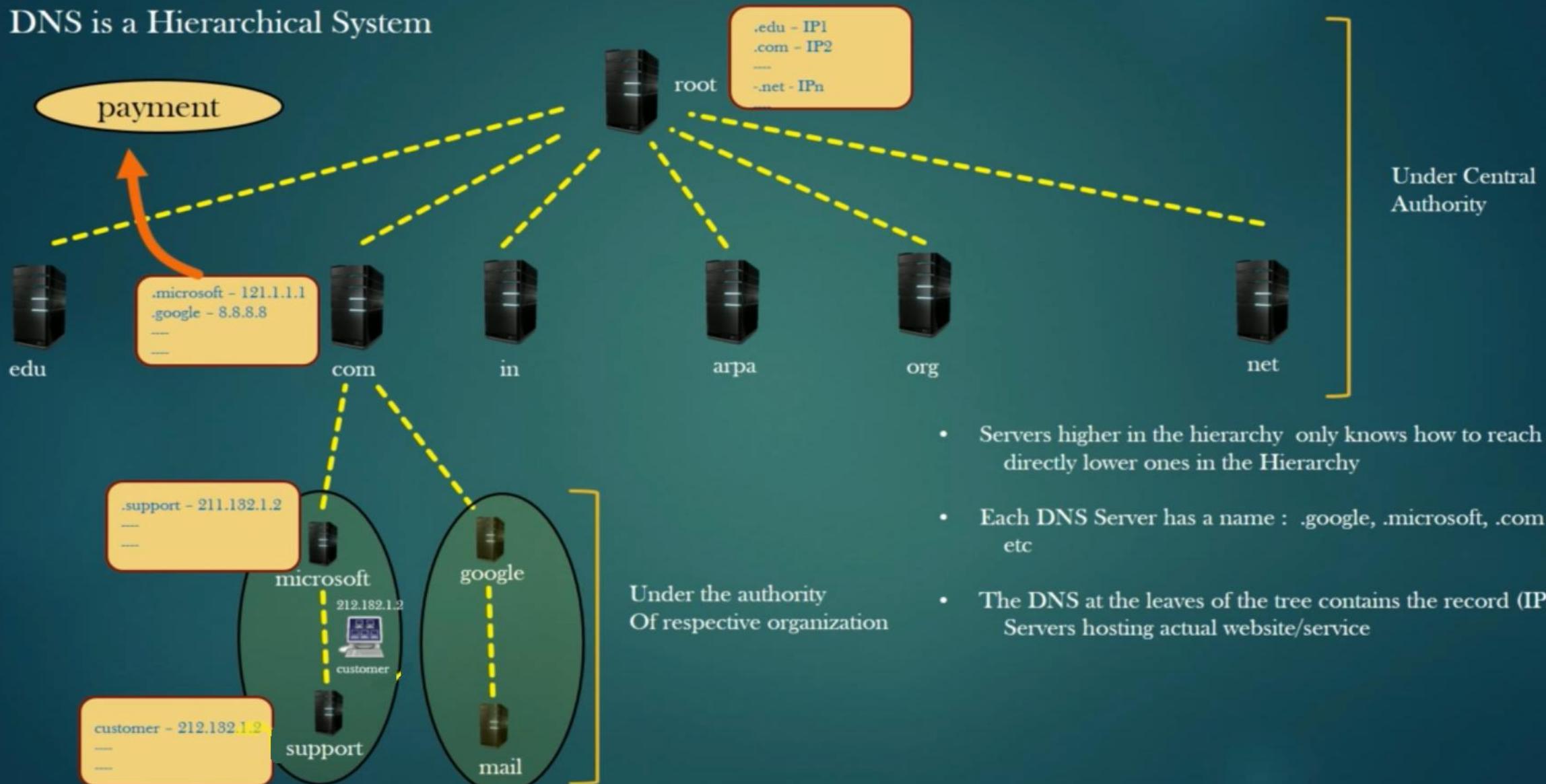
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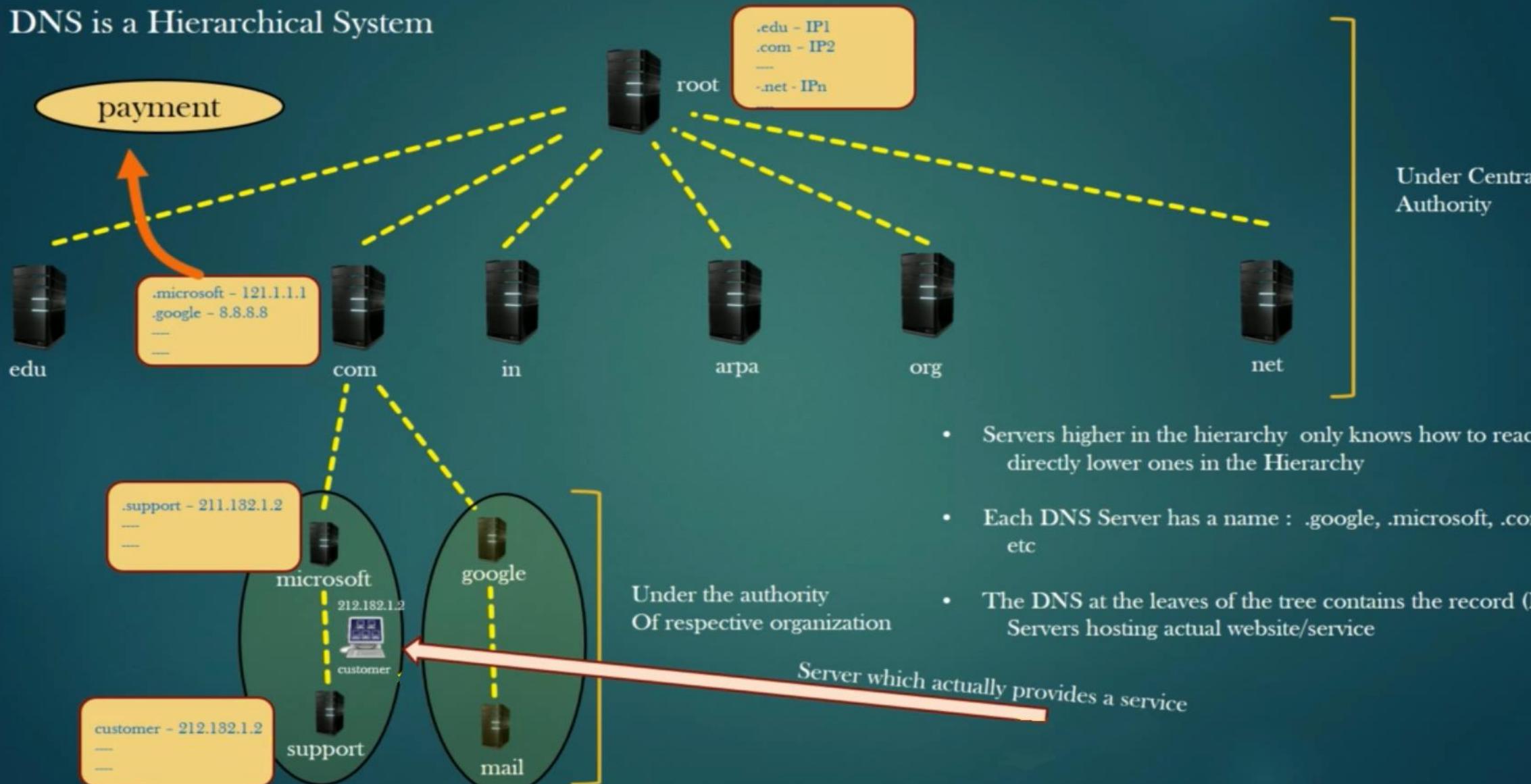
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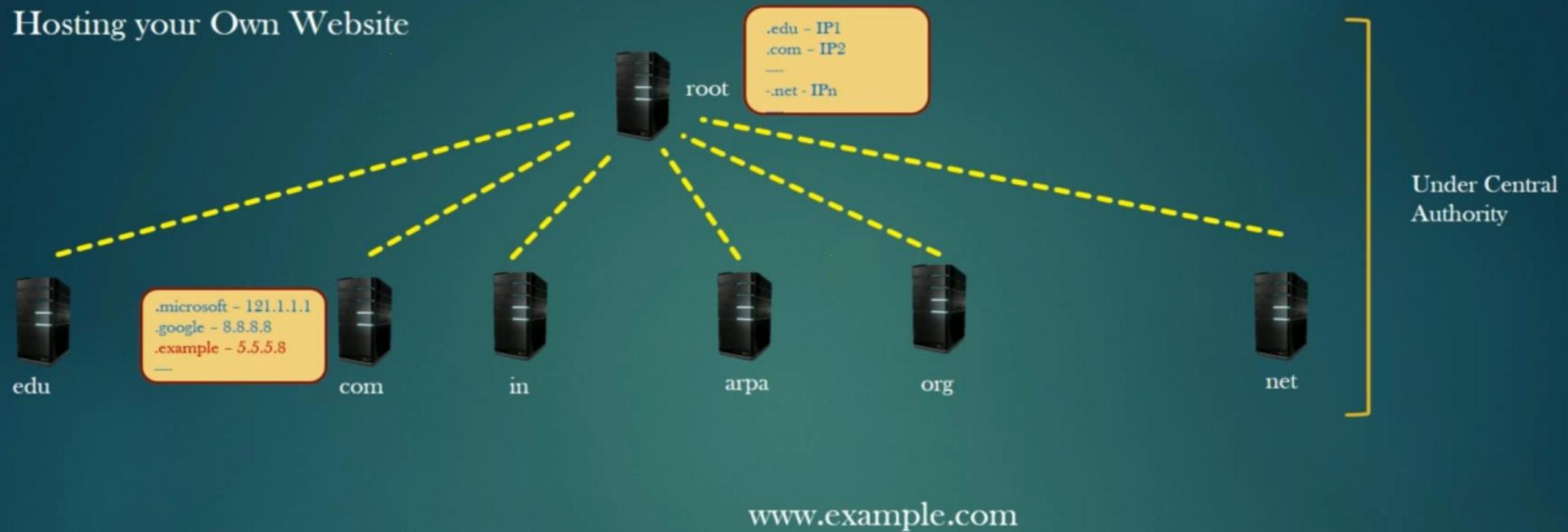
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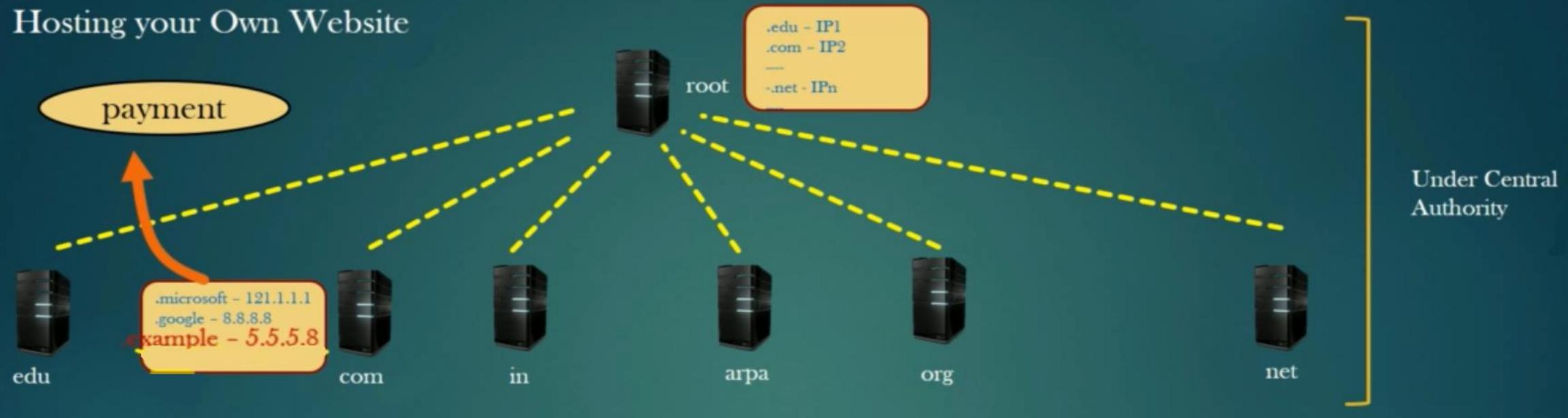
DNS-Hosting Your Own Website

Hosting your Own Website



DNS-Hosting Your Own Website

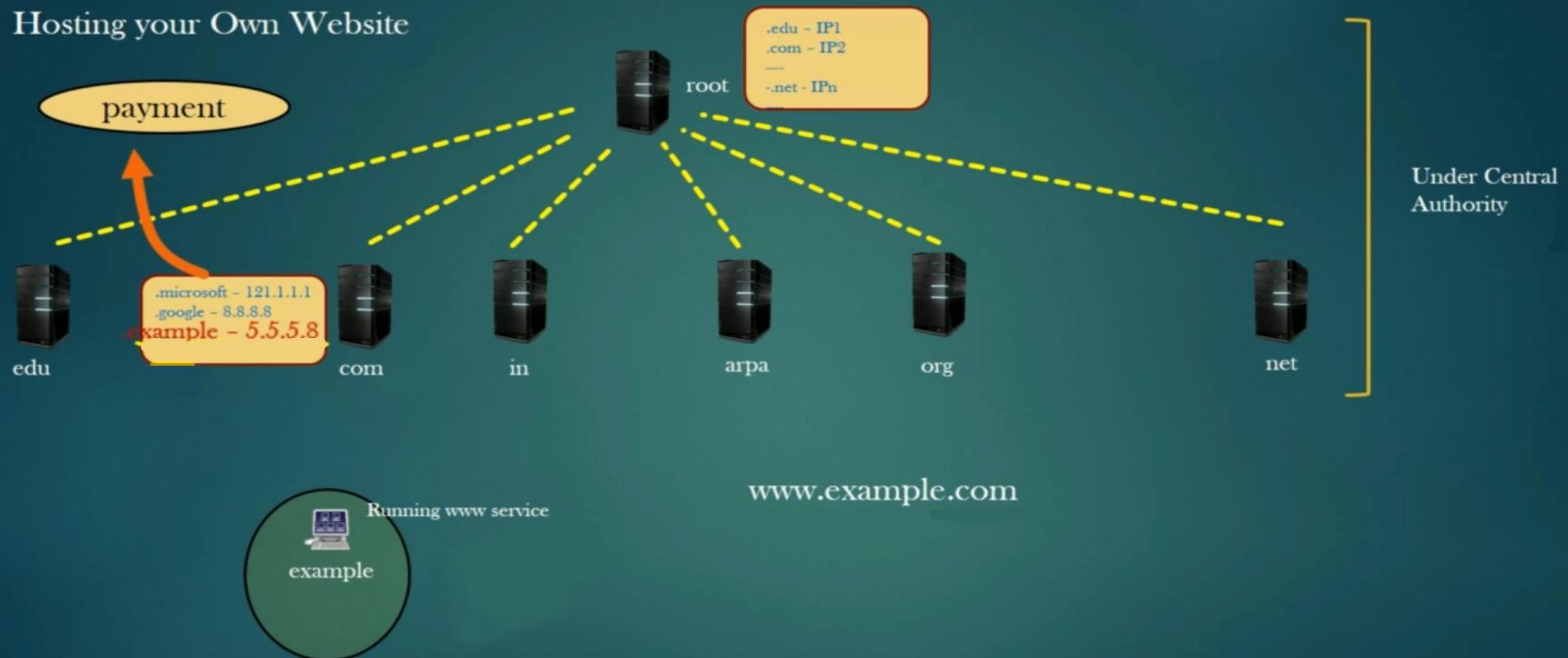
Hosting your Own Website



www.example.com

DNS-Hosting Your Own Website

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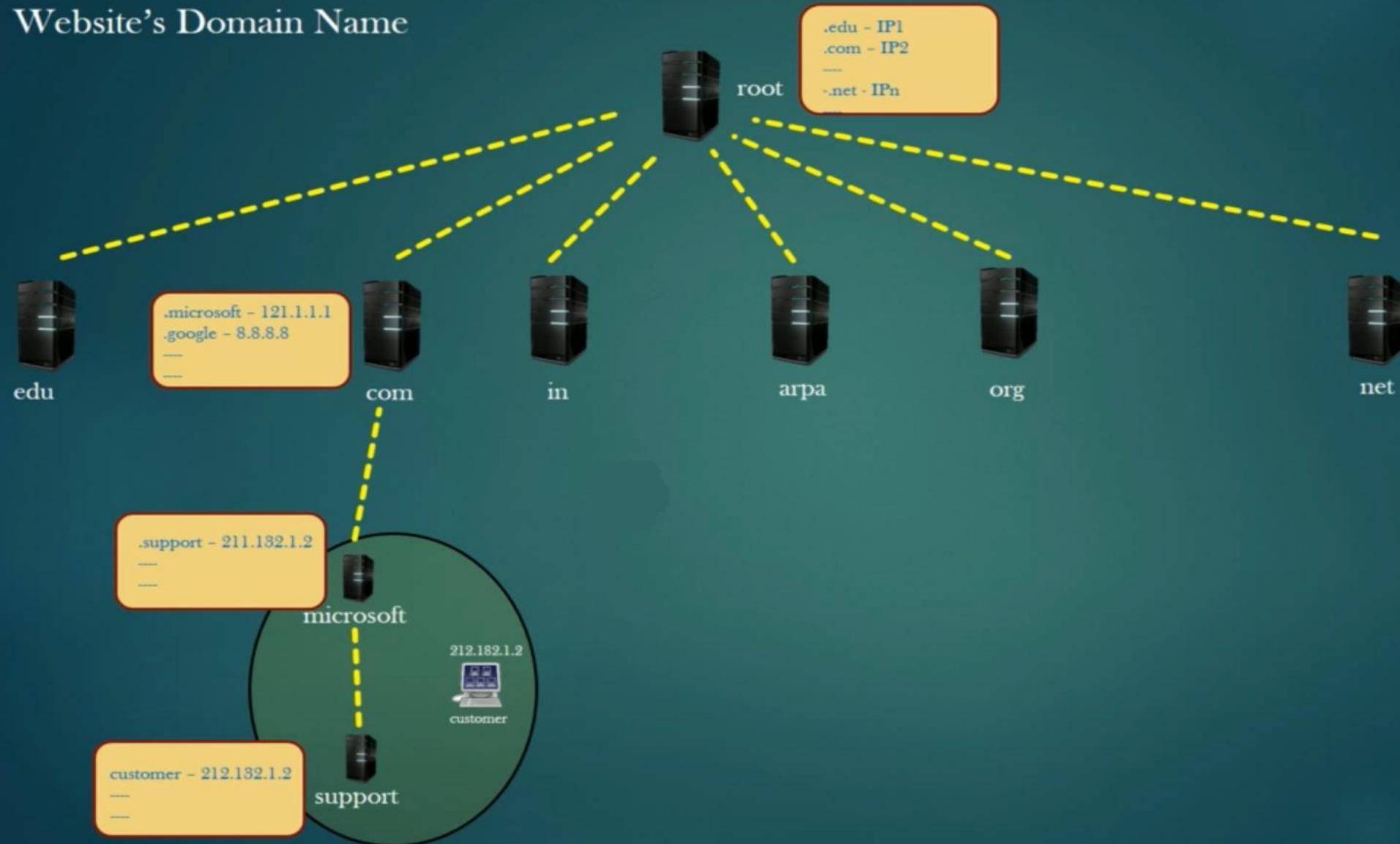


Website's Domain Name

- A website name, also called domain name is not just any random sequence of words.
- A website name needs to be constructed systematically keeping DNS hierarchy in mind.
- A website name is constructed of individual words called literals. These literals are actually the name of DNS Servers in the path of DNS tree starting from root towards the leaf of DNS tree.
- Eg: customer.support.Microsoft.com – consist of 4 literals
- Let us see, how website domain name is constructed or derived from DNS system with the help of example.

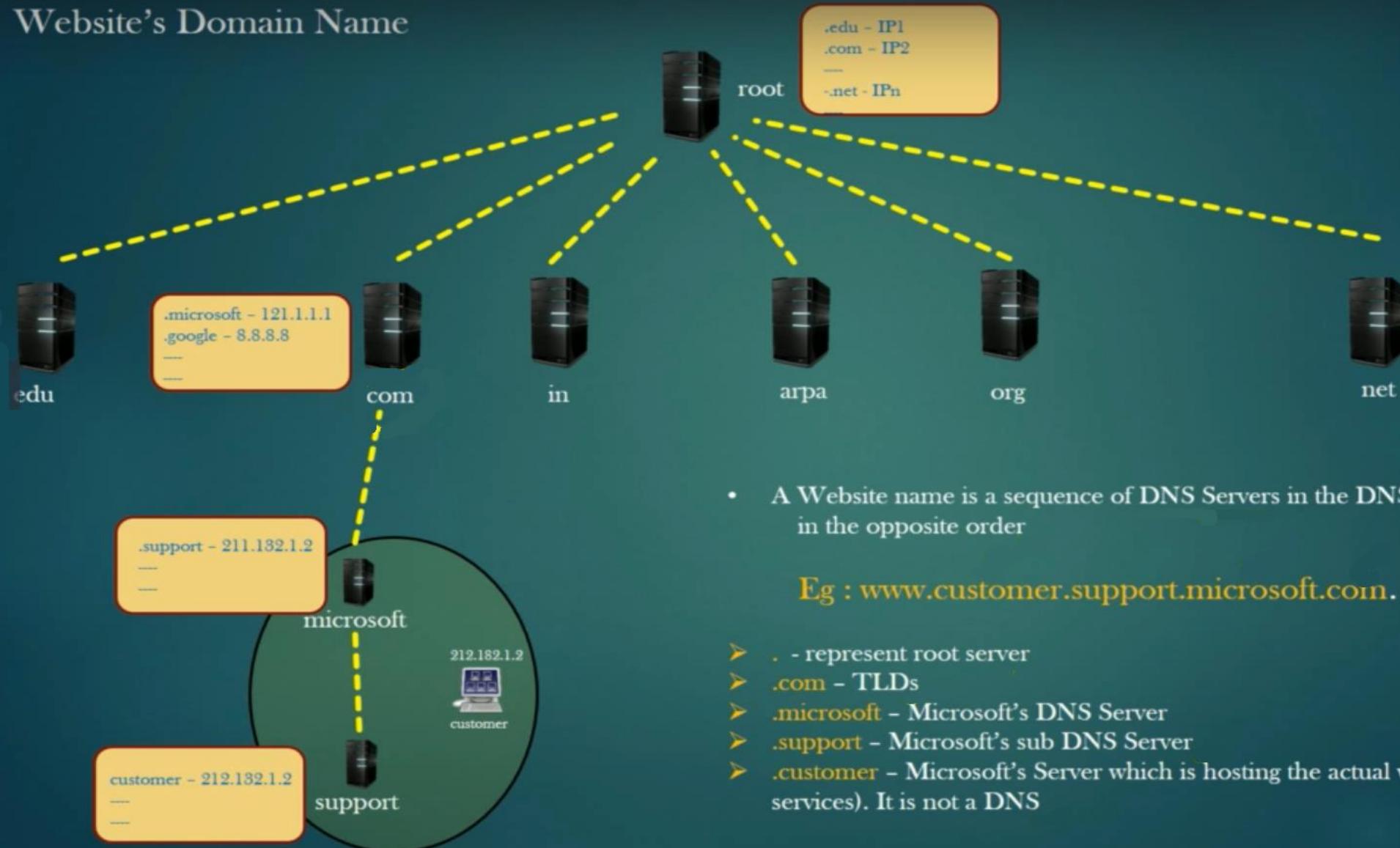
Website's Domain Name

Website's Domain Name



Website's Domain Name

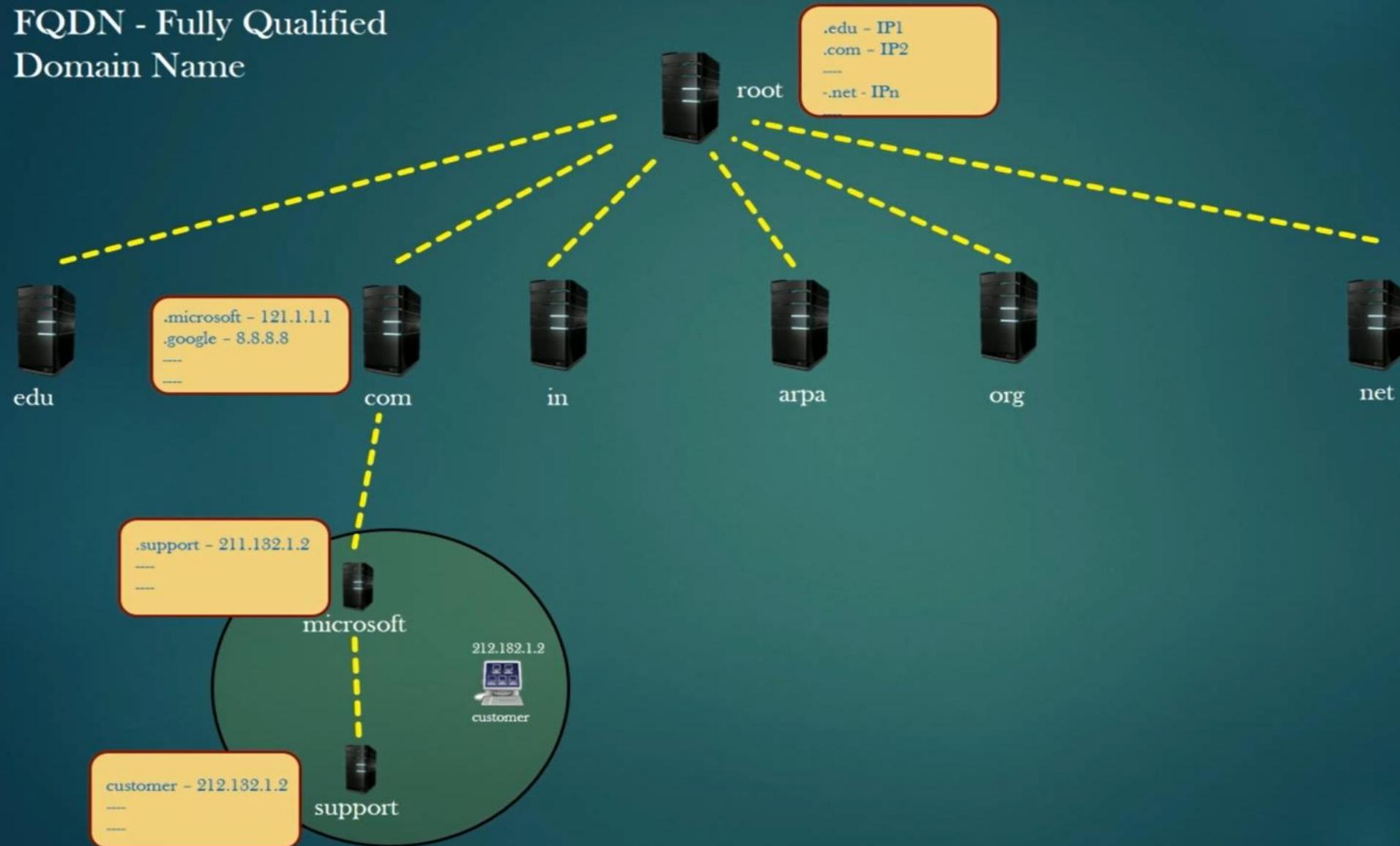
Website's Domain Name



- A Website name is a sequence of DNS Servers in the DNS tree but in the opposite order
 - Eg : **www.customer.support.microsoft.com.**
 - **.** - represent root server
 - **.com** - TLDs
 - **.microsoft** - Microsoft's DNS Server
 - **.support** - Microsoft's sub DNS Server
 - **.customer** - Microsoft's Server which is hosting the actual website (**www** services). It is not a DNS

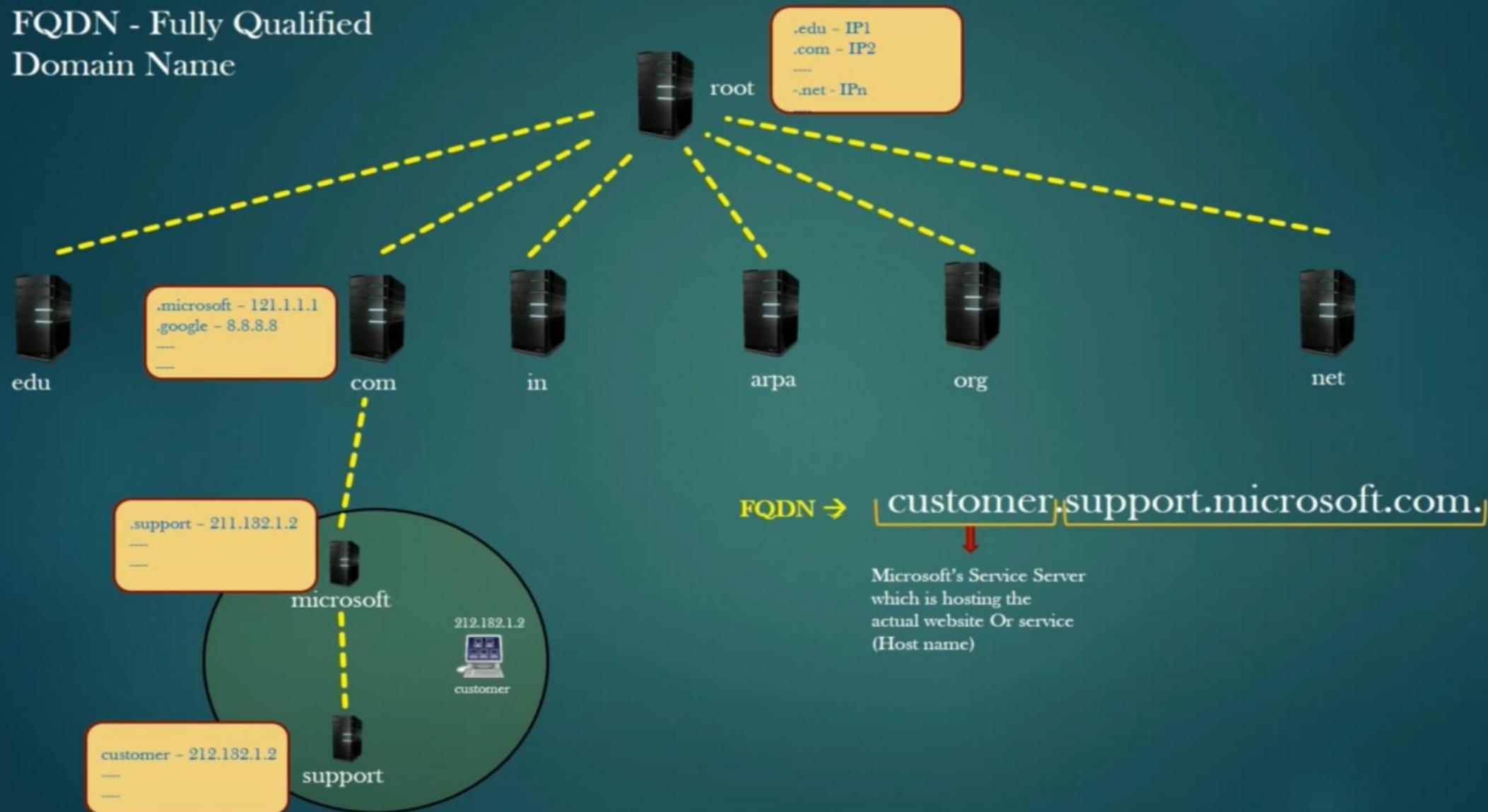
FQDN – Fully Qualified Domain Name

FQDN - Fully Qualified
Domain Name



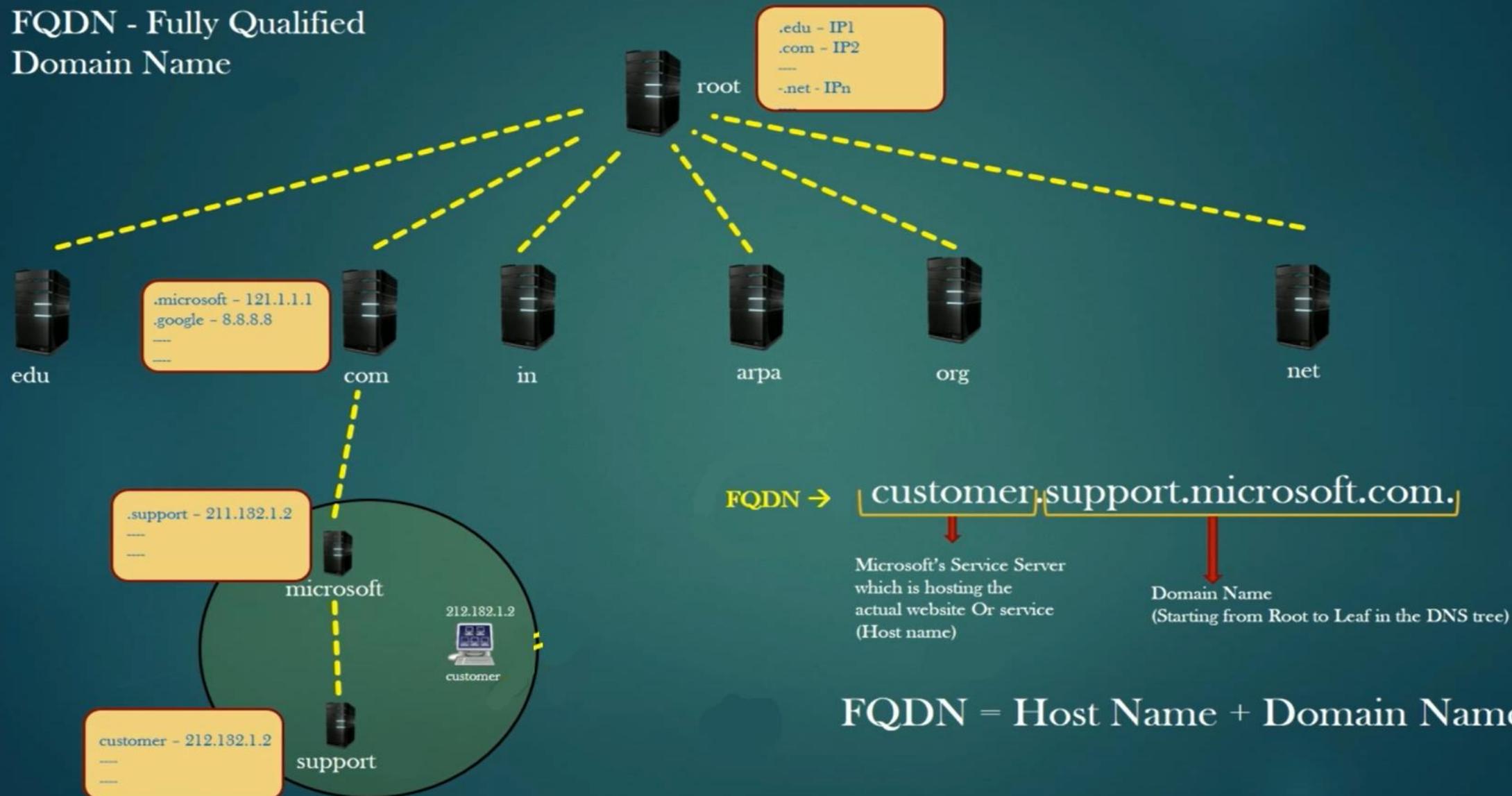
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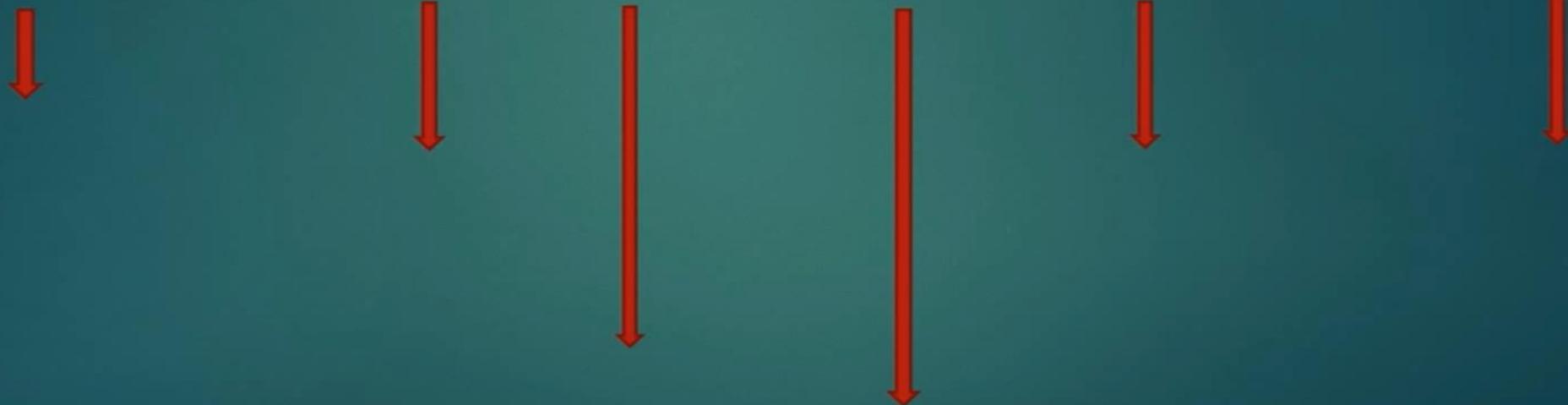
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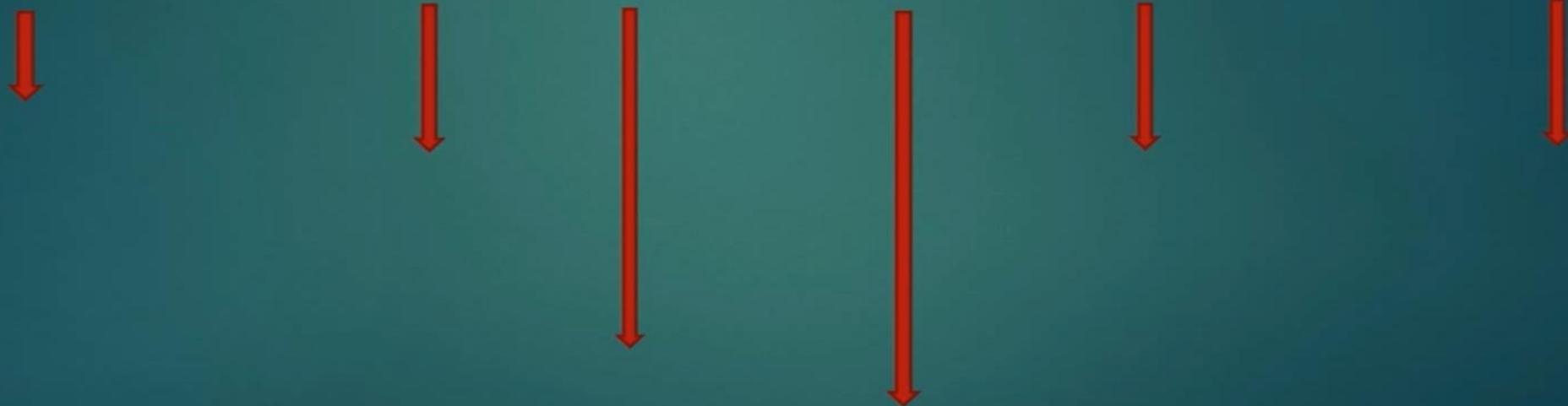
Top Level DNS Classification

Top Level DNS
Servers classification



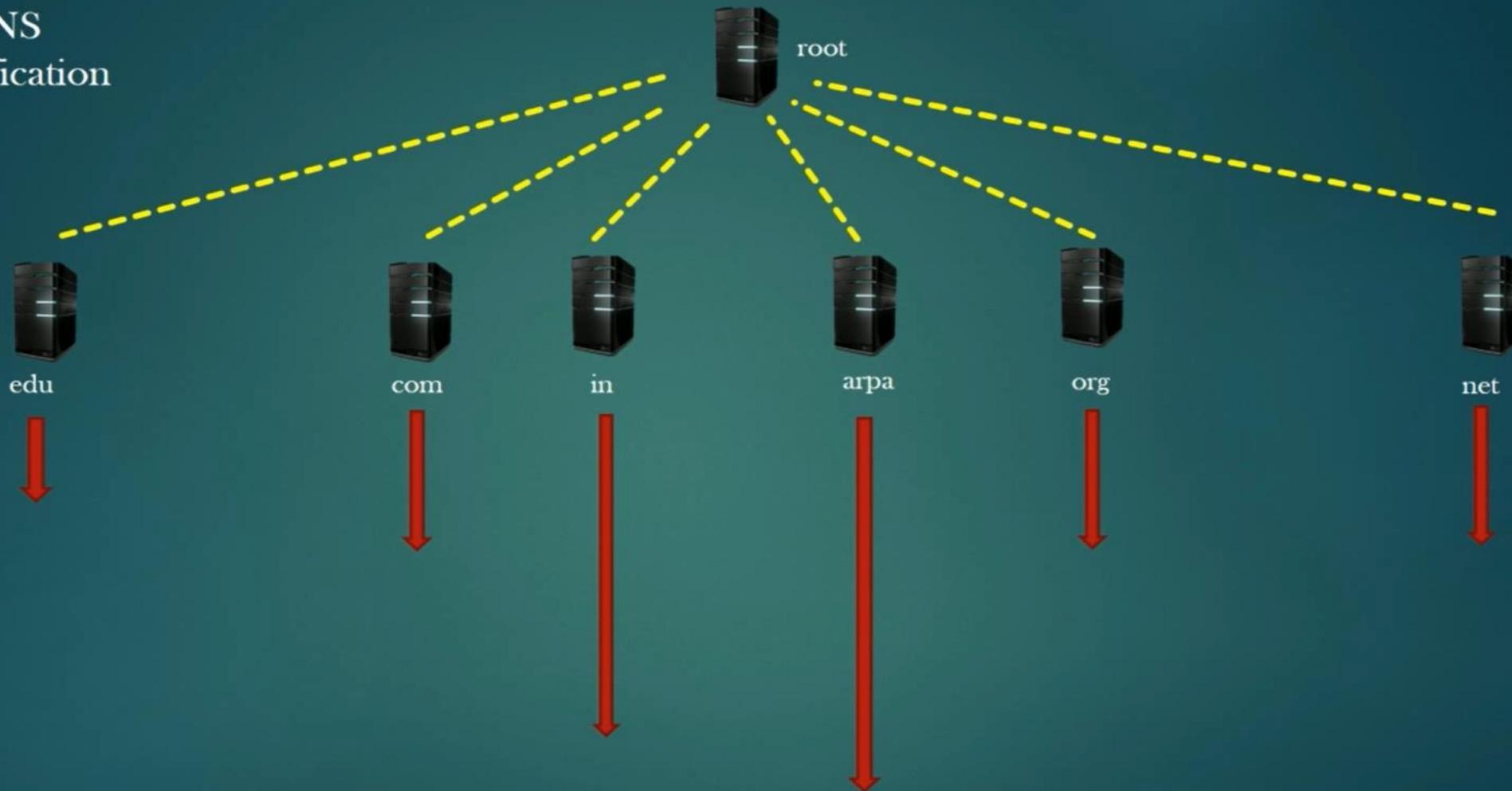
Top Level DNS Classification

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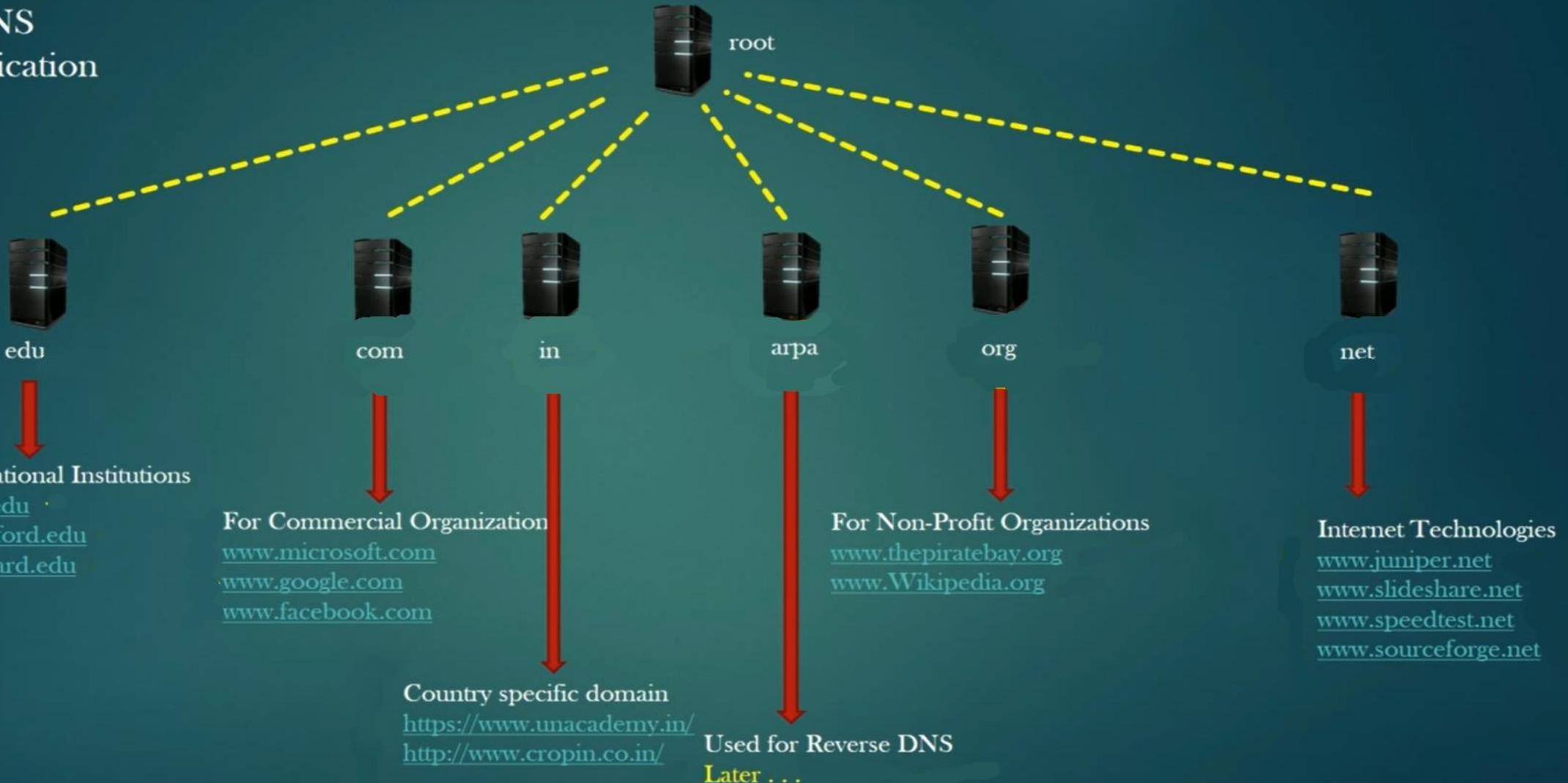
Top Level DNS Classification

Top Level DNS
Servers classification



Top Level DNS Classification

Top Level DNS Servers classification



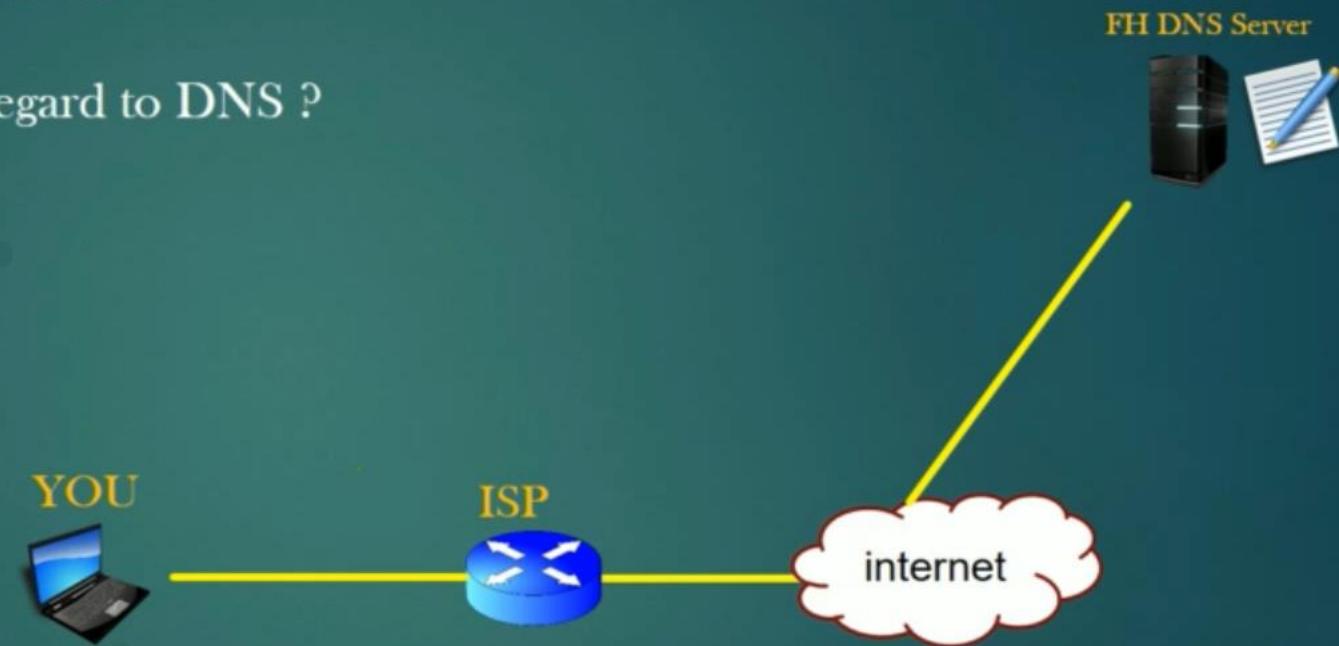
First Hop DNS Server

First Hop DNS Servers

What are FH DNS Server Machines ?

What is their purpose/role in regard to DNS ?

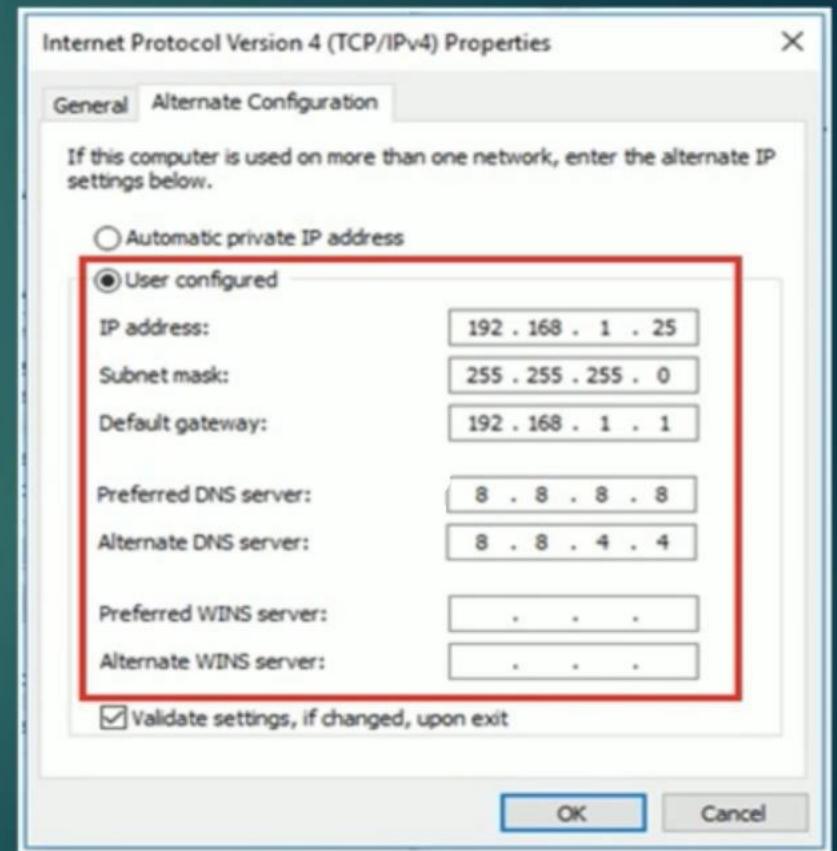
What problem do they solve ?



First Hop DNS Server

First Hop DNS Servers

- Our computer is assigned the address of First Hop DNS Server - Either statically/Manually configured Or Dynamically obtained from DHCP Servers
- Our computer always first ask FH DNS Server to obtain the IP address of a domain name of a website we are trying to access
- If FH DNS has the ip address of the host server which host the website, it returns the address to our computer, else, it query the root DNS server on our behalf for the website's IP Address
- FH DNS Server is also called **DNS resolver** for this reason



- FH DNS Server caches the recently accessed website's ip address in its local DNS Cache so that, in future, our computer can obtain the IP address of recently accessed website quickly from FH DNS only , FH DNS server is shared by several users
- Our computer also have its own local DNS Cache

Or : `ipconfig/all` in cmd prompt

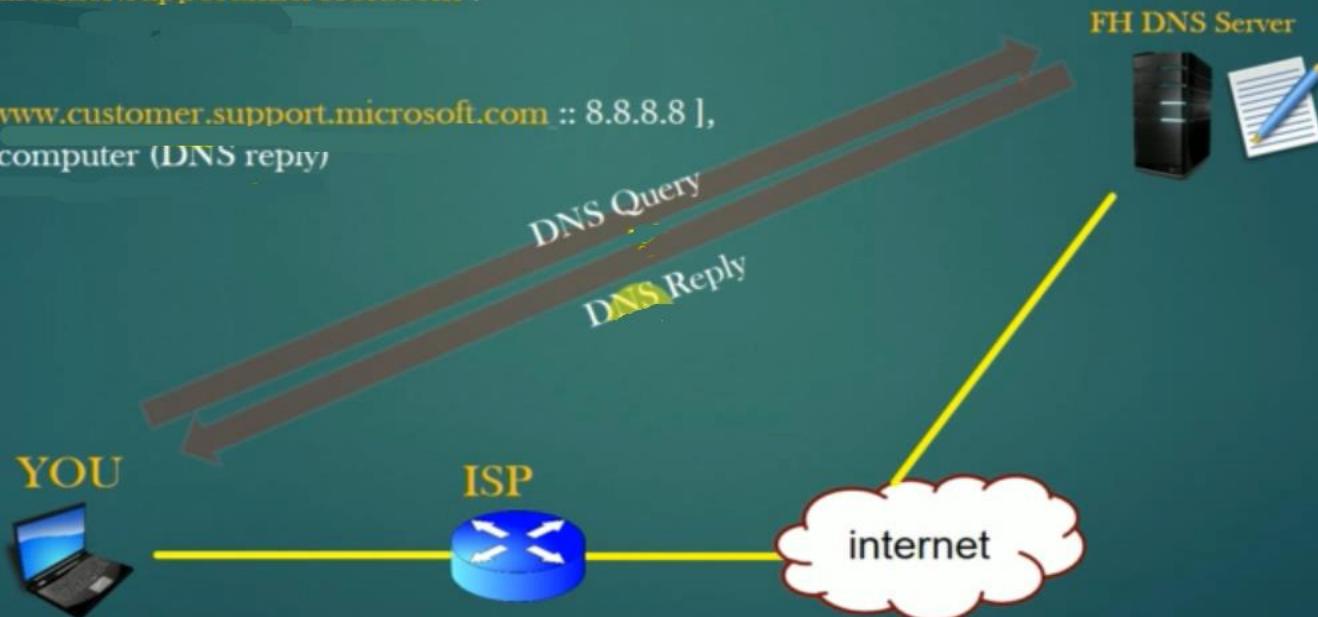
First Hop DNS Server

First Hop DNS Servers

- Lets Say : YOU try to access the website : www.customer.support.microsoft.com
- Our computer look up in its local DNS Cache.
- Assume it don't have IP address of www.customer.support.microsoft.com
- Our computer send DNS Query to FH DNS Server asking
What is IP address of www.customer.support.microsoft.com ?
- If FH DNS Server has entry : [www.customer.support.microsoft.com :: 8.8.8.8],
then it returns 8.8.8.8 to our computer (DNS reply)

DNS Query : What is the ip address of
www.customer.support.microsoft.com

DNS Reply : ip address of
www.customer.support.microsoft.com
is 8.8.8.8



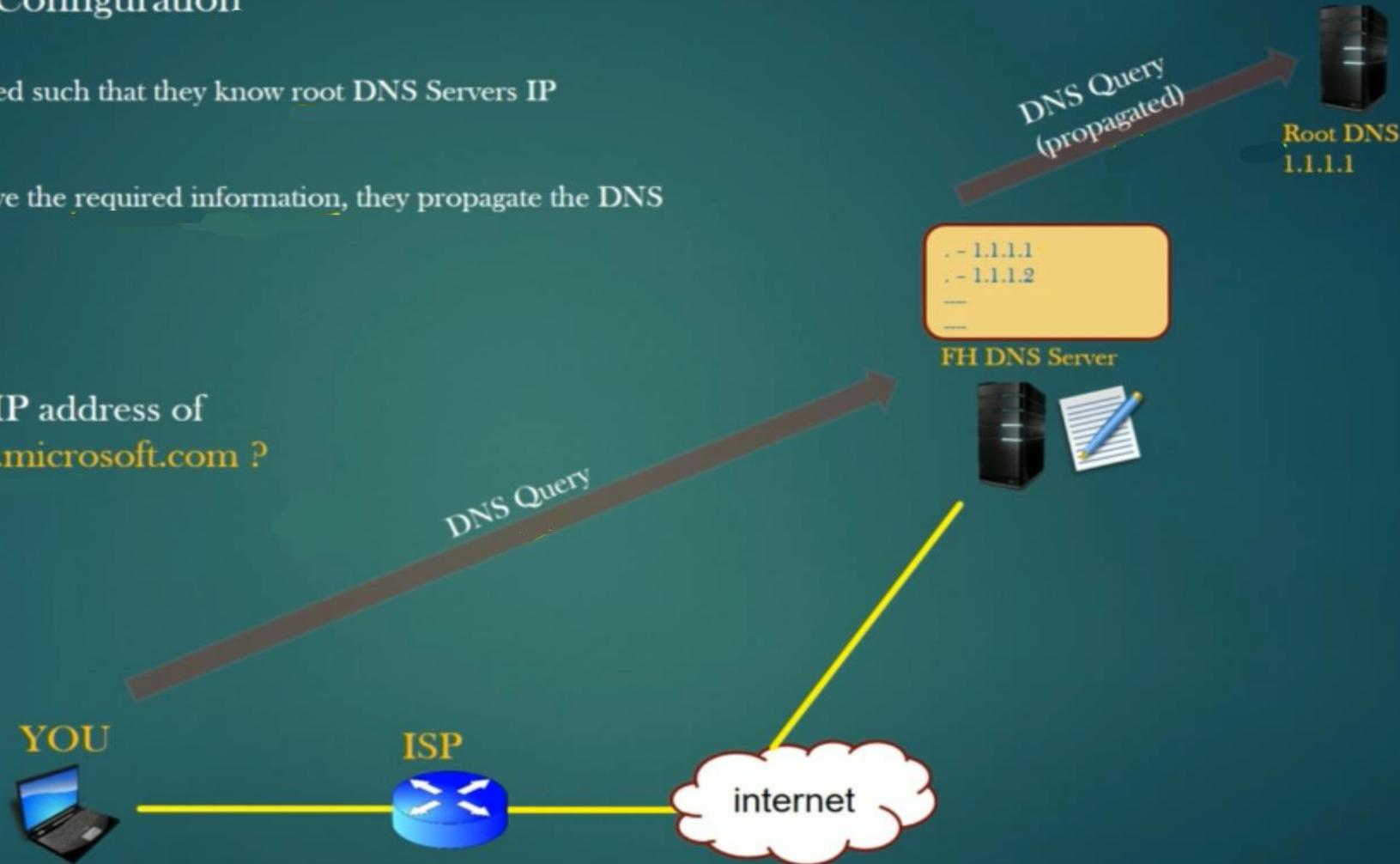
- But What if FH DNS Server also do not have IP address of www.customer.support.microsoft.com ?

First Hop DNS Server

First Hop DNS Servers Configuration

- FH DNS Servers are configured such that they know root DNS Servers IP Addresses
- If FH DNS Servers do not have the required information, they propagate the DNS Query to Root DNS Servers

DNS Query : What is IP address of
www.customer.support.microsoft.com ?



Next : Now, Lets try to understand the complete DNS Mechanism to resolve the website domain name to IP address

DNS Mechanism

The DNS Mechanism

The Goal of DNS mechanism is to find the Answer to DNS Query, that is to find the ip address of the host server which host the requested website

There are three different Mechanism to resolve DNS Query :

1. Recursive Method, DNS Query is called Recursive DNS Query
2. Iterative Method, DNS Query is called Iterative DNS Query
3. Reverse look up DNS Query

Let Us discuss each one by one !

Recursive DNS Query

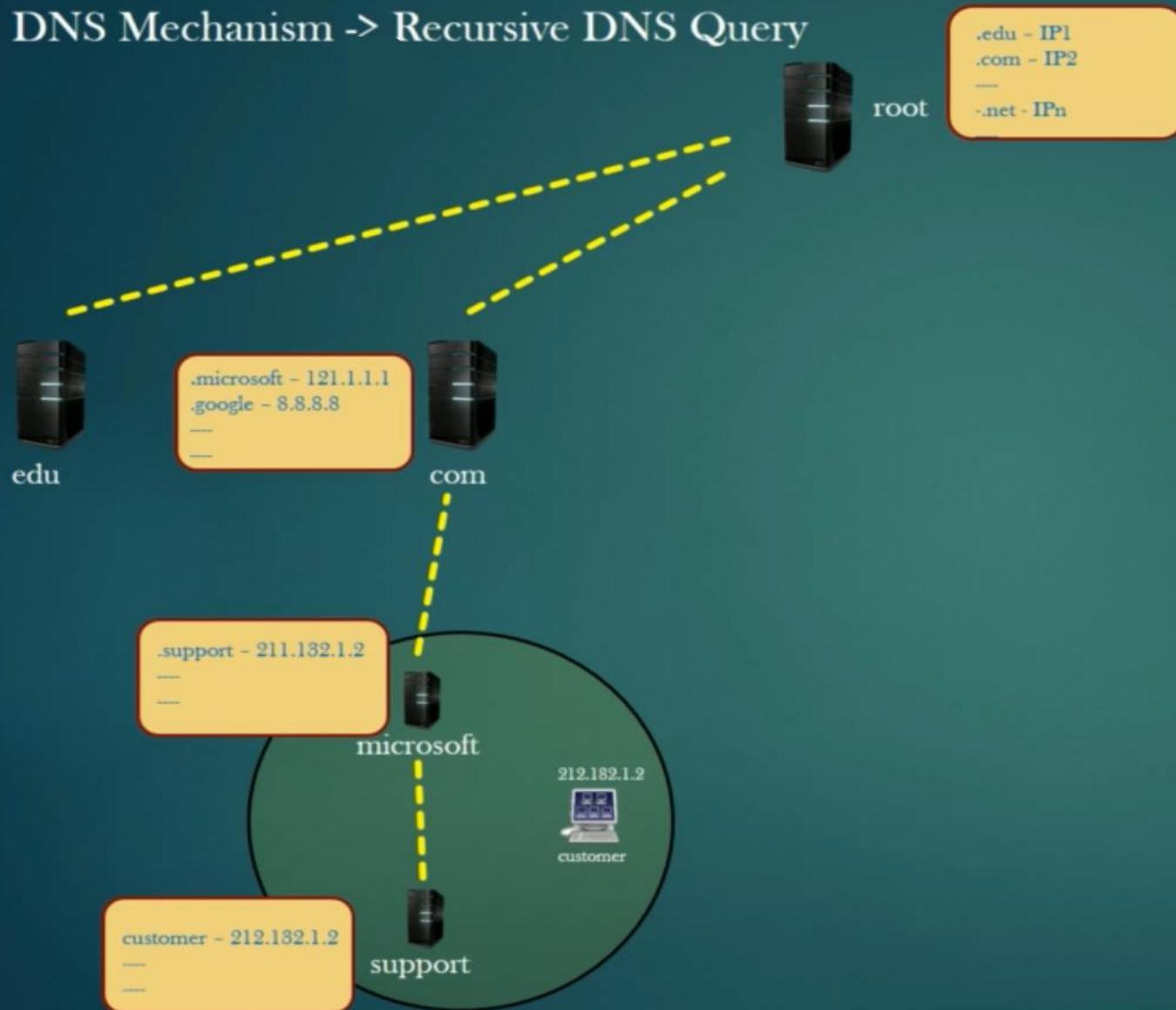
DNS Mechanism

FQDN → IP Address

customer.support.microsoft.com → 212.132.1.2

Recursive DNS Query

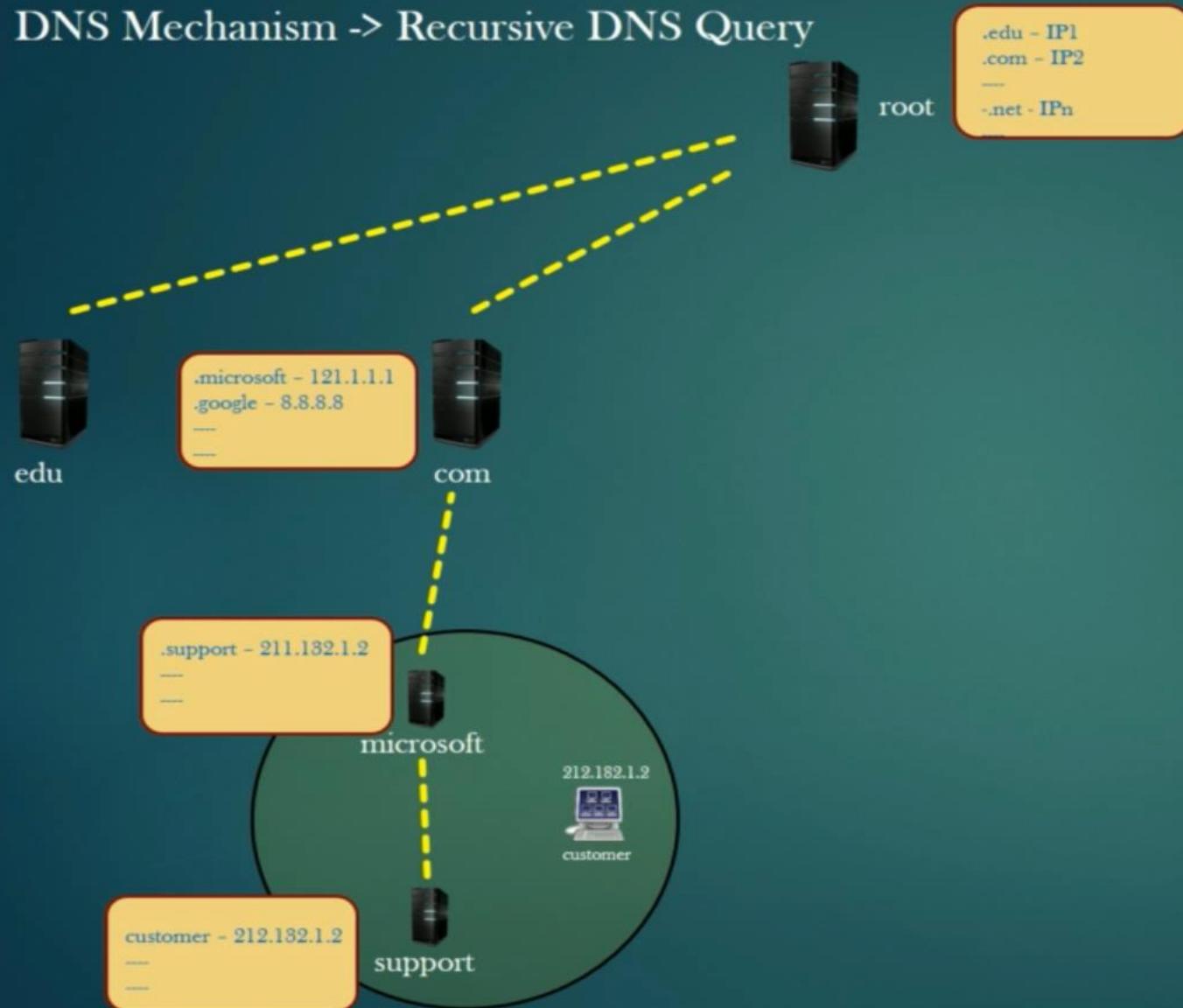
DNS Mechanism -> Recursive DNS Query



DNS Query : What is IP address of FQDN customer.support.microsoft.com ?

Recursive DNS Query

DNS Mechanism -> Recursive DNS Query



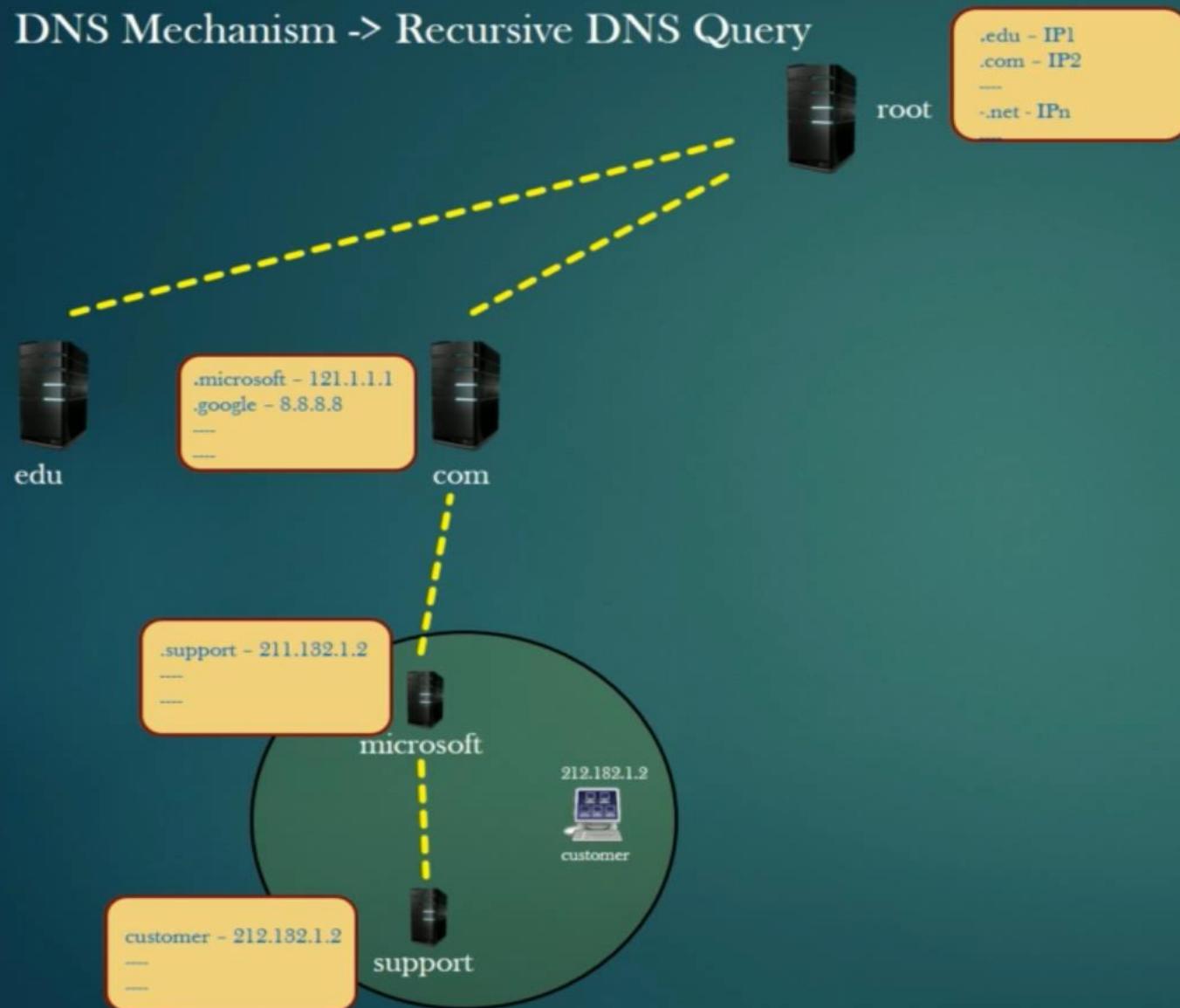
0. You type out “www.customer.support.microsoft.com” in your browser.



DNS Query : What is IP address of
FQDN customer.support.microsoft.com ?

Recursive DNS Query

DNS Mechanism -> Recursive DNS Query



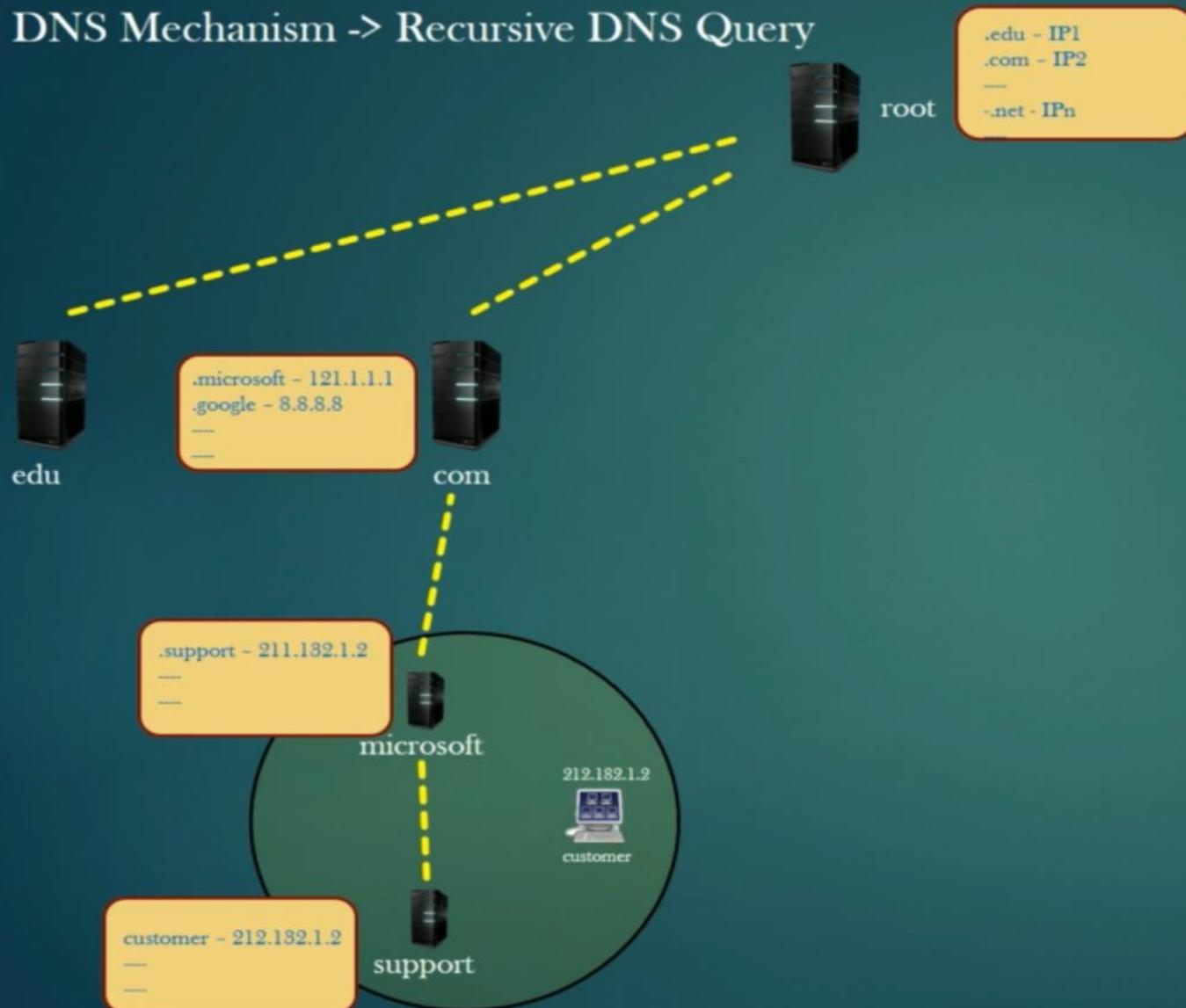
1. Your Local System lookups in its local cache to find the ip address of Domain name **customer.support.microsoft.com**. If it do not finds, it sends Recursive DNS Query to **DNS resolver**.



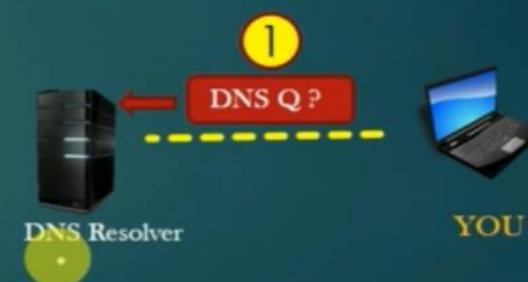
DNS Query : What is IP address of FQDN customer.support.microsoft.com ?

Recursive DNS Query

DNS Mechanism -> Recursive DNS Query



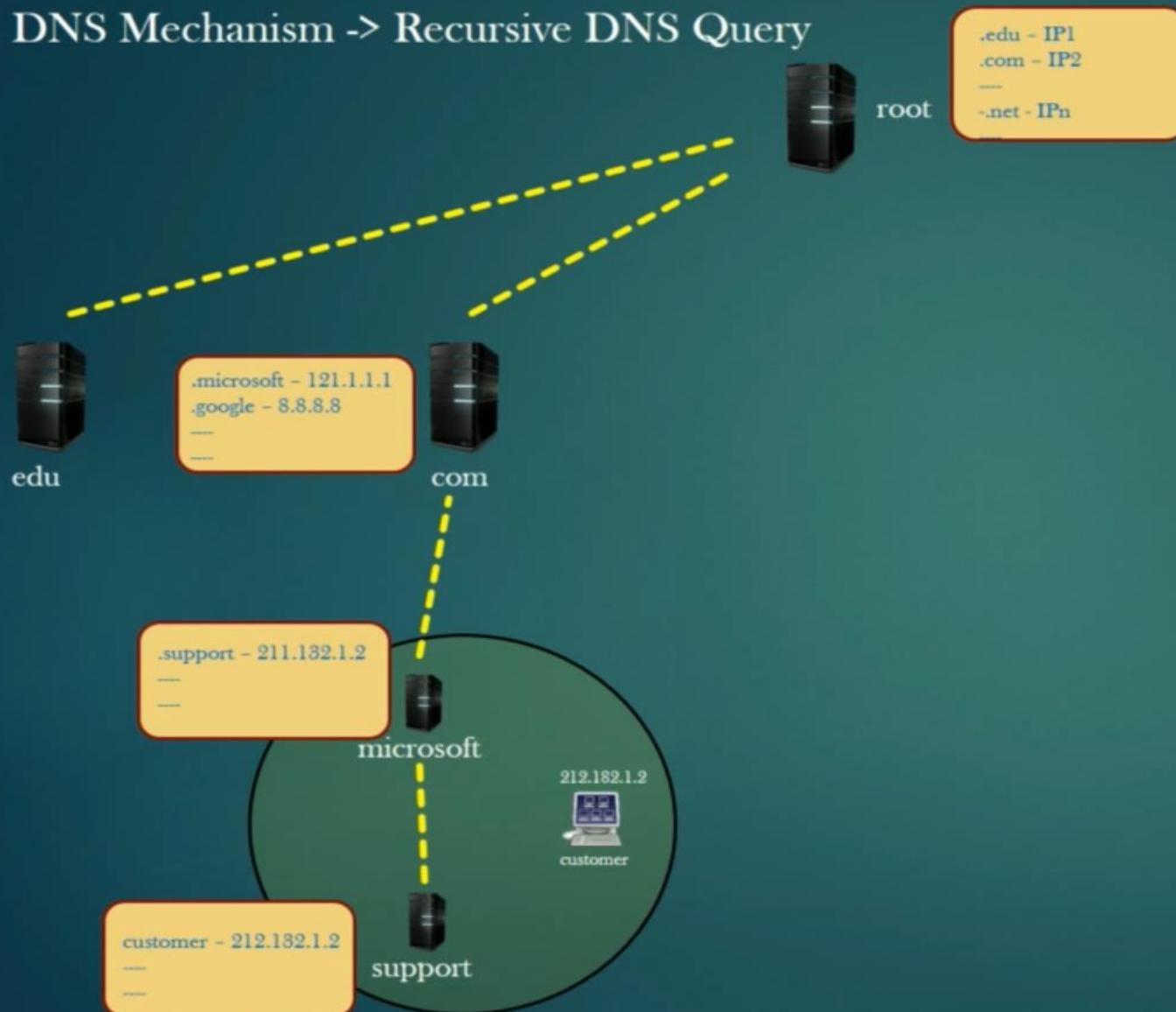
1. Your Local System lookups in its local cache to find the ip address of Domain name `customer.support.microsoft.com`. If it do not finds, it sends Recursive DNS Query to DNS resolver.



DNS Query : What is IP address of FQDN `customer.support.microsoft.com` ?

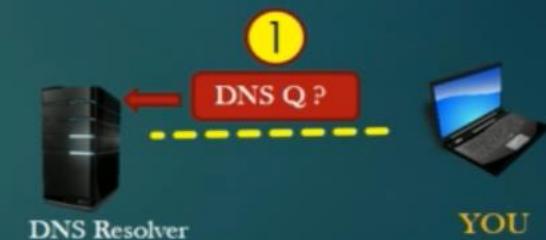
Recursive DNS Query

DNS Mechanism -> Recursive DNS Query



1. DNS Resolver looks up the IP address of the domain name **customer.support.microsoft.com** in its local DNS cache. If it does not find it, it sends a Recursive DNS Query to the Root DNS Server.

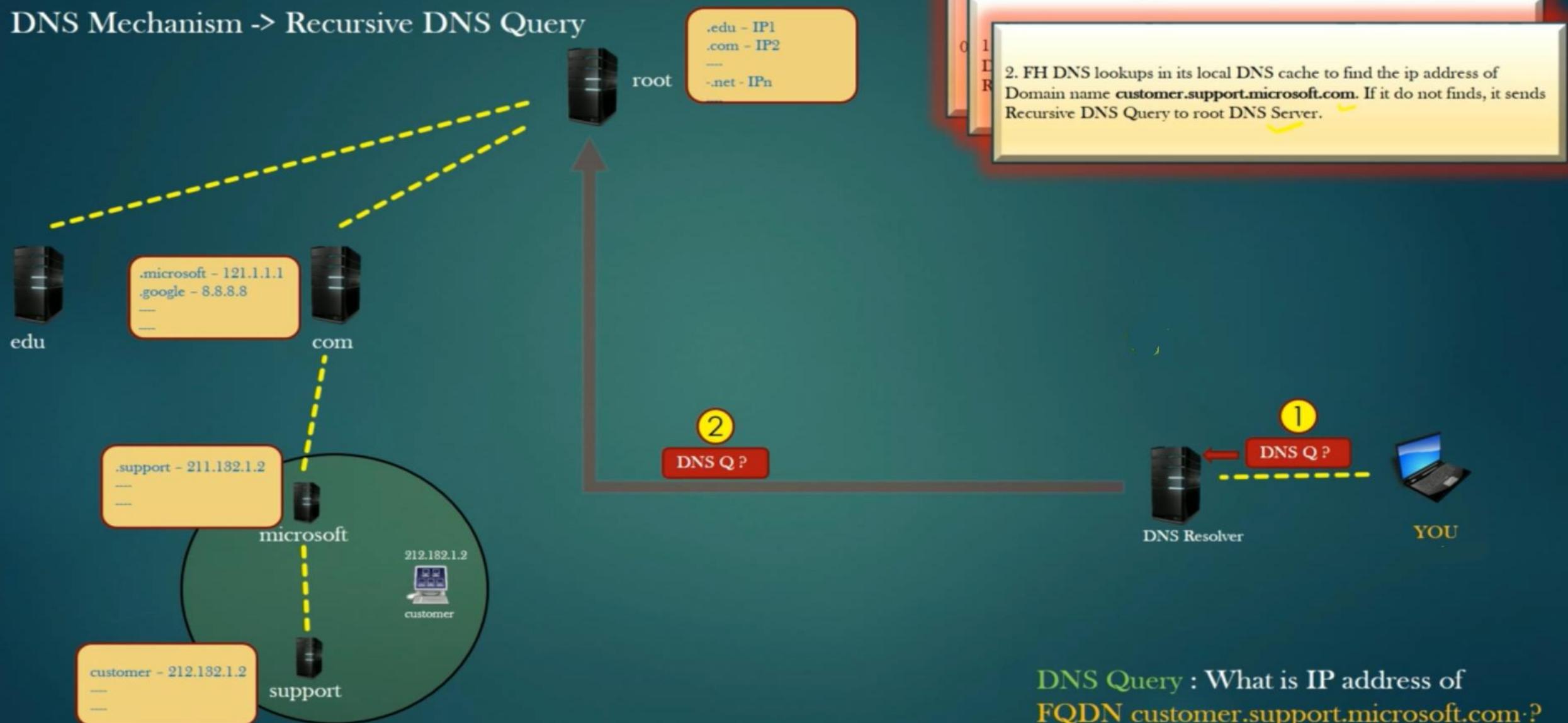
2. FH DNS looks up in its local DNS cache to find the IP address of Domain name **customer.support.microsoft.com**. If it does not find it, it sends Recursive DNS Query to Root DNS Server.



DNS Query : What is IP address of FQDN **customer.support.microsoft.com** ?

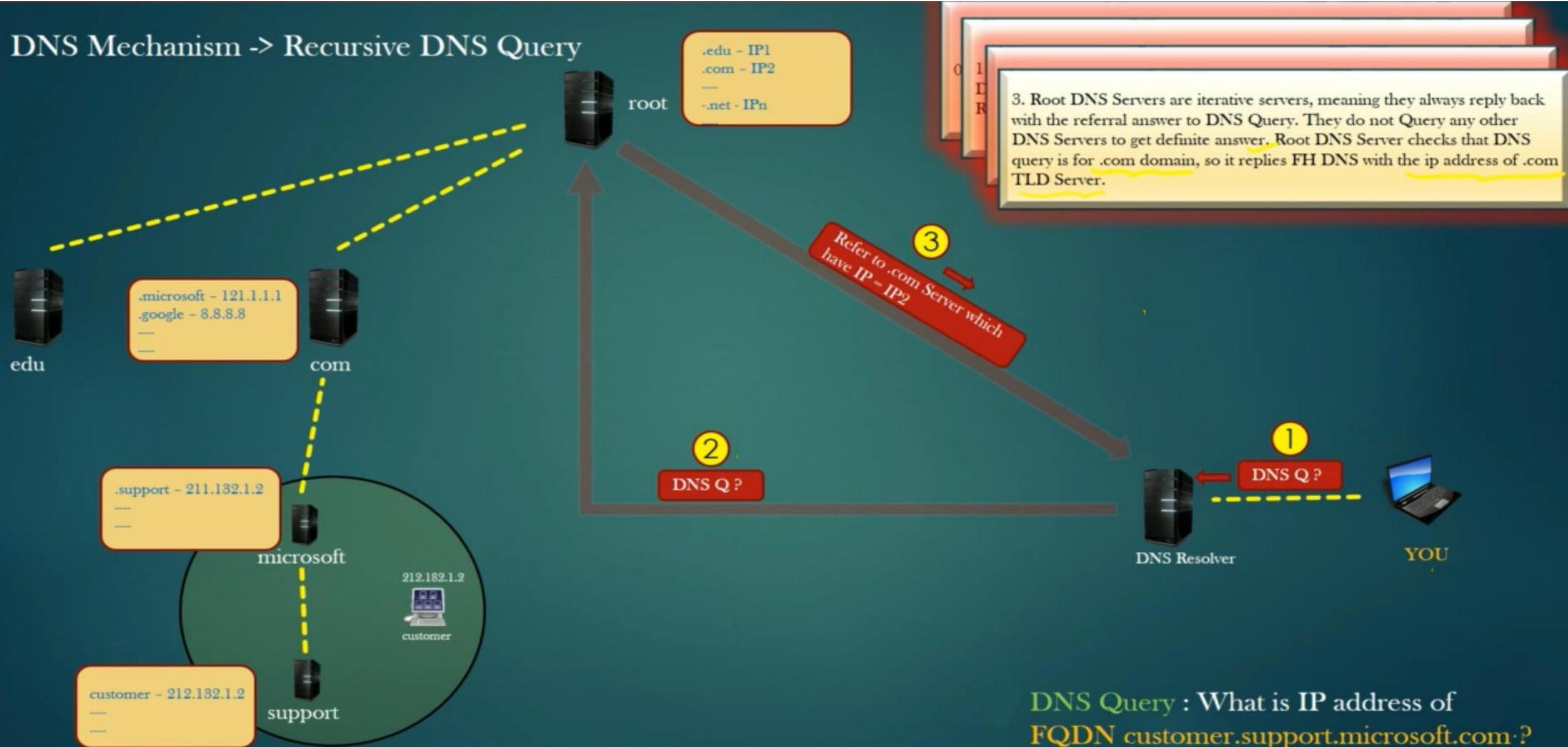
Recursive DNS Query

DNS Mechanism -> Recursive DNS Query



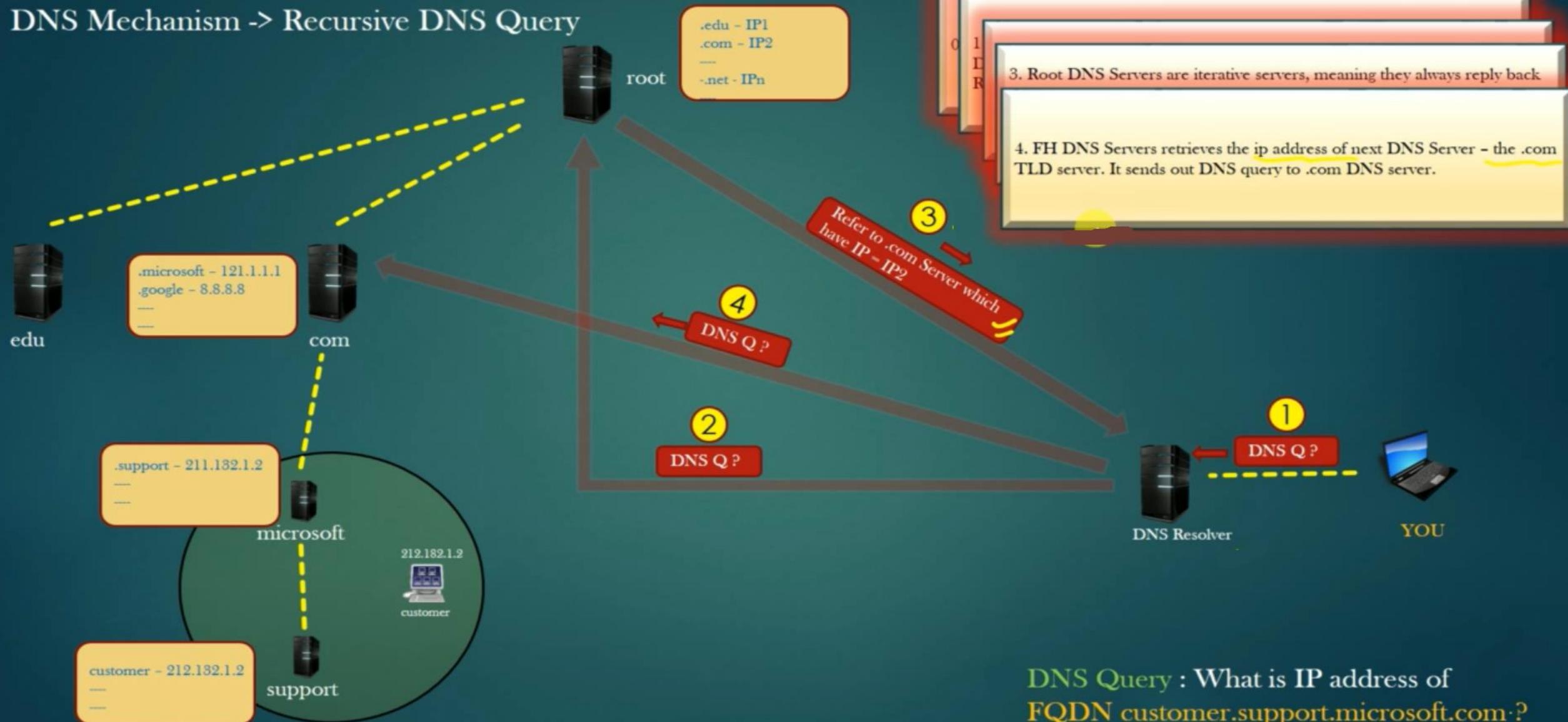
Recursive DNS Query

DNS Mechanism -> Recursive DNS Query



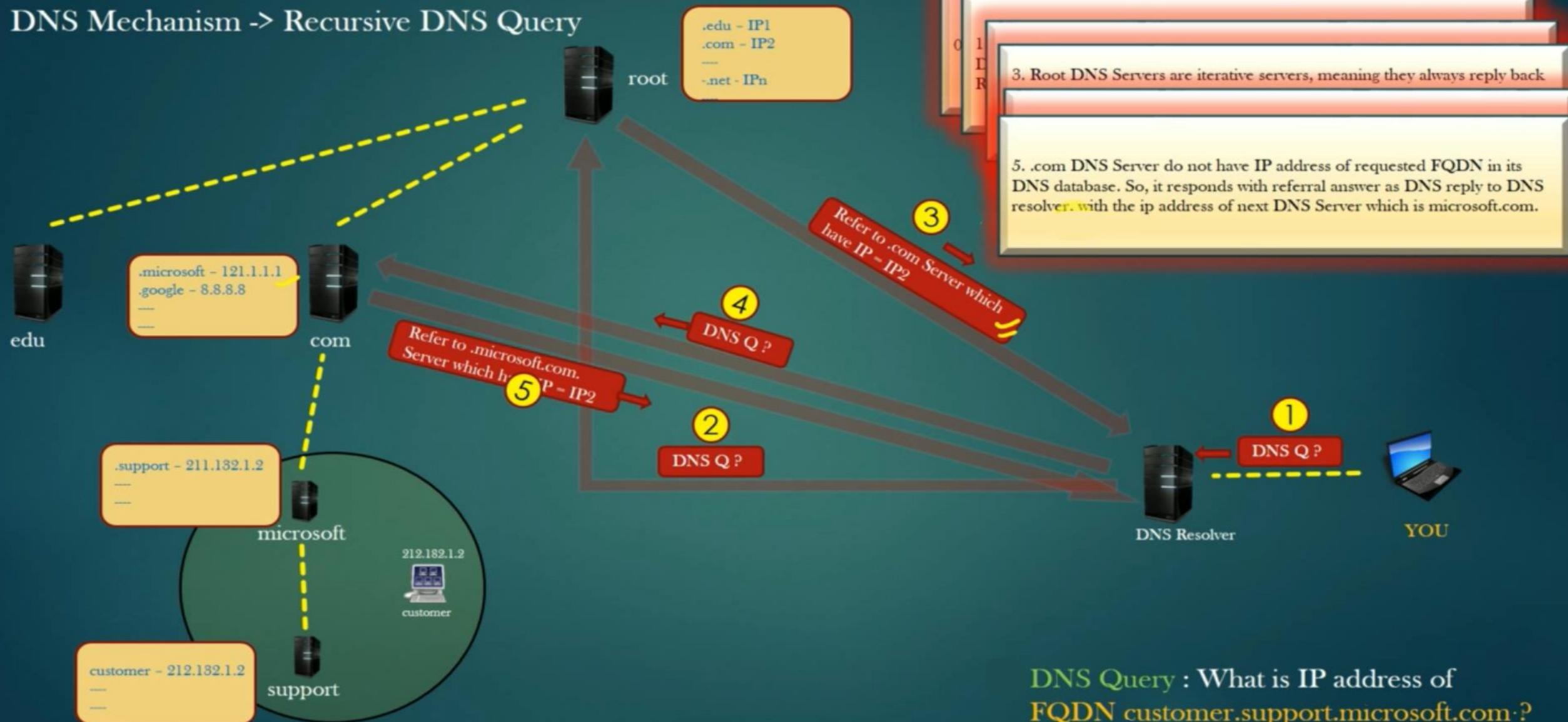
Recursive DNS Query

DNS Mechanism -> Recursive DNS Query



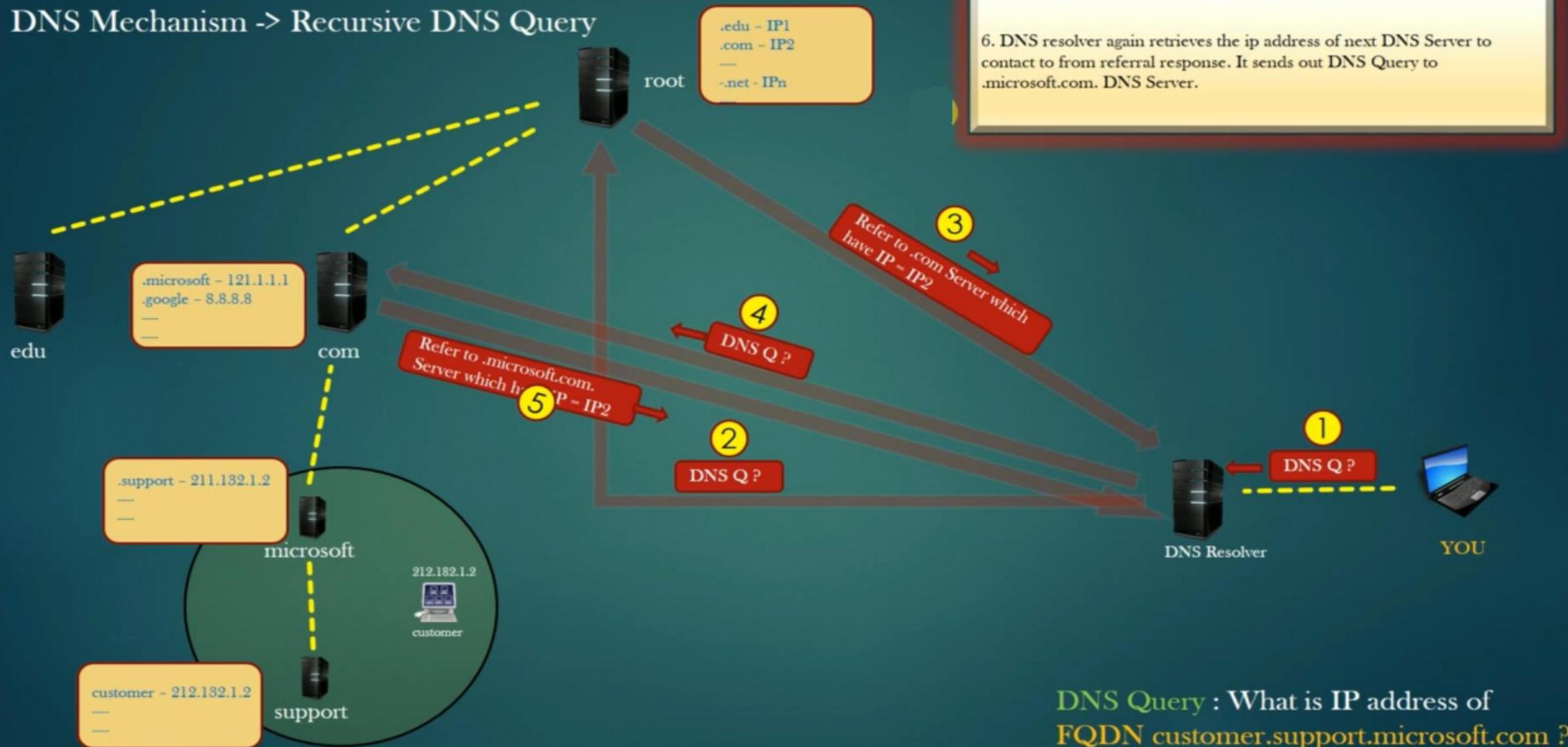
Recursive DNS Query

DNS Mechanism -> Recursive DNS Query



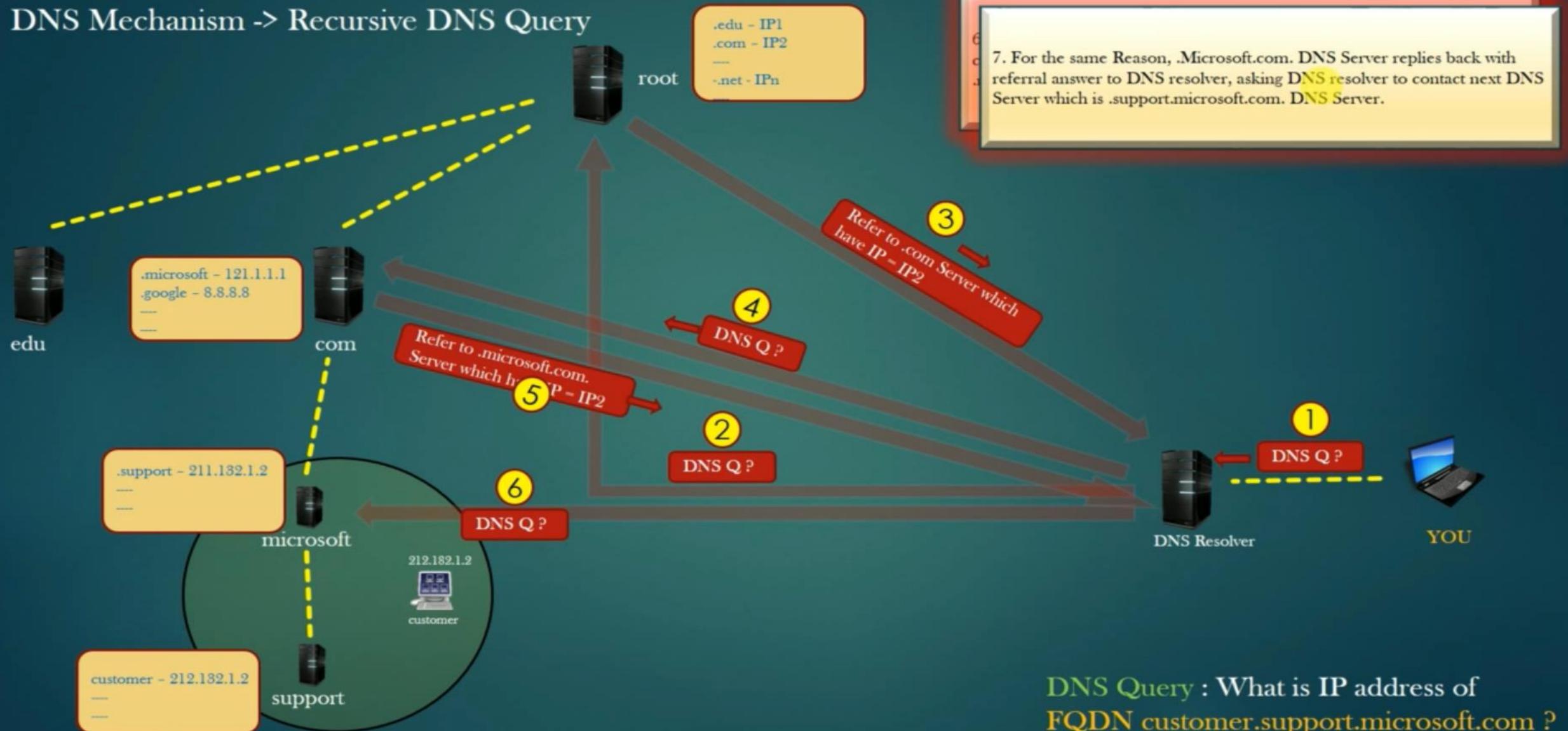
Recursive DNS Query

DNS Mechanism -> Recursive DNS Query



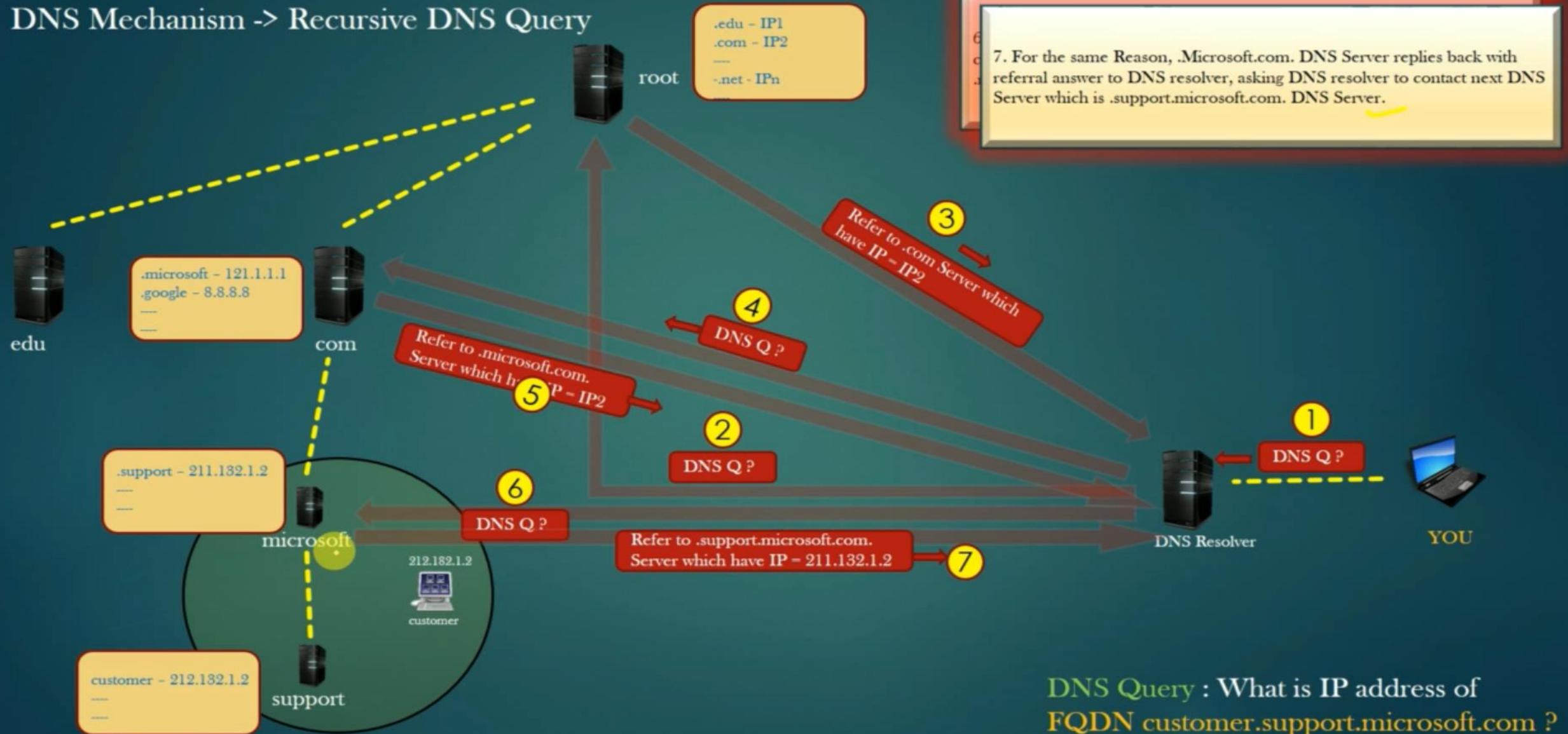
Recursive DNS Query

DNS Mechanism -> Recursive DNS Query



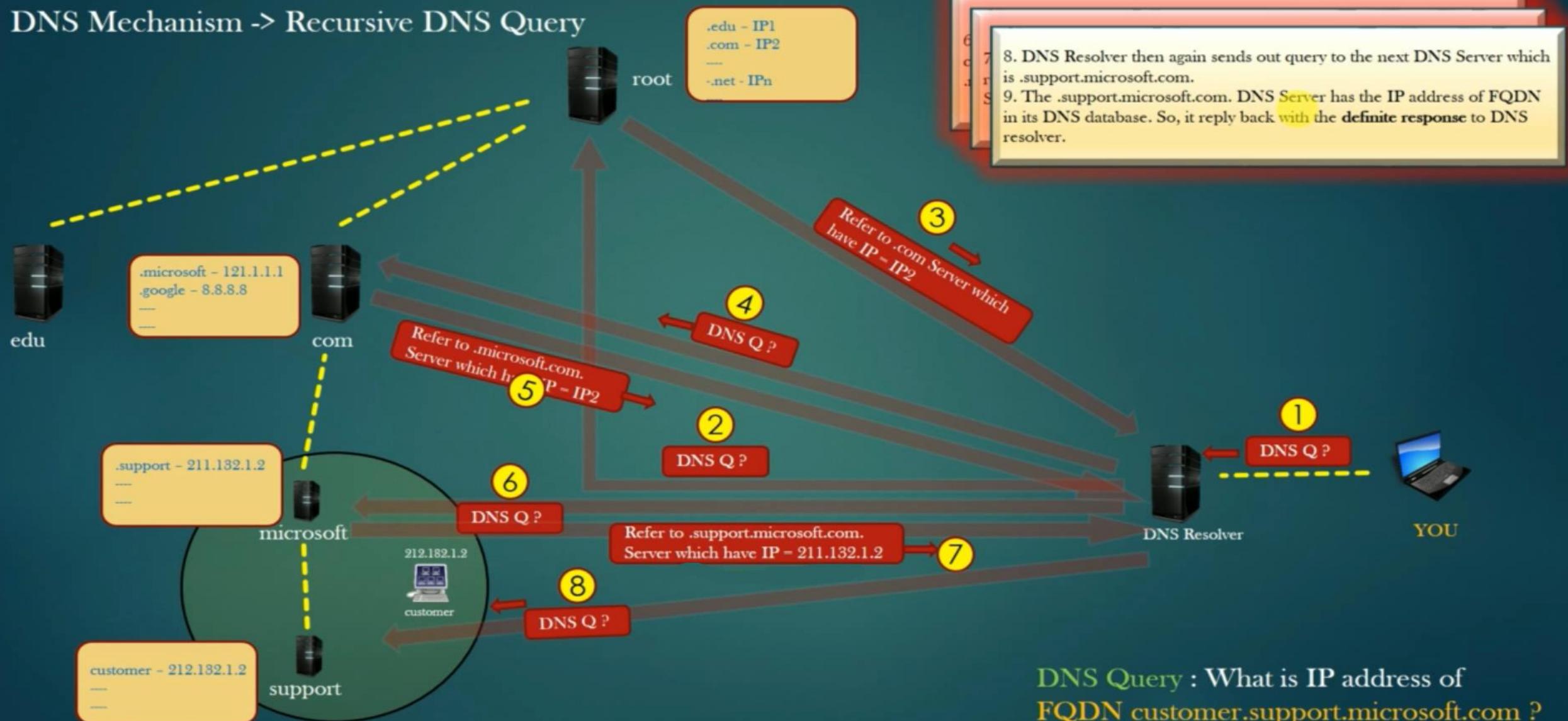
Recursive DNS Query

DNS Mechanism -> Recursive DNS Query



Recursive DNS Query

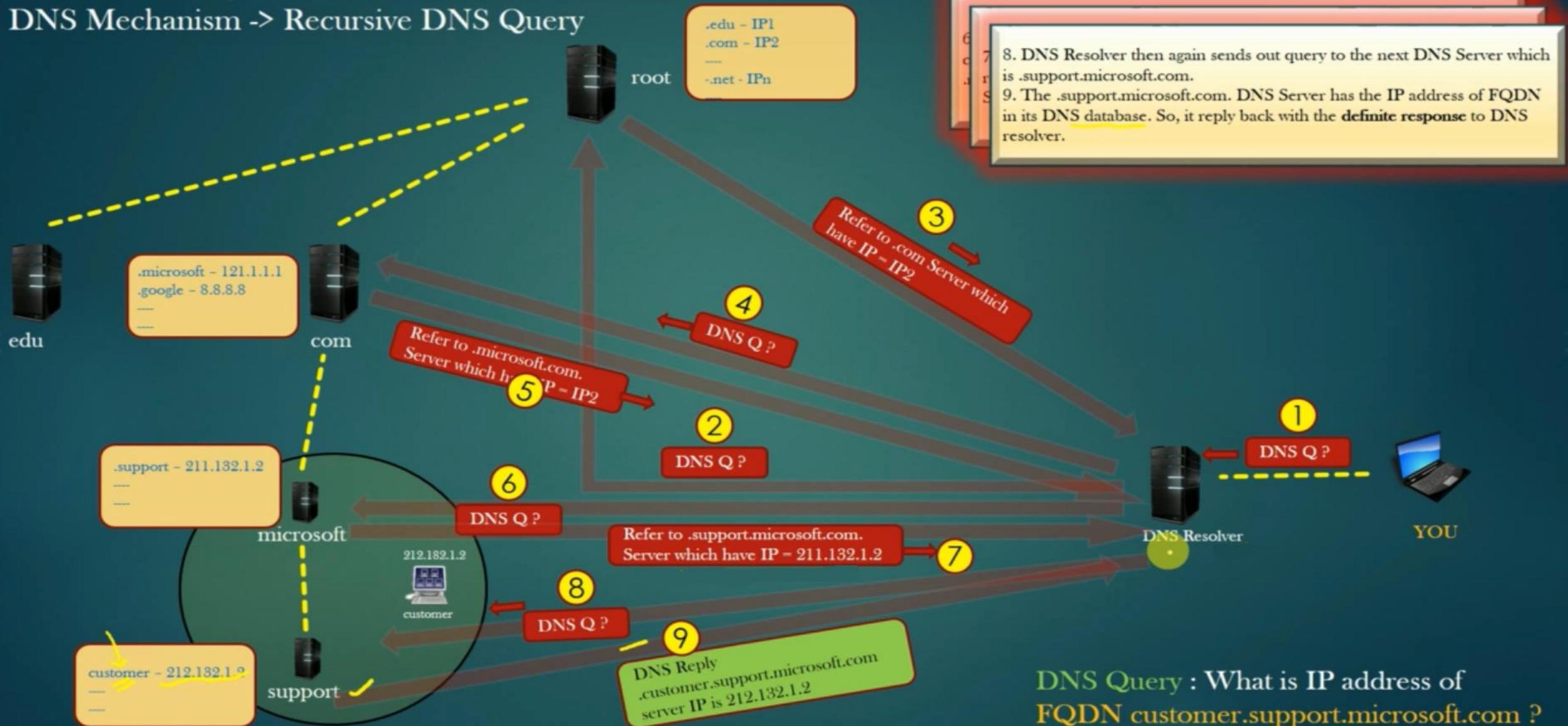
DNS Mechanism -> Recursive DNS Query



Recursive DNS Query

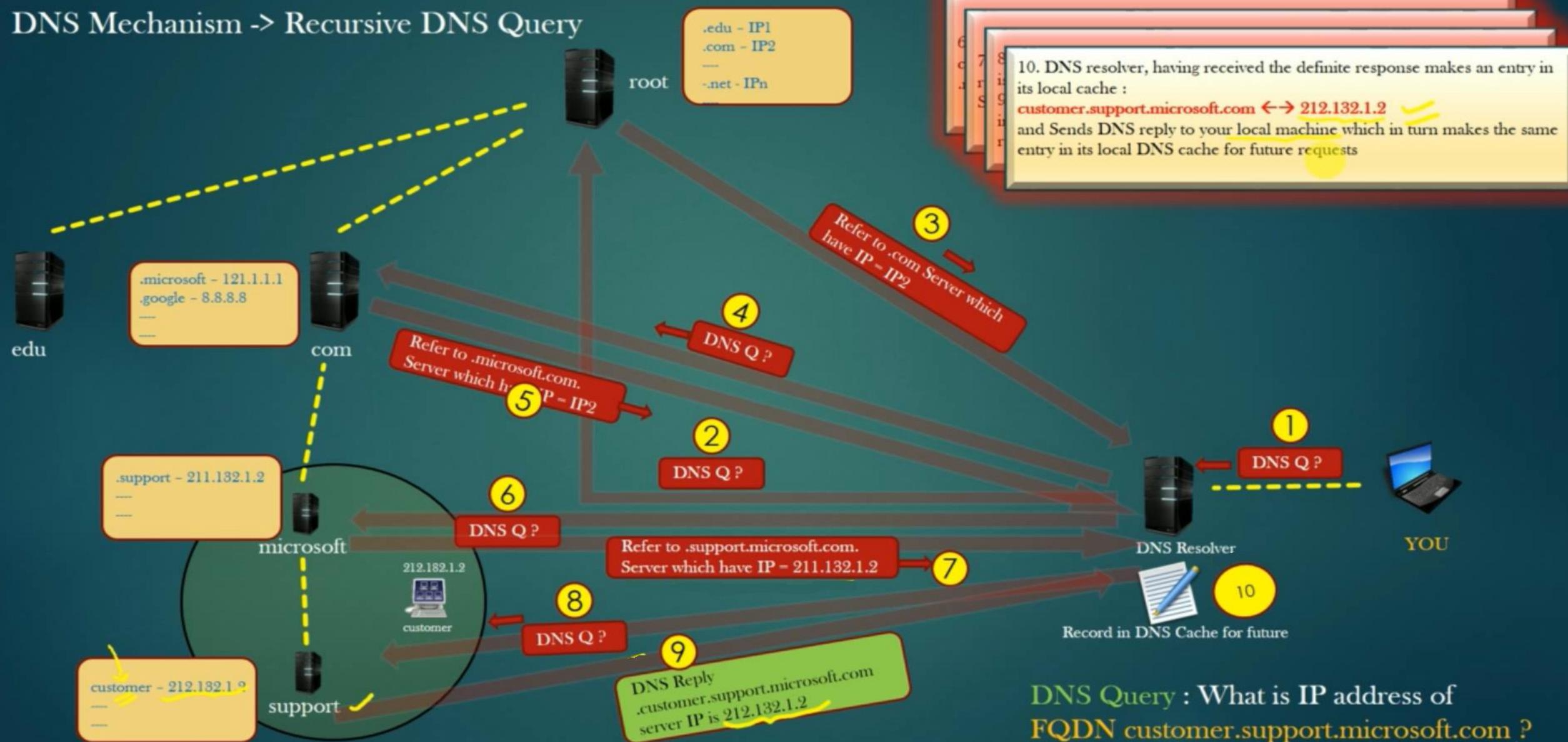
155. DNS Query – Recursive

DNS Mechanism -> Recursive DNS Query



Recursive DNS Query

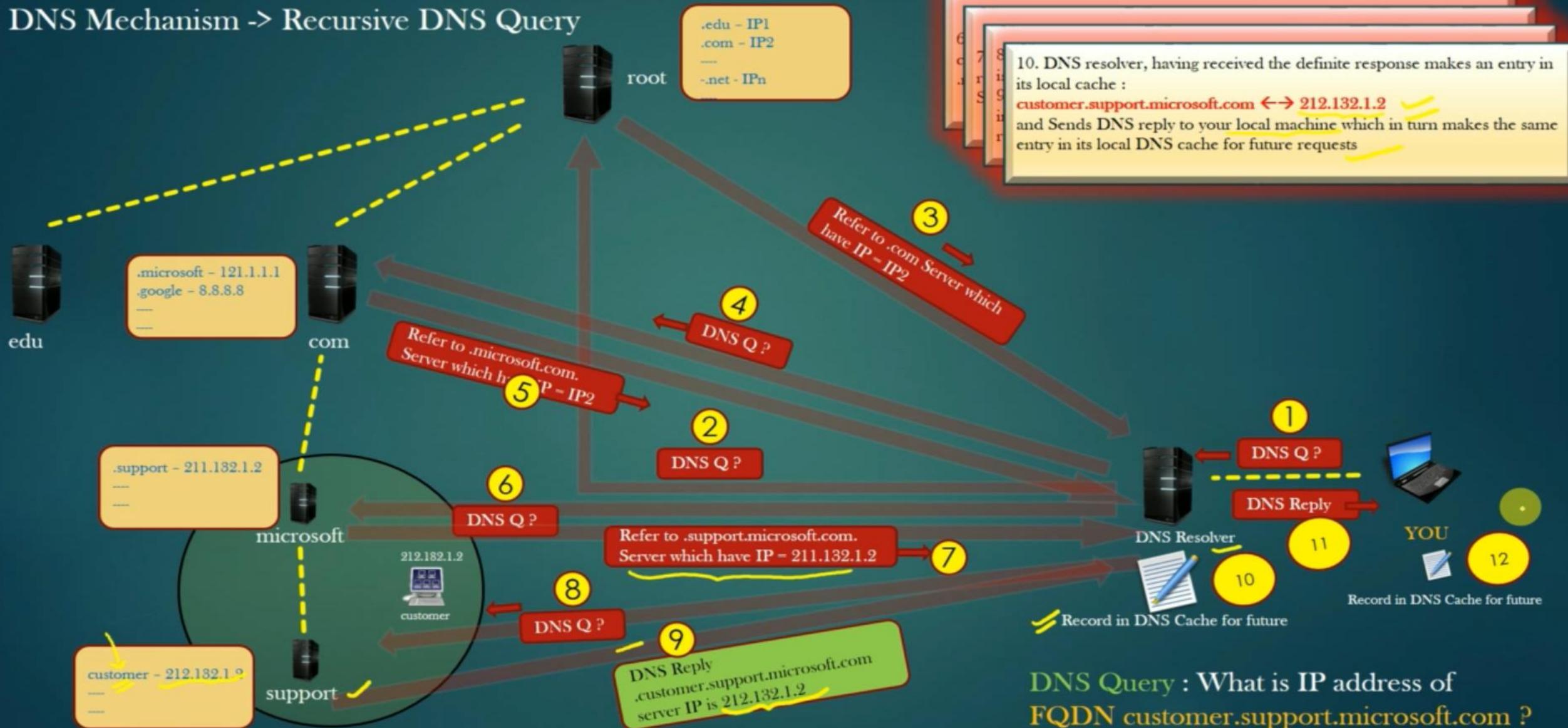
DNS Mechanism -> Recursive DNS Query



DNS Query : What is IP address of FQDN customer.support.microsoft.com ?

Recursive DNS Query

DNS Mechanism -> Recursive DNS Query



Recursive DNS Query

DNS Mechanism -> Recursive DNS Query

- It is the responsibility of DNS resolver DNS Server to yield a definite response to the requested DNS query
- DNS resolver keeps on sending the DNS query to subsequent DNS Servers in an attempt to obtain definite response to the DNS query
- DNS resolver replies to the host machines (**DNS client**) either with a definite response or an error msg
- Root and TLD DNS Servers replies with the referral answer to DNS resolver
- DNS Resolver makes an entry in its local DNS cache when it receives the definite DNS resolution for a DNS query to entertain future DNS query requests
- Your host machine also caches the DNS resolution to entertain future DNS query requests

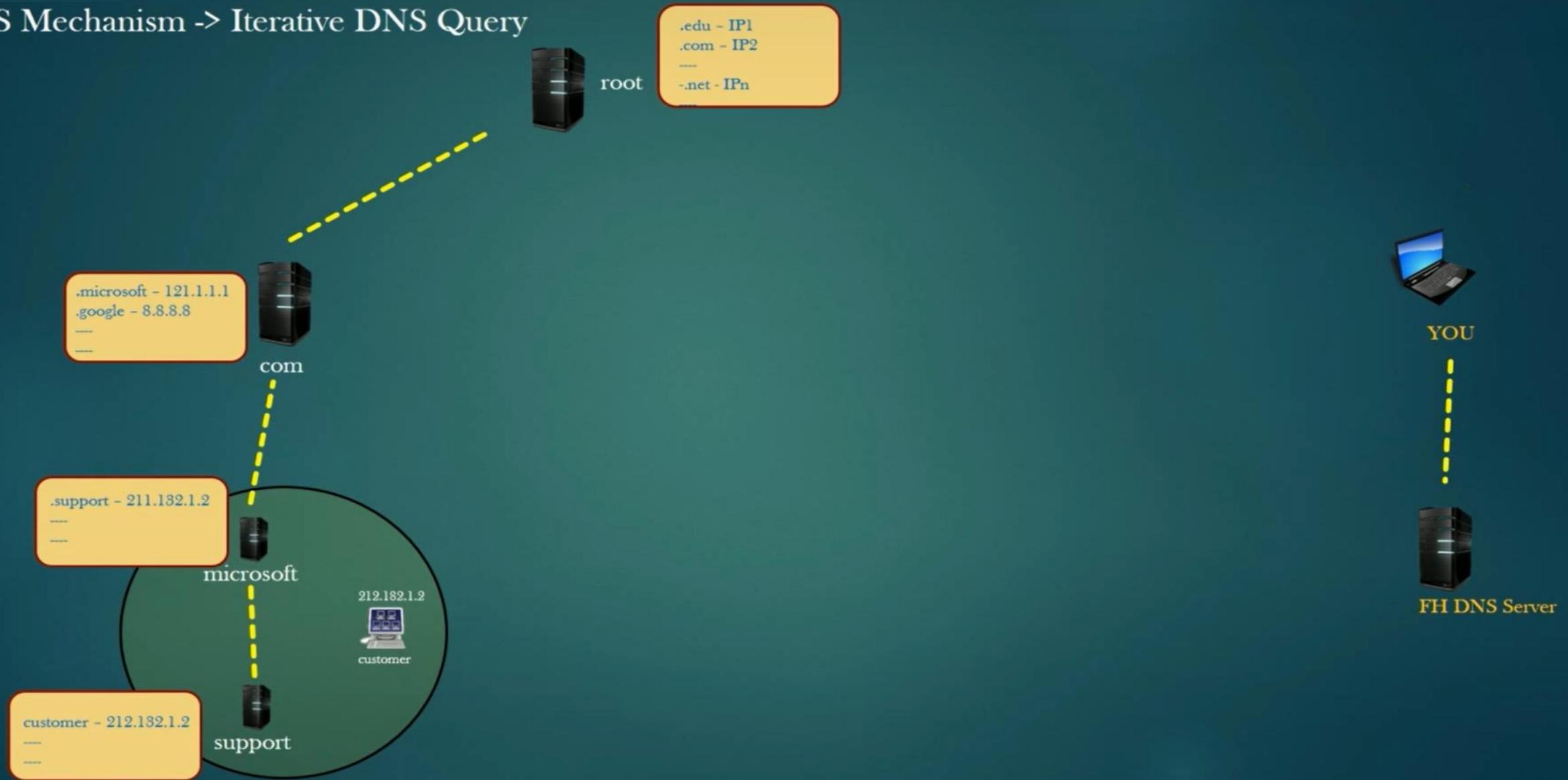
Iterative DNS Query

DNS Mechanism -> Iterative DNS Query

- In this DNS Mechanism, the host machine generates the Iterative DNS query
- DNS query packet format has a flag which states whether it is recursive DNS query Or Iterative DNS Query
- In this mode, DNS Resolver do not take responsibility to recursively ask the other DNS Servers in a hope for a definite response
- If DNS resolver itself do not know the DNS resolution for requested FQDN, it too, returns with the referral response to the DNS client host machine
- The DNS client machine, having received the referral response either from DNS resolver or other DNS Server, sends DNS query to next DNS Server specified in the last referral response
- DNS client machine, it self, takes up the role which DNS resolver was doing in case of recursive DNS query

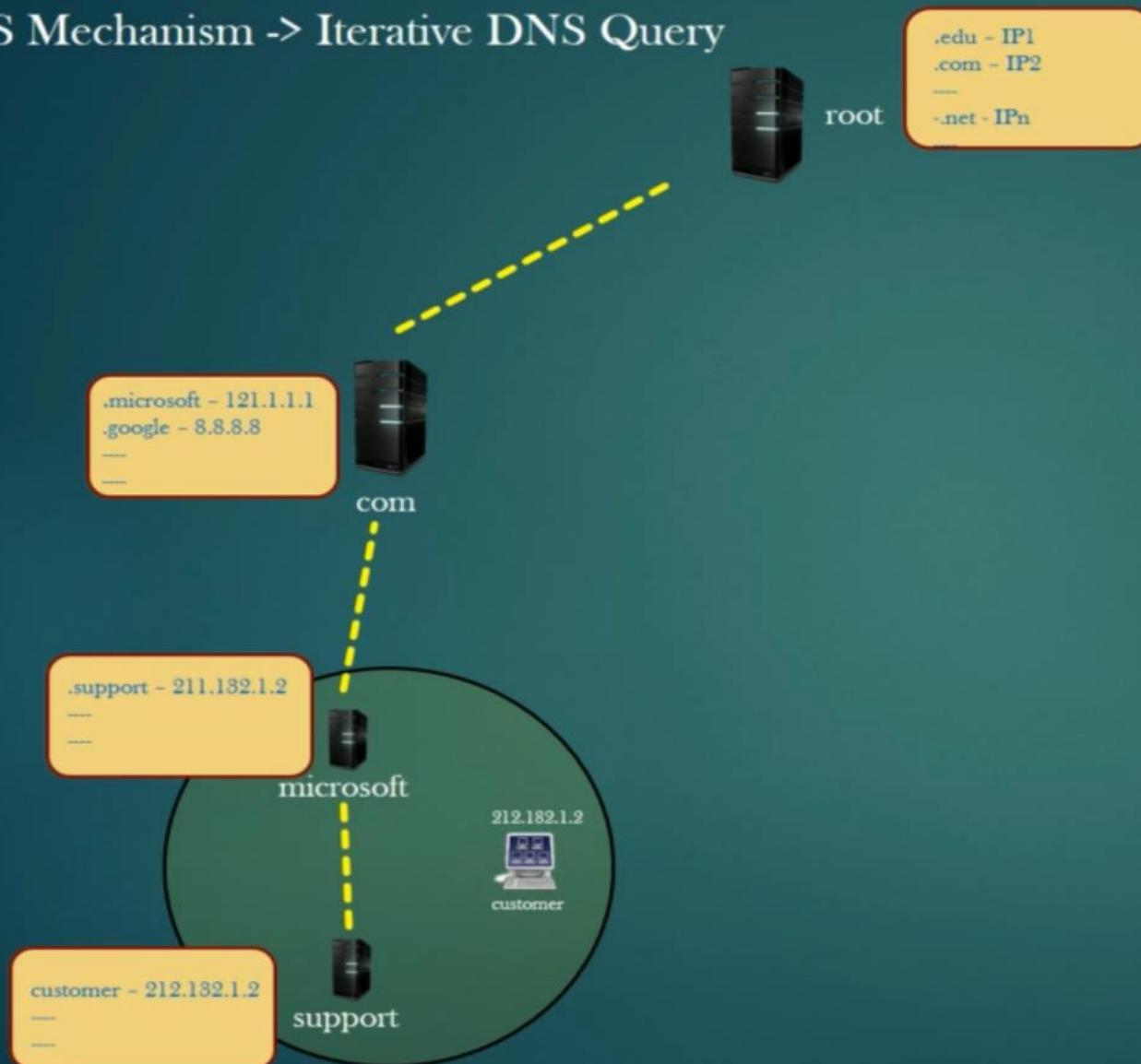
Iterative DNS Query

DNS Mechanism -> Iterative DNS Query



Iterative DNS Query

DNS Mechanism -> Iterative DNS Query



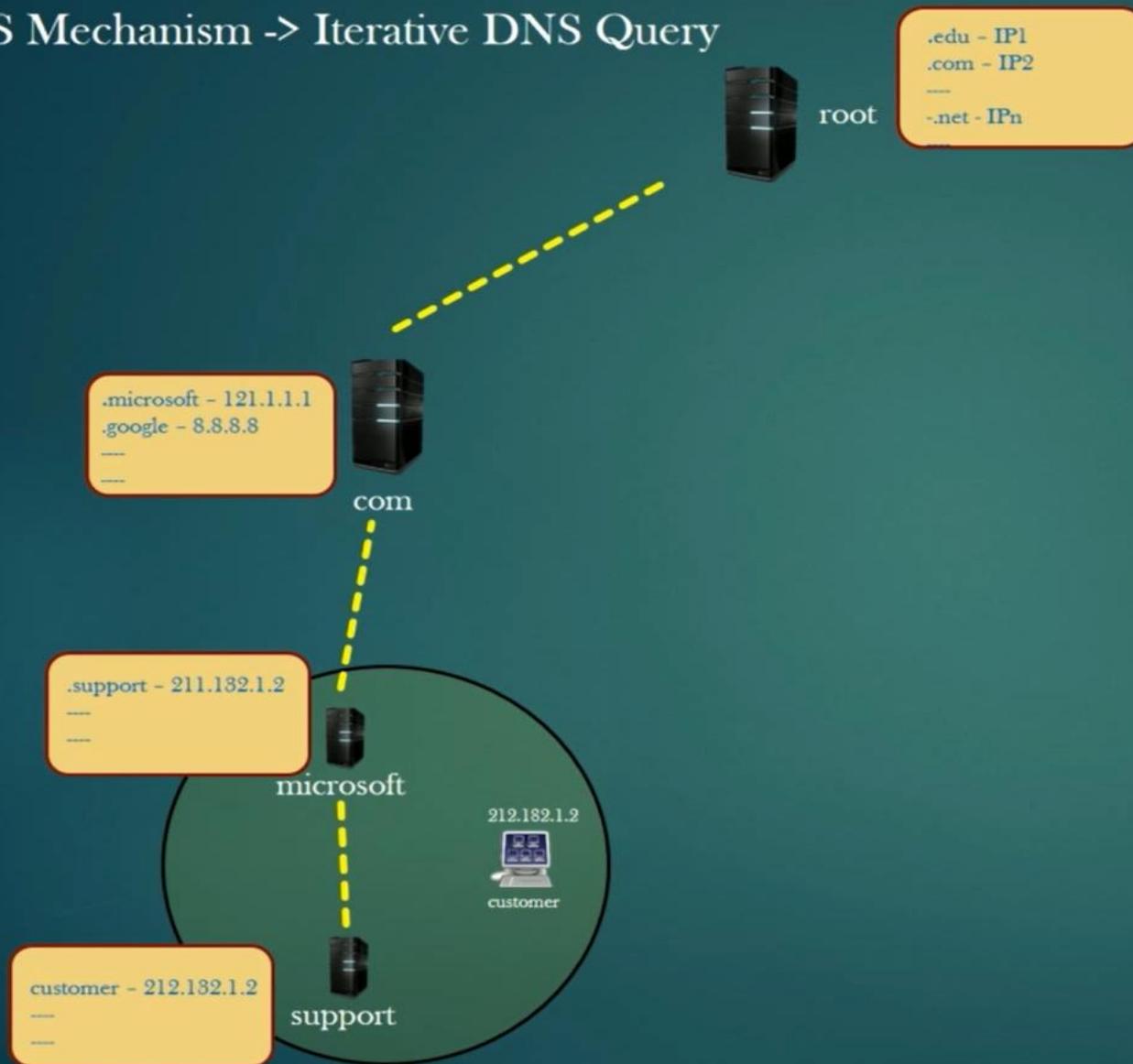
1. DNS Client generates DNS Query and send it to DNS resolver. If DNS resolver do not know the ip address of requested FQDN, it replies with referral answer to DNS client , suggesting to send the DNS query to root DNS Server



DNS Query : What is IP address of FQDN customer.support.microsoft.com. ?

Iterative DNS Query

DNS Mechanism -> Iterative DNS Query



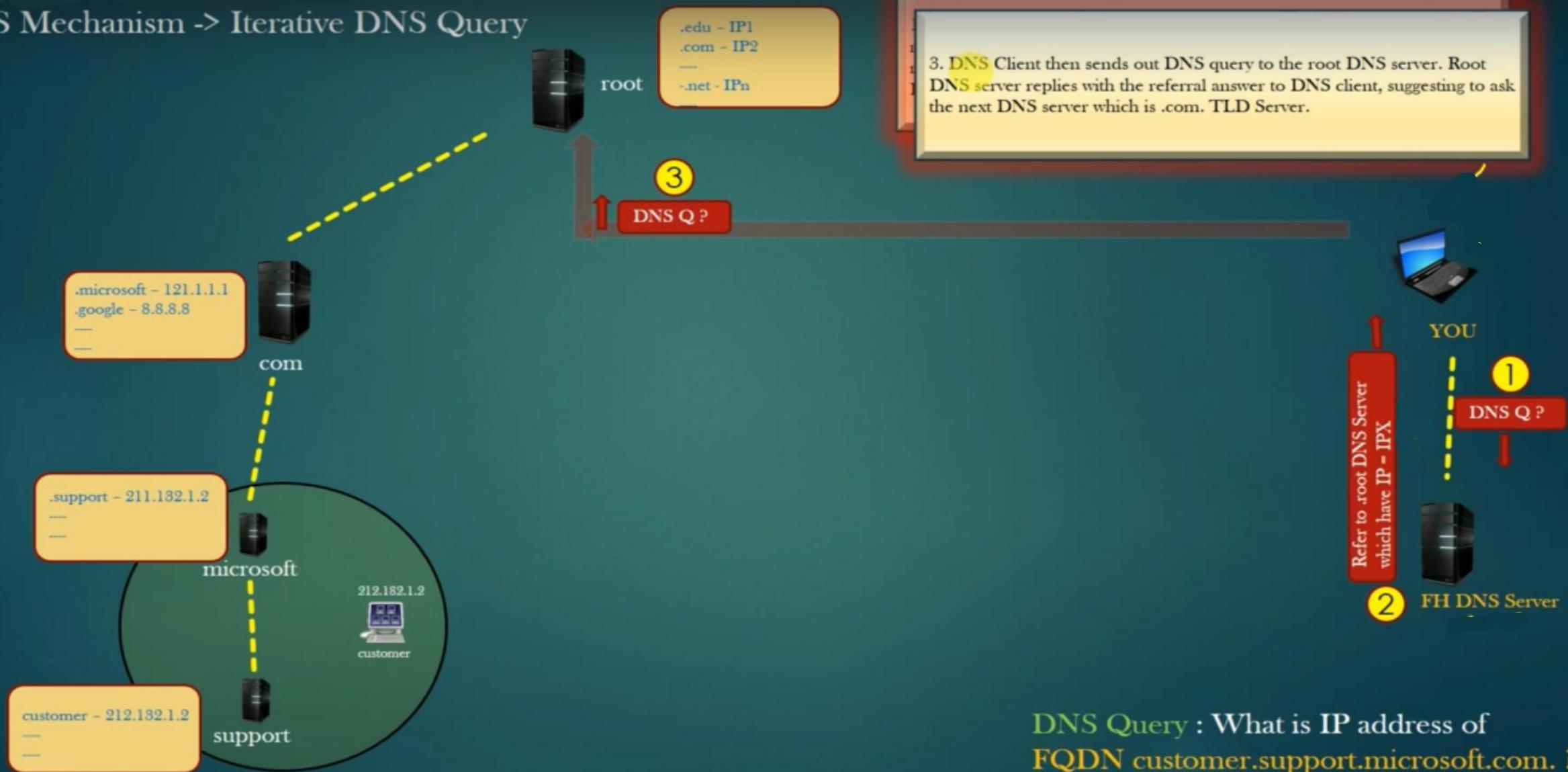
1. DNS Client generates DNS Query and send it to DNS resolver. If DNS resolver do not know the ip address of requested FQDN, it replies with referral answer to DNS client , suggesting to send the DNS query to root DNS Server



DNS Query : What is IP address of FQDN customer.support.microsoft.com. ?

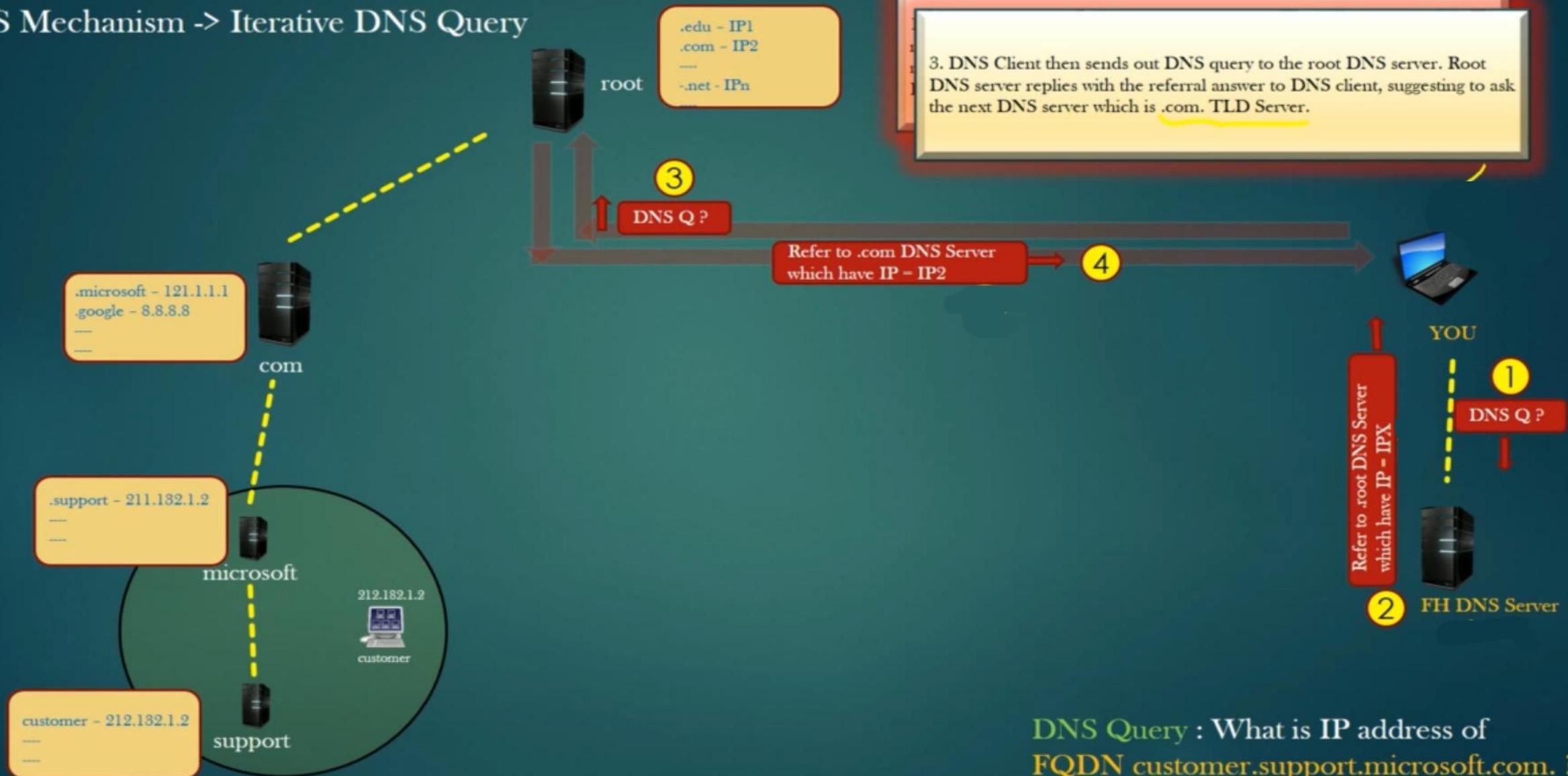
Iterative DNS Query

DNS Mechanism -> Iterative DNS Query



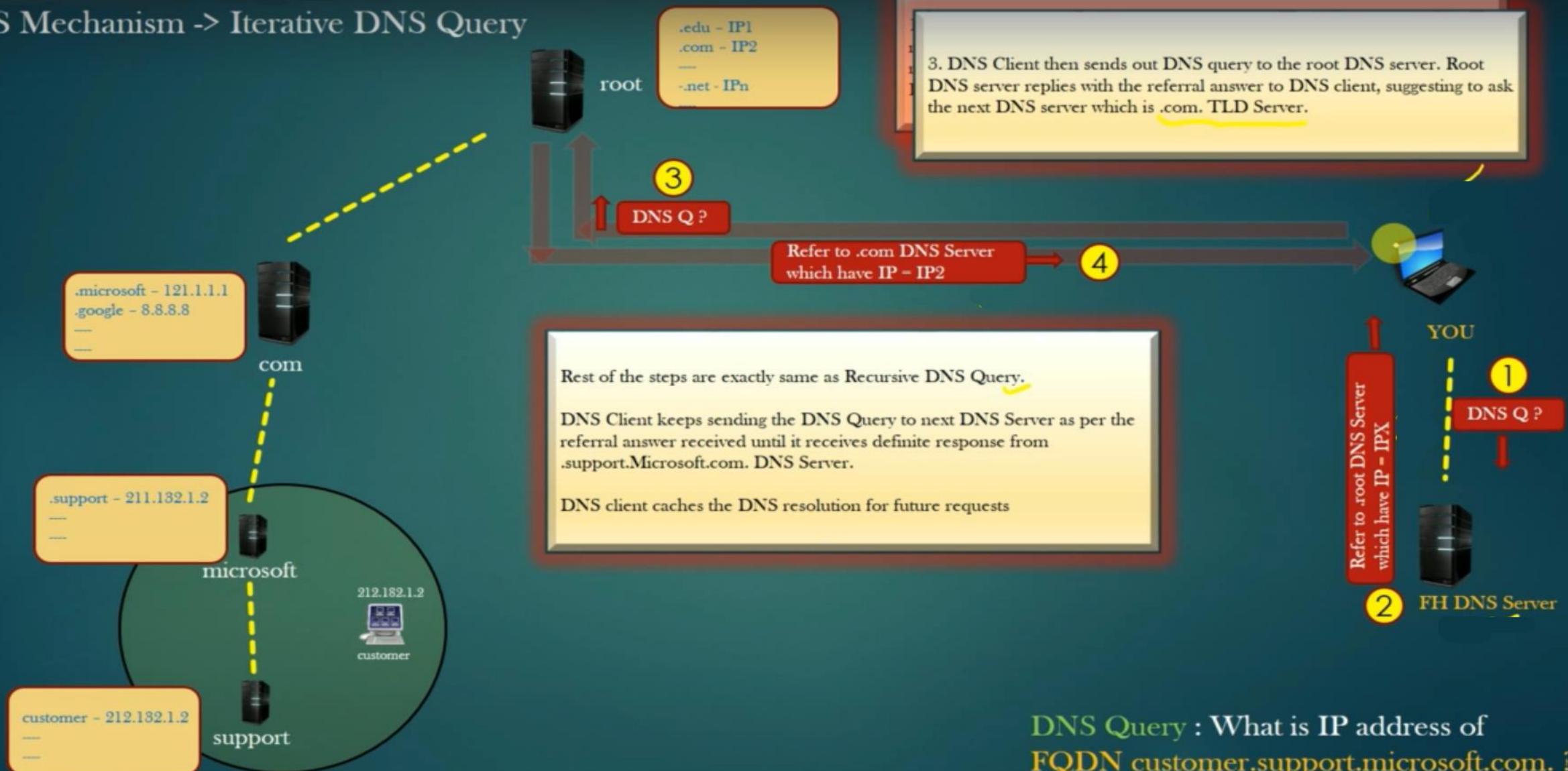
Iterative DNS Query

DNS Mechanism -> Iterative DNS Query



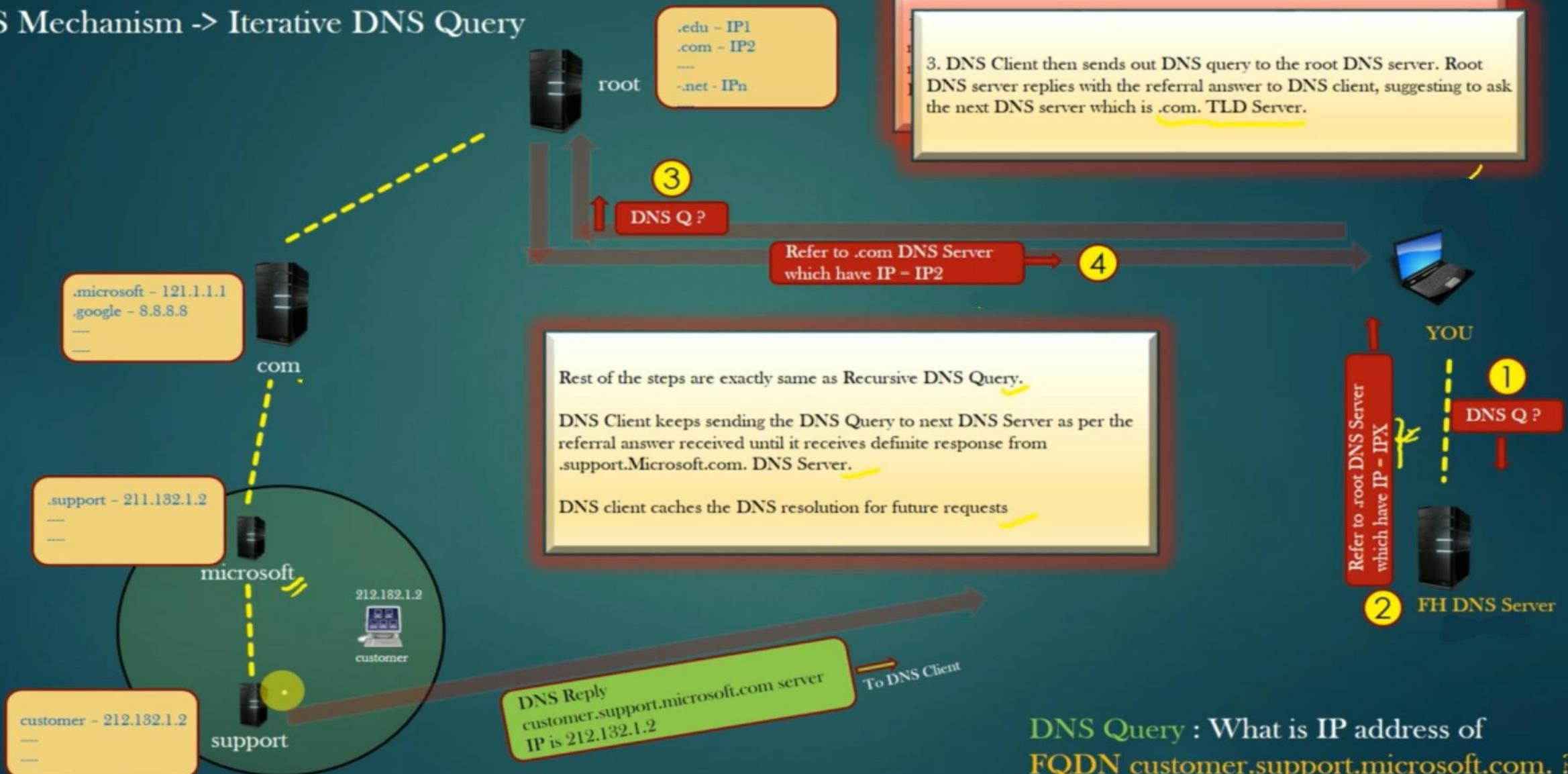
Iterative DNS Query

DNS Mechanism -> Iterative DNS Query



Iterative DNS Query

DNS Mechanism -> Iterative DNS Query



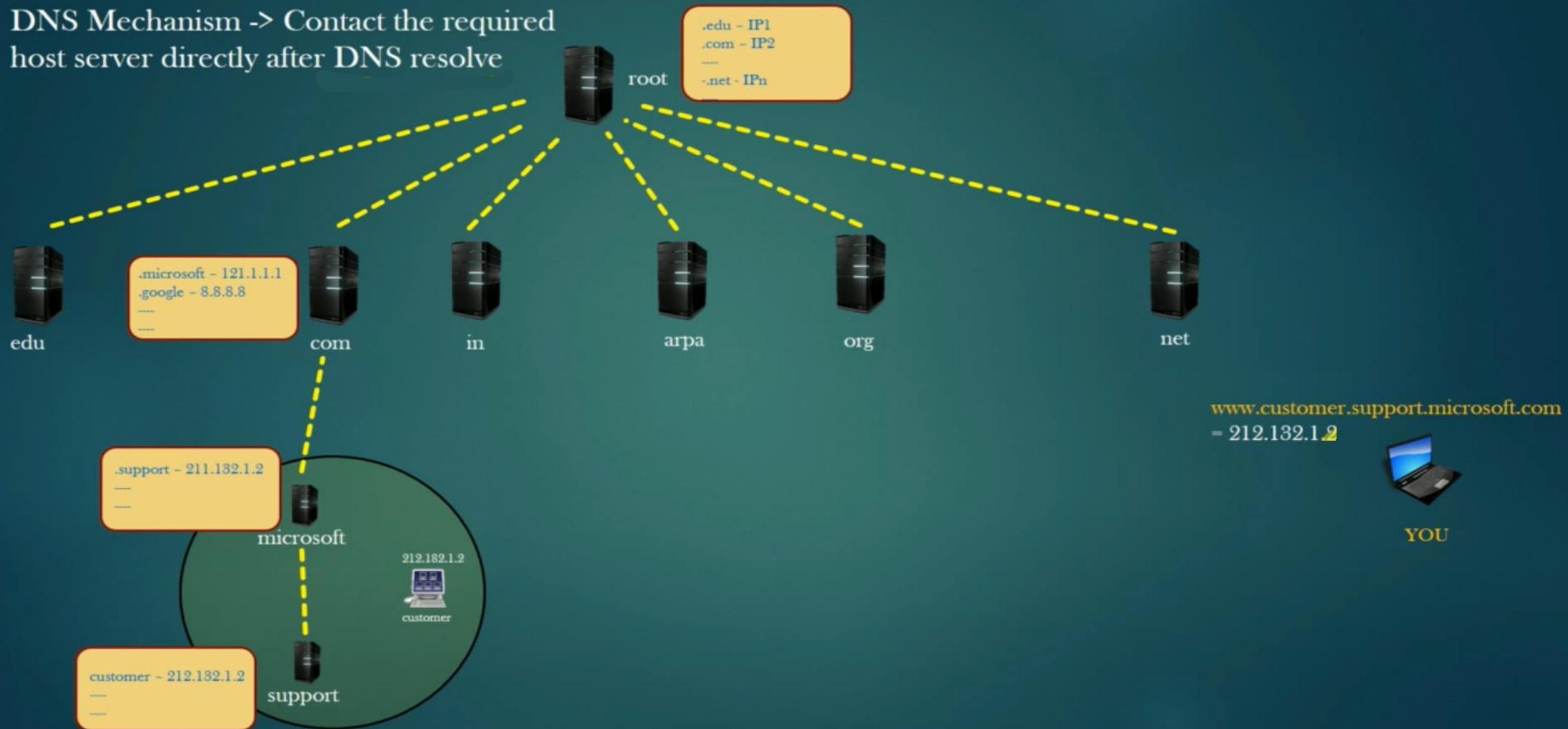
Iterative DNS Query

DNS Mechanism -> Iterative DNS Query Vs Recursive DNS Query

Recursive DNS Query	Iterative DNS Query
DNS Resolver takes the responsibility to get the final DNS resolution	DNS client has to work itself to get the DNS resolution
DNS resolver keep sending DNS Query to subsequent DNS server based on referral answer	DNS client keep sending DNS Query to subsequent DNS server based on referral answer
DNS client receives a definite answer : Either the DNS resolution Or error msg	DNS client receives a referral answer or error msg
Burden is on DNS resolver	Burden is on DNS client

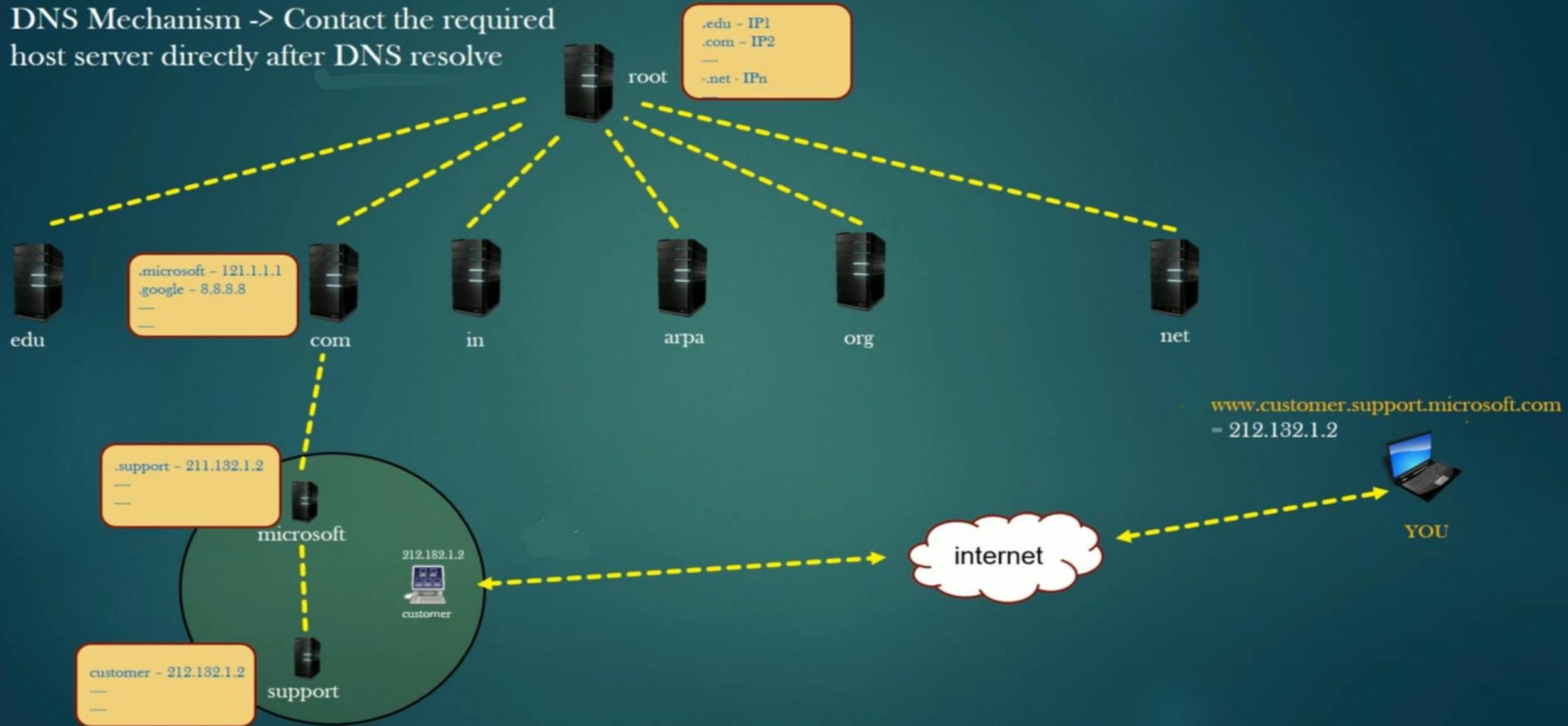
Iterative DNS Query

DNS Mechanism -> Contact the required host server directly after DNS resolve



Iterative DNS Query

DNS Mechanism -> Contact the required host server directly after DNS resolve



Reverse DNS Query

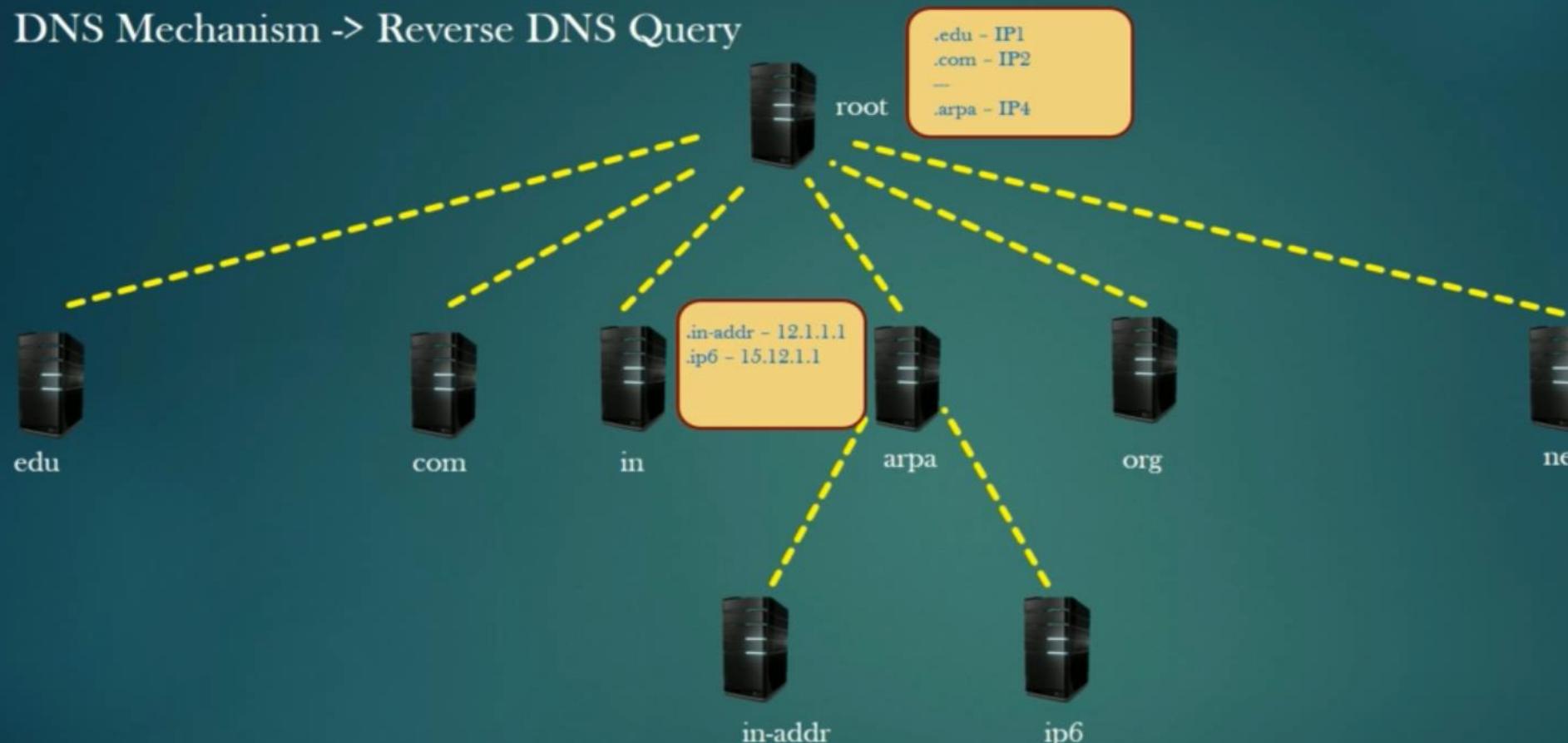
Reverse DNS Mechanism

IP Address → FQDN

212.132.1.2 → customer.support.microsoft.com

Reverse DNS Query

DNS Mechanism -> Reverse DNS Query



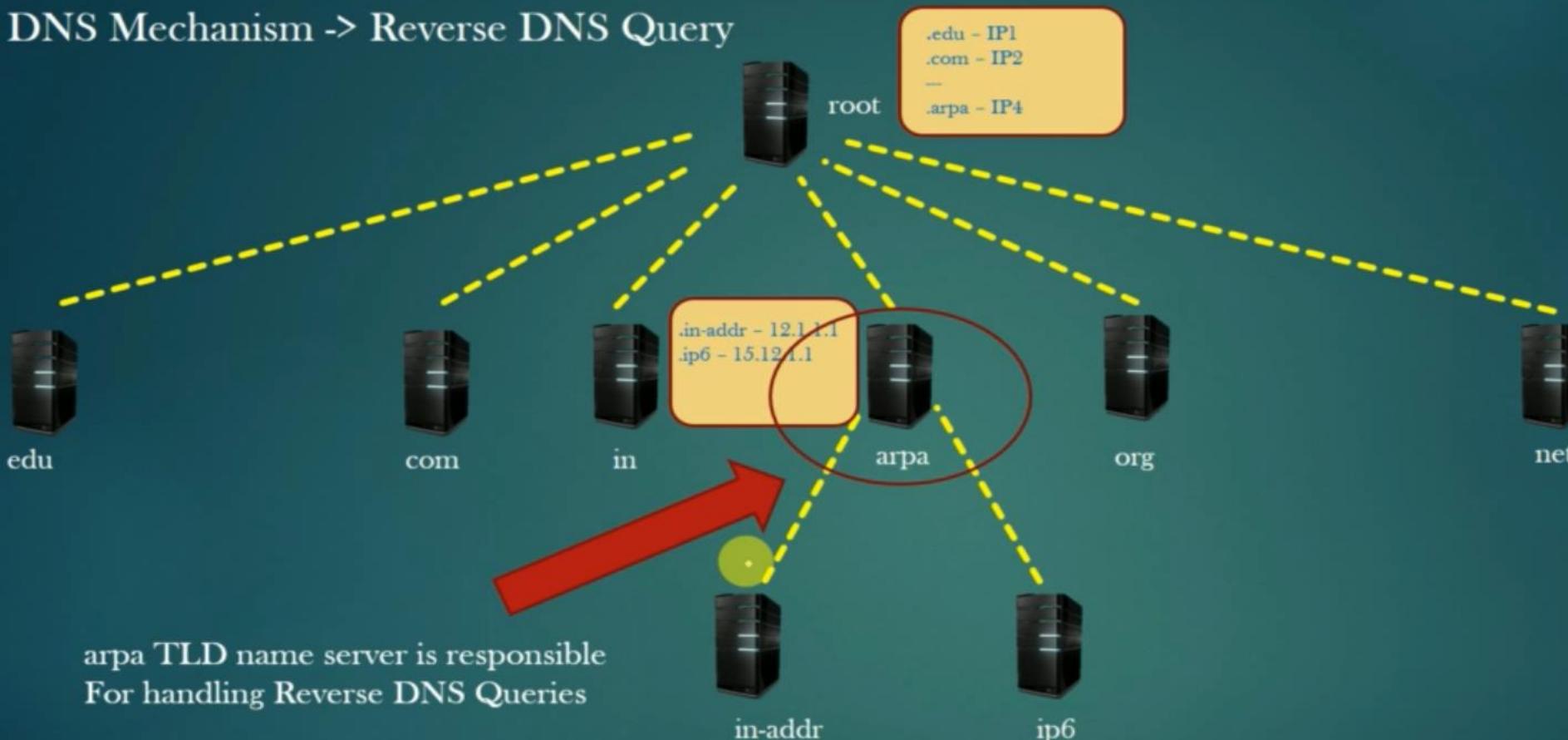
GOAL :

Given : 212.132.1.2

To Determine : customer.support.microsoft.com

Reverse DNS Query

DNS Mechanism -> Reverse DNS Query



GOAL :

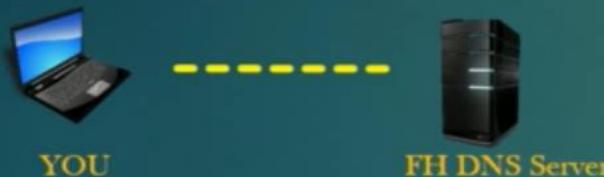
Given : 212.132.1.2

To Determine : customer.support.microsoft.com

Reverse DNS Query

DNS Mechanism -> Reverse DNS Query

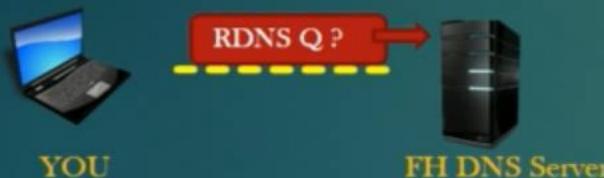
- The procedure is exactly same as Iterative/Recursive Query processing by DNS System



Reverse DNS Query

DNS Mechanism -> Reverse DNS Query

- The procedure is exactly same as Iterative/Recursive Query processing by DNS System
- When you issue a RDNS Query for IP 212.132.1.2, Your system do the following before issuing a RDNS Query :
 - Reverse the IP address : 2.1.132.212
 - append labels : in-addr.arpa.



Final RDNS Query formed :
What is domain name of
1.2.132.212.in-addr.arpa. ?

RDNS Query -> What is Domain name for IP 212.132.1.2 ?
Expected Answer to be returned by DNS System : customer.support.microsoft.com

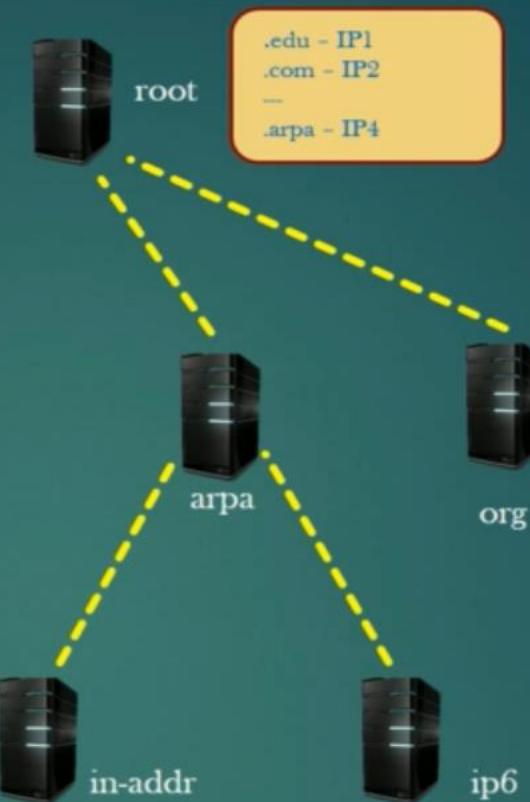
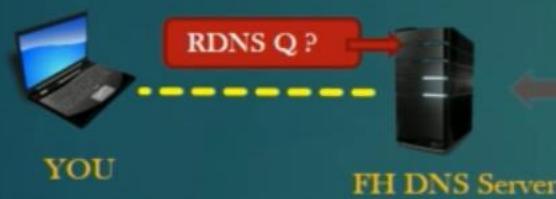
Reverse DNS Query

DNS Mechanism -> Reverse DNS Query

GOAL :

Given : 212.132.1.2

To Determine : customer.support.microsoft.com



RDNS Query : What is domain name of
1.2.132.212.in-addr.arpa. ?

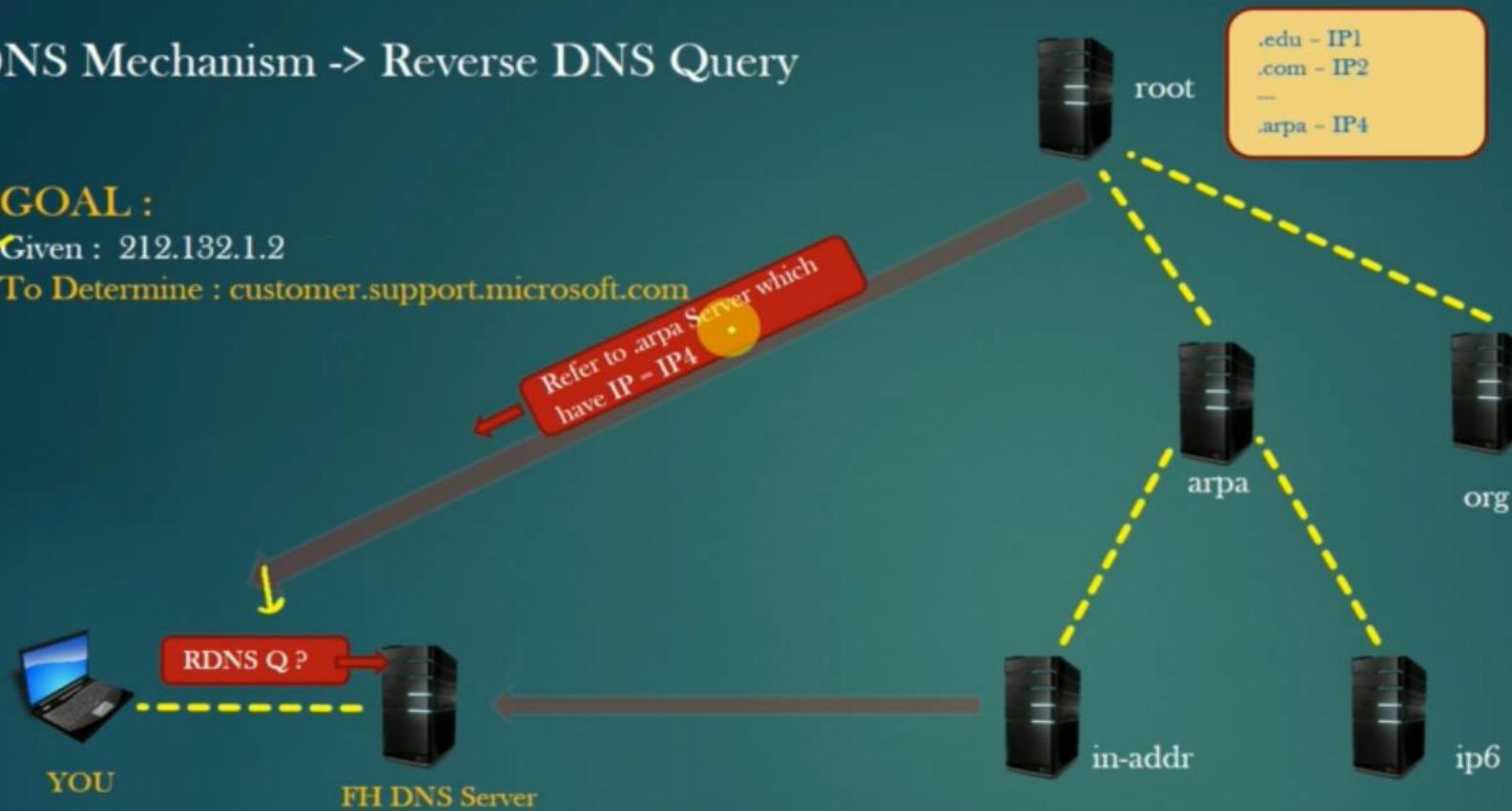
Reverse DNS Query

DNS Mechanism -> Reverse DNS Query

GOAL :

Given : 212.132.1.2

To Determine : customer.support.microsoft.com



RDNS Query : What is domain name of
1.2.132.212.in-addr.arpa. ?

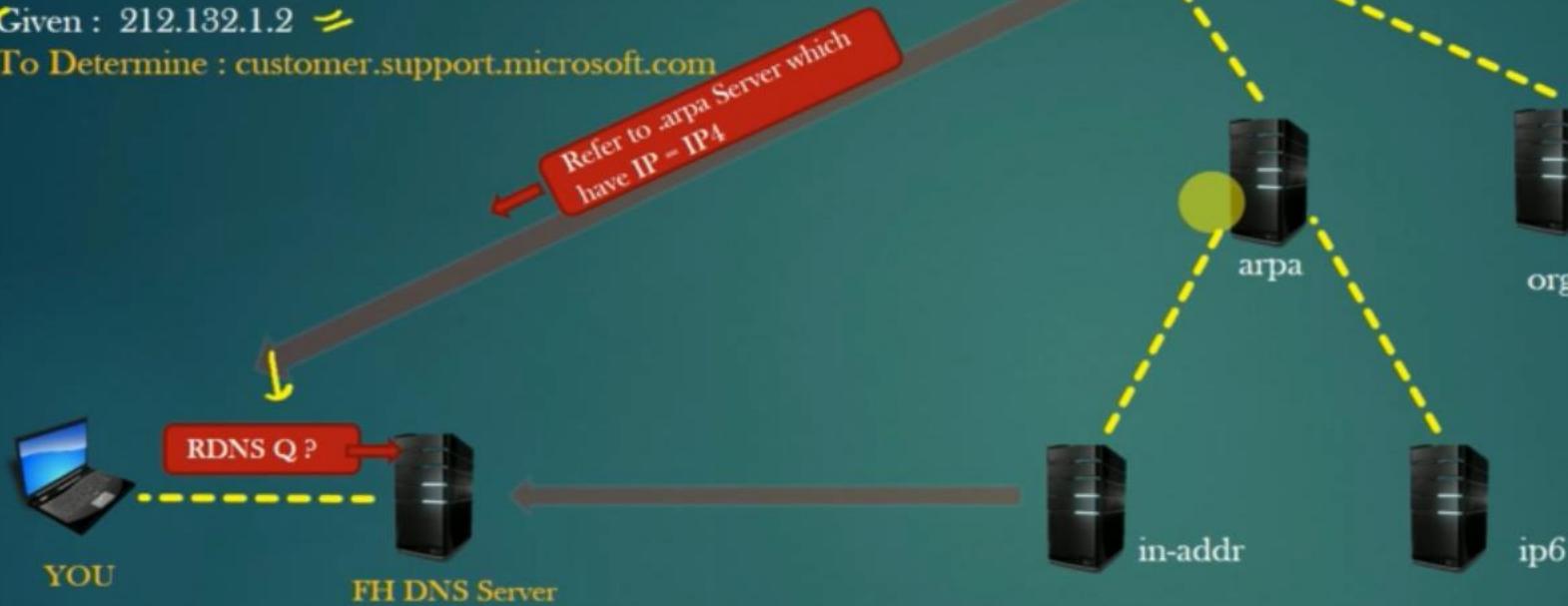
Reverse DNS Query

DNS Mechanism -> Reverse DNS Query

GOAL :

Given : 212.132.1.2

To Determine : customer.support.microsoft.com



RDNS Query : What is domain name of
1.2.132.212.in-addr.arpa. ?

Reverse DNS Query

DNS Mechanism -> Reverse DNS Query

GOAL :

Given : 212.132.1.2

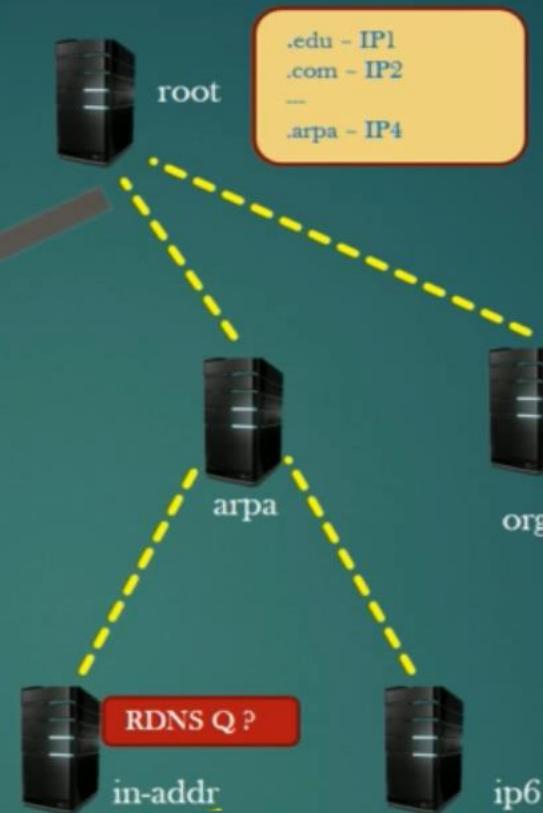
To Determine : customer.support.microsoft.com

Refer to .arpa Server which have IP = IP4



RDNS Q ?

FH DNS Server



RDNS Query : What is domain name of

1.2.132.212.in-addr.arpa. ?

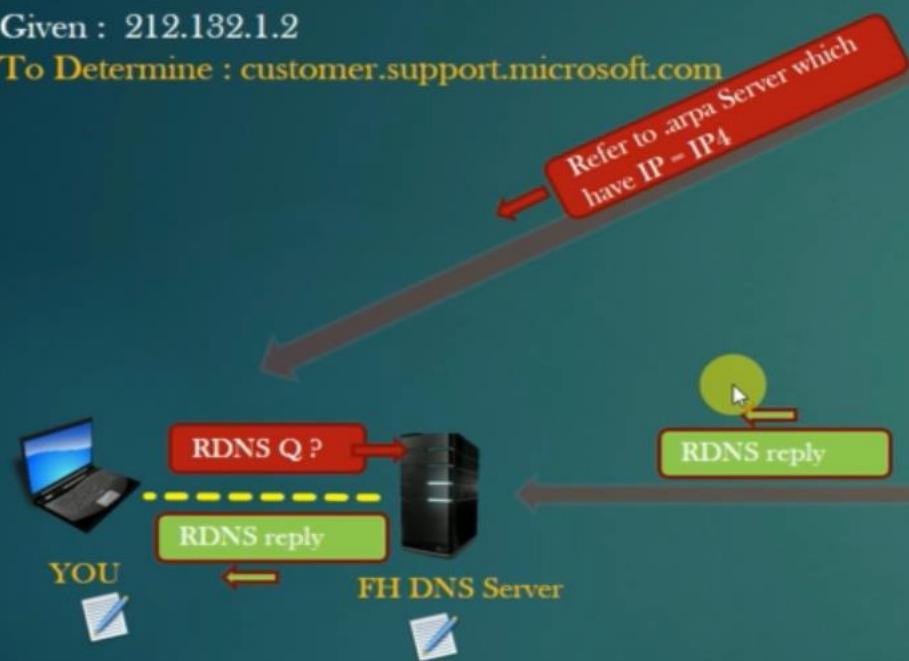
Reverse DNS Query

DNS Mechanism -> Reverse DNS Query

GOAL :

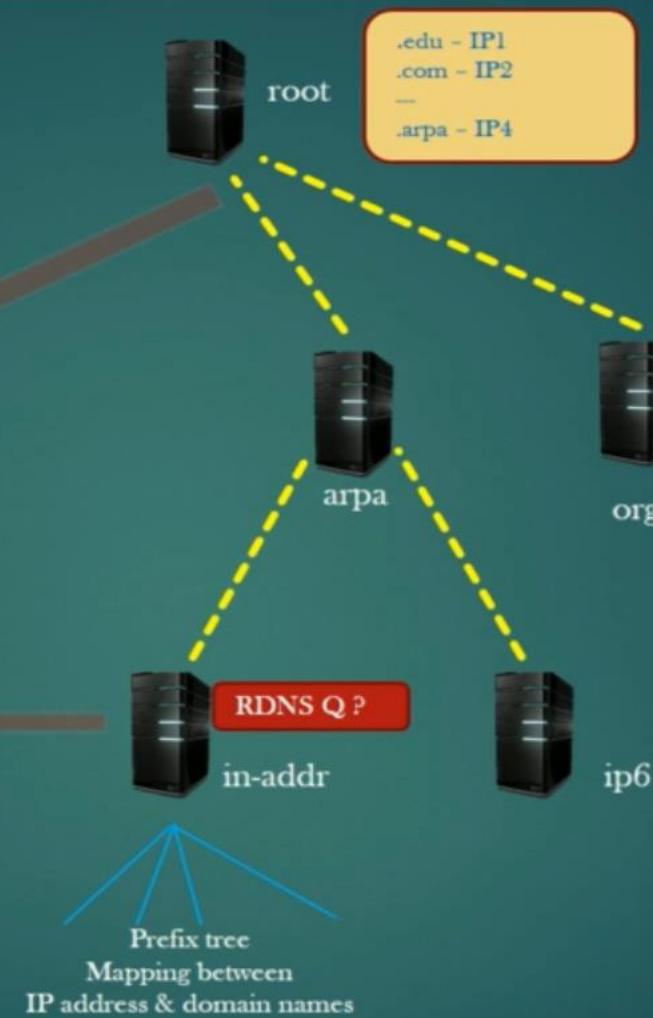
Given : 212.132.1.2

To Determine : customer.support.microsoft.com



RDNS Query : What is domain name of 1.2.132.212.in-addr.arpa. ?

RDNS Reply : customer.support.microsoft.com
domain name of 1.2.132.212.in-addr.arpa.



Entry : customer.support.microsoft.com
😊

Reverse DNS Query

DNS Mechanism -> Reverse DNS Query

- Reverse DNS lookup is opposite of normal DNS lookup
- Reverse DNS lookup query can be both - Iterative Or recursive
- *arpa* is TLD Server responsible for handling all RDNS queries
- *in-addr* for ipv4 addresses is the 2nd level DNS responsible to provide definite response to RDNS query
- *ip6* DNS is ipv6 counter part of in-addr DNS
- Reverse DNS is used in troubleshooting / traceroute commands etc

THANK YOU