

# Providing High Internet Traffic Using IXPs during the COVID-19 and its Impact on DBP

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**Abstract--** During the decays of 21st century and the past century, the networks technology has witnessed huge and continuous improvements in terms of speed and dissemination, and the internet as well. On the other hand, the demand on internet services have dramatically becomes more, and that demand has been increased rapidly during the crisis of COVID-19.

The demand on domestic bandwidth has been increased during and COVID-19 period, but what make things strange is that the demand after COVID is as the same as during the period of COVID, and some countries have exceeded the bandwidth range.

To fulfill such high demand of bandwidth, governments have resorted to new technologies represented by the Internet Exchange Point (IXPs) as a replacement of traditional exchange points, in order to achieve high bandwidth and speed rate.

This work represents the concept of IXP and its benefits, comparisons between countries that adopted this technology, and other comparisons to Arab Countries. It focuses on the demand of bandwidth in the world and the reasons of that demand stability during and after COVID period and the need for IXPs and how that affect the Domestic Broadband Production (DBP).

As a result, most of developed countries have extended the IXPs in order to provide high bandwidth, but still Arab World not familiar with it. Adopting the IXPs has reflected on the DBP in general positively.

**Keywords--** COVID-19, IXP, DBP, Networks, Bandwidth.

## I. INTRODUCTION

The modern and civilized world and nations aim at providing and maintaining all life aspects connected together and acting as integrated system. The main and backbone of this system is the infrastructure, represented by the network and global network – Internet.

The demand to high speed and capacity of internet traffic has been increased in the last few years due to the pandemic of COVID-19. IXPs is the solution that provides high capacity and low-cost solution to overcome the issue of internet congestion.

The Domestic Broadband Production has been increased during the outbreak and unexpectedly, after the outbreak. The IXP has huge impact on the percentage of increment of DBP in countries and continents.

This research aims at focusing on the IXPs and the high expansion of it in different countries and continents, usages and benefits of IXPs, and its effect on DBP.

Modern networks are using IXPs in order to provide wide bandwidth and high speed, and so local authorities in developed countries have started to adopt the IXPs and replace the traditional local exchanges.

There is a huge gap between the Western Countries and the Arab World in terms of using IXPs. Western Countries have used IXPs even before the pandemic of COVID19, and the usage has been increased rapidly during the pandemic, while the rest of world has started timidly adopting that technology despite the huge need of internet traffic as the world was moving to online mode.

And so, the production of bandwidth has been increased dramatically in most of the world which has been affected the DBP, but that effect was not as expected in the Arab World.

This work represents the concept of IXP, DBP, several comparisons between world countries in terms of IXPs, DBP, etc. to highlight the gap between countries in order to encourage the use of IXPs and enhance the DBP.

The remaining of this article organized as follows: part 2 is the literature review, part 3 presents bandwidth demand during the pandemic of COVID-19, part 4 presents the Internet Exchange Point (IXP), part 5 presents Domestic Bandwidth Production (DBP), part 6 presents how to maintain networks, and the last part is the conclusion.

## II. LITERATURE REVIEW

Several researches have addressed the COVID-19 outbreak and its consequences on daily life and internet traffic because the world has moved to online mode of life style in all life aspects.

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A work reviewed the impact of the first year of the COVID-19 pandemic on Internet traffic in order to analyse its performance. It collected and analysed internet traffic data from multiple locations, then it explained how the Internet reacted during these unprecedented times. [1]

Another research surveyed the information about IXPs and described their basic technical and operational aspects and highlighted the critical differences among the various IXPs in different regions of the world. It illustrated the role that IXPs has been playing in today's Internet ecosystem and discussed how IXPs in Europe and the world is shaping and redefining the Internet market. [2]

Few of researches focused on the role of IXP in ecosystem such as [3][4]

Some researched presented IXPs from the point of technical orientation such as [5] [6]

And few illustrated the IXPs role in enhancing DBP such as [7][8].

This work provides comparative study and analysis about the dissemination of IXPs per country, continent, and the Arab World, in addition to the effect of IXPs on the DBP.

### III. BANDWIDTH DEMAND DURING THE PANDEMIC OF COVID-19

The citizens of the Organisation for Economic Co-Operation and Development (OECD) countries are representing around 1.3 billion people, who were working, studying, and entertaining from home.[9]

Many classical jobs have been vanished, and more contemporary jobs have been created and others rebounded. Life style has been moved from outdoor to indoor; evolving the day life into digital counterpart. The day activities have been depended on the internet – entertainment, business, education, and communication; the make the demand on internet services more and more.

Despite the fact that the internet services' value has increased, the demand on those services has been increased as well, the business of internet providers and technical support has become more critical in this unprecedented situation. The internet traffic has experienced an increment of up to 60% during daytime weekday in OECD countries.[9]

### IV. INTERNET EXCHANGE POINTS[10]

Internet exchange point (IXP) is a technical infrastructure where networks come together to connect and exchange Internet traffic, it enables local networks to efficiently exchange information at a common point within a country rather than exchanging local Internet traffic overseas as shown in figure 1.

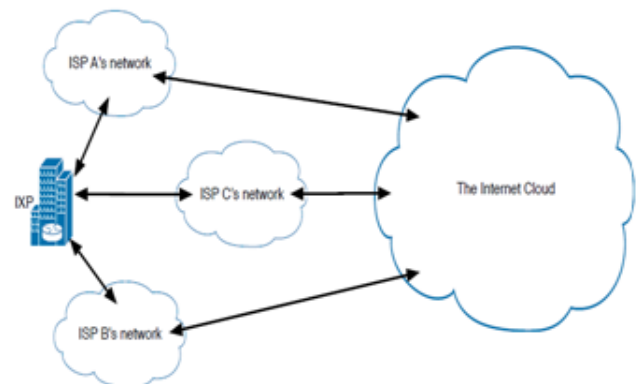


Figure 1. Internet exchange point (IXP)[11]

IXP has several types of networks: Internet service providers (ISPs), mobile operators and content delivery networks (CDNs) such as Google and Facebook. Setting up IXP is a competing and collaboration work; where organizations and even people contribute together to build the infrastructure of networks.

Sending and receiving messages are not straight forward process even when somebody is sending to person just next the door; when there is no shortest path between parties, message may travel to several countries and visit continents before landing in email inbox. Internet exchange point (IXP) can create that shorter and direct path between sender and receiver.

The IXP not only needs hardware components to run properly, such as, switches, routers, neutral locations, power supply, cooling system, etc, but also technical support by experts who can make stronger technical networks.

#### a) Benefits of IXP[12]

The IXP has several benefits that encourage countries to adopt it; IXP provides fast internet connection, nevertheless:

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- It is cheap because it uses cheap local connections between sender and receiver. It has high switching capabilities
- It can redirect traffic when there is connectivity problem.
- It provides direct connectivity between sender and receiver, which in turn improves access speed and quality.
- As a result of above, it invokes innovation and creates business opportunities and the new production of contents and applications

### *b) Usage of IXP*

The use of IXP has been increased by time because the need of high speed and low-cost internet connection is a high demand, especially during the Pandemic of COVID-19.

Table 1. represents the IXP numbers per country from October 2021 to October 2022. The table shows that United States have the highest IXP number in October 2021 and increment of 2 IXPs in October 2022, while countries such as Suriname, Oman, Iraq, etc. established new IXP in October 2022.

**Table 1.**  
**Internet Exchange Points per Country (October 2021 to October 2022). [13]**

Country	October 2021	October 2022	Extra Change	Percent Change
United States	119	121	2	2%
Russia	33	34	1	3%
Netherlands	13	15	2	15%
China	10	11	1	10%
Bangladesh	3	4	1	33%
Philippines	2	3	1	50%
Peru	2	3	1	50%
Brunei Darussalam	0	1	1	new
Iraq	0	1	1	new
Oman	0	1	1	new
Saint Barthelemy	0	1	1	new
Suriname	0	1	1	new

**Table 2.**  
**Internet Exchange Points per Continent (October 2021 to October 2022). [13]**

Continent	October 2021	October 2022	Extra Change	Percent Change
Europe	273	278	5	2%
Asia-Pacific	150	154	4	3%
North America	134	136	2	1%
Latin America	106	109	3	3%
Africa	55	55	0	0%

Table 2. represents the IXP numbers per continent from October 2021 to October 2022. The table shows that Europe has the highest IXP number in October 2021 and increment of 5 IXPs in October 2022, while Africa has the least number of IXP in October 2021 of 55 with no increment till October 2022.

Table 3. represents the IXP numbers per continent from April 2006 to April 2011. The table shows that Europe has the highest IXP number in April 2006 and increment of 52 IXPs in April 2011, while Africa has the least number of IXP in April 2006 of 18 with increment of 4 till April 2011.

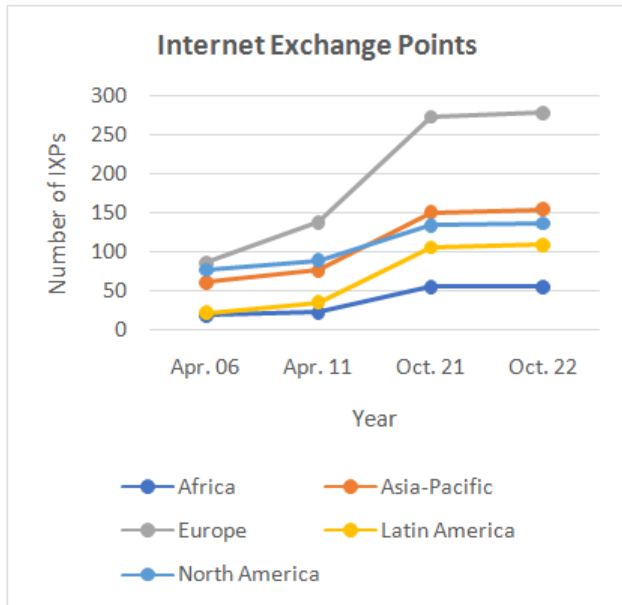
**Table 3.**  
**Internet Exchange Points per Continent (April 2006 to April 2011). [15]**

Continent	April 2006	April 2011	Extra Change	Percent Change
Africa	18	22	+4	+22%
Asia-Pacific	60	76	+16	+27%
Europe	85	137	+52	+61%
Latin America	20	34	+14	+70%
North America	76	88	+12	+16%

Tables 2 and 3 represent the domination of Europe in the number of IXP with a huge pace each year in the IXP's number, while Africa has the least numbers. Those results are illustrated together in Figure 2.

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**Figure 2. IXP per continent (Apr.2006-Oct.2022)**

Table 4. provide information about the IXPs in the Arab World from October 2021 to October 2022. It is clear the lack of IXPs in the Arab World up to October 2022.

**Table 4.**

**Internet Exchange Points – the Arab World (October 2021 to October 2022). [14]**

Country	October 2021	October 2022	Extra Change	Percent Change
Lebanon	2	2	0	0%
Palestine	2	2	0	0%
Saudi Arabia	2	2	0	0%
United Arab Emirates	2	2	0	0%
Iraq	0	1	1	new
Oman	0	1	1	new
Bahrain	1	1	0	0%
Egypt	1	1	0	0%
Jordan	1	1	0	0%
Kuwait	1	1	0	0%
Morocco	1	1	0	0%
Qatar	1	1	0	0%
Somalia	1	1	0	0%
Sudan	1	1	0	0%
Tunisia	1	1	0	0%

While table 5 represents the IXPs for the Arab world within the period April 2006 to April 2011. It is noted that the only country that had IXP was Egypt since April 2006, while Lebanon and Bahrain started to have IXPs since April 2011, other Arab World countries had no IXPs during that period.

**Table 5.**

**Internet Exchange Points – the Arab World (April 2006 to April 2011). [15]**

Country	April 2006	April 2011	Extra Change	Percent Change
Lebanon		1	1	new
Bahrain		1	1	new
Egypt	1	2	1	100%

## V. DOMESTIC BANDWIDTH PRODUCTION

Due to curfew during COVID-19 period, the life style of around 1.3 billion citizens of OECD countries has been changed; working and studying from home. The internet value chain, mobile and fixed mobile operators, cloud providers, etc. have formed the IXP because the demand on internet traffic has been increased by 60% than before the outbreak.

The Domestic Broadband Production (DBP) of countries have been increase during the outbreak; table 6. Shows the DBP of the first 10 countries that exchange the highest internet traffic, it shows that United State has the highest net change, and that is expected because the United States has the highest IXP as shown in table 1

**Table 6.**

**DBP per Country (October 2021 to October 2022). [16]**

Country	October 2021	October 2022	Net Change	Percent Change
United States	9.71T	12.4T	+2.69T	28%
Netherlands	14.3T	16.5T	+2.16T	15%
Brazil	19.2T	21.2T	+1.98T	10%
Germany	11.2T	12.2T	+1.06T	10%
Poland	4.12T	5.13T	+1.02T	25%
India	3.85T	4.76T	+912G	24%
Chile	6.03T	6.71T	+674G	11%
Ukraine	5.13T	5.71T	+583G	11%
Bulgaria	1.33T	1.89T	+561G	42%
Sweden	1.39T	1.85T	+462G	33%

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While table 7. Shows the DBP of the continents, it shows that Europe has the highest net change, while north America has the highest percent change and that is expected based on the number of IXPs in table 2.

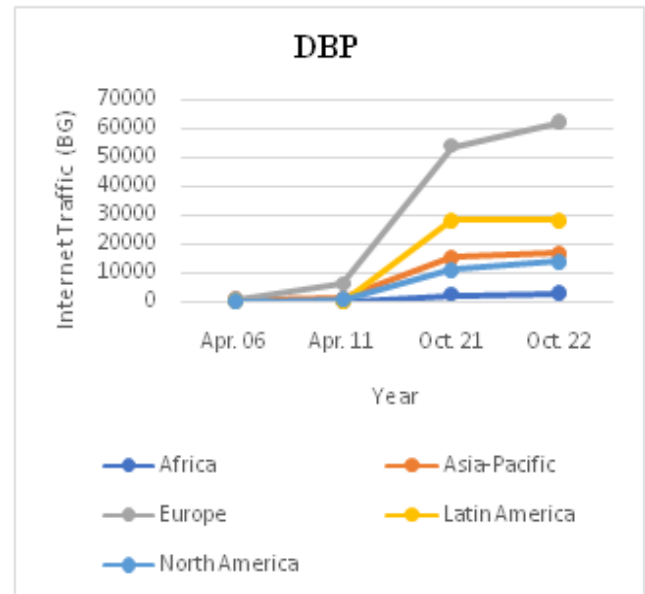
**Table 7.**  
**DBP per Continent (April 2006 – April 2011). [16]**

Continent	April 2006	April 2011	Extra Change	Percent Change
Africa	159M	3.22G	+3.06G	1921%
Asia-Pacific	636G	1.13T	+497G	78%
Europe	797G	6.28T	+5.49T	688%
Latin America	4.81G	62.3G	+57.4G	1193%
North America	121G	885G	+764G	634%

Comparing the period of October 2021-October 2022 to April 2006 – April 2011, table 8. Shows that Europe has the highest net change of DBP, while Africa has the highest percent change.

**Table 8.**  
**DBP per Continent (October 2021 to October 2022). [15]**

Continent	October 2021	October 2022	Extra Change	Percent Change
Europe	53.8T	62T	+8.23T	15%
Asia-Pacific	15.3T	16.7T	+1.34T	9%
North America	11.1T	14.1T	+3.02T	27%
Latin America	28.1T	28.3T	+105G	0.7%
Africa	2.5T	3.09T	+595G	24%



**Figure 3. DBP per Continent (April 2006 – October 2022)**

Figure 3. represents the whole image of DBP per continent from April 2006 – October 2022.

Table 9. represents the DBP of the available countries of the Arab World within the period of October 2021 to October 2022, it shows that United Arab Emirate has the highest DBP in October 2022, while Somalia has reduction in DBP.

**Table 9.**  
**DBP – the Arab World (October 2021 to October 2022). [14]**

Country	October 2021	October 2022	Net Change	Percent Change
Egypt	25.3G	25.4G	+105M	0.41%
United Arab Emirates	266G	284G	+18G	7%
Kuwait	21.5G	23.5G	+2.04G	9%
Somalia	1.2M	30K	-1.17M	-98%

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While table 10 shows the DBP of the available countries of the Arab World within the period of April 2006 to April 2011, it shows that only 2 countries had record during April 2006 to April 2011. Egypt had the low DBP but with high percent change from 2006 to 2011, while the record of Lebanon started in April 2011 with very low DBP.

**Table 10.**  
**DBP – the Arab World (April 2006 to April 2011). [15]**

Country	April 2006	April 2011	Net Change	Percent Change
Lebanon		8.34M	+8.34M	new
Egypt	12M	261M	+249M	2076%

### VI. MAINTAINING NETWORKS

Based on previous results, this section provides information about suggested means and methods for maintaining the networks in order to meet the high demand of internet traffic.

It is important to maintain access to hardware supplies; network operators need to upgrade the networks and replace fail components, that activity could not be achieved if countries closed their borders as the case during the pandemic.

Datacenters play a vital role in maintaining and providing internet traffic in the condition that granting access and permission to services even when there is maintenance or outbreak by balancing between maintenance and providing the services.

Countries applied curfew during the pandemic, which prevented the availability of workers and engineers to do the necessary support for cabling, troubleshooting, etc. and so, government should grant access and reduce restrictions for, at least, the minimum in order to keep life of network going on. [9][17]

It is important to anticipate amount of demand of traffic and prevent its congestion by increasing the inter-switch interconnection capacity, increasing the capacity of port by adding additional ports to IXPs or increasing the speed of ports. Avoiding Congestion in private interconnections by using fibre in cross-connects within datacenters and routers. [18]

Monitor the performance of key Internet infrastructure services specially Domain Name System (DNS) because the performance of DNS is a prerequisite to reaching any service on the Internet. [19]

Reduced mobility of people and bandwidth intensive applications may generate congestion as there will be more devices competing for the same cell capacity, and so regulators and policy makers could make use of unused spectrum into service.

Any Digital Subscriber Line (xDSL) [20] network uses the telephone infrastructure that was primarily built for low-speed analogue voice service; and so, replacing it with Fiber to the x (FTTx) [21] technologies by the transition from copper to fiber in order to address congestion issue in xDSL.

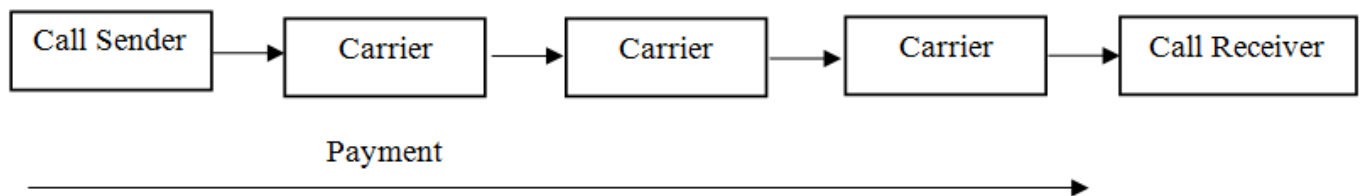


Figure 4. Legacy circuit-switched payment method

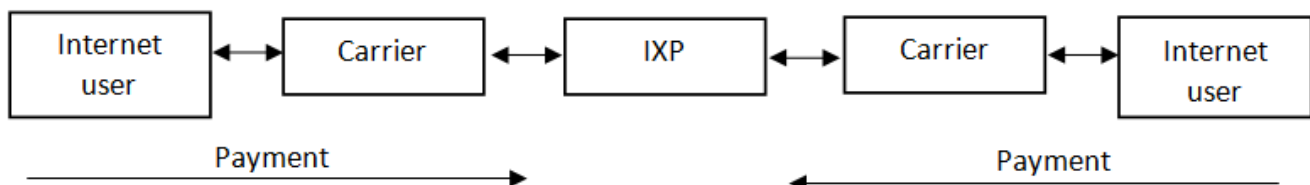


Figure 5. Internet payment method and compartmentalized

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### VII. ANALYSIS AND DISCUSSION

The internet usage, the DBP amount, and the number of IXP have been increased rapidly during the past decays. Several factors have affected those huge figures.

The internet has different method of allocating cost than the tariff of the legacy circuit-switched [22] voice market; calls were directional, from source to destination, and the payment follow the direction progress up to the destination carrier. Payment was received from both parties as shown in figure 4. While figure 5 represents the payment method for the internet user. The internet peering is symmetric, and each party pays his own bill, it is straightforward business model, and free of externally costs. And due to the exchange of the traditional circuit-switched by the Internet model, the internet traffic has been increased dramatically, in most of the world countries. The cost of traffic is lower for packet-switched networks than it has been for circuit-switched counterparts.

Another important factor is the huge Competition in internet exchange markets. Where maintaining competitive conditions is a primary policy goal of governments.

### VIII. CONCLUSION

Internet Exchange Points are vital elements of Internet infrastructure that enable networks to exchange traffic with each other. The primary purpose of an IXP is to allow networks to interconnect directly, via the exchange, rather than going through one or more third-party networks. The primary advantages of direct interconnection are cost, latency, and bandwidth.

There is a huge amount of internet traffic production due to the pandemic of COVID-19, which makes the use of IXPs is a critical matter in order to fulfill the high demand on internet traffic during the outbreak.

Statistical results shows that the expansion of IXPs has been increased rapidly due to the need of huge internet traffic. Several suggestions can be made to overcome the congestion which is made by the high demand for the internet traffic during the period of pandemic.

As a result, the domestic broadband production has been increased due to the high distribution of IXPs in most of countries in all continents.

The amount of DBP has been increased dramatically in the period of COVID-19 in most of the world countries. On the other hand, DBP still bit low in the Arab World in comparison to other world countries.

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