Broadband Network Technology

1. **What do you understand about the broadband network in terms of its Internet speed offered?**

   This question is a bit tricky. First, this question asks about broadband network specifically on the Internet speed it can offer. Secondly, broadband network does not limit to DSL technology only, but also includes others like PON, wireless mobile network like 3G, 4G, 5G,

   So answer to this question can be as follow:

   Broadband network offers faster Internet speed compared conventional dial-up Internet speed. It provides multi-rate / very broad range of network speed depending on technology used. For example, Streamyx service offered by Telekom Malaysia can range from 1 Mbps to 8 Mbps, Unifi offer 30 Mbps to 800 Mbps.

2. **What is access network? Explain it using an example of access network.**

   Access network is the network connection that connect end user to service provider network. For example, a student connects to campus network using WiFi or Ethernet, then WiFi and Ethernet is the access network for student. In terms of DSL subscriber, the access network is telephone network, fiber to the home service like Unifi, the access network is PON system.

   Some sample answers:

   1. Access network is types of telecommunication network that connects subscribers to their immediate service provider. For example, DSL (digital subcriber line). It brings a connection into user's home via telephone lines and it allows simultaneous use of telephone and broadband access on the same twisted pair. - by GOH KAI YEN

   2. There exist many large networks such as the Internet. to join such a highway of the network we need to have, 'a driveway out of our garage and small roads to join such highway', an access network. The access network is a user network that connects its clients to the service provider to as to help in accessing the larger highway possible via multiple types of network, example being Fiber optic networks (FTTH), DSL and cellular communications and sometimes even 2.4 GHz RF. - by MOHAMMAD FARHAAN IQBAL

   3. An access network is a network that connects subscribers to a particular service provider through a carrier network to other networks such as Internet. The common example is DSL or better known as Digital Subscriber Line. In short, it uses existing telephone line to provide broadband services for the users. - by AHMAD ANWAR ARIFFIN BIN MOHAMMAD

   4. Access network connects subscribers to a particular service provider through a network carrier to other networks. Wireless LANs are an example of access network that allows mobile users to connect through a wireless connection. by NURUL SHAHIDA SABIRIN

   5. Access network is a telecommunications network that provides a connection for the subscribers to service provider. For example is FTTH (fiber to the home) that uses optical fiber directly to individual buildings which gives high-speed Internet access. - by ANIS SYAFIKAH BINTI MOHD YUSRI

   6. Access Network is the is a type of network which connects end users to a particular ISPs. An example of an access network is Digital Subscriber Line (DSL) which brings a connection into homes

through telephone lines such as Telekom Malaysia's Streamyx. - by LINGKESWARY A/P J.JEYAKUMARAN -

Access network is a telecommunications network that gives user access to service providers. For example, ADSL (Asymmetric Digital Subscriber Line) is a technology for transmitting digital information at a high bandwidth on existing phone lines to homes and businesses.

3. <mark>Why the access network or last mile access always considered as a weakest link in network? Explain your answer.</mark>

The 'weakest' not only because the last mile is slow and limited coverage (from end user perspective), but the cost of implementing it due to massive deployment (from ISP perspective). Of cause, the answer needs to include the '**explain**'

Some sample answer:

1.　　　Unfortunately, last mile access always considered as a weakest link in network due to its complex and enormous structure. It is often very congested and in very high-density of users. Due to its limited coverage, it causes bottleneck in certain area and resulting in slow connection. - by TESHINIA TISA PHANG

2.　　　The last-mile network is heavily expose compared to the backbone link. Commutation infrastructure is more at risk of the environment and interferences out of the control of the link provider, the high cost of spanning the last-mile networks restrict the provider access to high-end resources promising the best quality of link, for example high-end gold alloy twisted pairs cabling for data transfer is not realistic to span to each house. -by MOHAMMAD FARHAAN IQBAL

3.　　　The last mile network need high cost to implement and in order to provide high-speed, high bandwidth services as it is the portion of the telecommunications network chain that physically reaches the subscribers such as the DSL lines. - by MOHD SYAFIQ BIN JAIM

4.　　　Last mile access is often considered a weakest link in the network due to the final stretch of an Internet connection which has the least control such as artificial congestion, violation of net neutrality, poor infrastructure and censorship automatically lead to Internet Exchange Points from tier to tier causing bottleneck speed, Artificial Internet Congestion occurs when ISP provides network control that slows down data delivery and poor network performance. - by MUHAMMAD ZULFIQAR BIN RAZALI

Because it has a slow connection, massive deployment and has limited coverage. It can be a bottleneck in networking throughput because of network traffic is funneled through that link.

4. <mark>Why ADSL is preferable by domestic customers?</mark>

To answer this question, first, we need to understand what is ADSL then what cause the domestic customers prefer to use this service.
ADSL stands for asynchronous digital subscriber line that provide different network rate for download and upload stream. For domestic customers, most for the Internet activities concerning

download like watching youtube, read email, read WhatsApp, or WeChat messages. As most of the ADSL services, offer faster download speed compare to upload speed, this fulfilling the need of of the domestic customers.

Why there is different speed for upload and download stream? Please have a look on https://www.quora.com/Broadband-Why-do-high-speed-Internet-connections-have-such-slow-upload-speed-compared-to-fast-download-speed-Is-there-some-sort-of-technical-hurdle-that-prevents-cable-modems-from-uploading-faster

Same sample answers:

1.   ADSL, utilizing existing infrastructure of telephone, has made it possible to ISP to provide its services at a lesser cost to alternative links. With the ability of phone line to sustain a few mbps with frequency splitting, casual internet users find it adequate for their needs at home, also very fitting of an asymmetric link pattern, for the subscription cost. However, at the turn of this decade with streaming services and working from home grows is popularity, we might see a shift away from such subscription lines towards other stronger broadband ISP services. - by MOHAMMAD FARHAAN IQBAL

2.   ADSL uses existing telephone line for broadband. It also allow users to use telephone line and using internet on the same time. Besides, ADSL allows faster download but slower upload which is sufficient for domestic users which rely more on download and less on uploads. - by FRANCO ANAK KEMIN

3.   ADSL offers unlimited Internet access under a flat-rate price which is available anytime. - SHEREENA ANAK OBENG

4.   Provides faster speed in the downstream than the upstream. Allows faster downstream data transmission over the same line used to provide voice service without disrupting regular telephone cells on that line. - LEONG WENG KIT

Asymmetric digital subscriber line (ADSL) technology uses the existing telephone line to provide broadband services. Domestic customers prefer ADSL because it enable user to use internet at the same time without interrupting voice call or phone call service.

Tutorial 2 (Optical Communication)

1. How light is used for transmitting data in optical fiber network?

   It is based on the principle of "Total Internal Reflection" which the concept is to convert electrical signal pulses into light pulses and send through hair-thin glass or plastic fiber to a detector at far end then reconverted back to electrical signal. The light in a fiber-optic cable travels through the core by bouncing from the cladding because the cladding does not absorb any light from the core, the light wave can travel great distances.

2. There are two major types of fiber optic cable, namely multi-mode and single mode fiber. Which of these fiber is better choice for long distance transmission? Justify your answer.

   Single-mode fiber is better choice for long distance transmission because the light travels in a single lightwave to be transmit down the core, eliminate any possibility of dispersion or overlap. The core diameter of single-mode is extremely small than multi-mode fiber.

3. What are the implications/effects (can be both positive or negative) if two fibers are spliced to make a longer fiber?

It can cause attenuation by splice loss when two fibers are spliced to make a longer fiber. Splice losses range from 0.1dB to 1dB which is huge compared to joining two metallic wires. For splicing and connecting loss, alignment is critical and everything must be clean, smooth and straight.

Tutorial 3 (Passive Optical Network) PON

1. Compared to copper / metal cable, why more and more broadband network deployments are prefer to use PON system?

The broadband network deployments are preferring to use PON system because it is used to divide one incoming signal into multiple signals. PON system can be fiber-to-curb (FTTC), fiber-to-building (FTTB) and fiber-to-home (FTTH). It also cheaper, massive and no need electricity while network is running.

There are quite a lot of answers mentioning the PON system offer high bandwidth but why high bandwidth is needed?

To answer this question, there should have some explanation on the issue of copper/metal cable and the users' need for the higher bandwidth. **Anyone want to have a try on answering this question from this aspect?**

2. What is the purpose to have ranging process to measure the round-trip time between an ONU and OLT?

Some of good sample answers:

"Ranging process is done to make sure the equalization delay is calculated. By that, any transmission collision between ONU is avoided". - by *TESHINIA TISA PHANG*

"It is part of the provisioning scheme of the OLT whereby the delay/distance to each ONU is determined to allow for adjustments on frames transactions" -by *MOHAMMAD FARHAAN IQBAL*

"To adjust and schedule the timing for data frames ~~and thus to~~ **avoid collision by setting the ONU with logical time reference." - by** *NUR HASYA BINTI MOHAMAD*

"To allow OLT to determine the relative distance of ONUs and act as time reference to prevent collision to occur in PON system." - by *HONG LI SIAN*

The purpose of ranging process is to avoid upstream collision occur between ONU.

1. Why network convergence is a must for today broadband services? What are the benefits if network convergence is applied?

   Some of the good sample answers:

   Because nowadays in PSTN system, voice is not the only thing that been carried out in the traffic. Video and data also part of the traffic.

   The benefits of network convergence after been applied are enhanced the transmission, congestion free and a better data flow for asynchronous and synchronous transmission. - by SITI NOR AISYAH BINTI HARIS FADZILLAH

   Because today broadband service needs to support different types of network traffic such as voice, video, and data in which voice and video are mostly used by the user nowadays.The benefit of network convergence is, provides high speed of transmission and reduces the time delays, which lead to better QoS for the user.- by SITI NURSYAHIRAH BINTI SARIJA

   Because network convergence is the combination of voice, video and data which meets the user demand. The benefits include high speed switching at hardware level and ease of integration with other technologies. - by FELICIA TAN LI FEN

   Network convergence is a must for today broadband services because it is capable to transmit convergence of voice, video and data on one network. This offers convenience and flexibility. The benefits of network convergence are high speed switching at hardware level, scalability in network size and speed, predefined and guaranteed QoS (quality of service) and CoS (class of service).

2. Voice, video, and data are the common types of the network traffic. What are the characteristics for this traffic in terms of their sensitivity to error and requirement bandwidth?

   Again, this is a tricky question. Three different network traffics, thus sensitivity to error and required bandwidth are different for this different traffic. Please refer to lecture note on ATM, slide #3 - #5.

   *Sensitivity to error: data > video > voice; bandwidth requirement: video, data > voice. The bandwidth requirement for video and data depends on the resolution/quality of video and amount of data transmitted. **Most of the answer are correct.***

   Voice: The signal contains a high degree of error but the information can still be retrieved correctly. For bandwidth required is relatively small and constant (64K).

   Video: Error controls should be tight otherwise the wrong information on the monitor may trigger wrongful actions. The bandwidth required is variable and it could range from under 64Kbps to several Mbps in same session.

   Data: It is extremely error-sensitive, so extreme caution must be exercised in transmission and error control must be very tight.

3. Voice, video, and data are the common types of the network traffic. What would be the impact to these network traffic if they are not delivered on time?

Again, this is a tricky question!

The question mentions 3 different type of network traffic, thus the impact should be discussed individually for these traffic. Most of the answers discuss the impact on voice and video, but not data. To answer this question, first we look at the requirement for these different network traffic. The requirement for voice and video is almost equivalent as they need to be delivery with minimum delay to have QoS. However, it is rather fine for data traffic experiences longer delay.

This will cause users to experience bad Quality of Service (QoS) and may face high latency and loss of data. For example, users will hardly understand the delivered information via video call if that network traffics are not delivered on time.

The impact on these network traffic if they are not delivered on time, it will cause delays, increase latency and loss of data.

Tutorial 5 (Gigabit Ethernet)

1. What is the advantage to have standard network frame structure across Standard, fast, Giga and 10 Giga Ethernet?

Comment:

Most of the answers given are looking at the network flexible, dependable and scalable. But what it means by "network flexible", "dependable" and "scalable"?

Sample answer for this question:

*The advantage is that it allows **easily upgraded** to fast ethernet, gigabit ethernet or even 10G ethernet ~~and also scalable~~. since these technologies sharing same/compatible underlying frame structure. - by LINGKESWARY A/P J.JEYAKUMARAN (edited)*

It would make the network flexible, dependable, reliable and scalable.

2. What is the different between ATM cell and Ethernet frame in terms of their size? Is there any advantages and disadvantages in their design?

Comment:

Most of the answers are correct on the ATM and Ethernet frame size, which are 53 bytes for ATM cell and 64-1518 bytes for Ethernet Frame size. However, when come to discussion on the advantages and disadvantages, the discussion should focus on the size design of the ATM cell and Ethernet Frame.

If looking at the ATM cell size, it is rather small compared to Ethernet's. Due to it relatively smaller size, there are overhead when segmenting the data in ATM cell size (more work), as compared to Ethernet's. This also lead to easier hardware design (the buffer) of the ATM switch.

Ethernet frame has variable size depending on the size of the data from the higher layer. This means less frames are required for the transmission, but due to its variable size the QoS is less as compared to ATM.

3. Ethernet adopts CSMA/CD protocol to control the computers access to the network. What would happen to this protocol if there is increasing number of computers in a network?

   Comment:

   Most of the answer given are focus on the collision happen. Yes, there going to be collision and the protocol itself is meant to detect collision. If we observe the question carefully, "what would happen to this protocol if there is increasing number of computers in a network" - Most of the answers have missed this part of the question.

   When the number of computers increase, the changes of collision to happen also increase. This increment will reach at point that causing too many collisions and lead to network performance degradation- the local area network becomes slow. In order word, the CSMA/CD will fail with increasing number of computer.

   If there is an increasing number of computers in a network, collision will occur in the network. CSMA/CD will detect and initiate an algorithm support a back-off procedure then wait until the medium is clear prior to initiate the retransmission process.

Tutorial 6 (xDSL)

1. UTP cables usually used in DSL network to provide access to the broadband Internet. Why the coverage area is relatively smaller compared PON system?

   The coverage area is relatively smaller due to the propagation loss in UTP. The attenuation of UTP increases with frequency due to distributed resistances and distributed inductances in series, distributed capacitances in parallel. On the other hand, PON system uses light to travel along the optical fiber and there is no EMI and RFI interference in adjacent wire.

2. Why splitter is used in DSL network?

   Splitter is used in DSL network to prevent interference problems. It separates POTS from DSL signals. so that both voice and data can be transmitted simultaneously on the same twisted pair.

3. both Broadband over Power Line (BPL) and DSL use existing infrastructure, that is PSTN and power transmission network to provide Internet service to the users. Why BPL and DSL opt to use these infrastructures? (What is the benefit offered by using these infrastructures?)

   Using the existing infrastructure like PSTN instead of new wiring, because it can help to reduce the cost of new deployment.