IT 2nd material

Network

Lecture 2

Chapter 3:

NETWORK HARDWARE & LOCAL AREA NETWORK

Networks Hardware

This section contains information on the following items:

- File Server
- The stations
- Network interface cards
- Switch
- The repeater
- Bridges
- Router

The file servers

A file server is considered the heart of networks. Fundamentally, it must be a quick and powerful computer with Big RAM and storage space with an interface card with a good performance.

Workstations

Used computers connected to a network are named workstations. A workstation is a device installed with a network

Network interface cards

The network interface card (NIC) provides the physical Connection between the network and the computer workstation.

Network interface cards are the main factor to determine the speed and performance of a network.

The famous network interface cards are Ethernet, and Token Ring

Ethernet is more popular than a Token Ring

Ethernet Cards

Ethernet Cards have wo types of connections. twisted pair cable or coaxial.

Token Ring Cards

Token Ring cards have a type connector DIN 9 pin.

Hub

A **hub** is a basic device that connects multiple computers in a network. It sends the data it receives from one computer to all other connected computers, even if the data is only meant for one of them.

Switch

Unlike hubs, switches examine each packet and process it accordingly rather than simply repeat the signal to all ports.

Switches Map the Ethernet addresses(MAC Adress) of the nodes residing on each network segment and then allow only the necessary trattic to pass through the switch.

The repeaters

A signal loses power as it passes through a cable; there is a need to increase the power of the signal with a device called a repeater.

The repeater amplifies the strength of the signal it receives and sends it again.

** The repeaters can be split, or devices included in a switch.

**The repeaters are used when the long cable exceeds the standard length.

Bridges

A bridge is a device to segment a large network into two smaller networks or more. If there is an older system of wiring and the desire for the new network to be up to date, a bridge can connect the two.

**The bridge handles traffic to maintain optimal performance on the two sides of the network.

**Bridges can be used to connect the different types of wiring.

Router

A router converts the information between two networks. The router is considered a super-intelligent bridge. Routers choose the optimal path to route a message, depending on the destination address and the sender.

The router can route trattics to avoid collisions and it is intelligent to recognize when to direct traffic .

**Routers recognize the addresses of computers, bridges, and other on the network.

**The routers "listen" for the entire network to decide about which sections are busiest.

**Routers use various routing protocols, such as RIP (Routing Information Protocol), OSPF (Open Shortest Path First), or BGP (Border Gateway Protocol), to exchange routing information with other routers and dynamically update their routing tables.

** router can perform such as NAT to translate private IP addresses to public IP addresses

Simple revision

Hub:

- **Purpose**: Connects multiple devices in a network.

- **Data Handling**: Sends data to all devices connected (not smart).
- **Layer**: Physical layer (Layer 1).
- **Efficiency**: Less efficient due to unnecessary data broadcasts.

Switch:

- **Purpose**: Connects multiple devices like a hub, but smarter.
- **Data Handling**: Sends data only to the device it's intended for.
- **Layer**: Data Link Layer (Layer 2).
- **Efficiency**: More efficient, reduces unnecessary traffic.

Repeater:

- **Purpose**: Extends the range of a network by boosting signals.
- **Data Handling**: Amplifies the signal, no data filtering.
- **Layer**: Physical layer (Layer 1).
- **Efficiency**: Simple and used for long-distance connections.

Bridge:

- **Purpose**: Connects two different network segments.
- **Data Handling**: Filters traffic between segments based on MAC addresses.
- **Layer**: Data Link Layer (Layer 2).
- **Efficiency**: Helps reduce traffic by isolating network segments.

Router:

- **Purpose**: Connects different networks (e.g., LAN to the internet).
- **Data Handling**: Directs data between networks based on IP addresses.
- **Layer**: Network Layer (Layer 3).
- **Efficiency**: Essential for directing traffic and connecting to the internet.

Network topologies

A topology is a physical layout, of nodes on a network. It describes a network to a wide range.

There are five basic topologies possible: mesh, star, Tree, Bus, and Ring, here's a simple comparison between them:

Bus Topology:

- **Structure**: All devices are connected to a single central cable (bus).
- **Data Flow**: Data travels in both directions along the bus.
- **Advantages**: Simple, cheap, easy to set up.
- **Disadvantages**:
    - Single point of failure (if the bus fails, the network goes down), harder to troubleshoot. ○ The terminators are necessary at both ends of the main cable.
    - Not suitable for a large building.

Ring Topology:

- **Structure**: Devices are connected in a circular chain; each device connects to two others.
- **Data Flow**: Data travels in one direction, passing through each device.
- **Advantages**:
    - Over heavy network load, it gives a good performs than other topologies. ○ Direct Connectivity between devices and file server was not essential.
- **Disadvantages**:
    - A workstation fault influences all networks. ○ Adds, changes, and moves any computer has an attected the entire network. ○ Slower compared to an Ethernet network.

Star Topology:

- **Structure**: All devices are connected to a central hub or switch, can be implemented in the home, office, or building.
- **Data Flow**: Data is sent to the hub, which then forwards it to the correct device.
- **Advantages**: Easy to add or remove devices, Easy to install and wire, centralized control, if one device fails, the network remains unaffected.
- **Disadvantages**:
    - If the hub fails, the entire network goes down. ○ Need an additional cable than a linear topology. ○ Expensive more than bus topology.
    - The protocols for the star configuration are Ethernet.

Tree Topology:

- **Structure**: A hybrid of bus and star, with groups of starconfigured networks connected to a bus.(multiple-star) • **Data Flow**: Data travels up and down the tree hierarchy.
- **Advantages**:
    - Point-to-point wiring for the individual segments.
    - Supported by several companies for hardware and software.
- **Disadvantages**: ○ If the main bus fails, it affects the entire network.
    - The size of each segment is determined by the type of cabling used.
    - Difficult to install than the other topologies.

Mesh Topology:

- **Structure**: Every device is connected to every other device.

- **Data Flow**: Data can travel along multiple paths.
- **Advantages**: Highly reliable, redundant paths ensure that if one device or connection fails, the network can still function.
- **Disadvantages**: Expensive and complex to set up, not scalable for large networks.

Select a suitable topology:

The length of cable required: The Bus network uses shorter lengths of cable.

Scalability: In a star topology, the development of a network is simple.

Cables Type: unshielded twisted-pair cable is the most common which used by the star topologies.

Local Area Networks

A local area network starts from the region of a floor of a house to several kilometers.

Local Area Network is used in business, office buildings, college or university campus, or others.

**Transport speeds of data to 100 or 1 Gbit/s megabits per second.
**The modern LAN operates at up to 10 Gbps compared to wireless networks.

The IEEE 802.11 wireless local area network is standard, commonly named WiFi.

The LAN topology is wired standard IEEE 802.3, which is usually called Ethernet.

It is easier to send data above a wire or during a fiber than the air.

LANs SPECIFICATIONS

- The local networks provide multiple media with a high bandwidth
- A company manages the private LAN as well. LAN rarely closed or limited access to the connection of workstations; local services are regularly for all available time.
- The LAN connects physically adjacent devices on the media.
- RJ 45 connectors can be used now for 10BaseT and others.
- Various connectors can deal with various transmission speeds due to materials used in their manufacture.
- RJ-1 1 connectors can be used for modems, telephones, and faxes.

1. Throughput Rate is the rate of incoming data, and possibly passing through a particular point in a network.
2. The bandwidth is the variation between the highest and lowest frequencies. It is measured in megahertz (MHz).

طيب ب ص

Bandwidth

هو أقصى كمية بيانات الشبكة تقدر تنقلها في وقت معين، يعني كأنك بتقول "الطريق ده يقدر يشيل كام عربية في نفس الوق ت".)الحالة المثالية الي مبتحصلش غالبا أو دائما(

Throughput

فهو فعليًا كمية البيانات اللي بتعدي من الطريق ده في وقت معين، يعني "قد إيه عربيات فعليًا بتعدي على الطريق ".

Chapter 4:

Open System Interconnection Reference Model (OSI Model)

The Open Systems Interconnection Reference Model (OSI Model) has been a vital aspect of the design of networking since its approval in 1984. The OSI is a model of how equipment communicate and network protocols work together.

Benefits of the OSI model

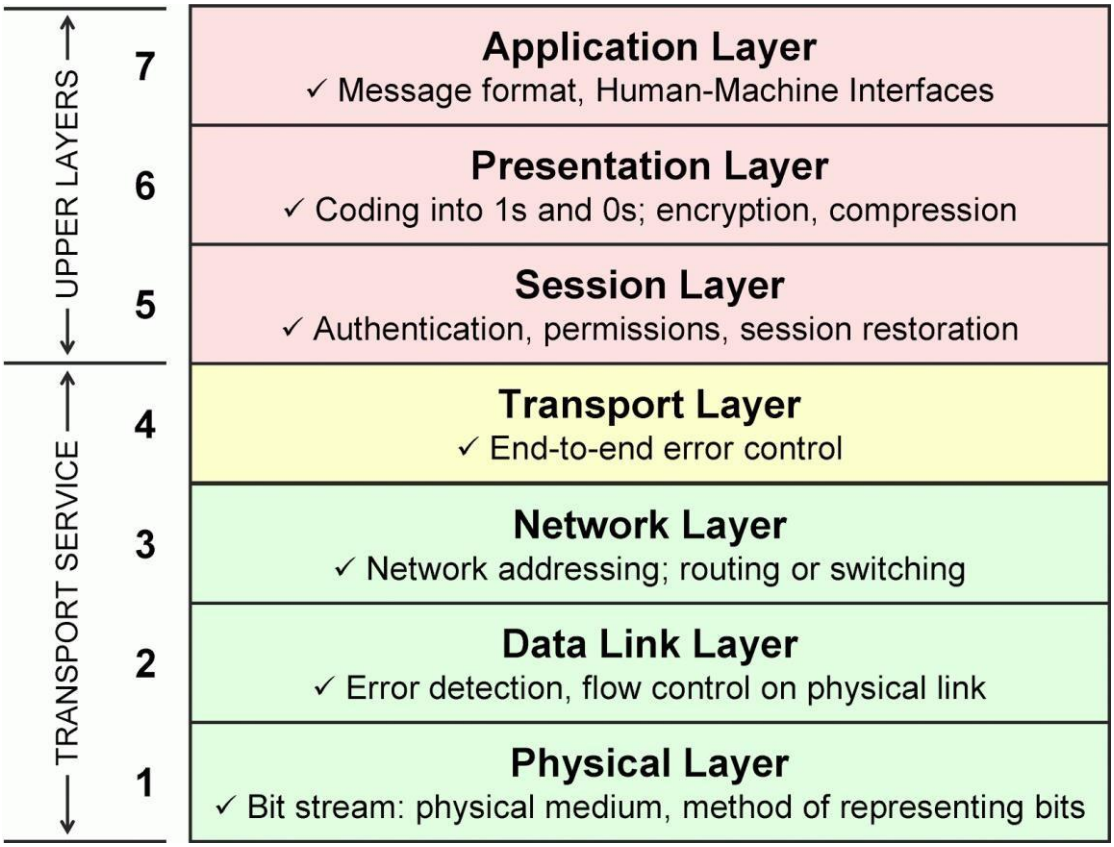
-The OSI model has been planned to ensure different types of devices must all be compatible, if devices are built by various manufacturers.

- The OSI model network designs also gives more scalable as new protocols and additional network services are added.

- This model according to a suggestion of the International Organization for Standardization (ISO) is a first step to standardization of protocols used in the different layers.

The principles of the OSI are:

1. Each layer must execute a well-defined function.
2. The work of each layer must be selected considering the standardized protocols.
3. The limits of the layers have been chosen to reduce the flow of information through interfaces. OSI Model itself is not networked architecture, for this reason, it does not specify exactly which services and protocols are used in each layer.



The OSI reference model consists of seven layers:

The physical layer

The physical layer is concerned with the transferred raw bits over a communication channel. The main challenge here is concerned with the mechanical, electrical, and technical interface, and the means of physical communication

The data link layer

1. The data link layer is the second layer of the OSI model responsible for the reliable transfer of data between adjacent network nodes.

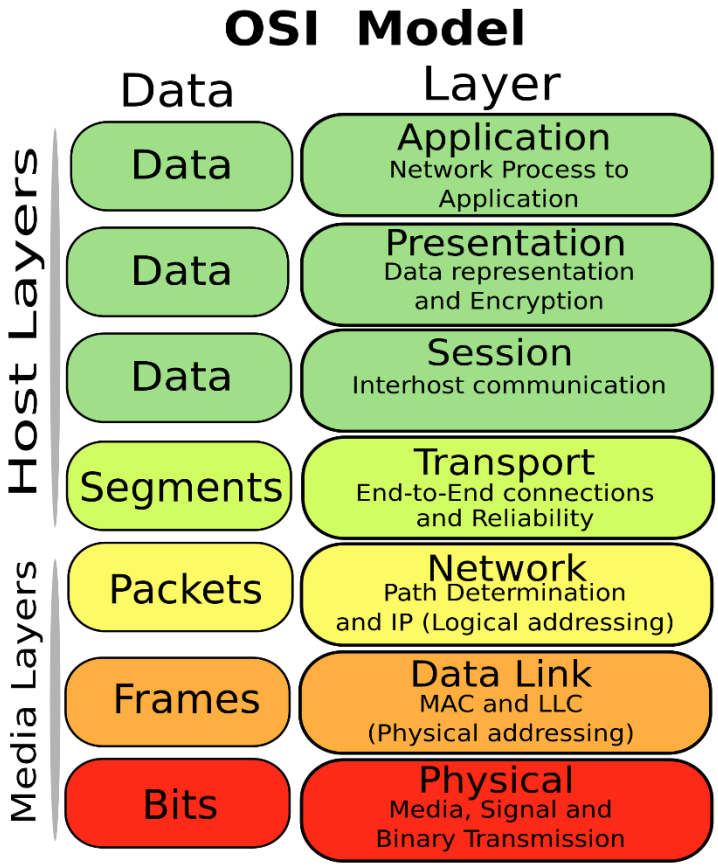
2. It provides services such as framing, error detection and correction, and flow control to ensure the accurate and efficient transmission of data.

3. The data link layer establishes and maintains the logical link between two connected network devices, such as switches or network interface cards (NICs).

4. It utilizes protocols like Ethernet, Point-to-Point Protocol (PPP), and Wi-Fi to facilitate communication and coordinate the exchange of data frames.

5. The data link layer also handles addressing at the Media Access Control (MAC) sublayer, which uniquely identifies devices on a local network.

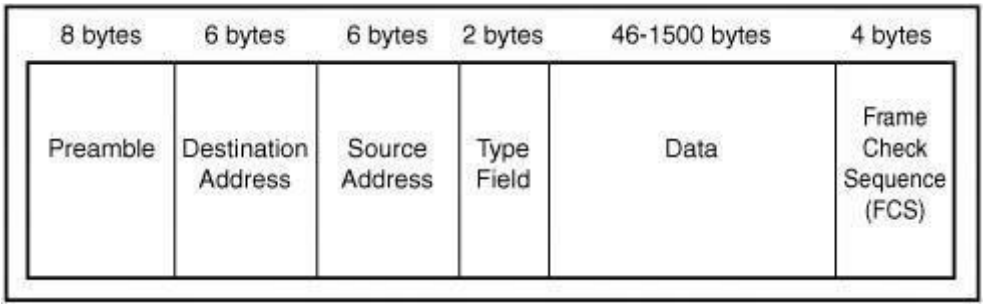
6. Overall, the data link layer plays a crucial role In ensuring the integrity and reliable transmission of data over a physical connection, acting as a bridge between the physical layer and the network layer.

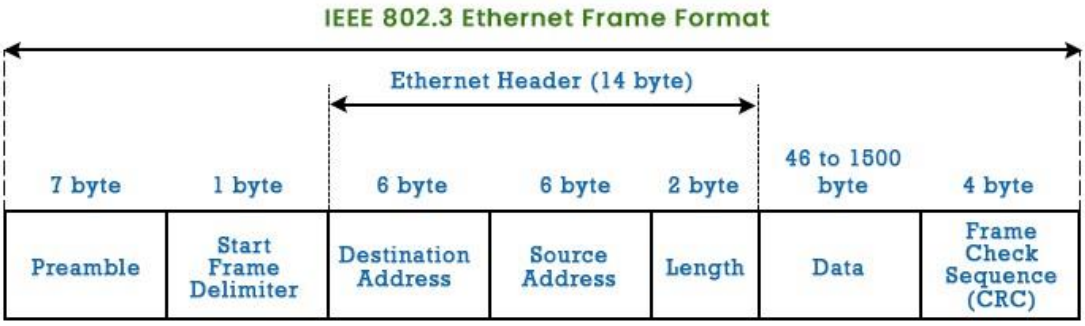


- The data link layer creates frame boundaries. This can be established by attaching particular bit patterns for the start and end of the frame.

The data link layer can offer several different classes of service to the network layer.

Original Ethernet Frame:





The network layer.

1. The network layer, also known as the third layer of the OSI model, is responsible for logical addressing and routing of data packets across different networks.

2. It provides the necessary protocols and services to enable communication between devices on different networks, regardless of their physical connections.

3. One of the key functions of the network layer is to determine the optimal path for data packets to reach their destination by utilizing routing algorithms and maintaining routing tables.

4. The network layer encapsulates the data received from the transport layer into packets, adding necessary header information such as source and destination IP addresses.

5. It also performs fragmentation and reassembly of packets if the data is too large to fit within a single packet, ensuring efficient transmission across the network.

6. Network layer protocols, such as Internet Protocol (IP), enable the identification and addressing of devices by assigning unique IP addresses to each device on a network.

7. The network layer is responsible for the delivery of packets from the source device to the destination device, even if the devices are located on different networks.

8. It handles issues such as packet loss, congestion control, and quality of service (QoS) to ensure reliable and efficient data transmission.

9. Network layer devices, such as routers, operate at this layer and make forwarding decisions based on the destination IP address of the packets.

10. The network layer plays a crucial role in the overall functioning of the internet, allowing for interconnectivity and global communication between networks and devices.

The transport layers.

1. The transport layer, the fourth layer of the OSI model, is responsible for the reliable delivery and end-to-end communication of data between hosts on a network.

2. It provides services such as segmentation, reassembly, and error checking to ensure that data is transmitted correctly and efficiently.

3. The transport layer establishes connections between applications running on different hosts using protocols like Transmission Control Protocol (TCP) and User Datagram Protocol (UDP).

4. TCP, a connection-oriented protocol, guarantees the delivery of data by establishing a reliable connection, managing flow control, and performing error recovery.

5. UDP, a connectionless protocol, offers a lightweight alternative to TCP, providing a best-effort delivery mechanism without the overhead of establishing a connection or performing extensive error recovery.

Session layer

1. The session layer, the fifth layer of the OSI model, is responsible for establishing, managing, and terminating sessions or connections between applications running on different network devices.

2. It provides services that allow applications to communicate and exchange data reliably, including session establishment, synchronization, and maintenance.

3. The session layer handles session control protocols, which manage the dialogue and coordination between communicating applications, ensuring that data is transmitted in an organized and synchronized manner.

4. It also handles session checkpointing and recovery, allowing for the resumption of interrupted sessions in case of network failures or disruptions.

5. The session layer provides mechanisms for authentication, authorization, and accounting (AAA) to ensure secure and controlled access to network resources during session establishment.

6. It enables session data encryption and decryption, protecting the confidentiality and integrity of data transmitted between applications.

The transition is executed in the database is not lost even if the user has not committed. This activity is called synchronization.

Another function of this layer is the control unit that determines who gets to speak at a meeting. That is very useful for video conferencing.

Presentation layer

1. The presentation layer, the sixth layer of the OSI model, focuses on the formatting, encryption, and compression of data to ensure its compatibility and secure transmission between different systems.

2. It handles the translation of data from the application layer into a format that can be understood by the receiving system, and vice versa, through processes such as data encoding and decoding.

3. The presentation layer is responsible for data compression techniques, reducing the size of data for efficient transmission over the network, and decompressing it at the receiving end for proper interpretation.

4. It also handles data encryption and decryption, providing a layer of security for sensitive information during transmission, ensuring confidentiality and integrity.

5. The presentation layer defines a common language or syntax that allows different systems to communicate and interpret data correctly, regardless of their underlying hardware or software differences.

6. It deals with the conversion of data formats, such as converting text files from one character encoding scheme to another, to ensure seamless interoperability between systems with different encoding standards.

7. The presentation layer plays a vital role in ensuring the seamless and accurate transfer of data between applications, while also providing security and data manipulation capabilities to enhance the overall communication process.

Functions of the presentation layer:

- Translation: The networks can deal with different types of computers, for example, Macintosh, PC, Unix, and Mainframe systems which all can be presented to the same network. These systems have many different features and represent the data in different ways; different character sets can be used. The presentation layer manages the group to hide the differences between machines.
- Compression: It is the responsibility layer of compression.
- Encryption: encryption and decryption can be prepared at the presentation layer.

The application layer

An application layer is a layer of abstraction that specifies the protocols and methods of common interface used by the computer in a communication network.

The abstraction Layer application is used for both standard models of computer networks; the Internet protocol suite (TCP / IP) and reference model for Open Systems Interconnection (OSI). Although both models use the same term to its highest respective layer, detailed definitions and functions are different.

**Characteristics of the 7 OSI MODEL LAYERS 7-4 are responsible for end-to-end communications between the sender and the destination. Layers 3-1 are responsible for the communications between network devices.

<table>
<tr><th>OSI Model</th><th>TCP/IP Model</th></tr>
<tr><td>Application Layer</td><td rowspan="3">Application layer</td></tr>
<tr><td>Presentation Layer</td></tr>
<tr><td>Session Layer</td></tr>
<tr><td>Transport Layer</td><td>Transport Layer</td></tr>
<tr><td>Network Layer</td><td>Internet Layer</td></tr>
<tr><td>Data link layer</td><td rowspan="2">Link Layer</td></tr>
<tr><td>Physical layer</td></tr>
</table>

Brief

هو نموذج يوضّح كيف البيانات بتتنقل عبر الشبكات عن طريق تقسيمها OSI Model
الـلطبقات، كل طبقة ليها وظيفة معينة وبتتعاون مع باقي الطبقات عشان البيانات توصل من جهاز
لجهاز تاني.

7. Application Layer

دي الطبقة اللي بتتعامل مباشرة مع المستخدم أو البرامج. الطبقة دي بتسمح للبرامج إنها HTTP تتواصل مع الشبكة، زي لما تفتح المتصفح وتدخل على موقع. بتشمل بروتوكولات زي
اللي بتستخدم في تصفح الإنترنت ونقل الملفات وإرسال الإيميلا ت SMTPو FTPو.

6. Presentation Layer

الطبقة دي بتجهز البيانات عشان تكون بالشكل المناسب وتتفهم في الطبقات اللي بعدها. يعني لو، بتتم العملية هنا. (decryption) أو فك تشفير (encryption) في بيانات محتاجة تشفي ر
برضه بتعمل تحويل لصيغ البيانات زي تحويل الصور والنصو ص.

5. Session Layer

الطبقة دي بتدير الجلسات بين الأجهزة لما يكون في اتصال بيهم. يعني لو عندك اتصال مفتوح بين جهازين، الطبقة دي بتحدد وقت بداية ونهاية الاتصال وبتدير إعادته لو حصل انقطاع.

4. Transport Layer

طبقة مهمة لأنها مسؤولة عن نقل البيانات بشكل مضمون. البروتوكولين الرئيسيين هنا هما:

- TCP (Transmission Control Protocol): بيستخدم لو عايز البيانات توصل مضمونة وفي الترتيب الصح.
- UDP (User Datagram Protocol): بيستخدم لما السرعة أهم من الدقة، زي الفيديوهات والبث المباشر.

3. Network Layer

الطبقة دي مسؤولة عن توجيه البيانات للعنوان الصحيح عبر الشبكة. البروتوكول الأشهر هناIP (Internet Protocol)ه و اللي بيحدد عنوان IP ، أفضل مسار للجهاز المستلم ويختار للبيانا ت.

2. Data Link Layer

دي الطبقة اللي بتتعامل مع الأجهزة على نفس الشبكة. بتقسم البيانات لحزم (frames) أصغرلكل جهاز عشان تضمن إن البيانات توصل MAC عشان تسهّل نقلها، وبتضيف فيها عنوان .للجهاز الصحيح على نفس الشبكة

1. Physical Layer

عبر الكابلات أو (signals) دي أقل طبقة في النموذج، ومسؤولة عن نقل الإشارات الفعلي ة اللاسلكي. الطبقة دي بتتعامل مع التوصيلات، الأسلاك، والنبضات الكهربائية.

اللَّهُمَّ صَ ل علَى مُحَمَّدٍ ، وعلىَ آ ل مُحَمَّدٍ ، كما صَلَّيْ تَ علىَ آ ل إبْرَا هيمَ، إن كَّ حَ ميد مَ جيد ، اللَّهُمَّ ."باَ ركْ علَى مُحَمَّدٍ ، وعلَ ى آ ل مُحَمَّدٍ، كما باَرَكْ تَ علَى آ ل إبْرَا هيمَ ، إنكَّ حَ ميد مَ جيد