

Networks & Server Structures

OSI

Protocols

TCP/IP



OSI Model

Open Systems Interconnection

OSI

- Open Systems Interconnection
- Started in 1977 at ANSI
- Formalized by the ISO in 1983
- Developed to define the basic standards for network communication
- A reference model used to conceptually visualize networking

OSI

- 7 layer model
- Two functional blocks
 - Application block
 - Network block

OSI Layers

- Application - Layer 7
- Presentation - Layer 6
- Session - Layer 5
- Transport - Layer 4
- Network - Layer 3
- Data-Link - Layer 2
- Physical - Layer 1

Application Layer

- Network Processes to Applications
- Controls how the operating system and its applications interact with the network
- Layer where the end users interact with the network

Presentation Layer

- Data Representation
- Takes the data supplied by the lower-level layers and transforms it so it can be presented to the system

Session Layer

- Internet Communications
- Establishes a connection between network devices, maintains that connection, and then terminates it when appropriate
- Controls HOW, WHEN, and FOR HOW LONG a device transmits

Transport Layer

- End to End Connections
- Ensures reliable data transmission
- Ensures that messages are delivered error-free, in sequence, and with no losses or duplications

Network Layer

- Data Delivery
- How packets get from one point to another on a network and what goes into each packet

Data-Link Layer

- Access to Media
- Establishes a reliable protocol through the physical layer so the network layer can transmit its data
- 2 Sub-Layers
 - Logical Link Control (LLC)
 - Media Access Control (MAC)

Data-Link Layer

- LLC - Link establishment and termination
- MAC - handles frame assembly and disassembly, error detection and correction, and addressing

Physical Layer

- Physical Media
- Moves bits of data on and off the physical cabling
- Receives the data from the Data-Link layer and puts it on the cable

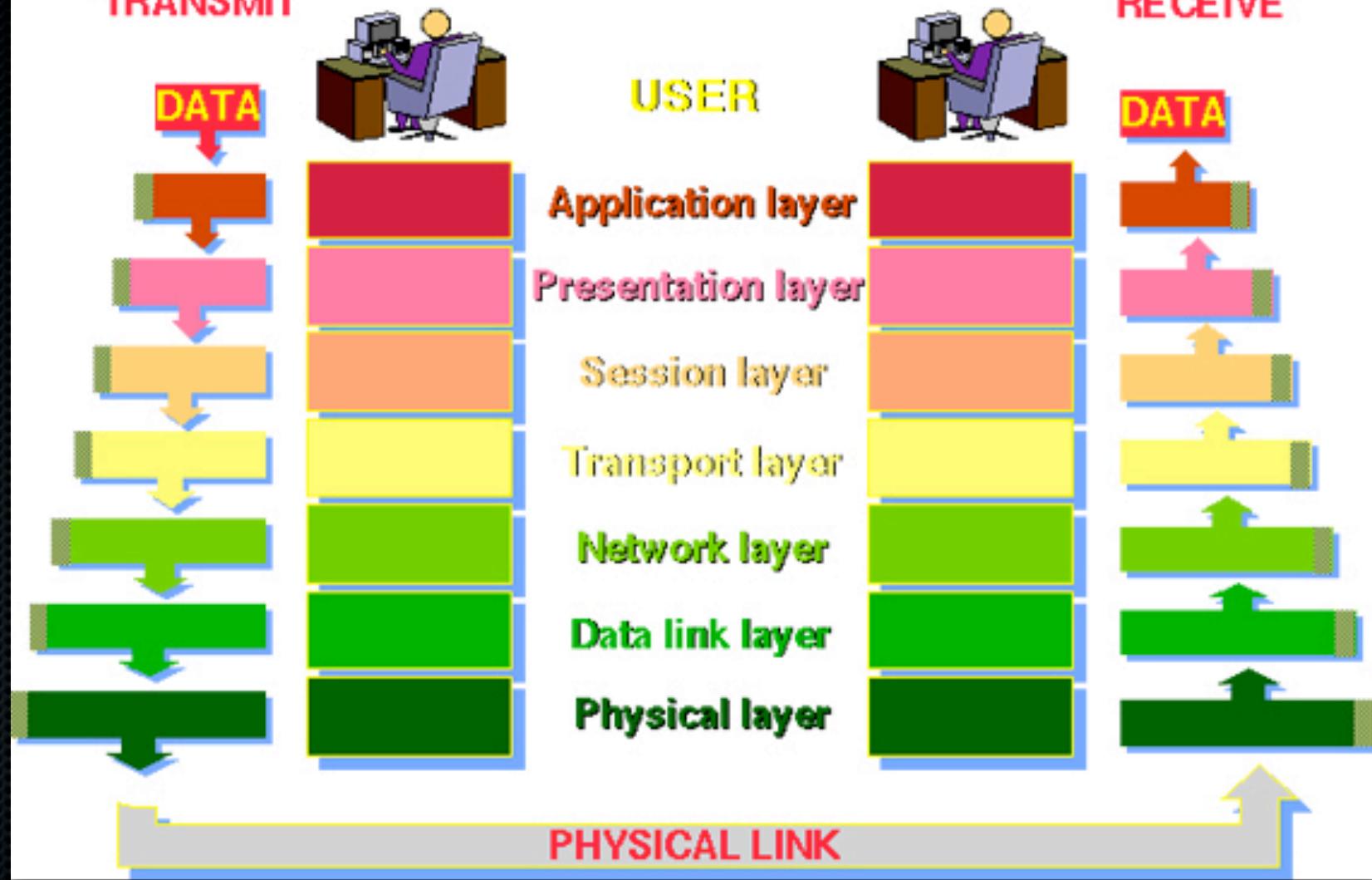
OSI Model			
	Data unit	Layer	Function
Host layers	Data	7. Application	Network process to application
		6. Presentation	Data representation and encryption
		5. Session	Interhost communication
	Segment	4. Transport	End-to-end connections and reliability (TCP)
	Packet/Datagram	3. Network	Path determination and logical addressing (IP)
	Frame	2. Data link	Physical addressing (MAC & LLC)
Media layers	Bit	1. Physical	Media, signal and binary transmission

THE 7 LAYERS OF OSI

TRANSMIT

USER

RECEIVE



OSI Model

- Application
- Presentation
- Session
- Transport
- Network
- Data-Link
- Physical
- All
- People
- Seem
- To
- Need
- Data
- Processing

OSI Model

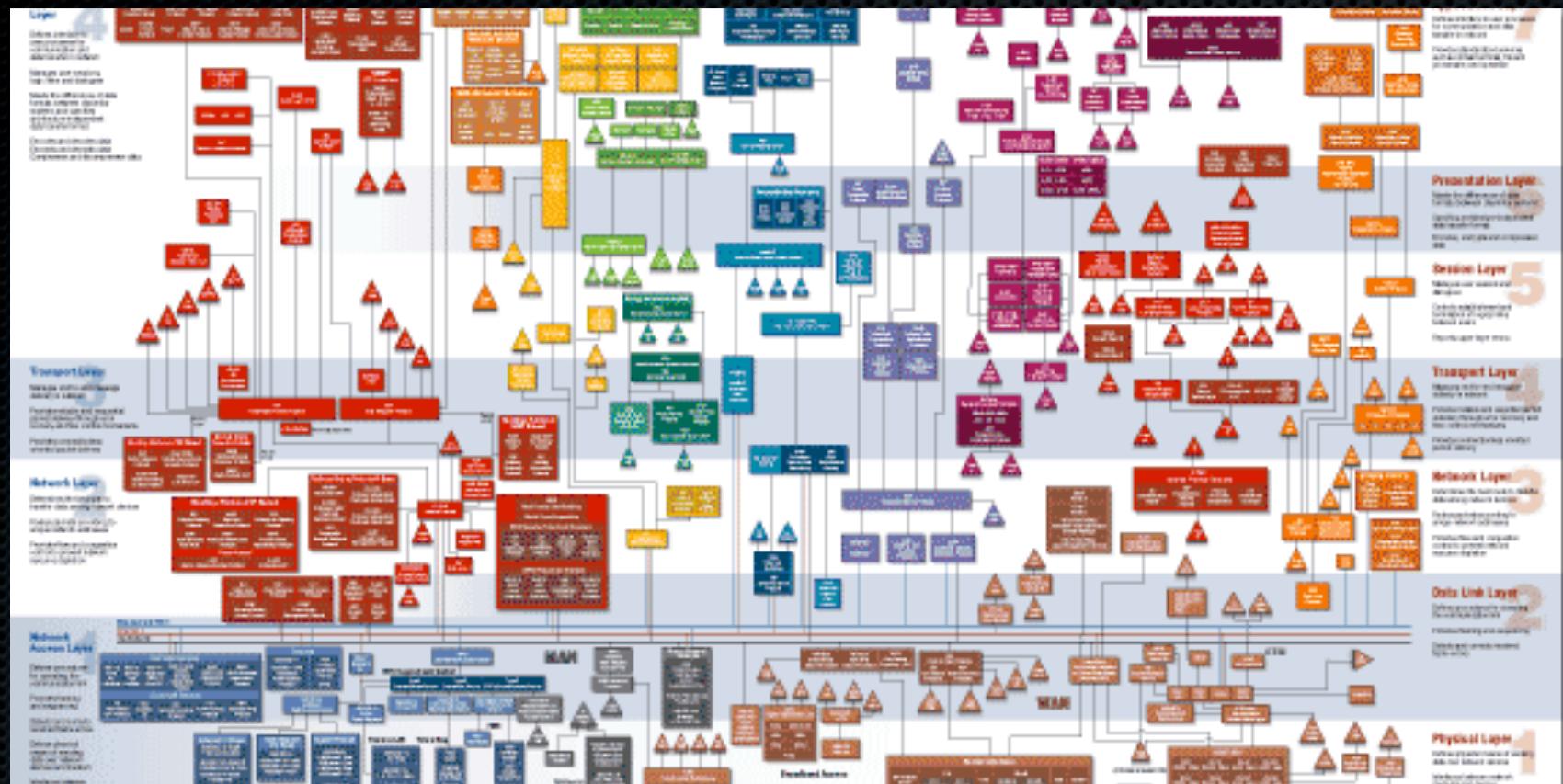
- Application
- Presentation
- Session
- Transport
- Network
- Data-Link
- Physical
- Activity
- Police
- See
- To
- Need
- Don't
- Parties

OSI Model

- Application
- Presentation
- Session
- Transport
- Network
- Data-Link
- Physical
- Data
- Segment
- Packet
- Frame
- Bits

OSI Model

- Data
- Segment
- Packet
- Frame
- Bits
- Don't
- Serve
- People
- Flat
- Beer



Network Protocols

I hope you like acronyms

Protocol

- Rules by which network operations are conducted
- Classified into general families that share common features

Protocols

- Reliability protocols - provide a way to ensure that reliable data transfer occurs
- Connection Protocols - used for establishing and maintaining a connectionless or connection-oriented service for upper layers

Connection-Oriented

- Sending and receiving stations maintain constant communication to mediate the transfer of data
- Sequencing, flow control and reliability are monitored by both ends

Connectionless

- Message is packaged and delivered. Little if any communication takes place between the two parties other than the message itself

Routing Protocols

- Provide a way to ensure that data is transferred to the correct destination



TCP/IP

TCP/IP

...or GTFO

TCP/IP

- Transmission Control Protocol / Internet Protocol
- Network protocol suite that enables computers to communicate over all types of networks
- Native protocol of the internet
- Required for all internet activity
- Developed by Vint Cerf and Bob Kahn in 1974

TCP/IP Suite

- Application Layer
- Transport Layer
- Network Layer
- Data-Link Layer
- Physical Layer

TCP/IP Application Layer

- DHCP
- DNS
- FTP
- HTTP
- POP
- IMAP
- SMTP
- SSH
- Telnet
- SSL
- TLS
- LDAP

DHCP

- Dynamic Host Configuration Protocol
- Automatically assigns IP addresses to computers on the network

DNS

- Domain Name System
- Matches domain names to IP addresses

FTP

- File Transfer Protocol
- Used to send and receive files between an FTP client and an FTP server

HTTP

- Hyper Text Transfer Protocol
- Controls the transactions between a web client and a web server

Application Layer

HTTP Status Codes

- 1xx Class - Informational
 - Request received, continuing process.
 - Indicates a provisional response
- 100 - Continue
 - Server has received the request headers, and that the client should proceed to send the request body
- 101 - Switching Protocols
 - Tells the client that the server will switch protocols to that specified in the Upgrade message header field during the current connection

HTTP Status Codes

- 200 Class - Success
- Indicates that the client's request was successfully received, understood, and accepted.

HTTP Status Codes

- 200 - OK
 - The request sent by the client was successful.
- 201 - Created
 - The request was successful and a new resource was created.
- 202 - Accepted
 - The request has been accepted for processing, but has not yet been processed.
- 203 - Non-Authoritative Information
 - The returned meta information in the entity-header is not the definitive set as available from the origin server.

HTTP Status Codes

- 204 - No Content
 - The request was successful but does not require the return of an entity-body.
- 205 - Reset Content
 - The request was successful but the User-Agent should reset the document view that caused the request.
- 206 - Partial Content
 - The partial GET request has been successful.

HTTP Status Codes

- 3xx - Redirection
 - Indicates that further action needs to be taken by the user agent in order to fulfill the request.

HTTP Status Codes

- 300 - Multiple Choices
 - The requested resource has multiple possibilities, each with different locations.
- 301 - Moved Permanently
 - The resource has permanently moved to a different URI.
- 302 - Found
 - The requested resource has been found under a different URI but the client should continue to use the original URI.
- 303 - See Other
 - The requested response is at a different URI and should be accessed using a GET command at the given URI

HTTP Status Codes

- 304 - Not Modified
 - The resource has not been modified since the last request.
- 305 - Use Proxy
 - The requested resource can only be accessed through the proxy specified in the location field.
- 306 - No Longer Used
 - Reserved for future use.
- 307 - Temporary Redirect
 - The resource has temporarily been moved to a different URI.
The client should use the original URI to access the resource in future as the URI may change

HTTP Status Codes

- 4xx - Client Error
- The request contains bad syntax or cannot be fulfilled.
- Intended for cases in which the client seems to have erred

HTTP Status Codes

- 400 - Bad Request
 - The syntax of the request was not understood by the server.
- 401 - Not Authorized
 - The request needs user authentication
- 402 - Payment Required
 - Reserved for future use.
- 403 - Forbidden
 - The server has refused to fulfill the request.
- 404 - Not Found
 - The document/file requested by the client was not found

HTTP Status Codes

- 405 - Method Not Allowed
 - The method specified in the Request-Line is not allowed for the specified resource.
- 406 - Not Acceptable
 - The resource requested is only capable of generating response entities which have content characteristics not specified in the accept headers sent in the request.
- 407 - Proxy Authentication Required
 - The request first requires authentication with the proxy.
- 408 - Request Timeout
 - The client failed to send a request in the time allowed by the server.

HTTP Status Codes

- 409 - Conflict
 - The request was unsuccessful due to a conflict in the state of the resource.
- 410 - Gone
 - The resource requested is no longer available and no forwarding address is available.
- 411 - Length Required
 - The server will not accept the request without a valid Content-Length header field.
- 412 - Precondition Failed
 - A precondition specified in one or more Request-Header fields returned false.

HTTP Status Codes

- 414 - Request URI Too Long
 - The request was unsuccessful because the URI specified is longer than the server is willing to process.
- 415 - Unsupported Media Type
 - The request was unsuccessful because the entity of the request is in a format not supported by the requested resource for the method requested.

HTTP Status Codes

- 416 - Requested Range Not Satisfiable
 - The request included a Range request-header field, and not any of the range-specifier values in this field overlap the current extent of the selected resource, and also the request did not include an If-Range request-header field.
- 417 - Expectation Failed
 - The expectation given in the Expect request-header could not be fulfilled by the server.

HTTP Status Codes

- 5xx - Server Error
- The server failed to fulfill an apparently valid request.
- Indicate cases in which the server is aware that it has erred or is incapable of performing the request

HTTP Status Codes

- 500 - Internal Server Error
 - The request was unsuccessful due to an unexpected condition encountered by the server.
- 501 - Not Implemented
 - The request was unsuccessful because the server can not support the functionality needed to fulfill the request.
- 502 - Bad Gateway
 - The server received an invalid response from the upstream server while trying to fulfill the request

HTTP Status Codes

- 503 - Service Unavailable
 - The request was unsuccessful due to the server being down or overloaded.
- 504 - Gateway Timeout
 - The upstream server failed to send a request in the time allowed by the server.
- 505 - HTTP Version Not Supported
 - The server does not support or is not allowing the HTTP protocol version specified in the request

Email Protocols

- POP - Post Office Protocol
 - Retrieve email from a remote server
- IMAP - Internet Message Access Protocol
 - Maintains connection with server and saves message state information
- SMTP - Simple Mail Transfer Protocol
 - Used between email servers, and for sending mail at the user level

IRC

- Internet Relay Chat
- A form of real-time Internet chat or synchronous conferencing.
- Mainly designed for group communication in discussion forums called channels, but also allows one-to-one communication via private message, as well as chat and data transfers via Direct Client-to-Client.

Telnet

- Used to access remote computers
- Log onto a system as a regular user

SSH

- Secure Shell Handler
- Allows data to be exchanged using a secure channel between two computers
- Typically used to log into a remote machine and execute commands

SSL

- Secure Sockets Layer
- Provide secure communications for web browsing, e-mail, instant messaging and other data transfers

Application Layer

TLS

- Transport Layer Security
- Basically the same as SSL

Application Layer

LDAP

- Lightweight Directory Access Protocol
- Application protocol for querying and modifying directory services

```
dn: cn=John Doe,dc=example,dc=com
cn: John Doe
givenName: John
sn: Doe
telephoneNumber: +1 888 555 6789
telephoneNumber: +1 888 555 1232
mail: john@example.com
manager: cn=Barbara Doe,dc=example,dc=com
objectClass: inetOrgPerson
objectClass: organizationalPerson
objectClass: person
objectClass: top
```

Transport Layer Protocols

- TCP - Transmission Control Protocol
 - Connection oriented, guaranteed-delivery protocol
- UDP - User Datagram Protocol
 - Connectionless, best-effort delivery protocol
 - Sends data but does not take responsibility for the data's integrity

TCP 3-Way Handshake

- 3 Way Handshake
- Connection requester sends a SYN packet to receiving device
- Receiving device responds with a SYN and ACK packet
- Initiating device acknowledges the receiver's SYN packet

Network Layer Protocols

- IP - Internet Protocol
- ARP - Address Resolution Protocol
- ICMP - Internet Control Message Protocol
- RIP - Routing Information Protocol
- OSPF - Open Shortest Path First
- IGRP - Interior Gateway Routing Protocol
- BGP - Border Gateway Protocol

IP

- Internet Protocol
- The principal communication protocol used for relaying packets across network boundaries

ARP

- Address Resolution Protocol
- Determines the Data-Link layer address (MAC address) for known IP addresses

ARP

- How ARP works
- Incoming packet destined for a host machine arrives at a gateway
- Gateway asks the ARP program to find a MAC address that matches up with the IP address
- ARP looks in the ARP cache, if no match is found ARP broadcasts a request packet to all machines on the LAN asking who owns the IP address
- The machine with that IP address replies
- ARP updates the ARP cache for future reference and sends the packet to the MAC address that replied

ICMP

- ❖ Internet Control Message Protocol
- ❖ A message control and error-reporting protocol
- ❖ Echo request

Data-Link Layer Protocols

- Wi-Fi
- WIMAX
- ATM
- Token Ring
- Ethernet
- FDDI
- EVDO
- PPP
- PPTP
- L2TP
- ISDN

Ethernet - 802.3

- a family of frame-based computer networking technologies for LAN's. Defines a number of wiring and signaling standards and a common addressing format.
- In use since the early 80's.
- Developed at Xerox PARC by Bob Metcalfe
- Most popular and widely deployed network technology in the world

Wi-Fi - 802.11

- Wireless Fidelity
- Wireless network access
- Certification by the Wi-Fi Alliance
- Actually a superset of 802.11 - Wi-Fi technology builds on the IEEE 802.11 standards

IEEE 802.11 Standards

- 802.11a - 54 Mbps, (22 Mbps actual) 50 ft
- 802.11b - 11 Mbps, 100 ft - prone to interference
- 802.11g - 54 Mbps, 100 ft
- 802.11n - 150 Mbps, 50 ft

- IEEE 802.1 Bridging (networking) and Network Management
- IEEE 802.2 Logical link control (inactive)
- IEEE 802.3 Ethernet
- IEEE 802.4 Token bus (disbanded)
- IEEE 802.5 Defines the MAC layer for a Token Ring (inactive)
- IEEE 802.6 Metropolitan Area Networks (disbanded)
- IEEE 802.7 Broadband LAN using Coaxial Cable (disbanded)
- IEEE 802.8 Fiber Optic TAG (disbanded)
- IEEE 802.9 Integrated Services LAN (disbanded)
- IEEE 802.10 Interoperable LAN Security (disbanded)
- IEEE 802.11 Wireless LAN & Mesh (Wi-Fi certification)
- IEEE 802.12 demand priority (disbanded)
- IEEE 802.13 Cat.6 — 10Gb lan (new founded)
- IEEE 802.14 Cable modems (disbanded)
- IEEE 802.15 Wireless PAN
 - IEEE 802.15.1 (Bluetooth certification)
 - IEEE 802.15.4 (ZigBee certification)
- IEEE 802.16 Broadband Wireless Access (WiMAX certification)
 - IEEE 802.16e (Mobile) Broadband Wireless Access
- IEEE 802.17 Resilient packet ring
- IEEE 802.18 Radio Regulatory TAG
- IEEE 802.19 Coexistence TAG
- IEEE 802.20 Mobile Broadband Wireless Access
- IEEE 802.21 Media Independent Handoff
- IEEE 802.22 Wireless Regional Area Network

PPP

- Point to Point Protocol
- Used to establish a direct connection between two nodes over serial cable, phone line, trunk line, cellular telephone, specialized radio links, or fiber optic links
- Typically used for dial-up access

PPTP

- Point to Point Tunneling Protocol
- Used for implementing virtual private networks

Data-Link Layer

L2TP

- Layer 2 Tunneling Protocol
- Used for tunneling network traffic between two peers over an existing network (usually the Internet)

Physical Layer

- Physical Ethernet
- Optical Fiber
- Coaxial Cable
- Twisted Pair Wiring



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