TCP/ IP

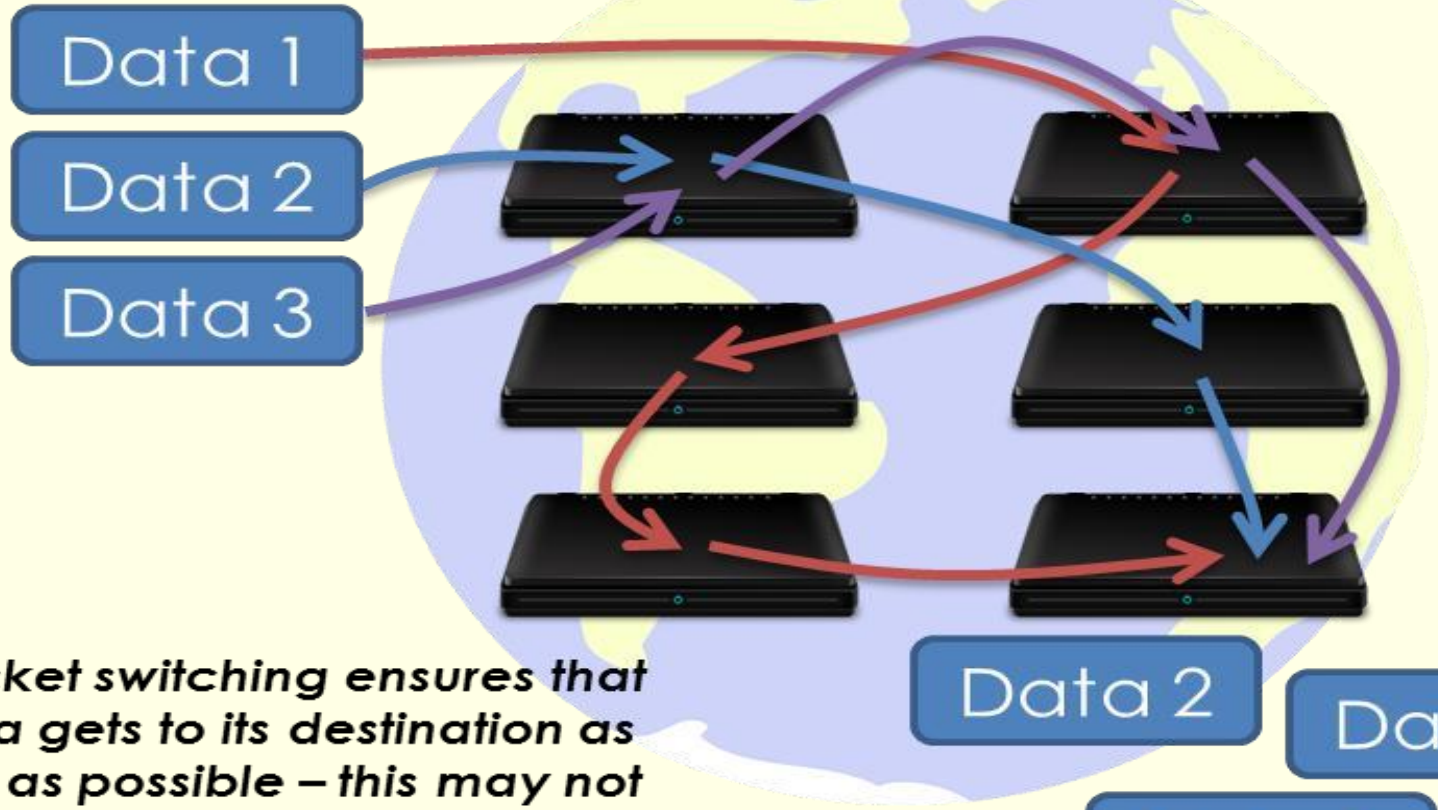
Concept of network layers

Packet Switching - TCP/IP – Transmission Control Protocol

1. A file is split into data packets

2. Routers follow the IP rules and direct data packets towards their destination.

3. Due to network traffic, packet switching may occur where the packets may take different routes and be directed to other routers before arriving at the destination.



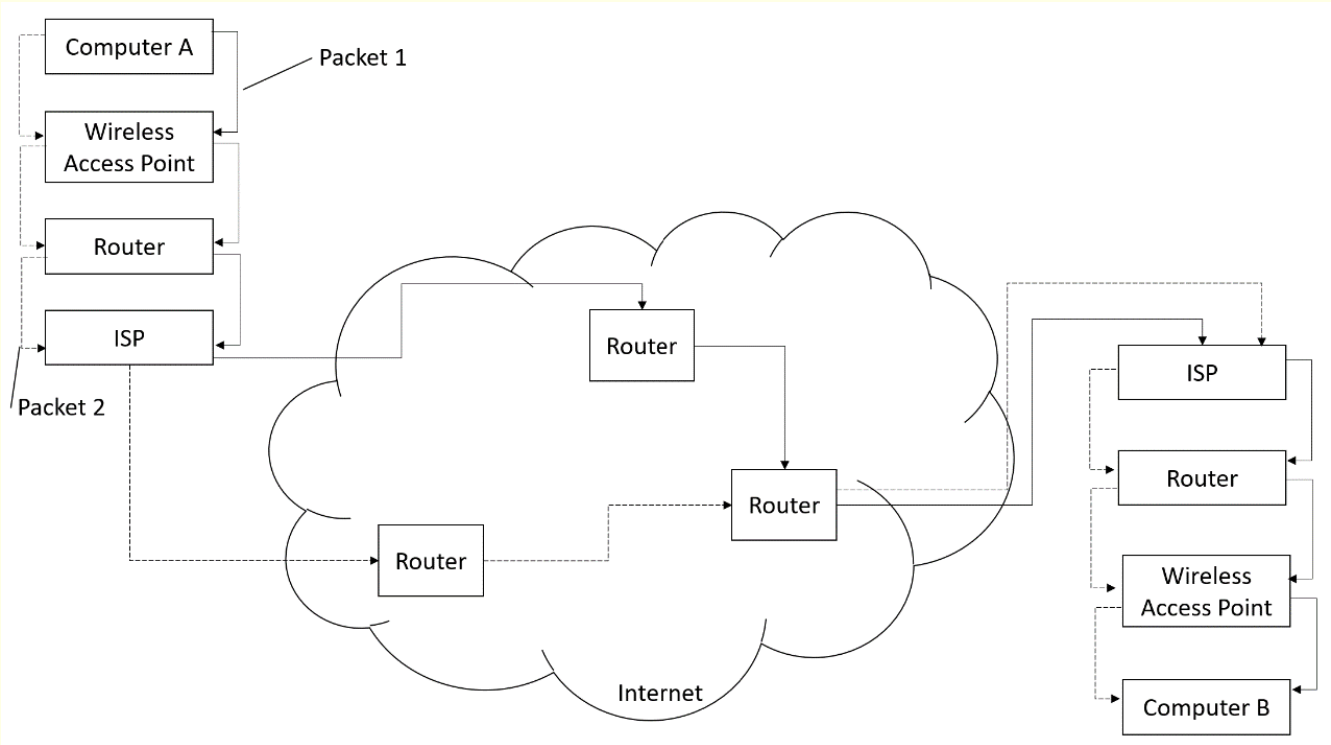
4. If the packets are in the wrong order, the packet number can be used to reorder them back into the original file.

Packet switching ensures that data gets to its destination as fast as possible – this may not be the shortest distance however.

This is what happens when Computer A wants to send data to Computer B across the internet.

- Computer A splits the data into packets according to an agreed set of protocols.
- A header is attached to each packet containing important information, including:
  - the IP address of the sending computer (source)
  - the IP address of the recipient computer (destination)
  - the sequence number of the packet
  - the total number of packets being sent
  - a **checksum**.
- Packets are forwarded by a router on Computer A's network to the ISP.

- The ISP's router inspects the packet header to find the destination address and uses a **routing table** to determine where to send the packet next. It is likely that a packet will be forwarded from one router to another several times before reaching its destination.
- Routers keep each other informed of traffic conditions on their part of the network. If there is congestion on one route, the next packet to arrive will be sent a different way to avoid it.
- Once a packet arrives at its destination, the checksum formula is applied to the data. The generated checksum is compared to the one calculated at the source and sent with the packet. If they do not match, the destination will request the packet to be resent from the source.
- Packets from the same transmission may arrive at their destination via different routes and on arrival may be out of sequence.
- Once all the packets have reached Computer B, it uses the same set of agreed protocols to reassemble them in the correct order.



A data packet

Header	IP address of source IP address of destination Sequence number of packet Total number of packets Checksum
Body	Data
Footer	End of packet flag

Why split into packets?

- Speeds up data transfer
- Packets can be sent via different routes so they don't have to be sent along a single pathway
- Reduces the impact of data corruption

Packet Structure

An error check is an important aspect of a data packet.

This aspect of the packet is a '**checksum number**'. A checksum is made up of a calculation and its correct answer. Once the packet has been received by the destination computer, If the calculation is run and still produces the correct answer, then we know the data hasn't been corrupted on its journey.

This this the data itself.

The Header contains 3 pieces of information:

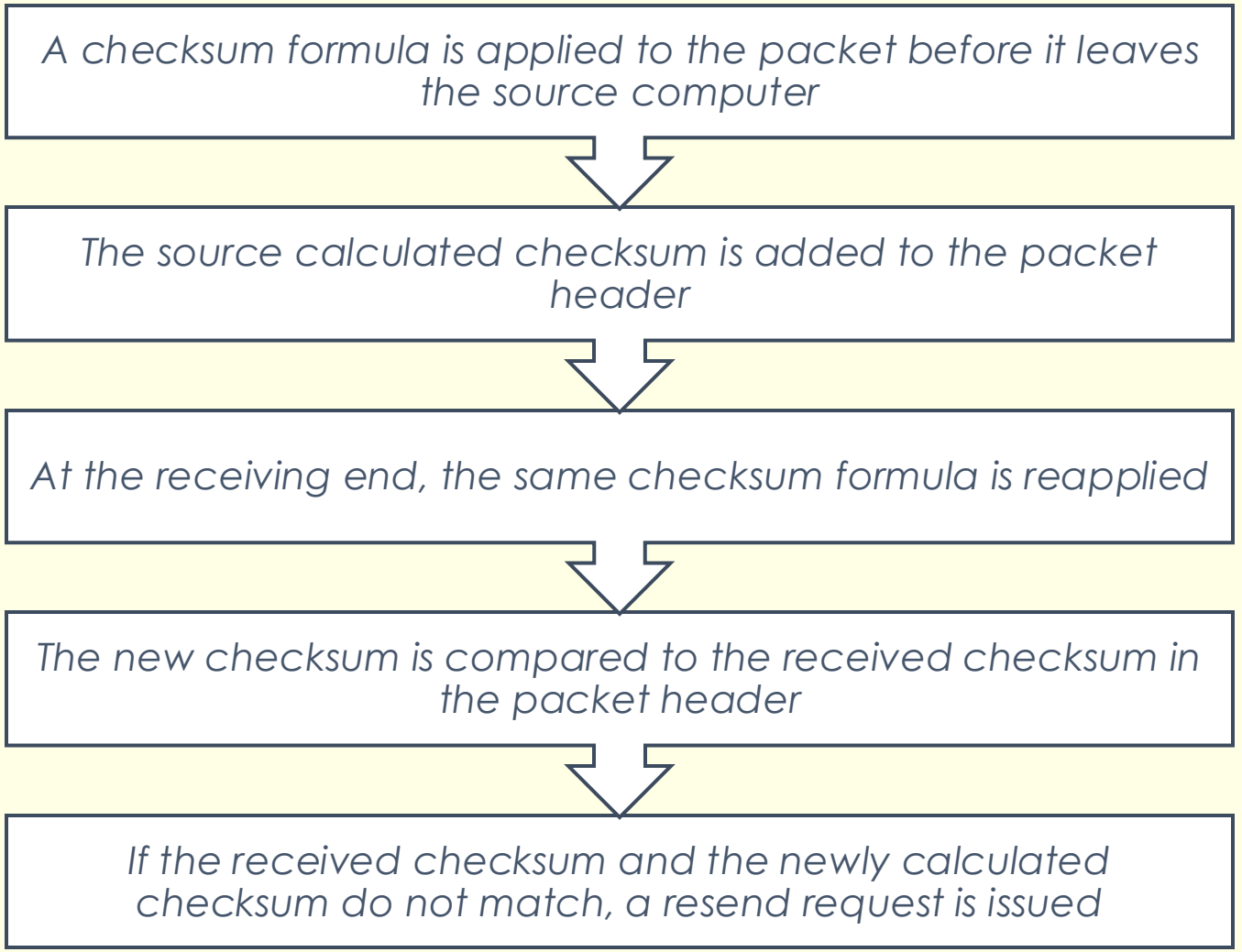
Sequence Number
Return Address
Destination Address.

As data is split into packets, the sequence number allows the file to be rebuilt by putting the packets back together in the correct order.

When data arrives, the computer which sent the data can be notified that it arrived safely. And if a packet arrives corrupted, the computer which sent the data can be asked to send it again.

Obviously a data packet needs a destination address so that it can be routed to the correct location.

Check sum - *Describe how a checksum is used to identify packets that have been corrupted during transmission.*



Network Layers – TCP/IP model

A division of network functionality so that it allows a developer to concentrate on one aspect of the network

Layer	Example Protocols	Layer Purpose
Application Layer	FTP, HTTP, SMTP	Selects the correct protocol depending application, e.g. sending an email or viewing a web page.
Transport Layer	TCP	Provides transport of data between devices by splitting files into data packets and checking that they have been sent and received correctly.
Internet Layer	IP	Provides the routing of data across the network by making use of IP addressing. Adds the source and destination IP's to the packets.
Data Link Layer	Ethernet, WiFi	Provides the physical transport of data, such as the NIC and Cabling

For example, if you are accessing a website (HTTP – application layer), it requires data to be split into packets and sent across the internet (TCP – Transport layer / IP – network layer), which in turns requires the physical transport of data via cables (cables / Wi-Fi – data link layer).

Sending data from Computer A to Computer B

There are four layers in the TCP/IP model. Each layer has a particular function. Data passes down the layers of the stack when sending and back up the layers in reverse order when receiving. Together the four layers of the stack enable packets of data, software applications and physical network equipment to communicate with one another over the internet ensuring that packets are sent to the correct location and that the data they contain is not corrupted.

Without this stack, each hardware and software supplier would need their own customised system which would make things much more complicated.

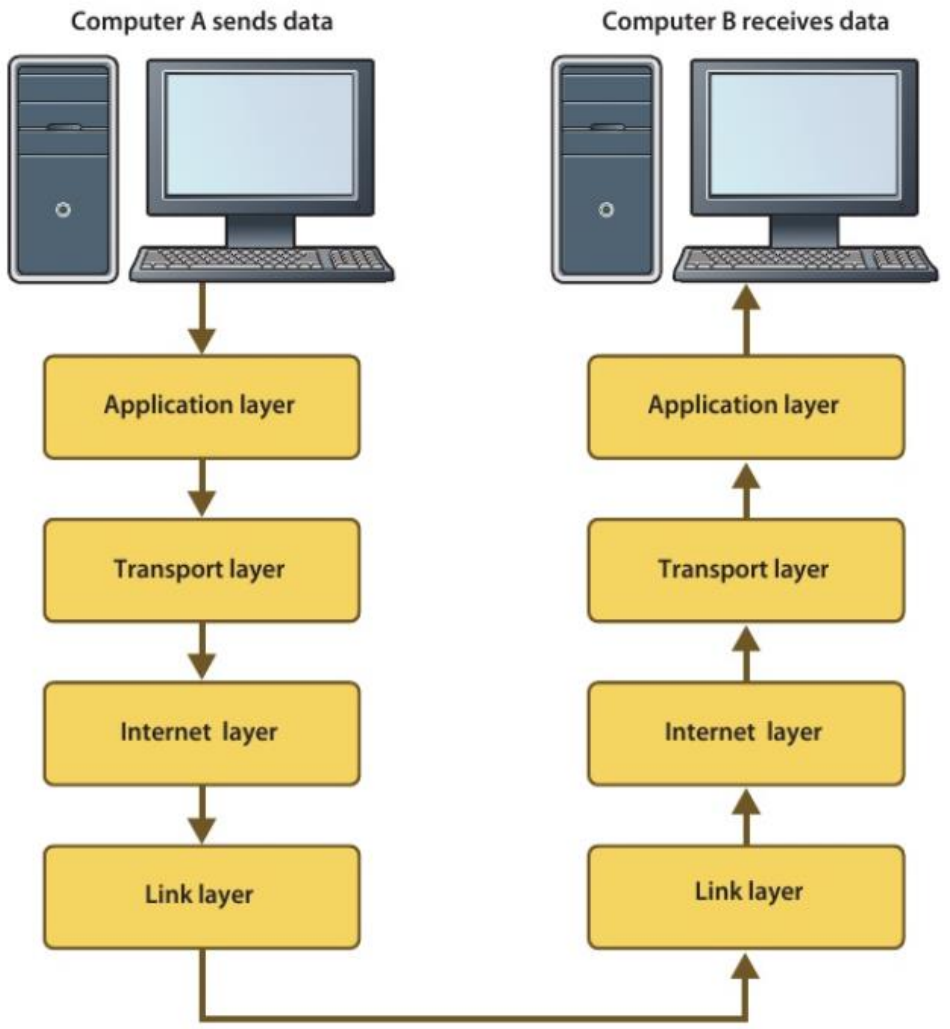


Figure 4.1.15 Layers within the TCP/IP suite pass data down the stack when sending and back up the stack when receiving

Sending data from Computer A to Computer B

	Computer A	Computer B
Application layer	FTP defines how the file must be requested.	FTP defines how the file will be provided.
Transport layer	TCP establishes a channel between the sending and receiving devices and splits the data into packets.	TCP reassembles the packets and checks that they are correct.
Internet layer	IP adds a packet header with the source and destination IP addresses.	IP removes the packet headers.
Link layer	Ethernet/Wi-Fi convert outgoing data packets into electric/radio signals for transmission to the network router. The packets are routed across the internet until they reach, and are received by, the link layer on Computer B.	Ethernet/Wi-Fi protocols specify how incoming signals should be converted back into data packets.

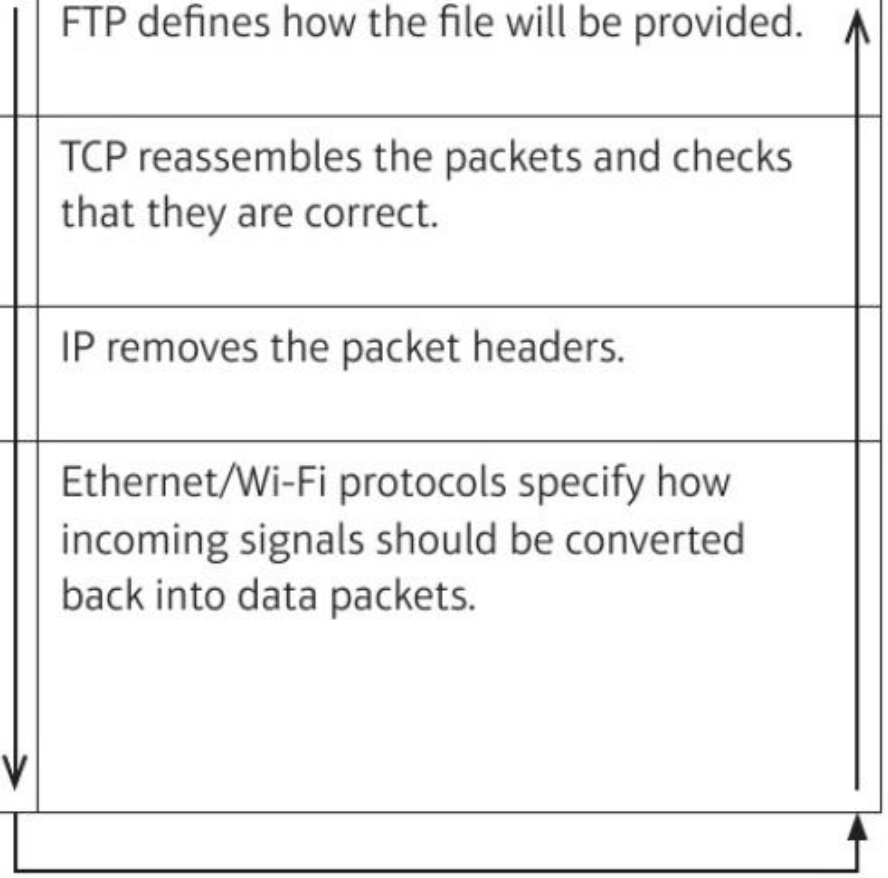


Figure 4.1.16 The role of the layers of the TCP/IP stack in transferring a file between two computers A and B. The data starts at the top of the stack in Computer A and works its way down to the bottom. When it reaches Computer B it works its way back up the stack to the top.