What's the difference between a hub, a switch, and a router?

> Hubs, switches, and routers are all computer networking devices with varying capabilities. Unfortunately, the terms are also often misused.

// *What's the difference between a hub, a switch, and a router?*

In a word, intelligence.

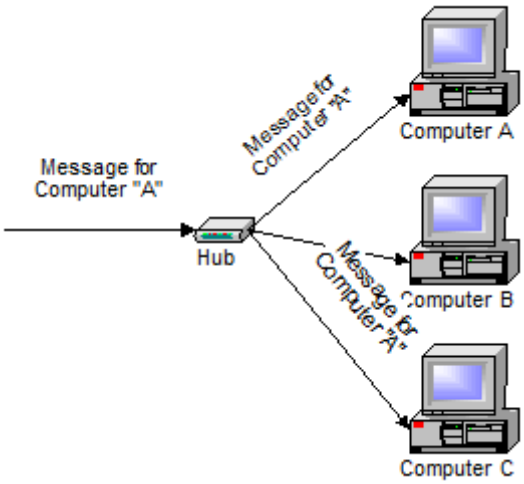
Hubs, switches, and routers are all devices that let you connect one or more computers to other computers, networked devices, or even other networks. Each has two or more connectors called ports into which you plug in the cables to make the connection. Varying degrees of magic happen inside the device and therein lies the difference. I often see the terms misused, so let's clarify what each one really means.

Hubs

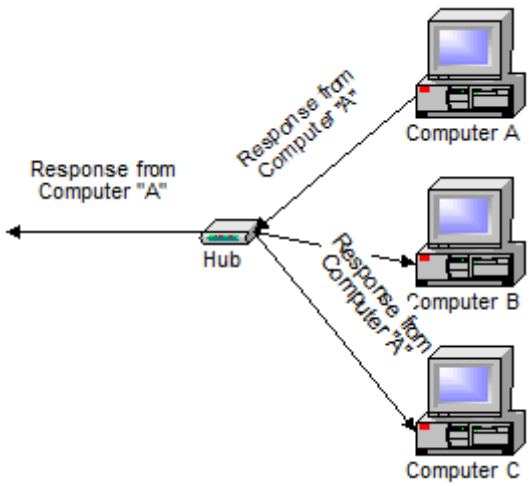
A **hub** is typically the least expensive, least intelligent, and least complicated of the three. Its job is very simple – anything that comes in one port is sent out to the others.

That's it.

If a message[1] comes in for computer "A", that message is sent out all the other ports, regardless of which one computer "A" is on:



And when computer "A" responds, its response also goes out to every other port on the hub:



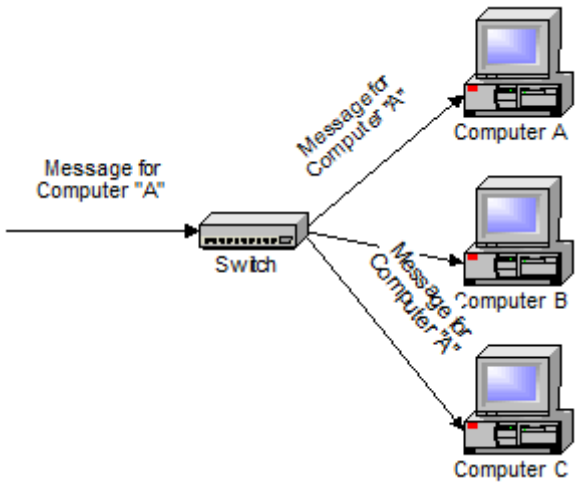
Every computer connected to the hub "sees" everything that every other computer on the hub sees. The computers themselves decide if they are the targeted recipient of the message and when a message should be paid attention to or not.

The hub itself is blissfully ignorant of the data being transmitted. For years, simple hubs have been quick and easy ways to connect computers in small networks.

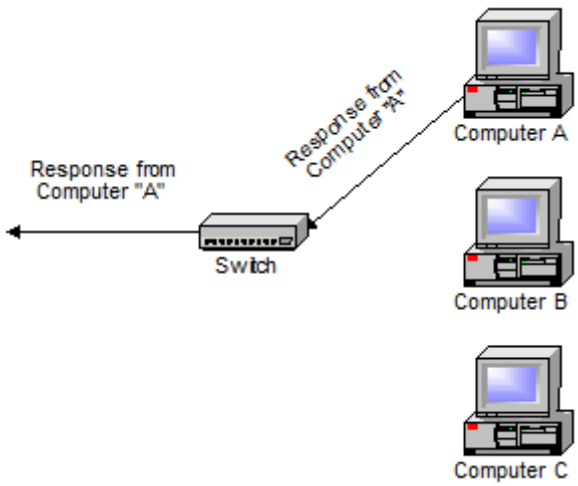
Switches

A **switch** does essentially what a hub does, but more efficiently. By paying attention to the traffic that comes across it, it can "learn" where particular addresses are.

Initially, a switch knows nothing and simply sends on incoming messages to all ports:

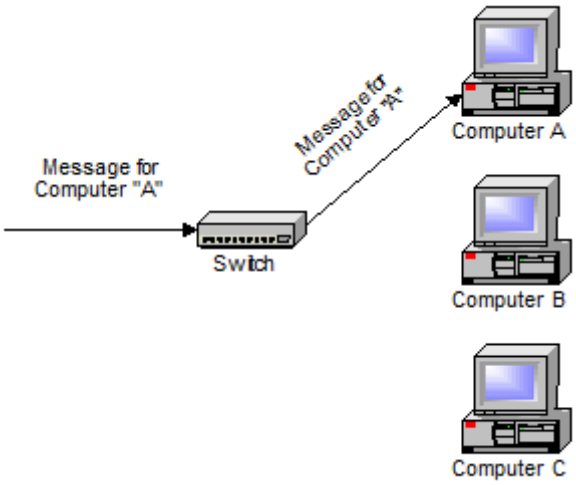


Even accepting that first message, however, the switch has learned something – it knows on which connection the sender of the message is located. Thus, when machine "A" responds to the message, the switches only need to send that message out to the one connection:



In addition to sending the response through to the originator, the switch has now learned something else – it now knows on which connection machine "A" is located.

That means that subsequent messages destined for machine "A" need only be sent to that one port:



Switches learn the location of the devices that they are connected to almost instantaneously. The net result is that most network traffic only goes where it needs to rather than to every port. On busy networks, this can make the network *significantly* faster.

Routers

A **router** is the smartest and most complicated of the bunch. Routers come in all shapes and sizes – from the small, four-port broadband routers that are very popular right now to the large industrial strength devices that drive the internet itself.

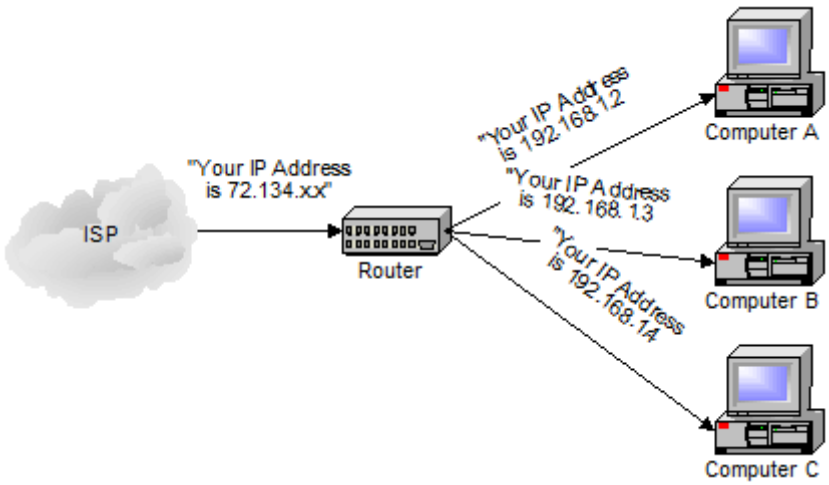
A simple way to think of a router is as a computer that can be programmed to understand, possibly manipulate, and route the data that it's being asked to handle. Many routers today are, in fact, little computers dedicated to the task of routing network traffic.

As far as simple traffic routing is concerned, a router operates exactly as a switch, learning the location of the computers on its connections and routing traffic only to those computers.

Consumer grade routers perform at minimum two additional and important tasks: DHCP and NAT.

DHCP – Dynamic Host Configuration Protocol – is the way dynamic IP addresses are assigned. A device asks for an IP address to be assigned to it from "upstream" and a DHCP server responds with an IP address assignment. A router connected to your ISP-provided internet connection will typically ask your ISP's server for an IP address; this will be your IP

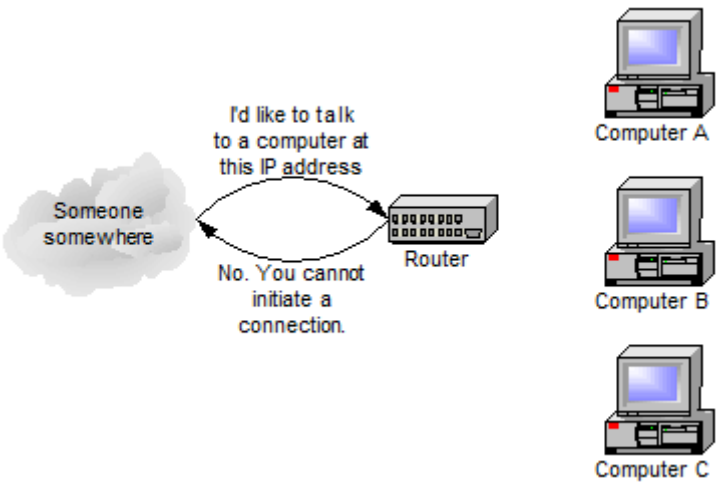
address on the internet. Your local computers, on the other hand, will ask the router for an IP address and these addresses are local to your network.



NAT – Network Address Translation – is the way that the router *translates* the IP addresses of packets that cross the internet/local network boundary. When computer "A" sends a packet out, the IP address that it's "from" is that of computer "A" – 192.168.1.2 in the example above. When the router passes that on to the internet, it replaces the local IP address with the internet IP address assigned by the ISP. It also keeps track, so that if a response comes back from somewhere on the internet, the router knows to do the translation in reverse – replace the internet IP address with the local IP address for machine "A" and then send that response packet on to machine "A".

A side effect of NAT is that machines on the internet cannot initiate communications to local machines – they can only respond to communications initiated by those local machines.

The net effect is that the router then also acts as a firewall:



What that means is that malware that might spread by trying to independently connect to your computer over the network cannot.

All routers include some kind of user interface for configuring how the router will treat traffic. The really large routers include the equivalent of a full-blown programming language to describe how they should operate as well as the ability to communicate with other routers to describe or determine the best way to get network traffic from point A to point B.

A note about speed

A quick note on one other thing that you'll often see mentioned with these devices and that's network speed. Most devices now are capable of both 10mbps (10 mega-bits, or million bits, per second) as well as 100mbps and will automatically detect the speed.

More and more devices are now capable of handling 1000mbps or a billion bits per second (1gpbs).

Similarly, many devices are now also wireless transmitters that simply act like additional ports on the device.

Read more:

- How do I secure my router? Your router is your first line of defense against malicious attacks from the internet. But is your router secure? I'll review the important settings.
- How should I set up my home network? Once you add a second computer to you're faced with setting up a network, at least to share the internet connection. Here are some general guidelines.
- What kind of router do I need? A router is a router is … actually, there are several different kinds of routers that are used in different situations. I'll review the most common.
- What's the difference between a router, a wireless router and a wireless access point? Unfortunately, terminology has become quite confused around routers and access points, I'll describe each, how they relate, and why differences matter.

This is an update to an article originally posted November 19, 2003

Footnotes and references

1: I use “message” here to keep things conceptually simple. The more correct term would be “packet,” as each of these devices operates on discrete packets of information traveling on the network.

Posted: February 23, 2013 in: Networking
Shortlink: https://askleo.com/1862
TAGS: BESTOF, DHCP, HUB, NAT, ROUTER, SWITCH

About Leo

Leo A. Notenboom has been playing with computers since he was required to take a programming class in 1976. An 18 year career as a programmer at Microsoft soon followed. After "retiring" in 2001, Leo started Ask Leo! in 2003 as a place for answers to common computer and technical questions. More about Leo.

« Why is there so much spam?

Why do so many tech support solutions start with “reboot” or “turn it off”? »

Comments

Felix October 10, 2016 at 12:50 pm

That's really informative. I was reading on https://www.libertycenterone.com/blog/routers-vs-switches-whats-the-difference/ that fixed switches are not expandable. Is this always true? I haven't found much other information on the topic.

REPLY

Leo October 10, 2016 at 1:34 pm

"Always" true? Hardly. Depends on what they mean by expandable, but I've certainly done it and seen it done.

REPLY

Liya Alex November 3, 2016 at 1:29 am

Hi Leo
Very good explanation Leo.
I like the way you explain. It is very very easy to understand especially for beginners.
Good job Leo

REPLY

Emmanuel Philip November 18, 2016 at 1:34 am

Well understood. Thanks leo

REPLY

Leo November 20, 2016 at 1:04 pm

This sounds like a test or school question. I'm afraid we won't do your homework for you.

REPLY

Ivona November 24, 2016 at 9:09 am

Thank you so much, you helped me a lot!

REPLY

Adnan November 28, 2016 at 6:39 pm

Good info, more easy understanding.
good job leo. Thank you.

REPLY

Drew Hayes December 22, 2016 at 1:05 am

Yes, very helpful article!

I have a question about how routers accurately direct traffic to local machines, about how exactly the router "also keeps track [of outgoing traffic], so that if a response comes back from somewhere on the internet, the router knows to do the translation in reverse – replace the internet IP address with the local IP address for machine "A" and then send that response packet on to machine "A" ". Say 'Computer A' and 'Computer B' are both trying to communicate with Gmail's servers (or, anything with a single IP address). The router will have seen both Computers send data to IP Address 'X'. When the router sees a response coming back from IP Address 'X,' how will it know which computer the response is meant for? Is this a corner case, or a common issue that routers have a way of dealing with?

REPLY

Rod Ayers January 4, 2017 at 11:31 am

I enjoy reading your articles Leo. As much as I think I know, I find out how much I don't!

REPLY

Isaac February 1, 2017 at 4:36 am

thanks Leo

REPLY

Stanis February 17, 2017 at 5:29 am

A very clean and helpful explanation. One thing that I want to point out though, maybe you should use Mbps instead of mbps, as upper-case M refers to Mega and lower-case m refers to mili (0.001). Same thing with Gbps, although there's nothing relates to lower-case g. Other than that, thanks for clearing everything out!

REPLY

John B
March 19, 2017 at 2:36 am

Excellent plain English explainations !!! Thanks

REPLY

Rahul Veerabathini
March 19, 2017 at 4:56 am

excellent LEO sir .....

very very wonderful ...EASY ..explanation ...

I could understood those topics by simply seeing the pictures only ....

very very thanks you sir ....

keep it up... sir.....tqqqqqqqq..

REPLY

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- **No personal information.** Email addresses, phone numbers and such will be removed.

VERY IMPORTANT: comments that do not ***add to the discussion*** - typically spammy, off-topic, or content-free comments - will be removed.

I'm strict about it so that comments can be valuable for *everyone*, including those who come later and take the time to read.

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