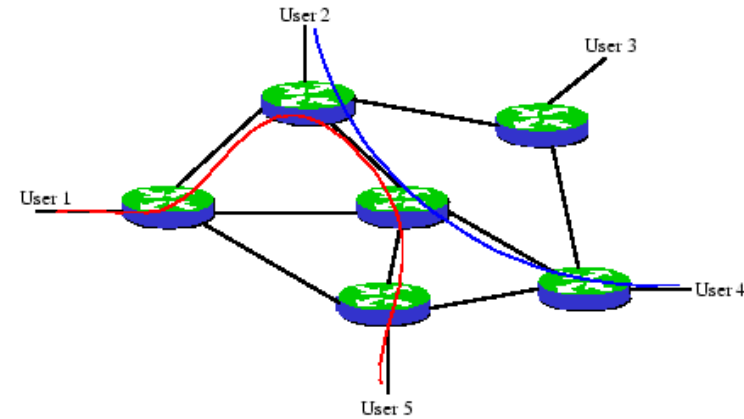
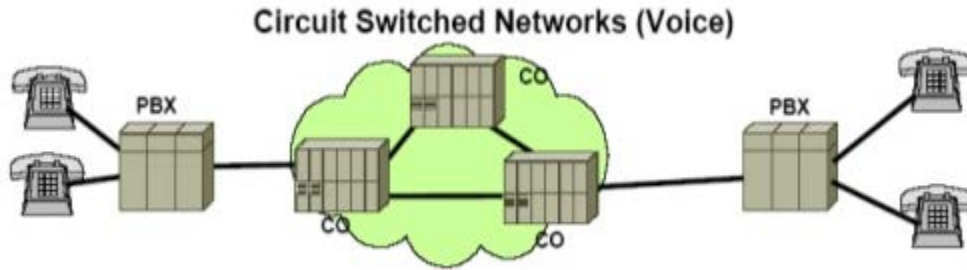
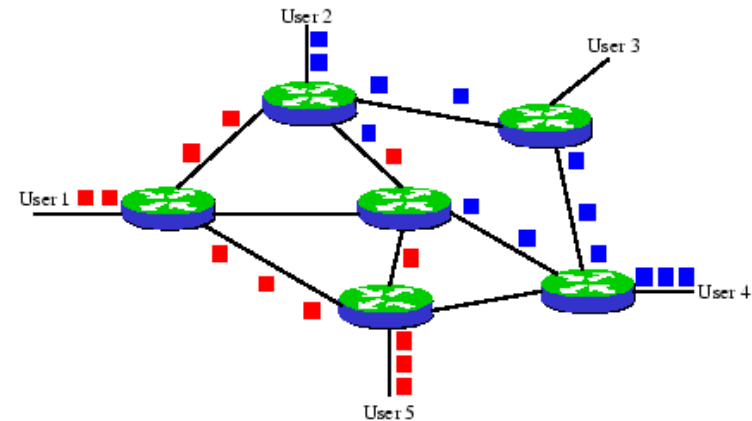
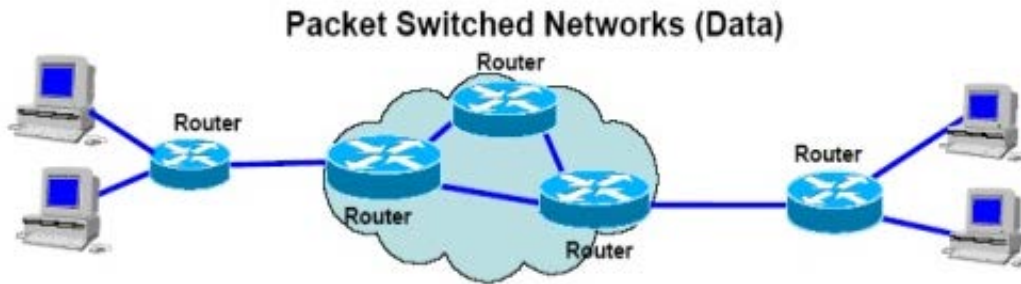


Two dominant WAN technologies currently existing in the world:¹

1) Circuit switching.



2) Packet switching.

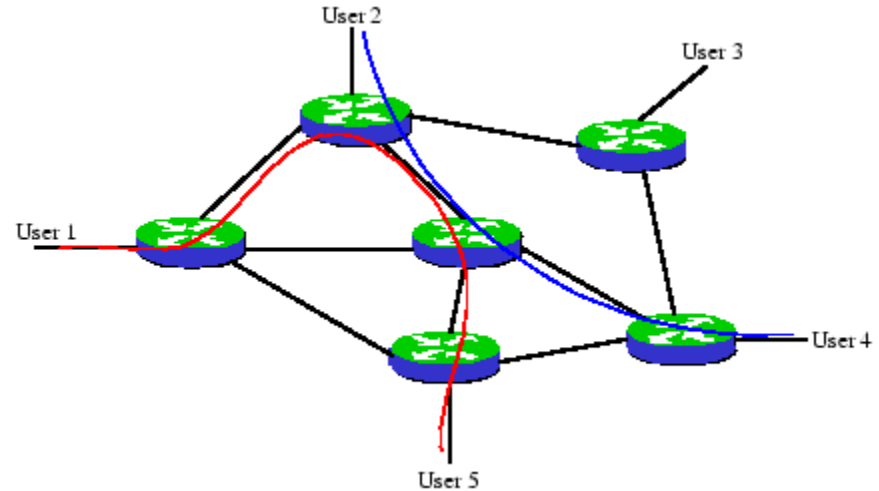
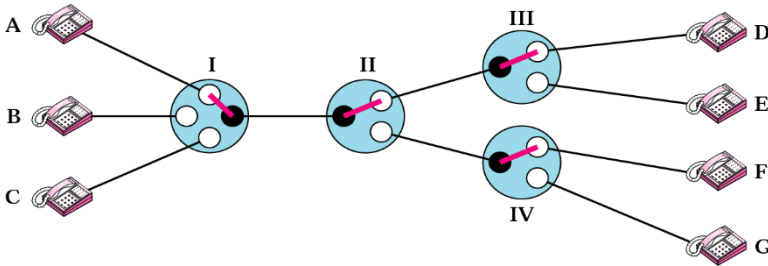


Assume you need to design a new WAN.
Which technology would you chose?
When and why?

Circuit vs. Packet Switching

Circuit-Switched Networks

(telephone networks)



Advantages

- **guaranteed Quality of Service** – data is transmitted at fixed (guaranteed) rate; no data is lost; data delay is negligible

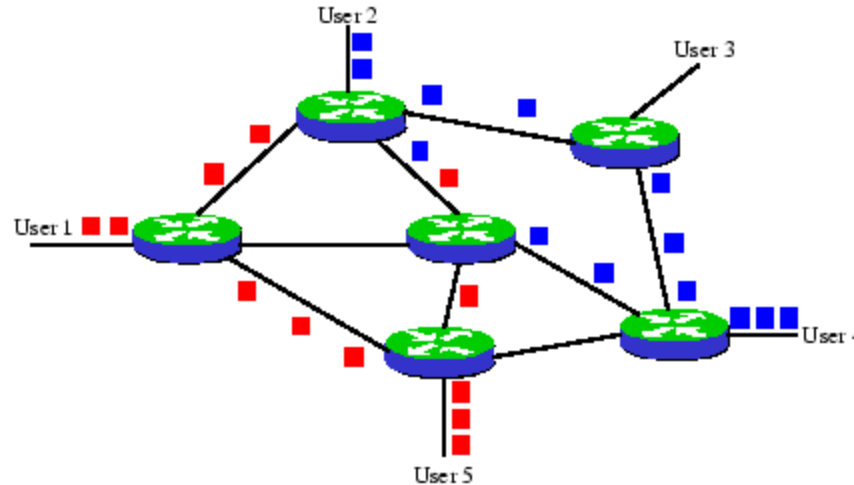
Disadvantages

- **inefficient use of capacity** – channel capacity is dedicated for the duration of a connection, even if no data is being transferred (e.g. silent periods in speech)
- **network complexity** – end-to-end circuit establishment and bandwidth allocation requires complex signaling software to coordinate operation of switches
- **circuit establishment delay** – circuit establishment introduces ‘initial delay’

QoS parameters: Loss, Delay, Jitter

- Loss—A relative measure of the number of packets that were not received compared to the total number of packets transmitted. Loss is typically a function of availability. If the network is Highly Available, then loss during periods of non-congestion would be essentially zero. During periods of congestion, however, QoS mechanisms can determine which packets are more suitable to be selectively dropped to alleviate the congestion.
- Delay—The finite amount of time it takes a packet to reach the receiving endpoint after being transmitted from the sending endpoint. In the case of voice, this is the amount of time it takes for a sound to travel from the speaker's mouth to a listener's ear.
- Delay variation (Jitter)—The difference in the end-to-end delay between packets. For example, if one packet requires 100 ms to traverse the network from the source endpoint to the destination endpoint and the following packet requires 125 ms to make the same trip, then the delay variation is 25 ms.

Packet-Switched Networks (the Internet)



Advantages

- **greater line efficiency** – network links are dynamically shared by many packets / connections
- **no blocked traffic** – packets are accepted even under heavy traffic, but delivery delay may increase

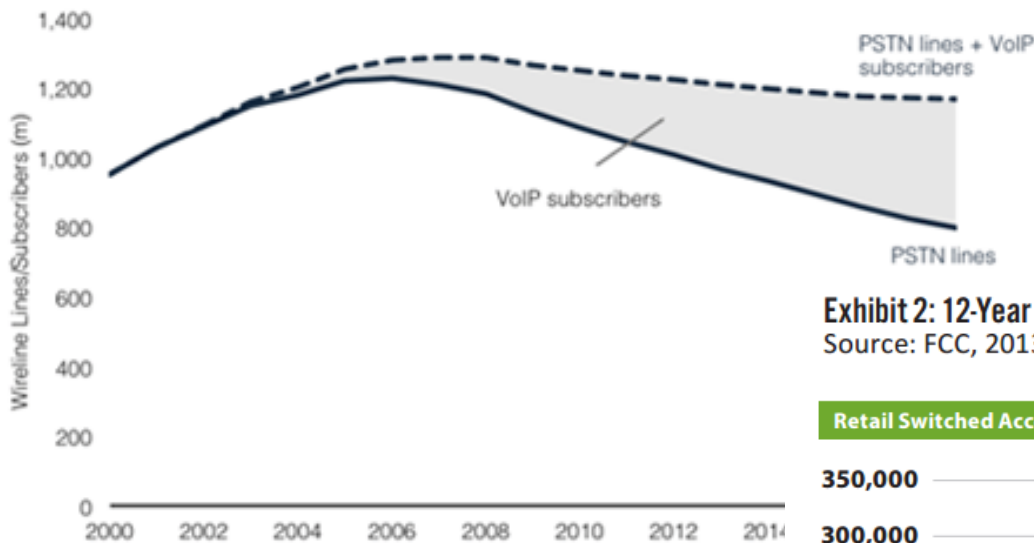
Disadvantages

- **no QoS guarantees** – packet delay and loss can be significant if too much data is ‘pumped’ into the network
- **overhead traffic** – to route packets through a packet-switching network, overhead information including the address of destination and/or sequence information must be added to each packet

Is PSTN / landline phone / circuit switching dead?



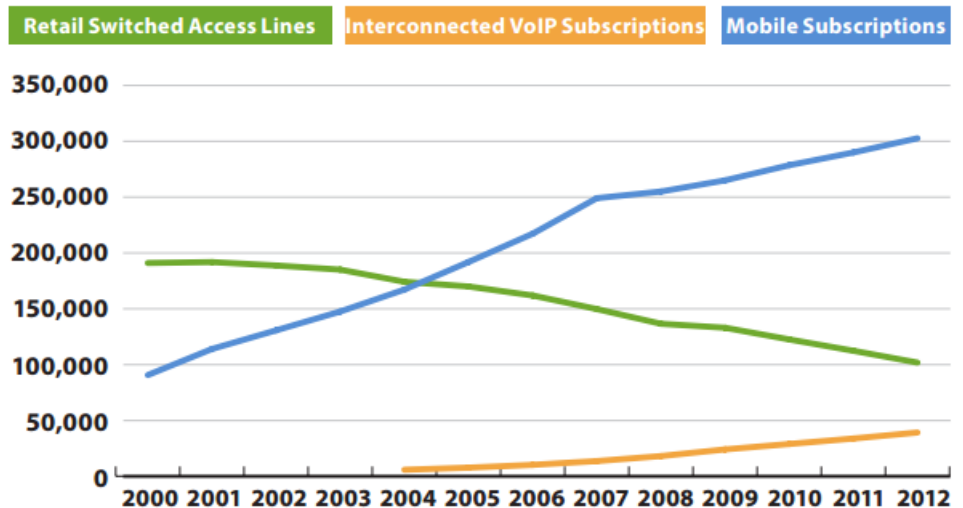
Global Wirelines, PSTN vs. VoIP, 2000-2018



Source: TeleGeography


Exhibit 2: 12-Year Trend Paints a Clear Picture

Source: FCC, 2013 and Yankee Group, 2014



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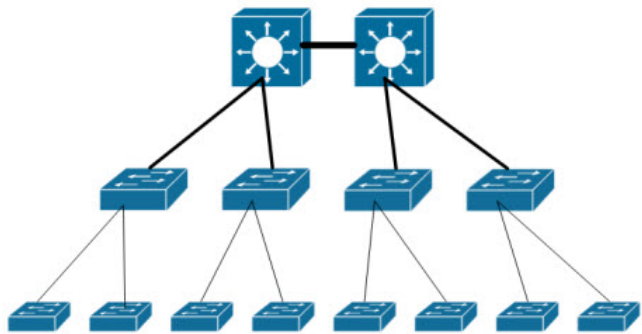
CORE NETWORKING AND SECURITY
By Scott Hogg | Follow

Clos Networks: What's Old Is New

What goes around, comes around – Clos Networks are back

Network World | Jan 11, 2014 1:29 PM PT

<http://www.networkworld.com/article/2226122/cisco-subnet/clos-networks--what-s-old-is-new-again.html>



Packet Switching in Data Centers:
all data traffic takes best path until that path gets congested

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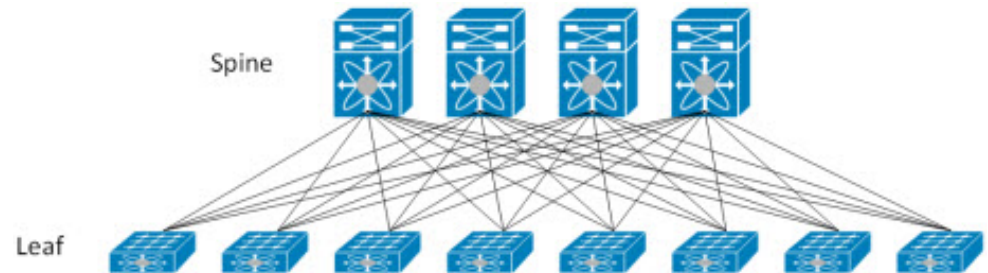
Input Devices Displays Printers Storage **Networking** Cameras

Home / Networking

How Google looked to the past to develop a network for the future

Telephone systems, not computer networks, provided inspiration for Google.

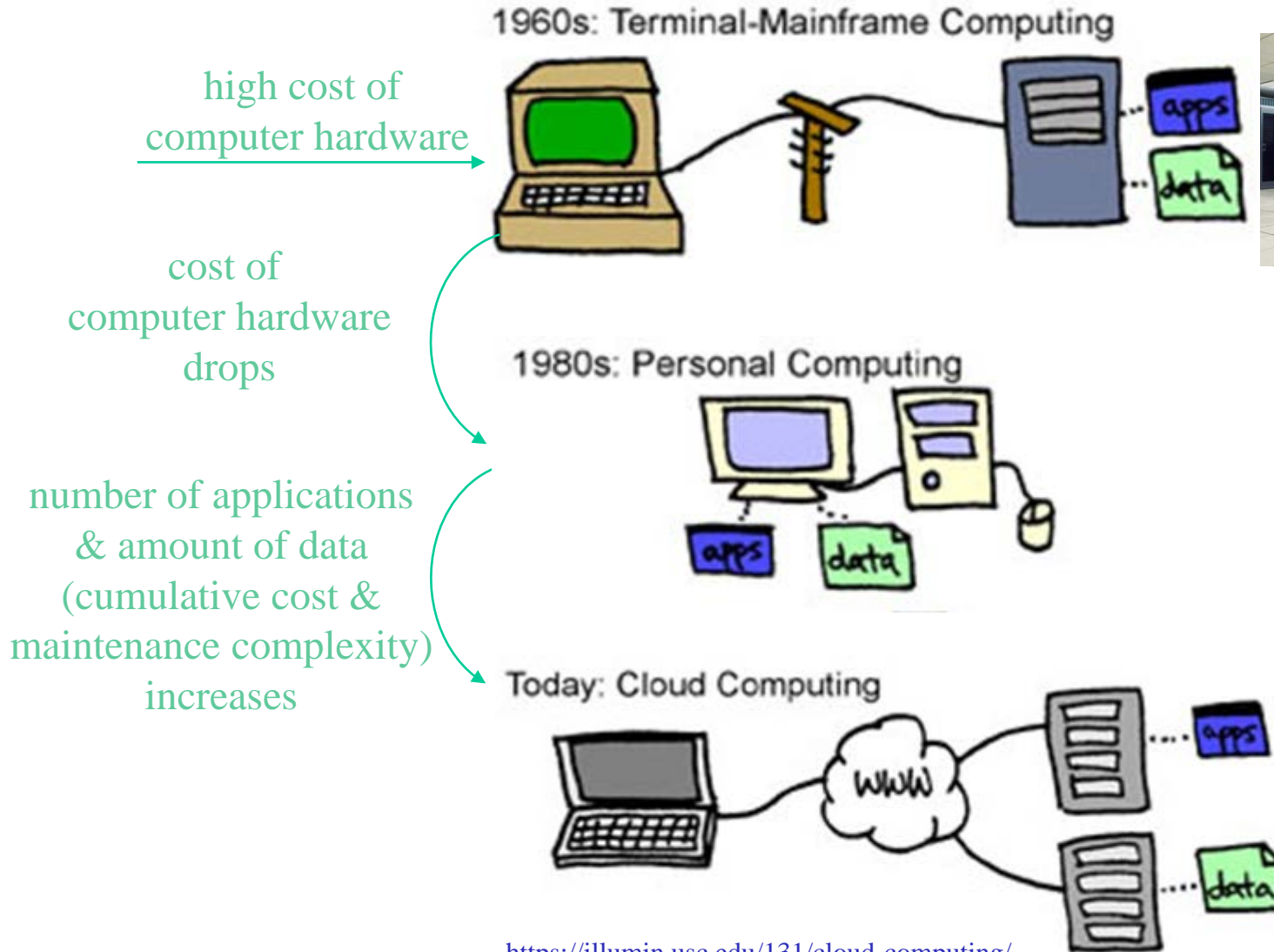
<http://www.pcworld.com/article/2972973/how-google-looked-to-the-past-to-develop-a-network-for-the-future.html>

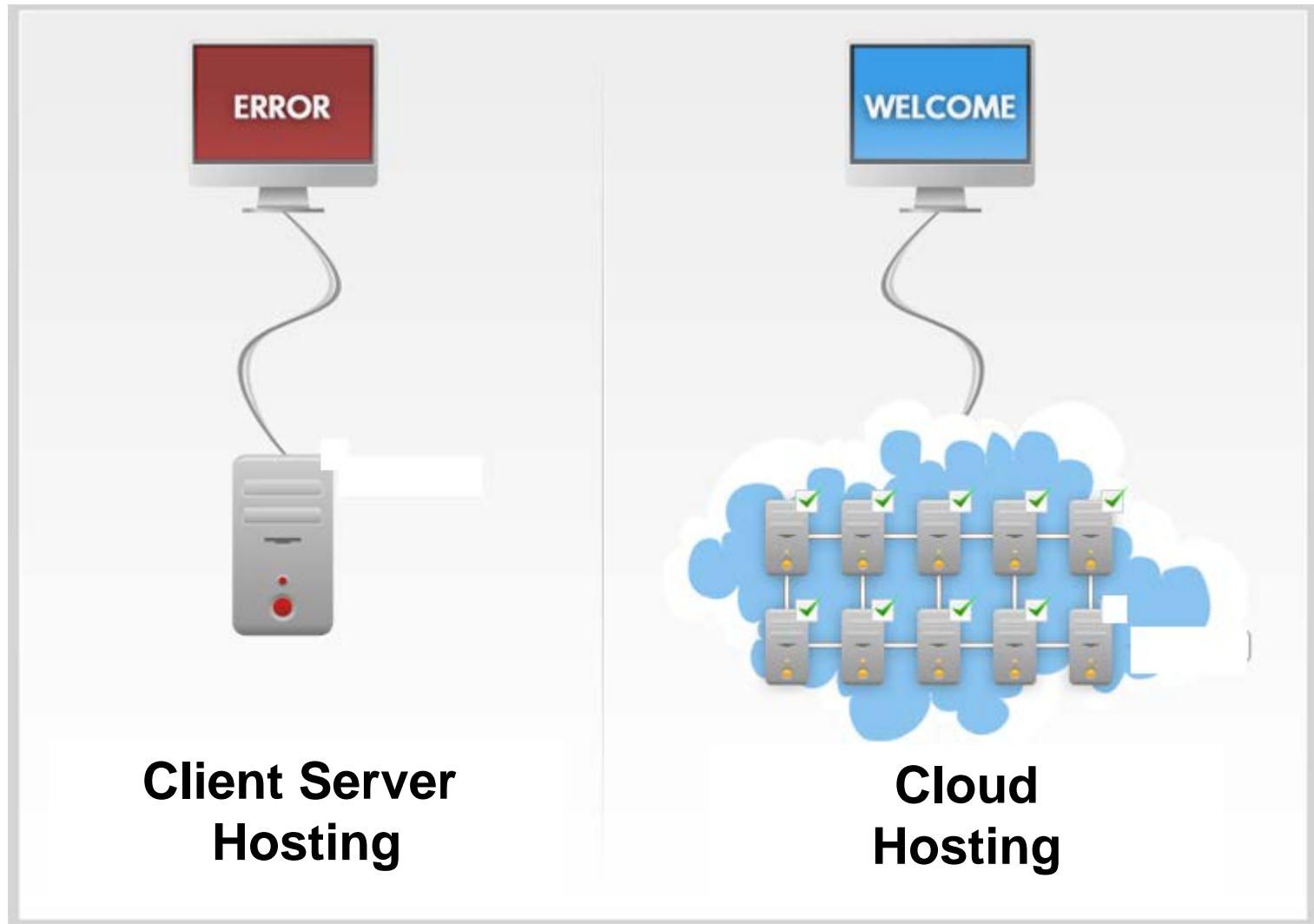


Circuit Switching (Clos) in Data Centers:
allows multiple paths to be taken => better load distribution & resilience to congestion

Mainframe vs. Personal vs. Cloud Computing

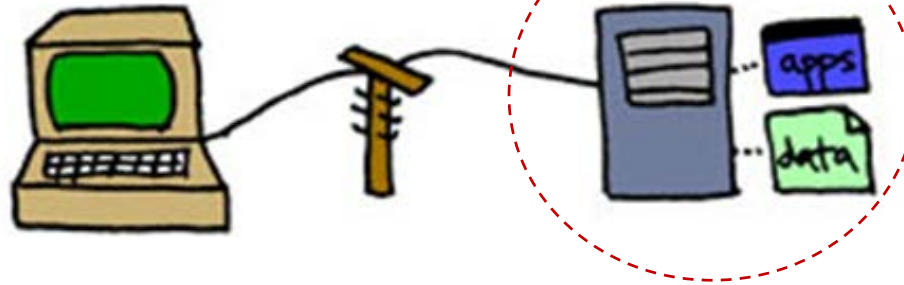
Term 'computing' describes the way storage & processing power is distributed and used.





Mainframe vs. Personal vs. Cloud Computing

1960s: Terminal-Mainframe Computing



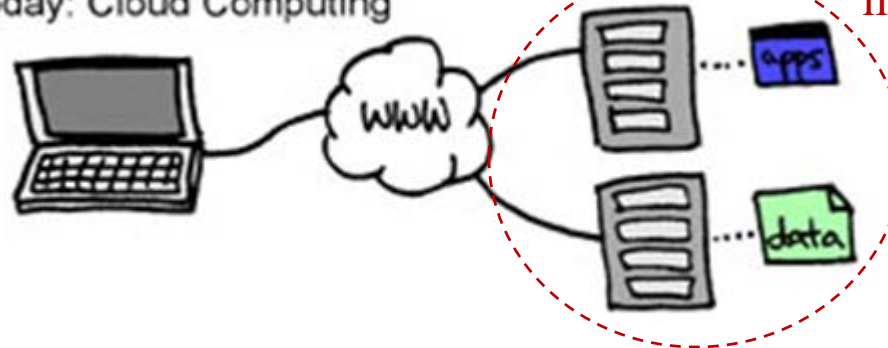
cost: 75 – 100 K

one integrated supercomputer

typically owned and used by one company

advantages: stability & reliability

Today: Cloud Computing



cost: n x 2 K

large groups of linked/distributed servers

running low-cost consumer PC technology

typically 'rented'

advantages: scalability & cost

Mainframe vs. Personal vs. Cloud Computing

Mainframe computing is still very much used in Banking Industry!!!

<http://www.banktech.com/infrastructure/how-do-banks-maintain-financial-data-mainframes/a/d-id/1318116>



https://en.wikipedia.org/wiki/IBM_System_z