CPSC 422/522 Design & Implementation of Operating Systems

Lecture 24: Distributed Systems

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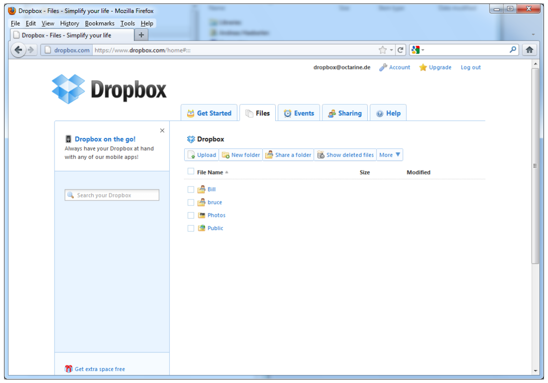
Acknowledgement: some slides are taken from previous lectures by Dr. Ennan Zhai

Have you used distributed system?

Have you used distributed system?



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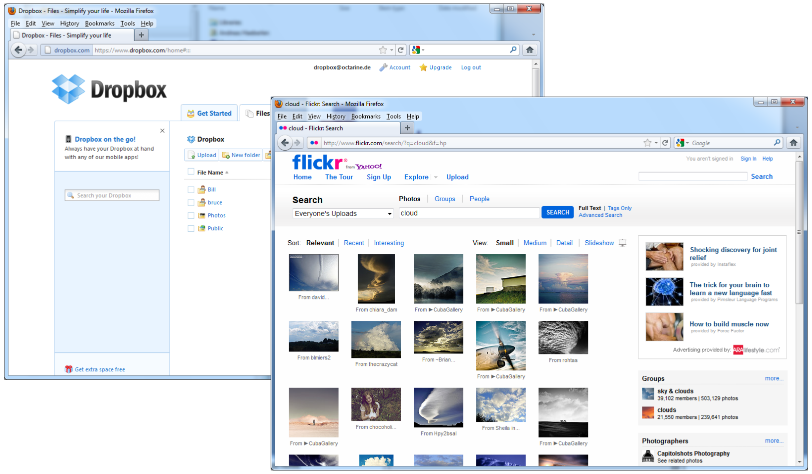

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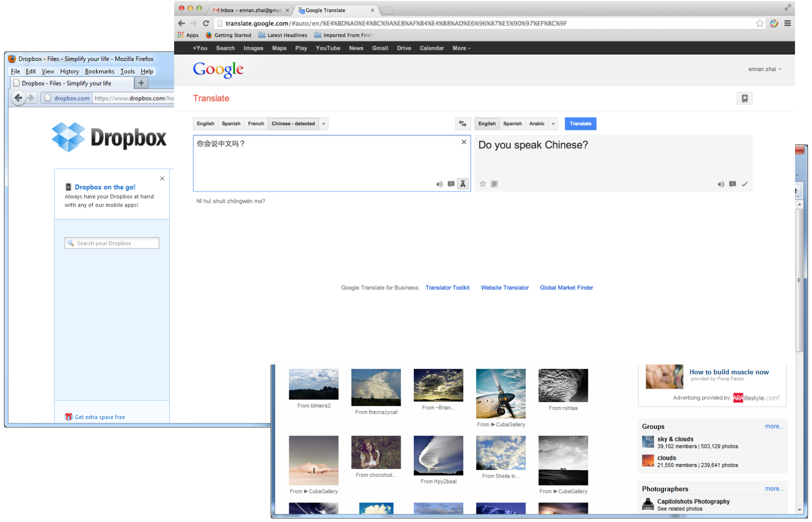
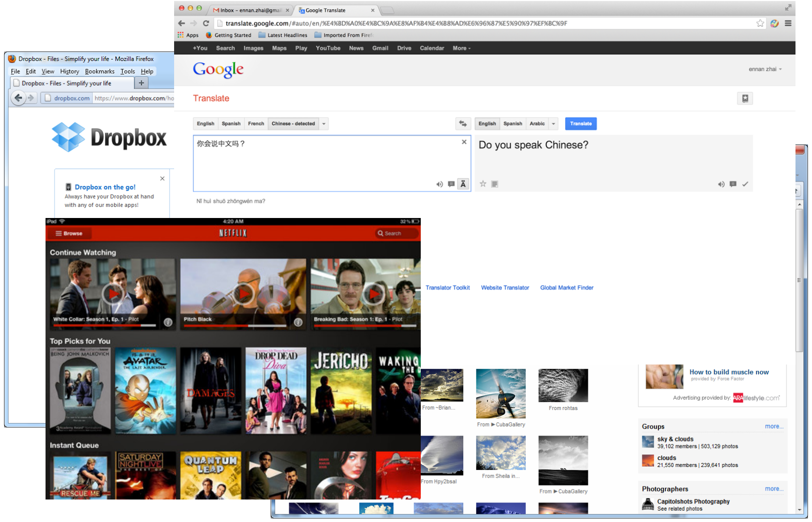


你会说中文吗？

Do you speak Chinese?

Have you used distributed system?



你会说中文吗？

Do you speak Chinese?

What is a distributed system?

- A system of multiple computers (nodes) communicating over a network

What is a distributed system?

- A system of multiple computers (nodes) communicating over a network
- Some following questions:
  - What is a decentralized system?
  - What is a cloud system?
  - What is a centralized distributed system?

Network Basics

- We connect computers via point-to-point links:
  - Local area network, DNS and ISP routers
  - Communications are unreliable
  - No global control of the network

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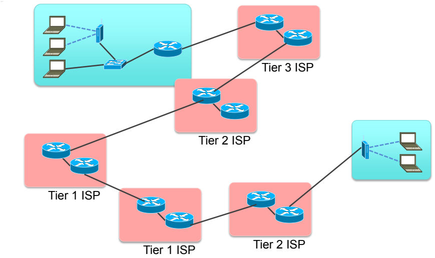
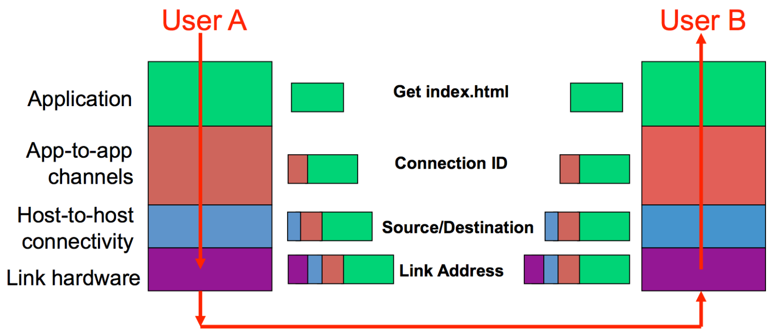
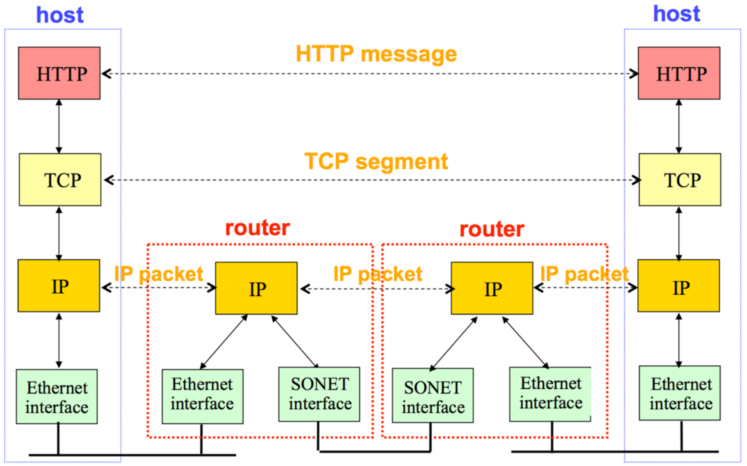


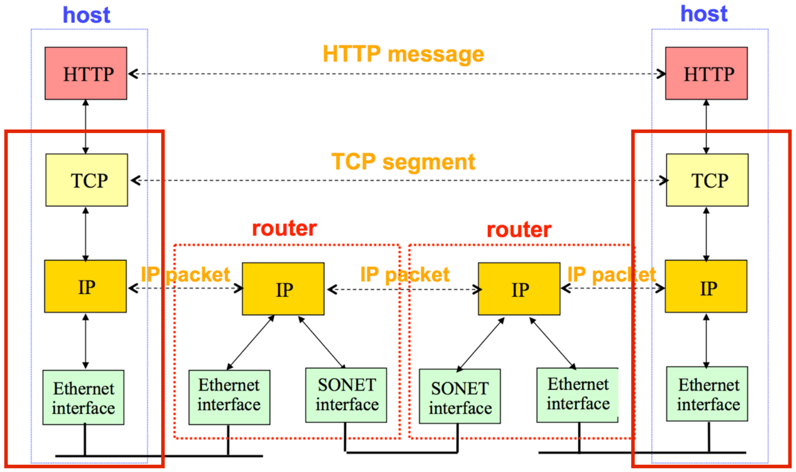
Example: HTTP Layer Encapsulation



End Hosts vs. Routers



End Hosts vs. Routers



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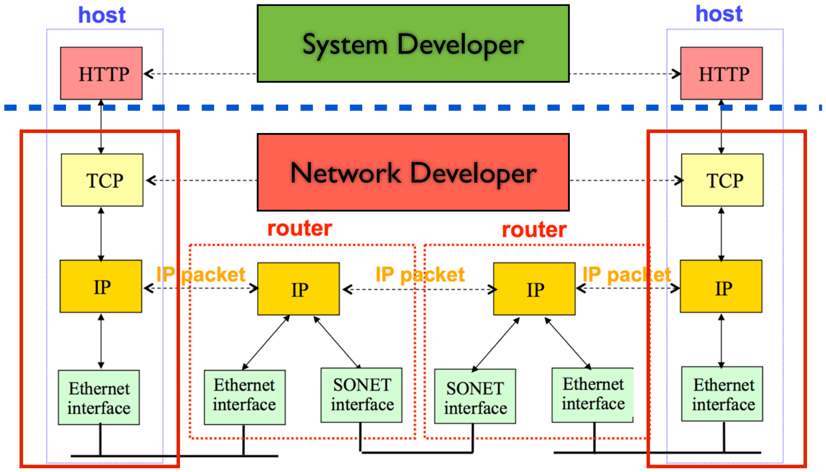
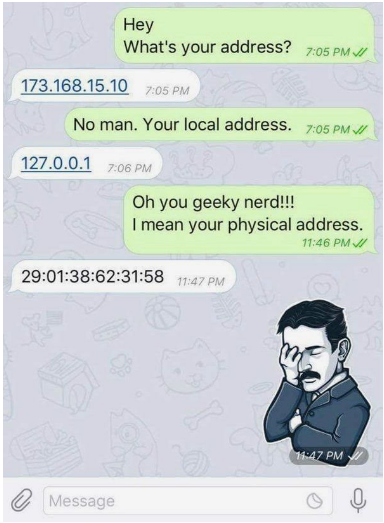


Finding Nodes



Hey
What's your address? 7:05 PM

173.168.15.10 7:05 PM

No man. Your local address. 7:05 PM

127.0.0.1 7:06 PM

Oh you geeky nerd!!!
I mean your physical address. 11:46 PM

29:01:38:62:31:58 11:47 PM

11:47 PM

Network Basics

- Each interface on a host has a unique MAC address:
  - My machine 48-bit ethernet address = 32:00:19:ac:b1:40

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Why we need a physical address?

Network Basics

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  - My machine 48-bit ethernet address = 32:00:19:ac:b1:40

Why we need a physical address?

Which layer in OSI model it belongs to?

Network Basics

- Each interface on a host has a unique MAC address:
  - My machine 48-bit ethernet address = 32:00:19:ac:b1:40
- This is *not* too interesting to us as programmers
  - We usually do not communicate at the data link layer

Network Basics

- Addressing applications:
  - IP address (32-bit for IPv4) and port number (16-bit)
  - Well-known port numbers (0-1023), e.g., ftp, ssh and http

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- Addressing applications:
  - IP address (32-bit for IPv4) and port number (16-bit)
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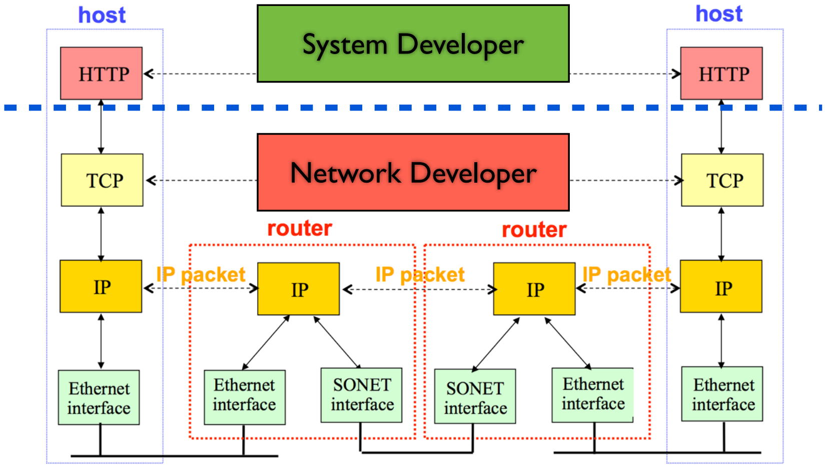
- We have two transport-layer protocols
  - TCP (SSH and FTP) and UDP (Streaming and local broadcast)
  - What is the difference?

End Hosts vs. Routers



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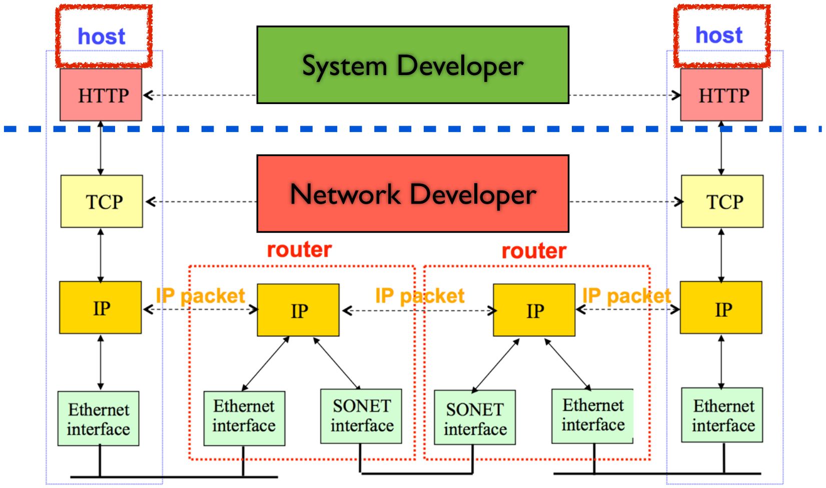

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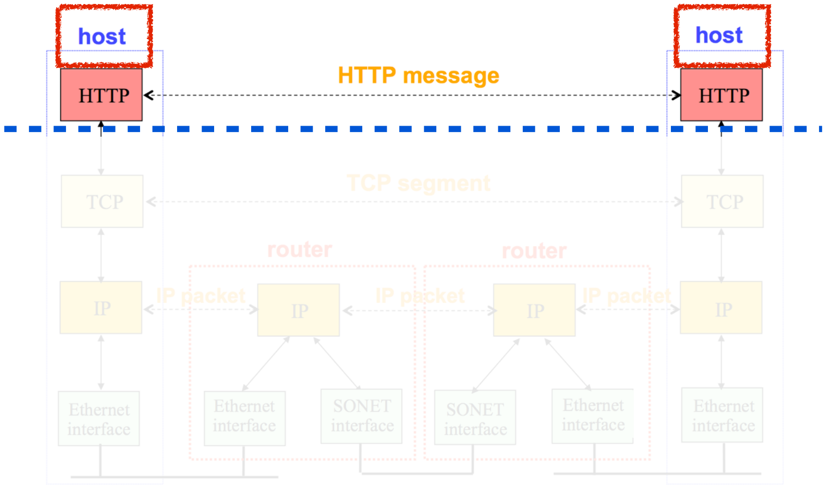


Today's Cluster

PC

Today's Cluster

PC

Server

Today's Cluster

PC

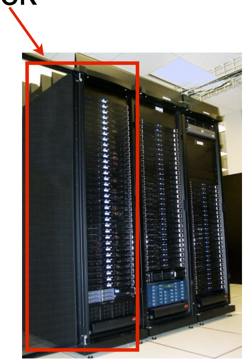
Server

Cluster

Today's Cluster

Today's Cluster

Rack



Today's Cluster

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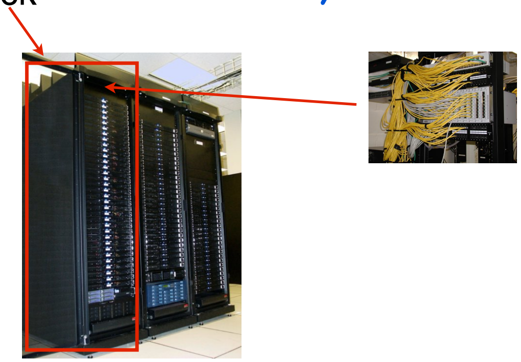

Network switches (connects nodes with each other and with other racks)

Today's Cluster

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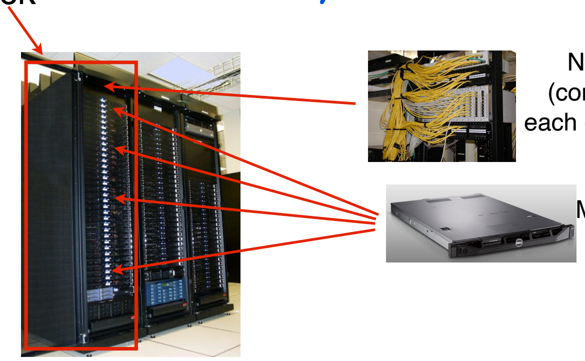

Network switches (connects nodes with each other and with other racks)

Many nodes/blades (often identical)

Today's Cluster

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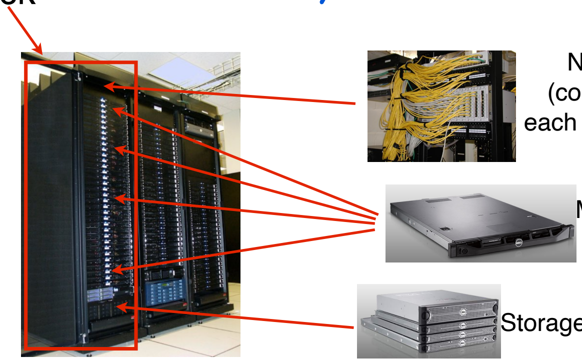


Network switches (connects nodes with each other and with other racks)

Many nodes/blades (often identical)

Storage device(s)

Today's Cluster

PC

Server

Cluster

- What if cluster is too big to fit into machine room?

Datacenter

PC

Server

Cluster

- What if cluster is too big to fit into machine room?
  - Build a separate building for the cluster
  - Building can have lots of cooling and power

Datacenter

PC

Server

Cluster

Data center

- What if cluster is too big to fit into machine room?
  - Build a separate building for the cluster
  - Building can have lots of cooling and power
  - Result: Data center

Google Datacenter in Oregon

Google Datacenter in Oregon

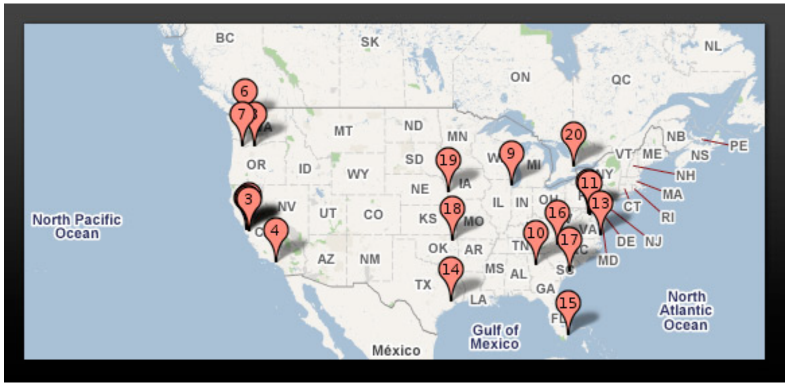
Data centers (size of
a football field)

Google Datacenter in Oregon

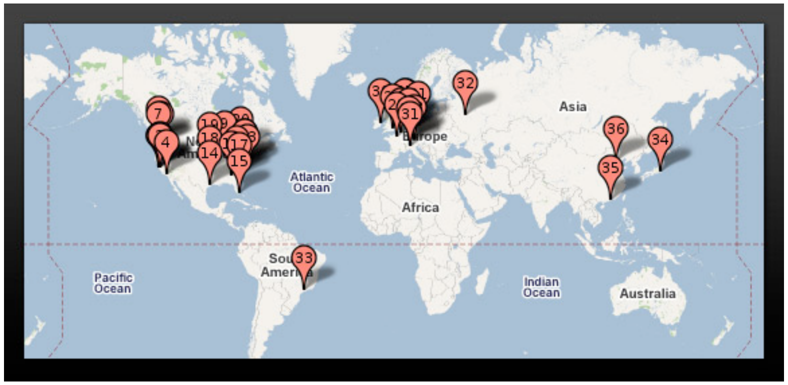
Data centers (size of
a football field)

- A warehouse-sized computer
  - A single data center can easily contain 10,000 racks with 100 cores in each rack (1,000,000 cores total)

Google Datacenters in the US



Google Datacenters in this World



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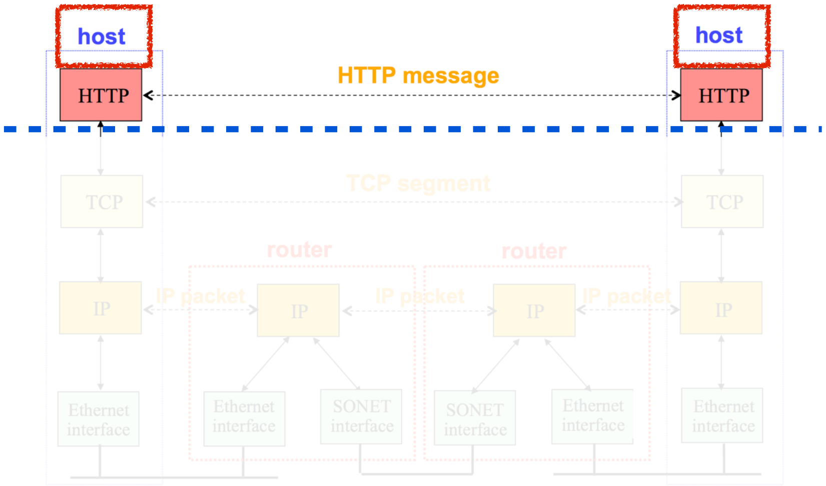
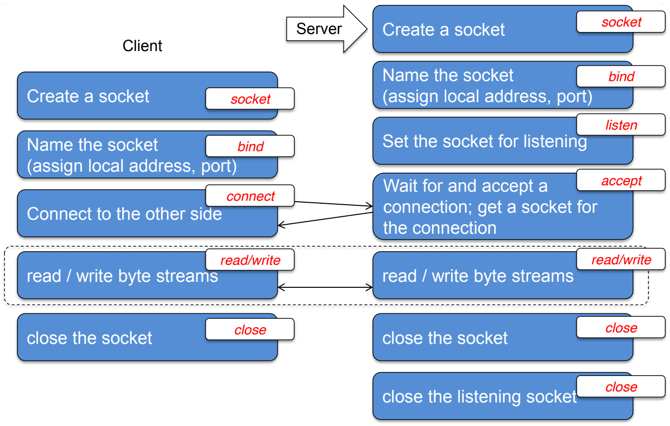


Network APIs

- Programmers need to access the network
- A network application programming interface (API)
  - Socket programming
  - Remote procedure calls

Socket (TCP)


Client

Server

Create a socket — socket

Name the socket (assign local address, port) — bind

Connect to the other side — connect

read / write byte streams — read/write

close the socket — close

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Socket (TCP)

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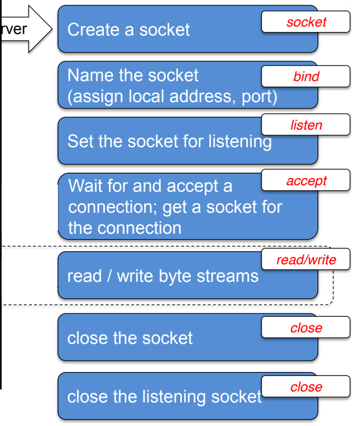
rver
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Socket (TCP)

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import socket

s = socket.socket(AF_INET,\
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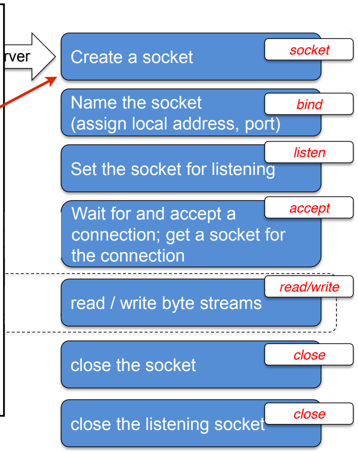

rver

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Socket (TCP)

```
import socket

s = socket.socket(AF_INET,\
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s.bind(host, port)
```

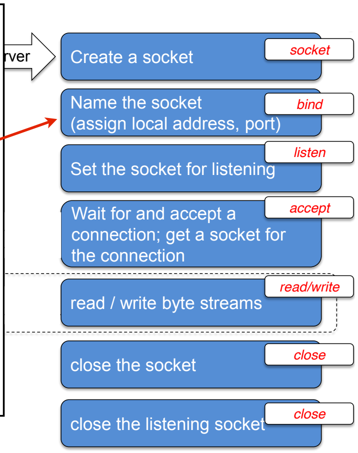

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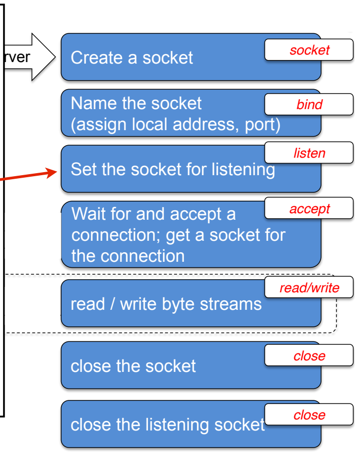
Socket (TCP)

```
import socket

s = socket.socket(AF_INET,\
                  SOCK_STREAM)

s.bind(host, port)
s.listen(5)
```



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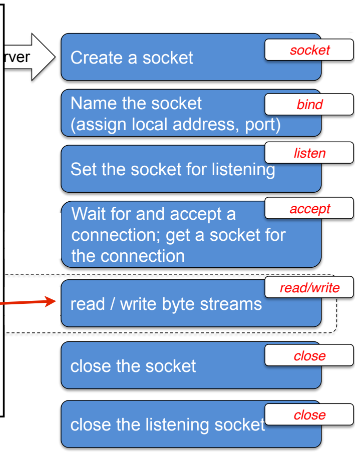
Socket (TCP)

```
import socket

s = socket.socket(AF_INET,\
                  SOCK_STREAM)

s.bind(host, port)
s.listen(5)

while 1:
  conn, addr = s.accept()
  msg = conn.recv()
  conn.close
```



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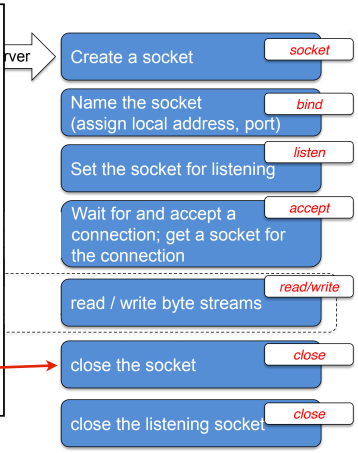

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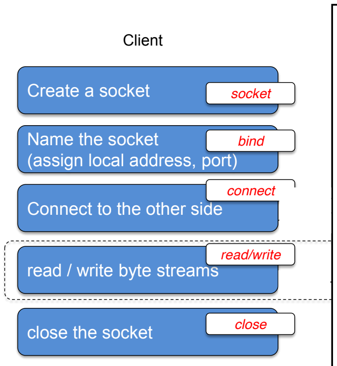

Client

Create a socket — socket

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Connect to the other side — connect

read / write byte streams — read/write

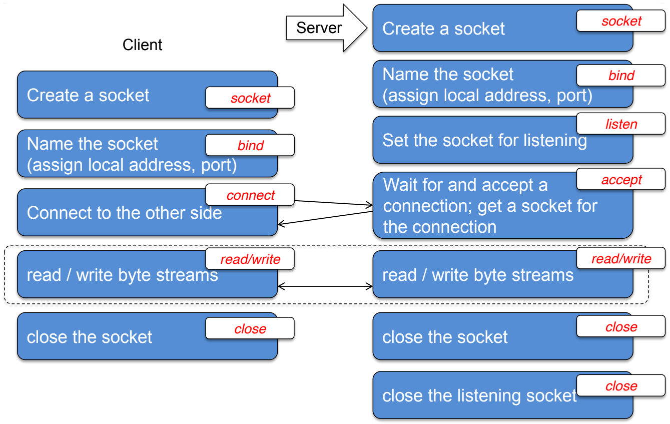
close the socket — close

```
import socket

s = socket.socket(AF_INET,\
                 SOCK_STREAM)

a = socket.gethostbyname(host)
s.connect(a, port)
s.sendall(msg)
```

Socket (TCP)



Client

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Server

Create a socket — socket

Name the socket (assign local address, port) — bind

Set the socket for listening — listen

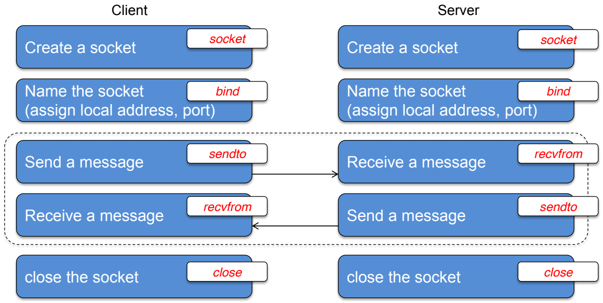
Wait for and accept a connection; get a socket for the connection — accept

read / write byte streams — read/write

close the socket — close

close the listening socket — close

Socket (UDP)



Client

Create a socket — socket

Name the socket (assign local address, port) — bind

Send a message — sendto

Receive a message — recvfrom

close the socket — close

Server

Create a socket — socket

Name the socket (assign local address, port) — bind

Receive a message — recvfrom

Send a message — sendto

close the socket — close

What’s the Cloud Computing

What’s the Cloud Computing

Cloud computing is a business model for enabling convenient network access to a shared pool of configurable resources which can be rapidly provisioned and released with minimal management effort or service provider interaction.

--- according to NIST(National Institute of Standards and Technology)

Have You Used the Cloud?

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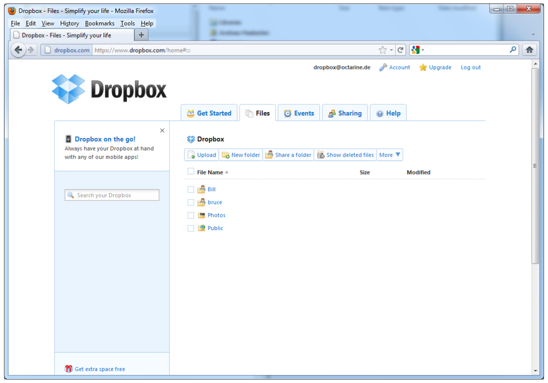
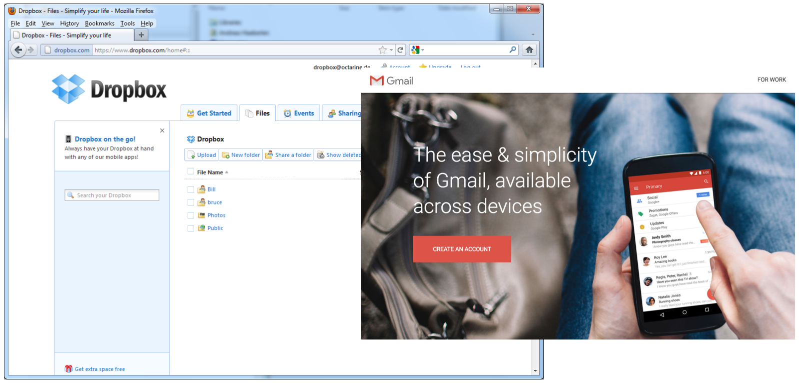

Dropbox - Files - Simplify your life - Mozilla Firefox
File Edit View History Bookmarks Tools Help
Dropbox - Files - Simplify your life
dropbox.com https://www.dropbox.com/home#:::
dropbox@octarine.de
Account
Upgrade
Log out
Dropbox
Get Started
Files
Events
Sharing
Help
Search your Dropbox
Get extra space free
Upload
New folder
Share a folder
Show deleted files
More

Dropbox on the go!
Always have your Dropbox at hand with any of our mobile apps!

Dropbox

File Name	Size	Modified
Bill		
bruce		
Photos		
Public		

Have You Used the Cloud?



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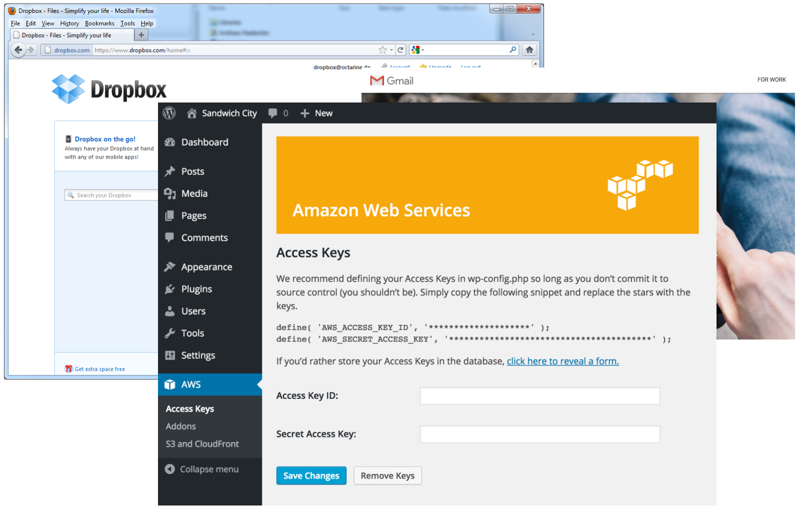

Access Keys

We recommend defining your Access Keys in wp-config.php so long as you don't commit it to source control (you shouldn't be). Simply copy the following snippet and replace the stars with the keys.

```
define( 'AWS_ACCESS_KEY_ID', '********************' );
define( 'AWS_SECRET_ACCESS_KEY', '****************************************' );
```

If you'd rather store your Access Keys in the database, click here to reveal a form.

Access Key ID:

Secret Access Key:

Why We Like It?

Why We Like It?

- Why users like it?
  - Do not care where it is, it is "just there"
  - Access from "any" platform

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Cloud Services v.s. Traditional Distributed Systems

Why We Like It?

- Why users like it?
  - Do not care where it is, it is “just there”
  - Access from “any” platform
- Why CS researchers like it?
  - High-performance computation with less money
  - Lots of *hard* and *interesting* new challenges

Building Blocks

- What techniques are used to support cloud?
  - Internet
  - Smart and cheap personal devices
  - Robust and scalable software systems
  - Virtualization
  - ... ...

Types of Cloud Services

- Three types of services:

Types of Cloud Services

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    it.

  - Infrastructure as a Service (IaaS)
    - Analogy: Grocery store. Provides raw ingredients.

Types of Cloud Services

- Three types of services:
  - Platform as a Service (PaaS)
    - Analogy: Take-out food. Prepares meal but does not serve it.
  - Infrastructure as a Service (IaaS)
    - Analogy: Grocery store. Provides raw ingredients.

Types of Cloud Services

- Three types of services:
  - Software as a Service (SaaS)
    - Analogy: Restaurant. Prepares&serves entire meal, does the dishes, etc
  - Platform as a Service (PaaS)
    - Analogy: Take-out food. Prepares meal but does not serve it.
  - Infrastructure as a Service (IaaS)
    - Analogy: Grocery store. Provides raw ingredients.

Software as a Service (SaaS)

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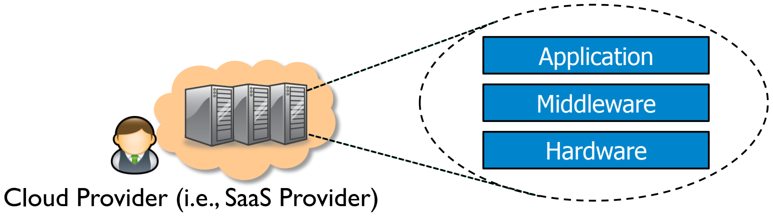
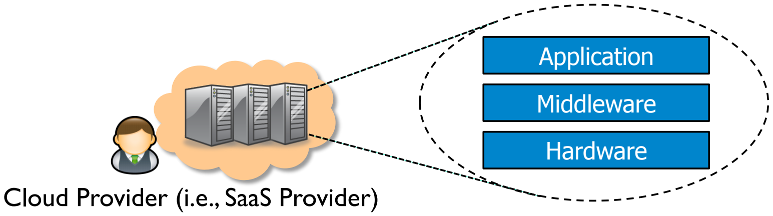
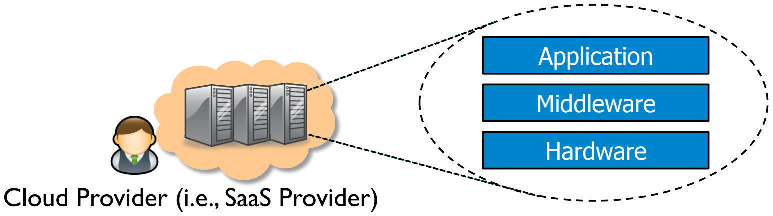


Software as a Service (SaaS)



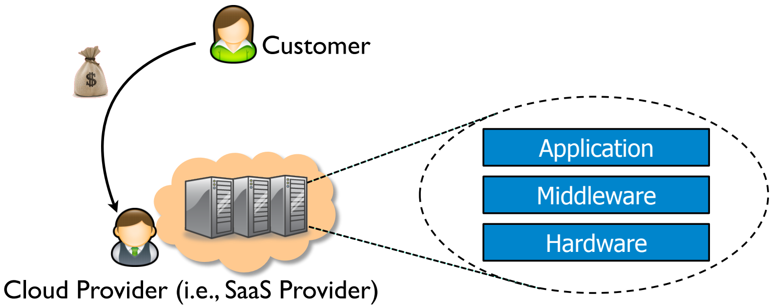
- SaaS provider offers an entire application

Software as a Service (SaaS)



- SaaS provider offers an entire application
  - Word processor, spreadsheet, CRM software, etc.

Software as a Service (SaaS)



- SaaS provider offers an entire application
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  - Customer pays cloud provider and uses the service

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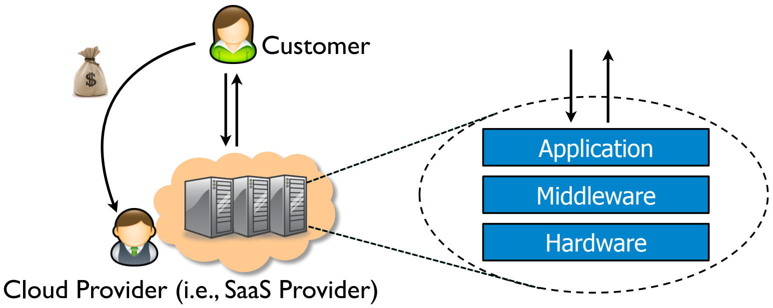

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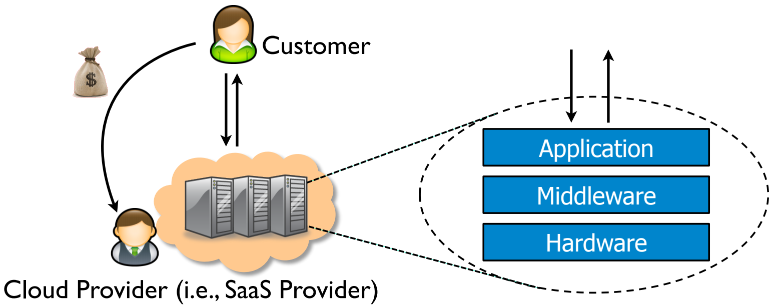

- SaaS provider offers an entire application
  - Word processor, spreadsheet, CRM software, etc.
  - Customer pays cloud provider and uses the service
  - Example: Google Apps, Salesforce.com, etc.

SaaS Example: Gmail

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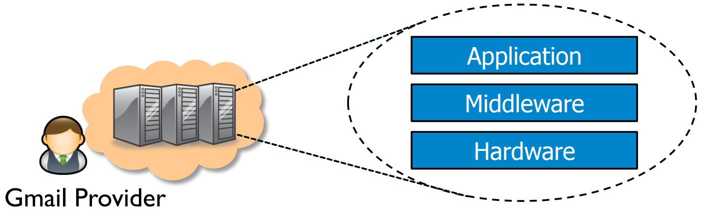
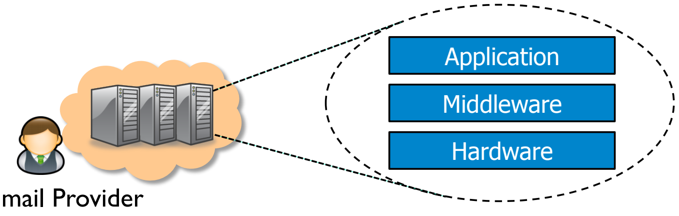


SaaS Example: Gmail



Application

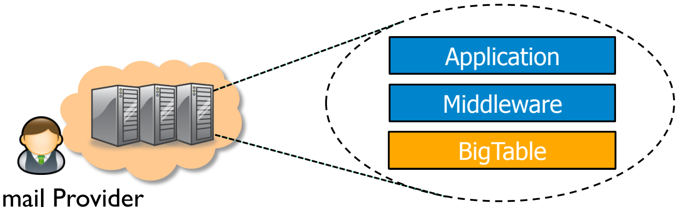
Middleware

Hardware

Gmail Provider

- Outsourcing your e-mail software:
  - Distributed, replicated message store in BigTable

SaaS Example: Gmail



Application

Middleware

BigTable

Gmail Provider

- Outsourcing your e-mail software:
  - Distributed, replicated message store in BigTable

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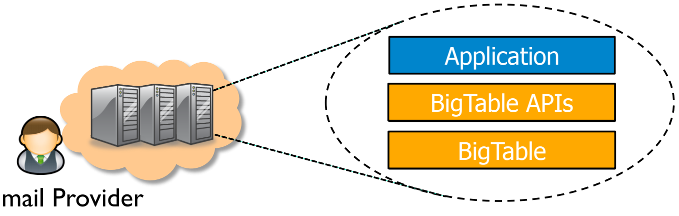

Application

BigTable APIs

BigTable

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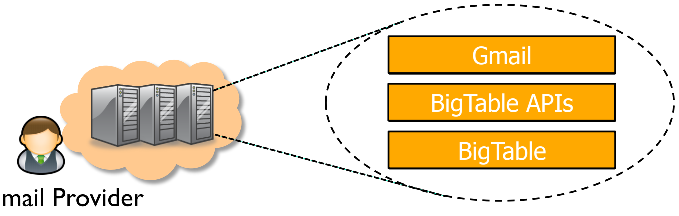

Gmail

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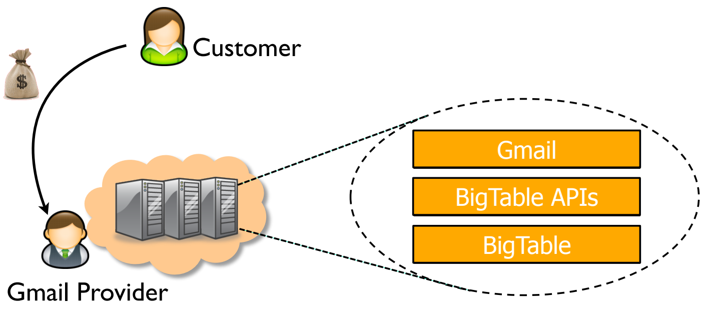

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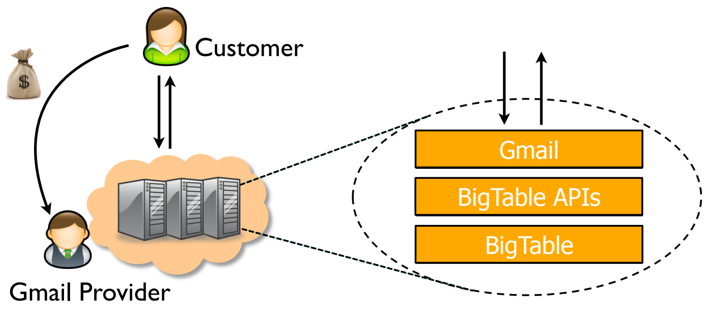

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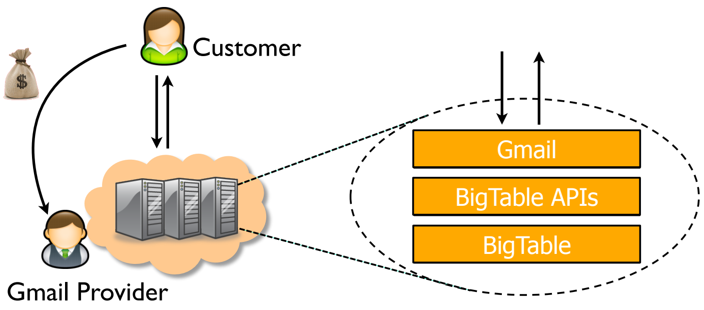

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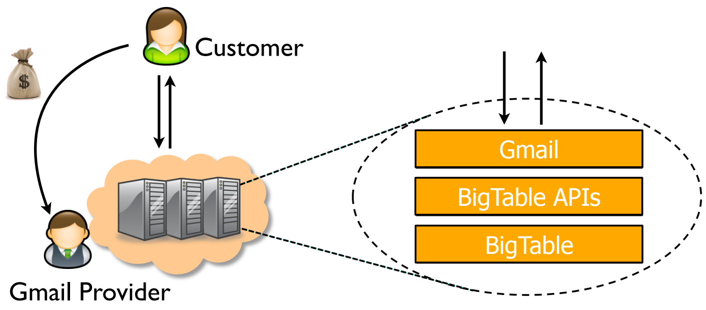

- Outsourcing your e-mail software:
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  - Weak consistency model for some operations (e.g., msg read)
  - Stronger consistency for others (e.g., send msg)

Platform as a Service (PaaS)

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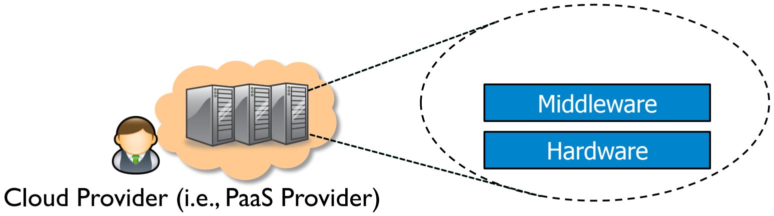
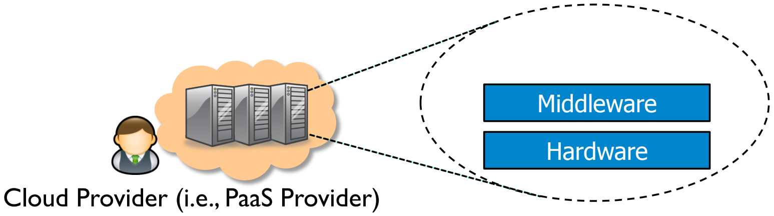


- Cloud provides middleware/infrastructure

Platform as a Service (PaaS)



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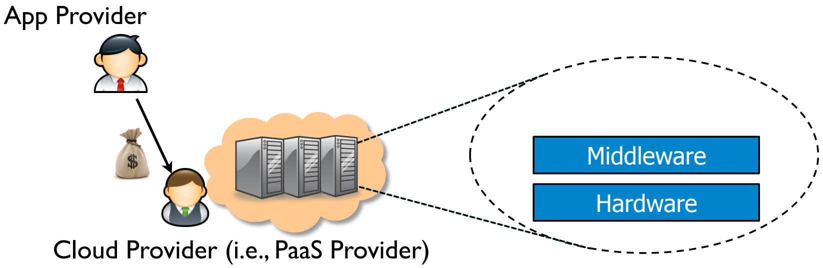

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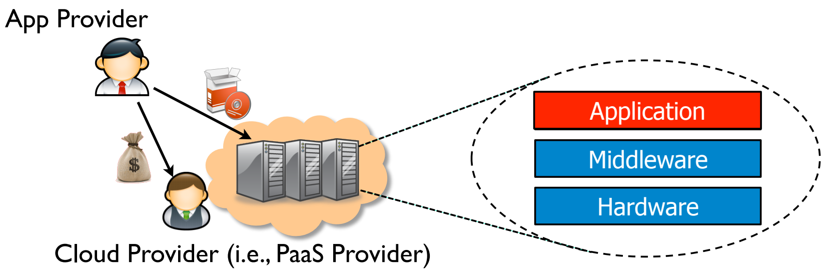

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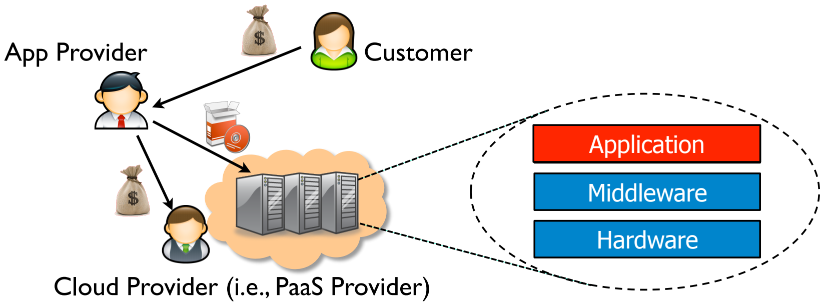

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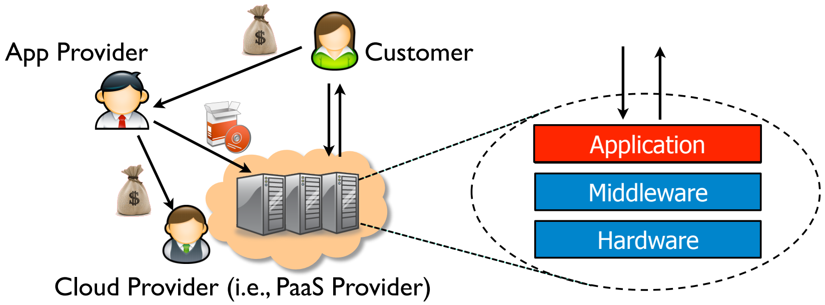

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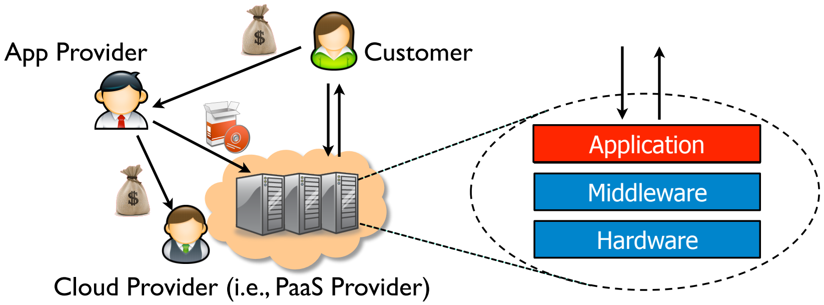

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  - Example: Windows Azure, Google App Engine, etc.

PaaS Example: Facebook

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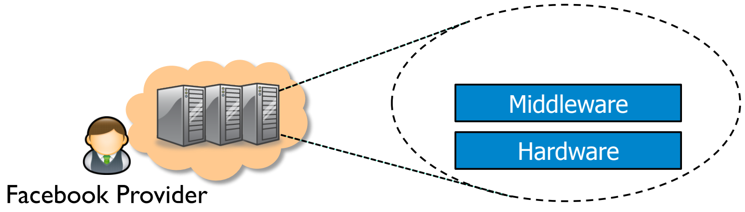

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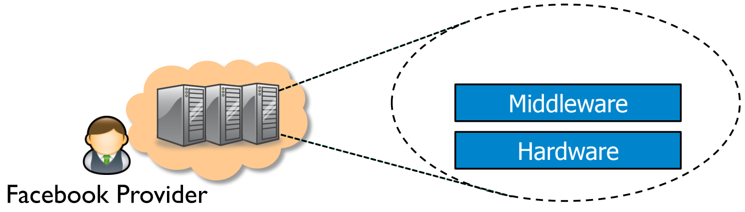
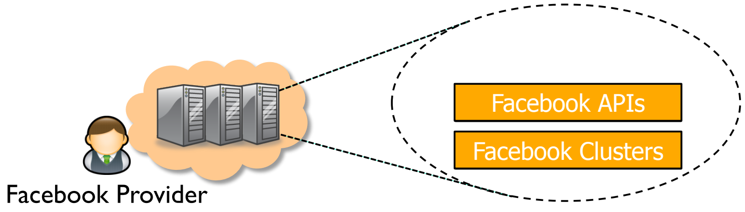


- Facebook offers PaaS capabilities to App provider

PaaS Example: Facebook



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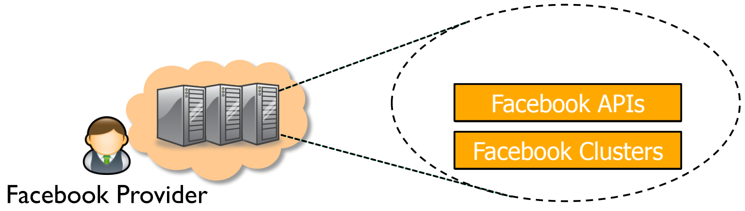

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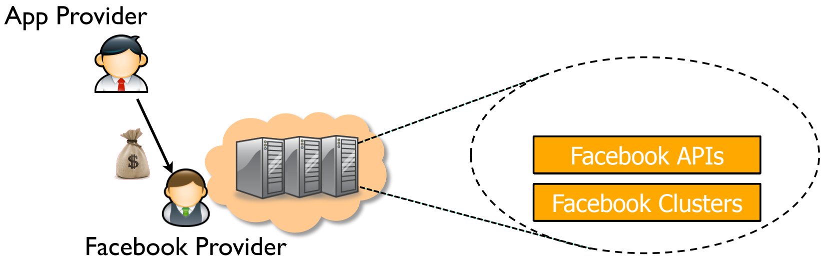

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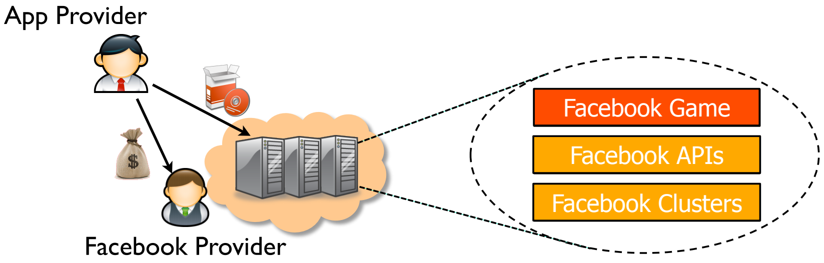

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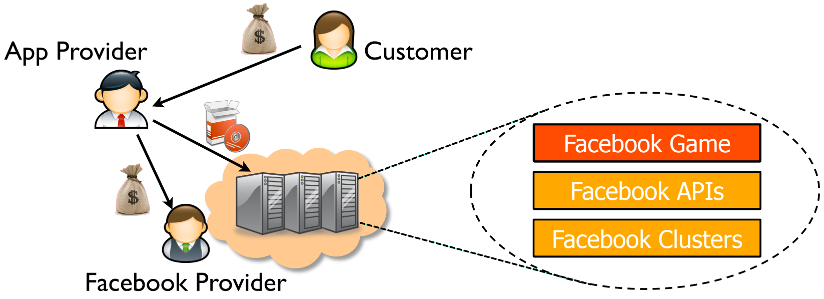

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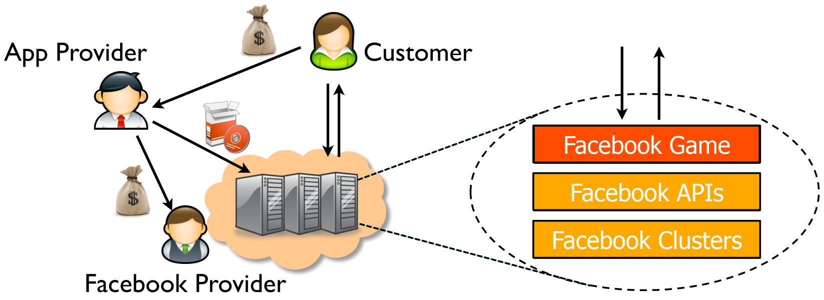

App Provider

Customer

Facebook Provider

Facebook Game

Facebook APIs

Facebook Clusters

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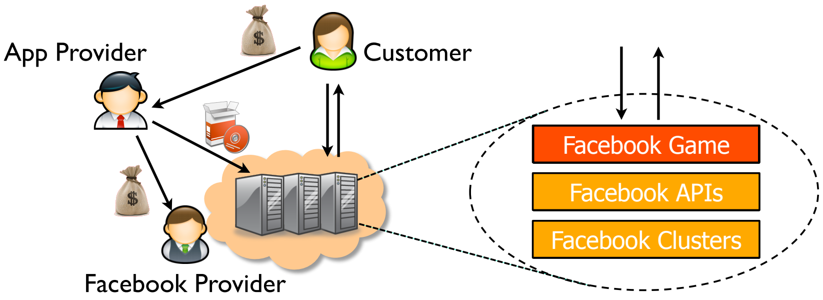

App Provider

Customer

Facebook Provider

Facebook Game

Facebook APIs

Facebook Clusters

- Facebook offers PaaS capabilities to App provider
  - Facebook APIs allow access to social network properties
  - App providers adopt their services (e.g., game) onto Facebook
  - Facebook itself also uses PaaS provided by its company, e.g., log analysis for recommendations

Infrastructure as a Service (IaaS)

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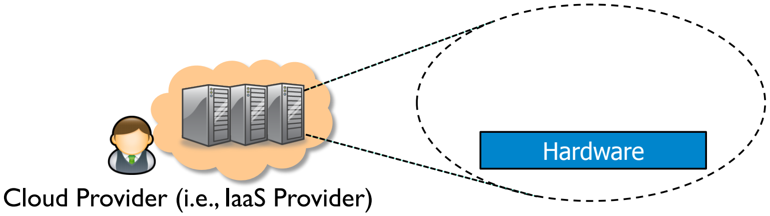
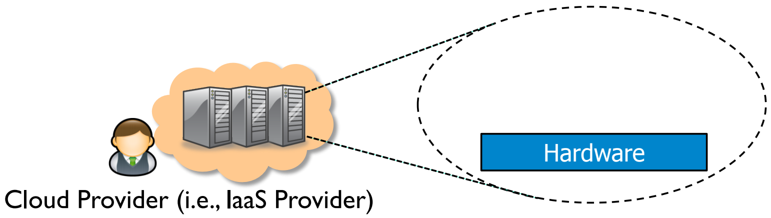


Hardware

Cloud Provider (i.e., IaaS Provider)

- Cloud provides raw computing resources

Infrastructure as a Service (IaaS)



- Cloud provides raw computing resources
  - Virtual machines, blade servers, hard disk, etc.

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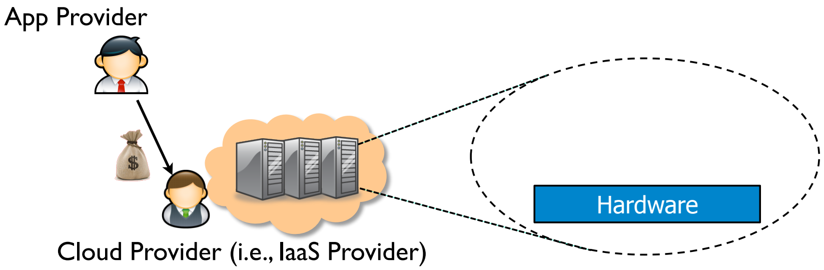

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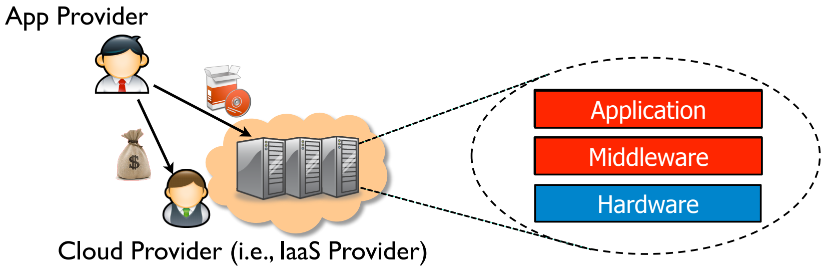

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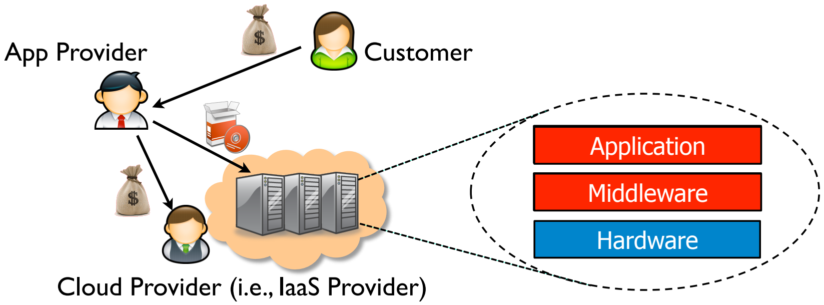

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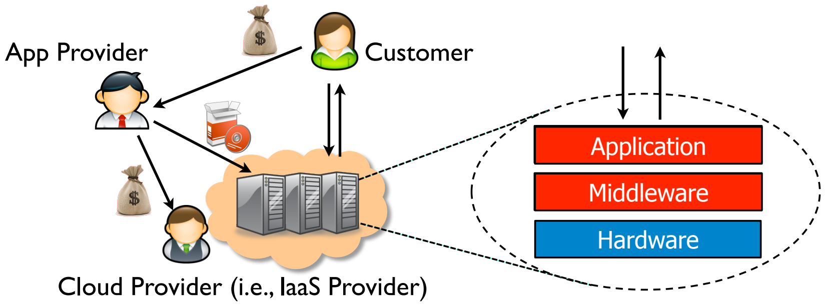

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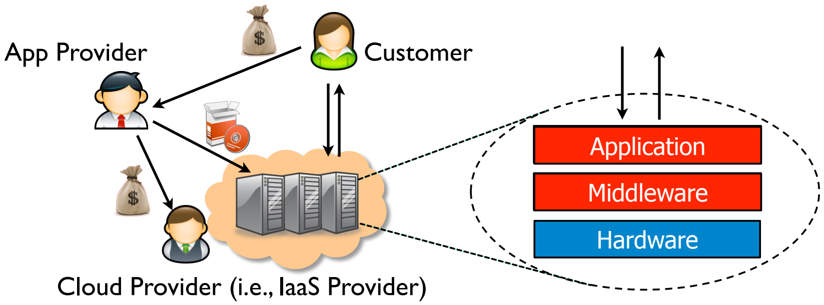

- Cloud provides raw computing resources
  - Virtual machines, blade servers, hard disk, etc.
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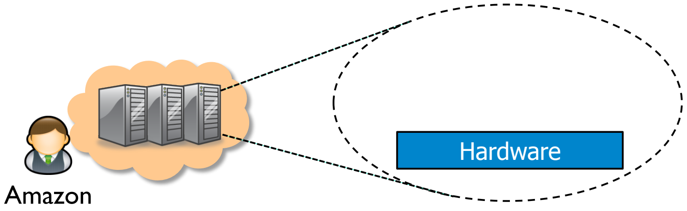
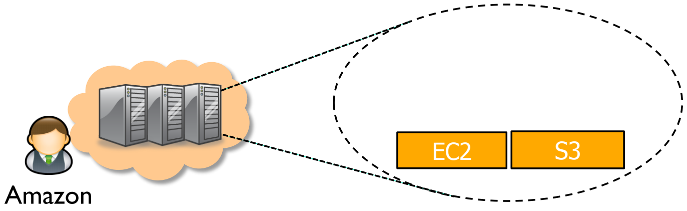
  - Example: Amazon Web Services, Rackspace Cloud, etc.

IaaS Example: EC2 and S3

(Elastic Compute Cloud & Simple Storage Service)



IaaS Example: EC2 and S3



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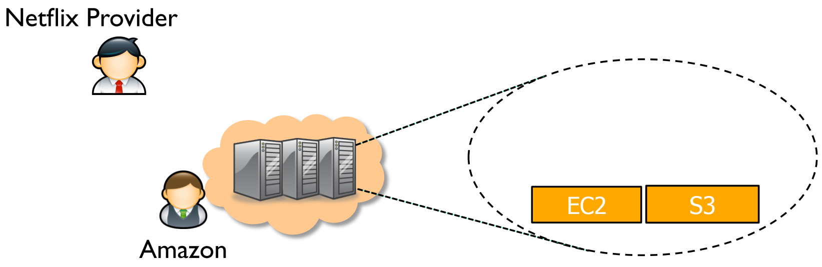
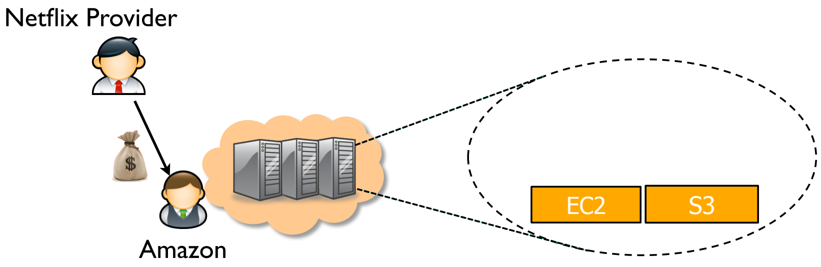


- Netflix (app) heavily depends on Amazon AWS:

IaaS Example: EC2 and S3



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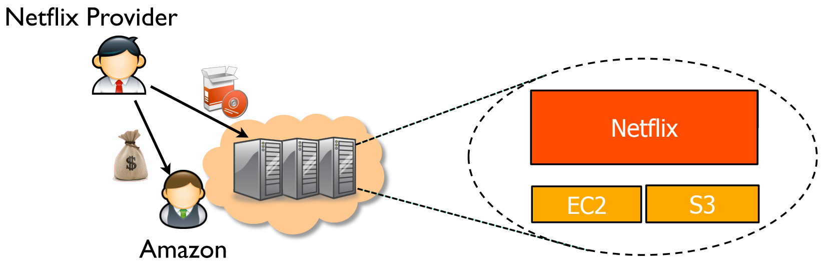

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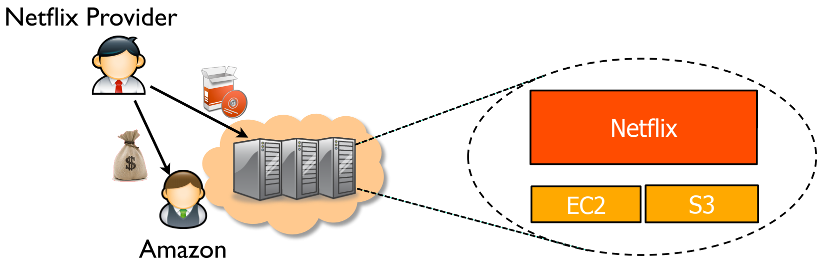

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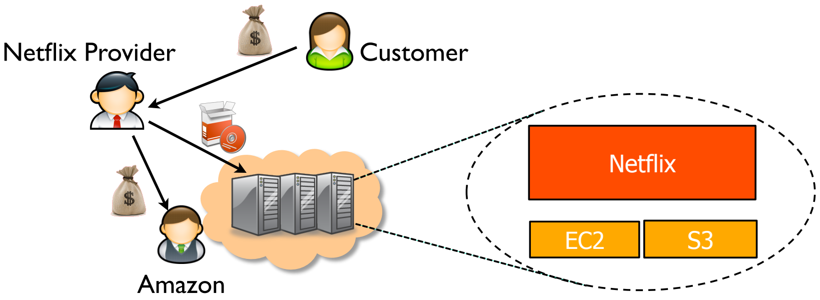
  - Media files are stored in S3
  - Transcoding to target devices (e.g., iPad) using EC2

IaaS Example: EC2 and S3



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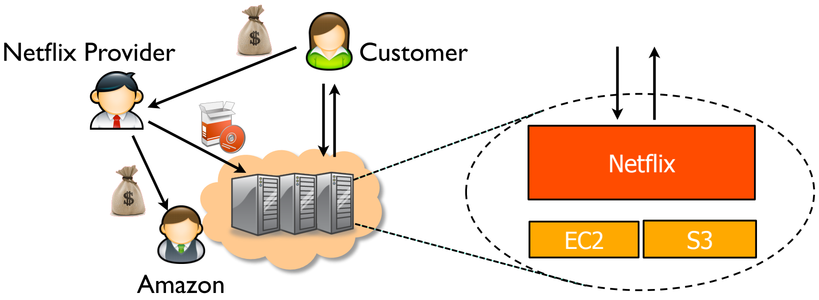

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Types of Cloud Services

- Three types of services:
  - Software as a Service (SaaS)
    - Analogy: Restaurant. Prepares&serves entire meal, does the dishes, etc
  - Platform as a Service (PaaS)
    - Analogy: Take-out food. Prepares meal but does not serve it.
  - Infrastructure as a Service (IaaS)
    - Analogy: Grocery store. Provides raw ingredients.

The Major Cloud Providers

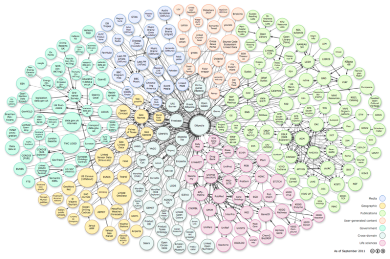
- Amazon is the big player:
  - Infrastructure as a service (e.g., EC2)
  - Storage as a service (e.g., S3)

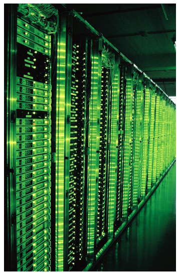
The Major Cloud Providers

- Amazon is the big player:
  - Infrastructure as a service (e.g., EC2)
  - Storage as a service (e.g., S3)
- But there are many others:
  - Microsoft Azure: It has similar services to Amazon, with an emphasis on .Net programming model
  - Google App Engine: It offers programming interface, Hadoop, also software as a service, e.g., Gmail and Google Docs
  - IBM, HP, Yahoo!: They seem to focus on enterprise scale cloud apps

Challenges?

In the cloud, we have much more data and users than before





Data! Users! Traffic!

PC

Server

Cluster

Data center

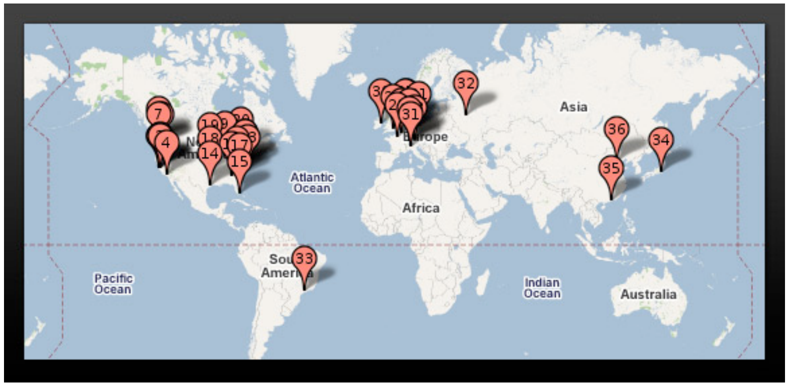
- What if cluster is too big to fit into machine room?
  - Build a separate building for the cluster
  - Building can have lots of cooling and power
  - Result: Data center

Google's Datacenter in Oregon

Data centers (size of
a football field)

- A warehouse-sized computer
  - A single data center can easily contain 10,000 racks with 100 cores in each rack (1,000,000 cores total)

Google's Datacenter Locations



Challenges?

- How to manage a huge group of data?
  - How to store the data?
  - How to process and extract something from the data?
  - How to handle multiple availability and consistency?
  - How to preserve the data privacy?

Example: Google

- How to manage a huge group of data?
  - How to store the data Google File System & BigTable
  - How to process and extract something fro MapReduce
  - How to handle multiple ava Paxos onsistency?
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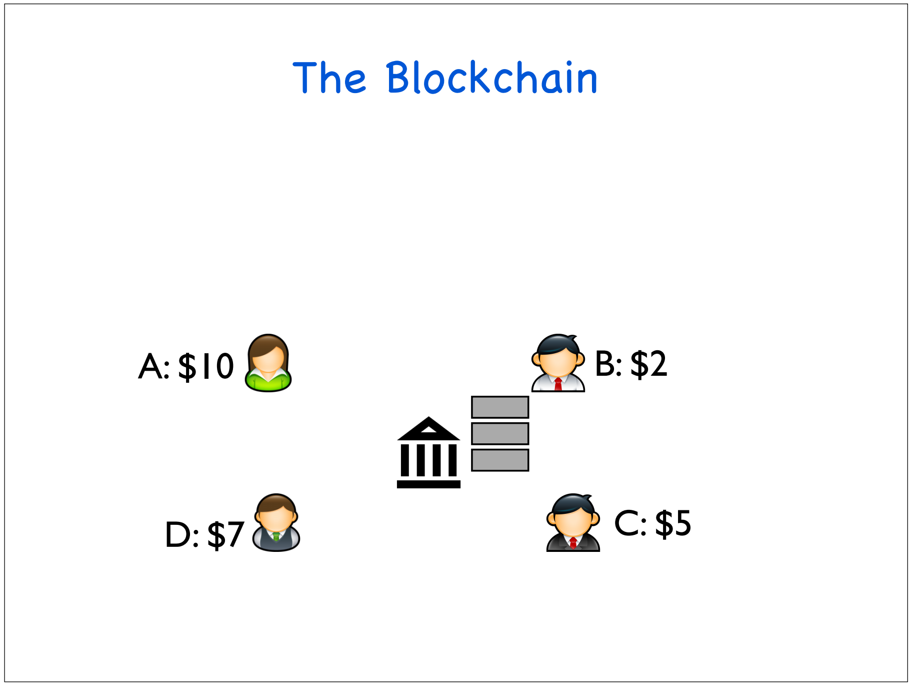
BitCoin ≠ Blockchain



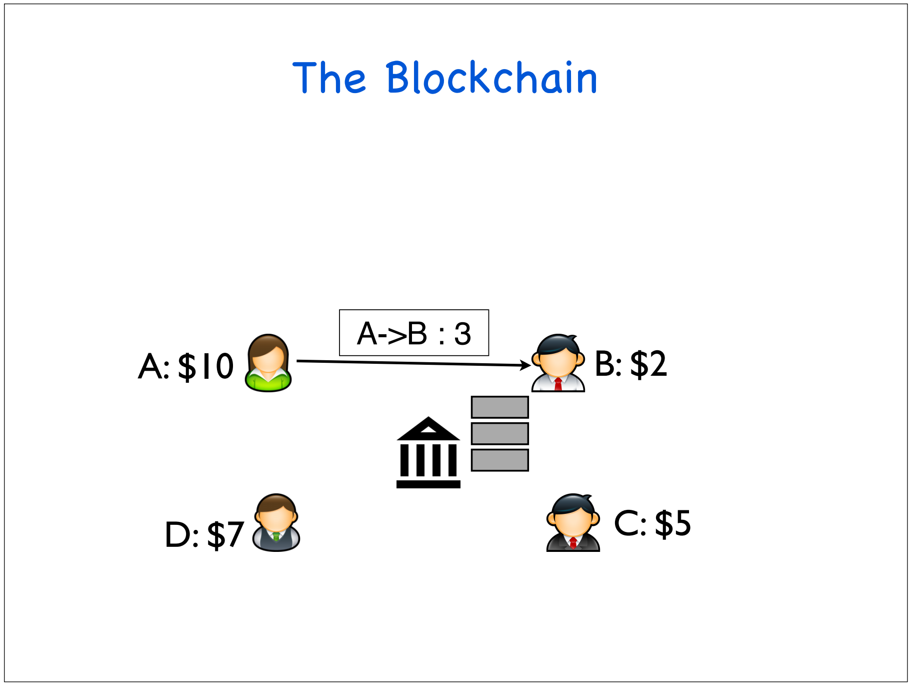
The Blockchain

A: $10

B: $2

D: $7

C: $5



The Blockchain

A->B : 3

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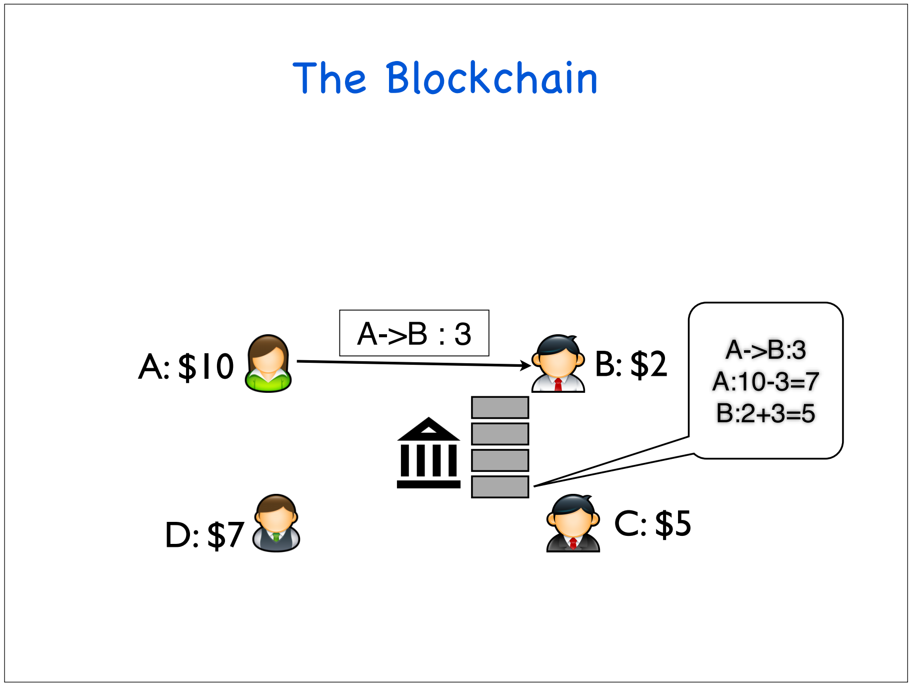

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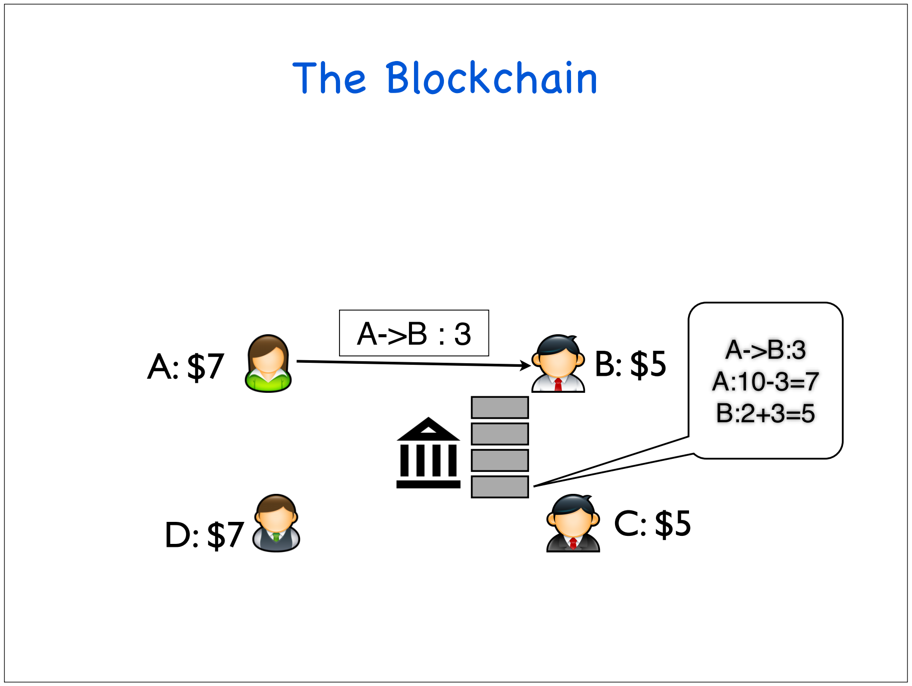

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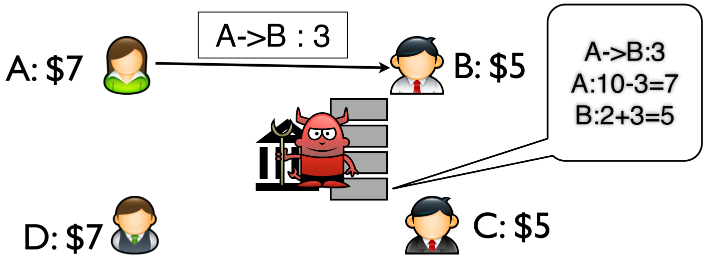
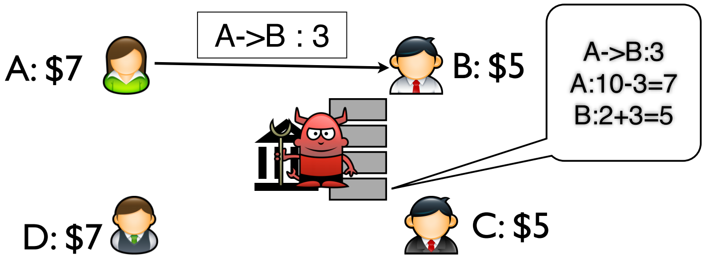


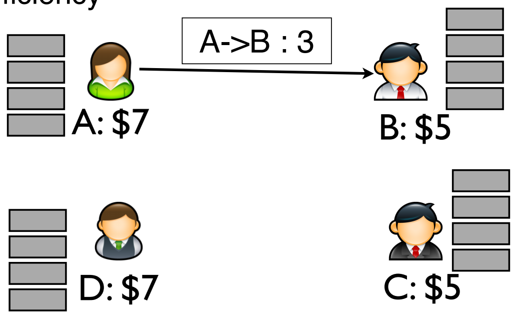
The Blockchain

- Blockchain is used to decentralize the log:



The Blockchain

- Blockchain is used to decentralize the log:
  - Decentralization
  - Public accountability
  - Efficiency



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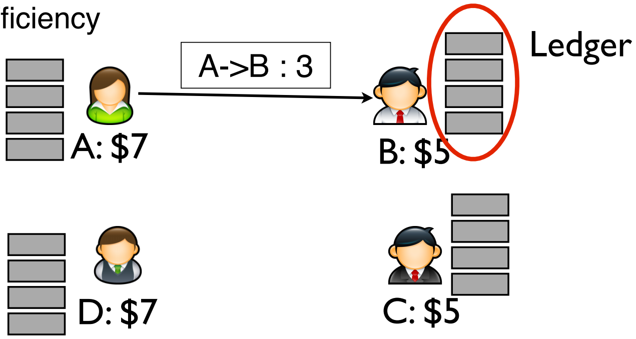

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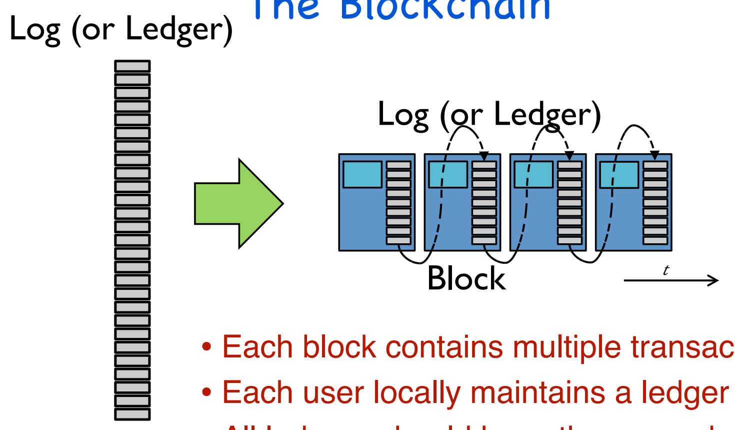
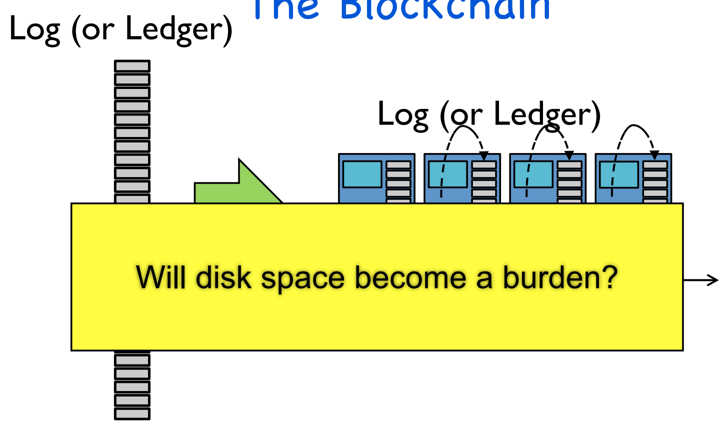


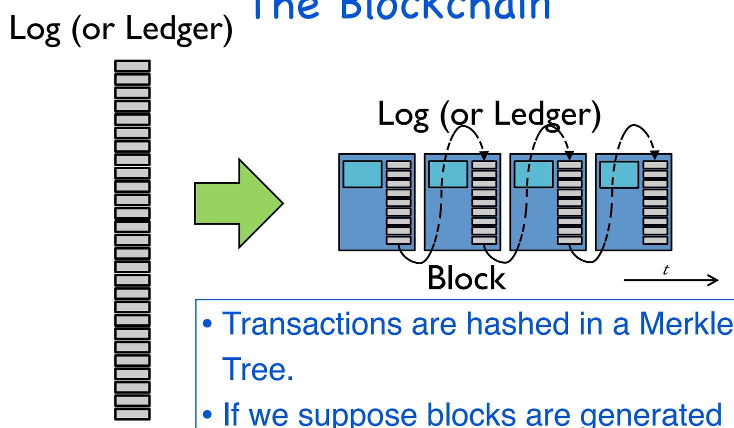
- Each block contains multiple transactions
- Each user locally maintains a ledger
- All ledgers should have the same data

The Blockchain



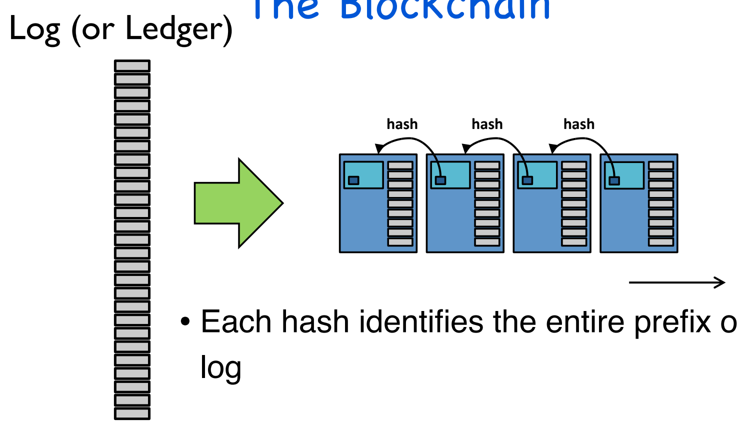
Will disk space become a burden?

The Blockchain



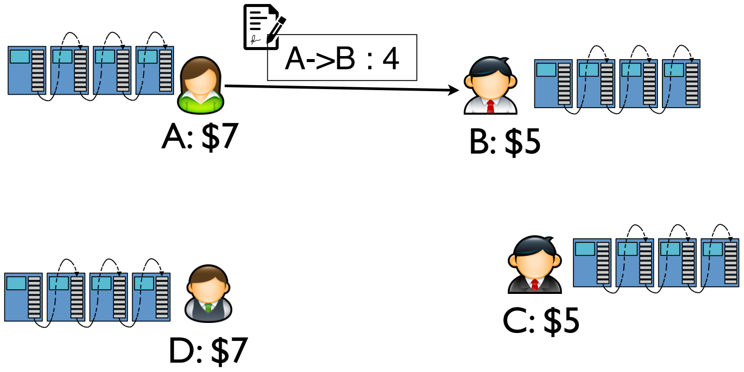
- Transactions are hashed in a Merkle Tree.
- If we suppose blocks are generated every 10 minutes, then 4.2MB per year.

The Blockchain

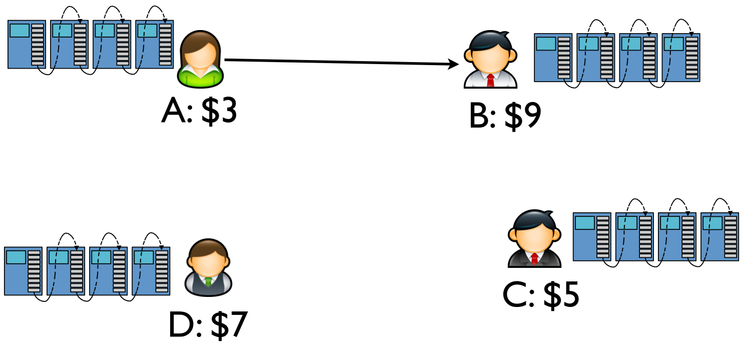


- Each hash identifies the entire prefix of the log

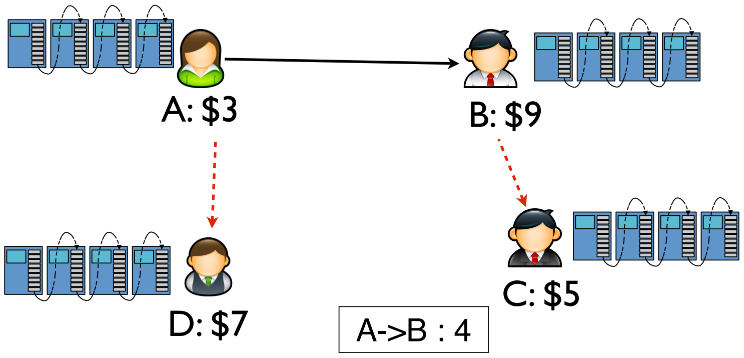
Transactions in the Blockchain



Transactions in the Blockchain



Transactions in the Blockchain



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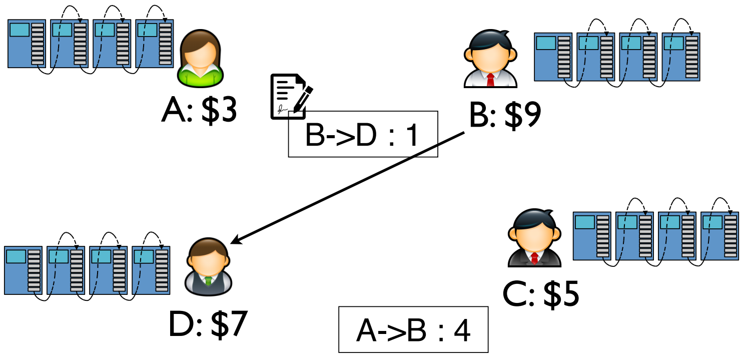

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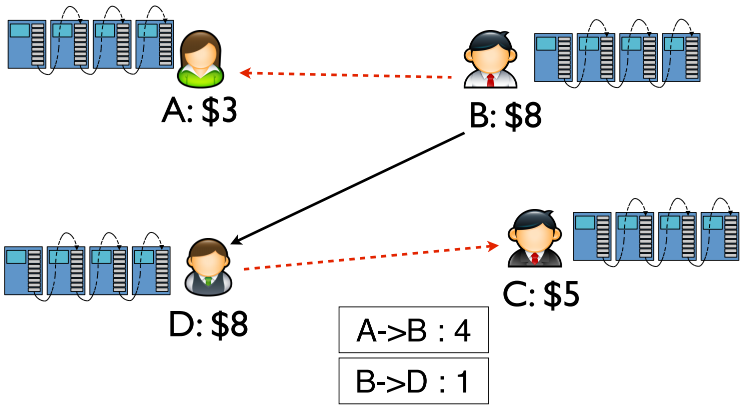


A: $3

B: $8

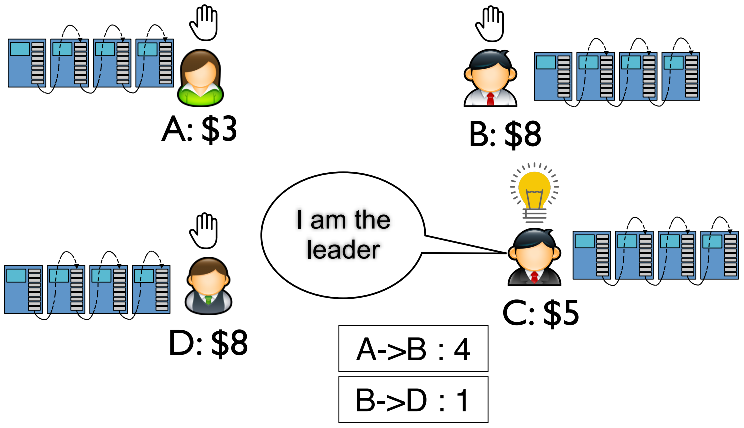
D: $8

C: $5

A->B : 4

B->D : 1

Consensus



A: $3

B: $8

I am the leader

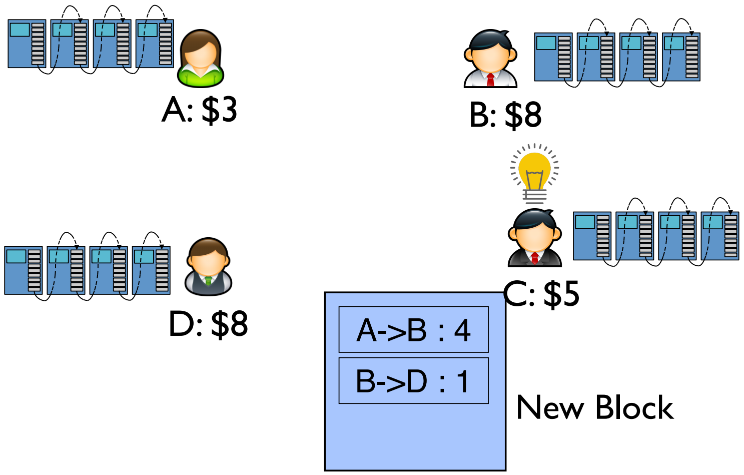
D: $8

C: $5

A->B : 4

B->D : 1

New Block Generation



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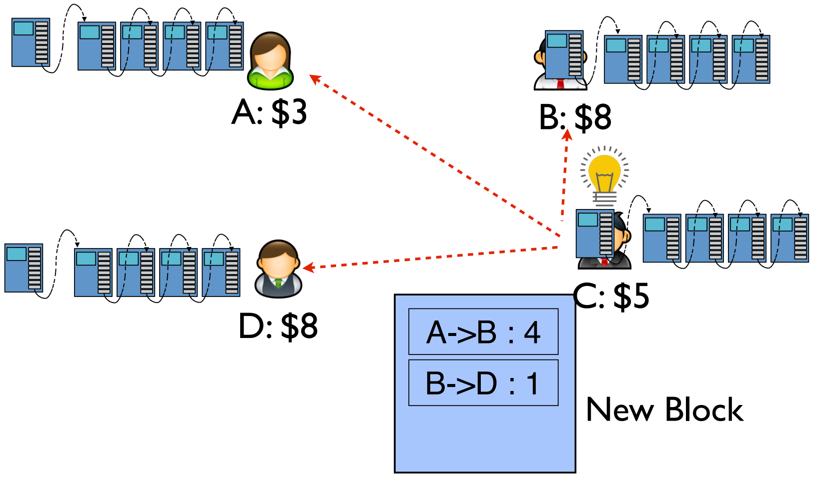
New Block

New Block Generation



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New Block

The Blockchain

- Blockchain can be used to decentralize any centralized service:
  - Making them decentralized (without single-point-fault)
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  - Making them decentralized (without single-point-fault)
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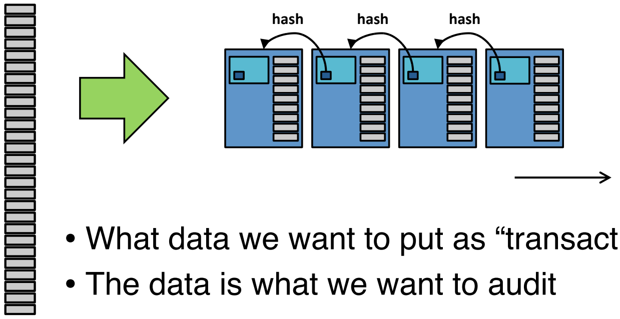
- We still have two problems:
  - How to achieve consensus?
  - How to preserve the privacy?

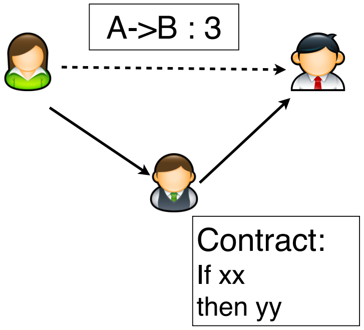
How to decentralize app via blockchain?

Log (or Ledger)

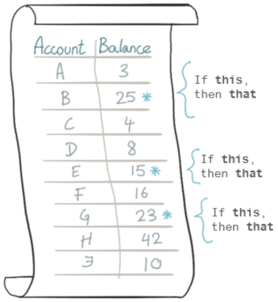


- What data we want to put as “transaction”
- The data is what we want to audit

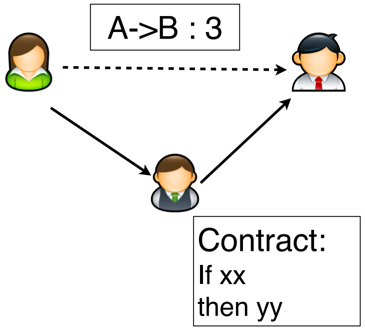
Smart Contract



Smart Contract



Account	Balance
A	3
B	25 *
C	4
D	8
E	15 *
F	16
G	23 *
H	42
I	10



A->B : 3

Contract:
If xx
then yy

Example

- You are planning to ship a laptop to your friend Bob
  - You trust Bob, but you do not trust trucker Tom
  - Tom will carry your laptop
  - Tom does not trust since maybe you will not pay him

Example

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  - You trust Bob, but you do not trust trucker Tom
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  - Tom does not trust since maybe you will not pay him

You and Tom have to sign a contract.

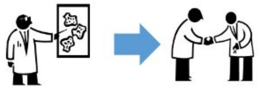
Example

- We can use smart contract:
  - You and Tom define all the rules in code
  - You make a payment for shipment to smart contract on a day of loading.
  - It holds payment till shipment delivery is confirmed by Bob.
  - Smart contract releases the payment and money is transferred to Tom automatically.

Another Example

Doctor informs patient that they need to exercise

Another Example

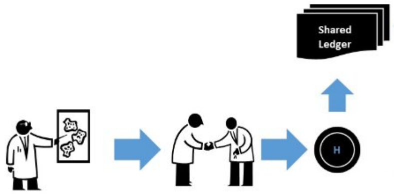


Doctor informs patient that they need to exercise

Patient agrees to exercise regime

Another Example

A ledger records all changes



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A "HealthCoin" is placed – a smart contract – is placed in the patients wallet (with demurrage)

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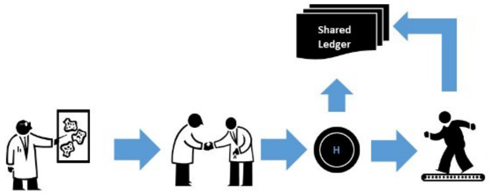

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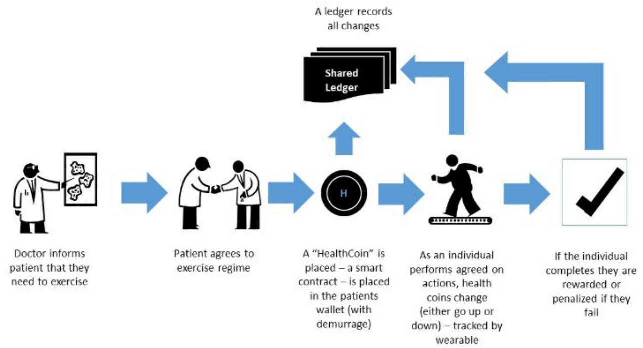
As an individual performs agreed on actions, health coins change (either go up or down) – tracked by wearable

Another Example



A ledger records all changes

Shared Ledger

Doctor informs patient that they need to exercise

Patient agrees to exercise regime

A "HealthCoin" is placed – a smart contract – is placed in the patients wallet (with demurrage)

As an individual performs agreed on actions, health coins change (either go up or down) – tracked by wearable

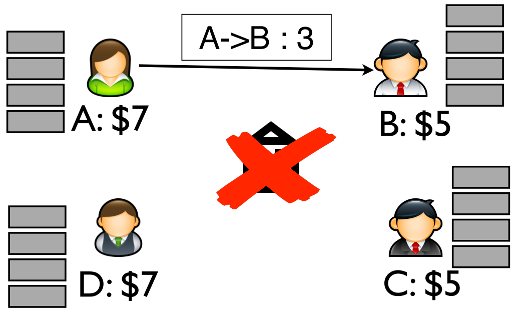
If the individual completes they are rewarded or penalized if they fail

The Blockchain

- Blockchain can be used to decentralize any centralized service:
  - Making them decentralized (without single-point-fault)
  - Public accountability
- We still have two problems:
  - How to achieve consensus?
  - How to preserve the privacy?

Deployment of BitCoin Nodes

- Blockchain is used for a decentralized bank:
  - Each user has several wallets (public keys)
  - They sign the money transaction using the private key



A->B : 3

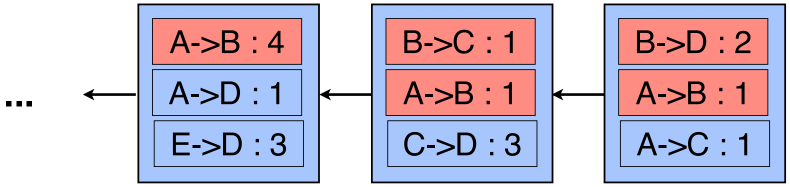
A: $7

B: $5

D: $7

C: $5

How to compute BitCoin?

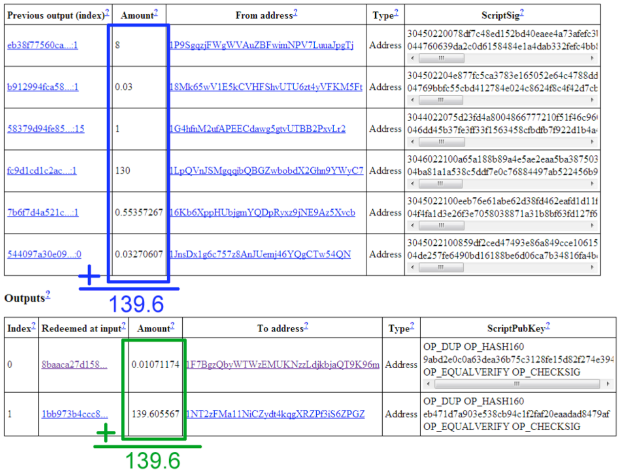


...		
A->B : 4	B->C : 1	B->D : 2
A->D : 1	A->B : 1	A->B : 1
E->D : 3	C->D : 3	A->C : 1

If B's initial value is 0, then B is 4-1+1-2+1=3

How to compute BitCoin?

Inputs



Previous output (index)?	Amount?	From address?	Type?	ScriptSig?
eb38f77560ca...:1	8	1P9SgqzjFWgWVAuZBFwimNPV7LuuaJpgTj	Address	30450220078df7c48ed152bd40eaee4a73afefc3 044760639da2c0d6158484e1a4dab332fefc4bb
b912994fca58...:1	0.03	18Mk65wV1E5kCVHFShvUTU6zt4yVFKM5Ft	Address	304502204e877fc5ca3783e165052e64c4788dd 04769bbfc55cbd412784e024c8624f8c4f42d7cb
58379d94fe85...:15	1	1G4hfnM2ufAPEECdawg5gtvUTBB2PxvLr2	Address	3044022075d23fd4a800486677721 0f51f46c96 046dd45b37fe3ff33f1563458cfbdfb7f922d1b4a
fc9d1cd1c2ac...:1	130	1LpQVnJSMgqqibQBGZwbobdX2Ghn9YWyC7	Address	3046022100a65a188b89a4e5ae2eaa5ba387503 04ba81a1a538c5ddf7e0c76884497ab522456b9
7b6f7d4a521c...:1	0.55357267	16Kb6XppHUbjgmYQDpRyxz9jNE9Az5Xvcb	Address	3045022100eeb76e61abe62d38fd462eafd1d11f 04f4fa1d3e26f3e7058038871a31b8bf63fd127f6
544097a30e09...:0	0.03270607	1JnsDx1g6c757z8AnJUemj46YQgCTw54QN	Address	3045022100859df2ced47493e86a849cce10615 04de257fe6490bd16188be6d06ca7b34816fa4b

+

139.6

Outputs?

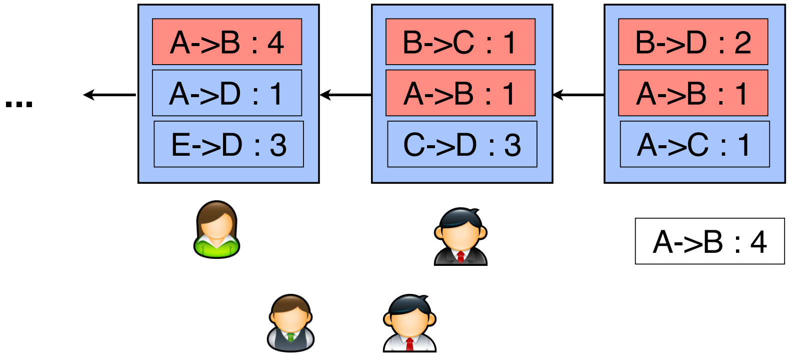
Outputs

Index?	Redeemed at input?	Amount?	To address?	Type?	ScriptPubKey?
0	8baaca27d158...	0.01071174	1F7BgzQbyWTWzEMUKNzzLdjkbjaQT9K96m	Address	OP_DUP OP_HASH160 9abd2e0c0a63dea36b75c3128fe15d82f274e394 OP_EQUALVERIFY OP_CHECKSIG
1	1bb973b4ccc8...	139.605567	1NT2zFMa11NiCZydt4kqgXRZPf3iS6ZPGZ	Address	OP_DUP OP_HASH160 eb471d7a903e538cb94c1f2faf20eaadad8479af OP_EQUALVERIFY OP_CHECKSIG

+

139.6

How to compute BitCoin?



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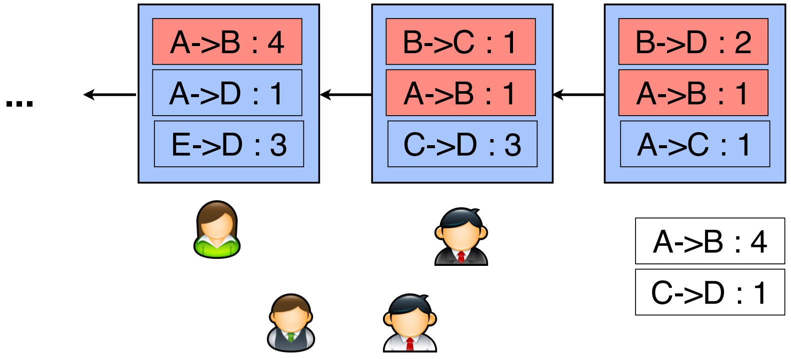
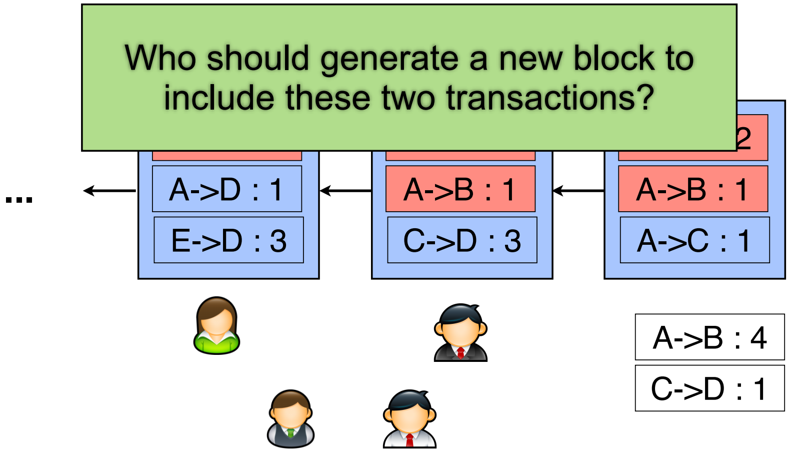
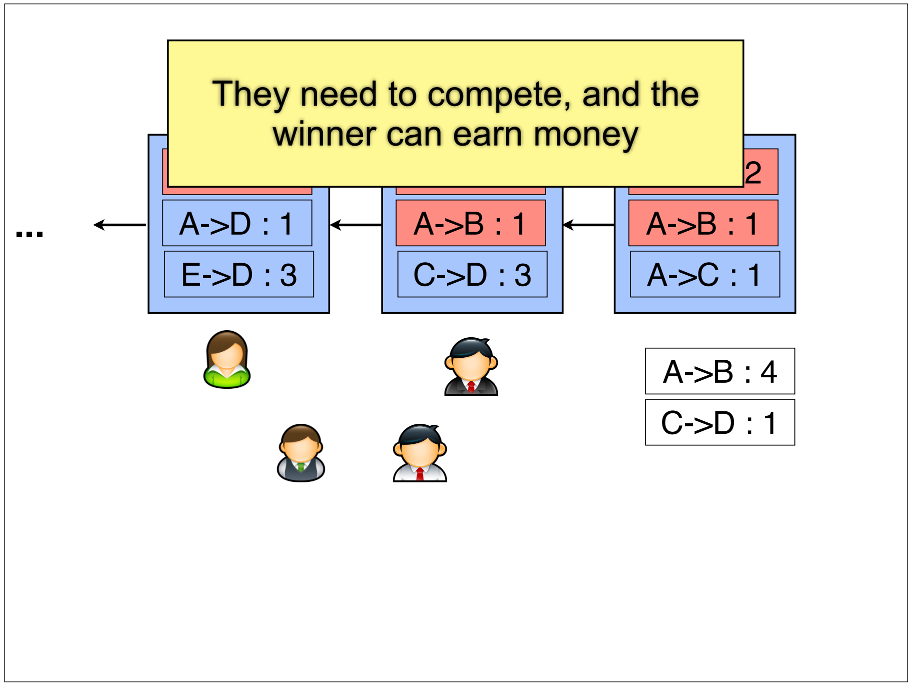
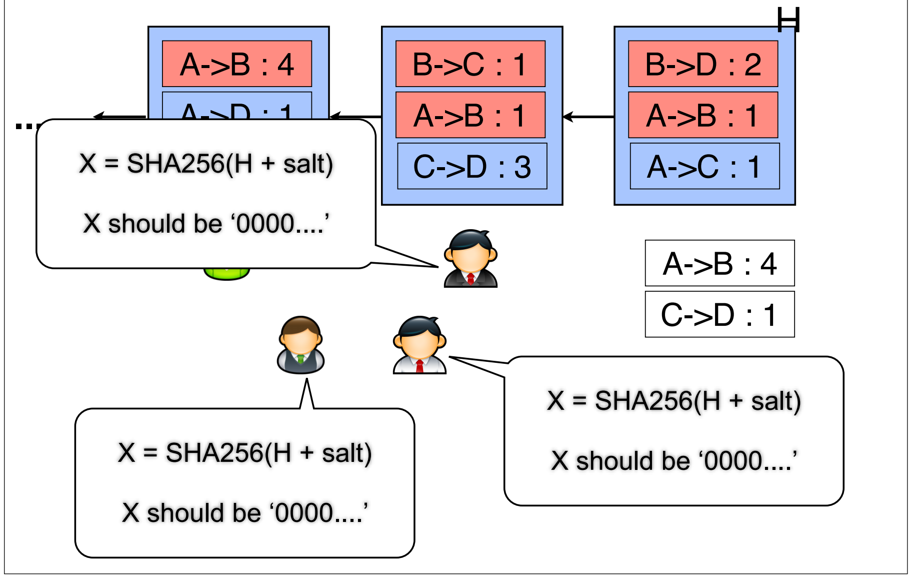




Who should generate a new block to include these two transactions?


They need to compete, and the winner can earn money

How to compute BitCoin?



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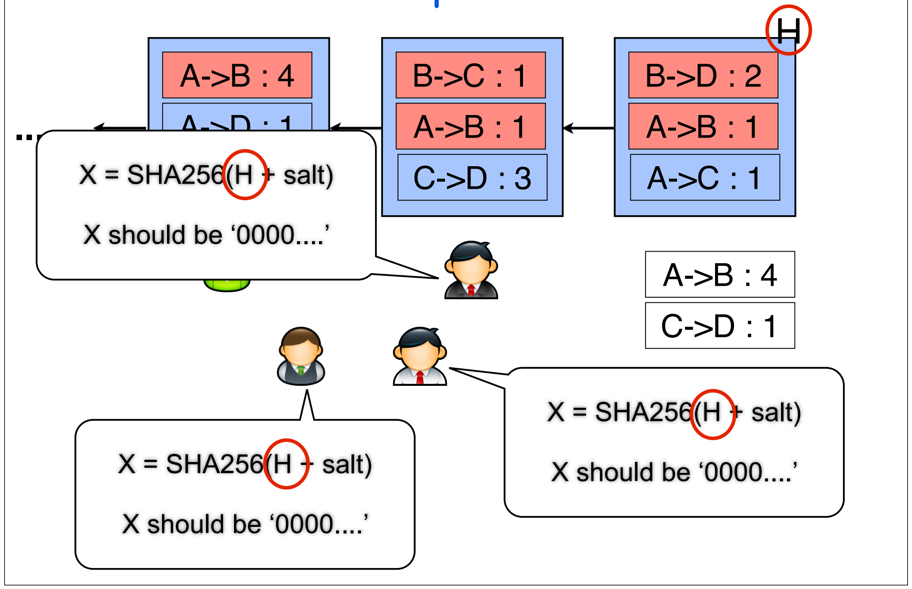
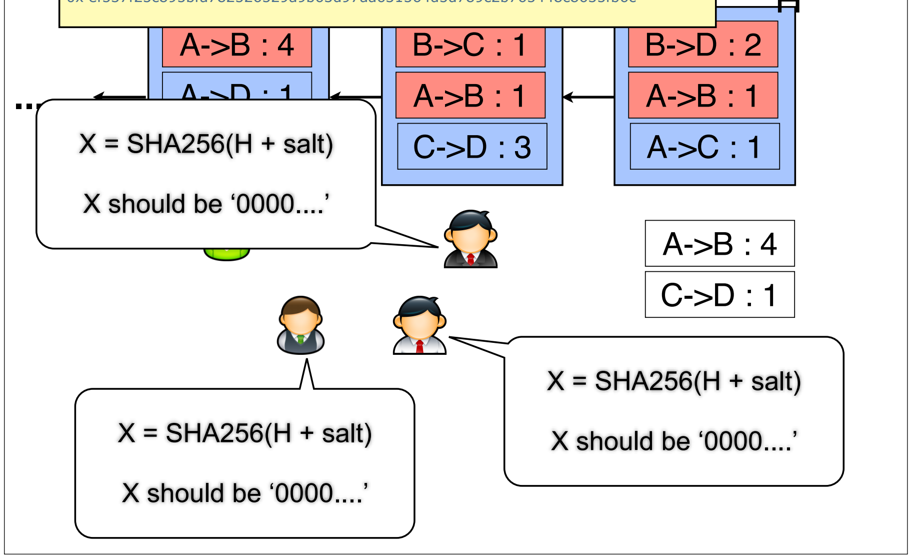
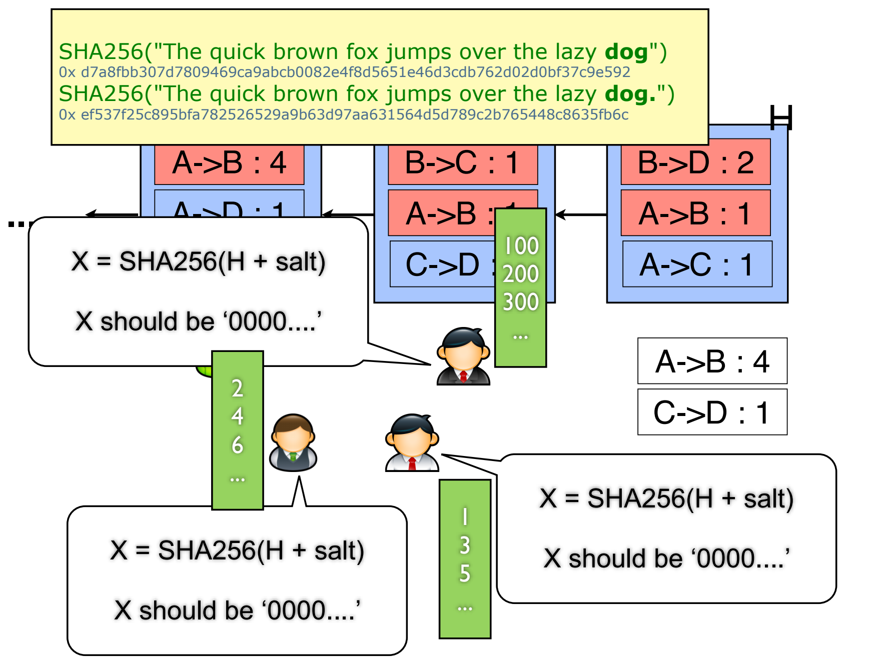


SHA256("The quick brown fox jumps over the lazy **dog**")
0x d7a8fbb307d7809469ca9abcb0082e4f8d5651e46d3cdb762d02d0bf37c9e592
SHA256("The quick brown fox jumps over the lazy **dog.**")
0x ef537f25c895bfa782526529a9b63d97aa631564d5d789c2b765448c8635fb6c





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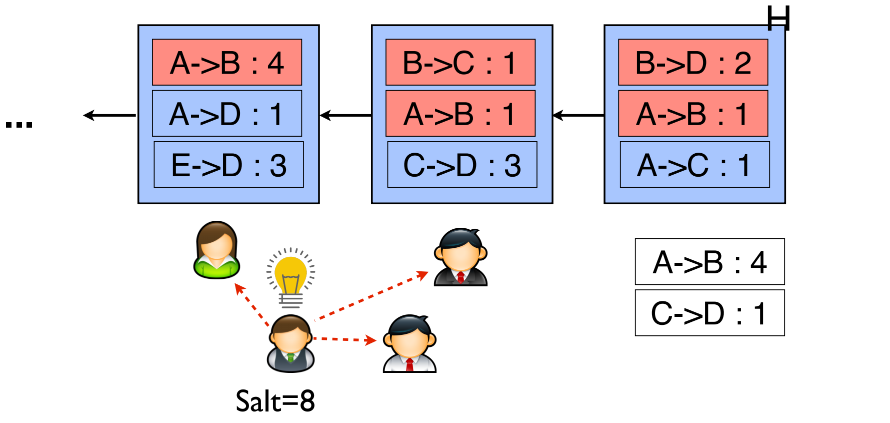

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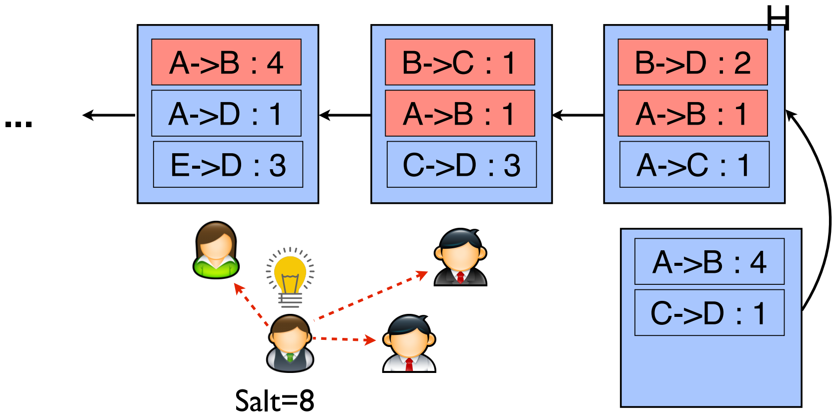

Proof of Work

- BitCoin uses the proof of work to achieve many goals:
  - Generating additional money
  - Achieving consensus while tolerating malicious users
  - A great incentive mechanism

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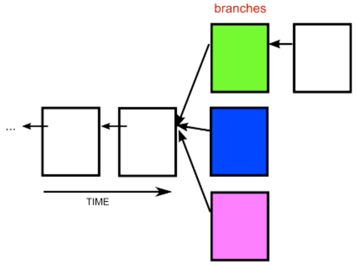
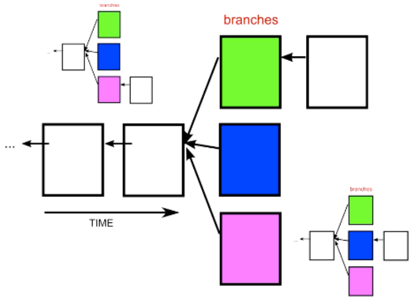
Proof of Work

- Occasionally, more than one block will be solved at the same time, leading to several possible branches

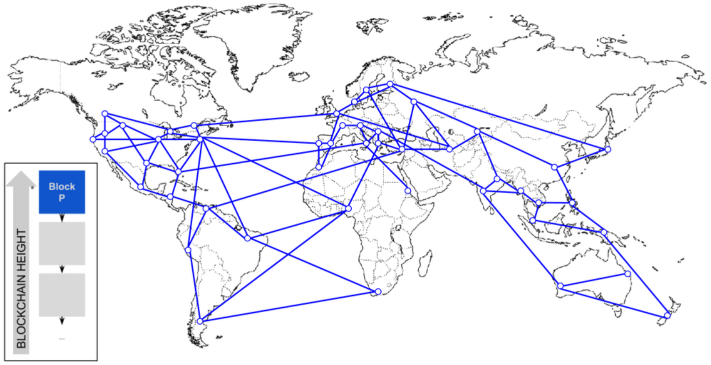


Proof of Work

- We should build on top of the first one you received.
- Others may have received the blocks in a different order, and will be building on the first block they received



Example



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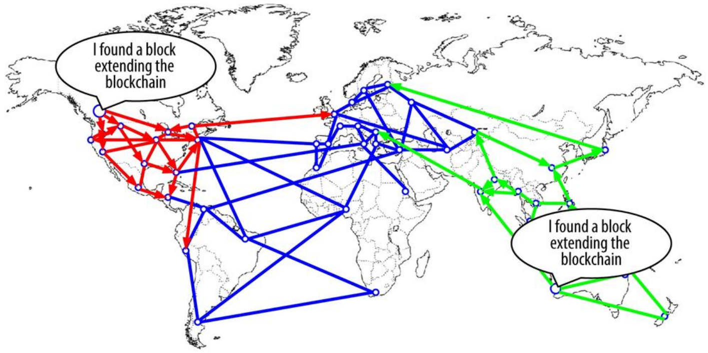
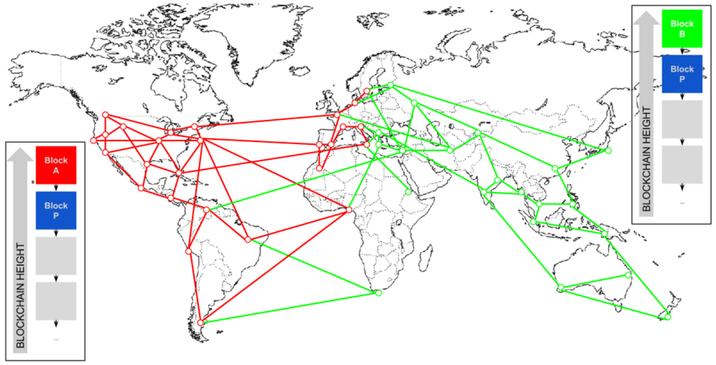

I found a block extending the blockchain
I found a block extending the blockchain

Example



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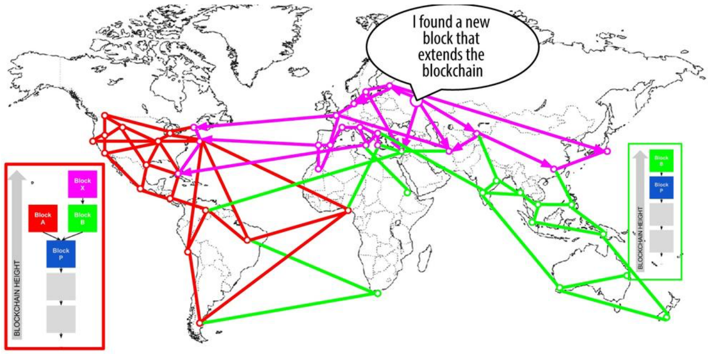

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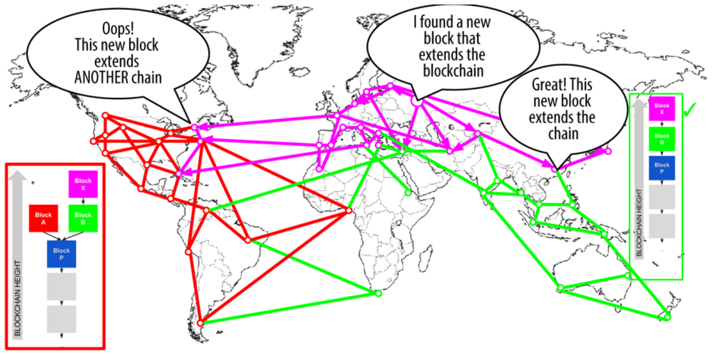
Oops! This new block extends ANOTHER chain
I found a new block that extends the blockchain
Great! This new block extends the chain
Block X
Block A
Block B
Block P
BLOCKCHAIN HEIGHT
Block X
Block B
Block P
BLOCKCHAIN HEIGHT
✓

Proof of Work

- We do not need to worry about the branch problem:
  - You always immediately switch to the longest branch
  - The math makes it rare for blocks to be solved at the same time, and even more rare for this to happen multiple times
  - The end result is the block chain quickly stabilizes

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- ~10 minutes to generate a new block
- Your transactions are confirmed after 6 blocks

Proof of Work

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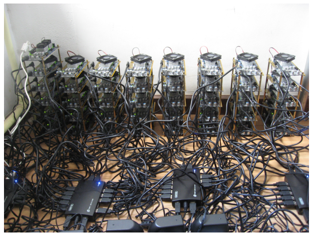
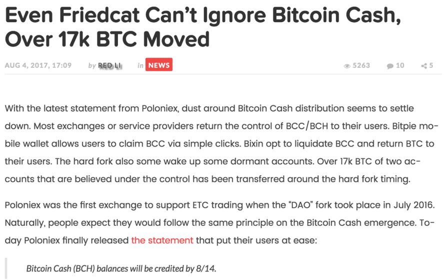
Miners in BitCoin can earn a lot of money!

- ~10 minutes to generate a new block
- Your transactions are confirmed after 6 blocks

Miner's life



Anyone heard Friedcat?



Even Friedcat Can’t Ignore Bitcoin Cash, Over 17k BTC Moved

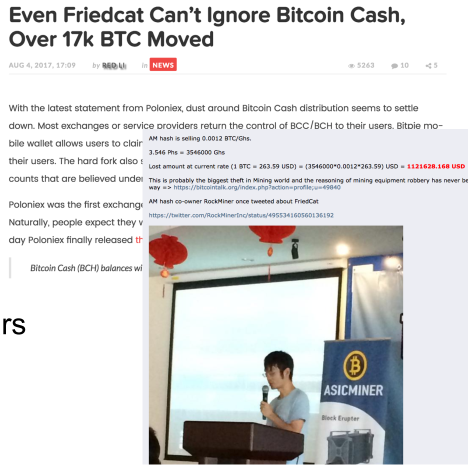
AUG 4, 2017, 17:09 by RED LI in NEWS 5263 10 5

With the latest statement from Poloniex, dust around Bitcoin Cash distribution seems to settle down. Most exchanges or service providers return the control of BCC/BCH to their users. Bitpie mobile wallet allows users to claim BCC via simple clicks. Bixin opt to liquidate BCC and return BTC to their users. The hard fork also some wake up some dormant accounts. Over 17k BTC of two accounts that are believed under the control has been transferred around the hard fork timing.

Poloniex was the first exchange to support ETC trading when the “DAO” fork took place in July 2016. Naturally, people expect they would follow the same principle on the Bitcoin Cash emergence. Today Poloniex finally released the statement that put their users at ease:

> *Bitcoin Cash (BCH) balances will be credited by 8/14.*

Friedcat



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> *Bitcoin Cash (BCH) balances wi*

AM hash is selling 0.0012 BTC/Ghs.

3.546 Phs = 3546000 Ghs

Lost amount at current rate (1 BTC = 263.59 USD) = (3546000*0.0012*263.59) USD = **1121628.168 USD**

This is probably the biggest theft in Mining world and the reasoning of mining equipment robbery has never be
way => https://bitcointalk.org/index.php?action=profile;u=49840

AM hash co-owner RockMiner once tweeted about FriedCat

https://twitter.com/RockMinerInc/status/495534160560136192

More than 100 million dollars