Bitcoin & Cryptocurrency

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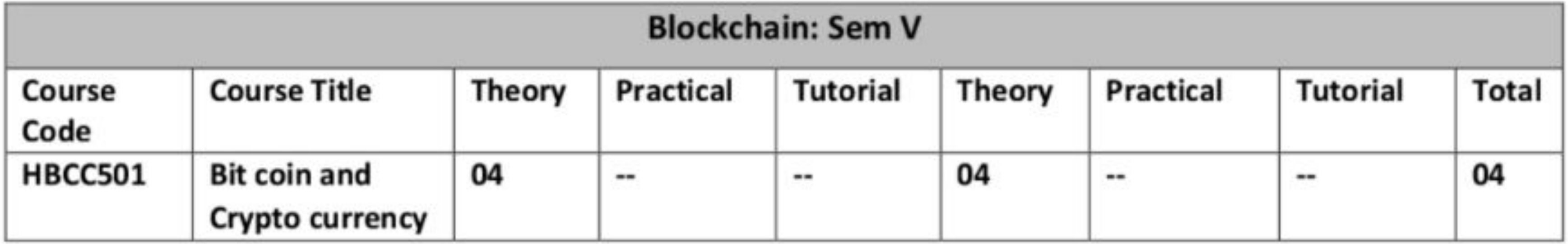
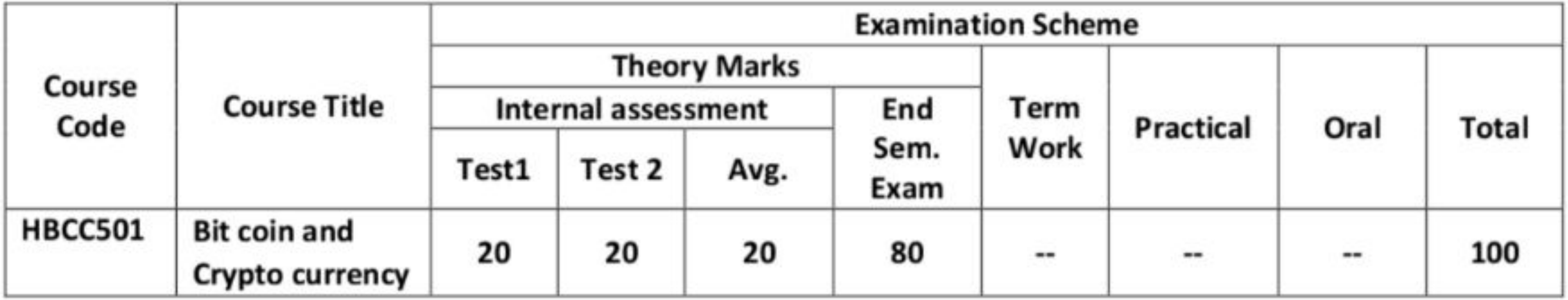
Agenda

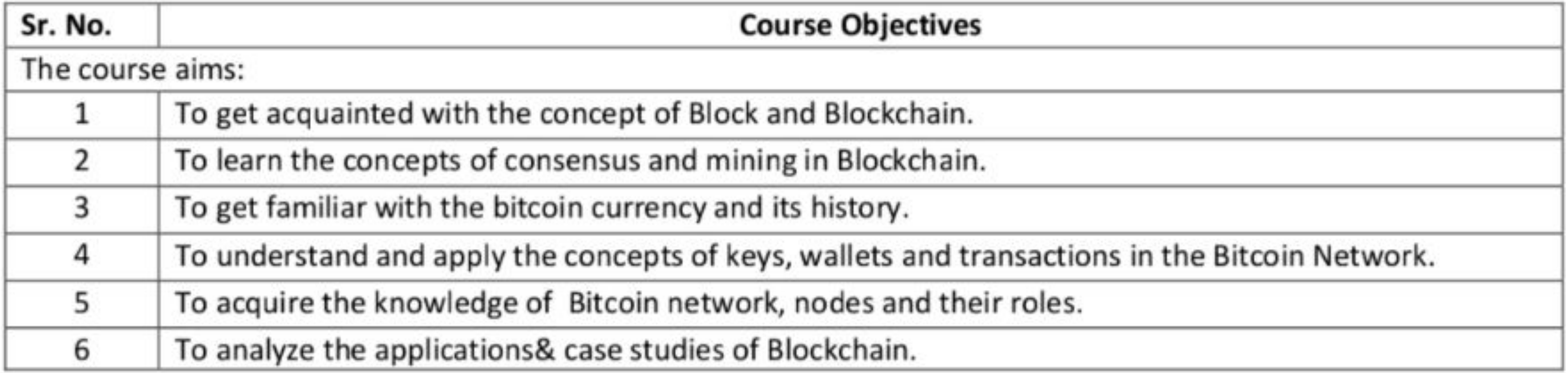
- Course Overview
- Why there is a hype in Blockchain?
- Why to learn Blockchain ?
- What is Web 3.0 ?
- What is Blockchain ?
- P2P Network in Blockchain - Challenges & Solutions



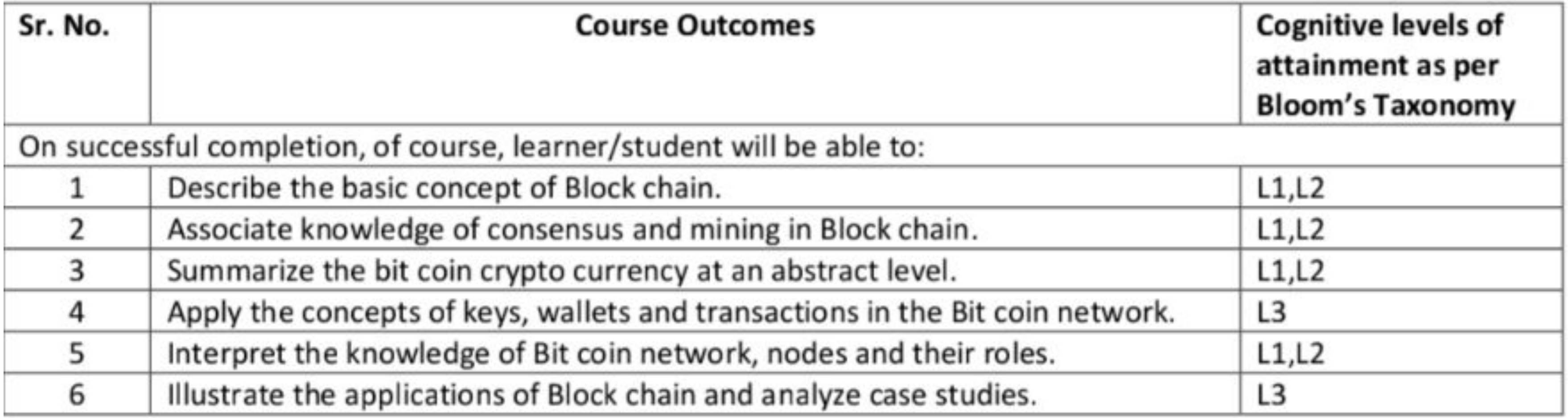
Blockchain: Sem V								
Course Code	Course Title	Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
HBCC501	Bit coin and Crypto currency	04	--	--	04	--	--	04



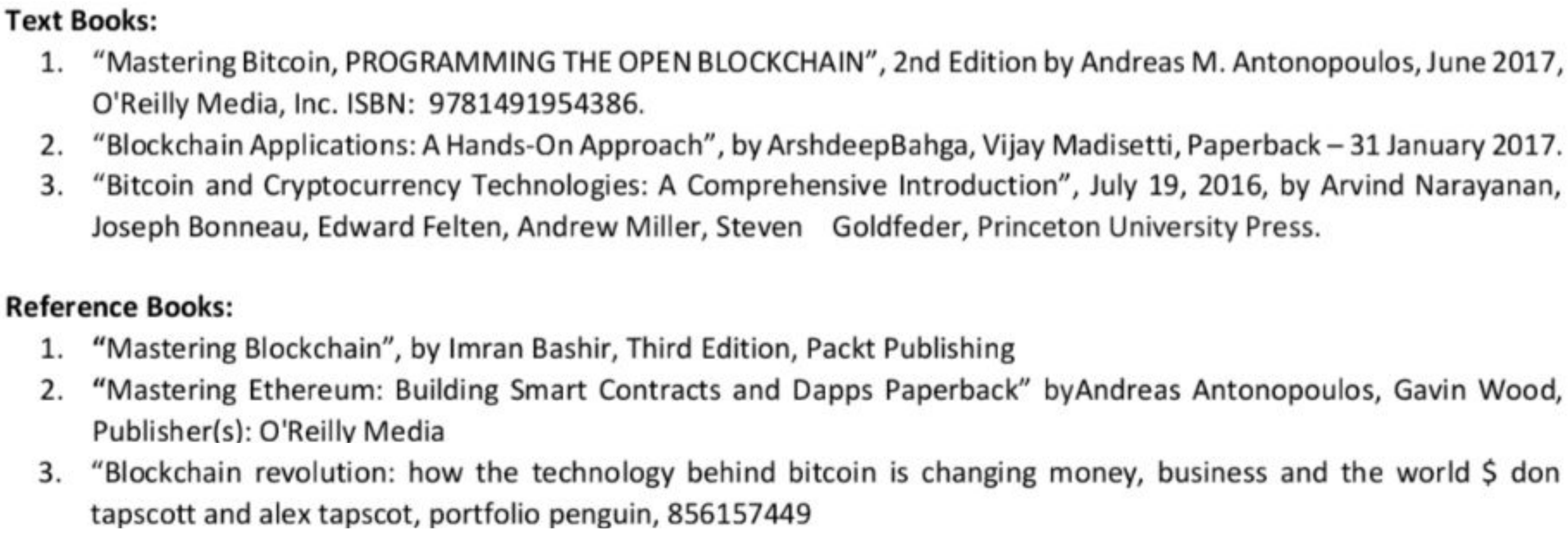
Course Code	Course Title	Examination Scheme								
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg.					
HBCC501	Bit coin and Crypto currency	20	20	20	80	--	--	--	100



Sr. No.	Course Objectives
The course aims:	
1	To get acquainted with the concept of Block and Blockchain.
2	To learn the concepts of consensus and mining in Blockchain.
3	To get familiar with the bitcoin currency and its history.
4	To understand and apply the concepts of keys, wallets and transactions in the Bitcoin Network.
5	To acquire the knowledge of Bitcoin network, nodes and their roles.
6	To analyze the applications& case studies of Blockchain.



Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Describe the basic concept of Block chain.	L1,L2
2	Associate knowledge of consensus and mining in Block chain.	L1,L2
3	Summarize the bit coin crypto currency at an abstract level.	L1,L2
4	Apply the concepts of keys, wallets and transactions in the Bit coin network.	L3
5	Interpret the knowledge of Bit coin network, nodes and their roles.	L1,L2
6	Illustrate the applications of Block chain and analyze case studies.	L3



Text Books:

1. "Mastering Bitcoin, PROGRAMMING THE OPEN BLOCKCHAIN", 2nd Edition by Andreas M. Antonopoulos, June 2017, O'Reilly Media, Inc. ISBN: 9781491954386.
2. "Blockchain Applications: A Hands-On Approach", by ArshdeepBahga, Vijay Madisetti, Paperback – 31 January 2017.
3. "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", July 19, 2016, by Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, Princeton University Press.

Reference Books:

1. "Mastering Blockchain", by Imran Bashir, Third Edition, Packt Publishing
2. "Mastering Ethereum: Building Smart Contracts and Dapps Paperback" byAndreas Antonopoulos, Gavin Wood, Publisher(s): O'Reilly Media
3. "Blockchain revolution: how the technology behind bitcoin is changing money, business and the world $ don tapscott and alex tapscot, portfolio penguin, 856157449

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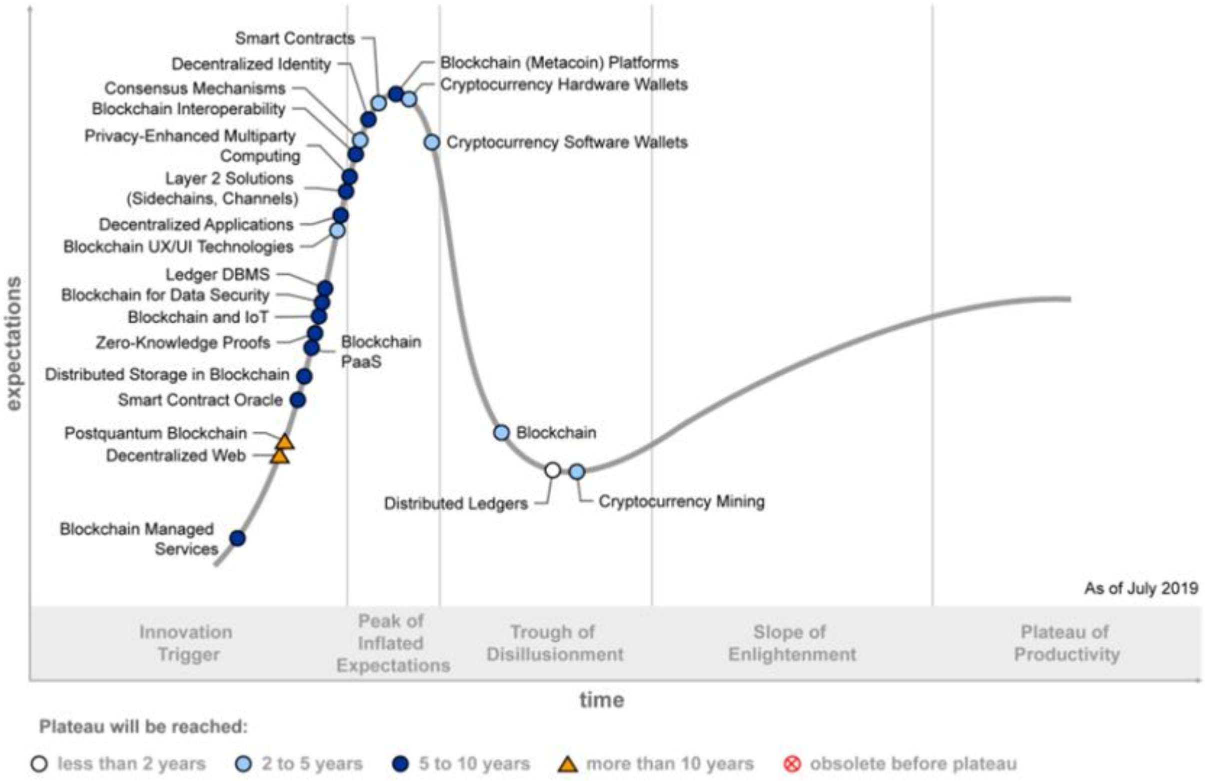
Why there is a hype in Blockchain?



Courtesy : https://emtemp.gcom.cloud/ngw/globalassets/en/newsroom/images/graphs/blockchain-hypecycle-oct-3-2019-2.png

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Why to Learn Blockchain ?

Current Scenario

- Internet is owned by Technical Giants
- Huge Transaction fees by 3rd Parties
- Time to complete Transactions..
- Ownership for Content Creators
- Lack of Transparency

Blockchain Offers …

- Decentralized with P2P Network
- Trust in a Trustless Network
- Immutable
- Security through Cryptography
- Transparency

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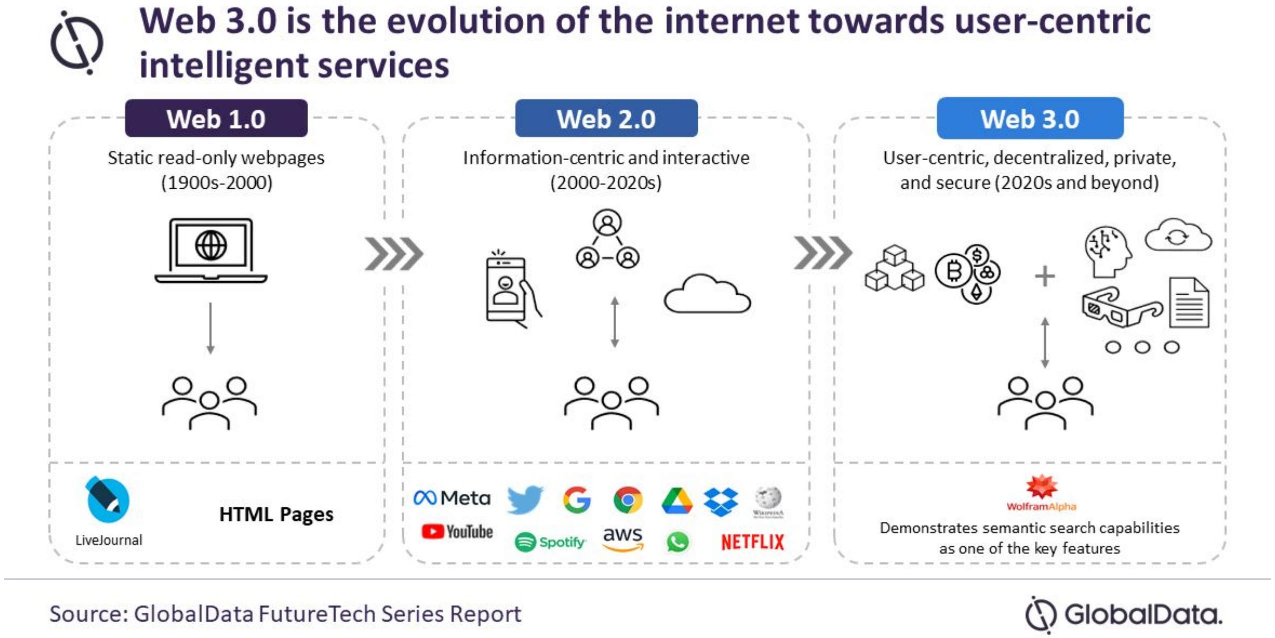
What is Web 3.0?



Web 3.0 is the evolution of the internet towards user-centric intelligent services

Web 1.0

Static read-only webpages (1900s-2000)

Web 2.0

Information-centric and interactive (2000-2020s)

Web 3.0

User-centric, decentralized, private, and secure (2020s and beyond)

Demonstrates semantic search capabilities as one of the key features

Source: GlobalData FutureTech Series Report

Courtesy : https://www.globaldata.com/wp-content/uploads/2022/03/220302_Web3.0_7and9_1.png

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- Why there is a hype in Blockchain?
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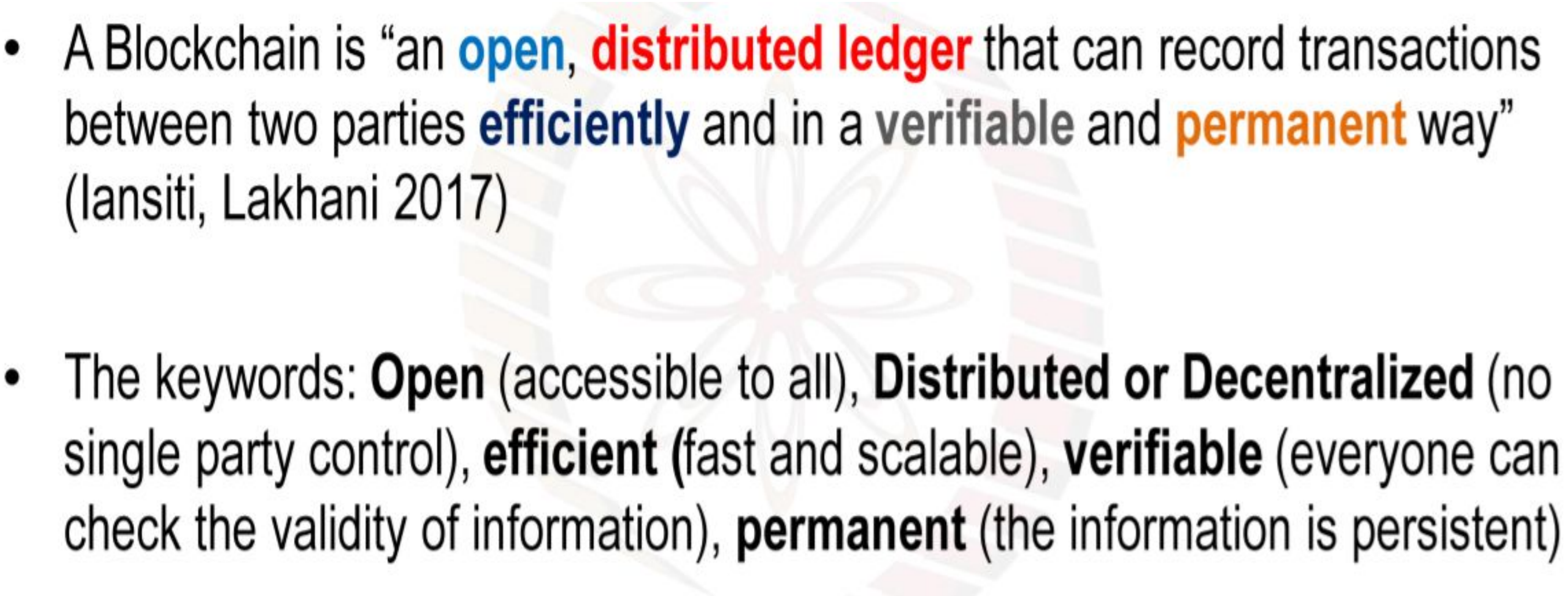
- What is Web 3.0 ?
- What is Blockchain with an Example Scenario
- P2P Network in Blockchain - Challenges & Solutions

What is Blockchain ?



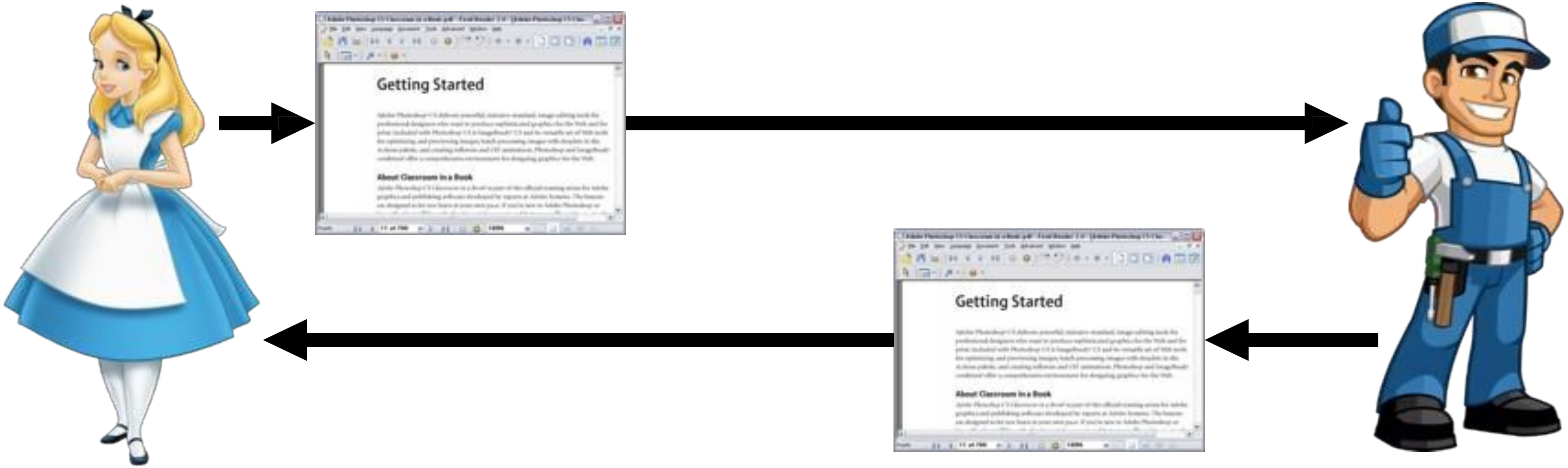
- A Blockchain is “an **open**, **distributed ledger** that can record transactions between two parties **efficiently** and in a **verifiable** and **permanent** way” (Iansiti, Lakhani 2017)

- The keywords: **Open** (accessible to all), **Distributed or Decentralized** (no single party control), **efficient** (fast and scalable), **verifiable** (everyone can check the validity of information), **permanent** (the information is persistent)

Courtesy : https://nptel.ac.in/courses/106105184

Example Scenario

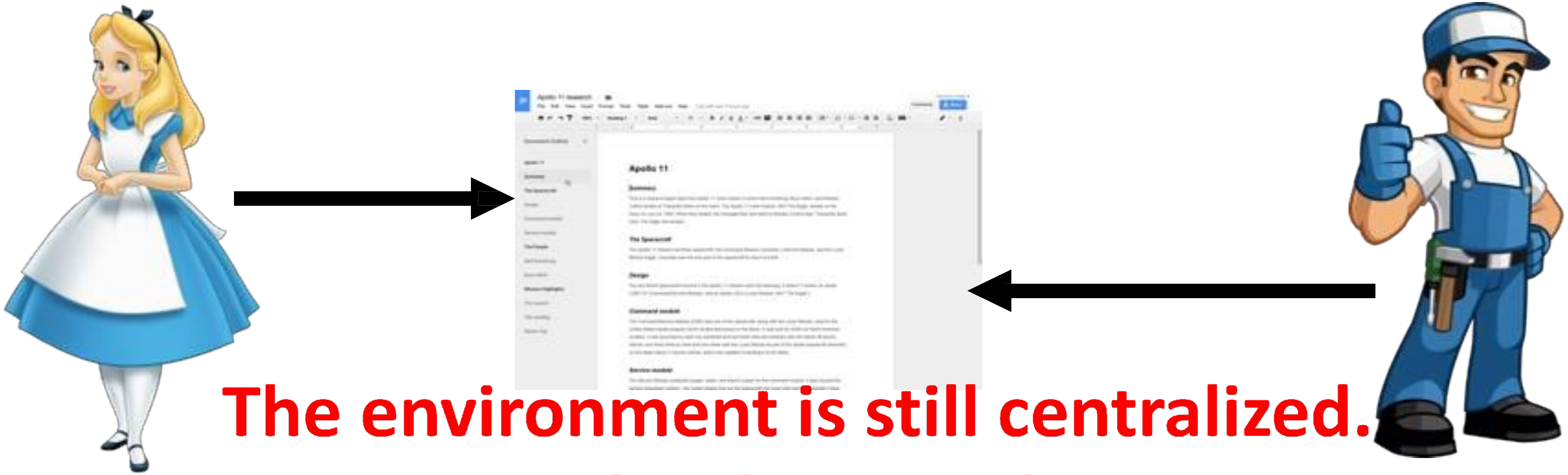
- Traditional way of sharing documents



Courtesy : https://nptel.ac.in/courses/106105184

Example Scenario

- Shared Google doc – both the users can edit simultaneously



The environment is still centralized.

Does centralized system harm?

Courtesy : https://nptel.ac.in/courses/106105184

Example Scenario

Problems with a Centralized System

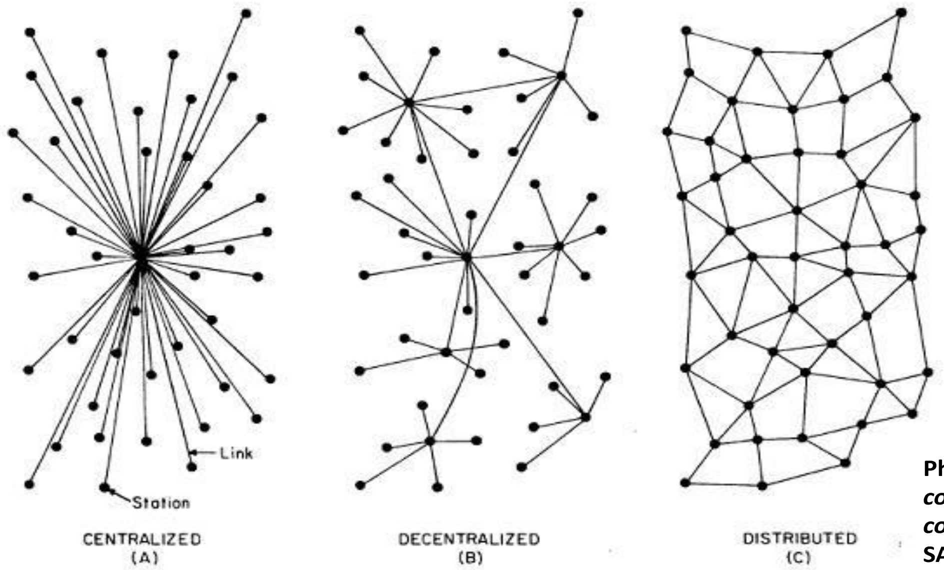
A single point of failure

- If you do not have sufficient bandwidth to load Google doc, you’ll not be able to edit
- What if the server crashes?

Courtesy : https://nptel.ac.in/courses/106105184

Example Scenario

Centralized vs Decentralized vs Distributed



Complete reliance on single point (centralized) is not safe

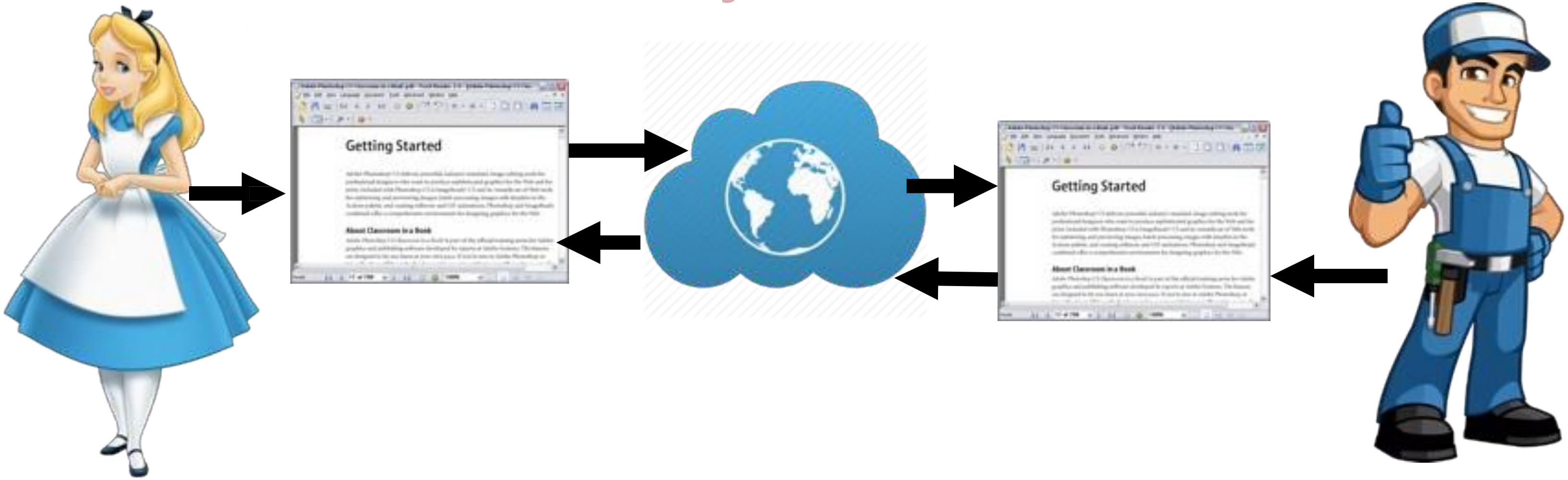
- Decentralized: Multiple points of coordination
- Distributed: Everyone collectively execute the job

Photo courtesy: Baran, Paul. *On distributed communications: I. Introduction to distributed communications networks*. No. RM3420PR. RAND CORP SANTA MONICA CALIF, 1964.

Courtesy : https://nptel.ac.in/courses/106105184

Example Scenario

A Plausibly Ideal Solution

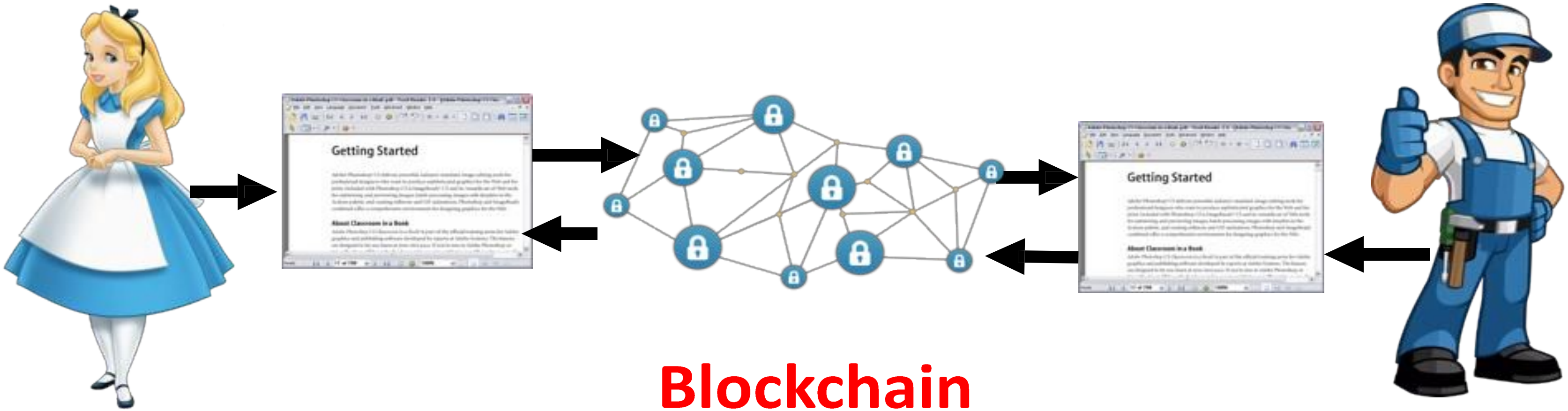


Everyone edits on their local copy of the document – the Internet takes care of ensuring consistency

Courtesy : https://nptel.ac.in/courses/106105184

Example Scenario

Blockchain – The Internet Database to Support Decentralization



Blockchain

A decentralized database with strong consistency support

Courtesy : https://nptel.ac.in/courses/106105184

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- What is Blockchain? With an example Scenario
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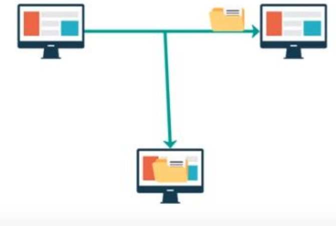
P2P Network in Blockchain

Challenges

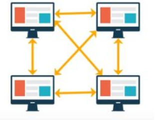
1. Confidentiality
2. Integrity
3. Non-repudiation
4. Authentication



Solution

- Cryptography

Courtesy : https://www.youtube.com/watch?v=06Un2_F4Y0E&list=PLsyeobzWxl7oY6tZmnZ5S7yTDxyu4zDW-&index=7



P2P Network in Blockchain

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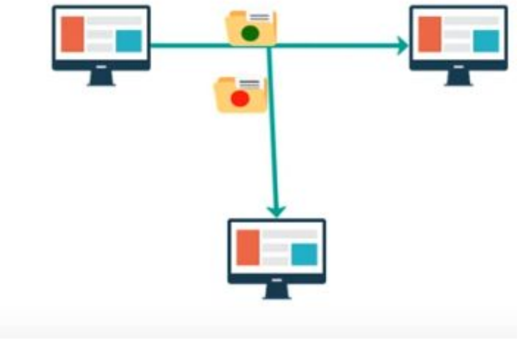

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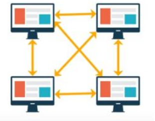
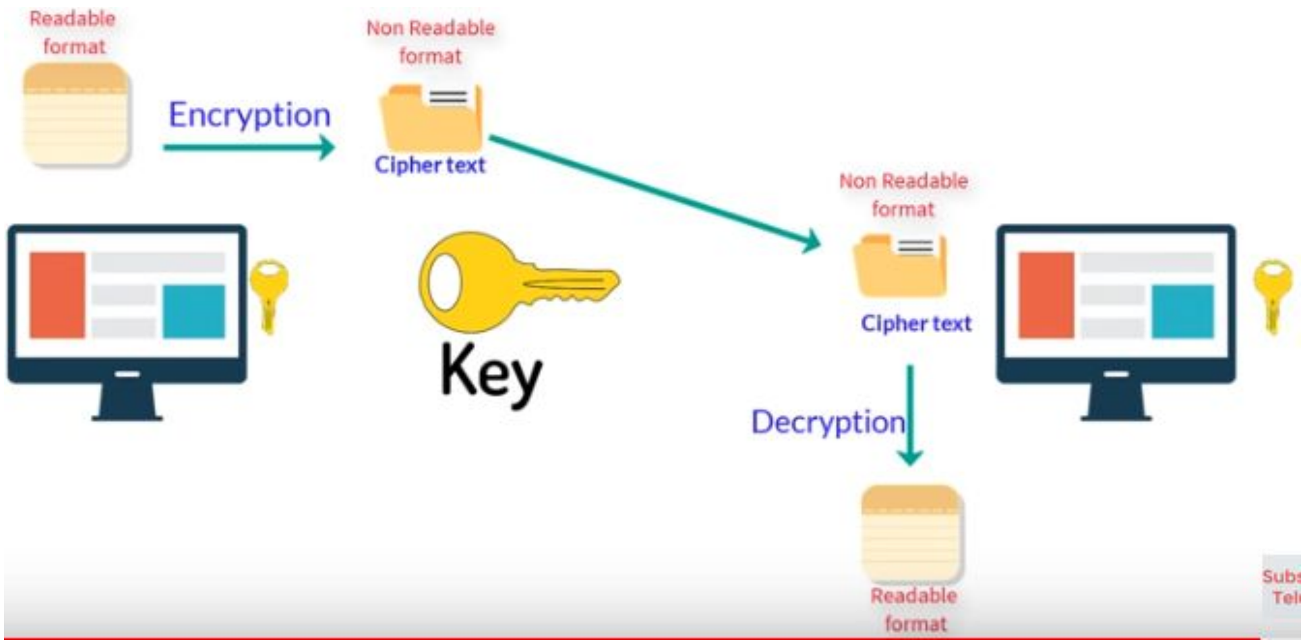
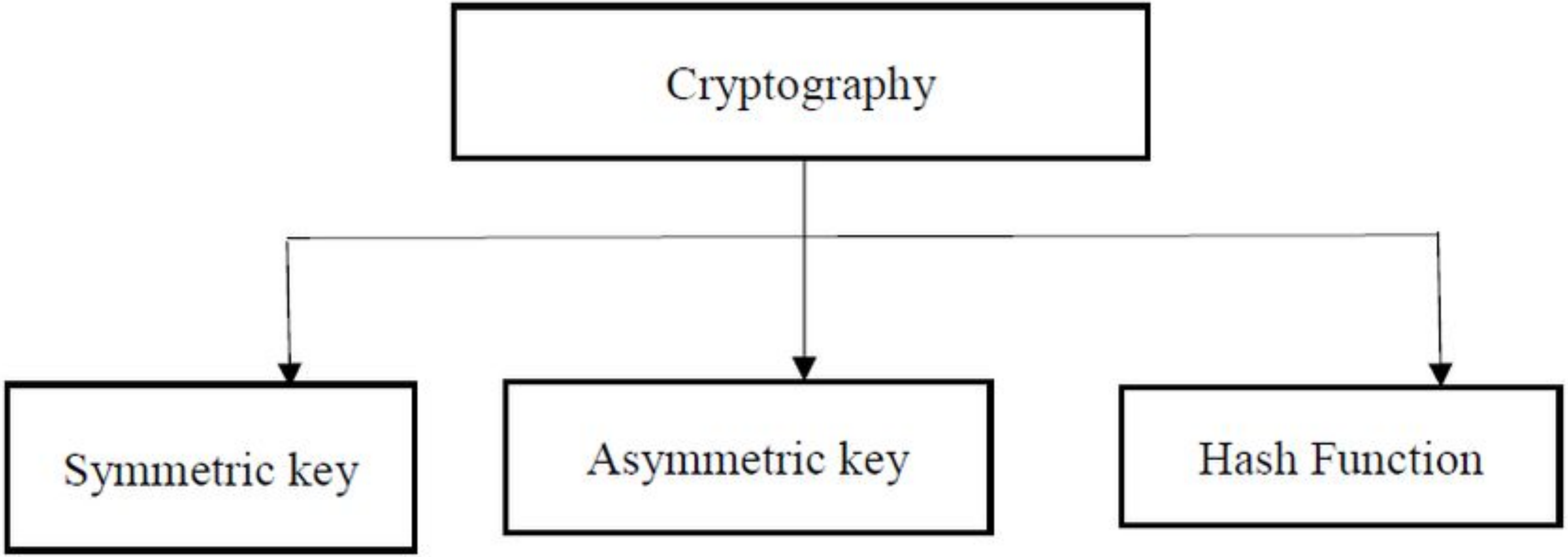


P2P Network in Blockchain → Cryptography

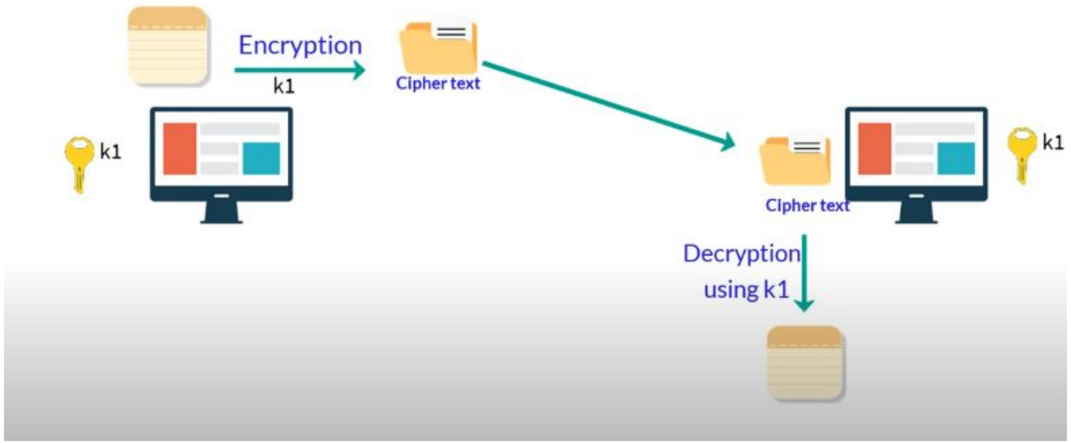


Courtesy : https://www.youtube.com/watch?v=06Un2_F4Y0E&list=PLsyeobzWxl7oY6tZmnZ5S7yTDxyu4zDW-&index=7

Cryptography - Types



Symmetric Key Cryptography

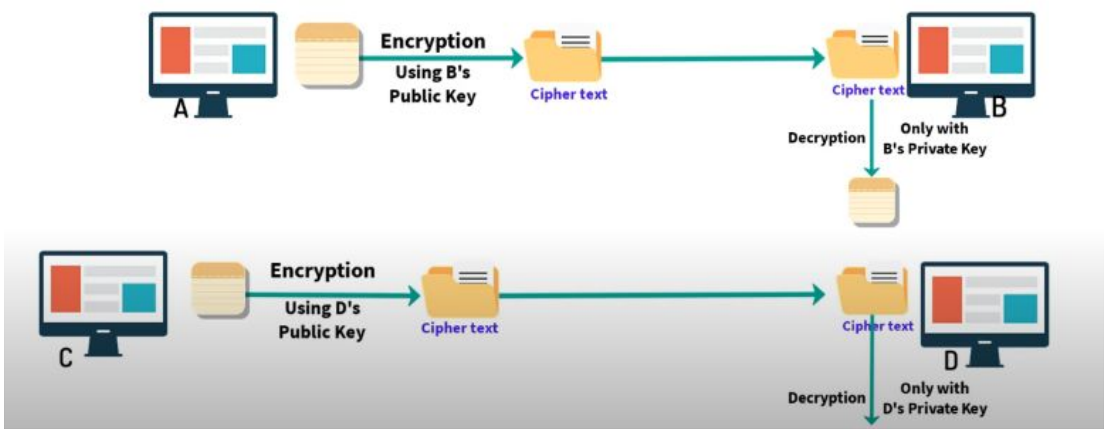


Challenges

- Key must be secure
- Need for Frequent Key changes
- Key Distribution Problem
- # Communication pairs

Courtesy : https://www.youtube.com/watch?v=06Un2_F4Y0E&list=PLsyeobzWxl7oY6tZmnZ5S7yTDxyu4zDW-&index=7

Public Key or Asymmetric Key Cryptography



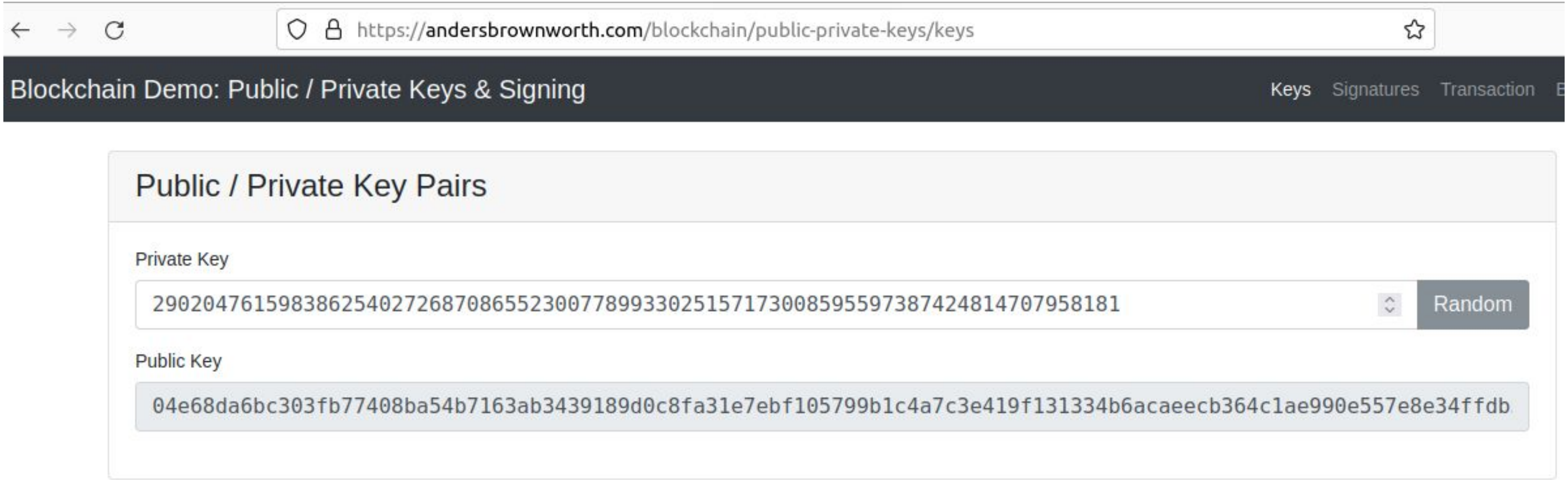
Challenges

- Require a pair of keys
- Expensive to generate
- Not efficient for long messages
- Require High Computational Power

Courtesy : https://www.youtube.com/watch?v=06Un2_F4Y0E&list=PLsyeobzWxl7oY6tZmnZ5S7yTDxyu4zDW-&index=7

Asymmetric Key Generation - Demo

Courtesy : https://andersbrownworth.com/blockchain/public-private-keys/keys



https://andersbrownworth.com/blockchain/public-private-keys/keys

Blockchain Demo: Public / Private Keys & Signing

Public / Private Key Pairs

Private Key

29020476159838625402726870865523007789933025157173008595597387424814707958181

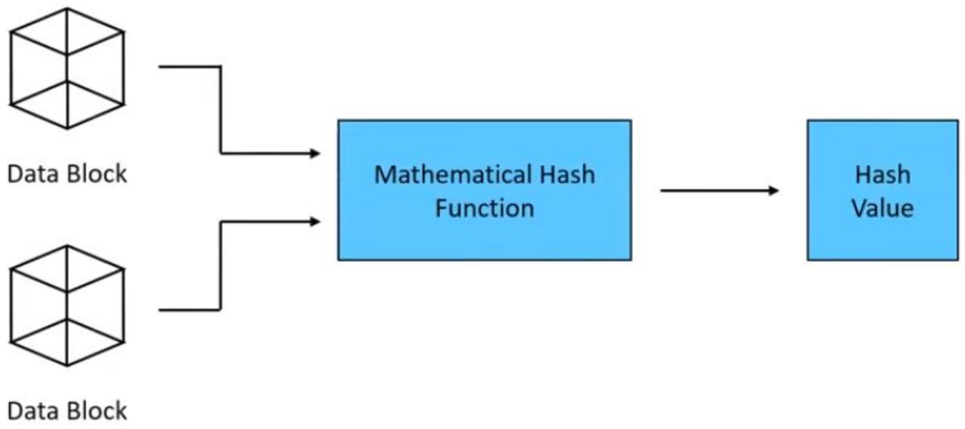
Public Key

04e68da6bc303fb77408ba54b7163ab3439189d0c8fa31e7ebf105799b1c4a7c3e419f131334b6acaeecb364c1ae990e557e8e34ffdb

Cryptographic Hash Functions

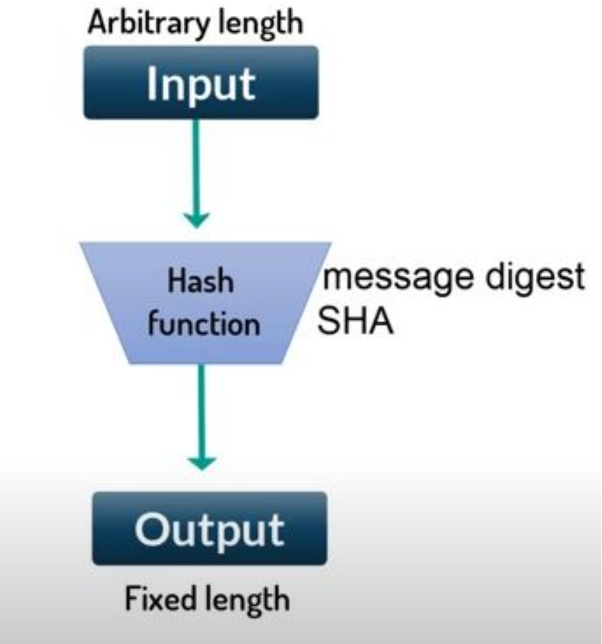
A hash function maps any type of arbitrary data of any length to a fixed-size output. They are efficient and are well-known for one property: they can't be reversed.

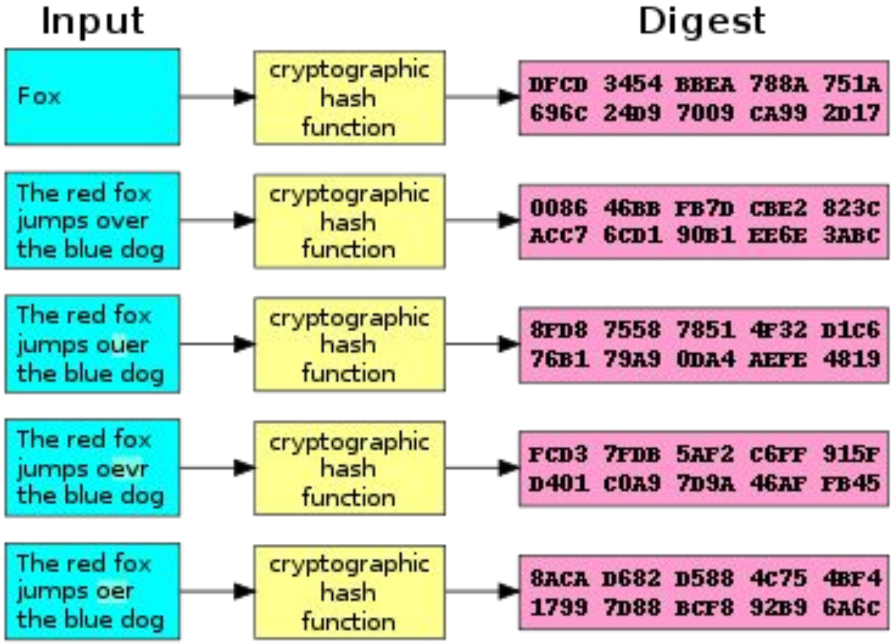
Hash Function for Blockchain



Courtesy : https://www.simplilearn.com/tutorials/blockchain-tutorial/merkle-tree-in-blockchain

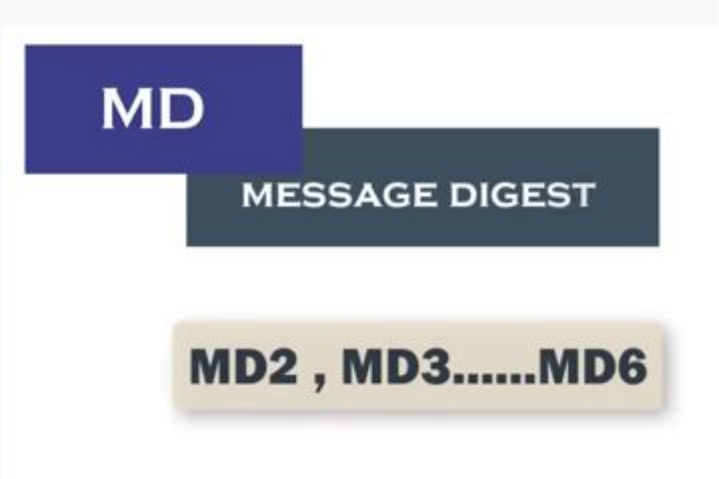
Cryptographic Hash Functions




Input
Digest
Fox
cryptographic hash function
DFCD 3454 BBEA 788A 751A 696C 24D9 7009 CA99 2D17
The red fox jumps over the blue dog
cryptographic hash function
0086 46BB FB7D CBE2 823C ACC7 6CD1 90B1 EE6E 3ABC
The red fox jumps ouer the blue dog
cryptographic hash function
8FD8 7558 7851 4F32 D1C6 76B1 79A9 0DA4 AEFE 4819
The red fox jumps oevr the blue dog
cryptographic hash function
FCD3 7FDB 5AF2 C6FF 915F D401 C0A9 7D9A 46AF FB45
The red fox jumps oer the blue dog
cryptographic hash function
8ACA D682 D588 4C75 4BF4 1799 7D88 BCF8 92B9 6A6C

Courtesy : https://en.wikipedia.org/wiki/Cryptographic_hash_function

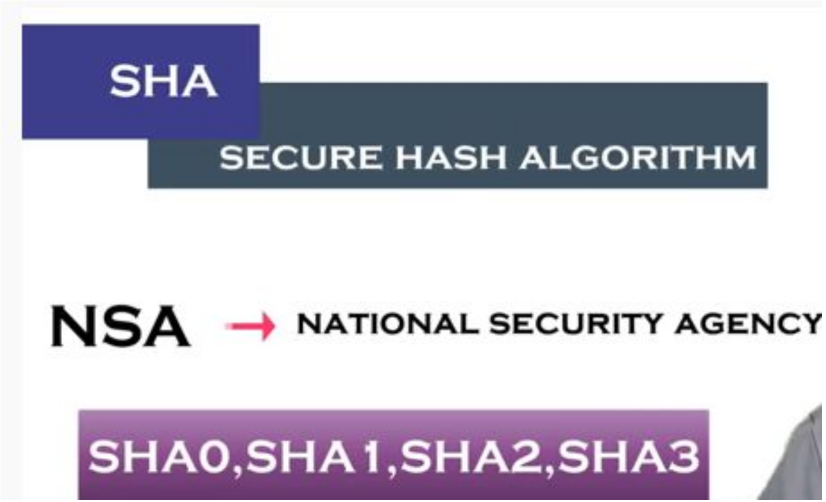
Cryptographic Hash Functions - Eg.



MD

MESSAGE DIGEST

MD2 , MD3......MD6



SHA

SECURE HASH ALGORITHM

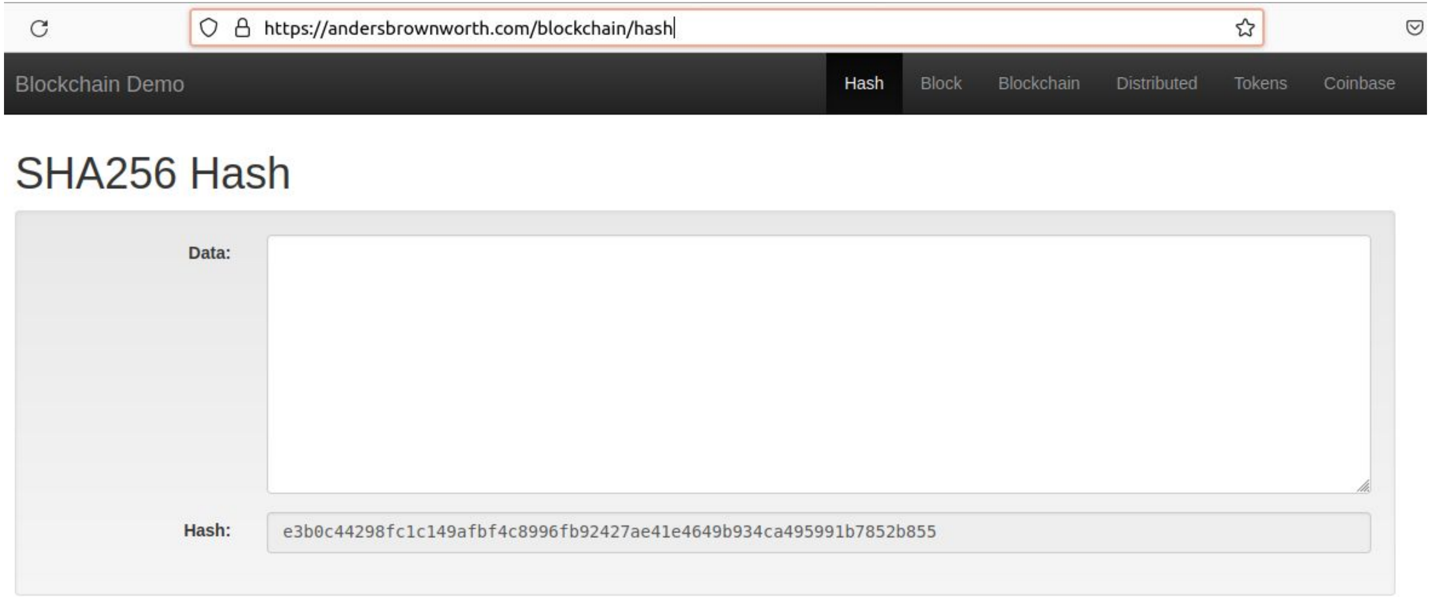
NSA → NATIONAL SECURITY AGENCY

SHA0,SHA1,SHA2,SHA3

Courtesy : https://www.youtube.com/watch?v=06Un2_F4Y0E&list=PLsyeobzWxl7oY6tZmnZ5S7yTDxyu4zDW-&index=7

Cryptographic Hash Functions - Demo

Courtesy : https://andersbrownworth.com/blockchain/hash



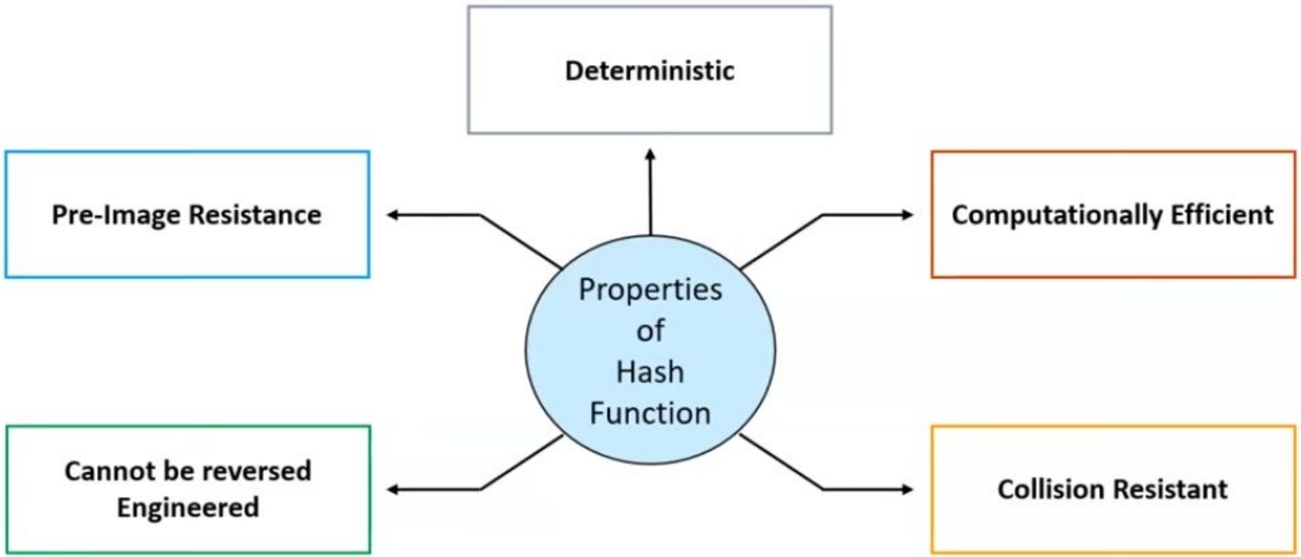
SHA256 Hash

Data:

Hash: e3b0c44298fc1c149afbf4c8996fb92427ae41e4649b934ca495991b7852b855

Cryptographic Hash Functions

Let’s take an example - If you use the SHA256 hash algorithm and pass 101Blockchains as input, you will get the following output:
fbffd63a60374a31aa9811cbc80b577e23925a5874e86a17f712bab874f33ac9



Properties of Hash Function

Deterministic

Pre-Image Resistance

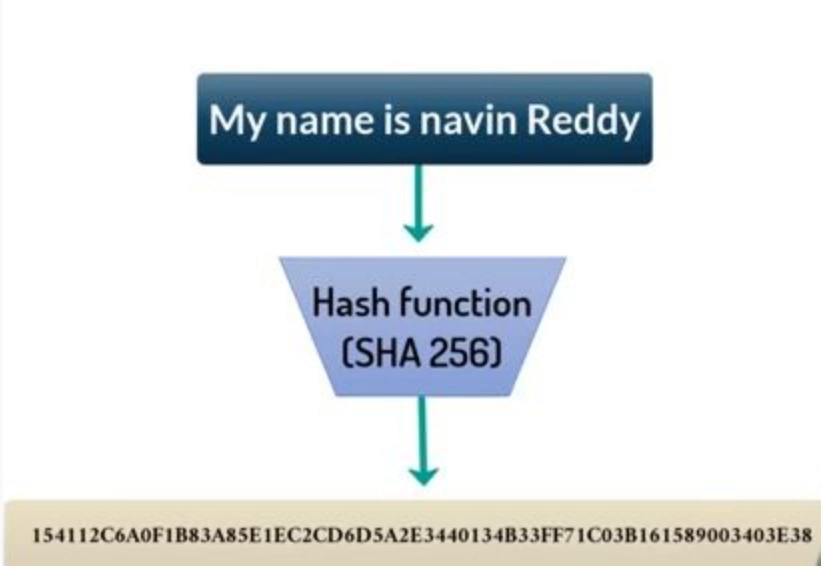
Computationally Efficient

Cannot be reversed Engineered

Collision Resistant

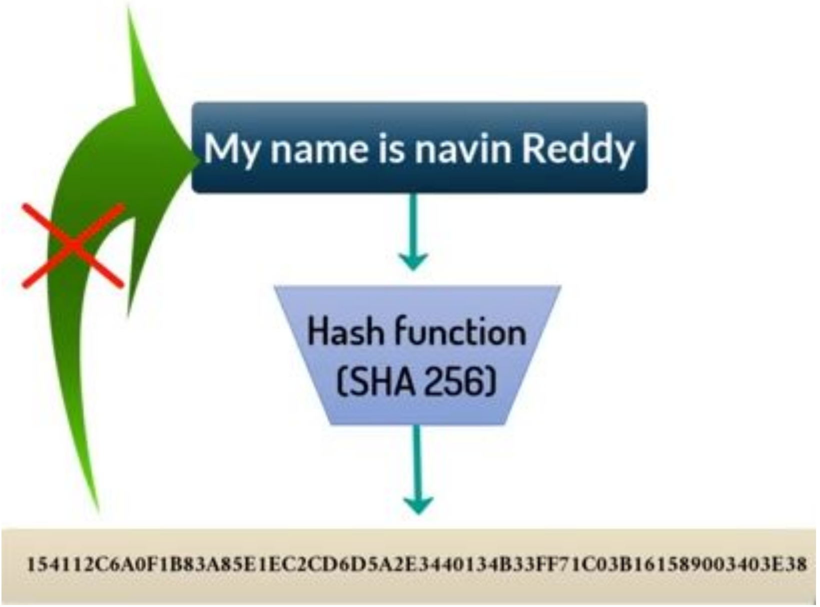
Courtesy : https://www.simplilearn.com/tutorials/blockchain-tutorial/merkle-tree-in-blockchain

Cryptographic Hash Functions - Deterministic


My name is navin Reddy
Hash function
(SHA 256)
154112C6A0F1B83A85E1EC2CD6D5A2E3440134B33FF71C03B161589003403E38

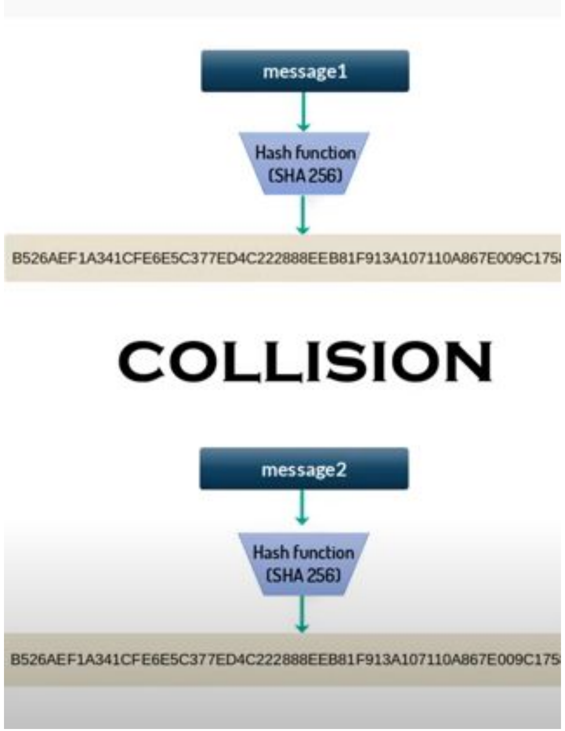
Courtesy : https://www.youtube.com/watch?v=06Un2_F4Y0E&list=PLsyeobzWxl7oY6tZmnZ5S7yTDxyu4zDW-&index=7

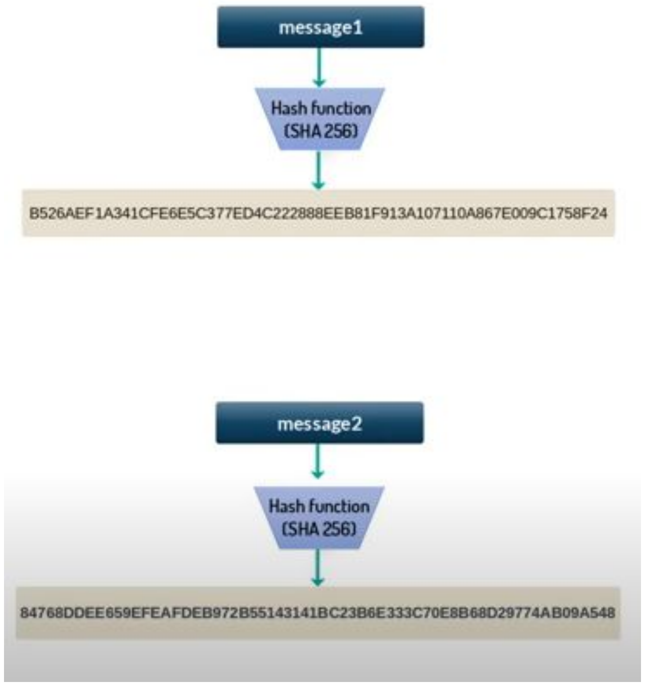
Cryptographic Hash Functions - Cannot be reverse engineered


My name is navin Reddy
Hash function
(SHA 256)
154112C6A0F1B83A85E1EC2CD6D5A2E3440134B33FF71C03B161589003403E38

Courtesy : https://www.youtube.com/watch?v=06Un2_F4Y0E&list=PLsyeobzWxl7oY6tZmnZ5S7yTDxyu4zDW-&index=7

Cryptographic Hash Functions - Collision Resistant


message1
Hash function
(SHA 256)
B526AEF1A341CFE6E5C377ED4C222888EEB81F913A107110A867E009C175
COLLISION
message2
Hash function
(SHA 256)
B526AEF1A341CFE6E5C377ED4C222888EEB81F913A107110A867E009C175


message1
Hash function
(SHA 256)
B526AEF1A341CFE6E5C377ED4C222888EEB81F913A107110A867E009C1758F24
message2
Hash function
(SHA 256)
84768DDEE659EFEAFDEB972B55143141BC23B6E333C70E8B68D29774AB09A548

Courtesy : https://www.youtube.com/watch?v=06Un2_F4Y0E&list=PLsyeobzWxl7oY6tZmnZ5S7yTDxyu4zDW-&index=7

P2P Network in Blockchain

Challenges

1. **Confidentiality**
2. **Integrity**
3. **Non-repudiation**
4. **Authentication**

Solution

- **Digital Signature**

Courtesy : https://www.youtube.com/watch?v=06Un2_F4Y0E&list=PLsyeobzWxl7oY6tZmnZ5S7yTDxyu4zDW-&index=7

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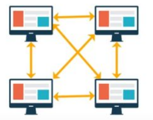
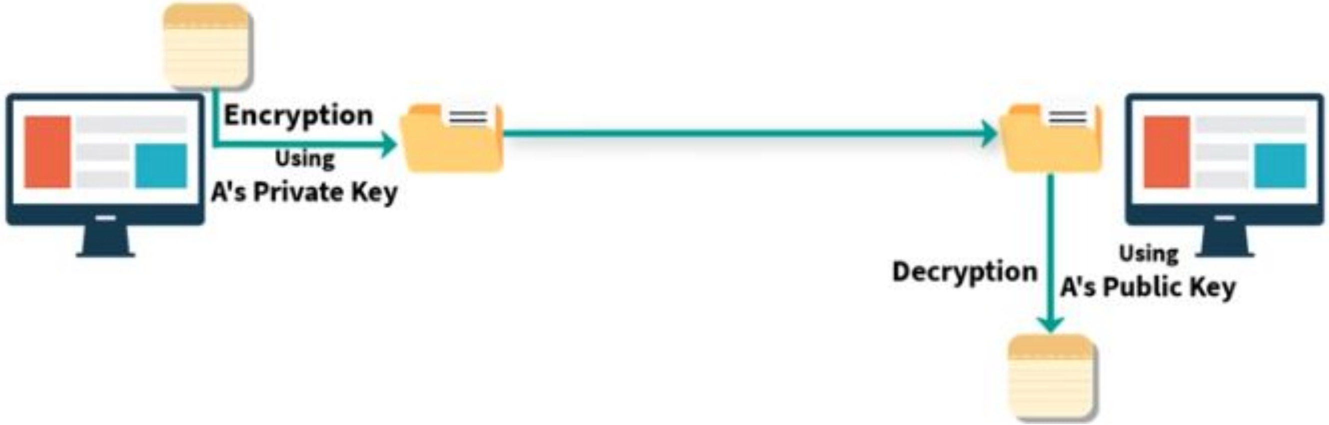
Courtesy : https://www.youtube.com/watch?v=06Un2_F4Y0E&list=PLsyeobzWxl7oY6tZmnZ5S7yTDxyu4zDW-&index=7



Digital Signature - Basic

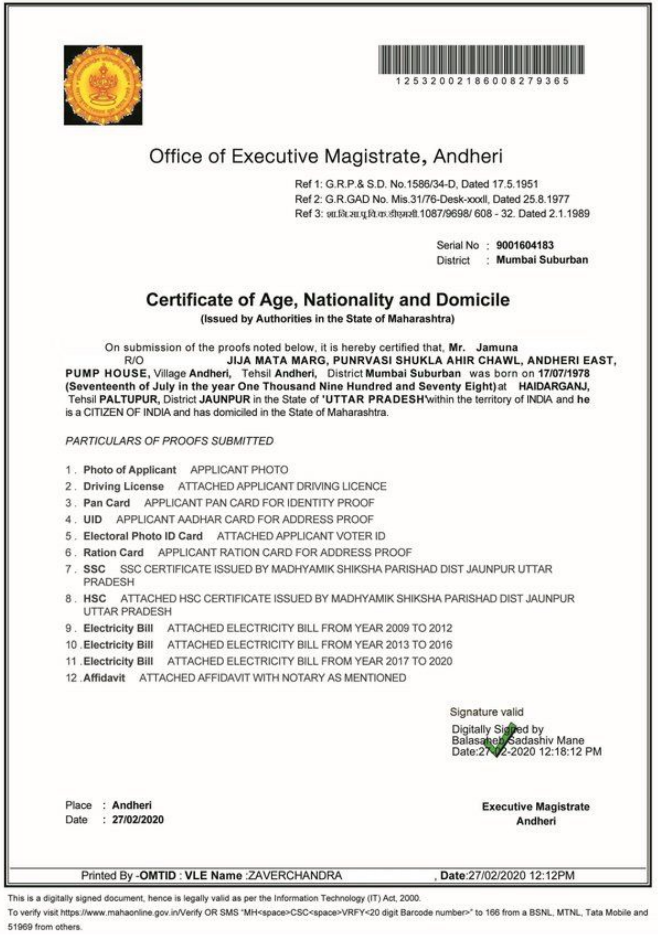


Courtesy : https://www.youtube.com/watch?v=06Un2_F4Y0E&list=PLsyeobzWxl7oY6tZmnZ5S7yTDxyu4zDW-&index=7

Digital Signature - Eg.

Courtesy : https://www.digilocker.gov.in/
https://github.com/jai-singhal/digiLocker

DOMICILE CERTIFICATE SAMPLE



12532002186008279365

Office of Executive Magistrate, Andheri

Ref 1: G.R.P.& S.D. No.1586/34-D, Dated 17.5.1951
Ref 2: G.R.GAD No. Mis.31/76-Desk-xxxll, Dated 25.8.1977
Ref 3: शा.नि.सा.प्र.वि.क्र.डीइसी.1087/9698/ 608 - 32. Dated 2.1.1989

Serial No : **9001604183**
District : **Mumbai Suburban**

Certificate of Age, Nationality and Domicile
(Issued by Authorities in the State of Maharashtra)

On submission of the proofs noted below, it is hereby certified that, **Mr. Jamuna** R/O **JIJA MATA MARG, PUNRVASI SHUKLA AHIR CHAWL, ANDHERI EAST, PUMP HOUSE,** Village **Andheri,** Tehsil **Andheri,** District **Mumbai Suburban** was born on **17/07/1978 (Seventeenth of July in the year One Thousand Nine Hundred and Seventy Eight)** at **HAIDARGANJ,** Tehsil **PALTUPUR,** District **JAUNPUR** in the State of **'UTTAR PRADESH'** within the territory of INDIA and **he** is a CITIZEN OF INDIA and has domiciled in the State of Maharashtra.

PARTICULARS OF PROOFS SUBMITTED

1 . **Photo of Applicant** APPLICANT PHOTO
2 . **Driving License** ATTACHED APPLICANT DRIVING LICENCE
3 . **Pan Card** APPLICANT PAN CARD FOR IDENTITY PROOF
4 . **UID** APPLICANT AADHAR CARD FOR ADDRESS PROOF
5 . **Electoral Photo ID Card** ATTACHED APPLICANT VOTER ID
6 . **Ration Card** APPLICANT RATION CARD FOR ADDRESS PROOF
7 . **SSC** SSC CERTIFICATE ISSUED BY MADHYAMIK SHIKSHA PARISHAD DIST JAUNPUR UTTAR PRADESH
8 . **HSC** ATTACHED HSC CERTIFICATE ISSUED BY MADHYAMIK SHIKSHA PARISHAD DIST JAUNPUR UTTAR PRADESH
9 . **Electricity Bill** ATTACHED ELECTRICITY BILL FROM YEAR 2009 TO 2012
10 .**Electricity Bill** ATTACHED ELECTRICITY BILL FROM YEAR 2013 TO 2016
11 .**Electricity Bill** ATTACHED ELECTRICITY BILL FROM YEAR 2017 TO 2020
12 .**Affidavit** ATTACHED AFFIDAVIT WITH NOTARY AS MENTIONED

Signature valid
Digitally Signed by
Balasaheb Sadashiv Mane
Date:27-02-2020 12:18:12 PM

Place : **Andheri**
Date : **27/02/2020**

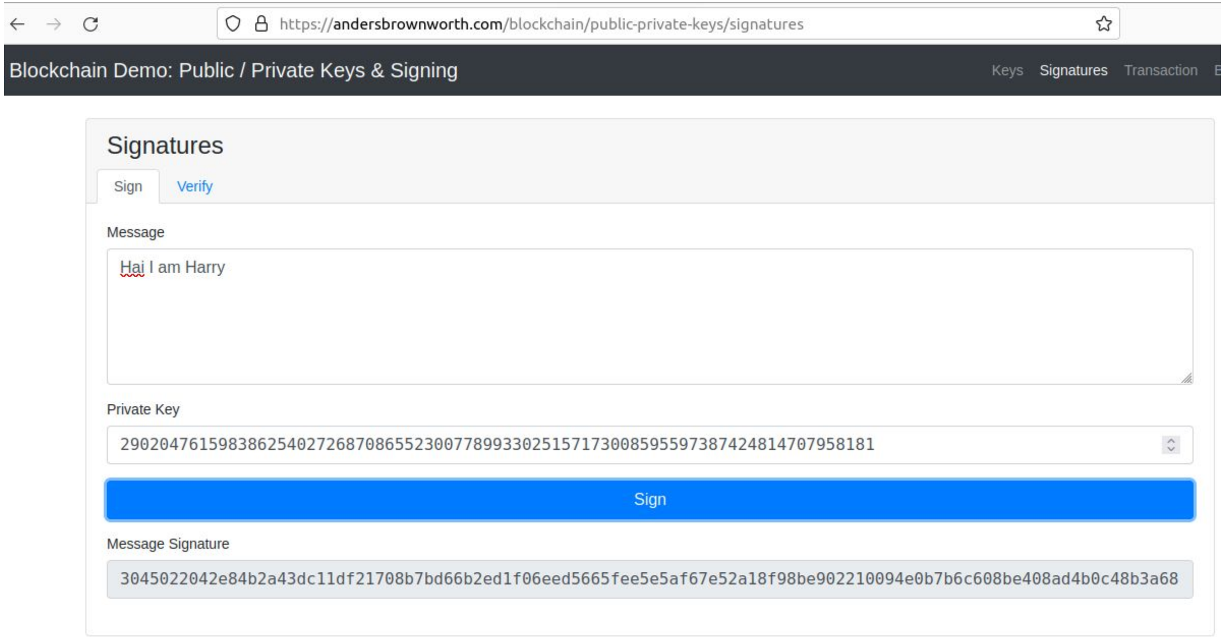
Executive Magistrate
Andheri

Printed By -**OMTID** : **VLE Name** :ZAVERCHANDRA , **Date**:27/02/2020 12:12PM

This is a digitally signed document, hence is legally valid as per the Information Technology (IT) Act, 2000.
To verify visit https://www.mahaonline.gov.in/Verify OR SMS "MH<space>CSC<space>VRFY<20 digit Barcode number>" to 166 from a BSNL, MTNL, Tata Mobile and 51969 from others.

Digital Signatures - Demo

Courtesy : https://andersbrownworth.com/blockchain/public-private-keys/signatures



https://andersbrownworth.com/blockchain/public-private-keys/signatures
Blockchain Demo: Public / Private Keys & Signing
Keys
Signatures
Transaction
Sign
Verify

Signatures

Message

Hai I am Harry

Private Key

29020476159838625402726870865523007789933025157173008595597387424814707958181

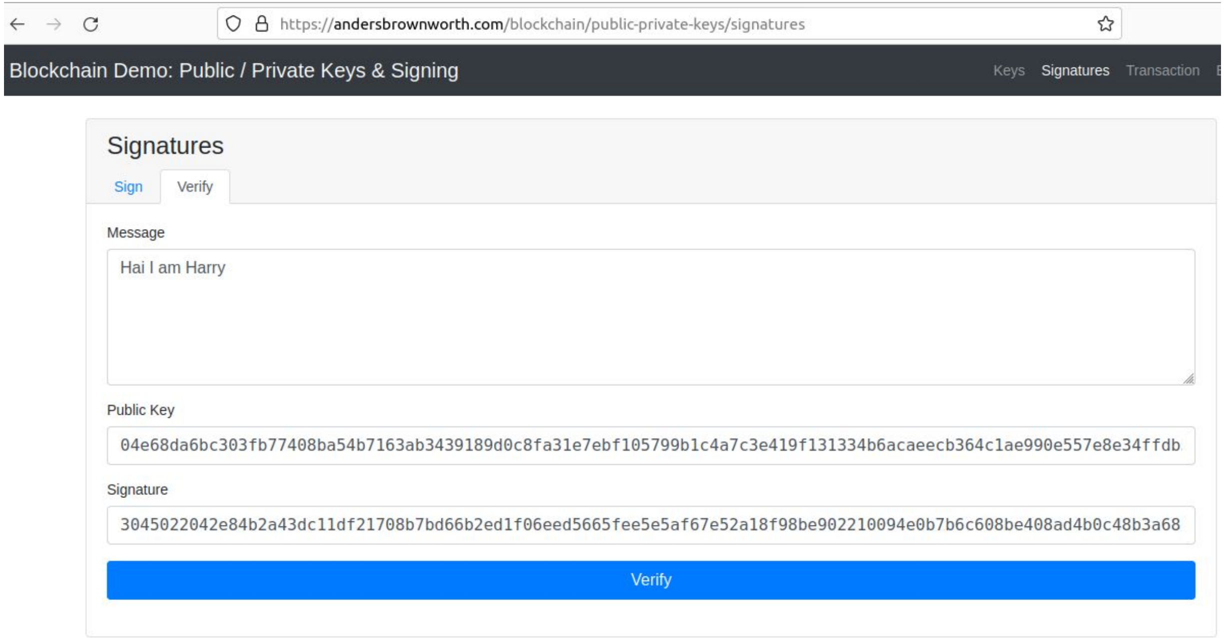
Sign

Message Signature

3045022042e84b2a43dc11df21708b7bd66b2ed1f06eed5665fee5e5af67e52a18f98be902210094e0b7b6c608be408ad4b0c48b3a68

Digital Signatures - Demo

Courtesy : https://andersbrownworth.com/blockchain/public-private-keys/signatures



https://andersbrownworth.com/blockchain/public-private-keys/signatures
Blockchain Demo: Public / Private Keys & Signing
Keys
Signatures
Transaction
Signatures
Sign
Verify

Message

Hai I am Harry

Public Key

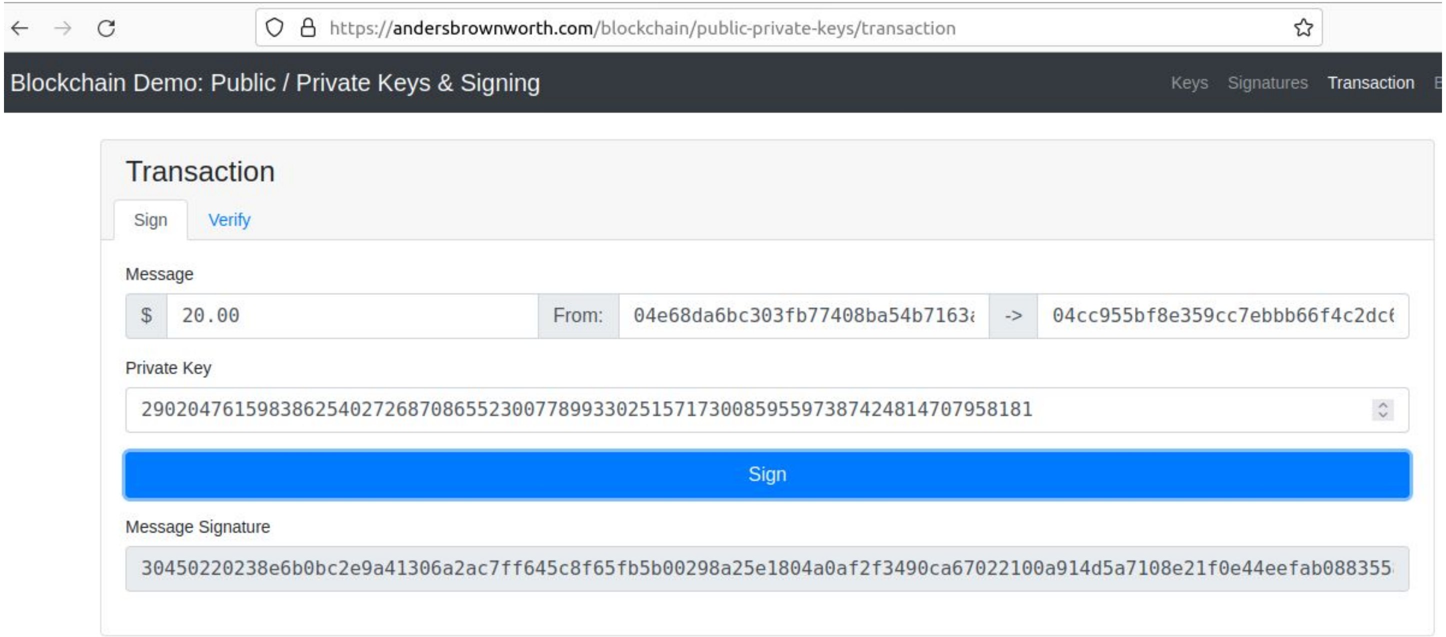
04e68da6bc303fb77408ba54b7163ab3439189d0c8fa31e7ebf105799b1c4a7c3e419f131334b6acaeecb364c1ae990e557e8e34ffdb

Signature

3045022042e84b2a43dc11df21708b7bd66b2ed1f06eed5665fee5e5af67e52a18f98be902210094e0b7b6c608be408ad4b0c48b3a68

Digitally Signed Transaction - Demo

Courtesy : https://andersbrownworth.com/blockchain/public-private-keys/transaction



https://andersbrownworth.com/blockchain/public-private-keys/transaction
Blockchain Demo: Public / Private Keys & Signing
Keys
Signatures
Transaction
E

Transaction

Sign | Verify

Message

$ 20.00 From: 04e68da6bc303fb77408ba54b7163a -> 04cc955bf8e359cc7ebbb66f4c2dc6

Private Key

29020476159838625402726870865523007789933025157173008595597387424814707958181

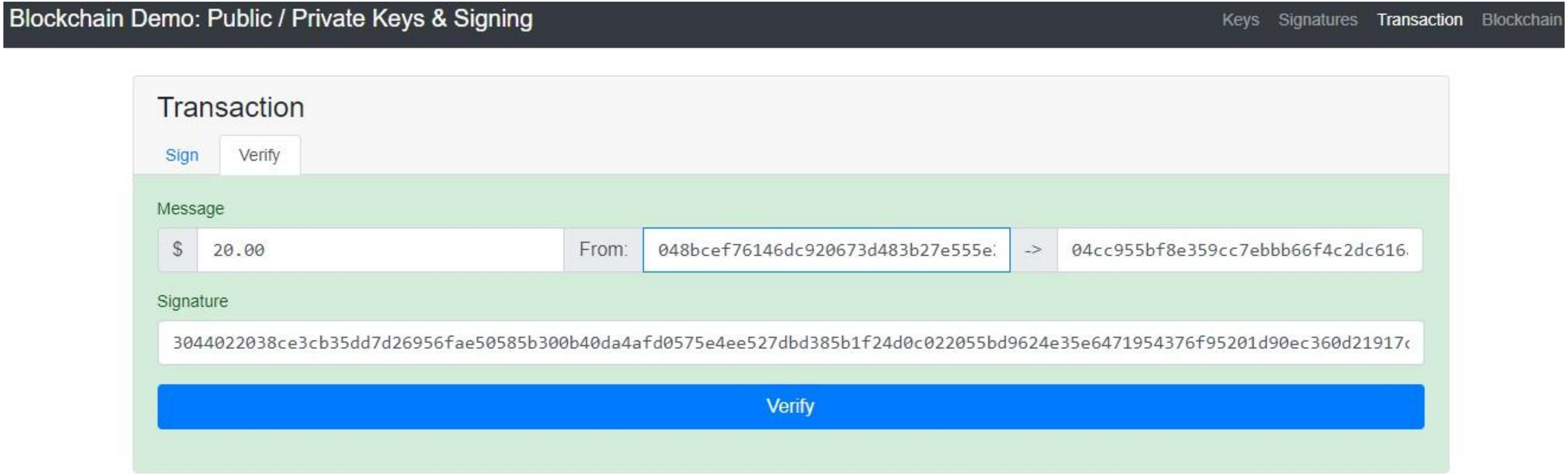
Sign

Message Signature

30450220238e6b0bc2e9a41306a2ac7ff645c8f65fb5b00298a25e1804a0af2f3490ca67022100a914d5a7108e21f0e44eefab088355

Digitally Signed Transaction - Demo

Courtesy : https://andersbrownworth.com/blockchain/public-private-keys/transaction



Transaction

Message

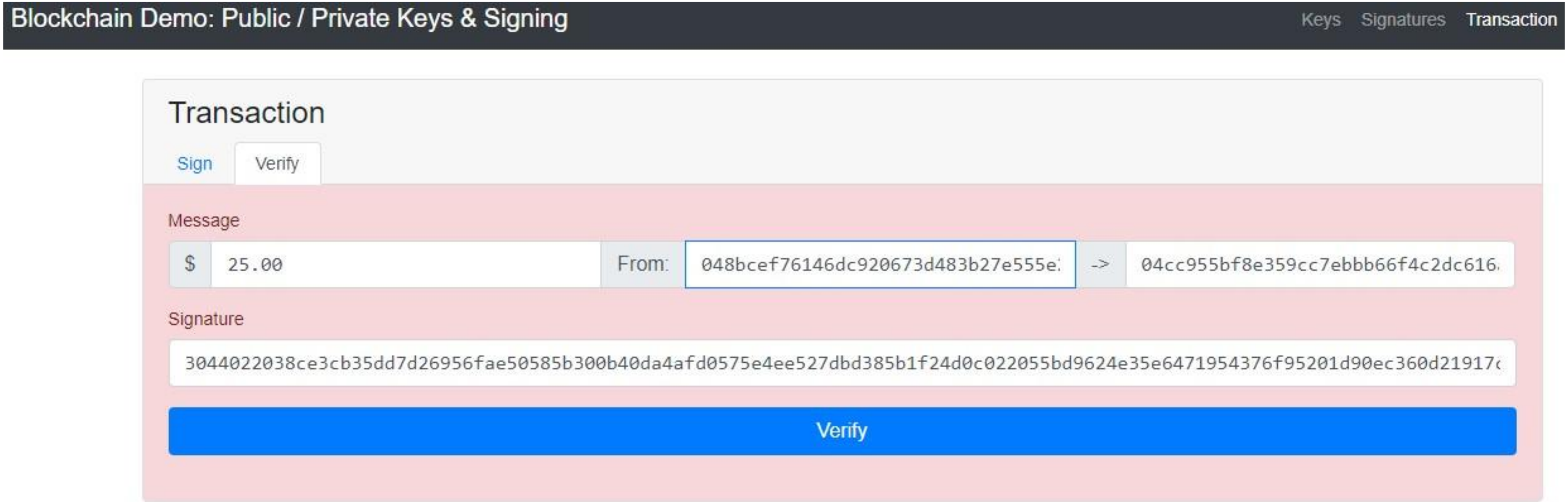
$ 20.00 From: 048bcef76146dc920673d483b27e555e -> 04cc955bf8e359cc7ebbb66f4c2dc616

Signature

3044022038ce3cb35dd7d26956fae50585b300b40da4afd0575e4ee527dbd385b1f24d0c022055bd9624e35e6471954376f95201d90ec360d21917

Digitally Signed Transaction - Demo

Courtesy : https://andersbrownworth.com/blockchain/public-private-keys/transaction



Transaction

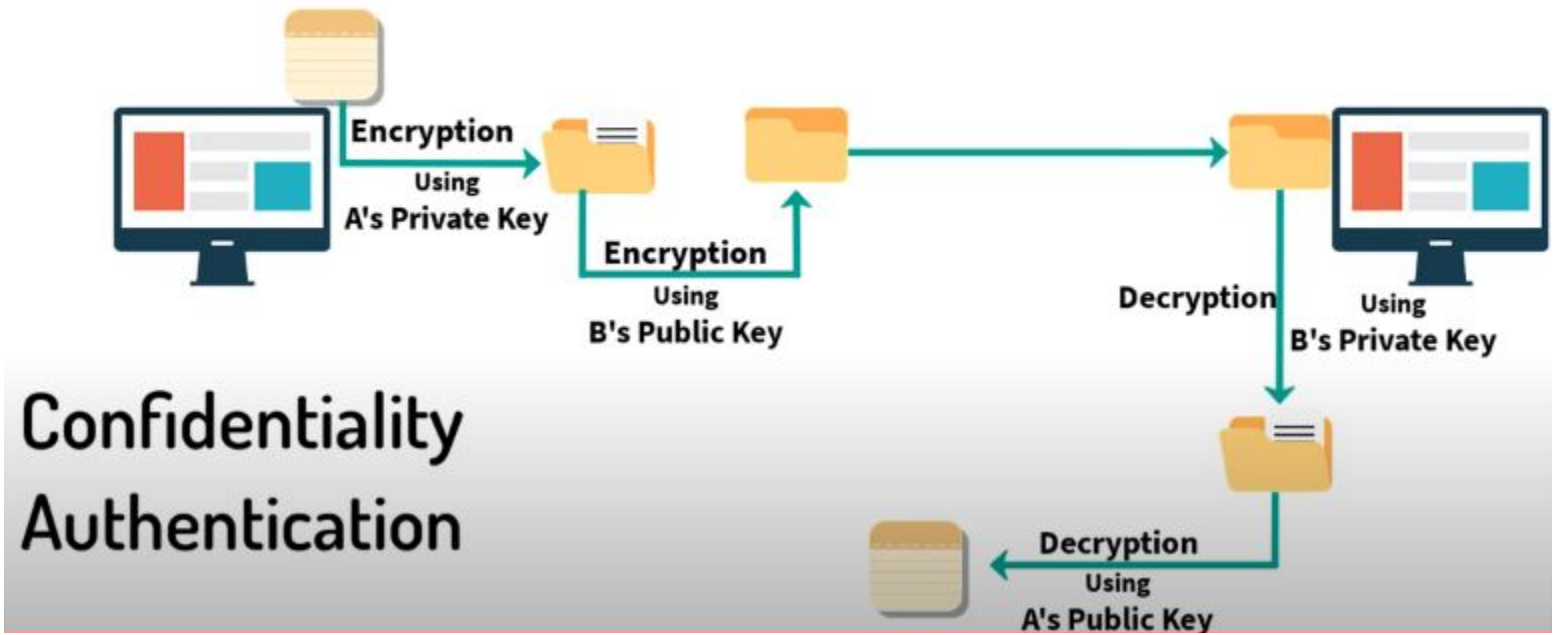
Message

$ 25.00 From: 048bcef76146dc920673d483b27e555e -> 04cc955bf8e359cc7ebbb66f4c2dc616

Signature

3044022038ce3cb35dd7d26956fae50585b300b40da4afd0575e4ee527dbd385b1f24d0c022055bd9624e35e6471954376f95201d90ec360d21917

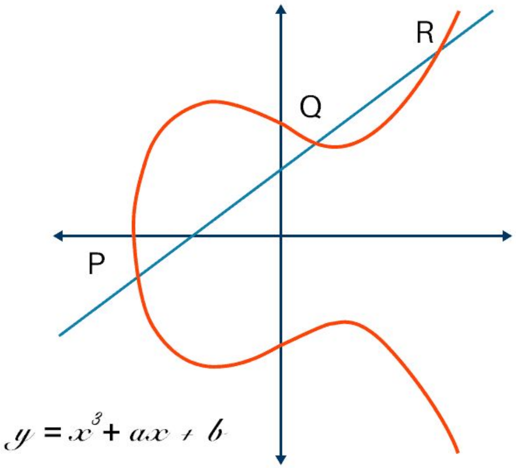
Digital Signature



Courtesy : https://www.youtube.com/watch?v=06Un2_F4Y0E&list=PLsyeobzWxl7oY6tZmnZ5S7yTDxyu4zDW-&index=7

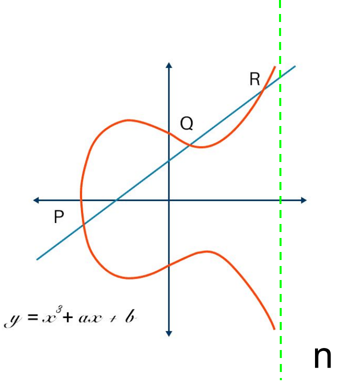
Elliptical Curve Cryptography

- Asymmetric Key Cryptography
- Provides **High Security with smaller key size** (compared to RSA)
- Uses **Elliptical Curves**
  - defined using equations of degree 3
  - Symmetric to x-axis
  - Line drawn will intersect atmost 3 points.

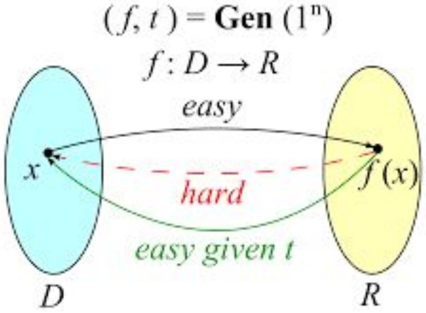


Courtesy : https://www.youtube.com/watch?v=0NGPhAPKYv4

Elliptical Curve Cryptography

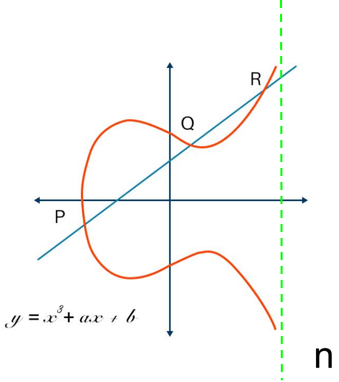


- **What makes ECC hard to crack ?**
    - **Discrete Logarithm Problem**
        - Let E_q (a,b) be the Elliptical Curve, consider the equation, Q = kP ; where Q & P are pts on curve and k < n
            - If k & P is given, its easy to find Q.
            - Otherwise, extremely difficult to find k
    - **Trapdoor Function**



Courtesy : https://en.wikipedia.org/wiki/Trapdoor_function

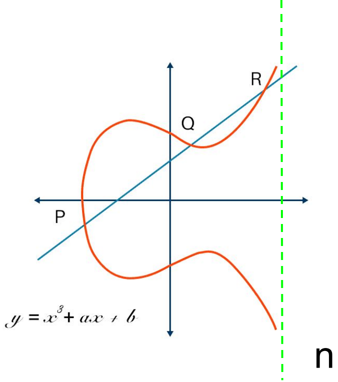
Elliptical Curve Cryptography



- **Global Public Elements**
  - E_q (a,b) :
    - a, b : parameters of elliptical curve
    - q : prime no. or an integer of the form 2^m
  - G : Point on the elliptical curve, > n

Courtesy : https://www.youtube.com/watch?v=0NGPhAPKYv4

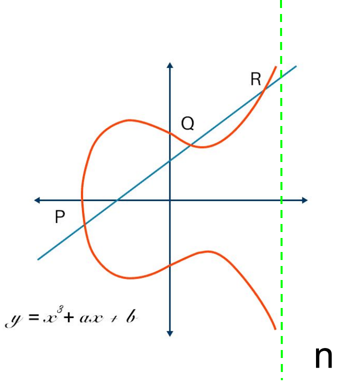
Elliptical Curve Cryptography



- **User A Key Generation**
  - Select Private Key n_A: $\mathbf{n_A < n}$
  - Calculate Public Key P_A: $\mathbf{P_A = n_A \times G}$
- **User B Key Generation**
  - Select Private Key n_B: $\mathbf{n_B < n}$
  - Calculate Public Key P_B : $\mathbf{P_B = n_B \times G}$
- **Key Exchange :**
  - **Calculation of secret key by User A :** $\mathbf{k = n_A \times P_B}$
  - **Calculation of secret key by User B :** $\mathbf{k = n_B \times P_A}$

Courtesy : https://www.youtube.com/watch?v=0NGPhAPKYv4

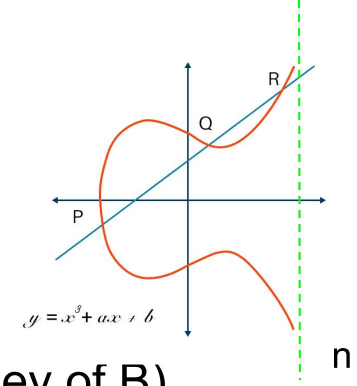
Elliptical Curve Cryptography



- **ECC Encryption**
  - Let **m** be the message.
  - Encode m into a point on the Elliptic curve, $\mathbf{P_m}$
  - For encryption, chose a random +ve integer, **k**
  - The Cipher point, $\mathbf{C_m = \{ kG, P_m + kP_B\}}$
  - $\mathbf{C_m}$ is forwarded to destination

Courtesy : https://www.youtube.com/watch?v=0NGPhAPKYv4

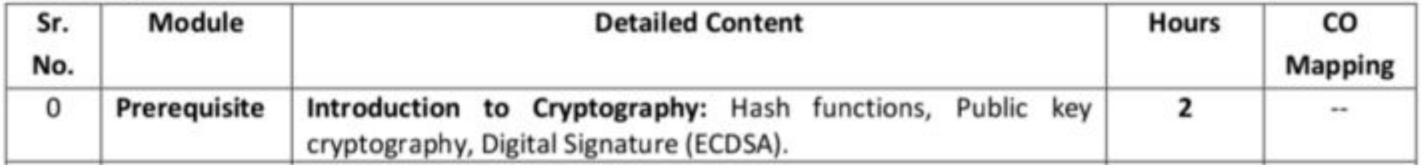
Elliptical Curve Cryptography



- **ECC Decryption** : $C_m = \{ kG, P_m + kP_B\}$
  - $kG \times n_B$ //(where, n_B : Private key of B)
  - $P_m + kP_B - (kG \times n_B)$ // we know $P_B = n_B \times G$
  - i.e., $P_m + kP_B - kP_B$
  - i.e., P_m // Receiver gets Encrypted point of message

Courtesy : https://www.youtube.com/watch?v=0NGPhAPKYv4

Questions



Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	**Introduction to Cryptography:** Hash functions, Public key cryptography, Digital Signature (ECDSA).	**2**	--

- What is Web 3.0 ?
- What is Blockchain? Explain its Significance with an example
- Differentiate between Centralized, Decentralized and Distributed Networks
- Explain Asymmetric Key Cryptography with an example
- Difference between Symmetric Key and Asymmetric Key Cryptography
- Properties of Cryptographic Hash Functions
- Explain Digital Signature with an example.

Online Resources

Theory

- https://en.wikipedia.org/wiki/Public-key_cryptography
- https://komodoplatform.com/en/academy/cryptographic-hash-function/
- https://cse.iitkgp.ac.in/~debdeep/pres/TI/ecc.pdf

Visualization

- https://andersbrownworth.com/blockchain/
- https://andersbrownworth.com/blockchain/hash
- https://andersbrownworth.com/blockchain/public-private-keys/

Useful Videos

- https://nptel.ac.in/courses/106105184
- https://www.youtube.com/watch?v=dCvB-mhkT0w
- https://www.simplilearn.com/tutorials/blockchain-tutorial/merkle-tree-in-blockchain
- https://www.youtube.com/watch?v=2uYuWiICCM0&list=PLsyeobzWxl7oY6tZmnZ5S7yTDxyu4zDW-