

## Faculty Development Program for IIHMR Group of Institutions

# Public Health Surveillance Using Blockchain

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Dr. Ashok Kumar Peepliwal is having more than 13 years of experience with Doctorate degree from Narsee Monjee Institute of Management Studies and M. Pharm. from Bombay College of Pharmacy, University of Mumbai, Mumbai. He learnt the project management by conducting of clinical studies in different therapeutic areas of Oncology, Rheumatoid Arthritis, Respiratory, Nephrology, Dermatology & Immunology etc. He expertise himself in planning, designing, executing, preparation of budgets, revenue generation, meeting the deadlines, marketing strategies, report preparation, meetings conductance, national, international pharmaceutical regulatory compliance of national & international regulatory in different pharmaceutical industries i.e. Torrent Pharmaceuticals Ltd; Lambda Therapeutics Research Ltd, Integrated Clinical Services Pvt. Ltd., PharmaNet Clinical Services Ltd., Wockhardt Pharmaceuticals Ltd., etc. As a true academician, he has past associations with School of Pharmacy & Technology Management, NMIMS University, Mumbai 2007-2011; NiMS University, Jaipur etc where he developed expertise of curriculum designing as per the industrial needs, Innovative teaching methods, writing of proposals for funding agencies, placement of students in different pharmaceutical industries across the country, guiding the M. Pharm. students, Participation of meetings, Conductance of cultural events, controlling of exam, Instrumental In-charge activities etc. He has also guided five PhD Scholars and has published many research papers in journals of National & International repute.

# PUBLIC HEALTH SURVEILLANCE USING BLOCKCHAIN

**Dr. Ashok Peepliwal**

Associate Professor

IIHMR University

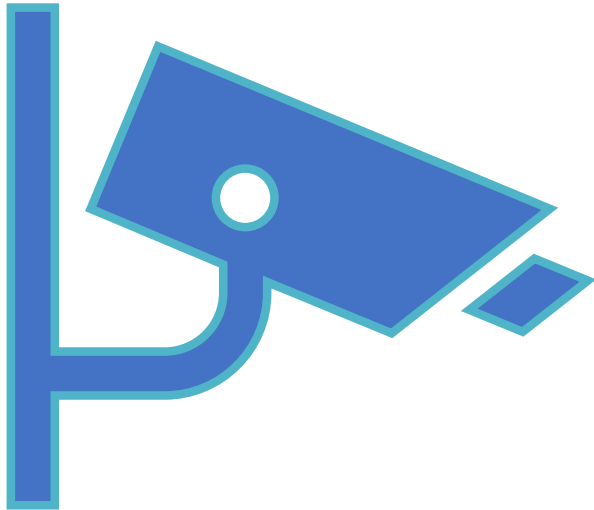
Jaipur

# Surveillance



SURVEILLANCE  
IS  
INFORMATION  
FOR  
ACTION

# Surveillance involves



- 1.Acquiring
- 2.Analyzing
- 3.Interpreting data and information  
from

**several sources**

across  
various systems.

# Characteristics of good surveillance

Simplicity

Flexibility

Quality

Authenticity  
and  
Acceptability

Validity

Sensitivity

Timeliness

Stability

- **Simplicity** refers to the system's structure and ease of operation.
- **Flexibility** is the ability of the system to adapt to changing information needs and operating conditions with minimal additional cost.
- **Data quality** is the completeness and validity of the data collected through the system.
- **Acceptability** is the willingness of persons and organizations to participate in the system, including those who operate the system, report cases of the disease, or use the data.
- **Sensitivity** is the proportion of cases of a disease detected by a surveillance system and the ability of the system to monitor changes in the number of cases over time, such as outbreaks.
- **Timeliness** reflects the delay between steps in a surveillance system and availability of information for control of the disease under surveillance when needed.
- **Stability** is the ability of a surveillance system to collect, manage, and provide data without failure and to be operational when needed.

# OBJECTIVE OF SURVEILLANCE



- To serve as an early warning system, identify public health emergencies
- To guide public health policy and strategies
- To document impact of an intervention or progress towards specified public health targets/goals
- To understand/monitor the epidemiology of a condition to set priorities and guide public health policy and strategies

# Steps in Surveillance

- A. Surveillance method for data collection
- B. Compilation and transmission of data
- C. Analysis and Interpretation
- D. Action
- E. Feedback



# SURVEILLANCE Process

## *A .Surveillance methods for data collection:*

1. Community level surveillance.
2. Routine reporting system.
3. Active and passive surveillance .
4. Sentinel surveillance.
5. Surveys and special studies.
6. Case and outbreak investigation.
7. Verbal autopsy.
8. Laboratory surveillance.
9. Entomological surveillance.

## 1. Community level surveillance:

ASHAs, Anganwadi workers, Self help groups ,  
village panches



Report births, deaths, outbreaks and  
unusual events

Informants at community level need to be  
contacted on regular basis.

## 2. Routine reporting system:

- ❖ Health staff collects information about number of cases of reportable diseases and deaths that occur in relation to all national health programmes.
- ❖ This system relies on government established system of sub centres , PHCs, CHCs and hospital data.
- ❖ Whosoever comes to these facilities are recorded and reported .Thus called passive routine reporting system.

### 3. Active surveillance

1. Means actively looking or searching for a particular type or group of diseases, is useful in detecting these unreported cases.

2. It involves active participation of health personals as well as the community .

3. Degree of reporting is more complete.

4. Important strategy for small pox and guinea worm.

5. Its importance for malaria control is still going on strong.

6. It has also been undertaken for acute flaccid paralysis.

### Passive surveillance

Collection of data from persons, themselves reporting to a facility (hosp., clinic, sub Centre, PHC and CHC,)

At times during outbreak investigator may conduct what is sometimes called stimulated or enhanced passive surveillance by sending a letter describing the situation and asking for reports of similar cases.

#### 4.Sentinel surveillance:

- ❖ A small number of health units are selected to report cases of diseases and deaths that are seen or diagnosed at their facility.
- ❖ These sentinel sites also collect and report additional information such as age , immunization status and other details.
- ❖ Staff at sentinel sites is given special training and supervised to ensure that reporting is complete and accurate.

### **Common sentinel sites:**

- Hospital( infectious diseases, TB, Pediatric hospital)
- Health centre
- Antenatal clinics
- STD clinic
- Laboratory
- Rehabilitation centre  
which attend large number of particular type of cases can be considered as a possible sentinel site.

## 5. Surveys and special studies:

- ❖ Sample surveys or disease surveys is an active and efficient method of surveillance, which can complement the other methods.
- ❖ Two surveys done at an interval of several years apart may be able to demonstrate changes in disease incidence.
- ❖ The first survey for collecting reliable baseline epidemiological information and the subsequent one for evaluation of the control programme or intervention. e.g.,

## 6. Case and outbreak Investigation:

```
graph TD; A[6. Case and outbreak Investigation:] --> B[Case investigation is an investigation of a single case of a disease or death.]; A --> C[An outbreak investigation is an investigation of many cases. However, when the occurrence of a particular disease is very low, Polio for example, even one case can be considered as an outbreak.];
```

Case investigation is an investigation of a single case of a disease or death.

An outbreak investigation is an investigation of many cases. However, when the occurrence of a particular disease is very low, Polio for example, even one case can be considered as an outbreak.



## 7. Verbal Autopsy:

- It is a special technique for investigation of cause of death.
- Trained worker or investigator conducts an in-depth investigation of the death (maternal or infant or any other death) through interviews with the mother or any one else who was a witness to the death and the circumstances leading up to it.
- The investigations are done on a standard designed format or protocol.

## **Purpose:**

1. To ascertain the most probable cause of death.
2. Whether the death could have been prevented or avoided by timely and appropriate measures.
3. Workers can educate community as to how to prevent deaths as also common causes of death in the community .

## 8. Laboratory surveillance :

Laboratory testing confirms the syndromes of presumptive cases and helps in diagnosis of cases for case management.

## 9. Entomological surveillance:

Regular surveillance for vectors of disease under national vector-borne disease control programme is being done to know vector density and sensitivity to insecticides.

## **B. Compilation and transmission of data:**

- The cases that have been detected and recorded need to be compiled and transmitted to the next level on regular basis once a week or daily .
- This could be done on a fixed date from each type of unit . All reporting units/centres will provide zero reporting if no cases were detected.

- The designation of the person responsible for data compilation and transmission at each level has been identified (pharmacist, computer statistical officer, lab technician and medical officer).
- The health workers, medical officers of PHCs and sentinel private practitioners will provide regular reports on prescribed formats on every Monday.

### **C. Analysis and interpretation:**

- The analysis should be encouraged at each level of surveillance system. Data are analyzed by count, divide and compare principles and then displayed by time, place and person analysis .
- The workers should learn to interpret the data they are collecting and thereby they will have better understanding of the needs of their community .

- The surveillance data can be easily tabulated in three ways: summary tables, disease charts and maps , which show the number of cases of disease for each reporting week and month. Data after analysis becomes useful information for action.

### **D. Action:**

- Surveillance without action is useless .
- Action for malaria surveillance is full therapeutic treatment, radical treatment and selective spray programme and to control breeding of vector as also to educate people .
- Similarly , action for outbreak of polio necessitates mass polio vaccination or outbreak response immunization .
- Outbreak of viral hepatitis needs super chlorination of water supply or boiling of water apart from personal hygiene.



# Challenges in Current Surveillance system



Data Management



Early Detection **of** Emerging Diseases



Control of Multiple Resources



Shortage **of** Skilled Staff



Emerging Data Useful for **Surveillance**



Real-Time Data



Electronic **Health** Records



**Health** Information Exchanges



Accuracy and Privacy

## WHAT IS BLOCKCHAIN?

A technology that:

permits transactions to be gathered into blocks and recorded;

allows the resulting ledger to be accessed by different servers.

cryptographically chains blocks in chronological order; and

# Blockchain

# Applications

- Online money Transfers
- Bank payments
- Automobile industries
- Cybersecurity
- Exit polls
- Education sector
- Insurance companies
- Forecasting time trends
- Patient data integration
- Pharma R &D
- Clinical research
- Surveillance systems

# MNCs using blockchain in healthcare security

burstIQ.

Factom.

Medicalchain.

Guardtime.

SimplyVital Health.

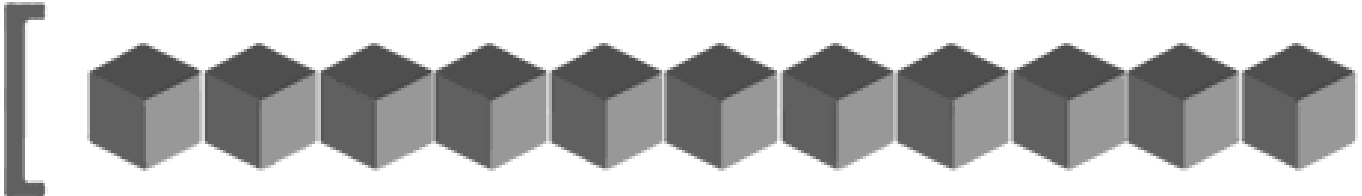
Coral Health Research  
& Discovery.

Robomed.

Patientory.

# BLOCKS CREATION IN BLOCKCHAIN

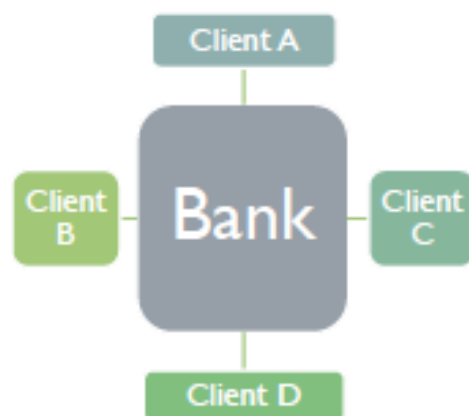
New Block



Blockchain →

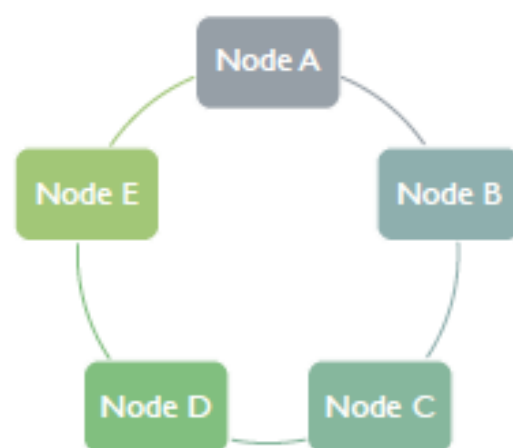
## WHAT IS A DISTRIBUTED LEDGER?

### Centralized Ledger



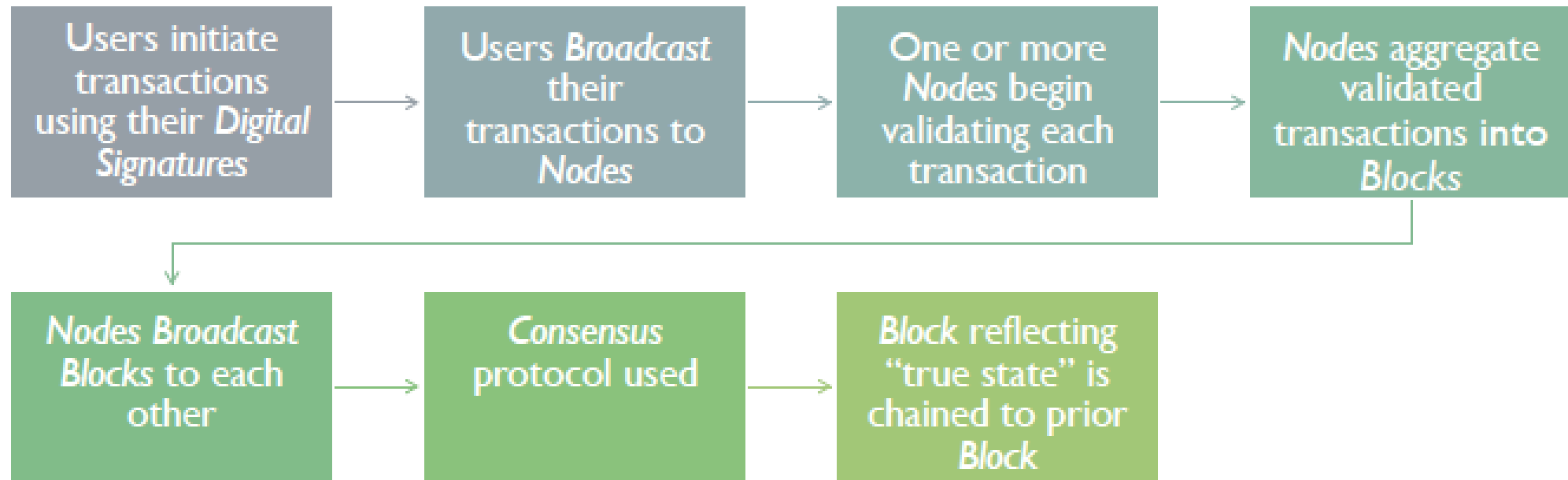
- There are multiple ledgers, but Bank holds the "golden record"
- Client B must reconcile its own ledger against that of Bank, and must convince Bank of the "true state" of the Bank ledger if discrepancies arise

### Distributed Ledger



- There is one ledger. All Nodes have some level of access to that ledger.
- All Nodes agree to a protocol that determines the "true state" of the ledger at any point in time. The application of this protocol is sometimes called "achieving consensus."

## HOW MIGHT A DISTRIBUTED LEDGER WORK?



# Features of Blockchain

Below are the most important features of Blockchain technology that has made it a revolutionary technology:

SHA256 Hash Function

Public Key Cryptography

Distributed Ledger & Peer to Peer Network

Consensus Algorithm (PoW,PoS,PoET,BFT,pBFT etc)

Incentives for Validation



# Why Blockchain



1. Immutable in Nature



2. Transparency



3. Privacy and Security



4. Time Stamp



5. Prospective change permissible



6. Authentic



7. Accuracy of data



8. Speedy Reporting

Hello World

Hello World!

hello world!

Hash Function



a591a6d40bf420404a011733cfb7b190d62c65bf0bcda32b57b277d9ad9f146e

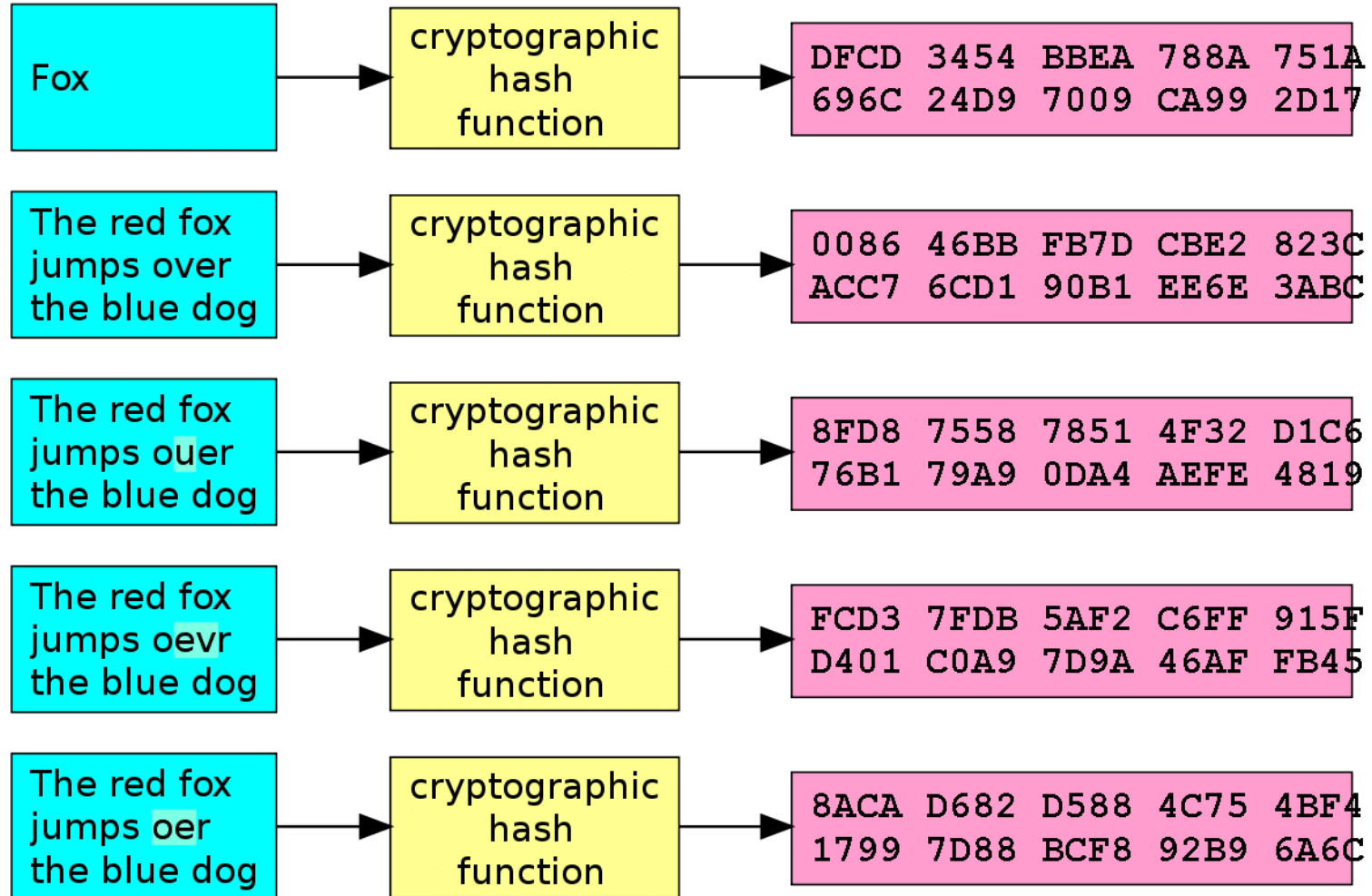
7f83b1657ff1fc53b92dc18148a1d65dfc2d4b1fa3d677284add200126d9069

7509e5bda0c762d2bac7f90d758b5b2263fa01ccbc542ab5e3df163be08e6ca9

# SHA256 Hash Function

## Input

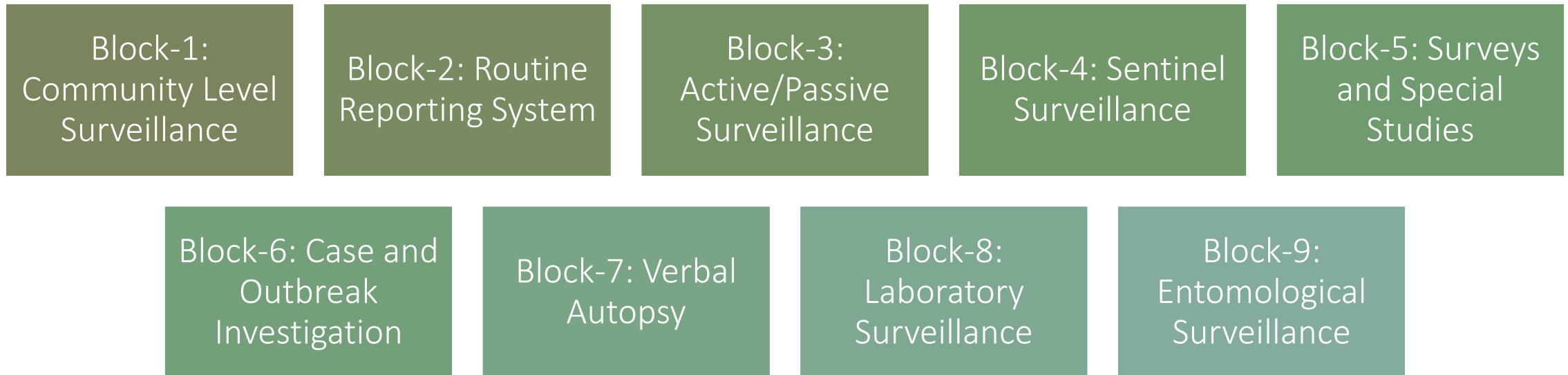
## Digest



# Blockchain in Surveillance

1. Stakeholder Identification
2. Stakeholders are considered as Blocks
3. Private and Public Keys creation for each blocks
4. Blockchain Creation
5. Ledger/Hyperledger
6. SHA256 : A Hashing Technique
7. A Consensus Algorithm: Byzantine Fault Tolerance (BFT)

# 1. Stakeholders in SURVEILLANCE

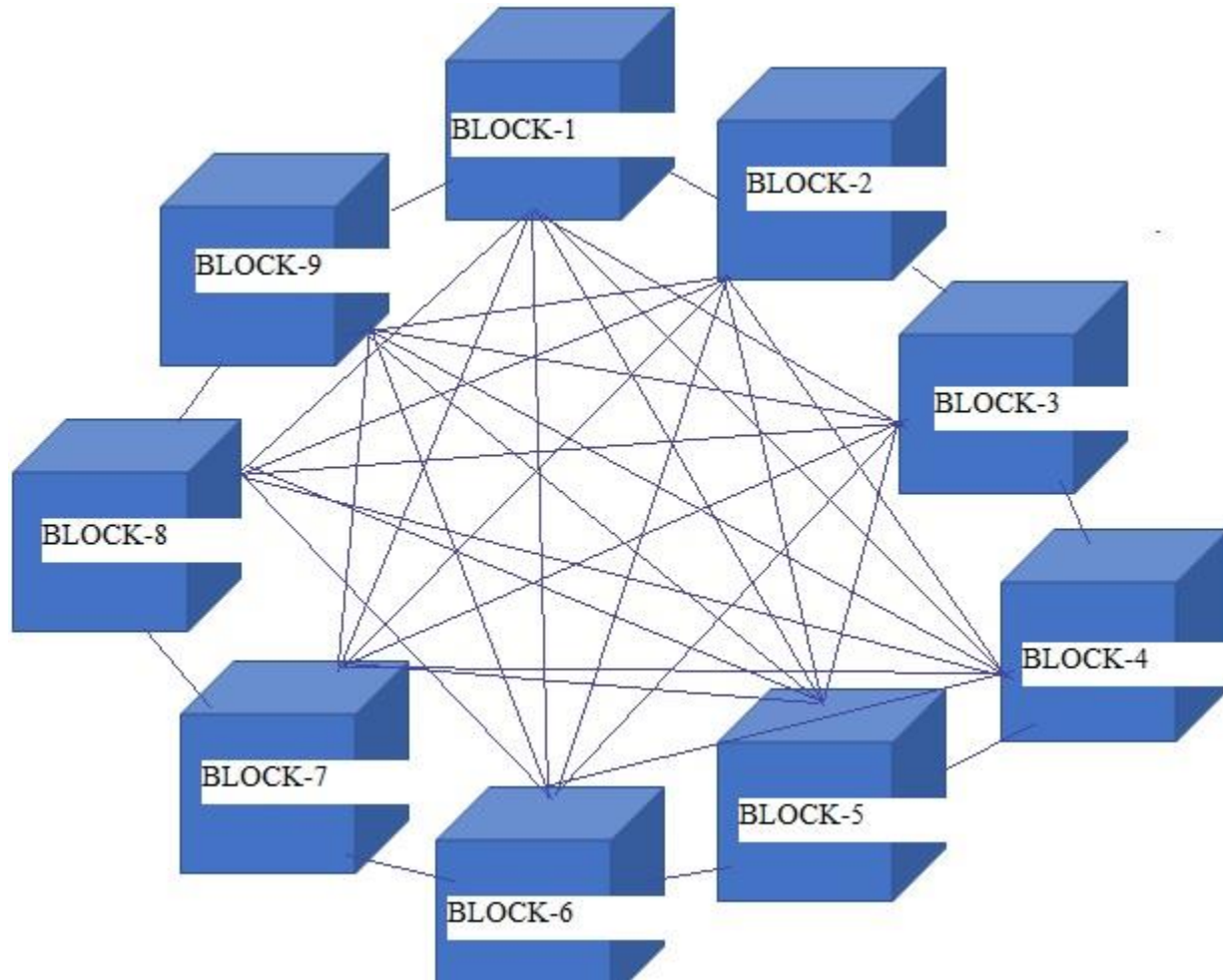


## 2. Private and Public Key

Private Key: Passwords

Public Key: Finger printing or Hash Generation using Hash Techniques

# 3. Creation of Blockchain



Block-1:  
Community Level  
Surveillance

Block-6: Case and  
Outbreak  
Investigation

Block-2: Routine  
Reporting System

Block-7: Verbal  
Autopsy

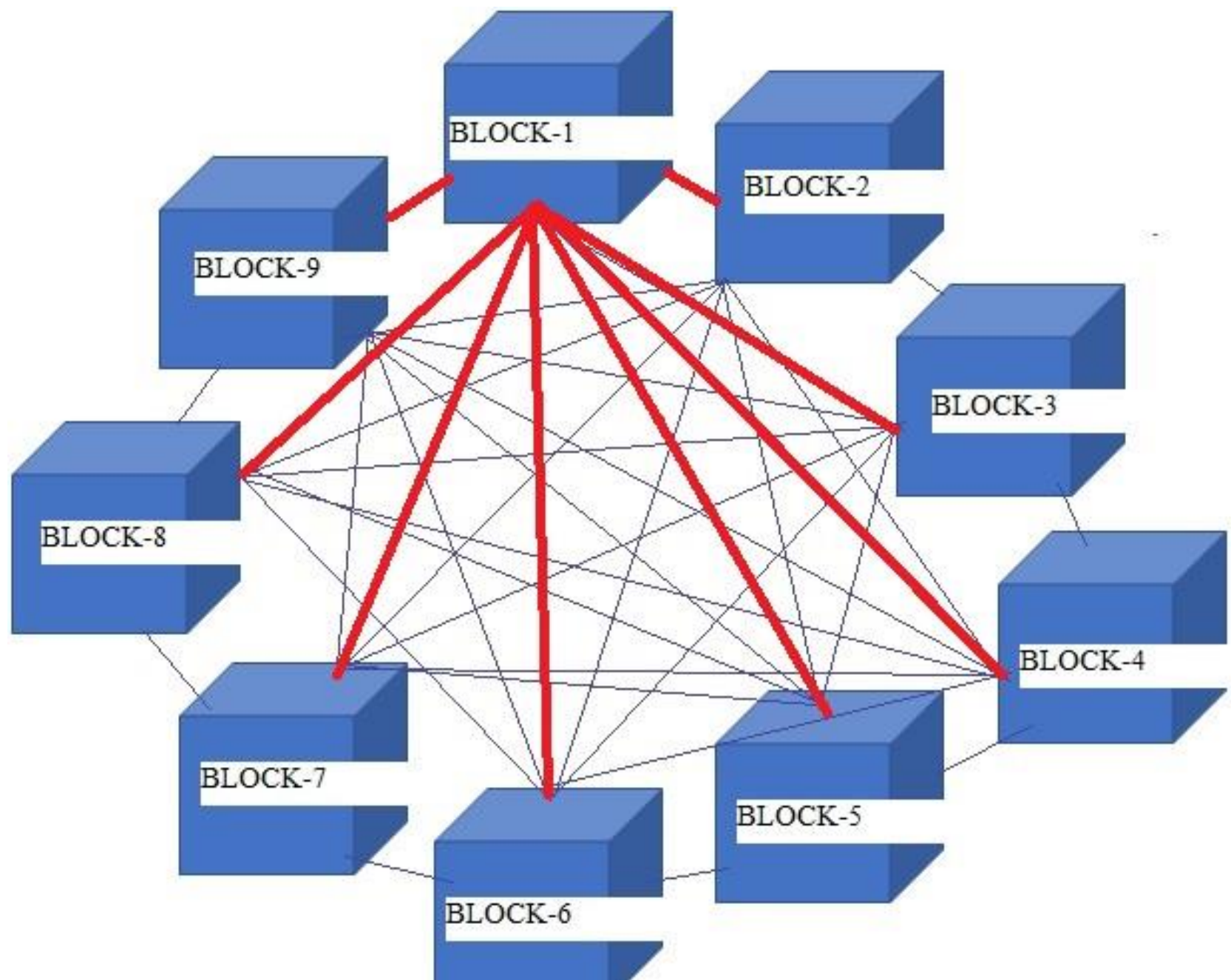
Block-3:  
Active/Passive  
Surveillance

Block-8:  
Laboratory  
Surveillance

Block-4: Sentinel  
Surveillance

Block-9:  
Entomological  
Surveillance

Block-5: Surveys  
and Special  
Studies



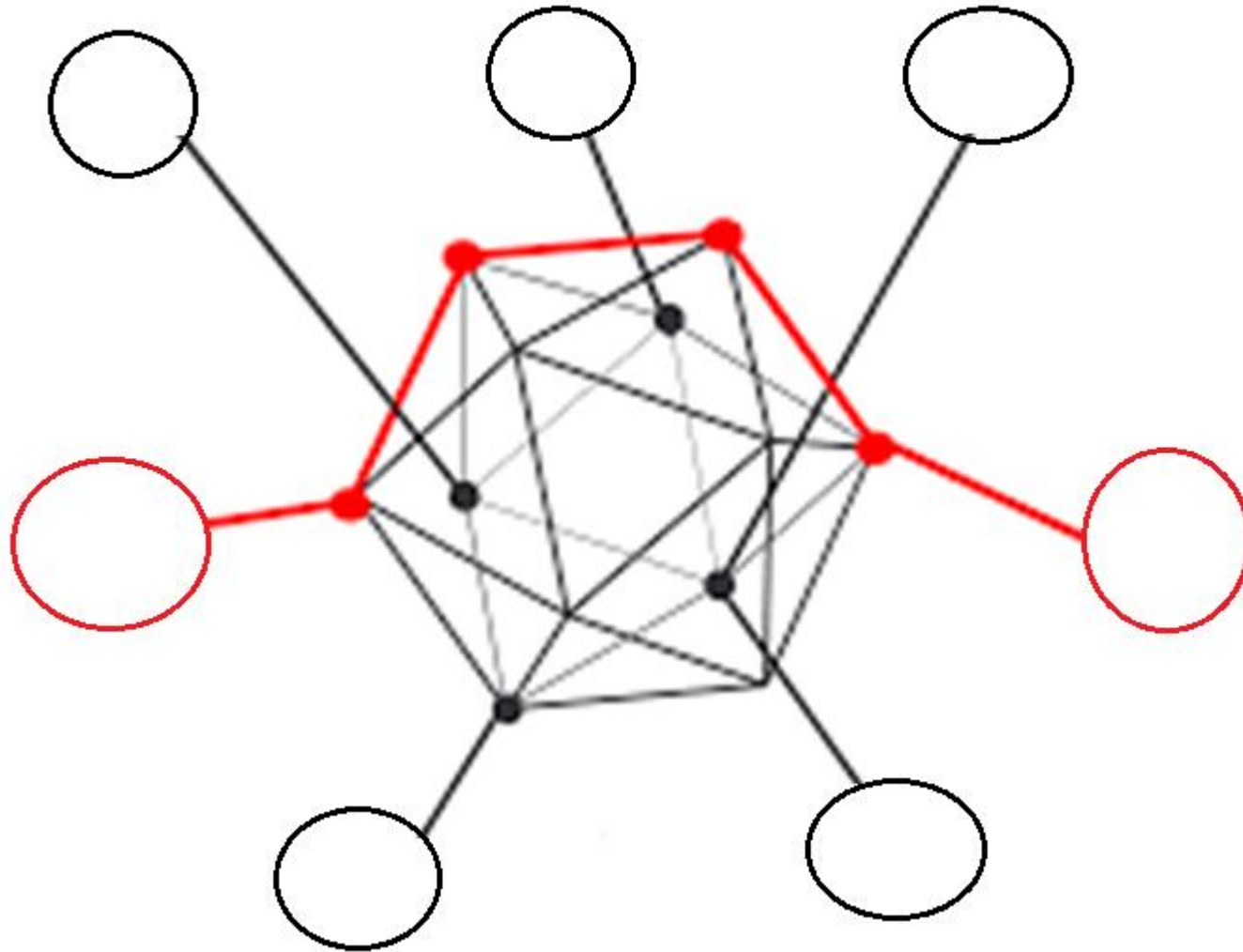


# Hyperledger

This is hosted by the Linux Foundation and Technology.

It is a system of people, organization, performance activity, updating, information, monitoring, and resources involved in the movement of data information from one node to another under control manner

# Hyperledger



Hyperledger is a peer-to-peer network of virtual computers that any developer utilizes it to run the distributed application.

These programs can be automatically executed when the conditions are met like a contract under the consensus algorithm Byzantine Fault Algorithm

it is a Specification for how trusted network should work.

Hyperledger specification has several implementations from different vendors:

1. Fabric - from IBM

2. Sawtooth Lake - from Intel

3. Corda - from R3 consortium

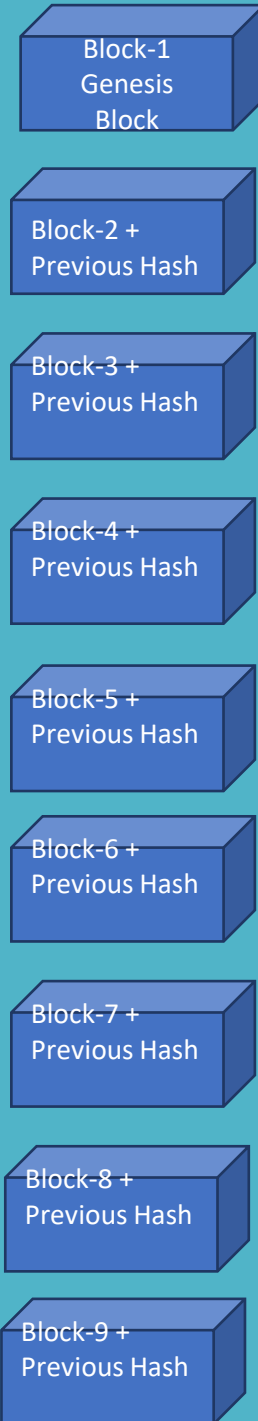
4. Iroha - from Soramitsu



The blocks are created on the blockchain platform from 1 to 9 which corresponds to all stakeholders of surveillance.

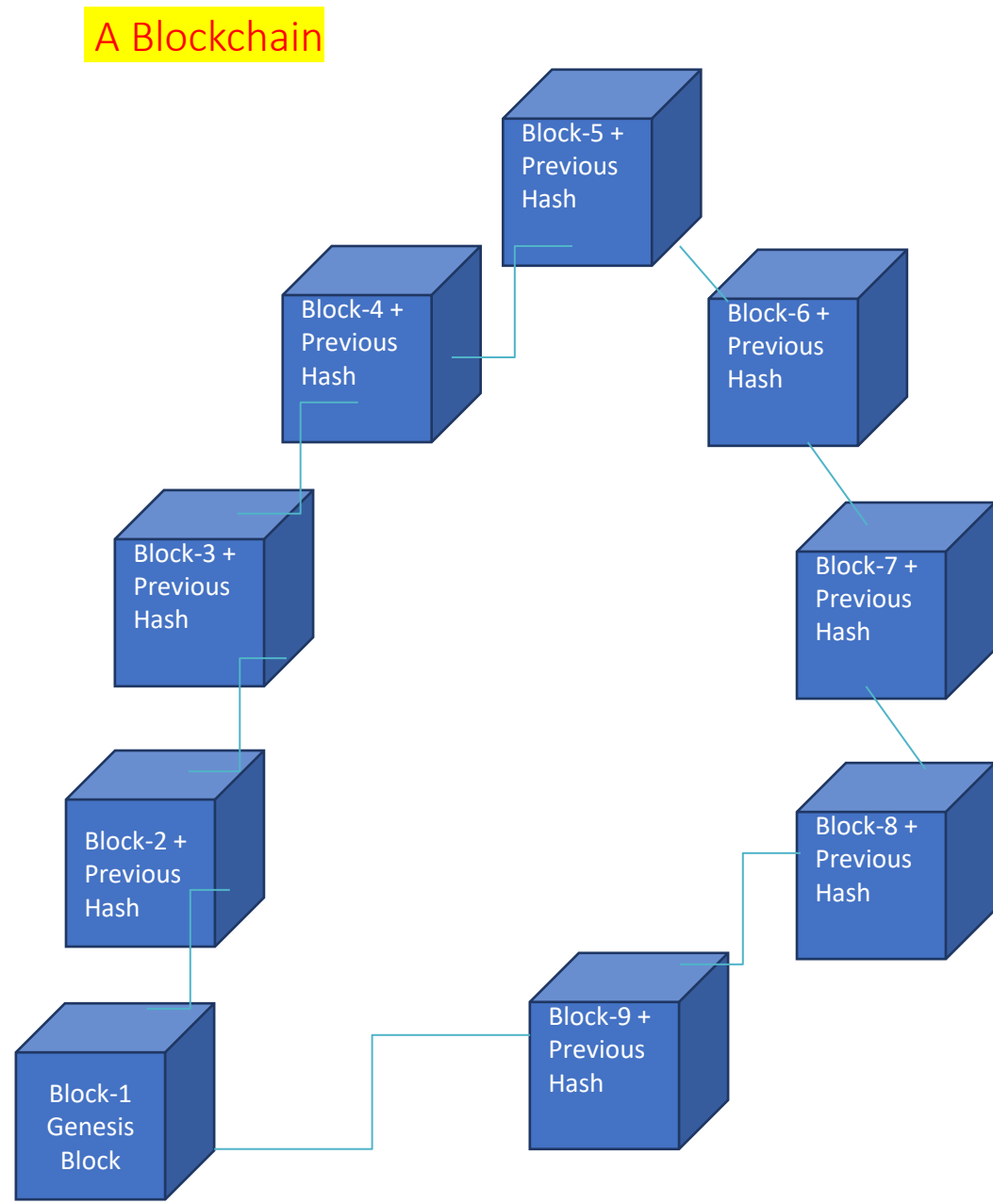


These partners are connected throughout the chain with the hash values which are the result of the hash techniques :Secure Hash Algorithm256 (SHA256).



The hash value of previous block to be added to input data of next block and generating the new hash value of the current block, now this blocks hash value added to the input data of the next block; and process is so on.

On the same principle, the following blocks are interconnected and depicted in given



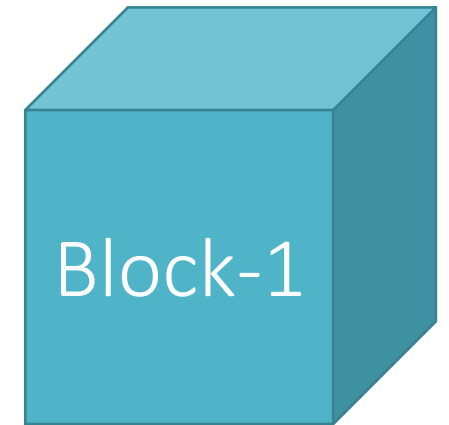
## Block-1

- ❑ Block-1 represents the Community level surveillance the details of all patient data recorded and reported under this block.

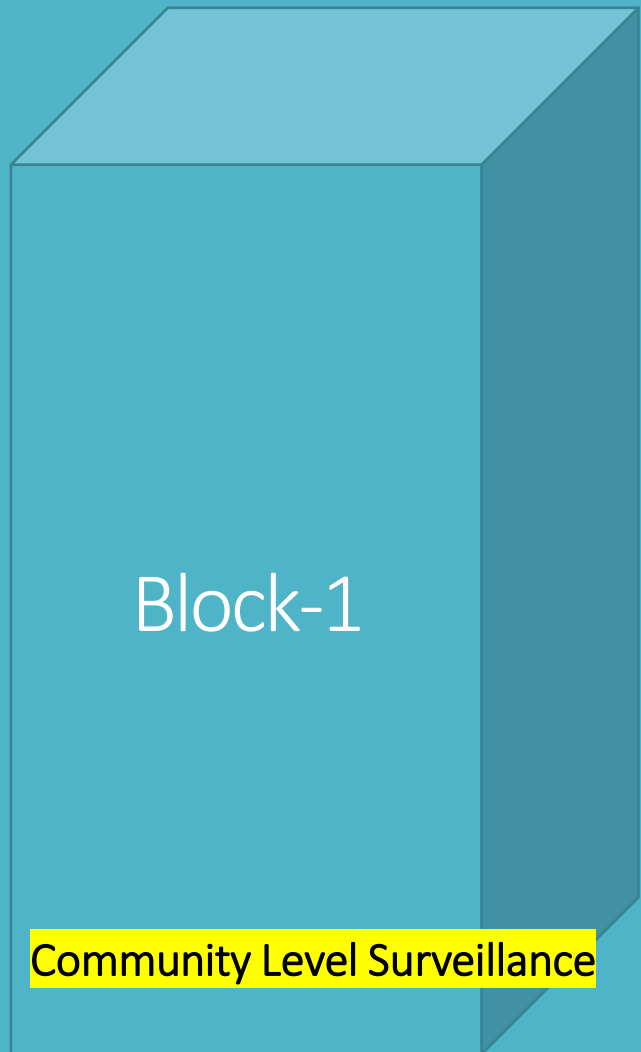
- ❑ The specific string of data requires a signature which is generated by cryptographic hash functions.

# (Community Level Surveillance)

Text/Data	<p>Case Data</p> <ol style="list-style-type: none"><li>1. Time</li><li>2. Place</li><li>3. Person</li><li>4. Clinical</li><li>5. Path Lab</li></ol> <p>Resources: Teams, Community Health Officers (CHOs) and CLS volunteers</p>
Genesis Hash	<p>A signature starting with at least ten consecutive zeroes, then a Block qualify to be added to the blockchain</p>
New Hash	<p>000000000008f6b96df89dda901c5176b10a6d83961dd3c1ac88b59b2dc327aa4</p>



Community Level Surveillance

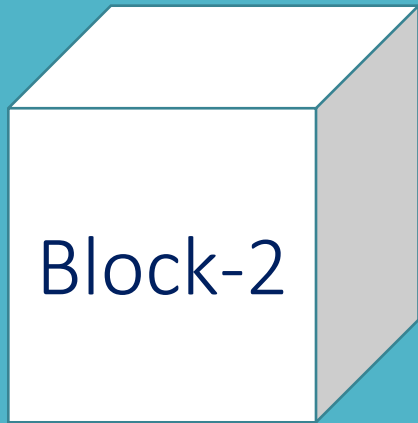


Once all details of Community level Surveillance; embedded in the form of text/data which turns into a **64-digit** string output (capital-small alphabetic numeric) by SHA256 hashing technique.

However, various techniques are available but SHA-256 has been in this presentation.

As per the inputs data of block-1, new hash has generated represents as:

“000000000008f6b96df89dda901c5176b10a6d83961dd3c1ac88b59b2dc327aa4”



(Routine Reporting System)



Block-2 represents the routine reporting system and information stored in form of data/text (64 String).



Block-2 links with block-1 because hash of previous block carry forwarded to the next block-2. In block-2 the previous hash as



“000000000008f6b96df89dda901c5176b10a6d83961dd3c1ac88b59b2dc327aa4”



added to the block-2 information and new hash of block-2 generated as

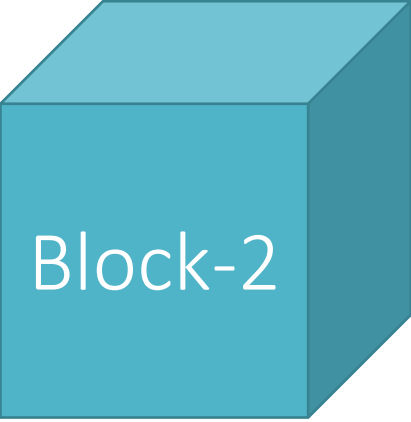


“e4e959eebbc14b64e7862595acd79d3a90917349d4be42d4908cd0c31d97b7bf”



# (Routine Reporting System)

Input Text/Data + Previous Hash	Case Data
	<ol style="list-style-type: none"><li>1. Time</li><li>2. Place</li><li>3. Person</li><li>4. Clinical</li><li>5. Path Lab</li></ol>
New Hash	000000000008f6b96df89dda901c5176b10a6d83961d d3c1ac88b59b2dc327aa4
	cbce37da53213b0d7df5717e33dd8531ed1f07dd970 00cd5a15a03070dc7b30d



(Routine Reporting System)



Block-3 represents “Active /Passive Surveillance” and it carry forward the previous hash of block-2 as:

“



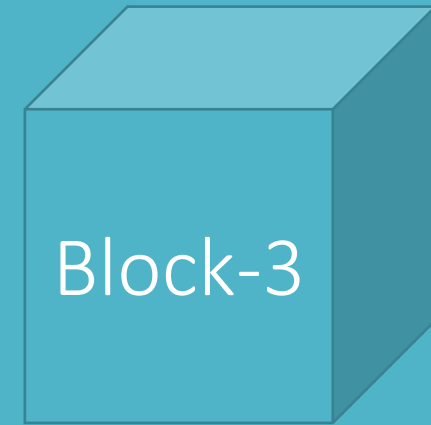
*cbce37da53213b0d7df571  
7e33dd8531ed1f07dd9700  
0cd5a15a03070dc7b30d”*



into the input data of logistic vendor, Block-3 and a new hash created for it given as:



*“4fc6413c236fee89a94f7e4  
fcf607e8e3aa822fcd85bc  
af b30e2ca5ae8c87696”*



Active/Passive  
Surveillance

## (Active/Passive Surveillance)

### Case Data

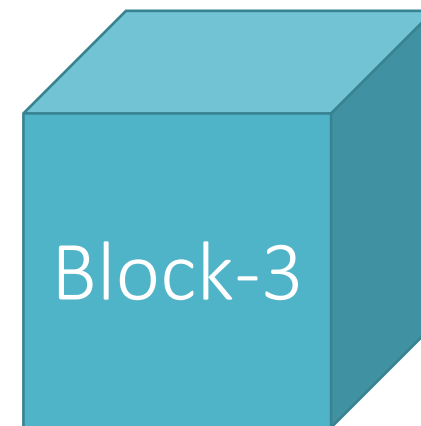
1. Time
2. Place
3. Person
4. Clinical
5. Path Lab

Input  
Text/Data  
+  
Previous  
Hash

cbce37da53213b0d7df5717e33dd8531ed1f07dd97000cd5a1  
5a03070dc7b30d

New Hash

4fc6413c236fee89a94f7e4fcf607e8e3aa822fcd85bcafb30e2ca



Active/Passive  
Surveillance



Block-4 presents the Sentinel Surveillance related data/information and it has previous hash of block-3 given below



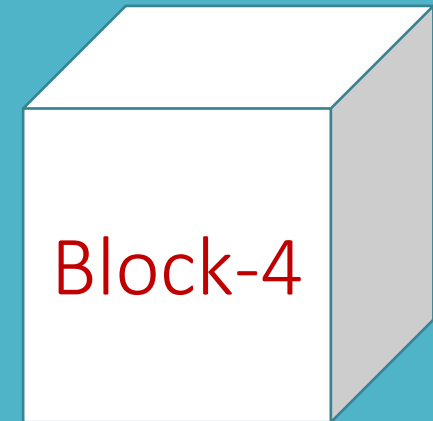
*“4fc6413c236fee89a94f7e4fc  
f607e8e3aa822fcd85bcafb30  
e2ca5ae8c87696”*



which is being added to block-4 and new hash for block-4 is generated as



“b5b3b923f069c45b6b4bb33  
b054386e1e6944537bbd6f95  
44e76044fcdab57aa”

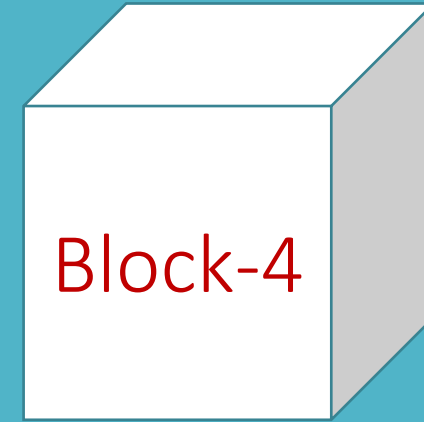


Sentinel  
Surveillance

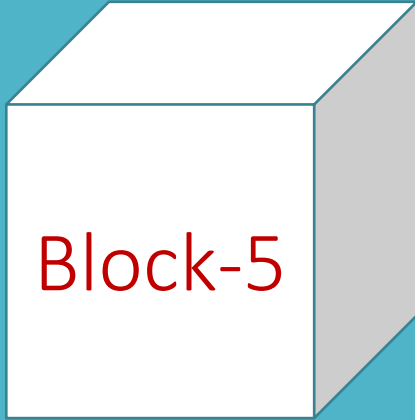
## Block-4

(Sentinel Surveillance)

<b>Input Text/Data + Previous Hash</b>	<b>Case Data</b>  1. Time  2. Place  3. Person  4. Clinical  5. Path Lab
	<i>4fc6413c236fee89a94f7e4fcf607e8e3aa822fcd85bcafb30e2ca5 ae8c87696</i>
<b>New Hash</b>	b5b3b923f069c45b6b4bb33b054386e1e6944537bbd6f9544e7  6044fcdab57aa



# Sentinel Surveillance



Block-5 represent the data of Surveys and Special Studies related information in the form of input text. The previous block-4 hash as:



*“b5b3b923f069c45b6b4bb33b  
054386e1e6944537bbd6f9544  
e76044fcdab57aa”*



added to the data of Block-5 and generated new hash for this block-5 as



*“4afef6b05bec13b16ac97643a  
cad419254f0fa0e153f2c1eccd0  
3344aae9972e”*

(Surveys and Special Studies)

Case Data

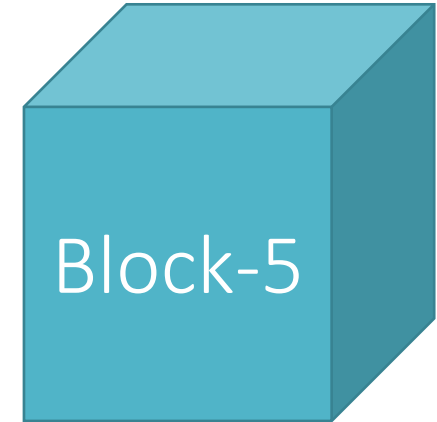
1. Time
2. Place
3. Person
4. Clinical
5. Path Lab

Input  
Text/Data  
+  
Previous  
Hash

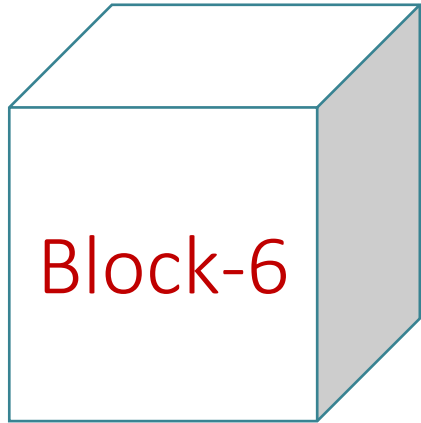
ed89b15c453f8ce76e1da5e1ac3f428af83574d222c28  
046b55e954c74e55667

New Hash

4afef6b05bec13b16ac97643acad419254f0fa0e153f2c  
1eccd03344aae9972e



(Surveys  
and  
Special Studies)



Block-6 represent the data of Case and Outbreak Investigation related information in the form of input text. The previous block-5 hash as:



*"4afef6b05bec13b16ac97643a  
cad419254f0fa0e153f2c1eccd  
03344aae9972e"*



added to the data of Block-6 and generated new hash for this block-6 as



*"324e35abac079d1466c75331  
55e57cf5c2b18175f98c84b72  
ed213340a59207b"*



(Case and Outbreak Investigation)

Case Data

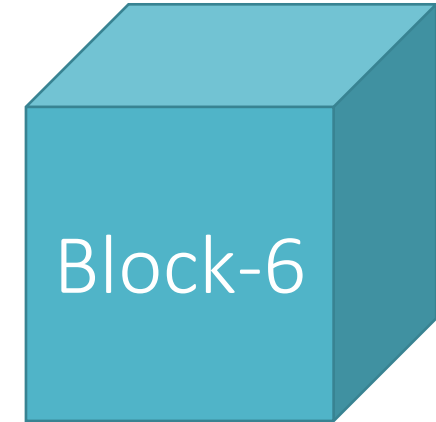
1. Time
2. Place
3. Person
4. Clinical
5. Path Lab

Input  
Text/Data  
+  
Previous  
Hash

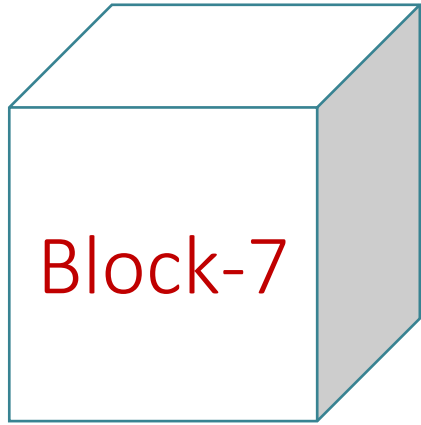
4afef6b05bec13b16ac97643acad419254f0fa0e153f2c  
1eccd03344aae9972e

New Hash

324e35abac079d1466c7533155e57cf5c2b18175f98c8  
4b72ed213340a59207b



(Case and Outbreak  
Investigation)



Block-7 represent the data of Verbal Autopsy related information in the form of input text. The previous block-5 hash as:



*"324e35abac079d1466c7533155e57cf5c2b18175f98c84b72ed213340a59207b"*



added to the data of Block-7 and generated new hash for this block-7 as



*"72b289ec78e0a928c565480a435453e30acb92eddb3b78ff168b28737cf6a849"*

(Verbal Autopsy)

Case Data

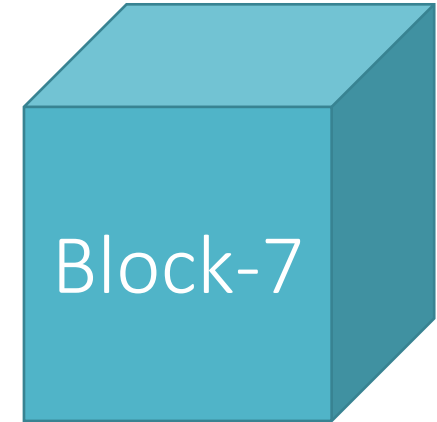
1. Time
2. Place
3. Person
4. Clinical
5. Path Lab

Input  
Text/Data  
+  
Previous  
Hash

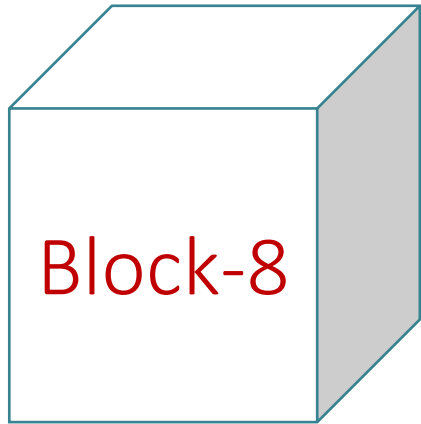
324e35abac079d1466c7533155e57cf5c2b18175f98c8  
4b72ed213340a59207b

New Hash

72b289ec78e0a928c565480a435453e30acb92eddb3b  
78ff168b28737cf6a849



(Verbal Autopsy)



Block-8 represent the data of LABORATORY SURVEILLANCE related information in the form of input text. The previous block-7 hash as:



*"72b289ec78e0a928c565480a  
435453e30acb92eddb3b78ff1  
68b28737cf6a849"*



added to the data of Block-8 and generated new hash for this block-8 as



*"e1bffc89474e48b5f629da5c1  
3733ca0d34949d1ffb8b8fe5ab  
b7c62573dc878"*

(LABORATORY SURVEILLANCE)

Case Data

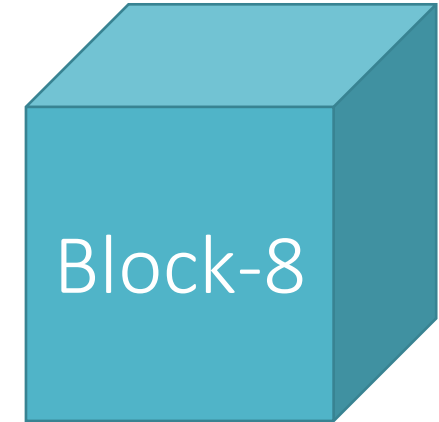
1. Time
2. Place
3. Person
4. Clinical
5. Path Lab

Input  
Text/Data  
+  
Previous  
Hash

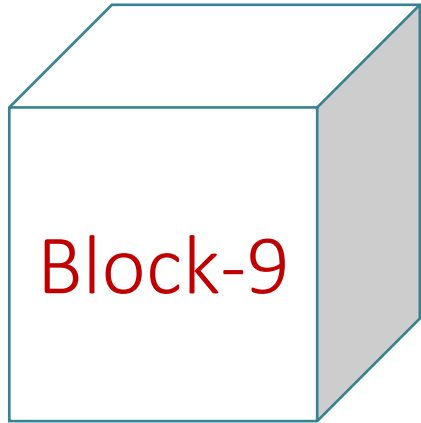
ed89b15c453f8ce76e1da5e1ac3f428af83574d222c28  
046b55e954c74e55667

New Hash

e1bffc89474e48b5f629da5c13733ca0d34949d1ffb8b8  
fe5abb7c62573dc878



(LABORATORY  
SURVEILLANCE)



Block-9 represent the data of ENTOMOLOGICAL SURVEILLANCE related information in the form of input text. The previous block-8 hash as:



*“e1bffc89474e48b5f629da5c  
13733ca0d34949d1ffb8b8fe5  
abb7c62573dc878”*



added to the data of Block-9 and generated new hash for this block-9 as



*“7724585bada0ca05821cf75  
a91a14f2c2bad5e9e1118d40  
765e63764518a3086”*

(Entomological Surveillance)

Case Data

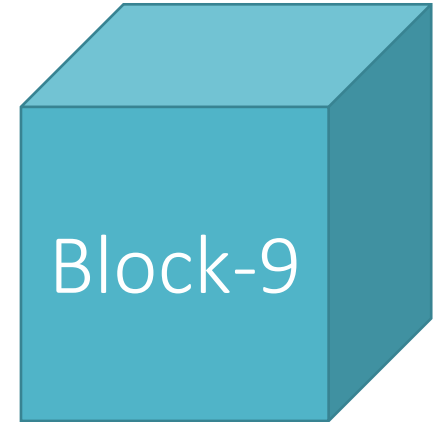
1. Time
2. Place
3. Person
4. Clinical
5. Path Lab

Input  
Text/Data  
+  
Previous  
Hash

7724585bada0ca05821cf75a91a14f2c2bad5e9e1118d40765  
e63764518a3086

New Hash

9e18d61e6db9dcb09cb67597ae57e3b807a3281a6ddd  
eb13075f3a11cc806425



(Entomological  
Surveillance)

**STEPS IN  
PUBLIC HEALTH SURVEILLANCE  
USING  
BLOCKCHAIN**



# Step-1

The block-1 of the COMMUNITY LEVEL SURVEILLANCE considered as a genesis block.

It will include data information and hash of block-1 given below.

“000000000008f6b96df89dda901c5176b10a6d83961dd3c1ac88b59b2dc327aa4”

In block 1, suppose the **Community Level Surveillance** Collected data from different places and different communities to identify a disease.

# Step-2/Block-2: Routine Reporting System

Block-1 Hash	0000000000008f6b96df89dda901c5176b10a6d83961dd 3c1ac88b59b2dc327aa4
Block-2 Hash (Block-1 hash + Block-2 data)	cbce37da53213b0d7df5717e33dd8531ed1f07dd970 00cd5a15a03070dc7b30d

In block 2, "Routine Reporting System" Collected data from to identify a specific disease.

The block-2 Routine Reporting System" 's data block and having the new hash in connection with the block-1. The hash for this block contains:

## Step-3/Block-3: Active/Passive Surveillance

Block-2 Hash	cbce37da53213b0d7df5717e33dd8531ed1f07dd97000cd5a15a03070dc7b30d
	Block-2 hash + block 3 text/data information
Block-3 Hash	<i>4fc6413c236fee89a94f7e4fcf607e8e3aa822fcd85bcafb30e2ca5ae8c87696</i>

## Step-4/Block-4: Sentinel Surveillance

Block-3 Hash	<i>4fc6413c236fee89a94f7e4fcf607e8e3aa822fcd85bcafb30e2ca5ae8c87696</i>
	Block-3 hash + block 4 text/data information
Block-4 Hash	b5b3b923f069c45b6b4bb33b054386e1e6944537bbd6f9544e7 6044fcdab57aa

# Step-5/Block-5: Surveys and Specifications

Block-4 Hash	b5b3b923f069c45b6b4bb33b054386e1e6944537bbd6f9544e7  6044fcdab57aa
	Block-3 hash + block 4 text/data information
Block-5 Hash	4afef6b05bec13b16ac97643acad419254f0fa0e153f2c1eccd0  3344aae9972e

## Step-6/Block-6: Case and outbreak investigations

Block-5 Hash	4afef6b05bec13b16ac97643acad419254f0fa0e153f2c1eccd03344aae9972e
	Block-5 hash + block 6 text/data information
Block-6 Hash	324e35abac079d1466c7533155e57cf5c2b18175f98c84b72ed213340a59207b

# Step-7/Block-7: Verbal Autopsy

Block-6 Hash	324e35abac079d1466c7533155e57cf5c2b18175f98c84b72ed213340a59207b
	Block-6 hash + block 7 text/data information
Block-7 Hash	72b289ec78e0a928c565480a435453e30acb92eddb3b78ff168b28737cf6a849

# Step-8/Block-8: Laboratory Surveillance

Block-7 Hash	72b289ec78e0a928c565480a435453e30acb92eddb3b78ff168b28737cf6a849
	Block-7 hash + block 8 text/data information
Block-8 Hash	8e2e2ed3d977c3b55dce39b4519a022947d2b4a774a2a88080859e12c099d463



# Step-9/Block-9: Entomological Surveillance

Block-8 Hash	8e2e2ed3d977c3b55dce39b4519a022947d2b4a774a2a88080859e12c099d463
	Block-8 hash + block-9 text/data information
Block-9 Hash	f3c113de3ab35676bb0164f9eb2b06650783227778aebf889f3525db6eada39a

# CONSENSUS ALGORITHM IN BLOCKCHAIN FOR SURVEILLANCE

# Consensus approach

It is essential that a consensus should be achieved among all nodes/stakeholders of public health surveillance to make the authentic data transaction and ledger entry in a transparent way.

As we know that Blockchain is a distributed ledger system which is

1. secured
2. tamper free
3. verifiable

due to consensus protocol which is a core part of Blockchain network.

All nodes/stakeholders of the chain should endorse the added transaction/information in their own ledger.





## Consensus approach

It could be done using the consensus algorithm.

However, various consensus algorithms i.e.

1. Proof of Work (POW)
2. Proof of Stake (POS)
3. Proof of Burn (POB) and
4. Byzantine Fault Tolerance (BFT) are used for consensus on nodes on Blockchain.
5. Proof of Elapsed Time (PoET)

# Consensus

Whenever the new information gets broadcasted to the blockchain network, actors or all partners have option either to include the information in their ledger or reject/ignore it.

When majority of the actors are on the single state, consensus is achieved.

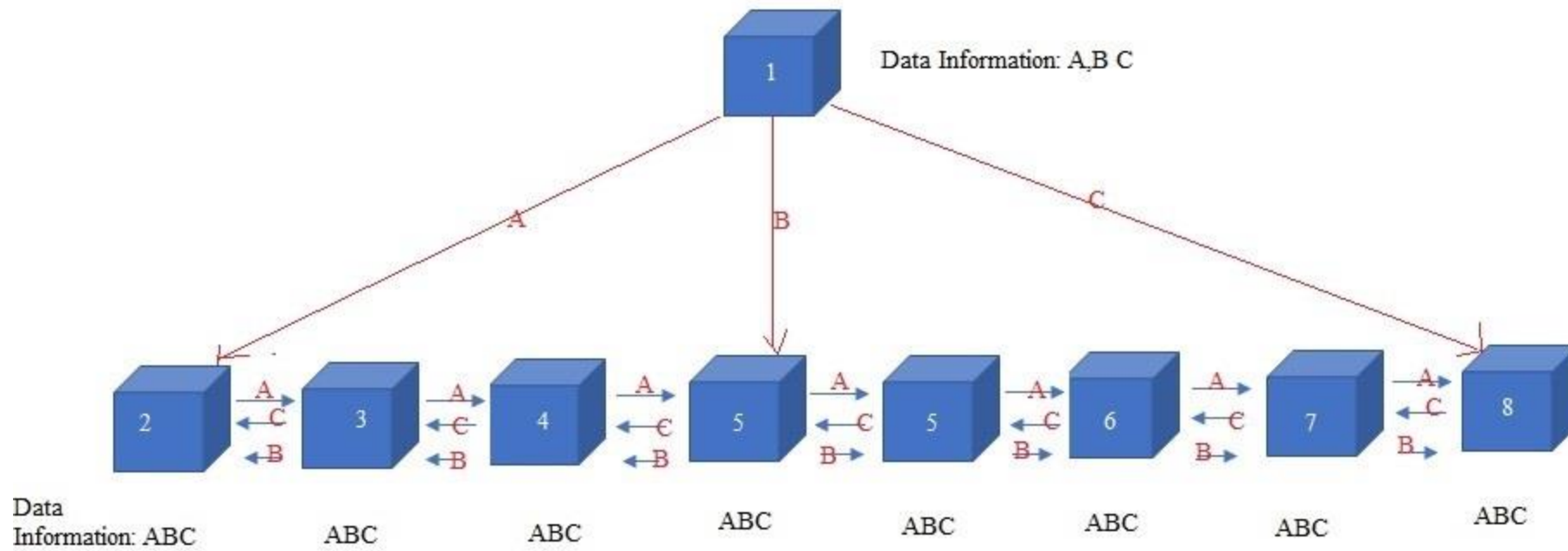
Here, Byzantine Fault Tolerance algorithm-based consensus algorithm described for mutual acceptability of all nodes.



# Consensus Algorithm

The Byzantine Fault Tolerance algorithm (in context of Public health surveillance)

The following steps described to achieve the mutual consensus among all stakeholders.



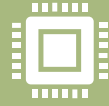
All nodes are on same updated data information on Ledger at particular time

## Byzantine Fault Tolerance Algorithm for Consensus

Steps	Byzantine Fault Tolerance Algorithm Description for Consensus		
Step 1	The Node-1 sends information A, B,C to 2, 5 , 8 nodes		
Step 2	Node-1 sends A to Node-2 & son on	Node-5 sends B to Node-4,3,2 and 6,7,8,9	Node-9 sends C to Node-8,7,6,5,4,3,2
Step 3	Majority nodes (2,3,4,5,6,7,8) updated their ledger with data information (ABC) with time stamp		
<p data-bbox="38 848 267 891">Consensus</p> <p data-bbox="38 1005 318 1048">Achievement</p>	<p data-bbox="377 848 2522 1405">Here it has observed that A,B,C are all different, but the value majority (A,B,C) is the same for all three actors in the Blockchain. In this way, information are verified by each node, everyone keeps the updating and correct version of the ledger updated at every partner. For more complex structure of several public health stakeholders, the same BFT algorithm can be used. The consensus among the partners achieved maintaining the transparency of information or data transactions. Now all nodes</p>		



# CONCLUSION



The Blockchain may controls the data information within the chain and immutability preserved.



Blockchain provides an immutable, reliable, transparent and capturing the data information in realistic manner



Secure Hash Algorithm256 (SHA256) applied to generate the hash values against the hash key, Hyperledger as a Blockchain platform and Byzantine Fault Tolerance (BFT) used to reach the consensus among the public health stakeholders.



many  
thanks



Questions