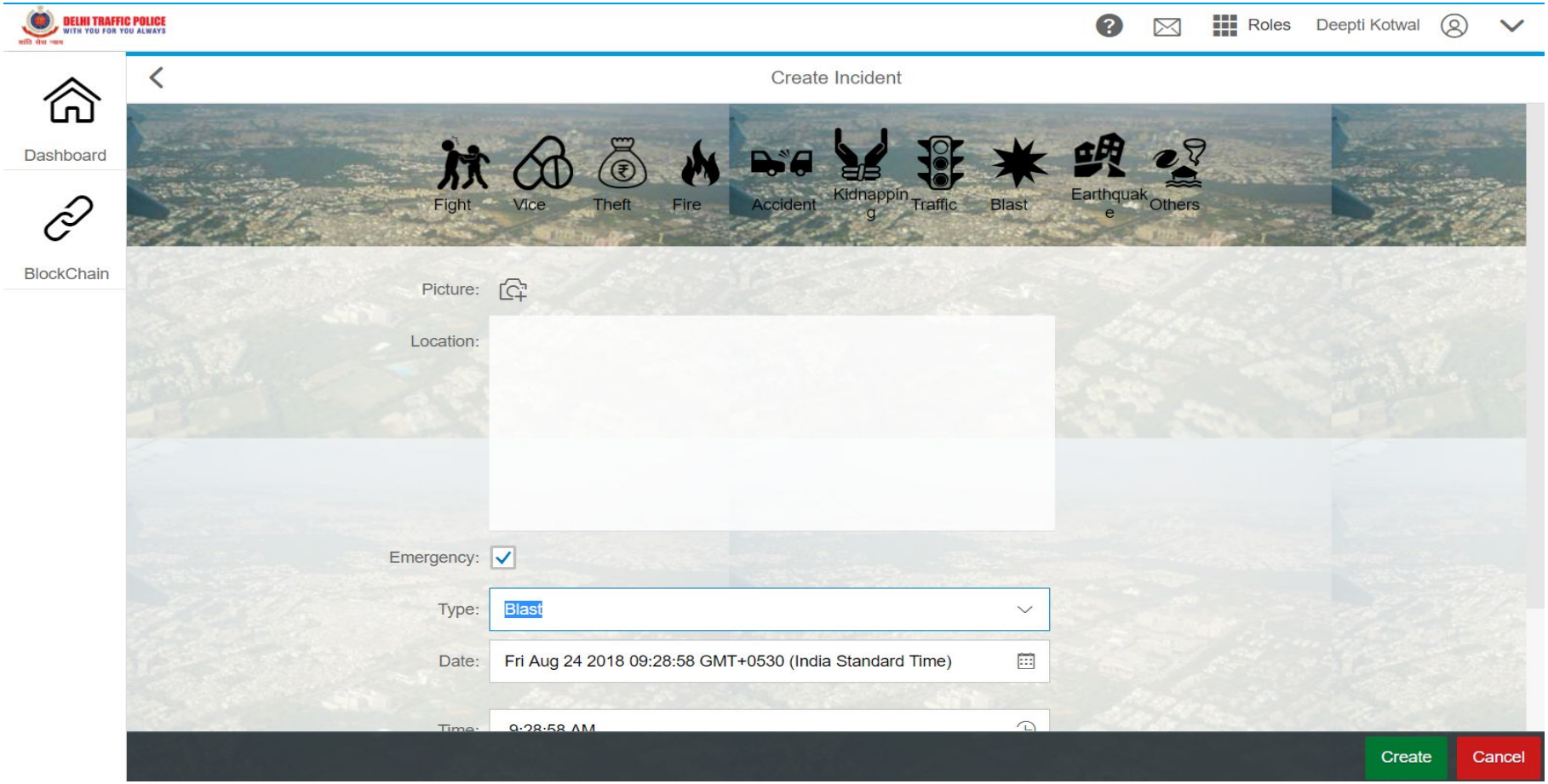
The Solution: How it works?

The technical solution demonstrates capabilities which are pluggable, extendable to 5 different personas :
Citizen, Police Officer, Dispatcher, Admin and Driver
Persona based Capabilities:

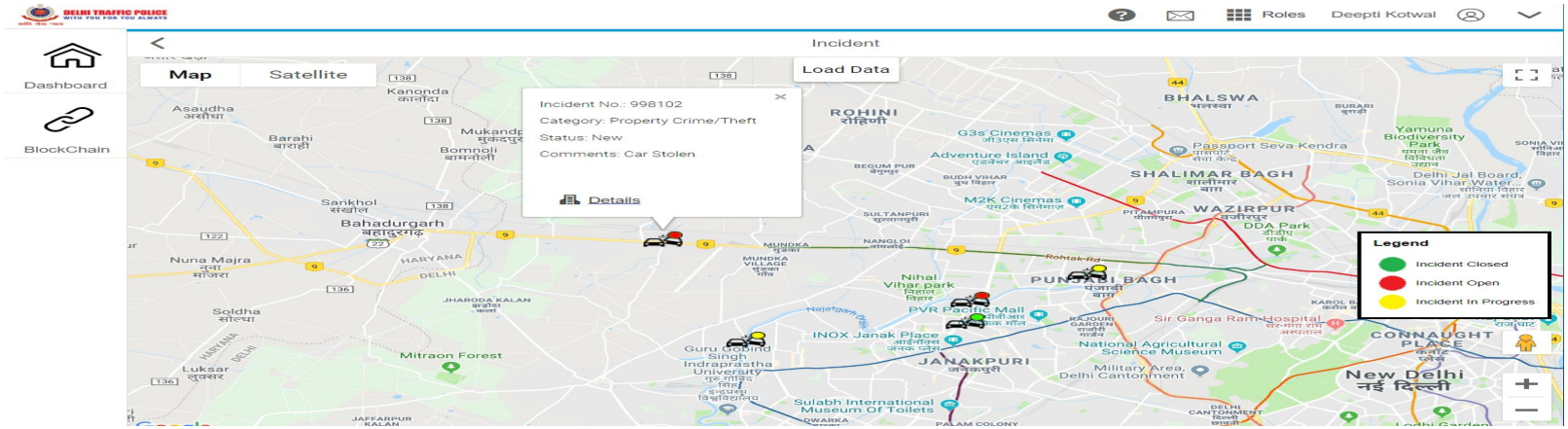
1) **As a citizen:** → Ability to create SOS: incident created automatically, added to ICM (Investigative Case management)
→ Create incident: Can directly create an incident/ticket on different categories.
→ Track the status of the incident (in progress/complete)/navigate to details of the same.
→ Provide feedback/view happiness review on the same.

The citizen functionalities are also made available on the mobile, which can provide live interactivity.

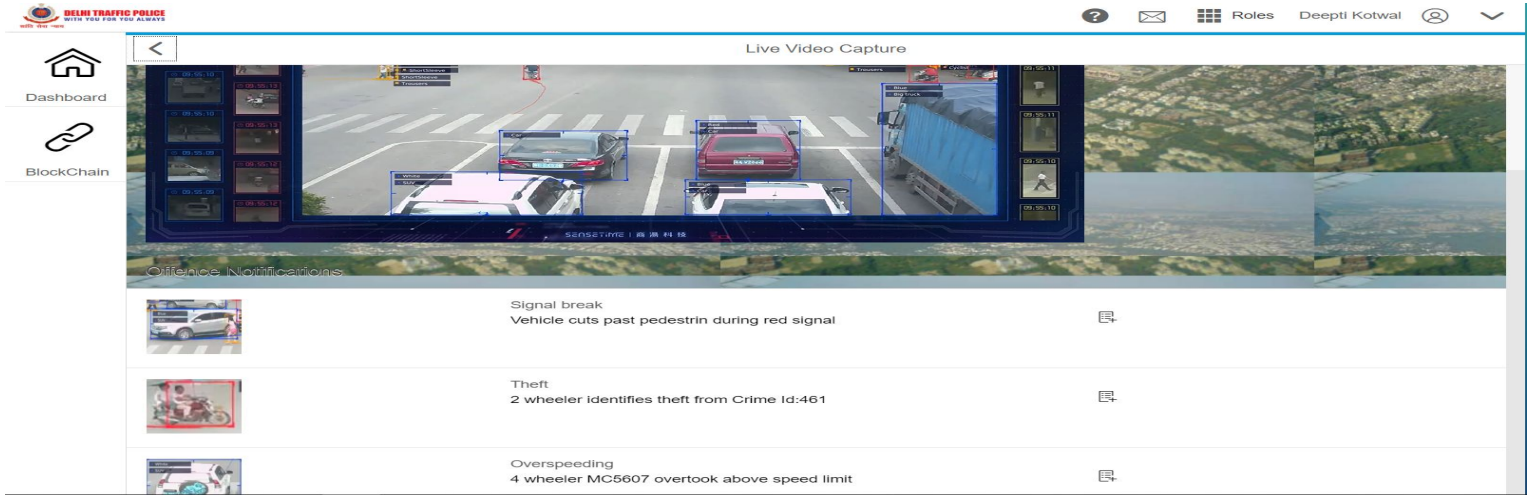


How it works?

2) As a police officer: A police officer can view incidents to which s/he is assigned. the ones new, in progress and can also upload evidence to close the same. S/he can view the same on the map and click on details to navigate further, view details, add details. All of this will be recorded in central investigative case management system (ICM).



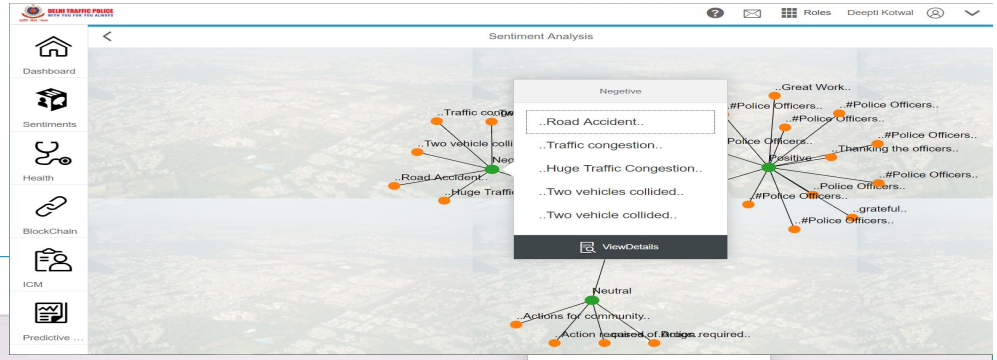
3) As a dispatcher assigning cases : Assigning incidents to police staff reported at run-time. Disptacher can view the nearest police station, which is available and can handle the cases based on their credibility. They have access to view the current situation using real-time camera application and sort information obtained from cameras. Video analytics brings in capabilities of what you could understand form the vehicles/license plates and identify suspicious object/issues.

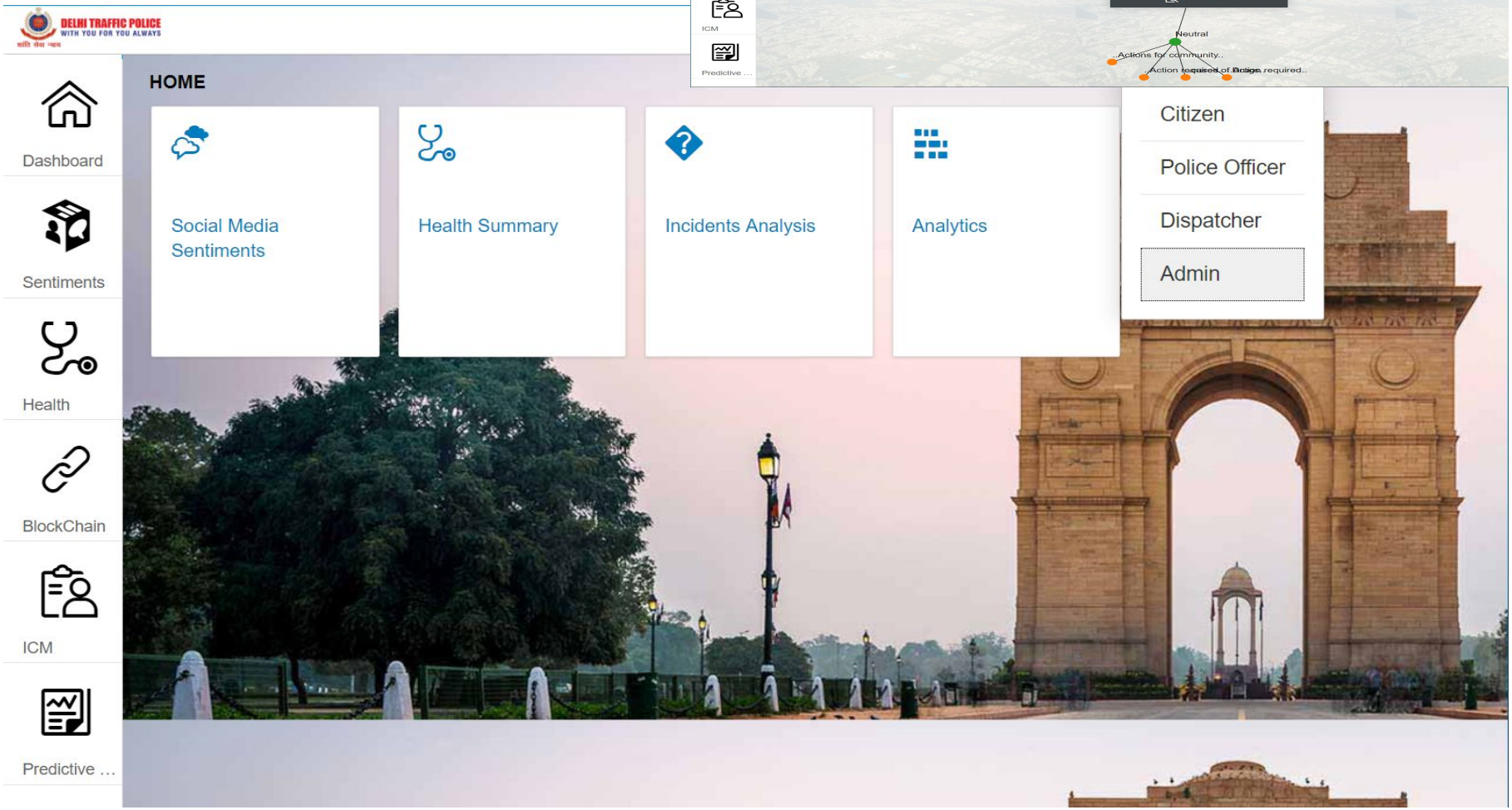


How it works?

4) **As an administrator /police head**: As an administrator, the police head could get complete overview of :

- Analytics of the incidents, road safety eco-system
- Analytics of the police force teams, staff members
- Understand social media trends, road safety norms
- Health summary of the police staff, scheduling and manging the staff, incident prevention data





Technical Solution Features for Driver

360 degrees access of the incidents to the action/ administration team. They can manage the complete lifecycle of incident reporting, overall status, traffic monitoring, managing police teams. Using machine learning they can also predict the incident occurrence at any area. This will help in taking necessary actions in advance to control the traffic. They can also use the solution for effective utilization of staff members and provide road safety counseling.

The Cloud-Connected Vehicle Drives IoT Monetization. Real-time access to car availability and mobile connectivity enables better decisions making systems.

Recognition area built in the central control to pick up your body movements, GAIT analysis

Vehicles become IoT devices which can connect to smartphones, take voice commands, change the user interface.

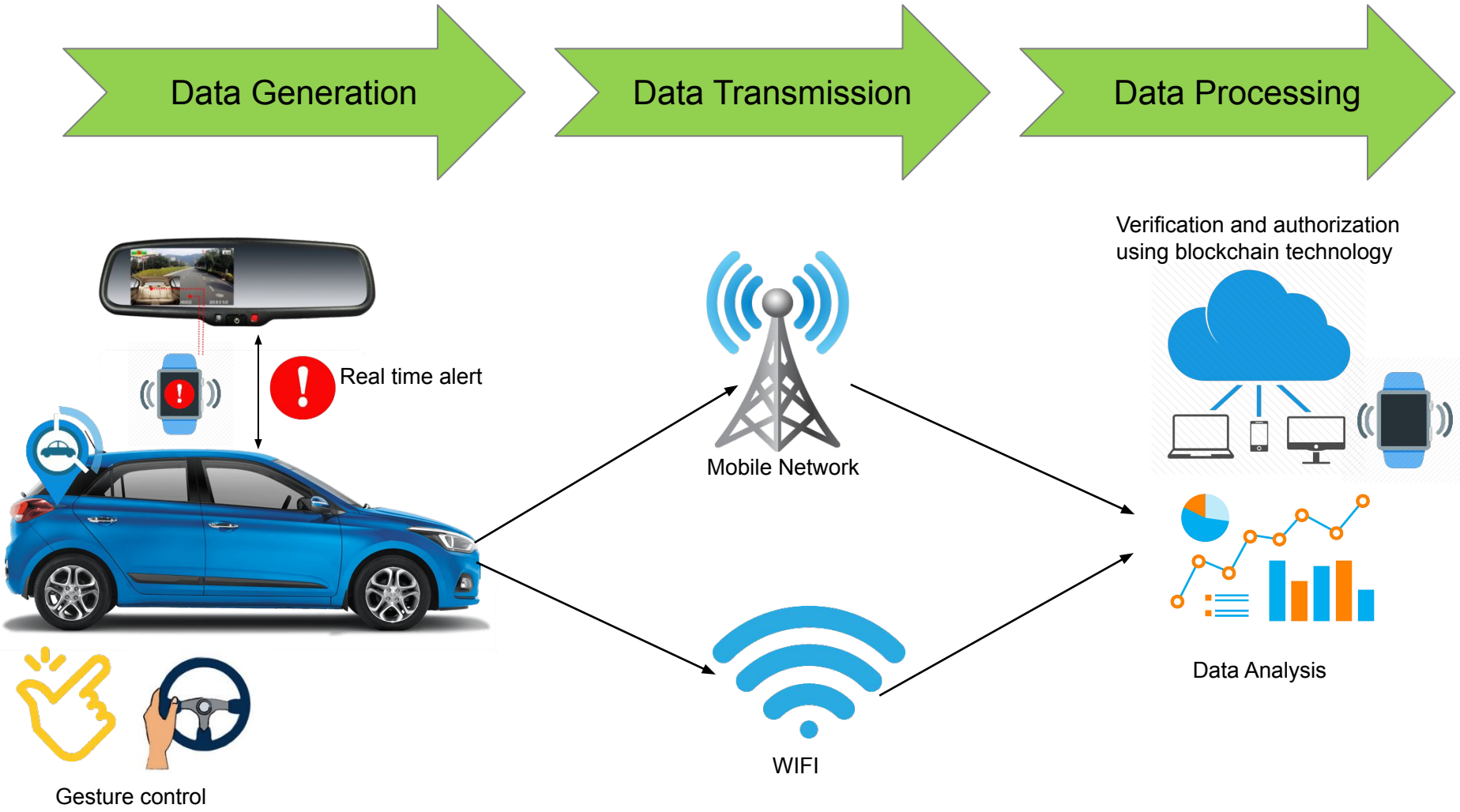
Incident-based reporting & Collision detection (even when a vehicle is parked) and video footage associated with it.

Video footage for abnormal driver behavior (complete view of the vehicle with 2 cameras – front and back)

Real-time alert and live streaming. Any abnormal behavior/activity can be displayed on the smart dashboard in the vehicle.

Built-in GPS technology useful in fleet management and tracking. Black box vehicle tracking to be able to pre-empt and diagnose breakdowns more quickly.

Architecture



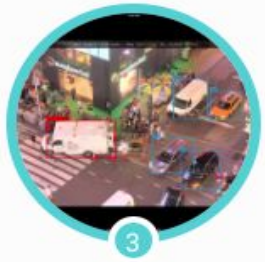
How it works?

Camera Management - add/edit/delete cameras

Click "+" icon to add cameras; Click "-" icon to delete cameras; Click "i" icon to edit cameras; Prepopulated 4 Onvif demo cameras, 10 http/rtsp cameras and 1 iOS back facing camera.

Object Detection Video Analytics Configuration

Go to Settings->Object Detection->Model to select engine; Go to Object Filters to configure selected engine object types to detect or alarm; Turn on/off detect/alarm for each object or bulk change.



Live Streaming with Object Detection Video Analytics

Implemented FFmpeg http/rtsp player; Overlays include Logo / Camera name / detected object type and location bounding boxes / Engine name and current FPS; Raise alarms in red bounding box.

Alarm Viewer - view alarms and archive in details

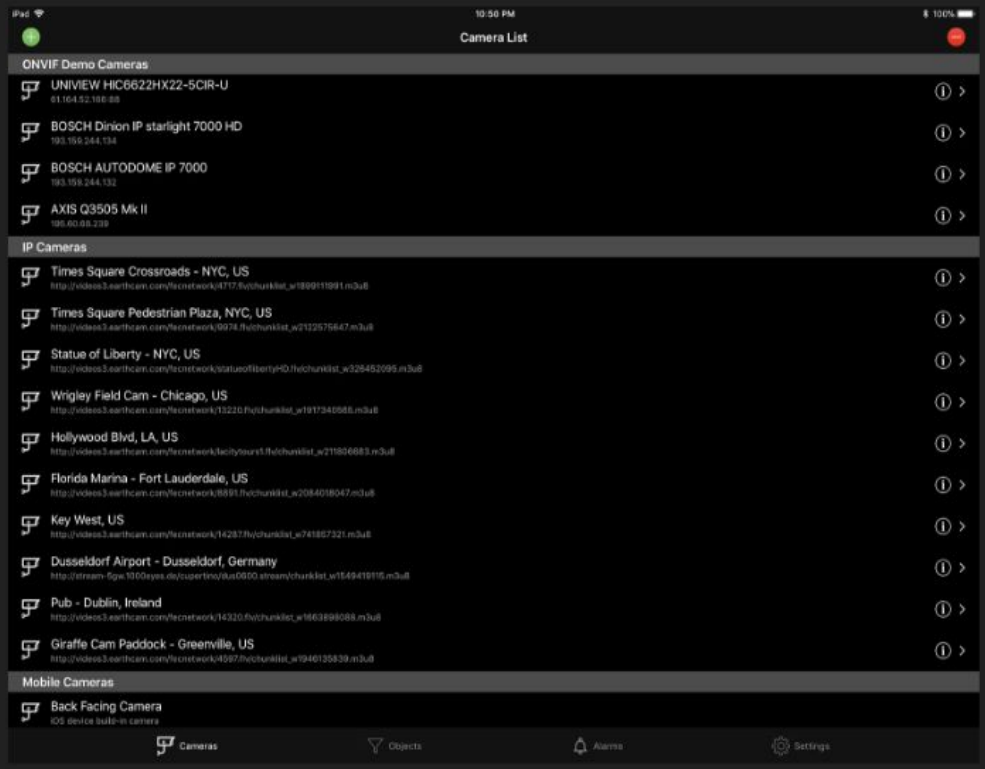
Load saved alarms (green border) from IPFS/Ethereum; Metadata includes timestamp, camera name, object type and engine; Double click alarm to show in fullscreen; Select alarm (grey back color) to save.

Blockchain Alarm Storage - alarm metadata & image

Save/Delete alarm metadata and image to/from IPFS p2p distributed web; Store the hash returned from IPFS to Ethereum Test Network; Provided links to access alarms and blockchain transaction details.

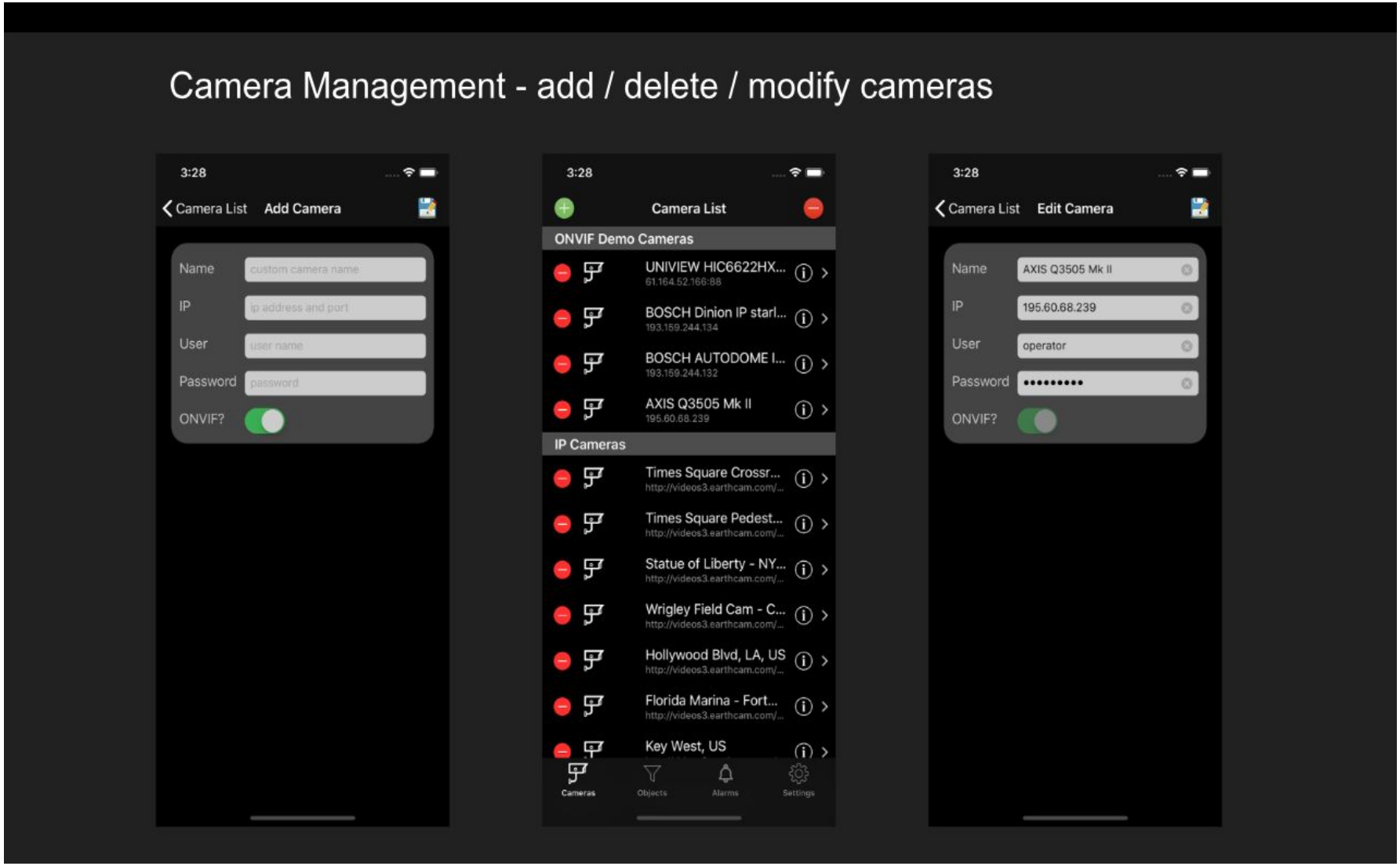
Camera Management

Camera Management - camera list



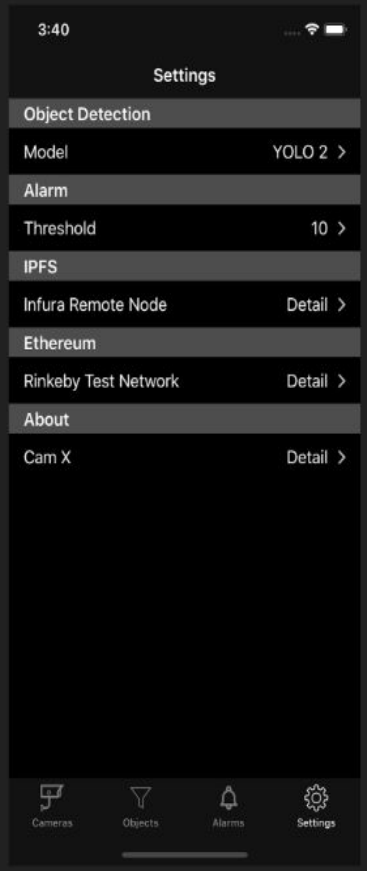
- App initial view
- Three types of cameras
  - **ONVIF** - supports onvif protocol
  - **IP -** supports http/rtsp protocol
  - **Mobile** - device build-in camera
- Prepopulated 4 ONVIF cameras, 10 IP cameras and 1 iOS back facing camera
- Click “+” icon on the top left navibar to show add camera dialog
- Click “-” icon on the top right navibar to show delete icon ahead of each camera row
- Click “i” icon at the end of each camera row to show camera edit dialog
- Click camera name to start playing live streaming

Camera Management Screens



Settings

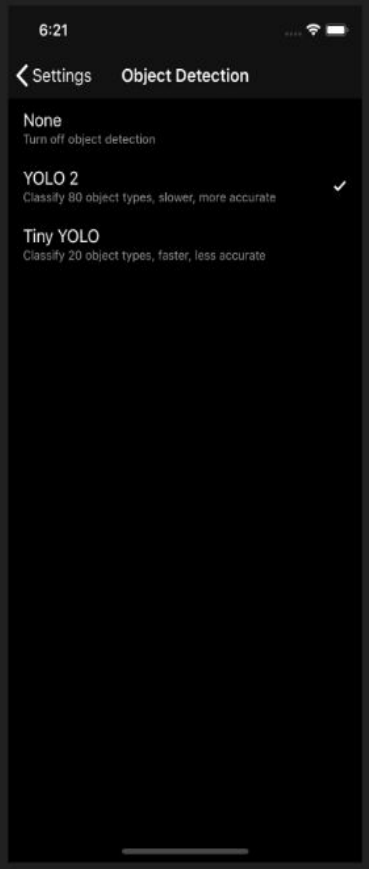
Settings



- Object Detection
  Select video analytics engine or turn off video analytics
- Alarm
  Set alarm threshold - the interval between taking alarm snapshots
- IPFS
  Infura remote node information
- Ethereum
  Wallet, balance, gas price and smart contract information
- About
  Author contact information

Settings – Object Detection selection options

Settings - Object Detection

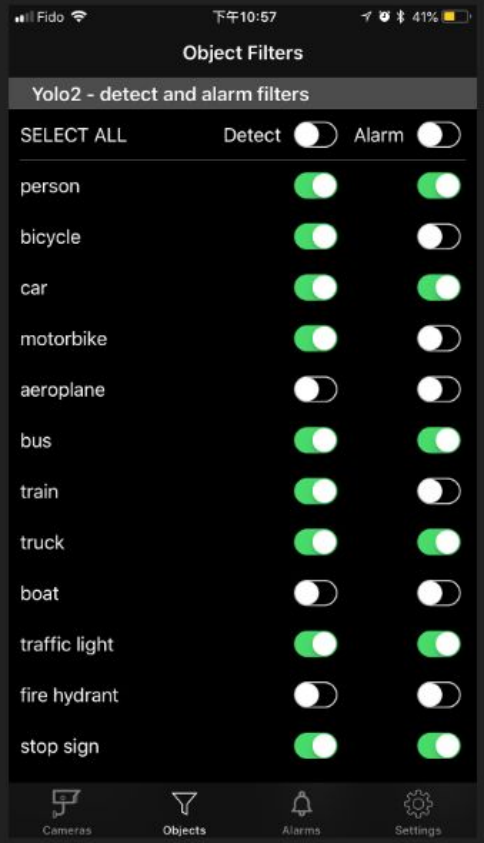


Three selection options

- None: show video streaming without running analytics
- YOLO 2: Object detection algorithm with pre-trained model can detect and localize 80 object types. It runs in 2-3 FPS on iPhone X or iPad Pro. Version 2 has better accuracy.
- Tiny YOLO: Object detection algorithm with pre-trained model can detect and localize 20 object types. It runs in nearly real-time (20-30 FPS) on iPhone X or iPad Pro. Tiny version has worse accuracy but faster detecting speed.
- YOLO 2 is the default option

Object Detection Video Analytics

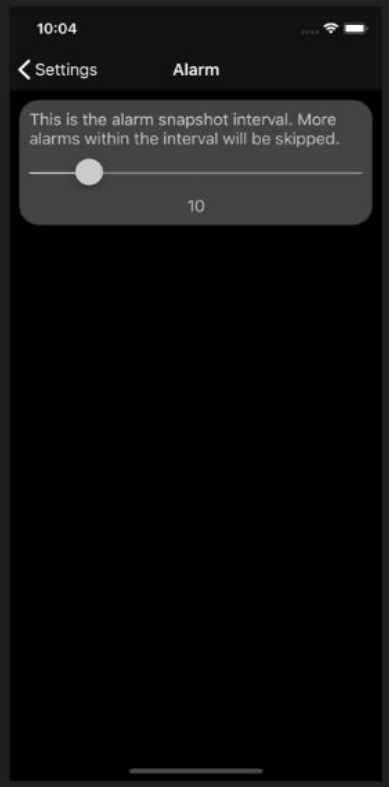
Object Detection Video Analytics Configuration



- The list content depends on the engine chosen in settings
- Yolo 2 classfies 80 object types which is listed in this diagram
- **Detect** refers to the bounding boxes and name around object on video
- **Alarm** refers to the red bounding boxes and ALARM label on object
- User can choose to turn on / off detect or alarm for each individual type
- User has option to turn on / off detect or alarm for all types
- Turn off detect would also turn off alarm automatically. If an object can't be detected, it can't be alarmed
- Detect is on by default for all object types
- Alarm is off by default for all object types

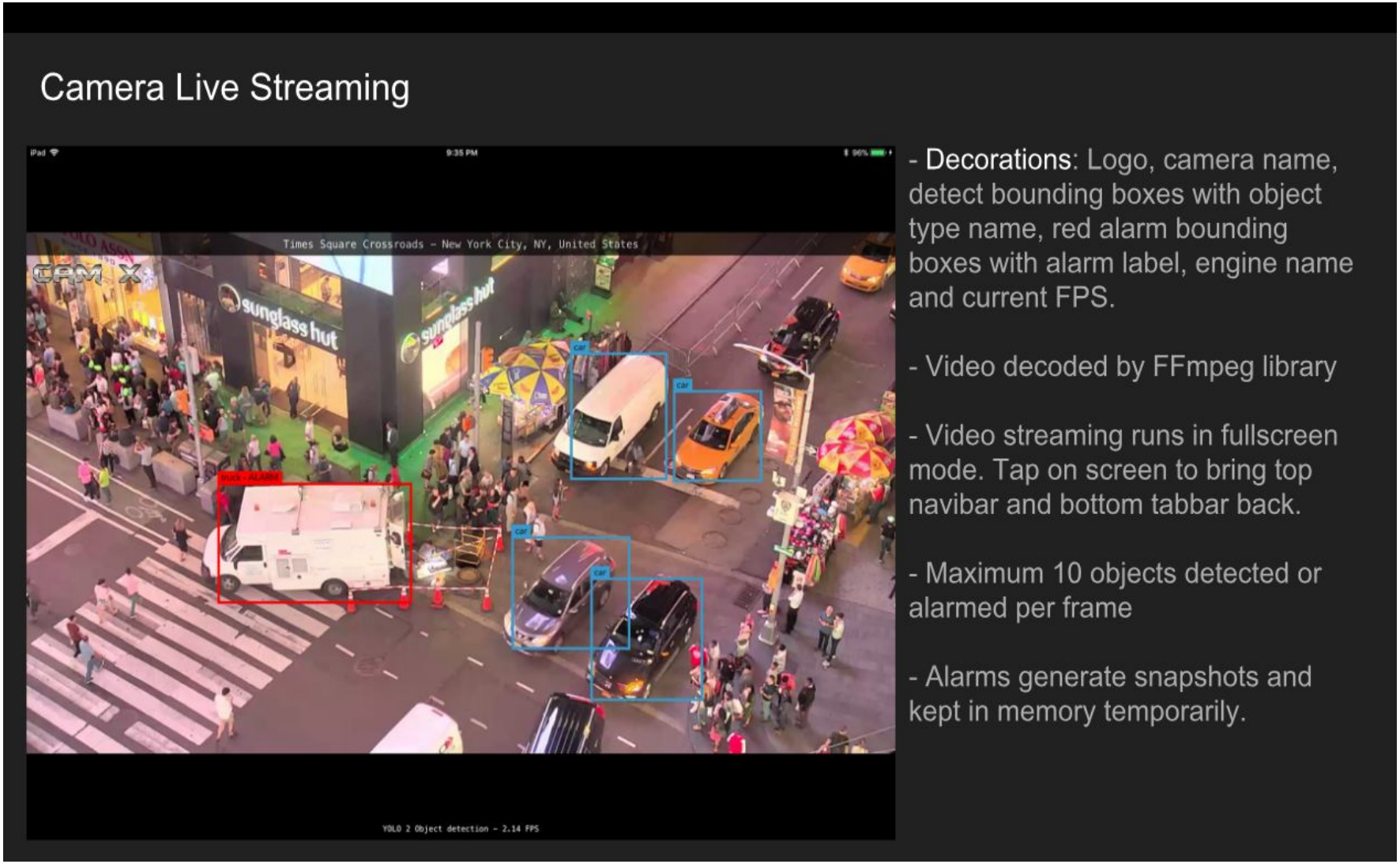
Alarm Settings

Settings - Alarm



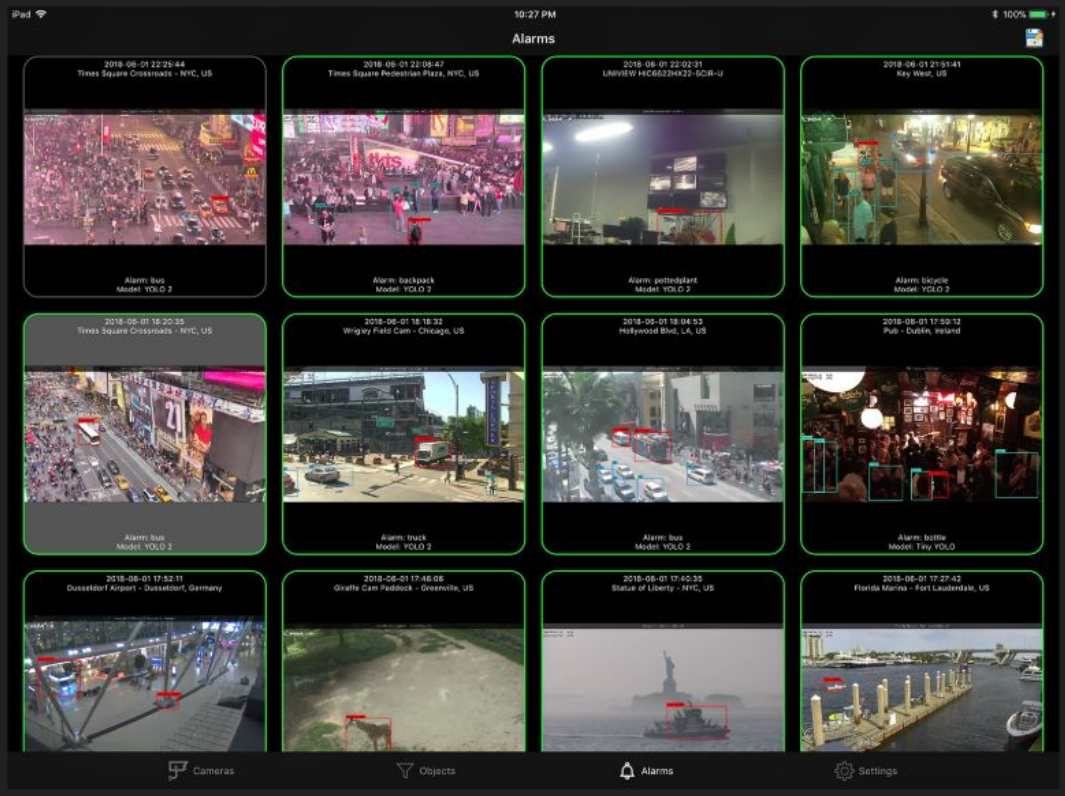
- When an alarm occurs, a snapshot is taken
- This setting is used to avoid taking too many useless snapshots. Multiple objects could be alarmed in a frame. Alarm on still object stays for every frame.
- Minimum threshold value is 1 second
- Maximum threshold value is 60 seconds
- Default threshold value is 10 seconds
- Additional alarms generated during the interval will be ignored

Camera Live Streaming Function



Alarm Viewer

Alarm Viewer



- First time visit this view per app launch loads saved alarms from IPFS & Ethereum
- Saved alarms have green border
- Unsaved alarms have gray border
- Only supports single selection
- Selected alarm has gray background
- Double click cell to show in fullscreen
- Each cell shows alarm timestamp, camera name, engine name, object name triggers the alarm, snapshot
- Tap Save icon at top right navibar to save / delete alarm or view details

IPFS

IPFS - what?

- IPFS stands for InterPlanetary File System
- IPFS is the Distributed Web
- IPFS is a peer-to-peer hypermedia protocol to make the web faster, safer and more open.
- IPFS aims to replace HTTP and build a better web for all of us.
- https://ipfs.io/

IPFS – Why?

IPFS - why?

	HTTP	VS	IPFS
	Inefficient and expensive. Get file from a single computer at a time.		Get pieces from multiple computers simultaneously. Zero duplication saves storage.
	Humanity's history is deleted daily. The average lifespan of a web page is 100 days.		Provides historic versioning (like git). Simple to set up resilient networks for mirroring of data.
	Centralization limits opportunity. Increasing consolidation of control is a threat.		Makes the original vision of the open and flat web a reality.
	Addicted to the backbone. Developing world. Offline. Natural disasters. Intermittent connections.		Powers the creation of diversely resilient networks which enable persistent availability.

IPFS – how?

IPFS - how?

Each file and all of the blocks within it are given a unique fingerprint called a cryptographic hash.

IPFS removes duplications across the network and tracks version history for every file.

Each network node stores only content it is interested in, and some indexing information that helps figure out who is storing what.

When looking up files, you're asking the network to find nodes storing the content behind a unique hash.

Every file can be found by human-readable names using a decentralized naming system called IPNS.

Ethereum

Ethereum - what?

- Ethereum is an open-source, public, blockchain-based distributed computing platform and operating system.
- Offers smart contract (scripting) functionality enables developers to build and deploy decentralized applications (DApp)
- Supports a modified version of Nakamoto consensus via transaction based state transitions.
- Provides a decentralized Turing-complete virtual machine, the Ethereum Virtual Machine (EVM) which can execute scripts using an international network of public nodes.
- “Gas” an internal transaction pricing mechanism is used to mitigate spam and allocate resources on the network.
- Ether is a cryptocurrency whose blockchain is generated by the Ethereum platform.
- Ether can be transferred between accounts and used to compensate participant mining nodes for computations performed.

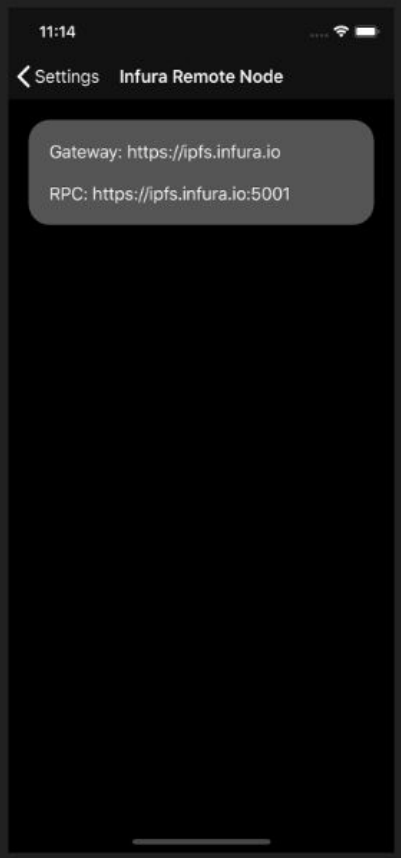
Ethereum – why?

Ethereum - why?

- Immutability: A third party cannot make any changes to data.
- Corruption & tamper proof: Apps are based on a network formed around the principle of consensus, making censorship impossible.
- Secure: With no central point of failure and secured using cryptography, applications are well protected against hacking attacks and fraudulent activities.
- Zero downtime: Apps never go down and can never be switched off.

Settings

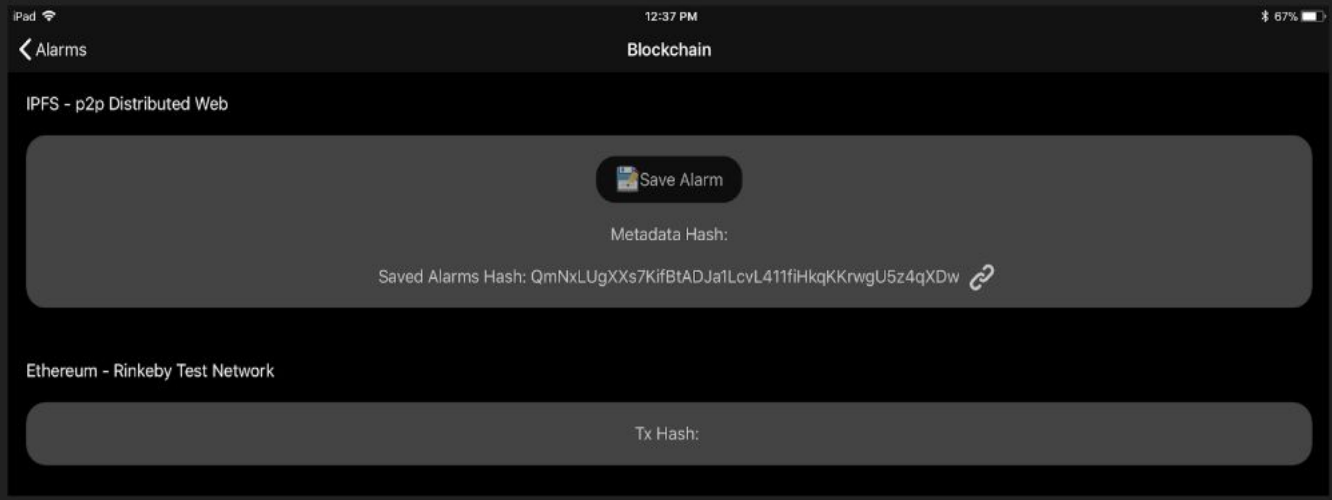
Settings - IPFS Infura remote node



- Infura provides secure, reliable, and scalable access to Ethereum APIs and IPFS gateways.
- https://infura.io

Blockchain – Save Alarm

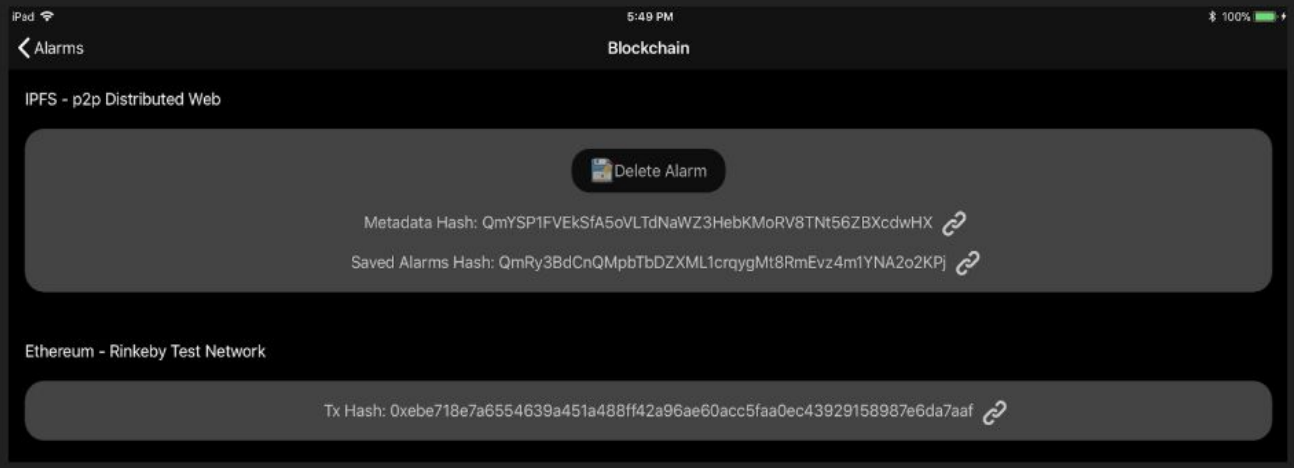
Blockchain - save alarm



- Click **Save Alarm** to save selected alarm image and metadata into IPFS.
- A **Metadata Hash** will be generated and displayed. Click link to view on web.
- **Saved Alarms Hash** is the link to file contains all saved alarms. It's empty when the user runs cam X first time after installation. An UUID generated as the hash key used in Smart Contract. Click link to view on web. The hash will change whenever the file content updates.
- Updated Saved Alarms Hash will be saved to Ethereum via smart contract.
- **Tx Hash** is the transaction receipt returned by Ethereum. Click link to view details.
- When the app runs next time, Saved Alarms Hash will be restored from Ethereum.

Blockchain – Delete alarm

Blockchain - delete alarm



- Click **Delete Alarm** to delete selected alarm image and metadata from saved alarms file. Alarm image and metadata are permanent.
- **Saved Alarms Hash** will be changed. Click to view on web and verify selected alarm deleted from the file.
- Updated Saved Alarms Hash will be saved to Ethereum via smart contract.
- **Tx Hash** is the transaction receipt returned by Ethereum. Click link to view details.

Ethereum – Smart Contract

Ethereum - Smart Contract

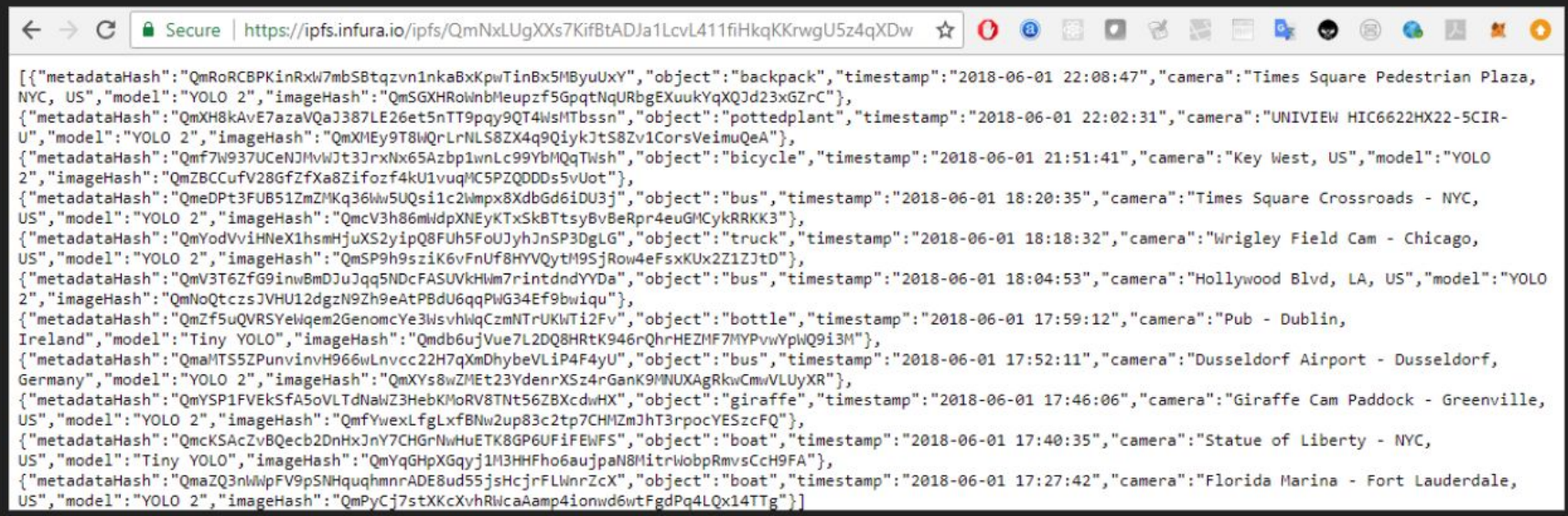
```
pragma solidity ^0.4.24;

contract CamX {

    mapping(string => string) ipfsHash;

    function addHash(string key, string value) public {
        ipfsHash[key] = value;
    }

    function getHash(string key) public view returns (string) {
        return ipfsHash[key];
    }
}
```

DApp steps:

1. Write smart contract code in Solidity *.sol
2. Compile at https://remix.ethereum.org
3. .sol binary sent back to dapp
4. Deploy contract to network
5. Return address and abstract binary interface (ABI)
6. APIs available to be called on blockchain

Blockchain – saved alarms hash web page

Blockchain - saved alarms hash webpage




```
[{"metadataHash":"QmRoRCBPKinRxW7mbSBtqzvn1nkaBxKpwTinBx5MByuUxY","object":"backpack","timestamp":"2018-06-01 22:08:47","camera":"Times Square Pedestrian Plaza,
NYC, US","model":"YOLO 2","imageHash":"QmSGXHRoWnbMeupzf5GpqtNqURbgEXuukYqXQJd23xGZrC"},
{"metadataHash":"QmXH8kAvE7azaVQaJ387LE26et5nTT9pqy9QT4WsMTbssn","object":"pottedplant","timestamp":"2018-06-01 22:02:31","camera":"UNIVIEW HIC6622HX22-5CIR-
U","model":"YOLO 2","imageHash":"QmXMEy9T8WQrLrNLS8ZX4q9QiykJtS8Zv1CorsVeimuQeA"},
{"metadataHash":"Qmf7W937UCeNJMvWJt3JrxNx65Azbp1wnLc99YbMQqTWsh","object":"bicycle","timestamp":"2018-06-01 21:51:41","camera":"Key West, US","model":"YOLO
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US","model":"YOLO 2","imageHash":"QmcV3h86mWdpXNEyKTxSkBTtsyBvBeRpr4euGMCykRRKK3"},
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{"metadataHash":"QmV3T6ZfG9inwBmDJuJqq5NDcFASUVkHWm7rintdndYYDa","object":"bus","timestamp":"2018-06-01 18:04:53","camera":"Hollywood Blvd, LA, US","model":"YOLO
2","imageHash":"QmNoQtczsJVHU12dgzN9Zh9eAtPBdU6qqPWG34Ef9bwiqu"},
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{"metadataHash":"QmaMTS5ZPunvinvH966wLnvcc22H7qXmDhybeVLiP4F4yU","object":"bus","timestamp":"2018-06-01 17:52:11","camera":"Dusseldorf Airport - Dusseldorf,
Germany","model":"YOLO 2","imageHash":"QmXYs8wZMEt23YdenrXSz4rGanK9MNUXAgRkwCmwVLUyXR"},
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US","model":"YOLO 2","imageHash":"QmPyCj7stXKcXvhRWcaAamp4ionwd6wtFgdPq4LQx14TTg"}]
```
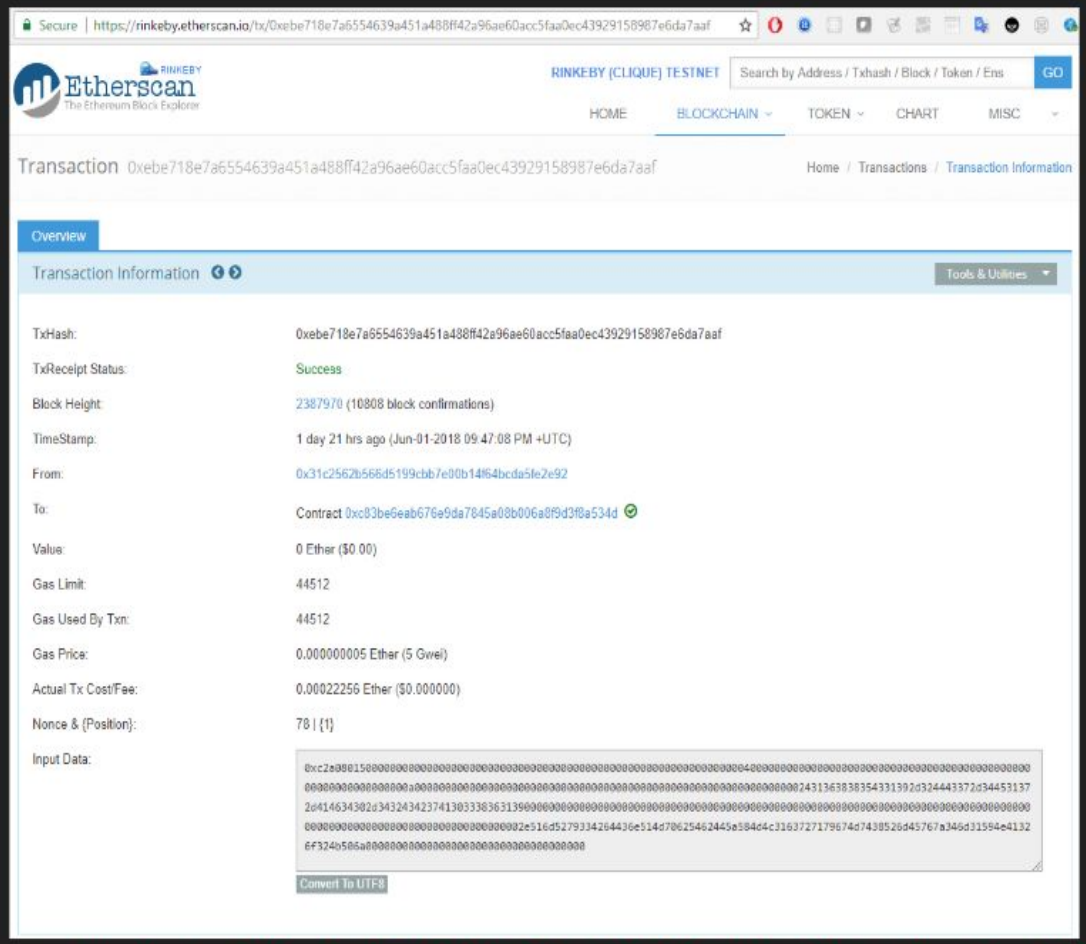


https://ipfs.infura.io/ipfs/QmNxLUgXXs7KifBtADJa1LcvL411fiHkqKKrwgU5z4qXDw

Alarms serialized in json format.

Ethereum Smart Contract Receipt

Blockchain - Ethereum smart contract transaction receipt



https://rinkeby.etherscan.io/tx/0xebe718e7a6554639a451a488ff42a96ae60acc5faa0ec43929158987e6da7aaf