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NORTH AMERICA

Computer Vision to Secure your Surroundings with AI/ML Solution Built using Open-Source Tools at the Edge

Samantha Coyle
Neethu Elizabeth Simon

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- Project Objective
- Architecture
- Challenges & Learnings
- Ethical Considerations



Speakers & Team



Samantha Coyle
Software Engineer



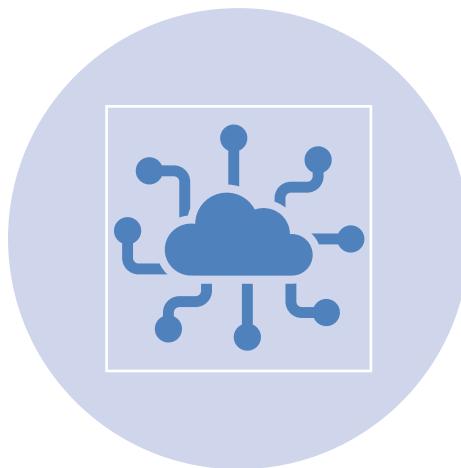
Neethu Elizabeth Simon
Senior Software Engineer



Introduction



Internet of Things (IoT)



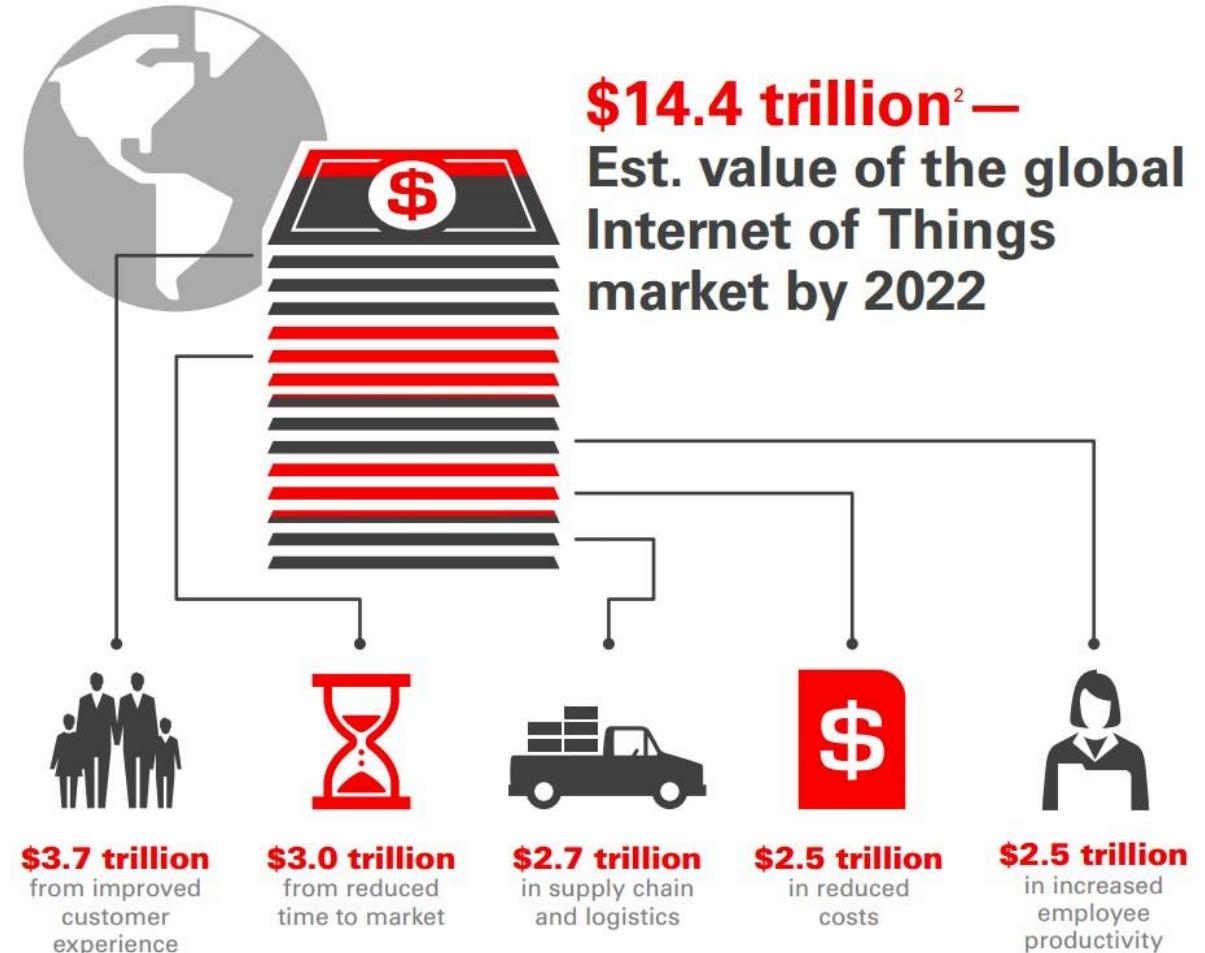
INTERNET OF THINGS IS A GROWING WEB OF
NUMEROUS DEVICES THAT ARE
INTERCONNECTED AND INTERACTING



NUMBER OF "THINGS" GETTING INSTALLED
AND CONNECTED IS GROWING

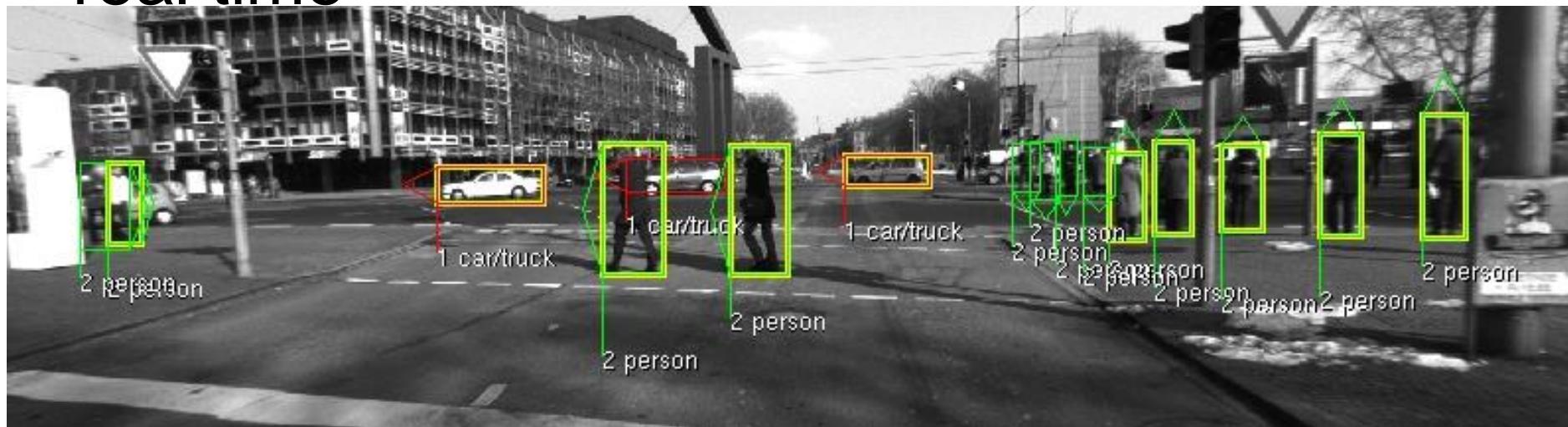
Growth of IoT

- New and innovative markets
- Increasing industry support
- Strong drivers:
 - Cheaper and fast processors and wireless networks



Growth of Computer Vision (CV) Applications

- Camera is the ultimate “Thing”
- CV + AI = “Eye of IoT”
- Smart city/home require the Smart Eye
 - System to detect, track, and analyze objects in real time



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Smart City Use Case

- Focus on improved city safety
 - Reduction in crime
 - Engaged safety officials
 - Edge analytics for better AI performance
- Deployment pain points:
 - Poor AI performance
 - Robustness of architecture
 - High Capex / maintenance



Project Objective

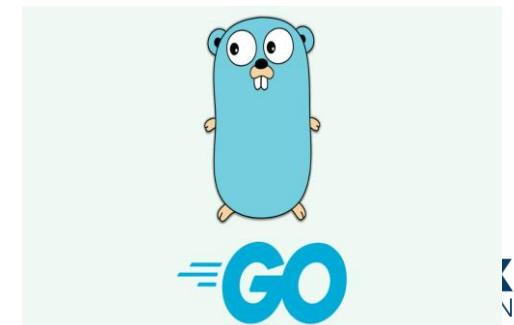
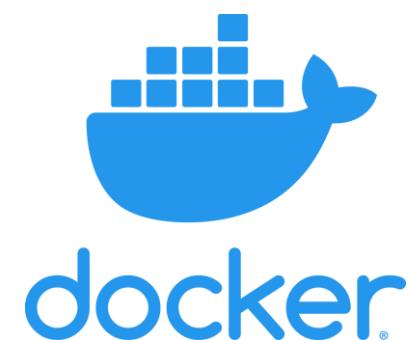


Project Objective

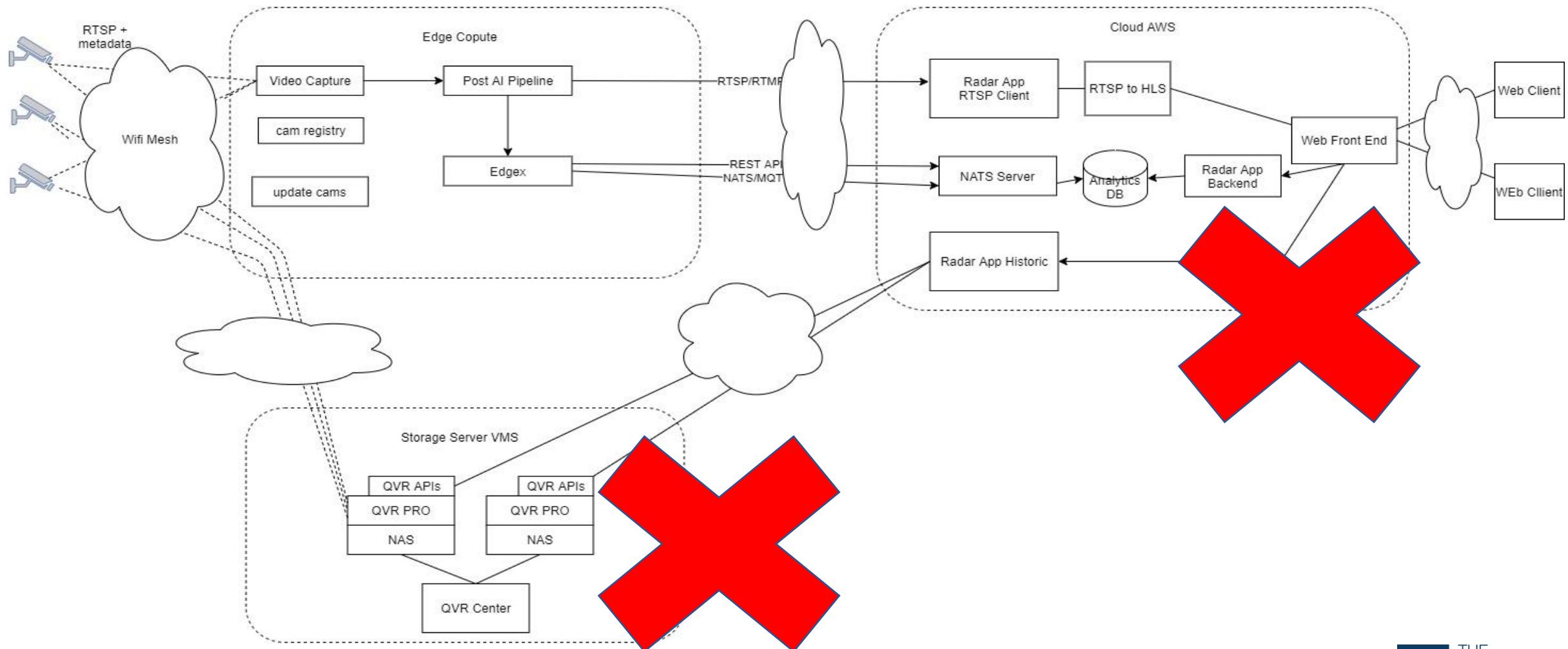
- Security as a Service
Reference Implementation
using Open-Source Software
- Situational awareness, property
security and management
- AI-Assisted, Multi-Camera
Solution of vehicular and
walkway traffic
- Microservices & Containerized



<https://intel.com/edgesoftwarehub>



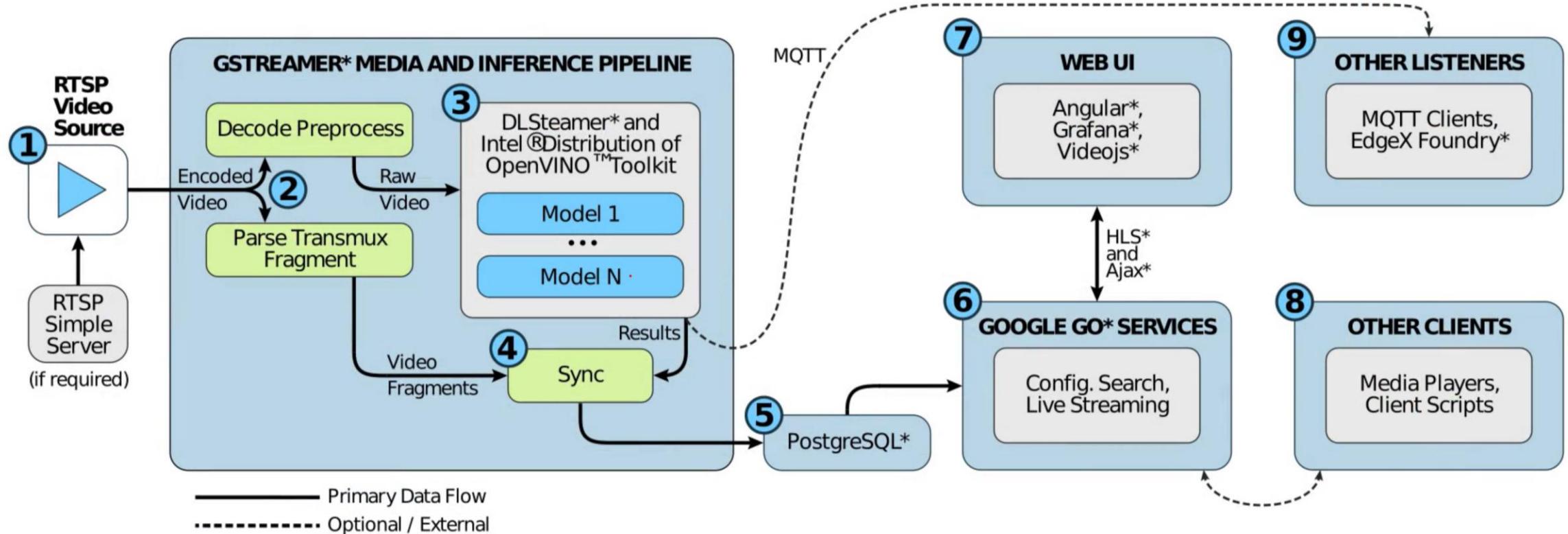
Smart City Solution using AI/ML



Architecture



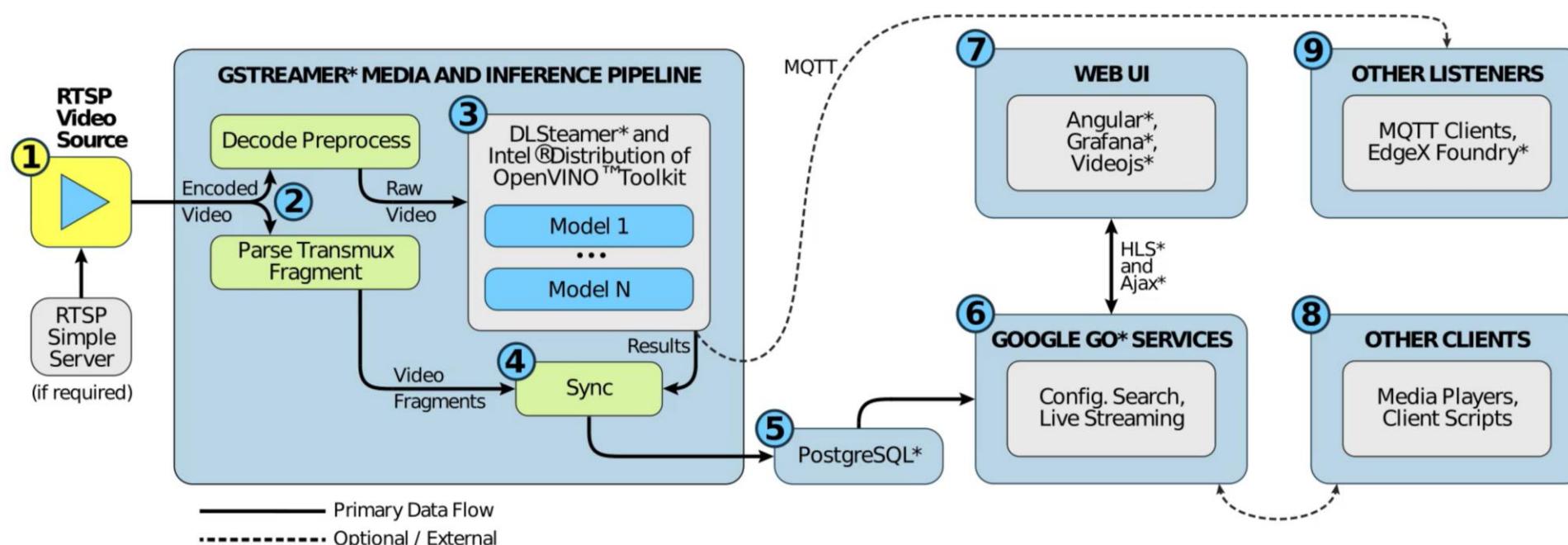
Smart City Architecture



Architecture – Video Source

- **RTSP Simple Server:**

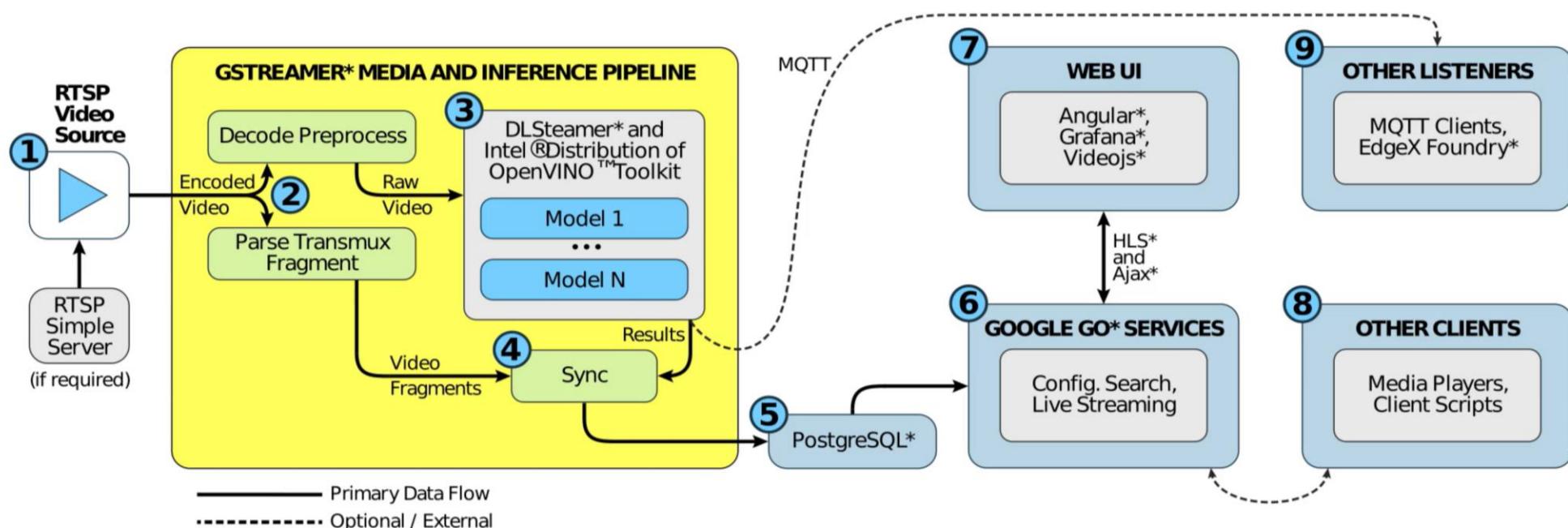
- Ready-to-use RTSP server and proxy for video/audio streams
- Handles, processes, and publishes multiple video streams
- Serves prerecorded video clips to demonstrate E2E functionality



Architecture – Multimedia Framework



- **GStreamer Multimedia Framework:**
 - Handles file format conversions, processes, and workflows
 - DLStreamer: GStreamer plugin for OpenVINO Inference Engine

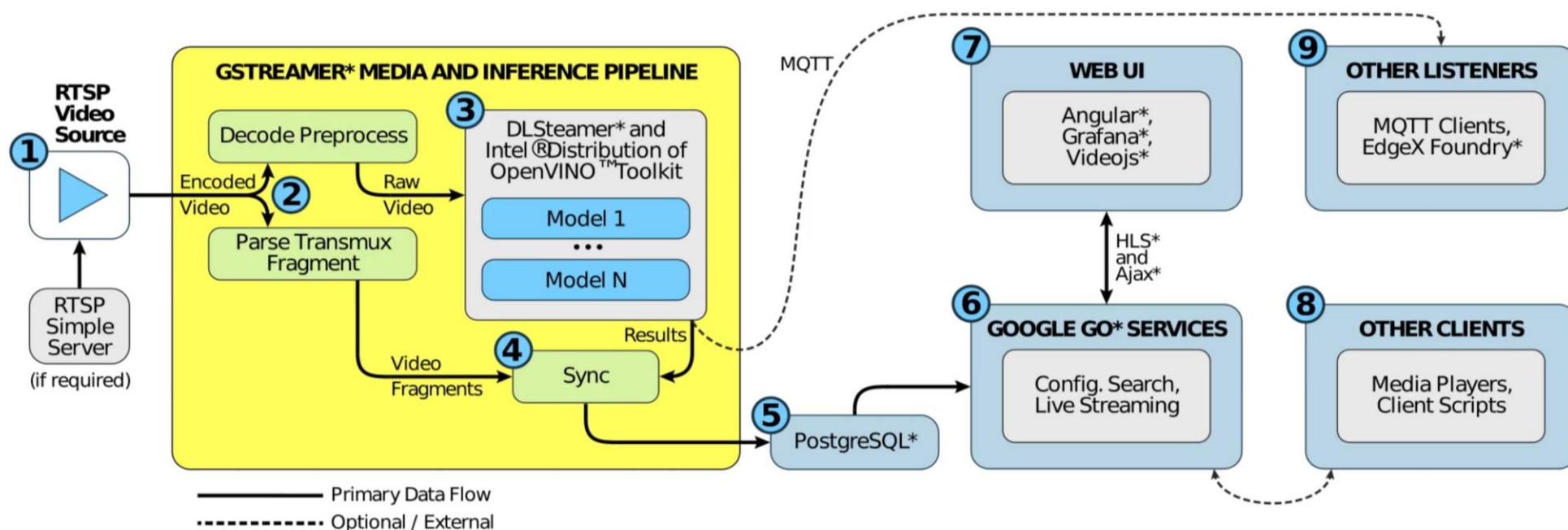


Architecture – OpenVINO Toolkit

OpenVINO™

• OpenVINO Inference Engine:

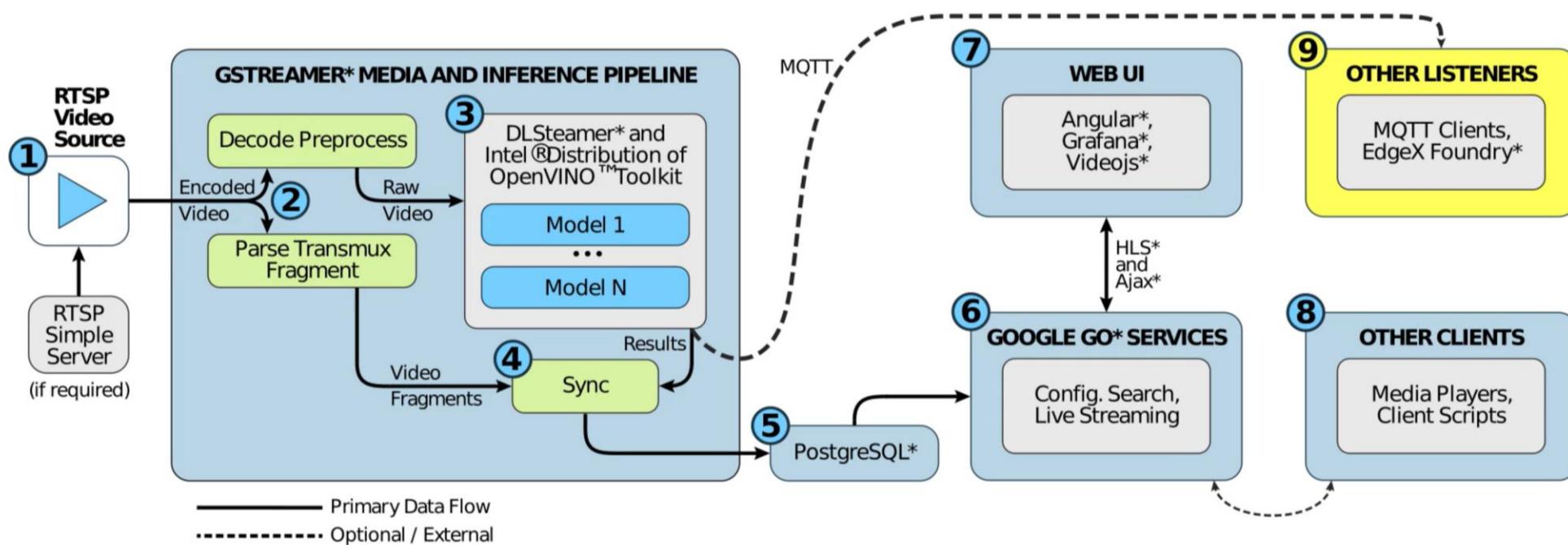
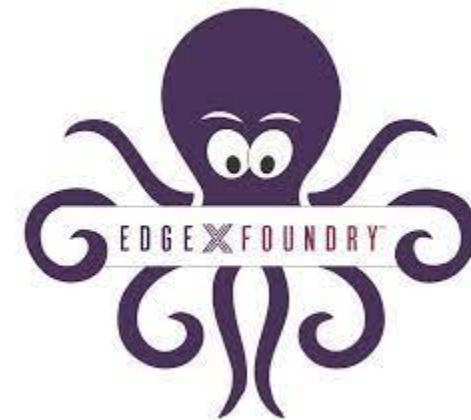
- Create ROI for inference output
 - Configure pre/post processing steps
 - DLStreamer tells IE to load weights / models into IR format



Architecture – Additional Listeners

- EdgeX Foundry:

- Hosted by LF
- Framework for industrial IoT edge compute
- EdgeX instance and MQTT broker



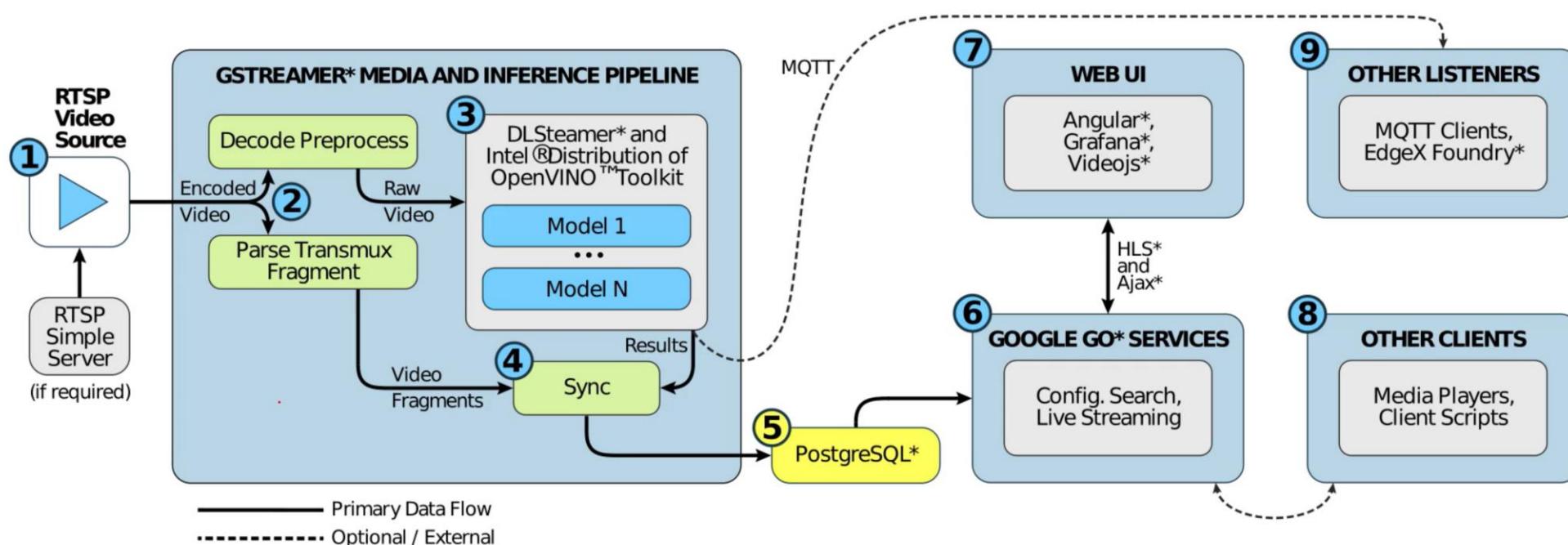
Architecture – Data Management



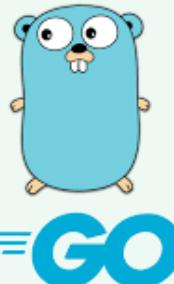
PostgreSQL

- PostgreSQL Database:

- Store both video feeds and related metadata
- Declarative Partitioning = performance benefits + simplified admin tasks

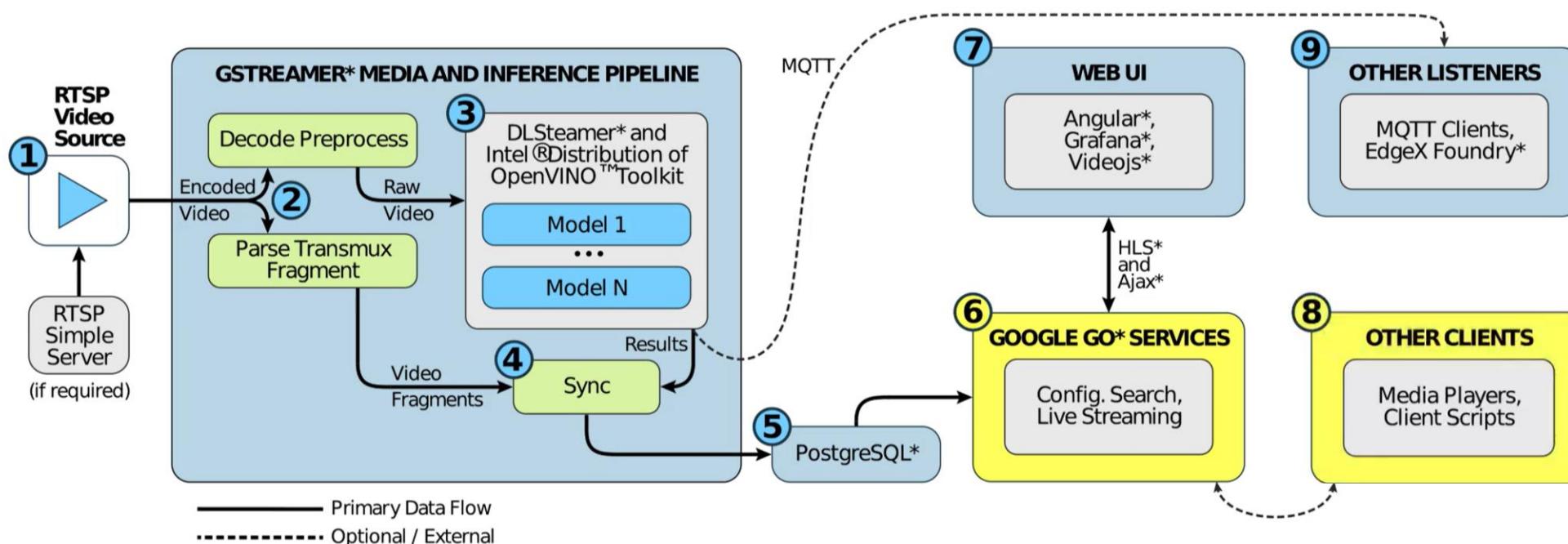


Architecture – Backend APIs



- **Go Microservices:**

- Consumed primarily by web UI
- Configure cameras, search inference results, perform live streaming operations



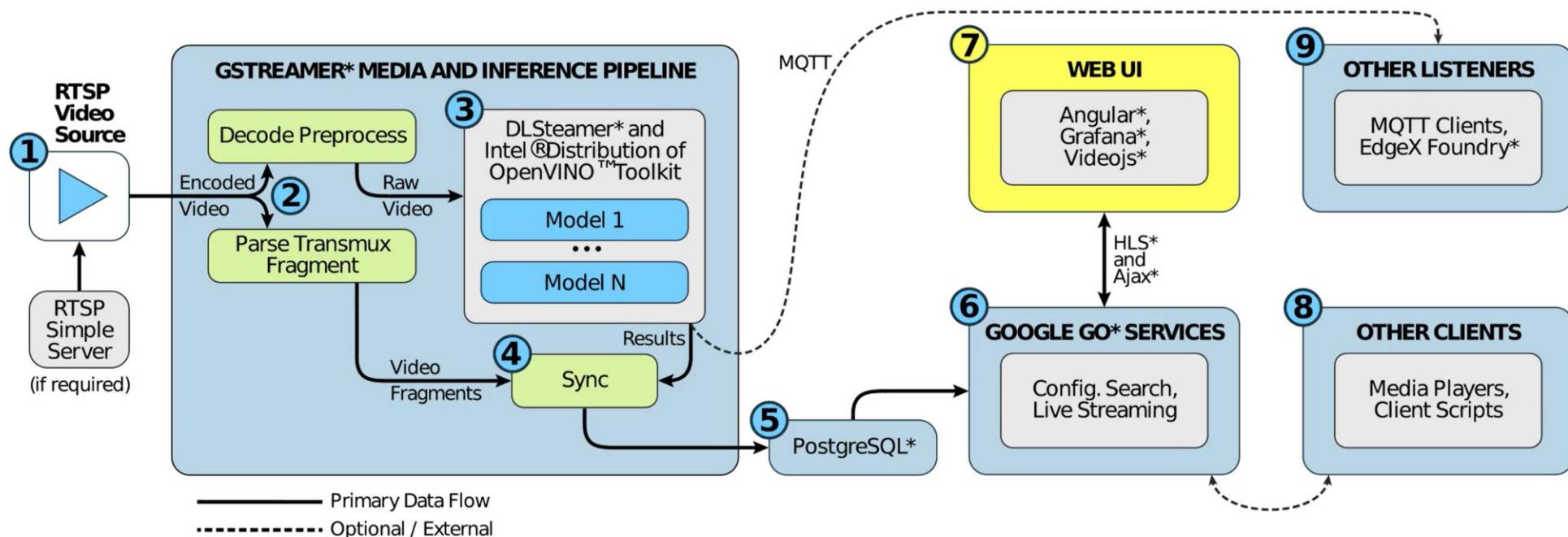
Architecture – UI



ANGULAR

- Angular UI:

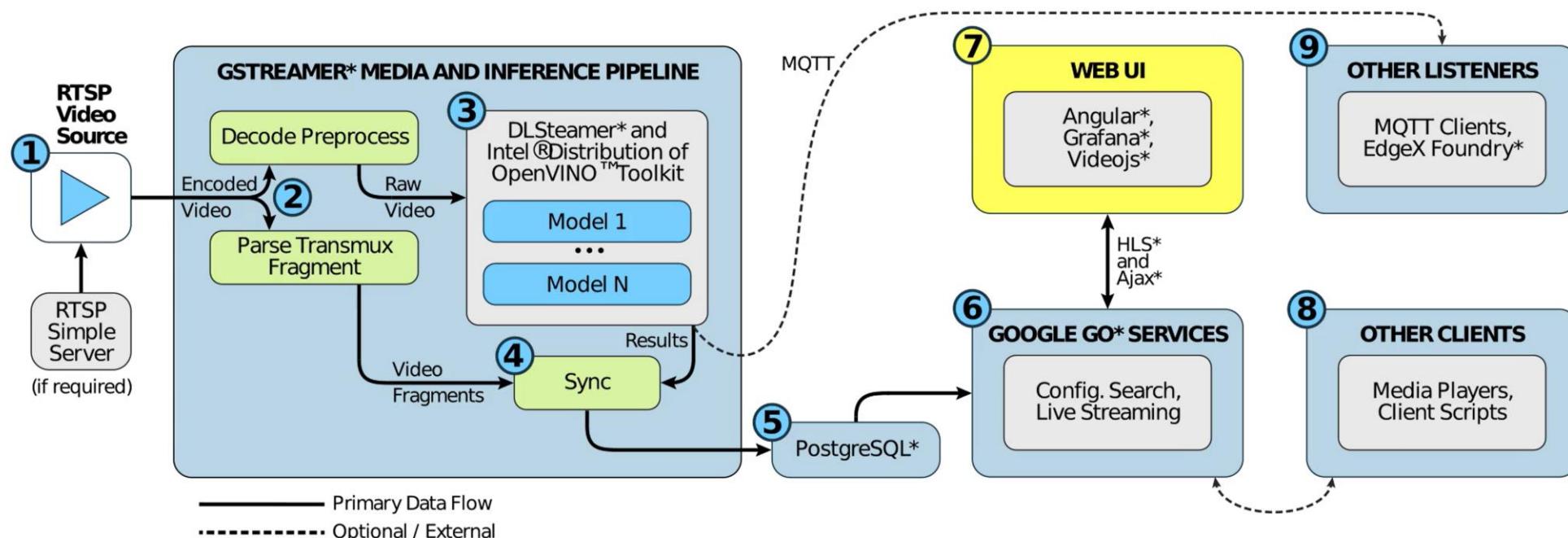
- Live and recorded videos displayed using VideoJS
- Multiple UX features to customize inference results



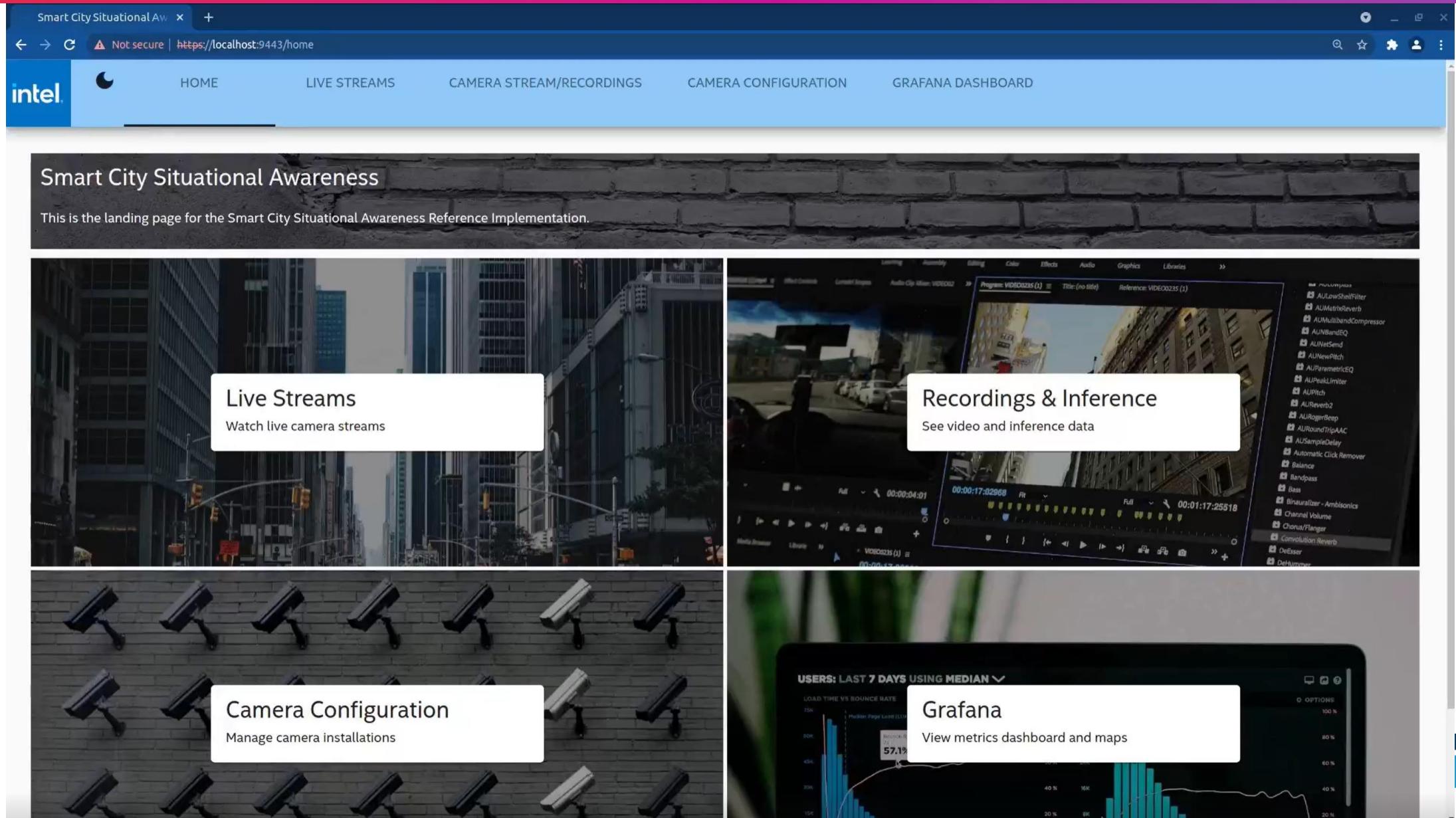
Architecture – Edge Device Display



- **Grafana Dashboard:**
 - Data visualizations, insights, and metrics
 - Preconfigured dashboards and plugins



Smart City UI – Landing



The screenshot shows the landing page for the Smart City Situational Awareness Reference Implementation. The page is titled "Smart City Situational Awareness" and features four main sections:

- Live Streams:** Watch live camera streams. This section includes a thumbnail of a city street view.
- Recordings & Inference:** See video and inference data. This section includes a thumbnail of a video editing interface showing multiple tracks and a sidebar of audio processing effects.
- Camera Configuration:** Manage camera installations. This section includes a thumbnail of a wall with multiple surveillance cameras.
- Grafana:** View metrics dashboard and maps. This section includes a thumbnail of a mobile device displaying a bar chart and a map.

The top navigation bar includes links for HOME, LIVE STREAMS, CAMERA STREAM/RECORDINGS, CAMERA CONFIGURATION, and GRAFANA DASHBOARD. The Intel logo is visible in the top left corner. The browser status bar indicates "Not secure | https://localhost:9443/home".

Smart City UI – Camera Configuration

The screenshot shows a web browser window for 'Smart City Situational Aw' at <https://localhost:9443/camera-config/add>. The page title is 'Add Camera Configuration'. The browser status bar indicates 'Not secure'. The top navigation bar includes links for HOME, LIVE STREAMS, CAMERA STREAM/RECORDINGS, CAMERA CONFIGURATION (which is active), and GRAFANA DASHBOARD. The Intel logo is visible in the top left corner.

Add Camera Configuration

Name *
Demo Camera

Location *
Demo Location

Latitude *

Longitude *

Direction

Description

RTSP URI *

You can use rtsp:// to enforce TCP streams

Inference Pipelines *

Smart City UI – Camera Configuration

Smart City Situational Aw + Not secure | https://localhost:9443/camera-config

intel HOME LIVE STREAMS CAMERA STREAM/RECORDINGS CAMERA CONFIGURATION GRAFANA DASHBOARD

Camera Configuration

Configure camera installations

<input type="checkbox"/>	Name	Location	Direction	Description	Latitude	Longitude	Status	Actions
<input type="checkbox"/>	Parking Lot	Intel Jones Farm	NW	Camera is located at parking lot	45.542876°	-122.9617765°	Active	
<input type="checkbox"/>	Stairway	Intel Chandler Campus	SW	Stairs of Intel Chandler Campus	33.3070131°	-111.9342688°	Maintenance	
<input type="checkbox"/>	West Exit	Intel Santa Clara Campus	W	Pointed at the west exit	37.3819495°	-121.9739497°	Active	
<input type="checkbox"/>	Hallway	Intel Ronler Acres Campus	SSW	Hallway at Intel Ronler Acres Campus	45.5410132°	-122.9168708°	Active	
<input type="checkbox"/>	Classroom	Intel Ocotillo Campus	E	Classroom in Intel Ocotillo Campus	33.2410961°	-111.8828675°	Active	
<input type="checkbox"/>	Second Floor	Intel Aloha Campus	NE	Intel Aloha Campus - Second Floor	45.4932494°	-122.8852223°	Active	
<input type="checkbox"/>	Store	Intel Hawthorn Farm Campus	NW	Intel Hawthorn Farm Campus - Store	45.531616°	-122.930686°	Active	
<input type="checkbox"/>	Parking Garage	Intel Austin Texas	NNW	Intel Austin Texas - Parking Garage	30.2626732°	-97.7955066°	Maintenance	

Add Camera Delete Selected

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Smart City UI – Live Streams

Smart City Situational Aw x +

Not secure | https://localhost:9443/live

intel. HOME LIVE STREAMS CAMERA STREAM/RECORDINGS CAMERA CONFIGURATION GRAFANA DASHBOARD

Live Streams

Live video streams

Parking Lot

West Exit

The screenshot displays a web-based user interface for a Smart City system. At the top, there's a navigation bar with tabs: HOME, LIVE STREAMS (which is currently selected), CAMERA STREAM/RECORDINGS, CAMERA CONFIGURATION, and GRAFANA DASHBOARD. The title bar shows the URL as https://localhost:9443/live and indicates it's not secure. On the left, a sidebar titled 'Live Streams' lists 'Live video streams'. Below the sidebar are three video preview boxes. The first box, labeled 'Parking Lot', shows an empty asphalt surface with white parking lines. The second box, labeled 'West Exit', shows a white car driving away from the camera on a paved road. The third box shows a view of a modern building facade with glass windows. Each video preview includes standard player controls at the bottom: a play/pause button, volume control, a progress bar, a red 'LIVE' indicator, and a full-screen icon.



Smart City UI – Recordings

The screenshot shows a web browser window titled "Smart City Situational Aw" with the URL "https://localhost:9443/camera-stream-recordings". The page has a blue header with the Intel logo and navigation links: HOME, LIVE STREAMS, CAMERA STREAM/RECORDINGS (which is underlined), CAMERA CONFIGURATION, and GRAFANA DASHBOARD. Below the header is a toolbar with various tabs like Learning, Assembly, Editing, Color, Effects, Audio, Graphics, Libraries, and a more button. A sub-toolbar below it shows "Program: VIDEO0235 (1)", "Title: (no title)", and "Reference: VIDEO0235 (1)". On the left, there's a sidebar titled "Select camera" containing a list of camera names: Parking Lot, Stairway, West Exit, Hallway, Classroom, Second Floor, Store, and Parking Garage. The "Store" item is currently selected, indicated by a cursor icon. The main content area is currently empty.

Smart City UI – Recordings

Smart City Situational Aw x +

Not secure | https://localhost:9443/camera-stream-recordings/6

Min Duration Min Confidence Min Event Count Max Gap Between Events

2500ms 50% 25 100ms

More Sensitive

Less Sensitive

Refresh

Inference Classes

Male

Female

Live Stream

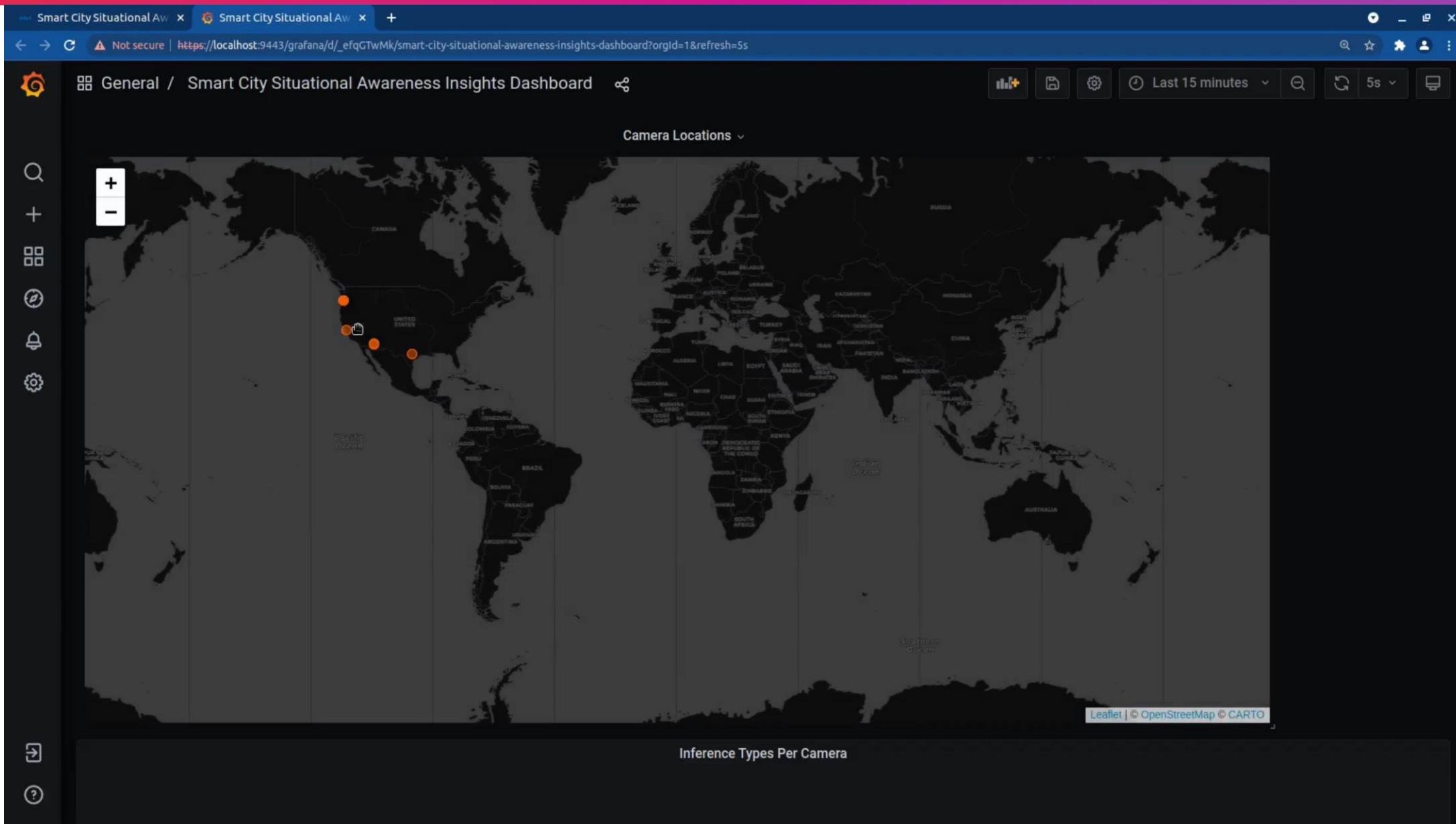


Showing results for: Jan 17, 2022, 12:40:33 PM — Jan 17, 2022, 5:08:13 PM

Begins ↑	Ends	Duration	Label ↗	Mean Conf.	Std. Dev.	Count
Jan 17, 12:40:38	Jan 17, 12:40:42	4.336s	Male	83.45%	0.095	53
Jan 17, 12:40:54	Jan 17, 12:40:58	4.345s	Male	86.773%	0.158	69
Jan 17, 12:41:10	Jan 17, 12:41:15	4.594s	Male	74.141%	0.12	95
Jan 17, 12:41:27	Jan 17, 12:41:31	3.926s	Female	91.82%	0.091	48
Jan 17, 12:41:38	Jan 17, 12:41:43	5.667s	Male	84.524%	0.094	69
Jan 17, 12:41:55	Jan 17, 12:41:59	4.245s	Male	86.772%	0.158	69



Smart City UI – Grafana



Smart City UI – Grafana

Smart City Situational Aw x Smart City Situational Aw x +

Not secure | https://localhost:9443/grafana/d/_efqGTwMk/smart-city-situational-awareness-insights-dashboard?orgId=1&refresh=5s

General / Smart City Situational Awareness Insights Dashboard

Last 15 minutes 5s

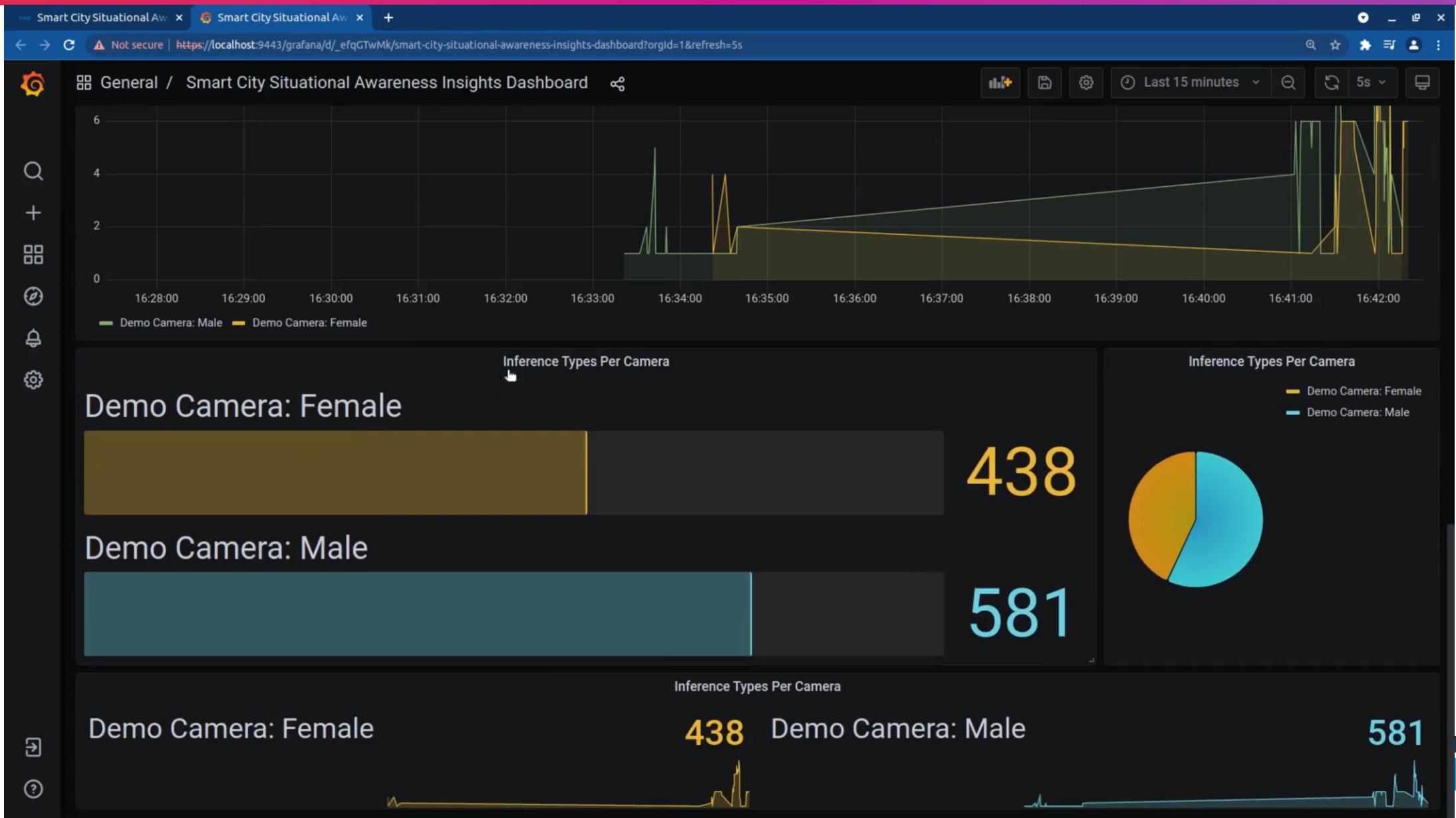
Camera Locations

Second Floor: undefined
name: Second Floor
location: Intel Aloha Campus
lat: 45.4932494
long: -122.8852223
camera_id: 6

Inference Types Per Camera

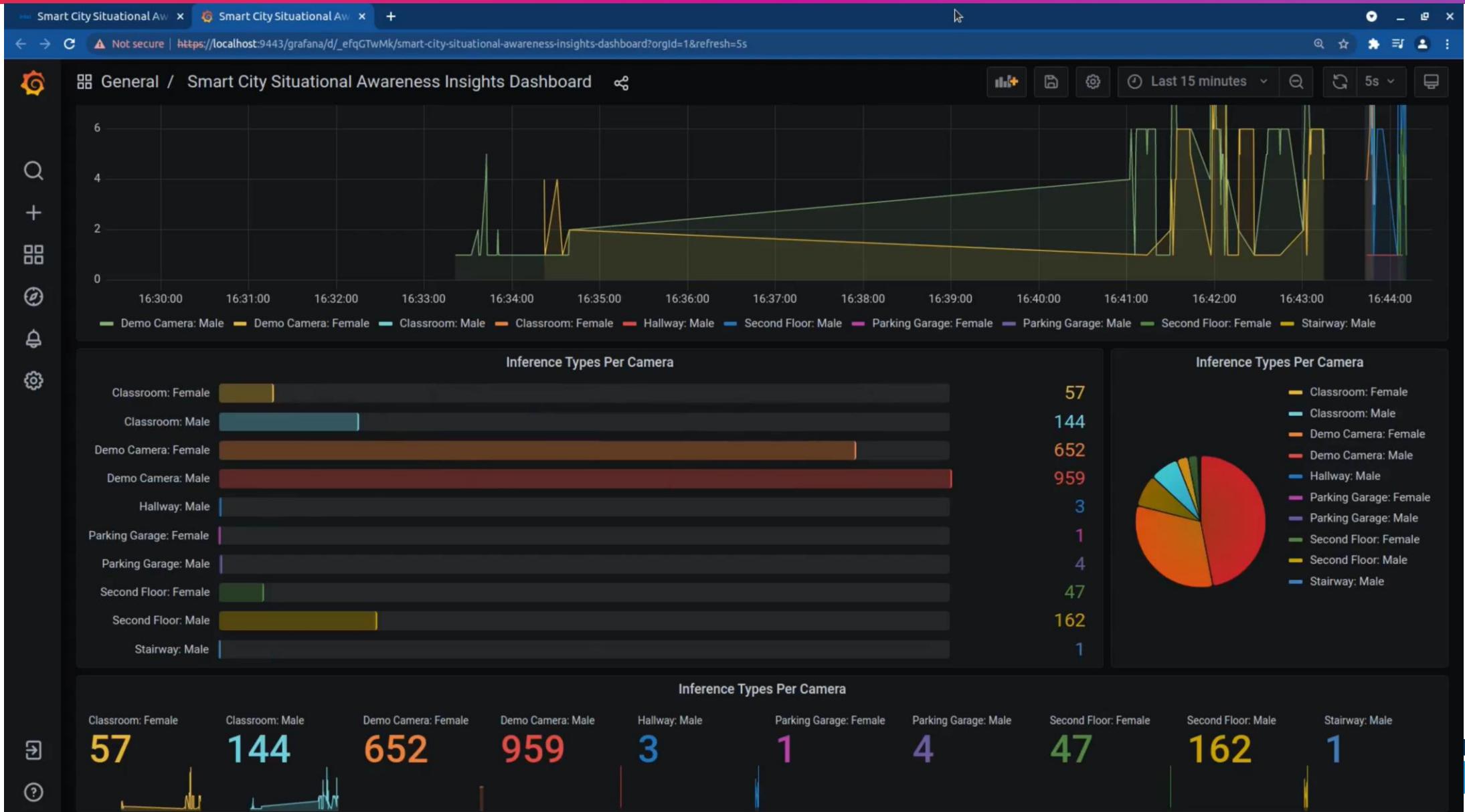


Smart City UI – Grafana



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Smart City UI – Grafana

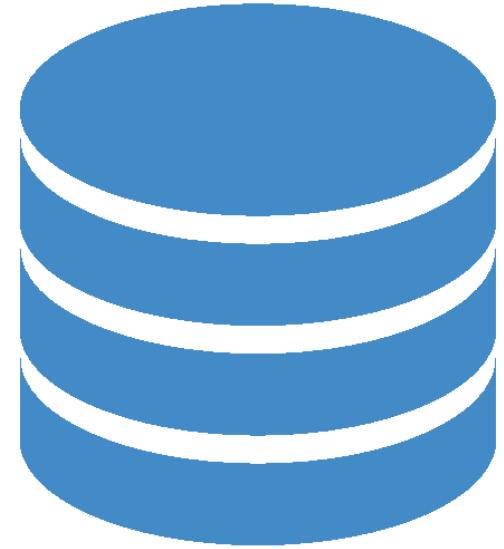
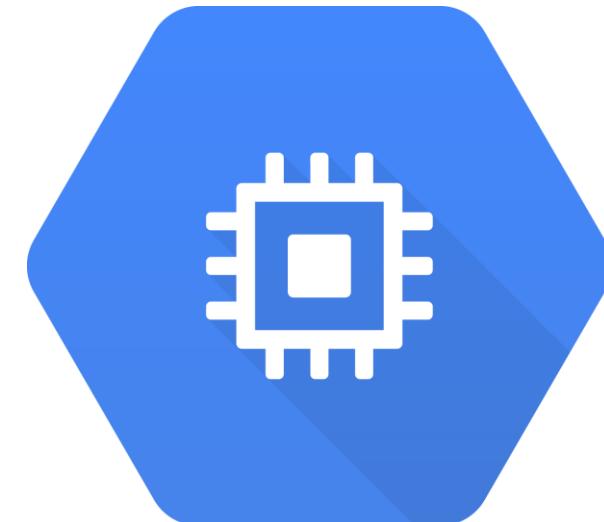


Challenges & Learnings



Challenges at the Edge

- Resource Constraints
 - Storage & Compute
 - Frequent Backup from Edge to Cloud/On-Prem Storage
 - Hardware Benchmarking



Challenges at the Edge

- Data Management
 - Record incoming data streams
 - Inference the video frames and store the results
 - Recorded data availability via a web browser/HTTP
 - Support maintenance tasks



VS



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Challenges at the Edge

- Security Hardening
 - Resource Authorization
 - Service Authentication
 - TLS Encryption
 - RTSP URI Encryption
 - Vault Provisioning
 - Obscure sensitive information on UI



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Ethical Considerations



Ethical Considerations



Thank You Questions ?

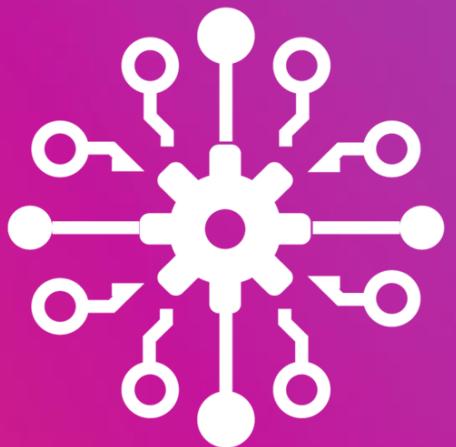


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Click to edit title

- Click to edit text
 - Second level
 - Third level
 - Fourth level
 - » Fifth level

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text here**