ASAPS Challenge Program

Automated Streams Analysis for Public Safety

Fostering Real-time Multi-modal Analytic Technology to Save Lives, Property, and Infrastructure ***Where Every Second Counts!***

***WACV*, January 5, 2021**

HADCV'21 Virtual Workshop

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The National Institute of Standards and Technology Institutional Review Board reviewed and approved the protocol for this project and all subjects provided informed consent in accordance with 15 CFR 27, the Common Rule for the Protection of Human Subjects. The above referenced study was received for final administrative review by the Research Protections Office (RPO) on 05/13/2020. This protocol has been reviewed in accordance with 15 CFR 27.112, Protection of Human Subjects: Review by Institution. The study is funded under a NIST award #GS-23F-0134N to Lafayette Group INC, with subaward to Kitware. This study was reviewed by the New England IRB (NEIRB) office and approved by the IRB with an expiration date of 23 April 2021. The RPO concurs with the institution's determination or approval.

Please note, unless mentioned in reference to a NIST Publication, all information and data presented is preliminary/in-progress and subject to change. Any concepts regarding emerging and future technologies and standards are the presenter's and not necessarily representative of NIST positions on technology needs, directions, and priorities.

PSCR INNOVATION ACCELERATOR PROGRAM

Middle Class Tax Relief and Job Creation Act of 2012 passed. FirstNet is created.

Section 6303 provides $300M to NIST to perform critical R&D to ensure success of FirstNet.

Focus on MCV & LMR to LTE.

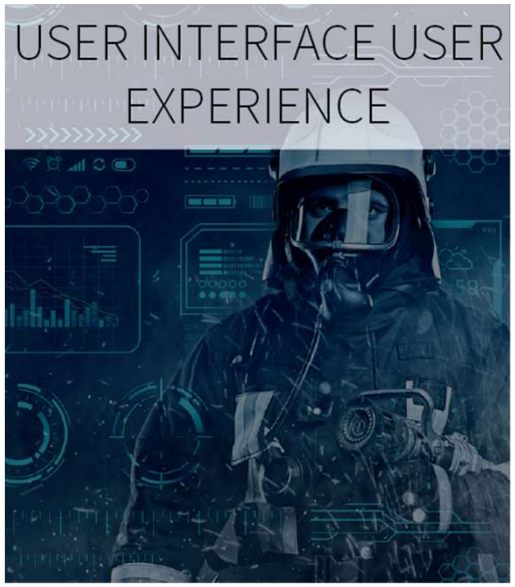
Addressing R&D necessary to push beyond current broadband technology.

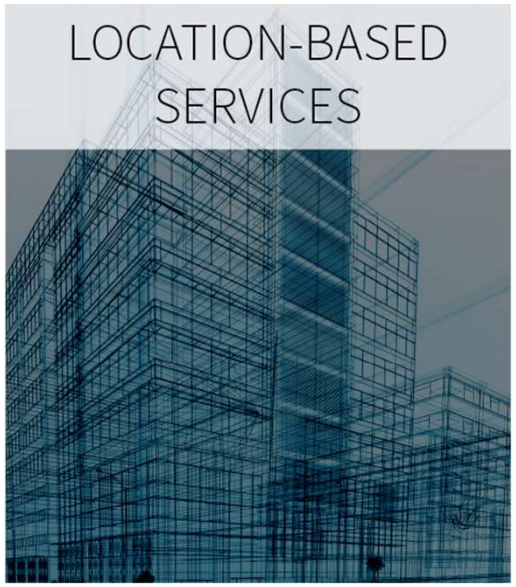
Working closely with Public Safety and FirstNet every step of the way.

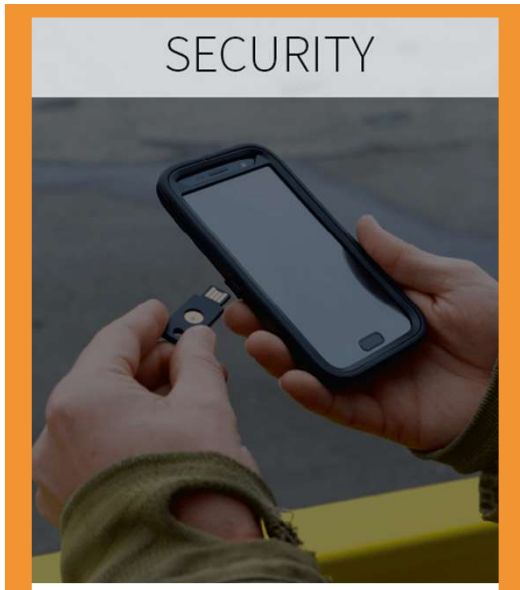
Open Innovation program utilizing grants and awards to address high priority public safety R&D needs.

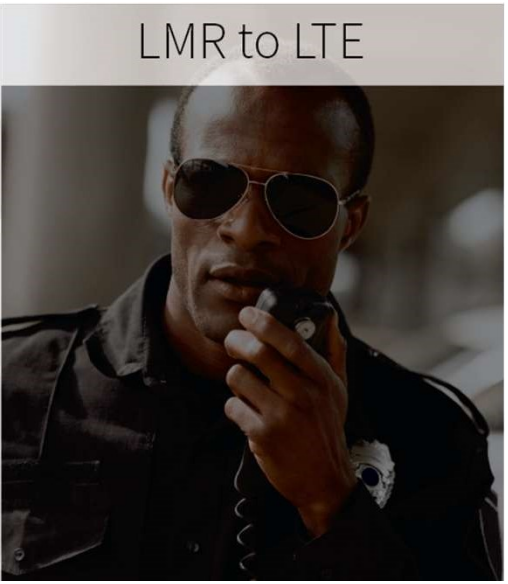
Public Safety Communications Research (PSCR) Program

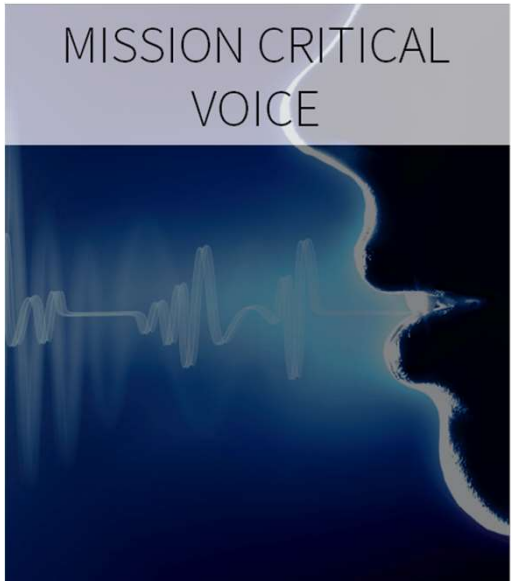
Research Areas:

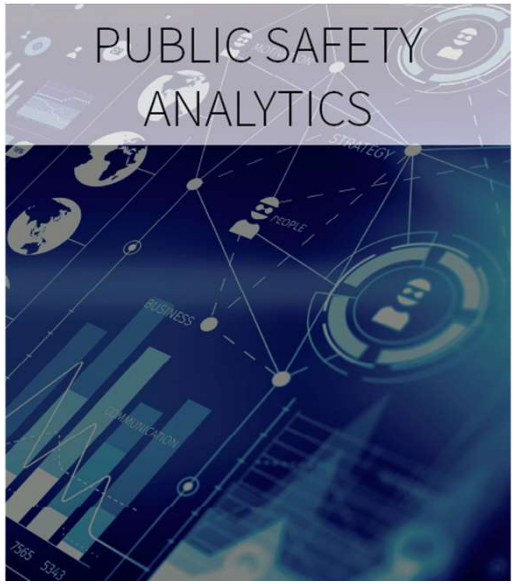












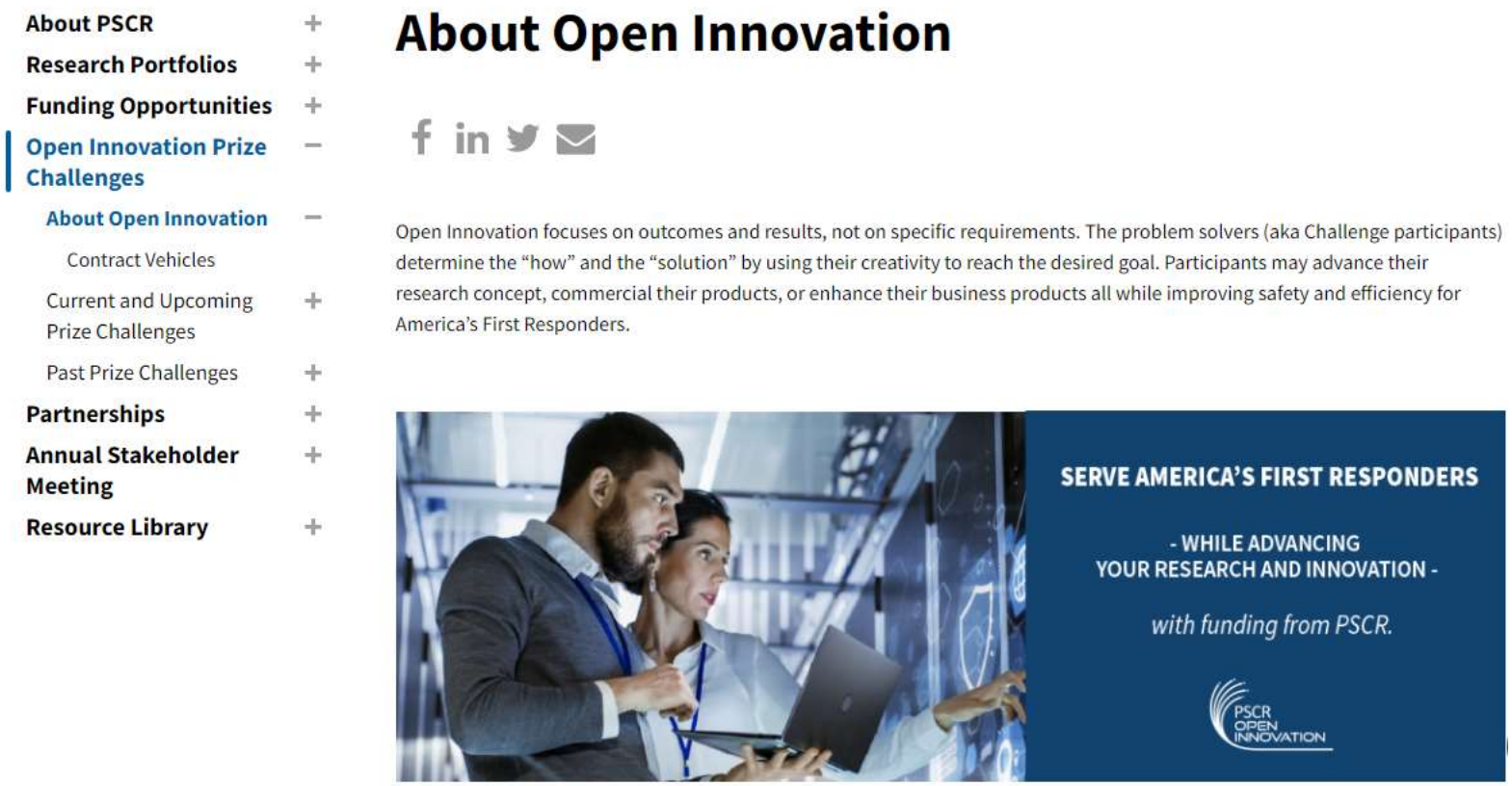
CROSS CUTTING RESEARCH AREAS

Enabling Research

HOW DOES PSCR ENABLE RESEARCH?

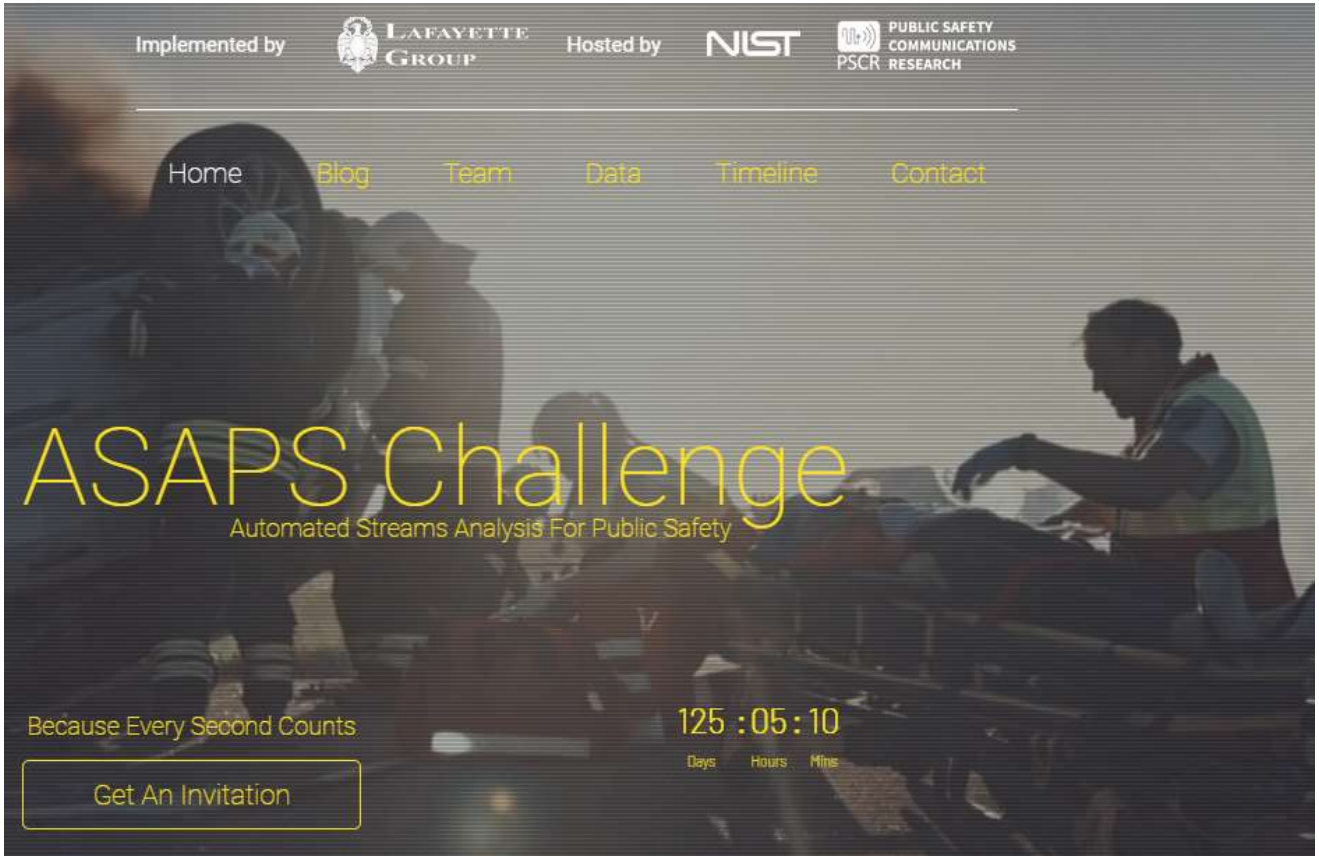
1. INTERNAL RESEARCH
2. EXTERNAL RESEARCH
3. PRIZES & CHALLENGES

PSCR Open Innovation



https://www.nist.gov/ctl/pscr/open-innovation-prize-challenges/about-open-innovation

ASAPS Challenge



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ASAPS Challenge

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Contest 1: Ideation

What are the goals of ideation?

- Drive innovation and solve problems
- Collect ideas from a wide and diverse population
- Increase opportunities for new thinking
- Identify cross-industry application opportunities
- Initiate or drive continuing technical progression of Challenges
- Create and foster a growing user community of experts
- Partner and collaborate within the user community

ASAPS Contest 1 Ideation Competition Winners *$30K Awards Each!*

Topic 1: Information Extraction Across ASAPS Streams and Data Sources Across 1 or More Data Categories

- **Multimodal Fusion for Public Safety Analytics:** Dan Morozoff, Joe Ellis, Gianni Galbiati, Peter Njenga (Vidrovr), Connor O'Day

Topic 2: Information Fusion Across Extracted Data and Generation of Live/Dynamic Information Representation Across 3 or More Data Categories (Tie – Two Awards Made)

- **Scalable Data Fusion for Real-Time Event Detection:** Mehmet Aktukmak, Keval Doshi (University of South Florida), Yasin Yilmaz
- **Balancing Space and Time with Asynchronous Models:** Jason Corso (University of Michigan), Chenliang Xu (University of Rochester), Yan Tom Yan (Texas State University)

Topic 3: Automated Emergency Event Analysis Across 3 or More Data Stream Categories, and Preferably Across All Data Categories

- **NEURATRACE: Detect, Trace, & Analyze Emergencies:** Madhukar Karmacharya, Kumar Apurv, Ananth BhimiReddy, Aamir Khan, Archith Krishnan Rammohan, SaiManoharReddy Peddireddy (Indiana University/Indiana Purdue University), Sahitesh Reddypelly

Topic 4: Extraction to Analysis Systems Approach Across All Data Categories (Two Awards)

- **Modular Design for Automated Event Analysis:** Dr. Roy Hayes Jr., Admiral Guy Curtis, Roy Hayes Sr., William Kimbark, Sreya Palnati, Tom Slattery (Systems Engineering Inc.)
- **Real-Time Multi-Source Event Analytics:** Alexander G. Hauptmann (CMU), Junwei Liang (CMU), Mubarak Shah (UCF), Yogesh Singh Rawat (UCF), Praveen Tirupattur (UCF), Shruti Vyas (UCF)

Our Most Important Stakeholders
The Public and First Responders Who Serve Them

Where every second counts!

Building technology for the future to help first responders save lives, property, and critical infrastructure by helping public safety to be more fully data-informed in responding to emergencies.

The Role of Analytics in Public Safety Operations

Analytic technologies will be part of every stage of the public safety communications workflow

Accuracy, Timeliness, Interoperability, Security, and Integrity are critical

Technology needs identified in

- **2016 Analytics R&D Roadmap and 2016 Analytics Summit Report** https://www.nist.gov/ctl/pscr/public-safety-analytics-publications
- **VAPS 2016 Workshop Report:** www.nist.gov/file/346141 and www.dhs.gov/sites/default/files/publications/First-Workshop-on-Video-Analytics_508.pdf

PSCR Analytics Portfolio Strategy

Focus: Increasing automation to **identify and analyze emergency events** in **real time** from a **large number of data streams** and **provide first responders with actionable information**.

Optimize data for downstream analysis

- quality/communications/encoding and understand analytic limitations

Analyze all streams effectively in real time

- information sorting, filtering, event detection and characterization

Provide **integrated information analysis**

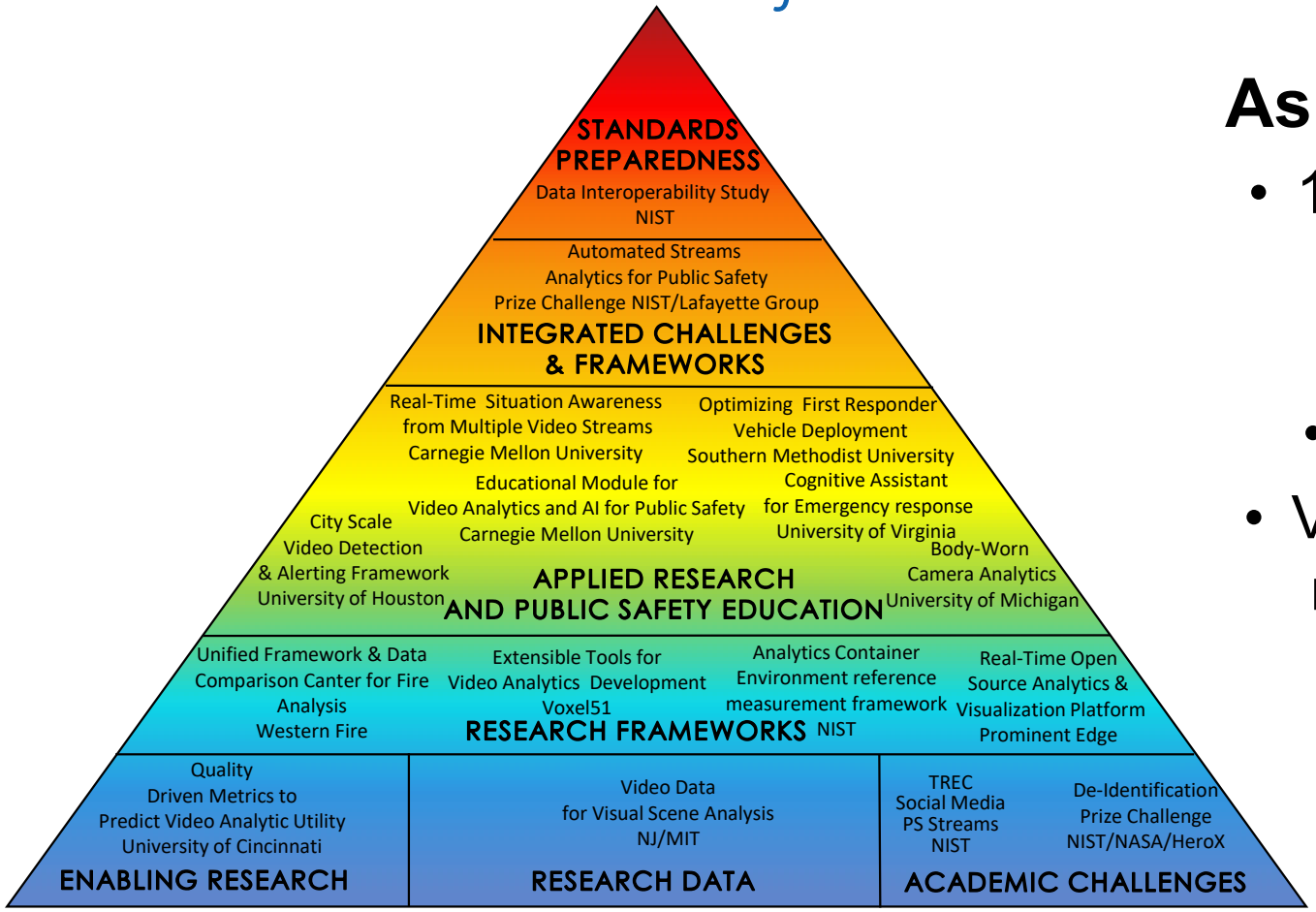
- fused data analytics across streams

Reduce cognitive information load on first responders

- tailored prioritized information delivery in actionable form

The PSCR Analytics Portfolio

Built on a Foundation of Robust Research

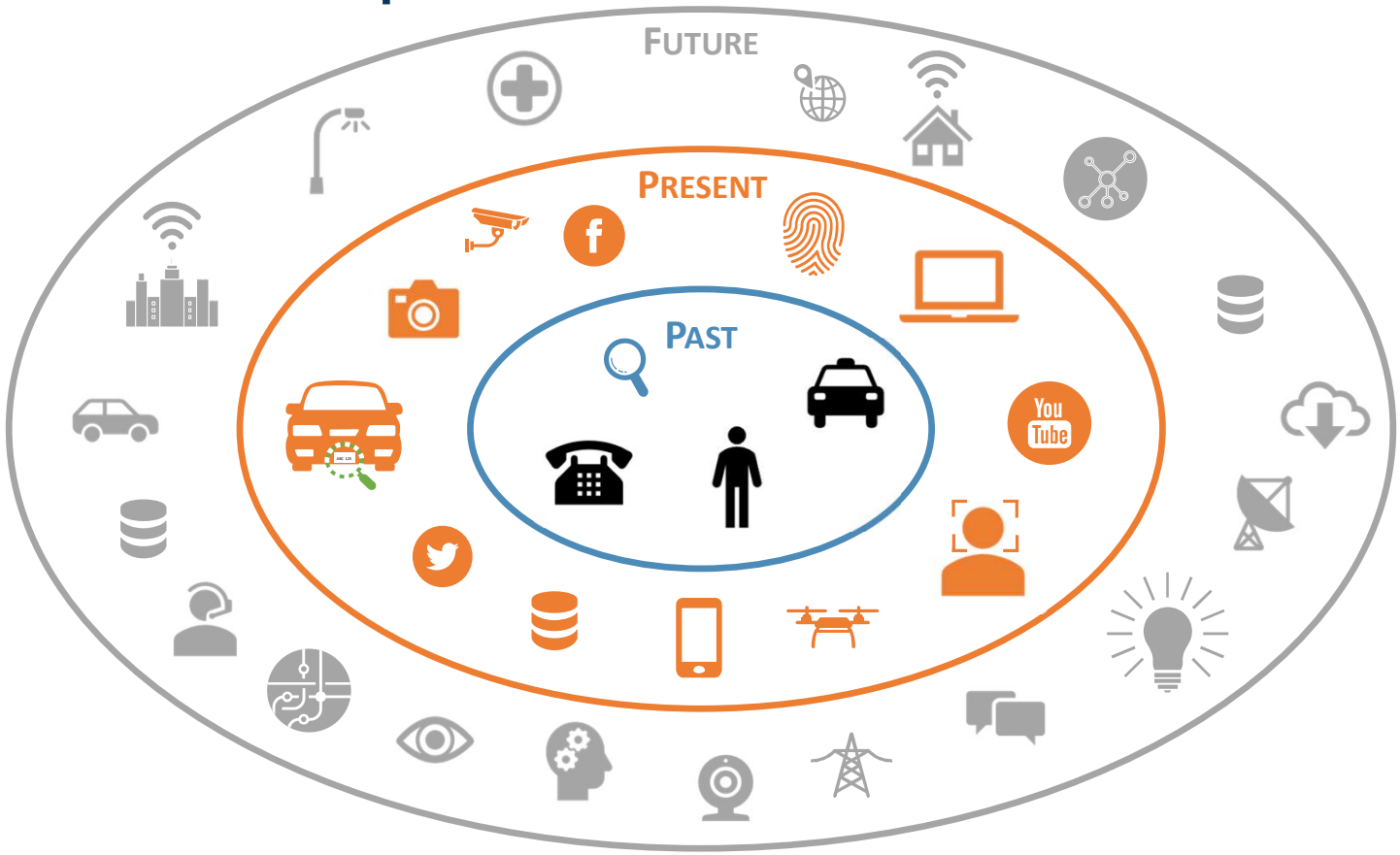


As of December, 2020

- 11 grants / agreements (4 completed)
  - 4 NIST projects
  - 2 Prize Challenges
- Variety of SW tools and research data created
- Over 25 reports published

Our Fast Increasing Sea of Data

The vast amount of data public safety must monitor has already outgrown human capabilities.



Current Public Safety Livestream Data Analysis Tools are Limited

Few public safety analytic tools work with unstructured data in real time.

Most of these tools have been developed for use with archival data and focus on post-event forensic analysis.

Most analytic tools rely on a non-evolving data representation.

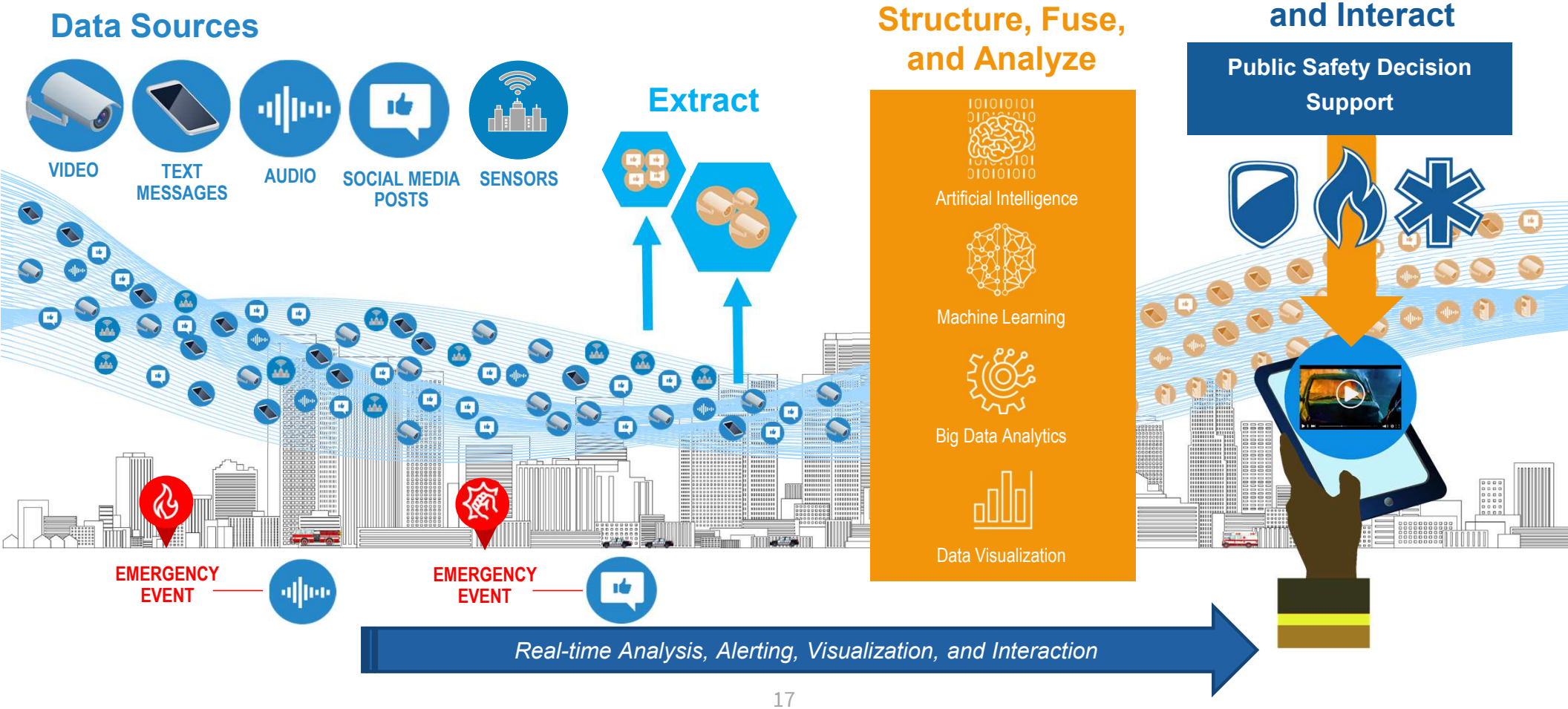
Most situational awareness tools generate an information dump that impedes critical response and decision making in real time.

Most analytic interfaces are primarily GIS-focused on *the where*, but inadequately integrate *the what* – especially from multiple sources.

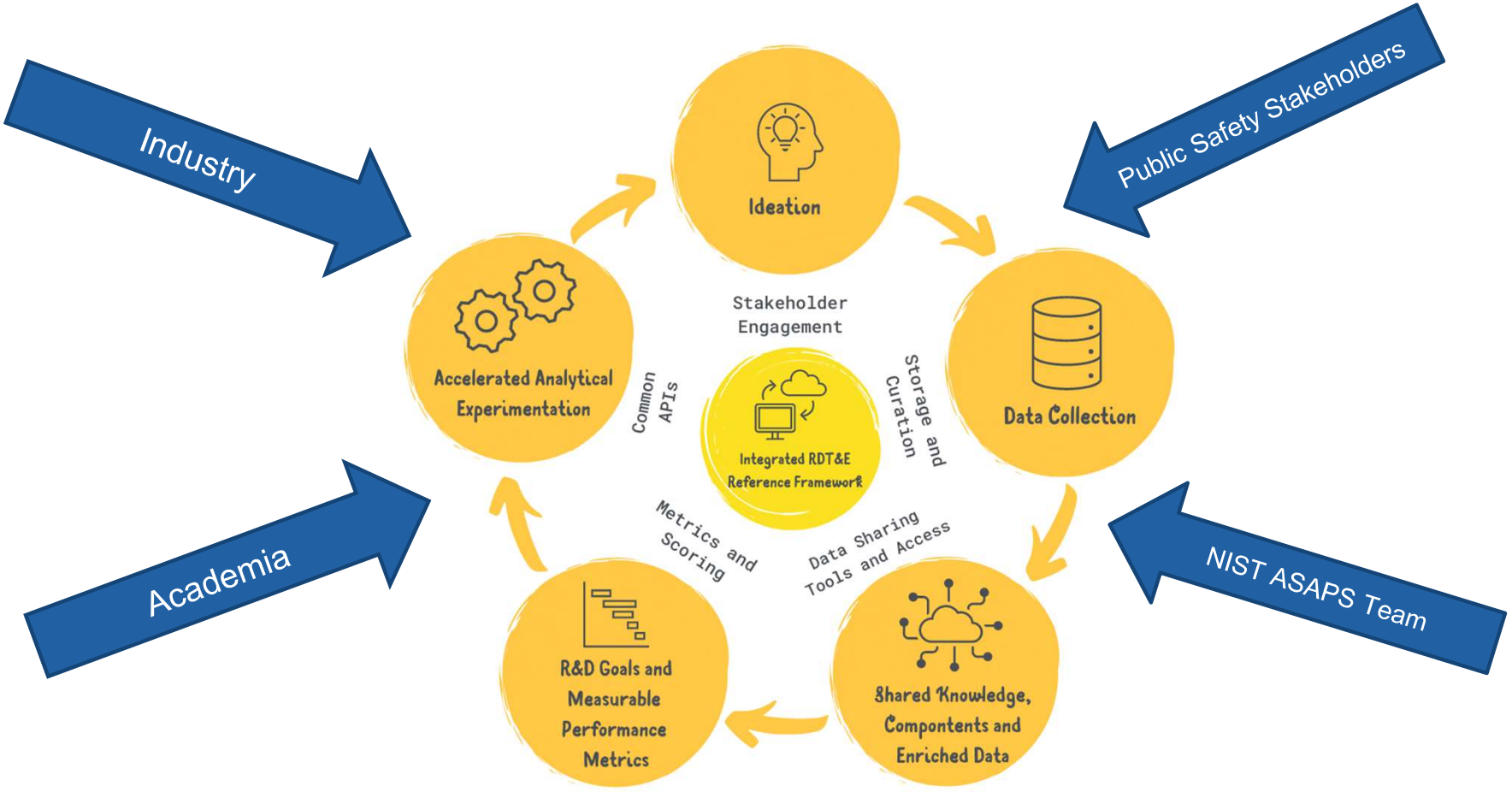
ASAPS is fostering:

Technologies that perform analysis and fusion of emergency related information from many heterogeneous data streams in real time and provide it to public safety in a usable way that will save lives, property, and infrastructure.

Automated Streams Analysis for Public Safety (ASAPS) Challenge

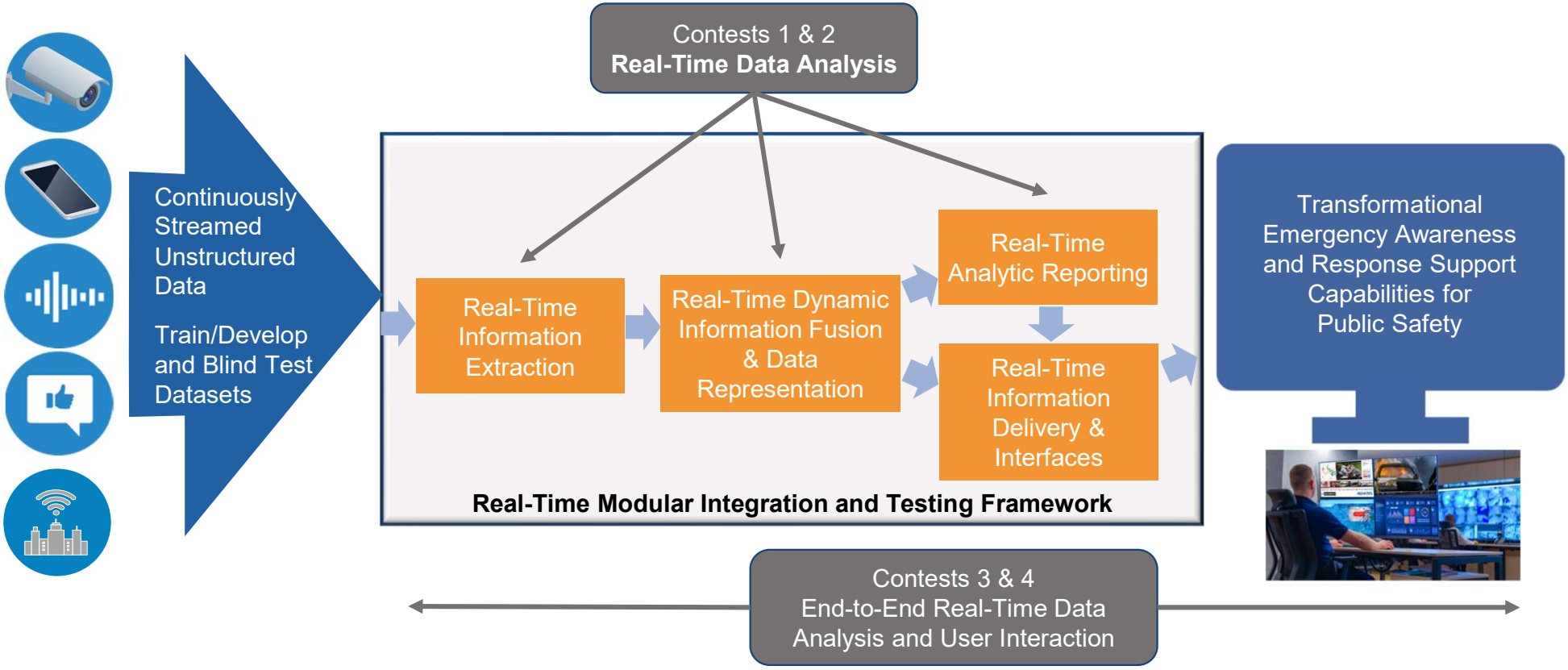


ASAPS Challenge Ecosystem Vision

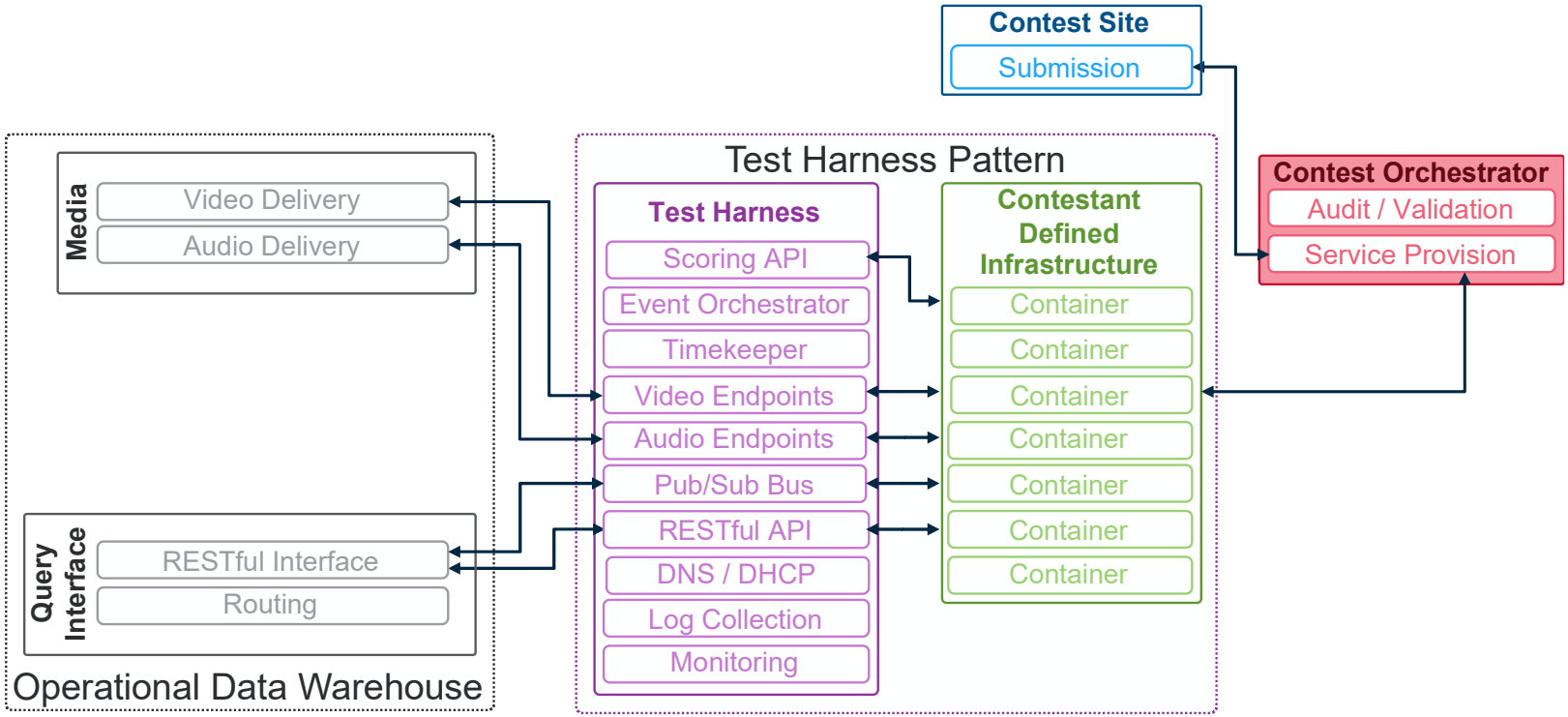


ASAPS Unique R&D Approach

The challenge features a series of progressive contests using a modular integration framework to foster collaboration, innovation, and knowledge and algorithm sharing.



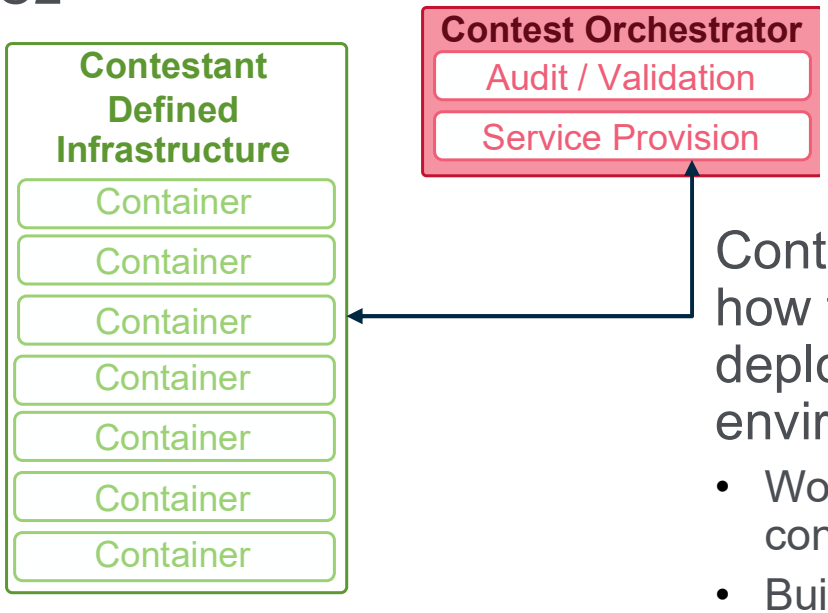
ASAPS Testing Framework
Concept of operations



ASAPS Contestant Defined Infrastructure

Contestant solutions will run on a dedicated Kubernetes node hosted on an AWS EC2 p3.8xlarge:

- 32 vCPU Cores
- 244 GB RAM
- 4 GPUs w/ 64 GB GPU RAM
- 900 GB of NVMe storage



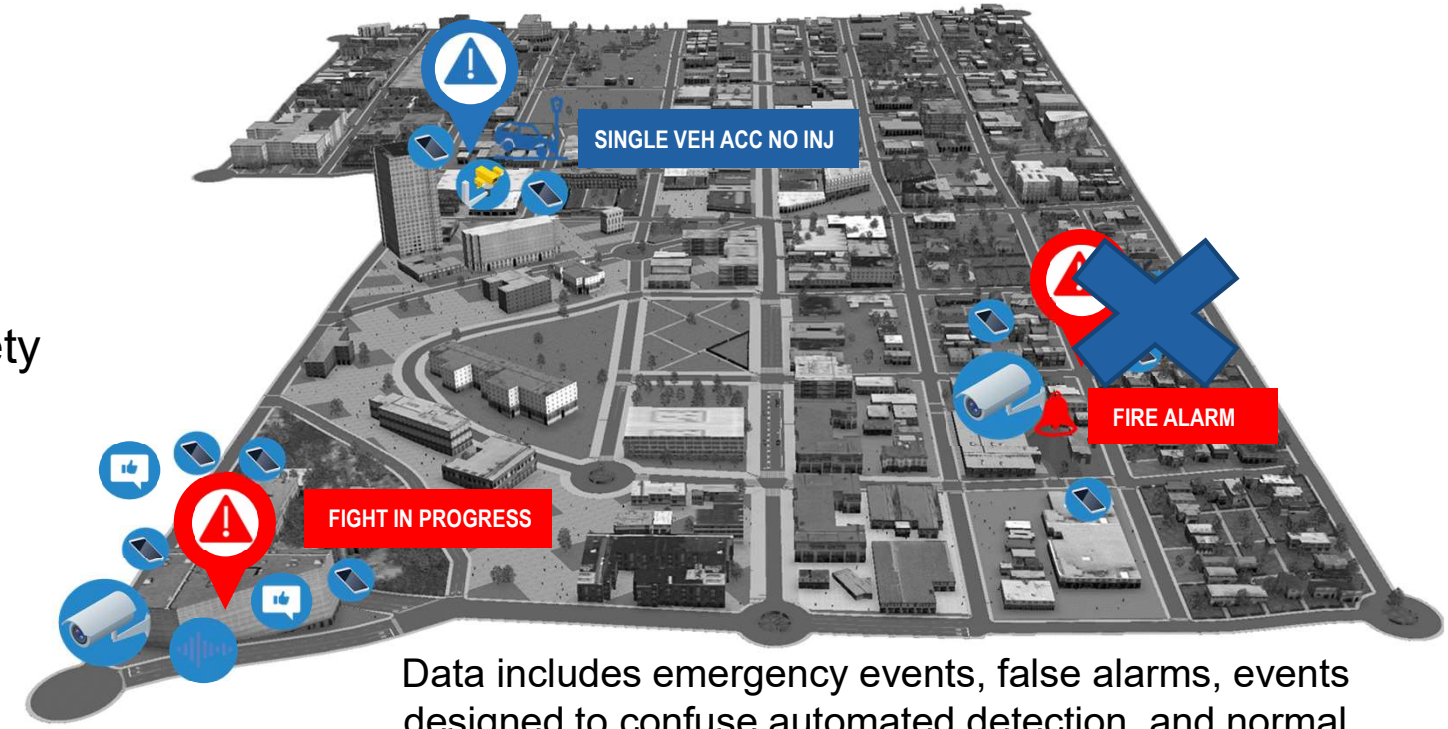
Contestants can customize how their solutions are deployed within the test environment by:

- Working within a predefined containerized environment
- Building their customized specifications into a configuration file via Terraform, learn more at www.terraform.io

Dataset 1- Training and Development

The **Automated Streams Analysis for Public Safety (ASAPS) Challenge Dataset 1** includes lifelike scenes, objects, behaviors and emergency incidents staged and recorded in ASAPS city.

- Dataset 1 captures eight hours of a day-in-the-life in ASAPS City
- **62 emergency events occur across the city** and are captured across a variety of data streams:
  - CCTV video
  - 911 Audio
  - 911-to-text
  - Dispatch Audio
  - Computer Aided Dispatch (CAD) text
  - Gunshot detector sensors
  - Social media (multimedia)



Data includes emergency events, false alarms, events designed to confuse automated detection, and normal activity across data streams and modalities.

ASAPS City – Hybrid Virtual City

62 emergency events over eight hours, captured in multiple continuous data streams, and distributed across a 0.85 km^2 area (viewable video area + other data areas)

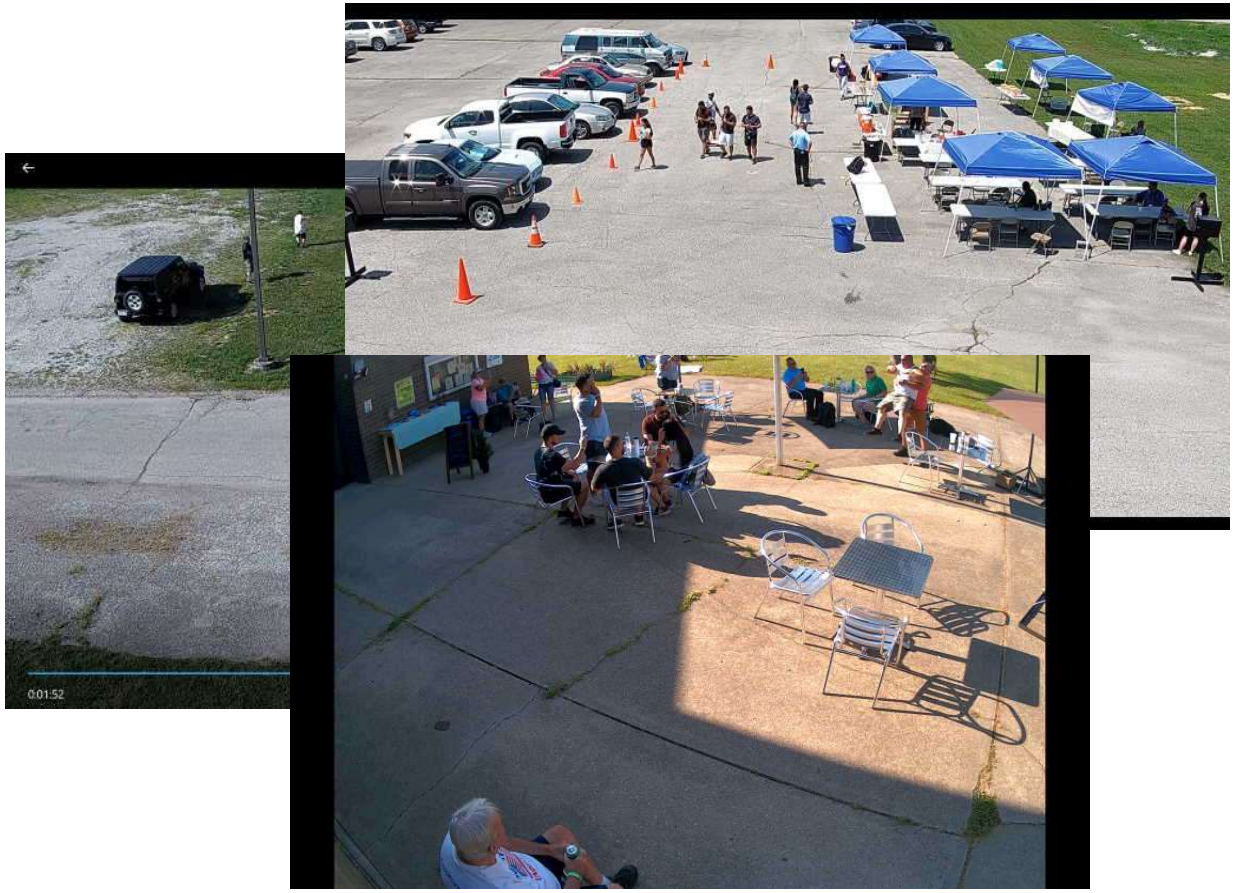
ASAPS Data – Unprecedented in scale

Real but enacted video/audio + synthetic data modalities

Description	Video & camera feeds	Audio	Gunshot Detector	Social Media Posts	Computer Aided Dispatch
Data Volume	~1.1 Terabytes	~9 Gigabytes	500 Kilobytes	~20 Megabytes	~1 Megabyte
Hours of Data	232 total hours	48 total hours	8 hours	8 hours	8 hours
Message Volume	29 CCTV IP Cameras	~60 911 calls ~240+ Radio Transmissions	~25 Sensor Notifications	~15,000 entries; ~400 relate to ASAPS City	400+ Dispatch Entries
Stream Details	Over 0.024 km^2 of PTZ and fixed camera coverage	3 x 911 DID Phone Lines 3 x LMR Talk Groups	Gun shot detections	Chitter and Friendnote Posts	Text Information for 911 info, incident details, location, unit assignment, call status
Stream Type	H.264 over RTSP	Opus over RTSP	RESTful API and pub/sub message bus	RESTful API and pub/sub message bus	RESTful API and pub/sub message bus
Annotation	Temporal	Temporal	Temporal	Temporal + Classification	Temporal

Creation of the Video Data

- Eight hours of ***continuous*** footage from each of the 29 cameras captures regular city life, as well as emergency incidents and similar events designed to confuse automated detection
- Data capture event included ~150 actors
- Set included multiple areas – for example a farmer's market, café, city park, and residential areas



ASAPS Takes A City of Collaboration to Build

ASAPS requires a multi-disciplinary approach spanning many diverse areas of expertise and features a variety of collaborative mechanisms.

Many Disciplines and Areas of Expertise Working Together

Multiple Contests
Progressive Ideation and Development Cycles

Support
Forums
Teaming
Workshops
Feedback

Outreach
Stakeholders
Public Safety

Resources
Unprecedented Data
R&D and Testing Framework

Long-Term Vision for ASAPS

Seamless and scalable real-time, multi-modal analytics frameworks that provide critical emergency information-awareness for public safety in saving lives, property, and infrastructure.

Envisioned R&D impacts include:

- Agile **multi-modal analytics and fusion models** for streaming data from video, audio, text, social media, and sensor data
- **Reusable R&D and test & evaluation frameworks**
- **Open source analytics development tools**
- Scalable deployable **emergency event analysis tools and methodologies**
- **Critical mass in R&D** related to scalable, real-time emergency analytics for public safety
- Creation of a **Community of Interest** supporting sustained R&D and multi-disciplinary collaboration in public safety emergency response analytics

Anticipated ASAPS Program Schedule

CONTEST 1

Develop Approach Concept for Live Automated Emergency Event Analysis

Innovative "Plans of Attack"

THINK // IDEATION

Completed Fall 2020

CONTEST 2

Implement live Automated Emergency Event Analysis

Automated Real-time Analysis

DO // ALGORITHMS

In Development for 2021
Kicked off With November 2020 Workshop

CONTEST 3

Develop approach concept to Live Automated Emergency Event Analysis with Intuitive Information Delivery and Interaction

THINK // IDEATION

TBD Late 2021

CONTEST 4

Implement live Automated Emergency Event Analysis with Intuitive Information Delivery and Interaction

Automated Real-time Visualization & Decision Support

DO // ALGORITHMS

TBD 2022

Contests Anticipated from 2020 through 2022

Contest 2 – Live Automated Emergency Event Analysis (Anticipated in 2021)

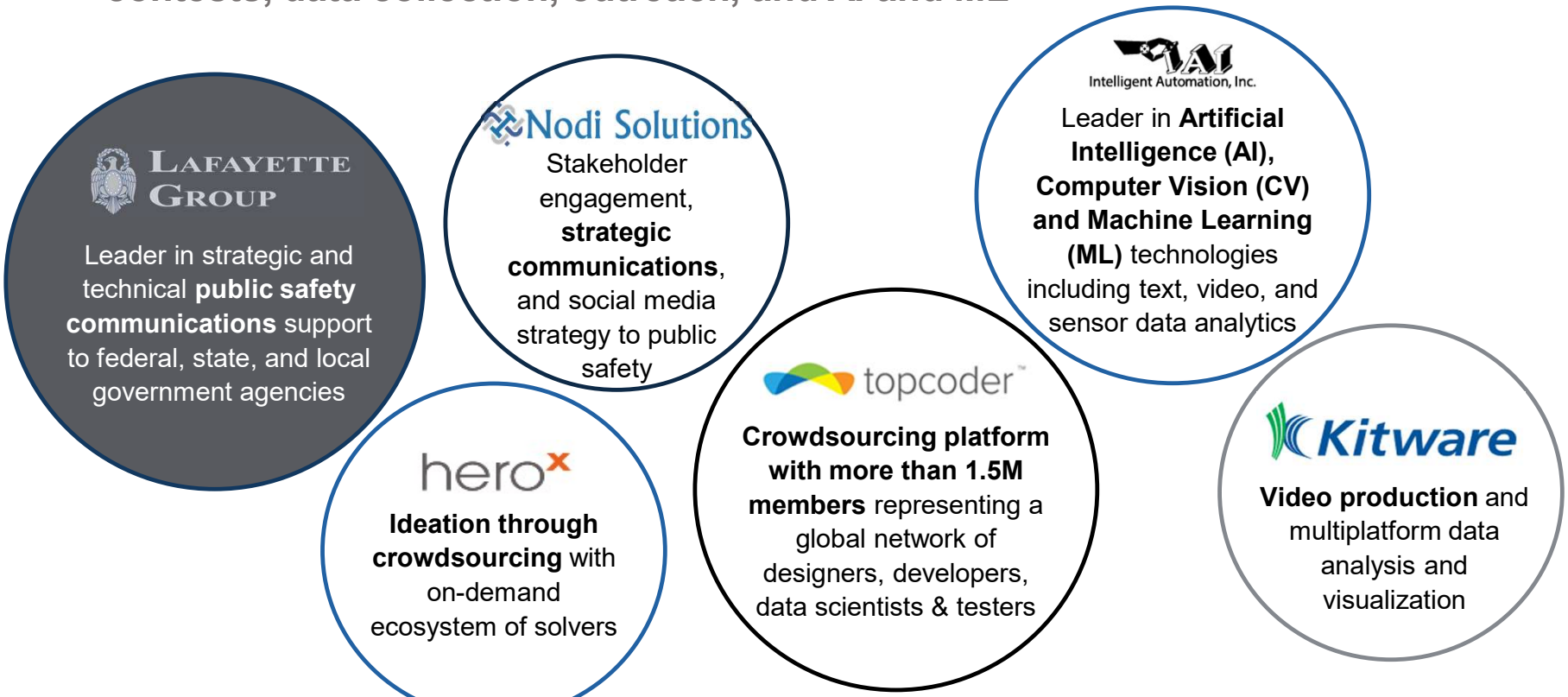
Planned Contest 2 Tasks:

- **Task 1: Evidence Detection**
  - **Automatically detect evidence by stream ID and time across all streams** that might be relevant for emergency event analysis. A list of potential evidence types will be pre-compiled and distributed with development data. Baseline algorithms will be collected and shared across contestants to support experimentation.
- **Task 2: Emergency Event Evidence Clustering**
  - **Cluster evidence detected in Task 1 by emergency event instance**. A list of potential evidence types will be pre-compiled and distributed with development data.
- **Task 3: Emergency Event Analysis**
  - **Detect start time, duration, and location of emergency super-events and their evolutionary sub-event elements.** A list of potential super-event and sub-event types will be pre-compiled and distributed with development data. A super-event can contain one or more sub-events that constitute evolutionary changes inside the super-event or may contain only a single sub-event.

Overall, this contest will focus on evaluating real-time algorithm performance with contrastive conditions to compare performance against the test data to performance with perfect inputs and other diagnostic conditions to provide informative feedback to contestants.

The ASAPS Implementation Team

Diverse expertise spanning public safety communications, technology contests, data collection, outreach, and AI and ML



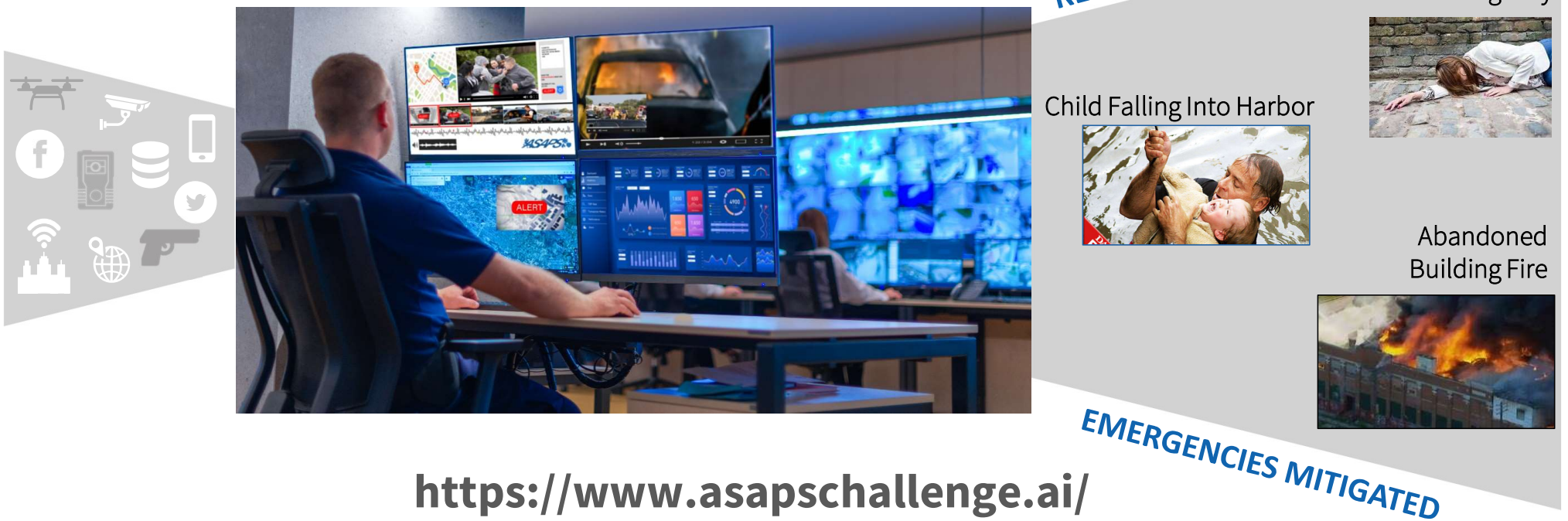
The ASAPS Challenge is sponsored by the NIST Public Safety Communications Research (PSCR) Program.

Beyond ASAPS and PSCR 2022
What are the future challenges?

- Balancing analytic workflows across dynamic heterogeneous networks with varying bandwidth
- Optimizing the balance of front-end edge device analytics with back-end analytics and analysis-embedded compression
- Computational topologies that agilely map to these dynamic needs
- Measuring uncertainty of each analytic process and cumulatively across analytic workflows
- Tools to support users creating and exchanging their own analytics from their own data
- Dynamic, intuitive interfaces that understand context and the user to deliver analytic information most effectively in emergencies
- Security, privacy, and interoperability for public safety analytic data systems

Imagine: Creating tomorrow's technology to save lives

Analytics to help first responders make more effective use of streaming data *where every second counts!*



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