NIST PSCR Analytics Portfolio Technical Overview

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San Diego, CA

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

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Disclaimer

Certain commercial entities, equipment, or materials may be identified in this document in order to describe an experimental procedure or concept adequately.

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*Please note, all information and data presented is preliminary/in-progress and subject to change.

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Acronym Glossary

- BWC = Body-Worn Camera
- CTL = Communications Technology Laboratory
- GOTS = Government Off-the-Shelf
- ITL = Information Technology Laboratory
- LMR = Land Mobile Radio
- MSE = Measurement and Science Engineering
- PII = Personally Identifiable Information
- PSIAP = Public Safety Innovation Accelerator Program
- R&D = Research and Development

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The role of Analytics in Public Safety

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

The needs are vast and diverse

Our approach must be strategic and focused

Needs identified in 2016 Analytics R&D Roadmap and 2016 Analytics Summit Report

- https://www.nist.gov/ctl/pscr/public-safety-analytics-publications

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Landscape and Drivers that influenced the Analytics Portfolio Strategy

Retrospective structured data analytics are riding the tide of the big data movement

Forensic analytics, defense technologies, and biometrics are already strongly supported in the federal government and industry

Key analytic technology-related gap areas for public safety:

- Analytic capabilities for unstructured public safety data sources/domains
- Analytics applications focused on emergencies, response, and training
- Real-time analytics at city scale to create actionable information in emergencies
- Data quality variability and its impact on analytic performance
- Tools to enable greater public safety engagement in analytic development

Key public safety analytic R&D ecosystem gaps:

- Academic engagement in public safety research and collaborations with public safety
- Public safety education and engagement in research and ecosystem development

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Analytics Portfolio Vision for 2022

Technology and community focused on transforming large amounts of fast-moving data into actionable information to help public safety respond efficiently and effectively to emergencies

- Critical mass in R&D community created, public safety informed and involved
- Critical tools for expanded relevant RDT&E: data, real-time frameworks, libraries of analytic components
- Deep knowledge regarding scaling real-time analysis of many/heterogenous data streams
- Positioned for future standards development activities

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Analytics Portfolio Strategy for 2022

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

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Analytics Portfolio Development Approach

Multi-Pronged Approach:

- **Foster research** in key fundamental technologies
- Create **data, tools/frameworks, and academic challenges** to lower barriers of entry, focus R&D, and increase research base
- Support the **development of applied technologies** in providing at-scale, real-time assistance to first responders
- **Build interest/critical mass in R&D community** and **public safety involvement**
- Implement **progressive application-focused analytic challenges** to bring communities and technologies together in novel/innovative ways
- **Lay the foundations for future R&D and standards** development in integrated, real-time analytic technologies

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R&D Vehicles in Analytics Portfolio

- **Public Safety Innovation Accelerator Grants** (NIST CTL PSIAP)
  - Development of R&D and R&D resources to support fundamental and applied technology R&D related to public safety communications
- **Measurement Science and Engineering Grants** (NIST ITL MSE)
  - Development of research and resources to support measurement science in analytics, usability, cyber security, and education in these areas
- **Prize Challenges via PSCR Open Innovation Opportunities**
  - Academic and integrative public safety communications technology R&D challenges
- **NIST Measurement Projects to support the underpinnings**
  - Reference Frameworks
  - Reference Data Collections
  - Performance Metric Development
  - Academic Technology R&D Evaluations (with no prize)

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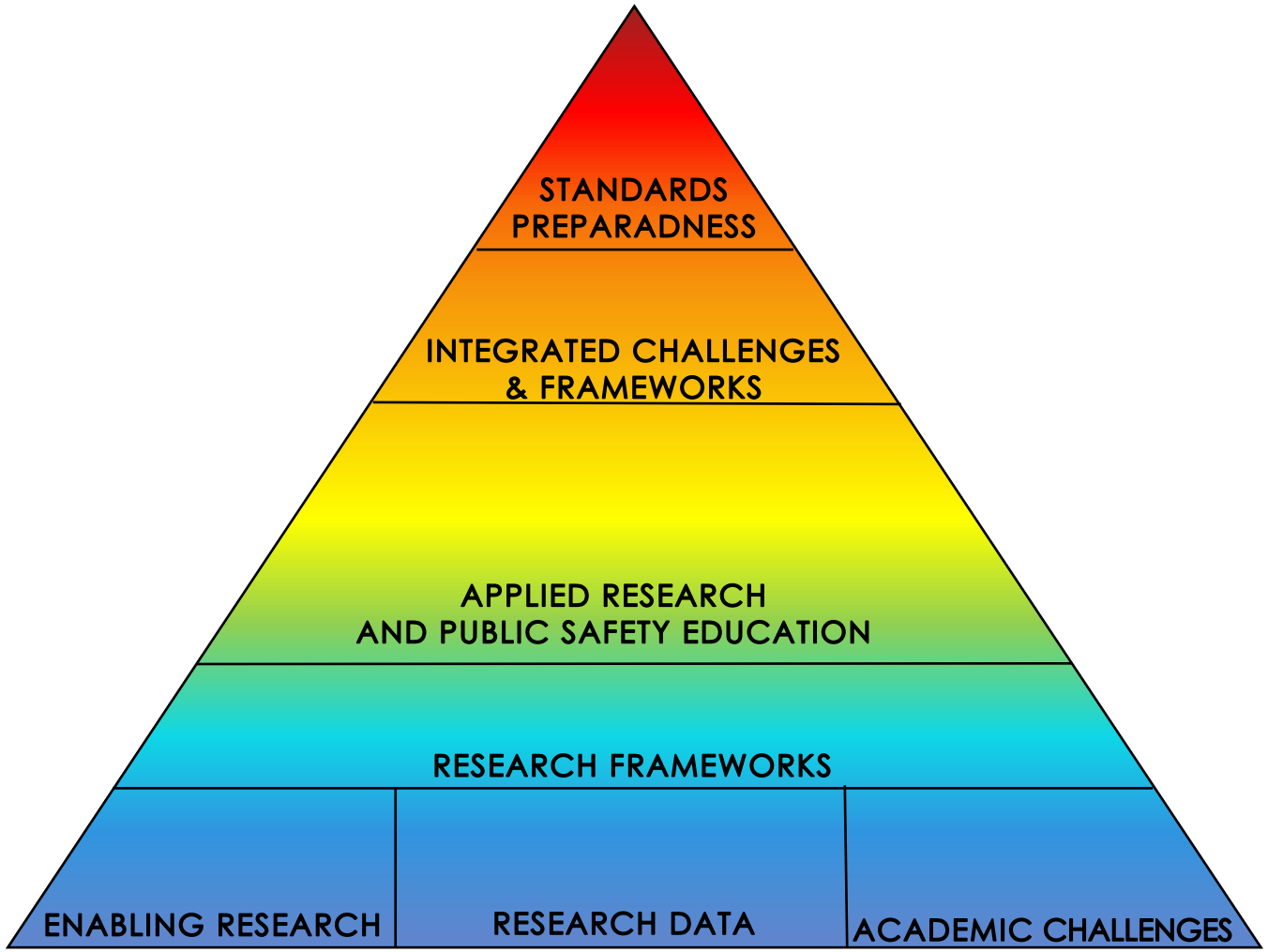
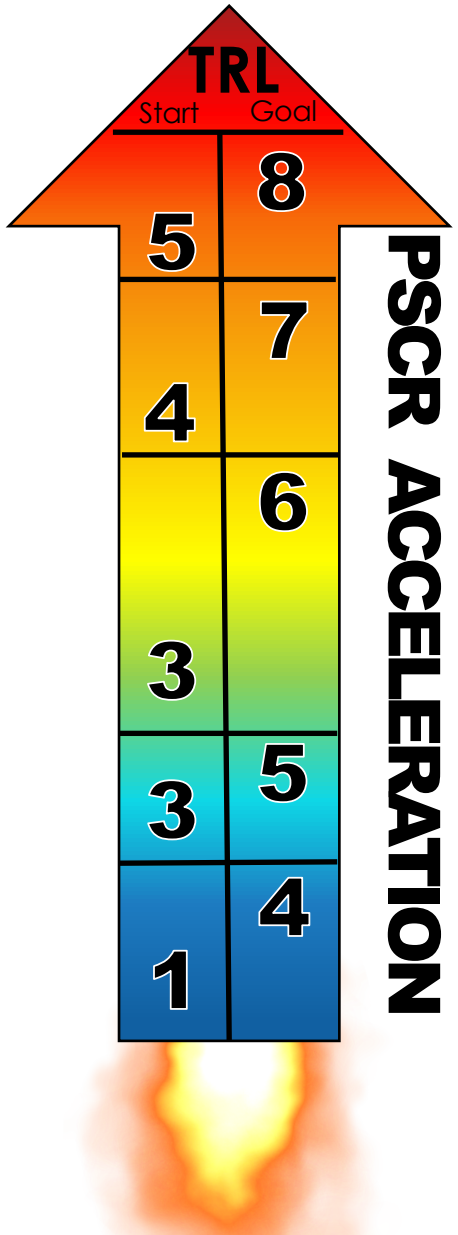
PSCR Analytics R&D Strategy FY17 – FY22





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Envisioned Analytics Portfolio Impacts

- Fundamental technologies accelerated and gap areas addressed
  - research conducted in gaps, published, and adopted/cited
- Application feasibility demonstrated in public safety environments
  - applications created, demonstrated, and feasibility established
- Public safety community engagement with research expanded
  - key early adopters identified and engaged
- Downstream efforts/collaborations inspired
- R&D community engagement with public safety expanded
  - increase in research and publications in public-safety-related work
- Pre-standards resources developed
  - cross-cutting communities of interest created
  - reference frameworks and tools created
  - studies conducted, and measurements and assessments made

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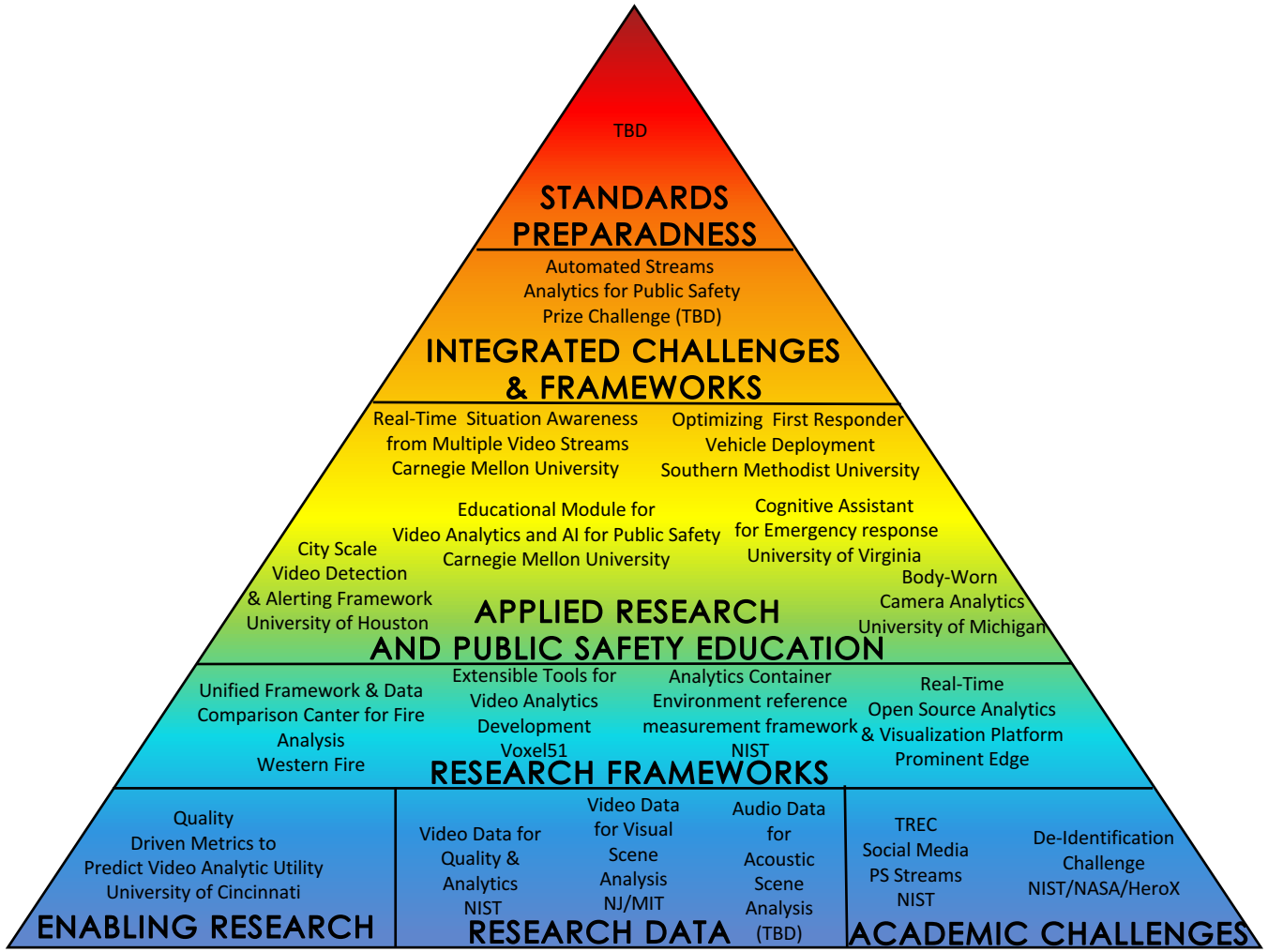
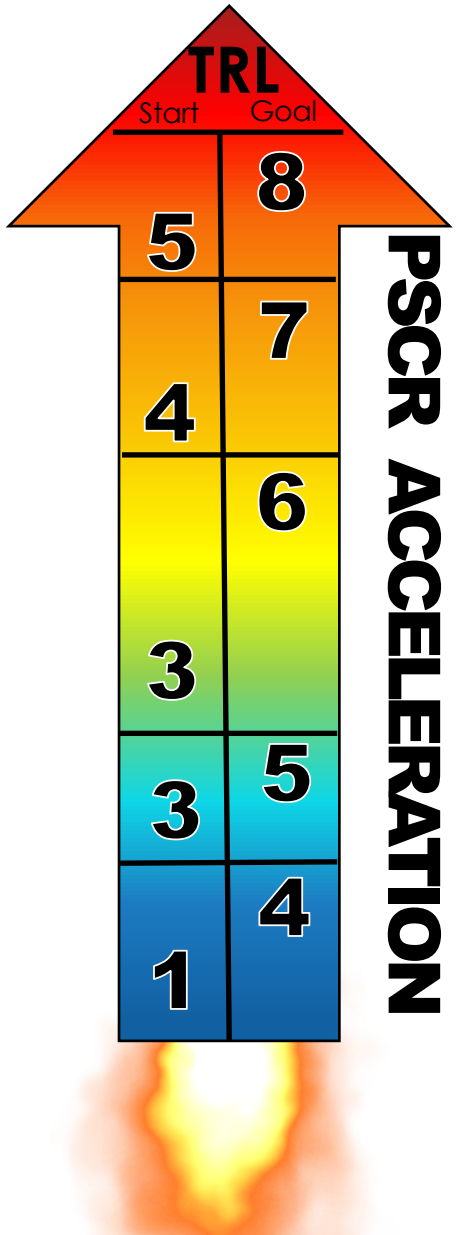
PSCR Analytics R&D Portfolio FY18





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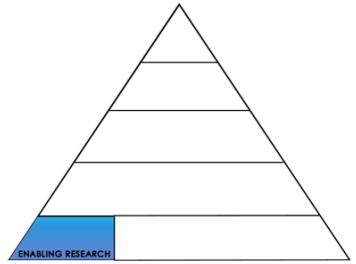
Where are we today?
Enabling Research



- Grant: **Information-Driven Video Communication for Public Safety Networks**, University of Cincinnati, Rui (April) Dai
  - Challenge: Need to optimize video for downstream analytics while minimizing bandwidth
  - Research: Making fundamental breakthroughs in quantitatively understanding the relationship between video quality and video analytic performance

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Where are we today:
Research Data

- Grant: **Public Safety Operations Video and Network Traffic Dataset: New Jersey Office of Homeland Security and Preparedness**, Andrew Weinert (MIT)
  - Challenge: Realistic research video data in public safety scenarios is needed to drive and foster critical video analytics R&D
  - Research: Creating data collections to support video analytic R&D in 3 public safety scenarios: traffic stop, lost backpacker, and foot pursuit

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Where are we today:
Research Data contd.

NIST Project: **Object In Situ Video Quality Dataset (FY18-19)**, James Horan

- Challenge: Video data resources to support key R&D in both automated video quality and video analytics are needed to drive and expand research
- Research: Develop unique Public Safety video dataset to support research at the intersection of object detection and video quality
  - Data will be collected from public safety surveillance environments using multiple cameras utilizing different locations and scenarios with variations in video quality and environment conditions
  - Collection scenarios and objects will be designed to closely represent public safety use cases
- Dataset will be used to support future challenge competitions and evaluations in video analytics, video quality analysis, and video content analysis
- This project will also provide reference data for future standards development
- Currently in acquisition phase

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Where are we today:
Research Data contd.

Future Grant: **Audio Data Collection for Acoustic Scene Analysis**

COMING SOON!

Challenge: Technology for non-speech audio analysis is under-researched and needed to support situation awareness applications for first responders and public safety centers

- Research: Develop unique public safety audio dataset to support research in non-speech/non-traditional acoustic scene by understanding analytics from mobile microphones (e.g., body cameras, LMRs, cell phones, 911 calls)
  - What can be determined about the physical environment?
  - How many people are nearby? What are their locations relative to the microphone? What is their emotional state?
  - What unique non-speech sounds can be identified that could help with emergency analysis?
- Grant opportunity to be announced later in 2018
- Long-term goal is to support research and challenges in this area

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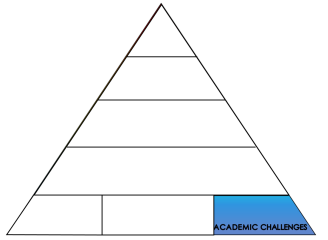
Where are we today?
Academic Challenges



- Prize Challenge: **De-ID Unlinkable Data Prize Challenge**, Mary Theofanos, Jason Suagee, Nancy Merritt
  - Challenge: Protecting PII is critical to sharing data across public safety agencies and jurisdictions, and with the public
  - Research: develop software through competition to de-identify textual data so that it preserves privacy while retaining its analytic utility
    - HeroX is challenge development contractor
    - Initial prize challenge began on May 1, 2018, for white paper approach proposals *https://www.challenge.gov/challenge/the-unlinkable-data-challenge-advancing-methods-in-differential-privacy/*
    - Second prize challenge in Oct. 2018 will be focused on evaluating the performance of algorithms created from selected proposals in phase 1
    - Later challenges will focus on enhancing the metrics and applying the algorithms to public safety-relevant data -- **We need data contributions!**
  - *www.nist.gov/ctl/pscr/funding-opportunities/prizes-challenges/2018-unlinkable-data-challenge*

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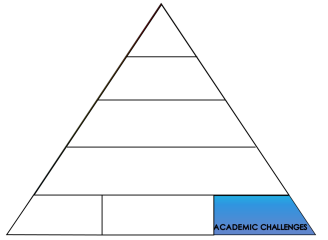
Where are we today?
Academic Challenges contd.



- NIST Project: **Social Media Incident Streams Academic Evaluation**, Ian Soboroff
  - Challenge: First responders need ways of monitoring social media for critical information from the public in real-time in emergencies
  - Research: technology to enable systems that can process live data from Twitter, identify when a tweet relates to a local public safety issue, and route that tweet to the right person who needs to see it
    - Evaluation: create software to filter the tweets looking for actionable incident-critical messages, and classify those into an ontology
    - Framework:
      - Noisy tweet dataset with 25-50 public safety relevant incidents
      - A public safety response ontology
  - Evaluation now being conducted through the summer 2018. Results reported at November 2018 NIST Text Retrieval Conference (TREC)
  - 25 organizations have signed up. https://trec.nist.gov/pubs/call2018.html

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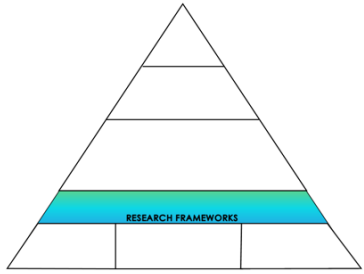
Where are we today?
Research Frameworks



- Grant: **Real-time Open Source Data Analytics & Visualization Platform: Prominent Edge**, Tyler Garner
  - Challenge: Fire departments need tools to help them to easily build custom analyses of their data
  - Research: Developing extensible fire department performance analysis tools utilizing open source architecture
- Grant: **Unified Analysis Framework and Data Comparison Center: Western Fire Chiefs Association**, David Blankinship (WFCA) and David Van Ballegooijen (Interra)
  - Challenge: Fire departments need systems to help them share data and analyses
  - Research: Creating cross-department fire database and analysis sharing network
- Grant**: ETA: Extensible Tools for Analytics in Public Safety: Voxel51,** Jason Corso and Brian Moore
  - Challenge: The public safety community needs tools to help them agilely build AI analysis applications for their unique needs and video data
  - Research: Developing building blocks on open source architectures to support the agile creation of customized video analytic applications by public safety IT professionals

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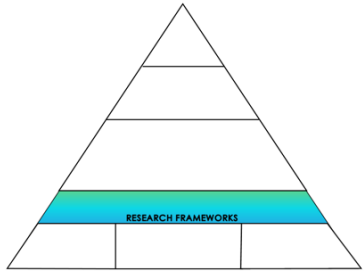
Where are we today?
Research Frameworks contd.



- NIST Project: **Analytics Container Environment Reference Framework (FY18-21)**, James Horan
  - Challenge: Reference framework is needed to evaluate the impacts of combining analytic technologies using novel distributed computing and communications architectures
  - Research: Reference framework for measurement of integrated analytic tools, computing architectures, and communications artifacts and impairments
    - Plan to use analytics tools from GOTS, open source, and grant/prize products as reference analytics and popular/emerging architectures/tools
    - Reference measurement tasks to include functional activities identified by public safety stakeholders
    - Performance measurements will address accuracy, utility, and efficiency as well as metrics identified by public safety stakeholders
    - Develop understanding of minimum requirements, bottlenecks, and tradeoffs
  - End goal is methodology, metrics, and physical framework for testing complex public safety analytics systems and supporting future standards development

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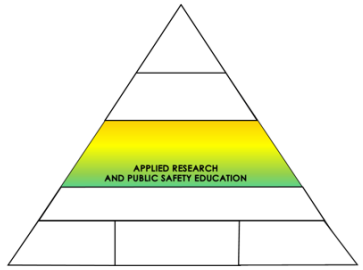
Where are we today?
Applied Research and Public Safety Education



- Grant: **SAFE-NET: An Integrated Connected Vehicle and Computing Platform: Southern Methodist University**, Khaled Abdelghany, May Yuan, Michael Hahsler
  - Challenge: A framework is needed to support research in combining information from heterogenous data streams to inform public safety logistics and resource deployment
  - Research: Developing a framework to analyze multiple data sources in optimizing logistics for emergency response in cities
- Grant: **Real-time Video Analytics for Situation Awareness, Carnegie Mellon University**, Alex Hauptmann and Junwei Liang
  - Challenge: Technology is needed to analytically combine spatially/temporally-related video streams in an effective way to maximize situation awareness in emergencies
  - Research: Developing a real-time approach to processing multiple sources of video to create a fused 3D understanding of an emergency scene
- Grant: **Cognitive Assistant Systems for Emergency Response: University of Virginia**, Homa Alemzadeh
  - Challenge: Hands-free technology is needed to support EMS responders in interacting with hospital databases and expert systems during triage
  - Research: Developing a multi-modal cognitive assistant to support hands-free communications between EMS and hospital databases and knowledge bases

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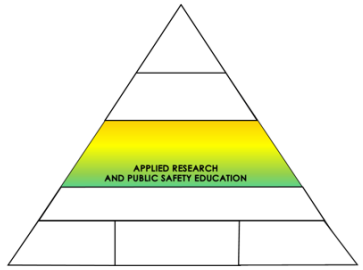
Where are we today?
Applied Research and Public Safety Education contd.



- Grant: **Body-Worn Camera Analytics in Public Safety: University of Michigan**, Jason Corso
  - Challenge: Analytically understanding the scene from the perspective of the BWC wearer is important in maximizing the use of BWCs in emergencies
  - Research: Developing wearer and scene analytics for body camera data
- Grant: **Multi-tiered Video Analysis for Abnormality Detection and Alerting: University of Houston**, Shishir Shah (UofH), Hinrich Schmidt (Smarter2Stream), Julie Stroup (City of Houston)
  - Challenge: Scaling up video analytics and making them dependable while preserving bandwidth in cities utilizing wireless communications systems is critically important
  - Research: Approaching the challenge with experts in public safety video, wireless communications, and computer vision to understand the gaps, bottlenecks, and technical challenges related to deploying video analytics at city scale
- Grant: **Educational Seminar on Video Analytics and AI for Public Safety stakeholders: Carnegie Mellon University**, Alex Hauptmann and Zinru Yang
  - Challenge: The public safety community lacks critical knowledge in terms of how AI-based technologies such as video analytics are developed and work
  - Research: An informative seminar for public safety on how video analytics and AI work (and fail), what's really under the hood, and how to best leverage your data to create and tune them

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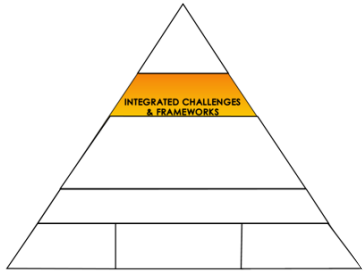
Where are we today?
Integrated Challenges and Frameworks



- Future Prize Challenge: **Automated Streams Analysis for Public Safety (ASAPS) Progressive Prize Challenge**

COMING SOON!

  - Challenge: Combining analytics across modalities and many live data streams in emergencies and providing essential information to first responders is critically important as sources of data continue to multiply
  - Prize Challenge Research Goal is to provide comprehensive information regarding the when, where, and what of emergency events from many streams of information in real-time in a way that helps first responders optimize the effectiveness and efficiency of their response
    - **Detection and analysis of a variety of emergency events** of interest to law enforcement, fire, and emergency medical services
    - **Real-time processing of many simultaneous data streams** from audio and textual first responder communications, public safety video, social media text, and sensors
    - **Delivery of information** to simulated public safety command center **in actionable form in innovative interactive interfaces**
  - *Industry Day Held on May 3 at NIST Boulder, CO for challenge development/coordination contract: Funding opportunity to be announced at*: https://www.fbo.gov/spg/DOC/NIST/AcAsD/SB1341-18-DRFP-0007/listing.html

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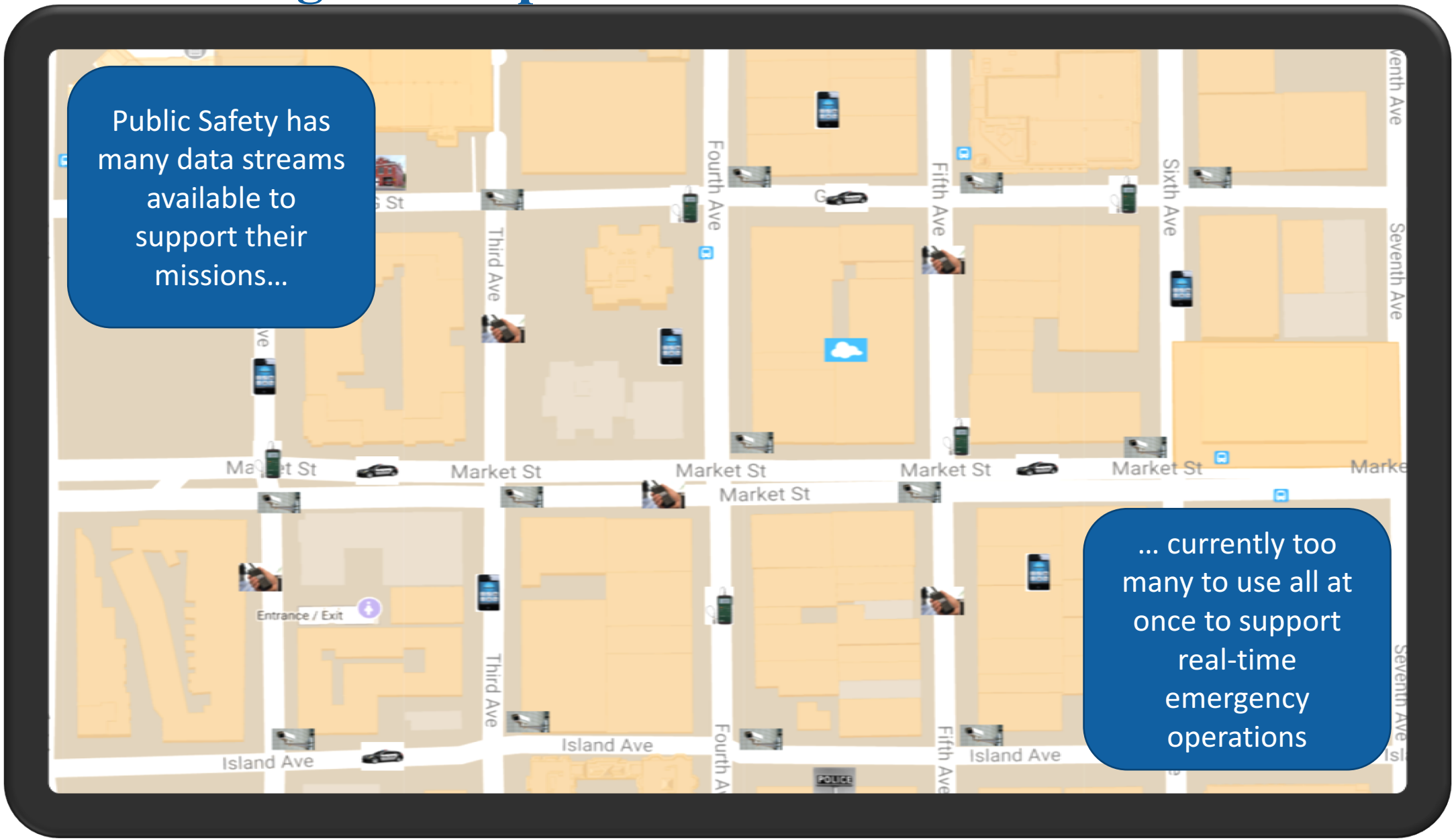
ASAPS Challenge Conceptual Vision



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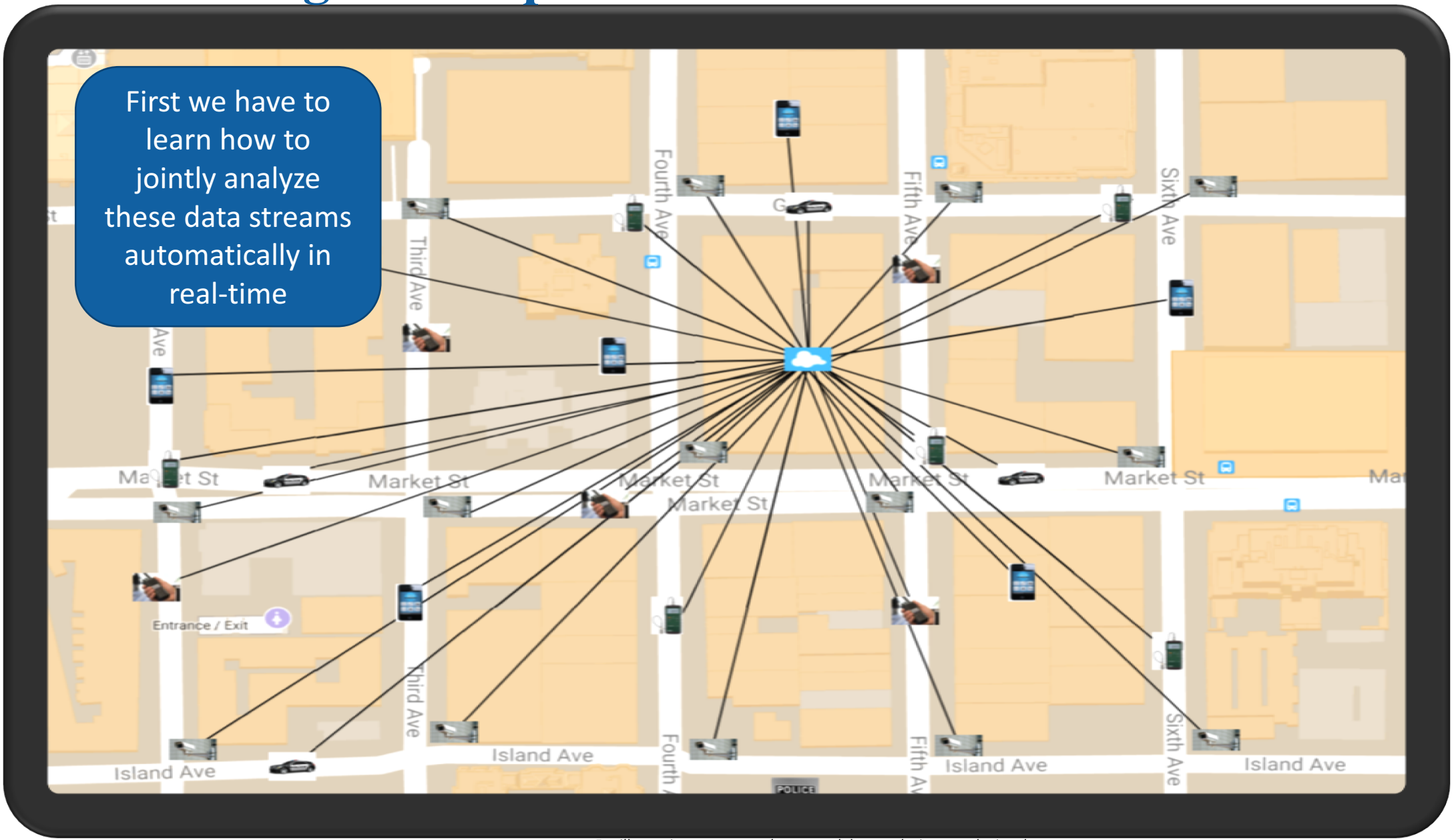
ASAPS Challenge Conceptual Vision



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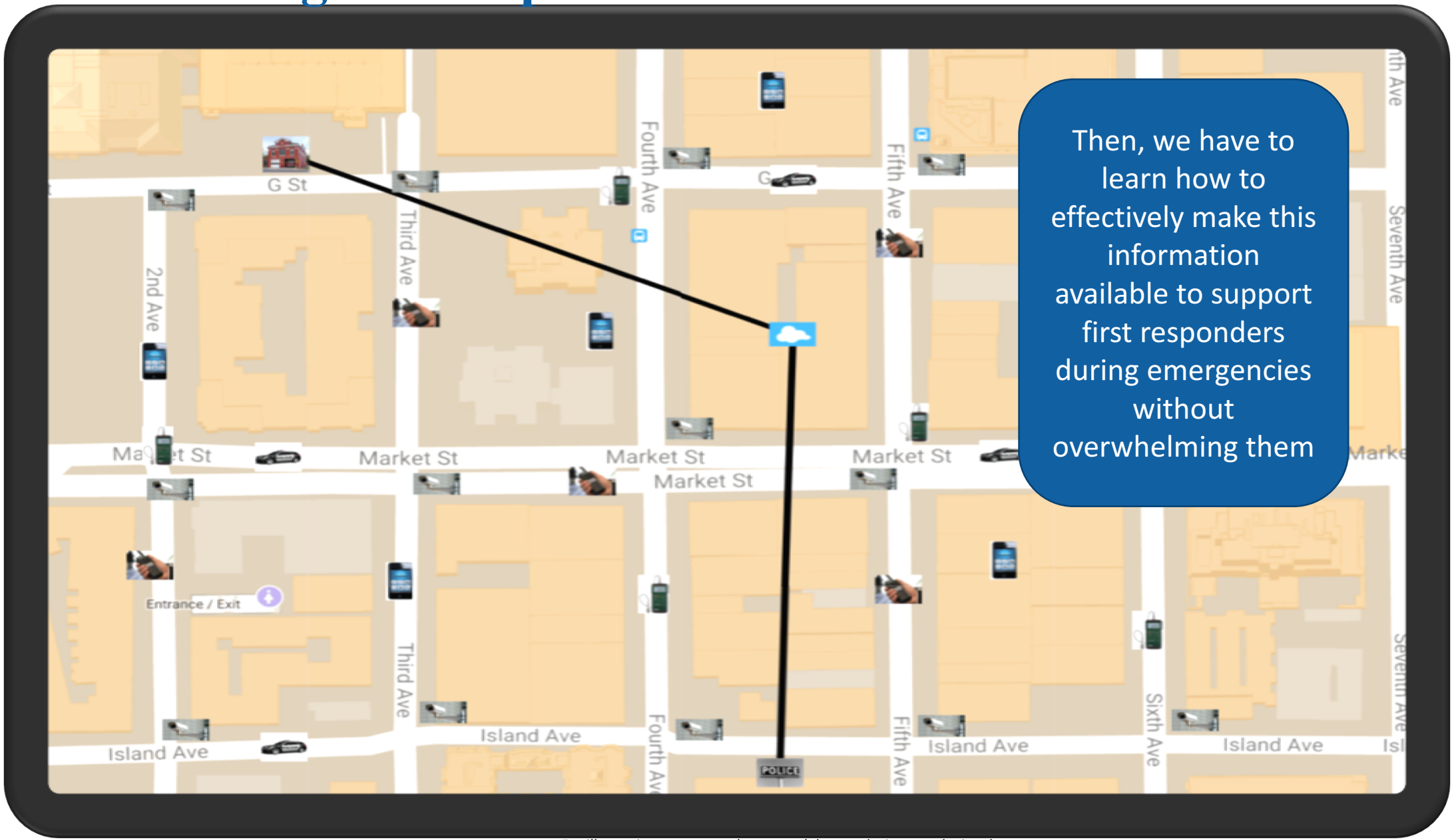

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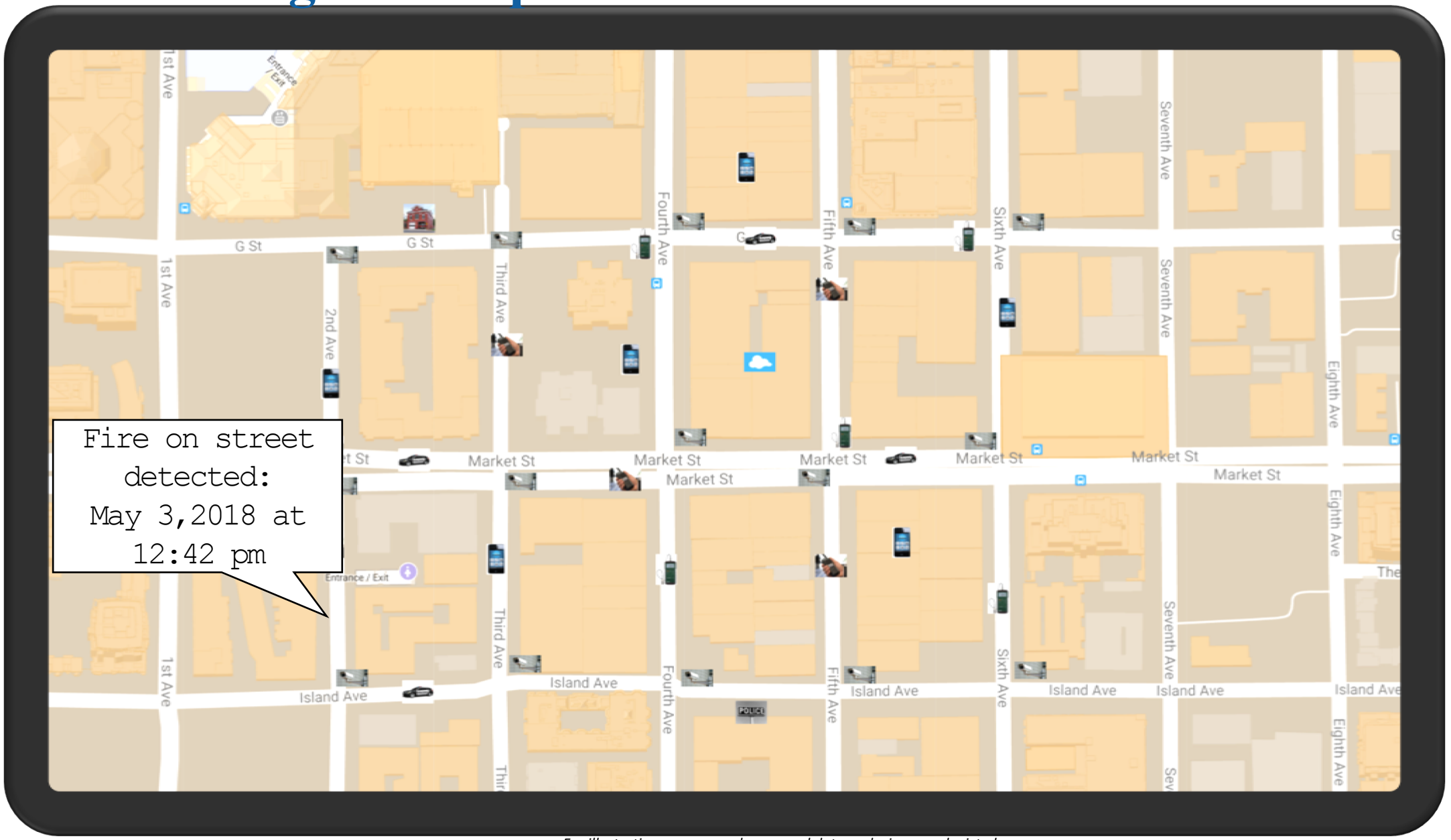

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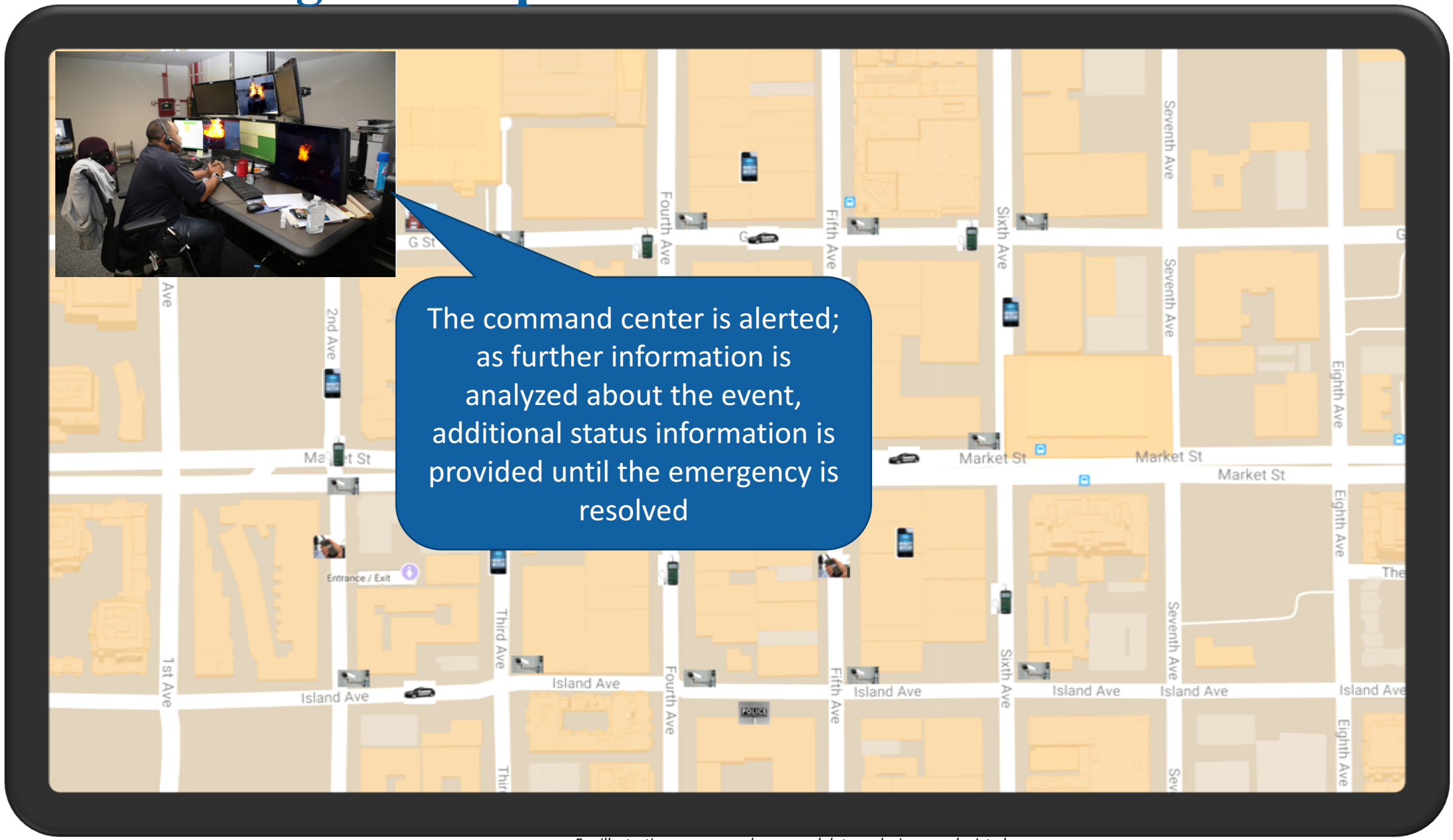

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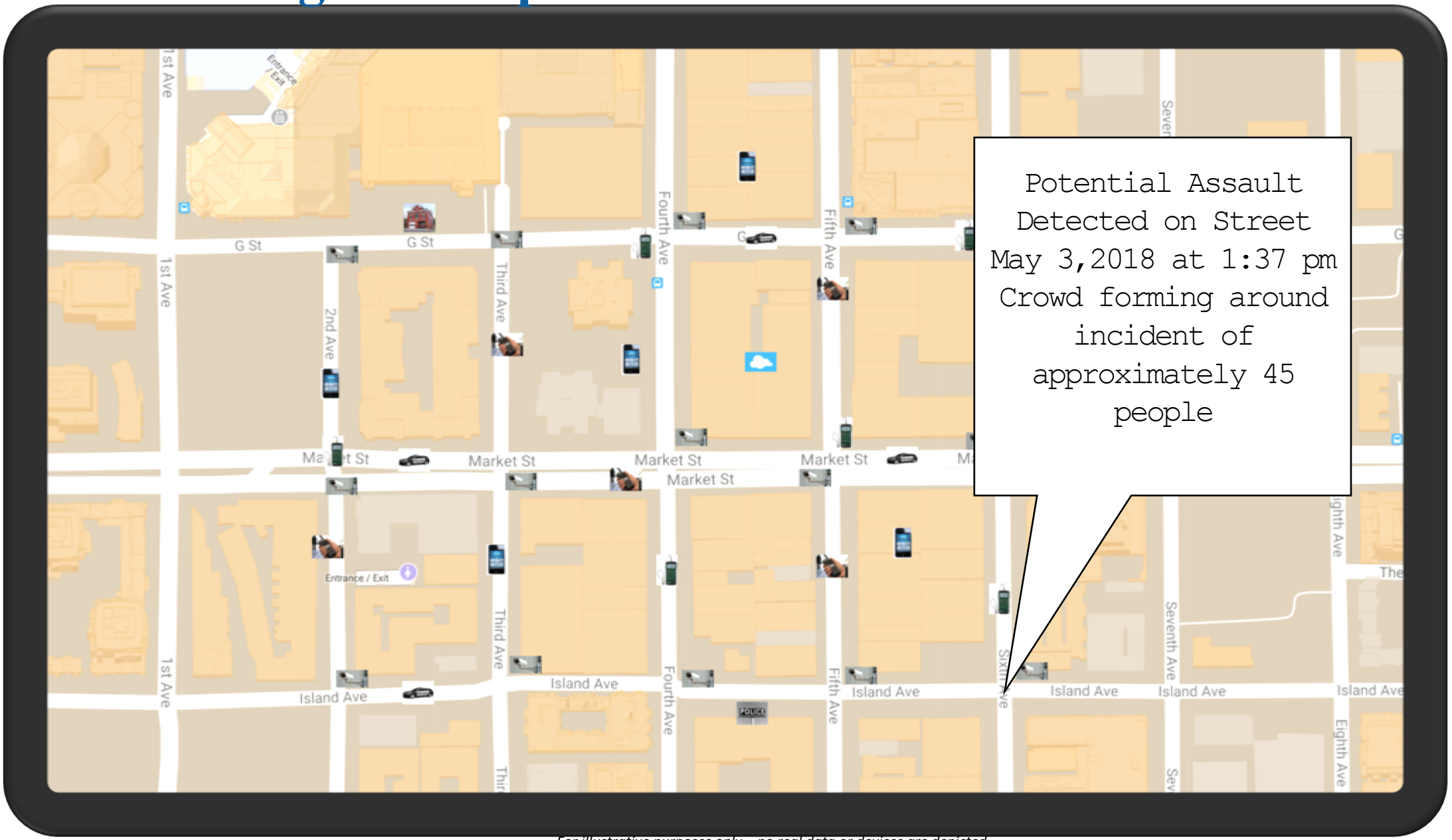

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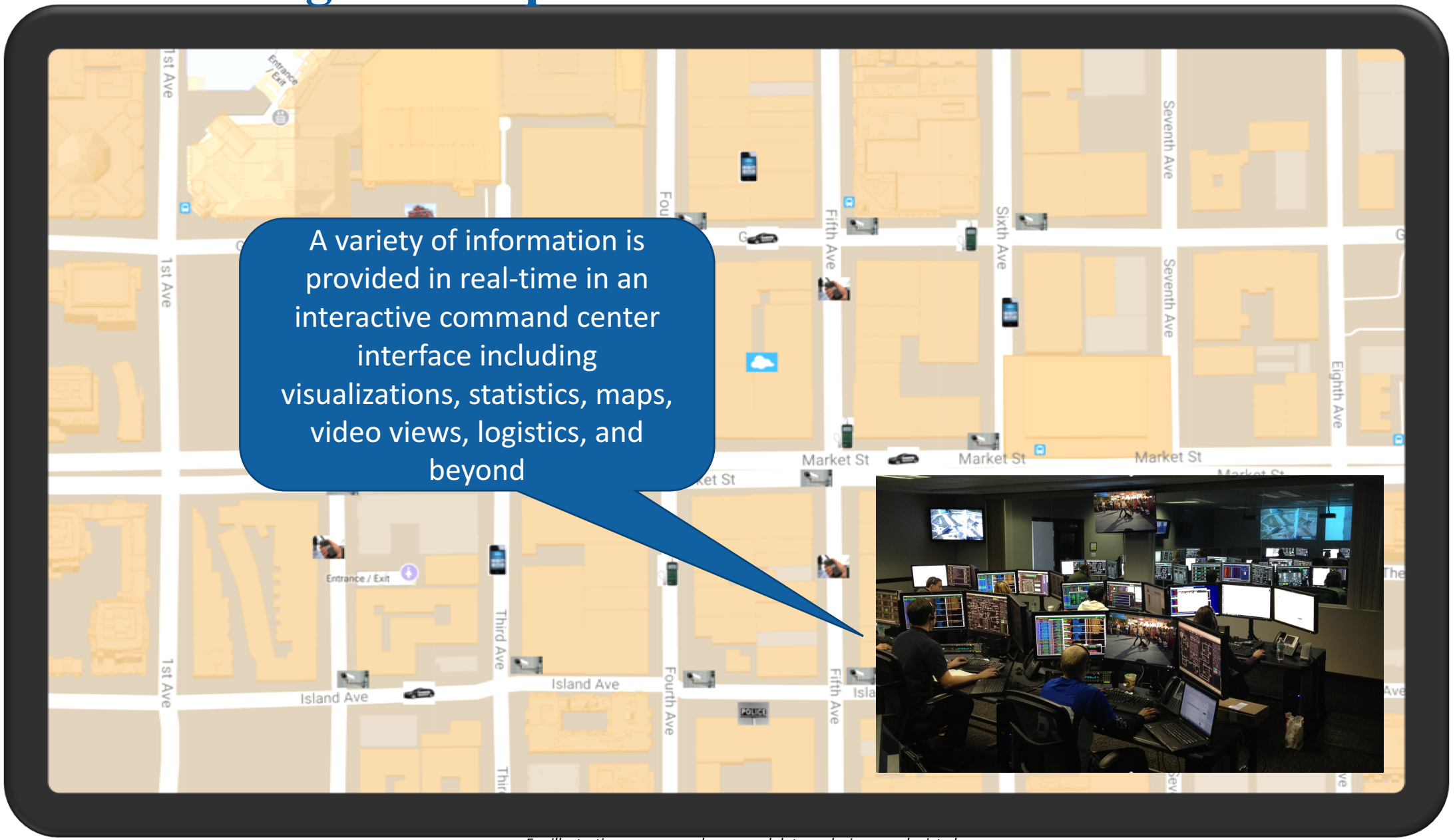

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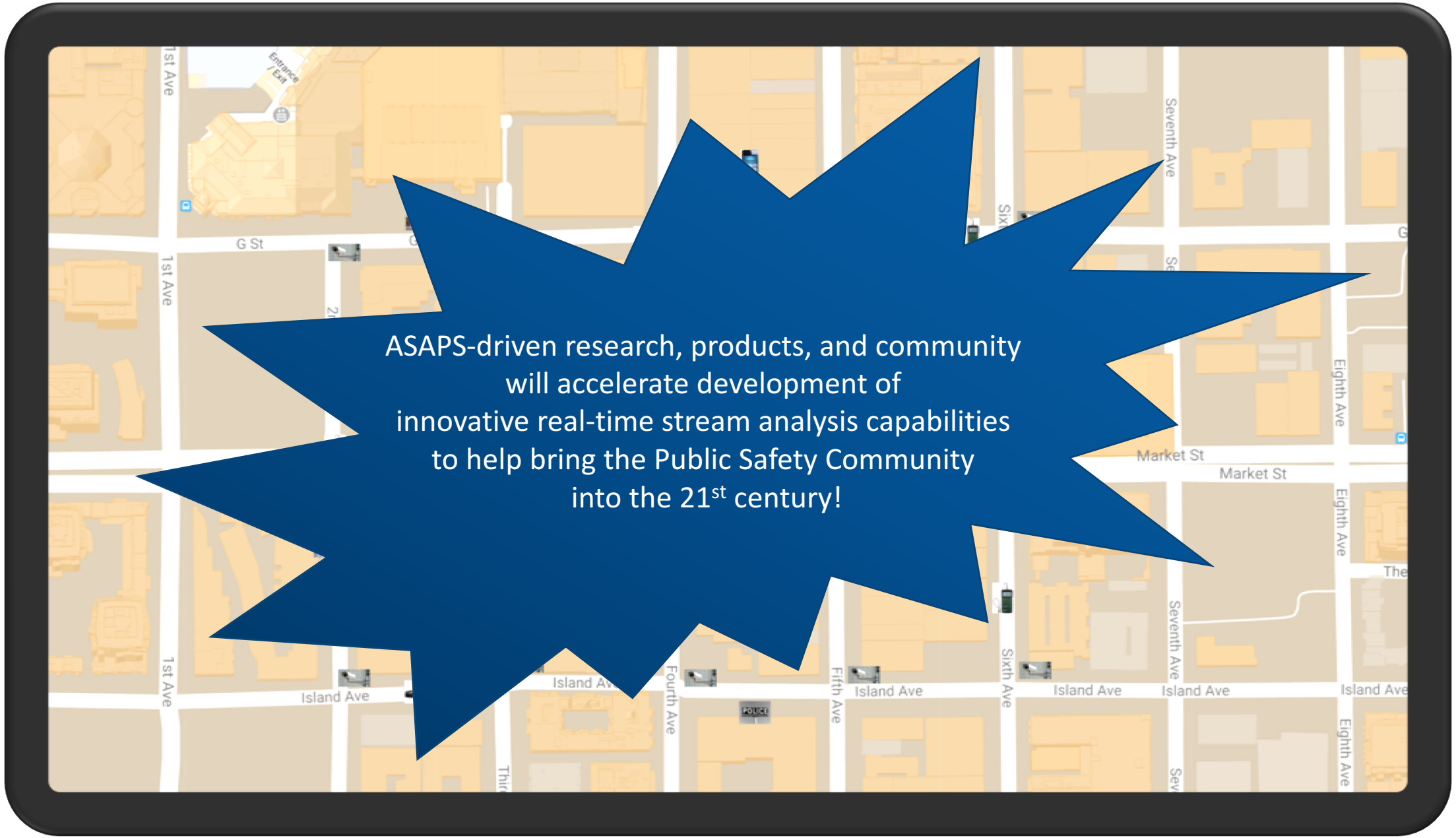

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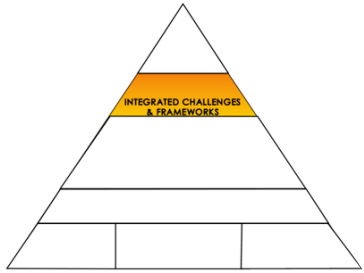
ASAPS will use staged approach to increase participation, reduce risk, and create resources for downstream challenges and lasting R&D



Automated Streams Analysis for Public Safety (ASAPS) Challenge Stages

T1 (6 Months) 04/19 – 10/19	T2 (6 Months) 10/19 – 04/20 Eval at 03/20	T3 (6 Months) 04/20 – 10/20 Eval at 09/20	T4 (6 Months) 10/20 – 04/21 Eval at 03/21	T5 (6 Months) 04/21 – 10/21 Eval at 09/21
Data Stream Creation	**Single Stream Detection Contest**	**Detection Integration Contest**	**Simulated Real-time Info Delivery Contest**	**Staged Interactive Live Contest**
Data collection and annotation, and RDT&E framework V1	*Single stream unimodal data analysis challenge and RDT&E framework V2*	*Multi-stream/multi-modal data analysis challenge and RDT&E framework V2*	*End-to-end real-time emergency detection, analysis, and information delivery and interaction*	*Live End-to-end real-time emergency detection, analysis, and information delivery and interaction*

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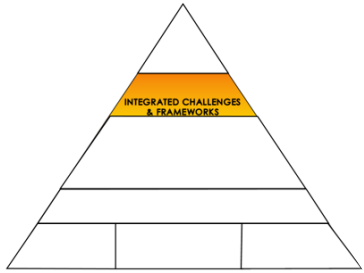
ASAPS will pull together the research across the Analytics Portfolio in a synergistic way!

Timelines, requirements, and deliverables subject to change prior to final posting of opportunity.

ASAPS Envisioned Impacts



- **Agile multimodal analytics and fusion models** for streaming data from video, audio, text, social media, and sensor data
- **Reusable Open Source** analytics algorithms, data, development tools, and test and evaluation frameworks
- **Scalable, deployable emergency event detection, analysis, and information delivery** application tools, systems, and methodologies
- **Critical mass in R&D community** focused on scalable real-time analytics for public safety
- **Challenge products and findings supporting research for future analytics interoperability standards**

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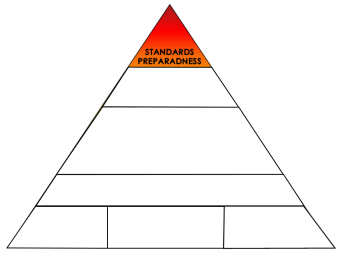
Where are we today?
Standards Preparedness



This will populate as the portfolio matures:

- Technology and measurement-related products from the portfolio R&D: algorithms, tools, frameworks, metrics, reference data, methodologies, and measured findings
- Knowledge products from applied experiments with prototypes, cross-cutting collaborations, interoperability-focused events, and outreach
- Informed cross-disciplinary communities that span public safety, academia, industry, and other areas of expertise

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Questions?

Email: John.Garofolo@nist.gov

Web: https://www.nist.gov/ctl/pscr/research-portfolios/public-safety-analytics

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