Making Sense of Sensors: Combining Visual, Laser and Wireless Sensors to Power Occupancy Insights for Smart Workplaces

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The Power of Sensors

- Electronic systems are increasingly equipped with perception sensors
  - Image
  - Thermal
  - Motion
  - Lidar
  - etc.

- When integrated with other data (e.g., key card swipes), these sensors provide actionable intelligence.

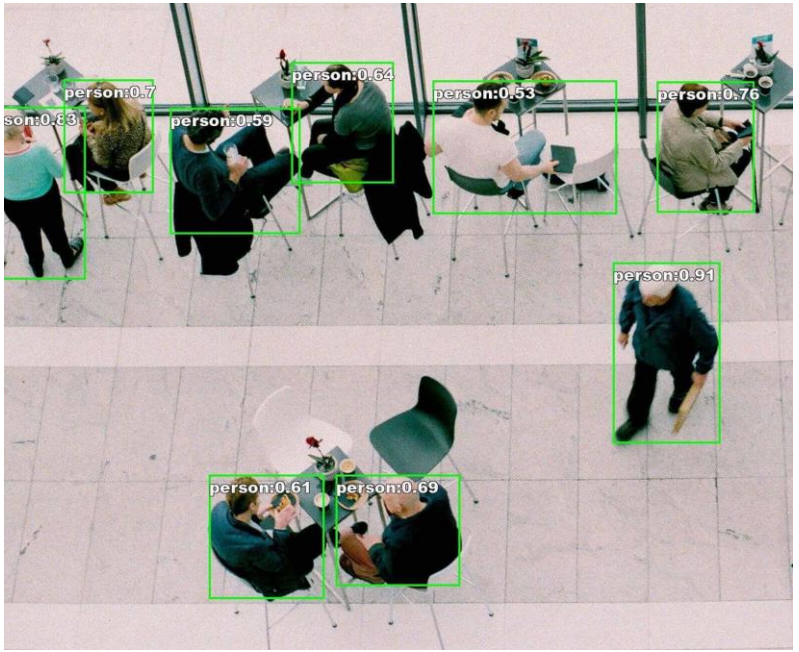
More Difficult than it Appears

But translating sensor data into actionable intelligence is challenging:

- Asynchronous data mapping
- Time windowing
  - Bucketing events into time window vs. point in time
- Limitations
  - Power
  - Connectivity
  - Software stack
- Different software stacks—push/pull-based
- Processing power requirements are unknown

Scenario: Occupancy Insights

- Occupancy information within defined areas—and time periods—drives insights:
  - Dwell times indicate crowds forming, trigger threat alerts
  - Identify people in sensitive/ restricted areas
  - Optimize space planning
  - Analyze sales performance
  - Inform staffing requirements



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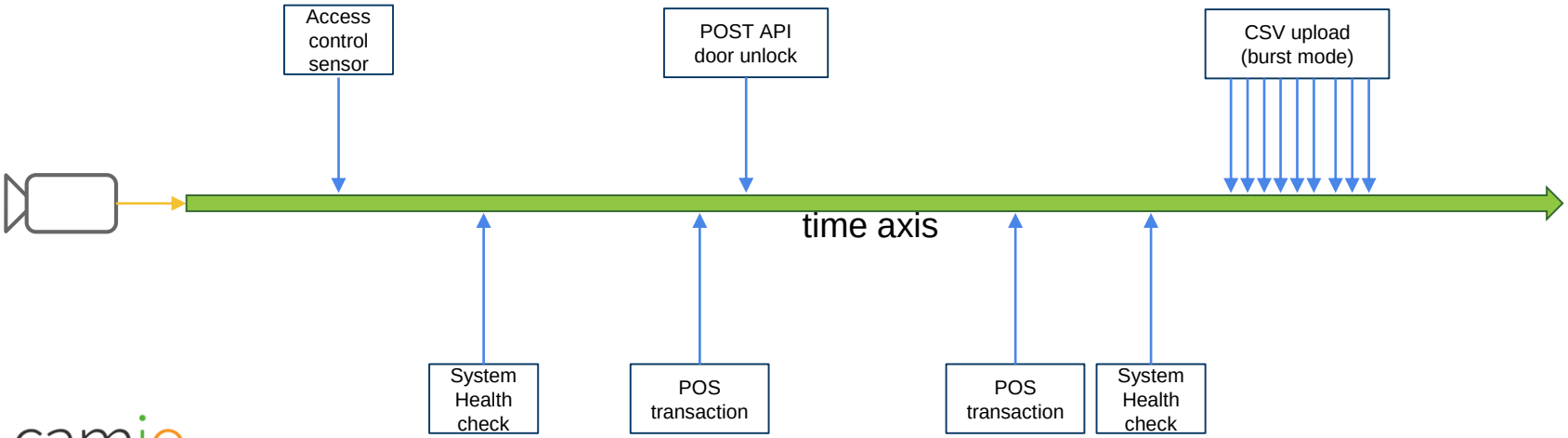
Asynchronous Data Mapping

- Video streams can serve as a continuous time series
- Different sensors generate data at independent points in time
- Each data point can be aligned on the time axis



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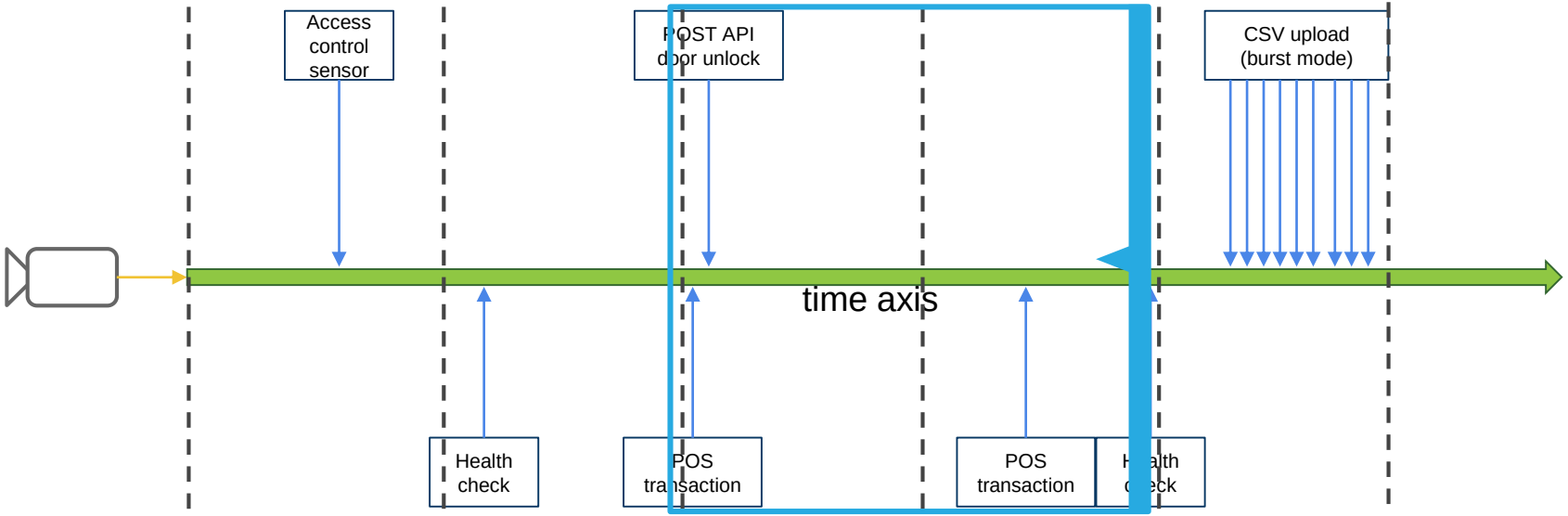
Aggregation and Consolidation

- Creating events by windowing across the time axis
- Consolidating events up to a point-in-time



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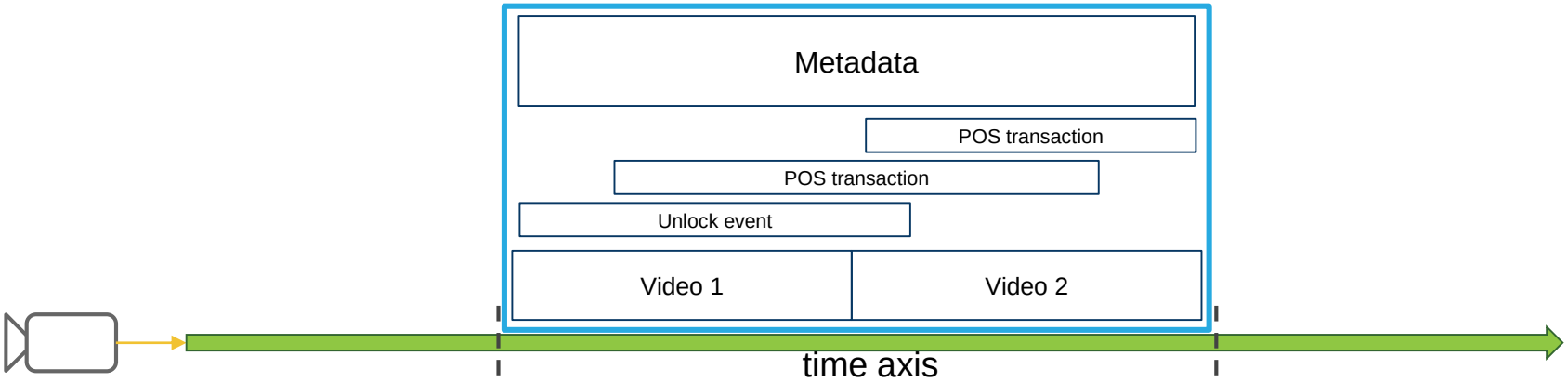
Time Blocks as Events

- Final information blocks with segments of video streams
- External sensor data adds to the metadata of the event
- Events retain source sensor data, and index over time



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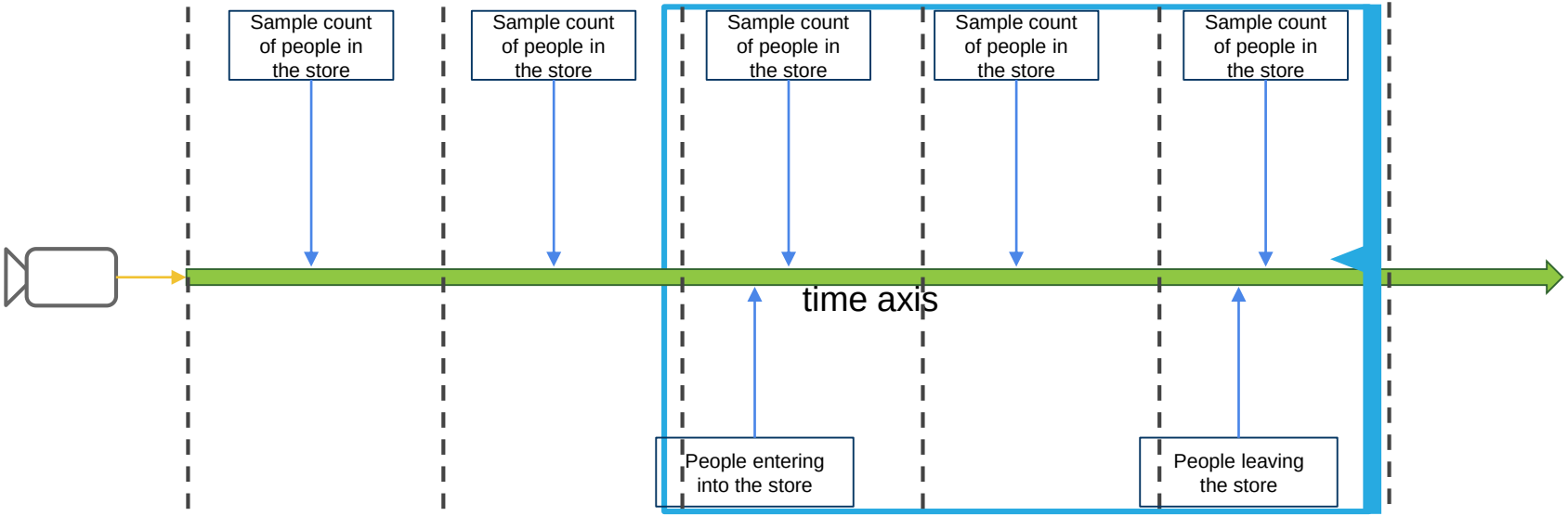
Occupancy Analysis

- Sampling counts from video (or directly from the camera)
- Computing the logic of entrance & exit over timed events



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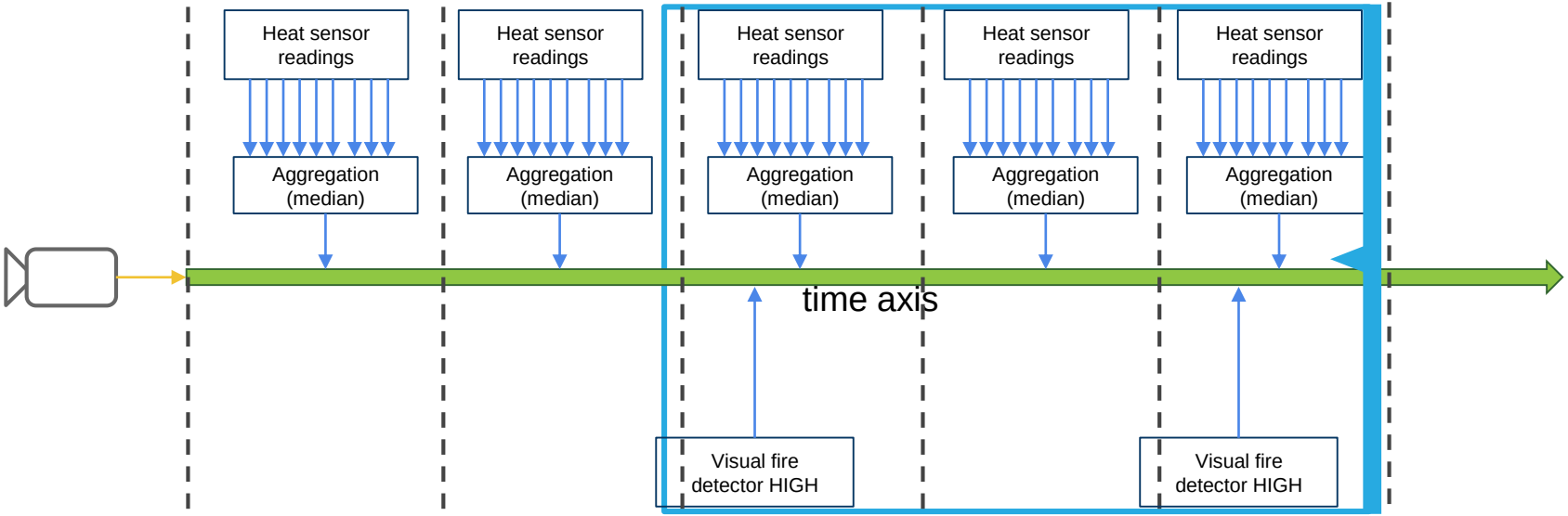
Heat Sensing

- Aggregation of thermal sensor data stream inputs
- Correlation with visual sensor to generate an alarm within the event



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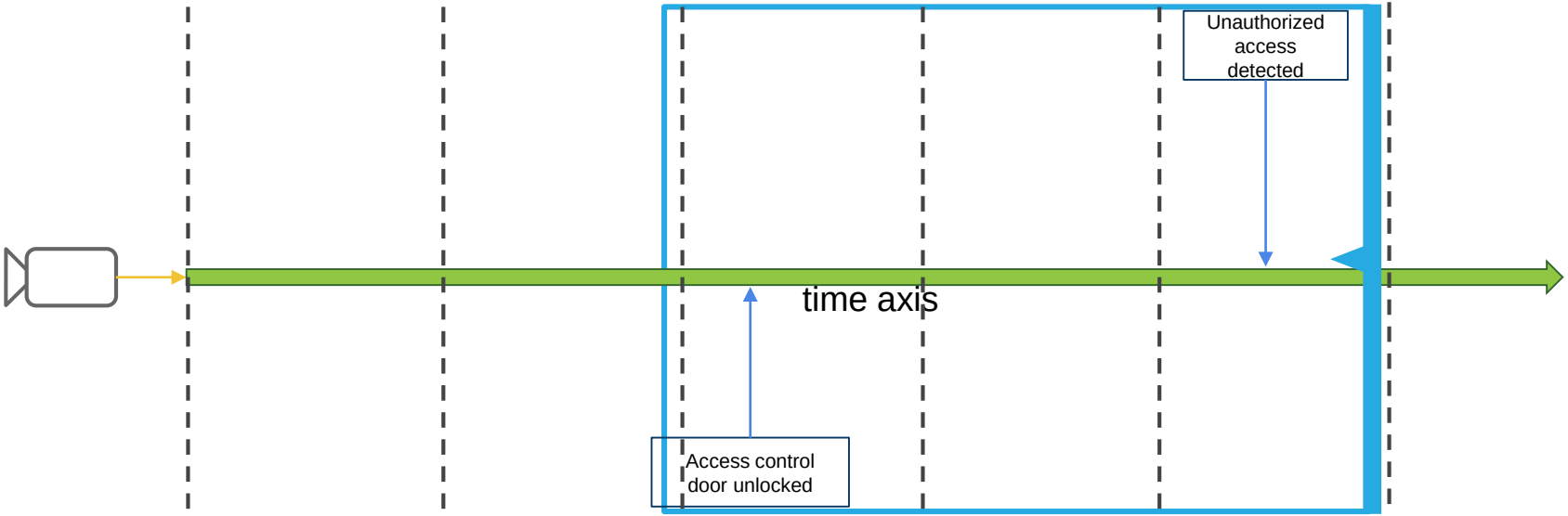
Unauthorized Access Control

- Gathering data from physical access control systems
- Combining with inference and calculation of humans in the scene



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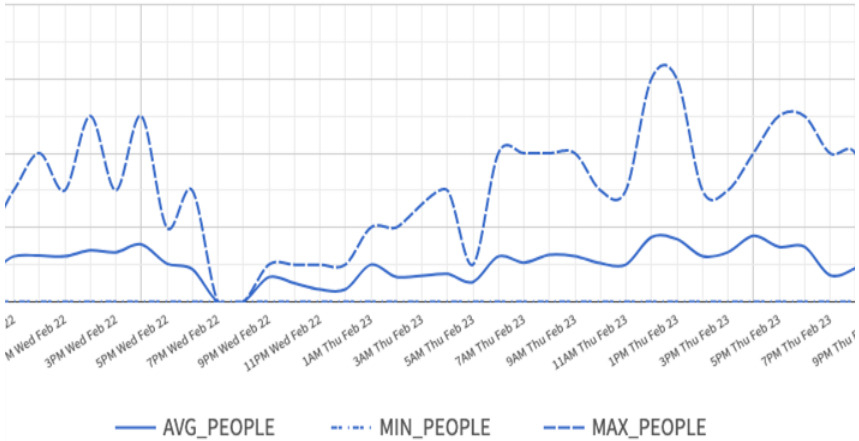
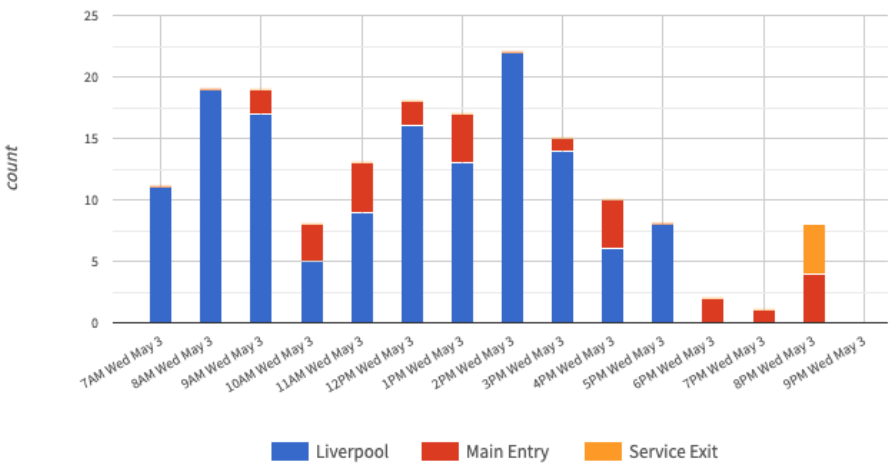
Integrating Elements

- Video streams
  - Some cameras have basic detection/analytics built-in
  - Other cameras just share video with no metadata
- External systems
  - Access control/entry system—verify authorized access
  - Analytics overlays/VMS with advanced ML
  - Advanced tracking algorithms to count transitions and movements

Trend Analysis

- Space utilization dashboards
- Direct data transfer for Business Intelligence systems





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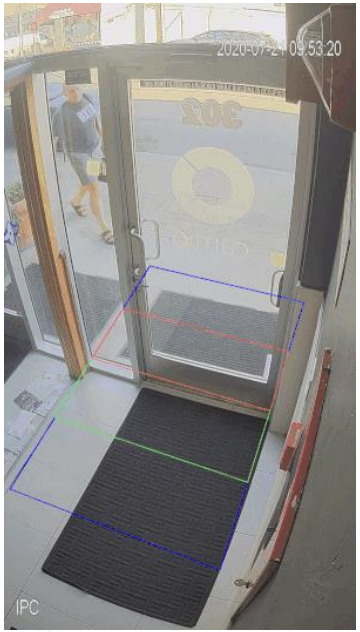
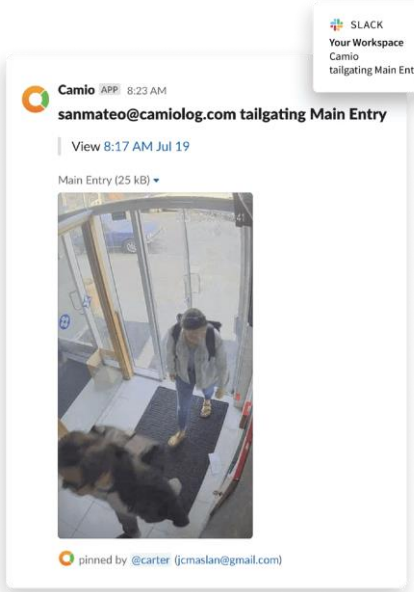
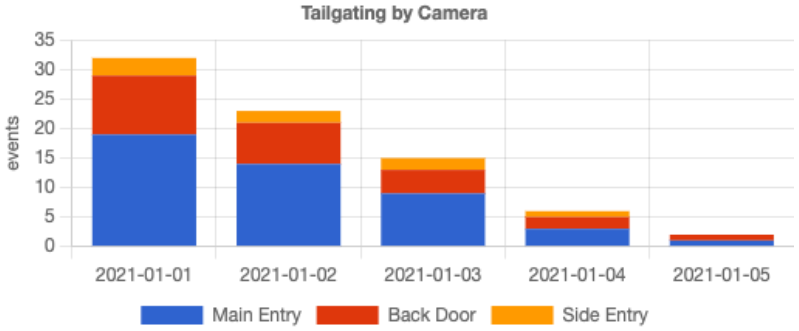
Additional Outcomes

- Annotations, alerts, dashboards, webhooks, …







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Sensor Isolation and Temporal Consensus

- Source
  - Each sensor manages data collection independently
  - System is agnostic to underlying sensor technology stack
  - For example, heat sensor works at a set frequency of sampling
- Transfer
  - Each sensor transmits data to a single location
  - Push queues/ Streaming/ Uploads, etc all write to the same store
  - Data adapters transform each entry to a standardized format
- Consolidation
  - Events capture standardized inputs
  - Generate metadata per event with consolidated data over time axis

Overcoming Challenges

- Sensor power limitations do not block consolidation since events are generated on an independent timeline
- Burst and late arrival of signals is easy to combine as events are indexed on time axis
- Asynchronous communication allows independent systems to use any programming language and relay data over json
- Events support both stream and batch processing

Key Takeaways

- Perception sensors provide real-world insights when combined with external data
- Aggregating sensor data into a logical system is challenging but achievable with techniques like breaking streams into time windows and point-in-time aggregation
- External data like access control systems and analytics overlays gain new relevance on the time axis
- Occupancy data and insights help drive safer and more efficient workplaces
- Data outcomes include real-time & trend analysis and alerts

Resources

- Camio Occupancy Insights
  camio.com/solutions/occupancy-insights

- Camio Unauthorized Access Detection
  camio.com/solutions/unauthorized-access-detection