Big Data in Transportation

Real-Time Traffic Monitoring with Spark Streaming and Traffic Safety Techniques

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Leveraging Big Data for Traffic Safety and Security

- Urbanization & Mobility Demands
- Role of Big Data Analytics
- Real-Time Predictions
- Apache Kafka and Fuzzy Stream Processing

Research Papers

- Choi Dojin, Song Seokil, Kim Bosung, Bae Insu, (2015) '**Processing Moving Objects and Traffic Events based on Spark Streaming**', https://ieeexplore-ieee-org.ccny-proxy1.libr.ccny.cuny.edu/stamp/stamp.jsp?tp=&arnumber=7434327

- Lian Yangi, Zhang Guoqing Lee Jaeyoung, Huang Helai, (2020),'**Review on big data applications in safety research of intelligent transportation systems and connected/automated vehicles**', https://www.sciencedirect.com/science/article/abs/pii/S0001457520307442

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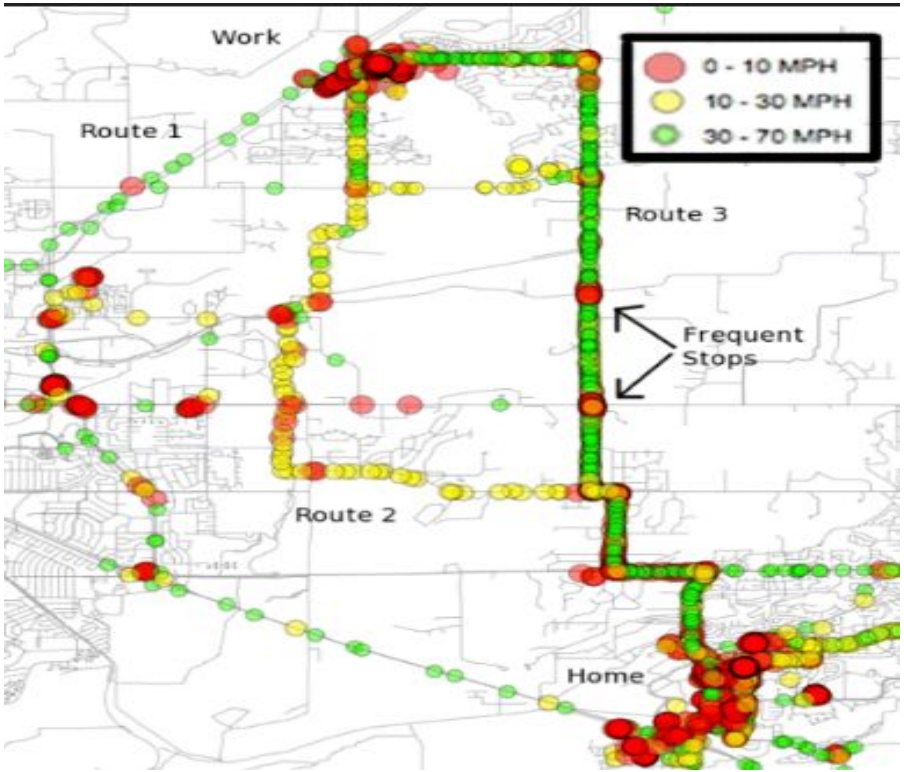
Why Does Real Time Traffic Data Matter?

THE NECESSITY of Real-time Traffic Data

- **Immediate Response:** Real-time data allows for quick reactions to traffic conditions, minimizing congestion and delays.
- **Enhanced Safety:** Instantaneous processing of traffic data can prompt timely warnings and interventions, reducing accidents.
- **Dynamic Traffic Management:** Adapts to changing conditions, optimizing traffic flow and reducing environmental impact.
- **User Convenience:** Provides commuters with up-to-date information for better route planning and travel time estimation.
- **Data-Driven Decisions:** Supports intelligent transportation systems that make automated decisions based on live data feeds.

WEVING (Social Driver Assistance) - Big Data Processing Technique



- **Smartphone Integration:** Utilizes standard smartphone sensors including cameras, GPS, gyroscope, and accelerometers.
- **Traffic Event Detection:** Automatically identifies various traffic events such as delays, congestion, and accidents.
- **Social Connectivity:** Shares real-time traffic updates and images with users in social groups.
- **User-Centric Design:** Empowers drivers with collaborative, community-driven information exchange.

WEVING System

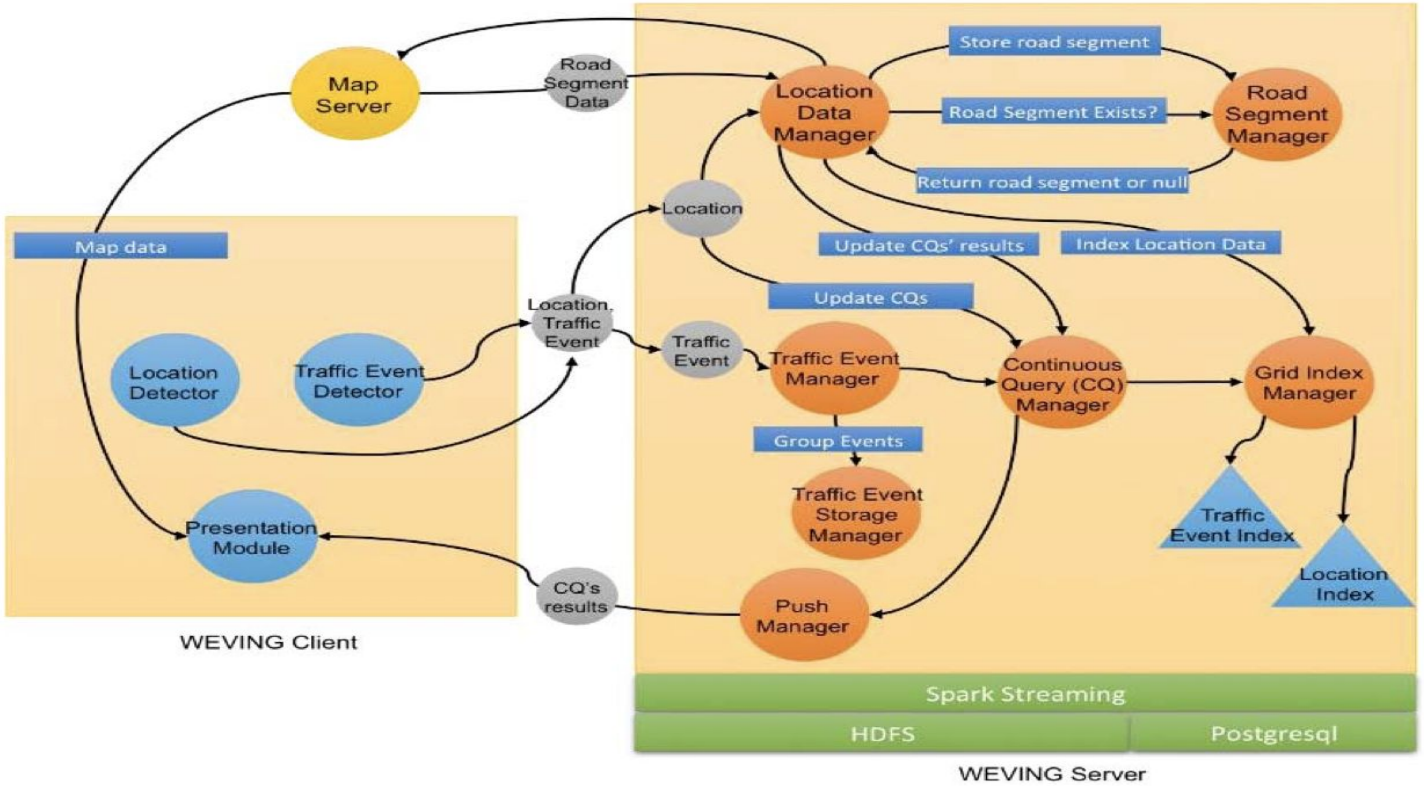


Figure 1. Architecture of the proposed In-memory big traffic data processing system

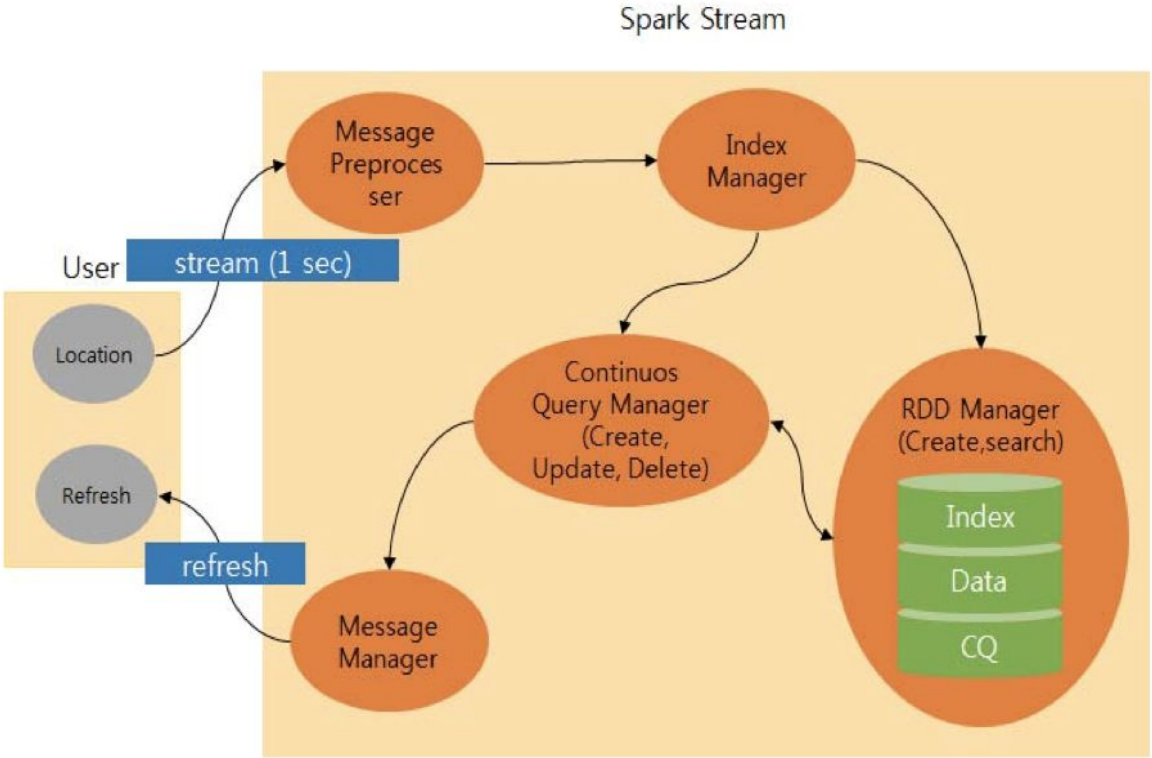


Figure 2. Architecture of the continuous query processing method

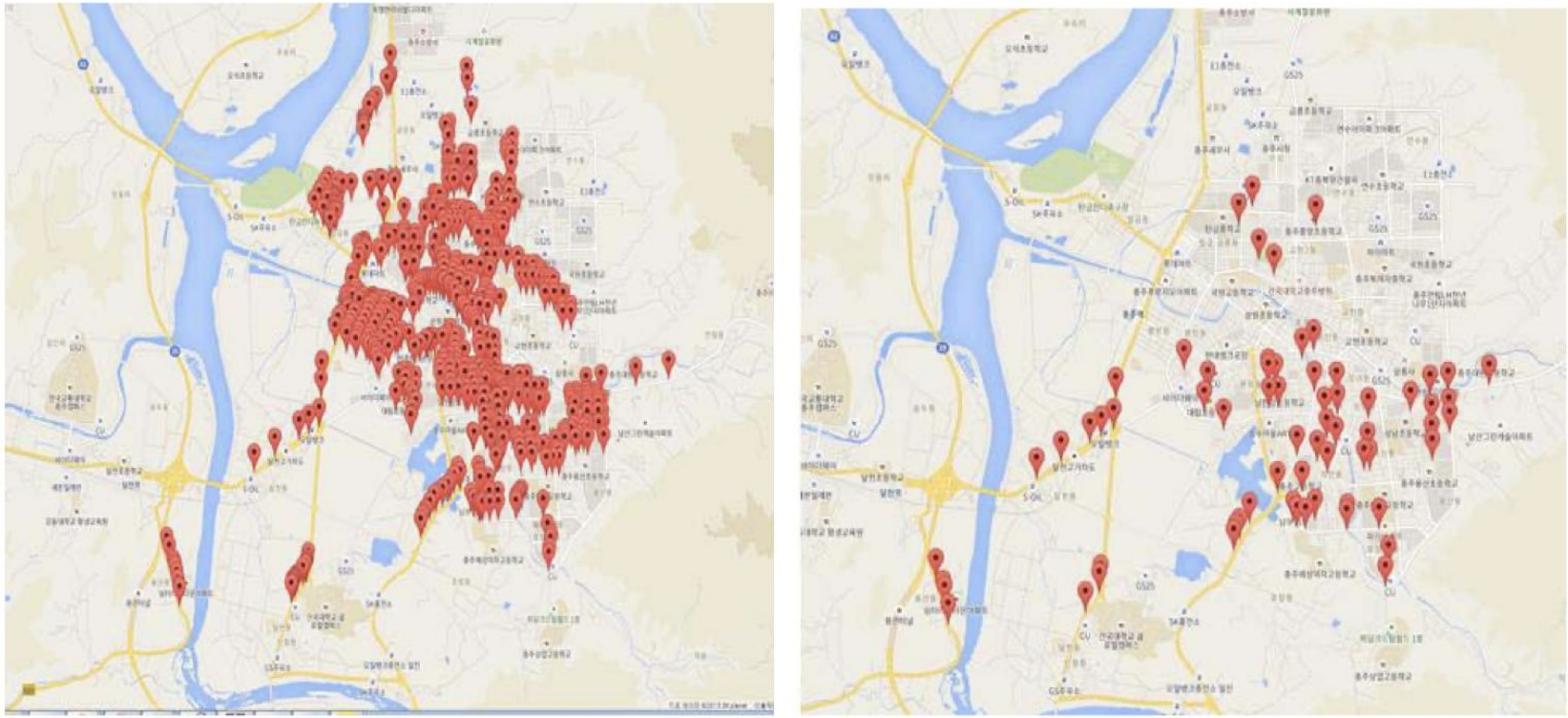
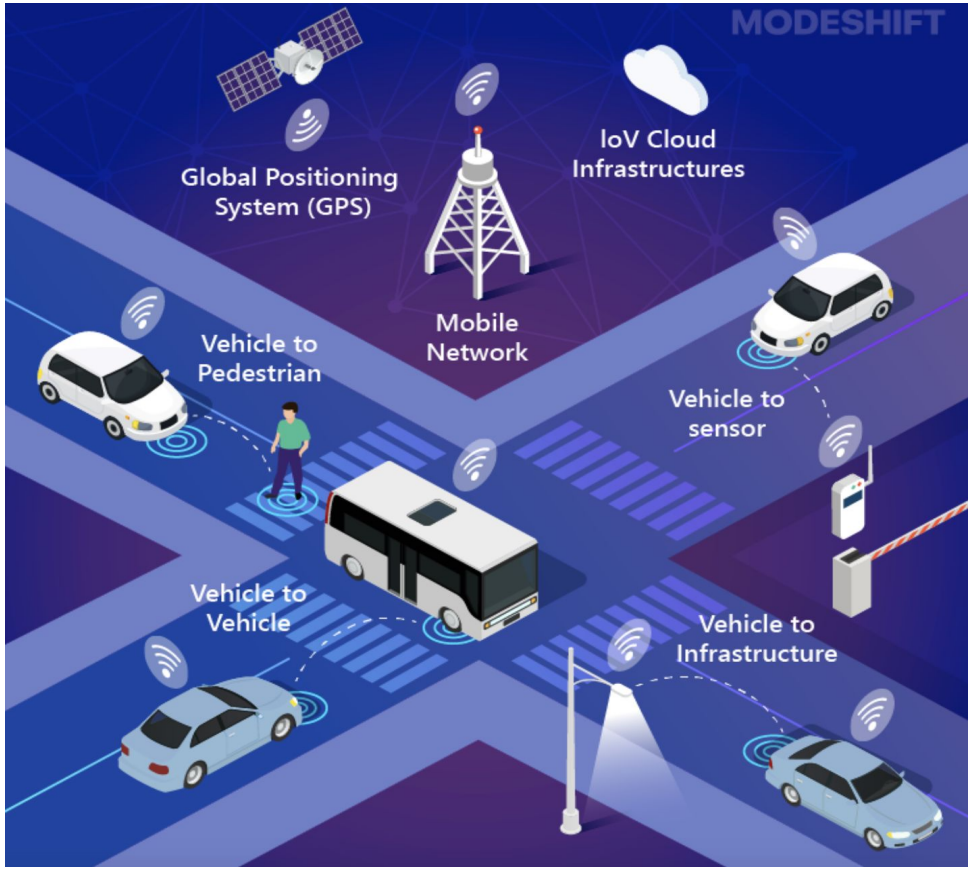


Figure 4. Result of the event grouping

Big Data Applications in Traffic Safety of ITS and CAV

Yanqi Lian, Guoqing Zhang, Jaeyoung Lee, Helai Huang

What are ITS and CAV?



Intelligent transportation systems (ITS) technologies include state-of-the-art wireless, electronic, and automated technologies.

CAV (Connected and Automated Vehicles), on the other hand, represents a subset of ITS focused on vehicles that can communicate with each other and the transportation infrastructure (connected vehicles), and vehicles that can operate without human intervention (automated vehicles).

Intelligent Transportation Systems?

- Continuous data collection from diverse sources on a large scale.
- Installation of Detectors/Sensors/other resources
- Emergence of CAV(connected/automated vehicles) and its processing capabilities

Big Data Safety analytics in ITS research

Key Research Areas:

- Crash Detection/Prediction
- Contributing Factors to Traffic Crashes
- Crash Hotspot Identification
- Driving Behavior Analysis

Big Data Analytics in CAV Research

- **Connected Vehicles (CVs) and Automated Vehicles (AVs)**
  - CVs communicate with other vehicles and infrastructure.
  - AVs operate without human input, enhancing transportation efficiency.
- **Impact of CAV**
  - Potential to revolutionize transportation by increasing capacity and safety.
  - Reduces congestion, energy use, and pollution.
- **Key Research Areas**
  - Crash prediction and detection using Big Data in CAV.
  - Studies utilize data from CVs and AVs, including V2V communications.
- **Notable Studies and Results**
  - Example: Using Neural Networks for rear-end crash prediction (Chen et al., 2018a).
  - Vehicle data analysis to identify risky driving behaviors (Peng and Shao, 2018).
  - Analysis of vehicle behavior data to understand crash frequencies and patterns (Arvin et al., 2019).

Frequency of equipment used to collect data

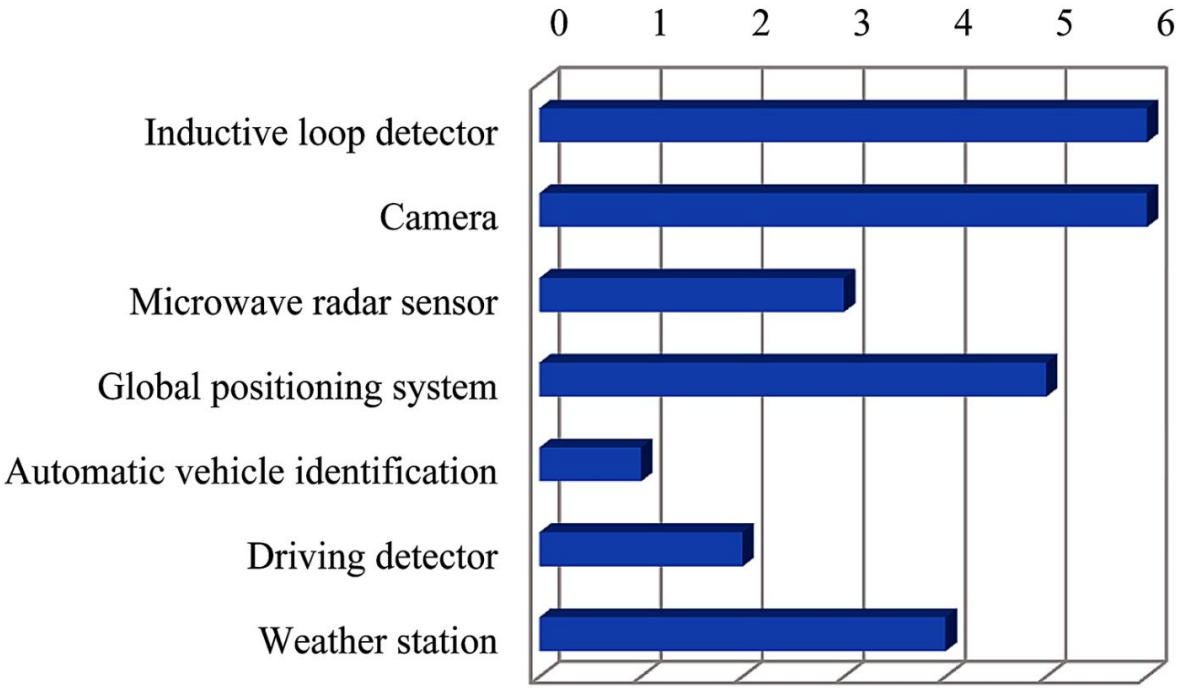


Fig. 2. Frequency of equipment used to collect data in the reviewed papers.

Equipment Categories

- Traffic Flow Detectors
- Weather Stations

Traffic Flow Detectors

- **In-roadway**: Inductive loop detectors (detects volume, speed, occupancy)
- **Over-roadway (Non-intrusive)**: Mounted above or alongside the road

Review Summary of 57 Articles on Big Data in Traffic Safety

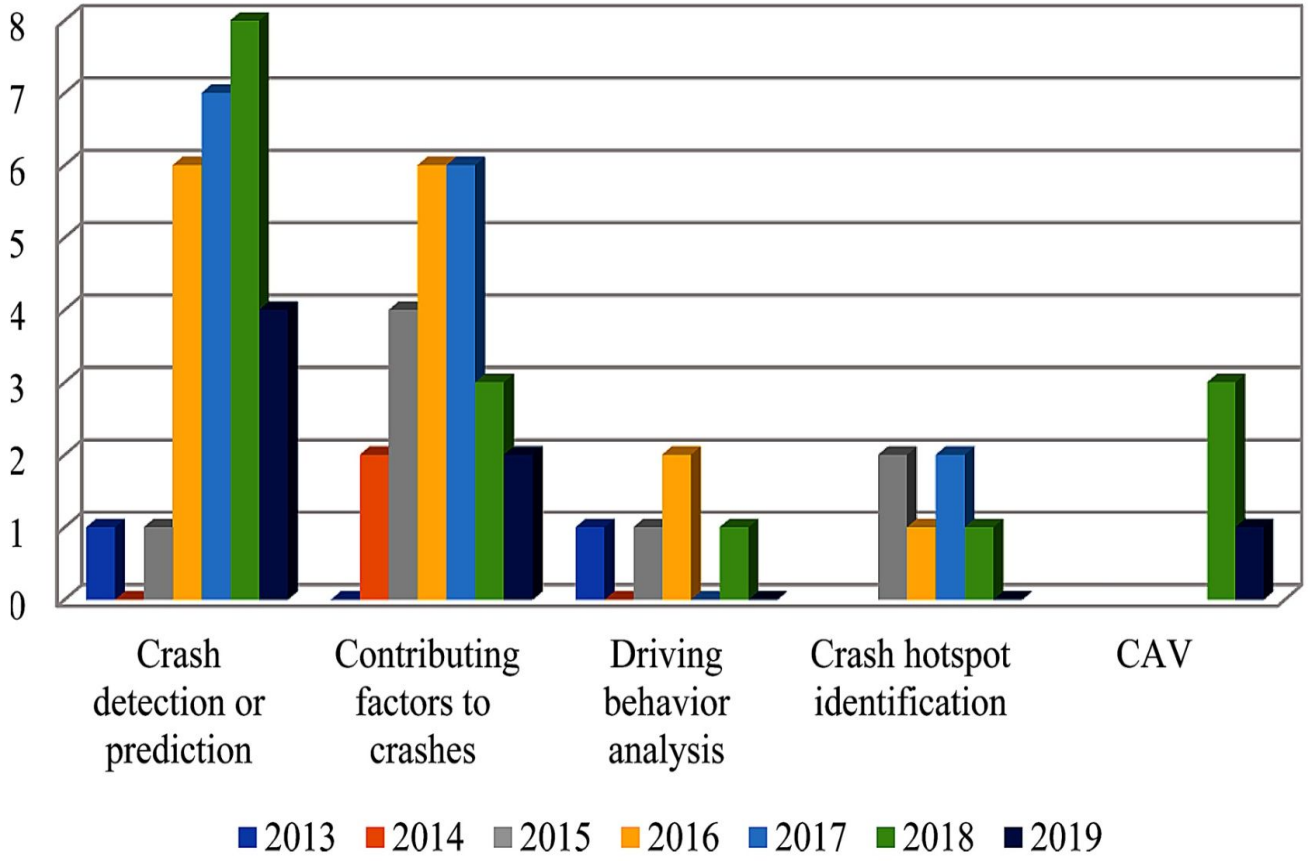


Fig. 5. Frequency of Big Data applications in the reviewed papers.

Key Insights

- Majority of studies focus on Crash Detection/Prediction
- 24 articles on discovering Contributing Factors to Crashes
- Less literature on Crash Hotspot Identification and Driving Behavior, yet consistently explored
- CAV research is emerging, with a current focus on crash detection, contributing factors, and driving behavior

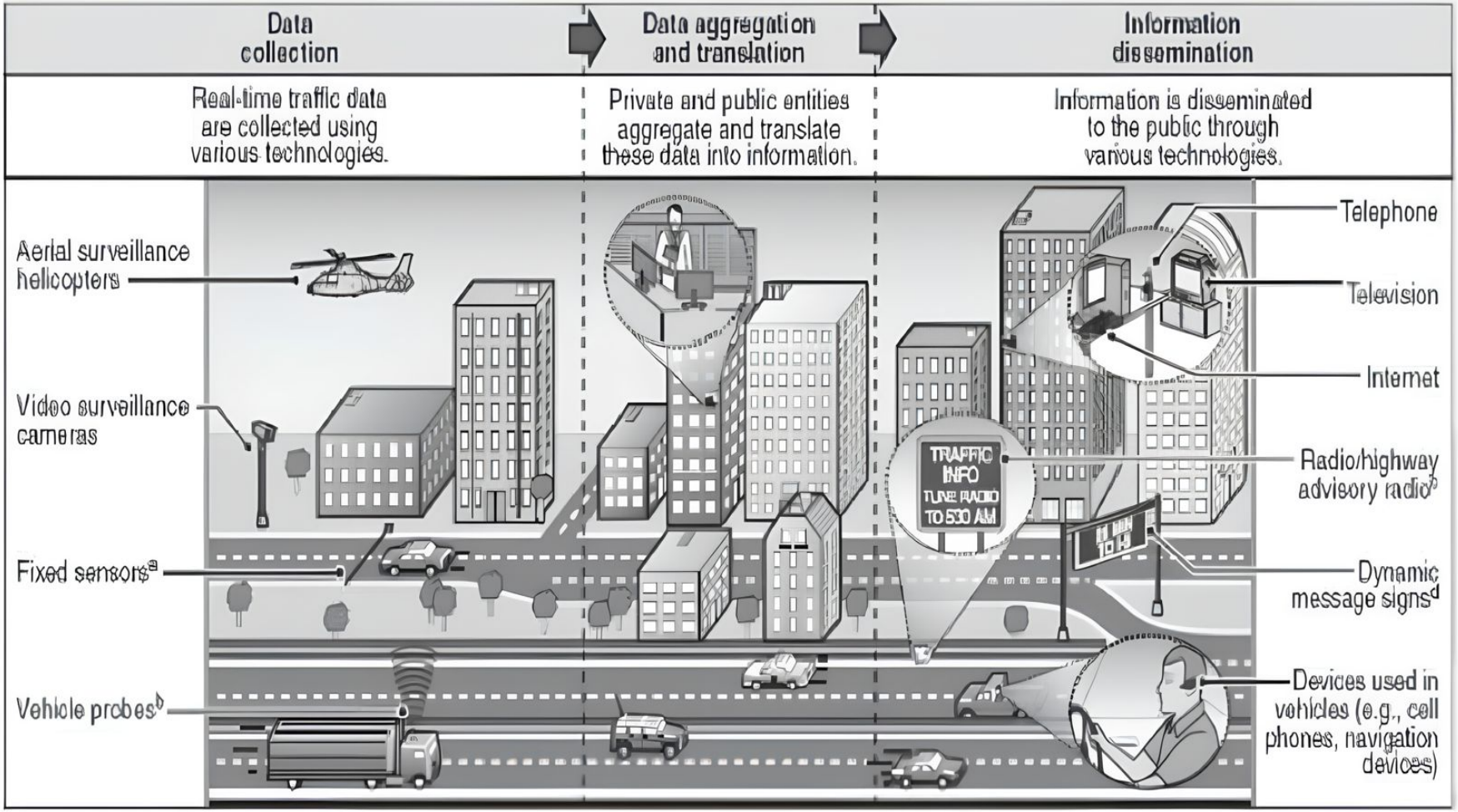


Figure 1: How Real time ITS works.

Balancing Surveillance, Privacy, and Safety

- Surveillance and Privacy Concerns
- Safety Enhancements and Security Risks
- Balancing Risks and Benefits
- Hype vs. Reality
- Ethical Framework and Regulations

Next Steps:

- Performing real-time data analytics to process and provide insights immediately, reducing the need for large data storage and retrospective analysis.
- Ethics of Smart City Initiatives

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