

Smart Cities--Smart Futures Idea:

Connecting the Milwaukee of Tomorrow: The Smart Streetcar Corridor for Greater Community Health, Equity, Livability, and Prosperity (HELP)

Technology areas

- Transportation
- 5G Technology
- Streetscapes
- Infrastructure
- 8K Video
- Internet of Things
- Artificial Intelligence



TEAM

- John December, M.S., Technical Communicator, student in the Osher Lifelong Learning Institute at the University of Wisconsin--Milwaukee
- Jie Yu, Assistant Professor, Center for Urban Transportation Studies, University of Wisconsin--Milwaukee (Faculty Advisor)
- Dahai Han, PhD Candidate, Center for Urban Transportation Studies, University of Wisconsin--Milwaukee
- Weijie Tan, PhD Candidate, Center for Urban Transportation Studies, University of Wisconsin--Milwaukee

Idea: Smart City Streetcar

Our team's idea is to tap into the power of emerging technologies--including 5G wireless, 8K video, and Internet-of-things--as data feeds to support The Hop's Main Line with smart transportation system analytics for improving the efficiency of the urban transportation system and the quality of life for the community.



The Milwaukee Streetcar - The Hop

- Brookville Liberty Modern Streetcar [1]*
- Operates using pantograph in contact with overhead catenary wires; OR
- Operates using onboard energy storage system (OESS) (lithium-ion batteries)



*For bracketed number reference sources, please see the document, "Connecting the Milwaukee of Tomorrow--Summary"

The Milwaukee Streetcar - The Hop

Interior



Controls

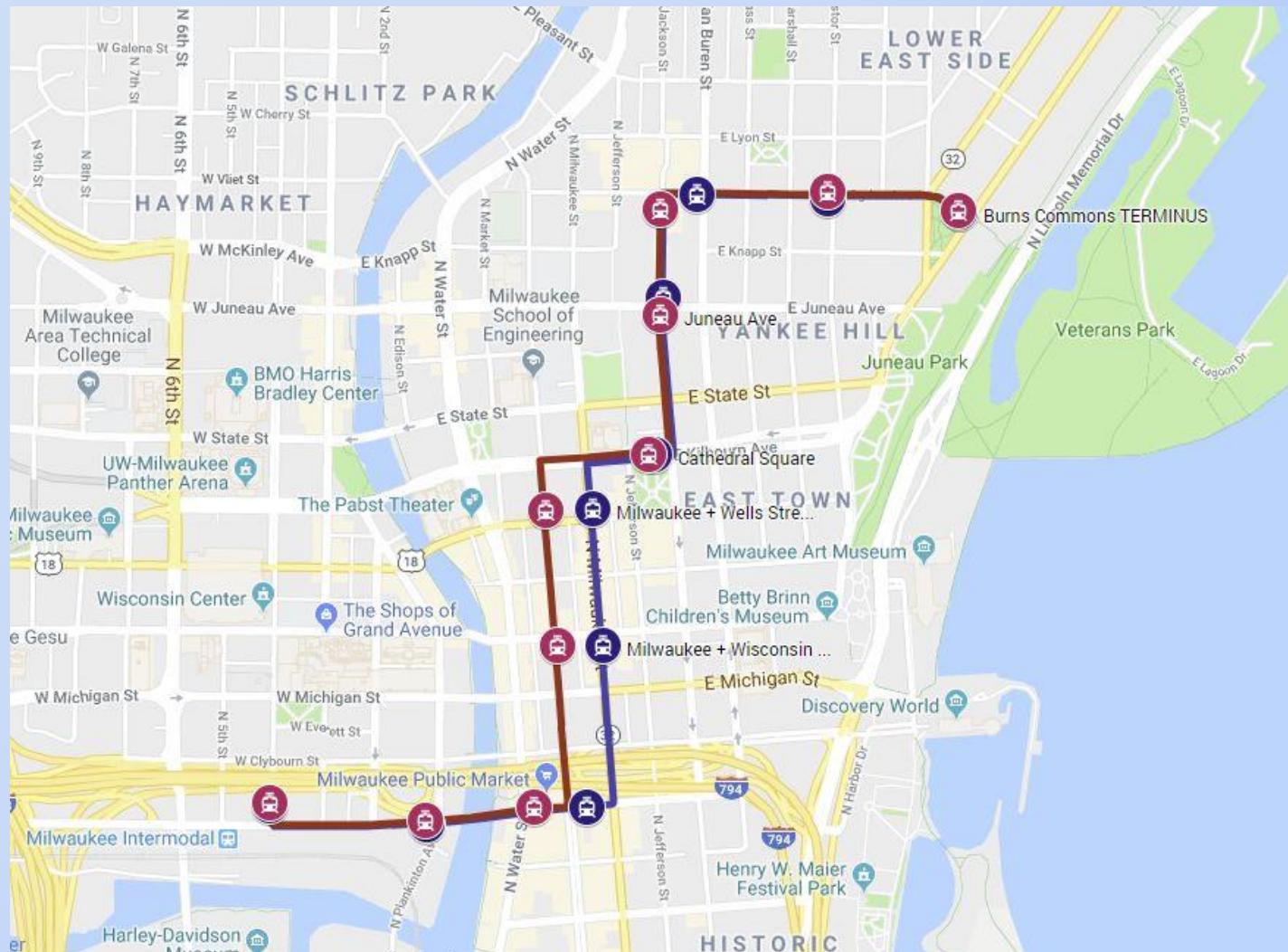


Operations and Maintenance Facility (OMF), N 5th St



The Hop Route (Main Line)

The Hop Main Line accepting passengers November 2, 2018 [2]



<http://www.december.com/places/mke/streetcar/destinations.html>

The Hop Expansions

- **Main Line [2]
complete; passengers
November 2018**
- Lakefront Line
portion of track complete, expected
2020
- Bronzeville
meetings and plans 2018 [3]
- Walker's Point
meetings and plans 2018 [3]
- Vision of wider services [4]
- Neighborhood-serving transit,
housing, commerce, and
development [5]

<http://www.movingmkeforward.com/>

Map: City of Milwaukee

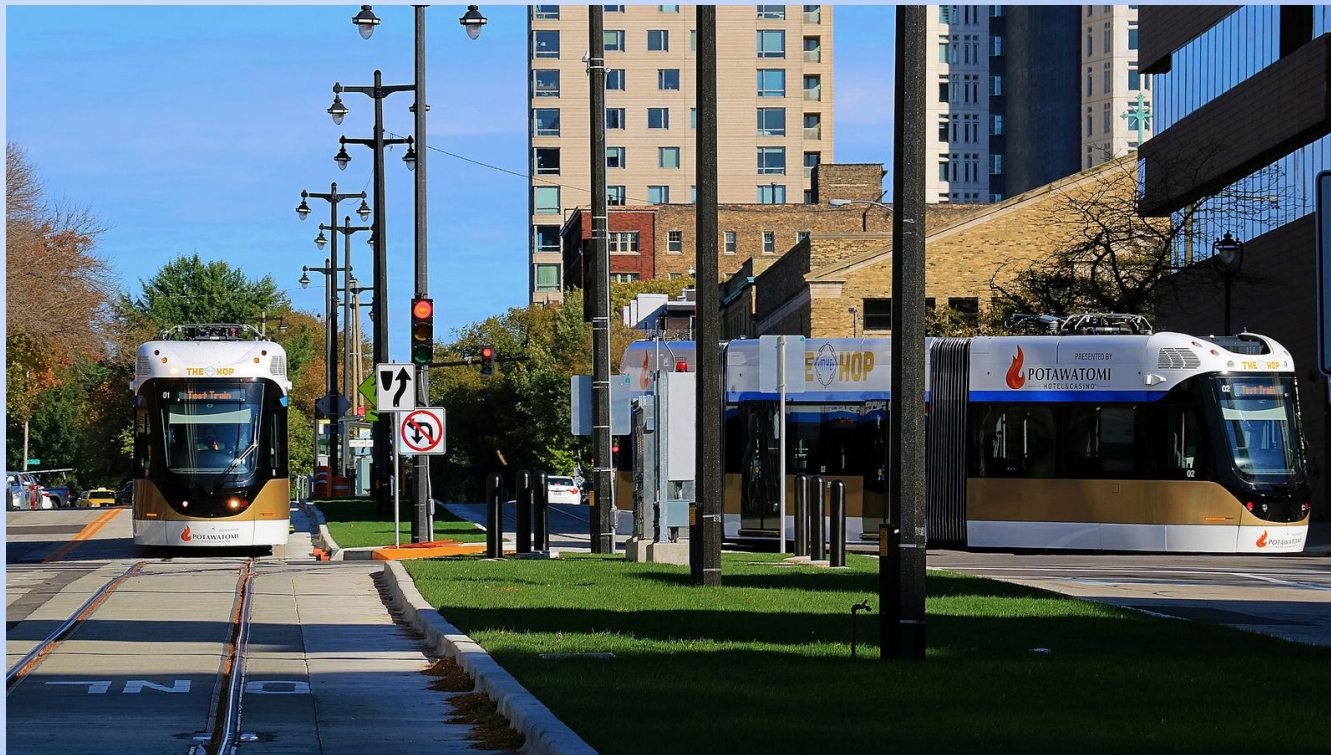


Smart Cities Theme: Transportation



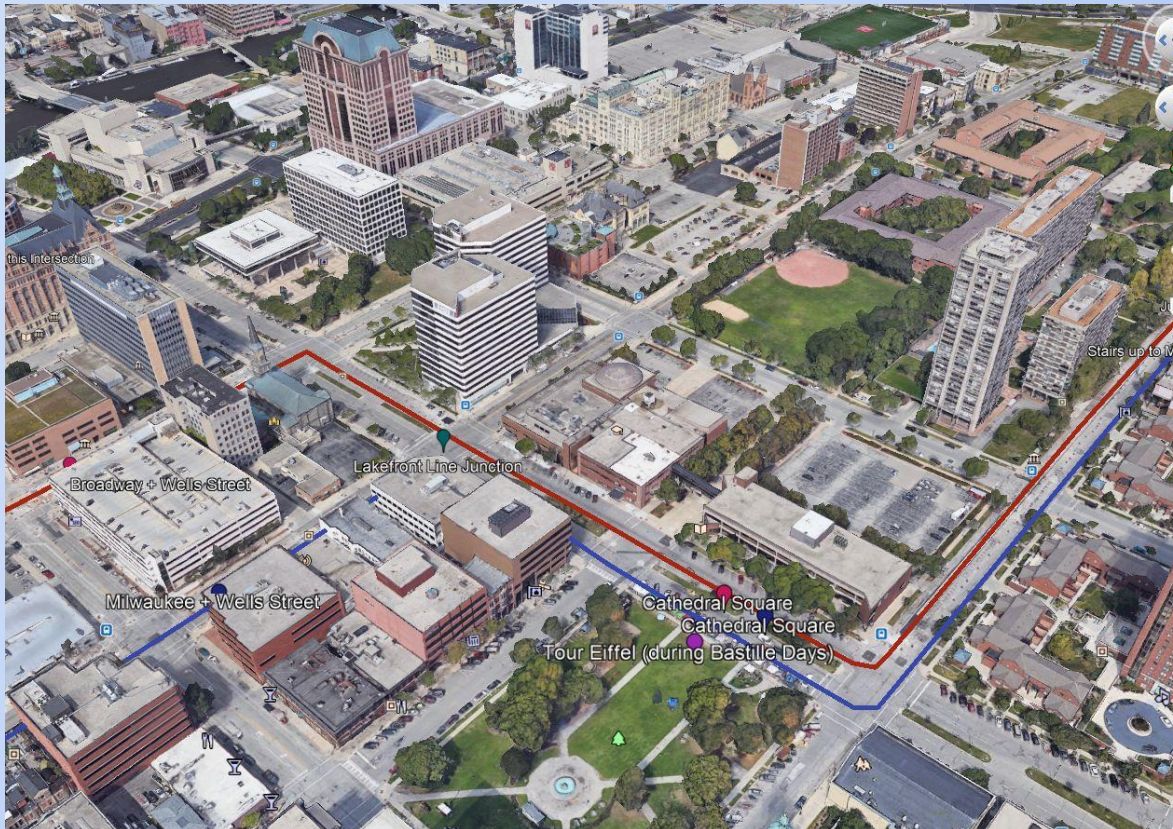
- VISION 2050 from Southeastern Wisconsin Regional Planning Commission [6]
- Kansas City “Smart City” with KC Streetcar as transportation corridor [7, 8, 9, 10]
- US Department of Transportation’s Smart City Challenge [11]

Common Theme: Cities of the future need smart transportation



Millimeter Waves for Transportation

- Japan-based operator KDDI completed the first 5G demonstration on a moving train traveling at over 100 km/hour in October, 2017 [12]
- The UK government has made a call for 5G connectivity on a rail route [13]
- Millimeter wave frequencies provide opportunities for high data rates for vehicle communications [14] and fast machine learning [15]
- **The Hop's route on tracks gives fixed line-of-sight to the streetcars and provides a testbed for wireless communications**



8K Video Technologies

"Foxconn Is Developing Affordable 8K Video Cameras With RED," 2/13/2018,
<https://www.lowyat.net/2018/154762/foxconn-developing-affordable-8k-video-cameras-red>



8K camera and 8K video screen display at Foxconn's presentation, 7/31/2017

Data Streams

8k video and 5G wireless can produce massive amounts of data



48Gbps



20Gbps downlink and
10Gbps uplink per mobile
base station

Smart Analytics



Center for Urban Transportation
Studies, University of
Wisconsin--Milwaukee

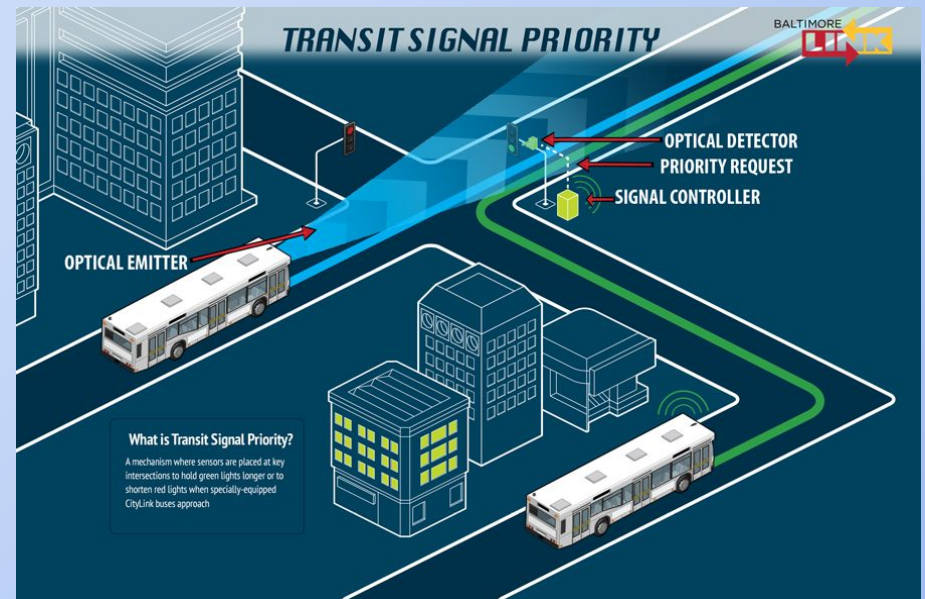
- Smart signaling
- Passenger demand management
- Decision support systems
- Integrated corridor management



**Technology + research + knowledge
= the *Smart* in Smart Cities**

Smart Signaling

- Based on mathematical models
- Real-time streams analyze and provide quick responses to problems [16]
- Traffic signal timing reduces tram (streetcar) travel time [17]
- Smart signaling improves the reliability of service and reduced travel delays [18], reduces travel time under congested, high-demand traffic conditions [19], reduces bus delays [20], and decreases passenger travel time in Bus Rapid Transit [21]



<https://baltimorelink.com/baltimorelink-basics/infrastructure>

Passenger demand management

- Methods can be used for estimating demand patterns of a transit route [22]
- Realtime information for mobile phone users can help with accurate information for transit choice [23]

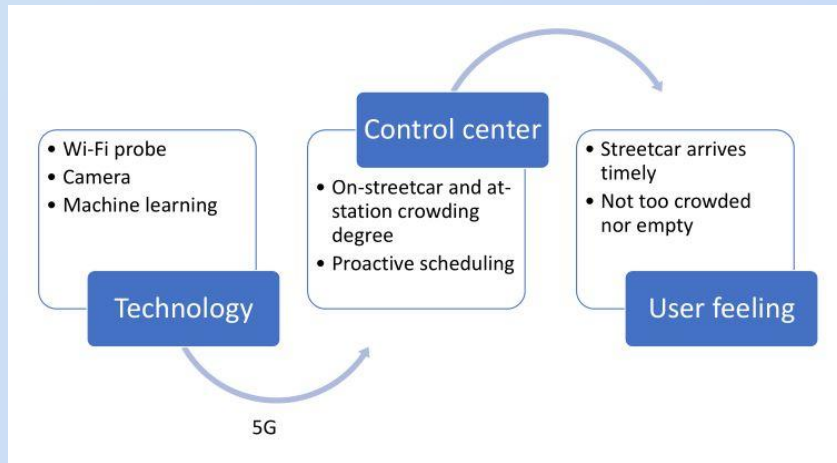


Streetcar Experience Analysis:

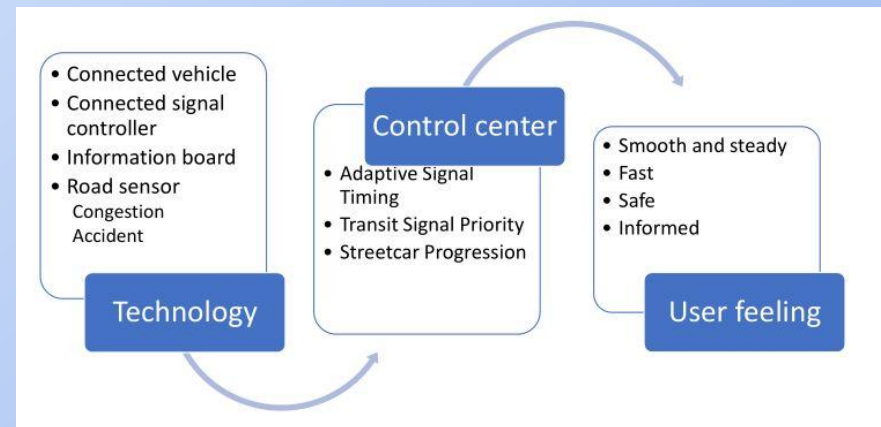
- Phone App gets data from users
- Control center integrates data from App, camera, other sensors
- Control center analyzes data and makes decisions to improve service (adaptive frequency)
- Data and decisions are recorded in data warehouse for decision evaluation
- Machine learning may be applied when data are abundant

Streetcar Experience Analysis

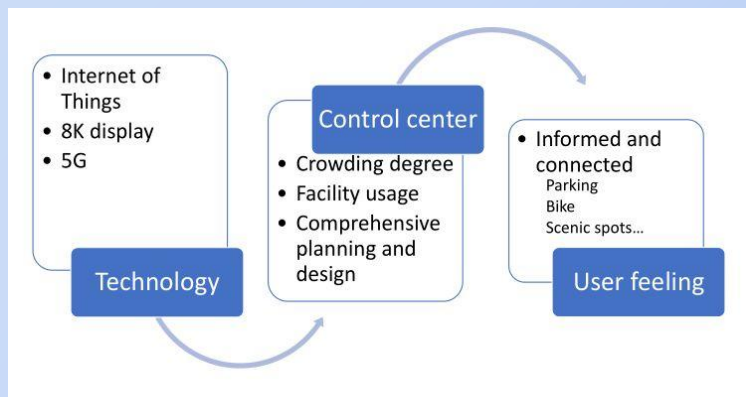
Boarding the Streetcar



In the Streetcar

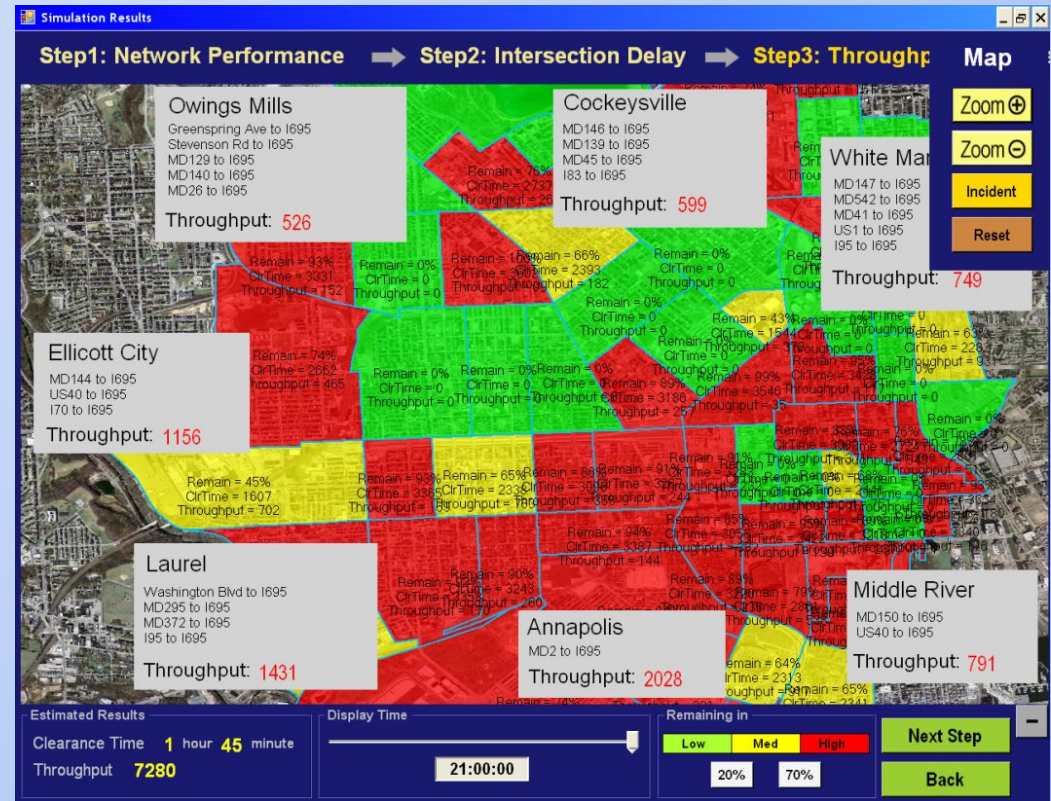


Off the Streetcar



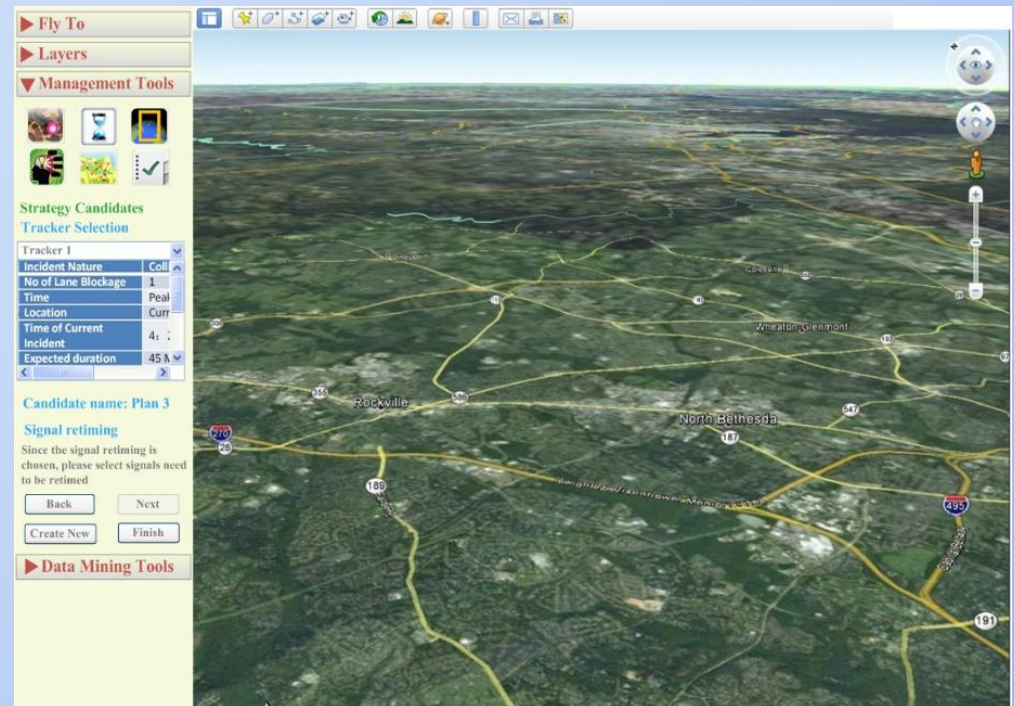
Decision Support Systems

- Decision support systems enhance the ability to plan for traffic flows in a specific time period, such as in an emergency evacuation or unusual traffic condition [24, 25, 26]
- Critical issues occurring in real-time can be supported with advanced traveler information [27] and for dilemma-zone intersections [28]

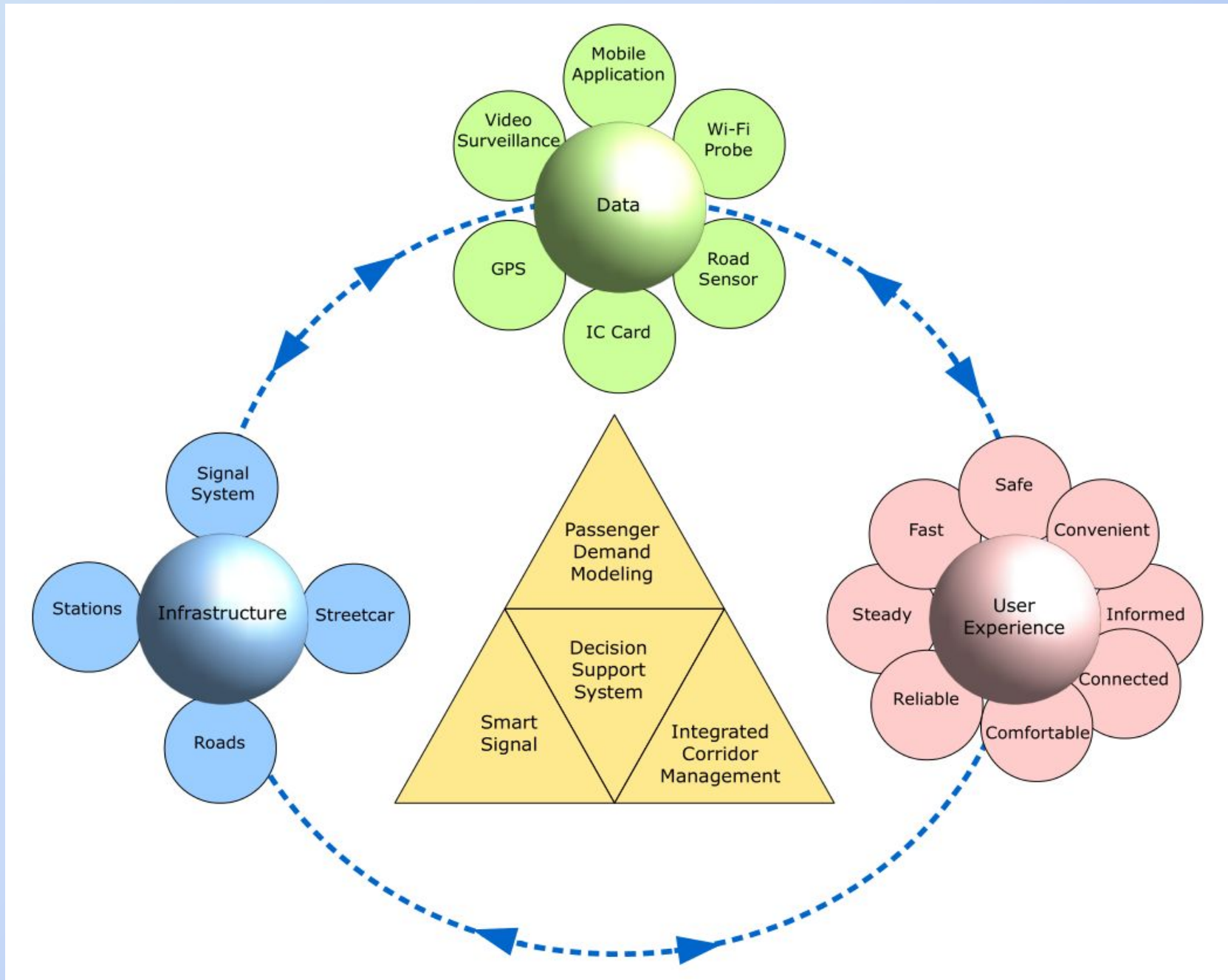


Integrated Corridor Management

- Integrated corridor management (ICM) approaches aim to make the best use of transportation infrastructure, facilities, and equipment [29]
- ICM has been applied to mitigating congestion [30]
- ICM provided a diversion control model for incident management for a case study on I-94 from Milwaukee to Waukesha [31]



Analytic Research Framework



Technology for the Streetcar

Fixed track infrastructure shows a commitment to apply technology

- 5G latency for real-time tracking of the vehicles
- 8K video monitoring on mounted cameras along the route to provide high-resolution to identify obstructions or security issues
- AI/machine learning viewing video to identify problems
- 5G service on the corridor for communication and as a testbed for smart services
- Internet of Things (IoT) for route safety, security, operations



The Hop Support

Real-time monitoring and services for

- Streetcar Locations
- Route monitoring (parked cars and roadway hazards, obstructions)
- Traffic Signal Timing
- Collision Avoidance
- Streetcar state information (status of electrical systems, position, mechanical systems state)
- 8K video on streetcar for advertising, promotion, user information
- User Services (streetcar locations, nearby destination features)



Video Operations Monitoring

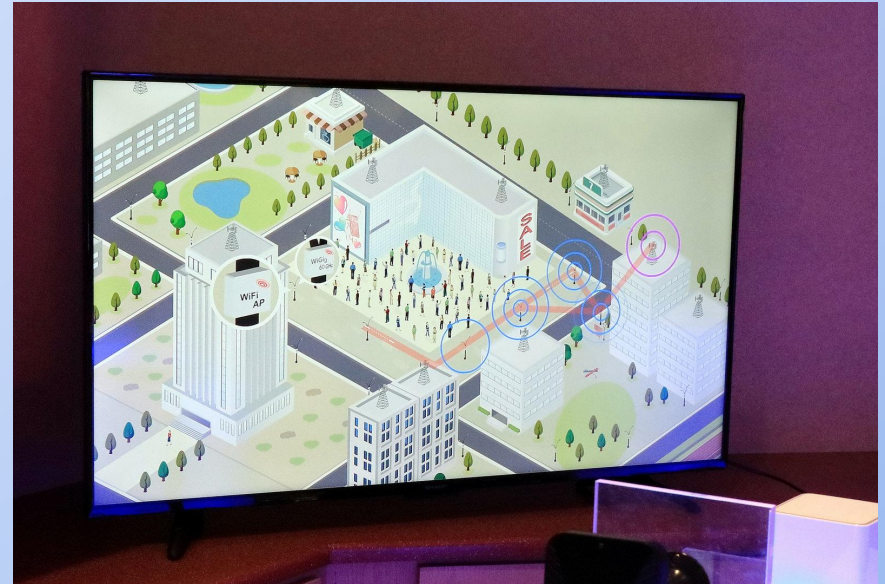
This is the Wisconsin DOT's Statewide Traffic Operations Center, Intermodal Station, Milwaukee



A similar center like this could be used for The Hop with 8K video monitors

Smart City Streetcar Impact

- Safer, more efficient, more user-friendly streetcar operations
- 5G service on the route for businesses and residents and as a testbed for devices
- 8K video monitoring on the route for safety, security, and efficiency of streetcar operations
- Increased ROI on streetcar infrastructure investment through business incubation
- Enhanced quality-of-life along the route: increased opportunities for education, business entrepreneurs, communication, entertainment
- Testbed for further transportation research



Display at Foxconn's presentation,
7/31/2017