

Smart Cities--Smart Futures Idea:

Connecting the Milwaukee of Tomorrow

NAME OF CONCEPT: Smart Streetcar Support

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**For bracketed references, please see
<https://johndecember.com/smartstreetcar>**

The City of Milwaukee, Wisconsin has built, tested, and now operates a streetcar system in its downtown. Opened in November 2018 as "The Hop," the streetcar includes 3.4 km of track and five Brookville Liberty Modern streetcars capable of running off-wire using an onboard energy storage system [1]. The Hop's Main Line connects 18 boarding areas of various configurations [2]. Planned extensions of this system include the Lakefront Line and lines to the Bronzeville and Walker's Point neighborhoods [3]. The City's vision is a streetcar system that serving neighborhoods with transit-oriented development and emissions-free (at street-level) vehicles [3, 4]. The streetcar and passengers interact with Milwaukee's existing multi-modal transportation choices along its route which is a setting for transit, commerce, housing, tourism, and economic development [5, 6]. Our team's idea is to tap into the power of emerging technologies--including 5G wireless, 8K video, and Internet-of-things--to support The Hop with smart transportation analytics and improve the quality of life for the community.

The need to support transit with new methods corresponds to the Southeastern Wisconsin Regional Planning Commission's VISION 2050 plan calling for "improving and expanding public transit" [7]. Kansas City has implemented technology along its streetcar line [8, 9, 10] and set goals to include public WiFi, smart streetlights, and sensors [11]. The US Department of Transportation's Smart City Challenge recognizes the importance of technology for future urban transportation [12].

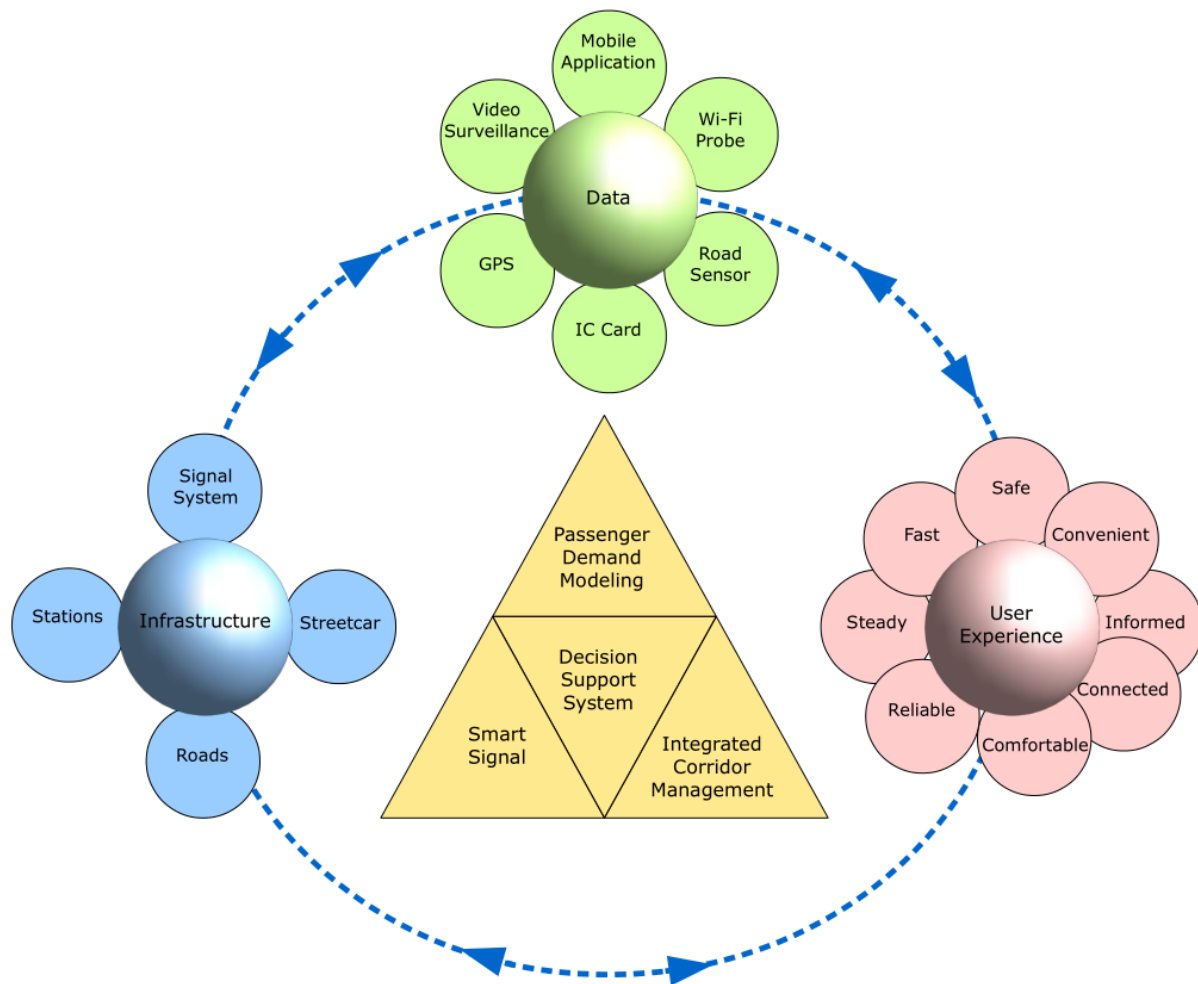
There is emerging interest in 5G wireless services for rail transit. Japan-based operator KDDI completed the first 5G demonstration on a moving train in October, 2017 [13]. The UK government called for 5G connectivity on a rail route [14].

Millimeter wave frequencies provide high data rates for vehicle communications [15] and fast machine learning [16]. The fixed nature of The Hop's tracks provide known locations for line-of-site communication to the streetcars and a testbed for 5G communications through low-latency (1 millisecond) signals and sensors in a density of up to 1 million devices per square kilometer [17]. Current technologies for vehicle communications encounter problems where "[t]he effectiveness and efficiency of a TSP [Transit Signal Priority] implementation quickly degrades as the communication latency increases" [18].

Our idea is that a smart city needs smart ways to utilize the vast amounts of data that new technologies produce. Research in urban transportation has shown how methodologies can improve transportation:

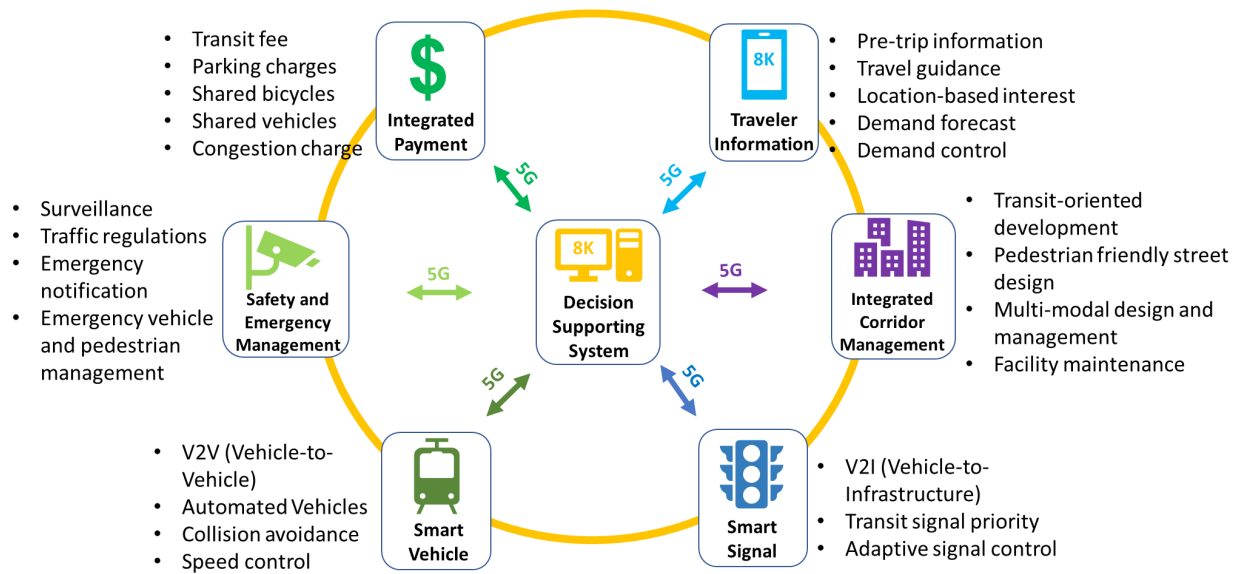
- Smart signaling, based on mathematical models, has improved the performance of transportation systems. Transit data can be analyzed and provide real-time responses to problems based on vehicle position [19]. Traffic signal timing has reduced streetcar travel time [20]. Smart signaling has improved the reliability of service and has reduced: travel delays [21], travel time in congested traffic [22], bus delays [23], and passenger travel time in Bus Rapid Transit [24].
- Passenger demand management techniques can estimate demand patterns of a transit route [25], and realtime information for mobile phone users can help with accurate information for transit choice [26].
- Decision support systems enhance the ability to plan traffic flows in a specific time period, such as in an emergency evacuation or unusual traffic condition [27, 28, 29]. Critical real-time issues can be supported with advanced traveler information [30] and for dilemma-zone intersections [31].
- Integrated corridor management (ICM) approaches aim to make the best use of transportation infrastructure, facilities, and equipment [32]. ICM has been applied to mitigating congestion [33] and for a diversion control model for incident management on I-94 from Milwaukee to Waukesha [34].

This picture summarizes the analytic research framework:



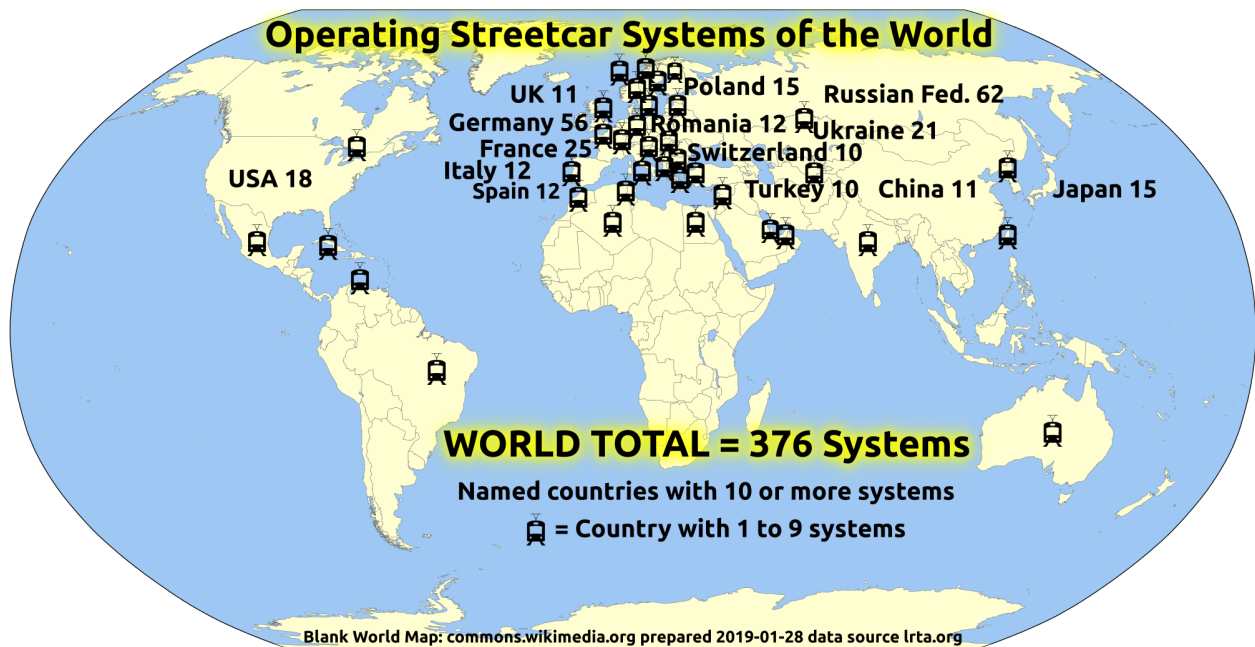
These transportation analytics can capitalize on the massive data produced by 5G and 8K systems. 5G wireless and 8K video along the Hop's route would provide the data feed for these analytics, improve operational safety and efficiency, and serve as a setting for economic development through community use of the 5G network. 8K video could detect blockages to the streetcar and improve safety and security. These data feeds could be monitored and signals sent to the streetcars through an operations center. The resulting smart corridor for The Hop could be a setting for improved transportation and services to enhance the life of the community.

This picture summarizes functions of our concept:



A market analysis shows 18 streetcar systems operating in the USA, 376 systems worldwide, and more than 70 in the construction or planning stages [35, 36]. *Metro Magazine* observes that streetcars "are making an unprecedented resurgence across the U.S. and around the world" [37]. Figures available from the American Public Transportation Association (APTA) show a capital expense in the US of \$3.5 billion in 2013 for both light rail and streetcar (streetcar was not separated out from the total) [38]. The APTA also shows proposed federal capital investment grant funds of \$454 million for streetcars during the fiscal year 2016 [38]. Currently, no streetcar systems have been identified that utilize millimeter wave technology as proposed in our idea. For example, RTAChicago shows that GPS & Wi-Fi is used for vehicle communication [39].

This picture shows world-wide streetcar systems [35]:



Our idea is to support safe, efficient, beneficial, and user-friendly streetcar operations with a unique approach. We propose applying the massive data capabilities of 5G and 8K and improving transit with smart analytics.

This picture shows the concept overview and the infrastructure, methods, and technology along The Hop route:



Our vision is to help the unique community of Milwaukee--and perhaps the world--through smart transportation. The benefit would be safe and efficient operations, support for business incubation and attraction, advancement of transportation research, and improvement of the quality-of-life along the route.

References

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