Improving Future Mobility and Safety with G-PALS

The eco-city of Whenua Aotearoa, located near the Bay of Plenty on a volcanic plateau, sits squarely on the Pacific Rim of Fire on North Island, New Zealand. The nearby majestic Rimutaka Mountain Range offers spectacular views of Mount Ruapehu, an active volcano. The region’s temperate climate, moderate rainfall, and abundant sunshine sustain a lush, diverse flora. Moreover, the pristine landscape attracts thousands of visitors annually, who take advantage of its plentiful outdoor activities.

In 2060, Whenua Aotearoa’s transportation system reached maximum capacity due to the exponential growth of commuter and commercial traffic. Recent trends indicate the city’s current population of 300,000 will swell to 350,000 over the next ten years. Likewise, the number of new jobs continues to grow and attract a well-educated labor force due to the opening of Whenua Aotearoa’s Geothermal Research Center. Increased economic activity and population growth is contributing to traffic congestion, a sharp rise in vehicle accidents, and unpredictable journey times. As a result, serious safety concerns and gridlock threaten the economic vitality and mobility of the city.

Faced with these critical problems, Whenua Aotearoa’s civil and transportation engineers teamed together to develop a three-pronged strategy in order to keep the city moving. This solution includes:

- Implementation of a multi-modal intelligent transportation control system called G-PALS (Global Positioning Altitude System). This innovative system tracks vehicle location coordinates and is equipped with Safety Scout, a cooperative vehicle monitoring system for road safety based on advanced connected vehicle infrastructure technology and enhanced wireless communication. This will enable pod-vehicles to communicate
seamlessly with each other and roadside infrastructure, thereby reducing traffic congestion and accidents significantly. (see fig. 1)

- Development of connected fuel cell-powered public transit pod-platoons equipped with Safety Scout technology, dedicated pod-lanes, and a network of Super Conducting Vacuum Trains (SCVT).
- Issuance of Personal Travel Pilot (PTP) or web-enabled devices to travelers, providing real-time multi-modal public transit information, thereby reducing travel time, cost, and personal carbon footprint.

A robust wireless mesh network is the core infrastructure, which supports G-PALS connected vehicle technology. This Enhanced Dedicated Short-Range Communication (EDSRC)
system interfaces with existing roadside infrastructure, pod-vehicles, and the traffic control center, allowing all components to communicate in real-time. EDSRC is fast, secure, reliable, and less vulnerable to interference, enabling traffic control operators to interact directly with pods in entirely new ways, such as by IP address. Now, traffic control operators are able to communicate directly with remote sensors located in individual pod and pod-platoons with the knowledge of every pod’s position, trajectory, and destination. This dynamic traffic control system has eliminated the need for traffic signals at intersections and has opened the way to provide personalized routing guidance, instantaneous traffic updates, and safety alerts. With G-PALS guidance system in place, traffic flows smoothly and localized congestion has virtually been eliminated, thus reducing the number of accidents dramatically. Overall, the primary benefits of G-PALS connected transit system are increased road capacity and utilization, reduced traffic congestion, less queuing time, and a decline in traffic-and pedestrian-related deaths.

Furthermore, zero emission hydrogen fuel cell-powered electric smart pods and connected pod platoons have replaced all fossil fuel-powered vehicles. Thanks to new rapid charge ionic compressor technology, refueling only takes about three minutes. Dual-purpose parking/charging lots will replace parking lots throughout the city. A smart phone application called Personal Travel Pilot will link commuters to travel alternatives, allowing them to make more efficient choices.

To reduce travel time, commuters are transported via a high speed SCVT operating in a frictionless vacuum tube. This train connects the inter-modal hub with the airport, hospital, research center, and surrounding suburban neighborhoods. Train collisions are prevented with the implementation of positive train control technology, which is comprised of a wireless GPS network, enabling engineers to monitor track conditions utilizing remote sensors.
Although the innovative G-PALS intelligent transit system has significantly improved safety and mobility, inevitable potential risks exist. Possible system crashes, technical malfunctions, power outages, earthquakes, weather-related interference, and satellite failures may result in unintended travel delays, which may compromise the functionality of the system. To mitigate these events, transportation engineers implemented a continuous monitoring system to reduce overall transit downtime. Back up computer systems will create system redundancy and minimize incidents of G-PALS system failure.

A key aspect of sustainable mobility is intermodality and the successful implementation of the city’s multi-modal transportation hub. Intermodality will allow travelers to combine modes of transportation seamlessly during the same journey, such as using train + pod + bicycle to reduce travel time and overall carbon footprint. Clearly, the implementation of G-PALS with PTP smartphone devices will enable travelers to take advantage of alternative options.

While engineers resolved the main problems of mobility and safety, underlying trade-offs were unavoidable. The initial short-term financial investment for the expansion of supporting wireless infrastructure is high; however, the benefit realized is the long-term restoration of economic vitality, safety and mobility of the traveling public. Other challenges experienced include the cooperation of public and private authorities by sharing data, as well as user acceptance and some loss of public privacy. Finally, changing commuter mindsets and travel patterns by encouraging shared use vehicles and public transit was also a consideration. Overall, the benefits to the community clearly outweigh the limited trade-offs.

The engineers most critical to this project are civil engineers specializing in transportation because they are required to design, build, and test a model of a wireless communications system, as well as control systems for G-PALS Safety Scout wireless
communication system. Transportation engineers worked in collaboration with computer systems and electrical engineers to ensure the system was installed according to the design specifications and within budget.

Ultimately, all of these measures working in concert are key contributors to the success of Whenua Aotearoa’s transit system and significantly reduce traffic congestion, improve mobility, enhance safety, and, most importantly, restore economic vitality to the region.

(988 words)

References


Hill, David. "Low-Cost Wireless Sensors Could Improve Infrastructure Monitoring." Civil


