



Bringing Wi-Fi up to Speed on Trains and Mass Transit Vehicles

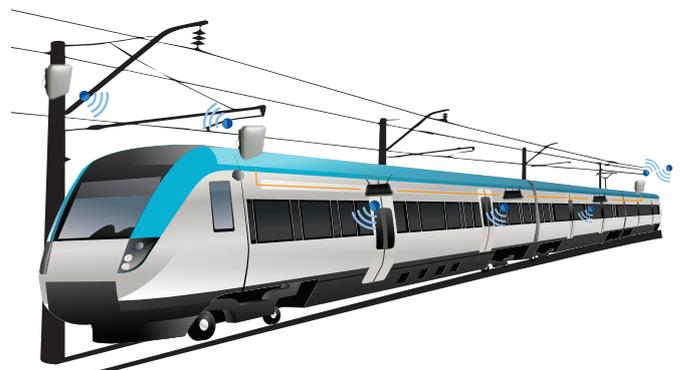
In recent years, commuter and high speed trains, as well as other mass transit vehicles, have been facing significant challenges. These include increased transport volumes due to growing urbanization, rising operating costs and heightened security awareness. The future of the industry is expected to rely upon smart transportation systems that leverage technologies over a large rail network infrastructure to alleviate these challenges. For both backhaul and on-board connectivity, the most ubiquitous technology is Wi-Fi. In fact, Wi-Fi on trains and other mass transit vehicles has become an essential requirement enabling commuters to connect and use high bandwidth applications including video streaming, email and internet usage while travelling at high speeds. However, poor connection performance in rural areas where cellular coverage is limited, coupled with the train's speed which stretches the limits of LTE and 4G cellular protocols, results in Wi-Fi connectivity that is less than 10Mbps for an entire train with hundreds of passengers connecting with multiple devices at the same time. In addition, with the heightened security awareness, on-board live video surveillance is essential to enhance responsiveness and efficacy of law enforcement personnel. However, high resolution video requires high bandwidth, which is just not available.

Added to that, many rail operators provide a Wi-Fi service strictly as an amenity to increase ridership and enhance the commuter experience. It doesn't generate additional revenue nor does it help Transit Authorities with their operational needs. With Celeno's Wi-Fi silicon and technology, rail operators have the opportunity to deliver a seamless, uninterrupted, high bandwidth Wi-Fi connectivity experience to their commuters

while maximizing revenue growth as well as ensure continuous network connectivity for security applications.

Bringing Wi-Fi up to Speed

Celeno's solution involves connecting trains and other mass transit vehicles via Wi-Fi to base stations installed along the track which are connected to a wayside Fiber network. This delivers broadband capabilities in excess of 1Gbps. Two wireless access points (APs) on the train are dedicated to continuous communication with the stationary base station while multiple APs are scattered in train cabins for on-board Wi-Fi connectivity.



Technology Differentiators

Celeno's solutions leverage Celeno's 802.11ac Wave 2 chipset technology as well as software technologies that improve the Wi-Fi communication link through advanced mechanisms. These include unique QoS service prioritization capabilities, spectrum optimization methods for overcoming noise

interference and channel selection, and a mechanism for optimizing the radiation patterns from an array of multiple antennas with an adaptive rate selection mechanism.

Maximizing Revenue through Prioritization

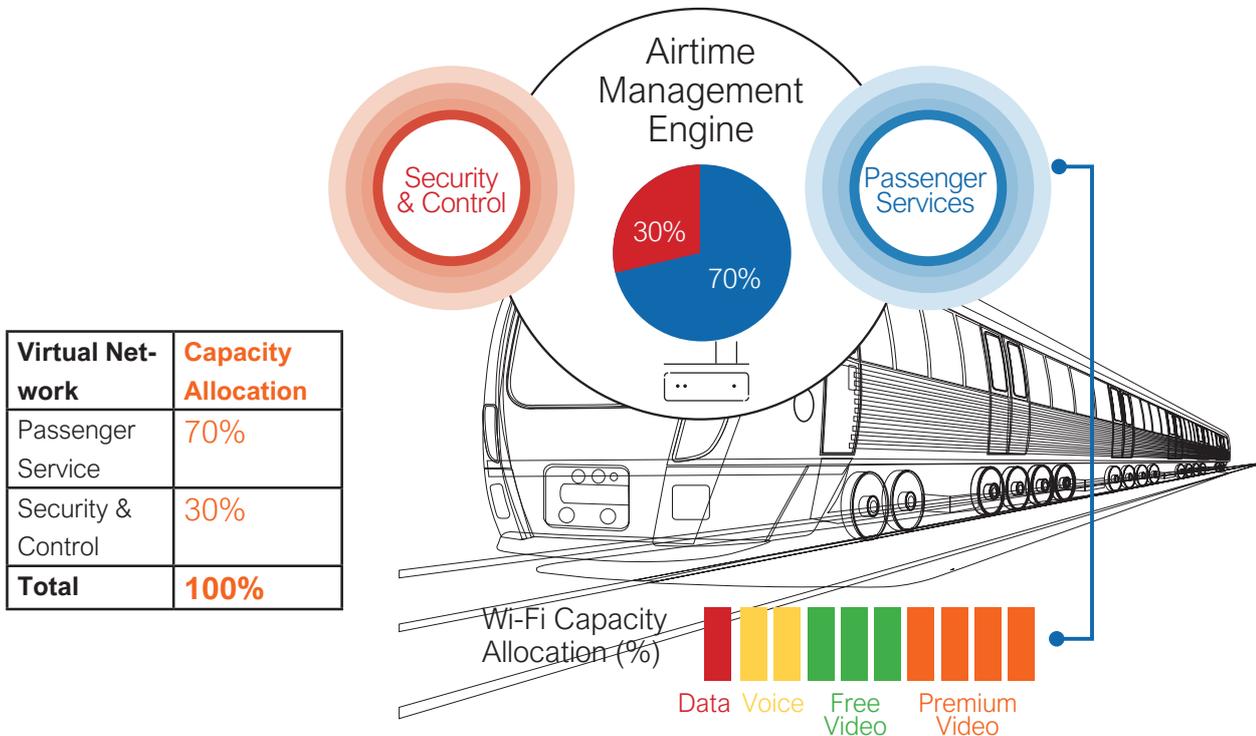
Celeno's advanced QoS mechanisms ensure reliable service under changing channel conditions and address the need to dynamically provide different service prioritizations to various data streams. By implementing advanced QoS and capacity allocation mechanisms, train operators can benefit from service differentiation and capitalize on package offerings, such as by offering high video quality for paid subscribers and premium channels while guaranteeing an undisruptive user experience throughout the entire journey.

Celeno's Wi-Fi innovation addresses the need to overcome radio interference in order to guarantee superb communication and video quality regardless of the interference levels. Celeno's solution continuously monitors the Wi-Fi channels and quickly

responds to noisy conditions or radar signals, enabling a quick and seamless switch to alternative channels that will ensure the best performance under the most current channel conditions.

Addressing the constantly changing Wi-Fi signal path of a fast moving train, Celeno's mechanisms dynamically optimize the Wi-Fi radiation pattern through an array of multiple antennas and leverage an advanced rate selection mechanism to adapt to fast changing channel conditions.

With these advanced mechanisms and technologies that enhance Wi-Fi connectivity, rail operators are provided with broadband capabilities in excess of 1Gbit/sec, are assured of uninterrupted and continuous streaming of security video while increasing revenues from on board connectivity and service prioritization. Passengers are provided with an enhanced passenger experience increasing their productivity and enjoyment during travel time.



Operational & Strategic Benefits

- Monitor operations in real time
- Deliver time-sensitive voice, video and security applications
- Ensure continuous, high-speed network connectivity
- Enhance commuter experience and productivity
- Offer new, revenue generating services
- Competitive differentiator
- Improve operational efficiency

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