

Breaking Down Barriers to Safer and Secure Driving

Monetizing the \$750B - Connected Vehicle Market Opportunity

The global market for Connected Vehicle (CV) services – focused on comfort, convenience, performance, safety and security – is forecast to exceed \$750B within the next five years. Rapid advances in the deployment of fifth generation cellular communications technologies (5G) are igniting developer ecosystems with the promise of high throughput, low lag, mobile connectivity capabilities that will enable ever-richer solution sets, including for driver assistance capabilities and enabling autonomous vehicles. However, monetizing this wave of innovation demands a thorough understanding of the risks presented by interruptions to network connectivity, particularly relating to vehicle operations, safety and security.

The Imperative for Reorienting Solutions around the Vehicular Ecosystem

Driver safety and autonomous vehicle operations must be maintained in both mountains and bayous, across bridges and through tunnels, and during wildfires, snow storms and hurricanes. Some might even say that such extremes are actually the most important use cases. Although wireless carriers enjoy presenting impressive national coverage statistics, arguably it is the *fine print* which matters most: a “best effort” cellular service is surely an inadequate guarantee for minimizing risks of catastrophic failure and loss of life on the world’s roadways. Accordingly, we recommend envisioning Connected Vehicle (CV) solutions not in the service of powerful wireless carriers but instead by *orienting around the vehicular ecosystem* and its undeniable need for highly reliable, resilient and recoverable connectivity.

Breaking beyond the Limitations of Cellular Coverage Dependencies

In the race for intelligent connectivity between automotive vehicles and cities, streets, services platforms and other road users, Cellular-Vehicle to Everything (C-V2X) was selected in 2021 by FCC to be the successor of original CV standard based on Wi-Fi, WAVE/DSRC/802.11p that has now been sunsetted by the FCC in the USA¹. The C-V2X definition created by the Third Generation Partnership Project (3GPP) is problematic, in our opinion. By adopting the specific term “Cellular” instead of a technology-neutral, functional descriptor such as “Connected”, an artificial and potentially insurmountable barrier has been erected: bureaucrats, not technologists, have created a unreasonable dependency on traditional wireless carriers to

¹ Source; <https://www.federalregister.gov/documents/2021/05/03/2021-08801/use-of-the-5850-5925-ghz-band>

blanket the target geography with unbroken cellular coverage, requiring multi-billion-dollar investments in acquiring licensed cellular communications spectrum, laying thousands of miles of optical fiber and building countless cell towers alongside transportation routes by extending the design conversation to embrace the concept of most effective technology (MET), such as licensed/unlicensed radio spectrum, satellite communications and multi-carrier cellular access, we can decouple from individual wireless carriers' capital spending plans and so greatly accelerate the innovation of CV solutions.

In the USA, C-V2X has provisions included for Device to Device (D2D) communications in 3GPP rel. 14 for LTE V2X and in rel. 16 it adds 5G-NR V2X which adds 'Sidelink' PC5 interface for low latency sensor communications and single hop² communications. It remains to be seen if and what type of IP data transfers it can reliably sustain and when numerous hops can be supported. This is where tried and true Edge Interlock™ Multi-mesh and Data-path Optimizer comes in.

Leveraging Mesh Technology to Enable Always-On Connectivity

The events of September 11th, 2001, laid bare the fallacy of single-technology platforms. With the loss of New York City's primary telecommunications hub situated in the World Trade Center, multiple first responder organizations struggled to communicate both within and between teams on the ground. Driven by the desire to enable law enforcement and emergency personnel to respond more effectively in subsequent episodic events, an expert team was formed to create persistent, self-healing communications architecture. Edge Velocity Corporation (Edge Velocity) was founded and we patented our "Multi-mesh network" featuring "Data-path Optimizer" technology: Multi-mesh is a multi-interface, typically multi-radio/multi-frequency IP data network and Data-path Optimizer proactively chooses the best gateway/backhaul such as whenever a wireless carrier cellular signal is weak or unavailable. Network devices (for example each installed in automotive vehicle) are able to form a "daisy-chain" - a persistent communication path to the next available zone of coverage till it finds an available 'gateway' to the Internet to backhaul data, as illustrated in Figure 1, below.

² Source: <https://arxiv.org/ftp/arxiv/papers/2102/2102.04538.pdf>

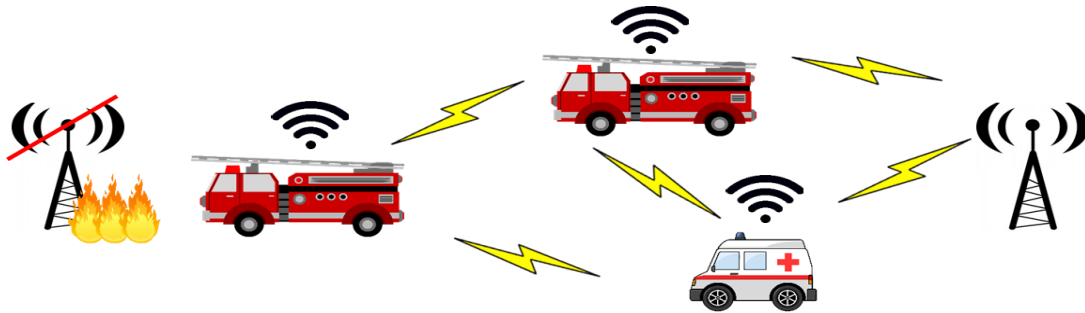


Figure 1. Edge Velocity Corporation's Persistent, Self-Healing, "Multi-Mesh Network" and "Data-path Optimizer" Architecture as a Critical Enabler for Connected Vehicle Solutions

Mesh Network Architecture Explained

Edge Velocity's mesh network architecture uniquely establishes a *one-to-multiple* relationship between the vehicle and a choice of communications technologies (for example, with primary and secondary wireless carriers, a satellite provider, and/or licensed/unlicensed radio frequency spectrum). When nearby vehicles are also enabled with Edge Velocity's technology, multiple dynamic high-throughput communication paths may be established both between the vehicles and with nearby wireless carrier platforms, with each vehicle utilizing the most effective path to enable the required connectivity. If one communication path is interrupted or degraded, or one of the connected vehicles moves away from the area, Edge Velocity's autonomous mesh network architecture automatically reroutes communications to different frequency or technology to maintain secure connectivity and best available performance.

Bring Your Own Network with Connected Vehicles

Edge Velocity contends that the current C-V2X innovation roadmap is overly constrained with network-centric thinking and carrier-led narratives, resulting in the revenue opportunity (the Connected Vehicle) being relegated to the very edge of the architecture. Conversely, Edge Velocity recommends reorienting discussions to position the vehicle (and the experience of its end users – the driver and passengers) at the center of the CV solution model. Rather than consider the optical fiber and cell towers of the "network" as something to be built out in advance and to which the vehicle must connect, one should instead think of the CV as a constituent of, and participant in, a dynamic and autonomous network mesh: a communications capability which "flows" from vehicle to vehicle along our highways, across bridges, through tunnels, over mountains and deep into valleys; a "Bring Your Own Network"

which becomes richer and stronger with every new member using any available backhaul network as a secure Internet gateway.

Bias to Action – Creating Compelling Market Advantage

In order to play to Edge Velocity’s strengths and side-step the well-funded C-VX2 marketing narratives from the large wireless carriers, Edge Velocity recommend attacking the CV market at Edge Velocity’s point of origin: first responders and law enforcement organizations who can immediately connect the dots between always-on connectivity and mission-critical safety and security outcomes. From there we can expand to the more discerning brands and the leading innovators in autonomous vehicles and smart cities.

Edge Interlock™ Multi-Mesh/Data-Path Case Study with Fire Department of New York

