A human-centric traffic revolution powered by AI

By

Dr. Duminda Wijesekera

Professor Department of Computer Science at George Mason University and acting chair of Cyber Security Engineering Department

Where the change begins

At the intersection of Duke and Van Dorn streets in Alexandria, Virginia, the scene is familiar: bumper-to-bumper traffic and frustrated commuters heading toward Washington, D.C. But this particular junction is about to make history. The city is flipping the switch on its first smart traffic light. That's good news for the more than 60,000 vehicles that pass through this intersection daily.

Using roadside sensors and AI, this system resets signal cycles every few minutes based on live traffic data. The result? The city estimates that drivers could save up to 10 minutes across the network. It may be a small pilot, but it signals a profound shift in how we manage mobility.

In 2024, D.C. area drivers spent an average of 62 hours stalled in traffic. In cities like New York, London, and Brisbane, the problem is worse. But the value of smart traffic systems isn't just measured in minutes. It's measured in lives improved. Less road rage. Faster emergency response. Cleaner air. Smoother flow of goods. Safer streets.

While a growing number of cities are experimenting with AI-powered traffic signals — systems that learn from traffic flow in real time, adjust lights dynamically, and can even communicate with each other — the opportunity is more than reduc- ing congestion. We often talk about traffic in terms of frustration, but the economics are also brutal. According to the U.S. Department of Energy, inefficient traffic flow contributes to 3.3 billion gallons of wasted fuel each year in the U.S. alone. AI-optimized signals could reduce fuel consumption by as much as 20% in urban corridors. In turn, that translates to a reduction of more than 30 million metric tons of CO_2 emissions — equivalent to taking 6.5 million cars off the road. Improvements in delivery reliability and transit efficiency can also yield billions in operational savings for fleets and agencies.

This isn't just a tech upgrade. AI-powered, cloud-based traffic control will be the gateway to the future of urban mobility — one where transportation becomes more predictive, equitable, and seamlessly connected to how we live, work, and move. When a city optimizes mobility, it improves commutes, access to jobs, education, services, and promotes sustainable urban growth.

How the technology works

Traditional signal systems are manually configured. Engineers adjust light timings based on static models — often over weeks. This outdated method leads to delays, poor coordination, and congestion. Adaptive lights exist, but they're fragmented, siloed, and slow to scale.

Smart traffic systems offer something radically better: self-learning, cloud-based platforms that adapt in real time. These systems require minimal hardware upgrades and no disruptive roadwork.

Using ultra-fast wireless networks and localized computing, the system forms a live, constantly evolving map of traffic flow. It calculates the most efficient signal patterns and communicates them across intersections.

Instead of static inputs, they process Basic Safety Messages (BSMs) transmitted by vehicles — tiny bursts of data indicating speed, direction, and intended movement.

Using ultra-fast wireless networks and localized computing, the system forms a live, constantly evolving map of traffic flow. It calculates the most efficient signal patterns and communicates them across intersections — reducing delays and adapting as conditions change. It's software-as-infrastructure: living, learning, and scaling with the city.

Economic gains and human benefits

For logistics companies, delivery fleets, ride-share platforms, and transit authorities, the ROI is tangible. A 10% improvement in delivery efficiency could translate to more than $1.3 billion in fuel savings annually — based on the above-mentioned 3.3 billion wasted gallons sitting in congestion. If large fleets also improve asset utilization — say by just one hour per vehicle per day — the resulting productivity gains could exceed another $1.3 billion across major operators. Uber drivers spend less time idling. UPS avoids congestion bottlenecks. Amazon delivers more on time.

But the deeper upside is human. Emergency responders gain automatic green-light priority, cutting response times by precious minutes. In cardiac arrest cases, every minute saved increases survival odds by 7%. School buses can trigger red lights at intersections, reducing pedestrian risk near schools. Smart cones reroute traffic dynamically during construction, improving worker safety and traffic flow. Children wearing connected bike helmets can signal intersections to extend crossing times or alert oncoming vehicles.

Debunking the infrastructure myth

Critics argue these systems require massive infrastructure overhauls. But most existing traffic systems already include IP interfaces. AI platforms can integrate with current MAP/SPAT messaging protocols without a complete hardware replacement.

In fact, legacy signal control boxes are often replaced every 10 years at significant cost. Cities that recently upgraded those boxes may hesitate — but they don't need to. This transition is incremental, not disruptive. Like the shift from paper to electronic health records, it's not a leap of faith. It's a step forward.

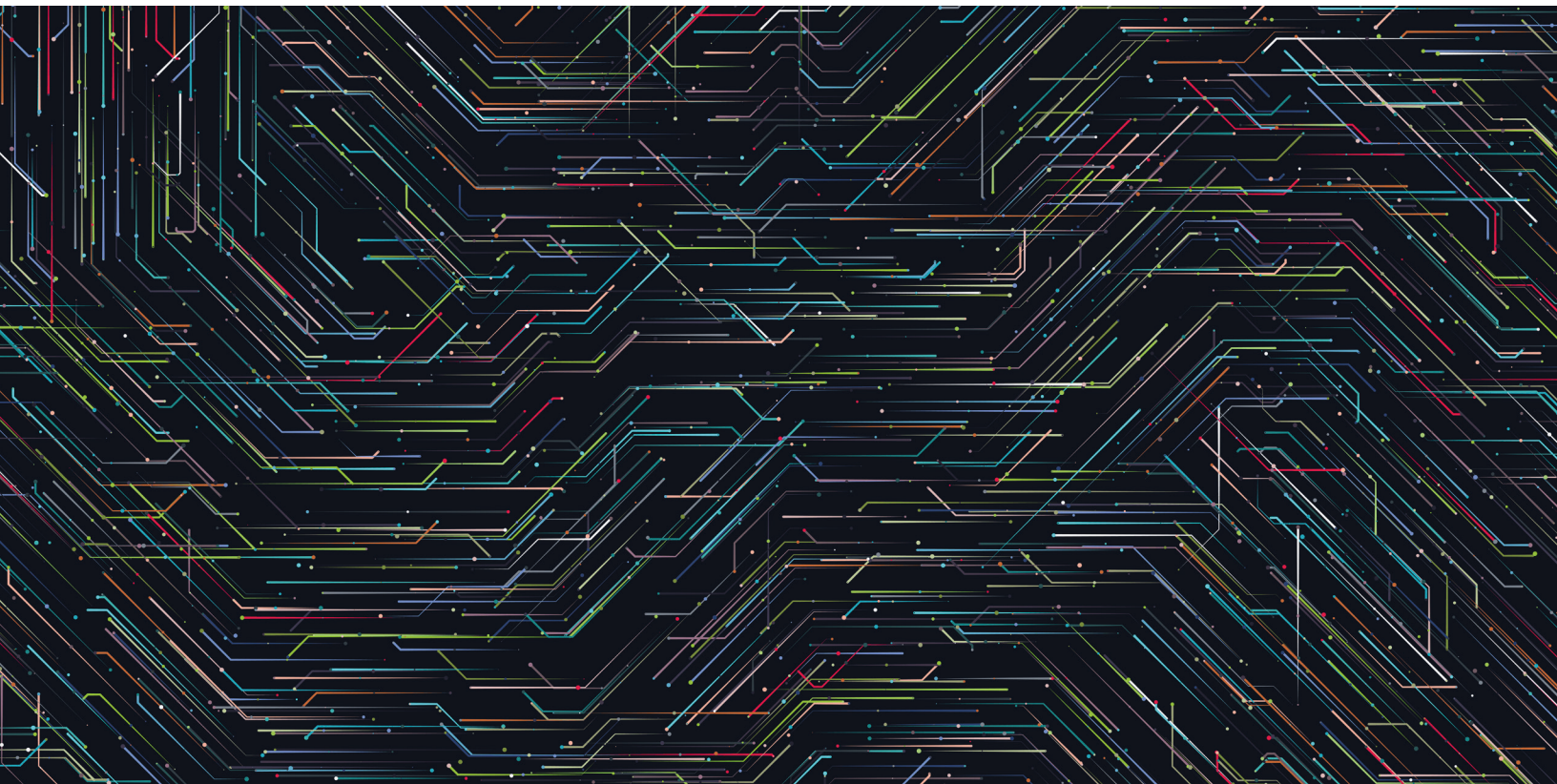
Security by design

Security is another hurdle frequently cited. But smart traffic systems don't require exposing personal data. They process anonymized, encrypted BSMs. With proper implementation of zero-trust architecture, penetration testing, and redundancy protocols, risks can be managed like any other digital infrastructure.

Cities protect water systems, utility grids, and emergency communications — all of which are digital and online. Traffic control can and should be treated with the same rigor and strategy.

The gateway to smarter cities

AI-powered intersections aren't the endpoint — they're a catalyst. They trigger a ripple effect that touches everything from traffic and transit to air quality, safety, and equity. Connected signals make roads safer and smoother for all travelers — whether in autonomous cars, city buses, or bicycles. Traffic that flows more smoothly burns less fuel, reducing emissions and delays while improving transit reliability and logistics efficiency. Emergency vehicles arrive faster. Streets get quieter and safer.



Autonomous vehicles play a supporting role — not because they drive themselves, but because of what they make possible. By reducing human error, which causes over 90% of traffic accidents, they can significantly improve safety. They also offer greater mobility to the elderly, people with disabilities, and underserved communities. And when connected through a smart traffic network, they help balance public and private transit — cutting redundancy, lowering emissions, and improving the overall system.

Cities that coordinate public and private transportation through real-time data unlock even greater value. Insurance companies could see fewer claims as collisions drop. Real estate developers may use traffic intelligence to guide investment. Public health agencies can link better air quality to improved outcomes.

The implications are enormous. What begins as a smart traffic signal quickly scales into an integrated urban operating system — linking mobility, emergency response, environmental monitoring, energy use, and planning. These signals aren't just the first step — they're a foundation for the democratization of urban living.

Crossroads for Action

We're at an inflection point. Urban congestion is worsening. The environment is straining. And the technology is ready.

But progress won't come from code alone — it demands strategic alignment between the public and private sectors. And for platform providers, the scale of opportunity is real: Research And Markets projects the North American AI-driven traffic management market will reach $37 billion by 2031, growing at a 29% CAGR — with U.S. adoption leading the way. Here are a few places to start thinking — and doing:

1. Start small

Partner with forward-thinking cities to launch low-risk, high-visibility pilots. Demonstrate measurable impact — on congestion, emissions, safety—and use those wins to scale up to larger regional deployments.

2. Build the digital curb

Lobby for infrastructure funding to include digital line items — edge sensors, cloud orchestration, V2X (Vehicle-to-Everything) integration — i.e. communication between vehicles and other entities in their environment such as infrastructure and pedestrians. Roads don't need to be rebuilt, but they do need to be rethought.

3. Design for trust and scale

Prioritize zero-trust security, supply chain integrity, interoperability, and transparency — embed ethical AI and inclusive access throughout the product lifecycle — not just in press releases.

4. Lead the ecosystem, not just the tech

Bring together transportation agencies, telecom and technology partners, investors, manufactures, research institutes, and civic planners.

Because the question isn't whether cities will adopt smart traffic systems. It's who will help shape them — and whether that vision is built around speed alone, or around something smarter.

The future in motion

Cities and states spend over $150 billion annually on transportation infrastructure in the U.S. alone — but only a fraction has gone to digital systems. That's changing. Globally, cities from Singapore to Dubai are adopting AI-powered mobility — laying the foundation for more livable, resilient cities where infrastructure actively improves quality of life.

In the U.S., Alexandria, Pittsburgh, and Palm Beach are already testing what comes next. The question isn't whether cities will adopt these systems. It's who will help to build them.

And when we do, we won't just be moving cars more efficiently. We'll be moving people, goods, and cities forward — with intelligence, equity, and purpose.

In the end, the promise of smart infrastructure is this: time to do the things that matter — in an environment that's empowering, safe, and built to help people thrive.

And when we do, we won't just be moving cars more efficiently. We'll be moving people, goods, and cities forward—with intelligence, equity, and purpose.