

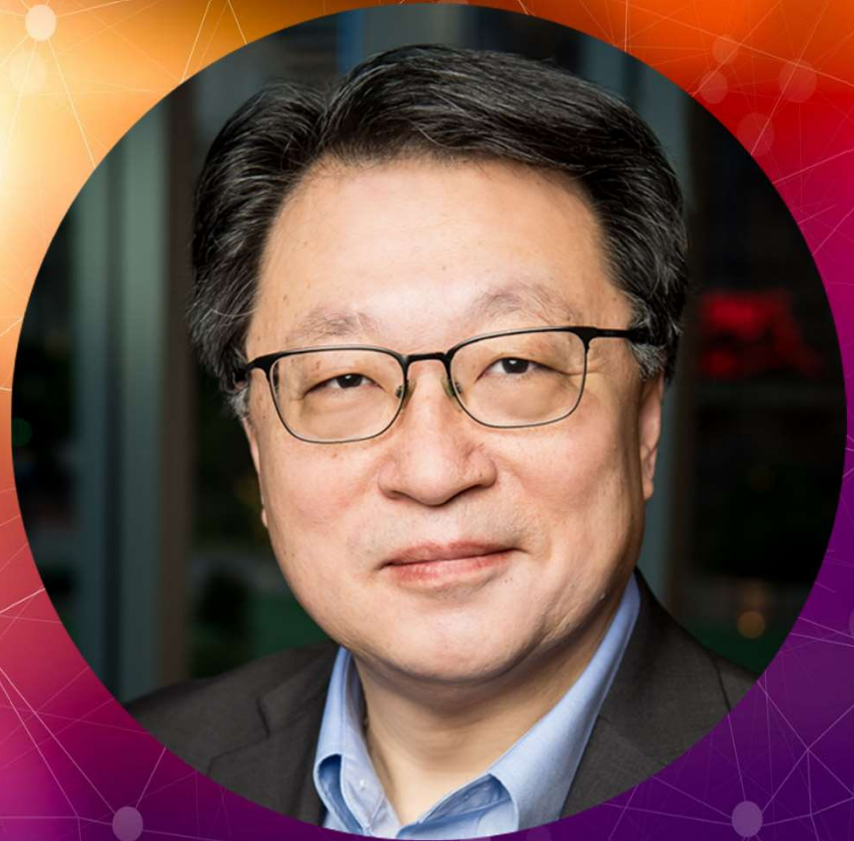
2025 IEEE RTC-CQR Conference

**Precision & Fault Tolerant
Autonomous Vehicle Ecosystem
Requirements**

David H. Lu, VP AT&T (Retired)

October 8, 2025

Chicago, IL, US



Agenda



Introduction – Current Technology Landscape & Development

Key Use Cases & App Requirements

Precision & Fault Tolerant Requirements

Regulation and Industry Standards

Future Considerations



Current Tech Landscape & Development

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Current Technology Landscape & Development

Technology Advancements in 2024

- Artificial Intelligence (AI)
- Quantum Computing
- Extended Reality (XR)
- Cybersecurity
- Edge Computing Faster Data Processing
- Digital Twins
- 5G+ and IoT
- Gene Editing
- Sustainable Technology

Latest Technology Advancement YTD

- AI-Augmented Development
- Nanotechnology for Medical Applications
- Climate Tech Advancements
- Human Augmentation
- Tiny Pacemakers
- Antiproton Annihilation Detector
- Cell Manipulation
- Laser Holograms for Chip Manufacturing
- Multi-Layer & Low Energy Consumption Nano Technologies, ...

The unimageable change driven by innovation and disruptive technologies are revolutionizing the way we live, learn, and interact every day!

David Lu. October 8, 2025



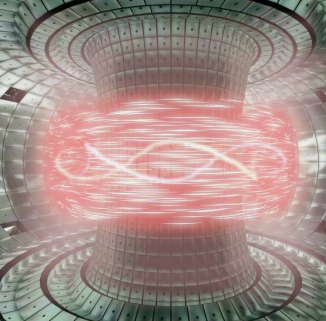
Generative AI



Quantum Computing & Communication



Blockchain



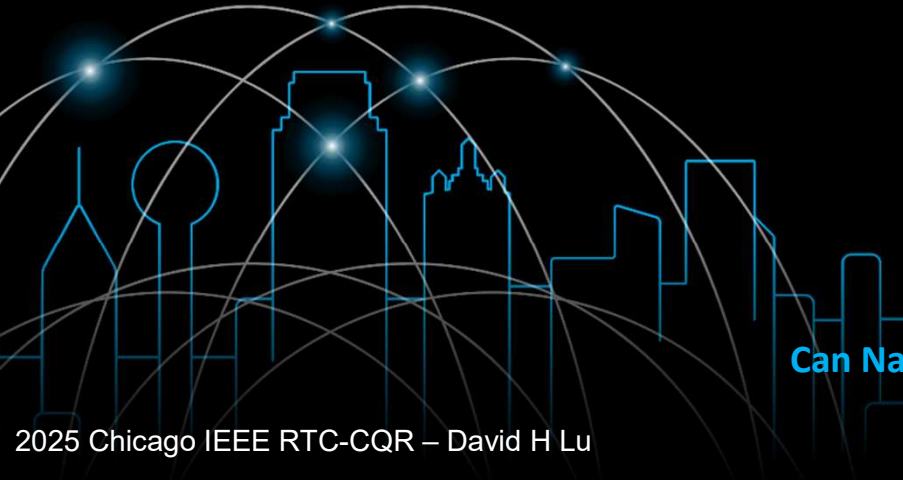
Nuclear Fusion



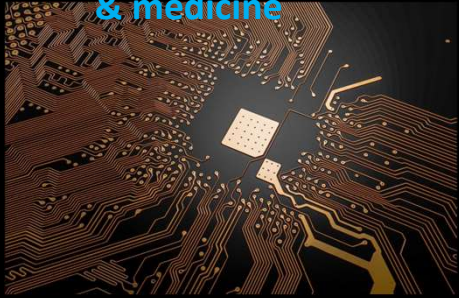
Degenerative genetics & medicine



LEO Satellite
(Space X: 7,135)
& 5G+/6G



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CPU to GPU/TPU
Can Nanometer go to Picometer?
(Multi-Layer Nano Chips)

SOFTWARE-DEFINED EVERYTHING & REVOLUTION

A World Is Colliding & Converging with Foundation Technologies for Generative AI

Configure

Nano Technology,
GPU, Sensors,
Quantum Computing,
Fiber (**400/800G**),
Access **1G-20G**,
Spectrum, Towers,
Small Cells,
5G/5GA/6G, WiFi6
& **WiFi7**,
LEO Satellite

Monitor

Explosive Network
Traffic, Video
(4K/8K),
Video Net Traffic
129 ZB (Global)*
VR/AR Apps
**Brain Computer
Interface**
**Comm-Sensing Net
Integration**
Trade Rules
Geopolitics
Global Supply
Chain

Modernize

Software Super-
Powered by
Cloud/Hyper DB,
Network Slicing,
Open API,
SaaS & NaaS,
Open Source,
SDN/VNF,
Generative AI
Hyper-Auto,
Scale Ecosystem,
SW Controlled
Security, etc.

Analyze

Business &
Operation
Automation
Data Analytics &
Insights
**User Centric
Integration**
Green Field App
Legacy Exit

Innovate

Explosion of
**New Use Cases &
Ideas** about
Consumer and
Enterprise -
Smart Cities,
Smart Streets
Smart Houses
Smart Health,
Smart Cars,
Drones,
Low Air Economy,
etc.

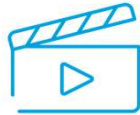
*Source "The Worldwide IDC Global DataSphere Forecast, 2023-2027"

21st Century Digital Transformation

In the
past
10 years



Video



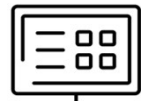
Media



Photos



Bill Payment



TV



Groceries



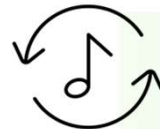
Email



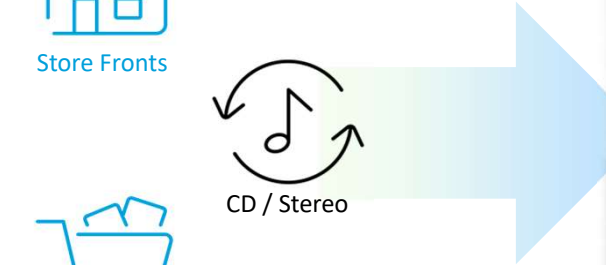
Store Fronts



Groceries



CD / Stereo



One Device | Anywhere



Key Use Cases

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Application Requirements



Speaking Impact

AI Chips (Blackwell)

Large Language Modeling

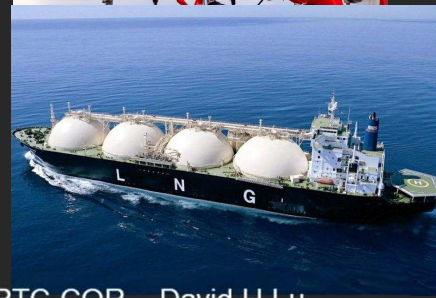
2 Nano Meter Chips

Commercial Quantum Computer Services

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Automobile, Airplane, High Speed Train, Oceanliner, and Space Craft Transformation of the Transport Industry



Autopilot Cars and Drones - Unthinkable



Driverless Taxi



Package Delivery Drone



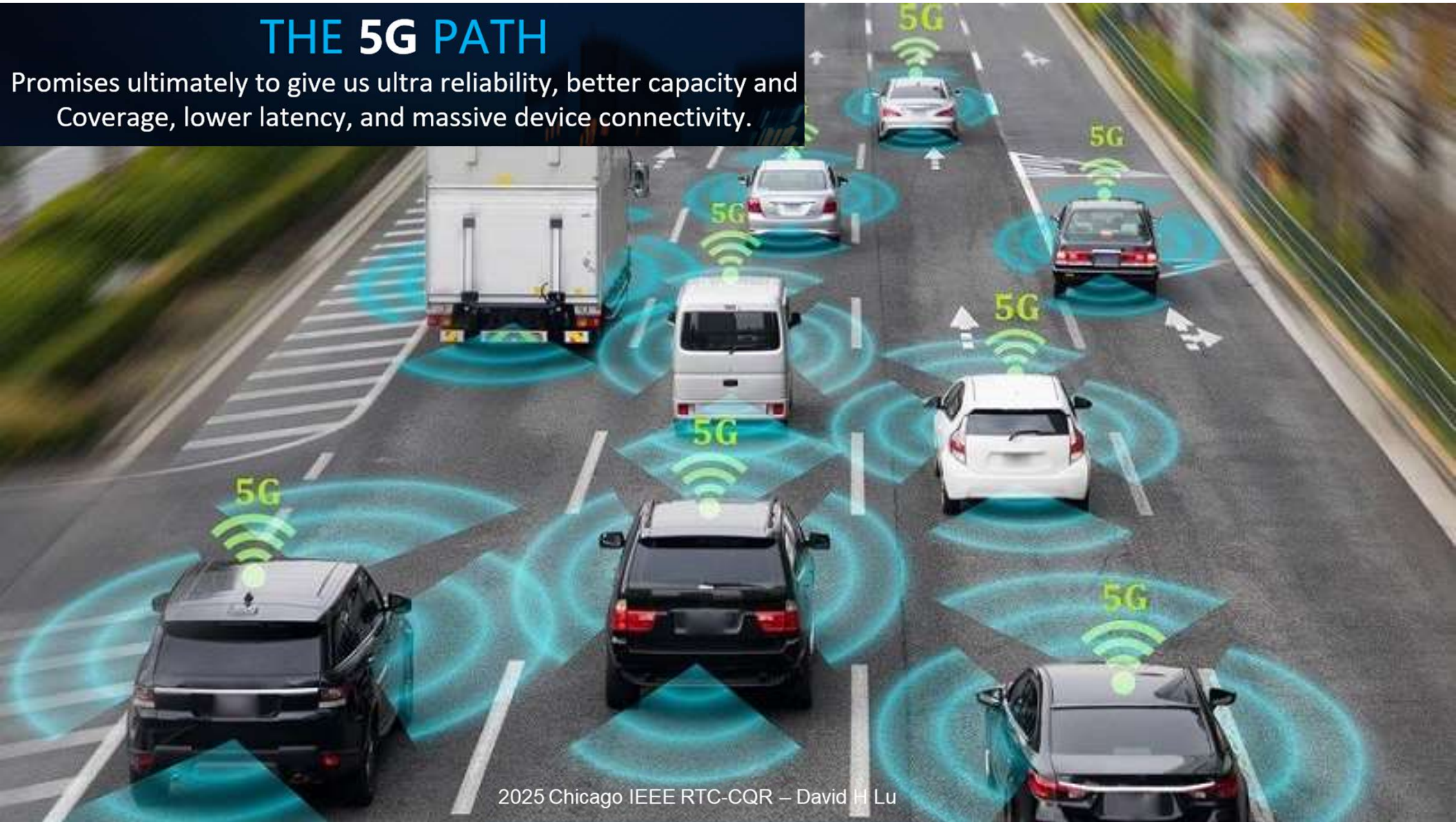
AT&T Flying COW



Unmanned Area Vehicle for Military Use

THE 5G PATH

Promises ultimately to give us ultra reliability, better capacity and Coverage, lower latency, and massive device connectivity.



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Driverless Taxi in San Francisco Waymo

Google – 1M+ rides per month in 8 trial cities including Atlanta, Austin, Phoenix, San Francisco, Los Angeles, and CA Highways.

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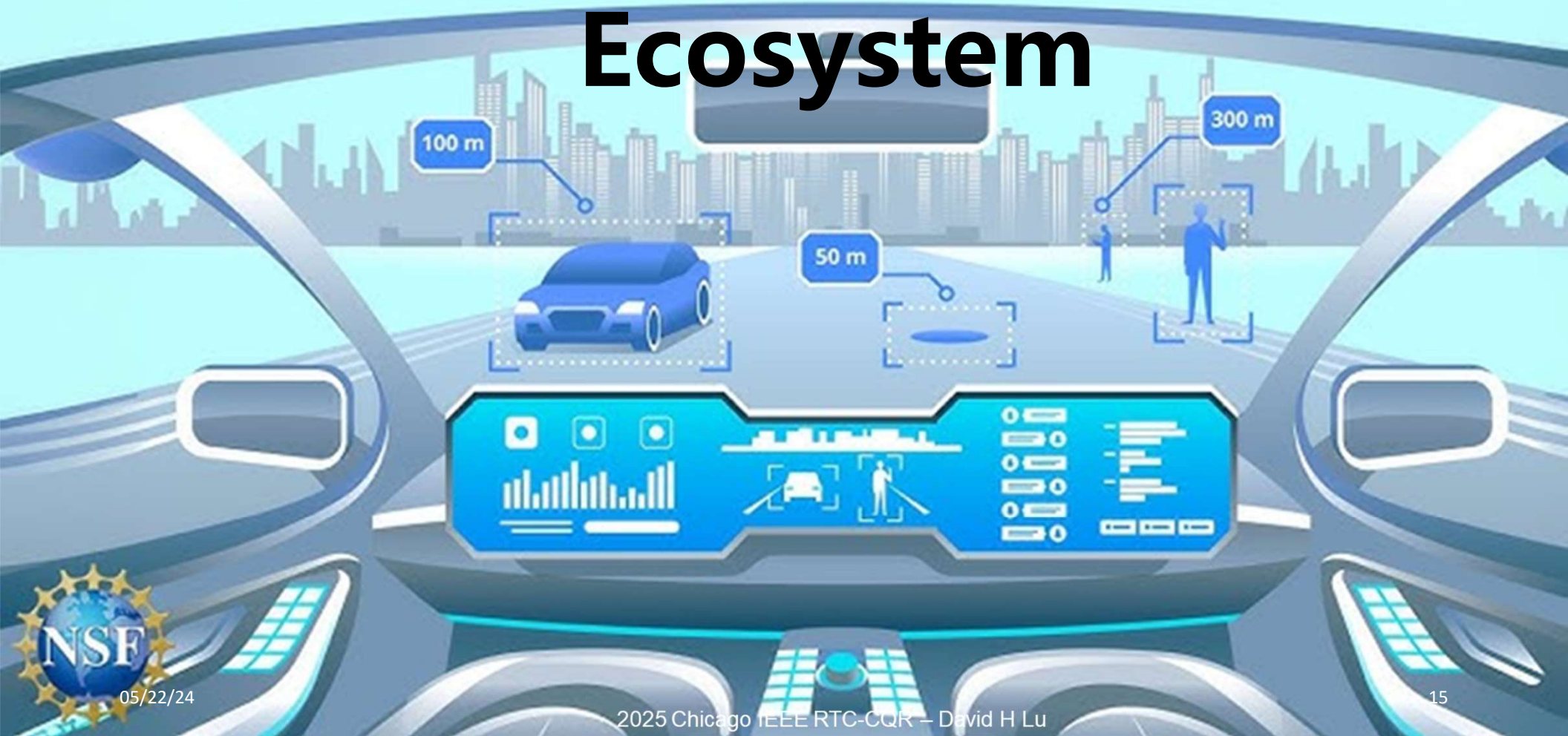




Precision & Fault Tolerant Requirements

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Autonomous Vehicle Ecosystem

Autonomous Vehicles Ecosystem



Precision & Fault Tolerant Requirements (1)

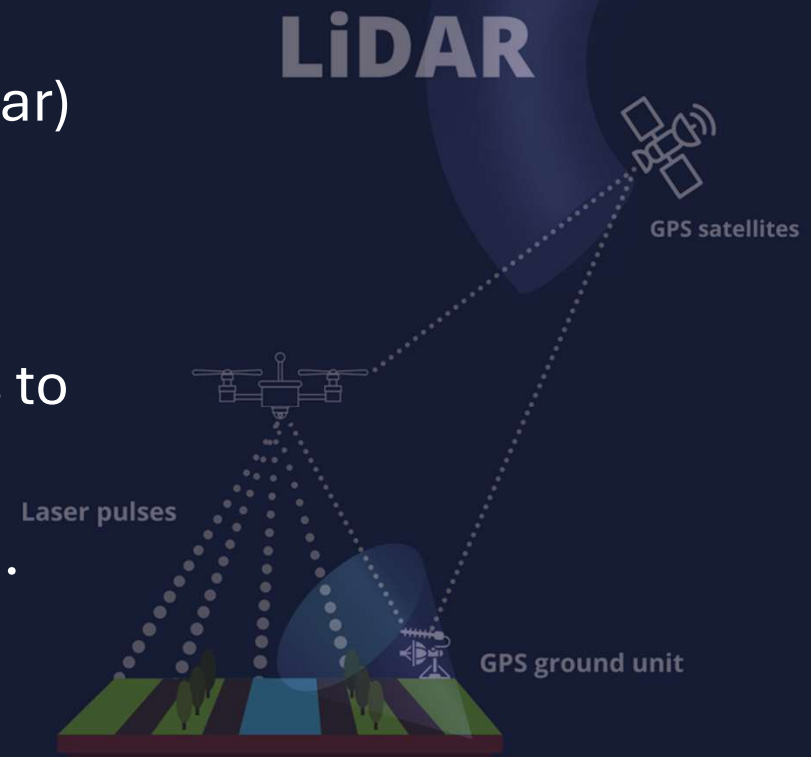
- Sustainable and uninterrupted energy supplies vs. dramatically increased energy consumption and dependency.
- Ultra-fast computing and communication platform performance under milliseconds to ensure seamless vehicle operations.
- Ultra reliable and resilient communication channel (mobile channel level COS and QOS) and overcome electronic or/and environmental interferences.
- Zero-tolerance cybersecurity features – protection and intent driven monitoring.

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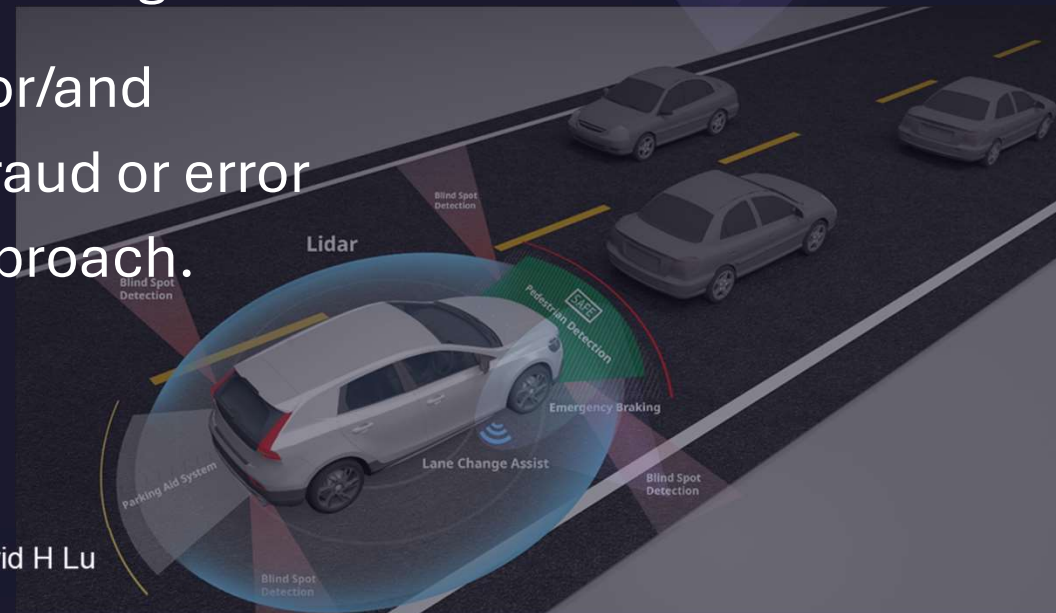
Precision & Fault Tolerant Requirements (2)

- Component and ecosystem error detection and self-healing/correction.
- Weather proven detection capabilities (Lidar) using more advanced technology such as LASER vs. optical camera alone.
- Road surface and traffic condition sensors to trigger speed control far in advance and without depending on manual intervention.
- Calibration, testing and self-diagnosis.



Precision & Fault Tolerant Requirements (3)

- Trace and logging capabilities, like airplane Blackbox in commercial usage.
- Self-learning loop using generative AI to adapt.
- Liability driven requirements and testing.
- Safety features such as stopping or/and aborting AI decisions when fatal fraud or error detected in a safe and smooth approach.
- ...



Government Regulations

Industry De Facto Standards

The image features a futuristic digital road scene. A blue car is driving on a road with yellow dashed lines, emitting a fan of purple and blue sensor beams. In the background, there are digital city buildings and a glowing green rectangular object on the road. The overall scene is set against a dark background with a grid of light lines. In the bottom right corner, there is a dark rectangular inset containing a glowing blue scale of justice icon surrounded by binary code.

Speed of Innovation vs. Consumer Safety vs. Government Regulations

Regulatory & Industry Standards

- Policies at Global, National, State, and Local Levels
- Urban and Road Infrastructure Planning
- Insurance and Liability Guidelines
- Technology Standards such as Minimum Precision & Fault Tolerant Requirements
- Ecosystem Serviceability vs. Components Liability
- Ethical Consideration for AV Ecosystem Decisions

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Future Considerations

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Technology Innovation & Humam Impact

Technology Innovation & Human Impact

- Technical Limitations – More advanced sensors and control system interprets data in sub millisecond speed.
- Safety and Security - Establishing comprehensive safety standards and testing protocols is essential to guarantee that these vehicles can handle all driving situations safely, and zero-tolerance security to avoid the control of the vehicle yielding to wrong hands.
- Infrastructure Adaptation – requiring significant road changes that demanding regulatory, urban planning, and investment changes.
- Economic and Business Model Challenges – cost, production, usage such as service model all requires tremendous changes from the current vehicle model.
- Regulatory and Legal Issues – An AV framework would involve usage, privacy, algorithmic bias, liability & insurance, and ethical transparencies.

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Future AV Market – Projected to Reach \$300B-\$400B by 2035

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Thank you

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