



Power for Mobility at Cummins

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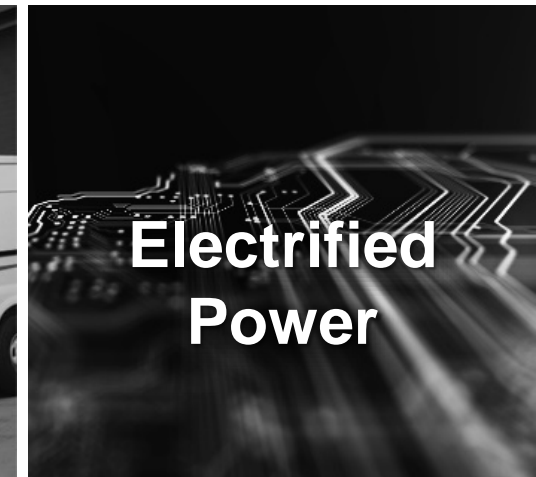
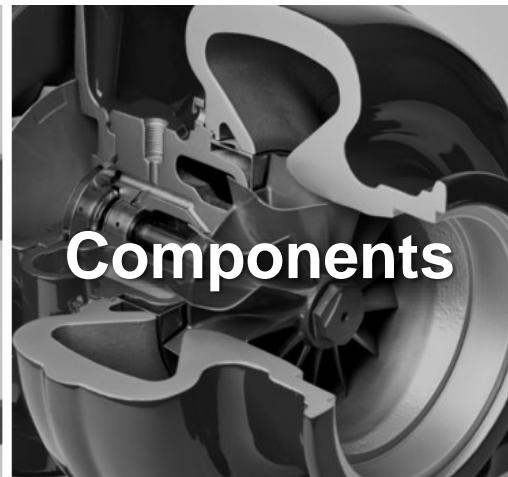
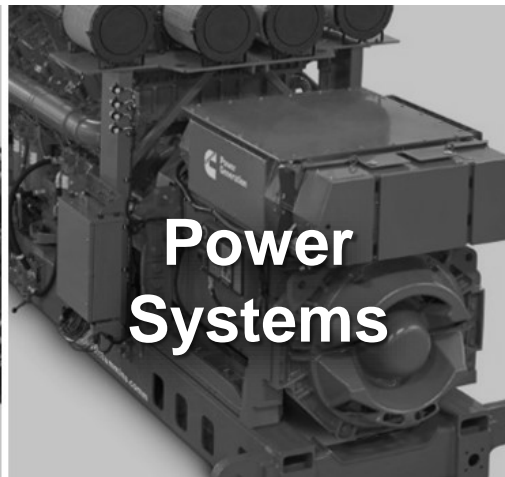
VP Global Research and Technology

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Internal Use Only

Five operating segments

Cummins has a nearly 100-year-long track record of delivering leading power solutions. As we look ahead, we know our industries and markets will continue to change, and we are committed to bringing our customers the right technology at the right time.



Cummins

100

years serving
customers

1M+

engines annually
produced

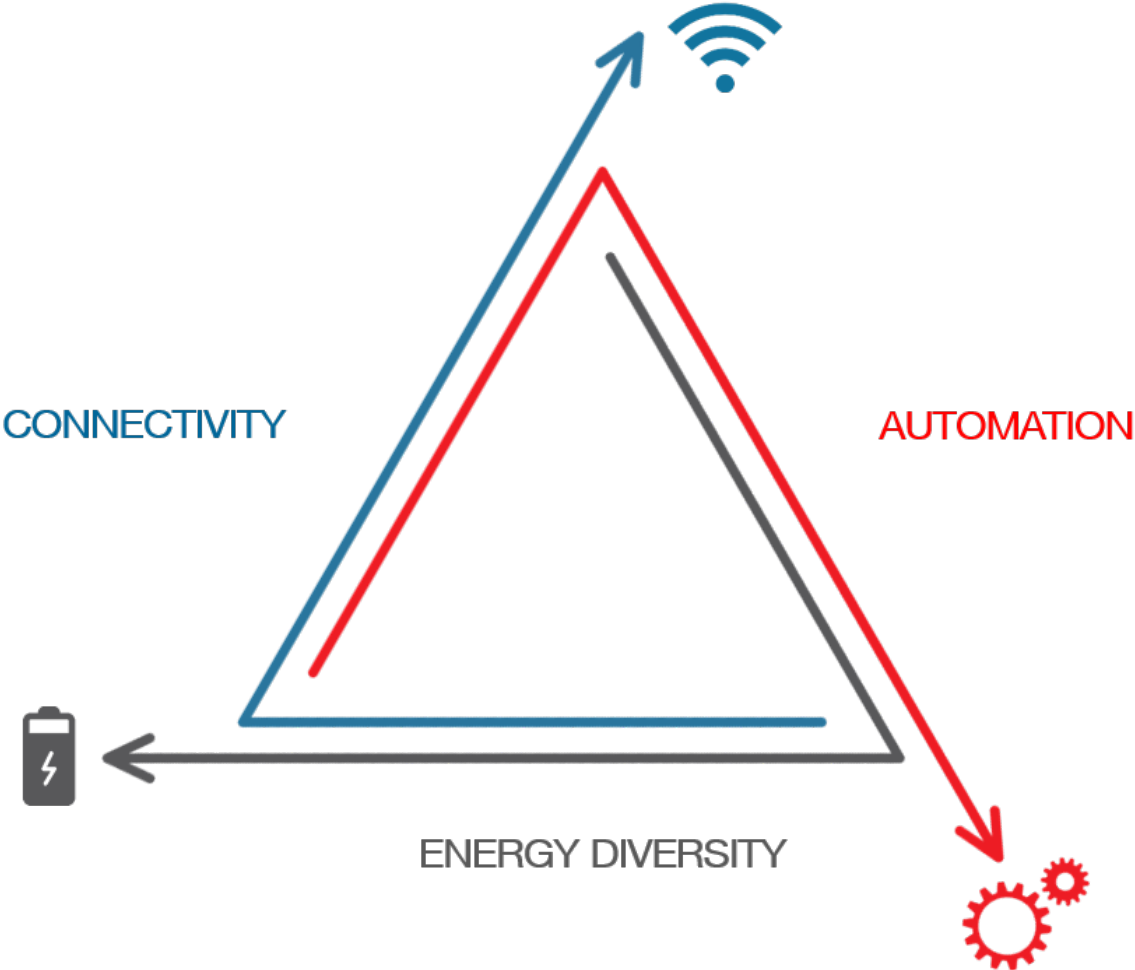
15M

engines in the
field

Understands power

— past, present and future.

The world is changing.



Diversity of Pickup and Delivery Market



DIESEL



ELECTRIFICATION

- Battery Electric Vehicle
- Range Extended EV
- Hybrid



SPARK IGNITED

- Gasoline
- Natural Gas
- Propane
- Bio/Renewable Fuels

Line Haul On-Highway Market



DEFINING ATTRIBUTES OF LINE HAUL

- More than 300 miles a day
- More than 60,000 miles annually
- Average moving speed 50 to 60 mph
- 5 to 40 percent idle time
- 70 to 95 percent top gear time
- Uptime is critical

Power Source

- Diesel
- Middle Distillates
- Bio/ renewable fuels
- Mild Hybrid Electrification

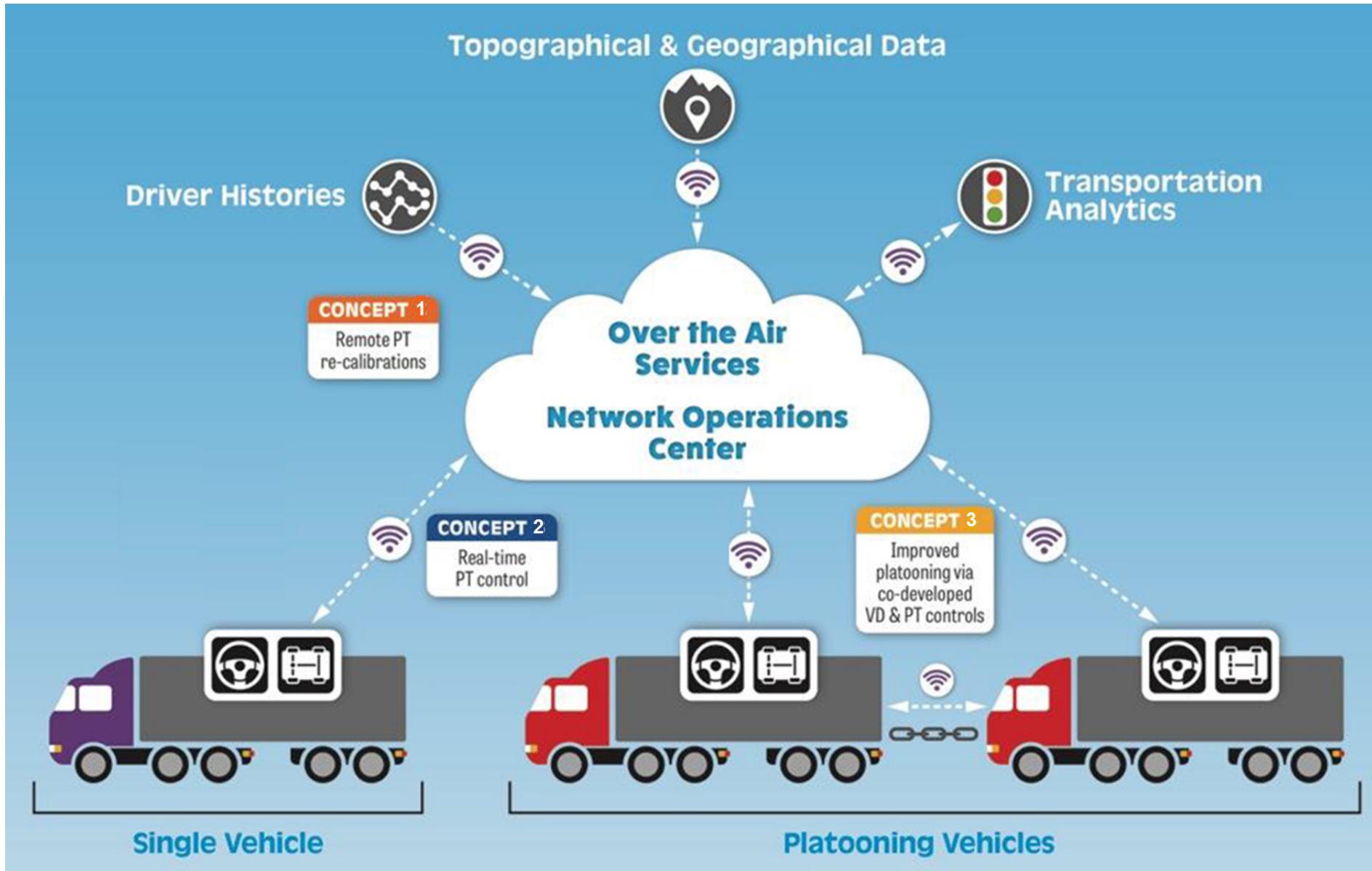
City buses are electrifying.

Urban Transit Bus

- Electricity readily available in route and at depot
- Decreased maintenance costs
- Meet tighter emissions and noise regulations
- Decrease emissions and improve air quality



NEXTCAR



Alternate Energy

electrification • natural gas •
gasoline • others

Intelligent Data Systems

connected systems •
controls • intelligent
transportation

Power Solution

Powertrain Integration

transmission • axles • brakes

Engine System

Diversity of application specific solutions

Electric power plays an increasingly important role, but pace of adoption is uncertain

Pure electric solutions for applications with lower energy requirements, fuel cell for higher energy applications

Autonomous changes missions and business models

Powertrain of the future?

FUEL CELL

High Energy Requirements

200-300+ miles/day

Fast refuel, better energy storage capacity

FULLY ELECTRIC

Low Energy

Requirements

Densely populated area
Air/noise quality issues

Electricity readily available in route & at depot

AUTONOMOUS

Where driver costs high

Hard to predict pace

May impact vehicle design and powertrain design

Cummins Cybersecurity Ecosystem

Not vertically integrated —products are put into customer networks

Products must interface with a large number of applications tailored to customer needs

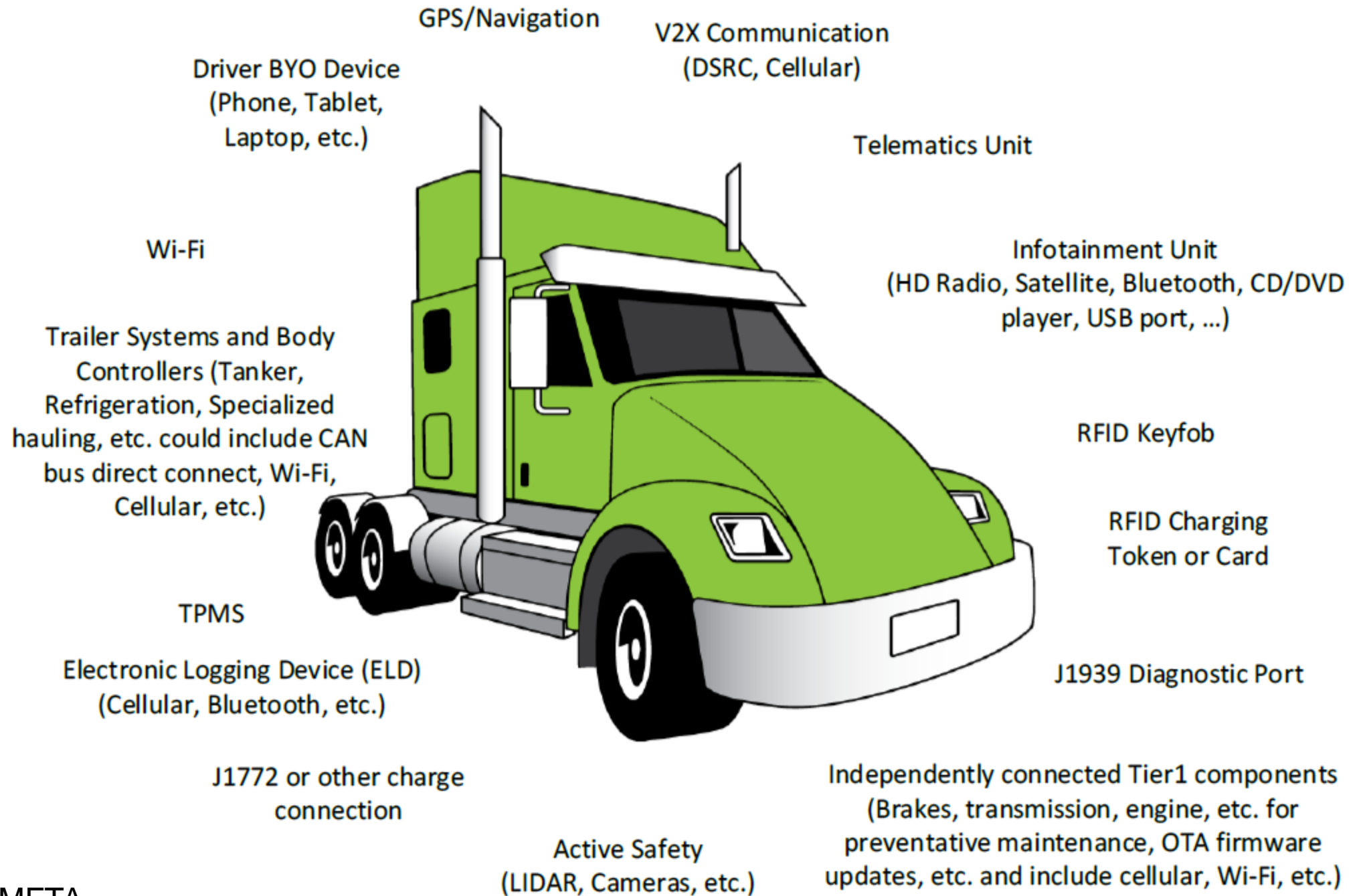
Controller Area Network (CAN) with J1939 protocol — trusting network

CAN Flexible Data

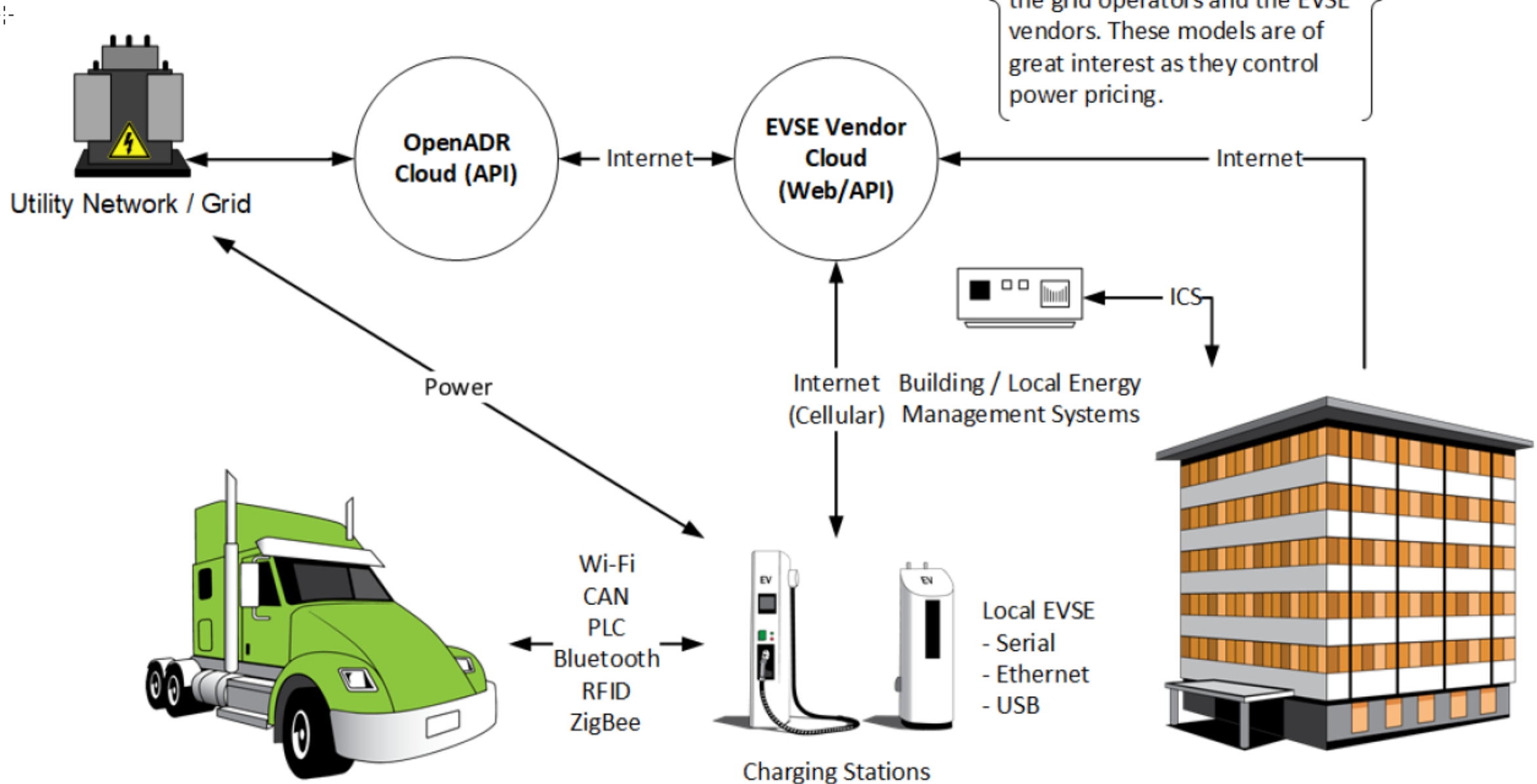
J1939 security (SAE)

Legacy products—inability to update remotely—have to physically touch them

Reuse the same products in different market segments



EV Charging Communication Paths



NOTE: The power pricing and demand models rely on the information exchange between the grid operators and the EVSE vendors. These models are of great interest as they control power pricing.

Our Strategy: What are we trying to do?

Goal: Cummins products meet or exceed industry cybersecurity standards and norms while maintaining a cost-effective risk posture.

What: Follow NIST Cybersecurity Framework

- Identify
- Protect
- Detect
- Respond
- Recover

How:

- Security by Design (Protect)
- Inform and Shape Standards and Regulations (Identify/Protect)
- Defense in Depth (Protect)
- Embrace the Hacker (Identify/Protect)
- Respond to Incidents (Respond/Recover)



Our Strategy: Security By Design

Basic Security Principles

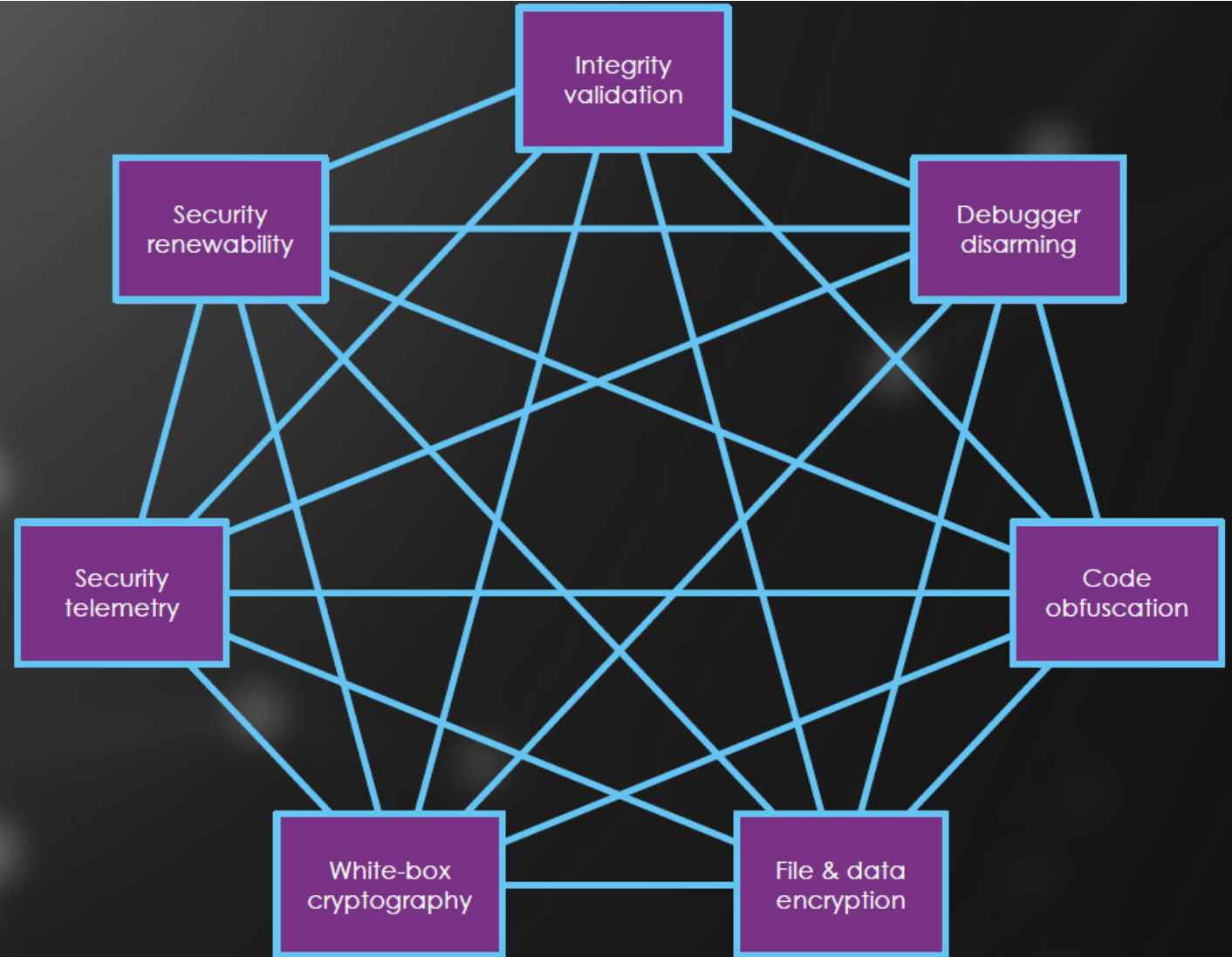
- Minimize attack surfaces
- Data secured in storage & transit
- Authenticate & authorization
- Only run trusted code
- Breach detection
- Update mechanism



Our Strategy – Defense in Depth

Advanced code hardening technologies that mutually reinforce each other

Layered security makes it exceedingly difficult for hackers to find and leverage vulnerabilities



Our Strategy – Embrace the Hacker



Summary


Power Train of the future is changing

Cybersecurity is a critical element for the safety of future mobility systems


Cummins ecosystem provides a challenging environment for Cybersecurity



Product Cybersecurity



Cummins Guidanz™
Mobile Technology For Ultimate
Efficiency And Uptime.



Product & IT Cyber Collaborate

