IEEE 802.24 AFV WP  
revised (final) outline

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# Introduction

## Problem statement: AFV fueling protocols don’t use mainstream networking Layer 2 standards and technologies. Consequently, they are not as economical, secure, performant, or extensible as they could/should be.

## This whitepaper describes how IEEE 802 LAN/MAN standards and technologies are being introduced to extend and enhance the communications capabilities, and could be used to enhance the security, of AFV charging infrastructure.

# A brief overview of current AFV fueling infrastructure communications and security at networking stack Layer 2.

## Electric Vehicle (EV) charging:

### AC charging control is done with analog control (1 KHz PWM baseband), there is no ISO-layered protocol stack.

### Some DC charging uses conventional automotive CAN bus. (CN, JP)

### Some DC charging uses PowerLine Carrier at Layer 1 and Ethernet at Layer 2 [per HomePlug Green PHY specification, peer-to-peer link]. (EU, KR, NA)

### TCP/IP is used at Layers 3-4 with compressed XML as payload (Layers 5-7)

### TLS (v1.2) is used to protect messaging in some charging sessions, not all.

* New standard requires mTLS (v1.3) but supports fallback to TCP/IP w/o TLS.

## Hydrogen Surface Vehicle (HSV) fueling:

### Currently, IrDA protocols are used by the vehicle only to indicate HSV fueling tank type (one-way, static info) per SAE J2799-2024.

### Weak physical security (easily thwarted), no data security.

### Next-generation HSV fueling protocols are being explored in ISO TC197.

## Conclusions:

### Almost all AFV fueling sessions use old, stale, not secure communications standards and technologies at the point of delivery (dispenser 🡨🡪vehicle).

### Security is almost exclusively physical; where digital security is required for EV charging, it currently relies on deprecated standards and often fails.

### There is plenty of room for improvement!

# Use cases for IEEE 802 LAN/MAN standards in AFV fueling infrastructures.

## EV charging: depot and public charging sites – passenger/delivery EV charging.

### Wireless LAN (802.11, 802.15) connecting EVSE/dispensers with site- or cloud-based energy/charging services management systems.

* Could support asset management, optimize energy use, enhance service delivery and fleet logistics.

### Wireless LAN (802.11, p2p) for robotic control of conductive coupler.

* Revise to use more recent 802.11 version/features, better architecture?

### Wireless LAN (802.11, 802.15) for controlling inductive charging.

* Could replace current, proprietary communications methods.
* LAN configuration sketched in OPCC V2.x (Local Gateway, Local Proxy) but no technical specification or requirements [check draft OCPP 2.1]

### Wireless LAN (802.11, 802.15) for valet parking/charging service

* Use Next-Gen V2X communications (802.11bd) to connect EV to site-based auto-pilot server, direct EV to available and suitable EVSE
* On a separate WLAN or a VLAN on a multi-service WLAN (e.g. supporting use case 3.a.iii).

## EV charging: depot and public charging sites – Medium/Heavy Duty EV charging.

### L1-2 standard for the Megawatt Charging System (MCS)

* Replace HomePlug GP at Layer 1-2 with SPE (IEEE 802.3cg, 10BASE-T1S)
* Being standardized by ISO TC22/JWG1/WG4 as ISO/IEC 15118-10.

### Site wired/wireless LAN connecting EV charging, DER, microgrid controllers.

* Supports next-gen EV charging energy resiliency requirements.
* Opportunity to use 802.1X and 802.1AE for industrial-strength security.
* Analogous to IEEE 802.1/IEC 60802 approach to evolving IACS comms.

## EV charging: integrated into Home and Building Energy Management Systems

### Opportunity for HEMS and BEMS systems to manage EV charging/BPT.

* EV charging is a new load category, growing in significance and impact.
* Potential for optimizing energy use via inter-device (source, load) micro-negotiations.

### Potential for EVs to provide energy services to homes, building sites, and property portfolios.

* Back-up energy during outages, replacing petrol/diesel fueled generators.
* Energy shifting/flexibility (e.g. responding to dynamic utility energy pricing).
* Participation in utility Demand Response programs (e.g using predictive analytics for aggregated loads).

## EV charging: Wireless Battery Management System

* Potential for IEEE 802.15.4 to replace proprietary wireless comms for EV battery module/pack management

## HSV fueling: dynamic two-way communications between vehicle and dispenser.

* Potential for IEEE 802.11 or 802.15 to replace IrDA standards
* Advantages in performance, security, functionality and performance, cost, supply chain, etc.

# IEEE 802 network and system considerations

## Medium flexibility and extensibility

### Support for wired and wireless endpoints

* E.g. IEEE 802.3 and IEEE 802.11 stations in controllers, actuators
* MAC (Layer 2): common architecture, addressing, bridging, VLANs, etc.
* WSNs (IEEE 802.15) less integrated but might be applicable

## IEEE 802.15 for sensors and IoT

* IEEE 802.24 IoT Whitepaper?

## Network security and management (802.1)

### Benefits from mainstream IT industry tools, techniques, insights, support

### YANG models, netconf

* “Belt and suspenders” approach: 802.1X+802.1AE (MACSEC) provides link security for any/all upper-layer protocols
* Being applied in other domains (IACS; aviation; automotive?; IoT?)
* Framework for EV charging/energy-edge domain-specific Layer 2 profiles

## Extensibility/innovation of standards and technologies

* Example: auto industry driving SPE for 10Mbps-10Gbps, copper and fiber
* Example: MAC address randomization (802.11bh) for enhanced privacy
* Example: IEC 60802 profile of TSN for IACS

# Performance requirements

## A table of message length and duration per use case / link / network segment.

## Summary: 10-100-1000 Mbps will largely suffice in the near term.

# Supply chain and ecosystem considerations

## AFV industry needs would probably be met by high-mix low-yield suppliers

## We’re in the early days of radio (horizontal integration is just beginning)

# Conclusion