802.1 Time Sensitive Networking (TSN)

Overview of IEEE 802 opportunities in
AFV* (EV and H₂V) Fueling

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* Alternative Fuel Vehicle
Agenda

• Summary of 802.24 discussion (began Sept 2022)
  – Survey of opportunities for IEEE 802
  – Example use cases for EV charging (depot, parking)
  – A brief look at Hydrogen Surface Vehicle fueling
• IEEE 802.1 and 802.3 opportunities
• Concrete, near-term ETH opportunity
• Potential relevance of TSN
• Discussion and next steps
802.24: Opportunity for IEEE 802 vertical application

- Explore a ‘Secure L2 EV charging comms fabric’
  - Develop LAN architecture supporting site-level (depot, public fueling) operations
  - Towards a secure, cohesive, extensible ‘AFV fueling edge’
  - Draw on existing and emerging 802.1/.3/.11 standards

- Explore how 802 services for e.g. TSN, location, and privacy could enhance site operations and systems integration

- Example next-generation (esp. fleet) AFV charging uses cases
  - Site-level comms fabric under 802.1 security and management framework
  - Wi-Fi for charging, transactions, robotics, Autonomous Vehicle (AV) control
  - SPE for control and management of high-power EV charging, integrating building/site DERs and the electrical utility edge
  - TSN features (e.g. time synchronization) for power systems controls
  - VLANs for security, QOS of high-data-volume applications, e.g. GIS data, route and schedule optimization, media services, trusted SW updates for vehicle ECU/DCU
“Anchor” near-term use case #1

*Use Wi-Fi® for large-scale EV (AC) charging*

- 800 parking spots, 400 AC charging stations (6.6 kW)
- Medium/long dwell (4-10 hour) charging
- Obvious opportunities
  - Replace PLC (L1/L2)
  - Managed charging
  - Data (logistics & tracking)
  - EV (ECU) maintenance
“Anchor” near-term use case #2

Use Wi-Fi for “over-the-top” transaction services

- EV joins site Wi-Fi network, negotiates fueling service parameters
- On-site edge (+cloud) services platform directs AFV to fueling bay
- Coupling to fueling device could be robotic, controlled via Wi-Fi
- Fueling control could be via Wi-Fi as well
A brief look at $\text{H}_2$ (HSV) fueling

- Current system uses IrDA standards for one-way communication
  - SAE J2799/J2600/J2601
  - Vehicle sends fixed fueling parameters ($V$, $T$, $p$)
  - Dispenser performs accordingly (“parameter-driven”)
  - Overly large margins for physical and functional safety
  - Doesn’t support higher fill rates, tank temp ranges
  - IrDA not very reliable (sunlight, fogging); easily damaged

- Opening for standards-based w/less comms
  - 2-way: tank characteristics; pre-cooling; dynamic control
  - Needed for higher-speed fueling (larger tank HSVs)
  - EU Project Prhyde -> ISO 19885-2/-3 (TC 297)
  - Contemplating transactional services (e.g. payment, loyalty points) and fleet management (fueling logs, maintenance)
  - Developing requirements for trust and security (PKI)
  - Interested in using Secure Layer 2 (802.1/802.11)
802.1/.3 opportunities

• How could 802.1 and 802.3 standards support AFV fueling?
  – Convergence/concentration of energy & data for transportation
  – Support for fueling, power/energy distribution, logistics, operations
  – Sites/locale: depots, ‘truck stops’, public transport hubs (LAN/MAN)

• Architecture
  – Distributed energy, computing, control
  – Coordinated security contexts
    • Fueling: vehicle, dispenser, energy sources and sinks; safety-critical?
    • Data: public/private, site/region, cooperating entities; trust domains
  – Orchestration of workloads between edge/cloud

• Applications:
  – SPE in EV charging cables/couplers, for sensors (situational awareness)
  – Power system controls (e.g. protection, UPS, load management)
  – Data services (Internet/media, goods tracking, mobility services)

• Inspiration: 802 Nendica Reports (Flex Factory IOT, Intelligent LDCN)
Concrete, near-term use case

• Use 802.3 (SPE) for control and management of high-power EV charging systems

CHAdEMO 3.0 aka ChaoJi

Megawatt Charging System (MCS)

• Both couplers have 2x pins with ~8mm spacing for comms
• CHAdEMO/ChaoJi are now testing “Two-wire Ethernet” over these pins
• MCS group is exploring alternatives to BPLC (CAN bus, 10Base-T1S)
• ISO 15118-10 launched (req’ts for Ethernet PHY/MAC for EV charging)
AFV ‘fueling edge network’ cartoon

AC charging
Wi-Fi network

Edge/Cloud GW

Security Manager
(KMS, PKI ICA)

Energy/Fueling
Mgmt Server

Workforce
Comms AP

HPC (high-power charging) bays

Charging Depot/Hub Local Area

Logistics
App Server

Asset Mgmt
Server

Craig Rodine, SNL
Potential relevance of TSN for AFV Fueling

• Critical transportation hubs must be robust and reliable
  – In normal and emergency operational conditions
  – Applies to charging, cybersecurity, data services

• Time Synchronization for power system control
  – Protection (AC: “sub-cycle” reaction times)
  – Coordination of distributed (local) sources and sinks
  – Next-gen switchgear; integration with utility grid
Discussion, next steps

- Ask: 802.1 & 802.3 work with 802.24 on AFV Fueling Vertical Opportunity
- Ask: 802 reach out to CHAdeMO Association and ISO (TC22, SC37, JWG1): ETH use in EV cables/couplers
- Discussion
Discussion, next steps

Thank you very much!

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