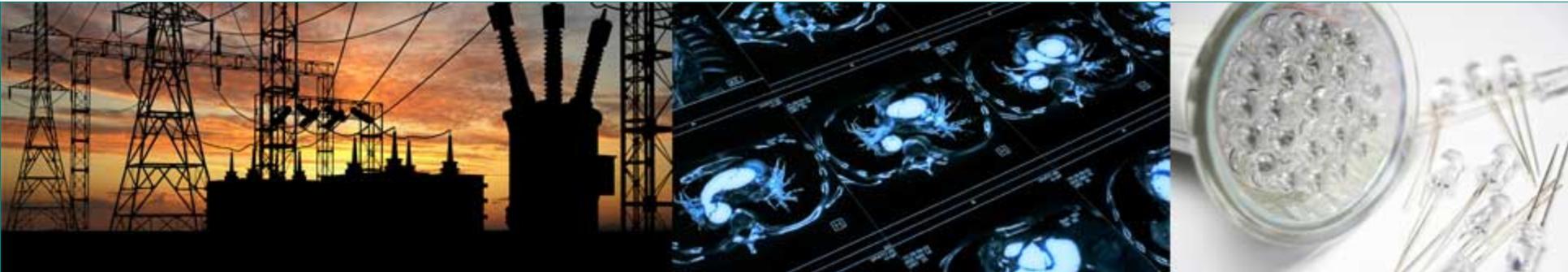


# EVSE Network Interoperability Standards (An Overview)



The Association of Electrical and Medical Imaging Equipment Manufacturers



# Network Interoperability for EV Driver Roaming

Residential



- Single Family (SF) Residences
- Apt/Condo Complexes
- Student and Shared Housing
- Hotels/Resorts

Charge at Different EV Charging Service Providers

Workplace



- Workplaces
- Customer Sites
- Fleet Vehicle Depots
- Universities and Schools

Public/Commercial



- Stores and Malls
- Inter-State Fueling Stations
- Airports and Hotels
- Downtown Workplaces

Roaming is a Daily Recurring Need for Lifetime of Vehicle





# ANSI EVSP Identified Standards Gaps

**Gap 1: Charging of roaming EVs.** There is a need to permit roaming EVs to charge at spots affiliated with a different EVSP.

**Recommendation:** Develop communications standards that support roaming EVs that require charging services from an EVSP other than the EV users Home EVSP.

**Priority:** Near-term.

**Potential Developer:** SAE, ISO/IEC, Zigbee Alliance, OpenSG, NAESB, **NEMA**, others?

**Gap 2: Locating and reserving a public charging station.** There is a need for a standardized communication method to permit EV drivers to locate a public charging spot and reserve its use in advance.

**Recommendation:** Develop a communication and messaging standard to permit EV drivers to universally locate and reserve a public charging spot.

**Priority:** Near-term.

**Potential Developer:** SAE, ISO/IEC, Zigbee Alliance, OpenSG, **NEMA**, others?

**Gap 3: Offline access control at charging stations.** It would be beneficial to standardize offline access control at charging stations where a vehicle or driver may be denied access to charging.

**Recommendation:** Develop communication standards for offline access control at charging stations.

**Priority:** Near-term.

**Potential Developer:** SAE, ISO/IEC, Zigbee Alliance, OpenSG, NAESB, **NEMA**, others?



# Overview & Summary



## Critical Issues Affecting EV Usability

- Difficulty Locating Charging Stations Across Various EV Charging Service Providers (EVCSPs)
- Inconsistent and Incompatible Credentials and Activation Methods Prevents Drivers from Using Chargers Across EVCSPs
- Disparate and Non-Interoperable Charging Service Networks Prevent Drivers from Having Consolidated Charging Service Plans (Like Roaming Cell Phones)



## Approach

- Create a Station Directory Data Schema and Protocol to Enable Sharing EVSE Attributes, Location, and Status Between Networks
- Define Standard Credentials and Service Activation Protocols To Enable Roaming and To Receive Charging Service On Any Standards Compliant Network
- Develop Communication Protocol Standards to Enable Authentication/Authorization, Conveyance of Charging Status, and Reconciliation of Customer Transactions



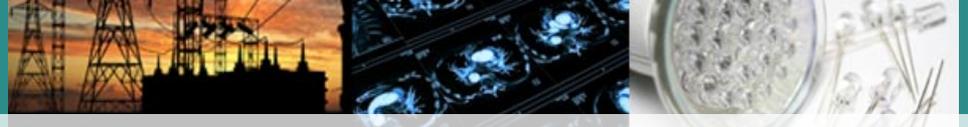
## Proposed Solution

- ISO14443a/b RFID Credentials with ISO7816-4/8 APDU Messaging Layer
- Common EVSE Identification and Naming
- Charging Service Interworking Via Gateways to Adapt Internal Networks to a NEMA-Defined Internetwork Protocol
- Peer-to-Peer or Clearinghouse Connectivity
- HTTPS SOAP Based Protocol for Directory Data Sharing, Authentication/Authorization, Charging Status, and Billing Reconciliation
- XML Data Schemas and WSDL Specifications



## Stakeholders

- National Standards Development Organizations (NEMA & ANSI) - Promoting Comprehensive National Solutions
- EVSE Manufacturers - Building Compatible Equipment
- EV Charging Service Providers - Interworking Their Networks to Enable Interoperable Charging Services Nationwide
- Local, State and National Governmental



# A Collaborative EV Infrastructure Industry Effort

- 💡 NEMA & ANSI
- 💡 ChargePoint (WG Chair - Dan Lee)
- 💡 ECOtality / Blink Network (WG Vice-Chair - Colin Read)
- 💡 GE Energy
- 💡 Leviton Electric
- 💡 Siemens
- 💡 PEP Stations
- 💡 Eaton
- 💡 Schneider Electric
- 💡 ABB
- 💡 ... and Growing



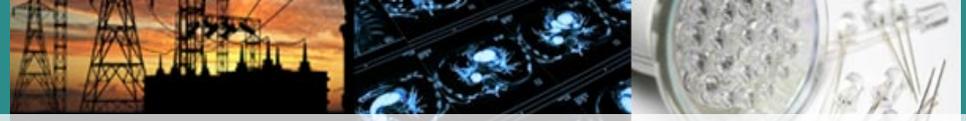
# Benefits of EVSE Network Roaming

## Benefits to Drivers

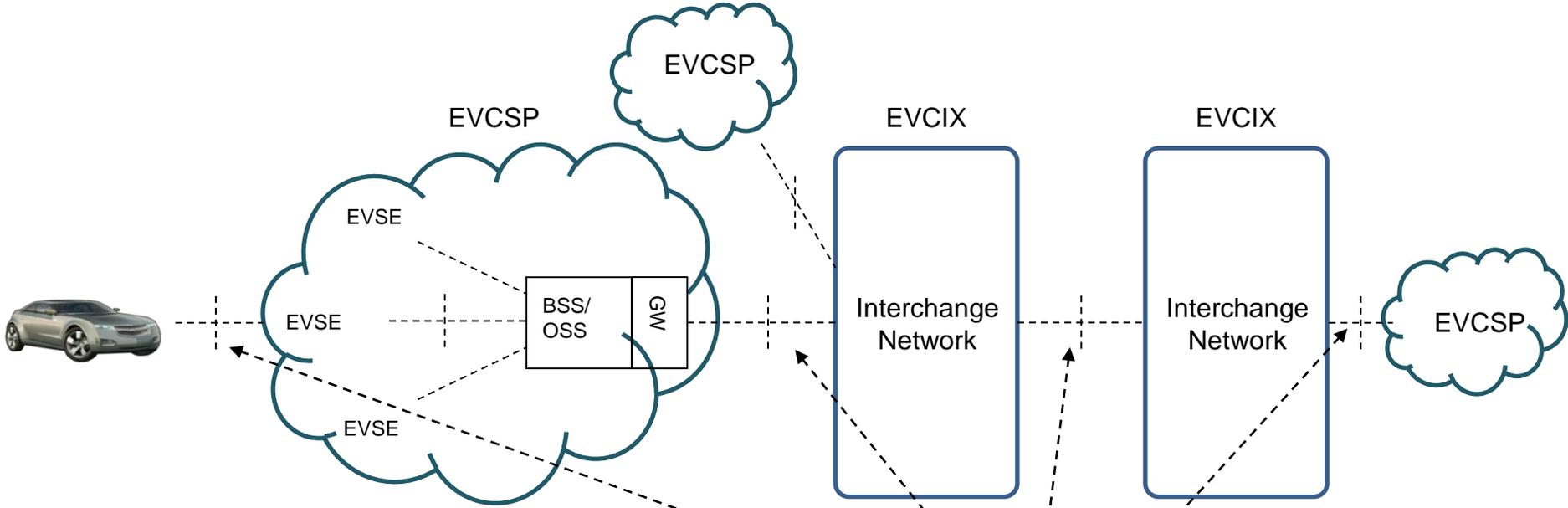
- Greater Choice of EV Charging Stations Near Driving Destinations
- Improved Availability and Driving Range for EV Drivers
- More Economical EV Fueling from Product Standardization and “Coopetition”
- Much Needed Convenience to Drivers
  - Reduced Need to Sign Up for Multiple Charging Service Plans
  - Fewer Service Access Credentials To Be Carried Around
  - Fewer Mobile-Apps and Web-Sites to Visit to Find Available Charging Stations
- New Service Plans - Single Bill Electricity Service Plans Covering Home, Work, and Public Charging
- Commercial Fleet Management Services
  - Cost and Greenhouse Credit Management

## Benefits to EV CSPs

- Increase Revenue From Your EV Charging Stations
- Drive More Consumers (with Long Shopping Times) to Host Store Locations
- Market an Expanded Service Foot Print to your Drivers and Hosts
- Enable Business Relationships Not Otherwise Possible with a Small Service Foot Print
- Encourage Smaller Mom & Pop Stores to Host EV Charging Services and Leverage “Network Effects”
- Retain Drivers/Subscribers by Providing a Better Driving Experience



# Inter- & Intra- Network Protocols



## Areas of NEMA Standardization

### Intra-Network Protocols

- OCNP, OCPP
- Proprietary
- etc.

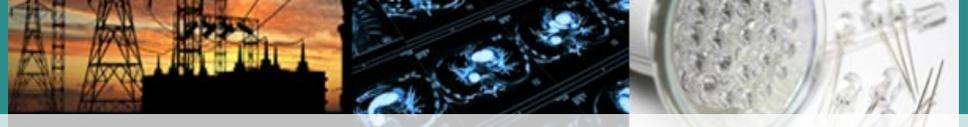
### Inter-Network Protocols

- Directory ( $I_D$ )
- Authentication/Authorization ( $I_A$ )
- Charging Session ( $I_C$ )
- Billing ( $I_B$ )

### Compatible Driver-Side Interfaces

- RFID ( $U_R$ )
- Station Identification Tags ( $U_T$ )

OSS: Operations Support Systems  
 BSS: Business Support Systems

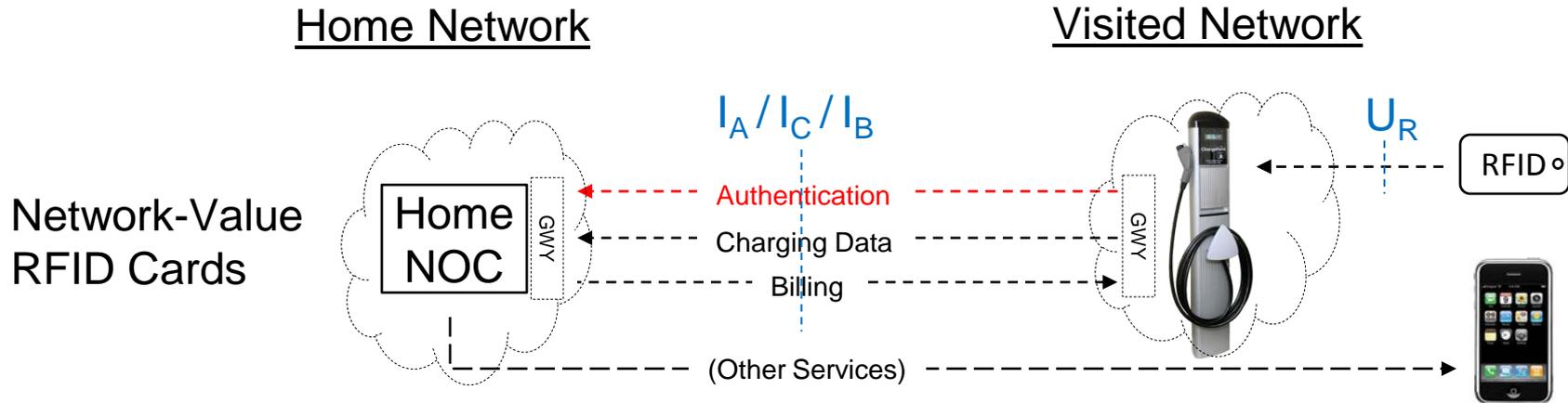


# Typical Driver Activity Flow

- 💡 1.) Find Charging Stations Near Desired Location
  - Web, Mobile Phone, or Vehicle-Installed Telematics Applications
- 💡 2a.) Authenticate and Activate Charging at Charging Station
  - RFID Application Specific Credentials
  - Payment Cards (Credit/Debit/Pre-Paid)
  - Vehicle Based Credentials (Future)
- 💡 2b.) Send Activate Request from Home Network to Foreign Network
  - Mobile Phone Applications (Scan QR Code, Text Recognition, Manual Entry)
  - Web Applications
  - Customer Service
- 💡 3.) Receive Record of Charging Activity and Pay for Transaction



# EV Driver Roaming Use Cases (1/2)



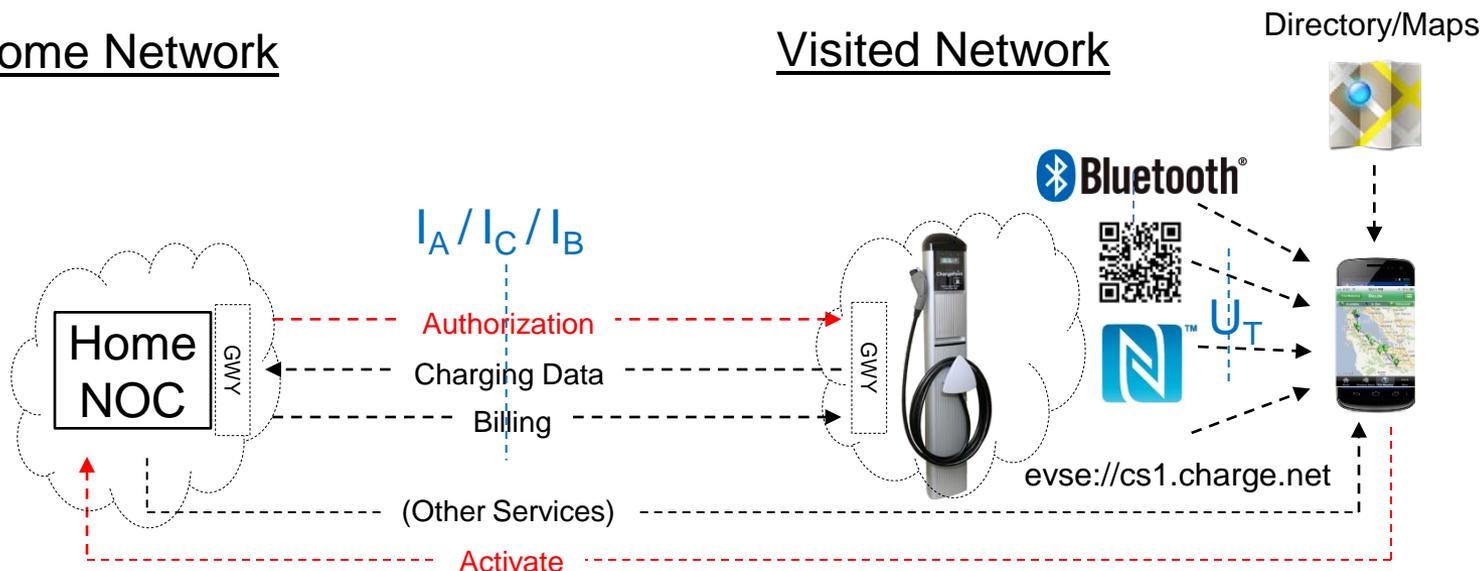
- Supports Subscription Based Service Plans or Per Session Transactions
  - Simple & Fast Service Activation
  - Low Transaction Overhead
- Enables Supplementary Services
  - Charging Status Notifications (EV Charging Done/Interrupted)
  - Usage Data and Receipts
  - Other Value Added Services May Help Subsidize Charging Costs

# EV Driver Roaming Use Cases (2/2)

## Home Network

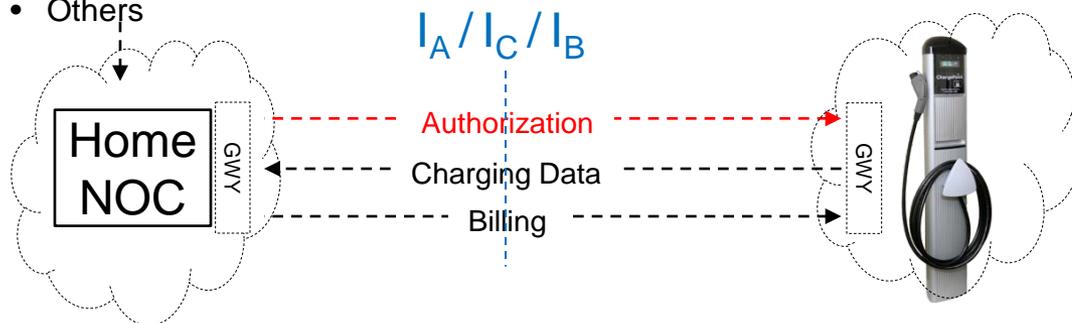
## Visited Network

Home-Network  
Initiated  
(Mobile App)



- Web-App
- Customer Service Call
- Others

Home-Network  
Initiated  
(Others)

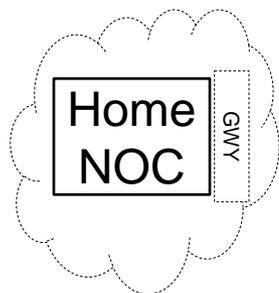


# Payments-Based Use Cases

## Home Network

### Simple Transactions, Non-Roaming

Payment Cards



## Visited Network

Pre-Authorization  
Settlement



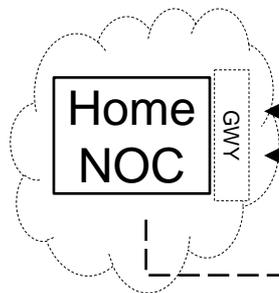
MagStripe  
Contactless (PayPass,  
PayWave)



$I_A / I_C$

### For Further Study

Payment Cards



Pre-Authorization  
Settlement



PayPass  
PayWave  
EMV



$I_A / I_C$

(NFC Loyalty)  
(Charging Data)

(NFC Loyalty)

(Other Services)





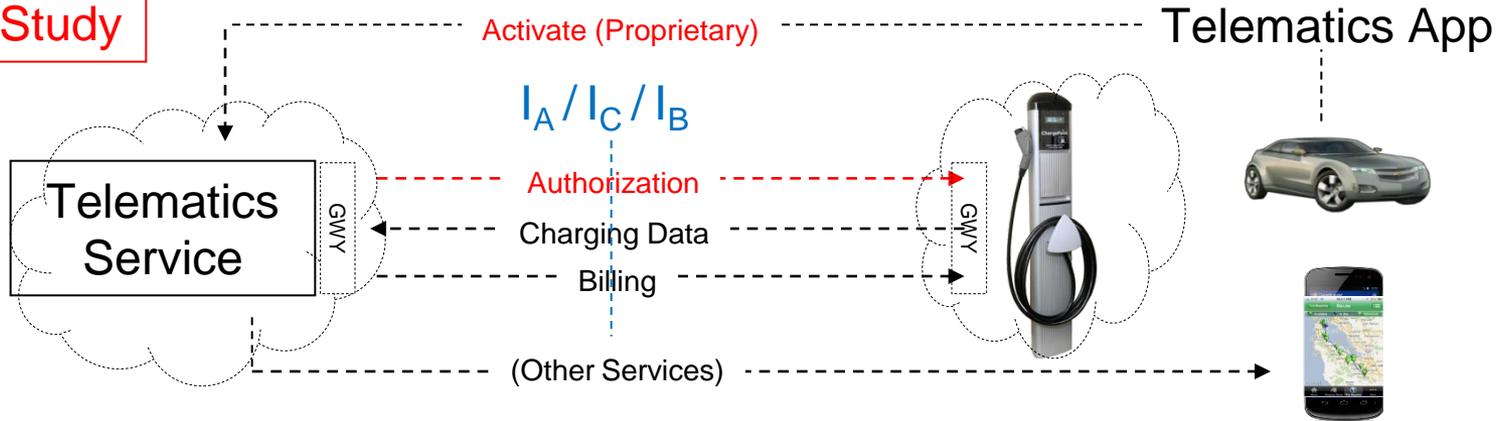
# Use Cases For Further Study (1/2)

## Home Network

## Visited Network

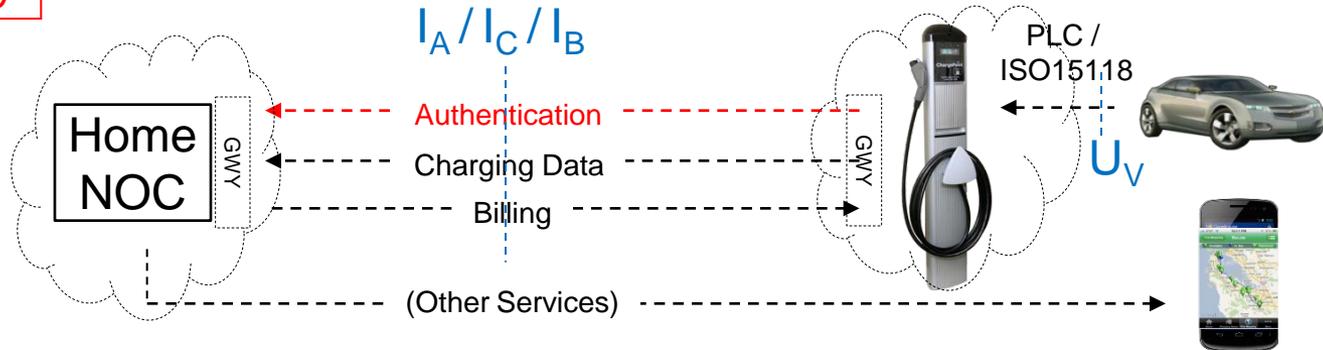
For Further Study

Vehicle Telematics Initiated



For Further Study

Vehicle Initiated



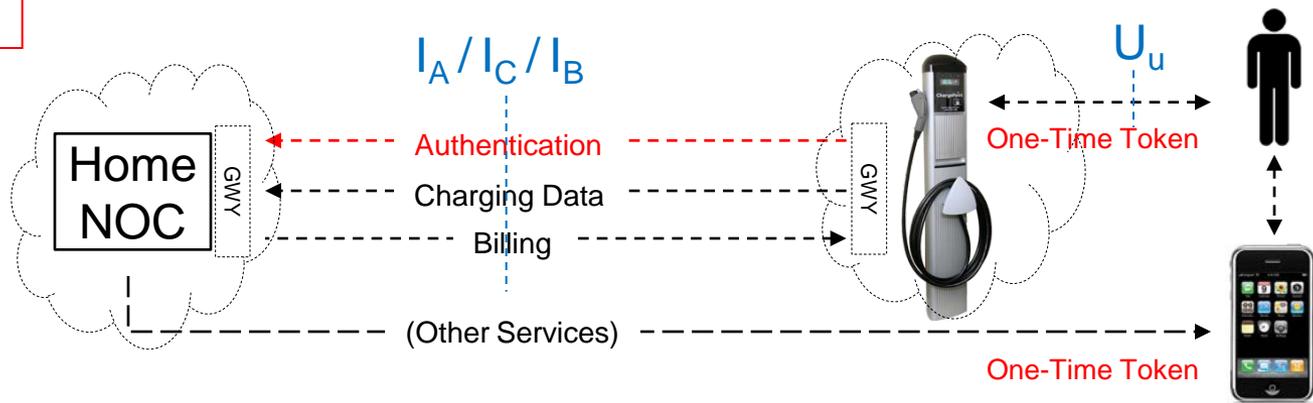
# Use Cases For Further Study (2/2)

## Home Network

## Visited Network

For Further Study

EVSE User Interface



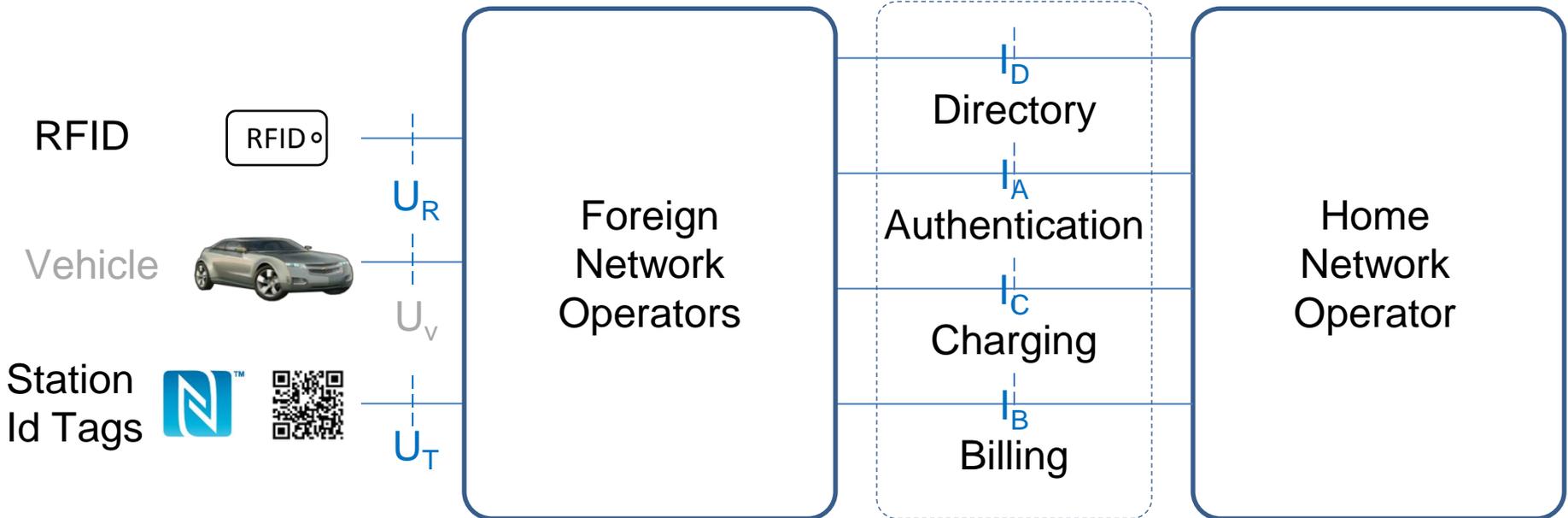
- Standardize Information Needed to Input Driver Account and Token Information
  - One-Time Token May Be Retrieved Out-of-Band
  - One-Time Token May Be Auto-Generated by Mobile-App
  - Not Intended to Standardize EVSE User Interface
  - Token To Be Included in Authentication Message



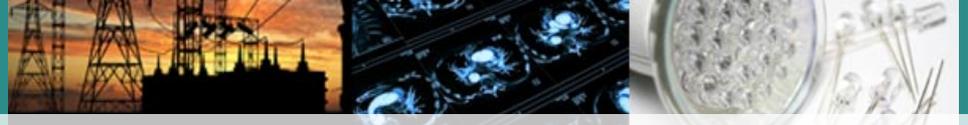
# Interface Standardization Reference Points

## Driver Interface

## Inter-Operator Interface



- Station Directory ( $I_D$ ) Provides an Integrated View of Stations on Participating Networks Along with Real-Time Status
- Common Station Station Identification ( $U_T$ ), Subscriber RFID Credentials ( $U_R$ ), and Authentication Protocols ( $I_A$ ) Enable Service Activation Across Any Network
- Roaming Service with Charging Status and Billing Across Networks ( $I_C$  and  $I_B$ )



# Station Directory Data Schema & Protocol (I<sub>D</sub>)

## Standardize Data Exchange Protocol, But Not Presentation of Data

- Each EVCSP To Differentiate Its User (Mobile) Apps

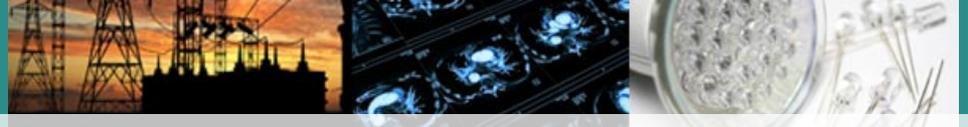
## Give Consumers Information To Choose According to Their Needs

- Proximity & Realtime Availability of Charging Service
  - Location and Site Picture Information
  - Potential for Electricity Delivery Curtailments
- Type of Charging Service
  - Number of Ports / Per-Port Charging Level Types / Total Power Delivery Capability
  - Parking Characteristics (with Possibility of Conveying Parking Sensor State Information)
- Price of Service
  - Time-Based Parking Fees / Electricity Usage Fees / Session Fees
  - Payment Types (Network-Specific Credentials, Payment Cards, Cash, etc.)

## Give Charging Stations Hosts/Owners Flexibility To Design Their Service Offering

- Allow Hosts/Owners to Respond to Different Market Conditions

## SOAP/WSDL/XSD Implementation



# Primary Station Directory XSD Elements

## EvseInfo (Pseudo-Static Data)

- IdentificationInfo / OperatorInfo / LocationInfo / AccessInfo
- ChargerPort
- ParkingSpot
- SessionFee / ElectricityFee / ParkingFee / OtherFee
- PaymentMethod

## EvseStatus (Near-Realtime Data)

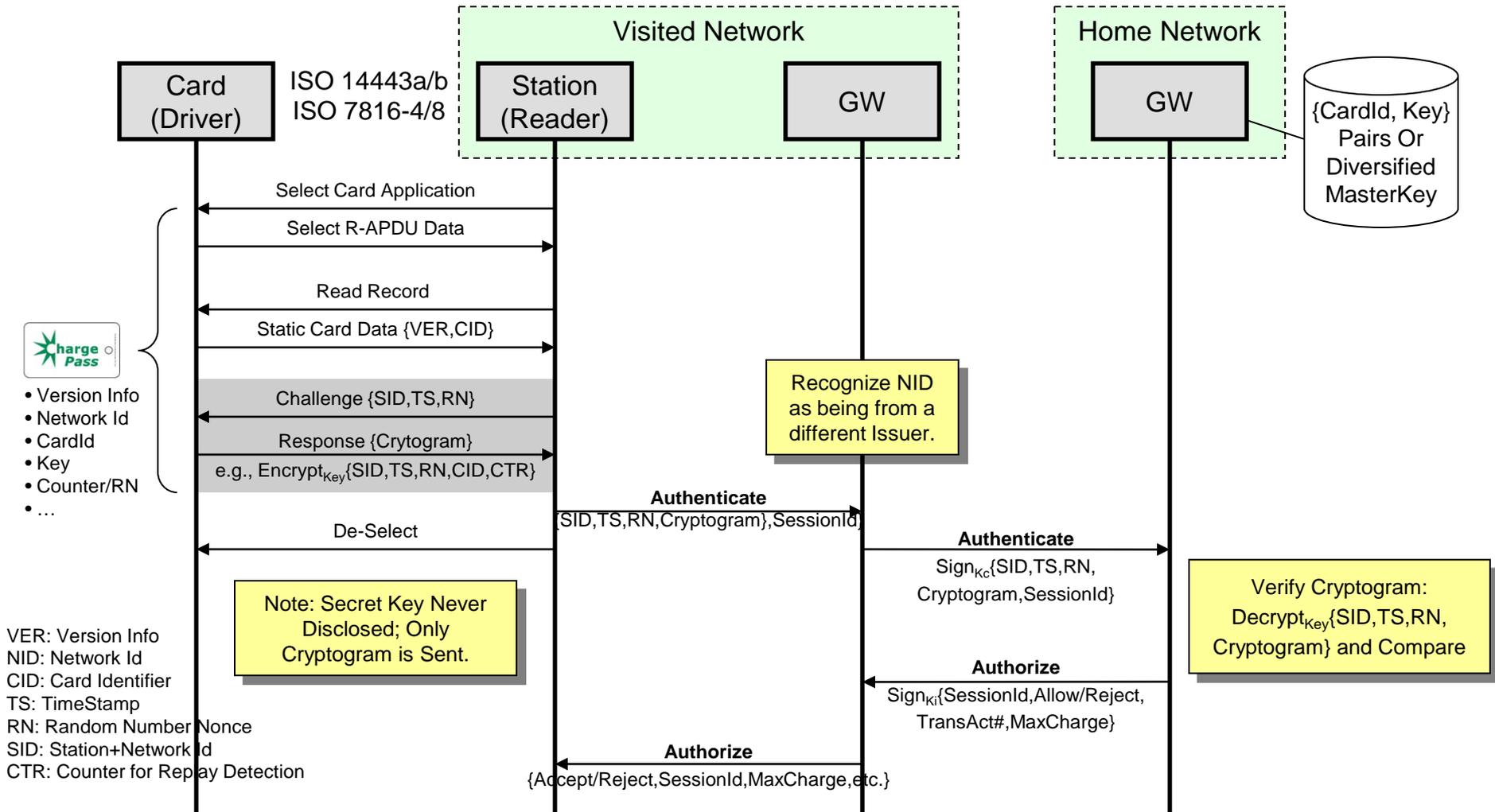
- ChargerPortStatus
- ParkingSpotStatus

## EvseSearchParameters (Search Interface)

- By Location
- By EvseInfo Data Attributes



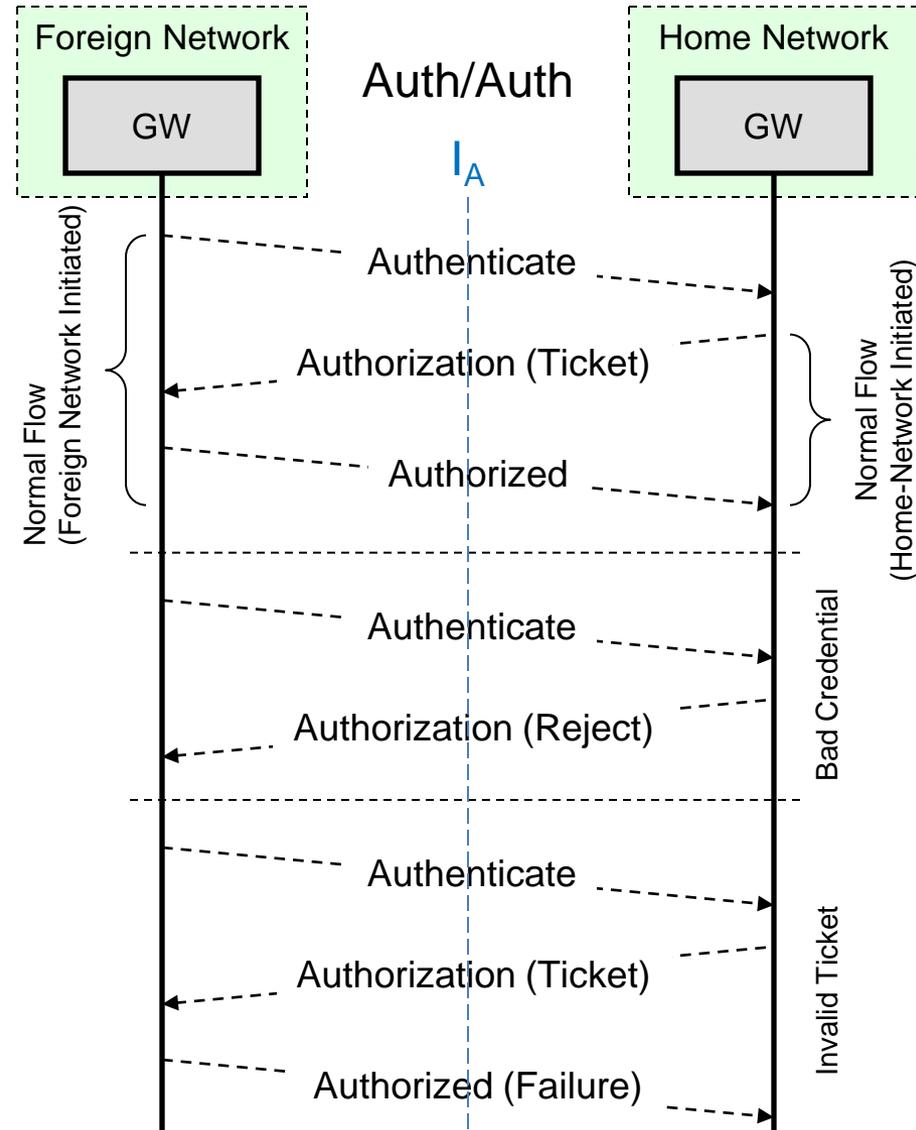
# RFID Authentication ( $U_R$ and $I_A$ )





# Authentication & Authorization ( $I_A$ ) - Proposed Msgs

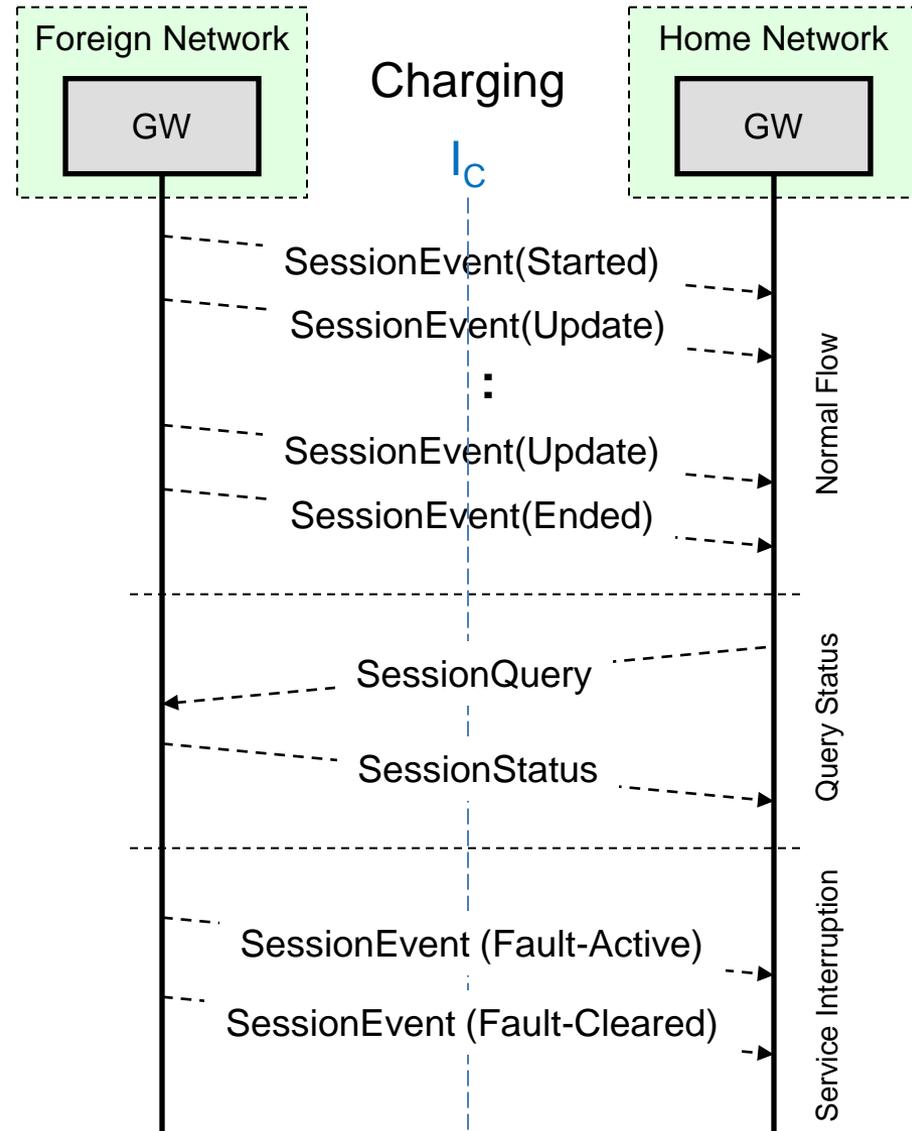
- **Authenticate**
  - Request to Authenticate a Credential Presented on the Foreign Network
  - Challenge/Response Data Carried in Msg.
- **Authorization**
  - A Response to the Authenticate Msg.
  - The Response Includes a Digitally Signed Ticket Authorizing Service
  - Authorization Can Be Rejected for Any Reason (Invalid Credential, In-Sufficient Funds, Un-Supported Network, ...)
- **Authorized**
  - Acknowledge Receipt of the Authorization Ticket
  - Indicates Ticket Was Received By Foreign Network and Was Accepted
  - Also Indicates Ticket Was Not Acceptable/Invalid

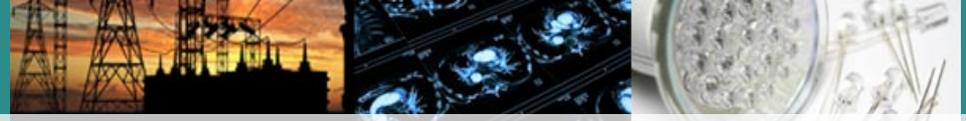




# Charging Session (I<sub>C</sub>) - Proposed Msgs

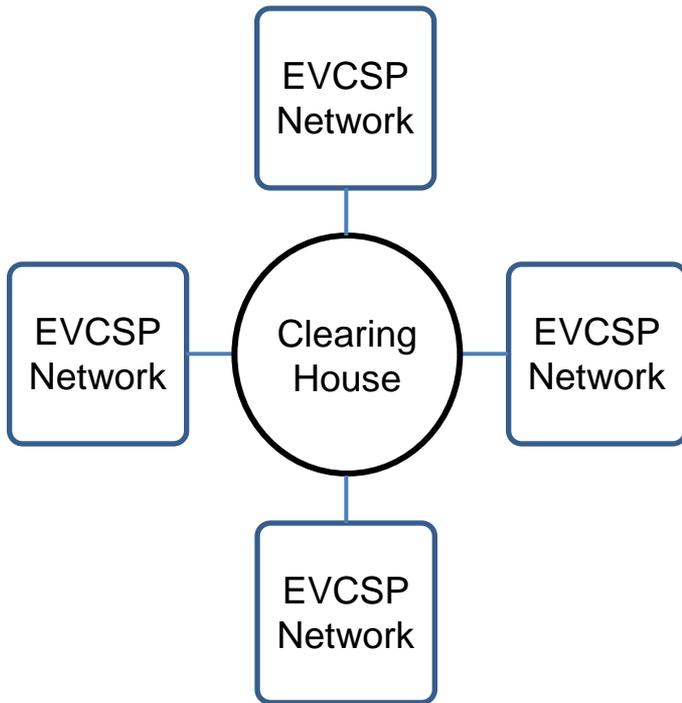
- **SessionEvent(Started)**
  - Indicates Session Was Started (Typically by the J1772 State Change or Other Sensor”)
- **SessionEvent(Update)**
  - A Message Providing the Home Network with an Update to the Charging Session Utilization Data
- **SessionEvent(Fault)**
  - An Event Occurred on the Session (e.g., GFCI Fault or Demand-Response Action)
- **SessionEvent(Ended)**
  - Session Was Ended by the Foreign Network
- **SessionQuery**
  - Allows the Home Network To Query for the Current Status of the Session
- **SessionStatus**
  - Gives Status of a Session



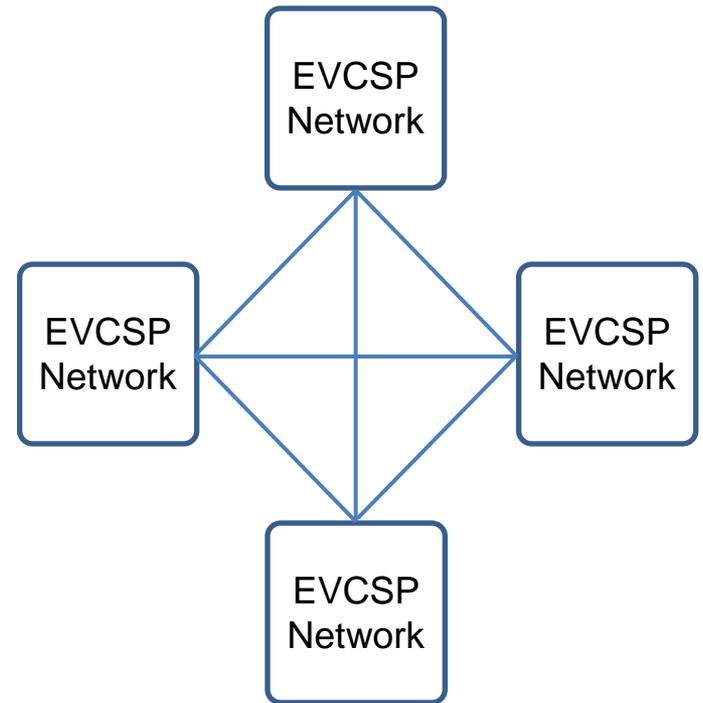


# Implementation Architectures

## Centralized Clearing House



## Peer-to-Peer Inter-Connection





# Standards Development Timeline

