

# IEEE iSSSC 2020

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## Software Architecture/Design for Electric Mobility Battery Charging/Swapping Stations

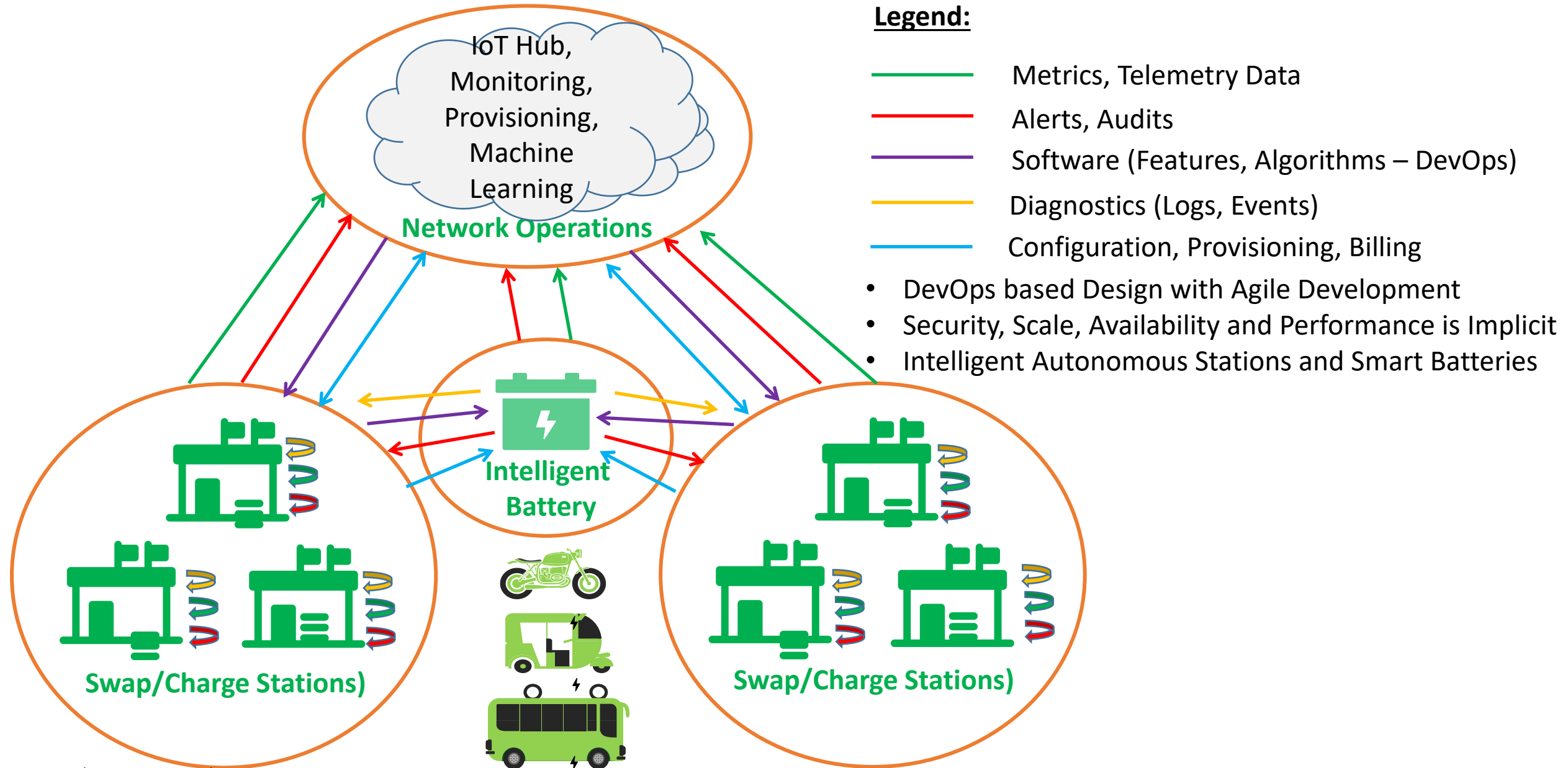
Narayanan Subramaniam

Technical Director of Engineering, Nutanix

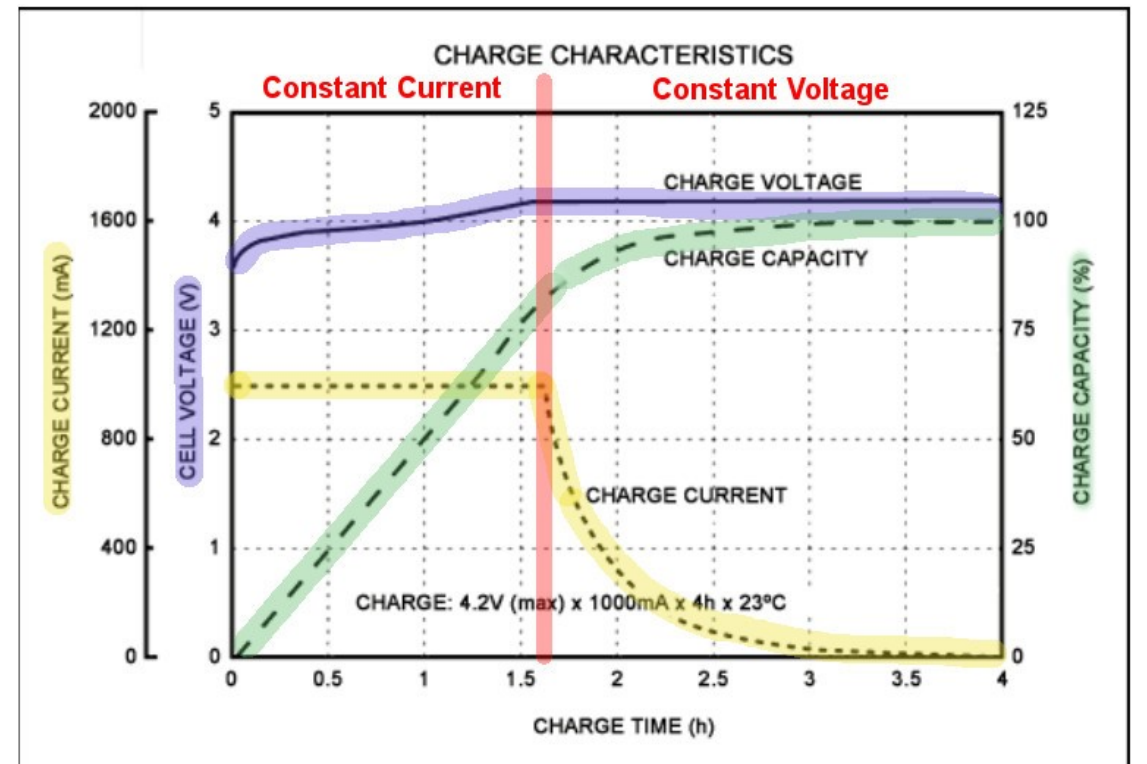
IEEE Bangalore Execom 2020,2021 – Co-Chair for Humanitarian Technologies

LinkedIn: <http://www.linkedin.com/in/cnsubramaniam>

# High Level Solution Architecture for Electric Mobility



# A Physical Overview of Charge/Swap Station Design



# Considerations for Edge Computing in Charge/Swap Stations

## Near Real Time Processing, Autonomous Operations vs Cloud Latency/Availability

- Operations:
  - Multiple streams of sensor and embedded based data e.g. Power Delivery, Charging, Braking
  - Thermal, Energy, Policy Management
  - Metrics Aggregation and localized Decision Algorithms, A/B Testing
- Safety and Security
  - Anomaly Detection and Isolation
  - Fire Detection and Suppression
  - Video-analytics – theft, environment
- Availability
  - Fault Patterns and Redundancy
  - Security Denial of Service issues
- Personalization
  - Secure content caching, offline modes for Billing/Payment

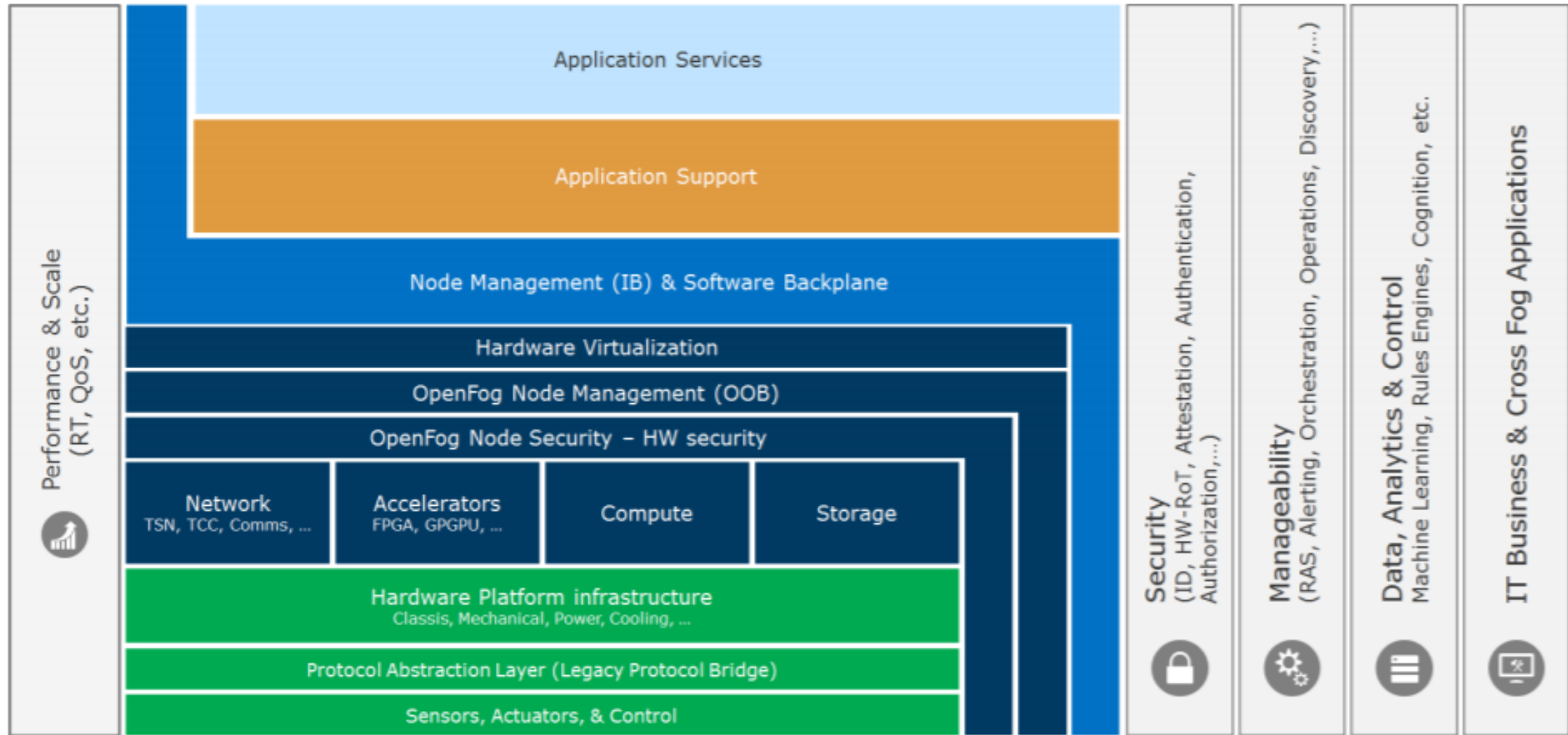
## Cost of Computing-In and Connectivity-To the Cloud, Vendor Lock-In

- 3-5 Year Cost Analysis:
  - Storage and Archival
  - Connectivity and Data Transit (APIs)
  - Computing (Serverless and Server Based) with ever increasing Data
- Technology Lock-In
  - Lock-In to vendor extensions
  - Data extraction and portability costs
- Delicate Balance
  - Skills vs Recurring Non Core Cost
  - How critical is Autonomy ?

## Privacy, Data Retention, Regulations/Compliance

- Data Retention:
  - Locally Managed – push only what is needed in the Cloud
- Privacy
  - Cloud Data Storage Privacy versus local Aggregation and/or Anonymization/Pseudonymisation of PII Data
  - Explicit Opt-In/Out Costs
- Data Sovereignty
  - Geo-location of Data At Rest

# Reference Architecture for Edge Computing



Credits: Reference from OpenFog Consortium: [https://www.openfogconsortium.org/wp-content/uploads/OpenFog\\_Reference\\_Architecture\\_2\\_09\\_17-FINAL.pdf](https://www.openfogconsortium.org/wp-content/uploads/OpenFog_Reference_Architecture_2_09_17-FINAL.pdf)

# Edge Computing Architecture on a Charge/Swap Station

Wireless  
(Bluetooth,  
Wifi, GPRS,  
GPS, NFC)

**Station Sensor  
and  
Battery Pack  
Interfaces**

Wired  
(CAN2.0,  
Modbus,  
Ethernet,  
TCP/IP, USB,  
GPIO, SPI)

**Protocol  
Adaptation,  
Model  
Adaptation  
Device  
Addressing  
and Routing**

**Station Application Stack:**

- **SWAP and Charge Orchestration**
- **Station Monitoring**
- **Energy Management**
- **Safety and Security Management**
- **Charging and Thermal Management**
- **Diagnostics**
- **Configuration and Provisioning**
- **SW/FW Management**
- **Entitlement and Billing**
- **UI/UX**
- **Containers**
- **Localized ML, Analytics**

**Cloud/IoT Interfaces (MQTT,  
REST)**

**Database:**

- **Metrics**
- **Alarm/Alert**
- **Audit, Transactions**
- **Event/Logs**
- **Configuration**
- **Toggle, A/B**
- **Diagnostics**
- **Security**
- **Algorithms/Policies**

**High Availability Messaging**

# Software Technology Choices on a Charge/Swap Station

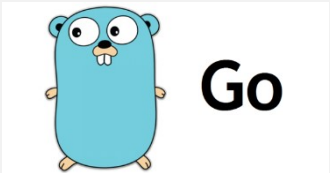
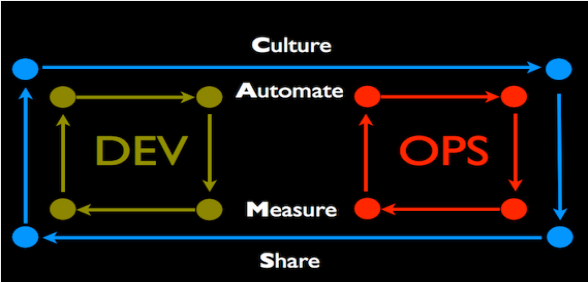
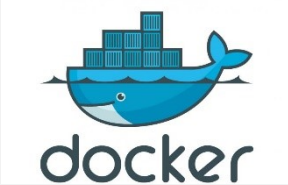
Station Sensor  
and  
Battery Pack  
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Protocol  
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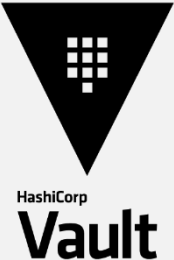
Station Application Stack:



Cloud/IoT Interfaces (MQTT,  
REST)



Database:



High Availability Messaging



# Key Challenges



## Skills and Cost

- Skills:
  - Multidisciplinary – Agile Software Engineering, DevOps, PC, Storage technologies, Networking/Telecom, Cloud, Machine Learning experience
  - Full Stack, Embedded Developers, need retraining in orthogonal skills
- Cost:
  - Buy vs Build results in vendor lock-in versus skills challenges
  - Multidisciplinary skills to use or build the Edge Platform effectively in a Buy vs. Build approach
  - Cost Effective Industrial Grade components for a range of Thermal, Environmental, Serviceability needs

## Communication Interfaces for (Big) Data

- Data Is Key:
  - Protocols like CAN and Modbus not appropriate for Bulk Data Transfer
  - Lower Cost Industrial Ethernet/Wifi and Convertor components to facilitate exploding Data requirements
- Clear separation of Control, Management and Data Plane with Enterprise grade Security

## Domain Specific Data Standardization

- Standardized Data Models that are Domain specific for common API level Orchestration and off the shelf Software components to solve baseline Use Cases
- Data Model Extension constructs for business differentiation and competitive benefits
- Design for Privacy



THANK YOU !