2022-09-15
EVerest @ Embedded Linux Conference 2022
Technical Introduction to EVerest:
Open Source Firmware for EV Charging Stations
How to charge a car?
Charging a car is easy, RIGHT?

ONE DOES NOT SIMPLY

PLUG IT IN AND IT CHARGES

That is how “easy” charging really is

Let’s focus on this today

- **EV**
  Electric Vehicle
- **EVSE**
  Electric Vehicle Supply Equipment
- **CPO**
  Charge Point Operator
- **Clearing House**
- **eMSP**
  eMobility Service Provider
- **DSO**
  Distribution System Operator (Utility)

Connecting car & charger

Protocols
A) IEC 61851
B) DIN SPEC 70121
C) ISO 15118 (multiple versions)
D) CHAdeMO

PHY
A) CP/PP/1kHz PWM/V
B) CAN BUS
C) PLC (GreenPhy)

Power
A) AC 110/230V, 1/3 phases, 6-63A
B) DC 400/800V, 0-1000A
C) Inductive
⇒ each: Unidirectional / Bidirectional
⇒ Metering: V/A/f, German metering law, ..
⇒ Electrical Safety (RCD)

https://en.wikipedia.org/wiki/Charging_station
Connecting charger to cloud

Protocols

A) OCPP 1.2 / 1.6 / 2.0.1
B) IEC63110
C) MQTT & OTHERS ;-) XML / JSON Web Sockets
VPN / Sim+private APN / HTTPS

OCPI, OCHP, ..... Roaming + Different Networks

>> 150 dialects

Plug & Charge will be here in 2 years™
original since 2014
Rollout of complex distributed PKI

https://link.springer.com/article/10.1007/s00450-017-0342-y
Connecting to local energy management

- MODBUS (std from the 80s)
- SunSpec
- EEBus
- TOO MUCH CUSTOM STUFF

PHY

- Ethernet
- Rs232/485
- ...

Protocols

- MODBUS (std from the 80s)
- SunSpec
- EEBus
- TOO MUCH CUSTOM STUFF
Balancing with the electric grid

- USEF
- ADR
- More

PHY
- Protocols

A) Radio teleswitch
B) Smart Meter
C) ...
A) USEF
B) ADR
C-Z) more
It’s a bit of a mess! And it is even growing

- Too many links
- Too many standards
- Too many Dialects
- Ever growing
- High fault-rate, poor UX
- Expensive & slow development
- Complex mechanisms to proliferate innovations
- Market fragmentation

Customers and industry suffering

No De-facto SW stack!
We cannot fix this by adding more standards...

EVerest provides a standard compliant open source implementation that serves as a defacto standard.

https://xkcd.com/927 - XKCD Comics licensed under a CC-by-NC.
EVerest is an open source charger SW for a broad community

Universities & Research Institutions
"On the shoulders of giants": Leverage deep access to broad industrial solutions and help to bring state of the art to the next level

Charger OEMs
Adopting EVerest into HW products and providing feedback from the field

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Charger OEMs
Adopting EVerest into HW products and providing feedback from the field
What is EVerest?
EVerest is a complete operating system for EV chargers

- Provides all functionality needed from smart home chargers to commercial fast chargers
- Runs on tiny embedded Linux
- Aims to support as many different HW platforms as possible
- Commercial friendly open source (Apache 2.0 licensed)
- Don’t reinvent the wheel: Use EVerest as common base layer and add some unique features of your product on top!

https://github.com/EVerest
**EVerest framework: Modular architecture**

### Module A

**Interface 1: Charger**

**Commands:**
- set_max_current(float ampere);

**Variables:**
- float energy_charged;

- Modules are individual Linux processes, can be loaded multiple times
- Modules expose (multiple) interfaces on MQTT
- Config file to connect module requirements/interfaces
- Can run on different computers / can spread over multiple chargers!
- Framework starts/stops/restarts modules

### Module B

call commands (with return value)

async event: energy_charged = 5.23kWh

- Communication via MQTT broker, transparent to modules
- Loose coupling: A does not know B, B does not know A
- Framework manages synchronous RPC, argument type safety, dependency checking
- Additional services: Logging, configuration management, code auto generation, …
Module config file

- JSON config file which modules to load/connections represent HW
- E.g. if your wallbox does not support RFID, simply do not load the module
- If it has 2 charging connectors, load the charging core modules twice
- in development: web interface to graphically edit module connections

https://lucid.app/lucidchart/5364a561-1881-414a-a33a-7ba29425a140/edit?page=0_0#
Graphical Setup Webinterface

https://youtu.be/xZQtN8vXM1k
Charging core

- EVSE: central charging module that controls CP signal and manages IEC61851 and ISO15118 interaction, charging session, ...
- ISO15118 protocol module
- ISO15118 support is under development with RISE-V2G, aiming for a complete rewrite including ISO15118-20 and DIN SPEC
Charging Station Hardware Abstraction Layer

- Simple interface to be easily portable
- Supports Pionix dev kit for now
- Porting to new hardware requires drivers for:
  - CP signal PHY, Relais, RCD, Power meter, SLAC (if different from QCA7000), NFC/RFID reader
Backend connectivity

- Communication with the cloud for payment and management
- OCPP 1.6 JSON
- Try to make it standard compliant
- Verify with as many commercial backends as possible
- Support for optional profiles such as Smart Charging
Energy Management

- Modules reflect the in-house grid
- Optimizer finds optimal (forecast) schedule for all cars, respects all limits in the tree
- Energy management runs on one Charger, other EVSE modules are remote
- Requires knowledge of SoC/energy required by car (ISO15118)
- Gets more interesting with bidirectional support
- Under heavy development right now

- Needs to leave asap
- Needs to leave 7am, prefers lowest price
- Long time parking, charges only with excess solar energy
- Already fully charged
- Unused
Local display app

- Based on flutter
- Runs locally on charger's display using flutter-pi
- Ongoing development
Software in the loop simulation

- Simulation for complete HAL
- Car simulator module that simulates everything a car can do on IEC61851
- You can run EVerest on your laptop and charge simulated cars with it
- ISO15118 SIL
Engineering toolset

- Build systems
- Build VM
- NodeRED

Node-RED Dashboard

- Home
- EVSE Configuration
- Simulation
- Solar Manager Settings
- Debug

Charger
- Maximum Current: 16.0000
- Energy Charged: -0.00

Control
- MaxCurrent

Solar Energy Management
- START SOLAR ENERGY MANAGEMENT
- STOP SOLAR ENERGY MANAGEMENT
- PAUSE CHARGING
- RESUME CHARGING
- RESET SOLAR ENERGY MANAGEMENT

Temperature: 37

Switch optimizer
- Select option
- Price limit (EUR / kWh)
How to get involved

● GitHub [https://github.com/EVerest](https://github.com/EVerest)

● **Weekly Dev Sync** - Tuesday’s 10:00 CEST/CET

● Technical Steering Committee meeting for EVerest
  Monthly, every 4th thursday
  Next: 22nd. September - 17:00 CEST

● Mailing list everest@lists.lfenergy.org
  [https://lists.lfenergy.org/g/everest](https://lists.lfenergy.org/g/everest)

● Slack
  [https://join.slack.com/t/lfenergy/shared_invite/zt-f9z7c305-SYbhNvb2ffXJ-8jGd_gpWQ](https://join.slack.com/t/lfenergy/shared_invite/zt-f9z7c305-SYbhNvb2ffXJ-8jGd_gpWQ)
Get in contact and contribute to EVerest

Join us along our journey to unify the EV charging ecosystem with open source.

GitHub: https://github.com/EVerest
On the Linux Foundation: https://www.lfenergy.org/projects/everest/
Mailing list: everest@lists.lfenergy.org
Slack: https://join.slack.com/t/lfenergy/shared_invite/zt-f927c305-5YbhNb2ffXU-8jGd_gpWUQ

Kai

Piet
Discussion
EVerest Roadmap

SW release:
- AC IEC61851
- SLAC/AC ISO15118-2
- OCPP 1.6J with all extensions
- display app controls all features
- price driven charging
- solar optimizer / local PV support (modbus/sunspec)
- OTA updates

new features:
- ISO15118-20 (bi direction AC/DC)
- Android/iOS app
- advanced energy management

beta quality:
- AC IEC61851
- SLAC/basic AC ISO15118-2
- OCPP 1.6J with RFID auth
- simple display
- price driven charging

new features:
- DC charging (DIN and ISO)
- Plug & Charge
- support for German Eichrecht powermeters
- local credit card payments

new features:
- OCPP 2.0.1
- EEBus
- predictive maintenance cloud
- energy & flexibility trading
- USEF / ADR

…prioritization pending community priorities…