

White Paper

The world's first large-scale migration of OCPP based PEV charging infrastructure



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By:



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1 Executive Summary

The Electric Vehicle Charging Infrastructure is a growing business, however there is still a lot to be learned and much knowledge to be acquired in the field of e-Mobility and the subsequent operational and business aspects.

With a growing number of EV's, 3,000 public charging points in the Netherlands, an extensive partners network (service center, maintenance parties) and a large number of different interfaces to external systems - the migration from the first charge point management system to the next was no small or easy task.

The charging infrastructure consists of a variety of organizations and technologies; charging stations (various makes & models), ICT (Information and Communications Technology), infrastructure (back office and cellular network operators), and various interfaces to 3rd parties such as roaming partners, the vehicles' clouds, charging station websites & apps as well as organizations such as customer and technical support, service providers and others.

In this complex environment, a need to replace the ICT of an operating network with thousands of active charging points arose.

In hindsight, the migration process proved successful, and despite the fact that occurrences were only found in well less than 5% of the stations, this process holds lessons and conclusions that can contribute to the knowledge base of the entire industry. This document describes the process and the lessons learned.

1.1 Background

The e-laad.nl foundation, operating since 2009, made electric driving possible in the Netherlands. Since its establishment ElaadNL has installed over 3,000 public charging points for electric vehicles throughout the country with over 20 different stations, made by various manufacturers.

In 2014 the e-laad.nl foundation split into two organizations, EVnetNL and the ElaadNL foundation; EvnetNL, manages the charge-stations network, infrastructure and various service providers, and the ElaadNL foundation, is responsible for the innovation and knowledge center.

The ElaadNL foundation, located in the Netherlands, is a center of knowledge and innovation in the field of Electric Vehicle (EV) Charging Infrastructure, and was appointed by the energy Distribution System Operators (DSO's) to be the body responsible for acquiring knowledge in the field of e-mobility, assessing and developing measures to handle grid impact and more.

All stations are managed and communicate using the Open Charge Point Protocol (OCPP), through a single back-end system. The OCPP was developed in 2009 in the Netherlands. ElaadNL promoted the idea of an open protocol development in order to

prevent vendor lock-in, to be as efficient and flexible as possible and to enable transparency in future system extensions of the back-end and charging points.

1.2 Motivation

In order to cope with the growing use of PEV (Plug-in Electric Vehicles), and with the aim of improving the stability of the network and reducing the cost of operations, ElaadNL decided to undertake a study of existing back office solutions in light of the market's future needs.

The criteria for a suitable back office system were defined as follows:

- Management of a network with multiple partners
- Simple implementation of new features to suite the requirements of an evolving market
- Fast resolution of operational issues as the number of drivers increases
- The system should support Smart Charging (in various forms)
- Ongoing cost reduction - in operations, development, and adaptation to innovation and future needs
- Flexibility for further developments with multiple players

Following a six month evaluation process, ElaadNL chose to migrate the entire existing network to **Driivz**, who had developed an innovative cloud-based, flexible, open platform system for the EV ecosystem.

The **Driivz** software platform includes tools for operators, drivers, station owners and fleets, and enables its customers to increase profitability and reduce operational costs of EV charging networks. **Driivz** platform, which serves as the innovation platform for projects worldwide, enables network operators to use stations manufactured by any hardware manufacturer, and allows drivers the freedom to charge anywhere they wish.

Following the decision, teams from ElaadNL, EVnetNL and Driivz engaged in preparations to perform the largest OCPP based migration of a charging station infrastructure in the EV world.

1.3 Conclusion and Recommendations

The main challenge of the EV charging station operator is the responsibility for the ongoing management of their stations in a new and rapidly evolving environment. Having an open and advanced back office system, in terms of flexibility, innovation and cost effectiveness, is therefore crucial.

General comment: The migration process, presented in this document, proves that an open standard between the charging stations and back office is business critical, as it allows the EV charging network operator to replace the stations and back office, if required.

The conclusions and recommendations detailed below include: technical, commercial and legal aspects of such a project, as well as process and implementation improvements.

This summary highlights some of the issues we encountered during the process. The complete document includes more detailed descriptions, conclusions and recommendations, in later sections.

1. Charging Station Firmware and OCPP Compliance

During the network mapping process it became clear that the charging station network consists of a large variety of station manufacturers with different station types, each of whom had interpreted the standard differently.

This impacted the stability of the network and the migration process.

2. Planning for a Smooth Transition from Old to New

The openness of the OCPP allows stations manufactured by different manufacturers to be managed using a single back office system. However, the migration process will need to utilize both the new and old back office systems in order to connect the stations to the new system. This requires careful planning and alignment of both the new and old parties in order to avoid pitfalls, which may occur due to technical and/or commercial limitations.

3. Third Party Buy-In & Teamwork

As getting 3rd party buy-in is one of the most challenging aspects of the project, we recommend: first, listing all 3rd parties (including charging station providers, help desk providers, cellular network providers, roaming partners, energy companies etc.), and second, creating a clear and detailed plan to tie them into the migration project, including time lines and attractive business and contractual agreements. Teams from all parties should be clearly instructed and motivated to cooperate seamlessly with their counterparts.

4. A Clear Methodology and Planning

It is imperative that a work methodology, including project planning, quality processes, and the establishment of a professional migration team are put in place during the initial phases of the project. The plan must be flexible enough to allow for adjustments throughout the process, and it must clearly define the decision points and escalation procedures.

5. Don't Compromise

Use gradual deployment and measured iterations to assure a smooth transition, achieve a quality product and the best results.

This document is presented by: ElaadNL, EVnetNL and Driivz, with the aim of contributing to the EV infrastructure community from experience gained during this large scale migration project. The parties also hope to assist companies to succeed in future e-mobility projects.

2 The Approach

2.1 Introduction

The Beginning

In the summer of 2014 the installed base of EVnetNL migrated to the Driivz back-end. The migration of such a large network of charging points from different vendors has never been done before.

In the Netherlands, the growth in the number of EVs is significant. See the recent numbers below:

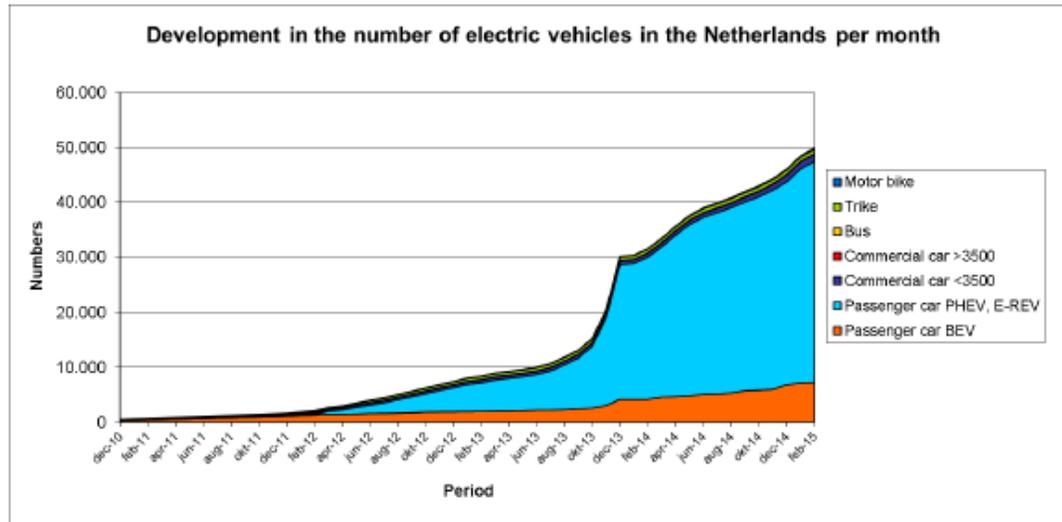
This overview pictures the development in the number of electric vehicles on the road in the Netherlands. It is composed by the Netherlands Enterprise Agency, on the authority of the ministry of Economic Affairs. Figures may be copied stating the source (Netherlands Enterprise Agency).

Number of registered electric vehicles¹

Number as of	31-12-2012	31-12-2013	31-12-2014	31-01-2015	28-02-2015
Type of vehicle					
Passenger car (BEV)	1,910	4,161	6,825	7,152	7,246
Passenger car (E-REV, PHEV) #	4,348	24,512	36,937	38,978	40,255
Commercial car < 3.5 tons	494	669	1,258	1,267	1,273
Commercial car > 3.5 tons	23	39	46	46	50
Bus *	67	73	80	80	80
Trike/quadricycle	469	632	769	774	786
Motorbike	99	125	196	203	232
Total	7,410	30,211	46,111	48,500	49,922

#: excluding full hybrid vehicles; *: including trolley busses and some hybrid busses

Development in the number of registered electric vehicles on the road in the Netherlands per month²



¹ & ² RDW (Dutch Road Admission Authority, starting 31-08-2013 the data model is based on powertrain type and fuel concept)

Data gathered shows a weekly energy usage of 80,000 kWh on the EvnetNL network with an average number of 10,000 weekly transactions. In the Netherlands only about 30% of homes have a private driveway. This means that a large percentage of EV drivers depend on public charging. Over the years, this will lead to growing demand for charge transactions provided by the EVnetNL network. The data also showed just how many EV drivers, which are dependent

on the EvnetNL network, "just" had to be able to charge their EV at all times. The network needed to continue to function.

There were a lot of questions to be answered before the actual migration:

Process questions

- Where to start? Perform the migration in one batch or gradually? What is the process we need to go through? What should the roles and responsibilities be? How can we align the teams? What should be the roll back plan?

Questions regarding the stations installed base

- What type of stations exist on the network? What are the relevant firmware versions? How can we test the successful migration of these stations?
 - How do you migrate a live station, an off-line station, a faulted station or a station that is still in a warehouse? What are the risks? What should the guiding principles be?
 - Should we align the firmware versions on the stations first?
 - How do we handle older hardware versions?

Questions regarding the different (other) interfaces and architecture

- What are the existing interfaces? How can we assure the successful migration of these interfaces? What are the risks? How should the communication architecture look like? Is there a need for extra development? Should we develop before or after the migration? How should the various parties be notified?

During the preparations and the actual migration, ElaadNL and Driivz utilized the team's vast experience in EV charging infrastructure and large scale Telco Migration projects.

The migration planning was based on the Driivz Methodology. As part of the project planning phase, the team adjusted the methodology and the existing state-of-the-art migration techniques and tools, to the EVnetNL installed base.

The approach combined well-defined methodology and a flexible operations model, enabling the project team to adjust it to the individual needs in a multi 3rd party environment.

2.2 Guiding Principles

Prior to the actual migration, the migration project team set up the following guiding principles:

- Lower the impact on the drivers as much as possible
- Reduce interim solutions and focus as much as possible on steady state solutions
- Enable future operation while setting the framework for the most advanced charging station infrastructure and smart grid management development in order to serve, learn and develop the EV industry
- Develop a clear migration strategy, including the amount of migrated stations in each migration phase, automation vs. manual operations, etc.

The strategy and plan following these guiding principles was focused on:

- Early identification of modifications required to implement the solution
- Division of roles and responsibilities between the project team members from the different parties
- Migration using a phased approach in order to cope with the requirement yet lower the risks
- Testing facility and Quality Assurance (QA) procedures definition
- Detailed definition of all the project requirements/deliverables during initial phase (the Detailed Functional Design (DFD) phase)
- Establishment of a mechanism for ongoing enhancements to the system software, benefiting ElaadNL with new functionality as well as expansion of the current system
- Set up phased approach development plan according to priorities defined by the steering committee
- Training the users on using the Driivz system and in addition creating task-specific manuals for the different user roles

2.3 Project Management

2.3.1 PROJECT STRUCTURE

The team behind the migration is one of the most important factors for the success of the project.

The project management efforts are headed by a Steering Committee that oversees the entire project. The Steering Committee is manned by both senior executives of ElaadNL, EVnetNL and Driivz. The Steering Committee served as the top escalation entity, receiving periodic progress updates from project management, taking decisions, as well as corrective actions when necessary.

The companies assigned project leads on each side and defined the roles and responsibilities in advance.

The ElaadNL & EVnetNL team included:

- Overall project manager
- 3rd party relationship manager (turned out to be one of the most crucial roles of the migration)
- Cellular communication manager
- Data migration manager
- Station migration manager
- Management level escalation point (steering committee member)

The Driivz team included:

- Overall project manager – from the operations division
- Development and customization manager – from the development division
- Cellular communication lead – from the operations division
- Management level escalation point (steering committee member)

2.3.2 PROJECT CONTROL AND ISSUE TRACKING

The project tracking included tasks, issues and bug tracking tools with supporting daily and weekly meetings as well as ongoing free communications which is of the highest importance.

Prior to the migration process, the companies engaged in a team building effort between the two teams that created a bond that assisted to overcome issues in the best cooperative way throughout the migration process and beyond.

The key goals of the project's management team engaged in control & tracking were:

- Evaluate the project's progress against the work plan
- Assess and predict the risks on an ongoing basis
- Detect project delays

2.4 Planning

The initial part of the project was based on the Driivz DFD (Detailed Functional Design) methodology.

During this planning phase, the team's initial task was to collect information about current activities including the interfaces, business processes, 3rd party systems, etc'.

The planning included:

- Charging stations: all aspect of the stations including the mapping of the various station types, different firmware versions, expected issues, available data and future required data
- Data communications: the communication channel between the stations and the back office as well as defining the scripts and tools to migrate the stations in the most seamless process as possible
- Migration: phased approach - gradually increase the amount of stations in growing batches while testing the functionality of the stations already migrated
- Quality assurance: testing of the behavior of each station and firmware version
- Risk assessment and Rollback planning

2.5 Software Development

There was a need to adjust the back office to support the large variety of interfaces and business logic that is part of the ElaadNL network. The philosophy was to keep current processes as-is where possible, but at the same time make daily operations easier to the operators, by improving and automating processes and lowering the load on operations as much as possible.

The initial step was the Detailed Functional Design (DFD) Phase which has several aspects:

- User interface updates design (screens and reports)
- Software internal updates design and customization (architecture updates, programming specifications, physical database specifications)
- Migration tools adjustments

The scope of the DFD phase includes the following stages:

- Preparation
- Requirements Study
- Requirements Analysis
- Customization and System Definition
- Implementation Planning
- Functional Specification Preparation
- Functional Specification Review and Approval

2.6 Communications between the back office and the stations

The charging stations network consists of SIM cards running on an APN (Access Point Name) connection with APN-user and APN-password. It is through this connection that a

VPN (Virtual Private Network) is created. This connection is used to securely and privately access a specific URL to establish two-way communications with the Driivz back office.

To perform the migration, everything had to be changed: the APN parameters (including the APN-user and APN-password), the VPN connection and the URL to the new back office.

Furthermore, the migration to the new APN also meant that a VPN (Virtual Private Network) had to be established where formerly a leased line was used. This VPN was necessary because Driivz is hosted in the cloud.

The SIM cards in the charging stations had to be reconfigured via the back office of the telecommunications provider without affecting the running network.

2.7 Migration

The migration phase included several phases, both on Driivz and EVnetNL side.

- Information gathering:
 - Stations Data –data extracted from the old system
 - Users & Usage Data - data extracted from the old system
- Data cleansing
- Data import to the Driivz system
- Integration tests stations to find possible differences in OCPP implementations
- Training senior user(s) in usage of backoffice system.
- Adapting the backoffice system to the wishes and needs of EVnetNL
- Upgrade of selected stations to the latest/proper firmware versions
- Development, testing and adjusting of the migration tools (Scripts/firmware) with each manufacturer.
- Communication: Setting up new APN, opening up inter-SIM card traffic, gaining access to SIM migration tools
- Communication: Setting up new VPN connection Driivz - Vodafone
- Creating training documents regarding how to migrate and how to use the new backoffice system and train the people themselves.
- The station migration itself. Most stations where migration remotely, about 10% needed to be visited locally. To keep a close eye to the stations status after and during migration we migrated all stations in batches of increasing size and remotely by hand, not via automated scripts.

The OCPP open approach assisted in the migration process yet it was found that each type of charging station had to be migrated in a specific way to the new back office. This means that each station type has its own method of modifying the APN settings and the URL of the back office to the new Driivz system. The reason for the various methods is that each charging station vendor had developed custom code in-house as this parameter had not been defined in OCPP.

For each station type a decision had to be made as to which firmware version should be running on the station and what would the migration strategy be, as well as the migration process and the best way to verify that it was migrated successfully.

Roughly, there were four methods to migrate the different charging stations:

- OCPP Set configuration
- Complete firmware update and APN modem settings adaptation
- Custom migration script
- Manual update

The suitable method was selected for each type of station as part of the migration planning phase. It was crystalized to a detailed migration road map. During the migration process, the methods were expanded and supplemented, especially due to small disturbances that occurred during migration.

2.8 Quality Assurance (QA)

The responsibility for quality assurance in Driivz is divided between two divisions within the organization in a multi-layered approach:

- Layer 1 - QA department (development division) – responsible for ongoing testing, nightly automated testing and feature validation. Once the version is approved, it is “Released to Operations” (not yet to production).
- Layer 2 - Operations department (operations division) – responsible for final validation before the product is released. Testing includes more robust on premise scenarios, customer hands-on testing and external interface validation with 3rd party partners. Once the version is approved, it is “Released to Production”.
- Layer 3 (optional) - Customer verification - the customer is requested to verify that the version works in a pre-production environment. During the migration, the main focus was on validating the migration scripts and the station’s response to it.

For the migration, the quality assurance of Driivz and ElaadNL/EVnetNL was focused on the successful migration of the stations and assuring proper functionality post migration. This was achieved via the following activities:

- Integration tests: first of all the different types of stations have been set manually to the Driivz environment to test how the stations behave and how they have implemented OCPP. If needed Driivz made separate “connectors” for the station types.
- Migration tests: after receiving the migration tools from the station manufacturers, these have been tested on the testing stations in the lab and near the ElaadNL office.
- Functional tests: after migrating the test stations they have been subjected to a functional test. This is a standard test to ensure the station functions correctly as per the requirement of ElaadNL/EVnetNL.
- Test batches: at the start of the migration a small batch of each type of station was migrated and monitored, to see if any issues come up.

3 Challenges and Lessons Learned

With the size of the network, the challenges outlined above and many parties involved, this migration turned out to be a complex process.

A great deal has been learned during the multiple phases of the migration: planning, preparation, execution and analysis. We consistently conducted “lessons learned” sessions throughout the process and implemented any conclusions in to the back office software, the supporting tools and QA processes. This paragraph outlines what we consider to be the most important lessons learned.

3.1 Protocol interpretation and variety of OCPP “Flavours”

Over several years of introduction of new types of stations, slightly different interpretations of the OCPP protocol were implemented by different vendors. The differences were not large, but rather subtle within the interpretation of the messages sent and received. It was believed that the way in which the charging stations responded to the various OCPP messages was well known, but as time passed by and with the integration of new stations a variety of OCPP protocol ‘flavours’ came to be.

The differences were not so much in the 'dialect' of the messages, but especially in the behaviour of the stations and the timing of the messages. The following issues emerged:

- Difference in behaviour of reporting socket status updates. For example, some charging stations let the back office know that a socket is available when a transaction is stopped, others expect the backend itself to interpret that a socket/station is free when the transaction is stopped.
- Difference in handling of an interruption of the data network connection. One charging station sends a boot notification when the data network connection is restored while other charging stations don't send a boot notification on a restored connection. Another difference is that some charging stations send a socket update to the back office and other charging stations do nothing.
- Difference in socket status updates. Some charging station don't send socket updates at all, and thus don't allow the back office to know for certain when a socket is occupied/available.
- Difference in behaviour following a firmware update. Some stations let the back office know their actual status and availability while some send partial updates or no specific notifications at all.
- Some stations report themselves as ‘faulted’ with faults such as ‘power meter failure’ and do not allow charging until the problem is resolved while other stations still allow new charging sessions which causes false meter values to be recorded. (This is not really an OCPP issue but a result of the choice of kWh meter used in the station. In the older stations “pulsmeters” are used, which can

not be reached to check their status. If they do malfunction, then all meter values reported will be 0 but the station does not report faulted status as it should have)

Below is an overview of some aspects of the different implementations that were encountered:

	Boot notification after data network link loss	Socket update notification after transaction stop	Socket update notification after transaction start	Socket update after data network link loss	Status notifications after firmware update	Stays in fault-mode after 'power meter failure'
Supplier A	✓	✓	✓	✓	✓	✓
Supplier B	✓	✓	✓	✗	✓	✓
Supplier C	✗	✓	✓	✗	✓	✗
Supplier D	✓	✗	✗	✗	✗	✓
Supplier E	✓	✗	✗	✗	✓	✓
Supplier F	✓	✓	✓	✓	✗	✓
Supplier G	✓	✓	✓	✓	✓	✓

Recommendation and resolution

Our selected option: We mutually decided that for the short to medium term we would use the Driivz back office capability to create a variety of OCPP interpretations rules in the back office for the variety of stations.

In this manner we have managed to normalize the operations of the various stations based on the flexible protocol interpretation method in the Driivz back office and without having to request for additional changes in the stations firmware. The result is that operators always see what they expect regardless of the station's "quirks".

Future recommendation:

The recommendation for the future is that the OCPP-protocol should be further standardized and unified in order to ensure that future migrations, but also smaller updates and introductions of new stations to the back office systems, will have less impact on the operation of the charging station and no manual actions will need to be

performed to get every charging station online with the back office. To achieve this, OCPP needs to be more clearly defined. Our suggestion is that standardization and formalization of the OCPP protocol is performed through a solid compliancy and certification process within the Open Charge Alliance OCA (Open Charge Alliance, www.openchargealliance.org) protocol, which will ensure the required uniformity.

The further recommendation in this area is that in the protocol specification (the relevant parts of) the expected behavior of the charge point should also be specified in more detail in order to reduce “personal” interpretations. This could, for example, be done by using UML schemes. In this way the OCPP specification becomes more and more mature, leading to more standardized messages and station behavior which leads to less integration problems.

(At this moment OCA is working hard to develop a compliancy toolkit- and program as suggested by this paper.)

3.2 Major Charging station firmware issue - example

In one of the early migration phases we encountered a "Plug stuck" failure (the plug was stuck in a way that the drivers could not release the cable after charging). We could not reproduce this scenario in the test lab. After applying a firmware hotfix to all the stations of this specific type, it has not been reproduced but it was not 100% clear whether the malfunction still could occur or not. Eventually we decided to continue with the migration process.

When almost all stations from a certain manufacturer where migrated, a problem with these stations occurred. Suddenly a lot of stations malfunctioned and encountered a “Plug stuck” failure (the plug was stuck in a way that the drivers could not release the cable after charging). This issue was not detected in any of the tests, also not the tests which were done during the back office system selection procedure which took about half a year. It turned out not to be a regular malfunction.

Following this, the manufacturer was immediately notified and a mutual effort of creating a hotfix was started. After applying this firmware hotfix to all the stations of this specific type, it has not reoccurred but it was still not 100% clear whether the malfunction still could occur or not.

After the migration process the team, being ElaadNL, Driivz and the manufacturer of the specific station, cooperated in delivering a final solution for the firmware hotfix. This (software) solution was found after collaborative analyses, developed and installed, making sure this problem would not happen again.

Recommendation and resolution

We learned that there are two ways of mitigating this risk: First of all you can just accept this risk, but mitigate it contractually with your charge point supplier. This moves the responsibility of a full & correct fix to the charge point supplier. This means you could

also apply a financial clause which states that in case of a fault, or faulty update, the charge point supplier is responsible for fixing the issue.

Another way is to test the charge point in-house with a testing team. The difficulty here is that you often don't get full access to the charge point software, or full access to the logging of the charge point. The openness in terms of getting access to charge station software by the operator, not being the manufacturer, differs from vendor to vendor. The software is vendor specific and sometimes even station(type) specific. We are a long way from open source software in charge stations or even receiving complete logging of station behavior of all existing vendors. Furthermore, using this approach the operator needs quite thorough technical skills to dive into the problem. This means you are limited in solving issues, but nevertheless you can still try to reproduce the failure.

At this point in time our recommendation is to choose the first option illustrated above.

Future recommendation:

What has been learnt here is that it is important to have the ability to prepare, monitor and analyze the stations respectively before, during and after testing. To be able to do this we recommend to have the following support:

- Easy access to the station for configuration
- Access to live logging/monitoring
- Access to logging and diagnostics
- Clear instructions (and access codes if needed)
- Support from the developers/manufacturers of the firmware/station

When these needs are met the stations can be easily set up for testing, issues can be detected quickly and these can be easily shared via the loggings and diagnostics to the proper responsible party.

In our case our recommendation is to use both options. If there is only a financial risk, the first option will suffice. However, there is also the risk to the company's reputation and the risk that it might have a negative impact on the emerging market of electric driving. Also, in our situation tests are performed to ensure that stations behave in a similar manner in order to prevent confusion for the drivers and unnecessary service calls.

3.3 Opening up inter-SIM card traffic

Some types of stations have the ability to remotely login too. So, when a direct connection to the station can be established we can remotely login to the station (using username/password credentials) and change the settings. The one thing needed for this is to open up inter-SIM card traffic.

Recommendation and resolution

If your stations support this kind of remote login, you can ask your cellular service provider to open up the inter-SIM card traffic. If this is on, you can use a cellular USB modem and a regular SIM card from your batch connected to the same APN to login using the supplied username/password on to the URL of the station.

Be aware there is a security risk to this. Anyone with a SIM card that is connected to the same APN environment can try to reach your stations when this is on.

3.4 Roll-back mechanisms in firmware updates

When remotely sending a firmware update to a station there is always a chance the update will go wrong, which might lead to a station being non-functional and/or non-reachable. A solution would be to add a rollback mechanism to the update.

Recommendation and resolution

The station firmware should have a built-in rollback mechanism which must verify that the new firmware file is consistent and once the new update is applied, the mechanism must work as a watchdog which checks if it functions correctly. If it doesn't, it should automatically rollback the update and go back to the previous state.

3.5 Healthy network

Before and during the migration some stations malfunctioned, which made it impossible to migrate them remotely to the new back office. Making sure the network is in optimal health makes sure the maintenance parties can focus on their migration tasks.

Recommendation and resolution

Get the downtime of your stations before migration as low as possible. This will save a lot of work during migration. Also, make sure the stations are in good condition and that they can handle the firmware or configuration update without problems.

3.6 Migration decision turning point

We had a very tight time constraint and had to perform fast migration as the previous back-end was about to go offline due to the contract expiration. There came a time during the migration where we had to push through the migration. Since all the charging stations communicate via the back-end system, taking it offline due to contract expiration would make communications with the charging stations no longer possible. If this were to happen, it would mean that all charging stations would later have to be manually brought back online by going on site to thousands of locations.

Recommendation and resolution

Supplier contracts should be more flexible, such as for example the back office terminable per month. This prevents the risk that needs to be paid for a longer period to keep the system temporarily running, and mitigate extra payments just because the system was already scheduled to go offline.

Also prevent a top-down push on the time aspect alone. Making a migration plan and sticking to it is best-practice project management but you must significantly consider unplanned issues and risks that may arise.

3.7 Configuring charging stations / remote upgrade

The configuration of the charging stations needs to be change in order to communicate with the new Driivz system. Migration of one of the charging stations had to be done in 3 separate messages (!). This was labor intensive and risky. Migration of other types of stations had to be done via a firmware update in the size of about 400KB and configuration change was not possible. A 400KB update is relatively large when using a GPRS connections as this has to be sent to every charge point separately.

Some manufacturers do not support remote upgrade, so in theory in that case each charging station should be manually migrated on-site.

Recommendation and resolution

Migration of a charge point should be made possible using one single message or action. The implementation should not require that multiple messages will be used, as each message can potentially fail individually which complicates the process. The probability of errors increases exponentially with the increase of additional messages.

'Change configuration' of multiple parameters should be within a single message, so the data format should allow sending multiple parameters via a single message. In this scenario, if the configuration is not accepted, there is nothing that was applied and no problems can arise. When there are multiple messages sent and the update fails in one of them, it is more difficult to understand and solve the problem. This also calls for a built-in fallback mechanism so that the charging station uses its previous configuration in case of an error during any of the parameters of the requested configuration change.

We recommend to make arrangements with suppliers for enabling and supporting a live and remote (but obviously also local) configuration change without involving the supplier. Update / migration through a change configuration message are preferred compared with a firmware update that requires the supplier's attention.

We recommend that the following requirements be added to EVSE tenders:

- It must be contractually allowed and technically possible to remotely update/upgrade the internal firmware of the charging station and to reset it and for the tenderer to read out the firmware version on demand through the back-office system.
- It must be possible to make configuration changes both locally and remotely, without the need for a complete firmware update.
- It must be possible to change the OCPP access point address for connecting to a back-end system both locally and remotely, without the need for a full firmware update.
- Remote update capability of the communication parameters should be a requirement to all charging station vendors. It is important to have an agreement with suppliers about the option for live and remote migration of APN, back office URL and other settings. This should be implemented by means of a change configuration command because it has the least impact and minimizes the potential for interruption.
- No hardcoded settings. A specific supplier/manufacturer had hardcoded the IMSI number in to the firmware. Supplier should never be allowed to hard code the IMSI number (or any other settings that are transient). This needs to be retrieved dynamically from the modem and to be in accordance with the effective IMSI code. The IMSI code must be sent within the boot notification of the charging station as per the OCPP specification

3.8 Support charging station maintenance parties

The SLA analysis with the various 3rd parties shows that the contracts were not good enough in this aspect. In the some cases, only response times were mentioned, however, resolution time and/or work around time is crucial when a failure occurs, especially during the course of a migration process.

Recommendation and resolution

When remote updates are supported by a supplier the contract should ensure that in case of an emergency the response time provided by the supplier is appropriate, and there is a clear definition of resolution and escalation processes.

In addition, we recommend to make sure that prior to the migration process a specific agreement on the availability and service from the suppliers is put in place.

We recommend to have pilots for every charging station type, where a variety of charging stations serve as a testing ground for these pilots. Nevertheless, the charging stations have to keep working as EV drivers remain dependent on these charging stations. It is important to define the agreements per these pilots with the suppliers with reference to the service that will be delivered, so that the inconvenience to the EV drivers is minimized.

3.9 Backoffice update test

There should be a test, during the migration phase, of how the overall network behaves when the back office applies an update and is therefore unavailable for a short period of time. During this period of time some stations may experience problems of various sorts due to dropped communication with the back office or to the back office being partially or fully inaccessible.

Recommendation and resolution

There should be a test added to the set of integration tests to check how the stations react to the backoffice being (partly) down as is the case during updates. Because each backoffice has a different set up and may behave differently during the course of an update, this test is backoffice specific and should be set up in cooperation with your backoffice supplier.

3.10 Third party assistance

We now understand that one of the greatest challenges is the number of 3rd parties. Defining the project plan internally is a controlled process, yet getting 3rd party cooperation, understanding and commitment to the plan was the toughest and riskiest part of the project. There were many 3rd parties: Roaming partners, a Helpdesk company, a variety of charging station manufacturers, cellular providers, etc.

Recommendation and resolution

We have developed a way to minimize “finger pointing” and focus on the real technical issues. To facilitate this, **we have invested heavily in the development of monitoring tools** in order to record and present the issues to the 3rd parties in a way that will enable them to be aligned with us and plan together a resolution plan to the various issues.

Besides this, communications and planning in an early stage with these parties also contributed to the success of the migration.

4 About us:

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Driivz is a world leading provider of cloud-based, flexible and open platforms for the EV ecosystem. With tools for operators, drivers, station owners and fleets, Driivz enables its customers to increase profitability, reduce operational costs when operating EV charging networks and gain effective results in its innovative project initiatives. The Driivz open platform provides the network operator with freedom to use stations made by any hardware manufacturer and provides drivers the freedom to charge and drive anywhere.

To learn more about Driivz, please visit: www.driivz.com

ElaadNL, along with EVnetNL, has emerged from the foundation e-laad, which established a network of more than 3,000 public charging stations for electric cars across the Netherlands between 2009 and the beginning of 2014. ElaadNL is the knowledge and innovation center in the field of charging infrastructure in the Netherlands, providing coordination for the connections of public charging stations to the electricity grid on behalf of the involved network managers. Managing the existing charging stations is not one of ElaadNL's functions. This is done by EVnetNL in coordination with the relevant municipalities.

Innovation

The emergence of electric driving and sustainable charging is a significant development for the electricity grid. Through their mutual involvement via ElaadNL, the Distribution System Operators (DSO's) involved (including Cogas, Endinet, Enexis, Liander, Stedin and Westland) acquire an overview of the measures to be taken to ensure that the network remains reliable and affordable. Innovative solutions are investigated that will generate great benefits for society. For example, optimal use can be made of the existing network through 'smart charging', and fewer expensive alterations to the electricity grid are needed. ElaadNL also envisages free choice of supplier for the user. In addition, innovations are also put to use in other ways, for example in making the public charging stations more compact, more functional and cheaper and by enabling a more efficient connection and management process.

To learn more about ElaadNL, Please visit www.elaad.nl

The Open Charge Alliance (OCA)

We encourage you to contribute and join the OCA (open charge alliance), for more details please visit www.openchargealliance.org