INTRODUCTION AND THE STORY SO FAR

PROJECT ACHIEVEMENTS TO DATE, VISION AND CURRENT WORK FOCUS
Dr. Evangelia Portouli
ICCS – Institute of Communication and Computer Systems
2nd NeMo Stakeholder Forum Conference
Brussels, 10 October 2018
NeMo at a glance

Call identifier: H2020-GV-2015

Topic: GV-8-2015 Electric vehicles’ enhanced performance and integration into the transport system and the grid

EC funding: € 7.8 million

Duration: October 2016 – September 2019

19 partners

5 test sites & 1 cross-country demonstration

Coordinator: by ICCS (Institute of Communication and Computer Systems), Greece (Dr. Angelos Amditis, a.amditis@iccs.gr)

Website: http://nemo-emobility.eu

Join us at:
LinkedIn NeMo_Electro Twitter @NeMo_Electro
What are the challenges for NeMo?

- Limitation in Electric Vehicle range
- Lack of interoperability in electromobility services
- Diverse actors involved
- Impact to the Electric grid network
- Lack of common data exchange and commercial framework

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NeMo’s Vision

Develop a **Hyper-Network of tools, models and services**, to enable the provision of **seamless and interoperable electromobility services** creating an open, distributed and widely accepted ecosystem for e-mobility

- improved accessibility to charging infrastructure and ICT services through a **pan-European Inter-Roaming framework**
- facilitate increased availability, better planning and more secure electric grid operation
- create business opportunities (increased B2B connectivity)
NeMo’s strategic objectives

- **Distributed, decentralized, Secured**
  - (Shared distributed database / Ledger)
  - Business Network (B2B)

- **Common Information Models**
- **Standard ICT interfaces**
- **Core system** for provision of ICT services
- **Horizontal services**
- **Open APIs** that will enable an open B2B cloud Marketplace for electromobility
- **Services self-certification mechanism**
Expected impact

• Enhanced driver satisfaction: “Charge anywhere & anytime” across Europe via a single identification, authorisation & payment method

• Easy creation and delivery to a wide audience of innovative, interoperable electromobility services via an open cloud marketplace

✓ Improved attractiveness of electric vehicles
✓ Facilitation of EVs mass adoption
Expected impact

- Enable Information exchange among all involved actors

- Integration of smart-grid applications and services, to support the EVs integration in the electricity grid, by optimisation of electricity supply compared to demand.
Indicative NeMo services

**Horizontal**

Hyper-Network services:
- Electromobility actors’ monitoring and profiling
- Finder and optimiser
- Brokerage
- Service pricing (static and dynamic)

**EV driver / owner services:**
- Smart navigation and journey planning
- Wireless authentication solution

**Grid related services:**
- Navigation to Charging Point based on user and grid requirements
- Global customer charging behaviour
- Grid load management
- Load forecasting due to EV charging
- Local energy management

**EV and battery related services:**
- Adaptive State-of-Charge limit
- Capacity calculation; Load management; etc.
NeMo Common Information Models

- One of the pillars of NeMo Hyper-Network is the possibility to exchange data using a common NeMo meta-language

- Common Information Models (CIM)
- Data translators and common interfaces
- Smart Processing and Data Management algorithms
CIM Location in the Hyper-Network

- New services will generate and exchange data according to the CIM
- Data translators will enable the translation of data to the NeMo CIM

Standardised model for information sharing across the NeMo Hyper-Network

Implementation of the CIM
NeMo Common Information Models

• Discussed in the NeMo First Stakeholder Forum Conference
• Models have been submitted to eMi³ group for their consideration in future activities
• Liaison with other standardization groups and stakeholder groups
• CIM is continuously updated according to electromobility needs and second version will be released

Data Translators and Interfaces
Smart Services Integration
Services Interoperability

Common Information Models

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Contributes to a Pan European eRoaming framework, by linking existing eRoaming platforms:

• the direct communication between eRoaming platforms
• publishing of eRoaming platforms’ services to the NeMo Hyper-Network, providing eRoaming features, like any other NeMo service.
NeMo Hyper-Network

All participants have access to same data
Nemo Nodes operated by Business partners.

NeMo Business Network

Shared distributed Database / Ledger:
1. Partner Management
2. Services Marketplace
3. Contract Management

B2B services
CIM

eRoaming Hub #2

Charge Point Operator
CPO

Electro Mobility (service) Provider
EMP

NeMo Hyper-Network

Trustee Service Provider

OEM #1
OEM #2

DSO

Distribution System Operator - DSO

ITSP

3rd Party Service Provider

CPO #1
CPO #2

CPO

DSO
NeMo Test sites

- **Five test sites** across Europe to evaluate the results

  - **Spanish Test Site**
    - ✓ Local Interoperability
    - ✓ Horizontal services
    - ✓ Booking service
  
  - **French Test Site**
    - ✓ eMobility Report
    - ✓ Vehicle preconditioning
  
  - **German Test Site**
    - ✓ Capabilities of NeMo Hyper-Network
  
  - **Austrian Test Site**
    - ✓ Smart charging services
    - ✓ Grid services
  
  - **Italian Test Site**
    - ✓ Itinerary planning considering security features
NeMo Test sites

• Cross-country demonstration test drive in 2019
  – Evaluation of the post-NeMo situation for real users
  ✓ Itinerary Planning
  ✓ Cross-provider border booking authorization and payment management
First cross-country test drive (2-4 October 2017)

- Identified issues affecting long distance travel in electric vehicles
- 2 EVs (4 NeMo drivers) followed different routes covering a distance of over 950km from Turin to Barcelona (Italy-France-Spain)
Invitation to NeMo

✓ **JOIN** the *NeMo Stakeholder Forum*
  - Register via [https://nemo-emobility.eu/nemo-forum/](https://nemo-emobility.eu/nemo-forum/) or the *NeMo LinkedIn* group
  - Remain updated on all project news, results and events
  - Register your interest in joining the Hyper-Network as a developer, provider or user of services.

✓ **PARTICIPATE** in the upcoming *NeMo Hackathon and Webinars* → Early 2019
  - Contribute to the optimisation of the Hyper-Network Tools and Service Creation Environment;

✓ **ATTEND** the **FINAL EVENT** in September 2019

✓ **Follow us:**
  - Website: http://nemo-emobility.eu
  - Join us at: LinkedIn NeMo_Electro   🚶‍♂️ @NeMo_Electro

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Thank you!

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OVERVIEW OF THE NeMO HYPER-NETWORK

FUNCTIONALITY AND CONTENT
Dr. Udo Pletat
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2nd NeMo Stakeholder Forum Conference
Brussels, 10 October 2018
Electro-mobility IT challenges addressed by NeMo

- How to establish a decentral marketplace for players in the space of IT services for electro-mobility?
  - make it easy for interested parties to join Europe-wide NeMo Alliance
  - exploit Hyperledger/Blockchain technology

- How to develop interoperable and seamlessly integrated electro-mobility B2B services and B2C applications?
  - employ common information model and semantic search for services
  - provide data translation between proprietary and NeMo CIM data model

- How to combine commercial and technical aspects of developing and marketing e-mobility IT services?
  - provide key tools for creating state-of-the-art e-mobility services
  - enable positioning service offerings on the services marketplace
The NeMo Approach

NeMo Business and IT Network

- CRF Node
- IBM Node
- PoliBari Node
- Gireve Node

NeMo B2B Services / applications (Common Information Model based)

- Third party B2C application
- Trustee service
- Personal mobility probability
- eRoaming hub - by Gireve

Sample Services
More being developed

- OEM: FCA
- OEM: Renault

OEM: FCA
OEM: Renault

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Services registered in NeMo
Architecture of a single NeMo Node

NeMo (EMP) Business Partner Data Centre

- NeMo EM Application
- NeMo Service (atomic)
- NeMo Service (as process)
- BPMN Runtime
- Service Artefacts Server

Services registered at NeMo

NeMo Node

- Identity & Access Management
- Translation Specification
- Translator (from/to CIM)

NeMo Tools for Service Creation

Service Developer

NeMo Service & Contract Registry Web UI

Service Developer/Seller/Buyer

NeMo Service Developer/Reg. Data

Identity & Access Management Translator (from/to CIM)

Translation Specification
NeMo network view
- integration between participating business partners
NeMo cross-node service-to-service invocation
Engaging with NeMo

• Check out the NeMo vision
  ➔ https://nemo-emobility.eu

• Join the NeMo Alliance & participate in NeMo Marketplace
  ➔ will become active in 2019 and beyond

• Hook up to the NeMo IT infrastructure
  ➔ install a NeMo Node

• Develop & market your NeMo e-mobility IT services
  ➔ and/or consume some services for your e-mobility apps
Summary and Conclusion

NeMo provides:

✓ a distributed IT environment where partner, service & contract information are managed using distributed ledger technology (Hyper-ledger, Blockchain)

✓ a service execution infrastructure for cross-node service-to-calls enabled by a distributed Integration Bus

✓ an IT environment that lets market participants search & use third party services

✓ a BPMN-based tool-suite for implementing value-add e-mobility IT services

✓ an IT deployment / delivery mechanism allowing e-mobility providers to join the NeMo Open Marketplace easily

✓ a common information model unifying business objects for interacting electro-mobility services

✓ a platform enabling innovation for a uniform Digital e-mobility market for Europe
Thank you!

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USING HYPER-NETWORK SERVICES:
WHAT ARE THE BENEFITS?

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Brussels, 10 October 2018
NeMo – Levels definition

Services

Marketplace

Hyper Network

Core services

eRoaming Platforms

eMobility Services

Horizontal Services
Why develop services in NeMo?
Why services contribute?

Services give added value to the NEMO Hyper-network
Services use cases

Daily commute

Long distance trip
Services use cases

Daily commute

1. Go to work
2. Check battery SOC
3. Check CP availability
4. Choose suggested spot and schedule
Services use cases

Service Brokerage
- Fit the actors’ requests to existing services

Daily commute

Smart navigation
- Availability and location of CPs
- Road traffic and
- Battery SOC

Smart Journey Planner
- Route planning

EV driver monitor and profiling
- Mobility patterns
- User interests
- Generate valuable personal and non-personal information

CPO monitoring and profiling
- CP availability
- Irregular activity
- Generate valuable personal and non-personal information
Services use cases

Long distance trip

Go to a foreign city → Check CP availability and required EV charging time → Book a charging spot → Check information about pricing and payment options
Services use cases

- **Smart navigation**
  - Route calculation
  - CP availability
  - Required EV charge time
  - Battery SOC

- **Rating/pricing services**

- **CP Booking**

- **Long distance trip**

- **Wireless authentication service**
  - Access control
  - Identification, authentication and authorization

- **CPO monitoring and profiling**
  - CP availability
  - Irregular activity
  - Generate valuable personal and non-personal information
NeMo - Services

- Smart navigation
- Smart Journey Planner
- Wireless authentication service

- Navigation to CP based on user and grid power requirements
  - Global customer charging behaviour
  - Load management
  - Load forecasting due to EV charging
  - Local energy management

- Adaptive SOC limit
- Remote BMS Parameterization
  - Thermal battery pre-conditioning
  - Improved SOC estimation
  - Battery Capacity Calculation
  - Battery Load Management

- Service brokerage
- EV driver monitor and profiling
  - CPO monitoring and profiling
  - Application level finder
  - Rating/pricing services
Marketplace benefits

Provide seamless interoperability of B2B and B2C electromobility services

**Service providers**
- Provide a set of new and existing services
- Easy to publish
- Combine different services to give added value to the users
- Get a better knowledge of users

**Users**
- Access to global services
- Single platform/interface
- Easy to access
- Combine different services
- eRoaming interoperability
Thank you!
- Ideas for new services?

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EXAMPLE OF A HYPER-NETWORK SERVICE:
VIRTUAL SENSORS FOR INNOVATIVE ELECTRO-MOBILITY SERVICES
Dr. Michele Roccotelli
Polytechnic University of Bari
2nd NeMo Stakeholder Forum Conference
Brussels, 10 October 2018
Why Virtual Sensors?
Why Virtual Sensors?

- Virtual Sensors (VSs) are introduced as software sensors that provide indirect measurements of abstract conditions, by combining sensed data from heterogeneous physical sensors.
Why Virtual Sensors?

• Virtual Sensors (VSs) are introduced as software sensors that provide indirect measurements of abstract conditions, by combining sensed data from heterogeneous physical sensors

• A VS *logically reproduces* one or more *physical sensors* in the cloud platform, facilitating and increasing their functionalities, being capable of *performing complex tasks* that cannot be accomplished by physical sensors
Why Virtual Sensors?

• Virtual Sensors (VSs) are introduced as software sensors that provide indirect measurements of abstract conditions, by combining sensed data from heterogeneous physical sensors.

• A VS logically reproduces one or more physical sensors in the cloud platform, facilitating and increasing their functionalities, being capable of performing kinds of tasks that cannot be accomplished by physical sensors.

• VSs are used in different fields of research such as energy, healthcare, mobility, etc., to estimate or predict information/parameters values from the distributed instrumentation measurements.
Why Virtual Sensors?

In the electro-mobility framework... **Innovative services for EV users and stakeholders**

- **Battery** technology management
- Battery **charge planning**
- **Charge Point** availability
- **Itinerary** planning
- Personal / vehicle **mobility need**
- Estimating **faults**
- Ensuring **vehicles stability** and **reliability**
- Estimating **EV parameters** (overcome difficulty to measure key parameters by physical sensors); **Deriving new information** from sensors measurements
NeMo hyper-network

Traffic IT Services

Weather IT Services

eMP Electromobility service provider

CPO

Vehicle Manufacturer

ISO 15118

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A VS in the NeMo hyper-network

Virtual Sensor service on a NeMo node

- Traffic IT Services
- Weather IT Services
- Vehicle Manufacturer
- other IT Service Provider
- eRoaming
- eRoaming
- eMP
- CPO
- ISO 15118
- Vehicle Manufacturer

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VSs implementation methodology

1° Sensing phase:
gathering data from data providers and data sources
(wired and wireless sensors);
2° Planning phase: the collected data from external sources, together with the internal state of vehicle, are elaborated by internal algorithms to update the indirect measurement.
**VSSs implementation methodology**

3° **Acting phase:** the last computation of the VS is requested from external users or other services, and the corresponding last updated output is delivered to them.
Examples of VSSs for electromobility

1. Itinerary Planning
2. Personal Mobility Probability
3. Charge Point Availability
4. Charge Price Prediction

Diagram showing interactions between eMSP, CPO, Car maker, and Nemo.
Examples of VVs for electromobility

1. Itinerary Planning
2. Personal Mobility Probability
3. Charge Point Availability
4. Charge Price Prediction
Personal Mobility Probability

• Use of statistical algorithms and past trip history data to derive the driver most probable routes during the next calendar day with respective probabilities.
• Each route is a spatial-temporal path composed by the interpolation of Point Of Interest (POI).

The POI are the following:
• Start point (SP)
• Charge/other intermediate stops
• End point (EP)

Each POI of the trip will be described by six values (latitude, longitude, arrival_timestamp, departure_timestamp, arrival charge, departure charge).
Output example (1/2)

Start Point
Lat: 41.0660187,
Lon: 16.871654,
Arriv: --,
Dep: Tue 01-01-2009 8:00,
Res1: --,
Res2: 30%(100km)

Tue 01-01-2009,
Route #1, 80%
Personal Mobility Probability

Output example (1/2)

Stop Point
Lat: 41.0900655, Lon: 16.8873189,
Arriv: Tue 01-01-2009 8:20,
Dep: Tue 01-01-2009 8:30,
Res1: 20%(60km), Res2: 20%(60km)

Start Point
Lat: 41.0660187, Lon: 16.871654,
Arriv: --,
Dep: Tue 01-01-2009 8:00,
Res1: --, Res2: 30%(100km)

Tue 01-01-2009, Route #1, 80%

Stop Point
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Personal Mobility Probability

Output example (1/2)

Start Point
Lat: 41.0660187,
Lon: 16.871654,
Arriv: --,
Dep: Tue 01-01-2009 8:00,
Res1: --,
Res2: 30%(100km)

Charge Stop Point
Lat: 41.1067778,
Lon: 16.8791882,
Arriv: Tue 01-01-2009 8:40,
Dep: Tue 01-01-2009 9:00,
15%(40km),
30%(100km)

Stop Point
Lat: 41.0900655,
Lon: 16.8873189,
Arriv: Tue 01-01-2009 8:20,
Dep: Tue 01-01-2009 8:30,
Res1: 20%(60km),
Res2: 20%(60km)

Tue 01-01-2009,
Route #1, 80%
Output example (1/2)

End Point
Lat: 41.125259, Lon: 16.8733198,
Arriv: Tue 01-01-2009 9:30,
Dep: --,
Res1: 25%(70km),
Res2: --

Charge Stop Point
Lat: 41.1067778, Lon: 16.8791882,
Arriv: Tue 01-01-2009 8:40,
Dep: Tue 01-01-2009 9:00,
15%(40km),
30%(100km)

Stop Point
Lat: 41.0900655, Lon: 16.8873189,
Arriv: Tue 01-01-2009 8:20,
Dep: Tue 01-01-2009 8:30,
Res1: 20%(60km),
Res2: 20%(60km)

Start Point
Lat: 41.0660187, Lon: 16.871654,
Arriv: --,
Dep: Tue 01-01-2009 8:00,
Res1: --,
Res2: 30%(100km)

Tue 01-01-2009,
Route #1, 80%
Personal Mobility Probability

Output example (2/2)

Tue 01-01-2009,
Route #2, 20%

Start Point
Lat: 41.0660187,
Lon: 16.871654,
Arriv: --,
Dep: Tue 01-01-2009 8:00,
Res1: --,
Res2: 30%(100km)
Tue 01-01-2009, Route #2, 20%

Start Point
Lat: 41.0660187, Lon: 16.871654,
Arriv: --,
Dep: Tue 01-01-2009 8:00,
Res1: --,
Res2: 30%(100km)

Charge Stop Point
Lat: 41.1067778, Lon: 16.8791882,
Arriv: Tue 01-01-2009 8:20,
Dep: Tue 01-01-2009 8:50,
Res1: 20%(60km),
Res2: 30%(100km)
Output example (2/2)

**End Point**
Lat: 41.125259, Lon: 16.8733198,
Arriv: Tue 01-01-2009 9:15,
Dep: --
Res1: 25%(70km), Res2: --

**Start Point**
Lat: 41.0660187, Lon: 16.871654,
Arriv: --,
Dep: Tue 01-01-2009 8:00,
Res1: --, Res2: 30%(100km)

**Charge Stop Point**
Lat: 41.1067778, Lon: 16.8791882,
Arriv: Tue 01-01-2009 8:20,
Dep: Tue 01-01-2009 8:50,
Res1: 20%(60km), Res2: 30%(100km)

**Tue 01-01-2009, Route #2, 20%**
Examples of VVs for electromobility

1. Itinerary Planning
2. Personal Mobility Probability
3. Charge Point Availability
4. Charge Price Prediction
Charge Price Prediction

- To provide information about charge stations (latitude, longitude, tariff, power, distance, status), related to a specific time horizon (e.g. next 24 hours) and the area of interest of a given driver.

- To predict charge session cost for the given driver selecting specific charge point (€).

- It requires:
  - Charge point dynamic status
  - Charge detail record
  - Charge point tariff
  - Personal/Vehicle mobility need, EV position
  - Residual charge
  - Desired charge
Charge Price Prediction

Output example
Charge Price Prediction

Output example

Charge Station 1
Lat: 41.125259, Lon: 16.8733198,
Tariff: 3 €/kWh, Power: 22 kWh,
Dis: 2 km, Status: Free
Cost: 6€
Output example

Charge Station 1

Charge Station 2
Charge Price Prediction

Output example

Charge Station 1

Charge Station 2

Charge Station 3
Lat: 41.125259, Lon: 16.8733198, Tariff: 4 €/kWh, Power: 44 kWh, Dis: 2.5 km, Status: Occupied Cost: 8€
Thank you!

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USING THE HYPER-NETWORK: CREATION OF A SERVICE

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Brussels, 10 October 2018
Agenda

• **Electromobility Service Creation – Motivation & Challenges**
• NeMo Service Development - Overview
• Service Description & Search with Semantic Service Manager
• Service Process Development with Visual Service Design Tool
• Summary
Motivation

• Complexity of distributed systems is increasing
  – Huge amounts of services
  – High degree of dynamics
  – Heterogeneous service providers

• Management of an efficient interoperability gets more and more difficult

• Further dynamic behaviour in huge distributed systems is a key requirement for intelligent systems/agents/components

• Semantic Web Service concepts, such as Service Matchmaking and Service Composition are promising approaches
Challenges

- An important topic is the autonomic interpretation of services’ functionality

- There are multiple semantic service description languages:
  - WSMO, OWL-S, SAWSDL, SA-REST, etc.

- However:
  - Syntactical complexity of the descriptions high
  - Manual creation cumbersome and error-prone
  - Relation between development effort and benefit still not sufficient
Goals

• Provide **support for the semantical enhancement of functionalities** without changing the developers workflow completely

• Facilitate the development of **E-Mobility services** that automatically find, invoke and combine other services to reach a certain goal
Agenda

• Electromobility Service Creation – Motivation & Challenges
• NeMo Service Development - Overview
• Service Description & Search with Semantic Service Manager
• Service Process Development with Visual Service Design Tool
• Summary
• Provide a Service Development Environment that
  – allows for the specification of service processes
  – integrates service search at design-time based on semantic service descriptions
  – enables the composition of services to value-added services
  – is itself running within the cloud infrastructure
  – comes with testing features
Agenda

• Electromobility Service Creation – Motivation & Challenges
• NeMo Service Development - Overview
• **Service Description & Search with Semantic Service Manager**
• Service Process Development with Visual Service Design Tool
• Summary
Service Description & Search

How to create a Semantic Service Description for NeMo?
Service Description with SSM

- Eclipse View integrated in a larger tool-suite called Toolipse 3
- Support for the development of OWL-S service descriptions using OWL and SWRL
- Direct deployment to the NeMo Distributed Repository
Service Description & Search

How to find the right Service within the NeMo Network?
Service Search with SSM

- Service Designer can find available services at design time
- SSM invokes Service Matchmaker and searches for appropriate functionalities on the platform
- Direct request on the NeMo Service registry
Agenda

• Electromobility Service Creation – Motivation & Challenges
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• **Service Process Development with Visual Service Design Tool**
• Summary
Service Process Development with VSDT
Agenda

• Electromobility Service Creation – Motivation & Challenges
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• Service Description & Search with Semantic Service Manager
• Service Process Development with Visual Service Design Tool
• Summary
Summary

• NeMo Composite Services can be modeled in **Business Process Model and Notation (BPMN)** with dynamic behavior features via VSDT
• Support for the **semantical enhancement of functionalities** via tools like the SSM
• **NeMo low-level Search and Deployment features** within the Service Creation Environment, integration to the hyper-ledger via secured interfaces
• Facilitate the development of **E-Mobility services** by adding a semantic layer and integrating a SOA
Thank you!

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