Hyper-Network for electroMobility

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** **@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

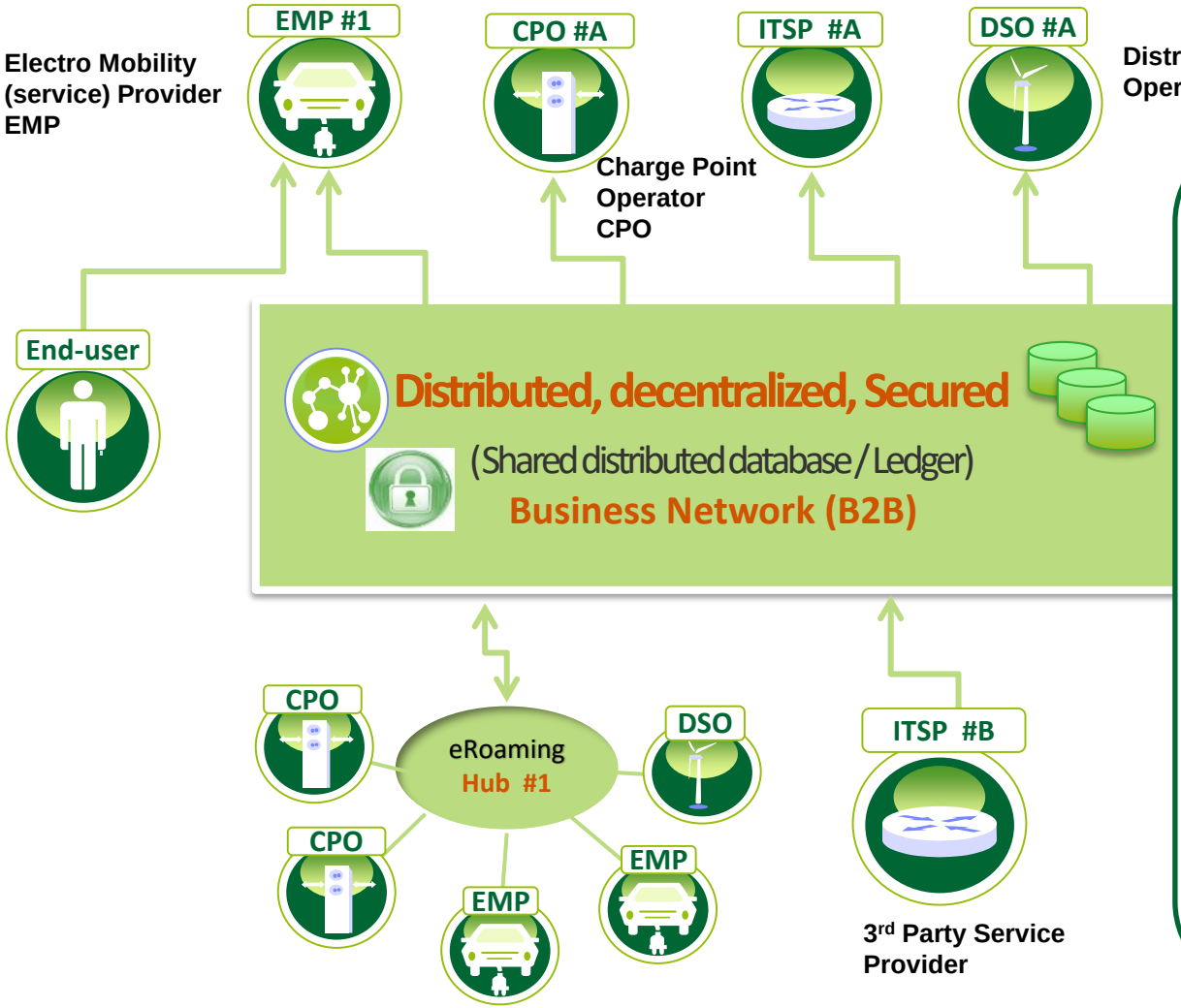
Lack of common data exchange and commercial framework

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



- **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

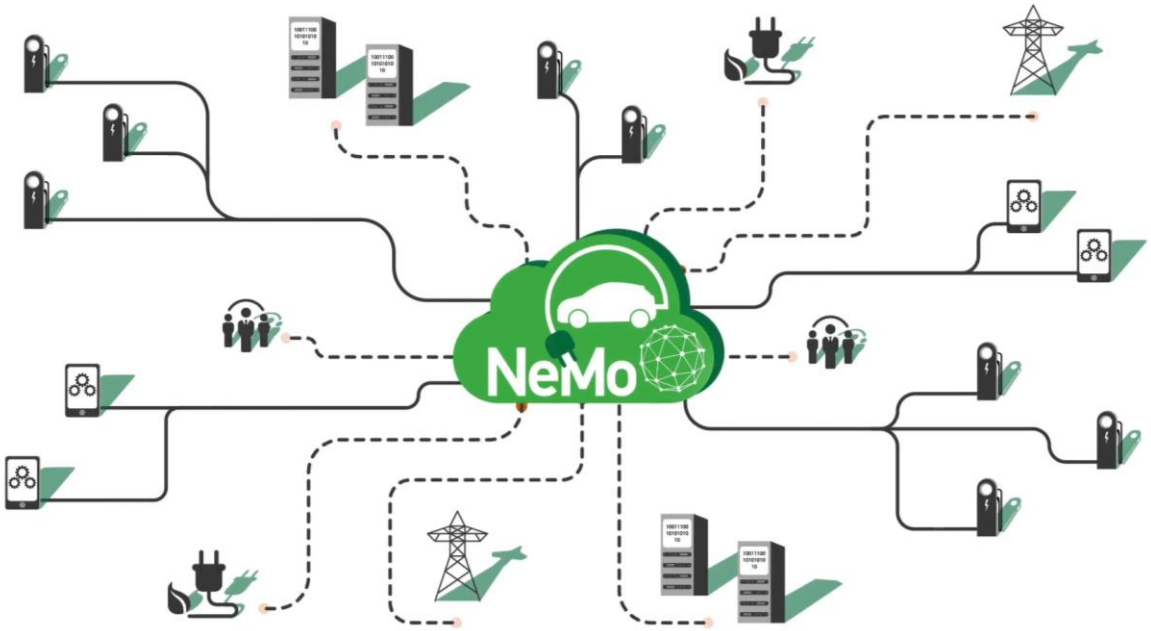
- Easy creation and delivery to a wide audience of innovative, interoperable electromobility services via an **open cloud marketplace**

- ✓ 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:

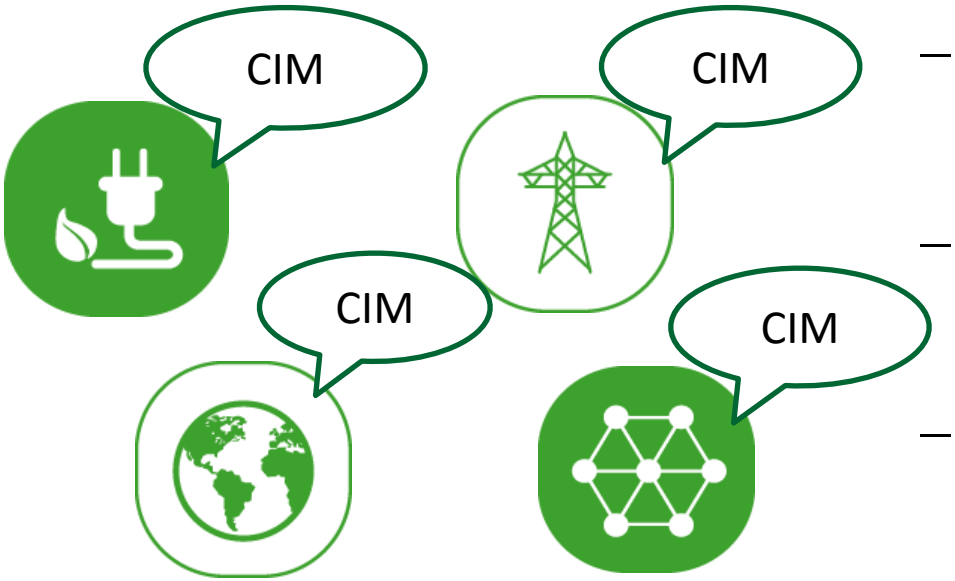
- Navigation to Charging Point based on user and grid requirements
- Global customer charging behaviour
- Grid load management
- Load forecasting due to EV charging
- Local energy management

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 <u>common NeMo meta-language</u>

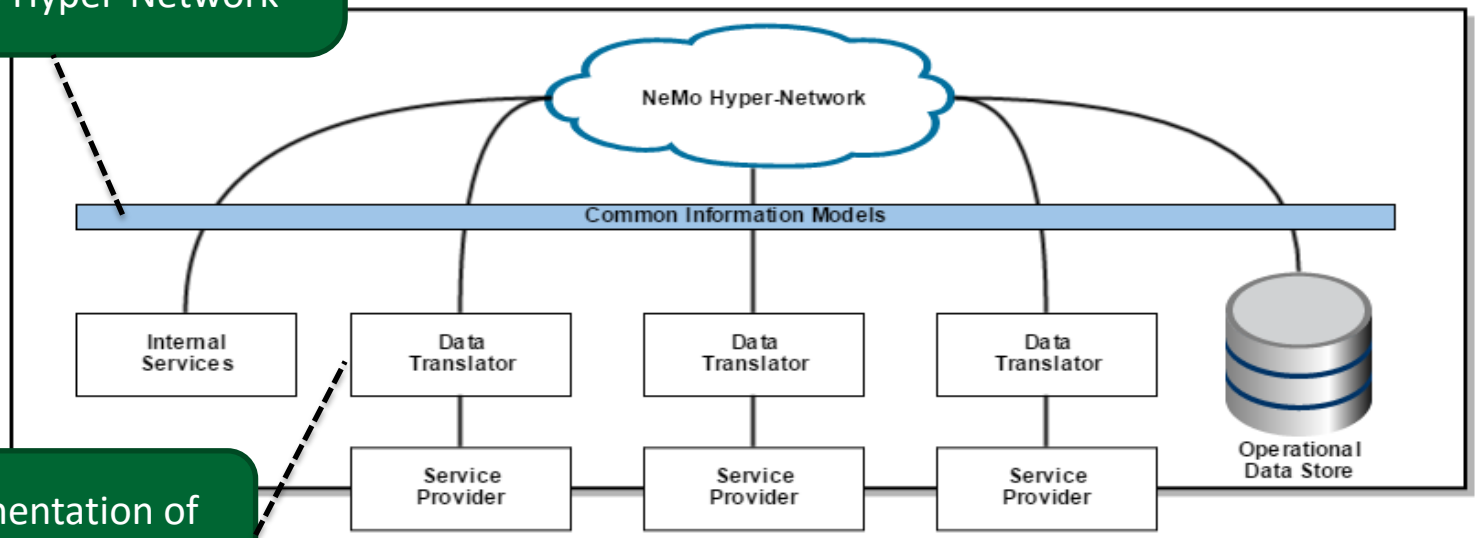


- Common Information Models (CIM)
- Data translators and common interfaces
- Smart Processing and Data Management algorithms

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 eMi^3 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

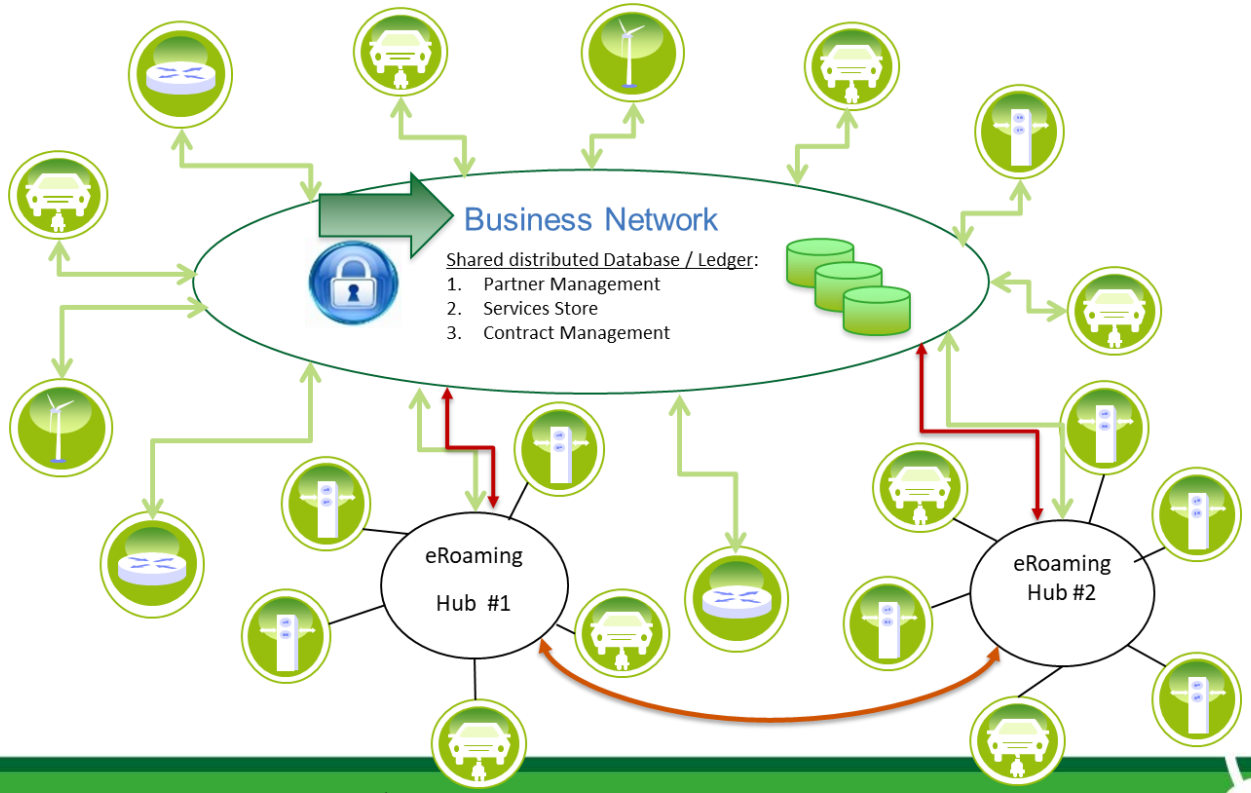
Services Interoperability

Common Information Models

NeMo Inter-roaming protocol

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

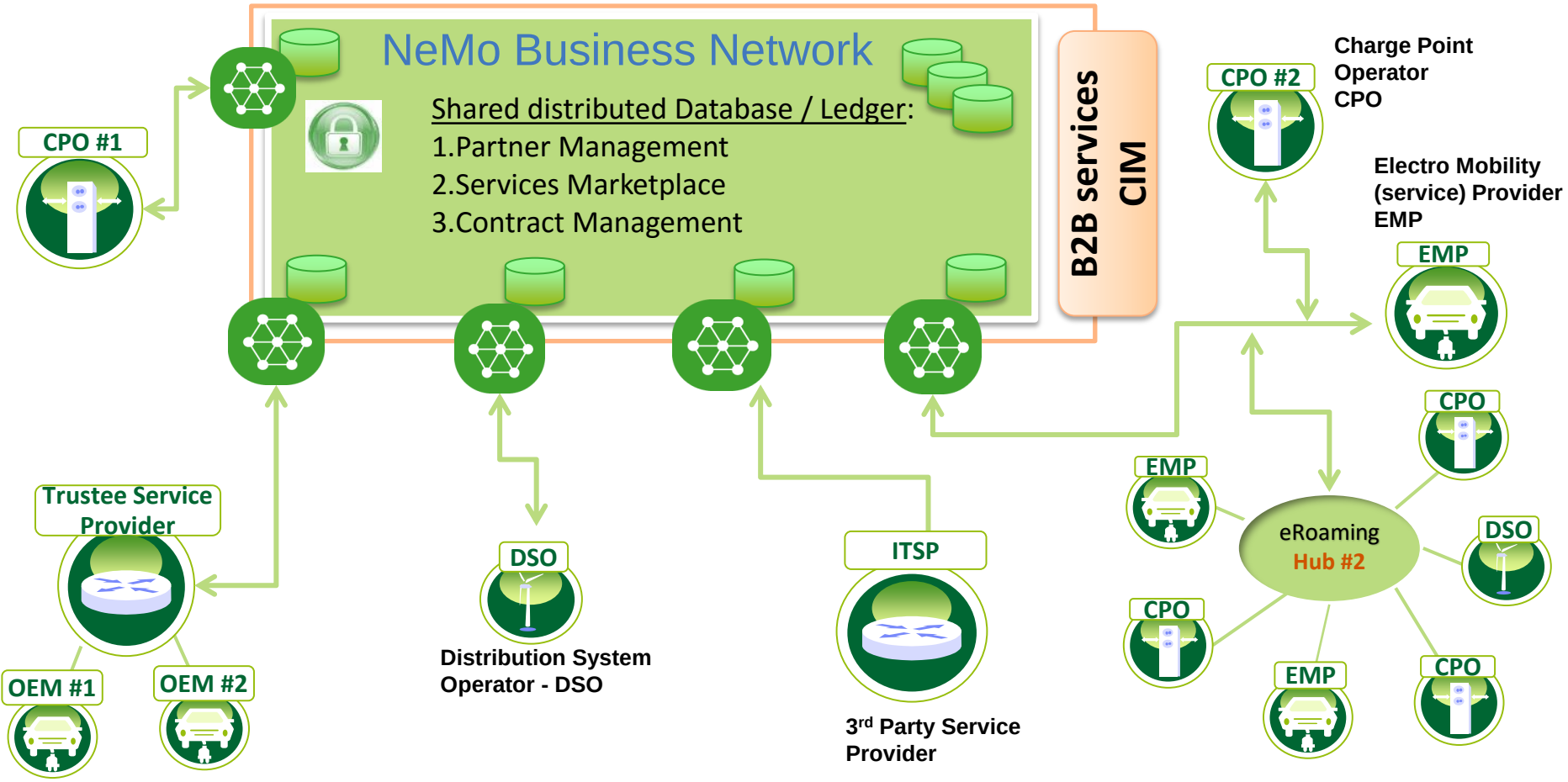
- the direct communication between eRoaming platforms
- publishing of eRoaming platforms' services to the NeMo Hyper-Network, providing eRoaming features, like any other NeMo service.



NeMo Hyper-Network

All participants have access to same data

Nemo Nodes operated by Business partners.



NeMo Test sites

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

French Test Site
- ✓ eMobility Report
- ✓ Vehicle preconditioning

German Test Site
- ✓ Capabilities of NeMo Hyper-Network

Austrian Test Site
- ✓ Smart charging services
- ✓ Grid services

Spanish Test Site
- ✓ Local Interoperability
- ✓ Horizontal services
- ✓ Booking service

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/ 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

Thank you!

Evangelia Portouli

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Overview of the NeMo Hyper-Network

Functionality and content

Dr. Udo Pletat

IBM Deutschland Research and Development

2nd NeMo Stakeholder Forum Conference

Brussels, 10 October 2018

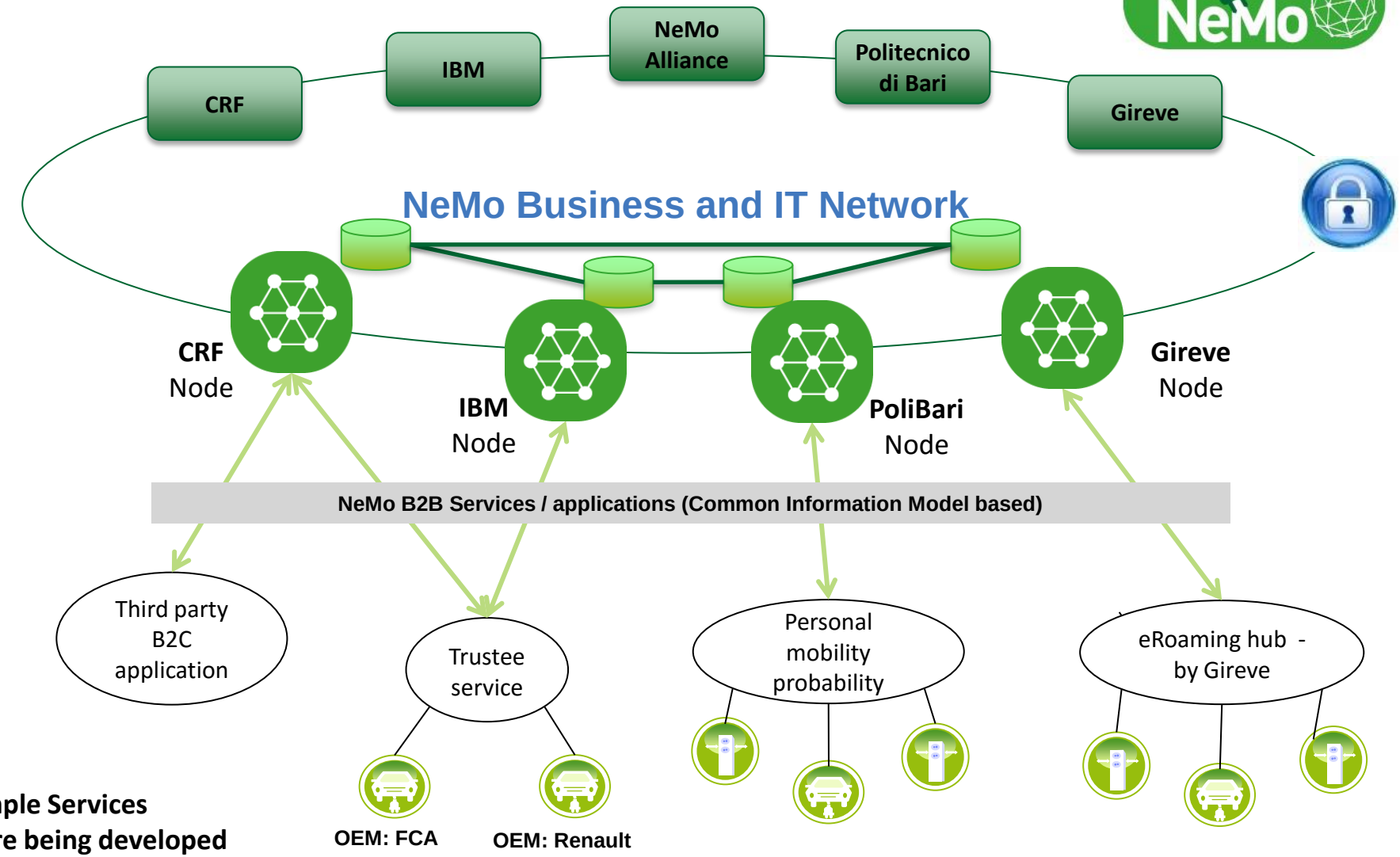
Electro-mobility IT challenges addressed by NeMo

- 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*

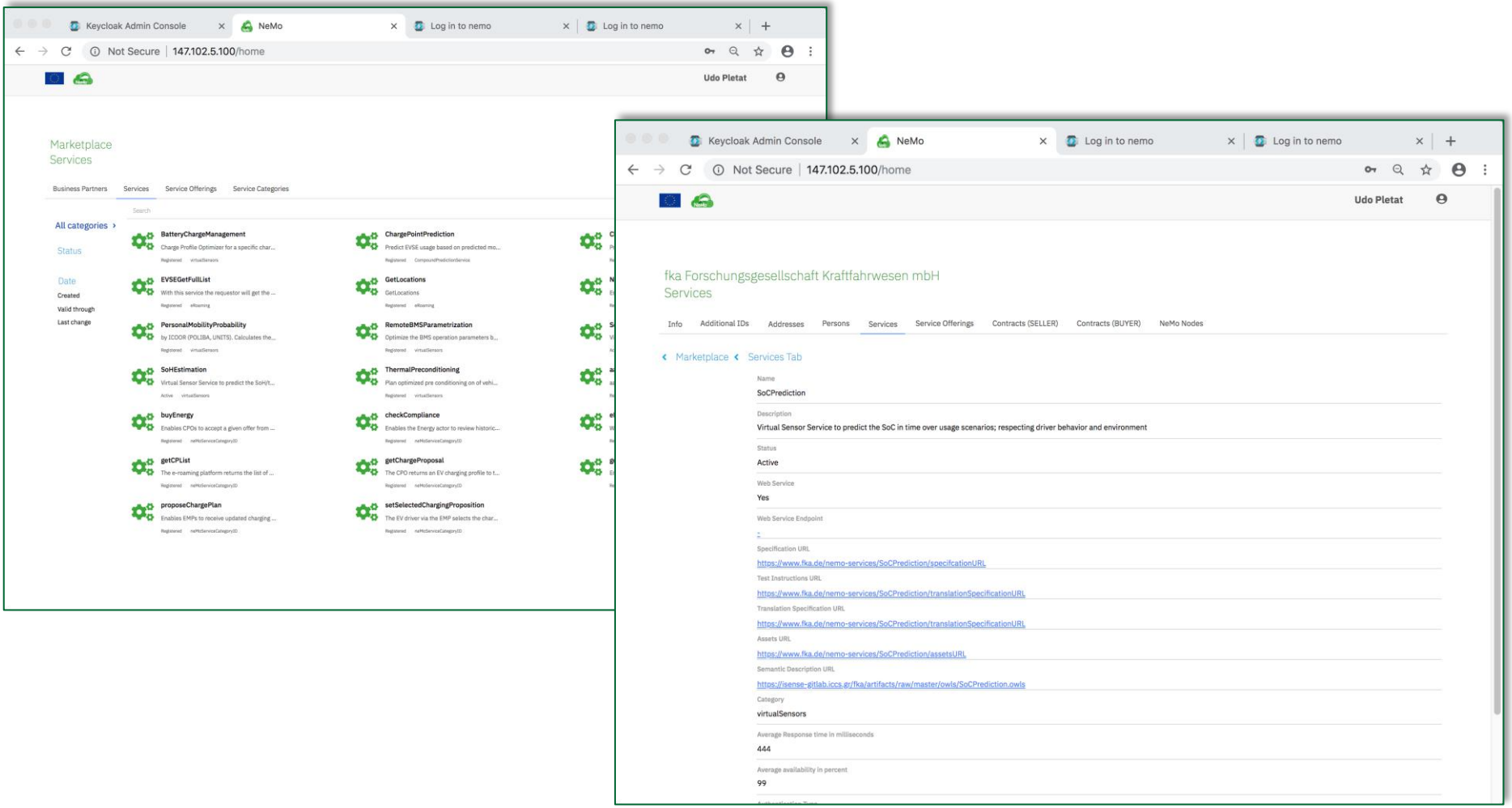
- How to **combine commercial and technical aspects of developing and marketing** e-mobility IT services?
  - ➔ *provide key tools for creating state-of-the-art e-mobility services*
  - ➔ *enable positioning service offerings on the services marketplace*

The NeMo Approach

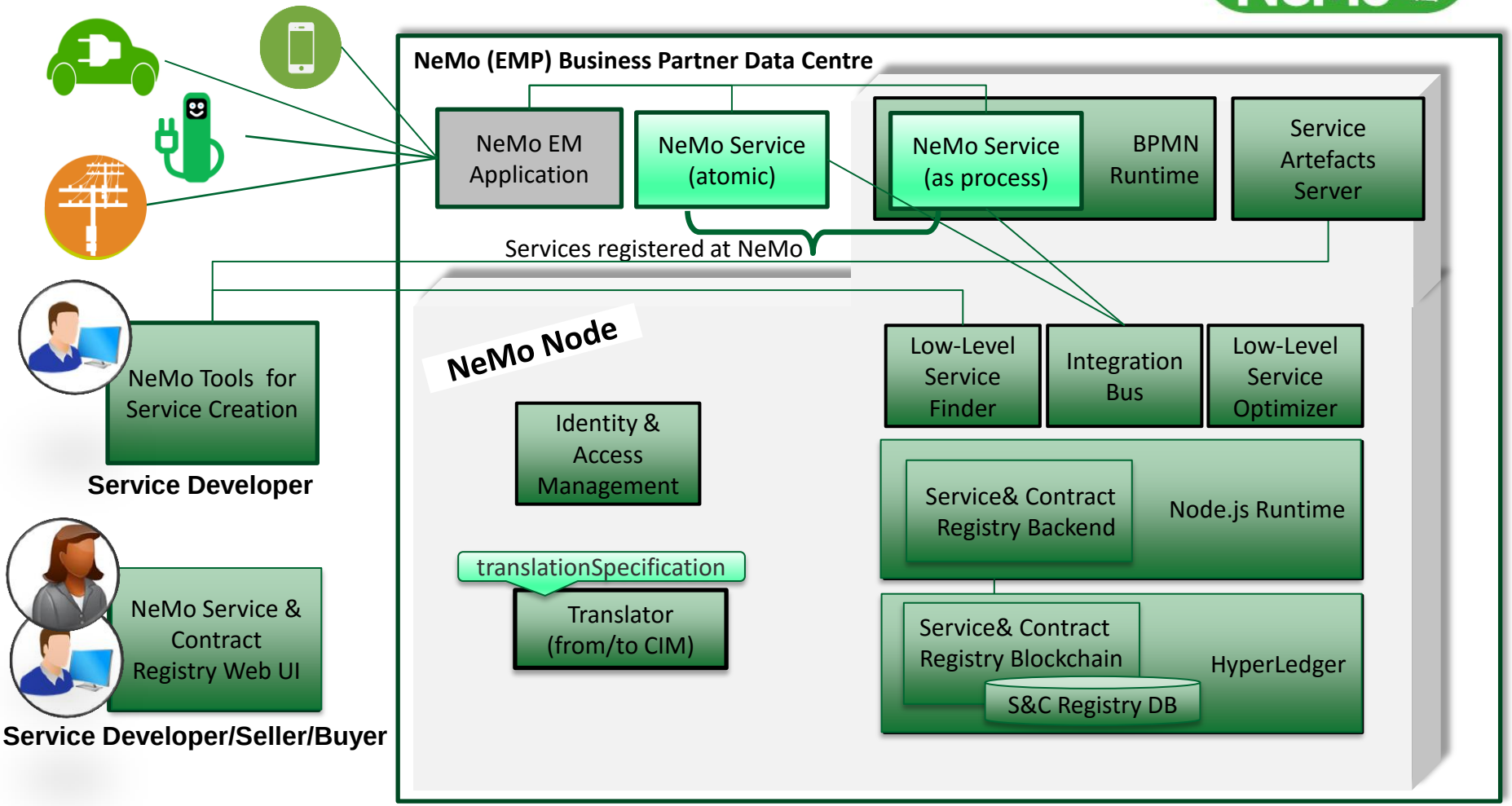


Sample Services
More being developed

Services registered in NeMo

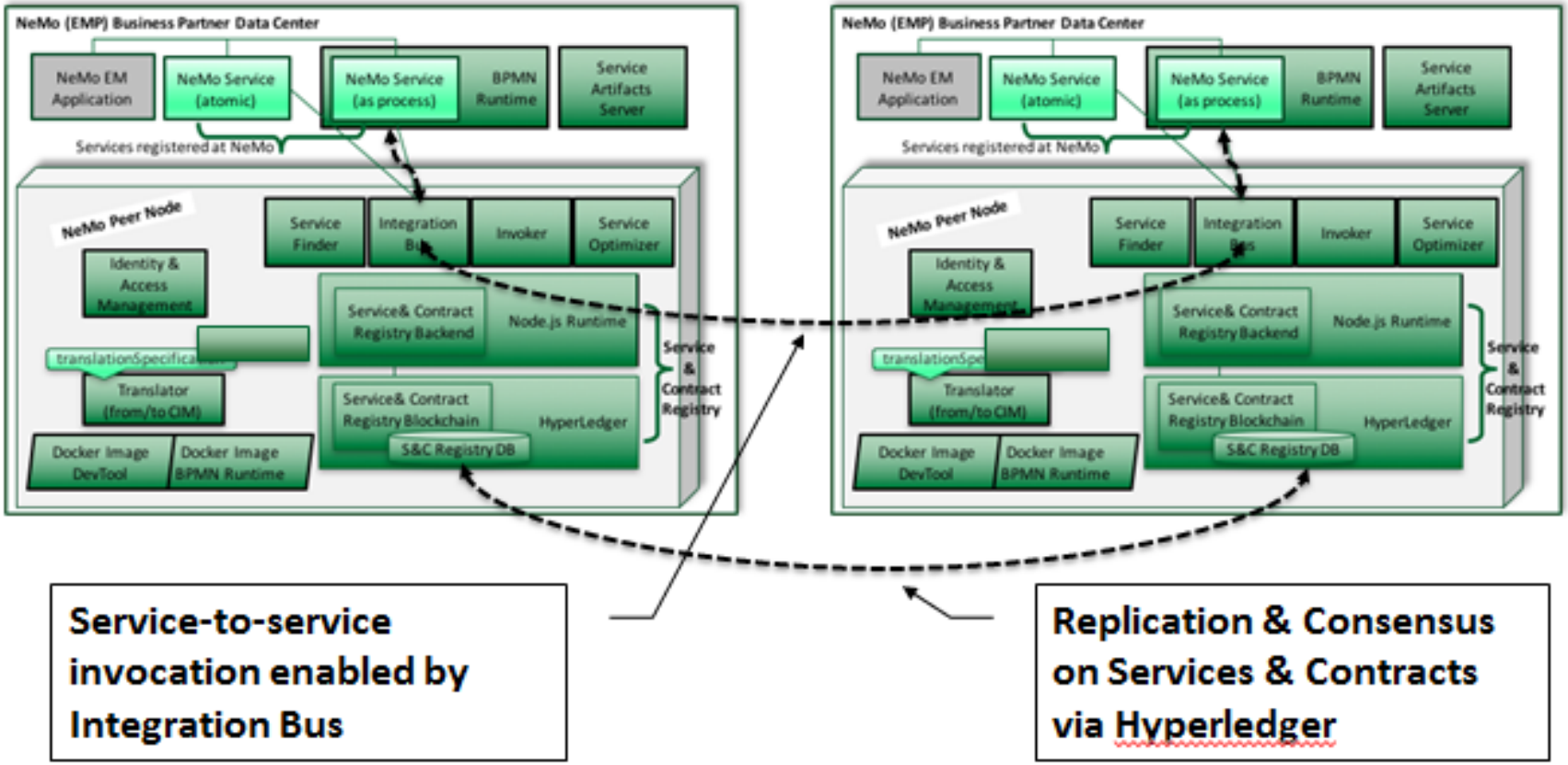


Architecture of a single NeMo Node

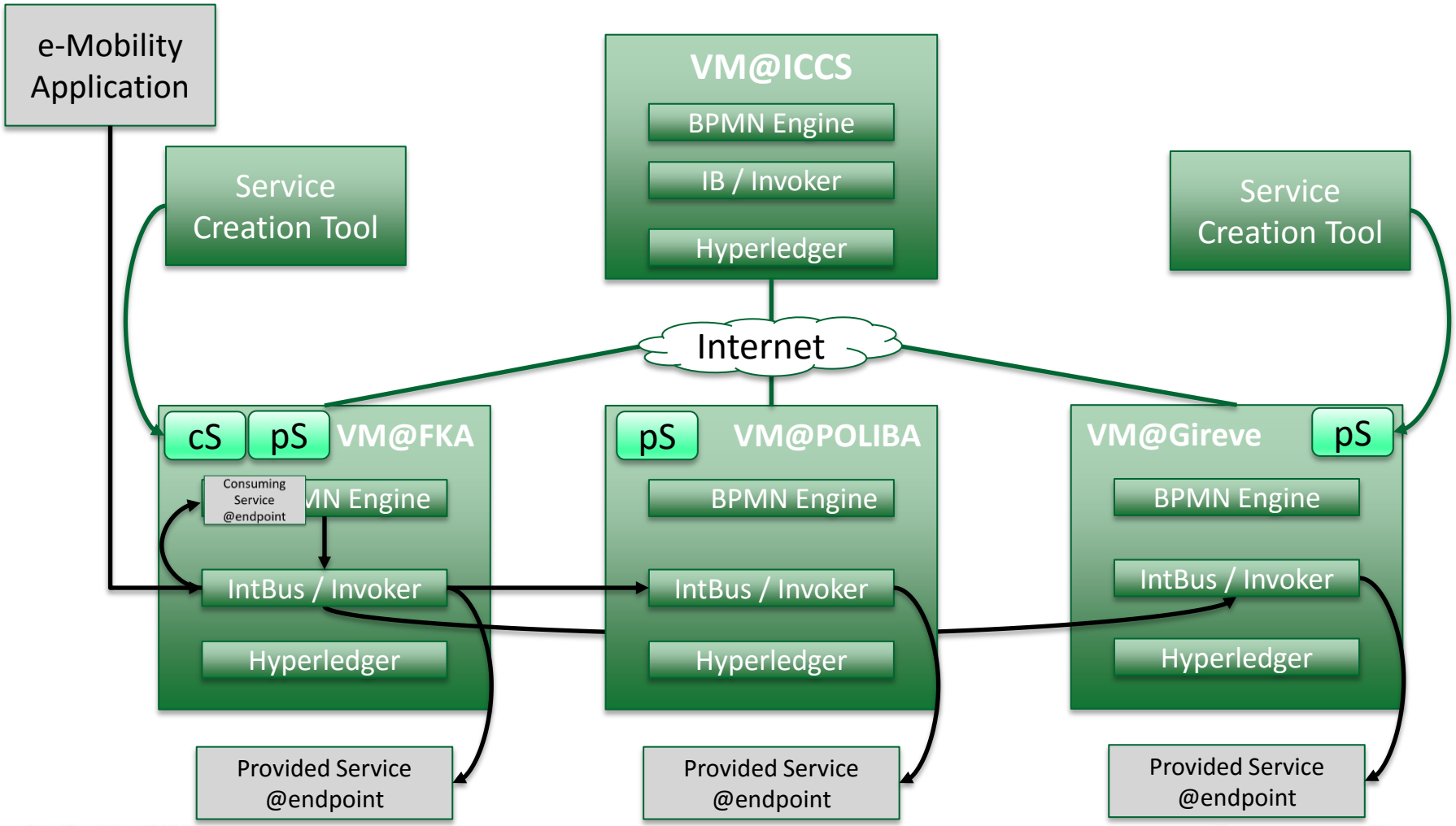


NeMo network view

- 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?

Stefano Persi

CEO of Mosaic Factor

2nd NeMo Stakeholder Forum Conference

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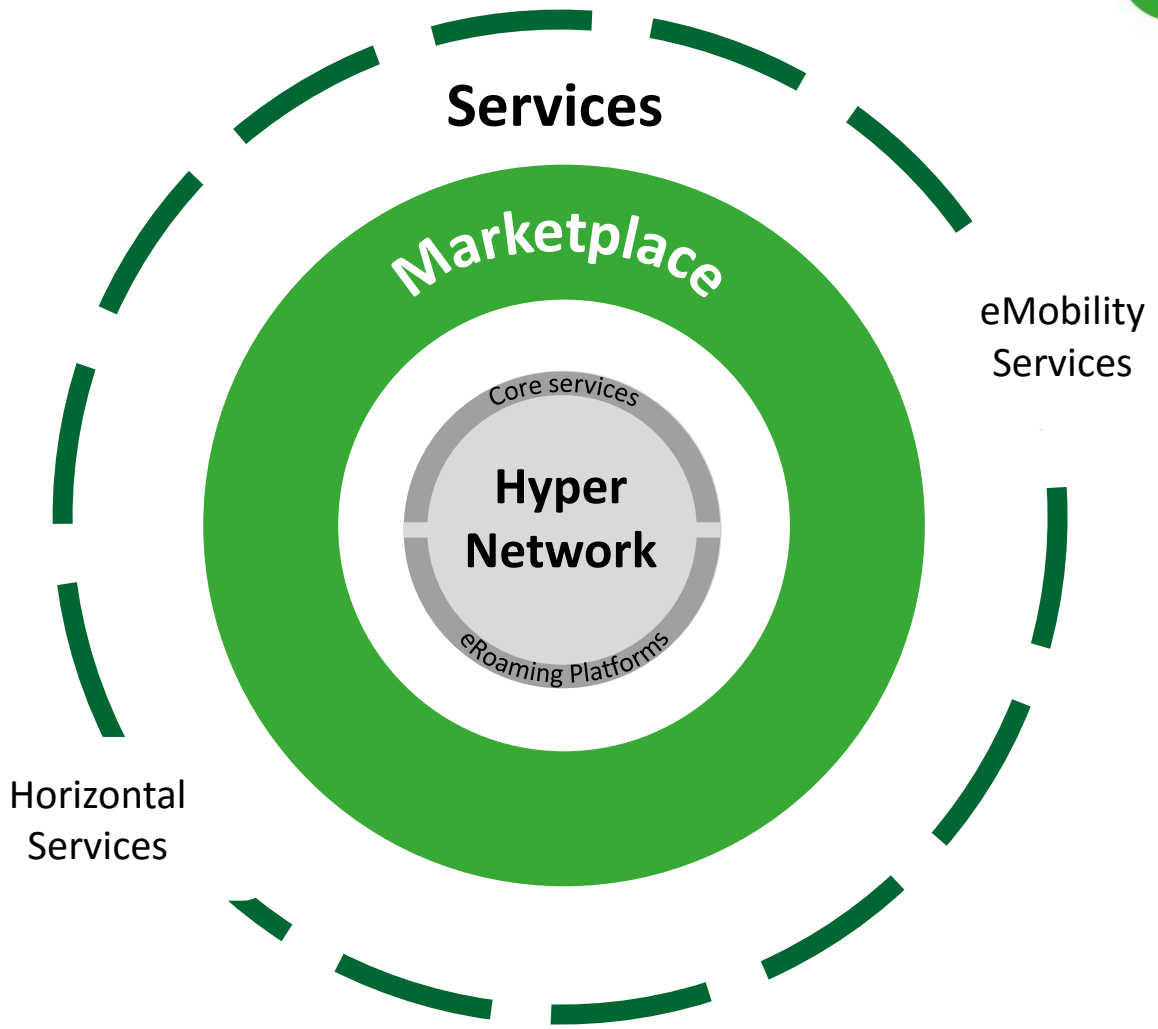
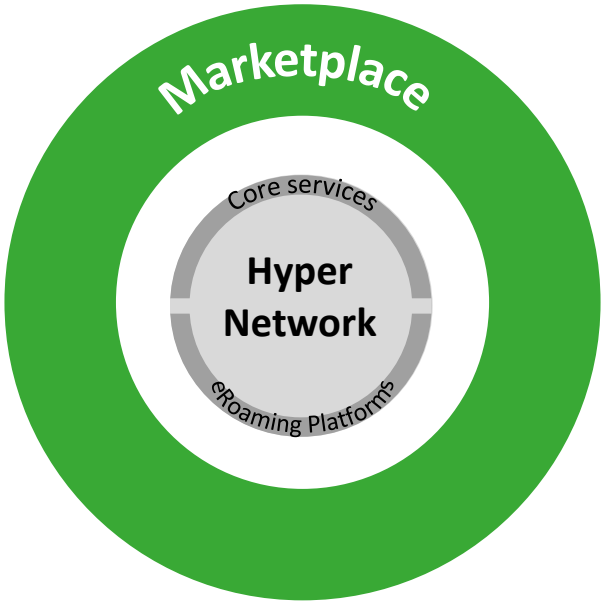
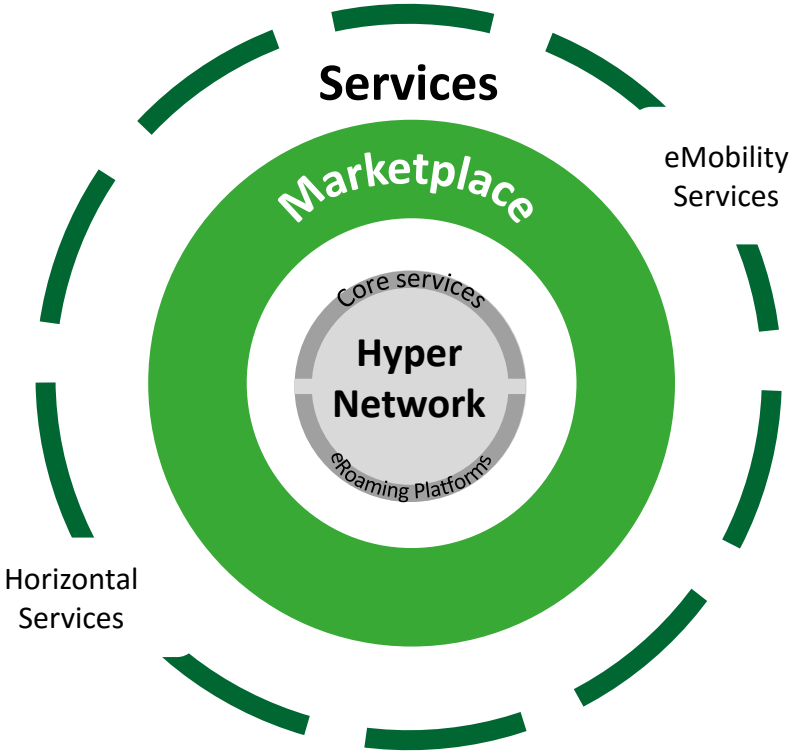
NeMo – Levels definition



Why develop services in NeMo?



Why services contribute?

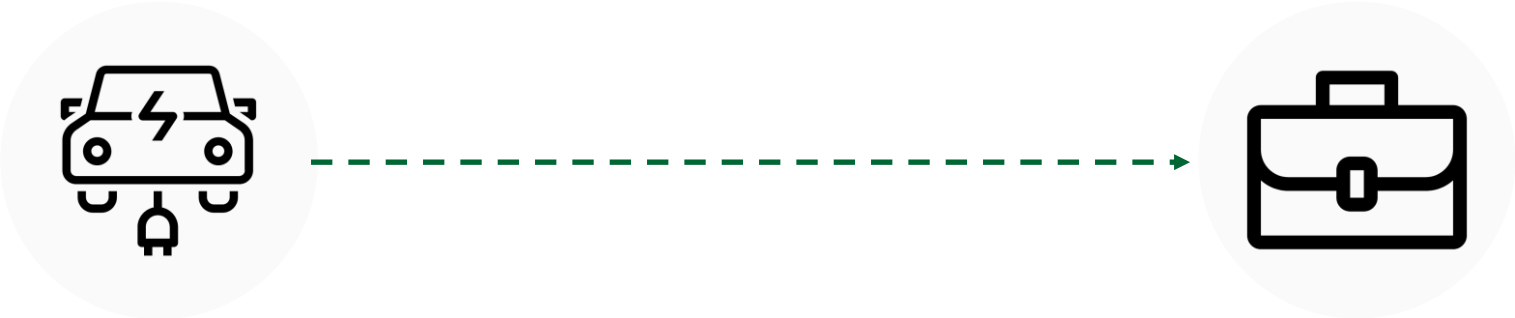


Services give added value to the NEMO Hyper-network


Featured
Top Charts
Categories
Purchased
Updates
Search
Categories
Business
Antivirus Zap - Virus & A...
App for Google Calendar...
Contacts Journal CRM
Developer Tools
SSH Tunnel
CodeRunner 3
MDB ACCDB Viewer
Education
Deluxe Moon Pro
Equation Solver
Vocab - Learn and Impro...
Entertainment
EPUB Viewer
GSE SMART IPTV PRO
Translator for Google Tra...
Finance
Money Pro: Personal Fin...
iCompta
MoneyWiz 2 - Personal F...
Games
The Sims™ 2: Super Coll...
Broken Sword - Shadow ...
Civilization® VI
Graphics & Design
Sweet Home 3D
Pixelmator Pro
Pixelmator
Health & Fitness
Pocket Yoga
iMuscle 2
Relax Melodies Premium
Lifestyle
Dress Assistant
WaitingList
Wallpapers HD
Medical
Human Anatomy Atlas 2...
Essential Anatomy 5
Muscle Premium - Huma...
Music
djay Pro 2
MP3 Encoder
Logic Pro X
News
Cleaner Doctor
ReadKit
Pulp
Photography
Affinity Photo
Duplicate Photos Fixer Pro
PhotoBulk: watermark in ...
Productivity
Magnet
Notability
PDF Expert - Edit and Si...
Reference
e-Sword X: Bible Study ...
Speak & Translate — Liv...
Wikibot — A Wikipedia A...
Social Networking
Direct Message for Insta...
Grids for Instagram
Social Pro for Facebook, ...
Sports
Basketball Manager 13
Basket 3D Viewer
DiveLogDT
Travel
GPX Viewer
World Explorer PREMIU...
GPX Editor
Utilities
RAR Extractor Star
Translator Tab - quickly t...
Keka
Video
Vidsify
Elmedia:universal video ...
Final Cut Pro
Weather
Weather Widget UK +
Clear Day® - Weather HD
Weather
Quick Links
Sign In
Account
Redeem
Support

Services use cases

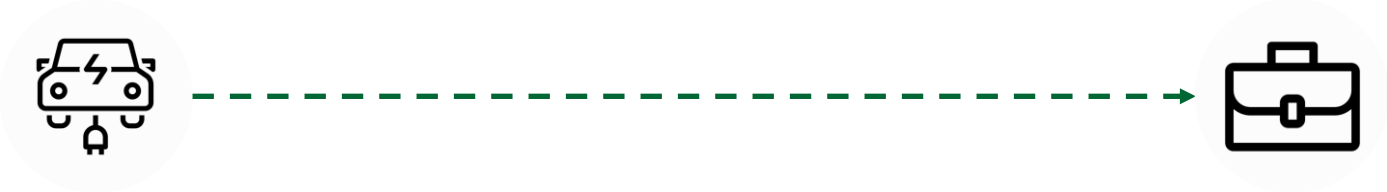
Daily commute



Long distance trip

Services use cases

Daily commute



Go to work → Check battery SOC → Check CP availability → 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

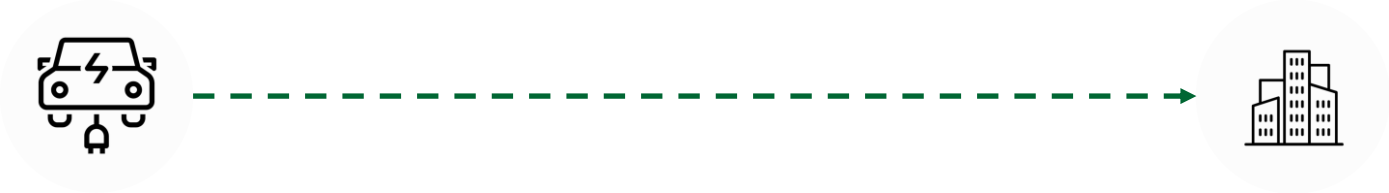
- Mobility patterns
- User interests
- Generate valuable personal and non-personal information

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

Rating/pricing services

Long distance trip

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

CP Booking

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?

Stefano Persi

CEO of Mosaic Factor

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Example of a Hyper-Network service:

Virtual Sensors for Innovative electro-mobility services

Dr. Michele Roccotelli

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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**

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- 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

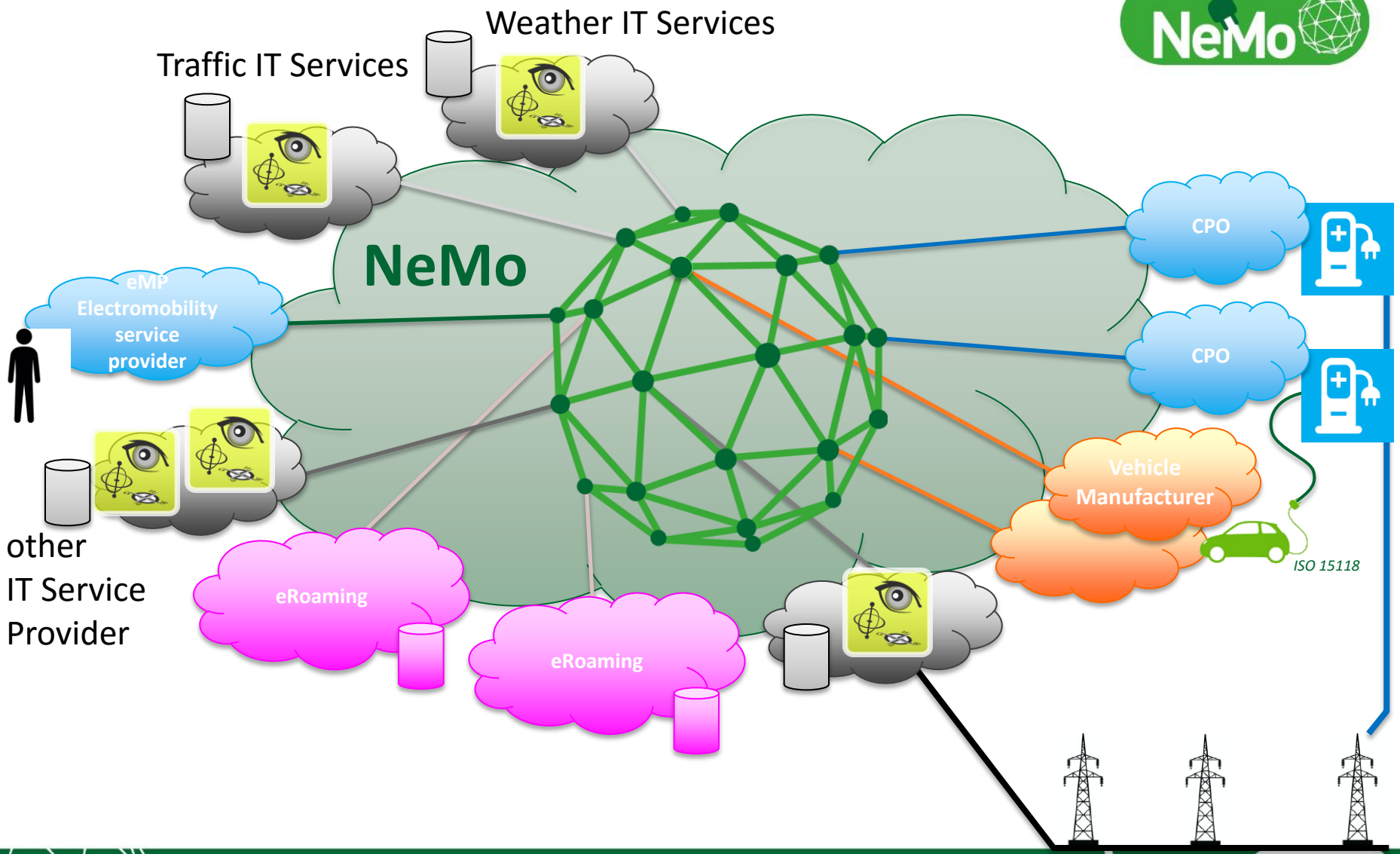
- VSs are used in different fields of research such as **energy, healthcare, mobility**, etc., to **estimate or predict information/parameters values** from the distributed instrumentation measurements

Why Virtual Sensors?

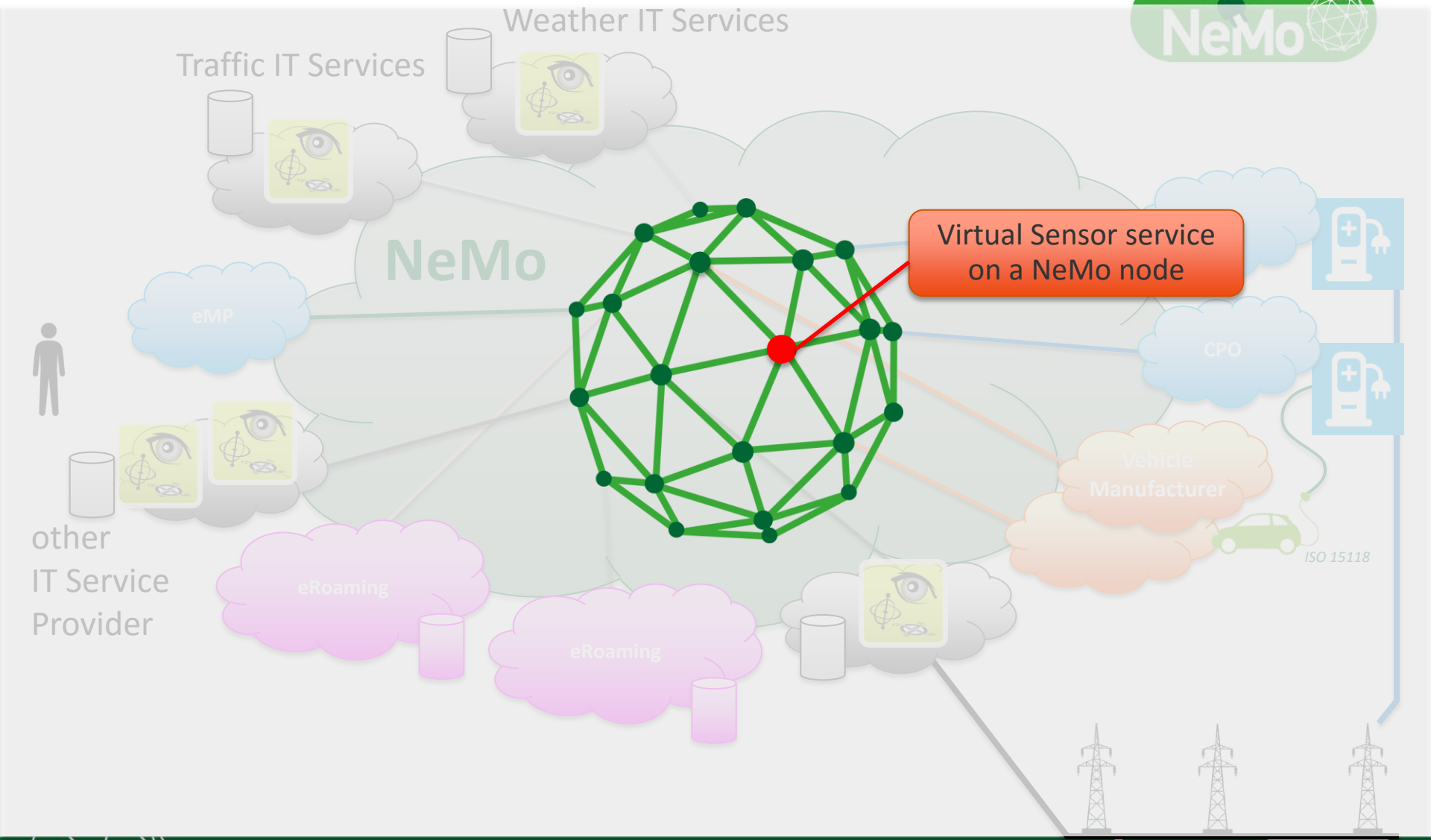
In the electro-mobility framework…**Innovative services** for **EV users** and **stakeholders**

- **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

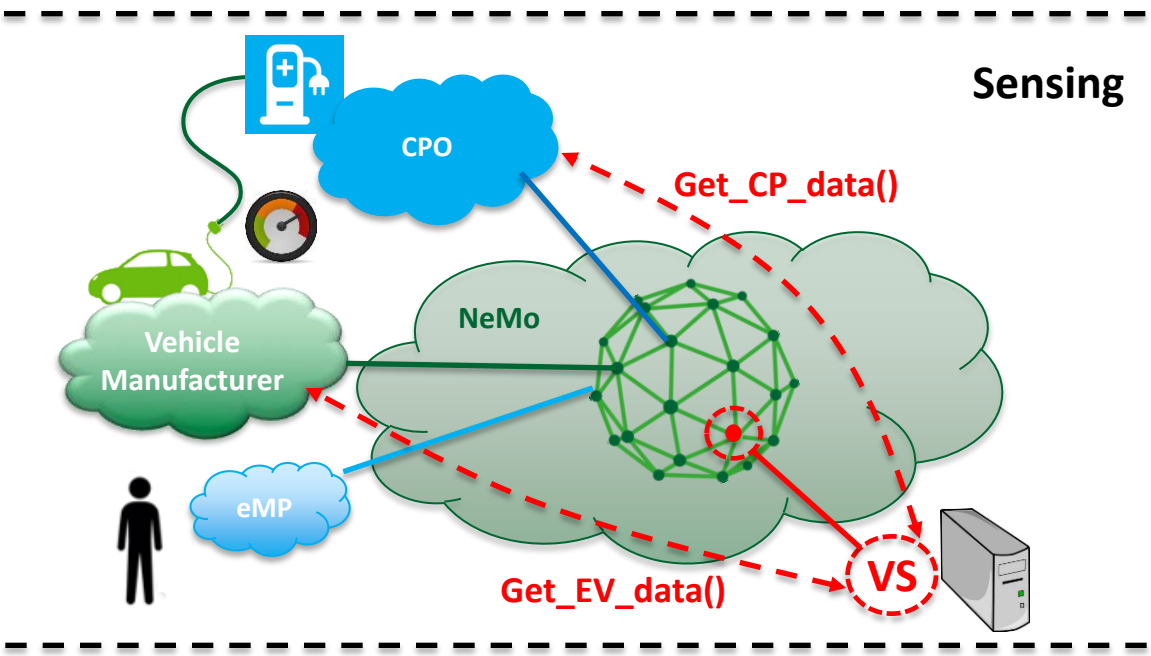
NeMo hyper-network



A VS in the NeMo hyper-network

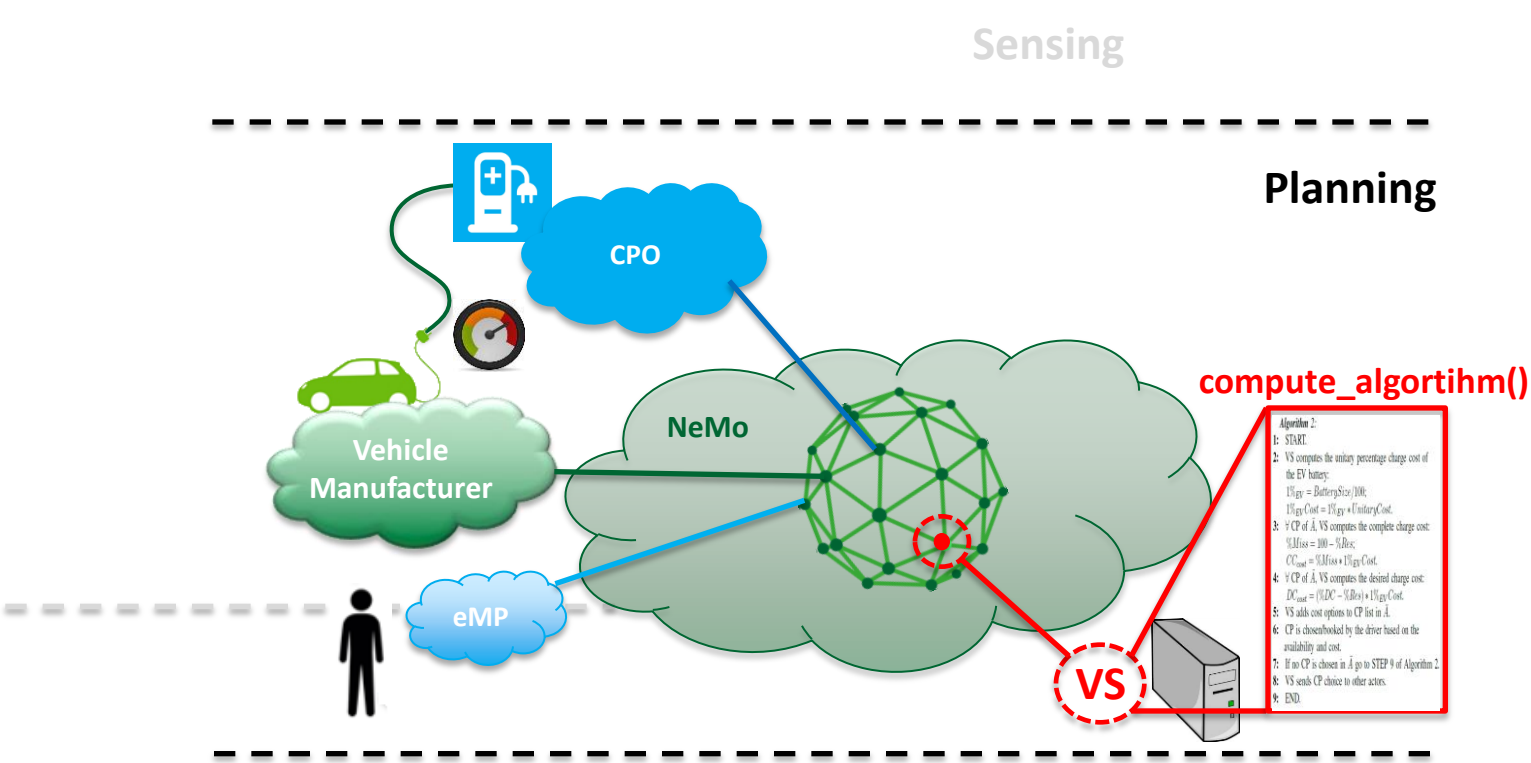


VSs implementation methodology



1° Sensing phase:
gathering data from data providers and data sources (wired and wireless sensors);

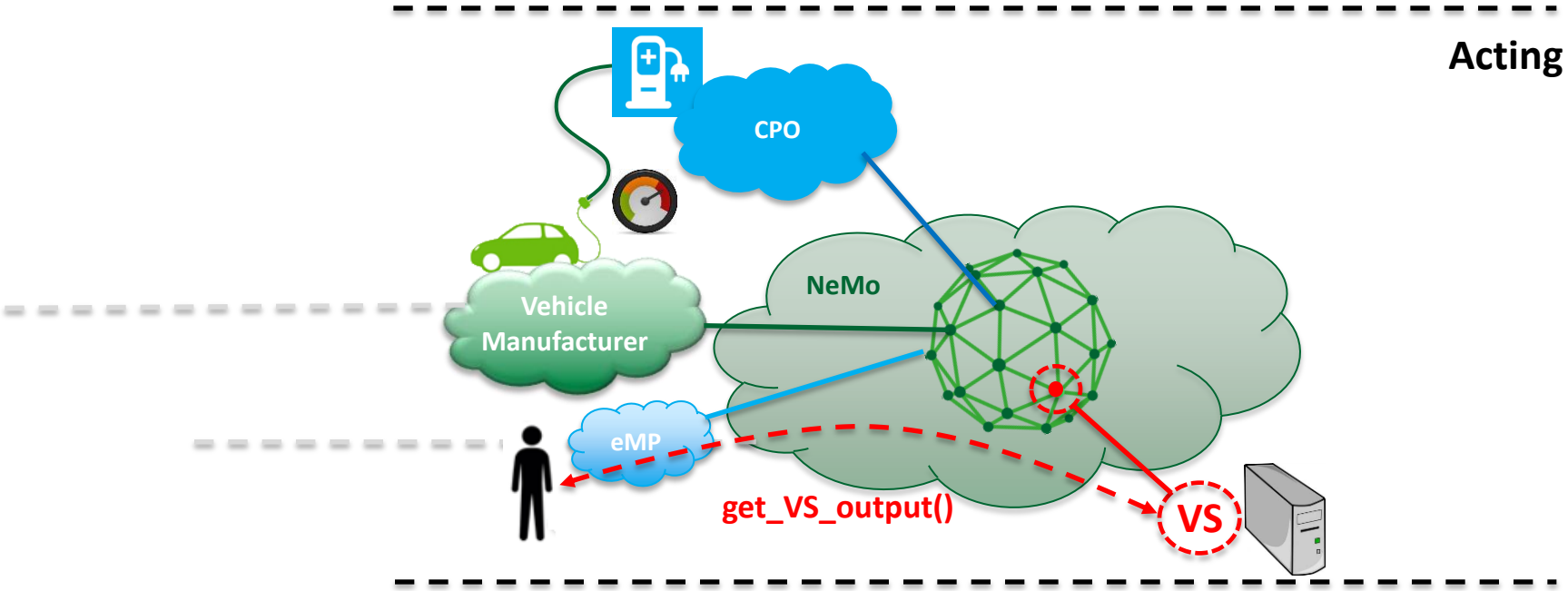
VSs implementation methodology



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.

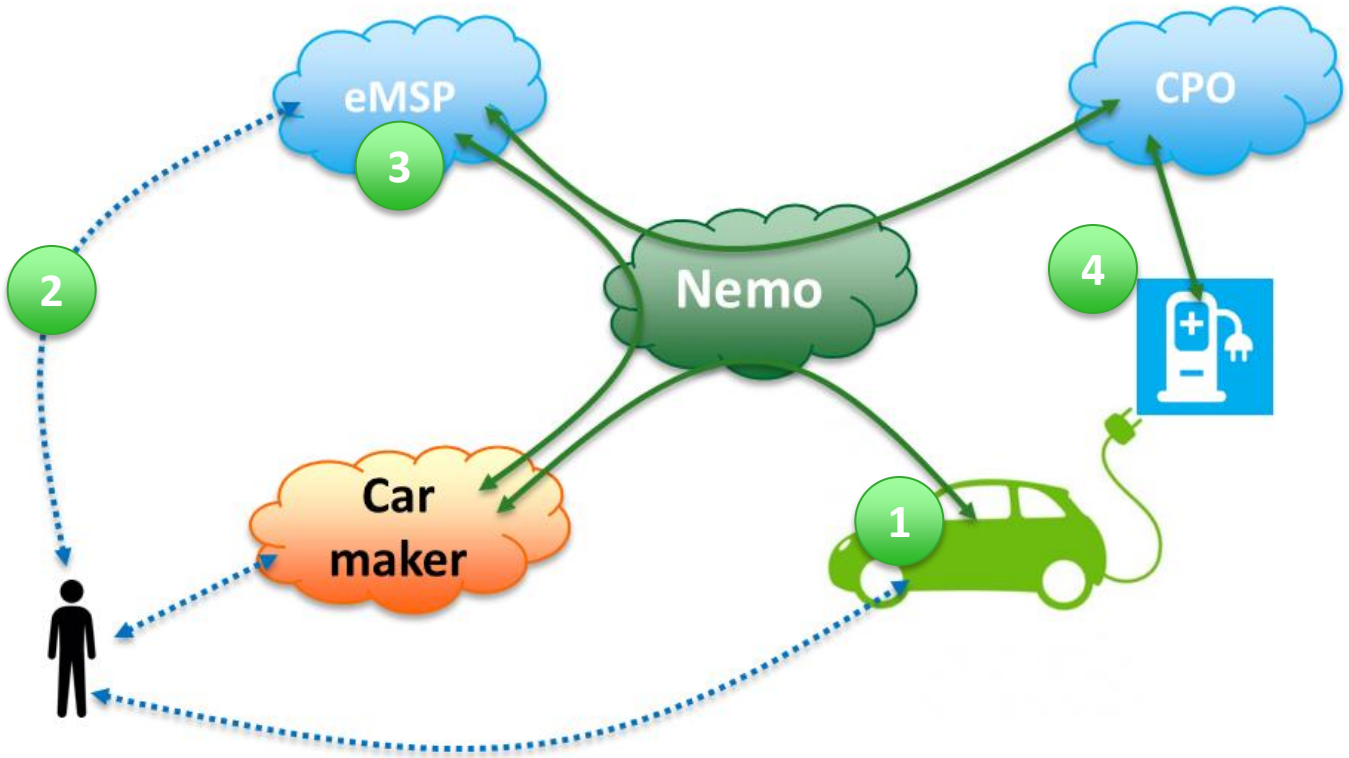
VSs implementation methodology

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 VSs for electromobility

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



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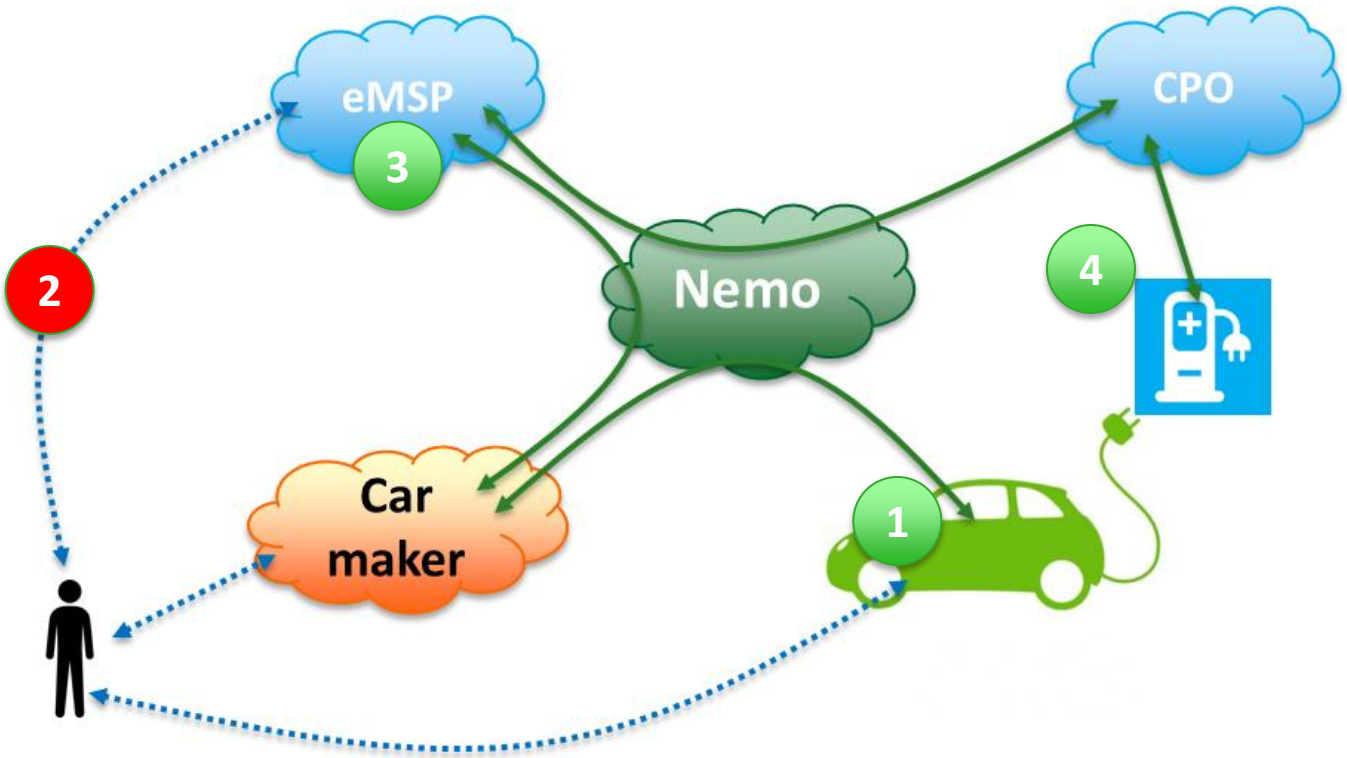


Personal Mobility Probability

- **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).**

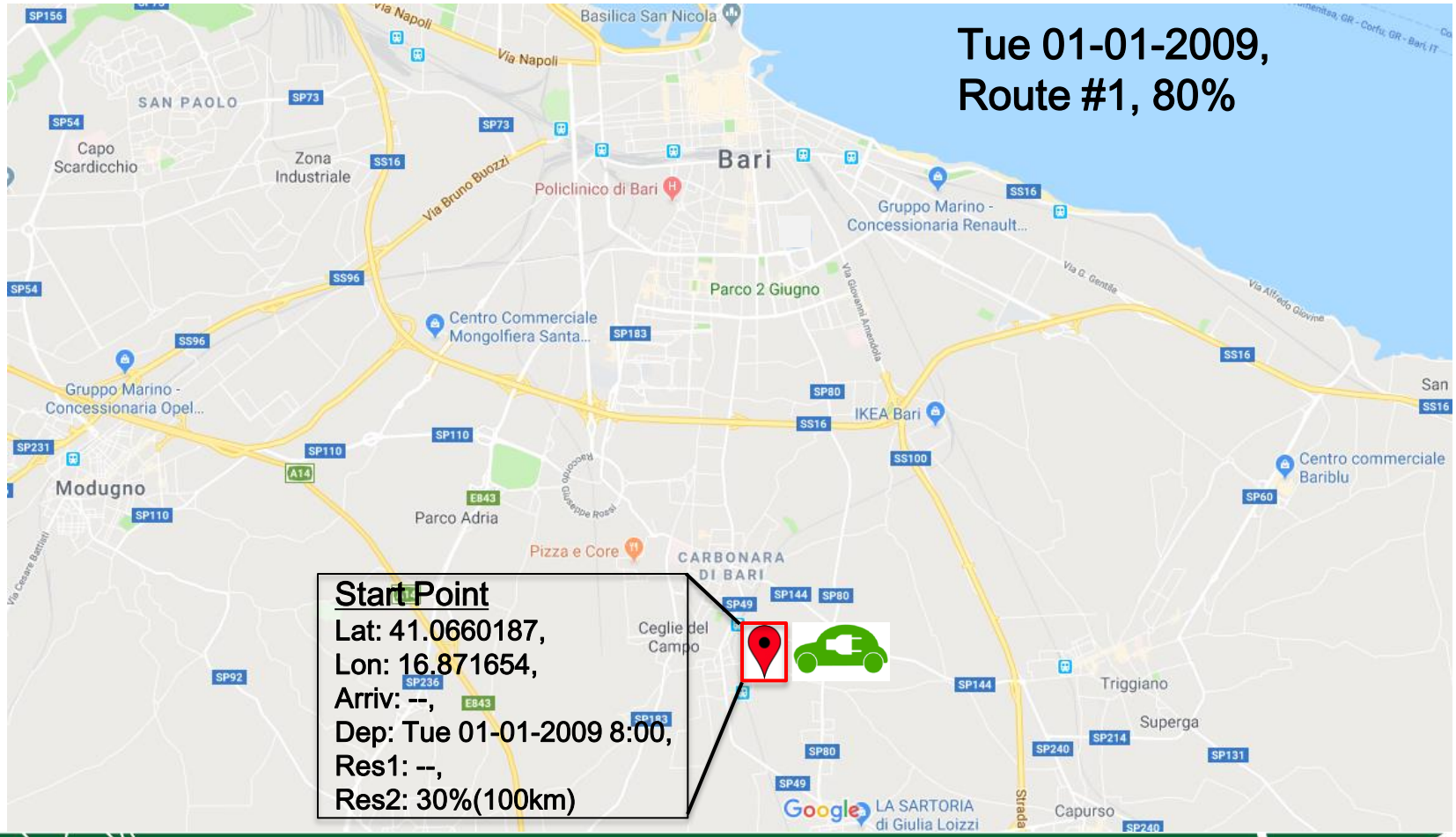
The POI are the following:

- 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*).

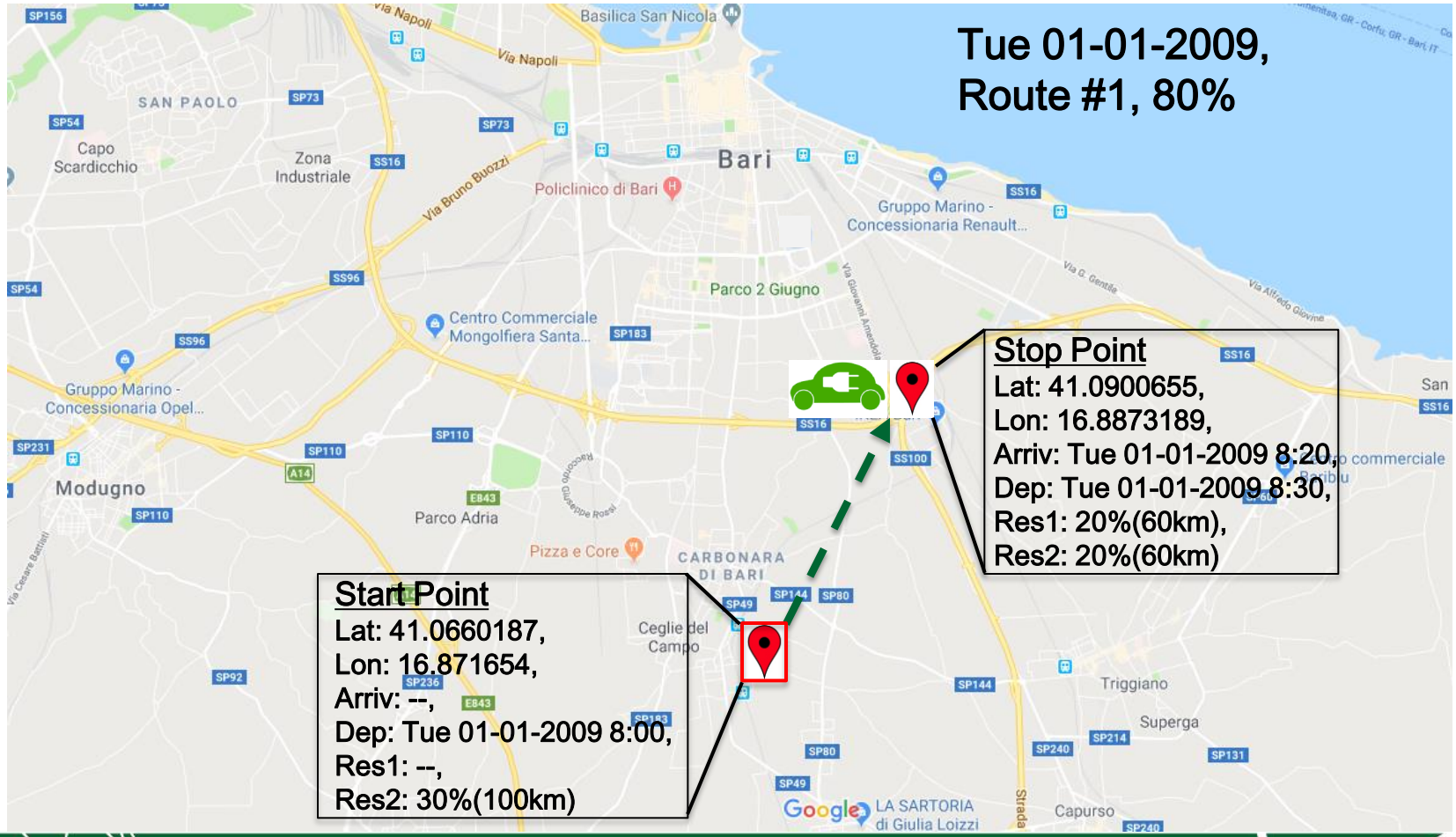
Personal Mobility Probability

Output example (1/2)



Personal Mobility Probability

Output example (1/2)



Personal Mobility Probability

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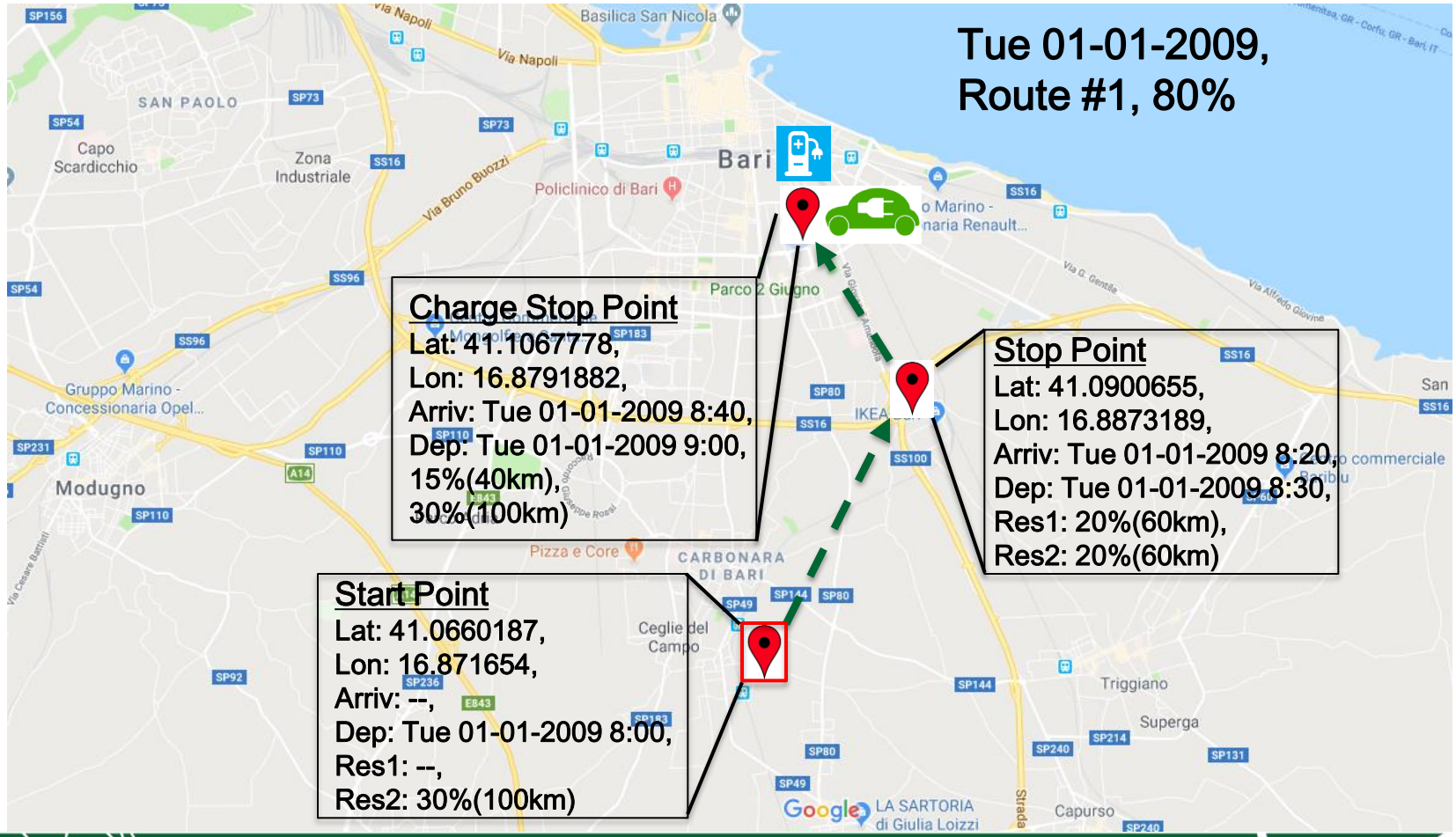
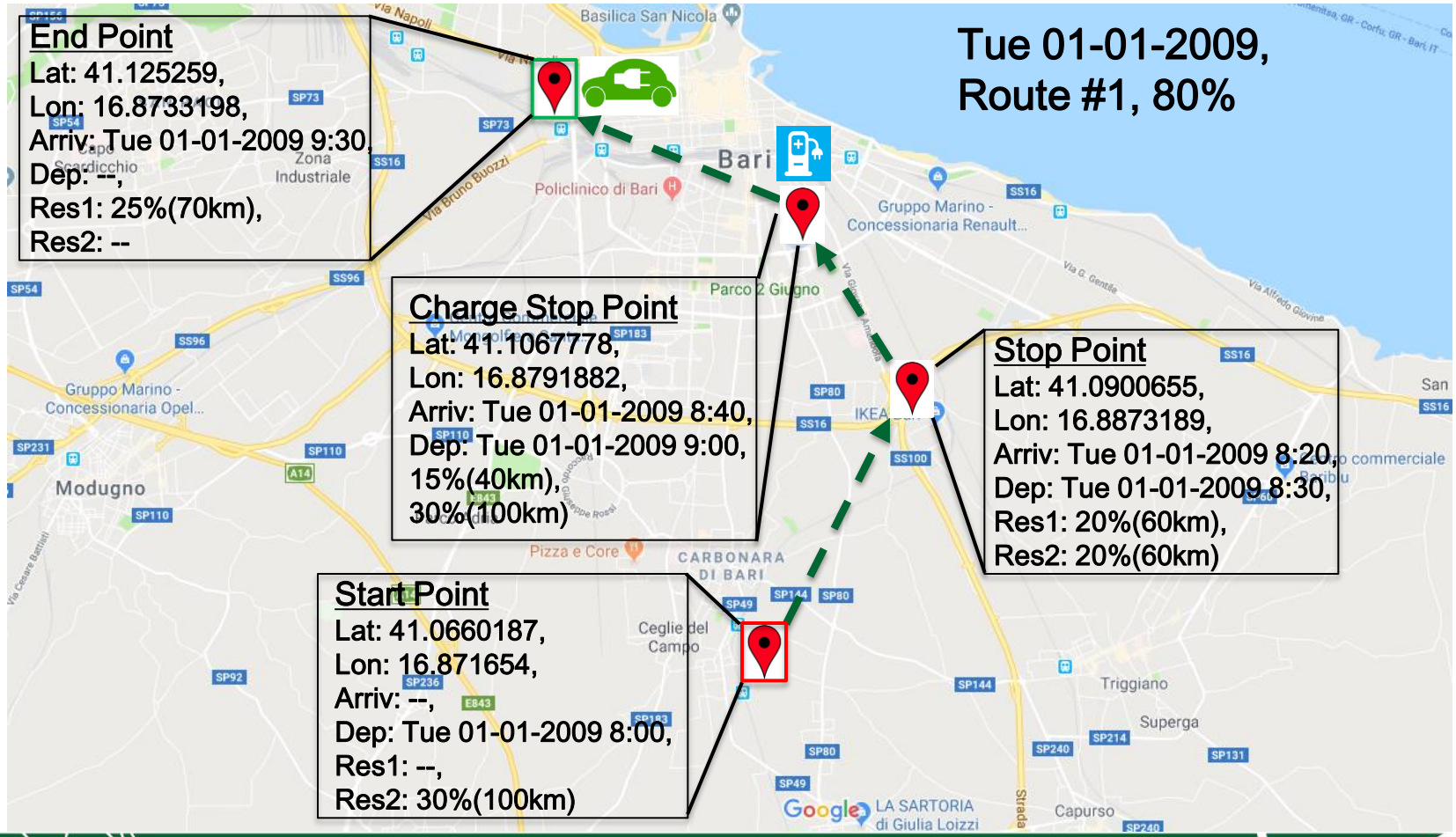


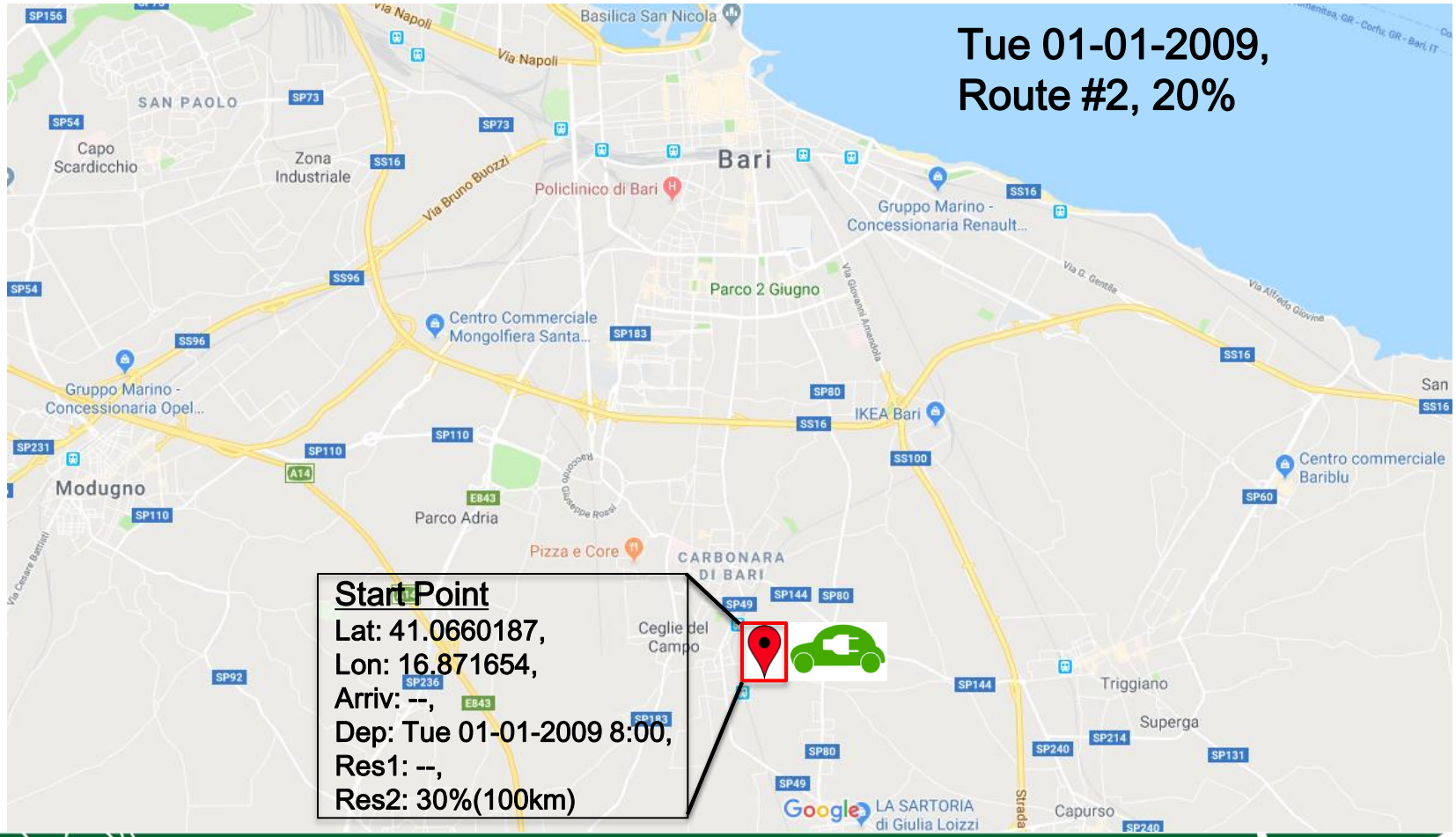
Personal Mobility Probability

Output example (1/2)



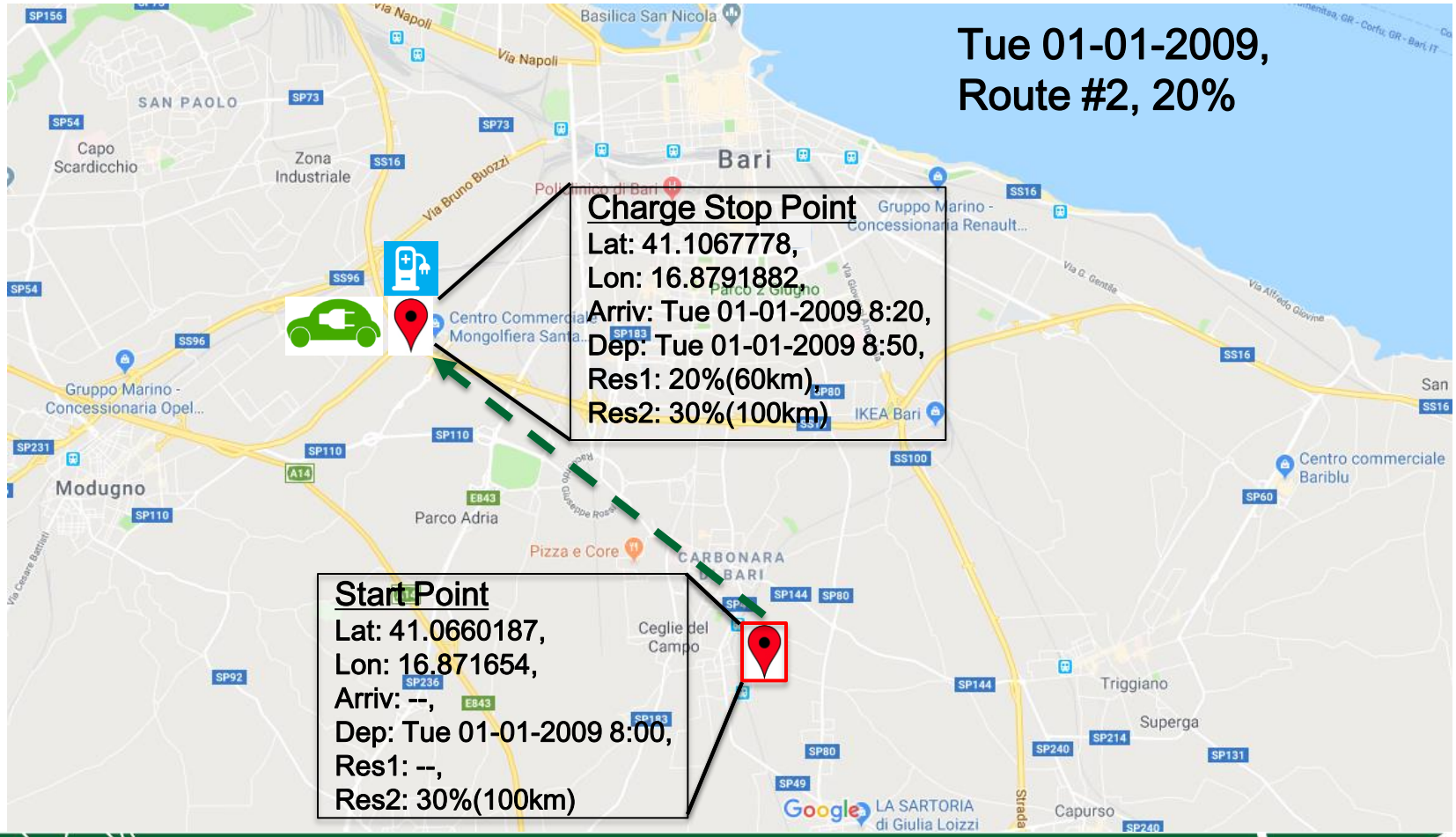
Personal Mobility Probability

Output example (2/2)



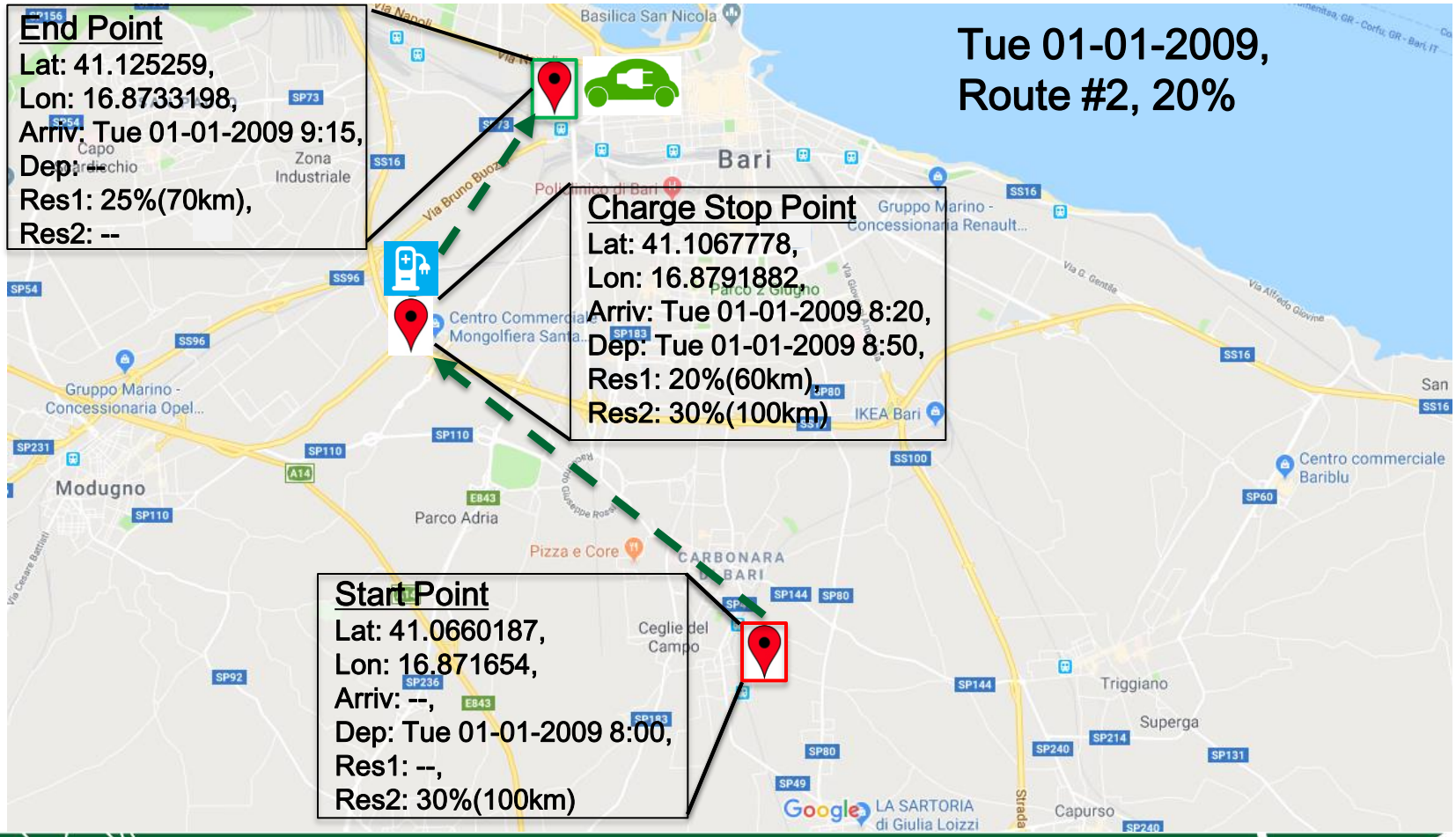
Personal Mobility Probability

Output example (2/2)



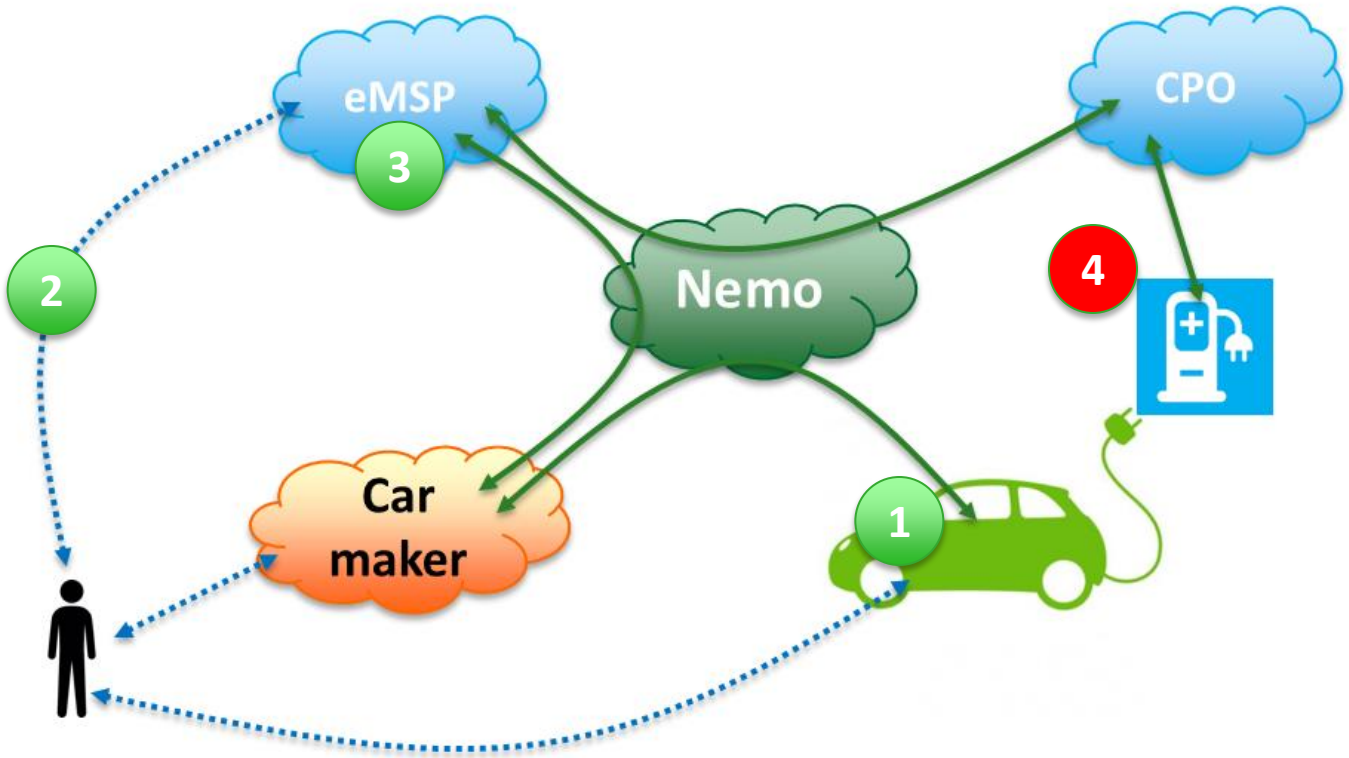
Personal Mobility Probability

Output example (2/2)



Examples of VSs for electromobility

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

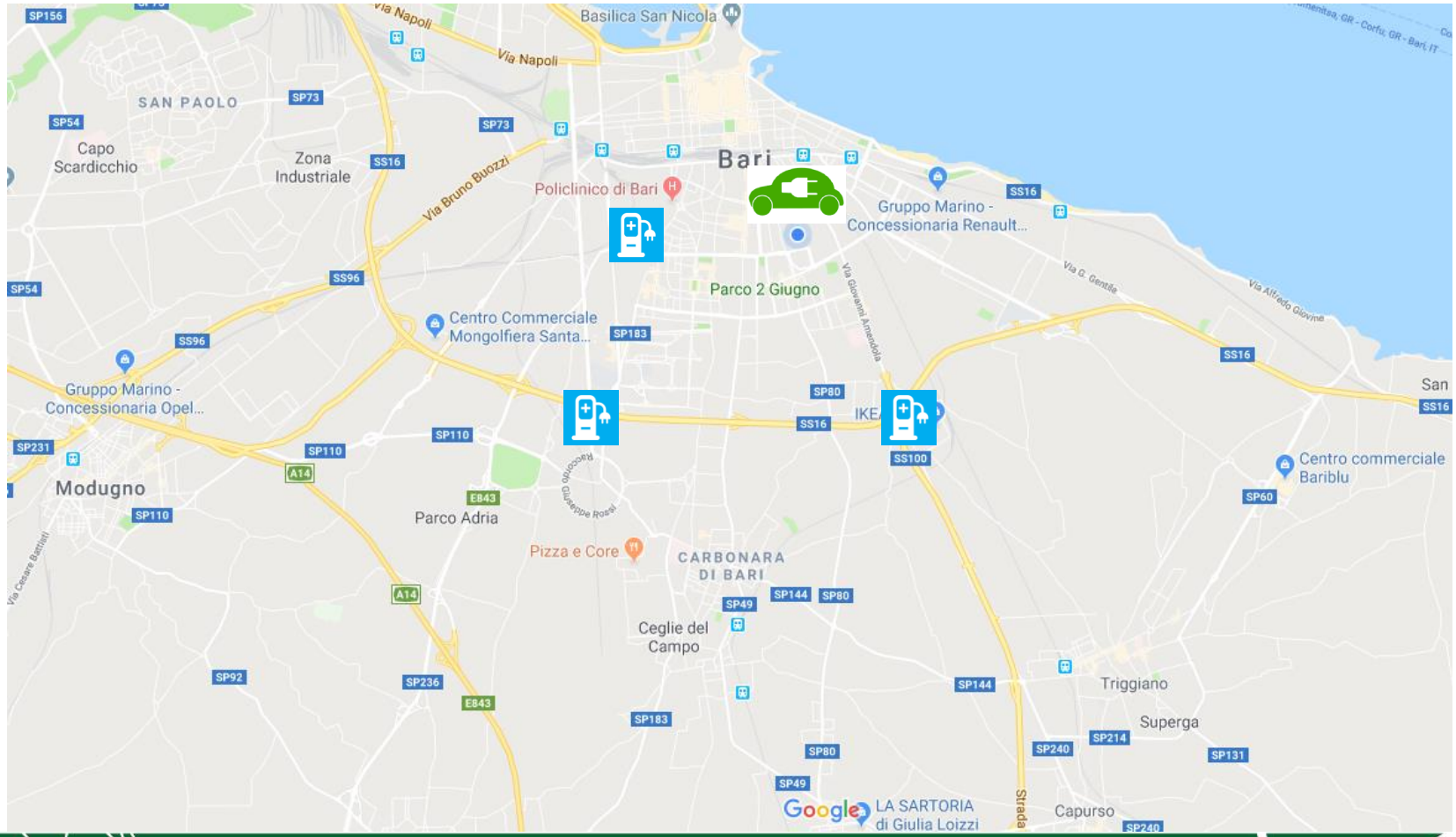


Charge Price Prediction

- **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

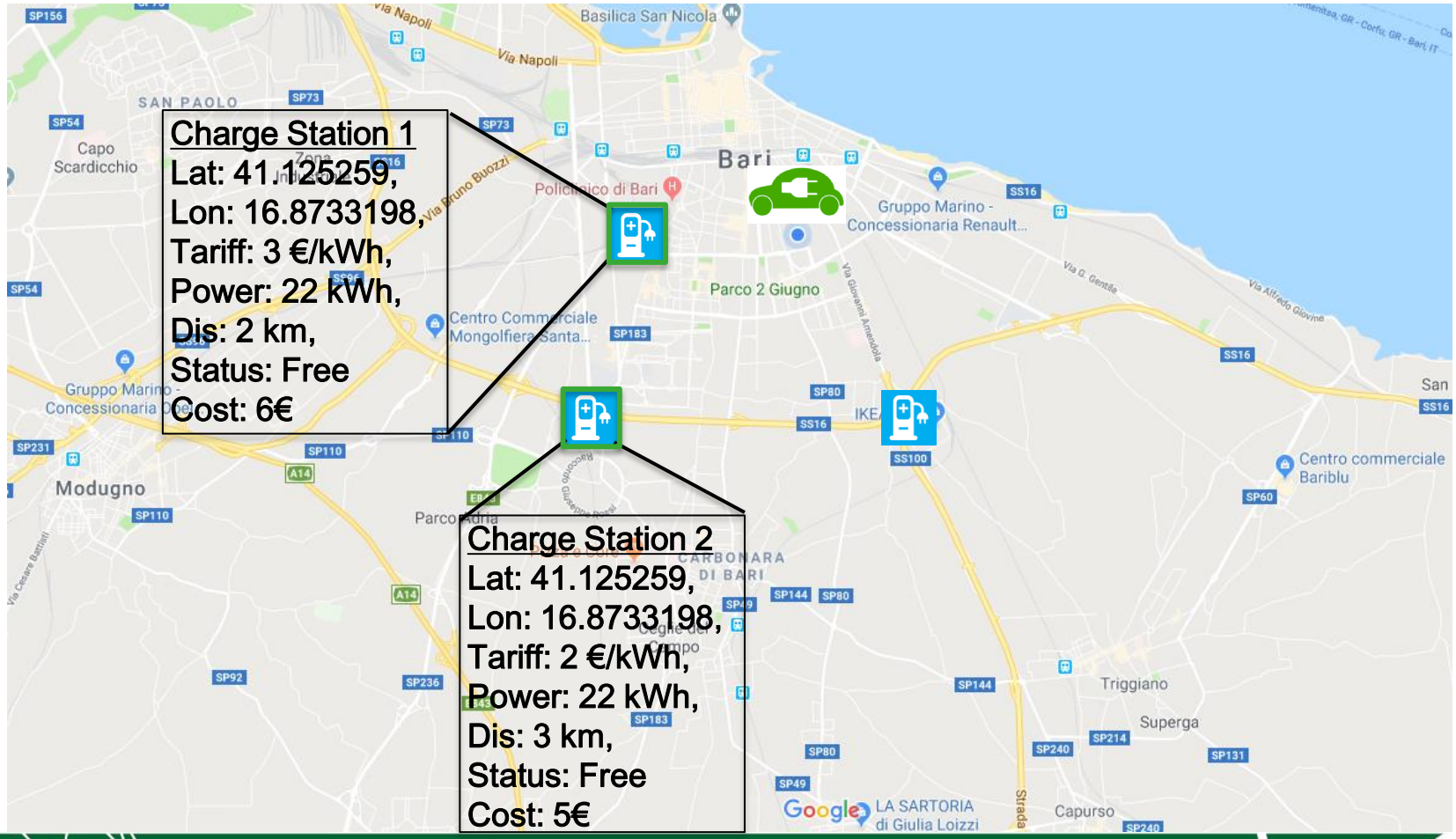


Charge Price Prediction

Output example

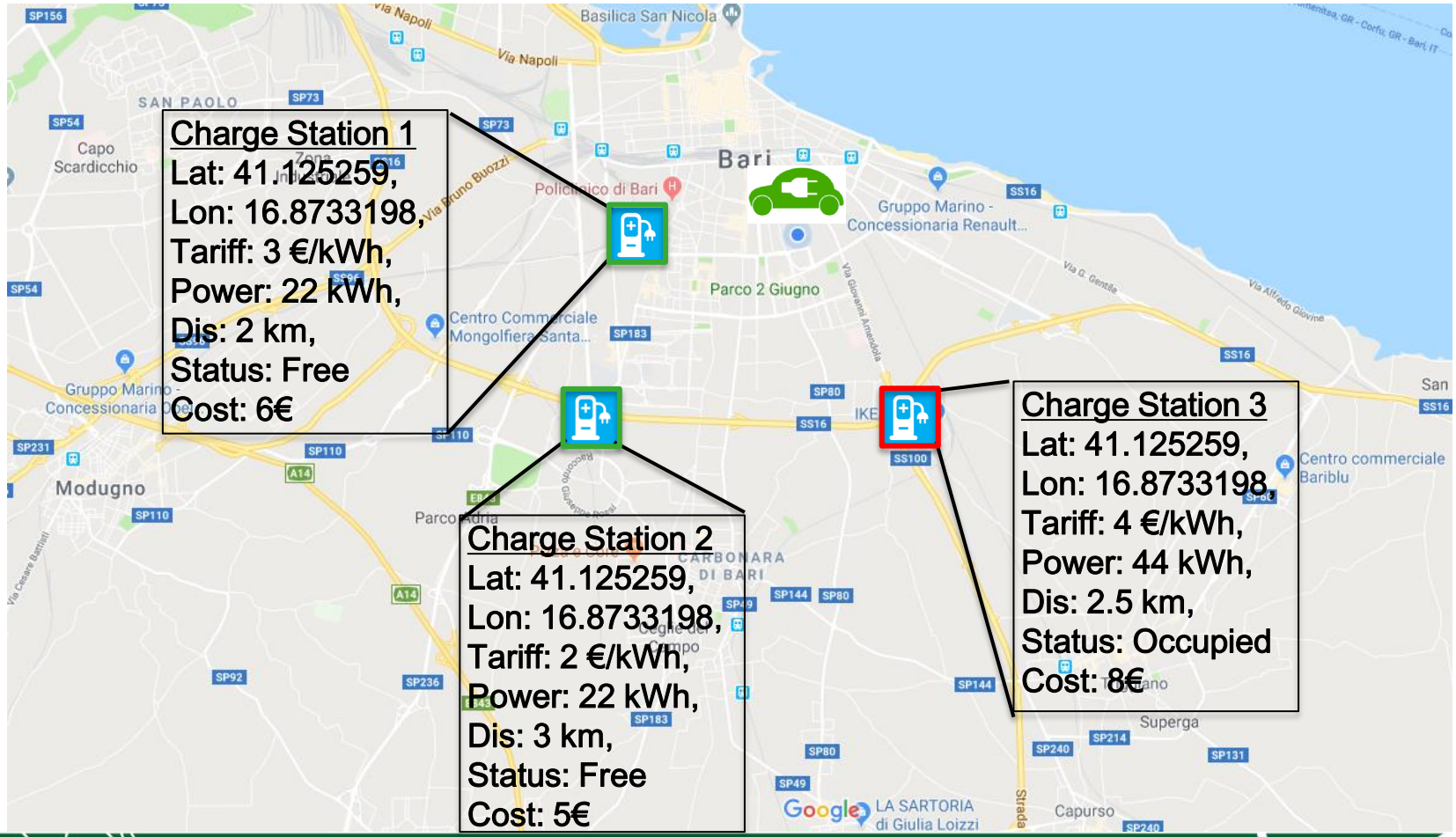
Charge Price Prediction

Output example



Charge Price Prediction

Output example



Thank you!

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Using the Hyper-Network: Creation of a service

Elif Eryilmaz
DAI-Labor, Technical University of Berlin

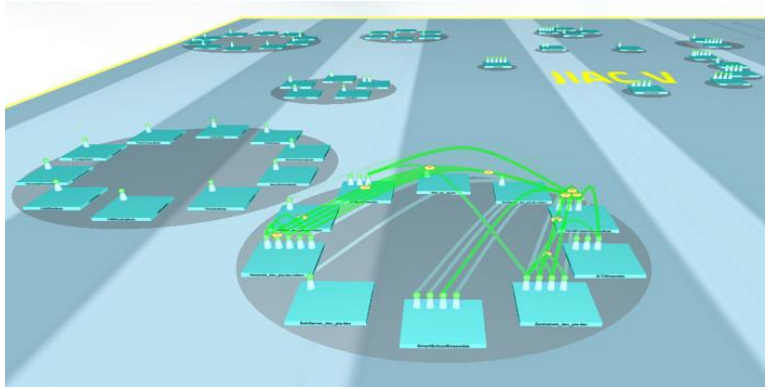
2nd NeMo Stakeholder Forum Conference

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

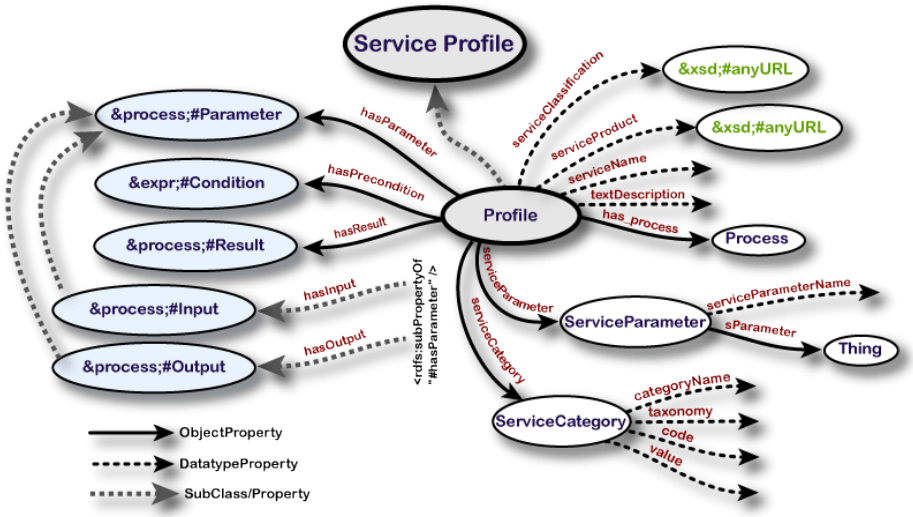
Motivation



- 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.**
- <u>However</u>:
  - 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

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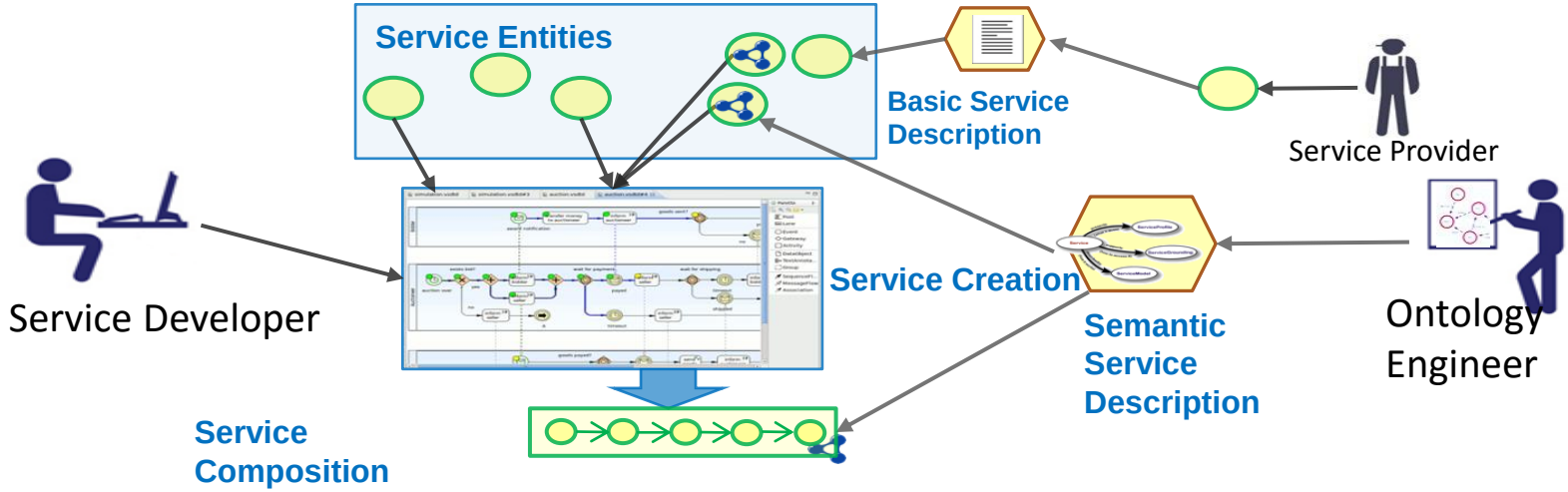
NeMo Service Development



- 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

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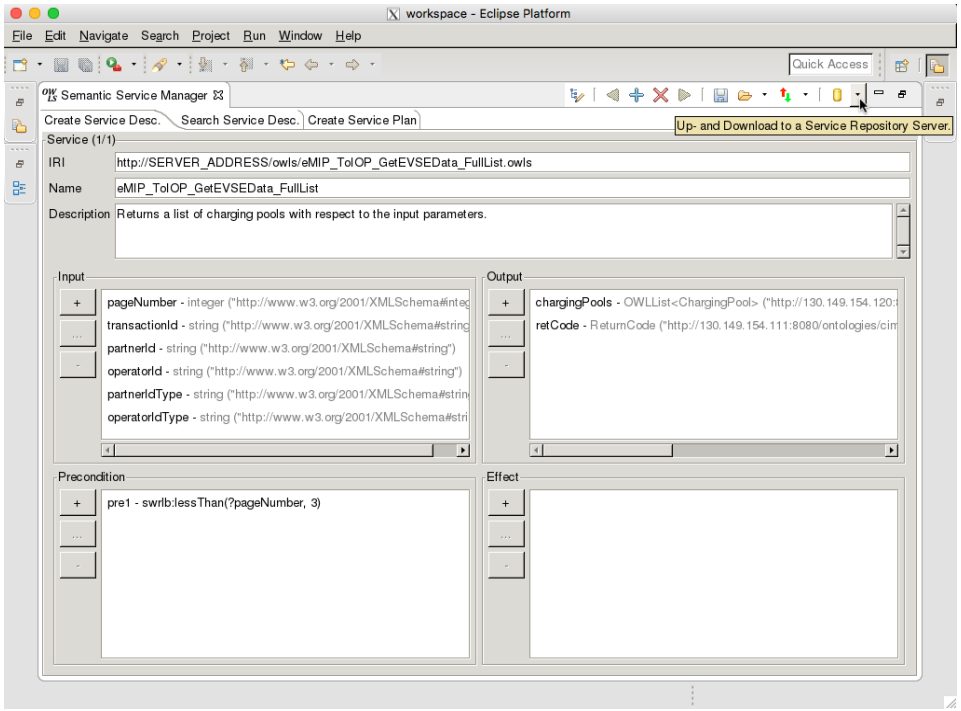
Service Description & Search

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

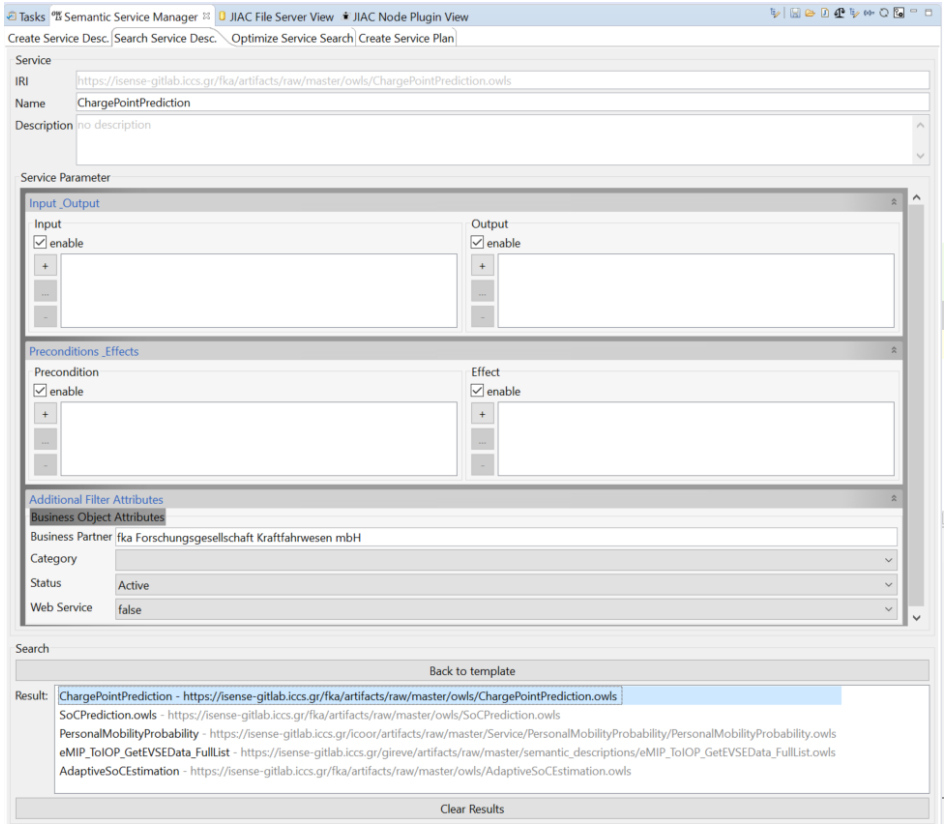


Service Description & Search

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



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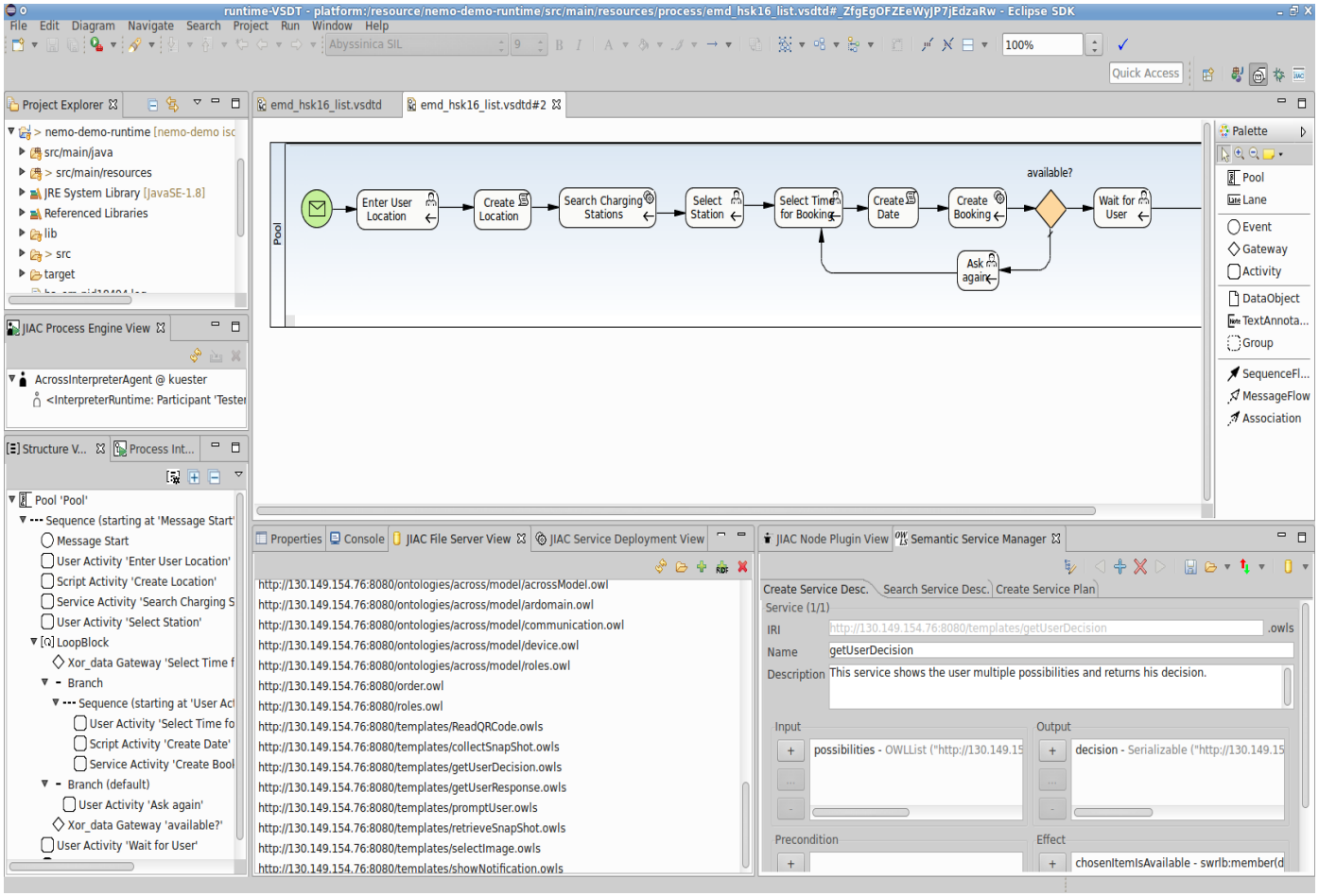
Service Process Development with VSDT



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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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