HiPEAC 2020 Conference
22 January 2020 - Bologna

Horizon 2020
European Union funding
for Research & Innovation

CERBERO

(Cross-layer modEl-based fRamework for multi-oBjective dEsign of Reconfigurable systems in unceRtain hybRid envirOnments)

SMART TRAVELLING USE CASE

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CRF: Antonella Toffetti, Giovanni Turi, Francesco Palma, Daniela Bertolino, Andrea Ghiro, Paolo Denti, Enrica Valente, Alessandro Petrera
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http://www.cerbero-h2020.eu/

CERBERO Goals

Main project goals of having the CERBERO Smart Travelling use for Electric Vehicles case are:

- **Validate CERBERO methodology** for development of multi-objective adaptive CPS
- **Improve toolset of CERBERO tool-chain** for development of multi-objective adaptive CPS
- **Validate developed KPI based adaptation loop** on **system** and **system-of-system levels**
- **Validate benefits for involved companies**

CRF (Research Center of FCA) **Goals**

Extend the **SCANeR™** based high end immersive driving simulator of CRF for Electric Vehicle simulation with:

- **New features for EV**, based on real user needs
- **Use realistic battery and motor models** and **user interface** in the simulator
- **Flexible framework** for support of new functionalities and scenarios
- **Use real maps of Turin** and surroundings for test scenarios

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Use case development

Steps in the development of the use case:

- **Collect user needs** via EV focus group sessions (held in 2017 in IT and NL)
- Build **driving scenarios** with situations requiring adaptation (initiated by internal, human and external triggers)
- **Extend relevant tools form the CERBERO tool set** to support the use case
- **Integrate the CERBERO tools** in the CRF driving simulator

Skeleton of CERBERO tools for Smart Travelling use case

Electric Motor model (TNO)

Battery model (TNO)

Vehicle model (TNO)

Model Simulator – DynAA (TNO)

Charging Infra model

Route calculation (S&T)

Knowledge Base (S&T)

Human Model (S&T)

SCANeR simulator

Driver Support – MECA (S&T)

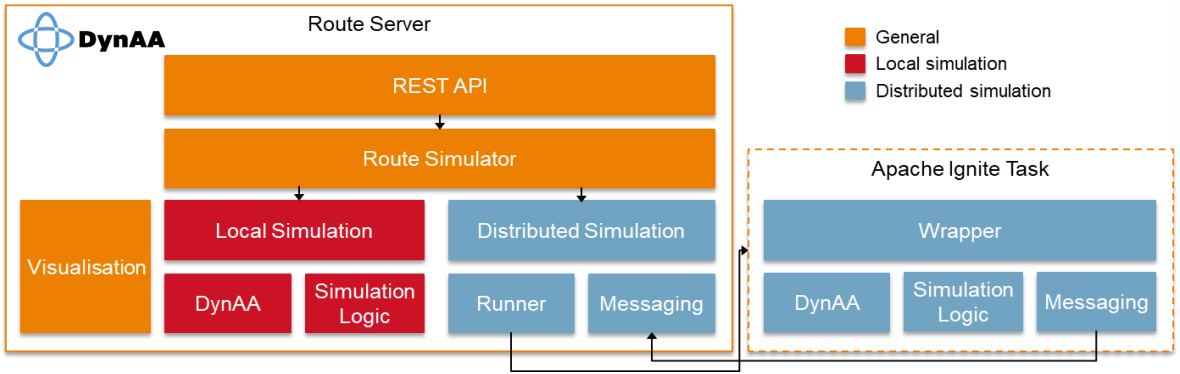
HMI (Abinsula)

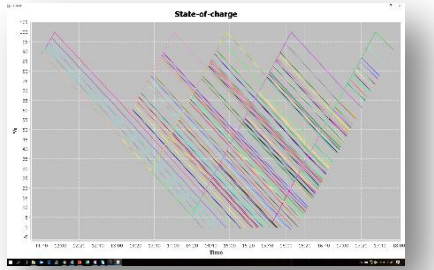
MECA (S&T – Mission Execution Crew Assistant) additions:

- Extended with **driver support functionalities** and **KPI handling**, like route calculation, charging pole planning and vehicle monitoring
- **Support of developed scenarios** (handling of internal and external triggers, use of Turin map)
- Integration with **DynAA** for **predictions**
- Integration with **HMI** to **provide advice**

DynAA (TNO – model simulation tool) additions:

- **System in the loop simulations** (SCANeR – TNO battery & motor models)
- **Integrate Battery and Motor models** of TNO in SCANeR simulator
- **Itinerary predictions** (using vehicle, battery and motor models)
- **Parallel simulation execution** (using Apache Ignite)



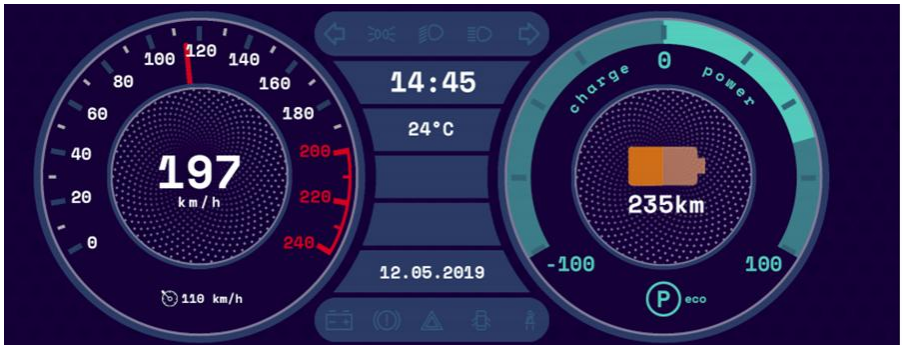


DynAA

TNO

HMI development and integration (for realistic driver interaction):

- **Dynamic info electric vehicle** (speed, voltage, state of charge)
- **Driver interaction on itineraries** (advice and itinerary selection)
- **Support of scenarios** (maps, Points Of Interest)



CRF driving simulator:

- **Platform overhaul** (e.g. motion platform, force feedback, projectors, etc)
- **Inclusion of drowsiness sensors**
- **Integration of CERBERO tools** (MECA and DynAA)
- **Integration of battery and motor models**
- **Configuration of Turin map to support scenarios** (synchronized with MECA and HMI)
- **Integration of HMI screens**

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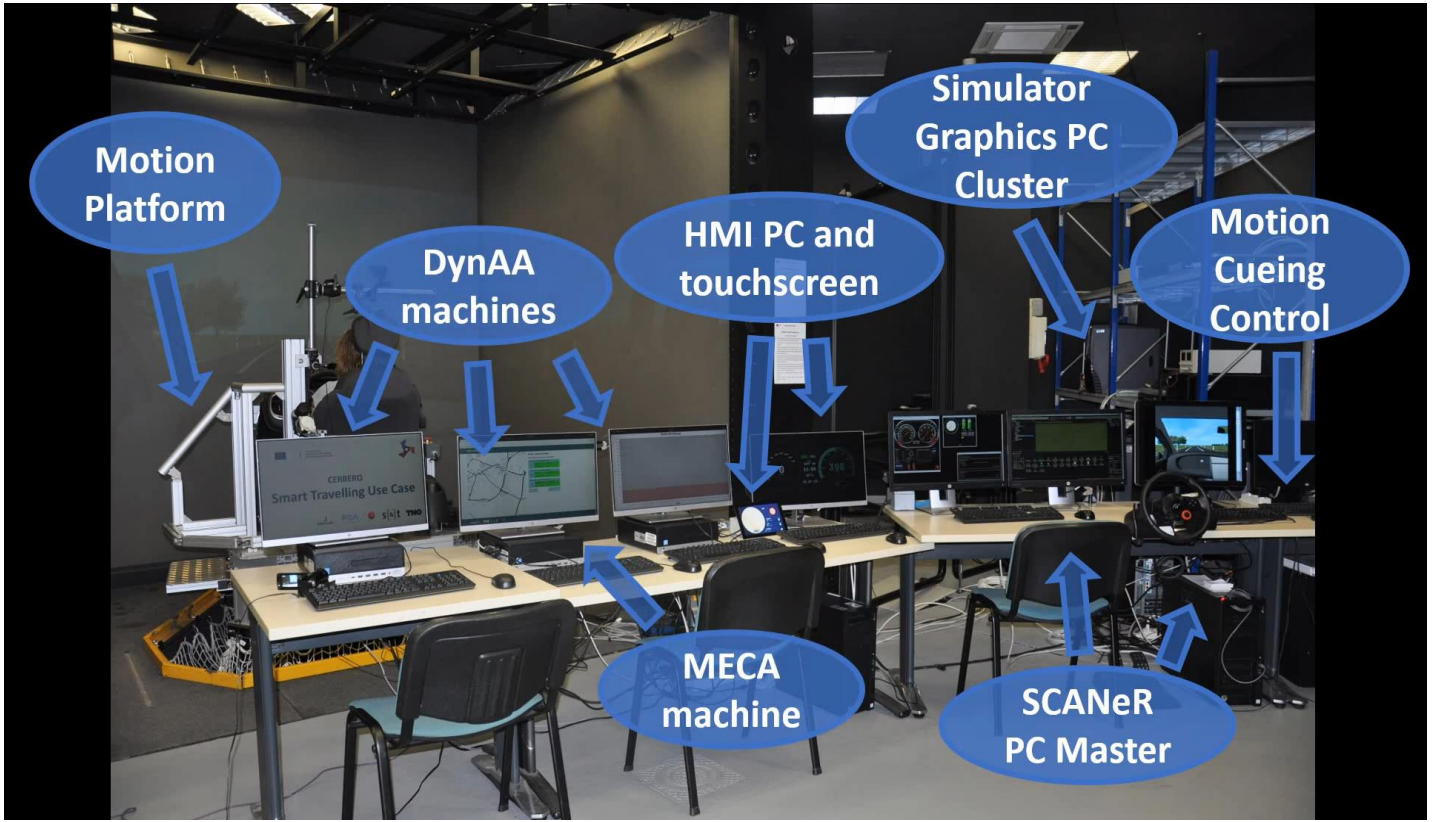
M36 DEMONSTRATOR

VIDEO

Backup slides

M36 Demonstrator setup



TNO

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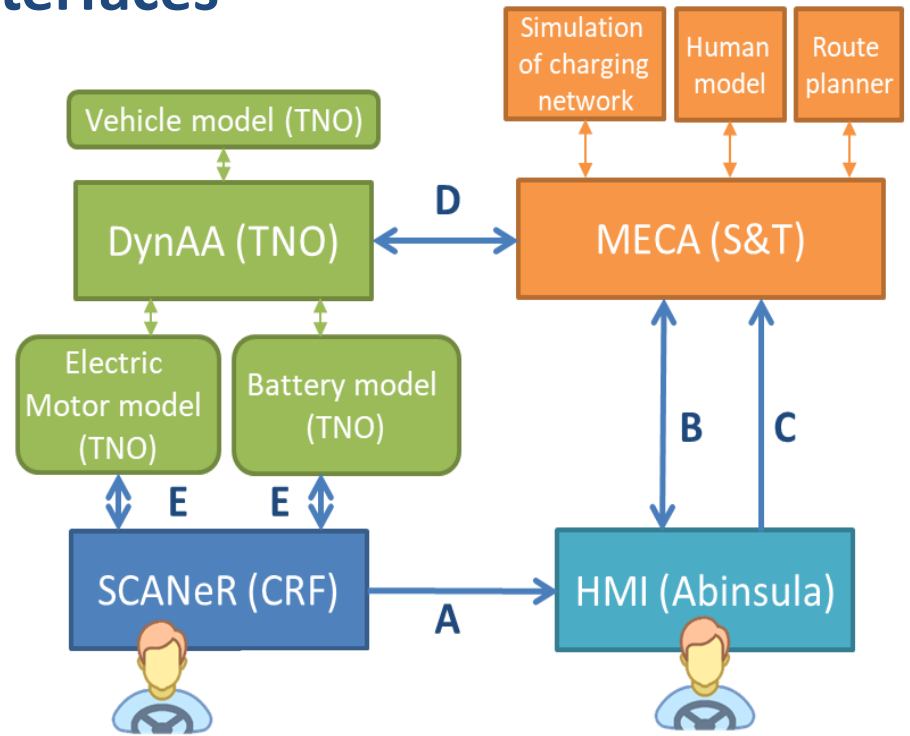
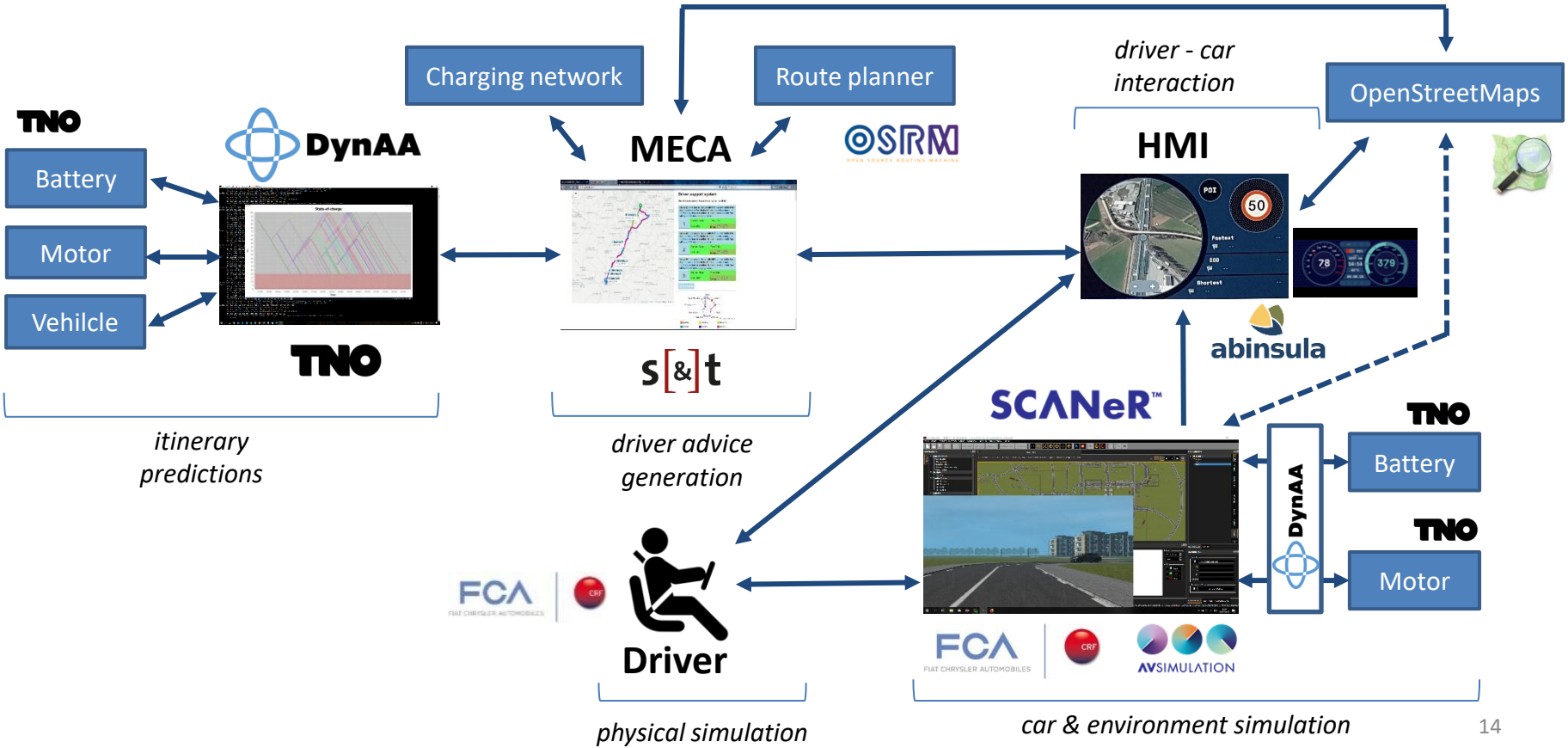
Interfaces



A. **CAR info**: battery SoC, GPS, speed, …
B. **User advice interaction**
   a) Propose and select itineraries
   b) Advice to driver, like how to reduce energy consumption
C. **Provide battery SoC and GPS data to MECA**
D. **Itinerary simulation request / response**
E. **Real time Battery & Motor models**

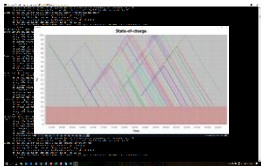
Smart Travelling scenario



Smart Travelling scenario

0

DynAA



TNO

MECA

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HMI

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SCANeR™

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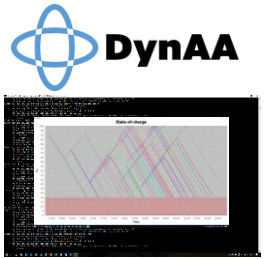
Driver

Smart Travelling scenario

1

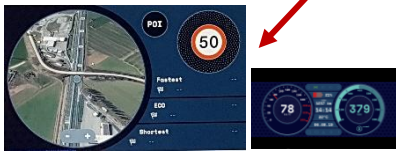


TNO

s[&]t

driver - car interaction

HMI



OpenStreetMaps

abinsula

SCANeR™

TNO
Battery
TNO
Motor
DynAA

User starts driving EV

FCA | CRF

Driver

FCA | CRF | AVSIMULATION

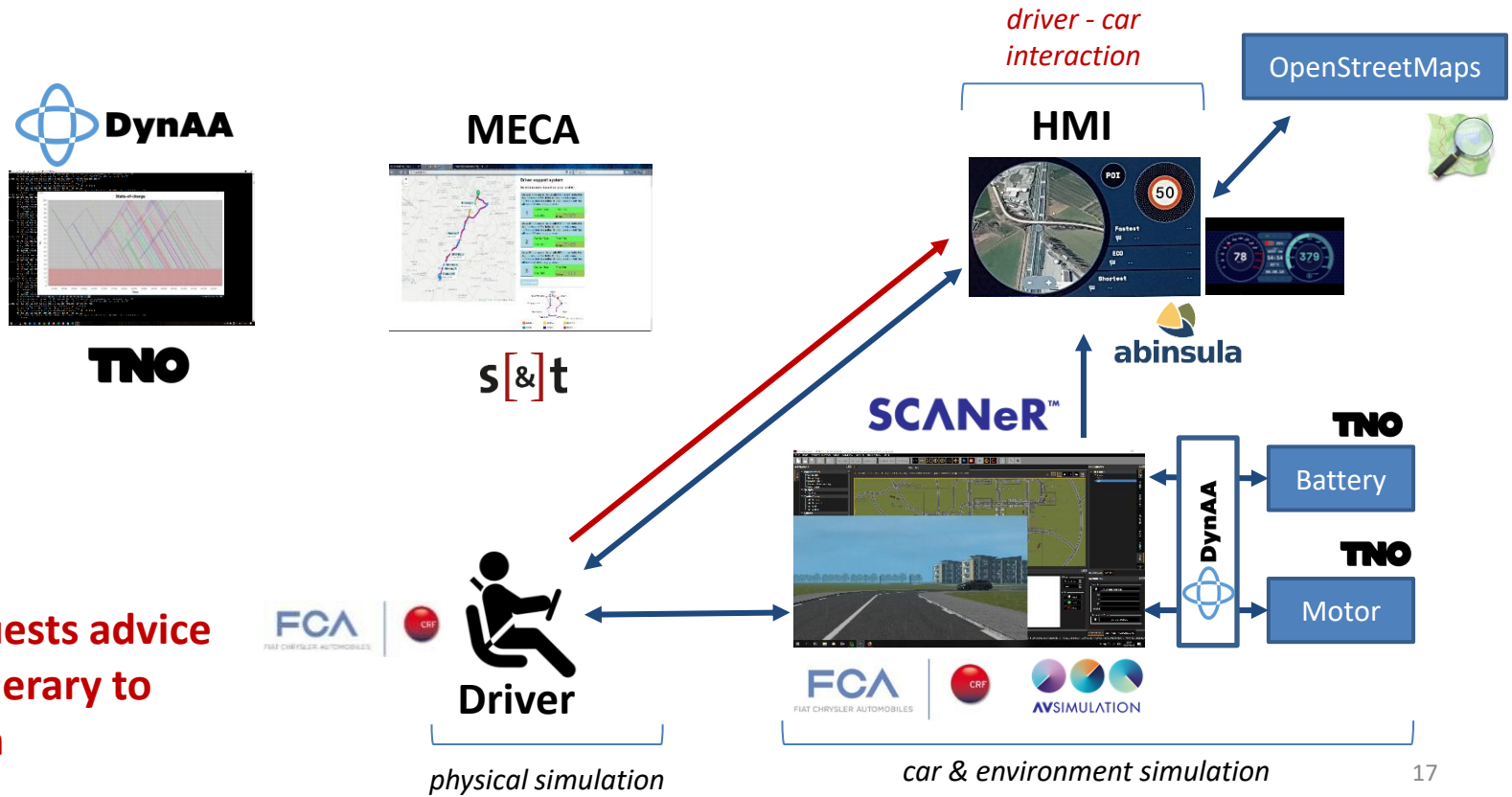
physical simulation

car & environment simulation

Smart Travelling scenario

2

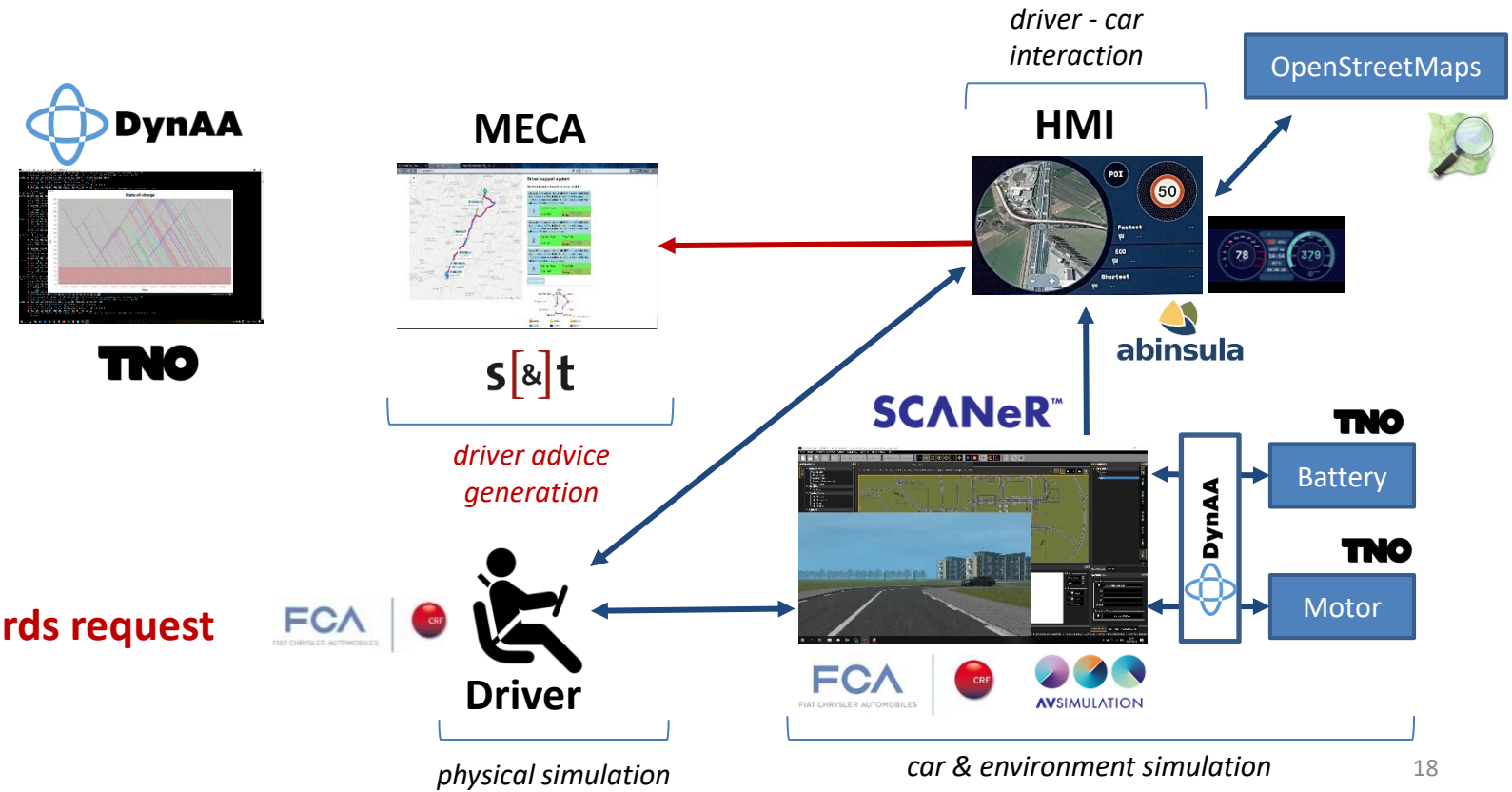
Driver requests advice on best itinerary to destination



Smart Travelling scenario

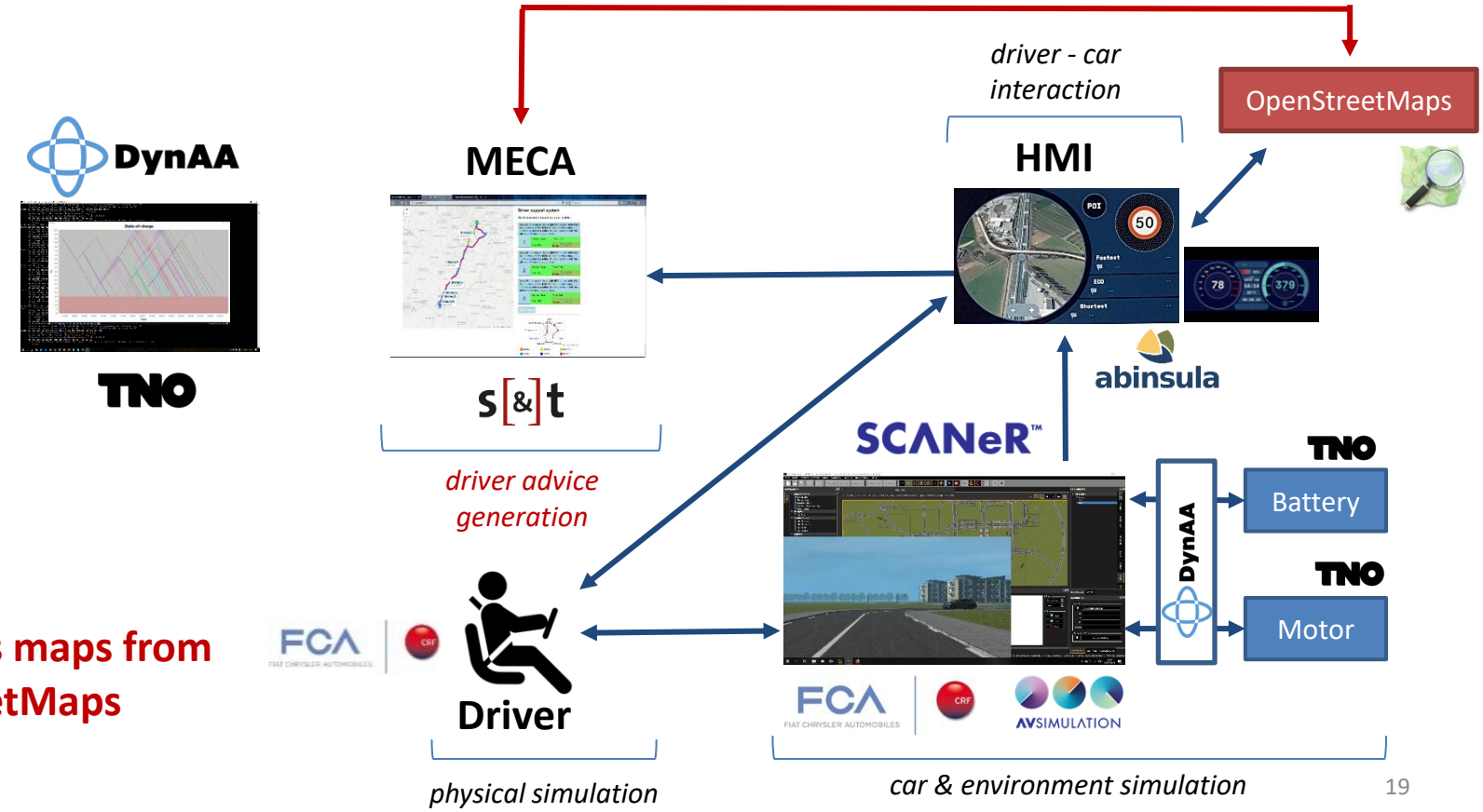
3

HMI forwards request to MECA



Smart Travelling scenario

4

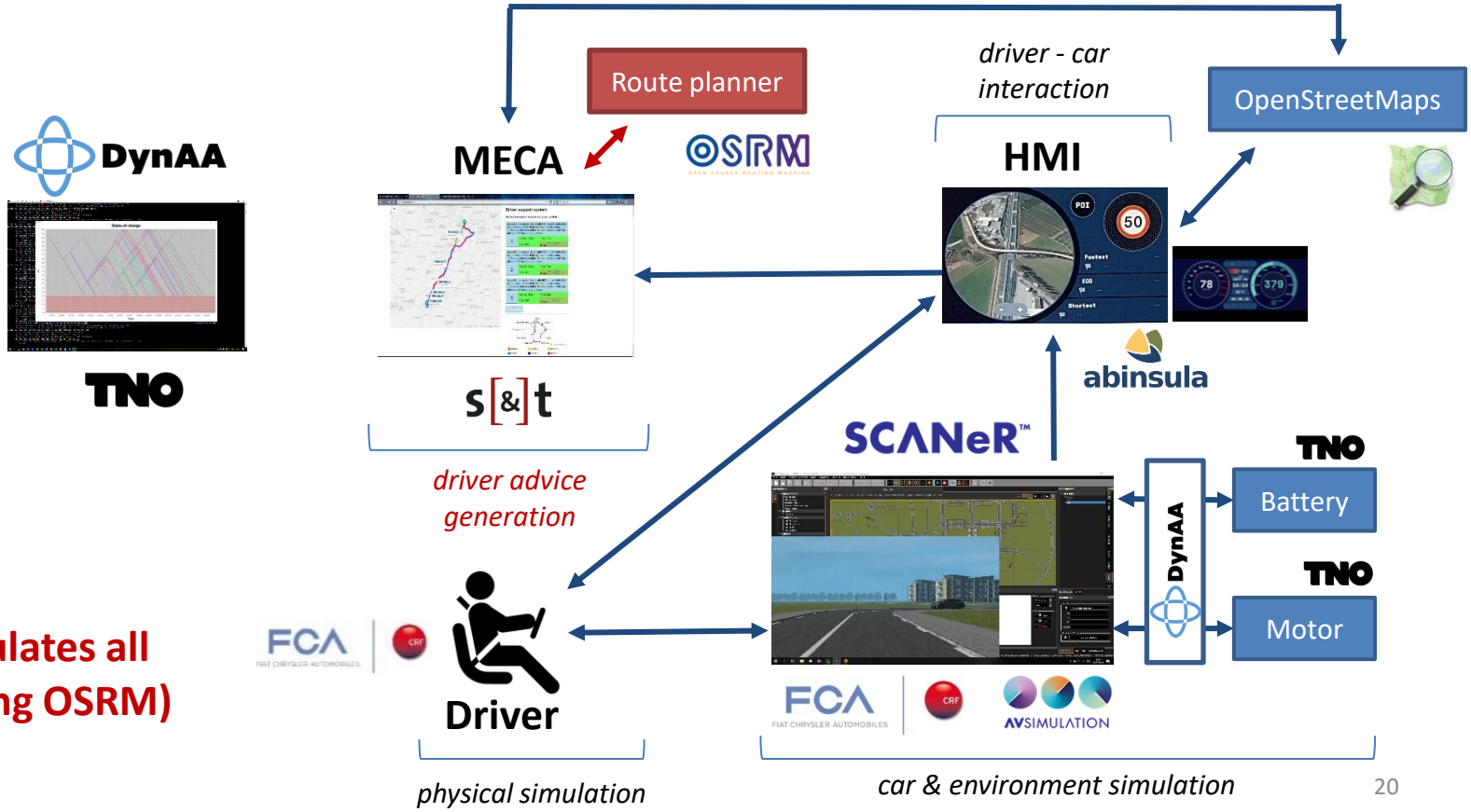


MECA gets maps from OpenStreetMaps

Smart Travelling scenario

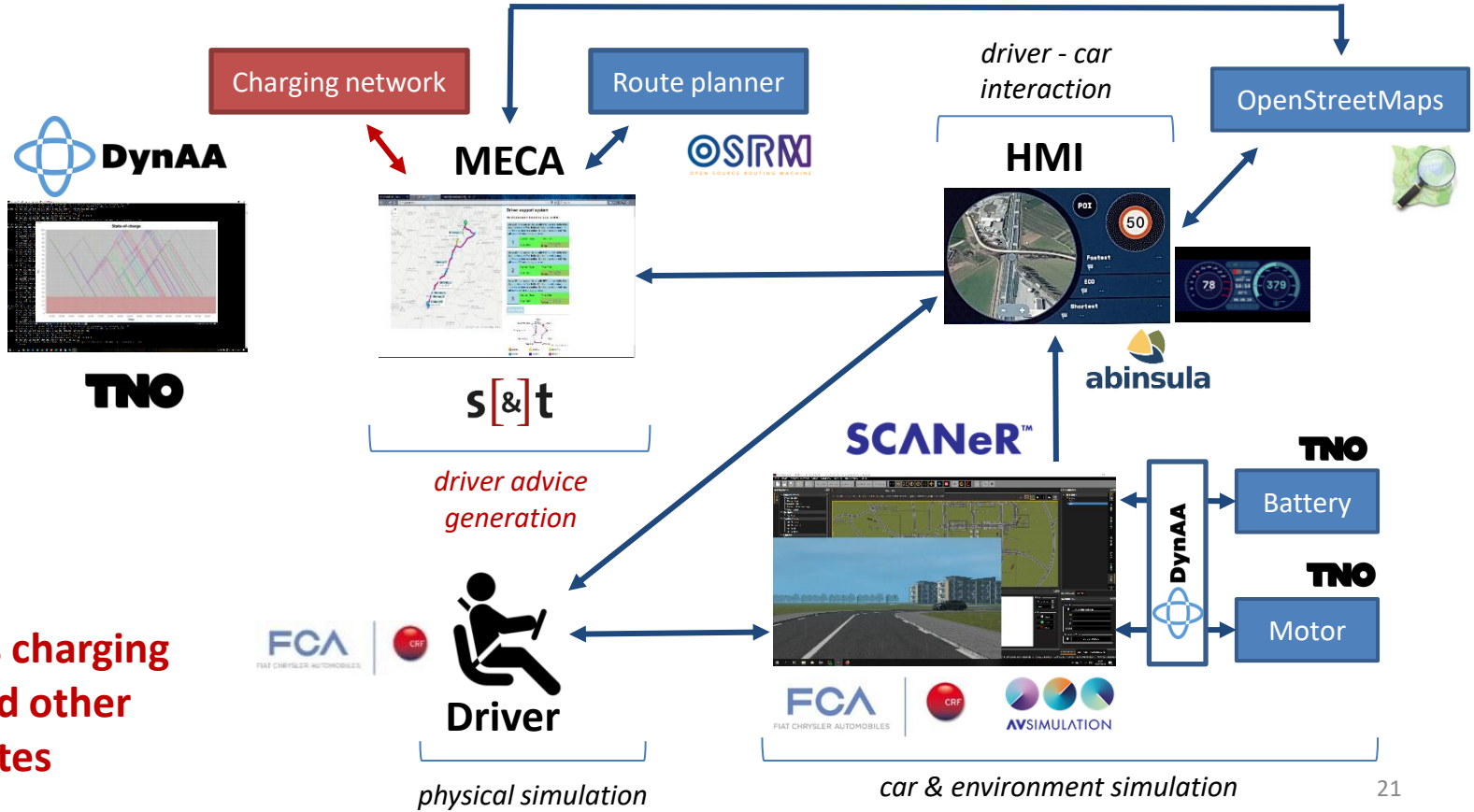
5

MECA calculates all routes (using OSRM)



Smart Travelling scenario

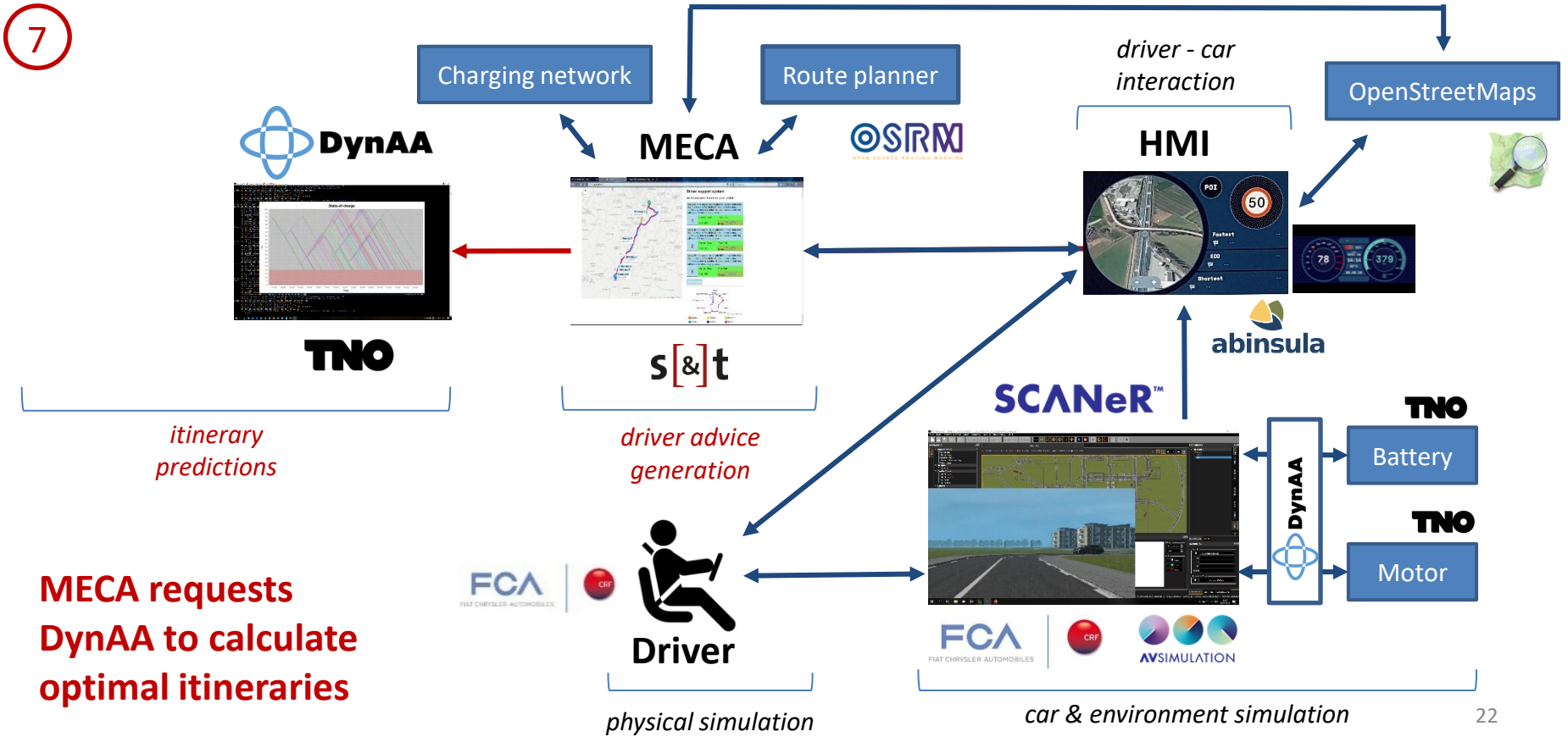
6



MECA adds charging stations and other info on routes

Smart Travelling scenario

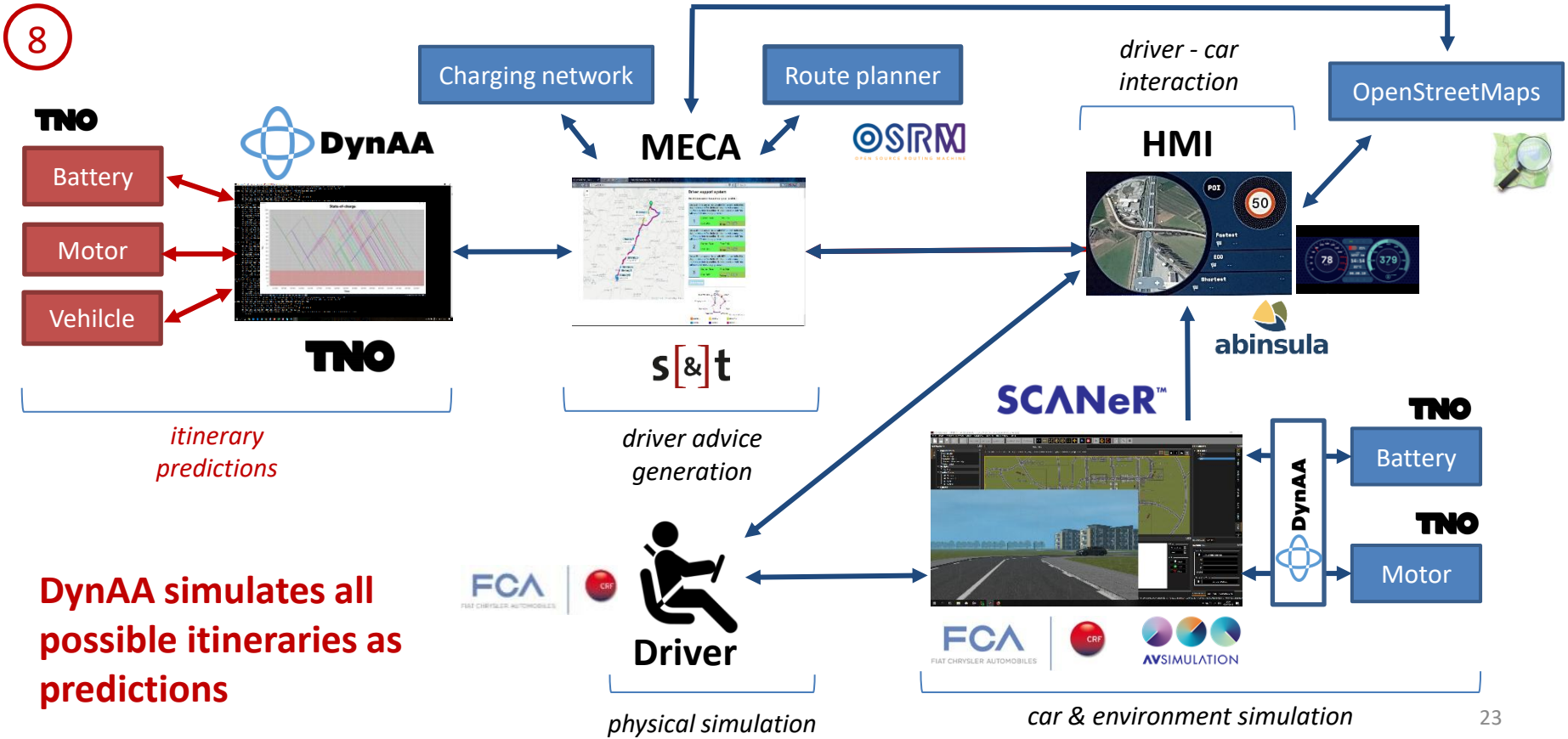
7



MECA requests DynAA to calculate optimal itineraries

Smart Travelling scenario

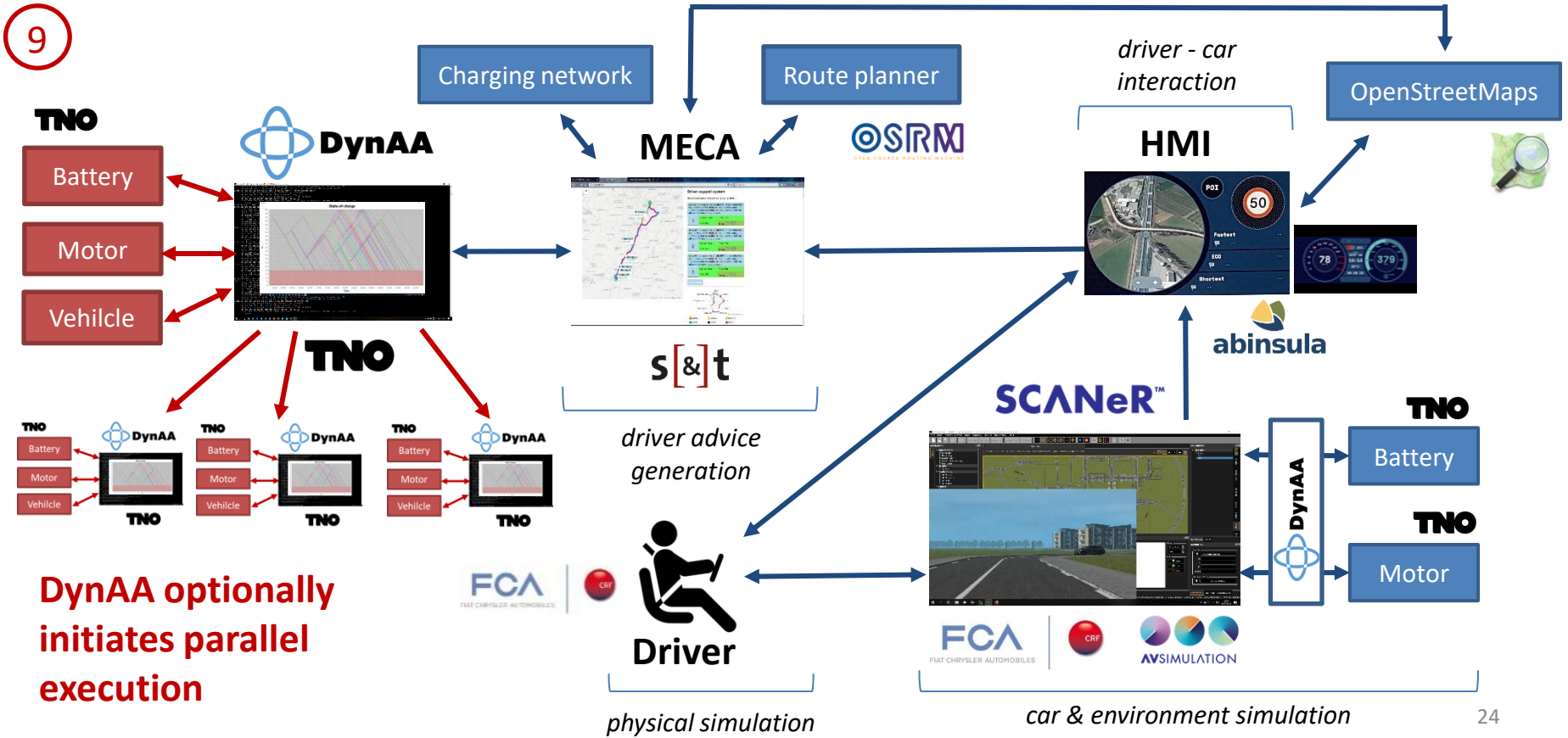
8



DynAA simulates all possible itineraries as predictions

Smart Travelling scenario

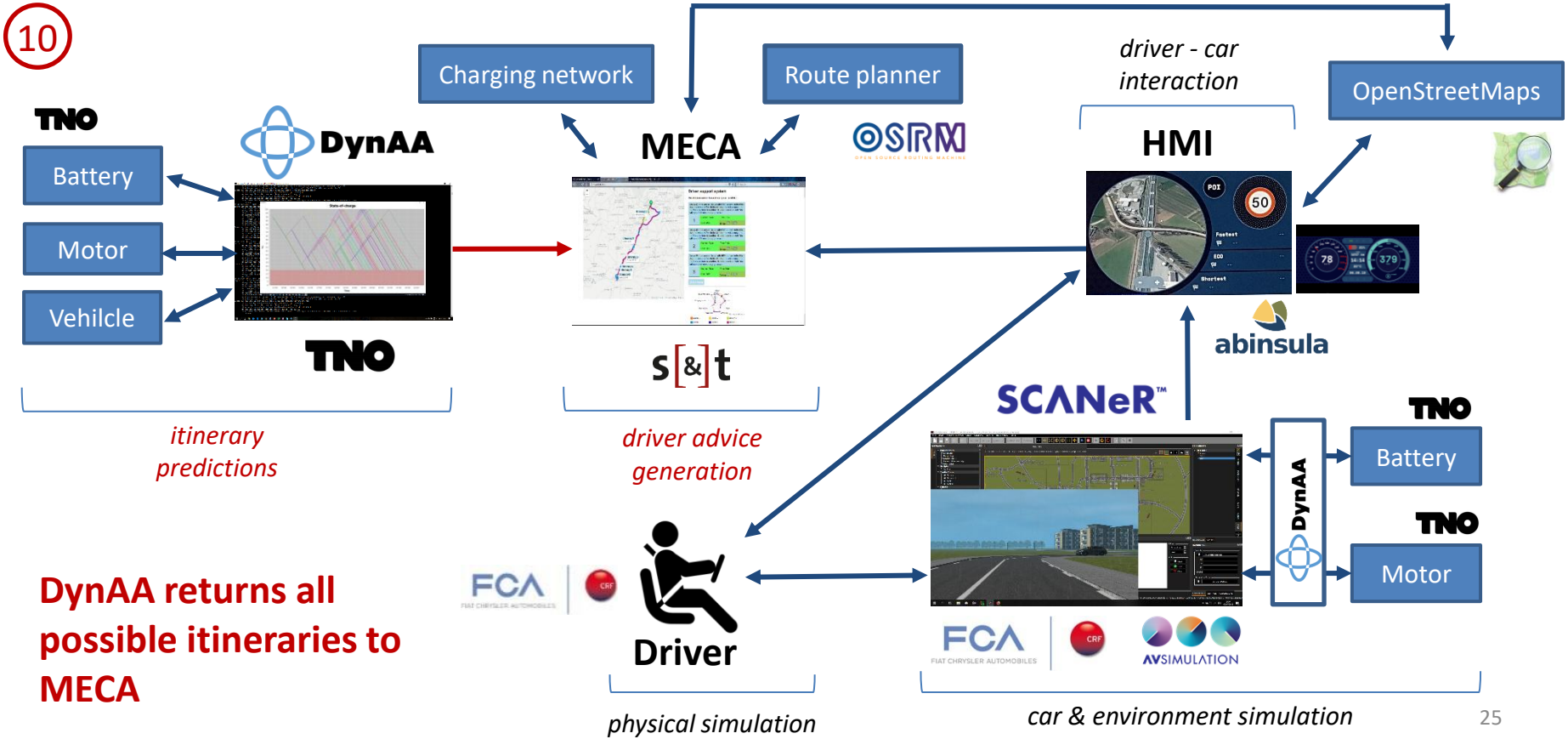
9



DynAA optionally initiates parallel execution

Smart Travelling scenario

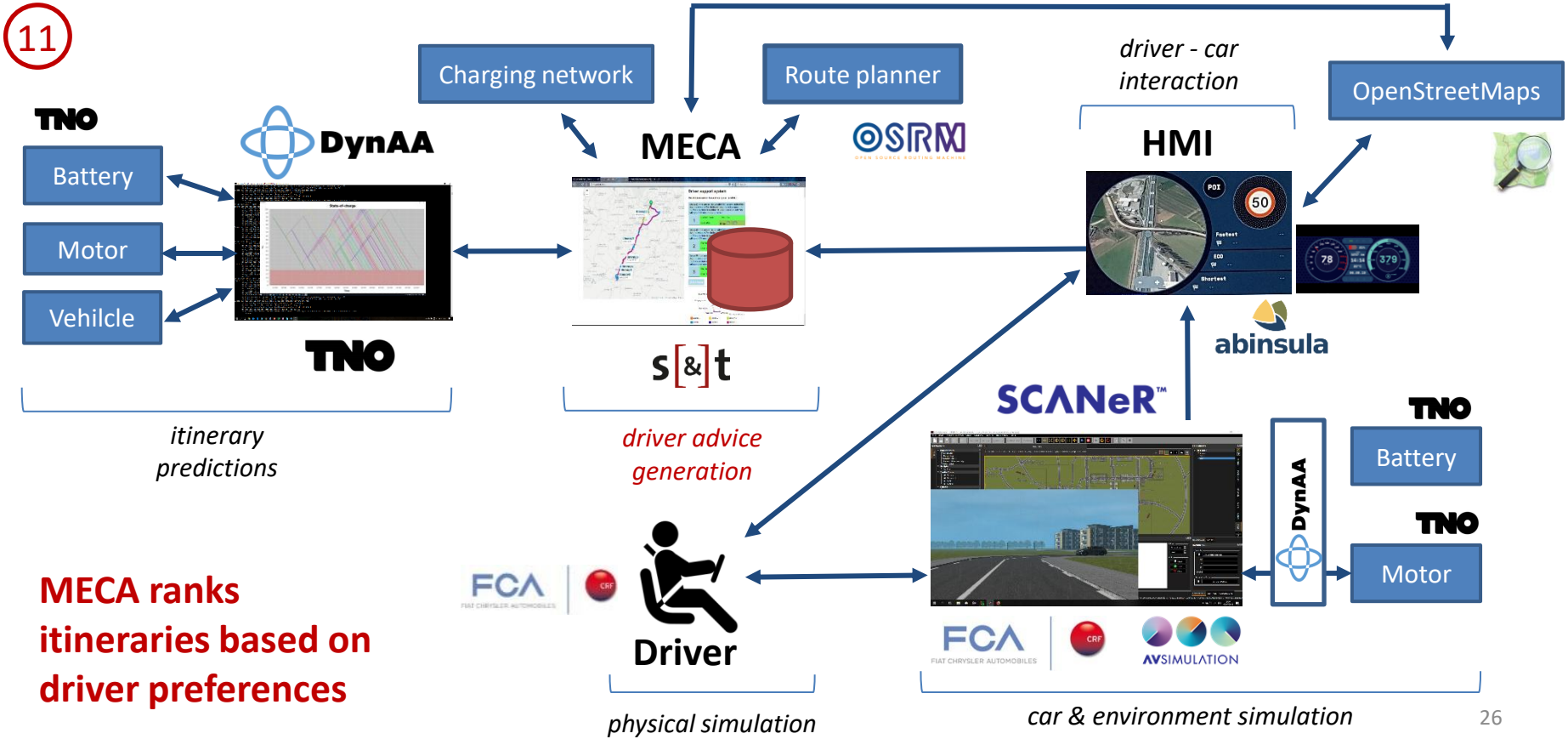
10



DynAA returns all possible itineraries to MECA

Smart Travelling scenario

11



MECA ranks itineraries based on driver preferences

Smart Travelling scenario

12

Charging network

Route planner

driver - car interaction

OpenStreetMaps

TNO

Battery

Motor

Vehilcle

DynAA

TNO

MECA

OSRM

HMI

abinsula

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SCANeR™

TNO

Battery

TNO

Motor

DynAA

FCA

CRF

Driver

FCA

CRF

AVSIMULATION

itinerary predictions

driver advice generation

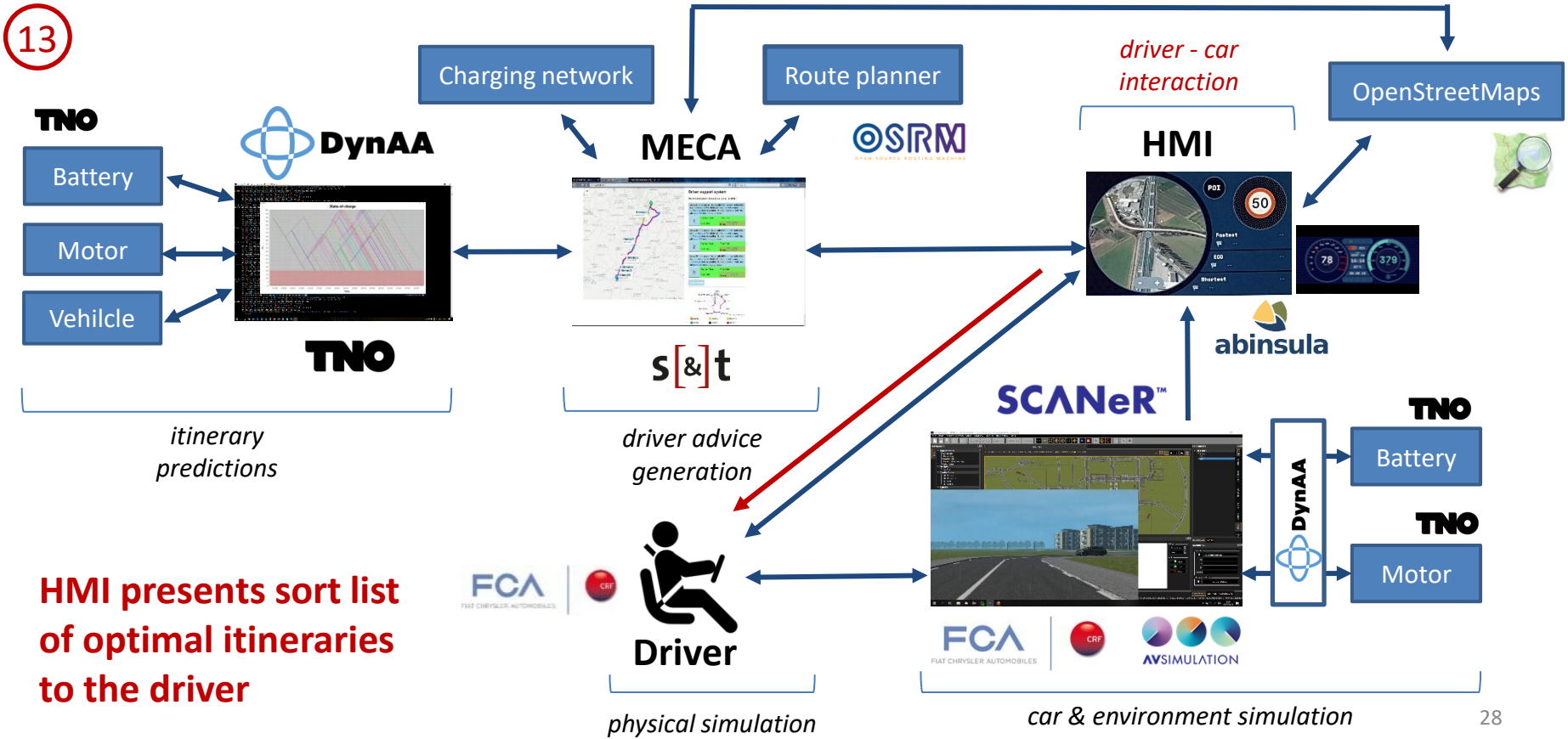
physical simulation

car & environment simulation

MECA returns optimal itineraries to the HMI

Smart Travelling scenario

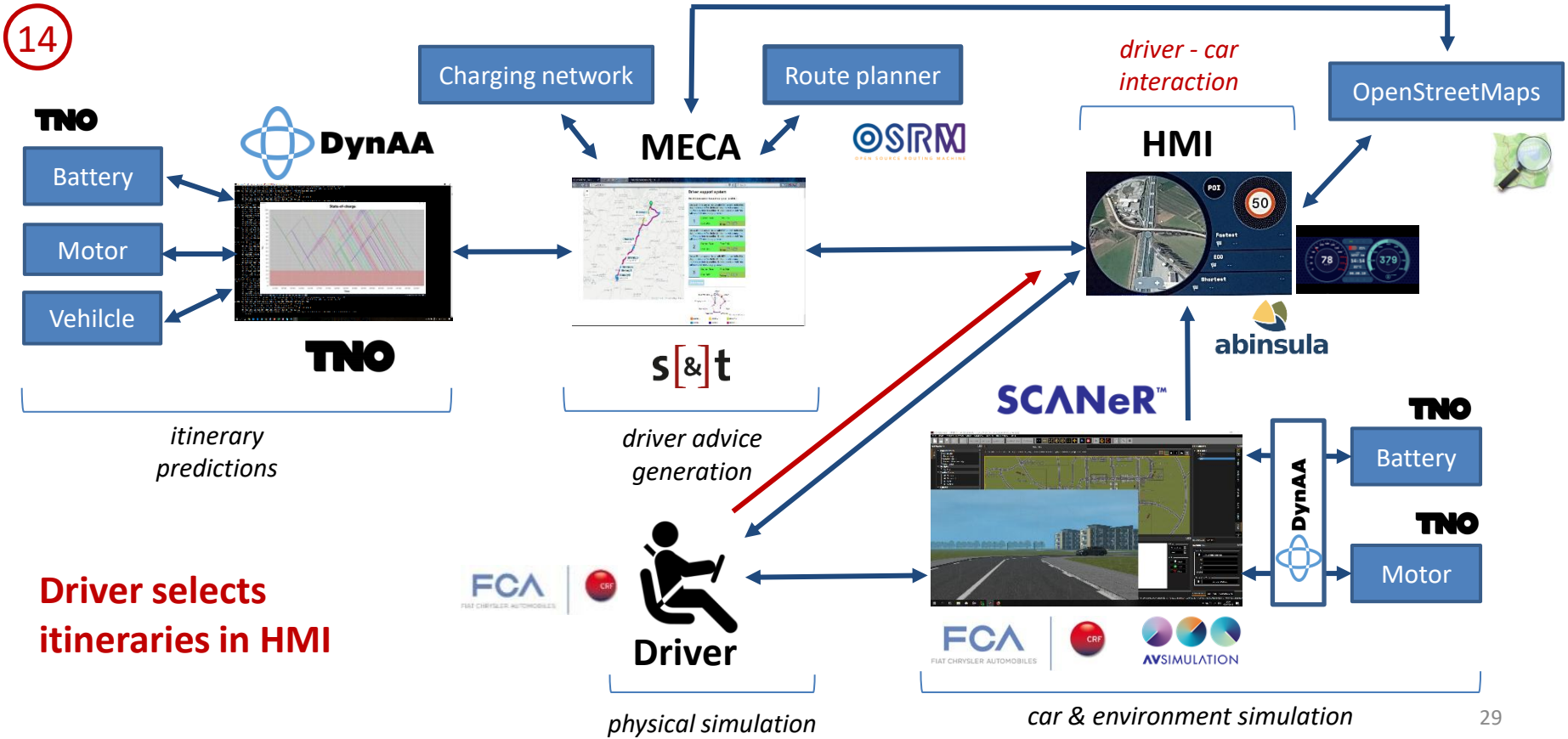
13



HMI presents sort list of optimal itineraries to the driver

Smart Travelling scenario

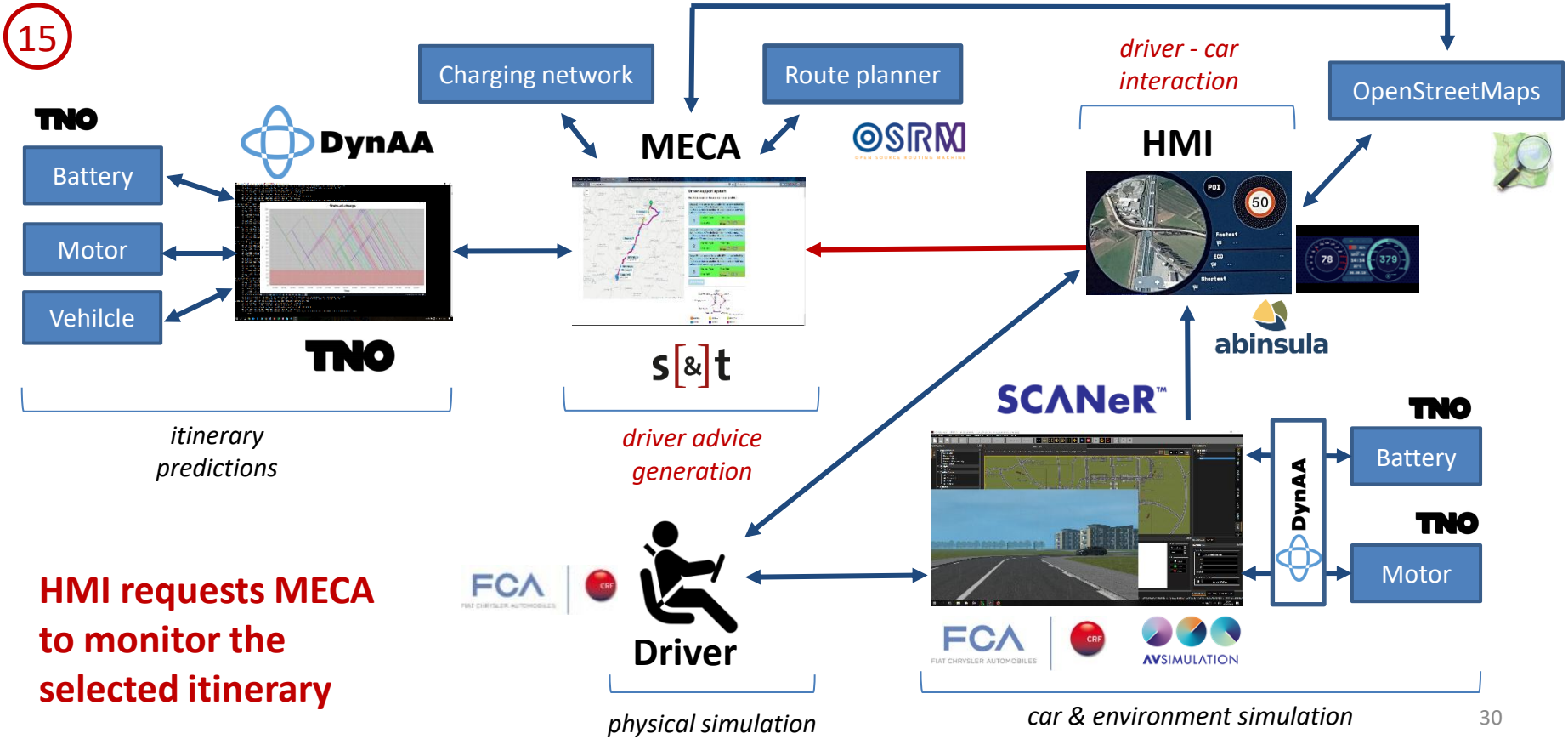
14



Driver selects itineraries in HMI

Smart Travelling scenario

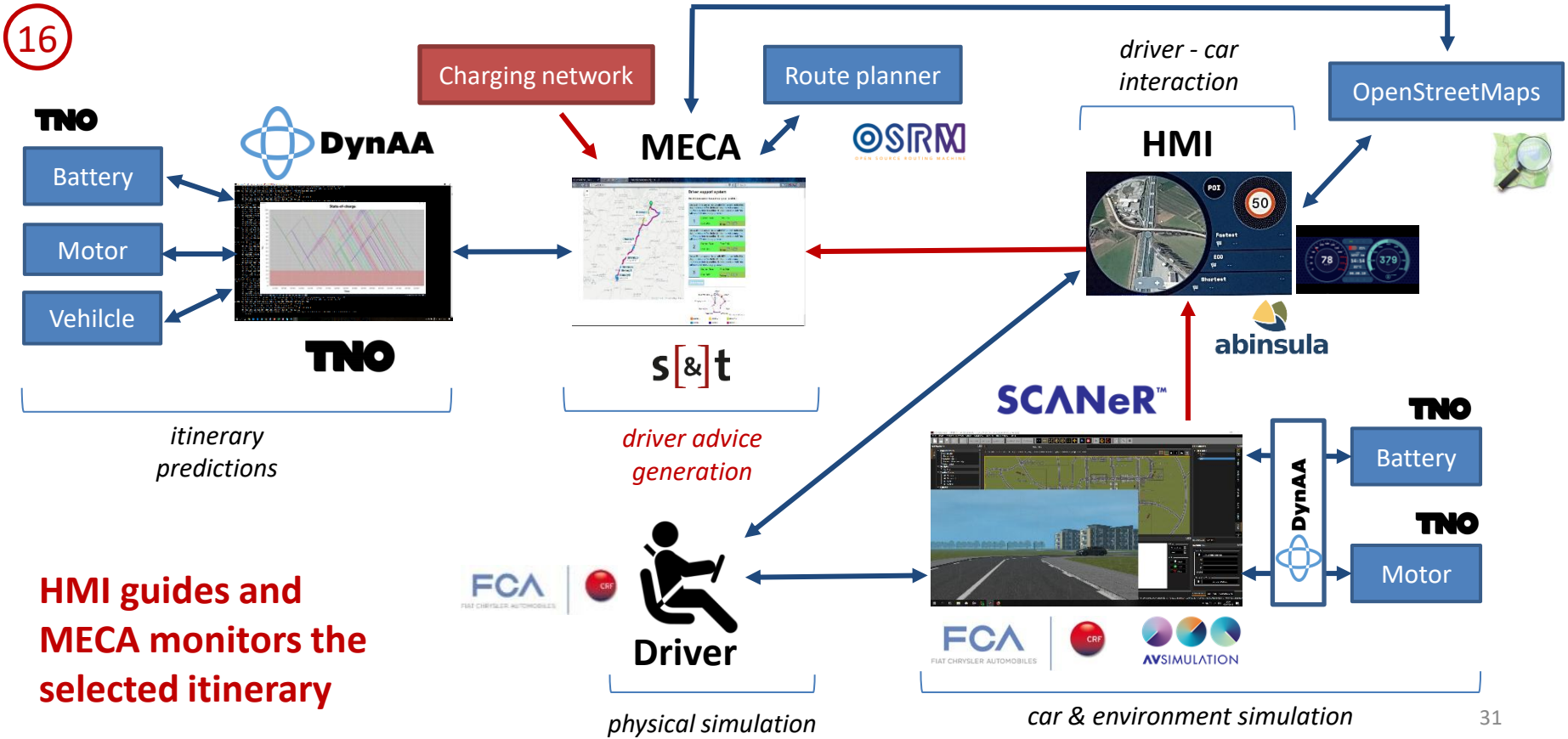
15



HMI requests MECA to monitor the selected itinerary

Smart Travelling scenario

16



HMI guides and MECA monitors the selected itinerary

Smart Travelling scenario

17 = 3

Charging network

Route planner

OpenStreetMaps

driver - car interaction

TNO

Battery

Motor

Vehilcle

DynAA

TNO

MECA

OSRM

HMI

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SCANeR™

itinerary predictions

driver advice generation

In case of a trigger MECA automatically recalculates itineraries

FCA

CRF

Driver

TNO

Battery

TNO

Motor

DynAA

FCA

CRF

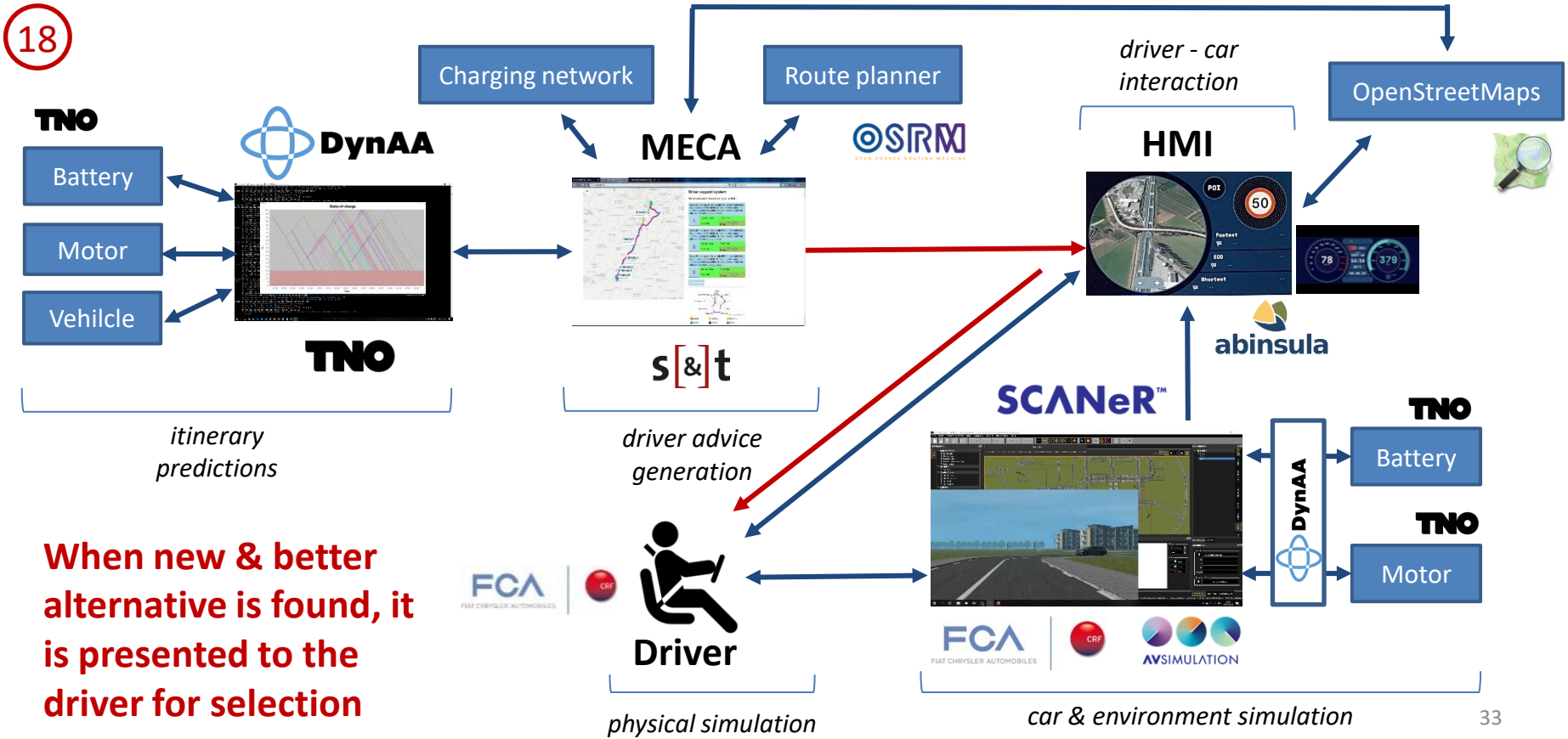
AVSIMULATION

physical simulation

car & environment simulation

Smart Travelling scenario

18



When new & better alternative is found, it is presented to the driver for selection