Microelettrica Scientifica

METERING RAIL VEHICLE

Energy Measurement and Management System (*ECO***System**)

May 2016

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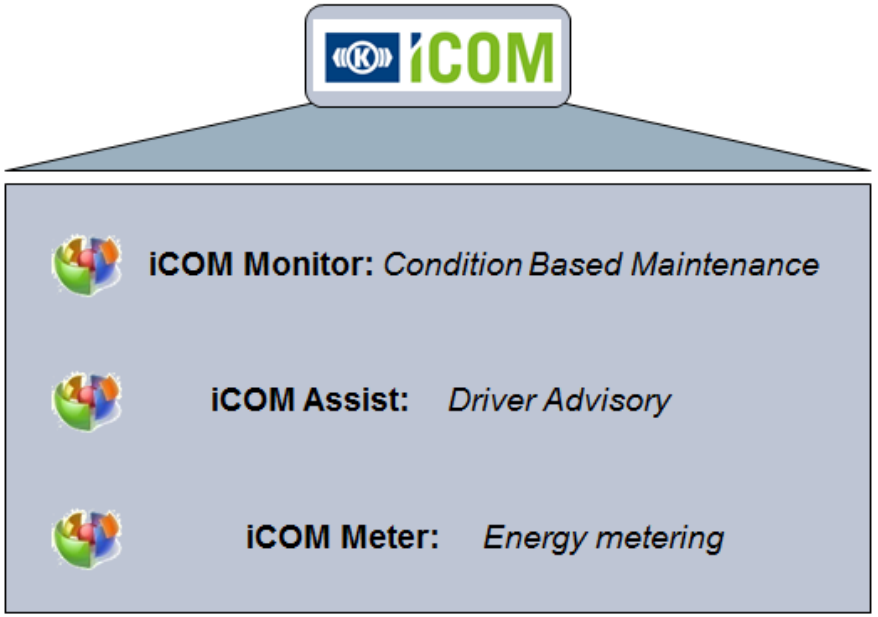
ECOSystem

The drivers of the innovation

EMMS: *ECO*System: Main Customer needs coverage

- **TSI Loc&Pas defines Energy Metering on board and Billing as mandatory. Related to TSI, the EN50463 series defines the new technical requirements to which the ECOSystem is fully conforming as assessed by one of the ERA notified body**

- **More and more the customers need functions like Fleet Monitoring and Management as regard as the electric energy consumption, with the aim of reduce it. These functions include statistic efficiency monitoring, overall style of driving evaluation, analysis of the quality of the current intake of trains from the power line.**



The ECOsystem Energy Management functions are developed taking advantage of the integration with the KB iCOM platform and using one single integrated back office software

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ECOSystem

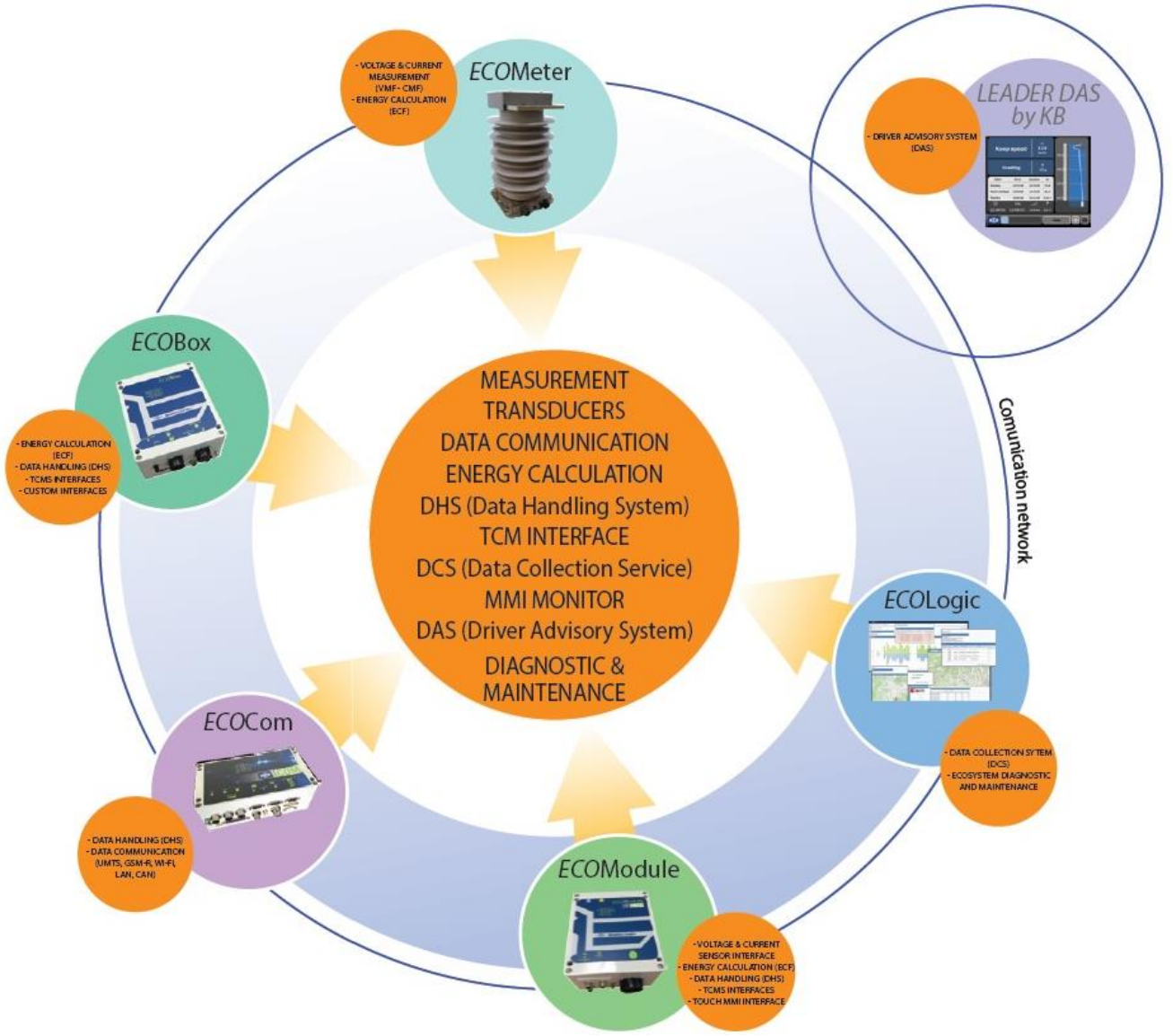
Functional and organic breakdown

Description of main modules

EMMS: *ECO*System platform

The Energy Measurement and Management System (EMMS) named ECOSYSTEM provides the Energy Measurement functions which are allocated in a flexible and scalable way to the different physical modules, as shown below:

- ✓ *ECO***Meter**: energy measurement function (EMF). it measure Voltage (VMF) Current (CMF) and Energy (ECF)
- ✓ *ECO***Box**: expansion box to provide vehicle interface (DO, AO, other communication interfaces)
- ✓ *ECO***Com**: data handling system (DHS) for generation and collection of CEBD and data communication to GND
- ✓ *ECO***Module**: energy measurement system. it use already existing metering devices. It integrate ECF and DHS functions
- ✓ *ECO***Logic**: groung SW to handle the CEBD data from DHS, store the data on the server and send the data to the billing provider. It also handle the system diagnostic and configuration



MEASUREMENT: *ECO*Meter

UNIVERSAL VOLTAGE/CURRENT/ENERGY SENSOR

FOR HIGH ACCURACY ENERGY CALCULATION ACCORDING TO STANDARD **EN50463**

AC 25 kV 50 Hz (OV4-PD4)

AC 15 kV 16,7 Hz

DC 3 / 1.5 / 0.75 kV

INPUT

*ECO*Meter-VI 170

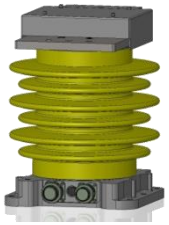
*ECO*Meter-V 170

AC 25 kV 50 Hz (OV3-PD3A)

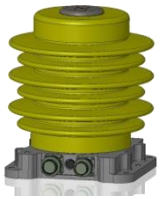
AC 15 kV 16,7 Hz

DC 3 / 1.5 / 0.75 kV

INPUT



*ECO*Meter-VI 125

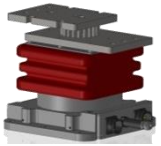


*ECO*Meter-V 125

DC 3 / 1.5 / 0.75 kV

INPUT

*ECO*Meter-DC-S (suspended)



*ECO*Meter-DC-F (flanged)

OUTPUT

HW outputs:

- ✓ O.F. Communication / RS485
- ✓ Ethernet communication
- ✓ Digital outputs

Available data:

- ✓ Catenary detection
- ✓ Catenary codification
- ✓ Short circuit detection
- ✓ Harmonic alarm detection
- ✓ Voltage: instantaneous/RMS
- ✓ Current: instantaneous/RMS
- ✓ Energy calculation consumed and regenerated (active/reactive)
- ✓ Energy data accumulation (max. 1 minute)

Remote diagnostic:

- ✓ Device configuration
- ✓ Device status
- ✓ Failure communication
- ✓ SW update

Expantion: *ECO*Box

Data Transmission from Sensor

INPUT

OUTPUT

- ✓ Analog Outputs (I/V class 1/0,5): Instantaneous or RMS
- ✓ Digital Outputs: cleaned contacts
- ✓ Ethernet
- ✓ Vehicle Bus
- ✓ Additional Serial ports RS 422/485
- ✓ Customer specific customisations

Data Handling System: *ECO*Com

_EMS Data from sensor
_Data communication DAS
_Other data sources

INPUT

OUTPUT

- ✓ Build in GPS for train position (GPS antenna integrated or external)
- ✓ Digital outputs (2+1)
- ✓ CAN: Standard compliant ISO 11898
- ✓ GSM/GPRS: 850/900/1800/1900 MHz (In alternative GSM-R)
- ✓ UMTS/WCDMA/HSDPA/HSUPA: 1700/1900/2100 MHz (In alternative GSM-R)
- ✓ WLAN: IEEE 802.11b/g, WiFi compliant
- ✓ LAN Ethernet: 2 LAN, Rate 10/100 Mbps

Energy Meter Module: *ECO*Module

_Sensors Analog input
_EMS Data from sensor
_Data communication DAS
_Other data sources

INPUT

OUTPUT

- ✓ Build in GPS for train position (GPS antenna integrated or external)
- ✓ Digital outputs (2+1)
- ✓ CAN: Standard compliant ISO 11898
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- ✓ LAN Ethernet: 2 LAN, Rate 10/100 Mbps

- ✓ Up to 6 configurable inputs for current and voltage sensors
- ✓ Energy accumulation period 1÷5 Minutes
- ✓ Energy instantaneous value every second
- ✓ ECF function: V*I Active/Reactive consumed and regenerated energy
- ✓ TCMS BUS Interface
- ✓ HMI interface by touch screen

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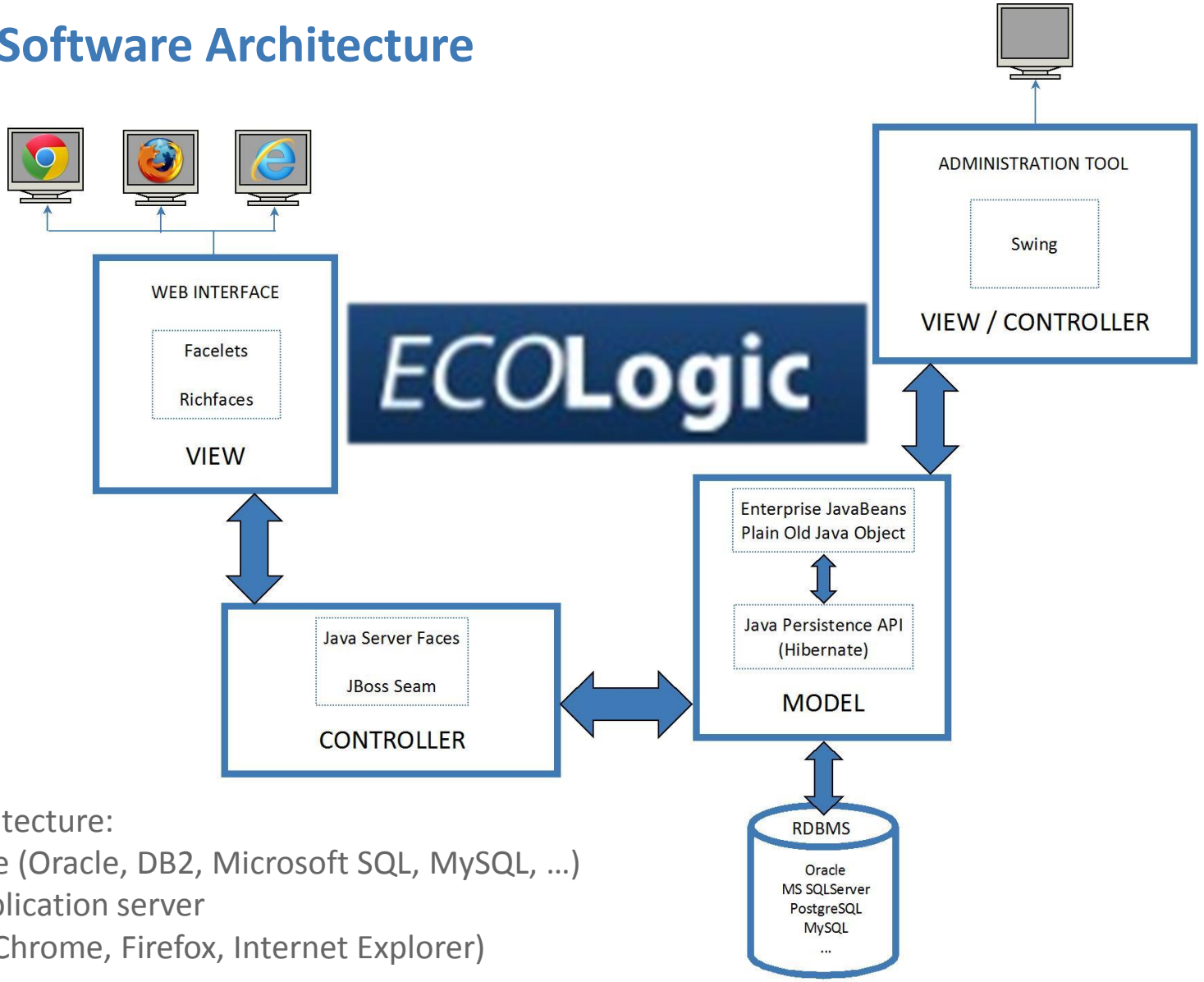
ECOSystem

ECOLogic DCS

ECOLogic Software Architecture



3-tier architecture:

- Database (Oracle, DB2, Microsoft SQL, MySQL, …)
- J2EE Application server
- Clients (Chrome, Firefox, Internet Explorer)

Overview of some functionalities

Energy consumption
- ✓ Data showed in charts and tables
- ✓ Possibility to extract Excel and PDF files
- ✓ CEBD and log files sent to ground server every X seconds
- ✓ On-board storage more than 60 days
- ✓ Consumed and regenerated energy calculated on different time intervals
- ✓ Possibility to record other data (e.g. speed)

Fleet overview and maintenance
- ✓ Real time state of each DHS
- ✓ DHS system parameters configuration

Localization
- ✓ Real time location data
- ✓ Routes covered (linked to energy consumption data)

ECOLogic

Support for billing
- ✓ Data exchange with billing systems

Customization
- ✓ Customer look and feel
- ✓ Possibility to add/remove different tools

Dashboard
- ✓ Widgets for a quick overview of the most important analyses

Login
- ✓ Username and password
- ✓ Users with different permissions

ECOSystem: ECOLogic

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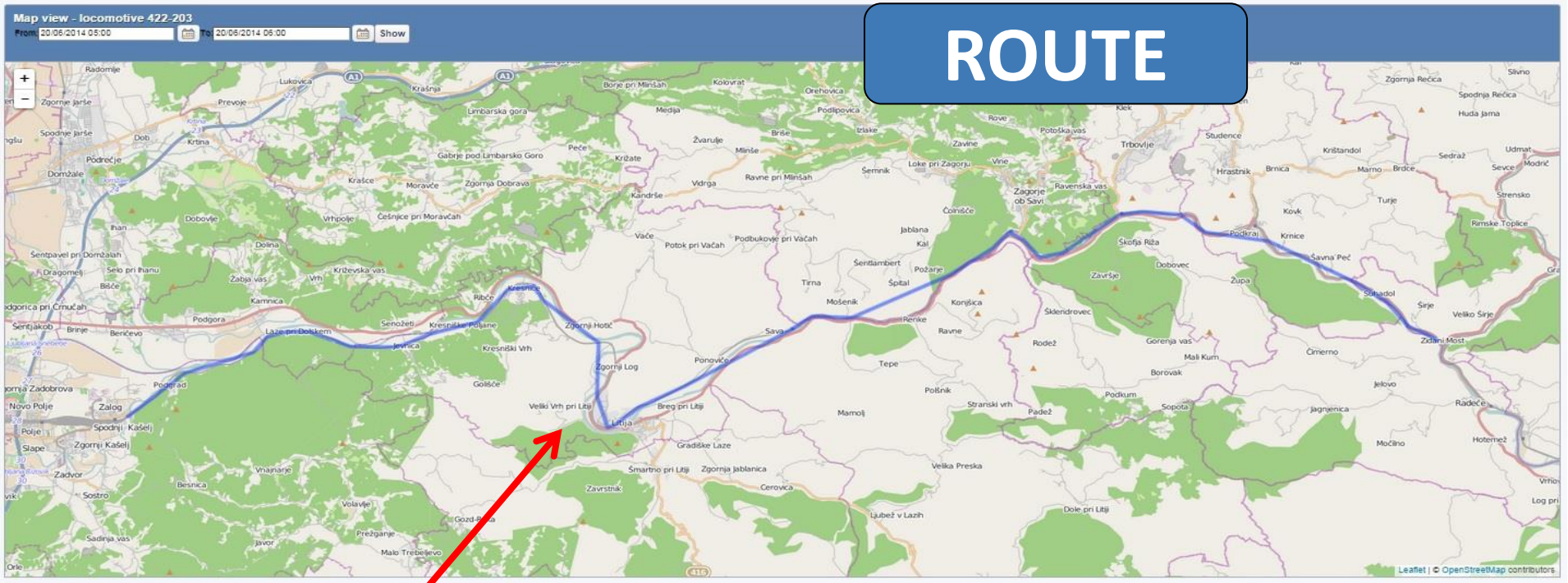
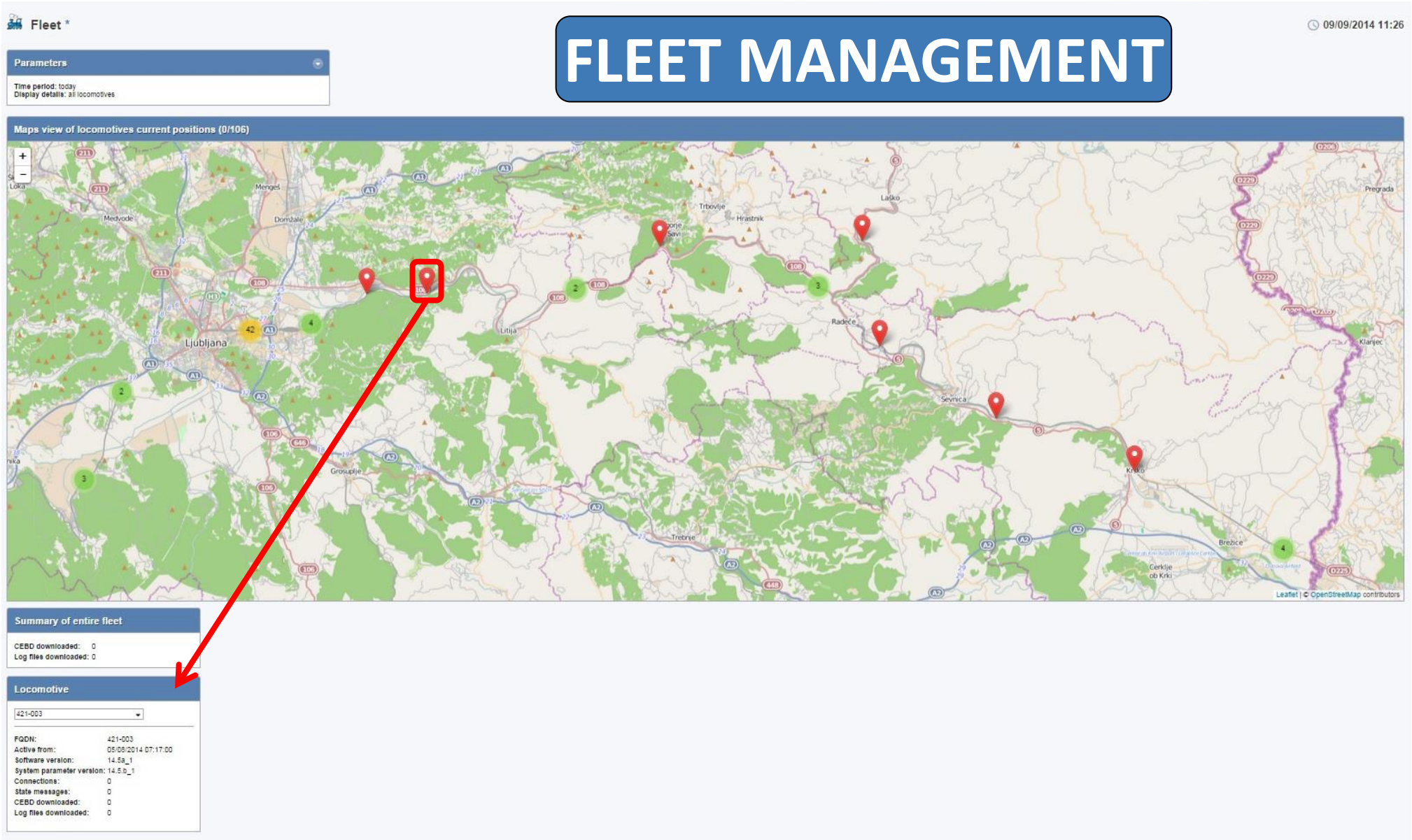


Table view

Date	Locomotive	Consumed energy [kWh]	Regenerated energy [kWh]	Speed [km/h]
20/06/2014 01:00	422-203	11.00	0.00	0.00
20/06/2014 02:00	422-203	12.00	0.00	0.00
20/06/2014 03:00	422-203	14.00	0.00	0.00
20/06/2014 04:00	422-203	28.00	0.00	0.00
20/06/2014 05:00	422-203	83.00	0.00	9.38
20/06/2014 06:00	422-203	304.00	0.00	50.41
20/06/2014 07:00	422-203	352.00	0.00	47.68
20/06/2014 08:00	422-203	412.00	0.00	53.54
20/06/2014 09:00	422-203	357.00	0.00	49.59
20/06/2014 10:00	422-203	76.00	12.00	7.70
20/06/2014 11:00	422-203	0.00	0.00	0.00
20/06/2014 12:00	422-203	11.00	4.00	0.91
20/06/2014 13:00	422-203	0.00	0.00	0.00
20/06/2014 14:00	422-203	6.00	0.00	0.25
20/06/2014 15:00	422-203	0.00	0.00	0.00
20/06/2014 16:00	422-203	20.00	0.00	1.10
20/06/2014 17:00	422-203	33.00	0.00	2.75

Export data to Excel | Create PDF report



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Driver Advisory System (DAS):

KB LEADER

LEADER - Advanced Driver Assistance for Energy Efficient Driving and Improved Punctuality

LEADER is an advanced driver assistant helping train drivers to operate their trains in a smooth and energy efficient way in timetable dominated operations. The system comes with an onboard advice system and a back office application with sophisticated analysis functionality.

Functions

- Dynamic run optimisation
- Foresight with dynamic driving recommendations
- Back Office
  - Real time status tracking
  - Advanced analysis tools
  - Update of operational data
- Interface to simulator-based driver training

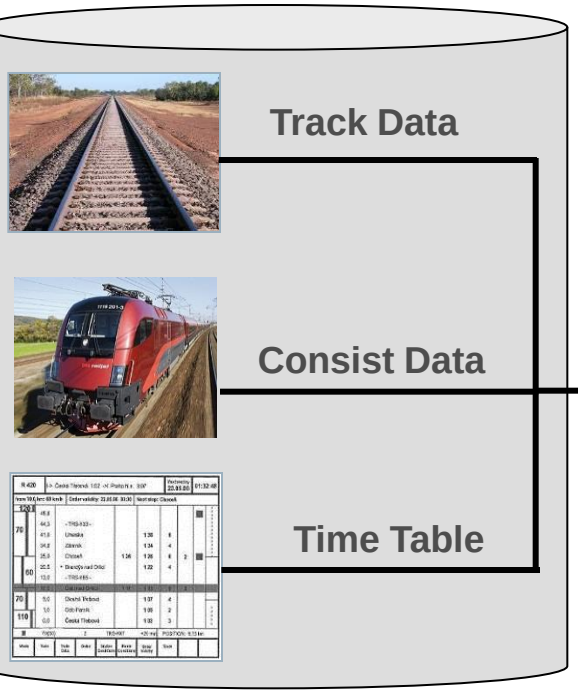
Customer advantages

- Reduction of energy consumption
- Improved punctuality
- Less wear and tear
- Long lasting operational improvements
- Easy implementation due to stand alone solution

LEADER:
Standard System Architecture

Position (GPS)

On-board Database

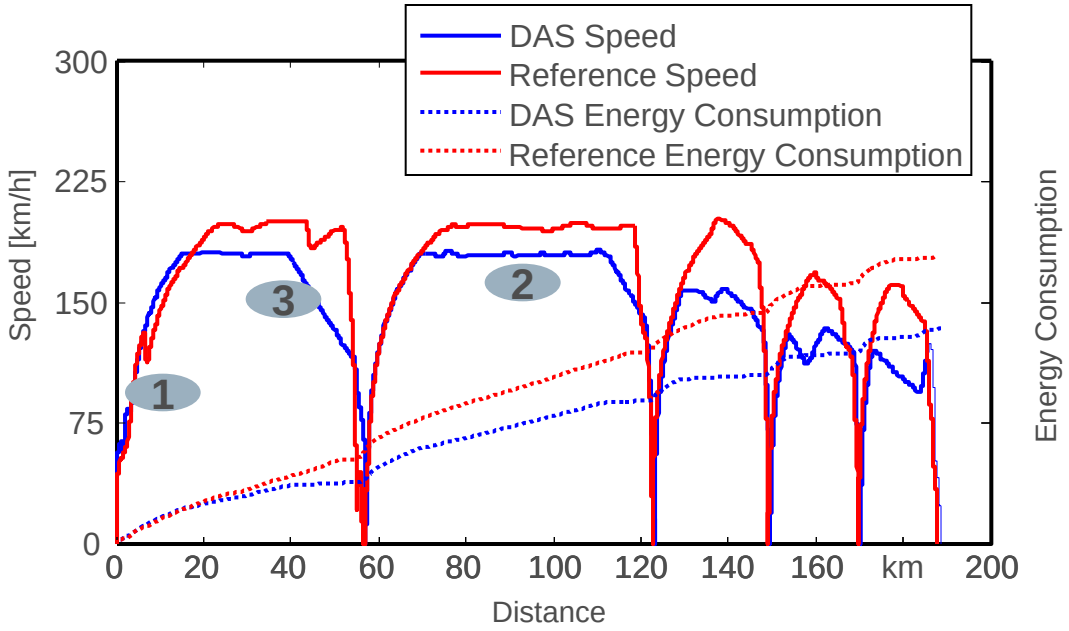


Driver advisory display with attached LEADER Processor

Training Simulator

Back Office

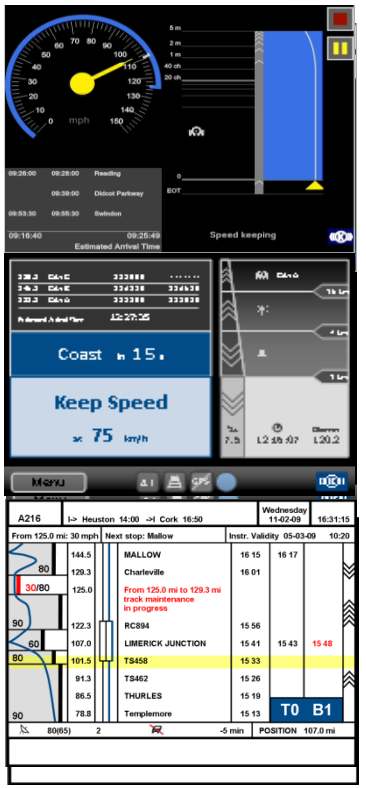
LEADER's Principle Way of Saving Energy



How does LEADER achieve Energy Savings?

1. Traction recommendation to run engine with a high degree of efficiency
2. Reduced top speed to avoid unnecessary build-up of kinetic energy and minimize speed-dependent factors (e.g. air resistance)
3. Early coasting to cut off power consumption for traction
4. Harmonization of driving behavior of train drivers

Customisable Display



The customer defines content and design of the display

- Optimiser recommends optimal speed profile until the next stop
- Full timetable and speed limit integration
- Integrated display solution which can be customised to specific needs
- Different display sizes allow integration into different vehicle types

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ECOSystem

Competitive advantages and market

*ECO*Meter competitive advantages

Integration

- The Ecometer is an unique multivoltage and multifunction sensor (AC+DC, V-I, Energy)
- All modules communicate by Ethernet
- The system HW configuration is scalable to any vehicle needs, with flexible standard functions allocation to each HW module

Performance

- The accuracy of the sensors exceeds the minimum requirements of TSI⟹ time between recalibration >15 y
- Sampling rate > 50kHz (16 bits resolution) allows current quality monitoring functions

Safety

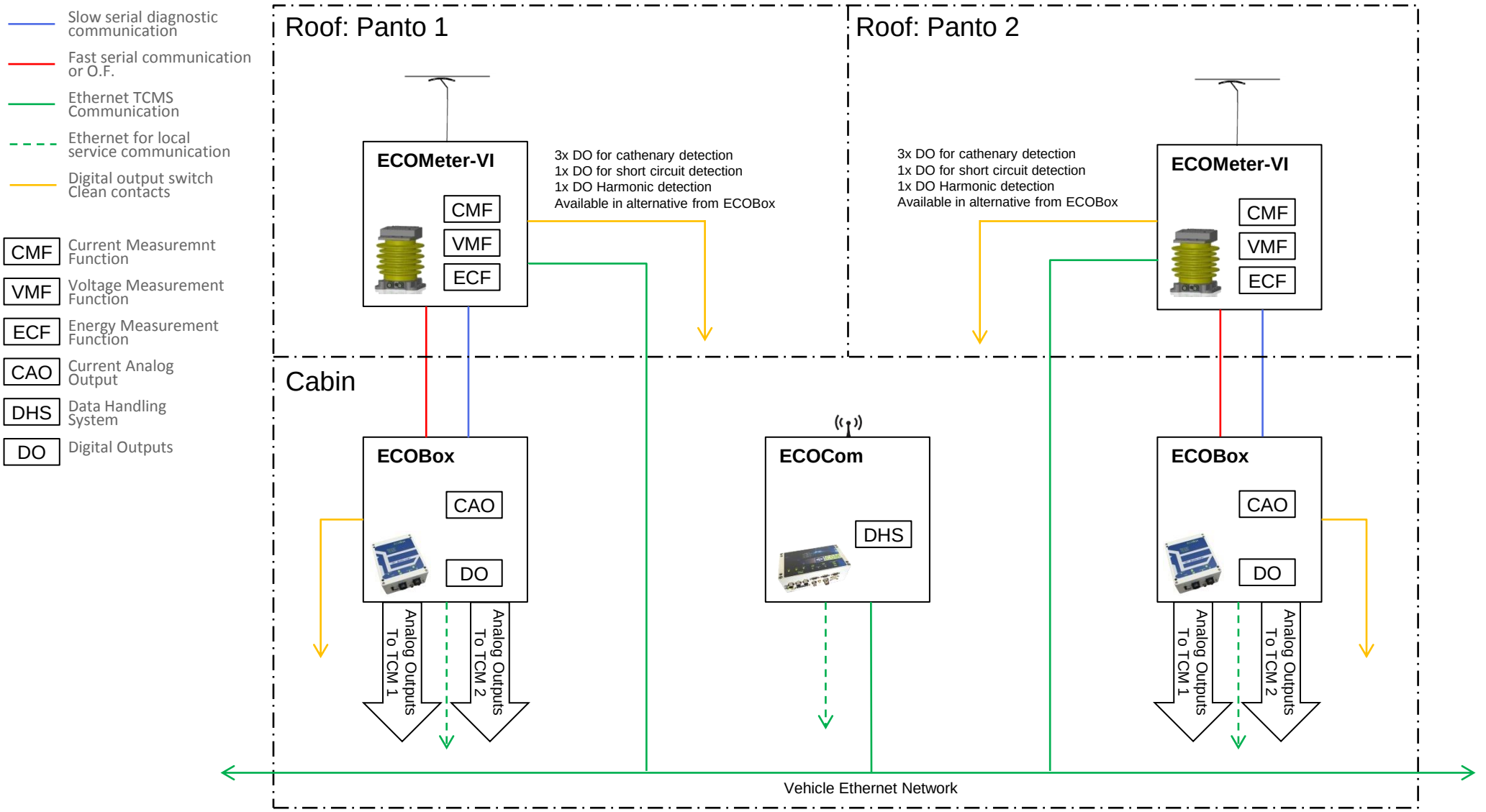
- Complete galvanic insulation between HV and LV
- Explosion free (no Ferro resonance as for measurement transformers)

Cost

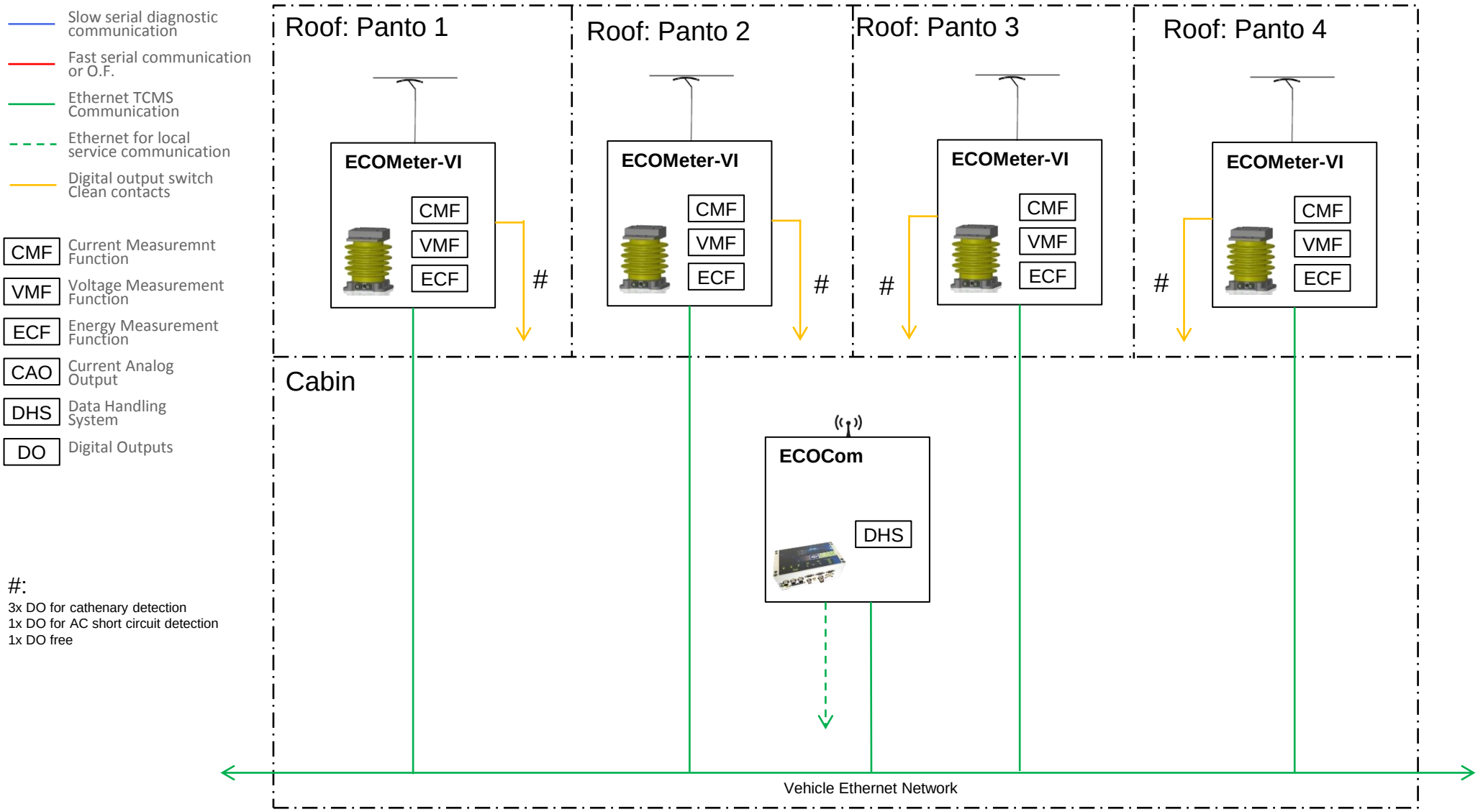
- Multivoltage sensors: ECOMeter competitive price
- Installation and cabling savings for the train integrator to be added
- LCC costs reduced at minimum

5 (appendix)
ECOSystem
architecture examples

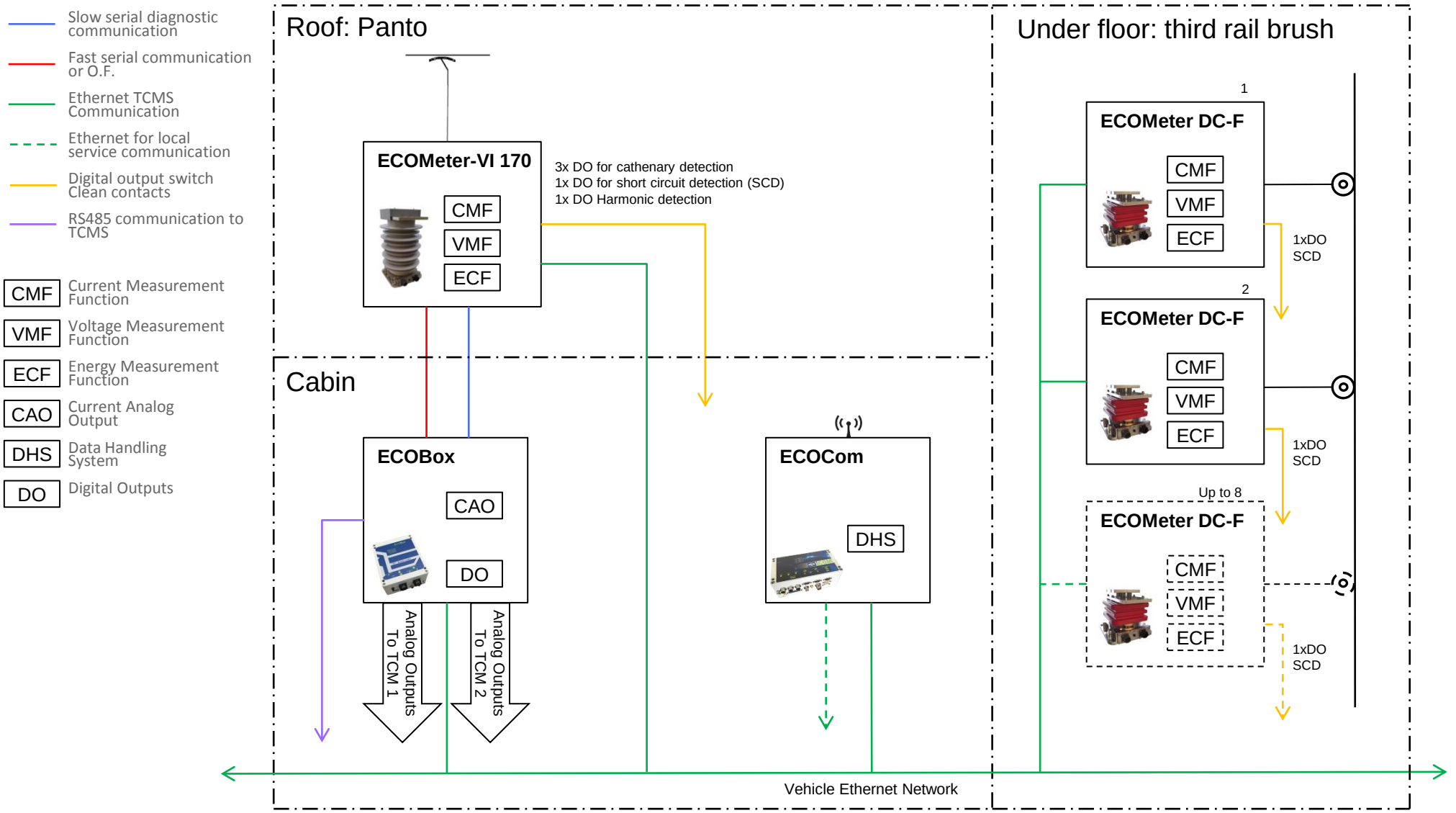
ECOSystem: Example 1



ECOSystem: Example 2



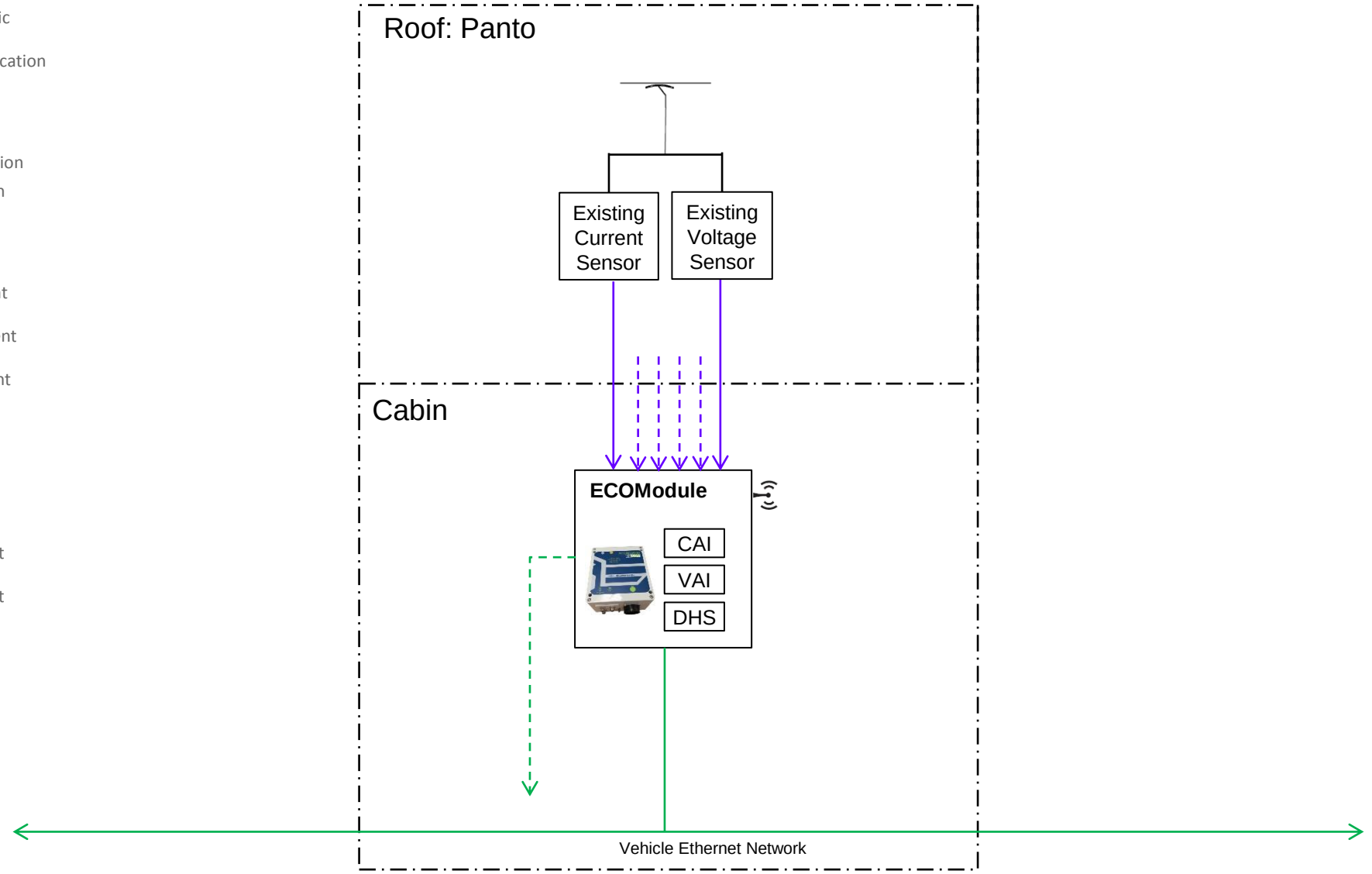
ECOSystem: Example 3



ECOSystem: Example 4

- Slow serial diagnostic communication
- Fast serial communication or O.F.
- Ethernet TCMS Communication
- Ethernet for local service communication
- Digital output switch Clean contacts
- Analog inputs

CMF	Current Measuremnt Function
VMF	Voltage Measurement Function
ECF	Energy Measurement Function
CAO	Current Analog Output
DHS	Data Handling System
DO	Digital Outputs
CAI	Current analog input
VAI	Voltage analog input



THANK YOU FOR YOUR ATTENTION

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