ecoCompute

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Methods to determine the environmental footprint of software – on the way to standardization

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Methods to determine the environmental footprint of software – on the way to standardization

Part 1: Bosch SW Eco Footprint model

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Invented for life




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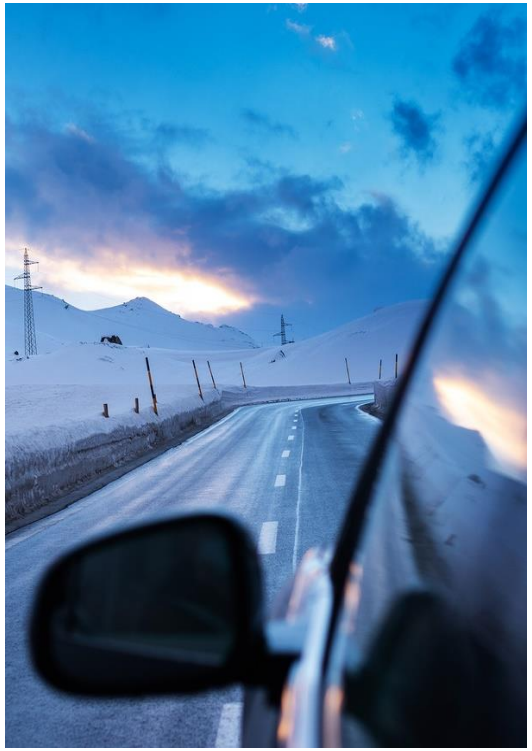
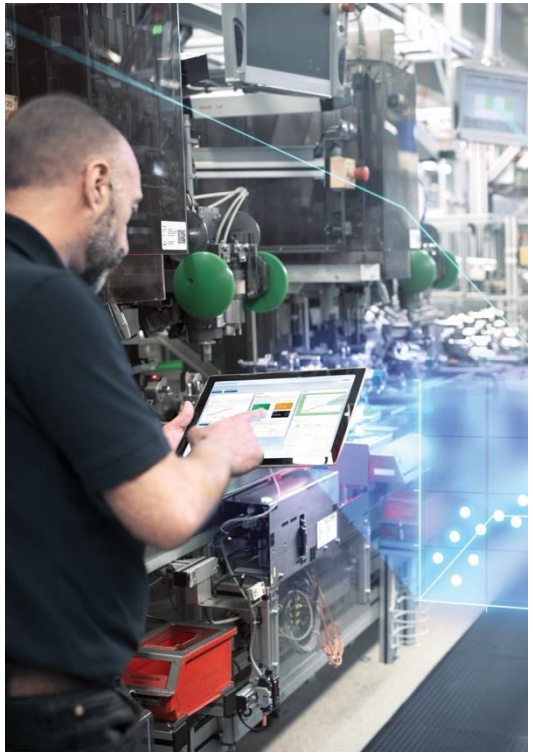
Who we are
Our business sectors



Mobility



Industrial Technology

Consumer Goods

Energy and Building Technology

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Source: Bosch Sustainability Report 2024

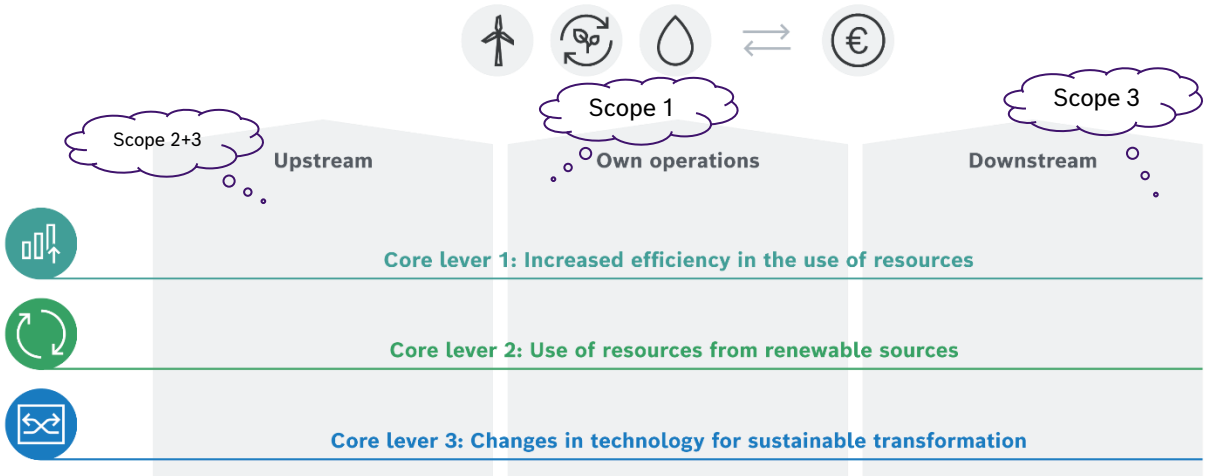
Sustainability at Bosch

Uniform sustainability methodology enables systematic control

The environmental dimensions of our vision for sustainability are underpinned by the same logic. This is characterized by **three core levers**, that can be applied along the value chain.

Sustainability methodology

Core levers for improving sustainability performance along the value chain



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Source: Bosch Sustainability Report 2024

Climate action

Carbon neutral in scope 1 & 2 since 2020

3.3

million tons CO_2 in 2018

at our over 400 locations worldwide (scope 1 & 2)

Energy Efficiency | **New Clean Power** | **Green Electricity** | **Carbon Offsets**

0

Carbon neutral

in scope 1 & 2 since 2020

	Energy Efficiency	New Clean Power	Green Electricity	Carbon Offsets
Goal 2030	Savings: **1.7 TWh**	In-house generation: **400 GWh**	Green Electricity: **100%**	Carbon Offsetting: **max. 0.5m t CO_2**
Achievement 2024	**67%**	**49%**	**99.5%**	**531,300 t CO_2**

-84% of CO_2 emissions since 2018

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Where we want to go
Our sustainability targets

CO_2

-30%

absolute reduction in
scope 3 carbon emissions
by 2030*

*compared with 2018 baseline year

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Where we want to go
Our sustainability targets

-25%

absolute reduction in water withdrawal in regions with water scarcity by 2025*

*compared with 2017 baseline year

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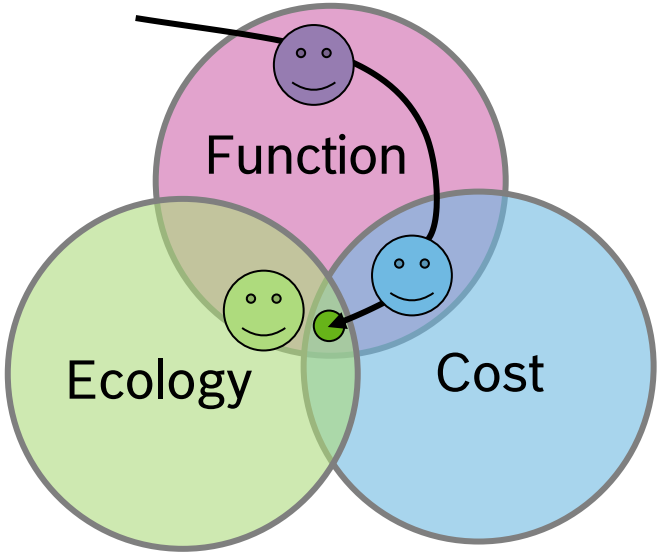
Sustainability strategy of Bosch
Design for Sustainability (Eco Design)

Reduce Ecological Footprint, especially Green House Gas emissions,
during the **entire** product lifecycle
by a considerate **product creation process**
with a **Product Lifecycle** view.



Lifecycle Analysis of Software Eco Footprint

SW has a different lifecycle profile than a typical HW

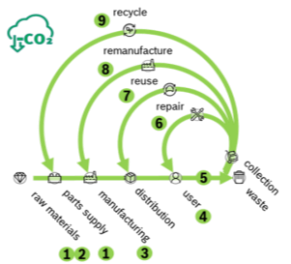
Example: Carbon Footprint

Software PLC Influencing factors	SW Architecture	Embodied	SW Deployment & Embodied Emissions	SW Operations	Negligible excpt. Replacement Re-Use and is a topic
PLC Phases*	Concept	Development	Production & Delivery	Product Operations	Phase Out
Hardware PLC Influencing factors	Design decisions Material decisions	Equipment Materials	Equipment Materials	Depends on physical function	Recycling / Second Life / Re-Use / Disposal

Build Pipelines

Operational

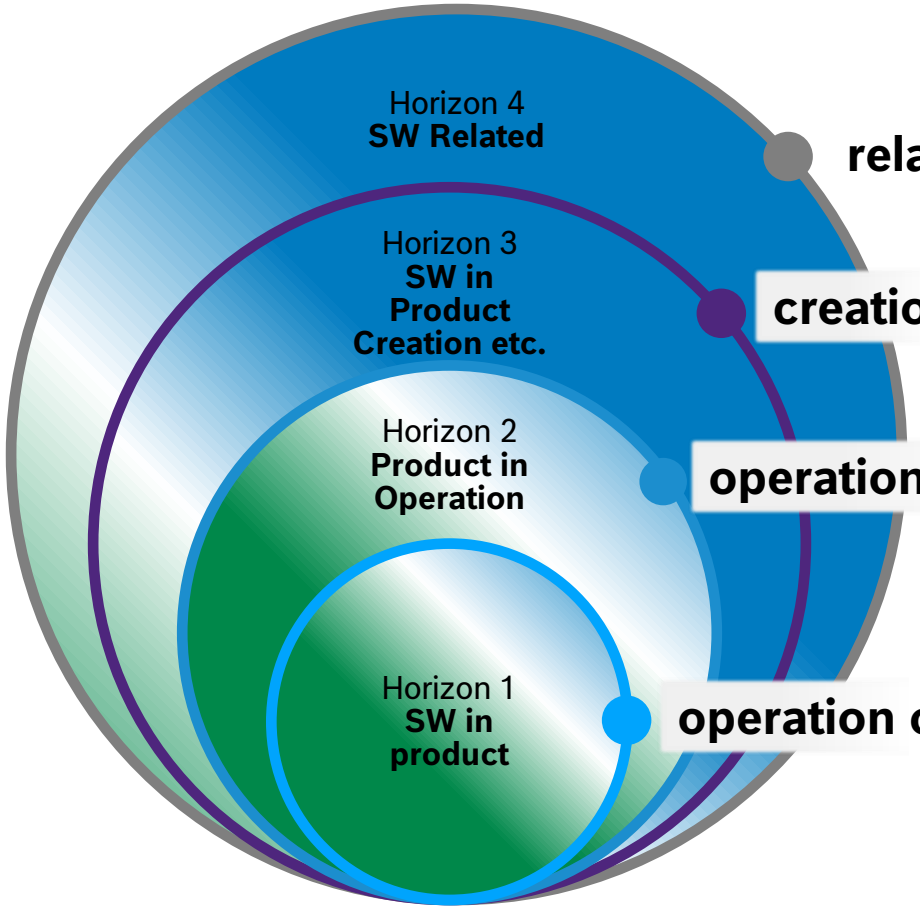
* Product Lifecycle Phases (BES)



PLC = Product Lifecycle, BES = Bosch Engineering System

The Bosch SW Eco Footprint model

Four Horizons and two Perspectives of the eco Footprint



related to the SW (catch all)

creation, maintenance, etc. of SW

operation of supporting SW and IT

operation of SW in/as the product

Perspective

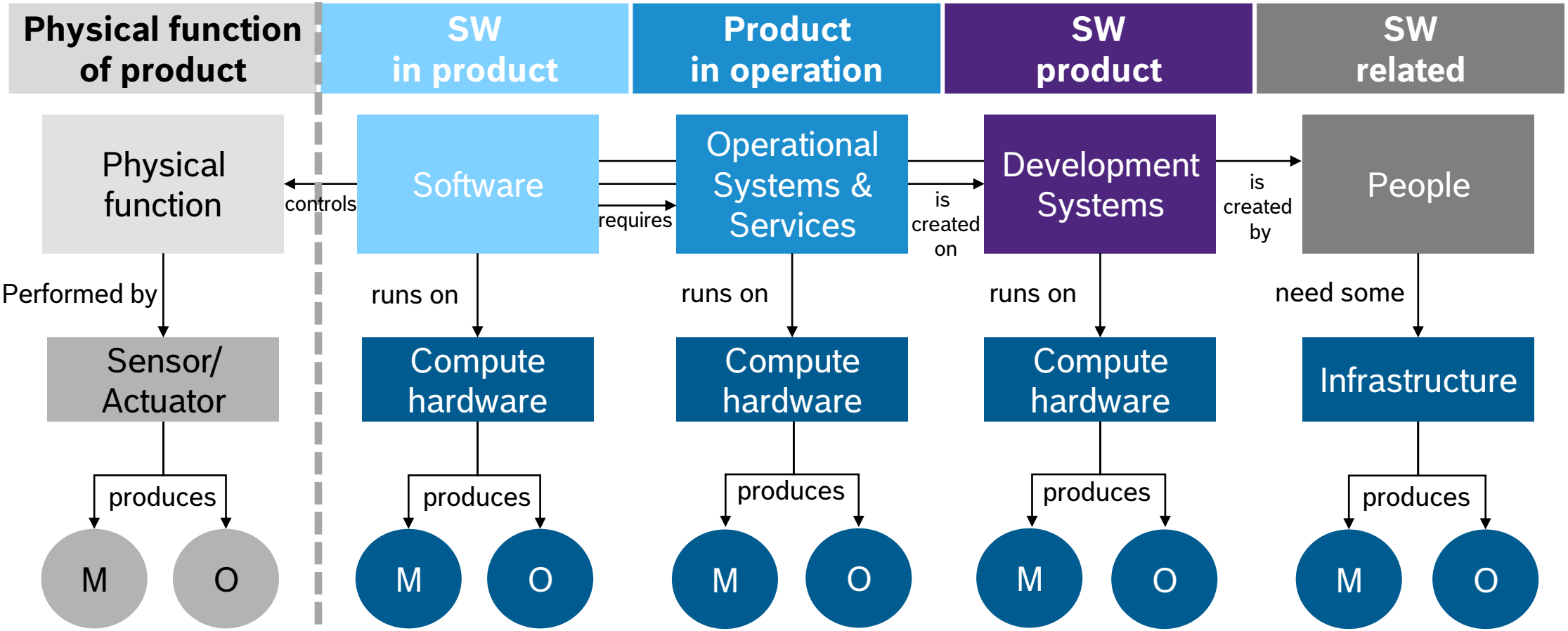
Producer

Operator

Concept Generation | Development | Production & Delivery | Product Operations | Phase Out

The Bosch Eco Footprint model

Big picture: The Software Boundary and Four Horizons of SW



M = embodied emissions, O = operational emissions, Derived from SCIS: Software Carbon Intensity Specification

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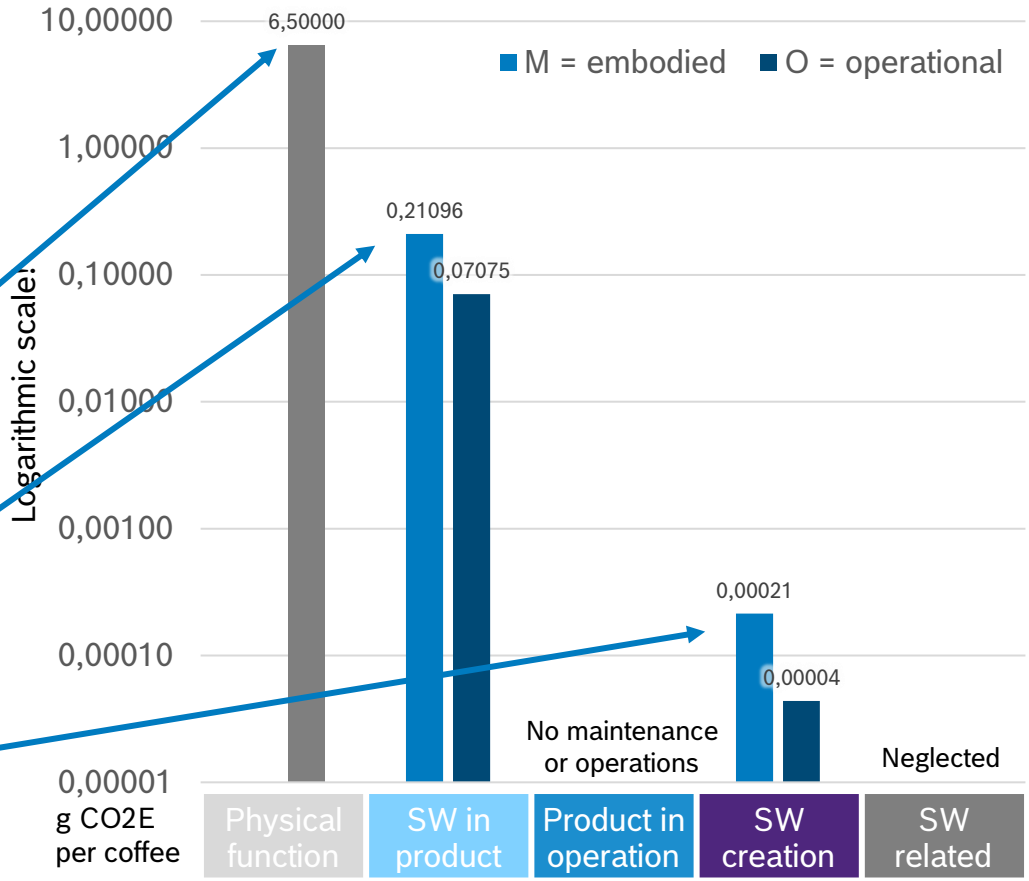
Software PCF (SCF)

Deep dive 1: Coffee maker (offline)

- Product function:
  Produce a cup of coffee
- Function of SW:
  Get user input, control coffee making process, display data.
- Functional unit for calculation:
  One cup of coffee
- Usage Profile:
  5 cups of coffee per day, 10 years usage

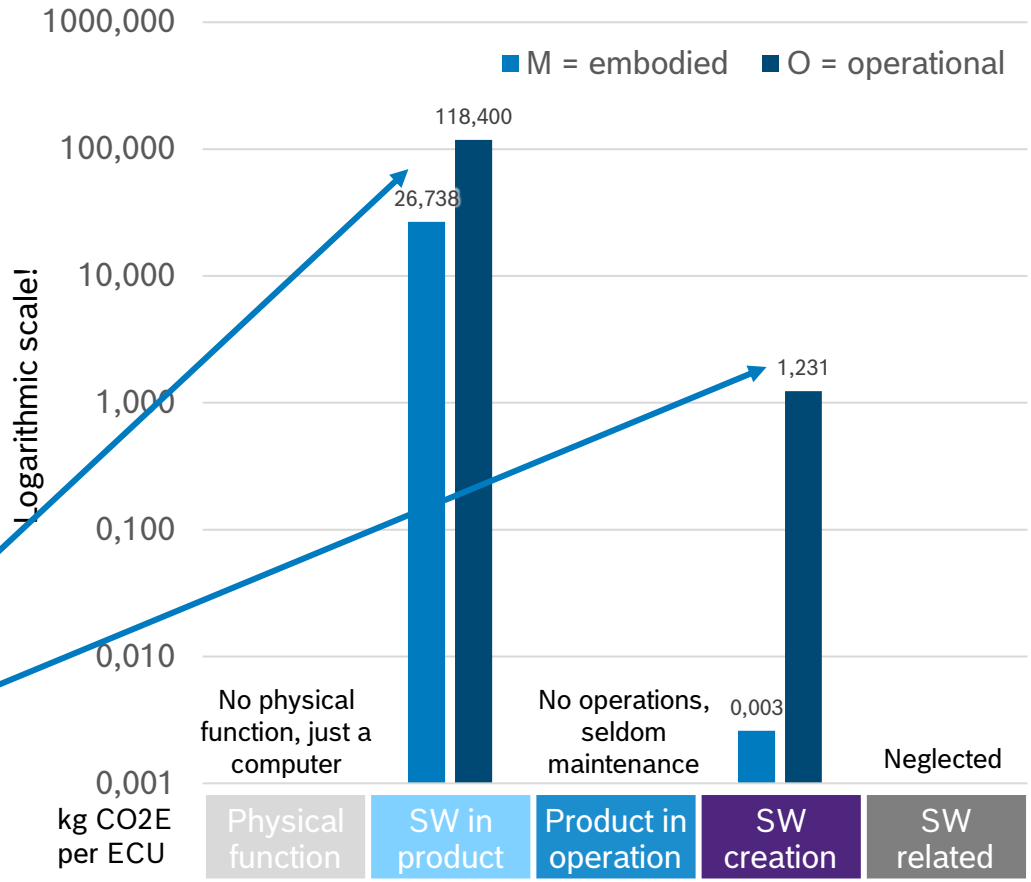
- Top levers of SCF:
  - Physical function. No real surprise.
  - $M_{SW\ in\ product}$ + $O_{SW\ in\ product}$ less than 5%, …
  - …but similar order of magnitude
  - $M_{SW\ in\ product}$ > $O_{SW\ in\ product}$
  - SW creation negligible



Software PCF (SCF)
Deep dive 2: Vehicle compute unit (VCU)

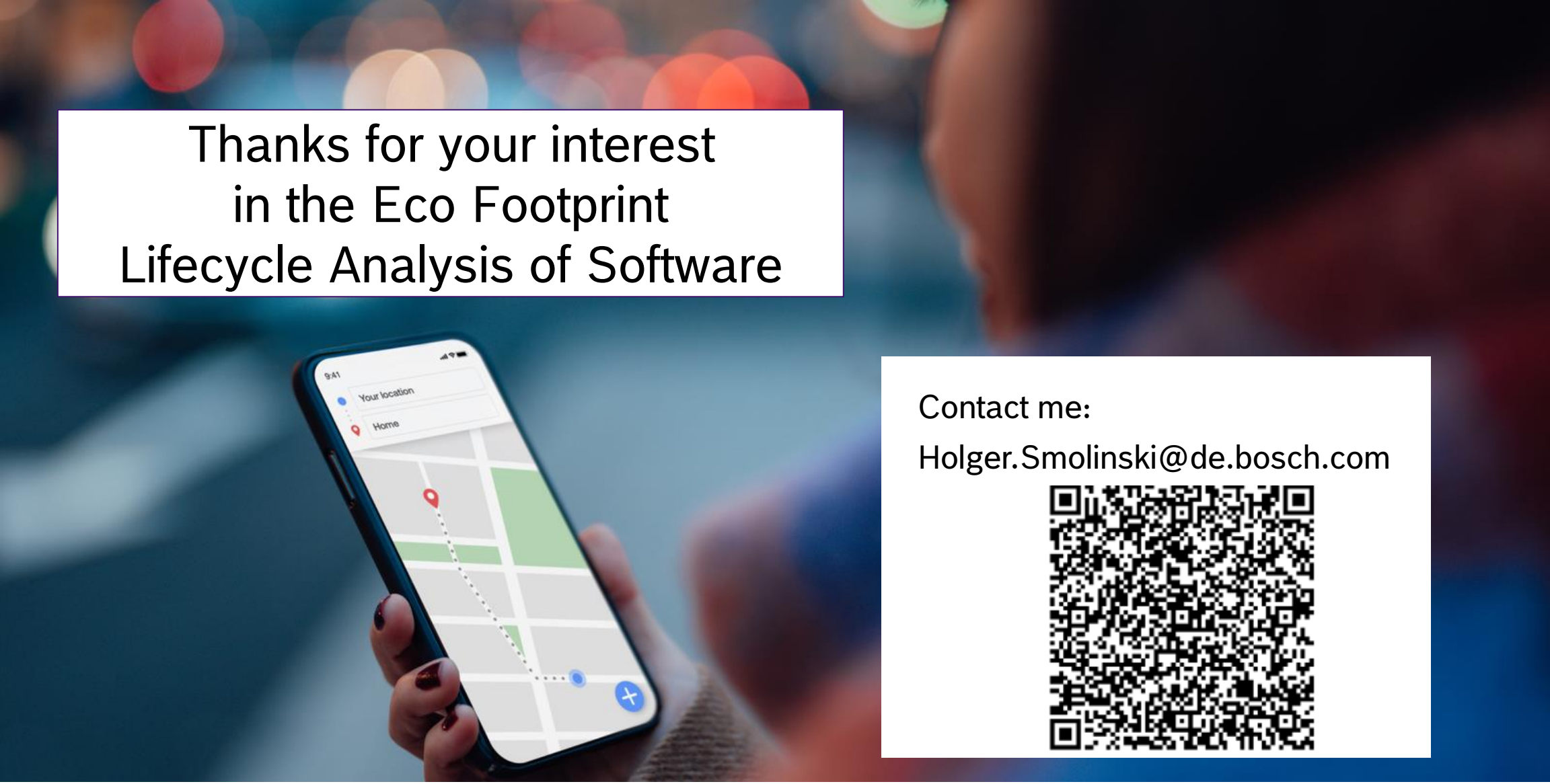
- Product function:
  Compute data, provide safety and comfort to driver.
- Function of SW:
  Collect sensor data, calculate driving trajectory based on environmental model.
- Functional unit for calc.:
  Lifetime of one ECU
- Assumptions, constraints (excerpt):
  1 million units, 100PB training data

Symbolic picture



- Top levers of SCF:
  - $M_{SW\ in\ product} < O_{SW\ in\ product}$, like any computer
  - SW creation negligible due to #units

Thanks for your interest in the Eco Footprint Lifecycle Analysis of Software



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