HOW AI (AND DATA) HAVE BEEN CHANGING THE GAME IN THE AUTOMOTIVE INDUSTRY

NEW TRENDS, CHALLENGES AND POTENTIAL SOLUTIONS

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AGENDA

1 ARTIFICIAL INTELLIGENCE vs SOFTWARE

KEY CONCEPTS

2 COMBINING VERY DIFFERENT ENGINEERING LIFECYCLES

3 OVERVIEW OF AI APPLICATIONS

4 EXAMPLE:
EMBEDDED SAFETY CRITICAL SYSTEM RELYING ON AI-POWERED CLOUD SERVICES

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ARTIFICIAL INTELLIGENCE vs SOFTWARE

KEY CONCEPTS

AI & GENERATIVE AI – (TECHNICAL) DEFINITIONS

- **ISO/IEC 22989** First edition (2022-07)
  - **AI**: research and development of mechanisms and applications of AI systems
  - **AI system**: engineered system that generates outputs such as content, forecasts, recommendations or decisions for a given set of human-defined objectives

What it DOES more than what it really IS!

- **3 questions that are important to me**
  - **How we (humans) create AI models.**
  - **Why? What are the benefits?**
  - **Are there any downsides?**

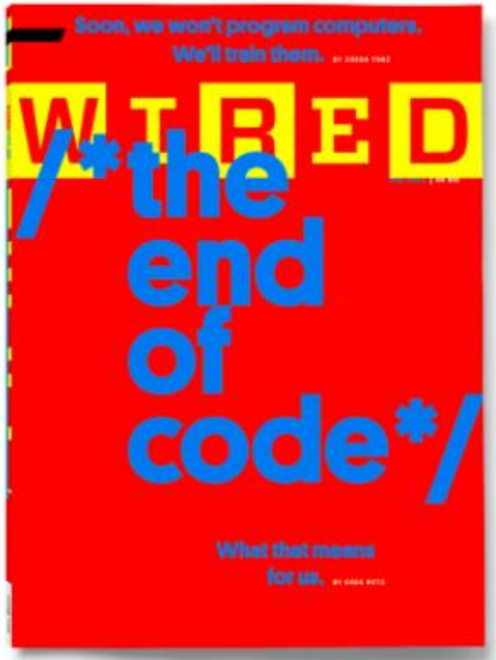
- **AI Act** (2024)
  - **AI system** means a machine-based system designed to operate with varying levels of autonomy and that may exhibit **adaptiveness after deployment** and that, for **explicit or implicit objectives**, infers, from the input it receives, how to **generate outputs** such as **predictions, content, recommendations, or decisions** that can influence physical or virtual environments
  - **General Purpose AI model (GPAI)** means an AI model, including when trained with a large amount of data using self-supervision at scale, that **displays significant generality and is capable to competently perform a wide range of distinct tasks** regardless of the way the model is placed on the market and that can be integrated into a variety of downstream systems or applications.

DECODING AI: 2 FUNDAMENTAL CONCEPTS

HOW WE (HUMANS) CREATE AI MODELS | **LEARNING, TRAINING**

2016

WIRED BACKCHANNEL BUSINESS CULTURE GEAR IDEAS SCIENCE SECURITY SIGN IN SUBSCRIBE



JUNE 2016. SUBSCRIBE NOW.

JASON TANZ IDEAS 05.17.2016 06:50 AM

Soon We Won't Program Computers. We'll Train Them Like Dogs

Welcome to the new world of artificial intelligence. Soon, we won't program computers. We'll train them. Like dolphins. Or dogs. Or humans.

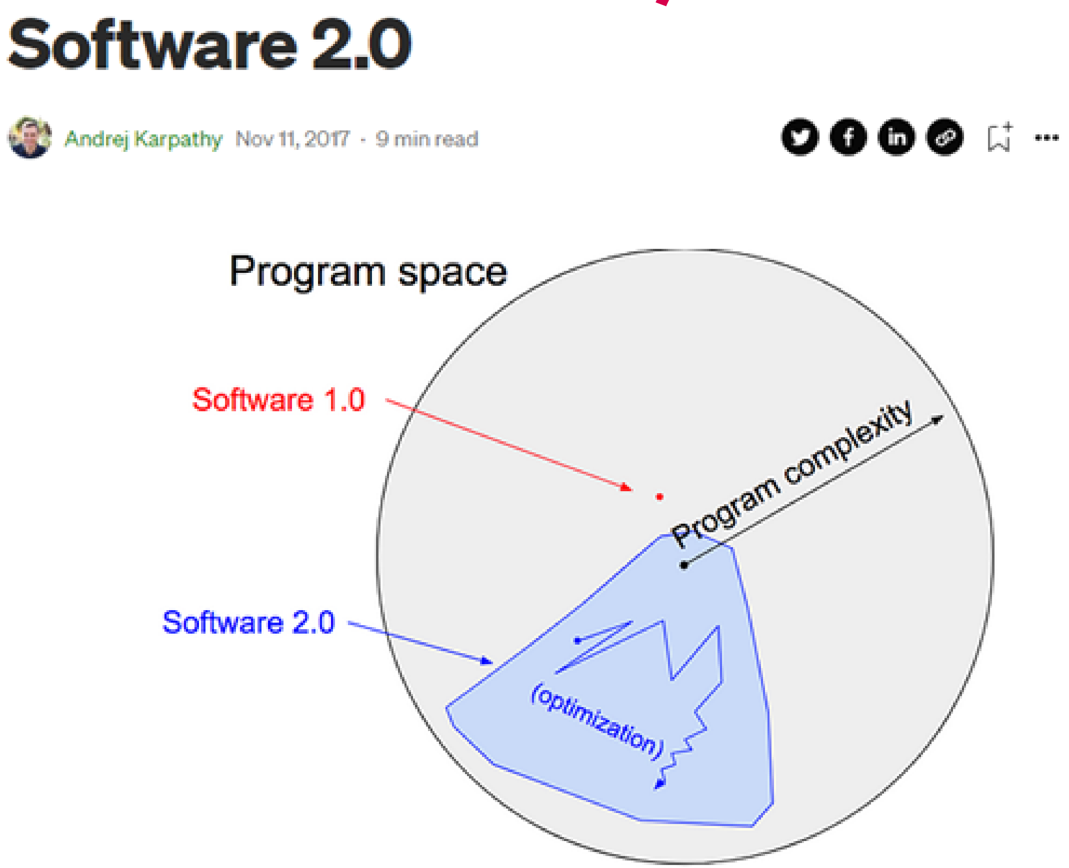
DECODING AI: 2 FUNDAMENTAL CONCEPTS

HOW WE (HUMANS) CREATE AI MODELS | **LEARNING, TRAINING**

> Software 2.0: No need that we (humans) must describe step-by-step solutions in an algorithm
> But still, humans organize and control the data-driven **training** of ML models
> A **lot** of different approaches and techniques:
  > **Complex** architectures (created by humans!)
  > New concepts **every day/week**
  > Most of them **open-source**

> Machine Learning, Neural Networks, Deep Learning
> Reinforcement Learning
> Supervised Learning, Unsupervised Learning, **Self-supervised Learning**
> Autoencoders
> Generative Adversarial Networks
> Diffusion Models
> **Transformers (attention)**
> Mamba (structured state space models)
> **Generative AI**
> Pretrained models, Foundation models
> …

2017



source: https://karpathy.medium.com/software-2-0-a64152b37c35

DECODING AI: 2 FUNDAMENTAL CONCEPTS

WHY USING AI? THE ABILITY TO **GENERALIZE**

> ML model are capable of **generalization**
  > Predictive AI: **Make (good) predictions from input data that have not been seen during training**
  > Warning: out-of-distribution problem:
    > unreliable predictions when encountering inputs significantly different from those seen during training

> AI models are best suited for problems that can leverage generalization capabilities:
  > eg: computer vision (cameras)
  > High dimensionality, "Large" problems
  > "Open" problems, possibly not completely defined, with many acceptable, "almost" optimal solutions
  > Complex decisions at a constant computation cost

Semantic Segmentation
Examples of DeepLabv3 Visualization results on Cityscapes dataset
https://arxiv.org/pdf/1706.05587v3.pdf

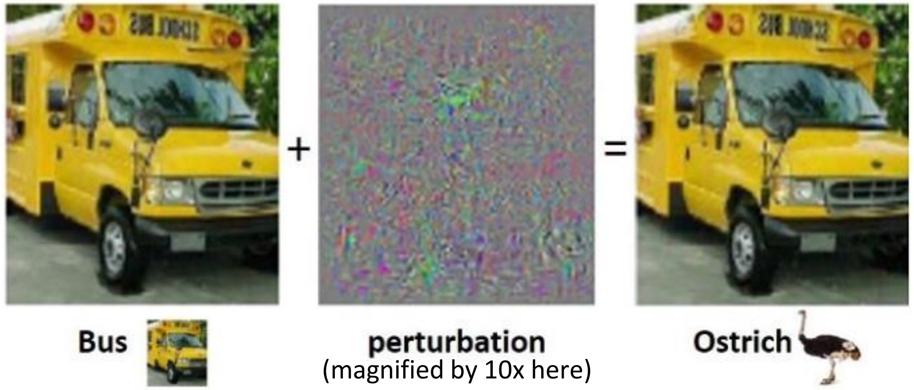
THE FLIP SIDE OF AI CAPABILITIES

LEARNING AND GENERALIZATION COME AT A PRICE…

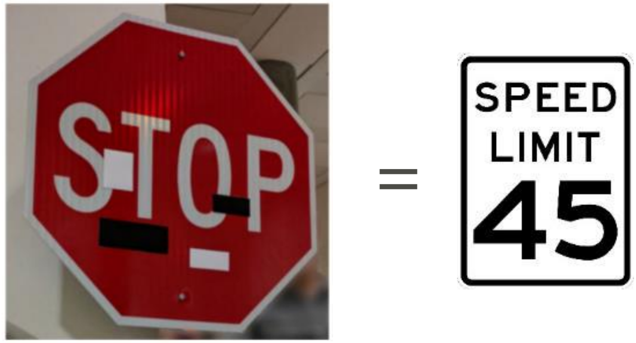
> **What does "good predictions" mean?**
  > We cannot list all possible cases (and requirements)!
  > We cannot just look at the neural network weights!
  > Chaos theory, strong dependence on initial conditions
  > Sparsity, only a small portion of the input space contains significant data points or information

Always a confidence level < 100%

> Consequence: many **transformation** stakes!
  > Engineering processes for data and AI systems are **radically different** than software development
  > Need for **new trustworthiness concepts** and indicators (never 100%)



Source "**Intriguing properties of neural networks**"
https://arxiv.org/abs/1312.6199



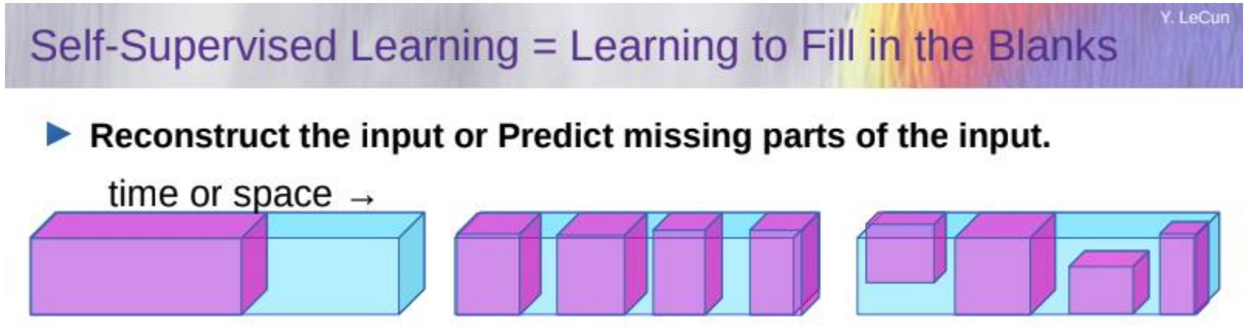
Source "**Robust Physical-World Attacks on Deep Learning Models**"
https://arxiv.org/abs/1707.08945

GENERATIVE AI – A STEP BEYOND

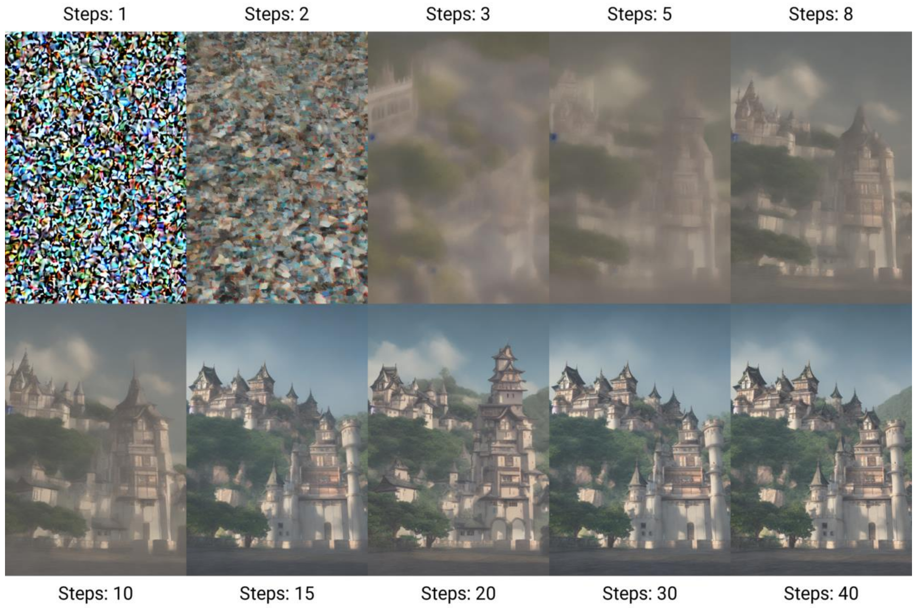
GENERATING DATA THAT ARE **SIMILAR** TO TRAINING DATA

- Learning **scaled to the limits** with Self-Supervised Learning
  - The “guess the next word” game is quite easy to setup
  - Same for “guess the noise I’ve added” for images
- Very large scale
  - Models with billions of parameters (1B to 500B)
  - Training data: 1 to 2 trillion tokens
- After such massive training, surprising capabilities are emerging
- “Confidence level” has no sense anymore!

No more confidence level!



source: Yann LeCun



The denoising process used by Stable Diffusion

https://en.wikipedia.org/wiki/Diffusion_model#/media/File:X-Y_plot_of_algorithmically-generated_AI_art_of_European-style_castle_in_Japan_demonstrating_DDIM_diffusion_steps.png

How AI Image Generators Work – Computerphile (short video <20 min)
https://www.youtube.com/watch?v=1CIpzeNxIhU

2 COMBINING VERY DIFFERENT ENGINEERING LIFECYCLES

ONCE UPON A TIME IN THE AUTOMOTIVE INDUSTRY

(WITH THE PERSPECTIVE OF A SOFTWARE ENGINEER)

Automotive Products Lifecycle

Design → Development → Manufacturing → Operations

2- 5 YEARS
(new product)

millions of vehicles

A REVOLUTION IN PROGRESS

ELECTRIFICATION, NEW ELECTRIC/ELECTRONIC ARCHITECTURES, SOFTWARE-DEFINED VEHICLE

FROM AUTOMOTIVE PRODUCTS TO MOBILITY SERVICES

CARMAKERS BECOMING TECH COMPANIES

RENAULUTION (2021)

> **"We'll move from a car company working with tech to a tech company working with cars."**

> https://group.renault.com/en/our-company/strategic-plan/

CARMAKERS BECOMING TECH COMPANIES

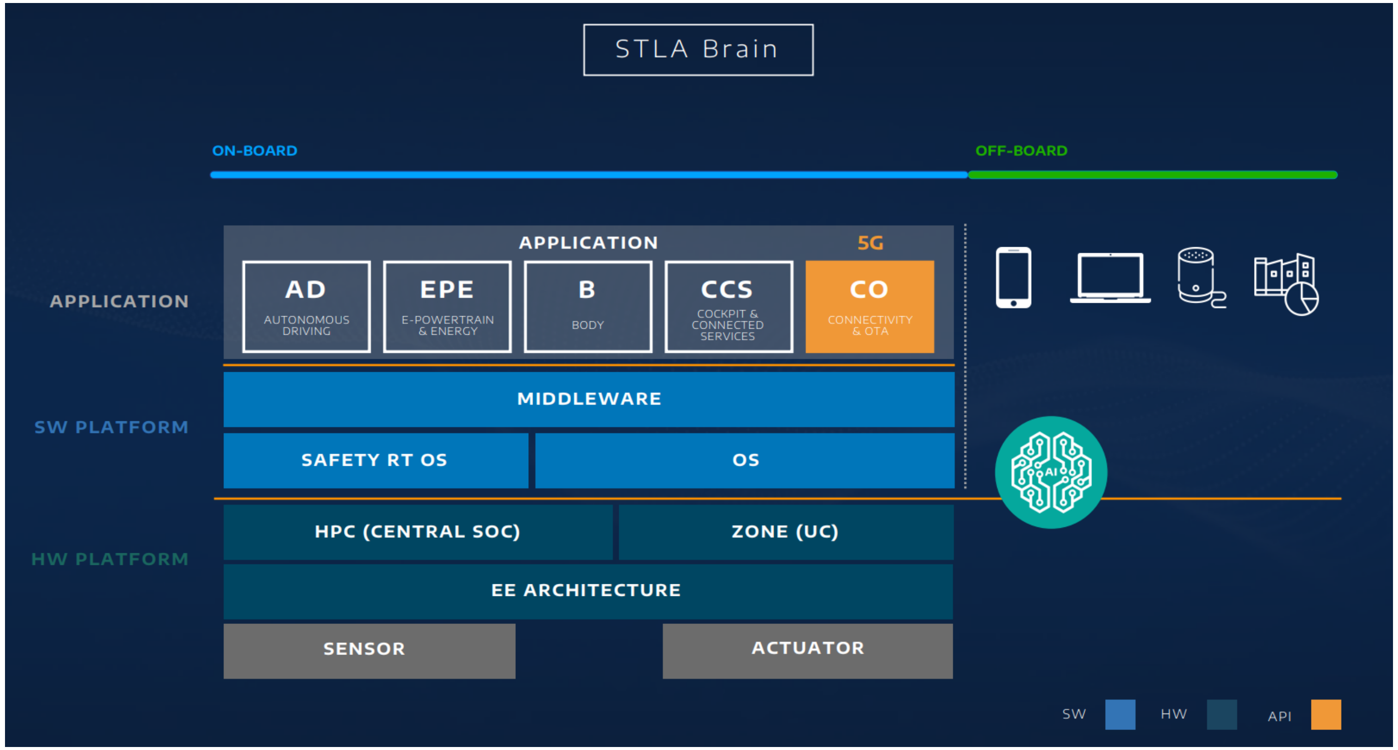
STELLANTIS SOFTWARE DAY (2021)

> “This transformation will move Stellantis’ vehicles **from today’s dedicated electronic architectures to an open software-defined platform** that seamlessly integrates with customers’ digital lives.”

> “Our electrification and software strategies will support the shift to become a sustainable mobility tech company to lead the pack […]
With the three all-new **AI-powered technology platforms** to arrive in 2024, […] we will leverage the **speed and agility associated with the de-coupling of hardware and software cycle**.” - *Carlos Tavares, Group CEO*

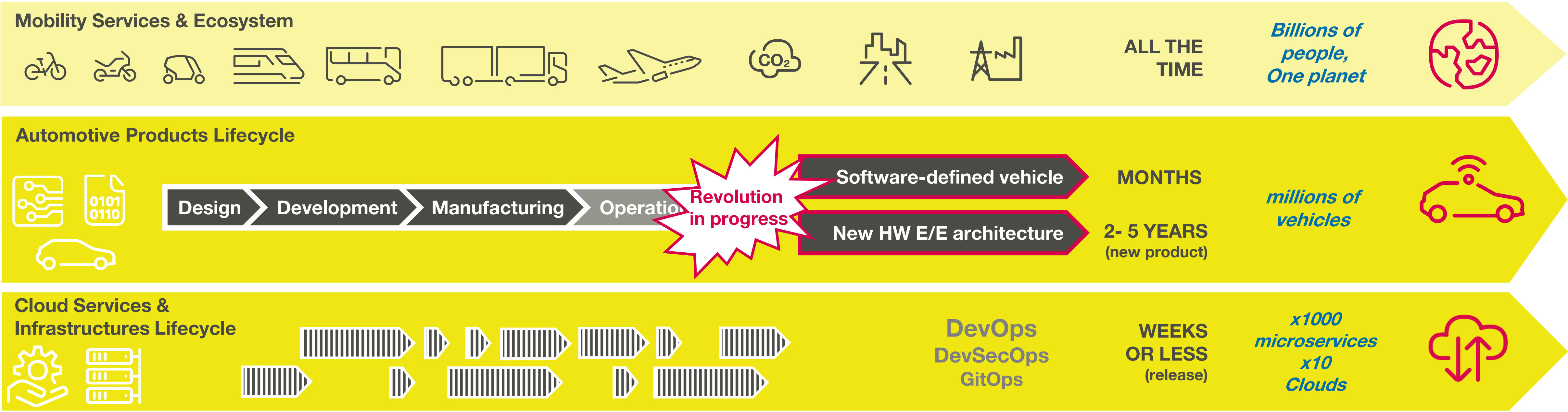
> https://www.stellantis.com/en/investors/events/sw-day-2021

December 7, 2021 - Stellantis Software Day 2021



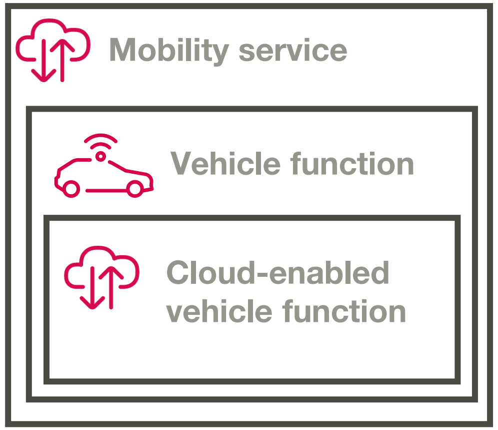
CONNECTED CARS

COMPLEX DEPENDENCIES BETWEEN EMBEDDED AND CLOUD SOFTWARE



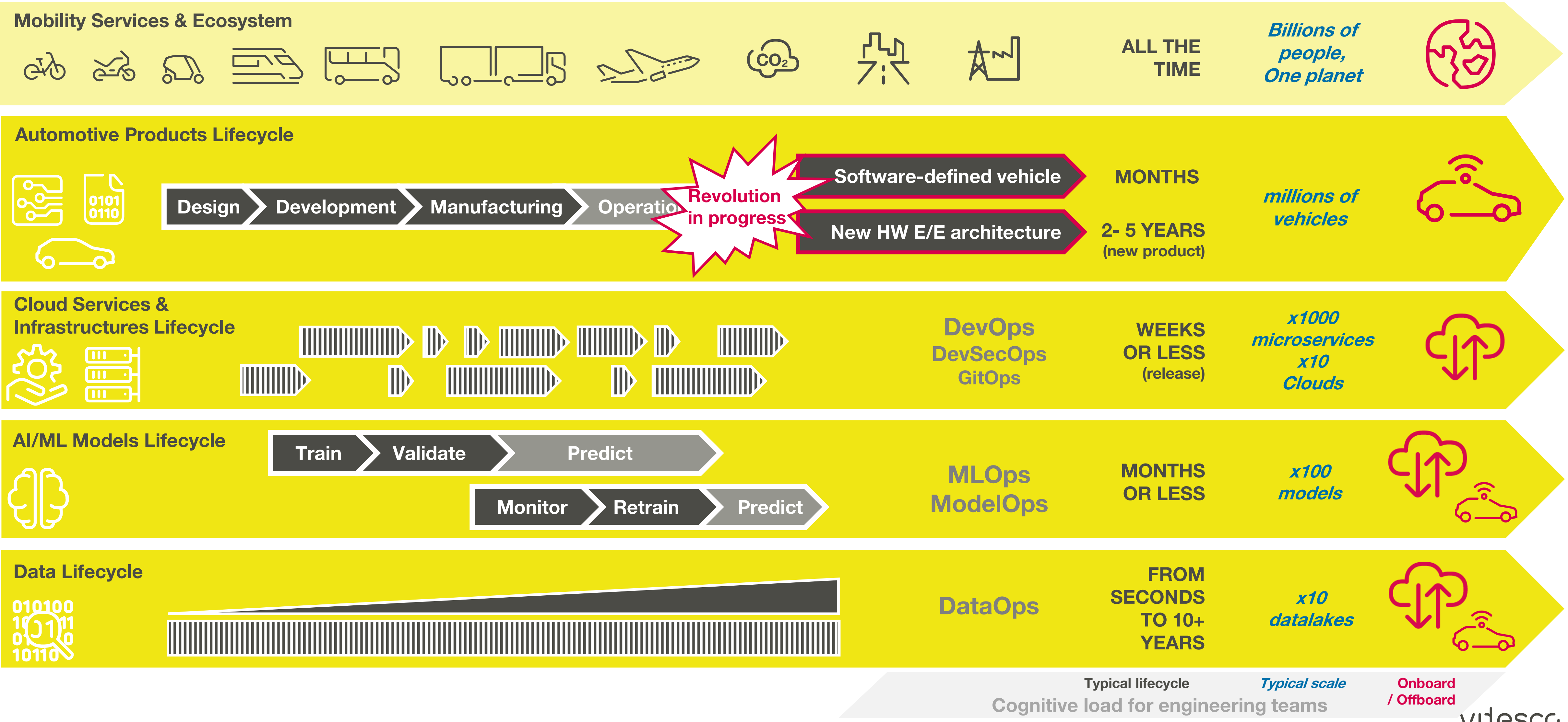
Note: actually, this is NOT a stack ☺

Cloud services
- for mobility services (downstream)
- for embedded automotive systems (upstream)



ADDING DATA & AI IN THE PICTURE

COMBINING VERY DIFFERENT ENGINEERING LIFECYLES



GENERATIVE AI IS CHANGING THE AI GAME

WITH PRETRAINED FUNDATION MODELS, FINE-TUNING...

Mobility Services & Ecosystem

ALL THE TIME

Billions of people, One planet

Automotive Products Lifecycle

Design → Development → Manufacturing → Operatio…

Revolution in progress

Software-defined vehicle

New HW E/E architecture

MONTHS

2- 5 YEARS (new product)

millions of vehicles

Cloud Services & Infrastructures Lifecycle

DevOps
DevSecOps
GitOps

WEEKS OR LESS (release)

x1000 microservices
x10 Clouds

AI/ML Models Lifecycle

Monitor → Retrain → Predict

Train → Validate → Predict

Revolution in progress

Pretrained model → Fine-tune → Predict

MLOps
ModelOps

MONTHS OR LESS

x100 models

Data Lifecycle

DataOps

FROM SECONDS TO 10+ YEARS

x10 datalakes

Typical lifecycle | *Typical scale* | Onboard / Offboard

Cognitive load for engineering teams

3 OVERVIEW OF AI APPLICATIONS

AI APPLICATIONS LANDSCAPE IN AUTOMOTIVE & MOBILITY

A WIDE RANGE OF PRODUCTS AND SERVICES – A WIDE RANGE OF USERS

upstream | downstream

What (scope)

Components — Systems & Functions — **Vehicle** — V2X — Fleets Mobility Services — Cross-domains collaboration

R&D Engineers — Workers — Drivers — (Mobility) Consumers — Citizens — Earth's inhabitants

Who (users)

Example later

Simulation

Energy management

Crowdsourced maps & info

Road traffic safety improvement

Torque / Power split

Eco driving

EV & Smart grids

Driving assistance

Autonomous driving

Traffic forecast

Life Cycle Engineering

Supply chain optimization

Robo-taxis operations

CO2 emissions reduction

Predictive maintenance

Pay as/how you drive insurance

Architecture, design, sizing

Manufacturing

Vehicles marketing & sales

Fleet management

Smart cities

Now my focus is more here

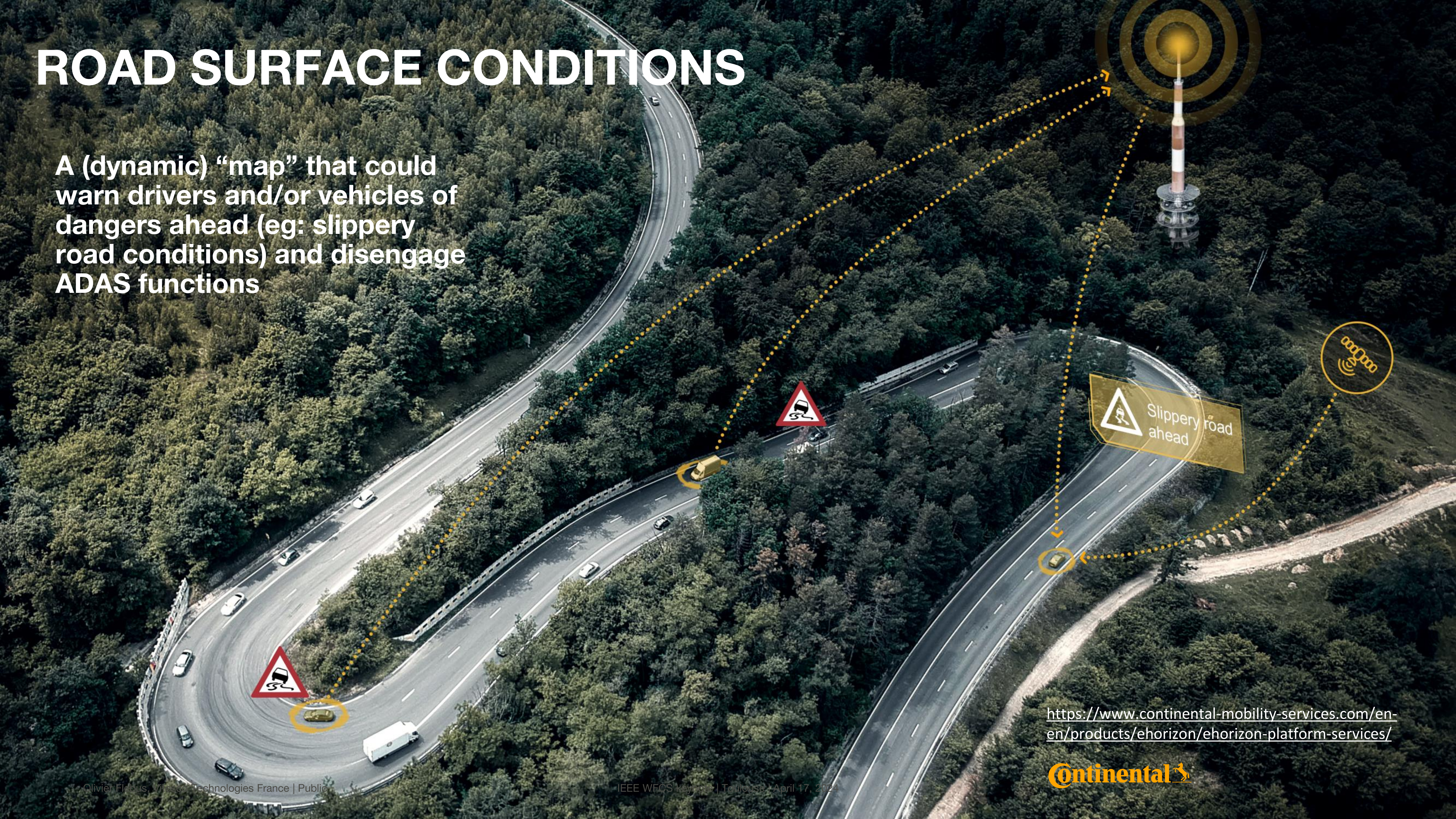
I started my automotive journey here

4

EXAMPLE:
EMBEDDED SAFETY CRITICAL SYSTEM RELYING ON AI-POWERED CLOUD SERVICES

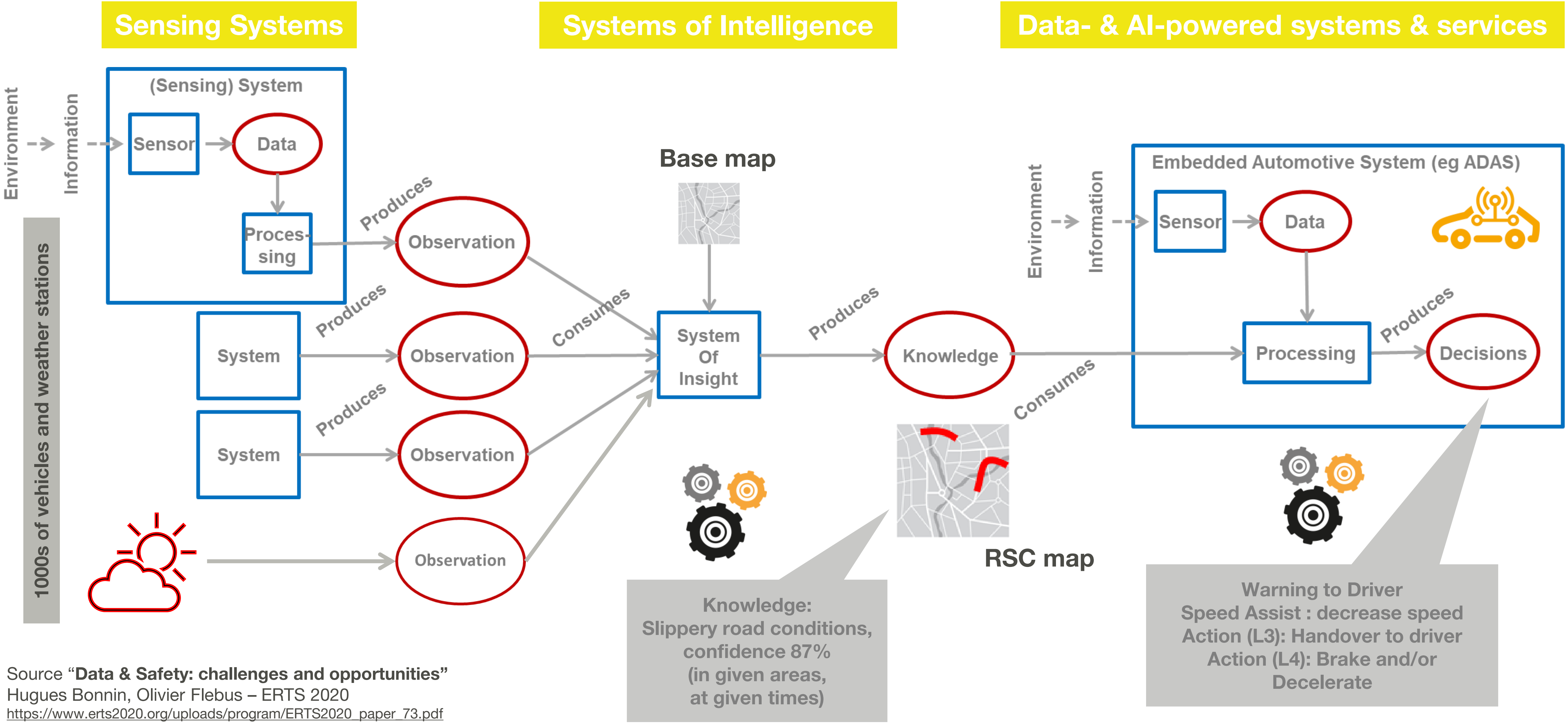
ROAD SURFACE CONDITIONS

A (dynamic) “map” that could warn drivers and/or vehicles of dangers ahead (eg: slippery road conditions) and disengage ADAS functions



https://www.continental-mobility-services.com/en-en/products/ehorizon/ehorizon-platform-services/

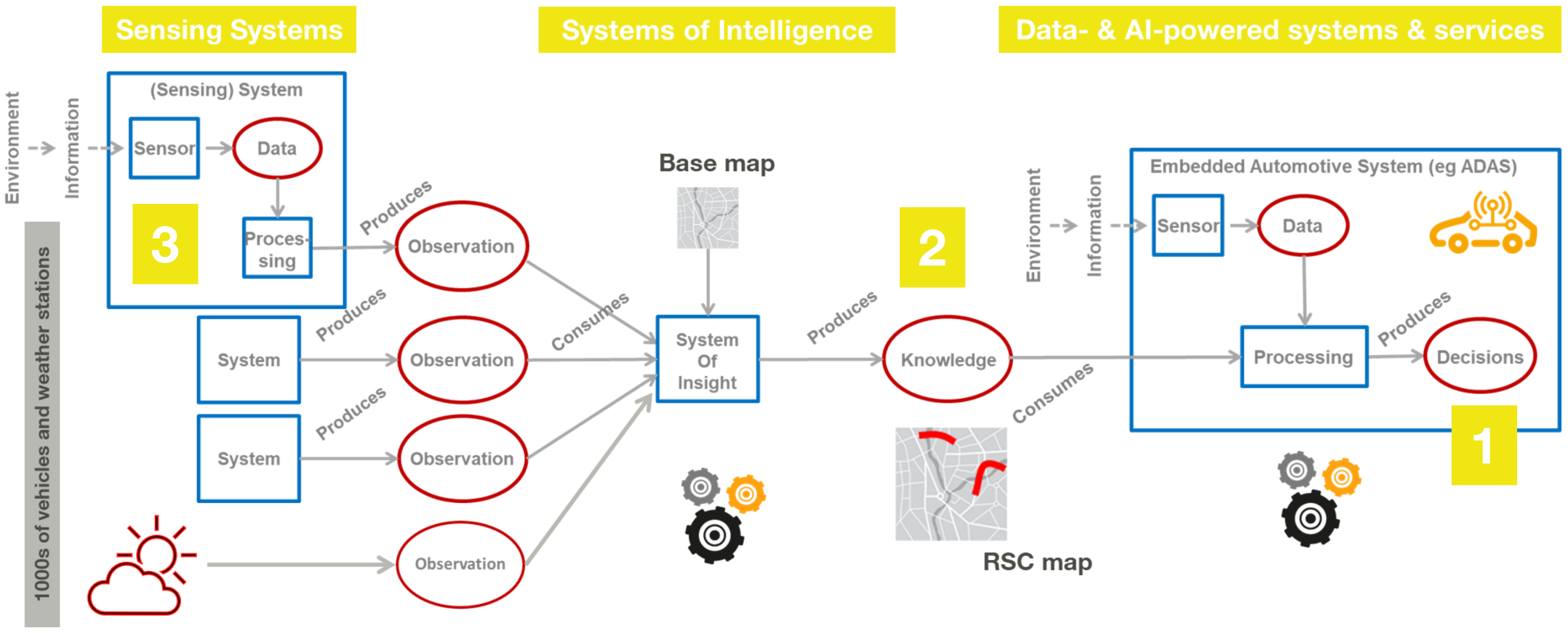
A (SIMPLIFIED) SOLUTION FOR ROAD SURFACE CONDITIONS



Source “**Data & Safety: challenges and opportunities**”
Hugues Bonnin, Olivier Flebus – ERTS 2020
https://www.erts2020.org/uploads/program/ERTS2020_paper_73.pdf

A FEW CHALLENGES

AND MAIN QUESTION: CAN WE CONSIDER ALL OF THEM AT THE SAME TIME?



1 Safety of Decisions?

- > Trust in Knowledge from the cloud
- > New interface?

2 Trust in Knowledge?

- > Safety of IA/ML
- > Data redundancy

3 Trust in Observation?

- > Data Quality
- > Sensor Quality
- > Processing Quality

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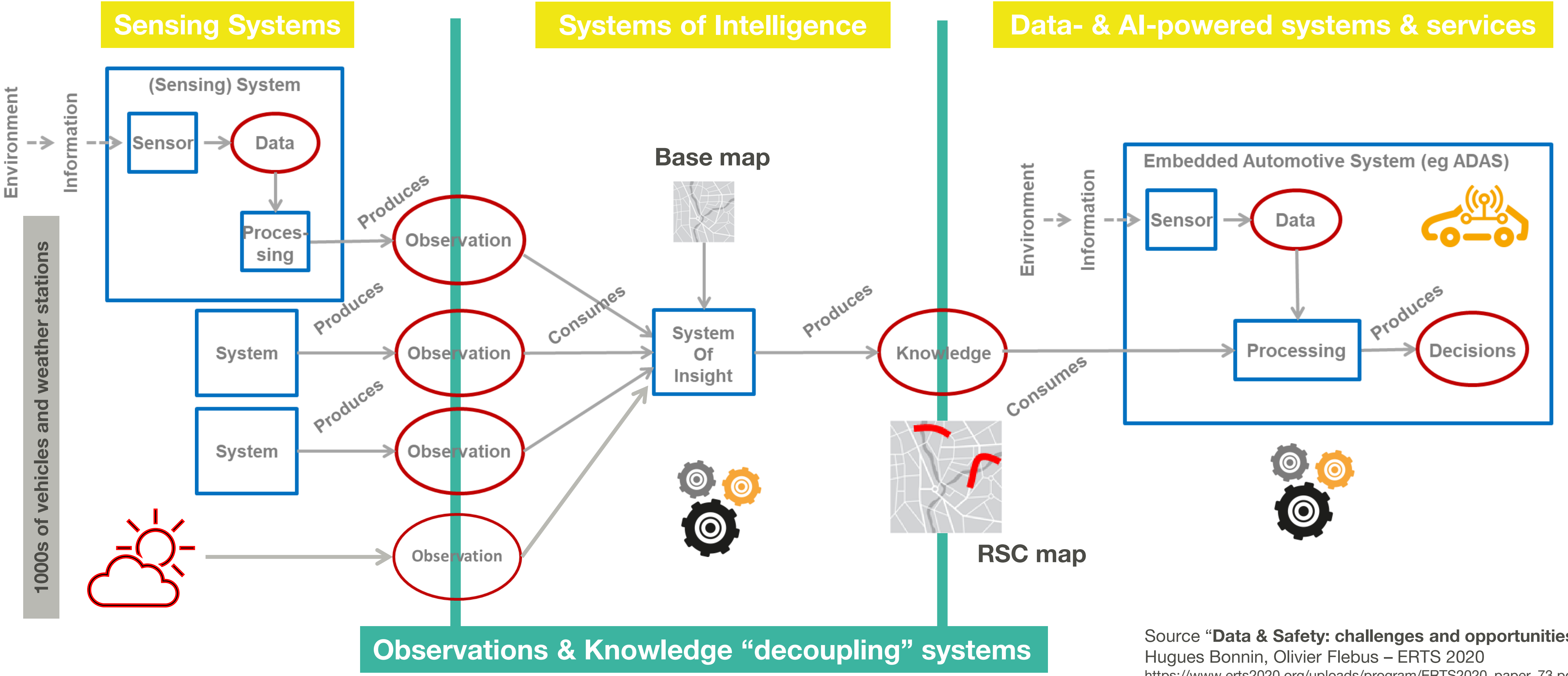
PROPOSED APPROACH

(EXTERNAL) DATA TO DECOUPLE SYSTEMS



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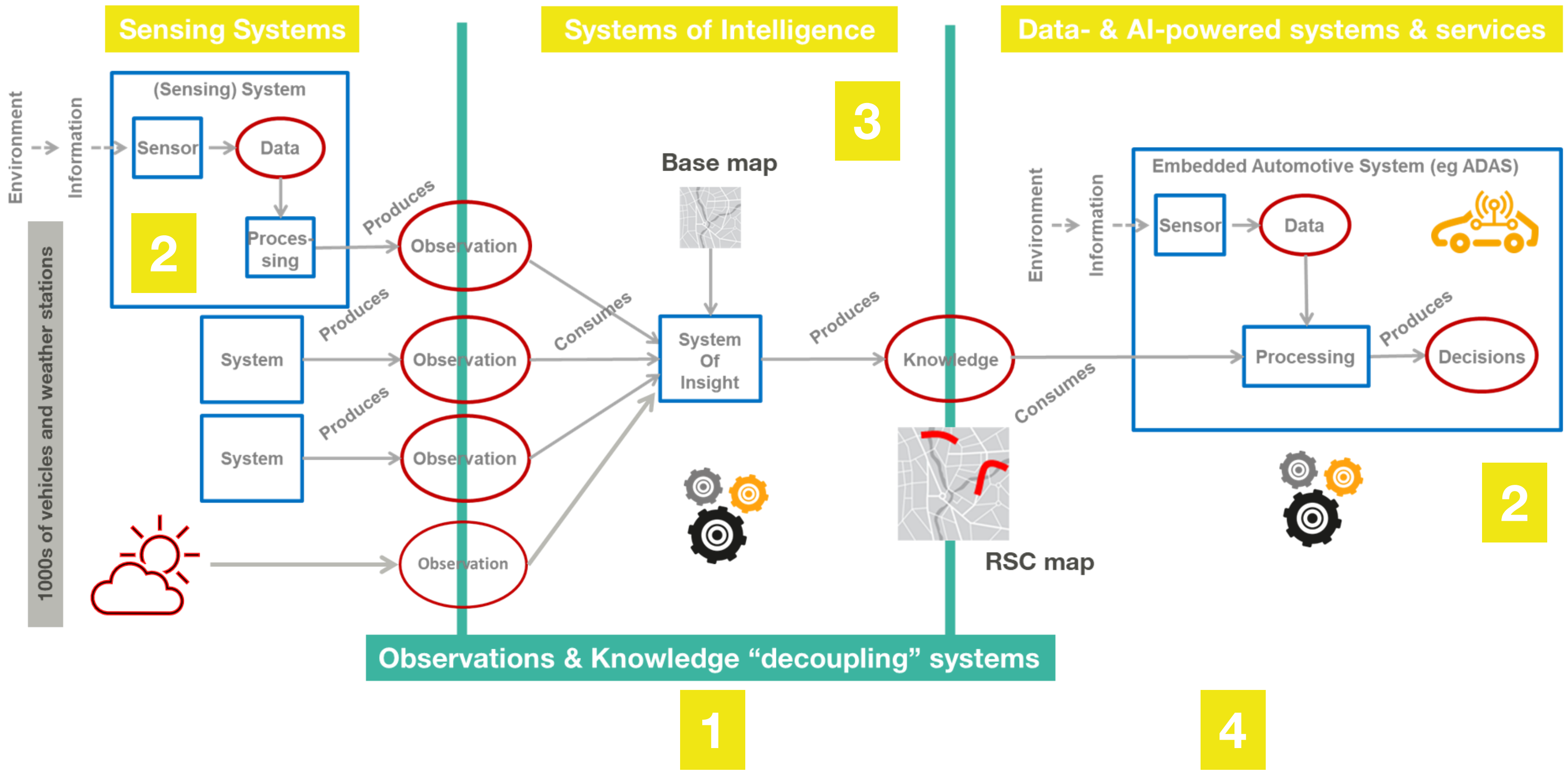
CHAINS OF TRUST COMBINING DATA & SYSTEMS

WHAT ARE THE NEXT STEPS?



1 Build the confidence in data (means, level, methods)

2 Adjust (or not) the existing standards to integrate the "Safe Data" ones

3 Define Safety for systems of intelligence

4 Don't forget the transfer integrity! (everywhere)

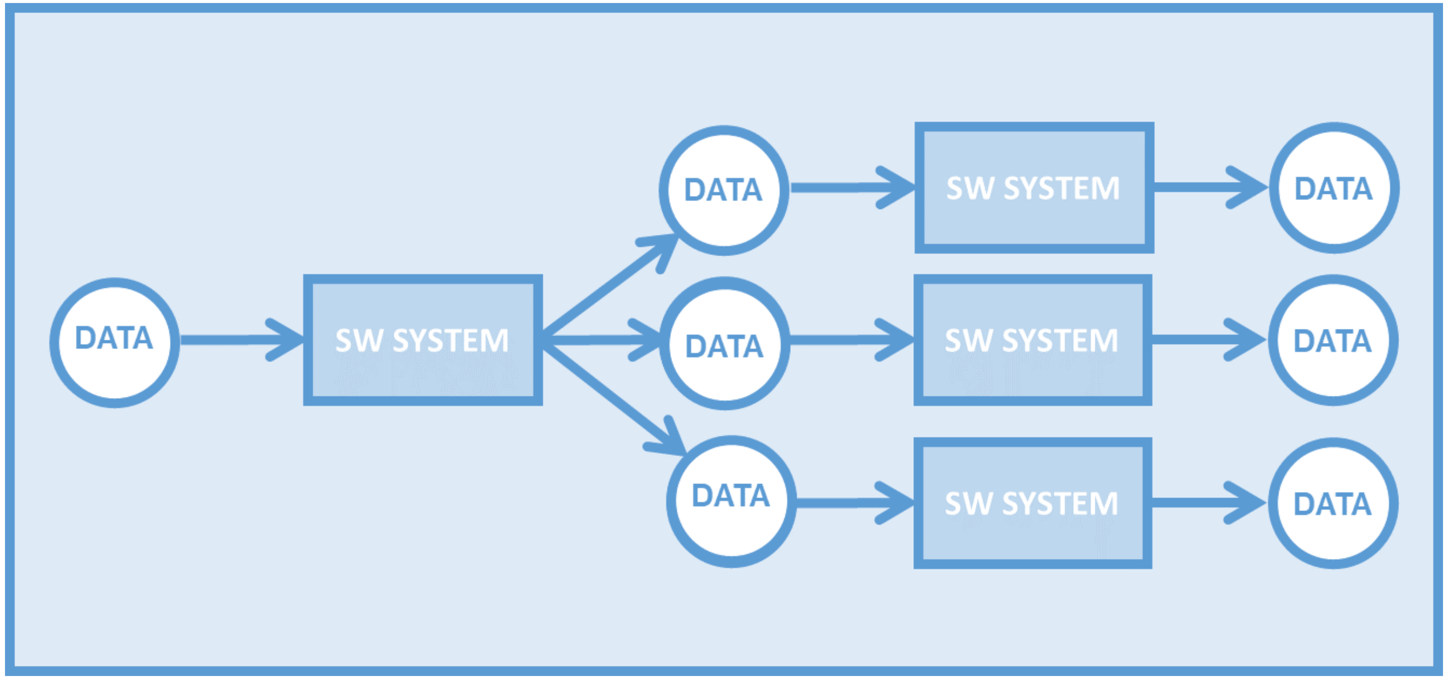
Source "**Data & Safety: challenges and opportunities**"
Hugues Bonnin, Olivier Flebus – ERTS 2020
https://www.erts2020.org/uploads/program/ERTS2020_paper_73.pdf

DATA INSIDE SYSTEMS

THE TRADITIONAL APPROACH…

> Data as a way to exchange/distribute information to “processors”
>> “Real-Time”

> Data as a way to connect Systems (into “bigger Systems”)
>> Limits?

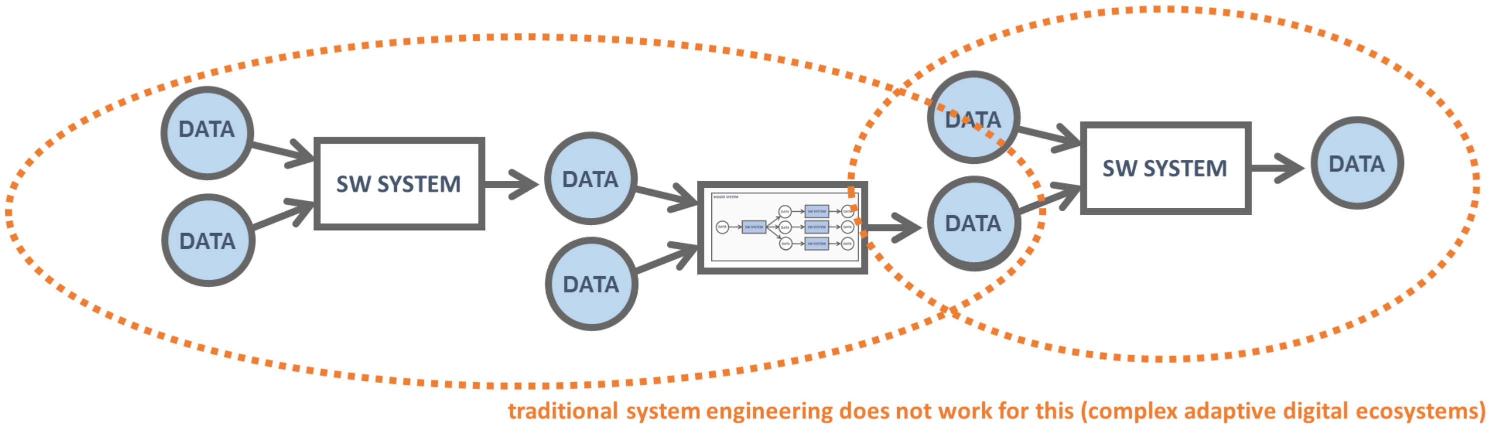


In that case Data MAY be governed by the System it belongs to

DATA OUTSIDE SYSTEMS ≈ DATA AS A PRODUCT

THE DATA-DRIVEN APPROACH…

- Data as a way to decouple systems
- Data that outlive the systems that have created/processed them!
- Data as a product, data as an asset
- Data to build "Chains of trust" that cover extended lifecycles across multiple organizations



In that case Data is likely to be governed on its own

CONCLUSION

AND A QUESTION

- Knowing that data outlive the systems that created them…
- …What should we most care about?
  - The pipes?
  - The water?
- BTW the lake is another system like the pipe…
  - Its governance a more complex though

ARE YOU INSPIRED?