1) Next Perception
and
2) a CTL* model checker

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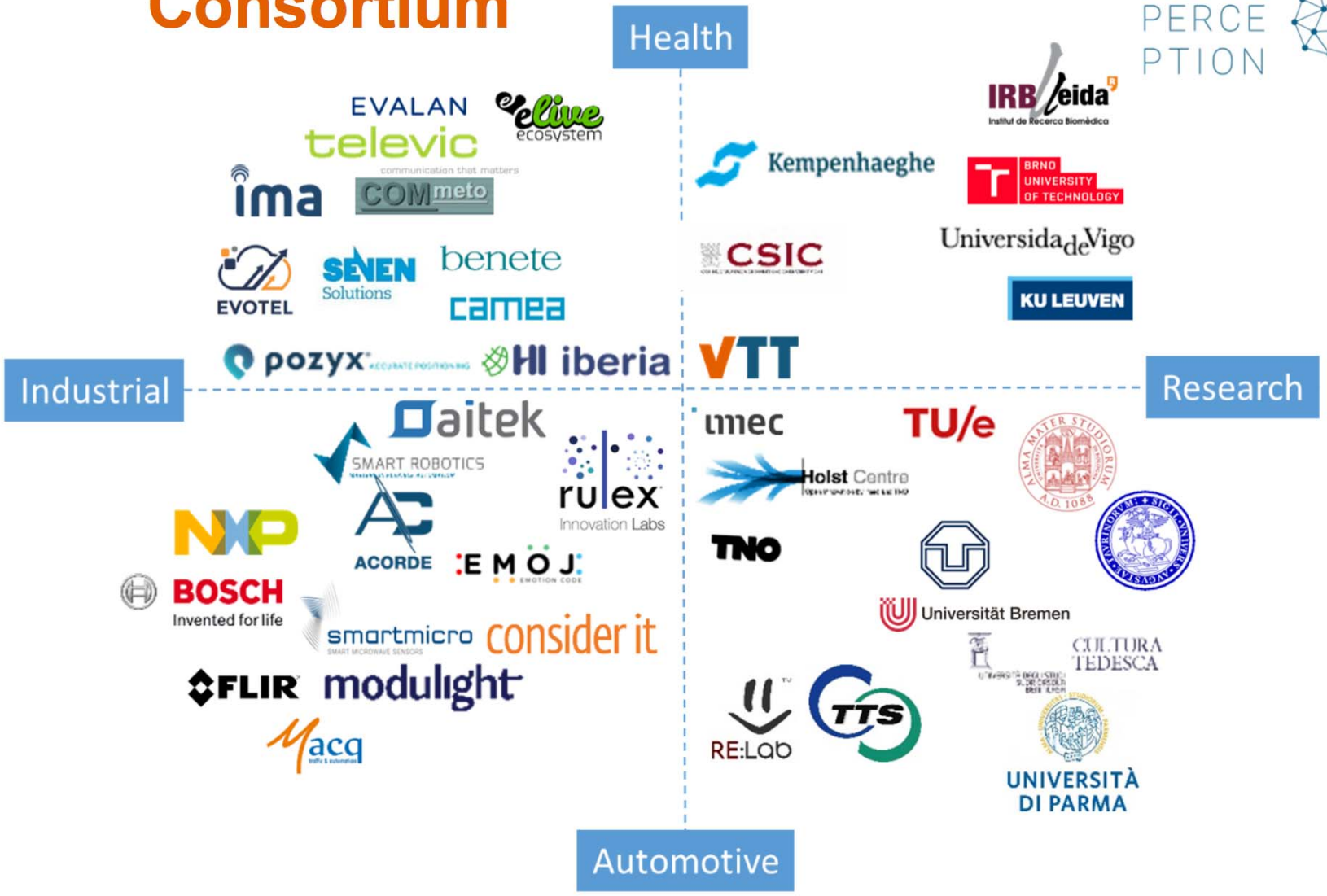
Next Perception

It is an ECSEL project coordinated by VTT (Finland), project coordinator is Johan Plomp

41 partners (usual mixture of academia, research center, and SME), more than 3K PM

Start date: May 2020

Consortium



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Partners

Participant organisation name	Participant short name	Country
Teknologian tutkimuskeskus VTT oy	VTT	FI
Acorde Technologies	ACORDE	ES
Aitek Societa per Azio	AITEK	IT
Benete	BENETE	FI
Robert Bosch Gmbh	BOSCH	DE
BUT	BUT	CZ
Camea	CAMEA	CZ
Commeto	CMMTO	BE
CSIC	CSIC	ES
eLive	ELIVE	FI
Emoj	EMOJ	IT
Evalan Bv	EVALAN	NL
Evotel Informatica Sl	EVOTEL	ES
Flir Systems Trading	FLIR	BE
Hi Iberia	HIB	ES
IMA	IMA	CZ
IMEC(NL) (HOLST)	HOLST	NL
IMEC	IMEC	BE
Univ Lleida (IRBLL)	IRBLL	ES
Stichting Kempenhaeghe	KPNHGE	NL
KU Leuven	KUL	BE

Participant organisation name	Participant short name	Country
Macq Sa	MACQ	BE
Modulight	MODUL	FI
NXP Semiconductors Germany	NXPDE	DE
Nxp Semiconductos NL	NXPNL	NL
Pozyx Labs	POZYX	BE
RELAB	RELAB	IT
RULEX	RULEX	IT
Sensoftia	SENSOF	FI
Seven Solutions	7SOLS	ES
Smart Robotics	SMR	NL
TNO	TNO	NL
TTS	TTS	FI
TU Dresden	TUD	DE
Technische Universiteit Eindhoven	TUE	NL
University of Bologna	UNIBO	IT
University of Bremen	UBREMEN	DE
University of Parma	UNIPR	IT
UNISOB	UNISOB	IT
UNITO	UNITO	IT
Universidad de Vigo	UVIGO	ES

UNITO work in NextPerception

Main GOAL:

A formal methodology for assessing the safety of machine learning enabled systems is the primary goal UNITO would like to achieve.

Goal

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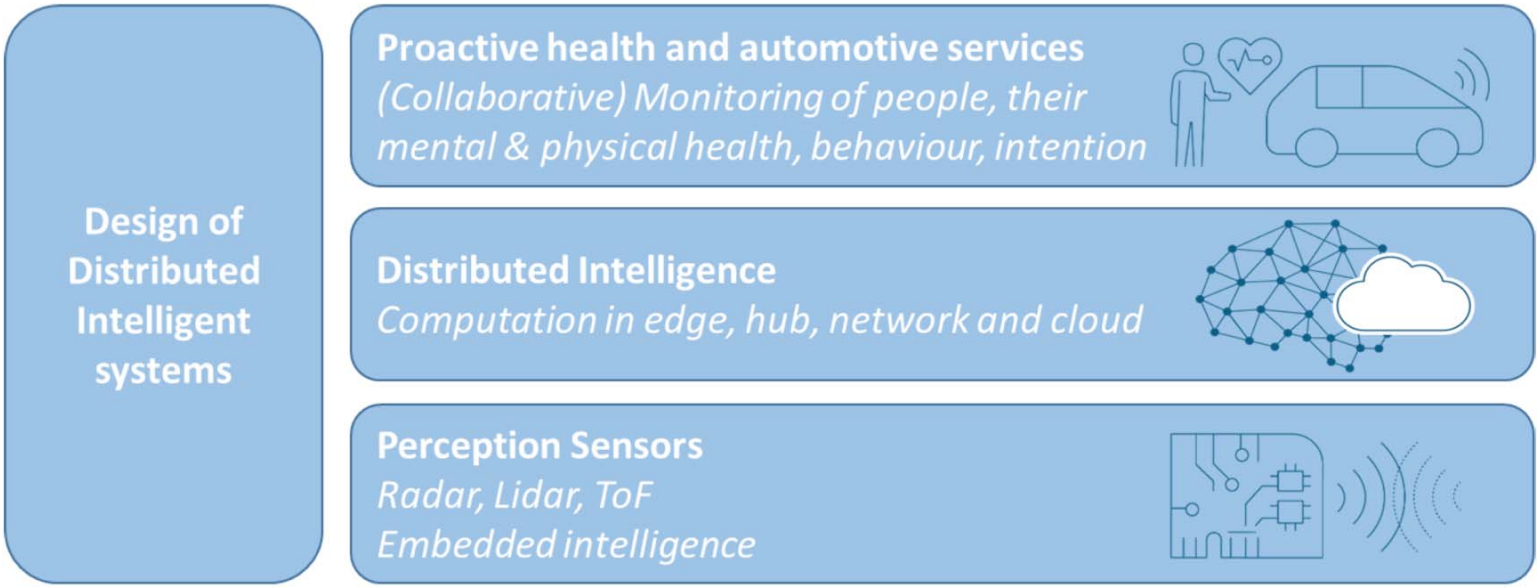
The goal is to develop next generation smart perception sensors and enhance the distributed intelligence paradigm to build versatile, secure, reliable, and proactive human monitoring solutions for the health, wellbeing, and automotive domains



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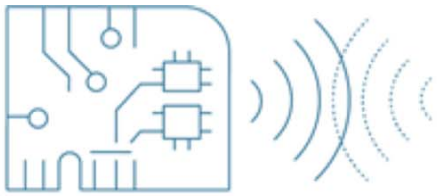
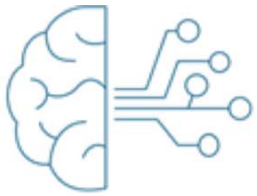
Objectives



O1: Accurate and unobtrusive sensing of human behaviour and physiological parameters by means of innovative perception and complementary sensors

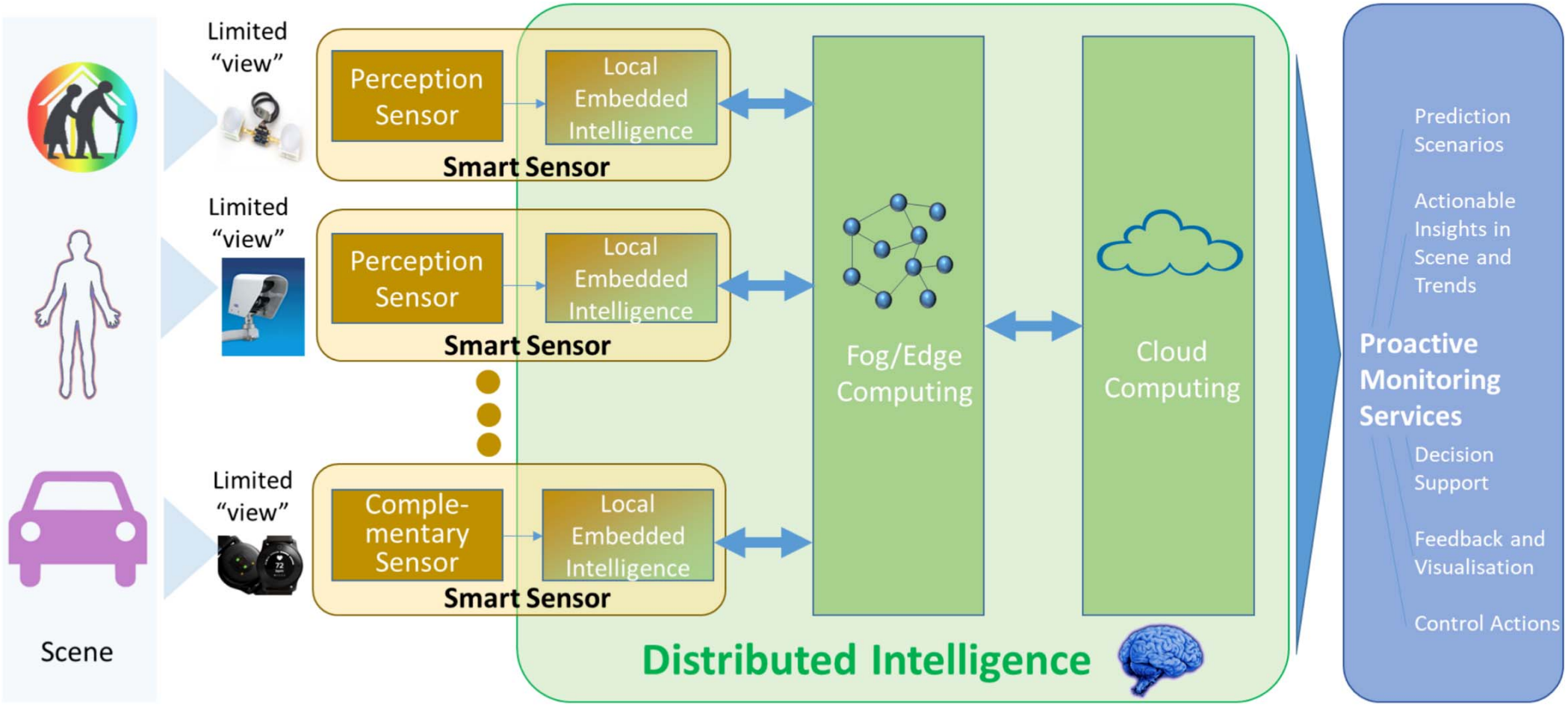


O2: Support proactive decision making ensuring Health, Wellbeing, and Traffic Safety by means of predictive analytics and explainable AI

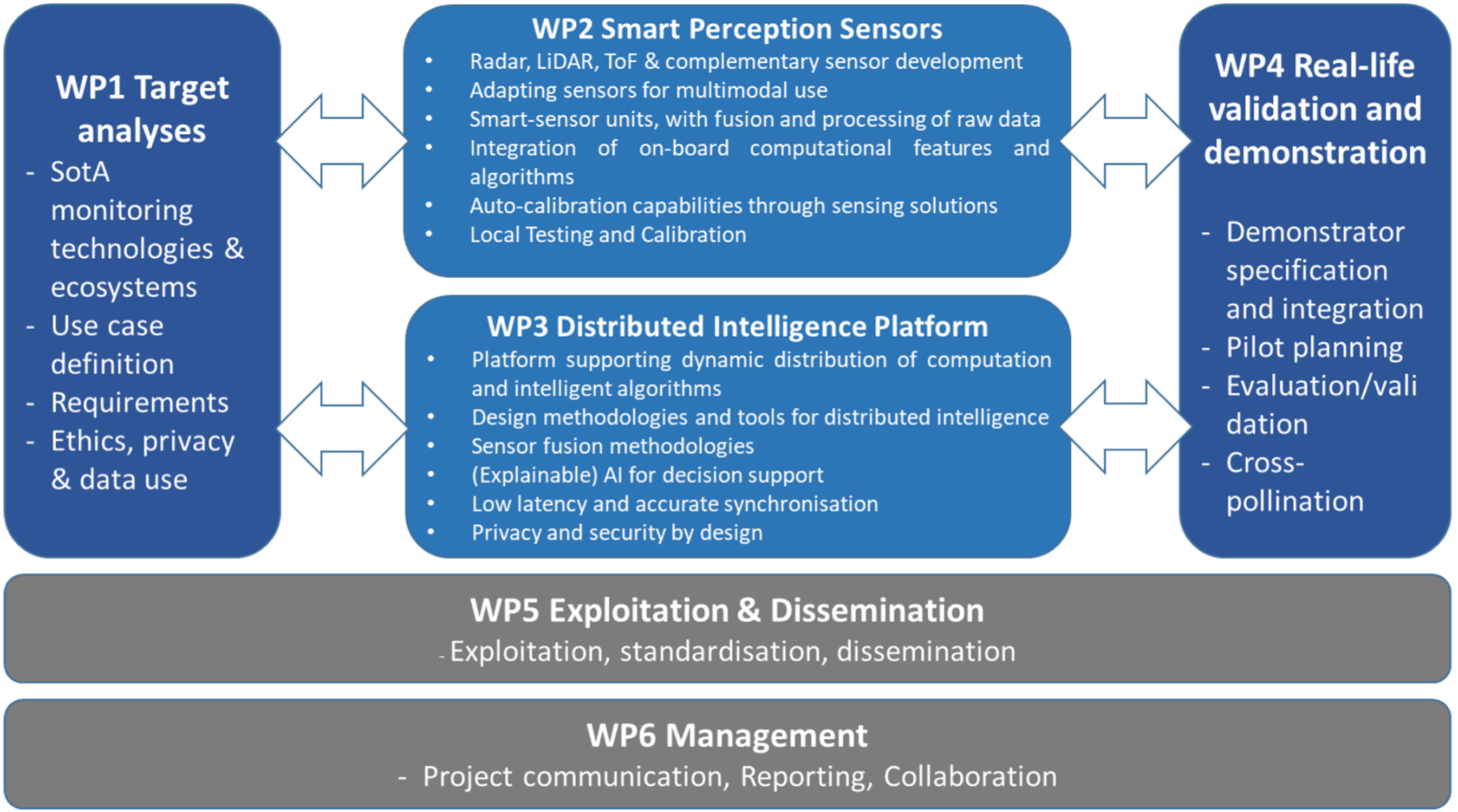
O3: Provide a reference platform to support the design, implementation and management of distributed sensing and intelligence solutions

O4: Demonstration and validation of proactive monitoring solutions in Health and Wellbeing and Automotive domains, including cross-sector applications

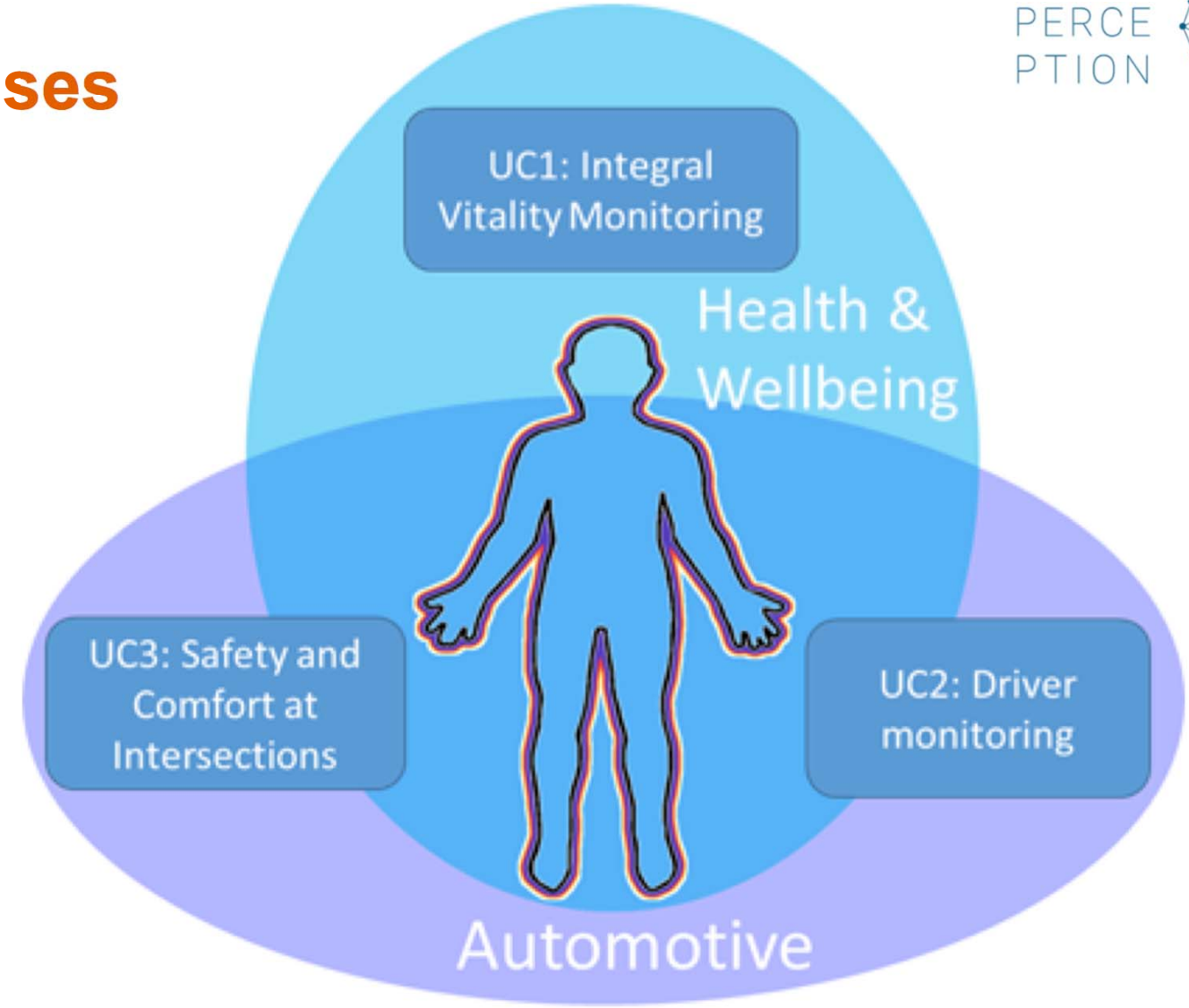
Conceptual architecture



Work breakdown structure



Use Cases


UC1: Integral Vitality Monitoring
Health & Wellbeing
UC3: Safety and Comfort at Intersections
UC2: Driver monitoring
Automotive

UC2: Driver monitoring

Driver Monitoring System (DMS), which can classify both the driver's cognitive states (distraction, fatigue, workload, drowsiness) and the driver's emotional (anxiety, panic, anger) state and intention (turn left or right), as well as the activities and position of occupants (including driver) inside the vehicle cockpit and traffic data. This information will be used for automonous driving functions, including take-over-request and driver support.

UC2 Demonstrators

- The vehicle in driving simulator demonstrator showing a Driver Monitoring System (DMS) able to cover both the cognitive and emotional states;
- The ‘Heavy-Good-Vehicle’ and ‘conveying automated passenger cars’ demonstration showing the detection of driver/operator capabilities to take over the vehicle control in case of automation system errors.

UNITO work in NextPerception

Main GOAL:

A formal methodology for assessing the safety of machine learning enabled systems is the primary goal UNITO would like to achieve.

UNITO work in NextPerception – WP3

- Development of the **conceptual model of the human operator's** state with a special focus on the automotive domain (driver state).
- Use of machine learning techniques for human **operator state classification**, recognition and inference (in collaboration with psychologists of UNISOB).
- To develop algorithms for watermarking sensor signals in order to check authenticity
- To contribute to the definition and implementation of the **distributed computational and intelligence platform**.
- **Verification** activity for what concerns the integration **of AI modules** in the decision system.
- To **integrate and test** the developed technologies into the driving simulator (in collaboration with ReLab)

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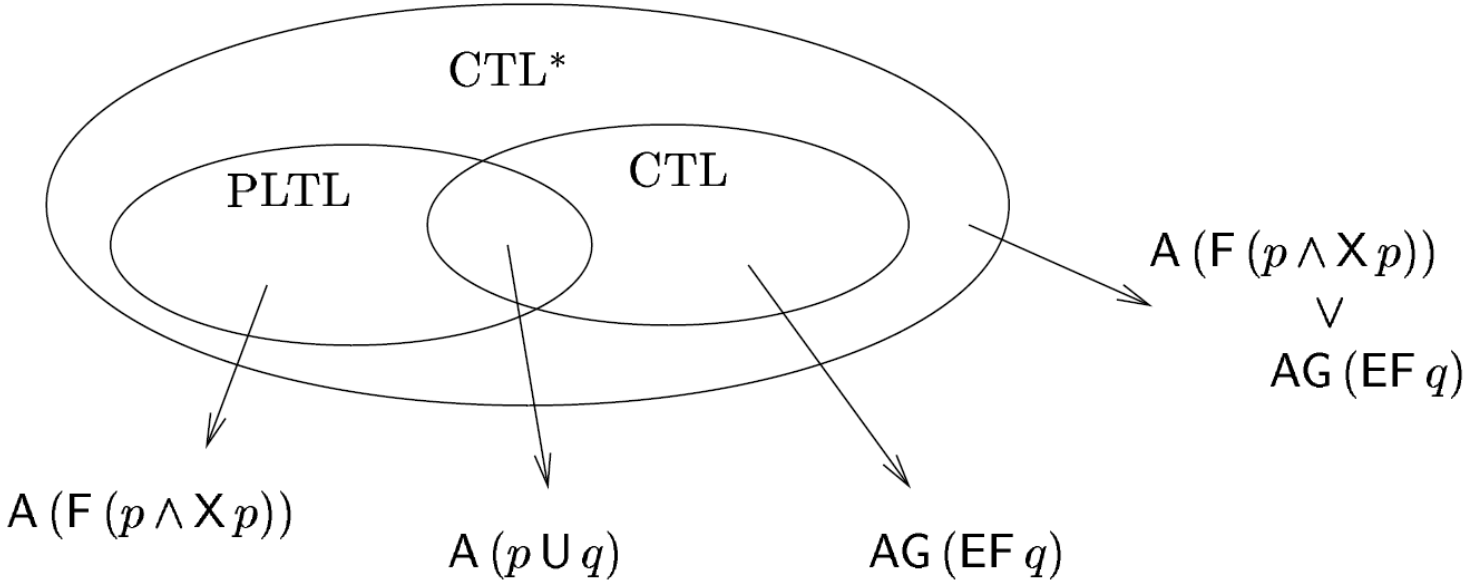


CTL* model-checker

LTL/CTL/CTL* are well-established temporal logics

CTL example: whenever p holds, it is possible to reach a state where q holds AG(p --> EFq)

LTL examples: FG p, F (p $\wedge$ X p), G F p --> Fq (if p holds infinitely often, then q will eventually hold)

CTL* examples: any mixture of path operators and quantifier

CTL* model-checker

- Well-known model-checkers exists since more than 30 years
- LTL --> SPIN
- CTL --> nu-SMV
- CTL* --> ??????

CTL* model-checker in GreatSPN

GreatSPN is a tool developed in Torino for performance evaluation, simulation, and (stochastic) verification of (stochastic) Petri nets

It features a CTL model checker based on Multivalued Decision diagrams (DD) --> sat-set computation, counterexamples and witnesses. No fairness constraint

CTL* model-checker in GreatSPN

Each formula is split into maximal LTL formulas.

Based on the product between the Buchi automata of the LTL formula and the state space of the Petri net

Uses the Emerson-Lei procedure for computing the sat-sets

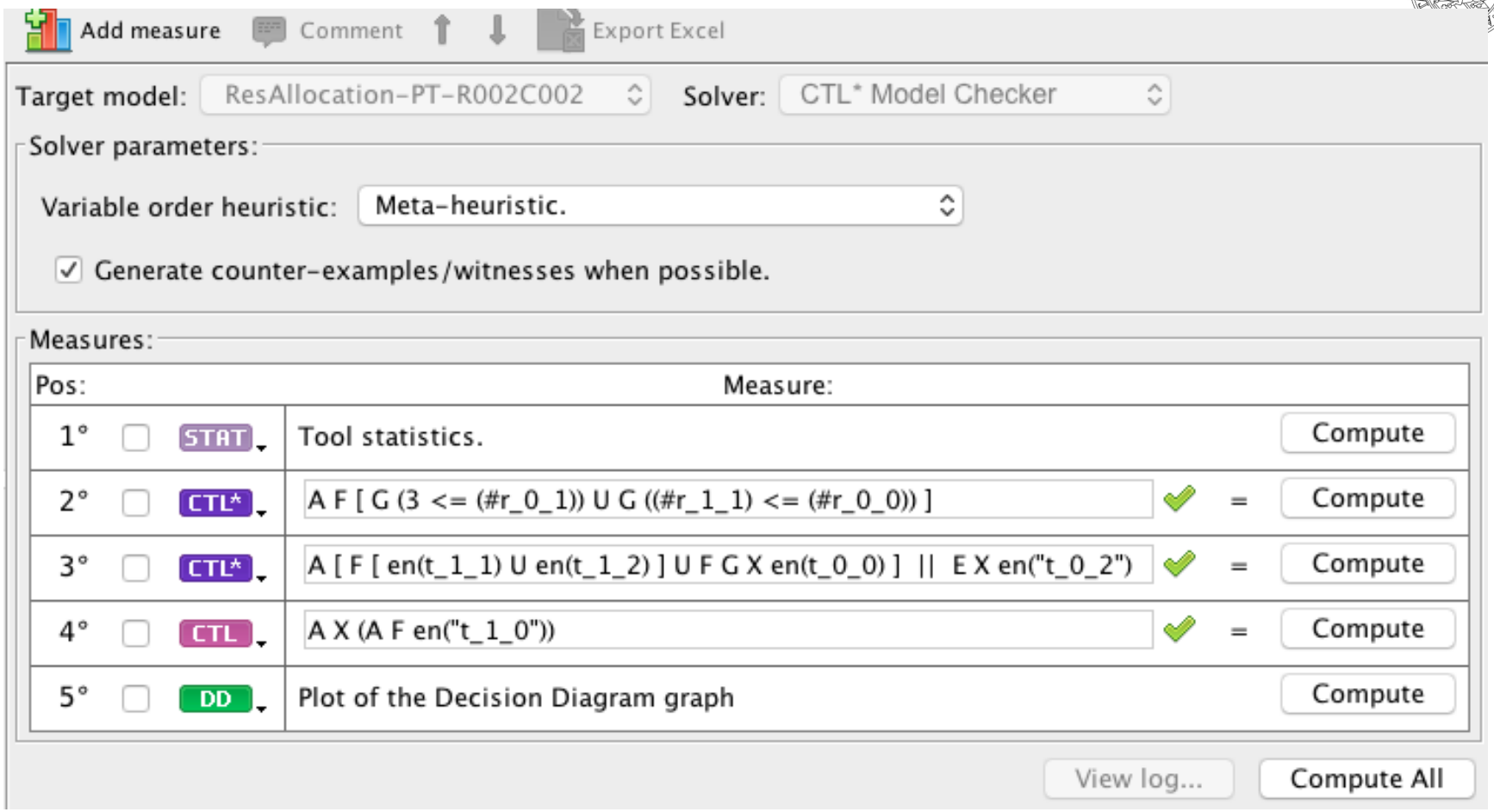
Fully based on DD (large state spaces can be dealt with)

Testing

We checked CTL and LTL properties against the published results for the thousands of (model, property) pairs of the Model Checking Contest 2018

For proper CTL* we did not have any other tool: we used LTSmin (a tool from University of Twente) that has a translation from CTL* to mu-calculus and a model-checker for mu-calculus.

GreatSPN apparently more reliable, on the average more than 80% faster


Add measure
Comment
Export Excel
Target model: ResAllocation-PT-R002C002
Solver: CTL* Model Checker
Solver parameters:
Variable order heuristic: Meta-heuristic.
Generate counter-examples/witnesses when possible.
Measures:
Pos:
Measure:
1° STAT Tool statistics. Compute
2° CTL* A F [G (3 <= (#r_0_1)) U G ((#r_1_1) <= (#r_0_0))] = Compute
3° CTL* A [F [en(t_1_1) U en(t_1_2)] U F G X en(t_0_0)] || E X en("t_0_2") = Compute
4° CTL A X (A F en("t_1_0")) = Compute
5° DD Plot of the Decision Diagram graph Compute
View log...
Compute All