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SAFE STRIP

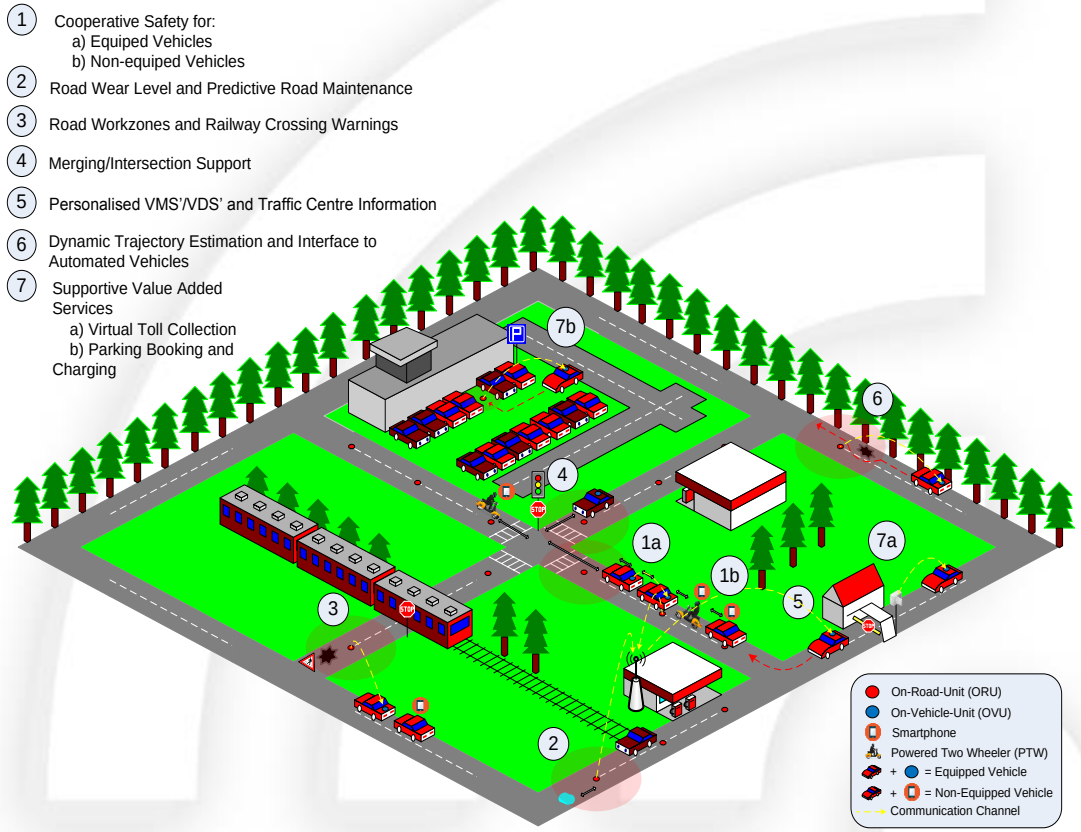
SAFE STRIP Use Cases

Dr. Maria Gkemou

HELLENIC INSTITUTE OF TRANSPORT
CERTH / HIT

Use Cases overview

1. **Cooperative Safety**
    1. **Advanced Driver & Rider Assistance Systems adaptation for equipped vehicles (“Enhanced ADAS/ARAS”)** – upgrading existing ADAS/ARAS with real-time accurate information
    2. **Virtual Advanced Driver & Rider Assistance Systems for non-equipped vehicles (“Virtual ADAS/ARAS”)** – simulating missing ADAS/ARAS (Advanced Rider Assistance System)
2. **Road wear level and predictive road maintenance** – for the TMC operators (although road wear level will feed also the safety applications for the driver/riders)
3. **Road workzones and (uprotected) railway crossing warning**
4. **Merging/ intersection support** – providing a global view of intersection geometry and characteristics as well as incoming vehicles dynamic trajectory estimation
5. **Personalised VMS/VDS and Traffic Centre Information** – aiming to substitute current infrastructure that is costly and not personalised
6. **Autonomous vehicles support** – aiming to address primarily: *enhanced friction & lane position data*; *lane – level virtual corridors in highways*; *automated toll collection*; *working zones safety function*
7. **Supportive Value Added Services**
    1. **Virtual Toll Collection** - for non-autonomous vehicles
    2. **Parking booking and charging**



"Enhanced ADAS/ARAS" & "Virtual ADAS/ARAS"

- **Dynamic and continuous forecasting of potential risks coming up with recommendations on the safest driving manoeuvre (speed/acceleration/ safe-stop distances) possible.**

- Based on the **Co-driver concept** – Interactive, Adaptive & e2Call projects - that combines human-like motion primitives into driving behaviours of increasing complexity to mimic human ones – **Integrated in Fiat car.** And on **enhanced DynamicMap** (static data) upgraded with SAFE STRIP.
- At each time frame for a given scenario, **the application simultaneously evaluates different driving hypotheses** (associated different plausible goals, such as driving at desired speed, stopping, etc.) **or different modalities for pursuing the same goal** (e.g. negotiating a curve cautiously, normally or aggressively).

- Same concept for equipped and non-equipped – Different operation and (potentially) level of support.

Info from Infrastructure

- ✓ Speed Limit
- ✓ Friction
- ✓ Hot spot locations (e.g. pedestrian crossing, etc.)
- ✓ Road surface conditions
- ✓ Host vehicle lane geometry (curvature width, number of lane)
- ✓ Presence of other adjacent lanes
- ✓ Host vehicle position in the lane (longitudinal, and possibly lateral)
- ✓ Other vehicle position and speed in the lane

Road wear level and predictive road maintenance

Info from Infrastructure

- ✓ Environmental conditions (temperature, moisture)
- ✓ Pavement type and mixture
- ✓ Strain vs time (lane specific)

- **Evaluation of the dynamic pavement response to moving vehicles; study of the effects of pavement surface deterioration on the dynamic pavement response; evaluation of pavement service life.**
- By measuring pavement strains one can evaluate pavement response and cracking performance.
- Longitudinal and transverse strains will be measured by asphalt strain gages. The strain gages will be encapsulated in polyamide with rugged solder tabs. The circuitry of the strain gage will be encapsulated in wax and epoxies for physical and environmental protection.

Road workzones and (uprotected) railway crossing warning

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- **Suggestion of the proper speed or the necessary speed reduction, the time to hot spot (e.g. work zone, rail crossing, etc.) or the need to stop in a given distance and/or the virtual lane to navigate through the approaching work zone.**

- Possible extension to automated vehicles providing feasible and plausible manoeuvres to navigate across the work zone.

Info from Infrastructure

- ✓ Speed restrictions
- ✓ Position of host vehicle: longitudinal and lateral position in the lane.
- ✓ Vehicle state estimation (heading of the vehicle respect to the lane, current path curvature, longitudinal velocity and acceleration)
- ✓ Current lane geometry and layout (including curvature)
- ✓ Adjacent lanes (including whether lane change is allowed)
- ✓ Signaling of railway and road workzones crossings – timing of barriers.

Merging/ intersection support

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Info from Infrastructure

- ✓ Speed Limit
- ✓ Position of stop/yield lines
- ✓ Information about priorities
- ✓ Traffic light phases
- ✓ Friction (useful when it is low)
- ✓ Pedestrian crossings
- ✓ Host vehicle lane geometry (curvature width, number of lane)
- ✓ Other vehicle lane geometry
- ✓ Existence of multiple paths that other vehicles or host vehicle may choose

- **Suggestion of the proper speed or speed adaptation to navigate through an intersection to avoid collision or to respect traffic light status or stop or give way signals.**

- Extension of the application developed in e2Call.

Personalised VMS/VDS and Traffic Centre Information

"Replacement of VMS/VDS":

- Present any data displayed in a VMS to a passing vehicle.
- Inform driver of the VMS's message through different ways.
- Personalisation aspects considering driver's profile parameter(s) such as:
  - Native language
  - Preferred way of appearance of received message; audio, visual
  - Vehicle equipment (in-vehicle display vs. separate display)
  - Content e.g. message filtering according to user's needs and preferences (interests)

- **Key functions:**
  - Communication between vehicle and Traffic Centre.
  - Communication between vehicle and road infrastructure.
  - Transmit VMS data to a vehicle.
  - Display VMS data to the driver according to his/her needs and preferences.

Info from Infrastructure

- ✓ Environmental conditions (temperature, humidity, ice)
- ✓ Speed limit

Autonomous vehicles support

Info from Infrastructure

- ✓ Presence of all safety risks ahead:
- ✓ Presence of ice, water (aquaplaning zones), defects (pot holes, tyres…)
- ✓ Speed limit
- ✓ Stopped vehicle in lane
- ✓ Traffic jam

Lane-specific data

- ✓ Dedicated lanes (bus, slow vehicles, …)
- ✓ Temporary lanes
- ✓ Automated tollgates lanes
- ✓ Lane width
- ✓ Lane number
- ✓ Lane geometry (curvature, topography)

1. **Dynamic trajectory estimation for automated vehicles**
2. **Definition of lane-level virtual corridors**
3. **Tollgate management**
4. **Workzone detection**

- Improvement of the **dynamic trajectory estimation** through SAFE STRIP – Support the perception and localization functions of the automated car so that it will allow the vehicle to keep a more accurate positioning of the vehicle in the centre of the lane.

- The sensors could bring the additional information **in which lane of the road the car is situated.** The OBU will integrate this additional information of positioning of the lane so that it will help to take decisions such as **lane changing** (e.g. in which lane is an overtaking permitted or not).

Autonomous vehicles support

- In **tollgates management the issue lies in guiding the vehicle at the right speed to the right gate.**
  - The data brought by the sensors should allow an anticipated approach: **information about the adapted speed limit and about the dedicated lane to reach. The vehicle can position itself in the right lane, the one that leads to the right automated gate.**

- Improvement of work zones detection. The temporary lanes during work zones **cannot be predefined with the mapping**. In that case, the SAFE STRIP sensors will send to the car the information that there is another dedicated temporary lane that will complete mapping information. **It will allow the vehicle to change its lane position if required, to follow the right temporary one and to return to its initial lane after the work zone is overtaken.**

Virtual Toll Collection (for non-autonomous cars)

- **Emulation of a toll charging interface.**

- The vehicle, while approaching the toll, is detected and classified. Through the app, it will be possible to activate the passage of the toll and manage the payments.
- Using the position of the vehicle in relation to the toll booth.
- Key advantages:
  - Reduce the pollution;
  - Reduce the crossover time of the toll booth, improving the traffic flow and the driver satisfaction.

Info from Infrastructure

✓ Toll crossing information (speed limit, position…)

Parking booking and charging

Info from Infrastructure

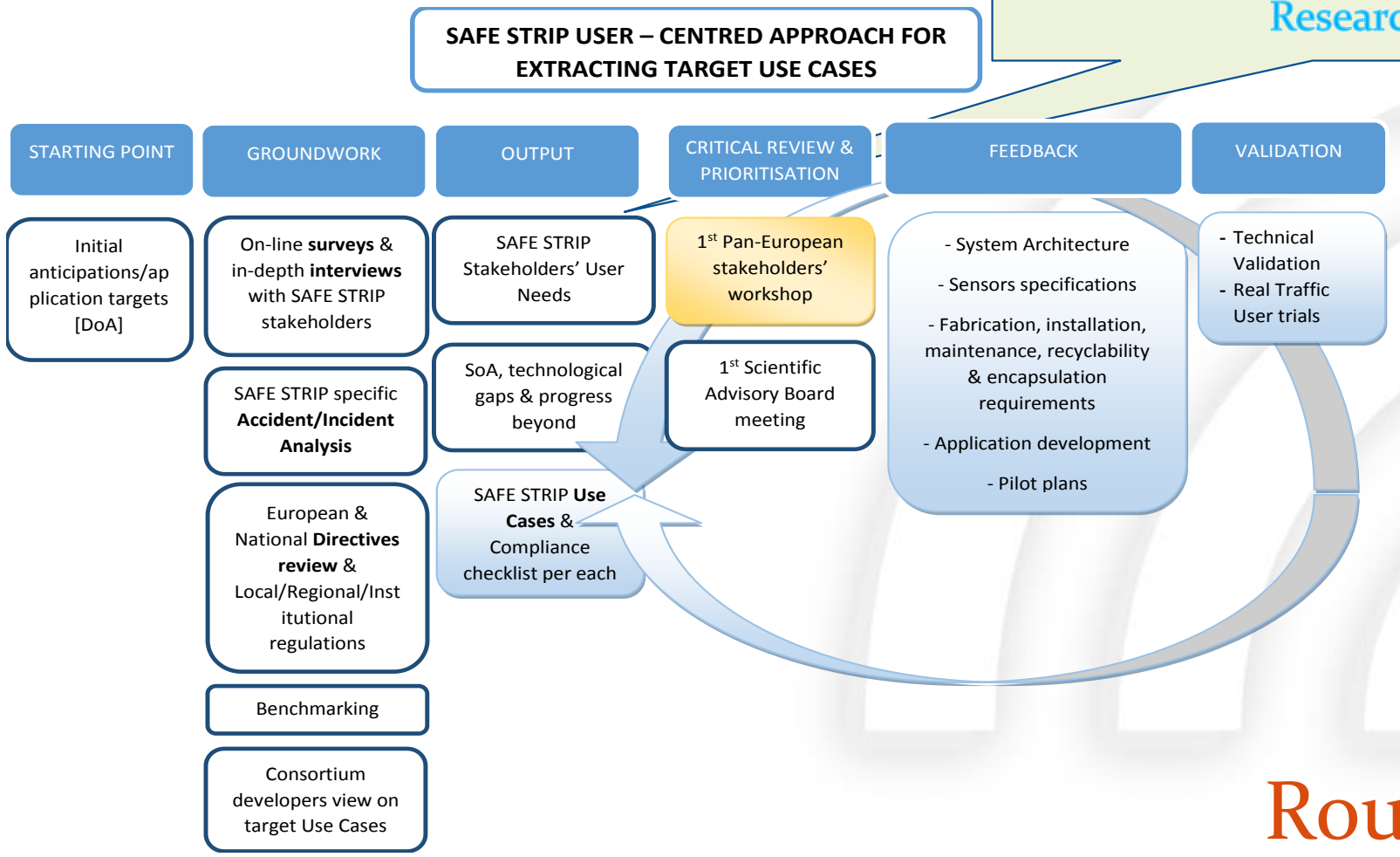
- ✓ Space availability for parking (in the application the information is provided by users & by sensors)

- **Parking booking and charging "in another way".**

- Simple, intuitive, secure and useful, allowing the user knowing the occupancy level of the parking slots.
- New collaborative scenario that introduces the user as an active participant in the system.
- Payment through mobile phone using a GPS receptor and 3G/LTE communication – "Virtual tickets".

Your feedback is appreciated!

Stakeholders: Drivers/Riders, Infrastructure Operators & Constructors/Integrators, OEM's, Tier1/Tier 2 suppliers, Authorities, Researchers



Round table…