



## Research partnership in technology innovation

Topic:

**Collaborative automotive community for real time, open road friction identification and information sharing for mobile App ADAS**

Advantages when integrating with OEM

- Leo Elisabetta
- Maroni Claudio
- Morandin Giulia
- Pezzola Marco Ezio

Estimation

Time

# Collaborative

Intelligence

Safety

Vehicle

System

Manoeuvres

Collision

Sensor

# Potential Friction

Improvement

Estimation

Time

# Collaborative

Intelligence

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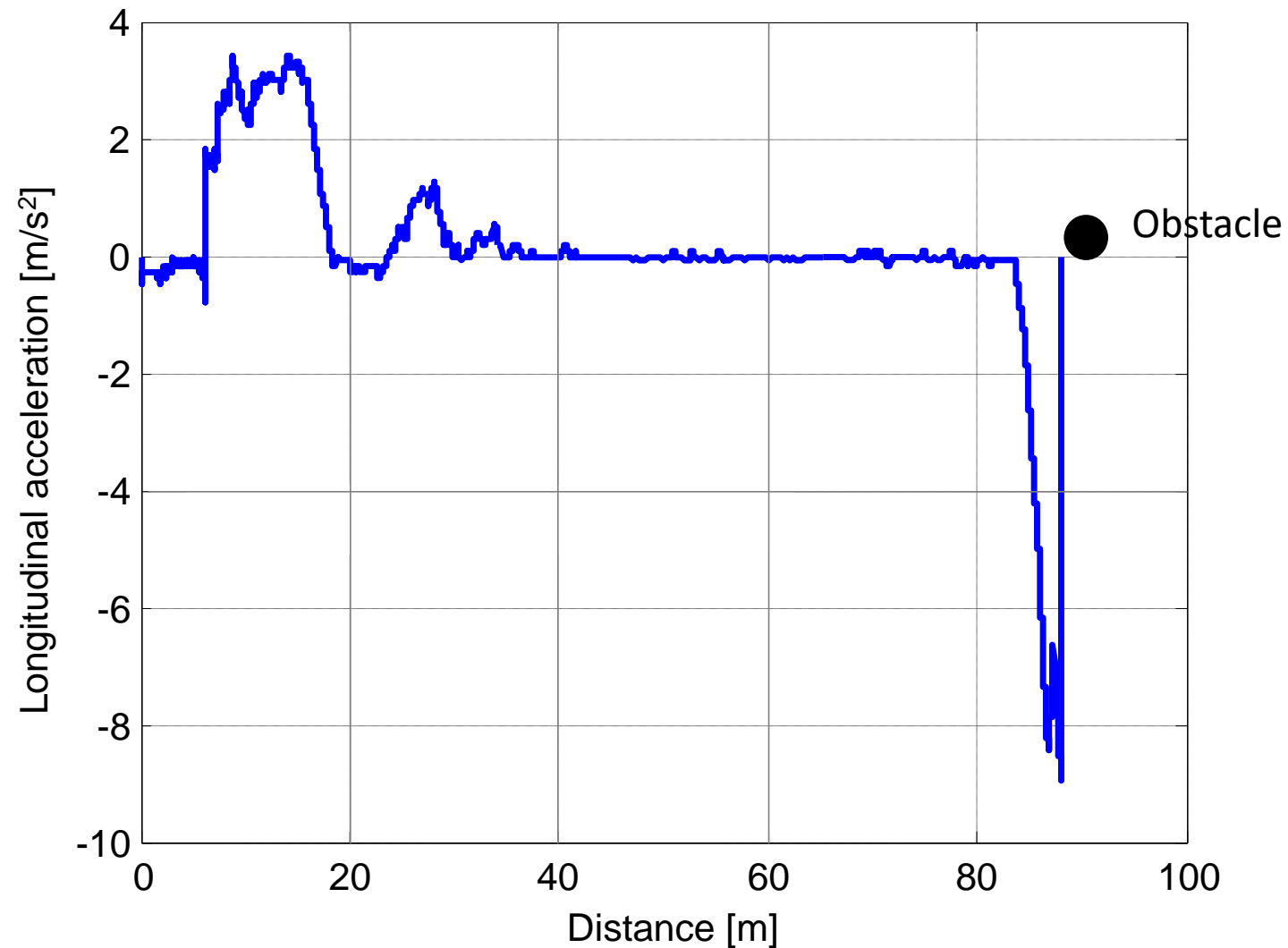
# Potential Friction

Improvement

No friction dependent ADAS

Surface → High friction

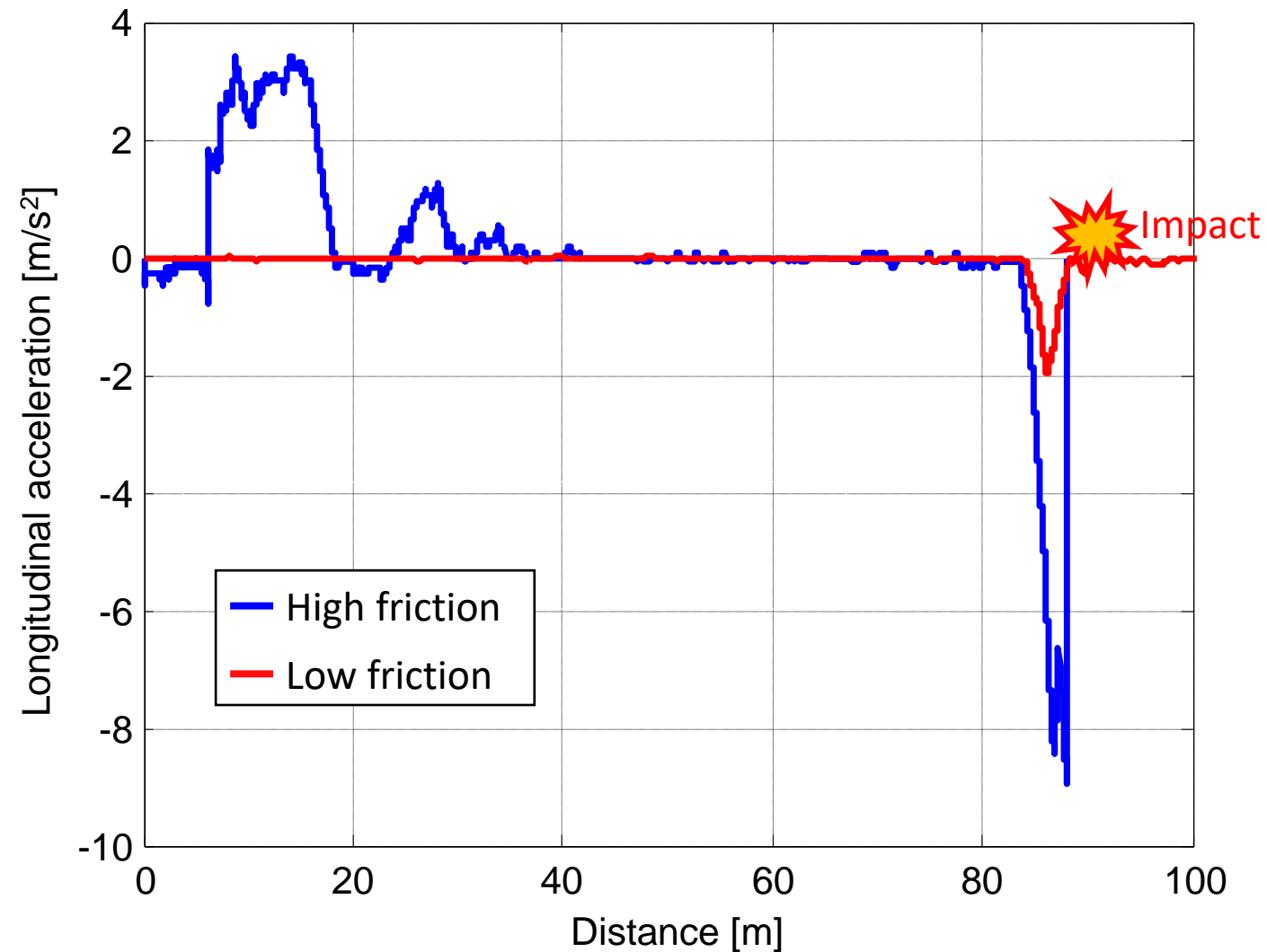
Cruising speed → 20 km/h



No friction dependent ADAS

Surface → Low friction

Cruising speed → 20 km/h



**Collaborative**

Estimation

Intelligence

System

Safety

Vehicle

Manoeuvres

Collision

Time

Sensor

**Potential Friction**

Improvement





# Collaborative



# Potential Friction

*The aim is to use a personal device to:*

- **identify** a critical road conditions*
- **send** this information to a collaborative cloud community*
- **provide** this information in **advance** to all the other road's users*

***For accident prevention***  
***I aM Safe***



# Collaborative

Estimation

Improvement

Safety

Vehicle

Intelligence

Manoeuvres

System

Collision

Time

Sensor

# Potential Friction

1 Collaborative approach

2 Potential friction ID

3 Adaptive Speed Limit Warning

4 Conclusion

# Collaborative

Estimation                      Improvement  
Safety  
Vehicle                      Intelligence                      Manoeuvres  
System  
Collision                      Time                      Sensor

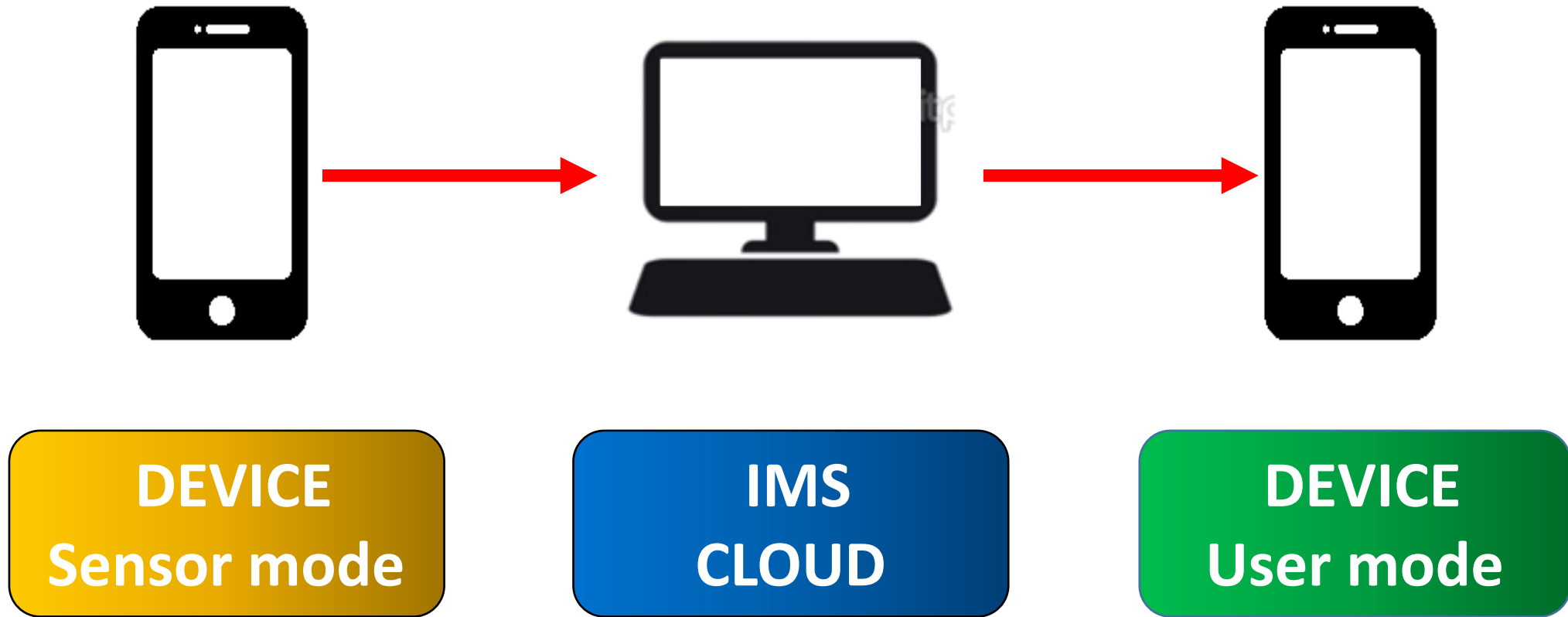
# Potential Friction

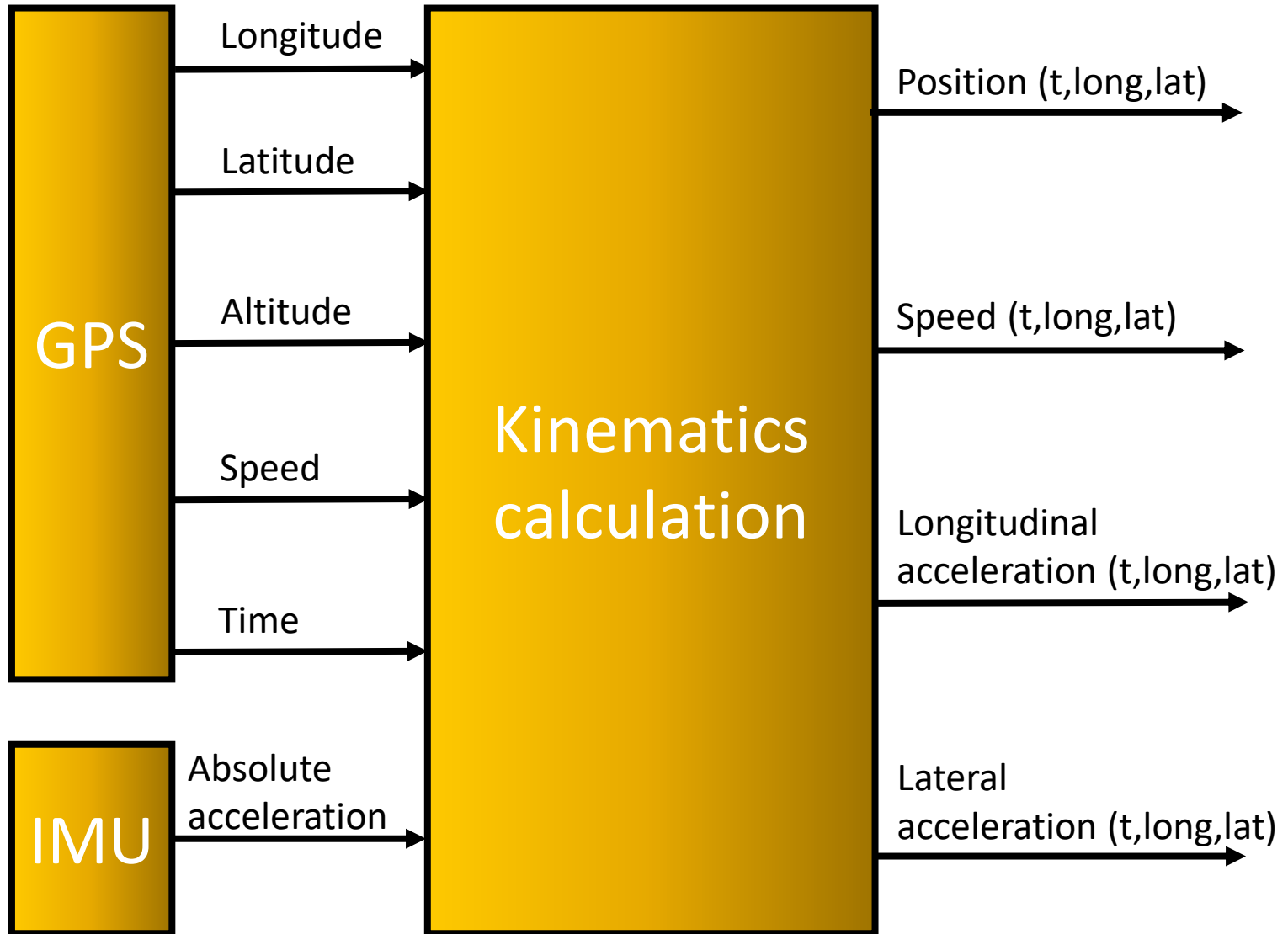
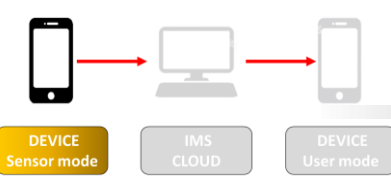
1 Collaborative approach

2 Potential friction ID

3 Adaptive Speed Limit Warning

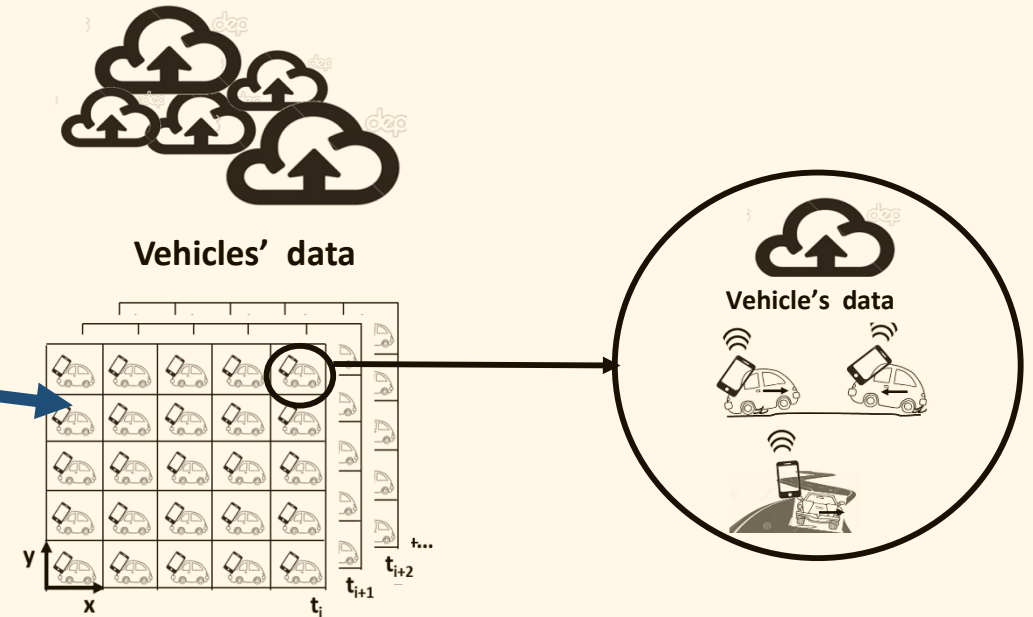
4 Conclusion







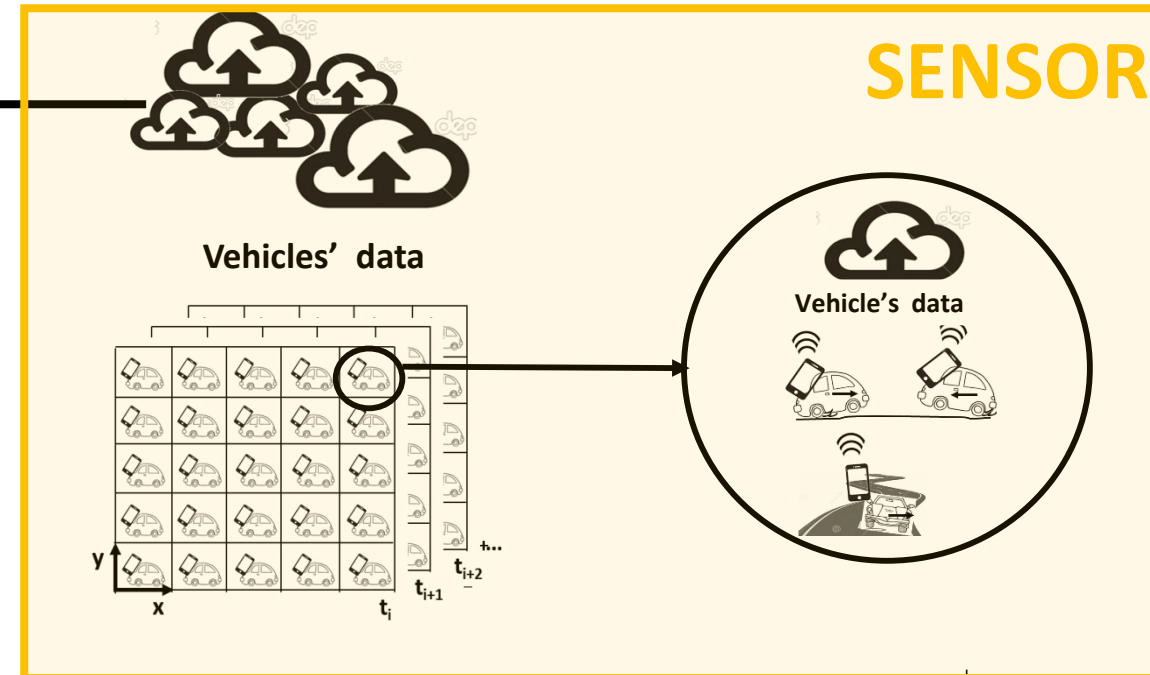
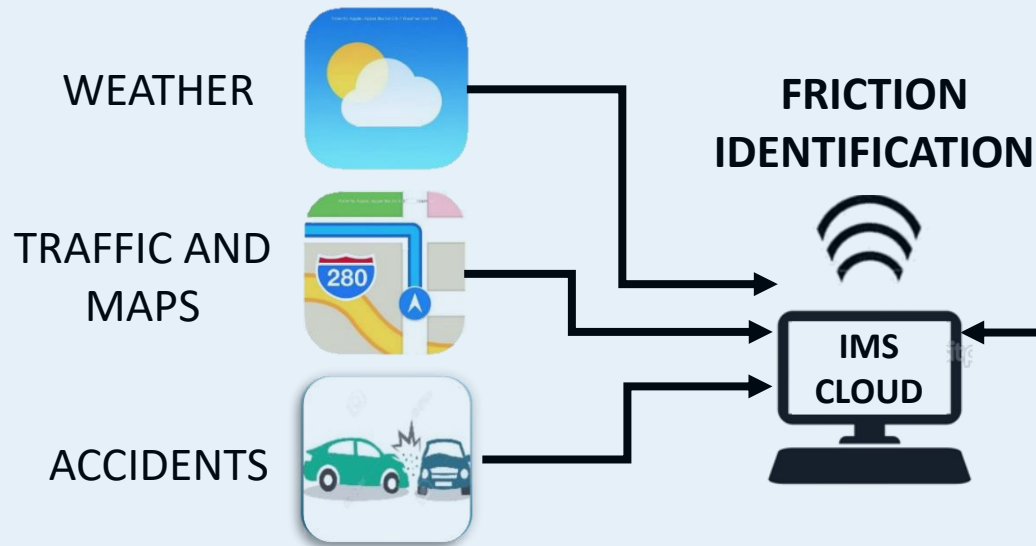
Each single user behave as a  
**COLLABORATIVE SENSOR**



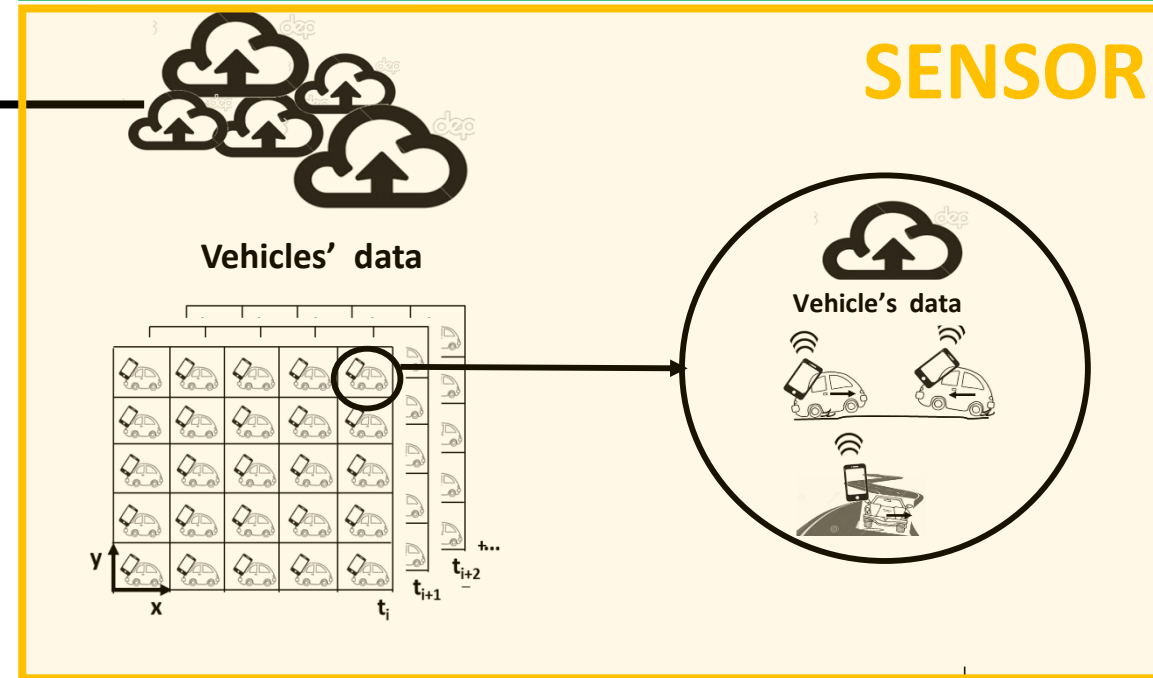
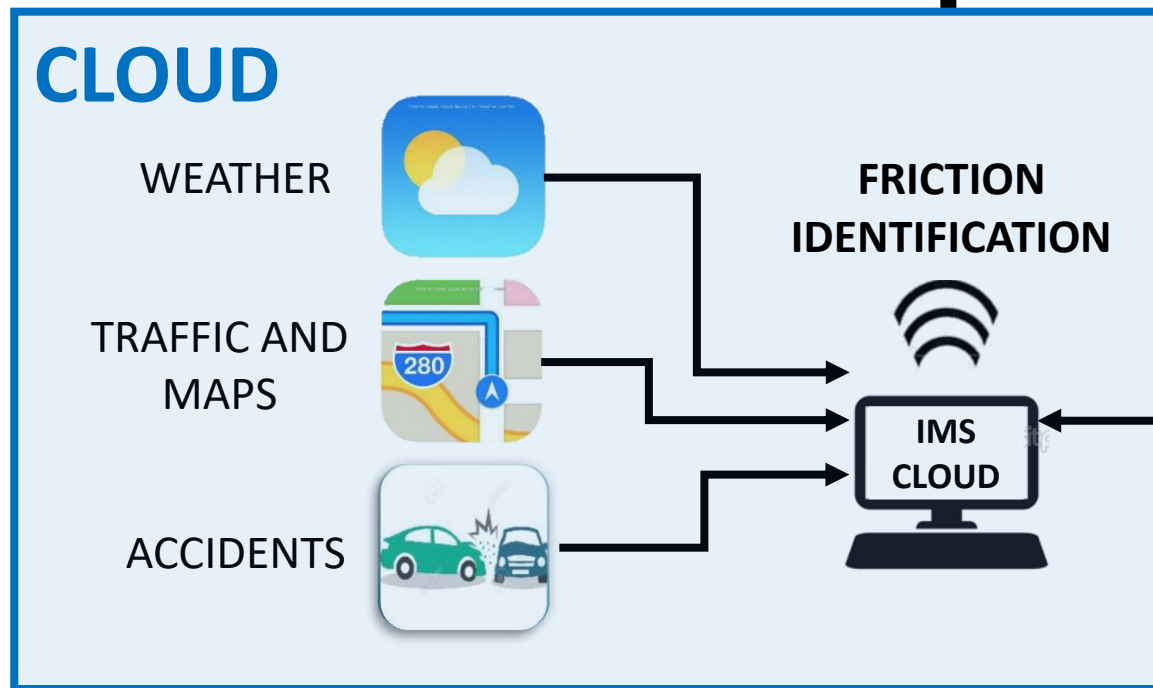
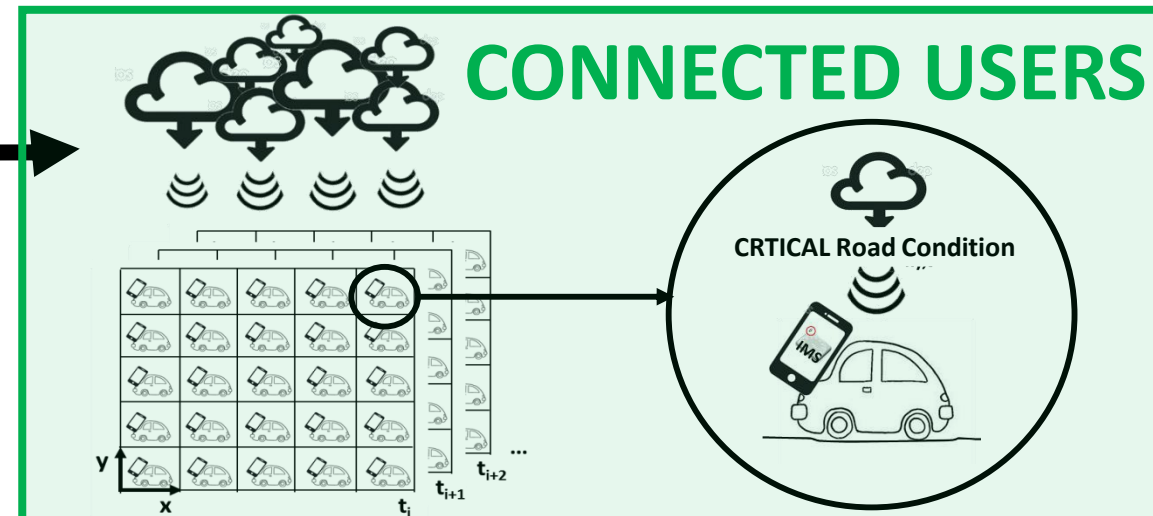
Additional data used: Weather, Traffic, Maps, Accidents ...



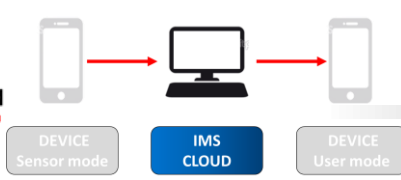
## Central Artificial Intelligence: CLOUD







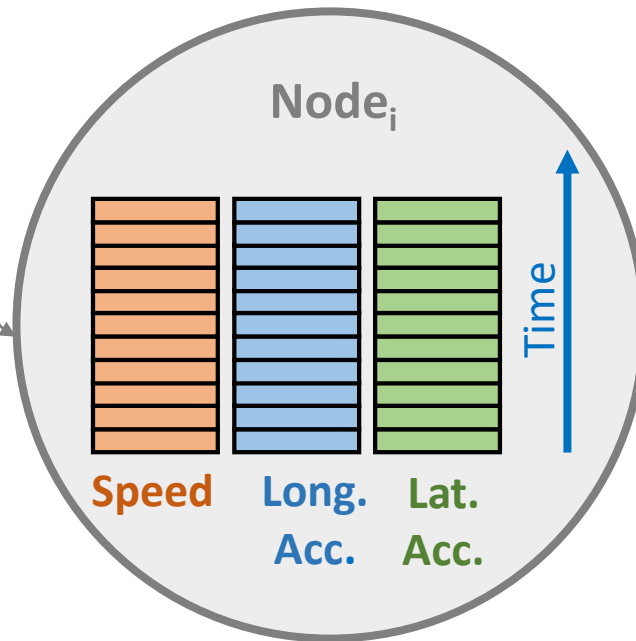
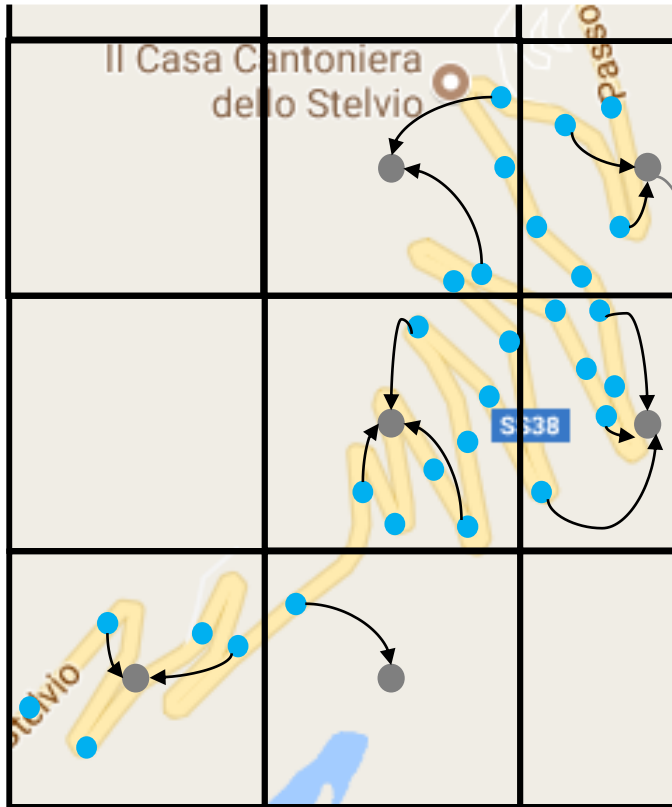
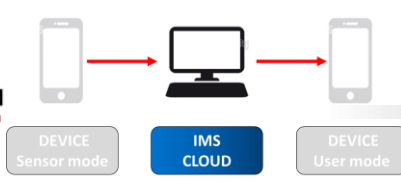




- High amount of users
- From different position on earth
- Asynchronous data sending
- Change of road conditions

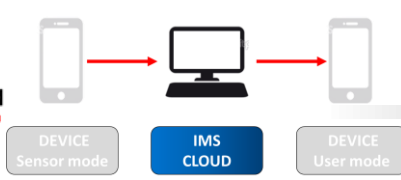


**GEODATABASE**



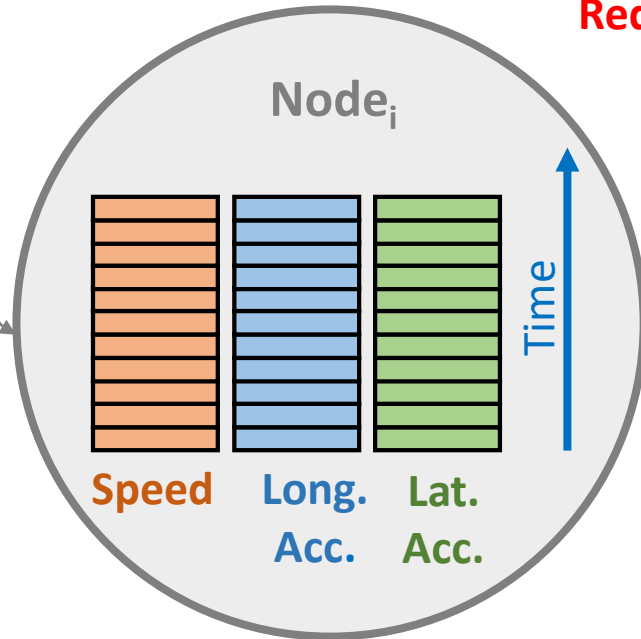
For each node a buffer of significant acquired data is saved.  
After some time the old data are deleted.

- Mobile device
- Geodatabase node

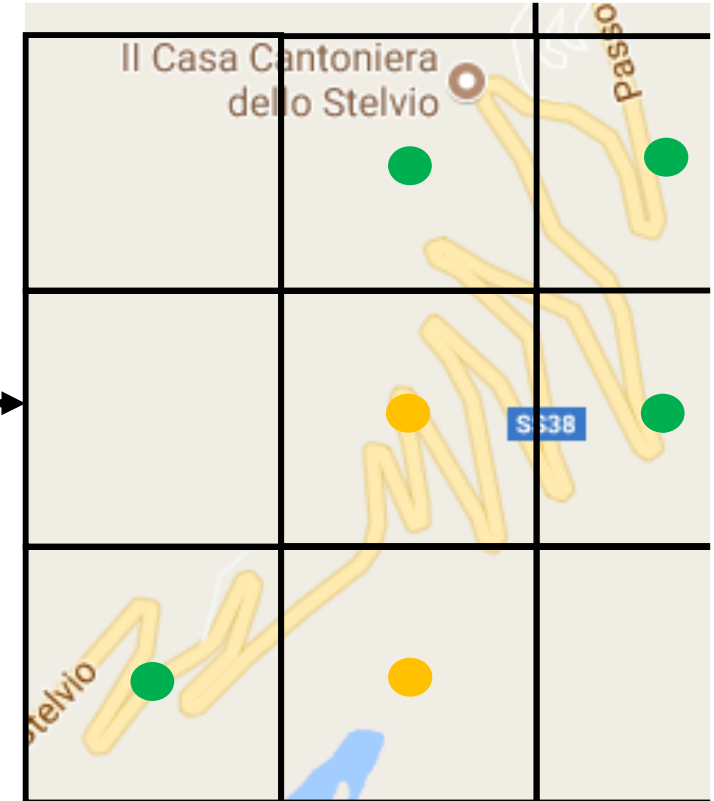


A value of criticality is assigned to each node of the server grid:

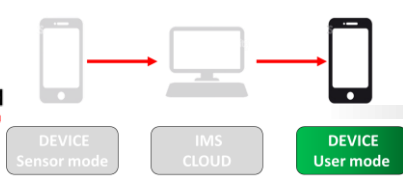
- Green** = good
- Yellow** = attention
- Red** = danger



Road Condition  
( $t, node_i$ )

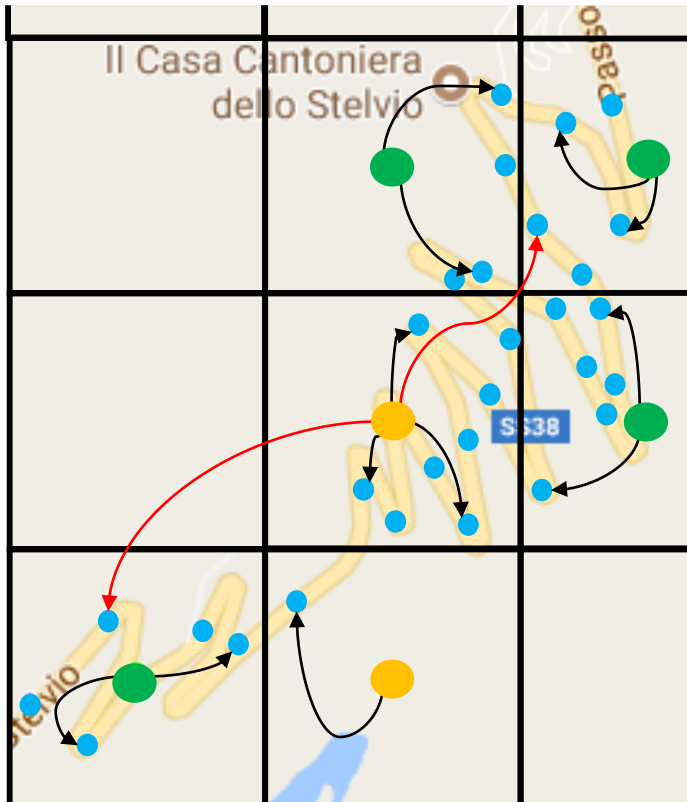


- Mobile device
- Geodatabase node



Road Condition (t,nodes)

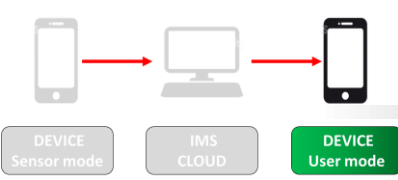
DISPLAY



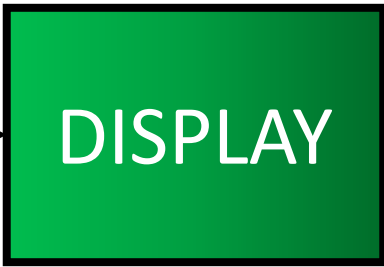
The roads condition was calculated by the server...

...and this information is sent to each user in the area...

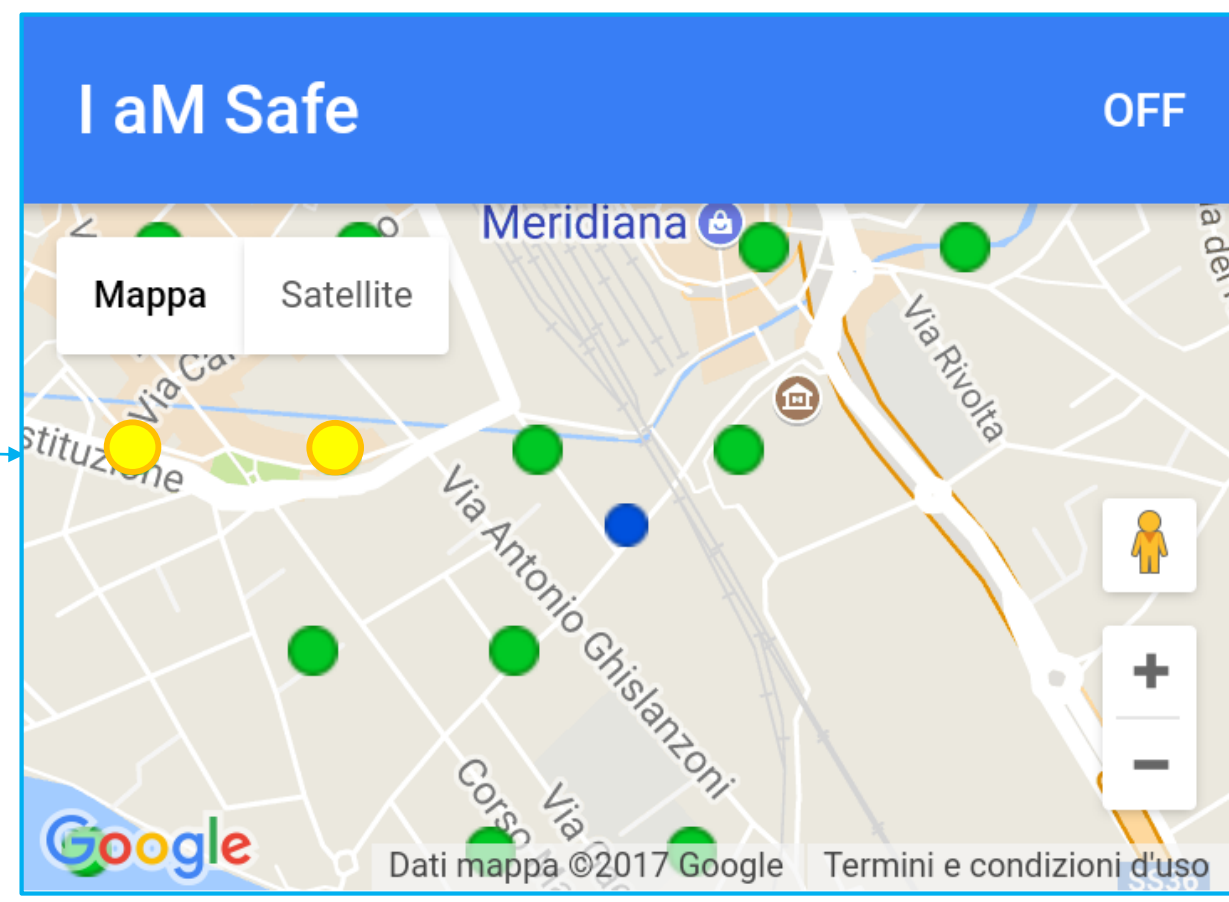
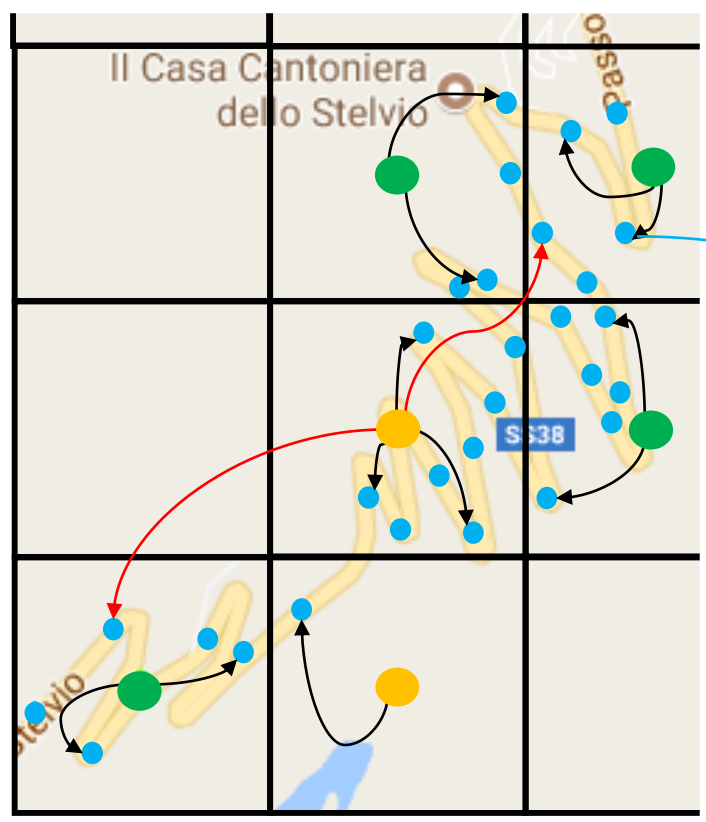
...and in the near areas



Road Condition (t,nodes) →



A map with the indication of the road conditions is shown to the user



# Collaborative



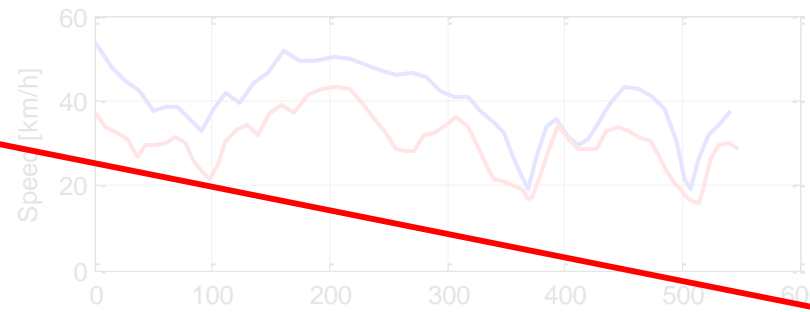
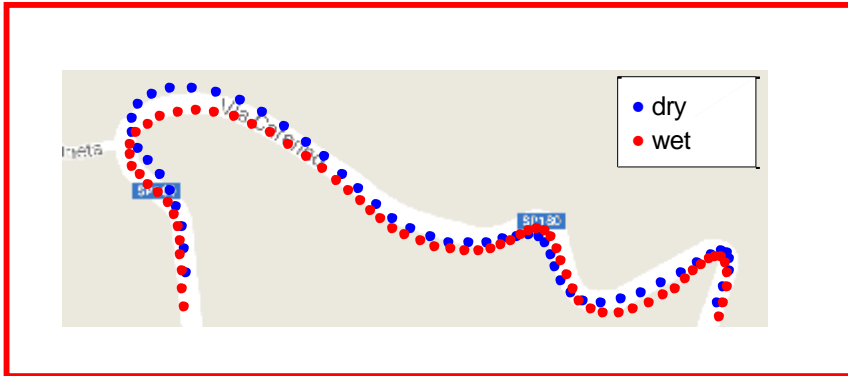
# Potential Friction

1 Collaborative approach

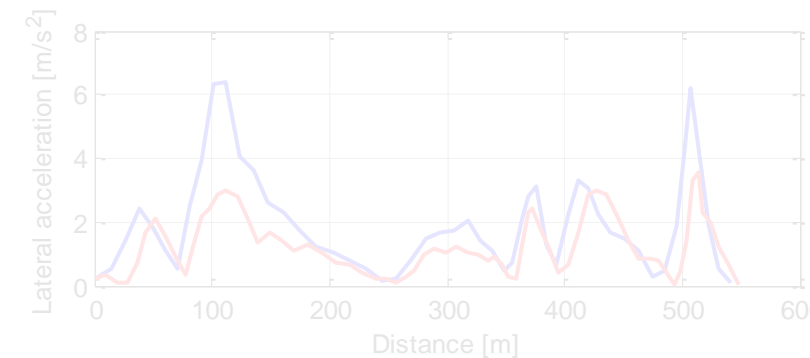
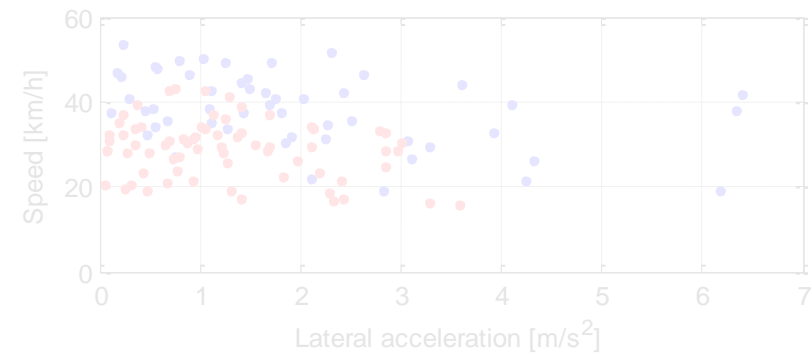
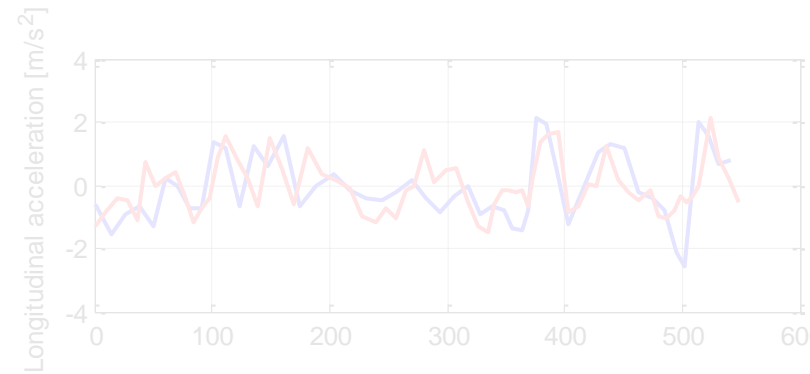
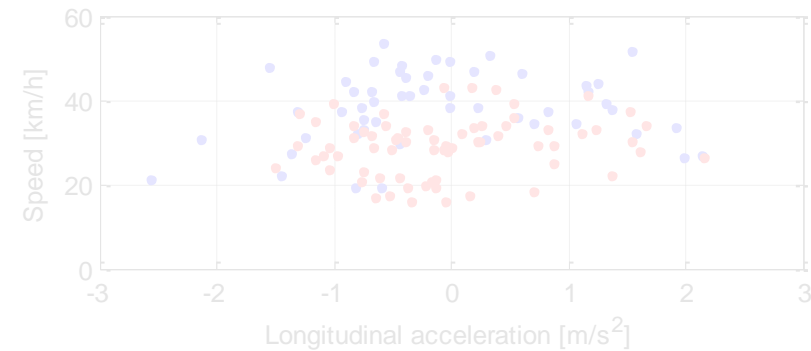
2 Potential friction ID

3 Adaptive Speed Limit Warning

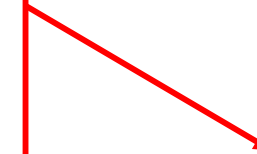
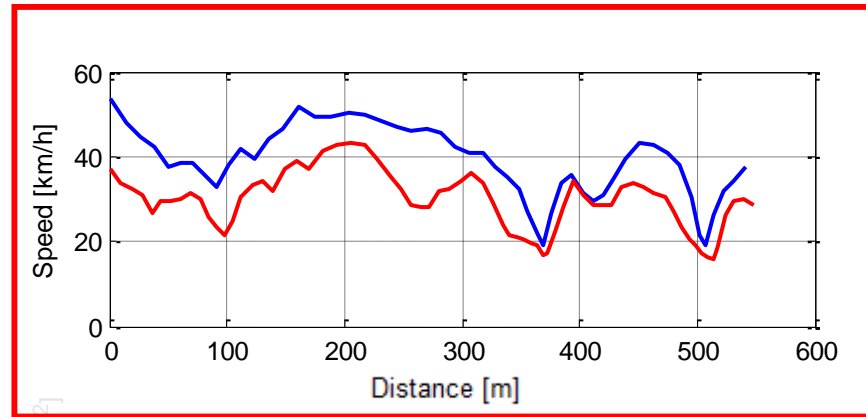
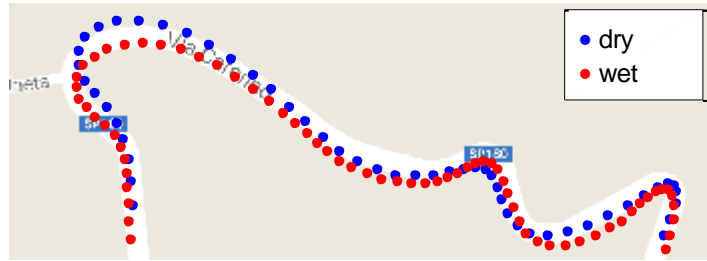
4 Conclusion



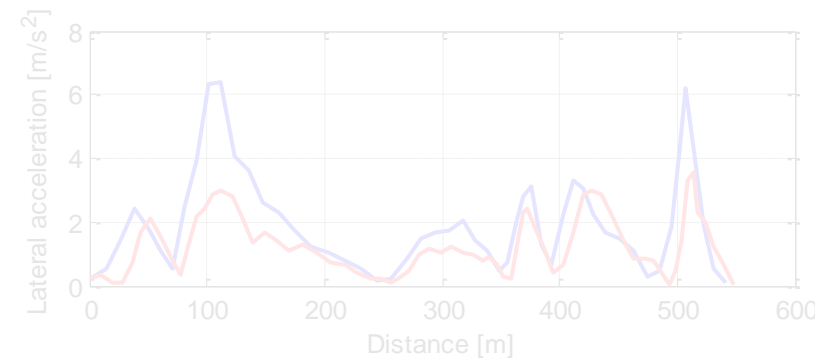
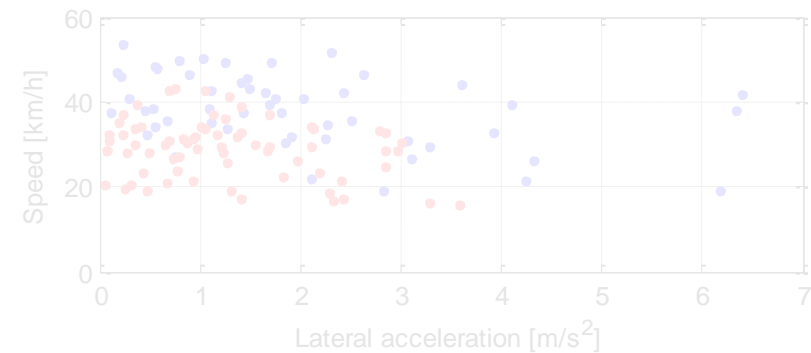
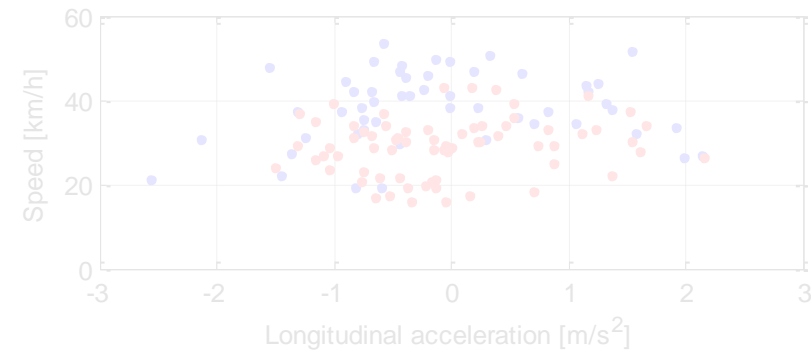
- Real experimental data
- Same road
- Same car
- Same driver
- Two different road condition:
  - Dry
  - Wet

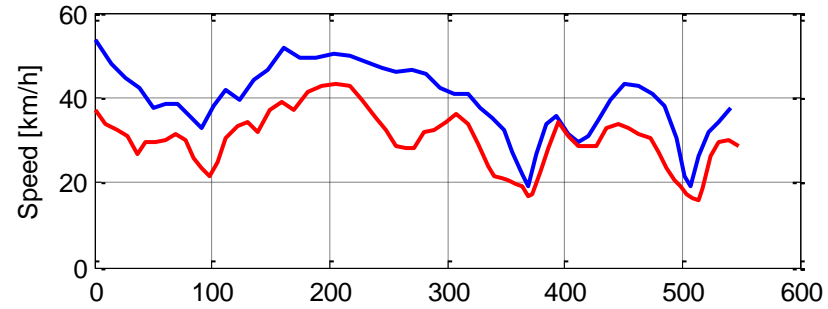
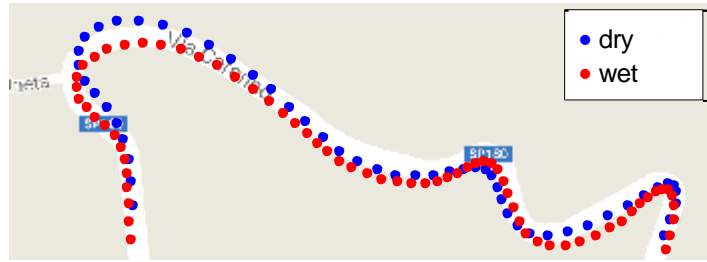




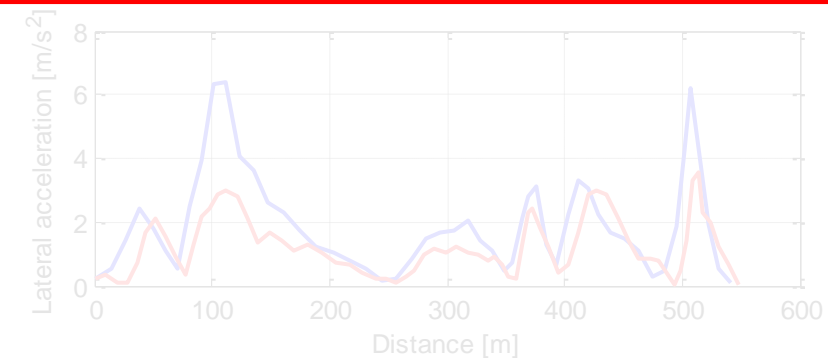
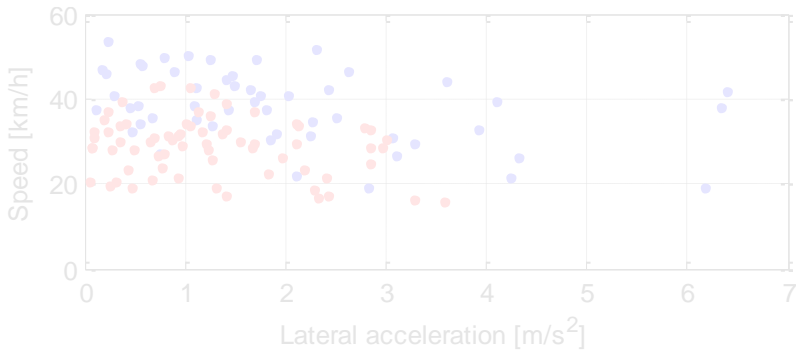
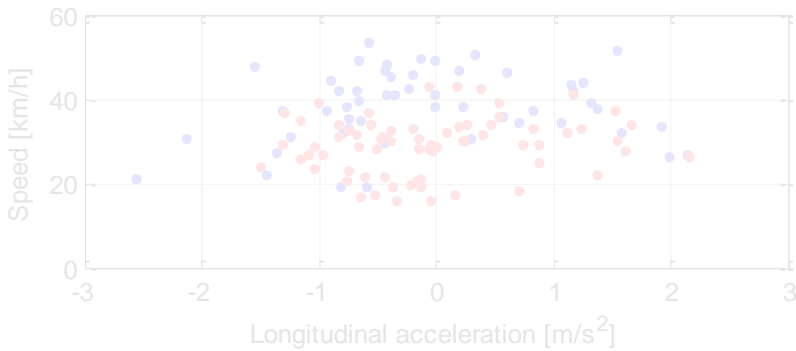
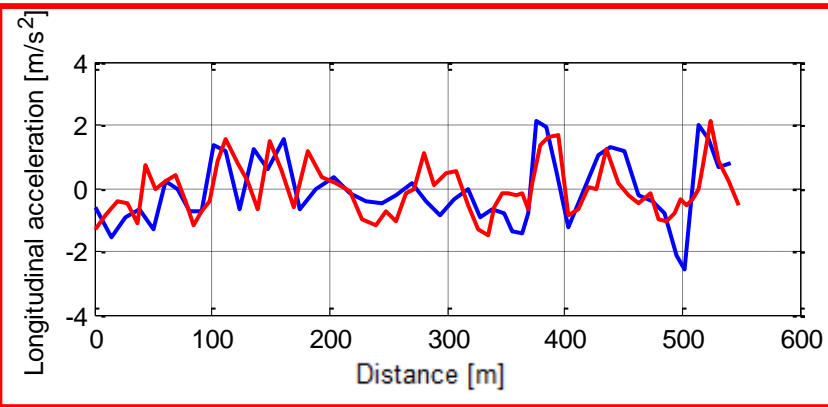


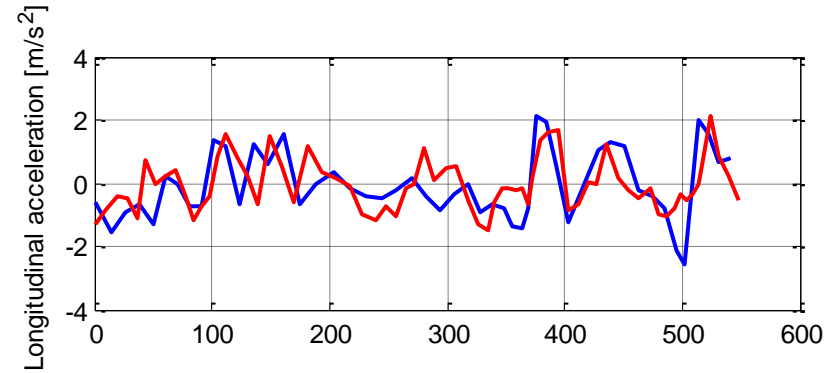
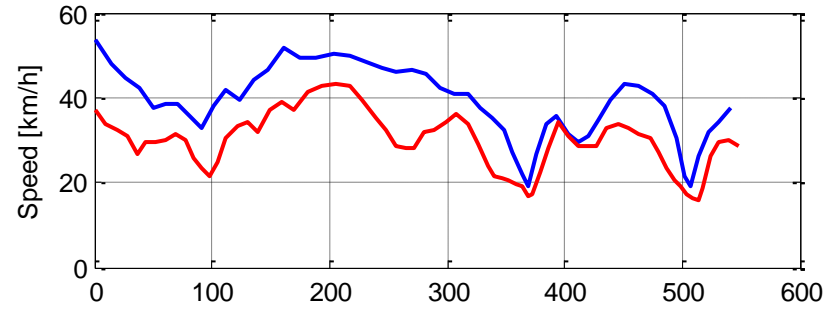
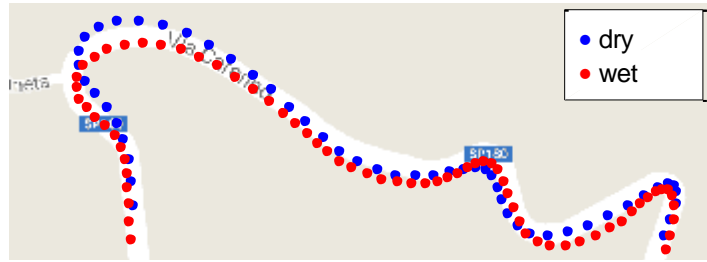
In **wet** condition the speed is on average **lower**



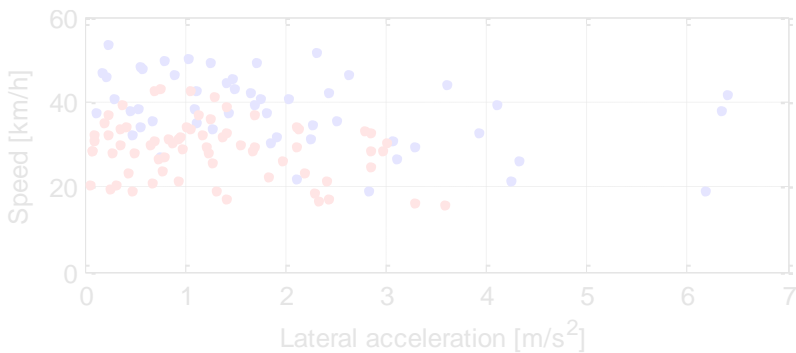
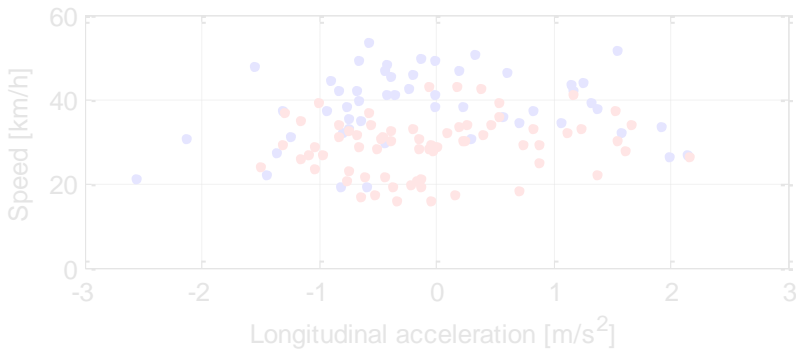
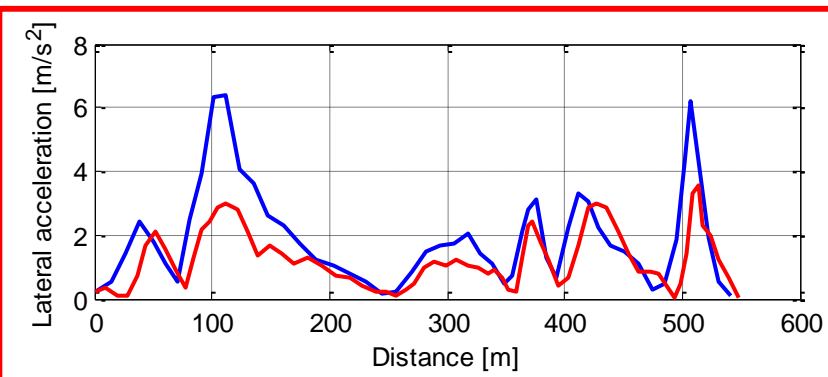


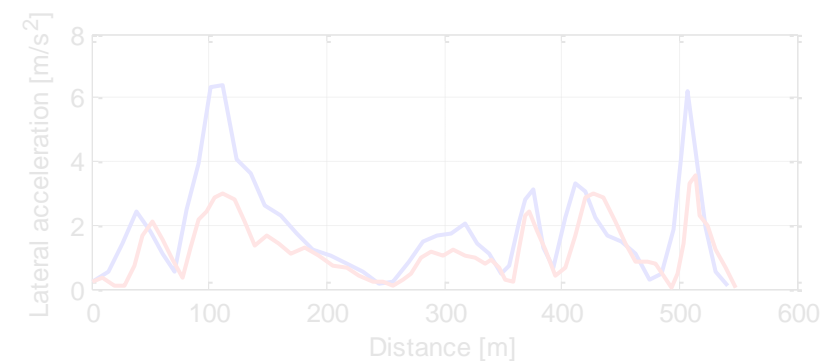
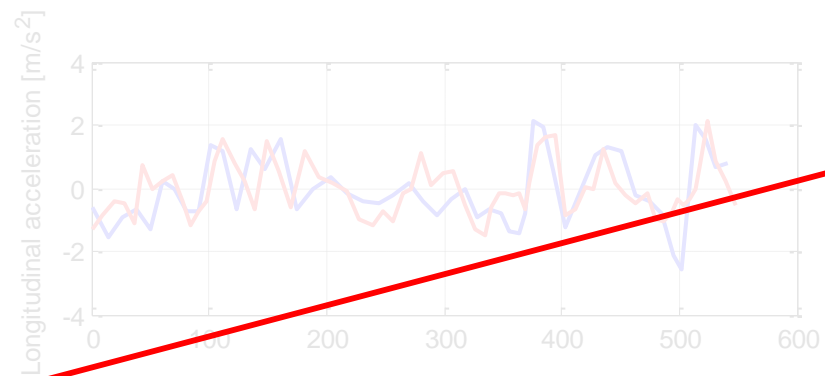
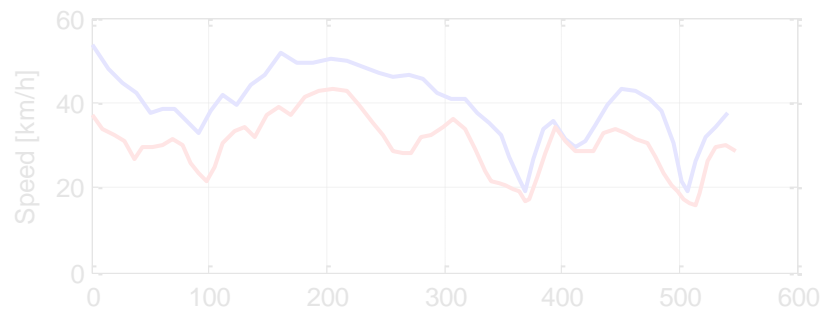
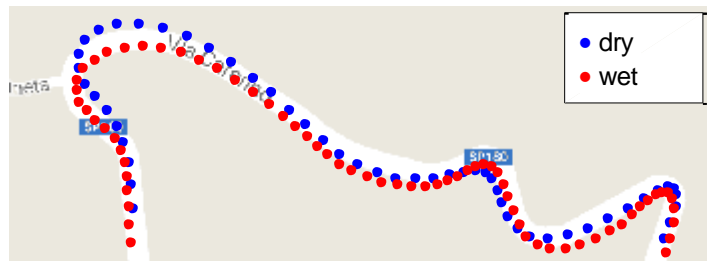
**Small difference in longitudinal acceleration (something during braking)**



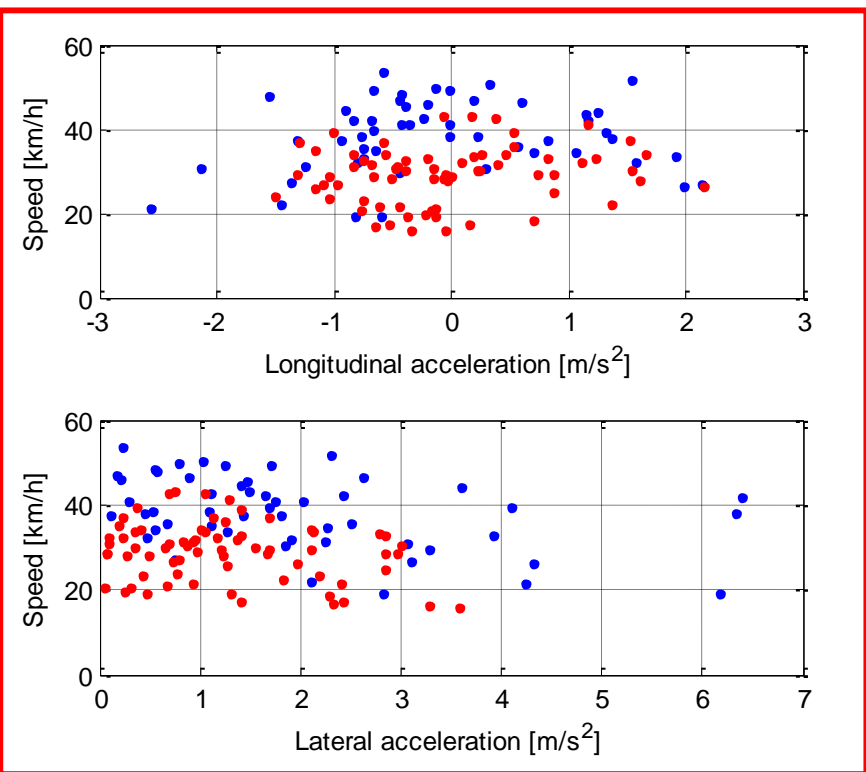


**Lateral acceleration peaks are higher in **dry** condition**





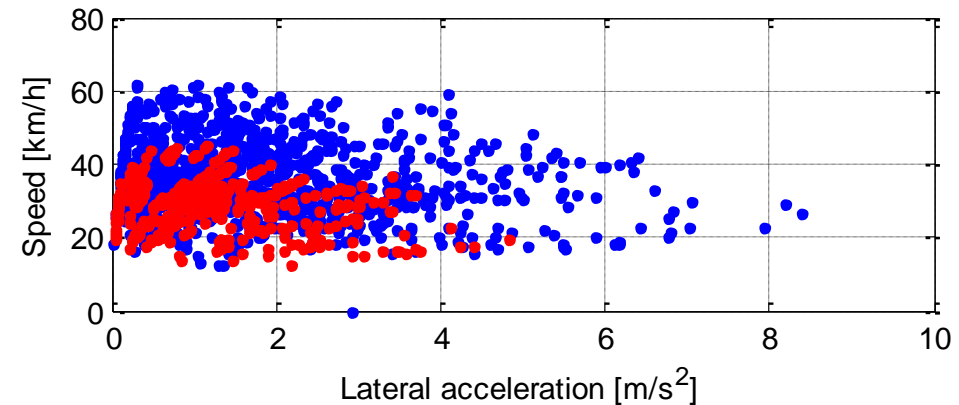
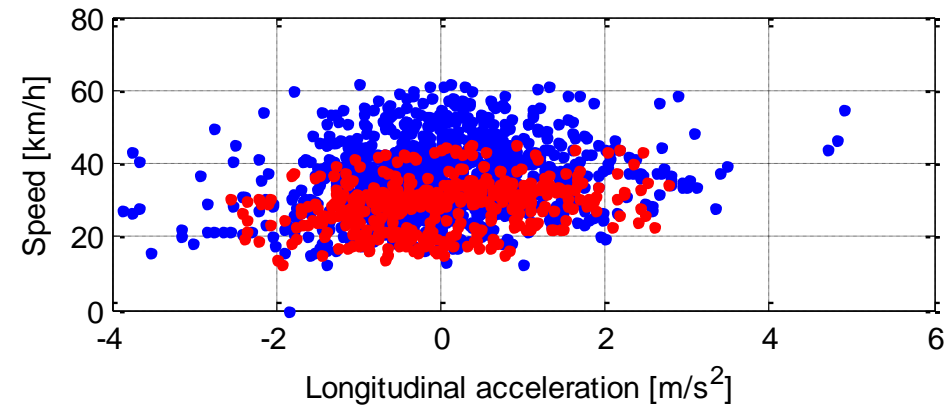
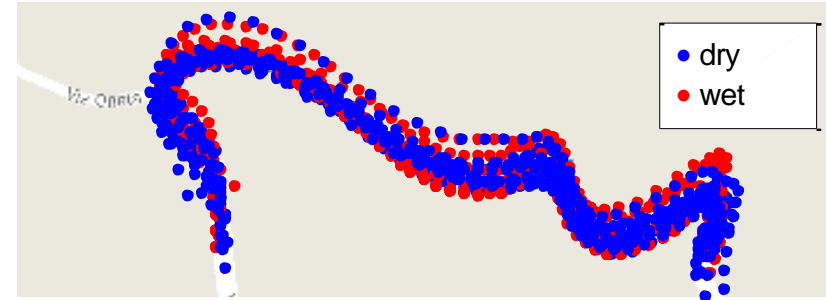
The **dry** condition cloud of points is on average **higher and larger** with respect to the **wet** one





This behavior is statistically confirmed on **more than two passages** and with **different drivers and vehicles?**

- Real experimental data
- Same road (in both direction)
- Different car
- Different driver
- 10 travel on **dry** road
- 6 travel on **wet** road

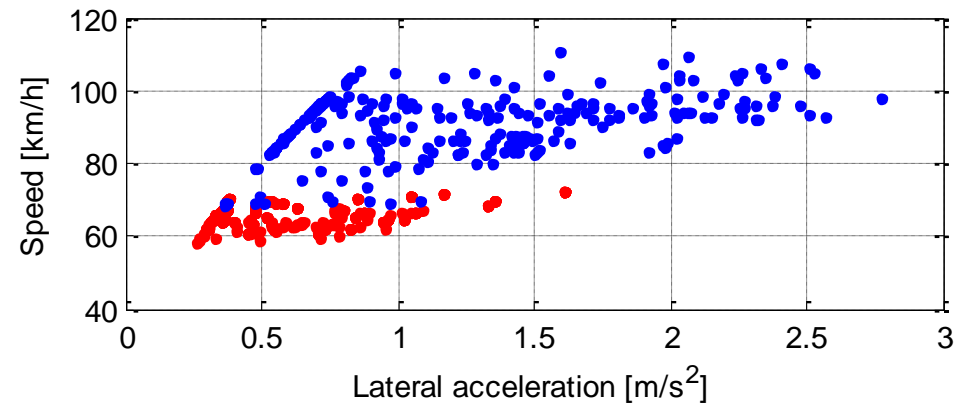
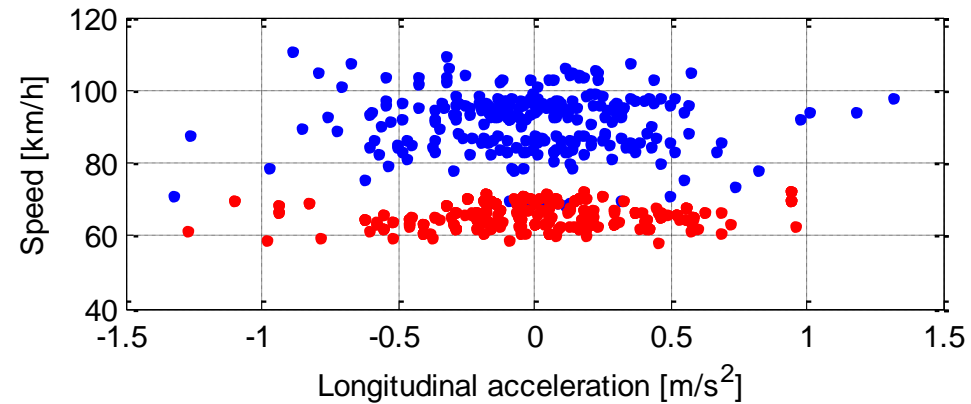




This behavior is statistically confirmed  
on a **different path?**

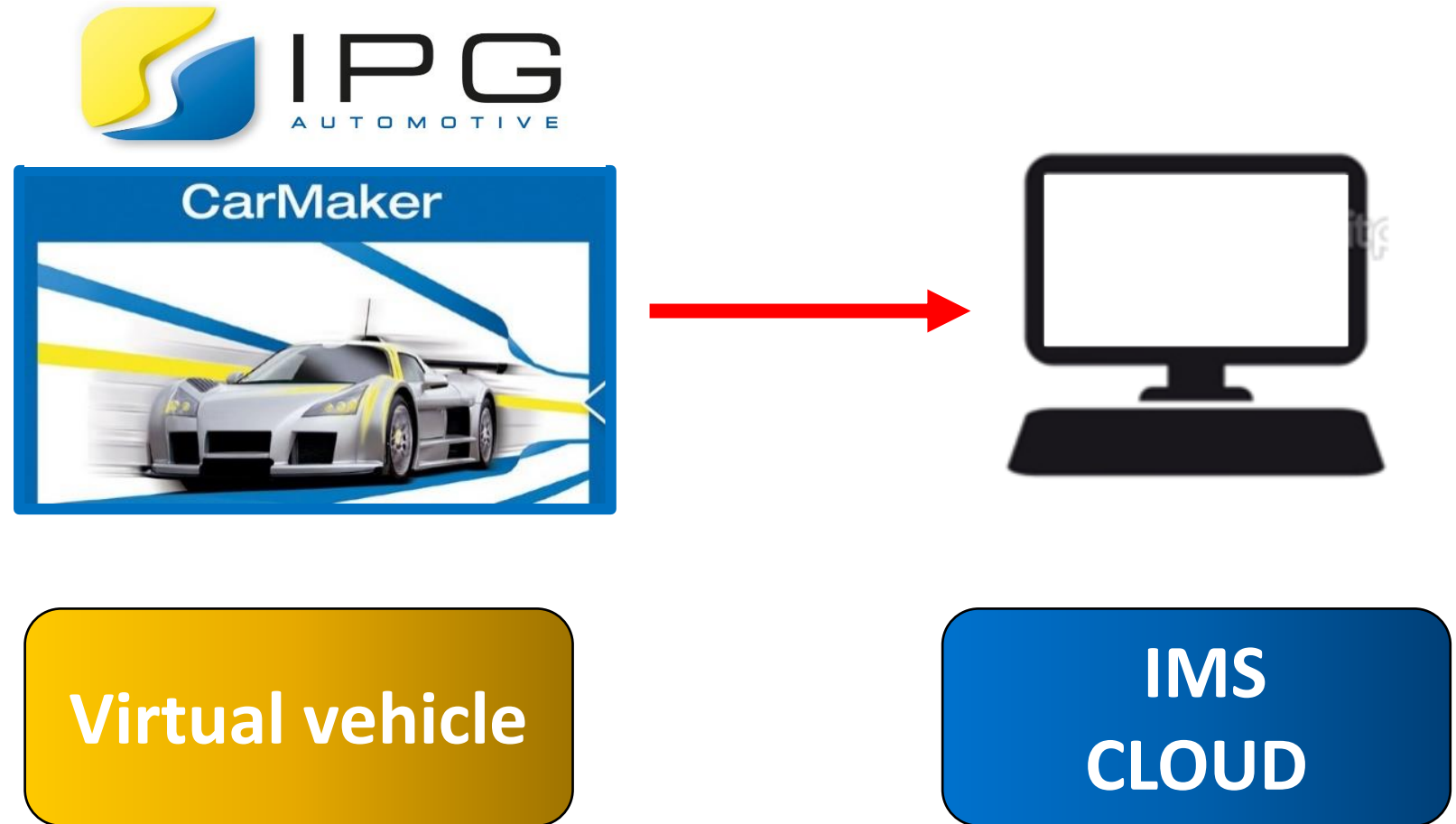


- Real experimental data
- Different road (in both direction)
- Different car
- Different driver
- 9 travel on **dry** road
- 4 travel on **wet** road



## NUMERICAL SIMULATON

- To check the communication with the cloud
- To populate the geodatabase
- To verify and train the friction identification logic



## NUMERICAL SIMULATION

- To check the communication with the cloud
- To populate the geodatabase
- To verify and train the friction identification logic

### Software In the Loop

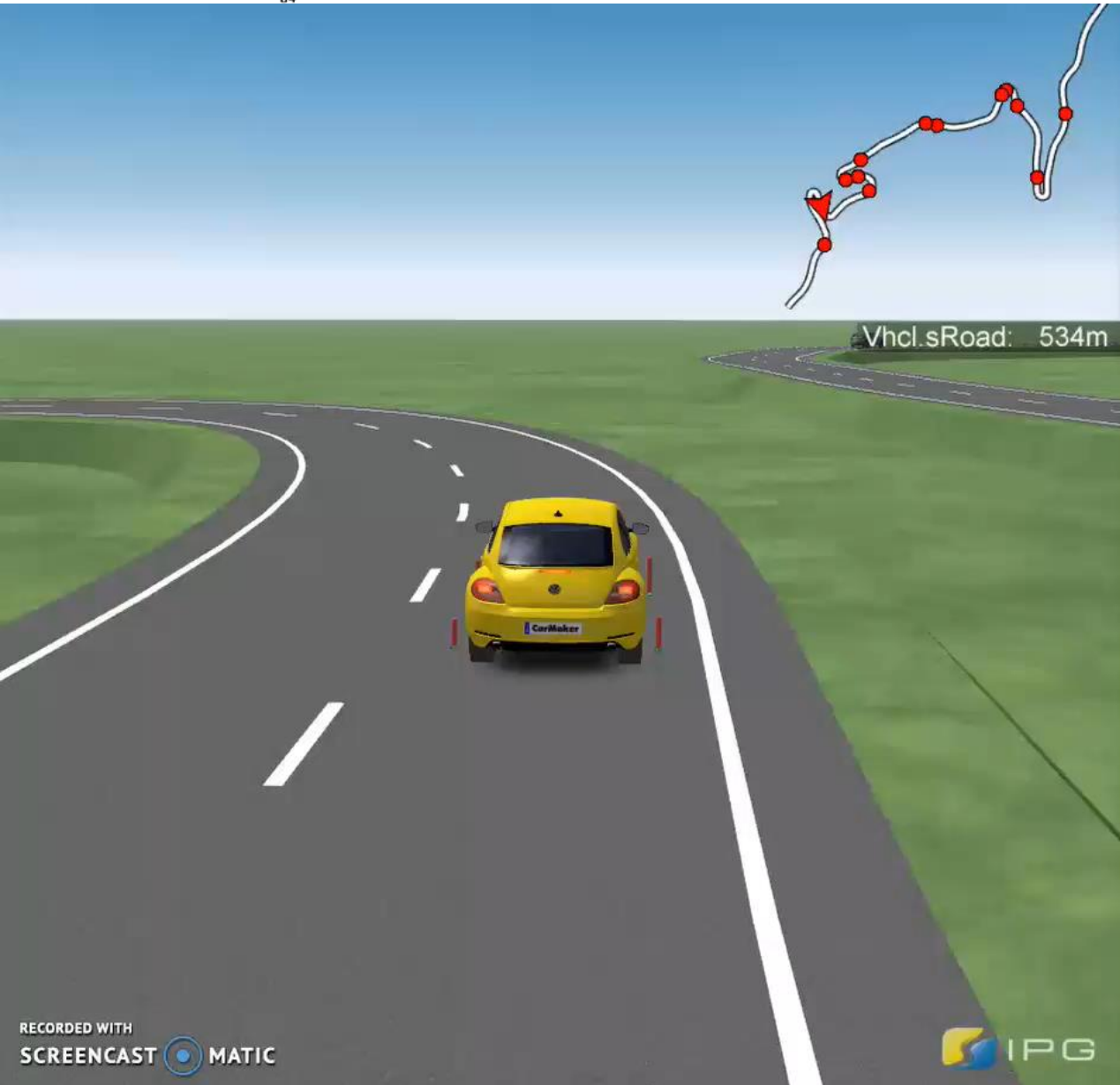



**Virtual driver  
Virtual vehicle**

### Driver In the Loop



**Real driver  
Virtual vehicle**




I aM Safe

Utente: Giulia Morandin (gmorandin) \* Logout

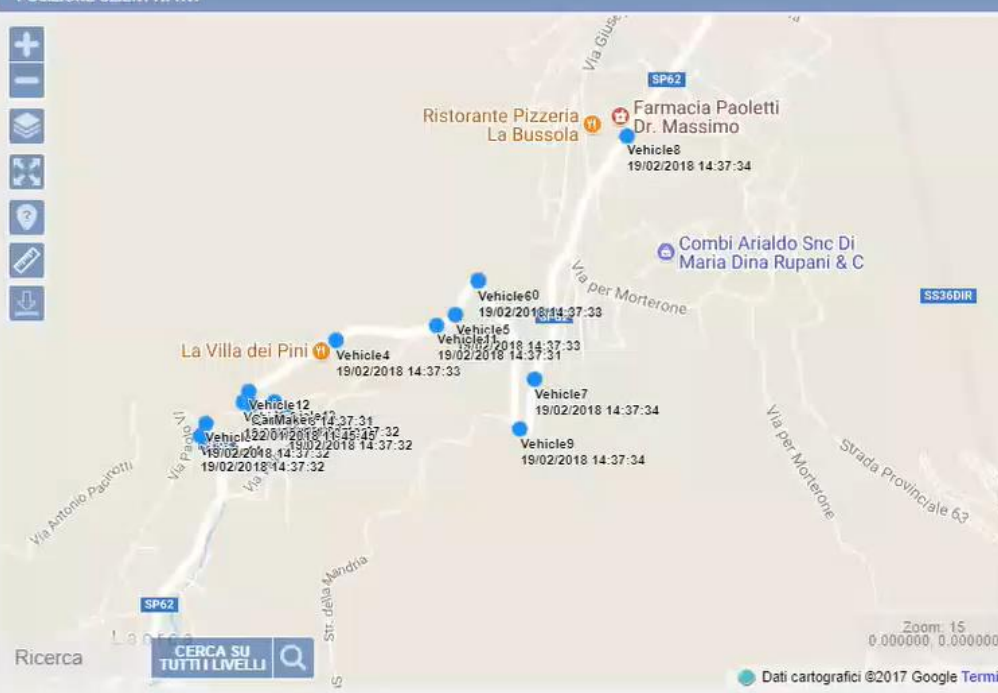
**STRUMENTI**

- Apri ticket
- Cambia password
- Ricerca
- Report & Statistiche

**ELABORAZIONE DATI**

- Blocchi di dati
- Estrazioni da mappa
- Celle griglia e Clients

**POSIZIONE CLIENTI ATTIVI**



Map showing active client positions. Labels include:
 

- Ristorante Pizzeria La Bussola
- Farmacia Paoletti Dr. Massimo
- Vehicle8 19/02/2018 14:37:34
- Combi Arialdo Snc Di Maria Dina Rupani & C
- SS36DIR
- Via per Morterone
- Strada Provinciale 63
- Via per Morterone
- Vehicle60 19/02/2018 14:37:33
- Vehicle5 19/02/2018 14:37:33
- Vehicle4 19/02/2018 14:37:33
- Vehicle7 19/02/2018 14:37:34
- Vehicle9 19/02/2018 14:37:34
- Vehicle12 19/02/2018 14:37:34
- Vehicle11 19/02/2018 14:37:32
- Vehicle10 19/02/2018 14:37:32
- Vehicle13 19/02/2018 14:37:32
- Vehicle14 19/02/2018 14:37:32
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- Vehicle58 19/02/2018 14:37:32
- Vehicle59 19/02/2018 14:37:32
- Vehicle60 19/02/2018 14:37:32
- Vehicle61 19/02/2018 14:37:32
- Vehicle62 19/02/2018 14:37:32
- Vehicle63 19/02/2018 14:37:32
- Vehicle64 19/02/2018 14:37:32
- Vehicle65 19/02/2018 14:37:32
- Vehicle66 19/02/2018 14:37:32
- Vehicle67 19/02/2018 14:37:32
- Vehicle68 19/02/2018 14:37:32
- Vehicle69 19/02/2018 14:37:32
- Vehicle70 19/02/2018 14:37:32
- Vehicle71 19/02/2018 14:37:32
- Vehicle72 19/02/2018 14:37:32
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- Vehicle80 19/02/2018 14:37:32
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- Vehicle96 19/02/2018 14:37:32
- Vehicle97 19/02/2018 14:37:32
- Vehicle98 19/02/2018 14:37:32
- Vehicle99 19/02/2018 14:37:32
- Vehicle100 19/02/2018 14:37:32

**coopolis**

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www.coopolis.it  
info@coopolis.it

Ricerca

CERCA SU TUTTI I LIVELLI

Zoom: 15  
0,000000, 0,000000

Dati cartografici ©2017 Google Termina

## NUMERICAL SIMULATION

- To check the communication with the cloud
- To populate the geodatabase
- To verify and train the friction identification logic

Software In the Loop



**Virtual driver**  
**Virtual vehicle**

Driver In the Loop



**Real driver**  
**Virtual vehicle**





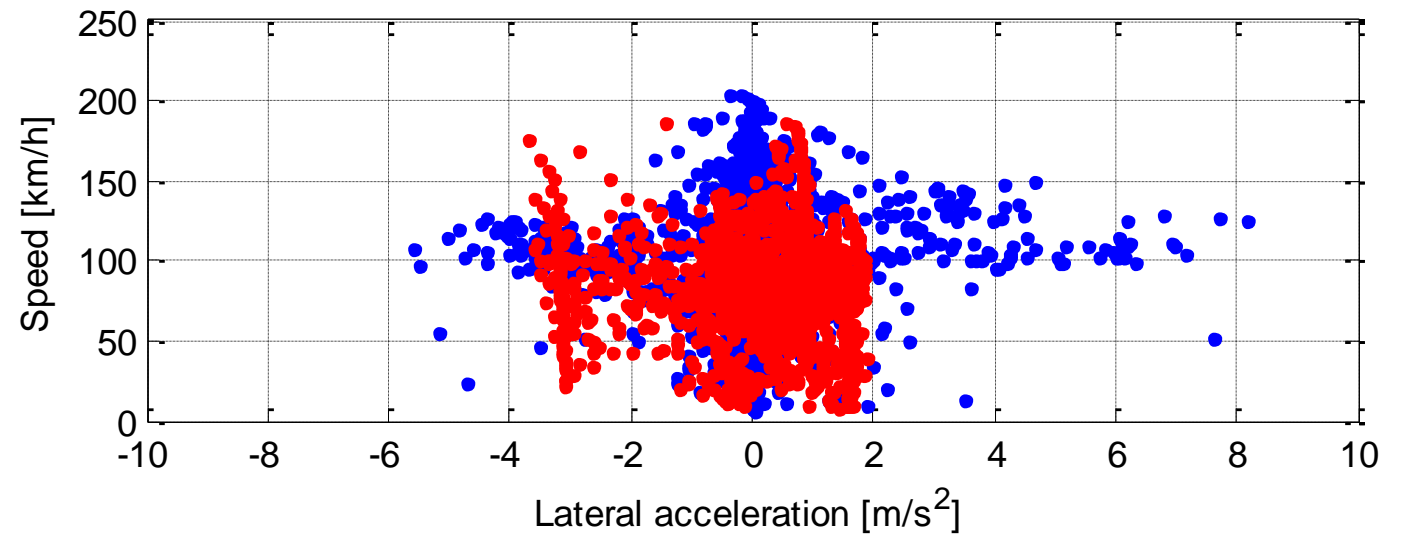
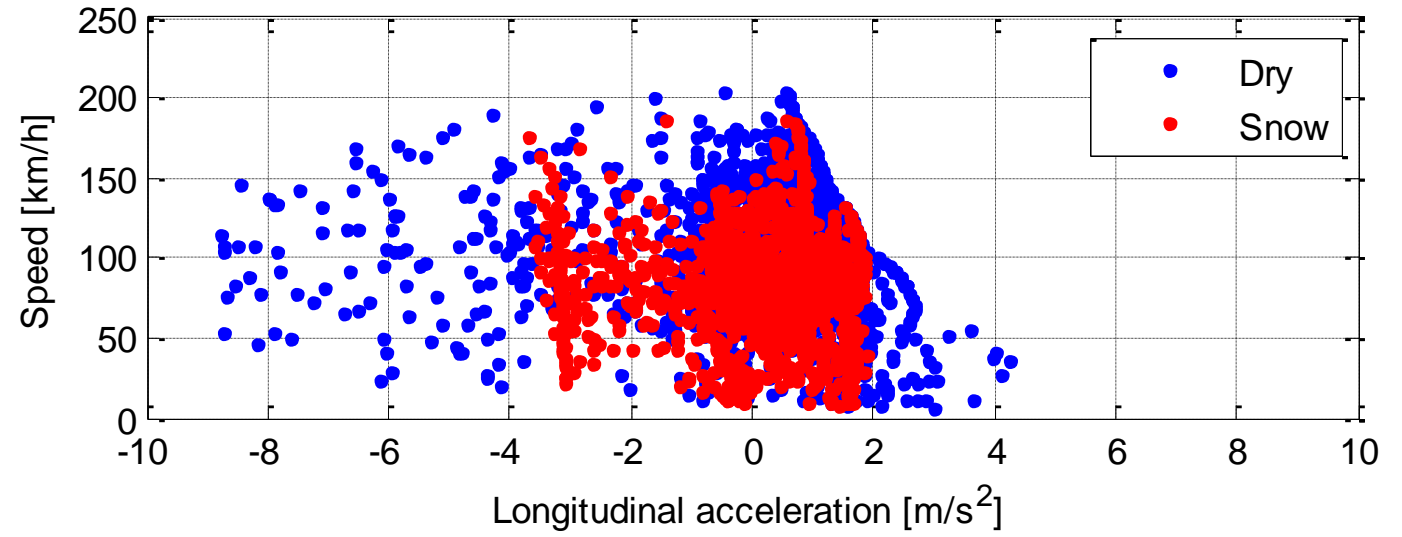
Highway road  
(high visibility, high friction)



- People: 10
- Gender: male
- Age: 25 - 35

Highway road with snow  
(good visibility, low friction)







# Collaborative

Estimation

Improvement

Safety

Vehicle

Intelligence

Manoeuvres

System

Collision

Time

Sensor

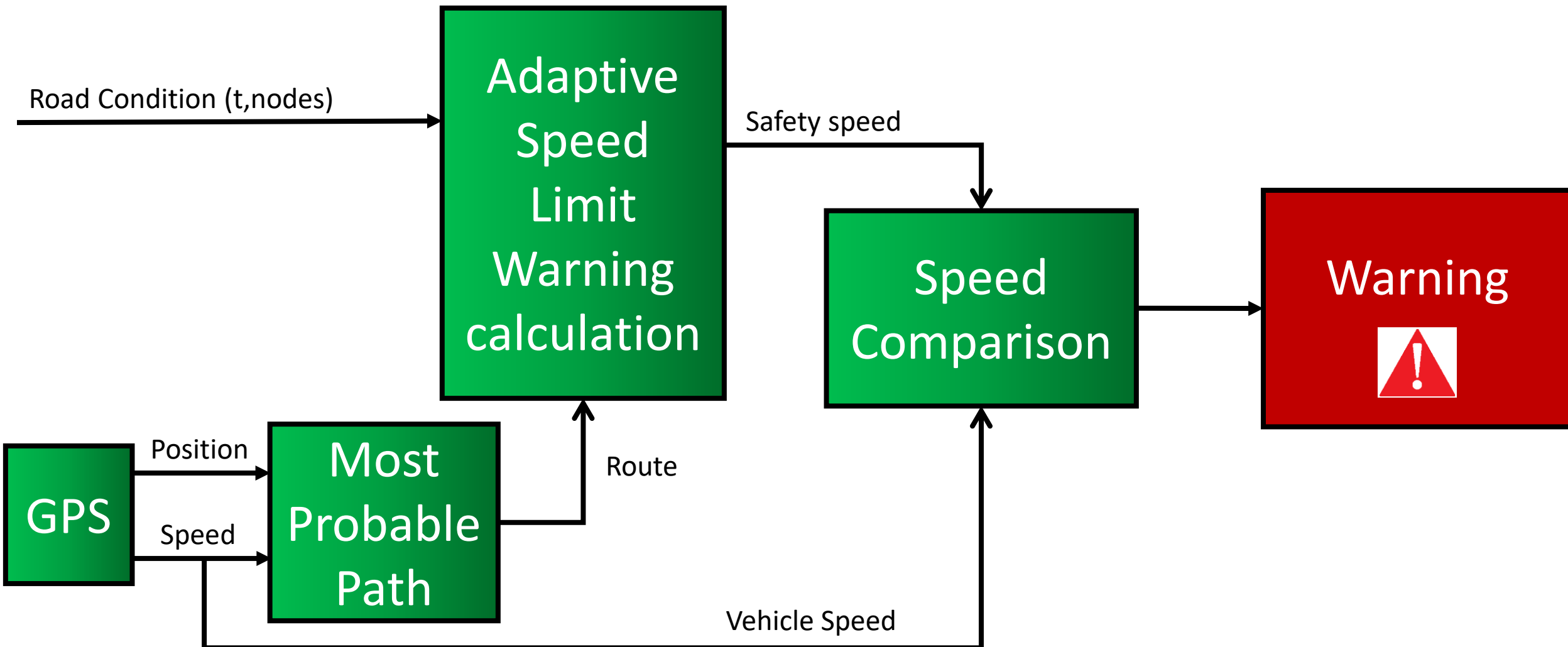
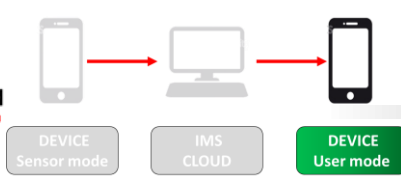
# Potential Friction

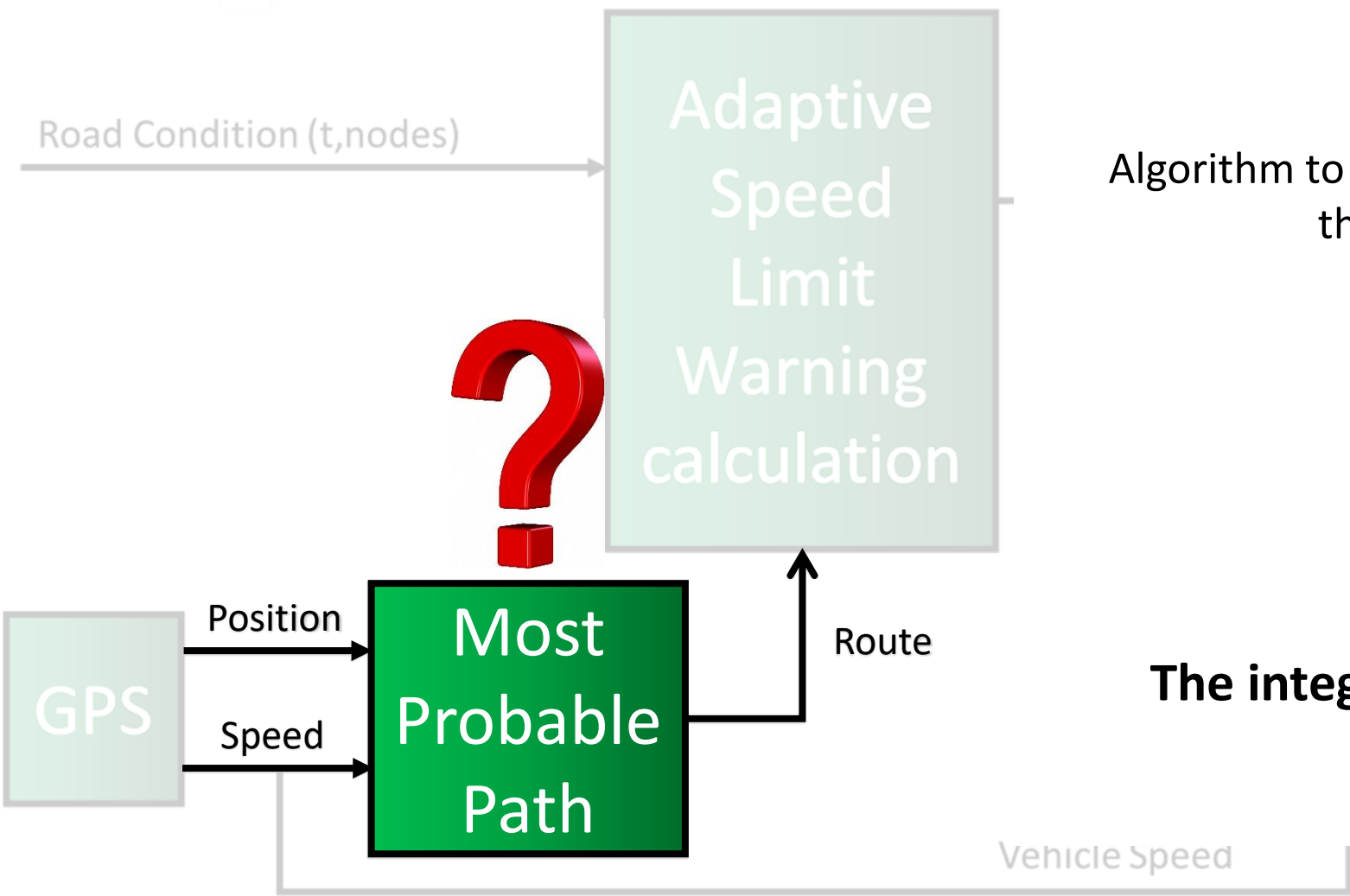
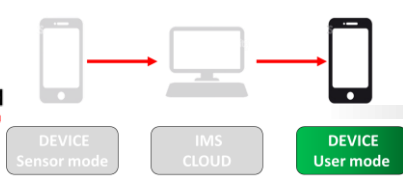
1 Collaborative approach

2 Potential friction ID

3 Adaptive Speed Limit Warning

4 Conclusion

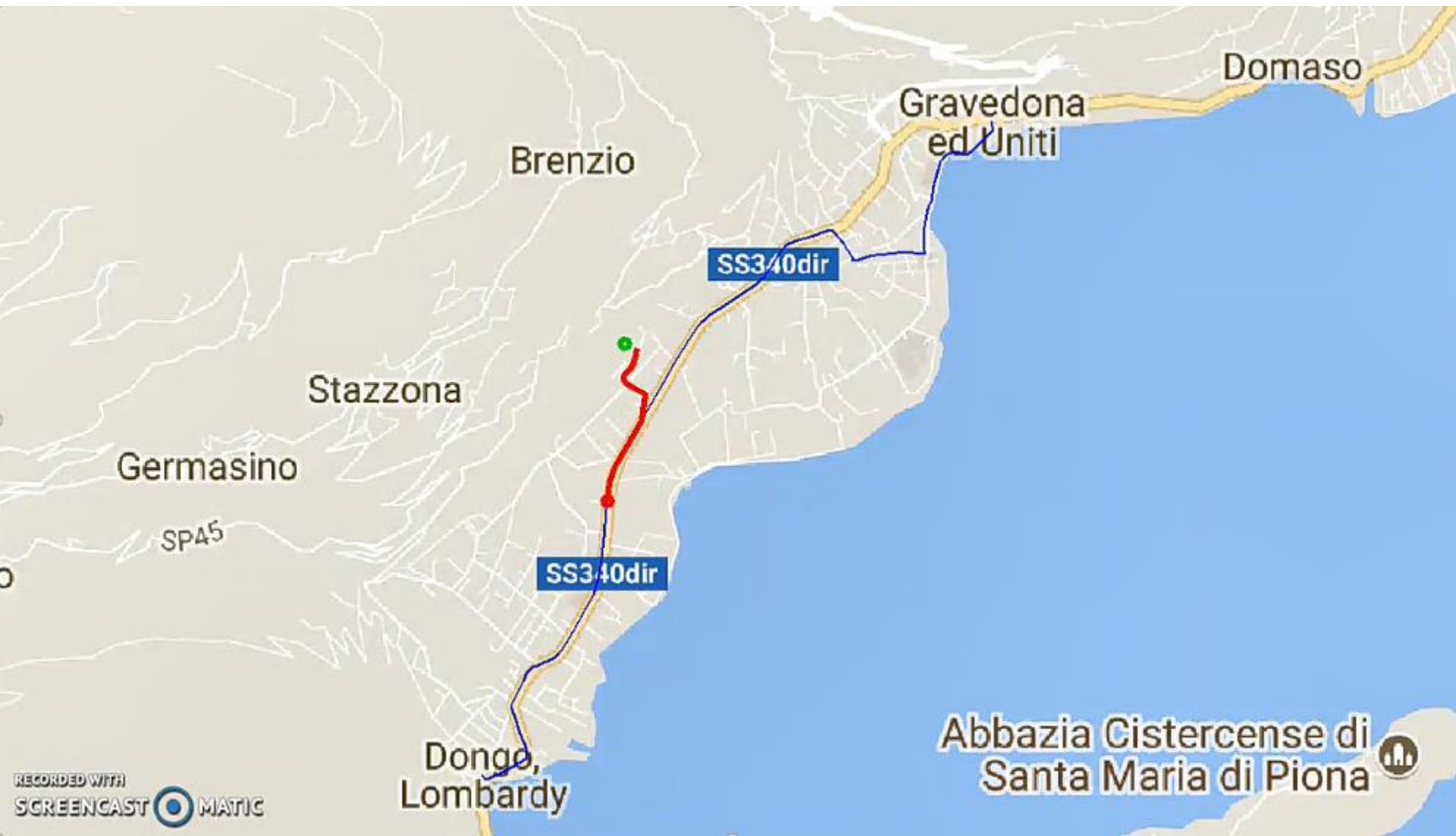
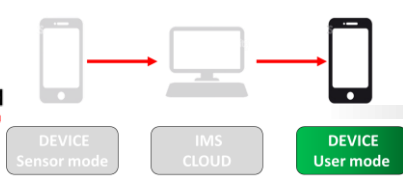




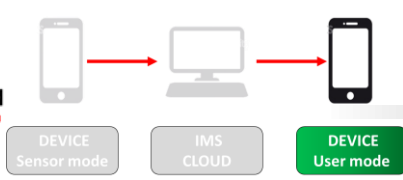
Algorithm to forecast which road will be travelled by the vehicle in the near future.



**The integration with a navigator is NOT necessary**



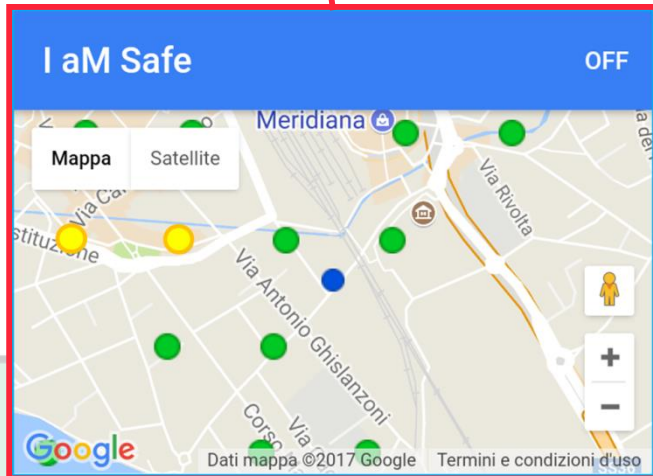
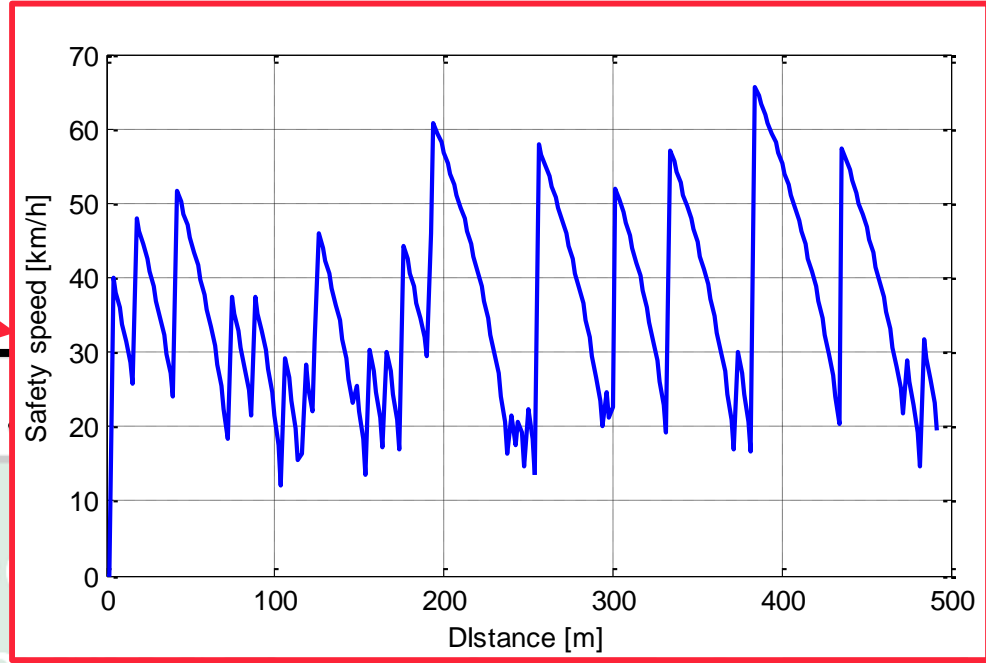
- Vehicle position
- Effective path
- Pointer position
- MPP



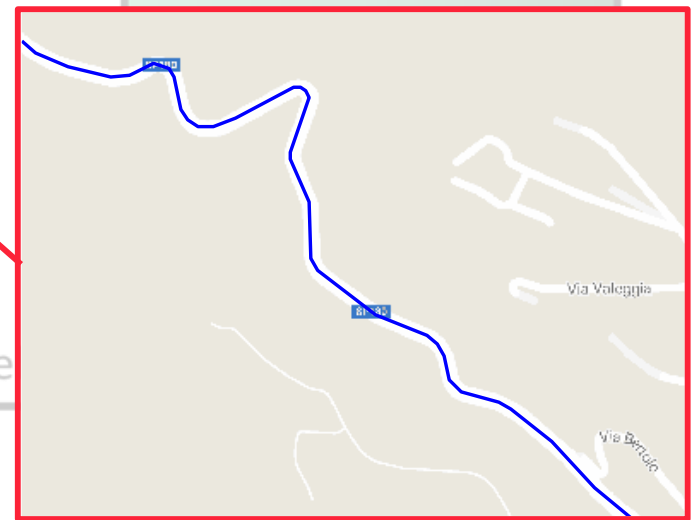
Road Condition (t,nodes)

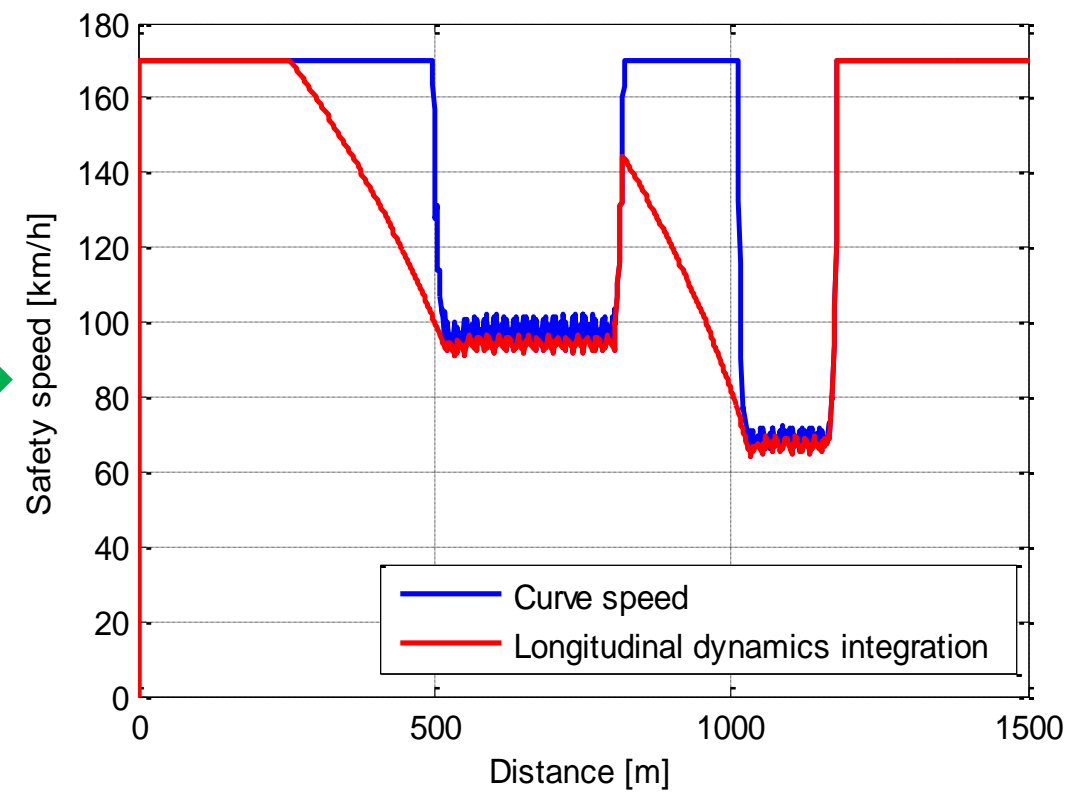
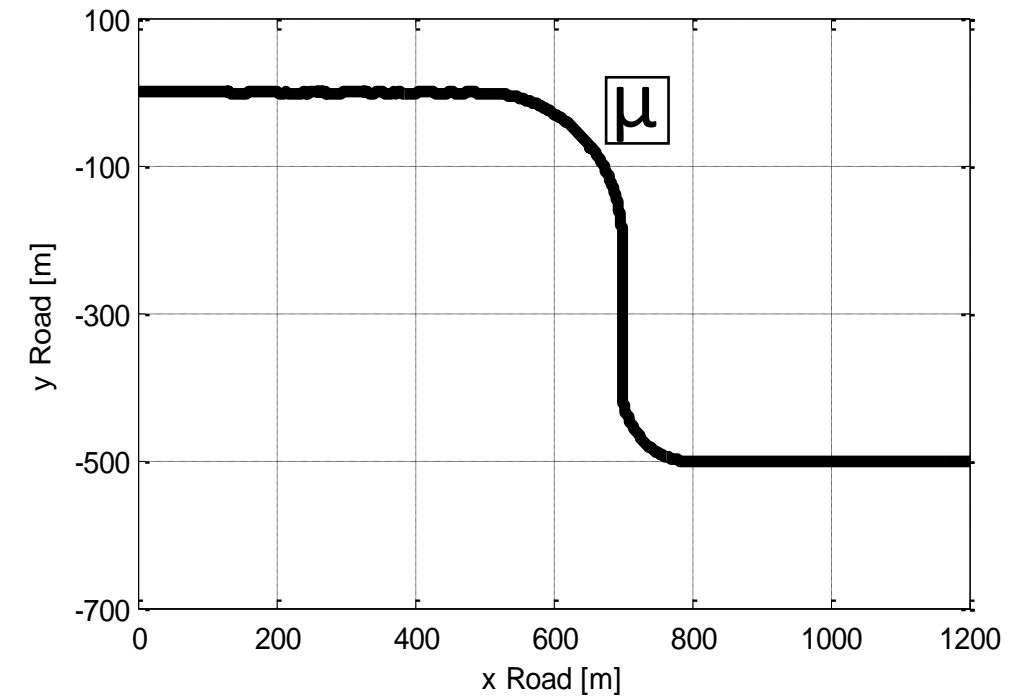
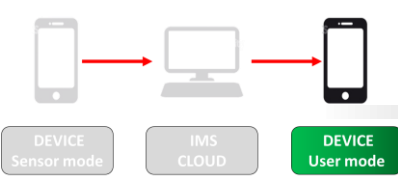
**Adaptive  
Speed  
Limit  
Warning  
calculation**

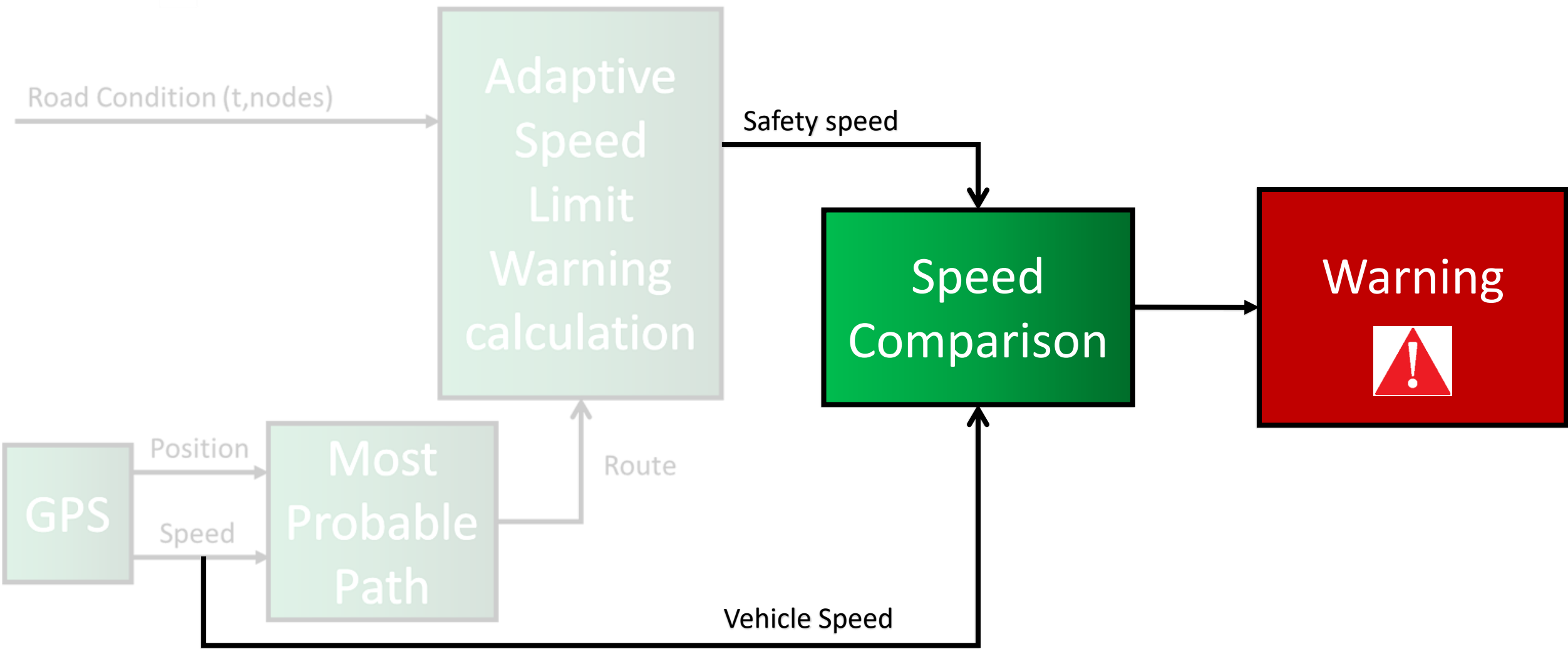
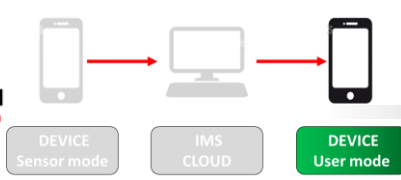
Safety speed

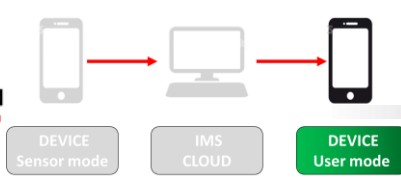


Route

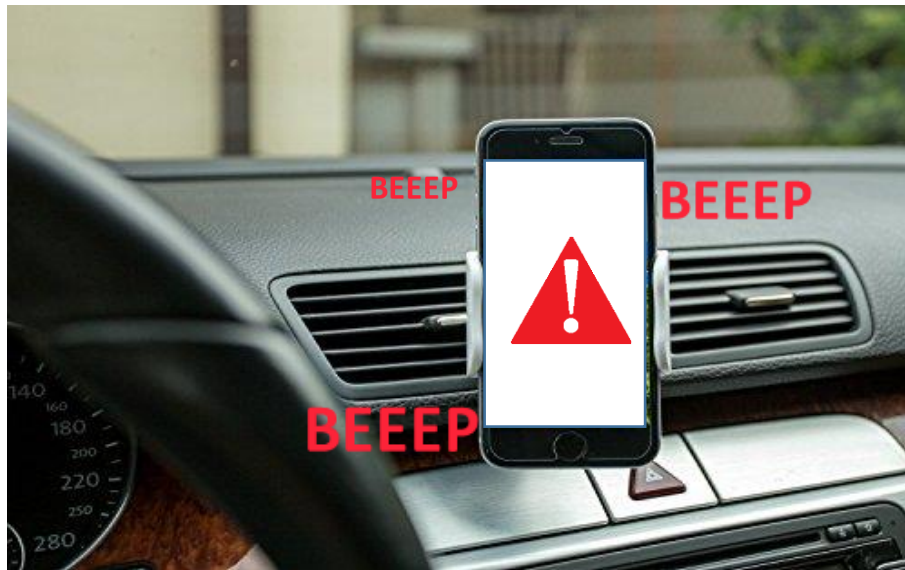








## DIFFERENT WAYS TO ADVISE THE DRIVER



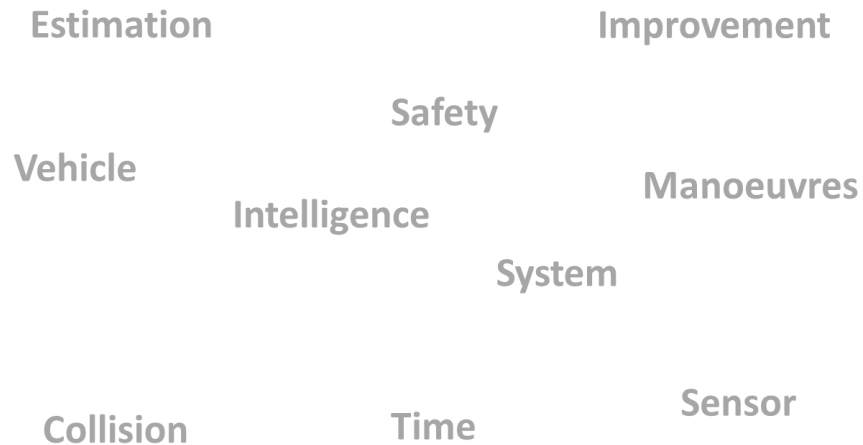
**SmartPhone Display**



**HeadUP Display**



# Collaborative



# Potential Friction

1 Collaborative approach

2 Potential friction ID

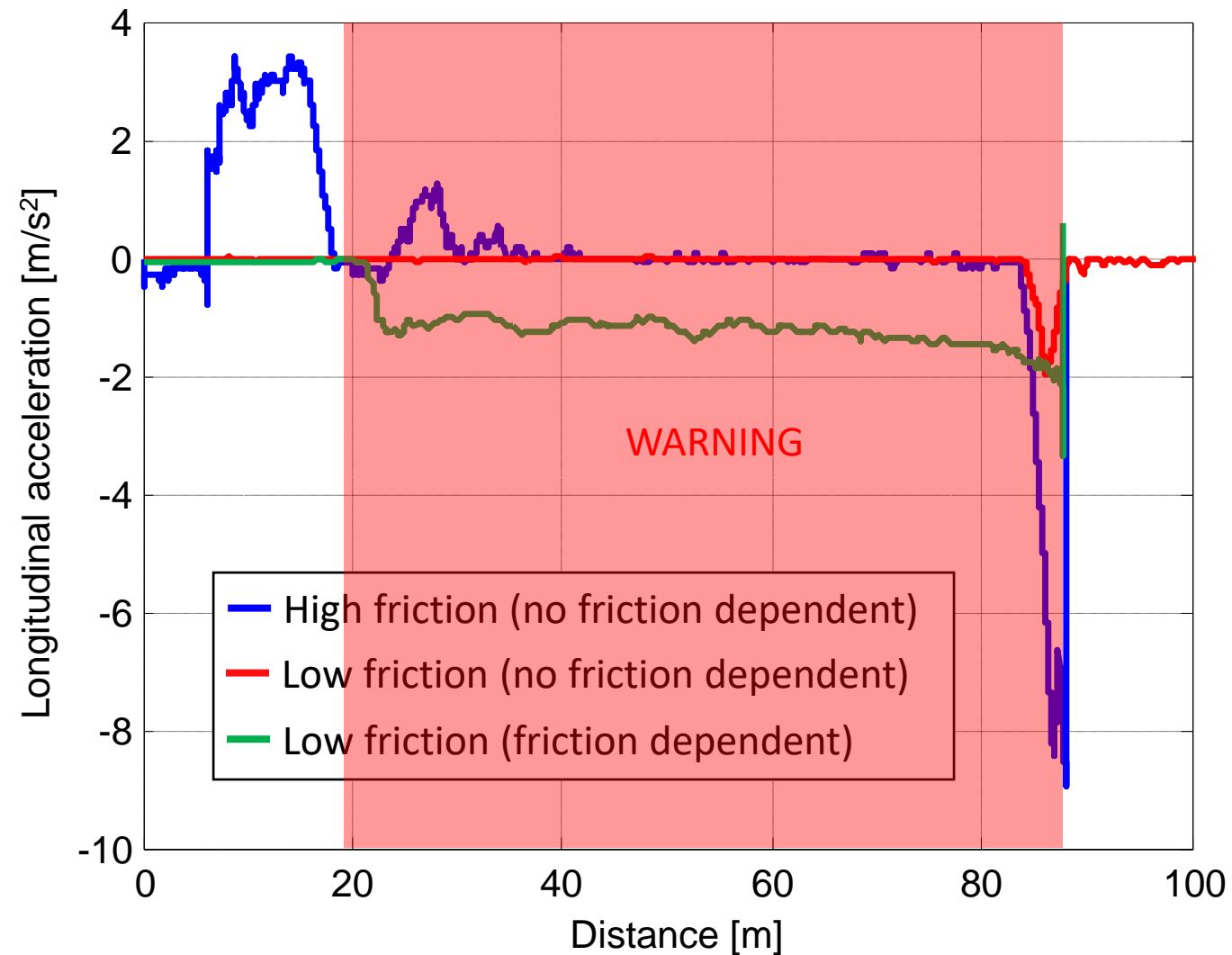
3 Adaptive Speed Limit Warning

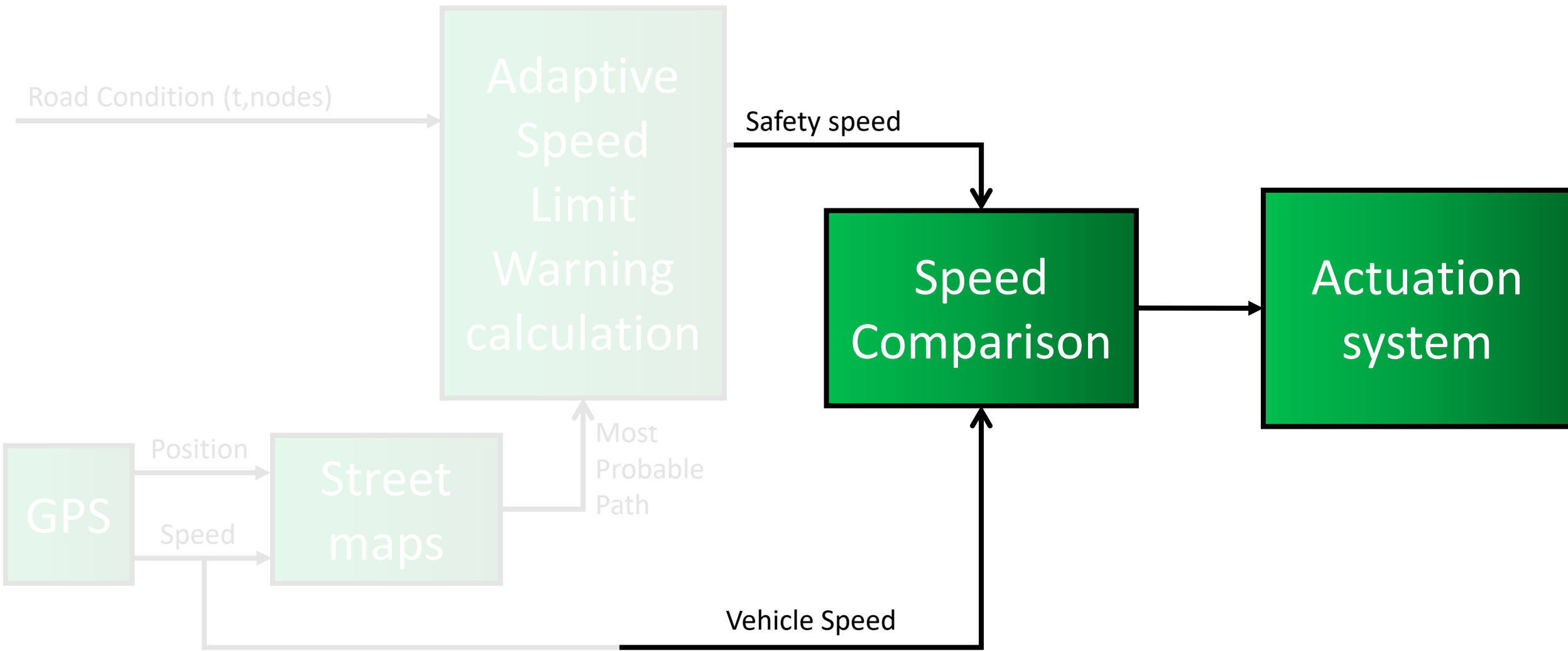
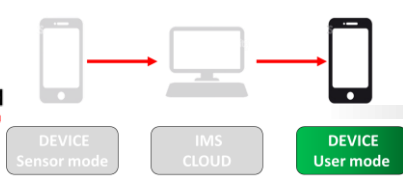
4 Conclusion

Friction dependent ADAS

Surface → Low friction

Cruising speed → 50 km/h





# Thank you for your attention



**Research partnership  
in technology innovation**