Radio & Mixed Signal Innovations

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A Real-Time Traffic Information System for Vehicle Navigation

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Outline

- Motivation
- System Overview
- Vehicle Sensing
- Velocity Calculation
- Best Path Calculation
- User Guidance
- Conclusions and Future Work

Motivation

The Morning Nightmare....

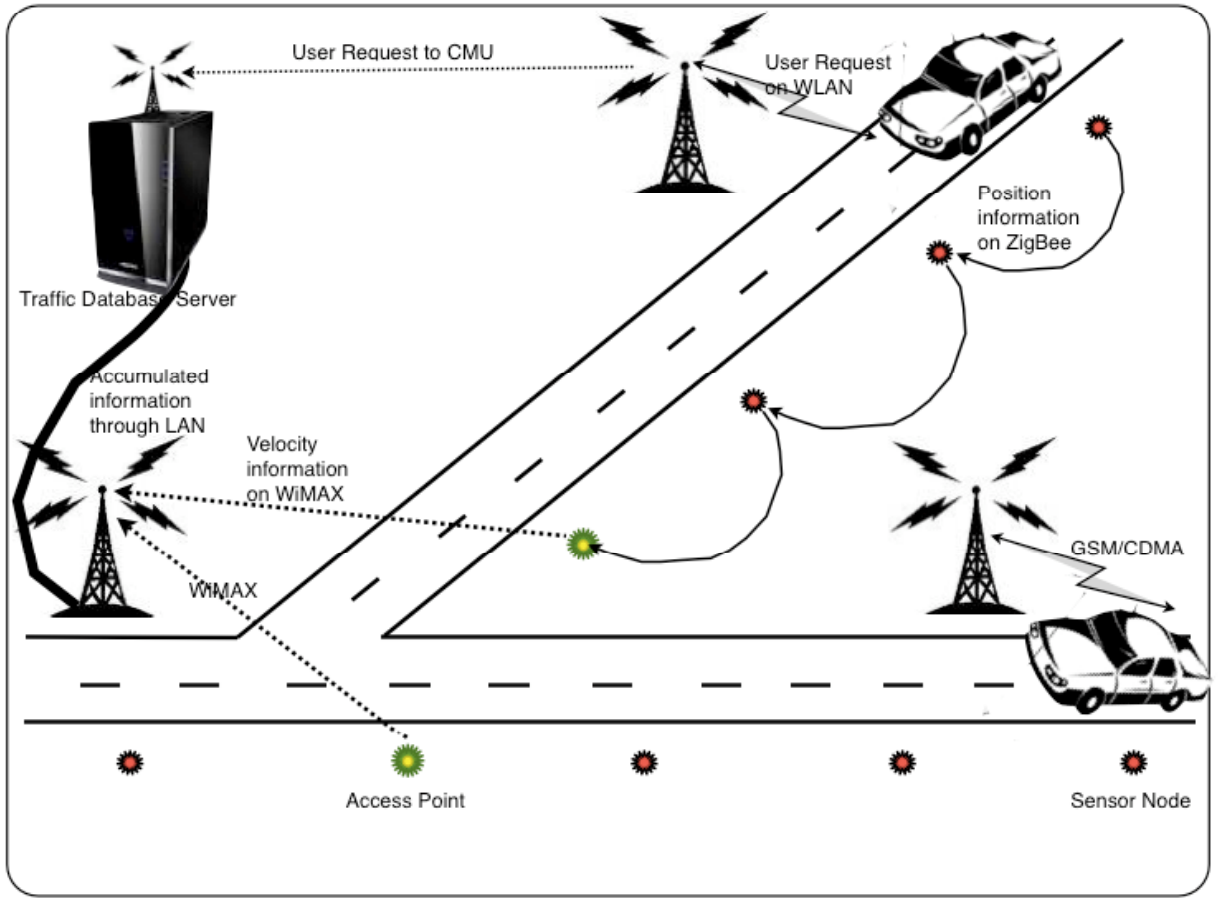
Picture from Vägverket's website

Motivation

Objectives

- Create an Advanced Traveler Information System (ATIS) that provide vehicles with route guidance over a wireless link that provides:
  - On-demand user specific information.
  - Best route calculation based on real-time traffic information.
  - Automated.
- Making use of available sensor and communications infrastructures.

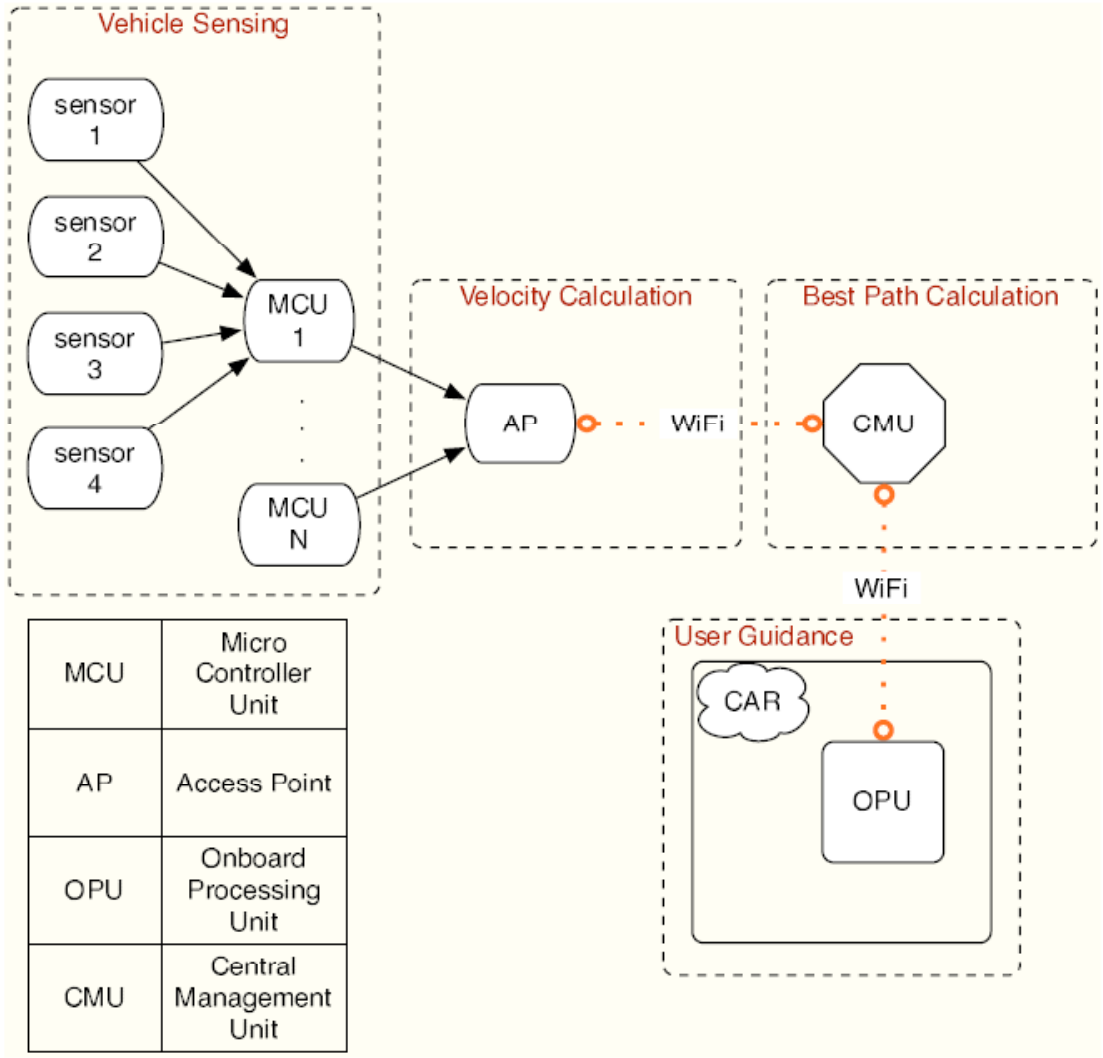
System Overview



Connectivity, data gathering and processing options of the proposed Traffic Information System

System Overview

Abstracted block diagram of the proposed ATIS demonstrator



MCU	Micro Controller Unit
AP	Access Point
OPU	Onboard Processing Unit
CMU	Central Management Unit

System Overview

Main tasks performed by the proposed ATIS demonstrator:

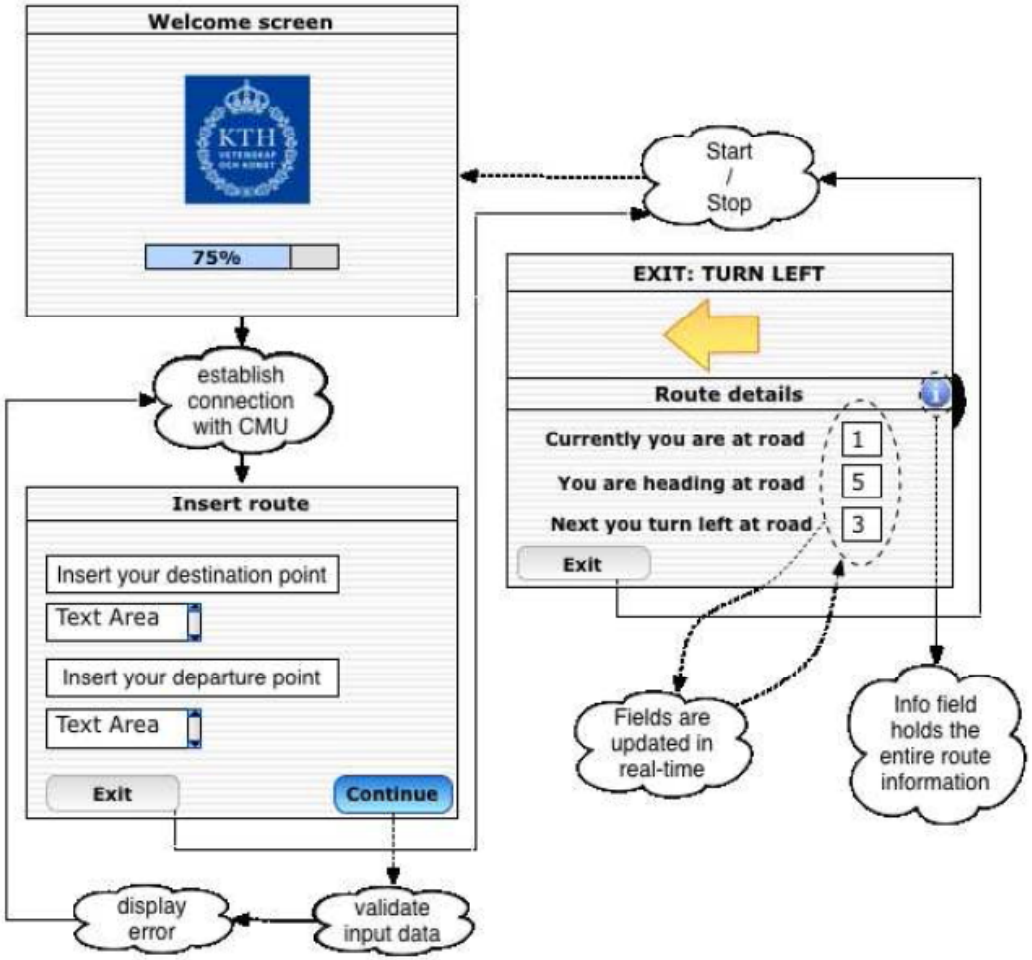
- Vehicle Sensing
- Velocity Calculation
- Best Path Calculation
- User Guidance

Operations supported by:

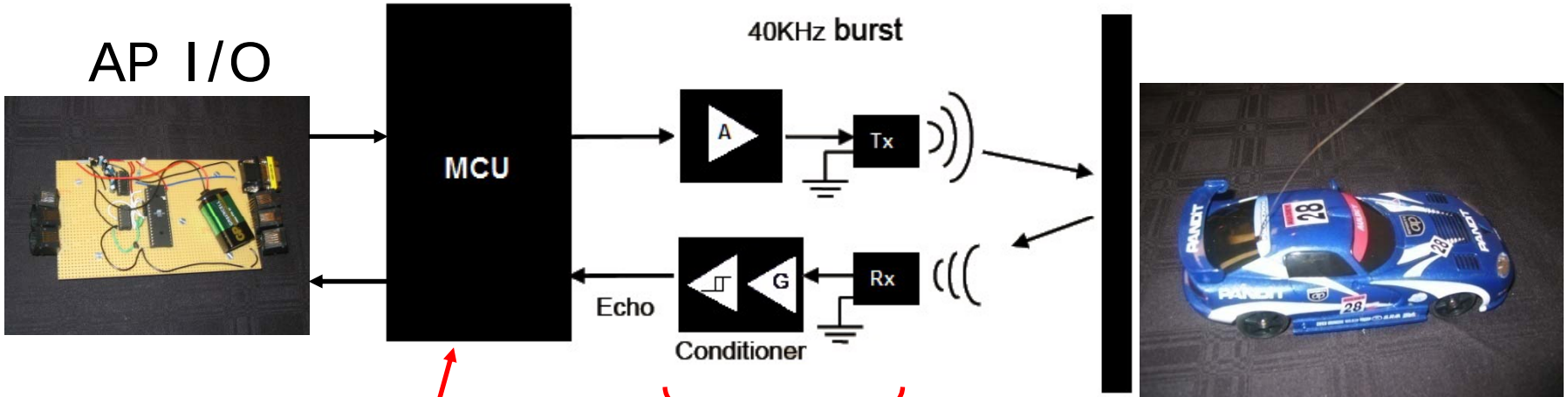
- Communication between the different subsystems.
- Database maintenance and accessing.

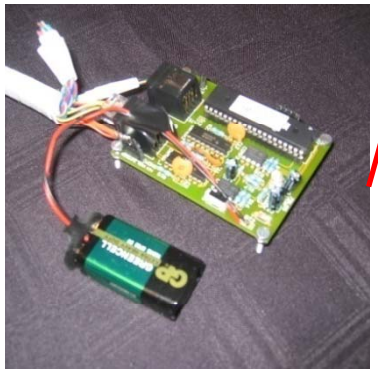
System Overview

Graphical User Interface (GUI) of the Demonstrator

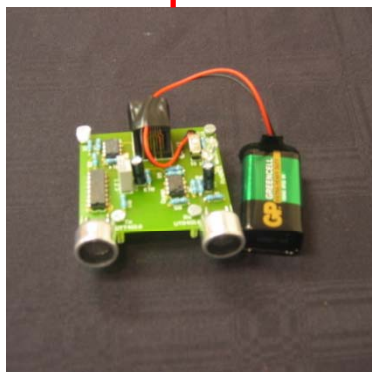


System Overview

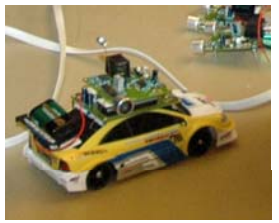




MCU



Sensor Node



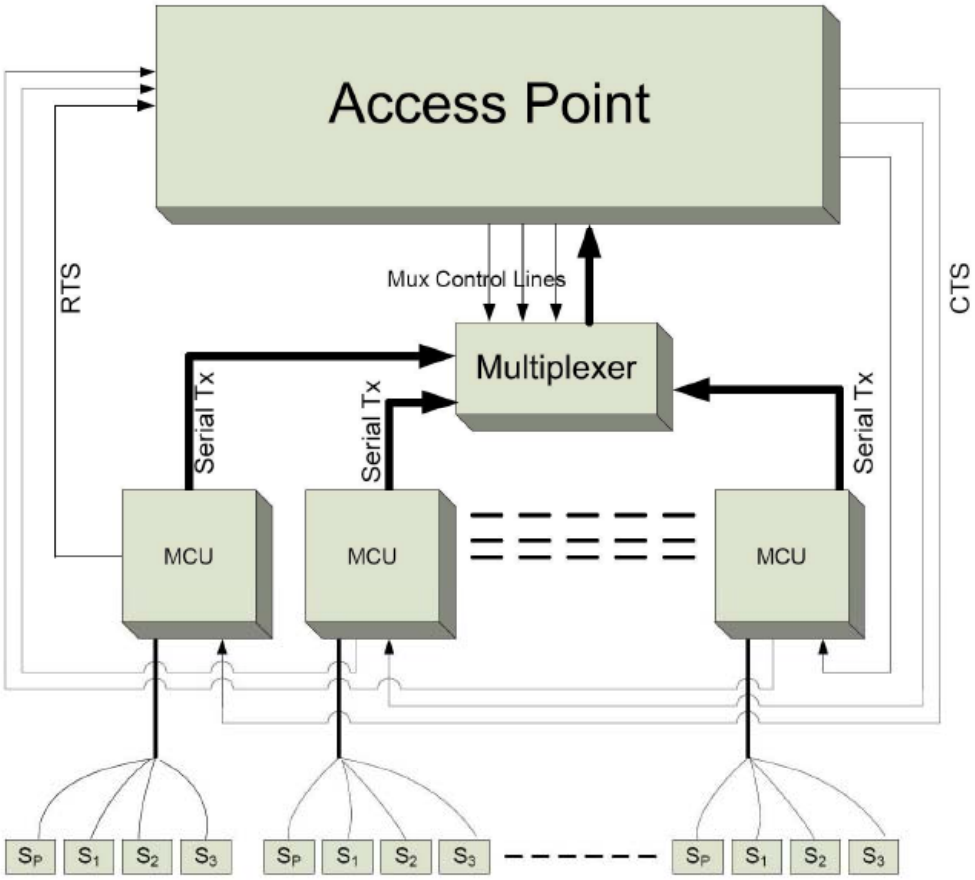
Self-awareness Tag

Demonstrator

Vehicle Sensing

- Sensor network is detecting and gathering the traffic information.
- Sensor nodes are placed along the roads to determine the position and velocity.
- Collected information is processed for determining traffic density and average velocity in each road segment.

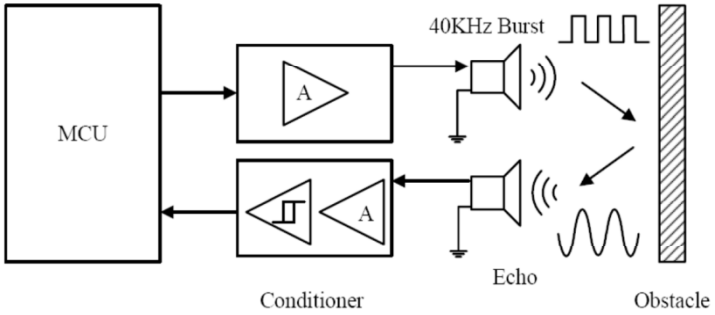
Vehicle Sensing

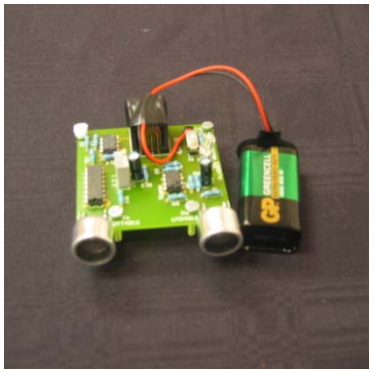


Block diagram of the sensor network deployed in the demonstrator.

Vehicle Sensing

Sensor Nodes

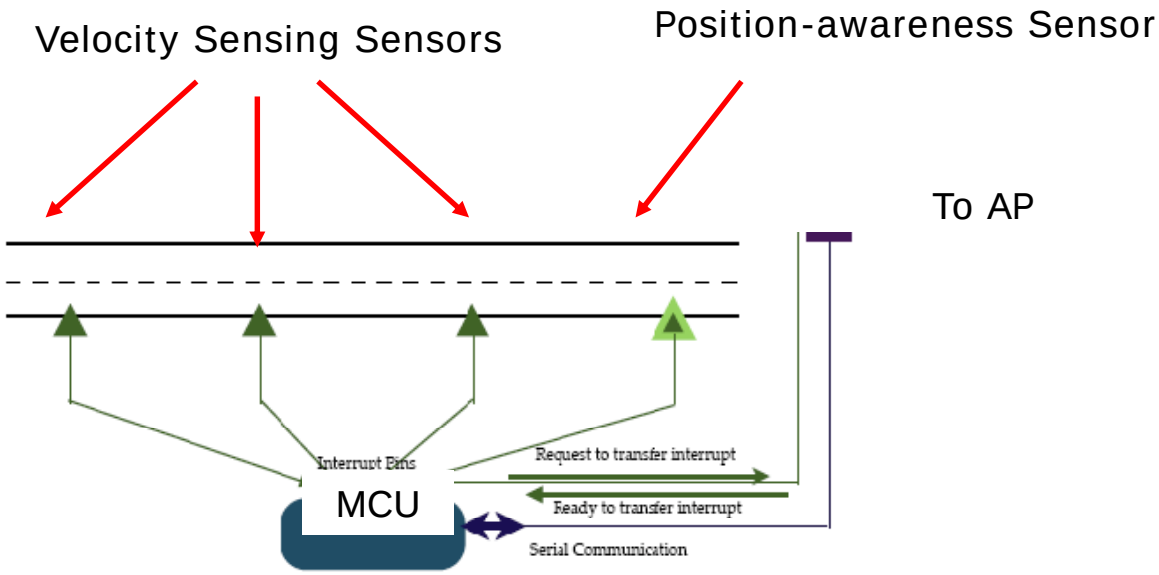




- Sensor nodes are based on ultrasonic transceivers.
- The ultrasonic Tx sends a 40 kHz burst.
- When there is an object in the range of the Trx, the Rx receives an echo.
- This echo is amplified and digitized by the conditioning electronics for further processing.

Vehicle Sensing

Sensor Network

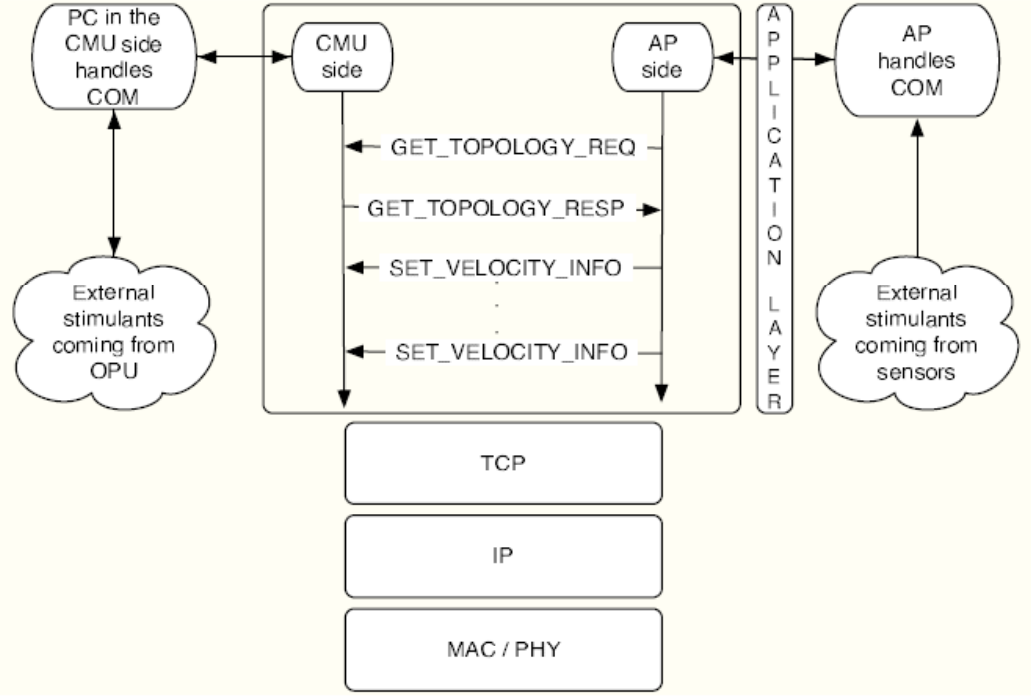


- The sensor network is built in a hierarchical way and a microcontroller ATMEGA162 is used.
- A time stamp is recorded by the MCU every time an echo is received.
- This allows to calculate the average velocity of the segment in the access point in real time.

Velocity Calculation

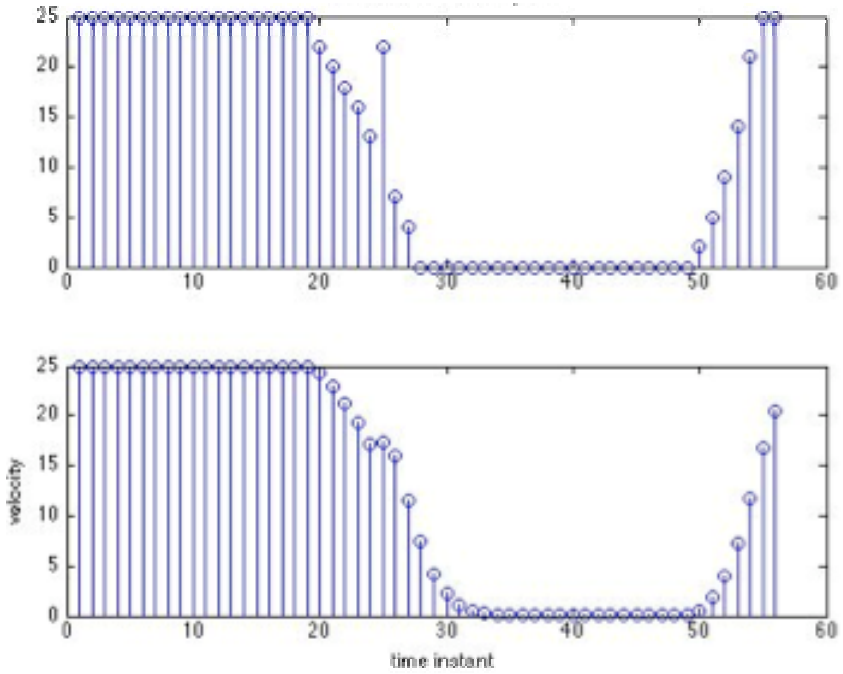
- Velocity of each road segment is a parameter in the cost function used in the best path calculations. Velocities are computed at the access points using the data coming from the different clusters' MCUs.

- The CMU receives the velocity data from the Access Point (AP) and performs the best path calculation.



Communication between MCU and the access point

Velocity Calculation



- The access point smoothens the raw velocity information using a Kalman filter.
- Processed velocity information is transfered to the Central Management Unit (CMU) over a wireless link using WLAN.

Upsizing the System

- The velocity sensing could be implemented when available using:
  - GPS (Cabs).
  - Traffic cameras + Pattern recognition + Velocity calculation.
  - Radar.
  - Other types of sensors.
- Velocity calculation can be performed by any kind of computing module.
- Trasferring the information to the central management unit can be carried out by any available communication means (WLAN, WiMAX, 3G networks, ...)

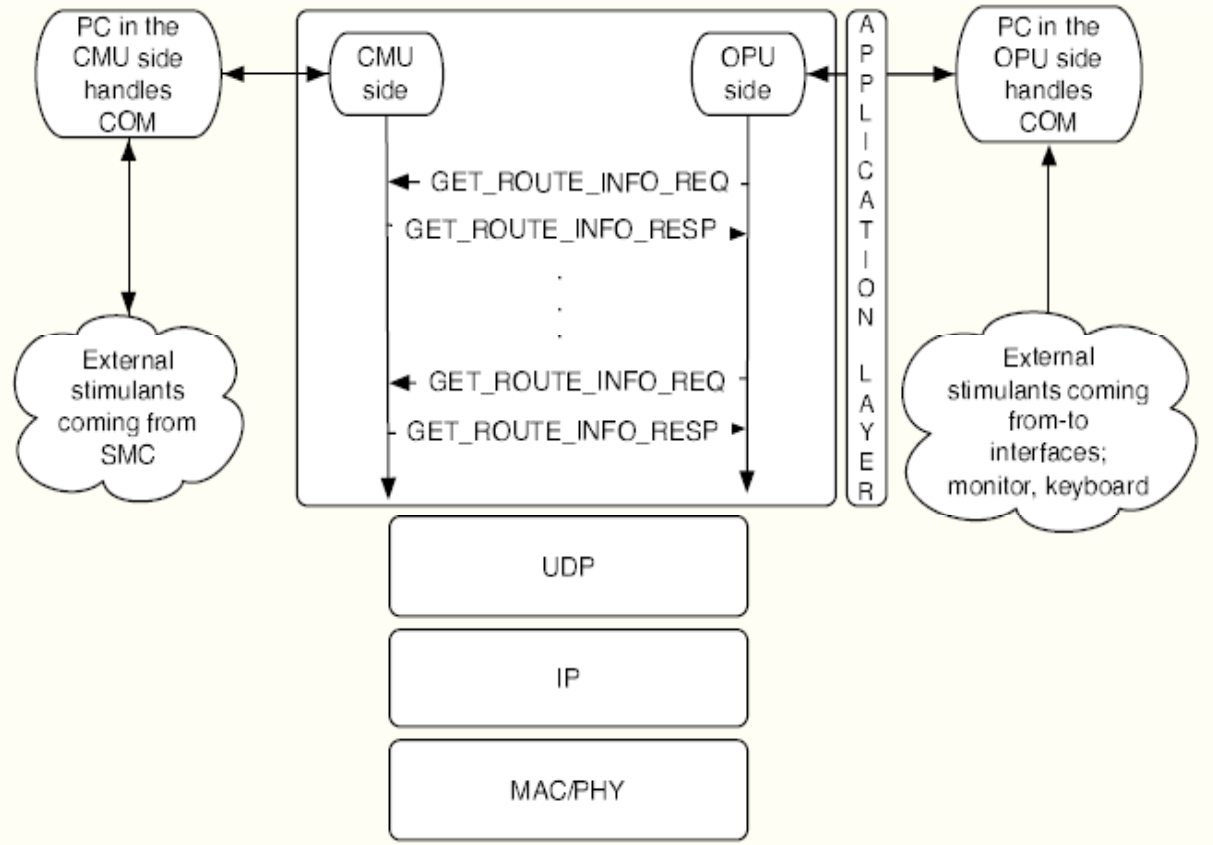
Best Path Calculation

- CMU performs the best path calculation between two points.
- Best path calculation based on Dijkstra's algorithm.
- The system can optimize for:
  - Minimum time.
  - Minimum distance.
  - Minimum fuel consumption.
- Each road segment has an associated weight, w, that depends on different parameters depending on what we optimize for.
  - Minimum time: w = f(d,v)
  - Minimum distance: w = f(d)
  - Minimum fuel consumption: w = f(d,v,L)

  d is the road length, v the road average velocity, and L the fuel consumption per 100 km of the selected car.
- User guidance at all times thanks to position-awareness.

User Guidance

CMU-OPU Communication



- The service subscriber receives route guidance through an On-board Processing Unit (OPU) over a wireless link.

Upsizing the system

- The communication system is TCP/IP based. It can run on top of virtually any physical communications flavor.
- Depending on the track size other best path algorithms might be more suitable.
  - Ad-hoc algorithms.
  - Geographical based algorithms.
- Hierarchical partitioning of large geographical areas.
- Improved User Inteface.

Conclusions and Future Work

- A future-proof ATIS system was devised.
- This ATIS provides real-time on-demand best route information based on the traffic conditions.
- A small-scale demonstrator was built in order to provide proof-of-concept.
- A large-scale ATIS based on existing wireless infrastructure is under development.

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Thank you for your attention!