# Connected and Automated Driving

*The key assets in VTT's automated driving are the three passenger cars Marilyn, Martti and Elvira which are based on Citroen C4, Volkswagen Touareg and Volkswagen eGolf bodies. The are converted to drive in automated mode with using special self-installed actuators. The cars are equipped with the latest sensors, sensor fusion and V2X connectivity technology. VTT is also developing machinery automation with using Pate off-road vehicle. Finally, VTT is involving digital infrastructure and mobile-edge computing with using special road-side unit called "Marsu". The trailer is equip with computing, camera, traffic light and connectivity technology.*

## Marilyn 2.0 - Citroen C4

Marilyn 2.0 is the first passenger car in Finland, which was permitted for automated driving in real traffic and mainly operating in urban environment. The car is equipped with advanced sensor technology, software solutions and automated driving functions. The electric actuators for controlling of throttle, steering wheel, gearbox and brake has been implemented. There 3-6 different LiDARs, RTK-GNSS positioning technology and ITS G5 and LTE cellular communication equipment on´-board.



## Martti - Volkswagen Touareg

The Martti research vehicle is dedicated to operate in rural areas. On the bumper of the vehicle VTT's sensor rack is installed, which contains similar type of sensors as Marilyn 2.0. Martti also has V2X communications and advanced HMI. Martti is able to operate in without lane markings in between snow banks in the areas where accuracy of maps is poor.



## Elvira – Volkswagen eGolf

Elvira is electric passenger car which will be equip with remote operation technology to supervise automated driving. The car will be equip with 360 deg sensing around the vehicle.



## MD15 – off-road track vehicle

MD15 is an off-road track vehicle having a 20 kW diesel engine and hydrostatic transmission. The top speed is 12 km/h and the engine can provide a traction force of up to 8 kN

§ Control system: PC 104 format PCs running real time Linux
§ Communication network: Ethernet and communication protocol is JAUS 3.3b (Joint Architecture of Unmanned Systems)
§ Thermal camera
§ 360° LiDAR
§ HDR stereo camera
§ Radars
§ Ultrasonic sensors
§ Weather station
§ Active IR-lightning
§ Odometer and inertial measurement units
§ software GPS units including RTK, DGPS and Precise Point Positioning (PPP) algorithms
§ 2.4 GHz and 5 GHz Wifi connectivity
§ LTE based Internet connectivity and ITS G5 short range radio link

## Mobile road side unit - Marsu

VTT has a mobile road side unit equipment, which can be setup in 20 minutes. This equipment can be used for testing road-side sensors and V2X technology. The following technology is installed:

§ 2 computer units
§ Road state monitoring unit
§ Software for gathering information from sensor units
§ ITS G5 and cellular communication (LTE/5G) units
§ MEC server



## Laboratory

A laboratory environment with servers, driving simulator, and software development tools:

§ 10 TB hard-disk capacity for vehicle fleet data management
§ ITS G5 station for connecting to vehicle fleets
§ 10 computer units with latest software development tools
§ Driver monitoring facility for pre-testing the equipment
§ SeeingMachine FaceLab driver monitoring system



## DemoKit – Sensor Kit

Special sensor verification and development tool with latest automated driving sensing tools:

§ Software acquiring and storing data
§ Continental short range radar
§ FLIR PathFinder thermal camera
§ 3 LiDARs: Velodyne PUCK-16, Ibeo Lux, Hokuyo



**The research topics:**

§ **Automated driving and ADAS**
§ **In-vehicle and roadside environmental perception**
§ **Sensor data fusion**
§ **Driver monitoring technologies**
§ **V2X communication technologies**
§ **IoT for vehicles**
§ **Artificial intelligence**
§ **Technical validation**

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