WICE: Automotive Telematics, Fleet Management, Rapid Prototyping and Remote Software Download for Connected Vehicles

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Introduction

The WICE system is a powerful and flexible automotive telematics platform developed by Alkit Communications AB, providing access to measurement data from connected vehicles, enabling fleet management and state-of-health services, rapid prototyping of new in-vehicle services and functions, and remote ECU software download.

The WICE platform and services

The WICE system consists of two main parts (see Figure 1):

1. An **in-vehicle data logging and monitoring system** (also known as Wireless Communication Unit, WCU), including connectivity and telematics services. A number of different hardware platforms are available for in-vehicle installation, including the MX-4 platform from Host Mobility and the MIIPS platform from Fältcom. The in-vehicle hardware unit supports communication interfaces for measuring and logging vehicular data (including CAN and FlexRay buses, analog inputs, digital inputs, USB and Ethernet).
2. A **back-end server infrastructure** including data storage, database with meta-information, and a web-based front-end user interface (known as the "WICE Portal").

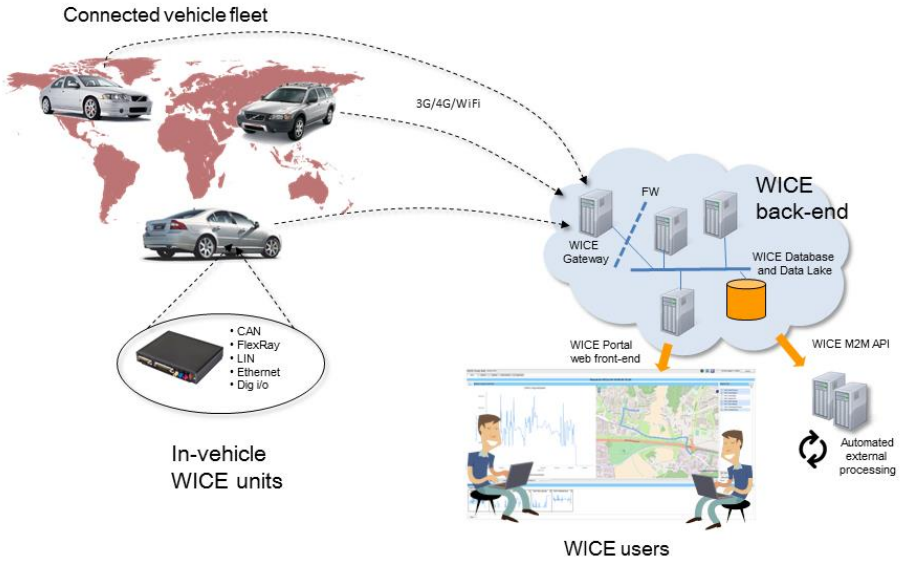

Figure 1: Overview of the WICE system

The following application services are supported by the WICE system:

- A **metrology service**, enabling engineers (or other users) to collect measurement data of different kinds (signals, frames, logs, video, etc.) from connected vehicles. Measurement task can be configured and assigned to connected vehicles through the WICE Portal user interface, and measurement data can be accessed, visualized and downloaded for analysis.
- A **fleet management service**, keeping track of the status of fleets of connected vehicles, including map-based positioning, mileage, uptime, Diagnostic Trouble Codes, ECU software version numbers, etc.
- A **rapid prototyping service**, enabling emulated execution of ECU services in the in-vehicle WICE unit, for proof-of-concept testing of new automotive functions and services.
- A **remote software download service**, making it possible to remotely re-program in-vehicle ECUs, enabling continuous deployment of ECU software in connected vehicle fleets.

The WICE back-end server infrastructure and the WICE Portal

The WICE back-end software system realizes the server-side functionality of WICE system. The WICE back-end software system is based on a service-oriented architecture (SOA), wherein the functionality is split up into a number of independent services, each realizing a key-function of the complete system. This approach is beneficial in that it allows distribution of the different services on a number of separate server machines, improving the scalability of the system through horizontal scaling, improving performance through load balancing, and providing fault tolerance through isolation of services. A high-level model of the system architecture is shown in Figure 2.

The WICE End Users interact with the system through a web-based front-end (known as the WICE Portal), typically accessible through a corporate Access Manager (AM). The WICE Master Application Server implements the core functionality of the supported services, including management of measurement tasks and data, fleet management of connected vehicles, data presentation, user management and administration. An access control framework based on user roles and resources regulates which users have access to particular data sets or application services.

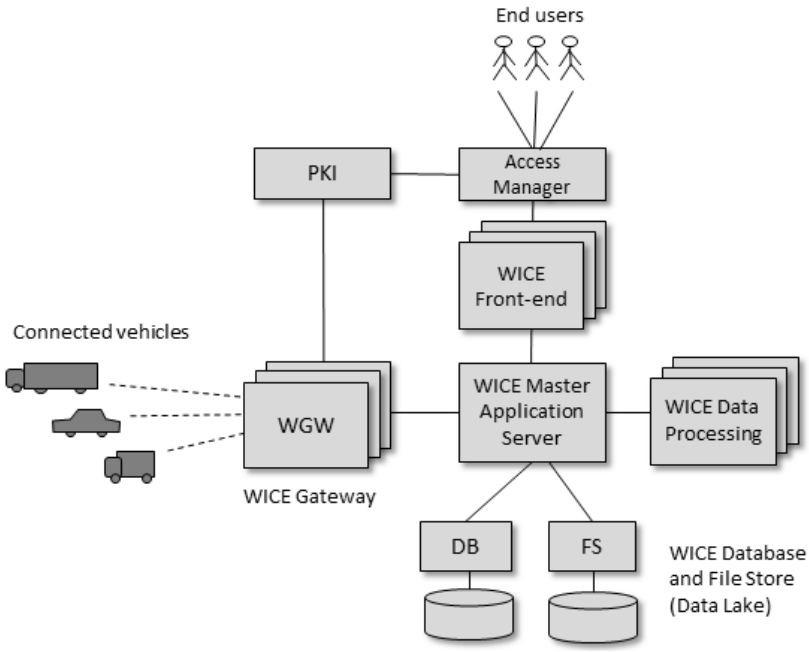

Figure 2: High level architecture of the WICE back-end infrastructure

The WICE Gateway (WGW) is the connection point for the connected vehicles through the WICE Telematics Services. Each connected vehicle has a WCU (Wireless Communication Unit) installed, which contains the vehicle side of the system, including data capture and monitoring modules, vehicle diagnostics modules, GPS positioning and vehicle status information.

Both the WGW and the AM can be connected to a corporate Public Key Infrastructure (PKI) managing certificates for access control.

The state of the WICE system is kept in the WICE database, which is a relational DBMS. The measurement data uploaded from vehicles is stored in the WICE File Store which is a large volume storage solution based on a Data Lake concept.

Processing of data for different purposes, such as data conversion and analytics, is typically performed in dedicated WICE Data Processing servers. The number of servers can be dimensioned based on the number of connected vehicles, the data volume and the data processing requirements.

The web-based User Interface

The web-based user interface gives users access to the WICE application services and data. An example screen-shot of a data visualization component of the user interface is shown in Figure 3.

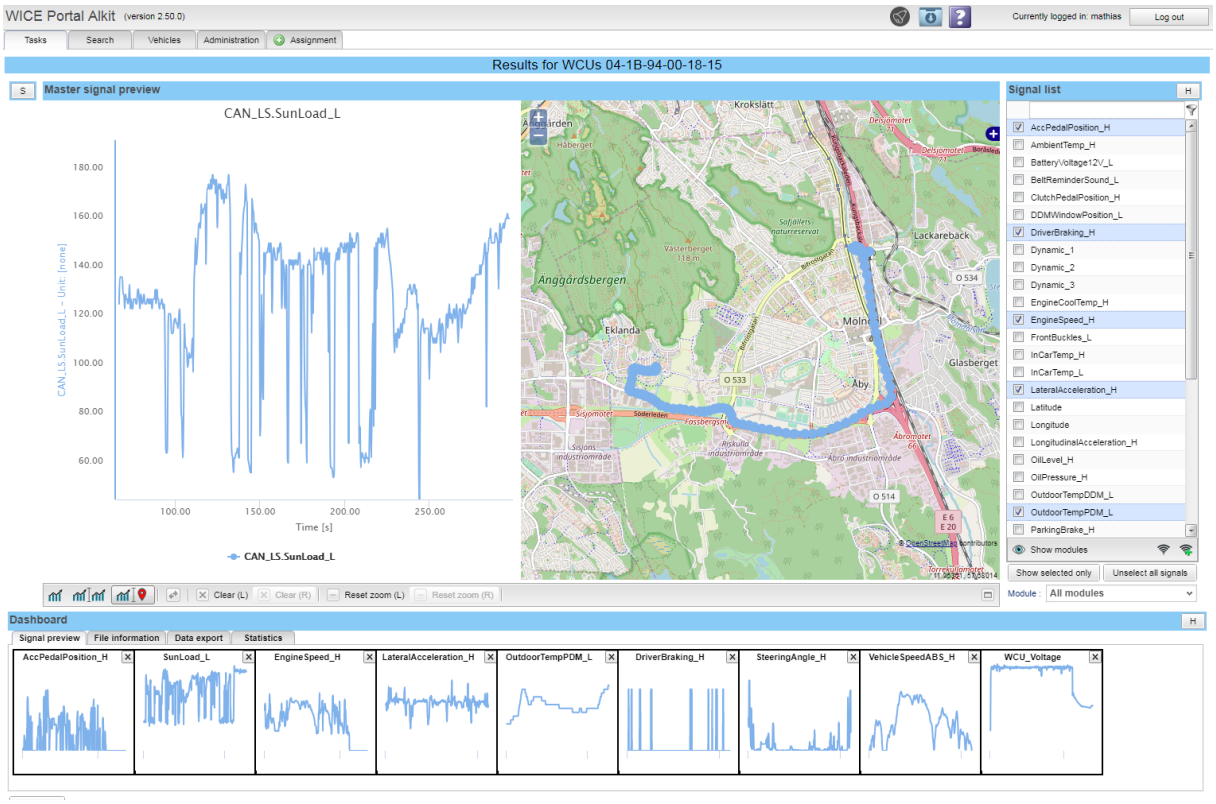

Figure 3: Example screen-shot of the web-based WICE user interface

The M2M API

In addition to the web-based user interface, there is an Application Programming Interface (API), called the M2M (Machine-to-Machine) API for programmatical access to the back-end services and data resources. The M2M API is based on the Representational State Transfer (REST) model, implemented using HTTP/HTTPs and JSON.

By using the M2M API it is possible to design automated data processing services for data analytics applications. It is also possible to realize structured data exchange between different stakeholders by means of the M2M API and the Access Control framework.

Measurement data collection using WICE

The WICE Metrology Service is a general purpose service providing powerful data capture mechanisms for many different kinds of data in fleets of connected vehicles. The concept is based on a usage model wherein the data capture activities to be performed in a group of connected vehicles are described by Measurement Tasks, designed by the user in the web-based user interface (the WICE Portal) or offline using a third-party authoring tool, and subsequently uploaded to the WICE Portal.

Many different Tasks can be defined for capturing different kinds of data, e.g. CAN or FlexRay frames/signals, video, or diagnostics data. When the Measurement Task has been created, and the target vehicles have been defined, a representation of the Measurement Task is downloaded from the WICE back-end to the WCUs installed in the fleet of vehicles, where

it executes. The data sets resulting from the Measurement Task are uploaded from the vehicles until the measurement task is terminated. The user can then accesses the data through the web-based interface of the WICE portal, or programmatically through the M2M REST API.

Each different Measurement Task is supported by a specific measurement Module. The measurement modules are realized as software components on the WCUs installed in the connected vehicle fleet. Some modules are dependent on dedicated hardware installed in vehicles and connected to the WCUs, whereas others are software-only modules on the WCU.

Key measurement modules include the following (see WICE documentation for a complete list):

- **IDC - Integrated Diagnostics Client**
  The IDC module gives the opportunity to capture data using ISO14229 Unified Diagnostics Services (UDS) on CAN or Ethernet interfaces.
- **M-log**
  The M-log module enables data capture from Ipetronik's M-log hardware loggers, connected to in-vehicle WCUs.
- **Signal Reader**
  The Signal Reader module enables powerful monitoring and recording of CAN and FlexRay signals. It also supports UDS diagnostics capabilities, advanced trigger conditions with pre-/post-trig recording options, and many additional features.
- **State-of-Health**
  The State-of-Health (SoH) module is used to repeatedly collect information about a vehicle's status and present this for the user in the WICE Portal. The kind of information collected is configurable and may include for instance mileage, battery voltage, uptime, ECU software versions, Diagnostic Trouble Codes and OBD-II PIDs.
- **Video**
  The video module enables capture of video from cameras connected to the WCU. Video recording can be triggered by conditions and events based on CAN/FlexRay signals or digital i/o. Video can also be streamed in real time for live monitoring.

The Rapid Prototyping platform

When developing new automotive functions and services, there is a need for a powerful platform where prototype implementations can be tested and concepts validated before necessary hardware is available in the target vehicle platform, and before the production cloud infrastructure software is deployed. This can be achieved using the WICE Rapid Prototyping service, which enables custom software components to be executed on the in-vehicle WICE units (WCUs), supported by WICE back-end services with open interfaces for accessing and processing streaming and bulk data from the vehicles.

To facilitate rapid development of in-vehicle software, the WICE RP concept includes a high-level Signal Broker API that makes it easy to read in-vehicle signals using a publish-subscribe

model. The Signal Broker, which is implemented by the Signal Reader module, takes care of the complexities of reading CAN and FlexRay frames and interpreting them.

The RP module furthermore supports the design of prototype user interfaces based on the Node.js JavaScript runtime environment. This allows automotive Digital User Experience testing to be realized in connected vehicle fleets.

Remote Software Download and Continuous Deployment

Using the remote software download (SWDL) service available in WICE, in-vehicle ECUs of connected vehicles can be remotely re-programmed. This enables continuous deployment of ECU software and gives the opportunity to carry out A/B testing in connected vehicle fleets, whereby different ECU software versions are tested, evaluated and compared in a highly efficient and cost-effective way.

The SWDL service is based on a diagnostics module in the WCUs, which handles the re-programming using UDS diagnostics services using either CAN or Ethernet communication with the vehicle. The ECU software packages (including VBF files and meta information) are managed by the WICE back-end infrastructure, and downloaded to the selected WCUs before the re-programming is initiated by the vehicle user, by means of a special-purpose web-based user interface available over Wi-Fi in the vehicle.

Contacts

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