SERVOTECH

Excellence in Technology . . .

Mechatronics, Embedded Control System Design, CAD, Finite Element Analysis, Information Technology and Big Data Areas.

Our Vision

is to be the best technology services and products company with global presence. Our mission is to be the most capable and trusted technology company.

We provide contract engineering and information technology (IT) services, both on-site and off-site, to Fortune 500 companies and government agencies globally.

Software Tools

Embedded Control: MATLAB&SIMULINK, dSPACE, National Instruments, vector, CANalyzer, CANape, CANoe, SAE J1939, TRACE32, Bluetooth, C/C++, python, Java, JavaScript, Perl, Visual Studio, .NET C#, Linux, Microsoft Windows CE Development Tools, git, AUTOSAR

IT: Windows Server, SharePoint, SQL Server, SAP Partner, Rhapsody, vmware, Microsoft Office Project, ORACLE

FEA: ANSYS, Abaqus/CAE, FLUENT The Right Answer in CFD

CAD: AutoCAD, CREO, SOLIDWORKS

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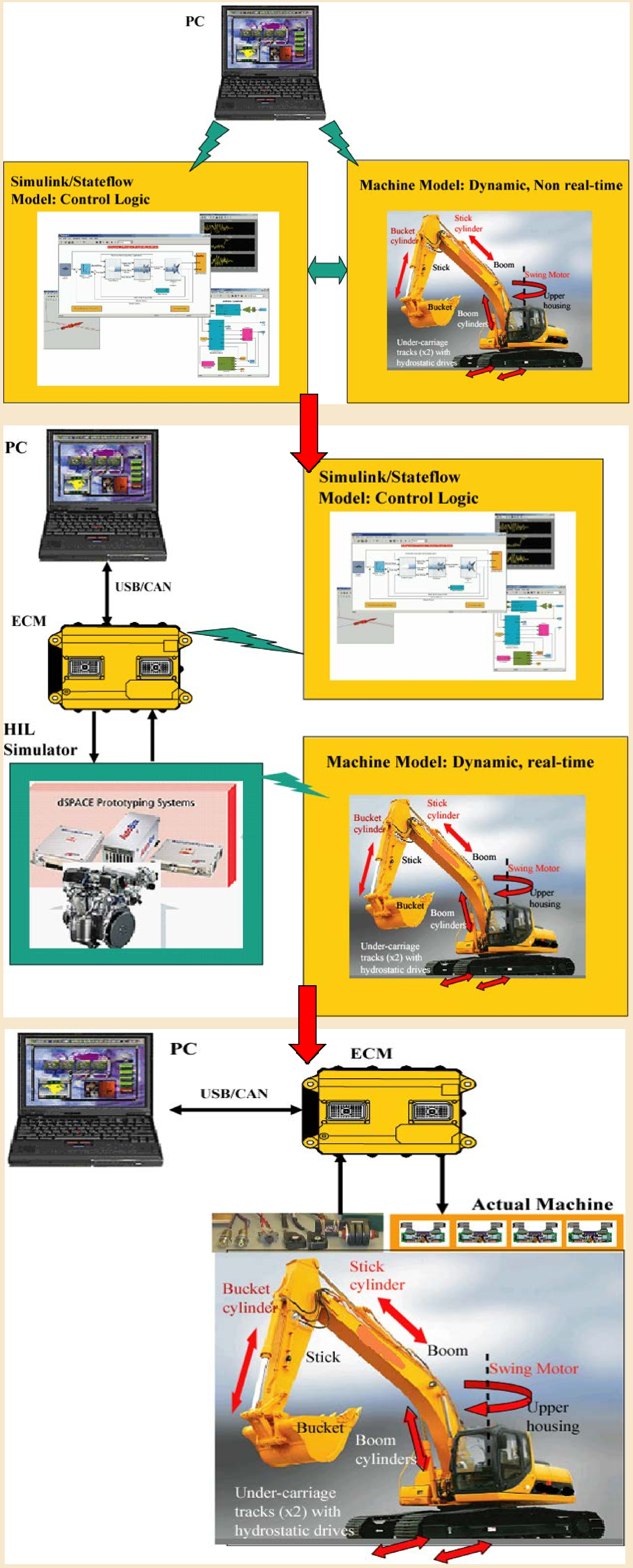
MECHATRONICS:
Our core expertise is in design and testing of embedded control system software using MATLAB/Simulink/Stateflow, Hardware in the Loop (HIL) technology, DSpace tools (MRET, ControlDesk), NI (LabVIEW), C/C++, Python languages, CANape, CANalyzer, GIT, ClearCase software tools. Model-based control system design and testing is one of our core expertise.

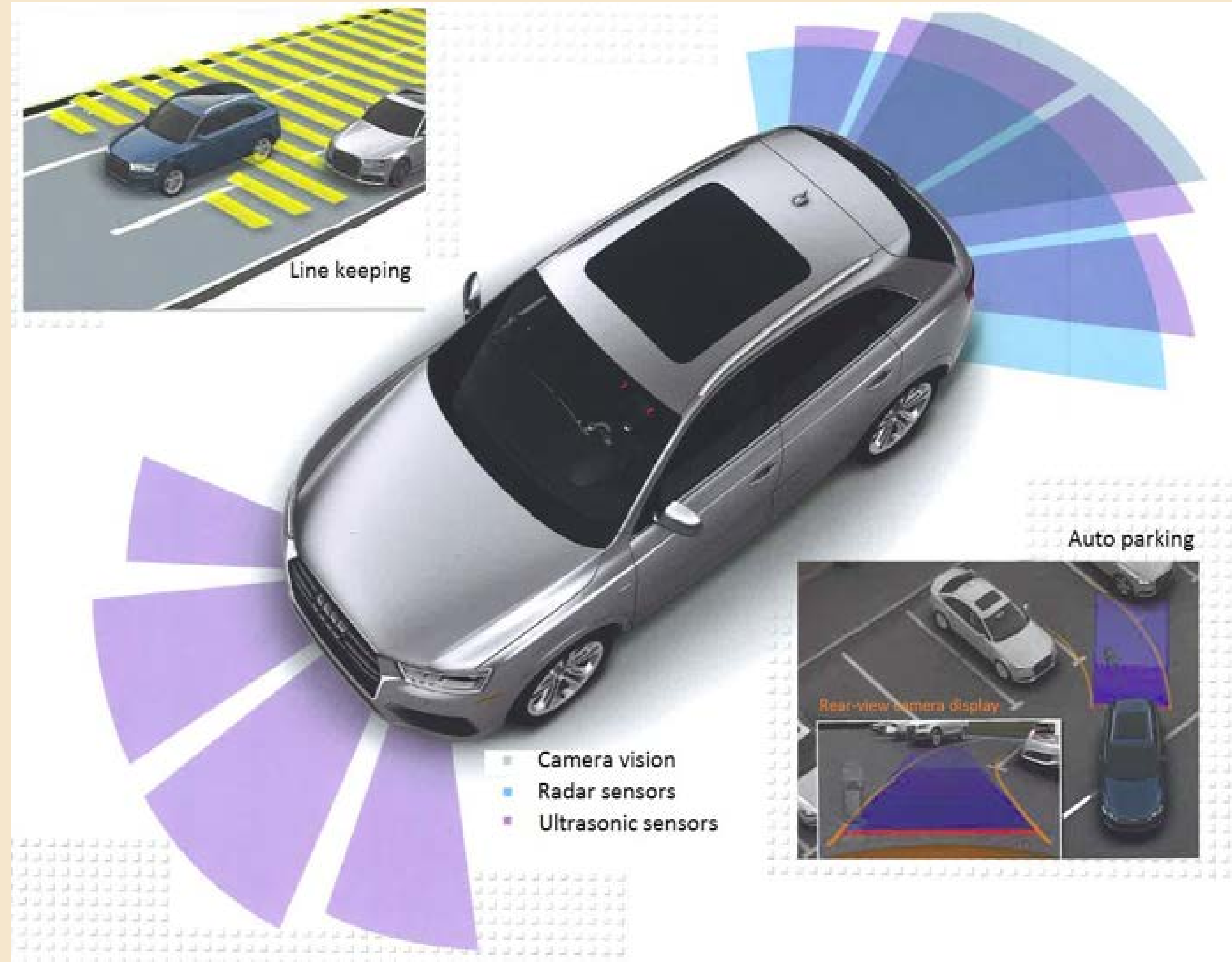


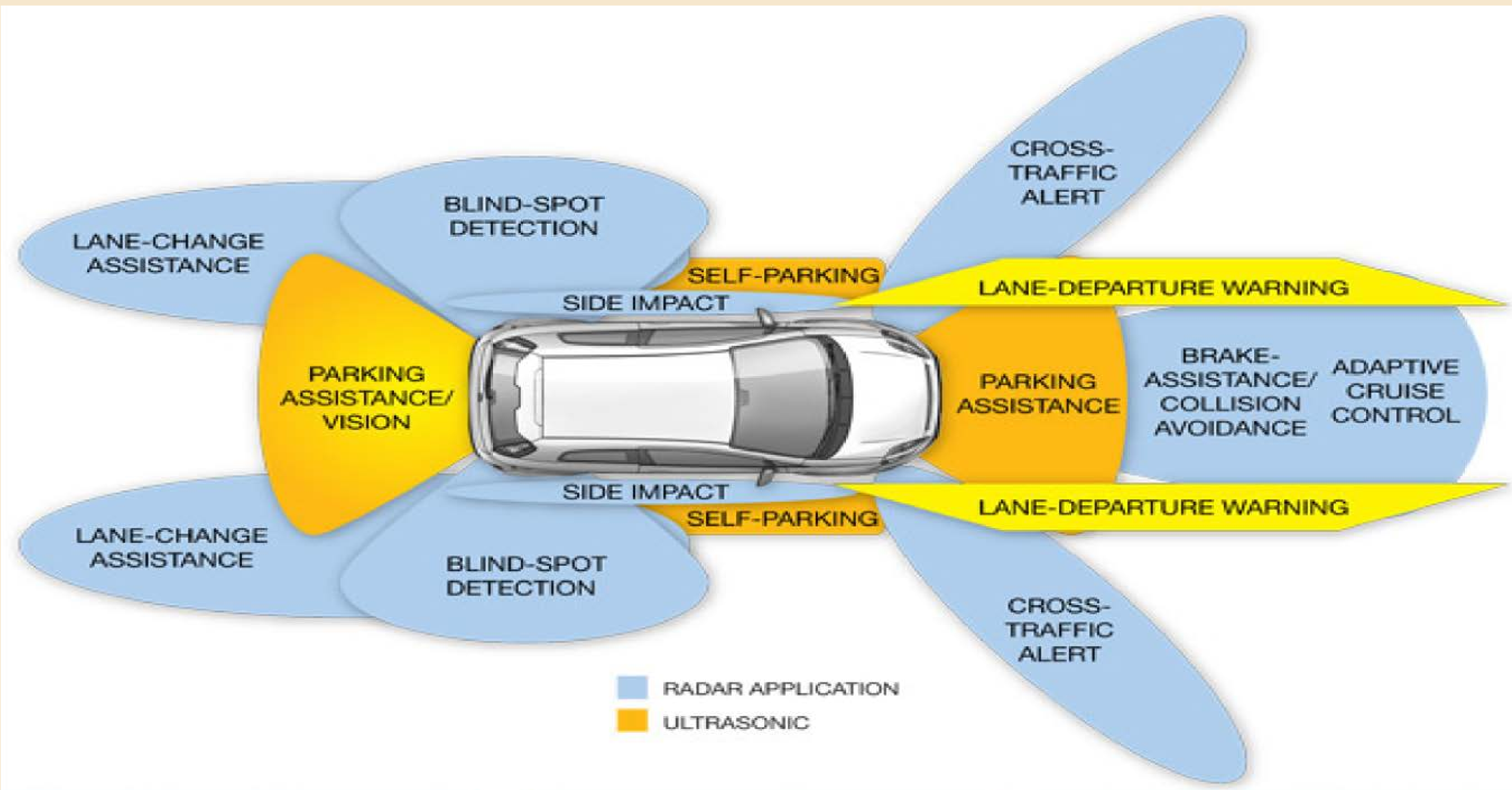
Step 1: Development and non real-time simulation: The embedded control system software ("the control logic") is developed by using a graphical software tool, such as Matlab, Simulink and Stateflow, simulated and analyzed on a non-real time computer environment. The "plant model", which is the computer model of the machine to be controlled, is a non-real time detailed dynamic model. Simulations and analysis are done in this non-real time environment. This is referred as model-in-the-loop (MIL) or software-in-the-loop (SIL) simulation.

Step 2: Hardware in the loop (HIL) real-time simulation and testing: The same control code developed in Step 1 (with minor I/O driver modifications) is auto-code generated to C-language and tested on a target embedded control module (ECM) in real-time. The ECM interacts with another real-time simulation computer which simulates the machine behavior. The simulated plant model in the hardware-in-the loop (HIL) computer must be simple enough to run in real-time, yet accurate enough to provide useful information. The engineering challenge in the HIL simulation and testing is finding the proper balance between "plant model" detail for accuracy and simplicity for ability to run in real-time.

Step 3: Testing and validation on actual machine: The electronic control module(ECM) with the production intent embedded control software is tested (including debugging, tuning, performance testing and validation) on prototype machine under normal operating conditions.

ADVANCED DRIVER ASSISTANCE SYSTEM (ADAS) consists of electronic control modules (ECMs) with specialized embedded control software that uses various sensor inputs (including vision, lidar, radar, sonar) to electronically control steering, engine, transmission and brake systems. The real time ADAS software, which runs on the ECMs, is also supported by inter-vehicular communication between ECMs, as well as supervised by the computers on the internet based local traffic monitoring systems and the computers on the real-time IT infrastructure.

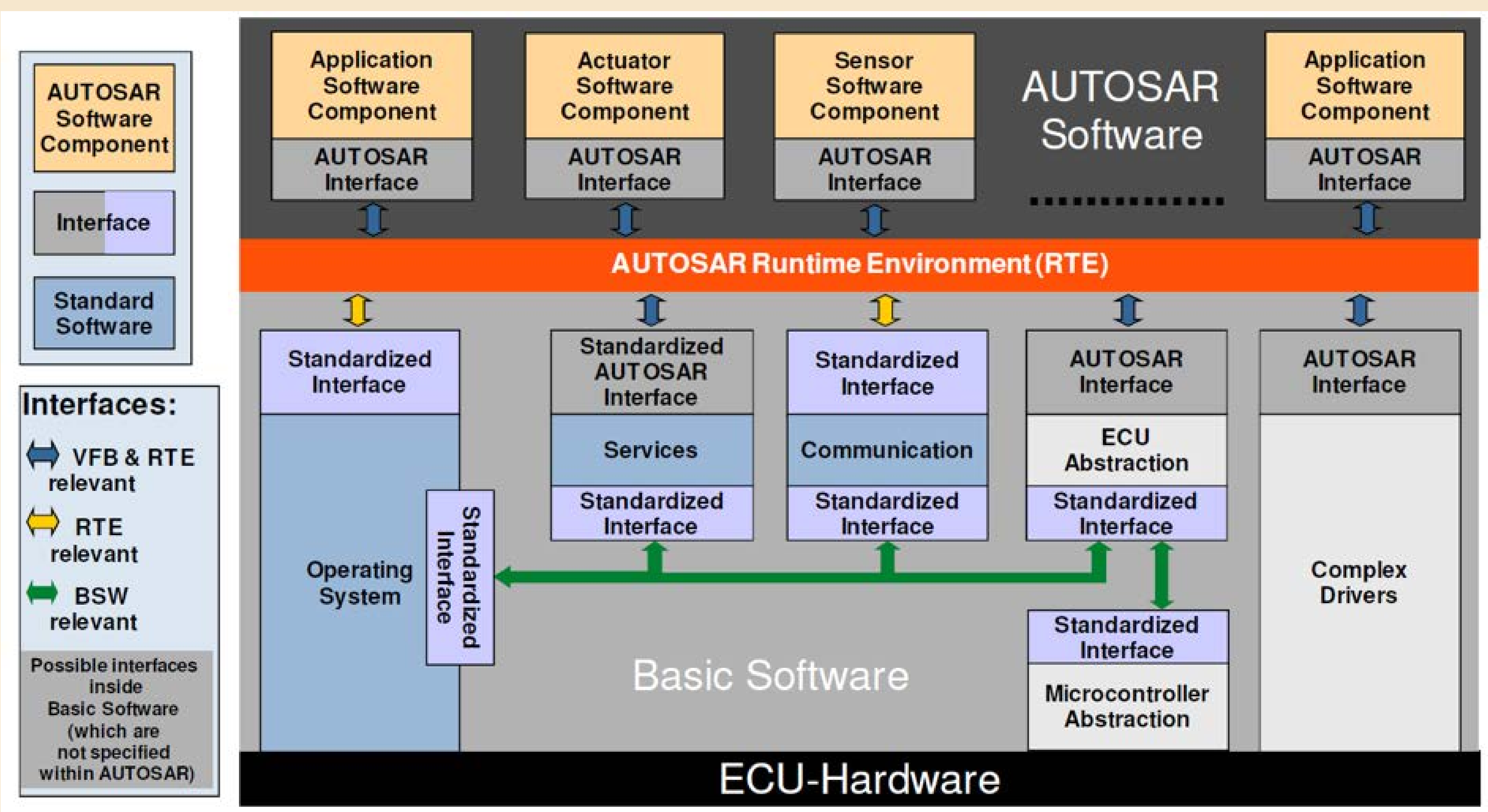




Functions

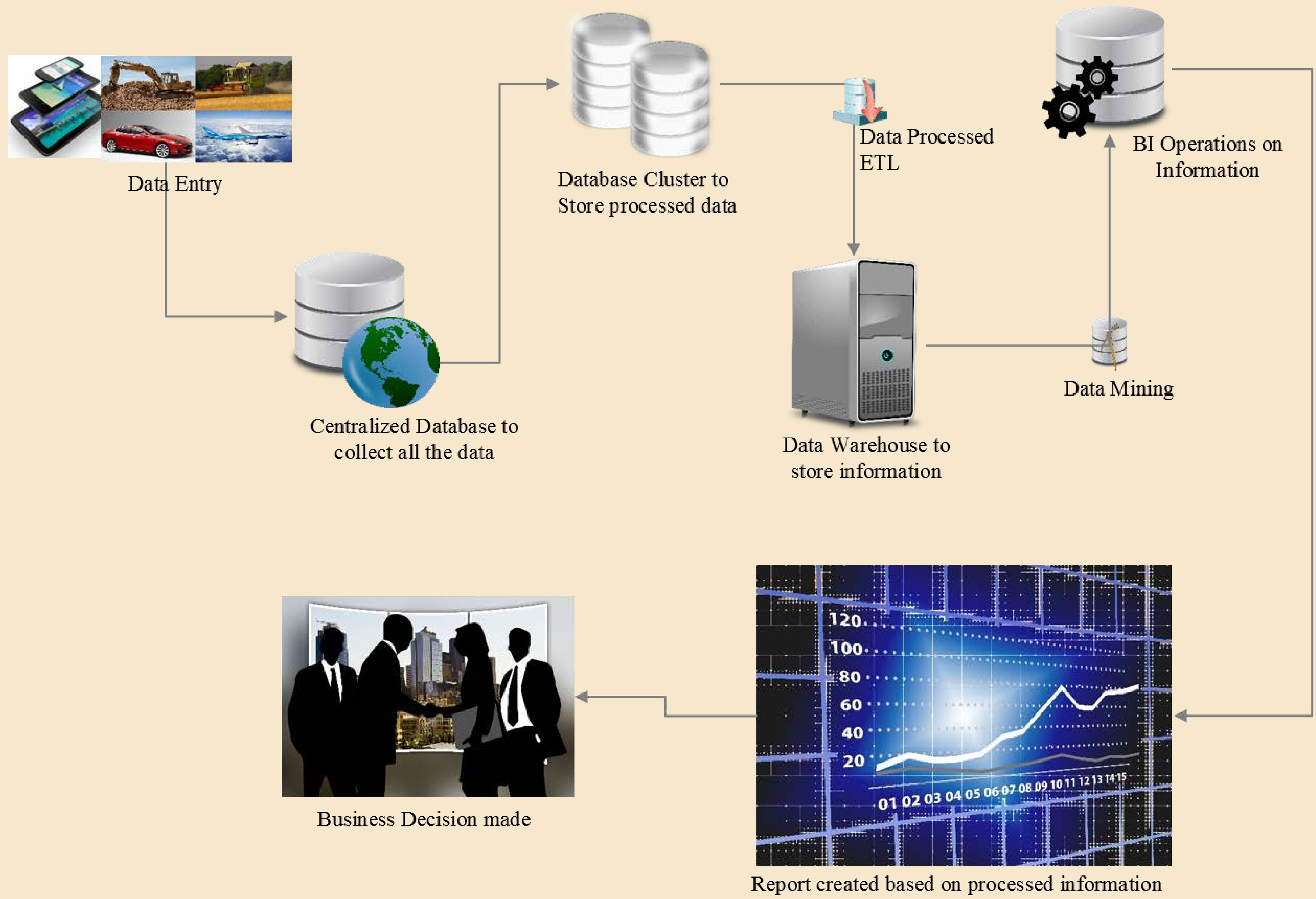
Various driving functions covered by this system include Advanced Cruise Control (CC) including Adaptive CC, Cooperative Adaptive CC, Super CC, Blind-Spot Monitoring, Lane Assist, Collision Prevention, Parking Assist, Driver Monitoring (Attention and Drowsiness), Night Driving Assist and Environment Recognition (Road sign, Traffic light, Pedestrian, Animals, Objects).

AUTOSAR compliant embedded software development



The software modules are developed for specified functionalities while having standard communication interface for other modules in the software, based on AUTOSAR standard. This results in hardware platform independent embedded software development.

IT : BIG DATA



From capturing the data, analyzing the data with state of art data analytics software tools, to decisions made, Servotech supports our customers through each step that will lead to smart business decisions.

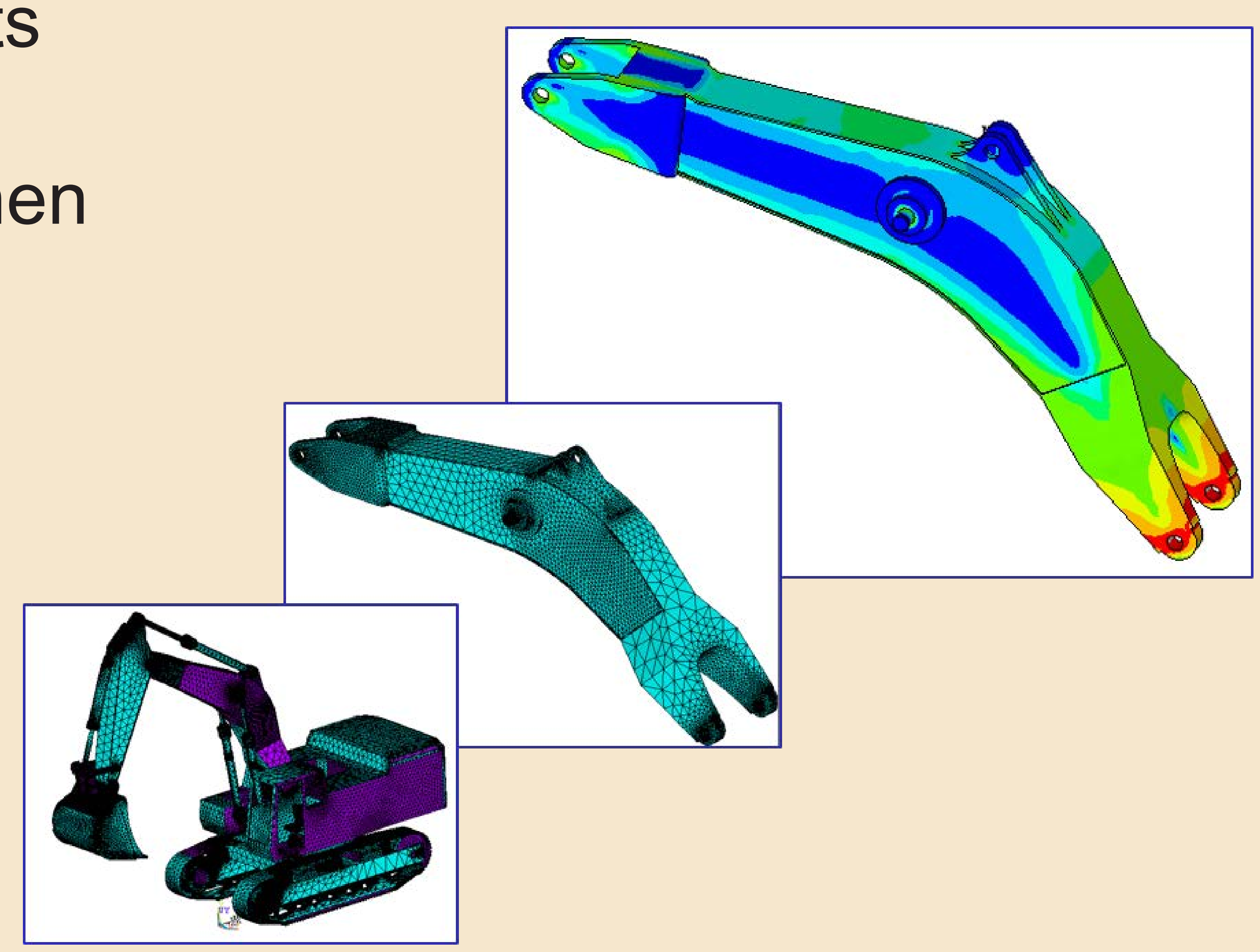
Data Analytics

Exponential growth of available real time data from sensors in engineering systems resulted in a paradigm shift in product support, maintenance, and design changes based on lessons learned using “big data”. Available real sensor data, in vast quantities, are used by mathematical algorithms based on statistical methods and artificial intelligence to extract information regarding real time condition of systems, then decisions are made on current operation optimization, maintenance scheduling, and even engineering design changes by identifying weaknesses in the design of the machine.

Data analytics on “big data” connects resources of IT technology (available vast data and computational resource distributed in the IT infrastructure), processes it using the IT infrastructure, and makes decisions to effect the embedded control system operation in real-time. For example, it links the embedded controller in your car’s engine with the IT infrastructure to support it, which brings about the benefits of the collaboration between engineers who design the embedded controller in your car and mathematicians who analyze the resulting big data.

CAD & FEA

Finite element analysis (FEA) software tools implement the physics based mathematical equations and numerical solutions in the background. All general purpose FEA software tools (ANSYS, Abacus etc.) provide a graphical user interface (GUI) to define the problem and desired simulation conditions: that is to define the 3D geometry, material properties (i.e. a rectangular plate made of cast aluminum), simulated conditions (external load conditions and boundary conditions). Then the FEA software provides tools to automatically customize finite element mesh, constructs the physics based equations and solves them using a selected numerical solution method. The results are then presented in the form of field variable distribution over space (for static simulations) and time (for dynamic simulations). For instance, the simulated results can be stress, strain, temperature, pressure, fluid speed as function of location in space (x,y,z) and time (t).



FEA Analysis Process

Pre-processing → **Solution** → **Post-processing**

Pre-processing

- Problem definition
  - ✓ Geometry
  - ✓ Material properties
  - ✓ Loads
  - ✓ Boundary conditions
- Discretization and mesh generation
  - ✓ Node/element generation
  - ✓ 2D/3D mesh
  - ✓ Element shape

Solution

- Physics & assumptions
  - ✓ Structural
  - ✓ Fatigue
  - ✓ Thermal
  - ✓ Vibration
  - ✓ Buckling
- Generate FEA equations & matrices
- Run linear / non-linear analysis
- Interactive or batch processing

Post-processing

- Result evaluation and interpretation
- Linear analysis
  - ✓ Contour plot of results over the whole geometry
  - ✓ Element tables and graphs
- Non-linear analysis
  - ✓ Time history
  - ✓ Result animation
- Sub-modeling
  - For small areas of concern in big geometries

Computer Aided Design (CAD): 3D solid modeling, dimensioning and tolerances, rendering, animation.

Finite Element Analysis (FEA): Analysis and simulation of stress, pressure, temperature, flow velocity distribution in space and time.

Failure Mode Effect and Analysis (FMEA): Extensive failure modes and effects analysis, and design iteration.

Example: Hydrostatic Transmission Control

Dozer (Track Type Tractor)

Excavator

Skid Steer Loader (Track Type)

Figure 1: Hydrostatic transmission (drive) application in tracked vehicles (Source: JohnDeere.com, Komatsu.com, volvoce.com).

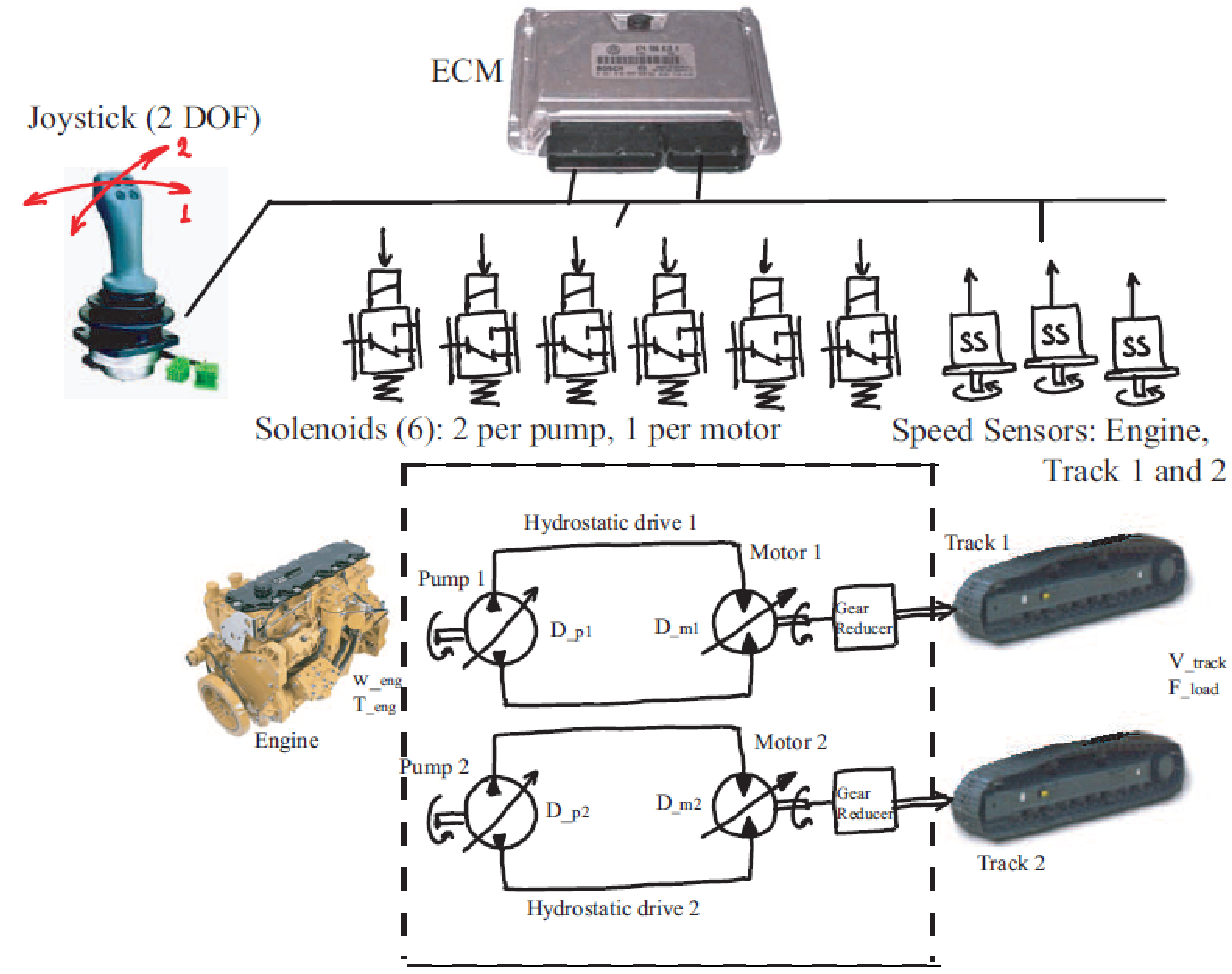


Figure 3: Control system: electronic control module, operator I/O, machine I/O.

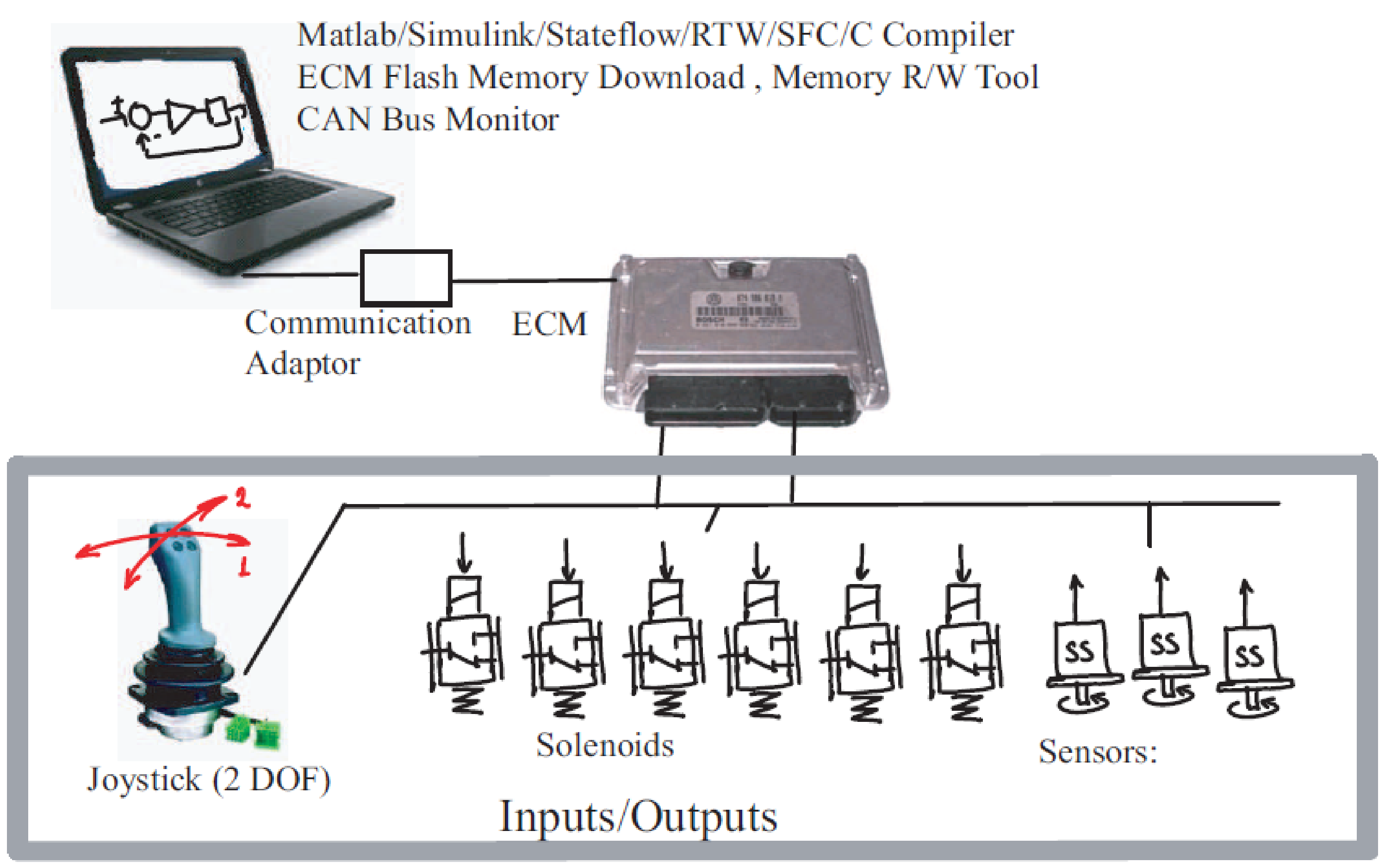


Figure 4: Control system with development tools: PC with code development, download and reads/write to ECM memory capability, electronic control module, operator I/O, machine I/O.

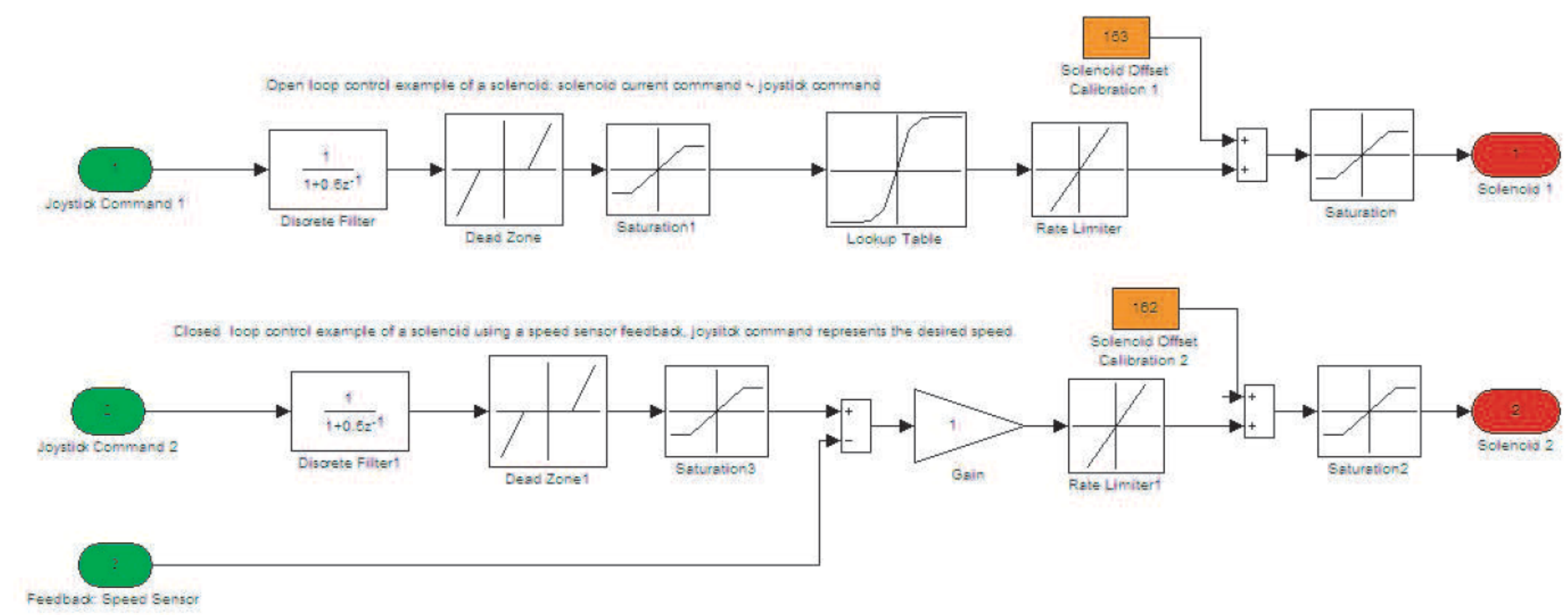


Figure 5: Control logic sample for open loop and closed loop control of hydrostatic transmission for dual track vehicle applications.

Remark 1: About the real-time code written in Simulink – for a realistic operator controlled system, there is always the following desired components in the control logic

1. Deadband between joystick position sensor and output signal in control logic so that small unintended movements of the joystick (due to vibrations and resolution of the operator control ability) do not cause motion in the hydrostatic drive.
2. Lowpass filter or rate limiter functions to limit the maximum accelerations and remove the sensor noise,
3. Gain (or look up table for variable gain) to determine the commanded speed based on joystick sensors. In practice, this is generally a variable gain, which is a curve or multiple lines with different slopes or a look-up table.
4. Offset signal to solenoids, since there are always variations in the manufacturing tolerances of the solenoids and valves they actuate, the initial offset current command needed to just start the motion of the solenoid need to be determined for each solenoid as part of a calibration process on the machine during manufacturing.

Remark 2: If the vehicle is to travel in a straight line: closed loop control on track speed and position to assure a better straight path motion. Further level of path tracking accuracy can be added by closed loop path tracking using GPS signals.

Remark 3: When the Dozer rams-into a pile of soil, real-time control must react to destroke the pumps quickly so that engine does not stall, but not to quickly that the Dozer looses its push ability.

Engineering Work Done by Servotech:

1. Hydraulic and Electrical Circuit Design and Component Sizing, Modeling and Simulation
2. ECM Embedded Software Testing in HIL (static only)
3. On Machine Testing in Proving Grounds