# FlexRay Tools from TTA

**TTAutomotive provides a complete software development chain that supports all development stages of the two-level design approach in a Time-Triggered Architecture. Originally developed for the TTP protocol, these tools will now be made available for FlexRay.**

This approach reduces the enormous complexity caused by the ever-increasing number of functions in event-triggered systems. In projects developed according to the Time-Triggered Architecture the precise coordination of different functions is done at the development stage. The behavior of functions and their coordination will thus be stable at the integration stage.
The FlexRay bus schedule allows for composability in the communication system by assigning distinct communication time-slots to all subsystems. In order to achieve functional composability in a distributed development environment for multiple suppliers a systematic development of both the software and the communication is required. First the global communication scheduling has to be done, then comes the local software task scheduling that is based on the global scheduling.

## Two-level-design

Within this two-level design approach the functionality of the system is broken down into subsystems connected by a time-triggered network. Subsystems are mapped to ECUs – the physical computer nodes. If a subsystem is mapped to two ECUs, the signals produced by the subsystem will be available twice in the network and failures of one subsystem can be tolerated. A two-level design project starts with the general system requirements as input. The cluster is divided into subsystems and the timing and bandwidth requirements for deterministic communication, such as sensor values, control signals and other real-time data, are specified. The ECUs are specified and the subsystems are mapped to these nodes. The output of this design stage is the cluster specification. The cluster specification is made available to the component suppliers. They can work independently on the basis of this specification and specify a number of tasks that implement the behavior of the subsystem. A static, periodic task schedule is needed to guarantee that all constraints are fulfilled. Such a task schedule is produced automatically with the node design tool TTXBuild. In a Time-Triggered Architecture each task starts after receiving all its input signals and will be finished before sending all its output signals according to the defined schedule. The operating system TTXOS has been specifically designed to guarantee timed execution and deadline checking. The runtime and period of the tasks are specified in the node specification which must be consistent with the signal specification from the cluster design. For instance, tasks must produce all output signals specified for a subsystem. The operating system TTXOS guarantees message updates that are consistent with the cluster specification.
Finally, a verification tool can be used to independently check the schedule against certain properties and a download tool supports the development process by putting the software of a node to an ECU.
TTXPlan and TTXBuild are fully integrated with MATLAB/Simulink. With the support of special MATLAB blocks provided by the simulation and design tool TTXMatlink, it is possible to generate cluster and node specifications out of a Simulink model. Additionally the node implementation can be done by generating code out of MATLAB.

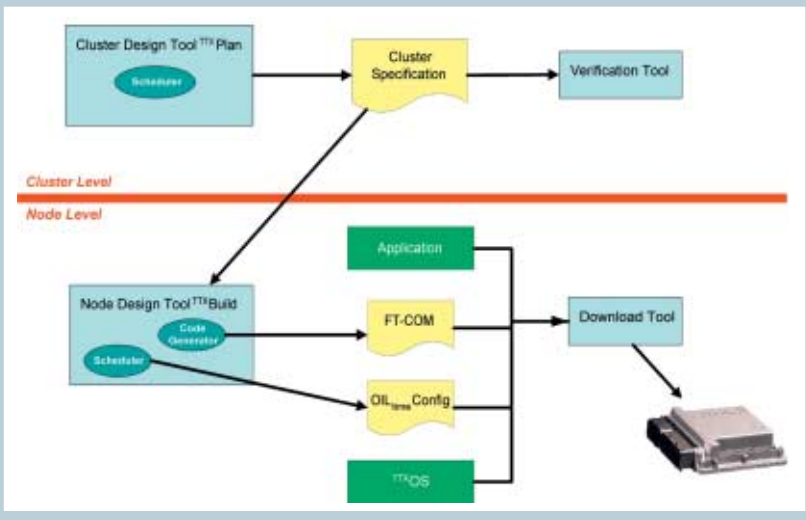


**Figure 1:The cluster-level design is prepared with the cluster design tool TTXPlan.**

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## Conclusion

these tools will now be made available for FlexRay.They form a unique development environment for fault-tolerant real-time systems in the embedded area and guarantee a fast and systematic development with a seamless integration in existing processes.