Embedded Network Performance & Robustness

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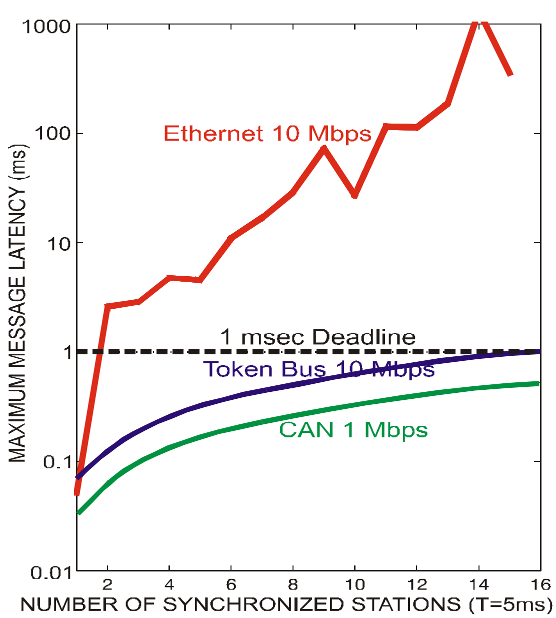
The Embedded Network Performance & Robustness project is creating tools and techniques for making informed design decisions as to which embedded network protocol to use, and understanding problems with robustness that may be present in off-the-shelf media access protocols.

EMBEDDED PROTOCOL SELECTION

Embedded communication networks are playing an increasingly important role in embedded and safety-critical systems. Networking is being used to give greater system design flexibility, improve diagnosability, and reduce wiring weight/size/cost. As an example, prototype vehicles are using "drive-by-wire" capabilities, in which critical functions are performed entirely by networked computers. As this shift toward digital technology takes place, the importance of designing inexpensive control networks for dependable real-time operation will increase dramatically.

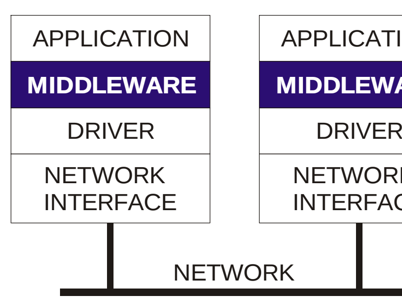
The current Embedded Protocol Selection project has created a Web-based simulation tool that provides a standard interface for entering a wide variety of communication workloads and a set of different media access protocol simulation models for performance studies. With this tool, an embedded network designer can use a web browser to determine which protocols will provide acceptable performance, and which protocols may have performance problems. Results of studying several real-world workloads indicate that the priority model and the possibility of message collisions are significant factors in determining if systems will work dependably. The Figure shows that for a particular example, Ethernet will miss deadlines, Token Bus will meet deadlines, but Controller Area Network (CAN) will meet deadlines with one tenth the bandwidth requirement.



EMBEDDED PROTOCOL ROBUSTNESS

As embedded communication networks pervade widely fielded safety-critical distributed systems, it is important to understand their robustness. Middleware fault injection offers advantages in flexibility and cost over adding specialized fault injecting network nodes. The research goal is accelerated testing of an automated vehicle system with respect to transient communication network faults.

While techniques for constructing dependable networks have been studied for many years, large-scale applications such as automobiles have somewhat different design concerns than traditional aerospace and military uses. For example, cost constraints limit the redundancy that can be installed, and the large installed base makes it likely that even improbable failure modes will be experienced somewhere within an operating fleet on a regular basis. Middleware fault injection has advantages beyond hardware fault injection tools, including the ability to: inject local errors at particular receivers, delay messages to explore the effects of jitter, delay control feedback to explore the stability of feedback loops, and instrument offered load as well as end-to-end latencies including queuing effects.



Currently a combination of a fault injection simulator and middleware software operating under the QNX operating system are being used to characterize the robustness of the CAN protocol. A problem has been discovered with CAN that leads to a greatly increased probability of garbled messages being accepted as valid despite error detection. The effects of this problem will be experimentally investigated by performing fault injection on a passenger vehicle with automated steering and throttle control.