CAN with eXtensible in-frame Reply: a Survey

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Abstract

Controller area network (CAN) has been the most popular solution for in-vehicle digital communications since the mid-1980s. Because of its access protocol, which closely resembles a distributed priority-based scheduler, it has gained wide acceptance in networked embedded systems as well, when control applications demand real-time behavior. Interestingly, the same techniques used for analyzing task set feasibility with non-preemptive schedulers can be used to assess a priori whether or not messages will meet timing constrains.

Among the main advantages of CAN there are the low cost, high robustness, and, very important, stability. For this reason, the protocol underwent significant changes only twice, the former in 1991 with the introduction of the extended frame format (CAN 2.0) [1] and the second in 2011 with the definition of the flexible data rate (CAN FD) [2], now included, in a slightly modified form, in the latest ISO standard specification [3]. CAN 2.0 substantially increased the number of available messages, by enlarging the identifier field from 11 to 29 bits (this resulting in half a billion different objects per network). On the other hand, CAN FD brought the concepts of bit rate overclocking and frame oversizing [4] to CAN, hence allowing, in theory, a tenfold increase in network throughput. Unfortunately, in both cases using the new frame formats breaks compatibility with the previous generations of controllers, which explains why the transition to systems exploiting the additional features offered by the newer flavors of CAN took several years.

In this presentation a proposal is illustrated, termed CAN with eXtensible in-frame Reply (CAN XR) [5][6], for a protocol extension, which applies to both classical CAN and CAN FD, aimed at enhancing performance further. Besides increasing throughput, thanks to a data slotting mechanism that operates according to the combined message principle, it natively supports service extensibility, hence enabling its adoption in a wider range of application scenarios including, e.g., security and distributed consensus. Basically, CAN XR relies on transactions, which are carried out by a group of cooperating nodes in the network (initiators and followers). Very importantly, the signal appearing on the bus, as a consequence of each single transaction, is almost indistinguishable from a conventional CAN frame. In this way, complete backward compatibility is retained with existing controllers.

References

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