TTP – Easy to read

Introduction

TTP is the mature network solution that is low cost and can handle safety-critical applications

- The number of electronic control units in cars will increase dramatically in the next few years as it is estimated that 90% of all automotive innovations in the next decade will be driven or enabled by electronics.

- As a consequence electronics costs are growing very fast

- Bad system integration only detected at a late stage in the development / testing phase or worse once the cars have been delivered needs to be avoided.

- Liability aspects linked to safety-critical applications such as x-by-wire and collision avoidance need to be addressed.

Given the fact that the system is at its limits today, we need to rethink the whole electronics system architecture and design approach today.

Event-triggered versus time-triggered network protocol work?

Event-triggered communication – CAN model
Imagine a board room.

Three people are present. Everyone can speak whenever he feels like contributing something relevant to the discussion. This form of communication is event-triggered. There is no structure. Whoever wants to say something has to wait until the others have stopped talking.
Now the rest of the board joins the meeting and brings the number of participants up to, let's say, 20 people. The former event-triggered communication style would almost certainly fail.

Time-triggered communication – TTP – the perfect moderator
Some sort of structure needs to be introduced so that every participant can voice his contribution and can be heard by the others. TTP gives this structure and takes over moderation. TTP asks one participant after the other for his contribution. It assures that everyone can speak and is heard. TTP is a good moderator as it allows every speaker only to use a pre-assigned time and not to spread out his message over hours. This happens at an incredible speed of only a few microseconds (= 1/1million of a second) each. After one complete round the first person is allowed to speak again.

To make the planning perfect a detailed agenda has been worked out. Speaker A will for example talk about topics: Am1, Am2, Am3 in round one, in round two about topics Am1 & Am5, in round three about Am1, Am2 and Am4 and then start over with Am1, Am2, Am3 in the next round. As everybody is only allowed his pre-assigned time slot, communication is very predictable. If person C for example is waiting for topic Am5, he knows exactly when he will receive this information and can therefore plan his actions accordingly.

TTP also ensures that no one breaks the rules.

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What can TTP achieve?

Enhance system integration and quality

Time-triggered architecture supports a very structured approach to system and interface design. Interfaces within the various subsystems are precisely defined and links clearly identified. These subsystems are thereby made into quasi-autonomous components, which can be developed and tested independently. Design changes with implications for the interface will immediately be taken into consideration by all other subsystems involved in avoiding problems during system integration.

Save costs

An integrated architecture allows moving and distributing functions across the network. This makes it possible to reduce the number of ECUs and sensors in the system thus reducing costs at equal or even higher safety and performance levels.

In addition, TTP provides hardware functions which guarantee the safety of communications. This reduces the complexity and verification cost of the application software. Verification typically accounts for 70% of a safety-critical system's cost.

Foster innovation

New complex functions will be distributed over the network. They will require partitioning of information throughout the system. It is therefore easy to understand why it is of utmost importance that all subsystems continuously share the same information. TTP can provide this consistent information basis and thereby enhance innovation.

Allows you to sleep well at night

Safety has always been a top priority for TTP. The core algorithms of TTP have been formally verified to prove their correctness. Moreover, multi-million fault injections have been carried out to validate the protocol functionality. TTP has been adopted by aerospace companies due to its rigorous and plain safety approach. After more than 20 years development work in research and prototype applications TTP is now used in commercial applications.

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Glossary of Time-Triggered Terms

Babbling idiot
Meeting member who does not stop speaking nonsense.

Bus Guardian
Meeting timer who allows people to speak within their predefined time frame.

Byzantine Failure
Is a failure where some meeting members receive a different message than others.

Cluster
All meeting participants taken together.

Cluster cycle
In TTP one full communication round where every meeting member speaks once is called a TDMA round. After a predefined number of TDMA rounds the same messages are repeated. This is called a cluster cycle.

Consistency
In our meeting all persons know about the information each of the other participants have. They all plan their actions on the basis of the information available to all.

Fault tolerance
Any component in a system can fail. TTP is designed so it can tolerate any one such failure.

Frame
One communication sequence of one of the meeting participants consisting of one or several messages.

Jitter
Difference between the maximum and the minimum duration of an action.

Message Descriptor List (MEDL)
Meeting timer or agenda covering the detailed timing of the meeting. The MEDL does not give any restrictions regarding the content or semantics of the messages.

Membership
List of correct (sane) meeting participants. In our meeting every participant starts his communication with a list of the other participants who he thinks receive and send meaningful information. By checking the list he receives from the other participants he can check if his information was received successfully.

Node
Meeting participant.

SOS Fault
Slightly off specification fault. One node sends a signal that is at the edge of what the receiver understands as "1" or "0". E.g., in a 5 V system the limit might be specified at 4,5 V. If a signal is exactly 4,5 ,V some receivers might understand "1" and others "0".

TDMA round (Time Division Multiple Access)
One round of communication in which every member has had a chance to speak.