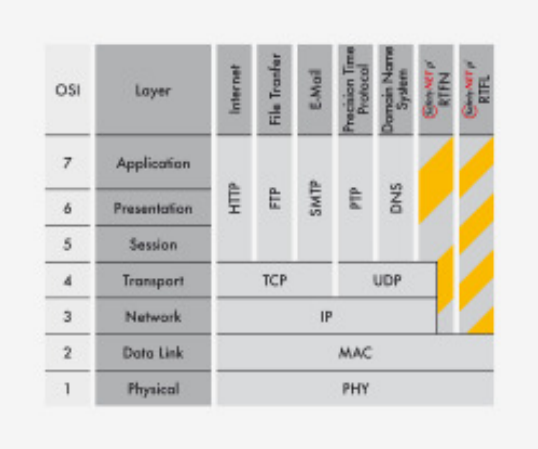
How is real-time implemented at SafetyNET p ?

Why is the standard Ethernet not deterministic ?



One of the main reasons why Ethernet is applied in automation is the advantage of cross-linking all machines with a single universal communication system. Ethernet, which was originally developed for office networks, reaches its limits when required to fulfill real-time demands in fast E/A data or Motion Control Systems. If these machines are also to be cross-linked with Ethernet, changes have to be made to the standard Ethernet and their protocols. The main 3 problems which must be resolved when using Ethernet for real-time communication are:

1. In an Ethernet network, every partner has access to the network at all times. If more than one partner sends at the same time there is the risk of collision on the communication path. This means the partner is required to re-send the data. This mechanism is called CSMA/CD. The result is a non-calculable delay.
2. In Ethernet, complex protocol stacks such as TCP/IP are used. The processing times for these protocol layers are higher or lower depending on the processing power.
3. Switches have been integrated within the Ethernet in order to reduce the communication load in each individual network segment. The disadvantage however, is that these switches take a certain amount of time to decide which partner to send a data packet to. This so-called latency period has a negative influence on the real-time conduct in the entire network. In particular when a selection of switches are arranged in succession, such as in line topologies, the latency period accumulates.

These problems have been solved by SafetyNET p.

The realisation of real-time communication at SafetyNET p

SafetyNET p provides two real-time performance levels. The RTFN (Real Time Frame Network) for „Soft Real Time“ and RTFL (Real Time Frame Line) for hard real-time requirements. The RTFN Communication is based upon UDP / IP and is equipped with standard Ethernet Hardware. For this reason, this type of communication is optimally suited for machines with standard Ethernet connections such as visualization machines or computers. With machines such as these the RTFN is installed as a software. Due to the use of standard Ethernet hardware however, the real-time characteristics are reduced. The minimum communication cycle times account for approx. one millisecond. In cases where more efficient real-time is required, the RTFL principle is installed. This is especially the case in Motion Control Systems or particularly fast E/A communication. RTFL is a hardware based solution, which means with a RTFL partner the standard MAC controller is replaced by an RTFL Chip. Protocol layers such as TCP/IP are bypassed by RTFL and communicate directly through MAC frames. In RTFL it is possible for multiple partners to communicate data through the same Ethernet frame. This way the protocol efficiency is increased due to the fact that it is not necessary to use a complete Ethernet frame to send data from a single partner. In order to reduce the processing times of switches which connect the individual partners, a switch function is implemented in RTFL machines. This switch runs in a cut-through mode. This means the data is cut or read whilst the telegram passes the partner. This is the reason why it is possible to realize very short cycle times in the line topology, which is commonly found in plants. With the mechanisms described above is it possible to realize RTFL cycle times of up to 62.5 micro-seconds or a jitter of 1 micro-second.

Therefore with RTFN and RTFL an ideally suited protocol is available for each individual application in various machines in an automation system. The universal standard Ethernet according to IEEE 802.3 is applied.