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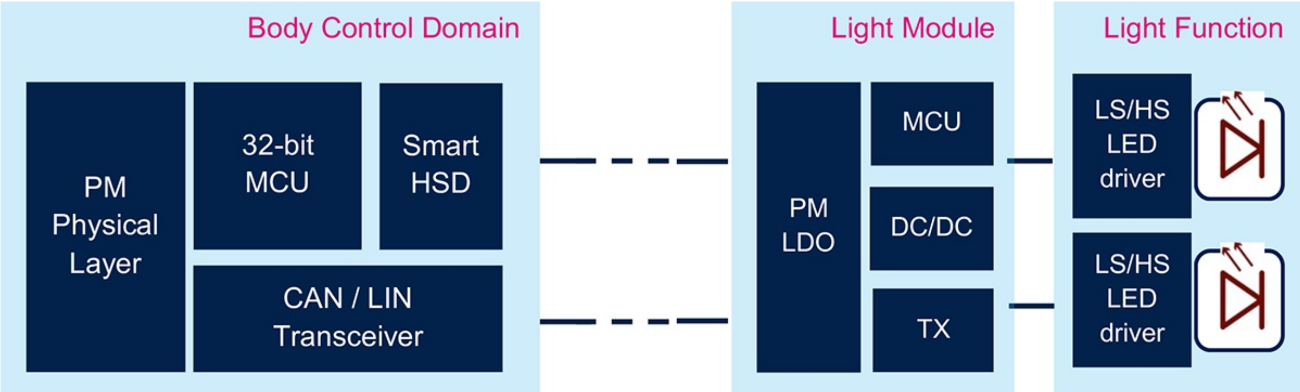
CAN FD Light - From lighting to lightweight

CAN FD Light is a network aimed at sensor/actuator communication in automotive and non-automotive applications. The need and the advantages for a lightweight CAN-based network is proven in lighting systems for modern cars.



Classic light control (Source: STMicroelectronics)

The complete article is published in the March issue of the CAN Newsletter magazine 2021. This is just an excerpt.

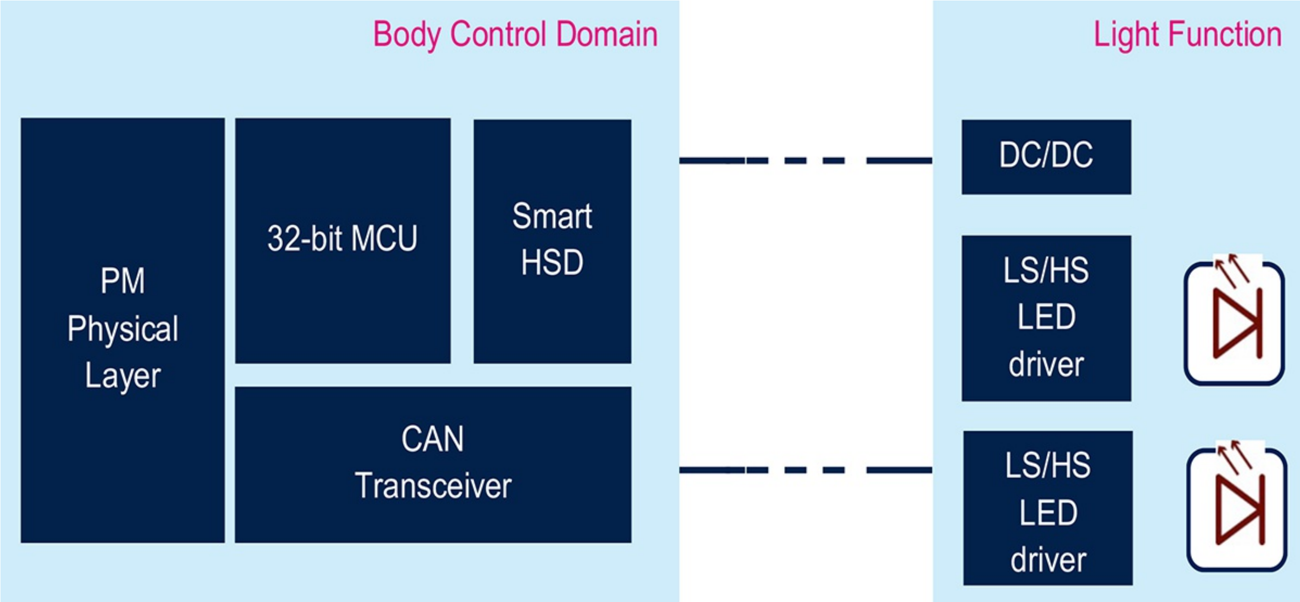
The necessity for a lightweight CAN FD network became evident during the development of a system for modern car rear lights. During the development phase the usefulness of a "CAN FD Light" with rear lighting being a frontrunner surfaced while looking at the future trends in car communication systems and other fields in the industry. Communication systems with a central controller and small actuator and sensor devices have been around for many years already. The need to drive hundreds of light sources in a dynamic way and the safety and reliability requirements plus the cost pressure inherent to the automotive industry extended the scope of this kind of system.

Today, car rear lights consist of a few drivers for the light sources that are locally controlled by a light controller, which is usually placed closely to these drivers. The light controller communicates by a CAN or LIN network with the domain controller responsible for lighting e.g. the body domain controller. This is shown in figure 1.

The light control part of the body domain controller consists among others of a micro-controller (e.g. 32-bit MCU), CAN/LIN transceivers, smart high-side drivers to control the power supply of the light module, and its associated power-management device. The light module embeds a small micro-controller for generating the light patterns and to communicate with the body domain controller, DC/ DC-convertors to generate the voltages needed for the light sources (LEDs), a simple communication interface like e.g. I2C and a power-management device for supply. The light sources are switched by high-side or low-side driver circuits.

Newer and future rear lights show dynamic light pat- terns that can be used for safety like warning the driver in the car behind of upcoming traffic hazards or for enhancing the design of a car for individualization or branding. Light is a very appealing design element for vehicles. For these uses of light, several hundreds of individual light sources must be controlled, each with its own intensity resolution of at least eight bits at a refresh rate in the range of several milliseconds. Since the light sources are now distributed over the rear of the car, the light module cannot be placed next to the drivers anymore.

This means that a reliable and safe communication is needed that provides a high bandwidth at a high level of immunity against the distortions faced in the harsh environment of a car. Since the light module cannot be placed anymore close to the drivers, a valid question to ask is: Why not using the body domain controller directly for controlling the light drivers? This change in the architecture can be seen in figure 2.



Future light system (Source: STMicroelectronics)

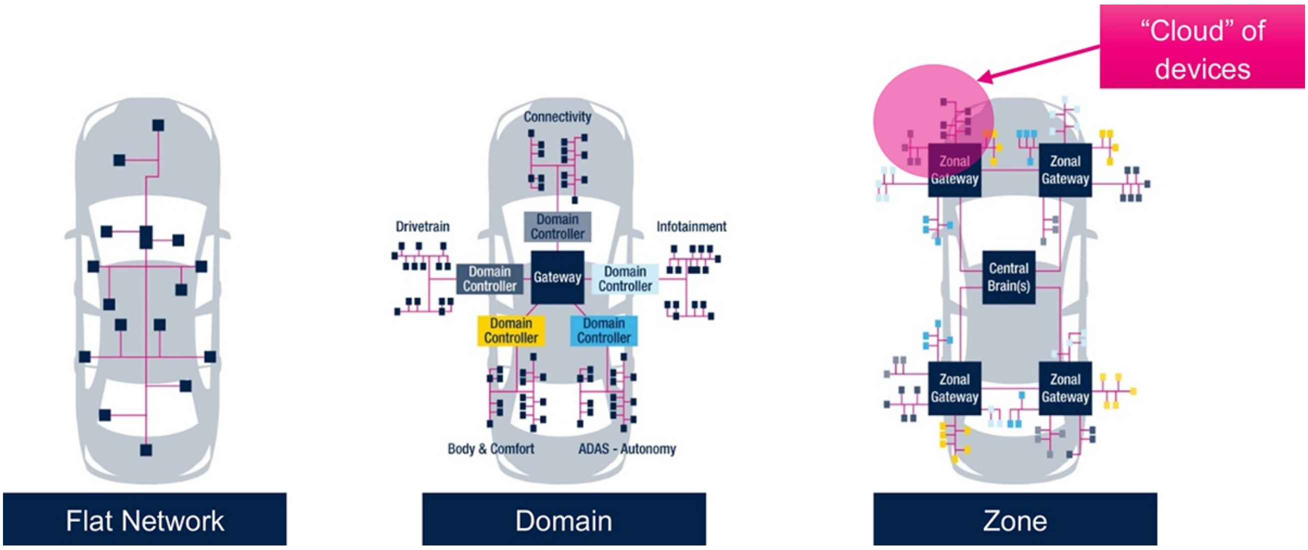
With a new robust and reliable network, the embedded light module can be spared, and its tasks be taken over by the powerful body domain controller. This not only enhances the functionality of the rear light, but also reduces the system cost and enables easier updates using wireless technologies ("Over-the-air"). Inside the light functions remain only the drivers that communicate directly with the domain controller without the need for any software.

When looking beyond the needs for rear light the same architectures can be seen in other areas of the car. Figure 3 shows the evolution from the flat network architecture towards the domain and zone architectures. Besides the various domain and zonal controllers that are interconnected by high bandwidth networks like Ethernet "clouds" of sensors and actuators exist, that are connected to these controllers. This is very similar to the described rear light network, which makes a lightweight CAN FD network applicable in various sections of the car.

System costs

A network for communication between a controller and many small devices like actuators and sensors must be reliable and cost efficient. The network protocol must be embedded in these devices without the use of a micro-controller and software. Also, external costly components must be spared. One of the most expensive components in a communication system, is the crystal for generating the accurate clock frequency to sample the received data-frame and to generate the frame to be transmitted. This crystal cannot be placed at each small communicating device since it would increase the system cost drastically.

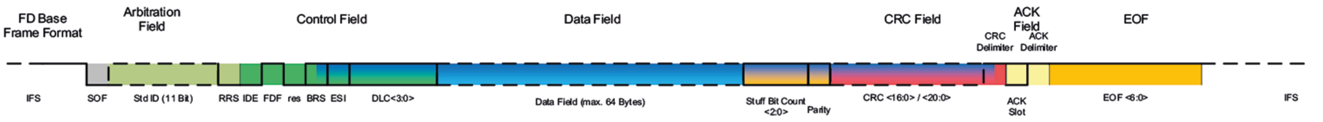
Besides the reliability and cost constraints, a network used in the car must not require a new infrastructure at the car makers. It must build on existing tools, software, measurement, and development equipment already available at the development, manufacturing, and service sites. In addition, the transceivers used for this network must already be proven to operate in the automotive environment.



Car network evolution (Source: STMicroelectronics)

Why CAN FD?

While new driver and sensor devices with a new communication protocol can be developed within the regular product upgrade cycle, the hardware inside of the domain controller cannot so easily be changed. Therefore, the network must be able to work with the existing network support the micro-controllers already provide. While taking all these considerations into account the choice was made to implement a network based on the well-known and widely used CAN FD.



CAN FD base frame format (Source: STMicroelectronics)

CAN FD provides a bandwidth of 1 Mbit/s, which is more than sufficient for small sensor and actuator networks including dynamic rear light applications. As shown in figure 4, a CAN FD frame provides a data-size of 64 bit per frame with minor control bit overhead. An eleven-bit field for frame identification and, with the inherent bit-stuffing rule a guaranteed edge density for synchronization. As bus network it is cost-efficient and with one frame, data to several devices can be sent. The frame is protected by a cyclic-redundancy-check (CRC), that has proven its reliability for years in many applications and products.

Hardware protocol controllers inside of existing micro- controllers are on the market, so the domain controllers are not burdened with software running on their cores to realize the network protocol. And, since CAN FD is widely used in the industry, experience and a large tooling environment including software exist in development, manufacturing, and service areas.

If you would like to read the full article from Fred Rennig (STMicroelectronics) you can [download](#) it free of charge or you [download the entire magazine](#).

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