For utility vehicle manufacturers, there is an urgent need to rework both the layout and design of the HMI while also improving the electrical/electronic architecture (E/E architecture). This need is made clear by the variations in HMI design and usability shown by the instrument cluster, infotainment and fleet management systems that are of particular relevance for HMI. A further problem is that existing designs cannot integrate driver assistance systems that use imagery or provide user interfaces to special-purpose vehicle bodies. Lastly, there is also the danger that excessive amounts of data spread over multiple display components will distract drivers and create road safety hazards. Fujitsu introduces a solution.
state of the vehicle or current tour data. There are also a large number of fixed-position warning lights that tell drivers about the presence of individual functions and whether these are active.

The infotainment system combines information and entertainment modules offering navigation, multimedia and communication functions. This system has its own display module and can also be connected to external devices – such as MP3 players or mobile phones, for example – via its Bluetooth or USB port. For route planning, an integrated navigation system informs drivers about traffic congestion. For entertainment, drivers have a radio, an audio CD player or a DVD system at their disposal. Driver assist systems using imagery – such as reversing cameras – are based on analogue cameras, for which a separate, additional display is normally required in the driver cab. In special cases, the operation of complex specialised vehicle bodies will also require a separate, touch screen display.

To increase the operational efficiency of both their vehicle pools and resource planning processes, increasing numbers of hauliers are now choosing to deploy fleet management systems. Drivers can use a touch screen display to access the jobs to be completed or make use of route planning features.

From an architectural perspective, the separate components are connected via the vehicle bus, from which they also source their data. Since the components themselves are generally standalone systems, there is very little intercommunication.

**INFLEXIBILITY HINDERS THE INTEGRATION OF INNOVATIONS**

Space in the instrument cluster is almost entirely exhausted, offering very few opportunities to display information from additional functionality. This problem generally stems from the static arrangement of gauges and warning lights, a layout that tends to appropriate most of the available display real estate for itself. As a result, any changes or improvements here incur heavy resource and cost penalties – assuming they are even feasible in the first place. A further disadvantage of the HMI model used to date is the way information is displayed using a range of different designs across multiple displays.

This has the effect of breaking the driver’s concentration while making driving more difficult. Apart from concentrating on the road, drivers must now also first filter out the information that they need. The number of displays is not merely a distraction, however, it is also a significant cost driver and limiting factor for available space in the driver cabin. The typical practice seen to date of adding extra displays for extra functions is a result of the systems’ poor interoperability, since in most cases no interfaces are provided for other data sources – such as a visual driver assist system, for example. Redundant functions constitute another negative characteristic of this HMI design, one example being the navigation features offered by both the infotainment and the fleet management systems.

**REQUIREMENTS FOR NEXT-GENERATION HMI**

Next-generation HMI systems must pursue the goal of better integrating the HMI functionality offered by instrument cluster, infotainment and fleet management components while also reducing the number of display modules. This also necessitates redesigning the actual display content itself. The principles involved here include improving ergonomics, relieving driver workload and increasing road safety. To achieve this, a model is required that enables the HMI content to be organised dynamically to meet the needs of the driver’s immediate situation.

**SOLUTION MODEL: BREAKING DOWN HMI DESIGN BARRIERS**

A flexible, application-oriented visualisation of HMI content can be achieved by deploying an individually programmable instrument cluster. This would involve replacing the mechanical gauges and static warning lights layout with a TFT display. One such system could be a 12.3” screen with a resolution of 1440 × 540 pixels, for example. In this way, the previous barriers disappear and HMI designers have unlimited options available. The driver’s instrument cluster would therefore not merely show conventional information such as RPM, speed, gear stick position, etc. but could also visualise any current data required from a range of vehicle functions. Higher-quality map data from
the navigation system could also be displayed in the instrument cluster, as could the smart phone’s address book or notifications of new orders received from the fleet management system. Functions whose visualisation uses the entire display would be accessible only under specific vehicle operating conditions. In this context, one could imagine displaying a vehicle operating manual or a guided troubleshooting system (Guided Diagnostics). The availability of these options depends on systems having the level of interoperability mentioned earlier, however. The appropriate requirements thus need to be considered when designing the E/E architecture.

Here, the architectural delegation of functionality and the selection of electronic components for the instrument cluster will be decisive.

A NEW ARCHITECTURE

Once we have clarified the functions and applications to be integrated into the HMI, these functions are then delegated to the individual systems. Here, we need to consider which systems will generate the graphical content for the HMI, the bus technologies these will use to communicate and the extent to which we can ensure the scalability of the architecture. One possible architecture is shown in ❶. To reduce the number of distributed systems, the infotainment and fleet management applications are consolidated into a “silverbox”, which is itself responsible for generating the graphical content. For data exchange, interfaces are provided to the vehicle data bus and the instrument cluster electronics. The latter also processes the graphical content intended for the instrument cluster autonomously, while also providing core management functions for all of the content to be visualised. In this way, the instrument cluster electronics manage HMI output and can also distribute the HMI’s informational content to additional display modules, according to its complexity. Depending on the specific use case, the information can either be distributed to displays or hidden as required. One example is shown in ❷: Here, the instrument cluster displays mapping data from the navigation system between the engine RPM and speed indicators, while order management system data is visualised on a separate display.

Fujitsu Semiconductor is using the latest semiconductor technology to lay the foundations for the architecture recommended here. A two-chip solution, ❸, is ideal for use as the basis for the core graphical control system. This approach envisages using the “Atlas” microcontroller to provide vehicle data bus communication plus power management for the graphics SoC (system-on-chip) “Emerald”, which is used to generate and manage graphical data. A striking feature of the graphics SoC’s chip design is the provision of four independent video inputs, for use by the Fujitsu 360° Wrap-Around View System, cameras to replace wing mirrors or other imaging sources. The integrated APIX2 interface is the recommended interface to the silverbox. The bus technology is based on LVDS (Low Voltage Differential Signal), and supports a bandwidth of up to 3 GBit/s, enabling the uncompressed transmission of image data and the flashing of control devices via
Ethernet. On the subject of flashing times, the use of Ethernet in the HMI – to support new and more complex graphics and applications – is of particular interest. The example envisages the flash process for the entire HMI being routed via the silverbox, which acts as an APIX2 gateway for flashing the instrument cluster.

The chip offers three display controllers for distributing display content to various display elements. If space permits, the instrument cluster display can be connected directly to the graphics board via RSDS (Reduced Swing Differential Signalling) technology. Otherwise, connectivity via APIX is also possible. For the APIX receiver component, Fujitsu offers the “Indigo” display chip with integrated APIX interface, stepper motor controller (SMC) for controlling gauge instrumentation and hardware-based HDCP (High Definition Content Protection) decoding. Since APIX offers bidirectional data transmission, the combination of bus and “Indigo” display chip presents a cost-efficient solution for the provisioning of a touch screen display.

For development work on the HMI interface, Fujitsu Microelectronics Embedded Solutions Austria (FEAT) offers the CGI Studio development tool, which creates connections between design elements from graphical applications and the instrument cluster or infotainment system software application. As regards scalability, the same architecture can be used in connection with instrument clusters that have a hybrid layout, i.e. possessing both mechanical gauge instrumentation and a display screen. Since the software architecture is modular, only minor modifications will need to be made in such cases.

CONCLUSION

The key characteristics of this new model are the individually programmable display and the core graphics management role given to the instrument cluster electronics. By enabling the processing of image and video data from a range of sources – and its distribution to various display systems – the chip technology is ushering in a new era of HMI design options. The required flexibility is available, and it is now the task of the HMI specialists to use this for designing an ergonomic and intuitive system.