Bluetooth trends and their adoption in automotive applications

by Anthony Murray, CSR

THIS ARTICLE LOOKS AT SOME OF THE CURRENT AND FUTURE APPLICATIONS OF BLUETOOTH, AND RECENT DEVELOPMENTS IN THE BLUETOOTH STANDARD.

The market for Bluetooth-enabled radios, phones, infotainment and navigation systems for in-car use is set to grow rapidly. Until recently, the only Bluetooth-capable products with any real presence in this sector were the embedded phone systems fitted by car manufacturers to some of their luxury vehicles; some of these communicated via Bluetooth with the driver's mobile phone, while others replaced early-generation DECT phones with Bluetooth personal handsets for passengers' use. Now, however, a growing number of in-car products featuring Bluetooth connectivity are available aftermarket, from both specialist system installers and high street retailers.

The advent of hands-free legislation in many regions of Europe, the USA and Asia led to a huge range of Bluetooth headsets, enabling drivers to make and receive calls via voice commands using a Bluetooth-equipped mobile phone. These headsets are inexpensive and have no installation requirements other than plugging them into the cigarette lighter socket whenever they need recharging. However, they hardly constitute part of an integrated in-vehicle communications system. These were followed by hands-free car kits that allow drivers to communicate with their Bluetooth mobile phones via a conveniently mounted microphone connected to a control box. The kits range from speaker-equipped standalone modules designed to plug into the cigarette lighter socket to more integrated models, some requiring professional installation, that utilise the car's stereo system as a speakerphone. Unfortunately, not all the plug-in models are able to mute the car's radio or stereo system during a phone call, which means the driver still has to do this manually. Car CD/MP3 players that support Bluetooth's HandsFree and Headset profiles were among the first products to break away from the phone-only mould, combining in-car entertainment with hands-free voice control of a Bluetooth equipped mobile phone.

To embed Bluetooth in the vehicle there are problems that need to be overcome. Bluetooth technology was originally developed to withstand harsh environments, such as that found in a vehicle cabin. This is the reason behind its rapid adoption by some of the world's leading carmakers. CSR's BlueCore silicon for example, exceeds the required temperature range of -40 °C to +85 °C for in-cabin applications and operates from -40 °C up to +105 °C.

In addition to temperature, other RF devices in a vehicle, such as car stereos, GPS navigation equipment, Satellite Digital Audio Radio Service (SDARS), GSM transceivers and other electrical devices, can all potentially cause interference, or can be susceptible to interference. A car is effectively a reflective "tin can", where radio waves are reflected within the vehicle cabin. This potentially results in a phase shift that, with superposition, can effectively cancel out or corrupt the desired signal. All this RF activity can be detrimental to the data throughput of a wireless system in a vehicle. As the applications for Bluetooth expand into infotainment, internet diagnostics and others, Bluetooth implementations are likely to become more widespread around the car, further compounding the potential risk of interference.

Bluetooth has an existing arsenal of defences to combat interference designed into the standard. The first line of defence built into the Bluetooth radio specification is frequency hopping which requires both the receiver and transmitter to tune/hop to one of its 79 different channels 1600 times per second in a pre-determined pattern. This provides a good level of immunity to interference but even with frequency hopping in place, the high amount of RF activity in the vehicle cabin can still be detrimental to data throughput and link reliability.

The Bluetooth specification also includes measures to combat any potential sources of RF interference, which are magnified in a vehicle cabin. Called CQDDR (Channel Quality Data Driven Rate), this technology monitors the noise in the environment allowing the Bluetooth device to gauge how much of the data is

being corrupted on transmission and then dynamically adjusts the packet types to best suit the environment. The result is that it maintains the most efficient data rates. Given the potentially busy RF environment in a vehicle cabin it is important that silicon chosen for automotive applications incorporates CQDDR to assure the highest data rate, especially in data applications such as dial-up networking – not all Bluetooth systems incorporate CQDDR.

Currently, the Bluetooth link combining the car entertainment systems with handsfree control over a Bluetooth handset is only used for relatively low bandwidth voice data. However, a number of device manufacturers have recently launched the first Bluetooth stereo headsets onto the market. These products have been enabled by new Bluetooth silicon, designed specifically for the streaming of stereo-quality music. CSR's BlueCore3-Multimedia chip for example, integrates an on-chip battery charger and DSP to improve audio quality and battery life. This technological development means that subsequent players will enable passengers to listen to music without distracting the driver.

The most recent product on the market is a combined navigation system, radio and CD/MP3 player, which uses Bluetooth technology to link to mobile phones, features voice-controlled functions, and can store address and telephone directories – which can be exchanged with those in the mobile phone via the Bluetooth link. This particular product uses CSR's BlueCore single-chip Bluetooth technology, and CSR also provided hardware and software integration support to help accelerate time to market. Perhaps the most significant technological improvement as far as in-car voice communication is concerned is the fact that the latest Bluetooth specification supports eSCO (extended Synchronous Connection Oriented) voice channels. These error-tolerant channels facilitate automatic re-transmission of voice data in the event of lost or missing voice packets, and allow negotiation of data transfer rates to maintain a high quality of service. Version 1.5 of the HandsFree profile, due later this year, will make full use of eSCO to provide a very robust communication link; it is actively promoted by the Car Working Group as a useful solution for electrically noisy environments.

Passenger entertainment is another growth area for Bluetooth. At present, all rear-seat entertainment systems such as game consoles and DVD players use wired or infra-red links for their stereo headsets. The former invariably end up as a tangled jumble of leads, while the latter are prone to the effects of sunlight, which often causes hissing or even loss of connection. Both application areas are obvious candidates for Bluetooth.

The EDR (enhanced data rate) capabilities of CSR's latest BlueCore4 chips are likely to prove the key enabler for this particular application. Capable of data transfer rates of up to 2.1 Mbit/s – three times faster than Bluetooth v1.2's standard rate – the increased bandwidth of EDR makes it useful for handling two separate stereo streams for a pair of stereo headsets. Furthermore, CSR recently added a host-side human interface device (HID) profile to the library supplied with its BlueCore Host Software (BCHS), enabling Bluetooth-equipped joysticks to be used with gaming consoles, and also implemented the advanced audio distribution profile (A2DP) for audio streaming. The A2DP handles both "source" and "sink" roles for audio devices, enabling an audio stream to be established or suspended by devices such as mobile phones, in-car infotainment systems, PDAs, MP3 players and headphones. The application containing the A2DP also contains an AV remote control profile (AVRCP), which allows a control link to be established between the sink and source devices. It will not be long before users are able to stream their choice of music from devices such as MP3 players to the car's central entertainment system. They will then be able to listen to their precompiled play-list via the vehicle's audio system, and use the system to control MP3 player operation. ■