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Case Study

Hands-Free Car Kit (HFCK)

Introduction

Hands-free Car Kit (HFCK) is a Car Telematics application for hands-free operation connecting any Bluetooth or non-Bluetooth mobile phone to a car. The system consists of a main unit, power supply, car interface, UI (User Interface), microphone and speaker.

This case study showcases Mistral's capability in building a versatile, ready-to-use, small form-factor, low-cost, Bluetooth or non-Bluetooth HFCK reference design; which is extremely easy to install, and ideal both as an OEM solution or an after-market solution.

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The Customer

The customer is one of the world's leading semiconductor companies specializing in high performance analog, mixed-signal and DSP chipsets.

The Requirement

The customer wanted a HFCK Platform using its newly released high-performance MSA (Micro Signal Architecture) processor; which executes highest quality of speech recognition and text-to-speech functionality.

The software framework defined for the HFCK system consisted of:

- Speech functionality:
  - Acoustic Echo Cancellation (AEC) & Noise Reduction (NR) Bluetooth interface
  - Voice Activated Dialing (VAD)
  - Text-To-Speech (American English) for voice guidance
  - Speech recognition (American English) for command/control
- Communication System:
  - Mobile phone connectivity
  - Bluetooth connectivity to local mobile devices
  - Handset Address book synchronization with Bluetooth handset
  - Automatic Call answer after preset number of rings
  - Voice Guidance
  - Three key remote with LED indicator to accept/reject call, volume control & for incoming call.

Solution Provided

Mistral designed and developed the entire hardware platform for the HFCK system along with the following software:

- The Complete BSP (Board Support Package) in modular structured APIs, to control the hardware modules on board. The Driver APIs remain the same for various flavors (as many as 6) of the hardware. With this modular approach, application developers are required to port their code only once. Subsequently, for newer scaled-up versions of the system designs, application porting is not needed
- An "Application Framework" which supports concurrent applications across multiple vendors. The applications are completely insulated from the underlying hardware platform

- A "System Executive" which handled the inbound/outbound data traffic on the HFCK platform:
  - The executive helps in proper switching between sub-applications, and guarantees system behavior in terms of response, response time, etc.
- A proprietary "Flash File System" that supports the following features:
  - Standard File operation API support with "seek" features
  - Multiple DAT files for HFCK application usage
  - Download / Upgrade / Delete boot images into the Flash
  - Download / Update / Delete DAT files (application specific) into the Flash
  - Fast boot time
  - The File System is portable across platforms/ flash technologies.

The Challenges

- Engineering all the functionality around a single processor:
  - The performance parameters of the individual applications, in terms of memory, MIPS, task deadline and priorities, were tweaked to fulfill the operational requirements
- Finding the right balance between using an external component or emulating the component in software, and handling processor resources; while controlling overall system cost
- Co-existence of audio, RF and High-speed digital signals on a single small form-factor, single processor board
- Seamless porting and integration of various applications from different IP vendors. The design team at Mistral had to interact with 8 teams in 5 geographical locations across the world at various stages. This was achieved by setting up a very close and consistent interaction system, with a risk management plan, between the various core developers and the customer
- Incorporating product-like application features (e.g. outgoing call handling through VAD integrated address book synchronization with Bluetooth handset, voice recognized dialing, etc).

Key Achievement

- Seamless integration of the Bluetooth stack, Obex profile and hands-free profile, with VAD and TTS engines
- Co-existence of multiple vendors for Bluetooth and NR/AEC applications in a single image
- Software optimization, to provide room to integrate many applications and provide "select" ability during boot time (vendor selection with keypress)
- System engineering all the functionality around a single processor; resulting in a low-cost, small form-factor product
- Supporting stereo audio streaming using Bluetooth A2DP profile, over and above the hands-free functionality.

Scalability

In addition to the Bluetooth enabled HFCK, Mistral designed multiple variants of the HFCK, from a low-cost basic version, to advanced hands-free versions; bringing in scalability into the system.

- Traditional cradle based basic hands-free
- Traditional cradle based basic hands-free with GPS for handsets, with map application
- Car phone with hands-free
- Advanced hands-free with ASR & TTS on Bluetooth interface
- Advanced hands-free with ASR & TTS on Bluetooth interface, with stereo audio streaming.

Customer Benefits

Mistral was able to provide the customer with a single processor based HFCK solution with Bluetooth support, speech recognition, synthesis and product-like user-level features; thereby highlighting the power and versatility of the newly released MSA processor. The system has a low BoM cost, and more than 30% of processor resources are available for application scalability.

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Mistral Solutions Pvt. Ltd.,
No.60, 'Adarsh Regent',
100 Feet Ring Road,
Domlur Extension, Bangalore - 560 071
Tel: +91-80-4562-1100
Fax: +91-80-2535-6444
E-mail: info@mistralsolutions.com

Mistral Solutions Inc.,
43092 Christy Street
Fremont, CA 94538
USA
Tel: +1-408-705-2240
E-mail: usa@mistralsolutions.com

Branch Offices:
INDIA
- Hyderabad
- New Delhi

USA
- Dallas, Texas