Vybrid Automotive Solutions

Cost-optimized, scalable solutions for connected radio and infotainment applications

The Vybrid automotive families are purpose-built and cost-optimized for connected radio, entry-level infotainment and digital instrument cluster applications. Generous 1.5 MB on-chip SRAM and multiple package options provide scalability from low-cost basic connected radios without external DRAM up to entry-level infotainment systems with dual displays and GPU-accelerated rich, compelling user interfaces. Standard vehicle connectivity is provided through integrated CAN controllers, MLB, UART/LIN and Ethernet with IEEE® 1588 support. Integrated video ADC allows for direct connection to analog cameras without the need for expensive external circuits. Dual USB 2.0 On-the-Go (OTG) controllers (with integrated PHY) and a large variety of serial interfaces such as UART, SPI and I²S provide connectivity to consumer electronic devices such as smartphones, tablets and Bluetooth® enabled devices.
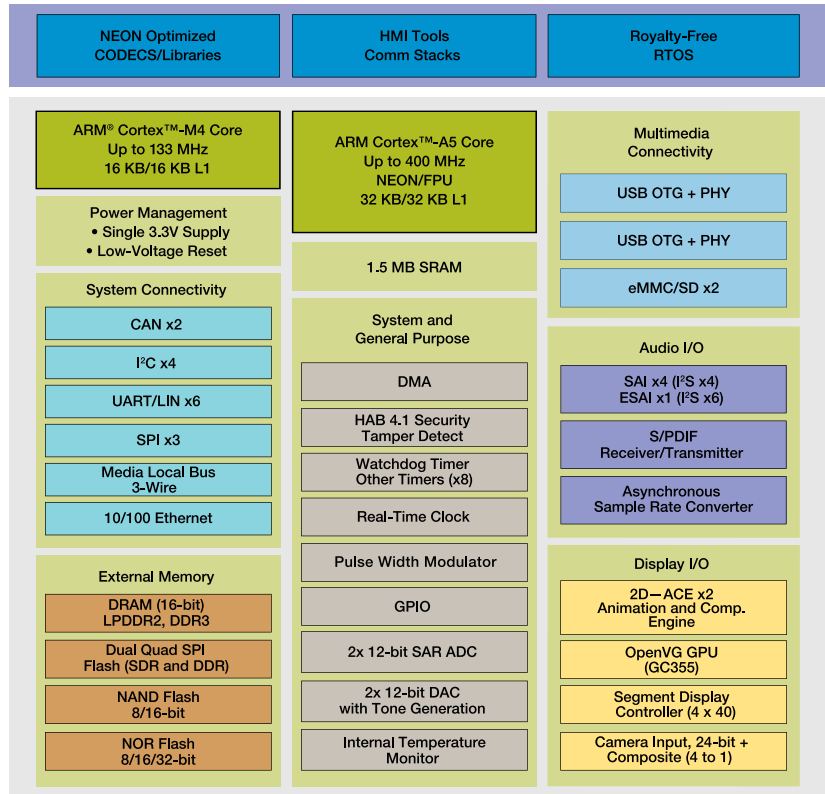
Target Applications

- Connected radios
- Entry-level infotainment
- Digital instrument clusters
- Backup camera applications

Production-Grade Software

The influence of the consumer market on automotive applications is undeniable. From desired features to connectivity options and applications, software is now a major differentiator critical to the success of radio and cluster platforms. However, there's a price to be paid in supporting these new features, both in terms of actual development dollars and in lost time to market.

We are committed to delivering total system solutions to reduce your development costs and speed your time to market. Vybrid automotive families introduce production-grade software for connected radio and cluster applications. Built upon auto-grade BSPs for Linux® and MQX™, our production-grade software is the ideal starting point for your radio and cluster designs. The enablement components are included with every chip we sell, and provide a full working system complete with BSP, middleware and example applications. Our software solution is highly configurable and architected with Vybrid families in mind, scaling from low-cost solutions that use the internal SRAM only, up to feature-rich, graphics-intensive solutions.

Features

- Complete MQX and Linux BSPs
- Complete multimedia framework: Player, media browser, cover flow, metadata and album art support
- CE connectivity for devices such as iPhone®, smartphones, USB/SD memory cards
- Comprehensive list of audio codecs

Vybrid Automotive Superset Block Diagram

Performance

- ARM® Cortex™-A5 core with frequency up to 400 MHz with 32 KB each instruction and data L1 cache and 512 KB L2 cache double-precision floating point, NEON media processing engine for acceleration of media and signal processing and TrustZone security extension
- ARM Cortex™-M4 core running up to 133 MHz with 16 KB of instruction/data L1 cache plus 64 KB of tightly coupled memory, DSP support for single cycle 32-bit MAC, single instruction multiple data extensions and single-precision floating point unit
- Up to 64-ch. DMA for peripheral and memory servicing with reduced CPU loading and faster system throughput
- Crossbar switch enables concurrent multi-master bus accesses, increasing bus bandwidth

Vybrid Automotive Family Details

Feature	Vybrid VF1xxR	Vybrid VF3xxR	Vybrid VF5xxR
CPU	• 266 MHz ARM® Cortex™-A5 • 133 MHz ARM Cortex™-M4	• 266 MHz ARM Cortex-A5 • 133 MHz ARM Cortex-M4	• 400 MHz ARM Cortex-A5 • 133 MHz ARM Cortex-M4
On-Chip Memory	1.5 MB (512 KB ECC)	1.5 MB (512 KB ECC)	1.5 MB (512 KB ECC) or 1 MB and 512 KB L2 cache
Serial Flash Interface	2x Quad SPI Flash with DDR Support	2x Quad SPI Flash with DDR Support	2x Quad SPI Flash with DDR Support
NAND	No	Yes (8-bit) Up to 32-bit HW ECC	Yes (16-bit) Up to 32-bit HW ECC
FlexBus Interface (Parallel NOR)	No	Yes (addr/data mux'd)	Yes, (addr/data mux'd plus 8-bit dedicated data)
DRAM Interface	No	No	16-bit LPDDR2/DDR3
Display Interface	TFT OR 40 x 4 Segmented LCD	TFT and 40 x 4 Segmented LCD or 2x TFT up to WQVGA	TFT and 40 x 4 Segmented LCD or 2x TFT up to WVGA
Video ADC/Camera Input	1x Composite 24-bit Parallel	2x Composite 24-bit Parallel	4x Composite 24-bit Parallel
Ethernet	1 x 10/100 Ethernet with IEEE® 1588	1 x 10/100 Ethernet with IEEE 1588	2 x 10/100 Ethernet with IEEE 1588
Analog-to-Digital Converter	10-channel 12-bit ADC	10-channel 12-bit ADC	10-channel 12-bit ADC
USB	1x USB OTG HS	1x USB OTG HS	2x USB OTG HS
Audio Interface	SAI x3 (I²S x3) ESAI x1 (2 Tx, 4 Tx or Rx)	SAI x3 (I²S x3) ESAI x1 (2 Tx, 4 Tx or Rx)	SAI x4 (I²S x4) ESAI x1 (2 Tx, 4 Tx or Rx)
UART, DSPI, I²C	3, 2, 2	4, 3, 4	6, 4, 4
SD/MMC Interface	1	1	2
CAN	2x FlexCAN	2x FlexCAN	2x FlexCAN
MOST	No	1x MLB50	1x MLB50
GPIO	Up to 88	Up to 115	Up to 136
Package	144-pin LQFP, 20 x 20 mm² 0.5 mm Pitch	176-pin LQFP, 24 x 24 mm² 0.5 mm Pitch	364-pin MAPBGA, 17 x 17 mm² 0.8 mm Ball Pitch

Memory

- 2x Quad SPI interfaces with support for DDR at up to 80 MHz
- Up to 1.5 MB SRAM, with 512 KB reconfigurable as L2 cache
- 16-bit DDR controller with support for LPDDR2 and DDR3 up to 800 MHz
- Boot ROM with optional high assurance boot for secure booting capability

Display and Video Support

- Dual TFT LCD display capable of up to XGA resolution
- 2D-ACE animation and composition engine
- OpenVG GPU for UI acceleration
- Video ADC with support for direct connection to analog cameras
- Video interface unit with parallel camera support for 8- and 10-bit ITU656 video, up to 24-bit digital RGB

Audio

- Up to four synchronous audio interfaces implementing full-duplex serial interfaces with frame synchronization such as I²S, AC97 and codec/DSP interfaces
- Asynchronous sample rate converter for rate conversion between 32, 44.1, 48 and 96 kHz

- Optional enhanced serial audio interface which provides a full-duplex serial port for serial communication with a variety of serial devices, including industry-standard codecs, SPDIF transceivers and other processors
- Sony Philips Digital Interface receives and transmits digital audio using the IEC60958 standard consumer format

External Peripheral Support

- Secure digital host controller supports SD, SDIO, MMC or CE-ATA cards for in-application software upgrades, media files or adding Wi-Fi® support
- NAND flash controller supports up to 32-bit ECC current and future NAND types
- ECC management handled in hardware, minimizing software overhead
- FlexBus external bus interface provides glueless interface options to memories and peripherals such as graphics displays. Supports up to four chip selects

Connectivity/Communications

- Dual USB 2.0 OTG controller with integrated PHY
- Two CAN modules and one MediaLB 3-pin interface for vehicle communications
- 10/100 Ethernet controller
- Up to six UARTs, four DSPI and four I²C interfaces

Mixed-Signal Capability

- Two 12-bit ADCs with configurable resolution. Single or differential output mode operation for improved noise rejection. 500 ns conversion time achievable with programmable delay block triggering
- Two 12-bit DACs for analog waveform generation for audio applications or sensor manipulation

Timing and Control

- Four FlexTimers with a total of 20 channels. Hardware dead-time insertion and quadrature decoding for motor control
- 4-ch., 32-bit periodic interrupt timer provides time base for RTOS task scheduler or trigger source for ADC conversion and programmable delay block

Reliability, Safety and Security

- TrustZone Address Space Controllers provide memory protection for all masters on the crossbar switch, increasing software reliability
- Cyclic redundancy check engine validates memory contents and communication data, increasing system reliability
- External watchdog monitor drives output pin to safe state external components if watchdog event occurs

Vybrid Automotive Key Partners

In addition to the enablement components, we have teamed up with select industry-leading partners that have rich automotive heritage and embedded systems know-how to provide third-party components for areas like Bluetooth®, human-machine interface (HMI) tools and acoustic echo cancellation/noise suppression. For information on solutions from our launch partners, visit **freescale.com/Vybrid**.

Altia Design with DeepScreen
User interface development tools

With Altia, you get a first-class embedded display from your artist's imagination to your lowest cost hardware in the shortest amount of time.

Altia's suite of user interface engineering tools offers a concept-to-code solution for getting best-in-class user interfaces for Vybrid product families.

Available Products

Whether you are creating a new product display or giving your current product a face-lift, Altia's user interface engineering tool chain gives you the capability to create amazing embedded HMIs.

- Develop concept: Altia PhotoProto (Adobe Photoshop add-on) and FlowProto (Microsoft Visio add-on)
- Build user interface: Altia Design
- Generate code: Altia DeepScreen

Altia Design UI Development Tools

Model-Based Development Process

Altia offers a unique and easy-to-use suite of product visualization tools for rendering, giving development teams the power to create custom, working HMI models without the need to program graphics.

Your Altia-built HMI can be paired with actual product logic to create an interactive model. This model provides a means for clear communication between different departments involved in development—from artists and designers to software and systems engineers. Generate code and run on your Vybrid hardware early in development to test the model with customers and managers. This gives you the opportunity to collect and incorporate feedback, thereby enhancing user experience and performance. Finally, generate C code from your model that is optimized to take full advantage of your selected Vybrid production platform.

Advantages
- Photoshop® integration allows graphic designers to get their pixels into production.
- Design environments include Windows® 7, XP and Vista. PC-based simulation capability offers HMI demo opportunity before hardware is available.
- Altia tools connect to popular simulation/state tools, including C/C++.
- Altia tools use open standards such as SVG, PNG, XML and fully editable ANSI C source code.
- Code generated by DeepScreen is optimized for performance and end use of embedded resources, like flash and RAM.
- Application code separation allows quick changes to graphics without affecting application.
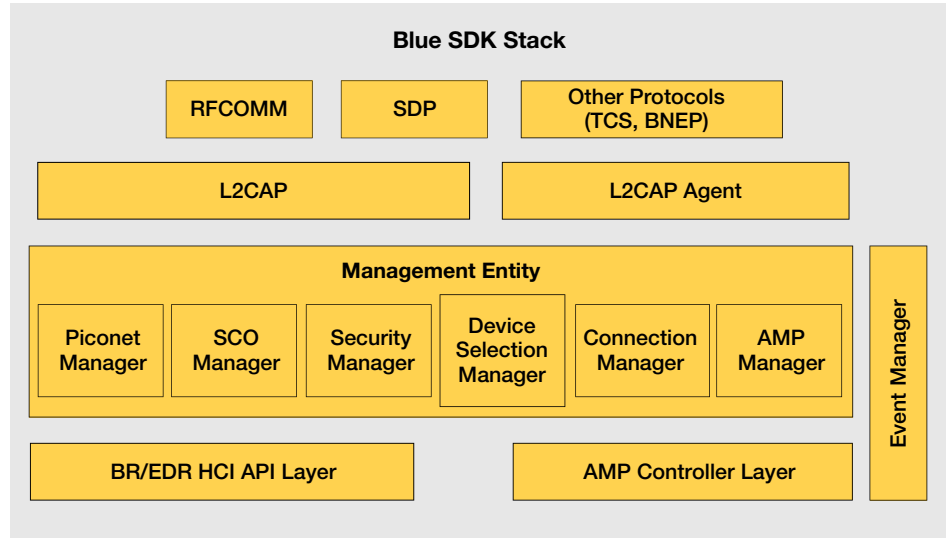
Sybase iAnywhere Blue SDK

Complete Bluetooth protocol stack

The Sybase iAnywhere Blue software development kit (SDK) provides an efficient way to add reliable Bluetooth radio communications to any embedded device. Sybase's Bluetooth SDK allows manufacturers to quickly implement and embed Bluetooth wireless technology into devices including cellular handsets, mobile devices and automotive applications.

Features

- 12-year maturity and evolution
- Seventh-generation stack
- Customer and market feedback for continuous reliability improvements
- Continuous participation and leadership in Bluetooth SIG and various working groups
- Ported to QNX, Linux®, Windows and MQX
- Unique experience of the automotive market

Blue SDK Stack Diagram

Advantages Using Sybase iAnywhere Products

- Small code base enables memory-limited implementation
- Portable C ANSI source code
- Operating system, processor and radio/transceiver/transport independent
- Sample applications
- Comprehensive and full documentation
- Software maturity and reliability
- Certified compliant by Bluetooth SIG
- Shorter time to market by reducing development costs
- Enables developers to focus on applications, data transports and system integration

Cybercom blueGO
Bluetooth software framework

Cybercom blueGO is a robust, generic and portable multi-profile Bluetooth software framework for advanced hands-free functionality in automotive multimedia systems. It minimizes the effort for Bluetooth application development and is subject to continuous interoperability testing ensuring device compatibility over the product life cycle.

Incorporating Bluetooth wireless technology into a system involves many design choices and component considerations. Cybercom blueGO offers tier 1 suppliers a robust, generic and portable multi-profile and multi-connection Bluetooth software framework that reduces development cost and time to market. It offers vehicle manufacturers the latest Bluetooth features and a system that is pre-tested for device interoperability.

blueGO is Bluetooth interoperability "off the shelf." blueGO is prepared for GENIVI® compliance through an optional D-Bus API extension layer. This extension layer implements all for blueGO applicable function APIs of the open source components.

Reduces Complexity and Effort

Unlike just a Bluetooth protocol stack, blueGO contains Bluetooth application managers, handles multi-profile and multi-connection use cases, encapsulates the complexity of Bluetooth and presents a high-level, easy-to-use framework API. Bluetooth related details are abstracted from the customer's application, minimizing project risks and saving the crucial

Cybercom blueGO
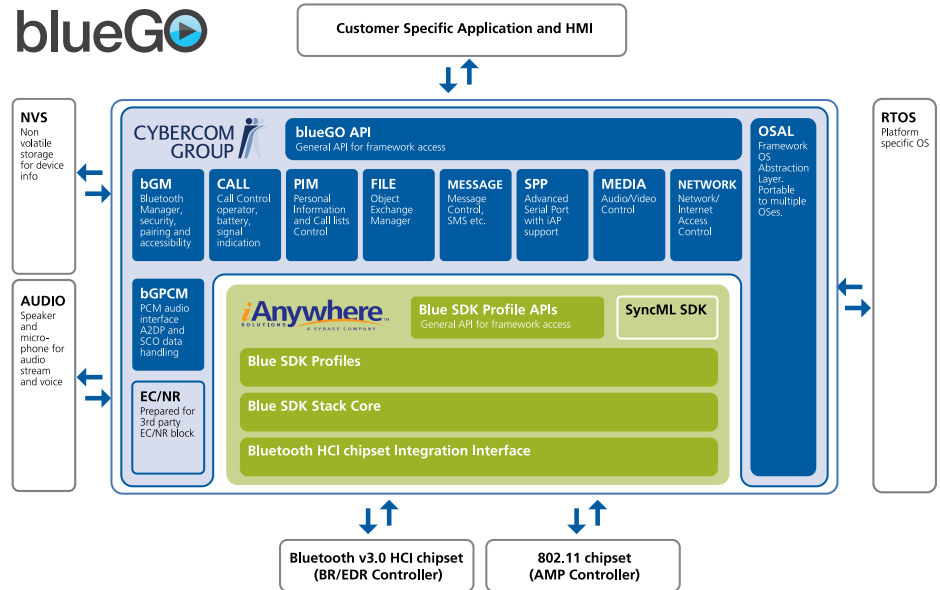
amount of time and money. The framework is built upon on iAnywhere's market-leading embedded Bluetooth protocol stack (Blue SDK). Cybercom and iAnywhere partner to offer customers the most well-proven and robust Bluetooth solution on the market. blueGO is delivered as one package, including iAnywhere stack and profiles.

The Cybercom framework contains functionality for typical user scenarios required for an in-vehicle telematics and multimedia system, including advanced phonebook access through methods like PBAP, SyncML and AT commands as well as a media manager offering AVRCP v1.4. It also supports messaging (SMS, email) using MAP/AT commands as well as networking using PAN and DUN.

iAnywhere's underlying software grants that blueGO always includes support for the latest Bluetooth core specification and available profiles. Today, it includes Buetooth core specification v3.0+HS with option v4.0.

iAnywhere is an active associate member of the Bluetooth SIG and drives the developments of Bluetooth in selected areas. Cybercom takes on the role of systems integrator and supplier of customized solutions, based on the blueGO application framework on top of iAnywhere stack and profiles.

Alango Voice Communication Package

Voice processing and echo cancellation

The Alango Voice Communication Package (VCP) is a suite of digital signal processing technologies enabling high-quality voice communication for a variety of applications, including automotive hands-free, mobile phones, Bluetooth headsets, audio and videoconferencing systems, intercom systems and others. VCP was designed to enable the highest possible voice quality in various acoustic environments while consuming relatively low MIPS and memory resources. VCP provides natural support for narrowband (8 kHz) and wideband (16 kHz) speech. For wideband speech, VCP implements special mechanisms providing significant reduction of MIPS and memory requirements compared to doubling them with the brute-force approach without a noticeable degradation of output speech quality.

The current seventh VCP generation accumulates many years of practical Alango experience to provide a scalable, highly optimized solution for voice communication applications. Beyond software DSP technologies, Alango has developed a unique set of auxiliary software and hardware tools facilitating development, debugging, testing, acoustic tuning, problem identification and reporting.

VCP Components and Structure

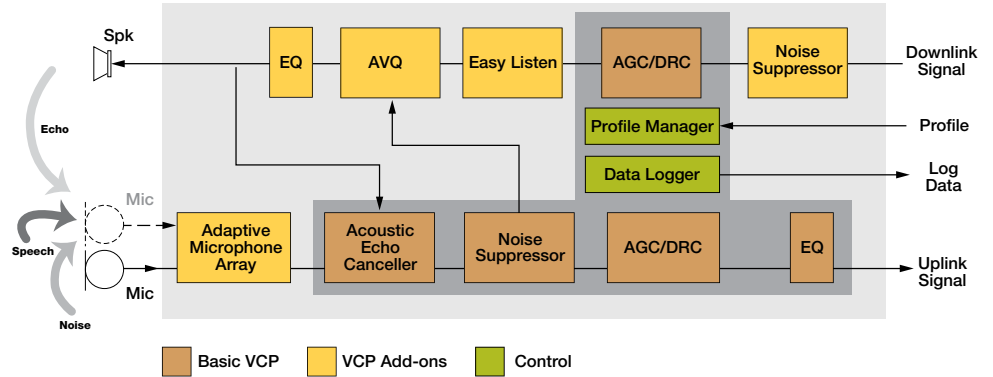VCP consists of basic, control and add-on blocks. Basic VCP comprises technologies that are "must have" for virtually any full-duplex, hands-free voice communication system. It also includes control blocks adding flexibility and ease of system debugging, testing and acoustic tuning. Add-on blocks include technologies providing additional benefits to end users.

Development and Tuning Tools: VCP Configurator

VCP Configurator is a PC Windows graphical application allowing controlling VCP functionality. All VCP blocks and their parameters are shown according to their real position in the signal processing chains. All parameters are provided with short prompts as well as detailed help. VCP configurator generates an acoustic profile structure that can be uploaded into a device under tuning in real time via UART or other available interface.

VCP Structure and Signal Flow

Figure 1: VCP structure and signal flow

VCP Features and Performance

- Supported sampling rates: 8 kHz, 16 kHz
- Fast filter convergence (< 300 ms) with no initial echo
- Convergence in double talk and intense noise
- Robustness to speaker signal distortion
- Echo canceller filter length up to 500 ms
- Residual echo level (echo suppression level): up to -70 dB
- Noise suppression up to -30 dB
- Noise adaptation time: 100–700 ms (depending on noise type)
- Maximal AGC gain: 24 dB

For more information about Freescale ARM products and documentation, please visit freescale.com/Vybrid.