Telephony software: the hidden glue in an HLOS-based smartphone

HLOS: The most effective 3G applications environment

The early generation mobile phones were designed with closed, proprietary or off-the-shelf Real Time Operating Systems (RTOS). The applications environment had minimal functionality resulting from moderate user expectations (voice and SMS being the primary applications), limited network bandwidth and meager phone processing power. With the deployment of 3G networks and the availability of powerful applications processors for mobile phones, High-Level Operating Systems (HLOS) represent the most effective way to meet increased user expectations while providing an efficient management of the application lifecycle. In this paper we will refer to an HLOS-based phone as a "smartphone."

WHITE PAPER

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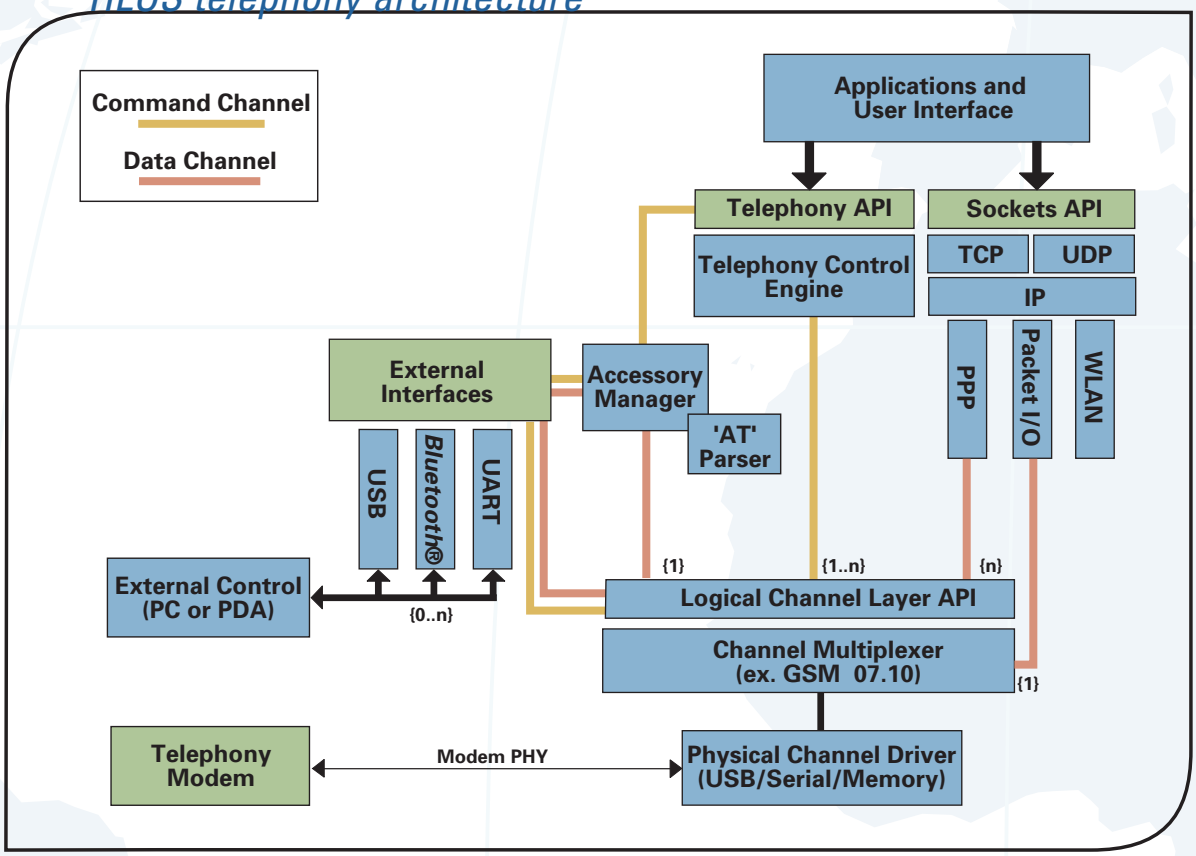
HLOS allow faster and more cost-efficient applications development while providing a large developer network that effectively meets operators' and end-users' requirements. HLOS, including Symbian OS™/Series 60 Platform, Microsoft® Windows Mobile™ and Linux®, provide several advantages over other applications environments:

- Standard APIs allow developers to more efficiently develop applications, reducing development time and costs. These APIs also allow OEMs and operators to easily port the same applications across different platforms.
- Stable User Interface (UI) and development tools allow developers to lower pre-sale applications development and test costs and operators to lower post-sale maintenance and support costs across devices.
- A large developers' network provides a large pool of applications from which to choose, creating economies of scale for the operators and making 3G more compelling for end-users.

HLOS telephony architecture



HLOS telephony: Definition and architecture

Current smartphone mobile phone architectures strive to separate the application execution environment from the modem module. With continually increasing processing demands of the communications software protocol stack, this isolation is often accomplished using a dedicated application processing unit (APU) and a modem processing unit (MPU). Regardless of whether the application and modem environments execute on separate processors or are integrated onto a single processor, there remains a challenging task of interfacing these domains to manage the complex call control features of a mobile phone.

HLOS telephony is the software layer that interfaces the application to the modem environment. It provides a command interface to regulate the exchange of information between the HLOS and the protocol stack and to control the various modem functions.

Generic HLOS telephony is composed of three major interfaces: telephony and sockets API, telephony modem and external. The telephony API is the application interface to access the telephony functionality. The telephony

API is unique for each operating environment and covers functions such as SMS, voice call setup and control and data call setup. A telephony engine is responsible for translating the telephony API into modem commands and is specific to the modem. The sockets API are the platforms standard network API to interface the network IP layers to the modem hardware.

The telephony modem interface is located between the applications and the modem. It provides a set of logical channels, a channel multiplexer, and a physical channel driver.

The external interface includes not only the interfaces between the mobile phone and external controllers, but also the accessory manager and debug/trace functions. The accessory manager tracks the state of attached devices and assigns communication channels to the accessories. The debug/trace interface enables the other modem components to run on a PC emulation environment to which the modem can be directly interfaced.

The challenges of HLOS telephony

Developing HLOS telephony is one of the most complex tasks in the overall development of a 3G smartphone. There are several challenges associated with developing HLOS telephony, including the need to choose any combination of HLOS/UI and modem, the need to support HLOS across different market segments with different architecture requirements, a long development and validation cycle, the need for a robust network of specialized third parties as well as many technical challenges.

OEMs want to choose any combination of HLOS/UI and modem without being forced into a proprietary one-vendor only solution. This in turn poses a great challenge for chipset vendors, who are required to support multiple HLOS/UI solutions across multiple modem technologies. To successfully handle this complexity, chipset vendors need to create a telephony architecture that abstracts the underlying modem hardware architecture and can easily be ported to multiple HLOS/UI. This result can be achieved through a standard modem interface that is independent of the modem technology (GSM/GPRS, EDGE, UMTS) or architecture (single or multiple cores) and a consistent set of APIs exposed to the HLOS. This allows the same telephony to be ported across multiple modems and HLOS/UI.

While HLOS started as a high-end applications environment, it is now moving to the mainstream market. This requires more cost-effective architectures where HLOS might run on the same core as the protocol stack. Making HLOS coexist with protocol stack on the same core poses additional challenges for the overall software architecture of the system and,

particularly, for the HLOS telephony. A scalable and flexible HLOS telephony architecture is required to handle these challenges and the different architecture requirements of the different market segments.

HLOS telephony involves a long development and validation cycle. In addition to architecting and developing the telephony, chipset vendors are required to validate it through FTA and IOT. This lengthy and expensive process requires deep wireless system knowledge. In order to successfully develop a 3G smartphone, OEMs need to partner with a chipset vendor that has extensive expertise in HLOS porting, protocol stack and telephony development and validation, and wireless system integration. A proven and stable protocol stack and telephony pre-validated through FTA and IOT and an experienced chipset partner allow OEMs to reduce development risks and ultimately time-to-market and development costs.

The need to scale support to multiple HLOS/UIs and modems requires chipset vendors to establish a robust network of specialized third parties. While the chipset vendor provides the protocol stack and generic telephony architecture, APIs and telephony commands, third parties specializing in Symbian OS™/Series 60 Platform, Microsoft® Windows Mobile™ and Linux® are key to accelerate the integration and validation of the telephony with the HLOS and to help OEMs get to market quickly.

Finally, there are several technical challenges associated with the development, integration and validation of HLOS telephony:

Native packet vs. PPP: A new architecture has to be developed to support a native packet interface instead of PPP as a new standard for communication between HLOS and the modem, enabling longer battery life, better system response time and less software overhead.

Large telephony command set: Special test procedures must be created to develop and validate a large set of commands; not only ETSI commands but also custom commands developed in cooperation with major HLOS vendors.

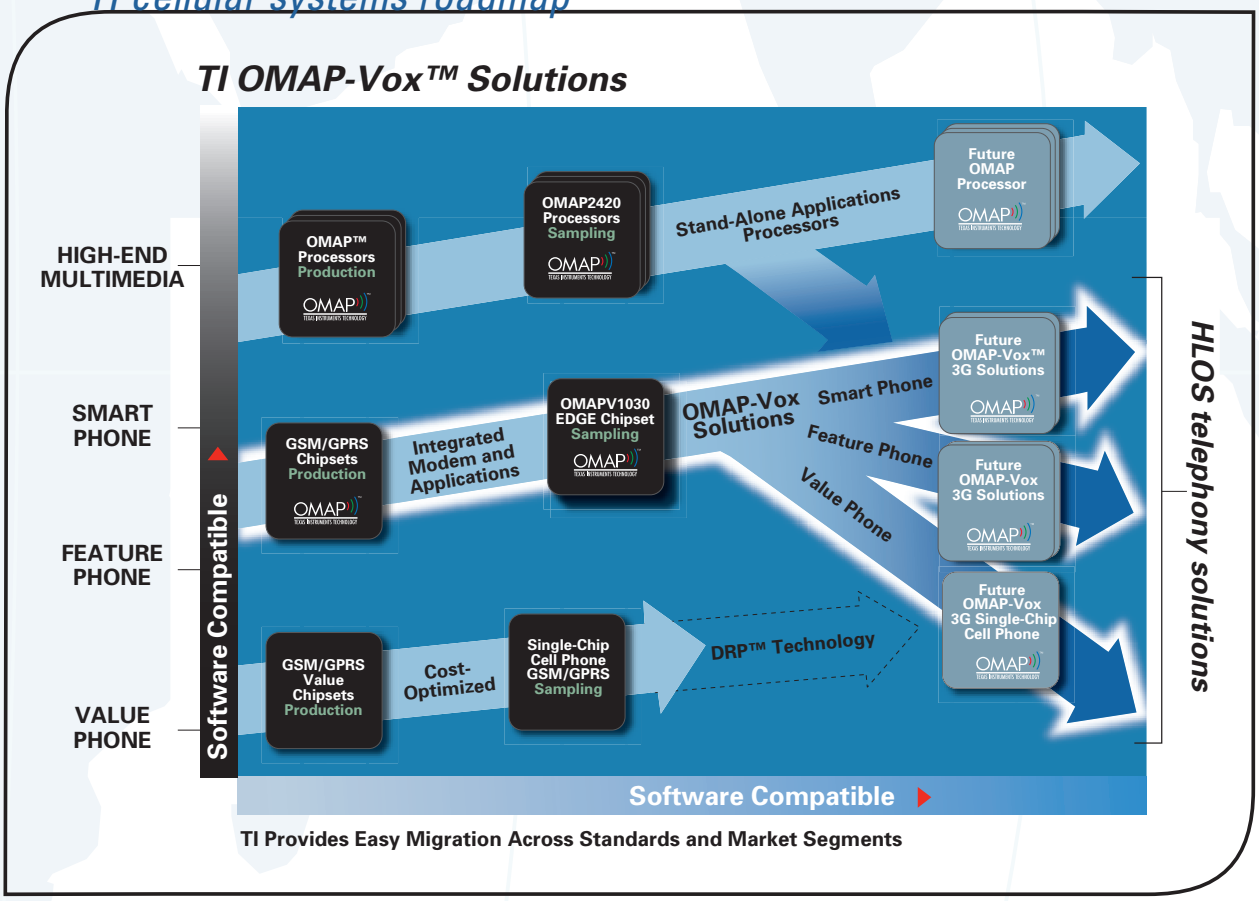
PC connectivity: To allow users to connect their phone to a PC and use the phone to transfer data, a special software interface is required and must be taken into account when developing the telephony.

Multiple data contexts: Support for multiple data contexts with low latency allows support of multiple connections to the network at the same time. For example, a user can download e-mails while watching a movie. This in turn requires specialized software architecture and an inter-domain communication mechanism.

Texas Instruments' HLOS telephony solution

Texas Instruments (TI) was the first chipset vendor to port all major HLOS/UIs to a mobile phone. In addition, TI offers multiple modem technologies and architectures. As a result, TI has accumulated unmatched experience in the development, integration and validation of HLOS telephony. TI has developed close relationships with multiple HLOS/UI vendors, including Symbian®, Nokia, Microsoft®, ChinaMobileSoft, PalmSource, Trolltech and Savaje. Many of these vendors now use TI reference designs and telephony as their standard development environment. TI has also built an extensive network of specialized partners, including Atelier, Digia, Teleca, Elektrobit and Hampex, with expertise in all aspects of HLOS and telephony development, integration and validation.

TI cellular systems roadmap



TI Provides Easy Migration Across Standards and Market Segments

TI's HLOS telephony has been architected to be compatible and easily portable across different HLOS/UIs and multiple modems. TI also works closely with HLOS vendors to maintain a stable and backward-compatible telephony interface.

TI's HLOS telephony is also scalable across different market segments, from the high-end to the mainstream. Its architecture is compatible with different phone architectures, allowing HLOS to run either on a dedicated core or on a core that is shared with the protocol stack.

TI HLOS telephony is based on standard native packet communication protocol and standard telephony commands. The adoption of a native packet interface allows the applications processor to view the modem like a network card, minimizing software complexity and power consumption by removing one layer of software necessary with PPP-based solutions. The use of standard telephony commands reduces development and validation time as well as costs while enabling efficient reuse across multiple HLOS/UIs and modems.

TI HLOS telephony provides a unique and comprehensive set of features:

Application control interface (ACI): TI's ACI is the portion of the telephony software that interprets the telephony commands and maintains an internal state through a complex state machine. The ACI supports all telephony commands in a consistent and predictable way with one interface across different modem technologies.

Support for all telephony command formats: TI's HLOS telephony supports all telephony command formats, both function-based, which allows low overhead binary interface, and text-based telephony commands.

Inter-domain communication: This is a software module complementary to the ACI that abstracts the modem hardware architecture, allowing portability of telephony across different modem technologies and architectures.

SIM toolkit: The SIM toolkit is an ETSI functionality enabled by TI HLOS telephony to allow the operators to customize the phone. In order to fully support SIM toolkit with all HLOS, TI has added several custom commands.

Native packet-based telephony: TI's HLOS telephony is based on a native packet interface communication protocol that reduces software overhead and improves response time and "always on" user experience. TI supports HLOS on all OMAP™ applications processors and OMAP-Vox™ chipsets.

Conclusion

As operators deploy 3G networks, HLOS represents the most efficient way to meet users' expectations for compelling applications while leveraging increased handset processing power. Standard, stable HLOS APIs, UIs, development tools and a large developers' network enable reduced time-to-market and development costs, while creating economies of scale for operators in the development and deployment of applications.

One of the key challenges in the development of a 3G smartphone is the development, integration and validation of the telephony. To minimize the risks, costs and time associated with the development of HLOS telephony, OEMs need to partner with a chipset vendor that has extensive expertise in HLOS porting, protocol stack and telephony development and validation, and wireless system integration.

TI was the first chipset vendor to offer all major HLOS (Symbian OS/Series 60 Platform, Microsoft Windows Mobile and Linux) on a mobile phone. As a result, TI has accumulated the most expertise in this market. In addition, TI has developed close relationships with all HLOS vendors and built an extensive network of specialized system integrators skilled in all aspects of HLOS porting and integration, including telephony adaptation and validation.

Finally, TI has developed a telephony architecture that allows efficient support for multiple HLOS/UIs and modem technologies/architectures. TI OMAP™ applications processors and OMAP-Vox™ chipsets bring the benefits of HLOS to 3G wireless phones, enabling operators to increase ARPU and lower applications-related costs and for users to experience new compelling services and usage models.

For more information

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