

Symbian OS Version 7.0s

Functional description

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Summary

Symbian OS is the open, standard operating system licensed by the world's leading mobile phone manufacturers. It is designed for the specific requirements of data-enabled 2G, 2.5G and 3G mobile phones. Symbian OS includes a robust multi-tasking kernel, integrated telephony support, communications protocols, data management, advanced graphics support, a low-level graphical user interface framework and a variety of application engines.

This paper gives a detailed overview of features and functionality available in Symbian OS Version 7.0s.

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1 Introduction

Symbian OS is the operating system licensed by the world's leading mobile phone manufacturers. Symbian OS is designed for the specific requirements of open, data-enabled 2G, 2.5G and 3G mobile phones. Symbian OS is already available in the Ericsson R380, Sony-Ericsson P800, the Nokia 9200 Communicator series, Nokia 7650, Nokia 3650, NTT DoCoMo F2051, Psion's PDAs, and soon in the Nokia N-Gage, Siemens SX1, BenQ P30 and Samsung SGH-D700. With the introduction of Symbian OS v7.0s, the range of mobile phones with Symbian OS will expand even further, beginning with the Nokia 6600.

Symbian OS is characterised by:

- **Integrated multimode mobile telephony** – Symbian OS integrates the power of computing with mobile telephony, bringing advanced data services to the mass market
- **Open application environment** – Symbian OS enables mobile phones to be a platform for deployment of applications and services (programs and content) developed in a wide range of languages and content formats
- **Open standards and interoperability** – With a flexible and modular implementation, Symbian OS provides a core set of application programming interfaces (APIs) and technologies that is shared by all Symbian OS phones. Key industry standards are supported
- **Multi-tasking** – Symbian OS is based on a micro kernel architecture and implements full multi-tasking and threading. System services such as telephony, networking middleware and application engines all run in their own processes
- **Fully Object-oriented and component based** – The operating system has been designed from the ground up with mobile devices in mind, using advanced OO techniques, leading to a flexible component based architecture
- **Flexible user interface design** – By enabling flexible graphical user interface design on Symbian OS, Symbian is fostering innovation and is able to offer choice to manufacturers, carriers, enterprises and end-users. Using the same core operating system in different designs also eases application porting for third party developers
- **Robustness** – Symbian OS maintains instant access to user data. It ensures the integrity of data, even in the presence of unreliable communication and shortage of resources such as memory, storage and power

This diagram provides a general overview of the operating system:

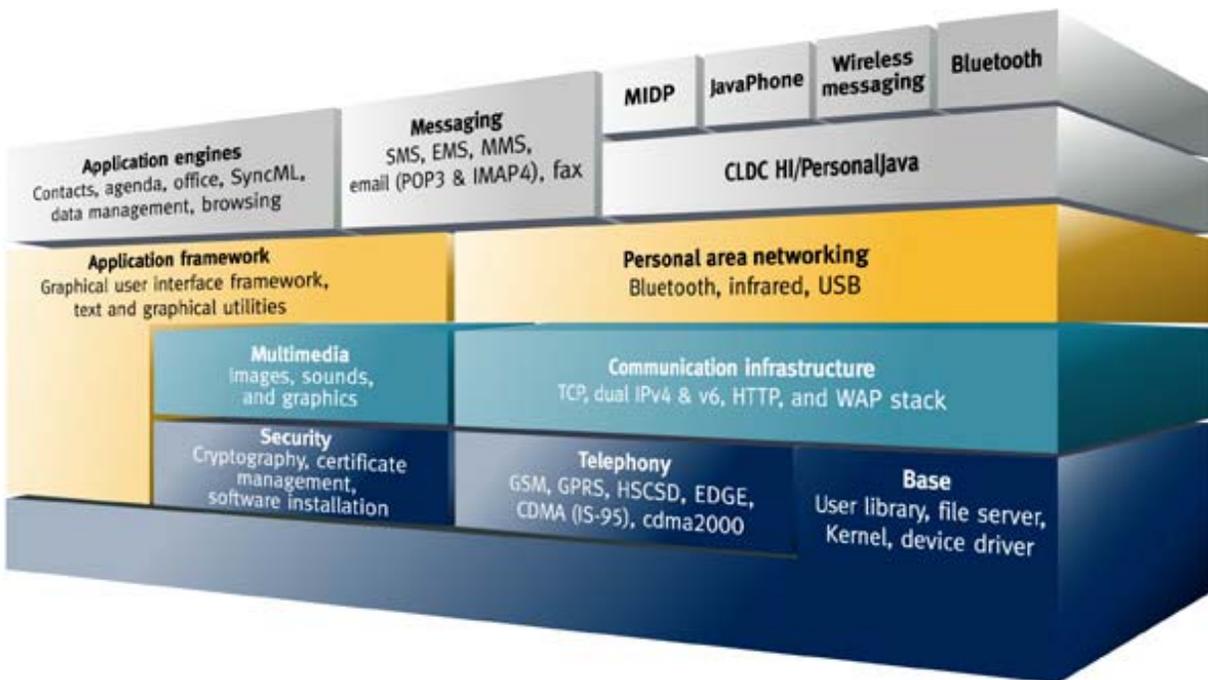


Figure 1 – Symbian OS v7.0s Architecture

2 Key Features of Symbian OS v7.0s

Symbian OS provides a rich core of application programming interfaces that are common to all Symbian OS phones. Key features of Symbian OS v7.0s are:

- **Rich suite of application engines** – the suite includes engines for contacts, schedule, messaging, browsing, utility and system control; OBEX for exchanging objects such as appointments (using the industry standard vCalendar) and business cards (vCard); integrated APIs for data management, text, clipboard and graphics.
- **Browsing** – a WAP stack is provided with support for WAP 1.2.1 for mobile browsing
- **Messaging** – multimedia messaging (MMS), enhanced messaging (EMS) and SMS; internet mail using POP3, IMAP4, SMTP and MHTML; attachments; fax
- **Multimedia** – audio and video support for recording, playback and streaming; image conversion
- **Graphics** – direct access to screen and keyboard for high performance; graphics accelerator API
- **Communications protocols** – wide-area networking stacks including TCP/IP (dual mode IPv4/v6) and WAP, personal area networking support include infrared (IrDA), Bluetooth and USB; support is also provided for multihoming capabilities and link layer Quality-of-Service (QoS) on GPRS/UMTS networks.
- **Mobile telephony** – Symbian OS v7.0s is ready for the 3G market with support for GSM circuit switched voice and data (CSD and EDGE ECSD) and packet-based data (GPRS and EDGE EGPRS); CDMA circuit switched voice, data and packet-based data (IS-95, cdma2000 1x, and WCDMA); SIM, RUIM and UICC Toolkit; Other standards can be implemented by licensees through extensible APIs of the telephony subsystem.

- **International support** – conforms to the Unicode Standard version 3.0
- **Data synchronization** – over-the-air (OTA) synchronization support using SyncML; PC-based synchronization over serial, Bluetooth, Infrared and USB; a PC Connectivity framework providing the ability to transfer files and synchronize PIM data.
- **Security** – full encryption and certificate management, secure protocols (HTTPS, WTLS and SSL and TLS), WIM framework and certificate-based application installation
- **Developing for Symbian OS** – content development options include: C++, Java (J2ME) MIDP 2.0 and PersonalJava 1.1.1a (with JavaPhone 1.0 option), and WAP; tools are available for building C++ and Java applications and ROMs with support for on-target debugging
- **User Inputs** – generic input mechanism supporting full keyboard, 0-9*# (numeric mobile phone keypad), voice, handwriting recognition and predictive text input

2.1 New in Symbian OS v7.0s

Symbian OS v7.0s provides new functionality providing a fit-for-purpose platform for the 3G market and enabling the OS for 3GPP compliance, enabling the delivery of 3G services.

The major new features of Symbian OS v7.0s are:

- lightweight multi-threaded multimedia framework
- support for W-CDMA
- Java MIDP 2.0, Bluetooth 1.1 and Wireless Messaging 1.0 profiles
- support for multiple primary/secondary PDP contexts
- support for bi-directional text (Thai, Arabic and Hebrew)

3 Telephony

The Telephony subsystem provides a multimode API to its clients. The abstract cellular networks include GSM, GPRS, EDGE, CDMA (IS-95) and 3GPP2 cdma2000 1x (Release A) and is ready for 3GPP W-CDMA making it easier for handset manufacturers to port Symbian OS from one mobile phone standard to another. The multimode telephony abstraction is key in Symbian OS to providing integration with the rest of the operating system to enable creation of advanced data services.

Functionality common to all networks includes:

- phone and network information: retrieve signal and battery strengths, provide access to the network names detected by the phone, information about the current network, receive notifications when there are network registration changes and retrieve the phone identity information
- phonebook: read, write, search and delete access to the phonebook storage areas of the phone and SIM (GSM 11.11) or R-UIM (cdma2000 1x) or UICC(W-CDMA)
- both one-box and two-box configurations are supported
- phonebook synchronizer: mechanism to synchronize phonebook entries stored on a SIM or R-UIM card to the contact database so that clients can access all contact data via the contacts model API

3.1 GSM/EDGE telephony

Support for GSM, GPRS and EDGE conforms to the 3GPP GSM Phase 2+ (releases R97/98).

3.1.1 GSM

The GSM telephony framework provides an abstract telephony interface for GSM voice, data and fax, and for landline modems for data and fax as well as phone number resolution and SIM Application Toolkit. Main features are:

- voice calls: initiate, terminate and answer voice calls
- circuit-switched data calls: initiate, terminate and answer data calls including HSCSD. Pass the control of serial port to communication protocols to stream data
- the abstraction supports a wide variety of ETSI GSM phase 2+ functionality
- GSM phase 2+ SIM Application Toolkit, Class 3 (ETSI 11.14 R98), with the exception of class 'a' and class 'b'
- supplementary services supported include: Alternative Line Service (ALS), Alternating Call Services (between voice and data, and voice and fax), retrieve NITZ time information, call forwarding, call waiting, call barring, Called/Calling Party Identity Presentation (CLIP) and Restriction (CLIR), setting up Closed User Group (CUG) call, User-User signalling (UUS), conference call, charging information, message waiting identification, network service requests (USSD)

3.1.2 GPRS

The General Packet Radio Service (GPRS) framework provides an abstract telephony interface for GPRS class B functionality. GPRS Release 97/98, Release 99 (GPRS and UMTS) and Release 4 (UMTS) packet services as well as CDMA/CDMA2000 are the specifications implemented. With class B functionality, phones are able to make and receive GSM calls while simultaneously remaining registered with GPRS. If a Packet Data Protocol context is active, GPRS services are automatically suspended and resumed. The main features are:

- attachment and detachment from the GPRS network
- activation and deactivation of a Packet Data Protocol (PDP) context for data transfer
- ability to activate and deactivate the PDP context automatically with no explicit client intervention
- ability to automatically suspend a GPRS data connection when an incoming or outgoing GSM voice call is made, and to resume a suspended GPRS data connection on notification from the GPRS network
- information and notification service to the client software of network information such as GPRS capabilities, current GPRS network availability, change in the current state of a GPRS connection and general PDP contexts parameters

3.1.3 EDGE

The Enhanced Data-rates for Global Evolution (EDGE) framework provides an abstract telephony interface for 3GPP GSM/EDGE. In addition to supporting the GSM and GPRS functionality described above, main features are:

- supports EDGE enhanced CSD (ECSD)
- supports EDGE enhanced GPRS (EGPRS)

3.2 CDMA telephony

3.2.1 CDMA (IS-95)

The CDMA telephony framework provides an abstract telephony interface for CDMA (IS-95) voice, data (circuit- and packet-switched) and fax. Main features are:

- voice calls: initiate, terminate and answer voice calls
- circuit-switched data: support for service options: asynchronous data and fax for both rate Set 1 and rate Set 2
- packet-switched data: support for service options: CDPD for both rate Set 1 and rate Set 2
- text messaging (SMS): SMS support is provided by an abstraction of the interface between the SMS teleservice layer and the SMS transport layer (IS-637)
- operation in AMPS (Voice only) networks
- forward compatibility with cdma2000 networks
- single stack Quick Net Connect (QNC): packet data service that runs on top of a circuit switched connection, typically at a rate of 14.4 Kbps. This service enables fast set-up of a direct connection to the Internet
- supplementary services supported include: set preferred band class operation (band class A only/preferred, or band class B only/preferred), set preferred network operation (digital only/preferred or analog only/preferred), call forwarding, call waiting, Called/Calling Party Identity Presentation (CLIP) and Restriction (CLIR), conference call, message waiting identification, network service requests

3.2.2 cdma2000 1x

The 3GPP2 cdma2000 1x telephony framework provides an abstract telephony interface for 3GPP2 cdma2000 1x (Release A) voice, data (circuit- and packet-switched) and fax. In addition to the functionality of CDMA (IS-95) described above, main features are:

- circuit-switched data: support for IS-95B services
- packet-switched data: support for IS-95B services plus service options 22-29, 33, 34 for high speed packet data
- Removable-User Identity Module (R-UIM): support access to R-UIM files such as phonebook entries and stored SMS messages
- phonebook synchronizer: mechanism to synchronize phonebook entries stored on a SIM or R-UIM card to the contact database so that clients can access all contact data via the contacts model API

3.2.3 W-CDMA 3GPP R99/R4

The WCDMA telephony framework provides an abstract telephony interface for voice, data (circuit- and packet-switched) and fax.

Main features are:

- UICC (USIM Integrated Circuit Card): support access to UICC phonebook and UICC security. Supports the new USIM phonebook entry fields: index up to two name tags per entry multiple phone numbers multiple email addresses user defined grouping hidden entry flag
- Supports USIM Application functionality
- QoS framework and QoS API
- The Toolkit API provides support for the R99 and R4 USAT commands.
- Support for Multimedia calls
- WMA/SMS Adapter
- Support for Multicall Service

4 Communication infrastructure

The Comms Infrastructure subsystem provides the key frameworks and system services for communications and networking. This includes:

- a communications database manager which controls the system-wide communications configuration
- a socket server and client-side API which provides a framework for implementing various communications protocols through a socket interface. Plug-in protocols are dynamically loaded.
- multi-homing support: multiple simultaneous OSI Level datalink interfaces, each with its own unique IP address. This is not limited to Primary PDP contexts but enables multiple access technologies to be provided such as WLAN, BNEP and Ethernet along with multiple PDP contexts
- a network interface manager which provides a framework for connection to other computers or networks. The manager provides a mechanism for the client to monitor progress over e.g., a PPP connection
- a serial communications server provides a serial port (RS232C) abstraction to allow Symbian OS phones to function as a DCE and a DTE as required. Dynamically loadable plug-in communications modules are used to actually communicate with device drivers and other protocol stacks.
- HTTP and WAP stacks

4.1 Networking

A dual stack is provided that supports both IPv4 and IPv6. The IP stack provides a plug-in architecture allowing licensees or ISVs to implement extensions. An important plug-in delivered is IPsec, for secure communications. See Appendix A for the list of supported RFCs.

Networking support in Symbian OS includes:

- Transmission Control Protocol (TCP)
- User Datagram Protocol (UDP)
- IPv4/v6 stack. The TCP/IP stack provides a plug-in architecture. Plug-ins can interact with OSI level 2, 3 and 4 components and can be installed, loaded and unloaded at runtime. IP-based Symbian OS clients such as email, HTTP, SSL, Java MIDP, SyncML over HTTP and web can use IPv6 addressing as well as IPv4 addressing:
- Internet Control Message Protocol (ICMP)
- Point to Point Protocol (PPP)
- Domain Name System (DNS)
- dial up networking support
- security protocols for secure electronic commerce: Transport Layer Security (TLS) and Secure Sockets Layer (SSL)
- IPsec: IP layer protocol used to secure host-to-host or firewall-to-firewall communication. IPsec is a plug-in module to the IP stack providing tunnelling, authentication and encryption for both IPv4 and IPv6. VPN clients based on IPsec will be commercially available from Symbian partners
- Telnet Protocol engine
- File Transfer Protocol (FTP) engine
- Ethernet support: wired interface (PCMCIA cards for WINS and on-board Ethernet chip for development board) supports 10BaseT and 100BaseTX in full or half duplex; Wireless interface (IrLAN); Support for Slow IR.

4.2 HTTP transport framework

Symbian OS 7.0s provides a generalized framework for Internet applications to use HTTP like protocols. The framework presents a unified, high level API that is independent of particular header representations, specific protocol details or the underlying transport layer. This framework is used as the interface to HTTP and WSP protocols.

The framework allows for extension and customization at an application or platform level by the use of filter plug-ins.

4.2.1 HTTP Client Stack

HTTP 1.0 and 1.1 Client stack with support for persistent connections, pipelining, and chunked transfer encoding.

Filters provided to support HTTP Redirection and HTTP Basic and Digest Authentication

Enables applications such as SyncML, OCSP, Web Based Application Installation. This stack can also be used by Third Parties for applications such as Web Browsing.

4.3 Multihoming

Multihoming is required for any scenario in which the terminal is a host on more than one network, for instance to provide Multiple Primary PDP Contexts, simultaneous GPRS/Ethernet; support for desktop PC connectivity.

Symbian OS 7.0s provides full multihoming support - multiple simultaneous OSI Level 2 datalink interfaces, each with its own unique IP address. Only available system resources limit the number of simultaneous interfaces. It is possible to load and unload network interfaces dynamically, without requiring a restart of the TCP/IP stack. Multiple IAPs can be active, and applications can specify which ones they will use.

Support also exists to allow applications to specify QoS parameters on GPRS/UMTS networks supporting Secondary PDP Contexts.

4.4 WAP stack

The WAP stack subsystem includes support for WAP 1.2.1 (WAP June 2000), push functionality and GPRS as a bearer. The WAP stack supports protocol specifications version 1.1 and 1.2.1 class C of the WAP Forum in connection-oriented mode. The WAP stack supports the following bearers: GSM CSD, GPRS UDP, CDMA and cdma2000 1x for connection-oriented browsing, GSM CSD, GPRS UDP, GSM SMS and GPRS SMS for connectionless push. The WAP 1.2.1 compliant communications stack, with interfaces to each of the layers of the protocol stack, has the following layers:

- WSP, session protocol for WAP
- WTP, transaction protocol for WAP
- WTLS, transport layer security protocol for WAP
- WDP, datagram protocol for WAP, client and server
- a WAP push watcher which listens for secure and non-secure push messages received using connectionless mode over all supported bearers (both GSM & GPRS are supported). Incoming push messages are identified by an application-id in the message header and handled by plug-in DLLs (a handler for the WML User Agent is provided). The WML User Agent handler identifies the content of the message by the MIME type specified in the header

5 Messaging

The messaging framework provides support for messaging protocols for sending and receiving of text messages (SMS), enhanced messages (EMS), multimedia messages (MMS), email and fax messages. The framework uses polymorphic Message Type Modules (MTMs) to handle specific types of message. MTMs can be added at run-time to expand the messaging capabilities of Symbian OS phones after market.

A “Send-As” API enables the creation of messages (email, fax, SMS, EMS or MMS) straight from any other application. For example, application-specific data such as vCards can be sent directly from Contacts applications.

Main features of Messaging are:

5.1 Bearer Independent Object Messaging

Bearer Independent Object (BIO) Messaging allows application to application communication of arbitrary data types between devices. BIO messaging uses a watcher framework to support messages sent over-the-air to the operating system or application rather than to the end-user, for instance via SMS, MMS and email.

BIO message types currently supported include compact business card, vCard, vCalendar, email notification, operator logo, ring tone, and settings for internet access, MMS and WAP. The framework is open, allowing third parties to add further capabilities and value at run-time.

The vCard and vCalendar BIO message file types are also supported over infrared and Bluetooth links.

5.2 Short Message Service (SMS)

SMS support consists of an SMS stack with a messaging API to send and receive SMS and provides the following features:

- the SMS stack is implemented as a plug-in protocol. The GSM (03.40) SMS protocol is provided
- the GSM SMS stack can be used as a bearer for the WAP protocol module
- transmission and reception of GPRS SMS
- SMS: send and receive streamed SMS messages. Enumerate, read, write and delete access to the SMS storage areas of the phone and SIM. Receive messages that match a specified text
- 7-bit SMS alphabet, 8-bit SMS alphabet and UCS2 data coding schemes are supported
- supports sending and receiving concatenated SMS messages
- scheduled sending: on a specific date/time, “now” or upon request. Specify and review scheduled actions

5.3 Enhanced Messaging Service (EMS)

EMS support in Symbian OS is compliant with 3GPP release 4 (TS 23.040) and supports the following features:

- mobile originated pictures: variable picture, pre-defined picture: 16 x 16, pre-defined picture: 32 x 32
- mobile terminated pictures: variable pictures (1024x1 to 8x128), small pictures 16 x 16 and large pictures 32 x 32
- animations: pre-defined animations (multiple separate animations), black & white animations and mobile terminated user-defined animation
- Sounds: iMelody
- formatting: both mobile originated and terminated formatting, text size (small, medium, large), text style (bold, underline, strikethrough, italic) and message alignment (left, center, right)

5.4 Multimedia Messaging Service (MMS)

MMS operates over CSD and GPRS and provides the following features:

- both WSP and HTTP transports are supported. Messages are received over WSP Get or HTTP Get, and sent using WSP Post or HTTP Post
- message notification is received over WAP 1.2.1 Push or over HTTP by a similar push mechanism
- parameters supported include: Message-Type, MMS-Version, Date, From, To, Cc, Bcc, Subject, Message-Class (only personal), Expiry, Priority, Delivery-Report, Content-Type, Response-Status and Response-Text
- both Internet and MSISDN addressing are supported, including mixed addressing
- message presentation is through SMIL 3GPP R5 (PSS 5). It is also possible to receive messages based on SMIL 1.0

5.5 Email

Email has the following main features:

- Internet mail: supports disconnected mode, cache management, single operation get-new-mail for both POP3 and IMAP4, SMTP client enhancements (copy-to-self, separate emails for Bcc: send email for specific SMTP servers via specific ISP accounts, multiple SMTP connections with multiple send sessions), UUE and MIME, MHTML, automatic receipt notification, automatic MIME character set conversion, automatic email signature (or vCard). Character set conversion takes place during sending or receiving messages
- Internet access points (IAP): connection over GPRS is supported as well as over GSM CSD. Multiple IAPs, both GPRS and GSM CSD, can be associated with each email MTM to specify whether the default preferred connection or a specific connection should be used.
- secure socket connections: facility to establish a TLS socket connection to email servers

5.6 Fax

The fax system interfaces to the messaging fax components at its upper boundary and to fax devices at its lower boundary. Fax supports the following features:

- fax class 1, 2 and 2.0 (ANSI/TIA/EIA 578 and ANSI/TIA/EIA 592), conforms to the ITU T.30 specification
- multiple recipient outgoing faxes
- ITU T.4 1D and 2D-encoding
- scheduling of sending: on a specific date, now or upon request. Specify and review scheduled actions

6 Multimedia

6.1 Multimedia framework

The Multimedia Framework (MMF) provides a lightweight, multi-threaded framework for handling multimedia data. The framework provides audio recording and playback, audio streaming and image related functionality. Support is provided for video recording, playback and streaming. The framework allows developers to write efficient and powerful plug-ins.

The main features are:

- generic multimedia plug-in system: plug-ins can be written using abstract and concrete classes that represent actual resources and abstract components. Concrete classes include files, descriptors, sockets, audio i/o, and video i/o
- the audio framework provides commonly used functionality including audio playback, audio recording, audio streaming and audio conversion, formats supported include WAV, AU, RAW (in various formats), PCM, uLaw, aLaw, GSM6.10 etc.; a codec API is provided and the framework supports codec plug-ins.
- audio Controller plug-in; file, descriptor and microphone source plug-ins, and file, descriptor and speaker sink plug-ins
- sound device abstraction and arbitration
- video playback/recording/telephony framework
- MIDI client API
- concurrent processing of multiple multimedia data streams

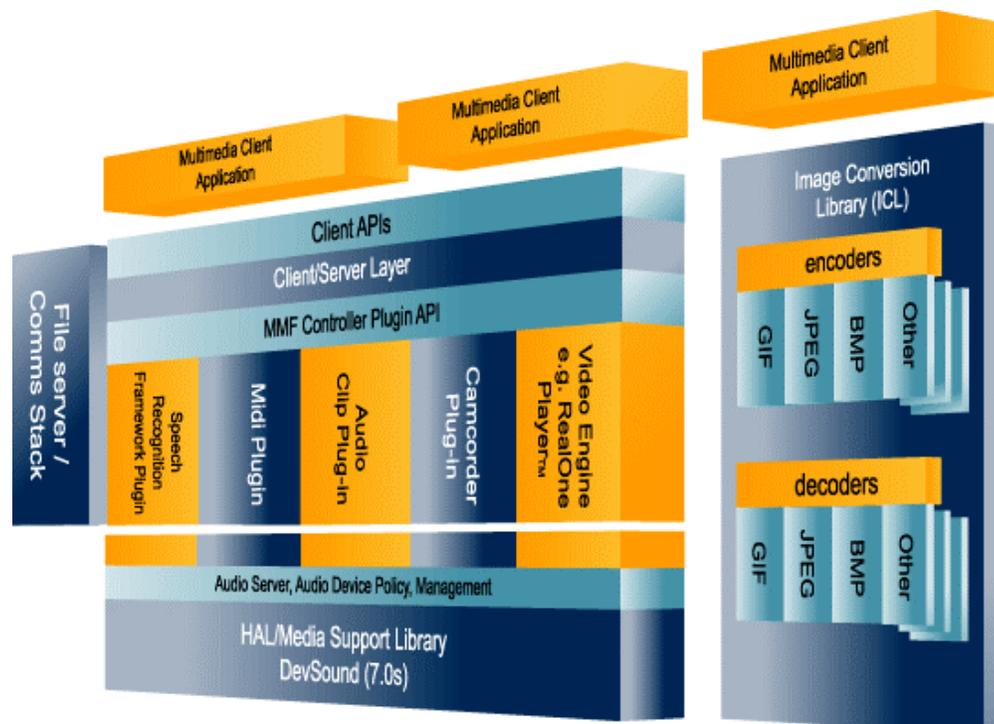


Figure 2 – Multimedia Symbian OS v7.0s

6.2 Image Conversion Library (ICL)

The image conversion library is a lightweight, optionally multithreaded, client-side framework for still image codecs and conversion; Plug-ins supplied by Symbian include JPEG, GIF, BMP, MBM, SMS, WBMP, PNG, TIFF, WMF and ICO.

Third party plug-ins are enabled through the extensible nature of the framework.

6.3 Camera support

An onboard camera API providing a consistent interface to basic camera functions.

7 Graphics

The graphics subsystem provides Symbian OS applications with shared access to the screen, keyboard and pointing devices input, bitmap fonts and scalable fonts (provided through the Open Font System), and bitmaps by using a shared heap. It also implements the Graphics Device Interface (GDI), providing a generic framework for drawing to any graphics device, and supplies concrete implementations for drawing to windows, bitmaps or to a printer.

Main features are:

- direct screen access: the window server allows video (as in any visual content or graphics) to be safely rendered from hardware or a device driver
- anti-aliasing support for text on all types of displays (monochrome, color, color using palette, etc) to improve readability
- 2D Hardware Abstraction Layer (HAL) that provides hardware accelerator support for common 2D graphics operations including BitBlit operations, rectangle fill, polygon drawing, rectangle invert and rectangle fade operations

8 Application Engines

The core application engines include agenda (schedule), to-do, contacts, spreadsheet, alarm and world servers and the help engine.

Main features are:

- agenda engine: provides client-server shared access; vCalendar support with send and receive functionality; synchronization with PIM applications using Symbian Connect
- to-do engine: integrated with the agenda engine for storing agenda type entries
- contacts model: provides a generic client-server shared access contacts database engine, integrates with messaging application for emails, faxes and SMSs, caller number matching receive a vCard (supports Versit vCard 2.1 standard), group support, support for multiple templates, support for extensible field types, current item support, connectivity requirements, searching and filtering by contact item type
- sheet engine: spreadsheet support for multiple worksheets, rich text formatting for cells, borders and shading, many general, scientific, financial and statistical functions, formula evaluation and charts, added a power function
- chart engine: renders the graphics for a chart view of a spreadsheet application
- help engine: context sensitive help engine consisting of four parts, a launching mechanism, the model (which describes the database to its clients), the SQL search engine (capable of relational-like searches across all the tables in the database), and incremental facilities for use by the PC-based help file authoring system client
- clipboard support for multiple media types (sound, images, etc.)
- data application engine: the engine for a free-form database application
- word application engine: the engine for a word processor application
- text to Symbian OS Word converter: provides conversion between plain text and a Symbian OS Word model stream, and back again

8.1 SyncML client

The SyncML DS (Data Sync) client is compliant to the SyncML DS 1.01 specification. The SyncML client has some very useful features:

- the SyncML DS client can be localized for non-English devices.
- database Adapter (DBA): provides a generic interface which de-couples the SyncML DS engine from the data being synchronized. The engine can extract and exchange data with the database without having to know what the data is.
- transport API (TAPI): this provides a common generic API to the Sync Client Engine so that it is able to initiate connections, send and receive data etc. in a manner that is independent of the underlying transport protocol and transport media used. An HTTP TPA is provided
- a contacts DBA and an agenda DBA are provided to allow contacts and schedule synchronization respectively
- database and transport adapters are plug-ins so that additional ones can easily be written and installed

9 Application framework

The Application framework subsystem provides a powerful environment for licensees and partners to create differentiated user interfaces while enabling applications written in C++ and Java, by Symbian, licensees, partners and third parties to run seamlessly on open Symbian OS phones. This subsystem is architecturally central to the support of graphical user interface (GUI) applications. It includes a number of system-wide plug-in mechanisms for instantiating components at run-time, powerful reusable libraries for data, graphics and text support.

Main features of the application architecture:

- runs applications as separate processes
- associates a document with its application with the appropriate application icon
- provides a data-type recognition framework (MIME-types and others)
- supports object embedding
- provides a generic error mechanism
- provides a notification framework
- a plug-in recognizer framework which locates all installed applications and associates application documents with them
- Internationalization support

9.1 Graphical user interface (GUI) framework

A principal objective of the graphical user interface (GUI) framework is to define as little policy as possible and therefore minimize the constraints placed on a product's UI designer. This eases the porting of the user interface of applications between different Symbian OS phones.

Main features of the GUI framework:

- an event-driven GUI and widget architecture

- a windowing system for sharing screen, keyboard and pointer between applications; clocks and animated bitmaps, and a control framework for sharing an application window between application components
- direct navigation link (DNL) system enables close task-based integration between applications
- a mechanism for the licensee to customize the look and feel (LAF) of the GUI.
- a plug-in mechanism for the user to input non-standard data (e.g., for ideogram input or voice recognition for phones that may not have a keyboard)
- control factory structure allows the framework to be extended by multiple applications
- a notifier framework allowing system events and alarms to be handled more flexibly by the GUI
- a flexible screen indicator and status bar framework
- runtime changeable color schemes
- bitmap animation performed in the Window Server thread

9.2 Application support services

The application services are composed of components, primarily used by application engines, that provide core services:

- task scheduler: schedules launching of applications or initiation of specific application features. The task scheduler intercepts the return value of the application when it closes and interprets this value to determine if the application has exited with an error. If an error condition is detected, it is logged to the log engine
- system agent: a general repository for system wide dynamic state information. Typically it contains knowledge about communications related states, such as telephony signal strength, battery state, etc.
- log engine: recording the use of any on-board devices (especially the phone)
- alarm server: alarm persistence, sound playing
- world server: country codes, world country and city information database
- calendar conversion between the Gregorian and the Chinese calendars
- support for Eastern-Asian character sets in vCard and vCalendar
- onboard converters reference implementation for converters between Symbian OS and Windows (Microsoft Word and Excel 95, 97 & 2000) formats for spreadsheet and word documents, and between Rich Text and HTML. Conversions may be lossy: round-trip integrity is not guaranteed, however the text content is maintained

9.3 Internationalization support

The main internationalization features are:

- conforms to the Unicode Standard version 3.0
- a framework to support European, Chinese, Arabic, Hebrew, Thai and Japanese locales
- a front-end processor (FEP) framework for text input using handwriting recognition or keyboard to enable input of far eastern ideographic characters. FEPs can take the form of a floating window, or a “transparent window”, or be invisible. They can also interact closely with their target controls, e.g. to do “inline editing”

- conversion between Unicode and other character sets, via a plug-in mechanism.
- Support for rendering and editing bi-directional text; Support for drawing bi-directional text to graphics objects

The character sets that are implemented are:

- General: UTF-7, UTF-8, modified UTF-7 (required by IMAP), modified UTF-8, 7 bit SMS (also known as 7-bit GSM), Code Page 1252, and ISO 8859-1
- reference implementations for JIS, EUC-JP (Packed), ISO 2022-JP, and ISO 2022-JP 1
- character set conversion support for NTT DoCoMo pictographs
- partial auto-detection of character set encoding, in that when given a specific text item various heuristics are used to find the most suitable converter
- support for static multi-lingual ROM, changes are put into effect after a re-boot of the phone

9.4 Various text and graphical utilities

Main other Application Framework features and utilities:

- rich text rendering for various locales, providing a text model with character and paragraph formatting, embedded graphics, and a text view which supports efficient formatting, display and interaction
- two multi-level undo/redo capabilities: a plain text undo system that can undo text insertion, deletion and clipboard operations, and a rich text undo system that can cope with anything a rich text object can do, including embedded objects
- generic support for plug-in parsers that recognize certain strings, eg URLs, email addresses, phone numbers. This enables to run services or applications from any application in the system
- support for PC-style changeable color schemes in editable text and for auto-sizing text editors
- background images: arbitrary graphics can be drawn behind text, with control of parameters like transparency and background scrolling

10 PAN connectivity

Personal Area Networking connectivity is available through support of Bluetooth, serial, USB, infrared (IrDA) and Ethernet devices.

Bluetooth support is provided with a core Bluetooth 1.1 protocol stack along with full Generic Access Profile (GAP), Generic Object Exchange Profile (GOEP) and Serial Port Profile implementations. The Host Controller Interface (HCI) provides a hardware interface via a UART based reference implementation. The OBEX implementation provides an OBEX v1.2 client and server that operate over Bluetooth and IrDA. The OBEX server also provides USB support.

The development of DUN, LAN, fax, headset, hands free, FTP, basic imaging and object push profiles by third parties is enabled. Security is provided at the application level (i.e. security level 2).

USB class support is provided for the WMCDC WHCM and OBEX class, and for the CDC ACM class. All classes are controlled by a USB Manager component. All USB support is provided ultimately by a USB v1.1 client driver.

The infrared IrDA stack is contained in a socket server protocol module that implements the following IrDA layers: IrLAP v1.1, IrLMP v1.1 and IrTinyTP v1.1. The following features are supported:

- infrared (SIR) supporting throughputs of 9.6 KBPS to 115.2 KBPS
- IrOBEX v1.2 (IrDA object exchange)

- IrTRANP v1.0 digital camera picture infrared transfer protocol
- IrCOMM v1.0 supports fax/modem functionality and is implemented in a serial communications server module

The infrared message type module integrates IrOBEX handling into the messaging framework.

11 Base

The Base subsystem provides the programming framework for all other components of Symbian OS. Base provides an abstraction to facilitate design across multiple platforms and resources making it easier to port Symbian OS to new types of hardware. The Base ensures Symbian OS robustness, performance and efficient power management - all essential in a mobile phone. The main user-visible parts of the base are the user library and the file server.

11.1 Kernel and user library

The kernel runs in privileged mode, owns device drivers, implements the scheduling policy, does power management and allocates memory to itself and user-mode (that is, unprivileged) processes. It runs natively on ARM cores. The kernel implements a message-passing framework for the benefit of user-side servers (such as the networking and telephony stacks and the file system). The user library is the lowest-level user-mode code, which offers library functions to user-mode code, and controlled access to the kernel. Here are the main features:

- process, thread, program and memory management
- error handling and cleanup framework
- descriptors: strings of characters and buffers of binary data
- container classes: arrays and lists
- active objects, for event-driven multi-tasking without requiring the overheads of multi-threading
- client-server architecture, for simple and efficient inter-process communication. The client-server architecture supports both thread-relative and process-relative client resource ownership. The latter is to ease porting of code written for other platforms to Symbian OS, and delivers considerably enhanced Java performance
- a hardware abstraction layer (HAL) presenting a consistent interface to hardware across all devices
- a kernel-side power model, to allow fine-grained power management
- silent running mode: device can operate with screen switched off
- locale support including currency, time and date formatting
- internal and tightly-coupled RAM support
- the kernel can be extended by the use of DLLs (such as device drivers and kernel extensions) that can link dynamically against the kernel

11.2 Target CPU architectures

The following CPU cores are supported:

- ARMv4: StrongARM SA1
- ARMv4T: ARM710T, ARM720T, ARM920T, ARM922T, ARM925T
- ARMv5T: XScale, ARM1020T
- ARMv5TJ: ARM926EJ

- Intel x86 (for the emulator)

11.3 Device Drivers

The Base subsystem provides device drivers and/or software controllers for the following devices:

- DTE serial port
- DCE serial port
- infrared
- HWA (Driver implementing the hardware acceleration API for managing DSP hardware)
- USB client
- PC Cards
- MultiMediaCards (including support for password protected cards)
- SD Memory Cards
- LCD
- Keyboard
- Digitizer

The majority of these are split into a logical layer component implementing the higher layer functionality common to all devices of that device type together with a physical layer component implementing the hardware specific functionality.

11.4 File server

The File server provides shared access to the filing systems, a client-side interface that hides the client-server architecture and a framework for dynamically mounting plug-in file systems, with physical storage of files associated with each filing system.

The ROM filing system is built into the File Server. Two concrete plug-in filing systems are implemented: VFAT and Logging Flash File System (LFFS). Media drivers have been developed to communicate with the following media types: RAM (non-removable), Flash (non-removable), ATA/CF, MultiMediaCard (MMC), SD Memory Card (including both the User and Protected areas of these devices).

Main features:

- file system drivers can be added when required without having to reboot
- clients can register for notification of file-server events, for example, entries changing in given directory, changing disk or disk space crossing a specified threshold
- the VFAT file system supports a 'rugged' mode of operation which provides improved data integrity in machine power loss situations

11.5 Standard library

Base also contains middleware widely used across Symbian OS. Here are the main ones:

- the C standard library
- a relational database access API. Two DBMS implementations are provided: a small and relatively lightweight client-side implementation; and, a client-server implementation for when multiple clients

must have write access to a database. Databases can be manipulated either through a subset of SQL or through a Symbian OS proprietary C++ API

- a stream store that defines two major abstractions: streams (an abstract interface to convert between an object's internal and external representations) and stores (an abstract interface to manipulate a network of streams). Stores allow externalizing and internalizing data structures as complex as whole application documents (e.g., word-processor or spreadsheet documents) or databases. Several implementations are provided for both streams and stores including memory-based and permanent file stores. It is possible to define stackable streams doing pre-processing, for example encryption and decryption streams are provided

12 PC Connectivity

PC-Connectivity toolkit consists of components on the Symbian OS phone and components on a PC, which co-operate to provide connectivity services and enable data synchronization.

12.1 Connection manager

The Connection manager based on Intuwave's m-Router manages connections between a PC and a Symbian OS phone using standard TCP/IP protocols for data transfer. It includes both PC-side and phone-side components. Key features of the Connection manager are:

- abstraction of the bearer from the protocol layer. The Connection manager works over a range of peer to peer bearers. Supported bearers include serial links, infrared and Bluetooth.
- ability to support multiple client applications on the PC. This is achieved by ensuring that all data transfers are atomic operations. The Connection manager can multiplex/de-multiplex data to/from a Symbian OS-side custom server component. In addition, the Connection manager has the ability to broadcast to all its clients changes of connection state
- supports for PC-side 'unify' operation. This permits a selection of tasks to be run at a single click/cradle button press
- support for PC or Symbian OS phone based connection initiation
- detection of unexpected disconnection of a phone and broadcast of disconnection to all clients on the PC. This ensures that all custom servers open on the Symbian OS phone are shutdown
- provision of APIs for the following functionality: engine interface, remote link and device-side custom servers

12.2 Connect toolkit

The PC-Connectivity toolkit has many features, some to offer functionality out of the box, and some to ease the job of developers wanting to plug into the synching architecture:

- framework architecture
- framework UI
- view plug-ins: an engine and a UI component, which plug into the framework UI
- archive application: lists and restores files archived using the backup facility
- task scheduler: carries out a number of regularly scheduled tasks including sync and backup. A 'unify' facility allows a selection of tasks to be run at a single click/cradle button press
- control panel: gives the user access to all the connectivity settings from one place. Individual control panel items are applets that plug into the control panel. These are: connection, log settings, machine manager, and file types

- task drivers: they consist of an engine and property pages, and plug into the task scheduler component
- backup task driver: provides the ability to back up a connected Symbian OS phone to the PC. Backed up files can later be restored using the archives view plug-in
- framework to enable sync components to be integrated

13 Java

The Symbian OS v7.0s implementation provides MIDP 2.0, CLDC 1.0 with Sun's CLDC HI Java VM, Bluetooth 1.0, and Wireless Messaging 1.0. It also includes PersonalJava with the JavaPhone APIs.

With PersonalJava and JavaPhone, mobile phones combine the full power of Java with access to more specialized functionality: the JavaPhone APIs provide access to PIM, messaging, telephony, etc.

J2ME MIDP 2.0 provides developers with increased functionality in a small footprint, and with a programming model more appropriate for wireless development.

13.1 MIDP 2.0 implementation

J2ME CLDC/MIDP2.0 provides a compact Java environment for mobile phones, with a particular emphasis on games support. Symbian's implementation will run the many MIDlets being developed for mobile phones, whilst at the same time allowing MIDlets specifically purposed for Symbian OS to benefit from many features of Symbian devices.

Symbian's implementation is fast, has a tight footprint, and provides an environment that scales smoothly from constrained smartphones to more capable ones. This is achieved by tight integration with the native platform and use of Sun's CLDC HI VM

- supports the OTA recommended practice document for MIDlet installation mandated by the MIDP 2.0 specification
- heap size, code size, and persistent storage are unconstrained, allowing larger, more compelling MIDlets to be run
- MIDlets look and behave very much as native applications: they use the native application installer and launcher, and native UI components
- supports native color depth (4096 colors)
- Generic Connection Framework implementation including sockets, server sockets, datagram sockets, secure sockets, HTTP and HTTPS
- provides debugging support
- implements Bluetooth (excluding push and OBEX)
- implements Wireless messaging

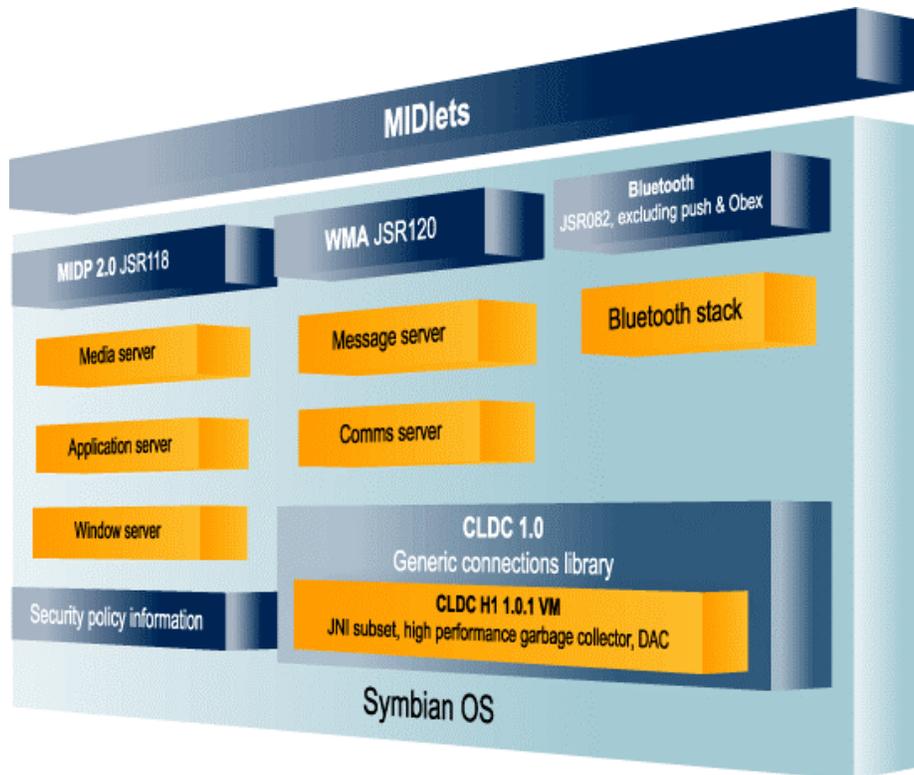


Figure 3 – MIDP 2.0 in Symbian OS v7.0s

13.2 PersonalJava

PersonalJava on Symbian OS implements the 1.1.1a PersonalJava Application Environment specification.

Features include:

- support for Unicode across the Host Porting Interface
- support for ARM JTEK (Jazelle) technology for Java hardware acceleration and ARM VTK (VMA technology kit) for Java software acceleration
- JVMDI for remote debugging (TCP/IP over the serial link)
- Symbian OS SDK for Java tools. Runtime customization tools

13.3 JavaPhone

The JavaPhone component delivers a set of APIs that extend the PersonalJava runtime to access important native functionality including telephony, agenda, contacts, messaging and power monitoring. Symbian OS provides the JavaPhone 1.0 reference implementation.

The following APIs are provided:

- JavaPhone APIs: address book (based on the contacts application engine), calendar (based on the agenda application engine), user profile, network datagram, and power monitor (minimal implementation).
- optional PersonalJava interfaces: serial communications, secure socket communications (HTTPS is supported, javax.net.ssl is not implemented)
- Java Telephony API: JTAPI Core package

- Java Telephony API (mobile): Java Mobile API Core interfaces, MobileProvider, MobileProviderEvent, MobileProviderListener, MobileAddress, MobileTerminal, MobileNetwork, MobileRadio, MobileRadioEvent and MobileRadioListener

14 Security

The security subsystem enables data confidentiality, integrity and authentication by providing underlying support for secure communications protocols such as TLS/SSL, WTLS and IPSec. It also supports the authentication of installable software using digital signatures

14.1 Cryptography module

The cryptography module includes the following significant components:

- cryptography algorithms allowing data to be encrypted and decrypted and supporting symmetric ciphers: DES, 3DES, RC2, RC4 and RC5, and asymmetric ciphers: RSA, DSA and DH
- hash functions: MD5, SHA1 and HMAC
- pseudo-random number generator for generating cryptographic keys

14.2 Cryptographic token framework

The cryptographic token framework enables licensees to integrate support for removable hardware devices, such as WIM modules, in a flexible manner. It consists of two parts:

- a framework which enables application code to query the system for the availability of implementations of specific cryptographic interfaces and their attributes (e.g., whether they are implemented in hardware, whether they are removable, whether they implement their own access control mechanism)
- the definition of a set of cryptographic interfaces. Licensees may supply their own implementations of any of the defined interfaces and these will be picked up by applications using the framework (so for example they may provide a WIM implementation which implements the certificate storage interface, and then certificates stored on the WIM will be visible in the certificate management application and available to the certificate validation module).

The following cryptographic interfaces are defined:

- a read-only certificate storage interface, supporting the retrieval of X.509 and WTLS format certificates, and certificate authority (CA) and user certificates
- a certificate storage interface supporting the retrieval, addition and deletion of X.509 and WTLS format certificates, and CA and user certificates
- a read-only private key storage interface
- an interface to authentication objects (e.g., PINs)
- a standard interface for performing security-critical user interface operations (e.g., PIN entry)

The following implementations of these interfaces are provided:

- an implementation of the read-only certificate storage interface providing access to the WTLS certificates used by the WAP stack supplied in this release
- an implementation of the writeable certificate storage interface providing access to certificates used by all other software (e.g., TLS and Software Install),

- an implementation of an application to manage stored certificates
- a reference implementation of the interface for performing security-critical user interface operations

14.3 Certificate management module

The certificate management module is used for authentication of other entities (e.g. third-party developers, web servers) to the user of the phone, and for authentication of the user of the phone. It supports WTLS certificates (as per the WTLS specification version used for the December 2000 WAP Conformance Release) and X.509 certificates according to the PKIX Certificate Profile (RFC 2459). This module provides the following services:

- storage and retrieval of certificates using the cryptographic token framework
- assignment of trust status to a certificate on an application-by-application basis
- certificate chain construction and validation
- verification of trust of a certificate
- certificate revocation checking using the Online Certificate Status Protocol (OCSP)

14.4 Software installation

The software installation system provides a secure and fast installation process. The installation tool supports:

- installation of C++ executables, including authentication of software components using digital signatures to provide a measure of confidence that applications being installed onto a Symbian OS phone are from a known reputable vendor
- installation of Java MIDP 2.0 MIDlets, including authentication of MIDlets using digital signatures
- installation of Java MIDP 1.0 MIDlets. The MIDP OTA recommended practice document is fully supported
- compression of install packages to reduce disk space and download times. The compression library is a generic shareable DLL which can be called by other applications
- different varieties of phones, allowing the installation package creator to ensure the correct software is installed onto an appropriate phone

15 Software development for device creation

The Symbian OS device creation community builds Symbian OS, device drivers, middleware components, GUI frameworks and applications into Symbian OS phones. This activity is supported with Symbian OS kits, together with hardware and software tools focused on C++ development.

15.1 Symbian OS Kits

Symbian delivers Symbian OS to its licensees and development partners in two products:

- Symbian OS Customization Kit, to enable licensees to quickly integrate their code bases into Symbian OS and support continued development
- Symbian OS Development Kit, a super-SDK supporting all forms of device creation development activity

The Symbian OS kits include:

- virtually all Symbian OS source code

- extensive documentation and examples
- TechView, a GUI framework for testing OS and middleware components.
- the Symbian OS emulator, supporting quick development and debugging of all Symbian OS based code (except kernel or device drivers) on Windows-hosted PCs
- ROM building tools to build ROMs for hardware development boards, for prototype or for final phone hardware

15.2 C++ Development Tools

Symbian OS kits support two IDEs and emulator-targeting compilers:

- Metrowerks CodeWarrior Development Tools for Symbian OS, an evolving product line being developed by Metrowerks in partnership with Symbian. Metrowerks CodeWarrior integrates build and debug of target binaries
- Microsoft Visual C++ Professional Edition 6.0. There are no plans to support Microsoft Visual Studio .NET, or to support Microsoft Visual Studio in future Symbian OS releases

For building binaries on target phones, Symbian OS kits include GCC 98r2, a modified version of the open-source GNU C++ compiler.

The target compiler and all tools that invoke it support three instruction sets:

- ARM4, for ROMs where performance matters more than space, or for applications if the ROM is known to be ARM4
- Thumb, for ROMs where space matters more than performance, or for applications if the ROM is known to be Thumb
- ARMI, for applications which inter-operate with ROMs built in either ARM4 or Thumb

15.3 On-target application debugging

In addition to debugging with the emulator, Symbian OS supports on-target debugging. The tool chain translates PE-COFF/STABS into a Symbian OS format for execution on the device.

Symbian ships the GDB GNU Debugger, which supports on-target debugging of user-mode programs. A stub on the target Symbian OS phone communicates, over a serial link, with GDB on the host. On the host the command-line interface is supported. Metrowerks includes an application debugger in its CodeWarrior for Symbian OS Professional product line called MetroTRK.

- the standard GDB command-line interface is extended to support Symbian OS-specific features: downloading files from the host to the target, selecting the program to debug and setting its command-line, connecting to the target, limited facilities to help debugging Unicode programs and loading DLL debugging information
- on the target, the stub can work in background mode without any UI or in interactive mode where it can accept arguments from the command-line and output information to a text console

15.4 On-target kernel debugging

For kernel debugging, debuggers are available from Lauterbach, ARM, Intel and Texas Instruments with Metrowerks providing a JTAG stop-mode debugger.

15.5 Reference boards

Symbian OS has been tested and verified on the following hardware reference platforms:

- Intel Lubbock (DBPXA250)

15.6 Hardware integration boards

Specific features and functionality have been verified on the hardware integration boards based on:

- Cirrus Logic 7211

15.7 Telephony stack integration and testing

A GSM telephony stack integration module is provided for test purposes. It supports voice, data, SMS, and phone information. The software module has been developed to work in conjunction with reference telephony platform from TTP Com. It may also be used by licensees as the basis of their integration component.

16 Application development

16.1 Symbian OS licensee SDKs

Symbian's licensees develop phones and support software development on these devices with SDKs for the ISV community. The Symbian OS Customization Kit provides tools required by licensees to build SDKs. SDKs may be delivered to the ISV market either directly by licensees or, along with tools offerings, by tools companies.

16.2 C++

Application development is supported in C++, for high performance, access to Symbian OS native APIs, and native application look-and-feel.

16.3 Java

Symbian OS Version 7.0s offers two configurations:

- for smartphones: MIDP v2.0 and CLDC
- for communicators: PersonalJava with JavaPhone, plus MIDP v2.0 and CLDC

The lighter smartphone configuration provides a Java environment suitable for smaller devices. The communicator configuration is the richest Java environment on mobile phones providing access to PIM, messaging and telephony functionality. With PersonalJava and JavaPhone, mobile phones combine the full power of Java with access to more specialized functionality such as messaging. With the lighter J2ME MIDP, phones have access to the many MIDlets being developed.

16.3.1 PersonalJava

PersonalJava on Symbian OS implements the 1.1.1a PersonalJava Application Environment specification.

Features include:

- support for Unicode across the Host Porting Interface
- support for ARM JTEK (Jazelle) technology for Java hardware acceleration and ARM VTK (VMA technology kit) for Java software acceleration
- JVMDI for remote debugging (TCP/IP over the serial link)
- Symbian OS SDK for Java tools. Runtime customization tools

16.3.2 JavaPhone

The JavaPhone component delivers a set of APIs that extend the PersonalJava runtime to access important native functionality including telephony, agenda, contacts, messaging and power monitoring. Symbian OS provides the JavaPhone 1.0 reference implementation.

The following APIs are provided:

- JavaPhone APIs: address book (based on the contacts application engine), calendar (based on the agenda application engine), user profile, network datagram, and power monitor (minimal implementation).
- optional PersonalJava interfaces: serial communications, secure socket communications (HTTPS is supported, javax.net.ssl is not implemented)
- Java Telephony API: JTAPI Core package
- Java Telephony API (mobile): Java Mobile API Core interfaces, MobileProvider, MobileProviderEvent, MobileProviderListener, MobileAddress, MobileTerminal, MobileNetwork, MobileRadio, MobileRadioEvent and MobileRadioListener

16.3.3 MIDP

J2ME MIDP provides a Java environment for even the most memory-constrained mobile phone. It provides an installation and execution environment for the many MIDlets being developed.

- Symbian's MIDP implementation is compliant with V2.0 of the MIDP specification and v1.0 of the CLDC specification
- supports installation of JAR and JAD files
- fast implementation with a small footprint
- uses light-weight threading with non-blocking IO support to ensure that waiting for IO on one thread will not block all other threads
- heap size and persistent storage are unconstrained, allowing larger, more powerful MIDlets to be run
- MIDlets look and behave very much as native applications, they use the native application installer and launcher, and native UI components
- supports native color depth
- Generic Connection Framework implementation including sockets, server sockets, datagram sockets, secure sockets, HTTP and HTTPS
- Conforms to Over-The-Air Recommended Practice document for MIDlet provisioning as mandated by the MIDP 2.0 specification

Appendix A. Supported messaging and networking RFCs

- Transmission Control Protocol: RFC 793 Transmission Control Protocol (TCP), RFC 1122 Requirements for Internet Hosts – Communication Layers, RFC 1323 TCP Extensions for High Performance, RFC 2018 TCP Selective Acknowledgement Options, RFC 2581 TCP Congestion Control, RFC 2414 Increasing TCP's Initial Window, RFC 2582 The NewReno Modification to TCP's Fast Recovery Algorithm, RFC 2873 TCP Processing of the IPv4 Precedence Field, RFC 2988 Computing TCP's Retransmission Timer, Proposed Modification to Nagle's Algorithm, RFC 3042 Enhancing TCP's Loss Recovery Using Limited Transmit and RFC 2001 TCP Slow Start Algorithm
- User Datagram Protocol: RFC 768 User Datagram Protocol (UDP)
- Internet Protocol v4 RFCs supported: RFC 791 Internet Protocol (IP), RFC 919 Broadcasting Internet Datagrams, RFC 922 Broadcasting Internet Datagrams in the presence of subnets, RFC 1144 Compression of TCP/IP Headers for Low Speed Links, RFC 1191 Path MTU Discovery and RFC 1853 IP in IP Tunneling
- Internet Protocol v6 RFCs supported: RFC 2460 Internet Protocol v6, RFC 2373 Addressing Architecture, RFC 2374 Aggregatable Global Unicast Address Format, RFC 2461 Neighbor Discovery, RFC 1981 Path MTU Discovery, RFC 2462 Stateless Address Autoconfiguration, RFC 2473 Generic Packet Tunneling, RFC 2464 Transmission of IPv6 Packets over Ethernet Networks, and RFC 2893 Transition Mechanism for IPv6 Hosts and Routers (dual stack functionality)
- Internet Control Message Protocol: RFC 792 Internet Control Message Protocol (ICMP), RFC 2463 ICMP v6 and RFC 950 Internet Standard Subnetting
- Point to Point Protocol: RFC1661 Point to Point Protocol (PPP) including use of LCP echo/reply packets to ensure link quality, RFC 1662 PPP in HDLC like framing, RFC 1334 PPP Authentication PAP and CHAP, RFC 1994 Challenge Handshake Authentication Protocol (CHAP), RFC 1332 Internet Protocol Control Protocol (IPCP), RFC 1877 IPCP Extensions for DNS (Domain Name Service) and NBNS (NetBios Name Service), RFC 1570 PPP LCP Extensions (callback, identification and time-remaining), RFC 1962 PPP Compression Control Protocol (CCP), RFC 1974 PPP Stack LZS Compression Protocol (only modes 1, 3 and 4, since no routers support mode 2), RFC 1978 PPP Predictor Compression Protocol, RFC 2118 Microsoft Point-to-Point Compression Protocol, RFC 2433 Microsoft PPP Chap Extensions and PPP Callback Control Protocol, RFC 2472 IPv6 over PPP, and RFC 2153 PPP Vendor Extensions
- Domain Name System (DNS): the parts of RFCs 1034, 1035 and 1101 appropriate to an IP client, namely the PTR, CNAME, NS and A DNS record types, and RFC 1886 DNS Extension to support IPv6
- security protocols for secure electronic commerce: RFCs: RFC 2246 TLS Protocol Version 1.0, RFC 2487 SMTP Service Extension for Secure SMTP over TLS and RFC 2595 Using TLS with IMAP, POP3, and ACAP
- IPSec: RFC 1828 IP Authentication using Keyed MD5, RFC 1829 The ESP DES-CBC Transform, RFC 2085 HMAC: Keyed-Hashing for Message Authentication, RFC 2401 Security for the Internet Protocol, RFC 2402 IP Authentication Header (AH), RFC 2403 The Use of HMAC-MD5-96 within ESP and AH, RFC 2404 The Use of HMAC-SHA-1-96 within ESP and AH, RFC 2405 The ESP DES-CBC Cipher Algorithm with Explicit IV, RFC 2406 IP Encapsulating Security Payload (ESP), RFC2407 The Internet IP Security Domain of Interpretation for ISAKMP, RFC 2048 Internet Security Association and Key Management Protocol, RFC 2409 The Internet Key Exchange (IKE), RFC 2410 The NULL Encryption Algorithm and its Use with IPSec, RFC 2459 Internet X.509 Public Key Infrastructure Certificate and CRL Profile, RFC 2451 The ESP CBC-mode Cipher Algorithms, RFC 2367 PF_KEY Key Management API Version 2 and RFC 2560 X.509 Internet Public Key Infrastructure Online Certificate Status Protocol – OCSP

- Telnet Protocol engine: RFC 854 Telnet Protocol Specification, RFC 855 Telnet Option Specifications, RFC856 Telnet Binary Transmission, RFC857 Telnet Echo Option, RFC858 Telnet Suppress Go Ahead Option, RFC859 Telnet Status Option, RFC727 Telnet Logout Option, RFC1091 Telnet Terminal Type Option, RFC1073 Telnet Window Size Option, RFC1079 Telnet Terminal Speed Option
- File Transfer Protocol (FTP) engine: RFC 959 File Transfer Protocol and RFC 2428 Extensions for IPv6 and NATs
- Ethernet support: connectionless IEEE 802.2, RFC 826 Ethernet Address Resolution Protocol (ARP), RFC 2131 Dynamic Host Configuration Protocol, RFC 1497 BOOTP Vendor Information Extensions, 2132 DHCP Options and BOOTP Vendor Extensions, Ethernet (EtherII) and IEEE 802 Encapsulation as defined in RFC 1122 Requirements for Internet Hosts - Communication Layers, RFC 894 Standard for the transmission of IP datagrams over Ethernet networks and RFC 1042 Standard for the transmission of IP datagrams over IEEE 802 networks
- HTTP and HTTPS: RFC 2616 Hypertext Transfer Protocol -- HTTP/ 1.1, RFC 2617 HTTP Authentication: Basic and Digest Access Authentication, RFC 2818 HTTP Over TLS, RFC 2396 Uniform Resource Identifiers (URI): Generic Syntax
- IMAP4: RFC 2060 Internet Message Access Protocol – Version 4
- POP3: RFC 1939 Post Office Protocol - Version 3
- SMTP: RFC 2821 Simple Mail Transfer Protocol (commands useful on a client), RFC 1869 SMTP Service Extensions (EHLO command)
- message presentation: RFC 822 Standard for the format of ARPA Internet text messages, RFC 2045 Multipurpose Internet Mail Extensions (MIME) Part One: Format of Internet Message Bodies, RFC 2046 Multipurpose Internet Mail Extensions (MIME) Part Two: Media Types, RFC 2047 MIME (Multipurpose Internet Mail Extensions) Part Three: Message Header Extensions for Non- ASCII Text, RFC 2557 MIME Encapsulation of Aggregate Documents, such as HTML (MHTML), RFC 2392 Content-ID and Message-ID Uniform Resource Locators, RFC 2806 URLs for Telephone Calls, RFC 2368 The mailto URL scheme, RFC 2183 Communicating Presentation Information in Internet Messages: The Content-Disposition Header Field, RFC 2279 UTF-8, a transformation format of ISO 10646, RFC 2152 UTF-7 A Mail-Safe Transformation Format of Unicode, and RFC 2306 Tag Image File Format (TIFF) - F Profile for Facsimile

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