
MOBILEHCIOS
APPLICATION DEVELOPMENT FOR MOBILE DEVICES
Enrico Rukzio
Michael Rohs
Daniel Wagner
John Hamard


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Michael Rohs – Symbian
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Goals

Learn enough about Symbian
- to judge whether is the right system for a project
- to quickly start application development in C++

Understand
- basic concepts of the Symbian operating system and the application framework
- how to set up a C++ development environment
- how to create a basic "Hello World" application

No mobile HCI course

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Symbian Characteristics

Symbian OS from the developer' s point of view =
operating system for handheld devices with limited resources
+ user interface framework
+ APIs (C++)
+ tools

Operating system
- pre-emptive multitasking, multithreading, memory protection, event-based
- special features: conserving memory, reliability, CPU switched off when applications are not dealing with events

Symbian OS from the user' s view
- consistent user interface, comprehensive set of PIM applications, extensible by 3rd party applications

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Outline

Symbian overview
Symbian OS structure
Setting up a development environment
Creating a "Hello World" example
Basic Symbian OS concepts
Application framework

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Outline

- Symbian overview
  - History
  - Market share
  - Device classes
- Symbian OS structure
- Setting up a development environment
- Creating a "Hello World" example
- Basic Symbian OS concepts
- Application framework

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History

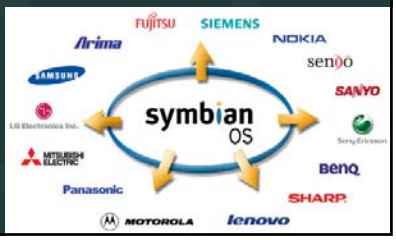
1997: Psion's EPOC OS

1998: Symbian consortium and Symbian OS

- independent of Psion
- Ericsson, Nokia, Motorola, Psion (founders)
- Panasonic, Sony Ericsson, Siemens, Samsung (shareholders)

2000: First Symbian OS phone

- Ericsson R380



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Symbian Shipments in 2004

Full year 2004: 14.38 million phones

- Q3 2004: 3.70 million phones
- Q4 2004: 5.68 million phones
- 41 phones models from 8 licensees

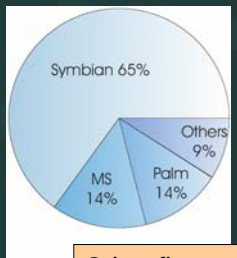
2005 shipments

- Q1 2005: 6.75 million phones
- 48 models from 9 licensees shipping

Installed base of almost 32 million phones

All mobile phone shipments full year 2004:
- 664.5 million (Source: IDC, January 27, 2005)
- 683.5 million (Source: Strategy Analytics)

Market share smartphones



Other figures:
Symbian: 80%
Microsoft: 7%

Sources: Symbian Ltd., Small Devices Ltd.

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Symbian Device Classes and OS Variants

Same basis, different look & feel

Series 60 

- smartphones with numeric keypad, "phone centric"

Series 80 

- organizers with full keyboard, "information centric"

UIQ 

- smartphones with pen input, "information centric"

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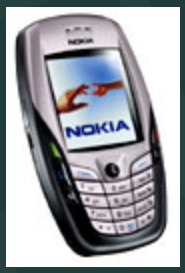
Series 60 Example Device: Nokia 6600

OS: Symbian OS 7.0s
CPU: ARM-9, 104 Mhz
Memory
- heap size: 3 MB
- storage: 6 MB + MMC

Display
- 65536 colors
- 176 x 208 pixels

Interaction
- numeric keypad
- 2 labeled soft keys
- 5-way direction key

Infrared, Bluetooth
Camera: 640 x 480 pixels



- Java: CLDC 1.0, MIDP 2.0
  - Wireless Messaging API (JSR-120)
  - Mobile Media API (JSR-135)
  - Bluetooth API (JSR-82 No OBEX)

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Series 80 Example Device: Nokia 9300

OS: Symbian OS 7.0s
CPU: ARM-based, ~150 MHz
Memory
- heap size: 20 MB
- storage: 80 MB + MMC

Display
- 65536 colors
- 128 x 128 pixels (outside)
- 640 x 200 pixels (inside)

Interaction
- numeric and qwerty keypads
- 3 labeled soft keys
- 9-way direction key

Infrared, Bluetooth

- Java CLDC 1.1, MIDP 2.0
  - Wireless Messaging API (JSR-120)
  - Mobile Media API (JSR-135)
  - Bluetooth API (JSR-82 No OBEX)
  - FileConnection and PIM API (JSR-75)
- Java CDC 1.0 (JSR-36)
  - Personal Profile (JSR-62)
  - Foundation Profile (JSR-46)

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UIQ Example Device: Sony Ericsson P910

OS: Symbian OS 7.0
CPU: ARM-9, 156 MHz
Memory
- heap size: 32 MB
- storage: 64 MB + Memory Stick

Display (touch sensitive)
- 262000 colors
- 208 x 320 pixels

Interaction
- stylus on touchscreen
- numeric and qwerty keypad
- 5-way direction key

- Java
  - CLDC 1.1
  - MIDP 2.0
- Infrared, Bluetooth
- Camera: 640 x 480 pixels

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Outline

Symbian overview
Symbian OS structure
- Hardware resources
- Software components
- Processes, threads, and context switching
- Kernel and user library
- Event handling and active objects
- Client-server framework

Setting up a development environment
Creating a "Hello World" example
Basic Symbian OS concepts
Application framework

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Hardware Resources

CPU: ARM, 32-bit, 36-220 MHz
ROM: OS, middleware, applications, Z: drive
RAM: working memory, "disk" space, C: drive
I/O: keypad, pen input, CF card slot, CCD camera
Communication: GSM/GPRS/UMTS, infrared, Bluetooth
Power source: rechargable battery 2000-3000 mWh (600-900 mAh, 3.5 V)
Display: 176x208 pixels, 65536 colors for smartphones

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Memory Organization and Disk Drives

RAM
- runtime memory (stack, heap)

C: Flash-RAM
- application files, user files

D, E, ...: compact flash cards, memory sticks
- application files, user files

Z: ROM
- operating system files

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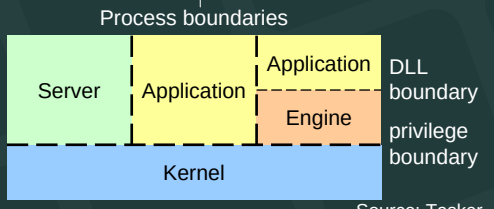
Software Components



Source: Tasker

Kernel
- manage and controls access to hardware resources
- hardware-supported privileges, kernel mode

Application
- program with a user interface
- runs in user mode in its own process

Server
- program without a user interface
- manages resources, provides interface to clients

Engine
- application part that manipulates data, often separate DLL

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Processes, Threads, and Context Switching

Process: fundamental unit of protection
- own address space
- virtual addresses –MMU→ physical addresses

Thread: fundamental unit of execution
- one or more per process
- preemptively scheduled by the kernel

Context switching: changing threads
- expensive between two threads in different processes
- typically just one thread per process → active objects

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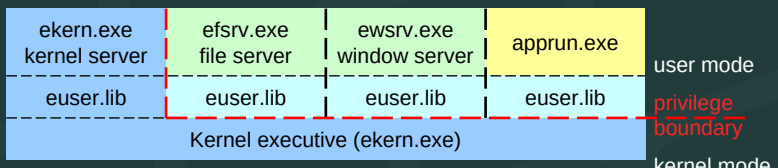
Kernel and User Library



Source: Tasker

Kernel runs in privileged mode
Kernel server: highest-priority thread in system
User library (euser.lib): basic library and kernel access
- entirely user-side (e.g. descriptors, arrays)
- cross into kernel executive (e.g. time checking)
- request services of the kernel server

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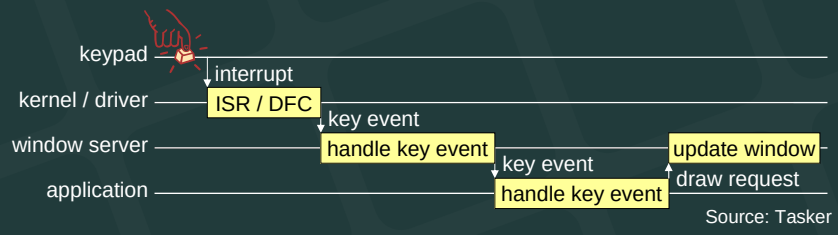
Event Handling and Active Objects

Symbian optimized for efficient event handling

Active objects and active schedulers

- non-preemptive event handling within a single thread
- well-suited for GUI systems
- active objects call asynchronous methods or register for events
- active scheduler calls RunL method of active object



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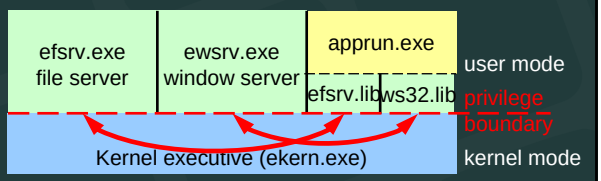
Client-Server Framework



Most important servers

- **file server:** operations on files
- **window server:** user input, screen drawing
- communications, databases, schedule, contacts, etc.

Client-server interface

- server proxy in client's address space (e.g. **R**File, **R**Window)
- kernel-supported message passing
- inter-thread read / write: server can access client's address space

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Outline

- Symbian overview
- Symbian OS structure
- Setting up a development environment
  - Development tools
  - Installation issues
  - Application wizard
  - Build process
- Creating a "Hello World" example
- Basic Symbian OS concepts
- Application framework

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Symbian Series 60 and UIQ Development Tools

Microsoft Visual Studio – C++ IDE (MSVS)
Metrowerks Code Warrior – C++ IDE (alternative)
[Makmake – makefiles for Windows and ARM, project files for MSVS]
Bldmake – generates abld.bat from bld.inf
Abld – Perl tool, creates makefiles, compiles project
Makesis – creates installation file ".sis" from ".pkg" file

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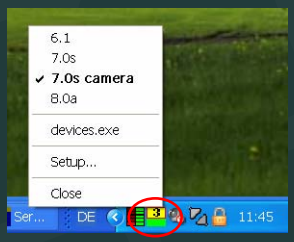
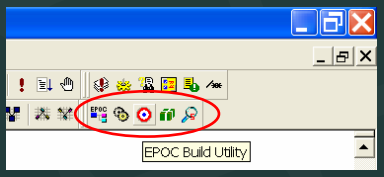
Symbian Series 60 and UIQ Development Tools

Emulator
- debugging on Windows ("epoc.exe")

Environment Switch
- choose SDK

EpocToolbar
- Plugin for MSVS





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Installation of the Symbian 7.0s SDK on Windows using Visual C++ 6.0

General hints
- avoid spaces in path and file names
  - especially in the installation path
- the installation directory has to be on volume C:
- installation requires "Administrator" privileges
- you need lots of disk space for Symbian
  - (about 720 MB for Nokia 6600 with camera API plugin)
- SDKs are device specific and version specific
  - see: http://www.forum.nokia.com/main/1,6566,034-4,00.html

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Installation of the Symbian 7.0s SDK on Windows using Visual C++ 6.0

Installation order

- install MS Visual C++ 6.0 (and latest service pack)
  - http://msdn.microsoft.com/vstudio/previous/vs6/downloads/default.aspx
- install latest Java J2SE
  - http://java.sun.com/j2se/
- install latest Active Perl
  - http://www.activestate.com/Products/ActivePerl/
- install Series 60 SDK 2.0 for Symbian OS
  - http://www.forum.nokia.com/main/1,6566,034-4,00.html

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Installation directories

Root: C:\dev\Symbian\7.0s\Series60_v20

- Epoc32 – gcc compiler, emulator, include files, etc.
- Examples – SDK examples
- Series60Doc – SDK documentation
- Series60Ex – Series 60 specific examples
- Series60Tools – tools

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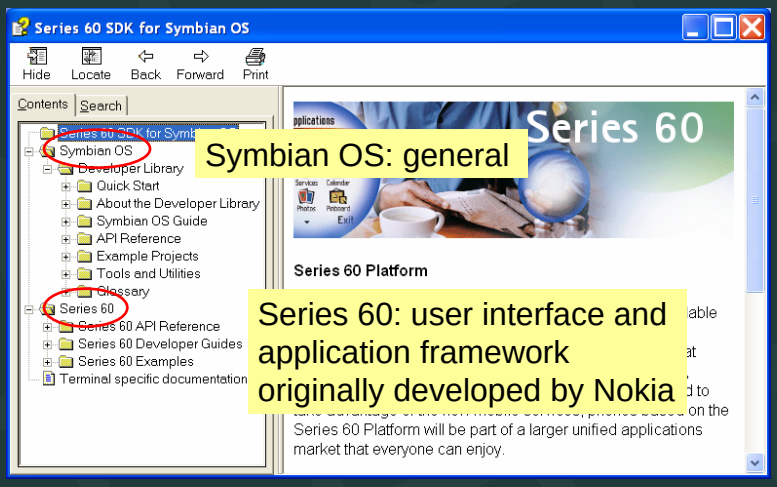
Platform SDK Documentation



Location: C:\dev\Symbian\7.0s\Series60_v20\Series60Doc\Start.chm

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Installing the Application Wizard Plug-in for Visual C++ 6.0

Location

- C:\dev\Symbian\7.0s\Series60_v20\Series60Tools\applicationwizard

Copy "avkonappwiz_v20.awx" and "avkonappwiz_v20.hlp" to

- C:\Program Files\Microsoft Visual Studio\Common\MSDev98\Template

Start MSVS

Standalone application wizard for Symbian 8.0a

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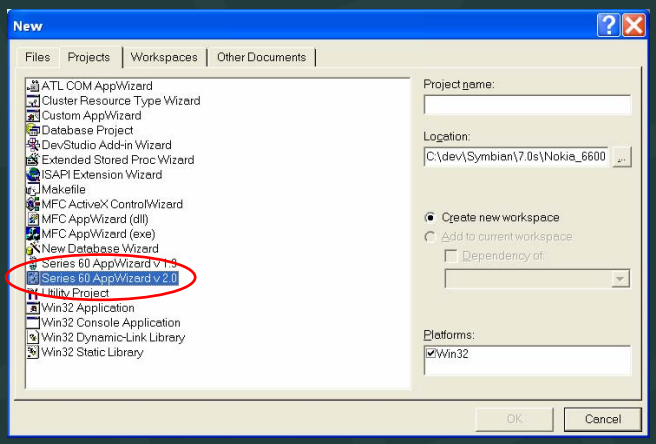
Using the Application Wizard



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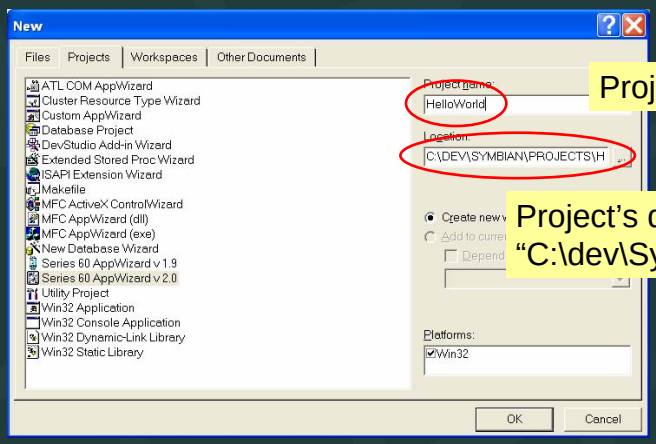
Using the Application Wizard



Project “HelloWorld”

Project’s directory
“C:\dev\Symbian\Projects”

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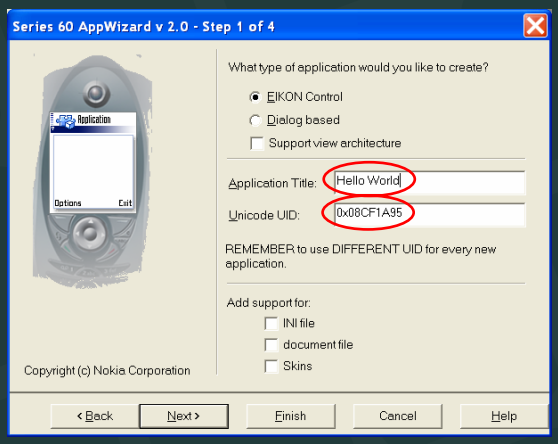
Using the Application Wizard



Application title will appear on the device

Each application has a unique identifier

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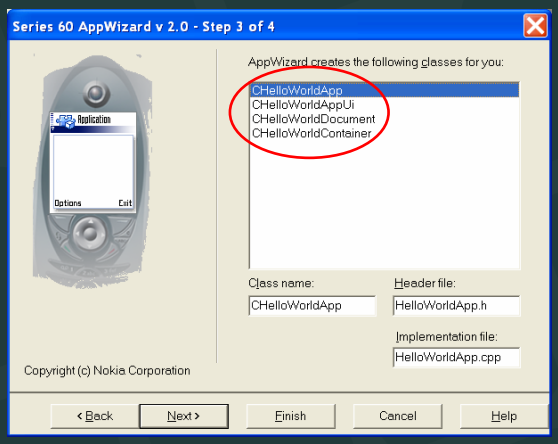
Using the Application Wizard



Generated classes:
- Application
- Document
- User interface
- Container

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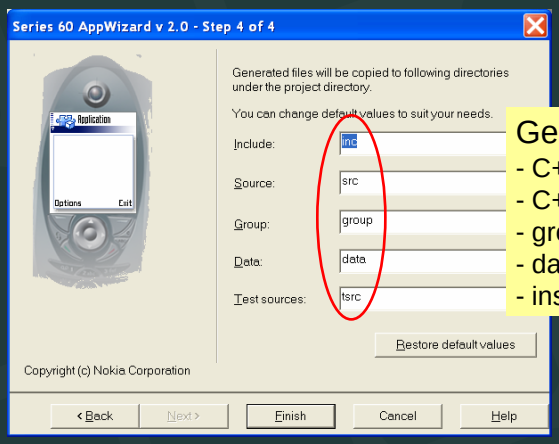
Using the Application Wizard



Generated directories:
- C++ include files
- C++ source files
- group: Symbian project files
- data, aif: resource files
- install: installation files

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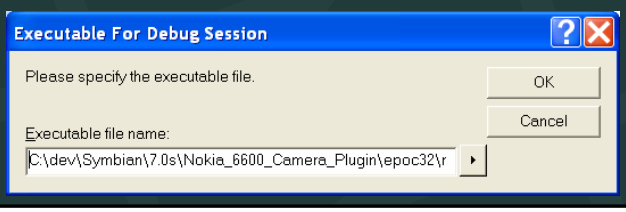
Debugging Programs in the Emulator

Compile (F7)

Execute (Ctrl + F5)

Enter file name of
emulator executable (epoc.exe)

- ...\epoc32\release\wins\udeb\epoc.exe



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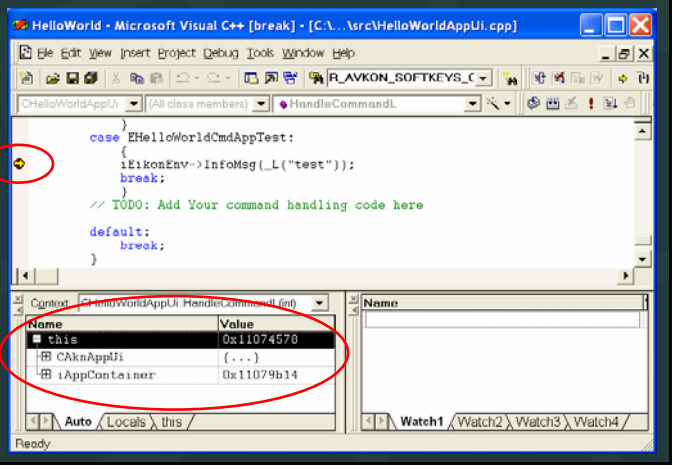
Debugging Programs in the Emulator

Set break-points (F9)

Debug (F5)

Break-point

Inspect variables



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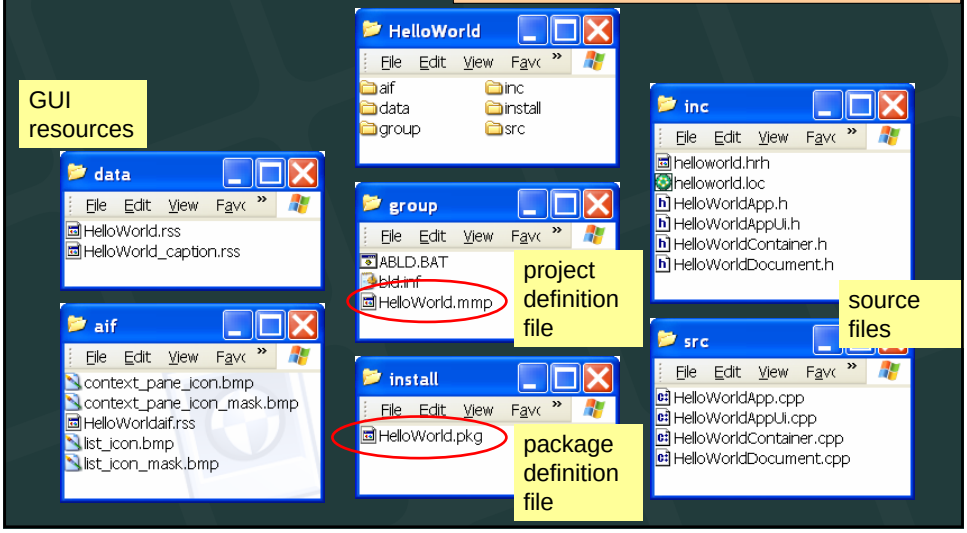
Generated Files

Visual C++ specific files in:
C:\dev\Symbian\7.0s\Series60_v20\Epoc32\BUILD\DEV\SYMBIAN\PROJECTS\HELLOWORLD

GUI resources



project definition file

source files

package definition file

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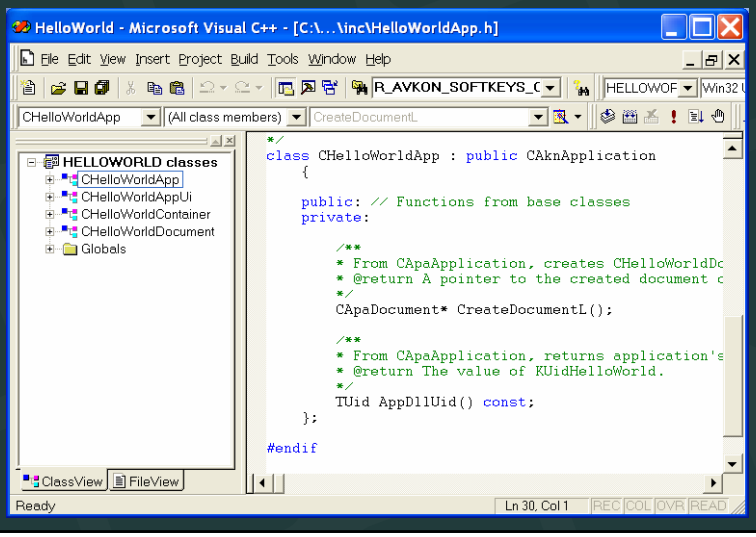
Generated C++ Source Code



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Project Definition File HelloWorld.mmp

```
TARGET  HelloWorld.app
TARGETTYPE  app
UID  0x100039CE 0x08CF1A95
TARGETPATH \system\apps\HelloWorld

SOURCEPATH ..\src
SOURCE  HelloWorldApp.cpp
SOURCE  HelloWorldAppUi.cpp
SOURCE  HelloWorldDocument.cpp
SOURCE  HelloWorldContainer.cpp

SOURCEPATH ..\data
RESOURCE HelloWorld.rss
RESOURCE HelloWorld_caption.rss
LANG     SC

USERINCLUDE .
USERINCLUDE ..\inc

SYSTEMINCLUDE .
SYSTEMINCLUDE \epoc32\include
```

```
LIBRARY euser.lib
LIBRARY apparc.lib
LIBRARY cone.lib
LIBRARY eikcore.lib
LIBRARY eikcoctl.lib
LIBRARY avkon.lib

AIF HelloWorld.aif ..\aif
   HelloWorldaif.rss c8
   context_pane_icon.bmp
   context_pane_icon_mask.bmp
   list_icon.bmp list_icon_mask.bmp
```

mak**m**ake **p**roject

After each change to the mmp file you need to update the Visual C++ project with **`abld makefile vc6`**

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Package Definition File HelloWorld.pkg

```
;Languages
&EN

; UID
#{"Hello World"},(0x08CF1A95),1,0,0

;Supports Series 60 v 2.0
(0x101F7960), 0, 0, 0, {"Series60ProductID"}

; Four files to install
"\dev\Symbian\7.0s\Nokia_6600_Camera_Plugin\Epoc32\release\thumb\urel\Hell
   oWorld.app" - "!:\system\apps\HelloWorld\HelloWorld.app"
"\dev\Symbian\7.0s\Nokia_6600_Camera_Plugin\Epoc32\data\z\system\apps\Hell
   oWorld\HelloWorld.rsc" - "!:\system\apps\HelloWorld\HelloWorld.rsc"
"\dev\Symbian\7.0s\Nokia_6600_Camera_Plugin\Epoc32\data\z\system\apps\Hell
   oWorld\HelloWorld_caption.rsc" -
   "!:\system\apps\HelloWorld\HelloWorld_caption.rsc"
"\dev\Symbian\7.0s\Nokia_6600_Camera_Plugin\Epoc32\data\z\system\apps\Hell
   oWorld\HelloWorld.aif" - "!:\system\apps\HelloWorld\HelloWorld.aif"
```


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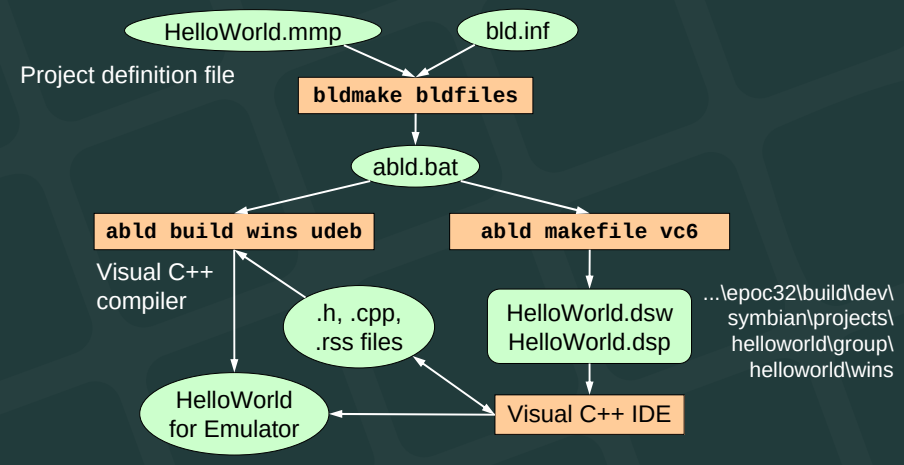
Build Process for Emulator (Intel / Windows)



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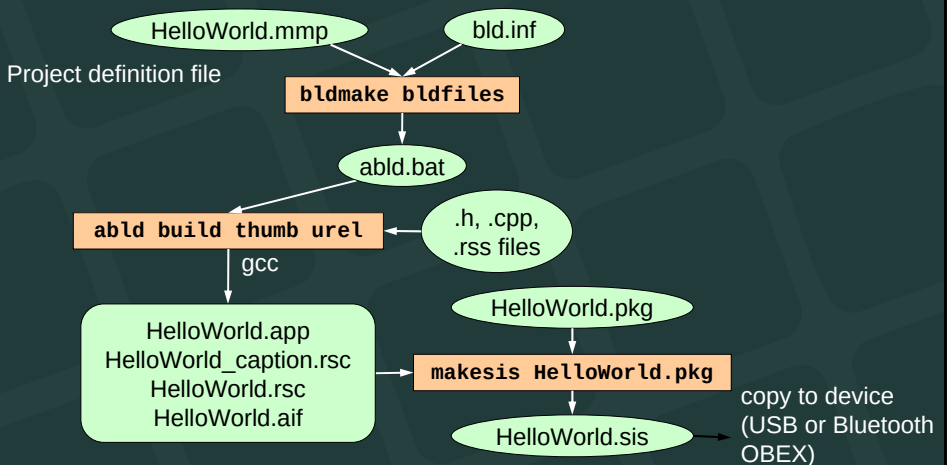
Build Process for Target Device (Arm / Symbian)



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Using Visual Studio .NET with Symbian OS SDKs (officially unsupported)

"abld makefile vc6" creates .dsw and .dsp files
open .dsp file in Visual Studio .NET
change project properties:

- Code Generation: Enable C++
- Exceptions: No
- Buffer Security Check: No
- Command Line
- Additional Options: /QIfist

set PATH environment variable to point to the new Visual Studio .NET
add the /QIfist flag to \epoc32\tools\cl_win.pm
http://www3.symbian.com/faq.nsf/0/30398B3E9500A24D80256C7F00693A91?OpenDocument

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Outline

- Symbian overview
- Symbian OS structure
- Setting up a development environment
- Creating a "Hello World" example
- Basic Symbian OS and Symbian C++ concepts
  - Naming conventions
  - Basic types
  - Exception handling
  - Resource management
  - Descriptors
- Application framework

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Naming Conventions for Types

One character prefix for consistency, readability

T ("type") classes: no pointers, no resources — **T**Point

C ("cleanup") classes: reside on the heap, derived from CBase, virtual destructor — **C**AknApplication

R ("resource") classes: client-side handle to an OS resource (file server, message server, etc.) — **R**Socket

M ("mixin") classes: interface, no implementation, pure virtual functions, observer design pattern — **M**EikMenuObserver

E ("enumeration") types: enumerations — **E**KeyOK

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Naming Conventions for Variables and Constants

One character prefix for consistency, readability

i: member (instance) variables — **i**Document

a: method arguments — **a**Index

no prefix: local variables on the stack — size

K: constants — **K**Pi

Method names: capitalized — **S**etName

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Basic Types – Integers, Void, Boolean

Signed integer

Name	Size (bytes)
TInt	≥4
TInt8	1
TInt16	2
TInt32	4
TInt64	8

Unsigned integer

Name	Size (bytes)
TUint	≥4
TUint8	1
TUint16	2
TUint32	4

Void

Name	Type
TAny	void

Boolean

Name	Size
TBool	4

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Basic Types – Floating Point, Characters

Floating point

Name	Size (bytes)
TReal	8
TReal32	4
TReal64	8
TRealX	12

Character

Name	Size (bytes)
TText8	1
TText	2
TText16	2
TChar	4

Hint: Minimize the use of floating point operations, since typical Symbian machines don't include hardware FPUs.

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Method Parameter Passing

	by value	by & reference	by * reference
input	`X`	`const X&`	`const X*`
output		`X&`	`X*`

"small" types
- by value

"larger" types
- by **&** reference preferred
- by ***** reference if **NULL** is possible or for transferring ownership

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Error Handling and Cleanup

Reliability on continuously running resource constrained devices

- Use memory efficiently and safely
- Release resources as early as possible
- Cope with out-of-memory and other errors and roll back to a consistent state when they occur

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Exception Handling

Symbian's own variant of C++ try, catch, throw

C++ throw → Symbian User::Leave()

C++ try, catch → Symbian TRAP macro

Cleanup stack

- clean up heap when exception occurs

Two-phase construction of complex objects

- 1st phase constructors never leave
- 2nd phase constructors can

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Exceptions, Panics, Leaves, and Traps

- **Exception**: runtime error that **is not** the programmer's fault
- **Panic**: programmatic error that **is** the programmer's fault
- **Leave**: execution leaves the method and jumps up the call stack to the closest exception handler
- **Trap** / **trap harness**: central exception handler

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Throw Exceptions: User::Leave()

L indicates that method may leave (naming convention)

```
void DoExampleL()
{
    CExample* example = new CExample;

    if (example == NULL) {
        User::Leave(KErrNoMemory);
    }

    // do something with example

    delete example;
}
```

throw exception with reason code

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Catch Exceptions: TRAP Macro

```
TInt r = 0; // leave
   variable

TRAP(r, DoExampleL());

if (r != KErrNone) {
    // handle error
}
```

trap harness will catch a leave in **DoExampleL**

error can be handled here, new leaves can be thrown

- L-functions do not need to be called from a trap harness. There must be one somewhere up the call-stack.
- traps may be nested

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Cleanup Stack: Avoid Memory Leaks

L indicates that method may leave (naming convention)

can be checked using leavescan <filename.cpp>

```
void DoExampleL()
{
    CExample* example = new (ELeave) CExample;

    // cannot leave: no protection needed
    example->iInt = 5;

    // can leave: use cleanup stack
    CleanupStack::PushL(example);
    example->DoSomethingL();
    CleanupStack::Pop();

    delete example;
}
```

overwritten operator **new**, may leave, **example** is never **NULL**

- method may leave,
- **example** would become orphaned,
- **CleanupStack** deletes **example** in this case

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Cleanup Stack: Avoid Memory Leaks

```
void DoExampleL()
{
    CExample* example = new (ELeave) CExample;

    // cannot leave: no protection needed
    example->iInt = 5;

    // can leave: use cleanup stack
    CleanupStack::PushL(example);
    example->DoSomethingL();
    CleanupStack::Pop();

    delete example;
}
```

can be replaced by:
`CleanupStack::PopAndDestroy();`

or give number of objects to pop and destroy:
`CleanupStack::PopAndDestroy(1);`

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Two-Phase Construction of Objects: The C++ Constructor Must Never Leave

```
class CExample : public CBase {
    CExample();
    CElement* iElement;
};

CExample::CExample() {
    iElement = new (ELeave) CElement();
}
```

```
...
CExample example = new (ELeave) CExample();
...
```

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Two-Phase Construction of Objects: The 2nd-Phase Constructor May Leave

```
class CExample : public CBase {
    CExample() {
        iElement = NULL; // CBase takes care of zero-initialization
    }
    void ConstructL() {
        iElement = new (ELeave) CElement();
    }
    CElement* iElement;
};
```

```
...
CExample example = new (ELeave) CExample();
CleanupStack::PushL(example);
example->ConstructL();
CleanupStack::Pop();
...
```

can be hidden inside a static factory method: **NewL** or **NewLC**

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Two-Phase Construction of Objects: Static Factory Method NewL

```
class CExample : public CBase {
    CExample() { iElement = NULL; }
    void ConstructL() {
        iElement = new (ELeave) CElement();
    }
    static void NewL() {
        CExample self = new (ELeave) CExample();
        CleanupStack::PushL(self);
        self->ConstructL();
        CleanupStack::Pop();
    }
    CElement* iElement;
};
```

naming convention: C denotes that object remains on cleanup stack

```
static void NewLC() {
    CExample self =
      new (ELeave) CExample();
    CleanupStack::PushL(self);
    self->ConstructL();
}
```

```
...
CExample example = CExample::NewL();
...
```

call static factory method

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Two-Phase Construction of Objects: Use Protected Constructors with NewL

```
class CExample : public CBase {
public:
    static void NewL() {
        CExample self = new (ELeave) CExample();
        CleanupStack::PushL(self);
        self->ConstructL();
        CleanupStack::Pop();
    }
    virtual ~CExample() { delete iElement; }
protected:
    CExample() { iElement = NULL; }
    void ConstructL() {
        iElement = new (ELeave) CElement();
    }
    CElement* iElement;
};
```


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Exception Handling Quiz: What's the problem with this code?

```
class CExample : public CBase {
public:
    ...
    void SetNameL(const TDesC& aName) {
        delete iName;
        iName = aName.AllocL();
    }
    ...
private:
   HBufC* iName;
};
```

What if **AllocL** leaves?

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Exception Handling Quiz: What's the problem with this code?

```
class CExample : public CBase {
public:
    ...
    void SetNameL(const TDesC& aName) {
        delete iName;
        iName = NULL;
        iName = aName.AllocL();
    }
    ...
private:
   HBufC* iName;
};
```

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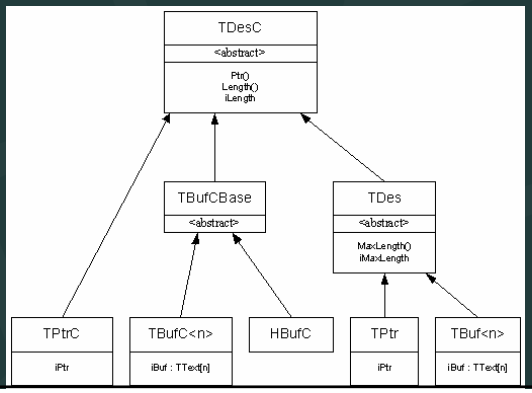
Descriptors: Containers for (16-bit) Text and (8-bit) Binary Data

- Runtime bounds checking
- API for buffer modification
- Used extensively in Symbian OS APIs
- Modifiable and nonmodifiable



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Descriptor Classes

Name	Instatiable	Modifiable	Description
TDesC	no	no	abstract base class; argument passing and return values (**const TDesC&**)
TDes	no	yes	abstract base class; argument passing return values (**const TDes&**)
TBufC	yes	no	templated buffer descriptor: (size, data) stored together
TPtrC	yes	no	pointer descriptor: (size, pointer) separate from data, data not owned
TBuf	yes	yes	templated buffer descriptor: (size, maximum size, data) stored together
TPtr	yes	yes	pointer descriptor: (size, maximum size, pointer) separate from data, data not owned
HBufC	yes	no	heap descriptor: (size, maximum size, data) stored together on the heap

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Descriptor API: Search, Extract, Insert, Delete, Replace, Format

Nonmodifiable

- TInt **Length**()
- TInt **Size**()
- const TUint* **Ptr**()
- HBufC* **Alloc**()
- TPtrC **Left**(TInt aLength)
- TPtrC **Mid**(TInt aPos, TInt aLength)
- TInt **Find**(const TDesC& aDes)
- const TUint16& **operator[]**()

- Modifiable
  - TInt **MaxLength**()
  - TInt **MaxSize**()
  - void **SetLength**(TInt aLength)
  - void **Append**(const TDesC& aDes)
  - void **Insert**(TInt aPos, const TDesC& aDes)
  - void **Delete**(TInt aPos,TInt aLength);

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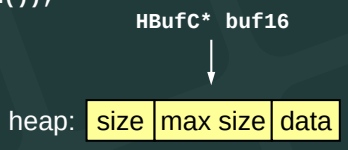
Heap Buffer Descriptors HBufC: heap: (size, max size, data)

Used if descriptor size unknown at compile time

Change to pointer descriptor to modify

```
HBufC* buf16 = HBufC::NewLC(buf8.Length());
TPtr ptr16 = buf16->Des();
ptr16.Copy(buf8);

buf16 = buf16->ReAlloc(4 * buf8.Length());
CleanupStack::Pop();
CleanupStack::Push(buf16);
...
CleanupStack::PopAndDestroy(buf16);
```



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Templated Buffer Descriptors: TBufC (size, data) and TBuf (size, max size, data)

Templated with a size known at compile time

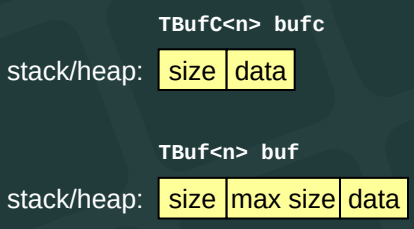
Modifiable (TBuf) and Non-modifiable (TBufC)

```
_LIT(KText, "this is a text");

TBuf<32> buf;
buf.Append(KText);
buf.AppendNum(123);
...
TBufC<32> bufc(KText);

bufc = buf;
```

assignment operator overloaded, replaces data



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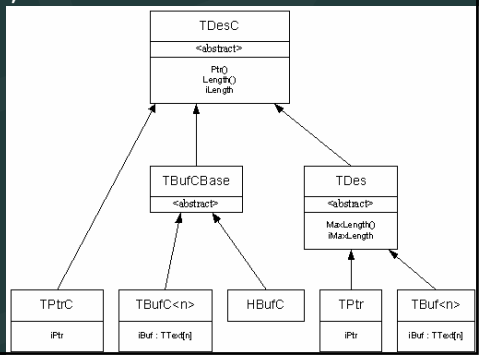
Descriptors as Arguments and Return Types

Abstract base classes TDes and TDesC as formal parameters for flexibility

```
void SetName(const TDesC& aName);
const TDesC& Symbol() const;
```



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Outline

Symbian overview
Symbian OS structure
Setting up a development environment
Creating a "Hello World" example
Basic Symbian OS and Symbian C++ concepts
Application Framework
- Application architecture
- GUI controls
- Resource files
- View architecture
- Event handling

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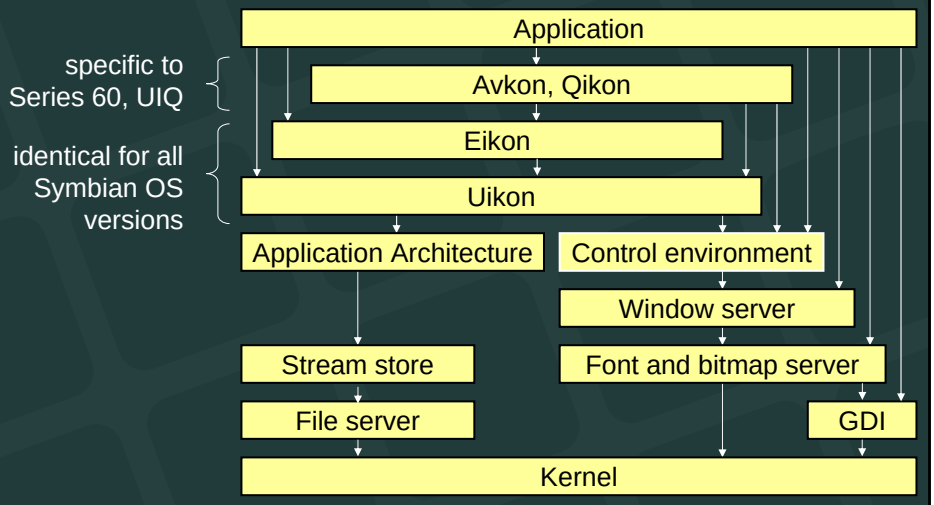
User Interface Architecture



Source: Gerlicher, Rupp

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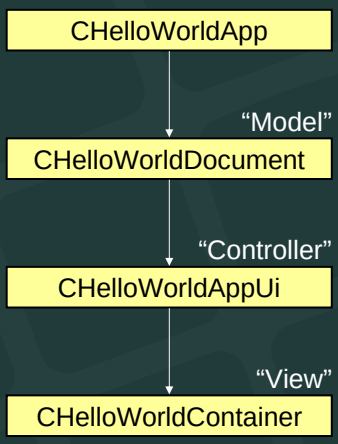
Application Architecture: Anatomy of HelloWorld

Entry point, information to framework (UID, icons, etc.)

Persistent application data

Handles or dispatches events from framework, manage controls

Container for controls (labels, list boxes, etc.)



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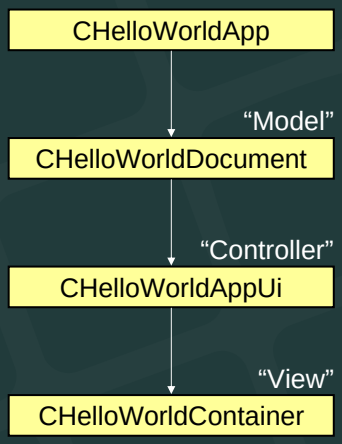
Application Architecture: Instantiation of HelloWorld by the Framework

```
E32Dll()
app = NewApplication()
uid = app->AppDllUid()
doc = app->CreateDocumentL()
ui = doc->CreateAppUiL()
[con = ui->ConstructL()]
con->Draw()
```



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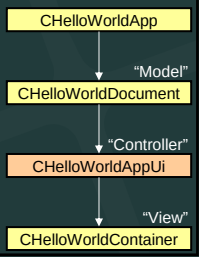
AppUi Methods for Event Handling, Called by the Framework

`HandleCommandL()`
- handles commands defined in resource files

`HandleKeyEventL()`
- key events

`HandleForegroundEventL(TBool aForeground)`
- application switched to foreground or background

and many more...



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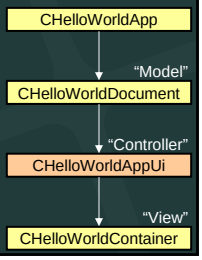
AppUi Class Implementation (1/3): Construction

```
void CHelloWorldAppUi::ConstructL()
{
    BaseConstructL();
    iAppContainer = new (ELeave) CHelloWorldContainer;
    iAppContainer->SetMopParent(this);
    iAppContainer->ConstructL(ClientRect());
    AddToStackL(iAppContainer);
}

CHelloWorldAppUi::~CHelloWorldAppUi()
{
    if (iAppContainer) {
        RemoveFromStack(iAppContainer);
        delete iAppContainer;
    }
}
```

for interaction with controls that are not in this hierarchy

enables dispatching key events to controls



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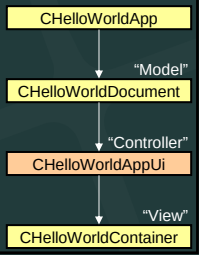
AppUi Class Implementation (2/3): Handling Key Events

```
TKeyResponse CHelloWorldAppUi::HandleKeyEventL(
const TKeyEvent& /*aKeyEvent*/,TEventCode /*aType*/)
{
    return EKeyWasNotConsumed;
}
```



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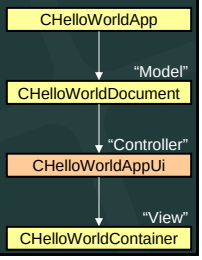
AppUi Class Implementation (3/3): Handling Menu Selection Events

```
void CHelloWorldAppUi::HandleCommandL(TInt aCommand)
{
    switch (aCommand) {
        case EAknSoftkeyBack:
        case EEikCmdExit:
            Exit();
            break;
        case EHelloWorldCmdAppTest:
            iEikonEnv->InfoMsg(_L("test"));
            break;
        default:
        break;
    }
}
```

defined as a menu item in HelloWorld.rss



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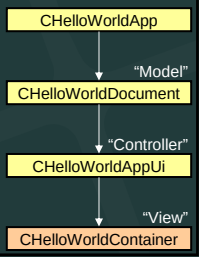
AppUI Focus Events: Switching between Background and Foreground

```
void CHelloWorldAppUi::HandleForegroundEventL(TBool aForeground) {
    if (aForeground) iAppContainer->NewColor();
    CAknAppUi::HandleForegroundEventL(aForeground);
}

void CHelloWorldContainer::NewColor() {
   iCurrentColor++;
   if (iCurrentColor >= 4) iCurrentColor = 0;
}

void CHelloWorldContainer::Draw(const TRect& aRect) const {
    CWindowGc& gc = SystemGc();
    gc.SetPenStyle(CGraphicsContext::ENullPen);
    TRgb colors[] = { KRgbRed, KRgbGreen,
                      KRgbYellow, KRgbBlue };
    gc.SetBrushColor(colors[iCurrentColor]);
    gc.SetBrushStyle(CGraphicsContext::ESolidBrush);
    gc.DrawRect(aRect);
}
```



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Resource Definition File: HelloWorld.rss

```
RESOURCE EIK_APP_INFO
  {
  cba = R_AVKON_SOFTKEYS_OPTIONS_BACK;
  menubar = r_helloworld_menubar;
  }

RESOURCE MENU_BAR r_helloworld_menubar
  {
  titles =
    {
    MENU_TITLE { menu_pane = r_helloworld_menu; }
    };
  }

RESOURCE MENU_PANE r_helloworld_menu
  {
  items =
    {
    MENU_ITEM { command = EHelloWorldCmdAppTest; txt = "Test"; }
    MENU_ITEM { command = EAknCmdExit; txt = "Exit"; }
    };
  }
```

cba = command button area

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Container Class Declaration

```
class CHelloWorldContainer : public CCoeControl, MCoeControlObserver
{
public:
   void ConstructL(const TRect& aRect);
   ~CHelloWorldContainer();
private:
   void SizeChanged();
   TInt CountComponentControls() const;
   CCoeControl* ComponentControl(TInt aIndex) const;
   void Draw(const TRect& aRect) const;

   void HandleControlEventL(
   CCoeControl* aControl, TCoeEvent aEventType);
private:
   CEikLabel* iLabel;
   CEikLabel* iToDoLabel;
};
```

a blank canvas:
- to draw in
- to put controls into
- can be nested in a hierarchy
- can receive key events

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Container Class Implementation (1/3)

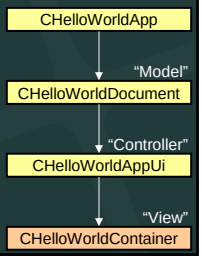
```
void CHelloWorldContainer::ConstructL(const TRect& aRect) {
    CreateWindowL();

    iLabel = new (ELeave) CEikLabel;
    iLabel->SetContainerWindowL(*this);
    iLabel->SetTextL(_L("Example View"));

    iToDoLabel = new (ELeave) CEikLabel;
    iToDoLabel->SetContainerWindowL(*this);
    iToDoLabel->SetTextL(
        _L("Add Your controls\n here"));
    SetRect(aRect);
    ActivateL();
}

CHelloWorldContainer::~CHelloWorldContainer() {
    delete iLabel;
    delete iToDoLabel;
}
```

Sets control as ready to be drawn.



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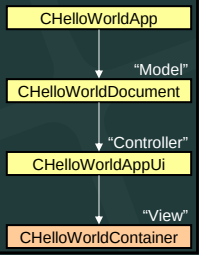
Container Class Implementation (2/3)

```
void CHelloWorldContainer::SizeChanged()
{
    iLabel->SetExtent(TPoint(10,10), iLabel->MinimumSize());
    iToDoLabel->SetExtent(TPoint(10,100), iToDoLabel->MinimumSize());
}

TInt CHelloWorldContainer::CountComponentControls() const {
    return 2;
}

CCoeControl* CHelloWorldContainer::
ComponentControl(TInt aIndex) const
{
    switch (aIndex) {
    case 0: return iLabel;
    case 1: return iToDoLabel;
    default: return NULL;
    }
}
```

All methods called by the framework



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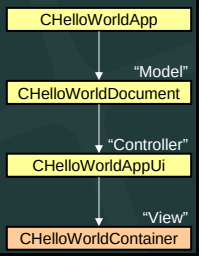
Container Class Implementation (3/3)

```
void CHelloWorldContainer::Draw(const TRect& aRect) const
{
    CWindowGc& gc = SystemGc();
    gc.SetPenStyle(CGraphicsContext::ENullPen);
    gc.SetBrushColor(KRgbGray);
    gc.SetBrushStyle(CGraphicsContext::ESolidBrush);
    gc.DrawRect(aRect);
}
```

Called by the framework

Redraw Events

- system-initiated redraws
  - framework calls Draw()
- application-initiated redraws
  - application calls DrawNow() or DrawDeferred()



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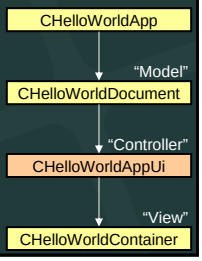
Handling Key Events in the Container Class

Window server routes key events to AppUi

Control stack controls order of key event delivery

Overwrite CCoeControl::OfferKeyEventL() for key handling

```
void CHelloWorldAppUi::ConstructL()
{
    BaseConstructL();
    iAppContainer = new (ELeave) CHelloWorldContainer;
    iAppContainer->SetMopParent(this);
    iAppContainer->ConstructL(ClientRect());
    AddToStackL(iAppContainer);
}
```



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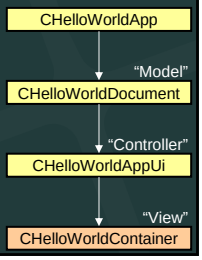
Handling Key Events in the Container Class

```
TKeyResponse CHelloWorldContainer::OfferKeyEventL(
    const TKeyEvent& aKeyEvent, TEventCode aType)
{
   if (aType == EEventKey) {
        TBuf<8> text;
        text.AppendNum(aKeyEvent.iCode);
        iToDoLabel->SetTextL(text);
        DrawNow();
        return EKeyWasConsumed;
   }
   return EKeyWasNotConsumed;
}
```



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Adding a Menu Item to the Options Menu

HelloWorld.hrh:

```
enum THelloWorldCommandIds {
    EHelloWorldCmdAppTest = 1, EHelloWorldCmdNewColor = 2
};
```

HelloWorld.rss:

```
RESOURCE MENU_PANE r_helloworld_menu
{
  items =
  {
    MENU_ITEM { command = EHelloWorldCmdNewColor; txt = "New color";},
    MENU_ITEM { command = EHelloWorldCmdAppTest; txt = "Test"; },
    MENU_ITEM { command = EAknCmdExit; txt = "Exit"; }
  };
}
```

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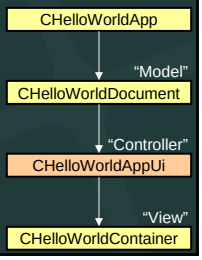
Adding a Menu Item to the Options Menu

HelloWorldAppUi.cpp:

```
void CHelloWorldAppUi::HandleCommandL(TInt aCommand) {
    switch (aCommand) {
        case EHelloWorldCmdNewColor:
            iAppContainer->NewColor();
            break;
        ...
    }
}
```



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Outline

- Symbian overview
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- Setting up a development environment
- Creating a "Hello World" example
- Basic Symbian OS concepts
- Application framework

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Thank you for your endurance!