The Qt and KDE Frameworks: An Overview

Kevin Ottens

Outline

Outline

Prerequisites and Goals

Knowledge is a brick wall built line after line

C++

- Use of object oriented concepts
- Templates (at least a bit, but nothing hardcore)

*nix

- To know what is a shell
- Recall the overall structure of a typical Unix based desktop

Goals

- Give an overview of what can be done with Qt and KDE
- Give clues on how to go further
- Eventually give you the will to contribute ☺

History (1/4)

Since our past experiences determine what we are

Trolltech

- 1994: Trolltech creation in Oslo, Norway
- 1996: First Qt selling! (ESA)
- 1999: Qt2, offices in Australia
- 2000: Qt/Embedded, offices in the US
- 2000: Qt/X11 available under the GPL!
- 2001: Sharp uses Qtopia in its products
- 2001: Qt3!
- 2002: Teambuilder is released
- 2003: Qt/Mac available under the GPL!
- 2004: Qtopia Phone Edition is released
- 2005: Qt4!! offices in China

History (2/4)

Since our past experiences determine what we are

KDE: Warmup

- 14 October 1996: Matthias Ettrich announce on Usenet the "Kool Desktop Environment"
- Willing to use Qt which already had a lot of potential
- November 1996: kdelibs-0.0.1.tar.gz
- Just before Christmas: kwm, kpanel et kfm...
- February 1997: creation of the KDE-FreeQt Foundation

KDE: First steps in the media

- May 1997: Linux-Kongress presentation
- August 1997: First paper in a german journal
- 28 August 1997: First developers meeting

History (3/4)

Since our past experiences determine what we are

KDE: First versions

- 12 July 1998: KDE 1.0 (after a few betas)
- Availability of OpenParts (CORBA based), and of KMail
- Other versions (1.1, 1.1.1, 1.1.2)
- Second developers meeting
  - Move away from CORBA, creation of KParts
  - Matthias et Preston Brown get drunk and think they can write an ORB in one night...
  - ... the result is DCOP!
- 23 October 2000: KDE 2 (Konqueror, KParts, KIO, KOffice, DCOP)
- Konqueror is the first web browser to fully support the CSS2 specification

History (4/4)

Since our past experiences determine what we are

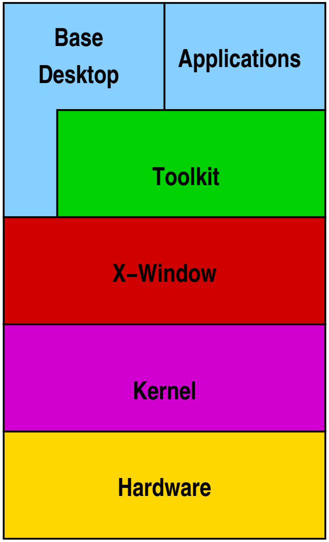
KDE: Fame and success

- 2001: talks about KDE in all the FOSS conferences
- 2 awards at the LinuxWorldExpo, 3 awards from the Linux Journal
- 25 February 2002: Third developers meeting
- 3 April 2002: KDE 3.0
- 22 August 2003: Kastle (Czeck Republic)
- 3 February 2004: KDE 3.2
- 21 August 2004: aKademy (Germany)
- 26 August 2005: aKademy (Spain)
- 29 November 2005: KDE 3.5
- 14 October 2006: KDE has ten years

Outline

Unix Desktop Software Stack

Like an onion, to find the heart you have to remove the layers



In our case...

- Base Desktop == KWin, Plasma, etc.
- Applications == Konqueror, KMail, Konversation, etc.
- Toolkit == Qt, kdelibs
- X-Window == XFree86 ou X.org
- Kernel == Linux, *BSD...
- Hardware == anything that can run a X server

KDE applications work under Windows or Mac OS X

Qt, an overview

Far away everything looks simpler

From the authors

- "Qt is a comprehensive C++ application development framework [...]"
- "Code Less. Create More." (Trolltech's slogan)

What Qt offers

- Slightly "modified" C++
- Tools and a *multi-plateform* API to...
  - ... develop graphical user interfaces
  - ... make multi-threaded applications
  - ... implement network and inter-process communication
  - ... access databases, or process XML
  - ... interact with OpenGL
  - ... and much more!

KDE, an overview

Hm, it looks huge... even from far away

From the authors

- "KDE is a powerful Free Software graphical desktop environment for Linux and Unix workstations[...]"

What KDE offers

- A desktop environment
- Loads of applications
- A development framework
  - network transparency
  - component based architectures
  - interacting with the hardware
  - multimedia (audio, vidéo, streaming...)
  - natural language processing
  - and much more!

Outline

Outline

3 Develop with Qt
- Key concepts and tools
- Complex Widgets
- IPC with D-Bus
- Rendering, Canvas

QObject

The mother of all thing... or almost

Features

- Parent/child relationship, useful for
  - Memory management
  - Widgets layout
- Signals and slots
- Introspection
- Properties system

Drawback

- Difficulties for multiple inheritance

Signals and Slots (1/4)

Morse is overrated

Metaphore

- An object "emits" a signal to signify something potentially interesting for the outside
- One or more objects receive the signal thanks to a method having a compatible signature

Primitives

- `connect()` / `disconnect()`
- `emit`

Advantages

- Loose coupling
- Easy event based programming

Signals and Slots (2/4)

Morse is overrated

Beacon

```
#include <QtCore/QObject>
#include <QtCore/QPoint>

class Beacon : public QObject
{
    Q_OBJECT

signals:
    void beamOfLight(QPoint pos, int degree);
};
```

Signals and Slots (3/4)

Morse is overrated

Boat

```
#include <QtCore/QObject>
#include <QtCore/QPoint>

class Boat : public QObject
{
    Q_OBJECT

public slots:
    void lightSpotted(QPoint pos, int degree);
};
```

Signals and Slots (4/4)

Morse is overrated

Connecting

```
Beacon *lighthouse;
Boat *tanker;

[...]

connect(lighthouse,
        SIGNAL(beamOfLight(QPoint, int)),
        tanker,
        SLOT(lightSpotted(QPoint, int)));
```

Implicit sharing

What is your is mine... almost

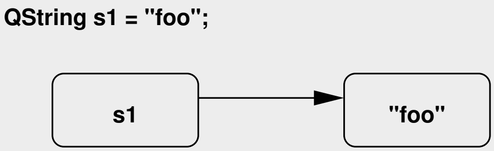
"Copy on write"

- Usable by value
- `operator=()` only duplicate a pointer
- Duplicate data on writing
- Reentrant operation

Implicit sharing
What is your is mine... almost

"Copy on write"

- Usable by value
- `operator=()` only duplicate a pointer
- Duplicate data on writing
- Reentrant operation

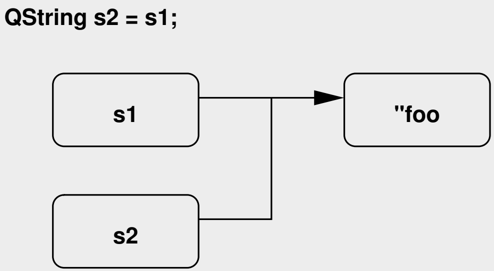


Implicit sharing

What is your is mine... almost

"Copy on write"

- Usable by value
- `operator=()` only duplicate a pointer
- Duplicate data on writing
- Reentrant operation

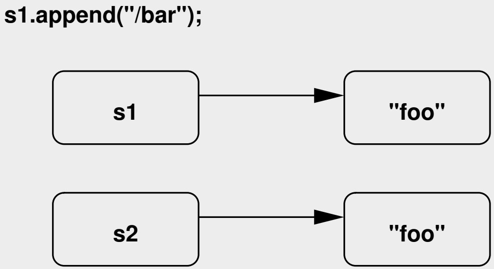


Implicit sharing

What is your is mine... almost

"Copy on write"

- Usable by value
- `operator=()` only duplicate a pointer
- Duplicate data on writing
- Reentrant operation

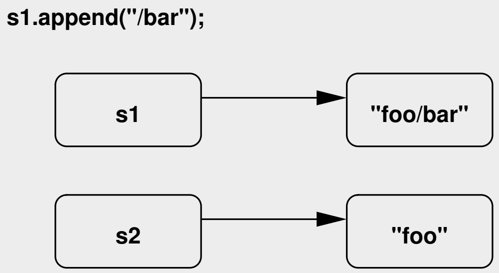


Implicit sharing

What is your is mine... almost

"Copy on write"

- Usable by value
- `operator=()` only duplicate a pointer
- Duplicate data on writing
- Reentrant operation

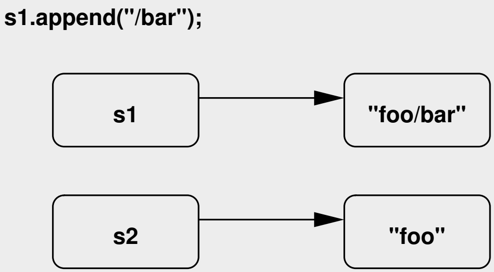


Implicit sharing

What is your is mine... almost

"Copy on write"

- Usable by value
- `operator=()` only duplicate a pointer
- Duplicate data on writing
- Reentrant operation



Implicit sharing

What is your is mine... almost

"Copy on write"

- Usable by value
- `operator=()` only duplicate a pointer
- Duplicate data on writing
- Reentrant operation

Covered classes

Images, polygons, strings, url, variants, collections...

Implicit sharing

What is your is mine... almost

"Copy on write"

- Usable by value
- `operator=()` only duplicate a pointer
- Duplicate data on writing
- Reentrant operation

(About collections)

- Everything necessary: `QList`, `QMap`, `QSet`, `QMultiMap`...
- Three available iteration styles:
  - STL iterators
  - Java iterators
  - `foreach()`

Graphical User Interface

Ooooh, beautiful!

Available bricks

- "Regular" widgets (`QPushButton`, `QCheckBox`, `QLineEdit`...)
- "Complex" widgets (`QTextEdit`, `QTreeView`...)
- OpenGL display
- QGraphicsView canvas

Short demonstrations?

- Borrowed and adapted from Qt examples
- texture: display an OpenGL object (243 lines of C++)
- widgets: showcase of a few Qt widgets with styling support (237 lines of C++)

Qt Designer (1/2)

Draw to win

Facts

- Writing GUI code by hand is boring
- Resulting code is generally heavy to maintain

designer + uic

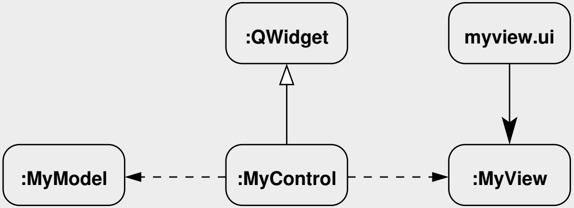
- Designer: GUI graphical editor
- Result: ".ui" files
- uic: generate C++ classes from ".ui" files

Way to work

- We keep **only** the ".ui" files
- Classes generated only during the build
- Push to apply MVC

Qt Designer (2/2)
Draw to win

MVC with Designer

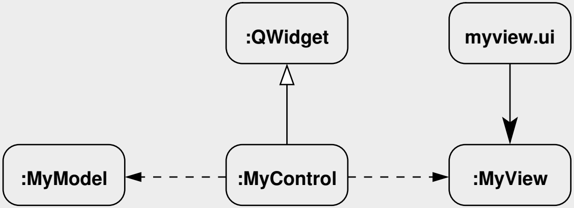


- `MyView` is generated by uic from `myview.ui`
- `MyModel` is a domain class to display or edit
- `MyControl` listen to `MyModel` and `MyView` widgets signals
- Inheriting from `QWidget` allow to use the control part like a build block in a more complex GUI

Qt Designer (2/2)

Draw to win

MVC with Designer



- `MyView` is generated by uic from `myview.ui`
- `MyModel` is a domain class to display or edit
- `MyControl` listen to `MyModel` and `MyView` widgets signals
- Inheriting from `QWidget` allow to use the control part like a build block in a more complex GUI

QMake (1/2)

Building is my passion... hmmmm, in fact not

Facilitate portability

- Describing application building rules
- Generate Makefile or Visual Studio files
- Possibility to add specific rules for a given platform

Important variables

- `TEMPLATE`: project type (app, lib, subdirs)
- `HEADERS`, `SOURCES` and `FORMS`: files used for building
- `TARGET`: name of the built product
- `CONFIG`: building options (debug, multi-thread...)

QMake (2/2)

Building is my passion... hmmmm, in fact not

A short example

```
TEMPLATE = app
TARGET   = seashore_simulator

CONFIG   += qt warn_on release

HEADERS  = beacon.h boat.h
SOURCES  = main.cpp beacon.cpp boat.cpp
FORMS    = seashoreview.ui
```

Outline

Interview (1/3)
Model/View finally usable

About MVC

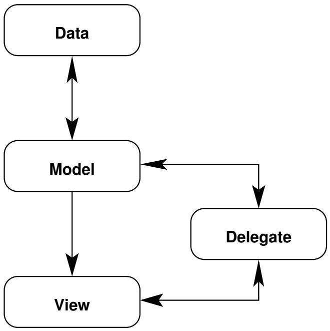
- **Architecture** Pattern
- Easy to understand... generally difficult to practice
- Useful for complex widgets or dialogs

Interview Specifics

- MVC architecture in place for complex widgets
- "Generic" models interface (table/list/tree)
- Objects communication through signals and slots

Interview (2/3)

Model/View finally usable



Model/View/Delegate

- The model interfaces the data source with the other components
- The view asks to the model the data to be displayed
- The delegate does the rendering with the view, and during an editing it indicates the modifications
- All the references to data are passed thanks to `QModelIndex`

Interview (3/3)

Model/View finally usable

Available classes

- `QAbstractItemModel`: Base interface for models
- `QAbstractListModel`: List oriented models
- `QAbstractTableModel`: Table oriented models
- `QListView`: List view
- `QTableView`: Table view
- `QTreeView`: Tree view
- `QAbstractProxyModel`: Filtering models interface

Short demonstration

And also...

In short!

Scribe: rich text management

- `QTextDocument`: read-only text content
  - Hierarchical structure
  - `QTextBlock`, `QTextFrame`, `QTextTable`, `QTextList`
- `QTextCursor` allows to manipulate the text using the cursor metaphor
- `QTextEdit`: text edit widget

Mainwindow: flexibility in the main window

- `QMainWindow`: Main window with a menu bar
- `QToolBar`: Tool bars on window borders
- `QDockWidget`: Movable and detachable panels

Short demonstration

Outline

Overview
D-Bus WTH?

D-Bus: Desktop Bus

- Grandson of DCOP: Desktop COmmunication Protocol
- Remote Procedure Call
- Keeps some concepts of Qt

Model

- Each application using D-Bus is a service
- The services communicate through a bus
  - Session bus, attached to a user session
  - System bus, unique for the system
- Each service exposes a hierarchy of objects
- Objects expose interfaces (methods+signals)

A few tools

Play with your desktop

qdbusviewer: graphical tool

- Useful for developers and power users
- List services, available objects and interfaces
- Allows to call methods

qdbus: command line tool

- Same features than qdbusviewer
- Ease shell scripts writing to control applications

QDBusInterface

D-Bus made easy

Method call using QDBusInterface

```
#include <QtDBus/QDBusConnection>
#include <QtDBus/QDBusInterface>
[...]
QDBusInterface interface("org.kde.application",
                         "/path/to/object",
                         "org.kde.Interface");
QDBusReply<QStringList>
    = interface.call("method", 2, "foo", 0.5);

if (reply.isValid()) {
    QStringList result = reply;
    [...]
}
```

Expose an object on the bus

Expose yourself to the world!

Use of QDBusConnection::registerObject()

```
class Example : public QObject
{
    Q_OBJECT
    [...]
public slots:
    Q_SCRIPTABLE QStringList method(int, QString);
    Q_SCRIPTABLE Q_NOREPLY void asyncMethod();
};
[...]
Example *ex = new Example;
QDBusConnection c = QDBusConnection::sessionBus(),
c.registerObject("/path/object", ex,
          QDBusConnection::ExportScriptableSlots);
```

Define a D-Bus interface (1/2)

Expose yourself to the world!

XML Specification

```
<node>
  <interface name="org.kde.Dummy">
    <method name="method">
      <arg name="arg1" type="i" direction="in"/>
      <arg name="arg2" type="s" direction="in"/>
      <arg name="ret" type="as" direction="out"/>
    </method>
    <method name="asyncMethod">
      <annotation
        name="org.freedesktop.DBus.Method.NoReply"
        value="true"/>
    </method>
  [...]
```

Define a D-Bus interface (2/2)

Expose yourself to the world!

Code generation

- qdbusxml2cpp -a ... : generate a QtDBus adapter
- qdbusxml2cpp -p ... : generate a QtDBus interface

Adapter use

```
#include "dummy_adaptor.h"
[...]
Dummy::Dummy() : QObject()
{
    new DummyAdaptor(this);
    QDBusConnection c
        = QDBusConnection::sessionBus();
    c.registerObject("/path/object", this);
}
```

Define a D-Bus interface (2/2)

Expose yourself to the world!

Code generation

- qdbusxml2cpp -a ... : generate a QtDBus adapter
- qdbusxml2cpp -p ... : generate a QtDBus interface

Interface use

```
#include "dummy_interface.h"
[...]

org::kde::Dummy *iface = new org::kde::Dummy(
        "org.kde.service", "/path/to/object",
        QDBusConnection::sessionBus(), this);

QStringList list = iface->method(2, "foo");
```

Outline

Arthur (1/2)

Draw me a round table!

Architecture

- `QPainter`: take care of the drawing operations (`drawLine()`, `drawRect()`, etc.)
- `QPaintDevice`: object on which you can draw thanks to a `QPainter`
  - `QWidget`
  - `QPixmap`, `QImage`, `QPicture`
  - `QPrinter`
- `QPaintEngine`: interface used by `QPainter` to effectively paint
  - Provided by a `QPaintDevice`
  - Several backends available (raster, OpenGL, PostScript, CoreGraphics, X11 with XRender)

Arthur (2/2)

Draw me a round table!

Noticeable points

- Double buffering on widgets
- Advanced drawing operations
  - Brushes `QGradient` and sons (linear, radial, conical)
  - Alpha channel support in `QColor`
  - Anti-aliasing: `painter.setRenderHint(QPainter::Antialiasing)`
- Tiny SVG 1.2 support since Qt 4.1
  - `QSvgWidget`: display able to render a SVG
  - `QSvgRendered`: allors to render an SVG on any `QPaintDevice`

Short demonstration: `pathstroke` and `svgviewer`

QGraphicsView

Model/View split for the canvas

Model

- `QGraphicsScene`
  - Allows to manage the objects in the scene
  - Distributes events to objects and manage their state
- `QGraphicsItem`, displayable objects
  - Texts, lines, polygons, pixmaps, SVGs, etc.
  - Collision detection
  - Drag'n'Drop, keyboard and mouse events, etc.

View

- Several views on the same scene
- Each view can have different render options, or different transformations

Demo "40 000 Chips"

Outline

Outline

4 Develop with KDE
- Build system: CMake
- kdecore & kdeui
- KParts
- KIO
- Phonon
- Solid

Features

Die autohell! Die!!

Summary

- Generate files for the native build system
  - GNU Make
  - KDevelop
  - XCode
  - Visual Studio
- Separation between source and build directories

Why use CMake?

- Build files easy to write
- Portability
- Faster builds (no libtool)

Example

Do your best with what I give you

CMakeLists.txt

```
project(myproject)
find_package(KDE4 REQUIRED)
include (KDE4Defaults)
include_directories(${KDE4_INCLUDES})

add_subdirectory(lib)

set(projectSources main.cpp someclass.cpp)
kde4_add_ui_files(projectSources view.ui)
kde4_add_kcfg_files(projectSources settings.kcfgc)
kde4_add_executable(myproject projectSources)
target_link_libraries(myproject ${KDE4_KIO_LIBS}
                                mylib)
```

Usage

The toad becoming charming prince... or the other way around

Preparing directories

- We assume the sources are in `project-src`
- `mkdir project-build; cd project-build`

Launching cmake

- `cmake ../project-src`
- Giving options is possible
  - `cmake -DCMAKE_INSTALL_PREFIX=/opt/kde4 ../project-src`
  - `cmake -DKDE4_BUILD_TESTS=ON ../project-src`
  - ...

Get back to the good old habits

- `make && make install`

Outline

Convenience classes and methods

No need to make our lives uselessly complicated...

Visual integration

- `KStandardGuiItem`: functions creating standard actions (`print()`, `saveAs()`...)
- `KIcon`: icons loaded by name respecting the current theme, with cache

System

- `KApplication`: session management, standard menus, D-Bus registering, etc.
- `KProcess`: `system()` under steroids
- `KStandardDirs`: find the ressources of the application on disk

Manage application settings

And now I check this one, disable this...

Configuration system: `KConfig`

- Default backend format similar to ".ini" files (grouped key/value sets)
- Takes care of the user language
- System configuration handled

To go further

- KConfigXT
  - XML description of the application settings
  - Automatic code generation (singleton)
- Kiosk
  - Locking of settings in the system configuration
  - Users profile management

Standard dialogs

Heteroclite monologues

KConfigDialog

- Manage the whole dialog life cycle
  - Memory freeing
  - Buttons activation state (defaults, ok, apply, cancel)
- Works with KConfigXT and Designer

KFileDialog (kio/kfile)

- User KIO: network transparency
- File previews

Short demonstration KConfigXT, KConfigDialog, KFileDialog

Outline

Overview

Let's explode our system in parts!

Graphical components system

- kdelibs has the needed facilities for component based architectures
- KParts is a family of those components
- "A widget with the associated feature, available as actions" (David Faure ^{TM})

Types of KParts available

- `ReadOnlyPart`: file display
- `ReadWritePart`: file editor
- `BrowserExtension`: browser logic integration

Component development is not covered here...

Loading a component

It has to be useful...

Loading "by hand"

- `KPluginLoader`: load a library dynamically while application is running
- `KPluginFactory`: create components available in a library
- `KServiceTypeTrader` and `KMimeTypeTrader`: query the system to know the libraries avaible for a given set of constraints

"Intelligent" loading

- `KMimeTypeTrader::createInstanceFromQuery()`
- `KServiceTypeTrader::createInstanceFromQuery()`

Example of usage

Woot! A web browser!

Demonstration D-Bus+KParts

- Code presented by George Staikos during the first OSDW (http://www.osdw.org)
- Slightly modified
- For 99 lines of code, we get
  - A working web browser...
  - D-Bus driven
- With 66 more lines (written for this talk), we get
  - A minimalist browser interface...
  - Able to control all the browsers of a sessions

Outline

4 Develop with KDE
- Build system: CMake
- kdecore & kdeui
- KParts
- KIO
- Phonon
- Solid

Overview

Lovin' ubiquity...

Implement protocols (slaves)

- Regular network protocols (pop3://, smtp://, etc.)
- Network filesystems (ftp://, webdav://, etc.)
- Virtual filesystems (system://, trash://, etc.)

Deal with protocols and files

- MIME types system (KMimeType)
- Obtain information about a protocol (KProtocolInfo)
- Use a protocol (send/receive data, create directories, etc.)

Synchronous Use

Go fetch it! I'm waiting here.

KIO::NetAccess

- download(): fetch the data of an URL in a temporary file
- removeTempFile()
- upload(): symmetric of download()
- and also mkdir(), move(), etc.

Example

```
QString tmpFile;
if(KIO::NetAccess::download(u, tmpFile, window)){
    loadFile(tmpFile);
    KIO::NetAccess::removeTempFile(tmpFile);
}
```

Asynchronous User

Hey! I've more to do than waiting...

`KIO::Job`

- Create a job instance with a KIO method (`KIO::stat()`, etc.)
- Connect the interesting signals of the job
  - `result()` being the minimum required to know that the job is finished
- No need to keep a pointer on the job or to deallocate it, it `deletes` itself automatically after `result()` is emitted

Short demonstration (88 lines)

Outline

4 Develop with KDE
- Build system: CMake
- kdecore & kdeui
- KParts
- KIO
- Phonon
- Solid

Phonon

An environment which pump up the volume!

Identity

- Leader: Matthias Kretz
- Goal: Strengthen the multimedia abilities of KDE

Technical details

- High-level API designed by collecting use cases
- Backends, allowing to support as many multimedia frameworks as needed
  - Xine, GStreamer, NetworkMultiMedia (NMM)
  - DirectX
  - QuickTime
- Unit tests, and validation tests for backends

Playback

Like Madonna...

Sources and their management

- MediaSource: multimedia source (audio, video) coming from a file, an URL, a disc, etc.
- MediaObject: control the stream from a source, queue management

Paths

- MediaNode: node of a pipeline
  - MediaObject: it's also a MediaNode
  - AudioOutput: audio output (soundcard, network, etc.)
  - VideoWidget: video display
- Path: connects two nodes, effects injection

Demo, "phonon-player" (53 lines)

Complementary tools

We all want our life to be easier

Widgets

- `VolumeSlider`: control the volume of an `AudioOutput`
- `SeekSlider`: control the progress of a `MediaObject`
- `EffectWidget`: effect configuration

Utilities

- `VolumeFaderEffect`: dynamic setting of the volume (fade to silence, cross-fading...)
- `VideoPlayer`: basic video player

Outline

4 Develop with KDE

- Build system: CMake
- kdecore & kdeui
- KParts
- KIO
- Phonon
- Solid

Solid

A robust environment

Identity

- Leader: hmm... yeah ok... I'm guilty
- Goal: Improve interaction between hardware and desktop applications

Technical details

- Architecture with backends
- "Fake backend" for unit tests writing
- Several domains
  - Hardware discovery
  - Network management
  - Power management
- High level API: make developers life easier

Hardware discovery (1/2)

What's good in there?

Principles

- The system has `Devices`, each one having a unique identifier
- `Devices` are organized in a hierarchy
- Each `Device` has interfaces of different types
- The set of `DeviceInterfaces` from a `Device` describes what the device can do

Notifications

- `Solid::DeviceNotifier::deviceAdded(QString)`
- `Solid::DeviceNotifier::deviceRemoved(QString)`

Hardware discovery (2/2)

What's good in there?

Find devices

- `Solid::Device::allDevices()`
- `Solid::Device::devicesFromType()`
- `Solid::Device::devicesFromQuery()`

```
QList<Solid::Device> all
    = Solid::Device::allDevices();
```

Hardware discovery (2/2)

What's good in there?

Find devices

- `Solid::Device::allDevices()`
- `Solid::Device::devicesFromType()`
- `Solid::Device::devicesFromQuery()`

```
QList<Solid::Device> processors
    = Solid::Device::listFromType(
            Solid::DeviceInterface::Processor);
```

Hardware discovery (2/2)

What's good in there?

Find devices

- `Solid::Device::allDevices()`
- `Solid::Device::devicesFromType()`
- `Solid::Device::devicesFromQuery()`

```
QList<Solid::Device> usbDrives
    = Solid::Device::listFromQuery(
            "StorageDrive.bus == 'Usb'");
```

Hardware discovery (2/2)

What's good in there?

Find devices

- Solid::Device::allDevices()
- Solid::Device::devicesFromType()
- Solid::Device::devicesFromQuery()

Manipulate devices

- Solid::Device::is<T>()
- Solid::Device::as<T>()

```
Solid::Device dev = ...
if (dev.is<Solid::Processor>()) {
    ...
```

Hardware discovery (2/2)

What's good in there?

Find devices

- `Solid::Device::allDevices()`
- `Solid::Device::devicesFromType()`
- `Solid::Device::devicesFromQuery()`

Manipulate devices

- `Solid::Device::is<T>()`
- `Solid::Device::as<T>()`

```
Solid::Device dev = ...
if (dev.is<Solid::Camera>()) {
      QVariant handle =
            dev.as<Solid::Camera>()->driverHandle();
      ...
```

Hardware discovery (2/2)

What's good in there?

Find devices

- `Solid::Device::allDevices()`
- `Solid::Device::devicesFromType()`
- `Solid::Device::devicesFromQuery()`

Manipulate devices

- `Solid::Device::is<T>()`
- `Solid::Device::as<T>()`

Demo, "storage-plug" (94 lines)

Network and Energy

Tree and Exhaustion

Solid::Networking

- status() / statusChanged()
- shouldConnect() / shouldDisconnect()

Solid::Powermanagement

- appShouldConserveResources()
- requestSleep()
- begin/stopSuppressSleep()

Network and Energy

Tree and Exhaustion

Solid::Networking

- `status() / statusChanged()`
- `shouldConnect() / shouldDisconnect()`

Solid::Powermanagement

- `appShouldConserveResources()`
- `requestSleep()`
- `begin/stopSuppressSleep()`

Network and Energy

Tree and Exhaustion

Solid::Networking

- status() / statusChanged()
- shouldConnect() / shouldDisconnect()

Solid::Powermanagement

- appShouldConserveResources()
- requestSleep()
- begin/stopSuppressSleep()

Network and Energy

Tree and Exhaustion

Solid::Networking

- status() / statusChanged()
- shouldConnect() / shouldDisconnect()

Solid::Powermanagement

- appShouldConserveResources()
- requestSleep()
- begin/stopSuppressSleep()

Network and Energy

Tree and Exhaustion

Solid::Networking

- status() / statusChanged()
- shouldConnect() / shouldDisconnect()

Solid::Powermanagement

- appShouldConserveResources()
- requestSleep()
- begin/stopSuppressSleep()

Questions?

Kevin Ottens
ervin@kde.org