Esto
An Eclipse-Based Embedded S/W Development Tool

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Outlines

- About ETRI
- Embedded S/W Technology Center
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    - Qplus/Target Builder
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  - Esto Project Manager
  - Esto Debugger
  - Esto Monitor
  - Device Driver Development Tool
  - Energy Profiling Tool
  - On-chip Debugger
ETRI is Korea’s largest government funded research facility in the fields of Information Technology and Communications.

- Established in 1976
- 1,900 researchers
- Organization
  - 10 Divisions
  - 1 Laboratory

Research Groups

- Telematics
- Mobile Telecom.
- Digital Broadcasting
- Digital Home
- Intelligent Robot
- Broadband Convergence Net.
- Digital Content
- Information Security
- IT Services
- Future Technology

Basic Research Lab
ETRI has world class research professionals with more than 90% holding master’s or doctoral degrees.
Customers

Industry
- Collaborative Research with Leading Companies
- A vital supplier for innovative technologies to small and medium-sized companies.

Public
- National R&D projects to boost the national economy.
- Basic and fundamental research to lead the country’s competitive power.
Embedded S/W Technology Center

- Embedded Software Development Tool Research Team
- Embedded OS Research Team
- Embedded GUI Research Team
- Real-time Multimedia Research Team
- Robot/Telematics S/W Platform Research Team
- Wireless Internet Platform Research Team
- Software Engineering Research Team
- Ubiquitous Computing Middleware Research Team
Vision of Our Center

Embedded, Everywhere

SmarTown

Smart Citizen

Smart Home

SmarTown

Server  HomeServer  Personal Server  Webservice Server
Client  Consumer Electronics  Wearable Device  Embedded Sys.
Network  Home Network  Personal Area Network  Ubiquitous Network
Service  Home Service  Mobile Service  Ubiquitous Service
Embedded Software Platform

- Crime/Disaster Prevention
- Information Appliances
- Education
- Personal Devices

- Network
- Broadband
- Wireless
- Internet

- Standard Embedded S/W Platform
- Micro Embedded S/W Platform
- Nano Embedded S/W Platform

- Environment
- Military / Aerospace
- Medical Service
- Transportation

Embedded S/W Technology Center
Embedded Software Platform

- **Standard Embedded S/W Platform IDE**
  - **Application**: Crime/Disaster Prevention
  - **Embedded GUI & Multimedia**: Standard OS
  - **Ubiquitous Computing M/W**: Connected MM
  - **Embedded OS**: Standard Embedded S/W Platform
  - **HAL**: Mid-to-large H/W

- **Micro Embedded S/W Platform IDE**
  - **Application**: Environment
  - **Embedded GUI & Multimedia**: Connected MM
  - **Ubiquitous Computing M/W**: Context Aware
  - **Embedded OS**: Micro Embedded S/W Platform
  - **HAL**: Small H/W

- **Nano Embedded S/W Platform IDE**
  - **Application**: Transportation
  - **Embedded GUI & Multimedia**: Connected MM
  - **Ubiquitous Computing M/W**: Context Aware
  - **Embedded OS**: Nano Embedded S/W Platform
  - **HAL**: Tiny H/W

- **Components**:
  - **Sensor**
  - **Actuator**
  - **Processing**
  - **Communication**
  - **Storage**
  - **Power**

- **Technologies**:
  - **Standard Embedded S/W Platform IDE**
  - **Micro Embedded S/W Platform IDE**
  - **Nano Embedded S/W Platform IDE**
  - **HAL**
  - **Embedded OS**
  - **Embedded GUI & Multimedia**
  - **Ubiquitous Computing M/W**
  - **Application**
  - **Sensor**
  - **Actuator**
  - **Processing**
  - **Communication**
  - **Storage**
  - **Power**
The HomeServer based on **Embedded Linux**

Embedded Linux Development Solutions including **Target Builder & Esto**

**Home Appliance Control**

**Home Entertainments**

**Multimedia Collaboration**

**HomeServer**
Home Entertainments

- DVD, MP3, D-TV
- Web Browser (named WebJABI)
  - Platform independent Java-based Web Browser
  - Supports W3C Standards (HTTP1.1, HTML4.0, CSS1, SSL)
  - Supports Javascript 1.5, Java Applet
  - Upgrading to support DHTML, XHTML, Flash, etc.

- eBook Reader
  - Platform independent Java-based eBook Reader
  - Supports the Open E-Book 1.0 International Standard
  - Displays XML, HTML4.0 and Web Images (GIF and PNG)
Home Appliance Control

**Middleware independent**
**Home Appliance Control Service**

The World 1st
**Integrated Control Middleware(CM)**

- **Jini** for Data network
- **HAVi** for AV Network
- **LonWorks** for Control Net.

Various Home Appliances
Multimedia Collaboration beyond DTV

Normal VoIP Service

- Telephone
- Camera
- HomeServer

VoIP service providers

call

push “**”

Voice talk

VoIP with Video and Collaboration

- Video
- Collaboration (CoBrowsing, WhiteBoard, FilePush)

DTV

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Embedded S/W Technology Center
Qplus

- Embedded Linux Solution for Digital Devices of ETRI

Qplus Components

- Linux Kernel 2.4.x with Preemptive Patch Applied
- GUI Libraries: TinyX/GTK, QT/Embedded, ...
- System Applications: Busybox, Tinylogin, Boa, ...
- Multimedia Applications: MPEG1-2-4, DVD, MP3 player, ...
- Java Applications: Web Browser(WebJABI), E-Book

Foot-print

- Start from 2MByte ~

Target Builder

- OS Configuration & Embedding Tool

Supported CPUs

- X86, ARM, StrongARM, Xscale, MIPS, PowerPC
An IDE for Developing Qplus (Embedded Linux) Applications

- 2001~2003

Main Features

- Host: Windows and Linux
  - Qt based GUI
- Target: X86, ARM, StrongArm, XScale, MIPS, PowerPC
- C/C++ Cross Compile Tool-chain Based on GNU
- Project Manager
- Remote Debugger
  - Multi-threaded debugging
  - Non-stop debugging
- Remote Monitor
- Remote Profiler
- Power Estimator for ARM Application
Towards Eclipse-Based Esto (Final Goal)

- Esto Project Manager
- Esto Debugger
- Esto Monitor
- Device Driver Development Tool
- Energy Profiling Tool
- On-chip Debugger
- Target Builder
- Timing Analyzer
- Ubiquitous Env. Simulator
- Optimization & Analysis Tool

Applications

Target Agent

Device Driver

Qplus
Towards Eclipse-Based Esto (Current Status)

- **Plug-in Tools in Esto to Eclipse**
  - Began in 2003

- **Tools Currently Plugged in to Eclipse**
  - Esto Project Manager
  - Esto Debugger
  - Esto Monitor

- **Tools to be Plugged in to Eclipse**
  - Device driver Development Tool
  - Energy Profiling Tool
  - On-chip Debugger
  - Target Builder
Embedded Application Development by Using Eclipse-Based Esto

Creating Application Project

Editing and Building Source Code

Remote Debugging

Remote Monitoring
Esto Project Manager

- **Management of Application Projects without Makefile**
  - Creating project
  - Modifying project information
  - Building project
  - Executing project remotely

- **Implementation for Plugging in to Eclipse**
  - Esto project manager core is plugged in to Eclipse.
  - Eclipse CDT is modified for Esto project manager GUI.
Esto Project Manager

Project Creating Window

Project Setting Window

Build Message
Esto Debugger

- **Remote Debugging**
  - Set remote debugging environment easily
  - Target IP, target port, GDB engine, and so on
  - Start with just one click

- **Non-Stop Debugging**

- **Implementation for Plugging in to Eclipse**
  - Eclipse CDT is modified for non-stop debugging GUI.
  - GDB is modified for non-stop debugging engine.
Esto Debugger

Non-Stop Debugging: Debugging Solution for Time-Sensitive Applications

- Stopping at Breakpoint
  - Behave abnormally
  - Expected event doesn’t occur

- Trace and Replay
  - Add tracepoints and specify what information to collect
  - Just Run!
  - Doesn’t stop at tracepoint
  - Application runs at normal speed
  - Replay application to inspect collected information
Esto Debugger

- Replay View
  - Tracepoint List
  - Tracepoint at Source
  - Traced Information View
  - Menu for Non-Stop Debugging
Monitoring Target Resources

- System Info.
- Memory Info.
- Process Info.
- Resource Info.
Device Driver Development Tool

- **Features**
  - **Driver Wizard**
    - Guide you to generate skeleton code of device driver
    - Immediate H/W access and diagnosis
  - **Remote Development Support**
    - Download device driver to target
    - Install/Remove/List device drivers
  - **Dedicated IDE**

- **Current Status**
  - GUI part is being plugged in to Eclipse.
Device Driver Development Tool

1. Select device bus type (USB/PCI)
2. Select device and enter driver file name
3. Test device
4. Define driver basic information
5. Select device driver file operations

- Device driver source browser
- Device driver skeleton code
- Generating skeleton code
- Output window
Energy Profiling Tool

- Measure Application’s Energy
  - By using digital multimeter
  - Target processor: XScale

Target System

- Embedded S/W
- System Monitor

Data Collection & Matching System

- Digital Multimeter
- Power Source
- Power Sample
- Ext. Trigger
- PC/PID Samples

- Energy Monitor
- Symbol Tables

Energy Analyzer

- Energy Profile

PC/PID Samples
Energy Profiling Tool

- Display Collected Data

![Diagram showing a screenshot of the Energy Profiling Tool interface. The interface includes a call tree, a table with columns for Function, Energy (mJ), Energy Ratio, Pf_1, PFRatio, Graph, and Optimization Method. It also highlights a line chart for Energy Ratio Graph and a section for Optimization Suggestion.]

- Location of Function

- Energy Consumption per Function

- Optimization Suggestion
On-chip Debugging

- Need Only a Cheap JTAG Adaptor
- Use GDB and Insight Debugger GUI

Diagram:
- Host
- JTAG Adaptor
- Simple Power Transformer
- Parallel
- XScale Target
On-chip Debugging

- Enable Economic On-chip Debugging with Eclipse

- **Current Status**
  - Slow Debugging due to low speed of parallel port
  - Plug in to Eclipse in progress

- **This Year’s Plan**
  - Use of USB 2.0 instead of parallel port → Faster debugging speed
Target Builder:
OS Configuration & Embedding Tool

- Unified Configuration System
  - You can configure kernel, packages and target specific options altogether.
  - Dependencies are checked automatically.

- Create Embedded Linux System in just a few minutes
  - Just load provided pre-configurations for each BSP
  - Point & Click selection of OS component with easy to use GUI interface
  - Deploy to the target simply by clicking a ‘Deploy’ button

- Current Status
  - Target Builder GUI is being plugged in to Eclipse.
Target Builder : Look & Feel

Unified Configuration Tree

Type, Size, ...

Help, File List, Dependency

Build Log
Future Works

- Improve Esto Debugger
  - Multi-threaded Debugging
- Develop Timing Analyzer for Real-Time System
- Develop Simulator for Ubiquitous Environment
- Develop Optimization and Analysis Tool for Power, Time, Size
Epilogue

Towards Eclipse-Based Esto

- Until now, we plugged in our basic embedded solution tools, project manager, debugger, and monitor to Eclipse.
- Currently, we are plugging in device driver development tool, target builder, on-chip debugger, and energy profiling tool to Eclipse.
- Finally, we will popularize our Eclipse-based embedded solution tools in Korea and then worldwide.
Opinions about Plugging in to Eclipse

- Eclipse is very powerful in adding new tool, but process of making plug-in is not easy.
- A more enhanced tool for developing plug-in is needed.
  - e.g., A tool to make a plug-in more easily
- A more enhanced tool or model for developing GUI program is needed.
  - A tool to help design of GUI part
  - A more enhanced event-handling model, e.g., Qt’s Signal&Slot model
- It is difficult for Eclipse beginner to learn Eclipse SDK at first since Eclipse IDE is a little bit complex.