The main feature of the proposed system

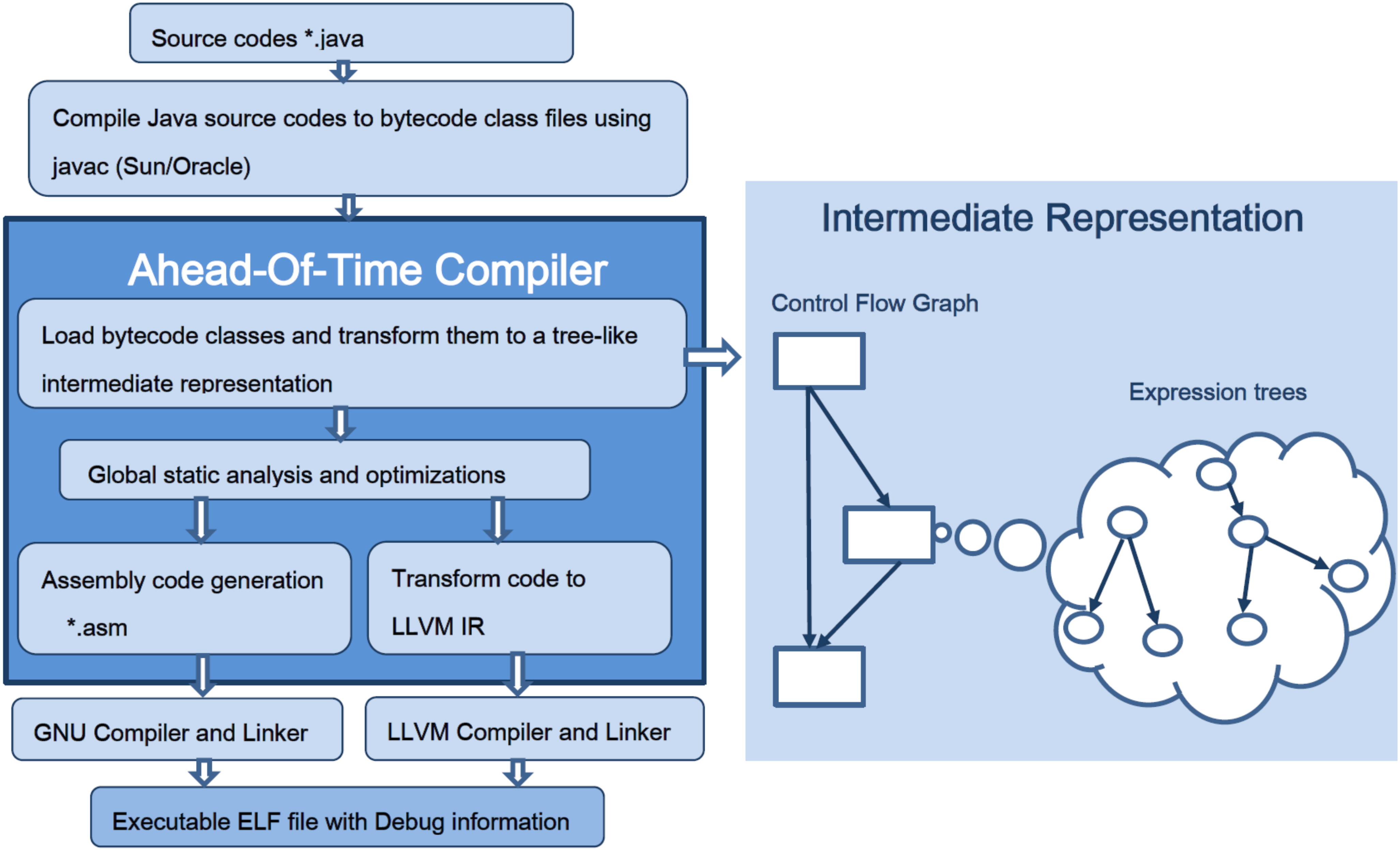
Easy and effective programming in Java with speed and fast responce inherent to C.

System description

The system consists of the following main parts

- Fully static compiler
- The compact and efficient runtime
- The GUI design can be extended with industry standard frameworks and APIs

Ahead-Of-Time compiler structure



Fully static compiler

- Translation of Java programs directly to the x86 assembler
- Seamless integration of Java programs with C programs in the same project
- Global static analysis in the compiler
- Fully static garbage collection

Translation of Java programs directly to the x86 assembler

*The system contains the original compiler, which uses *.class files, generated by javac as input.*

The compiler generates intermediate file in x86 assembly language.

The compiler also can generate code in the form of intermediate representation for LLVM, which then can be translated into an efficient assembly code for x86.

Seamless integration of Java programs with C programs in the same project

- Methods of the Java classes have a direct correspondence to the C functions, no intermediate layer like JNI;

- The project could be a mix of Java code and C code, there is Java subtree and C subtree in the main project;

- Building the project will be done by simple pressing a key, as is common in C projects;

- Debugger is easy to use, it shows breakpoints and debug info in Java and C sources.

Global static analysis in the compiler

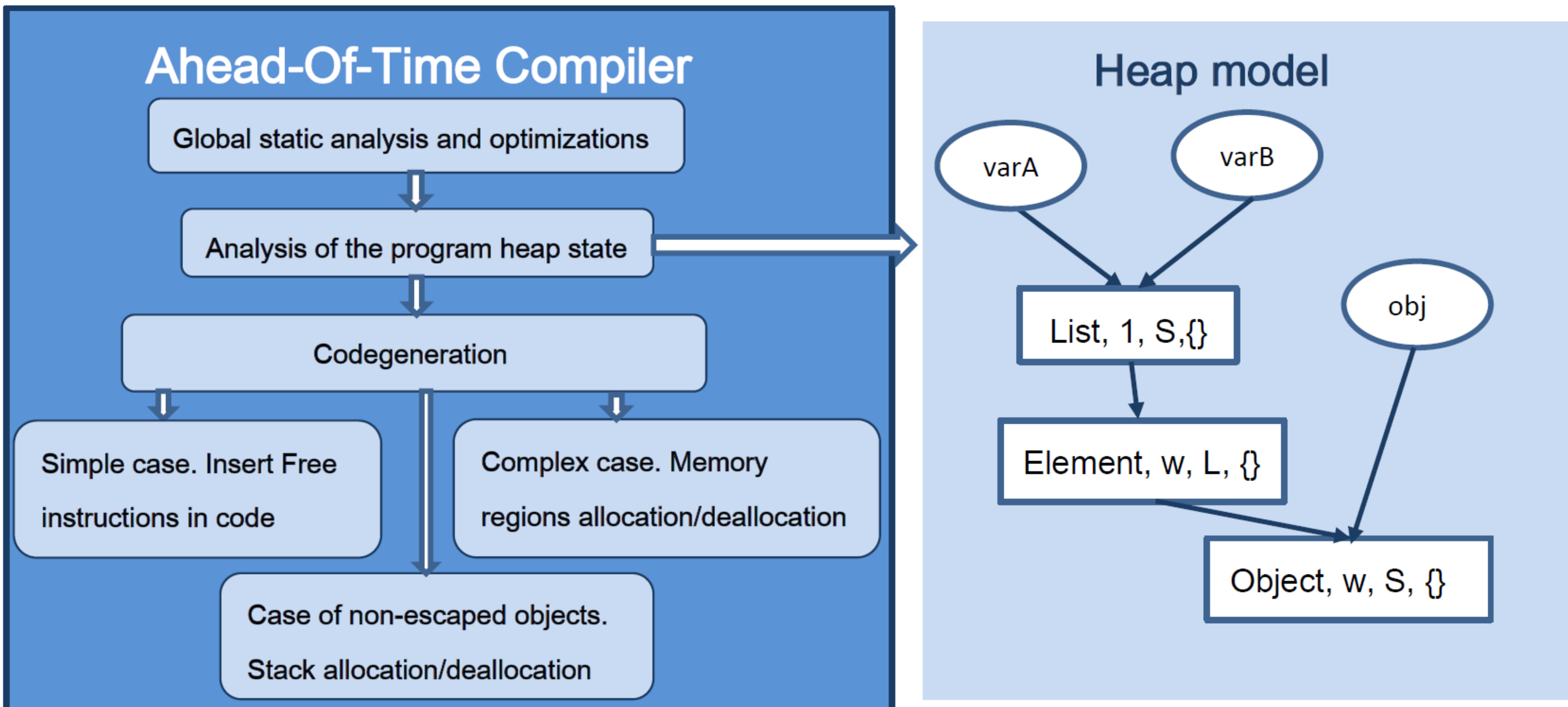
The compiler performs a series of global static analysis of the code. There are some analysis results:

- *Removing unused virtual method calls;*
- *Eliminating redundant monitors in synchronized methods, etc;*

Such code transformations improves performance and reduces code size, which is very important for embedded systems.

Fully static garbage collection

The garbage collection is a very important problem in the embedded systems, traditional methods creates too many non-determinism in program behavior. This problem is solved in presented system, garbage collection is made entirely statically.



The compact and efficient runtime system

- Ultra compact runtime core, which contains Java basic functionality (memory allocation , multitasking management , exceptions , …)

- Library of Java classes, for the various commonly used peripheral devices

Compact runtime core

The kernel size is less then 1 Kb minimum and is about 8-14 Kb typical of flash memory. All basic functions are implemented directly over CPU without any intermediate level. For example:

- *Multitasking is implemented as native methods java.lang.Thread;*
- *Synchronization is a direct implementation of the function enter to monitor or exit;*
- *Notification waiting is implemented as native methods java.lang.Object.wait/notify.*

So, typical kernel size is about few Kb and this is not overhead cased by using Java, because in fact, there is a special equivalent of the built-in RTOS is provided.

Library of Java classes, for the abstraction of various peripheral devices

System provides easy work with peripheral devices. Library of Java classes contains classes for different cases:

- *Various Java classes for commonly used peripherals(USART, SPI, I2C, ADC, Timer, Inputs/Outputs, Interrupted Inputs, PWM, Input Capture);*
- *Special classes for other devices(Matrix Keyboard, Lightweight Timer), including devices from the robotics (Servo Motor, Wheel Encoder, Ultrasonic Range Meter);*
- *The work with interrupts is comfortable, low-level part is hidden form user by default and a practical interrupt handling uses abstraction like DPC or interrupt listeners;*

All these features makes easy to create devices, for example based on Arduino, but is much more convenient to create actual complex projects.

The GUI design can be extended with industry standard frameworks and APIs

- Creating a GUI with common IDE, depending on the class of devices - JME or Android

- Compiling a GUI declarative structures in x86 assembler and linking with the rest part of the project

- Using of specially adapted graphical runtime library

System Use-Cases

Intel Quark Microcontroller Families	JME		Android	
	Without Display	Low Resolution Display	Low Resolution Display	High Resolution Display
Quark SRAM 8-32kb FLASH 16-128kb				
Quark SRAM 32-64kb FLASH 128-256kb				
Curie SRAM 80kb FLASH 384kb				
Quark SRAM 128 – 256kb FLASH 512-1024kb				
Quark SRAM over 256kb FLASH over 1024kb				

Not suitable	Less suitable	Suitable	Most suitable