

OneUp Wi-11 Simulator

Generated by Doxygen 1.7.2

Sat Jan 22 2011 16:36:22

Contents

1	Main Page	1
1.1	Introduction	1
1.2	Object Files	1
1.2.1	The Header Record	1
1.2.2	Text Records	2
1.2.3	The End Record	2
1.3	Interaction	3
1.3.1	Components	3
1.3.2	Wi11 Instruction Set	3
2	Directory Hierarchy	5
2.1	Directories	5
3	Namespace Index	7
3.1	Namespace List	7
4	Class Index	9
4.1	Class Hierarchy	9
5	Class Index	11
5.1	Class List	11
6	File Index	13
6.1	File List	13
7	Directory Documentation	15
7.1	code/ Directory Reference	15
7.2	code/test/ Directory Reference	17
8	Namespace Documentation	19
8.1	Codes Namespace Reference	19
8.1.1	Detailed Description	19
8.2	Decoder Namespace Reference	19
8.2.1	Detailed Description	20
9	Class Documentation	21

9.1	Wi11::CCR Struct Reference	21
9.1.1	Detailed Description	21
9.2	iDecoder Class Reference	21
9.2.1	Detailed Description	22
9.2.2	Member Function Documentation	22
9.2.2.1	DecodeInstruction	22
9.3	iLoader Class Reference	22
9.3.1	Detailed Description	23
9.3.2	Constructor & Destructor Documentation	23
9.3.2.1	iLoader	23
9.3.3	Member Function Documentation	23
9.3.3.1	Load	23
9.4	iMemory Class Reference	24
9.4.1	Detailed Description	25
9.4.2	Member Function Documentation	25
9.4.2.1	Reserve	25
9.4.2.2	Load	25
9.4.2.3	Store	26
9.5	Instruction Struct Reference	26
9.5.1	Detailed Description	26
9.5.2	Member Data Documentation	27
9.5.2.1	data	27
9.6	iObjParser Class Reference	28
9.6.1	Detailed Description	28
9.6.2	Member Function Documentation	28
9.6.2.1	Initialize	28
9.6.2.2	GetNext	29
9.7	iRegister Class Reference	29
9.7.1	Detailed Description	31
9.7.2	Member Function Documentation	32
9.7.2.1	GetValue	32
9.7.2.2	Add	32
9.7.2.3	Add	32
9.7.2.4	operator+	33
9.7.2.5	Subtract	33
9.7.2.6	Subtract	33
9.7.2.7	operator-	34
9.7.2.8	And	34
9.7.2.9	And	34
9.7.2.10	Or	34
9.7.2.11	Or	35
9.7.2.12	Not	35
9.7.2.13	Not	35
9.7.2.14	Store	36
9.7.2.15	Store	36
9.7.2.16	operator=	36

9.7.2.17	operator=	37
9.7.2.18	operator++	37
9.7.2.19	operator++	37
9.8	iWi11 Class Reference	37
9.8.1	Detailed Description	40
9.8.2	Constructor & Destructor Documentation	40
9.8.2.1	iWi11	40
9.8.3	Member Function Documentation	41
9.8.3.1	_GetRegister	41
9.8.3.2	_Add	41
9.8.3.3	_Add	41
9.8.3.4	_And	42
9.8.3.5	_And	42
9.8.3.6	_Branch	43
9.8.3.7	_Debug	43
9.8.3.8	_JSR	44
9.8.3.9	_JSRR	44
9.8.3.10	_Load	45
9.8.3.11	_Loadl	45
9.8.3.12	_LoadR	46
9.8.3.13	_Not	46
9.8.3.14	_Ret	47
9.8.3.15	_Store	47
9.8.3.16	_STI	47
9.8.3.17	_STR	48
9.8.3.18	_Trap	48
9.8.3.19	LoadObj	49
9.8.3.20	DisplayMemory	50
9.8.3.21	DisplayRegisters	50
9.8.3.22	ExecuteNext	50
9.9	iWord Class Reference	51
9.9.1	Detailed Description	53
9.9.2	Member Function Documentation	53
9.9.2.1	ToInt	53
9.9.2.2	ToInt2Complement	53
9.9.2.3	ToStr	54
9.9.2.4	ToHex	54
9.9.2.5	FromInt	54
9.9.2.6	FromStr	55
9.9.2.7	FromHex	55
9.9.2.8	Add	56
9.9.2.9	operator+	56
9.9.2.10	Subtract	56
9.9.2.11	operator-	57
9.9.2.12	And	57
9.9.2.13	Or	58

9.9.2.14	Not	58
9.9.2.15	Copy	58
9.9.2.16	operator=	59
9.9.2.17	operator++	59
9.9.2.18	operator++	59
9.9.2.19	operator[]	59
9.9.2.20	SetBit	60
9.10	Loader Class Reference	60
9.10.1	Detailed Description	62
9.10.2	Member Function Documentation	62
9.10.2.1	iLoader	62
9.10.2.2	Load	62
9.11	Memory Class Reference	63
9.11.1	Detailed Description	64
9.11.2	Member Function Documentation	64
9.11.2.1	Reserve	64
9.11.2.2	Load	65
9.11.2.3	Store	65
9.12	ObjectData Struct Reference	66
9.12.1	Detailed Description	66
9.13	ObjParser Class Reference	66
9.13.1	Detailed Description	68
9.13.2	Member Function Documentation	68
9.13.2.1	Initialize	68
9.13.2.2	GetNext	68
9.14	Register Class Reference	69
9.14.1	Detailed Description	72
9.14.2	Member Function Documentation	72
9.14.2.1	GetValue	72
9.14.2.2	Add	72
9.14.2.3	Add	72
9.14.2.4	operator+	73
9.14.2.5	Subtract	73
9.14.2.6	Subtract	73
9.14.2.7	operator-	74
9.14.2.8	And	74
9.14.2.9	And	74
9.14.2.10	Or	75
9.14.2.11	Or	75
9.14.2.12	Not	75
9.14.2.13	Not	76
9.14.2.14	Store	76
9.14.2.15	Store	76
9.14.2.16	operator=	76
9.14.2.17	operator=	77
9.14.2.18	operator++	77

9.14.2.19	operator++	77
9.15	ResultDecoder Class Reference	77
9.15.1	Detailed Description	78
9.15.2	Member Function Documentation	78
9.15.2.1	Find	78
9.15.3	Member Data Documentation	78
9.15.3.1	_codes	78
9.16	Wi11 Class Reference	79
9.16.1	Detailed Description	83
9.16.2	Member Function Documentation	83
9.16.2.1	_GetRegister	83
9.16.2.2	_Branch	83
9.16.2.3	_Debug	84
9.16.2.4	_Ret	84
9.16.2.5	_Trap	84
9.16.2.6	iWi11	85
9.16.2.7	LoadObj	85
9.16.2.8	DisplayMemory	86
9.16.2.9	DisplayRegisters	86
9.16.2.10	ExecuteNext	86
9.17	Word Class Reference	87
9.17.1	Detailed Description	90
9.17.2	Member Function Documentation	90
9.17.2.1	_HasBit	90
9.17.2.2	ToInt	90
9.17.2.3	ToInt2Complement	90
9.17.2.4	ToStr	91
9.17.2.5	ToHex	91
9.17.2.6	FromInt	92
9.17.2.7	FromStr	92
9.17.2.8	FromHex	92
9.17.2.9	Add	93
9.17.2.10	operator+	93
9.17.2.11	Subtract	94
9.17.2.12	operator-	94
9.17.2.13	And	94
9.17.2.14	Or	95
9.17.2.15	Not	95
9.17.2.16	Copy	95
9.17.2.17	operator=	96
9.17.2.18	operator++	96
9.17.2.19	operator++	96
9.17.2.20	operator[]	97
9.17.3	Member Data Documentation	97
9.17.3.1	_value	97

10 File Documentation	99
10.1 iDecoder.h File Reference	99
10.1.1 Detailed Description	100
10.2 iLoader.h File Reference	101
10.2.1 Detailed Description	101
10.3 iMemory.h File Reference	102
10.3.1 Detailed Description	102
10.4 iObjParser.h File Reference	103
10.4.1 Detailed Description	103
10.5 iRegister.h File Reference	103
10.5.1 Detailed Description	104
10.6 iWi11.h File Reference	104
10.6.1 Detailed Description	105
10.7 iWord.h File Reference	106
10.7.1 Detailed Description	106
10.8 Memory.h File Reference	106
10.8.1 Detailed Description	107
10.9 ObjParser.cpp File Reference	108
10.9.1 Detailed Description	108
10.10 ObjParser.h File Reference	109
10.10.1 Detailed Description	109
10.11 Register.h File Reference	110
10.11.1 Detailed Description	110
10.12 Wi11.h File Reference	111
10.12.1 Detailed Description	111
10.13 Word.cpp File Reference	112
10.13.1 Detailed Description	112
10.14 Word.h File Reference	112
10.14.1 Detailed Description	113

Chapter 1

Main Page

1.1 Introduction

The "Wi-11 Machine" is a simple, 16-bit computer architecture. It has 8 general purpose registers, 3 condition code registers (CCRs), and a program counter (PC). This software package is meant to emulate its execution, as well as present the user with information regarding the state of the machine after each instruction is executed. However, before one can delve into the behind-the-scenes details, one must understand the environment. In particular, an understanding of the object file syntax and the interactions between the components used in this project is necessary.

1.2 Object Files

The object files (usually file_name.o) that this simulator accepts are ascii text files with the following structure:

- One [Header Record](#)
- Several [Text Records](#)
- One [End Record](#)

1.2.1 The Header Record

The Header Record is a single line that prepares the system for the storing the instructions to come.

Components

- A capital 'H'. This designates that it is the Header Record.
- A 6 character "segment name" (anything will do).
- A 4-digit Hexadecimal value that corresponds to the "load address" of the program. Instructions can be written starting at this address.
- A second 4-digit Hexadecimal value that denotes the length of the program-load segment (the size of memory into which the instructions will be loaded).

At a glance: There is an 'H', a segment name, the first location where instructions can be written, and the number of memory locations for instructions.

1.2.2 Text Records

Following the Header Record are several Text Records. Each Text Record corresponds to a single machine instruction and, like the header record, is on a single line.

Components

- A capital 'T'. This designates that it is a Text Record.
- A 4-digit hexadecimal value -- The location in memory at which the instruction will be stored.
- A second 4-digit Hexadecimal value -- The encoding of the instruction to be stored.

At a glance: There is a 'T', the location to store the instruction, and the instruction itself.

1.2.3 The End Record

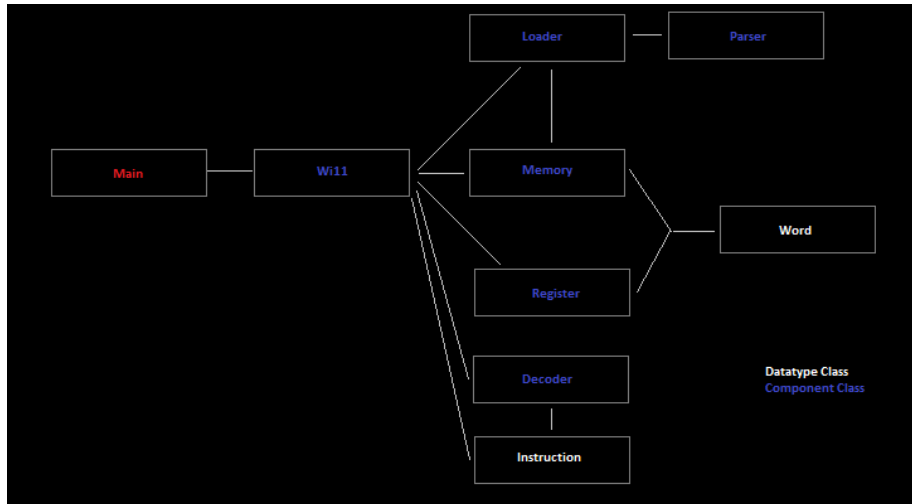
The End Record is, as the name would suggest, the last line of the line. Its purpose is to denote the end of instructions to be written and to give an initial value for the PC.

Components

- The End Record begins with a capital 'E'.
- Next, and last, a 4-digit hexadecimal value to be put into the PC.

At a glance: There is an 'E', and the location in memory from which the first instruction should be fetched.

1.3 Interaction



1.3.1 Components

1.3.2 Wi11 Instruction Set

Chapter 2

Directory Hierarchy

2.1 Directories

This directory hierarchy is sorted roughly, but not completely, alphabetically:

code	15
test	17

Chapter 3

Namespace Index

3.1 Namespace List

Here is a list of all documented namespaces with brief descriptions:

Codes (Values corresponding to the results of Wi-11 function calls)	19
Decoder (Declares register id's and instruction types for each register and instruction)	19

Chapter 4

Class Index

4.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

Wi11::CCR	21
iDecoder	21
iLoader	22
Loader	60
iMemory	24
Memory	63
Instruction	26
iObjParser	28
ObjParser	66
iRegister	29
Register	69
iWi11	37
Wi11	79
iWord	51
Word	87
ObjectData	66
ResultDecoder	77

Chapter 5

Class Index

5.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

Wi11::CCR (Condition code registers: negative, zero, positive)	21
iDecoder (Defines how Wi-11 instructions are decoded)	21
iLoader (Defines how the Wi-11 initializes memory)	22
iMemory (Defines the functionality of memory in the Wi-11 machine)	24
Instruction (Container to simplify interactions with Wi-11 instructions)	26
iObjParser (Defines how object files are processed)	28
iRegister (Defines a "register" in the Wi-11 machine)	29
iWi11 (Defines the internal logic of the Wi-11)	37
iWord (Defines a "word" of data on the Wi-11 Machine)	51
Loader (Implements iLoader)	60
Memory (Implements iMemory)	63
ObjectData (A simple encoding of a "record")	66
ObjParser (Implements iObjParser)	66
Register (Implements iRegister)	69
ResultDecoder (Finds the messages associated with a given result code) . . .	77
Wi11 (Implements iWi11)	79
Word (Implements iWord)	87

Chapter 6

File Index

6.1 File List

Here is a list of all documented files with brief descriptions:

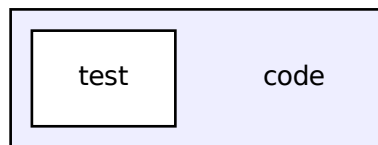
iDecoder.h (Definition of the Wi-11 instruction decoder)	99
iLoader.h (Definition of the Wi-11 program loader)	101
iMemory.h (Definition of Wi-11 memory)	102
iObjParser.h	103
iRegister.h (Definition of a "register" in the Wi-11 machine)	103
iWi11.h (Definition of the Wi-11 machine simulator)	104
iWord.h (Definition of a "word" of data)	106
Loader.h	??
Memory.h (Definition of private data for the "Memory" class)	106
ObjParser.cpp (Implements the declarations in "ObjParser.h")	108
ObjParser.h (Definition of private data for the "ObjParser" class)	109
Register.h (Definition of private data for the "Register" class)	110
ResultCodes.h	??
Wi11.h (Definition of the private data for the "Wi11" class)	111
Word.cpp (Implements the delcarations in "Word.h")	112
Word.h (Definition of private data for the "Word" class)	112

Chapter 7

Directory Documentation

7.1 `code/` Directory Reference

Directory dependency graph for `code/`:



Directories

- directory [test](#)

Files

- file [iDecoder.h](#)

Definition of the Wi-11 instruction decoder.

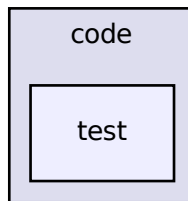
- file [iLoader.h](#)
Definition of the Wi-11 program loader.
- file [iMemory.h](#)
Definition of Wi-11 memory.
- file [iObjParser.h](#)
- file [iRegister.h](#)
Definition of a "register" in the Wi-11 machine.
- file [iWi11.h](#)
Definition of the Wi-11 machine simulator.
- file [iWord.h](#)
Definition of a "word" of data.
- file **Loader.cpp**
- file **Loader.h**
- file **Main.cpp**
- file **Memory.cpp**
- file [Memory.h](#)
Definition of private data for the "Memory" class.
- file [ObjParser.cpp](#)
Implements the declarations in "ObjParser.h".
- file [ObjParser.h](#)
Definition of private data for the "ObjParser" class.
- file **Register.cpp**
- file [Register.h](#)
Definition of private data for the "Register" class.
- file **ResultCodes.cpp**
- file **ResultCodes.h**
- file **Wi11.cpp**
- file [Wi11.h](#)
Definition of the private data for the "Wi11" class.
- file [Word.cpp](#)
Implements the declarations in "Word.h".

- file [Word.h](#)

Definition of private data for the "Word" class.

7.2 code/test/ Directory Reference

Directory dependency graph for code/test/:



Files

- file **MemoryTest.cpp**
- file **RegisterTest.cpp**
- file **WordTest.cpp**

Chapter 8

Namespace Documentation

8.1 Codes Namespace Reference

Values corresponding to the results of Wi-11 function calls.

Enumerations

- enum **RESULT** {
 ERROR_0, **SUCCESS**, **HALT**, **UNDEFINED**,
 INVALID_OBJECT_FILE, **INVALID_DATA_ENTRY**, **OUT_OF_BOUNDS**, **NOT_HEX** }

8.1.1 Detailed Description

Values corresponding to the results of Wi-11 function calls. An enum is used for efficiency. The code can be returned up the collaboration hierarchy quickly so that, if necessary, the program can print an appropriate error message

Note

[ResultDecoder](#) can be used to do a look-up of the error message.

8.2 Decoder Namespace Reference

Declares register id's and instruction types for each register and instruction.

Enumerations

- enum REGISTER_ID {
 R0, R1, R2, R3,
 R4, R5, R6, R7,
 PC }
• enum INSTRUCTION_TYPE {
 ADD, AND, BRx, DBUG,
 JSR, JSRR, LD, LDI,
 LDR, LEA, NOT, RET,
 ST, STI, STR, TRAP,
 ERROR }

8.2.1 Detailed Description

Declares register id's and instruction types for each register and instruction. With these definitions, the process of executing instructions is made easier as REGISTER_ID's and INSTRUCTION_TYPE's can be used instead of strings.

Chapter 9

Class Documentation

9.1 Wi11::CCR Struct Reference

Condition code registers: negative, zero, positive.

Public Attributes

- bool n
- bool z
- bool p

9.1.1 Detailed Description

Condition code registers: negative, zero, positive.

9.2 iDecoder Class Reference

Defines how Wi-11 instructions are decoded.

Public Member Functions

- virtual [Instruction DecodeInstruction](#) (const [iWord](#) &inst) const =0
Translates the binary instruction into more usable objects.

9.2.1 Detailed Description

Defines how Wi-11 instructions are decoded. This could be a struct or even a function. It is declared as an object for consistency purposes.

9.2.2 Member Function Documentation

9.2.2.1 virtual Instruction iDecoder::DecodeInstruction (const iWord & *inst*) const [pure virtual]

Translates the binary instruction into more usable objects.

Parameters

<i>in</i>	<i>inst</i>	The instruction to be translated.
-----------	-------------	-----------------------------------

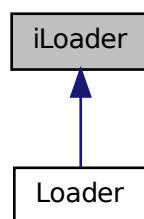
Returns

An [Instruction](#) object as specified in [its documentation](#).

9.3 iLoader Class Reference

Defines how the Wi-11 initializes memory.

Inheritance diagram for iLoader:



Public Member Functions

- virtual [iLoader](#) ([iMemory](#) *mem)=0

Set which [Memory](#) object is to be initialized by this object.

- virtual Codes::RESULT [Load](#) (const char *filename, [iWord](#) &PC_address) const =0

Perform the loads to memory (storing the instructions).

9.3.1 Detailed Description

Defines how the Wi-11 initializes memory. This class loads the instruction from the object file into memory.

9.3.2 Constructor & Destructor Documentation

9.3.2.1 iLoader::iLoader (iMemory * mem) [pure virtual]

Set which [Memory](#) object is to be initialized by this object.

Parameters

in	mem	The address where memory is located.
--------------------	---------------------	--------------------------------------

Note

Without this there would be nowhere to load the instructions.

Implemented in [Loader](#).

9.3.3 Member Function Documentation

9.3.3.1 virtual Codes::RESULT iLoader::Load (const char * filename, iWord & PC_address) const [pure virtual]

Perform the loads to memory (storing the instructions).

Parameters

in	filename	The name of the object file to be read.
out	PC_address	The value to be stored in the PC to start execution. SUCCESS or, if something goes wrong, an appropriate error code.

Note

Multiple object files can be loaded using this, but the PC will be overwritten every

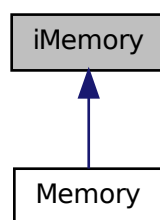
time, so only the last End Record will matter (HOWEVER: the End Records still need to be present in each file).

Implemented in [Loader](#).

9.4 iMemory Class Reference

Defines the functionality of memory in the Wi-11 machine.

Inheritance diagram for iMemory:



Public Member Functions

- virtual Codes::RESULT [Reserve](#) (const [iWord](#) &initial_address, const [iWord](#) &length)=0

Reserves an initial section of memory for instructions.

- virtual [Word Load](#) (const [iWord](#) &w) const =0

Performs a load.

- virtual Codes::RESULT [Store](#) (const [iWord](#) &address, const [Word](#) &value)=0

Performs a store.

- std::vector< [Word](#)[2]> [GetUsedMemory](#) () const =0

9.4.1 Detailed Description

Defines the functionality of memory in the Wi-11 machine. Its size is limited only by addressability ($2^{16}-1$ 16-bit words). It is meant to be implemented in such a way that the memory initialized for instructions can be accessed in constant time while addresses outside this range are accessed in $n \log n$ time.

9.4.2 Member Function Documentation

9.4.2.1 virtual Codes::RESULT iMemory::Reserve (const iWord & *initial_address*, const iWord & *length*) [pure virtual]

Reserves an initial section of memory for instructions.

Parameters

in	<i>initial_</i> - <i>address</i>	The smallest address for the instruction memory.
in	<i>length</i>	The number of addresses to reserve.

Returns

SUCCESS or, if something goes wrong, an appropriate error code.

The memory reserved here is dynamically allocated and provides constant-time access to addresses "initial_address" through "initial_address"+"length"-1.

Implemented in [Memory](#).

9.4.2.2 virtual Word iMemory::Load (const iWord & *w*) const [pure virtual]

Performs a load.

Parameters

in	<i>w</i>	The address from which to load data.
----	----------	--------------------------------------

Returns

The data stored a address "*w*".

Note

If "*w*" is in the range created by Reserve(), it can be accessed in constant time. Otherwise, a maximum of $n \log n$ time is required if *n* is the size of memory initialized outside of these boundaries.

Implemented in [Memory](#).

9.4.2.3 `virtual Codes::RESULT iMemory::Store (const iWord & address, const Word & value)`
`[pure virtual]`

Peforms a store.

Parameters

in	<i>address</i>	The address to store the data.
in	<i>value</i>	The data to store at "address".

Returns

SUCCESS or, if something went wrong, an appropriate error code.

Note

The efficiency constraints in Load() apply here as well.

Implemented in [Memory](#).

9.5 Instruction Struct Reference

Container to simplify interactions with Wi-11 instructions.

Public Attributes

- INSTRUCTION_TYPE [type](#)
The type of instruction.
- std::vector< [Word](#) > [data](#)
The arguemnts to the operation (including unnecessary bits).

9.5.1 Detailed Description

Container to simplify interactions with Wi-11 instructions.

9.5.2 Member Data Documentation

9.5.2.1 `std::vector<Word> Instruction::data`

The arguments to the operation (including unnecessary bits).

Example:

The add instruction comes in two forms:

- `dest_reg = source_reg_1 + source_reg_2` For this form, the encoding (as ordered) is as follows:
 - `dest_reg`
 - `source_reg_1`
 - a 0
 - 2 unused bits
 - `source_reg_2` These segments are each an element of the data vector.
- `dest_reg = source_reg + immediate_value` For this form, the encoding (as ordered) is as follows:
 - op code
 - `dest_reg`
 - `source_reg_1`
 - a 1
 - a 5-bit immediate value These segments are also each an element of the data vector.

In short, any division specified in [Wi11 Instruction Set](#) will be an element of the data vector.

Note

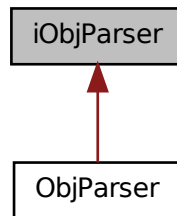
Both of the overloaded instructions (ADD and AND) can be differentiated by the number of divisions:

- ADD with two registers has 5
- ADD with a register and immediate has 4 and
- AND with two registers has 5
- AND with a register and immediate has 4 Thus the fifth bit (either a 1 or 0) is not needed to determine the variation of the instruction (HOWEVER: the 1 or 0 is still included).

9.6 iObjParser Class Reference

Defines how object files are processed.

Inheritance diagram for iObjParser:



Public Member Functions

- virtual `~iObjParser()`=0
Closes a file, if necessarily, when an `iObjParser` object goes out of scope..
- virtual `Codes::Result Initialize (const char *filename)=0`
Attempts to open th object file.
- virtual `ObjectData GetNext ()=0`
Pre-processes the next line of the object file.

9.6.1 Detailed Description

Defines how object files are processed.

9.6.2 Member Function Documentation

9.6.2.1 `virtual Codes::Result iObjParser::Initialize (const char * filename)` [pure virtual]

Attempts to open th object file.

Parameters

<i>in</i>	<i>filename</i>	The name of the object file to be opened.
-----------	-----------------	---

Returns

SUCCESS or, if something went wrong, an appropriate error code.

If another file is open, closes that file first before attempting to open the new one.

Implemented in [ObjParser](#).

9.6.2.2 virtual ObjectData iObjParser::GetNext () [pure virtual]

Pre-processes the next line of the object file.

Precondition

Initialize must have successfully opened a file.

Returns

The encoding of the next instruction.

If there is an error parsing the entry:

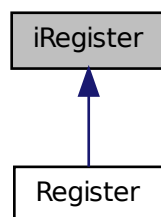
- [ObjectData.type](#) = 0;
- [ObjectData.data](#) = [the faulty encoding]

Implemented in [ObjParser](#).

9.7 iRegister Class Reference

Defines a "register" in the Wi-11 machine.

Inheritance diagram for iRegister:



Public Member Functions

- virtual [Word GetValue](#) () const =0
Retrieves a copy of the word of data store in the register.
- virtual void [Add](#) (const [iWord](#) &w)=0
Adds a word of data to the calling object.
- virtual [Register Add](#) (const [iRegister](#) &r) const =0
Adds a word of data to the calling object.
- virtual [Register operator+](#) (const [iRegister](#) &r) const =0
A standard add operator.
- virtual void [Subtract](#) (const [iWord](#) &w)=0
Subtracts a word of data from the calling object.
- virtual [Register Subtract](#) (const [iRegister](#) &r) const =0
Subtracts a word of data from the calling object.
- virtual [Register operator-](#) (const [iRegister](#) &r) const =0
A standard subtraction operator.
- virtual void [And](#) (const [iWord](#) &w)=0
Performs a bit-wise and.

- virtual **Register And** (const **iRegister** &r) const =0
Performs a bit-wise and.
- virtual void **Or** (const **iWord** &w)=0
Performs a bit-wise "or".
- virtual **Register Or** (const **iRegister** &r) const =0
Performs a bit-wise or.
- virtual void **Not** ()=0
Performs a bit-wise not.
- virtual **Register Not** () const =0
Performs a bit-wise not.
- virtual void **Store** (const **iWord** &w)=0
Stores a word of data.
- virtual void **Store** (const **iRegister** &r)=0
Stores a copy of another register.
- virtual **Register & operator=** (const **iWord** &w)=0
A standard assignment operator.
- virtual **Register & operator=** (const **Register** r)=0
A standard assignment operator.
- virtual **Register & operator++** ()=0
A standard pre-increment operator.
- virtual **Register & operator++** (int)=0
A standard post-increment operator.

9.7.1 Detailed Description

Defines a "register" in the Wi-11 machine. The methods present in this interface are meant to mimic the functionality of the Wi-11 machine, allowing for simplified execution of the instructions therein. This interface class will serve as a base from which the general purpose registers and program counter of the Wi-11 can be defined.

9.7.2 Member Function Documentation

9.7.2.1 virtual Word iRegister::GetValue () const [pure virtual]

Retrieves a copy of the word of data store in the register.

Postcondition

The value of the calling object is not changed.

Returns

A new [Word](#) object holding the value that is stored in the register.

Implemented in [Register](#).

9.7.2.2 virtual void iRegister::Add (const iWord & w) [pure virtual]

Adds a word of data to the calling object.

Parameters

in	w	The value to be added.
----	---	------------------------

Postcondition

The calling object equals its previous value plus the value of "w"; "w", however, will remain unchanged.

Implemented in [Register](#).

9.7.2.3 virtual Register iRegister::Add (const iRegister & r) const [pure virtual]

Adds a word of data to the calling object.

Parameters

in	r	The value to be added.
----	---	------------------------

Postcondition

Both the calling object and "r" will not be changed.

Returns

A new [Register](#) object holding the value of the calling object plus the value in "r".

Implemented in [Register](#).

9.7.2.4 `virtual Register iRegister::operator+ (const iRegister & r) const` [pure virtual]

A standard add operator.

Note

"result = p + r" is equivalent to "result = p.Add(r)".

Implemented in [Register](#).

9.7.2.5 `virtual void iRegister::Subtract (const iWord & w)` [pure virtual]

Subtracts a word of data from the calling object.

Parameters

in	<i>w</i>	The value to be subtracted.
----	----------	-----------------------------

Postcondition

The calling object equals its previous value minus the value of "w"; "w", however, will remain unchanged.

Implemented in [Register](#).

9.7.2.6 `virtual Register iRegister::Subtract (const iRegister & r) const` [pure virtual]

Subtracts a word of data from the calling object.

Parameters

in	<i>r</i>	The value to be subtracted.
----	----------	-----------------------------

Postcondition

Both the calling object and "r" will not be changed.

Returns

A new [Register](#) object holding the value of the calling object minus the value in "r".

Implemented in [Register](#).

9.7.2.7 virtual Register iRegister::operator- (const iRegister & *r*) const [pure virtual]

A standard subtraction operator.

Note

"result = p - r" is equivalent to "result = r.Subtract(w)".

Implemented in [Register](#).

9.7.2.8 virtual void iRegister::And (const iWord & *w*) [pure virtual]

Performs a bit-wise and.

Parameters

in	<i>w</i>	The value to be "and"ed.
----	----------	--------------------------

Postcondition

The calling object equals its previous value bit-wise and'ed with w.

Implemented in [Register](#).

9.7.2.9 virtual Register iRegister::And (const iRegister & *r*) const [pure virtual]

Performs a bit-wise and.

Parameters

in	<i>r</i>	The value to be "and"ed.
----	----------	--------------------------

Postcondition

Both the calling object and r are not changed.

Returns

A new [Register](#) object holding the value of the calling object bit-wise and'ed with r.

Implemented in [Register](#).

9.7.2.10 virtual void iRegister::Or (const iWord & *w*) [pure virtual]

Performs a bit-wise "or".

Parameters

<i>in</i>	<i>w</i>	The value to be "or"ed.
-----------	----------	-------------------------

Postcondition

The calling object equals its previous value bit-wise or'ed with *w*.

Implemented in [Register](#).

9.7.2.11 virtual Register iRegister::Or (const iRegister & *r*) const [pure virtual]

Performs a bit-wise or.

Parameters

<i>in</i>	<i>r</i>	The value to be "or"ed.
-----------	----------	-------------------------

Postcondition

Both the calling object and *r* are not changed.

Returns

A new [Register](#) object holding the value of the calling object bit-wise or'ed with *r*.

Implemented in [Register](#).

9.7.2.12 virtual void iRegister::Not () [pure virtual]

Performs a bit-wise not.

Postcondition

The calling object's bits are all flipped (e.g. 1001 -> 0110).

Implemented in [Register](#).

9.7.2.13 virtual Register iRegister::Not () const [pure virtual]

Performs a bit-wise not.

Postcondition

The calling object is not changed.

Returns

A new [Register](#) object holding the bit-wise not of the calling object.

Implemented in [Register](#).

9.7.2.14 virtual void iRegister::Store (const iWord & w) [pure virtual]

Stores a word of data.

Parameters

in	w	The value to be store.
----	---	------------------------

Postcondition

The calling object's value is now "w".

Implemented in [Register](#).

9.7.2.15 virtual void iRegister::Store (const iRegister & r) [pure virtual]

Stores a copy of another register.

Parameters

in	r	The register to be copied.
----	---	----------------------------

Postcondition

The calling object's value is now "r".

Implemented in [Register](#).

9.7.2.16 virtual Register& iRegister::operator= (const iWord & w) [pure virtual]

A standard assignment operator.

Note

"r = w" is equivalent to "r.Store(w)"

Implemented in [Register](#).

9.7.2.17 `virtual Register& iRegister::operator= (const Register r) [pure virtual]`

A standard assignment operator.

Note

"r1 = r2" is equivalent to "r1.Store(r2)"

Implemented in [Register](#).

9.7.2.18 `virtual Register& iRegister::operator++ () [pure virtual]`

A standard pre-increment operator.

Returns

A reference to itself.

The object increments its value BEFORE the execution of the current line.

Implemented in [Register](#).

9.7.2.19 `virtual Register& iRegister::operator++ (int) [pure virtual]`

A standard post-increment operator.

Returns

A reference to itself.

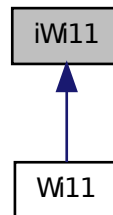
The object increments its value AFTER the execution of the current line.

Implemented in [Register](#).

9.8 iWi11 Class Reference

Defines the internal logic of the Wi-11.

Inheritance diagram for iWi11:



Public Member Functions

- virtual `iWi11` ()=0
Creates and organizes the componts of the `Wi11` machine.
- virtual bool `LoadObj` (const char *filename)=0
Loads the object file and sets up memory as it describes.
- virtual void `DisplayMemory` () const =0
Prints the state of memory to standard out.
- virtual void `DisplayRegisters` () const =0
Prints the state of every register to standard out.
- virtual bool `ExecuteNext` (bool verbose=false)=0
Executes the instruction pointed to by the PC.

Private Member Functions

- virtual `iRegister` & `_GetRegister` (const Decoder::REGISTER_ID &id)=0
Retrieves a reference to the register corresponding to "id".
- virtual Codes::RESULT `_Add` (const Decoder::REGISTER_ID DR, const Decoder::REGISTER_ID SR1, const Decoder::REGISTER_ID SR2)=0

Adds two registers and stores the result in a third.

- virtual Codes::RESULT [_Add](#) (const Decoder::REGISTER_ID DR, const Decoder::REGISTER_ID SR1, const [iWord](#) &immediate)=0

Adds a constant to a register and stores the result in another.

- virtual Codes::RESULT [_And](#) (const Decoder::REGISTER_ID DR, const Decoder::REGISTER_ID SR1, const Decoder::REGISTER_ID SR2)=0

Bit-wise ands two registers and stores the result in a third.

- virtual Codes::RESULT [_And](#) (const Decoder::REGISTER_ID DR, const Decoder::REGISTER_ID SR1, const [iWord](#) &immediate)=0

Bit-wise ands a register with a constant and stores the result in another register.

- virtual Codes::RESULT [_Branch](#) (const [iWord](#) &address)=0

Changes the last 9 bits of the PC.

- virtual Codes::RESULT [_Debug](#) ()=0

Deprecated?

- virtual Codes::RESULT [_JSR](#) (const [iWord](#) &w)=0

Initiate a jump to a subroutine (alter the PC).

- virtual Codes::RESULT [_JSRR](#) (const [iWord](#) &baseR, const [iWord](#) &address)=0

Initiate a jump to a subroutine (alter the PC). param[in] baseR A register whose value acts as a base address.

- virtual Codes::RESULT [_Load](#) (const Decoder::REGISTER_ID DR, const [iWord](#) &address)=0

Loads a word in memory into a register.

- virtual Codes::RESULT [_LoadI](#) (const Decoder::REGISTER_ID DR, const [iWord](#) &address)=0

Performs an indirect load.

- virtual Codes::RESULT [_LoadR](#) (const Decoder::REGISTER_ID DR, Decoder::REGISTER_ID baseR, const [iWord](#) &address)=0

Performs a register-relative load.

- virtual Codes::RESULT [_Not](#) (const Decoder::REGISTER_ID DR, const Decoder::REGISTER_ID SR)=0

Bit-wise nots a register and stores the result in another.

- virtual Codes::RESULT [_Ret](#) ()=0
Return from a subroutine.
- virtual Codes::RESULT [_Store](#) (const Decoder::REGISTER_ID SR1, const [iWord](#) &address)=0
Stores a register's value into memory at a specified address.
- virtual Codes::RESULT [_STI](#) (const Decoder::REGISTER_ID SR1, const [iWord](#) &address)=0
Performs an indirect store.
- virtual Codes::RESULT [_STR](#) (const Decoder::REGISTER_ID SR1, const Decoder::REGISTER_ID baseR, const [iWord](#) &address)=0
Performs a register-relative store.
- virtual Codes::RESULT [_Trap](#) (const [iWord](#) &code)=0
Branches to a trap vector.

9.8.1 Detailed Description

Defines the internal logic of the Wi-11.

The methods present in this interface are meant to simulate the Wi-11's fetch-execute loop. Any implementation of this will be expected to house 8 private instances of the [Register](#) class as general purpose registers and each of these should have an associated REGISTER_ID enum token. A reference to an [iMemory](#) class is also necessary.

The implementers of a super class will also have to incorporate some sort of interaction with a CCR structure. An interface for this interaction is not provided.

9.8.2 Constructor & Destructor Documentation

9.8.2.1 virtual [iWi11::iWi11](#) () [pure virtual]

Creates and organizes the componts of the [Wi11](#) machine.

Initializes the general purpose registers, CCR, and memory.

Implemented in [Wi11](#).

9.8.3 Member Function Documentation

9.8.3.1 `virtual iRegister& iWi11::GetRegister (const Decoder::REGISTER_ID & id)`
`[private, pure virtual]`

Retrieves a reference to the register corresponding to "id".

Parameters

in	<i>id</i>	A REGISTER_ID corresponding to one of the private registers.
----	-----------	--

Returns

A reference to the id'd register.

Implemented in [Wi11](#).

9.8.3.2 `virtual Codes::RESULT iWi11::Add (const Decoder::REGISTER_ID DR, const Decoder::REGISTER_ID SR1, const Decoder::REGISTER_ID SR2)` `[private, pure virtual]`

Adds two registers and stores the result in a third.

Parameters

out	<i>DR</i>	The destination register.
in	<i>SR1</i>	The first source register.
in	<i>SR2</i>	The second source register.

Postcondition

SR1 and SR2 are not changed.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

Note

Updates the CCR.

9.8.3.3 `virtual Codes::RESULT iWi11::Add (const Decoder::REGISTER_ID DR, const Decoder::REGISTER_ID SR1, const iWord & immediate)` `[private, pure virtual]`

Adds a constant to a register and stores the result in another.

Parameters

out	<i>DR</i>	The destination register.
in	<i>SR1</i>	The source register.
in	<i>immediate</i>	The immediate value.

Postcondition

SR1 and "immediate" are not changed.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

Note

Updates the CCR.

```
9.8.3.4 virtual Codes::RESULT iWi11::And ( const Decoder::REGISTER_ID DR, const
      Decoder::REGISTER_ID SR1, const Decoder::REGISTER_ID SR2 ) [private,
      pure virtual]
```

Bit-wise ands two registers and stores the result in a third.

Parameters

out	<i>DR</i>	The destination register.
in	<i>SR1</i>	The first source register.
in	<i>SR2</i>	The second source register.

Postcondition

SR1 and SR2 are not changed.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

Note

Updates the CCR.

```
9.8.3.5 virtual Codes::RESULT iWi11::And ( const Decoder::REGISTER_ID DR, const
      Decoder::REGISTER_ID SR1, const iWord & immediate ) [private, pure
      virtual]
```

Bit-wise ands a register with a constant and stores the result in another register.

Parameters

out	<i>DR</i>	The destination register.
in	<i>SR1</i>	The source register.
in	<i>immediate</i>	The immediate value.

Postcondition

SR1 and "immediate" are not changed.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

Note

Updates the CCR.

9.8.3.6 `virtual Codes::RESULT iWi11::_Branch (const iWord & address)` [private, pure virtual]

Changes the last 9 bits of the PC.

Parameters

in	<i>address</i>	The 9 bits to become the end of the PC.
----	----------------	---

Postcondition

"address" is not changed.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

Implemented in [Wi11](#).

9.8.3.7 `virtual Codes::RESULT iWi11::_Debug ()` [private, pure virtual]

Deprecated?

Does nothing.

Implemented in [Wi11](#).

9.8.3.8 virtual Codes::RESULT iWi11::JSR (const iWord & *w*) [private, pure virtual]

Initiate a jump to a subroutine (alter the PC).

Parameters

in	<i>w</i>	A 9 bit offset for the PC.
----	----------	----------------------------

Postcondition

The PC has "*w*" as its 9 least significant bits.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

Note

If the link bit was set for this instruction, R7 will hold the old value of the PC. However, the CCR will not be altered for this instruction, despite R7 being altered.

9.8.3.9 virtual Codes::RESULT iWi11::JSRR (const iWord & *baseR*, const iWord & *address*) [private, pure virtual]

Initiate a jump to a subroutine (alter the PC). param[in] *baseR* A register whose value acts as a base address.

Parameters

in	<i>address</i>	A 6 bit offset to the base address.
----	----------------	-------------------------------------

Postcondition

The PC is the value in *baseR* plus the value in *address*.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

Note

If the link bit was set for this instruction, R7 will hold the old value of the PC. However, the CCR will not be altered for this instruction, despite R7 being altered.

9.8.3.10 `virtual Codes::RESULT iWi11::_Load (const Decoder::REGISTER_ID DR, const iWord & address)` [*private, pure virtual*]

Loads a word in memory into a register.

Parameters

out	<i>DR</i>	The destination register.
in	<i>address</i>	When concatenated with the PC, forms address in memory from which to load.

Postcondition

[Memory](#) and "address" have not changed.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

Note

Updates the CCR.

9.8.3.11 `virtual Codes::RESULT iWi11::_LoadI (const Decoder::REGISTER_ID DR, const iWord & address)` [*private, pure virtual*]

Performs an indirect load.

Parameters

out	<i>DR</i>	The destination register.
in	<i>address</i>	A 9-bit offset to the PC.

Postcondition

[Memory](#) and "address" have not changed.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

Works similar to `_Load()` but when memory is read, it uses the address found to again access memory. In this indirect way, a load can be made from anywhere in [Memory](#).

Note

Updates the CCR.

9.8.3.12 `virtual Codes::RESULT iWi11::LoadR (const Decoder::REGISTER_ID DR,
Decoder::REGISTER_ID baseR, const iWord & address) [private, pure
virtual]`

Performs a register-relative load.

Parameters

out	<i>DR</i>	The destination register.
in	<i>baseR</i>	A register whose value works as a base address.
in	<i>address</i>	An 6-bit index from the base address.

Postcondition

[Memory](#), "baseR", and "address" have no changed.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

Loads from "baseR" plus "address".

Note

Updates the CCR.

9.8.3.13 `virtual Codes::RESULT iWi11::Not (const Decoder::REGISTER_ID DR, const
Decoder::REGISTER_ID SR) [private, pure virtual]`

Bit-wise nots a register and stores the result in another.

Parameters

out	<i>DR</i>	The destination register.
in	<i>SR</i>	The source register.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

Note

Updates the CCR.

9.8.3.14 `virtual Codes::RESULT iWi11::Ret () [private, pure virtual]`

Return from a subroutine.

Postcondition

The PC now holds the value that was (and still is) in R7.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

Note

This can be used to jump anywhere in memory. However, this is not the intended usage.

Updates the CCR.

Implemented in [Wi11](#).

9.8.3.15 `virtual Codes::RESULT iWi11::Store (const Decoder::REGISTER_ID SR1, const iWord & address) [private, pure virtual]`

Stores a register's value into memory at a specified address.

Parameters

in	<i>SR1</i>	The source register (holds the data to be stored).
in	<i>address</i>	When concatenated with the PC, forms the address for the store.

Postcondition

SR1 and "address" are not changed.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

9.8.3.16 `virtual Codes::RESULT iWi11::STI (const Decoder::REGISTER_ID SR1, const iWord & address) [private, pure virtual]`

Performs an indirect store.

Parameters

in	<i>SR1</i>	The source register (holds the data to be stored).
in	<i>address</i>	A 9-bit offset to the PC.

Postcondition

"SR1" and "address" are not changed.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

Works similar to `_Store()` but when memory is read, it uses the address found to again access memory. In this indirect way, a store can be made to anywhere in [Memory](#).

```
9.8.3.17 virtual Codes::RESULT iWi11::_STR ( const Decoder::REGISTER_ID SR1, const
      Decoder::REGISTER_ID baseR, const iWord & address ) [private, pure
      virtual]
```

Performs a register-relative store.

Parameters

in	<i>SR1</i>	The source register (holds the data to be stored).
in	<i>baseR</i>	A register whose value acts as a base address.
in	<i>address</i>	A 6-bit index from the base address.

Postcondition

SR1, baseR, and "address" are not changed.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

```
9.8.3.18 virtual Codes::RESULT iWi11::_Trap ( const iWord & code ) [private, pure
      virtual]
```

Branches to a trap vector.

Parameters

in	<i>code</i>	The trap code.
----	-------------	----------------

Postcondition

"code" is not changed.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

The traps are as follows:

- 0x21 - OUT - Write the character formed from the eight least significant bits of R0 to standard out.
- 0x22 - PUTS - Write the a string to standard out starting at the address pointed to by R0 and ending at a null character.
- 0x23 - IN - Prompt for, and read, a single character from standard in. Re-print it and store its ascii value in R0 (with leading zeros).
- 0x25 - HALT - End execution and print an appropriate message to standard out.
- 0x31 - INN - Prompt for, and read, a positive decimal number from standard in. Re-print it and store it in R0 (the number must in 16-bit range).
- 0x43 - RND - Generate a random number and store it in R0.

Note

Traps 0x23, 0x31, and 0x43 all update the CCR.

Standard in is the keyboard.
Standard out is the console.

Implemented in [Wi11](#).

9.8.3.19 virtual bool iWi11::LoadObj (const char * *filename*) [pure virtual]

Loads the object file and sets up memory as it describes.

Parameters

<i>in</i>	<i>filename</i>	The name of the object file.
-----------	-----------------	------------------------------

Postcondition

"filename" is not changed.

Returns

True if and only if the load was successful.

If "false" is returned, prints an appropriate error message to the user.

Note

This function can be called multiple times. Each time the PC is overwritten.

Implemented in [Wi11](#).

9.8.3.20 virtual void iWi11::DisplayMemory () const [pure virtual]

Prints the state of memory to standard out.

Postcondition

The calling object is not changed.

Implemented in [Wi11](#).

9.8.3.21 virtual void iWi11::DisplayRegisters () const [pure virtual]

Prints the state of every register to standard out.

Postcondition

The calling object is not changed.

The values of all 8 general purpose registers, the CCR, and PC are all printed.

Implemented in [Wi11](#).

9.8.3.22 virtual bool iWi11::ExecuteNext (bool *verbose* = false) [pure virtual]

Executes the instruction pointed to by the PC.

Parameters

<i>in</i>	<i>verbose</i>	If true, machine state information is displayed after each step.
-----------	----------------	--

Returns

True if and only if the end of the program have been reached.

This function is the brains of the operation, so to speak. Almost the entire fetch-execute loop of the Wi-11 is present here. In particular, this function must interpret the instructions and manage the CCRs.

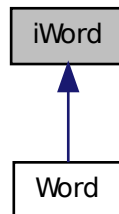
For a complete list of the instructions, see [Wi-11 Instructions](#).

Implemented in [Wi11](#).

9.9 iWord Class Reference

Defines a "word" of data on the Wi-11 Machine.

Inheritance diagram for iWord:



Public Member Functions

- virtual int [ToInt](#) () const =0
"To non-negative Integer"
- virtual int [ToInt2Complement](#) () const =0
"To Integer as 2's Complement"
- virtual std::string [ToStr](#) () const =0
"To String"
- virtual std::string [ToHex](#) () const =0

"To Hexadecimal"

- virtual bool [FromInt](#) (int value)=0
"From Integer"
- virtual bool [FromStr](#) (const std::string &str)=0
"From String"
- virtual bool [FromHex](#) (const std::string &str)=0
"From Hexadecimal"
- virtual [Word Add](#) (const [iWord](#) &w) const =0
Adds two words.
- virtual [Word operator+](#) (const [iWord](#) &w) const =0
A standard addition operator.
- virtual [Word Subtract](#) (const [iWord](#) &w) const =0
Subtracts two words.
- virtual [Word operator-](#) (const [iWord](#) &w) const =0
A standard subtraction operator.
- virtual [Word And](#) (const [iWord](#) &w) const =0
"And"s the bits of two words.
- virtual [Word Or](#) (const [iWord](#) &w) const =0
"Or"s the bits of two words.
- virtual [Word Not](#) () const =0
"Not"s the bits of a word.
- virtual void [Copy](#) (const [iWord](#) &w)=0
Copies a word.
- virtual [Word & operator=](#) (const [Word](#) w)=0
A standard assignment operator.
- virtual [iWord & operator++](#) ()=0
A standard pre-increment operator.
- virtual [iWord & operator++](#) (int)=0

A standard post-increment operator.

- virtual bool [operator\[\]](#) (const int i) const =0
An accessor to the 'i'th bit of the value.
- virtual void [SetBit](#) (const int i)=0
Sets the 'i'th bit of the value.

9.9.1 Detailed Description

Defines a "word" of data on the Wi-11 Machine. The methods present in this interface are meant to mimic the functionality of the Wi-11 machine, allowing for simplified execution of the instructions therein. As the size of a "word" depends on the architecture, classes implementing this interface should define the word length to be 16 bits in length.

9.9.2 Member Function Documentation

9.9.2.1 virtual int iWord::ToInt () const [pure virtual]

"To non-negative Integer"

Postcondition

The value of the word is not changed.

Returns

The bits of the word interpreted as a positive integer value.

Implemented in [Word](#).

9.9.2.2 virtual int iWord::ToInt2Complement () const [pure virtual]

"To Integer as 2's Complement"

Postcondition

The value of the word is not changed.

Returns

The bits of the word interpreted as a signed (2's complement) integer value.

Implemented in [Word](#).

9.9.2.3 `virtual std::string iWord::ToStr () const` `[pure virtual]`

"To String"

Postcondition

The value of the word is not changed.

Returns

16 characters: each either a 1 or 0

Examples:

If the object holds a (2's comp.) value 4: "0000000000000100"

If the object holds a (2's comp.) value -1: "1111111111111111"

Implemented in [Word](#).

9.9.2.4 `virtual std::string iWord::ToHex () const` `[pure virtual]`

"To Hexadecimal"

Postcondition

The value of the word is not changed.

Returns

"0x" + <4 characters in the range [0-9],[A-F]>

Examples:

If the object holds (2's comp.) value 8: "0x0008"

If the object holds (2's comp.) value -2: "0xFFFF"

Implemented in [Word](#).

9.9.2.5 `virtual bool iWord::FromInt (int value)` `[pure virtual]`

"From Integer"

Parameters

<code>in</code>	<code>value</code>	The value to be stored into the word.
-----------------	--------------------	---------------------------------------

Postcondition

"value" is not changed.

Returns

True if and only if "value" can be represented in 16 bits

When this function returns "False", the value of the word is unchanged.

Otherwise, the word now holds the value "value".

Implemented in [Word](#).

9.9.2.6 virtual bool iWord::FromStr (const std::string & str) [pure virtual]

"From String"

Parameters

<code>in</code>	<code>str</code>	A string of characters meant to represent a "word" to be stored.
-----------------	------------------	--

Postcondition

"str" is not changed.

Returns

True if and only if "str" is well-formed (as defined in toStr()).

When this function returns "False", the value of the word is unchanged.

Otherwise, the word now holds the value "str".

Implemented in [Word](#).

9.9.2.7 virtual bool iWord::FromHex (const std::string & str) [pure virtual]

"From Hexadecimal"

Parameters

<code>in</code>	<code>str</code>	A string of characters meant to represent a "word" to be stored.
-----------------	------------------	--

Postcondition

"str" is not changed.

Returns

True if and only if "str" is well-formed (as defined in toHex()).

When this function returns "False", the value of the word is unchanged.

Otherwise, the word now holds the value "str".

Implemented in [Word](#).

9.9.2.8 virtual Word iWord::Add (const iWord & w) const [pure virtual]

Adds two words.

Parameters

<i>in</i>	<i>w</i>	A word value to be added.
-----------	----------	---------------------------

Postcondition

Both "w" and the calling object do not change.

Returns

A new "Word" object containing result of adding "w" and the calling object.

Note

The addition is carried out with no regard to logical overflow.

Implemented in [Word](#).

9.9.2.9 virtual Word iWord::operator+ (const iWord & w) const [pure virtual]

A standard addition operator.

Note

"result = p + w" is equivalent to "result = p.Add(w)".

Implemented in [Word](#).

9.9.2.10 virtual Word iWord::Subtract (const iWord & w) const [pure virtual]

Subtracts two words.

Parameters

<i>in</i>	<i>w</i>	A word value to be subtracted.
-----------	----------	--------------------------------

Postcondition

Both "w" and the calling object do not change.

Returns

A new "Word" object containing the result of subtracting "w" from the calling object.

Note

The subtraction is carried out with no regard for logical overflow.

Implemented in [Word](#).

9.9.2.11 `virtual Word iWord::operator- (const iWord & w) const [pure virtual]`

A standard subtraction operator.

Note

"result = p - w" is equivalent to "result = p.Subtract(w)".

Implemented in [Word](#).

9.9.2.12 `virtual Word iWord::And (const iWord & w) const [pure virtual]`

"And"s the bits of two words.

Parameters

<i>in</i>	<i>w</i>	A word value to be "and"ed.
-----------	----------	-----------------------------

Postcondition

Both "w" and the calling object do not change.

Returns

A new "Word" object containing the result of performing a bit-wise and on "w" and the calling object.

Implemented in [Word](#).

9.9.2.13 `virtual Word iWord::Or (const iWord & w) const` [pure virtual]

"Or"s the bits of two words.

Parameters

<code>in</code>	<code>w</code>	A word value to be "or"ed.
-----------------	----------------	----------------------------

Postcondition

Both "w" and the calling object do not change.

Returns

A new "Word" object containing the result of performing a bit-wise or on "w" and the calling object.

Implemented in [Word](#).

9.9.2.14 `virtual Word iWord::Not () const` [pure virtual]

"Not"s the bits of a word.

Postcondition

The calling object do not change.

Returns

A new "Word" object containing the result of performing a bit-wise not on the calling object.

Implemented in [Word](#).

9.9.2.15 `virtual void iWord::Copy (const iWord & w)` [pure virtual]

Copies a word.

Parameters

<code>out</code>	<code>w</code>	The value to be copied.
------------------	----------------	-------------------------

Postcondition

The caller equals that parameter.

Equivalent to the assignment "caller = parameter".

Implemented in [Word](#).

9.9.2.16 `virtual Word& iWord::operator= (const Word w) [pure virtual]`

A standard assignment operator.

Parameters

<code>in</code>	<code>w</code>	The value to be copied.
-----------------	----------------	-------------------------

Returns

A copy of the parameter.

The return value and parameter here must be declared as "Word"s as C++ does not work well with polymorphic assignment operators.

Implemented in [Word](#).

9.9.2.17 `virtual iWord& iWord::operator++ () [pure virtual]`

A standard pre-increment operator.

Returns

A reference to itself.

The object increments its value BEFORE the execution of the current line.

Implemented in [Word](#).

9.9.2.18 `virtual iWord& iWord::operator++ (int) [pure virtual]`

A standard post-increment operator.

Returns

A reference to itself.

The object increments its value AFTER the execution of the current line.

Implemented in [Word](#).

9.9.2.19 `virtual bool iWord::operator[] (const int i) const [pure virtual]`

An accessor to the *i*'th bit of the value.

Parameters

<code>in</code>	<code>i</code>	The index of the bit in question.
-----------------	----------------	-----------------------------------

Precondition

The index must be less than the size of a word, ie. 16.

Returns

True \Leftrightarrow 1, False \Leftrightarrow 0.

The number of the bits starts at zero and rises into the more significant bits.

Examples:

If the object holds a value of 4 (0...100 in binary): num[2] = 1.

If it holds a value of 1 (0...001 in binary): num[0] = 1.

If it holds a negative value (Starting with a 1 in 2's complement): num[15] = 1.

Implemented in [Word](#).

9.9.2.20 `virtual void iWord::SetBit (const int i) [pure virtual]`

Sets the 'i'th bit of the value.

Parameters

<code>in</code>	<code>i</code>	The index of the bit in question.
-----------------	----------------	-----------------------------------

Precondition

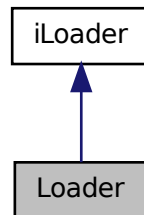
The index must be less than the size of a word, ie. 16.

Works in a similar way to operator[] but sets the bit instead of determining if it is set.

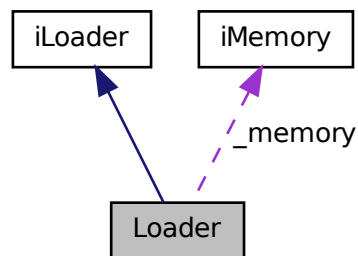
9.10 Loader Class Reference

Implements [iLoader](#).

Inheritance diagram for Loader:



Collaboration diagram for Loader:



Public Member Functions

- **iLoader** (**iMemory** *mem)
*Set which **Memory** object is to be initialized by this object.*
- Codes::RESULT **Load** (const char *filename, **iWord** &PC_address) const
Perform the loads to memory (storing the instructions).

Private Attributes

- [iMemory](#) * `_memory`

9.10.1 Detailed Description

Implements [iLoader](#).

9.10.2 Member Function Documentation

9.10.2.1 `Loader::iLoader (iMemory * mem)` `[virtual]`

Set which [Memory](#) object is to be initialized by this object.

Parameters

<code>in</code>	<code><i>mem</i></code>	The address where memory is located.
-----------------	-------------------------	--------------------------------------

Note

Without this there would be nowhere to load the instructions.

Implements [iLoader](#).

9.10.2.2 `Codes::RESULT Loader::Load (const char * filename, iWord & PC_address) const` `[virtual]`

Perform the loads to memory (storing the instructions).

Parameters

<code>in</code>	<code><i>filename</i></code>	The name of the object file to be read.
<code>out</code>	<code><i>PC_address</i></code>	The value to be stored in the PC to start execution. SUCCESS or, if something goes wrong, an appropriate error code.

Note

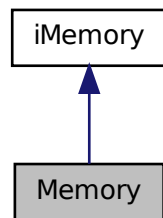
Multiple object files can be loaded using this, but the PC will be overwritten every time, so only the last End Record will matter (HOWEVER: the End Records still need to be present in each file).

Implements [iLoader](#).

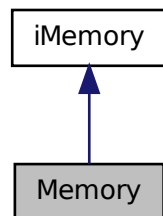
9.11 Memory Class Reference

Implements [iMemory](#).

Inheritance diagram for Memory:



Collaboration diagram for Memory:



Public Member Functions

- virtual Codes::RESULT [Reserve](#) (const [iWord](#) &initial_address, const [iWord](#) &length)

Reserves an initial section of memory for instructions.

- virtual [Word Load](#) (const [iWord](#) &) const
Performs a load.
- virtual Codes::RESULT [Store](#) (const [iWord](#) &address, const [Word](#) &value)
Performs a store.
- std::vector< [Word](#)[2]> [GetUsedMemory](#) () const

Private Attributes

- std::vector< [Word](#) * > [_bounded_memory](#)
Provide constant time access to reserved memory.
- std::vector< int > [_segment_offsets](#)
Keep track of the initial addresses.
- std::vector< int > [_segment_lengths](#)
Keep track of the size of reserved memory.
- std::map< int, [Word](#) > [_unbounded_memory](#)
Map out-of-bounds values to new Words.

9.11.1 Detailed Description

Implements [iMemory](#).

9.11.2 Member Function Documentation

9.11.2.1 RESULT Memory::Reserve (const [iWord](#) & *initial_address*, const [iWord](#) & *length*) [virtual]

Reserves an initial section of memory for instructions.

Parameters

in	<i>initial_ - address</i>	The smallest address for the instruction memory.
in	<i>length</i>	The number of addresses to reserve.

Returns

SUCCESS or, if something goes wrong, an appropriate error code.

The memory reserved here is dynamically allocated and provides constant-time access to addresses "initial_address" through "initial_address"+"length"-1.

Implements [iMemory](#).

9.11.2.2 Word Memory::Load (const iWord & w) const [virtual]

Performs a load.

Parameters

<i>in</i>	<i>w</i>	The address from which to load data.
-----------	----------	--------------------------------------

Returns

The data stored a address "w".

Note

If "w" is in the range created by Reserve(), it can be accessed in constant time. Otherwise, a maximum of nlogn time is required if n is the size of memory initialized outside of these boundaries.

Implements [iMemory](#).

9.11.2.3 RESULT Memory::Store (const iWord & address, const Word & value) [virtual]

Performs a store.

Parameters

<i>in</i>	<i>address</i>	The address to store the data.
<i>in</i>	<i>value</i>	The data to store at "address".

Returns

SUCCESS or, if something went wrong, an appropriate error code.

Note

The efficiency constraints in Load() apply here as well.

Implements [iMemory](#).

9.12 ObjectData Struct Reference

A simple encoding of a "record".

Public Attributes

- char [type](#)
The type of record: 'H', 'T', or 'E'.
- std::vector< std::string > [data](#)
The segments of the record.

9.12.1 Detailed Description

A simple encoding of a "record".

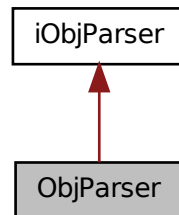
The format of this component is dependent upon the kind of record it is representing.

- Header Record (type = 'H')
 - data.size() = 3
 - * data[0] = [Segment Name]
 - * data[1] = [Initial Load Address (as a hex string)]
 - * data[2] = [Segment Length (as a hex string)]
- Text Records (type = 'T')
 - data.size() = 2
 - * data[0] = [Address of Data (as a hex string)]
 - * data[1] = [Data (as a hex string)]
- End Records (type = 'E')
 - data.size() = 1
 - * data[0] = [Initial PC Address (as a hex string)]

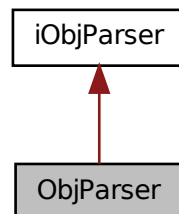
9.13 ObjParser Class Reference

Implements [iObjParser](#).

Inheritance diagram for ObjParser:



Collaboration diagram for ObjParser:



Public Member Functions

- [~ObjParser](#) ()
Closes _fileStream if it is currently open.
- Codes::Result [Initialize](#) (const char *name)
Closes _fileStream if necessary, then opens the file defined by "name".
- [ObjectData GetNext](#) ()

Reads the next line from the current object file and parses it into an [ObjectData](#) struct for use by the loader.

Private Attributes

- ifstream [_fileStream](#)

Maintains an input stream from the object file specified by the "name" parameter to Initialize.

9.13.1 Detailed Description

Implements [iObjParser](#).

9.13.2 Member Function Documentation

9.13.2.1 Codes::Result iObjParser::Initialize (const char * *name*) [virtual]

Closes [_fileStream](#) if necessary, then opens the file defined by "name".

Parameters

<i>name</i>	The name of the file to be opened, including extension.
-------------	---

Returns

Codes::SUCCESS if the file is successfully opened, Codes::FILE_NOT_FOUND otherwise.

Closes [_fileStream](#) if it is currently open.

Opens the file defined by "name".

Determine whether the file was successfully opened and return the appropriate result code.

Implements [iObjParser](#).

9.13.2.2 ObjectData iObjParser::GetNext () [virtual]

Reads the next line from the current object file and parses it into an [ObjectData](#) struct for use by the loader.

Precondition

Initialize(name) has been called and _fileStream is currently open.

Postcondition

The get pointer within _fileStream has been advanced to the next line.

Returns

A well-formed [ObjectData](#) struct if a valid line is received, a 'dummy' [ObjectData](#) struct otherwise.

Checks if the file is ready to be read and reads the line if ready or returns a 'dummy' [ObjectData](#) struct if not.

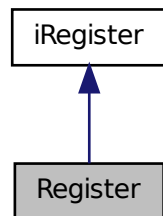
Determines what type of line has been read, then parses the line accordingly.

Implements [iObjParser](#).

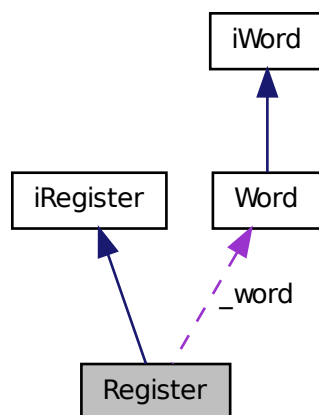
9.14 Register Class Reference

Implements [iRegister](#).

Inheritance diagram for Register:



Collaboration diagram for Register:



Public Member Functions

- **Register** (const **Word** w)
- **Word GetValue** () const
Retrieves a copy of the word of data store in the register.
- void **Add** (const **iWord** &w)
Adds a word of data to the calling object.
- **Register Add** (const **iRegister** &r) const
Adds a word of data to the calling object.
- **Register operator+** (const **iRegister** &r) const
A standard add operator.
- void **Subtract** (const **iWord** &w)
Subtracts a word of data from the calling object.
- **Register Subtract** (const **iRegister** &r) const
Subtracts a word of data from the calling object.

- **Register operator-** (const **iRegister** &r) const
A standard subtraction operator.
- void **And** (const **iWord** &w)
Performs a bit-wise and.
- **Register And** (const **iRegister** &r) const
Performs a bit-wise and.
- void **Or** (const **iWord** &w)
Performs a bit-wise "or".
- **Register Or** (const **iRegister** &r) const
Performs a bit-wise or.
- void **Not** ()
Performs a bit-wise not.
- **Register Not** () const
Performs a bit-wise not.
- void **Store** (const **iWord** &w)
Stores a word of data.
- void **Store** (const **iRegister** &r)
Stores a copy of another register.
- **Register & operator=** (const **iWord** &w)
A standard assignment operator.
- **Register & operator=** (const **Register** r)
A standard assignment operator.
- **Register & operator++** ()
A standard pre-increment operator.
- **Register & operator++** (int)
A standard post-increment operator.

Private Attributes

- [Word _word](#)

The word of data held in the register.

9.14.1 Detailed Description

Implements [iRegister](#).

9.14.2 Member Function Documentation

9.14.2.1 `Word Register::GetValue () const` [virtual]

Retrieves a copy of the word of data store in the register.

Postcondition

The value of the calling object is not changed.

Returns

A new [Word](#) object holding the value that is stored in the register.

Implements [iRegister](#).

9.14.2.2 `void Register::Add (const iWord & w)` [virtual]

Adds a word of data to the calling object.

Parameters

<code>in</code>	<code>w</code>	The value to be added.
-----------------	----------------	------------------------

Postcondition

The calling object equals its previous value plus the value of "w"; "w", however, will remain unchanged.

Implements [iRegister](#).

9.14.2.3 `Register Register::Add (const iRegister & r) const` [virtual]

Adds a word of data to the calling object.

Parameters

in	r	The value to be added.
----	---	------------------------

Postcondition

Both the calling object and "r" will not be changed.

Returns

A new [Register](#) object holding the value of the calling object plus the value in "r".

Implements [iRegister](#).

9.14.2.4 Register Register::operator+ (const iRegister & r) const [virtual]

A standard add operator.

Note

"result = p + r" is equivalent to "result = p.Add(r)".

Implements [iRegister](#).

9.14.2.5 void Register::Subtract (const iWord & w) [virtual]

Subtracts a word of data from the calling object.

Parameters

in	w	The value to be subtracted.
----	---	-----------------------------

Postcondition

The calling object equals its previous value minus the value of "w"; "w", however, will remain unchanged.

Implements [iRegister](#).

9.14.2.6 Register Register::Subtract (const iRegister & r) const [virtual]

Subtracts a word of data from the calling object.

Parameters

in	r	The value to be subtracted.
----	---	-----------------------------

Postcondition

Both the calling object and "r" will not be changed.

Returns

A new [Register](#) object holding the value of the calling object minus the value in "r".

Implements [iRegister](#).

9.14.2.7 Register Register::operator- (const iRegister & r) const [virtual]

A standard subtraction operator.

Note

"result = p - r" is equivalent to "result = r.Subtract(w)".

Implements [iRegister](#).

9.14.2.8 void Register::And (const iWord & w) [virtual]

Performs a bit-wise and.

Parameters

in	w	The value to be "and"ed.
----	---	--------------------------

Postcondition

The calling object equals its previous value bit-wise and'ed with w.

Implements [iRegister](#).

9.14.2.9 Register Register::And (const iRegister & r) const [virtual]

Performs a bit-wise and.

Parameters

in	r	The value to be "and"ed.
----	---	--------------------------

Postcondition

Both the calling object and r are not changed.

Returns

A new [Register](#) object holding the value of the calling object bit-wise and'ed with *r*.

Implements [iRegister](#).

9.14.2.10 void Register::Or (const iWord & *w*) [virtual]

Performs a bit-wise "or".

Parameters

<i>in</i>	<i>w</i>	The value to be "or"ed.
-----------	----------	-------------------------

Postcondition

The calling object equals its previous value bit-wise or'ed with *w*.

Implements [iRegister](#).

9.14.2.11 Register Register::Or (const iRegister & *r*) const [virtual]

Performs a bit-wise or.

Parameters

<i>in</i>	<i>r</i>	The value to be "or"ed.
-----------	----------	-------------------------

Postcondition

Both the calling object and *r* are not changed.

Returns

A new [Register](#) object holding the value of the calling object bit-wise or'ed with *r*.

Implements [iRegister](#).

9.14.2.12 void Register::Not () [virtual]

Performs a bit-wise not.

Postcondition

The calling object's bits are all flipped (e.g. 1001 -> 0110).

Implements [iRegister](#).

9.14.2.13 Register Register::Not () const [virtual]

Performs a bit-wise not.

Postcondition

The calling object is not changed.

Returns

A new [Register](#) object holding the bit-wise not of the calling object.

Implements [iRegister](#).

9.14.2.14 void Register::Store (const iWord & w) [virtual]

Stores a word of data.

Parameters

in	w	The value to be store.
----	---	------------------------

Postcondition

The calling object's value is now "w".

Implements [iRegister](#).

9.14.2.15 void Register::Store (const iRegister & r) [virtual]

Stores a copy of another register.

Parameters

in	r	The register to be copied.
----	---	----------------------------

Postcondition

The calling object's value is now "r".

Implements [iRegister](#).

9.14.2.16 Register & Register::operator= (const iWord & w) [virtual]

A standard assignment operator.

Note

"r = w" is equivalent to "r.Store(w)"

Implements [iRegister](#).

9.14.2.17 Register & Register::operator= (const Register r) [virtual]

A standard assignment operator.

Note

"r1 = r2" is equivalent to "r1.Store(r2)"

Implements [iRegister](#).

9.14.2.18 Register & Register::operator++ () [virtual]

A standard pre-increment operator.

Returns

A reference to itself.

The object increments its value BEFORE the execution of the current line.

Implements [iRegister](#).

9.14.2.19 Register & Register::operator++ (int) [virtual]

A standard post-increment operator.

Returns

A reference to itself.

The object increments its value AFTER the execution of the current line.

Implements [iRegister](#).

9.15 ResultDecoder Class Reference

Finds the messages associated with a given result code.

Public Member Functions

- [ResultDecoder](#) ()
Generates the code-to-message mappings.
- `std::string Find (const Codes::RESULT &result) const`
Looks up a result code.

Static Private Attributes

- `static std::map< Codes::RESULT, std::string > _codes`
Maps a result code to, in every case but SUCCESS, an error message.

9.15.1 Detailed Description

Finds the messages associated with a given result code.

9.15.2 Member Function Documentation

9.15.2.1 `std::string ResultDecoder::Find (const Codes::RESULT & result) const`

Looks up a result code.

Parameters

<i>in</i>	<i>result</i>	The result code to look up.
-----------	---------------	-----------------------------

Returns

The messages associated with "result".

9.15.3 Member Data Documentation

9.15.3.1 `std::map<Codes::RESULT, std::string> ResultDecoder::_codes` [static, private]

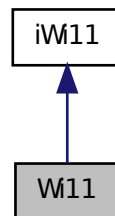
Maps a result code to, in every case but SUCCESS, an error message.

It is static because the result code messages should be available from anywhere.

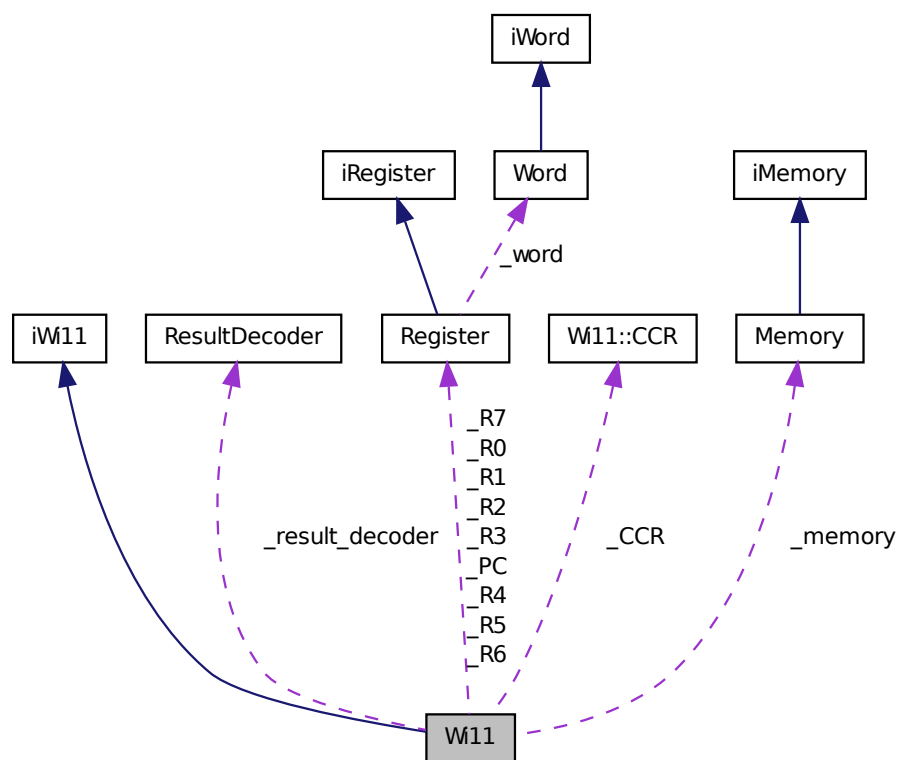
9.16 Wi11 Class Reference

Implements [iWi11](#).

Inheritance diagram for Wi11:



Collaboration diagram for Wi11:



Classes

- struct [CCR](#)

Condition code registers: negative, zero, positive.

Public Member Functions

- virtual [iWi11](#) ()

Creates and organizes the componts of the [Wi11](#) machine.

- virtual bool [LoadObj](#) (const char *)
Loads the object file and sets up memory as it describes.
- virtual void [DisplayMemory](#) () const
Prints the state of memory to standard out.
- virtual void [DisplayRegisters](#) () const
Prints the state of every register to standard out.
- virtual bool [ExecuteNext](#) (bool verbose=false)
Executes the instruction pointed to by the PC.

Private Member Functions

- REGISTER_ID [_Word2RegisterID](#) (const [Word](#) &) const
- [iRegister](#) & [_GetRegister](#) (const Decoder::REGISTER_ID &)
Retrieves a reference to the register corresponding to "id".
- void [_UpdateCCR](#) (int)
- virtual Codes::RESULT [_Add](#) (const Decoder::REGISTER_ID &DR, const Decoder::REGISTER_ID &SR1, const Decoder::REGISTER_ID &SR2)
- virtual Codes::RESULT [_Add](#) (const Decoder::REGISTER_ID &DR, const Decoder::REGISTER_ID &SR1, const [iWord](#) &immediate)
- virtual Codes::RESULT [_And](#) (const Decoder::REGISTER_ID &DR, const Decoder::REGISTER_ID &SR1, const Decoder::REGISTER_ID &SR2)
- virtual Codes::RESULT [_And](#) (const Decoder::REGISTER_ID &DR, const Decoder::REGISTER_ID &SR1, const [iWord](#) &immediate)
- virtual Codes::RESULT [_Branch](#) (const [iWord](#) &address)
Changes the last 9 bits of the PC.
- virtual Codes::RESULT [_Debug](#) ()
Deprecated?
- virtual Codes::RESULT [_JSR](#) (const [iWord](#) &, bool)
- virtual Codes::RESULT [_JSRR](#) (const Decoder::REGISTER_ID &baseR, const [iWord](#) &address, bool link)
- virtual Codes::RESULT [_Load](#) (const Decoder::REGISTER_ID &DR, const [iWord](#) &address)
- virtual Codes::RESULT [_Loadl](#) (const Decoder::REGISTER_ID &DR, const [iWord](#) &address)

- virtual Codes::RESULT **_LoadR** (const Decoder::REGISTER_ID &DR, const Decoder::REGISTER_ID &baseR, const [iWord](#) &address)
- virtual Codes::RESULT **_LoadEA** (const Decoder::REGISTER_ID &DR, const [iWord](#) &address)
- virtual Codes::RESULT **_Not** (const Decoder::REGISTER_ID &DR, const Decoder::REGISTER_ID &SR)
- virtual Codes::RESULT **_Ret** ()

Return from a subroutine.

- virtual Codes::RESULT **_Store** (const Decoder::REGISTER_ID &SR, const [iWord](#) &address)
- virtual Codes::RESULT **_STI** (const Decoder::REGISTER_ID &SR, const [iWord](#) &address)
- virtual Codes::RESULT **_STR** (const Decoder::REGISTER_ID &SR, const Decoder::REGISTER_ID &baseR, const [iWord](#) &address)
- virtual Codes::RESULT **_Trap** (const [iWord](#) &code)

Branches to a trap vector.

Private Attributes

- [Memory _memory](#)

Acts as the Wi-11's memory.

- [Register _R0](#)

The 8 general purpose registers and PC.

- [Register _R1](#)
- [Register _R2](#)
- [Register _R3](#)
- [Register _R4](#)
- [Register _R5](#)
- [Register _R6](#)
- [Register _R7](#)
- [Register _PC](#)
- struct [Wi11::CCR _CCR](#)
- [ObjLoader _loader](#)

For loading the object file.

- [Decoder _decoder](#)

For decoding instructions fetch from memory.

- [ResultDecoder _result_decoder](#)

For error messages.

9.16.1 Detailed Description

Implements [iWi11](#).

9.16.2 Member Function Documentation

9.16.2.1 `iRegister & Wi11::_GetRegister (const Decoder::REGISTER_ID & id)` [private, virtual]

Retrieves a reference to the register corresponding to "id".

Parameters

in	<i>id</i>	A REGISTER_ID corresponding to one of the private registers.
----	-----------	--

Returns

A reference to the id'd register.

Implements [iWi11](#).

9.16.2.2 `RESULT Wi11::Branch (const iWord & address)` [private, virtual]

Changes the last 9 bits of the PC.

Parameters

in	<i>address</i>	The 9 bits to become the end of the PC.
----	----------------	---

Postcondition

"address" is not changed.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

Implements [iWi11](#).

9.16.2.3 RESULT Wi11::_Debug () [private, virtual]

Deprecated?

Does nothing.

Implements [iWi11](#).

9.16.2.4 RESULT Wi11::_Ret () [private, virtual]

Return from a subroutine.

Postcondition

The PC now holds the value that was (and still is) in R7.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

Note

This can be used to jump anywhere in memory. However, this is not the intended usage.

Updates the [CCR](#).

Implements [iWi11](#).

9.16.2.5 RESULT Wi11::_Trap (const iWord & code) [private, virtual]

Branches to a trap vector.

Parameters

in	code	The trap code.
----	------	----------------

Postcondition

"code" is not changed.

Returns

SUCCESS or, if something went wrong, an appropriate error code.

The traps are as follows:

- 0x21 - OUT - Write the character formed from the eight least significant bits of R0 to standard out.
- 0x22 - PUTS - Write the a string to standard out starting at the address pointed to by R0 and ending at a null character.
- 0x23 - IN - Prompt for, and read, a single character from standard in. Re-print it and store its ascii value in R0 (with leading zeros).
- 0x25 - HALT - End execution and print an appropriate message to standard out.
- 0x31 - INN - Prompt for, and read, a positive decimal number from standard in. Re-print it and store it in R0 (the number must in 16-bit range).
- 0x43 - RND - Generate a random number and store it in R0.

Note

Traps 0x23, 0x31, and 0x43 all update the [CCR](#).

Standard in is the keyboard.
Standard out is the console.

Implements [iWi11](#).

9.16.2.6 Wi11::iWi11 () [virtual]

Creates and organizes the componts of the [Wi11](#) machine.

Initializes the general purpose registers, [CCR](#), and memory.

Implements [iWi11](#).

9.16.2.7 bool Wi11::LoadObj (const char * filename) [virtual]

Loads the object file and sets up memory as it describes.

Parameters

in	<i>filename</i>	The name of the object file.
----	-----------------	------------------------------

Postcondition

"filename" is not changed.

Returns

True if and only if the load was successful.

If "false" is returned, prints an appropriate error message to the user.

Note

This function can be called multiple times. Each time the PC is overwritten.

Implements [iWi11](#).

9.16.2.8 void Wi11::DisplayMemory () const [virtual]

Prints the state of memory to standard out.

Postcondition

The calling object is not changed.

Implements [iWi11](#).

9.16.2.9 void Wi11::DisplayRegisters () const [virtual]

Prints the state of every register to standard out.

Postcondition

The calling object is not changed.

The values of all 8 general purpose registers, the [CCR](#), and PC are all printed.

Implements [iWi11](#).

9.16.2.10 bool Wi11::ExecuteNext (bool *verbose* = false) [virtual]

Executes the instruction pointed to by the PC.

Parameters

<i>in</i>	<i>verbose</i>	If true, machine state information is displayed after each step.
-----------	----------------	--

Returns

True if and only if the end of the program have been reached.

This function is the brains of the operation, so to speak. Almost the entire fetch-execute loop of the Wi-11 is present here. In particular, this function must interpret the instructions and manage the CCRs.

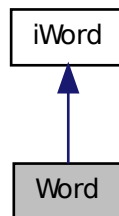
For a complete list of the instructions, see [Wi-11 Instructions](#).

Implements [iWi11](#).

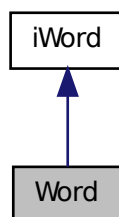
9.17 Word Class Reference

Implements [iWord](#).

Inheritance diagram for Word:



Collaboration diagram for Word:



Public Member Functions

- int `ToInt` () const
"To non-negative Integer"
- int `ToInt2Complement` () const
"To Integer as 2's Complement"
- std::string `ToStr` () const
"To String"
- std::string `ToHex` () const
"To Hexadecimal"
- bool `FromInt` (int value)
"From Integer"
- bool `FromStr` (const std::string &str)
"From String"
- bool `FromHex` (const std::string &str)
"From Hexadecimal"
- `Word Add` (const `iWord` &w) const
Adds two words.

- **Word operator+** (const **iWord** &w) const
A standard addition operator.
- **Word Subtract** (const **iWord** &w) const
Subtracts two words.
- **Word operator-** (const **iWord** &w) const
A standard subtraction operator.
- **Word And** (const **iWord** &w) const
"And"s the bits of two words.
- **Word Or** (const **iWord** &w) const
"Or"s the bits of two words.
- **Word Not** () const
"Not"s the bits of a word.
- void **Copy** (const **iWord** &w)
Copies a word.
- **Word & operator=** (const **Word** w)
A standard assignment operator.
- **iWord & operator++** ()
A standard pre-increment operator.
- **iWord & operator++** (int)
A standard post-increment operator.
- bool **operator[]** (const int i) const
An accessor to the 'i'th bit of the value.
- void **SetBit** (const int, bool)

Private Member Functions

- bool **_HasBit** (int) const
Tests for powers of two in binary representation.

Private Attributes

- unsigned short `_value`
Used to store the "word" of data.

9.17.1 Detailed Description

Implements [iWord](#).

9.17.2 Member Function Documentation

9.17.2.1 `bool Word::HasBit (int i) const` `[private]`

Tests for powers of two in binary representation.

Parameters

<code>i</code>	The index of the digit desired from the binary representation of <code>_word</code> .
----------------	---

Returns

True if and only if the `i`'th bit is 1.

The indexing of the bits works as defined in [operator\[\]\(\)](#).

9.17.2.2 `int Word::ToInt () const` `[virtual]`

"To non-negative Integer"

Postcondition

The value of the word is not changed.

Returns

The bits of the word interpreted as a positive integer value.

Implements [iWord](#).

9.17.2.3 `int Word::ToInt2Complement () const` `[virtual]`

"To Integer as 2's Complement"

Postcondition

The value of the word is not changed.

Returns

The bits of the word interpreted as a signed (2's complement) integer value.

Implements [iWord](#).

9.17.2.4 string Word::ToStr () const [virtual]

"To String"

Postcondition

The value of the word is not changed.

Returns

16 characters: each either a 1 or 0

Examples:

If the object holds a (2's comp.) value 4: "0000000000000100"

If the object holds a (2's comp.) value -1: "1111111111111111"

Implements [iWord](#).

9.17.2.5 string Word::ToHex () const [virtual]

"To Hexadecimal"

Postcondition

The value of the word is not changed.

Returns

"0x" + <4 characters in the range [0-9],[A-F]>

Examples:

If the object holds (2's comp.) value 8: "0x0008"

If the object holds (2's comp.) value -2: "0xFFFFE"

Implements [iWord](#).

9.17.2.6 `bool Word::FromInt (int value)` `[virtual]`

"From Integer"

Parameters

<i>in</i>	<i>value</i>	The value to be stored into the word.
-----------	--------------	---------------------------------------

Postcondition

"value" is not changed.

Returns

True if and only if "value" can be represented in 16 bits

When this function returns "False", the value of the word is unchanged.

Otherwise, the word now holds the value "value".

Implements [iWord](#).

9.17.2.7 `bool Word::FromStr (const std::string & str)` `[virtual]`

"From String"

Parameters

<i>in</i>	<i>str</i>	A string of characters meant to represent a "word" to be stored.
-----------	------------	--

Postcondition

"str" is not changed.

Returns

True if and only if "str" is well-formed (as defined in toStr()).

When this function returns "False", the value of the word is unchanged.

Otherwise, the word now holds the value "str".

Implements [iWord](#).

9.17.2.8 `bool Word::FromHex (const std::string & str)` `[virtual]`

"From Hexadecimal"

Parameters

<i>in</i>	<i>str</i>	A string of characters meant to represent a "word" to be stored.
-----------	------------	--

Postcondition

"str" is not changed.

Returns

True if and only if "str" is well-formed (as defined in toHex()).

When this function returns "False", the value of the word is unchanged.

Otherwise, the word now holds the value "str".

Implements [iWord](#).

9.17.2.9 Word Word::Add (const iWord & w) const [virtual]

Adds two words.

Parameters

<i>in</i>	<i>w</i>	A word value to be added.
-----------	----------	---------------------------

Postcondition

Both "w" and the calling object do not change.

Returns

A new "Word" object containing result of adding "w" and the calling object.

Note

The addition is carried out with no regard to logical overflow.

Implements [iWord](#).

9.17.2.10 Word Word::operator+ (const iWord & w) const [virtual]

A standard addition operator.

Note

"result = p + w" is equivalent to "result = p.Add(w)".

Implements [iWord](#).

9.17.2.11 Word Word::Subtract (const iWord & w) const [virtual]

Subtracts two words.

Parameters

<i>in</i>	<i>w</i>	A word value to be subtracted.
-----------	----------	--------------------------------

Postcondition

Both "w" and the calling object do not change.

Returns

A new "Word" object containing the result of subtracting "w" from the calling object.

Note

The subtraction is carried out with no regard for logical overflow.

Implements [iWord](#).

9.17.2.12 Word Word::operator- (const iWord & w) const [virtual]

A standard subtraction operator.

Note

"result = p - w" is equivalent to "result = p.Subtract(w)".

Implements [iWord](#).

9.17.2.13 Word Word::And (const iWord & w) const [virtual]

"And"s the bits of two words.

Parameters

<i>in</i>	<i>w</i>	A word value to be "and"ed.
-----------	----------	-----------------------------

Postcondition

Both "w" and the calling object do not change.

Returns

A new "Word" object containing the result of performing a bit-wise and on "w" and the calling object.

Implements [iWord](#).

9.17.2.14 Word Word::Or (const iWord & w) const [virtual]

"Or"s the bits of two words.

Parameters

in	w	A word value to be "or"ed.
----	---	----------------------------

Postcondition

Both "w" and the calling object do not change.

Returns

A new "Word" object containing the result of performing a bit-wise or on "w" and the calling object.

Implements [iWord](#).

9.17.2.15 Word Word::Not () const [virtual]

"Not"s the bits of a word.

Postcondition

The calling object do not change.

Returns

A new "Word" object containing the result of performing a bit-wise not on the calling object.

Implements [iWord](#).

9.17.2.16 void Word::Copy (const iWord & w) [virtual]

Copies a word.

Parameters

out	w	The value to be copied.
-----	---	-------------------------

Postcondition

The caller equals that parameter.

Equivalent to the assignment "caller = parameter".

Implements [iWord](#).

9.17.2.17 Word & Word::operator= (const Word w) [virtual]

A standard assignment operator.

Parameters

in	w	The value to be copied.
----	---	-------------------------

Returns

A copy of the parameter.

The return value and parameter here must be declared as "Word"s as C++ does not work well with polymorphic assignment operators.

Implements [iWord](#).

9.17.2.18 iWord & Word::operator++ () [virtual]

A standard pre-increment operator.

Returns

A reference to itself.

The object increments its value BEFORE the execution of the current line.

Implements [iWord](#).

9.17.2.19 iWord & Word::operator++ (int) [virtual]

A standard post-increment operator.

Returns

A reference to itself.

The object increments its value AFTER the execution of the current line.

Implements [iWord](#).

9.17.2.20 `bool Word::operator[] (const int i) const` `[virtual]`

An accessor to the 'i'th bit of the value.

Parameters

<code>in</code>	<code>i</code>	The index of the bit in question.
-----------------	----------------	-----------------------------------

Precondition

The index must be less than the size of a word, ie. 16.

Returns

True \Leftrightarrow 1, False \Leftrightarrow 0.

The number of the bits starts at zero and rises into the more significant bits.

Examples:

If the object holds a value of 4 (0...100 in binary): `num[2] = 1`.

If it holds a value of 1 (0...001 in binary): `num[0] = 1`.

If it holds a negative value (Starting with a 1 in 2's complement): `num[15] = 1`.

Implements [iWord](#).

9.17.3 Member Data Documentation**9.17.3.1** `unsigned short Word::_value` `[private]`

Used to store the "word" of data.

The type "unsigned short" was chosen because in c++, shorts are 16bits (the same size as our words) and having it unsigned allows for easy "reading" as a positive int or a 2's complement int.

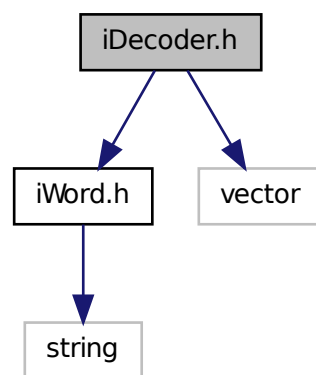
Chapter 10

File Documentation

10.1 iDecoder.h File Reference

Definition of the Wi-11 instruction decoder.

Include dependency graph for iDecoder.h:



Classes

- struct [Instruction](#)
Container to simplify interactions with Wi-11 instructions.
- class [iDecoder](#)
Defines how Wi-11 instructions are decoded.

Namespaces

- namespace [Decoder](#)
Declares register id's and instruction types for each register and instruction.

Enumerations

- enum REGISTER_ID {
 R0, R1, R2, R3,
 R4, R5, R6, R7,
 PC }
• enum INSTRUCTION_TYPE {
 ADD, AND, BRx, DBUG,
 JSR, JSRR, LD, LDI,
 LDR, LEA, NOT, RET,
 ST, STI, STR, TRAP,
 ERROR }

10.1.1 Detailed Description

Definition of the Wi-11 instruction decoder.

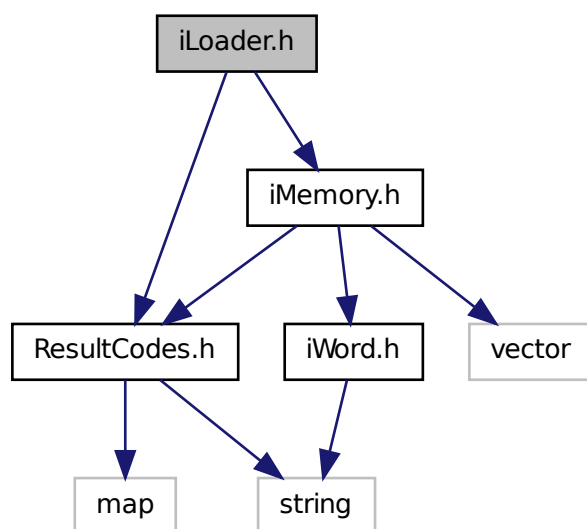
Author

Joshua Green
Andrew Groot

10.2 iLoader.h File Reference

Definition of the Wi-11 program loader.

Include dependency graph for iLoader.h:



Classes

- class [iLoader](#)

Defines how the Wi-11 initializes memory.

10.2.1 Detailed Description

Definition of the Wi-11 program loader.

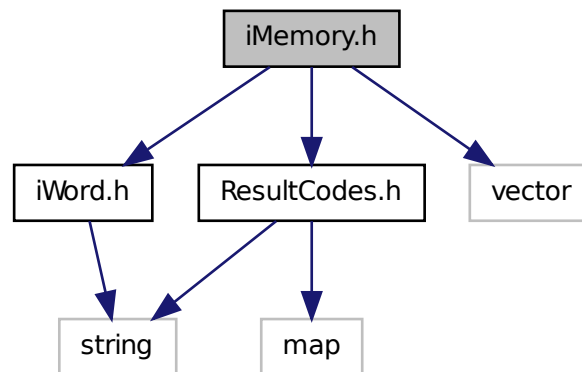
Author

Joshua Green
Andrew Groot

10.3 iMemory.h File Reference

Definition of Wi-11 memory.

Include dependency graph for iMemory.h:



Classes

- class `iMemory`

Defines the functionality of memory in the Wi-11 machine.

10.3.1 Detailed Description

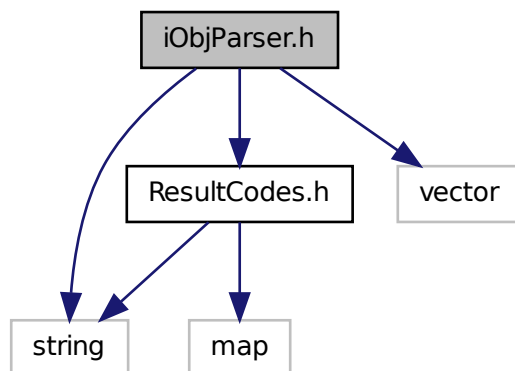
Definition of Wi-11 memory.

Author

Joshua Green
Andrew Groot

10.4 iObjParser.h File Reference

Include dependency graph for iObjParser.h:



Classes

- struct [ObjectData](#)
A simple encoding of a "record".
- class [iObjParser](#)
Defines how object files are processed.

10.4.1 Detailed Description

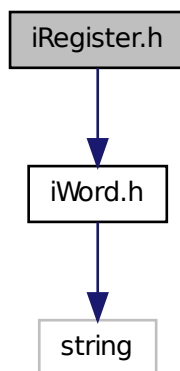
Author

Joshua Green
Andrew Groot of the Object File Parser.

10.5 iRegister.h File Reference

Definition of a "register" in the Wi-11 machine.

Include dependency graph for iRegister.h:



Classes

- class [iRegister](#)

Defines a "register" in the Wi-11 machine.

10.5.1 Detailed Description

Definition of a "register" in the Wi-11 machine.

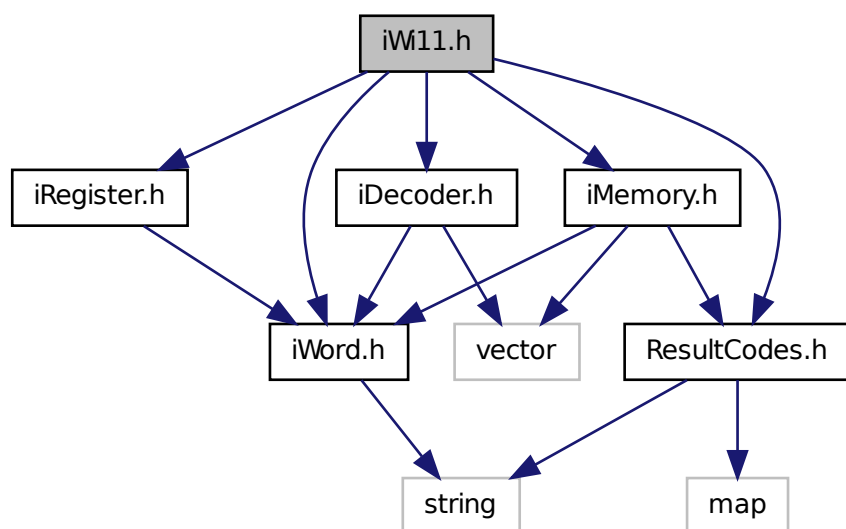
Author

Joshua Green
Andrew Groot

10.6 iWi11.h File Reference

Definition of the Wi-11 machine simulator.

Include dependency graph for iWi11.h:



Classes

- class `iWi11`

Defines the internal logic of the Wi-11.

10.6.1 Detailed Description

Definition of the Wi-11 machine simulator.

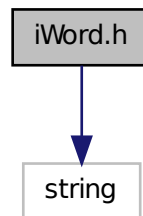
Author

Joshua Green
Andrew Groot

10.7 iWord.h File Reference

Definition of a "word" of data.

Include dependency graph for iWord.h:



Classes

- class [iWord](#)

Defines a "word" of data on the Wi-11 Machine.

10.7.1 Detailed Description

Definition of a "word" of data.

Author

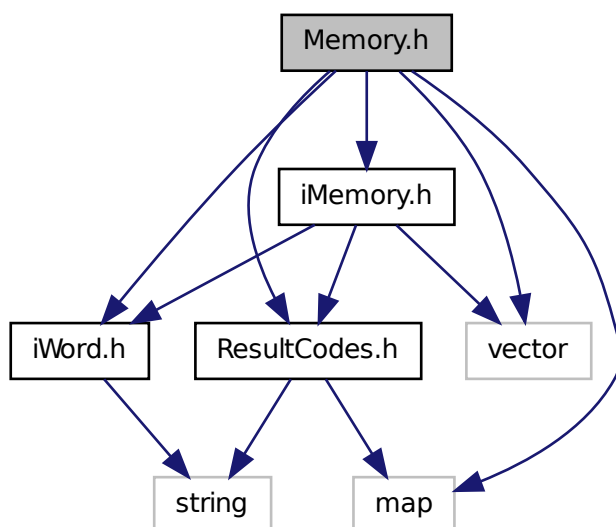
Joshua Green
Andrew Groot

Defines the operations and signatures by which a "word" class should operate. The signatures, while intended to be coded to the interface, are done as to this as C++ allows.

10.8 Memory.h File Reference

Definition of private data for the "Memory" class.

Include dependency graph for Memory.h:



Classes

- class [Memory](#)
Implements [iMemory](#).

10.8.1 Detailed Description

Definition of private data for the "Memory" class.

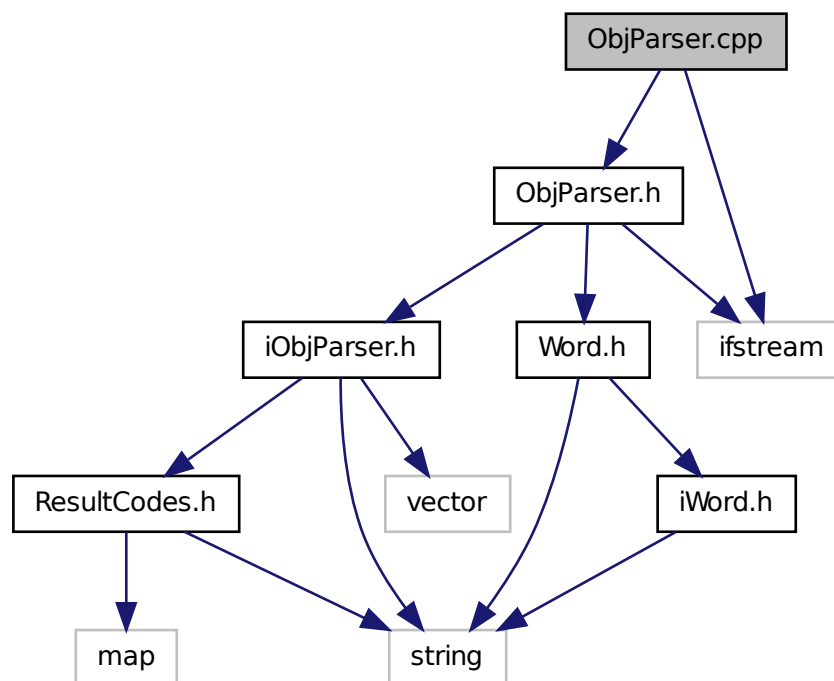
Author

Joshua Green
Andrew Groot

10.9 ObjParser.cpp File Reference

Implements the declarations in "ObjParser.h".

Include dependency graph for ObjParser.cpp:



10.9.1 Detailed Description

Implements the declarations in "ObjParser.h".

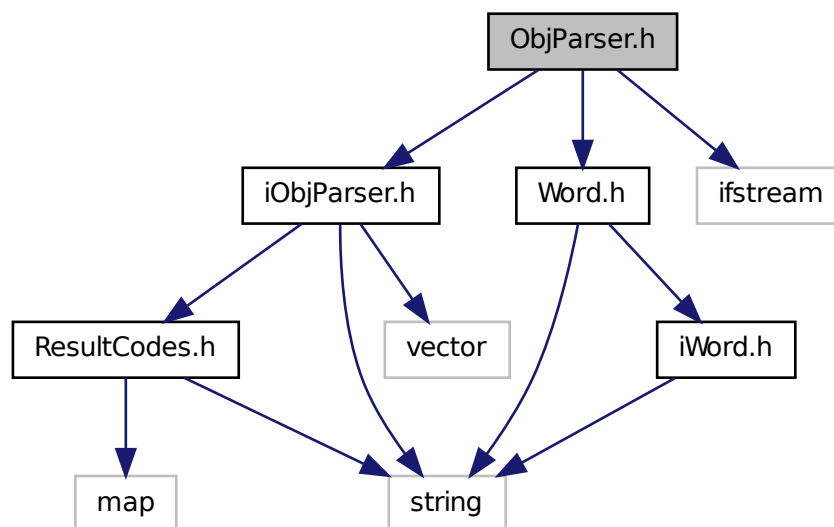
Author

Ryan Paulson

10.10 ObjParser.h File Reference

Definition of private data for the "ObjParser" class.

Include dependency graph for ObjParser.h:



Classes

- class [ObjParser](#)
Implements [iObjParser](#).

10.10.1 Detailed Description

Definition of private data for the "ObjParser" class.

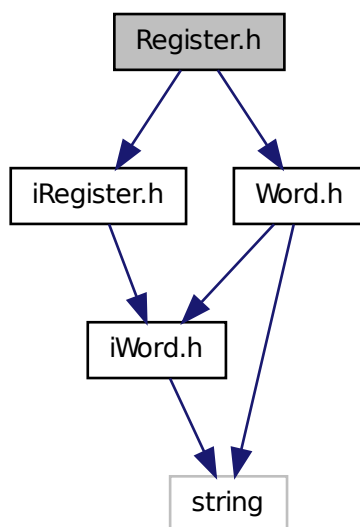
Author

Ryan Paulson

10.11 Register.h File Reference

Definition of private data for the "Register" class.

Include dependency graph for Register.h:



Classes

- class [Register](#)
Implements [iRegister](#).

10.11.1 Detailed Description

Definition of private data for the "Register" class.

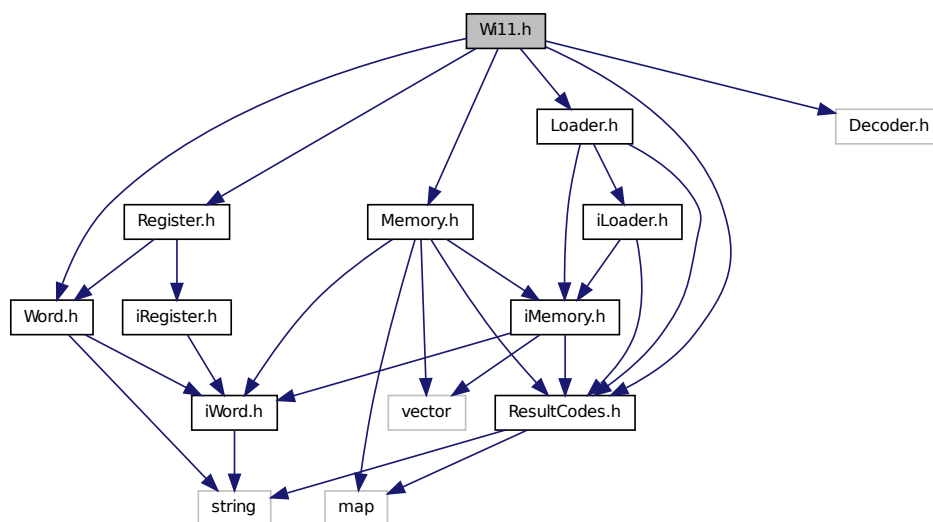
Author

Andrew Groot

10.12 Wi11.h File Reference

Definition of the private data for the "Wi11" class.

Include dependency graph for Wi11.h:



Classes

- class [Wi11](#)
Implements [iWi11](#).
- struct [Wi11::CCR](#)
Condition code registers: negative, zero, positive.

10.12.1 Detailed Description

Definition of the private data for the "Wi11" class.

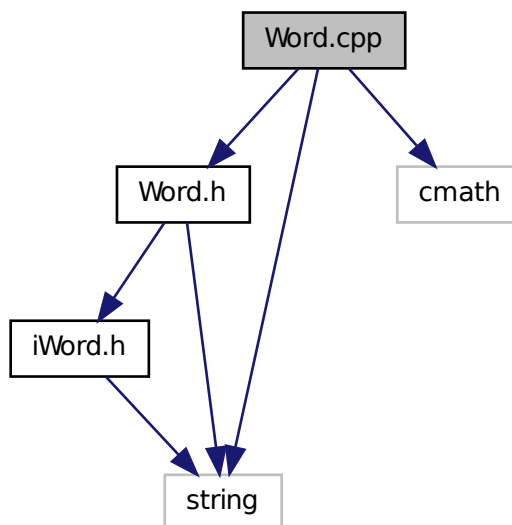
Author

Joshua Green
Andrew Groot

10.13 Word.cpp File Reference

Implements the declarations in "Word.h".

Include dependency graph for Word.cpp:



10.13.1 Detailed Description

Implements the declarations in "Word.h".

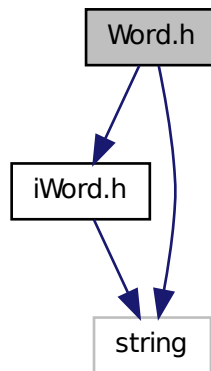
Author

Joshua Green
Andrew Groot

10.14 Word.h File Reference

Definition of private data for the "Word" class.

Include dependency graph for Word.h:



Classes

- class [Word](#)
Implements [iWord](#).

Defines

- `#define WORD_SIZE 16`

10.14.1 Detailed Description

Definition of private data for the "Word" class.

Author

Joshua Green
Andrew Groot

Index

- [_Add](#)
 - [iWi11, 41](#)
 - [_And](#)
 - [iWi11, 42](#)
 - [_Branch](#)
 - [iWi11, 43](#)
 - [Wi11, 83](#)
 - [_Debug](#)
 - [iWi11, 43](#)
 - [Wi11, 83](#)
 - [_GetRegister](#)
 - [iWi11, 41](#)
 - [Wi11, 83](#)
 - [_HasBit](#)
 - [Word, 90](#)
 - [_JSR](#)
 - [iWi11, 43](#)
 - [_JSRR](#)
 - [iWi11, 44](#)
 - [_Load](#)
 - [iWi11, 44](#)
 - [_Loadl](#)
 - [iWi11, 45](#)
 - [_LoadR](#)
 - [iWi11, 45](#)
 - [_Not](#)
 - [iWi11, 46](#)
 - [_Ret](#)
 - [iWi11, 46](#)
 - [Wi11, 84](#)
 - [_STI](#)
 - [iWi11, 47](#)
 - [_STR](#)
 - [iWi11, 48](#)
 - [_Store](#)
 - [iWi11, 47](#)
 - [_Trap](#)
 - [iWi11, 48](#)
 - [Wi11, 84](#)
- [_codes](#)
 - [ResultDecoder, 78](#)
- [_value](#)
 - [Word, 97](#)
- [Add](#)
 - [iRegister, 32](#)
 - [iWord, 56](#)
 - [Register, 72](#)
 - [Word, 93](#)
- [And](#)
 - [iRegister, 34](#)
 - [iWord, 57](#)
 - [Register, 74](#)
 - [Word, 94](#)
- [code/ Directory Reference, 15](#)
- [code/test/ Directory Reference, 17](#)
- [Codes, 19](#)
- [Copy](#)
 - [iWord, 58](#)
 - [Word, 95](#)
- [data](#)
 - [Instruction, 27](#)
- [DecodeInstruction](#)
 - [iDecoder, 22](#)
- [Decoder, 19](#)
- [DisplayMemory](#)
 - [iWi11, 50](#)
 - [Wi11, 86](#)
- [DisplayRegisters](#)
 - [iWi11, 50](#)
 - [Wi11, 86](#)
- [ExecuteNext](#)

- iWi11, 50
- Wi11, 86
- Find
 - ResultDecoder, 78
- FromHex
 - iWord, 55
 - Word, 92
- FromInt
 - iWord, 54
 - Word, 91
- FromStr
 - iWord, 55
 - Word, 92
- GetNext
 - iObjParser, 29
 - ObjParser, 68
- GetValue
 - iRegister, 32
 - Register, 72
- iDecoder, 21
 - DecodeInstruction, 22
- iDecoder.h, 99
- iLoader, 22
 - iLoader, 23
 - Load, 23
 - Loader, 62
- iLoader.h, 101
- iMemory, 24
 - Load, 25
 - Reserve, 25
 - Store, 26
- iMemory.h, 102
- Initialize
 - iObjParser, 28
 - ObjParser, 68
- Instruction, 26
 - data, 27
- iObjParser, 28
 - GetNext, 29
 - Initialize, 28
- iObjParser.h, 103
- iRegister, 29
 - Add, 32
 - And, 34
 - GetValue, 32
 - Not, 35
 - operator+, 33
 - operator++, 37
 - operator-, 33
 - operator=, 36
 - Or, 34, 35
 - Store, 36
 - Subtract, 33
- iRegister.h, 103
- iWi11, 37
 - _Add, 41
 - _And, 42
 - _Branch, 43
 - _Debug, 43
 - _GetRegister, 41
 - _JSR, 43
 - _JSRR, 44
 - _Load, 44
 - _Loadl, 45
 - _LoadR, 45
 - _Not, 46
 - _Ret, 46
 - _STI, 47
 - _STR, 48
 - _Store, 47
 - _Trap, 48
 - DisplayMemory, 50
 - DisplayRegisters, 50
 - ExecuteNext, 50
 - iWi11, 40
 - LoadObj, 49
 - Wi11, 85
- iWi11.h, 104
- iWord, 51
 - Add, 56
 - And, 57
 - Copy, 58
 - FromHex, 55
 - FromInt, 54
 - FromStr, 55
 - Not, 58
 - operator+, 56
 - operator++, 59
 - operator-, 57

- operator=, 59
- Or, 57
- SetBit, 60
- Subtract, 56
- ToHex, 54
- ToInt, 53
- ToInt2Complement, 53
- ToStr, 53
- iWord.h, 106
- Load
 - iLoader, 23
 - iMemory, 25
 - Loader, 62
 - Memory, 65
- Loader, 60
 - iLoader, 62
 - Load, 62
- LoadObj
 - iWi11, 49
 - Wi11, 85
- Memory, 63
 - Load, 65
 - Reserve, 64
 - Store, 65
- Memory.h, 106
- Not
 - iRegister, 35
 - iWord, 58
 - Register, 75
 - Word, 95
- ObjectData, 66
- ObjParser, 66
 - GetNext, 68
 - Initialize, 68
- ObjParser.cpp, 108
- ObjParser.h, 109
- operator+
 - iRegister, 33
 - iWord, 56
 - Register, 73
 - Word, 93
- operator++
 - iRegister, 37
 - iWord, 59
 - Register, 77
 - Word, 96
- operator-
 - iRegister, 33
 - iWord, 57
 - Register, 74
 - Word, 94
- operator=
 - iRegister, 36
 - iWord, 59
 - Register, 76, 77
 - Word, 96
- Or
 - iRegister, 34, 35
 - iWord, 57
 - Register, 75
 - Word, 95
- Register, 69
 - Add, 72
 - And, 74
 - GetValue, 72
 - Not, 75
 - operator+, 73
 - operator++, 77
 - operator-, 74
 - operator=, 76, 77
 - Or, 75
 - Store, 76
 - Subtract, 73
- Register.h, 110
- Reserve
 - iMemory, 25
 - Memory, 64
- ResultDecoder, 77
 - _codes, 78
 - Find, 78
- SetBit
 - iWord, 60
- Store
 - iMemory, 26
 - iRegister, 36
 - Memory, 65

- Register, [76](#)
- Subtract
 - iRegister, [33](#)
 - iWord, [56](#)
 - Register, [73](#)
 - Word, [93](#)
- ToHex
 - iWord, [54](#)
 - Word, [91](#)
- ToInt
 - iWord, [53](#)
 - Word, [90](#)
- ToInt2Complement
 - iWord, [53](#)
 - Word, [90](#)
- ToStr
 - iWord, [53](#)
 - Word, [91](#)
- Wi11, [79](#)
 - _Branch, [83](#)
 - _Debug, [83](#)
 - _GetRegister, [83](#)
 - _Ret, [84](#)
 - _Trap, [84](#)
 - DisplayMemory, [86](#)
 - DisplayRegisters, [86](#)
 - ExecuteNext, [86](#)
 - iWi11, [85](#)
 - LoadObj, [85](#)
- Wi11.h, [111](#)
- Wi11::CCR, [21](#)
- Word, [87](#)
 - _HasBit, [90](#)
 - _value, [97](#)
 - Add, [93](#)
 - And, [94](#)
 - Copy, [95](#)
 - FromHex, [92](#)
 - FromInt, [91](#)
 - FromStr, [92](#)
 - Not, [95](#)
 - operator+, [93](#)
 - operator++, [96](#)
 - operator-, [94](#)
 - operator=, [96](#)
 - Or, [95](#)
 - Subtract, [93](#)
 - ToHex, [91](#)
 - ToInt, [90](#)
 - ToInt2Complement, [90](#)
 - ToStr, [91](#)
- Word.cpp, [112](#)
- Word.h, [112](#)