Workshop on Essential Abstractions in GCC

The Retargetability Model of GCC

GCC Resource Center

(www.cse.iitb.ac.in/grc)

Department of Computer Science and Engineering,

Indian Institute of Technology, Bombay

July 2009

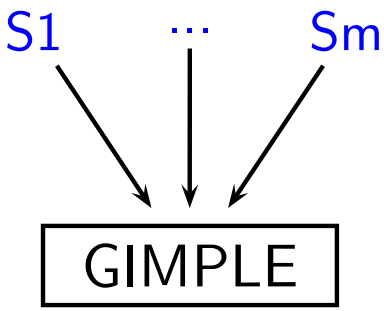
Outline

- A Recap
- Generating the code generators
- Using the generator code generators

Part 1

A Recap

Recapitulate: The GCC Build

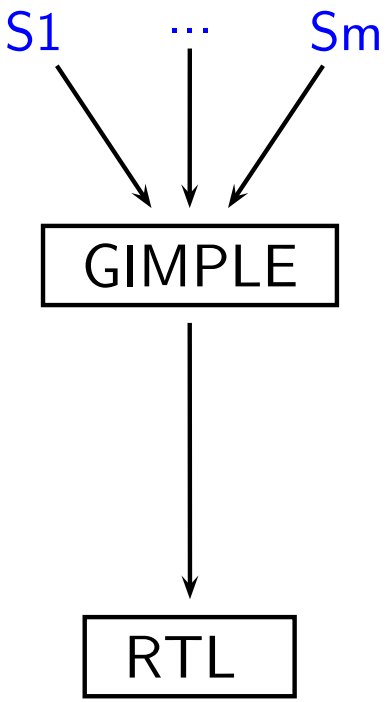


Front end: Multiple source languages

- Separate HLL dependent part of code
- Selection mechanism required
- Parsers for each source
- Reduce to a common IR – GIMPLE

GCC Structure

Recapitulate: The GCC Build

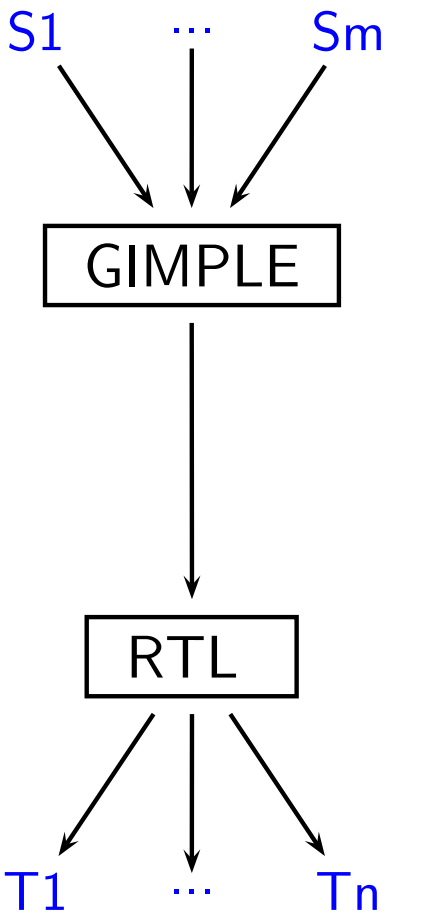


Middle: Optimisations, translations

- Decide: placement in phase sequence
- Try: match optimiser needs & IR properties

GCC Structure

Recapitulate: The GCC Build

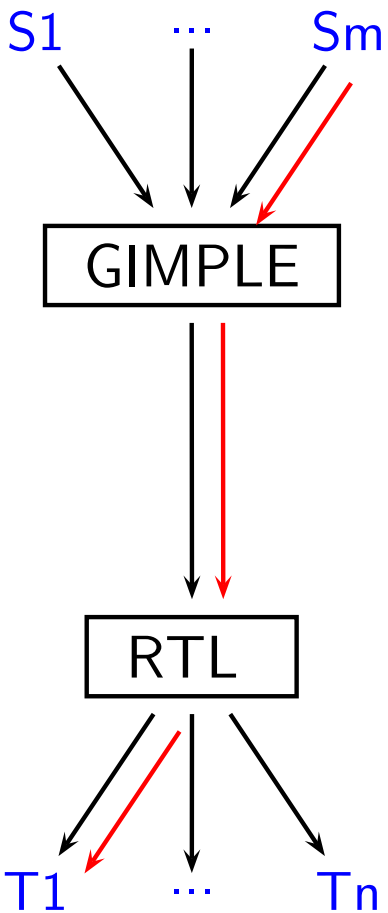


GCC Structure

Back end: Multiple targets

- Separate target dependent part
- Description system for target props
- Linear IR preferable

Recapitulate: The GCC Build

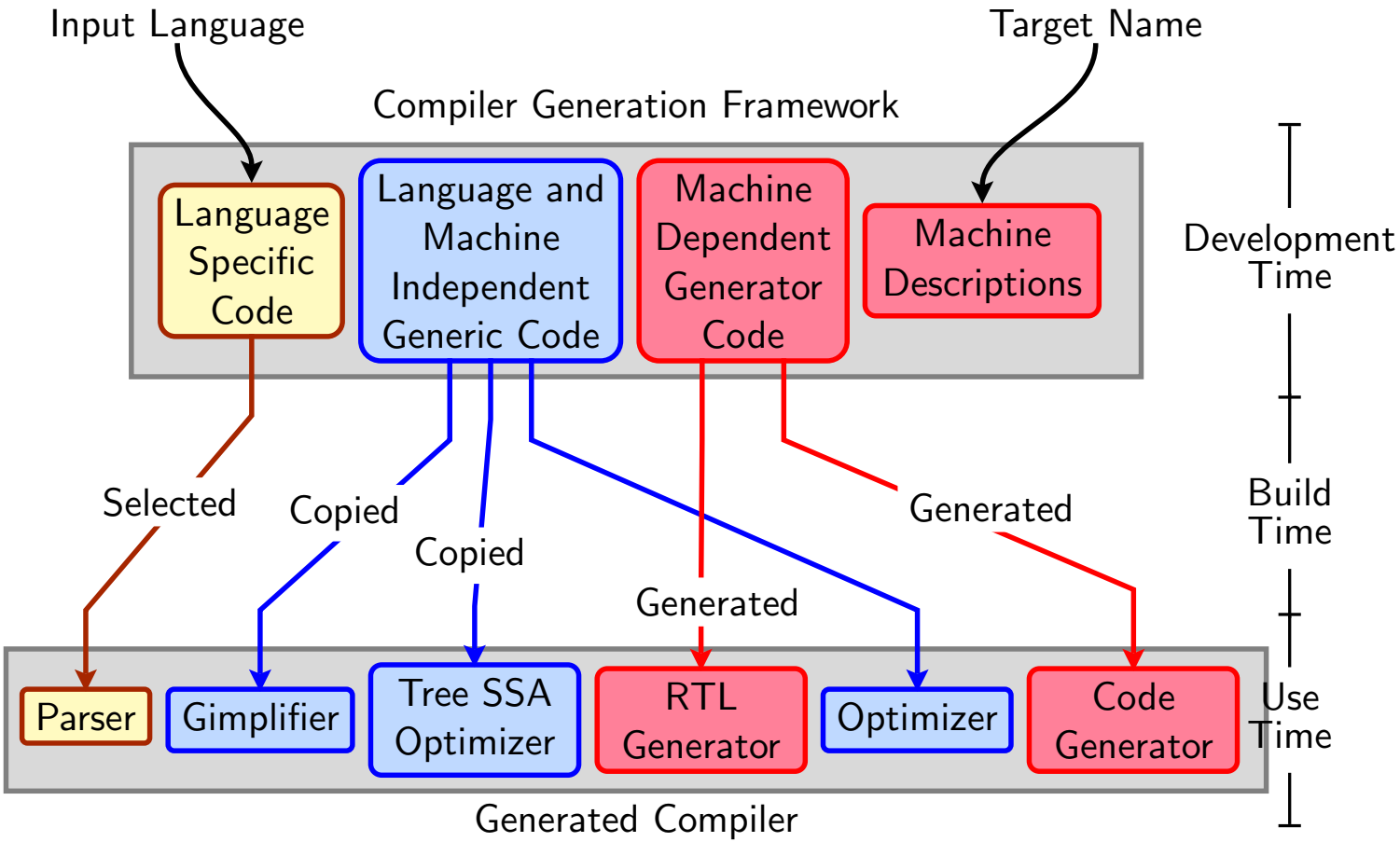


GCC Structure

GCC → gcc/cc1: Build:

- Select Input Language and Target Processor
- Generate target specific code+data
- Compile the generated code along with the common code

Retargetability Mechanism of GCC



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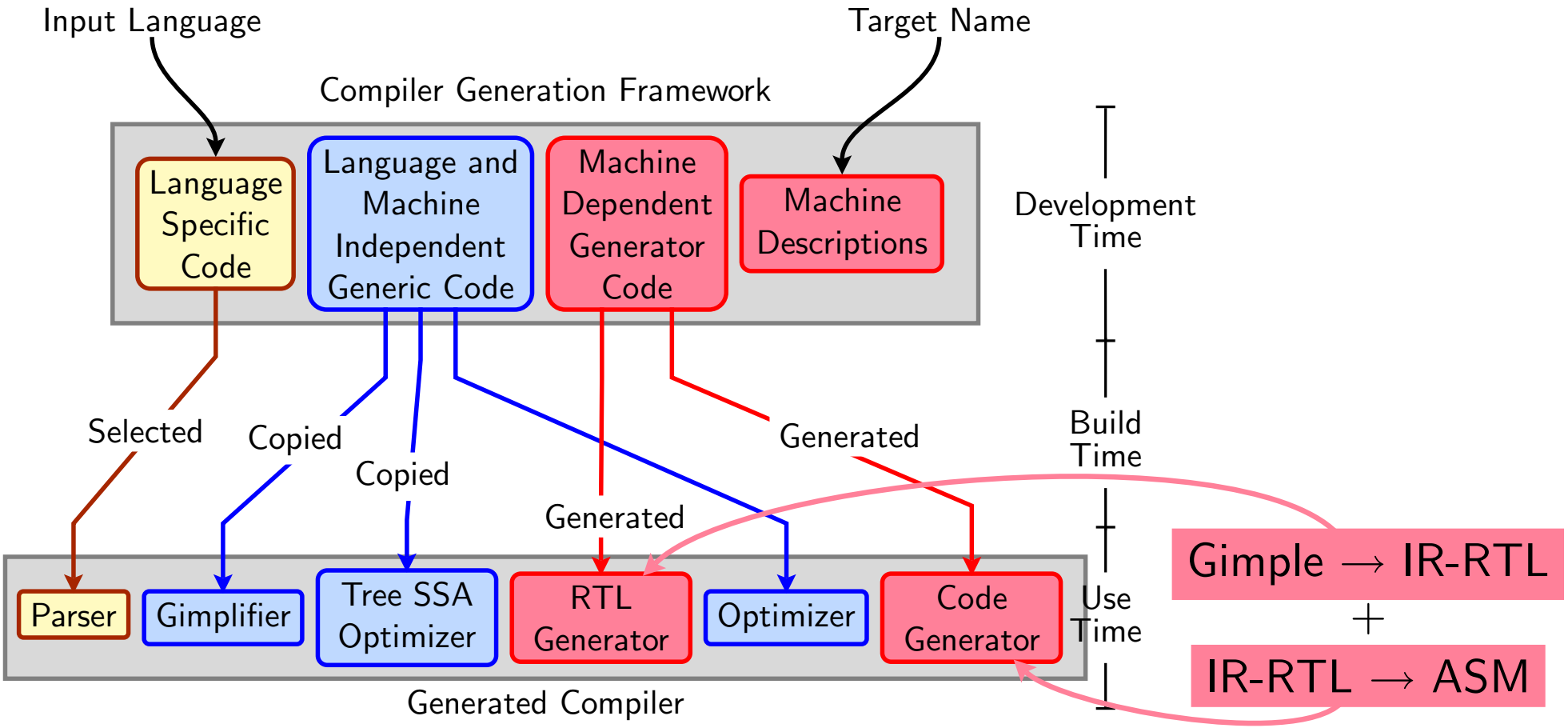

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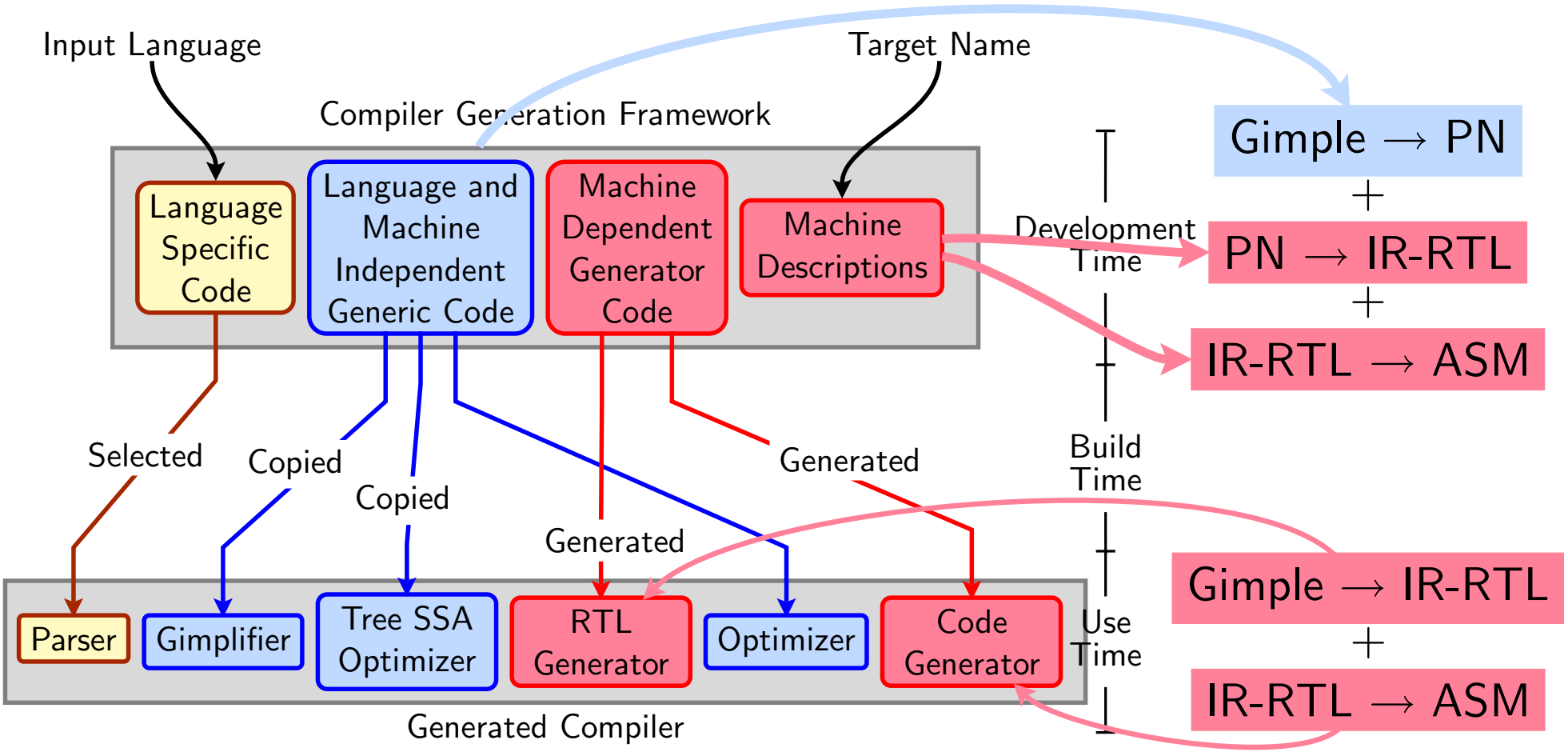

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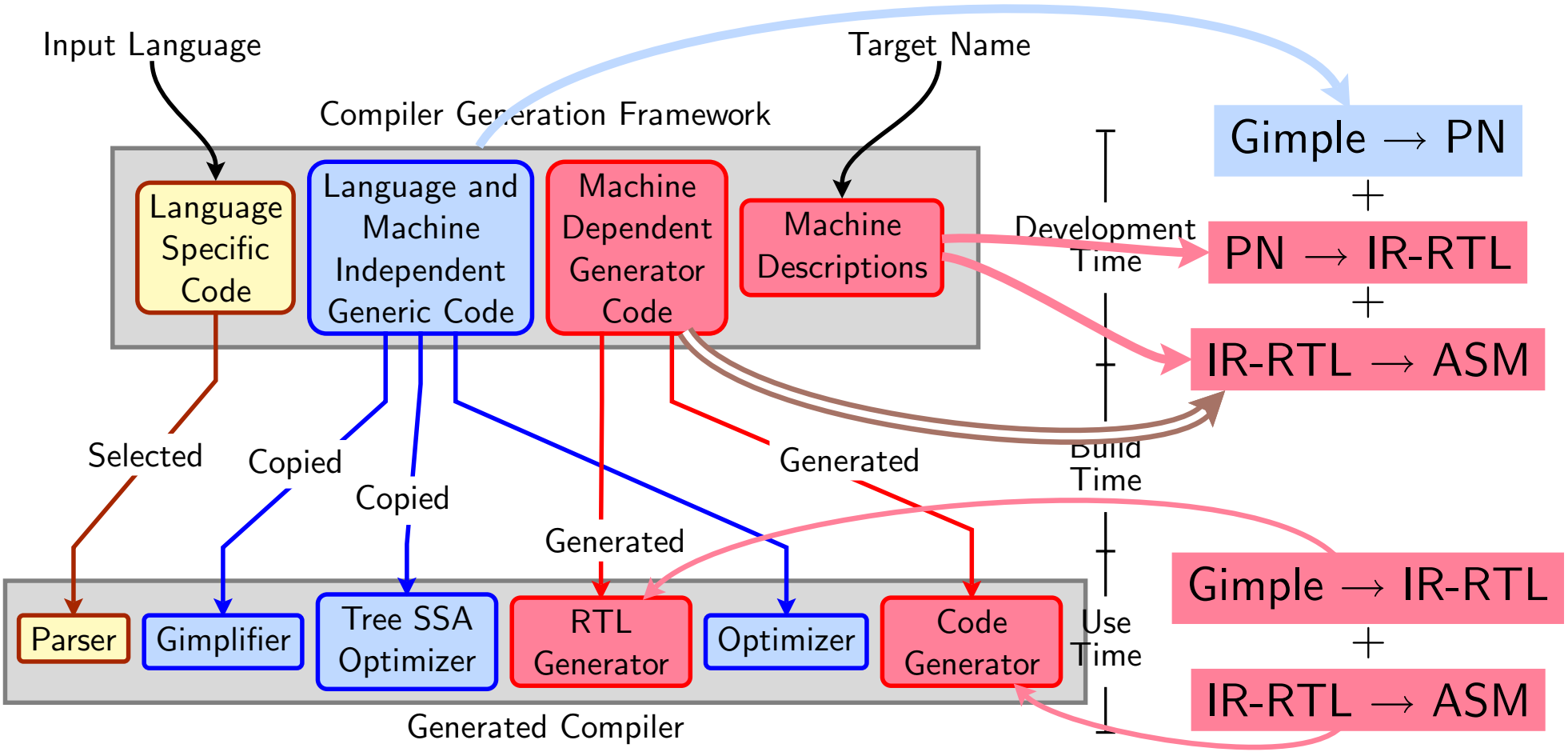
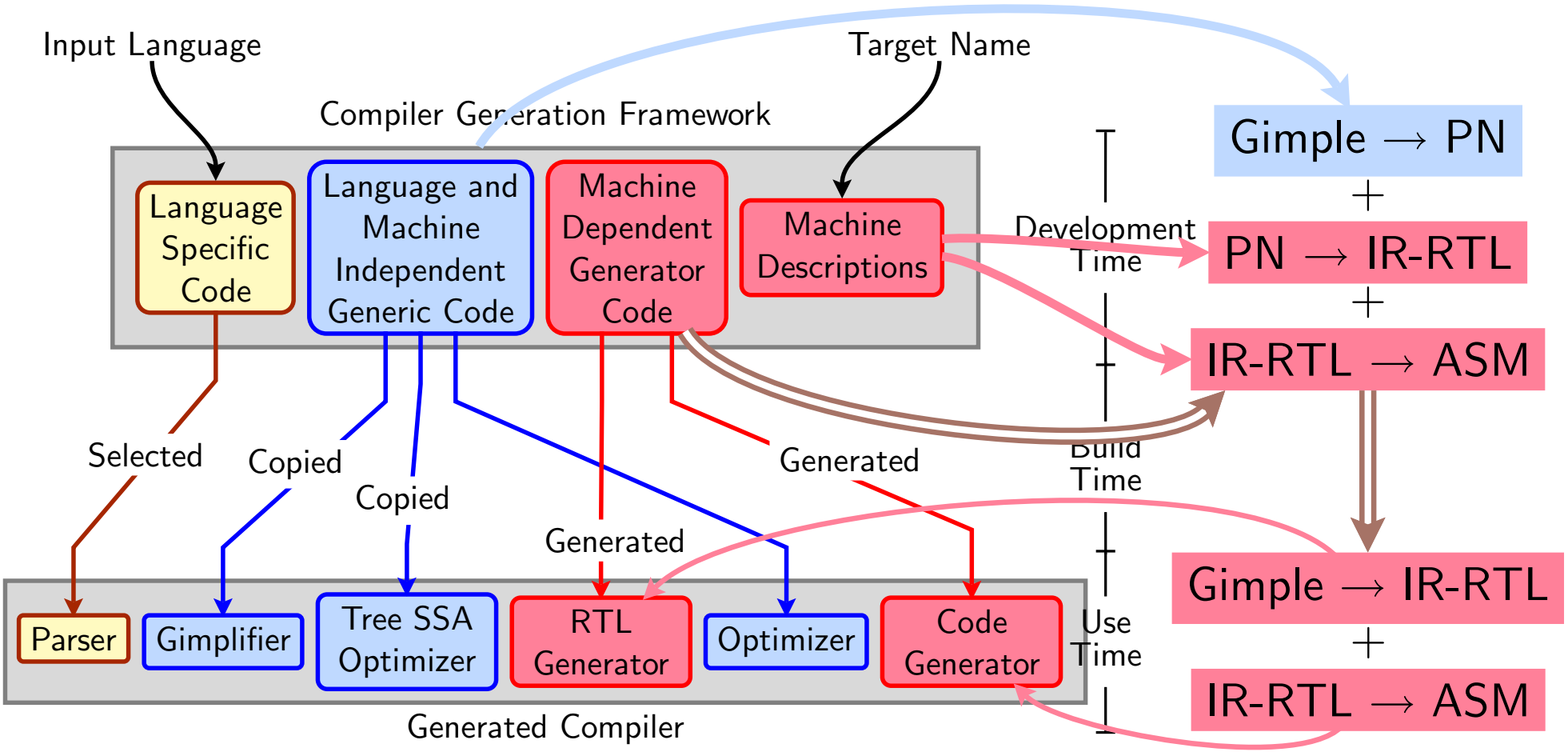


Retargetability Mechanism of GCC



What is "Generated"?

- Info about instructions supported by chosen target, e.g.
  - Listing data structures (e.g. instruction pattern lists)
  - Indexing data structures, since diff. targets give diff. lists.
- C functions that generate RTL internal representation
- Any useful "attributes", e.g.
  - Semantic groupings: arithmetic, logical, I/O etc.
  - Processor unit usage groups for pipeline utilisation

Information supplied by the MD

- The target instructions – as ASM strings
- A description of the semantics of each
- A description of the features of each like
  - Data size limits
  - One of the operands must be a register
  - Implicit operands
  - Register restrictions

Information supplied	in `define_insn` as
The target instruction	ASM string
A description of it's semantics	RTL Template
Operand data size limits	predicates
Register restrictions	constraints

Part 2

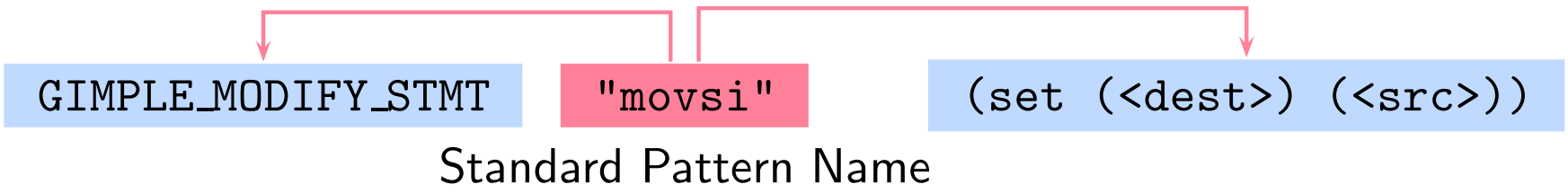
Generating the Code Generators

How GCC uses target specific RTL as IR

`GIMPLE_MODIFY_STMT`

```
(set (<dest>) (<src>))
```

How GCC uses target specific RTL as IR



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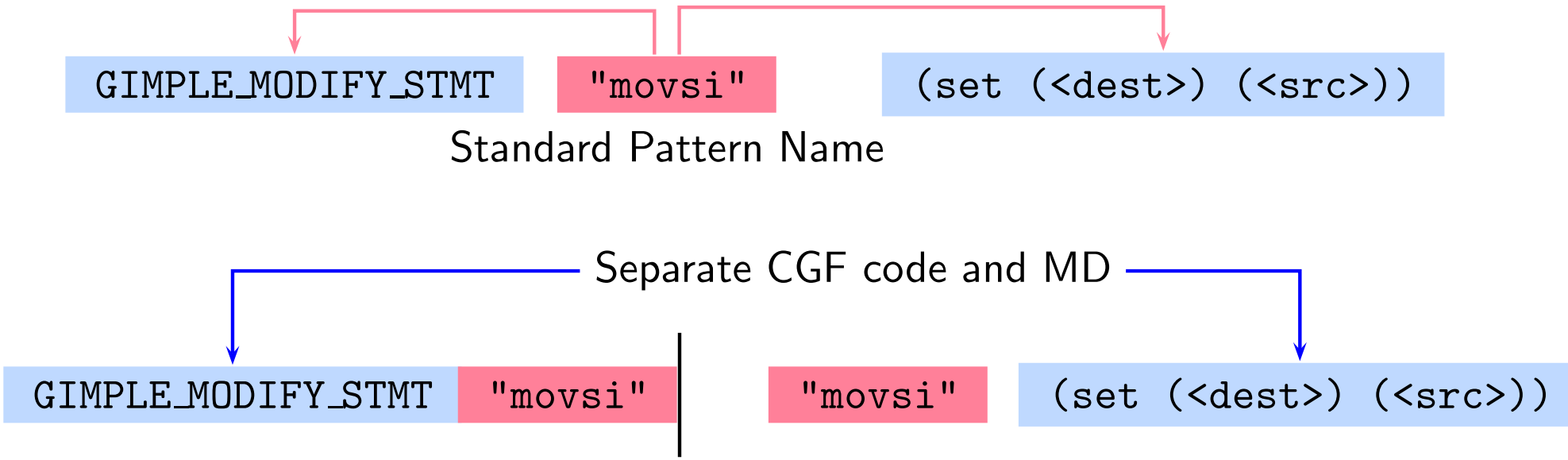

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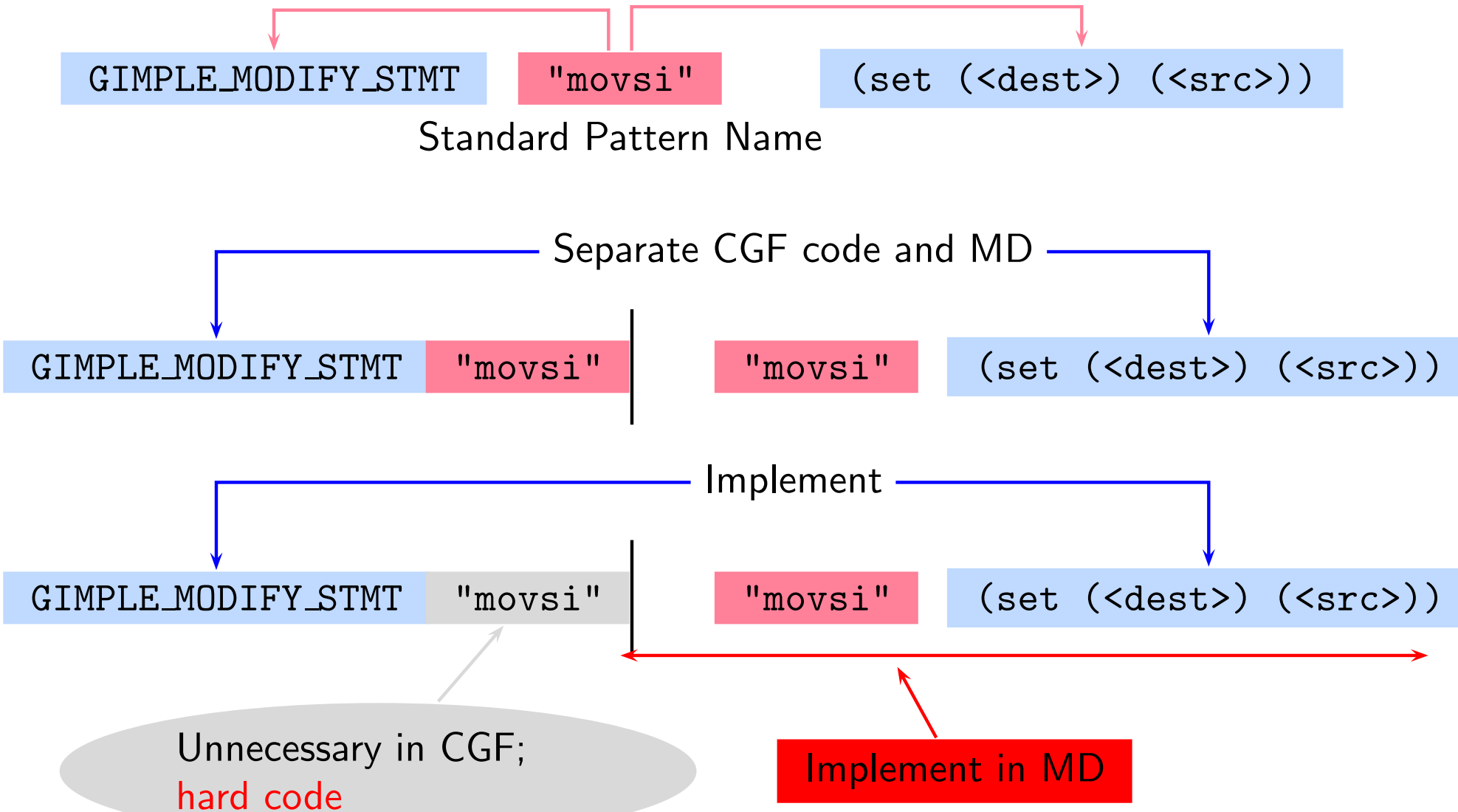
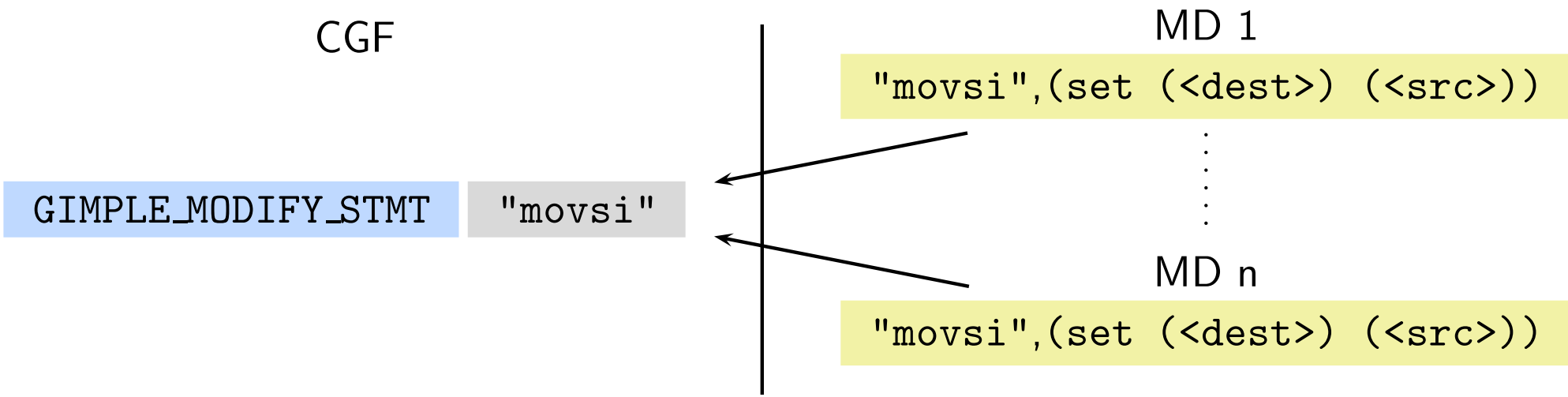


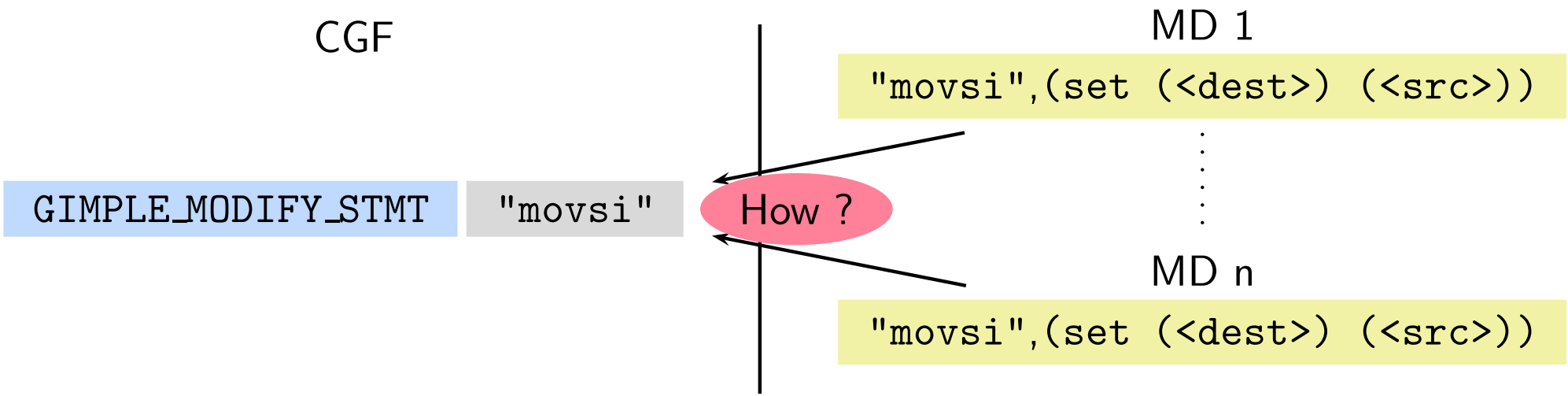
Retargetability ⇒ Multiple MD vs. One CGF!



CGF needs:

An interface immune to MD authoring variations

Retargetability ⇒ Multiple MD vs. One CGF!



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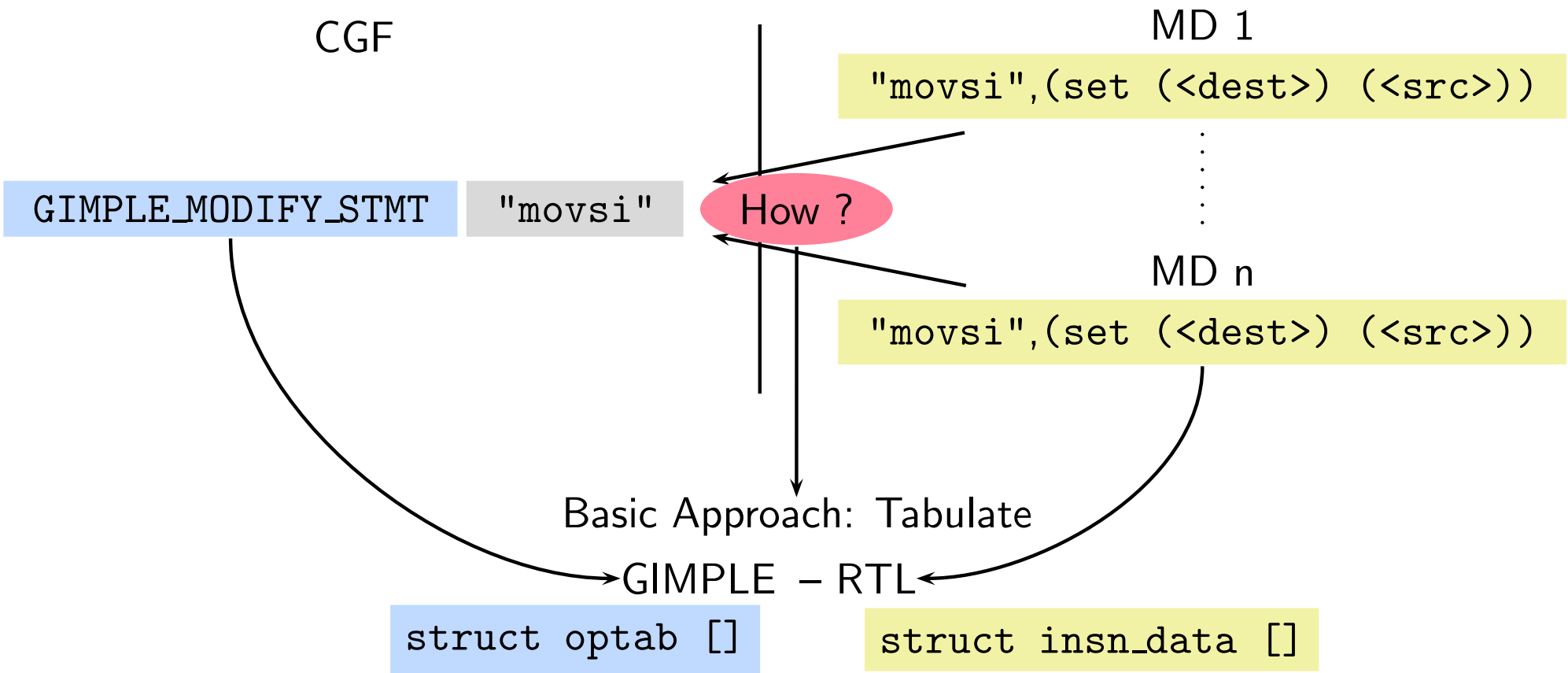


CGF needs:

An interface immune to MD authoring variations

MD Authoring Immune Tabulation

- List insns as they appear in the chosen MD
- Index them
- Supply index to the CGF

Note

An SPN may be written at any suitable place for a given MD

MD Information Data Structures

Two principal data structures

- `struct optab` – Interface to CGF
- `struct insn_data` – All information about a pattern
  - Array of each pattern read
  - Some patterns are SPNs
  - Each pattern is accessed using the generated index

Supporting data structures

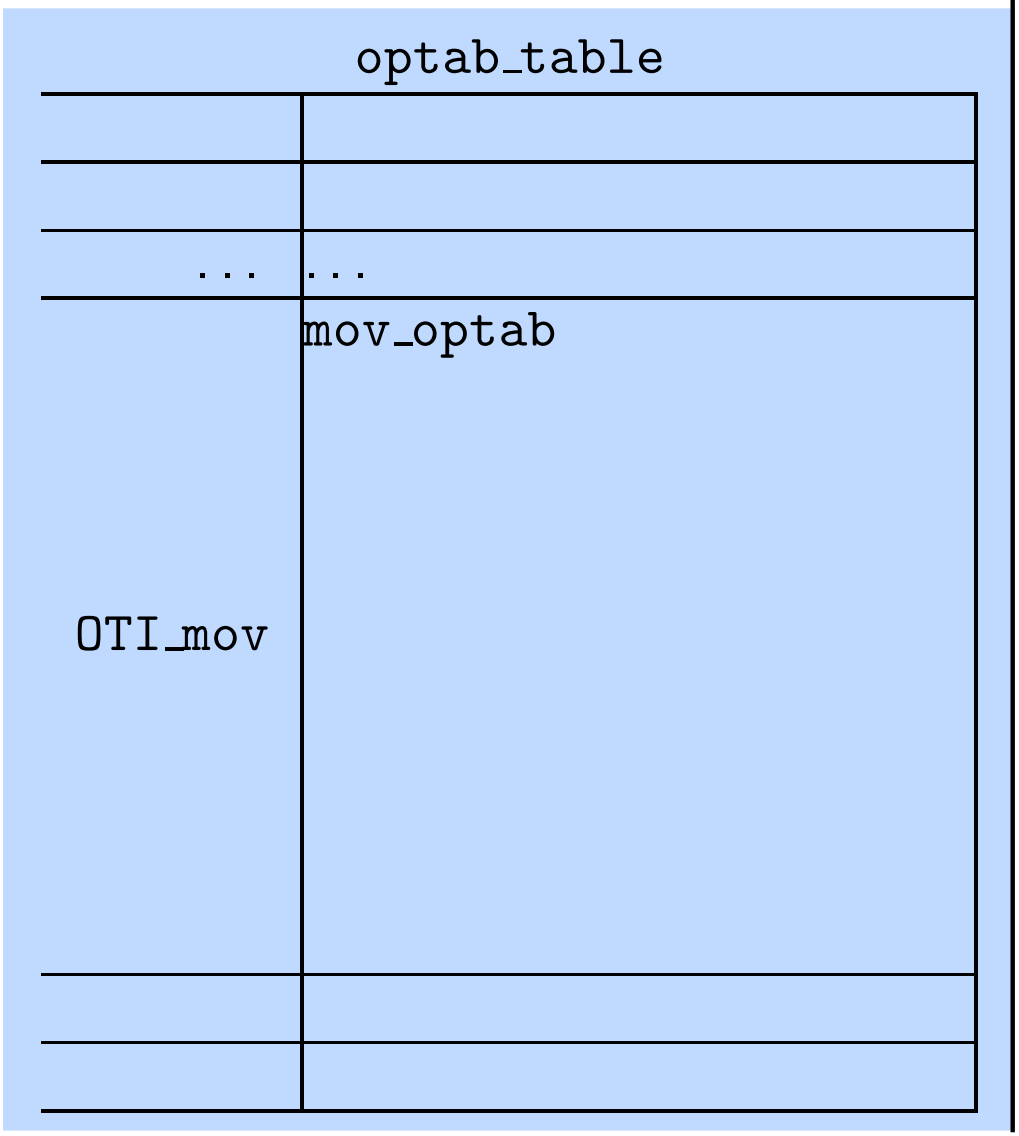
- `enum insn_code`: Index of patterns available in the given MD

Note

Data structures are named in the CGF, but populated at build time.
Generating target specific code = populating these data structures.

Assume movsi is supported but movsf is not supported...

$(SOURCE)/gcc/optabs.h
$(SOURCE)/gcc/optabs.c



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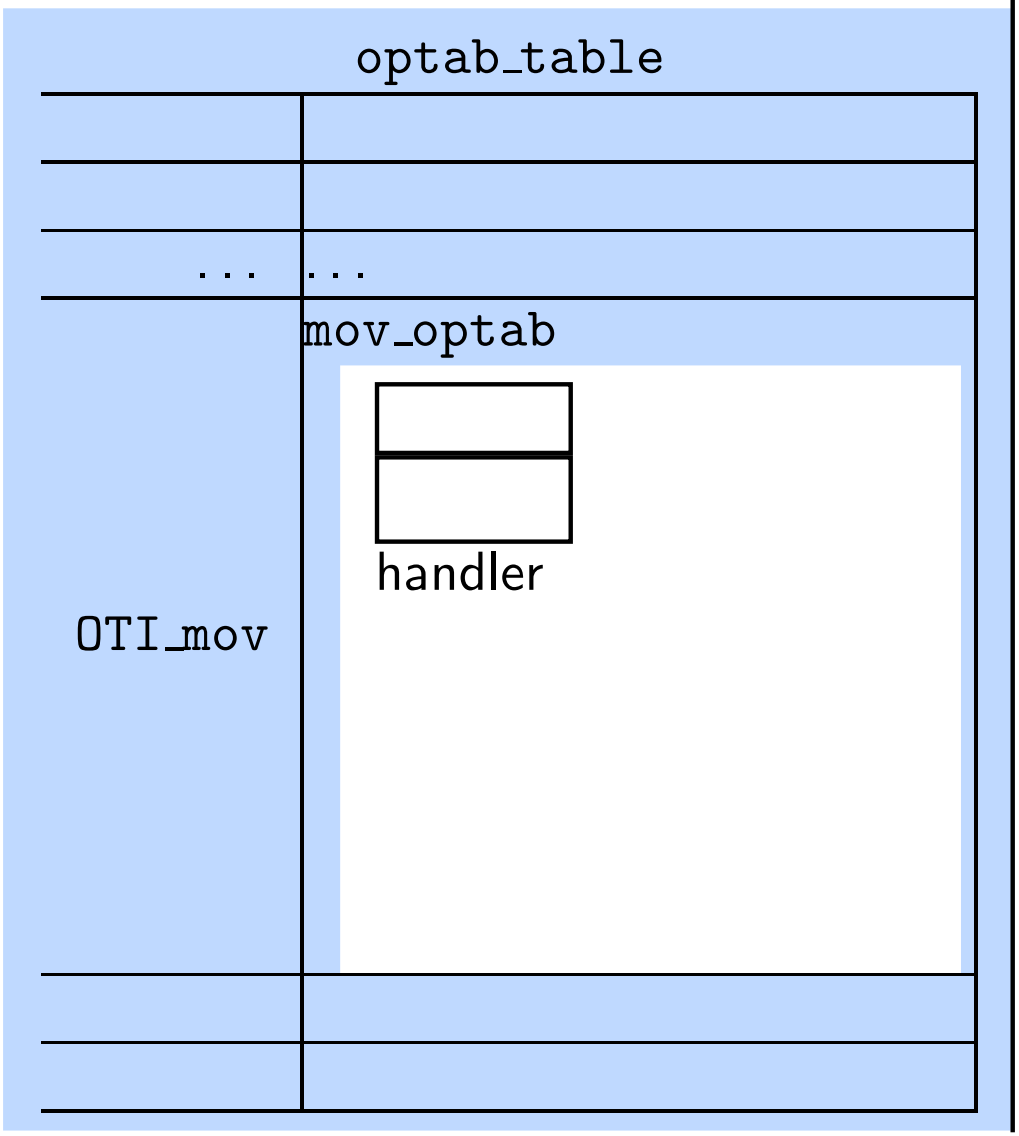

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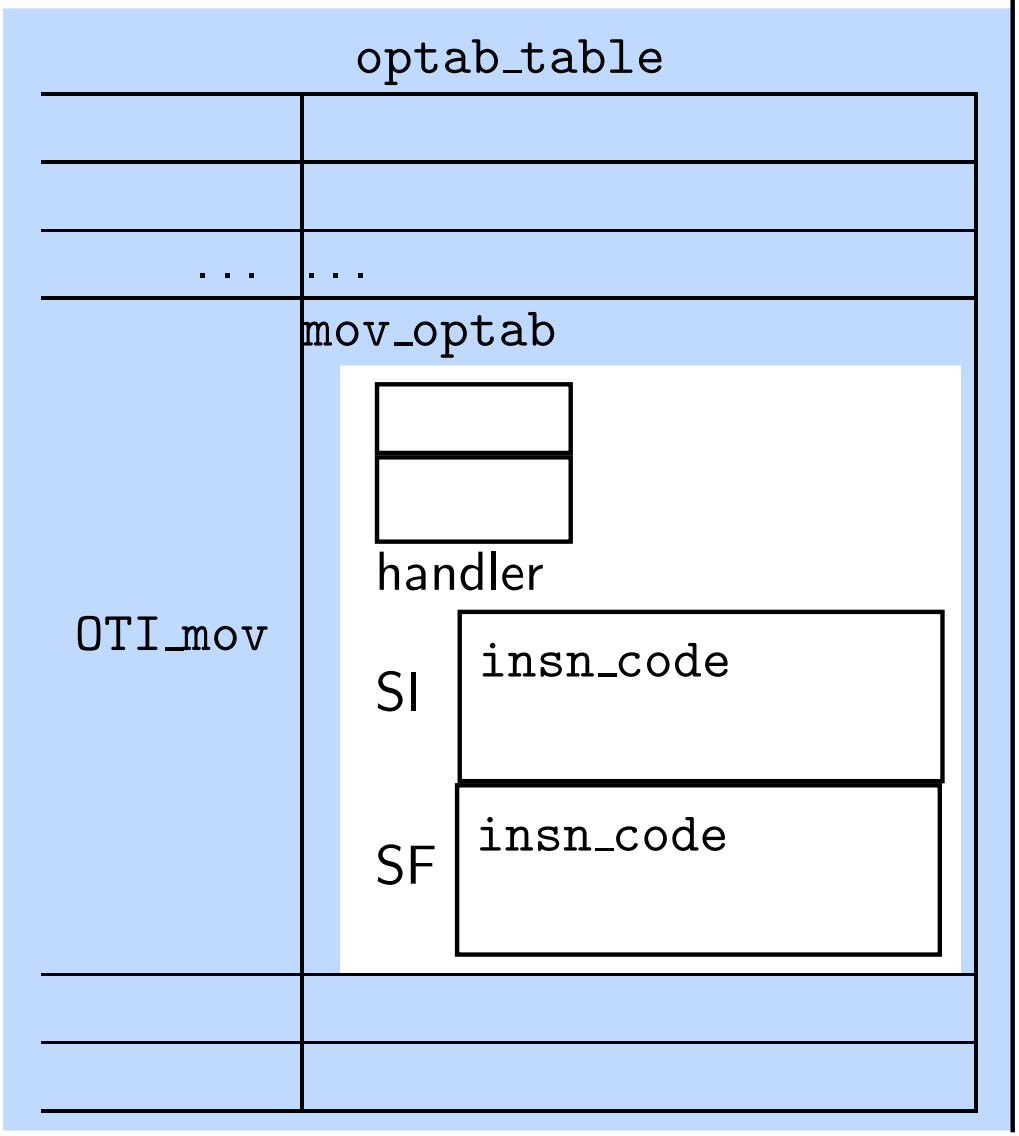

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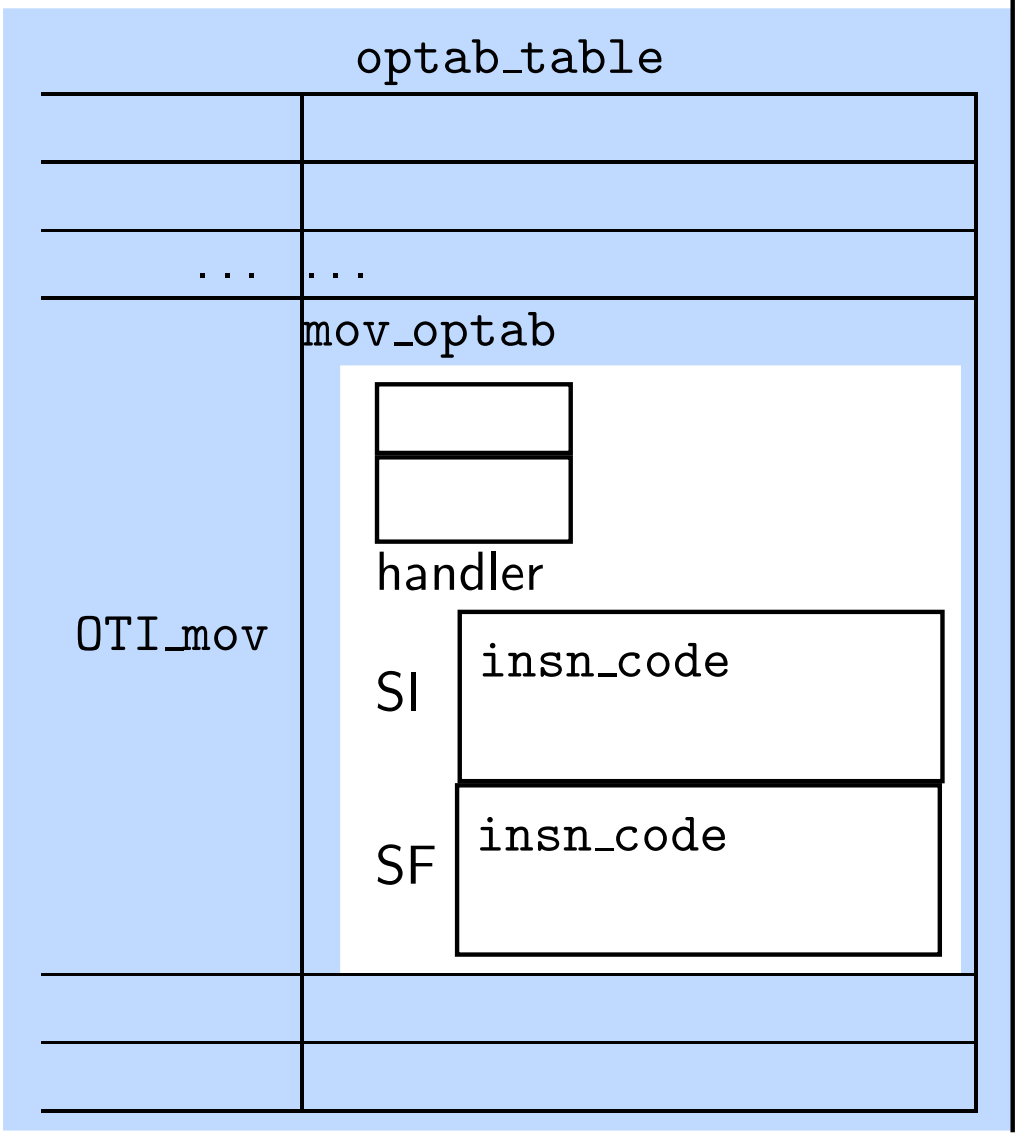
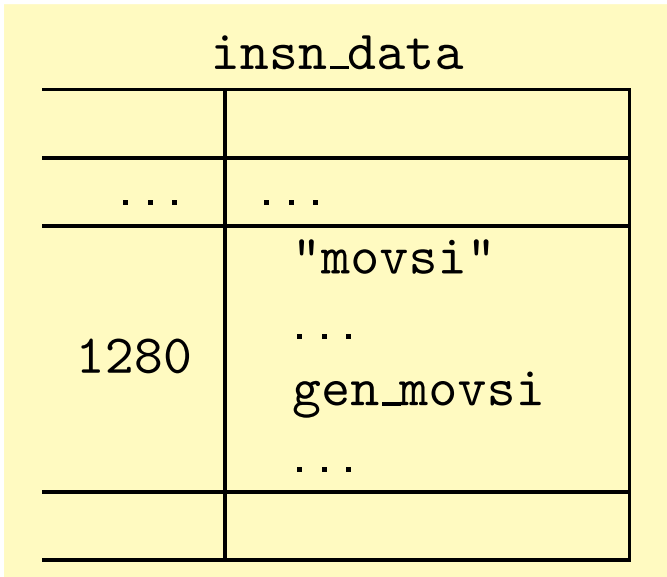


$(BUILD)/gcc/insn-output.c



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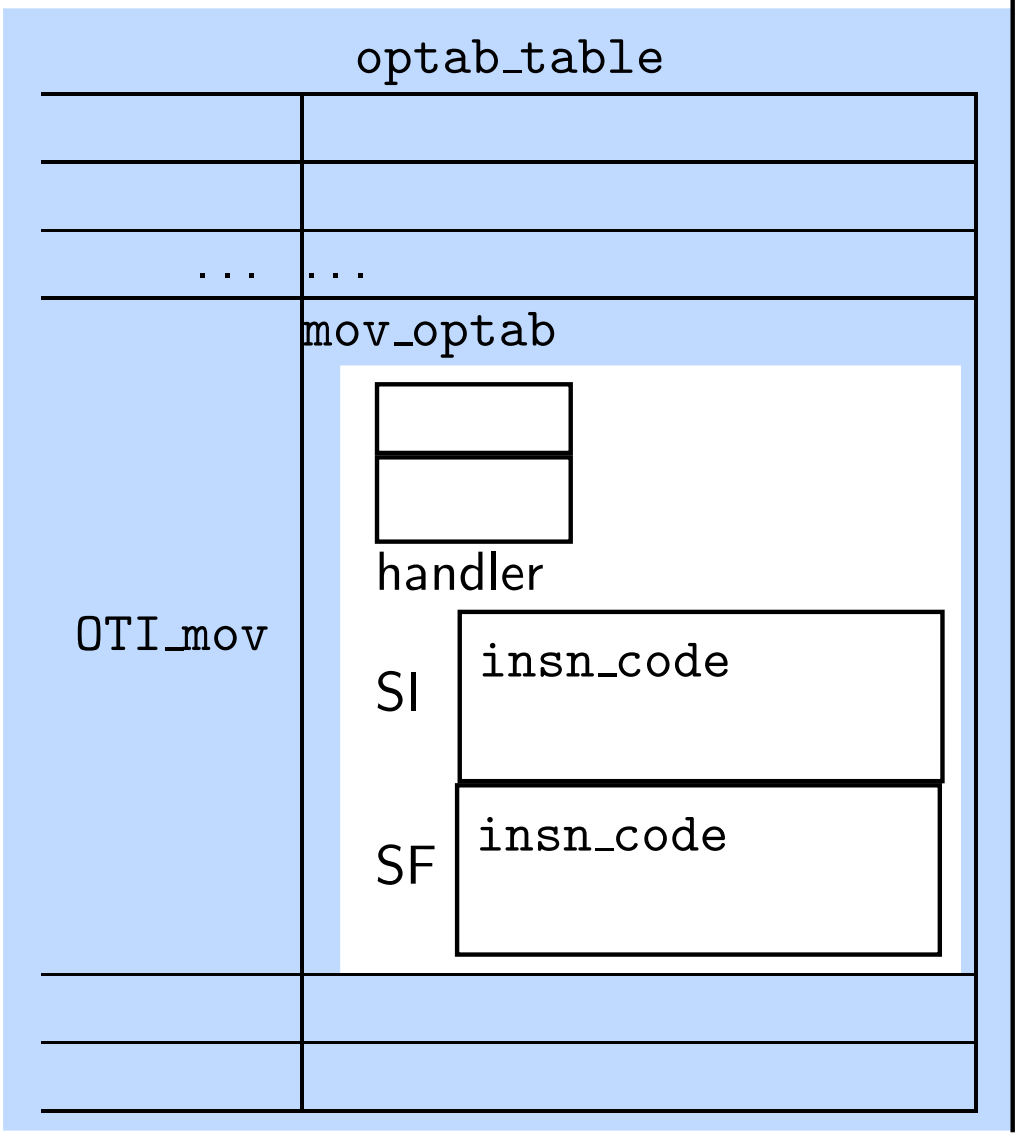

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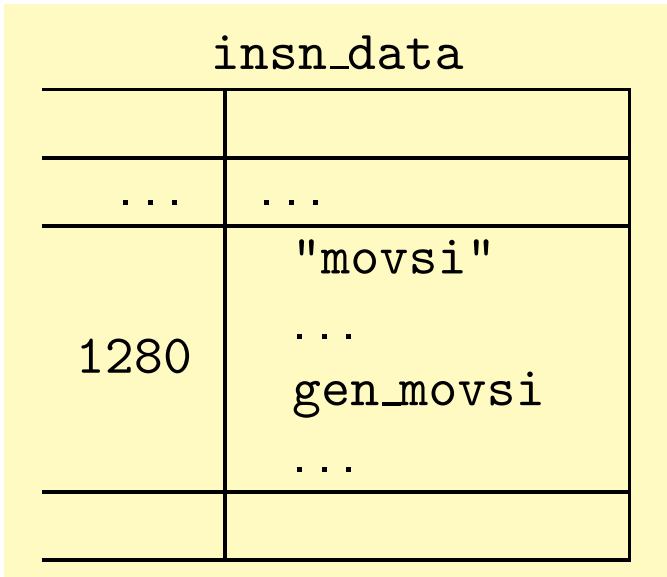

$BUILD/gcc/insn-codes.h

```
CODE_FOR_movsi=1280
CODE_FOR_movsf=CODE_FOR_nothing
```


Assume movsi is supported but movsf is not supported...

$(SOURCE)/gcc/optabs.h
$(SOURCE)/gcc/optabs.c

optab_table

...	...
OTI_mov	mov_optab

mov_optab

handler	
SI	insn_code
SF	insn_code

$(BUILD)/gcc/insn-output.c

insn_data

...	...
1280	"movsi" ... gen_movsi ...

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CODE_FOR_movsi=1280
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$(SOURCE)/gcc/optabs.c

optab_table

...	...
	mov_optab

Runtime initialization of data structure

OTI_mov

SI	insn_code CODE_FOR_movsi
SF	insn_code CODE_FOR_nothing

$(BUILD)/gcc/insn-output.c

insn_data

...	...
1280	"movsi" ... gen_movsi ...

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$BUILD/gcc/insn-opinit.c

...

GCC Generation Phase – Revisited

Generator	Generated from MD	Information	Description
genopinit	insn-opinit.c	void init_all_optabs (void);	Operations Table Initialiser
gencodes	insn-codes.h	enum insn_code = {... CODE_FOR_movsi = 1280, ...}	Index of patterns
genooutput	insn-output.c	struct insn_data [CODE].genfun = /* fn ptr */	All insn data e.g. gen function
genemit	insn-emit.c	rtx gen_rtx_movsi (/* args */) {/* body */}	RTL emission functions

Explicit Calls to gen<SPN> functions

- In some cases, an entry is not made in `insn_data` table for some SPNs.
- `gen` functions for such SPNs are explicitly called.
- These are mostly related to
  - Function calls
  - Setting up of activation records
  - Non-local jumps
  - etc. (i.e. deeper study is required on this aspect)

Handling C Code in define_expand

```
(define_expand "movsi"
   [( set  (op0) (op1))]
   ""
   "{  /* C CODE OF DEFINE EXPAND */  }")


rtx
gen_movsi (rtx operand0, rtx operand1)
{
   ...
   {
      /* C CODE OF DEFINE EXPAND */
   }
   emit_insn (gen_rtx_ SET  (VOIDmode, operand0, operand1)
   ...
}
```

Part 3

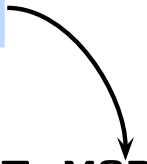
Using the Code Generators

RTL Generation – The Internals

```
case GIMPLE_MODIFY_STMT: ... expand_assignment (...);
   ... /* Various cases of expansion */
/* One case: integer mode move */
icode = mov_optab->handler[SImode].insn_code
if (icode != CODE_FOR_nothing) {
   ... /* preparatory code */
   emit_insn (GEN_FCN(icode)(dest,src));
}
```

RTL Generation – The Internals

TREE node



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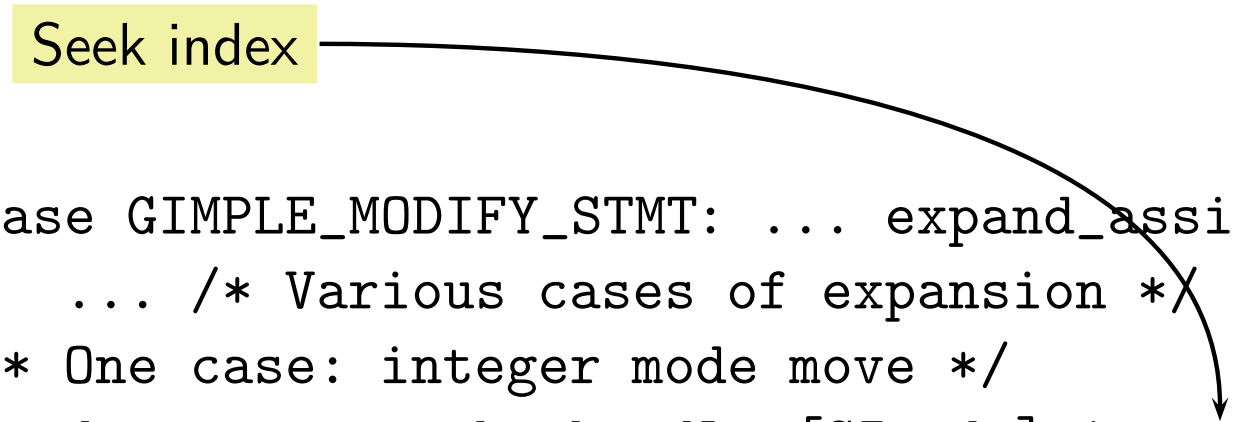


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RTL Generation – The Interr

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insn-codes.h

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= {...
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insn-codes.h

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```

Got index into optab

RTL Generation – The Internals

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if (icode != CODE_FOR_nothing) {
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   emit_insn (GEN_FCN(icode)(dest,src));
}
```

Use icode (= 1280)

```
#define GENFCN(code) insn_data[code].genfun
```


RTL Generation – The Internals

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   emit_insn (GEN_FCN(icode)(dest,
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```

insn-output.c

```
insn_data[1280].genfun
= gen_movsi
```

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RTL Generation – The Internals

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case GIMPLE_MODIFY_STMT: ... expand_assignment (...);
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#define GENFCN(code) insn_data[code].genfun
```

Execute: `gen_movsi (dest,src)`

RTL to ASM Conversion

- Simple pattern matching of IR RTLs and the patterns present in all named, un-named, standard, non-standard patterns defined using `define_expand`.
- A DFA (deterministic finite automaton) is constructed and the first match is used.