

Systems Programming

Chapter 2 Assemblers – part 2

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Modification record (revised):

Col 1	M
Col. 2-7	Starting address of the field to be modified, relative to the beginning of the control section
Col. 8-9	Length of the field to be modified, in <u>half bytes</u> .
Col 10	Modification flag (+ or -)
New! Col 11-16	External symbol whose value is to be added to or subtracted from the indicated field

See Fig. 2.17

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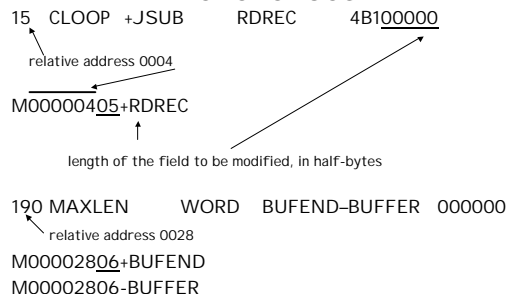
Homework #2

(Due: Mar 24th & 31st)

- Design and implement a SIC assembler simulator by following the software engineering and procedural / object-oriented design principles given in Chapter 8.
- Part 1: Due Mar 24th
 - Submit a document that includes
 - a system specifications document
 - object-oriented system design
 - module interfaces
 - system testing strategy.
- Part 2: Due Mar 31st
 - Implement your assembler in C++ using an object-oriented approach. Submit your full codes and a document that relates your actual work to the Part 1.

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Linking up external references



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Outline

- Machine-independent features
 - handling expressions
 - program blocks
 - control sections and program linking
- Assembler design options
 - one-pass assemblers
 - multi-pass assemblers

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Doing program relocation

- Exactly the same mechanism can be used for program relocation and for program linking.
 - the modification required is adding the beginning address of the control section to certain fields in the object program.
 - The symbol used as the name of the control section has as its value the required address - control section name is automatically an external symbol.
- M00000705 → M00000705+COPY
M00001405 → M00001405+COPY
M00002705 → M00002705+COPY

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Handling of expressions in the existence of multiple CSs

- Def: All of the relative terms in an expr. must be paired (absolute), or that all except one must be paired (relative.)
- + Both terms in each pair must be relative within the same CS (Control Section.)
 - BUFEND-BUFFER vs. RDREC-COPY

When an expr. involves external refs, assembler cannot in general determine whether or not the expr. is legal. **why?**

- It forms an initial expr. value, and leaves the rest to the loader.

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Two types of one-pass assemblers:

1. **Load-and-go assembler:** produces object code directly in memory for immediate execution.
 - no object program is written out
 - no loader needed
 - useful in heavy development/testing envs.
 - programs are re-assembled nearly every time they are run.
 - often used on systems where external working-storage devices are not available or when external storage is slow or inconvenient to use

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Assembler Design Options

- Two-Pass Assemblers (we have covered)
- One-Pass Assemblers
- Multi-Pass Assemblers

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Handling of forward refs in load-and-go assemblers

- less difficult since object program is produced in memory
 - assembler generates object code as it scans the program
 - if an instr operand is a not-yet-defined symbol,
 - operand address is omitted
 - symbol is entered into symbol table
 - address of operand field is added to a list of forward refs associated with the symbol table entry
 - when the definition is encountered, the forward ref list for that symbol is scanned, and the proper address is inserted into any instrs previously generated.

See Fig. 2.18 → 2.19 (a) & (b)

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One-Pass Assemblers

- Main problem: forward references
 - Instruction operands often are symbols that have not yet been defined in the source program.
- Is elimination possible?
 - usually applied to reduce complexity eliminate forward refs to data items: all should be defined before they are ref'd.
 - EASY! ACCEPTABLE!
 - BUT cannot eliminate forward refs to labels on instrs
 - NOT easy. We need forward jumps frequently!

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Two types of one-pass assemblers:

2. Type 2: produces usual kind of object program for later execution
 - forward refs are entered into lists as before
 - However when the def of a symbol is encountered, instrs that made forward refs to that symbol may no longer be available in memory for modification
 - they have been written out as part of a Text record
 - Assembler must generate another Text record with the correct operand address
 - this is inserted into the correct place by the loader

See Fig. 2.20

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Multi-Pass Assemblers

- Remember: any symbol used on the right-hand side be defined previously in the source program, e.g., EQU
 - The reason for this is the symbol definition process in a two-pass assembler.

ALPHA	EQU	BETA	} A 2-Pass assembler cannot resolve such sequence of defs.
BETA	EQU	DELTA	
DELTA	RESQ	1	

Forward refs are even difficult even for human reader! We can prohibit them.

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- But the general solution is multi-pass assemblers:
 - can make as many passes as ar needed to process the definitions of symbols
 - does not have to do > 2 passes over the entire program – Pass 1 saves portions that involve forward refs, Pass 2 re-scans them
- Store symbol defs that involve forward-refs in the symbol table
 - table also indicates which symbols are dependent on the values of others
 - See **Fig.2.21**

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