Moderní trendy v korporátních informačních technologiích

Moderní trendy v korporátních informačních technologiích

- Predstavíme si zľahka HLASM a priblížime problematiku jeho spracovania
- Hlavnou náplňou predmetu je prispieť do projektu HLASM Language Support - pridáva podporu pre HLASM do Visual Studio Code
- Na začiatku semestra zopár prednášok na vysvetlenie základov, potom samostatná práca na vybratej úlohe s konzultáciami.

- Stranka predmetu: https://github.com/michalbali256/uvod-do-smf
- Kontakt: michalbali32@gmail.com

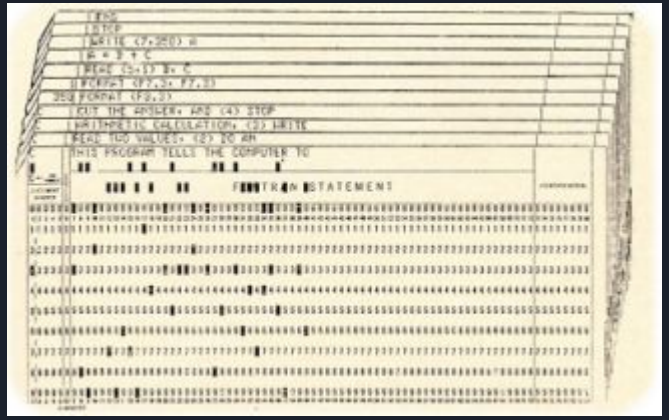
Dnešný program

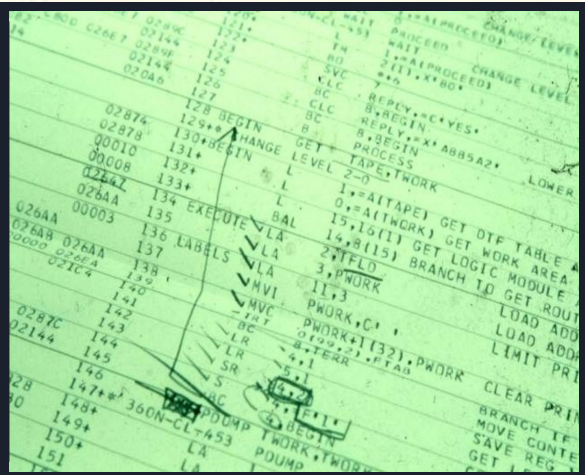
- Syntax HLASM a ako sa kompiluje.
- Čo je to HLASM Language support
- Témy úloh na semester

High Level Assembler Language support

IBM High Level Assembler

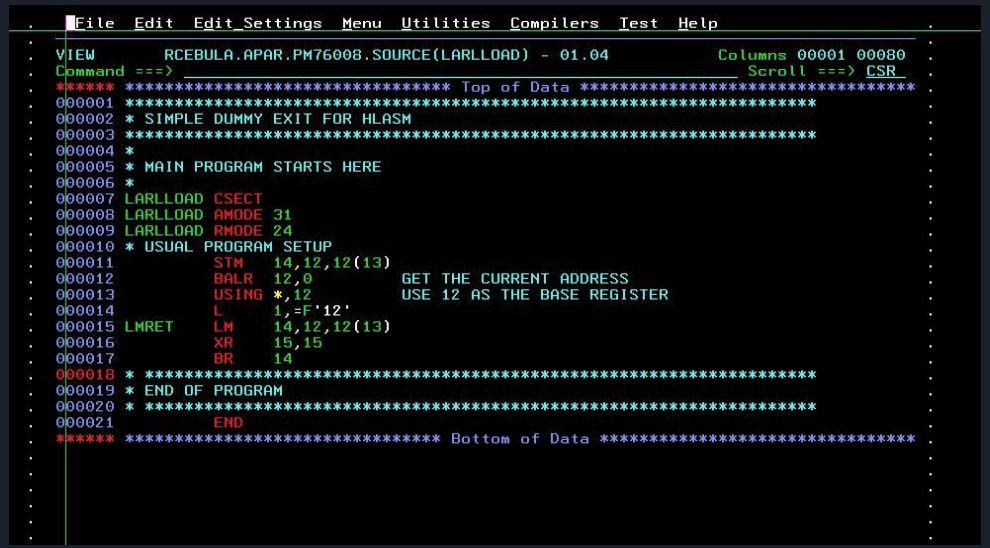
- Current version released in 1992
- Origins in 1960s
- Still developed, maintained and used
- Multiple products maintained by Broadcom, hundreds of megabytes of code





Mainframe in 2020

- Old green-screen terminal
- Tedious workflow
  - Change the source code
  - Run build job
  - Check the listing
  - >30 seconds to notice a typo…



HLASM Language Support

- Open Source plugin for modern IDEs, such as Visual Studio Code
- Provides:
  - Semantic highlighting
  - Modern IDE features, e.g. go to definition or hover
  - Validation of all machine instructions
  - Interpretation of a large subset of code-generating instructions
  - Tracing of macro expansions similar to debugging procedure
- Compliant with LSP and DAP specifications

Basic use cases

“Am I using this LR instruction correctly?”

Mainframe workflow:

- Find the instruction in the HLASM documentation OR
- Guess and try to compile it

HLASM Plugin workflow:

- In case you are not, the error message with the explanation will appear
- Autocomplete for instructions with information about their format

“Where was this VAR symbol defined?”

Mainframe workflow:

- List through tens of source files manually

HLASM Plugin workflow:

- The go to definition feature on the VAR symbol will take you to the definition

High level assembler

There are 3 types of instructions:

- Machine instructions
- Assembler instructions
  (static variables, object layout, modifications of assembler program state)
- Conditional Assembly instructions
  (basically a Turing-complete macro system)

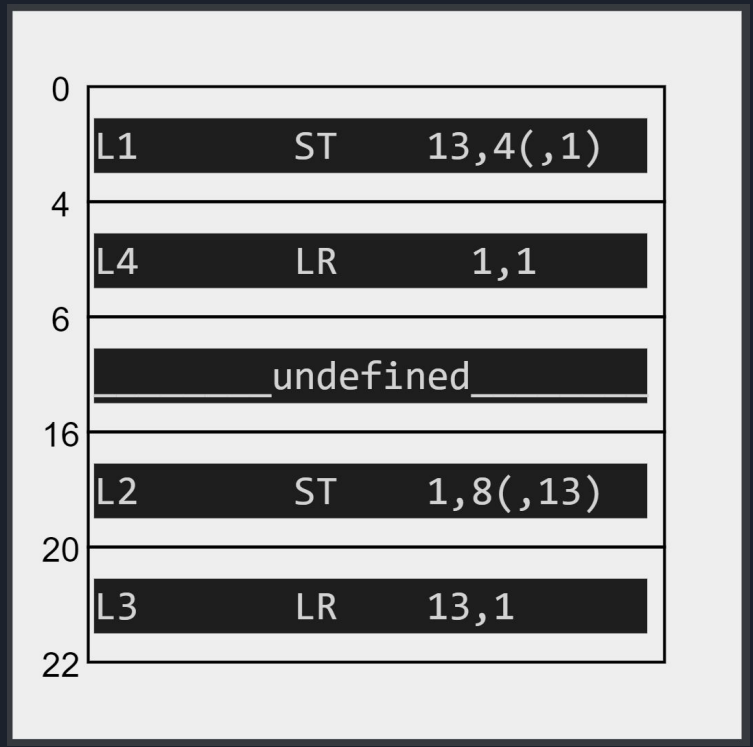
Object code layout interpretation

Source file

```
1    PART1    LOCTR
2
3    L1        ST     13,4(,1)
4
5    PART2    LOCTR
6
7              ORG     *,16
8
9    L2        ST     1,8(,13)
10   L3        LR     13,1
11
12   PART1 LOCTR
13
14   L4        LR      1,1
```

20
Relocatable Symbol
L: 2
T: I

Object file



Conditional assembly instructions

- Turing-complete compile time metalanguage

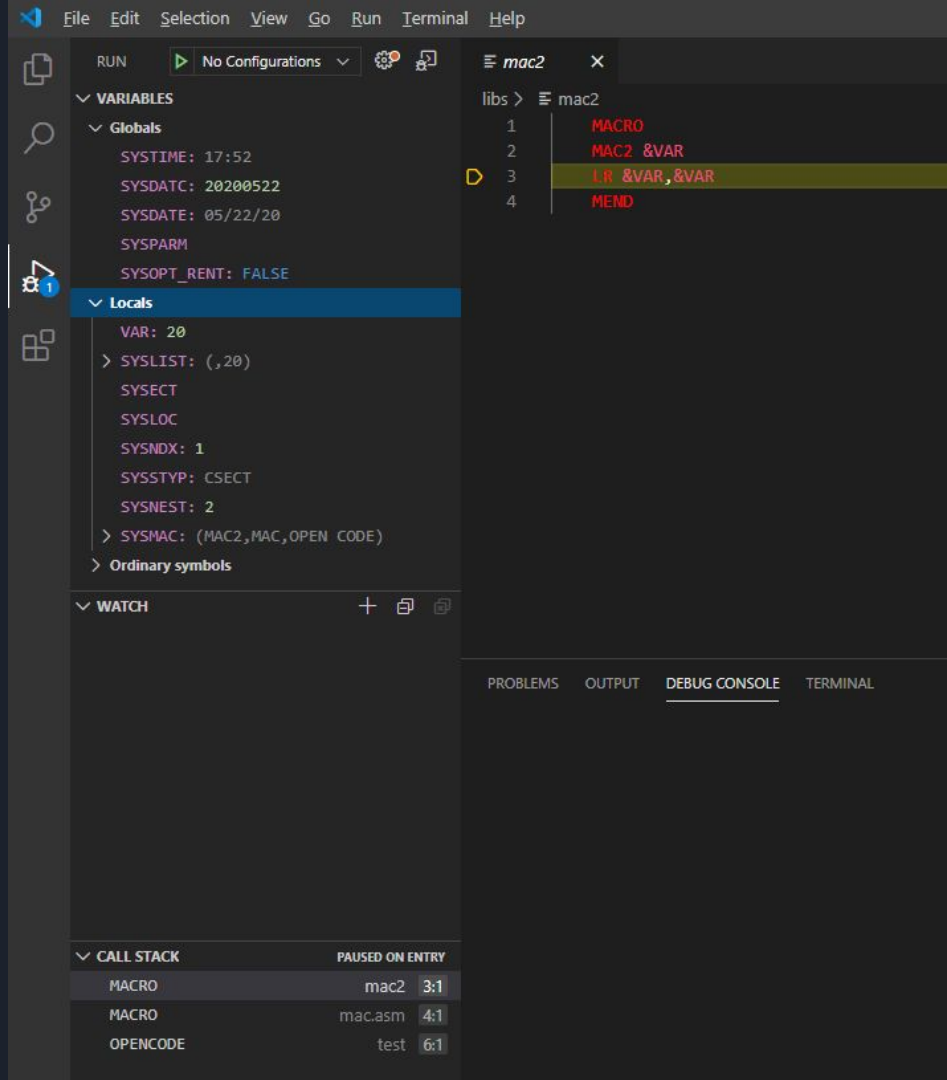
```
*************************  FACTORIAL  ****************************
*  The following recursive macro computes factorial of its parameter
*  during compile time.  The result will be in variable symbol RES.
          MACRO
          FACT  &A
*
          GBLA  RES  We create global variable symbol RES
*  It is created with default value 0, so initialize it to 1 if this is
*  the topmost call of this macro.
          AIF   (&SYSNEST NE 1).INITEND
&RES      SETA  1
.INITEND  AIF   (&A EQ 0).SKIP   Nothing to do if computing fact of 0.
&RES      SETA  &RES*&A          Do the actual multiplication
*  The 'NEXT' variable is local to the scope of current macro execution.
&NEXT     SETA  &A-1
          FACT  &NEXT            Do the factorial of a-1
.SKIP     ANOP
          MEND
*
          GBLA  RES   We have to unhide the global variable RES,       X
                      otherwise, it would not be visible to this scope.
          FACT  5     Now we 'call' the macro, and it will assign 5! to X
                      &RES
```

HLASM Language Support features

- Diagnostics - extension shows an error in the IDE, when the source code would not compile on mainframe - includes more or less complete list of HLASM instructions and interpretation of most important assembler and CA instructions
- Go to definition and Go to references for ordinary, variable and sequence symbols, macro definitions, COPY files
- Context-aware highlighting
- Completion for instructions, macro names and variable symbols
- Hover over symbols in source codes to show additional information that the parser has available

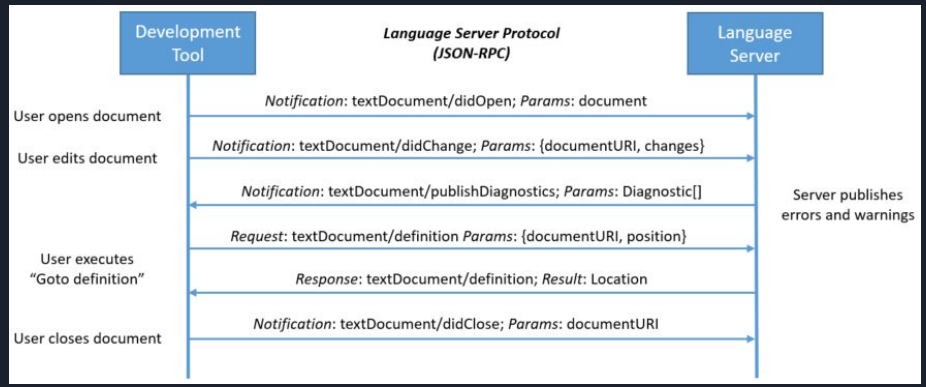
Macro Tracer

- Debugger for code generation
- Traces compile-time variables and macro expansions
- Starts an analyzer in a new thread
- Listens for callbacks and stops the thread using conditional variable when a breakpoint is hit
- While the thread is stopped it is possible to inspect parsing context and show it to the user



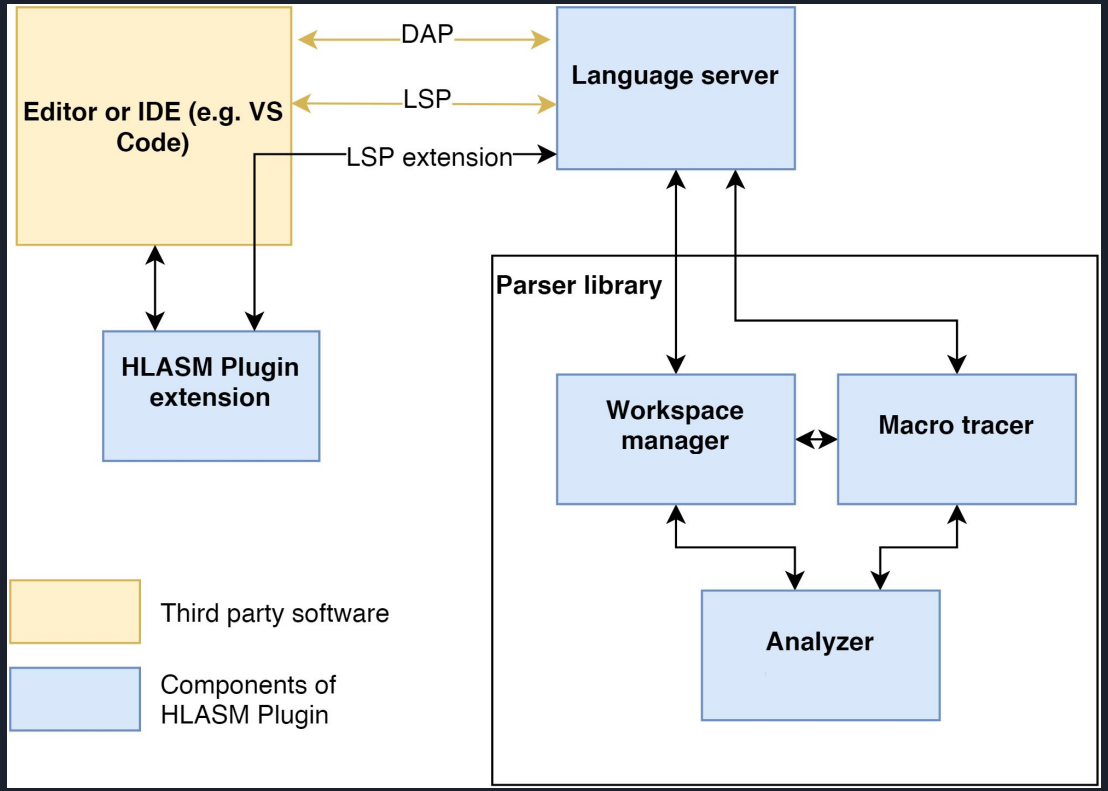
Language Server Protocol

- The Language Server Protocol (LSP) defines the protocol used between an editor or IDE and a language server that provides language features like auto complete, go to definition, find all references etc.
- Solves the N:M problem
- Based on JSON RPC



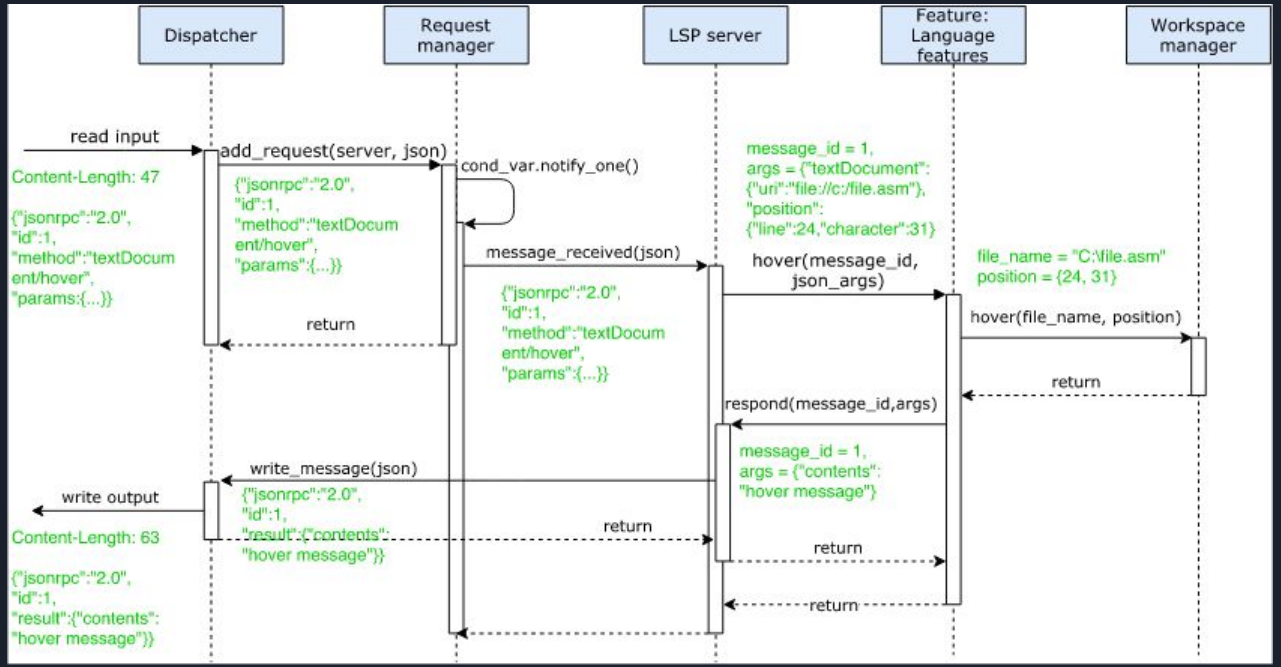
Architecture Overview

- 3 main components
  - Language server (C++)
  - Parser library (C++)
    - Workspace Manager
    - Macro Tracer
    - Analyzer
  - VSCode Extension (TypeScript)



Language server & Workspace Manager

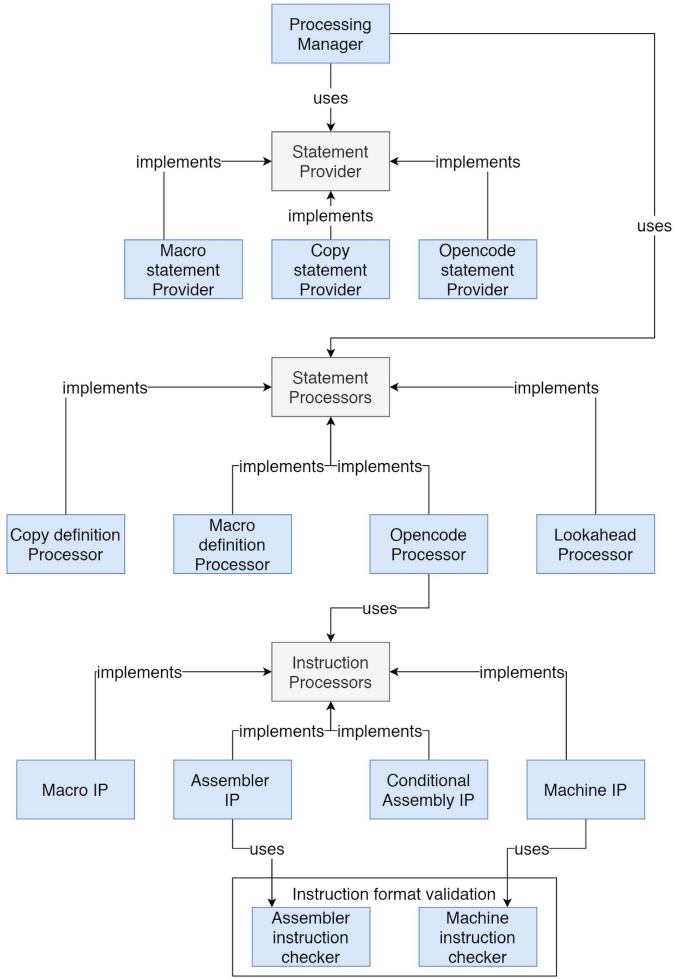
- These components expose the analyzer to the user
- Interface compliant with the LSP and DAP specifications
- Manage input files and workspaces
- Presentation of parsing results to the user
- Uses Analyzer for processing and sends back the results



Code analyzer

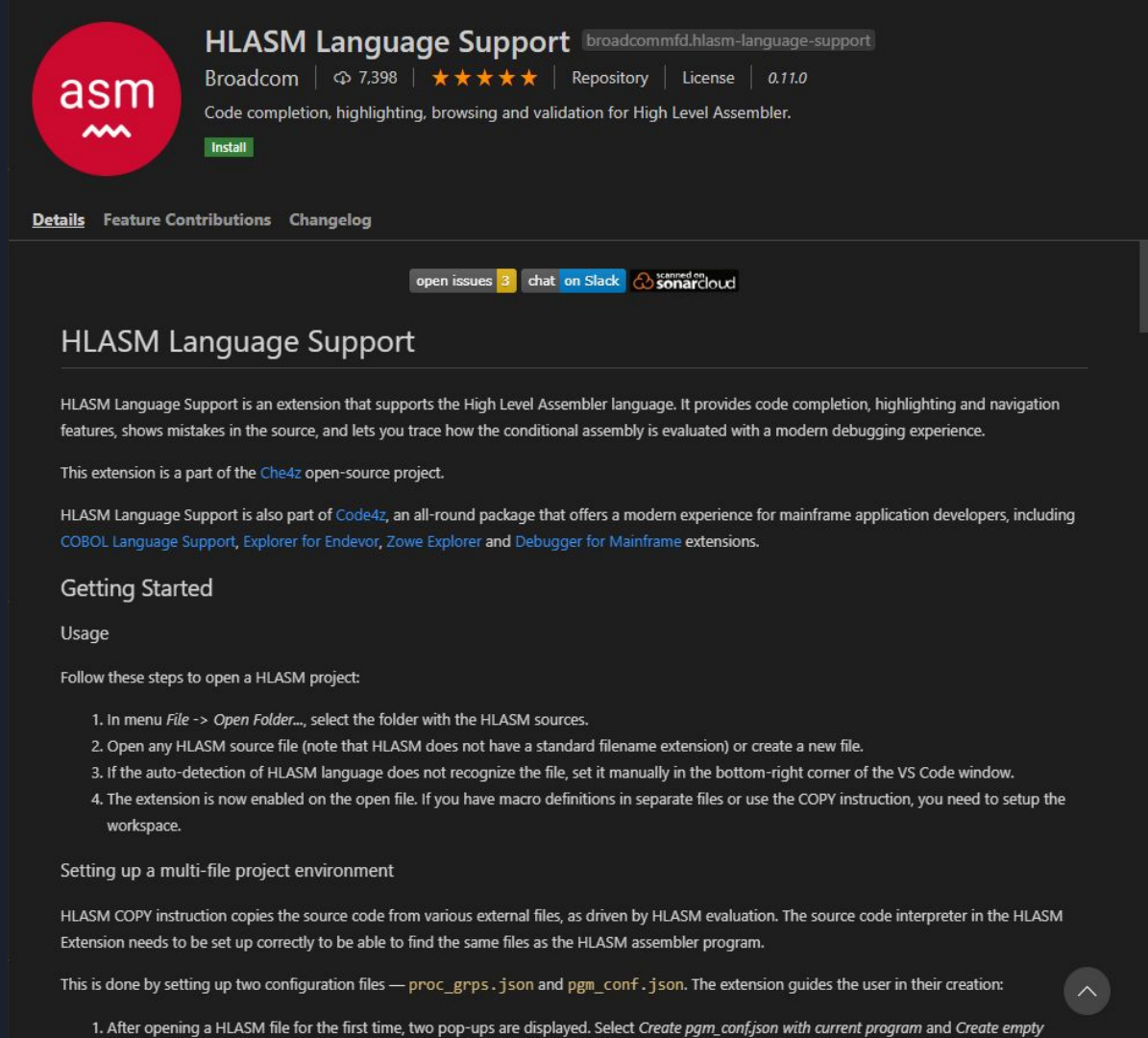
- Processes the contents of HLASM source code
- Different processors for different situations
- Validates machine instructions
- Interprets assembler and conditional assembly instructions

```
1335        add_machine_instr(result, "LEXTR", mach_format::RRF_b, { reg_4_U, reg_4_U, reg_4_U }, 32, 1512);
1336        add_machine_instr(result, "LTDTR", mach_format::RRE, { reg_4_U, reg_4_U }, 32, 1513);
1337        add_machine_instr(result, "LTXTR", mach_format::RRE, { reg_4_U, reg_4_U }, 32, 1513);
1338        add_machine_instr(result, "FIDTR", mach_format::RRF_e, { reg_4_U, mask_4_U, reg_4_U, mask_4_U }, 32, 1514);
1339        add_machine_instr(result, "FIXTR", mach_format::RRF_e, { reg_4_U, mask_4_U, reg_4_U, mask_4_U }, 32, 1514);
1340        add_machine_instr(result, "LDETR", mach_format::RRF_d, { reg_4_U, reg_4_U, mask_4_U }, 32, 1517);
1341        add_machine_instr(result, "LXDTR", mach_format::RRF_d, { reg_4_U, reg_4_U, mask_4_U }, 32, 1517);
1342        add_machine_instr(result, "LEDTR", mach_format::RRF_e, { reg_4_U, mask_4_U, reg_4_U, mask_4_U }, 32, 1518);
1343        add_machine_instr(result, "LDXTR", mach_format::RRF_e, { reg_4_U, mask_4_U, reg_4_U, mask_4_U }, 32, 1518);
1344        add_machine_instr(result, "MDTR", mach_format::RRF_a, { reg_4_U, reg_4_U, reg_4_U }, 32, 1519);
1345        add_machine_instr(result, "MXTR", mach_format::RRF_a, { reg_4_U, reg_4_U, reg_4_U }, 32, 1519);
1346        add_machine_instr(result, "MDTRA", mach_format::RRF_a, { reg_4_U, reg_4_U, reg_4_U, mask_4_U }, 32, 1520);
1347        add_machine_instr(result, "MXTRA", mach_format::RRF_a, { reg_4_U, reg_4_U, reg_4_U, mask_4_U }, 32, 1520);
1348        add_machine_instr(result, "QADTR", mach_format::RRF_b, { reg_4_U, reg_4_U, reg_4_U, mask_4_U }, 32, 1521);
1349        add_machine_instr(result, "QAXTR", mach_format::RRF_b, { reg_4_U, reg_4_U, reg_4_U, mask_4_U }, 32, 1521);
1350        add_machine_instr(result, "RRDTR", mach_format::RRF_b, { reg_4_U, reg_4_U, reg_4_U, mask_4_U }, 32, 1524);
1351        add_machine_instr(result, "RRXTR", mach_format::RRF_b, { reg_4_U, reg_4_U, reg_4_U, mask_4_U }, 32, 1524);
1352        add_machine_instr(result, "SLDT", mach_format::RXF, { reg_4_U, reg_4_U, dxb_12_4x4_U }, 48, 1526);
1353        add_machine_instr(result, "SLXT", mach_format::RXF, { reg_4_U, reg_4_U, dxb_12_4x4_U }, 48, 1526);
1354        add_machine_instr(result, "SRDT", mach_format::RXF, { reg_4_U, reg_4_U, dxb_12_4x4_U }, 48, 1526);
1355        add_machine_instr(result, "SRXT", mach_format::RXF, { reg_4_U, reg_4_U, dxb_12_4x4_U }, 48, 1526);
1356        add_machine_instr(result, "SDTR", mach_format::RRF_a, { reg_4_U, reg_4_U, reg_4_U }, 32, 1527);
1357        add_machine_instr(result, "SXTR", mach_format::RRF_a, { reg_4_U, reg_4_U, reg_4_U }, 32, 1527);
1358        add_machine_instr(result, "SDTRA", mach_format::RRF_a, { reg_4_U, reg_4_U, reg_4_U, mask_4_U }, 32, 1527);
1359        add_machine_instr(result, "SXTRA", mach_format::RRF_a, { reg_4_U, reg_4_U, reg_4_U, mask_4_U }, 32, 1527);
1360        add_machine_instr(result, "TDCET", mach_format::RXE, { reg_4_U, dxb_12_4x4_U }, 48, 1528);
```



VSCode Extension

- End-user component
- Standard extension for VSCode
- Semantic highlighting is an addition to the LSP



Technologies

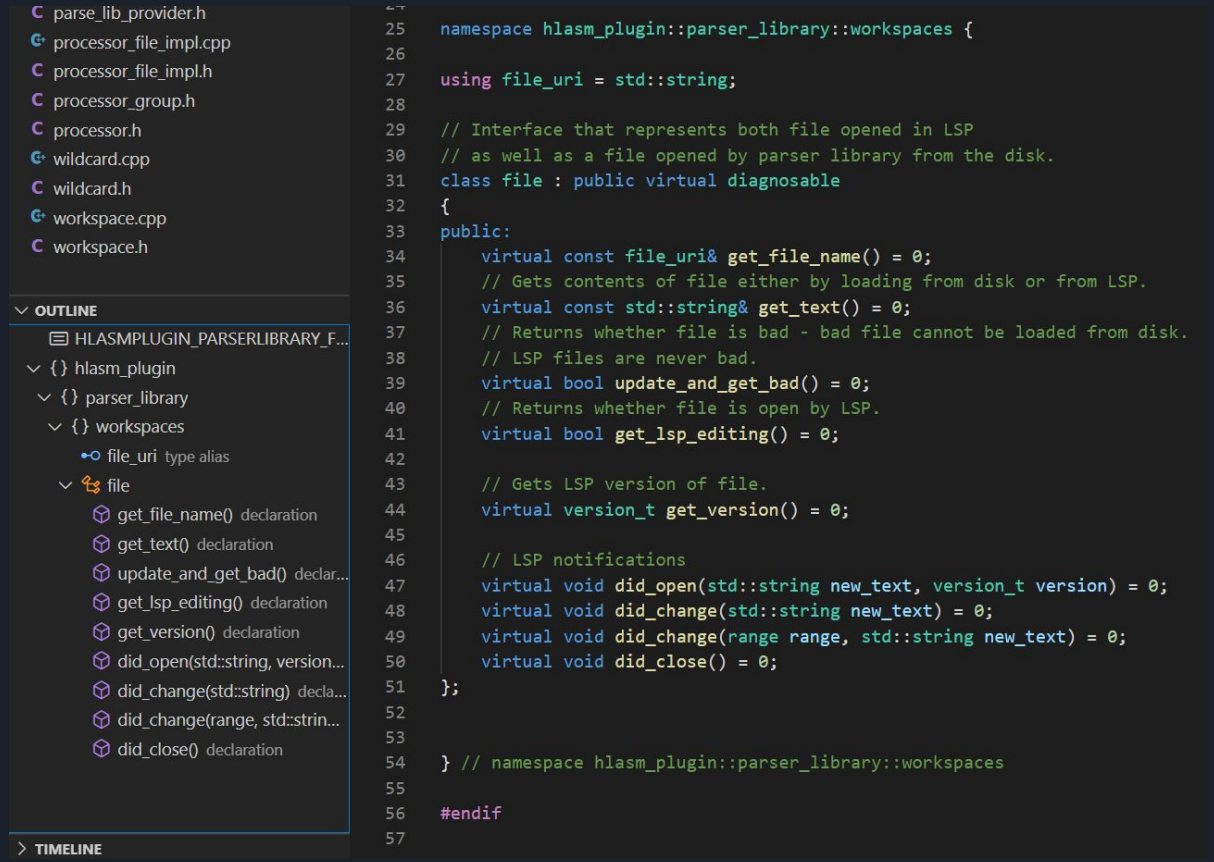
- Crossplatform - Windows, MacOS, Linux
- Languages - C++17, Typescript
- Parser - ANTLR
- Build system - CMake
- Pipeline/continuous integration - Github Actions
- Sonarcloud

Themes for projects

- Outline
- Folding ranges
- Processor group switching
- HLASM listing highlighting

Outline

- A list of defined symbols in opened file
- Implementation of LSP request documentSymbol



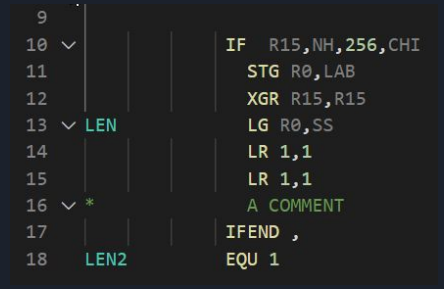
Outline implementation in C++ extension

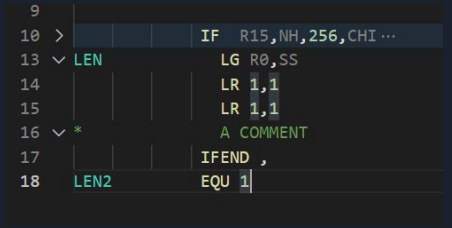
Outline

- For HLASM, it should list defined ordinary symbols (including location counters and *SECTs), sequence symbols, variable symbols
- Symbols defined in an external file should be enclosed under common node
- STRETCH - There are commonly used pair macros (FUNCENTRY-FUNCEND) that mark the beginning and the end of functions.

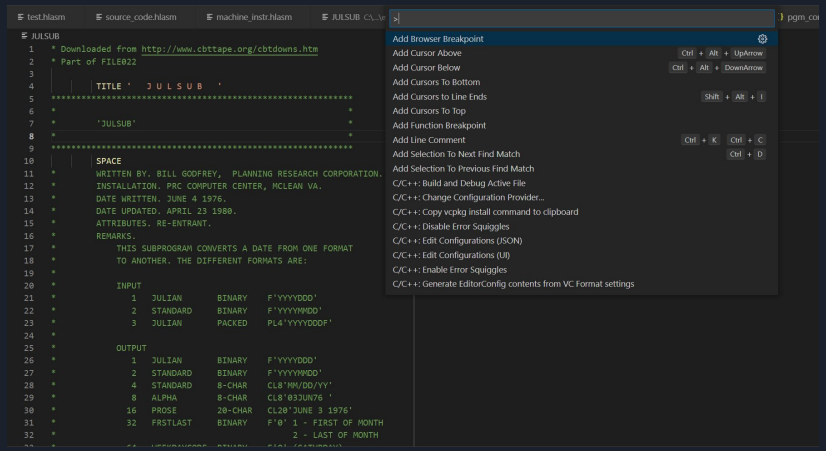
Folding ranges

- Currently, there are default VS Code folding ranges based solely on indentation.
- However, that does not work that well for HLASM, since label always starts at the first column and only then do we indent the instruction
- Comments should be ignored
- In presence of structured macros, the problem can be approached either based solely on indentation, or recognize the actual macros (configuration needed for the user to define which macros does he want to fold)
- Implementation of LSP request foldingRange





UI element for processor group switching



- proc_grps.json define several processor groups; one processor group is essentially a list of directories where our parser should look for external macros and copy files
- pgm_conf.json defines which processor groups should be used for which source files
- For some files, there may be more processor groups - differentiating different versions of the source file.
- The task is to create a UI element that would allow to quickly choose processor group for currently opened source file (open code), i.e. modify pgm_conf.json appropriately.

HLASM listing highlighting

- A HLASM listing is a byproduct of HLASM compilation. It shows expansion of macros, variable symbols and much more additional information
- HLASM developers spend (too) much time by studying it. The first step is to have it colored
- Add a new “language” to the VS Code extension
- Write TextMate grammar

Thank you for your attention