1 Introduction

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Lehrstuhl für Informatik 4
Systemsoftware

Friedrich-Alexander-Universität
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http://sys.cs.fau.de/lehre/ss24
Introduction

- **Deepen** knowledge of concepts and techniques of computer science and software development
  - Starting point: Algorithms, Programming, and Data Representation
  - Main focus: System-Level Programming (SLP) in C

- **Development** of software in C for a \(\mu\)Controller (\(\mu\)C) and an operating-system platform (Linux)
  - SPiCboard learning development platform with an ATmega-\(\mu\)C
  - Practical experience in hardware and system-level software development

- **Understanding** of technological language and hardware basics for the development of system-level software
  - Being able to understand and assess the language C and
  - Dealing with concurrency and hardware proximity
  - Dealing with the abstractions of an operating system (files, processes, ... )
Motivation: Embedded Systems

Omnipresent: 98–99 percent of processors are being used in embedded systems [7].

Cost-sensitive: 70–80 percent of all produced processors are DSPs and µController, based on 8-bit architecture or lower [7, 8].

Relevant: 25 percent of job offers for EE engineers do contain the terms embedded or automotive (http://stepstone.com).
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Source: IC Insights 2014 McClean Report
Motivation: The ATmega-μC Family (8-bit)

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ATmega variants (selection) and market prices (Reichelt Elektronik, April 2023)
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Becomes visible: **resource scarcity**

- **Flash** (storage for program code and constant data) is **scarce**
- **RAM** (storage for runtime variables) is **extremely scarce**
- few bytes “wasted” ↞ significantly higher cost per piece
Motivation: C as a Language

- System-level software development predominantly takes place in C.
- **Why C?** (and not Python/Java/Scala/<favourite language>)
  
  - **Runtime efficiency (CPU)**
    - Translated C code runs on the processor directly
    - No checks for programming errors at runtime
  
  - **Space efficiency (storage)**
    - Code and data can be stored rather compact
    - No checks for data access at runtime
  
  - **Immediacy (machine proximity)**
    - C allows for direct access to storage and registers
  
  - **Portability**
    - There is a C compiler for every platform

C was “invented” (1973), to implement the OS UNIX portable [4, 6]; C is the lingua franca of system-level programming!
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- C stands for a multitude of important features
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→ **C is the **lingua franca** of system-level programming!**
Teaching objective: system-level programming in C
- This is a really broad field: hardware programming, operating systems, middleware, data bases, distributed systems, compiler construction, ...
- Additionally, we have the goal of learning the language C itself

Approach
- Concentration on two domains
  - μC programming
  - Software development for Linux system interface
- Experience contrast μC-environment ↔ operating system
- Concepts and techniques get teachable and tangible with the help of various examples
- **High relevance** for the target audience (EE, ME, ...)

© klsw System-Level Programming (ST 24) 1 Introduction – Why C?
Motivation: SLP

At the end of the lecture, everyone should be able to assess,
what a $\mu$Controller can (not) do,
how labor-intensive & beneficial its programming is,
what an operating system does (not) provide,
how labor-intensive & beneficial it is, to use one.

Everyone should be able to work with a computer scientist, if necessary...
Lecture Notes

- This handout of the lecture notes will be provided online.
  - Chapters are available as individual files
  - The handout contains (some) additional information

- However, the handout cannot be used as a substitute for making your own notes!
Literature Recommendations

[3] Recommended for Beginners:


[5] The “classic” (more suitable as a reference):

References


