Karlsruher Institut für Technologie

r3k.vhdl - MIPS R3000 auf einem FPGA

Basispraktikum Technische Informatik

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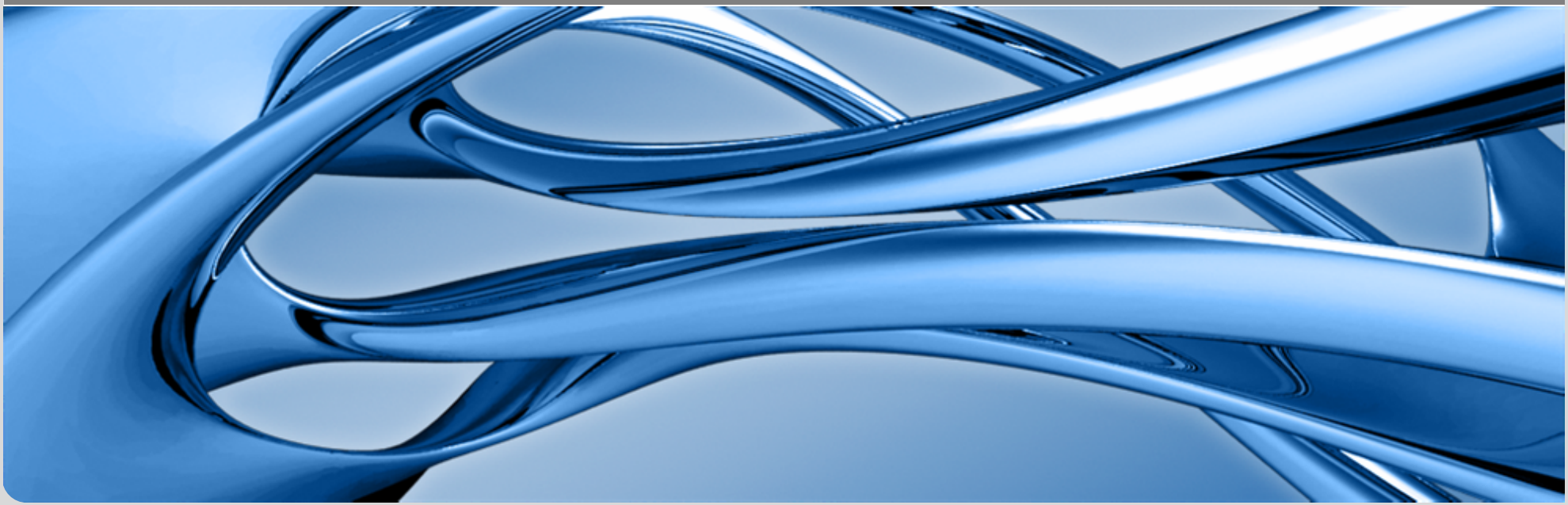
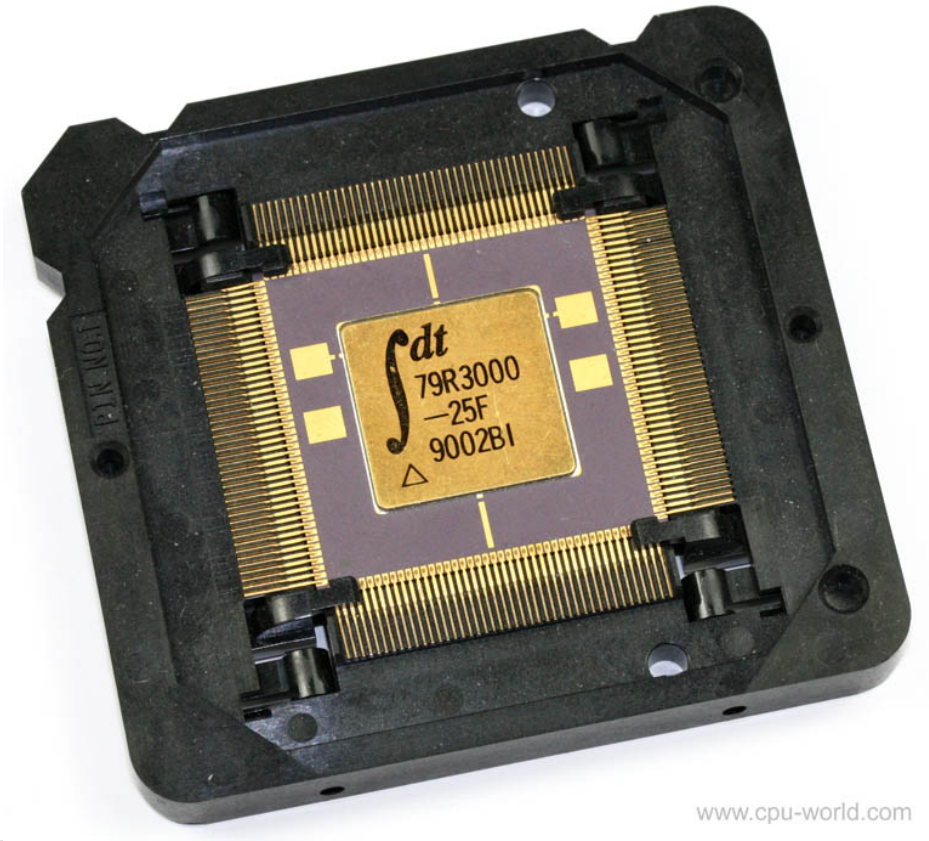
LEHRSTUHL SYSTEMARCHITEKTUR



Der MIPS R3000

- 1988 auf dem Markt gekommen
- 32-bit, RISC Architektur mit 25 Instruktionen
- 32 Register
- 5-Stufige Pipeline



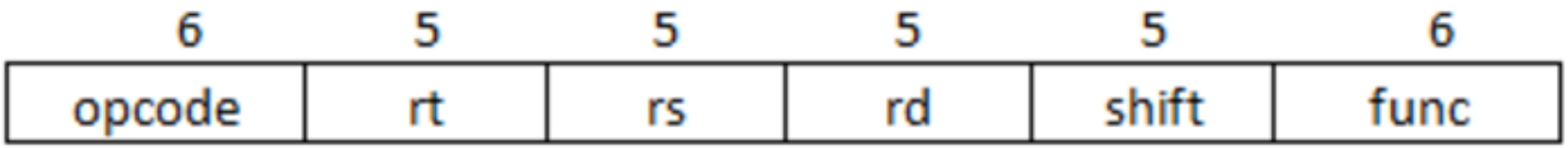
MIPS Befehlssatz

Category	Instruction	Example	Meaning	Comments
Arithmetic	add	add $1,$2,$3	$1 = $2 + $3	3 operands; exception possible
	subtract	sub $1,$2,$3	$1 = $2 - $3	3 operands; exception possible
	add immediate	addi $1,$2,100	$1 = $2 + 100	+ constant; exception possible
	add unsigned	addu $1,$2,$3	$1 = $2 + $3	3 operands; exception possible
	subtract unsigned	subi $1,$2,$3	$1 = $2 - $3	3 operands; exception possible
	add immediate unsigned	addi $1,$2,100	$1 = $2 + 100	+ constant; exception possible
	Move from coprocessor register	mfc0 $1,$epc	$1 = $epc	Used to get of Exception PC
Logical	and	and $1,$2,$3	$1 = $2 & $3	3 register operands; Logical AND
	or	or $1,$2,$3	$1 = $2 | $3	3 register operands; Logical OR
	and immediate	and $1,$2,100	$1 = $2 & 100	Logical AND register, constant
	or immediate	or $1,$2,100	$1 = $2 | 100	Logical OR register, constant
	shift left logical	sll $1,$2,10	$1 = $2 << 10	Shift left by constant
	shift right logical	srl $1,$2,10	$1 = $2 >> 10	Shift right by constant
Data transfer	load word	lw $1,(100)$2	$1 = Memory[$2+100]	Data from memory to register
	store word	sw $1,(100)$2	Memory[$2+100] = $1	Data from memory to register
	load upper immediate	lui $1,100	$1 = 100 * 2^{16}	Load constant in upper 16bits
Conditional branch	branch on equal	beq $1,$2,100	if ($1 == $2) go to PC+4+100	Equal test; PC relative branch
	branch on not equal	bne $1,$2,100	if ($1 != $2) go to PC+4+100	Not equal test; PC relative
	set on less than	slt $1,$2,$3	if ($2 < $3) $1 = 1; else $1 = 0	Compare less than; 2`s complement
	set less than immediate	slti $1,$2,100	if ($2 < 100) $1 = 1; else $1 = 0	Compare < constant; 2`s complement
	set less than unsigned	sltu $1,$2,$3	if ($2 < $3) $1 = 1; else $1 = 0	Compare less than; natural number
	set less than immediate unsigned	sltiu $1,$2,100	if ($2 < 100) $1 = 1; else $1 = 0	Compare constant; natural number
Unconditional jump	jump	j 10000	goto 10000	Jump to target address
	jump register	j $31	goto $31	For switch, procedure return
	jump and link	jal 10000	$31 = PC + 4;go to 10000	For procedure call

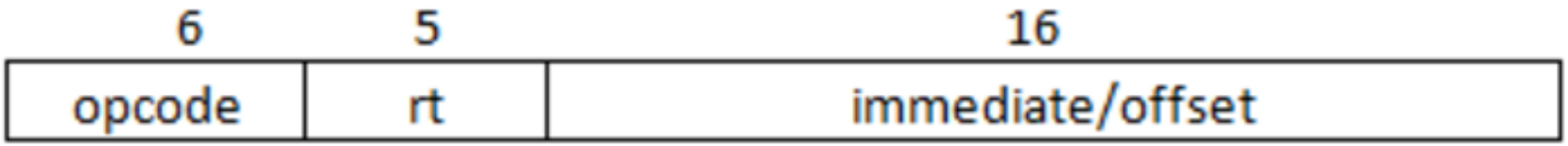
MIPS Befehlsformate

- R-Type – Arithmetik and Logik
- I-Type – Laden/Speichern, Verzweigen, Direktwert
- J-Format – Jump

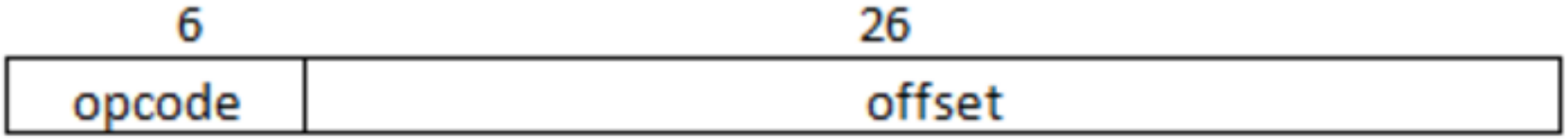
R-Type



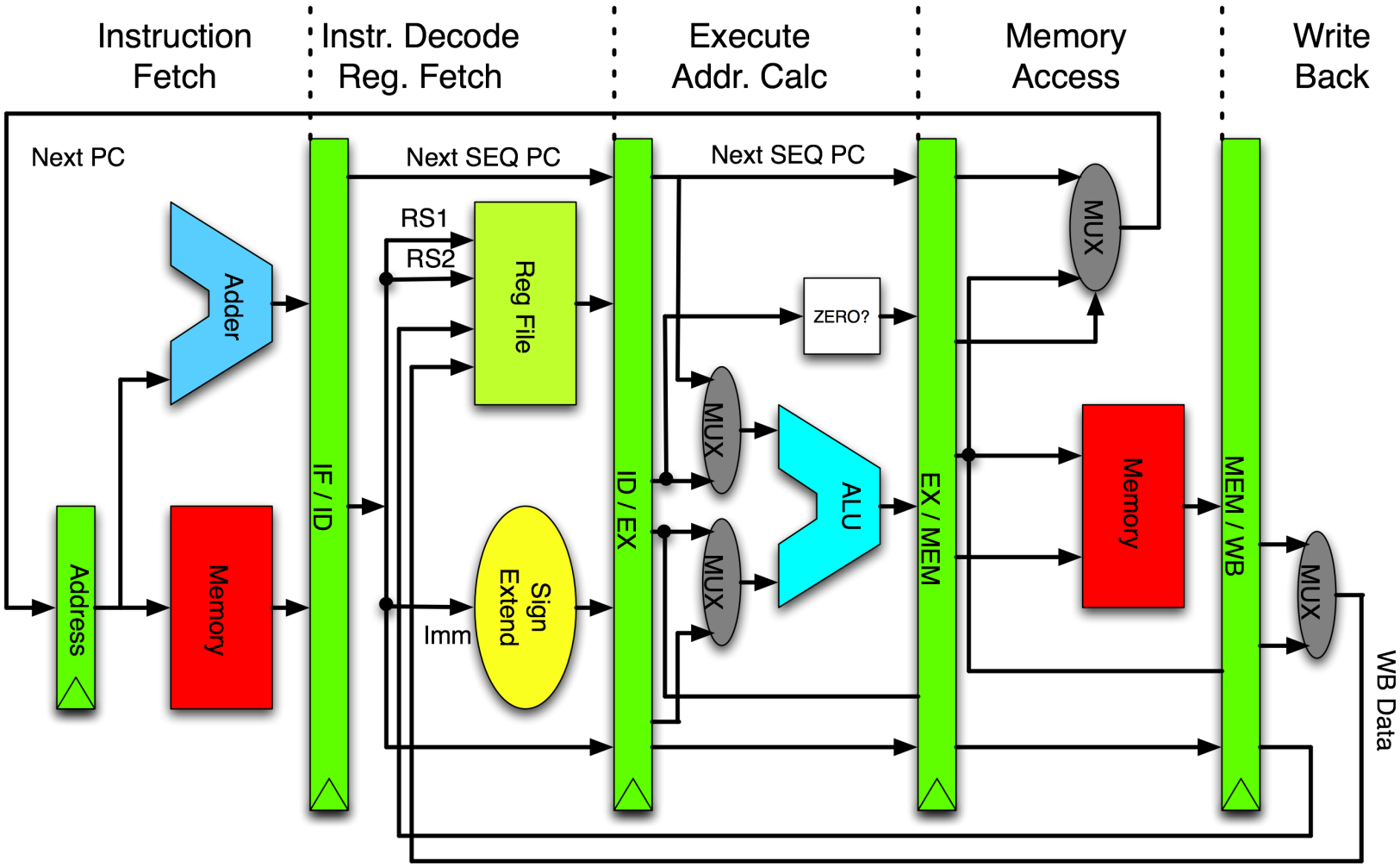
I-Type



J-Type



MIPS Pipeline



Hardware-Komponenten

- MIPS R3000
- ROM, RAM
- NS8250-class UART
- VGA Framebuffer

UART

A scheduler is said to be preemptive if it is permitted to interrupt an executing job and have its execution resumed at some point in the future

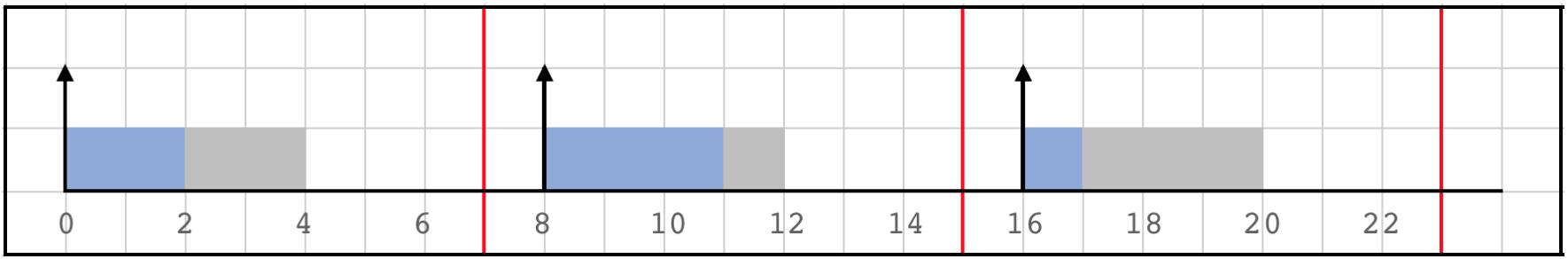
Migration

The preemption of a job and rescheduling thereof on a different processor

VGA

Tasks denoted by 2 parameters:

- Worst case execution time
- Period, which is equal to its deadline



A scheduling algorithm is said to be optimal if it finds a schedule if feasible schedules exists. For example, Earliest-Deadline-First

ROM

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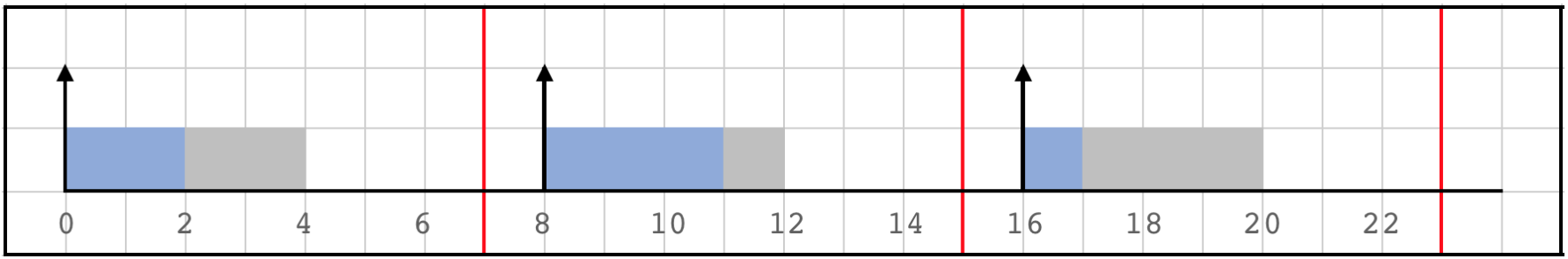

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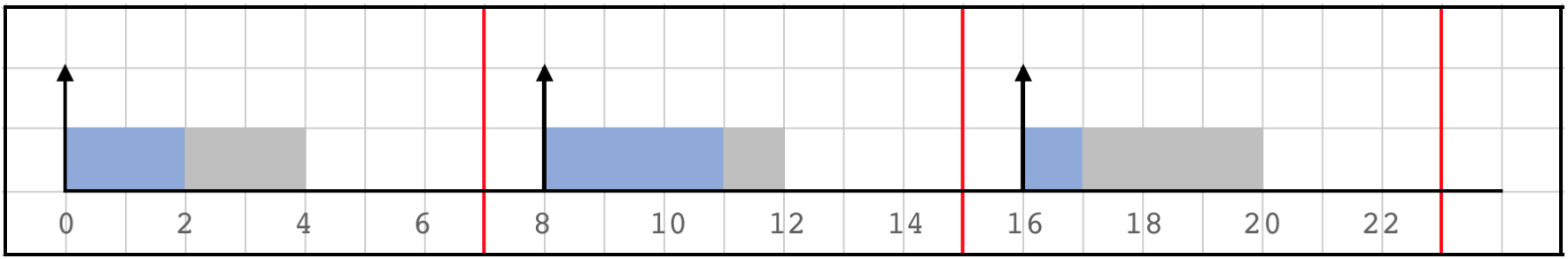

Not a LL Task: $WCET = 4$, $Period = 8$ but $Deadline = 7$

A scheduling algorithm is said to be optimal if it finds a schedule if feasible schedules exists. For example, Earliest-Deadline-First

Strom da. Was nun?

Reset Vektor wird angesprungen. Assembler Code verantwortlich für

- Globale Variablen (.BSS) nullen
- Daten von ROM in den RAM kopieren
- Stack initialisieren
- main() im C Code anspringen

BIOS (

Verantwortlich für

- Initialisiert UART
- Startet Kommandozeilen Interpreter auf UART
- Startet Applikationen
- Traps und Interrupts?

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C-Toolchain

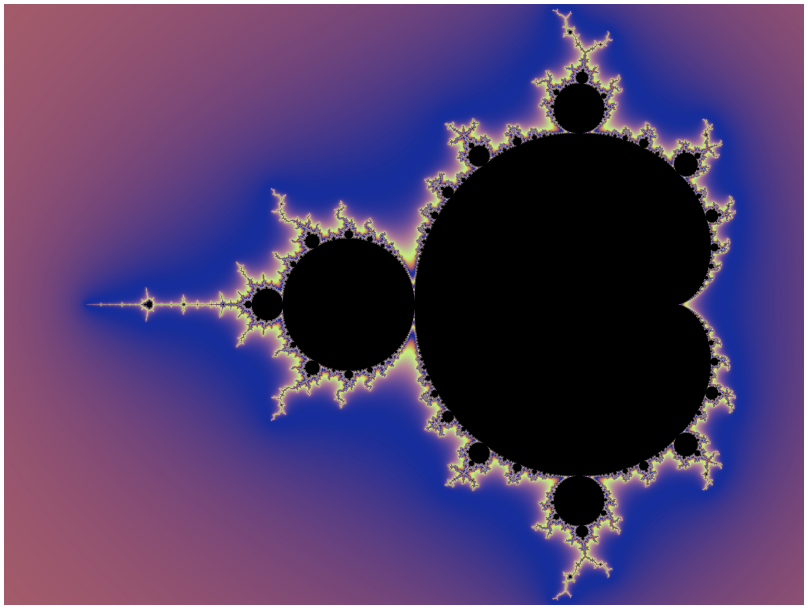
- GCC 6.2.0 MIPS Barebones Cross-Compiler
- `-ffreestanding -nostdlib -nostartfiles`
- Wie kommt das Programm in den Speicher?
  - Linker Script: Spezifiziert Addressvergabe an Symbole
  - objcopy: Extrahiert rohen Maschinen Code
  - iMPACT: Spielt extrahierte Binärdatei auf ROM

Komplexität im Griff behalten?

- Emulation:
  - QEMU mit R3000, UART und VGA
  - Code lokal Testebar vor Auspielen auf den FPGA
- Testbenches: z.B. ALU und Instruktionsdecoder. Alleinstehend, gut testbar.

Applikationen

- Mandebrot-Fraktal
- Vllt. DOS Demos portieren



Doom?

Fragen? Anregungen?