Translating ETC to LLVM Assembly

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1983-1984

INMOS Transputer released.

occam is born.

1989

SGS Thompson acquires INMOS.

occam reaches version 2.1 (occ21).

1993-1994

INMOS subsumed.

Transputer and occam development ends.

1995-1997

occam for All (Welch, BAE, Formal Systems, Marconi, etc)

KRoC is born (octran, tranpc).

2000-2003

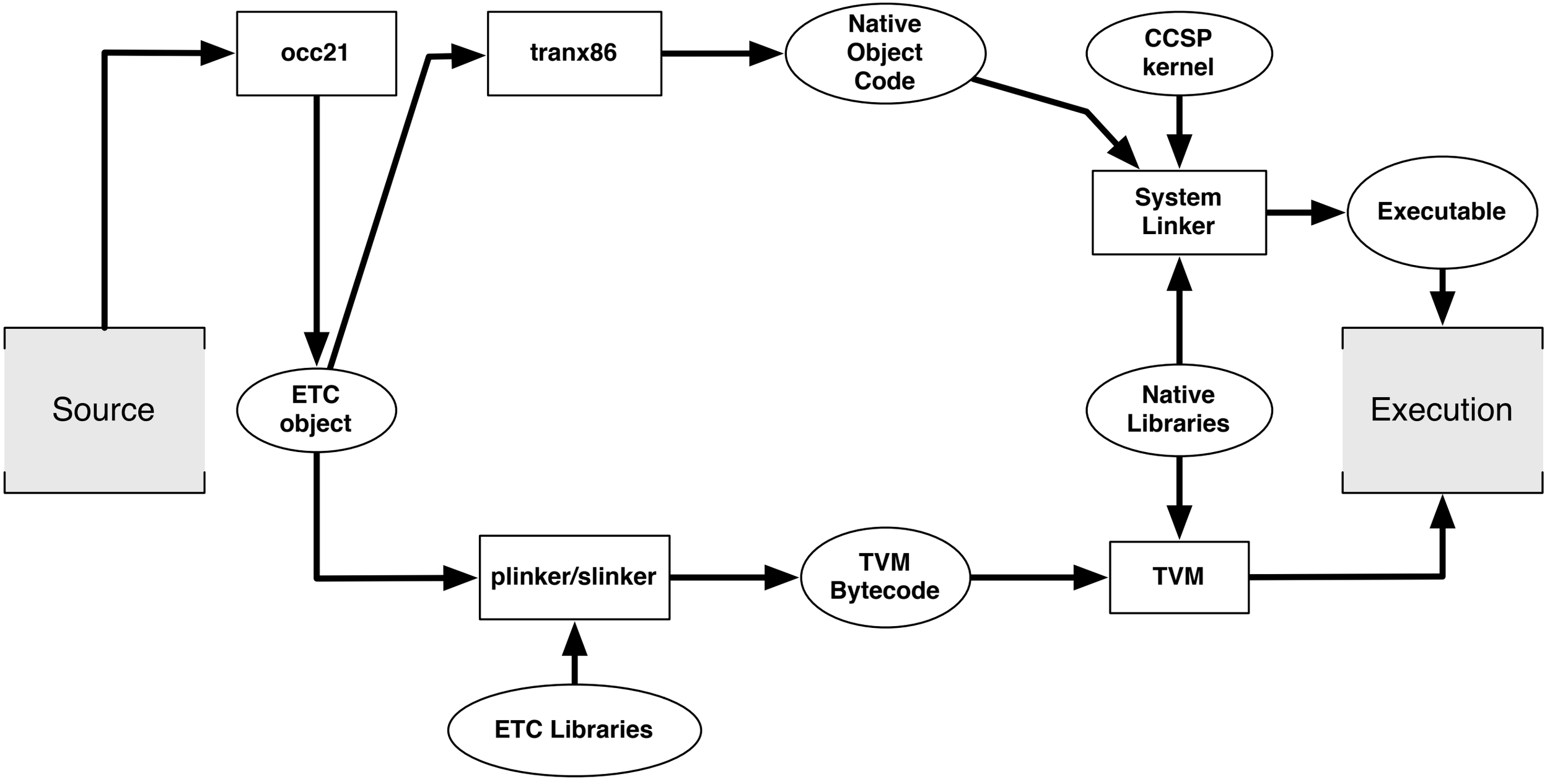
occam-π (Welch, Barnes)

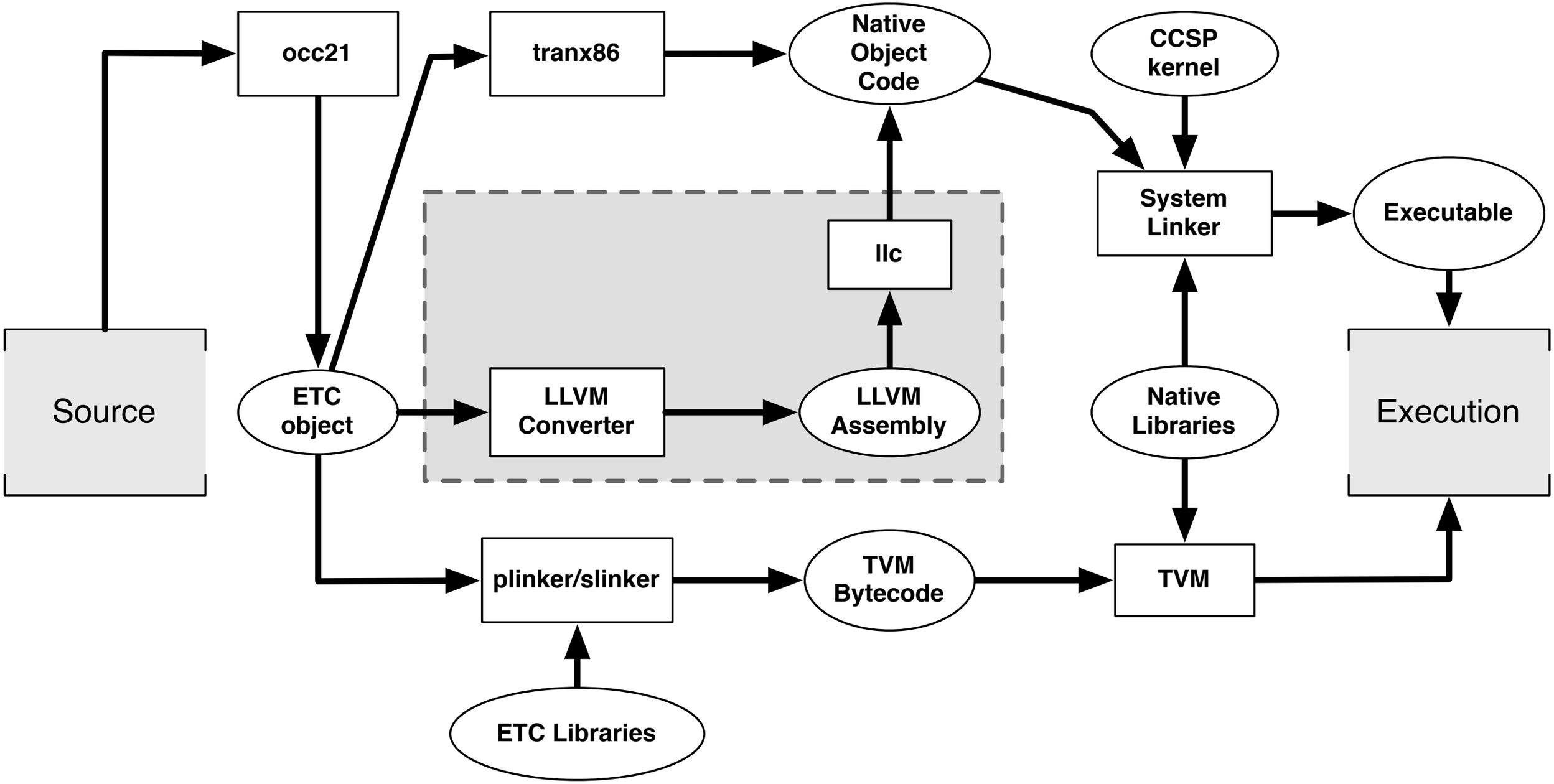
tranx86 (Barnes)

2004-2007

More occam-π (Welch, Barnes)

The Transterpreter (Jacobsen, Jadud, Dimmich)


occ21
tranx86
Native
Object
Code
CCSP
kernel
System
Linker
Executable
Source
ETC
object
Native
Libraries
Execution
plinker/slinker
TVM
Bytecode
TVM
ETC Libraries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Extended Transputer Code

Targets 3-place stack machine, with workspace.

Small set of RISC-like instructions with CISC secondaries.

LLVM

Machine independent program representation.

Generic analysis and optimisation passes.

Why LLVM?

More control than C.

Code generation for x86, x86-64, ARM, PPC, ...

LLVM Assembly

Typed SSA-form with procedures and calling conventions.

Obviates data flow and control flow graphs.

```
define i32 @cube (i32 %x) {
  %x_0 = mul i32 %x  ,%x
  %x_1 = mul i32 %x_0,%x
  ret i32 %x_1
}
```

```
PROC foo (VAL INT x, y, CHAN INT out!)
  INT z:
  SEQ
    z := x + y
    out ! z
:
```

```
.L0:
  AJW  -1   -- allocate workspace
  LDL  2    -- load x
  LDL  3    -- load y
  ADD
  STL  0    -- store to z
  LDLP 0    -- load pointer to z
  LDL  4    -- load channel
  LDC  4    -- load size of INT
  OUT
  AJW  1    -- deallocate workspace
  RET
```

The Transformation

Trace and numerate operand stack.

Extract control flow into procedures.

```
.L0:
  AJW  -1
  LDL  2    --                                  => %reg_0
  LDL  3    --                                  => %reg_1
  ADD       -- %reg_1, %reg_0                   => %reg_2
  STL  0    -- %reg_2                           => ()
  LDLP 0    --                                  => %reg_3
  LDL  4    --                                  => %reg_4
  LDC  4    --                                  => %reg_5
  OUT       -- %reg_5, %reg_4, %reg_3 => ()
  AJW  1
  RET
```

```
define void @O_foo (i8* %sched, i32* %wptr_0) {
L0:

    ; AJW -1
    %wptr_1 = getelementptr i32* %wptr_0, i32 -1
```

```
; LDL 2
%tmp_0 = getelementptr i32* %wptr_1, i32 2
%reg_0 = load i32* %tmp_0
```

```
; LDL 3
%tmp_1 = getelementptr i32* %wptr_1, i32 2
%reg_1 = load i32* %tmp_1
```

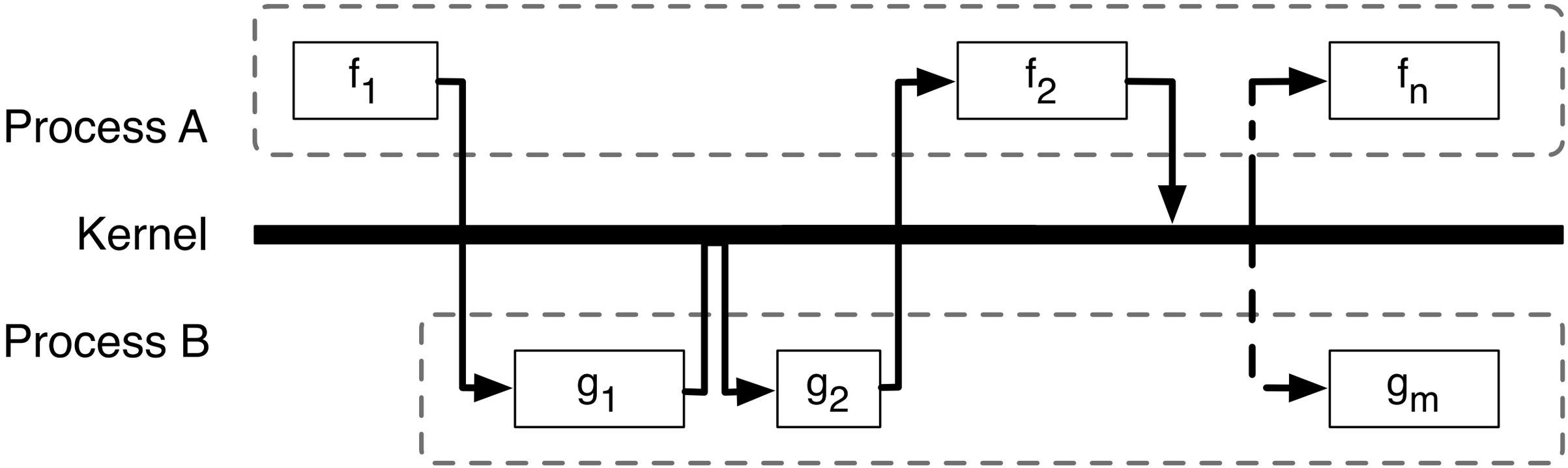
```
; ADD   { (reg_1, reg_0) => (reg_2) }
%tmp_2 = call {i32, i1}
  @llvm.sadd.with.overflow.i32
                    (i32 %reg_0, i32 %reg_1)

%reg_2 = extractvalue {i32, i1} %tmp_2, 0
%tmp_3 = extractvalue {i32, i1} %tmp_2, 1
```

```
  br i1 %tmp_3, label %tmp_4_overflow_error,
                label %tmp_4_ok
tmp_4_overflow_error:
  %tmp_5 = load i8** @C_0 ; “foo.occ”
  call void @etc_error_overflow
                (i8* %sched, i32* %wptr_1,
                 i8* %tmp_5, i32 5)
tmp_4_ok:
  ; STL 0
  store i32 %reg_2, i32* %wptr_1
```

Control Flow

Branching and blocking, via co-operate scheduling.

Functions over workspaces, e.g. P = <f_1,f_2,f_3,...,f_n>.


Process A
Kernel
Process B
f_1
f_2
f_n
g_1
g_2
g_m

Continuation Passing Style

Collapses stack, obviates dependencies.

Very appropriate for occam-like languages.

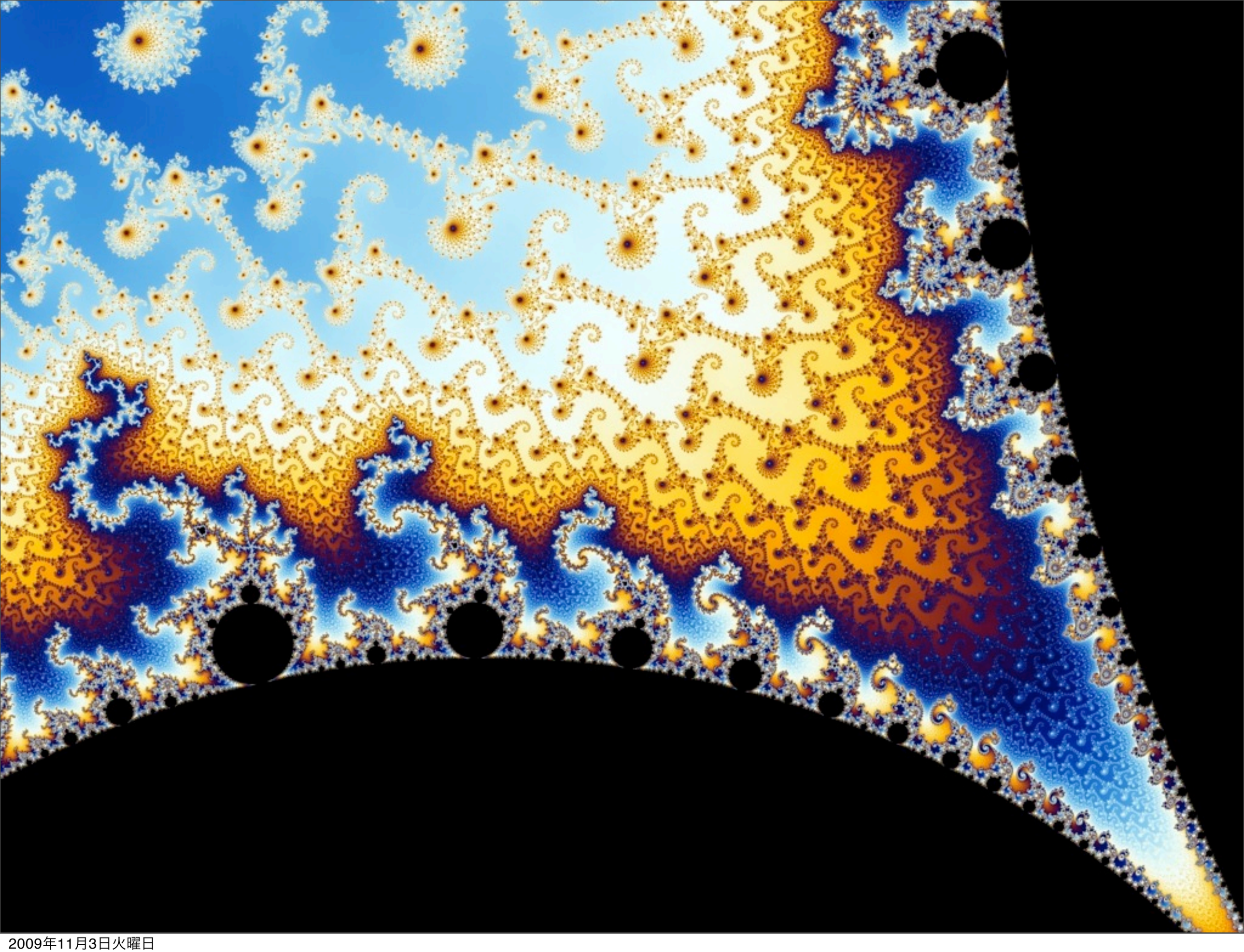
Run-time Simplification

Kernel calls become native C calls.

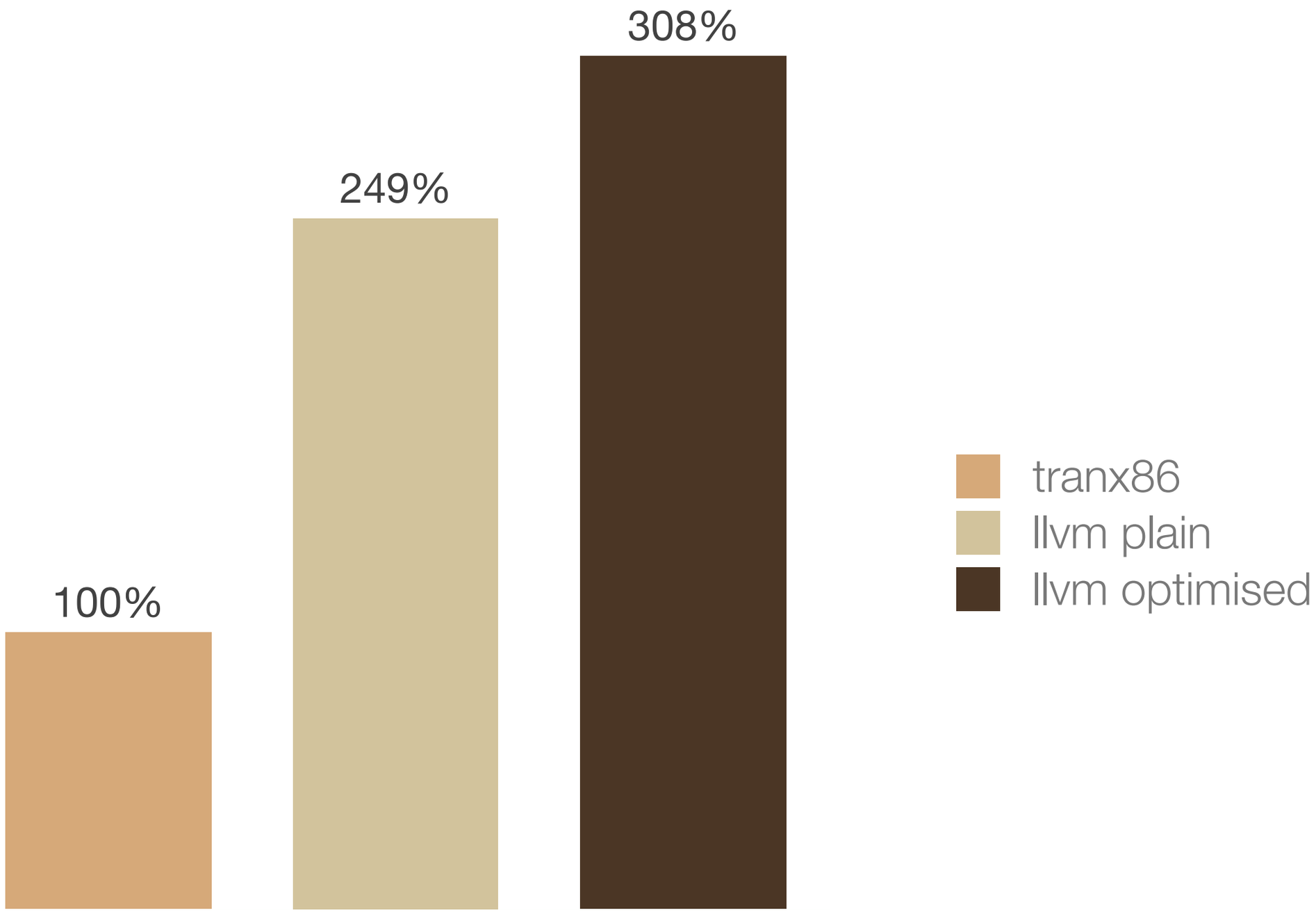
Run-time state more tractable.

mandelbrot

KRoC Distribution

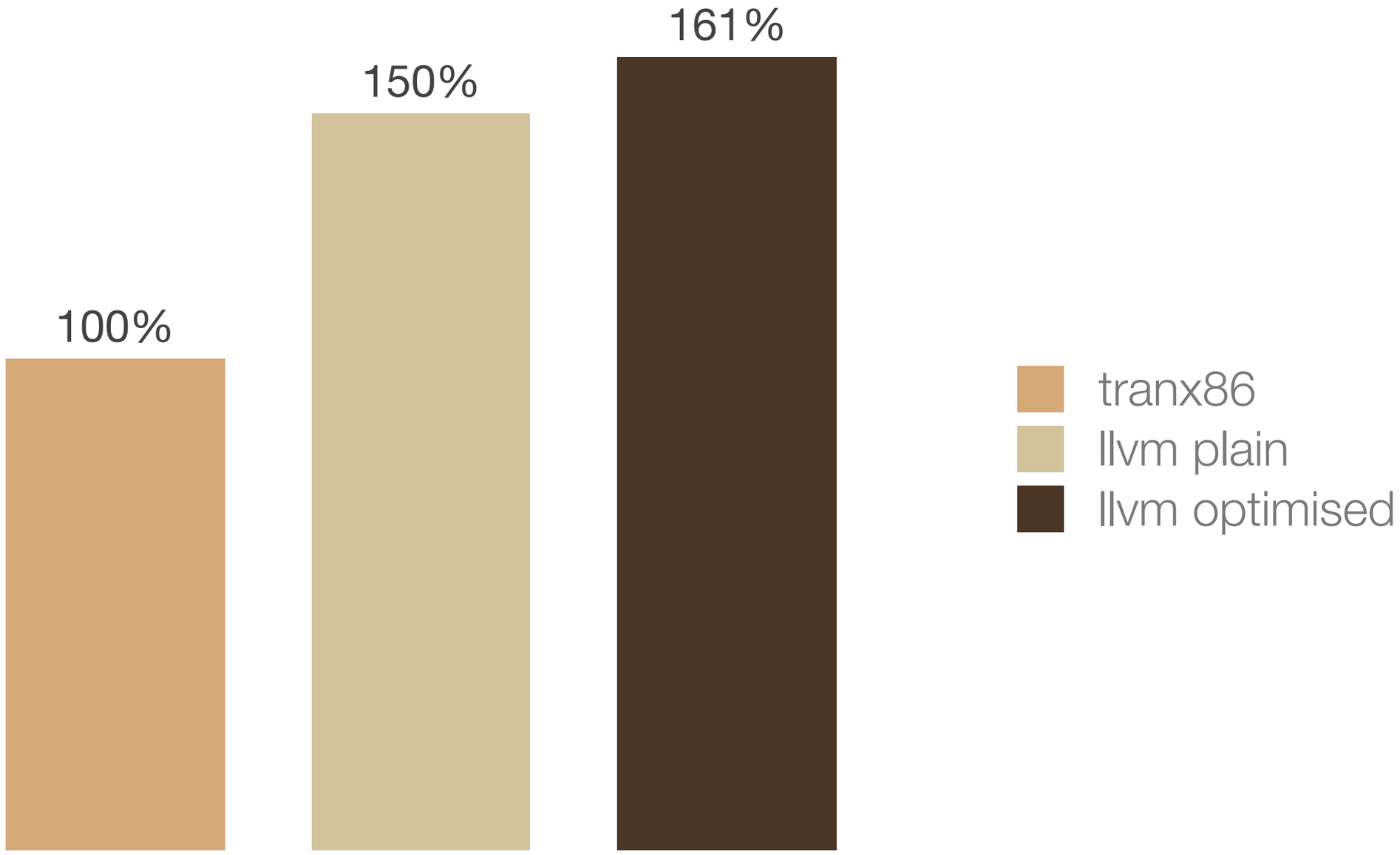


2009年11月3日火曜日


308%
249%
100%
tranx86
llvm plain
llvm optimised

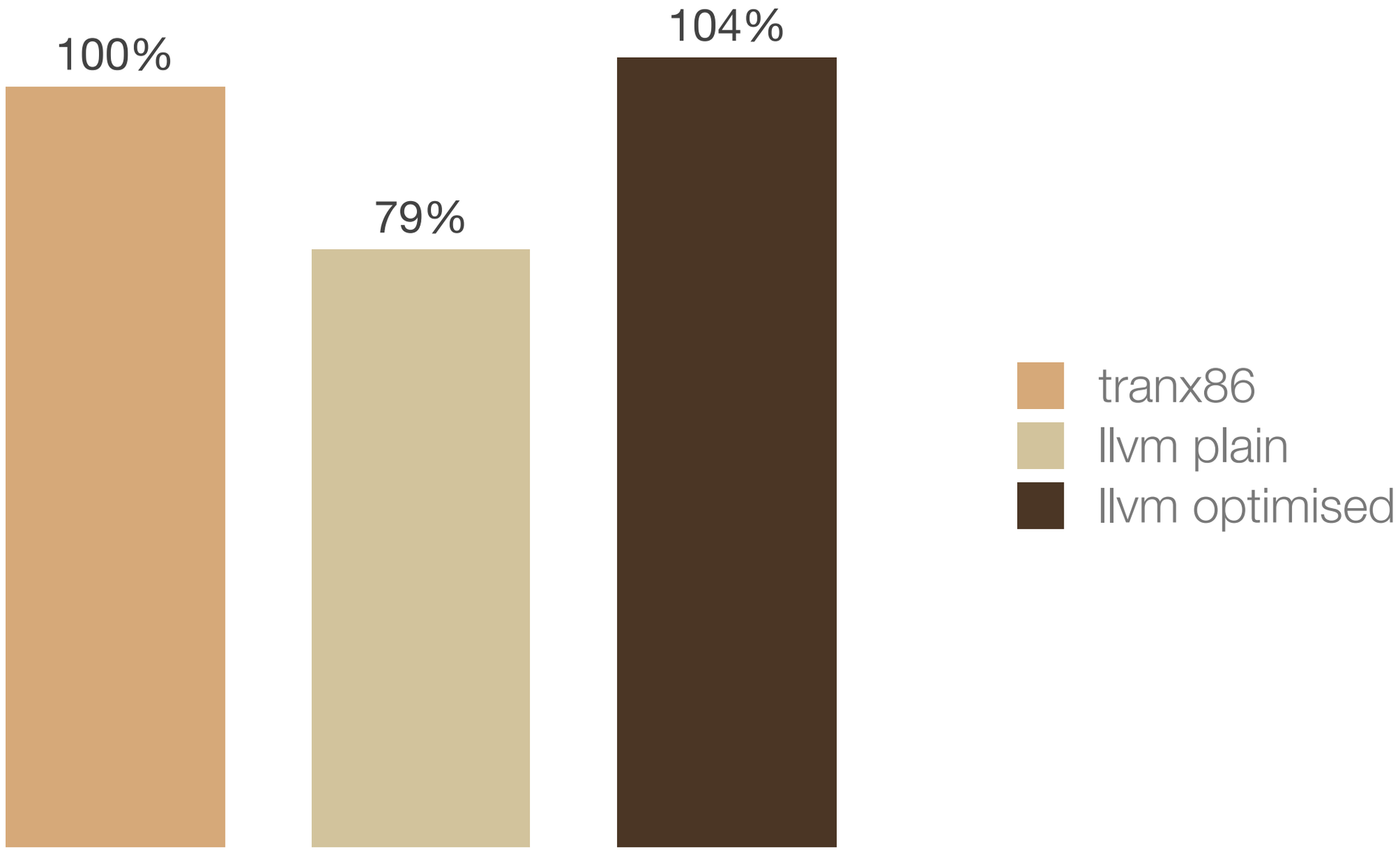
spectralnorm

Language Games


100%
150%
161%
tranx86
llvm plain
llvm optimised

agents

CCSP Comparisons


100%
79%
104%
tranx86
llvm plain
llvm optimised

Benefits

Simplifies: run-time, floating point, corner cases.

Off-the-shelf optimisations improve performance.

Difficulties

Unclear semantics of tail-calls (for CPS).

Toolchain issues.

Future Work

Porting, refactoring, bypass ETC.

Add to LLVM support for this style of compilation.

Thanks

Questions?

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