

A DSL for Video Device Drivers: from Design to Implementation

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GPL vs. DSL

GPL

- ❑ Low-level
- ❑ Programming
- ❑ All programs
- ❑ Compiler

DSL

- ❑ High-level
- ❑ Instantiation
- ❑ Small set of programs
- ❑ Application generator

Program Family

Set of applications having enough commonalities to be studied as a group.

DSL: pros & cons

Features

- ❑ Small high-level programs
- ❑ Reuse: design & implementation

Advantages

- ❑ Productivity
- ❑ Prototyping
- ❑ Debugging
- ❑ Maintenance
- ❑ Analyzability
- ❑ Mobility
- ❑ Usability

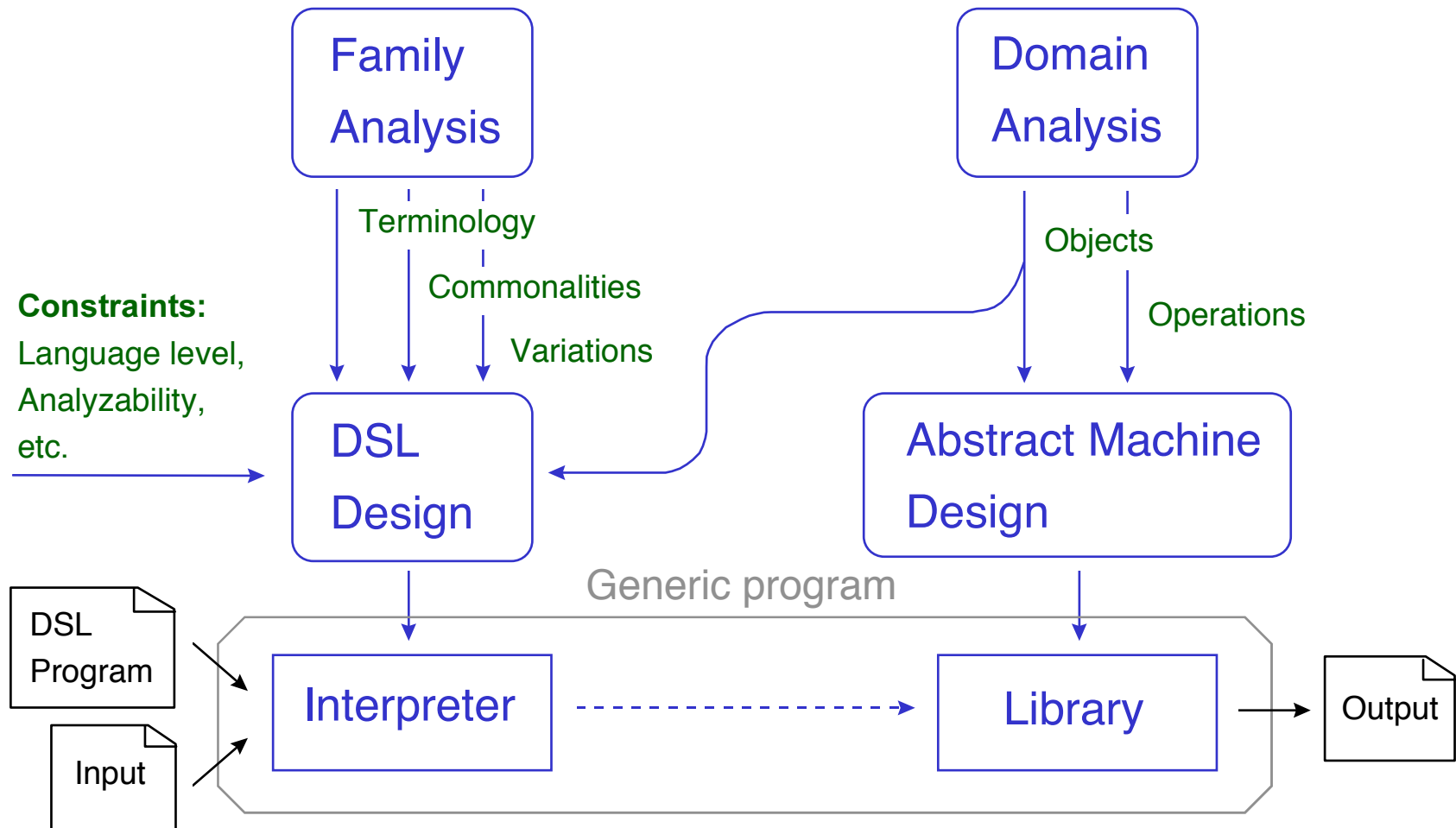
Drawbacks

- ❑ Compiler development
- ❑ Performance
- ❑ Compiler maintenance
- ❑ Limited functionality
- ❑ Compiler extension
- ❑ Standardization
- ❑ Training

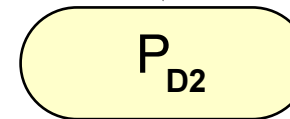
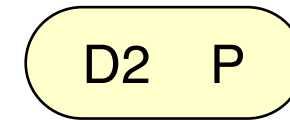
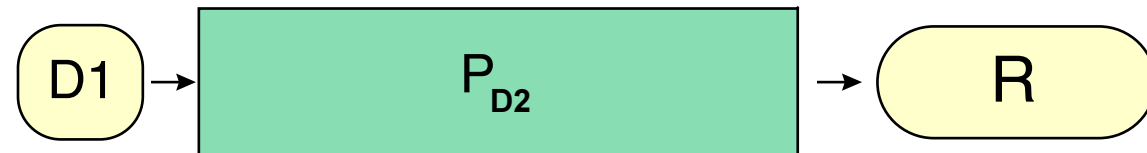
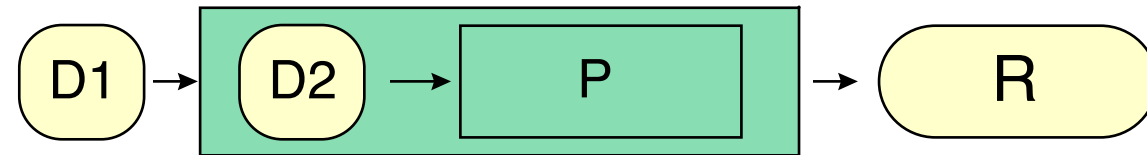
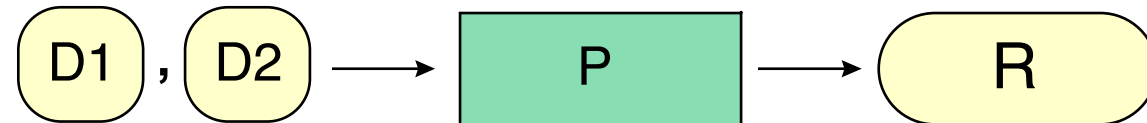
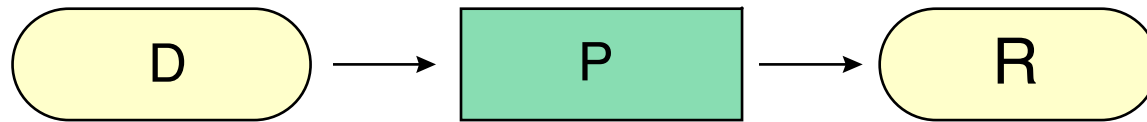
Contents

- ❑ **Flexible framework of program family design**
- ❑ **Efficient implementation via partial evaluation**
- ❑ **Application: GAL, a DSL for video device drivers**
- ❑ **Assessment of GAL's pros and cons**

DSL / Program Family Design



Partial Evaluation



Partial Evaluation Example

```
mini_printf(char fmt[], int val[])
{
    int i = 0;
    for(; *fmt; fmt++) {
        switch(*fmt) {
            case '%' :
                switch(*++fmt) {
                    case '%' :
                        putchar('%'); break;
                    case 'd' :
                        putint(val[i++]); break;
                    default :
                        abort(); break;
                } break;
            default :
                putchar(*fmt);
        }
    }
}
```

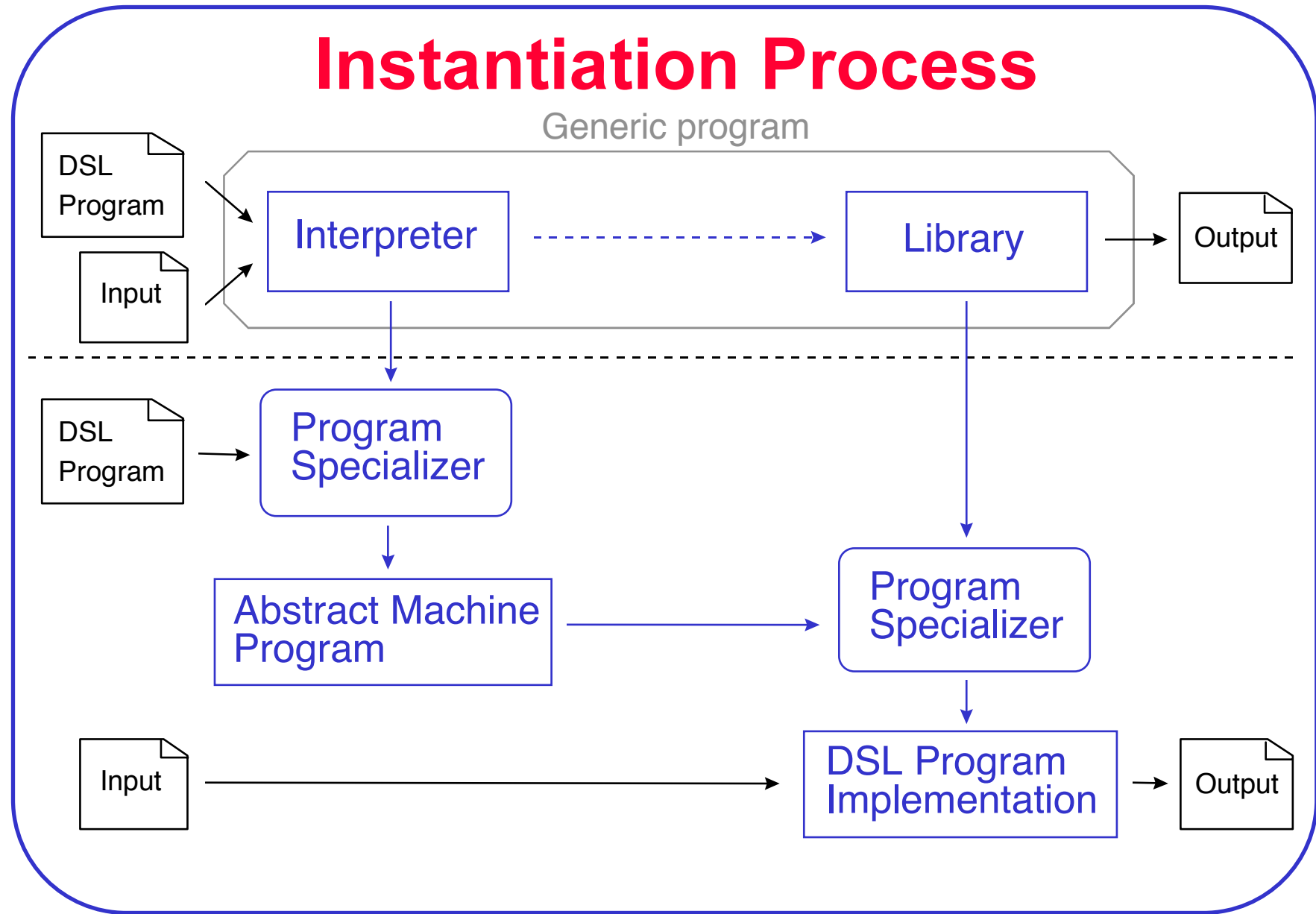
Specialized `mini_printf` with respect to `fmt = "n: %d"`:

```
mini_printf_fmt(int val[])
{
    putchar('n');
    putchar(':');
    putchar(' ');
    putint(val[0]);
}
```

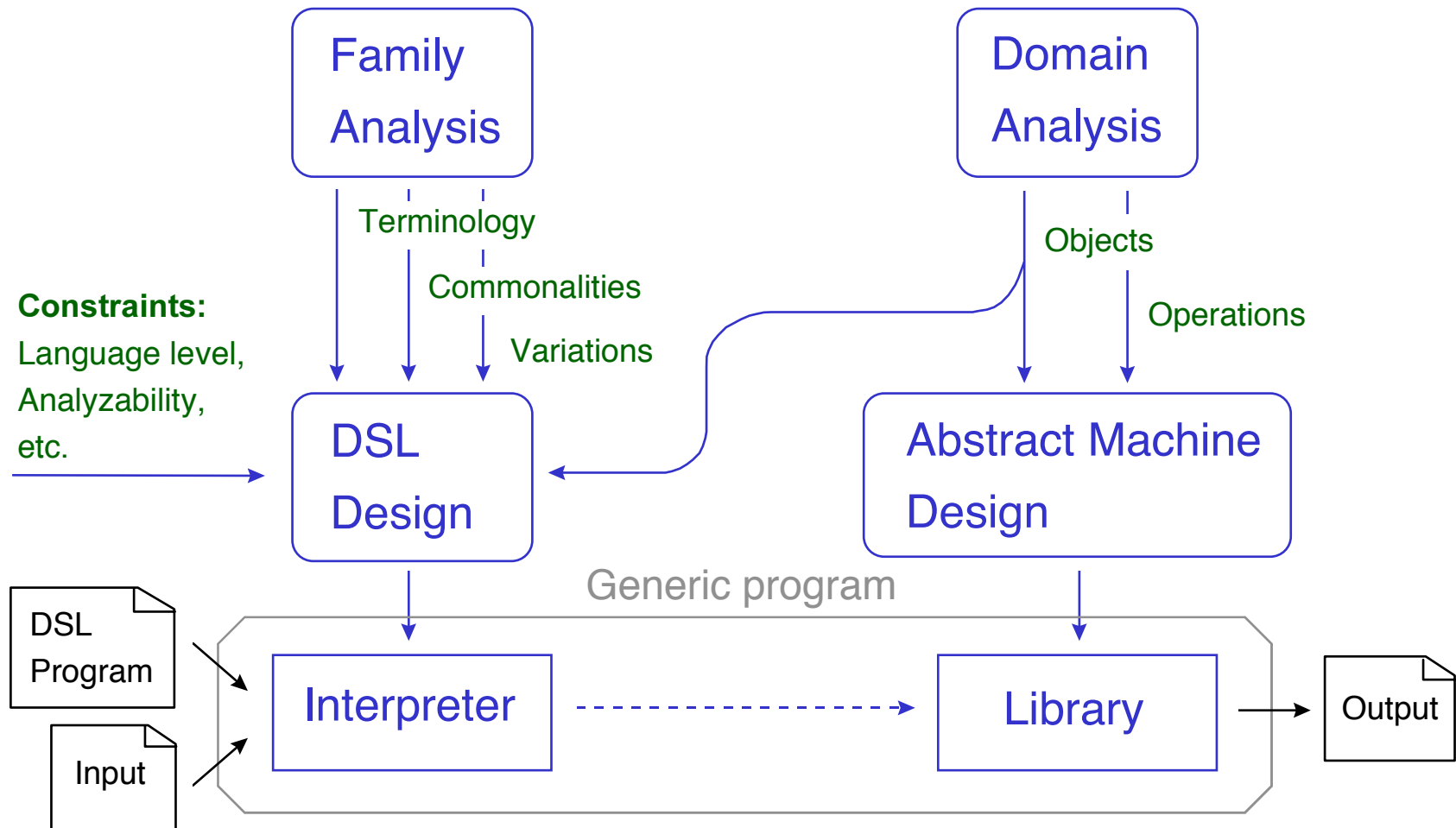
Some Issues in Partial Evaluation

- ❑ **Speed**
- ❑ **Code size**
- ❑ **Termination**
- ❑ **Degree of specialization**
- ❑ **Use of specialized code**

Instantiation Process



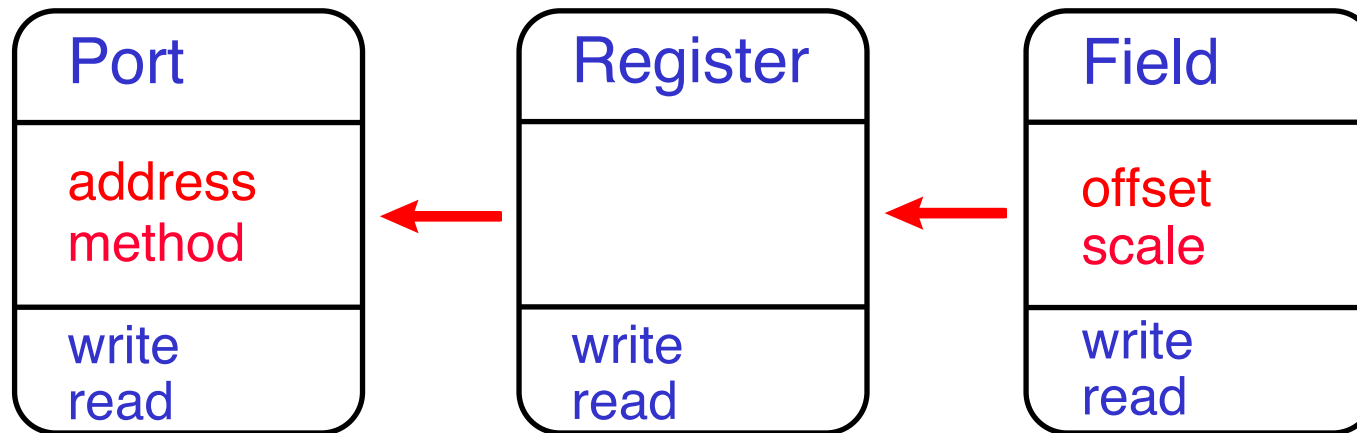
DSL / Program Family Design



Design of GAL / Abstract Machine

- ❑ **Documentation of existing video cards**
 - **Objects / Terminology**
 - **Attributes related to variations**
 - **Declarative statements to specify attributes**
- ❑ **Inspection of existing device drivers**
- ❑ **Level of abstraction**
 - **No bitwise operations**
 - **Draw the line between the interpreter and the AM**
- ❑ **Level of restriction**
 - **No loops**
 - **Detection of common errors**

Video Device Driver Domain



```
port svga indexed:=0x3d4;
```

```
register Offset:=svga(0x13);
```

```
field LogicalWidth:=Control2[5..4]#Pitch scaled 8
```

DSL Benefits Realized

- ❑ **Increased level of abstraction**
 - Less errors, more readable, easier to write
- ❑ **Design re-use**
 - Knowledge about communications with the card
- ❑ **Productivity gains**
 - Drivers 9 times smaller
- ❑ **Automatic analysis**
 - Verification, documentation

Example Analysis

Profile of S3_TRIO32 + S3_TRIO64

Maximum resolution: 4088x2047

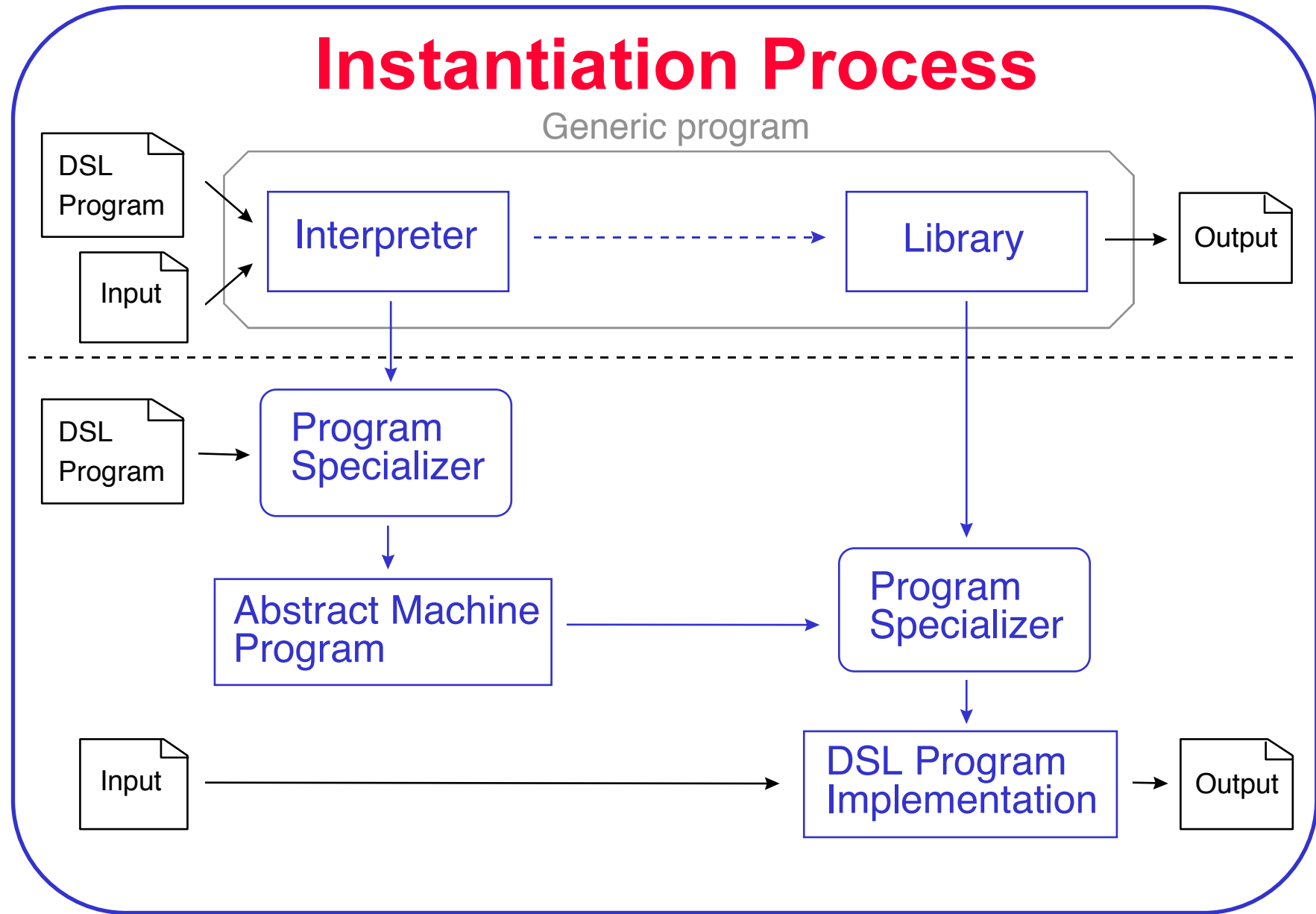
Max. virtual screen with max. RAM: 3328x2520

Ram size: 512k-8192k

Clock range: 135-270MHz

Resolution limited to 2304x1728 by clock
(max. refresh 67Hz)

Instantiation Process



Achieved Benefits of the Framework

Application of Tempo, a partial evaluator for C

❑ Reduced implementation costs

- Interpreter vs. compiler

❑ Comparable performance

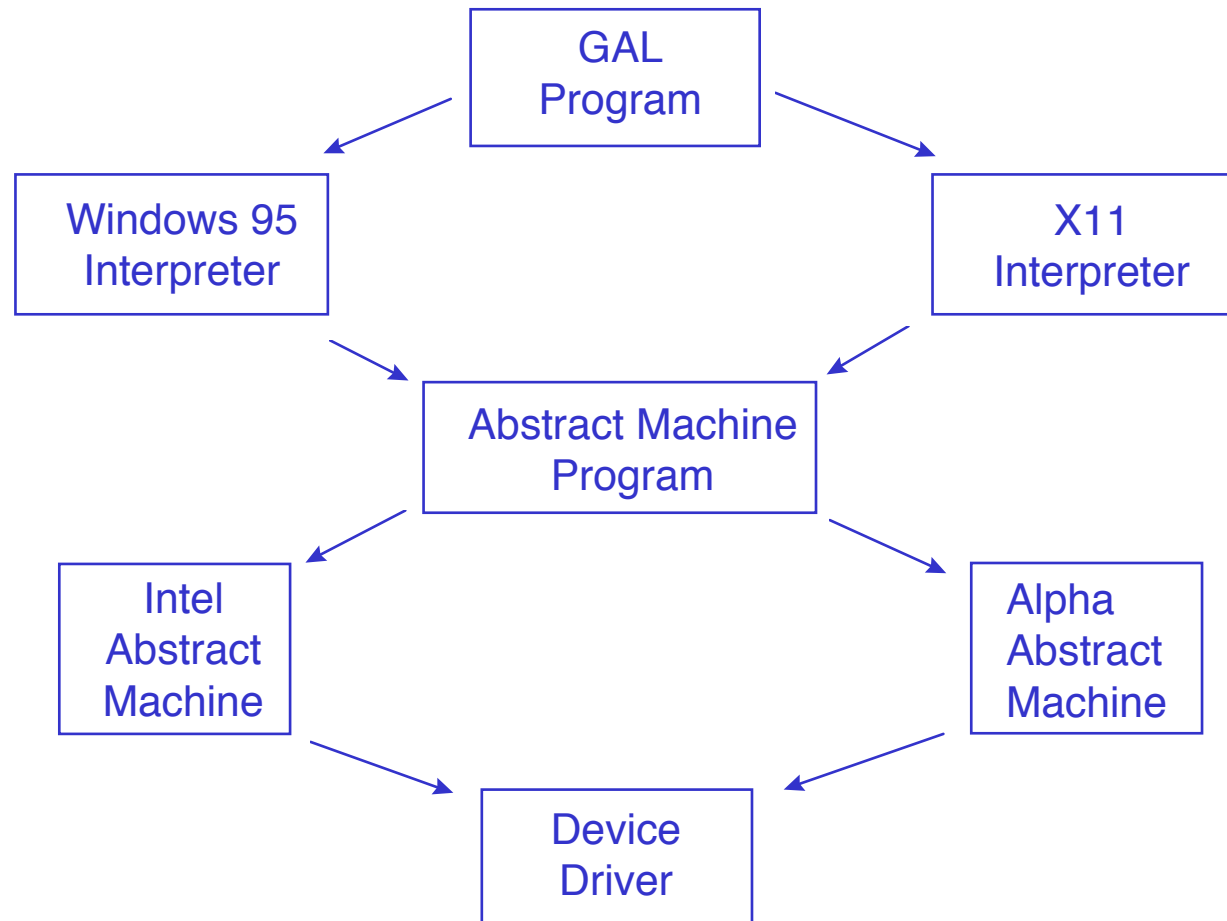
- Interpreter 10-100 times slower
- AM 20% slower
- Fully specialized driver ~ hand coded driver

❑ Further possibilities of analysis

- Analysis of generation process
- Analysis on AM programs

❑ Multiple implementations at two levels

Multiple Implementations



GAL: assessment

Features

- ✓ Small high-level programs
- ✓ Reuse: design & implementation

Advantages

- ✓ Productivity
- ✓ Prototyping
- ✓ Debugging
- ✓ Maintenance
- ✓ Analyzability
- ✓ Mobility
- ✓ Usability

Drawbacks

- ♥ Compiler development
- ♥ Performance
- ♥ Compiler maintenance
- ♣ Limited functionality
- ♥ Compiler evolution
- ✓ Standardization
- ♣ Training

Future Work

- ❑ Components for implementing interpreters & AM
- ❑ Techniques for language extension / composition
- ❑ Techniques for analysis extension / composition
- ❑ More applications

COMPOSE Home Page (and access to GAL):

<http://www.irisa.fr/compose>