Better and Faster Virtual Platform (VP) Modeling using a Domain-Specific Language (DSL)

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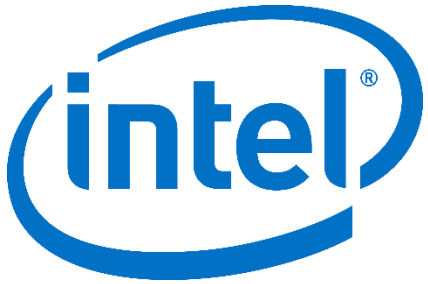
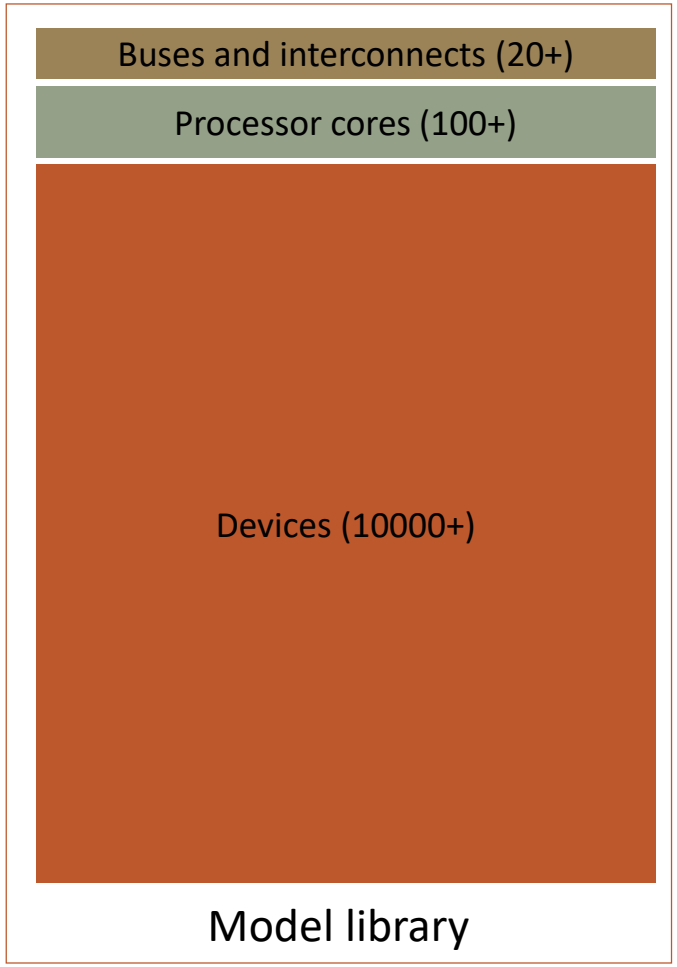


About us

- Jakob Engblom
  - Product management engineer and simulation evangelist
  - Working with Intel® Simics® virtual platforms since 2002
  - PhD from Uppsala University

- Erik Carstensen
  - Senior SW engineer, lead developer of the DML compiler
  - Simics developer since 2006
  - MSc from Uppsala University

Device Modeling Dominates VP Creation



- Virtual platform (VP) value is higher the earlier the platform is available for use – faster is better
- Device models dominate the virtual platform models
  - Many
  - Varied
  - Rapid change
- The major problem is **efficiently building device models** (for the VP modeling organization)
  - Minimum work, minimum time

Speeding up Modeling with Simics® DML

The Simics® **Device Modeling Language** (DML) is a **domain-specific language** (DSL) for device models for **fast functional** virtual platforms

- First version released in 2005, second revision in 2007, third in 2019
- Before DML, we used the Simics API from C code for modeling

The Design of Simics® DML

- **Domain-specific language == standard way to increase productivity**
  - *Strictly better than a modeling library embedded in a general language*
  - *Domain: fast functional models (also known as transaction-level modeling, or TLM)*
- Goal for DML design:
  - Make it hard to write bad models
  - Readable and maintainable code
  - Good target for code generators
    - DML compiler combines different parts of the model from different files
  - Automatically generate support for simulator platform features
    - Such as checkpointing, instrumentation, register metadata, …
- DML generates C code with Simics API calls

What it Looks Like

- Provide natural modeling constructs
  - Banks, registers, bit fields, …
  - Connects, interfaces, …
  - Attributes, data, …
  - Arrays and groups of objects
- Expressive template mechanisms
  - **Standard library** for common behavior
  - **Templates** for common device classes
  - **Custom template** libraries for specific models or families of models

```
// Partial example of as device model
dml 1.4;

device sample_i2c_device;

import "simics/devs/i2c.dml";  // generic i2c
import "platform-i2c.dml";     // i2c logic shared with other platforms
import "fuse-common.dml";      // common platform fuse mechanisms

// generated code with register declarations
import "DevBank_gen_code.dml";

// instantiate the register bank from the file
bank regs is i2c_ctrl_reg_bank {
  register hst_cnt {           // Added manual code
        method write_action() {
            if (START.get() != 0) {
                START.set(0);
                send_start();
} } } }
```

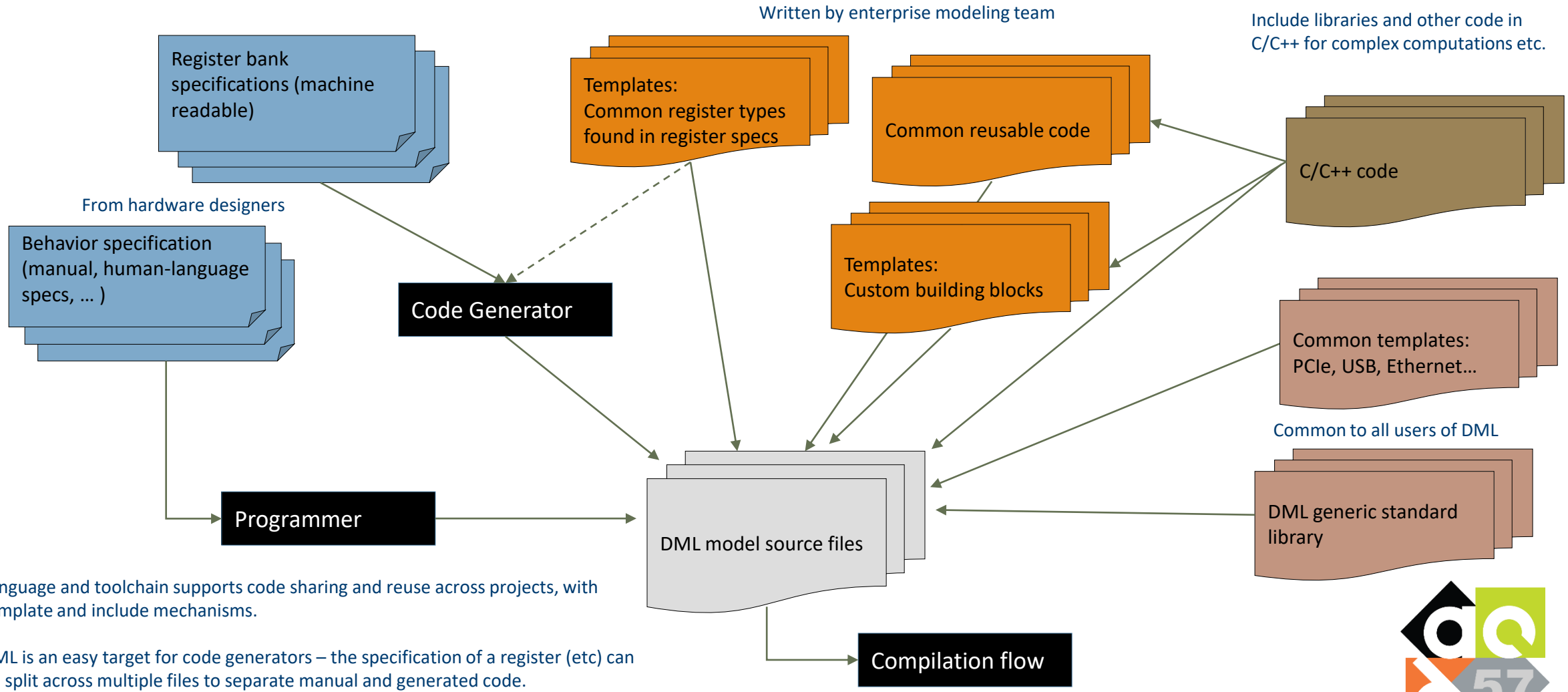
```
// Generated file DevBank_gen_code.dml
dml 1.4;
import "access_templates_14.dml";

template i2c_ctrl_reg_bank {
    param    bank_reset_signal;
    param    register_size = 2;

    register hst_sts        @ 0x00 "Host Status";
    register hst_cnt        @ 0x02 "Host Control";
    // array of registers
    register tx[i < 8]      @ 0x08 + i "Transmit data";

    // flesh out fields in hst_sts
    register hst_sts {
        field BYTE_DONE_STS @ [7:7] is write_1_clears;
        field INUSE_STS     @ [6:6] is write_1_clears;
        ...
```

Enterprise-Level Modeling: Reuse & Code Gen

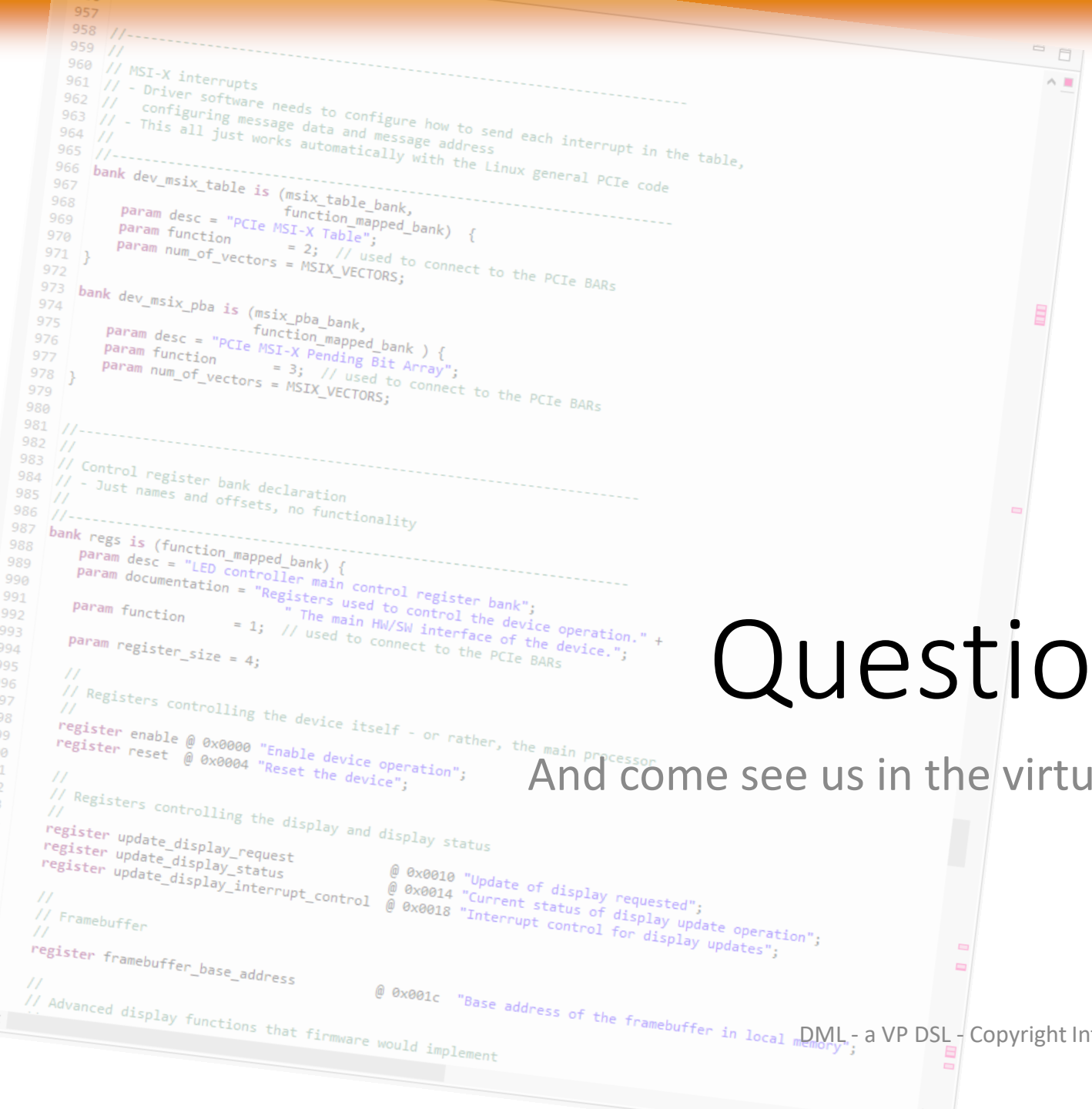


Language and toolchain supports code sharing and reuse across projects, with template and include mechanisms.

DML is an easy target for code generators – the specification of a register (etc) can be split across multiple files to separate manual and generated code.

DML Works – Observed Benefits

- Proven in use for 15 years
- 50% to 80% smaller code than if written in plain C (using the Simics API)
- Faster device modeling than using other approaches (by experience)
- Small teams can manage dozens of 1000+ device model platforms
- Scales to devices with 100000s of registers and complex behaviors
- New developers get started within a **day**, useful within a **quarter**, **independent** within six months
- New Simics® features can be supported by just changing the code generator (*higher semantic level than libraries or API*)



Questions?

And come see us in the virtual poster session!

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