POK – Code Generation for Partitioned Architectures

Julien Delange <julien@gunnm.org>

Forewords

- The POK project
  - Design and implement safe and secure system
  - Complete development process with model-based engineering

- Now, focus on code generation
  - How you can generate code from AADL models
  - Code generation benefits
  - Code generation patterns

Outline

- Code generation overview
- Generation patterns
- Benefits
- Conclusion

Outline

- **Code generation overview**
- Generation patterns
- Benefits
- Conclusion

Code Generation Overview

- Generate the whole architecture
  - Configuration for module an partitions
  - Deployment
- Existing work
  - Ada/C code generation
  - Rely on general-purpose operating systems

Code Generation - toolset

- **Ocarina**
  - **C code generation functionalities**
  - **POK-specific code generator**
  - **ARINC653 flavor to generate ARINC653-compliant code**

- **POK toolchain**
  - **Automatize code generation**
  - **Also verify architecture correctness before generation**

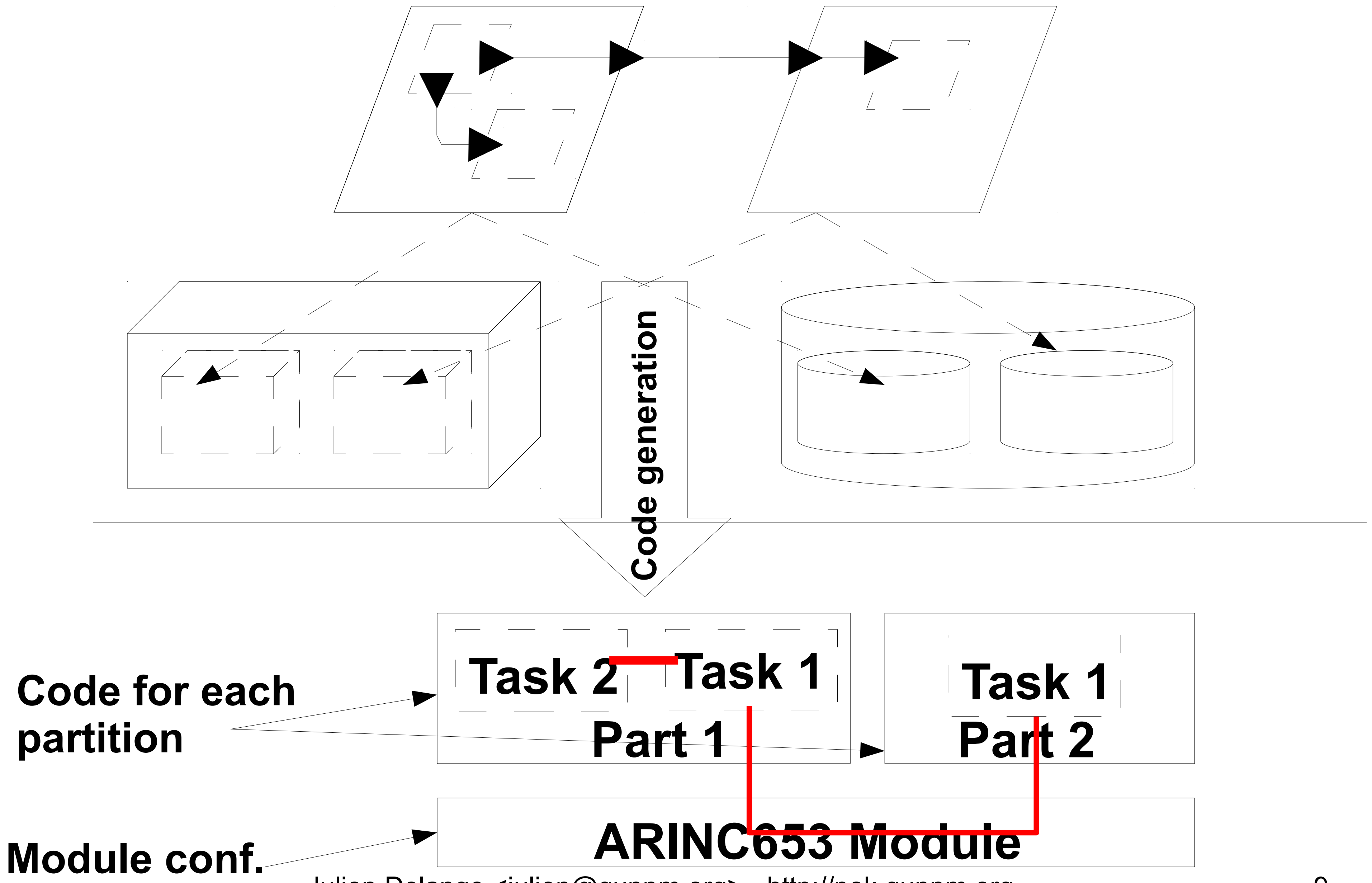
Ocarina - functionalities

- ARINC653 configuration
  - AADL to XML code generator
- Partitioned architecture code generator
  - POK flavor: use the POK API
  - ARINC653 flavor
  - Auto-generation of assertions, improve error detection
- CARTS generator (scheduling simulation)
  - Interfacing with other analysis tools
- REAL: model validation

POK toolchain

- **Model validation with Ocarina/REAL**
  - **Architecture consistency**
  - **Health Monitoring policy impacts**
  - **Security analysis**
- **Generation of ARINC653 configuration**
  - **XML file generation with Ocarina**
  - **Ease system integration & portability**
- **Auto-generation of the whole application**
  - **Code generation with Ocarina**
  - **Compilation & integration with the POK operating system**

Generation process

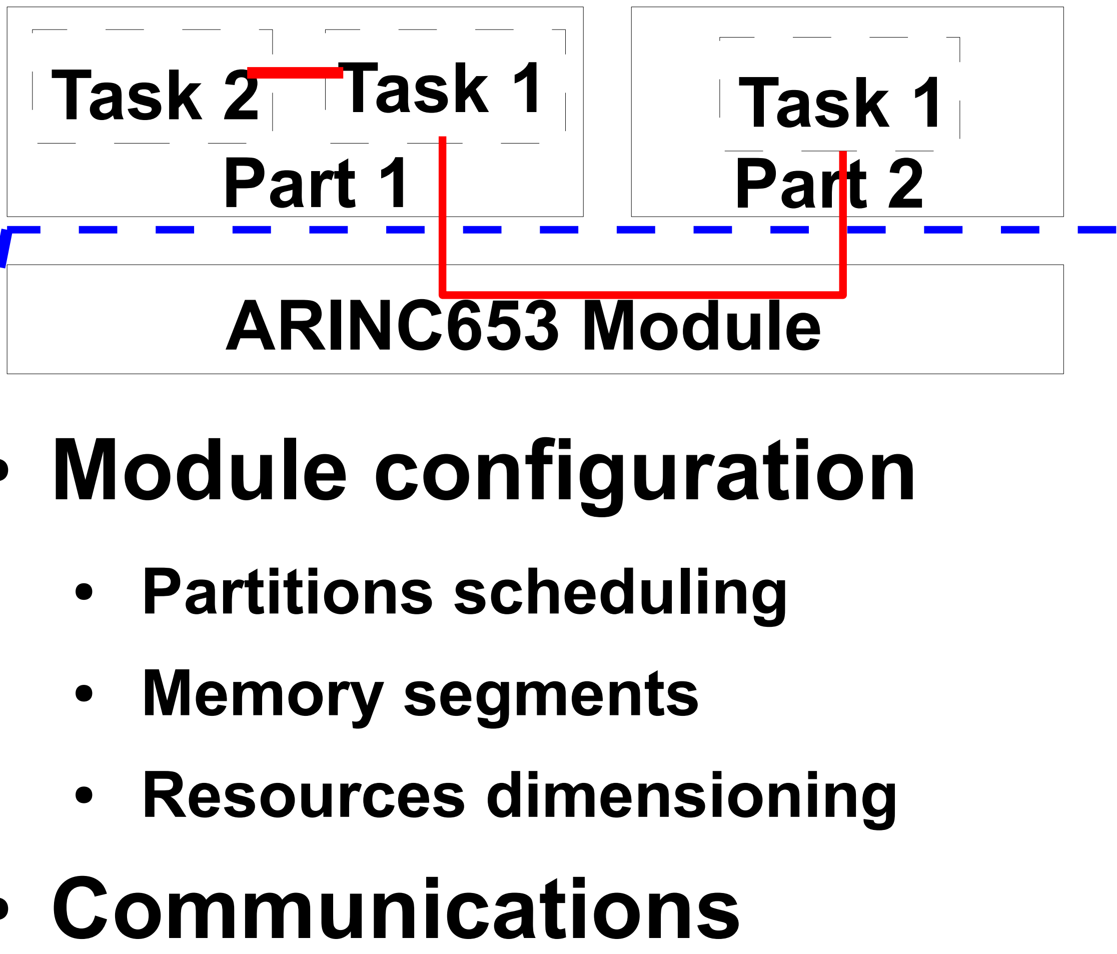


Outline

- Code generation overview
- **Generation patterns**
- Benefits
- Conclusion

Generation requirements

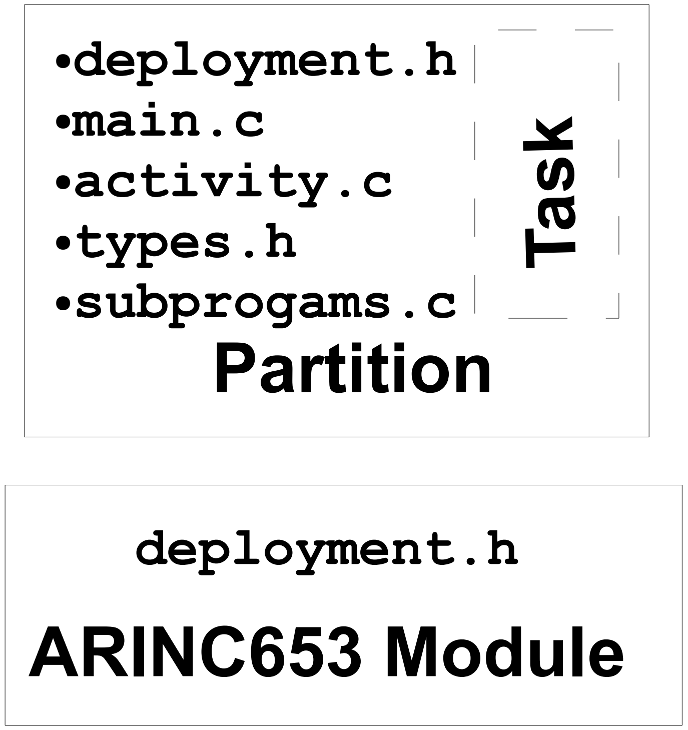
- **Partition configuration**
  - Resources dimensioning
  - Intra-partition ports routing
- **Partition initialization**
  - Resources creation
  - Tasks initialization
- **Tasks execution**
  - Interface with application
  - Send/receive data



- **Module configuration**
  - Partitions scheduling
  - Memory segments
  - Resources dimensioning
- **Communications**
  - Inter-partitions ports routing

Generated files

- **Module**
  - **`deployment.[h|c]`: module configuration**
- **Partition**
  - **`deployment.[h|c]`: partition configuration**
  - **`subprograms.[h|c]`: interface with application code**
  - **`activity.[c|h]`: tasks activity**
  - **`main.[c|h]`: partition initialization**
  - **`types.h` : types**

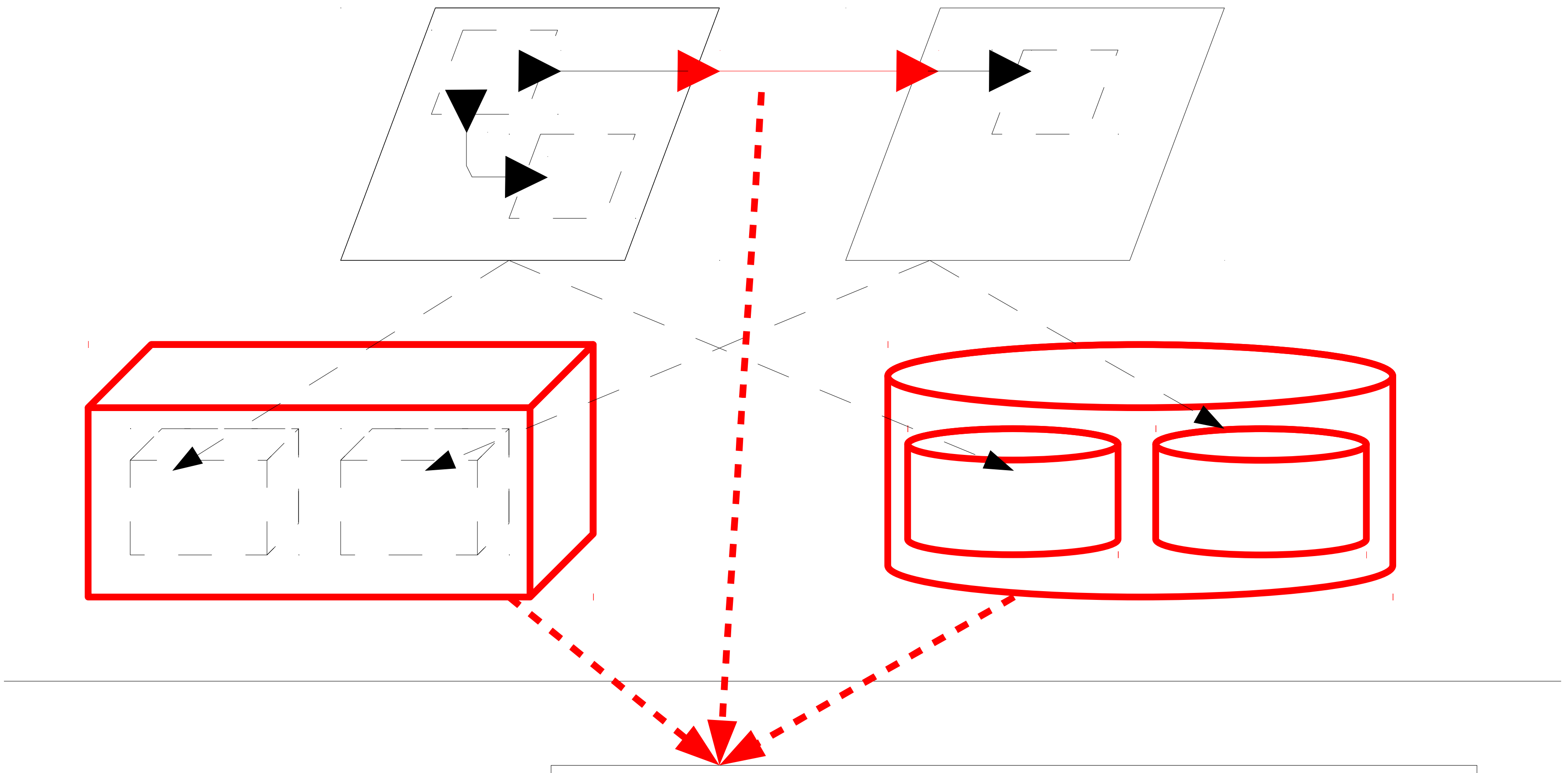


Module configuration

`(deployment.h)`

- **Partition scheduling (time isolation)**
  - **Module scheduling policy: time frame allocation**
- **Memory segments (space isolation)**
  - **Segments allocation across partitions**
- **Resources dimensioning**
  - **Amount of partitions, ports, etc.**
- **Inter-partitions ports**
  - **Ports kind, routing policy**

Module configuration - sample



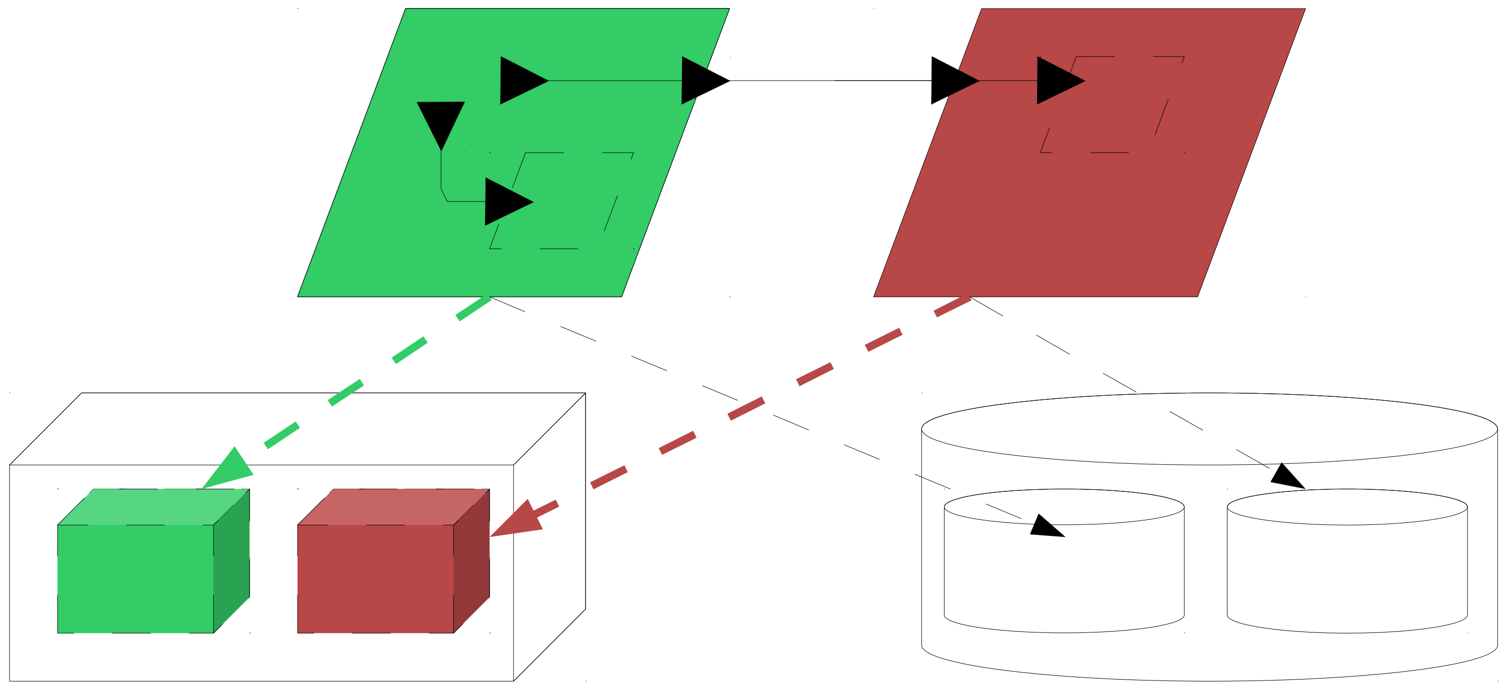
Module conf. → ARINC653 Module

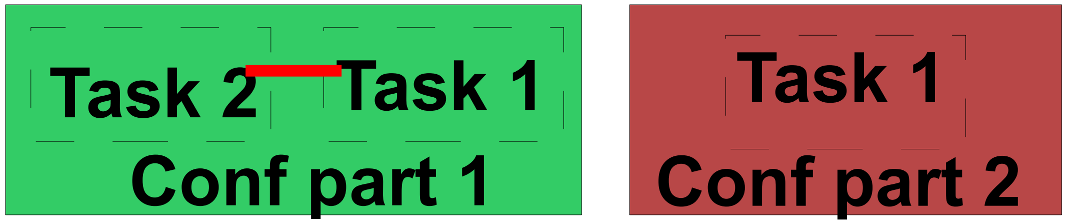
Partition configuration

`(deployment.h)`

- **Process scheduling**
  - **Partition scheduling policy (algorithm)**
- **Resources dimensioning**
  - **Amount of threads, ports, allocatable memory, ...**
- **Determine included functionalities**
  - **Cipher algorithms, libc, libm, ...**
- **Intra-partition ports**
  - **Routing policy**

Partition configuration

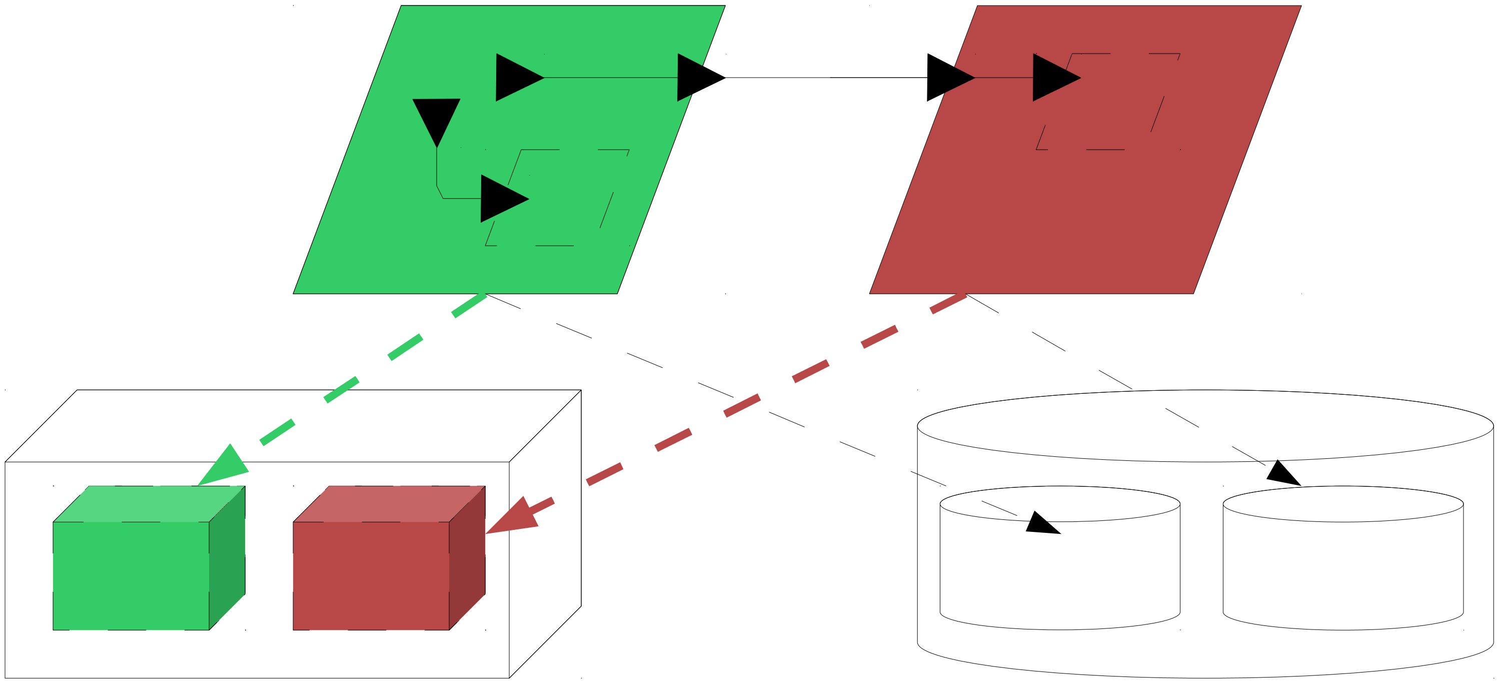


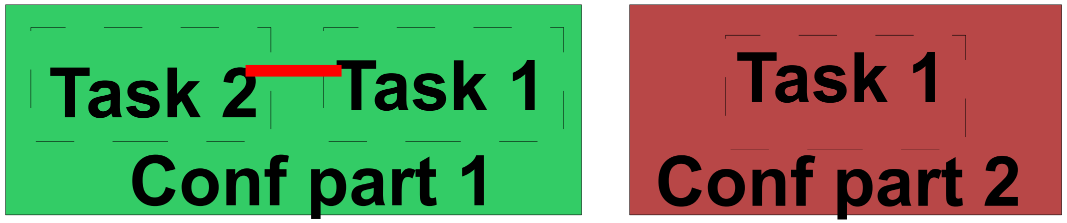


Partition initialization `(main.c)`

- **AADL threads**
  - **Create threads according to their type**
- **AADL ports**
  - **Initialize inter and intra-partition channels**
  - **Consistency with configuration**
- **Misc initialization**
  - **Cipher algorithms**

Partition configuration

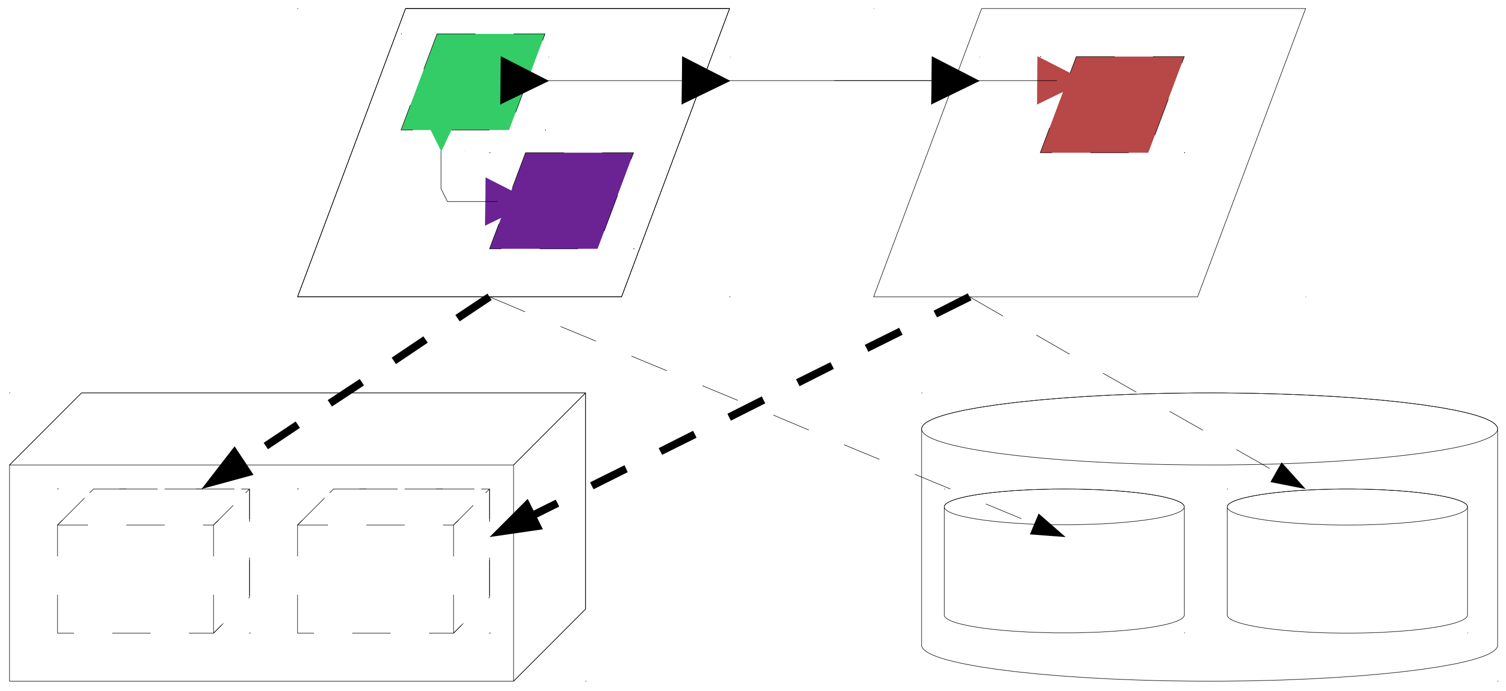


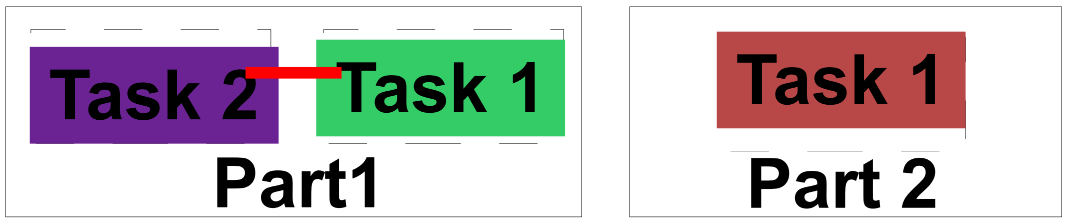


Partition behavior

- **AADL threads** `(activity.c)`
  - **Thread type (period vs. sporadic)**
  - **Call sequence**
  - **Ports (intra and inter-partition) : receive/send data**
- **Subprograms** `(subprograms.c)`
  - **Traditional subprograms (C/Ada vs. Simulink/Esterel)**
- **Types** `(types.h)`
  - **Interface AADL with C/Ada types**

Partition behavior





Outline

- Code generation overview
- Generation patterns
- **Benefits**
- Conclusion

Improve reliability

- **Avoid traditional errors**
  - **Ease certification**
- **Enforce specification**
  - **Code generation according to designer's requirements**
- **Consistency with configuration**
  - **Avoid use of unallocated resource**

Better analysis

- **Predictable code**
  - **Code created from patterns**
  - **Predictable overhead**

- **Ravenscar compliance**
  - **Useful for High Integrity systems**
  - **Past experiments with PolyORB-HI-C**

Outline

- Code generation overview
- Generation patterns
- Benefits
- **Conclusion**

Conclusion

- **Improve system creation**
  - **Predictable code, better analysis**
  - **Enforce specification requirements**
  - **Avoid all errors introduced by developers**
- **Support for various operating systems**
  - **Generation of ARINC653 XML files**
  - **ARINC653 compliant code generation**

Questions ?