Towards SystemC Code Generation from UML/MARTE Concurrent System-Level Models

Pablo Peñil
Fernando Herrera
Eugenio Villar

Outline

- Motivation
- Code Generation Preserving Temporal Semantics
- Implementation and Example
- Conclusions
- Future Work

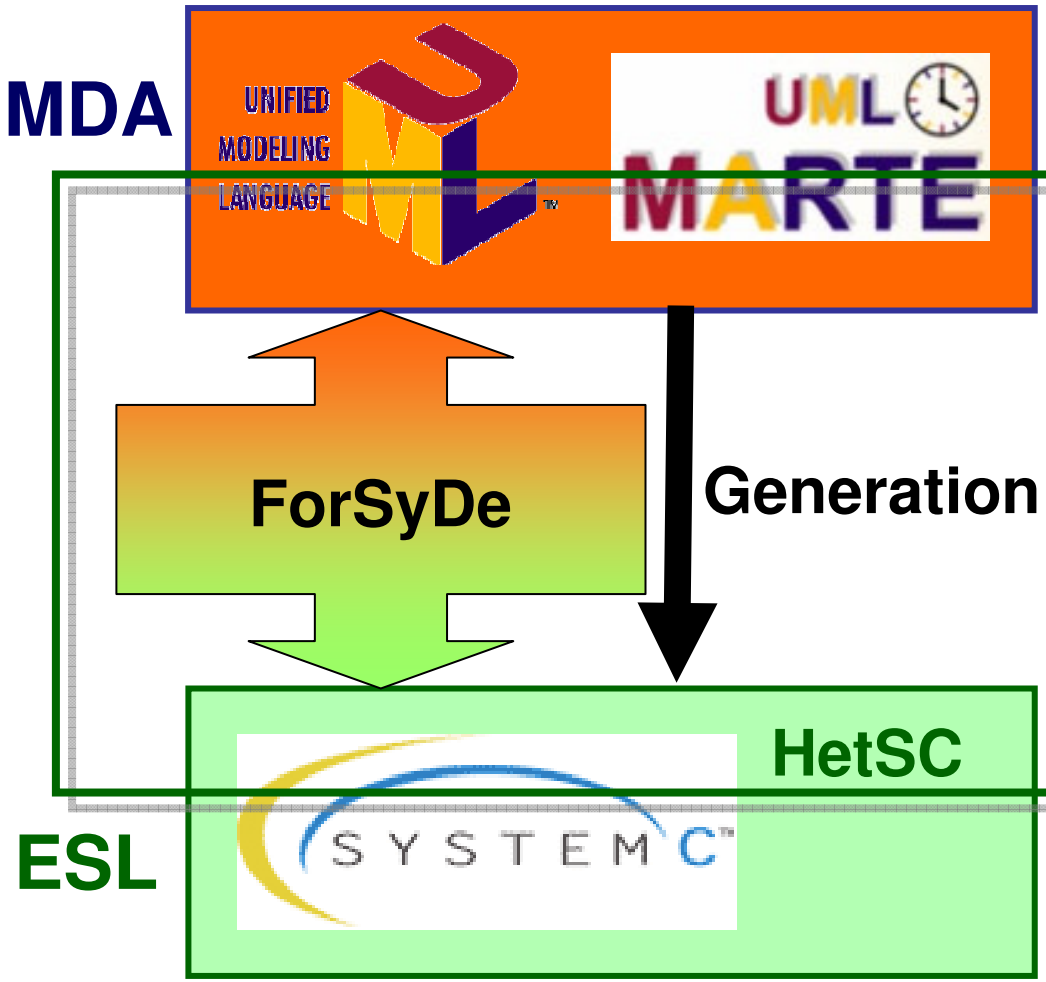
Motivation

- System-Level Specification
  - Functionality
  - Concurrency
    - Exploit Real Parallelism of today platforms (e.g., MPSoCs)
  - Early Validation and Analysis

- Concurrency is a Problem! → Formal Support (MoC support)
  - Separation of Communication and Computation
  - MoC support: untimed (KPN, CSP, SDF,…)

"Freedom from Choice"

Motivation

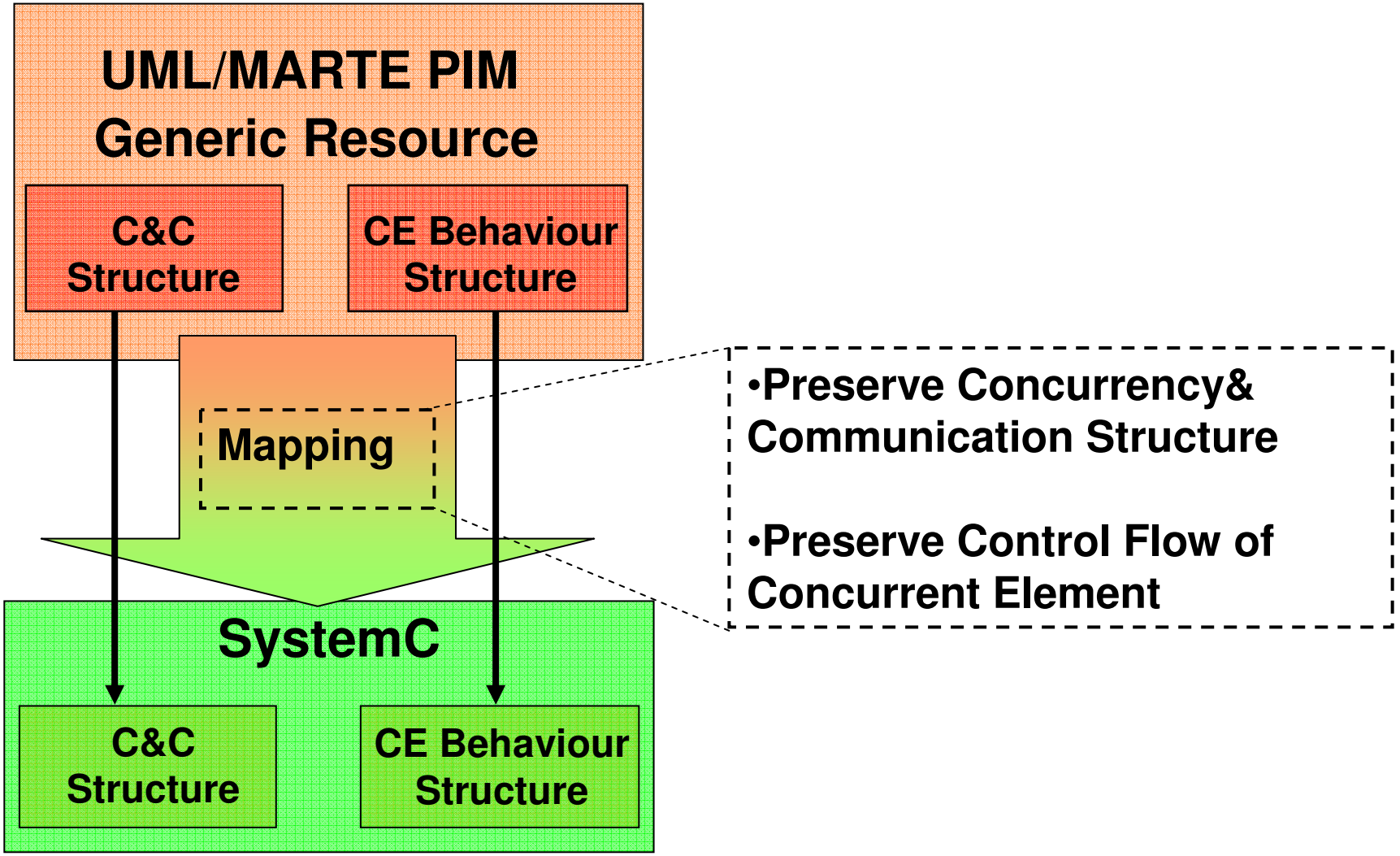


- System-Level Specification of Embedded Systems
- PIM (MARTE:GRM)
- Untimed MoC semantics Partial Orders (P.O.)

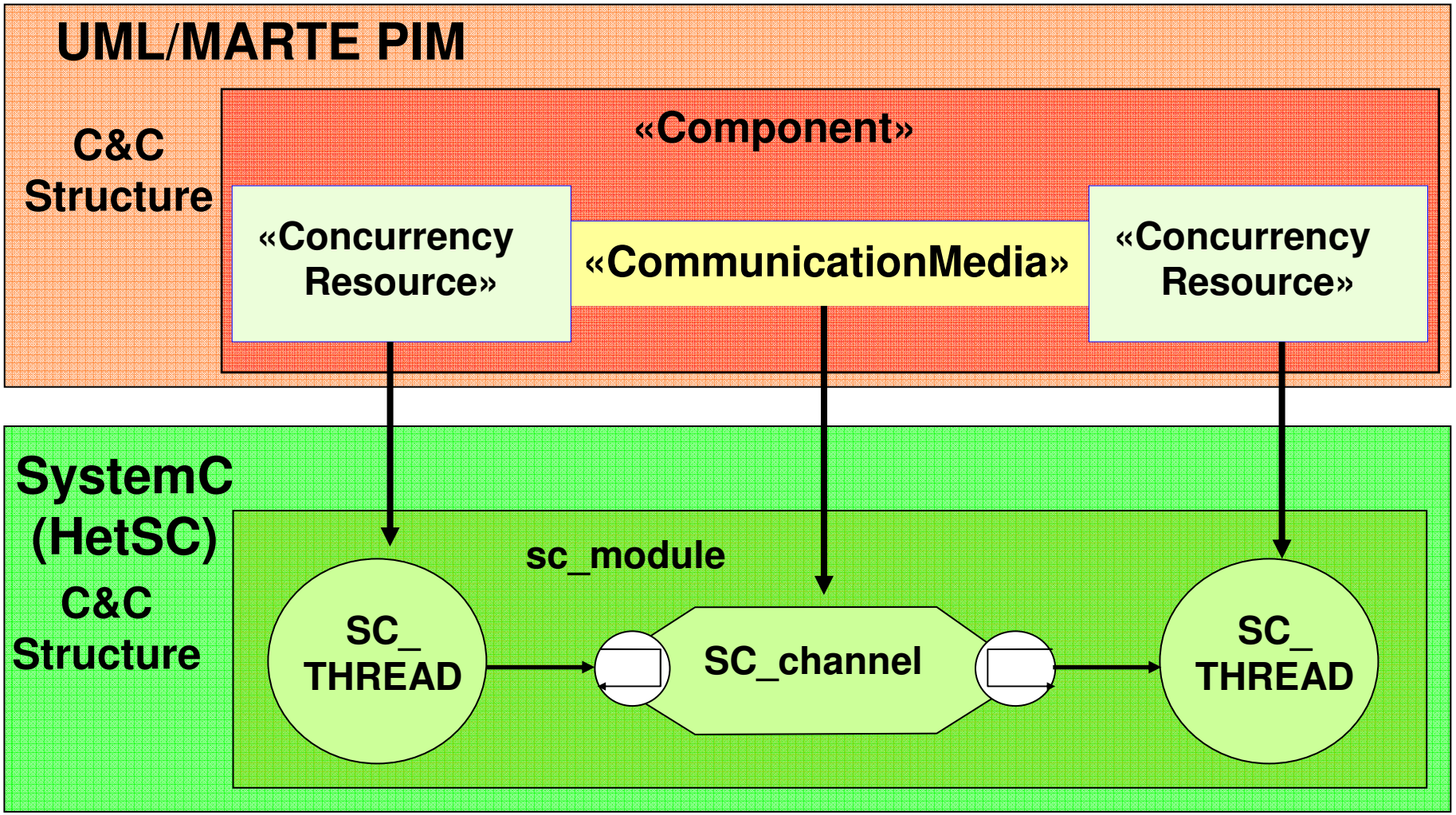
- Formal Support (MoCs)
- Automatic
- Portable
- Preserving Temporal Semantics

- Executable
- Validation

Code Generation Preserving Untimed Semantics (P.O.)



Preserving Concurrency&Communication Structure

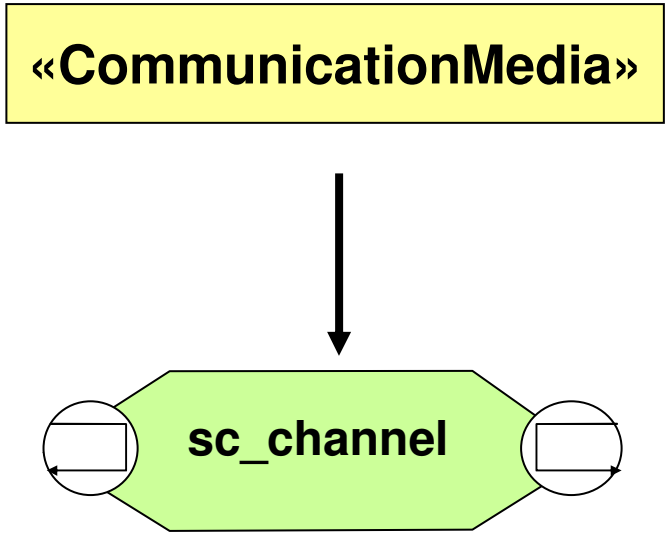


Preserving Communication Semantics

Untimed MoCs

e.g., Kahn **P**rocess **N**etworks (**KPN**)

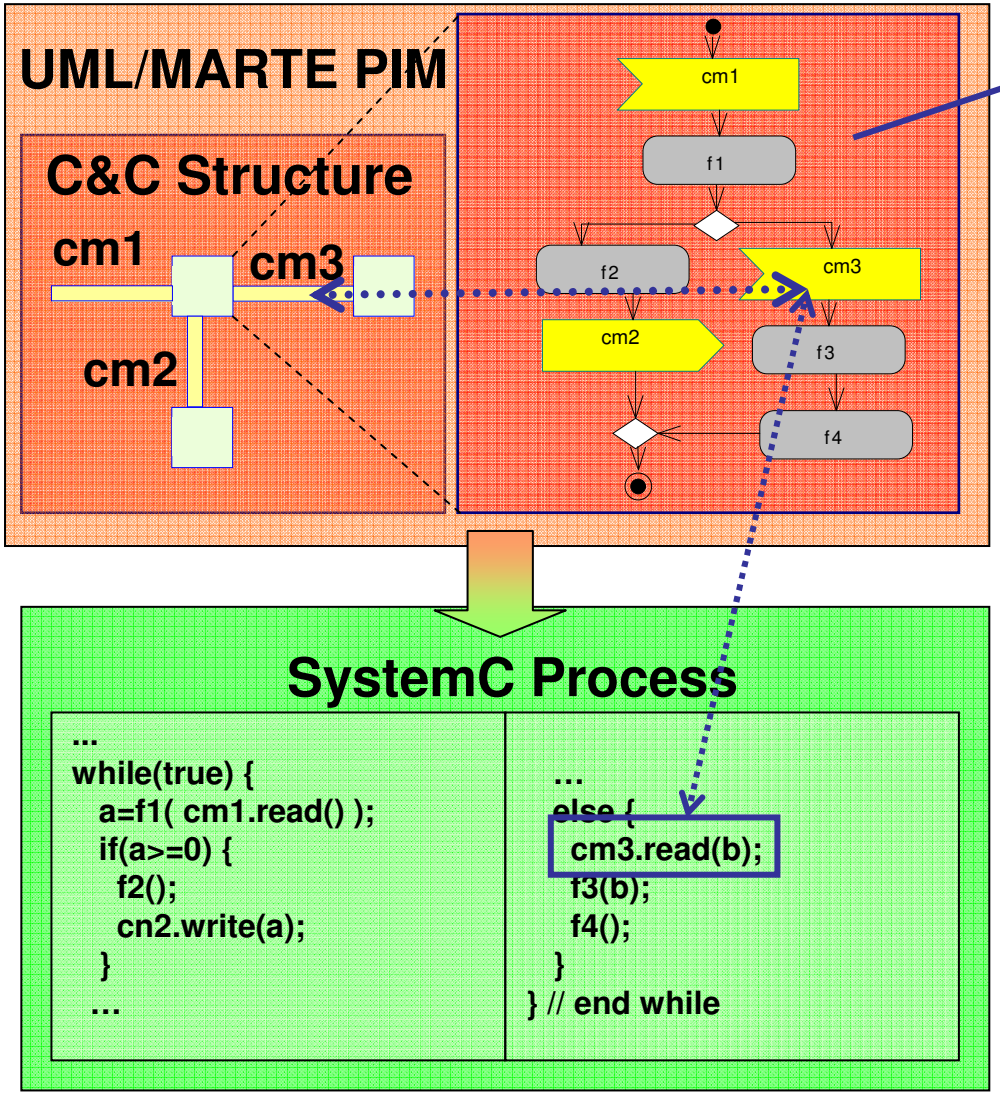
- **Communication Semantics:**
  - Blocking infinite fifo
  - Blocking finite fifo



- Buffering capacity
  - **storageResource**
  - **resMult** attribute:
    - Defined → finite fifo
    - Undefined → infinite fifo

- **uc_fifo (sc_fifo)**
- **uc_inf_fifo**

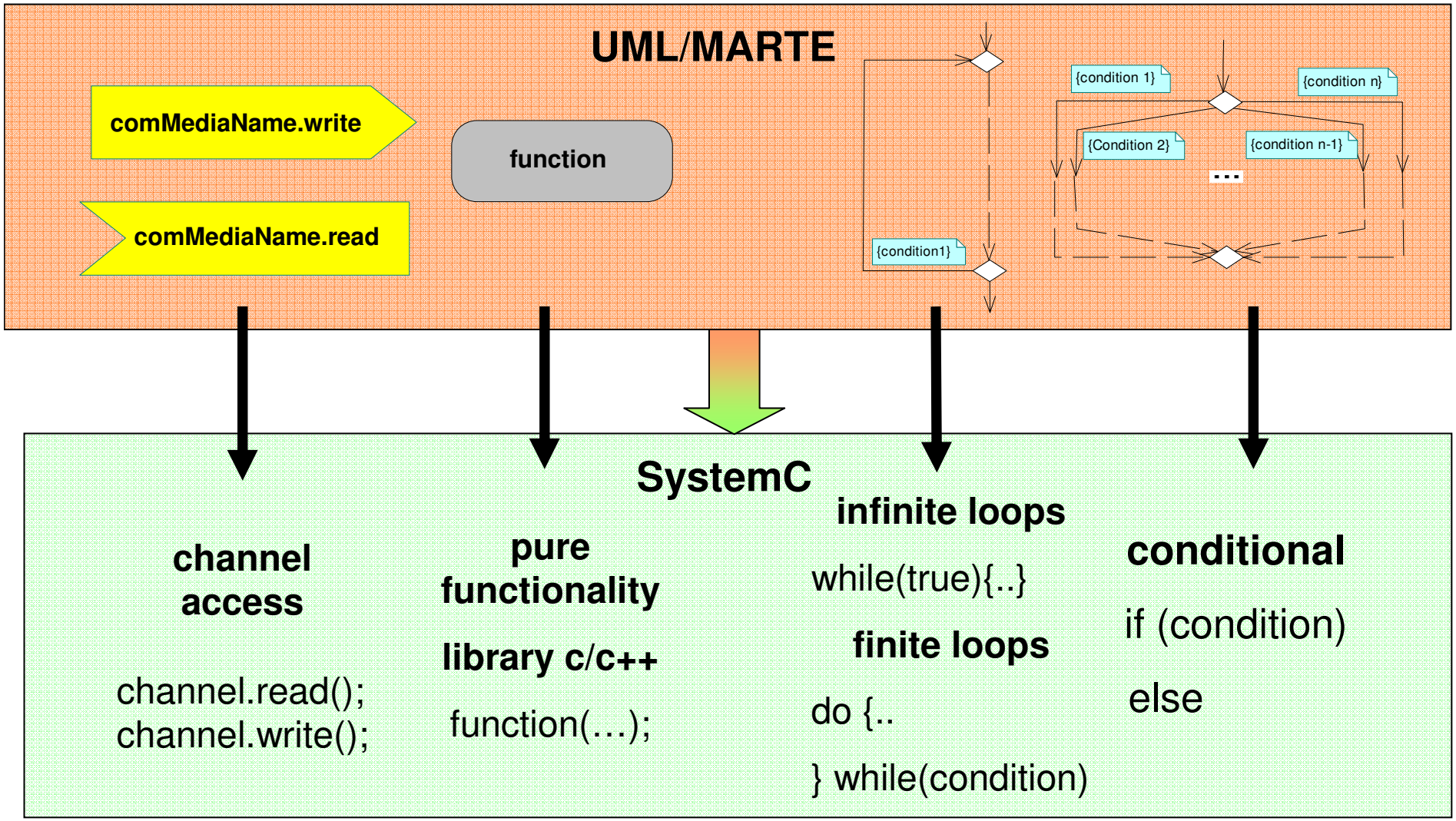
Preserving Structure of the Concurrent Element Behaviour



CE Beh. Structure

- Preserve Control Flow:
  - path structures
  - Ordering of Functional Computation (FCs) & Communication Media (CM) Accesses
- Generate References to CM method accesses

Detail of Mapping of the Elements of the Behaviour of Concurrent Elements



Code Generator

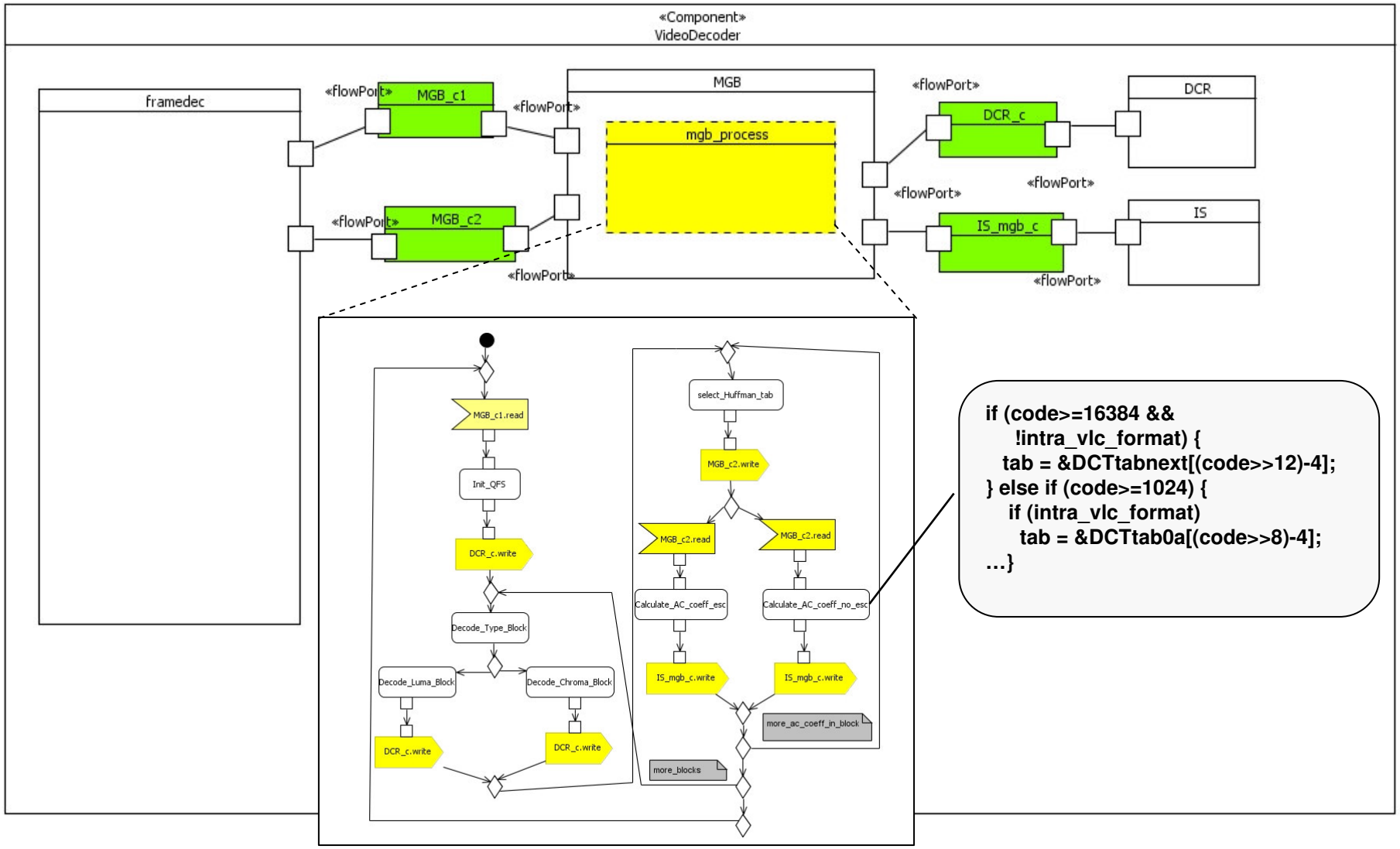
- First prototype of code generator
- Implementation Language: MTL/M2T

- Development Framework: Eclipse Helios

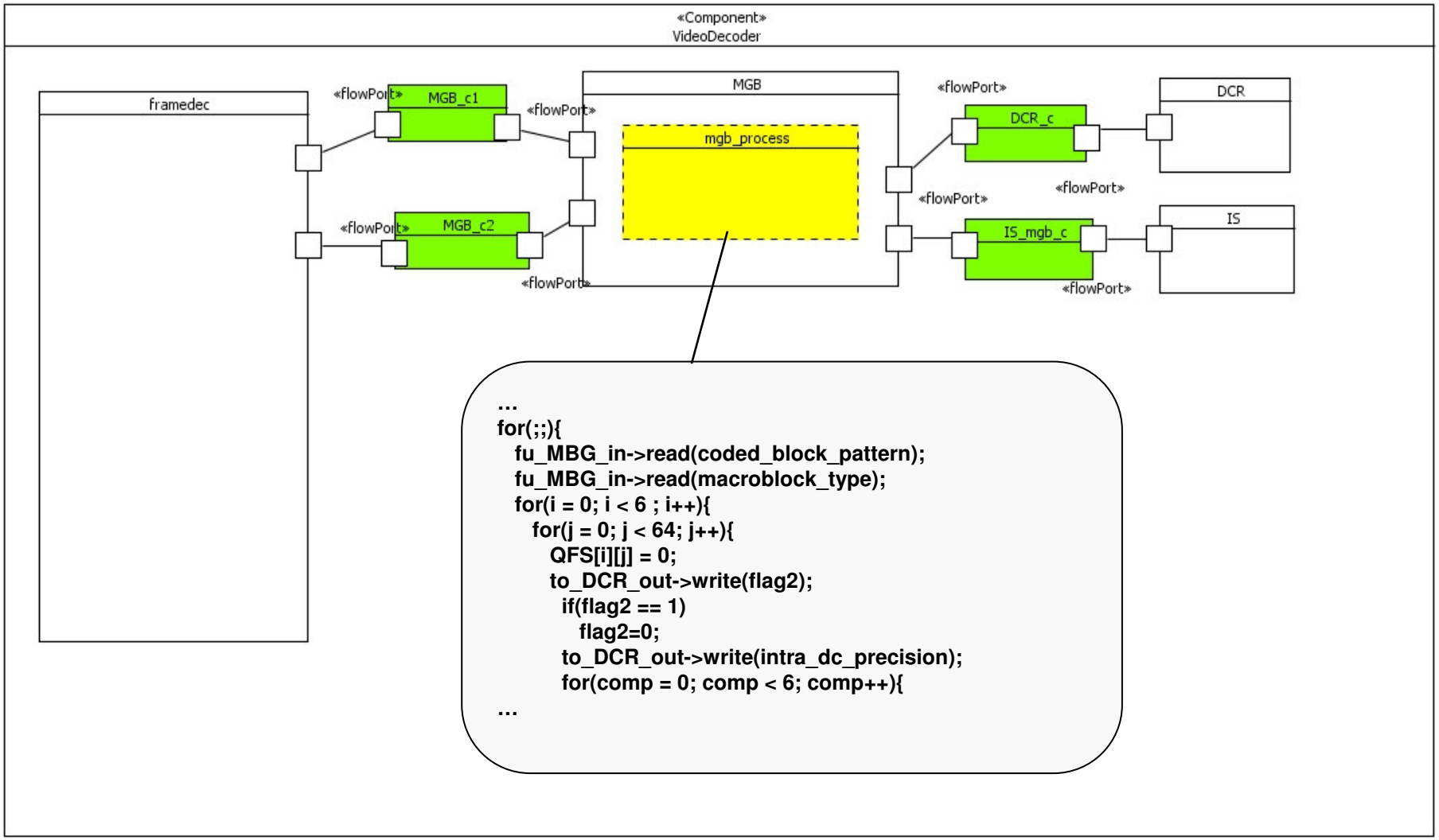
  - Generation: **Acceleo MTL**

  - UML/MARTE capture: Papyrus MDT

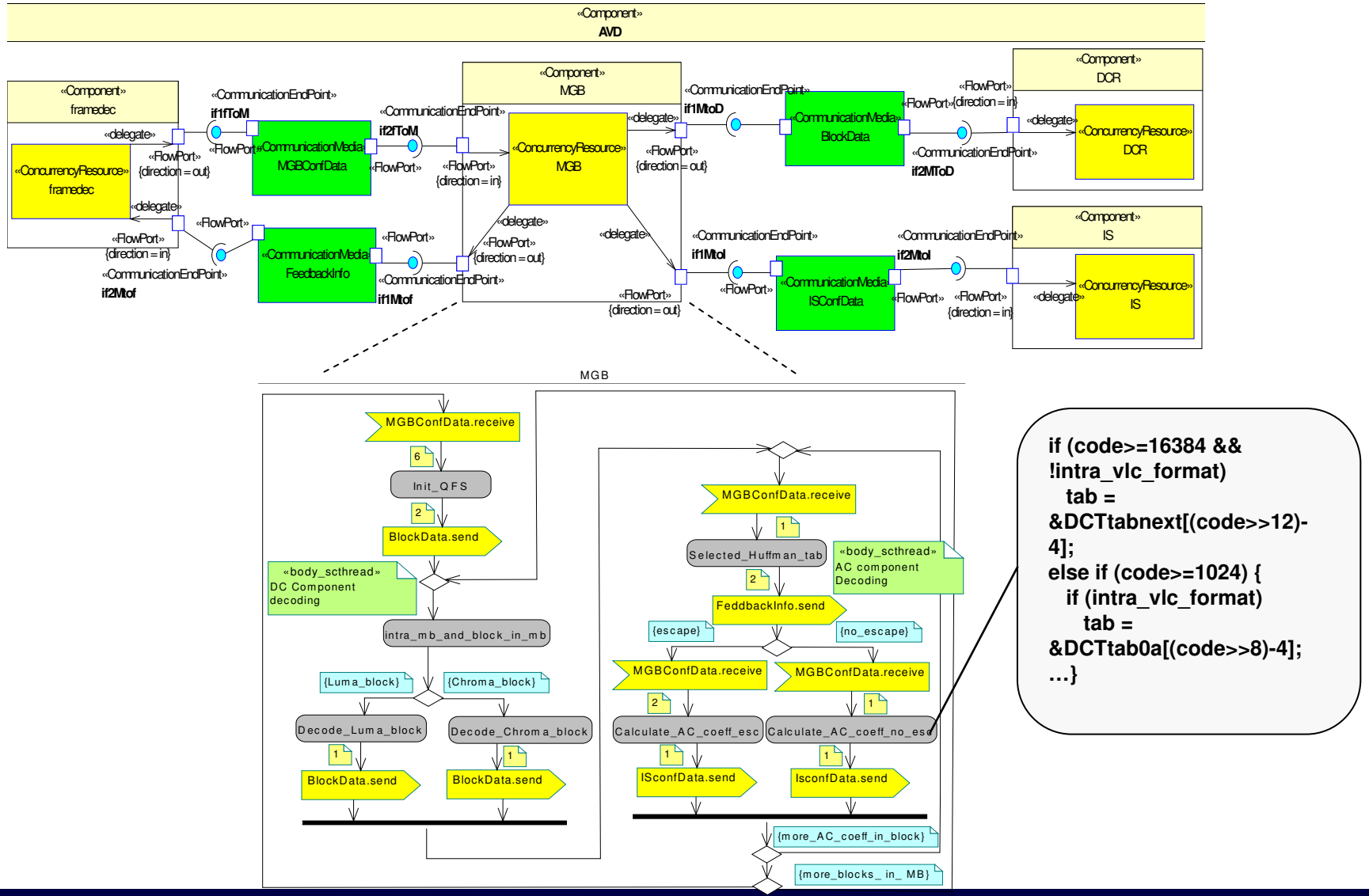
Application example: Video Decoder



Application example: Video Decoder

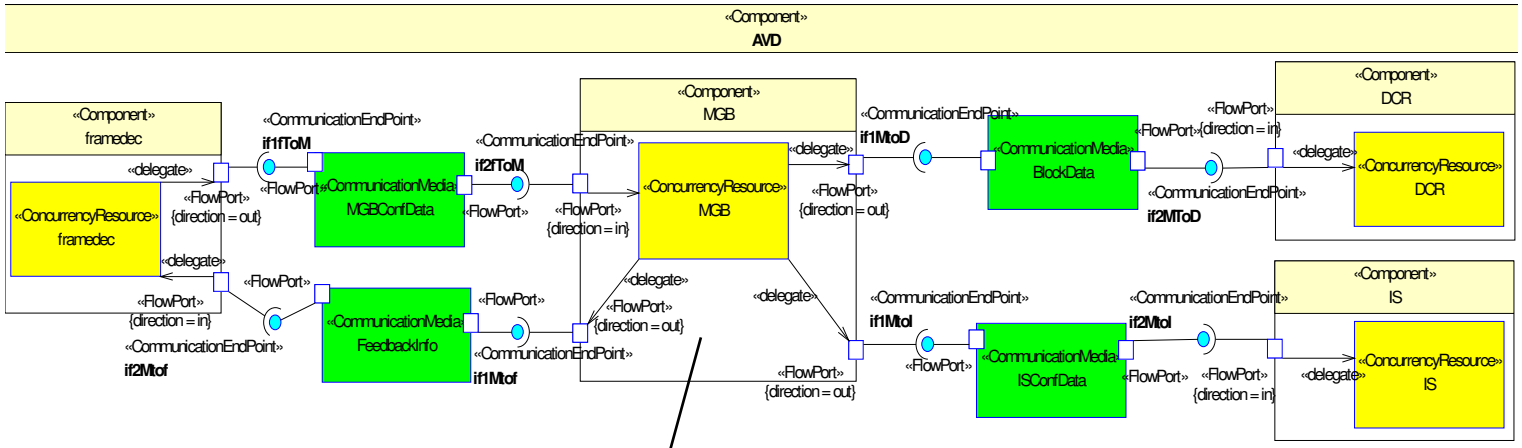


Application example: Video Decoder (in ARTISAN)



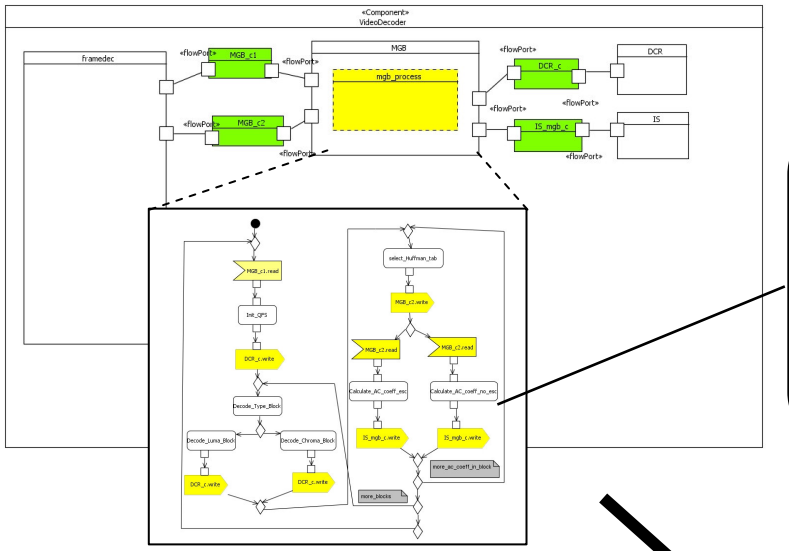

```
if (code>=16384 &&
!intra_vlc_format)
   tab =
&DCTtabnext[(code>>12)-
4];
else if (code>=1024) {
   if (intra_vlc_format)
      tab =
&DCTtab0a[(code>>8)-4];
…}
```

Application example: Video Decoder




```
...
for(;;){
  fu_MBG_in->read(coded_block_pattern);
  fu_MBG_in->read(macroblock_type);
  for(i = 0; i < 6 ; i++){
    for(j = 0; j < 64; j++){
      QFS[i][j] = 0;
      to_DCR_out->write(flag2);
       if(flag2 == 1)
         flag2=0;
       to_DCR_out->write(intra_dc_precision);
       for(comp = 0; comp < 6; comp++){
...
```

Application example: Video Decoder




```
if (code>=16384 &&
!intra_vlc_format)
   tab =
&DCTtabnext[(code>>12)-4];
else if (code>=1024) {
   if (intra_vlc_format)
      tab =
&DCTtab0a[(code>>8)-4];
...}
```

MARTEPIM2SC

AVD.cpp

MGB.h

MGB.cpp

...

Conclusions

- UML/MARTE+SystemC sinergistic System-Level modelling framework requires code generation supporting preservation of temporal semantics
- Code generation methodology preserving:
  - C&C structure (different communication semantics)
  - Behavior structure of concurrent element
- 1st prototype:
  - Standard based chain UML/MARTE→MTL→SystemC

Future Work

- Support generation for further untimed Modelling Approaches
  - CSP, SDF
- Extension to Synchronous models

Thanks

- Thanks
  - For Your Attention
  - Funding

- Further Information:
  - Authors: {pablop, fherrera, evillar}@teisa.unican.es
  - www.teisa.unican.es/gim