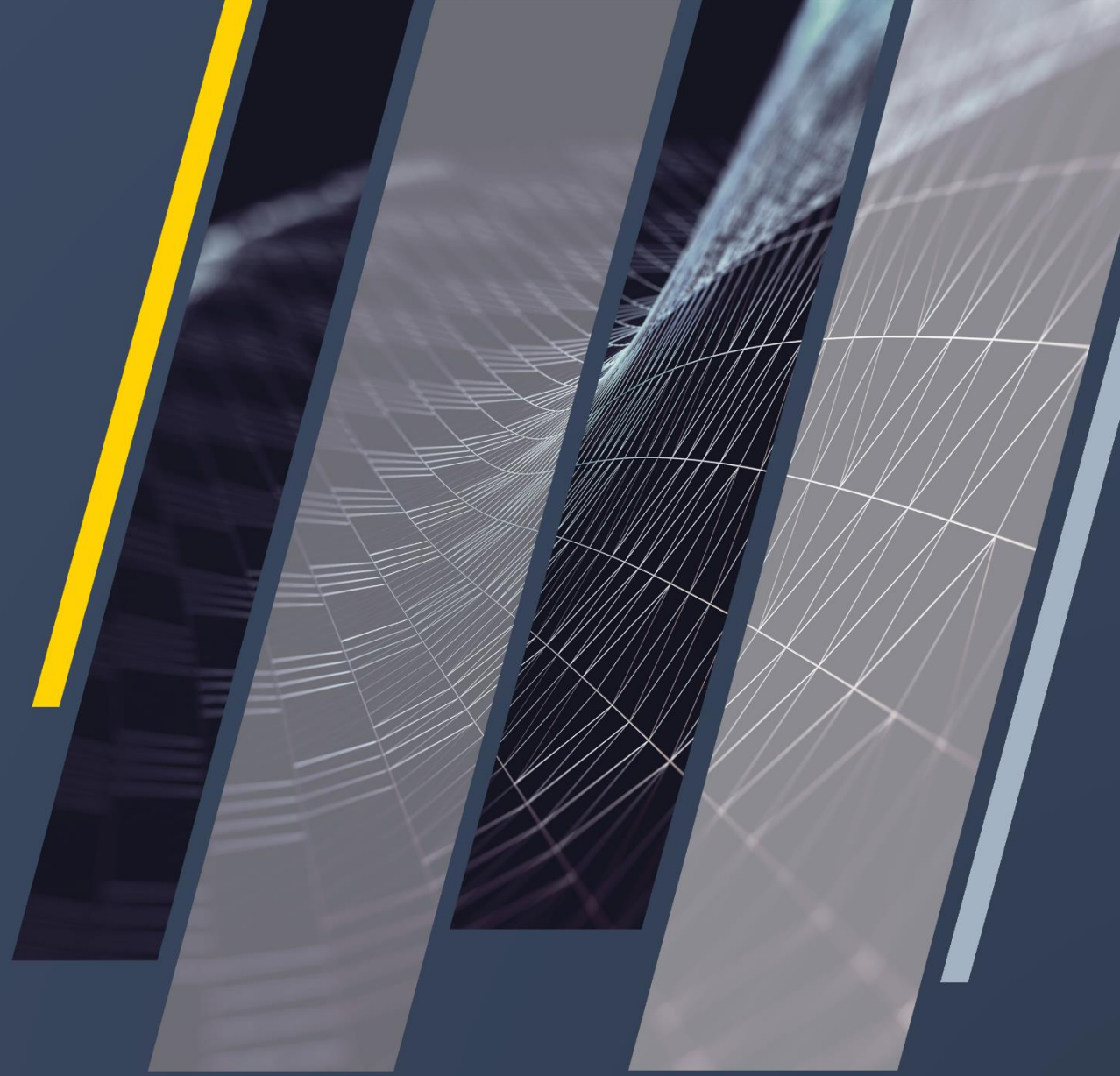

Model-Based System and Software Analysis and Development Tools

Gui Goretkin
Senior Application Engineer – ANSYS SCADE
guilherme.goretkin@ansys.com

Thierry Le Sergent
SCADE Architect Product Manager
Thierry.lesergent@ansys.com

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Content

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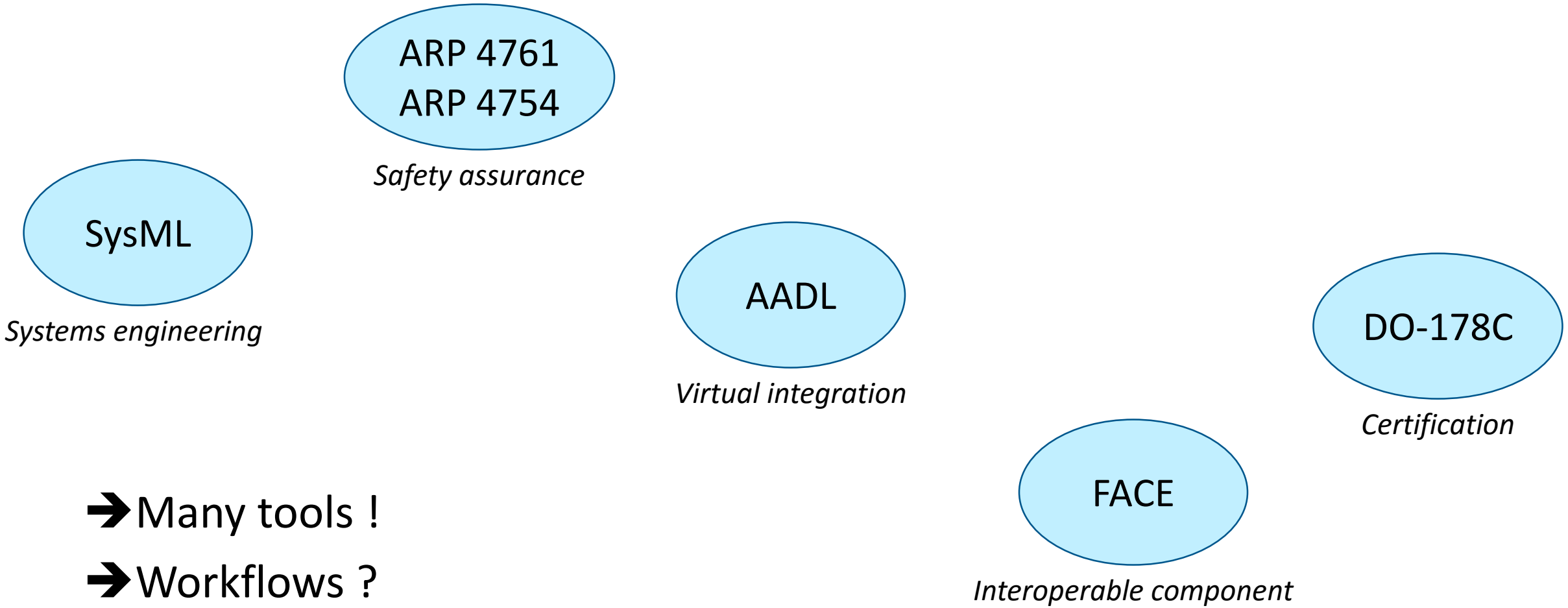
- SCADE solution for AADL

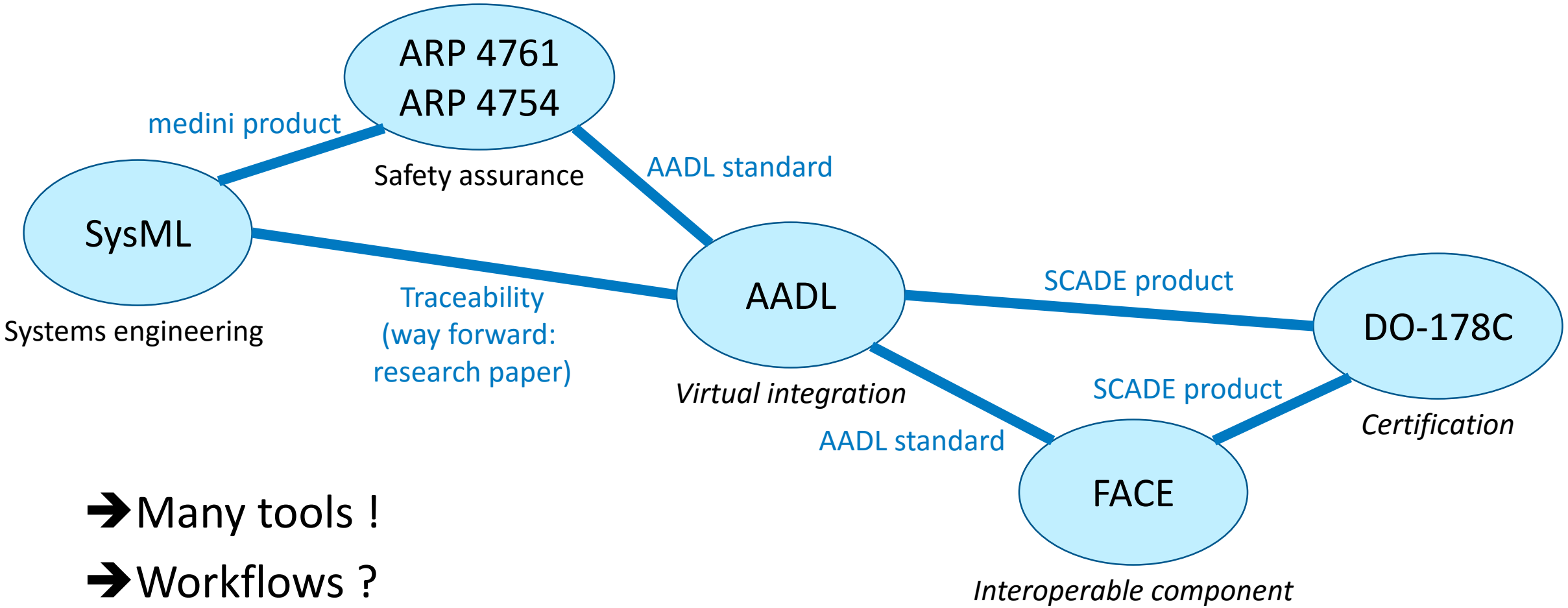
AADL is not an island !



➔Many tools !

➔Workflows ?

AADL is not an island !



➔Many tools !

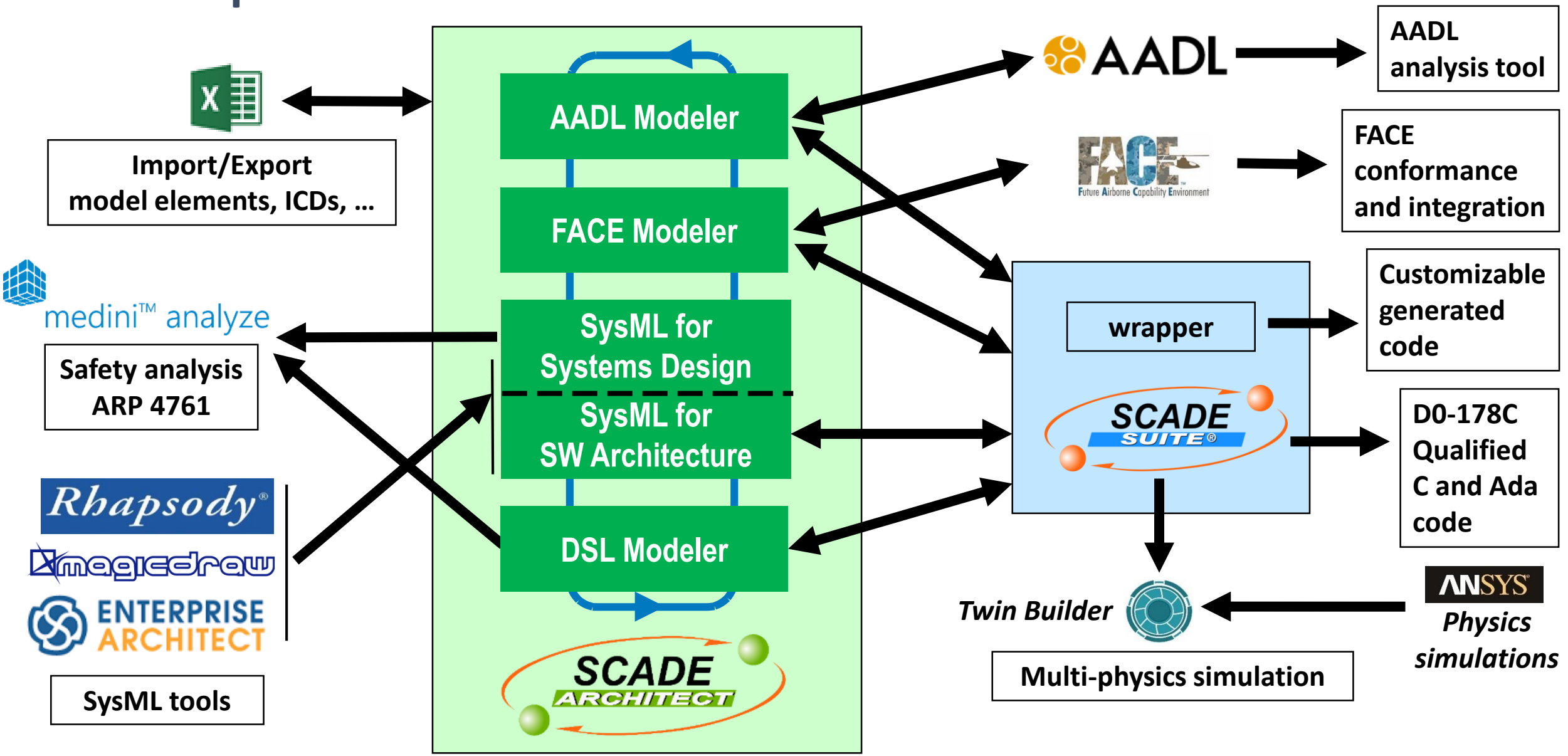
➔Workflows ?

AADL is not an island

Bridges with the other models

- Possible means
  - A. Traceability between objects
    - Supported by most tools
    - Allows for completion checks
  - B. “Allocations” between objects
    - Straightforward when several kind of models supported in the same tool
    - Ease checks, tables, reports, …
  - C. “Synchronization” of models
    - Automated model transformation where it make sense
    - Example:
      - AADL - FACE mapping specified in AADL FACE Annex
      - SW Architecture components - SCADE Suite operators
- SCADE Architect supports all these means

SCADE capabilities for MBSE workflows

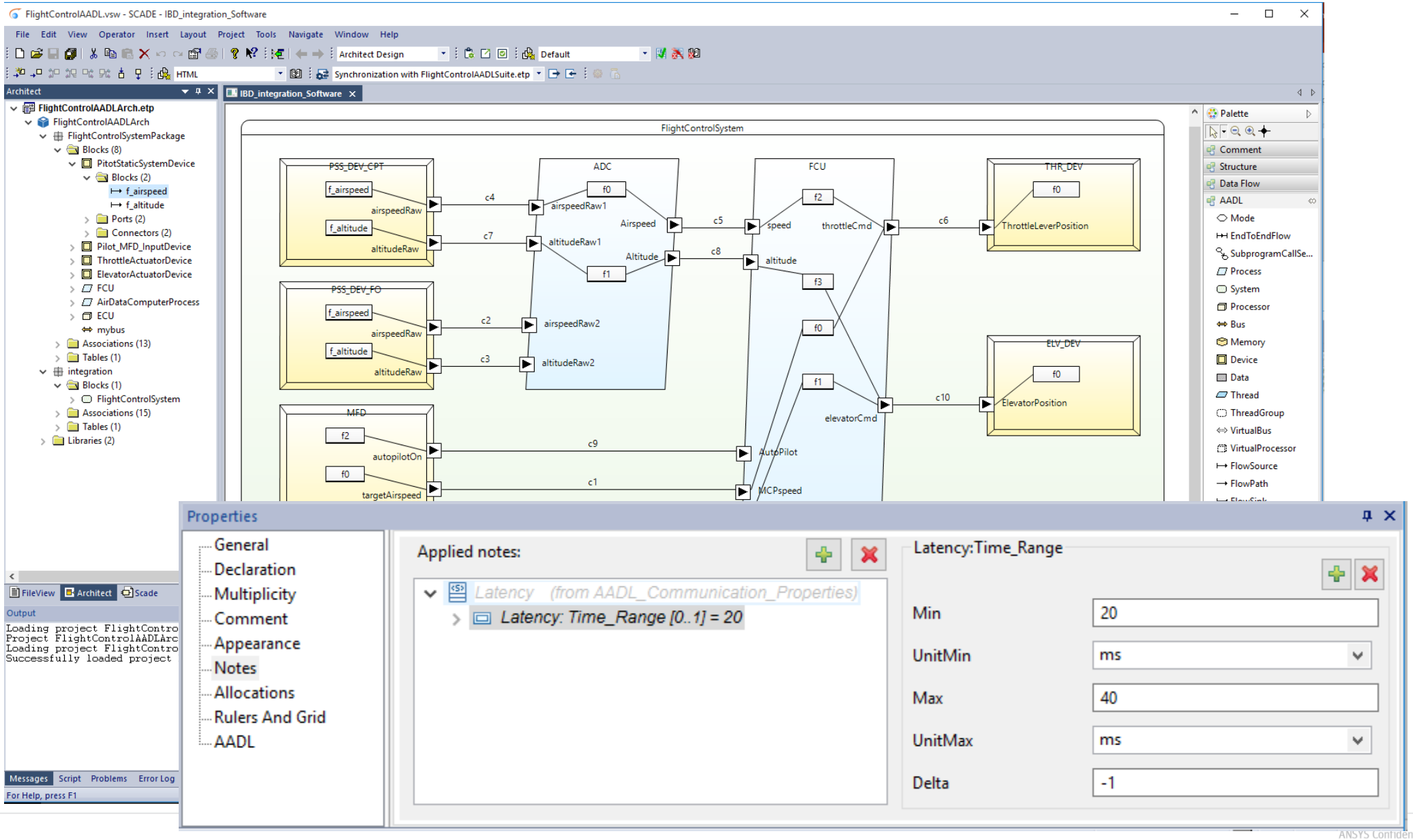


SCADE solution for AADL

- AADL is an SAE International standard dedicated to real-time embedded systems
  - Modeling software and hardware resources for V&V
  - Powerful Property Sets extension concept

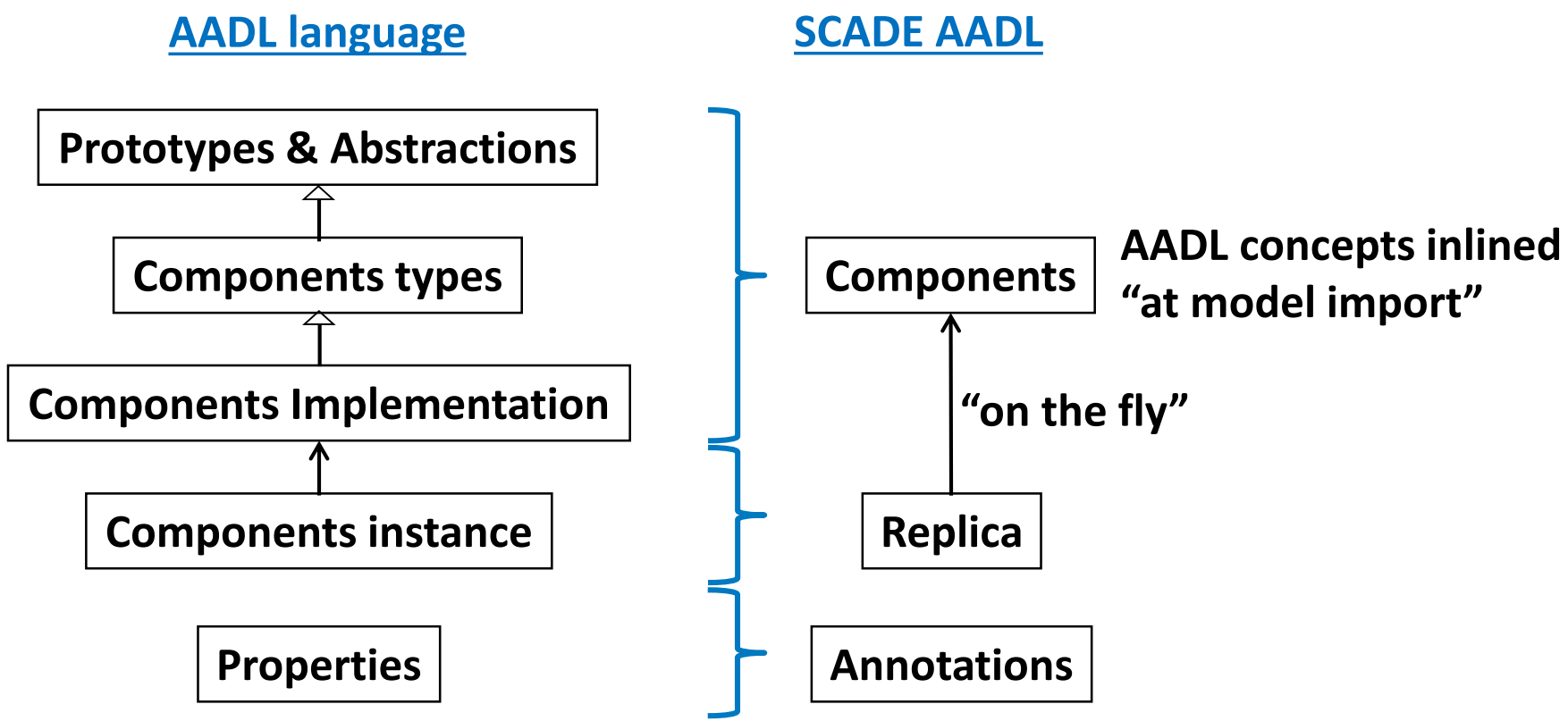
- AADL Support with SCADE
  - Full compatibility with AADL v2.2 standard
    - Allows for legacy models import
    - Allows for export to third party analyzers
  - Easy to use
    - AADL expressiveness simplified: just concrete components
    - Nice graphical interface & diagrams
  - Benefit from SCADE tools ecosystem
    - Bi-directional synchro with SCADE Suite for SW component development, verification & certification
    - Traceability through SCADE ALM gateway
    - Same IDE as for SysML and FACE modeling (mixed designed supported)

SCADE solution for AADL: graphical interface & diagrams



SCADE solution for AADL: ease of use

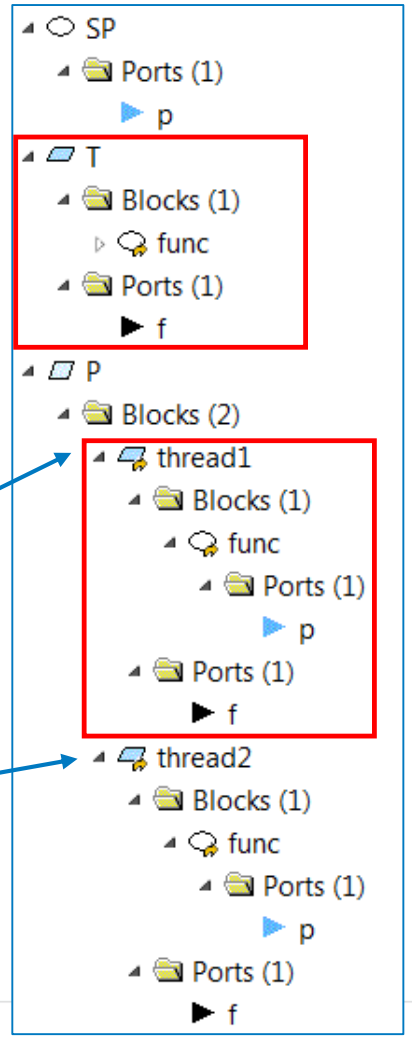
- Support for AADL “instance-based modeling”: much simpler model understanding



Import AADL files in SCADE AADL

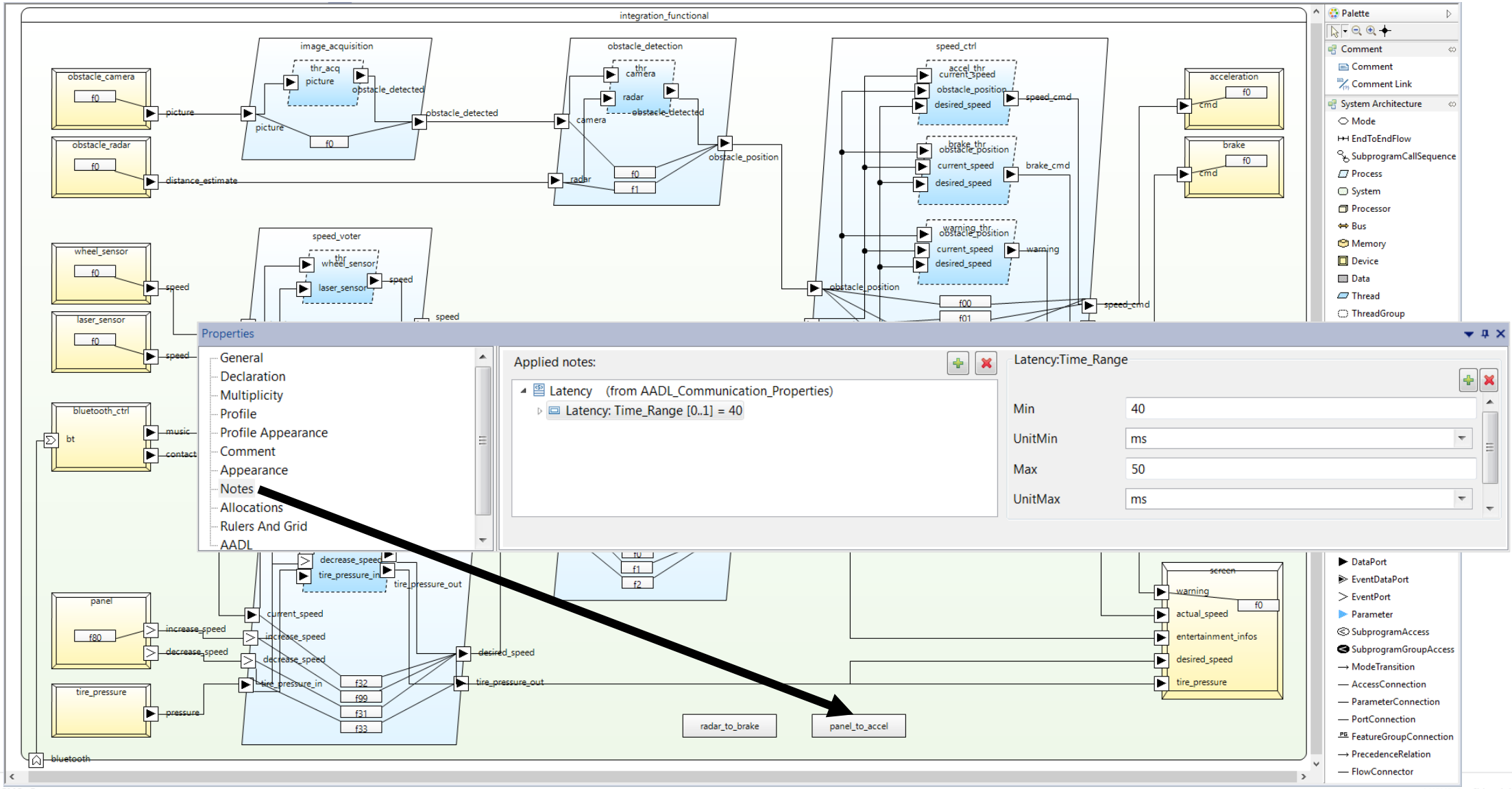
1. Merge component type and implementation in a single object
2. SCADE Architect replication mechanism for immediate instantiation of components.

```
subprogram SP
  features
    p : in parameter Base_Types::Boolean;
end SP;

thread T
  features
    f: in data port Base_Types::Unsigned_16;
end T;

thread implementation T.impl
  subcomponents
    func: subprogram SP;
end T.impl;

process P
end P;

process implementation P.impl
  subcomponents
    thread1 : thread T.impl;
    thread2 : thread T.impl;
end P.impl;
```



Case study

A simple self-driving car example. “AADL In Practice”, Julien Delange: http://www.aadl-book.com



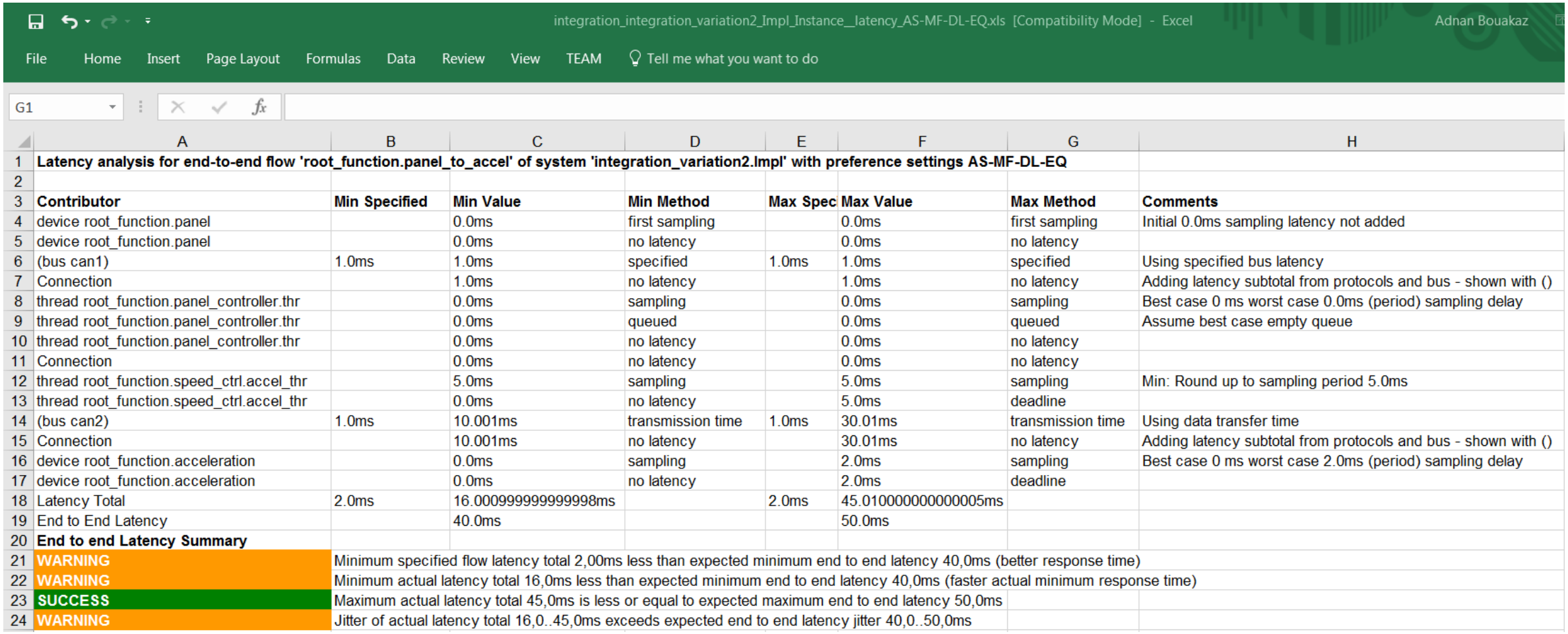
Case study

- Export self-driving car example from SCADE AADL to textual aadl file

```
end T;
package aadlbook::integration
public
   with aadlbook::platform;
/cut
   system implementation integration_functional.Impl
      subcomponents
         image_acquisition: process aadlbook::software::image_acquisition::image_acquisition.Impl;
         obstacle_detection: process aadlbook::software::obstacle_detection::obstacle_detection.Impl;
/cut
      connections
         c21: port tire_pressure.pressure -> panel_controller.tire_pressure_in;
         c04: port wheel_sensor.speed -> speed_voter.wheel_sensor;
/cut
      flows
         radar_to_brake: end to end flow obstacle_radar.f0 -> c02 -> obstacle_detection.f1 -> c03 -> speed_ctrl.f10 -> c09 -> brake.f0 {
            Latency => 100ms .. 300ms;};
         panel_to_accel: end to end flow panel.f80 -> c11 -> panel_controller.f99 -> c13 -> speed_ctrl.f02 -> c08 -> acceleration.f0 {
            Latency => 40ms .. 50ms;};
   end integration_functional.Impl;
/cut
```

Case study

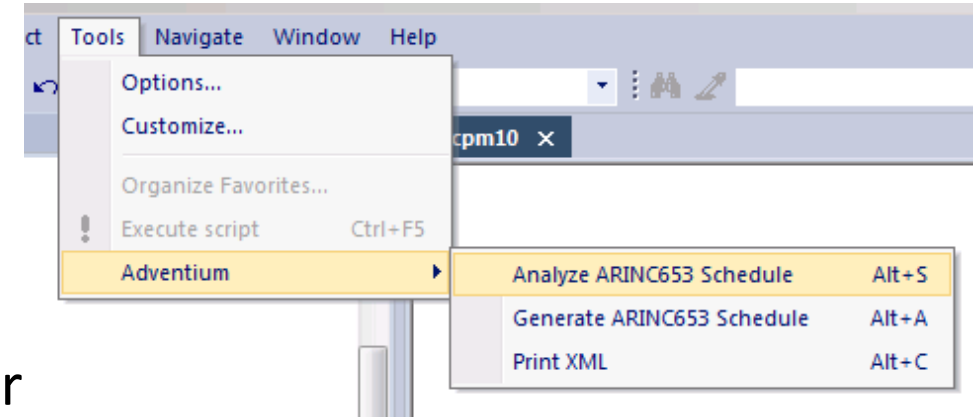
- Analysis example
  - End-to-end latency analysis result from Open Source tool OSATE

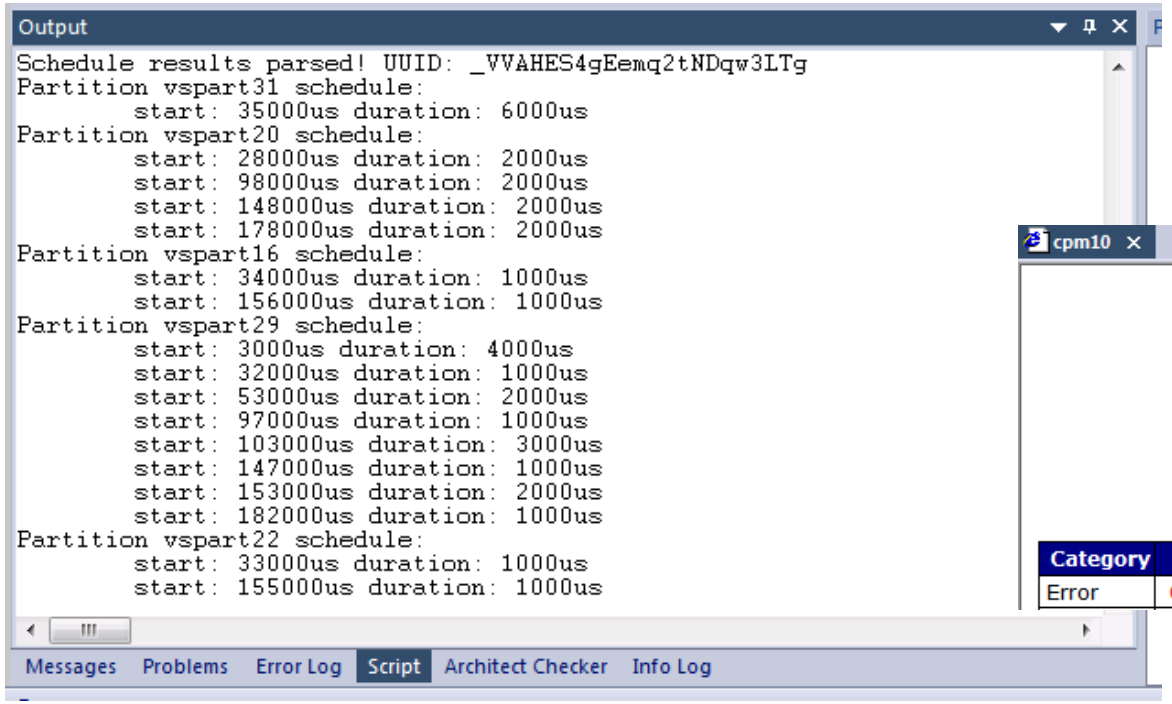


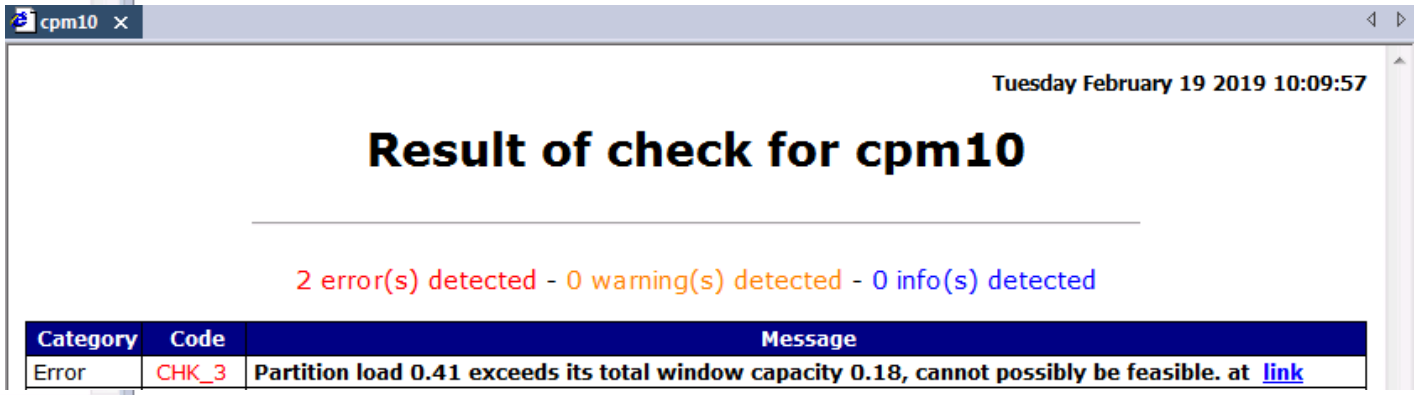
	A	B	C	D	E	F	G	H
1	**Latency analysis for end-to-end flow 'root_function.panel_to_accel' of system 'integration_variation2.Impl' with preference settings AS-MF-DL-EQ**							
2								
3	**Contributor**	**Min Specified**	**Min Value**	**Min Method**	**Max Spec**	**Max Value**	**Max Method**	**Comments**
4	device root_function.panel		0.0ms	first sampling		0.0ms	first sampling	Initial 0.0ms sampling latency not added
5	device root_function.panel		0.0ms	no latency		0.0ms	no latency	
6	(bus can1)	1.0ms	1.0ms	specified	1.0ms	1.0ms	specified	Using specified bus latency
7	Connection		1.0ms	no latency		1.0ms	no latency	Adding latency subtotal from protocols and bus - shown with ()
8	thread root_function.panel_controller.thr		0.0ms	sampling		0.0ms	sampling	Best case 0 ms worst case 0.0ms (period) sampling delay
9	thread root_function.panel_controller.thr		0.0ms	queued		0.0ms	queued	Assume best case empty queue
10	thread root_function.panel_controller.thr		0.0ms	no latency		0.0ms	no latency	
11	Connection		0.0ms	no latency		0.0ms	no latency	
12	thread root_function.speed_ctrl.accel_thr		5.0ms	sampling		5.0ms	sampling	Min: Round up to sampling period 5.0ms
13	thread root_function.speed_ctrl.accel_thr		0.0ms	no latency		5.0ms	deadline	
14	(bus can2)	1.0ms	10.001ms	transmission time	1.0ms	30.01ms	transmission time	Using data transfer time
15	Connection		10.001ms	no latency		30.01ms	no latency	Adding latency subtotal from protocols and bus - shown with ()
16	device root_function.acceleration		0.0ms	sampling		2.0ms	sampling	Best case 0 ms worst case 2.0ms (period) sampling delay
17	device root_function.acceleration		0.0ms	no latency		2.0ms	deadline	
18	Latency Total	2.0ms	16.000999999999998ms		2.0ms	45.010000000000005ms		
19	End to End Latency		40.0ms			50.0ms		
20	**End to end Latency Summary**							
21	WARNING	Minimum specified flow latency total 2,00ms less than expected minimum end to end latency 40,0ms (better response time)						
22	WARNING	Minimum actual latency total 16,0ms less than expected minimum end to end latency 40,0ms (faster actual minimum response time)						
23	SUCCESS	Maximum actual latency total 45,0ms is less or equal to expected maximum end to end latency 50,0ms						
24	WARNING	Jitter of actual latency total 16,0..45,0ms exceeds expected end to end latency jitter 40,0..50,0ms						

Integration with Adventium for AADL Analysis

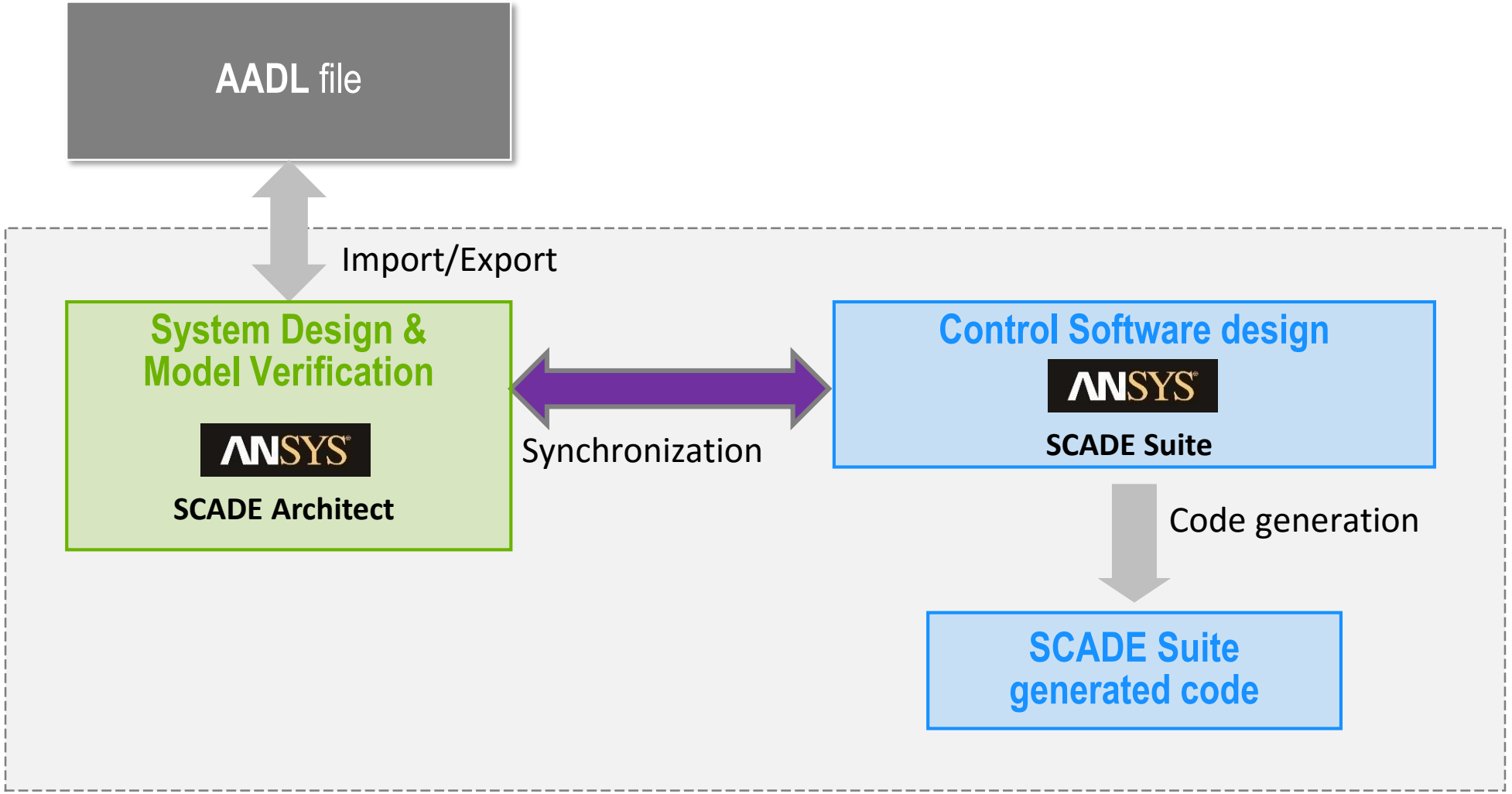
- Invoke Adventium backend tools directly from SCADE Architect to run AADL analysis such as generating and analyzing ARINC 653 scheduling
- Integrated with Architect checker to report timing error



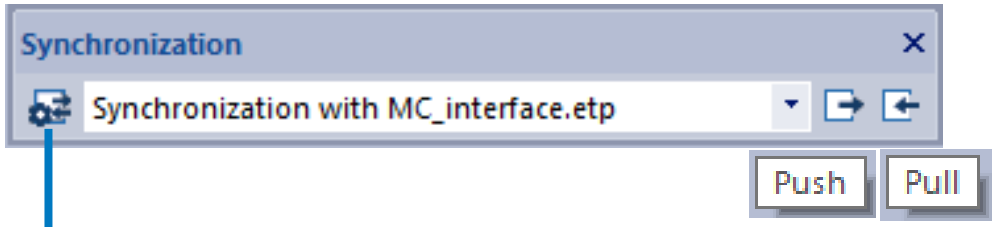




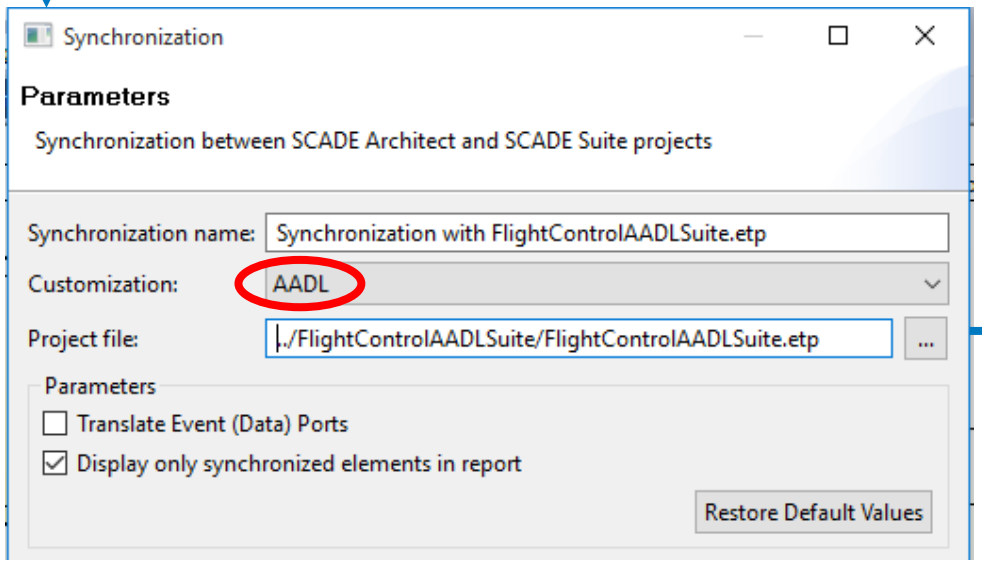
SCADE solution for AADL: Workflow to DO-178C certified code



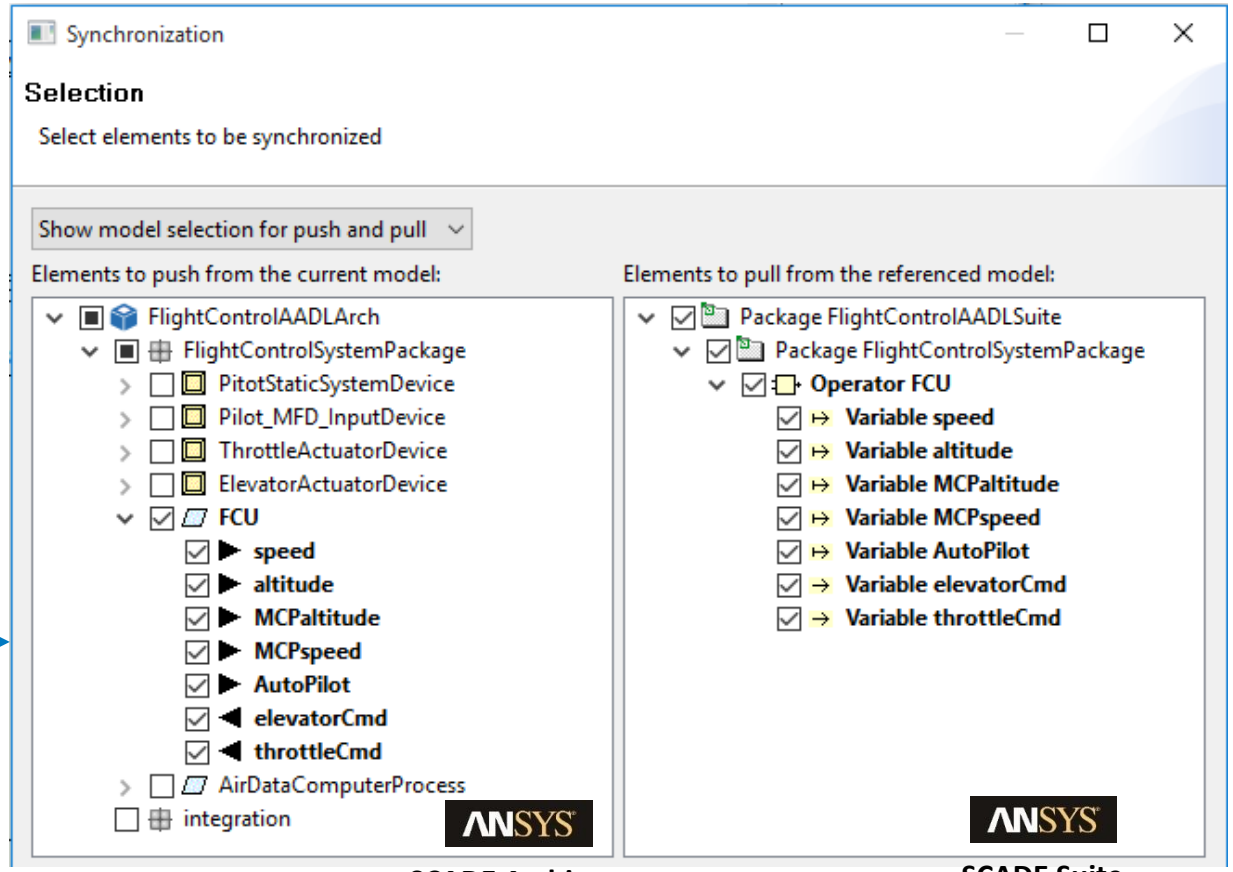
Synchronization ANSYS SCADE AADL – ANSYS SCADE Suite



1) Define synchronization settings



2) Select model objects to synchronize



SCADE Architect

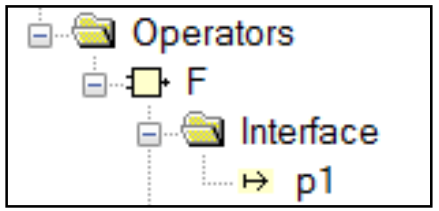
SCADE Suite

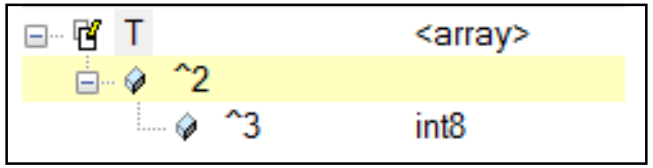
Synchronization ANSYS SCADE AADL – ANSYS SCADE Suite

```
subprogram F
  features
    p1: in parameter T;
end F;
data T
  properties
    Data_Model::Data_Representation => Array;
    Data_Model::Base_Type => (classifier (Base_Types::Integer_8));
    Data_Model::Dimension => (2, 3);
end T;
```

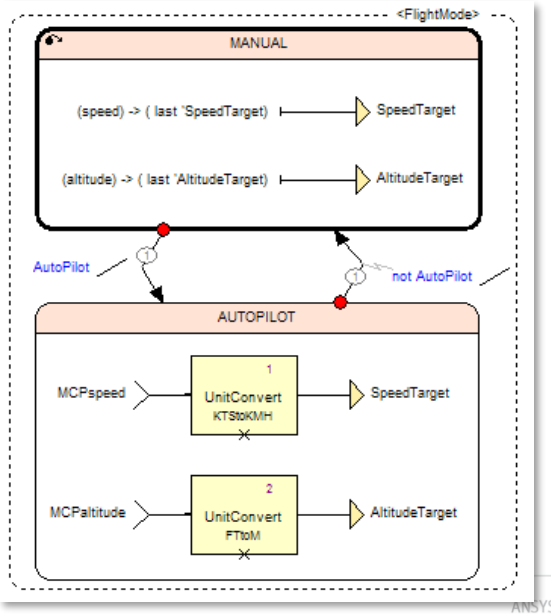
SCADE AADL

SCADE Suite



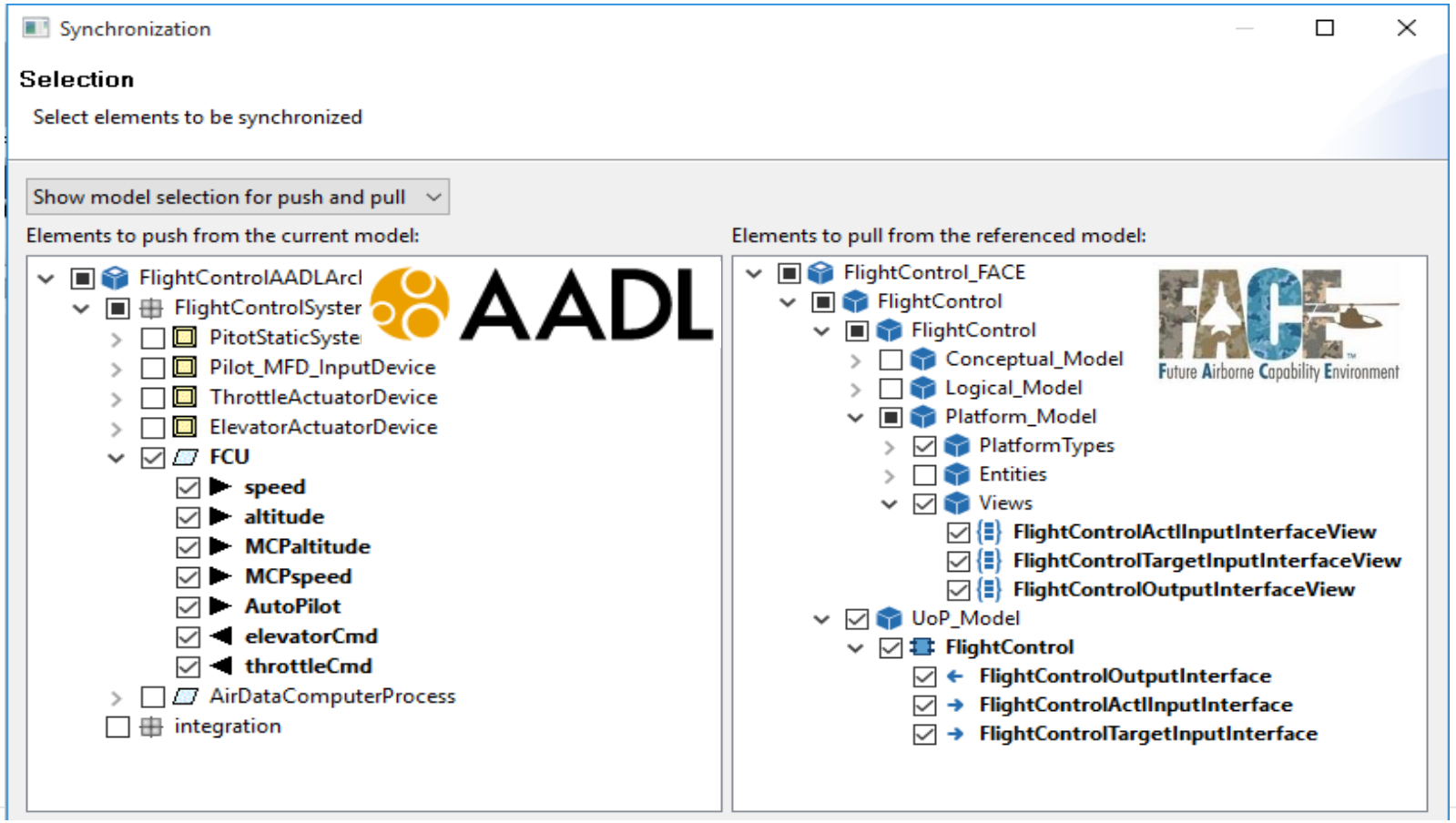


- Bi-directional synchronization
  - AADL threads, devices and subprograms with SCADE Suite operators
  - AADL data with SCADE Suite datatypes
- Behavior implementation in SCADE Suite
  - Simulation, certified C/Ada code generation,
  - Test procedures and model coverage with SCADE Test



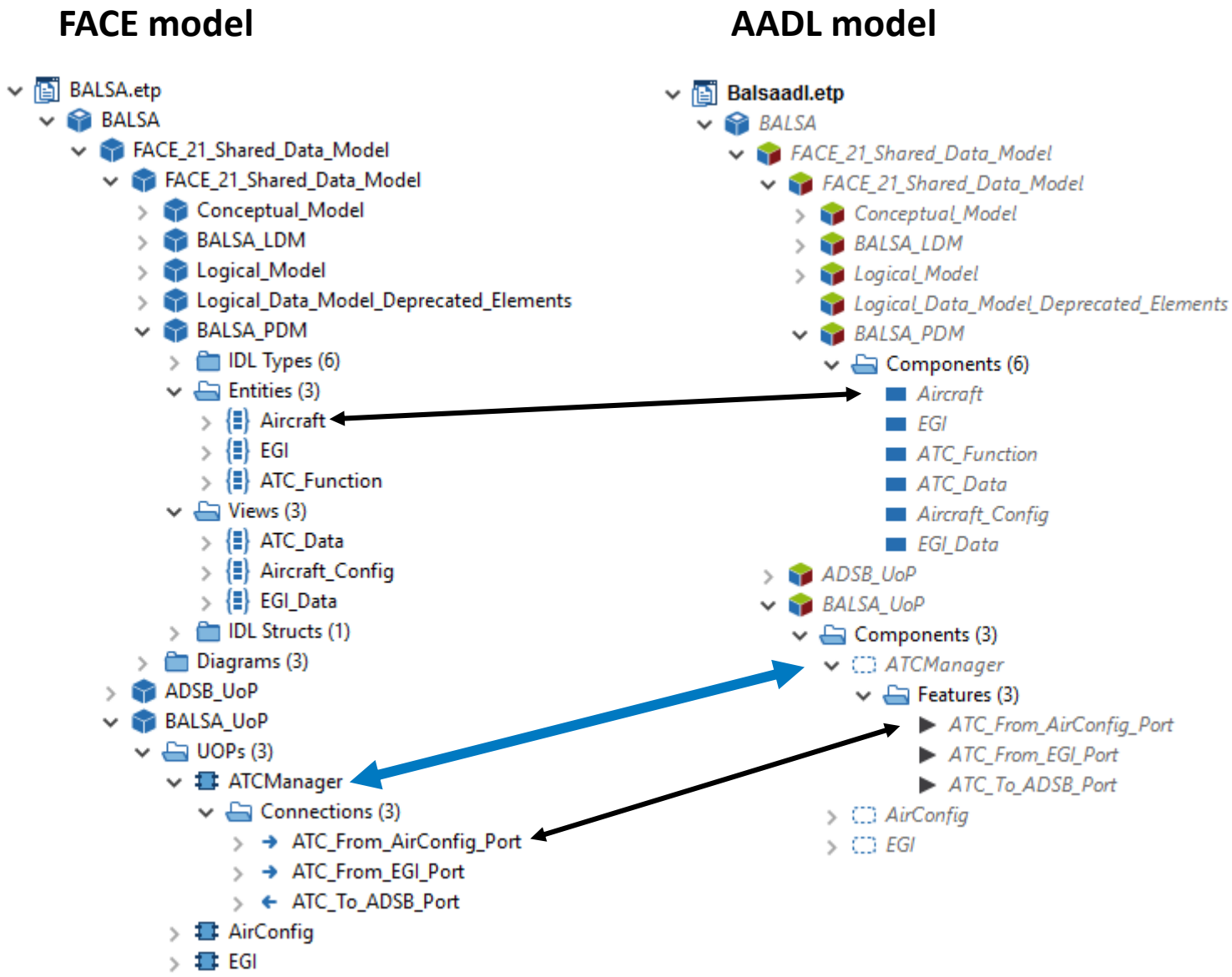
AADL - FACE models synchronization

- New AADL “FACE Annex”
- SCADE Architect AADL – FACE models synchronization



AADL - FACE models synchronization

- Implements the AADL "FACE annex"
  - AADL thread group ← → FACE UoP
- Bottom-up way
  - Allows for AADL systems analysis from existing FACE components
- Top-down way
  - Allows for FACE data model initialization from AADL software architecture specification



ANSYS SCADE solution for AADL - CONCLUSION

- Full compatibility with AADL v2.2 standard
  - Allows for legacy models import
  - Allows for export to third party analyzers
- Easy to use
  - Nice graphical interface & diagrams;
  - AADL expressiveness simplified
- Large ecosystem
  - Modeling SysML, AADL and FACE in the same IDE
  - Import/Export tables with Excel; Model API for scripting
  - Traceability to requirements management tools
  - Synchronization with SCADE Suite for SW component development, V&V, DO-178C certification

ANSYS SCADE solution for AADL - distribution

- Product packaging
  - Included in SCADE product installation.
  - Latest release: “SCADE 2019R3”
  - License “SCADE Avionics Package” and “SCADE AADL modeler”

- Sales manager: brian.rachele@ansys.com

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Thank you