AADL: Bindings and Resources

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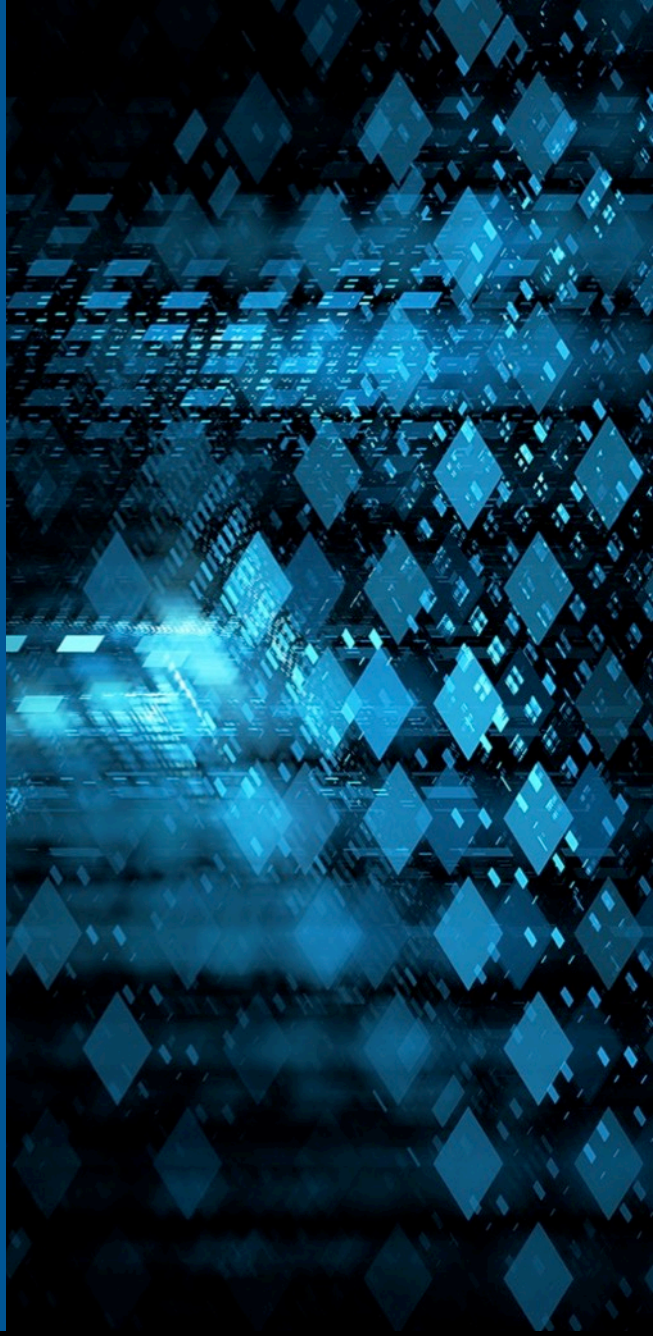

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Bindings between System Hierarchies

AADL supports a (primary) containment hierarchy

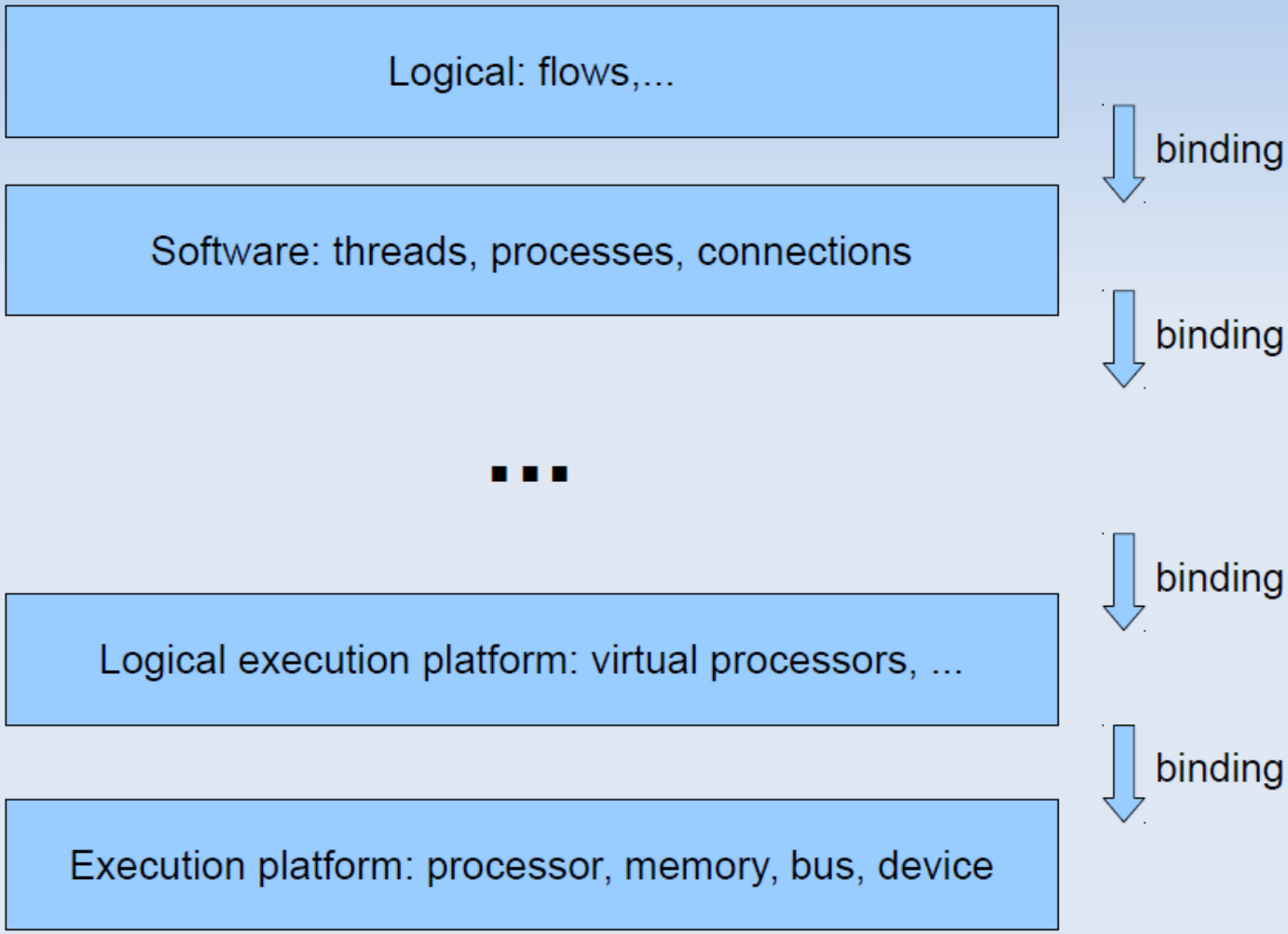
Semantic connections represent flow between and within subtrees

- Managed interaction complexity by requiring connections up and down the hierarchy to restrict arbitrary connectivity
- Note: for subprogram calls we offer both a connection and a mapping specification

Deployment bindings (aka. allocations) are a mapping from elements of one subtree to elements of another subtree

- The subtrees represent different virtual machine layers with the lower layer typically representing resources to the higher layer
- Bindings represent resource allocation

Multi Layer Architecture



Issues in Current Binding Approach

Bindings are currently expressed by properties

Binding related properties are not distinguishable from others

- Properties that express bindings
- Properties that relate to bindings

EMV2 propagation paths are derived from bindings

- binding points currently are identified by special keyword

Binding properties reach down the instance containment hierarchy

- A primary driver for introducing contained property associations

Resource Flow and Resource Allocation

Resource flow within an architecture: follows interface rules

- Continuous: Electricity, fluid flow, … Discrete: data samples, messages
- Directional flow with continuous characteristics: producer –> consumer
- Resource type represented as type (or abstract component type)
  - Annotations for discrete or continuous flow
- Fan out/in of flow “volume”
  - multiple features & multiple connections from one feature

Resource allocation/binding: Across different architecture layers

- Resource usage that needs to be allocated/scheduled
- SW to computer platform
- Logical to physical
- Resource capacity and demand as provides and requires features
  - Feature acts as binding point: resource type as classifier
  - Multiple

Binding Specification Proposal

Binding Types

Binding points

- Properties, constraints

Binding instances

- Specify source and target of binding

Binding Types

Define binding type

- User defined name, sets of source and target types

```
Binding ProcessorBinding : union( thread, thread_group, process) ->
union (  processor, virtual processor )
```

Predefined binding types

- *FunctionalBinding* to bind elements of a functional architecture to elements of a physical architecture.
- *ThreadBinding* to bind a thread to a processor, or to a virtual processor which in turn is the source of a processor binding to ultimately a processor.
- *CodeBinding* to bind source code associated with processes or threads to memory components.
- *DataBinding* to bind data components as well as source code data including stacks and heaps.
- *ConnectionBinding* to bind a connection to a flow sequence in hardware platform, or a virtual hardware platform whose elements are ultimately bound to a physical hardware platform.

Binding Instances

Deployment binding

- Binding source and target are components
  - Explicit binding type specification
  - Binding point identified by binding type

```
Configuration AS.deploymentconfig extends AS.systemconfig is
Binding1 : ThreadBinding binding Appsys.sub.proc.thread1 ->
platform.node.cpu1;
Binding2 : ProcessorBinding binding Appsys.sub.proc.thread2 ->
platform.node.cpu2;
```

Binding Point Specification

As **provides/requires binding** feature

- As abstraction for targets contained inside a system
- Similar to access features

One component can have multiple binding points

- Binding points of different types
  - Need/provision of different resources, e.g., at system level
- Binding points of same type
  - E.g., subsets of total resource capacity

Binding Point Specification

Explicit in features section:

- Directional features to be used as source or target of binding
- Identify type of binding
  - Binding type

```
thread task1 is
RequiredMemory: Requires binding Storage;
RequiredCycles: Requires binding Cycles;

System LinuxBox is
ProvidedDisk: Provides binding Storage;
ProvidedCycles: Provides binding Cycles;
end;

type Cycles : union (thread) -> union {processor, virtual processor };
```

Visibility of Binding Points

How far down can the allocation declaration reach

- Parameterized configuration as boundary for external use

Map binding point at configuration interface to component(s) in implementation that manage or represent resource

```
System ASplatform
ComputeCycles: provides binding #ProcessingCycles;
  Storage: provides binding #cache;
End ASPlatform;
ASplatform.boundconfig configures ASPlatform.impl {
ComputeCycles -> cpu,
Storage -> Cachememory
};
```

Connection Bindings

Currently: sequence of target elements

Connection acts as binding point

- Propagation identifies connection by name

```
connections
Conn1: port sub1.p1 -> sub2.p1 Requires XferBandwidth;
Conn2: abstract sub1.fe1 -> sub2.fe1 Requires WattsPerHour;
```

Platform flow sequence as binding target

- Expressed by end to end flow declaration
- Source and destination of ETE flow must match binding target of connection source and destination
- Each element of the flow has binding point of matching type

Virtual bus as binding target

- Virtual bus itself needs to be bound to a sequence of items => ETE flow

Flow sequence as closed platform configuration binding point

- How to expose platform internal ETEF as external binding point? => access to virtual bus that is bound to ETE flow

Qualified and Quantified Resources

Resource specification

- Via property on binding point or providing/requiring component
- Quantified via numeric type
- Qualified via enumeration type

```
thread task1
RequiredCycles: Requires binding Cycles {#Resources::ProcessingCycles => 200
MIPS;};
thread task2
RequiredInstructionSet: Requires binding IntelX86 {#Resources:: InstructionSet =>
X86;};


Processor IntelX86 is
  #Resources::ProcessingCycles => 1200 MIPS;
  #Resources:: InstructionSet => X86;

Property InstructionSet : enumeration ( X86, ARM, RISC) applies to Processor,
virtual processor, system, binding point;

Property ProcessingCycles : real units CycleUnits applies to Processor, virtual
processor, system, binding point;
```

Binding Type Multiplicity

1-to-n binding Alternatives (*):

- example – multiple cores

```
Binding MultiCoreBinding :
  union( thread, thread_group, system ) ->* union ( processor)
```

Bind to virtual processor (resource) or enclosing system:

- It schedules multiple cores