Bindings, Resources & Layers

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Bindings between System Hierarchies

AADL supports a (primary) containment hierarchy

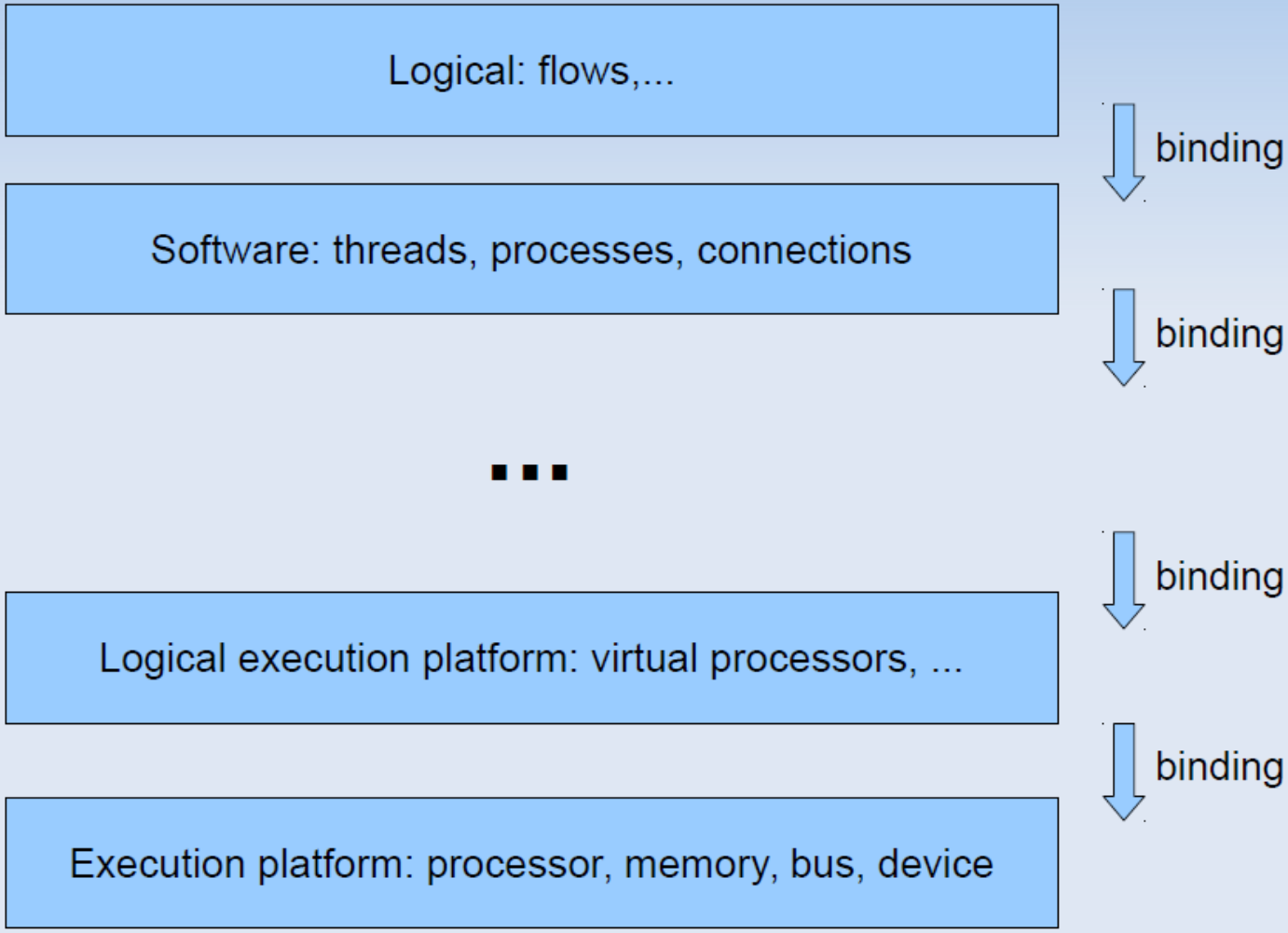
Semantic connections represent flow between and within subtrees

- 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 Level 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

- Electricity, fluid flow, …
- Directional flow with continuous characteristics: producer –> consumer
- Can be modeled with abstract (physical) feature and connections
- Resource type represented as type (or abstract component type)
  - Annotations for discrete or continuous behavior
- 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 points

- Properties, constraints

Binding instances

- Source and target configurations
- Deployment bindings aka allocations

Binding Point Specification

Explicit in features section:

- Named features to be used as source or target of binding
- Optional identification of type of binding (type of resource involved in binding
- Properties related to (resource) type: capacity/budget, other target characteristics
- Optional classifier(s) to restrict the type of target

```
thread task1
features
RequiredCycles: Requires ProcessingCycles;

Processor IntelX86
features
ProvidedService: Provides ProcessingCycles;

Virtual bus myprotocol
features
RequiredService: Requires Bandwidth of ProtocolX;
ProvidedService: Provides Bandwidth ;
```

Binding Point Specification

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
  - Provider: subsets of total resource capacity
  - Other characteristics: address range for memory, encryption

Binding related properties

- Number of acceptable bindings
  - Provider: multiple binding points and one per binding point
  - Requestor: multiplicity of resource providers
- Resource related
  - Provider: capacity per binding point & provider component
  - Requestor: demand(budget)
- Other characteristics

Binding Constraints

AADL V2 had constraint on classifier and instances

- (“Allowed_xx” property)

Constraint notation or special syntax?

- Classifier of provides and requires must match
- Constraint on category or classifier of target component
  - E.g., Processor type
  - as part of **requires**
- Constraint on source of binding
  - As part of **provides**
- Use of constraint language

```
thread task1
features
RequiredCycles: Requires ProcessingCycles of X86;
```

Binding Instances

- Declared as a system implementation
- Source and target declared as subcomponent
- Binding declared as connection

```
System implementation AS.deploymentconfig
Subcomponents
Platformlayer: system myplatform:Asplatform.config
Applayer: system myapp:ASApp.config;
Vplatform: system myvplatform;
connections
  b1: binding Appsys.sub.proc.thread1.RequiredCycles ->
node.cpu1.ProvidedService,
 c1: port Appsys.sub.proc.thread2.bp1 -> node.cpu2.bp2;
```

Binding Instances

- Binding of unchangeable source and target hierarchies (Configurations)
- Declared like a configuration
- Identifies and names source and target subtrees
  - Existing subcomponent vs. classifier to be instantiated

```
allocation AS.deploymentconfig
For TopSystem.App_Platform
-- For appsys: ASApp.config -> platform: myplatform.config
(
  Appsys.sub.proc.thread1.RequiredCycles -> platform.cpu1.ProvidedService,
  Appsys.sub.proc.thread2.bp1 -> platform.cpu2.bp2 );
```

Partial and Nested Bindings

Partial binding configurations

- Partially configured source and target system
  - Only for those elements that have been configured
- Subset of elements are bound
  - Bindings cannot be overridden

Configurations with binding points

- System may make part of its resources externally available, e.g., camera provides some of its processing capacity for a user plugin
- System may have some driver software that needs to run on an external resource

Visibility of Binding Points

How far down can the allocation declaration reach

- Configuration as boundary
- Processor, memory, bus as boundary

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

- To do

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;
```

Binding target options:

- end-to-end flows in next/platform level
- sequence as binding target

Flows and Connection Bindings

End-to-end flow across virtual and hardware platform elements

- 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

Binding Multiplicity

Types of multiplicities

- Alternatives: one of x
  - Statically chosen: binding point specifies choices: multiple classifiers
- Scheduling over multiple
  - On one or on one at a time is a scheduling issue
  - Virtual processor (scheduler) responsible for scheduling multiple resources
- Static allocation
  - Partial allocation: multiple bindings each with percentage
  - Replicated allocation: multiple binding targets

- Sequence: ordering, same demand on all elements of sequence
  - If needed we would introduce a property on the binding to indicate the type

Binding of Ports Across Layers

Processors provide ports and subprogram access

Processor features

Portx: **provides** **in data port** DT;

Applications declare processor port proxies in the processor features section of an implementation.

Move to features section of type

Portx: **requires** **in data port** DT;

Actual binding

- Once a binding of the application to the processor is specified a “connection” between the application level and the platform level is inferred by name matching of port
- Do we need to separately define the binding of the two or keep inferring?

System Layers (Levels) and Binding

Currently:

System contains multiple subcomponents

Binding between elements of two subcomponents that represent two layers

Semantics of Layer, Platform, Level, Tier

Restriction on accessing only same or lower layer(s)

- **Direct**
- **More than one layer**

Multi tier (aka level)

Abstraction layers (data, function : libraries)

Virtual machine layers (p-code, OS services)

OSI Layers

GOA Platform, Layer (System , Logical and Physical Resource)

Examples

Software libraries

- **Represent API to common services**
- **Shared vs. separate instances**

Multi-tier architectures

- Tiers as layers
- Each tier has SW and HW layer vs. SW tiers mapped to HW layer

OS modularity & Layers

- Memory mgnt
- Process mgnt

System and Task hierarchies

- Physical: Aircraft, brakes, engines (SAVI Tiers)
- AADL hierarchy: system, process, thread
- Control system hierarchy
- SW task hierarchy