Arrays in AADL

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V2 Array Support

We have

- multi-dimensional arrays for components
- single dimension for features
  - Intended for components like voters
  - Feature arrays only at the leaves of the component hierarchy
- Users can specify the dimensions and later add each dimension size via refined to
  - Sizes can be supplied by property constant or as numeric value
- Arrays at different levels of the component hierarchy
- Array declarations at different levels of the hierarchy result in multi-dimensional instance arrays for the leaf components
  - We configure connection instances for resulting arrays in instance model
- Currently array dimensions not reflected in enclosing interface features
  - We do reflect feature aggregation as feature group

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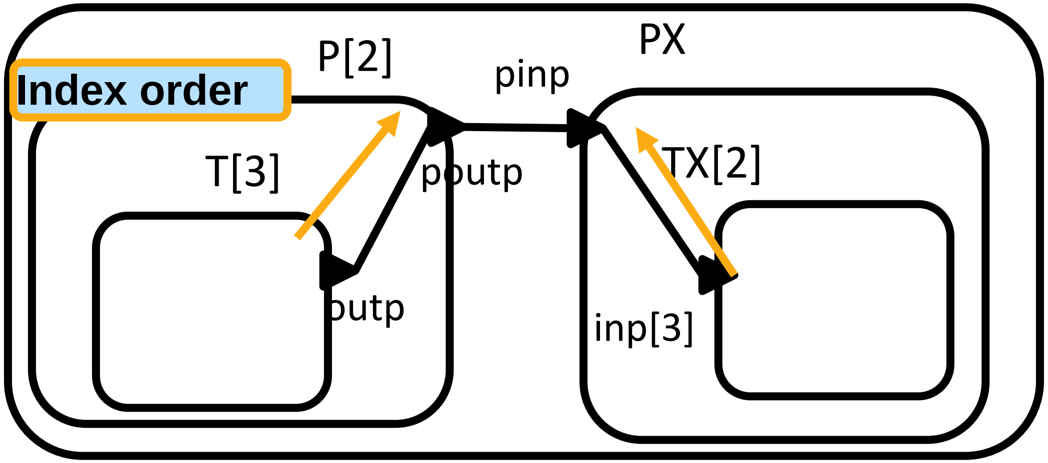
Connection Instances and Arrays



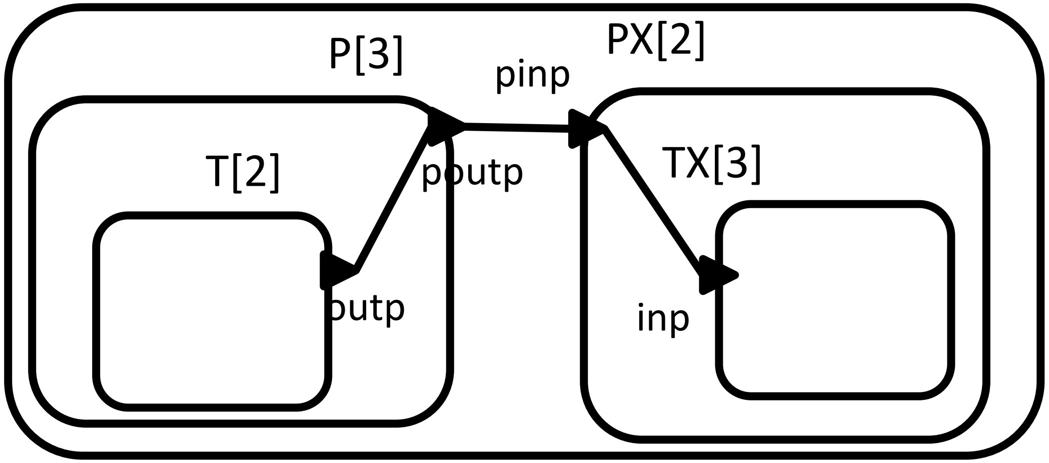
For P.T.outp [3][2] -> PX.TX.inp[3][2]

[1,1] => [2,1]
[3,2] => [1,2]

For P.T [2][3] -> PX.TX[3][2]

[1,1] => [1,1]
[2,1] => [1,2]
[3,1] => [1,3]

Swapped dimensions



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Exposing Dimensions in Interface

Approach

- Expose externally visible dimensionality through interface
- Allows for connection declarations for specific array elements

Similar to exposing feature grouping in interface

- Desire to connect elements within nested feature groups at the top level connection

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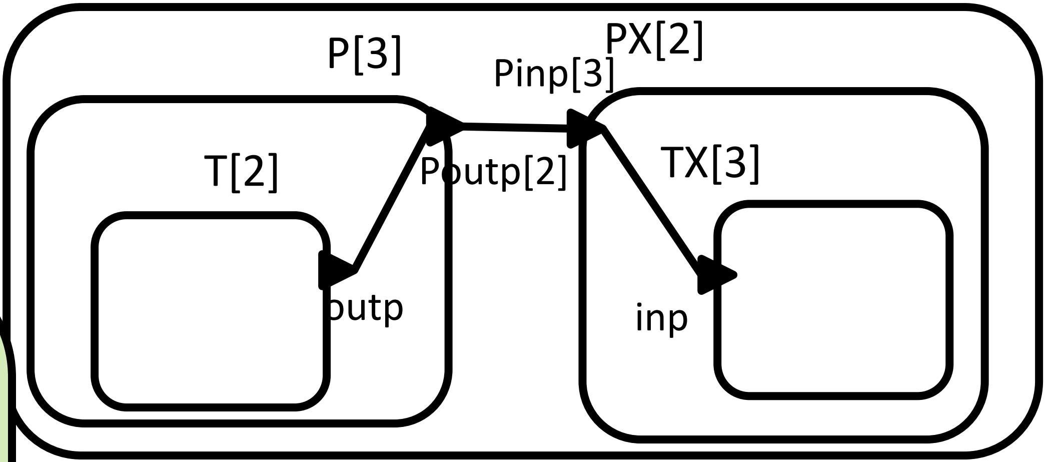
Expose Inner Dimensions as Feature array dimension

```
System p
Features
Poutp: out event port [2]
```

```
System px
Features
Pinp: in event port [3]
End px;

System implementation px.i
Subcomponents
Tx: system tx[3];
Connections
 pinp[1] -> Tx[1].inp;
 pinp[2] -> Tx[3].inp;
 pinp[3] -> Tx[2].inp;
Or
Pinp[] -> Tx[].inp; -- one-to-one
```

Up/down connection is one to one as default



```
System implementation top.i
subcomponents
 p: system P[3];
Px: system PX[2];
Connections
C1: p[1].poutp[2] -> px[2].pinp[1];
Or
Cx: p[k].poutp[j] -> px[j].pinp[k];
```

Cross connection flips dimensions

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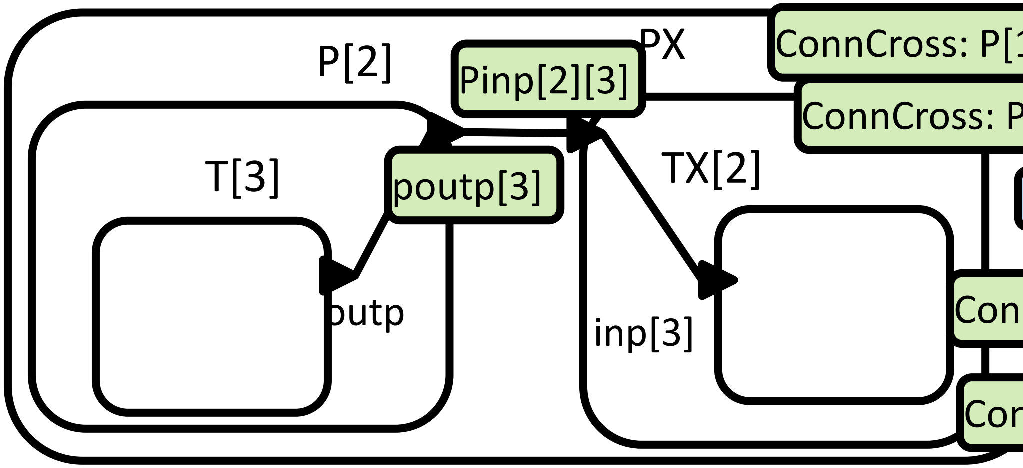
Connection Instances and Arrays



ConnCross: P[1].poutp[2] -> PX.Pinp[1][2]

ConnCross: P[].poutp[] -> PX.Pinp[][]

Left to right dimension order

Conndown: pinp[1][2] -> TX[1].inp[2]

Conndown: pinp[][] -> TX[].inp[]

Need for specifying dimensions in connections representing the whole array?

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Connection Index Mapping

Inline index mappings

- Option 1: Individual connection declarations:

```
Conn1: port sub1.lfea1[1,2] -> sub2.rfea1[2,1];
Conn2: port sub1.lfea1[2,1] -> sub2.rfea2[1,2];
```

- Option 2: mapping inline with interface connection:

```
Conn1: port sub1 -> sub2
       {[1,2] == [2,1], [2,1] == [1,2]};
```

Reusable index mapping for connections between different instances of the same source and target

```
map1: mapping
[1,2] == [2,1], [2,1] == [1,2]
end mapping ;
```

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Connections on array subsets

Systems as arrays

```
 Src: system s[10];
 Dst1: system a[3];
 Dst2: system b[7];


 Conn1: Src[1..3].p -> Dst1[1..3].p ;
Conn2: Src[4..10].p -> Dst2[1..7].p ;


 Map1: Src[1..3].p -> extp1[1..3] ;
Map2: Src[4..10].p -> extp2 [];
```

If mapped to whole array allow []?

Connection Patterns

Applicable to Cross connections

- Same as in V2: pattern across all dimensions
- One-to-one, all-to-all, next, previous: within a dimension
- Changing dimension order (e.g., first to second & vice versa)

Dimension index or label plus pattern

Applicable to up/down connections

- Primary pattern: one-to-one
- Change in dimensionality: X[10].p == outerp[5][2]

What up/down mapping patterns make sense without making it overly complex? One-to-many, many-to-many, etc.?

Configuration of Array Sizes

- Configuration of array sizes

```
System implementation top.design
subcomponents
Sub1 : system S[];
Sub2 : system S[];

top.config configures top.design
( Sub1 => [10] ,
Sub2 => S.impl[15]);
```

Dimensions are declared for subcomponents and features

Sizes are configured in for existing classifier

Sizes are configured in together with specific classifier

Parameterized Configuration of Array Sizes

- Configuration of dimensions

```
System top
Features outp: out data port[2][];
```

Example with one dimension size already set

```
System implementation top.design
subcomponents
Sub1 : system S[];
Sub2 : system S[];
```

Internal subcomponent arrays mapped into feature array

```
connections
C1: port Sub1.outport[] -> outp[1][];
C2: port Sub2.outport[] -> outp[2][];
```

Acceptable values within range
Also allow power of 2(?): 2^(2..10)

```
top.config(copies: integer 2..10) configures top.design
( outp => [][copies],Sub1 => S.impl[copies] , Sub2 => S.impl[copies]);
```

Use in subcomponents

```
Topsub: system  top.config( copies => 5);
```

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Parameterized Configuration of Array Sizes

- Configuration of classifier and size

```
top.config1(mysub: system s, copies: integer 2..10) configures
top.design
```

```
( outp => copies, Sub1 => mysub[copies] , Sub2 => mysub[copies]);
```

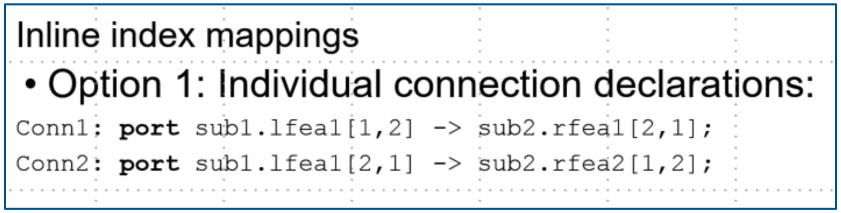
Use in subcomponents

```
Topsub: system  top.config( s.i, copies => 4);
```

Index-based Array Connections Revisited

How does this work when we have parameterized dimension sizes?

- Once the sizes are configured users can associate an index mapping as part of the configuration
  - Conn1: `{[1,2] == [2,1], [2,1] == [1,2]}`
- algorithmic specification operating on size parameters
  - Bren was going revive such a proposal



Inline index mappings

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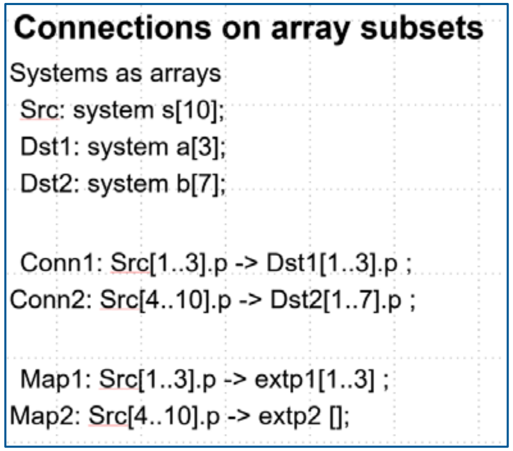

Connections on array subsets

Systems as arrays

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