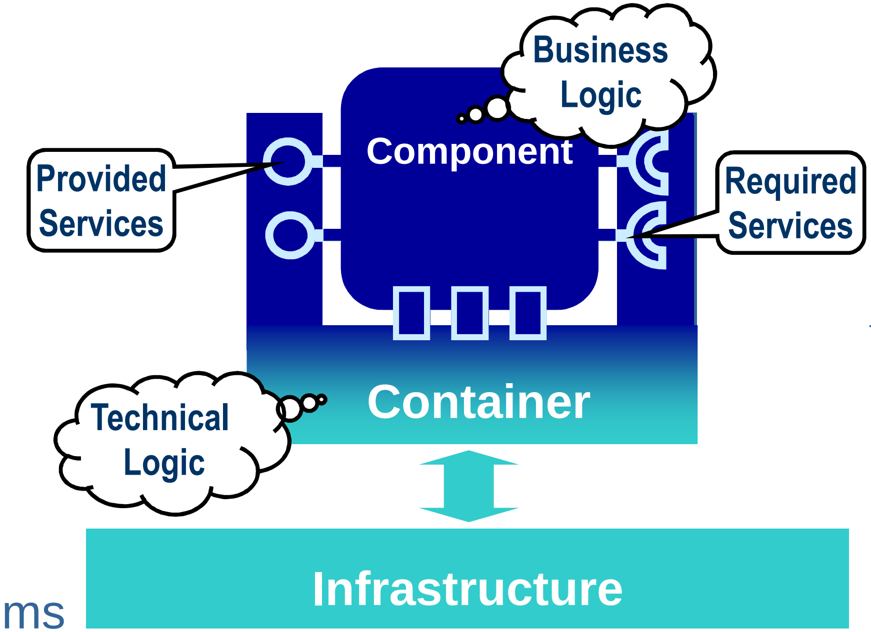
THALES

DDS for LwCCM
March 2013

virginie.watine@thalesgroup.com

Component Model =

- A generic packaging format
  - Deployment and configuration external to the application
- Ports to describe
  - Provided & required "services"
    - In initial CCM: facets & receptacles event sinks & sources
    - Other interactions useful for RTE systems
  - ➔ *Explicit dependencies*



- Separation of concerns between business logic (components) and "technical" logic (containers)
  - Containers to be provided by the framework and configured
    - Providing technical support adapted to the domain
    - Mediators with the underlying platform
  - ➔ *Explicit dependencies*

➔ *All dependencies explicit ➔ reuse & fast integration*

<<This RFP solicits submissions for an extension of the current LwCCM to include data distribution using DDS>>

Specification in two parts:

- Definition of a Generic Interaction Support (GIS)
  - Results in Extended Ports and Connectors
- Application of the GIS to DDS
  - Results in DDS Extended Ports and Connectors

Rationale for this two-parts proposal

- Interaction support is the key enabler for component definition
  - Many interaction kinds are relevant - Notably, but not only, DDS
- GIS to allow further extensions with no additional changes
- GIS to favour consistency of the new ports definition

Extended Ports and Connectors

- Generic support for new component interaction

Application to DDS

- DDS/DCPS extended ports and connectors
- DDS/DLRL extended ports and connectors

Conclusion

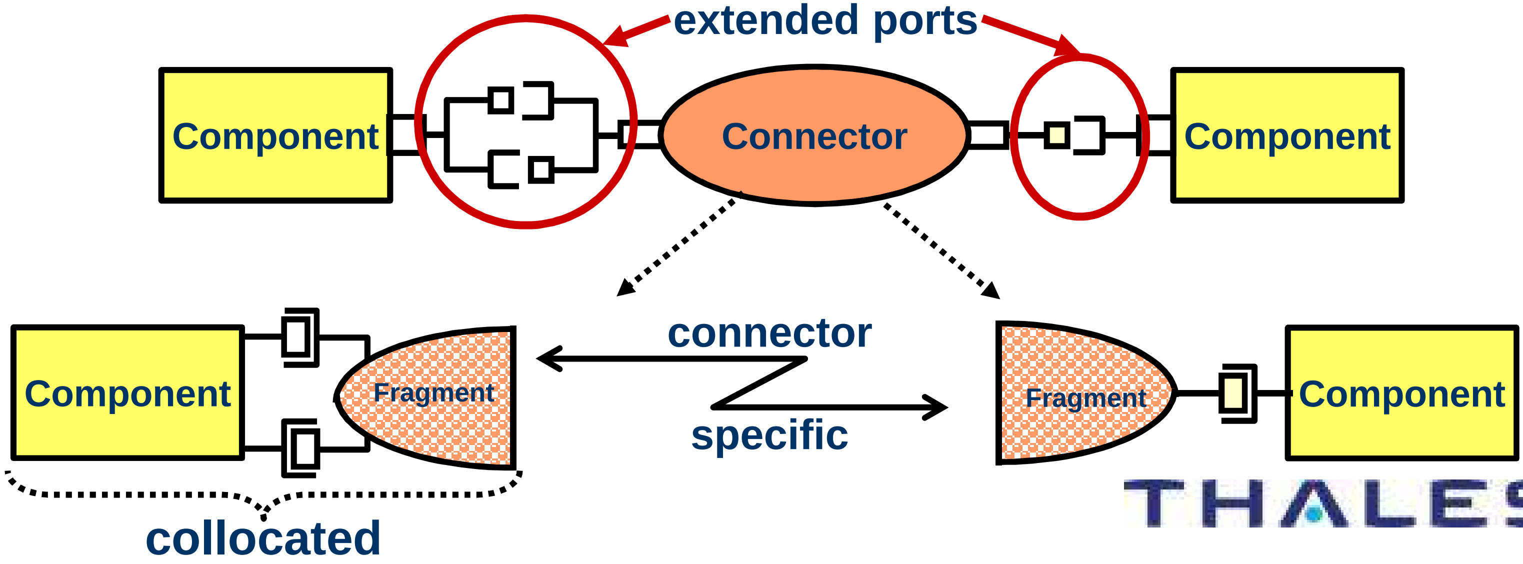
DDS4CCM / GIS: Extended Ports and Connectors

Generic support for new component interactions

- *Connector* = conceptual interaction entity between components
  - Actual connection may be explicit or implicit (e.g., via DDS)
- A Connector is made of several fragments:
  - Each fragment = part of the Connector implementation co-located with a component
- *Extended Port* = how the Component interact with its Connector fragment
  - Is made of 0..n provided facets ("*provides*") combined with 0..n required receptacles ("*uses*")

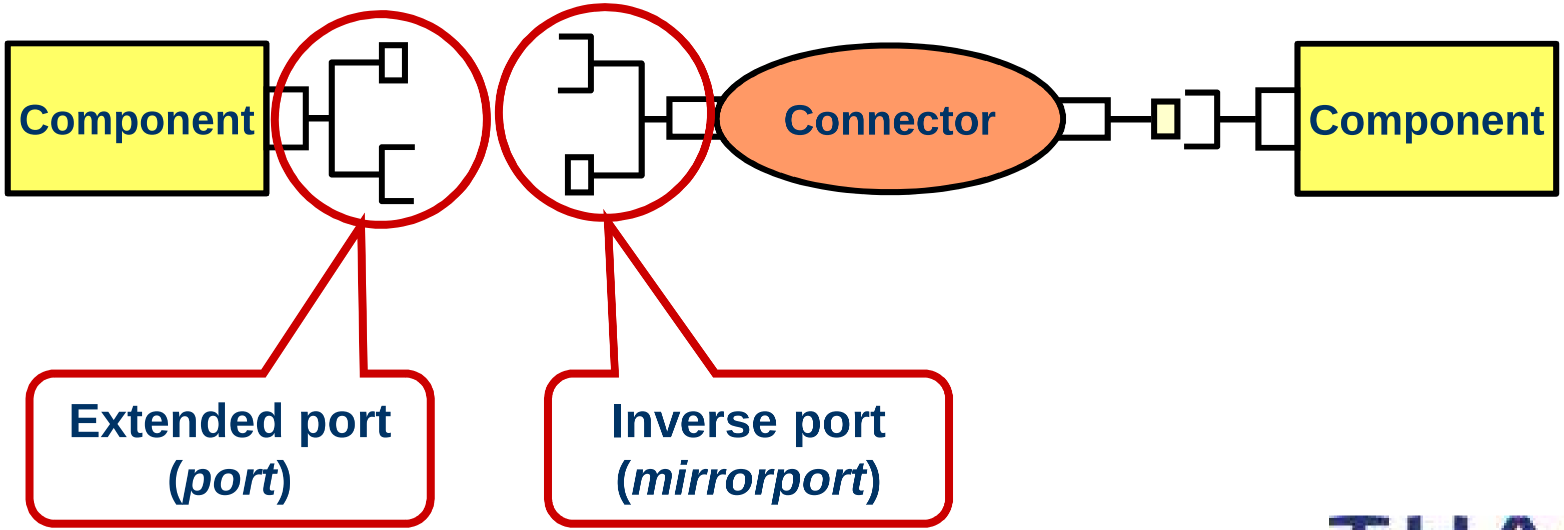
From conceptual view...

...to realisation



New keywords introduced to:

- Define a new port (***porttype***)
- Declare an port for a component (***port***)
- Declare an inverse port (***mirrorport***)
  - An inverse port is the “mirror” of an extended port
    - All *uses* translated to *provides* and vice-versa
  - Inverse ports are very useful at least for connectors



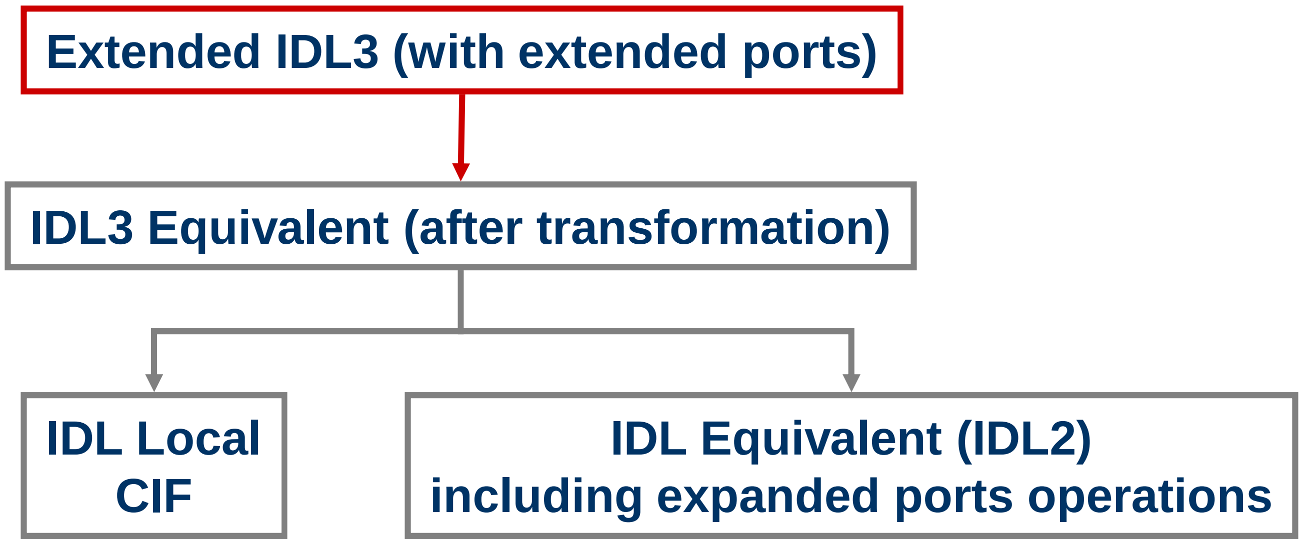
Example:

```
// interfaces
interface Pusher {
     void push (in TheDataType data);
     };
interface PushControl {
     void suspend ();
     void resume();
     readonly attribute long nb_waiting;
     };

// port type definition
porttype ControlledPusher {
     provides Pusher          pusher;
     uses PushControl         control;
     };

// Component declaration with a port
Component C {
     port ControlledPusher the_port;
     };
```

Extended IDL3 can be easily translated in plain IDL3

- With simple transformation rules
  - Example:

```
Component C {
     provides Pusher          the_port_pusher;
     uses PushControl         the_port_control;
     };
```



New keyword to declare a Connector

- Connector declaration (***connector***) similar a component declaration
  - Example

```
connector cnx {
        mirrorport ControlledPusher   controlled_push;
        provides Pusher               raw_pusher;
        };
```

This declaration:

- Is not translated in the plain IDL3 (does not affect the components)
- Is used to provide type information at the assembly level

Connectors == Composite components

- Connector fragments = plain basic components

At assembly level:

- Connectors are seen as connection entities between components
- Fragments do not appear
- Only connections between extended ports are described

At deployment level:

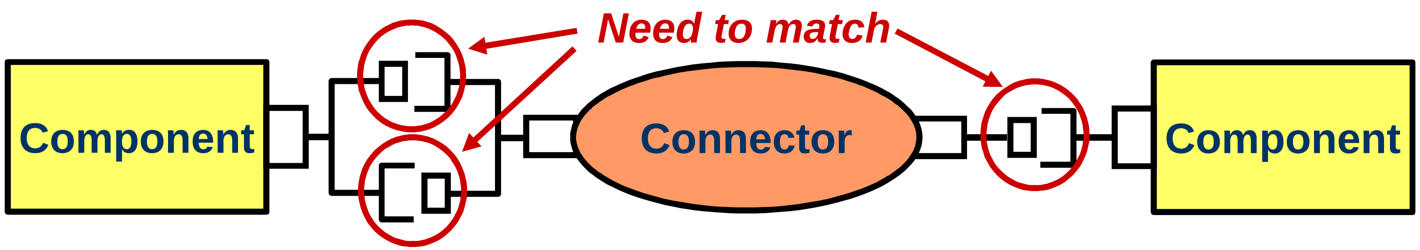
- Connectors are flattened in fragments *(exactly as composite components are substituted by their included components)*
- Fragments are part of the CDP (shall be generated at planning phase)
- Basic connections (facet to receptacle) are described

All the new constructs may be parameterized

- Parameterization very useful to capture generic interaction semantics
  - Example: a **`ControlledPusher`** valid for any data type and not only **`TheDataType`**

Parameterization placed at module level (template modules)

- Modules are the only grouping constructs in IDL
- Always needed to group in the same template scope port types and connectors (as they need to result in matching instantiated interfaces)



- No need for naming conventions for instantiated types
  - (in line with other IDL practices)

Parameterization: What can be Templated?

Modules

- With the following restrictions
  - A template module cannot embed a template sub-module
    - Rationale: would result in in over-complication
  - A template module cannot be re-opened
- Means that all embedded constructs are de facto templates
  - With the consequence that they are in the same template space
    - Embedded modules can provide structuring if needed

Only modules

- Template modules are required for GIS
  - Interfaces “used” or “provided” through extended ports are required to be the same as the ones “provided” or “used” through connectors
- Template modules are easier to add to existing IDL definition
  - Looks as an extension rather than as a revolution
- Template modules offer all the needed flexibility
  - All embedded constructs are de facto parameterised

One to many formal parameters

Type of formal parameters can be:

- Any type
  - introduced by **`typename`**
- Some more restricted:
  - **`interface`**, **`valuetype`**, **`struct`**, **`union`**, **`exception`**, **`enum`**, **`sequence`**
- Const primitive types
  - **`const`** { [**`unsigned`**] **`short`**, [**`unsigned`**] **`long`**, [**`unsigned`**] **`long long`**, **`string`**...}
    - Purpose is to allow passing any constant
- **`sequence`**<T>
  - with T being a previous formal parameter
    - The concrete parameter will have to be a previously instantiated sequence<Foo> (assuming that instantiation is created for T = Foo)

Two steps:

- Definition of the template ➔parameterized types
- Instantiation with concrete parameters ➔concrete types

Instantiation rules

- Explicit instantiation required for the template module
  - Explicit instantiation required to allocate a name
  - No on-the-fly instantiation, that would result in an anonymous type
    - rationale: compliance with current IDL strategy regarding template instantiations (anonymous types proven difficult to map in some languages)
- Explicit instantiation of the module ➔instantiation of the embedded/referenced constructs
  - The embedding structure (module instantiation) provides a namespace that isolates the implied instantiations (no other name required)
    - Embedded constructs
    - Referenced template module (see below)

Templates: Syntax as Simple as Possible (1/2)

Template definition

module template-name < {parameter-type formal-parameter}+ > {...}

- parameter-type =
  - typename
  - interface, valuetype, struct, union, exception, enum, sequence
  - const any-primitive-type
  - sequence<a-previous-formal-parameter>
- Example
  - **module MyTemplateModule<typename T> {...}**

Template instantiation

module template-name **<** {parameter}+ **>** instantiation-name;

- Example
  - **module MyTemplateModule<Foo> MyFooMod;**
- Rationale:
  - moduledef is already used in the IFR definition (ModuleDef)
  - typedef would be confusing (it does not provide a type)
  - No new keyword

THALES

Templates: Syntax as Simple as Possible (2/2)

Template reference

- It is sometimes needed to reference an externally defined template module inside another one and to give it a name
  - Purpose is to reuse definitions
  - Constraint: the formal parameters of the referenced template module have to be a subset of the formal parameters of the referencing one
- Instantiation will be performed when the referencing template is instantiated
- Syntax

alias template-name **<** {formal-parameter}+ **>** alias-name;

  - alias-name can be identical to template-name
- Example:
  - `module MyTempModule <typename T1> {...}`
  -
```
module MySecondTempModule <typename T1, typename T2>{
  alias MyTempModule<T1> MyTempModule;
  ...}
```

Generic Interaction Support provides great flexibility

- By decoupling the programming contract from the actual interaction
- By allowing definition of new interactions without further changes in CCM and D&C

GIS may support sophisticated interactions

- As programming contracts, Extended Ports may combine freely basic facets (caller) and receptacles (callee)
- As interaction artefacts, Connector Fragments are restriction-free

It reuses as much as possible from CCM and D&C

- Extended Ports benefit from the CIF unchanged
- Connectors are plain composite components wrt D&C

Integrated in CCM since v3.2
(Template modules could be used for many other purposes)

Extended Ports and Connectors

- Generic support for new component interaction

Application to DDS

- DDS/DCPS extended ports and connectors
- DDS/DLRL extended ports and connectors

Conclusion

Apply Separation of Concerns also to DDS

- Keep the business code apart from the "technical" code
  - For DDS, means externalising the creation and configuration of the DDS entities
- Integrate DDS configuration in the general D&C scheme

Simplify the use of DDS

- Easy “out of the box” DDS operation
  - No entity creation / configuration burden
  - Simpler API
- Easy and secured QoS setting

What should be avoided

- Performance degradation
- Usefulness degradation

Identify most commonly used DDS patterns

A DDS pattern =

- A set of roles
- Their related DDS entities and how they are to be used
- Their related QoS settings (QoS profiles)

Examples of patterns:

- State (Observer / Observable)
- Event (Supplier / Consumer)
- Continuous Data (Supplier / Consumer)
- Alarm (Activator / Handler)
- WatchDog (WatchDog / Monitor)
- Consensus (Participant)
- LoadBalancing (LBServer / LBClient)
- ...

Patterns → Ports, Connectors,Configuration, etc.

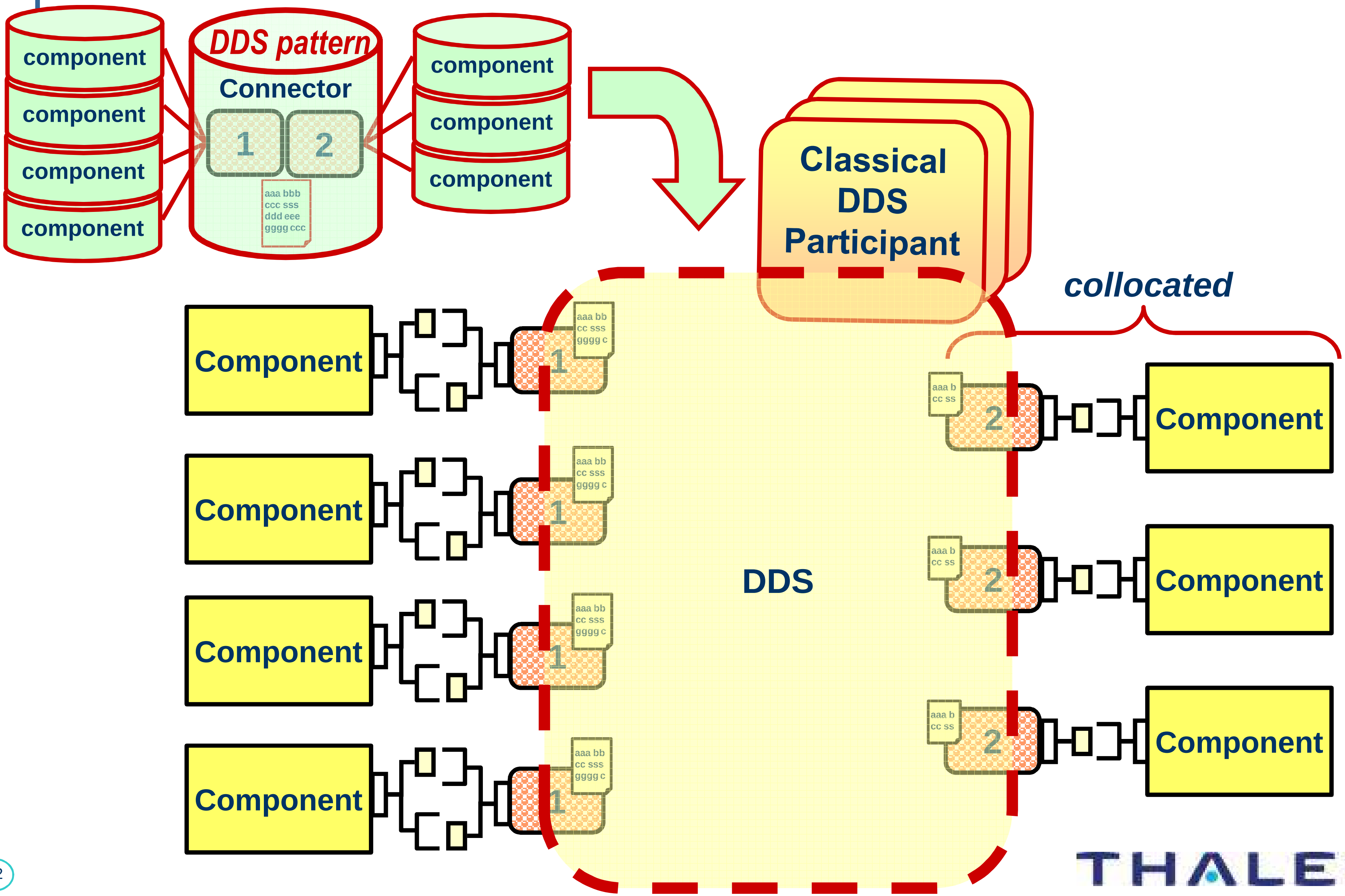
One Role should be supported via (only) one Extended Port

- But no need for a different port type per role
  - One port = one programming contract
    - Usually linked to one Topic (parameter), but several Topics could be handled
  - Variability points:
    - Read or write
    - One or Many data instances......

Connector Fragments correspond to Roles:

- Hide related DDS entities and implementation logics (ex: take vs. read)
- Configured by means of an integrated consistent QoS Profile (expressed in XML)
- All the roles of a given pattern can be gathered in a Connector
  - Does NOT imply physical connection between the components
  - Helps logistics

Connector =/= Physical Connection



THALES

DDS Normative Ports and Connectors

Following those principles, a very huge set of ports could be defined

DDS4CCM standardises:

- A set of DDS/DCPS Ports
  - Covering all sensible programming contracts involving one Topic
- Two very typical DDS/DCPS patterns
  - State Transfer & Event Transfer
- Optionally, a composition rule to define DDS/DLRL ports and connectors

Nothing prevents to create other DDS ports and/or connectors in order to implement other DDS use patterns

- In particular, by reusing some standardised interfaces

DDS/DCPS Port IDL Definition - Rules

DDS ports made of several 'basic' ports

- One basic port by '*area of functionality*' X '*interaction direction*'
  - Areas of functionality:
    - data access
    - status access
    - DDS entity access
  - Interaction direction = whether the component invokes (*uses*) operations on the fragment or *provides* a callback to the fragment

Parameters as simple as possible:

- Simplified ReadInfo to accompany data values
- Use of port attributes to capture recurrent operation settings
- Exceptions to report errors

DDS-DCPS ports and connectors meant to be parameterized by one data type (the one of the related Topic)

All are grouped in one module, with a template sub-module for the part specific to the data type:

```
module CCM_DDS {
    // declarations that are not T specific
    module Typed <typename T, sequence<T> Tseq> {
        // declarations that are T specific
        // sequence<T> to be provided at instantiation
        }
    }
```

```
module CCM_DDS::Typed<Foo, FooSeq> FooPorts;
```

➔ Note : **`sequence<T>`** provided by the application so as not to create a new type

THALES

DDS/DCPS Basic Port Interfaces

Data Access – Writer Side

- Writer — when the instance lifecycle is not a concern
- Updater — when the instance lifecycle is a concern

Data Access – Reader Side

- Reader — to just read the data
- Getter — to wait for fresh data
- Listener — to be notified of a fresh value of an instance whose lifecycle is not a concern
- StateListener — to be notified of instance state changes

Other interfaces

- InstanceHandleManager — root for Writer and Updater
- DataListenerControl / StateListenerControl
- PortStatusListener / ConnectorStatusListener

DDS/DCPS Extended Ports (1/2)

Writer Side

```
porttype DDS_Write {
    uses Writer                     data;
    uses DDS::DataWriter            dds_entity;
    };
porttype DDS_Update {
    uses Updater                    data;
    uses DDS::DataWriter            dds_entity;
    };
```

Reader Side

```
porttype DDS_Read {
    uses Reader                     data;
    uses DDS::DataReader            dds_entity;
    provides PortStatusListener     status;
    };
porttype DDS_Get {
    uses Reader                     data;
    uses Getter                     fresh_data;
    uses DDS::DataReader            dds_entity;
    provides PortStatusListener     status;
    };
```

DDS/DCPS Extended Ports (2/2)

Reader Side – ctn'd

```
porttype DDS_Listen {
    uses Reader                    data;
    uses DataListenerControl       data_control;
    provides Listener              data_listener;
    uses DDS::DataReader           dds_entity;
    provides PortStatusListener    status;
    };
porttype DDS_StateListen {
    uses Reader                    data;
    uses StateListenerControl      data_control;
    provides StateListener         data_listener;
    uses DDS::DataReader           dds_entity;
    provides PortStatusListener    status;
    };
```

Note that all the reader side extended ports comprise a Reader to set the read context and perform the init phase

State Connector

```
connector DDS_State : DDS_TopicBase {
    mirrorport DDS_Update          observable;
    mirrorport DDS_Read            passive_observer;
    mirrorport DDS_Get             pull_observer;
    mirrorport DDS_Listen          push_observer;
    mirrorport DDS_StateListen     push_state_observer;
    };
```

Event Connector

```
connector DDS_Event : DDS_TopicBase {
    mirrorport DDS_Write           supplier;
    mirrorport DDS_Get             pull_consumer;
    mirrorport DDS_Listen          push_consumer;
    };
```

Same objectives...

- Simplify programming
  - No entity creation / configuration burden
  - Simpler API
- Easy and secured QoS setting, in the general D&C scheme

...But a different realisation

- DLRL offers plain object manipulation that interfaces under the scene with DCPS operations → very simple
- DLRL supporting entities to be created by the Connector fragment
  - Object Homes and Cache
- All topics used by a DLRL Cache are to be managed consistently
  - To be grouped in a single DDS/DLRL Extended Port
- A fixed set of DLRL ports and connectors cannot be designed
  - Instead basic building blocks and a composition rule

DDS/DLRL Ports and Connectors (1/2)

DLRL Extended Port

- Should give access to all related objects
- Comprises:
  - A receptacle for each ObjectHome
  - Another receptacle for Cache functional operations
    - I.e, excluding all the operations that are related to configuration (thus will be for the only use of the Connector implementation)

DLRL Connector

- Natural support to gather all the DLRL extended ports related to the same set of topics in order to master their configuration system-wide
- Could provide as many mirror ports as there are DLRL participants to this set of topics
  - Nothing prevents several DLRL participants to share the same object model, thus the same DLRL port

DDS/DLRL Ports and Connectors (2/2)

Example

- A DDS/DLRL Extended Port

```
porttype MyDlrlPort_1 {
   uses DDS_CCM::CacheOperation cache;
   uses FooHome                 foo_home;// entry point for Foo objects
   uses BarHome                 bar_home// entry point for Bar objects
   };
```

  - DDS_CCM::CacheOperation is a subset of DDS::Cache
  - FooHome and BarHome are provided by the DLRL tooling

- A DDS/DLRL Connector

```
connector MyDlrlConnector : DDS_CCM:DDS_Base {
   mirrorport MyDlrlPort_1 p1;
   mirrorport MyDlrlPort_2 p2;
   mirrorport MyDlrlPort_3 p3;
   };
```

  - Inherits from DDS_Base to be given a ConnectorStatusListener and to set domain id and QoS profile

Extended Ports and Connectors

- Generic support for new component interaction

Application to DDS

- DDS/DCPS extended ports and connectors
- DDS/DLRL extended ports and connectors

Conclusion

DDS4CCM specification formally published

- http://www.omg.org/spec/CORBA/3.3
- http://www.omg.org/spec/dds4ccm/1.1

DDS4CCM implemented

- By Thales (Cardamom & MyCCM)
- By RemedyIT in the scope of CIAO / Dance

Simple DDS ports added to CCM – Extension possible

GIS fully generic and root for a CCM revival

- Moved to CCM (now in CORBA specification / part 3 – chapter 7)
- In the process of being used for other CCM ports & connectors
  - AMI (Asynchronous Machine Invocation), Events…

➔ Note: will allow CCM w/o CORBA (aka UCM)
  - e.g. by implementing those connectors on top of DDS

Thank you for your attention
Questions ?