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Your challenge - our solution

rti Presents

LONDON CONNEXT CONFERENCE 2015

Connecting Our Users: The DDS Experts. — October 14-15, 2015

Integrating DDS into AXCIOMA, the component approach

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CTO Remedy IT

https://www.remedy.nl

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Your challenge - our solution

- Remedy IT is specialized in communication middleware and component technologies
- Strong focus on open standards based solutions
- Actively involved in the Object Management Group, chairing several OMG standardization efforts
- Our customers are in various domains including telecom, aerospace and defense, transportation, industrial automation
- For more information take a look at our website https://www.remedy.nl

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What We Do

- Global Service Delivery Partner for RTI Connext DDS
- Develop implementations of OMG open standards
  - Open source: TAOX11, AXCIOMA, TAO, CIAO, R2CORBA
- Deliver services related to OMG standards including the CORBA, CCM, and DDS standard
- Develop open standards as part of the Object Management Group

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What is AXCIOMA?

- AXCIOMA is a comprehensive software suite combining several Object Management Group (OMG) open standards
  - LwCCM, DDS, DDS4CCM, AMI4CCM, CORBA, IDL, IDL2C++11, and D&C
- AXCIOMA is based on
  - Interoperable Open Architecture (IOA)
  - Component Based Architecture (CBA)
  - Service Oriented Architecture (SOA)
  - Event Driven Architecture (EDA)
  - Model Driven Architecture (MDA)

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AXCIOMA

- AXCIOMA supports the design, development, and deployment of a distributed component based architecture
- A component based architecture encapsulates and integrates the following mechanisms in a “container”
  - Threading model
  - Lifecycle management
  - Connection management

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What Is a Component?

- Independent revisable unit of software with well defined interfaces, called ports
- Can be packaged as an independent deployable set of files
- Smallest decomposable unit that defines standard ports is called a monolithic component
- An component assembly is an aggregation of monolithic components or other component assemblies

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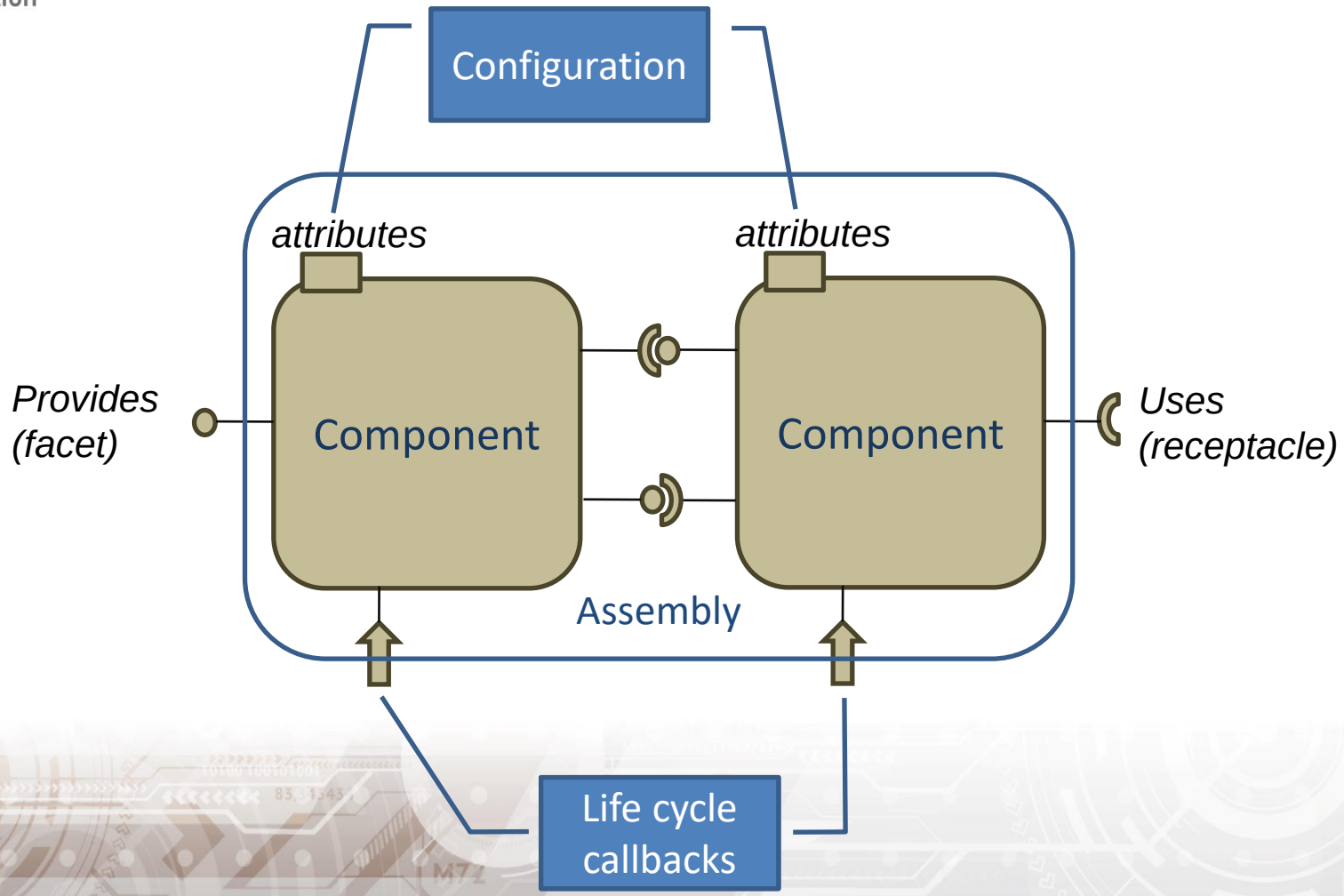
Component



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Component Framework

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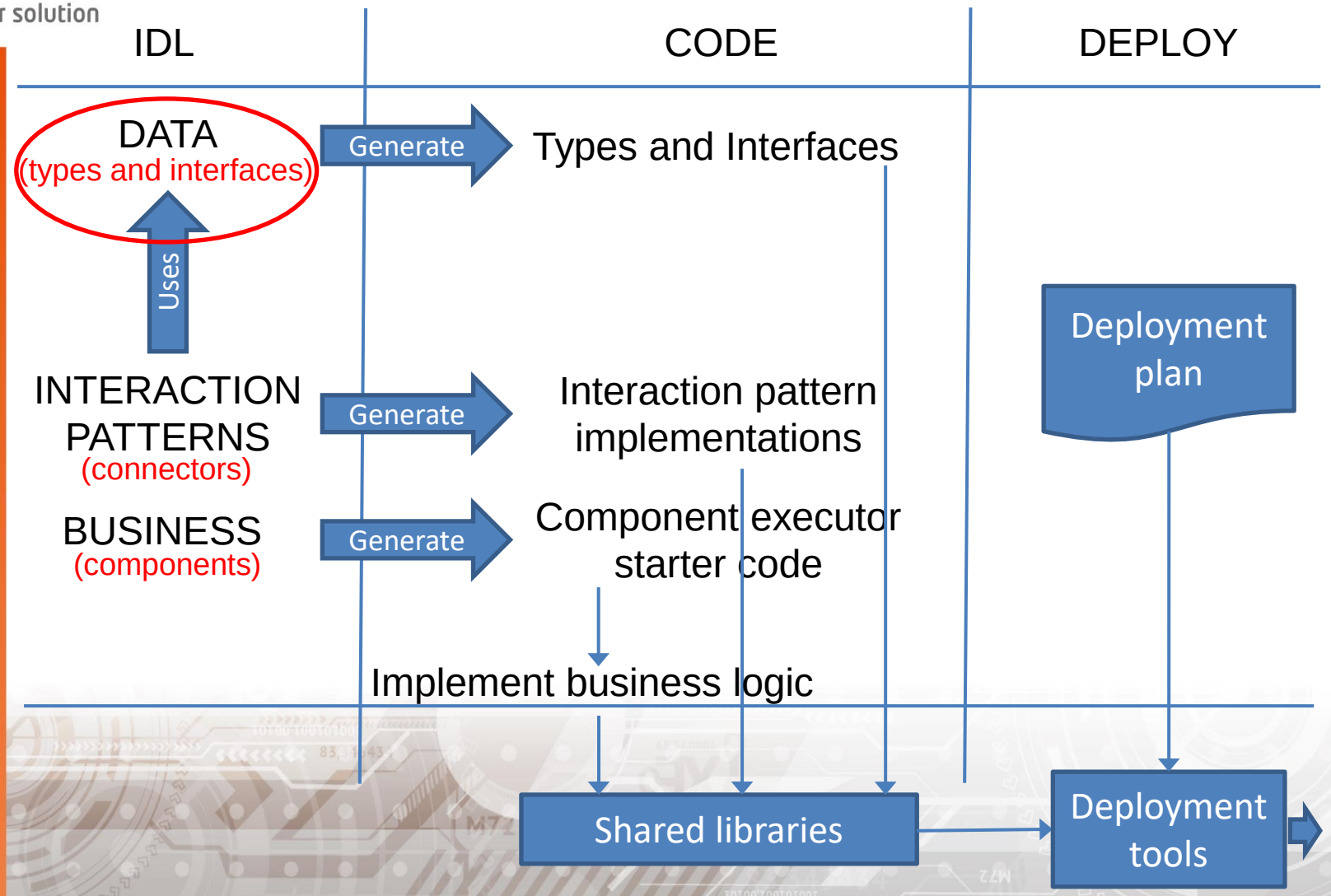

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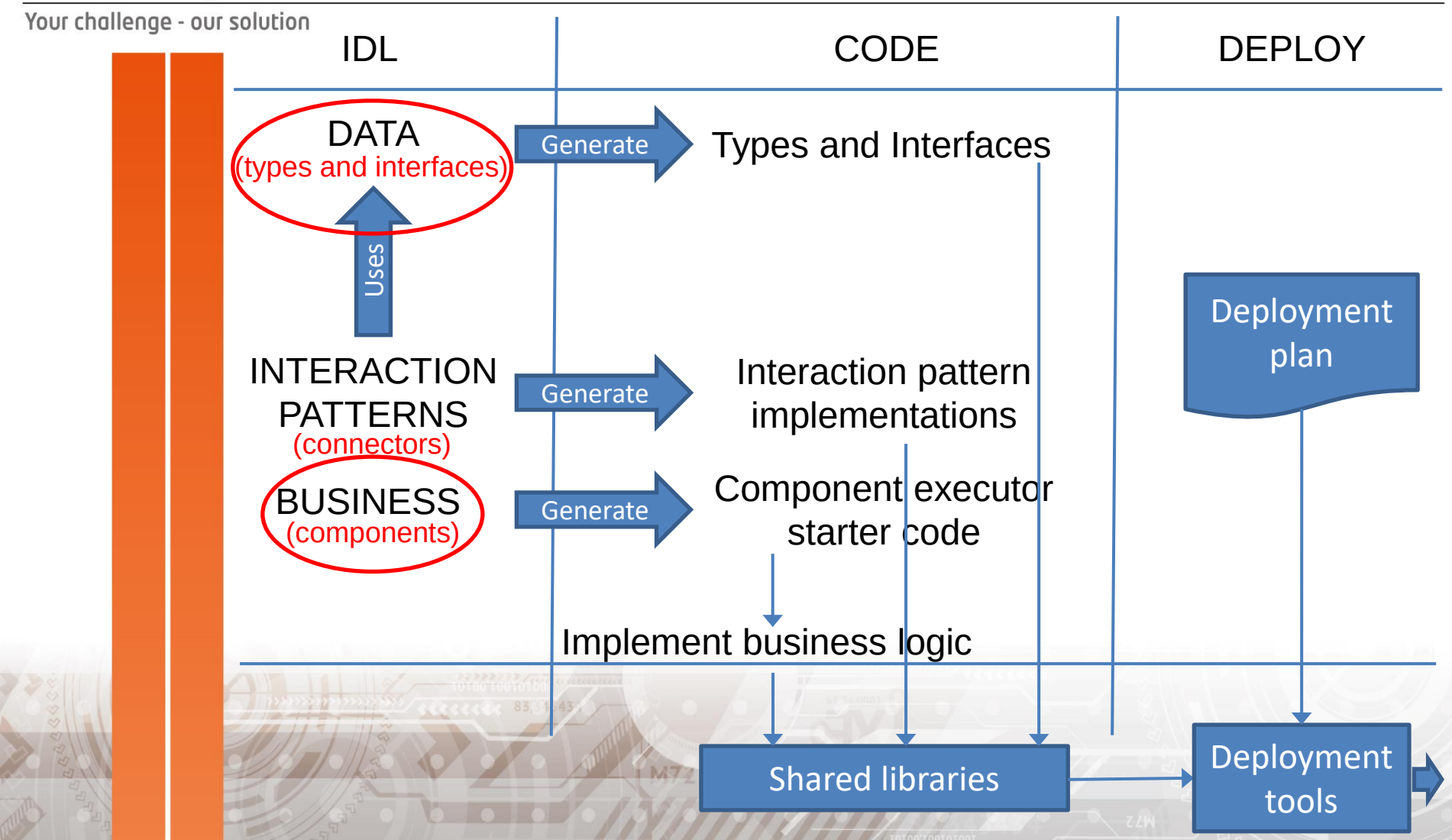
Component Framework



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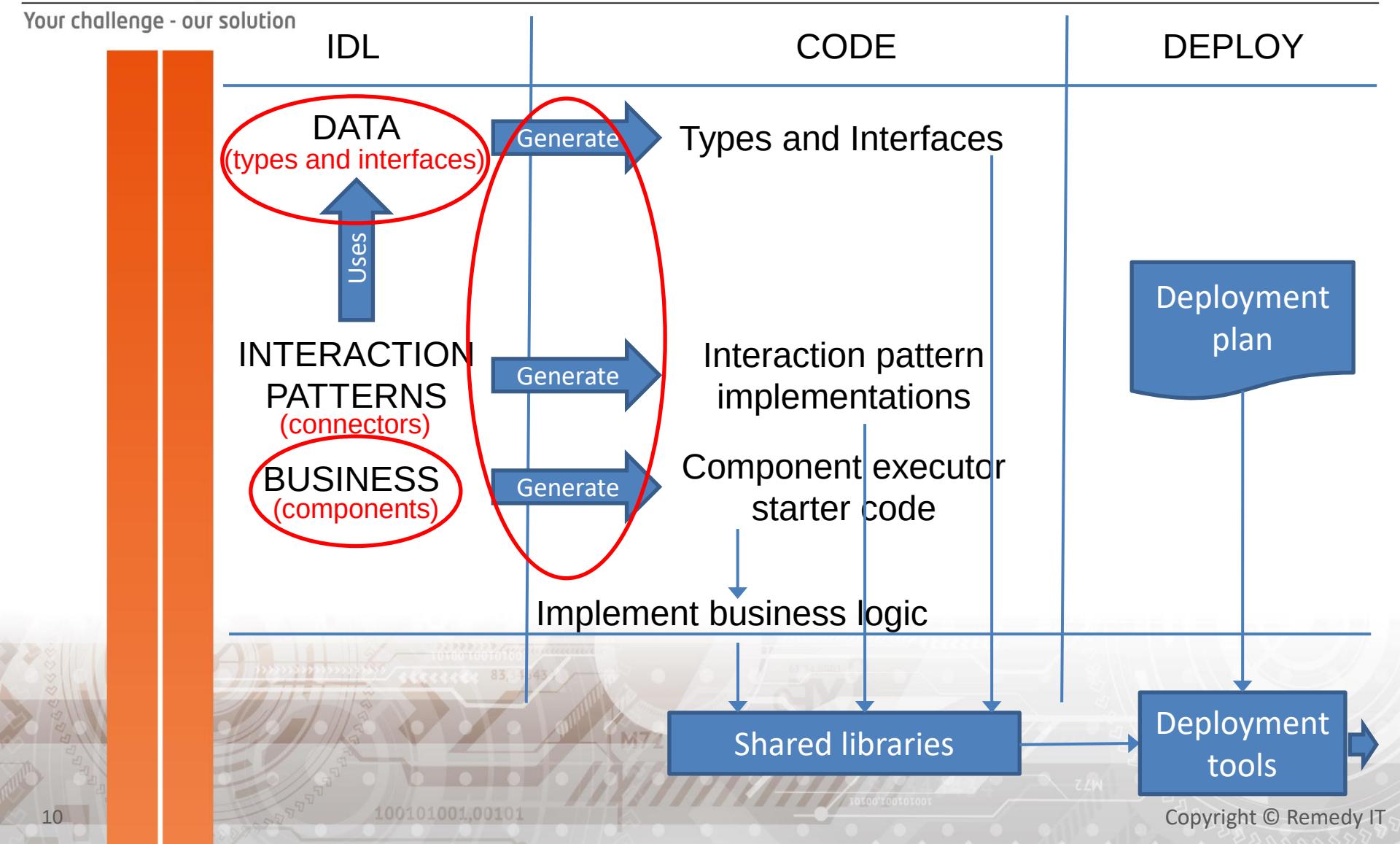
Component Framework



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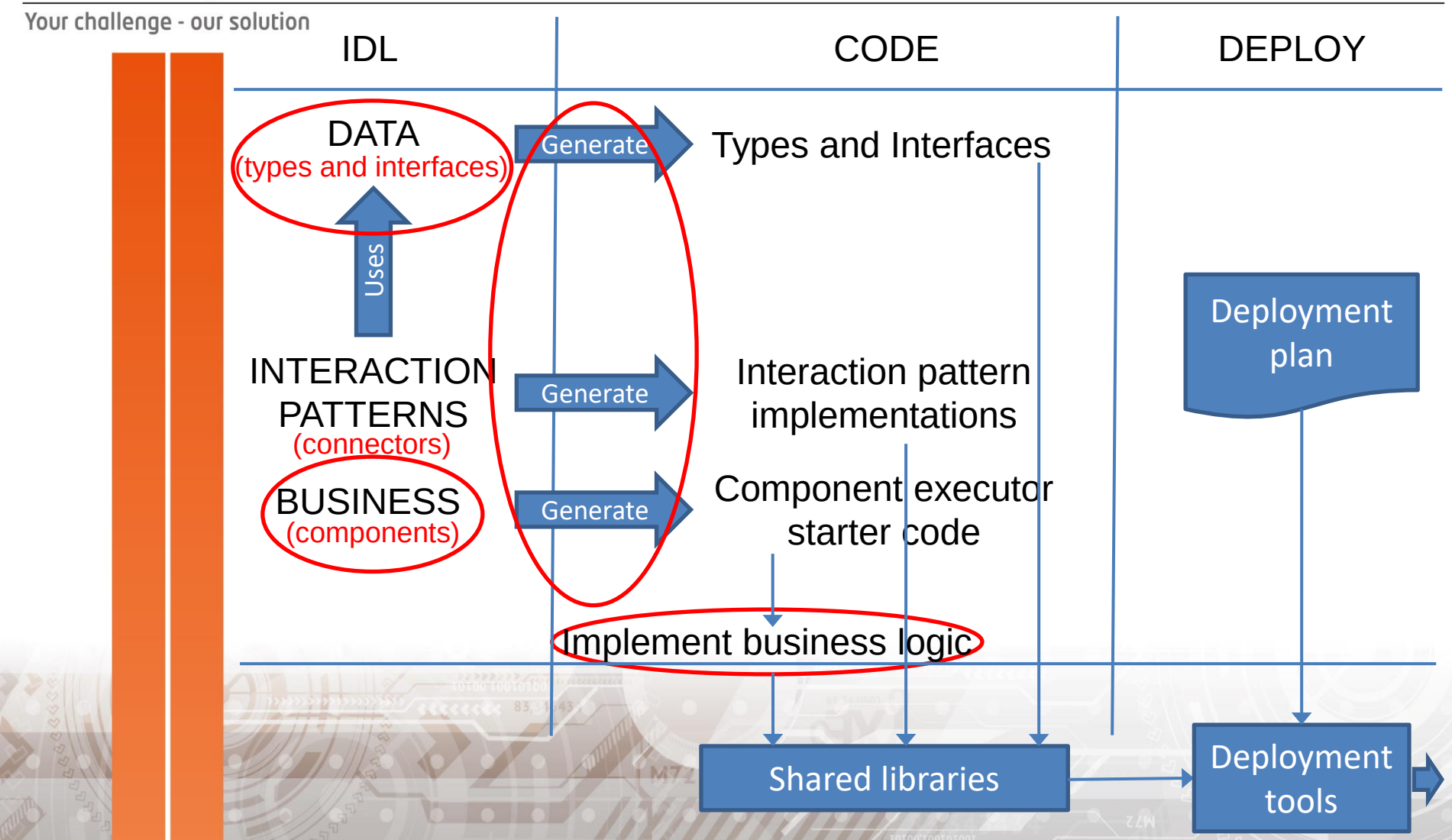
Component Framework



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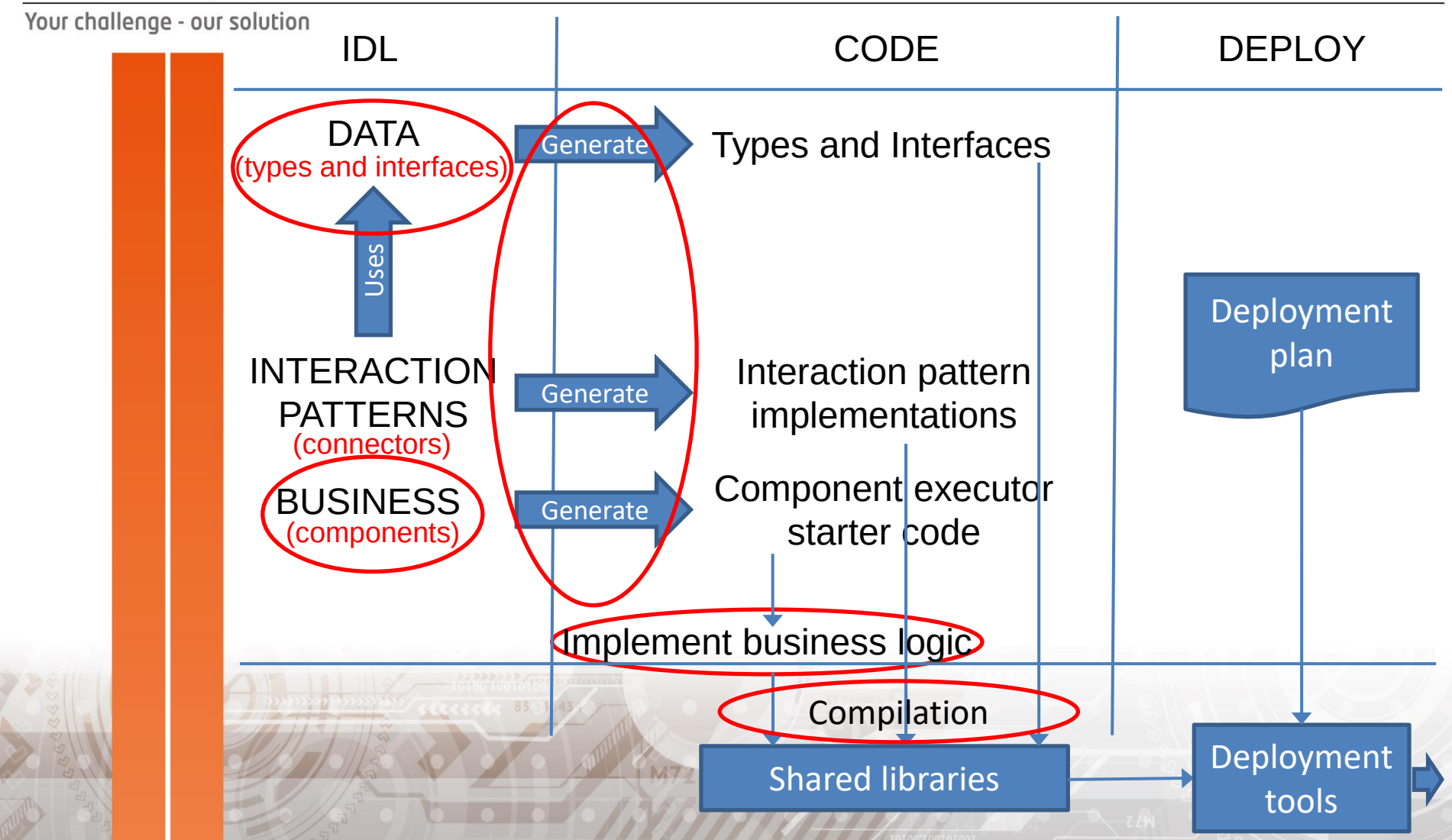
Component Framework



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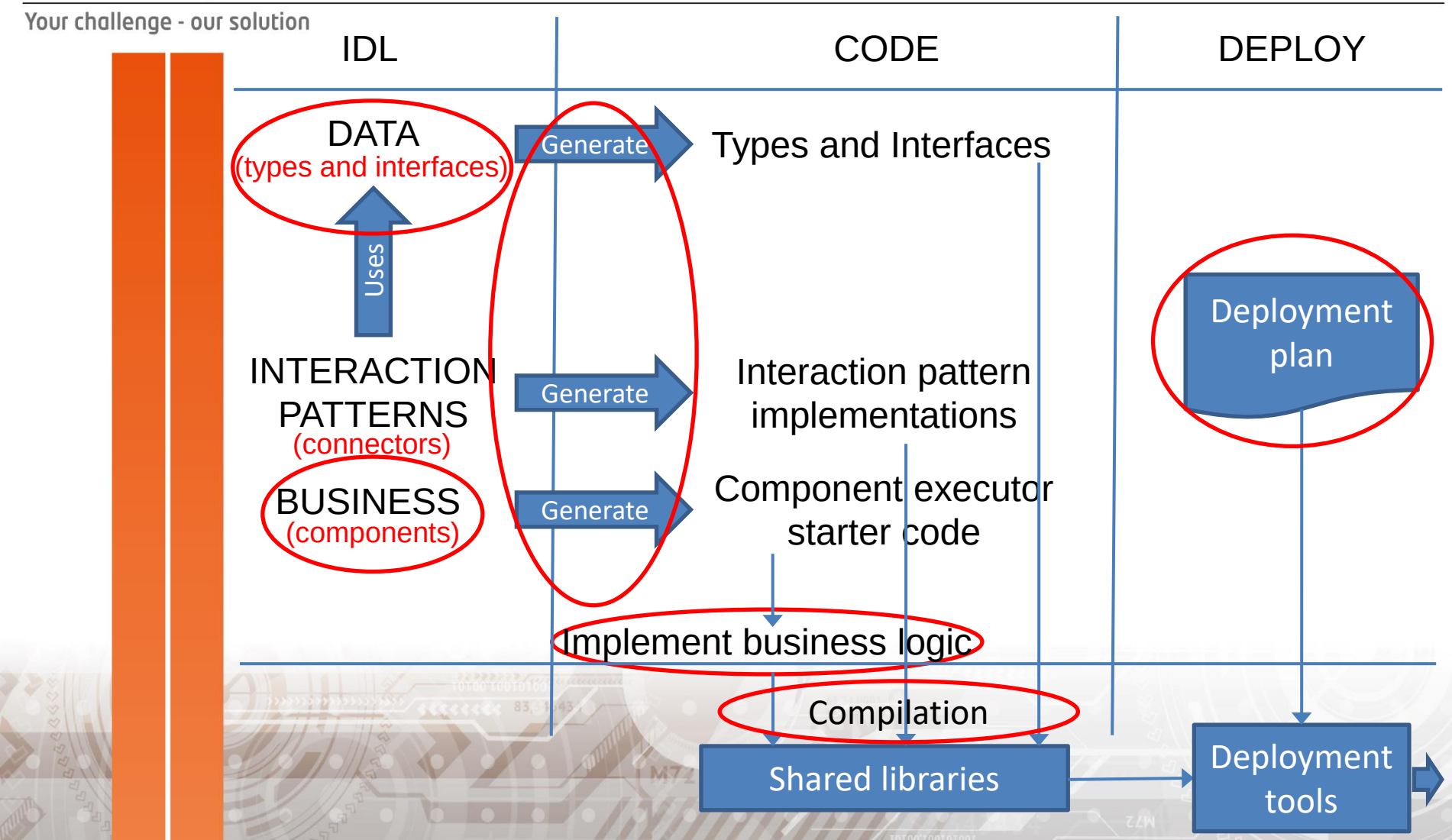

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Interaction Patterns

- Define how components interact with the outside world
  - Request/Reply interaction
    - client, server, asynchronous client, and asynchronous server
  - Event interaction
    - supplier, push consumer, and pull consumer
  - State interaction
    - observable, passive observer, push observer, pull observer, and push state observer
- All these interaction patterns can be realized using DDS

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Our AXCIOMA DDS Challenge

- Integrate RTI Connext DDS into AXCIOMA
- Provide the IDL to C++11 API to our users
- Abstract and optimize DDS through the interaction patterns
  - Request/reply
  - State
  - Event

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IDL to C++11 Language Mapping (I)

- Simplified mapping for C++
  - Make use of the standard C++ library as much as possible
- Make use of the C++11 features to
  - Reduce amount of application code
  - Reduce amount of possible coding errors by providing a safer API
  - Gain runtime performance
  - Speedup development and testing
    - Faster time to market
    - Reduced costs
    - Reduced training time

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IDL to C++11 Language Mapping (II)

- An IDL interface maps to so called reference types
- Reference types are automatically reference counted
- A nil reference type is represented as `nullptr`
- A boolean operator for reference comparison is available
- Invoking an operation on a nil reference results in a `INV_OBJREF` exception, no need whether object references are valid throughout your business code

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DDSX11

- RTI Connext DDS currently does not support the IDL to C++11 language mapping
- DDSX11 performs the bridging between the IDL to C++11 and RTI Connext DDS C++ API
- Hides all vendor API details from the programmer
- Combination of
  - IDL based code generation
  - C++11 code generation
  - Core support classes and templates

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DDSX11 Conversion traits

- For DDSX11 the C++11 types are leading
- For each IDL defined type we provide a trait with helper methods to convert between C++ and C++11
  - Basic type traits are part of the core
  - Constructed type traits are generated by our RIDL IDL compiler
    - Generated for a specific vendor
- DDSX11 uses the traits and is unaware of the real type

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DDSX11 Conversion traits

- Conversion traits are currently optimized for RTI Connext DDS using the ‘old’ C++ API
- Traits can be generated differently for other vendors or a different RTI version
- At the moment the C++ and C++11 type are the same the conversion traits are optimized away by the compiler
  - DDSX11 and user code doesn’t need to be changed

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Optimizing DDS Usage

- DDS API is hidden from the programmer
- Knowledge about how DDS setup is part of the connector
- The DDS usage knowledge is implemented and optimized once
  - Usage of domain participants (how many)
  - Reuse of topics
  - Clean shutdown of DDS
- DDSX11 can use IDL4 annotations which are converted to the DDS vendor specific setting

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Component and DDS Execution Model

- Components run in a single threaded, re-entrant environment
- Callbacks from DDS threads are going dispatched onto our main thread
- No locking in user code necessary
- Additional Execution Models will be available for more complex execution environments

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Testing

- All our connector and framework functionality has to be tested automatically
- No need for special DDS test connectors
- Special test components that trigger fault conditions
  - Sometimes need to be combined with specific QoS settings
- On heavy loads sometimes DomainParticipant discovery is missed
  - Wait on DDS callbacks like publication_matched before starting the real test code
- Keep QoS and configuration as simple as possible

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Shapes Example

Publisher

Event interaction

...

Event interaction

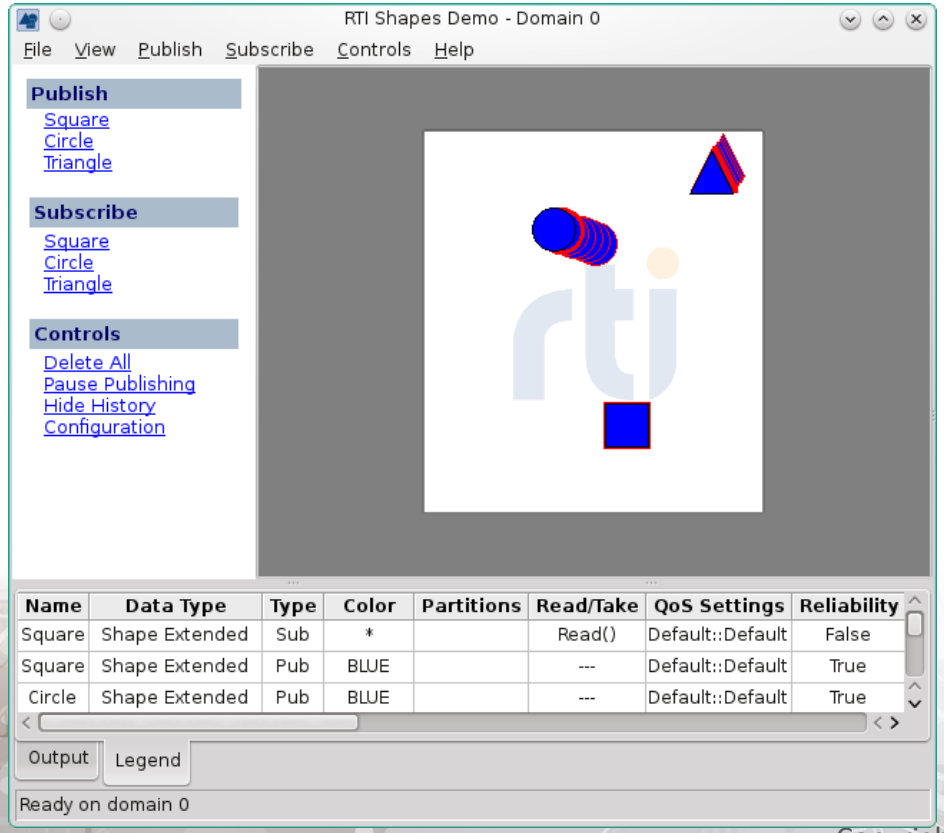
Subscriber

Request/Reply interaction

...

Request/Reply interaction

Controller



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Generated ShapeType Class


```
class ShapeType
{
public:
  ShapeType () = default;
  ~ShapeType () = default;
  ShapeType (const ShapeType&) = default;
  ShapeType (ShapeType&&) = default;
  ShapeType (color_type color, int32_t x, int32_t y, int32_t shapesize);
  ShapeType& operator= (const ShapeType&) = default;
  ShapeType& operator= (ShapeType&&) = default;
  …
  // Getters and Setters
private:
  // Struct members as private members
};

ShapeType shape {"GREEN", 0, 0, 15 };
std::cout << "Created ShapeType " << shape << std::endl;
ShapeType shape1 = shape;
ShapeType shape2 (shape1);
```


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Component Executor Class


```
/// Component Executor Implementation Class : Publisher_comp_exec_i
class Pubisher_comp_exec_i final
  : public virtual IDL::traits<CCM_Publisher_comp>::base_type
{
public:
  /// Constructor
  Publisher_comp_exec_i ();
  //@@{__RIDL_REGEN_MARKER__} - END :
                          Shapes_Publisher_comp_Impl::Publisher_comp_exec_i[ctor]

  /// Destructor
  virtual ~Publisher_comp_exec_i ();

  /** @name Component port operations. */
  //@{
  /// Factory method and getter for the control facet
  /// @return existing instance of facet if one exists, else creates it
  virtual IDL::traits<Shapes::CCM_Control>::ref_type
  get_control () override;
  //@}
  ...
```


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Facet Executor Class


```
Shapes::ReturnStatus
control_exec_i::setLocation (
    uint16_t x,
    uint16_t y)
{
  Shapes::ReturnStatus status = Shapes::ReturnStatus::RETURN_ERROR;
  auto cex = IDL::traits<Publisher_comp_exec_i>::narrow (
    this->component_executor_.lock ());
  if (cex)
    status = cex->setLocation (x, y);
  else
    std::cout << "setLocation - failed to lock executor." << std::endl;
  return status;
}
```


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Write a DDS sample


```
// Get the writer port which we use to write a DDS sample
IDL::traits< ::Shapes::ShapeType_conn::Writer>::ref_type writer =
        this->context_->get_connection_info_write_data ();

// Write one sample square for the given instance handle
writer->write_one (this->square_, this->instance_handle_);
```


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Receive a DDS sample


```
// Data is delivered through a callback
void
info_out_data_listener_exec_i::on_one_data (
    const ::ShapeType& datum,
    const ::CCM_DDS::ReadInfo&)
{
  std::cout << "Received " << datum << std::endl;
}
```


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Conclusion

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- DDS fits perfect into a component based approach
- DDSX11 abstracts vendor differences and improves portability of user code
- Fully automated testing is possible but takes time to implement
- IDL to C++11 simplifies user code, increases performance, and reduces time to implement

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