THE VALUE OF PERFORMANCE.

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Model Driven, Component Based Development for CBDDS

OMG DDS Information Day

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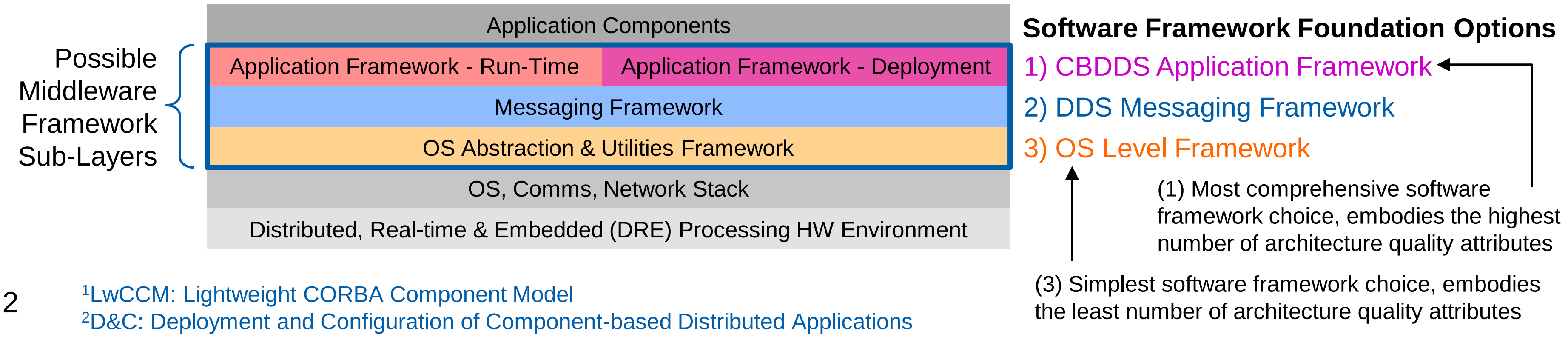
Component Based DDS (CBDDS)

Full Application Framework Support for DDS Middleware

- CBDDS is a commercial term for the comprehensive, integrated suite of the following seven OMG open standards
  - LwCCM[1], **DDS**, DDS4CCM, AMI4CCM, CORBA, IDL and D&C[2]
- Supports architecture development at a higher level of abstraction
  - On a more comprehensive application vs. messaging DRE software framework
- Encapsulation of event queue/dispatch, threading model, boilerplate code, app lifecycle management, extensions and connection management in a “container”
- CCM Generic Interaction Support (GIS) encapsulates DDS or any other middleware functionality inside a “connector” with APIs defined by local IDL interfaces
- DDS4CCM APIs for DDS access are middleware agnostic and vendor independent
- CBDDS extends DDS to fill in the holes needed to define a complex, full featured DRE architecture with open standard vs. custom solutions


Application Components
Possible Middleware Framework Sub-Layers
Application Framework - Run-Time
Application Framework - Deployment
Messaging Framework
OS Abstraction & Utilities Framework
OS, Comms, Network Stack
Distributed, Real-time & Embedded (DRE) Processing HW Environment
Software Framework Foundation Options
1) CBDDS Application Framework
2) DDS Messaging Framework
3) OS Level Framework
(1) Most comprehensive software framework choice, embodies the highest number of architecture quality attributes
(3) Simplest software framework choice, embodies the least number of architecture quality attributes

[1]LwCCM: Lightweight CORBA Component Model
[2]D&C: Deployment and Configuration of Component-based Distributed Applications

Why Are We Using CBDDS?

It Addresses All Five of Our Guiding Architectural Tenets

- Our 5 Guiding Architectural Tenets:
  - **OA** Open Architecture (MOSA)
  - **MDA** Model Driven Architecture
  - **CBA** Component Based Architecture
  - **SOA** Service Oriented Architecture
  - **EDA** Event Driven Architecture (DOA)

Focus of this presentation

- We have adopted CBDDS as our application framework technology of choice to meet a larger set of goals and requirements
  - CBDDS addresses all five architectural tenets
- DDS by itself only *fully* addresses two of our five guiding tenets (OA & EDA)
  - Future OMG RPC4DDS spec anticipated to add SOA support
  - New MDA tooling is much more useful for CBDDS, but *can* help DDS-only users as well
- High performance not compromised to improve modularity, reuse and portability, as well as functionality, scalability and time/cost of development
  - The integrated CBDDS solution is designed to target distributed, real-time & embedded (DRE) operational technology (OT) domains
  - Insignificant pub-sub run-time overhead – run-time performance the same as DDS
    - Threading model encapsulation adds ~1-2% overhead, but most proprietary frameworks incur that too unless they do all their work in DDS Reader threads
  - Collocated components using request-reply with “local” IDL interfaces also offer very high performance (IDL “interface” definitions become virtual function calls)
- CBDDS adds structure, which is the very definition of architecture
  - MDA tools leverage this structure, and component based development (CBD) principles

CBDDS MDA Tooling Development History

- NGC[1] has been helping the OT community develop CBDDS technology since 2008
  - Many customer & NGC funded sponsorships of OSS/commercial middleware implementations and MDE tooling
- Early recognition: MDA tooling for DDS in general was lacking for architecture & design
  - In 2008-2009 time frame, DDS specific tooling mostly limited to run-time debug & integration
- Initial efforts began with the CoSMIC GME-based research tool from Vanderbilt ISIS
  - CoSMIC already supported CCM and D&C artifact generation, but had no DDS support
  - Leveraged expertise of Dr. James Hill at IUPUI and Vanderbilt ISIS to improve it
    - Added DDS4CCM, AMI4CCM & improved D&C support to CoSMIC – still available
  - Established tool use for CBDDS as a viable, desirable and necessary approach (D&C CDP files are complex)
- Soon looked toward UML-based, commercially supported alternatives
  - Easier to develop a fully integrated, MDA-driven, soup-to-nuts systems/software engineering approach
    - SysML UML profile for systems architecture
    - CBDDS UML profile for component-level software architecture supporting a CBD[2] process
    - Vanilla UML for class-level, intra-component software design & implementation
  - Added support for CBDDS architecture/design, rather than just deployment planning (primary CoSMIC strength)
- Began dual development efforts with Zeligsoft (now PrismTech) and Atego in 2009
  - Zeligsoft already proficient in CBD for its SDR products, Atego was our sector's enterprise UML tool vendor
  - CoSMIC generated artifacts and research results used as gold standard reference for both efforts
  - Today we have two capable commercial products available to support OMG CBDDS and DDS open standards

[1]NGC: Northrop Grumman Corporation
[2]CBD: Component Based Development (process)

MDA Tools are Available to Support CBD for CBDDS and Auto-Generation of Critical Artifacts

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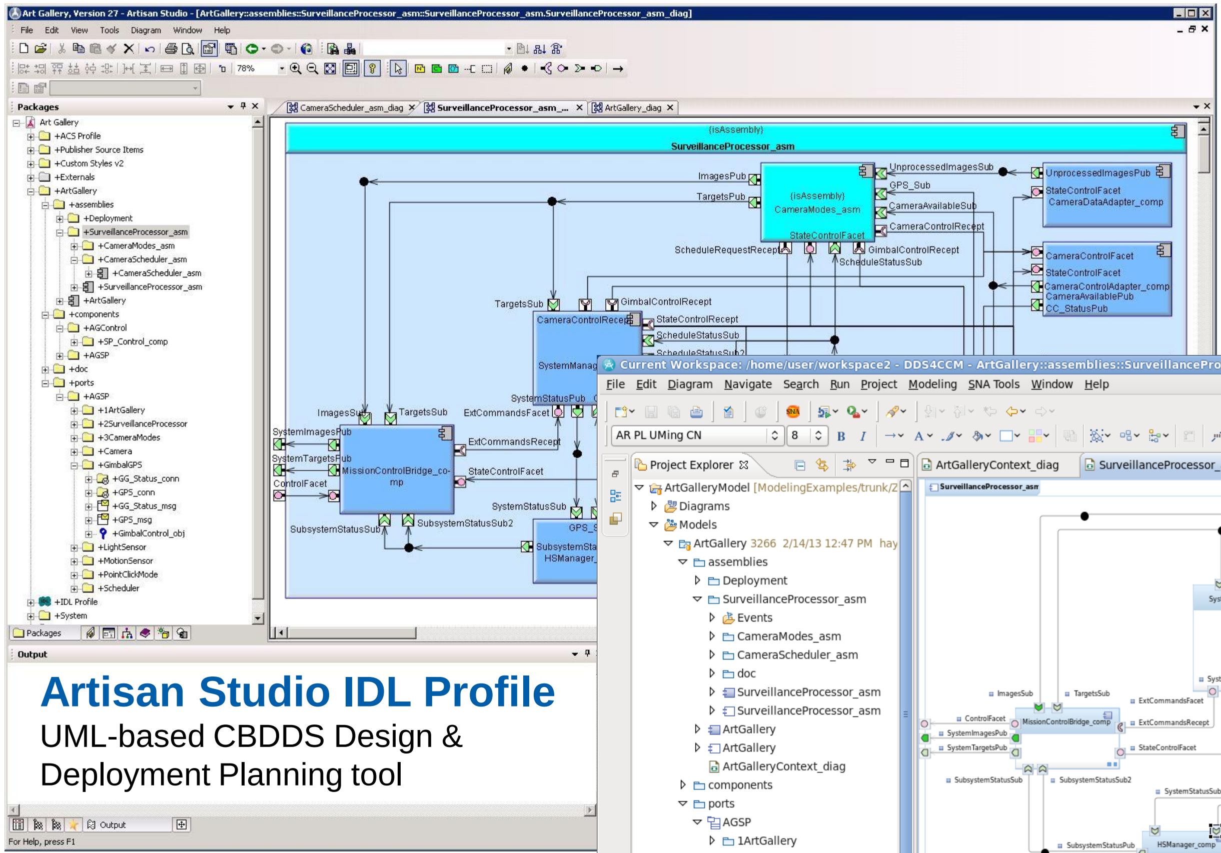
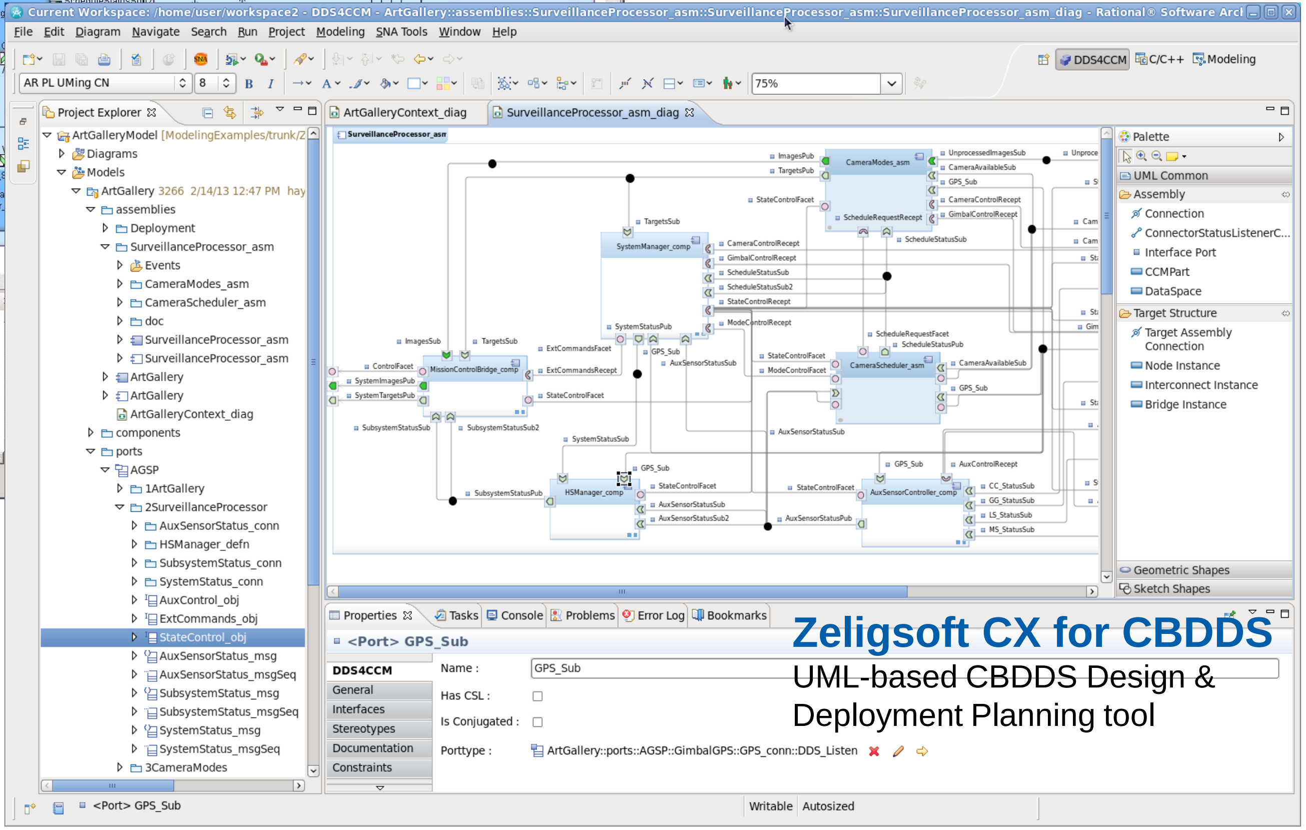
- Component Based Architecture (CBA) captured as a PIM
- Maps to a CBDDS IDL and D&C PSM
- Key auto-generated OA artifacts drive the overall process (IDL 3.5, D&C 4.0)


Art Gallery, Version 27 - Artisan Studio - [ArtGallery::assemblies::SurveillanceProcessor_asm::SurveillanceProcessor_asm.SurveillanceProcessor_asm_diag]
Packages
Art Gallery
CameraScheduler_asm_diag
SurveillanceProcessor_asm...
ArtGallery_diag
{isAssembly}
SurveillanceProcessor_asm
CameraModes_asm
MissionControlBridge_comp
Output
For Help, press F1

Artisan Studio IDL Profile

UML-based CBDDS Design & Deployment Planning tool



<Port> GPS_Sub

Name : GPS_Sub

Has CSL :

Is Conjugated :

Porttype : ArtGallery::ports::AGSP::GimbalGPS::GPS_conn::DDS_Listen

Zeligsoft CX for CBDDS

UML-based CBDDS Design & Deployment Planning tool

- Integration with Eclipse IDE in our Scalable Node Architecture (SNA) SDK offers ability to very quickly build & deploy *initial* DRE “executable architecture” skeletons w/o writing a single line of code

Component Based Software Lifecycle Process

Agile, Iterative Six-Step Process Driven by Standard File Artifacts

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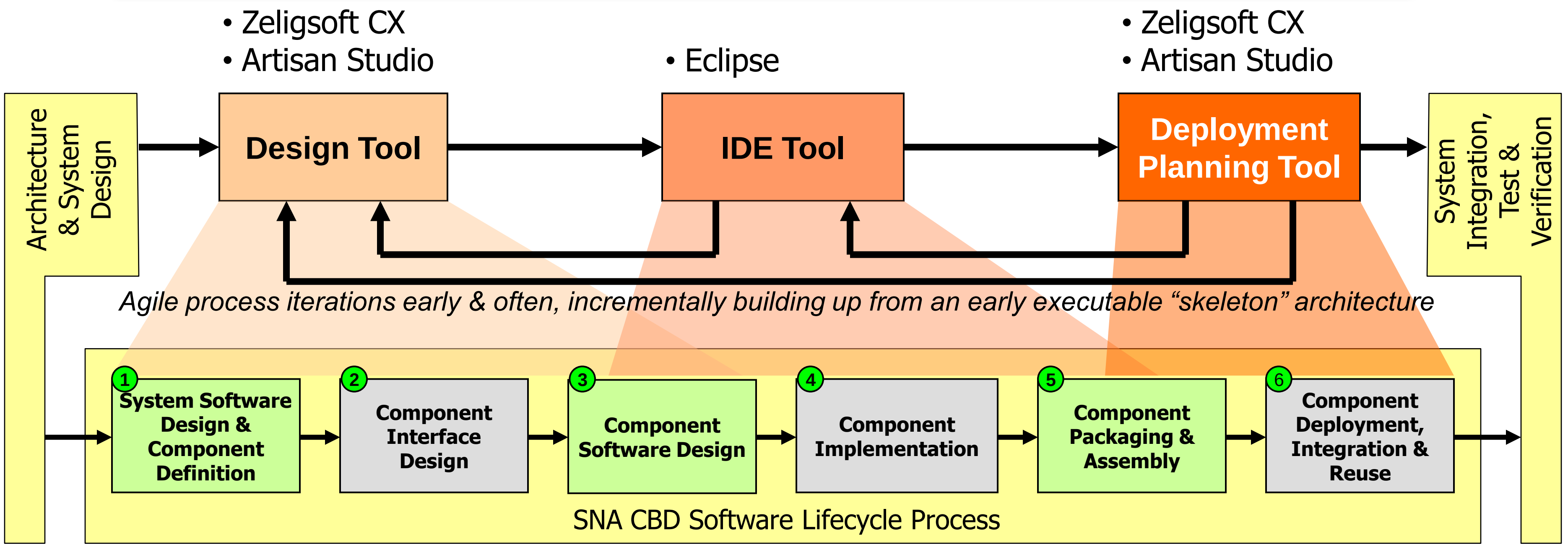
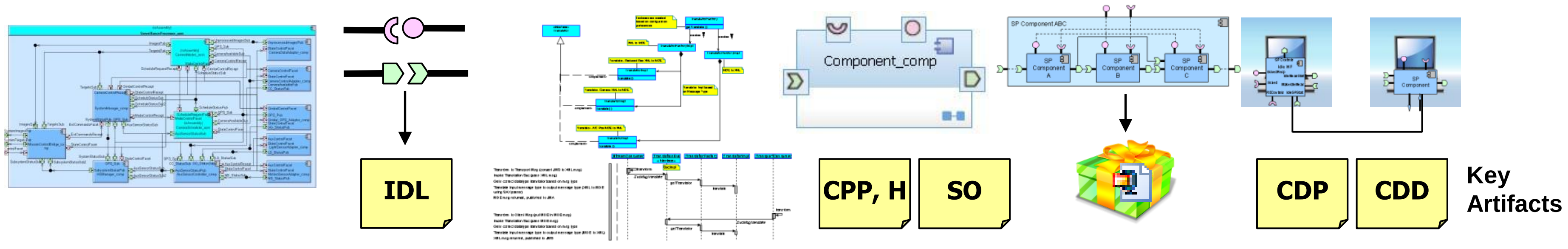
Tool-Centric CBD Software Lifecycle Process View



• Zeligsoft CX
• Artisan Studio
• Eclipse
• Zeligsoft CX
• Artisan Studio
Architecture & System Design
Design Tool
IDE Tool
Deployment Planning Tool
System Integration, Test & Verification
Agile process iterations early & often, incrementally building up from an early executable "skeleton" architecture
1 System Software Design & Component Definition
2 Component Interface Design
3 Component Software Design
4 Component Implementation
5 Component Packaging & Assembly
6 Component Deployment, Integration & Reuse
SNA CBD Software Lifecycle Process

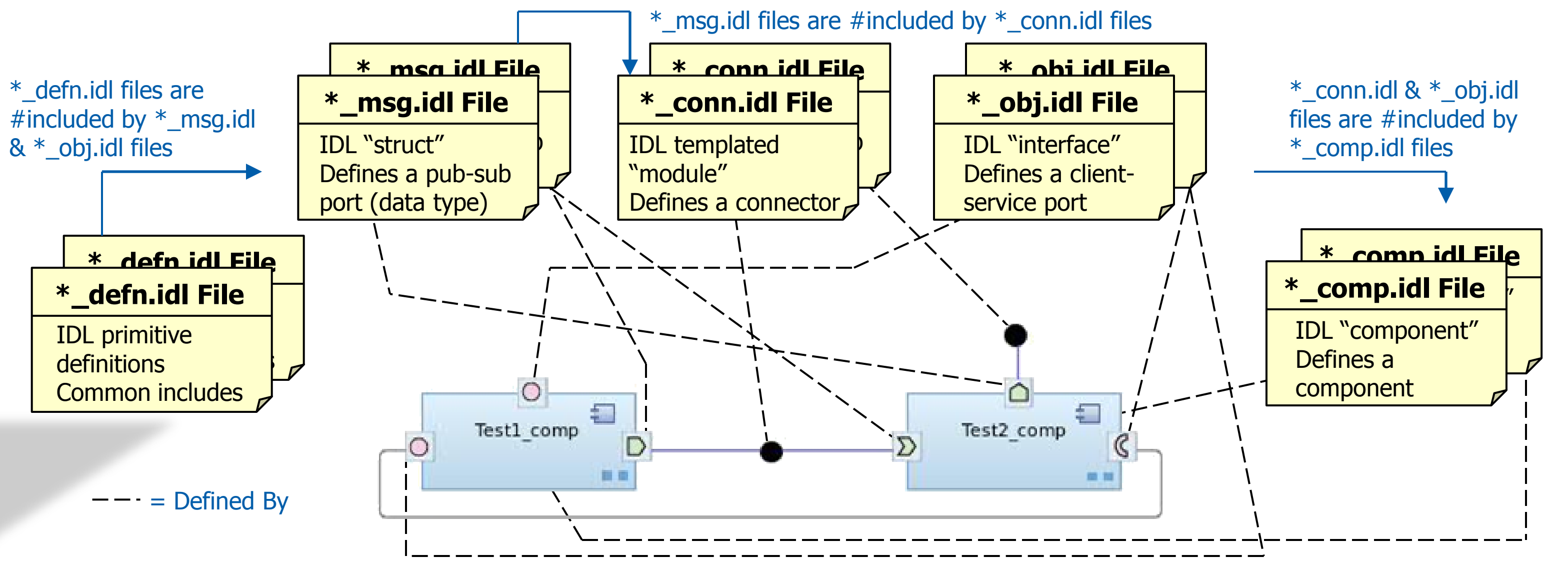


- **IDE**: Integrated Development Environment
- **CBD**: Component Based Development
- **SNA**: Scalable Node Architecture
- **IDL**: Interface Definition Language (OMG)
- **CDP**: Component Deployment Plan
- **CDD**: Component Domain Descriptor

OMG IDL Defines All CBDDS Elements

Components, Connectors, Messages, Interfaces & Basic Def's

IDL 3.5 File Taxonomy Supported by MDA Tools
-
5 Standard File Types
-
Use of optional file extensions enables "smart" build by an SDK


*_msg.idl files are #included by *_conn.idl files
*_defn.idl files are #included by *_msg.idl & *_obj.idl files
*_conn.idl & *_obj.idl files are #included by *_comp.idl files
*_msg.idl File
IDL "struct" Defines a pub-sub port (data type)
*_conn.idl File
IDL templated "module" Defines a connector
*_obj.idl File
IDL "interface" Defines a client-service port
*_defn.idl File
IDL primitive definitions Common includes
*_comp.idl File
IDL "component" Defines a component
Test1_comp
Test2_comp
- - - = Defined By

- IDL offers vendor, programming language & middleware independent format
  - OMG standards exist for IDL to C++ or C++11 mappings, IDL to Java, IDL to Python, etc.
- A given middleware standard implementation provides an IDL to language compiler
  - Model generated IDL -> IDL compiler generated source = large percentage of design code base
  - NGC's SNA SDK *currently* uses tao_idl and rtiddsgen IDL compilers (others in future)
- File extensions not part of tools – NGC SDK conventions/suggestions only
  - Modular structure leveraged to auto-generate makefiles for entire component-based projects
  - Run CCM IDL compiler on all types, only run DDS IDL compiler on *_defn.idl & *_msg.idl files
- MDA tool modular IDL 3.5 convention offers many advantages & important features
  - Supports component/port reuse & modularity (vs. all IDL in one project IDL file)
  - IDL import & export feature of all CBDDS MDA tools enables basic model interchange using IDL

Examples of Modular IDL 3.5

Important for Modularity, Reuse & Tool Interoperability

```
// File: EX_Common_defn.idl
// Example definitions package
// Well-defined, using OMG IDL

module EX
{
  const long TEST_CONSTANT = 9876;
  typedef double SystemTime;
  enum ReturnStatus {
    SUCCESS,
    FAILURE
  };
  typedef string<512> BoundString;
  // more...
};
```

N types from a single UML package

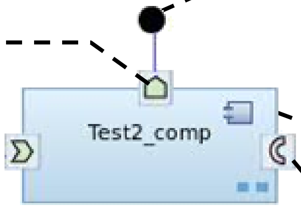
- Modeling & generation of IDL for definitions & DDS messages also useful to DDS-only users

```
// File: EX_PubSub_conn.idl
// Example module instantiation of one or more connectors
// Well-defined, using OMG IDL 3.5

#include <Components.idl>
#include <ccm_dds.idl>
#include "EX_PubSub_msg.idl"
#pragma ciao lem "EX_PubSub_connE.idl"

module AGSP
{
  typedef sequence<PubSub_msg> PubSub_msgSeq;
  module CCM_DDS::Typed<PubSub_msg, PubSub_msgSeq> PubSub_conn;
};
```

ONE "connector" module instantiation per file



```
// File: EX_PubSub_msg.idl
// Example pub-sub message
// Well-defined, using OMG IDL

#include "EX_Common_defn.idl"
#pragma ndds typesupport
   "EX_PubSub_msgSupport.h"

module EX
{
  struct PubSub_msg
  {
    SystemMode modeID;
    JobID_t jobID; //@key
    StatusEnum status;
    ErrorEnum errorVal;
    SystemTime startTime;
    unsigned long long duration;
    short currPicCount;
    boolean valid;
  }; //@top-level true
};
```

ONE struct/union per file, any/all required types #included from *_defn.idl file(s)

```
// File: EX_ControlService_obj.idl
// Example request-reply service
// Well-defined, using OMG IDL

#include "EX_Common_defn.idl"
#pragma ciao lem
   "EX_ControlService_objE.idl"

module EX
{
  interface ControlService_obj
  {
    ReturnStatus changeState(
      in SystemState newState);
    SystemState getCurrentState();
    ReturnStatus setMode(
      in SystemMode newMode);
    SystemMode getCurrentMode();
    boolean setStateTimeout (
      inout TimeStruct timer,
      in long timeValue);
  };
};
```

ONE interface per file, any/all required types #included from *_defn.idl file(s)

```
// File: EX_Test2_comp.idl
// Example component definition
// Well-defined, using OMG IDL 3.5

#include <Components.idl>
#include "EX_PubSub_conn.idl"
#include "EX_MyMsg_conn.idl"
#include "EX_ControlService_obj.idl"
#pragma ciao lem "EX_Component_compE.idl"

module EX
{
  component Test2_comp
  {
    attribute string myProp;

    uses ControlService_obj ClientRecept;

    port PubSub_conn::DDS_Write ExamplePub;
    port MyMsg_conn::DDS_Listen MyMsgSub;
  };
};
```

ONE component per file, plus optional home

Model Element to CBDDS Artifact Mappings

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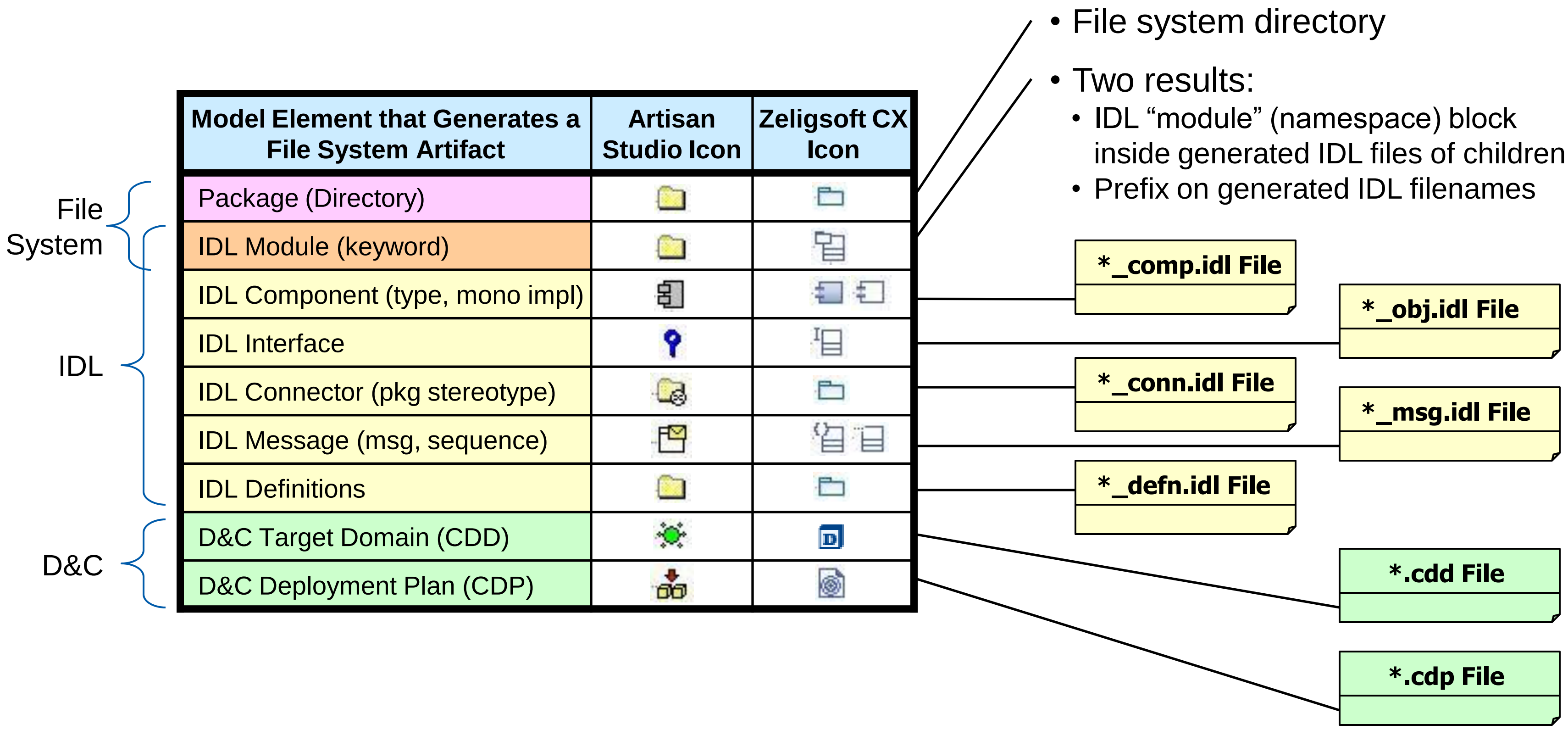
- Each of the model elements in this table creates a corresponding artifact in a source project file system on generation
- Models can contain other types and elements as desired, but only the uniquely stereotyped elements in this table will generate CBDDS artifacts



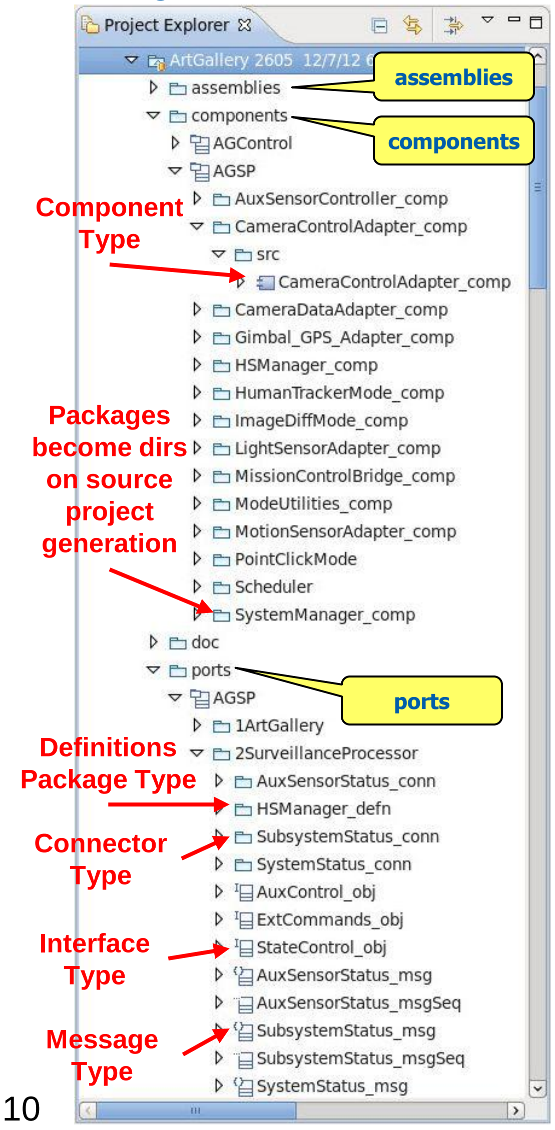
Model Element that Generates a File System Artifact	Artisan Studio Icon	Zeligsoft CX Icon
Package (Directory)	📁	📁
IDL Module (keyword)	📁	▤
IDL Component (type, mono impl)	▣	▣ ▢
IDL Interface	●	▤
IDL Connector (pkg stereotype)	📁	📁
IDL Message (msg, sequence)	✉	▤ ▤
IDL Definitions	📁	📁
D&C Target Domain (CDD)	✸	D
D&C Deployment Plan (CDP)	▣	◎

- File system directory
- Two results:
  - IDL “module” (namespace) block inside generated IDL files of children
  - Prefix on generated IDL filenames

Module/Package View

CX Project Explorer & Study Package Browser

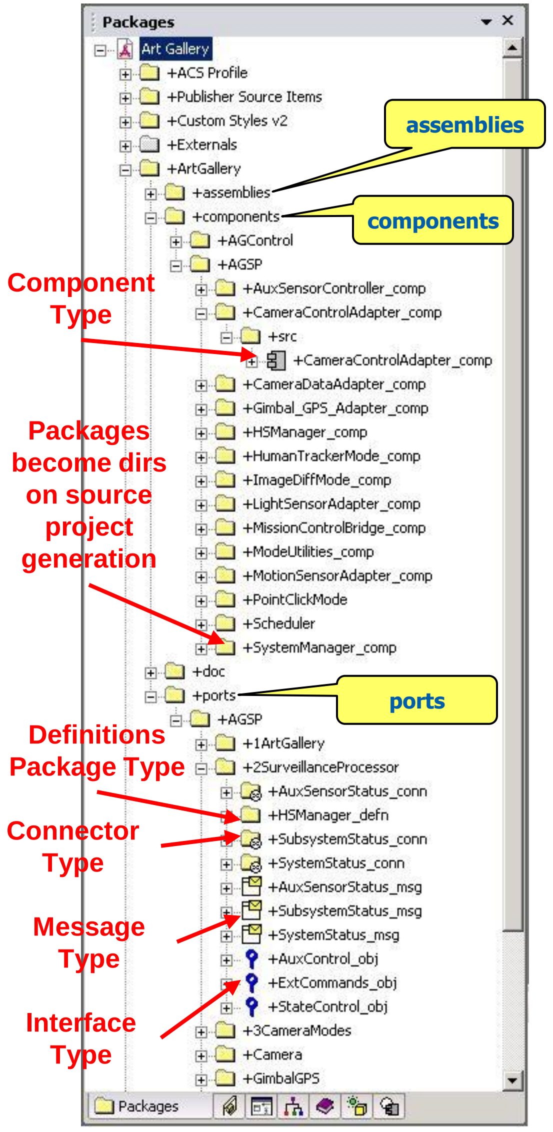
Zeligsoft CX for CBDDS



```
Project Explorer
ArtGallery 2605 12/7/12
  assemblies
  components
    AGControl
    AGSP
      AuxSensorController_comp
      CameraControlAdapter_comp
        src
          CameraControlAdapter_comp
      CameraDataAdapter_comp
      Gimbal_GPS_Adapter_comp
      HSManager_comp
      HumanTrackerMode_comp
      ImageDiffMode_comp
      LightSensorAdapter_comp
      MissionControlBridge_comp
      ModeUtilities_comp
      MotionSensorAdapter_comp
      PointClickMode
      Scheduler
      SystemManager_comp
  doc
  ports
    AGSP
      1ArtGallery
      2SurveillanceProcessor
        AuxSensorStatus_conn
        HSManager_defn
        SubsystemStatus_conn
        SystemStatus_conn
        AuxControl_obj
        ExtCommands_obj
        StateControl_obj
        AuxSensorStatus_msg
        AuxSensorStatus_msgSeq
        SubsystemStatus_msg
        SubsystemStatus_msgSeq
        SystemStatus_msg
```

- Project static architecture view in model used to define and generate project source tree
  - Initially populated with modular IDL 3.5 and D&C 4.0 descriptor files
  - Developers add business logic classes to initial component executor stubs
- Integrated soup-to-nuts SDK offers architecture, design, eventual coding & implementation, deployment planning, launch & debug in a common tool
  - Integrated steps include:
    - Define components, connectors & ports
    - Create instances & connections in an assembly
    - Create a domain & basic deployment plan (including component server process instances as needed for deployment)
    - Generate IDL and D&C artifacts
    - Auto-gen makefiles and build project
    - Compile (IDL & source in one compile)
    - Launch executable architecture
    - Test & Debug
  - Entire process can be completed in just a few minutes for a small set of components
    - For initial executable skeleton architecture w/o code added to "your code goes here" callback stubs

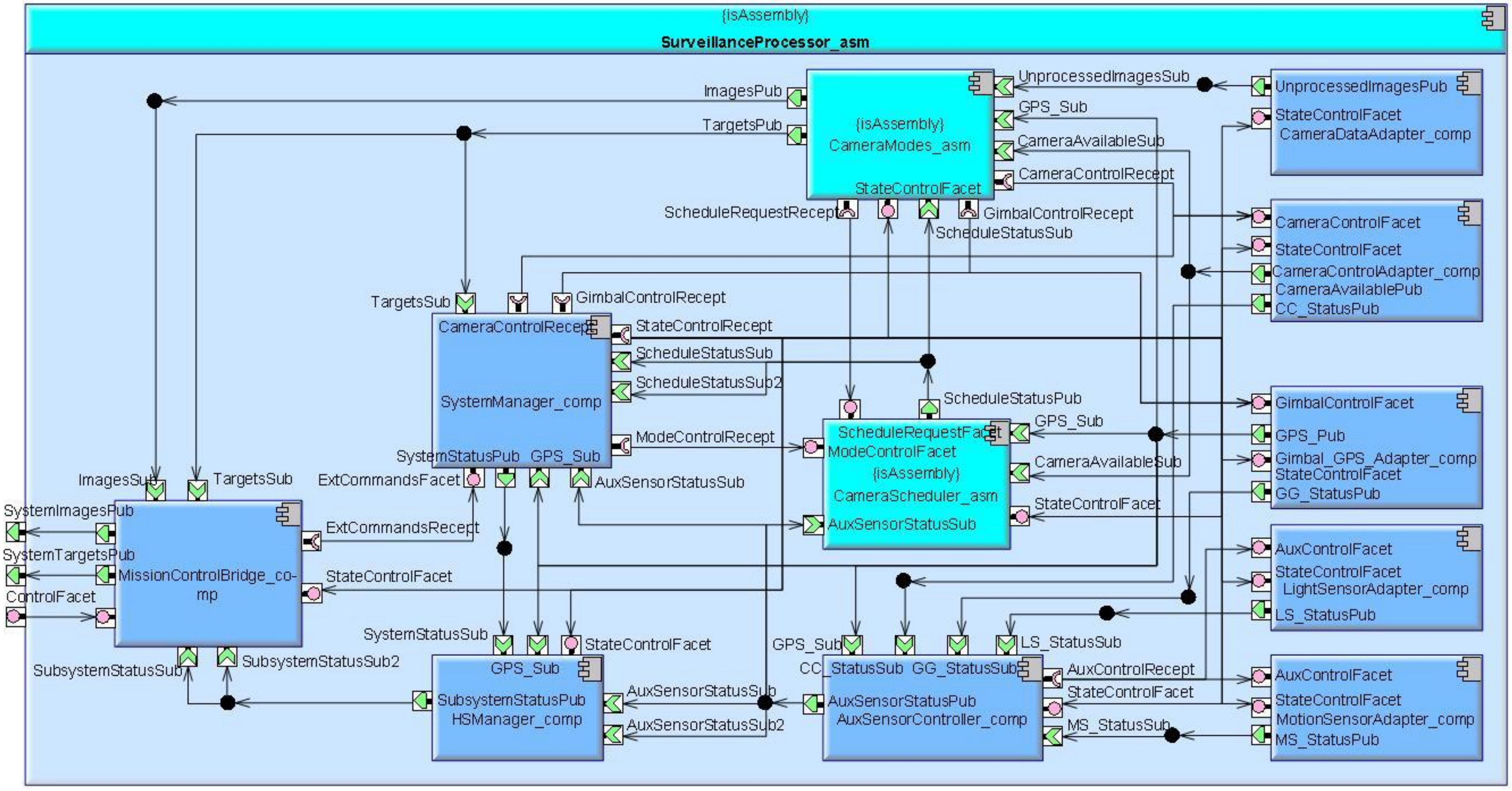
Artisan Studio IDL Profile



```
Packages
Art Gallery
  +ACS Profile
  +Publisher Source Items
  +Custom Styles v2
  +Externals
  +ArtGallery
    +assemblies
    +components
      +AGControl
      +AGSP
        +AuxSensorController_comp
        +CameraControlAdapter_comp
          +src
            +CameraControlAdapter_comp
        +CameraDataAdapter_comp
        +Gimbal_GPS_Adapter_comp
        +HSManager_comp
        +HumanTrackerMode_comp
        +ImageDiffMode_comp
        +LightSensorAdapter_comp
        +MissionControlBridge_comp
        +ModeUtilities_comp
        +MotionSensorAdapter_comp
        +PointClickMode
        +Scheduler
        +SystemManager_comp
    +doc
    +ports
      +AGSP
        +1ArtGallery
        +2SurveillanceProcessor
          +AuxSensorStatus_conn
          +HSManager_defn
          +SubsystemStatus_conn
          +SystemStatus_conn
          +AuxSensorStatus_msg
          +SubsystemStatus_msg
          +SystemStatus_msg
          +AuxControl_obj
          +ExtCommands_obj
          +StateControl_obj
        +3CameraModes
        +Camera
        +GimbalGPS
```

Component Assembly Hierarchy Example

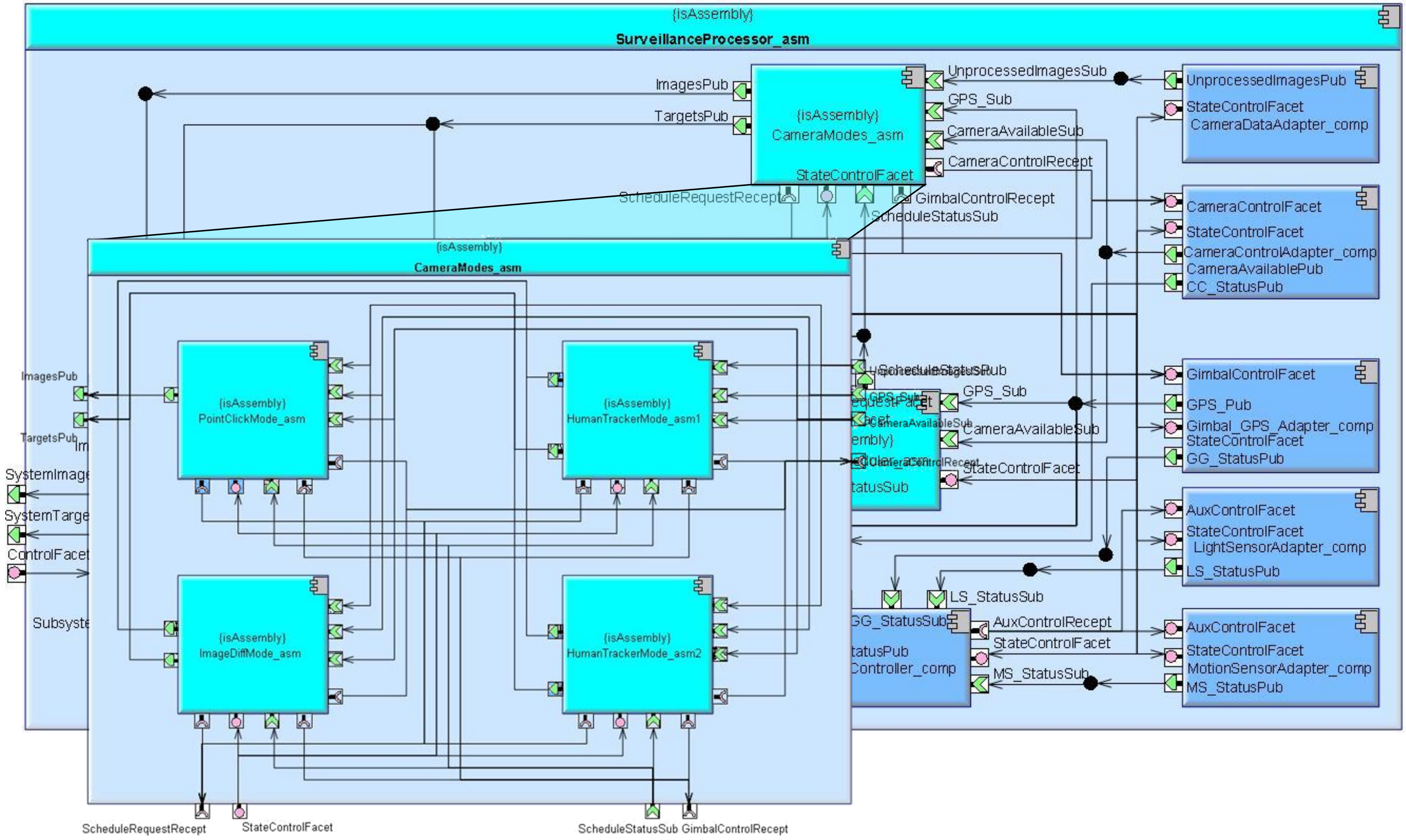
Artisan Studio IDL Profile



- A formal Architecture Description Language (ADL) for CBDDS enables indirect auto-generation (IDL -> compiles to a source language) of a large percentage of the operational software for a software intensive system
  - The structural "boxes and lines" on block diagrams, as defined in Component & Connector (C&C) style views
- CBDDS graphical notations and component diagrams are proving invaluable at NGC for cross-program understanding & sharing

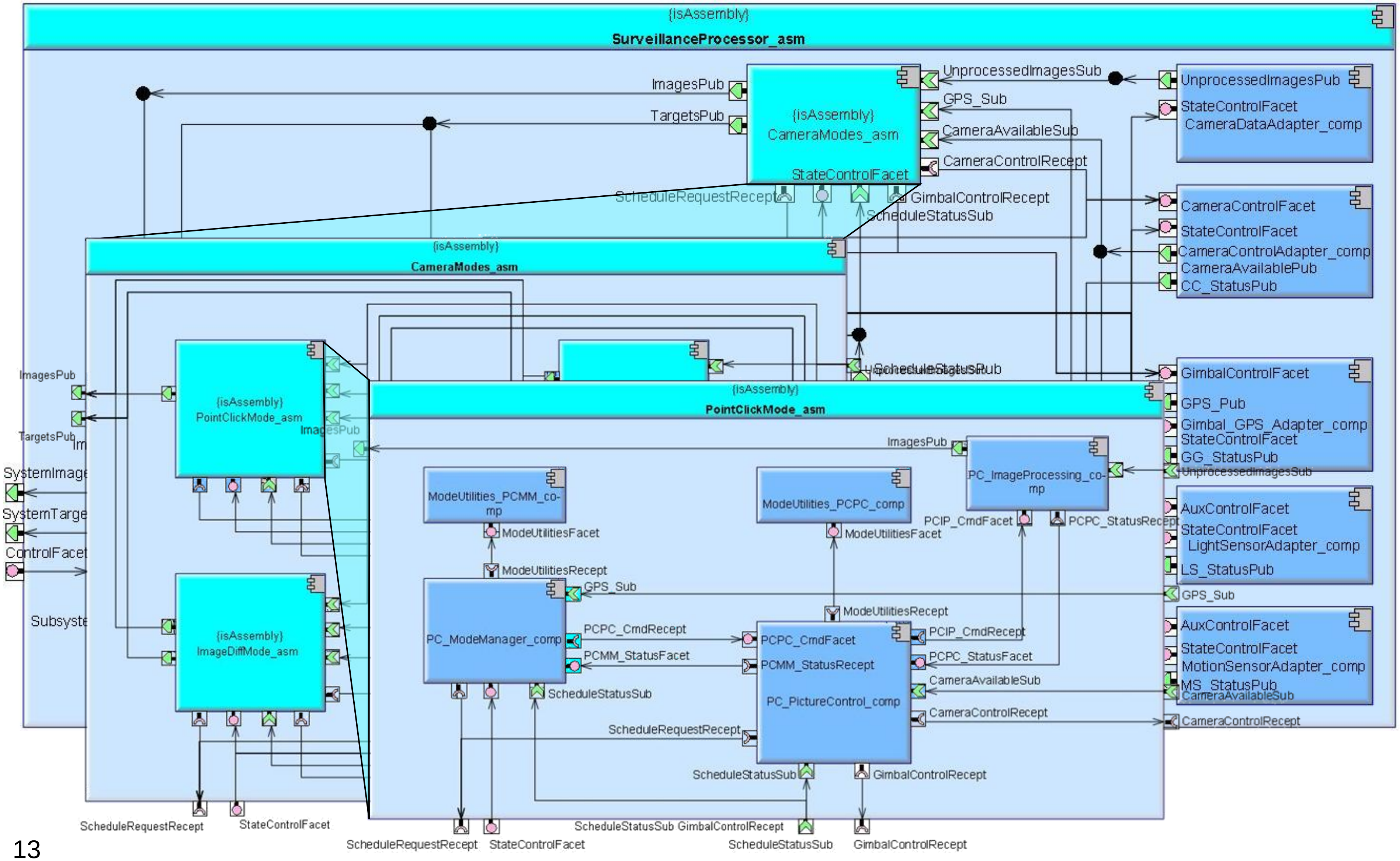
Component Assembly Hierarchy Example

Artisan Studio IDL Profile



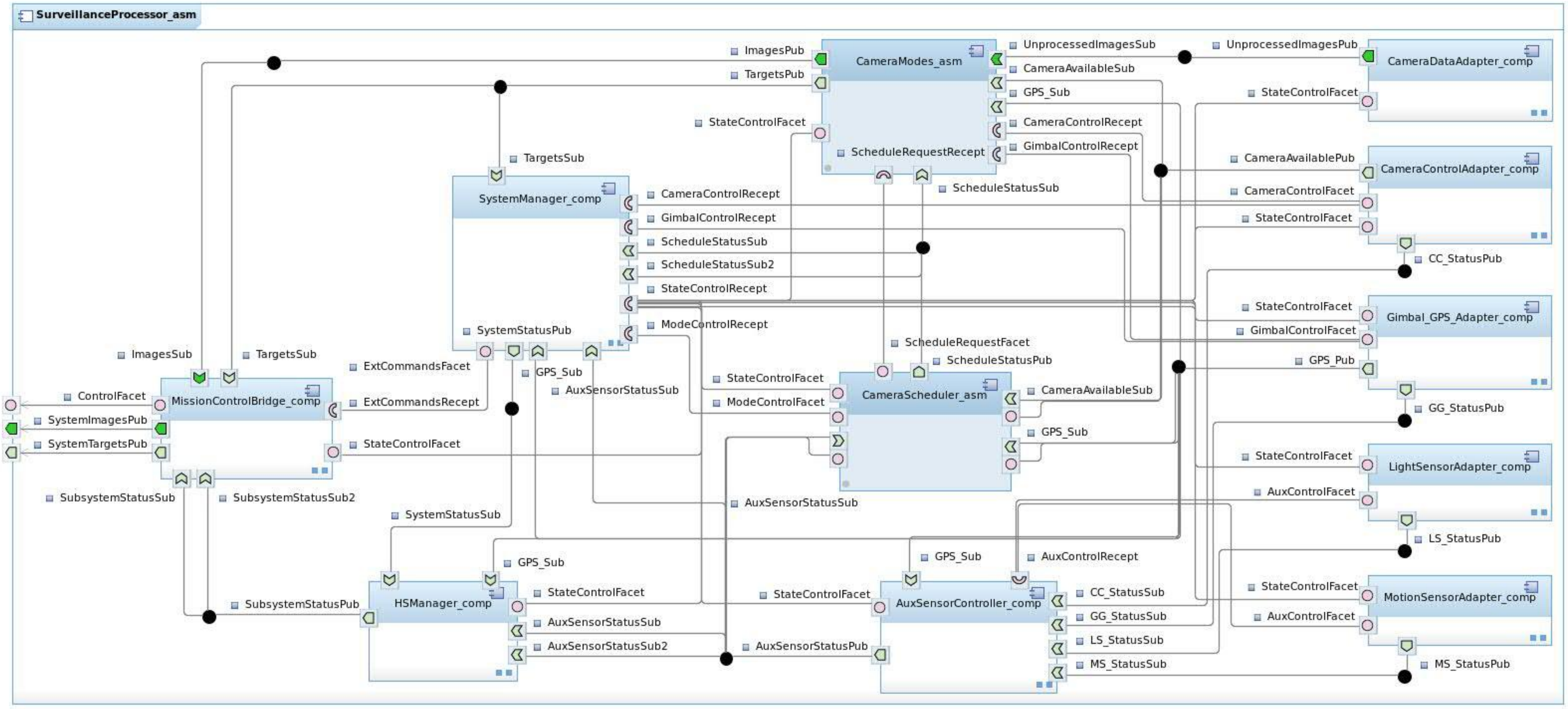
Component Assembly Hierarchy Example

Artisan Studio IDL Profile



Component Assembly Hierarchy Example

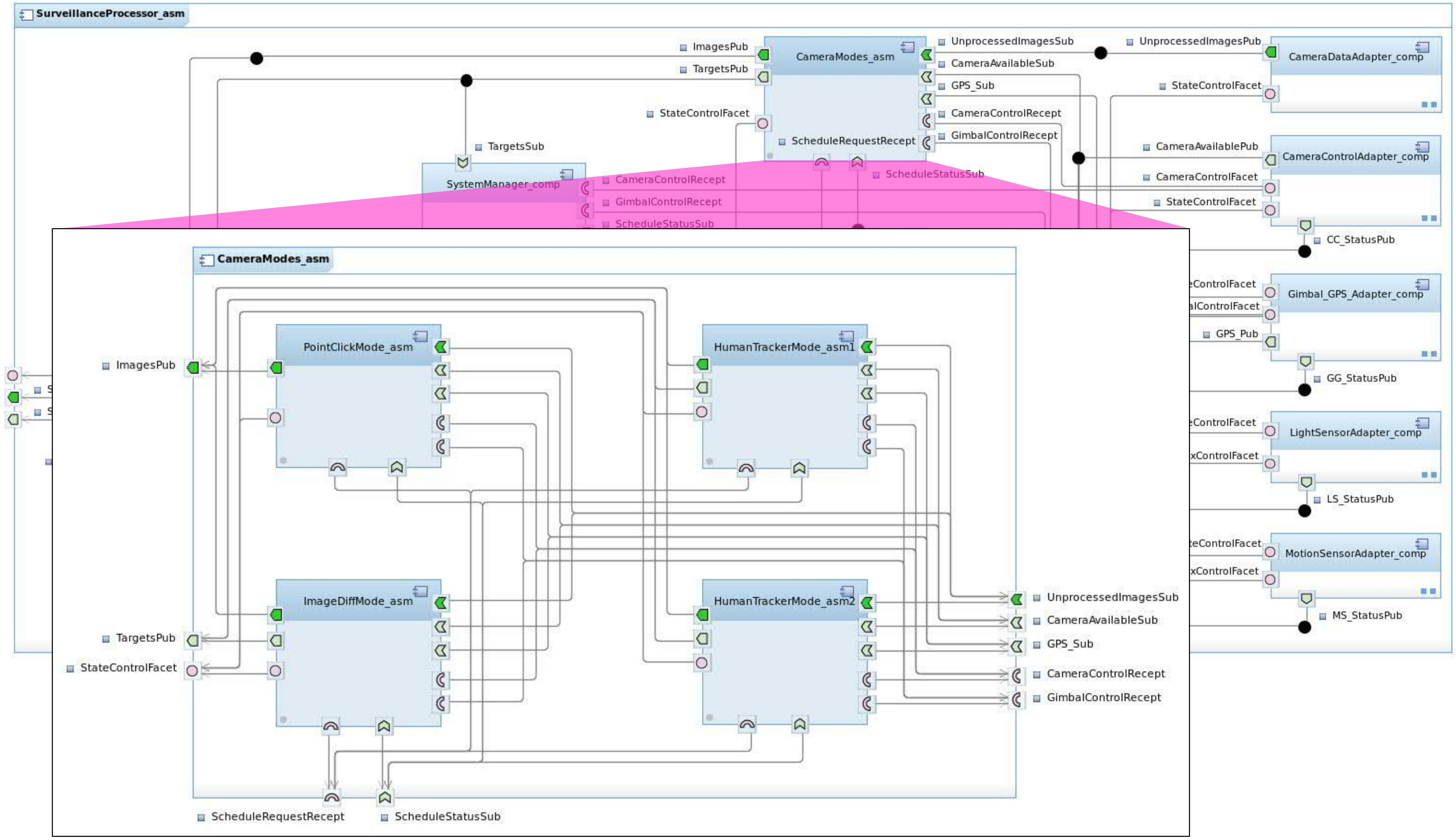
Zeligsoft CX for CBDDS



- C&C style Component Assembly diagrams offer a “software schematic” view of your run-time structural architecture
  - Shows system run-time composition using standard “software parts”
  - Similar to hardware schematics connecting standard hardware parts
  - Connections drawn in an MDA modeling tool are automatically established during the deployment launch phase by the D&C deployment framework – big time/code savings to developers

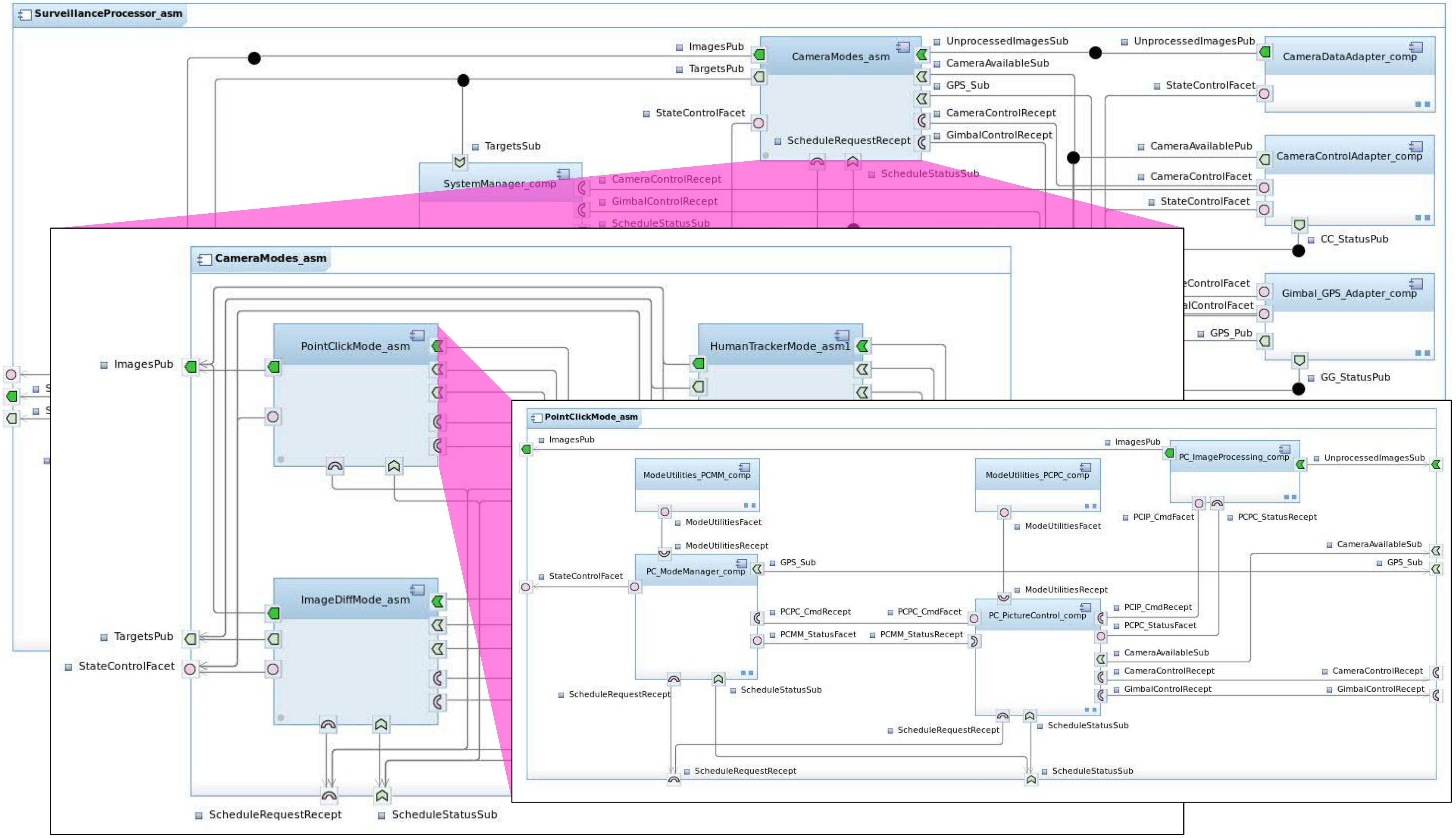
Component Assembly Hierarchy Example

Zeligsoft CX for CBDDS



Component Assembly Hierarchy Example

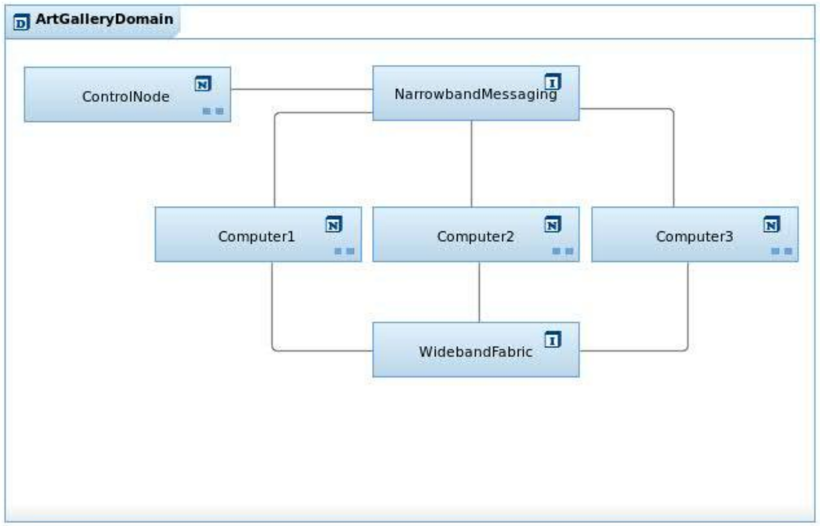
Zeligsoft CX for CBDDS

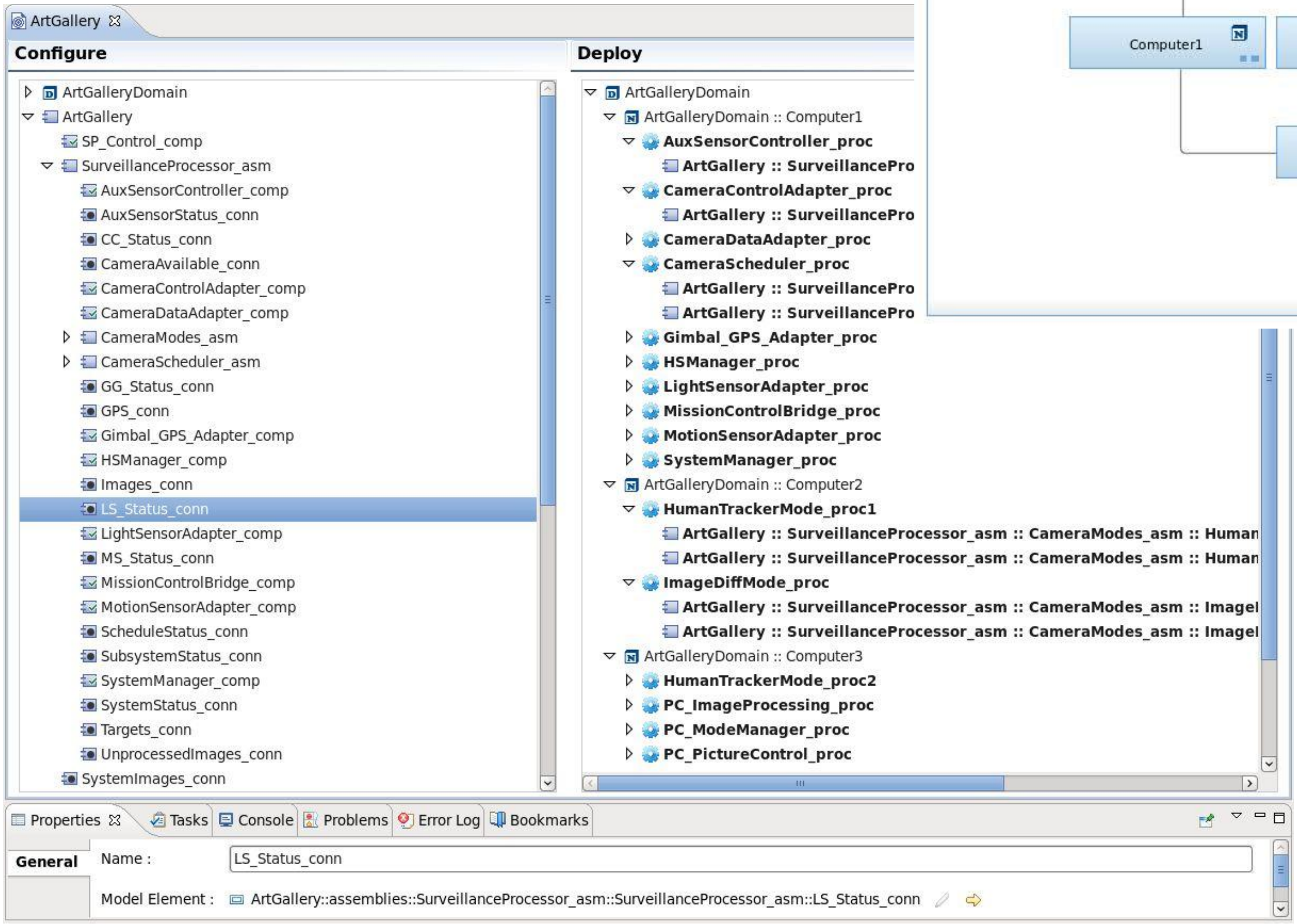


Domain Diagram & Deployment Plan Editor

Zeligsoft CX for CBDDS

- Allocation style Domain & Deployment diagrams capture QoS, config & aspects of system resource utilization for resource allocation and concurrency





Configure

```
▷ ArtGalleryDomain
▽ ArtGallery
    SP_Control_comp
  ▽ SurveillanceProcessor_asm
      AuxSensorController_comp
      AuxSensorStatus_conn
      CC_Status_conn
      CameraAvailable_conn
      CameraControlAdapter_comp
      CameraDataAdapter_comp
    ▷ CameraModes_asm
    ▷ CameraScheduler_asm
      GG_Status_conn
      GPS_conn
      Gimbal_GPS_Adapter_comp
      HSManager_comp
      Images_conn
      LS_Status_conn
      LightSensorAdapter_comp
      MS_Status_conn
      MissionControlBridge_comp
      MotionSensorAdapter_comp
      ScheduleStatus_conn
      SubsystemStatus_conn
      SystemManager_comp
      SystemStatus_conn
      Targets_conn
      UnprocessedImages_conn
    SystemImages_conn
```

Deploy

```
▽ ArtGalleryDomain
  ▽ ArtGalleryDomain :: Computer1
    ▽ AuxSensorController_proc
        ArtGallery :: SurveillancePro
    ▽ CameraControlAdapter_proc
        ArtGallery :: SurveillancePro
    ▷ CameraDataAdapter_proc
    ▽ CameraScheduler_proc
        ArtGallery :: SurveillancePro
        ArtGallery :: SurveillancePro
    ▷ Gimbal_GPS_Adapter_proc
    ▷ HSManager_proc
    ▷ LightSensorAdapter_proc
    ▷ MissionControlBridge_proc
    ▷ MotionSensorAdapter_proc
    ▷ SystemManager_proc
  ▽ ArtGalleryDomain :: Computer2
    ▽ HumanTrackerMode_proc1
        ArtGallery :: SurveillanceProcessor_asm :: CameraModes_asm :: Human
        ArtGallery :: SurveillanceProcessor_asm :: CameraModes_asm :: Human
    ▽ ImageDiffMode_proc
        ArtGallery :: SurveillanceProcessor_asm :: CameraModes_asm :: ImageI
        ArtGallery :: SurveillanceProcessor_asm :: CameraModes_asm :: ImageI
  ▽ ArtGalleryDomain :: Computer3
    ▷ HumanTrackerMode_proc2
    ▷ PC_ImageProcessing_proc
    ▷ PC_ModeManager_proc
    ▷ PC_PictureControl_proc
```

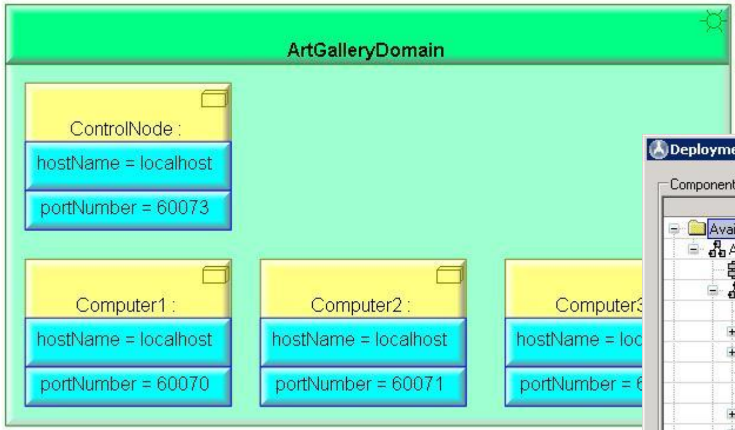
Name : LS_Status_conn

Model Element : ArtGallery::assemblies::SurveillanceProcessor_asm::SurveillanceProcessor_asm::LS_Status_conn

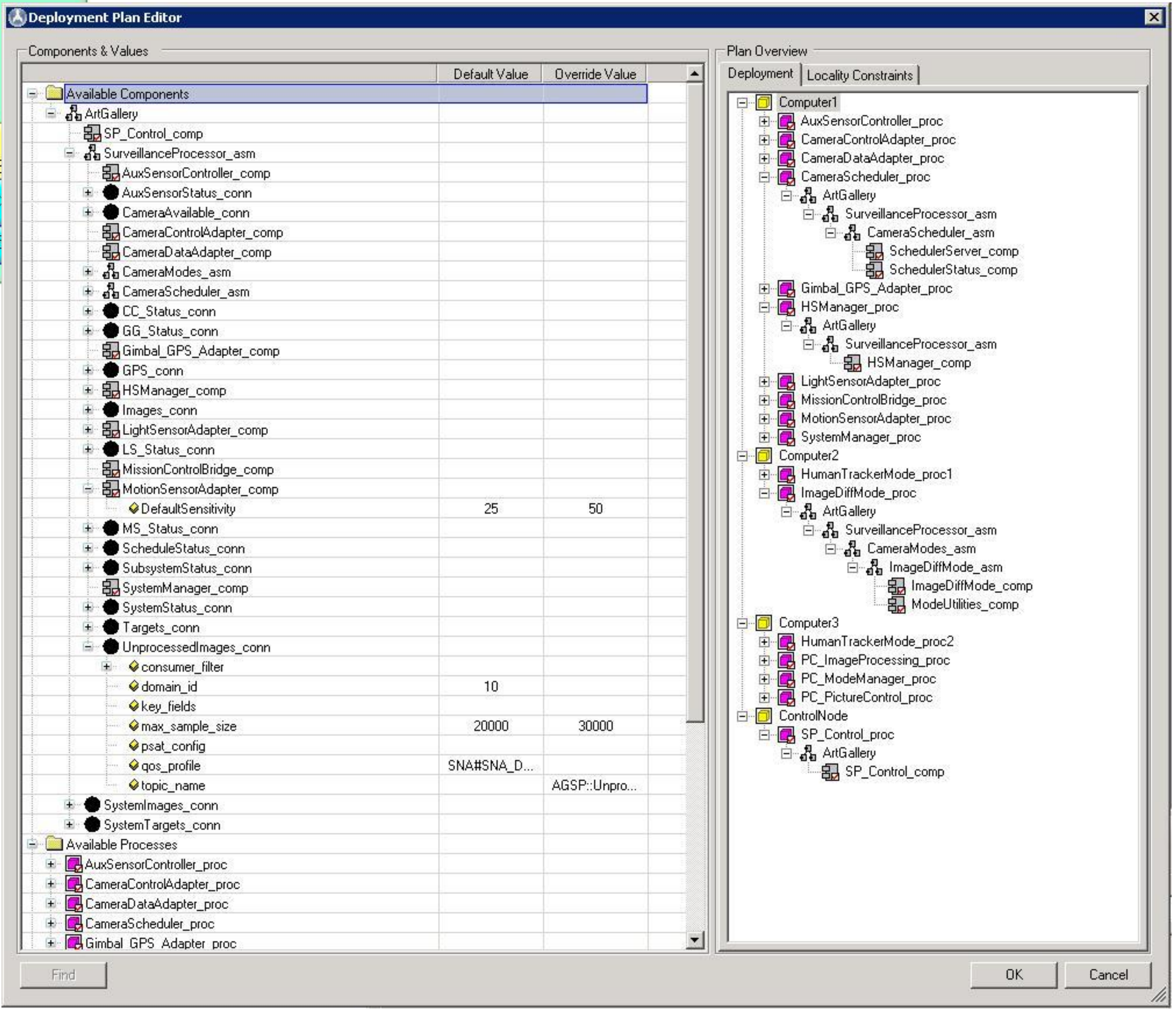
- A Deployment "diagram" maps:
  - Each component instance to a component server process (+ container)
  - Processes to compute nodes (OS instances) defined for a Domain

Domain Diagram & Deployment Plan Editor

Artisan Studio IDL Profile



- Each deployment plan starts with a 1) Domain, 2) Top level assembly (contains component/connector instances & connections), and 3) a set of process instances created for the plan


Deployment Plan Editor

Components & Values

	Default Value	Override Value
Available Components		
ArtGallery		
SP_Control_comp		
SurveillanceProcessor_asm		
AuxSensorController_comp		
AuxSensorStatus_conn		
CameraAvailable_conn		
CameraControlAdapter_comp		
CameraDataAdapter_comp		
CameraModes_asm		
CameraScheduler_asm		
CC_Status_conn		
GG_Status_conn		
Gimbal_GPS_Adapter_comp		
GPS_conn		
HSManager_comp		
Images_conn		
LightSensorAdapter_comp		
LS_Status_conn		
MissionControlBridge_comp		
MotionSensorAdapter_comp		
DefaultSensitivity	25	50
MS_Status_conn		
ScheduleStatus_conn		
SubsystemStatus_conn		
SystemManager_comp		
SystemStatus_conn		
Targets_conn		
UnprocessedImages_conn		
consumer_filter		
domain_id	10	
key_fields		
max_sample_size	20000	30000
psat_config		
qos_profile	SNA#SNA_D...	
topic_name		AGSP::Unpro...
SystemImages_conn		
SystemTargets_conn		
Available Processes		
AuxSensorController_proc		
CameraControlAdapter_proc		
CameraDataAdapter_proc		
CameraScheduler_proc		
Gimbal_GPS_Adapter_proc		

Plan Overview

Deployment | Locality Constraints

```
Computer1
  AuxSensorController_proc
  CameraControlAdapter_proc
  CameraDataAdapter_proc
  CameraScheduler_proc
    ArtGallery
      SurveillanceProcessor_asm
        CameraScheduler_asm
          SchedulerServer_comp
          SchedulerStatus_comp
  Gimbal_GPS_Adapter_proc
  HSManager_proc
    ArtGallery
      SurveillanceProcessor_asm
        HSManager_comp
  LightSensorAdapter_proc
  MissionControlBridge_proc
  MotionSensorAdapter_proc
  SystemManager_proc
Computer2
  HumanTrackerMode_proc1
  ImageDiffMode_proc
    ArtGallery
      SurveillanceProcessor_asm
        CameraModes_asm
          ImageDiffMode_asm
            ImageDiffMode_comp
            ModeUtilities_comp
Computer3
  HumanTrackerMode_proc2
  PC_ImageProcessing_proc
  PC_ModeManager_proc
  PC_PictureControl_proc
ControlNode
  SP_Control_proc
    ArtGallery
      SP_Control_comp
```

Find | OK | Cancel

- The Deployment Plan editor in both tools allows users to set many configurable parameters post-design, later generated to a D&C CDP deployment plan
  - Per-instance user defined component attributes, accessible at run-time
  - Connector attributes, including topic names, domain IDs, QoS profiles & content filter expressions & parameters to auto-define content filtered topics
  - Component server OS process attributes, including name, process priority, and core affinity for real-time tuning

CBDDS Tools Allow Domain Customization

Custom GIS Connectors Built and In Service at NGC

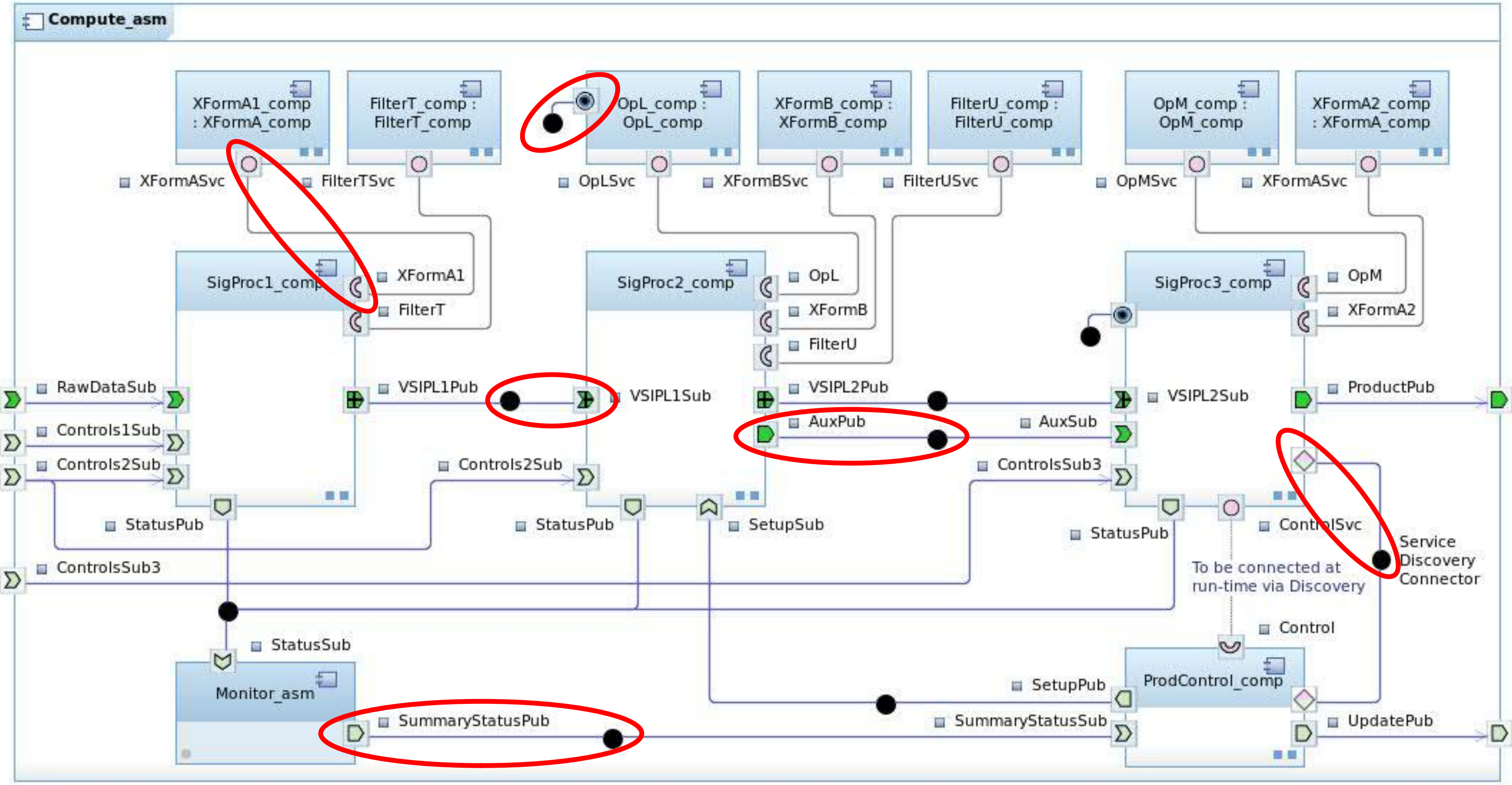
- Publish Subscribe Attachment Transfer (PSAT) connector
  - High performance, general purpose & location independent pub-sub transport of wideband data with DDS signaling
- Signal Processing Data Model (SPDM) connector
  - PSAT extension to support transport of OMG VSIPL++ or VSIPL[1] blocks and views for signal and image processing applications
- Application Instrumentation (AI) connector
  - CBDDS PSM simplification of the DDS PSM, providing a very easy to use encapsulation of in-development OMG AI standard for binary data instrumentation
- Discovery connector
  - Directory services access to support dynamic, run-time registration, discovery/lookup and binding of component service endpoints and topic data

GIS connectors can be built and deployed for team use by users w/o tool vendor support

[1]VSIPL = Vector, Signal & Image Processing Library

Support for User-Defined Connectors

Example Showing Basic and Extended Port Types & Connectors



Basic Port Types

○ Service (Facet)

☾ Client (Receptacle) Sync or Async (AMI4CCM)

Extended Port Types

▷ DDS_Write, DDS_Update

◁ DDS_Listen, DDS_Read, DDS_StateListen, DDS_Get

🟩 PSAT_Write

🟩 PSAT_Listen

✚ SPDM PSAT_Base::PSAT_Write

✚ SPDM PSAT_Base::PSAT_Listen

◉ AI_Save

◇ Discover (Data or Services)

Productivity and Quality Improvement Trends

Model Driven, Component Based CBDDS In Practice

- Use of our CBDDS-based SNA Platform continues to grow at Northrop Grumman
  - Used so far on 14 programs, up to 20 IRAD efforts, with plans and proposals for many more
  - Some efforts are large and complex - 100's of components, deep assembly trees, many compute nodes
- Emerging themes common to all efforts using CBDDS & MDA tools include…
  - Significant productivity gains during design, reduced I&T efforts (shift of focus from I&T to design)
  - Complexity & SLOC reductions (56% reduction on one effort refactored to run on CBDDS)
  - Very high stability in executing systems
  - Shortened overall development times (= lower development costs)
  - Excellent and extremely quick application framework portability between disparate target hardware architectures
- Innate modularity feature of the CBDDS component model enabling improved reuse
  - Independent component, assembly & sub-system product development, as well as modular modeling approaches, further enabled by D&C progressive deployment features
  - Revised sector Software Reuse Library (SRL) built around component based software engineering approaches
- CBDDS is helping to advance and improve MDA for software engineering in general
  - CBDDS ADL proving to be an excellent means of capturing, viewing and sharing high level software architectures between disparate teams
  - Early efforts to extend and integrate with our systems engineering SysML community
  - CDP deployment plans are powerful, yet complex, and definitely require a tool to generate them
    - Side benefit: forces teams to keep model up to date – vs. gen documentation, abandon it & start coding

Where is CBDDS Going in the Future?

- Unified Component Model (UCM)
  - Future alternative to the LwCCM component model used today for CBDDS
  - Transition from LwCCM to UCM anticipated to be straightforward
    - Very similar in approach, common foundational technologies, IDL centric
- Future UCM-based CBDDS framework to offer the following features:
  - Vendor, programming language & middleware agnostic APIs
    - Current LwCCM dependency on CORBA removed
    - Middleware products like DDS, CORBA, others… - become selectable *options*
  - Same fundamental GIS connector framework used today by LwCCM
    - All middleware options abstracted into connectors – no native middleware
    - Enables domain customization and extension
  - All-DDS transport option for both pub-sub and request-reply pattern oriented port APIs
  - Lighter weight, smaller memory/storage footprint, higher performance
- Impact on CBDDS MDA tooling
  - Minimal - most model content & tooling capabilities are already either platform independent (PIM), or IDL specific (high level, middleware agnostic PSM)
  - Add support for extended ports for request-reply as well as pub-sub patterns
  - Updates to OMG D&C CDP descriptor file generation algorithms (backend generator)

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Backup Slides

Abstract

A Component Based DDS (CBDDS) application framework encompasses an integrated suite of seven OMG open standard technologies, including CCM, DDS, DDS4CCM, AMI4CCM, CORBA, IDL and D&C (DEPL). Two relatively new UML-based commercial tools are now generally available from vendors Atego and Zeligsoft to support the full CBDDS technology suite. These tools offer significant productivity gains for development of distributed, real-time, embedded (DRE) component-based applications that leverage DDS, particularly for large, complex systems. Their CBDDS UML profiles and workflows provide support for independent component-oriented engineering design and deployment planning methodologies, and they generate IDL 3.5 and D&C 4.0 compliant file artifacts to greatly simplify the construction of CBDDS deployments. Supplemented by future DDS QoS file generation per a standardized UML4DDS profile, hierarchical CBDDS component & connector (C&C) style dynamic architecture views, plus DDS-annotated IDL file output artifacts, there is also potential value for software intensive systems that leverage a simpler, less-structured, DDS-only messaging framework.

This presentation will provide an overview of the comprehensive features and capabilities available in the Artisan Studio IDL Profile and Zeligsoft CX for CBDDS model-driven tool suites, citing real-world examples, custom DDS4CCM compliant “connector” extensions, and Model Driven Architecture (MDA) lessons learned at Northrop Grumman over the past 3 years through wide application of this technology. We will cover the agile, model-based, component-based development (CBD) process we have established, driven primarily by standards-based file artifacts that enable use of any current or future tool at the various lifecycle stages of CBD development. Finally, we will present the productivity gains we are seeing as a result of building complex DRE systems at the higher, more structured application framework layer of abstraction offered by CBDDS, and the numerous advantages offered by CBDDS over DDS in terms of MDA tooling, enforced modularity, portability, more efficient development, complexity reduction and scalability through threading model encapsulation, and improved component level software reuse.