

# SEMI e-Manufacturing Standards

*A Summary*

**e-Manufacturing Workshop**

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# Current DDA Specifications

- **3507 – Equipment Client Authentication & Authorization**
  - Abstract model of authenticated communication and ACL (Access Control List) management
- **3510 – Equipment Self Description**
  - Abstract model of equipment metadata describing units, types, equipment structure, state models and events, alarms/exceptions, etc.
- **3509 – Data Collection Management**
  - Abstract model of Data Collection Plans, DCP management interface and state models, and DCP reporting formats
  - DDA – Diagnostics Data Acquisition – SEMI Task Force
  - EDA – Equipment Data Acquisition – refers to interface

# EDA Interim Solution & Supporting Stds

- **3563 – Proposed Standard for Equipment Data Acquisition**
  - Concrete specification of SOAP 1.1 reduced-scope interface for data collection
  - Definition of an ‘interim’ interface to synchronize the industry on concepts and technology
  - Facilitate near-term e-Diagnostic systems while specs are developed
  - Proposed Standard to be introduced at SEMICON Japan, 2002.
- **Common Equipment Model (CEM)**
  - Documents the model of physical equipment structure
  - ✓ Doc. 3522A passed at SEMICON Southwest 2002
- **Guidelines for XML Usage Within SEMI**
  - ✓ XML Style Guide – Doc. 3523 passed at SEMICON Southwest 2002
  - XML Messaging - Draft in Q4, 2002, Ballot at Winter Mtgs 2003
  - Common XML Components - Draft in Q4, 2002, Ballot by Winter 2003

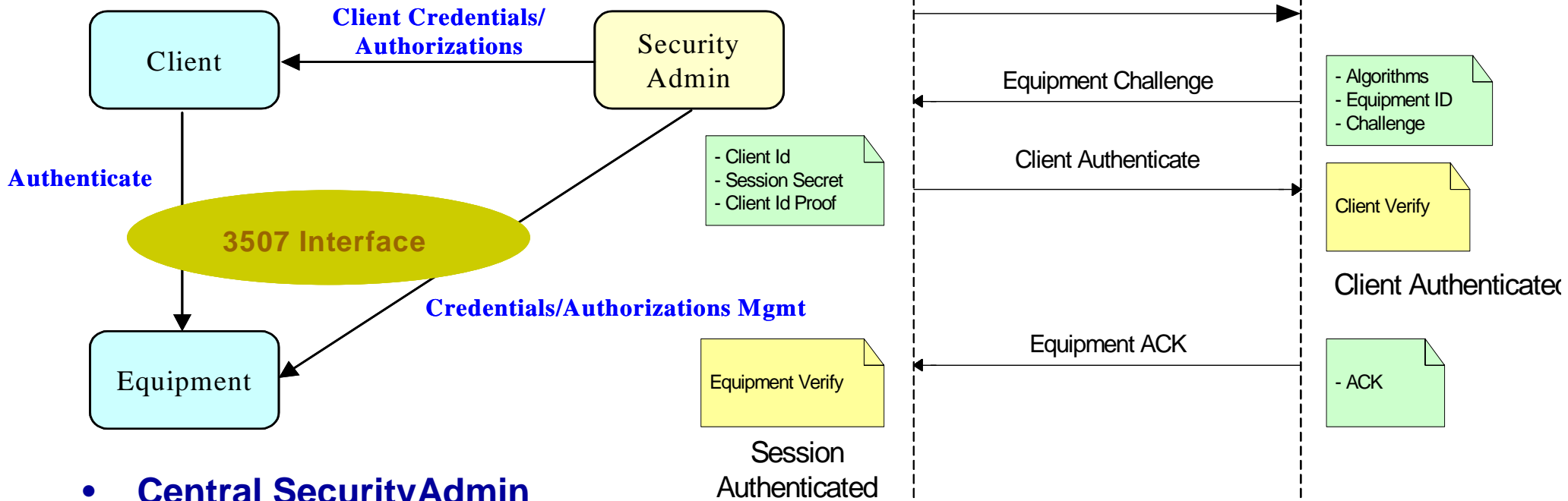
# Additional e-Manufacturing Standards

- **Recipe and Adjustable Parameters (RAP)**
  - Focused on improved recipe parameterization, documentation of recipe content, and facilitation of host-side recipe management
  - Updated RAP pre-ballot currently available
  - Ballot targeted for 2003 N.A. Winter Meetings (March)
- **Process Control Systems**
  - Defining input requirements for process control and interactions among control systems
  - First element of “Interface B” – ballot expected in 2003
- **Integrated Measurement**
  - Standardized integration of 3<sup>rd</sup> party metrology modules with process equipment
  - Enables on-board APC, FDC, etc.
  - Yellow ballot expected for 2003 Winter Meetings
- **Data Quality**
  - Defining Data Quality metrics and test methods
  - Building on ISMT TP2 and Atlas programs

# 3507 – Authentication & Authorization

- **Purpose**
  - Control of which applications may communicate with the equipment
  - Control of which equipment capabilities may be used by the client
- **Scope**
  - EDA interface only (SECS-II communication will not be addressed)
  - Implementation to be specified separately in 3507.1
- **Goals**
  - Centralized administration of client credentials
  - Scalable from “single equipment--single client” to “many-to-many”
  - Efficient authentication - once during a session
- **Benefits**
  - Helps protect equipment from unauthorized data collection loads
  - Limits the flow of equipment data to legal clients
  - Enables enforcement of factory “single-point-of-control” policies

# Authentication Model

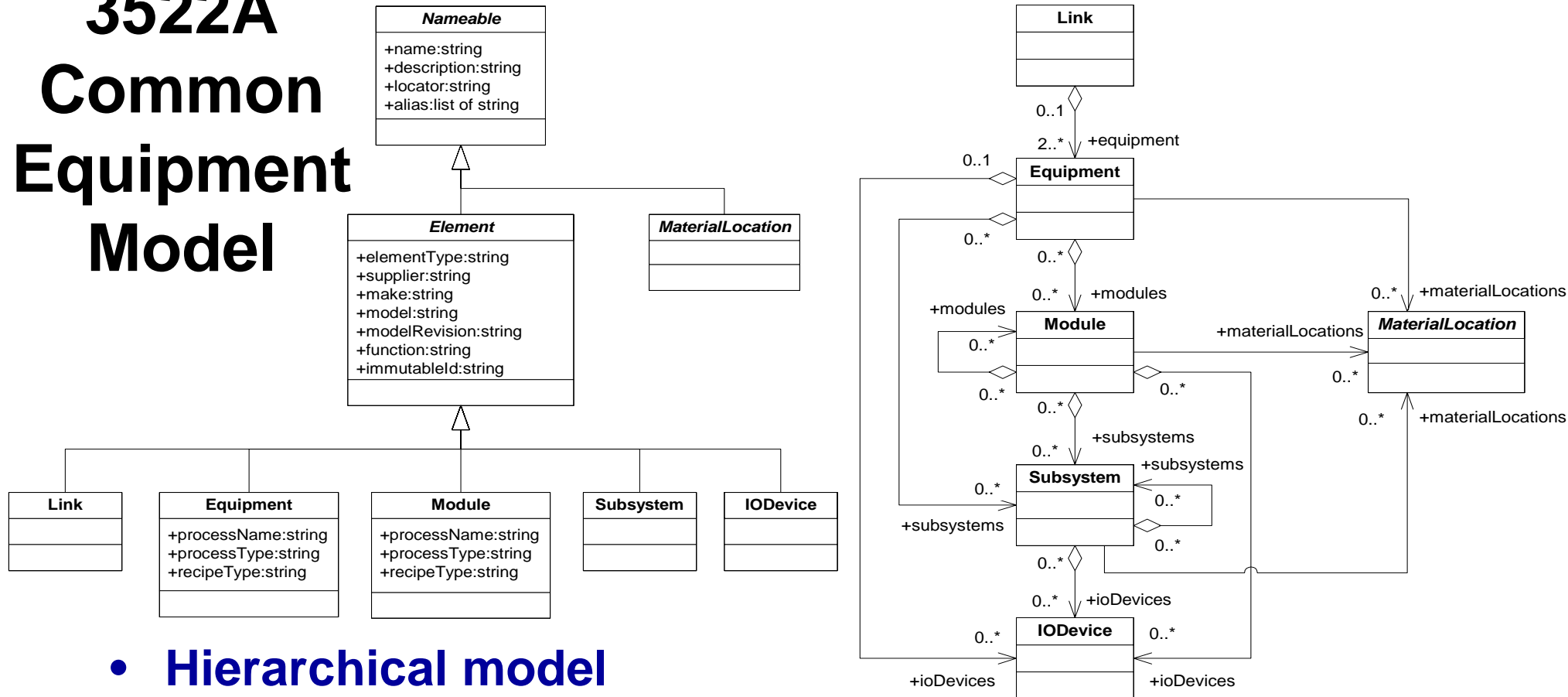


- **Central SecurityAdmin**
  - Implemented by factory, assigns credentials to applications
- **Equipment client**
  - Establishes session with equipment, provides credentials
- **Equipment**
  - Challenges client for credentials, denies session if not accepted

# 3522A – Common Equipment Model

- **Purpose**
  - Enable common approach for description of physical equipment structure
    - Enable the factory to comprehend key elements of equipment structure
    - As basis for other SEMI standards that depend on equipment structure
- **Scope**
  - Factory production equipment down to the actuator/sensor level.
  - Behavior is left to other standards defining specific functions
- **Goals**
  - Accommodate all known equipment configurations
  - Maintain consistency with other SEMI automation standards
    - For example, modeling of actuators/sensors should be consistent with SensorBus models
- **Benefits**
  - Standard mechanism for describing physical equipment structure
  - Basis for enabling data collection targeted at specific equipment components

# 3522A Common Equipment Model



- Hierarchical model
- Supports description of low-level sensors, higher-level processing modules, and the overall equipment
- Allows ‘nesting’ (e.g., modules within modules)

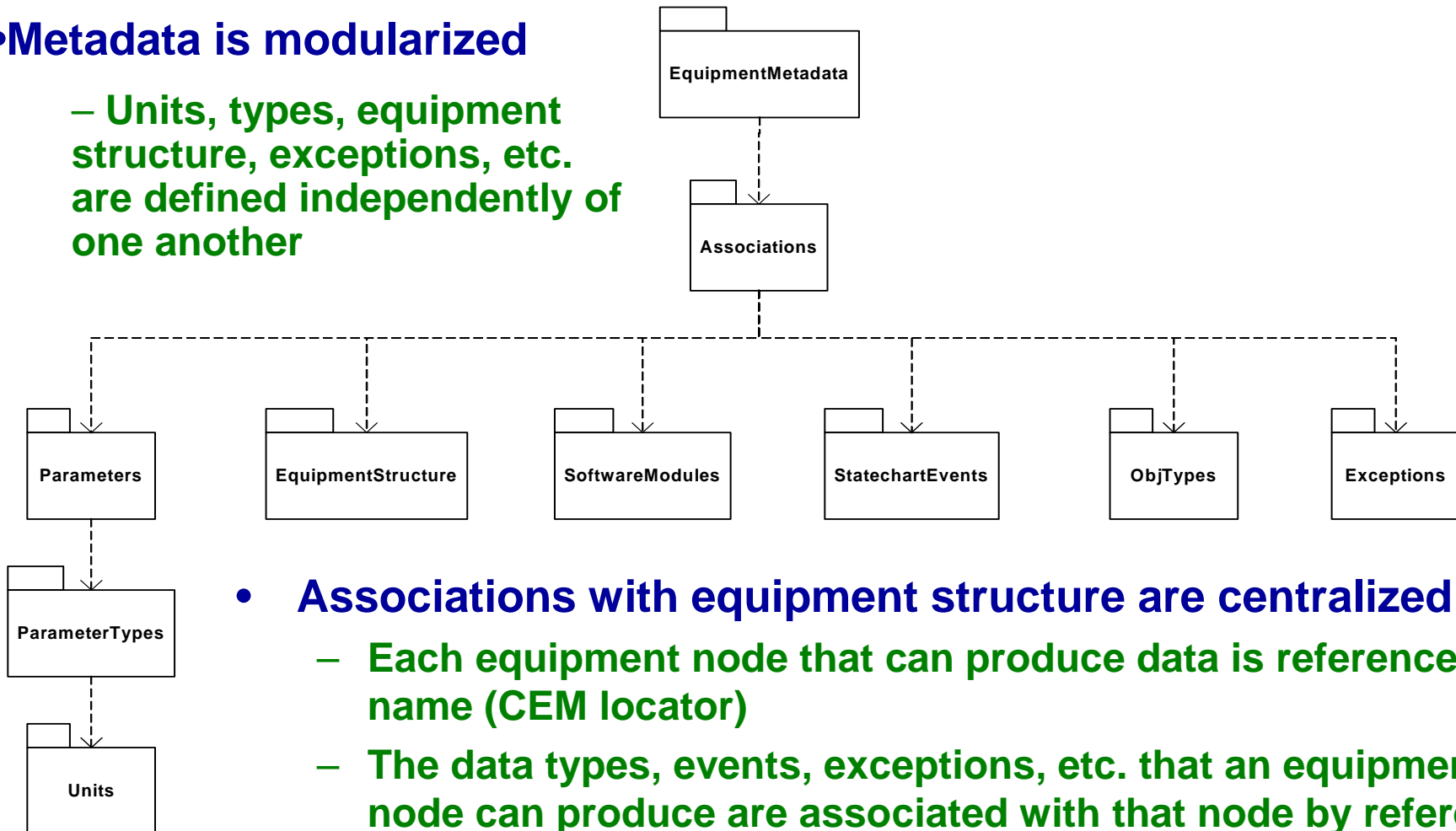
# 3510 – Equipment Self Description

- **Purpose**
  - Allow automated discovery of in-depth equipment description
- **Scope**
  - Includes equipment structure (via CEM), events, alarms & exceptions, data/configuration/control parameters, state models, types, and units,
  - Implementation to be specified separately in 3510.1
- **Goals**
  - Sufficient information provided as efficiently as possible
  - Data item, event, and exception descriptions compatible with 3509
  - Discovery of details of suppliers implementation of standards
  - Discovery of supplier specific data, models, etc.
- **Benefits**
  - Enables automated data collection setup
  - Enables generic applications to provide “data menus” for engineers
  - Improved mechanism for preventing equipment-host mismatch

# 3510 Equipment Metadata

## <sup>a</sup> Metadata is modularized

– Units, types, equipment structure, exceptions, etc. are defined independently of one another



- **Associations with equipment structure are centralized**
  - Each equipment node that can produce data is referenced by name (CEM locator)
  - The data types, events, exceptions, etc. that an equipment node can produce are associated with that node by reference to a unique id

# 3510 Metadata Access

```
«interface»  
EquipmentMetadataManager  
+GetUnits()  
+GetTypes()  
+GetSoftwareModules()  
+GetEquipmentStatecharts()  
+GetSEMISatecharts()  
+GetObjTypes()  
+GetExceptions()  
+GetEquipmentStructure()  
+GetEquipmentAssociations()
```

- **Equipment metadata is supplier-sensitive information**
  - Access to it is via an authenticated session with the equipment
- **Metadata interface is modular**
  - Follows the modularity of each type of metadata

# 3509 – Data Collection Management

- **Purpose**

- Provide a means to organize all data needs (trace, exception, event) into logical, named units that can be individually controlled

- **Scope**

- Data collection plan (DCP) definition,
- DCP management interface,
- State models,
- Data reporting formats
- Implementation to be specified separately in 3510.1

- **Features**

- Event-driven “push” style data collection (events, traces, exceptions)
- On-tool buffering of collected data
- Equipment performance warnings
- DCP management privilege model

## 3509 (cont.)

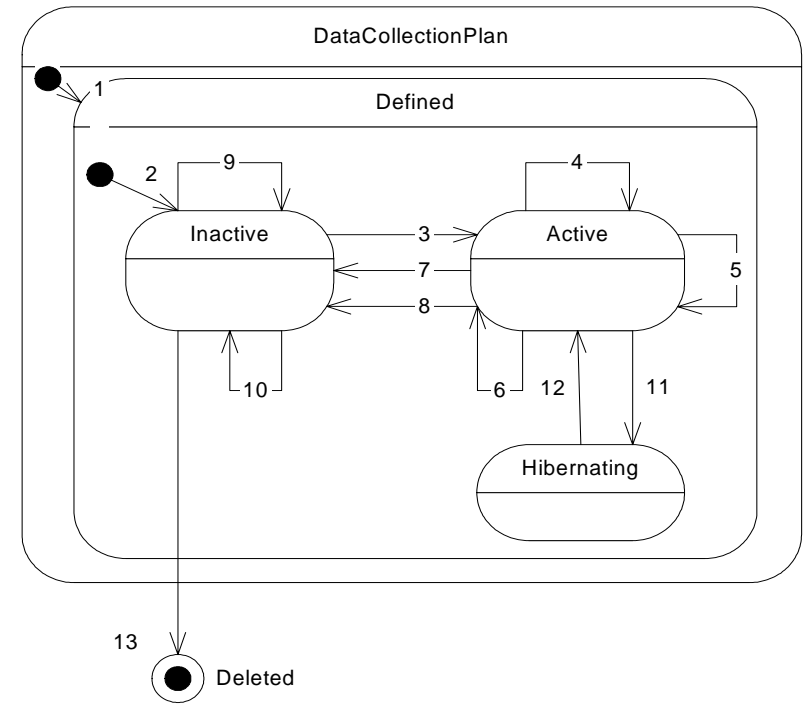
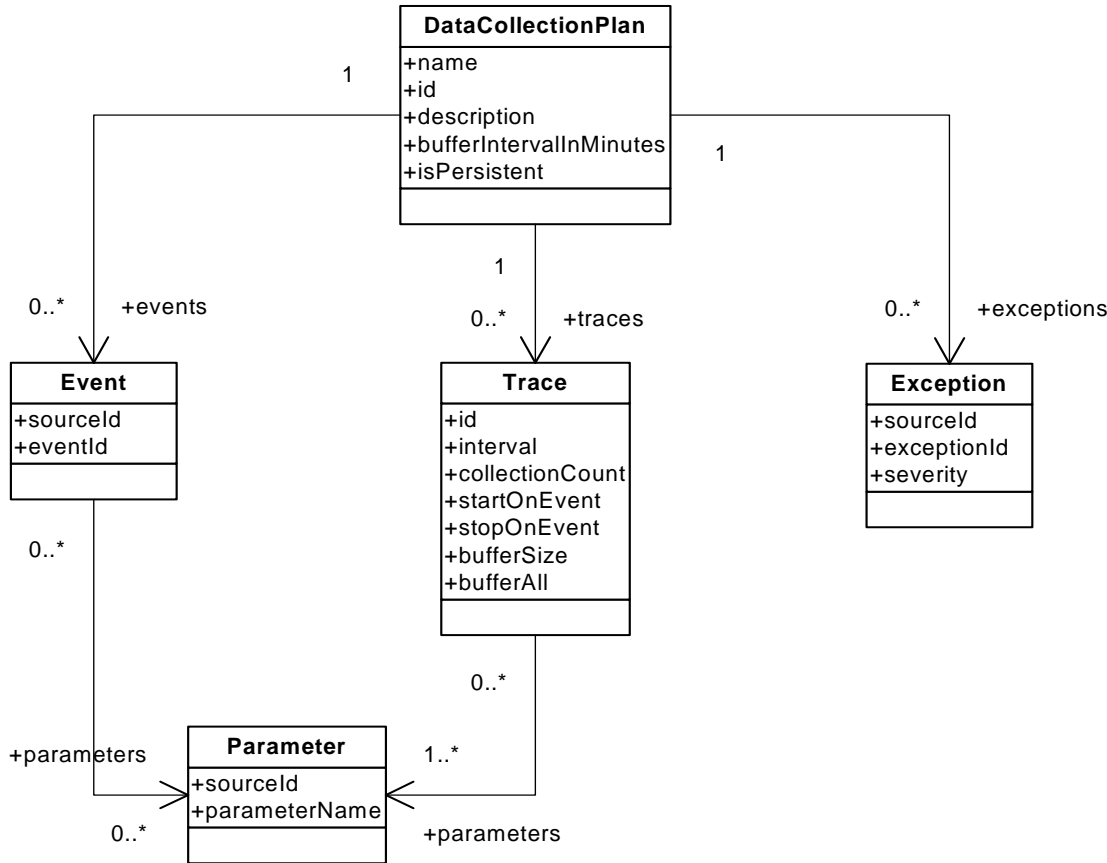
- **Goals**

- Compatibility with 3510 definition of data, events, etc.
- Control client access to data collection functions
- Support data collection needs for diagnostic, health monitoring, utilization tracking, and process control
- Support multiple independent clients
- Permit data collection during equipment power-up

- **Benefits**

- Enables data collection independently of the SECS-II control interface
- Simplifies data collection setup for all applications
  - one message to define, one to activate
- Improves management of data collection through named DCP's
- Non-real-time applications can utilize buffering features to collect data that need not be streamed

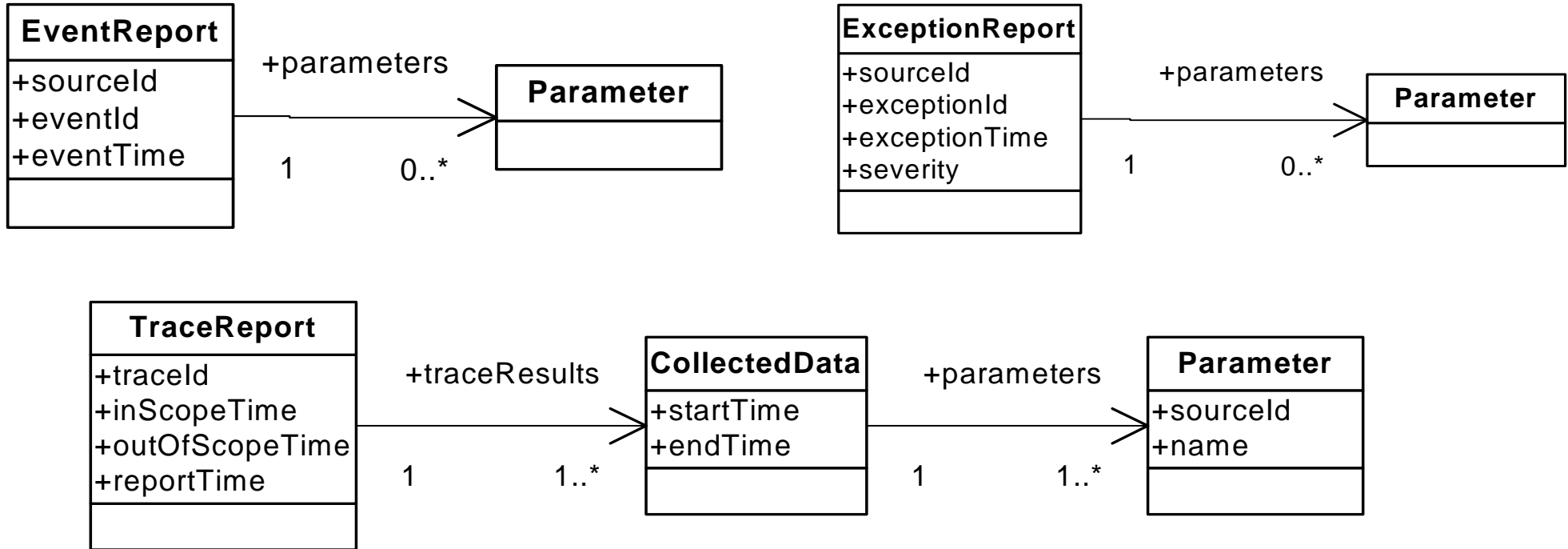
# 3509 Data Collection Plans



- Data items are identified by two fields
  - Source and identifier
- Each plan can include all data needed for a specific purpose
  - Events, exceptions, and trace data

- DCP's can specify on-tool buffering policy for all data
- DCP's can be 'active' across equipment shutdowns
  - Permits collection of data during power up
- Acquisition follows 'push' model

# 3509 Data Collection Reports



- **Defines formats for communicating each type of data**
  - **Includes specification of timestamp format & resolution**

# 3563 – EDA Proposed Standard

- **Purpose**

- Provide a means for the semiconductor industry to begin prototyping and early development of essential EDA concepts using the targeted technology

- **Scope**

- Event-driven “push” style data collection (events & exceptions)
- On-tool buffering of collected data is supported
- Equipment performance warnings
- DCP management via SOAP or SECS-II

- **Implementation**

- Specified inline using SOAP1.1 and HTTP1.1
- XML Schema and WSDL documents provided separately from the standard document itself

## 3563 (cont.)

- **Goals**

- Small in scope (compared to the full suite of standards)
- Based on target technologies (XML, SOAP)
- Features & concepts that are analogous to those defined in the long-term specifications (3507, 3509, 3510)
- Implement-able on current generation of 300mm equipment
- Sufficient flexibility to permit experimentation and learning

- **Benefits**

- Encourages **early adoption** and prototyping of EDA solutions
- Employs standard, open, **mainstream technologies** for enhanced interface performance
- Mitigates risk associated with transition to new technology

**3563 Proposed Standard To Be Voted by I&CC This Week**

## 3563 - Differences in scope

- **Metadata concepts and formats not specified**
- **Data collection plan formats and definition process not specified**
- **Authentication and authorization not required**
- **Multi-client support not required**
- **Data management messages can alternatively be sent via SECS-II**

# Standards Roadmap

SEMI Document/Standard	2002	2002	2002	2002	2003	2003	2003	2003	2004
	Cycle 1 Winter Mtg US/Jpn SEMICON Europa	Cycle 2 SEMICON West Japan June Mtgs	Cycle 3 SEMICON Southwest	Cycle 4 SEMICON Japan	Cycle 1 Winter Mtg US/Jpn SEMICON Europa	Cycle 2 SEMICON West Japan June Mtgs	Cycle 3 SEMICON Southwest	Cycle 4 SEMICON Japan	Cycle 1 Winter Mtg US/Jpn SEMICON Europa
<b>EEC Related Standards Activities</b>									
International Equipment Engineering (IEE)									
#TBD - Time Synchronization			Interim I/F Complete			Blue Ballot	Yellow	Interface C to be Addressed in 2003	
<b>Diagnostics Data Acquisition (DDA)</b>									
#3571 - e-Diagnostics Guide (Overview)		SNARF			Blue Ballot	Yellow Ballot	2nd Yellow		
#3563 - EDA Interim Interface (was 3508)	Blue Ballot	Guideline		Prop Std					
#3509 - Data Collection Std.	Blue Ballot			Yellow Ballot		Re-Ballot			
#3510 - Meta Data/Equipment Descr.	Blue Ballot			Yellow Ballot	Re-Ballot				
#3507 - Authentication/Security	Blue Ballot			Yellow Ballot		Re-Ballot			
#TBD - 3510.1 Tech. Spec (XML/SOAP)					SNARF	Blue Ballot	Yellow Ballot		2nd Yellow
#TBD - 3507.1 Tech. Spec (XML/SOAP)				XML Guidelines	SNARF	Blue Ballot	Yellow Ballot		2nd Yellow
#TBD - 3509.1 Tech. Spec (XML/SOAP)					SNARF	Blue Ballot	Yellow Ballot		2nd Yellow
<b>XML</b>									
#3523 - XML Style & Usage Guidelines	SNARF	Yellow Ballot	Re-Ballot	<<Passed					
#3569 - XML Messaging Protocols		SNARF	Blue Ballot		Yellow Ballot				
#3570 - XML Common Components (Data)		SNARF	Blue Ballot		Yellow Ballot	Expansion	Expansion		
#???? - Extend 3523A - XML Style Guide					Yellow Ballot				RaP Standardized
<b>Recipe and Adjustable Parameters (RaP)</b>									
#3442 - RaP Standard (split to 3649-50)		Blue Ballot		Blue Ballot					
#3649 - Recipe and Parameter Mgt					Yellow Ballot				
#3650 - Recipe Structure					Blue Ballot	Yellow Ballot			
#TBD - RaP Mapping to XML					Blue Ballot		Yellow Ballot		
<b>Data Quality (DQ)</b>									
#3652 - Data Quality		TFOF			Blue Ballot	Yellow Ballot			1st Interface B Standard
<b>Process Control System (PCS)</b>									
#3527 - Process Control System Std.	SNARF		Blue Ballot		Yellow Ballot	Re-Ballot			
#3634 - Withdrawal of E93					Yellow Ballot				
<b>Integrated Measurement (IM)</b>									
#3529 - IM Object-Based IM Modules	Preview Doc	Blue Ballot	No Ballot		Re-Ballot				Integr. Metrology
<b>Object-Based Equipment Model (OBEM)</b>									
#3493 - OBEM-XML Mapping (Japan)	Yellow Ballot		Common Equipment Model Standardized	Re-Ballot					
#3522 - Common Equipment Model		Yellow Ballot	Re-Ballot	<<Passed					
#3568 - XML Schema for CEM				Blue Ballot	Yellow Ballot				
#3645 - Revise E98					Yellow Ballot				
#3646 - CEM - Remove Provisional Status					Yellow Ballot				
<b>Equipment Control Systems (ECS)</b>									
#3511 Key Quality (Control) Parameters	Preview Doc	Yellow Ballot	Re-Ballot		Re-Ballot	Expansion			
<b>Equipment Performance Tracking (EPT)</b>									
#3296 - Provisional EPT Standard	Passed E116								EPT Standardized
#3564 - E116.1 SECSII Mapping			Yellow Ballot	<<Passed					
#3565 - Revisions to E116			Yellow Ballot	<<3/4 Passed	Re-Ballot				
#3566 - Revisions to E116			Blue Ballot		Yellow Ballot				
#3647 - Revise E116.1 EPT					Yellow Ballot				
#3648 - Revise E116 EPT					Yellow Ballot				
<b>Electronic Service Docum. (ESD)</b>									
#3651 - XML Info Model for ESD					Yellow Ballot				

# Summary

- **DDA Long-Term Specifications**
  - Secure, flexible, self-describing data collection
  - Conceptual models nearing acceptable level of completeness
  - Need ongoing input from supplier and ICM communities on applicability and functionality through active participation in TF activities and reviews
- **DDA Interim Specification**
  - Scaled-down self-describing data collection
  - Need engagement in prototyping and pilot activities to enable early implementations based on the long-term concepts and technologies
- **XML Mappings for Long-Term Specs will Follow**
- **Additional e-Manufacturing Standards will Build on DDA work**



JEITA



# Backup Foils



# UML References

## 1 UML Specification

- Unified Modeling Language (UML) Specification, Version 1.4, OMG Specification 01-09-67, available from [http://www.omg.org/technology/documents/modeling\\_spec\\_catalog.htm](http://www.omg.org/technology/documents/modeling_spec_catalog.htm).

## 2 Web Tutorials

- “Practical UML - A Hands-On Introduction for Developers” from TogetherSoft, available at [http://www.togethersoft.com/services/practical\\_guides/umlonlinecourse/index.html](http://www.togethersoft.com/services/practical_guides/umlonlinecourse/index.html).
- “UML Tutorial” from Sparx Systems, available at [http://www.sparxsystems.com.au/UML\\_Tutorial.htm](http://www.sparxsystems.com.au/UML_Tutorial.htm).
- “An Introduction To The Unified Modeling Language (UML)” from CraG Systems, available at [http://www.cragystems.co.uk/UMLIntro1\\_files/frame.htm](http://www.cragystems.co.uk/UMLIntro1_files/frame.htm).
- “UML Poster” from Rational, available at [http://www.rational.com/uml/resources/quick/uml\\_poster.jsp](http://www.rational.com/uml/resources/quick/uml_poster.jsp).
- “UML Tutorials” from TutuorialFind available at <http://www.tutorialfind.com/tutorials/programming/uml>.

## 3 Other Web Resources

- “UML Resource Page” from OMG, available at <http://www.omg.org/uml>.
- “UML Resource Center” from Rational, available at <http://www.rational.com/uml>.
- “UML Central” from Embarcadero Technologies, available at [http://www.embarcadero.com/support/uml\\_central.asp](http://www.embarcadero.com/support/uml_central.asp).

## 4 Introductory Books

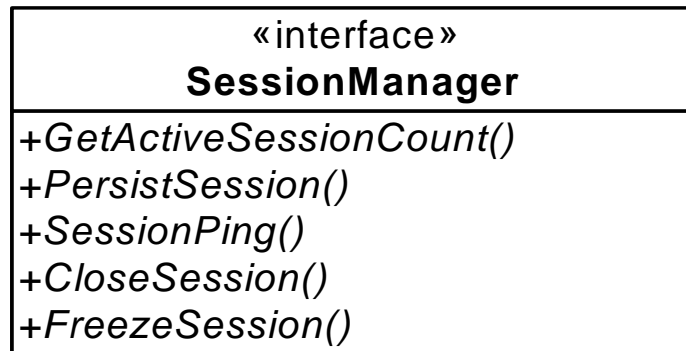
- UML Distilled: A Brief Guide to the Standard Object Modeling Language (2nd Edition), Martin Fowler, ISBN: 020165783X, 1999
- Fundamentals of Object-Oriented Design in UML; Meilir Page-Jones; ISBN: 020169946X; 1999.
- The Complete UML Training Course, Student Edition; Grady Booch, James Rumbaugh, Ivar Jacobson; ISBN: 0130870137; 2000

## 5 Reference Books

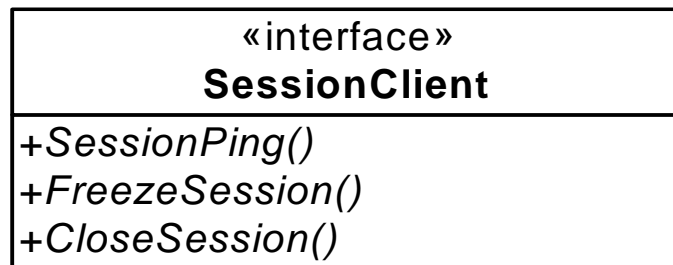
- The Unified Modeling Language User Guide; Grady Booch, Ivar Jacobson, James Rumbaugh; ISBN: 0201571684; 1998
- The Unified Modeling Language Reference Manual (Addison-Wesley Object Technology Series); James Rumbaugh, Ivar Jacobson, Grady Booch; ISBN: 020130998X. 1998



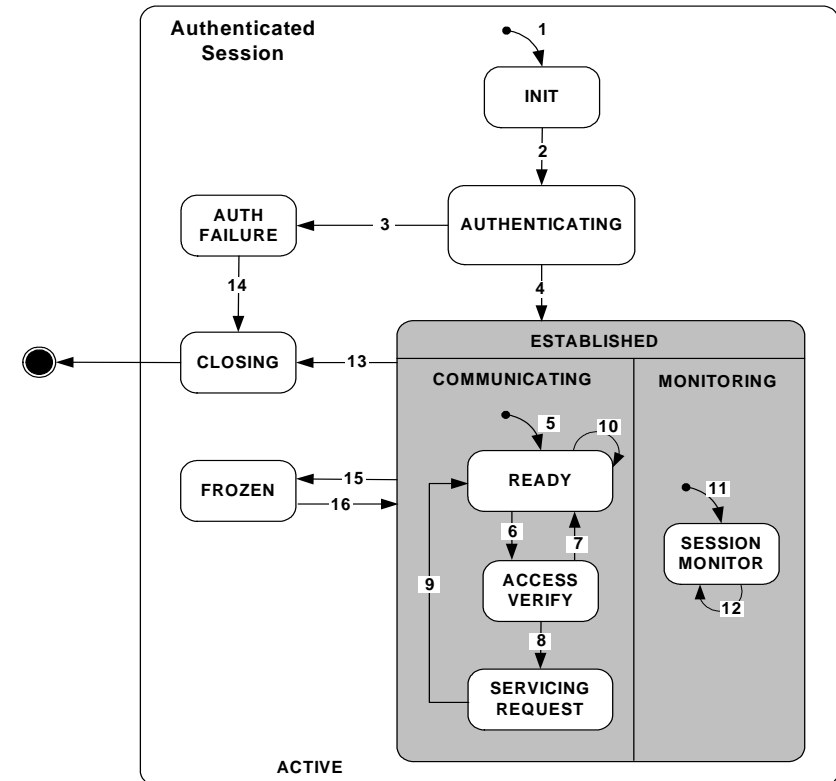
# 3507 Session Management



Implemented by Equipment

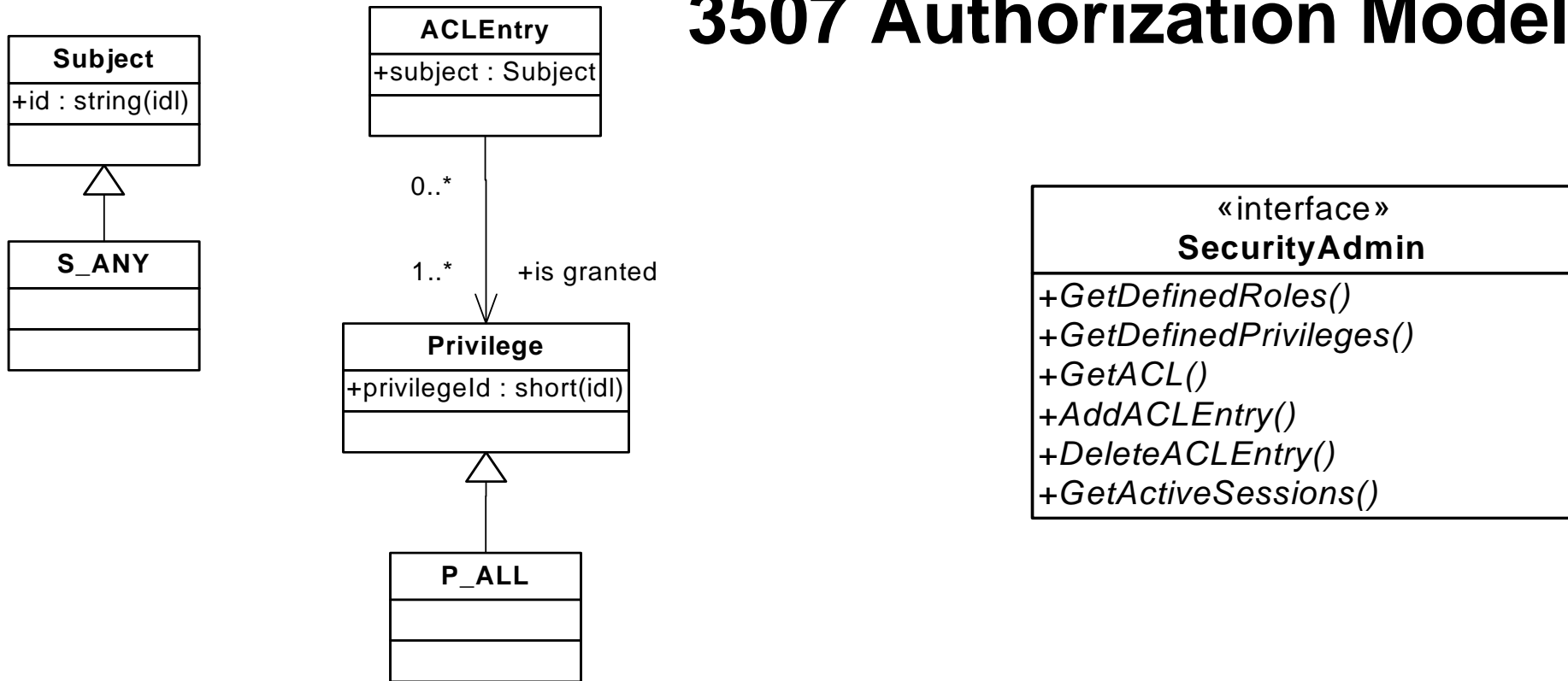


Implemented by Equipment Clients



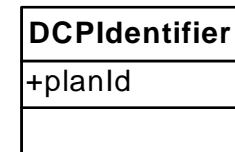
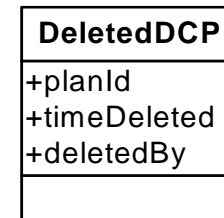
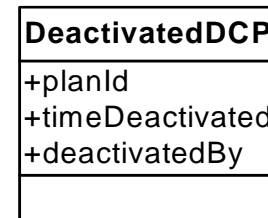
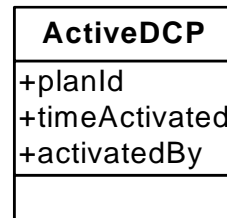
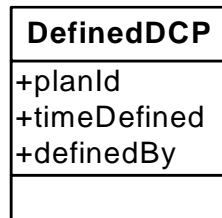
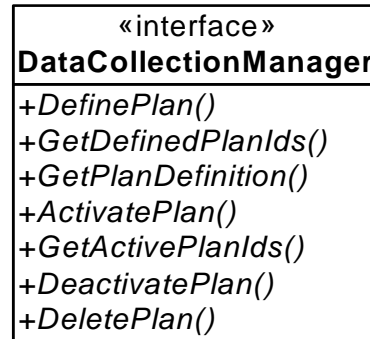
- **Equipment communication scoped by “sessions”**
  - Session is created if client successfully authenticates
- **Client sends messages to begin and end sessions**
  - Admin (only) has privilege to end any client’s session
- **Sessions can be ‘persisted’ across shutdowns**
  - Facilitates notification to clients of equipment availability

# 3507 Authorization Model



- Security principals are represented as “Subjects”
  - Can be an application id or a role
- Privileges are assigned to subjects to create an ACL entry
  - All service requests originating from a principal are checked against these entries before the request can proceed

# 3509 DCP Management



- **Equipment supports DCP management interface**
  - Definition, lookup, activation, de-activation, deletion, etc.
- **Key operations have associated privileges**
  - Helps support factory single point of control policies
- **No a-priori limitations**
  - No pre-specified limit to number of plans that can be defined or concurrently activated

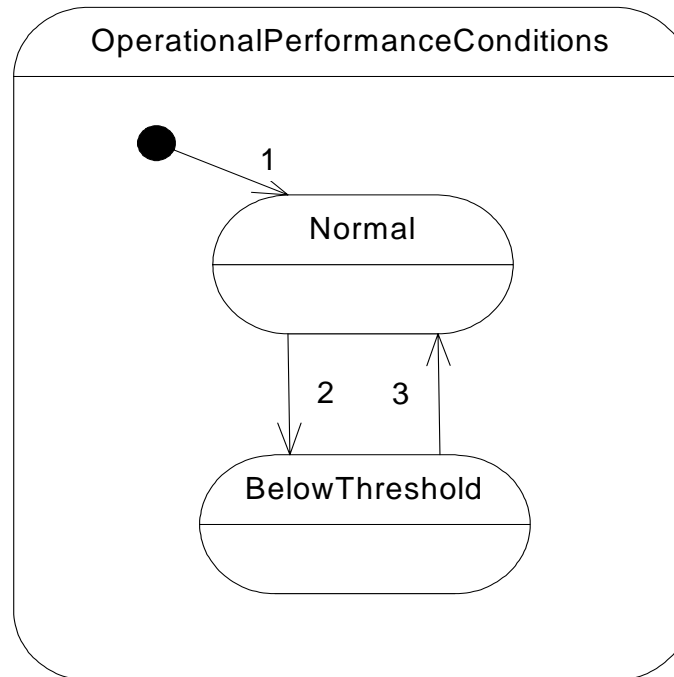


# 3509 DCP Management Privilege Model

«privilege» DefinePlans	«privilege» ViewAnyPlanDefinintion	«privilege» ActivateAnyPlan	«privilege» ViewAllActivePlans	«privilege» DeactivateAnyPlan	«privilege» DeleteAnyPlan

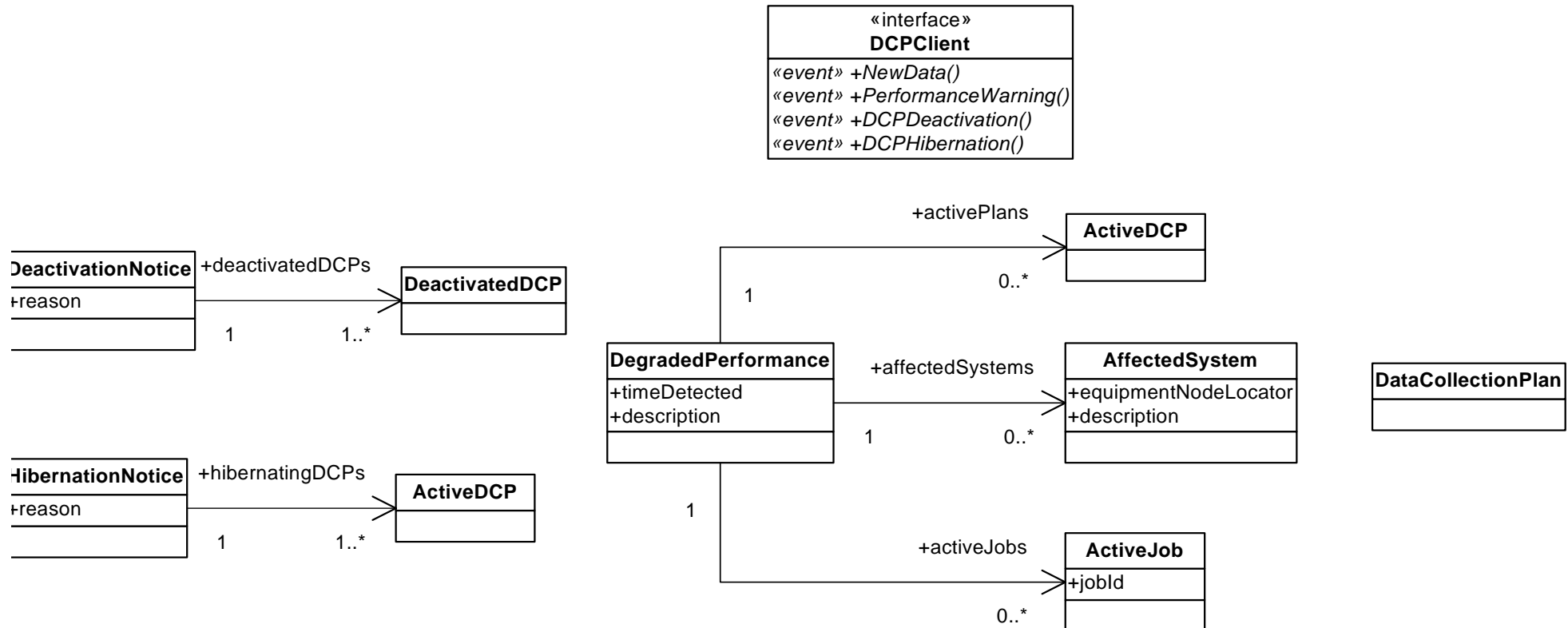
- **Definition, viewing, activation, and deletion all have associated privilege**
  - **Allows factory to enforce policy of choice**
    - If a client has none of these privileges, it is not possible to do anything related to data collection
    - Can restrict a client to its own sandbox, unable to view, activate, or delete any DCP's other than those it defines
    - Can assign a client 'administrative' privilege to activate/de-activate view and delete any DCP at any time

# 3509 Equipment Performance Self-Monitoring



- **Allows equipment to warn clients of performance problems**
  - **Notifies clients periodically while performance remains below threshold**
- **Suppliers define performance thresholds**
  - **Supplier defines criteria and mechanism/algorithm for detecting performance related problems**
- **Decision regarding how to respond is owned by the factory**
  - **May decide to disable some DCP's or continue running, depending on factory policy**

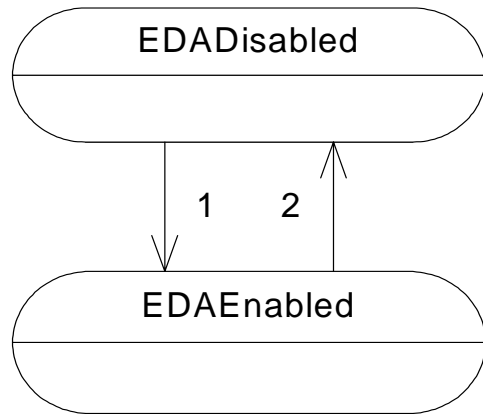
# 3509 EDA Client Interface



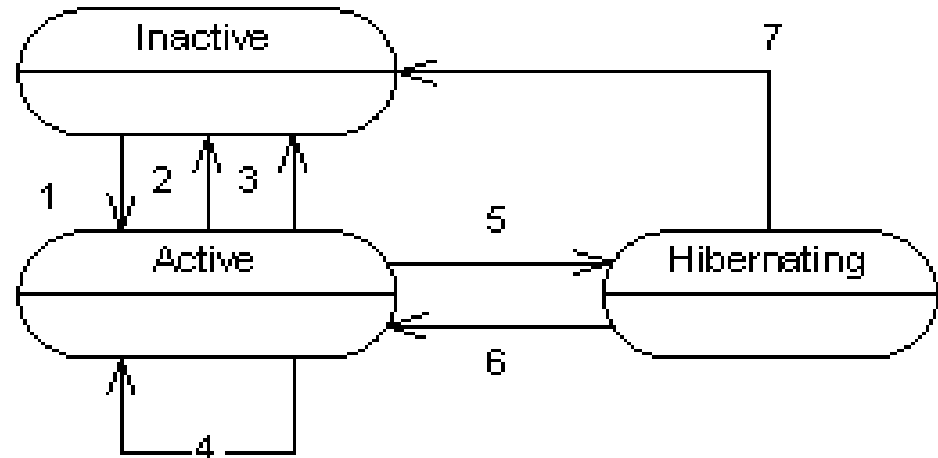
- **Specifies client interface**

- For asynchronous notification of data, performance warnings, and de-activation/hibernation of active DCP's

# 3563 Port and DCP State Models



EDA port state model



DCP state model

- **Port state model**
  - Describes the accessibility of EDA communications
  - Analogous to 3507 description of communication state model
- **DCP state model**
  - Describes behavior of DCP's
  - Analogous to 3509 DCP state model

# 3563 Data Management

```
<GetActivePlanIds xmlns="urn:semi.org:schema:eda_ps_v0.0">
  <EquipmentID>
    <Supplier>RoboFurnace, Inc.</Supplier>
    <Model>Zippo 355</Model>
    <ImmutableID>39d-JDII-Uj399</ImmutableID>
  </EquipmentID>
</GetActivePlanIds>
```

```
<ActivatePlan xmlns="urn:semi.org:schema:eda_ps_v0.0">
  <EquipID>
    <Supplier>RoboFurnace, Inc.</Supplier>
    <Model>Zippo 355</Model>
    <ImmutableID>39d-JDII-Uj399</ImmutableID>
  </EquipID>
  <PlanID>DCP-72</PlanID>
  <UntilDeactivated>>false</UntilDeactivated>
</ActivatePlan>
```

```
<GetDefinedPlanIds xmlns="urn:semi.org:schema:eda_ps_v0.0">
  <EquipID>
    <Supplier>RoboFurnace, Inc.</Supplier>
    <Model>Zippo 355</Model>
    <ImmutableID>39d-JDII-Uj399</ImmutableID>
  </EquipID>
</GetDefinedPlanIds>
```

```
<DeactivatePlan xmlns="urn:semi.org:schema:eda_ps_v0.0">
  <EquipID>
    <Supplier>RoboFurnace, Inc.</Supplier>
    <Model>Zippo 355</Model>
    <ImmutableID>39d-JDII-Uj399</ImmutableID>
  </EquipID>
  <PlanID>DCP-72</PlanID>
</DeactivatePlan>
```

- **Specifies data management messages**
  - Formats conceptually described in 3563 document, XML Schema and WSDL provided separately
  - Operations analogous to DCP management interface in 3509
  - Data management (only) also supported via SECS-II
  - DCP definition/deletion messages not specified
- **Implemented by Equipment**



# 3563 Data Reports

- **Specifies data reporting format**
  - Described conceptually in document, XML Schema and WSDL provided separately
  - Supports strong typing of single-valued and structured data
  - Supports on-tool buffering
- **Format is different from 3509**
  - Because DCP format is not specified in 3563
- **Implemented by EDA Clients**

```

<EdaData xmlns="urn:semi.org:schema:eda_ps_v0.0">
  <EquipmentID>
    <Supplier>RoboFurnace, Inc.</Supplier>
    <Model>Zippo 355</Model>
    <ImmutableID>39d-JDII-UJ399</ImmutableID>
  </EquipmentID>
  <Event>
    <EventTime>2002-09-22T04:19:50.000000-07:00</EventTime>
    <Locator>Furnace</Locator>
    <EventID>TempSetpointReached</EventID>
    <Data>
      <Param>
        <Locator>Furnace.Chamber-1.Heater</Locator>
        <Name>Temperature</Name>
        <Value>
          <DoubleVal>44.203647416413375</DoubleVal>
        </Value>
      </Param>
      <Param>
        <Locator>Furnace.Chamber-2.Heater</Locator>
        <Name>Temperature</Name>
        <Value>
          <DoubleVal>4424.4468085106382</DoubleVal>
        </Value>
      </Param>
    </Data>
  </Event>
  <ExEvent>
    <ExTime>2002-09-22T04:31:43.414000-07:00</ExTime>
    <Locator>Furnace.Chamber-2.Heater</Locator>
    <ErrorCode>45144</ErrorCode>
    <ExType>Alarm</ExType>
    <ExState>Set</ExState>
    <ExDesc>Chamber 2 is overflowing with Nitrogen. Help.</ExDesc>
    <Data>
      <Param>
        <Name>N2-Flow</Name>
        <Value>
          <DoubleVal>45.126934984520126</DoubleVal>
        </Value>
      </Param>
    </Data>
  </ExEvent>
</EdaData>
  
```

# 3563 Equipment Performance Warning

```
<EdaError xmlns="urn:semi.org:schema:eda_ps_v0.0">
  <EquipID>
    <Supplier>RoboFurnace, Inc.</Supplier>
    <Model>Zippo 355</Model>
    <ImmutableID>39d-JDII-UJ399</ImmutableID>
  </EquipID>
  <Error>
    <ErrorTime>2002-09-22T02:22:14.3220000-07:00</ErrorTime>
    <ErrorType>PerformanceWarning</ErrorType>
    <ErrorCode>Performance.Subsystem</ErrorCode>
    <ErrorDesc>Chamber 4 overheating by 6 degrees
      Celsius</ErrorDesc>
  </Error>
</EdaError>
```

- Specifies performance warning message
  - Factory decides how to respond
  - Supplier defines performance criteria
  - Conceptually analogous to 3509 warnings
  - Format differs from 3509
    - Because of reduced scope of 3563
- Implemented by EDA clients

# 3563 EDA Port Availability

```
<EdaEnabled xmlns="urn:semi.org:schema:eda_ps_v0.0">  
  <EquipID>  
    <Supplier>RoboFurnace, Inc.</Supplier>  
    <Model>Zippo 355</Model>  
    <ImmutableID>39d-JDII-UJ399</ImmutableID>  
  </EquipID>  
</EdaEnabled>
```

```
<EdaDisabled xmlns="urn:semi.org:schema:eda_ps_v0.0">  
  <EquipID>  
    <Supplier>RoboFurnace, Inc.</Supplier>  
    <Model>Zippo 355</Model>  
    <ImmutableID>39d-JDII-UJ399</ImmutableID>  
  </EquipID>  
</EdaDisabled>
```

- **Notifies clients of accessibility**
  - **Asynchronous notification when EDA port availability changes**
- **Implemented by EDA clients**