Lessons Learned Building an Interface A Host System Using a Commercial Application Platform

Alan Weber

Alan Weber & Associates

Tim Sowell

Invensys Wonderware

Outline

- Presentation objectives
- Background
  - Industry context
  - APC/EES application requirements
- Implementation approach
  - Development/test environment
  - Application platform basics
- Lessons learned
- Benefits summary
  - Developer perspective
  - End user operational impact
- Acknowledgements

Presentation Objectives

- Explain rationale for choosing an application platform as the Interface A host implementation environment
- Describe the impact of this choice on the software development process
- Share the implementation lessons learned
- Highlight the benefits of this approach from the development and end user operational perspectives

Background

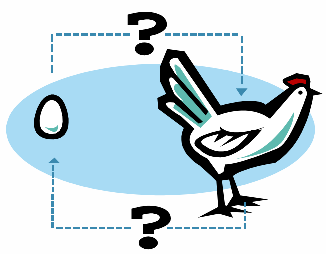
Background
Industry Context for Interface A

- Standardization status
  - Detailed specifications complete and balloted, but still a moving target
  - Adoption underway
- The "other end of the wire"
  - Most effort to date has been on the tool side
  - Very little focus on the host side
  - "What are we going to do with all this data??"
- Will likely spawn an entirely new application market
  - Hard to predict what process engineers will want next after a few months of unprecedented tool data access!

Background
Interface A Adoption Challenge

- Bad news
  - It is difficult to validate an implementation of a communications interface when there's nobody to talk to…
  - It can be expensive to be first

- Good news
  - There are bridging/migration technologies for breaking this "chicken-and-egg" cycle
  - Use of commercial communications packages and applications platforms offer attractive alternatives to in-house development

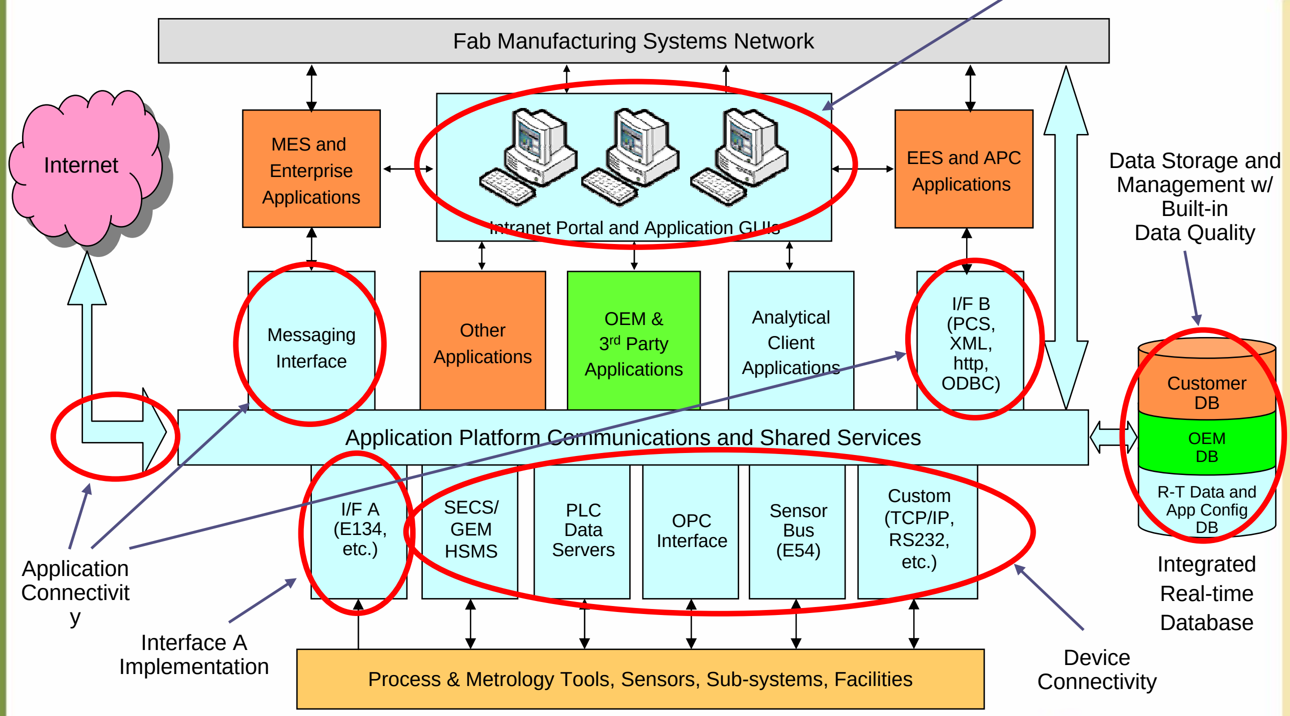


Background
APC/EES Application Requirements

What will fab users need to fully deploy Interface A?

- Connectivity
  - Devices
  - Applications
  - People
- Data storage and management
  - Real-time, granular, voluminous
  - Data quality
- Security and reliability
- High performance and scalability
- Agility to support changing requirements

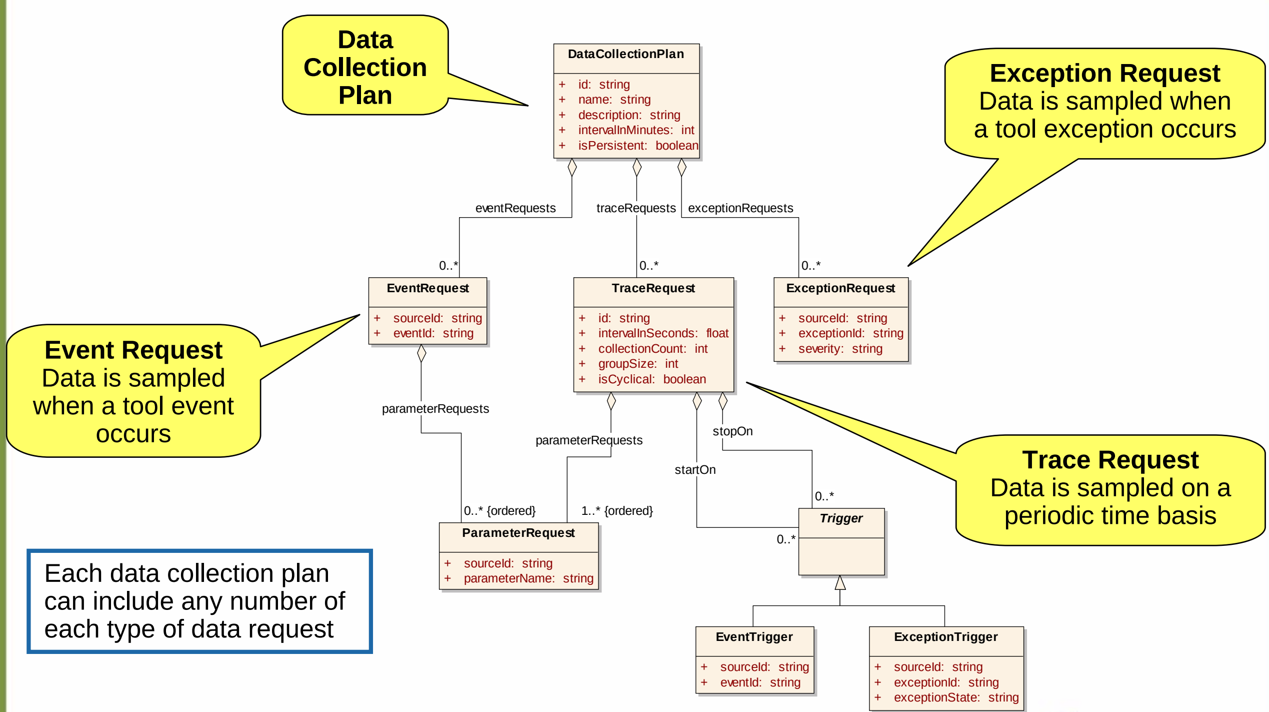
APC/EES Environment
Application Platform Architecture



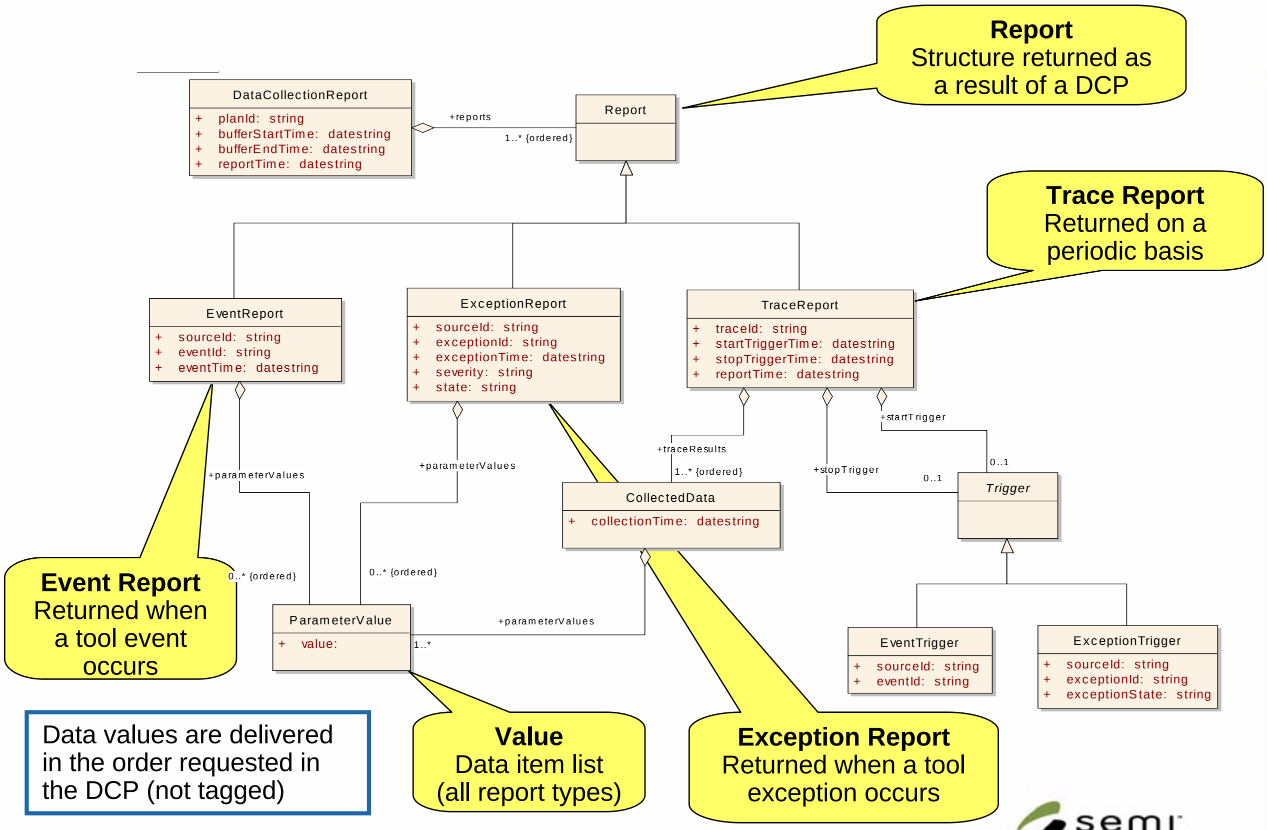
Interface A Host Implementation
Minimal Product Requirements

- Provide process and operational data to APC/EES applications
- Comply with E134 – no proprietary shortcuts
- Support all types of tool data request
  - Trace data
  - Event data
  - Exception data
  - Ad hoc data (on-demand data)
- Insulate users from details and dynamics of E134
  - Application developers
  - Process engineers

E134 Data Collection Plan (DCP)



E134 Report Structure



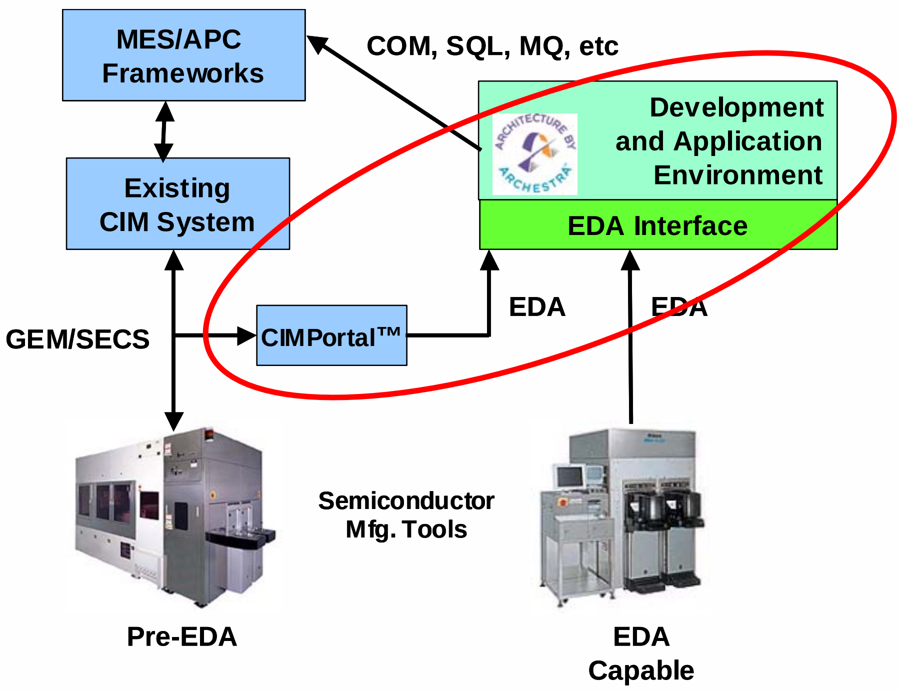
Data values are delivered in the order requested in the DCP (not tagged)

Implementation Approach

Implementation Approach

- Used Wonderware ArchestrA application platform as Interface A host system
  - Complete development, integration, deployment, execution and support environment for mission-critical manufacturing systems
  - Configurable client applications suite for common visualization, reporting, and analysis functions
- Used Cimetrix CIMPortal product as Interface A equipment-side test vehicle
  - Includes Equipment Modeler and Equipment Simulator for assembling complex behavior from E120 nodes

Development/Test Environment



Lessons Learned

Lessons Learned (1)

- Development in an application platform environment requires a careful mapping between two (or more) domains
  - Interface A syntax and semantics
  - ArchestrA development and execution environment
- You must truly understand how a platform is used to do this mapping effectively
  - Development tools and processes; built-in services
  - End user application functions and interaction modes
  - A couple of design iterations are required to get this right
  - A good mapping results in a very natural end user "feel" (and rapid acceptance)
- Corollary: the job is a lot easier if you pick a platform that is well suited for the domain

Lessons Learned (2)

- Example mappings include
  - Data types across the various standards/systems
  - DCP structure and interface object configuration tools
  - Visualization/navigation of all DCPs
    - Equipment level
    - Fab level
  - Report structure and application variable naming
  - DCP life cycle and interface run-time behavior

See following slides….

Data Type Mapping

User provided at DCP config time

SOAP message contents

Application platform representation

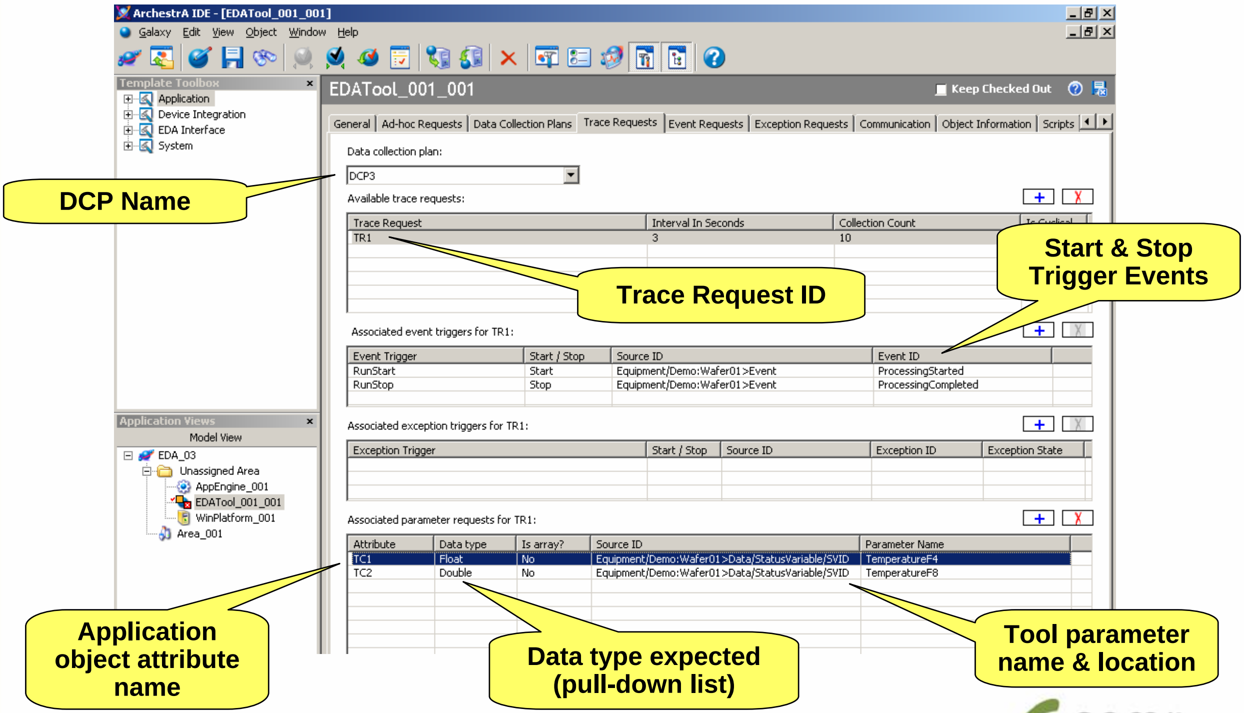
E125.1 Type	E134.1 Parameter Value Type Name	E134.1 Parameter Value XML Schema Type	ArchestrA Attribute Data Type
StringType	S	xsd:string	MxString
BooleanType	B	xsd:boolean	MxBoolean
Base64BinaryType	B64	xsd:base64Binary	MxBigString; base64 encoded value
ByteType	I1	xsd:byte	MxInteger
ShortType	I2	xsd:short	MxInteger
IntType	I4	xsd:int	MxInteger
LongType	I8	xsd:long	MxString, ascii encoded numeric value
FloatType	F4	xsd:float	MxFloat
DoubleType	F8	xsd:double	MxDouble
DateTimeType	D	xsd:dateTime	MxTime; as Universal Coordinated Time
AnyURIType	URI	xsd:anyURI	MxString; URI value
VariableType	Var	dcm:VariableValueType	Archestra data type varies as needed
ArrayType	Arr	dcm:ArrayValueType	Array of appropriate ArchestrA data type
StructureType	Su	dcm:StructureValueType	MxBigString; XML encoded value
EnumeratedType	ES	dcm:StructureValueType	MxString
EnumeratedType	EI	dcm:StructureValueType	MxInteger

Note: Exotic Data Types!

Useful for Exception Reports

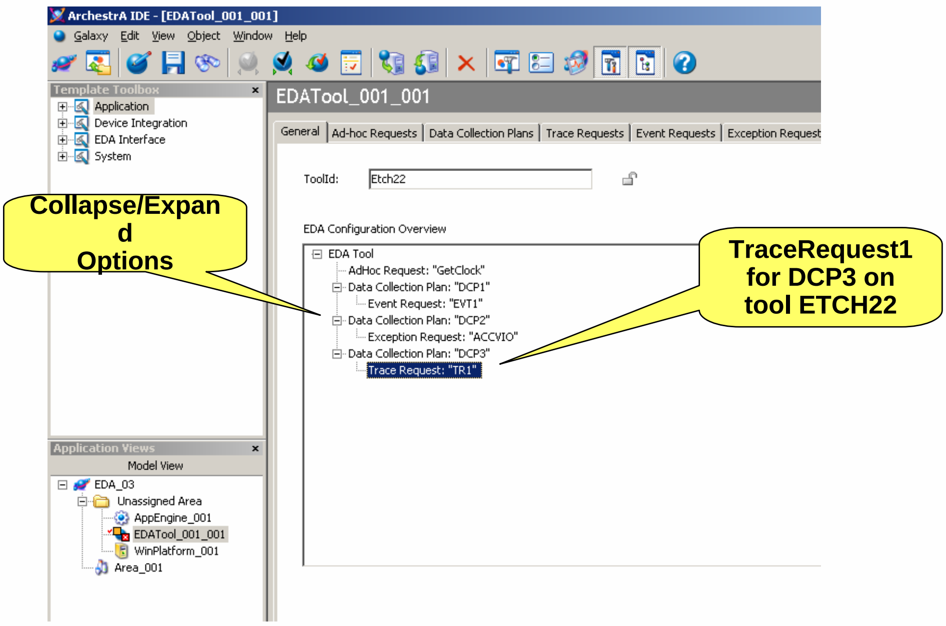
Data Collection Plan Definition

EDATool Object Configuration

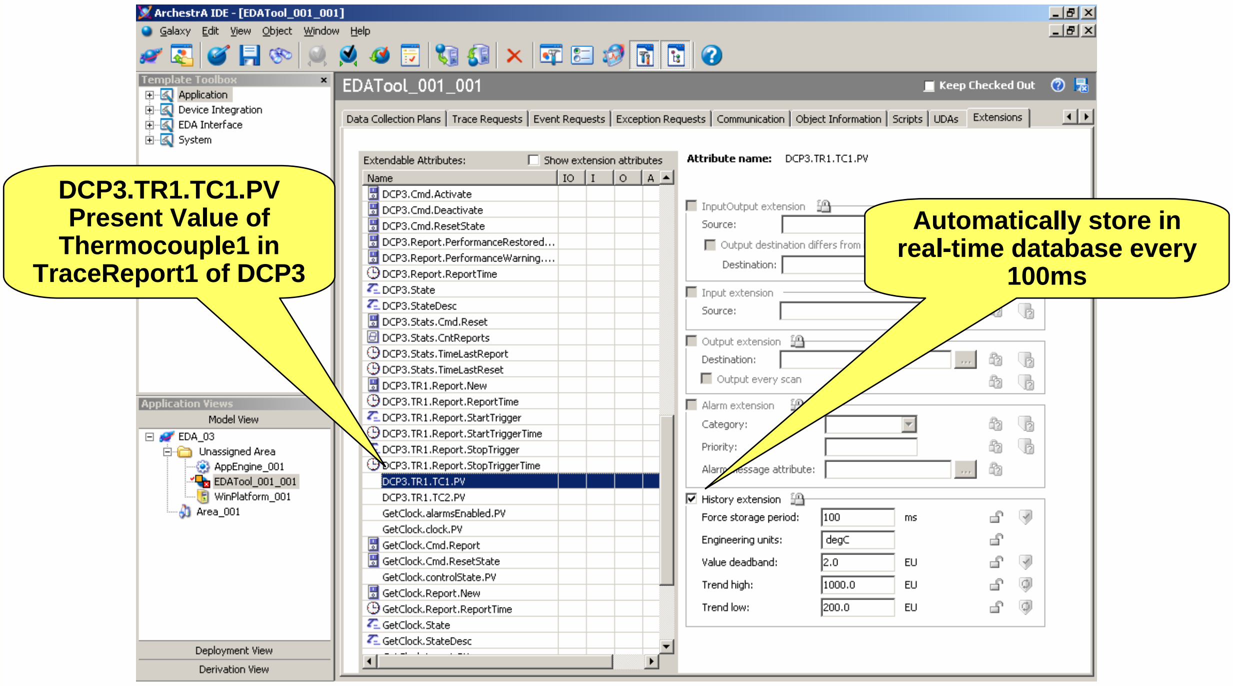


Tool/Fab-Level Visualization/Navigation

EDATool DCP Treeview Display



Hierarchical Variable Naming Scheme
and Historization Configuration



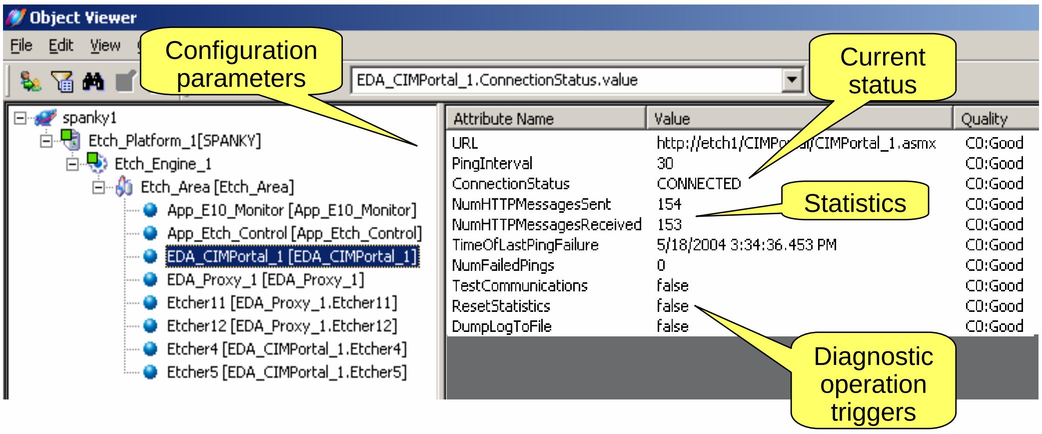
SEMI Standards Workshop on e-Manufacturing and e-Diagnostics

Lessons Learned (3)

- It is impossible to build [one end of] an interface without something robust to talk to
  - Must also be clear which version of the standard is implemented
- Debugging this kind of software is still very tricky
  - For example…. If the requested data doesn't come through, where's the problem?
    - Client didn't request properly
    - Tool didn't understand the request
    - Tool didn't handle event properly
    - Client didn't process the response properly
  - Must anticipate/handle errors from many sources
  - But the problem is well bounded, and support tools exist [in an application platform environment]

Monitoring and Debug Tools

- Object Viewer can be used to monitor EDA Interface status and monitor statistics
- Diagnostic operations invoked by setting diagnostic triggers
- Note "Quality" column…. this item exists for all attributes



Lessons Learned (4)

- Built-in data quality support features are <u>very</u> useful
  - Separate field for every object attribute
  - Prevents making bad decisions from data
  - Values defined by OPC specifications

- **<u>Good Quality</u>**
  - **Non-specific**
  - **Local Override**
- **Uncertain Quality ? ?**
  - **Non-Specific**
  - **Last Usable Value**
  - **Sensor Not Accurate**
  - **Engineering Units Exceeded**
  - **Sub-Normal**
- ***Bad Quality ! ! !***
  - **Non-Specific**
  - **Configuration Error**
  - **Not Connected**
  - **Device Failure**
  - **Sensor Failure**
  - **Last Known Value**
  - **Comm Failure**
  - **Out of Service**

Lessons Learned (5)

- Requirements for a host implementation of an interface standard go well beyond the standard itself
  - Must walk in your customers' shoes
  - This is the real opportunity for differentiation
- Example deltas to the Interface A specs include
  - Pre-defined ad hoc report request (query)
  - Auto-activate feature on DCPs
  - Import/export format (enables all sorts of fab-level capability)
  - Treeview navigation, collapse, expand, etc.
  - UUID assignment and management tools (à la Recipe Mgmt)

Lessons Learned (6)

- There were MANY things we did NOT have to build which are well covered by built-in application platform services
  - Logging, alarm generation and management
  - Schema generation, attribute naming and delivery to the applications, persistence, historization
  - Fault tolerance, load balancing/performance management
  - Security, change management/effectivity/propagation, packaging and deployment, installation
- The ISMI Scenarios document was a useful functional checklist and guide to test plan development
  - The Exception scenarios additions will help as well

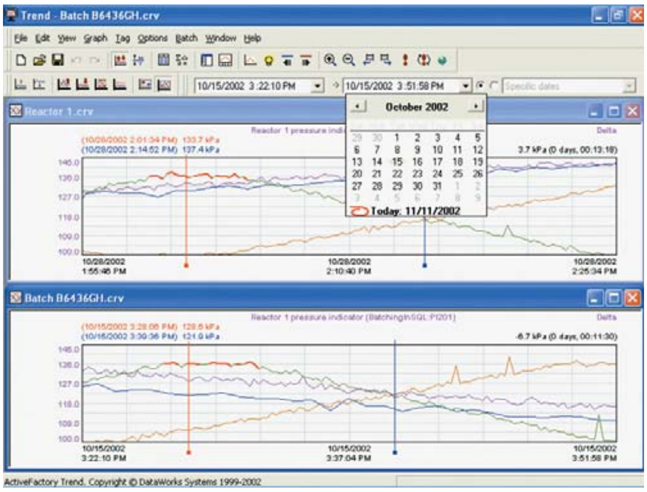
Benefits Summary

Benefits Summary
Developer Perspective

- Use of an application platform allows developers to focus on domain issues rather than distributed computing infrastructure
  - Eliminates most difficult architecture decisions
  - Don't fall into the "I'm sure we can build what we need here for a fraction of the license fee" trap
  - Once you've built a couple of frameworks, you don't really want to do it again anyway….
- Reliable solutions can be developed and deployed more quickly

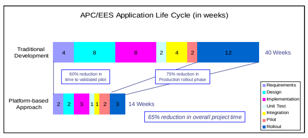
Benefits Summary
End User Impact

- Once data is collected by an application platform, a wide range of standard, familiar clients can use that information
  - Visualization, monitoring, analysis, control, reporting, etc.



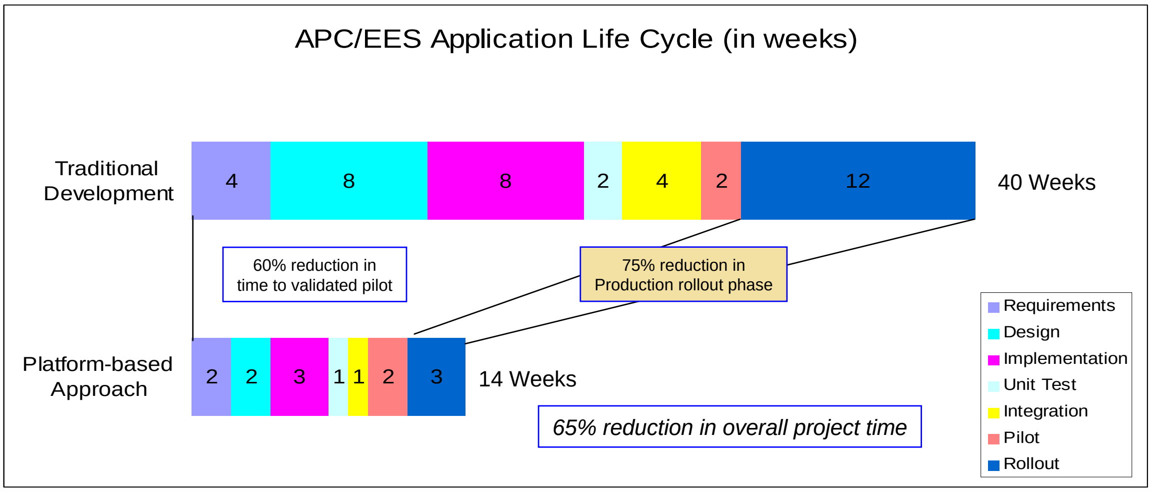
SEMI Standards Workshop on e-Manufacturing and e-Diagnostics

Operational Impact
Development Cycle Time Reduction

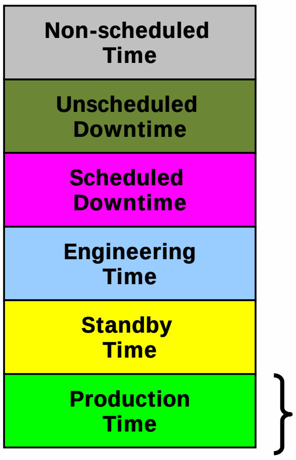


- Application platforms affect almost every phase of manufacturing system development
  - Requirements cover unique value add, not system technologies
  - Design focuses on how to use existing features and services rather than basic application architecture
  - Implementation consists of configuration, specialization, scripting with minimal new code development
  - Unit test only required for completely new functions
  - Integration effort limited to new data sources and transactions
  - Production rollout and other scale-up processes are standard system administration tasks

Operational Impact
Development Cycle Time Reduction



Operational Impact
Improving Overall IT Efficiency

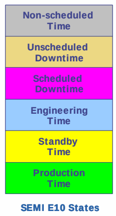


SEMI E10 States

For a piece of equipment, OEE is the time a tool is actually working on a product that will be sold for revenue

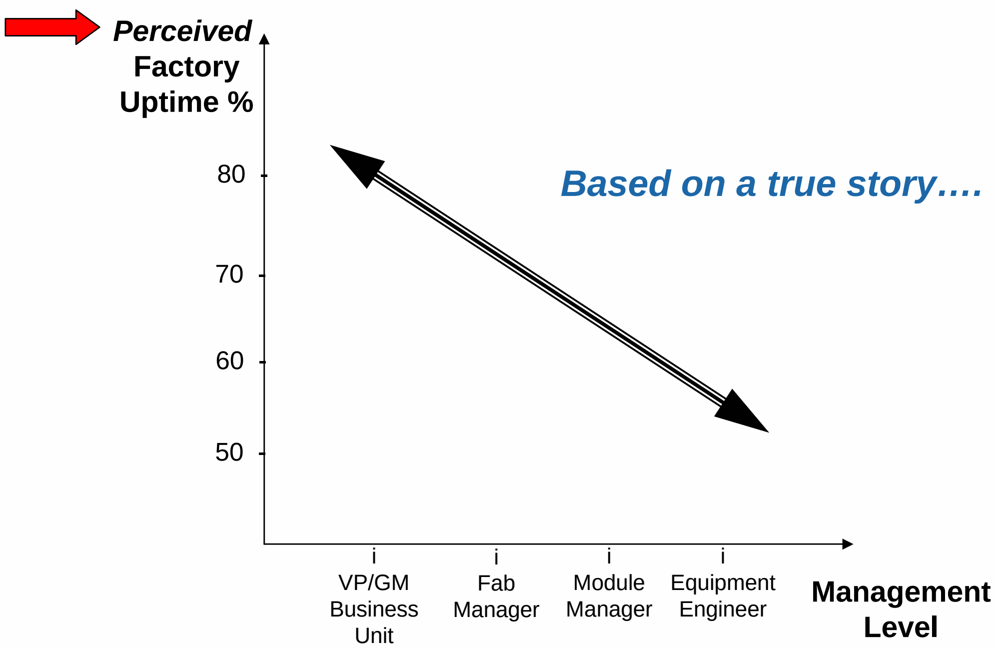
The same model applies to an IT organization….

Operational Impact
Improving Overall IT Efficiency



- Application platforms can reduce much of the time spent in the non-productive activities
  - Unscheduled downtime – reacting to system excursions, crashes, corrupted databases, log file overflows, network system overloads
  - Scheduled downtime – maintenance activity, such as installing new patches or releases, backups, maintaining user profiles, virus scans, database integrity checks
  - Engineering time – evaluation of new system technologies, prototype development, experimental programs that may never make it to production
  - Standby time – waiting for required resources, such as capital/expense budget, specialized expertise, project approval

Operational Benefits
Value of On-line Real-time Information



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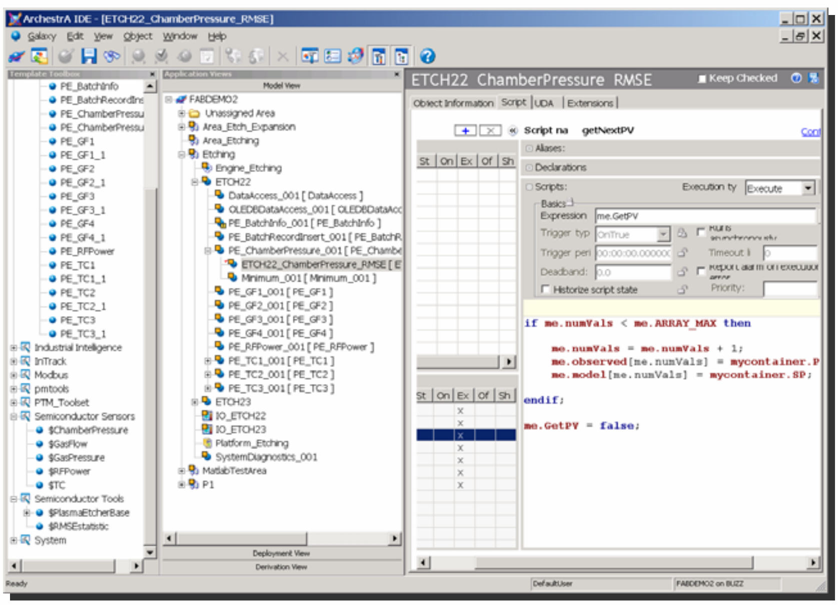
- Dedicated volunteers and staff of SEMI Standards
- International SEMATECH

Backup Material

Industrial Application Platform
Key Product Requirements

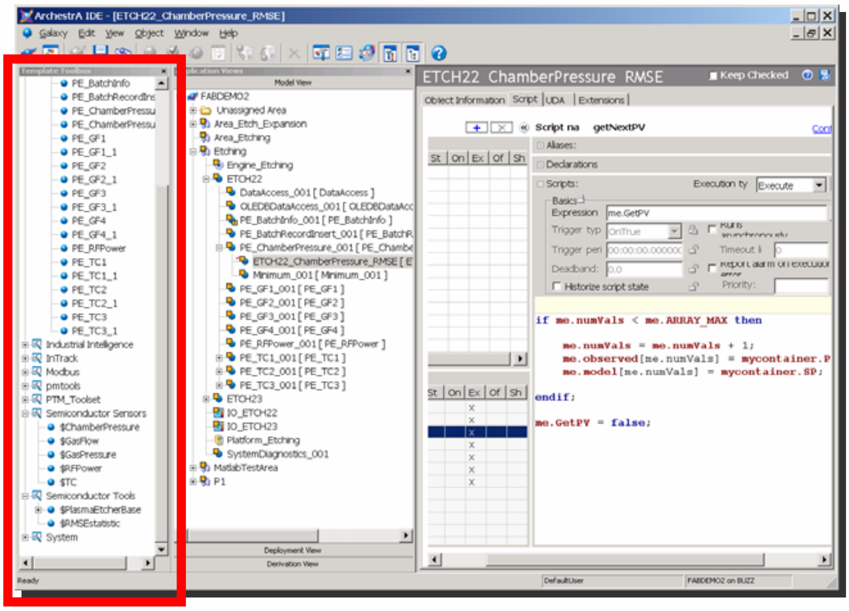
- Design and development environment
- Event-based processing, scripting and calculation capabilities
- Data acquisition and field device integration
- Data visualization and monitoring
- Reporting and ad hoc query capability
- Alarm and event management, historization and security
- Support for industry standards such as SEMI E134, OPC, SQL
- Internationalization
- Inter-application communications and name service
- System diagnostics and system administration
- Version management
- License management and centralized deployment

ArchestrA Application Platform
Integrated Development Environment (IDE)



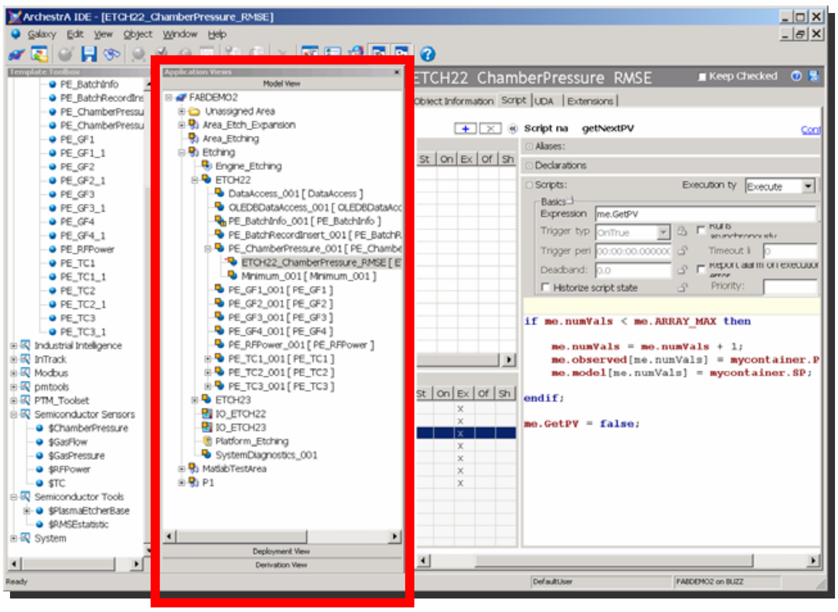
- Fab-wide application server IDE/GUI
- Serves as both development tool and online admin tool

ArchestrA IDE
Object Templates



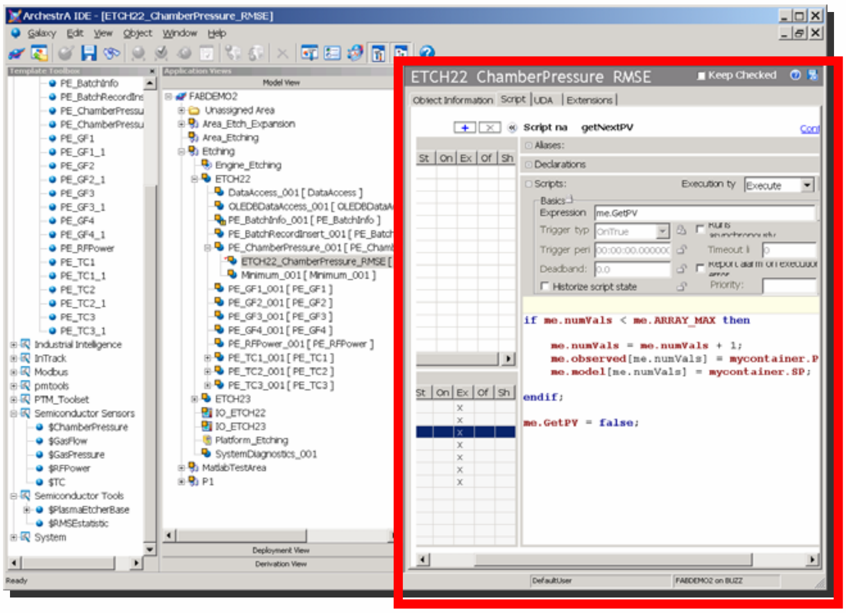
- Templates define abstract objects for managing fab equipment and applications
- Also includes objects for computing environment
- Templates can be composed hierarchically

ArchestrA IDE
Hierarchical Model/Views



- Displays fab model as instances of templates
- Can be viewed by
  - Model hierarchy
  - Computing node deployment
  - Derivation dependencies
- Manages assignment and deployment of objects

ArchestrA IDE
Object Details and Properties



- Displays details for selected object
- User can customize objects
  - UDAs
  - Alarms
  - Scripts
- Changes managed via change control and managed deployment

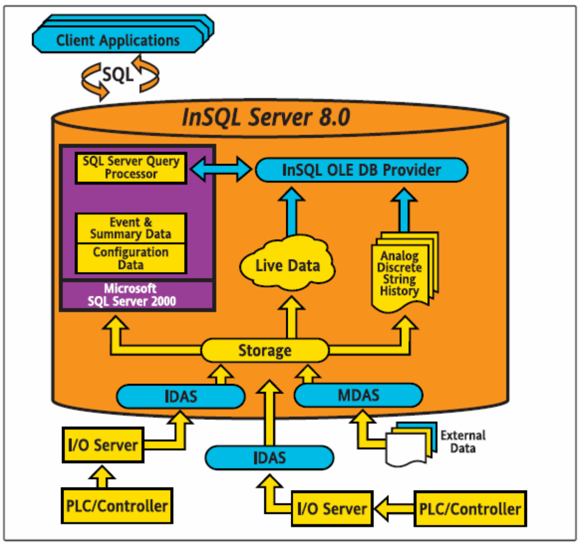
Shared Services
Support Platform Longevity

Security Service (Flexible Model)	Deployment Service	Scripting Service
Alarm Service	Event Service	Messaging/ Name Service
Historian/Storage Service	Visualization Service	Internationalization Service
Configuration Service	Configuration Service	External Data Integration Service (E134/ OPC)
Diagnostics Service	Admin/ Version Service	Licensing Service

Real-Time Database Requirements
Handling Tool/Process Data

- High performance and scalability
- Schema generation and management tools
- Direct/flexible integration with data collection system
- Universal access from applications and workstations
- Built-in standard functions for
  - Data quality verification
  - Limits checking
  - Alarm generation
  - Transformations for common queries
  - Historization
- Comprehensive self-diagnostics and system administration capabilities

IndustrialSQL Real-time Database



Granular Security Model