A Semiconductor Advanced Process Control Application Using JBoss

AMD

Contributors

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- APC engineers
- Configuration Management

Agenda

- Advanced Process Control at AMD
- Decision process towards a new architecture
- High level architecture
- Test results
- Future extensions
- Conclusions

APC @ AMD

Advanced Process Control (APC) is a software layer in a plant automation system above the primary controls that is responsible for maintaining:

- operations within the desired limits or at desired targets
- stable operations after process upsets
- coordination of operating changes
- a drive for improved economics through:
  - ✓ Increase feed
  - ✓ Increase in preferred product rates
  - ✓ Reduced energy consumption
  - ✓ Reduced waste

APC @ AMD

Advanced Process Control (APC): an automated methodology in tool operation to achieve desired process results by:

- Determining values for the manipulated variables ("knobs" or controller settings) to achieve desirable or satisfactory machine performance
- Using real-time measurements of controlled variables and compare-to-target values

APC @ AMD

- APC provides ability to automatically adjust recipes
- APC detects faults (FDC)
- Real time monitoring to improve yield
- AMD 300mm vision - Process Tools with Integrated Metrology & Sensors using APC

APC @ AMD

Effect on Microprocessor Speed Distributions

AMD-K6® drive current distribution before APC control

3x increase in ASP

AMD-K6® drive current distribution after APC control

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APC @ AMD - Summary

- Traditional benefits of APC are well documented
  - ✓ Reduces process variability, rework, scrap, etc.
  - ✓ Increases level of automation, leading to increased tool utilization and higher throughput
  - ✓ Control methodologies can become more flexible, complex & comprehensive
  - ✓ Improved manufacturability

End result: Enhanced Productivity, Predictability, and Profitability

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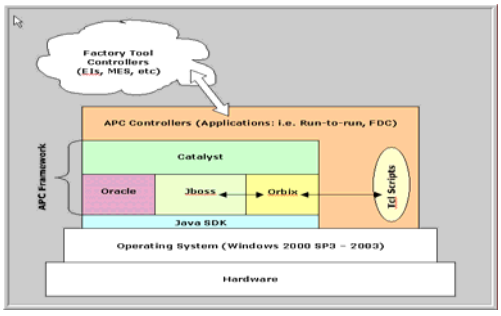
Catalyst role in APC



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Catalyst role in APC

Advanced Process Control is encapsulated in APC Controllers consisting of Scripts that enable:

- Reading of previously computed and persisted [control] data
- Invoking Matlab to perform mathematical computations
- Retrieving and invoking other scripts that perform specialized tasks
- Persisting results of computations in control records
- Persisting performance information about the APC controller
- Returning results from APC controller execution tool setting adjustment.
- Logging

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Catalyst -Business and Design Constraints

- Stability
  - ✓ critical 24/7 application – downtime equal revenue loss
- Real time processing
- Scalability
- Fail over capabilities
- Integration with different Manufacturing Execution Systems
- Integration with different External Systems

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Catalyst -Business and Design Constraints

Provide User interface

- ✓ Data visualization
- ✓ Application control

- Monitoring capabilities for application health
- Notification capabilities for the control process
- Meet 300mm requirements; able to extend

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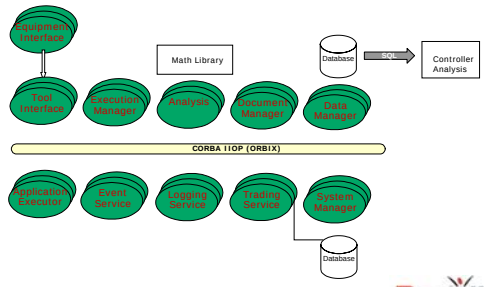
Catalyst - Legacy Architecture



Catalyst -Legacy application evaluation

- Uses non supported framework
  - ✓ Object Persistence
  - ✓ ORB version
- Performance improvements required
- Software development
  - ✓ Difficult to extend and support from software development perspective
  - ✓ Intensive development effort to support new requirements for the 300mm manufacturing
- Lacked security features

Catalyst Infrastructure Upgrade Alternatives

- Option 1: Remain on the same Orbix version
  - ✓ Unsupported
  - ✓ Unable to distribute
- Option2: Port Catalyst to new Orbix version
  - ✓ In time will be in same position as we are
  - ✓ No technical benefits
- **Option3: Port Catalyst to Orbix ASP ORB**
  - ✓ CORBA/Services are very stable
  - ✓ CORBA technology/utilization is not progressing

Catalyst Infrastructure Upgrade Alternatives

- Option4: Port Catalyst to open-source ORB (TAO)
  - ✓ Avoid introduction of new supplier with new variables/issues
  - ✓ No support for Java binding
- **Option5: Move Catalyst to J2EE Application Server**

=> Move Catalyst to J2EE

Summary Evaluation

Evaluation Criteria	CORBA Upgrade	J2EE
Initial development cost		
• Cost of 3rd party product licenses	-	+ If JBOSS
• Internal resources required	+	-
• Subcontract resource cost	+	-
• Training cost	-	+
• AMD acquires application/technology knowledge	-	+
Ongoing development cost		
• Perceived development productivity, services not in code	-	+
Deployment cost		
• Runtime licenses for Catalyst servers	-	+ If JBOSS
• Runtime licenses for Catalyst clients	-	+ If JBOSS

Summary Evaluation

Evaluation Criteria	CORBA Upgrade	J2EE
Maintenance cost		
• License cost for 3rd party product	-	+
• Development cost	-	+
Technical merit		
• Administration/management		
✓Configuration, deployment, runtime instrumentation, hot deployment, etc.	-	+
• Minimize impact to baseline/application scripts	+	-
• Quality attributes		
✓Reliability, scalability, performance, efficiency	-	+
• Support for new requirements		
✓Security, alternative scripting engines, client/GUI support	-	+

Summary Evaluation

Evaluation Criteria	CORBA Upgrade	J2EE
Technical merit (cont.)		
• Integration, interoperability & portability	-	+
✓Decoupling of systems, support other station controllers, support for alternative scripting, support for integration protocols, hardware/OS platform support, language support, standards support		
• Persistence technology support	-	+
✓Support for multiple database technologies		
✓Support for multiple database suppliers	-	+

Summary Evaluation

Evaluation Criteria	CORBA Upgrade	J2EE
Technical merit (cont.)		
• Instrumentation support		
✓Application, component, system logging	-	+
• Ease of development		
✓Support future requirements, development productivity, enable lightweight applications, services not in code	-	+
• Messaging QoS		
✓Support various messaging types, fault-tolerance	-	+
• Technology roadmap & direction		
✓Technology maturity, standards evolution & direction, consistent with AMD technical direction	-	+

Summary Evaluation

Evaluation Criteria	CORBA Upgrade	J2EE
Technical merit (cont.)		
• Migration		
✓Smooth migration path for 24 x 7 fabs running previous version of Catalyst	+	+
Business merit	+ If JBOSS	-
• Stability of supplier/technology		
• Technology growth	-	+
• Support from supplier (cost, quality, availability)	+	+
• Quality (open software vs. commercial product)	+	+
• Ability to utilize alternative technology supplier	-	+

Summary Evaluation

Evaluation Criteria	CORBA Upgrade	J2EE
Impact on commercialization		
• License cost of 3rd party products	-	+ If JBOSS
• Maintenance cost of 3rd party products	-	+ If JBOSS
• Market acceptance of technology	+	+
• Support for alternative scripting engines/languages	-	+ If JBOSS
• Ability to utilize alternative technology supplier	-	+

Catalyst 2.x - Key features

- Integration with key external systems via http, MQ and CORBA
- GUI interface
  - ✓ Data viewing and charting capabilities
  - ✓ System maintenance
- Security
  - ✓ Catalyst security - user data stored in Catalyst database
  - ✓ MES integration security
- Flexibility - Provide different installation options
- Scalability and fail over capabilities
- Provide rollback and fallback strategy

Catalyst 2.x - Technologies & Tools

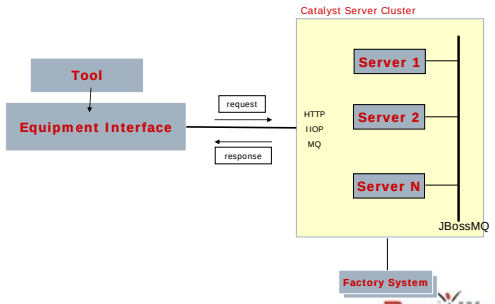
Commercial Applications

- Borland's JBuilder
- IONA's ASP
- Oracle
- Sun's Java
- Matlab

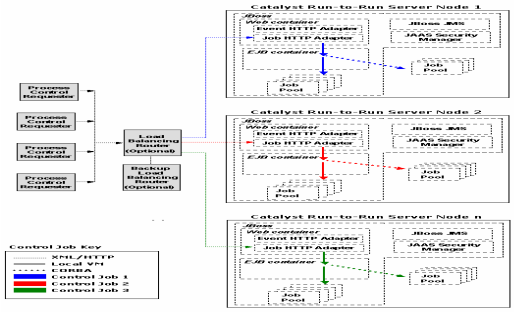
Source Accessible Applications

- Jboss J2EE Application Server
- ANT, CVS
- JUnit, XDoclet

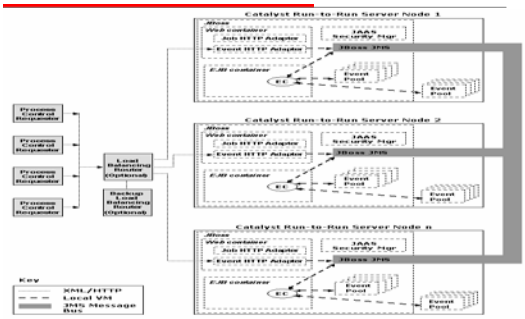
Catalyst 2.x - High level application flow



Catalyst 2.x - Job request flow



Catalyst 2.x - Event request flow



Catalyst 2.x - JBoss Features

- Security Infrastructure
  - ✓ JAAS
  - ✓ Several security modules
- Web Container
  - ✓ For the Web user interface
- Clustering/HA
  - ✓ Failover mechanism

Catalyst 2.x - JBoss Features

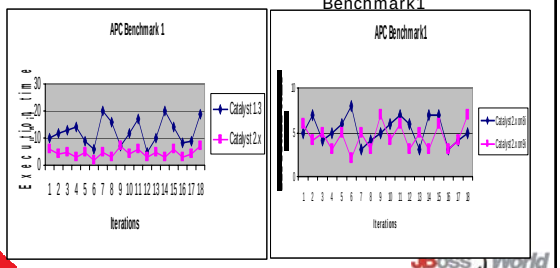
- CORBA Communications
  - ✓ Communication with legacy systems - JACORB
- Message Bus
  - ✓ JBossMQ for controller events
- Web Service Support
  - ✓ JBoss .NET (Axis) used for external services
- Interceptors
  - ✓ Monitoring component – collect data for troubleshooting

Test Results

- APC benchmarks
  - ✓ Overall test
  - ✓ Component based
- Reliability tests
  - ✓ Stress
  - ✓ Duration
- Others
  - ✓ DB
  - ✓ Caching
  - ✓ JVM versions

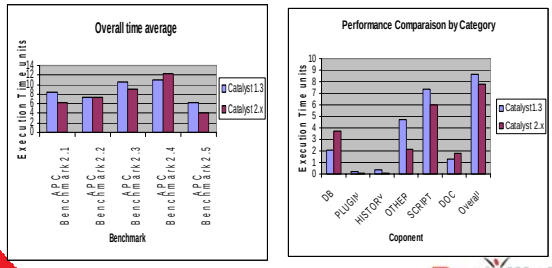
Test results – APC benchmark 1

- Catalyst 1.3 and Catalyst 2.x test results for APC Benchmark1
- Catalyst 2.x test results using different DB versions for APC Benchmark1



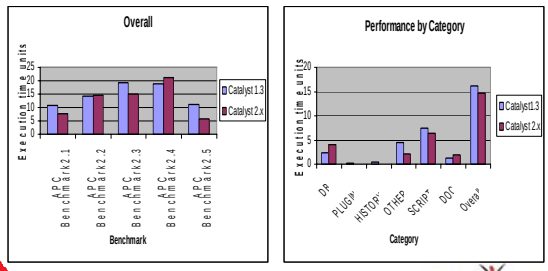
Test results – APC benchmark 2

- Overall
- By Category



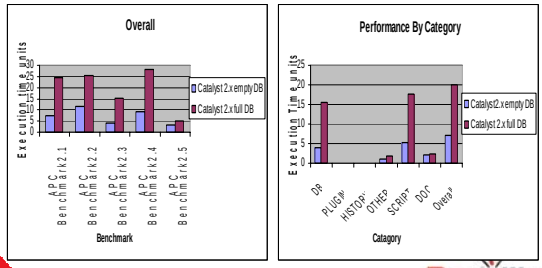
Test results – APC benchmark 2 stress test

- Overall
- By Category



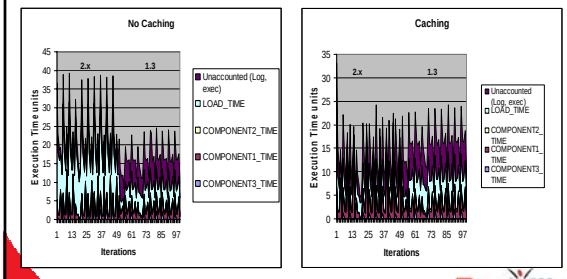
Test results – APC benchmark 2 DB tests

- Overall
- By Category



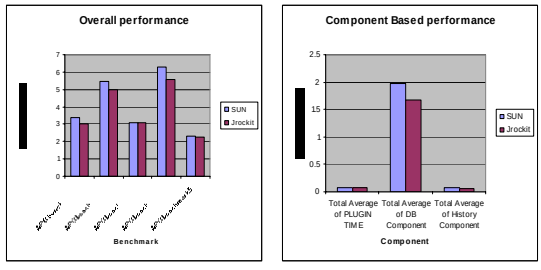
Test results – Caching

- No Caching
- Caching



Test results – JRockit VM and SUN VM

- Overall
- By Category



Catalyst road map

- Additional functionality to support application development and configuration
  - ✓ Ongoing work to complete new requirements demanded by different facilities
  - ✓ Extend integration with external systems
- Support Fault Detection Classification applications
- Build Framework to support development of new APC applications

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Catalyst road map

- JBOSS 4.0
  - ✓ Features evaluation
  - ✓ Functional testing
  - ✓ Stress and stability tests
- Performance analysis and improvements
- Studies
  - ✓ Jvm
  - ✓ Databases

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Conclusions

- Advanced Process Control (APC) is a vital function at AMD - ability to automatically adjust recipes at tools in the manufacturing process flow
- AMD decided to take the initiative in APC framework development
- Legacy application needed to be replaced
  - ✓ Middleware products utilized by Catalyst were obsolete and no longer supported
  - ✓ Performance problems

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Conclusions

- Evaluated various alternatives for upgrading Catalyst
  - ✓ Orb update
  - ✓ Move to J2EE
- Build new J2EE application using JBOSS
  - ✓ Real time application
  - ✓ Meet 300mm requirements in terms of features and performance

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