

# An Architectural Approach to Support Online Updates of SPL Products

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# Problem context: Egemin integrated logistic systems



*E'car*



*E'con*

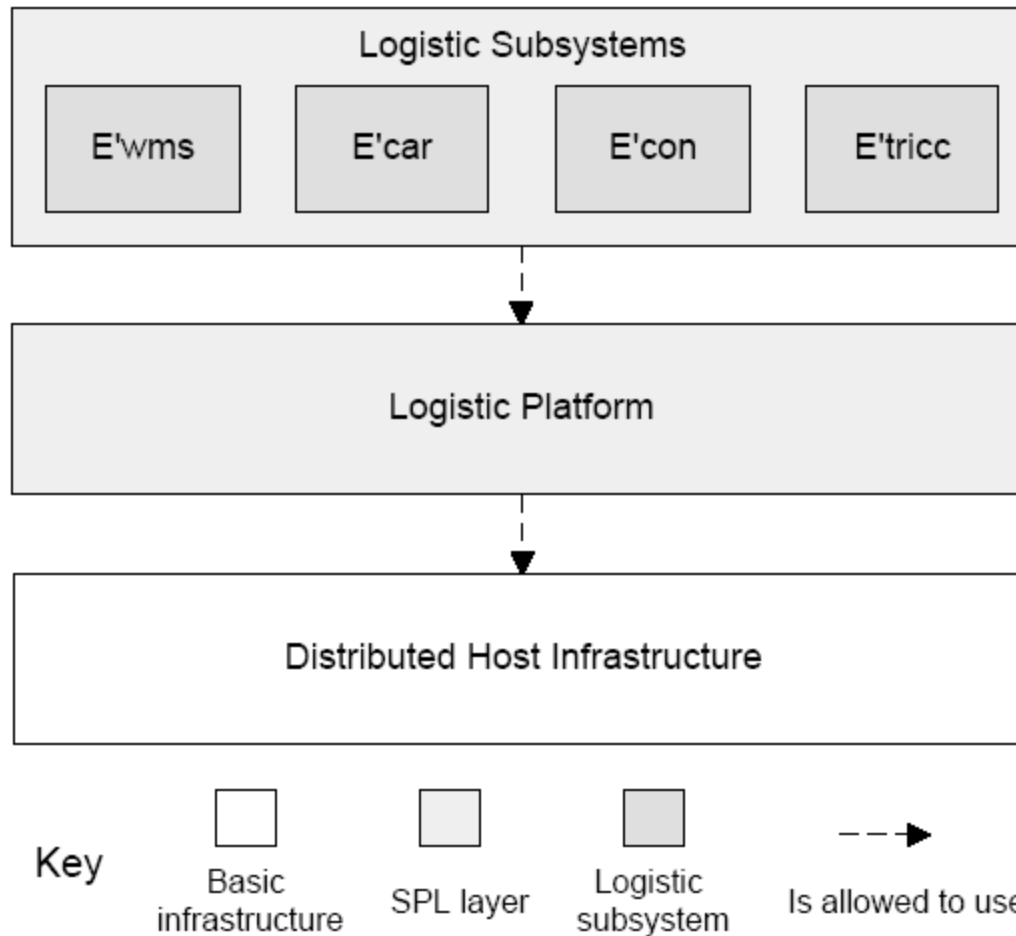


*E'gv*

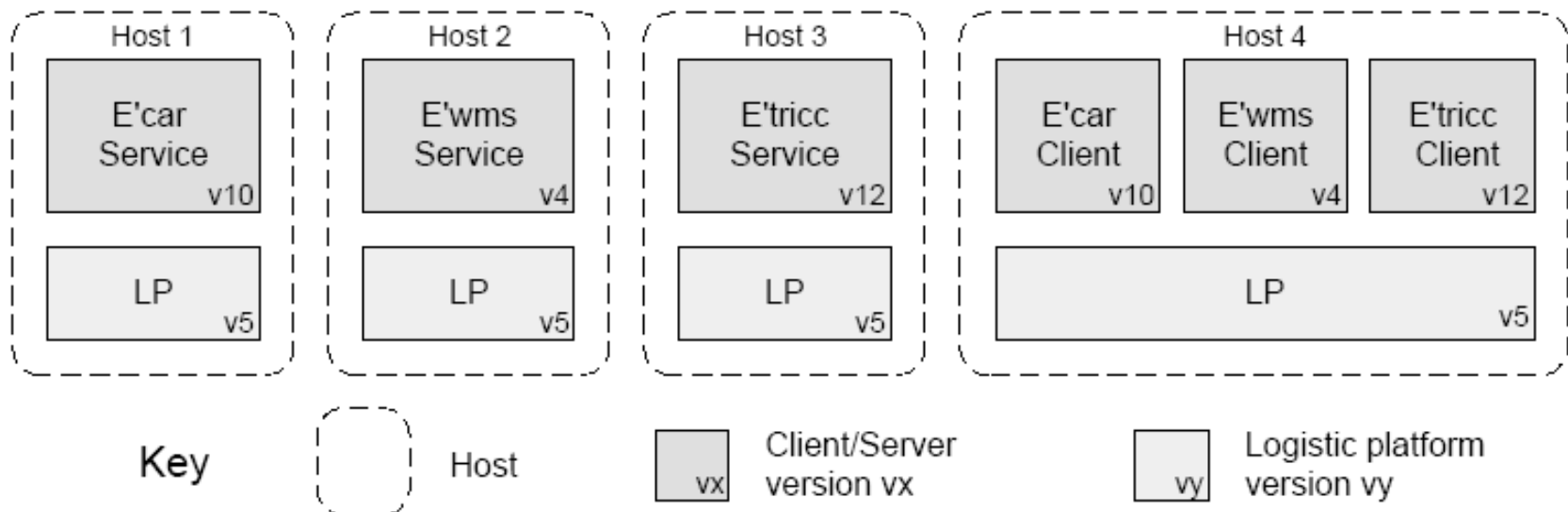


*E'wms*

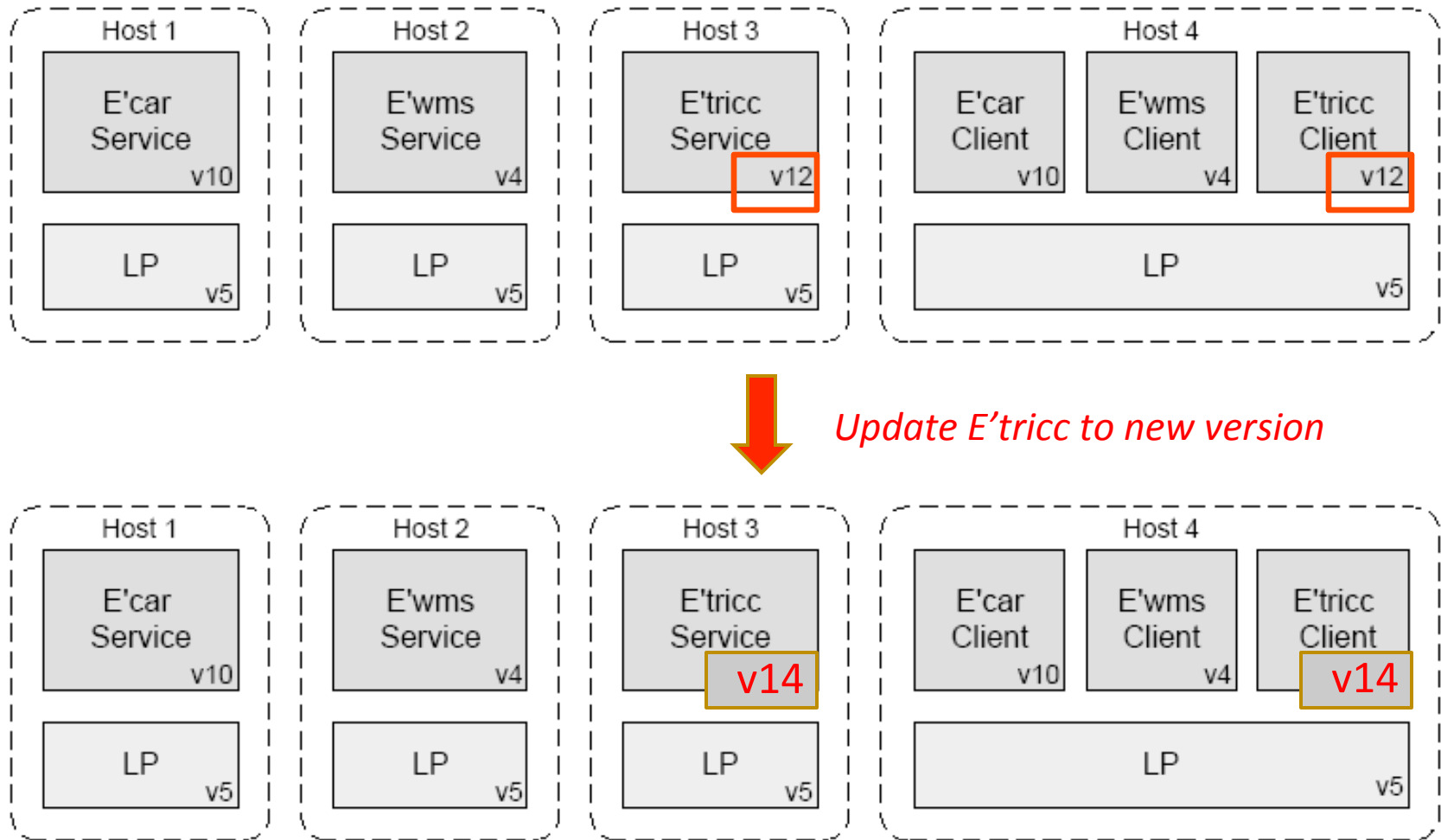
# Egemin SPL architecture



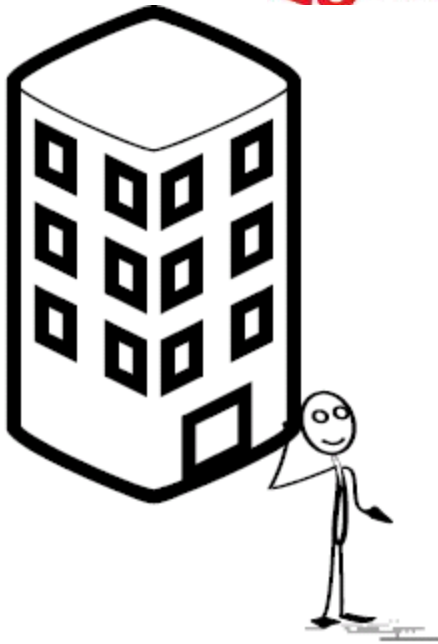
# Typical configuration of a product



# Simple update scenario



# Problem



SPL development organization



Integrator

## *NV Logistics*



System admin

# Problem

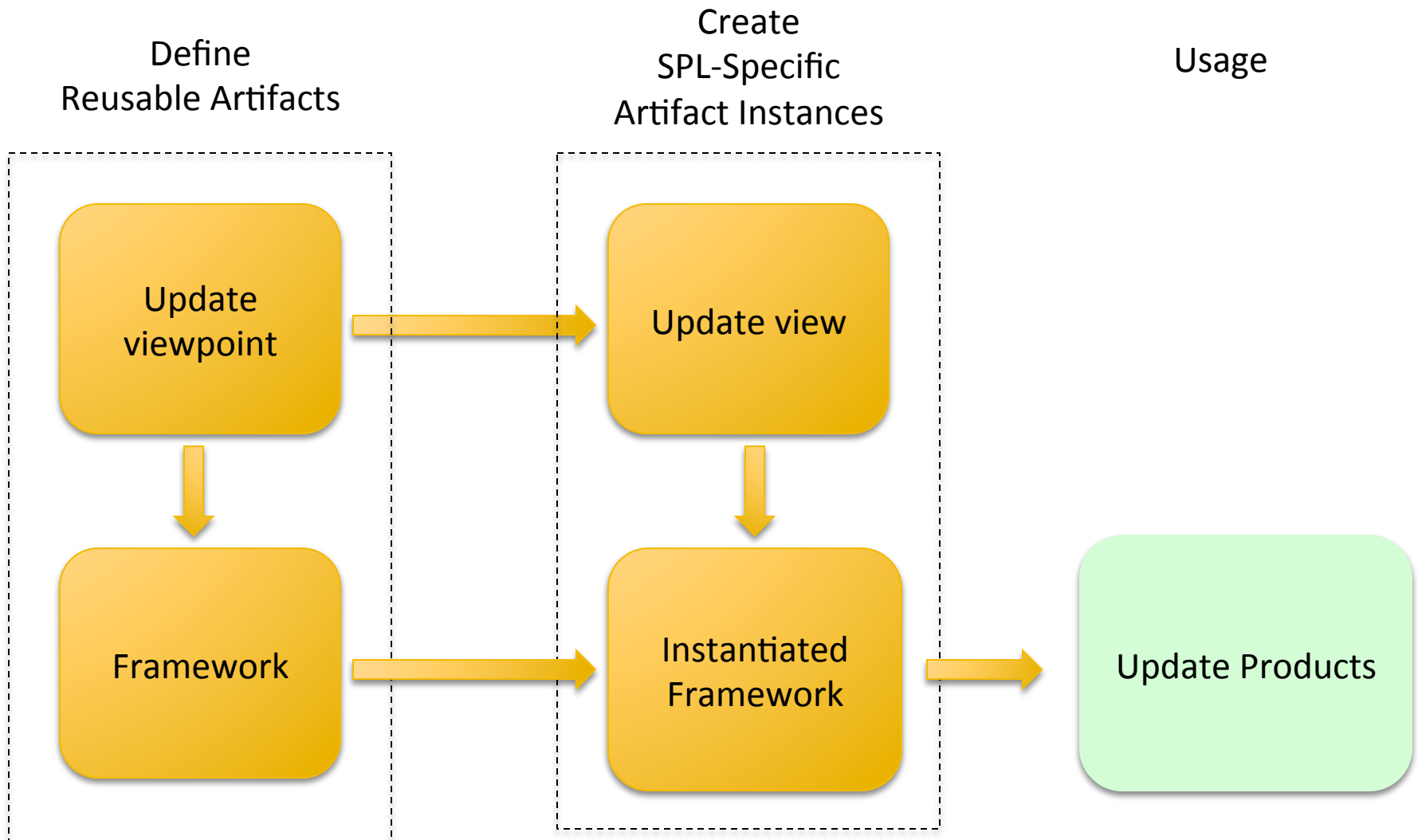
- Coarse grained updates of deployed SPL products
  - Product = set of assets each consisting of set of resources
  - Supporting infrastructure for dynamic updates of components is available
  - 200 products deployed; after initial phase +/- 1 update/year
- Egemin's current practice: updates often contain errors and/or are not performed efficiently
- Problem: how to support integrators to
  - Perform correct updates with minimal interruption of service
  - Given a lack of precise architectural information

# Overview

- Architectural approach
- Update viewpoint
- Framework
- Evaluation
- Conclusions and future work



# Architectural approach



# Overview

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- Update viewpoint
- Framework
- Evaluation
- Conclusions & future work

# Update viewpoint: overview

- Update concerns
- Model kinds
- Meta-models
- Analysis

D. Weyns, B. Michalik, A. Helleboogh, N. Bouke, An Architectural Approach to Support Online Updates of Software Product Lines, IEEE/IFIP Conference on Software Architecture, WICSA 2011

# Update concerns

- Understandability
- Availability
- Correctness

# Update concerns

- **Understandability**
  - What are assets and resources for the SPL
  - What are the dependencies between assets/resources?
  - Which assets are currently/should be installed?
  - Where are resources deployed?
  - Where should resources be deployed after update?
- **Availability**
- **Correctness**

# Update concerns

- Understandability
- Availability
  - How to perform the update with minimal interruption of service?
  - Which resources have to be replaced?
  - Which processes have to be stopped and (re-)started and when?
- Correctness

# Update concerns

- Understandability
- Availability
- Correctness
  - What is the procedure to perform a correct update?
  - What kind of inconsistencies exist?
  - When is the update performed correctly?

# Update viewpoint: overview

- Update concerns
- Model kinds
- Meta-models
- Analysis



# Update viewpoint model kinds

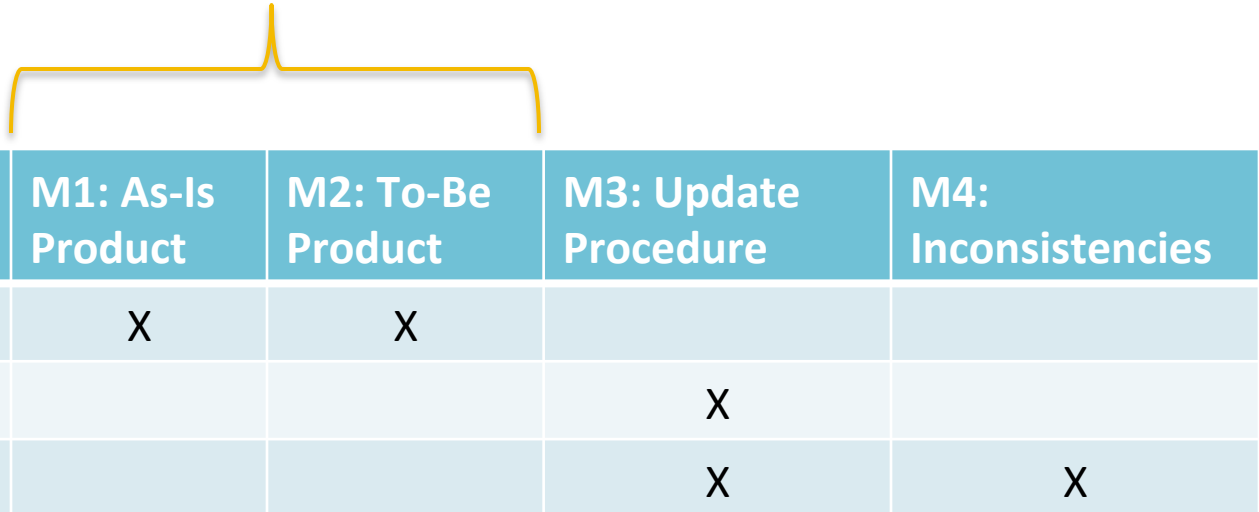
- M1 - As-is product deployment
  - Browse-able model of the current product
- M2 - To-be product deployment
  - Browse-able model of the future version of the product
- M3 - Update procedure (update script)
  - Model showing the steps to perform the update
- M4 - Inconsistencies
  - Model showing the inconsistencies in updated product.

# Update viewpoint model kinds

	M1: As-Is Product	M2: To-Be Product	M3: Update Procedure	M4: Inconsistencies
Understandability	X	X		
Availability			X	
Correctness			X	X

# Update viewpoint model kinds

Models harvested from system sources



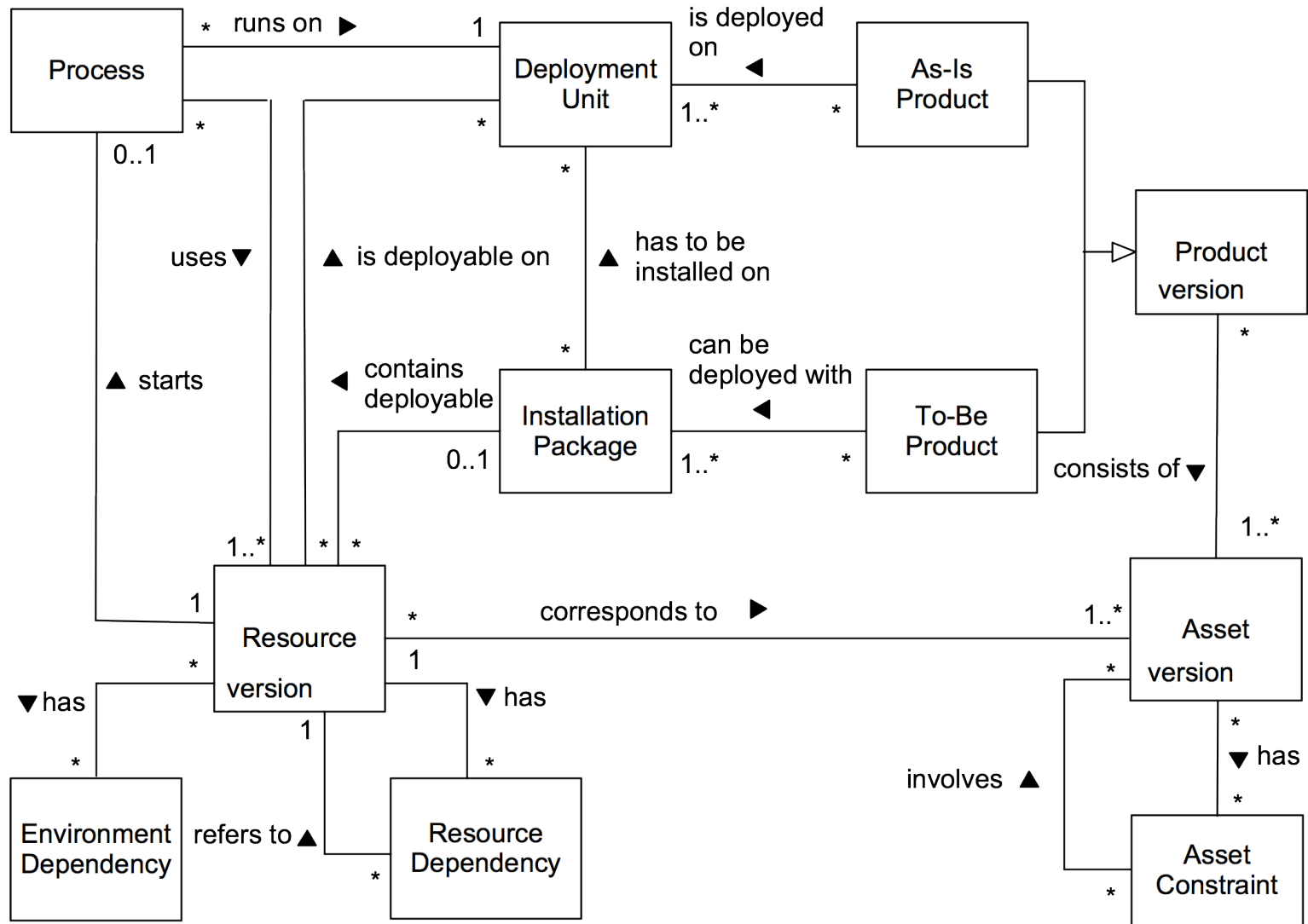
	M1: As-Is Product	M2: To-Be Product	M3: Update Procedure	M4: Inconsistencies
Understandability	X	X		
Availability			X	
Correctness			X	X

Models derived from analysis of M1 and M2

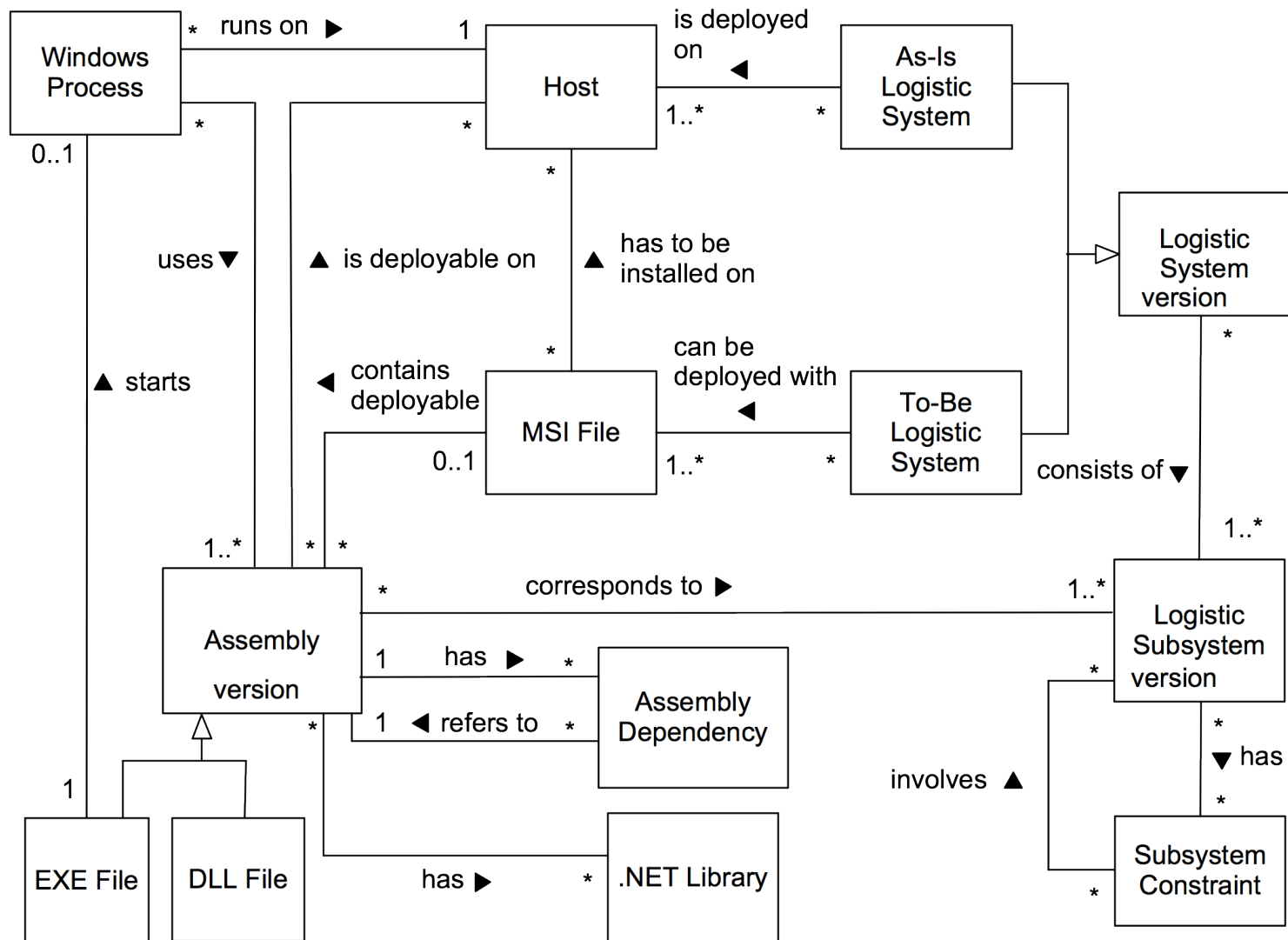
# Update viewpoint: overview

- Update concerns
- Model kinds
- Meta-model (M1, M2)
  - Integrated meta-model
  - Mapping to Egemin's context
- Analysis (M3, M4)

# Integrated meta-model



# Egemin's Integrated Meta-Model



# Update viewpoint: overview

- Update concerns
- Model kinds
- Meta-model (M1, M2)
- **Analysis (M3, M4)**
  - **A1: Update procedure**
  - **A2: Product inconsistencies**

# A1: Update procedure

- Analysis of delta between as-is and to-be
  - Resources to be added (in to-be, not in as-is)
  - Resources to be removed (in as-is, not in to-be)
  - Resources to be replaced (versions)
  - Affected processes (to stop and start)
  - Domain-specific rules about order of process manipulations
- Result is an update script



## A2: Product inconsistencies

- Check inconsistencies of product under update
  - Violations of asset constraints
  - Incomplete/inconsistent set of resources for a particular asset
  - Resource dependencies that cannot be resolved
  - Violations of versions of assets/resources
- Result is an inconsistency model

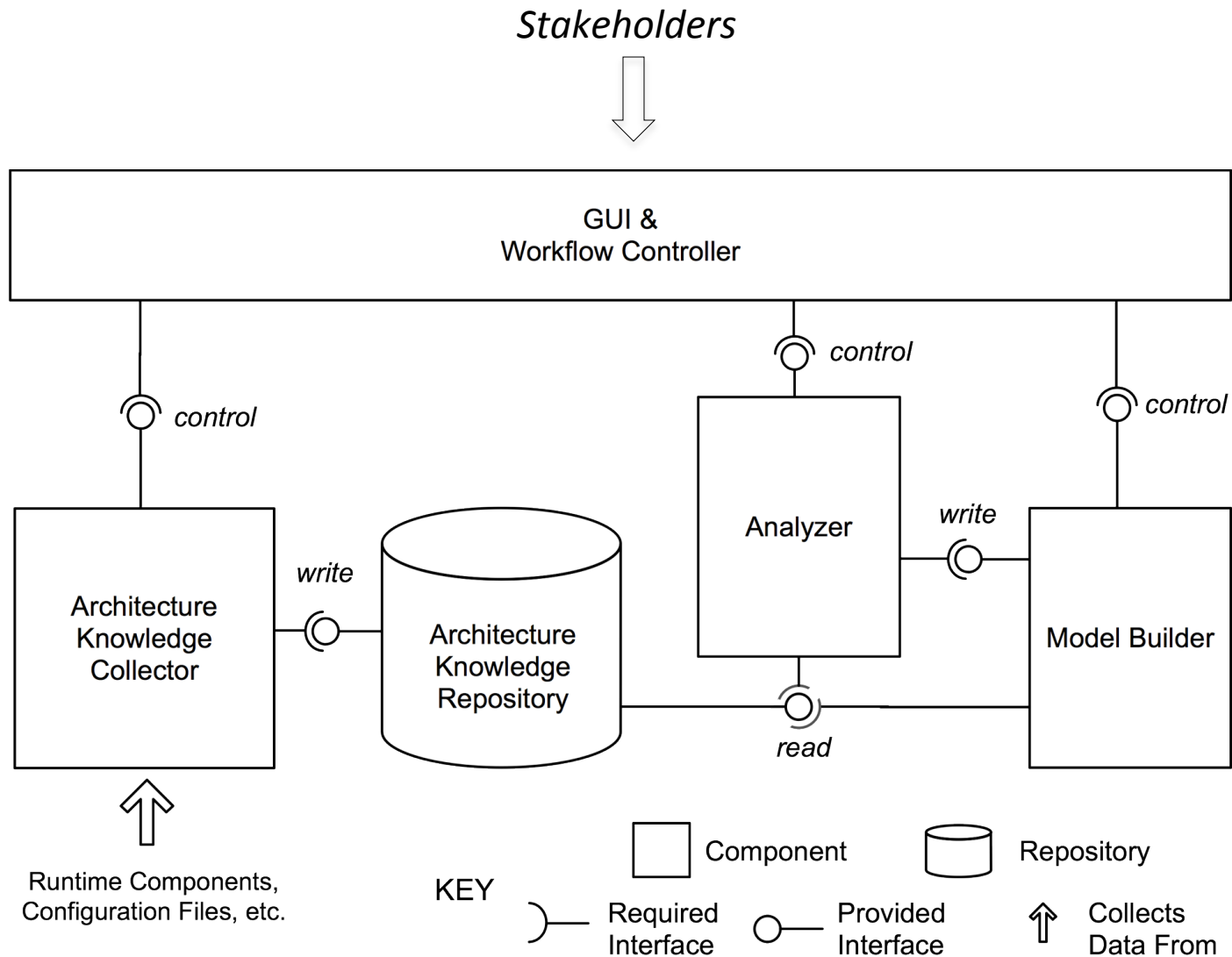
# Overview

- Architectural approach
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# Framework

- Reusable and extensible infrastructure for updating deployed SPL products
- Key functions
  - Harvesting architectural relevant information
  - Analyzing architectural information
  - Visualizing architectural models for the stakeholders
- Built in Java reusing several of the Eclipse projects

# Framework



As-Is tab

.../Documents/Research/ArchRepo/projects/egemin-ade/trunk/egemin-ade/TestData/caseKimberlyClark/

AsIs As-is dependency consistency As-is version consistency To be To-be version consistency Comparison: Replacements

Locations	
Name	Path
KimberlyClark	C:/dev/mesh/Espls/Kimberly Clark - Last known Good - 2010-05-03 14u00/S
Etricc	C:/dev/installation - mail wim 4 april 2010/Etricc/Server
ShellHost	C:/dev/mesh/Espls/Kimberly Clark - Last known Good - 2010-05-03 14u00/C

Product		
Name	Date	No
Epia	2010-04-02	1

Available locations

Assets on selected location

Asset Name	Assembly Version	File Version	Version Build
Microsoft.Practices.ObjectBuilder2	2.1.0.0	2.1.0.0	unknown
LinqTransaction	1.0.0.0	1.0.0.0	unknown
Egemin.Ewcs.Tools.DatabaseFiller	1.0.0.0	1.0.0.0	⚠ Egcs.Tools.DatabaseFiller
Egemin.Epia.Presentation.Configuration.Interfaces	1.0.0.0	2010.2.17.6	Epia - Version_20100402.1
Egemin.Ewcs.ExtraBuildOutput	1.0.0.0	1.0.0.0	⚠ ExtraBuildOutput
Microsoft.Practices.CompositeUI.WinForms	1.0.51205.0	1.0.51205.0	unknown
Egemin.Epia.Foundation.Alarming.Interfaces	1.0.0.0	2010.3.29.4	Epia - Version_20100402.1
Egemin.Ewcs.Components.Core.Interfaces	1.0.0.0	1.0.0.0	⚠ Egcs.Components.Core.Interfaces
Egemin.Etricc.Components.Interfaces	1.0.0.0	1.0.0.0	⚠ Etricc.Components.Interfaces
Egemin.Epia.Foundation.Communication.Interfaces	1.0.0.0	2010.2.17.6	Epia - Version_20100402.1
Egemin.Ewcs.Server	1.0.0.0	1.0.0.0	⚠ Egemin.Ewcs.Server
ObjectListView	1.0.0.12	1.0.0.12	unknown
TsOpcDaNet20.v6			unknown
Microsoft.Practices.EnterpriseLibrary.Common			unknown
Egemin.Epia.Foundation.Globalization.Interfaces			Epia - Version_20100402.1
Egemin.Ewcs.DataAccess			⚠ Egcs.DataAccess
Egemin.Epia.Foundation	1.0.0.0	2010.3.29.5	Epia - Version_20100402.1
Egemin.Epia.Components	1.0.0.0	2010.2.24.1	Epia - Version_20100402.1
Egemin.Ewcs.Components.Core	1.0.0.0	1.0.0.0	⚠ Egcs.Components.Core

Deployed assemblies of selected location/asset

Depends on	
Name	Assembly Version
mscorlib	2.0.0.0
System	2.0.0.0
Egemin.Epia.Foundation	1.0.0.0
Egemin.Ewcs.Communication.Interfaces	1.0.0.0
System.Core	3.5.0.0
Egemin.Etricc.Components	1.0.0.0
System.ServiceModel	2.0.0.0
Egemin.Epia.Pr	
System.Run	
Egemin.Epia.Fc	

Required by	
Name	Assembly Version
Egemin.Ewcs.Tools.DatabaseFiller	1.0.0.0
Egemin.Ewcs.Modules.Core	1.0.0.0
Egemin.Ewcs.Components.Core	1.0.0.0
Egemin.Ewcs.FltSimulator	1.0.0.0
Egemin.Ewcs.SAPReadFromDead Queue	1.0.0.0
Egemin.Ewcs.Tools.DataImporter	1.0.0.0
Egemin.Ewcs.Modules.ShopFloor	1.0.0.0

Dependencies of selected assembly

Assemblies that use selected assembly

Locations

Name	Path
KimberlyClark	C:/dev/mesh/Espls/Kimberly Clark - Last known Good - 2010-05-03 14u00/Server
Etricc	C:/dev/installation - mail wim 4 april 2010/Etricc/Server
ShellHost	C:/dev/mesh/Espls/Kimberly Clark - Last known Good - 2010-05-03 14u00/Client

Consistency of as-is product

Lacking assemblies

Name	Assembly Version	Location
<input checked="" type="checkbox"/> Egemin.EPIA.WCS	5.5.5.0	ShellHost
<input checked="" type="checkbox"/> Egemin.Ewcs.Communication	1.0.0.0	ShellHost
<input checked="" type="checkbox"/> Egemin.Ewcs.DataAccess	1.0.0.0	ShellHost
<input checked="" type="checkbox"/> Microsoft.ReportViewer.WinForm	9.0.0.0	ShellHost
<input checked="" type="checkbox"/> Microsoft.VisualBasic	8.0.0.0	ShellHost
<input checked="" type="checkbox"/> UIAutomationProvider	3.0.0.0	ShellHost
<input checked="" type="checkbox"/> UIAutomationTypes	3.0.0.0	ShellHost

Lacking assemblies for selected location

Ignored for location

Name	Assembly Version
------	------------------

System assemblies that can be ignored

Required by

Name	Assembly Version
Infragistics2.Win.UltraWinEditors.v8.3	8.3.20083.1009
Infragistics2.Win.v8.3	8.3.20083.1009

Required assemblies for selected assembly

Ignored for system

Name	Assembly Version
<input checked="" type="checkbox"/> EnvDTE	8.0.0.0
<input checked="" type="checkbox"/> Microsoft.Practices.EnterpriseLibrary.Data	4.0.0.0
<input checked="" type="checkbox"/> Microsoft.VisualStudio.DebuggerVisualizers	9.0.0.0
<input checked="" type="checkbox"/> Microsoft.VisualStudio.OLE.Interop	7.1.40304.0
<input checked="" type="checkbox"/> Microsoft.VisualStudio.Shell	2.0.0.0
<input checked="" type="checkbox"/> Microsoft.VisualStudio.Shell.Design	9.0.0.0
<input checked="" type="checkbox"/> Microsoft.VisualStudio.Shell.Interop	7.1.40304.0
<input checked="" type="checkbox"/> OpcRcw.Comn	1.10.2.0
<input checked="" type="checkbox"/> OpcRcw.Da	3.0.3.0
<input checked="" type="checkbox"/> PresentationCore	3.0.0.0
<input checked="" type="checkbox"/> PresentationFramework	3.0.0.0
<input checked="" type="checkbox"/> System	1.0.3300.0

Locations	Name	Path
	KimberlyClark	C:/dev/mesh/Espls/Kimberly Clark - Last known Good - 2010-05-03
	Etricc	C:/dev/installation - mail wim 4 april 2010/Etricc/Server
	ShellHost	C:/dev/mesh/Espls/Kimberly Clark - Last known Good - 2010-05-03

Product installers	File Name	Version Build
MSI		
Epia.msi	Server	E'pia Framework 20
Ewcs KimberlyClark.msi	Server	E'wcs (KimberlyCla

Concrete tasks to be performed on the selected location

Update script

Task	Name	Current Version	New Version	Reason
REPLACE	Egemin.Epia.Components.dll	2010.2.24.1	2010.5.7.1	Included in "Epia.msi" within bundle "Epia Server"
REMOVE	Egemin.Epia.Foundation.Communication.Inter	2010.2.17.6		No msi contains this assembly.
REMOVE	Egemin.Epia.Foundation.Communication.dll	2010.2.17.6		No msi contains this assembly.
REPLACE	Egemin.Etricc.Components.Interfaces.dll	1.0.0.0	2010.5.11.1	Included in "Ewcs KimberlyClark.msi" within bundle "Ewcs Server"
ADD	Egemin.Etricc.Components.dll		2010.5.11.1	Included in "Ewcs KimberlyClark.msi" within bundle "Ewcs Server"
REPLACE	Egemin.Ewcs.Communication.Interfaces.dll	1.0.0.0	2010.5.26.3	Included in "Ewcs KimberlyClark.msi" within bundle "Ewcs Server"
REPLACE	Egemin.Ewcs.Communication.dll	1.0.0.0	2010.5.26.3	Included in "Ewcs KimberlyClark.msi" within bundle "Ewcs Server"
REPLACE	Egemin.Ewcs.Components.Core.Interfaces.dll	1.0.0.0	2010.6.8.1	Included in "Ewcs KimberlyClark.msi" within bundle "Ewcs Server"
REPLACE	Egemin.Ewcs.Components.Core.dll	1.0.0.0	2010.6.8.1	Included in "Ewcs KimberlyClark.msi" within bundle "Ewcs Server"
REPLACE	Egemin.Ewcs.DataAccess.dll	1.0.0.0	2010.5.26.3	Included in "Ewcs KimberlyClark.msi" within bundle "Ewcs Server"
REMOVE	Egemin.Ewcs.ExtraBuildOutput.dll	1.0.0.0		No msi contains this assembly.
REMOVE	Egemin.Ewcs.FltSimulator.exe	1.0.0.0		No msi contains this assembly.
REMOVE	Egemin.Ewcs.Modules.Core.dll	1.0.0.0		No msi contains this assembly.
REMOVE	Egemin.Ewcs.Modules.ShopFloor.dll	1.0.0.0		No msi contains this assembly.
REMOVE	Egemin.Ewcs.Modules.Shopfloor.Animations.d	1.0.0.0		No msi contains this assembly.
REMOVE	Egemin.Ewcs.Presentation.Development.dll	1.0.0.0		No msi contains this assembly.

# Overview

- Architectural approach
- Update viewpoint
- Framework
- **Evaluation**
- **Conclusions & future work**



# Evaluation

- Empirical experiment focusing on correctness and availability
  - 17 professionals performed 68 updates
- Comparing Egemin's current practice (baseline approach) with architectural approach
- Hypothesis
  - H1. Architectural approach improves the correctness of updating a product
  - H2. Architectural approach improves the availability of services during a product update

# Evaluation: summary of results

- Update correctness

		Correct	Incorrect
Simple Scenarios	Architectural Approach	17	0
	Baseline Approach	14	3
Complex Scenarios	Architectural Approach	17	0
	Baseline Approach	3	14

Evidence for “The correctness of updates is higher in case of the architectural approach” for complex scenarios

# Evaluation: summary of results

- Process shutdowns

		Optimal	Number of shutdowns > optimal	Number of shutdowns < optimal
Simple Scenarios	Architectural Approach	17	0	0
	Baseline Approach	11	5	1
Complex Scenarios	Architectural Approach	16	1	0
	Baseline Approach	8	3	6

Evidence for “The number of shutdowns is smaller with the architectural approach” for complex scenarios

# Evaluation: summary of results

- Treats to validity
  - Experiments performed in a controlled lab setting
  - Test persons not allowed to interact with colleagues

*B. Michalik, D. Weyns, A. Helleboogh, N. Bouke, Supporting Online Updates of Software Product Lines: A Controlled Experiment, 5th ACM/IEEE International Symposium on Empirical Software Engineering and Measurement, ESEM 2011*

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# Conclusions

- Research of online updates typically takes a *technical perspective* on the problem
- Concerns of integrators which crucial for the success of updates are often neglected
- Lack of accurate knowledge of the deployed system is a reality
- Architecture approach
  - Stakeholder perspective on problem of online updates
  - Positive value/cost balance in SPL context

# Ongoing / future work

- Application to different domain/technology
  - EduSPL: educational software product built on top of OSGi
- Formally prove correctness and availability properties
- “Autonomic SPL”
  - Base level: domain SPL
  - Adaptation level: SPL of reusable assets to add autonomic properties to domain SPL (support for self-adaptation to add quality attributes)

# An Architectural Approach to Support Online Updates of SPL Products

<http://homepage.lnu.se/staff/daweaa/index.htm>

*Thanks! Questions?*

## ACKNOWLEDGMENTS

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