



11th International

# Software Product Line Conference (SPLC 2007)

Sept. 10-14, 2007, Kyoto, Japan



## Service Oriented Architectures and Product Lines - What is the Connection? (SOAPL - 07)

10 September 2007, Kyoto

- |                                           |                                          |
|-------------------------------------------|------------------------------------------|
| • <a href="#">Description</a>             | • <a href="#">Contact Information</a>    |
| • <a href="#">Audience</a>                | • <a href="#">Workshop Organizers</a>    |
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- 

### Workshop Proceedings

Cohen, Sholom & Krut, Robert. [Proceedings of the First Workshop on Service-Oriented Architectures and Product Lines](#) (CMU/SEI-2008-SR-006).

### Post-workshop Information

The following presentations were given at the SOAPL - 07 workshop. Information gathered during the workshop and the workshop papers will be incorporated into a workshop report from the Software Engineering Institute. The report will be published during calendar year 2008.

- [Service Oriented Architectures and Product Lines - What is the Connection?](#)  
Bob Krut, Software Engineering Institute
  - [A Taxonomy of Variability in Web Service Flows](#)  
David Benavides, University of Seville
  - [Comparison of Service and Software Product Family Modeling](#)  
Mikko Raatikainen, Helsinki University of Technology
  - [Identifying and Specifying Reusable Services of Service Centric Systems Through Product Line Technology](#)  
Jaejoon Lee, Fraunhofer Institute for Experimental Software Engineering
  - [Product Lines that supply other Product Lines: A Service-Oriented Approach](#)  
Christian Kästner, University of Magdeburg
- 

### Pre-workshop information

#### Description

Service-Oriented Architectures (SOA) and software product line (SPL) approaches to software development share a common goal. They both encourage an organization to reuse existing assets and capabilities rather than repeatedly redeveloping them for new systems. The intent is that organizations can capitalize on reuse to achieve desired benefits such

as productivity gains, decreased development costs, improved time to market, higher reliability, and competitive advantage. Their distinct goals may be stated as:

- SOA: "enable assembly, orchestration and maintenance of enterprise solutions to quickly react to changing business requirements" (Wienands)
- SPL: systematically capture and exploit commonality among a set of related systems while managing variations for specific customers or market segments

This workshop will explore the connections from two perspectives:

1. Can web services support product lines using a service-oriented architecture?
2. How can use of product line practices support web services and service-oriented architectures?

Topics of interest for the workshop include, but are not limited to:

- Practice areas that span both SOA and product lines (e.g., domain analysis, legacy mining, operations/governance, etc.)
- Handling variability through services
- Cost models to justify investment in SOA for product lines
- Use of support technology such as: domain specific languages, tools, other
- Differences between service-oriented and more conventional product line development approaches.

## Audience

Participants in the SOA and Product Lines Workshop will include product line practitioners who have experience in using service-oriented architectures, or who are interested in migrating their software product lines to SOA in the future. These include practitioners in product line engineering as well as product line management roles. We also welcome participation from architects/developers of SOA-based systems who are interested in applying product line practices in development of their systems.

## Schedule

The workshop will be highly interactive and focused on making tangible progress towards answering the two questions relating to the connections between SOA and product lines. The morning session will feature invited speakers and selected presentations based on position papers. Participants will be assigned to groups that reflect specific topics. After the workshop, the leader of each working group will be asked to write a summary of the working group's discussion and (especially) its conclusions.

## Submission instructions

Prospective participants are required to either

1. Submit a 3-6 page position paper. All submissions will be reviewed by members of the program committee for quality and relevance. Accepted papers will become part of the workshop proceedings. Three or four papers will be chosen to be presented during the workshop to foment discussion. Submit your paper in PDF format to [soa-workshop@sei.cmu.edu](mailto:soa-workshop@sei.cmu.edu) or by July 1, 2007.
2. Submit an experience report describing the software architecture or other system artifacts that are SOA-based.

### Workshop Organizers:

- [Sholom Cohen](#), Software Engineering Institute
- [Paul Clements](#), Software Engineering Institute
- [Andreas Helfrich](#), University of Stuttgart
- [Bob Krut](#), Software Engineering Institute
- [Grace Lewis](#), Software Engineering Institute
- [Dennis Smith](#), Software Engineering Institute
- [Christoph Wienands](#), Siemens Corporate Research

Notifications of paper or experience report acceptance will be sent by July 15, 2007.

## Contact Person

Sholom Cohen

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## Workshop Organizers

### Service Oriented Architectures and Product Lines - What is the Connection?

10 September 2007, Kyoto

**Paul Clements** is a senior member of the technical staff at Carnegie Mellon University's Software Engineering Institute. There, he works in areas of software architecture and software product lines. He has co-authored four books in software engineering, including *Software Product Lines: Practices and Patterns*, as well as over fifty papers in architecture, documentation, software structure, and product line methodologies. He was the conference chair for the 2004 International Software Product Line Conference and program co-chair for the first one. He has organized or co-organized ten workshops at AOSD, OOPSLA, and ICSE conferences, as well as at SPLC-Europe 2005 and SPLC 2006. He holds a Ph.D. in computer sciences from the University of Texas at Austin, and a M.Sc. in computer science from the University of North Carolina at Chapel Hill. For more information visit <http://www.sei.cmu.edu/staff/clements/>. E-mail: [clements@sei.cmu.edu](mailto:clements@sei.cmu.edu).

**Sholom Cohen** is a senior member of the technical staff at the Software Engineering Institute. Mr. Cohen is a member of the Product Line Systems Program and has authored major technical reports and conference papers on product lines, including: asset development, product development, and variability management. He is a contributor to the Product Line Framework and the Product Line Business and Acquisitions Guidelines. Mr. Cohen has supported product line development and acquisition for both DoD and industrial organizations in various practice areas, including: Architecture Definition and Evaluation, Understanding Relevant Domains, Scoping, Configuration Management, Building A Business Case, and others. Mr. Cohen has organized panel sessions at ECOOP and at the International Conference on Software Reuse (ICSR). He has chaired workshops at OOPSLA, ICSR, and at prior Software Product Line Conferences, including 2002 and 2004. He holds degrees from the Massachusetts Institute of Technology, University of Michigan, and Columbia University. For more information visit <http://www.sei.cmu.edu/staff/sgc/>. E-mail: [sgc@sei.cmu.edu](mailto:sgc@sei.cmu.edu).

**Andreas Helfrich** is a lecturer and researcher at the University of Stuttgart, Germany. He is also currently working on his PhD on the application of the concept of Mass Customization to complex information systems. His recent publications include papers presented at SPLC 05 and 06, ECIS 2005, and the 2005 World Conference on Mass Customization and Personalization, as well as articles published in the *Communications of the ACM* and *Wirtschaftsinformatik*. Andreas holds a Master in Business Administration (Dipl.-Kfm.) from the University of Stuttgart and a M.Sc. in Management Information Systems from the University of Missouri - St. Louis. E-mail: [helfrich@wi.uni-stuttgart.de](mailto:helfrich@wi.uni-stuttgart.de).

**Robert Krut** is a member of the technical staff at Carnegie Mellon University's Software Engineering Institute. He currently works in the areas of software architecture and software product lines. He has authored technical reports in product lines, domain engineering, and domain analysis. He is a contributor to the Product Line Framework and has lead strategy and implementation teams for the SEI's web-based information. He holds degrees in computer science, electrical engineering, and physics from Johns Hopkins University, Pennsylvania State University, and Edinboro State University, respectively. For more information visit <http://www.sei.cmu.edu/staff/rk/>. Email: [rk@sei.cmu.edu](mailto:rk@sei.cmu.edu)

**Grace Lewis** is a Senior Member of the Technical Staff at the Software Engineering Institute. She is currently the lead for the System of Systems Engineering team within the Integration of Software-Intensive Systems (ISIS) initiative. Her current interests and projects are in service-oriented architecture, technologies for interoperability, modernization of

legacy systems, and characterization of software development life cycle activities in systems of systems environments. Her latest publications include several reports published by Carnegie Mellon on these subjects and a book in the SEI Software Engineering Series. She is also a member of the technical faculty for the Master in Software Engineering program at CMU. Grace holds a B.Sc. in Systems Engineering and an Executive MBA from Icesi University in Cali, Colombia; and a Master in Software Engineering from Carnegie Mellon University. For more information visit <http://www.sei.cmu.edu/staff/glewis/>. E-mail: [glewis@sei.cmu.edu](mailto:glewis@sei.cmu.edu).

**Dennis Smith** is a Senior Member of the Technical Staff and Lead of the Integration of Software-Intensive Systems (ISIS) Initiative at the Software Engineering Institute (SEI). This initiative focuses on developing and applying methods, tools and other technologies that enhance the effectiveness of complex networked systems and systems of systems. Currently he has been involved with working with DoD organizations to develop an SOA capability, including issues of SOA strategy, governance and migration of legacy assets to SOA. Previously, he was a member of the Product Line Systems Program and technical lead in the effort for migrating legacy systems to product lines. He has published a variety of books, articles and technical reports, and has given talks and keynotes at conferences and workshops. Dennis was the co-editor of the IEEE and ISO recommended practice on CASE Adoption, and has been general chair of two international conferences. Dennis holds an M.A. and PhD from Princeton University, and a B.A. from Columbia University. For more information visit <http://www.sei.cmu.edu/staff/dbs/>. E-mail: [dbs@sei.cmu.edu](mailto:dbs@sei.cmu.edu).

**Christoph Wienands** is a Member of Technical Staff at Siemens Corporate Research, a central research organization within Siemens. His activities focus mostly on product lines, Software Factories and model-driven development. He is author of "Practical Software Factories in .Net" and presented at conferences such as UML & Design World, SD West, and others. Over the past years he has been architecture lead for the development of a SOA-based system. Christoph holds a Diplom-Informatiker (FH) from Furtwangen University, Germany. Email: [Christoph.wienands@siemens.com](mailto:Christoph.wienands@siemens.com)



### Related References

## Service Oriented Architectures and Product Lines - What is the Connection?

10 September 2007, Kyoto

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The following references present examples of previous work in the area of SOA and Product Lines. If you would like to include additional references, please submit the reference to [soa\\_workshop@sei.cmu.edu](mailto:soa_workshop@sei.cmu.edu)

- Butler, John. *Applying Product Lines Techniques to SOA*, CDBi Journal, February 2006.
- Butler, John. *Applying Product Line Techniques to SOA - Part II: Exploring Configuration Management Patterns for SOA*, CDBi Journal, May 2006.
- Helferich, Andreas; Herzwurm, Georg; Jesse, Stefan; Mikusz, Martin. *Software Product Lines, Service-oriented Architecture and Frameworks: Worlds Apart or Ideal Partners?*,

# Service Oriented Architectures and Product Lines - What is the Connection?

Software Engineering Institute  
Carnegie Mellon University  
Pittsburgh, PA 15213

Bob Krut  
10 September 2007  
SPLC 2007, Kyoto, Japan



**Software Engineering Institute**

**CarnegieMellon**

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# Agenda

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09:00-09:30	Introductions and Goals
09:30-10:30	Topic Presentations and Discussion
10:30-11:00	Break
11:00-11:30	Topic Presentation and Discussion
11:30-12:30	General Discussion: working groups or new topics
12:30-13:30	Lunch
13:30-15:00	General Discussion Continued
15:00-15:30	Break
15:30-16:00	General Discussion Continued
16:00-16:30	Working Group Report(s)
16:30-17:00	Conclusion: Goals Addressed, Topics for Limerick, Future Work





# Accepted Papers

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## Product Lines that supply other Product Lines: A Service-oriented Approach

Salvador Trujillo, IKERLAN Research Centre, Mondragon, Spain  
Christian Kästner, University of Magdeburg, Magdeburg, Germany  
Sven Apel, University of Passau, Passau, Germany

## A Taxonomy of Variability in Web Service Flows

Sergio Segura, David Benavides and Antonio Ruiz-Cortés, University of Seville, Seville, Spain

## Identifying and Specifying Reusable Services of Service Centric Systems through Product Line Technology

Jaejoon Lee, Dirk Muthig, and Matthias Naab, Fraunhofer Institute for Experimental Software Engineering (IESE), Kaiserslautern, Germany  
Minseong Kim and Sooyong Park, Sogang University, Seoul, R.O.Korea



# Accepted Papers Continued

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## Comparison of Service and Software Product Family Modeling

Mikko Raatikainen, Varvana Myllärniemi, and Tomi Männistö, Helsinki  
University of Technology, Finland

## Software Product Lines and Service-oriented Architecture: A Systematic Comparison of Two Concepts

Andreas Helferich, Georg Herzwurm, and Stefan Jesse, Universität Stuttgart,  
Stuttgart, Germany

## A Framework for Software Product Line Practice, Version 5.0, FAQ

[http://www.sei.cmu.edu/productlines/frame\\_report/FAQ.htm#other\\_approaches](http://www.sei.cmu.edu/productlines/frame_report/FAQ.htm#other_approaches)



# Paper Topics

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Topic 1. Methods for SOA and Product Line Development

Topic 2. Managing Service Features and Variability

Topic 3. Example Applications



# Topic 1. Methods for SOA and Product Line Development

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**Presentation:** Comparison of Service and Software Product Family Modeling

**Authors:** Mikko Raatikainen, Varvana Myllärniemi, Tomi Männistö  
Helsinki University of Technology, Software Business and Engineering Institute (SoberIT)

**Questions:** Could criteria from the Service Migration and Reuse Technique (SMART) serve as an approach for the migration of legacy components for product lines? What specific criteria would apply here? Are there detailed examples or a comparison of models, e.g. feature models vs. SDL/BPEL/BPMN?



# Topic 2. Managing Service Features and Variability

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**Presentation:** A Taxonomy of Variability in Web Service Flows

**Authors:** Sergio Segura, David Benavides and Antonio Ruiz-Cortés,  
Department of Computer Languages and Systems University of Seville

**Questions:** Where an application in a SOA-based product line is built using services from external core asset sources, how would product development manage variability and selection of variation of features within those assets? Could entire services be substituted? Variations within a service? Any implementation of the taxonomy?



# Topic 3. Example Applications

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**Presentation:** Identifying and Specifying Reusable Services of Service Centric Systems through Product Line Technology

**Authors:** Jaejoon Lee, Dirk Muthig, and Matthias Naab, Fraunhofer Institute for Experimental Software Engineering (IESE). Minseong Kim, Sooyong Park Sogang University, Seoul, R.O.Korea

**Questions:** How would identified services be used in applications? Might we see hybrid service/component oriented applications? What evidence is there of an actual "right" scale of granularity? Do case study artifacts beyond the limited figures in the paper actually exist?



# Conclusion

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## Goals Addressed

- Where the goals of the workshop addresses?

## Future Work

- What future SOAPL work will the participants being working on?

## SPLC 2008

- Should we continue this topic at SPLC 2008? If so, what should we focus on?





**Software Engineering Institute**

**Carnegie Mellon**





# ***A Taxonomy of Variability in Web Service Flows***

***Sergio Segura, David Benavides, Antonio Ruiz-Cortés and P. Trinidad***

***Department of Computer Languages and Systems  
University of Seville, Spain***

UNIVERSIDAD DE SEVILLA

## ***The Path***

- Introduction
- Web Service Flows
- Variability points in WS-Flows
- Conclusions and Future Work

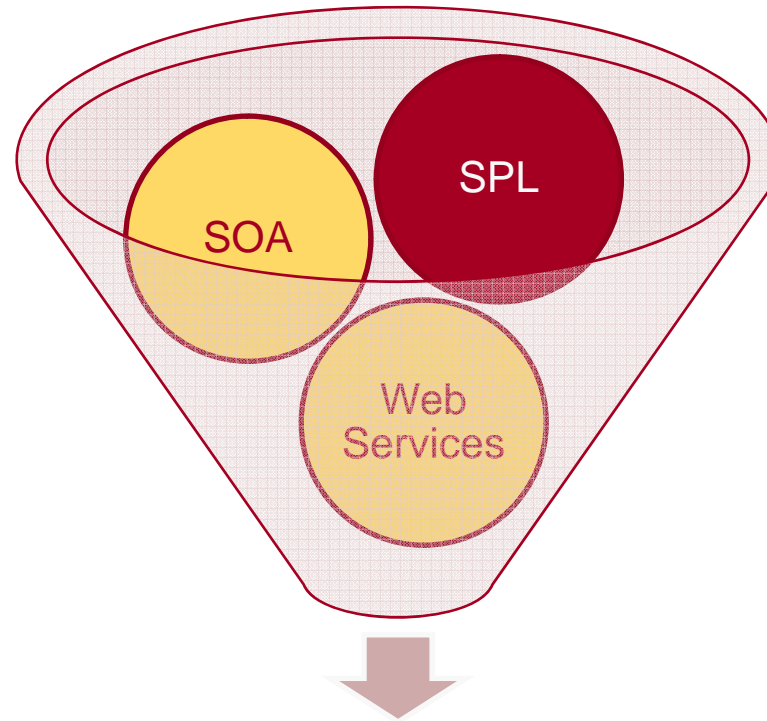


# ***The Path***

- **Introduction**
- Web Service Flows
- Variability points in WS-Flows
- Conclusions and Future Work



# *Introduction*



**Discoverability**

**Reusability**

**Quality**

**Time-to-market**

**Productivity**

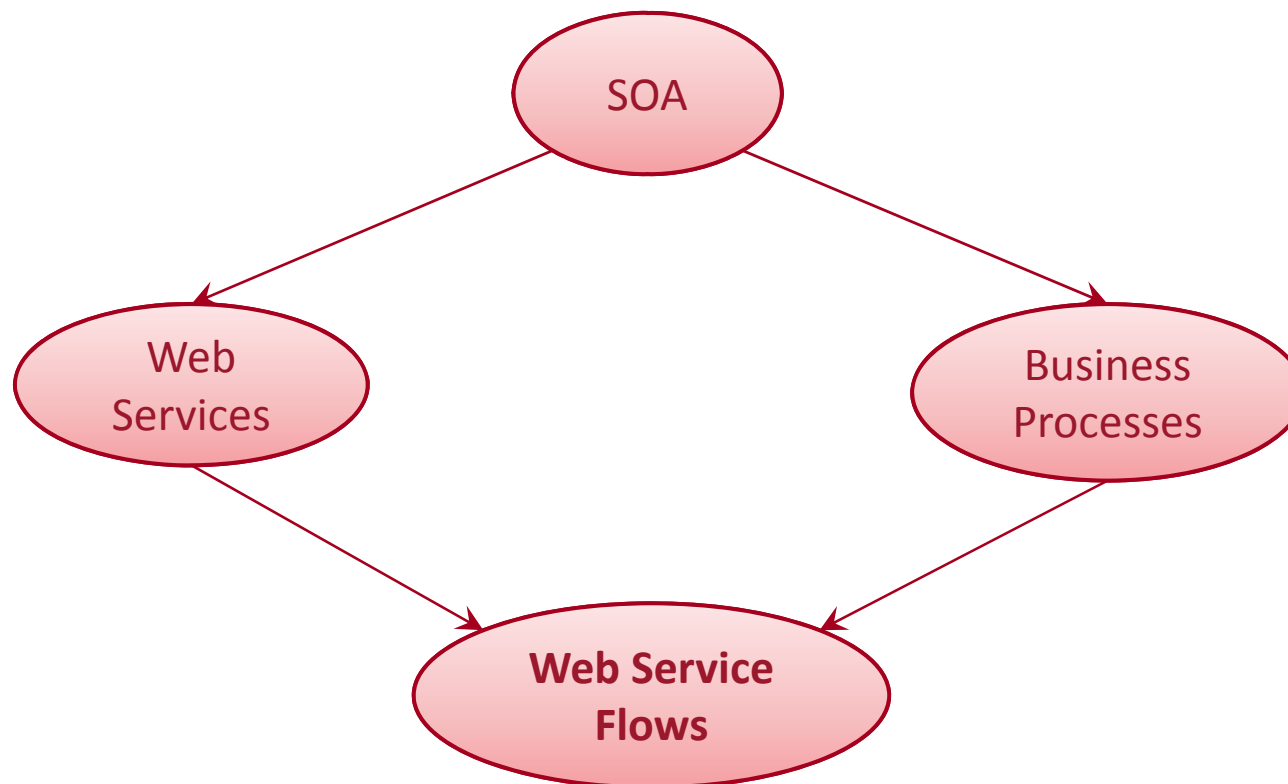
**Loose Coupling**

**Stateless**



# *Introduction*

How handling variability through services?



# ***Introduction***

## **A taxonomy of variability in Web Service Flows**

- Starting point for a base of knowledge about variability in WS-flows that can be later used for both:
  1. Evaluating the different mechanisms for implementing variability in WS-flows.
  2. Identifying factors that affect the selection of such variability mechanisms.



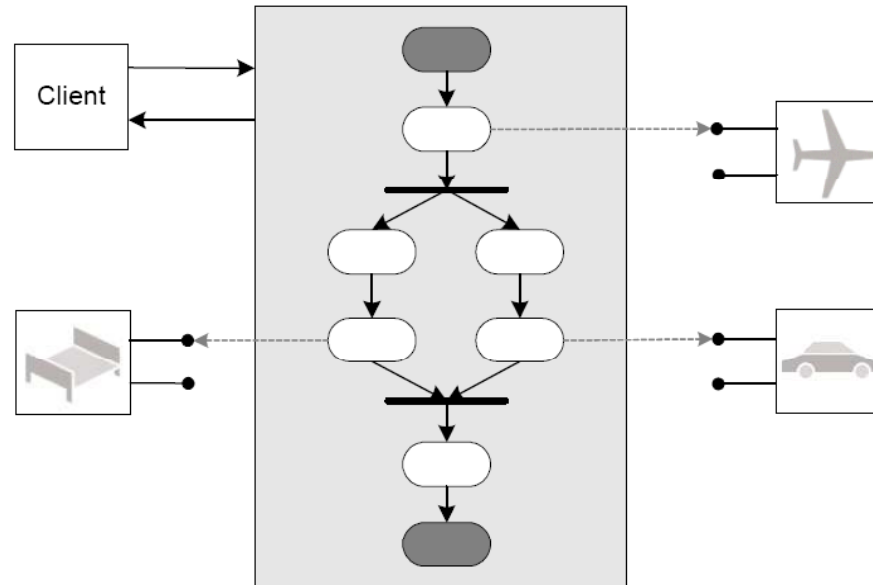
## ***The Path***

- Introduction
- **Web Service Flows**
- Variability points in WS-Flows
- Conclusions and Future Work



# Web Service Flows

- A *Web Service Flow (WS-flow)* is as a composite Web service implemented using a process-based approach.
- Languages: WSCI, BPML, **BPEL**.





## ***The Path***

- Introduction
- Web Service Flows
- **Variability points in WS-Flows**
- Conclusions and Future Work



# *Variability in WS-Flows*

*Service Invocation*

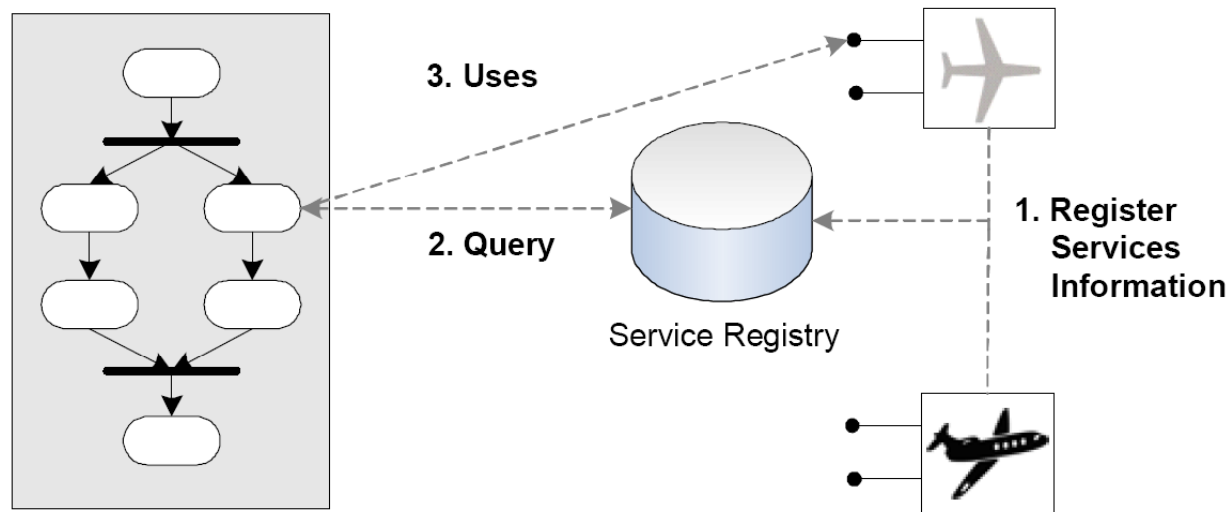
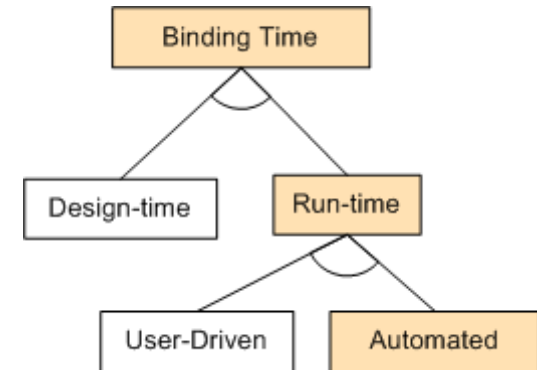
*Process Workflow Structure*



# *Variability in WS-Flows*

## *Service Invocation*

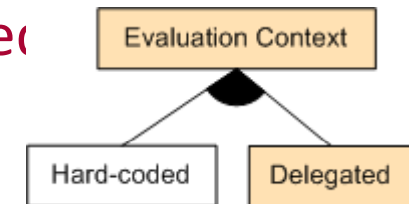
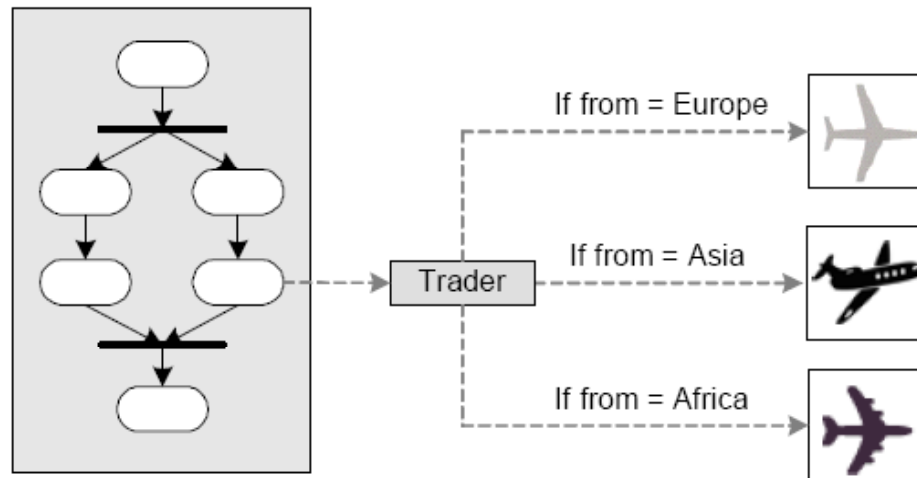
- **Partner Selection. Design-time VS Run-time**



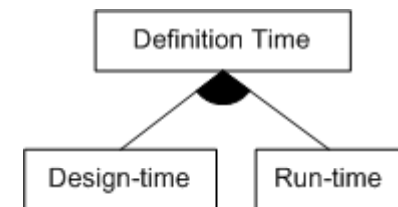
# Variability in WS-Flows *Service Invocation*

- Partner Selection Criteria

- a) Evaluation Context. Hard-coded VS Delegated

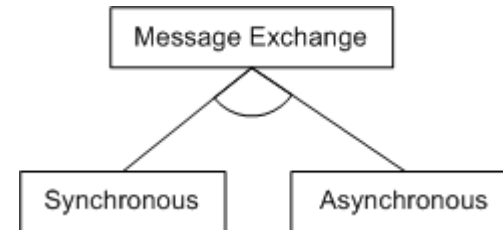


- b) Definition Time. Design-time VS Run-time

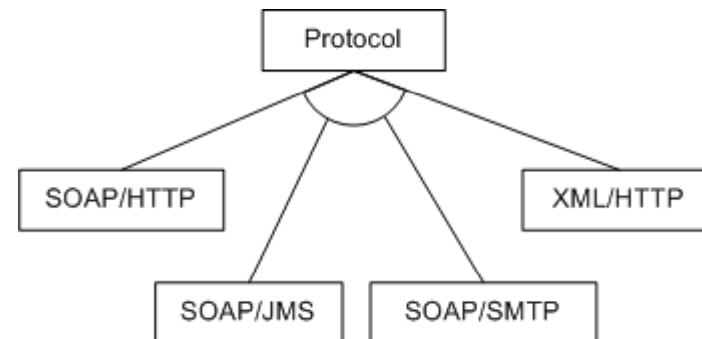


# ***Variability in WS-Flows*** *Service Invocation*

- **Message Exchange**
  - Synchronous VS Asynchronous

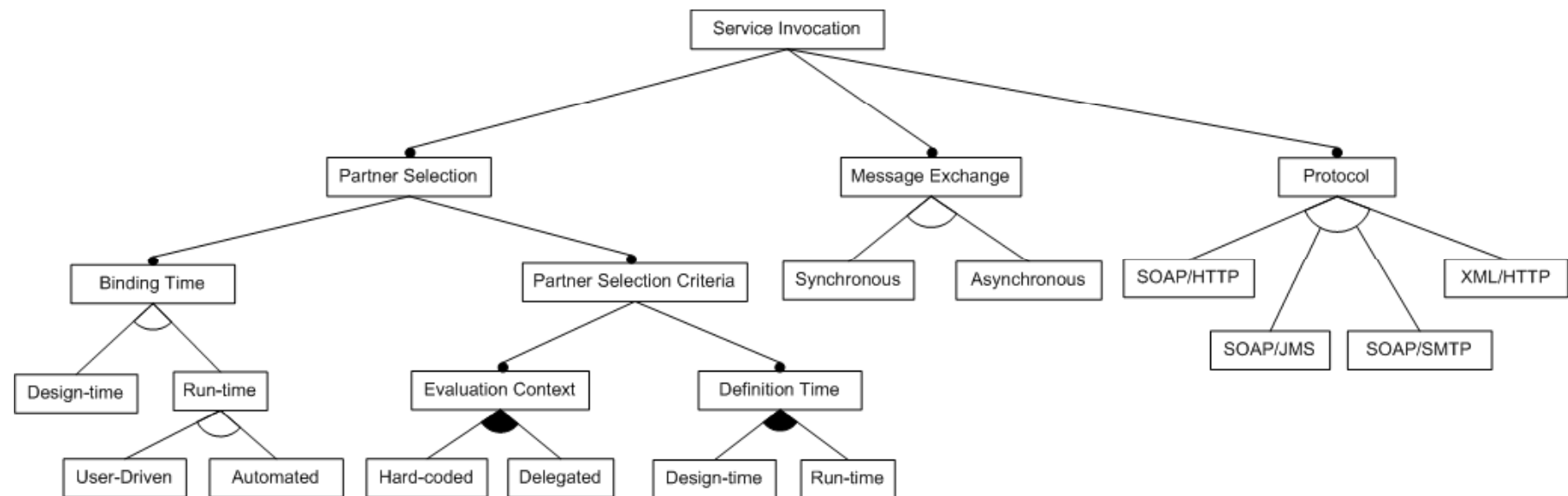


- **Protocols**
  - SOAP/HTTP
  - SOAP/JMS
  - XML/HTTP



# *Variability in WS-Flows*

## *Service Invocation*



# ***Variability in WS-Flows***

## *Process Workflow Structure*

- **Control Flow.**
  - Task to be executed.
  - Execution order.
- **Data Flow**
  - Exchange of data between services.



## ***The Path***

- Introduction
- Web Service Flows
- Variability points in WS-Flows
- **Conclusions and Future Work**



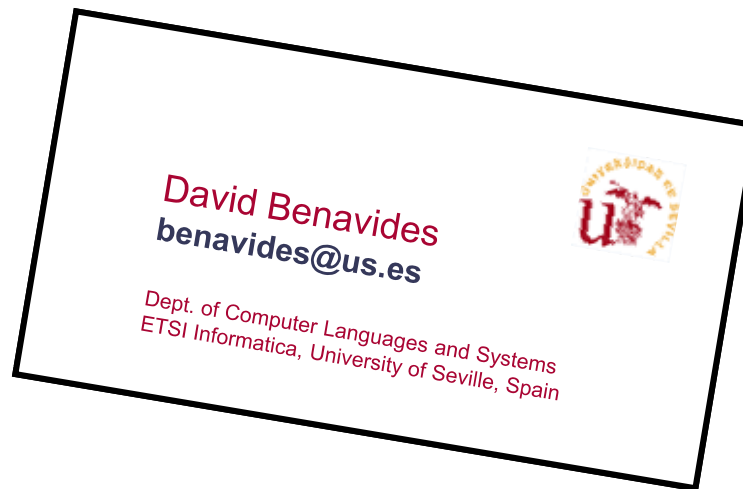


## *Conclusions and future work*

- A starting point for a base of knowledge about variability in WS-flows.
- We focus on service invocation and workflow structure.
- Next step: Implementation technologies
- Toward service-based implementation of business driven SPLs.



**Thanks!**



**Can we improve this talk?**

Contact us at **benavides@us.es**

Drop by our e-page at **www.lsi.us.es**



## Comparison of Service and Software Product Family Modeling

Mikko Raatikainen, Varvana  
Myllärniemi, Tomi Männistö

Helsinki University of Technology  
Finland



## Agenda

- Problem
- Modeling in software product family
- Modeling in Services
- Comparison
- Conclusions
- Question specific to this paper

## Problem

- Similarities in software product families and service oriented computing
    - Both aim at efficiently developing application from existing pieces of software
    - Both rely on models
  - But also differences
    - Typically services are dynamic computational elements
    - Typically software product families deal with static elements
- ➔ we discuss the similarities and differences in service oriented computing modeling and software product family modeling

## Software Product Family Modeling

- Domain model including variability and product model to express the product of a software product family
- Several approaches to model variability
  - Specific approaches for variability modeling
  - Extension to existing approaches such as UML
  - Variability models to augment existing models

## Service Oriented Computing Modeling

- Dominated by web service initiatives
- Basic concepts relatively mature such as WSDL
- Advanced concepts not as established
- Typically driven by different standards, such as WSDL and BPEL

## Comparison

- No domain or variability modeling in services
- Service typically composition whereas software product family decompositional
  - No technical reason to do the opposite
- Both focus on architectural level concepts
  - Services typically dynamic elements whereas components static
- Composition, interfaces, and connections in both approaches



## Comparison

- Notations in software product families typically graphical whereas in service XML-based
- Service modeling driven by standards, whereas in software product families plethora of approaches
- Services focus on dynamic aspect and stakeholders relevant to that whereas software product family adhere to different architectural viewpoints

## Conclusions

- Feasibility of variability modeling in services
- Behavior modeling and analysis of services in software product families
- The actually needed concepts for modeling of services and software product families
  - Different viewpoints in services
- Unify variability modeling concepts
- Apply and reuse the modeling methods from other approaches

## Question specific to this presentation

*Are there detailed examples or a comparison of models, e.g. feature models vs. SDL/BPEL/BPMN*

- To best of our knowledge modeling in the approaches has not been compared before
- We have tried to apply our software product family modeling tools (KumbangTools) to service composition
  - To some extended feasible
  - Not suitable for complex behavior

# Thank you!

Questions?

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is a secure document that has been embedded in this document. Double click the pushpin to view.



# Product Lines that supply other Product Lines: A Service-Oriented Approach

**Salvador Trujillo**  
IKERLAN Research Center  
Spain



**Christian Kästner**  
*University of  
Magdeburg  
Germany*



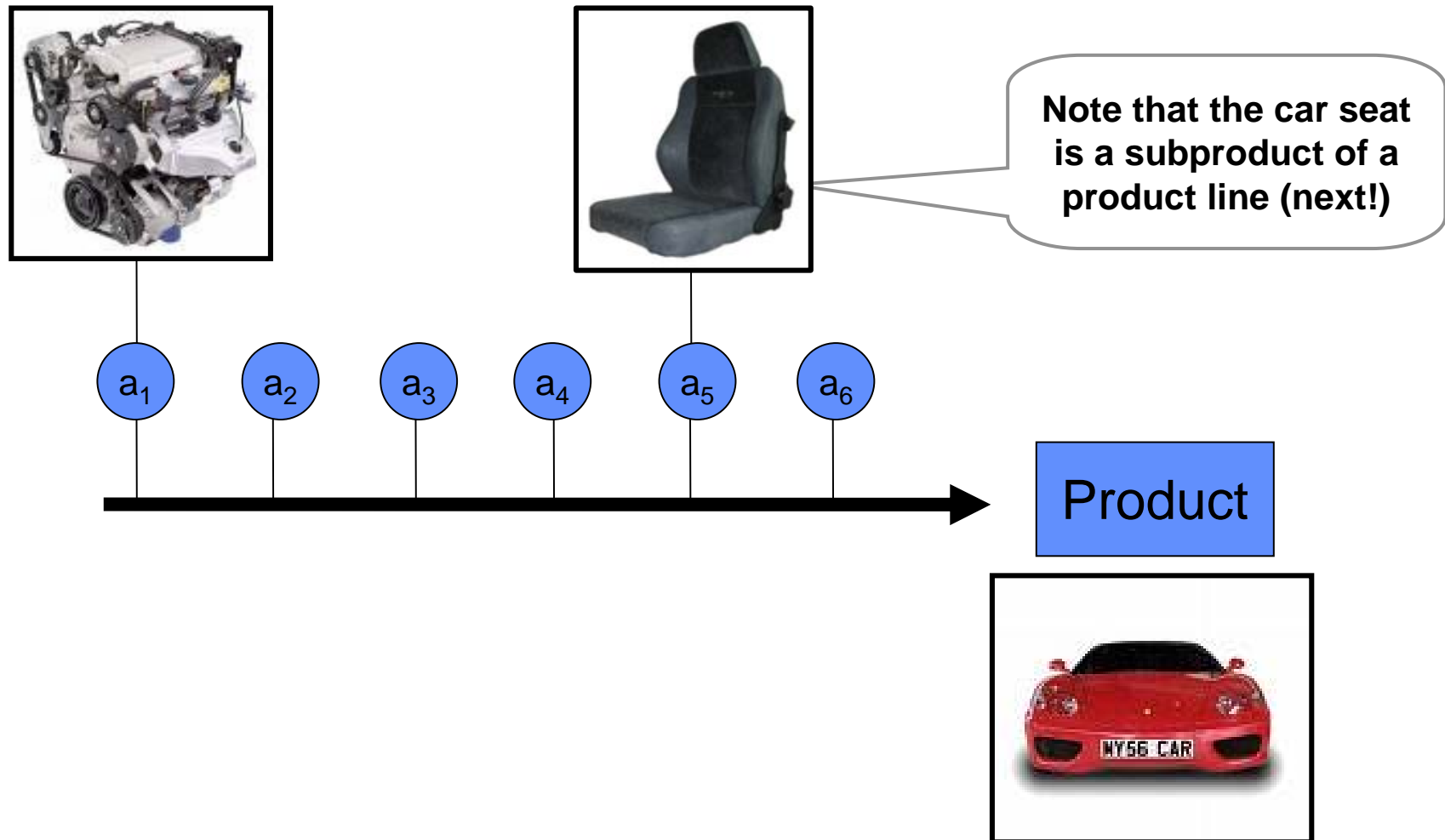
**Sven Apel**  
University of Passau  
Germany



## Overview

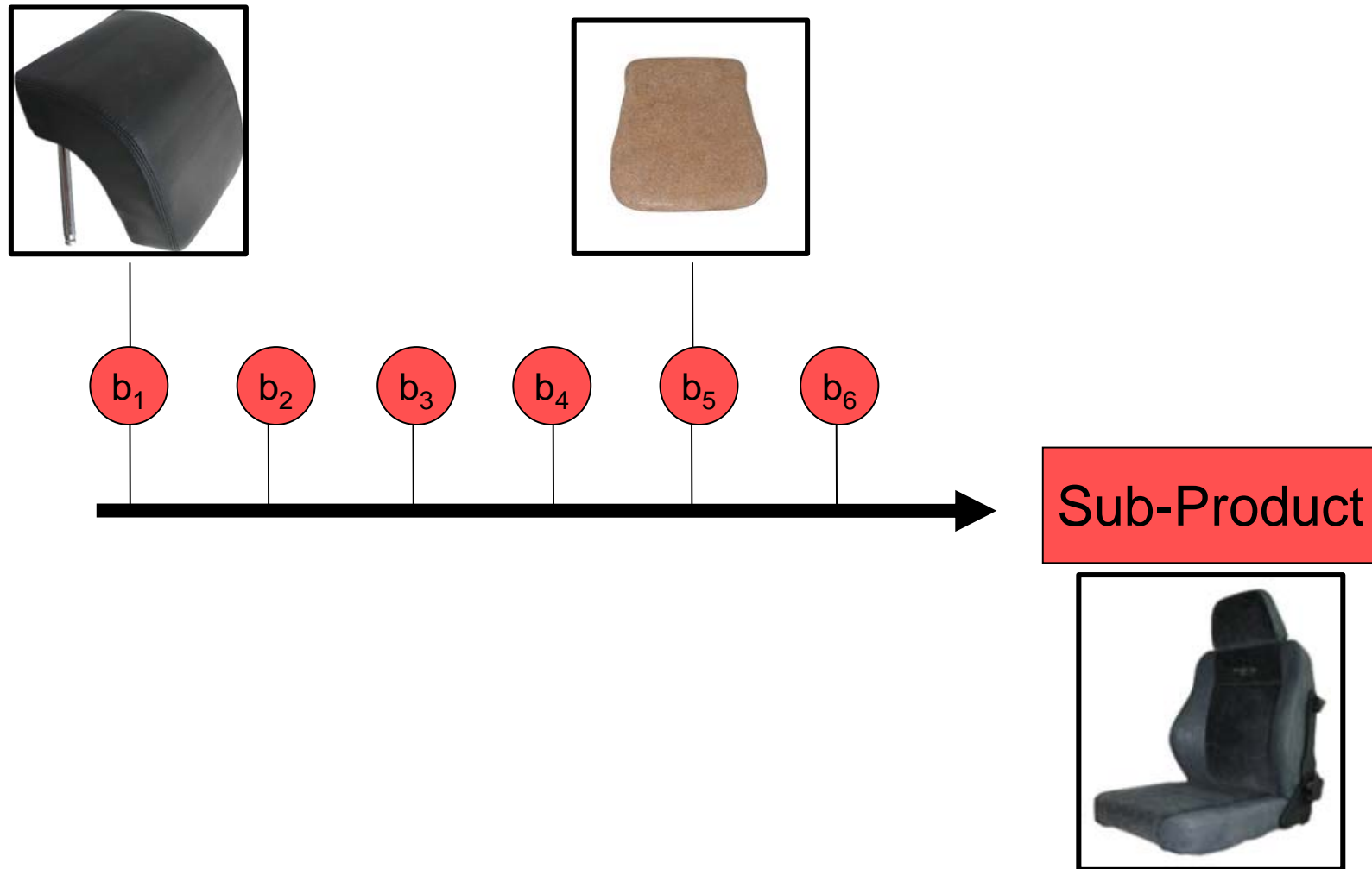
- In industry, product-lines commonly use parts of other product lines
- So far, this situation is unlikely for software product lines
- The problem is the combination of different parts produced by different product lines
  - ◆ We propose a service-oriented architecture to do so,
  - ◆ in which product lines are regarded as services,
  - ◆ which are consumed by service-oriented product lines
- We illustrate these ideas with an example, but we believe that much more work is needed

## An Introductory Example: car assembly line

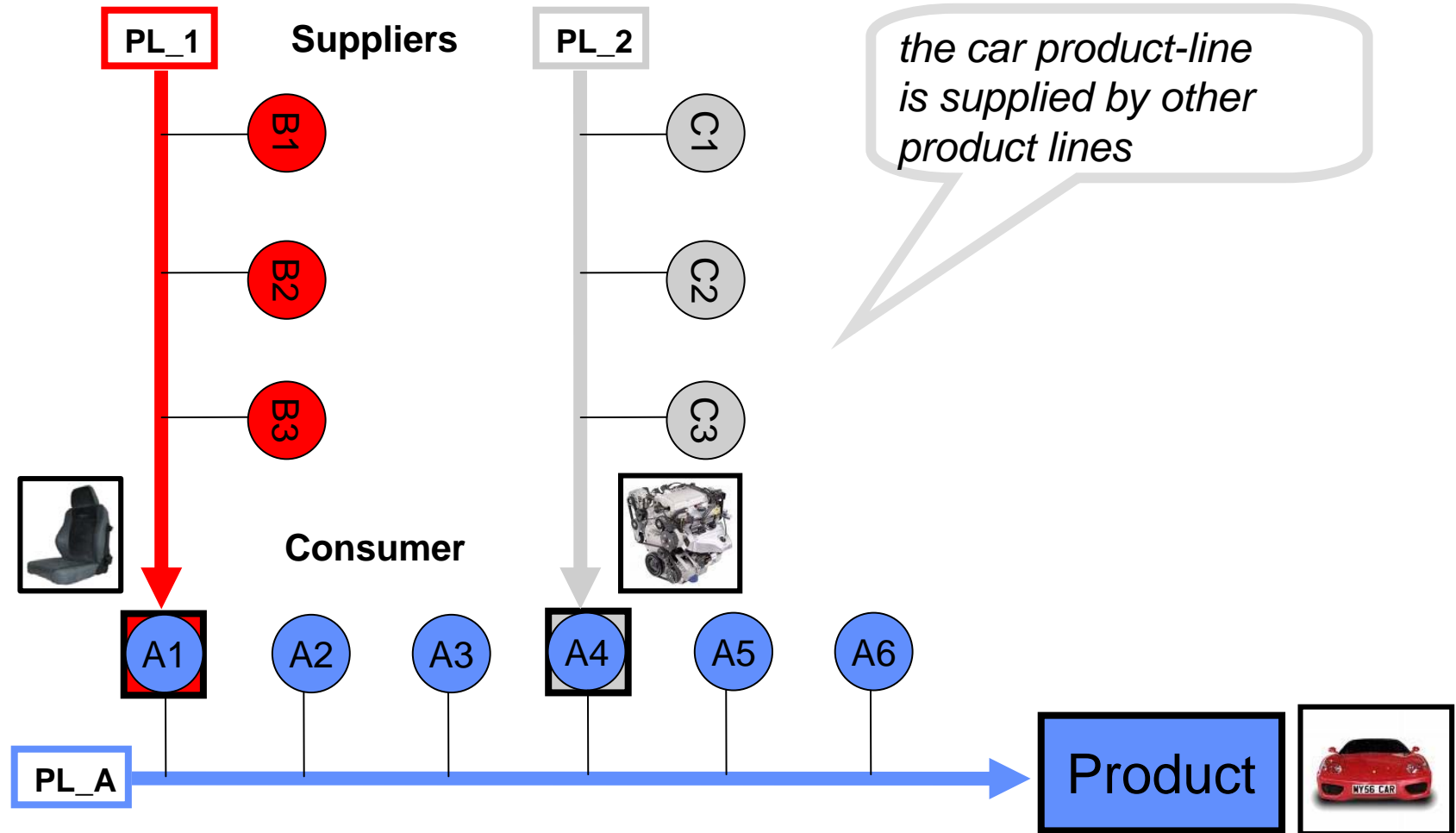




## An Introductory Example: car seat assembly line



## An Introductory Example: product lines that supply other product lines



# A Portal / Portlet scenario

## Portals & Portlets

- A **Portal** is a Web application that provides centralized access to a variety of services
- Services are often offered by 3rd party components called Portlets

- ◆ are presentation-oriented web services
- ◆ business logic *and* web user interface

The screenshot shows a WebSphere Portal interface. The main content area contains several portlets. An orange callout bubble points to the 'My Weather' portlet, which displays weather information for various locations. A red callout bubble points to the 'My Stocks' portlet, which displays stock market data. A pink callout bubble points to the 'My News' and 'Financial Services' sections on the right side of the page. The interface includes a top navigation bar with links like 'New Page', 'Edit Page', and 'Assign Permissions'. The left sidebar contains a 'PortletPreview' section and a 'Welcome' message. The bottom of the page shows a 'Get Quote' button and a 'Symbol Lookup' link.

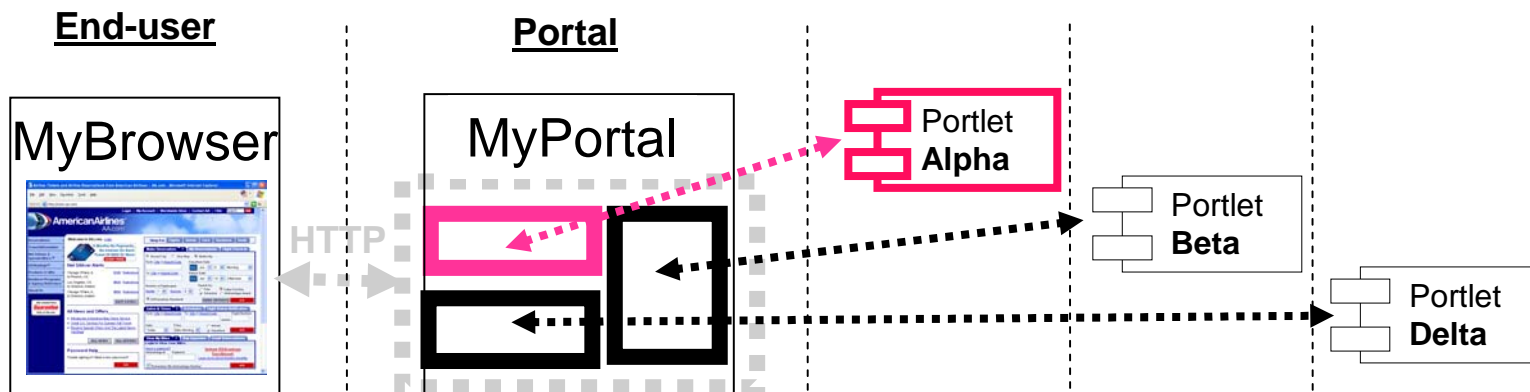
a Portlet

another Portlet

more Portlets

## Portal Architecture

- End-user accesses Portal with web browser
- Portal aggregates different portlets
- Portlets provide business logic and representation



## Scenario: Portlet Product Lines

*Different portals demand similar **portlets** that overlap in functionality*

**Portlet\_A\_1**

**Portlet**

FlightBookingPortlet

Flight Booking Portlet - Search (1)

Para comprobar disponibilidad y tarifas, dinos cuando y como quieres volar

Desde  A

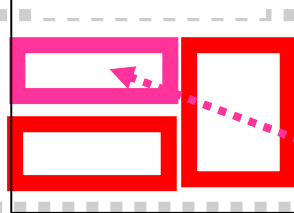
Dia de Salida  Mes  Año

Dia de Vuelta  Mes  Año

Adultos

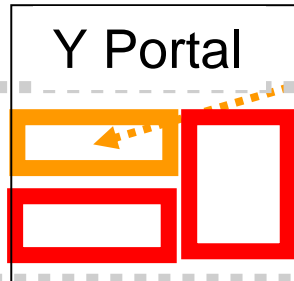
MyBrowser

X Portal



Portlet  
Alpha

Y Portal



*Different customers demand similar **portals** that overlap in functionality*

**Portlet**

FlightBookingPortlet

[Hotels & Car Hire](#) [Special offers](#)

Flight Booking Portlet - Search (1)

To check availability and fares, simply tell us where you want to fly and when

From  To

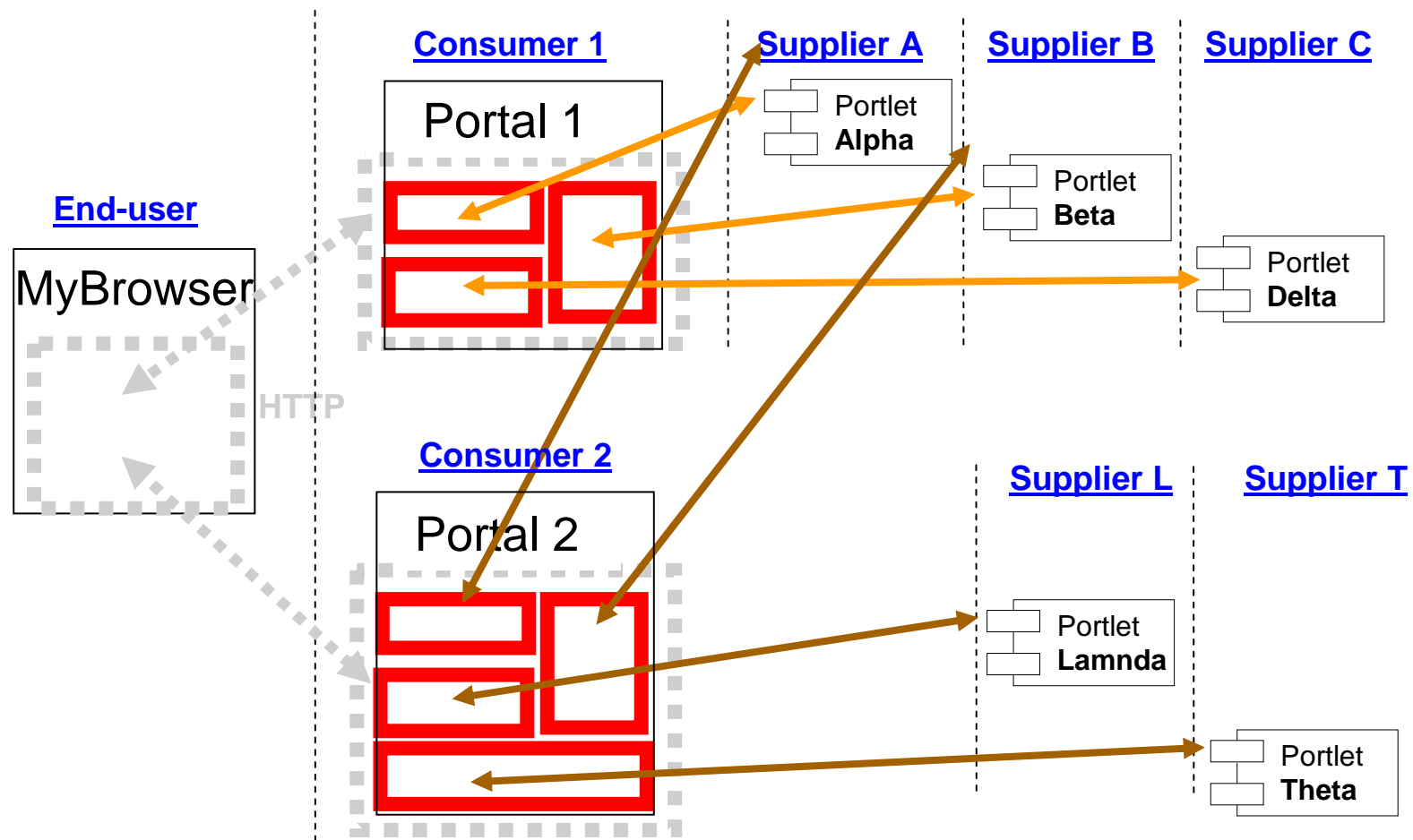
Departure Day  Month  Year

Return Day  Month  Year

Adults

**Portlet\_A\_2**

# Scale



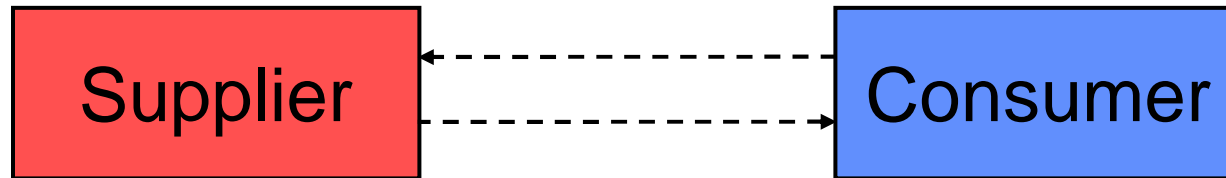
## Implementing Product Lines of Product Lines

- Current solutions (e.g., software populations) require manual integration of individual supplied products.
- Supplying product lines can come from different vendors
- How can a software product line automatically request and consume a product from another product line?
- Can we automate registration, consumption and production?
- Our proposal  
use SOA as infrastructure: *Service Oriented Product Lines*



# Service Oriented Product Lines?

## Supplier & Consumer



- A **supplier** is a product-line that supply products to other product lines (e.g., travel portlet product line)
  - ◆ Descriptive info (registration purposes)
  - ◆ Product info (which features are offered to distinguish product functionality)
  - ◆ Production interface (how is the product ordered, delivered, etc)
- A **consumer** is a product-line that consumes products from other product lines (e.g., research portal product line)
- Operation involves registration and consumption (based on existing SOA standardization efforts & tooling)

## Discussion

- How to ensure consistency, e.g., when propagating features (requirements) over different SPLs?
- How can we ensure products from supplying SPLs are provided in time for a production schedule?
- Can we use or learn from concepts like BPEL for orchestration?
- Can we use service oriented product lines to refactor one product line into several smaller supplying product lines to separate concerns?
- Can we build a market for SPLs that can supply products to other SPLs?

## Conclusions

- Product lines that supply other product lines appear frequently in industry
- Can we confer this concept on software product lines?
  - ◆ We believe that SOA is a powerful paradigm to do so
  - ◆ We present an illustrative example and its scenario
  - ◆ We sketch initial ideas to implement it (using SOA)
- Further work is needed to assess our approach
  - ◆ We need more work to create the infrastructure to make this really a viable approach with models, tools, etc.

## Service Oriented Architectures and Product Lines - What is the Connection?

- We would say that SOA techniques can be used as infrastructure to build more complex SPL systems.
- Our longstanding envision is to facilitate the emergence of a concurrent market where atomic products from supplier product lines can be automatically integrated into a larger product line.

# Thank you!

## Product Lines that supply other Product Lines: A Service-Oriented Approach

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