TECHNISCHE UNIVERSITÄT DRESDEN

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Faculty of Computer Science, Institute of Software and Multimedia Technology, Chair of Software Technology

Dynamic Configuration Management of Cloud-based Applications

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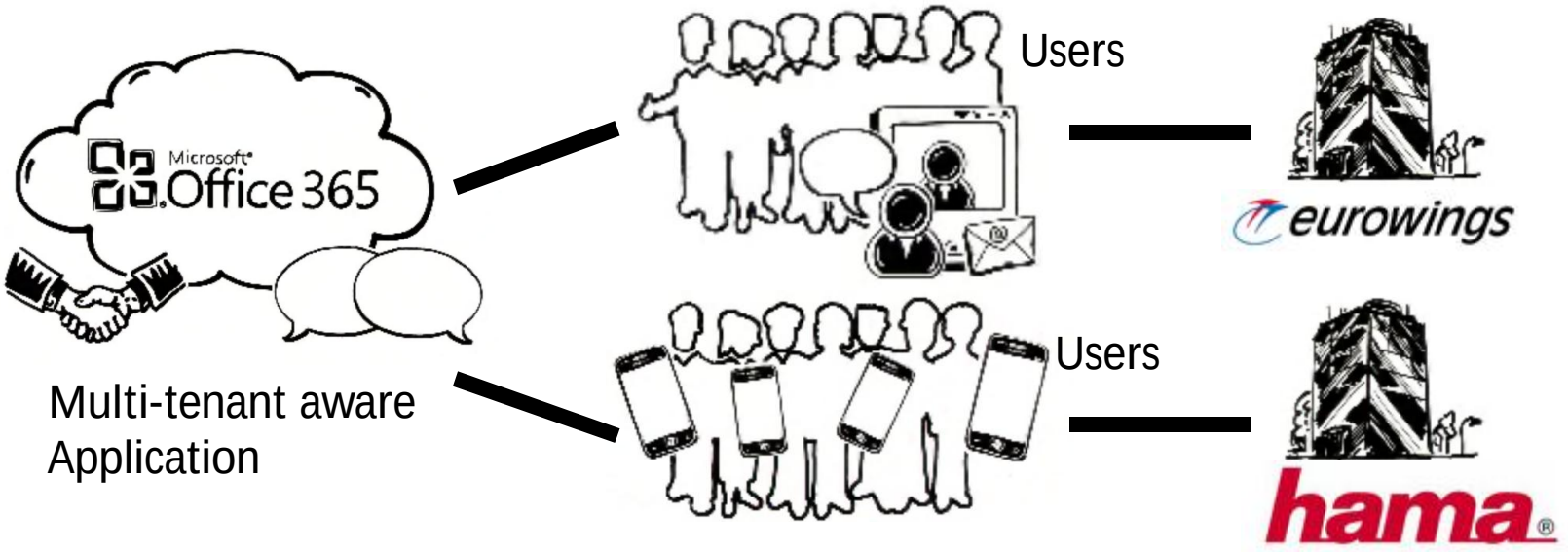
Motivation

- Multi-tenant aware applications are a special kind of multi-user applications

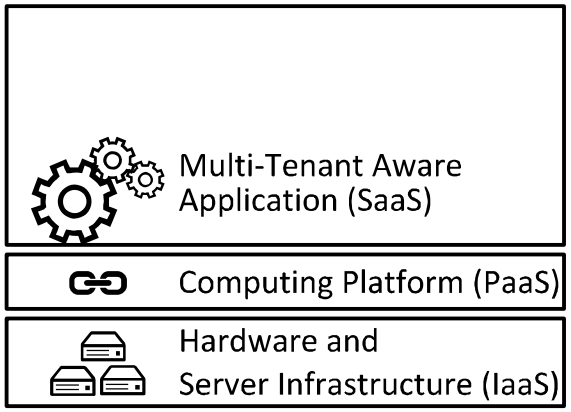


- Single-instance multi-tenancy
  - One application instance shared among various tenants
  - One-size-fits-all paradigm

One size fits all?

- Tenants have different requirements
- Requirements may change
- Various stakeholders involved in provisioning application
- Need for efficient dynamic configuration management

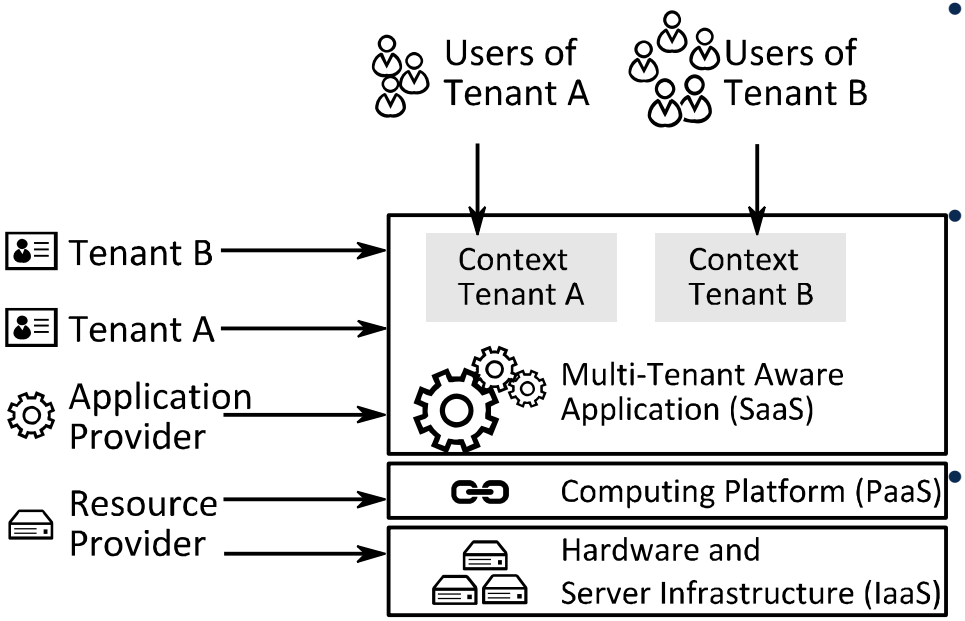
Cloud-computing Stack [MG11]



- Software as a Service (SaaS)
  - Business application
- Platform as a Service (PaaS)
  - Multi-tenancy support
  - Load balancing
  - Persistence service
- Infrastructure as a Service (IaaS)
  - Storage
  - Computing capacity

[MG11] *P. Mell and T. Grance*. The NIST definition of cloud computing. NIST Special Publication 800-145, National Institute of Standards and Technology, Information Technology Laboratory, 2011.

Stakeholders Involved in Configuration Process



- User
  - Various devices to access application
- Tenant
  - Functional requirements
  - Quality requirements (service level agreements)
- Application Provider
  - Provide application functionality
  - Platform pre-configuration
- Resource Provider
  - Infrastructure, platform pre-configuration

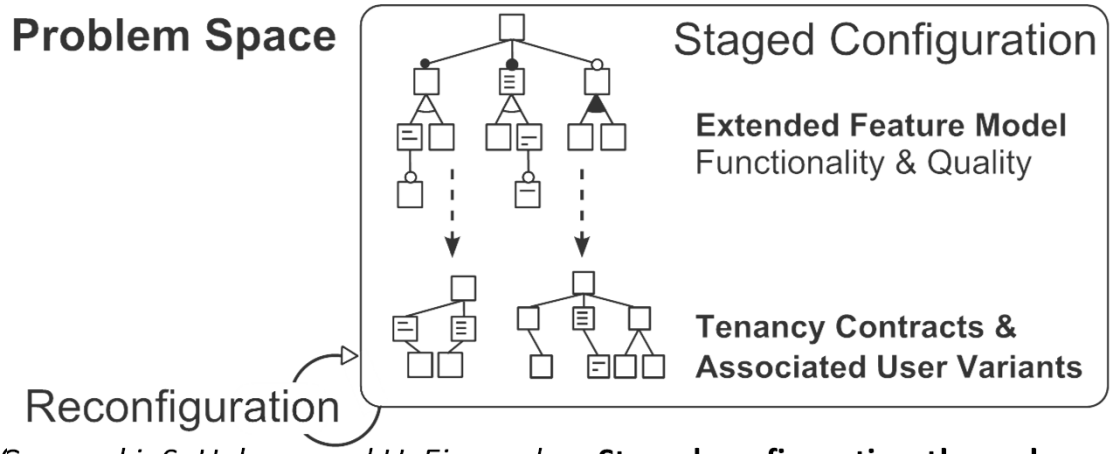
Characteristics of Cloud-based Applications

- Multi-tenant aware application architecture
- Sharing of resources as well as the application instance
- Variable functionality and extra-functional qualities
- Runtime onboarding and decomissioning of tenants
- Not all tenants are known beforehand
- Various stakeholders involved in configuration process
- Change of a stakeholder‘s objectives

Dynamic Configuration Management

- Apply software product line (SPL) variability management

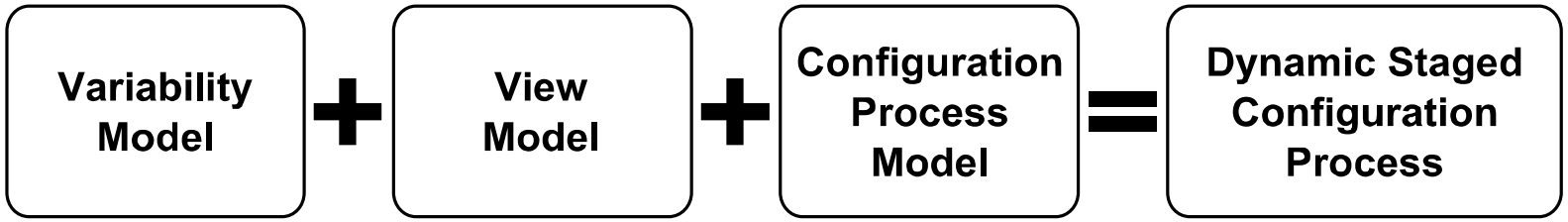
- Extend staged configuration proposed by Czarnecki et al.[CHE05]
  - Pre-configuration stages
  - Adding stakeholders at runtime to a stage
  - Reconfiguration on defined entry points



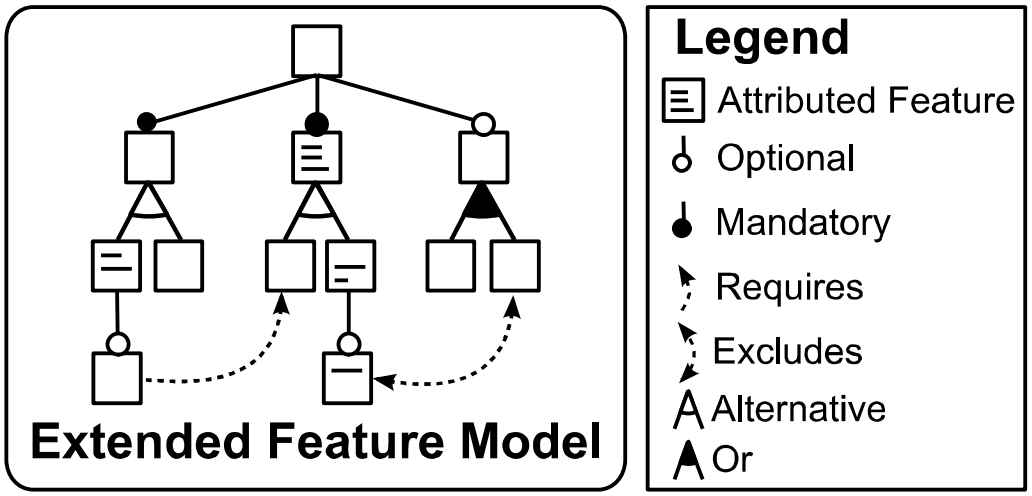
[CHE05] *K. Czarnecki, S. Helsen, and U. Eisenecker*. **Staged configuration through specialization and multi-level configuration of feature models.** Journal of Software Process: Improvement and Practice, 10(2):143–169, 2005

Dynamic Staged Configuration

- Model staged configuration process
- Separation of concerns
- Enable reuse



Variability Model

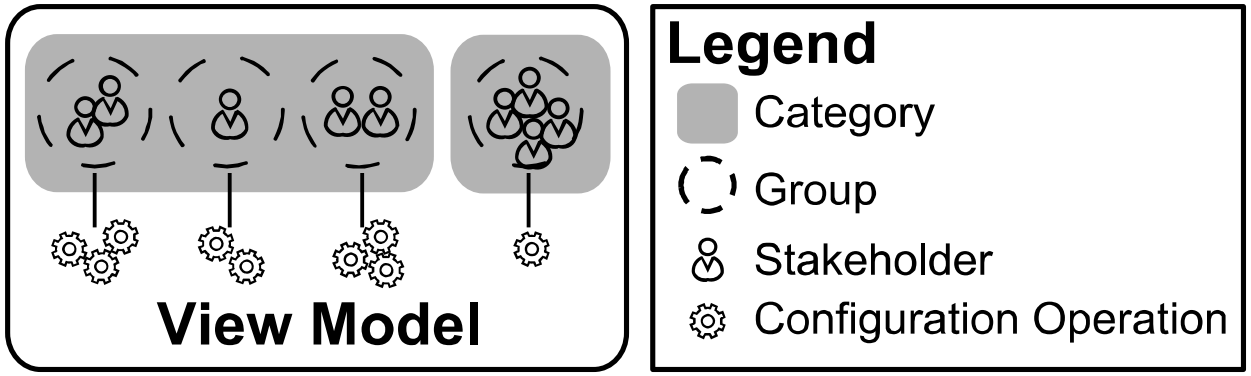


- Functionality represented as features
- Quality properties represented as attributes
- Cross-tree constraints among features and attributes

Configuration Operations on the Variability Model

- Atomic operations
  - ✓ Select feature
  - ✗ Deselect feature
  - = Set attribute value
  - − Limit an attribute domain
- Autocompletion to fulfill feature model constraints

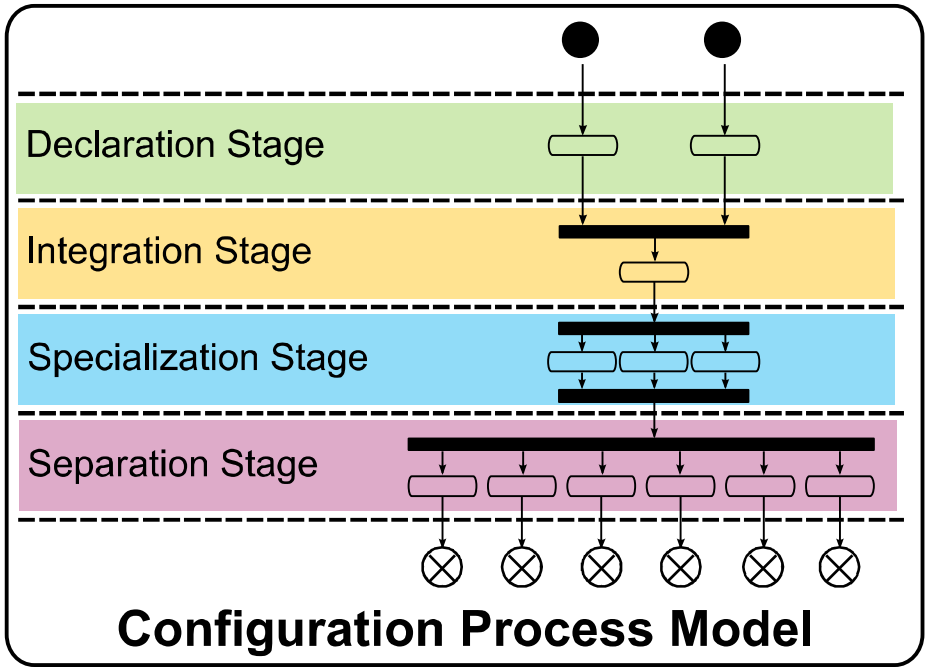
View Model



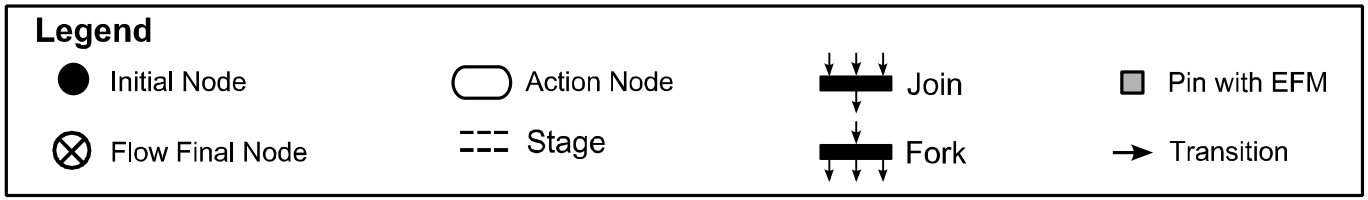
- Group stakeholders
- Assign configuration operations to (groups of) stakeholders
- Apply concepts of role based access control (RBAC) [FK92]

[FK92] *D. Ferraiolo and D. Kuhn*. Role based access control. Proceedings of the 15th National Computer Security Conference (NCSC '92), pages 554–563, 1992.

Configuration Process Model

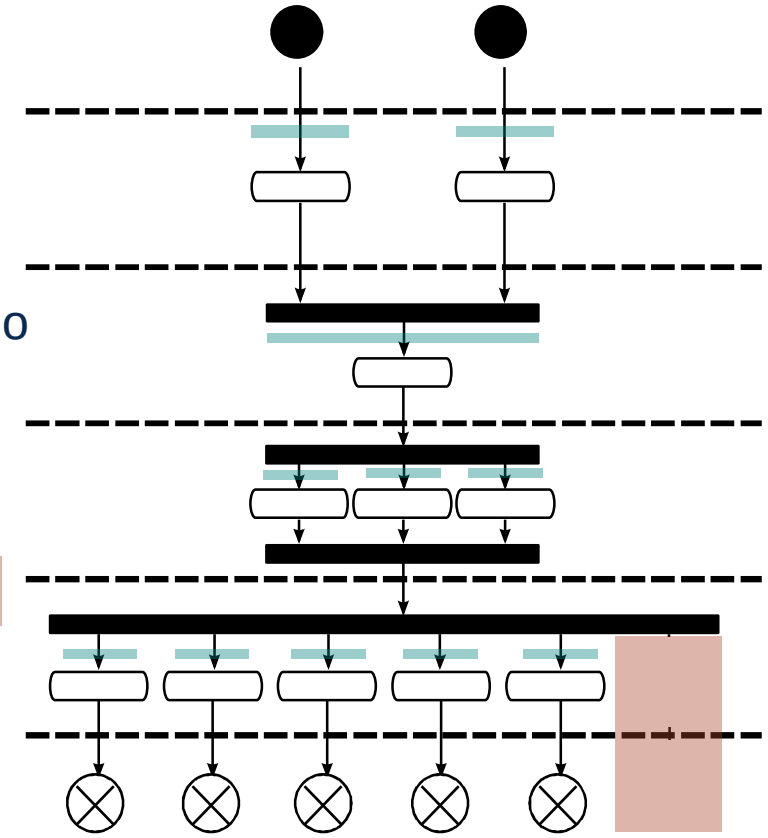


- Different stage types
- Free ordering of stage types
- Result of stages are pre-configurations with left variability
- Final results are complete configurations

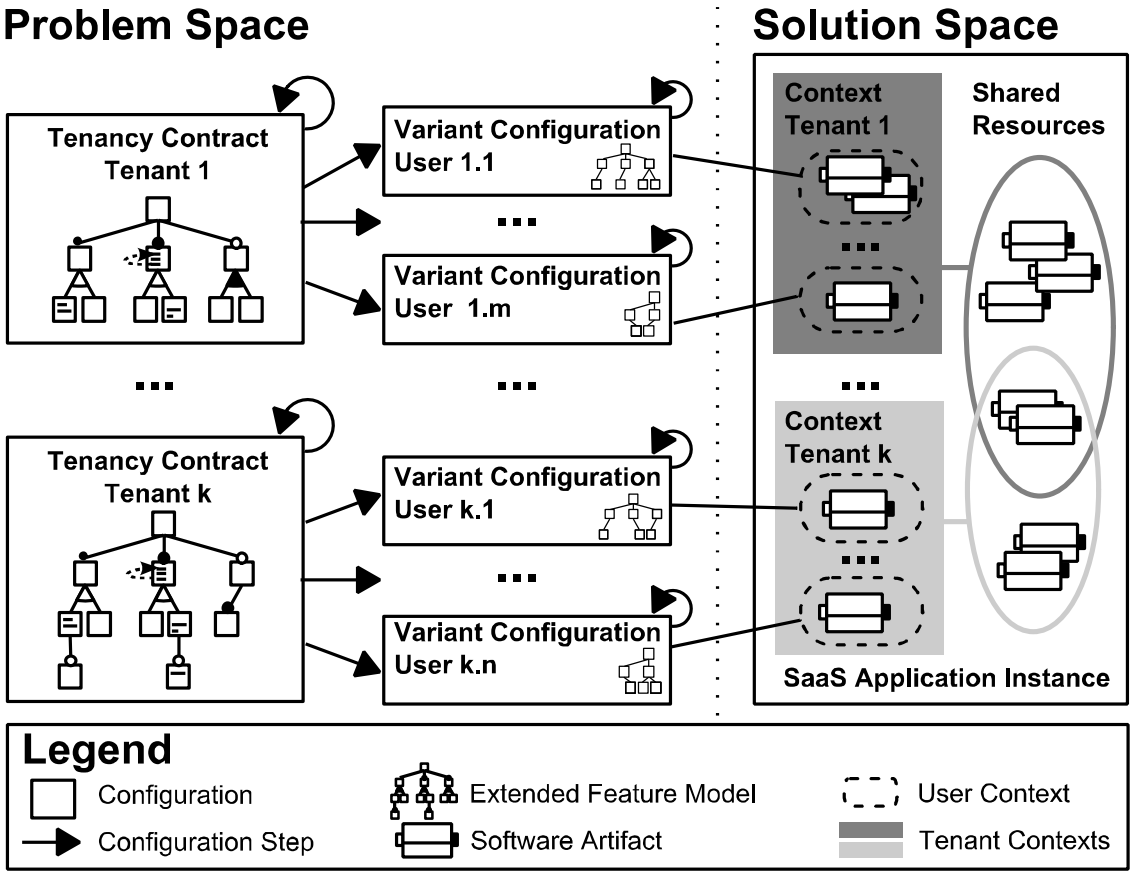


Dynamic Concepts

- Reconfiguration
  - On defined entry points
  - Changes are propagated to subsequent stages
- Add / remove stakeholder
  - At application runtime
  - Update view model
  - Add / remove actions in the configuration process



Configuration Artifacts



- Independent in the problem space
  - Tenancy contracts
  - User variant configurations
- Dependent in the solution space [SCG+12]
  - User context
  - Tenant context

[SCG+12] *Julia Schroeter, Sebastian Cech, Sebastian Götz, Claas Wilke and Uwe Aßmann.* Towards Modeling a Variable Architecture for Multi-Tenant SaaS-Applications. Proceedings of VaMoS '12, ACM Press, 2012.

Conclusion and Outlook

- Support variability in cloud-based applications
- Staged configuration with various stakeholders involved
- Reconfiguration support to handle changing objectives
- Add and remove stakeholders dynamically

- Implementation of configuration management and the staged configuration process
- Tooling support for extended feature models needed
- Evaluation using different case studies

Contact

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