Facilitating Migration of Cloud Infrastructure Services
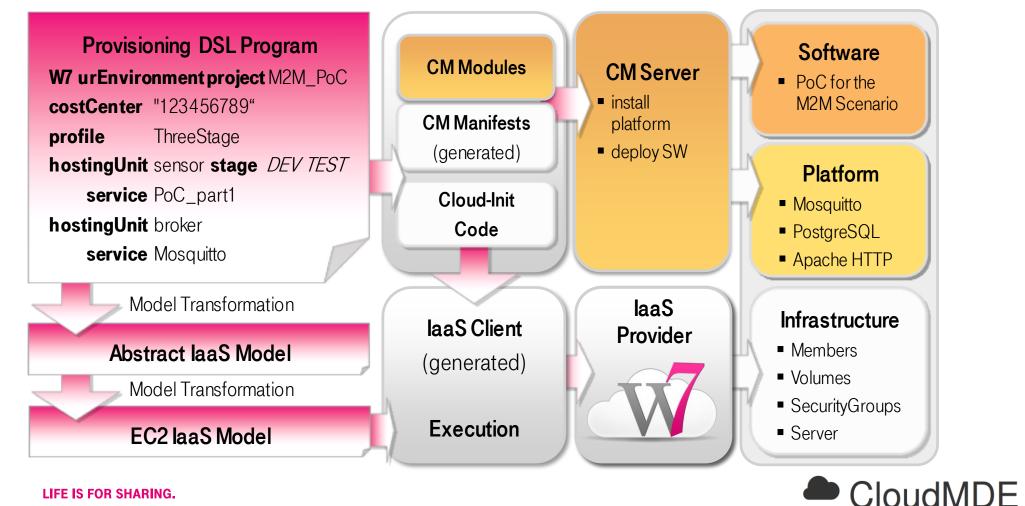## — A Model-Based Approach

CloudMDE @ MODELS, Ottawa, Canada, 2015-09-29

Ta'id HOLMES
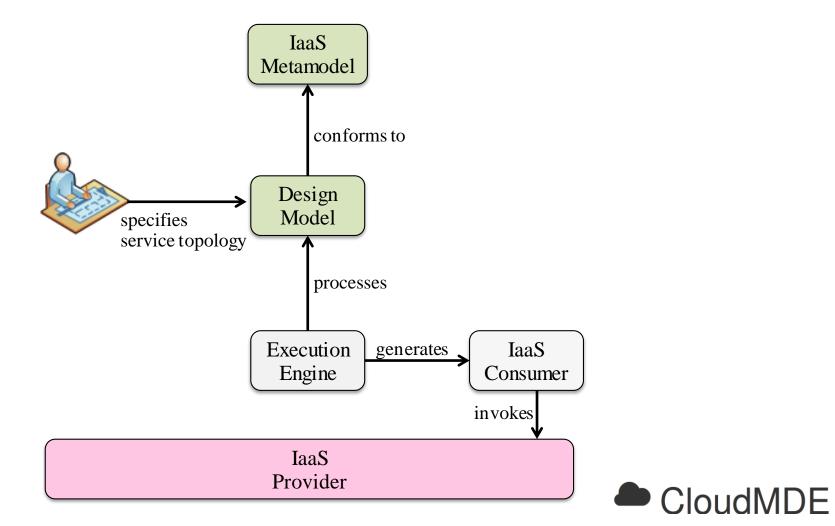Infrastructure Cloud, Deutsche Telekom Technik GmbH

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Starting Point: Model-Driven Forward Engineering
last year's presentation [Holmes T., CloudMDE 2014, pp. 46–55]

Provisioning DSL Program
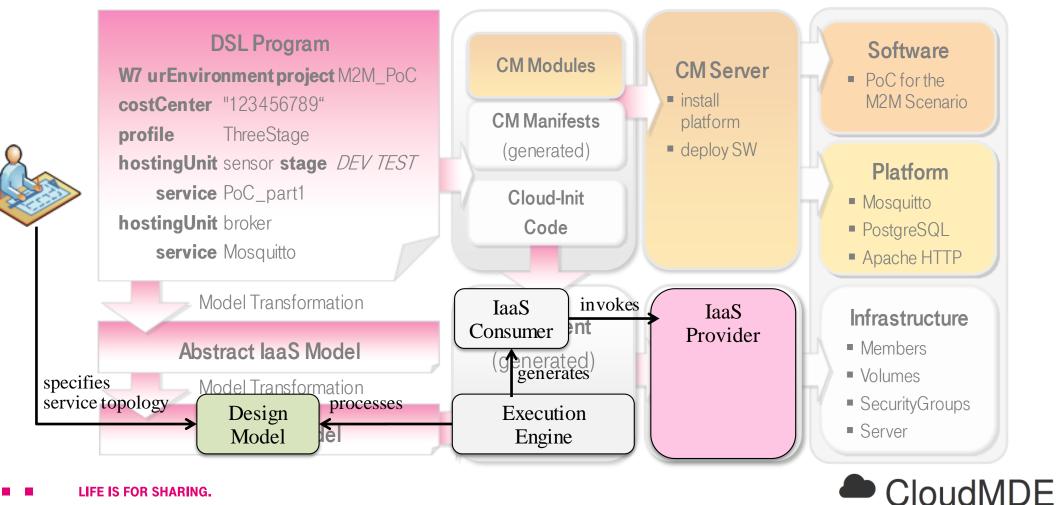
W7 urEnvironment project M2M_PoC

costCenter "123456789"

profile ThreeStage

hostingUnit sensor **stage** *DEV TEST*

　　service PoC_part1

hostingUnit broker

　　service Mosquitto

↓ Model Transformation

Abstract IaaS Model

↓ Model Transformation

EC2 IaaS Model

CM Modules

CM Manifests
(generated)

Cloud-Init Code

IaaS Client
(generated)

Execution

CM Server
- install platform
- deploy SW

IaaS Provider

Software
- PoC for the M2M Scenario

Platform
- Mosquitto
- PostgreSQL
- Apache HTTP

Infrastructure
- Members
- Volumes
- SecurityGroups
- Server

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Forward-Engineering Approach
simplified

Forward-Engineering Approach
simplified

DSL Program

W7 urEnvironment project M2M_PoC

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   service PoC_part1

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Model Transformation

Abstract IaaS Model

Model Transformation

Design Model

specifies service topology

processes

CM Modules

CM Manifests

(generated)

Cloud-Init Code

IaaS Consumer

generates

Execution Engine

invokes

IaaS Provider

CM Server

- install platform
- deploy SW

Software

- PoC for the M2M Scenario

Platform

- Mosquitto
- PostgreSQL
- Apache HTTP

Infrastructure

- Members
- Volumes
- SecurityGroups
- Server

Pains and Limitations

- initial provisioning only
- no incremental changes
- reprovisioning necessary

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Goals

- evolve forward-engineering approach
  - apply incremental changes
  - consider current status (i.e., existing services)
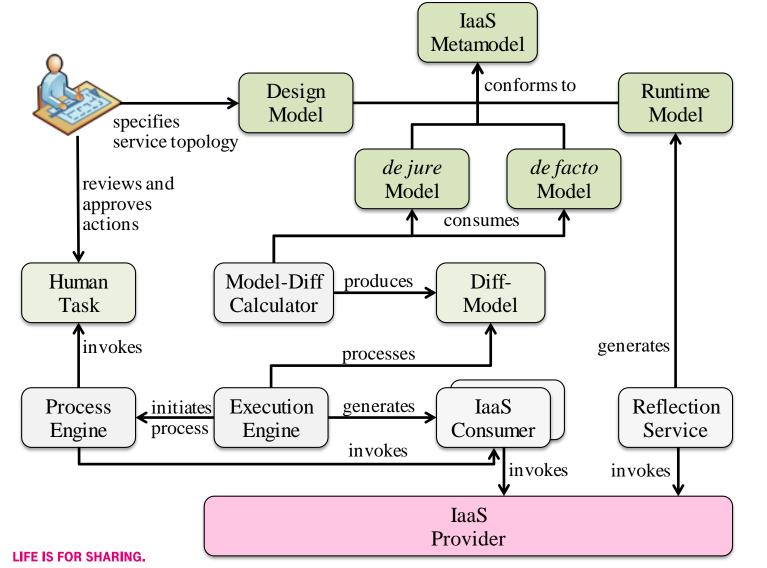- compare infrastructure services
- migrate infrastructure services

Model-Based Roundtrip Engineering Approach

- operate on a diff-model instead of a model

- reverse engineer a de facto model

- enrich metamodel with runtime aspects (optional)

- applicable in a multi-cloud environment

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Approach Overview

IaaS Metamodel

conforms to

Design Model ← specifies service topology — (user)

Runtime Model

de jure Model

de facto Model

consumes

reviews and approves actions

Human Task

invokes

Model-Diff Calculator — produces → Diff-Model

processes

Process Engine ← initiates process — Execution Engine — generates → IaaS Consumer

invokes

generates

Reflection Service

invokes

invokes

IaaS Provider

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Technical Realization

- Eclipse Modeling Framework
  - Xtext (IaaS Metamodel)
  - EMF Compare (Model-Diff Calculator)
  - Xtend (Execution Engine)
  - Ecore (Reflection Service)
- OpenStack (IaaS Consumer & Reflection Service)

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Reflection Service

- REST service

- uses the IaaS provider's APIs

- populates an Ecore model

Metamodel
enriched

Calculating a Diff-Model

- realized by EMF Compare

  - two way comparison

  - matching strategy: object content

  - ignoring identifiers

- generic as metamodel agnostic

- automated

Model Transformation
relating model differences to IaaS API calls

Model Element	API	Kind	REST Operation	Description
Member.publicKey	Keystone	+	POST keypairs	sets/updates publicKey of a user
IaaSProject.groups	Nova	-	POST {tenant_id}/os-security-groups	creates a new security group
IaaSProject.servers	Nova	+	POST {tenant_id}/servers	creates a new instance
		-	DELETE {tenant_id}/servers/{server_id}	deletes an instance
IaaSProject.volumes	Nova	+	POST {tenant_id}/os-volumes	creates a new volume
Server.devs	Nova	+	POST {tenant_id}/servers/{server_id}/os-volume_attachments	attaches a volume to a server

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Model Transformation – Challenges

- processing order (composition relationships)
- transcription (e.g., `change` as `deletion` and `addition`)
- gaps in abstraction levels
- API exceptions to a potential naming convention

Application Scenarios

- initial provisioning of infrastructure services

  - design model

- design time modification and runtime adaptation

  - revised design model

- alignment of infrastructure services

  - runtime models

- migration of infrastructure services

Comparing Forward and Round-Trip Approaches

	Forward Engineering	Round-Trip Engineering
metamodels	IaaS metamodel	IaaS metamodel diff-metamodel
model reverse engineering	✘	✔
models	design time	design time runtime
execution engine processes	IaaS model	diff-model
initial provisioning	✔	✔
incremental changes/adaptations	✘	✔
multi-cloud applicability	✘	✔

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Related Work
Positioning

- distinctions of this work:

  - introduces runtime models showcasing how to evolve a forward engineering approach

  - reverse engineering of runtime models

  - differentiation of adaptations & integration of human reviews

  - diff-model calculation is metamodel agnostic

Related Work
CloudML and models@run.time

- comparing target model against reality: base of many studies
- CloudML
  - does not address migration; focus of this work
  - presumes a causal connected system
  - manually implemented specific comparisons

Related Work
TOSCA

- not limited to infrastructure services

- current advancements are driven by design time

  - no reverse-engineering (yet)

- approach can be realized using the TOSCA metamodel

Related Work
CloudFormation / Heat

- not at a modeling level

- reverse-engineering may be possible

- yet, technology is limited to initial provisioning

- no comparison & resolution for aligning infrastructure services

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Conclusions

- **evolving** from a forward to a round-trip engineering **approach**
  - **enriching metamodel** with runtime aspects
  - basing the **execution engine** on processing a **diff-model**
- **migration** of **infrastructure** services

THANK YOU!

QUESTIONS?

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