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Engineering Cloud-based Applications: Towards an Application Lifecycle

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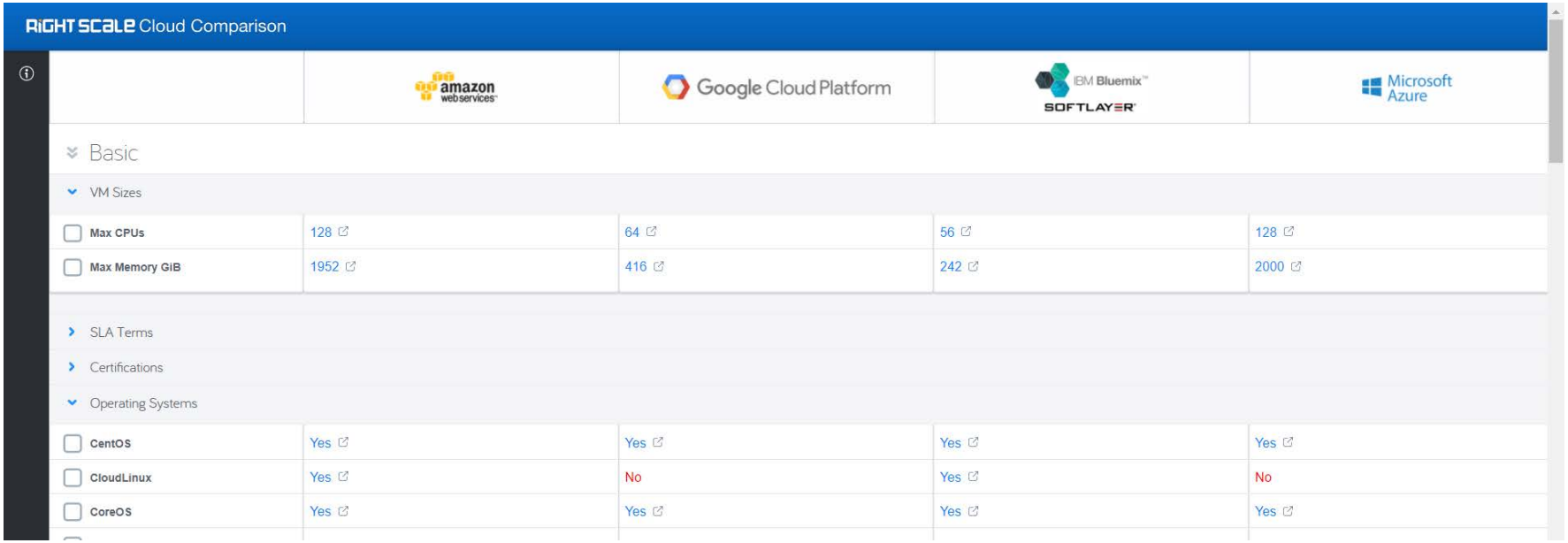
Context – the state of the Cloud

- Cloud as the *de facto* platform for software
- Early confusion resolved by NIST SP 800-145
- Multiple (similar) offerings by the Stacks



Related movements

- **Movement #1:** DevOps
  - CD/CI frameworks + deployment automation tools = shortened dev cycle + agile practices
  - OS-level virtualization a la Docker -> applications as independent software stacks

- **Movement #2:** Microservices
  - Loosely coupled component lifecycles

Key message

› *Software development in practice has changed, software engineering (research) should do the same*

› Scoping: Cloud-based applications, i.e. both cloud-enabled and cloud-native

Def: Cloud-based applications (CBAs) are applications that **rely on** one or more **cloud services** in order to be able **to deliver their functionality** to their users

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Challenges for CBA engineering

› Stem from the Cloud essential characteristics

	*aaS model	Multi-tenancy	Utility computing	Distributed topology
On-demand self service	✓			✓
Broad net access	✓			
Resource pooling		✓		✓
Rapid elasticity			✓	
Measured service			✓	

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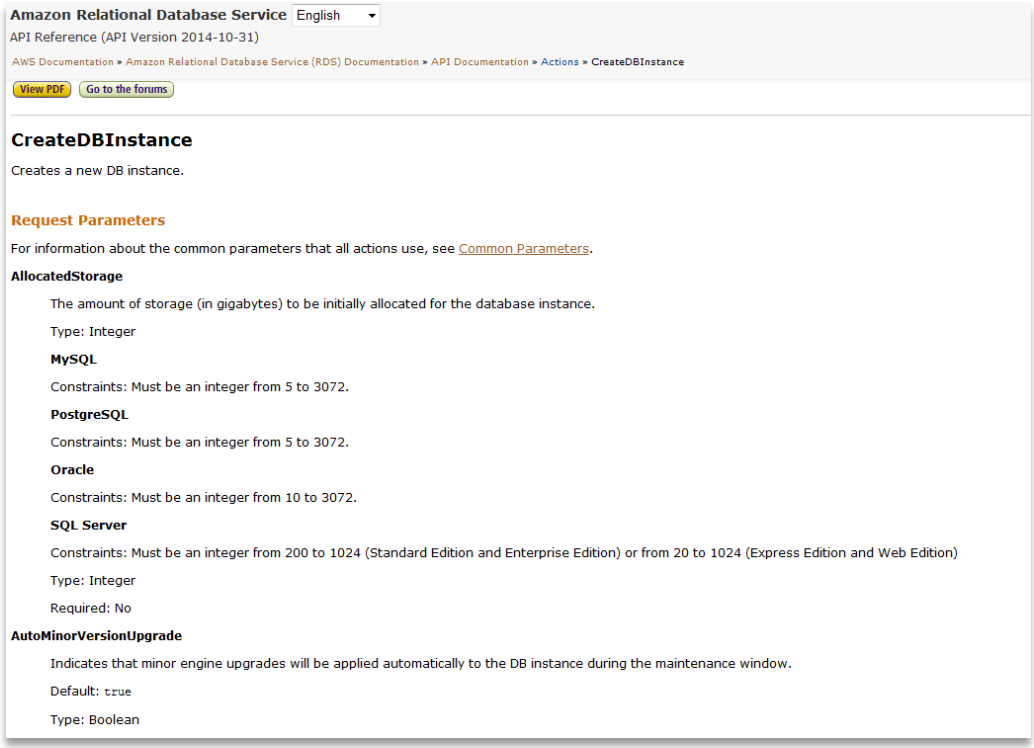
Challenge #1: *aaS software model

- Access to resources as services means dealing with:
  - **Information hiding**
  - **Lack of control and observability**
  - **Distributed**, potentially **heterogeneous** environment
  - **Evolution** driven by 3rd parties
  - Service design issues



Amazon Relational Database Service English

API Reference (API Version 2014-10-31)

AWS Documentation » Amazon Relational Database Service (RDS) Documentation » API Documentation » Actions » CreateDBInstance

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CreateDBInstance

Creates a new DB instance.

Request Parameters

For information about the common parameters that all actions use, see Common Parameters.

AllocatedStorage

The amount of storage (in gigabytes) to be initially allocated for the database instance.

Type: Integer

MySQL

Constraints: Must be an integer from 5 to 3072.

PostgreSQL

Constraints: Must be an integer from 5 to 3072.

Oracle

Constraints: Must be an integer from 10 to 3072.

SQL Server

Constraints: Must be an integer from 200 to 1024 (Standard Edition and Enterprise Edition) or from 20 to 1024 (Express Edition and Web Edition)

Type: Integer

Required: No

AutoMinorVersionUpgrade

Indicates that minor engine upgrades will be applied automatically to the DB instance during the maintenance window.

Default: `true`

Type: Boolean

http://docs.aws.amazon.com/AmazonRDS/latest/APIReference/Welcome.html

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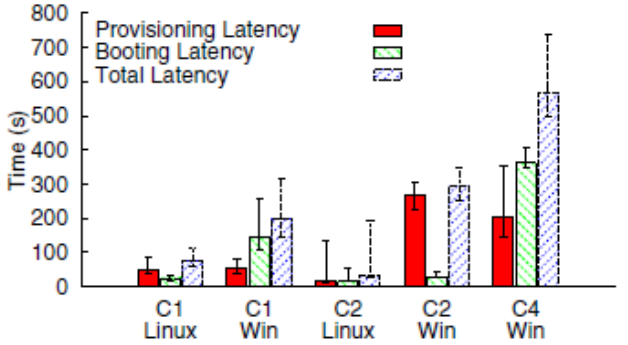
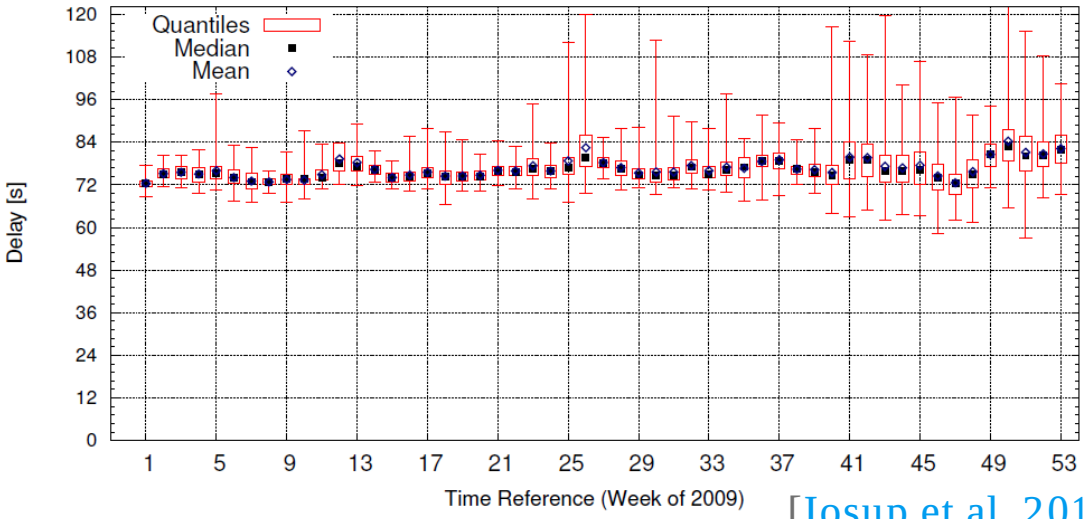
Challenge #2: Multi-tenancy

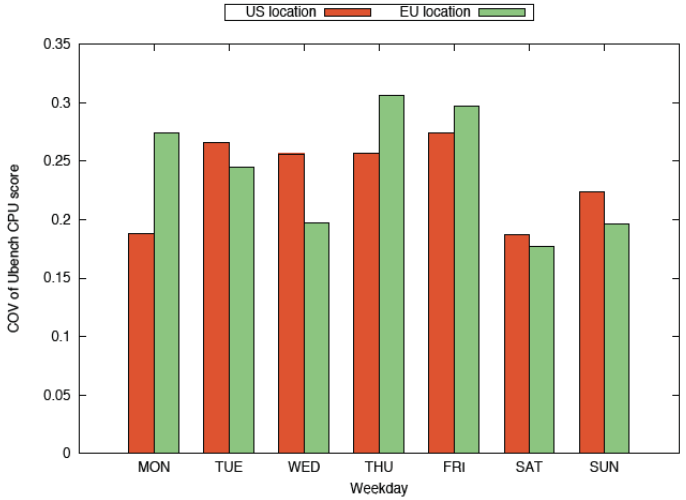
- Multiple tenants sharing infrastructure enable **economies of scale** for service providers
- Sharing of resources leading to **performance variability** external to the application



[Li et al. 2010]



[Iosup et al. 2011]



[Schad et al. 2010]

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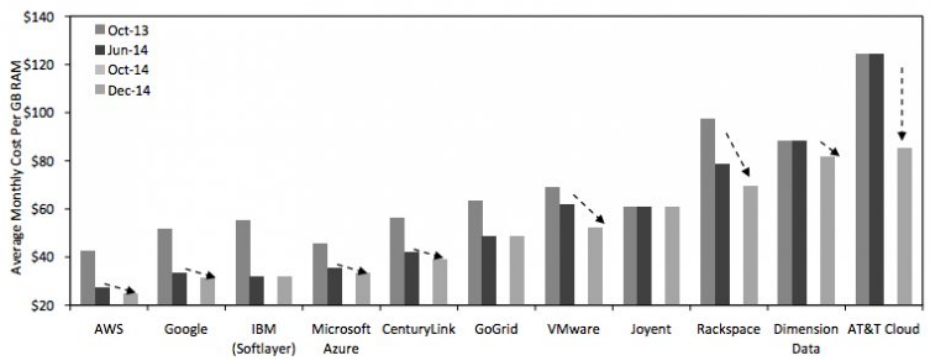
Challenge #3: Utility computing

- Access to computational resources in a **utility-oriented model**
- Economies of scale drive a price **race to zero** over time
- Cheap is not the same as free (costless)
- Unused VM cycles is an important cost factor for mature adopters

Exhibit 14: Average Monthly Cost / GB RAM across various RBC Use Cases (excluding support costs)



(excluding optional support costs)
Average Monthly Cost Per GB RAM across various RBC Use Cases

	Oct-13	Jun-14	Dec-14	Change
AWS	$42	$27	$25	-8%
Google	$52	$34	$32	-6%
IBM (Softlayer)	$55	$32	$32	0%
Microsoft Azure	$46	$35	$34	-5%
CenturyLink	$56	$42	$39	-7%
GoGrid	$63	$49	$49	0%
VMware	$69	$62	$52	-15%
Joyent	$61	$61	$61	0%
Rackspace	$98	$79	$70	-11%
Dimension Data	$88	$88	$82	-8%
AT&T Cloud	$125	$125	$85	-32%

(including high-touch support)
Average Monthly Cost Per GB RAM across various RBC Use Cases

	Oct-13	Jun-14	Dec-14	Change
AWS	$53	$38	$35	-6%
Google	$93	$69	$68	-2%
IBM (Softlayer)	$56	$32	$32	0%
Microsoft Azure	$70	$60	$58	-3%
CenturyLink	$56	$46	$43	-7%
GoGrid	$75	$60	$60	0%
VMware	$79	$71	$61	-13%
Joyent	$72	$72	$72	0%
Rackspace	$108	$89	$70	-22%
Dimension Data	$88	$88	$81	-8%
AT&T Cloud	$129	$129	$88	-32%

* Change Dec-14 vs. Jun-14

Source: RBC Capital Markets, Company Reports

Source: RBC Group

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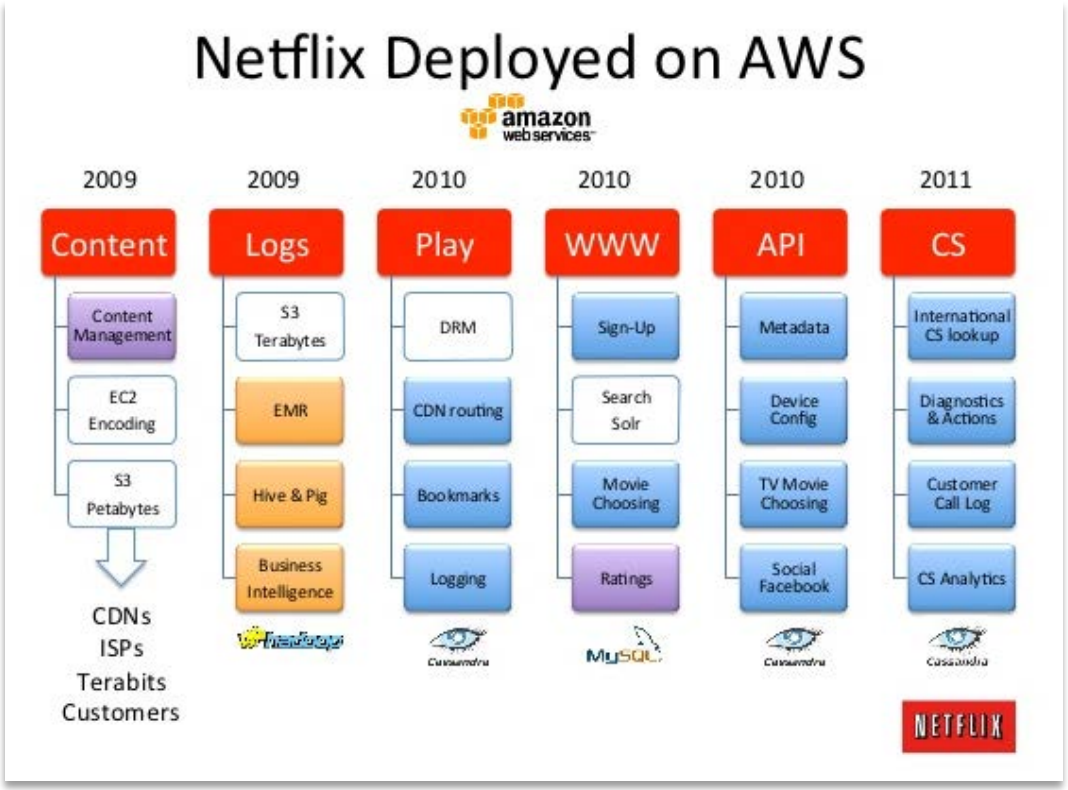
Challenge #4: Distributed topology

- Many possible **system configuration** options, **optimal** under different dimensions
- **Multiple offerings** by service providers as alternatives to application components

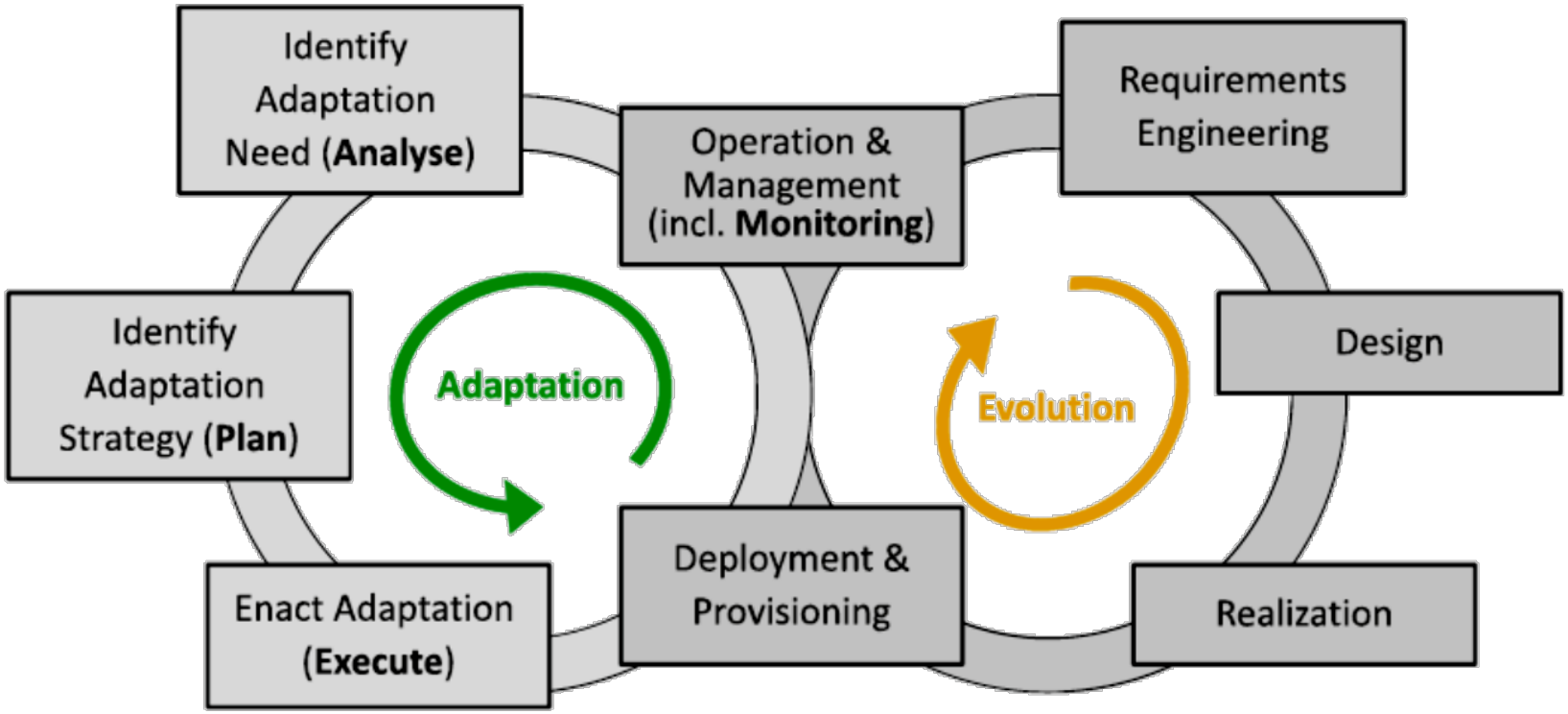


http://www.slideshare.net/adrianco/netflix-global-cloud

Requirements on the solution space

1. CBA engineering should incorporate *service-orientation concepts* like composition
2. System design should be based on *evolving dynamic topologies*
3. *Self-* characteristics* are essential in dealing with provider-induced variability
4. *Awareness of consumed resources* should be enabled for both development and operation

The S-Cube SBA Reference Lifecycle



S-CUBE http://s-cube-network.eu/

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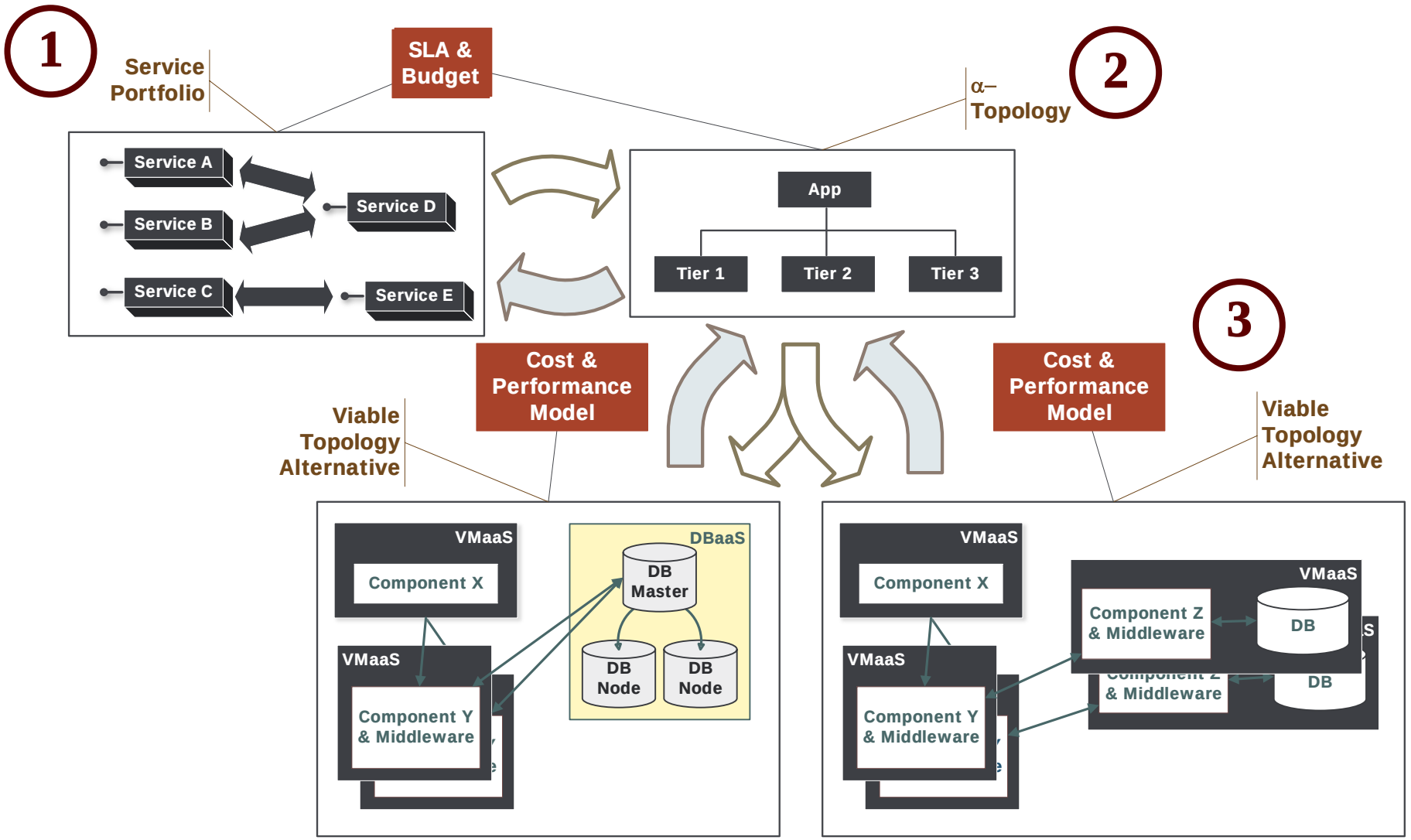
The proposed CBA lifecycle



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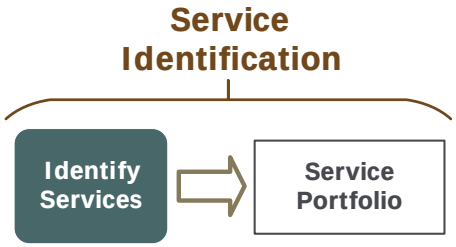
Phases of the CBA lifecycle: 1/4



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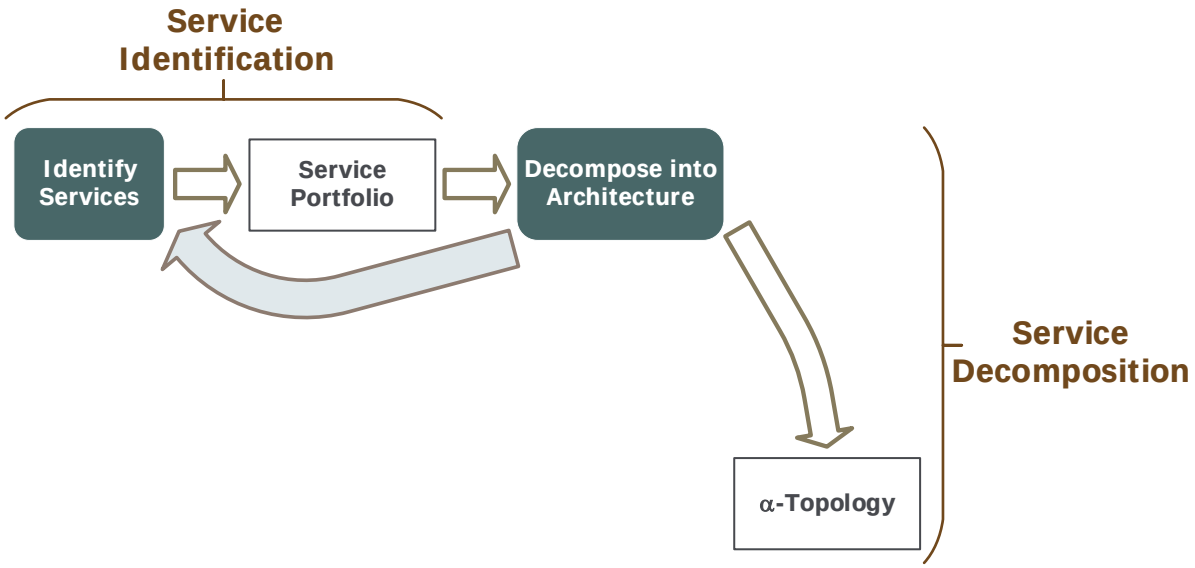
Phases of the CBA lifecycle: 2/4



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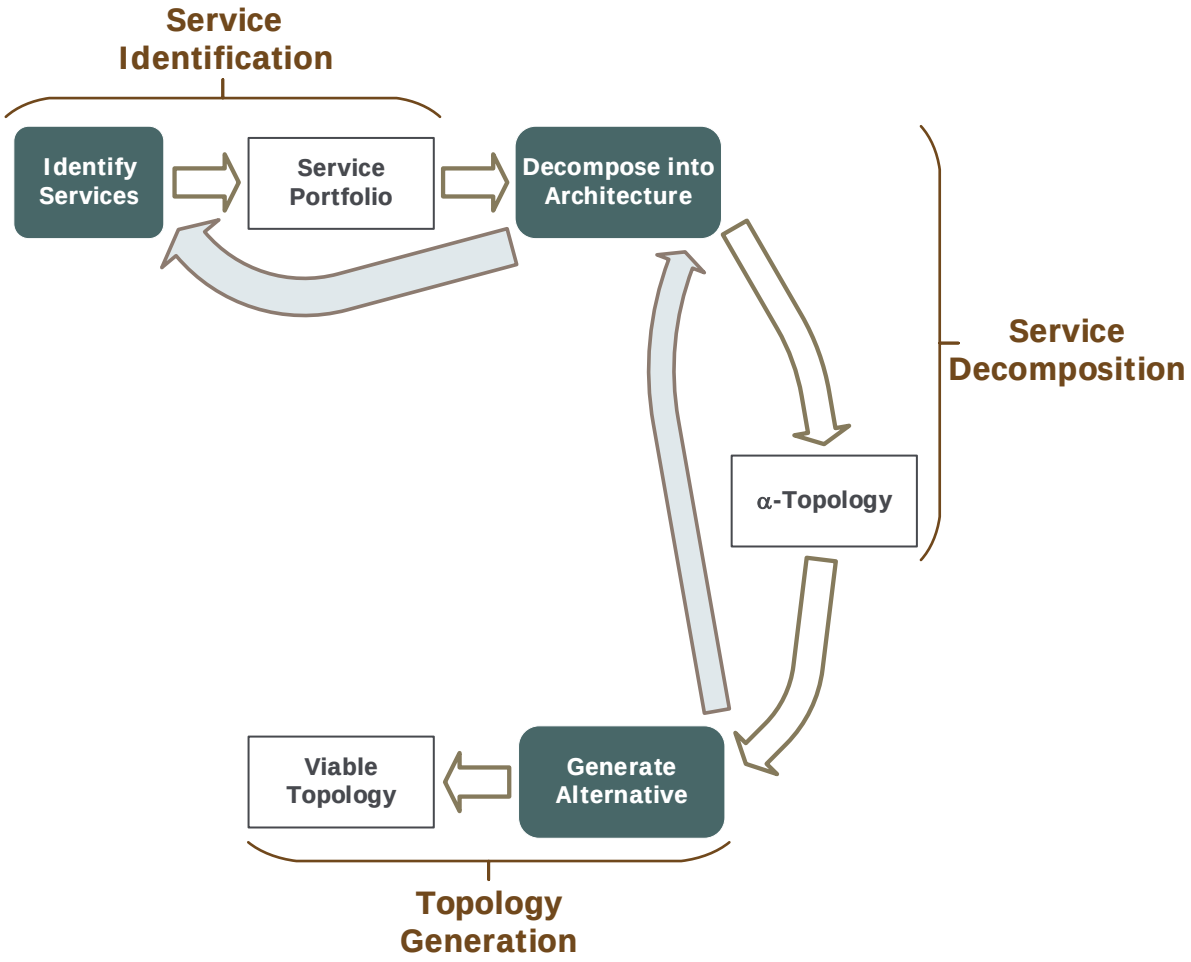
Phases of the CBA lifecycle: 3/4



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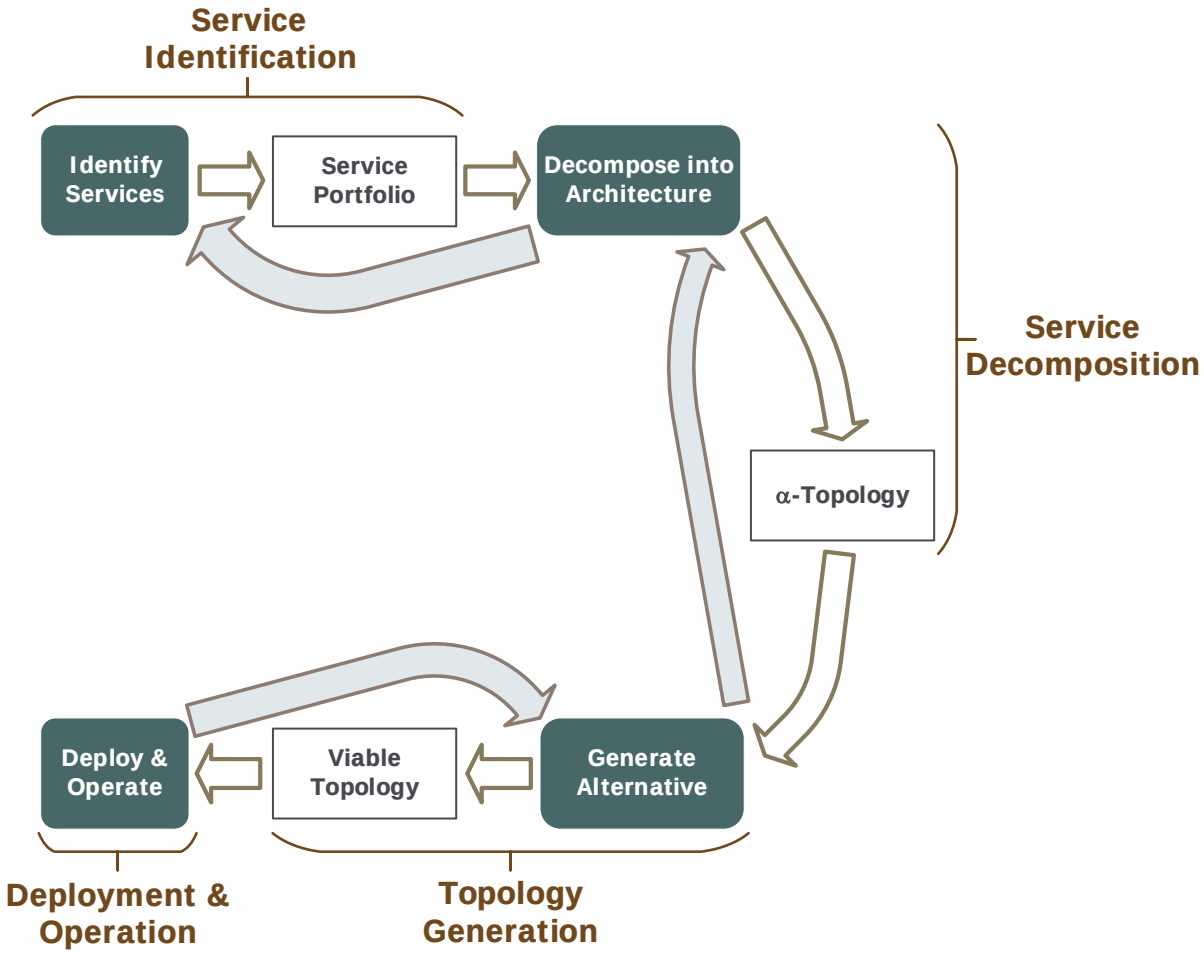
Phases of the CBA lifecycle: 4/4



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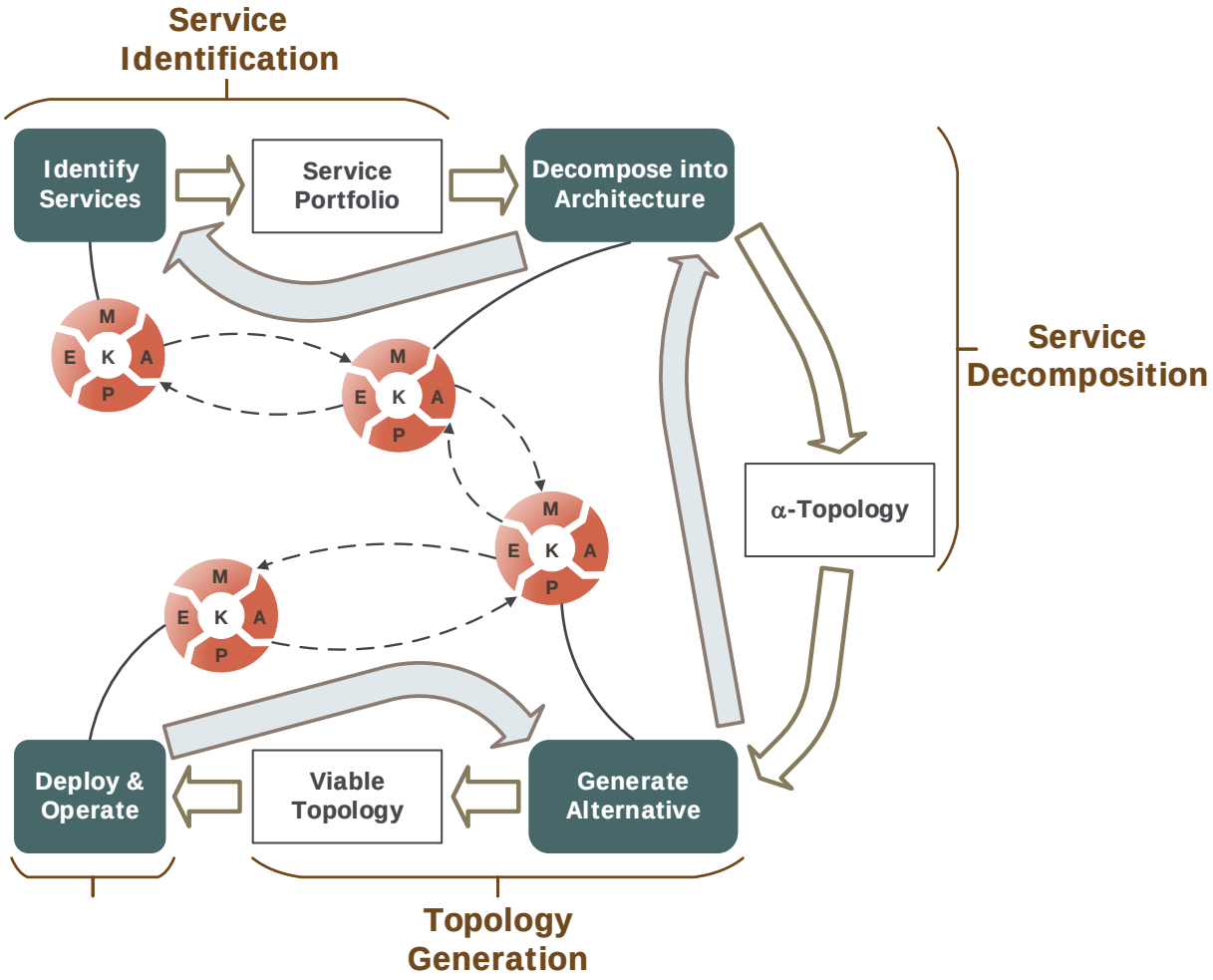
CBA lifecycle: self-*



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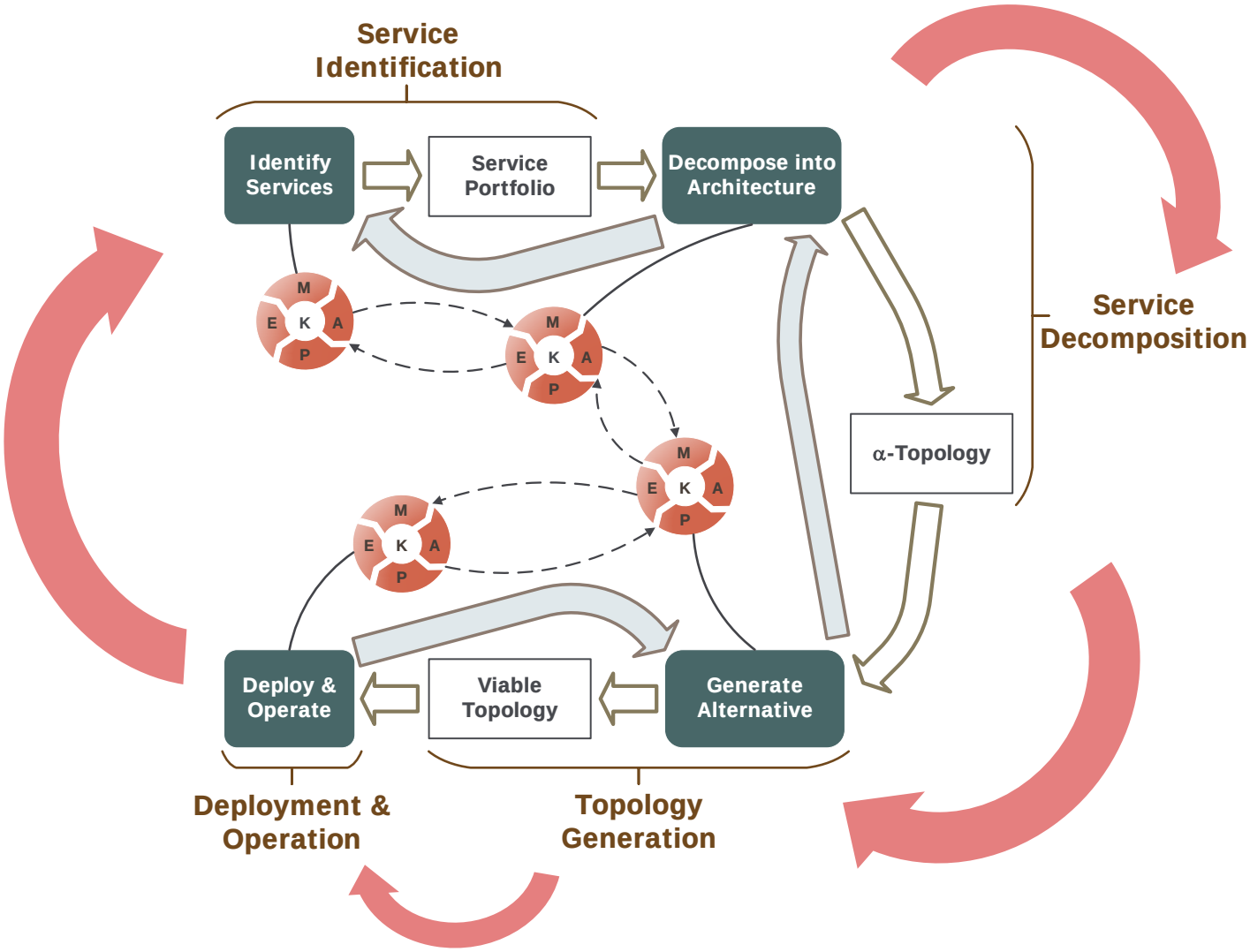
Phases of the CBA lifecycle: reprise



Principles of CBA engineering (proposal)

#1: Transitioning between viable topologies should be fast and easy

#2: No need for separation between design and run time anymore

#3: Optimizing for a noisy environment is sub-optimal and potentially unnecessary

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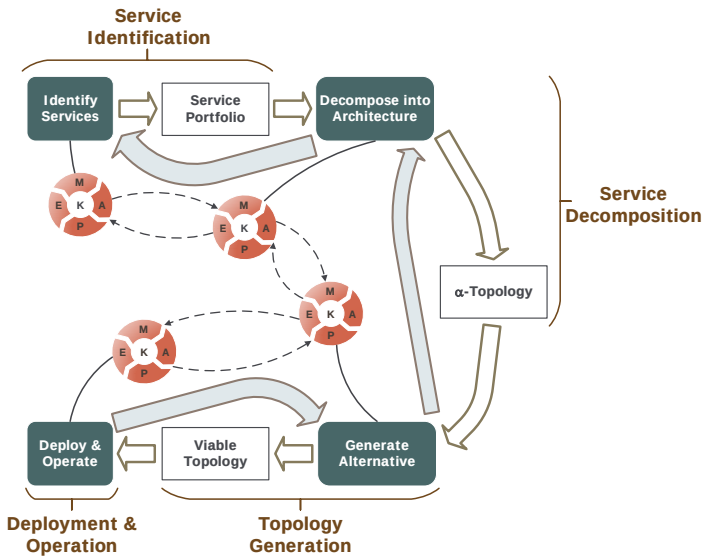
Conclusions

- Adoption of cloud computing + DevOps (incl. virtualization) + microservices → need for new take on CBA engineering
- CBA lifecycle as interconnected loops
- Open issues
  - Security
  - QA
- Future work
  - Tooling
  - Validation



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