

DHBW Informatik Wahlpflicht Cloud Computing Introduction

Juergen Schneider



Jürgen Schneider .. wo komm ich her ?



IBM Research and Development

Über Uns

Client Center

Projekte

IBM Deutschland Research &
Development – einer der größten IT
Think Tanks Europas



<http://www-05.ibm.com/de/entwicklung/about.html>

Agenda

- Einführung und Definitionen
- IaaS
 - Physical Layout der Cloud Data Centers
 - Compute, Network und Storage Virtualization basierend auf Open Stack
 - Automated Configurations mit Terraform and Ansible
- PaaS
 - Container (Docker) und Docker Swarm
 - Kubernetes
 - Serverless (Knative, Code Engine)
- SaaS
 - What is Cloud Native
 - Micro Services.
- Data Storage Services in der Cloud
- Praktische Übungen
- Klausur : Schriftlicher Test in der letzten Stunde

Praktische Übungen

- bwCloud Zulassung erwerben
 - [https://www.bw-cloud.org/de/erste schritte](https://www.bw-cloud.org/de/erste_schritte)
- Free Account bei Amazon, Azure oder andere
 - Links am Ende dieses chart deck
- Übungen oder Demo (als Teil unserer montäglichen Sitzung)
 - bwCloud für IaaS und Terraform basierte Deployments
 - IaaS deployments in Azure oder AWS
 - Basic Docker und Docker Compose (Node.js or Python Deployments)
 - minikube für Kubernetes Basic Deployments
 - Code Continuous Delivery (Code Engine oder ähnliches)
 - Serverless Computing (OpenWhisk Functions)
- Wir benötigen eine mini Anwendung die wir in die Cloud deployen können und über das Internet auch zugreifen können.
 - Node.js mit statischer HTML File oder einfaches Python Program (siehe nextcloud/Übungen/ Folder)

Generell Setup

- Scripts (PDFs) for each topic will be distributed ahead and can be used during the sessions. Script Language (D)English
 - Access and PWD in our Session
 - [https://owncloud.dhbw-stuttgart.de/index.php/s/
ApXMZDmaE2QFbBg](https://owncloud.dhbw-stuttgart.de/index.php/s/ApXMZDmaE2QFbBg)
 - Password : cloud4inf@dhbw#2025!
- Folders
 - Vorlesung
 - Übungen
 - Lösungen
 - Benotung

Benotung

Klausur in der letzten Sitzung (**am 19.5**)

- Es können **maximal 100 Punkte** erreicht werden
 - 50 Fragen, freier Text (je 2 Punkte)
 - 1 Stunde Zeit
 - Ab 60 Punkten bestanden (Punkte Abgabe)
- Nach jedem Kapitel ein Recap.
- Wichtig, die Erfahrungen in den Übungen (die wir im Unterricht auch durchsprechen) helfen..
- Wir planen nochmals eine finale Fragestunde am 12.5 ein

Jetzt geht es nun endlich bald los...

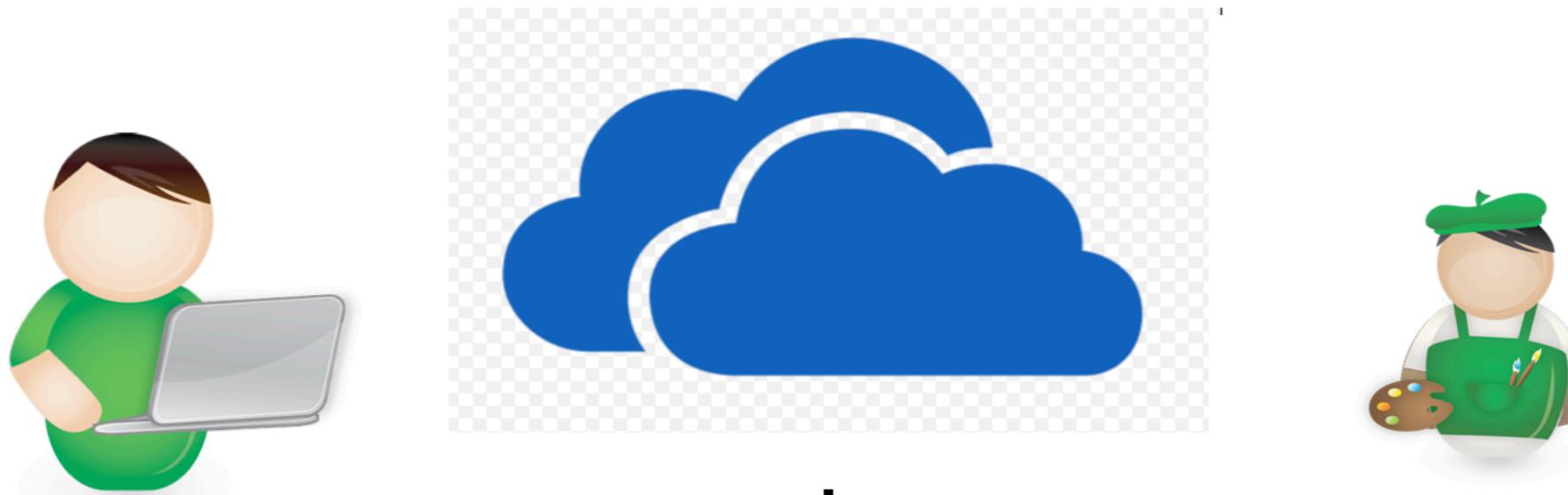
Aktive Teilnahme ...

- Die Benutzung des Laptops ist OK (brauchen wir sowieso für die Übungen)
- Benutzung von Handy eigentlich gar nicht (nur in **extremen** Ausnahmen)
- Pausen je nach Bedarf... (e.g. nach 90 mins für 10-15 mins)
- Abwesenheit:
 - Abwesenheit muss bei der Studienleitung gemeldet werden. Auch ich bitte um kurze Rückmeldung (email).
- Zoom oder nicht Zoom ?
 - Wir sind alle krank (e.g. Pandemie)
 - Ich bin krank, kann aber noch zoomen
 - Bahn Streik mit Ansage, geht aber nur wenn der **ganze Tag nicht** in Präsenz stattfinden kann (somit wahrscheinlich gar nicht)
 - Verspätung durch Bahnausfall .. ich melde mich per email .. es ist dann aber nur eine Verspätung d.h. der Unterricht findet statt
 - Alle anderen Fälle bei Bedarf
- Du, Sie oder so..
- Fragen, Fragen, Fragen
- Wir werden ggfls. am Anfang jeder Wochensitzung Zeit einplanen und wiederholen
- Email jschnei1@lehre.dhbw-stuttgart.de

Introduction

What is Cloud Computing in one Sentence ??

- It is a IT Service Model
- With a significant separation of the consumer and provider (There is a cloud in between)



Consumer

- Don't care about the technical details, I am interested in the Service (SLA)
- Don't care about the location of the Data Center
- Don't know who behind the cloud does what
- I want my service fast, reliable and cost competitive
- I interact with the Self Service Portal

Services
Service Usage and Metering
Service Level Objectives
Service Level Agreement

Provider

- Don't know who is really my customer/consumer (public cloud)
- I want to reach out to the whole world with a service everybody likes
- I communicate via the Self Service Portal
- I need to support the SLO efficiently and cost competitive (I care about the details)
- SLO/SLA

Cloud Computing Definition

- Cloud computing is a new **consumption and delivery model** inspired by consumer internet services
- Essential characteristics:
 1. Location independent resource pooling
 2. Rapid elasticity
 3. On-demand self-service
 4. Broad network access
 5. Measured Service

- Cloud computing, often referred to as simply “the cloud,” is the delivery of on-demand computing resources —everything from applications to data centers— over the Internet on a pay-for-use basis
- Essential characteristics:
 1. Elastic resources
 2. Pay for use
 3. Self service

IBM

National Institute of Standards and Technology



Cloud

- <https://csrc.nist.gov/publications/detail/sp-800-145/final>

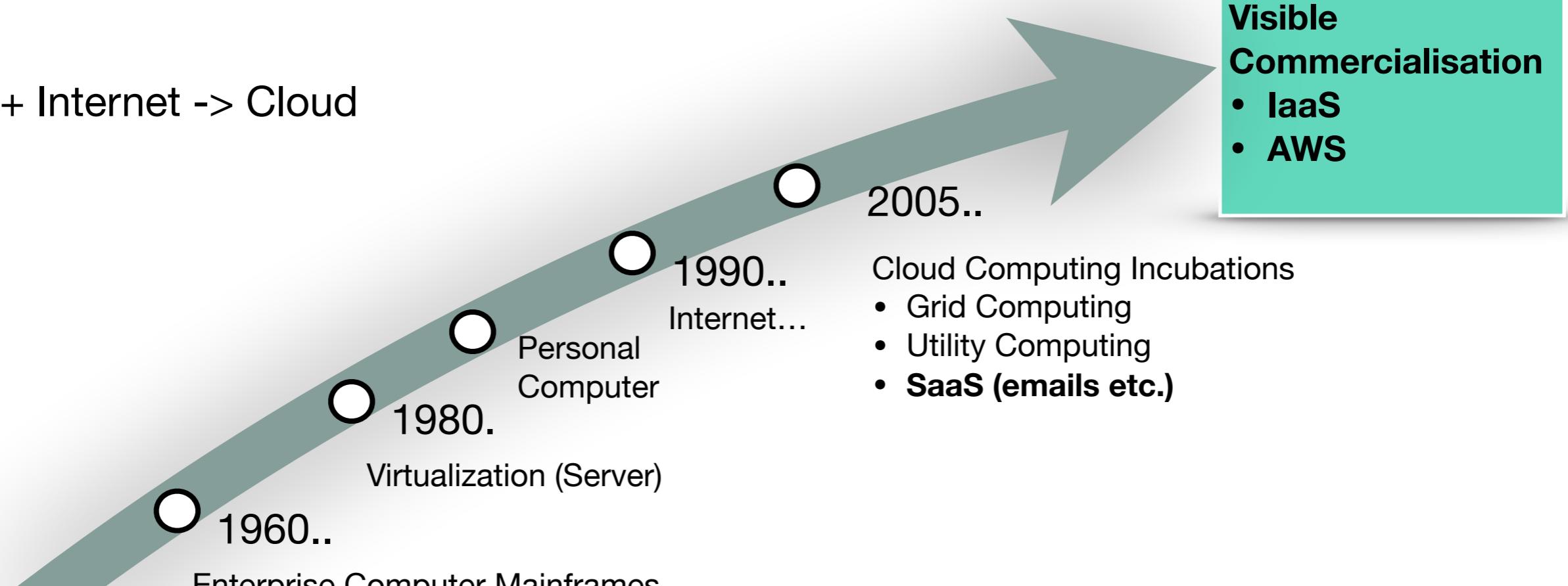
- <https://www.ibm.com/cloud/learn/cloud-computing>
- <https://aws.amazon.com/what-is-cloud-computing/>
- <https://azure.microsoft.com/en-us/overview/what-is-the-cloud/>
- <https://cloud.google.com/what-is-cloud-computing>

Service Models and Deployment Types

- Service Models
 - IaaS : Infrastructure as a Service
 - PaaS: Platform as a Service
 - SaaS: Software as a Service
- Deployment Types (Think about the provider view and the consumer view and think about IT sharing)
 - Public Cloud (the true cloud...)
 - **Consumer** -> I can access similar services via different urls (Accounts) and I don't know who else is using the IT
 - Provider -> everybody (for me unknown) with an Internet Access (and a credit card) can use the globally shared service
 - Private Cloud (Community Cloud)
 - **Consumer** -> I identify me as a member of this organisation / community for access and I may know the provider
 - Provider -> I know the member of the organisation / community who uses the service exclusively, and they probably know me
 - Hybrid Cloud
 - **Consumer** -> I do this and that, sometimes only shared with my community and sometime shared with the internet world
 - Provider -> I maybe only a part of Hybrid composition. (Or I am a service broker)

Cloud History

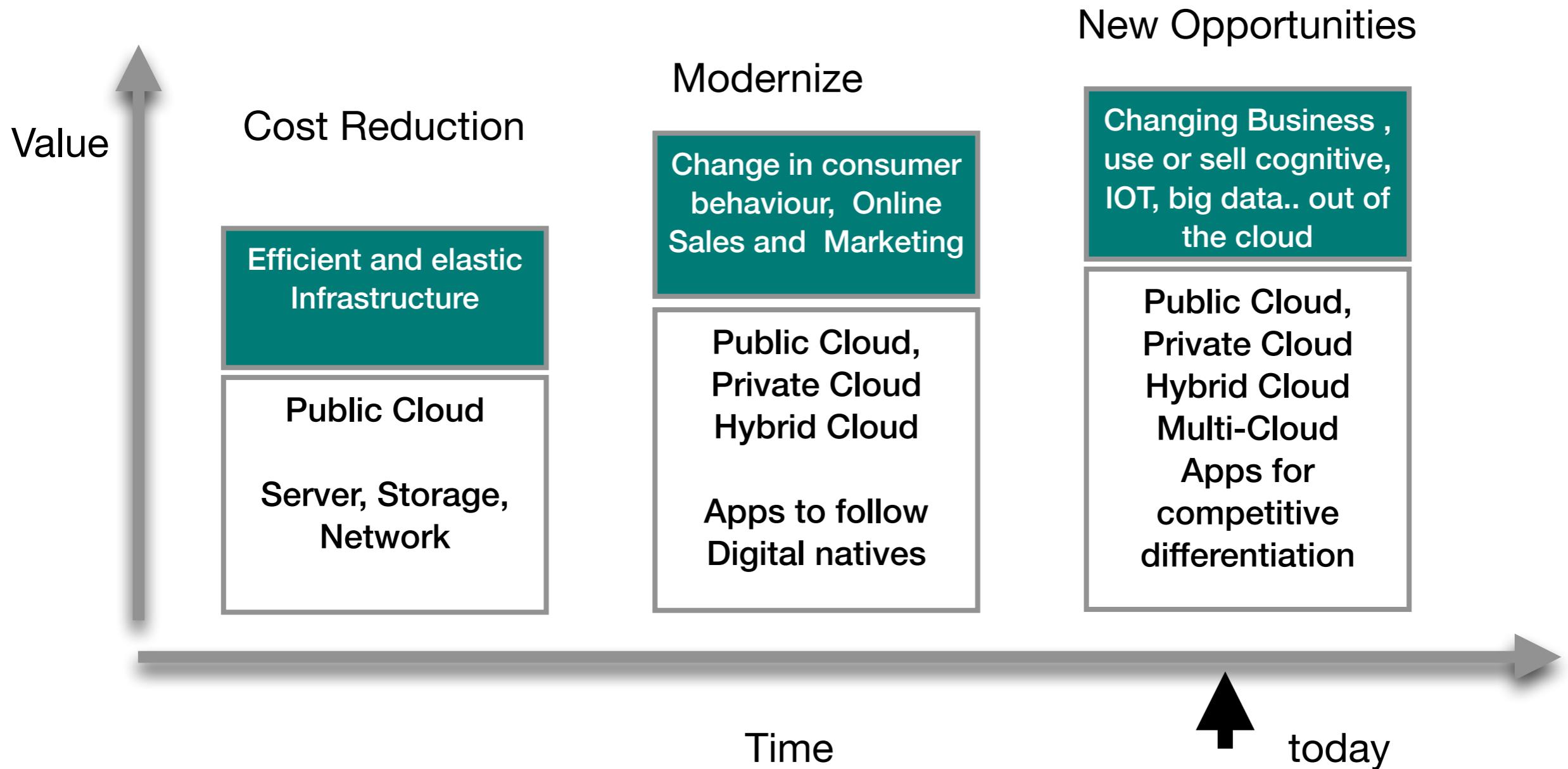
PC + Internet -> Cloud



IT as
differentiator

IT as
commodity

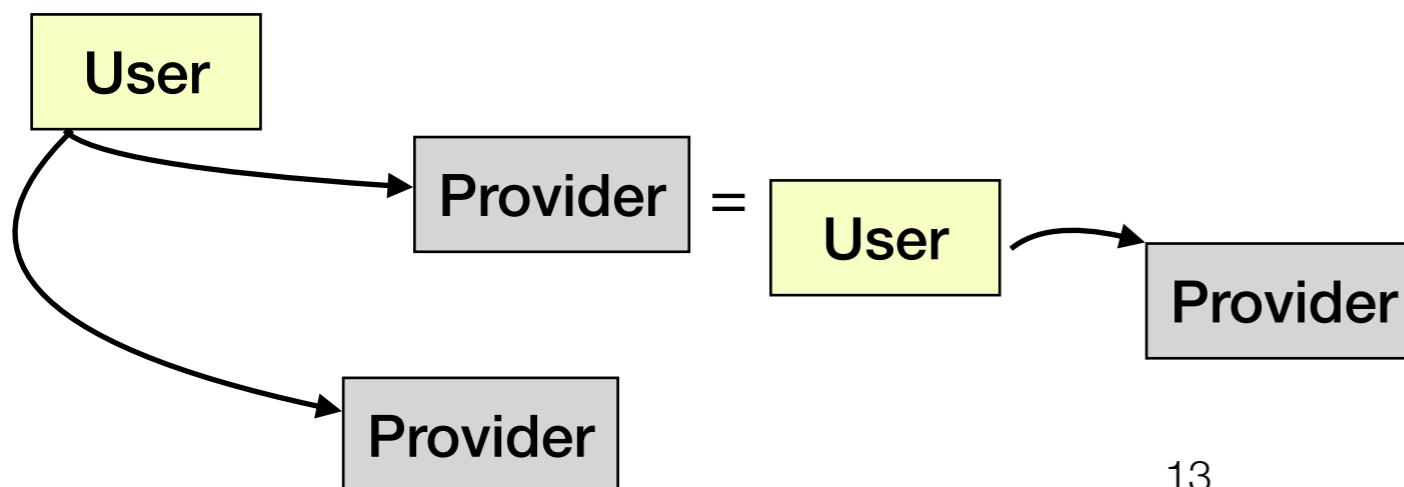
Cloud History



..as a Service

Let's think a bit over it..

- Real practical examples :
 - Until this weekend I need to renovate my room
 - (repaper and painting)
 - This evening I want to eat a (upper level) Hamburger together with a good friend
 - Until this weekend I need to change and store my car tires
- Think about
 - The parts you need in order to fulfill your desire
 - Service models
 - I do everything by my own, I buy everything as a service and the mixtures of both (I do parts and I buy parts)
 - Service roles



..as a Service

Hamburger as a Service

on your own

Table
Dishes
Oven
Cocking Set
Meat
Spices
Bread
Tomato
Salad

Frozen Hamburger

Table
Dishes
Oven
Cooking Set
Meat
Spices
Bread
Tomato
Salad

Hamburger Service

<u>lieferando.de</u>
Table
Dishes
Oven
Cooking Set
Meat
Spices
Bread
Tomato
Salad

Restaurant

Table
Dishes
Oven
Cooking Set
Meat
Spices
Bread
Tomato
Salad

Restaurant
Party Service.. Essen,
Tische Musik,
Erlebnisküche etc.

Grossküche, Catering
mit Lieferservice

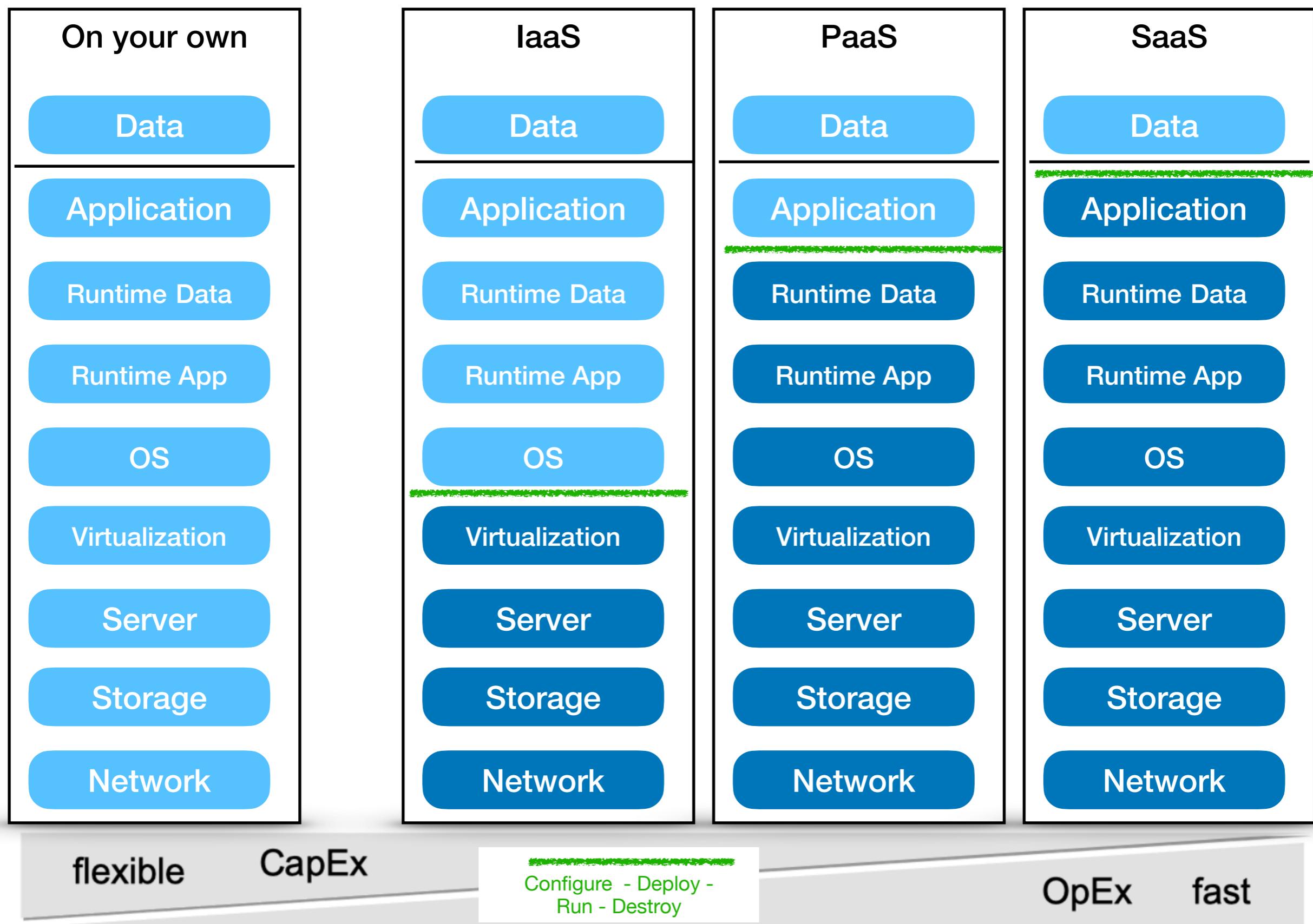
Gemüse Grosshandel mit
veganen Bürger
Essen vorbereitet wie im
Flugzeug

flexible

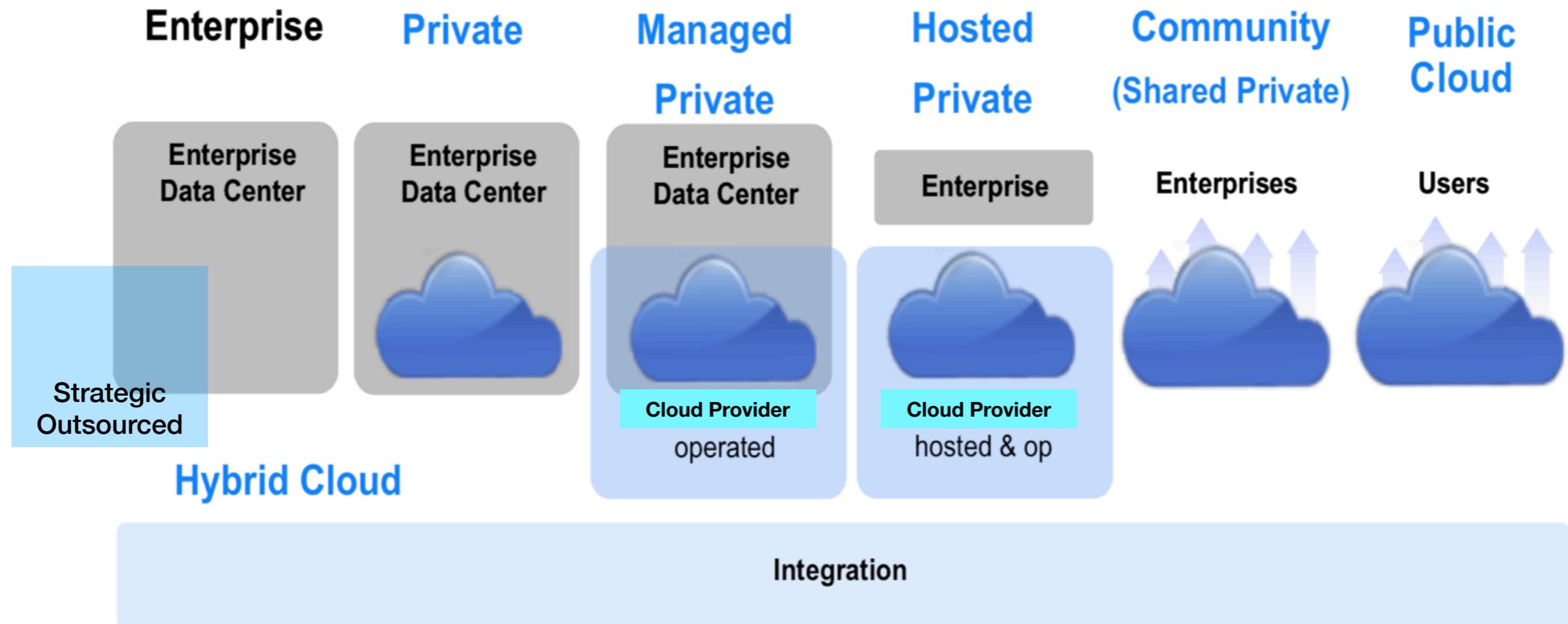
CapEx

OpEx fast

Cloud Service Models



Cloud Deployment Types



Hybrid Cloud = Integration of different flavours of cloud

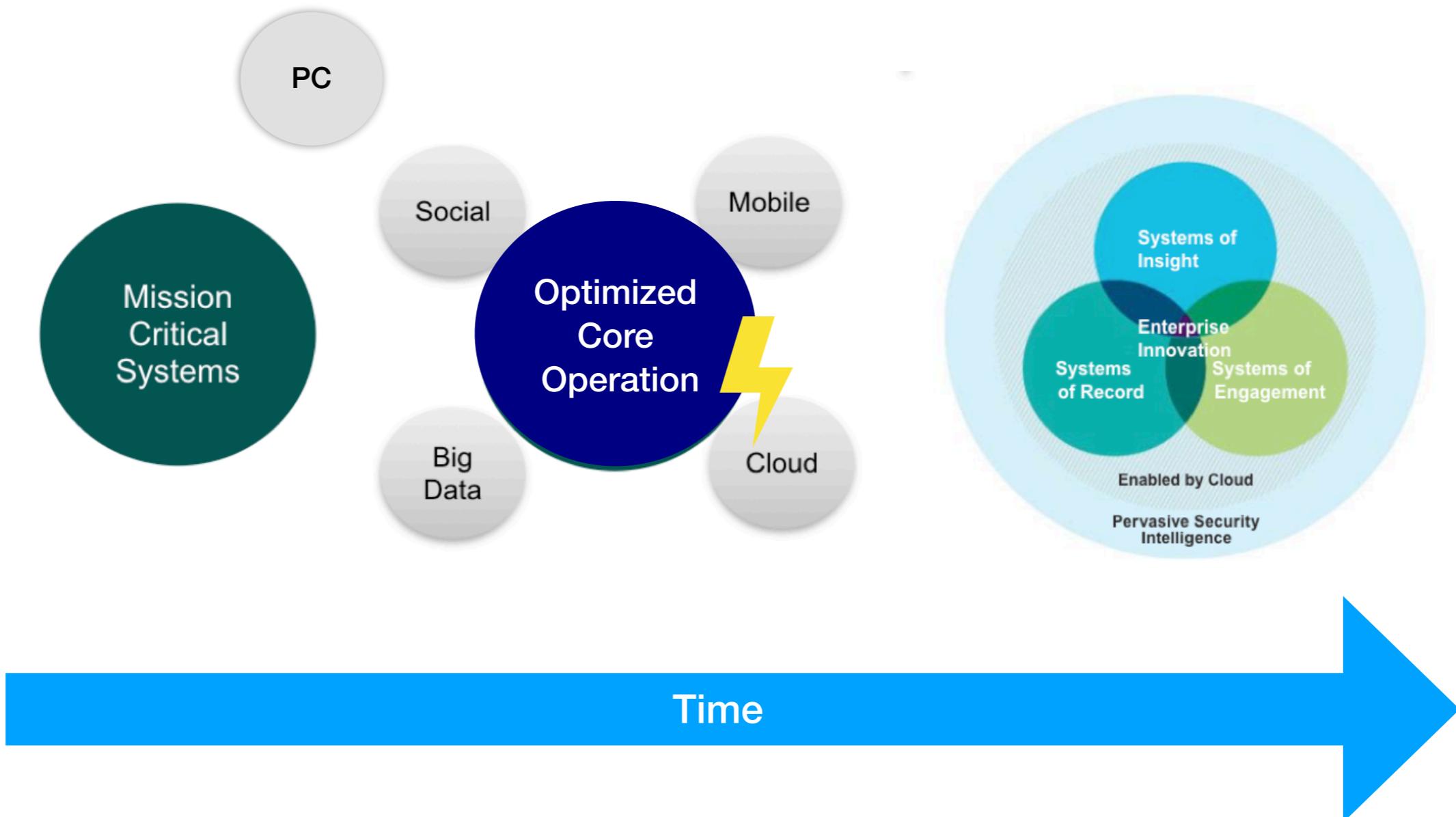
- public/private Cloud !!
- Different Cloud Providers (Multi Cloud)

Hybrid IT (Enterprise) = Integration Enterprise Data Center with flavours of cloud

IT Transformation

Enterprise Innovation:

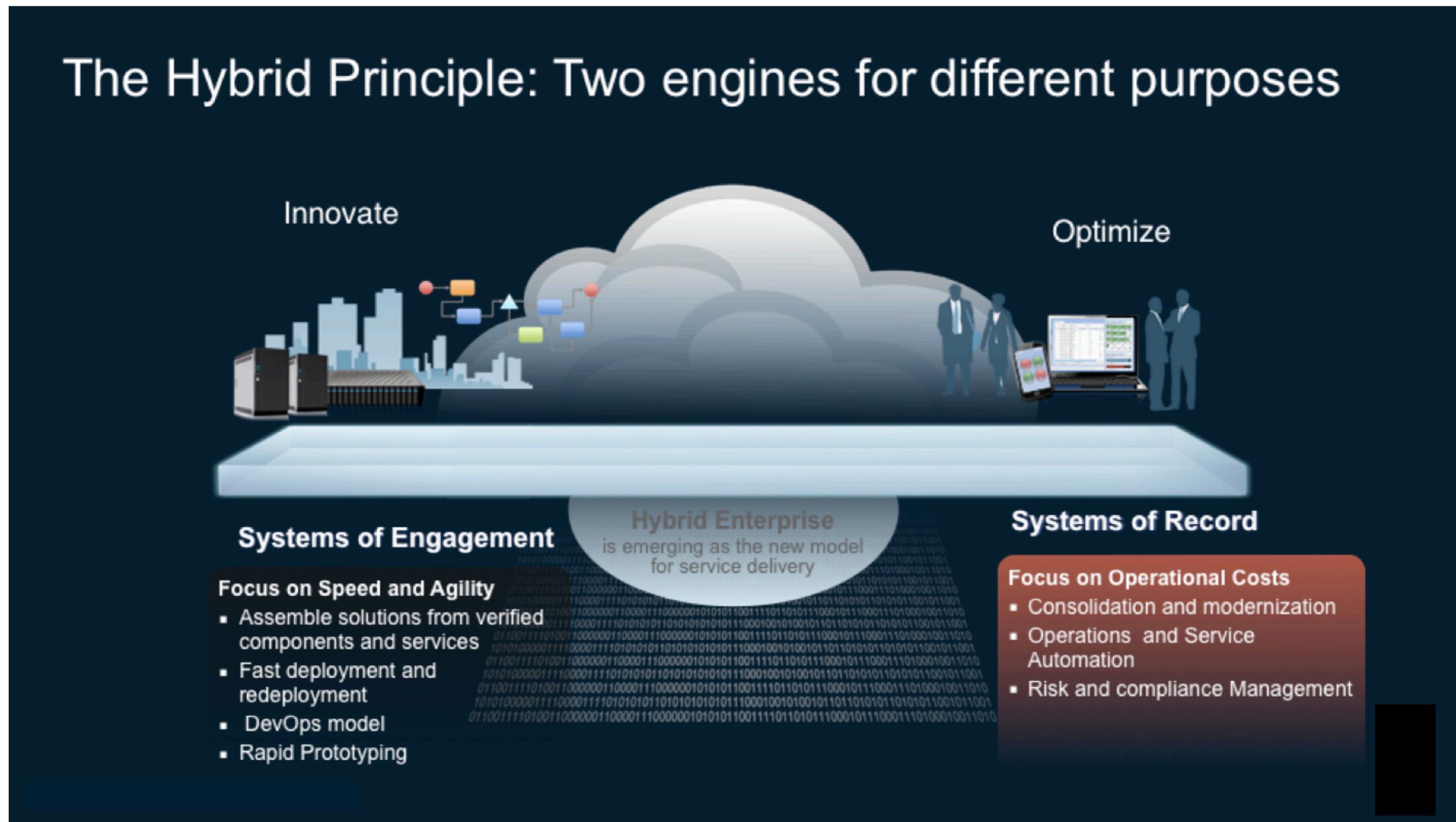
Integration of new era technologies with core systems



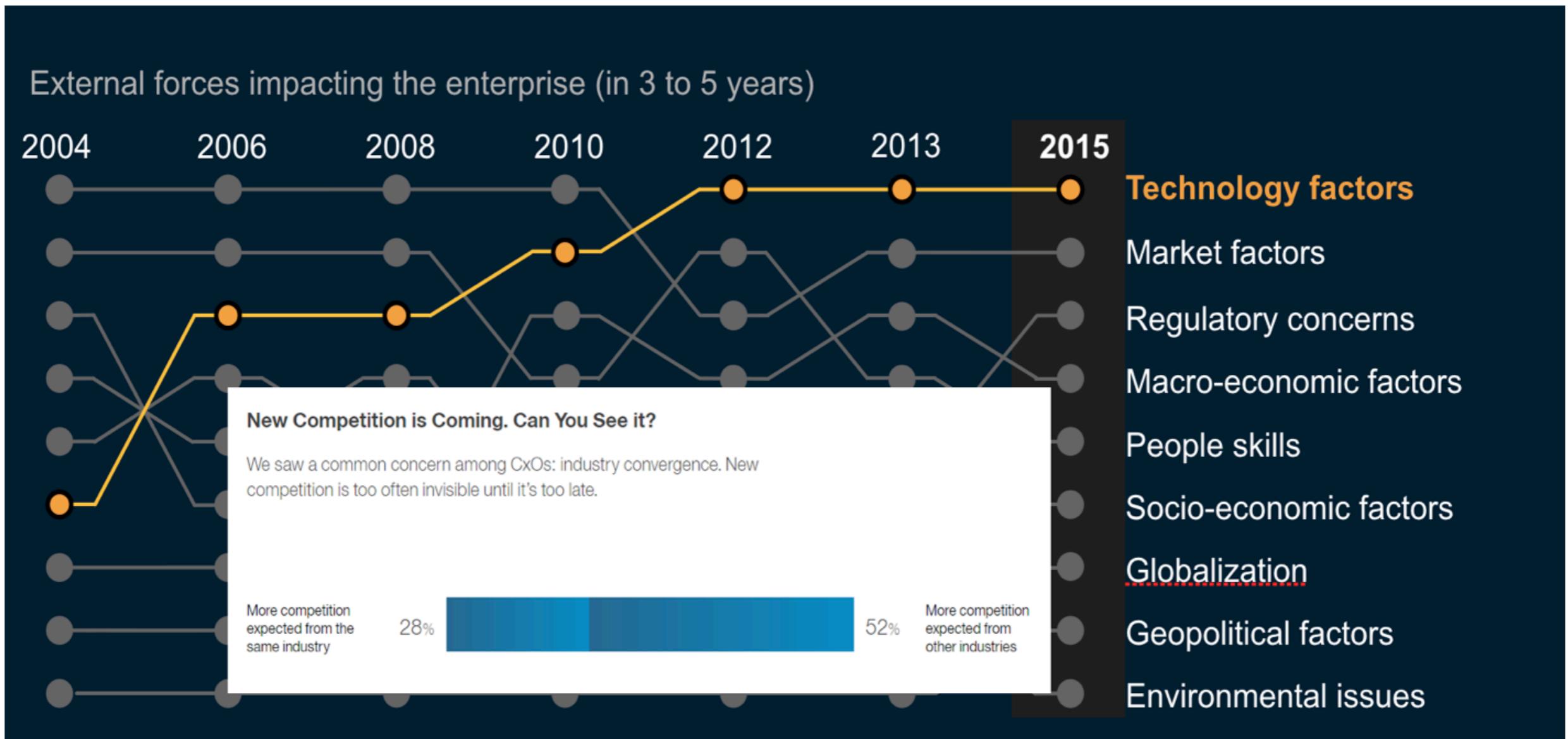
In Anlehnung an Gartner Research - Terminologie

How to combine the different worlds .. what are those System of xyz bubbles

Hybrid IT = Mixed Deployment Models

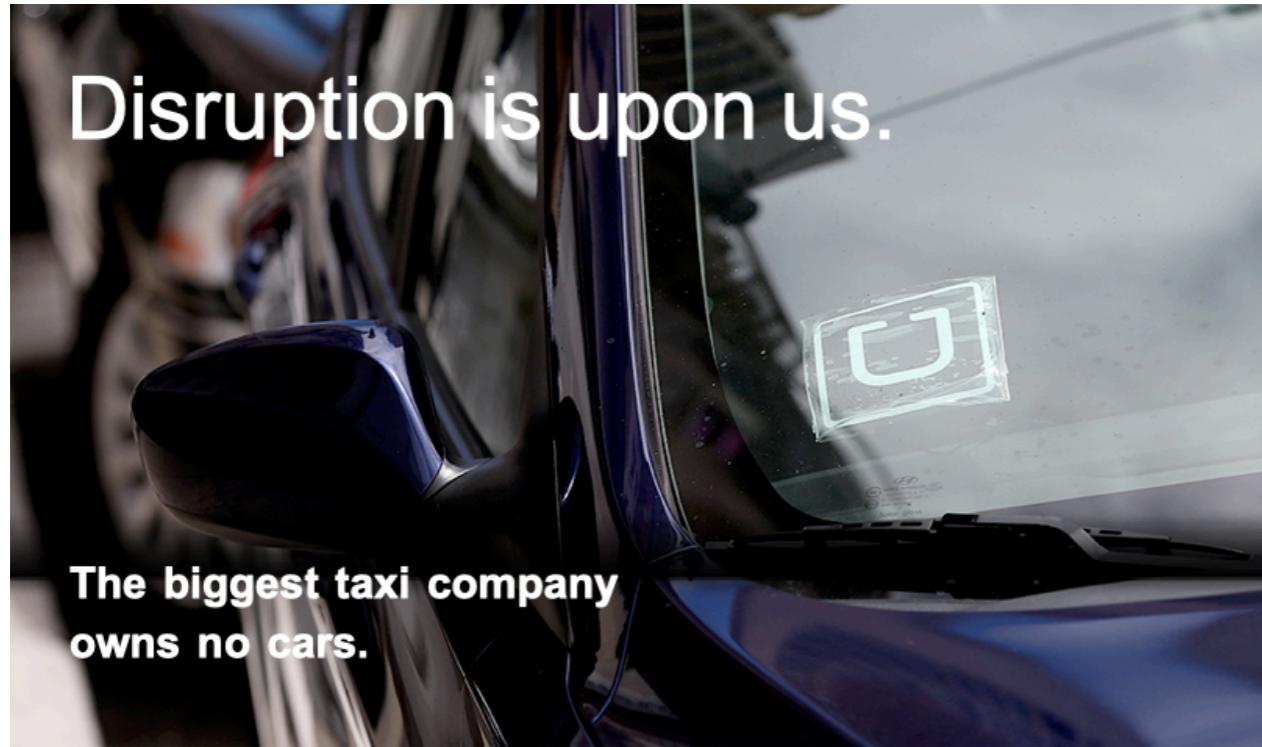


Impacting Enterprises



A bit outdated, and maybe today different, but the message keeps to be true....

Attractive Disruption : less upfront investment, no heritage



Other Quotes

Why does Cloud matter

“People need banking, but they don’t necessarily need banks.”

- Heather Cox, Citibank Chief Client Experience, Digital and Marketing Officer

“Two guys in a Starbucks now have access to the same computing power as a Fortune 500 company.”

- Jim Deters, Founder, Galvanize

The Fortune 500 is an annual list compiled and published by Fortune magazine that ranks 500 of the largest United States corporations by total revenue for their respective fiscal years.

IT Enterprise and Cloud

The questions are now ..

- How much of both is needed and when ?
- How to build an Hybrid IT ?
- Technology, People, Processes ?
- More innovation faster but how ?
- No additional budget !!
- What are our competitors doing ?



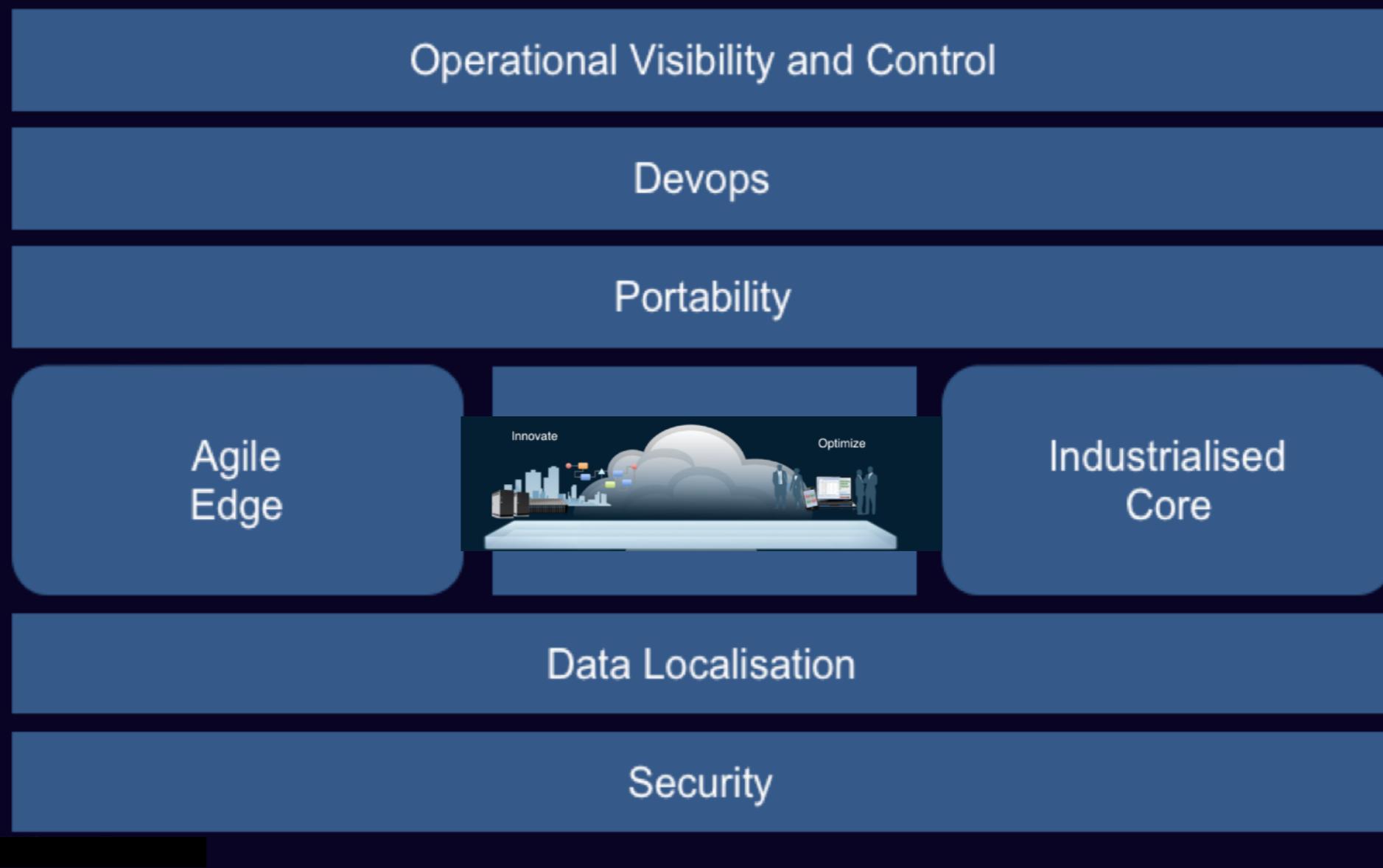
Hybrid IT (mixed Deployment Models)

Use Cases:

- **Application Scale out**
 - Additional Capacity Demand from the Cloud at a certain time
- **Cloud as Backup or Disaster Recovery Site**
 - Additional Capacity for IT Redundancy
- **Innovation Prototyping**
 - Experiment with new stuff and early development in the cloud
- **Split (existing) Application**
 - Access to shared Data/Service from the Presentation Logic implemented in a public Cloud. Enterprise Data are kept on-prem
- **Extend existing or new Apps with Innovation from the Cloud**
 - e.g. a Chatbot for the Help Center, or IoT for predictive Maintenance
- **Regional Workload Distribution using the Cloud DCs**
 - (e.g Asia Pacific and China)

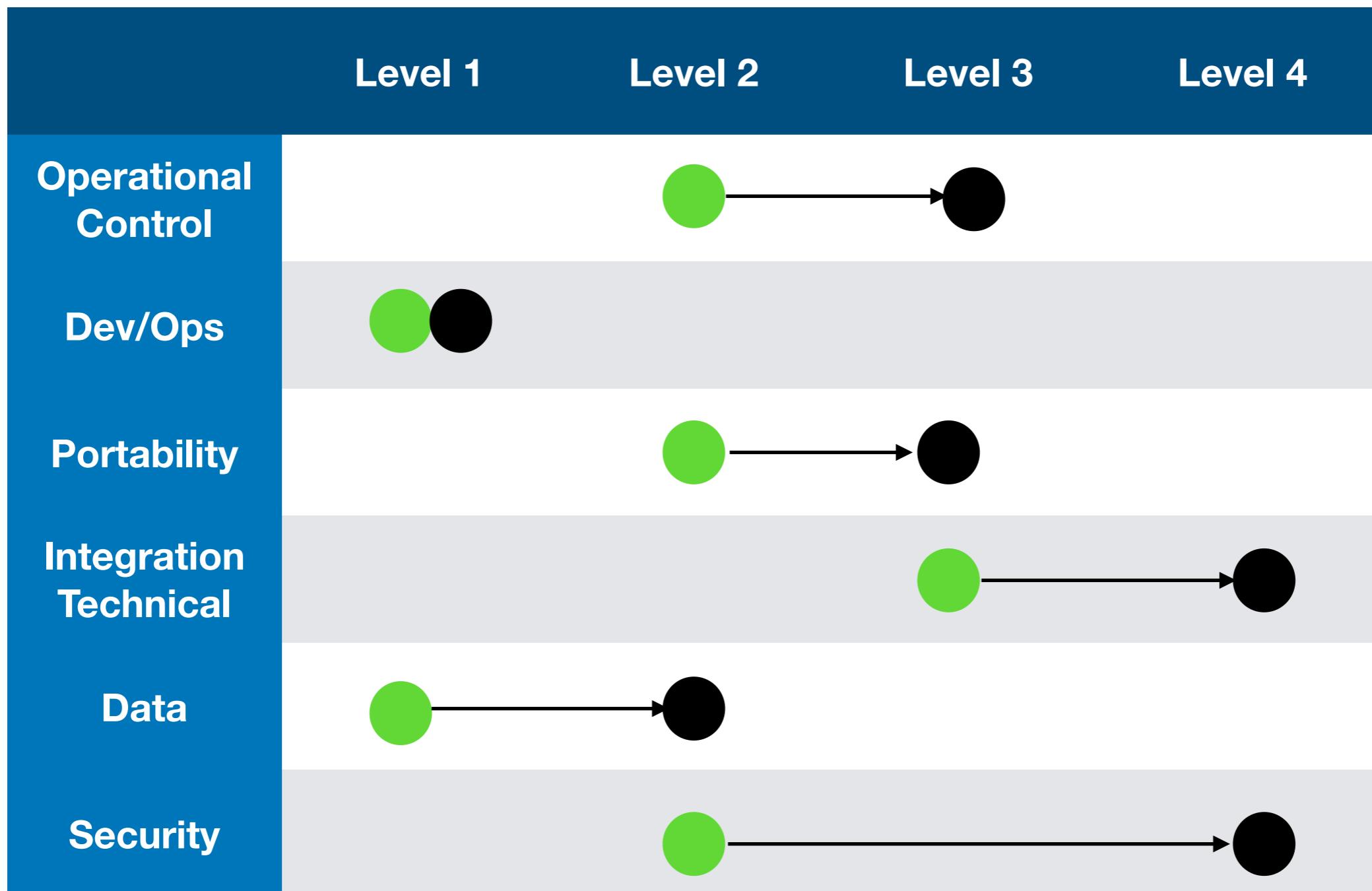
Hybrid IT Maturity Model

Hybrid IT is the Technology Foundation of Digital Reinvention



Hybrid IT Maturity Model

Current - Desired State



Cloud Service

.. and there are no silver bullets in the air



Gut jetzt.. und was macht der Provider ??

Provider : Consolidation, Standardization and Automation

Consolidate (everything)



Automate



Automate



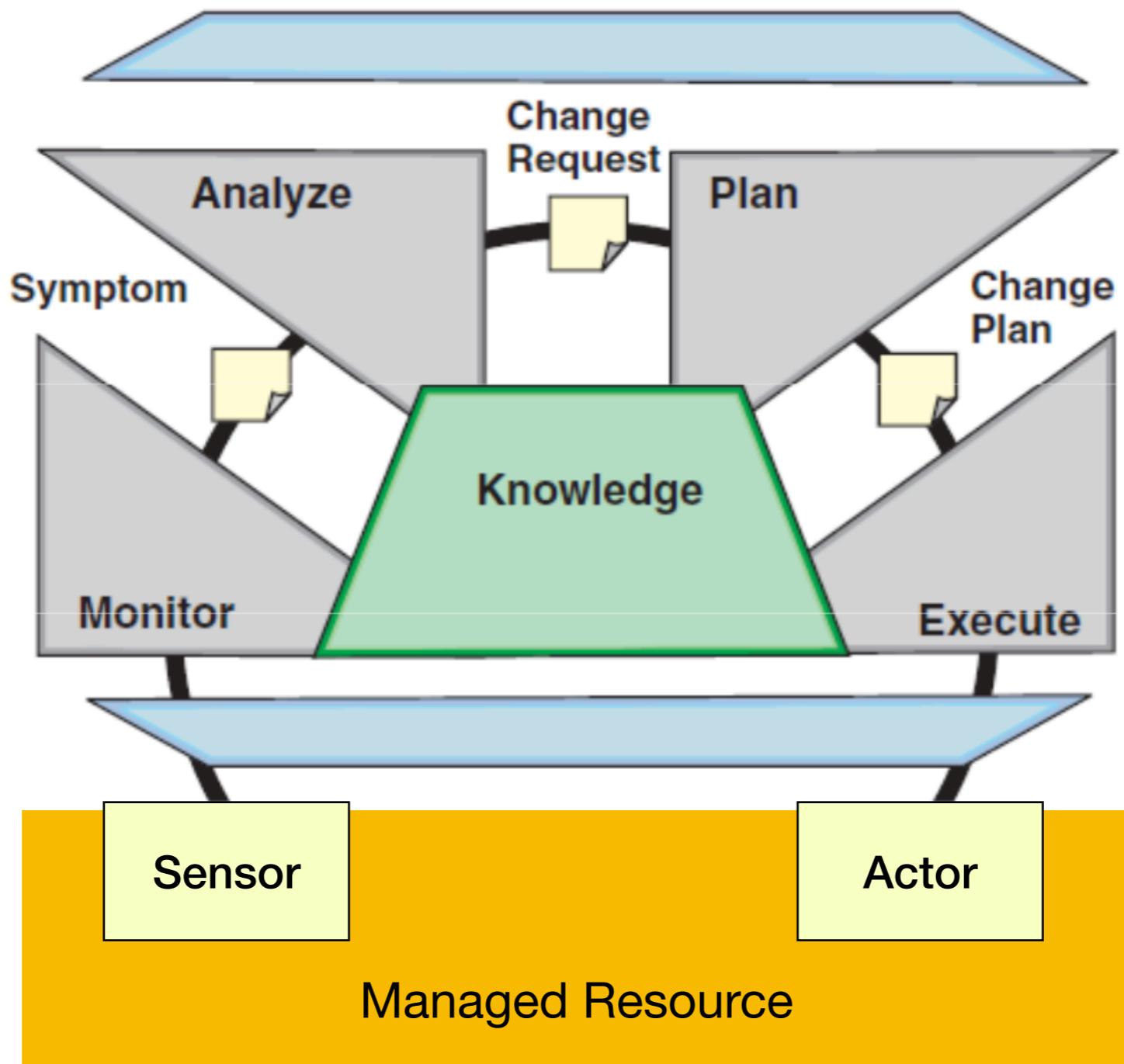
Extended set of offerings

Minimum set of offerings

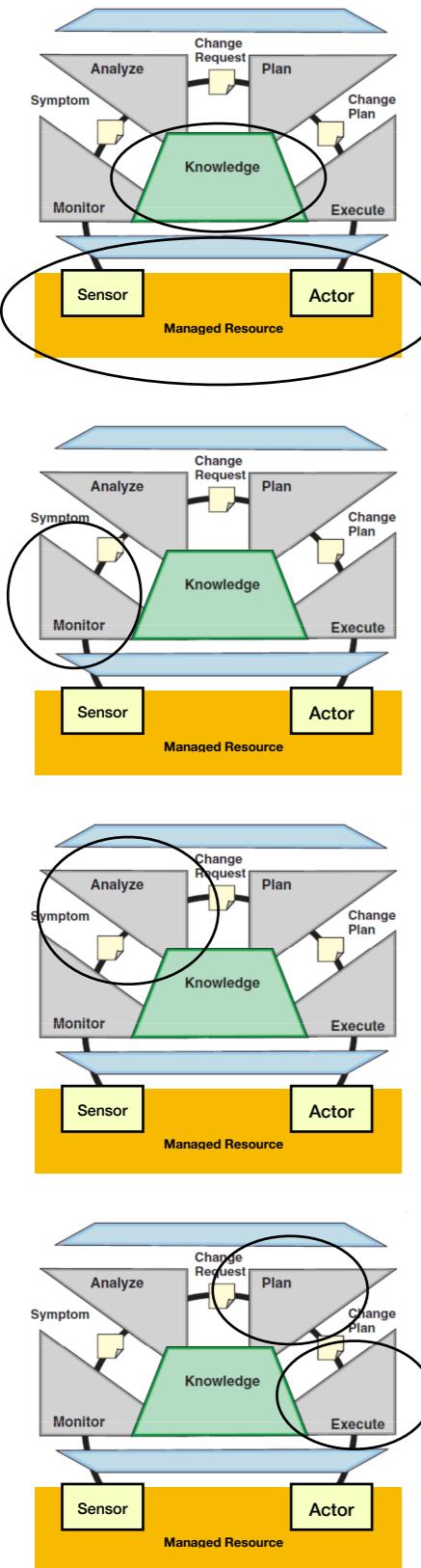
Henry Ford, the Model T

How many variations you want the customer to select ?

Control Loop - MAPE-K -Loop

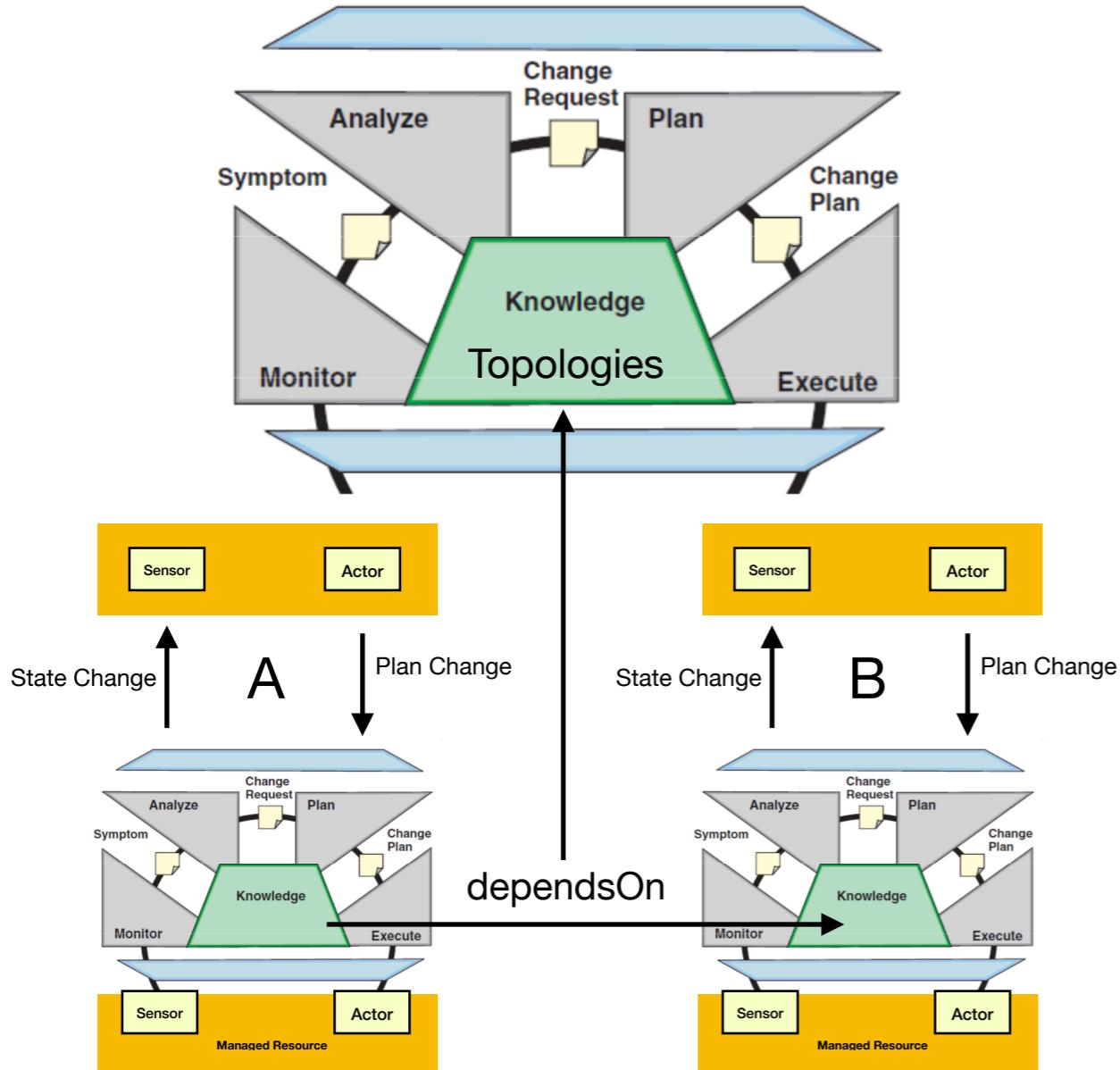


MAPE-K Loop



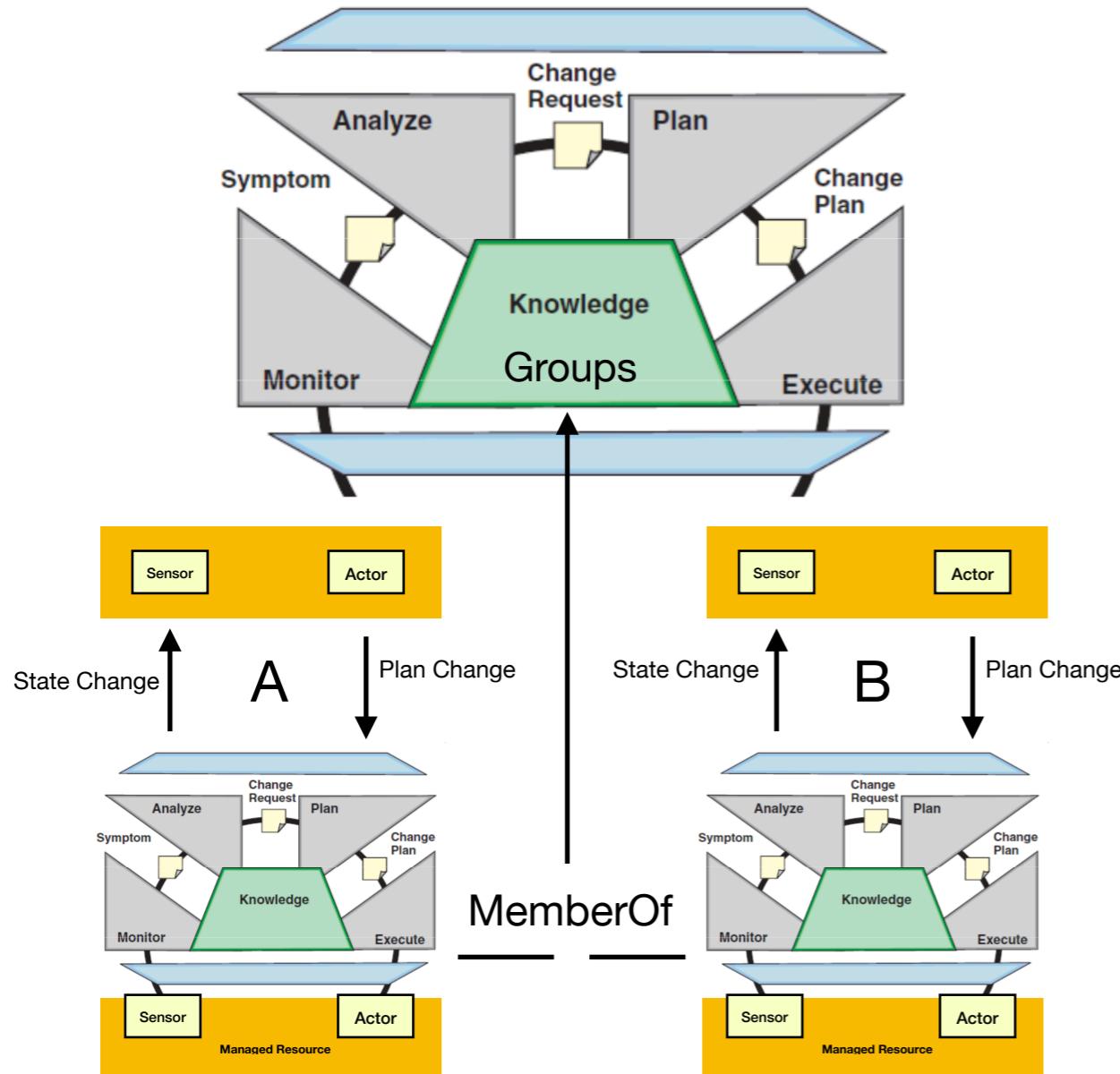
- Managed Resource
 - can be anything, (virtual, real) which can be monitored and controlled using Sensors and Actors
 - Can have a **state** (up, down, online, offline, broken, starting, stopping) and other properties (e.g capacity, config data..)
- Knowledge
 - Data shared among the monitor, analyze, plan and execute functions
 - The shared knowledge includes data such as topology, historical logs, metrics, symptoms and policies
- Monitor
 - Retrieves and filters (a lot) of sample data
 - A Filter can be time (need data every 5 seconds) or thresholds (e.g. retrieved a high water mark (5 times in 20 secs))
 - Sends significant data (= symptoms)
- Analyze
 - A more complex task to decided whether the retrieved symptom is actionable (often a mismatch between a desired state and the current state)
 - Includes knowledge data (e.g. learning)
 - A Symptom at a certain time (an event) can be correlated to other monitored events or documented events. (Event Correlation Rules)
- Plan, Execute
 - Plan : what to do next to get back to the **desired state**. **current state → desired state**
Setting this desired state can be done via an external interface (plan change)
 - Execute : Interface to the actor to run the action (often a script, program)

MAPE-K - Resource Dependencies



- A abstract Resource representing the dependency topology (graph)
 - Its plan is to fulfil the dependency
 - Traverse the topology to make **plan changes** to resources (via its actors)
 - Observe the **state changes** and run next action to reach the final desired state
 - In our example
 - Resource A (e.g. Linux Server) can only run when Resource B (e.g. IP address) is activated and available to be used

MAPE-K - Resource Groupings



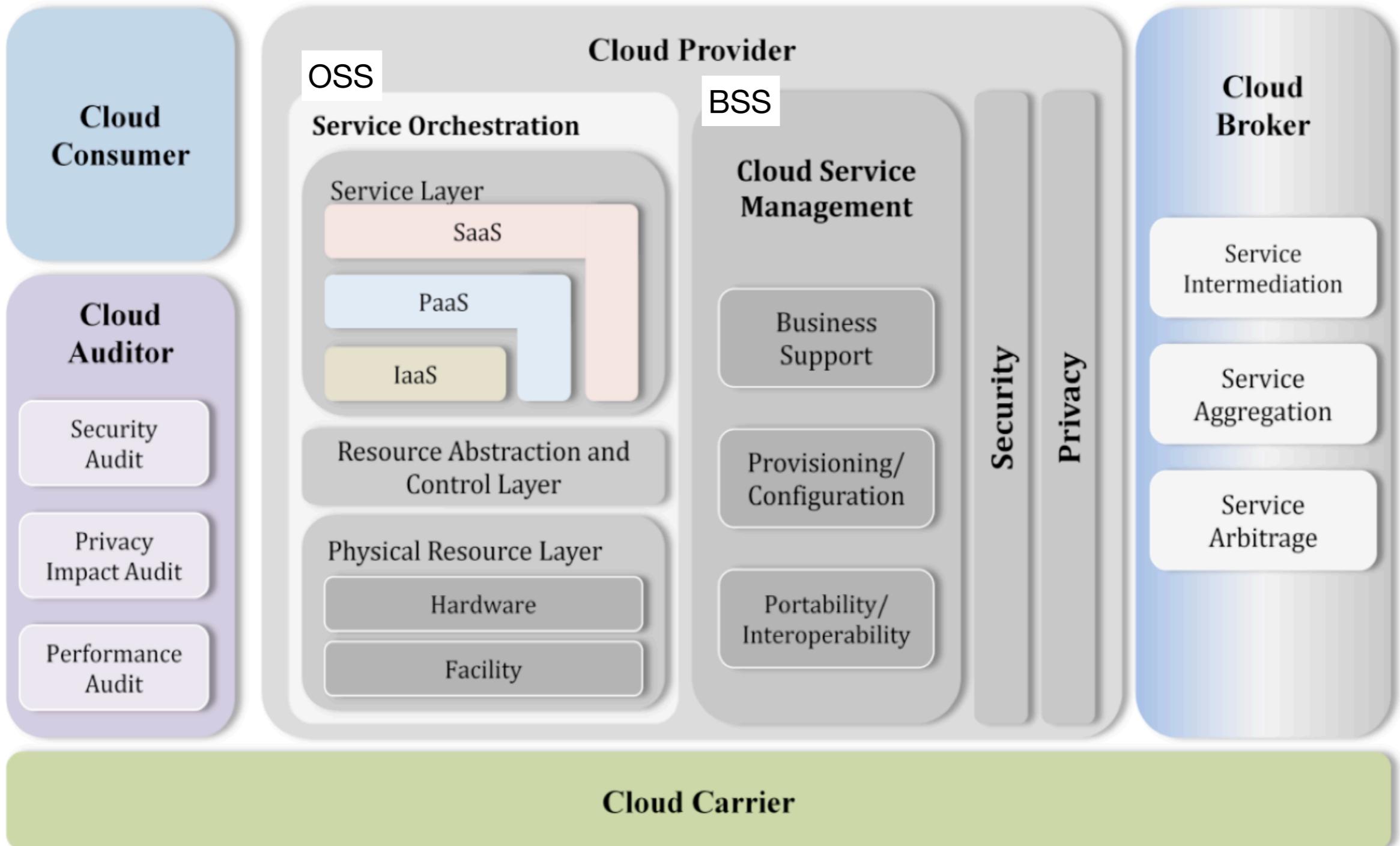
- A abstract Resource representing a Group of Resource
 - e.g. All Resources which belong to an Web Application or DB Server
 - Policies e.g.
 - All resource must be up to consider the Group as up
 - Exactly 1 must be up (others are alternatives in case of failures -> HA Clusters)
 - 3 out 5 (at least) must be up (Scaling Group)
 - Resource Group Members can be
 - Other Resource Groups
 - Dependencies Groups
 - Single Resource
 - A combination of above
 - A Resource Group can be a member of a Dependency Group
 - Start a DB group before you start a the App Group

Cloud Referenz Architecture

A broader view

NIST Reference Architecture

https://tsapps.nist.gov/publication/get_pdf.cfm?pub_id=909505



Cloud Actors (NIST Reference Architecture)

Actor	Definition
Cloud Consumer	A person or organization that maintains a business relationship with, and uses service from, <i>Cloud Providers</i> .
Cloud Provider	A person, organization, or entity responsible for making a service available to interested parties.
Cloud Auditor	A party that can conduct independent assessment of cloud services, information system operations, performance and security of the cloud implementation.
Cloud Broker	An entity that manages the use, performance and delivery of cloud services, and negotiates relationships between <i>Cloud Providers</i> and <i>Cloud Consumers</i> .
Cloud Carrier	An intermediary that provides connectivity and transport of cloud services from <i>Cloud Providers</i> to <i>Cloud Consumers</i> .

Cloud Actors (NIST Reference Architecture)

Cloud Auditors

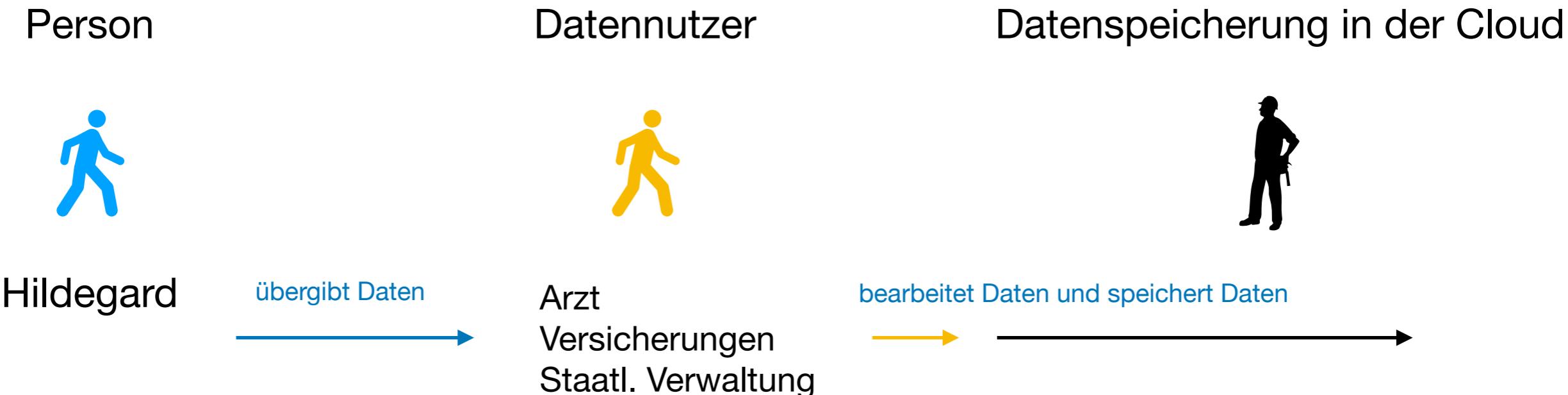
- A independent third party who conducts audits to have Cloud Data Center being compliant:
- Cloud Data Center are very much audited



Cloud Services brokerage:

- **Cloud Service Intermediation:** An intermediation broker provides value added services on top of existing cloud platforms, such as identity or access management capabilities.
- **Aggregation:** An aggregation broker provides the “glue” to bring together multiple services and ensure the interoperability and security of data between systems.
- **Cloud Service Arbitrage:** A cloud service arbitrage provides flexibility and “opportunistic choices” offering multiple similar services to select from.
- The Cloud Brokerage Enablement market will grow from \$225.42 million in 2013 to \$2.03 billion by 2018, at a CAGR of 55.3%.

Auszug zum Thema Datenschutz und Cloud



PI (Person Information)

- PII = **Person Identifiable Information**
- PSI = **Person Sensible Information (PSI)**
= PII die aber sehr persönliche Daten einer Person enthalten)

DSGVO / GDPR

- Hildegard hat die Souveränität über Ihre Daten
 - Welche Daten, Dateneinsicht, Recht auf Vergessen
- **Datennutzer beschreibt die Nutzung und Weiterverarbeitung der Daten**
 - Hildegard kann ablehnen

Datennutzer sucht sich den Cloudanbieter der seine Versprechungen gegenüber der Hildegard für die Speicherung der Daten gewährleistet.

DSGVO / GDPR / Audits

- Wann gilt EU Recht
 - Ort der Daten
- Wie setze ich GDPR technisch um
 - Certifications



- Wir geben keine Daten weiter
- Wir verarbeiten keine Daten (ausser Verschlüsselung und Backup)

Aber :

- Global agierende Firmen haben technische Möglichkeiten auf ihre DC zu zugreifen.
- Missbrauch über Forderungen von nationalen (US) Regierungen (Notstand) oder Industriespionage
- Beste technische Sicherheit : Datennutzer hat einen Master Key für den Schlüsselkasten und könnte im Bedarfsfalle alles sperren (oder löschen)

Cloud Actors (NIST Reference Architecture)

Cloud Carrier (The network to connect DCs and the Internet)

- is a class of capabilities that integrates wide area networks (WAN) and other attributes of communications service providers' carrier grade networks to enable the deployment of highly demanding applications in the cloud.
- Such Capabilities includes
 - Content Delivery Network, Global LBs, MPLS (Multiprotocol Label Switching instead of Internet)

Best Practices Architecture Center (for Consumer)

The screenshot shows the Microsoft Azure Architecture Center page. At the top, there's a navigation bar with links for Overview, Solutions, Products, Documentation, Pricing, Training, Marketplace, Partners, Support, Blog, and More. Below the navigation is a search bar and a sign-in link. A banner at the top of the main content area says, "Is your code ready for leap day? February 29, 2020 is fast approaching. Make sure your code can handle the extra day. Learn more about how to prevent leap year bugs." The main content area is titled "Azure Architecture Center". It features several cards: "Azure Application Architecture Guide" (with a compass icon), "Reference Architectures" (with a book icon), "Microsoft Cloud Adoption Framework for Azure" (with a cloud icon), "Example Workloads" (with a server icon), and "Build Microservices on Azure" (with a cluster icon). On the left, there's a sidebar with a "Filter by title" dropdown and a list of categories including Data architectures, DevOps, Disaster recovery, Enterprise integration, High performance computing (HPC), Hybrid infrastructure, Identity, Internet of Things (IoT), Microservices, Networking, SAP, Scalability, Serverless applications, VM workloads, Web apps, Other technologies, and Cloud Adoption Framework.

The screenshot shows the AWS Architecture Center page. At the top, there's a navigation bar with links for Products, Solutions, Pricing, Documentation, Learn, Partner Network, AWS Marketplace, Customer Enablement, Events, Explore More, and a search bar. Below the navigation is a banner with the text "AWS Architecture Center" and "Guidance from experts on architecting in the AWS Cloud". The main content area is titled "AWS Architecture Center". It features four cards: "AWS Well-Architected" (with a hexagonal icon), "AWS Solutions" (with a gear and wrench icon), "AWS Whitepapers & Guides" (with a document icon), and "AWS Reference Architecture Diagrams" (with a blueprint icon). A note at the bottom states: "The AWS Architecture Center provides a collection of technical resources to help you build more effectively and efficiently in the AWS Cloud. All the content found below is official AWS content, produced by AWS and AWS Partners."

<https://aws.amazon.com/architecture/>

<https://docs.microsoft.com/en-us/azure/architecture/>

Get started .. using your Cloud account

bwCloud (mandatory)



[Erste Schritte](#)

[bwCloud SCOPE](#)

[Fragen & Antworten](#)

[News](#)

[Kontakt](#)

Wichtige Information (23.01.2020):

Am Dienstag den 18.02.2020 findet eine Wartung aller bwCloud Betriebsstandorte statt.

Weitere Informationen dazu unter [News: Wartung aller bwCloud Betriebsstandorte am Dienstag den 18.02.2020](#)

Erste Schritte - Wie komme ich in die bwCloud?

Um die bwCloud Infrastruktur nutzen zu können, ist eine Registrierung erforderlich. Die Registrierung ist an das [bwIDM \(Föderatives Identitätsmanagement der baden-württembergischen Hochschulen\)](#) angebunden, weshalb prinzipiell alle Angehörigen von baden-württembergischen Einrichtungen die bwCloud nutzen können. Die Registrierung für die bwCloud wird derzeit zentral über einen Server der Universität Freiburg abgewickelt.

Voraussetzungen: Was Sie zur Nutzung der bwCloud benötigen

[prereqs]

Zur individuellen Nutzung der bwCloud benötigen Sie einen gültigen Account beziehungsweise Zugang zu einer Universität, Hochschule oder sonstigen Landeseinrichtung in Baden-Württemberg, die an das [landesweite bwIDM](#) angebunden ist. Ob Ihre Einrichtung an das landesweite bwIDM angebunden ist, können Sie mit einem Blick auf die Liste unter dem Link <https://bw-cloud.org/q/regapp> überprüfen. Sollte Ihre Einrichtung *nicht* in der Liste aufgeführt sein, kontaktieren Sie bitte Ihren technischen Support vor Ort.

Screenshot

[Voraussetzungen: Was Sie zur Nutzung der bwCloud benötigen](#)

[Vor der Nutzung bitte beachten: Was die bwCloud leistet und was nicht](#)

[Schritt 1: Registrieren](#)

[Schritt 2: Dienstpasswort setzen](#)

[Schritt 3: Einloggen in die bwCloud](#)

[Schritt 4: SSH-Key Registrierung](#)

https://www.bw-cloud.org/de/erste_schritte

AWS Account (Optional) 12 month but you need a credit card

The screenshot shows a web browser window for the AWS Console Signup at https://portal.aws.amazon.com/billing/signup?nc2=h_ct&src=header_signup&redirect_url=https%3A%2F%2Faws.amazon.com%2Fregistration-confirmation#/start. The page title is "AWS Console - Signup". The main heading is "Create an AWS account". On the left, there's a promotional message: "AWS Accounts Include 12 Months of Free Tier Access" and "Including use of Amazon EC2, Amazon S3, and Amazon DynamoDB". It also says "Visit [aws.amazon.com/free](#) for full offer terms". The right side contains a form with fields for "Email address", "Password", "Confirm password", and "AWS account name". A yellow "Continue" button is highlighted. Below the form is a link to "Sign in to an existing AWS account". At the bottom, there's a copyright notice: "© 2020 Amazon Web Services, Inc. or its affiliates. All rights reserved." and links to "Privacy Policy" and "Terms of Use".

AWS Accounts Include
12 Months of Free Tier Access

Including use of Amazon EC2, Amazon S3, and Amazon DynamoDB

Visit [aws.amazon.com/free](#) for full offer terms

Create an AWS account

Email address

Password

Confirm password

AWS account name i

Continue

Sign in to an existing AWS account

© 2020 Amazon Web Services, Inc. or its affiliates.
All rights reserved.

[Privacy Policy](#) | [Terms of Use](#)

https://portal.aws.amazon.com/billing/signup?nc2=h_ct&src=header_signup&redirect_url=https%3A%2F%2Faws.amazon.com%2Fregistration-confirmation#/start

Azure Services

The screenshot shows a web browser window with the URL <https://azure.microsoft.com/en-us/free/>. The page has a dark header with the Microsoft Azure logo and navigation links like Overview, Solutions, Products, Documentation, Pricing, Training, Marketplace, Partners, Support, Blog, and More. A top banner reads "Get started with 12 months of free services" with a "Start free" button and a link to "Or buy now". Below this is a preview of the Azure portal interface showing recent resources and various service icons. The main content area is titled "What do I get?" and lists the benefits of the free account.

What do I get?

With your Azure free account, you get all of this—and you won't be charged until you choose to upgrade.

12 months of popular free services	\$200 credit to explore any Azure service for 30 days	Always free 25+ services
--	---	------------------------------------

<https://azure.microsoft.com/en-us/free/>

IBM Bluemix Account (optional)

<https://console.bluemix.net/registration/>

The screenshot shows a web browser window for console.bluemix.net. The title bar includes the URL, a tab for 'LinkedIn', and links for 'IBM Academic Initiative | Academic Software Discounts' and 'Sign up for IBM Cloud'. The main content area has a blue sidebar on the left with text about signing up for an IBMid, guaranteed free development with Lite plans, starting projects right away, and getting a \$200 credit when upgrading. It also features a 'Ready to get started? Sign up today!' button. The right side contains a registration form with fields for Email*, First Name*, Last Name*, Country or Region* (set to Germany), and Password*. Below the form is a checkbox for opting in to receive contact data, followed by terms and conditions links and a privacy statement link.

Already have an IBM Cloud account? [Log in](#)

Email*

First Name*

Last Name*

Country or Region*

Germany

Password*

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**Now let us re-visit the Cloud Deployment Models
in a greater detail**

Cloud Deployment Models

IT Outsourcing	Public Cloud Deployment
Individuell suit with a perfect fit done by the known tailor/dressmaker	Suit off-the-shelf (Anzug von der Stange)
outsourced Processes and Service fully understood and agreed in great detail.	Processes and Service shared among many customers and standardized for a global reach
Outsourced Resources (IT and people) can be located 'inhouse' or a provider property	Globally spread DCs (interesting for Global Companies)
Single Tenant IT	Multi Tenant IT
Incremental growth of existing unique and often complex Setup	Technology refresh generalized for all users (often on the latest levels)
Tight supervision and joint strategy (in extreme cases just body leasing)	Self Service Access to deploy and administer the Service
Cost reduction driven, and strong dependencies of the provider	Global Market Success, if I get ten new customers I am fine to loose a single one
Big single wins	Many many small wins

What is a private Cloud (a closer look)

1. I have the suits off-the shelf for a private audience (not everybody is allowed to enter my shop)
2. A Private Cloud has some (all) the attributes of a Cloud (elastic, usage based, Self Service etc) for a well known set of consumers (typically part of the same company)
3. Knowing the audience
 - we have a set of more dedicated services
 - DC are less globally (therefore no extreme scaling)
 - focus on strict Data Privacy (assuming that the Operation belongs to the same organization)
 - probably more single tenant setup
4. Enterprise IT often use the concepts of Cloud Computing including Dev/Ops, and Micro Services etc. to modernize their classical IT

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