An Agency Perspectice to Cloud Computing

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Frank Pallas
Karlsruhe Institute of Technology /
FZI Research Center for Informatics
Karlsruhe / Berlin
frank.pallas@kit.edu

In Brief

Images: http://www.americaskeswick.org/support/current-opportunities/buy-a-brick

In Brief

What are the hindrances currently constraining a broader adoption of cloud computing?

How can these be understood on an abstract, theory-founded level?

What can we learn from this in matters of fostering a broader cloud adoption?

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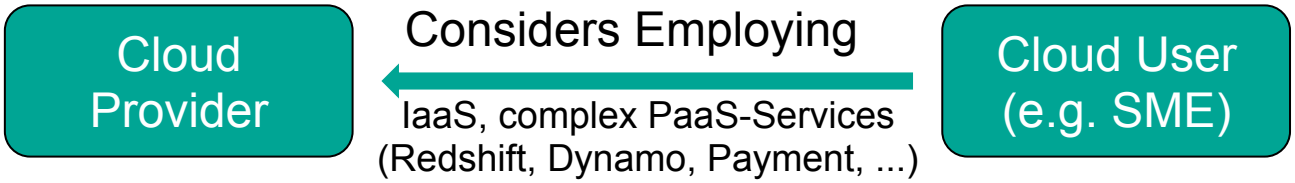
A Usual Case


Cloud Provider
Considers Employing
IaaS, complex PaaS-Services
(Redshift, Dynamo, Payment, ...)
Cloud User
(e.g. SME)

A Usual Case

Law enforcement obligations

Functional requirements

Risk of data exploitation

Squeeze out customers

Data protection law

Limit security efforts

Availability needs

Optimized resource allocation

Cloud Provider

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IaaS, complex PaaS-Services (Redshift, Dynamo, Payment, ...)

Cloud User (e.g. SME)

Isolation from competitors

Exploit customer data

Promises toward customers

Dynamic geo-relocation

Performance needs

SLAs enforceable?

SLA-exceptions

...

Must be highly „secure“

...

We would find

dozens of possible reasons

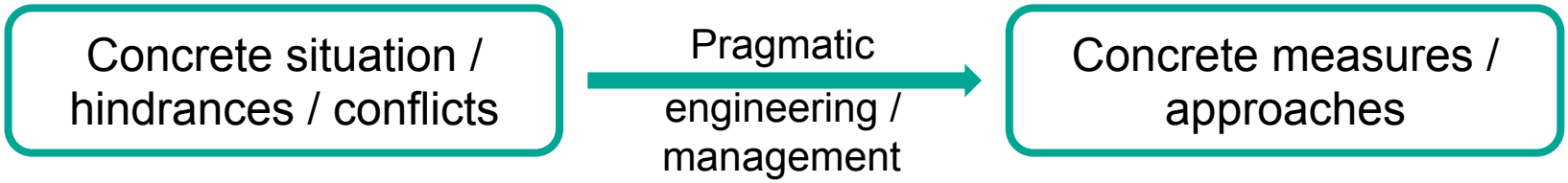
speaking against cloud computing

And for each, we would

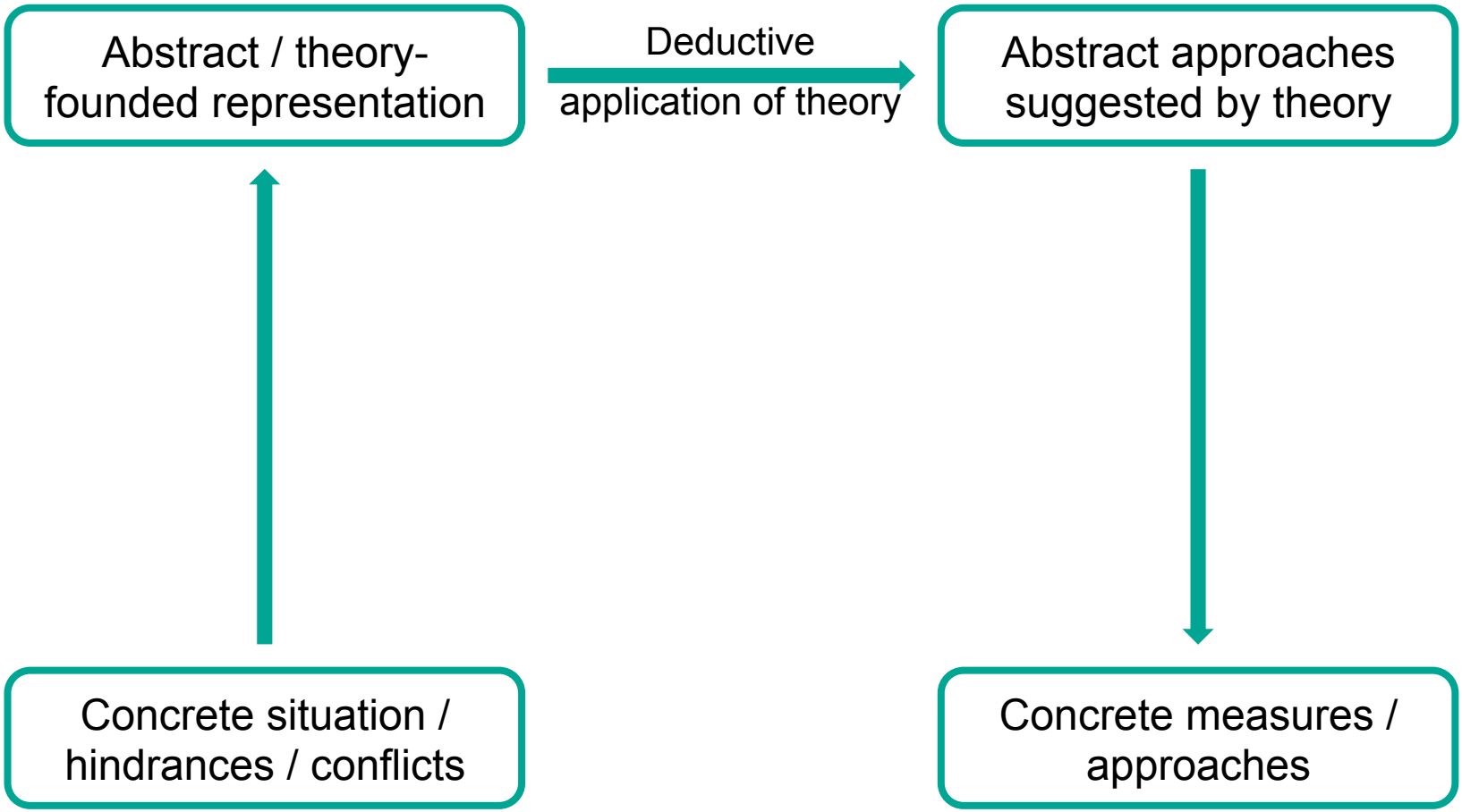
immediately find possible countermeasures

employing technological, legal, ... instruments

„Pragmatic engineering“



Metodological Approach: Positive/Normative Economics



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„America has no permanent friends or enemies, only interests“

H. Kissinger

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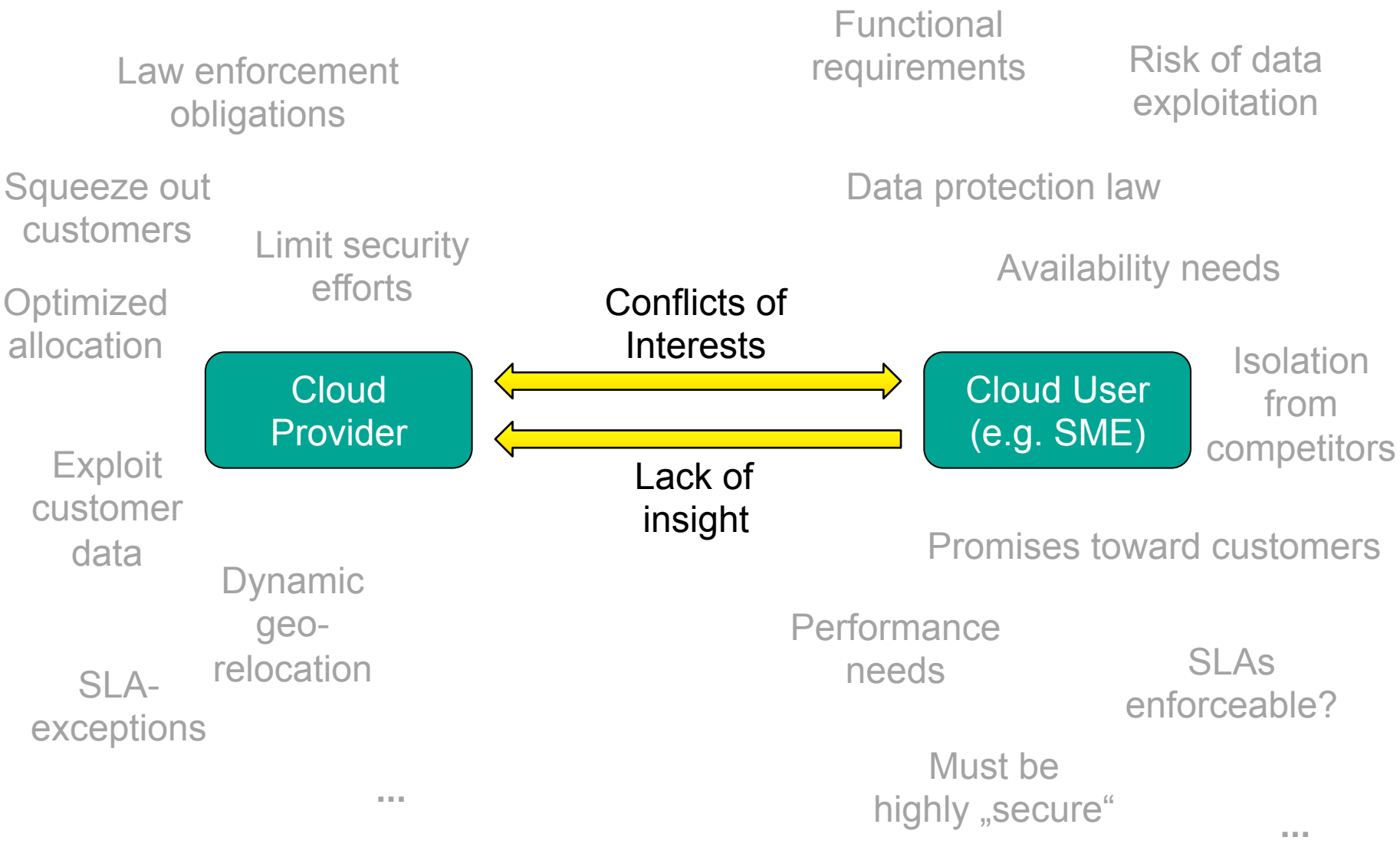

Functional requirements
Risk of data exploitation
Law enforcement obligations
Squeeze out customers
Data protection law
Limit security efforts
Availability needs
Optimized allocation
Conflicts of Interests
Cloud Provider
Cloud User (e.g. SME)
Isolation from competitors
Exploit customer data
Lack of insight
Promises toward customers
Dynamic geo-relocation
Performance needs
SLAs enforceable?
SLA-exceptions
...
Must be highly „secure“
...

Agency Theory

Agency Theory

Two parties: Principal and agent

Both are „opportunistic utility maximizers“
→ Primarily serve own individual goals

Agency Theory

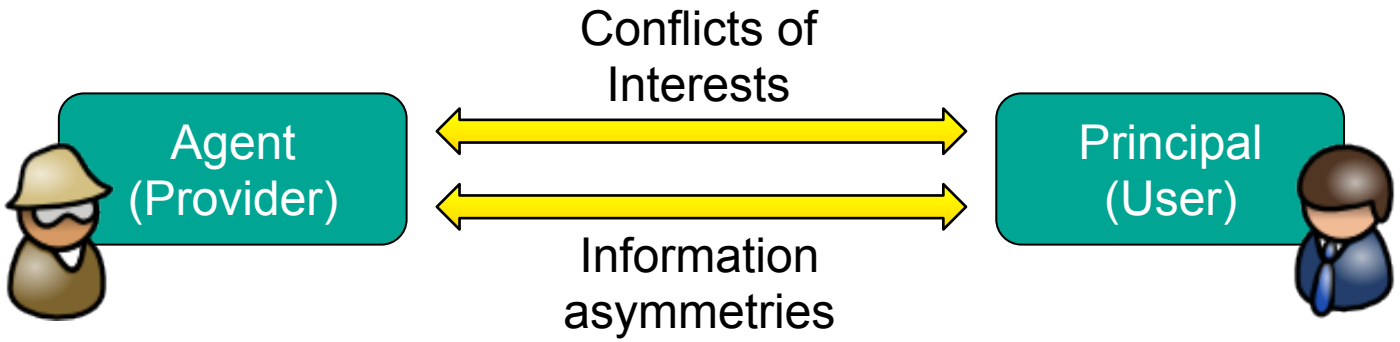
Karlsruher Institut für Technologie

The „principal engages the agent to **perform some service on** his **behalf**, and to facilitate the achievement of the activity, he **delegates** some **decision-making authority** to the agent"

Information is „asymmetric in the sense that
(1) the **agent's action** is **not** directly **observable** by the principal [...] or
(2) the **agent** has **made some observation** that the principal has not made"

Furubotn/Richter (2005, p. 162)

Cloud Computing as Agency Relation



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Agency Theory

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Three main challanges in agency relations:

Adverse Selection

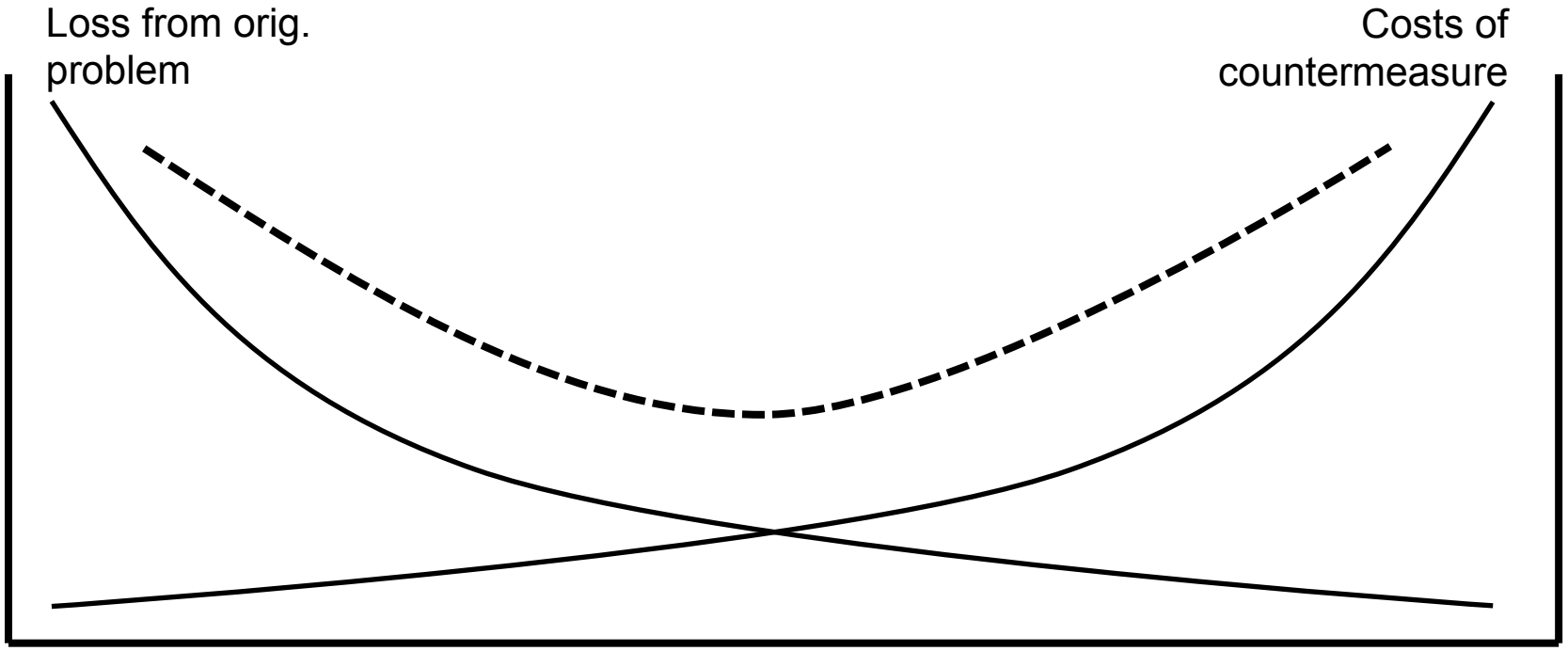
Moral Hazard

Hold-Up

Agency Theory

Second-order problem:

Optimizing achieved loss reductions against newly incurred cost



Agency Theory

Karlsruher Institut für Technologie

Three main challanges in agency relations:

Adverse Selection

Moral Hazard

Hold-Up

Adverse Selection

General Problem:

- Principal must choose appropriate agent
- Principal does not know the quality of a single agent
  - Assumes „medium quality“ for each agent
  - Medium „willingness to pay“

- Downward spiral for quality and prices → „Lemons market“ (Akerlof 1970)

General Approaches:

- Screening (inspections, assessment centers in job market)
- Signalling (certificates, university degrees, ...)
  → Signals **must** be less expensive to emit for „high quality“ agents
- Self-Selection (insurance contracts → Agent reveals priv. knowledge)

Images: http://www.theguardian.com/education/2011/oct/24/cribsheet-which-university

Adverse Selection in Cloud Computing

How do you evaluate the „quality“

(e.g. security / reliability / ... capabilities)

of a given cloud provider?

Screening in Cloud Computing

E.g. CloudHarmony

Cloudhelix VMWare Cloud Hosting	london	99.9971%	1.23 mins
BlueLock vCloud	indianapolis	99.9971%	1.27 mins
GoGrid	us-west-1	99.9971%	1.27 mins
Blue Box VPS	seattle	99.9968%	1.37 mins
Amazon EC2	ap-southeast-2	99.9968%	1.38 mins
Hosting.com	san-francisco	99.9967%	1.42 mins

Service	Location	Time (secs)	# of Samples	Min ms	Max ms	Std Dev	Median ms	Avg ms
CloudSigma	ZRH	0.85	5	116	122	2.2%	119	118.6
Joyent Cloud	us-east-1	1.06	4	207	214	1.4%	210	210
Amazon S3	eu-west-1	0.43	7	44	49	3.85%	47	46.71
City Cloud	london	0.49	5	66	69	1.62%	68	67.8
Flexiscale	london	0.56	6	69	71	1.08%	70	69.83
Microsoft Azure Virtual Machines	eu-north	0.64	6	77	81	2.06%	80	79.33

→ Can be valuable for certain, easily measurable quality properties (e.g. **abilities** to provide high performance / availability)

→ Hardly efficient (screening effort vs. contract volume) for others (e.g. security-related **abilities**)

Images: http://www.theglobeandmail.com/technology/a-look-inside-the-mind-of-google/article15115146/

Signalling in Cloud Computing

„ISO 27001:2013 certified“

→ Can efficiently provide choice support if sufficiently expensive to achieve for qualitatively bad providers („lemons“)

→ Does, however, **say nothing about actual provider conduct**, only about provider capabilities!

Images: http://eurocloud-staraudit.eu/, https://www.signamus.com, http://www.heg.com

Self-Selection in Cloud Computing

„Offer several contract options to the agent,
stimulating the agent to reveal knowledge about own capabilities“

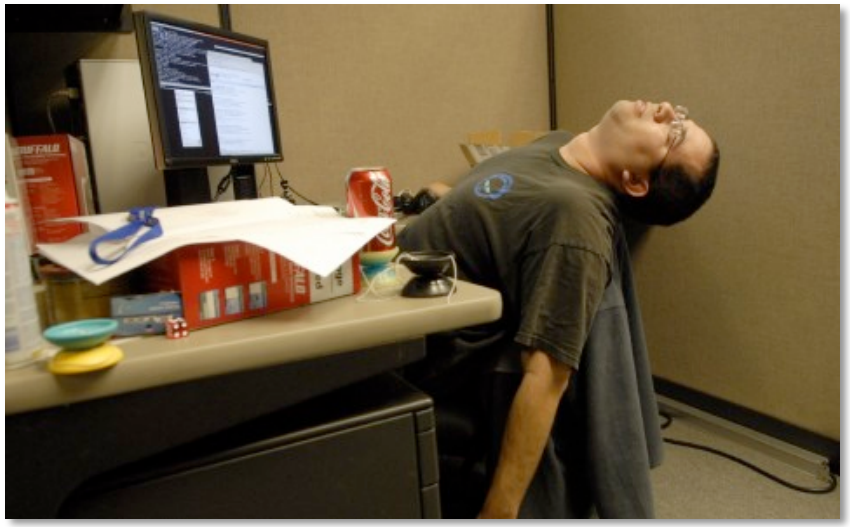
a) Base price: X€, malus for outage / data brach: Y€
b) Base price: >X€, malus for outage / data breach: >Y€

→ „Good“ Providers will choose b) – „bad“ ones a)
→ No established scheme yet
(But requires bargaining power for P and measurability)

Moral Hazard

General Problem:

- Principal is not aware of agent‘s actual effort
- Agent is aware of information asymmetries
  → incentive to make low effort
- Principal can only evaluate agent based on observable outcome
- Agent will attribute good outcomes to own efforts, poor ones to adverse situational givens



Images: http://www.germanpulse.com/2012/04/11/retiring-german-state-employee-admits-to-doing-nothing-for-14-years/

General Approaches:

- Monitoring (behavior **and** external conditions → reduces inform. asym.)
- Bonding (guarantees, deposits → discourages „cheating“)

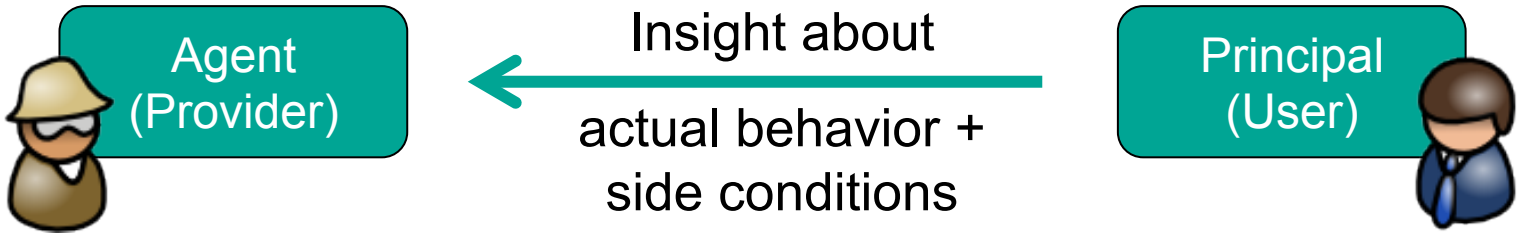
Moral Hazard in Cloud Computing

How do you ensure that the provider acts in your interest

(e.g. promtly installs security patches / adheres to country constraints / does not exploit data / spends effort on availability / ...)

instead of „cheating“ for own profit maximization?

Monitoring in Cloud Computing

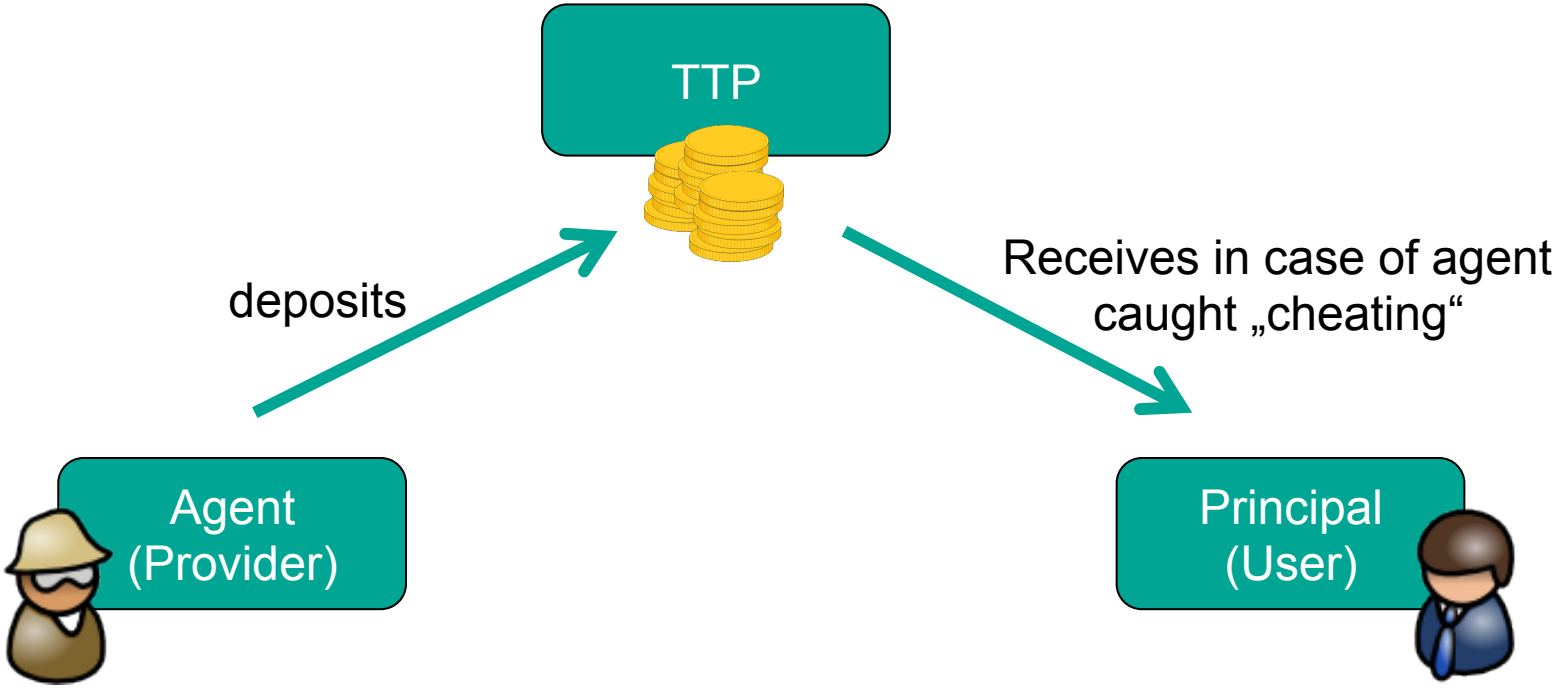


→ „Random auditing“:
hardly efficient in cloud context

→ „Trustworthy event logging“ / „provision of digital evidence“:
highly promising (esp. if including external conditions)

→ **Fundamental conflict** with paradigm of maximum **opacity**

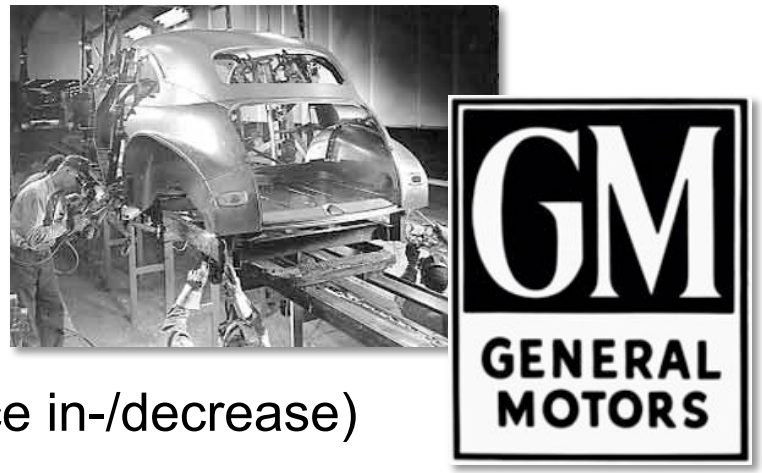
Bonding in Cloud Computing



→ Scheme not established yet

→ Requires sufficient probability of shirking to be recognized (→ Monitoring)

Hold-Up



General Problem:

- One party (P or A) has to make specific investments
- Once investment is done, investing party is „locked in“
- Other party can exploit (e.g. through price in-/decrease)

General Approaches:

- Long-term contracts (anticipation → need to be sufficiently complete)
- Ensure availability of multiple, substitutable counterparties (avoid lock-in → costs for multiple specific investments)
- Non-contractual long-term relations (mutual trust, reputation, anticipated future rewards)
- Vertical integration (merge P+A → abandon benefits from delegation)

Images: http://buchholtzsidoramericanstudies.wikispaces.com , http://theoldmotor.com/?tag=fisher-body-co

Hold-Up in Cloud Computing

How do you ensure that the provider does / will not exploit you

(e.g. increases prices / does not reduce prices / ...)

once you are „locked“ into his services / platform?

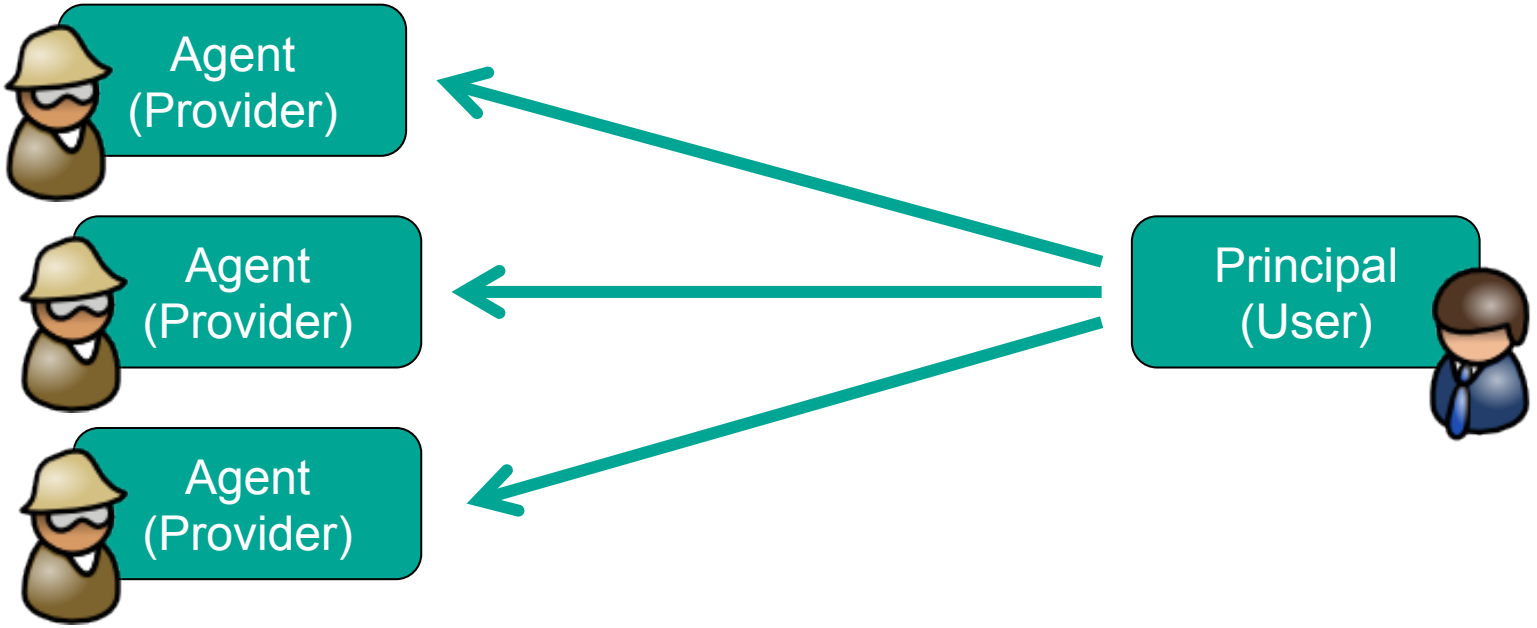
Long-Term Contracts in Cloud Computing

Ex-ante agreements on periodic future price reductions / performance increases?

→ Questionable with regard to other potential dimensions of hold-up (service quality, ... → completeness of contracts)

→ Conflict with concept of ad-hoc self-provisioning?

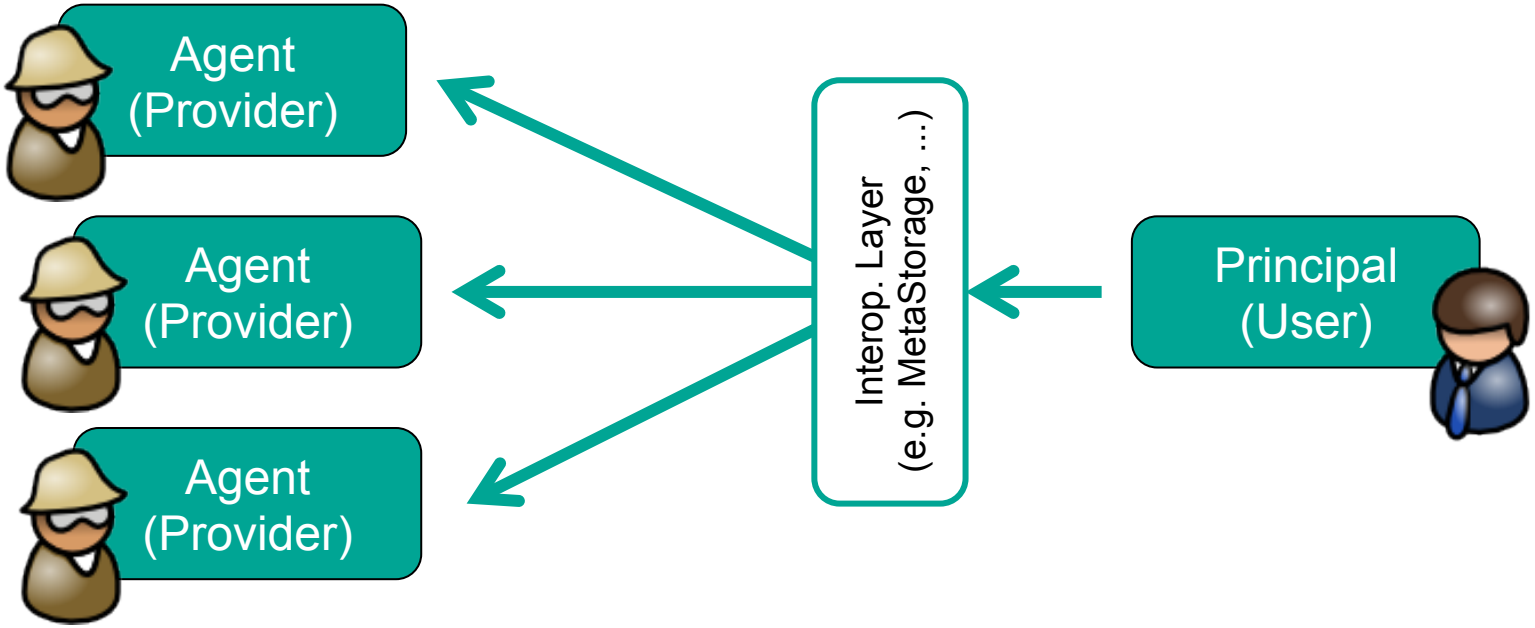
Multiple Counterparties in Cloud Computing



→ Multiple effort of adoption to specifics of several cloud providers
(e.g. Amazon RedShift + xyz + abc)

Images: http://eurocloud-staraudit.eu/, https://www.signamus.com, http://www.heg.com

Multiple Counterparties in Cloud Computing



→ Efficiently realizable for lower-level services, esp. IaaS („Cloud Federation“)

→ Increasingly inefficient with increasing service specifity (PaaS, SaaS)

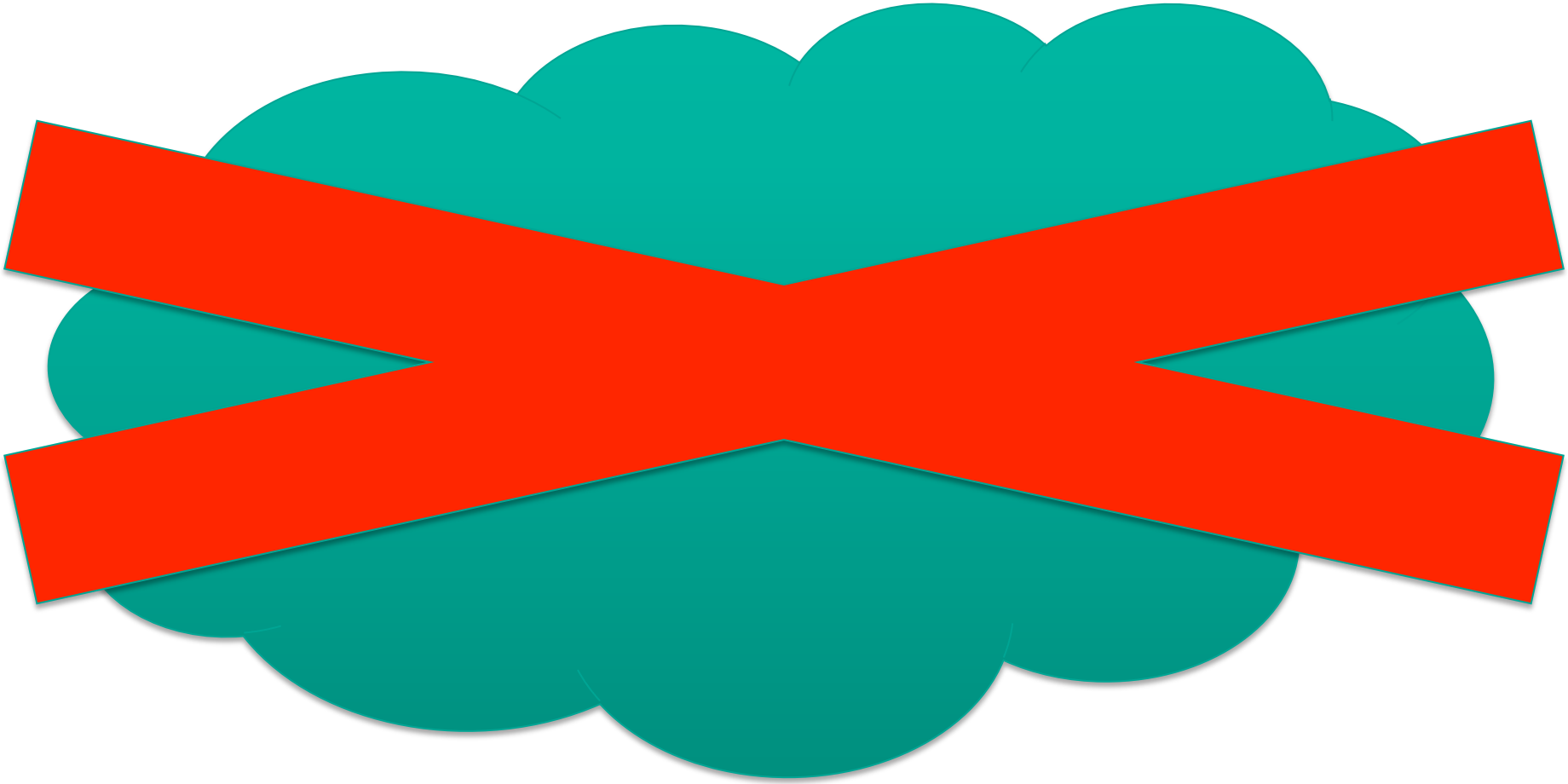
Images: http://eurocloud-staraudit.eu/, https://www.signamus.com, http://www.heg.com

Non-Contractual Long-Term Relations in Cloud Computing

Trust, reputation, anticipated future rewards?

Images: http://ecx.images-amazon.com/images/I/41PFKRsyHbL._SL500_AA300_.png

Vertical Integration in Cloud Computing



Given the clear agency-relationship and the current status quo of existing countermeasures,

it seems highly rational

for many potential users not to employ cloud computing.

Measures Suggested by PA-Theory

- Audit certificates as credible signals, **not as statements about actual conduct**
- Novel **contract schemes** (self-selection, bonding, long-term)
- ~~Self-conducted on-site audits~~
- Role of **trust mechanisms** for current usages of cloud computing **needs further examination**
- Technical mechanisms for achieving **interchangeability** of providers
- Technologies for providing **credible information** about actual **conduct** and **external conditions** („trustworthy event logging“ / „digital evidence“)
- **Policy** Implications?

Roundup

The relation between **cloud provider and cloud user** is clearly shaped by **conflicts of interests** and **information asymmetries**.

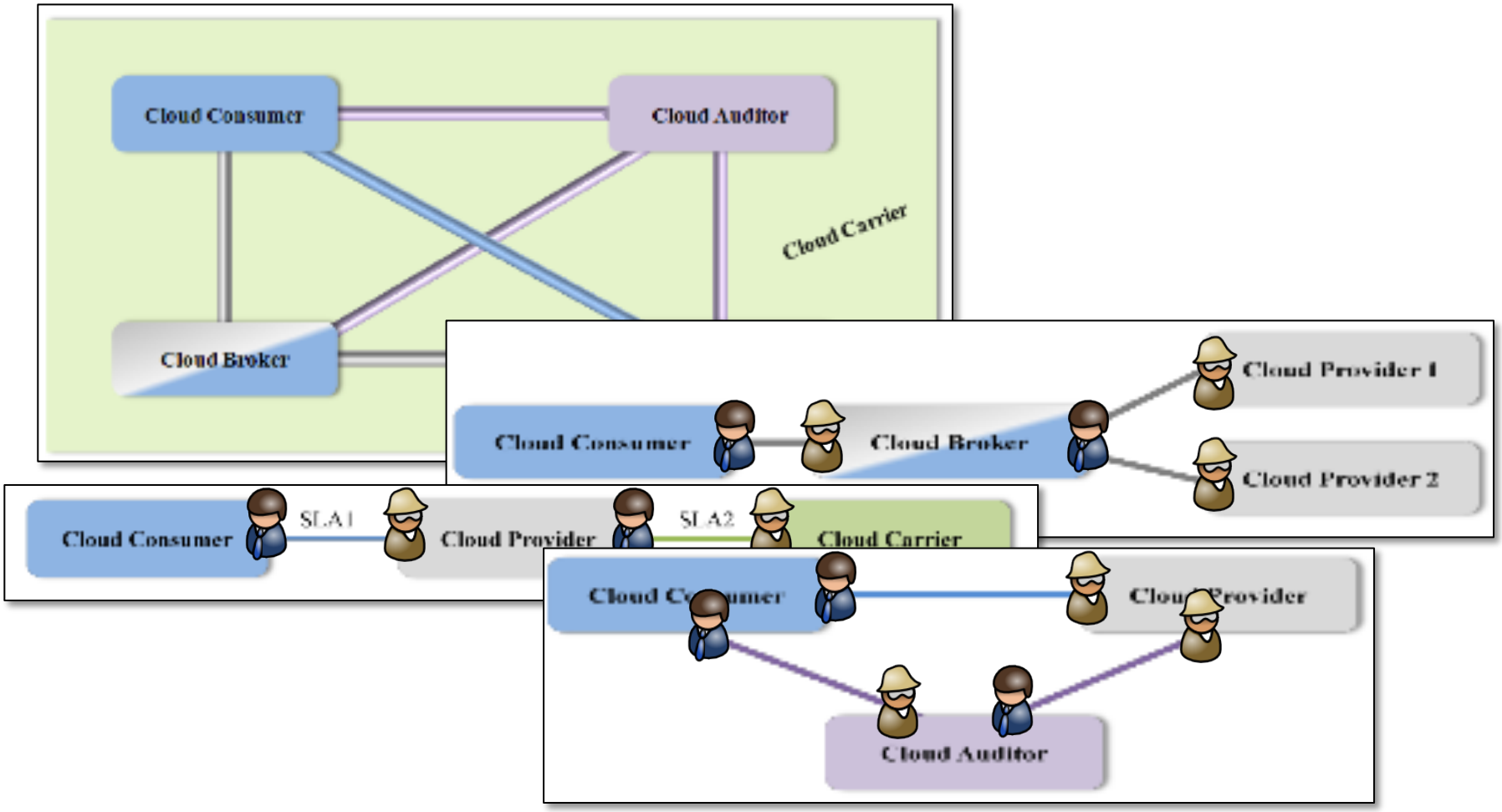
It can therefore be interpreted as **principal-agent** relation.

This allows for a better, **theory-founded understanding** of the factors currently hampering broader cloud adoption, ...

... helps **discussing** commonly suggested **measures** (e.g. certifications, ...) and **forecasting their viability**, ...

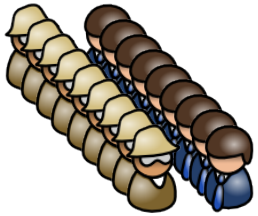
... and, finally, fosters the **identification** of auspicious starting points for developing **novel instruments** as suggested by economic theory.

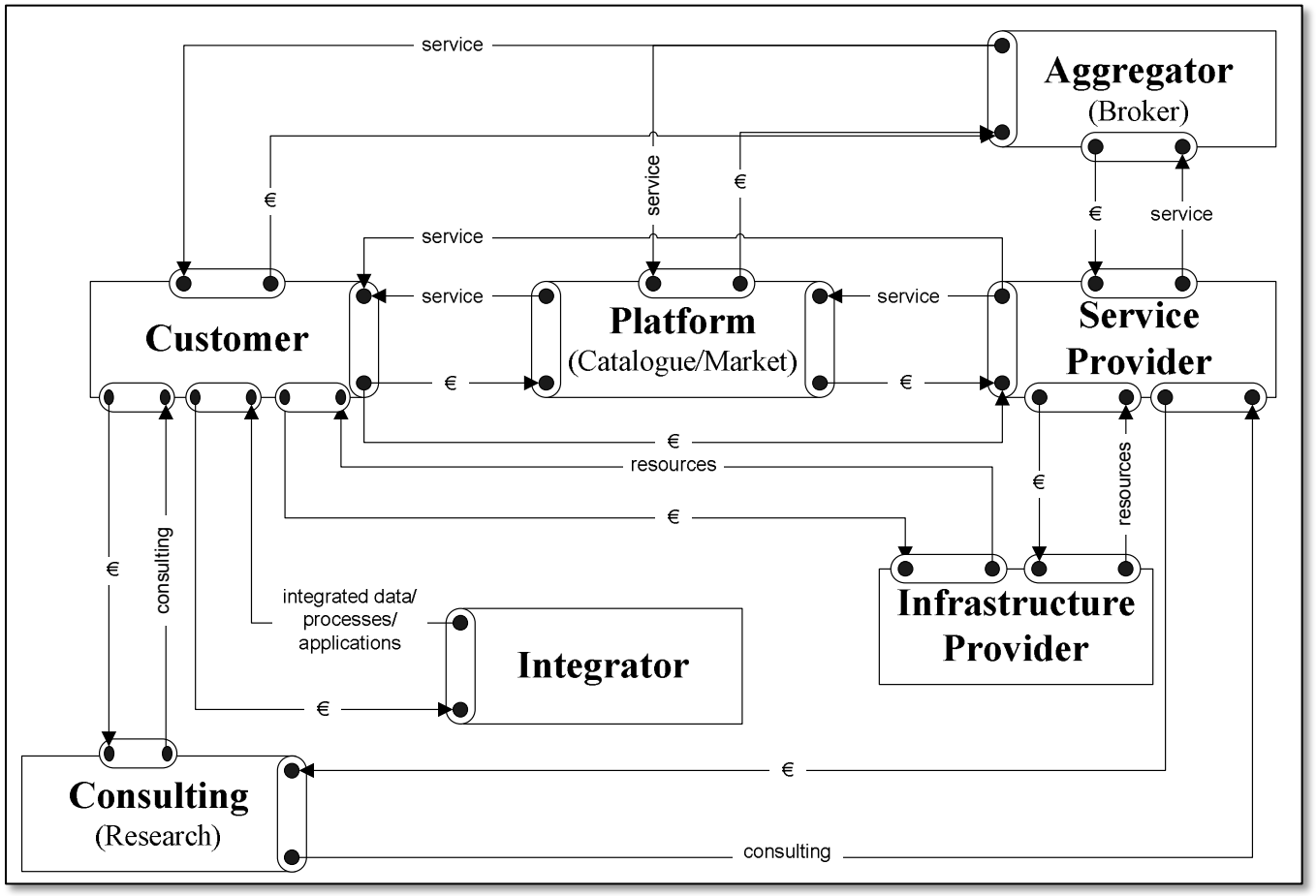
Outlook



NIST Cloud Computing Reference Architecture

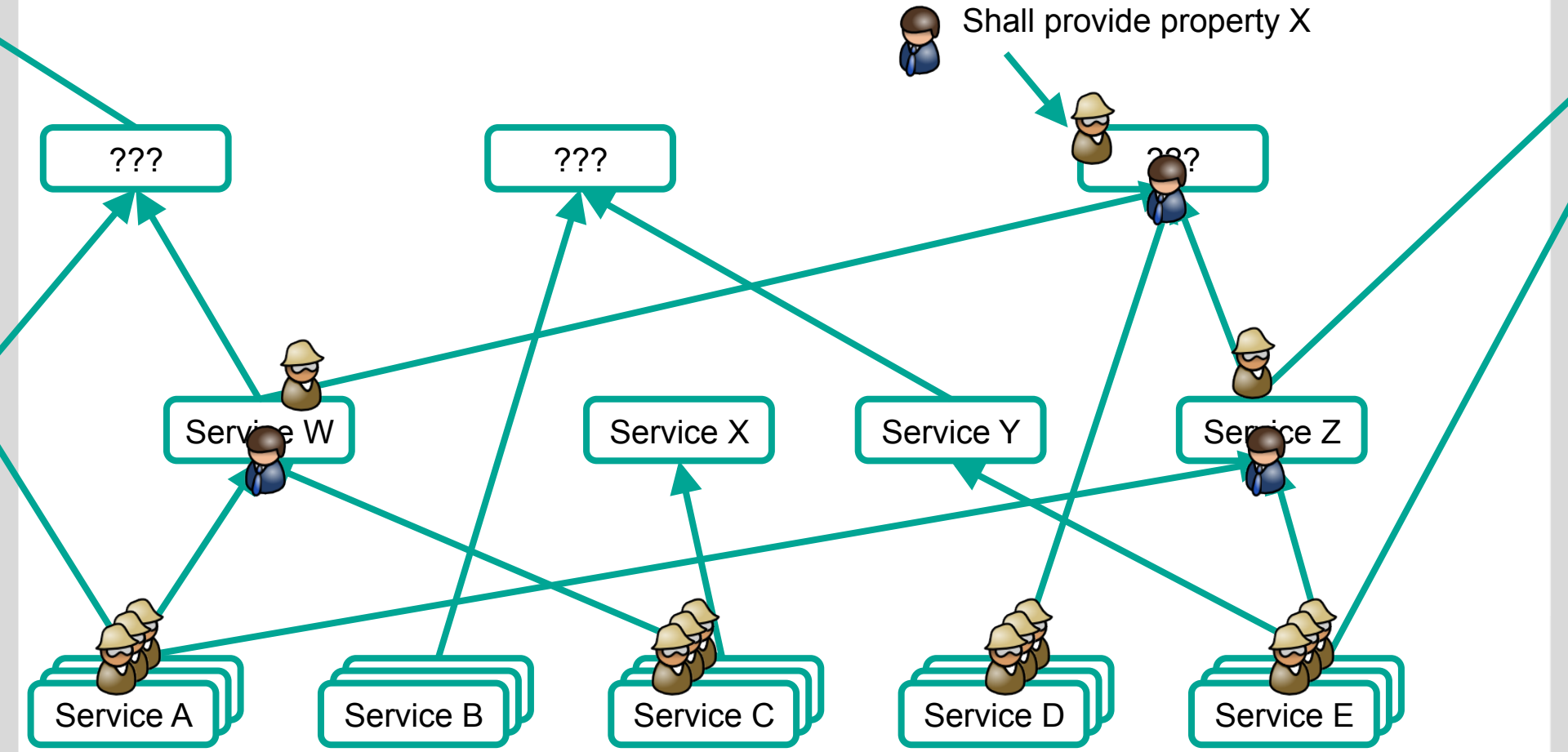
Outlook





Leimeister ea: The Business Perspective of Cloud Computing

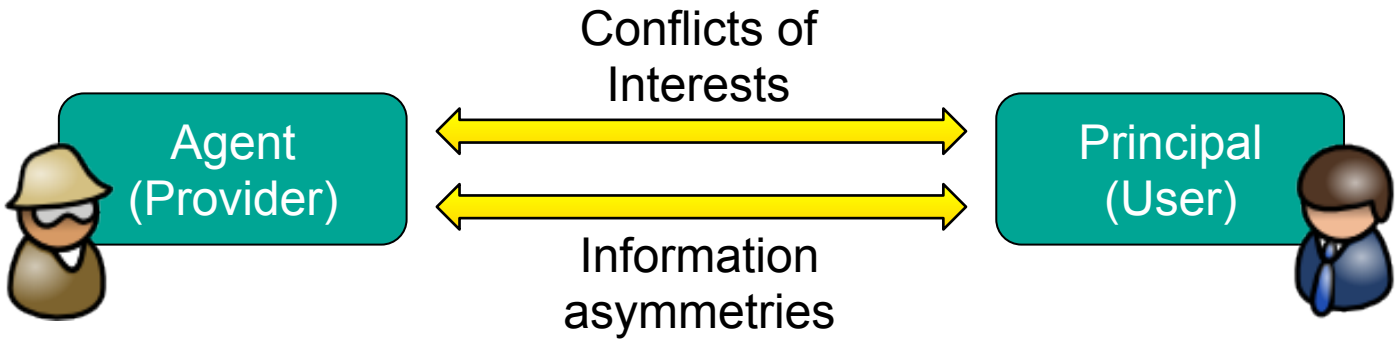
Outlook


Shall provide property X
???
???
???
Service W
Service X
Service Y
Service Z
Service A
Service B
Service C
Service D
Service E

Roundup

Agency theory as theoretical basis for analyzing relations between different stakeholders in cloud and service scenarios

Roundup


Conflicts of Interests
Agent (Provider)
Principal (User)
Information asymmetries

Roundup

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Contact

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Karlsruhe Institute of Technology and
FZI Research Center Informatics

frank.pallas@kit.edu
http://compliance.zar.kit.edu

SECCRIT

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