The Business - IT Alignment Challenge

Seminar Topics

Roland Schütze
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1. Enablers and Inhibitors of Business-IT Alignment
2. Fuzzy based Service Level Management: Challenges and Opportunities for IT Service Providers
3. Design of a Fuzzy System for Coupling Detection
4. Analysis of Business Impacts – Implementing a system with graph database
5. Towards Customer Oriented IT Service Level Agreements applying Fuzzy Concepts
6. Design of a Recommender System for Service Levels
7. Fuzzy Recommendation on Cloud Bursting
Business Service Management (BSM)

BSM links the availability and performance status of IT infrastructure components to business-oriented IT services that enable business processes.
The old answer

- Measure and benchmark every SLA, KPI, data point, and throughput to show systems work (most of the time)
The better answer

- Measure what makes sense, that is, what impacts the bottom line.
  - Revenues
  - Margins
  - Profits

- Identify opportunities to increase each factor
  - Revenues
  - Margins
  - Profits
Evolvement of SLA‘s

• The early SLAs were IT-centric, written in IT technical terms, and predominantly provided the IT user with service levels that had more to do with internal IT performance measurements than with business-oriented service achievement. Frequently metrics were inappropriate, measurements imprecise and monitoring weak. The SLA reports simply did not reflect the experience of the customer when using the service.

• SLAs are now becoming increasingly business-focused and measured in real-time. SLAs are more seen as a strategic tool to align IT support services directly to business mission achievement. Now, the more mature organization writes business-centric SLAs and has sophisticated performance measurement tools that accurately reflect the customer's or service user's actual experience.

• Service Level Agreements (SLAs) related to customer satisfaction or other front end measures (response time, wait time, correctness, etc.) of the composed service are often used to manage delivery contracts and have revenue impacts for service providers.
Business-IT alignment is a dynamic state in which a business organization is able to use information technology (IT) effectively to achieve business objectives - typically improved financial performance or marketplace competitiveness. Some definitions focus more on outcomes (the ability of IT to produce business value) than means (the harmony between IT and business decision-makers within the organizations);

for example, *alignment is the capacity to demonstrate a positive relationship between information technologies and the accepted financial measures of performance.*\(^[1]\)

This alignment is in contrast to what is often experienced in organizations: IT and business professionals unable to bridge the gap between themselves because of differences in objectives, culture, and incentives and a mutual ignorance for the other group's body of knowledge.

This rift generally results in expensive IT systems that do not provide adequate return on investment. For this reason, the search for Business / IT Alignment is closely associated with attempts to improve the business value of IT investments.
A Fuzzy cognitive map is a cognitive map within which the relations between the elements (e.g. components, IT resources) can be used to compute the "strength of impact" of these elements.

So the value $A_i$ for each quality indicator $KQI_i$ can be calculated by the following rule:

$$A_i = f \left( \sum_{j=1, j \neq i}^{n} A_j W_{ji} \right) + A_i^{old}$$

where $A_i$ is the activation level of quality parameter $KQI_i$ at time $t+1$, $A_j$ is the activation level of quality parameter $KQI_j$ at time $t$, $A_i^{old}$ is the activation level of quality parameter $KQI_i$ at time $t$, and $W_{ji}$ is the weight of the dependence coupling between $KQI_j$ and $KQI_i$, and $f$ is a threshold function.

The weights of the dependencies between the KQI$ _i$ and KQI$ _j$ could be positive ( $W_{ji}>0$ ) which means that an increase in the value of KQI$ _i$ leads to the increase of the value of KQI$ _j$, and a decrease in the value of KQI$ _i$ leads to the decrease of the value of KQI$ _j$. Or there is negative causality ( $W_{ji}<0$ ) which means that an increase in the value of KQI$ _i$ leads to the decrease of the value of KQI$ _j$ and vice versa.
What are the Enablers and Inhibitors of Business-IT Alignment and

- How can we map the influence and importance of each to a degree between 0 and 1?
- How can we do a graphical representation of the dependencies and assign the weights for impacts?
- Proposed is a Representation as a Fuzzy Cognitive Map where the QoS are shown as quality concepts having an activation status and a defined impact to other quality concepts.
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Topic 2: Fuzzy based Service Level Management: Challenges and Opportunities for IT Service Providers

- Service Quality Evaluation
- Fuzzy Root Cause analysis
- Fuzzy Clustering
- Fuzzy Web Service Matching for QoS
- User Experience
- Etc.

How can Fuzzy based Service Management be in-cooperated within ITIL v3 Best Practices.

There are several areas in the ITIL v3 Service Lifecycle Modules where dependency and impact analysis or similar reliability engineering techniques are used. Those techniques are mainly applied in ITIL v3 within Service Design, Service Operation and Continual Service Improvement. In the following chapters the four in ITIL v3 referred methods and tools, Configuration Management Database (CMDB), Fault Tree Analysis (FTA), Component Failure Impact Analysis (CFIA) and Business Impact Analysis (BIA) will be discussed in detail, as these will be the basis for the proposed framework in this project work.
Failure and Impact Analysis in ITIL v3 Service Lifecycle Modules

- **ITIL Configuration Management Database (CMDB)** (Service Transition) A database used to store Configuration Records throughout their Lifecycle. The Configuration Management System maintains one or more CMDBs, which is populated by auto-discovery tools and each CMDB stores Attributes of ConfigurationItems (CIs), and Relationships with other CIs.

- **ITIL Failure Analysis (SFA)** (Service Design) An Activity that identifies underlying causes of one or more IT Service interruptions. SFA identifies opportunities to improve the IT Service Provider’s Processes and tools, and not just the IT Infrastructure.

- **ITIL Root Cause Analysis (RCA)** (Service Operation) An activity that identifies the root cause of an incident or problem. RCA typically concentrates on IT infrastructure failures.

- **ITIL Pain Value Analysis (PVA)** (Service Operation) An activity used to help identify the Business Impact of one or more Problems. A formula may be defined to calculate Pain Value based on the number of Users affected, the duration of the Downtime, the Impact on each User, and the cost to the Business.

- **ITIL Business Impact Analysis (BIA)** (Service Strategy) BIA is the Activity in Business Continuity Management that identifies Vital Business Functions and their dependencies. These dependencies may include Suppliers, people, other Business Processes, IT Services etc. BIA defines requirements which include Recovery Time Objectives, Recovery Point Objectives and minimum Service Level Targets for each IT Service.

- **ITIL Component Failure Impact Analysis (CFIA)** (Service Design) A technique that helps to identify the impact of CI failure on IT Services. A matrix is created with IT Services on one edge and CIs on the other. This enables the identification of critical CIs (that could cause the failure of multiple IT Services) and of fragile IT Services (that have multiple Single Points of Failure).

- **ITIL Fault Tree Analysis (FTA)** (Continual Service Improvement) A technique that can be used to determine the chain of Events that leads to a Problem. Fault Tree Analysis represents a chain of Events using Boolean notation in a diagram.

- **ITIL Component Failure Impact Analysis (CFIA)** (Service Design) A technique that helps to identify the impact of CI failure on IT Services. A matrix is created with IT Services on one edge and CIs on the other. This enables the identification of critical CIs (that could cause the failure of multiple IT Services) and of fragile IT Services (that have multiple Single Points of Failure).

- **ITIL Failure Modes and Effects Analysis (FMEA)** This proactive troubleshooting method can be part of a CFIA and allows the engineer to consider how the failure modes of each system component can result in system performance problems and to ensure that appropriate safeguards against such problems are put in place.

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ITIL v3 Best Practices: CMDB auto-discovery

The automated discovery engine of a CMDB to retrieve attributes of Configuration Items (CIs), and relationships with other CIs is handled by tools called Application Dependency Discovery Manager.

EMA Radar Map for ADDM
[Craig, EMA ADDM Radar Dec 10]
ITIL v3 Best Practices: Fault Tree Analysis (FTA)
ITIL v3 Best Practices: Component Failure Impact Analysis (CFIA)

Example of basic CFIA Matrix

CFIA Worksheet with Failure Modes [Bailey et al. IBM Systems Journal VOL 47, NO 4, 2008]
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Topic 3: Design of a Fuzzy System for Coupling Detection

Dependence Coupling
is a measure that we propose to capture how dependent the component or service is on other services or resources for its delivery.

In general the goal is to build components that do not have tight dependencies on each other, so that if one component were to die (fail), sleep (not respond) or remain busy (slow to respond) for some reason, the other components in the system are built so as to continue to work as if no failure is happening. Loose coupling describes an approach where integration interfaces are developed with minimum assumptions between the sending/receiving parties, thus reducing the risk that change in one application or module will effect to other applications or modules. Loose coupling isolates the components of an application so that each component interacts asynchronously with the others and treats them as a “black box”. E.g. in the case of web application architecture, the app server can be isolated from the web server and from the database.
approach for loosely coupled services
Topic 3: Design of a Fuzzy System for Coupling Detection

where the
• level of coupling between components corresponds
to the intuitionistic fuzzy degrees of truth
• and the resilience maps to the intuitionistic fuzzy
degrees of falsity
of an impact

Dependence Coupling
is a measure that we propose to capture how dependent the component or service is on
other services or resources for its delivery.

In an initial assessment the type of relationship between two components should indicate the principle
measurement which can be applied to specify the level of coupling. When the dependency is between a
service and some resource it uses, coupling will essentially be a function of how often the resource is used.
For instance, the dependence of a service on the network layer might be measured by how often it is making
a socket call, or how much data it is transferring. The dependence of a database on compute partition will be
determined by how much compute resources it needs from that partition. For web-services we can examine
an environmental coupling which is caused by calling and being called by other services.
Formula in Software Engineering due to Dhama:

Service Coupling

\[ C(x,y) = \frac{1}{i + u + g + r} \]

- \( i \) = in data parameters – data sent from calling service \( x \) to called service \( y \)
- \( u \) = out data parameters – data sent from called service \( y \) to calling service \( x \)
- \( g \) = number of global variables
- \( r \) = number of times \( x \) calls \( y \)

The lower this measure, the more tightly coupled the two services are.
Resiliency Assessment via a Maturity Index

Organizational resilience is an orthogonal entity that cuts across all layers.
## Loosely Coupling Measurements in CFIA Grid

### Example extended CFIA Grid with coupling

| Component       | Discovered Node id | Parent Node id's | % Availability | MTTR (hours) | Mean Time Between Failures (MTBF) (hours) | Failover Method | Procedures (Y/N) | Tasted (Y/N) | Recovery Procedure | Procedures (Y/N) | Recovery Time (hours) | Integrally Integrated | Single Point Failure (SPF) | Failure Mode and Effect | Loosely Coupling Index (resilience) | Certainty TC-vary High, Low | Certainty TC-vary High, Low | Certainty TC-vary High, Low | RTO 2 hours | RTO 12 hours | RTO 12 hours | RTO 12 hours |
|-----------------|---------------------|------------------|----------------|-------------|------------------------------------------|----------------|------------------|--------------|-------------------|------------------|------------------------|------------------------|----------------------------|------------------------|------------------------|------------------------|-----------------|---------------|---------------|---------------|
| Switch A        | S-01                | BusServ          | 99.99          | 24          | 10.000                                   | N              | N                | Y            | Y                 | Y                | N                     | Outage                  | 0.75                      | VH                      | 0.30                    | H              |               |               |               |
| Firewall A      | F-01                | S-01             | 98.85          | 24          | 10.000                                   | Y              | Y                | N            | N                 | N                | N                     | Outage                  | 0.88                      | VH                      | 0.90                    | H              |               |               |               |
| Firewall B      | F-02                | S-01             | 98.85          | 24          | 10.000                                   | Y              | Y                | N            | N                 | N                | Y                     | Outage                  | 0.88                      | VH                      | 0.90                    | H              |               |               |               |
| Load-Balancer A1 | L-01               | F-01,F02        | 98.50          | 24          | 10.000                                   | Y              | Y                | N            | N                 | N                | Y                     | Outage                  | 0.88                      | M                       | 0.78                    | M              |               |               |               |
| Load-Balancer A1 | L-01               | F-01,F02        | 98.50          | 24          | 10.000                                   | Y              | Y                | N            | N                 | N                | Y                     | Outage                  | 0.88                      | M                       | 0.78                    | M              |               |               |               |
| Load-Balancer A2 | L-02               | F-01,F02        | 98.50          | 24          | 10.000                                   | Y              | Y                | N            | N                 | N                | Y                     | Outage                  | 0.88                      | H                       | 0.88                    | H              |               |               |               |
| HTTP Server A   | HS-01               | L-01,L02        | 98.10          | 43          | 5.000                                    | Y              | Y                | N            | N                 | N                | Y                     | Outage                  | 0.76                      | VH                      | 0.76                    | H              |               |               |               |
| HTTP Server B   | HS-02               | L-01,L02        | 98.10          | 43          | 5.000                                    | Y              | Y                | N            | N                 | N                | Y                     | Outage                  | 0.76                      | VH                      | 0.76                    | H              |               |               |               |
| Firewall C      | F-03                | HS-01,HS-02     | 98.85          | 24          | 10.000                                   | Y              | Y                | N            | N                 | N                | Y                     | Outage                  | 0.75                      | VH                      | 0.45                    | M              |               |               |               |
| Firewall D      | F-04                | HS-01,HS-02     | 98.85          | 24          | 10.000                                   | Y              | Y                | N            | N                 | N                | Y                     | Outage                  | 0.76                      | VH                      | 0.76                    | H              |               |               |               |
| Application Server A | AS-01         | F-03,F04       | 98.20          | 12          | 2.000                                    | Y              | Y                | N            | N                 | N                | Y                     | Outage                  | 0.82                      | M                       | 0.82                    | M              |               |               |               |
| Application Server B | AS-02         | F-03,F04       | 98.20          | 12          | 2.000                                    | Y              | Y                | N            | N                 | N                | Y                     | Outage                  | 0.82                      | M                       | 0.82                    | M              |               |               |               |
| Content Server C | CS-03              | AS-01,AS-02     | 98.10          | 43          | 5.000                                    | N              | N                | Y            | Y                 | Y                | N                     | Slow Response           | 0.68                      | H                       | 0.30                    | H              |               |               |               |
| Directory Server | DIS-01             | AS-01,AS-02     | 98.30          | 12          | 2.000                                    | Y              | Y                | N            | N                 | Y                | Y                     | Outage                  | 0.35                      | M                       | 0.75                    | M              |               |               |               |
| Ext. Data Feed Server | ES-01           | AS-01,AS-02     | 88.70          | 43          | 5.000                                    | N              | N                | Y            | Y                 | Y                | N                     | Limited Function         | 0.48                      | M                       | 0.67                    | VL             |               |               |               |
| Monitoring Server | MS-01              | HS-01,HS-02     | 99.30          | 48          | 5.000                                    | N              | N                | Y            | Y                 | Y                | N                     | none (no monitoring)    | 0.65                      | M                       | 0.20                    | M              |               |               |               |
| Database Server A | DS-01              | AS-01,AS-02     | 95.50          | 12          | 10.000                                   | Y              | Y                | N            | N                 | N                | Y                     | Limited Function         | 0.57                      | L                       | 0.67                    | L              |               |               |               |
| Database Server B | DS-02              | AS-01,AS-02     | 95.50          | 12          | 10.000                                   | Y              | Y                | N            | N                 | N                | Y                     | Limited Function         | 0.57                      | L                       | 0.30                    | L              |               |               |               |
| SAN              | SAN-01             | DS-01,DS-02     | 98.85          | 24          | 50.000                                   | N              | N                | N            | N                 | N                | Y                     | Outage                  | 0.69                      | H                       | 0.89                    | H              |               |               |               |
Topic 3: Design of a Fuzzy System for Coupling Detection
(3a) Tightly Coupling, (3b) Loosely Coupling

Automated detection of couplings and dependencies

Passino, K., Yurkovich, S.: FUZZY CONTROL. Addison-Wesley, Reading (1998)
Topic 3: Design of a Fuzzy System for Coupling Detection

The fuzzy system is based on the transformation of our knowledge into a set of fuzzy rules. Input and output of the fuzzy system are expressed by the linguistic values of the fuzzy variables of the system. A fuzzy system is composed of the following four elements:

- A fuzzification interface, which converts the inputs into fuzzy information that the inference mechanism can easily use to activate and apply rules.
- A rule base (a set of If-Then rules), which contains a fuzzy logic quantification of the linguistic description of our knowledge.
- An inference mechanism which emulates the expert’s decision making in interpreting and applying knowledge about how to compute the correct output.
- A defuzzification interface, which converts the conclusions of the inference mechanism into numerical output.
Topic 3: Design of a Fuzzy System for Coupling Detection

- Each input and output of the system is described by linguistic values and their membership functions. Linguistic values are terms, such as LOW, HIGH, MEDIUM, that intuitively describe the fuzzy input/output parameters. Membership functions of a linguistic value describe the degree of certainty of the numeric value of an input or output to be classified under the specific linguistic value. Typical membership functions can be triangular, but can also have different shapes, like Gaussian or trapezoid.

- One interesting property of membership functions is that a numerical input can be converted into two linguistic values simultaneously. This feature is appropriate for modelling quantitative attributes that do not use hard boundary intervals like time and confidence variables.


- The difference between the start timestamps of two event of a event pair, \( dt = ts_2 - ts_1 \).
- The confidence variable \( c_1(f_1, f_2) \) of an event pair (If a specific event pair occurs many times, then our confidence for this pair is high).
- The confidence variable \( c_2(f_1, f_2) \) of an event pair not having a correlation, which is used to separate correctly correlated from wrongly identified event pairs.
- The output of the fuzzy system is the degree of dependency for every event pair,
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Topic 4: Analysis of Business Impacts - Implementing a system with graph database

Displaying 70 nodes, 121 relationships
Calculation of Indirect Couplings based on direct Coupling Assessments

Example:
Servers connected parallel
And Servers connected in a series
For each direct relation the coupling is defined and indirect couplings can be calculated automatically

worst case impact coupling: (0.36/0.014)
moderate impact coupling: (0.18/0.06)
best case impact coupling: (0.3/0.44)
classical fuzzy coupling: (0.5/0.3)
Indirect Coupling Calculations

\[ \text{indcpl}(C_{\text{whatzit:4002}}, B_{\text{LogisticsManagement}}) = \text{indcpl}(C_{\text{whatzit:4002}}, C_{\text{hpux1:3880}}) \land \text{dircpl}(C_{\text{hpux1:3880}}, B_{\text{LogisticsManagement}}) \lor \text{indcpl}(C_{\text{whatzit:4002}}, C_{\text{cleopatra:4580}}) \land \text{dircpl}(C_{\text{cleopatra:4580}}, B_{\text{LogisticsManagement}}) \]

\[ = \text{dircpl}(C_{\text{whatzit:4002}}, C_{\text{histronix:7021}}) \land (\text{dircpl}(C_{\text{histronix:7021}}, C_{\text{hpux1:3880}}) \land \text{dircpl}(C_{\text{hpux1:3880}}, B_{\text{LogisticsManagement}})) \lor (\text{dircpl}(C_{\text{histronix:7021}}, C_{\text{cleopatra:4580}}) \land (C_{\text{cleopatra:4580}}, B_{\text{LogisticsManagement}}))) \]

Moderate impact assessment:
\[ \text{indcpl}_{\text{moderate}}(C_{\text{whatzit:4002}}, B_{\text{LogisticsManagement}}) = (0.3438, 0.4675) \]

Worst case impact assessment:
\[ \text{indcpl}_{\text{worst}}(C_{\text{whatzit:4002}}, B_{\text{LogisticsManagement}}) = (0.5500, 0.3125) \]

Best case impact assessment:
\[ \text{indcpl}_{\text{best}}(C_{\text{whatzit:4002}}, B_{\text{LogisticsManagement}}) = (0.2200, 0.6288) \]

Classical impact assessment:
\[ \text{indcpl}_{\text{classic}}(C_{\text{whatzit:4002}}, B_{\text{LogisticsManagement}}) = (0.5000, 0.4000) \]
Indirect Dependency Calculation (Star Representation)
**Topic 4: Analysis of Business Impacts - Implementing a system with graph database**

IT Enabled Services (ITeS) model which typically include a large human element. For operation of IT systems we need to know also about dependencies to e.g. IT users and roles, IT staff, IT organizational elements, business units and supporting processes and functions e.g. helpdesk or maintenance services. This can be expressed also with a logical association relationship like – is coupled to: a procedure, a Service Level Agreement or a manual, a user documentation or a support function like help desk.

Adding the Costs of Failure

\[ CCI = \sum_{i=1}^{n} \mu_A(x_i) * C_i \]

\( CCI \) denotes the hourly cost of a of the component item, \( \mu_A(x_i) \) is the degree of membership of tightly coupling to the business application \( i \) and \( C_i \) denotes the hourly cost of a failure of the business application \( i \). For instance the hourly cost of failure for the node HS-01 Http Server as it is \( \text{CHttpServer} = 0.6 \times 10.000 + 0.5 \times 3,000 = 7500 \)
Topic 4: Analysis of Business Impacts - Implementing a system with graph database

Implementation Topics

Analysis of Business Impacts - Implementing a system with graph database

Part I: User Interface

Part II: Cost of Failure

Part III: Simulation: Root Cause and Business Impact Analysis
Engineering education and process improvement actions always stress the importance of “SMART”ness of requirements.

The meaning of SMART:
- Specific
- Measurable
- Assignable (Achievable, Attainable, Action oriented, Acceptable, Agreedupon, Accountable)
- Realistic (Relevant, Result-Oriented)
- Time-related (Timely, Time-bound, Tangible, Traceable)

The original use of this acronym was by George T. Doran, in an article about management goals and objectives. Today the acronym is mostly used to stress the specificity and measurability.
The "Fuzzy" needs of the User

Fashionable
Usable:
- Easy to use
- Portable (small, light)
- Non Obtrusive
- Robust
- Attractive content

Good Performing:
- Responsive
- Crisp images
- Fluent dynamic images
- Realistic sound

Affordable (integral!)

The customer needs are often ill-defined or fuzzy. The need for specific and verifiable user requirements is obvious. The smartening process of fuzzy requirements often significantly increases the understanding of the requirements requirements, mostly due to the need to articulate everything explicit.

Example: Gerrit Muller
Embedded Systems Institute, Netherlands
Example of Fuzzy Logic for quality parameters with trapezoidal membership function

- fuzzy set A
- \( A = \{(x, \mu_A(x))| x \in X\} \) where \( \mu_A(x) \) is called the membership function for the fuzzy set A. \( X \) is referred to as the universe of discourse.
- The membership function associates each element \( x \in X \) with a value in the interval \([0,1]\).

If response time is a linguistic variable then its term set is
\( T(\text{response time}) = \{ \text{good, not good, very good, not very good, …… acceptable, sufficient, … bad, not too bad, very bad, more or less bad, not very bad, …not very good and not very bad, …}\).
Quality of Service parameter: types of membership functions

- examples: type of membership function, depending on the property of the QoS parameter:
  - \textit{QoS parameter} - \textit{should} have Gaussian waveform when missing might cause a drastic loss of the perception
  - \textit{QoS can have a} trapezoidal function when quality remains the same until we reach a threshold (that is usually referred to as the JND - Just Noticed Difference) after which the quality starts decaying.
  - \textit{Psychological measures have often best a linear triangular membership function} as they are linearly distributed based on the user.
  - \textit{User Satisfaction} is again a Gaussian membership function because of the normal distribution of human satisfaction measures.
  - \textit{Quality of perception} - This can be a simple triangular membership function when linearly distributed.

Source: A Fuzzy Logic System for Evaluating Quality of Experience of Haptic-Based Applications, 2008
A. Hamam et al, Distributed & Collaborative Virtual Environments Research Laboratory University of Ottawa, Canada
How to define QoS targets with regard to user acceptance

Possible Approach for defuzzification: After setting a triangular fuzzy number per QoS (KQI) based on responses from a questionnaire to a stakeholder we can compute crisp values against these obtained fuzzy weights with the following method:

- Place these fuzzy linguistic terms on a scale of triangular fuzzy numbers.
- Crisp intervals at a given level of confidence coefficient $\alpha$ given can be obtained. In literature, $\alpha$-cut of a fuzzy set is defined as the crisp set that contains all the elements whose membership grades are greater than or equal to the specified value of $\alpha$. Thus higher value of $\alpha$ indicates higher confidence in that parameter and implies that stakeholders are more confident about the persistence of most promising crisp value of a fuzzy number in a smaller range of crisp interval owing to higher value of $\alpha$.
- An alpha of 0.5 shows the moderate level of confidence in most promising crisp value.
- A crisp value can be computed in dependency to a degree of optimism and facilitates a stakeholder to switch from the crisp interval to a single most promising value. We can assume the same level of optimism for all stakeholders, or it can be set individually.
End-2-end method for SLA deployment

Step 1 – Questionnaire to crisp SLA attribute values

Step 2 - Requirement Categorization and Ranking
Fuzzy Rules

Step 3 - SLA and corresponding Cloud Template selection
Fuzzy Rules

Step 4 – Template Configuration
Fuzzy Rules

Step 5 – Placement and Service Activation

Service Pool with SLA template

Cloud Service selected SLA/SLO

Cloud Template Disposition and Configuration

Fuzzy Logic Algorithm

Need for new template

Placement and activation workflow

Develop new template

Goals & Constraints Service Impact Management

Assessment

Financial Information
Translating User Preferences into Fuzzy Rules for Selection of Services

a rule-based approach using the weighted non-functional requirements as input into a fuzzy inference system for the overall recommended SLA determination
Automated SLA Selection for Services

Step 1 – Questionnaire to crisp SLA attribute values

Step 2 - Requirement Categorization and Ranking

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Step 3 - SLA and corresponding Cloud Template selection

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Step 4 – Template Configuration

Fuzzy Rules

Step 5 – Placement and Service Activation

Fuzzy Logic

Service Pool with SLA template

Cloud Service selected SLA/SLO

Cloud Template

Disposition and Configuration

Fuzzy Logic Algorithm

Template

Parameter 1-m

Config

Cloud

Template n

Cloud Template

placement and activation workflow

Need for new template

develop new template

placement and service activation workflow

Step 2

Requirement Categorization and Ranking

Fuzzy Rules

Step 3

SLA and corresponding

Cloud Template selection

Fuzzy Rules

Step 4

Template Configuration

Fuzzy Rules

Step 5

Placement and Service Activation

Fuzzy Logic
An intelligent recommendation system may rank service configurations by measuring the similarity between the SLA of service configurations in the database and the requested SLAs of the target service. Then the user can adjust his needs on certain features of the recommended services, and accordingly ask the system to suggest new configuration items. In this way the user can gradually find out the best service that meets his needs.
a simple rule-based approach using the weighted non-functional requirements as input into a fuzzy inference system for the overall “User Experience” determination

- Fuzzification operation maps a crisp point into a fuzzy set. To design a representation system for fuzzy features we need a type of membership functions (e.g. triangular, trapezoidal, sigmoidal, generalized bell, Gaussian) and we have further to state, how many fuzzy sets and what kind of distribution is necessary to describe the behavior of the quality of experiences (QoE) which can be done in a 4 step approach:

1. Model Definition:
   - Requirements model
   - Requirements weight definition
2. Definition of Fuzzy Representation
   - Number of fuzzy sets
   - Shape of membership function
3. Calculation of Importance Function
   - This is a product of the requirement’s belongingness to the given set, which is a result of the defuzzification process, and the weight of the requirement contained in the importance vector
4. Inference Process based on rule knowledge
   - The associations between the non-functional requirements to a specific User Experience may be described on the basis of the conditions like:
     IF performance and security and picture quality and usability and design > 0.9 and availability > 0.7 Then Interactive Experience
Use Case : boarding process for cloud appliance

Example Scenario :
Boarding process and service activation for a Cloud Appliance :

Within a customer workflow application a business user can order a Cloud Service

1) the business user fills a questionnaire, afterwards the IT staff add the technical questions, the endusers can specify required QoE’s and last the financial input is provided.
2) afterwards we place fuzzy linguistic terms from the questionnaire on a scale of triangular fuzzy numbers and compute a crisp value per attribute (α-cut / level of confidence)
3) via Fuzzy Logic algorithm (rule based) the business and technical attributes are related to business / technical categories
4) special user requirements and cost view are applied to the categories as goals and constraints (fuzzy logic algorithm)
5) as output we have determined the required SLA/SLO targets which we can match now against the templates and decide which is the most appropriate (fuzzy distance or fuzzy rules) from existing templates in the cloud pool or whether a new template needs to be developed.
6) the chosen template is afterwards parametrized and configured. (rules)
7) last step is the placement and service activation.
Cloud bursting is a deployment model in which applications run in a private cloud or data center and "burst" into a public cloud when an organization needs more computing capacity. A cloud-burst approach is an excellent solution for organizations that have a lot of existing infrastructure but need to add support for high-traffic events.

For example, a business may have all the servers it needs to host its e-commerce website on an average day. But on "Cyber Monday," the Monday following Thanksgiving, when marketers encourage people to do holiday shopping online, the company may expect 10 times the normal amount of traffic. When using cloud bursting, companies do need to worry about interoperability.

Obviously, most companies prefer to avoid buying extra servers just for that one day's usage. Instead, cloud computing vendors now offer support to help businesses "cloud burst" -- that is, offload their extra requests to the cloud on top of their existing infrastructures.

Typically, entering into a cloud-burst arrangement involves obtaining consulting expertise to make sure that the company's applications will properly migrate to the cloud and handle scaling to the cloud as needed. Such arrangements usually aren't the right call in cases involving launching a new business or application. But for companies that already have solid infrastructures, the cloud-burst approach can provide a great way to add elasticity.

Typically, companies taking the cloud-burst approach will put their master servers in their data centers with backup servers on the cloud-computing platform. They may be able to host load balancers in both locations, or they may wish to control that entirely within their own infrastructures. In the end, it's the company's choice to decide how much control -- and how much risk -- they want to take by placing more services in the cloud.
Use Case:
Usage planning of flexible computing systems applying fuzzy mechanism

IT spending that is based on fix quantities does not always get aligned to actual demand and needed service levels. Customers who utilize flexible computing capacities expect to pay only for the amount of capacity that they really needed and used at a specific point in time. In order to pass this flexibility on to agreements with the customer also powerful usage analysis and planning instruments are necessary.