SLA models for cloud computing infrastructures

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Introduction

- Cloud computing is growing rapidly and has gained popularity due to several benefits, such as on-demand self-service, virtualization, geographic distribution, resilient computing, etc.
- Google, Amazon, Microsoft, IBM, HP, Apple, Oracle, and Salesforce are a few examples of companies that are making a massive investment on cloud services [17].

Motivation

- Until the present moment, providers can offer negotiation considering quality of service (QoS) guarantees. However, obtaining cloud services according to the needs of customers and specific constraints remains a challenge.
- To guarantee QoS, service level agreements (SLAs) are established between cloud providers and customers.

Problem

- SLA may involves conflict of interest because customers always need to obtain a high-quality service at low costs. Hence, obtaining cloud services according to SLA constraints remain an open issue.

Objective

- The main goal is to reduce such conflict of interest through the set of parameters required for negotiating (i.e.: availability, costs and downtime), as well as the modeling and evaluation of SLA configurations in order to find a cloud architecture suitable for both parts.

Contributions

- (i) SLA model that combine dependability metrics, costs based on operational, renting and maintenance of cloud infrastructure activities; (ii) dependability models of cloud computing infrastructure based on reliability block diagram and stochastic Petri nets and (iii) modeling evaluates to support decision making.

Architecture

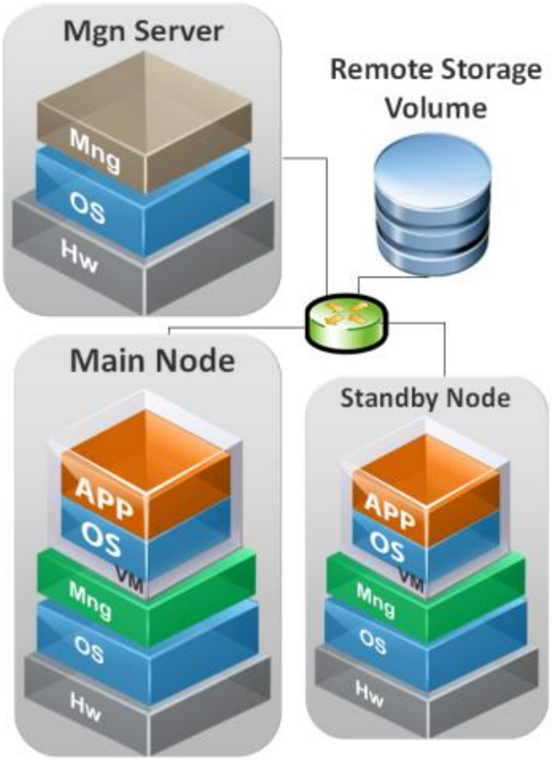


Fig. 2 Architecture Overview.

Model

- Service Level Agreement
  - TSLA i = { Si, St, N, V M, Δt, D, A, TCe } .

$$TCe = Cr + Cm + Cop \quad (1)$$

$$Cr = \sum Lc \times R_t \times N \times T \times Av \quad (2)$$

$$Cm = (Dwt \times Lb_{Dw} \times Sf \times N \times VM \times T) + \sum Cr \quad (3)$$

$$Cop = (Ec \times E_p \times N \times T \times Av) + (Lb_{Up} \times Sf \times Av \times N \times VM \times T) \quad (4)$$

Model

- Reliability Block Diagram
- Stochastic Petri Nets

Models

- Front-end Model:

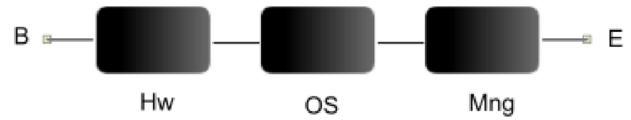


Fig. 4. Frontend RBD Model.

- Node Model:

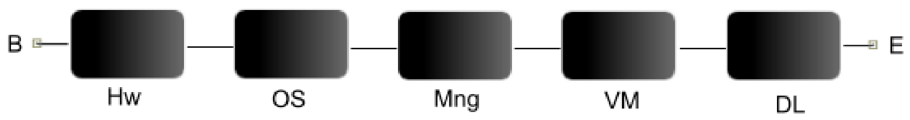


Fig. 5. Node RBD Model.

Models

- Composition Model:

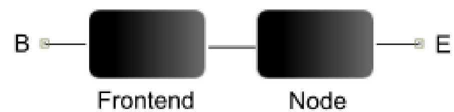


Fig. 6. Frontend and Node RBD Model.

- Front-end and Redundant Node:

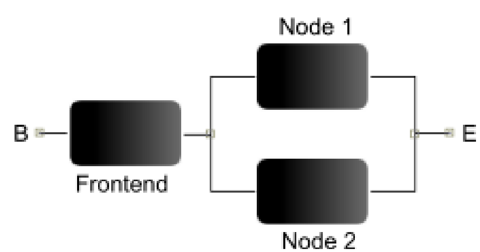


Fig. 7. Frontend + Redundant Node RBD Model.

Models

- SPN Models: **Stochastic Petri Nets** (SPN), which allows the association of probabilistic delays to transitions using the exponential distribution.

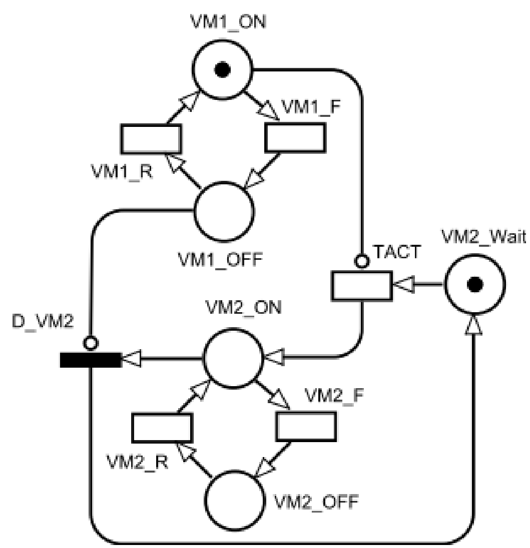


Fig. 8. Cold standby model.

Results

- The SLA models can be useful for cloud providers during design and analysis of IaaS cloud.
- In design, providers can use these models to determine a set of configurations to offer specifics availability SLAs.
- The quantification of operational cost of cloud infrastructures can be employed as a resource of negotiation between customers and providers.

Results

- Parameters

Table 1 RBDs parameters.

Parameters	MTTF (Hr)	MTTR (Hr)
Hw	8760	1.67
OS	1440	1
Management tool	788.4	1
VM	2880	0.17
Digital Library	6865.3	0.17
Frontend	481.46	1.03
Node	389.12	0.91

Table 2 Cost parameters.

Parameters	Value
E_p	0.1547 (USD)
Ec	0.4 (kWh)
Lb_{Up}	0.04 (USD)
Lb_{Dw}	0.40 (USD)
R_t	0,002%
Gold	1.42
Silver	1.26
Bronze	1.15

Table 3 MTTR for SLA type.

Type	Frontend	Node (1VM)	Node (2VMs)
Gold	1.0337 h	0.9063 h	0.9205 h
Silver	1.1337 h	1.0063 h	1.0205 h
Bronze	1.2037 h	1.0763 h	1.0905 h

Results

- TSLA for bronze service

Table 4 *TSLAs* for bronze service.

TSLA	*Si*	*St*	N	VM	Δt (hr)	D (hr)	Availability	TCe (USD)
1	N/R	bronze	1	1	730	3.828991	0.994754807	174.64
2	Hot	bronze	1	2	730	3.574088	0.995103989	209.64
3	Hot	bronze	2	1	730	1.825989	0.997498646	711.75
4	Hot	bronze	2	2	730	1.824672	0.997500450	416.93
5	Hot	bronze	3	1	730	1.820464	0.997506214	522.35
6	Hot	bronze	3	2	730	1.820458	0.997506221	625.39
7	warm	bronze	1	2	730	3.652725	0.994996267	209.70
8	warm	bronze	2	1	730	1.912268	0.997380454	347.51
9	warm	bronze	2	2	730	1.899349	0.997398151	417.02
10	cold	bronze	1	2	730	3.688270	0.994947576	209.70
11	cold	bronze	2	1	730	2.137536	0.997071868	347.93
12	cold	bronze	2	2	730	2.094004	0.997131501	416.80

Results

- TSLAs for silver service

Table 5 *TSLAs* for silver service.

TSLA	*Si*	*St*	N	VM	Δt (hr)	D (hr)	Availability	TCe (USD)
1	N/R	silver	1	1	730	3.593348	0.995077605	177.80
2	Hot	silver	1	2	730	3.356396	0.995402197	216.06
3	Hot	silver	2	1	730	1.719673	0.997644284	354.63
4	Hot	silver	2	2	730	1.718528	0.997645853	429.77
5	Hot	silver	3	1	730	1.714836	0.997650904	531.94
6	Hot	silver	3	2	730	1.820458	0.997650910	644.65
7	warm	silver	1	2	730	3.441780	0.995285233	216.12
8	warm	silver	2	1	730	1.806062	0.997525943	354.67
9	warm	silver	2	2	730	1.793265	0.997543473	429.88
10	cold	silver	1	2	730	3.475454	0.995239105	216.14
11	cold	silver	2	1	730	2.028306	0.997221498	354.79
12	cold	silver	2	2	730	1.985367	0.997280319	430.15

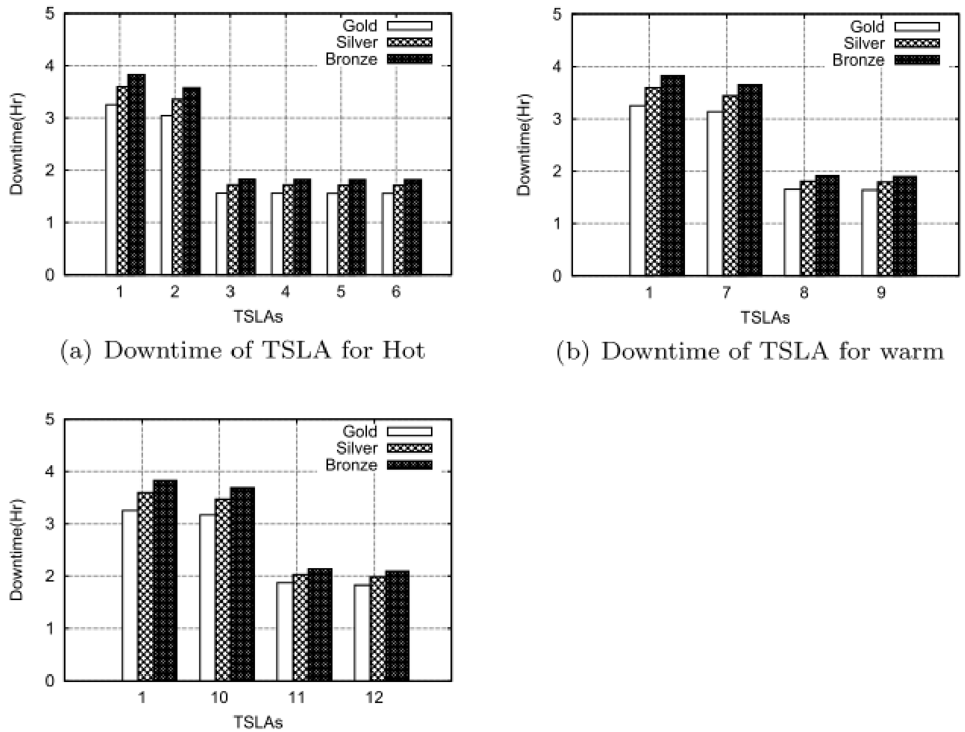
Results

- TSLAs for gold service

Table 6 *TSLAs* for gold service.

TSLA	*Si*	*St*	N	VM	Δt (hr)	D (hr)	Availability	TCe (USD)
1	N/R	gold	1	1	730	3.256515	0.995539020	182.58
2	Hot	gold	1	2	730	3.045237	0.995828442	225.52
3	Hot	gold	2	1	730	1.567820	0.997852301	364.07
4	Hot	gold	2	2	730	1.566900	0.997853562	448.60
5	Hot	gold	3	1	730	1.563896	0.997857676	546.10
6	Hot	gold	3	2	730	1.563893	0.997857680	672.89
7	warm	gold	1	2	730	3.140145	0.995698432	225.61
8	warm	gold	2	1	730	1.654255	0.997733898	363.33
9	warm	gold	2	2	730	1.641634	0,997751186	448.72
10	cold	gold	1	2	730	3.170356	0,995657047	225.61
11	cold	gold	2	1	730	1.871501	0,997436300	363.80
12	cold	gold	2	2	730	1.829526	0,997493801	448.52

Results



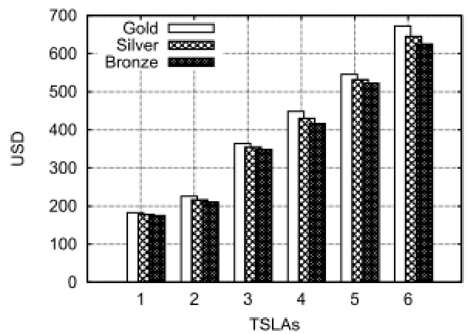
(a) Downtime of TSLA for Hot

(b) Downtime of TSLA for warm

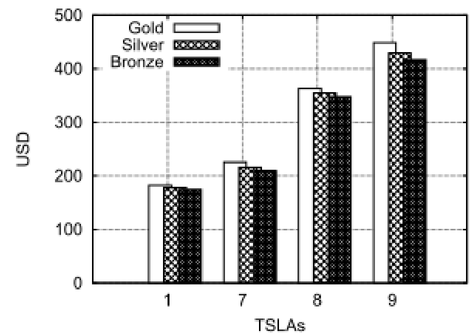
(c) Downtime of TSLA for cold

Fig. 9 Downtime and total cost estimation of TSLA cloud infrastructure under different redundant strategies.

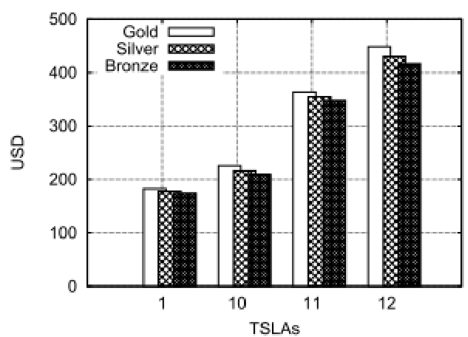
Results



(d) Cost of TSLA for Hot



(e) Cost of TSLA for warm



(f) Cost of TSLA for cold

Fig. 9 Downtime and total cost estimation of TSLA cloud infrastructure under different redundant strategies.

Conclusion

- A major challenge that grows every moment is how to compose SLA constraints transparently to customers and providers. This work presented an approach for describing service level agreements considering a cloud infrastructure.

Thank you!