Availability Modeling and Cost Analysis for VoD Streaming Service

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Script

- Introduction
- Architecture
- Case Studies
    - Case Study III
    - Cost Analysis
- Results
- Future works

Introduction

Entertainment

Distance Learning

Sections

Case Study - I

Case Study - II

Case Study - III

1. Definition of the baseline;
2. Modeling;
3. Dependability results;
4. Model Validation.

Sections

Case Study - I | Case Study - II | Case Study - III

1. Sensitivity analysis;
2. Redundant architecture;
3. Modeling;
4. Recalculate dependability results.

Sections

Case Study - I

Case Study - II

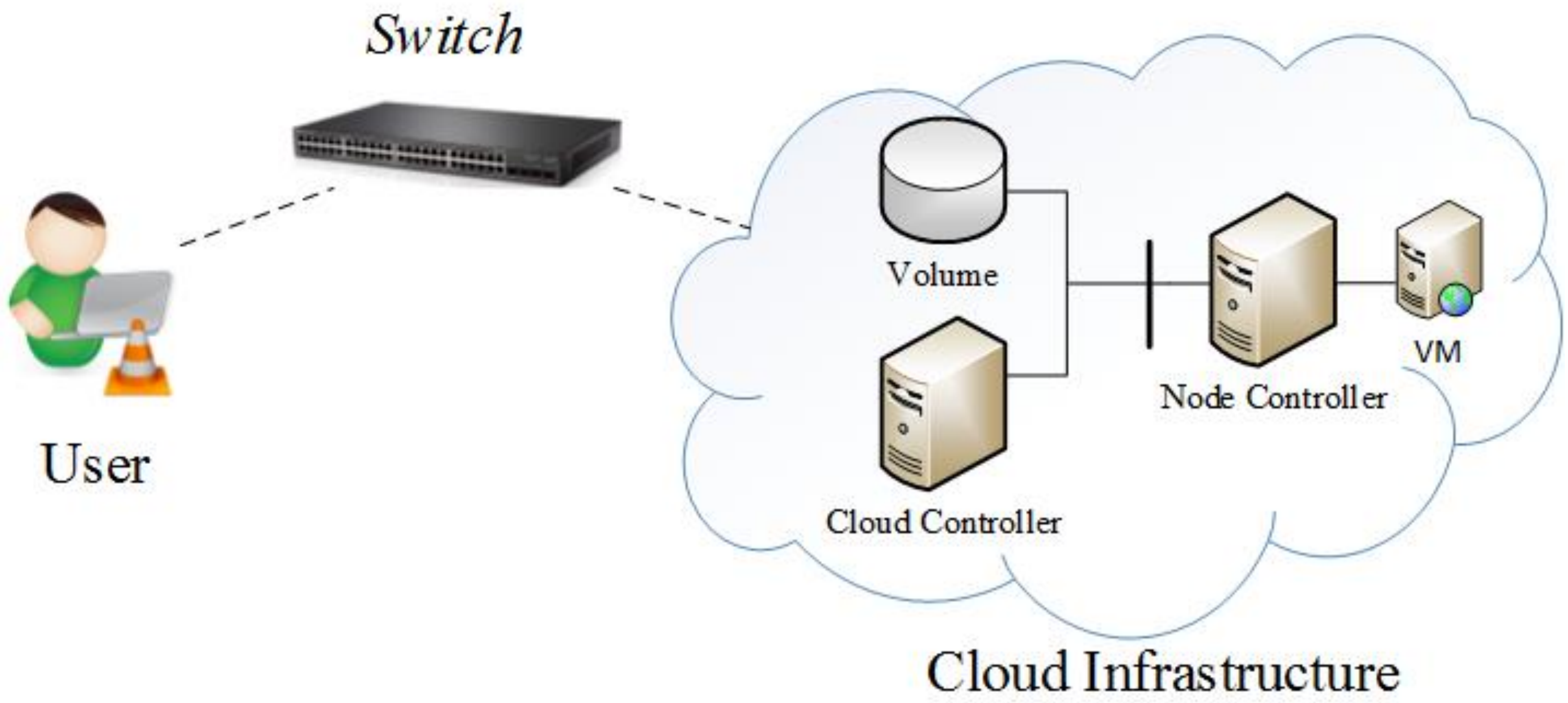
Case Study - III

1. Sensitivity analysis;
2. Redundant architecture;
3. Recalculate dependability results;
4. **Cost Analysis.**

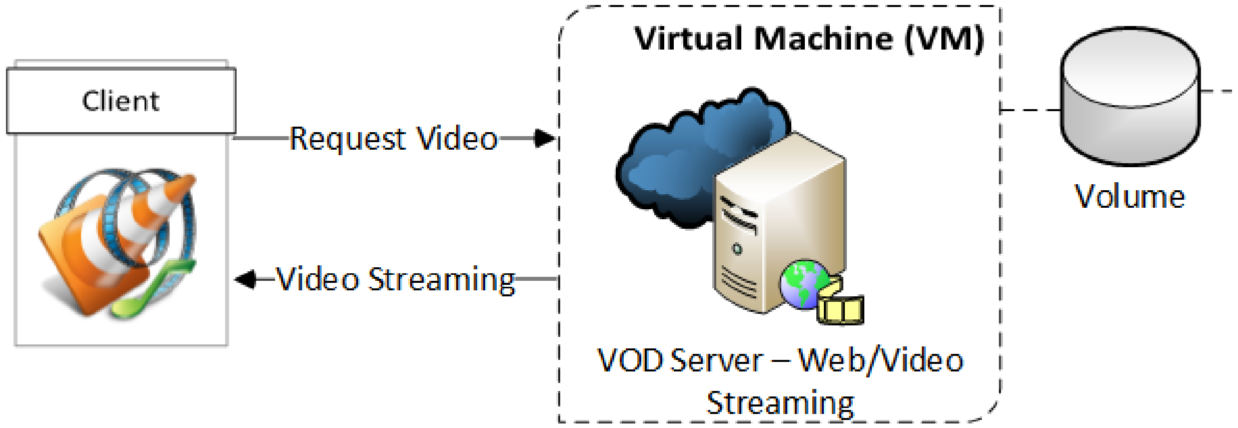
Introduction

In this paper, we present a modeling approach to evaluate dependability and cost issues for a VoD streaming service in three different architectures, basead on private cloud, for a distance learning environment which supports an average of 30 simultaneous users, who demand video transmission quality of 1.5 Mbps.

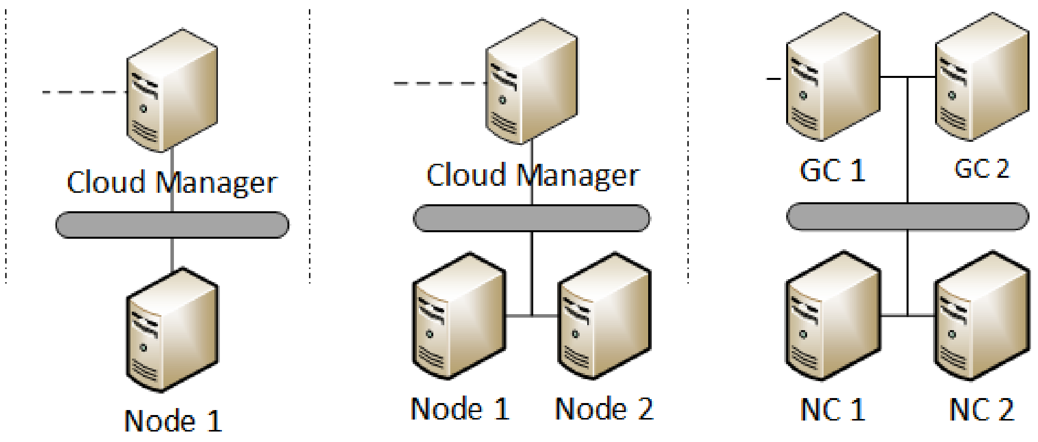
Architecture



Previous Results



Baseline | Redundant I | Redundant II



Dependability Models

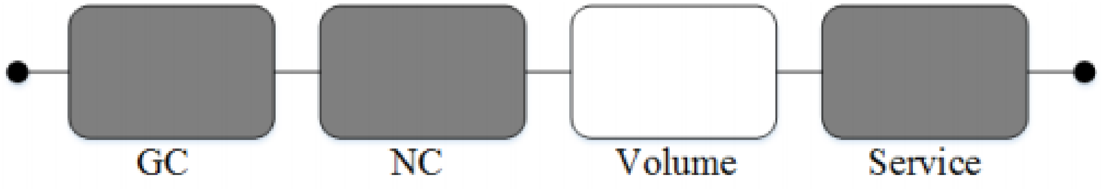


Figure 3: Baseline Architecture - RBD Model.

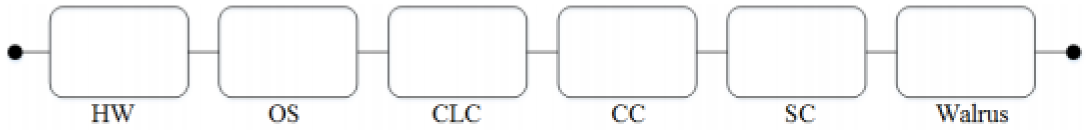


Figure 4: GC Subsystem.

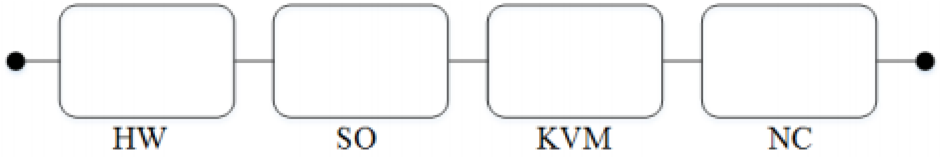


Figure 5: NC Subsystem.

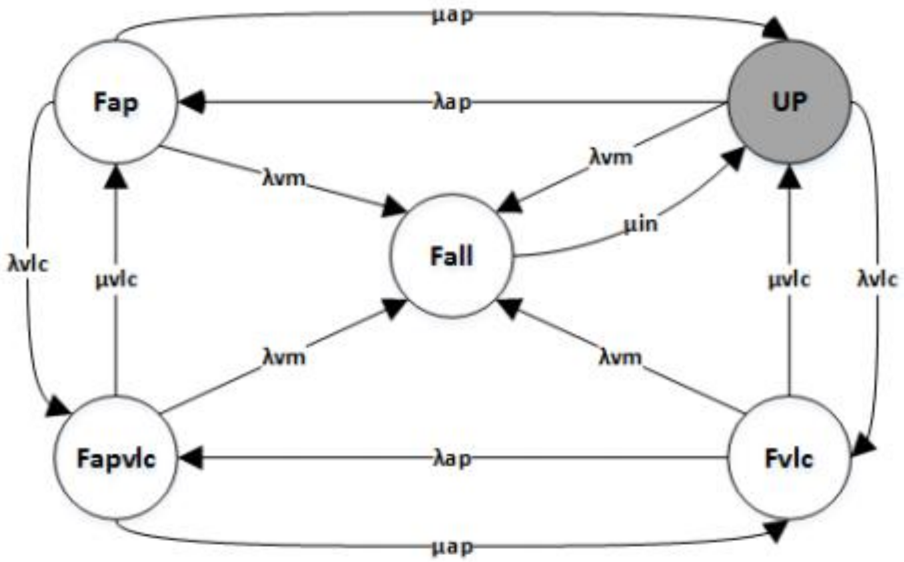


Figure 6: Baseline VoD Streaming Service.

Dependability Models

Closed-form equation for baseline architecture

$$A_s = \frac{(\mu_{in}(\lambda_{ap}\lambda_{vm}(\beta) + \lambda_{ap}(\beta_1)\mu_{vlc} + (\beta_1)(\beta_2)(\beta + \mu_{vlc})))}{((\lambda_{ap} + \beta_1)(\lambda_{vm} + \mu_{in})(\beta)(\lambda_{ap} + \beta + \mu_{vlc}))}, \quad \text{(V)}$$

where:

$$\beta = \lambda_{vlc} + \lambda_{vm} + \mu_{ap},$$
$$\beta_1 = \lambda_{vm} + \mu_{ap} \text{ and}$$
$$\beta_2 = \lambda_{vm} + \mu_{vlc}.$$

Availability for baseline architecture

$$A = A_{GC} \times A_{NC} \times A_{vol} \times A_s$$

Dependability Models

Figure 8: Redundant Architecture (NC) - RBD Model.

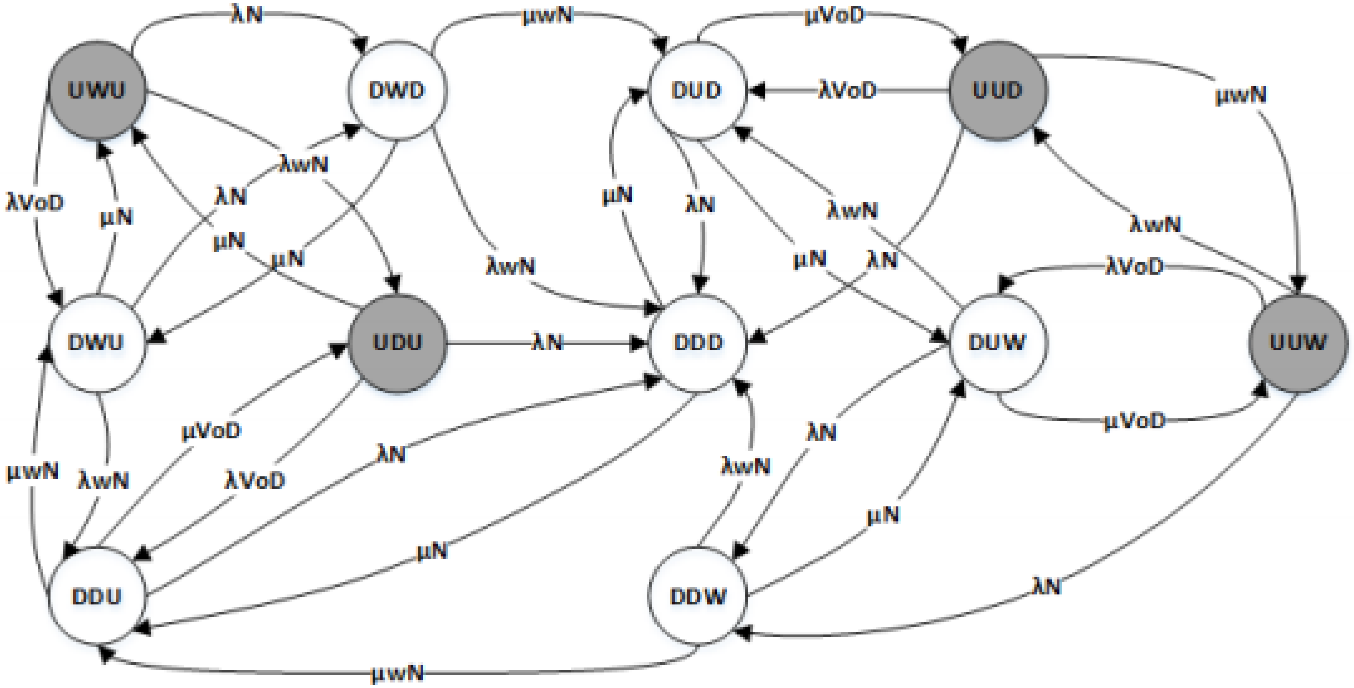


Figure 9: Redundant VoD Service - NC.

Dependability Models

Closed-form equation for baseline architecture

$$A_{VoD} = \frac{\alpha(2\beta^2\alpha_1 + \beta\alpha_2\beta_1 + \alpha_3)\beta_1^2 + \alpha_4\beta_1^3}{\alpha_5(\beta^2\alpha_1(\lambda N + 2\mu N) + \beta\varphi\beta_1 + \varphi_1\beta_1^2 + \beta_7\beta^3)}, \quad \text{(X)}$$

Where

$$\begin{aligned}
\beta &= \lambda_{WN}, \\
\beta_1 &= \mu_{WN}, \\
\alpha &= \mu_N \mu_{VoD}, \\
\alpha_1 &= (\lambda_N + \beta + \mu_N)2(\lambda_N + \beta + \mu_N), \\
\alpha_2 &= 4\lambda_{N^2} + 17\lambda_N\beta + 13\beta + 5\lambda\mu_N + 12\beta\mu_N + 2\mu_{N^2}, \\
\alpha_3 &= (8\beta(2\beta + \mu_N) + \lambda_N(11\beta + \mu_N)), \\
\alpha_4 &= (7\beta + 2\mu_N)(\mu_{WN^3}), \\
\alpha_5 &= \lambda_N + \lambda_{VoD} + \mu_{VoD}, \\
\alpha_6 &= 2\lambda_N(\lambda_N + \beta)(\lambda_N + 3\beta), \\
\beta_2 &= (8\lambda_{N^2} + 24\lambda_N\lambda_{WN} + 13\beta^2)\mu_N, \\
\beta_3 &= (7\lambda_N + 12\beta)\mu_{N^2} + 2\mu_{N^3}, \\
\beta_4 &= 2\lambda_N\beta(2\lambda_N + 3\beta), \\
\beta_5 &= (\lambda_N + \beta)(\lambda_N + 16\beta)\mu_N, \\
\beta_6 &= (\lambda_N + 8\beta)\mu_{N^2}, \\
\beta_7 &= (\lambda_N(\beta + 2\mu_N) + \mu_N(7\beta + 2\mu_N)) \\
\varphi &= \alpha_6 + \beta_2 + \beta_3, \mathit{and} \\
\varphi_1 &= \beta_4 + \beta_5 + \beta_6.
\end{aligned}$$

Availability for baseline architecture

$$A_{RedArchitectureNC} = A_{GC} \times A_{VoI} \times A_{VoD}$$

Dependability Models

Figure 11: Redundant Architecture (NC and GC) - RBD Model.

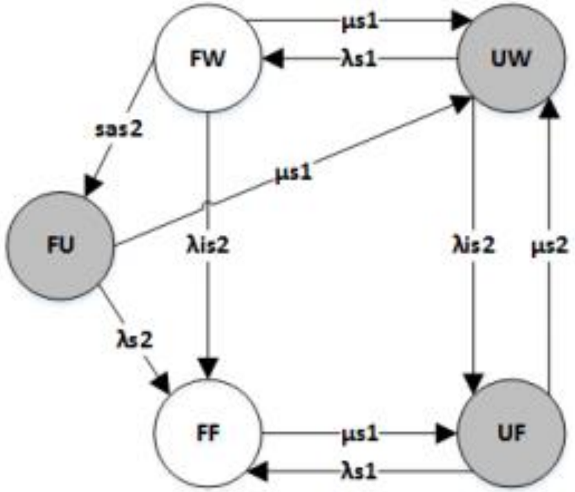


Figure 12: Redundant GC.

Closed-form equation for baseline architecture

$$A_{GC} = \frac{\mu(\beta + (\alpha^2) + sa(\lambda + \alpha))}{sa(\lambda^2 + \lambda(\alpha) + \mu(\alpha)) + (\lambda + \mu)(\beta + (\alpha)^2)}, \quad \text{(XIII)}$$

where:

$\alpha = \lambda_i + \mu$ and

$\beta = \lambda \times \lambda_i$.

Availability for baseline architecture

$$A_{rvod} = A_{GC} \times A_{vol} \times A_{service},$$

Previous Results

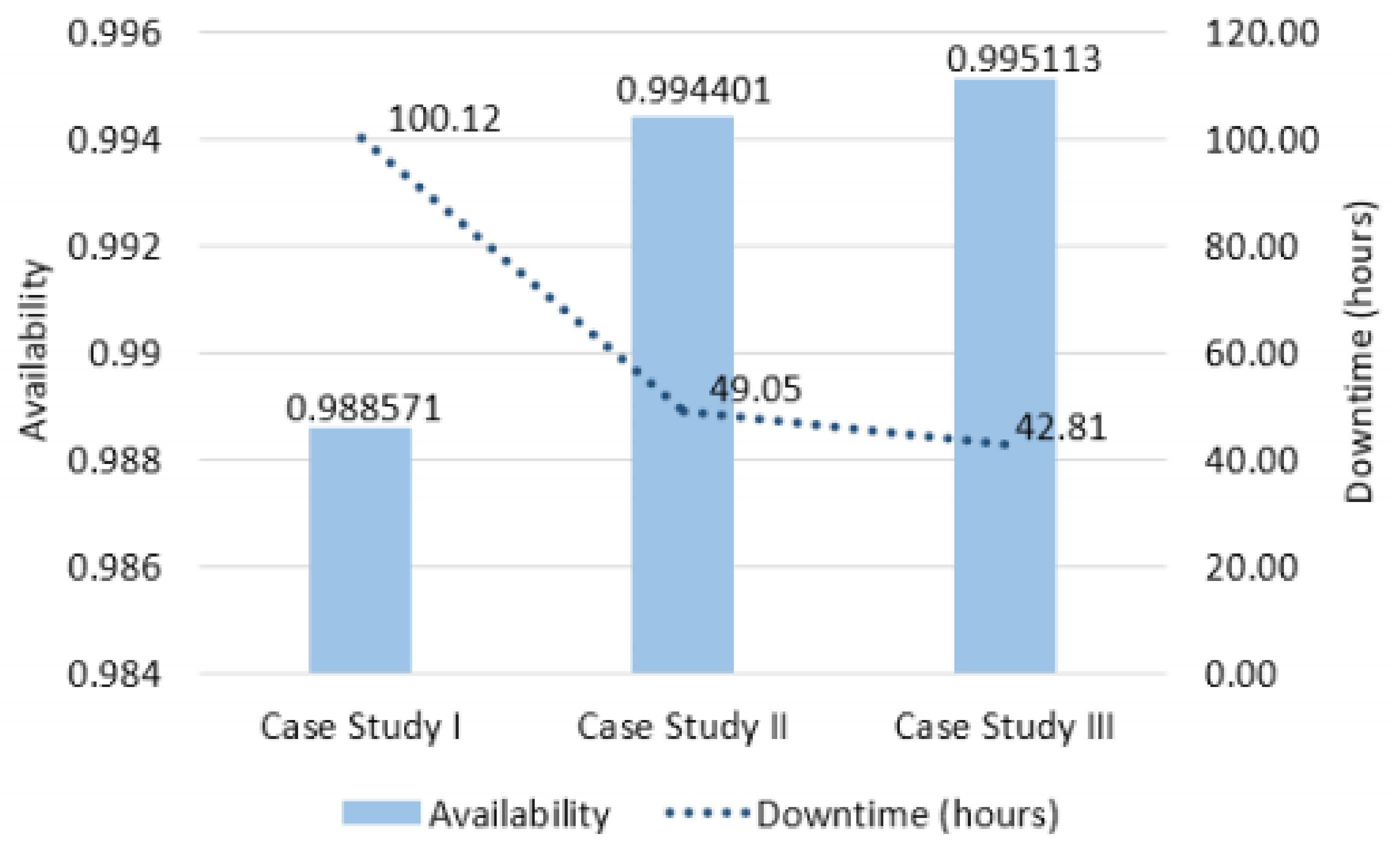


Figure 12: Case studies comparison.

Analysis

In this paper, we present a modeling approach to evaluate dependability and cost issues for a VoD streaming service in three different architectures, basead on private cloud, for a distance learning environment which supports an average of 30 simultaneous users.

Table I: Settings of VMs.

Parameters	m1.small	m1.medium	m1.xlarge
CPU	1	1	2
Memory (MB)	256	512	1024
Hard Disk (GB)	5	10	10
Number of users	5	15	36
Mbps suported	0.25	1	2.5

Analysis

Private cloud

Table XXIX: Comparison between parameters of architectures.

Parameters	Basic	Red. NC	Red. NC and GC
Size of VM	m1.small	m1.medium	m1.xlarge
Bandwidth	10/100	10/100	10/100
Number of users supported	5	15	36
Availability	0,988571	0,994401	0,995113
Number of Nines	1,9420	2,5118	2,3109
Annual Downtime	100,11	49,04	42,81
TCO mdio	R$ 4.331,19	R$ 6.361,75	R$ 10.210,87

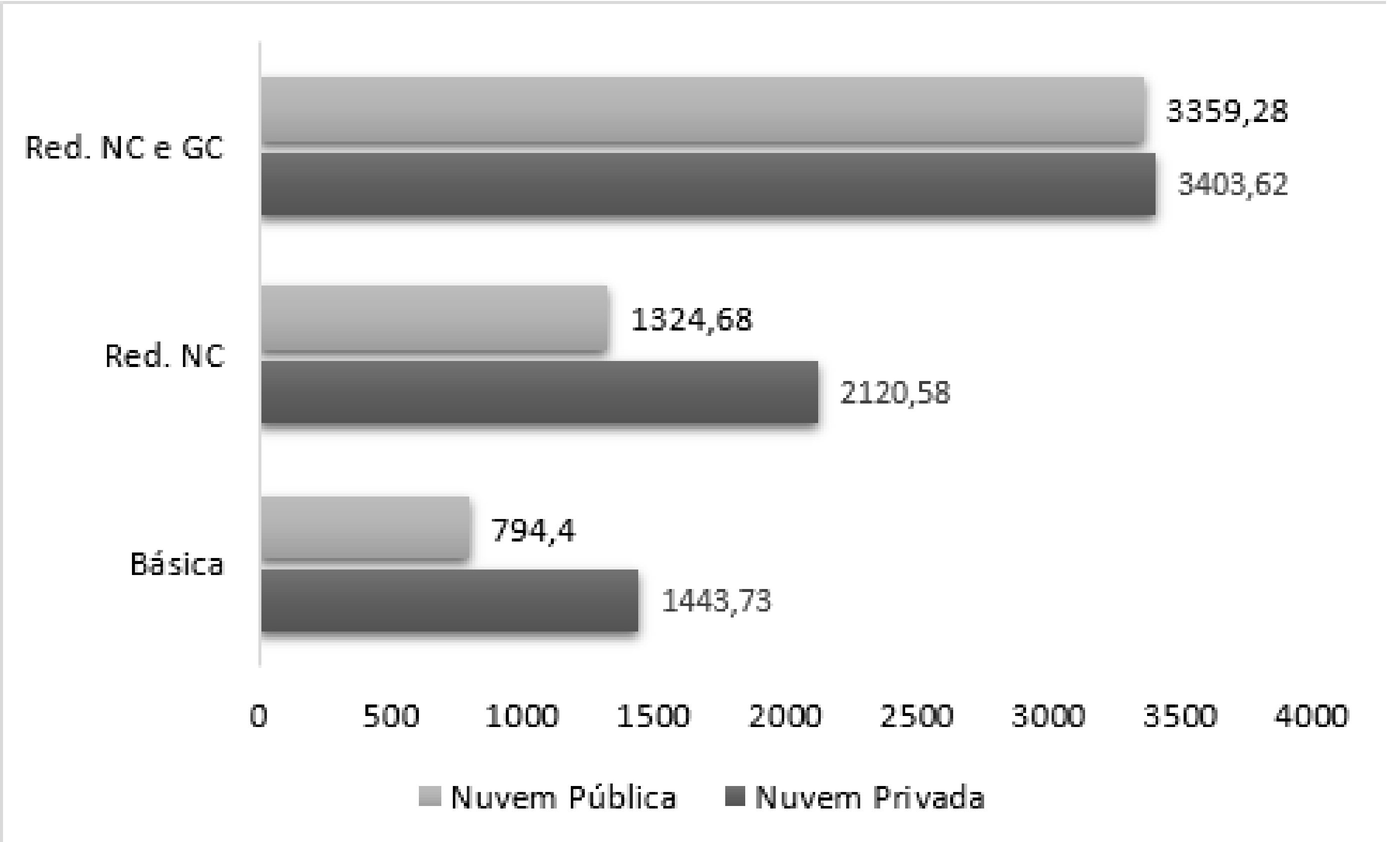
Where:
Basic = Baseline Architecture;
Red. NC = Redundant Architecture (NC);
Red. NC and GC = Redundant Architecture (NC and GC).

Analysis

Public cloud

Parameters	Basic	Red. NC	Red. NC and GC
Size of VM	m1.small	m1.medium	m1.xlarge
Number of users supported	On demand	On demand	On demand
VM's availability	0.995	0.995	0.995
Number of nines	2,3010	2,3010	2,3010
Annual Downtime	43.8	43.8	43.8
CMA	$ 794.40	$ 1,324.68	$ 4,387.08

Analysis



Red. NC e GC
3359,28
3403,62
Red. NC
1324,68
2120,58
Básica
794,4
1443,73
0
500
1000
1500
2000
2500
3000
3500
4000
Nuvem Pública
Nuvem Privada

Results

- A análise dos benefícios da adoção de mecanismos de replicação warm standby em um serviço de VoD streaming na nuvem baseado na plataforma Eucalyptus;

- Modelagem analítica de três tipos de arquiteturas (uma básica e outras duas com redundância) para o serviço através de modelos RBD e CTMC, que podem ser utilizados em extensões de outras arquiteturas para esse serviço em trabalhos futuros;

- A identificação de componentes de infraestrutura que geram gargalos de disponibilidade em serviços na nuvem, e que podem embasar a elaboração de arquiteturas redundantes em propostas futuras;

- O alcance de equações de fórmula fechada para cálculo de disponibilidade do serviço de VoD streaming na nuvem;

Results

- Maria Bezerra, Rosangela Melo, Jamilson Dantas, Paulo Maciel, and Francisco Vieira, “Availability modeling and analysis of a VoD service for Eucalyptus platform”, na 2014 IEEE International Conference on Systems, Man and Cybernetics (IEEE SMC 2014), San Diego, Califórina, 2014;

- Rosangela Melo, Maria Bezerra, Jamilson Dantas, Rubens Matos, Ivanildo Melo, Paulo Maciel, “VoD in Eucalyptus Platform: Availability Modeling and Sensibility Analysis", na International Conference on Network and Service Management, 2014, Rio de Janeiro. CNSM 2014, 2014;

- Rosangela Melo, Maria Bezerra, Jamilson Dantas, Rubens Matos, Ivanildo Melo, Paulo Maciel, “Sensitivity Analysis of Availability of Video Streaming Service in Cloud Computing", na IEEE International Performance Computing and Communications Conference, 2014, Austin. IEEE IPCCC 2014, 2014.

- Rosangela Melo, Maria Bezerra, Jamilson Dantas, Rubens Matos, Ivanildo Melo, Paulo Maciel, “Redundant VoD Streaming Service in a Private Cloud: Availability Modeling and Sensitivity Analysis", no periódico Mathematical Problems in Engineering (Print), v. 2014, p. 1-14, 2014.

Results

- Maria Bezerra, Rosangela Melo, Jamilson Dantas and Paulo Maciel "Availability modeling and analysis for VoD Service".

- Maria Bezerra, Rosangela Melo, Jamilson Dantas and Paulo Maciel "Availability models and costs analysis for VoD Service".

Future Works

- RI x Costs;
- SLA;
- Analyze others dependability metrics;
- Redundant architectures.

Questions?

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