Availability Analysis of NFV VoD Caching Models Supported by Sensitivity Analysis

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Telecom Service Providers

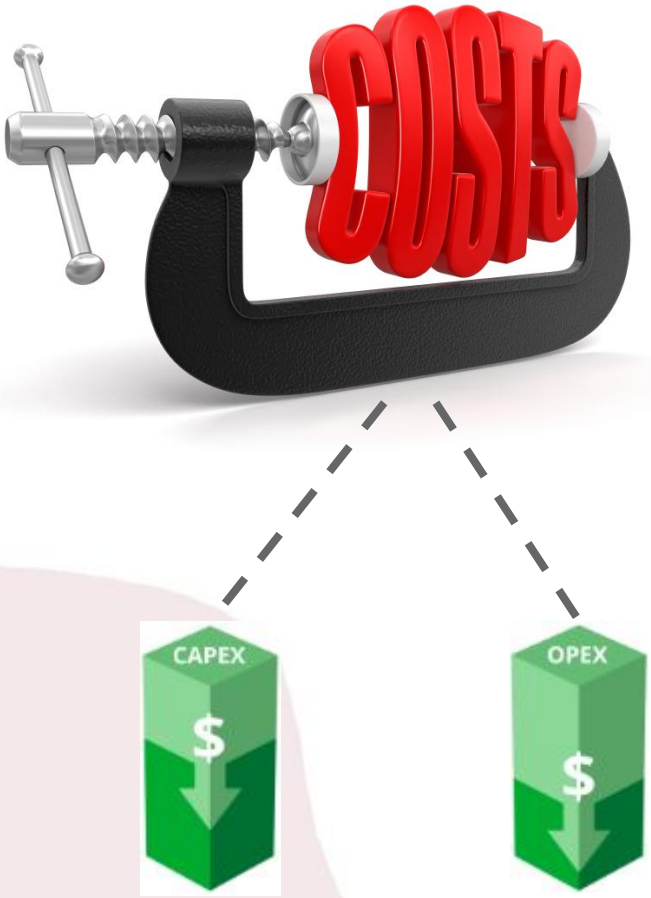
Rank					Brand Value (USD $ Millions)		Brand rating	
2016	2015	Logo	Name	Country	2016	2015	2016	2015
1	1		Verizon		63,116	59,843	AAA-	AAA-
2	2		AT&T		59,904	58,820	AA+	AA+
3	3		China Mobile		49,810	47,916	AAA-	AAA-
4	4		T (Telekom)		33,194	31,108	AA+	AA+
5	5		Vodafone		27,820	27,287	AA+	AA+
6	9		SoftBank		19,135	16,039	AA	AA
7	6		Orange		19,096	19,867	AA+	AA+
8	8		BT		18,442	16,175	AAA-	AAA-
9	10		NTT		31,678	27,376	AA	AA
10	-		Xfinity		17,186	-	AA+	-
11	13		au		14,209	12,677	AA	AA+
12	11		China Telecom		13,684	14,064	AA	AA+
13	14		NTT Docomo		13,492	12,641	AA+	AA+
14	18		Sky		11,060	8,697	AAA-	AAA-
15	17		Telstra		10,707	8,708	AAA-	AAA-
16	12		China Unicom		10,414	13,791	AA	AA+
17	16		DirecTV		9,476	10,335	AA	AA+

Source: http://brandirectory.com/league_tables/table/telecoms-500-2016

ETSI NFV Members

Network Function Virtualization

NFV Expected benefits



NFV Expected benefits

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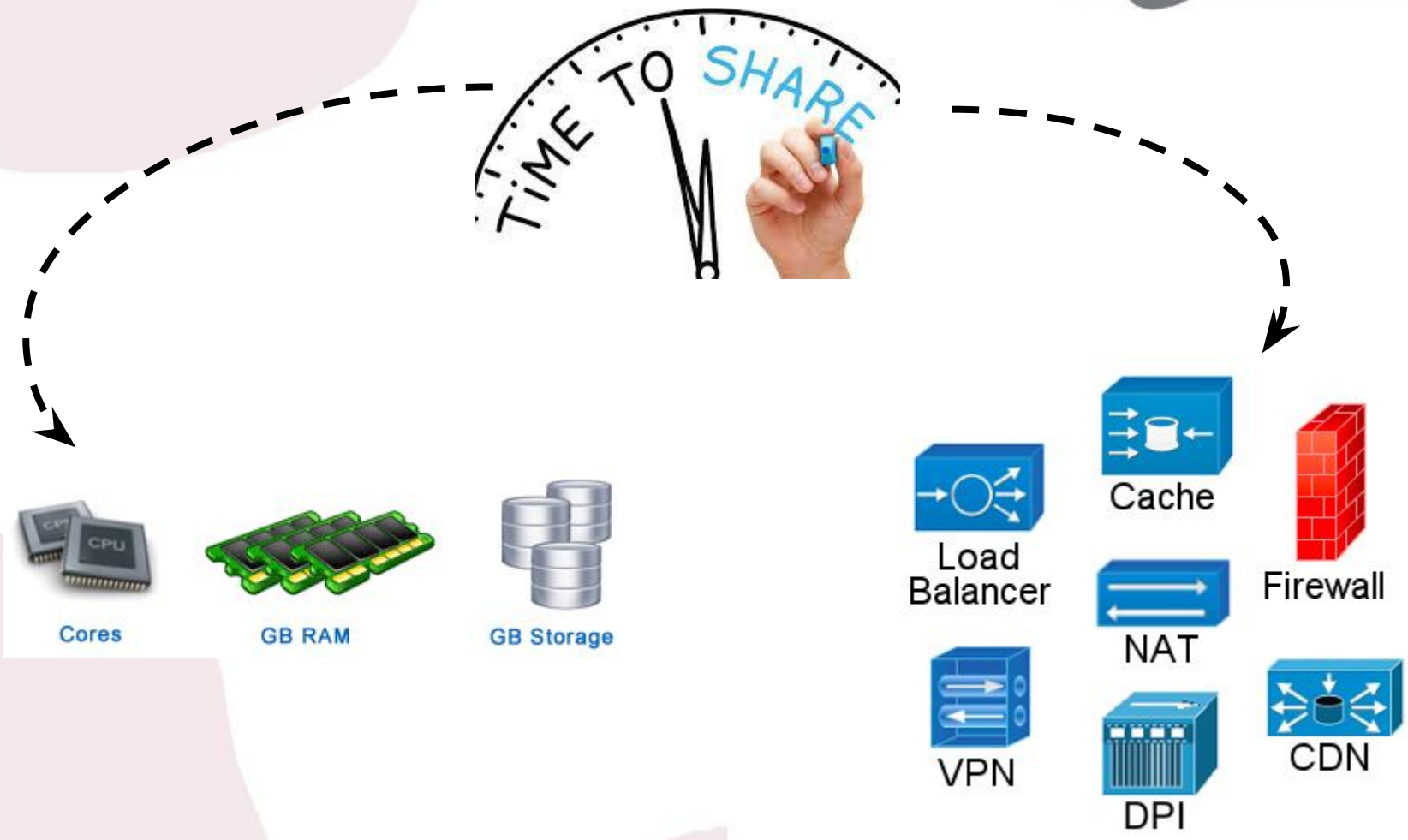


Nevertheless...

- Telecom Service Providers have an important requirement (challenge):


EUREKA!


It's one of our research field!

Question

- How to meet the requirement of five 9's of availability?

SERVICE AVAILABILITY AND DOWNTIME RATINGS

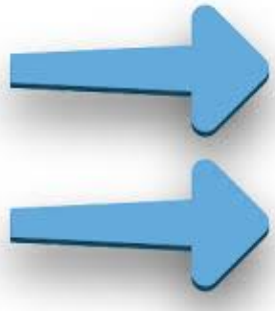
Number of 9's	Service Availability (%)	System Type	Practical Meaning
1	90	Unmanaged	Down 5 weeks per year
2	99	Managed	Down 4 days per year
3	99.9	Well managed	Down 9 hours per year
4	99.99	Fault tolerant	Down 1 hour per year
5	99.999	High availability	Down 5 minutes per year
6	99.9999	Very high availability	Down 30 seconds per year
7	99.99999	Ultra availability	Down 3 seconds per year

Telecom needs HA!

Question

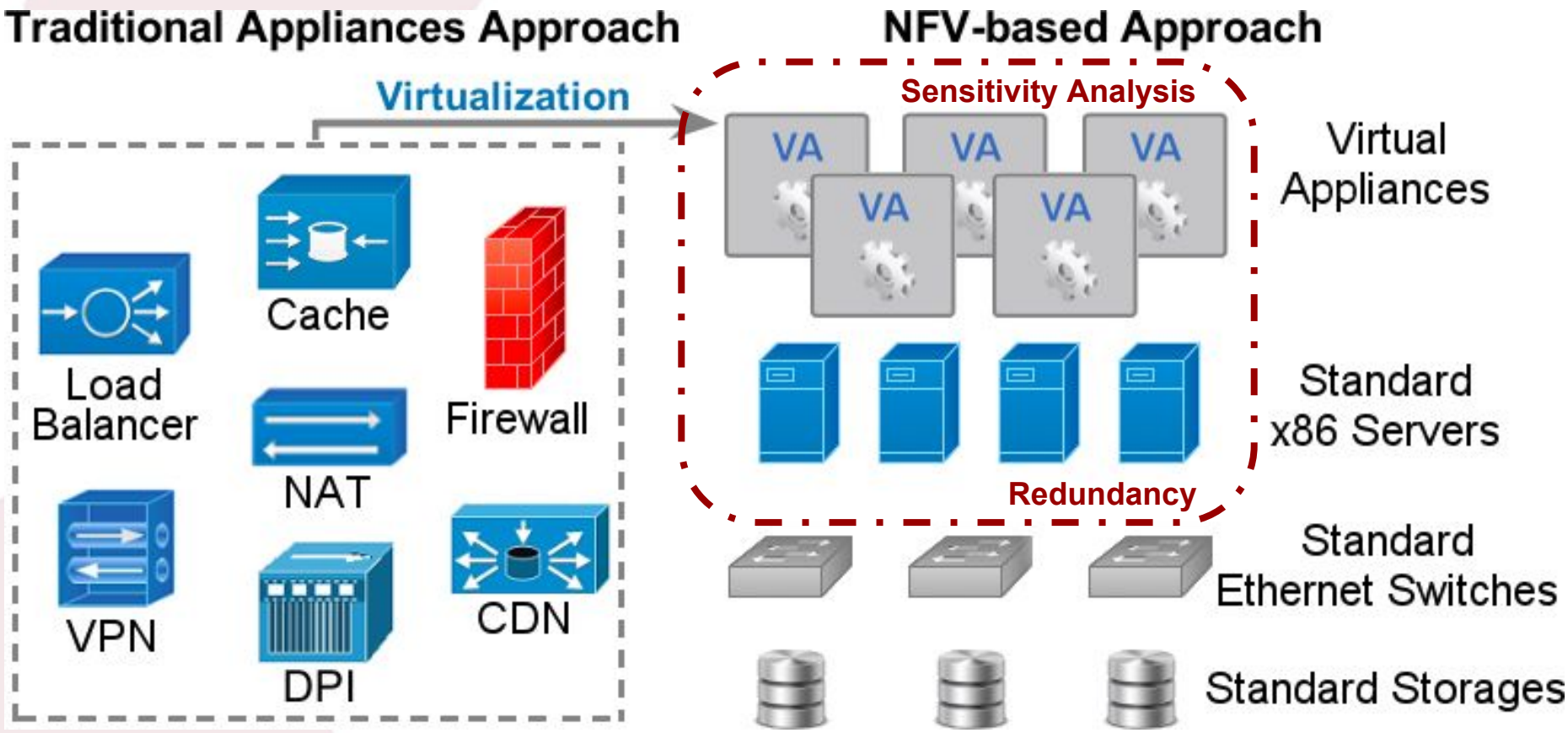
- **Which techniques can be applied for five 9's?**

  - **Redundancy**



  - **Sensitivity Analysis (SA)**

Redundancy & SA



Proposals

Without dependency

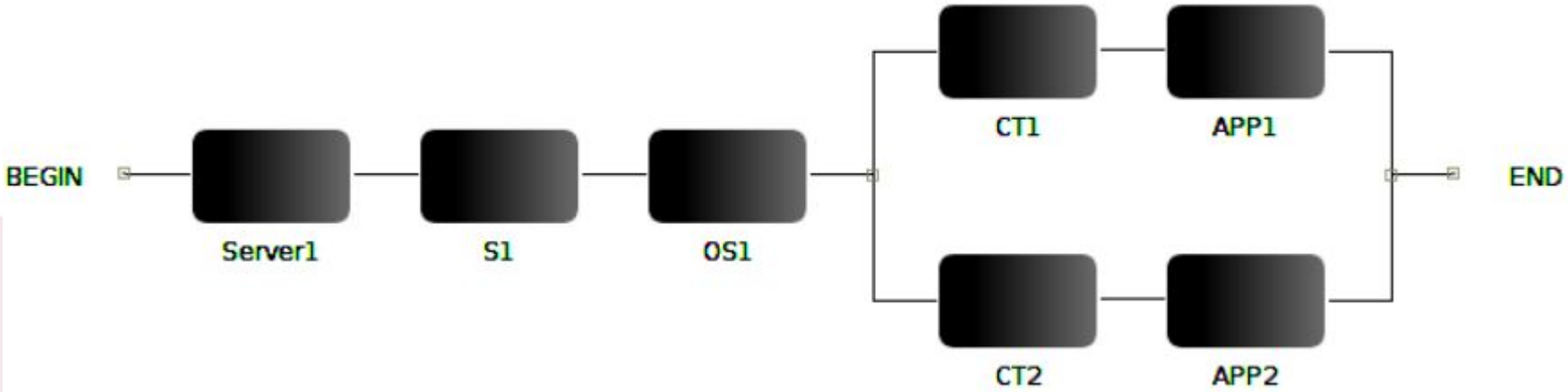
- To model **active-active redundancy** in NFV VoD Cache Service
  - Goal: five 9's

- To model initial Service Function Chaining of **Load Balancer and VoD Caching**
  - Goal: identify most relevant parameters(λ, μ) for Capacity Oriented Availability(COA)

With dependency

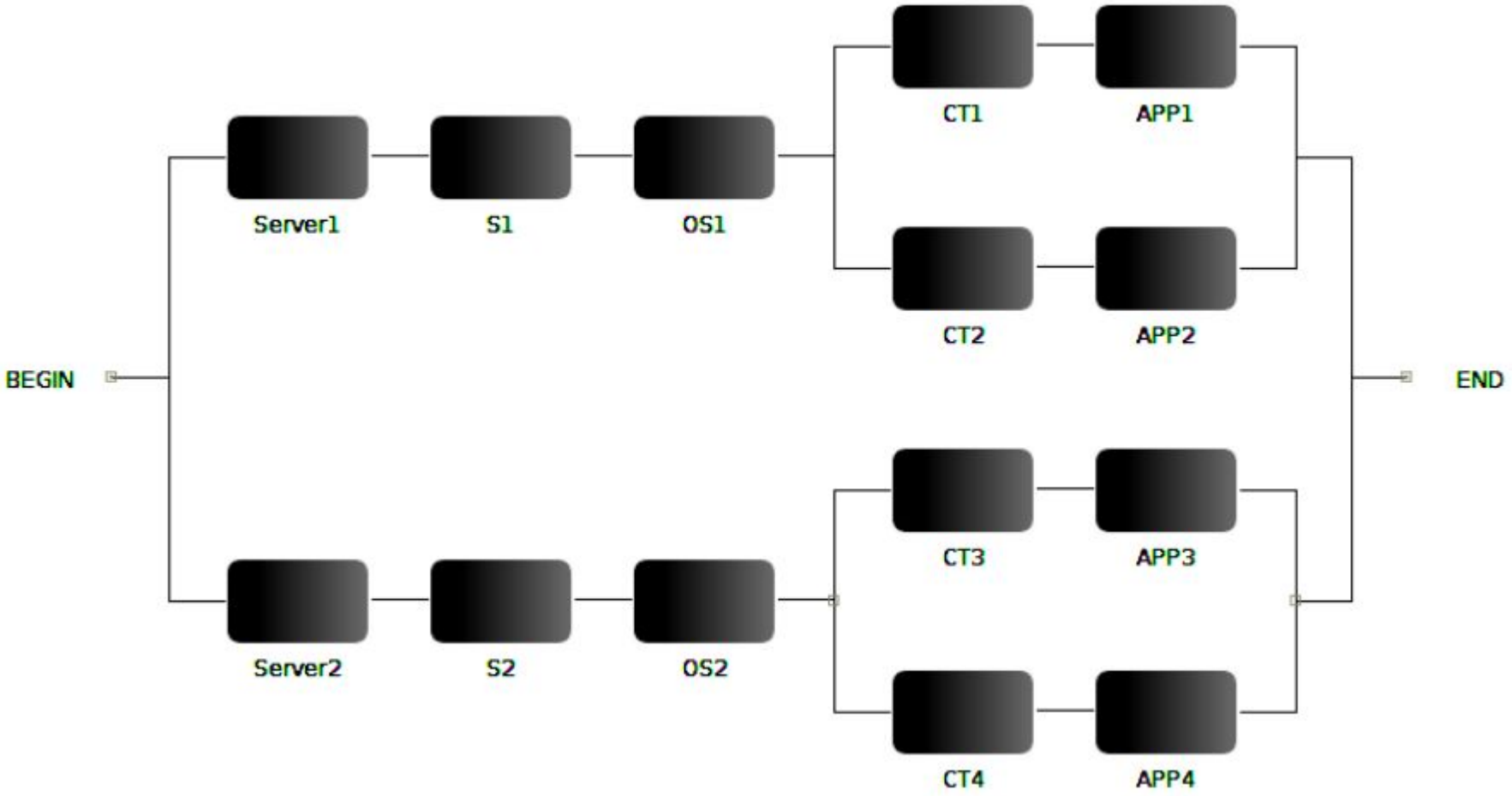
NFV VoD Cache Models

- **Baseline**



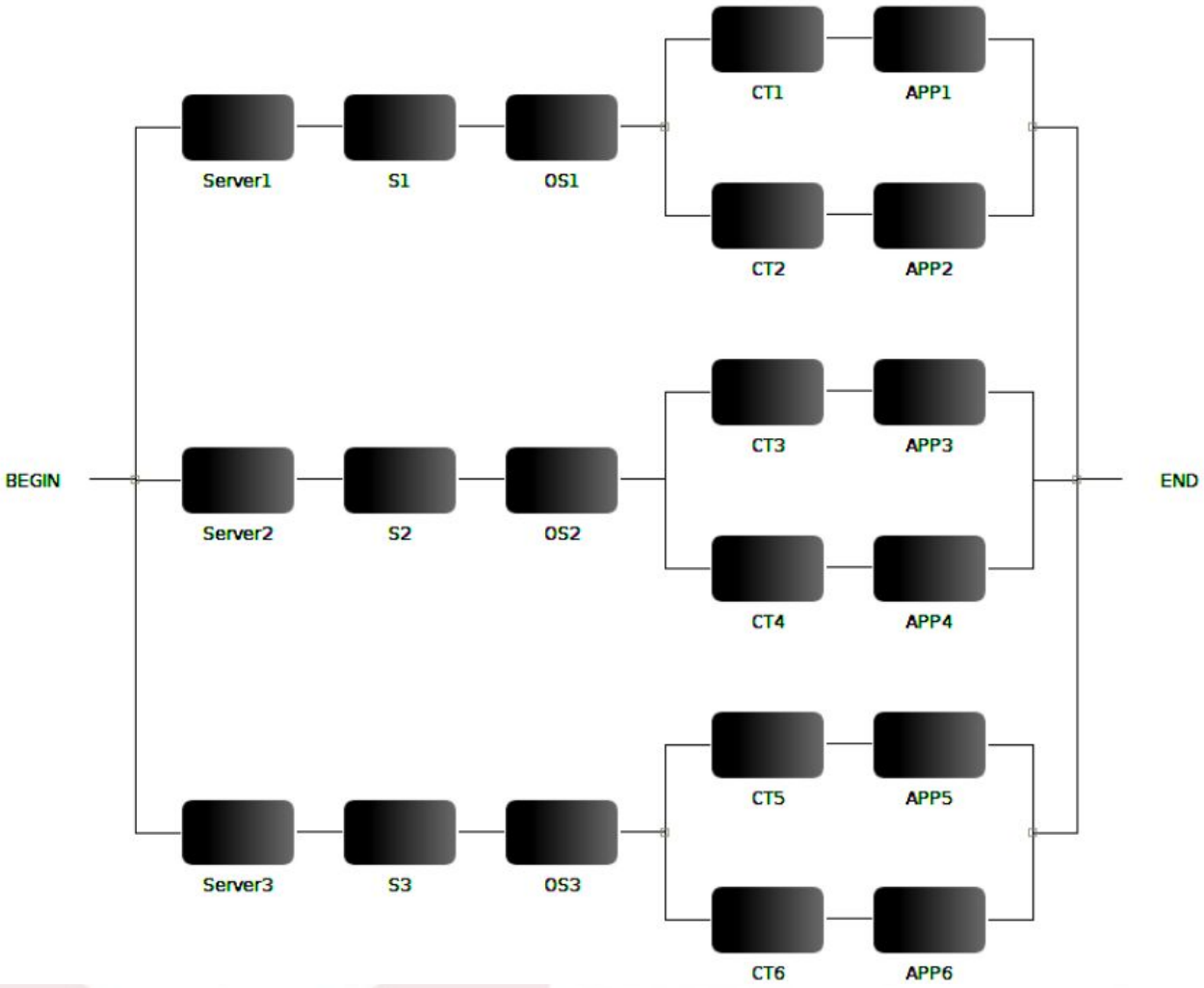
NFV VoD Cache Models

- Redundant



NFV VoD Cache Models

- TMR



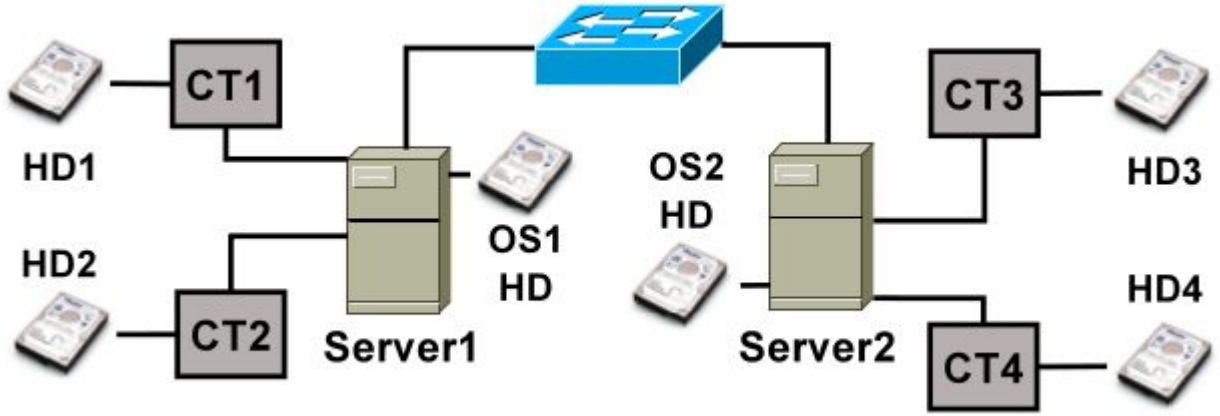
NFV VoD Cache Models

- Input Parameters
  - 4 techniques to state input parameters were identified:
    - Measurements
    - Fault injection
    - System overload
    - Guess estimation

Picked

Assembled Testbed

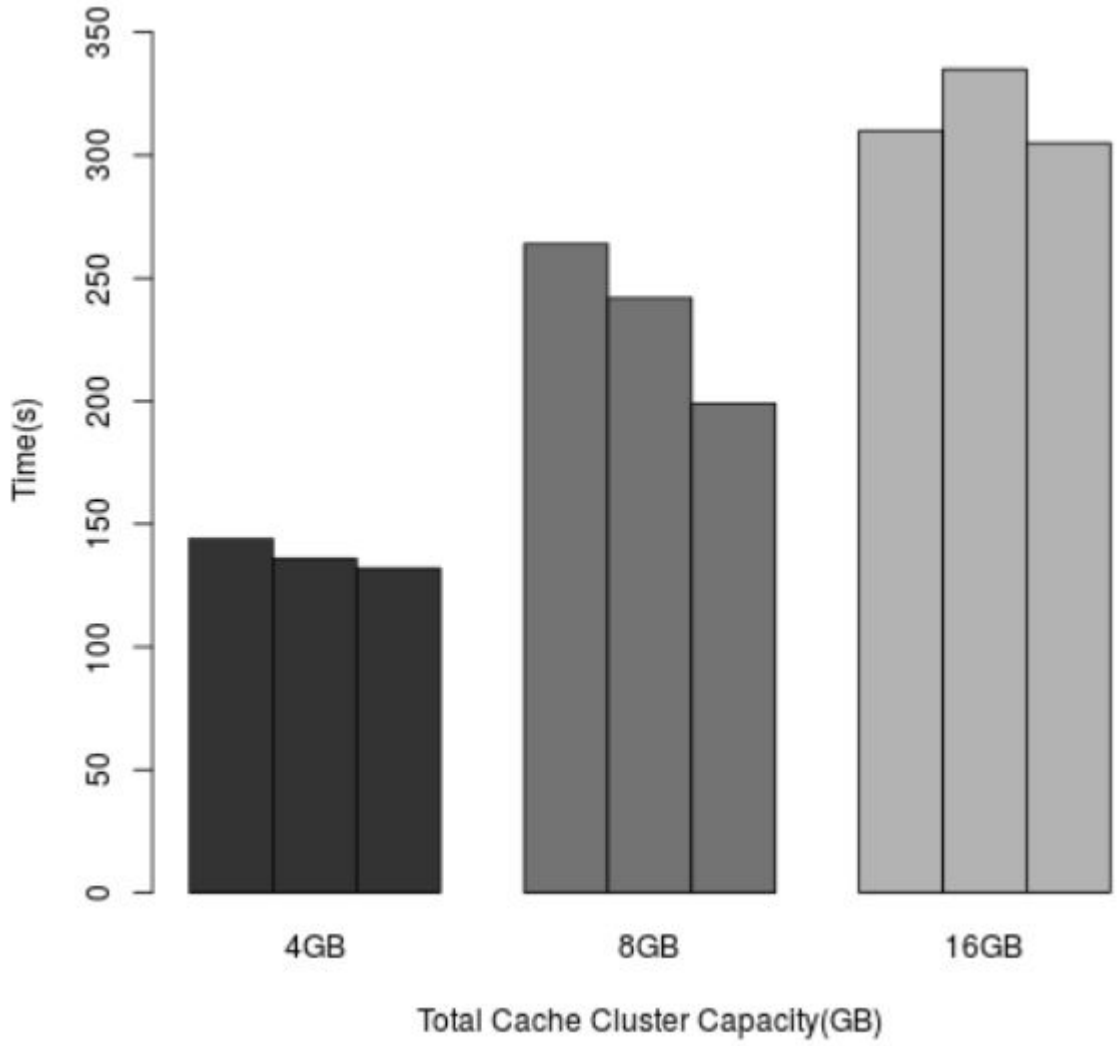
- Goal: To State NFV VoD Caching **failure rate**



System Overhead:
- reduced storage capacity

Container-based Virtualization

Resulting Failure Rates



Applied MTTFs and MTTRs

- Guess Estimation

Component	MTTF	MTTR
HW	8760h	1.67h
S	4380h	5 min
OS	2893h	0.25h
CT	2990h	1h

Availability Modeling and Analysis of a Virtualized System

Dong Seong Kim[1], Fumio Machida[2], Kishor S. Trivedi[1]
[1]*Dept. of Electrical&Computer Eng., Duke University, Durham, NC 27708, USA*

VM restart rate, and detection rates. We use arbitrary *Japan* (but reasonably) chosen input parameters values, since some parameters values are not available or are confidential.

- System Overhead

Component	MTTF	MTTR
APP	0.0875925926h	0.0027777778h

Resulting Availability Analysis

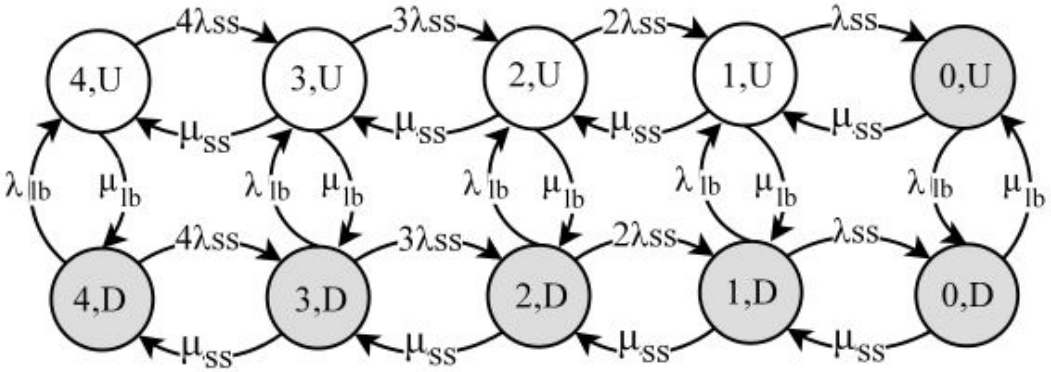
Measure	Non redundant cluster	Parallel redundancy	TMR
Availability(A)	99.928647%	99.99984%	99.9999997%
Number of 9's	3.14659	5.79887	8.69830
Annual Downtime	6.254635h	0.013929h	0.0000175h

RANKING OF SENSITIVITIES FOR A OF REDUNDANT CLUSTER

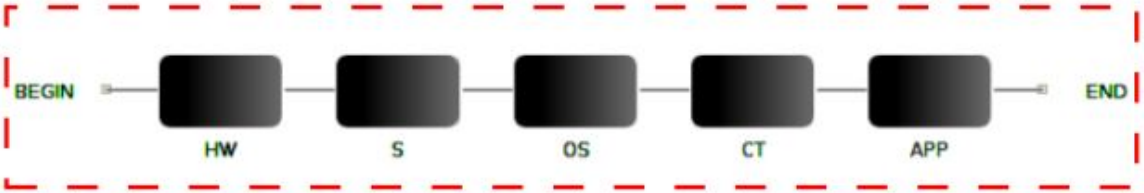
Parameter	S(A)
OS_n	0.001258975333926233
$Server_n$	0.001258975333925807
S_n	0.001258975333925541
CT_n	0.000037927888515153
APP_n	0.000037927888515153

SFC: Load Balancer/Cache

- Hierarchical Modeling



$$\lambda ss = \frac{1}{MTTF_{ss}}$$



Empirical MTTFs of cache application	Resulting MTTFs of subsystem
4380h	799.43h
8760h	879.71h
13140	910.18h

Load Balancer:
- BIG-IP 500 series server appliances
- **MTTF= 50.000h**
- **MTTR=24n**

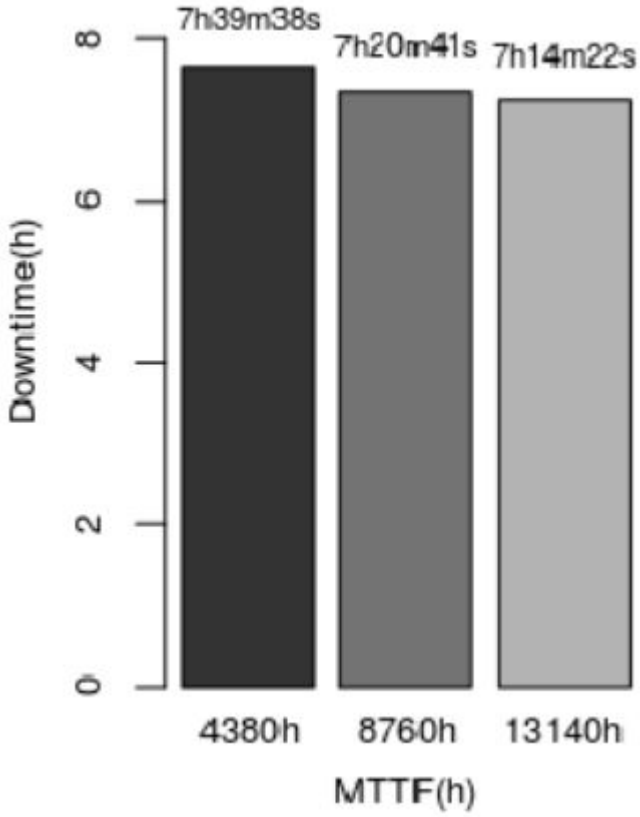
Results: A and COA

AVAILABILITY AND COA FOR CTCM

$MTTF_{APP}$	A	COA
4380	0.9995202318999544	0.9991255086973436
8760	0.9995202335300842	0.9991615583459230
13140	0.9995202390330438	0.9991735787165449

RANKING OF SENSITIVITIES FOR COA

Parameter	$MTTF_{APP}$=4380	$MTTF_{APP}$=8760	$MTTF_{APP}$=13140
μ_{HW}	-1.3149542472	-1.3151442436	-1.3152075697
μ_{CT}	-0.7873977528	-0.7875115231	-0.7875494429
λ_{OS}	0.6897427496	0.7591192445	0.7854484607
λ_{CT}	0.6673664798	0.7344922991	0.7599673568
λ_{APP}	0.4555766609	**0.2506999970**	**0.1729301671**
λ_S	0.4555766609	0.5013999941	0.5187905015
λ_{HW}	0.2277883304	0.2506999970	0.2593952507
μ_{OS}	-0.1968494382	-0.1968778807	-0.1968873607
μ_{APP}	-0.1312329588	-0.1312519205	-0.1312582404
μ_S	-0.0656164794	-0.0656259602	-0.0656291202
μ_{LB}	0.0011994253	0.0011994249	0.0011994248
λ_{LB}	-0.0011994242	-0.0011994242	-0.0011994242



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Thank you

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Questions...

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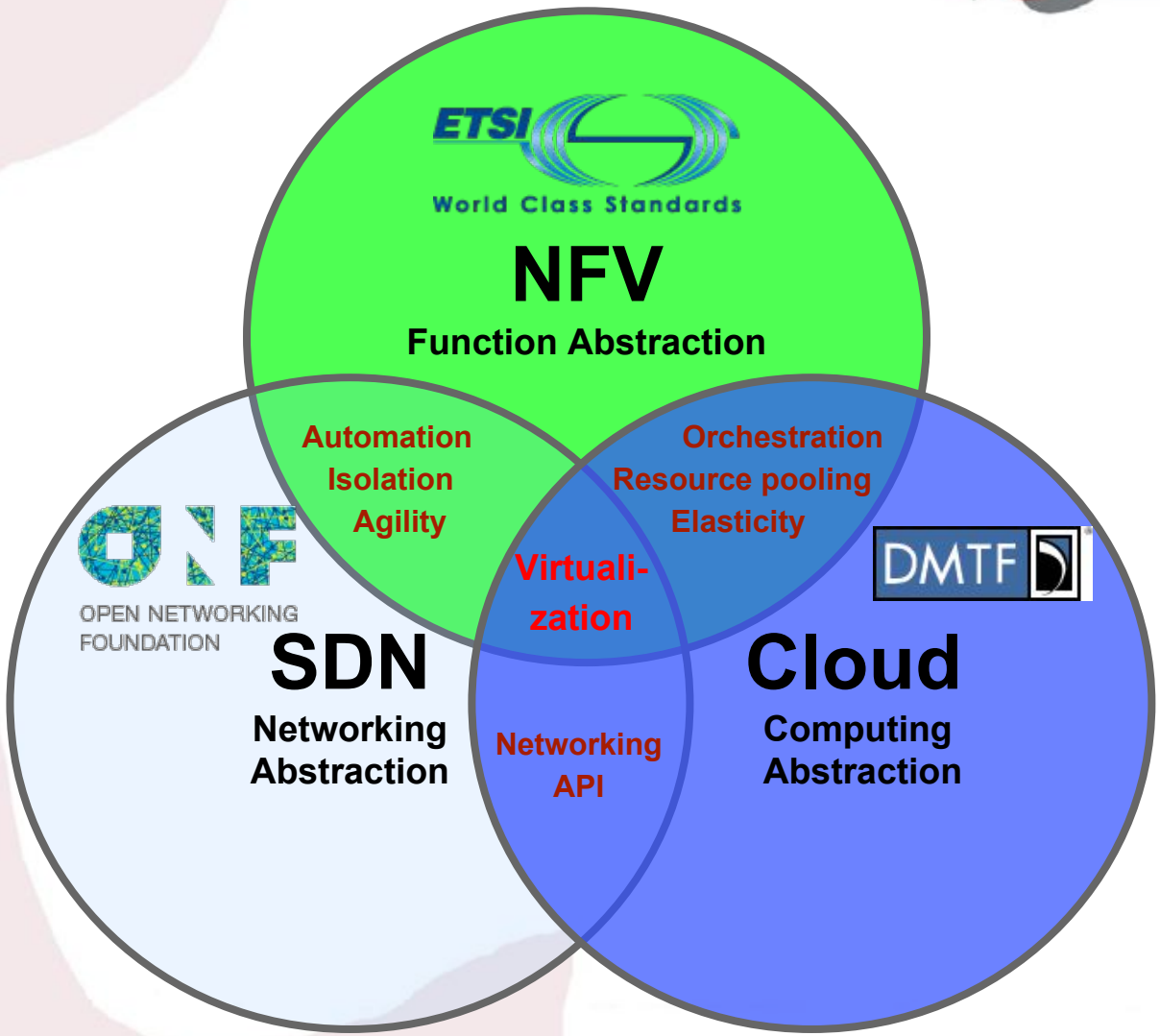
NFV x SDN x Cloud



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