A Concept of Storage System Control with Decision Trees for Storage QoS Provisioning

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Presentation Outline

1. Problem
2. Model
3. Proposed Solution
4. Conclusions & Future Work

Problem definition

Provisioning Quality of Service for Storage Systems...

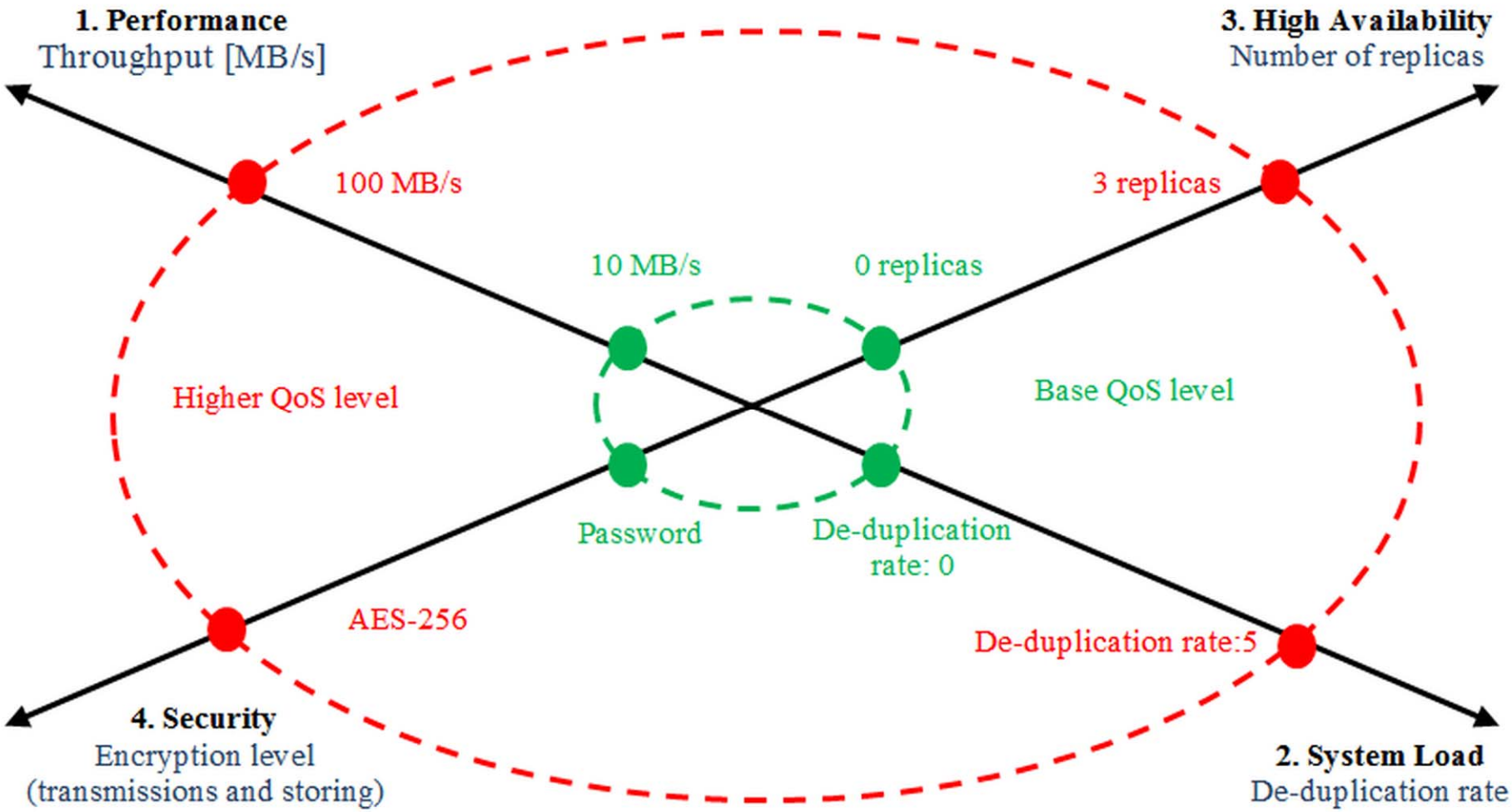
...in Cloud environments such as:

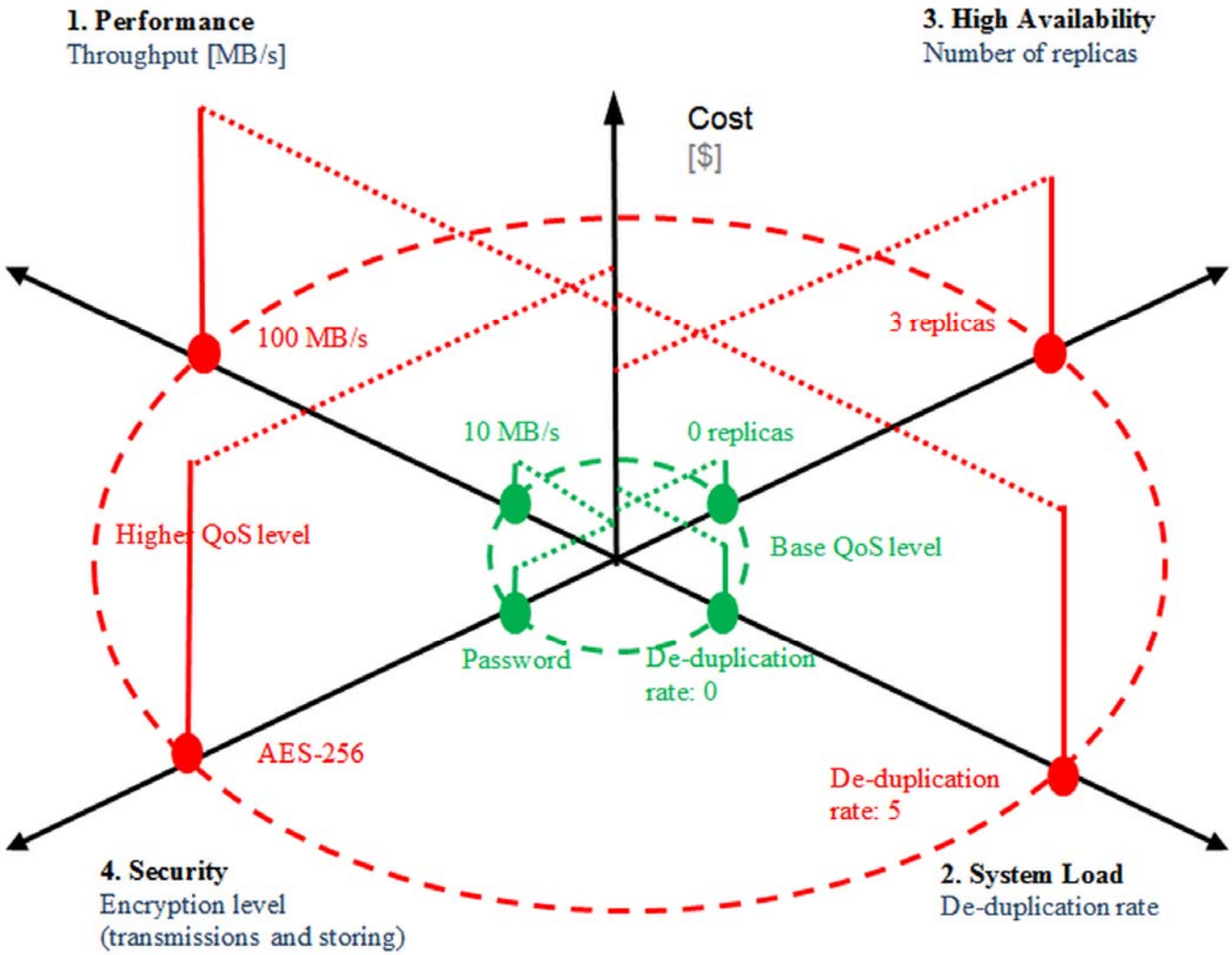
Backup as a Service (BaaS)

Archive as a Service (AaaS)

Resource Storage Management Model

- definitions of key system parameters
- connect QoS to cost ($)
- defines specialized management policies
- policies define actions for SLA esurance


1. Performance
Throughput [MB/s]
3. High Availability
Number of replicas
100 MB/s
3 replicas
10 MB/s
0 replicas
Higher QoS level
Base QoS level
Password
De-duplication
rate: 0
AES-256
De-duplication rate:5
4. Security
Encryption level
(transmissions and storing)
2. System Load
De-duplication rate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Example: Performance Policy

Policy type/Use-Case	Backup	Restore
Proactive	Reservation of disk space i.e.: N*TB on SSD disks	Data stored on disks i.e.: moving data T2D
Interactive	Staging i.e.: moving data D2T	Analysis of the state of the system, and selection of the best- copy/replica
Best Effort	The lowest quality, insufficient resource jobs are rejected	The lowest quality, insufficient resource jobs are rejected

Example: High Availability Policy

Policy type/Use-Case	Backup	Restore
Proactive	Storage Nodes load balancing, RAID level	Asynchronous replication
Interactive	Synchronous replication (during backup)	Analysis of the state of the system, and selection of the best copy/replica, or parallel recovery
Best Effort	No replica	Only the original file no replica

How such systems work? They...

…monitor Storage System parameters

…monitor Service Level Agreement fulfilment

…load balance the system with simple heuristic

…take little action if SLA fails

BEST EFFORT

How such systems should work?

…monitor Storage System parameters

…monitor Service Level Agreement fulfilment

…predict if SLA will be fulfilled

…take action to ensure SLA

…provide insight for administrators

Is machine learning an answer?

- train using historical data
- classify incoming requests for SLA fulfillment
- partially solve the problem - no silver bullet
- minimize SLA violations vs. ensure all SLA

What method should we use?

Decision Trees

- simple to understand and to interpret
- uses a **white box** model
- implicitly perform **feature selection**
- rules generation in the fields where experts have difficulties with formalising their knowledge

Decision Trees

- possible to **validate a model** with statistical tests
- able to handle numerical and **categorical data**
- requires little **data preparation**
- performs well with large datasets

$$O(n_{features} n_{samples} \log(n_{samples}))$$

Tests description

Small test infrastructure: Disk Array and HSM

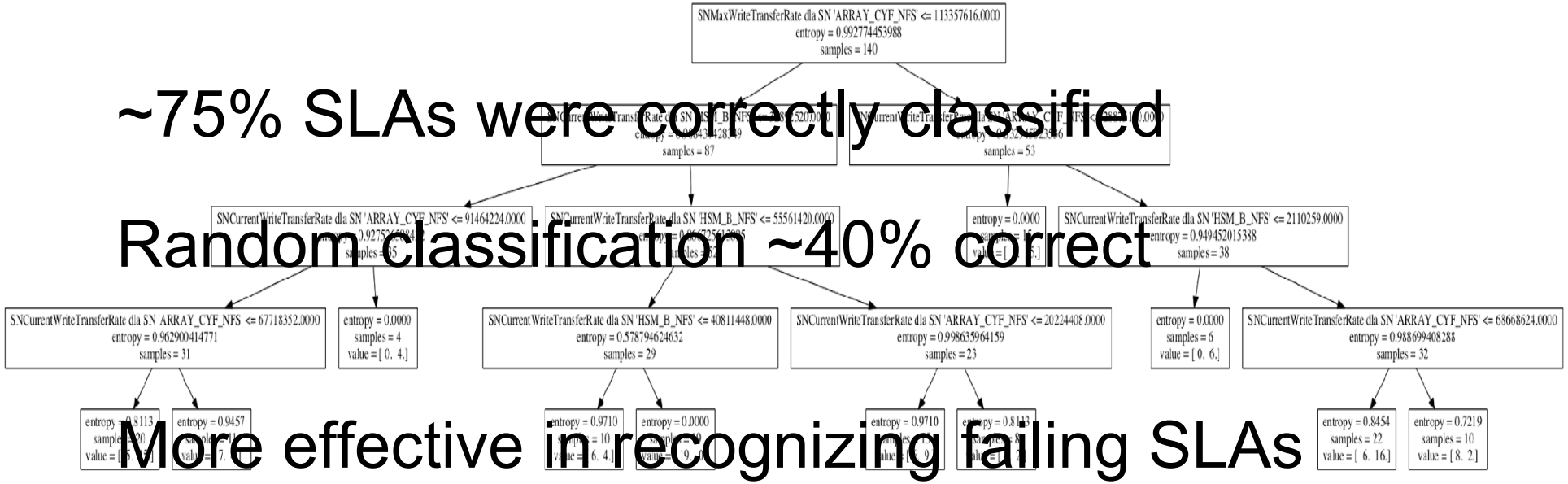
System capable of monitoring SLA

Best effort load balancing

3 users, 6GB files, different SLAs, 200 writes

40% of SLAs were not fulfilled

Acceptable early results



~75% SLAs were correctly classified

Random classification ~40% correct

More effective in recognizing failing SLAs

Conclusion & Future Work

- QoS provisioning is a multidimensional problem
- there is no silver bullet for QoS provisioning
- DT hold a promise of a more robust system

- more tests, larger and more diverse training set
- define actions aiding SLA fulfillment

Questions?

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Example: Security Policy

Policy type/Use-Case	Backup	Restore
Proactive	Encryption of transmission i.e.: AES 128/256	Encryption of stored data (disk array/tape library)
Interactive	Encryption of stored data (disk array/tape library)	Encryption of transmission i.e.: AES 128/256
Best Effort	The lowest quality, insufficient resource jobs are rejected	The lowest quality, insufficient resource jobs are rejected