Security Aware and Energy-Efficient Virtual Machine Consolidation in Cloud Computing Systems

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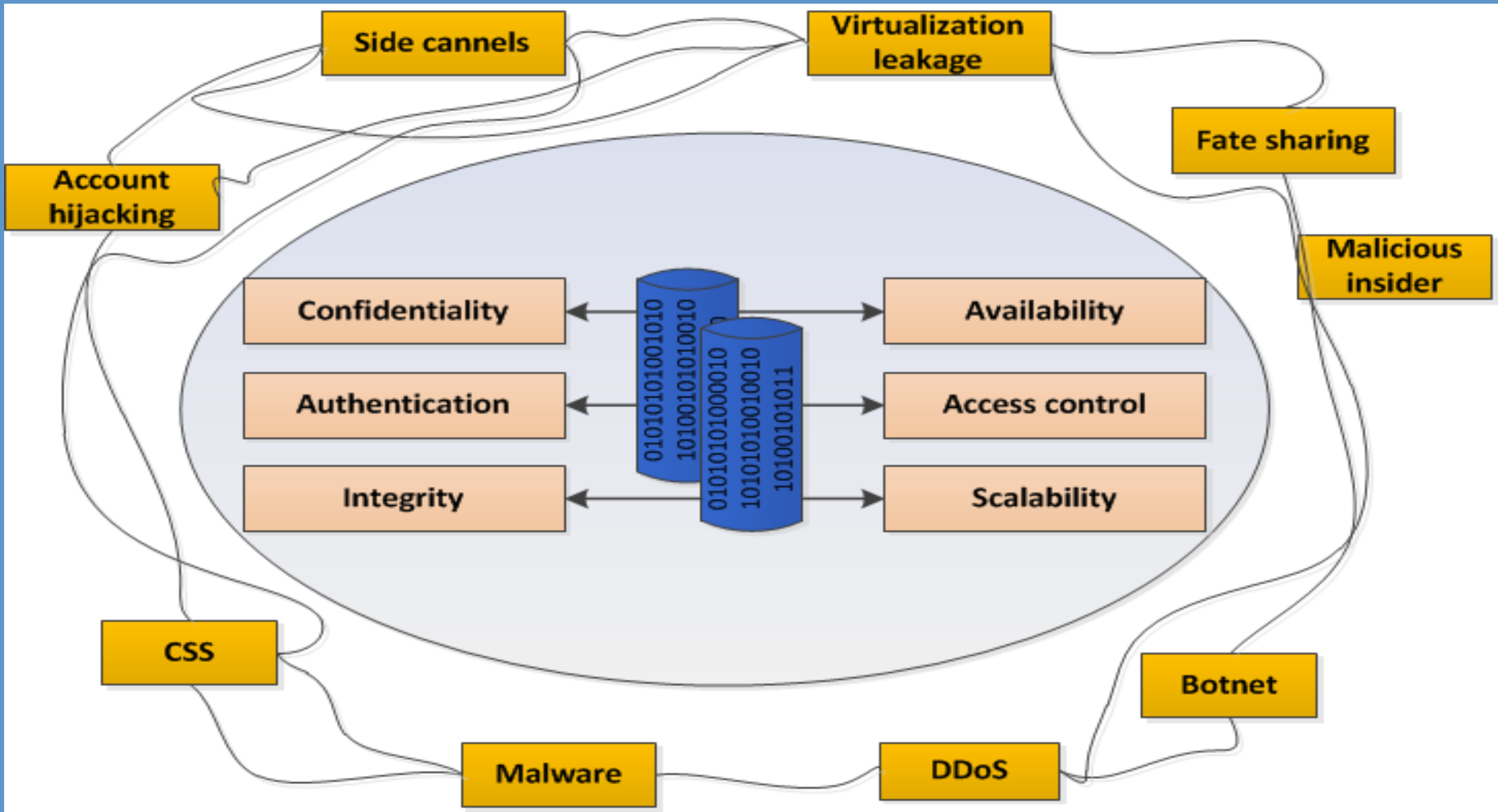
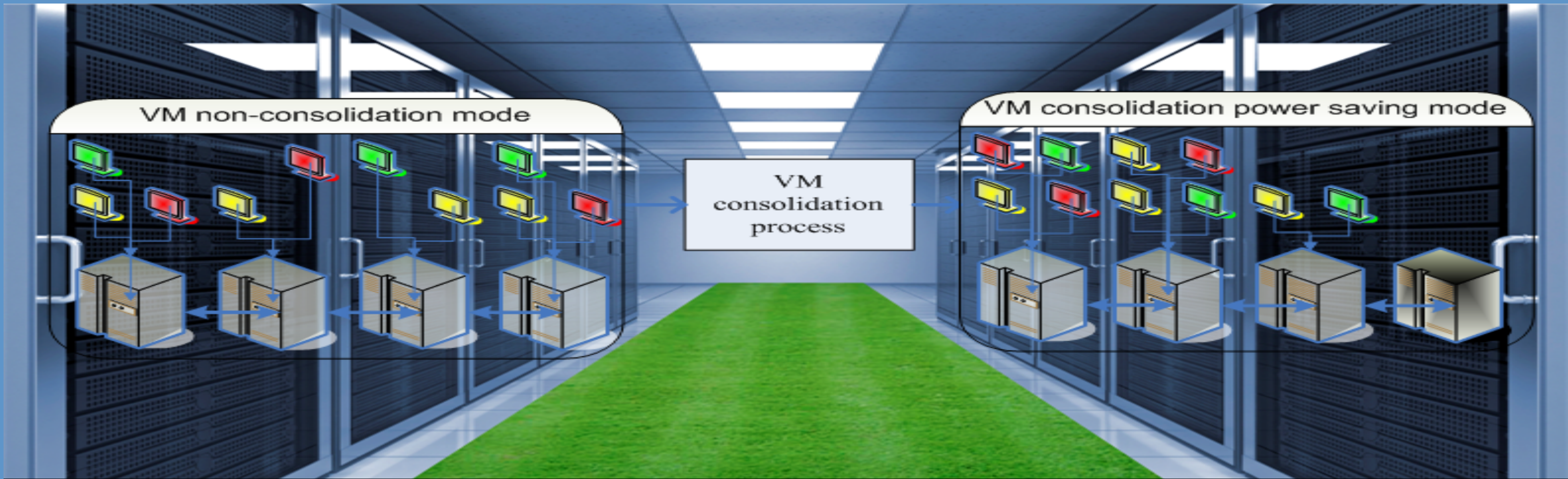
Security Concerns in Cloud Computing

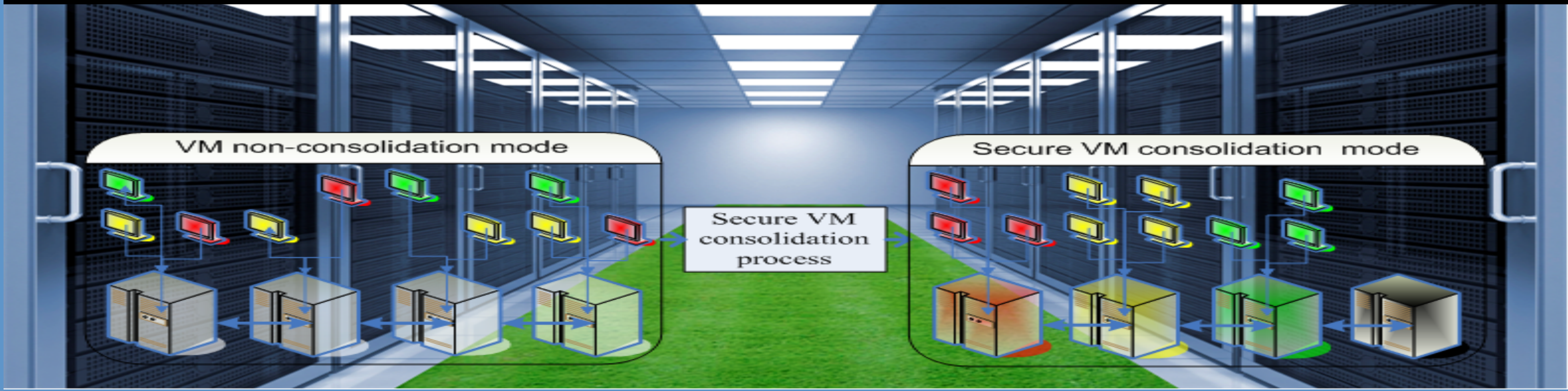


Attack types – considering resource sharing issue

VM consolidation – What and why ?



How do we ensure that our data in the Cloud is not *living* with a malicious neighbour?



Proposed Approaches

a) The Compartment Isolation Approach of Secure Virtual Machine Consolidation
b) Security Profiles for the Virtual Machines

Secure VM Consolidation

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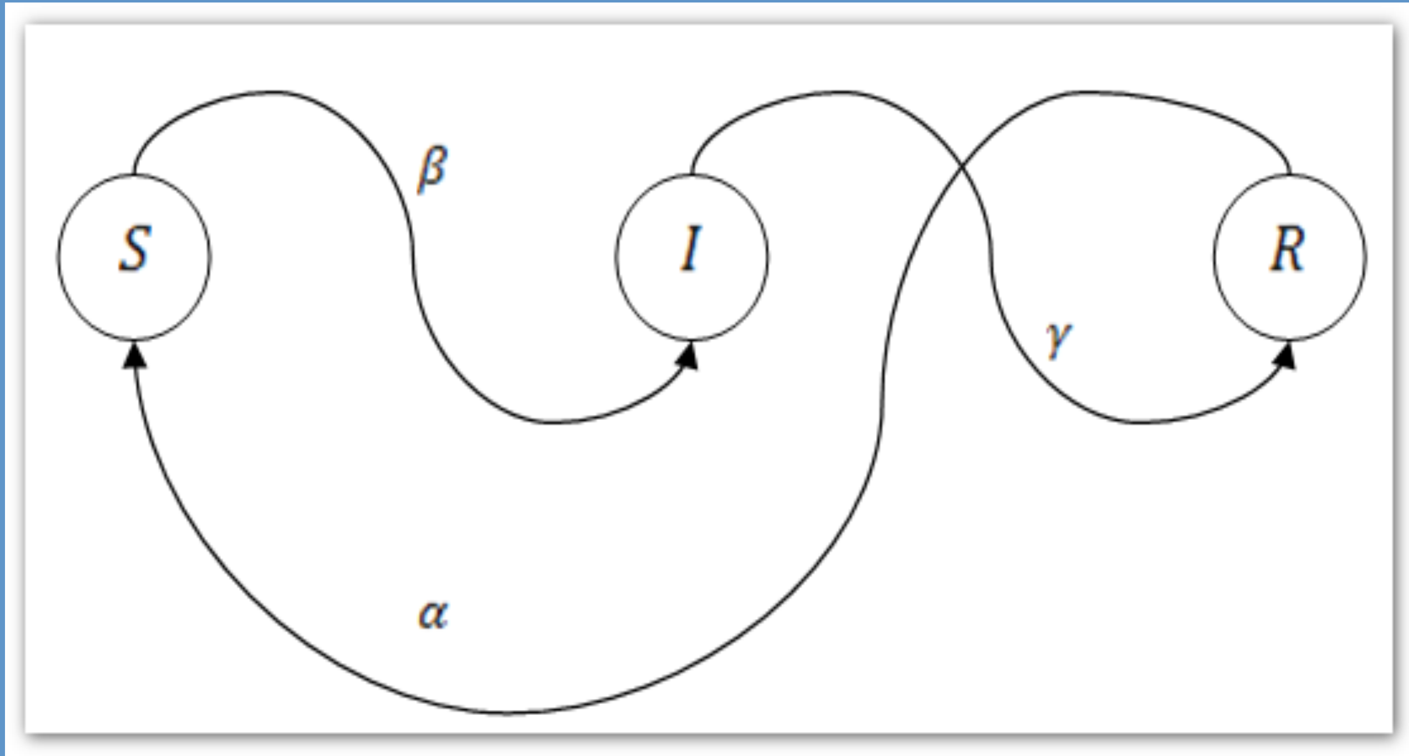
The Compartment Isolation Approach of Secure Virtual Machine Consolidatior

R model

- Susceptible
- Infected
- Recovered

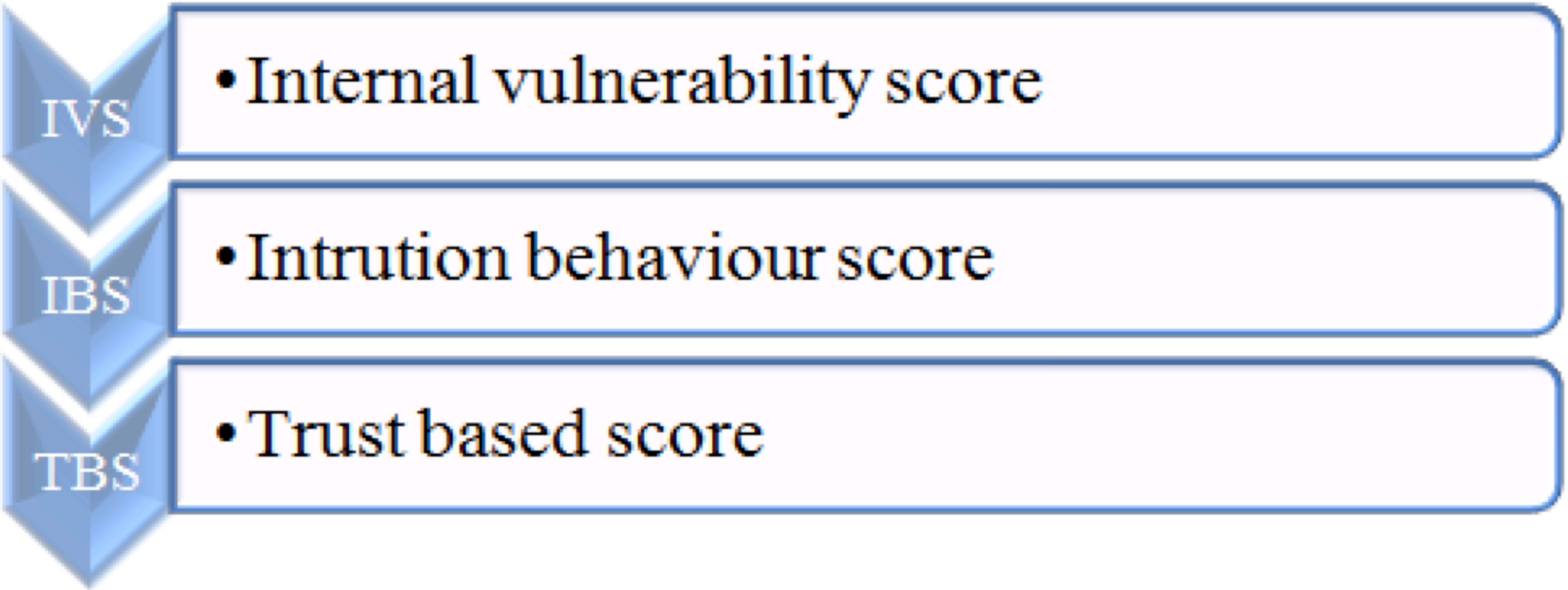


Using the isolated compartment strategy;
separation of VMs reduces the probability cross computer malware spreading.

$$p(S) > p(S/r)$$

Secure VM Consolidation

Security Profiles for the Virtual Machines



Step 1. Compute and generate score of the VMs based on the relevant security parameters

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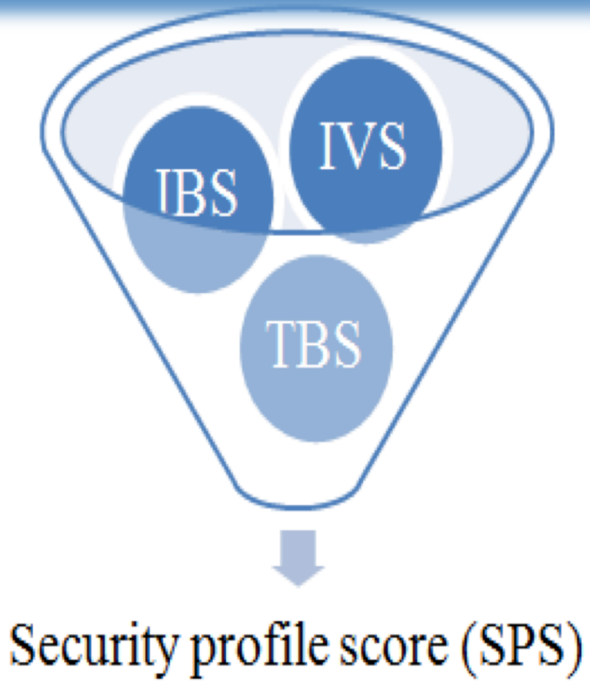
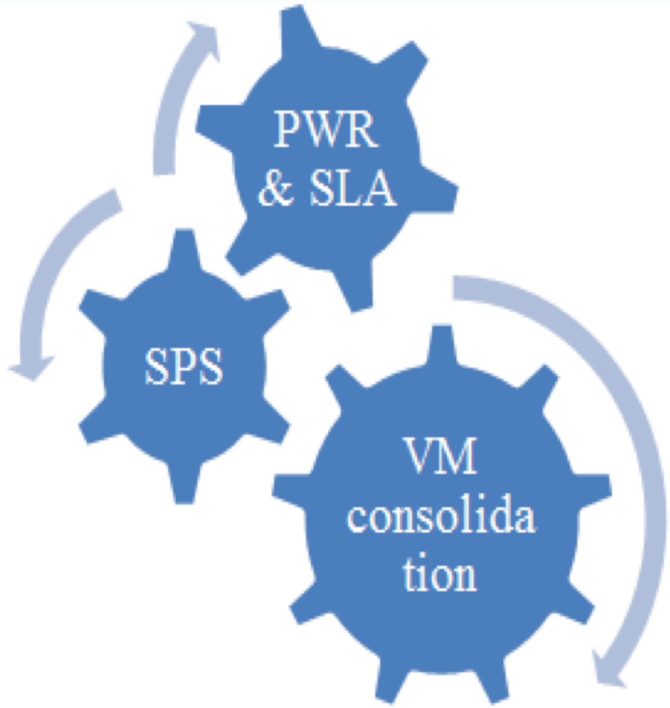
Security Profiles for the Virtual Machines



p 2. Weighted average of the multi-dimension
ty score



Step 3. Develop VM consolidation job integr
security profile

Internal vulnerability

Internal vulnerability and Intrusion analysis score

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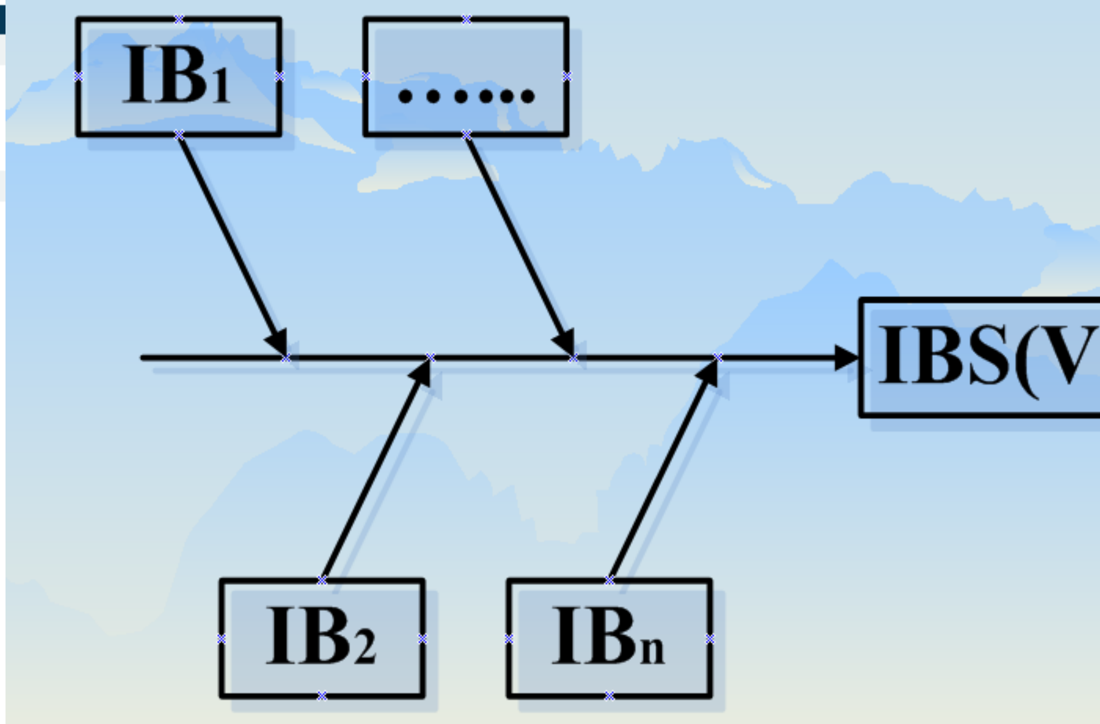
16

High	Medium	Low	Info	Total
0	3	1	21	25

	Plugin Id	Name
(5.1)	18405	Microsoft Windows Remote Desktop Protocol Server Man-in-the-Middle Weakness
(5.0)	57608	SMB Signing Disabled
(4.3)	57690	Terminal Services Encryption Level is Medium or Low
)	30218	Terminal Services Encryption Level is not FIPS-140 Compliant
	10114	ICMP Timestamp Request Remote Date Disclosure
	10287	Traceroute Information
	10394	Microsoft Windows SMB Log In Possible
	10397	Microsoft Windows SMB LanMan Pipe Server Listing Disclosure
	10736	DCE Services Enumeration
	10785	Microsoft Windows SMB NativeLanManager Remote System Information Disclosure
	10940	Windows Terminal Services Enabled



Intrusion based score is being formed fr
n number of intrusion behavior inputs

$$BS(VM_i) = \frac{w_1 \times IB_1 + w_2 \times IB_2 + \cdots\cdots + w_n \times IB_n}{\sum_{j=1}^{n} w_j} \quad (1$$

Ranking of the security profiles of the VMs

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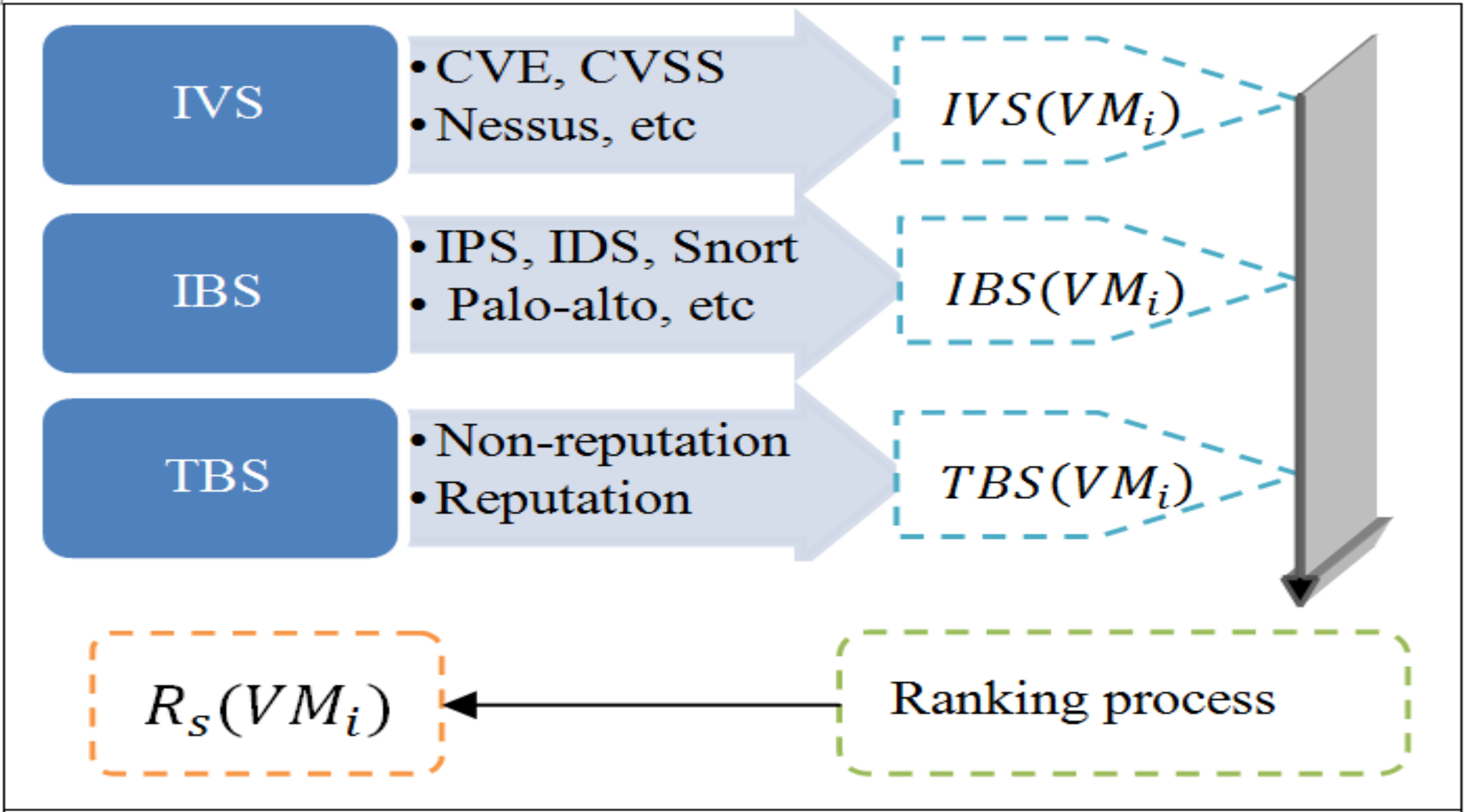

Weighted ranking of the security profile

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High level procedure of the VM migration

I Migration Selection

1. Random Selection (RS)
2. Minimum Migration Time (MMT)
3. Maximum correlation (MC)
4. Minimum Utilization (MU)

VM Migration Placement

1. Local Regression (LR)
2. Local Regression Robust (LRR)
3. Median Absolute Deviation (MA
4. Static Threshold (THR)

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Secure VM Selection Algorithm (SBS)

```
Algorithm 1: Secure VM selection to migrate
Input host : Output vmToMigrate

migratableVMs <- getMigratableVMs(host)
minMetric <- MAX
foreach vm in migratableVMs do
    if vm is not in migration then
        metric = vm.getRam()
        if metric < minMetric  then
            if hostSecurityLevel != vmSecurityLevel
                vmToMigrate <- vm
return vmToMigrate
```

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Secure VM Placement Algorithm (SBP)

```
Algorithm 2: Secure VM placement
Input vmList, hostList Output

vmList.sortDecreasingUtilization()
foreach vm in vmList do
    minPower <- MAX
    allocatedHost <- NULL
    foreach host in hostList do
        if hostSecurityLevel Equals vmSecurityLevel then
            if host has enough resources for vm then
                power <- estimatedPower( vm, host)
                if (power < minPower) then
                    if( VMsInPM < AllowedMaxVM )
                        allocatedHost <- host
                        minPower <- power
    If allocatedHost !=NULL then
        allocation.add(allocatedHost, vm)
return allocation
```

Simulation Setup

a) CloudSim Simulator
b) PlanetLab Workload
c) Power Consumption Profile

Server load	HP ProLiant G4(W)	HP ProLiant G5(W)
0%	86	93.7
10%	89.4	97
20%	92.6	101
30%	96	105
40%	99.5	110
50%	102	116
60%	106	121
70%	108	125
80%	112	129
90%	114	133
100%	117	135

VM and PM initial configuration for simulation

Virtual Machine Details	
Total MIPS of VM	2500
Total PES (Processor unit) of VM	1
Total RAM of VM	1024 MB
Network Bandwidth of VM	100 Mbit/s
Total Storage size of VM	2.5 GB
Physical Machine Details	
Total MIPS of PM	2660
Total PES (Processor unit) of PM	2
Total RAM of PM	8192 MB
Total Storage size of PM	80 GB

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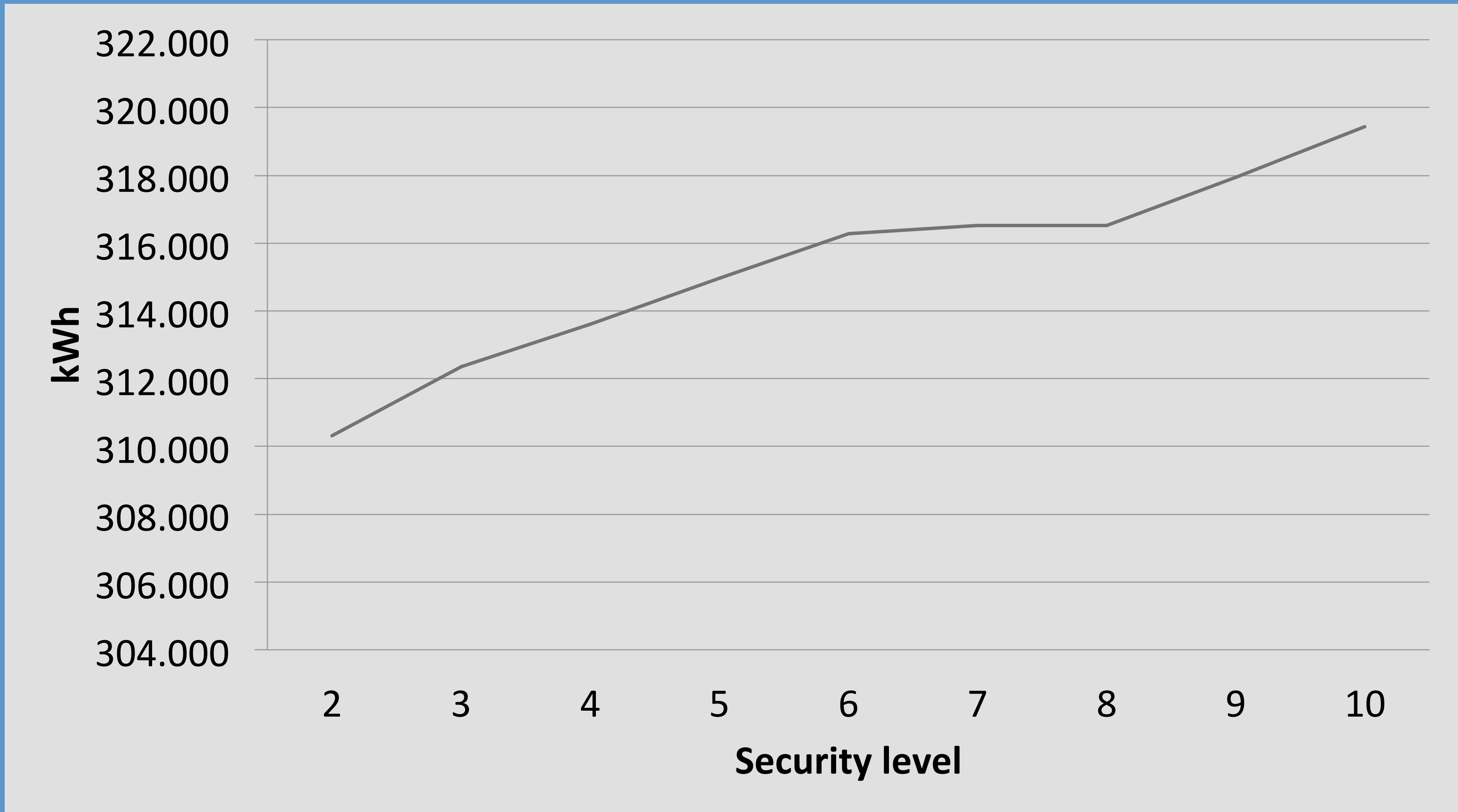
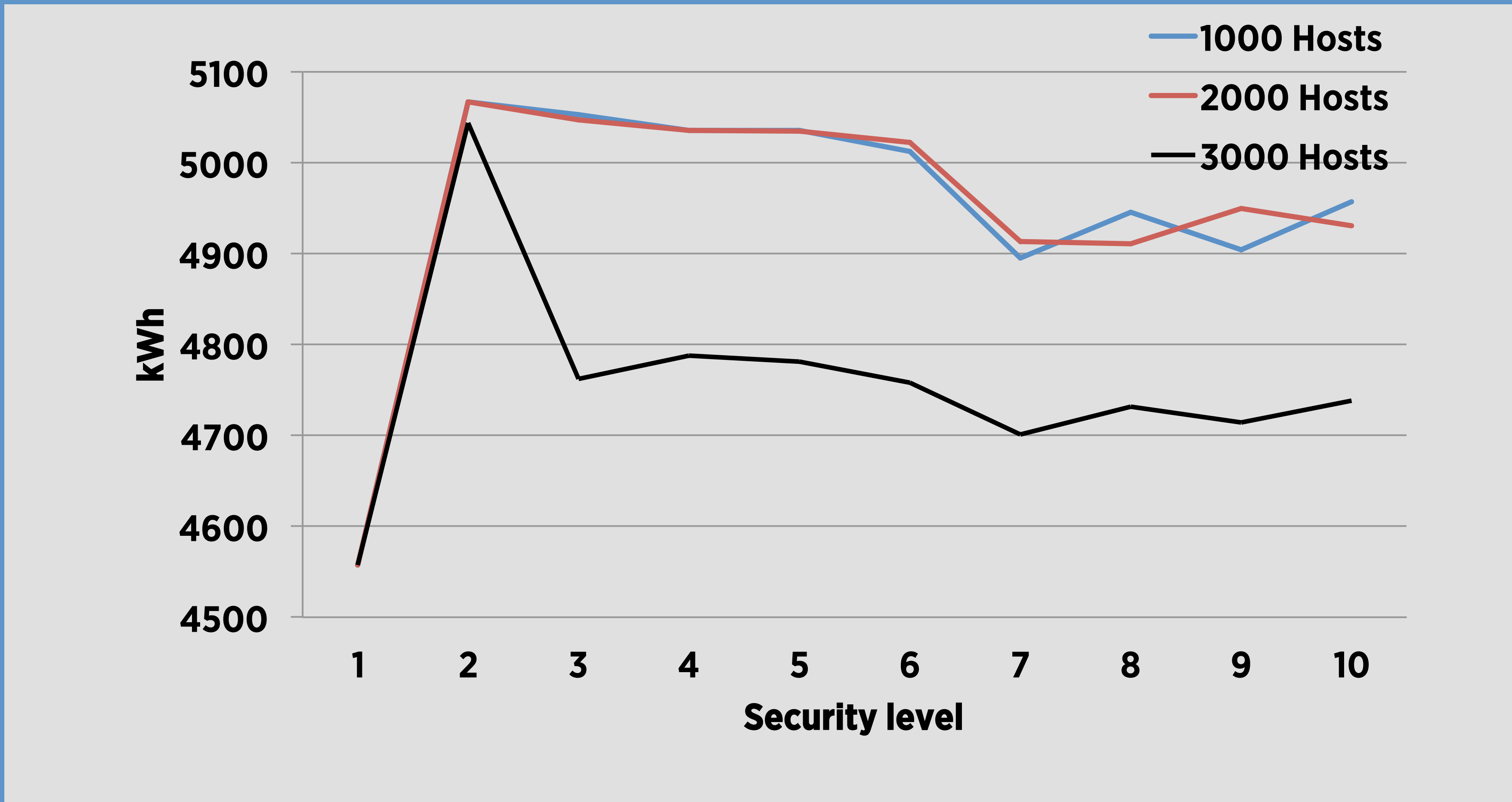
Security aware VM consolidation comparison for low-medium workload for 800 hosts



ergy consumption versus security graph when the number of PMs are 1000, 2000 and 3000



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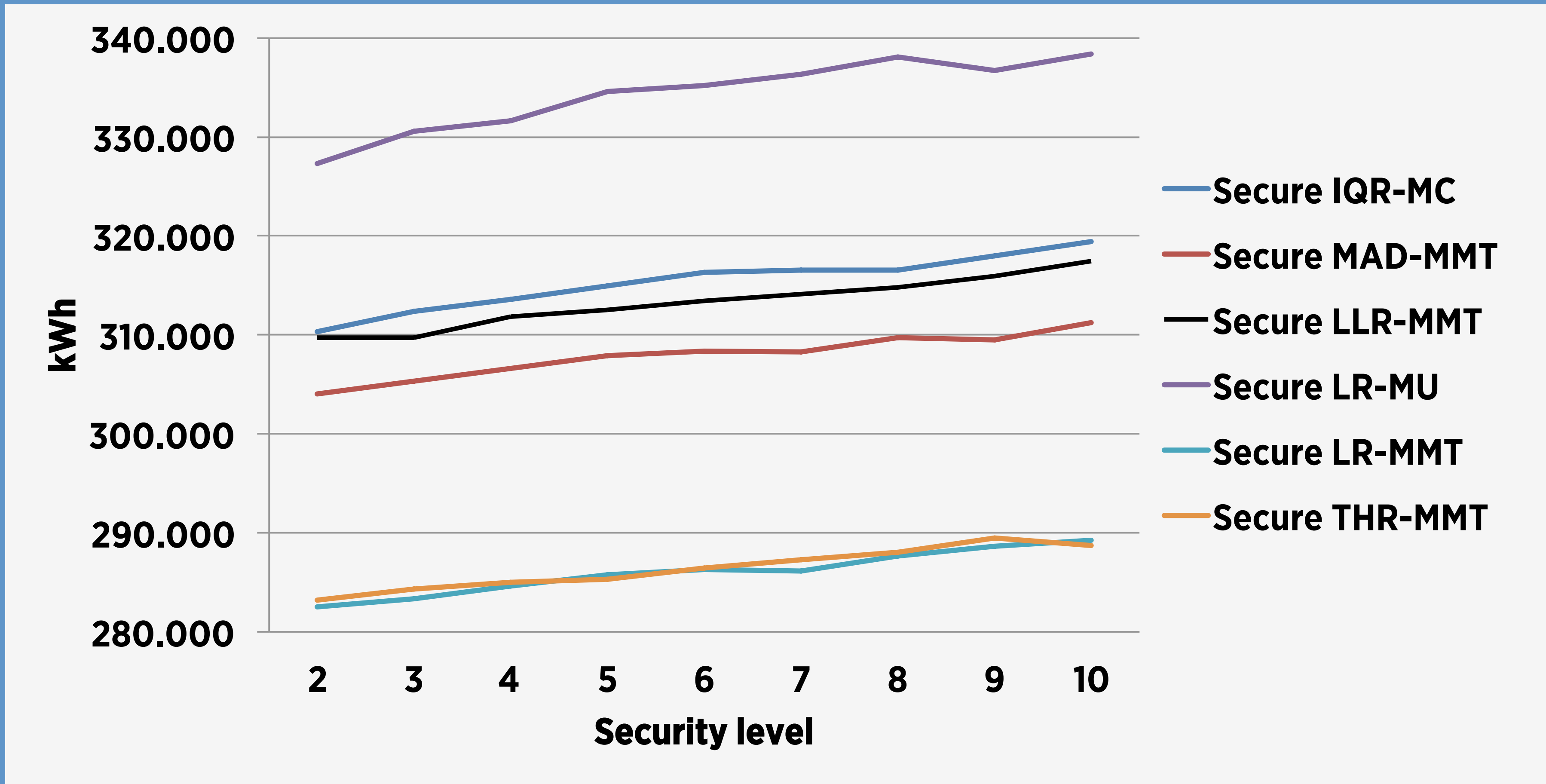
Security level vs. energy consumption in multiple security-aware algorithms



Conclusions

Introduced the compartment isolation technique to achieve the security aware VM consolidat

Different types of simulation setup and the subsequent result confirms that there are no abrup changes in power consumption to achieve security aware VM consolidation.

The solution presents an added protection measure with the minimal impact on energy efficie algorithm.

This work could be extended to improve the VM reliability as well as security and energy consumption.