Multi-Cloud Distribution of Virtual Functions and Dynamic Service Deployment: OpenADN Perspective

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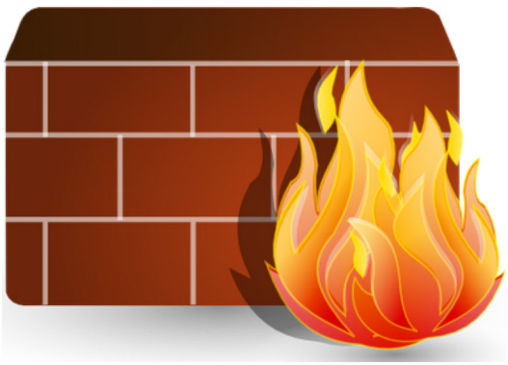
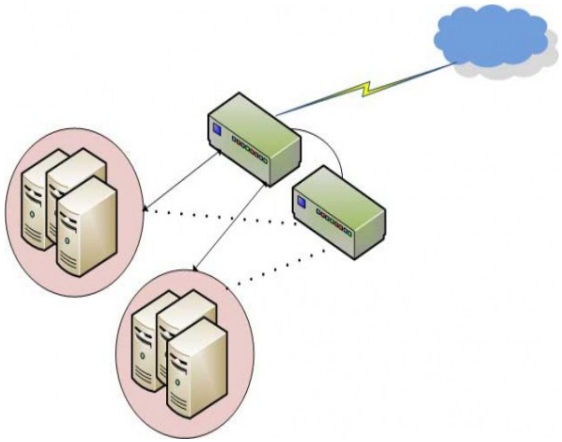
These slides and audio/video recordings of this talk are at:
http://www.cse.wustl.edu/~jain/talks/vm_distp.htm

1. Virtual Functions
2. Optimal and non-optimal location
3. Integer Linear Programming Formulation
4. Minimum Residue Algorithm
5. Comparison with Max-Min Algorithm

Virtual Functions

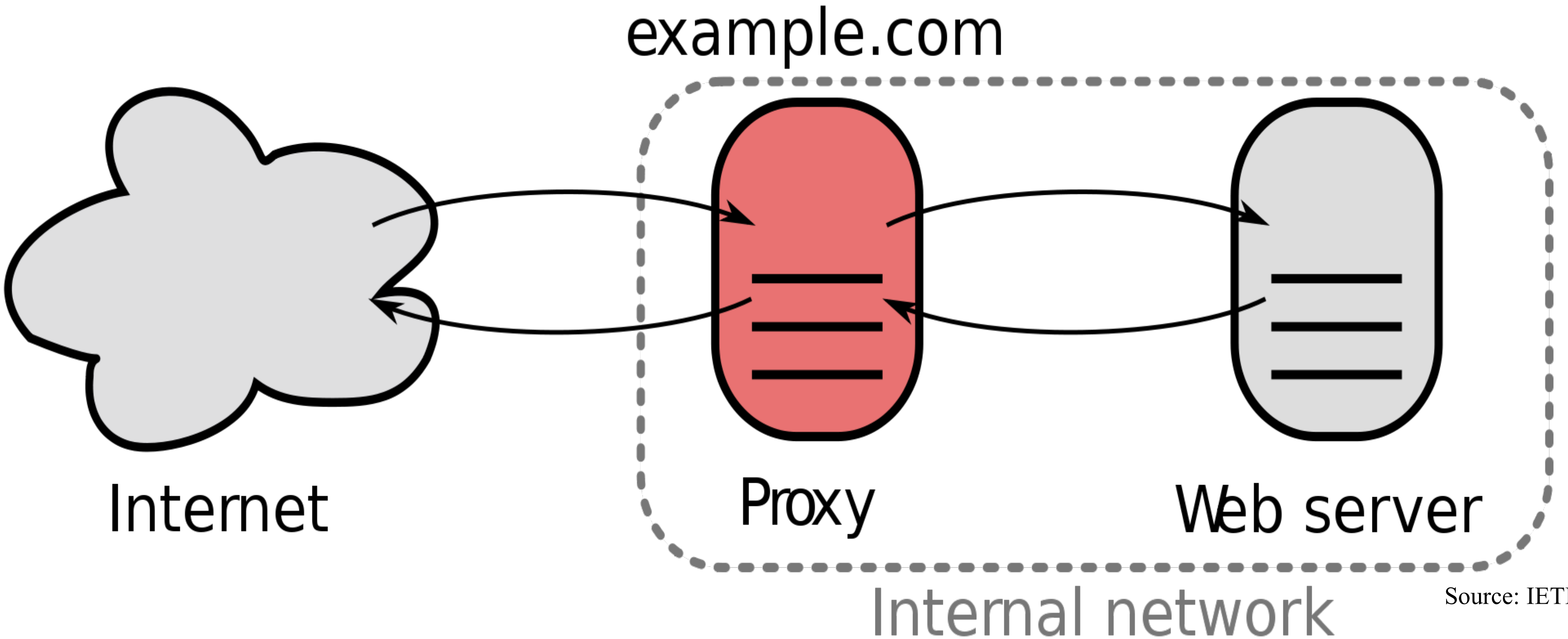
- **Virtual Functions:** Distributed entities: e.g., Web server, load balancers, data base servers, Proxy servers and many others





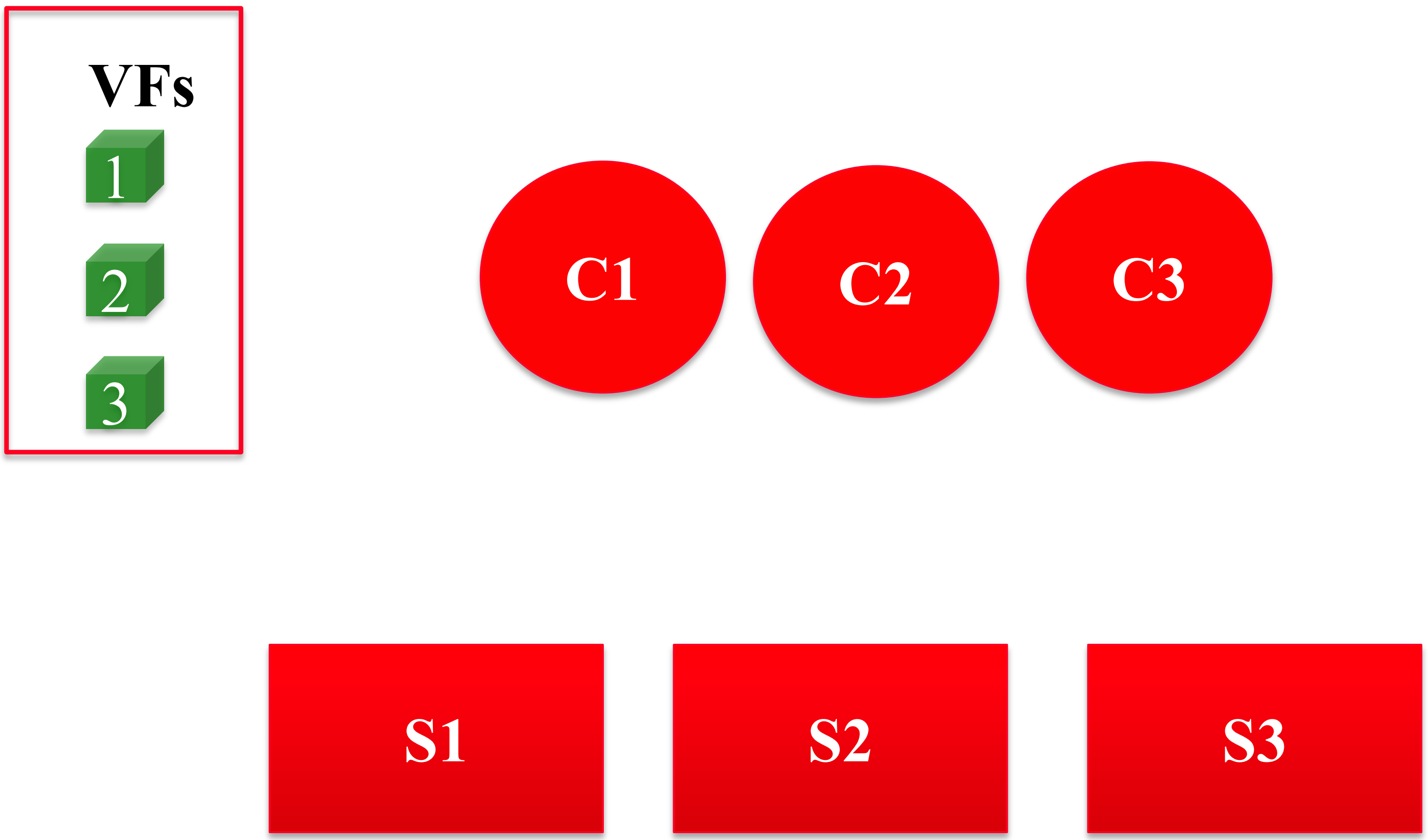
Service Chaining

- Individual Virtual Functions communicate with each other in defined ways
- Traffic between components is required (by policy) to flow through specialized network services (e.g., firewalls, IDS, etc.)

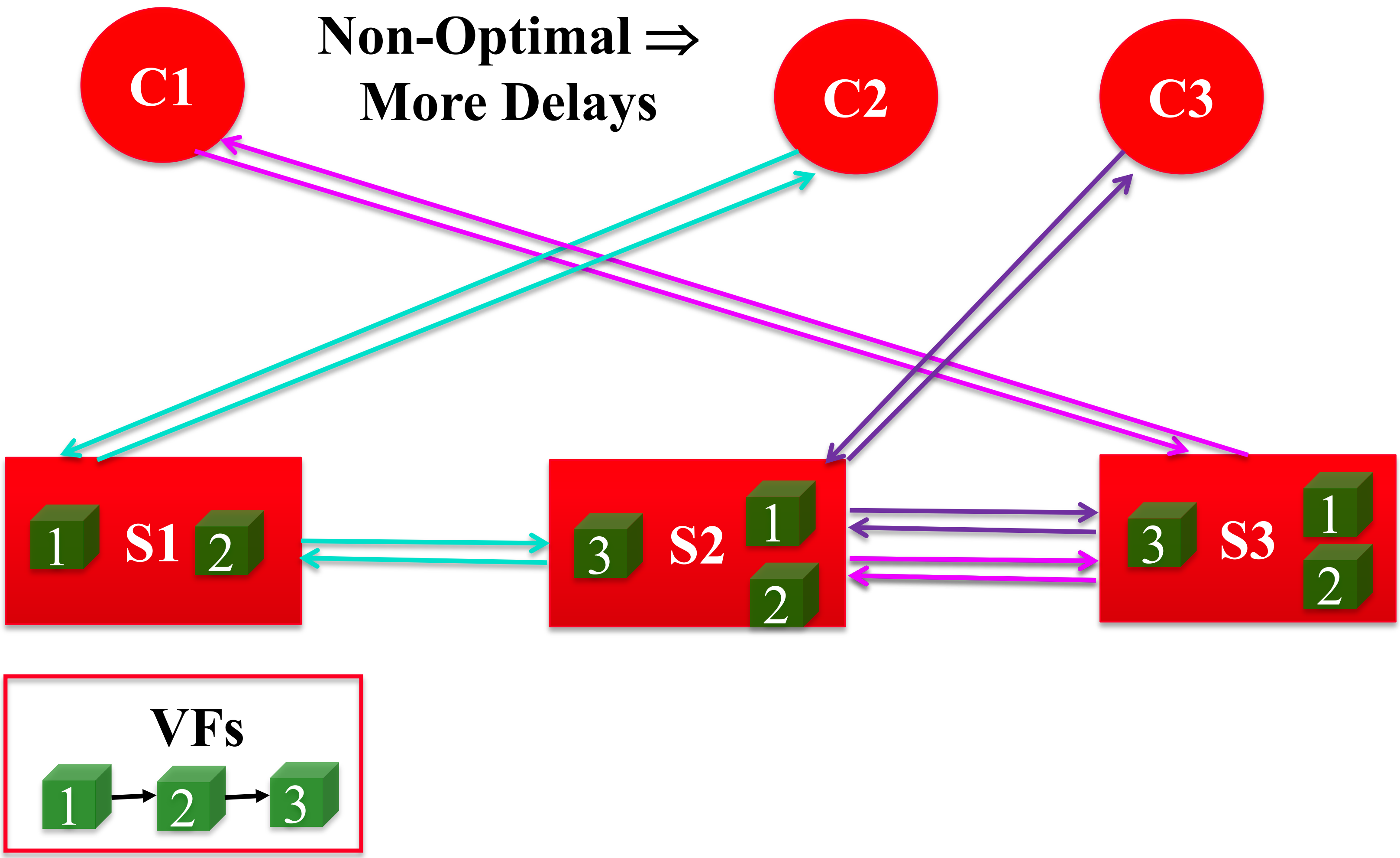


Source: IETF-87

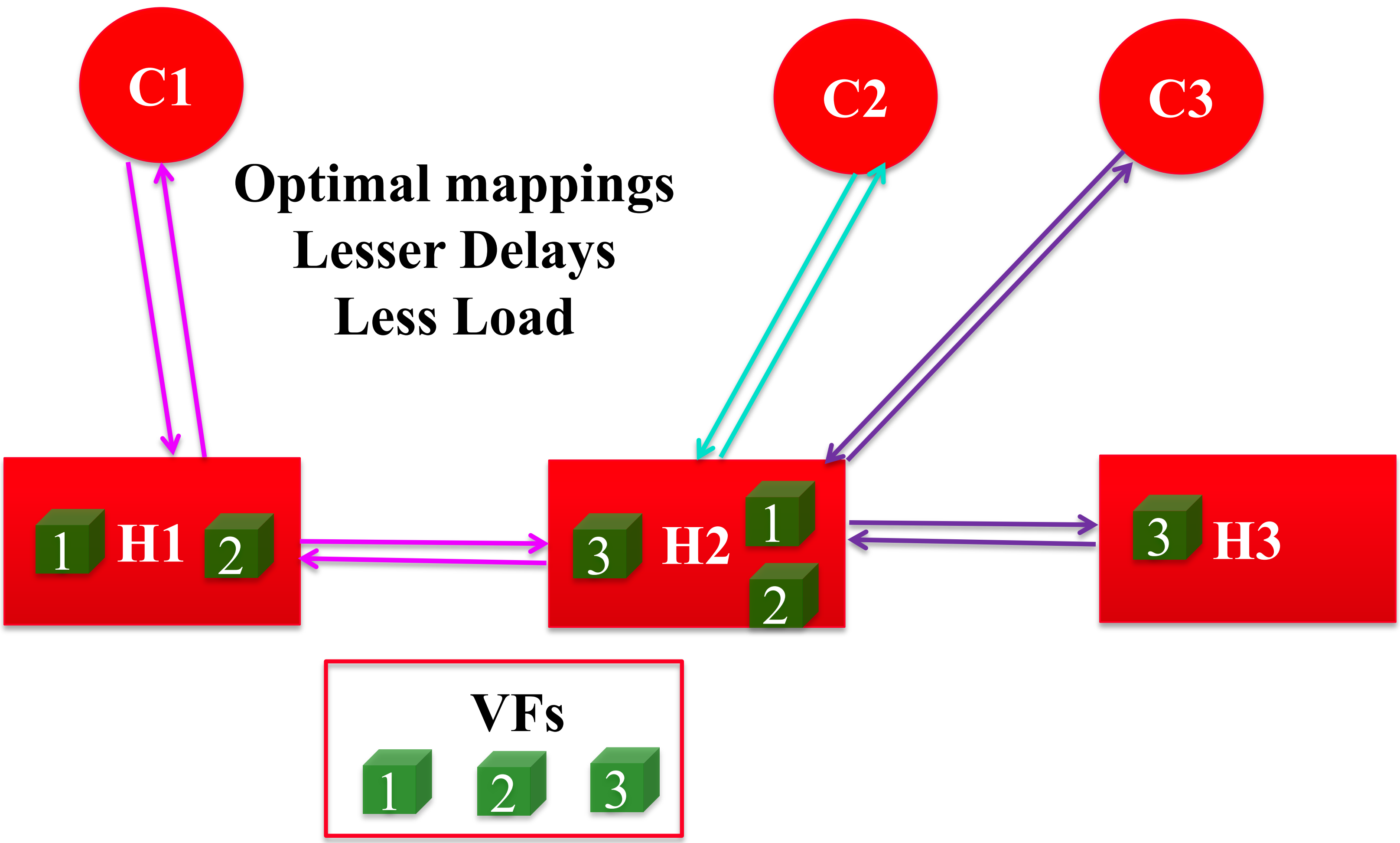
VFs, Clients, and Locations



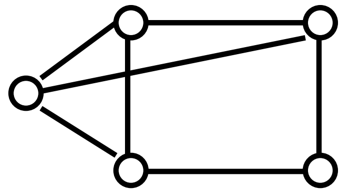
Mappings: Non-Optimal



Mappings: Optimal



Integer Linear Programming Formulation



- $G = \{V, E\}$ ➔ Network
- $E \subseteq V \times V$ ➔ Edges or Links
- λ ➔ Total VF instances ($\lambda_{min} \geq \lambda \geq \lambda_{max}$)
- C ➔ Capacity Matrix
  - $(C^1{}_1 + C^2{}_1 + C^3{}_1)$: Capacity of node 1 (CPU, Storage, NW)
- P ➔ Transmission Delay Matrix
- W ➔ Traffic Matrix
- **D** ➔ Demand Matrix
  - $(D^1{}_1 + D^2{}_1 + D^3{}_1)$: Demand of VF 1 (CPU, Storage, NW)
- A ➔ Allocation Matrix
- **T** ➔ Instance Matrix (How many instances of VF i are installed at server j = T_{ij})

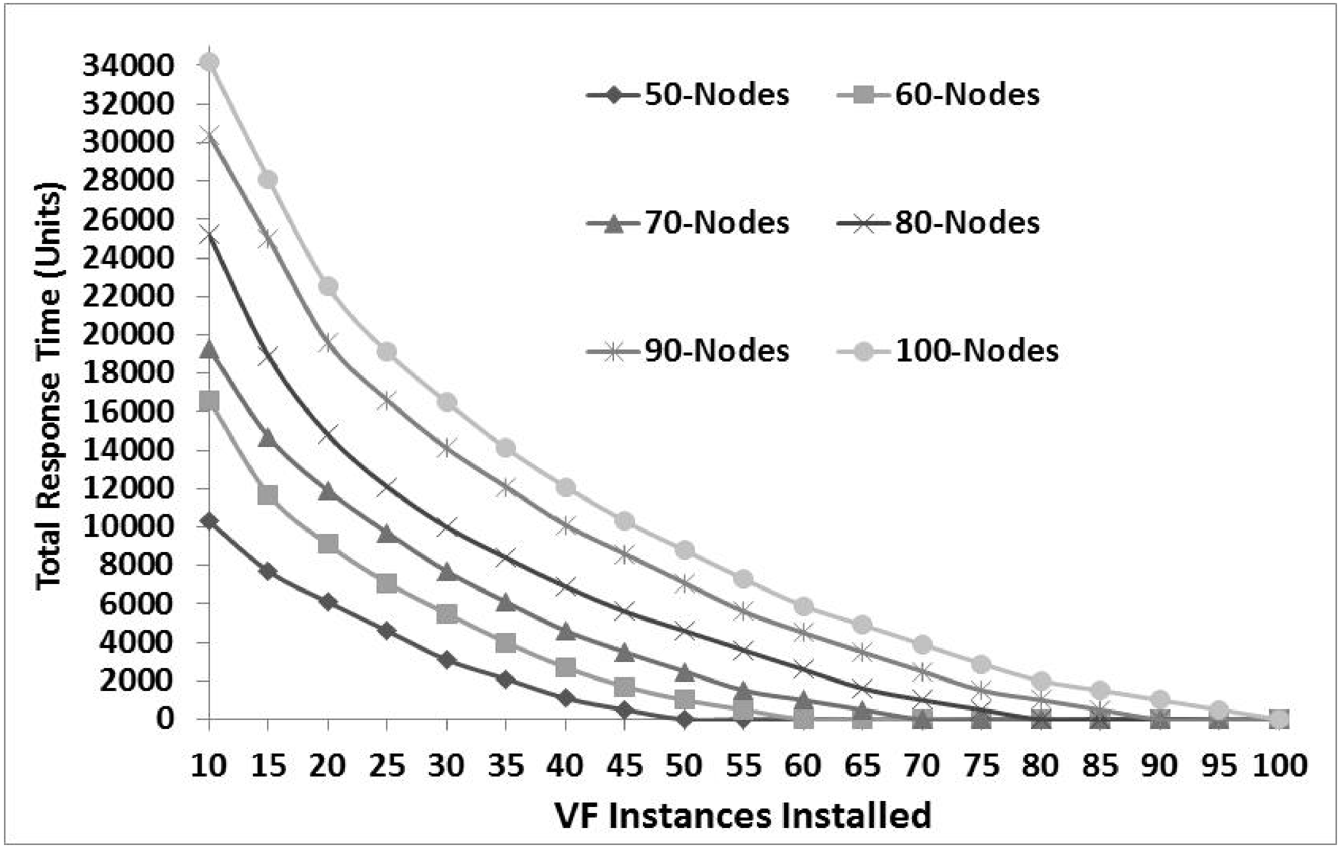
Minimization Function

- Minimize total delay without exceeding the server capacity

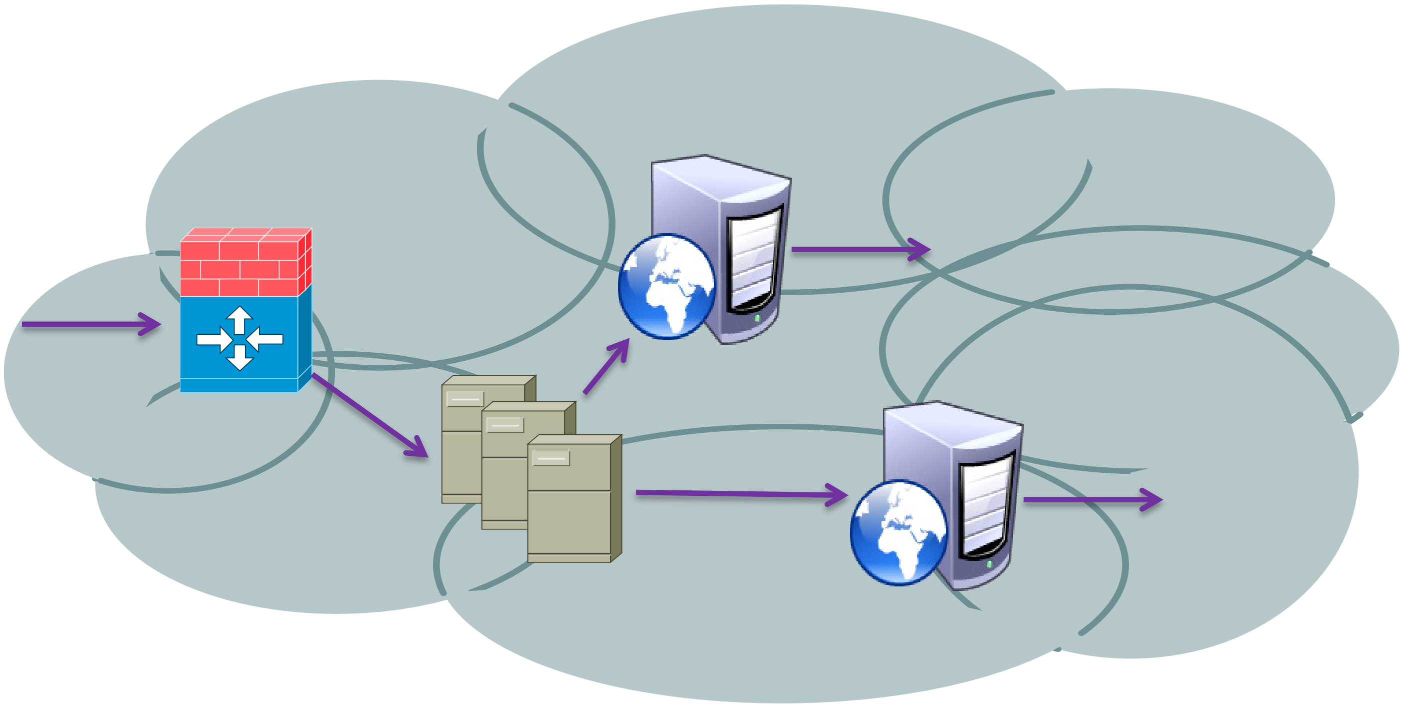
$$\sum_{i \in |V|} \sum_{j \in |V|} (w_i \times A_{ij}) / p_{ij}$$

- **P** is a Transmission Delay Matrix,
- **W** is a Traffic Matrix,
- ***A*** is an Allocation Matrix.

Response Time (10-100 Nodes)



Dynamic Mappings



- In the Cloud, a single ASP may have a set of services to be deployed.
- Each server may host a specific set of VFs.
- We propose a scheme for Dynamic Allocation of VFs to the servers.

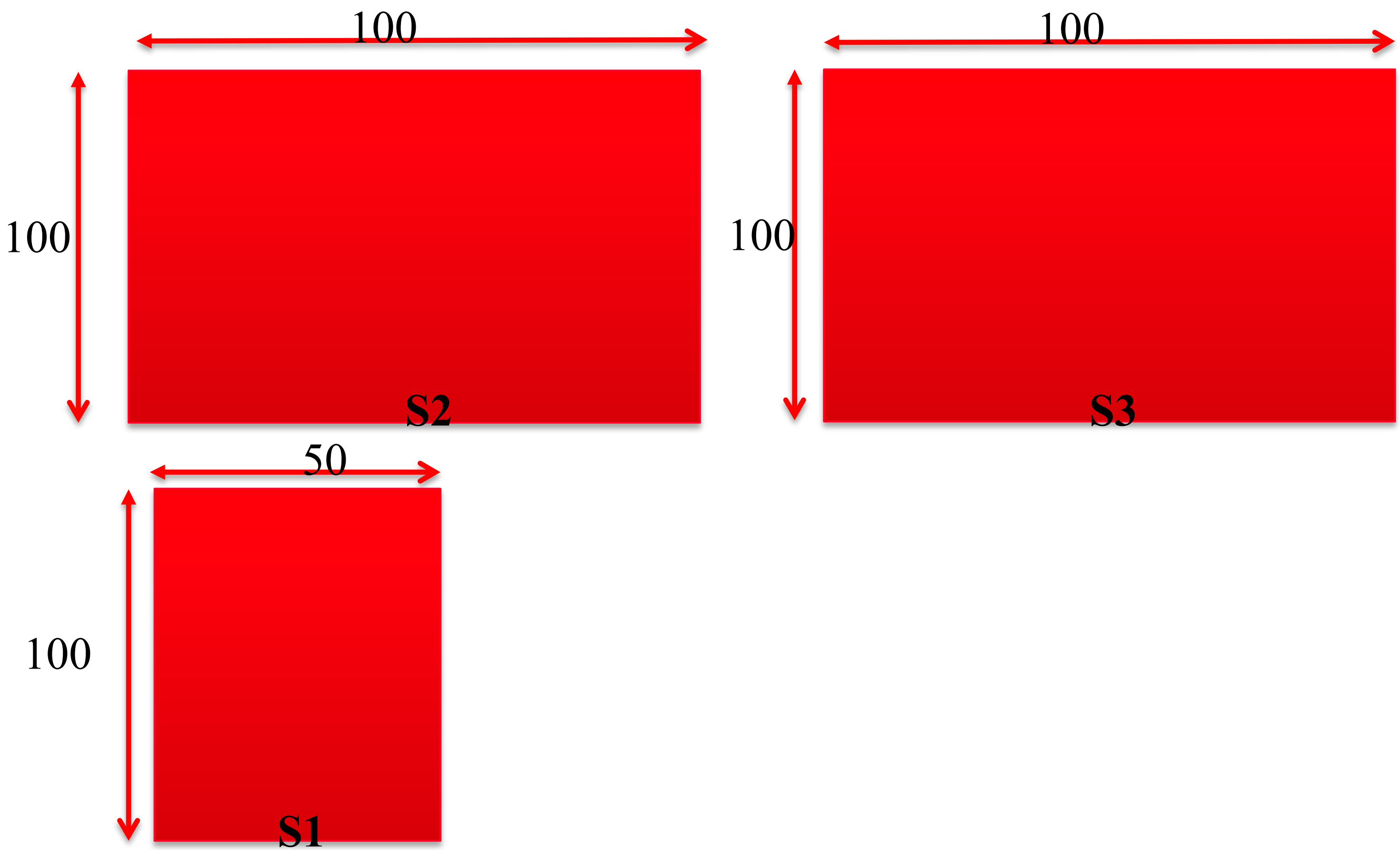
Simple Example

- 5 VFs and 3 servers. Each with 2 resources (2-dimension)

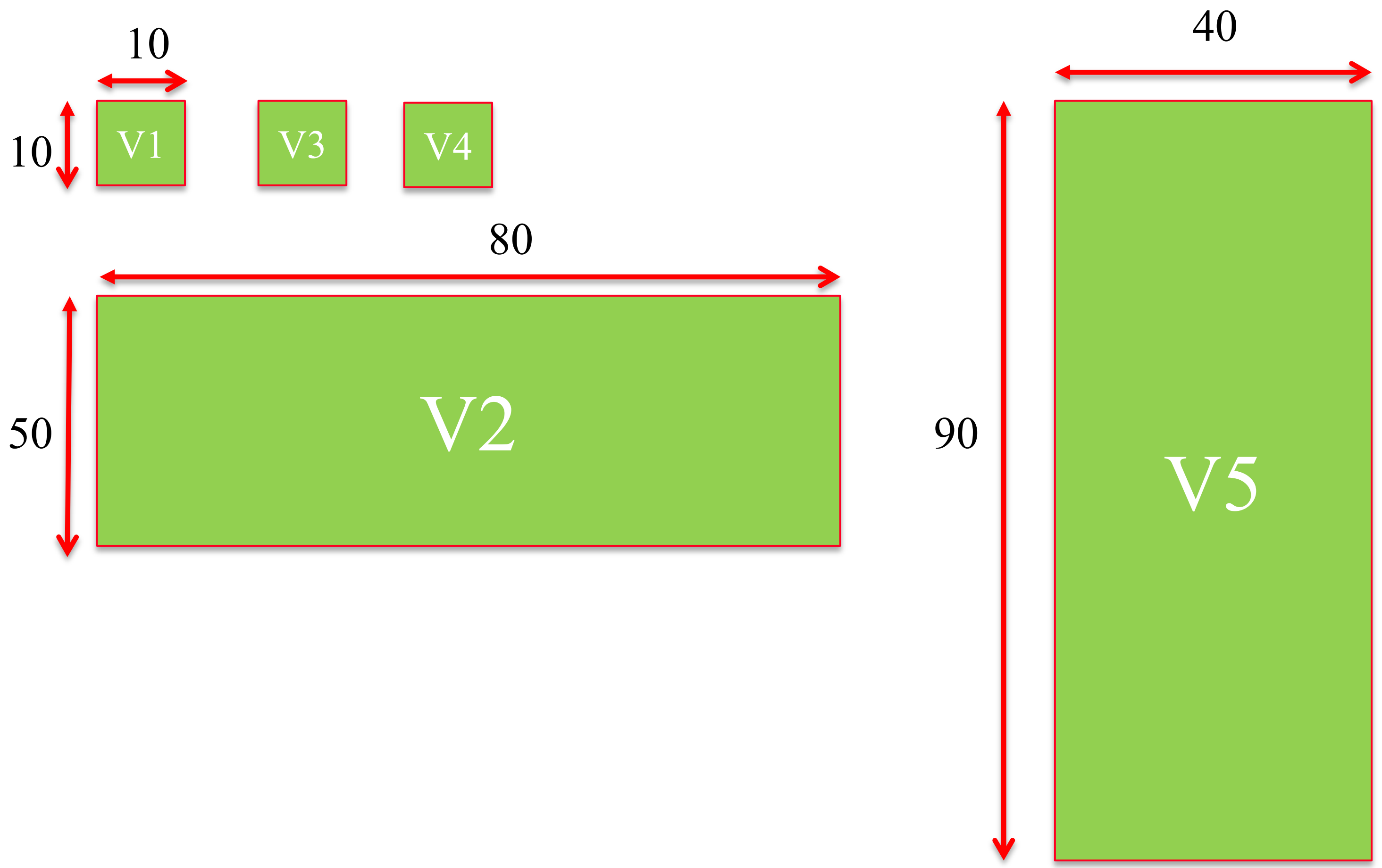
VFs	V1	V2	V3	V4	V5
r_1	10	80	10	10	40
r_2	10	50	10	10	90

Servers	S1	S2	S3
r_1	50	100	100
r_2	100	100	100

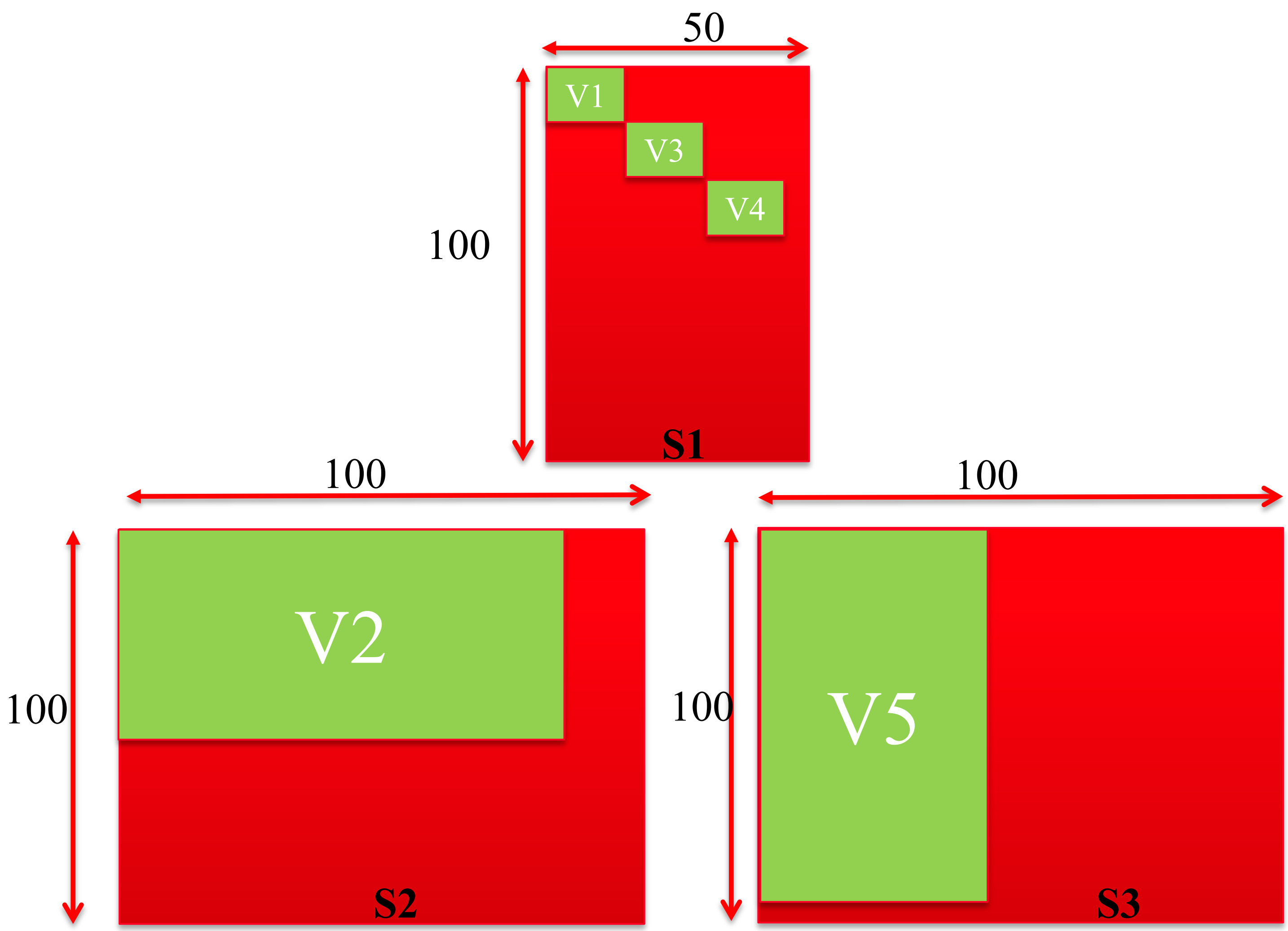
Resources



Demands

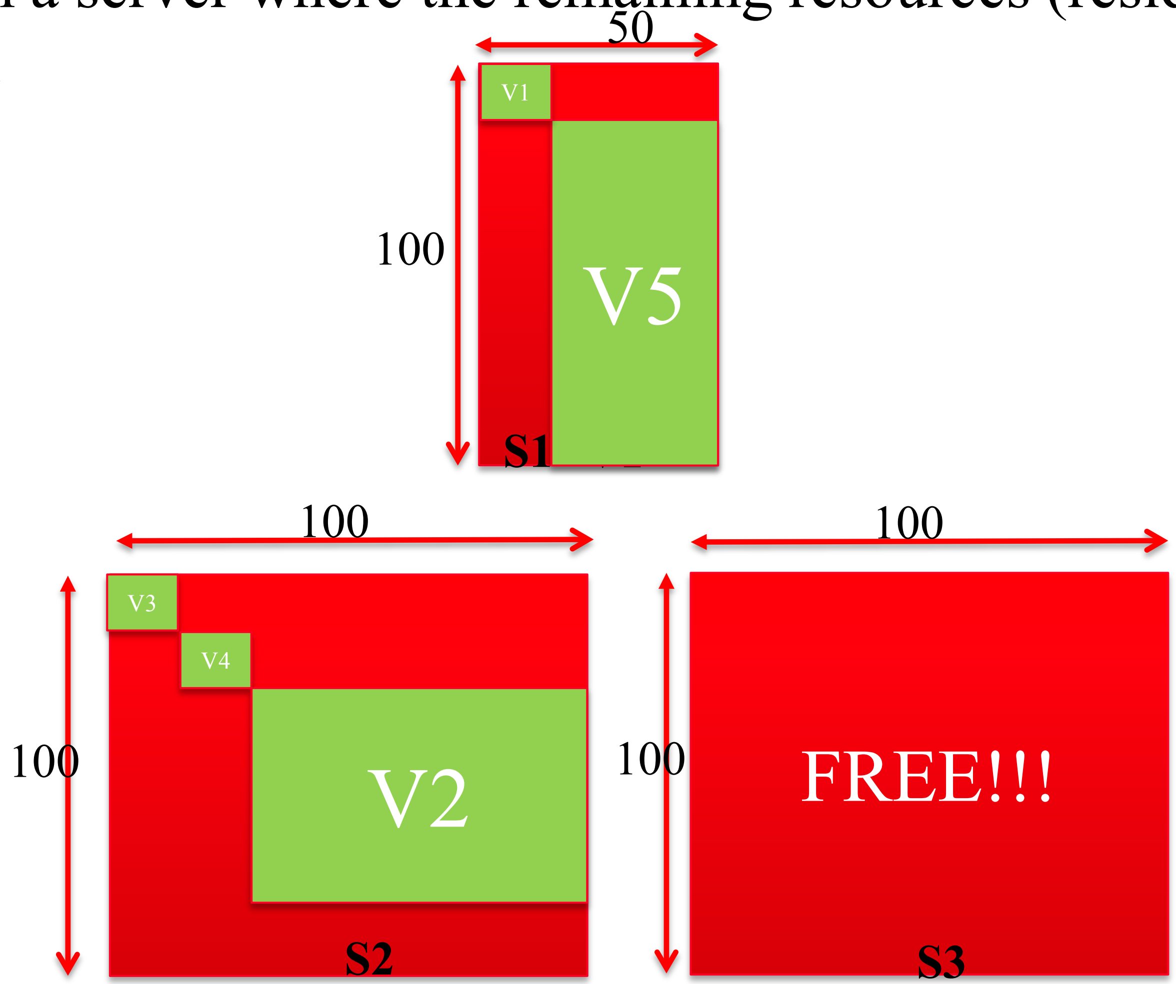


Max-Min Allocation

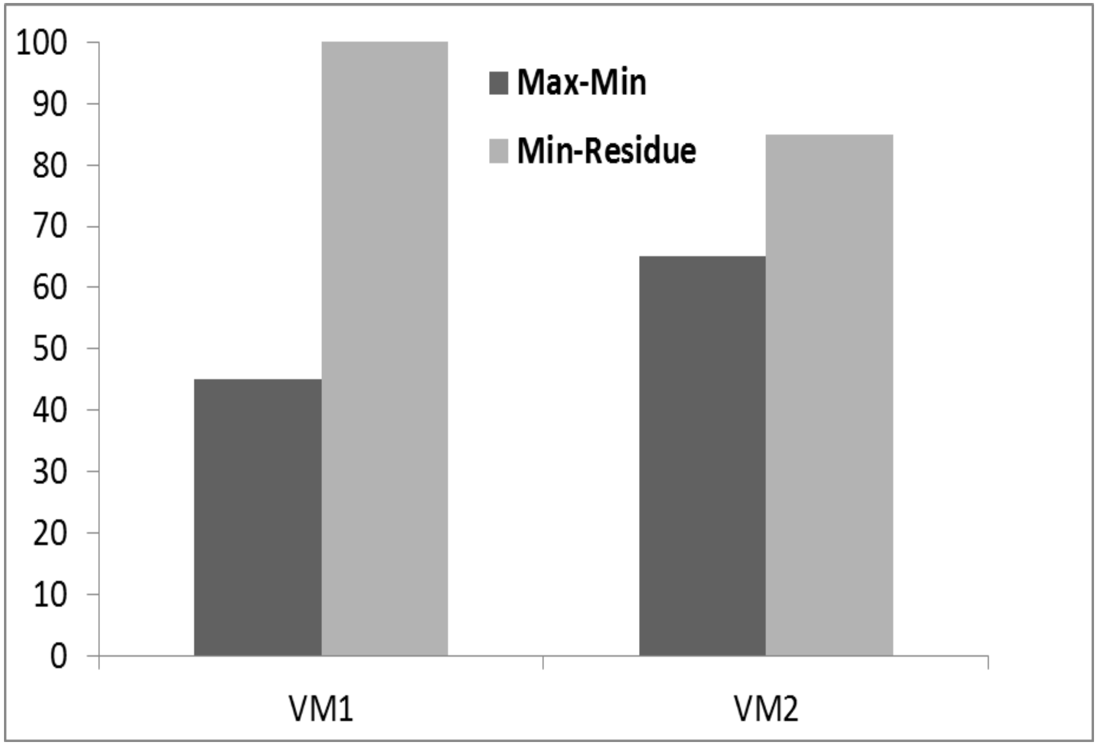


Minimum Residue Allocation

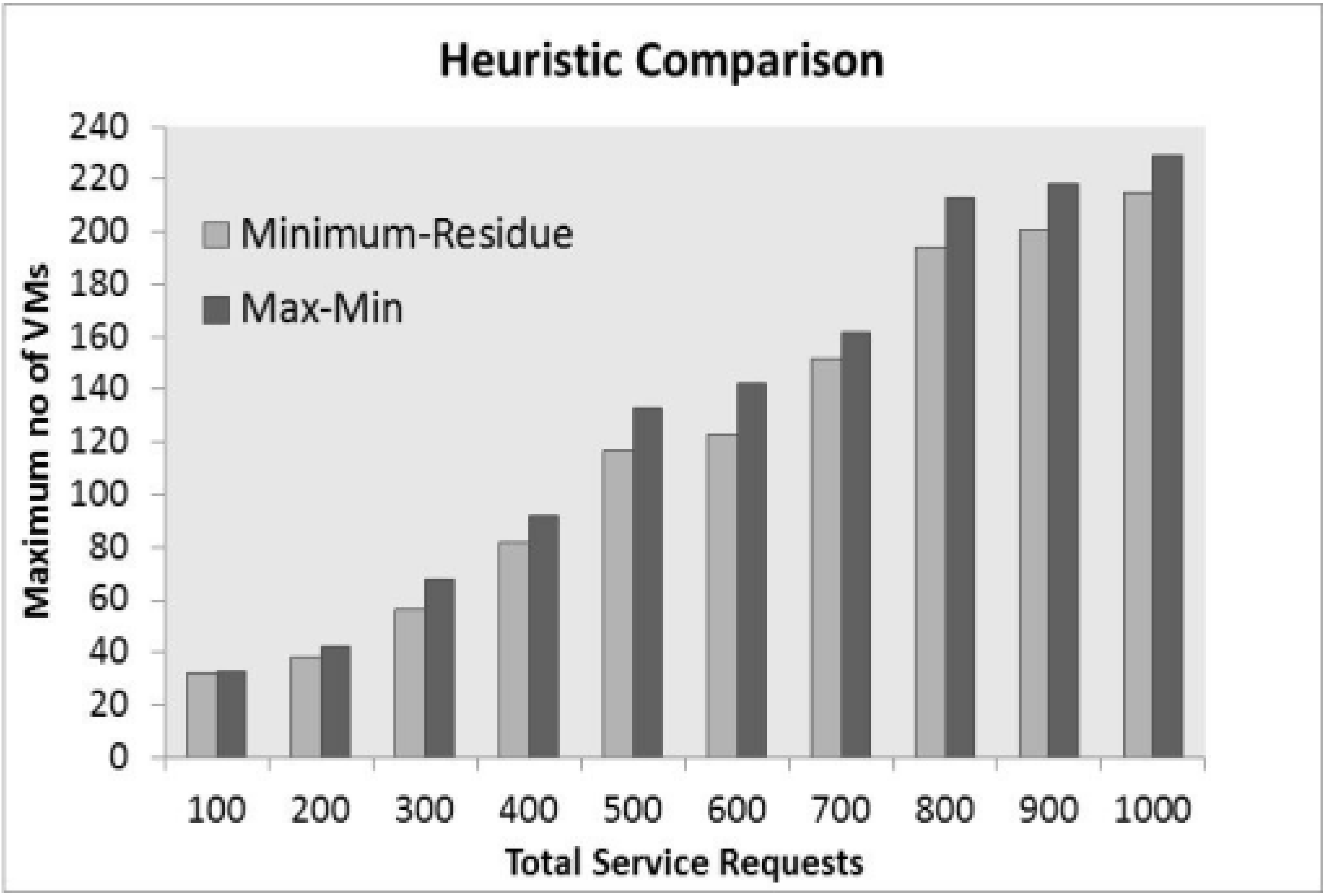
- Place a VF in a server where the remaining resources (residue) is minimized



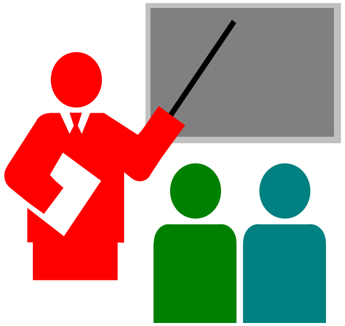
Average Utilization



Average Utilization of the VMs



Summary



1. We propose an Optimization model to ***Locate*** the Virtual Functions in the given network and ***Allocate*** the clients accordingly.

2. We propose a Heuristic scheme "***Minimum Residue***" for dynamic VF deployment.

3. The proposed scheme is compared against the standard ***Max-Min*** approach and improvements are showcased.