

Resource Allocation in NFV: A Comprehensive Survey

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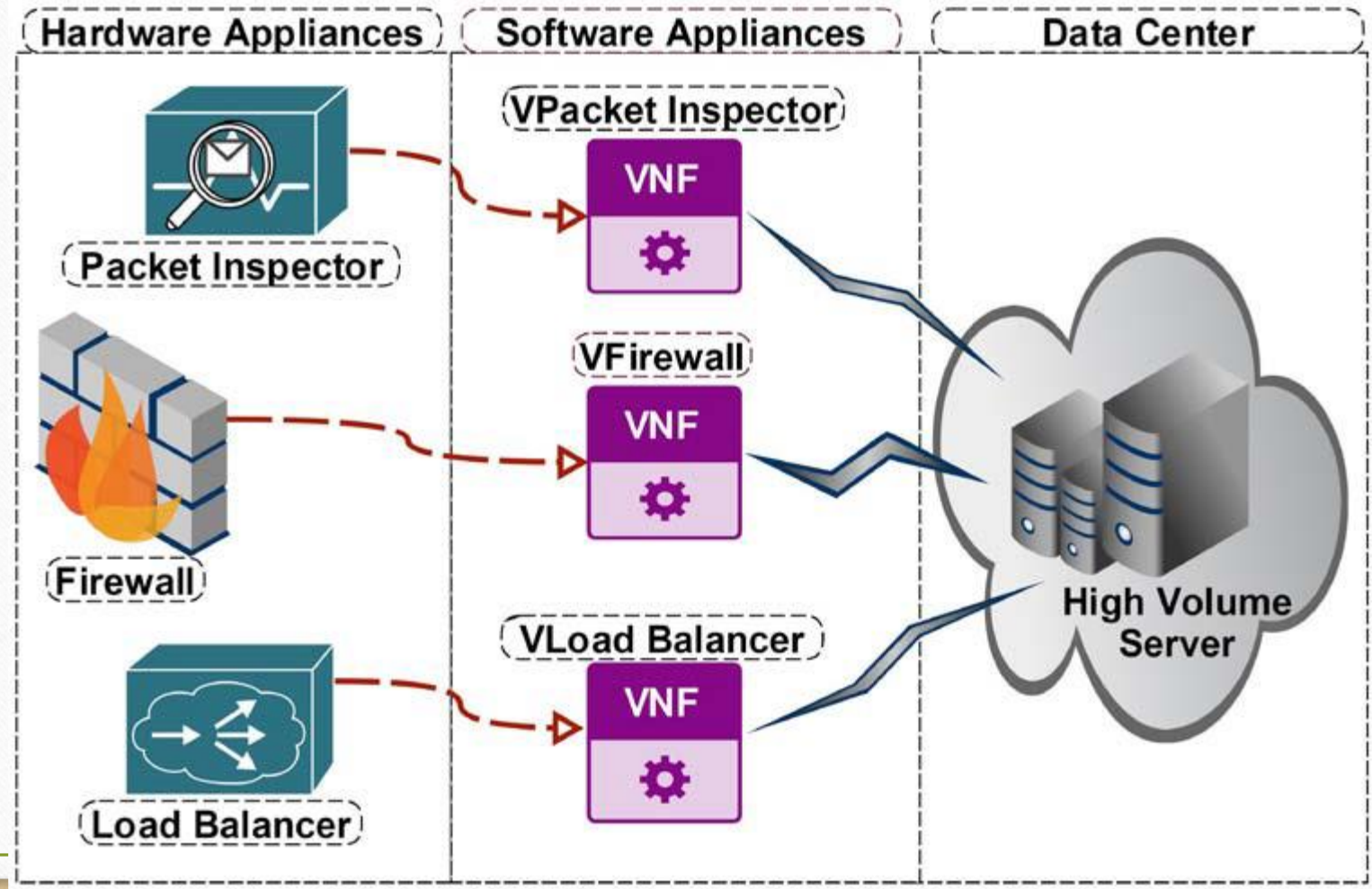
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NF vs NFV

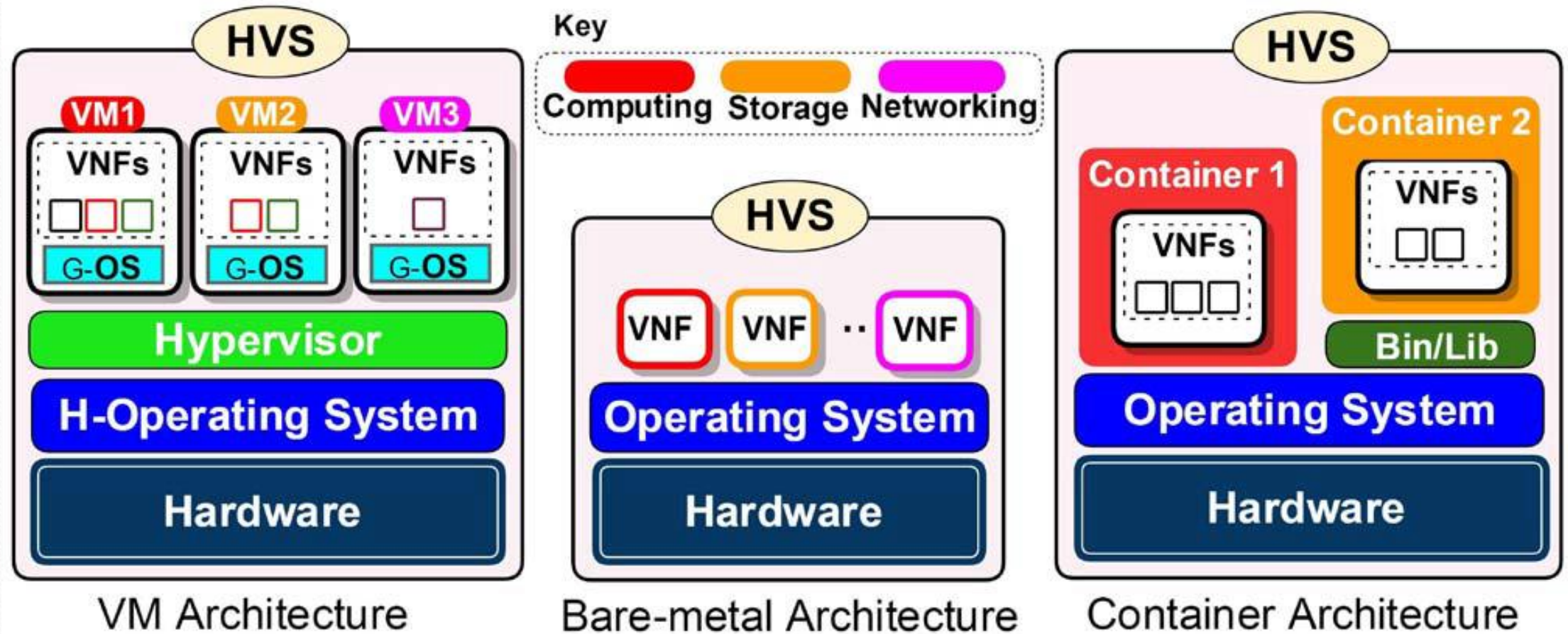
- Network Function(NF)
 - Middleboxes orchestration: choose the needed middleboxes and steer the traffic in Network Service.
 - Destined to become ineffective
 - Costly change the hardwares
- Network Function Virtualization(NFV)
 - Modularity of each function
 - Easy to dynamically migrate virtual network functions
 - Network optimization
 - Cost reduction

Network Function Virtualization(NFV)

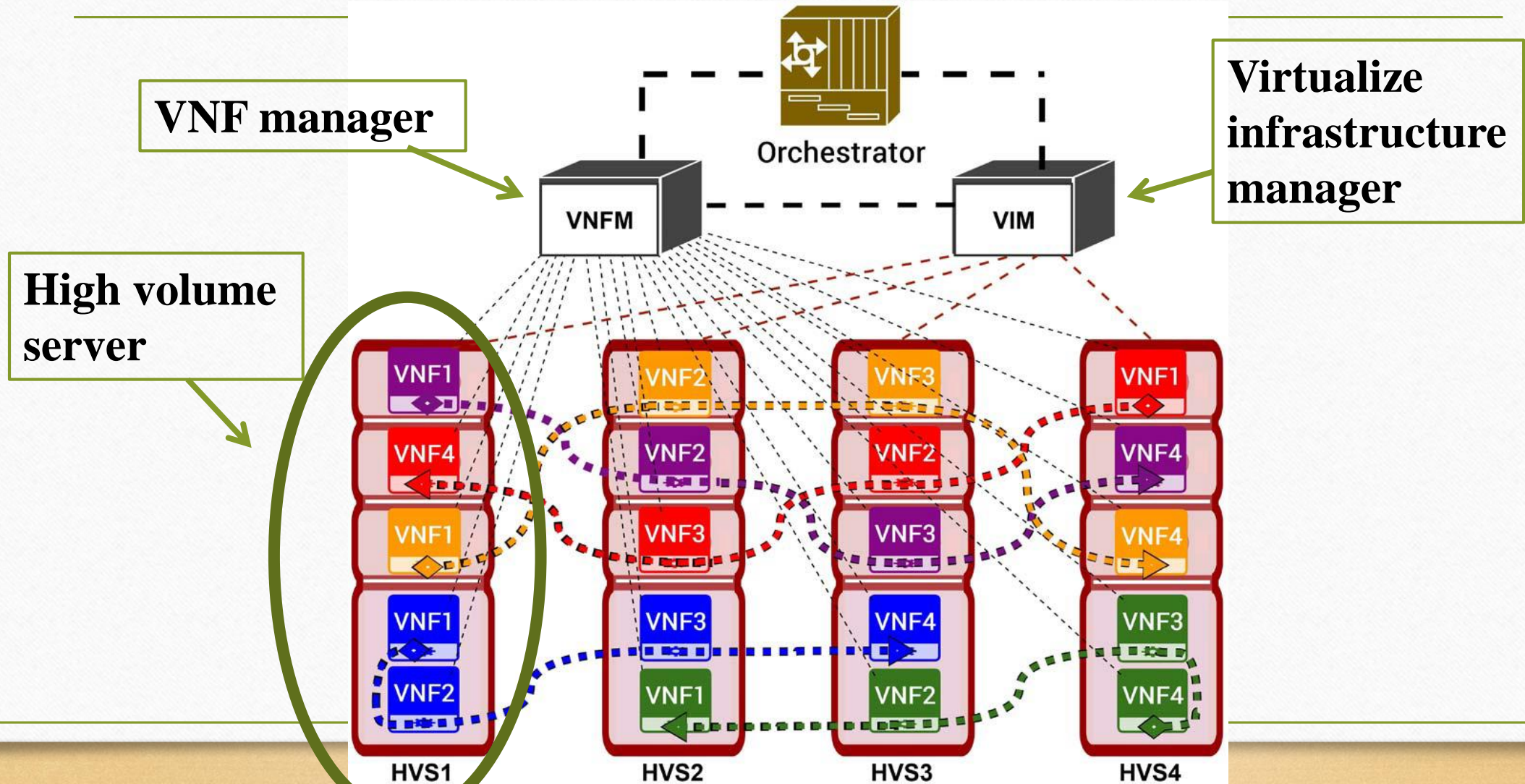
- NFV Environment:



NFV architecture



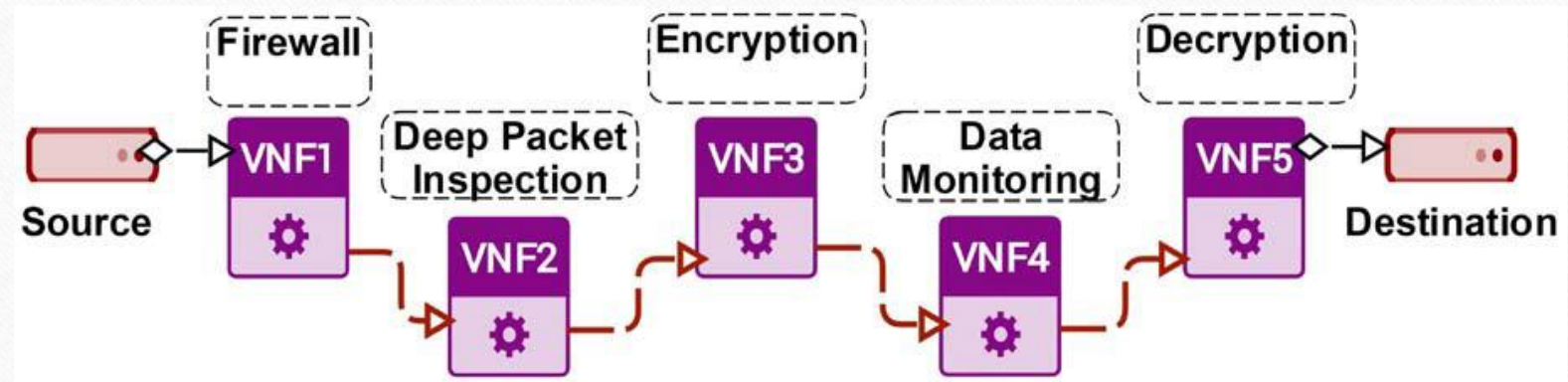
NFV Management and Orchestration



Network Function Virtualization(NFV)

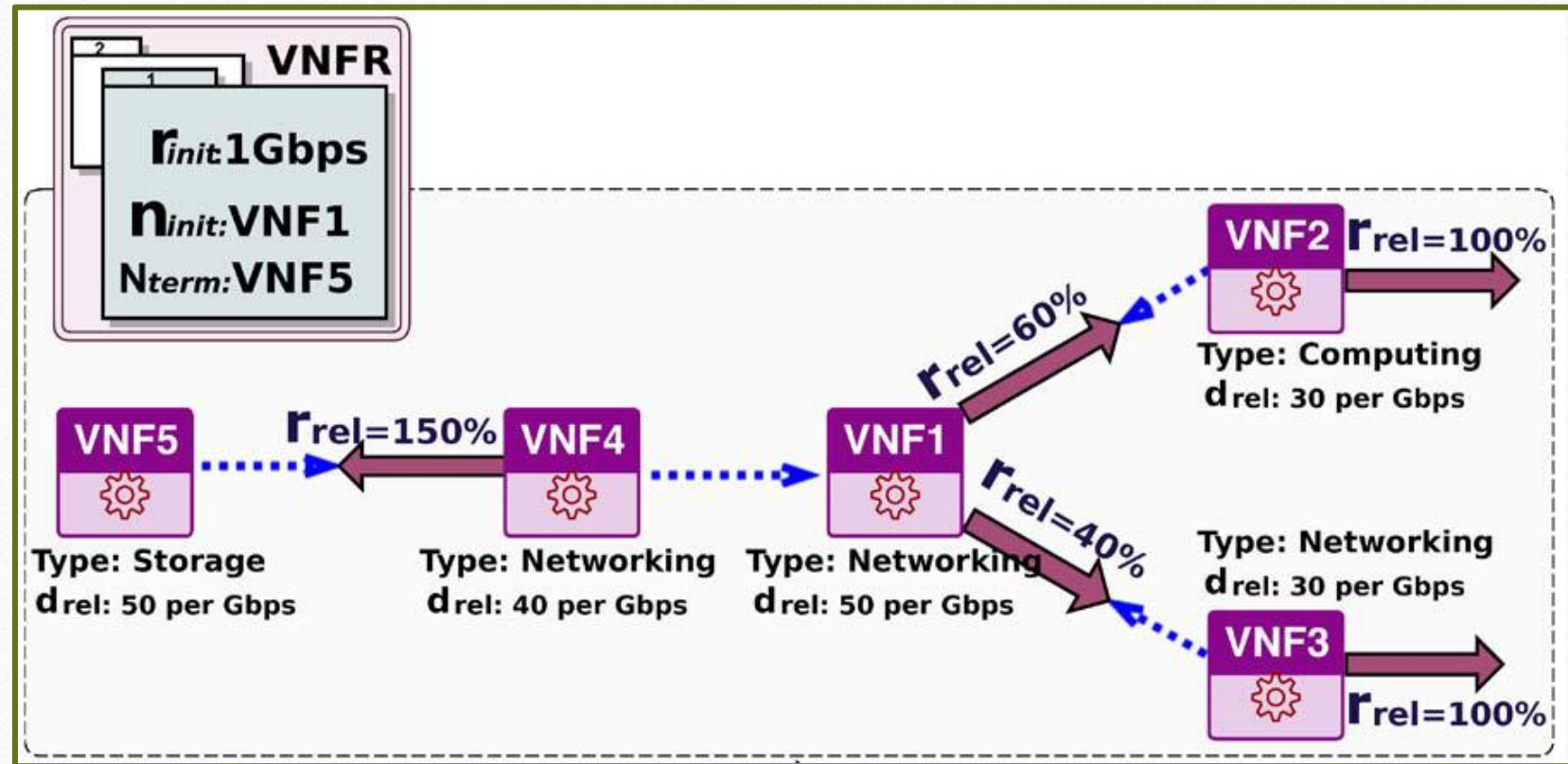
- The main challenge: NFV Resource Allocation (NFV-RA) problem
- NEF-RA three stages:
 - 1) VNFs - Chain Composition (VNFs-CC)
 - 2) VNF - Forwarding Graph Embedding (VNF-FGE)
 - 3) VNFs - Scheduling (VNFs-SCH)

Service chain:



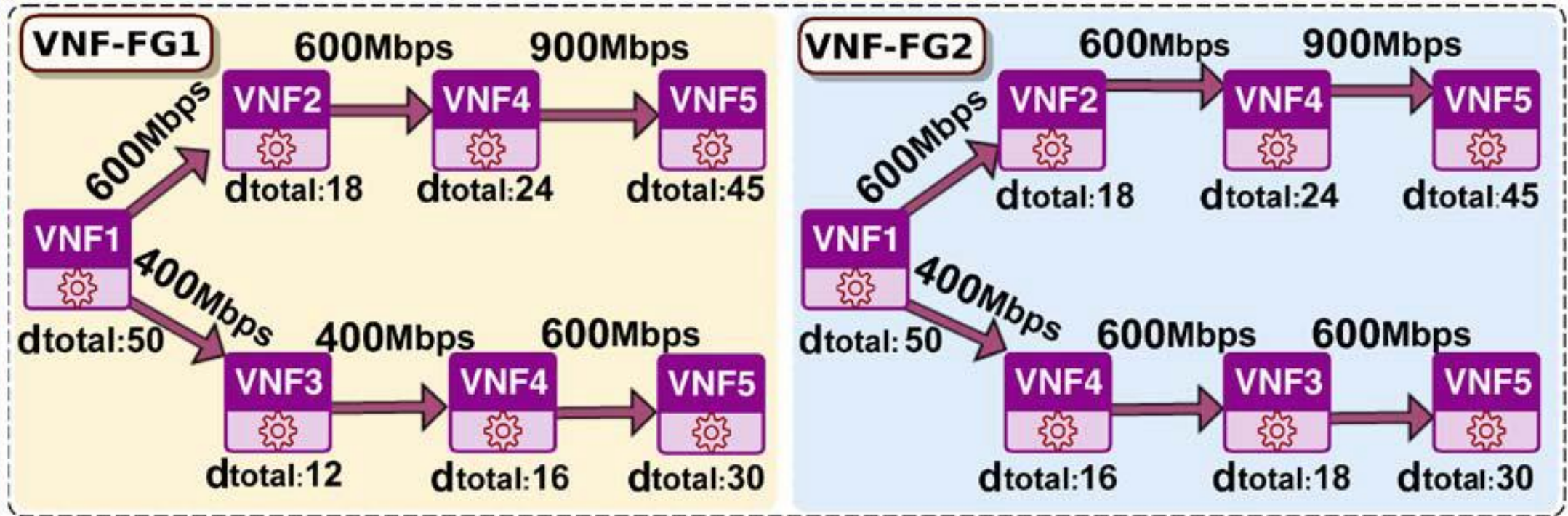
(1) VNFs - Chain Composition (VNFs-CC)

Input:
VNFs request



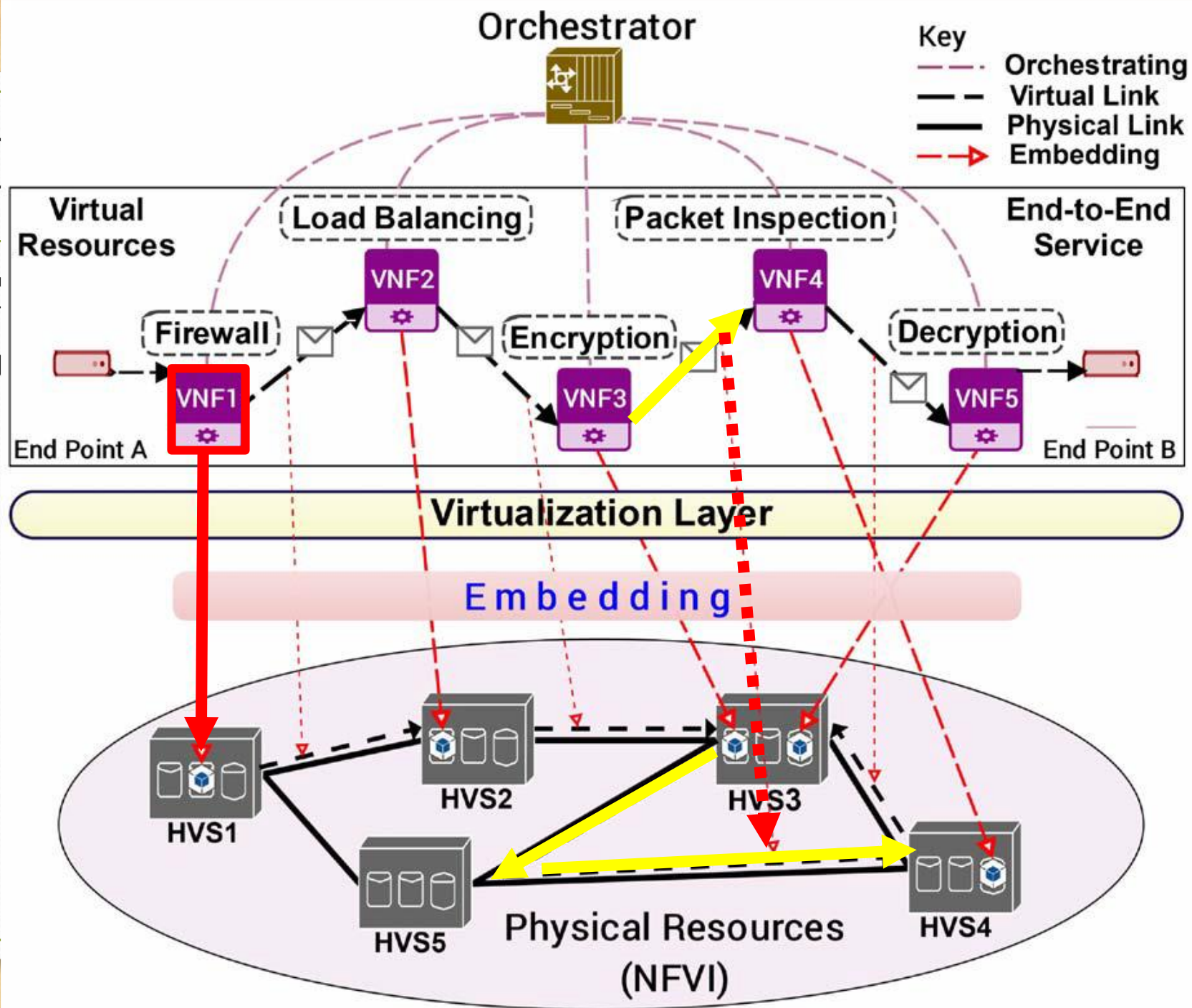
(1) VNFs - Chain Composition (VNFs-CC)

Output: VNFs forwarding graph (VNF-FG)



(2) VNF

- Input: VNF
- Output: VNF

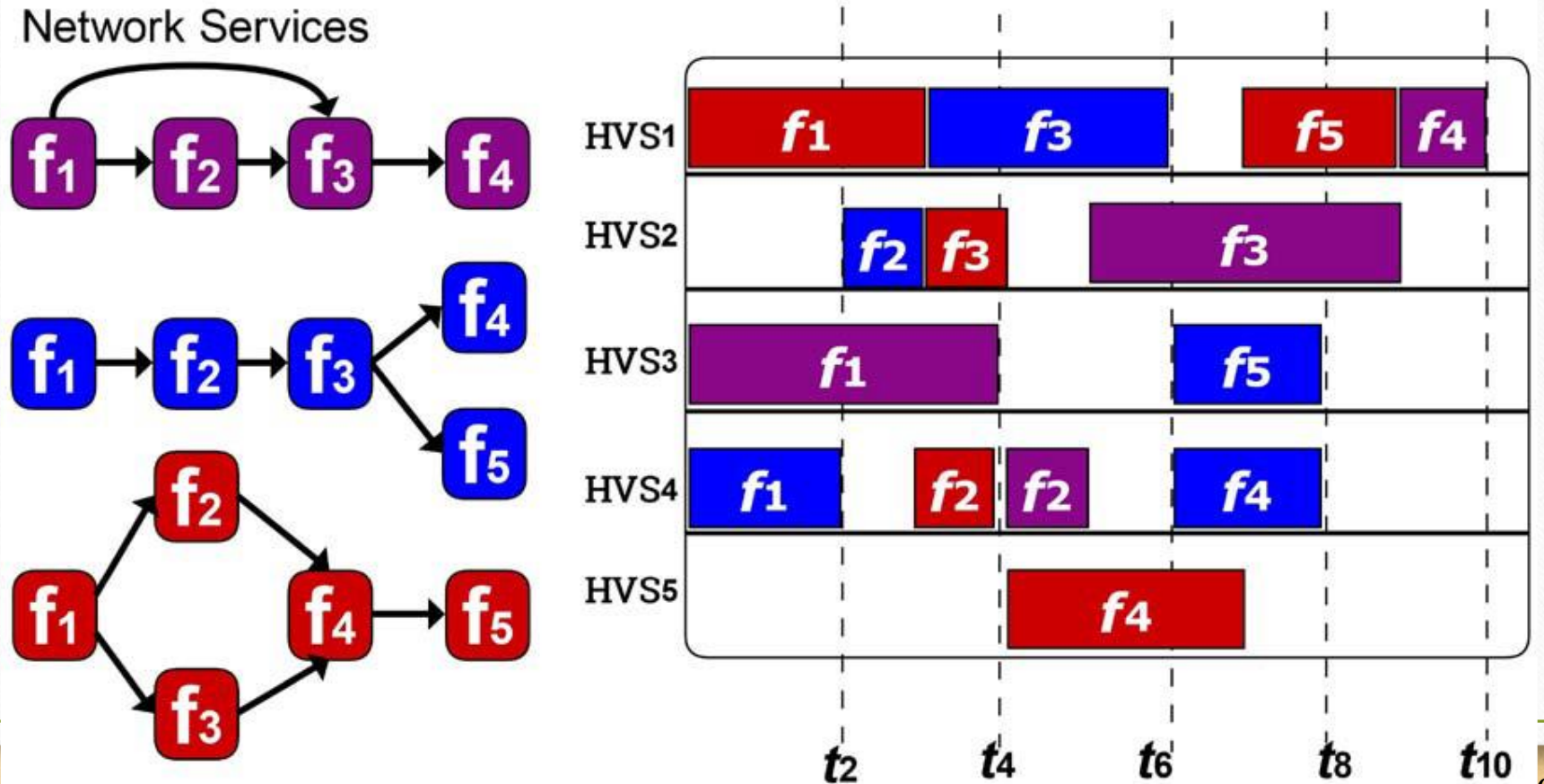


F-FGE)

(3) VNFs - Scheduling (VNFs-SCH)

- Input: VNFs forwarding-graph embedding (VNF-FGE)

Output:
VNFs Scheduling



Coordination of NFV-RA Stages

- Uncoordinated:
 - Solve NFV-RA problem stage by stage
 - The output of each NFV-RA stage is the input of the one that follows.
 - Does not guarantee that the generated VNF-FG is able to be embedded in the second stage.
- Coordinated:
 - Perform two or three stages simultaneously
 - Improves the likelihood of successful embedding as the building of the VNF-FG

NFV-RA Optimization Strategies

- The NFV-RA is a *NP*-hard optimization problem

1) Exact solutions:

- Optimal solutions can be achieved by linear programming algorithms.
(Particularly, ILP can be used to optimally formulate the VNF-FGE problem.)
- There are exact algorithms that solve small instances of the problem in reasonable time.
- Software tools: solvers e.g., GLPK, CPLEX

NFV-RA Optimization Strategies

2) Heuristic solutions:

- NFV deals with dynamic online environments
- Arrival time of service requests is not known in advance.
- Execution time of the algorithms should be minimized.

3) Metaheuristic solutions:

- NFV-RA can be seen as a combinatorial optimization problem
- The optimal solution for large instances of these problems is hard to find
- Find near-optimal solutions by iteratively improve problem solutions

Classification

1. Scenerio
2. NFV-RA stages
3. NFV-RA Optimization Strategies

References	Scenario	Stage	Strategy	Contribution
Bari et al. [12] (2015)	TSP's networks	VNF-FGE	Exact, Heuristic	Provides an ILP formulation with implementation in CPLEX and a dynamic programming based heuristic to solve larger instances of the VNFs-FGE problem.
Mijumbi et al. [68] (2015)	TSP's networks	VNF-FGE, VNFs-SCH (Coord)	Heuristic, meta-heuristic	Formulates the online virtual function mapping and scheduling problem and proposes a set of heuristic and metaheuristic algorithms to solve the VNF-FGE and VNFs-SCH in a coordinated way.
Basta et al. [24] (2014)	Mobile network	VNF-FGE	Heuristic	An optimization model is presented for the placement of mobile core gateways (SGWs and PGWs) with respect to latency constraints and different gateway virtualization scenarios.
Beck and Botero [52] (2015)	TSP's networks	VNFs-CC, VNF-FGE (Coord)	Heuristic	Proposes a heuristic method to coordinate the composition of VNF chains and their embedding into the substrate network.
Mehraghdam et al. [56]	TSP's networks	VNFs-CC.	Exact, Heuristic	Provide a model for formalizing the chaining of NFs using a context-free language

Conclusion

- Introduction much information about NFV
 - Architecture, features, simulation tools...etc.
- Discussed a comprehensive survey about NFV-RA problem.
- Key contribution is to give a detailed categorization of research works in the NFV-RA context, including
 - Stages: chains composition, embedding, and scheduling of VNFs into NFVI.
 - Optimization strategies: exact, heuristic or metaheuristic.
 - Scenario in realism

Q&A
