Introduction to the UNIT Research Group

presented by **Tuan-Minh Pham**

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July 13, 2023

Outline

- Research interests

- Selected research projects

- Selected research problems

Research Interests

- UNIT is an independent group of researchers who work for Phenikaa, UET, and USTH.
- Main research interests:
    - Optimization problems in network virtualization
    - The application of Deep Reinforcement Learning for a networked system
    - Optimization problems in big data analytics

People

- Dr. Giang Son Tran, Vietnam France University (USTH)
- Dr. Linh Manh Pham, VNU University of Engineering and Technology (UET)
- Dr. Trinh Thanh, Phenikaa University
- Dr. Tuan-Minh Pham, Phenikaa University (coordinator)
- Current Ph.D students:
  - Thi-Thuy-Lien Nguyen: Resilient NFV
  - Thanh-Tung Hoang: Dynamic service function chaining
  - Xuan-Truong Nguyen: Smart IoT-enabled livestock farming

Research Sponsors

Outline

- Research interests
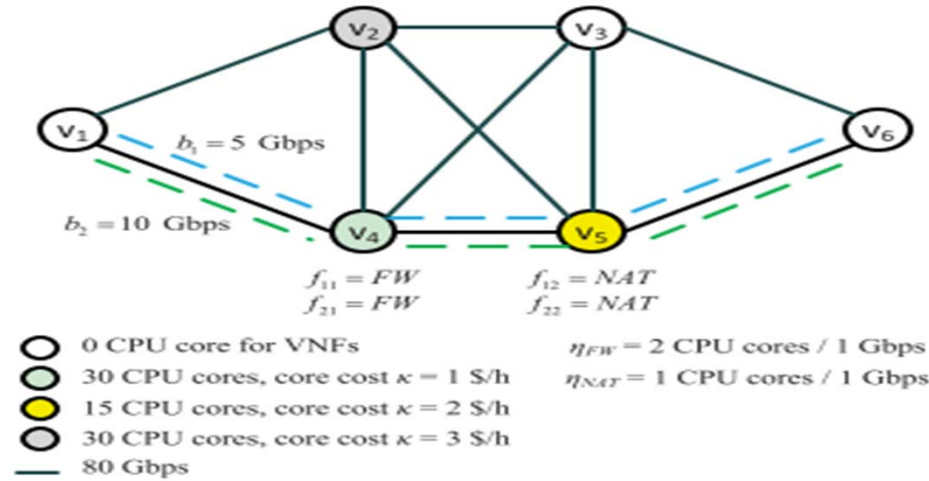- **Selected projects**
- Selected problems

TEN: An Efficient and Reliable NFV based System

- TEN was supported by the Vietnam National Foundation for Science and Technology Development (NAFOSTED)
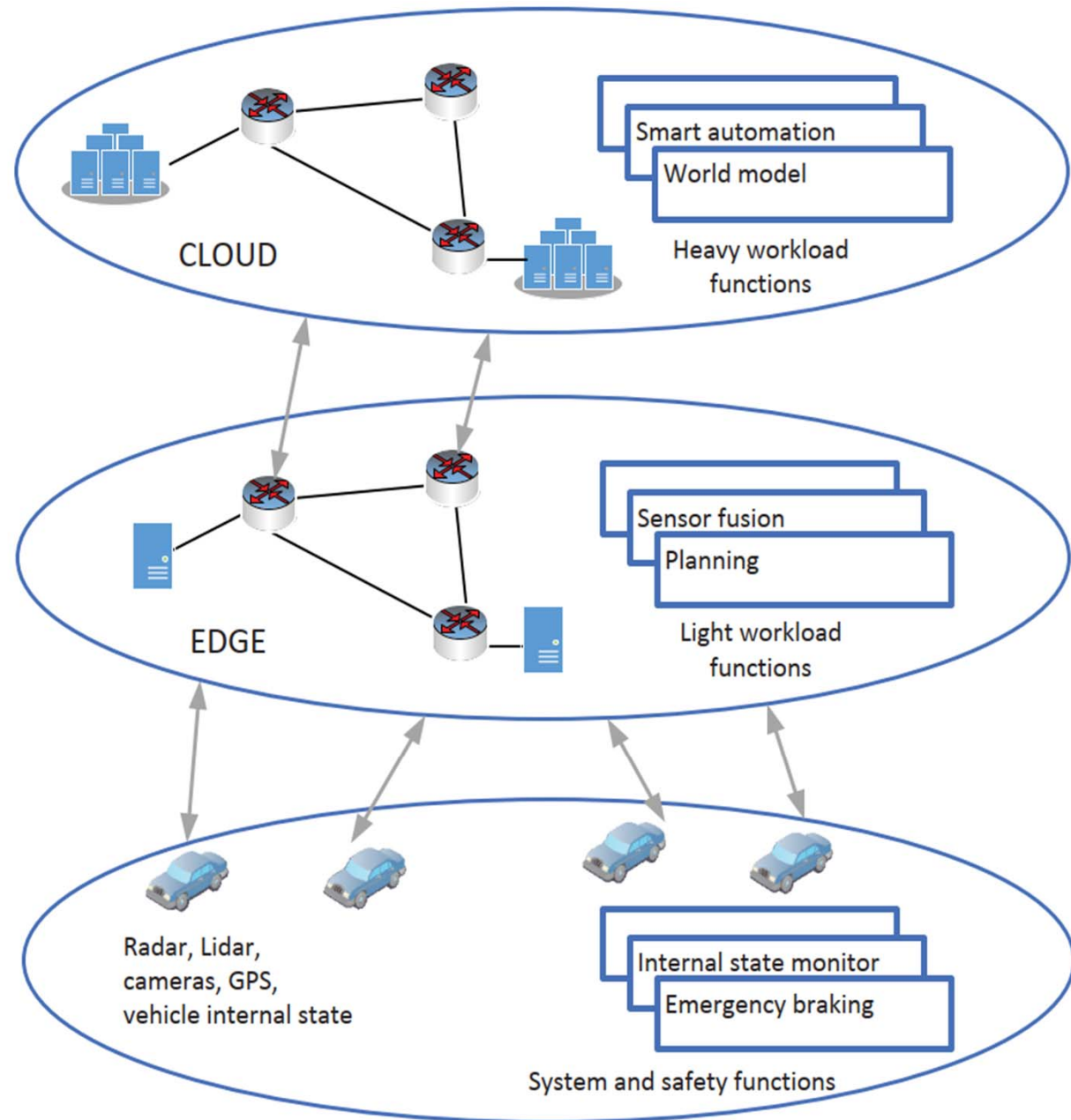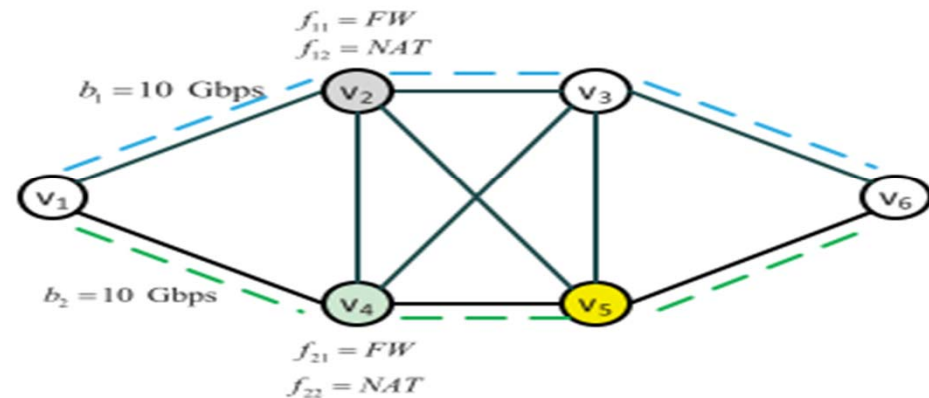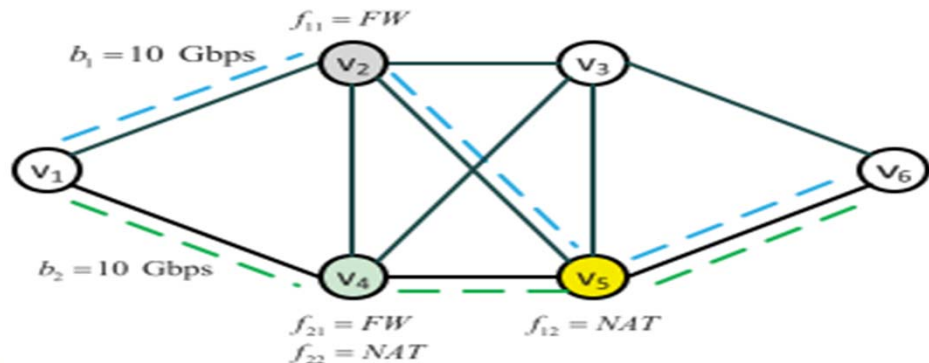
TEN's Objectives

- Optimize the VNF placement and routing for resilient services in an NFV-based system

  - QoS-guaranteed SFC solution

  - Reliability-guaranteed SFC deployment

 - Dynamics of traffic demands

  - Dynamics of SFC demands

$b_1 = 5$ Gbps

$b_2 = 10$ Gbps

$f_{11} = FW$
$f_{21} = FW$

$f_{12} = NAT$
$f_{22} = NAT$

0 CPU core for VNFs
30 CPU cores, core cost $\kappa = 1$ \$/h
15 CPU cores, core cost $\kappa = 2$ \$/h
30 CPU cores, core cost $\kappa = 3$ \$/h
80 Gbps

$\eta_{FW} = 2$ CPU cores / 1 Gbps
$\eta_{NAT} = 1$ CPU cores / 1 Gbps

(a) The optimal placement solution

$f_{11} = FW$
$f_{12} = NAT$

$b_1 = 10$ Gbps

$b_2 = 10$ Gbps

$f_{21} = FW$
$f_{22} = NAT$

(b) The migration solution when considering a set of pre-computed paths

$f_{11} = FW$

$b_1 = 10$ Gbps

$b_2 = 10$ Gbps

$f_{21} = FW$
$f_{22} = NAT$

$f_{12} = NAT$

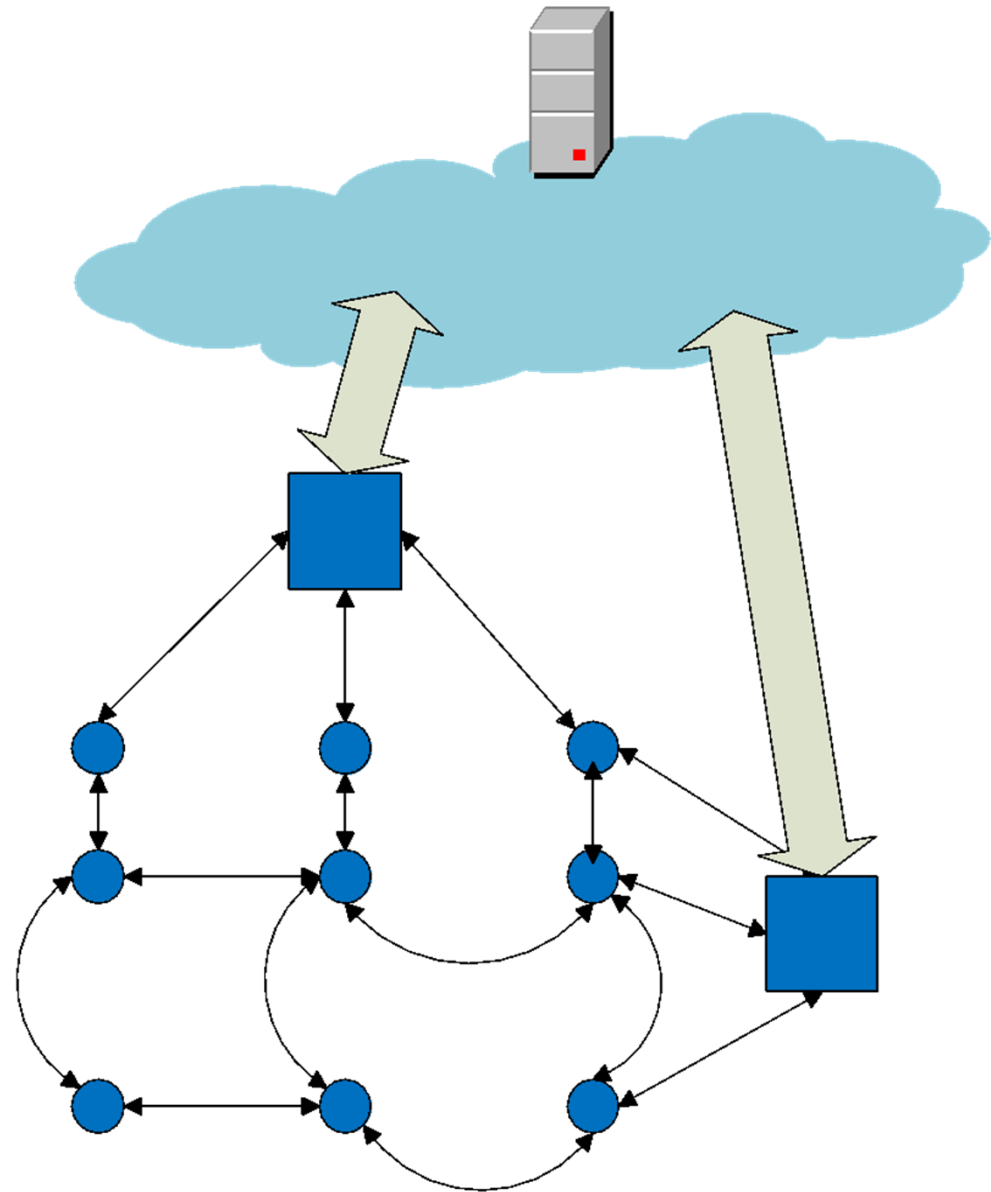(c) The migration solution when considering dynamic routing paths

SIR: A Smart IoT-based Farming System

- SIR was partly supported by Thuyloi University (TLU)
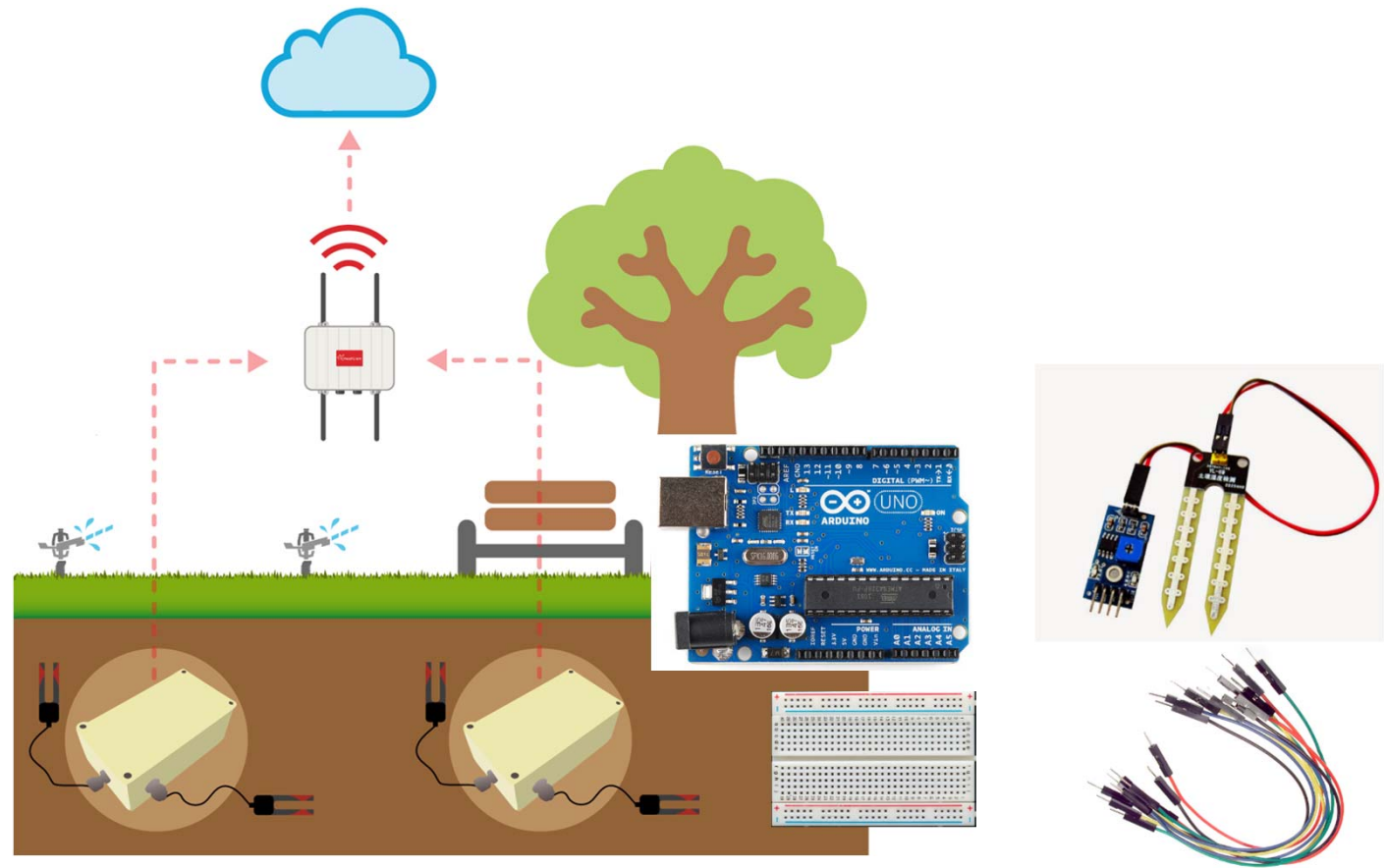
SIR's Objectives

- Optimize gateway placement

- Optimize data routing to minimize the total energy consumption

- Integrate data processing for forecasting and optimizing the farming process

UNIT: Development of Service Composition in a Multi-provider and Multi-domain NFV Environment

- UNIT was supported by the Vietnam Ministry of Education and Training (MOET)
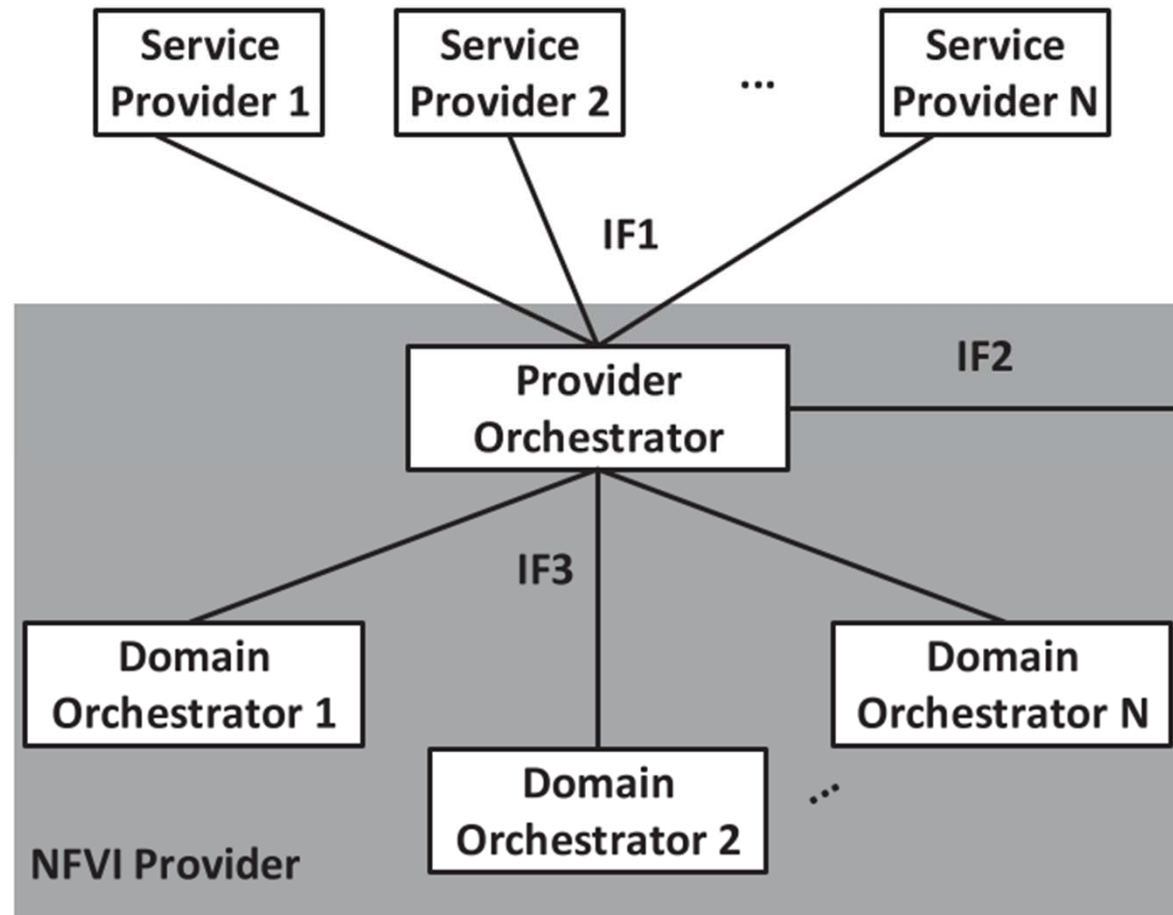
UNIT's Objectives

- What is the impact of a resource reservation strategy of a NSP on the others?

- What is the optimal resource reservation strategy?

- What is the impact of the number of domains?

- Can a NSP profit from the diversity of resource domains?
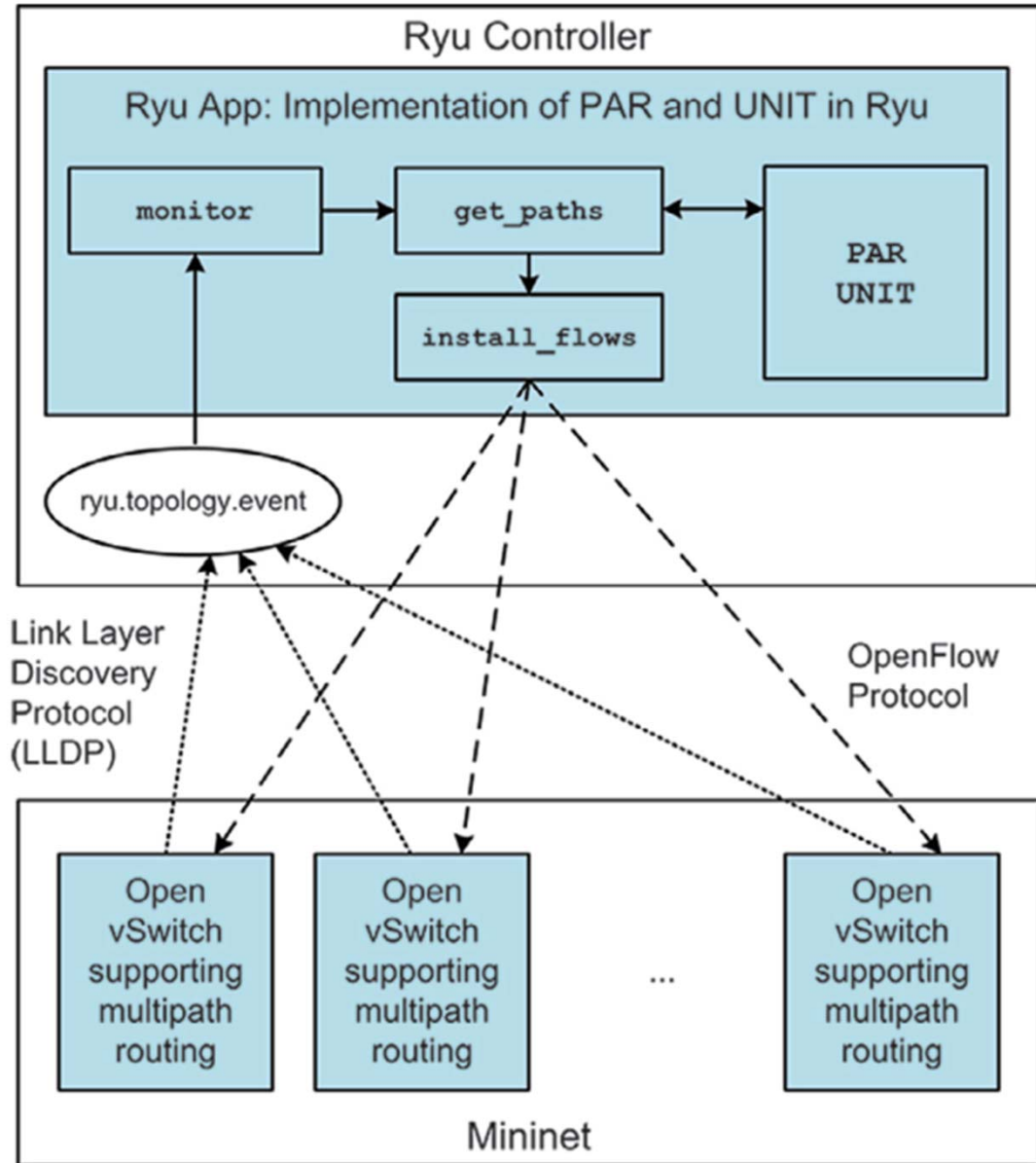
ULake: USTH Big Data Platform

- Ingest data from different sources, store data for easy integration, export and sharing, in multidisciplinary research

- ULake was supported by the Vietnam Academy of Science and Technology (VAST)
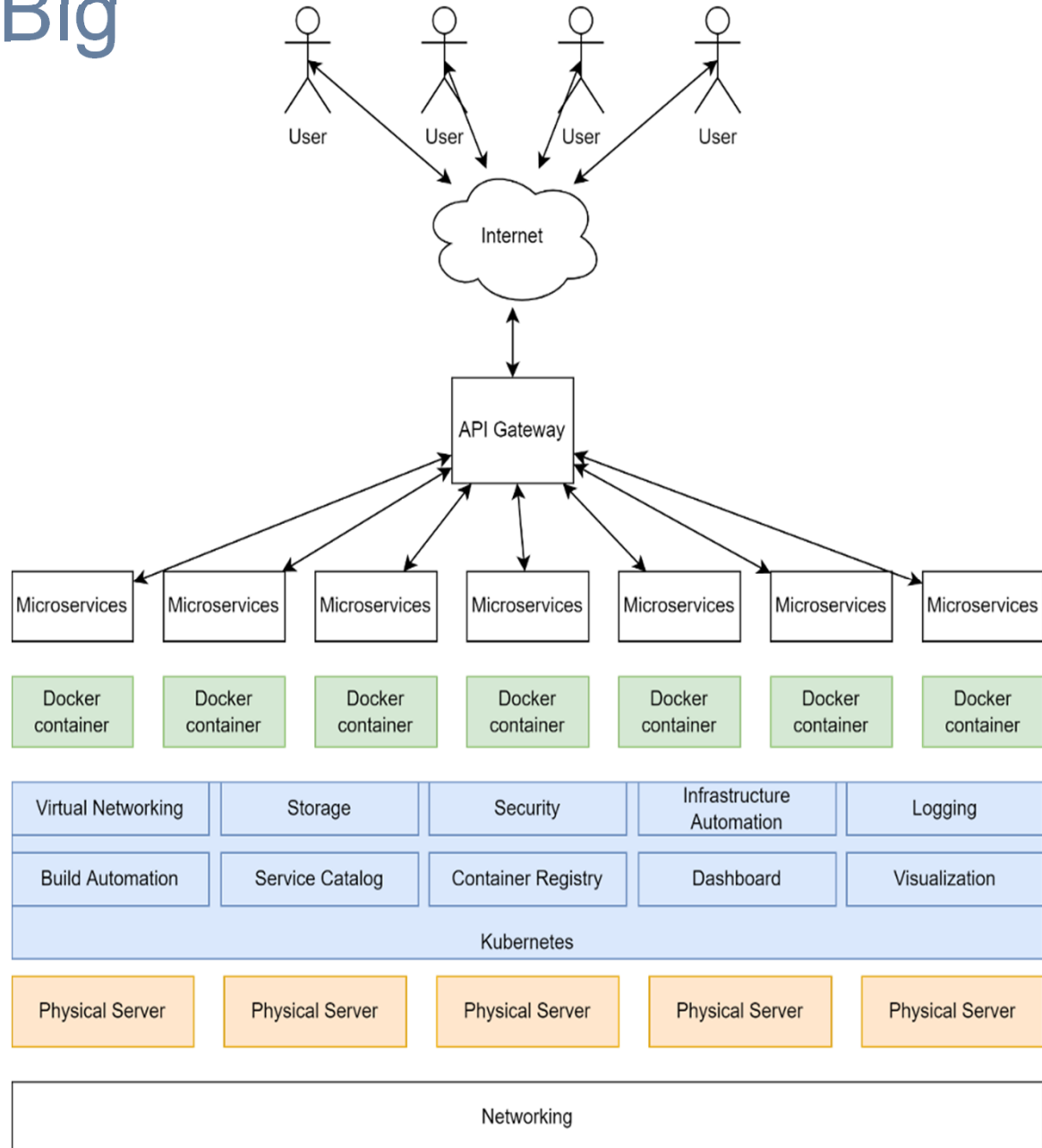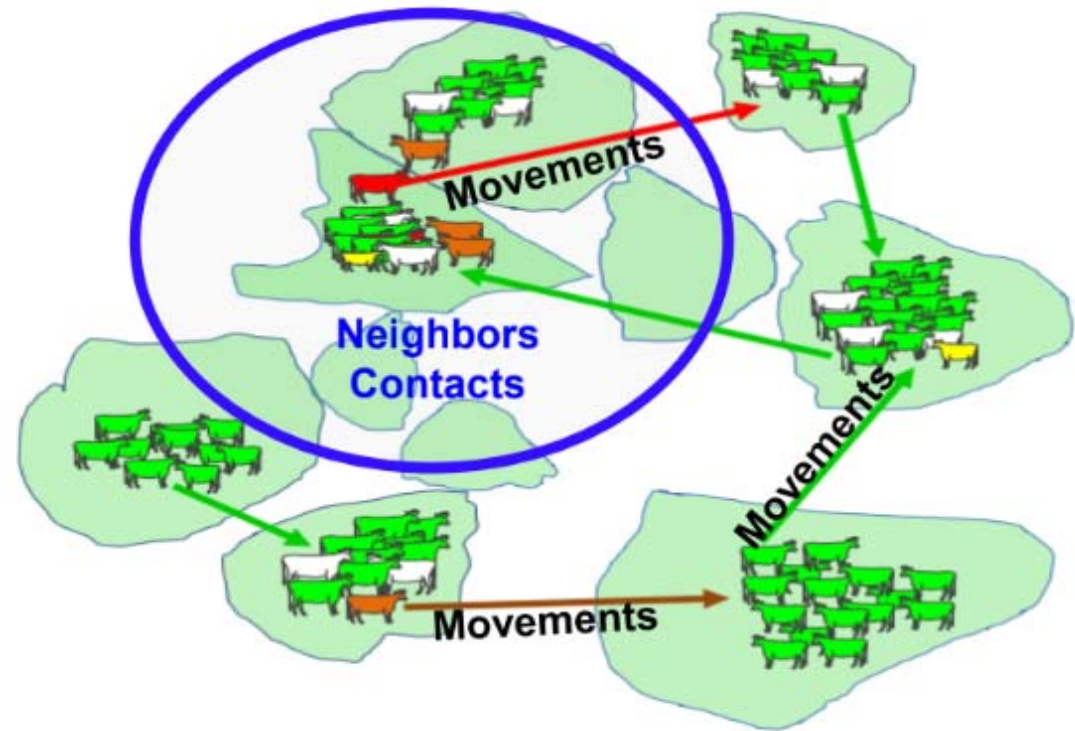
E-BDA: Elastic Big data analytics on Fog/Cloud computing

- Propose an architectural framework for IoT big data stream processing on cloud and fog environments

- E-BDA was supported by the Vietnam Academy of Science and Technology (VAST)
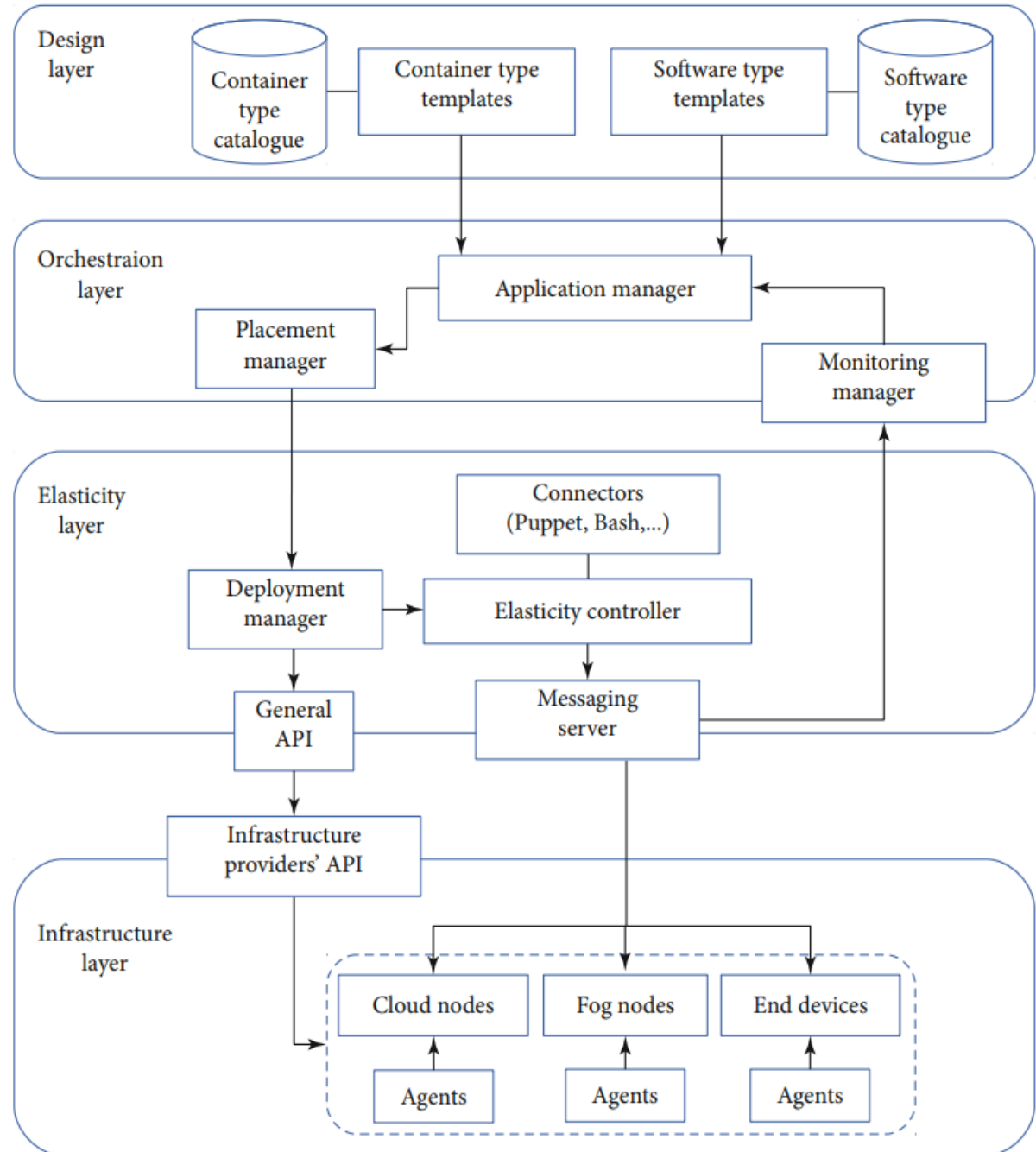
VEA: Veterinary Epidemiology - Analyze and Warn of disease spreads on the animal herds
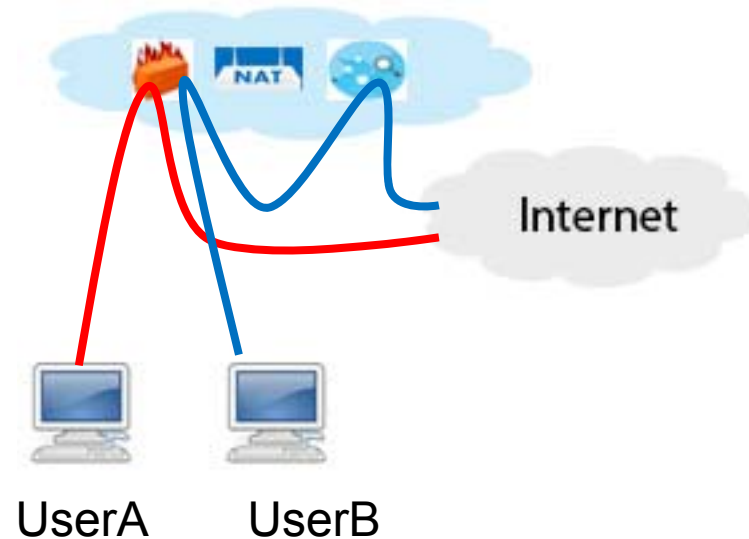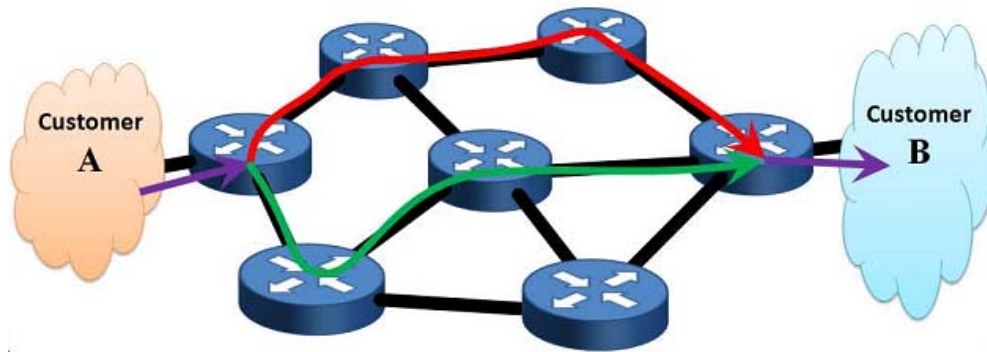

- Build cloud computing service system that analyzes and warns of the spread of diseases on livestock

- VEA was supported by the Vietnam National University (VNU)
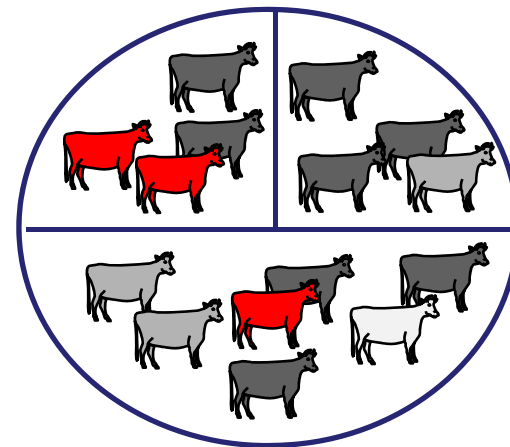
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Online Load Balancing for Network Functions Virtualization

UserA   UserB

- Work within the UNIT project funded by the Vietnam Ministry of Education and Training (MOET)

- Some issues:
  - How to maintain strict performance requirements of virtual network functions (VNF), alike in traditional networks?
  - What is a solution to the online load balancing problem in NFV?
  - What is the performance guarantee of an online algorithm?

Equal-cost Multi-path Routing in NFV
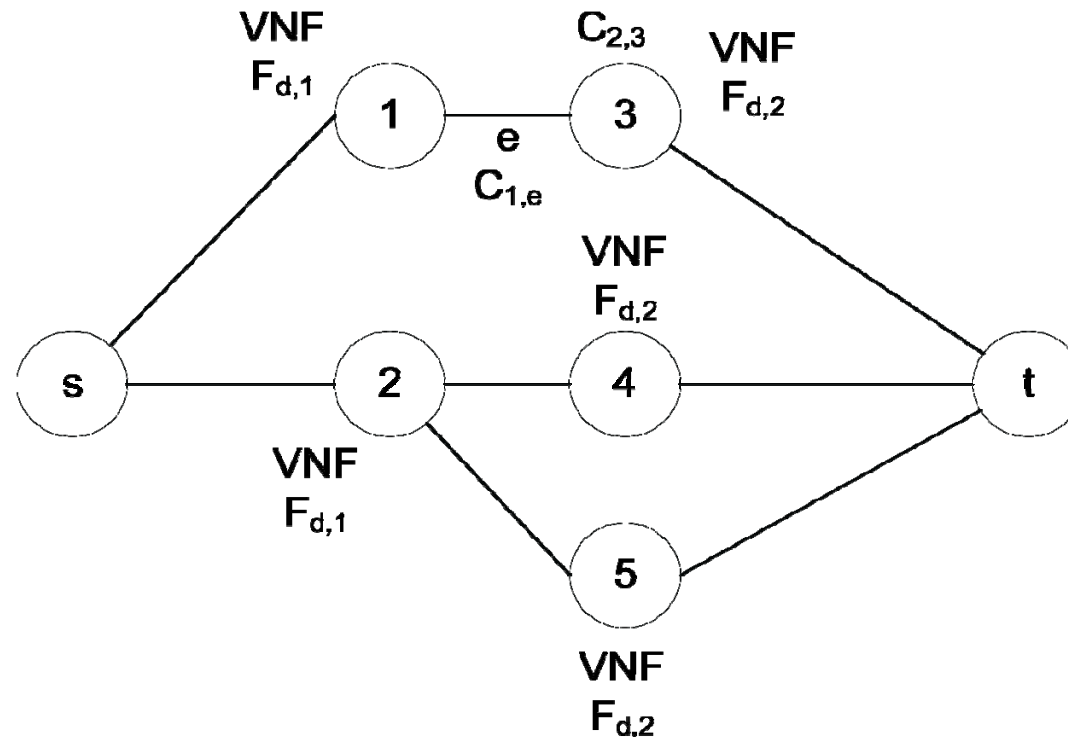
- Load balancing using ECMP (Equal-cost Multipath)

- Many routing protocols support ECMP: OSPF, IS-IS

- Constraints on the shortest path routing and equal load sharing

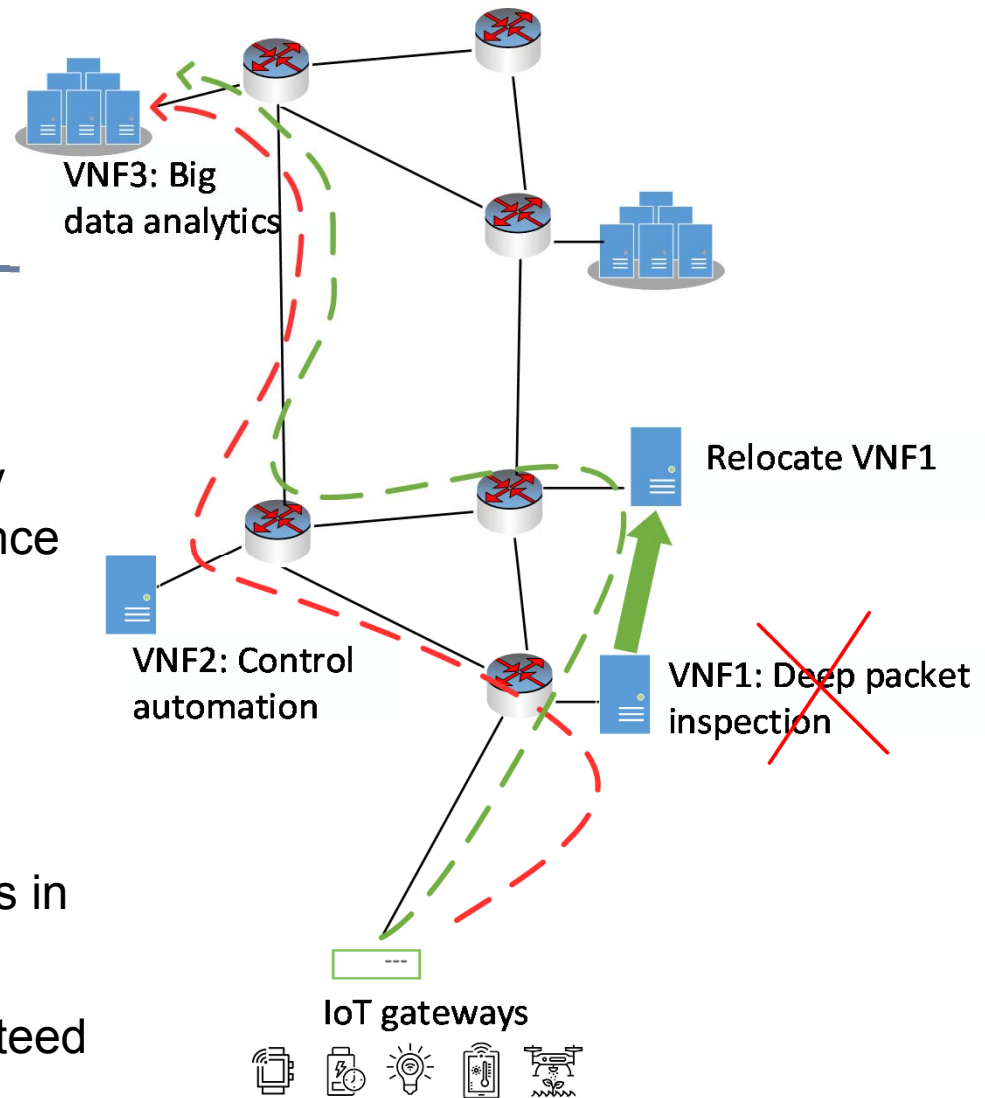- Service Function Chaining (SFC): Each traffic flow of a demand is required to be processed by a chain of VNFs

Problem Statement

- We consider an optimization problem of load balancing for NFV, which takes into account the fundamental features of NFV, constraints on the NFVI resource, and ECMP routing

- Goals:

  - Formulate the optimization problem of load balancing across multiple paths in NFV for finding an offline optimal solution

  - Develop an efficient algorithm for the online load balancing in NFV

  - Evaluate the performance guarantee of the online solution in comparison with the optimal offline solution

- References:

  - T.-M. Pham*, S. Fdida, T.-T.-L. Nguyen, H.-N. Chu, Modeling and Analysis of Robust Service Composition for Network Functions Virtualization, *Computer Networks* Vol. 166 (2020), 106989 (**Computer Networks 2021 Best Paper Award**)

  - T.-M. Pham, T.-T.-L. Nguyen, S. Fdida, H. T. T. Binh, Online load balancing for Network Functions Virtualization, in Proc. IEEE ICC, 2017.

  - T.-M. Pham and L. M. Pham, Load Balancing using multipath routing in Network Functions Virtualization, in Proc. the 12th IEEE RIVF, Hanoi, Vietnam, Nov. 2016.

Fast Optimal Resource Allocation for Resilient Service Coordination in an NFV-Enabled Internet-of-Things System

- Work within the TEN project funded by Vietnam National Foundation for Science and Technology Development (NAFOSTED).

- Some issues:

  - What is an efficient strategies for resource reservation under failures in networks?

  - What is quality of services guaranteed in a failure scenario regarding the dynamics of SFC and service demands?

VNF3: Big data analytics

Relocate VNF1

VNF2: Control automation

VNF1: Deep packet inspection

IoT gateways

Problem Statement

- Given an NIoT system, find a resource allocation solution for a set of service demands, in order to minimize the system disruption when a failure occurs under constraints on the availability of system resource and the coordination of IoT functions.

- References:

  - T.-T.-L. Nguyen*, T.-M. Pham*, L. M. Pham, Efficient Redundancy Allocation for Reliable Service Function Chains in Edge Computing, Journal of Network and Systems Management Vol. 31 (2) (2023)

  - H. D. Le, G. S. Tran*, Free-size accelerated Kuwahara filter, Journal of Real-Time Image Processing Vol. 18, no. 6 (2021), pp. 2049-2062.

  - T.-M. Pham, T. -M. Nguyen, X. -T. -T. Nguyen, H. -N. Chu and N. H. Son, Fast Optimal Resource Allocation for Resilient Service Coordination in an NFV- Enabled Internet-of- Things System, in Proc. IEEE ATC 2022, Hanoi, Vienam, 2022

- What is the impact of funding agencies/institutions on prioritizing areas of study?
- What is your experience in evaluating your proposed solution in comparison with existing solutions?

A MASSIVE THANK YOU

- Prototype or Products?
- Basic research or Applied research?
- Theoretical contributions or practical applications?

- Collaboration model?
- Suggestions for research collaboration?