



# 2019「中技社科技獎學金」

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## 境外生研究獎學金

Research Scholarship for International Graduate Students

### Knowledge Defined Orchestration and Control

A Machine Learning Approach for Infrastructure Management

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Abstract

Software-Defined Networking (SDN) and Multi-access Edge Computing (MEC) enable provider to provision services on-demand, orchestrate and control their infrastructures efficiently. However, the current infrastructure operation lacks true service automation. In this research work, we introduce a novel paradigm called **Knowledge Defined Orchestration and Control (KDOC)** which is a result of accommodating a joint orchestration and control with cognitive techniques. This research falls within the following areas: network control, service orchestration and artificial intelligence. **First**, we contribute to the control plane of SDN by incorporating a lightweight authentication mechanism to its control channel. **Next**, we provide a transparent service continuity across orchestrated MECs. **Finally**, we propose a knowledge layer that gathers telemetric data and intelligently control and orchestrate the infrastructure.



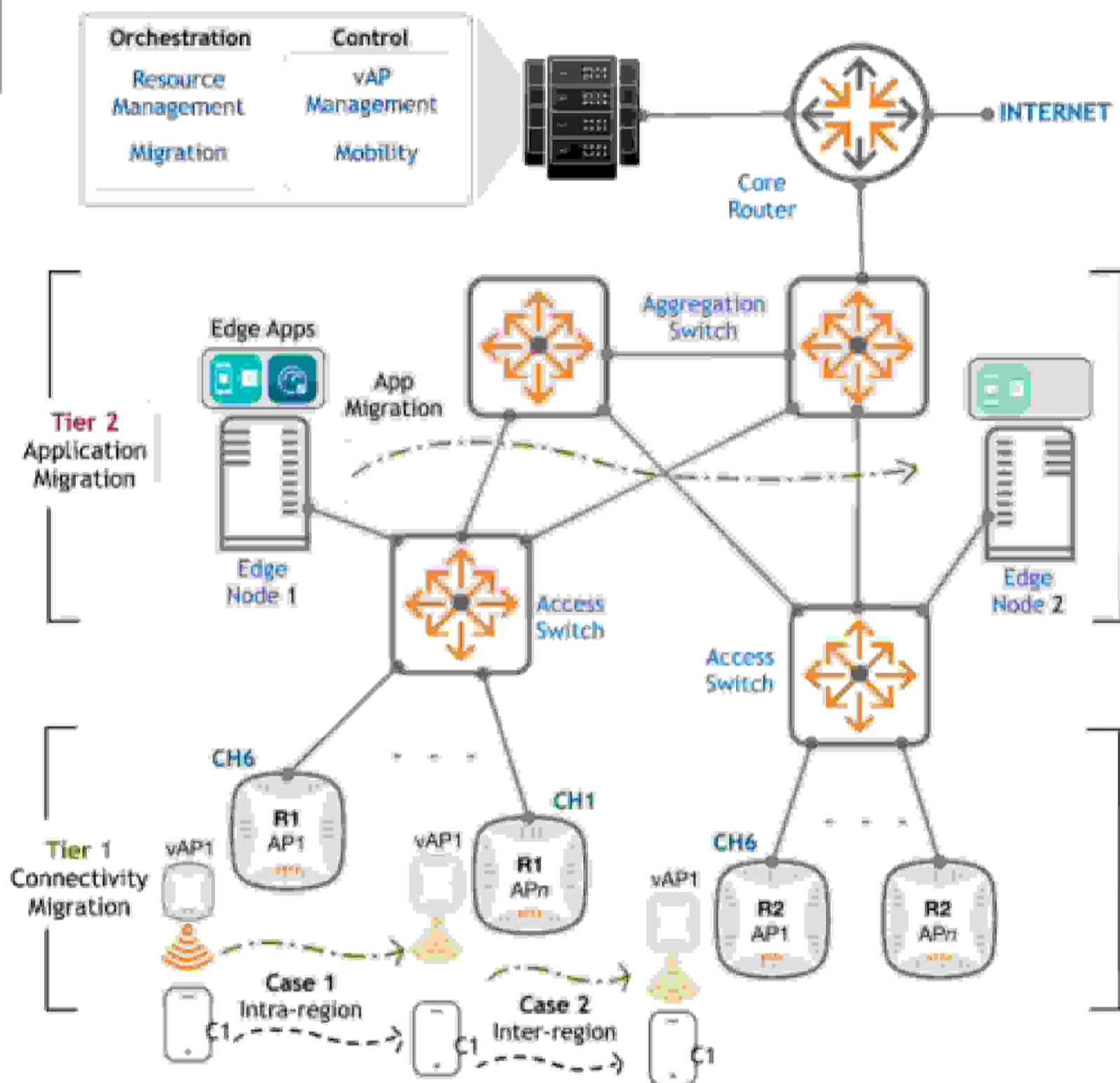
#### Research Focus

Service Orchestration

#### ARNAB: Enabling Mobile Service Continuity across Orchestrated Edge Networks

##### Problem - Service interruption issue in edge-enabled WiFi networks

- Handoff decision is locally made by clients and the re-association process takes 1~2 seconds. During this process, clients experience connectivity interruption.
- Latency increases as clients move away from the initial serving edge. This may effect user experience especially for latency-sensitive applications.



##### Solution - double-tier migration

An architecture for service continuity with double-tier migration. The term **ARNAB** means *rabbit* in Arabic. The service with ARNAB behaves like a rabbit hopping through the WiFi infrastructure.

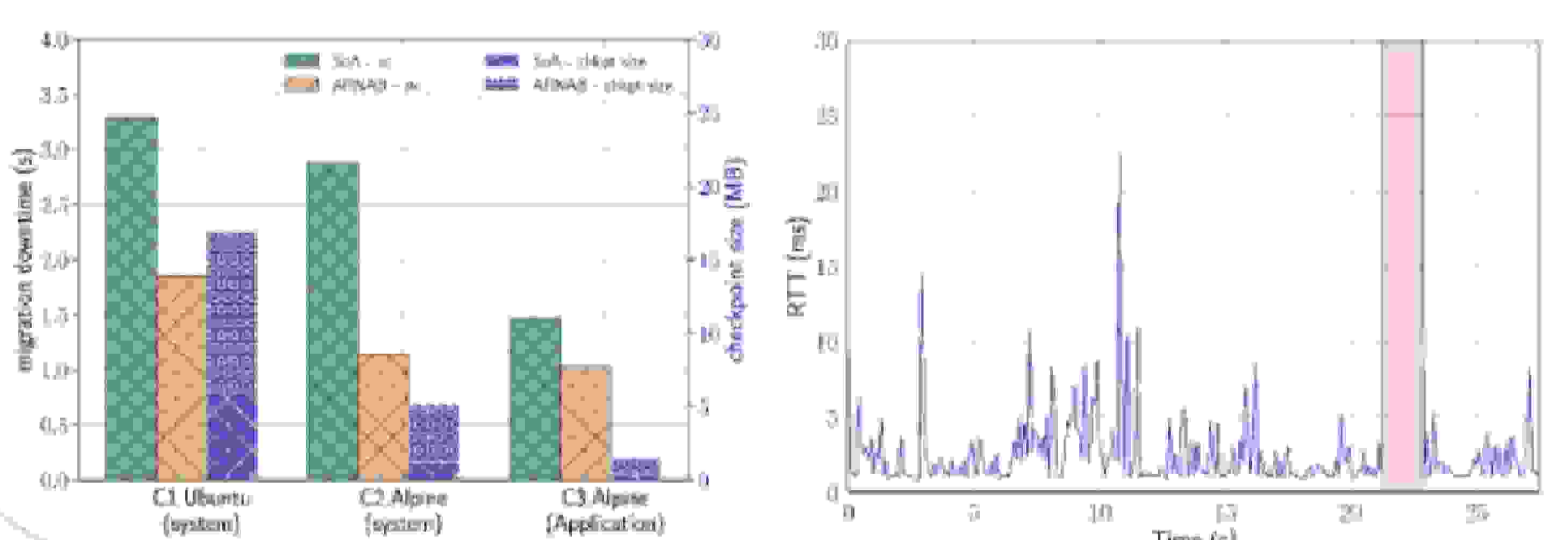
##### Tier 1 - User Connectivity Migration

Utilize virtual access point (vAP) to deliver seamless WiFi experience using commodity hardware.

##### Tier 1 - Edge Application Migration

Propose a pre-copy container migration scheme to deliver seamless applications experience at the proximity of the users.

**Results (downtime):** vAP migration (right), application migration of different container images (bottom-left) and application reachability impact (bottom-right).



Manages one or more virtual infrastructures.

**Control** → provisions, configures network devices and defines network topology.

**Orchestration** → manages virtual resources and the lifecycle of the virtual functions and applications.

Currently, machine learning techniques are being developed to address the following:

- Detection of insider denial of service attacks.
- prediction of migration downtime

#### Latest Journal Publications

- O.I. Abdullaziz, Wang LC, S. B. Chundrigar, Huang KL "Enabling Mobile Service Continuity across Orchestrated Edge Networks", IEEE Transactions on Network Science and Engineering (accepted).
- O.I. Abdullaziz, Chen YJ, Wang LC "HiAuth: Hidden Authentication for Protecting Software Defined Networks", IEEE Transactions on Network and Service Management, Vol. 16, No. 2, pp.618-631, 2019.

#### HiAuth: Hidden Authentication for Protecting Software Defined Networks

##### Problem - Transport Layer Security (TLS) adoption in SDN

- TLS Configuration complexity:** because the tasks to configure a secured TLS are very challenging, many SDN vendors do not adopt TLS in their products.
- Lack of Enforcement:** because OpenFlow specifications has made TLS optional, there is no enforcement for authentication mechanism in the SDN control channel.

**Solution:** hide the identities of the forwarding devices into the control packets via lightweight operations.

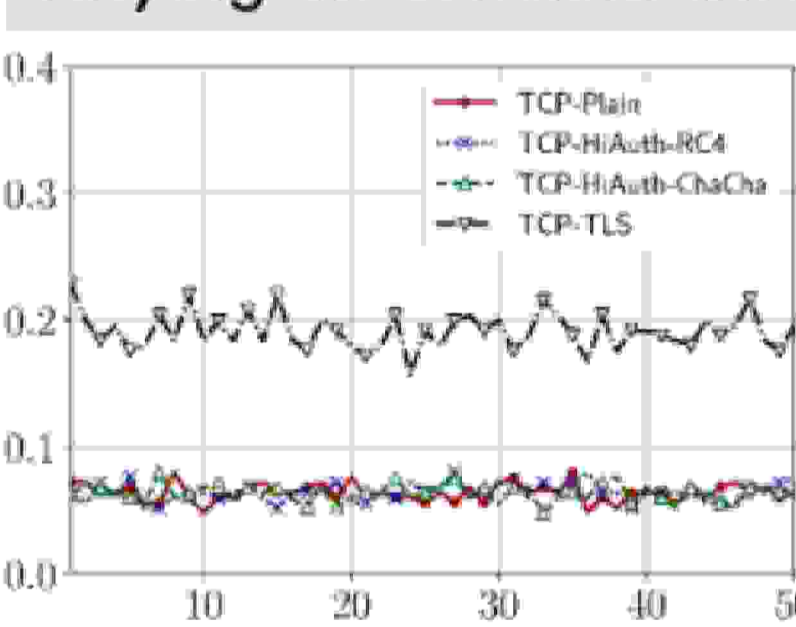
##### Feature 1 - Obscure

Mimics the original statistical distributions of the values generated by the OS to stay undetectable by attackers.

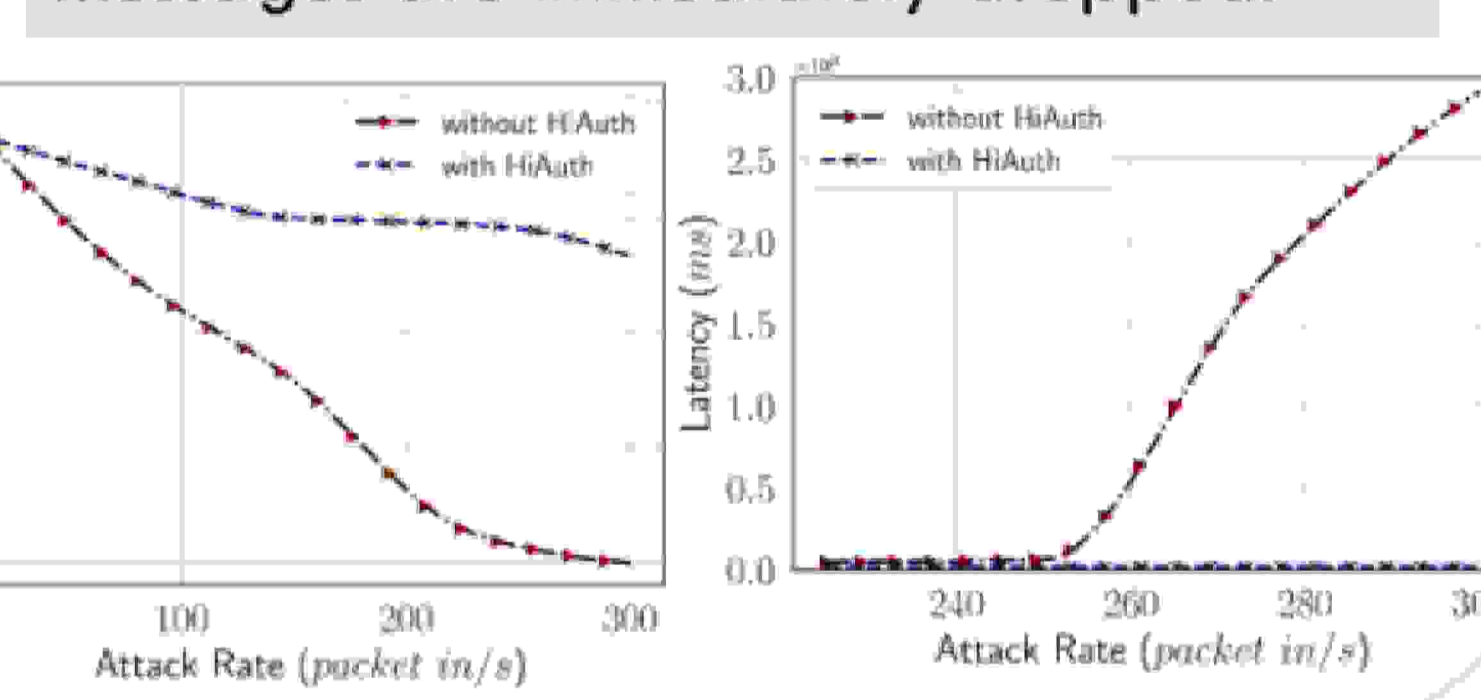
##### Feature 2 - Lightweight

Relies on bitwise operations for computations. Thus, it does not require specialized hardware.

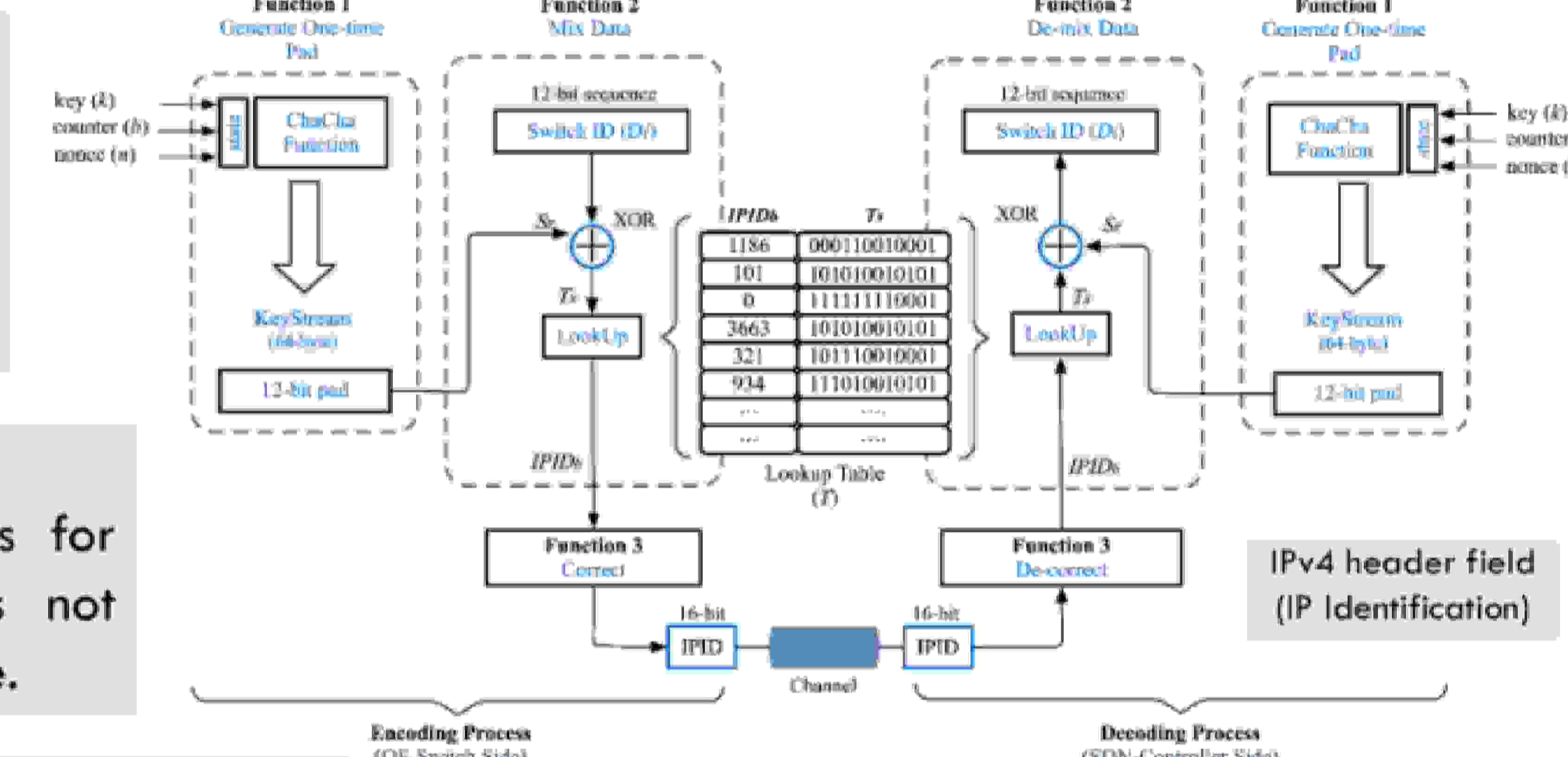
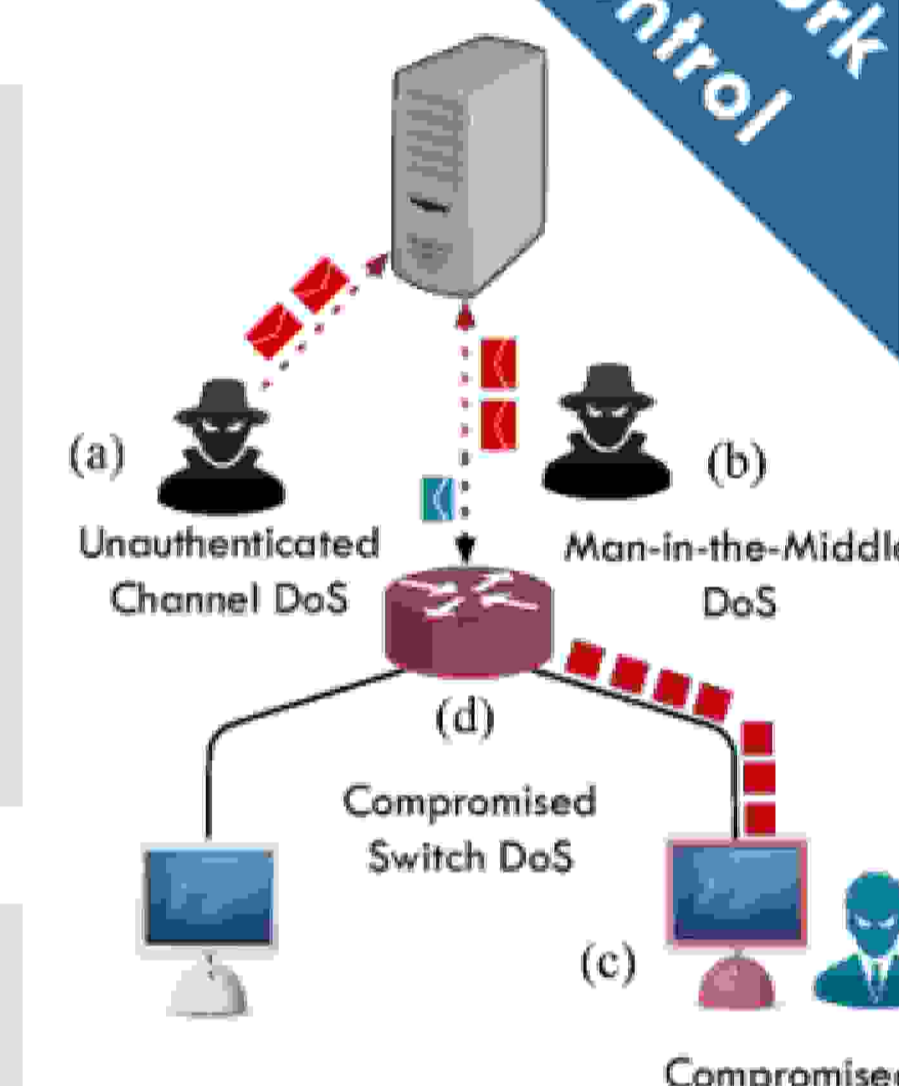
**Results (overhead):** lightweight due to relying on efficient bitwise operations.



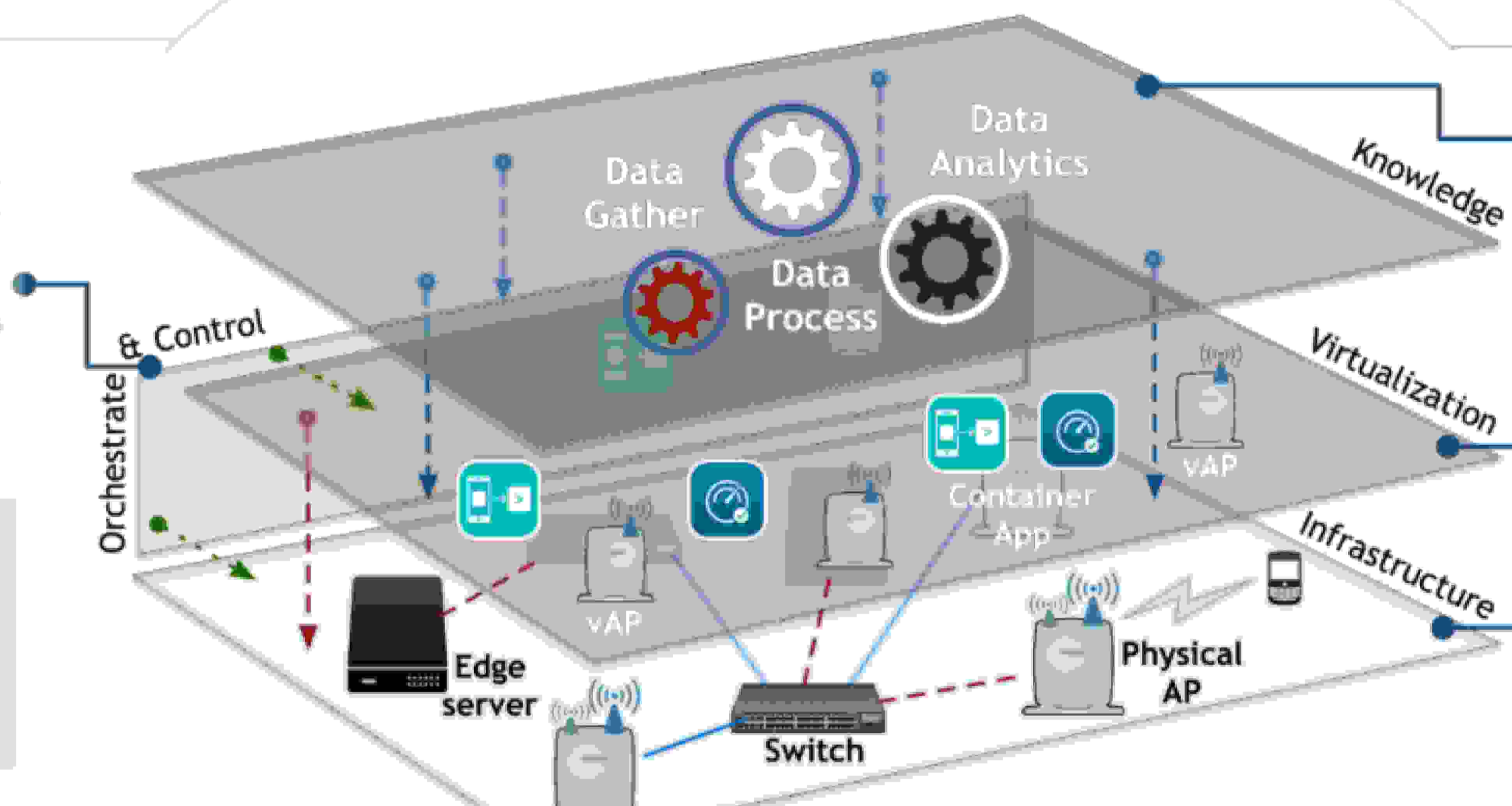
**Results (DoS mitigation):** legitimate messages are processed and attack messages are immediately dropped.



Network Control



#### KDOC Architecture



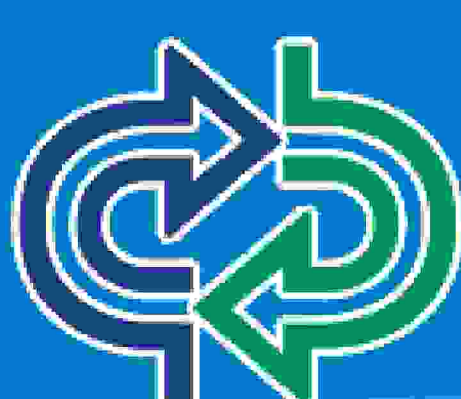
Gathers intelligence (rich global view) from the infrastructure, transforms it to knowledge through machine learning techniques, then utilize that knowledge for decision making.

Provides a pool of virtual computing, storage and network resources for provisioning virtual and isolated functions and applications.

Contains the hardware components on which virtual infrastructure are built on top including computation, storage, and networking resources.

#### Contributing to Projects:

- Europe/Taiwan H2020 Project (5G-CORAL) <http://5g-coral.eu/>
- Europe/Taiwan H2020 Project (5G-DIVE) <https://5g-dive.eu/>



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