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Advances in Next Generation Networks

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Abstract—This report provides recent advances in next generation networks (NGNs) from multi-access edge computing, resource allocation, edge intelligence, and information-centric networks (ICN). It represents an undergoing work, and not being finished.

I. RESEARCH ON EDGE COMPUTING

Edge computing: Edge computing consists in processing data and tasks at the edge of the network closer to where the data is generated [1], [2]. Such an approach opens door to many new paradigms to take place such as edge caching [3]–[8] requires that resource should be efficiently managed and allocated [9], [10].

Services virtualization: services virtualization is considered to be one of the 5G and beyond network enablers [11] where parts of the network are being virtualized into software pieces. Work in [?], [12] presented a resource allocation scheme for different network functions and entities of the network. The process of resource allocation for service function chaining was proposed and consists in placing, routing and scheduling the different network functions. Authors in [?], [12] proposed a mean field game to cope with such a problem, and considered the functions as a population that the mean field offers the dynamic of this population. In further use cases, in addition the aforementioned resource allocation requirements, services migration is also required and need to be considered. The work of [13] proposed a services migration scheme based on deep reinforcement learning to proactively migrate services to guarantee their continuity. On the other hand, network slicing also represents an enabler for 5G and beyond technology. Work of [14] presents a federated deep reinforcement learning approach to deal with RAN slicing for different MVNOs under the same InP.

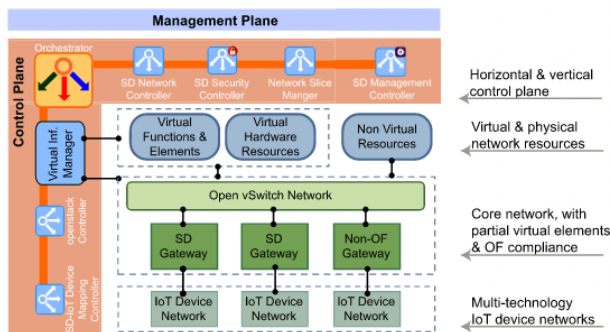


Fig. 1. Next-Generation Networks Layered Architecture

II. RESEARCH ON NEXT-GENERATION NETWORKS

Naming: [15], [16] present scheme targets smart IoT applications and provides built-in scalability, efficient routing, and security features. The authors incorporated a variable-length encoding method, with a prefix-labeling scheme in order to describe hierarchical location names with various embedded semantic functionalities. Moreover, the scheme supports fast local IoT communication using Name-to-Code translation concept, as well as multi-source content retrieval through in-network function. [17] targets the naming aspect in vehicular named data networks and proposes a Name-to-Hash Encoding scheme. The idea consists of hashing each name components separately to a fixed length, then perform a heuristic Wu-Manber-like algorithm lookup process. The former process enhances the NDN to consume less memory compared to hierarchical names, the latter process provides a fast lookup time.

Forwarding: [18] presents a new congestion control mechanism for NDN based on link quality estimation. The authors focused to provide fast data transmission, decrease packet dropping rate, and maximize the link utilization. The simulation results show that the designed solution outperforms the NDN schemes in terms of throughput and drop packets. [19] proposes a new multi-metric robust interface ranking scheme that combines multiple metrics with different objective functions. Furthermore, The paper also introduces different forwarding modes to handle the forwarding decision according to the available ranked interfaces. Extensive simulation experiments demonstrate that the proposed scheme selects the best and suitable forwarding interface to deliver content.

Caching: [6] presents a Near-ICN Cache Placement (NCP) scheme for IoT taking traffic class into consideration. NCP is designed to select the optimal replica cache by minimizing: the cost of moving the data from content producer to replica nodes, the cost of caching the content in the replica and the cost of delivery the content to consumers. Hence, the authors presented a multi-objective optimization problem, with a heuristic caching selection algorithm. [7] designs a distributed and efficient content caching scheme for 5G-enabled ICN networks, namely Cache and Split (CnS). CnS is designed to make a trade-off between the cache utilization and the content delivery time based on the number of received demands and content popularity. The authors evaluated the scheme using various performance metrics against different caching strategies. [20] proposes an ICN cache placement strategy at the edge network for IoT applications. More precisely, the authors designed a distributed cache placement scheme that aims to push the popular content to the edge network and keep the relatively less-popular content at the core. They also proposed a collaborative mechanism to fetch

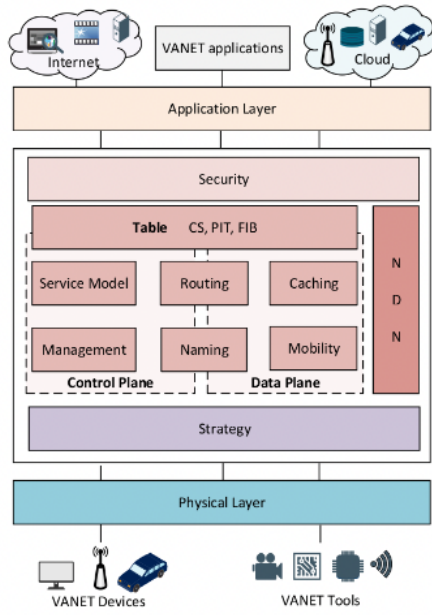


Fig. 2. Next-Generation Networks Layered Architecture

content from the nearest neighbor's content-store as well as propose a cache replacement policy based on the content popularity. [8] studies the effectiveness of in-network caching for VANET. The authors simulated and compared various strategies in different scenarios. Furthermore, they provided different research guidelines to enhance the use of caching in such a challenging network. [21] focuses on the content delivery issue and propose an optimized caching scheme that proactively predicts the moving direction of a vehicle and brings into the next encountered RSU cache only the required content of interest to that vehicle. According to the obtained results from different measured metrics, the proposed solution outperforms in many ways other proposed schemes in the literature.

Security: [22] focuses on the vehicular named data networking environment, targeting the security attacks and privacy issues. The authors presented a state of the art of existing VANET attacks and how NDN can deal with them. They classified these attacks based on the NDN perspective. Furthermore, they defined various challenges and issues faced by NDN-based VANET and highlight future research directions that should be addressed by the research community.

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