# Abstract

Society 5.0 revolutionizes connected living by employing an abstract system that provides automated and end-to-end services based on the demands of all the citizens or users in society. In this context, the communication framework of Society 5.0 needs to orchestrate different network services, such as real-time data transmission with global connectivity, end-to-end application management, and data privacy and security. In this context, this thesis explored different technologies and concepts such as 6G technology, Information-Centric Satellite Network (ICSN), Cyber-Physical Social System (CPSS), Attribute-based encryption (ABE), and Public blockchain network (PBCN) that provide such network services. Additionally, this work also provides solutions to address the issue of integrating these technologies and concepts in Society 5.0 to employ such network services.

For facilitating real-time data transmission, 6G offers to employ Society 5.0 with serialized data transmission, dense network deployment, and fast data delivery among multiple devices. However, in the absence of concurrent and intelligent data transmission in 6G which is discussed in Chapter 3, a 6G-based Society 5.0 increases the network delay and overall energy consumption. Consequently, such a absence of concurrent and intelligent data transmission in 6G affects the Quality-of-Service (QoS). To address this lacuna in 6G-based Society 5.0, this thesis introduces the concept of virtual machine (VM), Virtual Access Point (VAP), and Virtual Path (VP) in the user devices, which execute such a concurrent and intelligent data transmission. On the other hand, Information-Centric Satellite Network (ICSN) promises to enable Society 5.0 with global connectivity, efficient data caching in satellites, and real-time content delivery. As the satellites are storage-constrained, storing information in such satellites in the long run, is an unsuitable solution. Additionally, the existing solutions increase the delay of the communication framework envisioned in Society 5.0, while a cache-miss occurs in ICSN due to inappropriate mechanisms to address cache-miss in satellites. In the case of cache-miss at a satellite in ICSN, these solutions suggest searching the data at other satellites. Considering a specific type of data being archived in multiple satellites, if a satellite is accessed continuously at the state-of-the-art ICSNs during cache-miss, the delay for accessing the data in Society 5.0 also increases. This thesis addresses the issues of the increased service delay in an ICSN-enabled Society 5.0 by introducing a 2-level profile matching scheme.

Cyber-Physical Social System (CPSS) is expected to enable Society 5.0 with the remote observation of users' information using Internet of Things (IoT) devices. The analysis of the collected data provides personalized services to the users and enables end-to-end application management. Typically, in Society 5.0, a CPSS is expected to offload the tasks of analyzing users' information from the edge to the fog devices for minimizing the overall energy consumption and decision-making delay. However, the

static association between edge and fog devices in the existing CPSSs increases the overall energy consumption and decision-making delay in the communication framework of Society 5.0. Moreover, such static associations between edge and fog devices result in increased overall energy consumption and decision-making delay in the dynamic network topology of Society 5.0. We observe such an increase in overall energy consumption and decision-making delay as the network topology of Society 5.0 is exposed to periodic and aperiodic changes due to the presence of mobile edge devices. This thesis uses the features of CPSS in Society 5.0 to enable end-to-end application management. This thesis also addresses the issues of overall energy consumption and decision-making delay in a CPSS-based Society 5.0 by using a game theory-based mobility-aware intelligent task offloading scheme.

The abstract system envisioned in Society 5.0 needs to transact various types of entities such as users' personal information and money. Thus, this system needs to employ proper mechanisms to secure data and preserve users' privacy during such transactions. In this context, in this thesis, we apply the features of Attribute-based encryption (ABE) and Public blockchain network (PBCN) in Society 5.0 for secured data transactions and secured data archival with group data accessibility. The existing ABE solutions enforce users to manually provide their contextual information, namely attributes, to encrypt/decrypt data. Thus, it is conjectured that incorrect attribute selection by a user raises the issue of unauthenticated access to information. Nevertheless, the existing PBCNs allow every user to validate information, which increases the validation latency. Additionally, the existing PBCNs are unable to detect malicious end-users, which may degrade the efficiency of Society 5.0 by validating the data wrongly. This Thesis also addresses these issues that occur due to the conceptual integration of ABE and PBCN for orchestrating security services in Society 5.0 by introducing mechanisms for intelligent attribute learning and efficient validation device selection.

**Keywords:** Society 5.0, AI, IoT, 6G, ICSN, CPSS, CP-ABE, BCN, PBCN