

# Chapter 15

## Security Implications of IoT Applications with Cryptography and Blockchain Technology in Healthcare Digital Twin Design

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### **ABSTRACT**

*Over the last few years, the world has witnessed a fast-paced digital transformation in many aspects of human life in healthcare owing to the coronavirus (COVID-19) pandemic. Business and service providers had to adapt to digital changes quickly to overcome containment challenges and survive in an ever-changing world. Healthcare-related data collection, preservation, and analysis using digital technologies are helping pandemic mitigation strategies. With the rapid development of virtual systems integration methods and data acquisition techniques, digital twin (DT) technology is ushering in a new dawn for modern healthcare services and information systems. However, IoT-based information systems are vulnerable to privacy and security-related issues. This chapter presents an information system framework that consists of IoT with blockchain technology to mitigate vulnerability issues using lightweight cryptography.*

### **INTRODUCTION**

Competent healthcare is one of the strategic priorities shared by the primary healthcare service initiatives, such as using the Internet of things (IoT), sensor technologies, and big data analytics. *The digital twin* technology concept is an emerging concept that has become the center of attention for the healthcare industry in recent years. It is at the forefront of the healthcare industry revolution facilitated through advanced data analytics and IoT technology connectivity. This is recognized as a *building block* of the Metaverse, another fast-emerging case representing an immersive digital world that allows real-life

DOI: 10.4018/978-1-6684-5925-6.ch015

experiences and interactions in the healthcare industry. In this way, digital twin technology can tackle the challenge of seamless integration between IoT and data analytics by creating a connected physical and virtual twin (Digital Twin). In addition, a digital twin environment allows for rapid analysis and real-time decisions made through accurate analytics.

The general digitalization process across the healthcare industry and its services, rapidly increasing data processing and analysis capacity enabled by fast-paced technological revolutions, and continuous advancements in cognitive and artificial intelligence (AI) of which have accelerated digital twin technology. It is becoming more evident that Digital Twin runs in parallel with AI and IoT technology resulting in shared challenges. The first step in tackling the challenges is to identify them. Some common challenges are found with data analytics and IoT technology, and the end aim is to identify shared challenges for Digital Twins. The two most important challenges in Digital Twins are: (i) data analytic challenges and (ii) data privacy, security, and trust-related issues.

In data analytics, the most critical challenge is the general Information Technology (IT) infrastructure. The rapid growth of AI needs to be met with high-performance infrastructure in the form of up-to-date hardware and software to help execute machine learning algorithms. The current challenge with the infrastructure is the cost of installing and running these systems. For example, the costs of high-performance graphics processing units (GPUs) that can run machine learning algorithms are heavily costly. As well as this, the infrastructure needs updated software and hardware to run such a system successfully. Overcoming this challenge is seen through GPUs “*as a Service*,” providing on-demand GPUs at cost through the cloud. Amazon, Google, Microsoft and NVIDIA, to name a few, are offering unique on-demand services similar to traditional cloud-based applications, breaking the barrier to demand, but the poor infrastructure and high cost are still challenging for data analytics. However, using the cloud for data analytics and Digital Twins still pose challenges in ensuring that the cloud infrastructure offers robust security.

From a data point of view, it is essential to ensure it is not of inferior quality. The data needs to be sorted and cleaned, ensuring the highest data quality is fed into the AI algorithms. In addition, privacy and security are essential topics for the healthcare industry in the context of data analytics performance. Laws and regulations are yet to be fully established because of AI’s infancy. The challenge is more security, regulation and measure concerning AI in the future as the technology grows. Future regulation ensures the development of algorithms that take steps to protect user data. For example, the General Data Protection Regulation (GDPR) ensures the privacy and security of personal data worldwide. Despite being an umbrella regulation concerning data and security, this highlights the concerns with handling data when developing AI algorithms.

Regulation is one step to ensure personal data is protected, while another method is federated learning, a decentralized framework for training models. It allows users’ data in a learning model to stay localized without data sharing, addressing privacy and security issues when implementing data analytics within a Digital Twin. In addition, with the growth of IoT devices in the healthcare and industry setting comes the challenge of collecting factual data. The challenge is controlling data flow, ensuring it can be organized and used effectively. The challenge becomes a bigger problem with the advent of big data. The use of IoT increases the large volumes of unstructured data. For IoT to manage the amount of data, sorting and organization are necessary and will result in more data being usable and providing value.

One of the supporting technologies of digital twin deployment is the Internet of Things (IoT). The IoT seems crucial in addressing various challenges in healthcare applications (Pal, 2021). These applications are motivated by mobility, mobile communications, web-based services, and the requirements

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