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Digital Twins and Its Security Issues and Implications

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Abstract: ***A digital twin is a digital or virtual copy of physical assets or products. It has the virtual and real world by collecting real-time data from the sensors which are installed in the devices. The collected data is either locally decentralized or centrally stored in cloud. Then the data is evaluated and simulated in virtual copy of the assets. After revising the information from stimulation the parameters are applied to real assets and we can predict current and future conditions in both design and operational environment. Also these are the next big thing in fourth industrial revolution for the development of new products and process. Because of vast amount of data used and the risk this poses to sensitive system data. To overcome these. The key enabling technology for digital twins data analytics and IoT must follow the updated security policies, and data sharing based on Distributed Ledger Technology can help to overcome the challenges in sharing data.***

Keywords: Cyber-Physical System, Digital Twins, Security Attacks, Sharing Data, Security Measures. Theme of the work: detecting security issues/challenges in digital twin.

I. INTRODUCTION

Digitization created a awfully huge revolution in our society, nothing created a revolution as digitization. At its early time, data was captured and stored digitally from everyday life. After attaining some amounts of digital data techniques, we are now making things more advantage by leveraging Artificial Intelligent, Big Data Analysis and so on which are already existing techniques. A next step in in the digital world is emerging in the form of a Digital Twin.

The Digital Twin is the digital representation of real-world scenarios, that serves as the real-time digital counterpart of a physical object or process. In simple words Digital Twin is a digital replica. Digital Twin is also at the forefront of the Industry 4.0 revolution. Digital Twin is the advanced level of Data Analysis and it is also advanced in Internet of Things, so it is forefront of the industrial revolutions. It analyzing the real world asset and present it digitally and it can predict the required resources for maintaining and detecting faults.

A Digital Twin is a computer program that uses data available in real world to create simulations that will predict the performance and also the process of the product. It is an integration of various technologies that develops various functions. The integration of the Internet of Things, AI and software analytics to reinforce the output.

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It can be used to overcome the limitations of the product and to improve the quality by allowing Artificial Intelligent(AI) to analyze data from available/provided resources. With the advanced Machine Learning and factors like big data analysis, we can drive innovation and improved performance using these virtual models in these modern engineering.

Digital Twin can manage the challenge when new modal or future is added between Internet of Things and Data Analytics. It's a virtual representation of how an IoT devices perform throughout its lifecycle. We can analysis things quickly and exactly and make things easy to make real-time decisions with more accuracy.

This paper provides detailed review about enabled technologies in Digital Twin and current problems and security issues in sharing data in Digital Twin and also covers about Digital Twin in the industrial revolution.

II. BACKGROUND

As of now, Digital Twin remains in its drafting board. Even it's in its drafting stage, implementation and design of this concepts are addressed to the data, particularly in the industrial revolution. Industrial assets are described by Automation ML format and it provides object orientation for modeling the asset's physical and logical. There are many proposed frameworks for using Digital Twins simulation mode for security purpose. For example, -penetration test also known as pen testing is a simulated cyber-attack against computer system to check for exploitable vulnerabilities, for these Digital Twin proposes a framework for security purpose. These are the initial development of Digital Twin, still the data sharing functions are missing. Integration of Digital Twin in Industrial application is mainly because it helps to run the process smoothly and effectively in the industrial system. Excessive data generated from different systems can be used for making smart decisions. Interaction between human and product(machine) can become more smooth and easier when we use Digital Twin. When it comes to data sharing in Digital Twins there'll be communication between Digital Twin and its real-world things, these is two-way communication and additionally communication between lifecycle parties takes place, both the communications need to be considered. Digital Twin is an concept associated with the cyber-physical integration which is the concept also associated with Cyber-Physical System. Basically Cyber-Physical System is the integration of physical process and computational process. Cyber Physical System (CPS) could be a new trend within the Internet-of-Things (IoT) connected analysis works,

wherever physical systems act because the sensors to gather real-world data and communicate them to the computation modules (i.e. cyber layer), which additional analyze and send word the findings to the corresponding physical systems through a feedback circuit. So both Digital Twin and Cyber Physical System are used to describe the cyber-physical interactions.

A. Applications of Digital Twin:

Digital Twin is an integration of various technologies that improves various functions. Various technologies are used in proposed model of an physical product and using Digital Twin we can identify the problems of the product and overcome.

Digital Twins are used to optimize machines as these are accurate copy of the physical product. Process optimization, product design, quality management, predictive maintenance, supply chain management, and analyzing the experience of user are the some of the characteristic of Digital Twin. Using Digital Twin can result in improved productivity with more advantages, increase reliability and reduces risk in various areas. Digital Twins are used in various industries such as manufacturing industry, healthcare industries, automotive industries

a. Digital Twin in Internet of Things (IoT):

Nowadays the use of sensors, wireless communication at low-power, signal processing algorithm and the use of Internet of Things devices in physical applications are more in number. Real world can be connected with various targets like cyberspace, and to gather data, and for collecting feedbacks using IoT technology. The backbone technology of Digital Twin is Internet of Technology for real-time data gathering of multiple source. As much as Digital Twin can produce the duplicates of the physical product, the information about the product can be gathered with IoT sensors and using those information we can improve the advantage of the product.

b. Digital Twin in Machine Learning:

Machine Learning models requires real data to acquire knowledge about the device then Digital Twin also works similarly with the real products using validated machine learning models and stimulate production to identify the required improvements. Digital Twin verifies the specific part of the machine learning model in unusual situations in particular Digital Twin is important for prior analysis of dangerous situations especially when it is not possible to test Machine Learning with real data.

c. Digital Twin in Cloud Technology:

Data analysis methods are included in Digital Twin that they collect data from different sensors that are installed in the real system. Digital Twin is the group of complex systems composed of computational methods, mathematical model and software services that permit real time synchronization between read process and virtual system. In cloud system large amount data are stored, for that Container-as-a-service method is used. The information collected from the production plant is sent to cloud storage for Digital Twin elaboration and data were stored there.

d. Digital Twin in Cyber Physical System:

Cyber Physical System is interconnected intelligent device that is capable of adaption whereas Digital Twin is a virtual model that interacts with the actual system. Cyber Physical System is about how a physical system integrates with computing, sensors, control and communications in large scale cyber infrastructure. It is basically a cross section of digital and physical world. Digital Twin is an subset of the Cyber Physical System and both integrates to produce smart product and used in Internet of Things. Digital Twin acts as a mirror for the Physical System inside the Cyber Physical System.

e. Digital Twin in Industry 4.0:

Many manufactory industries have production lines that are not monitored and may not be optimized. So the aim of fourth industrial revolutions are to increase automation of production plans, to improve communication among machineries, and also to allow self-monitoring. These can be reached through dynamic plants reconfiguration, predictive analysis of plants reconfiguration, complete production monitoring enabling Digital Twin.

III. LITERATURE SURVEY

S.no	Research Paper Name and Author	Description	Summary
1	Digital Twin: Enabling Technologies, Challenges and Open Research Author: AIDAN FULLER1, ZHONG FAN, CHARLES DAY AND CHRIS BARLOW	This paper focusses on the applying of digital twin, discussing the domain, sectors, and specific issues for Digital Twin technology. For the moment the term and idea of a Digital Twin area unit growing across world, and also the advancements in IoT and artificial intelligence (AI) area unit enabling this growth to increase	The paper revolves round the standing of Digital Twins with IoT/IIoT and knowledge analytics known as sanctionative technologies It is changing into a lot of evident that Digital Twin runs in parallel with AI and IoT technology leading to shared challenges. The first step in effort the challenges is to spot them. Some of the common challenges area unit found with each knowledge analytics and also the web of Things, and also the finish aim is to identify shared challenges for Digital Twins.
2	Communication-Efficient Federated Learning and Permissioned	Traditional cloud-based computing design may be used	The Digital Twin technology offers nice potential to bridge

	Blockchain for Digital Twin Edge Networks Author: Yunlong Lu, Xiaohong Huang, Ke Zhang, Sabita Maharjan, Yan Zhang	to build digital twin models, by assembling knowledge and capital punishment machine learning algorithms at the centralized server	the gap between the speed of knowledge generation from IoT sensors and the needed level of fast and real-time knowledge analysis. By maintaining a tamper-proof, immutable distributed ledger, blockchain will establish trust among distributed users and enhance knowledge security in a very network. several studies have exploited blockchain for resource management in Mobile Edge Computing (MEC) networks
3	Design and Development of Digital Twins: a Case Study in Supply Chains Author: Jose Antonio Marmolejo	Digital twin technology consists of making virtual replicas of objects or processes that simulate the behavior of their real counterparts. Applied to product, machines and even complete business ecosystems, the digital twin model will reveal info from the past, optimize the current and even predict the long run performance of the various areas analyzed. within the context of provide chains, digital twins area unit ever-changing the approach they are doing business, providing a variety of choices to facilitate cooperative environments and data-based creating deciding higher cognitive process} and making business processes a lot of sturdy.	The digital twin conception of the availability chain isn't however a customary. The basic concepts and functions that the planning of those should have are known, however the event of applications has been scarce. Some examples may be found in. powered by a mix of computing (data mining, deep learning, and analytics), digital twins can mirror a physical twin and reveal problems before they occur, they consider a spread of sensors embedded within the physical world to transfer period information concerning the operative process and atmosphere
4	Digital Twins Driving Model Based on Petri Net in Industrial Pipeline	Aiming at the matter of information synchronization between digital twin and physical entities, supported the first simulation capability of Petri web, the structure of the state incremental update place was freshly outlined, that enabled Petri web to own the aptitude basis of period of time information processing, and therefore the state progressive update algorithmic rule of the place was designed to comprehend the operate of period of time simulation. This paper deals with the matter of feedback management of digital twins on physical entities. The feedback management structure was additional to Petri web and therefore the coordination algorithmic rule of the feedback management structure was designed to change Petri Net to observe and management the operation of physical instrumentality	A CTPN model with state incremental update place and feedback control structure is proposed to drive the operation of digital twins in real time. Through the incremental update algorithm of the place and the incremental update algorithm of the state, the twin-body online update data is realized, and the process control of pipeline is realized by arc suppression monitoring algorithm and control coordination algorithm. Through the evaluation of machining pressure, model stability, machining efficiency and flexible line performance, the validity and practicability of the model
5	A Digital Twin for Operational Evaluation of Vertical Transportation Systems Author: Mikel González, Oscar Salgado, Jan Croes, Bert Pluymers, Wim Desmet	The Digital Twin (DT) may be a promising construct that aims at making a virtual duplicate of an individual system, which will offer data otherwise not on the market. mistreatment it to judge the system condition and potential corrective solutions. Exploiting the benefits of object-oriented modeling, this DT has been engineered making certain that it should be dynamically custom-made to totally different observation eventualities.	Its adaptability is tested showing that reduced models behave equally. The ensuing reduced models area unit used to estimate installation parameters during a bottom-up manner, mistreatment the measurements of a scaled check bench. The estimated parameters area unit wont to update a accurate model and simulate the impact of corrective actions.
6	A digital twin architecture reference model for the cloud-based cyber-physical systems Author: K. M. Alam and A. El Saddik	Cyber Physical System (CPS) could be a new trend within the Internet-of-Things (IoT) connected analysis works, wherever physical systems act because the sensors to gather real-	The analysis community is showing tremendous interests about the cycle per second field latterly. a replacement model to

		world data and communicate them to the computation modules (i.e. cyber layer), which additional analyze and send word the findings to the corresponding physical systems through a feedback circuit. up to date researchers suggest integration cloud technologies within the Hertz cyber layer to confirm measurability of storage, computation and cross domain communication capabilities	describe the IoT is Sensing-as-a-service (SenAS), where four abstract layers square measure involved from the information provider to the consumption process Sensors square measure deployed to collect information relating to the surroundings device owners have the correct to publish the device services. Atzori et al. have introduced Social internet of Things (SIoT).
7	Implementation of a Petri-net based Digital Twin for the development procedure of an Electric Vehicle", Control and Automation (MED) 2020 28th Mediterranean Conference, 2020. Author: George J. Tsinarakis, Polychronis S. Spanoudakis, George Arabatzis, Nikos C. Tsourveloudis, Lefteris Doitsidis	The model isn't used offline as a passive component but is connected and interacts with the physical system (development procedure). supported the data exchange between physical and digital system, other ways to overcome delays square measure studied and therefore the best answer is calculated, tested and applied. Results square measure provided according to completely different situations, so as to point out the potency and applicability of the planned technique.	The Timed Petri net models of the four types of task dependencies as shortly presented in are implemented and combined to model the overall development procedure. Each task may have multiple dependencies with other tasks. Modularity of the approach simplifies the modeling and management of models of any structure and complexity. The dependencies describe the relationships between two) tasks, such that one is the independent task and the other is the dependent one
8	On the Implementation of IoT-Based Digital Twin for Networked Microgrids Resiliency Against Cyber Attacks Author: Ahmed Saad, Samy Faddel, Tarek Youssef, Osama A. Mohammed	An IoT-based digital twin (DT) of the cyberphysical system that interacts with the system to make sure its correct operation. The IoT cloud provision of the energy cyber-physical and therefore the DT area unit mathematically developed. Unlike other cybersecurity frameworks within the literature, the planned one will mitigate a personal similarly as coordinated attack. The framework is tested on a distributed system and the security measures area unit enforced victimization cloud computing	An IoT-based digital twin (DT) for the cyberphysical networked microgrids is introduced to boost the resiliency against cyber attacks. The cloud-based DT platform is enforced to be a central oversight for the NMG system. The cloud system hosts the controllers (cyber things) and therefore the sensors (physical things) into the cloud IoT core in terms of the IoT shadow. The projected DT covers the digital duplicate for each the physical layer, cyber layers and their hybrid interactions.
9	Digital twinning [information technology virtual reality] Author: D. Ross	Companies building the net of Things infrastructure have began to develop the idea of digital twins for merchandise, in which the entity – maybe a bicycle, a car or every a part of that automotive for instance – is replicated digitally from the plant floor to the end of its life. Sensors develop everything the physical product experiences, send that to the digital twin therefore faults may be diagnosed and issues solved before the important product breaks down.	The online fashion retail business can be value $300bn worldwide by 2018, says Bernd Gill, horsepower Enterprise's manager of service innovation. however the item come back rate averages thirty per cent, most of that is due to customers selecting the incorrect size or the incorrect color. HP's avatar plan would allow customers to envision however they'd look in the garments, share those pictures with friends or family for second opinions, and, most importantly, order the proper size.
10	End-to-end security validation of IoT systems based on digital twins of end-devices. In 2020 Global Internet of Things Summit. Author: Maillet-Contoz, L., Michel, E., Nava, M. D., Brun, P. E., Leprêtre, K., & Massot, G.	End-to-end digital twin abstract model that represents its complementary entity from the bottom to the cloud. The paper presents the planned digital twin model's multi-layers, namely, physical, communication, virtual house, knowledge analytic and visualization, and application similarly because the overlapping security layer. The hardware and software package technologies that square measure utilized in building such a model are explained well. A use case are	The planned work is completely different from the present work as a result of it proposes associate degree end-to-end conceptual model for a digital twin. On the opposite hand, most of the present work on digital twins has focused solely on the simulation side of the digital twin for emulating the mechanical method and therefore the physical element of a machinery within the virtual layer of the design or the cloud. The planned conceptual model incorporates completely different communication technologies and machine learning algorithms

		presented to point out however the layers collect, exchange, and method the entity knowledge from the ground to the cloud.	as well as security for simulating a digital twin. These layers area unit essential for seamless integration of data in real time from the physical layer up to the applying layer encapsulated with a security framework for prognostic maintenance. as an example, our planned digital twin model was used throughout the producing and operation. In alternative words, the planned digital twin collects the product's real-time operational knowledge and close atmosphere parameters
11	QUILT: Quality inference from living digital twins in IoT-enabled manufacturing systems Author: S. R. Chhetri, S. Faezi, A. Canedo, and M. A. A. Faruque	Many bequest producing systems don't have multi-physics sensors integral by default. Moreover, it might not be possible to intrusively place sensors in these systems once they are factory-made. To bring the benefits of digitalisation to bequest producing systems, this paper contributes with AN Internet-of-Things (IoT) based mostly methodology to make digital twins using AN indirect medium like side-channels, which may localize abnormal faults and infer the standard of the product being manufactured whereas keeping itself up-to-date	The digital twin of the product (the 3D object being created) is at first delineate employing a software system (CAD) tools. The CAD tool then produces StereoLithography (STL) files that contains geometry description of the thing in coordinate space. Then a Computer-Aided producing (CAM) tool takes the STL file and slices it into multiple layers and finds a trace to be followed to print the thing in every layer. The output of the CAM layer is that the G/M-code
12	On the Implementation of IoT-Based Digital Twin for Networked Microgrids Resiliency Against Cyber Attacks Author: Ahmed Saad, Samy Faddel, Tarek Youssef, Osama A. Mohammed	The IoT cloud provision of the energy cyber-physical and therefore the DT are mathematically developed. Unlike other cybersecurity frameworks within the literature, the projected one will mitigate a private similarly as coordinated attack. The framework is tested on a distributed system and the security measures square measure enforced mistreatment cloud computing. The physical controllers square measure enforced mistreatment single-board computers	An IoT-based digital twin (DT) for the cyberphysical networked microgrids is introduced to reinforce the resiliency against cyber attacks. The cloud-based DT platform is enforced to be a centrical oversight for the NMG system. The cloud system hosts the controllers (cyber things) and also the sensors (physical things) into the cloud IoT core in terms of the IoT shadow.

IV. SECURITY ISSUES IN DIGITAL TWIN

So basically, when someone gets System Access to any digital twin, then directly they can get knowledge over the system and also get control over the physical assets also which is very dangerous. We are sharing data in Digital Twin, and one of the major privacy issues is sharing of data regarding production. Even IP Theft is also a threat by which hackers can reproduce the property and develop their own model for existing product. People can access our data in Digital Twin and make some unauthorized changes can mislead. The collected data are stored in the cloud and the more amount of information were stored in the cloud were the risk to security become more important. So we must prevent our data in secure/ manner and we need to interpret it correctly and prevent unauthorized modifications. Also the collected data must be stored securely since it has very vast amount of data and leakage of those data may leads to very big disorder. So sharing of data among people for industrial purpose and also the collected data from sensors must be stored securely.

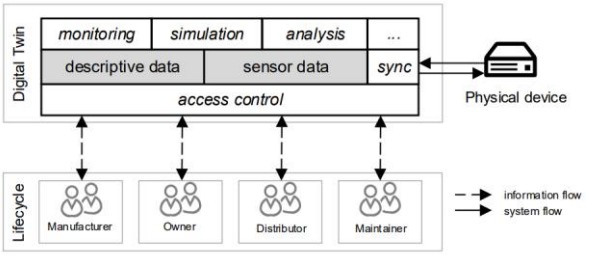

Fig.1 Overview of the Asset Lifecycle Participants Interacting with the Digital Twin.

The diagram is a model Digital Twin sharing data and exemplary set of lifecycle stakeholders. Descriptive data and Sensor data are the two type of data in the system. Descriptive data refers to the static properties of the device and it is produced mainly from user side. Sensor data will be generated by sensors will occur often and it should be available in near real time. It provides valuable information on the asset's environmental conditions. Furthermore both type of data need to be synchronized with the physical counterpart.

Digital Twin interacts with the physical device which involves monitoring, simulation, analysis which are advanced operation of access control, that they can provide authentication to enable data sharing.

So from the information flow we can notice how information about physical device is collected from and shared to lifecycle parties. The system flow represents bidirectional synchronization between Digital Twin and its real world counterpart. Both the flow should contribute for making data sharing activity traceable.

V. SECURITY IMPLICATIONS

Many security measures are there but those traditional protective measures won't be enough to keep our system and data safe. so those security measure won't keep our data safe and the security must be expanded to protect software and hardware and mainly the data shared between two sources. There are lot of security tools and technologies are available to protect our data. So the thing is we have to select which technique we must use and what are the updates we must made in that technology and we can mix all tools and can also get customized new solution for our security needs.

The purpose of the Digital Twin is the information along with its complete lifecycle from different stakeholders be accessed. For single device instance, two separate standalone Digital Twin exists. One standalone at the customer side and another one for the manufacturer, because of security reasons. Sometimes information among the life cycle may be missing, various data formats were used, missing standards and missing data are some problems in data sharing.

So for secure data sharing in Digital Twin, there will be many stakeholders involved in data sharing process. So every stakeholder must be considerd, they can be manufacturer to maintainer everyone should pre-register. So by these we can prevent unwanted manipulation or using of data. Data integrity and confidentiality mechanisms helps to ensure the quality of input data from responsible parties. So here we can use Distributed Ledger approach for secure data sharing in Digital Twin.

Storing of collected data securely will be a must important thing in Digital Twin. The Collected data can be stored in various methods. Even we can store our data in cloud database. The data stored in cloud uses the container as a service to manage large amount of data. There are few solutions provide by cloud vendors such as IBM, Amazon, Microsoft Azure etc.

Digital Twin could build on IBM Watson IoT. It offered by IMB provides complete solution for storing data in cloud using Container-as-a-Service. There is an another solution proposed by the Microsoft, that is Azure IoT solution. These model has Device Twin model as a part of device management. These device stores the information and these will be updated in real-time the data coming from the real system. By introducing the concept of Digital Twin in Cyber-Physical system we can increase the security of CPS. These will help engineers to develop more secure Cyber-Physical System.

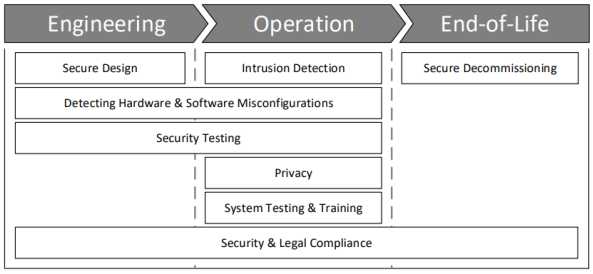

Fig. 2 Security-Relevant use Case of the Digital Twin within the Lifecycle of Cyber-Physical System

So these is a diagram referred from (Digital Twins for Cyber-Physical Systems Security: State of the Art and Outlook) that is security use cases of Digital Twin. These is the outlook of Digital Twin that is within the lifecycle of Cyber-Physical System. The -security testing will be takes place in these process inside the CPS. We can analyze how the system to be engineered behaves under attack. Engineers can estimate the damage by which may facilitate designing the security and safety measures od Cyber-Physical System from its authors state. By these the security measure will be improved.

VI. ANALYSIS

There will be two different attacks at Digital Twin, that are attacks based on Digital Twin and attacks against Digital Twin. In attacks against Digital Twin the consequences of attacks against Digital Twins are unknown that may happen in Engineering and Operation phase. There is also an attack based on Digital Twins is unknown hoe Digital Thread or Digital Twins can be exploited for launching advanced, convert attacks in the Engineering and Operation phase.

One of the real time example that attack happened based on Digital Twin and against Digital Twin is there is an significant equipment damage at the nuclear facility. So these happens by manipulating the speed of centrifuge rotors that is done only when attacker have deep knowledge about the plant design which makes attack to tailor the malware to the target. To prevent such type of attacks more research need to be done and the security measures must be improved as its data leakage may led to very major attacks based on where the attacks takes places. The estimation results of attacks were very worst so the security measures must be developed according.

VII. CONCLUSION

These paper has proposed about Digital Twin and the implication of Digital Twin with its safety measure. The applications of Digital Twins were covered and the security issues and its implications are discussed briefly. Since its in its emerging stage there are not must algorithms and technologies are available. Maintaining data security become major requirement while use Digital Twins and sharing its data with different parties. There are only few technologies are used for sharing data securely and these are not up to the level, so the security measure must be improved.

Digital Twin is going to be future and there is lot more to do with Digital Twin since it is only in its emerging stage. It is used in various fields/industries. It can be used in hardware products and also in software side. It can be used in every field and can overcome disadvantages and make product with more advantages.

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Ethical Approval and Consent to Participate	No, the article does not require ethical approval and consent to participate with evidence.
Availability of Data and Material/ Data Access Statement	Not relevant.
Authors Contributions	I am only the sole author of the article

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