

# HEALTH CARE IOT

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**Abstract**— Today health problems such as cardiac failure, lung failures and the heart related diseases are occurring day by day at very high rates. Due to these problems time to time health monitoring is very important. A modern concept is health monitoring of a patient in wireless ways. It is a huge development in medical field. Health professionals have invented a brilliant and less expensive health monitoring system or providing more comfortable living to the people who are suffering from various diseases using trending technologies like wireless communications, wearable devices and portable remote health monitoring devices. As the visit of doctors to the patients constantly are decreased as the information regarding patient's health directly reaches to doctor's monitor screen from anywhere the patient is residing. In addition based on this the doctors can save many lives by imparting them as a fast and valuable service. Health is the very fundamental necessity humans require to acquire, feel, and act effectively, and as such, it act as a primary element in the development of the individual, but also in the environment to which humans belongs. That is why, it is very necessary to provide different ways and means to ensure the proper healthcare delivery based on parameters monitoring and direct providing of the medical assistance. Internet of Things (IoT) based health care systems play a significant role in Information and Communication Technologies and has contribution in development of medical information systems. The developing of IoT-based health care systems must make sure and increase the safety of patients, the quality of lives and other health care activities. The tracking, tracing and monitoring of patients and health care actors activities are challenging research areas.

**Keywords:** Internet of Things (IoT), healthcare, medical assistance, tracking, tracing.

## I. INTRODUCTION

The ability of everyday devices is to communicate with each other with humans is becoming more prevalent and often is referred to as the Internet of Things (IoT). IOT is a highly dynamic and radically distributed networked system; this composes a very large number of smart objects [1]. Three main system-level characteristics of IoT [2] are:

- Anything communicates;
- Anything is identified; and
- Anything interacts.

The smart object of IOT is a sensor node and it is basic and most important, or more precisely, Sensor Web (SW), which can be defined as a web of interconnected heterogeneous sensors that are interoperable, intelligent, dynamic, scalable and flexible. Smart objects are envisaged to provide smart metering, e-health logistics, building and home automation and many new uses not yet defined.

Internet of Things (IoT) is “a new revolution of the Internet”, it has the ability to connect remote and mobile things or machines or assets through the use of wireless communications and low-cost sensors, computing and storage devices. So, the Internet is now advancing from a network of computers to a network of things.

Currently there are many definitions of IoT, which may vary depending on the context, the effects and the views of the person giving the definition. The definition of IoT can be “a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual things have identities, physical attributes, and virtual personalities”

The Internet of Things offers solutions based on the integration of Information Technology (IT), which refers to hardware and software used to store and process data, and Communications Technology, which includes electronic systems used for communication between individuals.

Healthcare organizations around the world are transforming themselves into more efficient, coordinated and user-centered systems. This tendency implies more integrated interoperable and ubiquitous healthcare services, a greater and easier access to health records and related information, and to engage patients in their own healthcare. The information and communication technology should play a more central role in achieving efficiencies and enhancing distributed healthcare systems that should fulfill diverse and frequent update demands

Health-IoT ecosystems are based on a network of devices that connect directly with each other to capture and share vital data, and significant context information, through a secure service layer that connects to a central command and control server in the cloud.

Home healthcare market is: independent living services, consumer medical devices, tele health, wearable technologies, monitored fitness devices, health gaming and personal emergency response systems. Particularly, in the field of tele care, remote monitoring of patients allows more self-management of chronic conditions, and significant service improvements and cost reductions.

Health IoT ecosystems has to deliver the right information, at the right time, to all key stakeholders, in order to have a real Information-driven Healthcare.

The systems engineering (SE) and system-of-systems engineering (SoSE) viewpoints ensure that the elements of Health-IoT ecosystems fit together to achieve the general objectives of the corresponding stakeholders, and fulfil the associated evolving programs.

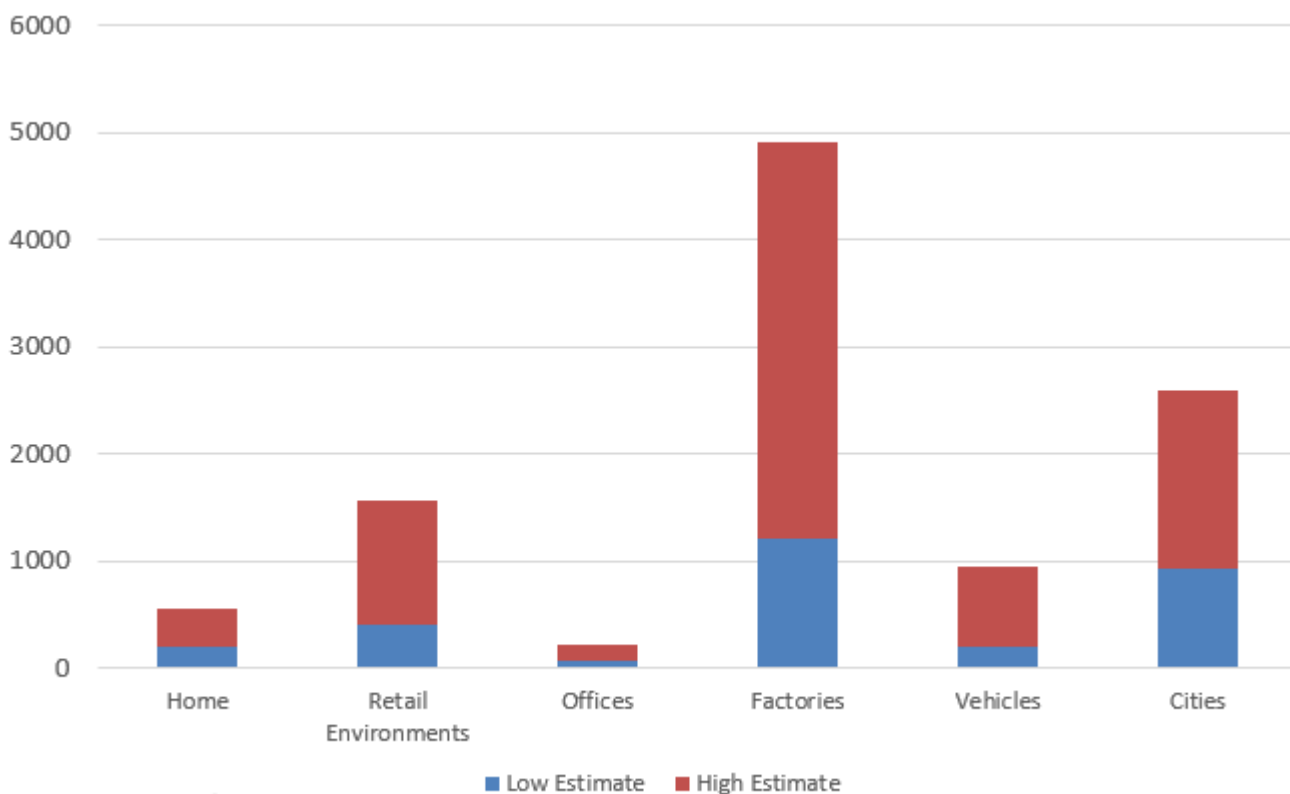
IoT powered e-health creates a lot of opportunities to improve outcomes. Some of the most promising use cases of connected e-health include preventive health, proactive monitoring, follow-up care and chronic care disease management [5]. It can be stated that the IoT is a disruptive innovation, which bridges interoperability challenges to radically change the way in which healthcare will be delivered, driving better outcomes, increasing efficiency, and making healthcare affordable.

In order to track and record personal data it is necessary to use sensors or tools which are readily available to the general public. Such sensors are usually wearable devices and the tools are digitally available through mobile device applications. These self-monitoring devices are created for the purpose of allowing personal data to be instantly available to the individual to be analyzed. The biggest benefit of self-monitoring devices is the elimination of the necessity for third party hospitals to run tests, which are both expensive and lengthy. These devices are an important advancement in the field of personal health management. This paper analyses the involved system engineering decisions, to build cost-effective Health-IoT platforms that enhance the corresponding medical services, clinical care and remote monitoring, to respond to new society challenges.

## II. IoT and Healthcare

In order to improve human health and well-being is the ultimate scope of any economic, social and technological development. The concept of the IoT encourages the use of electronic devices that monitor data and they are connected to a private or public cloud, enabling them too automatically trigger (start action) on certain events[1][4]. Now a day's does the IoT offer bigger promise than in the Field of health care. McKinsey Global Institute has represented in its report predictions and economic feasibilities of IoT powered healthcare, which says that by 2025 the largest percentage of the IoT incomes will go to healthcare shown in figure1 [7].

Economic Impact of IoT in 2025



Market Realist

Source:- Consultancy.uk

Fig 1: Economy impact of IoT in 2025.

Internet-connected devices, discovered to patients in various forms, enables the tracking health information what is necessary for some patients. It creates an access for smarter devices in order to deliver more valuable data, decreasing the need for direct patient-healthcare professional interactions. With faster, better insights, providers can improve more, chronic disease management, patient care, and hospital administration and supply much different efficiency, and provide medical services to more people at reduced costs [2]. The IoT has already brought in significant changes in many different aspects of healthcare. Figure 2 illustrates remote heart rate monitoring using IoT.

Advances in telecommunication, information and network technologies play a significant role in health care systems and also have a large contribution in development of medical information systems. However, health care offers one of the most important social and economic challenges that are faced by every country, and health care administrators, researchers, clinicians and other health practitioners are going through increasing pressure in order to adjust to the growing expectations that arises from both the public and the private sector[3]. A major affect on the quality of people’s life is the increasing cost of medical care and these high costs are even higher in the case of chronic diseases [5]. The number of elderly is increasing continuously, which puts pressure on social and health services [6].

The development of health care systems requires a concerted effort to harness to the power of information and communications technologies in the service of health care with aim to create more efficient, more effective, and highly secure data sharing, large-scale health information processing’s, and more effective communications [7].

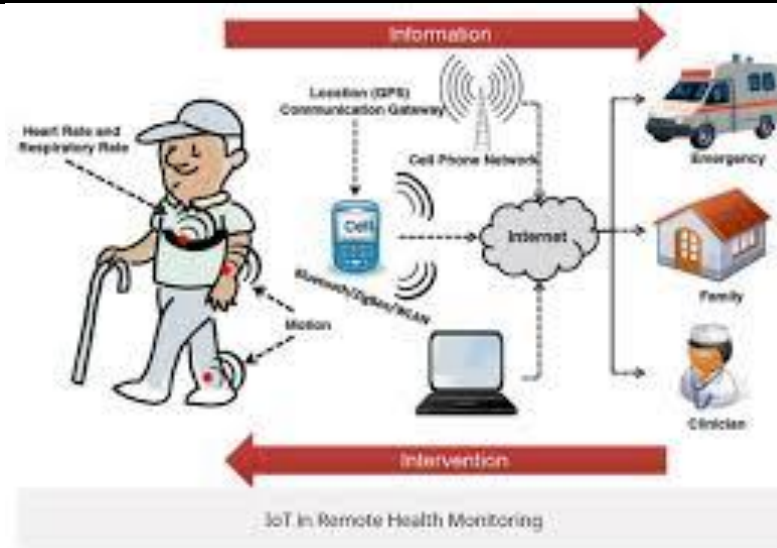


Fig 2: Remote health monitoring using IoT.

A number of many connected devices have been developed in order to improve health care delivery using sensors to collect all the information and cloud hosted analytics software that analyses all the data [4]. From the past 10-15 years, health care providers have increasingly become connected through the use of mobile computers, tablets, PCs, smart phones, Wi-Fi phones, and communications badges and help them to become far more active about Health Services Delivery.

The example from Sierra Wireless [9], describes how a health care provider could theoretically use real time that the data collected from hospitals, different wearable devices, home health monitoring devices, and from all other means to provide better services [8].

### III. System Design

The Design part mainly focuses on consumer centric and architectural requirements for IoT based on smarter, connected and personalized healthcare services. All the requirements are later translated into a functional architecture and then the mapping of its components on physical infrastructure is carried out. Discoveries in information, telecommunications, and network technologies play an important role in health care systems and have provided contribution in development of medical information systems [8]. The figure 3 illustrates architecture of healthcare using IoT. In recent years the aging of the population has caused to a change in the health held with a more special attention to the issue of home care and e-health. The main aim is to provide different types of health care services to the patient's staying at home rather than in hospital so to improving the quality of life of patients by allowing them to stay in their own homes. The healthcare sector is undergoing in huge transformation so thanks to the possibilities offered by the Internet of Things and the new technologies, the mobile and wearable. The new model is designed to the overall health of the patient, stimulated and implemented through strong activities of the patient and it is realized using mobile devices and multi-channel technologies.

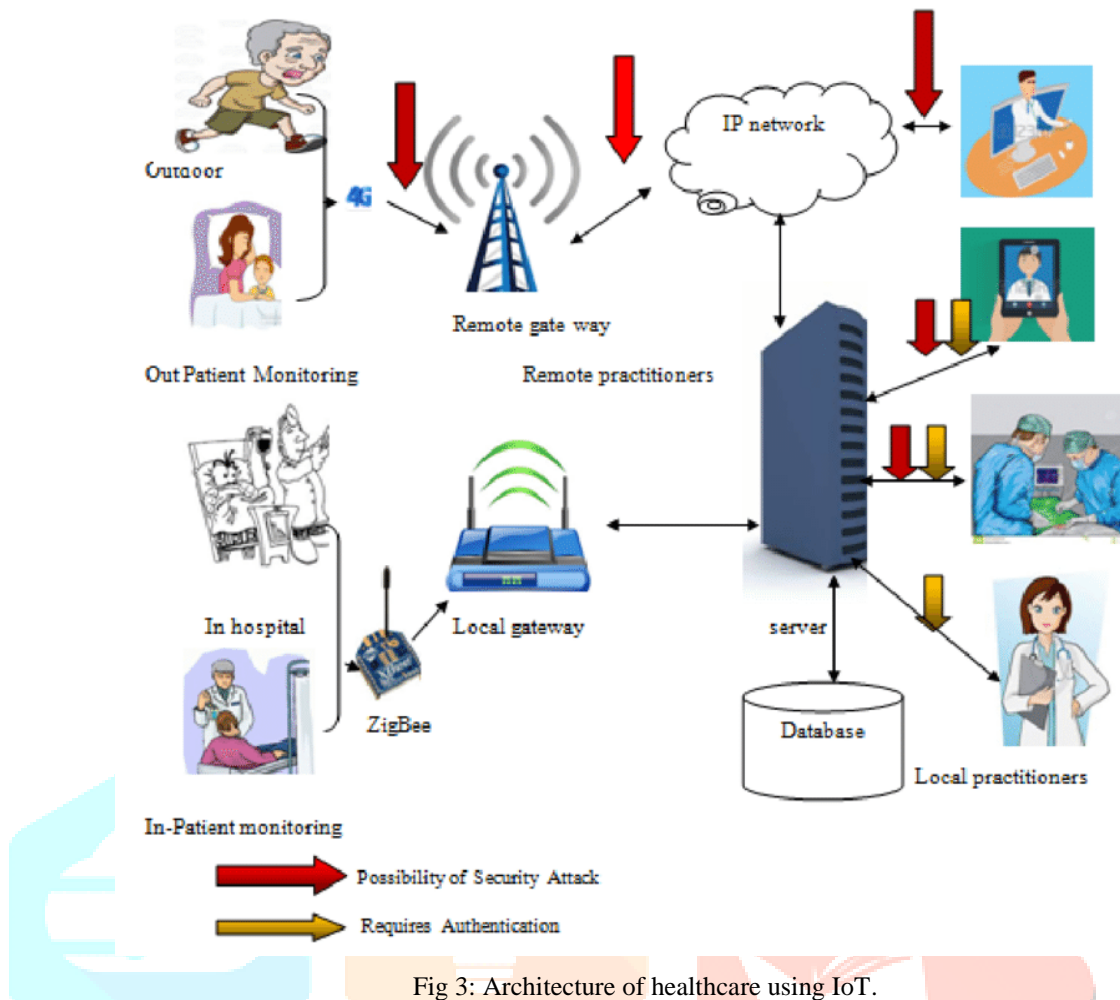


Fig 3: Architecture of healthcare using IoT.

The main idea is to insert a set of functionalities in order to support the family or the patient, to work independently or to support existing treatment systems. With the aim mentioned the paper offers architecture, based on a cognitive model, to realize a system for daily living activities which depends on solving a problem as a human. The aim is to handle the process of gaining skills as a transition from use of declarative knowledge of procedures that can be applied fast and automatically in specific situations.

In this paper includes, the architecture of a health care system for monitoring of patients at the risk in the smart Intensive Care Units, using the concepts of Internet of Things (IoT). The Intensive Care Unit (ICU) is hospital area where patients need close observation and also need constant attention or special drugs because they may have suffered from serious injuries or they may have recently gone through major surgery.

The monitoring in the Intensive Care Unit (ICU) is made through ICU monitors and all the patients are connected to a bed side monitor. This monitoring of patients includes diagnosis of patients, monitoring of many vital parameters, prevention and treatment of all the major functions. The patients have many different types of sensors or sensing devices that are attached to the patient's body which are connected to the ICU monitor using wires. The sensing devices send the electronic signals through wires to the ICU monitor. This monitor displays specific signals and can generate alarms, which can signal to the medical staff if a body function needs any attention. However, some of the patient's movements can cause the removal of the sensing devices wires. The general architecture of health care system for patient monitoring at risk in smart Intensive Care Units is presented in Fi 4.

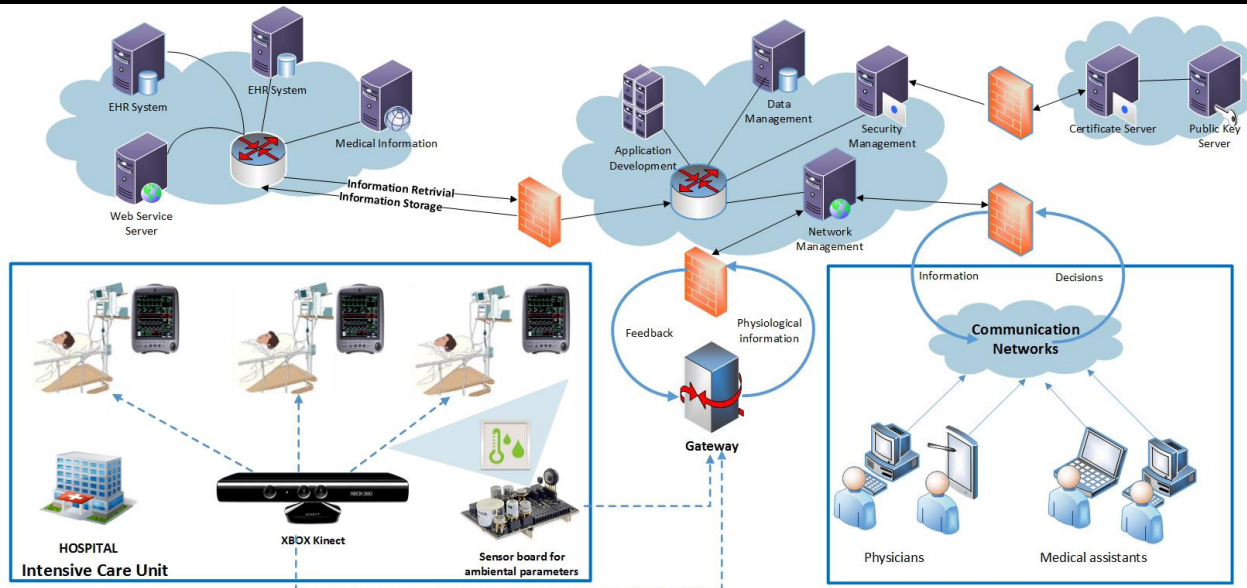


Figure 4 Architecture of the health care system for patient monitoring

In order to develop a smart environment for Intensive Care Unit (ICU) monitoring of patients who are at risk the following components are used:

**Intensive Care Unit:** Bedside monitors that are already used in the hospital units to monitor and record many different physiological parameters of patients as shown in figure 5. In the intensive care unit people are constantly looked after constantly and also monitored by a team which is highly specialized, which also includes consultants, many different physiotherapists, dieticians and nurses, and each of them with specialist knowledge and skills. Mainly trained nurses provide round-the-clock care the care every moment and monitoring, and there is a high ratio of nurses to patients such that each person in ICU is usually given his or her own 'named' nurse.

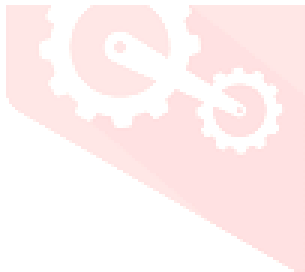


Fig 5: Intensive care unit Patient.

**Microsoft XBOX Kinect™:** Using sensors to monitor the movements of the patient with the aim order to eliminate situations in which the patient has removed from the sensing devices wires or the monitor has triggered a false alarm. In this movement device will act only in cases in which the sensor device itself has not the ability to measure the contact resistance with patient as illustrated in figure 6. In order to monitor the movements of the patient who are at the risk from ICU and to create a smart environment the sensors from Microsoft XBOX Kinect™ is used[9]. The device has a set of different sensors that is able to detect movements, identify faces and recognize speech, through the sensors that can gain images, audio and deep information. The Kinect™ does not need the patient to wear any kind of sensors or devices.



Figure 6: Microsoft XBOX Kinect™.

Kinect can detect at highest six skeletons in a simultaneous manner, and the number of all the detected people is limited only by the property that how many people will fit in the field-of-view of the camera that is in the covering area of camera. Whenever a patient is detected, he/she is modeled with a class "Skeleton" [12]. The class Skeleton has many different information fields which are related to joints, positions, tracking's, etc. An interesting point is that the 20 different joint points that identify specific parts of the body as the head, hands, feet, shoulders, knees, spine, foot etc., as showed in Fig. For every joint there are information related to the tracking and the positions, in 3 space coordinates x, y and z, and each joint is marked as "tracked" or "inferred"[10] as shown in figure 7.



Fig 7: Skeleton of a user with all the tracked points .

Sensors for monitoring of environmental parameters like temperature, humidity, atmospheric pressure and different types of gases. To monitor the environmental parameters from Intensive Care Unit (ICU) inside hospitals board is used that has sensors integrated to collect the information about the indoor parameters and then send it to a Gateway device. The figure 8 illustrates

sensor network. The sensors has been designed in order to monitor temperature, humidity, atmospheric pressure and the types of gases such as Carbon monoxide, Carbon dioxide, Nitrogen dioxide, Methane, Ammonia, Alcohol derivate, etc. As well as, movements and vibrations can also be measured by the internal accelerometer. The device receives sensor data and forwards the data t to the Internet via Ethernet, Wi-Fi or GPRS protocols depending on the connectivity options available in that area [11][12]. In case if the connectivity fails, data can be stored in an internal data base. The gateways are used to sends the information to the Tunneling machine that will further send the information to Servers that are located on the Internet, where users are connected.

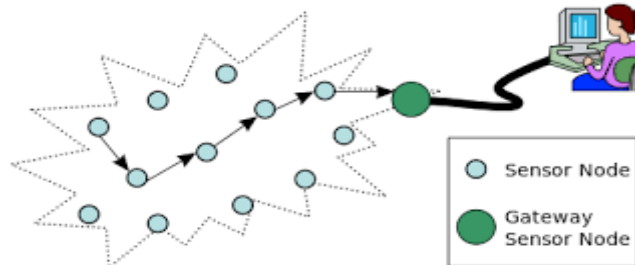


Fig 8: Sensor network.

All the health records and measurements that were stored into a computer server and a data base can be easily accessed by the doctors or the nurses through a user friendly interface[13].

#### IV. CONCLUSIONS

In Internet of Things area there are usually many different technical options available for healthcare applications, which helps in the concrete projects and in analyzing the whole set of possible solutions in order to find the optimal ones, by considering the particular constrains and priorities of the specific applications. So, it is important to have structured systems engineering methodologies to provide guidance to the corresponding decision processes for developing of Health-IoT systems. The paper advocates for applying IoT architecture to provide the smarter, connected and personalized healthcare solutions in smart homes. The requirements for healthcare services are analyzed thoroughly and they are translated into a functional architecture

The enhanced development of technology and the Internet leads to development of applications of new technological solutions at a high global level. With the help of the Internet of Things concept, elements, such as sensors and sensor networks, are becoming available and applicable in all fields of human activity, thus providing possibilities for the creation of expert systems that are easily opera table anytime and anywhere. Following the emerging trends, an important application of it is in healthcare, where the application can be found in health monitoring, diagnostics and treatment more personalized, timely and convenient. All of this significantly improves health by increasing the availability and quality of care followed with radically reduced costs.

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