INTELLIGENT ACCIDENT DETECTION AND NOTIFICATION SYSTEM ON AWS

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ABSTRACT

With ongoing advancements in the automotive industry and increasing traffic volume, the risk of fatalities in road accidents has also risen. This necessitates the development of a reliable solution to reduce these fatalities. One effective approach is to create a system that detects road accidents and promptly notifies medical services. This research paper aims to present a robust accident detection and notification system, which communicates data collected from the accident site to emergency medical service providers as well as the victim's emergency contacts, such as family members or close friends. The system described in this paper successfully sends notifications via text message and email using AWS to the concerned parties, with a latency of approximately 20 seconds, achieved using an internet connection with a speed of 3.76 Mbps. Due to AWS's reliability, scalability, and speed, the cloud infrastructure offers an optimal platform for the system.

Index Terms: Accident detection, emergency notification, AWS, cloud infrastructure, automotive safety, road accidents, medical services notification, traffic fatalities reduction.

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I.INTRODUCTION

According to the WHO Global Status Report on Road Safety - 2018, approximately 1.35 million people lose their lives in road accidents every year worldwide. These accidents result in significant economic losses for the families affected. In 2019, the Ministry of Road Transport and Highways (Government of India) reported 151,113 accident-related deaths, highlighting road accidents as a leading cause of death, disability, and hospitalization in India. India ranks highest among 199 countries for accident-related fatalities, accounting for approximately 11% of such deaths globally.

Figure 1 illustrates a pie chart detailing fatalities categorized by the type of vehicles involved, including buses, auto rickshaws, trucks, and lorries. These vehicles, classified as four-wheelers with slight adjustments to the acceleration threshold algorithm, contribute significantly to road accident statistics. A robust Accident Detection and Notification System (ADNS) holds potential to substantially reduce fatalities and serious injuries. By promptly alerting emergency services, such a system enables timely medical intervention, thereby mitigating the risk of fatalities due to delayed treatment.

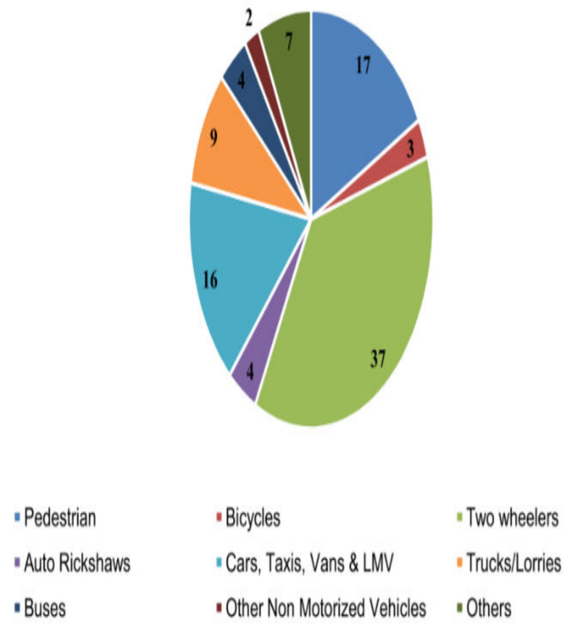


Figure.1

In critical situations such as severe accidents, the first hours are crucial for providing essential emergency care, significantly enhancing the chances of victim survival. The system proposed in this paper leverages cloud infrastructure (AWS) and IoT technology, proving invaluable in remote areas such as mountains, villages, and isolated roadways, as well as during nighttime when few people are present. Such a system could potentially save lives by swiftly responding to accidents under various conditions.

To effectively reduce fatality rates, there is a pressing need for a robust, versatile system that can be universally installed across different vehicles.

II.LITERATURE SURVEY

- Zainab Salim Alwan and Hamid M. Ali Alshaibani present the outcomes of applying large-scale data mining techniques on Finnish roads. The research study highlights the difficulties due to the uncertainty, incompleteness, and errors in the collected data, making data exploration a challenging task. The data used in the process were collected from Finnish road administration datasets. The main objective of the project is to evaluate the practicability of robust clustering, identify associations and frequent itemsets, and apply apprehend methods for analyzing road accidents. The results demonstrate that the selected mining techniques and methods effectively reveal understandable patterns. To calculate the accident frequency count, the c-means algorithm is used to cluster locations. Association rule mining is applied to characterize surface conditions. Data mining skills revealed various environmental factors associated with road accidents. Intersections on highways were identified as particularly dangerous for fatal accidents.

- May Al-Merri, Humaid Al-Ali, and Ruba Abu-Salma proposed that traffic accidents are inevitable. While accidents are sometimes unavoidable, studies show that the long response time required for emergency responders to arrive is a primary reason behind increased fatalities in serious accidents. One way to reduce this response time is to shorten the time it takes to report an accident. Smartphones, being ubiquitous and network-connected, are perfect devices to immediately inform relevant authorities about accidents. This paper presents the development of a system that uses smartphones to automatically detect and report car accidents promptly. Data is continuously collected from the smartphone's accelerometer and analyzed using Dynamic Time Warping (DTW) to determine the severity of the accident, reduce false positives, and notify first responders of the accident location and the owner's medical information. Additionally, accidents can be viewed on the smartphone over the Internet, offering instant and reliable access to information concerning the accident. By implementing this application and adding a notification system, the response time required to notify emergency responders of traffic accidents can be reduced, potentially helping to decrease fatalities.

- Bruno Fernandes and Vitor Gomes present HDy Copilot, an Android application for accident detection integrated with multimodal alert dissemination via eCall and IEEE 802.11p. The proposed accident detection algorithm receives inputs from the vehicle through ODB-II and from smartphone sensors, including the accelerometer, magnetometer, and gyroscope. The Android smartphone also serves as a human-machine interface, allowing the driver to configure the application, receive road hazard warnings issued by other vehicles in the vicinity, and cancel countdown procedures upon false accident detection. A prototype implementation was validated through laboratory tests.

- Bilal Khalid Dar and Munam Ali Shah discuss that emergencies, by definition, are unpredictable, and rapid response is crucial in emergency management. Globally, a significant number of deaths occur each year due to excessive delays in rescue activities. Vehicles embedded with sophisticated technologies, along with roads equipped with advanced infrastructure, can play a vital role in the timely identification and notification of roadside incidents. However, such infrastructure and technologically rich vehicles are rarely available in less developed countries. Therefore, low-cost solutions are required to address the issue. Systems based on the Internet of Things (IoT) are increasingly used to detect and report roadside incidents. Most systems designed for this purpose involve using the cloud to compute, manage, and store information. However, the centralization and remoteness of cloud resources can result in increased delays, raising serious concerns about their feasibility in emergency situations; in life-threatening situations, all delays should be minimized where feasible. To address the problem of latency, fog computing has emerged as a middleware paradigm that brings cloud-like resources closer to end devices. In light of this, the research proposes and develops a low-cost, delay-aware accident detection and response system called the Emergency Response and Disaster Management System (ERDMS). An Android application utilizes smartphone sensors for incident detection. When an accident is detected, a plan of action is devised. Initially, a nearby hospital is located using the Global Positioning System (GPS). The emergency department of the hospital is notified about the accident and directs an ambulance to the accident site. Additionally, the victim's family contacts are informed about the accident.

- Sushma M. Ahirrao and Laxminanda A. Mahant explain that in Thailand, approximately ten thousand people die each year from 2007 to 2016 due to roadside accidents. One cause of death is the lack of timely access to the scene. This paper proposes an Android application that automatically notifies emergency responders about accidents. When an emergency or accident occurs to a person with this application installed on their phone, the application is automatically activated by the immediate deceleration to zero of the smartphone's acceleration, indicating a sudden stop. An emergency message containing the scene's location, obtained from the smartphone's GPS sensor, is sent to the nearest available emergency responder. There are two modes of emergency notification in this application: the message is delivered via an

Internet connection if available, or via SMS if not. Recipients of the emergency message can view the map and directions to the scene. This application helps improve the speed and accuracy of accident severity reporting by providing precise information to emergency services as soon as possible, potentially saving lives.

III.EXISTING SYSTEM

- There are several other research papers published on this topic. The algorithm mentioned in the current paper was tested on data from NHSTA, USA's crash- data for accuracy of accident severity, which is mentioned in the later part. The work published in utilized Android smartphone sensors for car crash detection.
- Ahirrao et al suggested a separate collision detection circuit installed in the car and a separate notification system using Android App. The circuitry utilizes LDR and photodiode as the sensors for collision detection.
    - The work presented in and explains an accident detection and notification system using an accelerometer and Raspberry Pi.
    - Various approaches can be seen in research papers published on this topic recently. One of the solutions is e-Notify which aids in detecting and notifying traffic accidents. An onboard unit (OBU) is required for this system. This can be costly and it's difficult to equip every vehicle with an OBU.
    - There is also an eCall system developed by The European Commission and its deployment is, by law, necessary in all vehicles that are manufactured after the year 2015. This system detects an accident and then the emergency services like 112 (or 999 in UK) are informed.

LIMITATIONS OF EXISTING SYSTEM

- costly and it's difficult to equip every vehicle
- No Information available of riders or drivers
- Not able to notify beloved ones
- Requires Police action for Information which will be time consuming

IV.PROPOSED SYSTEM

- The system described in this papersuccessfully sends notifications, a text message and an email using AWS tothe concerned parties with the latency of approximately 20seconds and this was achieved by using an internet connection with a speed of 3.76 MBPS. Since AWS is reliable, scalable andfast, the cloud infrastructure provides a better platform for thesystem.
- Our system uses cloud infrastructure (AWS). This system is useful in many secluded areas like mountain range, villages, interior roadways; even in night time where there's almost no-one around. In such cases, if an accident occurs due to any reason, the system could be proven life-saving.
- In order to reduce the fatality rate, there is a strong need for a system which is robust, generic and can be installed in any vehicle.
- A simple web application is developed. This application is useful for receiving push notifications i.e., "An accident is detected!!!" whenever the algorithm triggers AWS SNS. The app receives notifications using AWS SNS. More features like displaying details of accident and owner can be added.
- A website is developed using HTML, CSS, JavaScript. The purpose of this website is preliminary to be the software at the hospitals and the medical centers. The website shows the last accident's details as well as all the records of the accidents that have happened. Entire system is implemented using python with Django framework and MySQL as database.

ADVANTAGES OF PROPOSED SYSTEM

- No cost and efficient
- No separate installation of any hardware

- Any person can scan and send notification to their beloved ones from anywhere
- Within 20sec information can be passed
- Nearby Hospital gets information about accident
- Can pass information about type of accident, persons onboard, dead or alive, location.

V.SYSTEM ARCHITECTURE

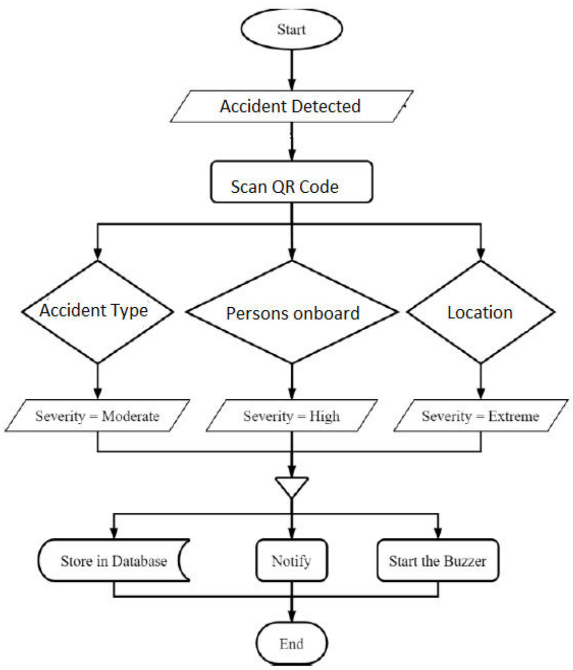


Figure2.System Architecture

VI.IMPLEMENTATION

A. Calibrating the Accelerometer

(MPU-6050) MPU-6050 needs to be calibrated first since every module will have different off-set errors and they need to be checked and edited in the source code accordingly for every system that is developed. These offset-errors are present in the accelerometers due to misalignment caused during manufacturing process. For that, the accelerometer needs to be placed on a flat surface and measure the acceleration values in each direction i.e., x-axis, y-axis and z-axis. The acceleration values for x-axis, y-axis and z-axis ideally should be 0g, 0g and 1g respectively. But practically, there would be offset errors and they need to be added or subtracted accordingly to get the desired output with minimized error.

B.Accident Detection and Severity Algorithm

The flowchart of the basic working of the algorithm. If the acceleration/deceleration value exceeds 5g (where g=9.8 m/s2) then it needs to be considered as an accident [22]. To take an estimation of the severity, the acceleration values can be broken down as follows: if the acceleration is between 5g and 13g, it's considered High and for 13g and above, it's considered extreme. The acceleration values can directly be obtained by the accelerometer i.e., MPU6050. However, to estimate the severity, the change in velocity is also required. The duration for which deceleration exists determines the change in velocity. The longer the duration, the larger the change in velocity i.e., Δv or DeltaV. Just like acceleration, there are two ranges of DeltaV to estimate the severity. If the DeltaV ranges from 12.8 kmph to 22.5 kmph, it's considered High and above 22.5 kmph, extreme. These velocities can be obtained by performing integration on the acceleration values. One such approach is to pass the acceleration values through a Butterworth Low-Pass Filter of order '2'. MPU-6050 has such a filter inbuilt. So, the values obtained thus are the filtered values and they can be directly integrated to get values of DeltaV (Δv) and now steps can be taken to estimate severity. The pseudo code for detection and severity estimation is mentioned below:

1. Get acceleration/deceleration values.
2. Integrate values and calculate velocity.
3. Get Pi = magnitude of maximum deceleration in i th direction. (i = x,y)

B.ADS Hardware

The most important part of the system is detection and computation of severity. AWS Command Line Interface (AWS CLI) is installed on the Raspberry Pi's Raspbian operating system so that AWS can be accessed and the credentials can be verified. The algorithm is implemented in Python3 and will run locally on Raspberry Pi. The algorithm will constantly run on the system and the accelerometer (MPU-6050) will measure acceleration values and the algorithm along with pressure sensor will detect if there was an accident and then start buzzer and send notifications accordingly. Since the computation for severity and detection runs locally on Raspberry Pi, it takes about 6-8 seconds to do it (considering the 3b model). When the algorithm detects an accident, AWS services i.e., SNS, DynamoDB and PinPoint are triggered. All of which use boto3 client which is a library to help us integrate AWS functionalities locally in the main program. Boto3 clients fetch AWS credentials from the installed AWS CLI or they can be passed as parameters manually. In addition to this, additional parameters like weight of the vehicle could be added. Also, the system can be customised according to the different types of terrains like slippery, rocky etc. However, that would require testing in a standard facility with different real vehicles.

B.AWS Credentials, DynamoDB, SNS and PinPoint

AWS Command Line Interface is installed on the Raspberry Pi so that basic AWS commands can be run locally as well since important and essential credentials can be set in a separate hidden file which AWS client would read from. These credentials contain three details: 'AccessKeyID', 'SecretAccessKey' and 'Region'. Each of these is different for different users and need to be configured while developing the system to maintain reliability and security. Setting up AWS cloud credentials needs to be done for every user. AWS DynamoDB provides a scalable and easy to use NoSQL database. This database has two tables named Accidents and Vehicle. The Accidents table contains 'AccTime', 'Impact Area', 'Impact Type', 'Overall Severity' and 'OwnerID'. The Vehicle table contains 'OwnerID', 'Name', 'Vehicle', 'Plate No.', 'Insurance ID' and 'License No.'. The Accidents table is triggered when the algorithm detects the accident and the data computed by the algorithm is sent to the appropriate field in the table accordingly. The Vehicle table is also triggered at the same time and is used to show the owner's details in the notification in the Android app, email and website. AWS SNS (Simple Notification Service) comes handy when you want to send a notification to the user on their phone. When the accident is detected, the boto3 client of SNS is invoked and two types of notifications are sent. One using the Firebase Cloud Messaging and the android app as push notification which basically shows that an accident is detected with severity. The second notification goes as an email containing the accident details and the owner's details i.e., all the fields from both the DynamoDB tables - Accidents and Vehicle. AWS PinPoint is a service to send voice messages. Along with the push notification, a voice-note saying "An accident has occurred" is sent to the contacts.

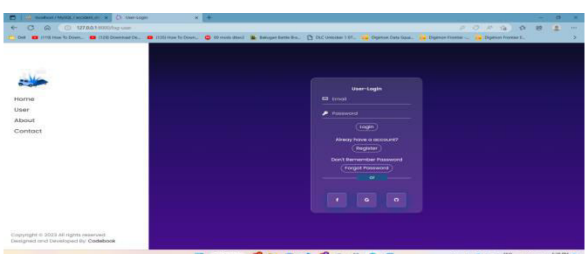
B.Android Application and Website

A simple android application is developed. This application is useful for receiving push notifications i.e., "An accident is detected!!!" whenever the algorithm triggers AWS SNS. The app receives notifications using AWS SNS and FCM. More features like displaying details of accident and owner can be added. A website is developed using HTML, CSS, JavaScript. The purpose of this website is preliminary to be the software at the hospitals and the medical centers. The website shows the last accident's details as well as all the records of the accidents that have happened. Entire system is implemented using various technologies; references of which you can find from . The GitHub Repository for the code is mentioned at

[40]. To test the algorithm, experimentations were performed on these two systems of trolley-carts. A series of experiments were performed to make accident-detection possible. The accelerometer and pressure sensor are interfaced to the Raspberry Pi and the system is rigidly tied to the trolley. The algorithm in Raspberry Pi takes real time data from the accelerometer and sends the output to the assigned output device. Different accident scenarios were replicated on these prototype models. After 7-8 seconds of one collision, the accident is detected and a notification, a text message, an email and a voice note are received through AWS showing the impact area and severity. The results are shown in the following section. However, the proposed work is to be extended by including camera, microphone, GSM module, some more AWS services and enhanced

VII.RESULTS

Figure.3



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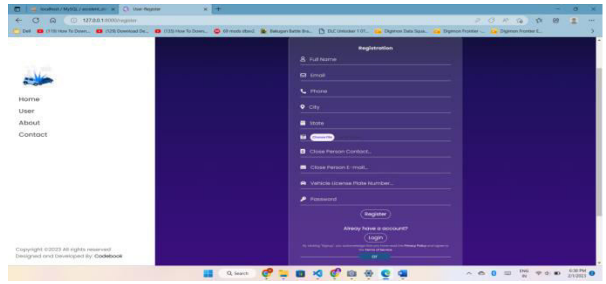

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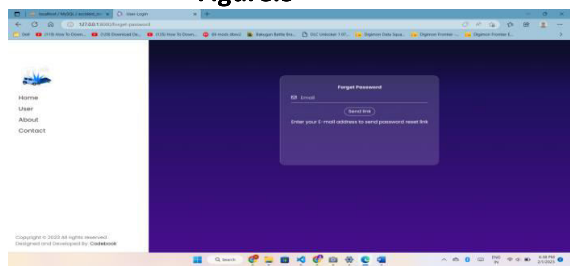
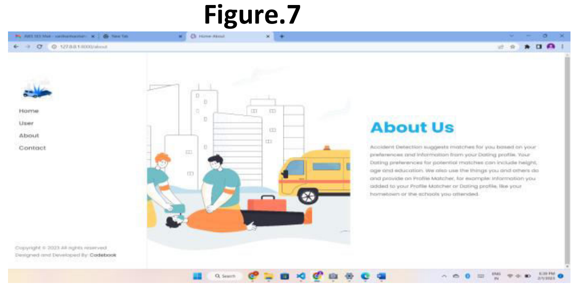


Figure.6

Figure.7



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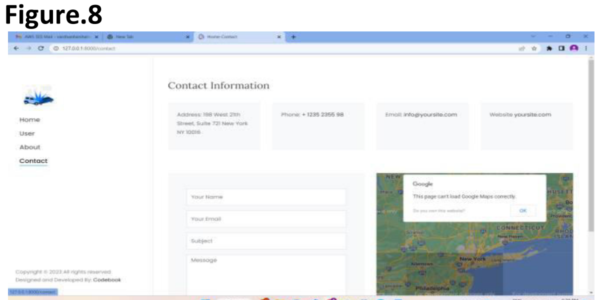

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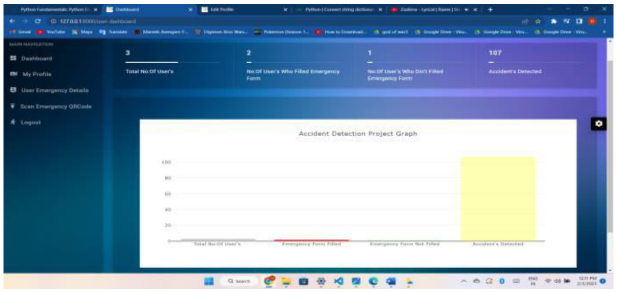

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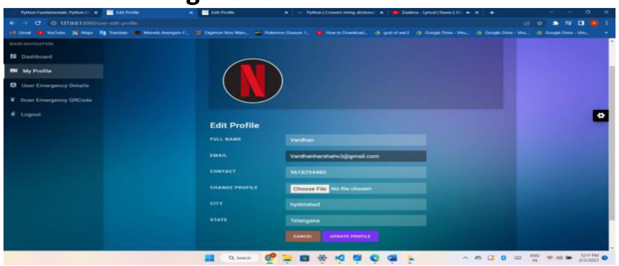

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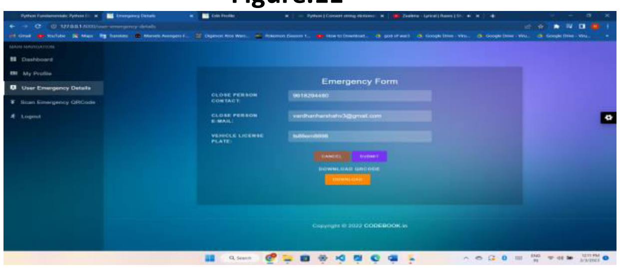
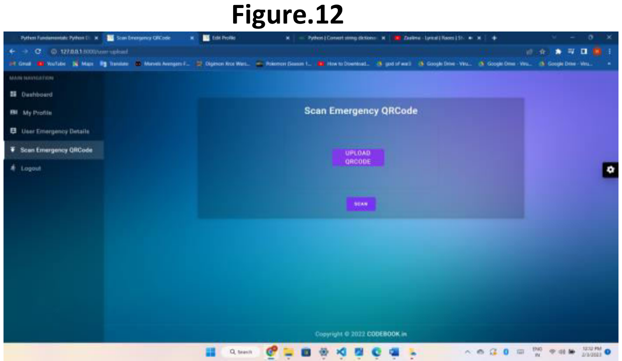


Figure.12



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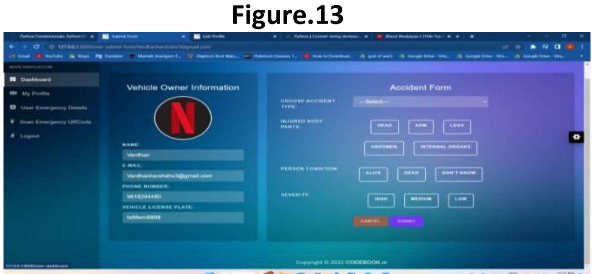

Figure.14

VIII.CONCLUSION

The increasing transportations are causing more and more road accidents resulting into people's deaths. It is crucial to get them immediate medical attention and the system described in this work provides just that. AWS is a reliable, scalable and easily maintainable cloud service. Also, since the sensors are rigidly mounted to the vehicle's body, the reliability isn't compromised, compared to the approaches involving smartphone sensors. Apart from that, unlike other approaches, the proposed model successfully estimates severity as well. As mentioned in the Results and Analysis section, the system successfully detects an accident and notifies the concerned within approximately 20 seconds and medical treatment can be started as soon as possible and hence, it increases chances of survival. The system was tested with internet speed of 3.76 MBPS; but this latency depends on factors like network connectivity, network-traffic etc. and may take longer to notify.

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