

# Development of Earthquake Early Warning Dissemination System for Northern India

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## Abstract

Himalaya is one of the most seismically active and earthquake-prone regions of the world. Recently an Earthquake Early Warning System (EEWS) for Northern India has been developed which includes around 165 strong ground motion accelerometers installed in Uttarakhand (India). A timely earthquake early warning of few seconds can save people's lives and thus the development of an improved Warning Dissemination System (WDS) component of EEWS is much required. For this purpose, an improved WDS has been developed. This system currently uses newly designed low-cost public sirens and smartphone apps to alert people in case of an earthquake. The developed sirens have been currently installed in two major cities of Uttarakhand (India) and in all district emergency operations centers for the last 2 years. On 4th August 2021, the newly developed app "Uttarakhand Bhookamp Alert" for WDS has been officially launched by the Uttarakhand State Disaster Management Authority for operational use. Further, a GIS-based maintenance system is also developed for the maintenance of the complete system, which automatically checks the health and keeps records of the sirens along with the smartphone users. This app gives the facility to the users for sharing their current location with disaster rescue teams after the earthquake early warning alert. Detailed scientific principles and working mechanism of newly developed dissemination system along with its applicability to disseminate the real-time information in case of an earthquake will be presented.



# Development of Earthquake Early Warning Dissemination System for Northern India

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## ABSTRACT

Himalaya is one of the most seismically active and earthquake-prone region in the world. Recently an Earthquake Early Warning System (EEWS) for Northern India has been developed which includes around 165 strong ground motion accelerometers and 79 public sirens installed in Uttarakhand (India) at various public places such schools, hospitals, police stations, district emergency operation center etc. A timely early warning of earthquake can save more than 50% injuries and many casualties. So, the development of an automated Warning Dissemination System (WDS) component of EEWS is much required. We have developed a WDS, which disseminate the early warnings through low-cost public sirens and smartphone apps in public. The smart phone app is officially launched in public by Uttarakhand State Disaster Management Authority (USDMA) on 4<sup>th</sup> August 2021.

## EEW SYSTEM FOR NORTHERN INDIA

The developed EEW is operational for public. The sensors are streaming the real time to central server situated at IIT Roorkee for detecting the events in real-time. On event detection information is passed to the developed warning server on cloud, from where it is disseminated to sirens, smartphones, and desktop apps based on different conditions.

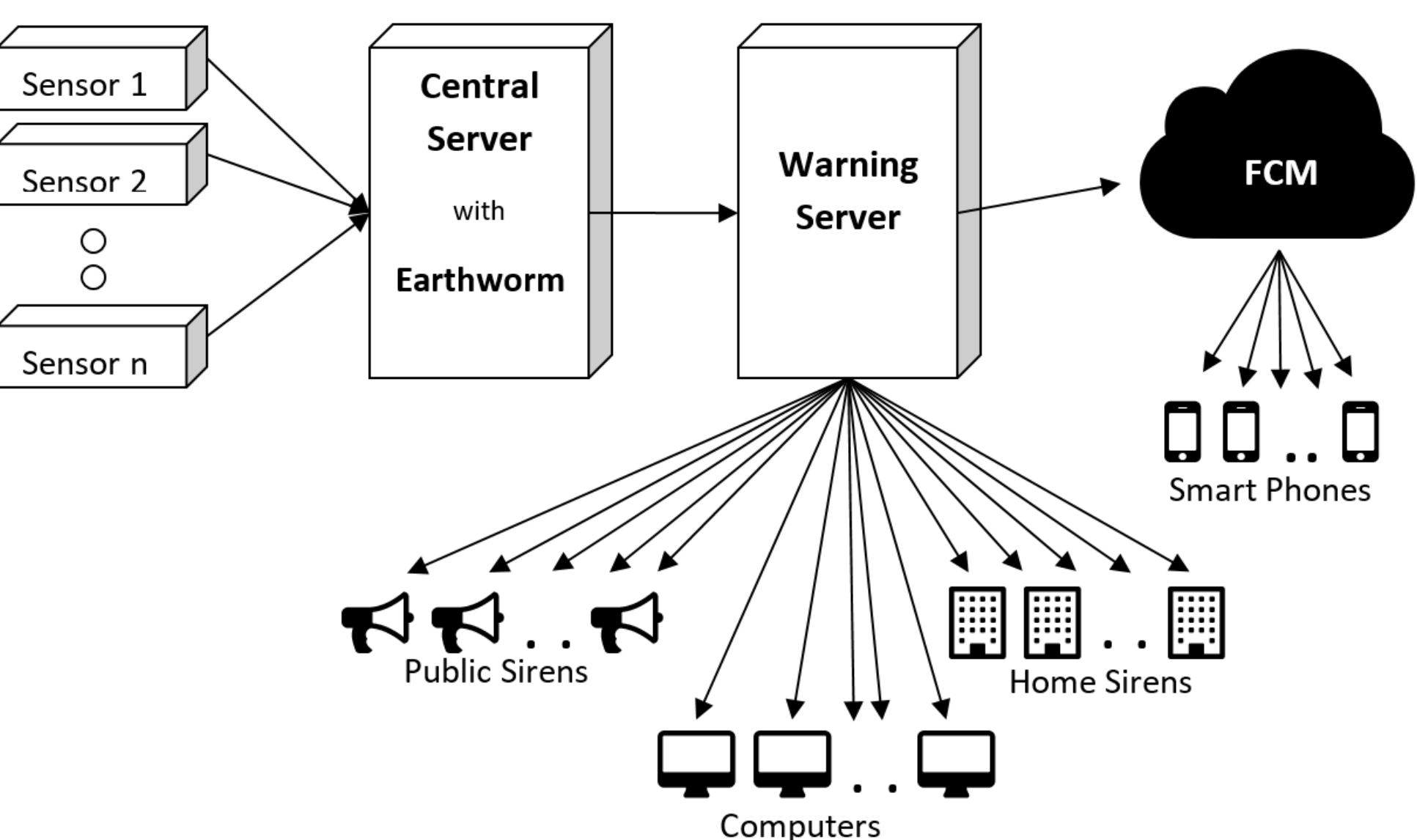


Figure 1: Architecture of the Complete EEW System for Northern India

## EEW INFRASTRUCTURE

The locations of deployed sensors and sirens in Uttarakhand for EEW system are shown in figure 2. As shown in figure, most of the area is out of siren coverage, which creates a need for development of warning dissemination app for smart phones.

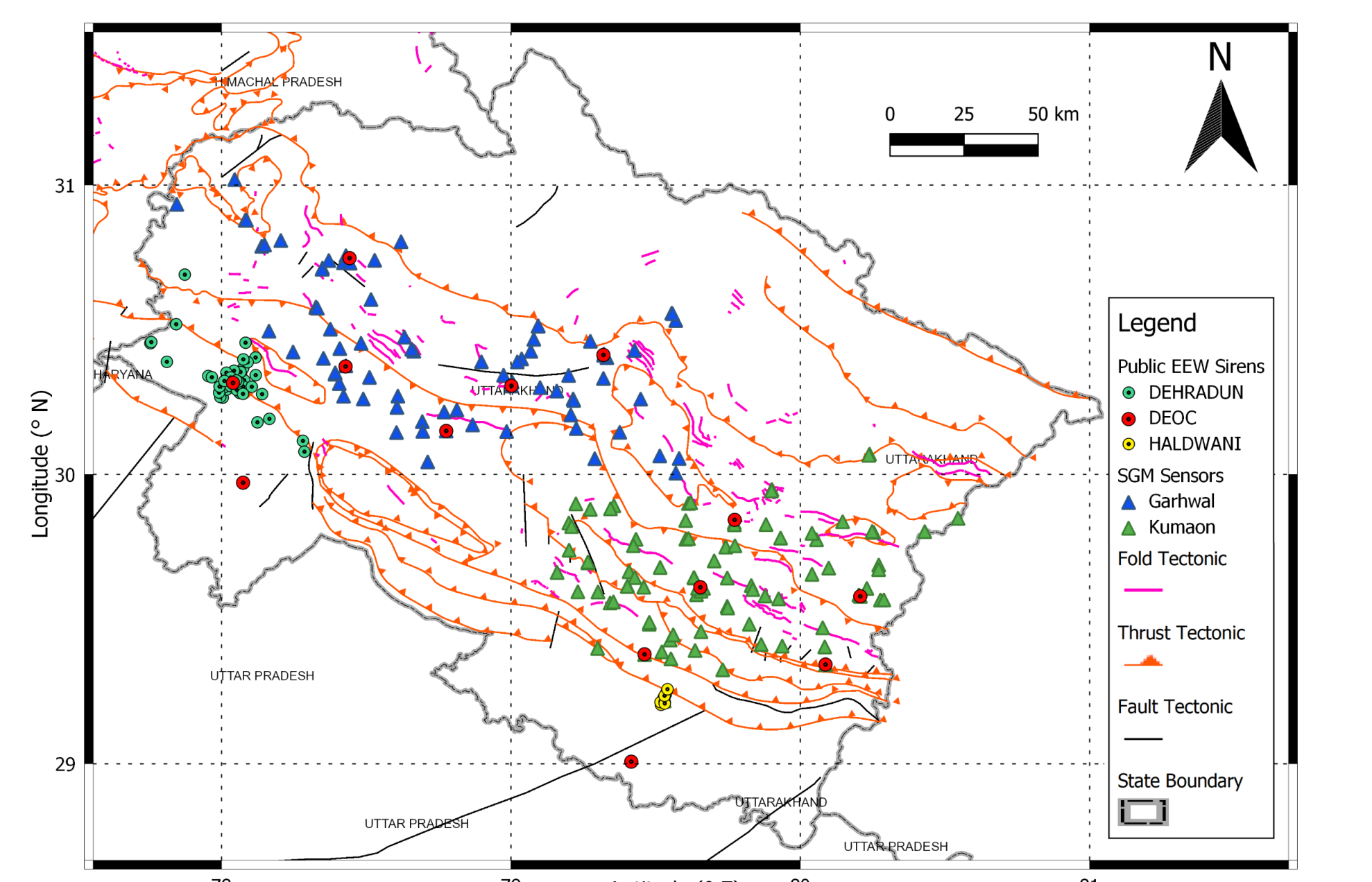


Figure 2: Installed EEW Sensors and Sirens in Uttarakhand

## WARNING DISSEMINATION SYSTEM

The warning server has a MQTT broker installed, which is used to connect all sirens and desktop/laptop apps and a dedicated web portal for providing assistant to our maintenance team. Further, a database is created to store all information related to sirens, desktop apps and smart phone applications. A program (Siren Manager) is developed for logging the status of all sirens into the database. Warning to smartphones is disseminated through Firebase Cloud Messaging (FCM) service.

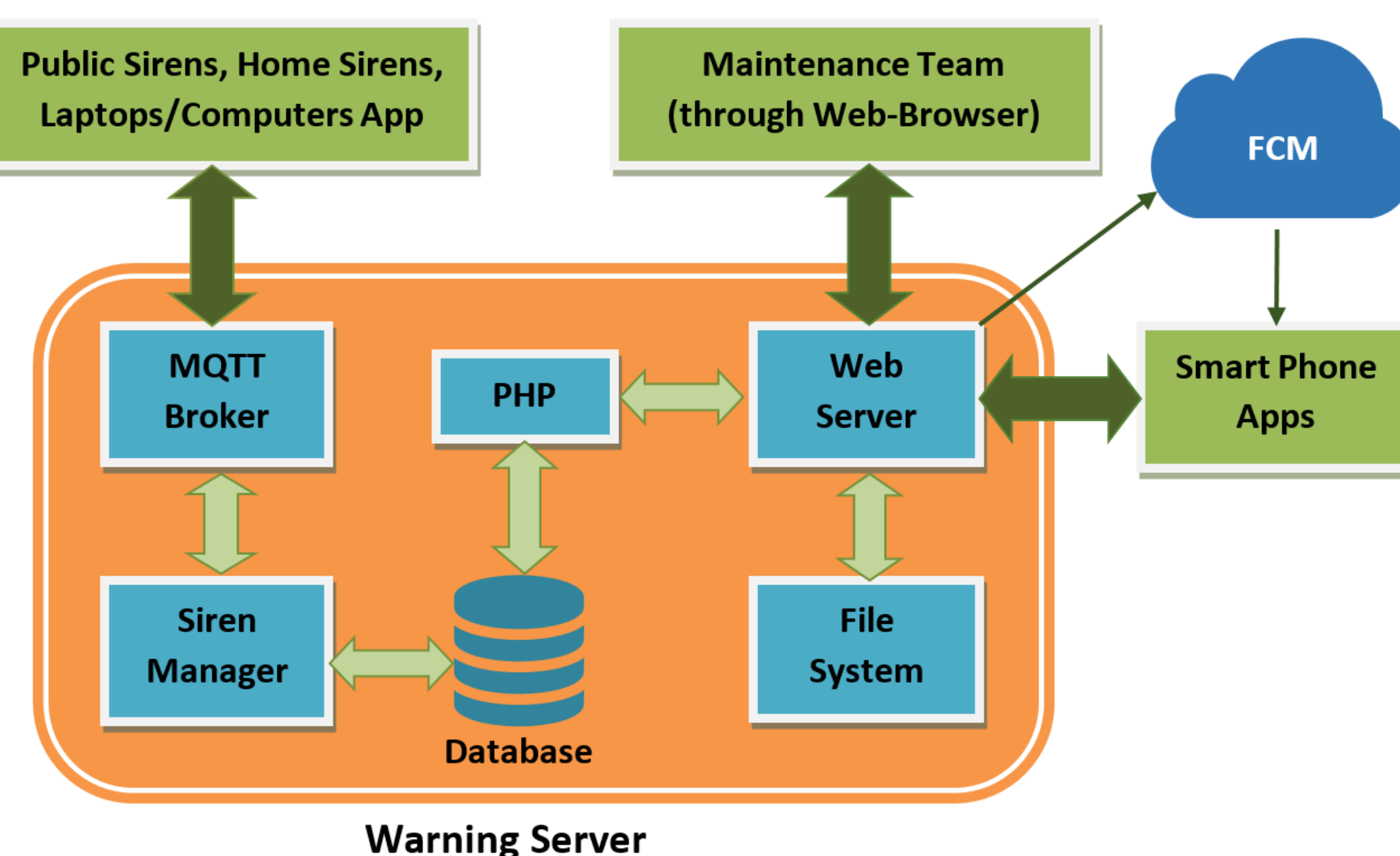
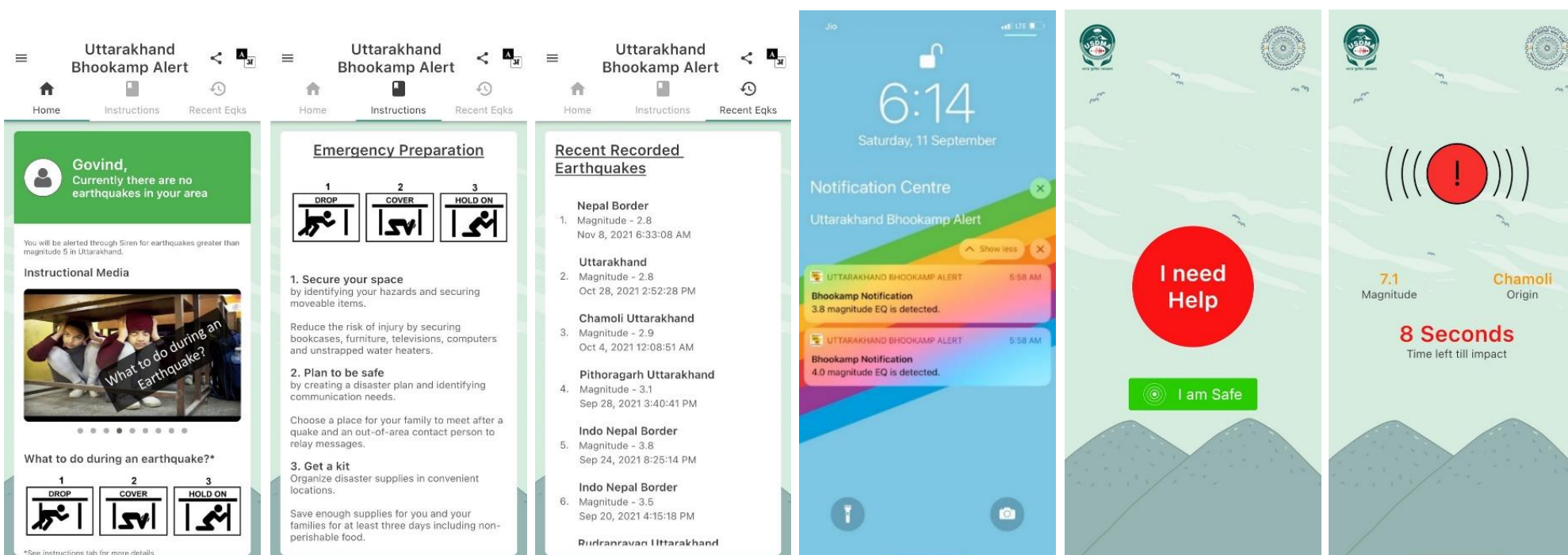


Figure 3: Architecture of Warning Dissemination System

## WARNING DISSEMINATION APP

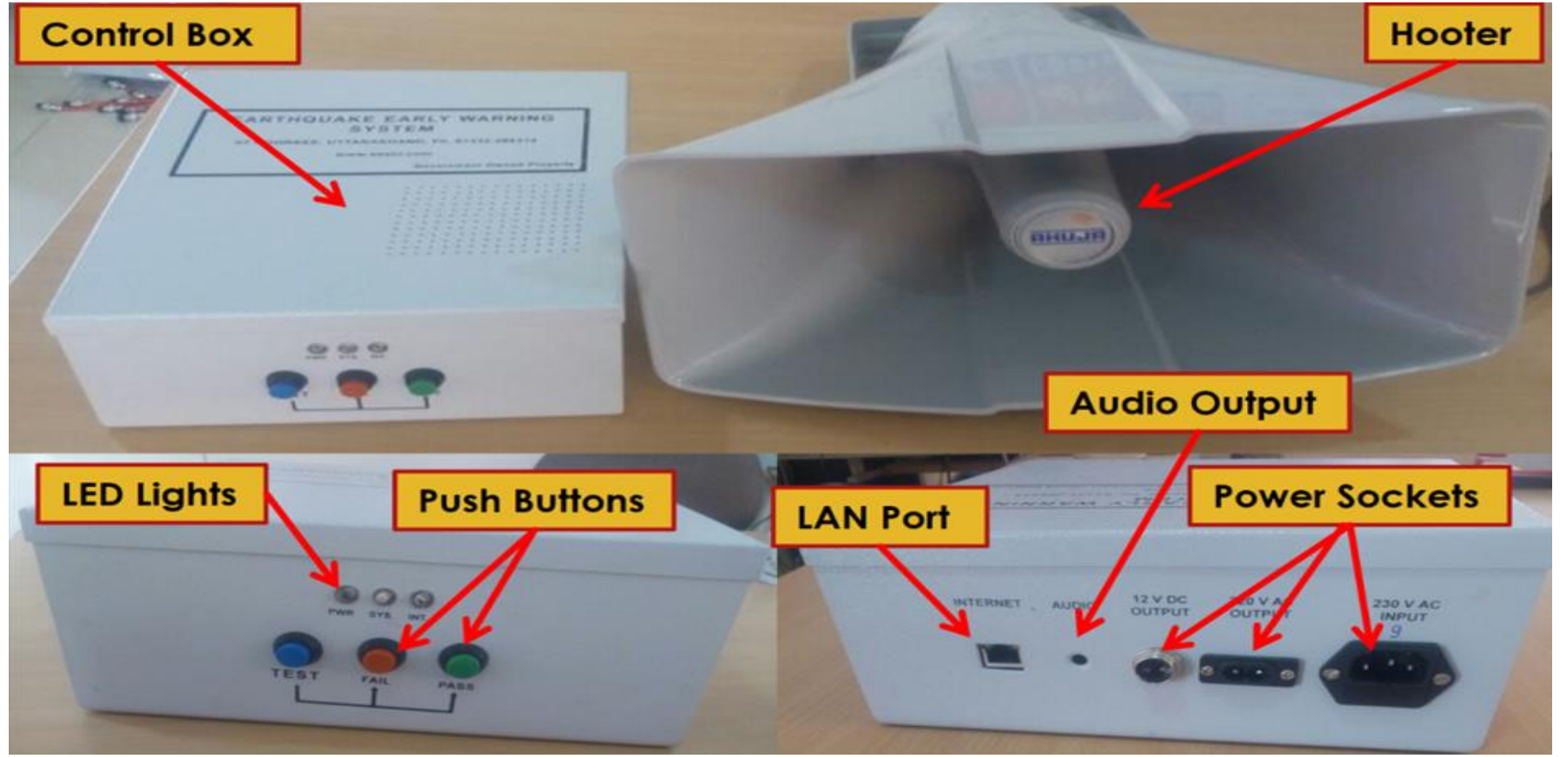
The developed app is freely available on Play Store and App Store for users. Users can install this app by scanning the QR code for receiving early warning of earthquake originated in Uttarakhand.



The home screen has three tabs Home, Instructions and Recent Earthquakes for instructional video tutorial about safe-guarding users during earthquakes, textual instructions for safety and details about past earthquake in this region. Early warning is sent through a notification with a loud human voice to alert users. On tapping alert notification user get information about origin, magnitude and time left. 1 minute after when timer stops, users are asked for their conditions. If user presses "I need Help" then this information is shared disaster management authority and if user presses "I am Safe" then user is marked as safe.

## DEDICATED EEW SIRENS

EEW Public Sirens for public were developed in-house and are being used in the fields more than 3 years. Further a new low cost EEW Public Siren along with a low cost Home Siren are being developed, which are ready for deployment in fields.



Three LEDs for giving information about Power, System, Internet. Push buttons for validating connections at the time installation for easy testing of siren, creating easy test records. Panel power connector for making installation easy.

## SUCCESS STORY

On 11<sup>th</sup> September, 2021, Uttarakhand Bhookamp Alert App sent a early notification of earthquake to public within few seconds after the earthquake originated. As magnitude was less than 5.0, therefore non-alarming notification was sent on smart phone apps only and public sirens were not activated as earthquake was not damaging. This notification on smart phones created confidence in public and encouraged people to install the app for their safety. 3 mock drills are also successfully conducted in public through public sirens and smart phone app.

## ACTIVITIES & AWARENESS OF EEWs



## ACKNOWLEDGEMENTS

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