The role of technology in disaster management

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Information and communication engineering development

A disaster is a series of events, either natural or unnatural, that disrupt our daily lives and result in significant losses for individuals and communities as a whole

Emerging technology has the potential to transform disaster management if correctly integrated with present infrastructure. Artificial intelligence (AI), the Internet of Things (IoT), Big Data, drones, and blockchain will all help to improve disaster response and assistance.

Disruptive technologies can help with the faster transmission of essential information, a better understanding of catastrophe causes, improved early warning systems, creative damage assessment, and the addition to the knowledge base of social behavior and economic ramifications following a disaster.

While the use of drones and the Internet of Things is increasing, older technologies like satellite imagery and seismometers are still the most important tools for detecting, monitoring, and accessing catastrophes.

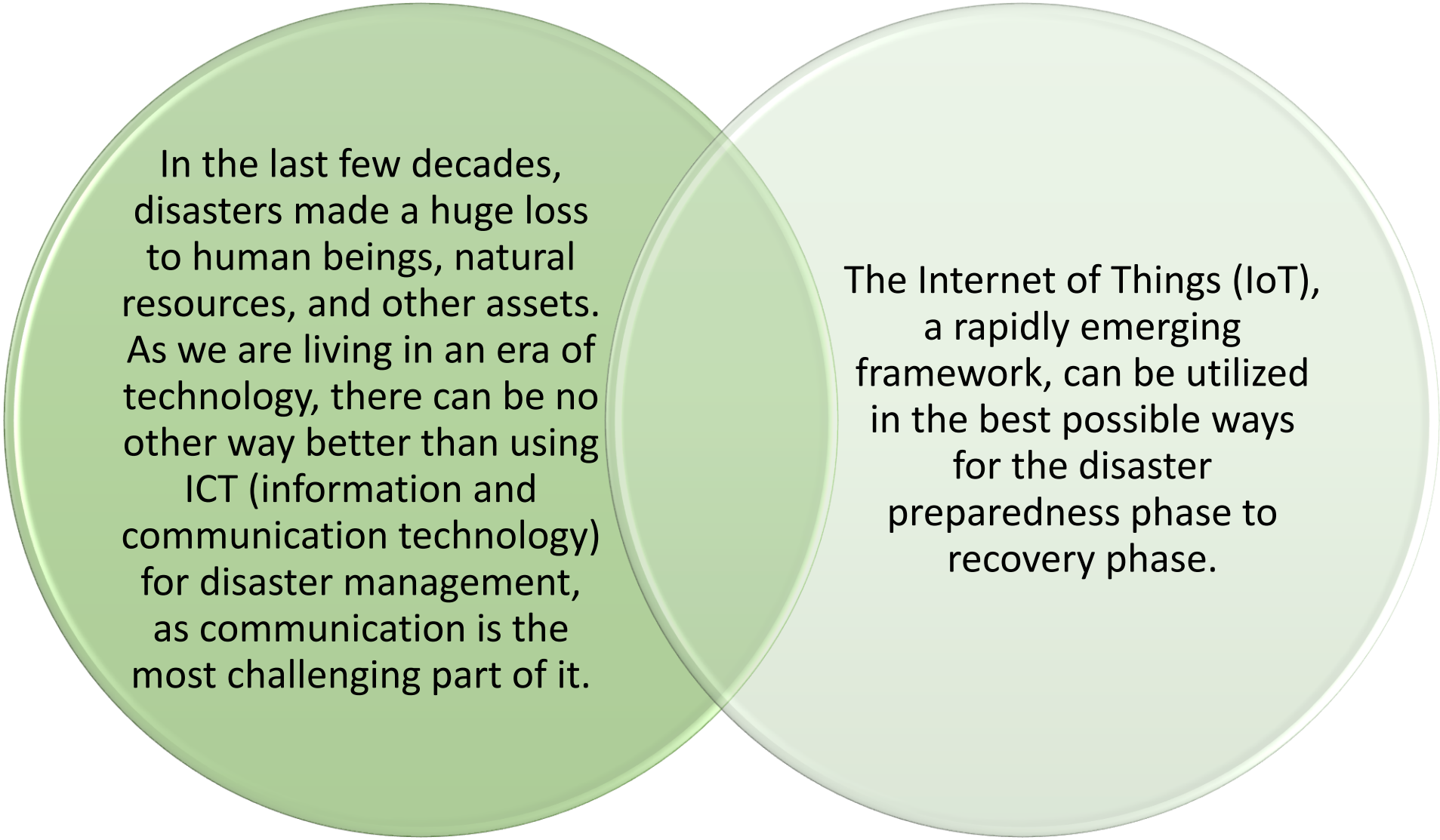
Introduction:

Worldwide, natural disasters have increased. It causes huge losses to live, infrastructure, natural resources, and other assets. We can use most benefits of AI and IoT to manage disasters from preparation to recovery.

The Internet of Things (IoT) provides real-time information, analytics, and networking with other technologies. Thus, it is a game changer for managing and controlling disaster risks. It plays a major role in research, planning, and analysis. Therefore, it prevents natural and other disasters in the long term.

Disasters occur globally, affecting citizens, the government, the economy, and the environment. There is a need to spread awareness about IoT to reduce the risks of disaster occurrence worldwide.

Introduction:



Disaster management phases

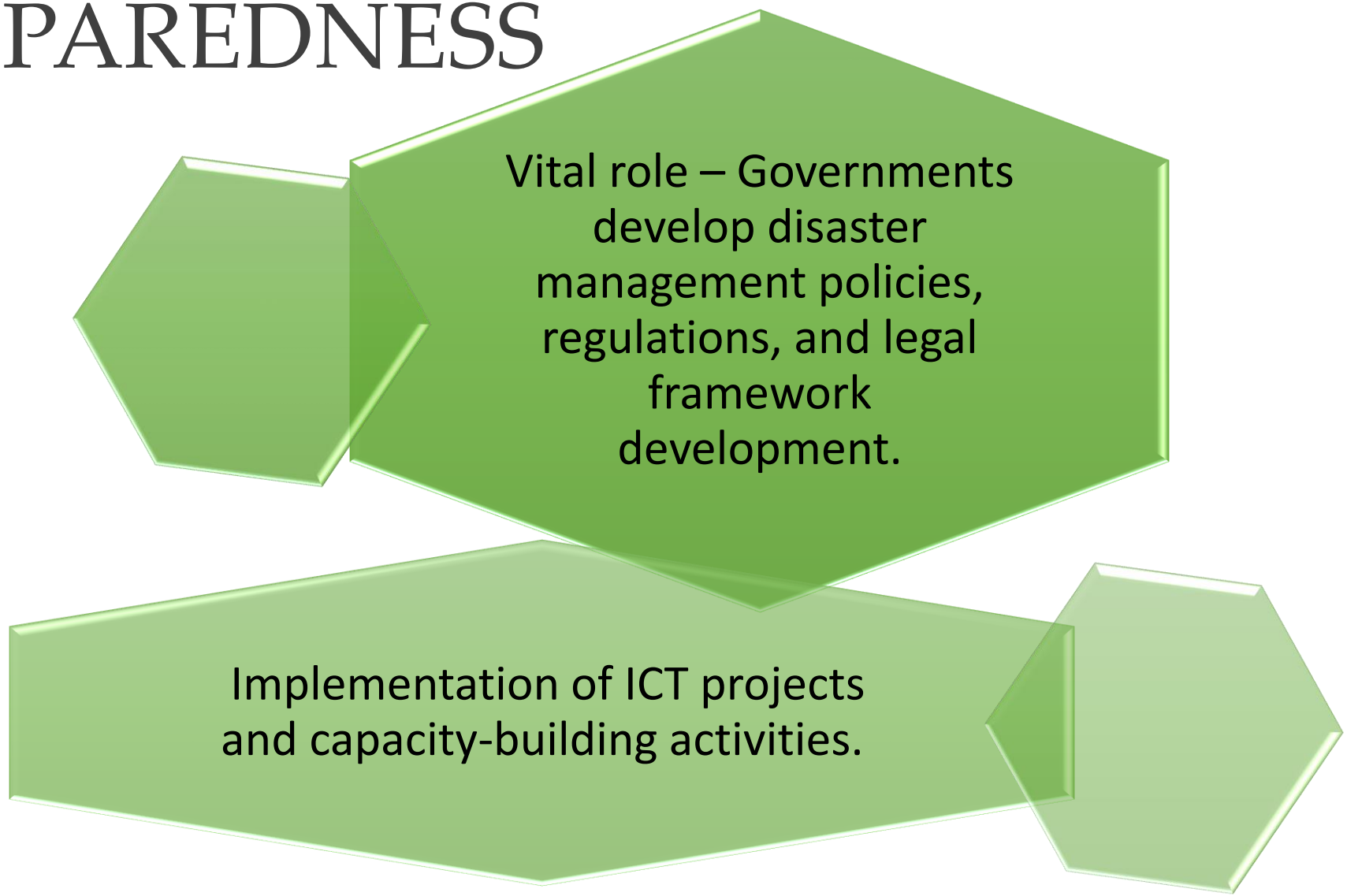
Pre-Disaster Management

- Mitigation
- PREPAREDNESS

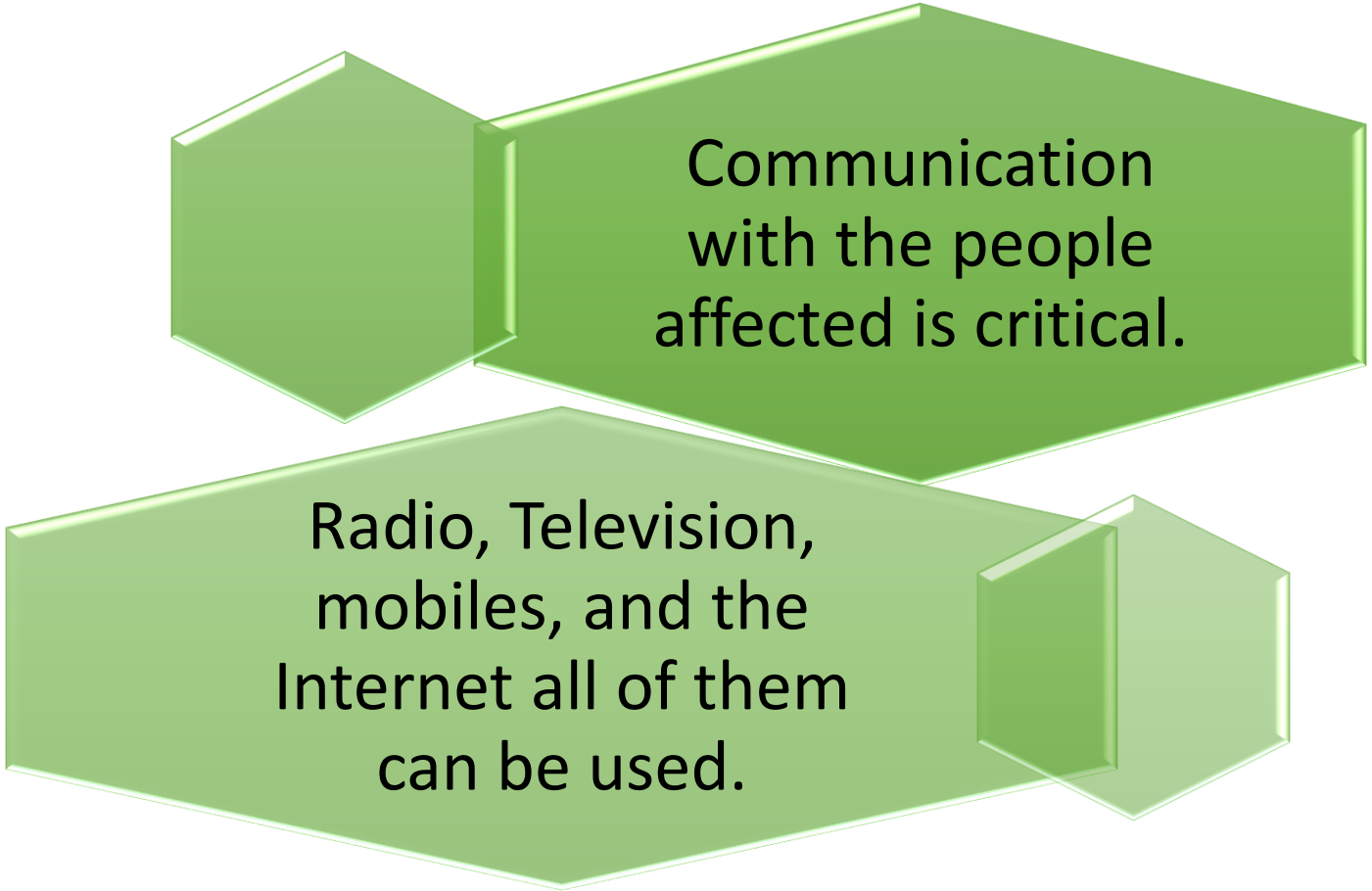
Post-Disaster Management

- Response
- Recovery

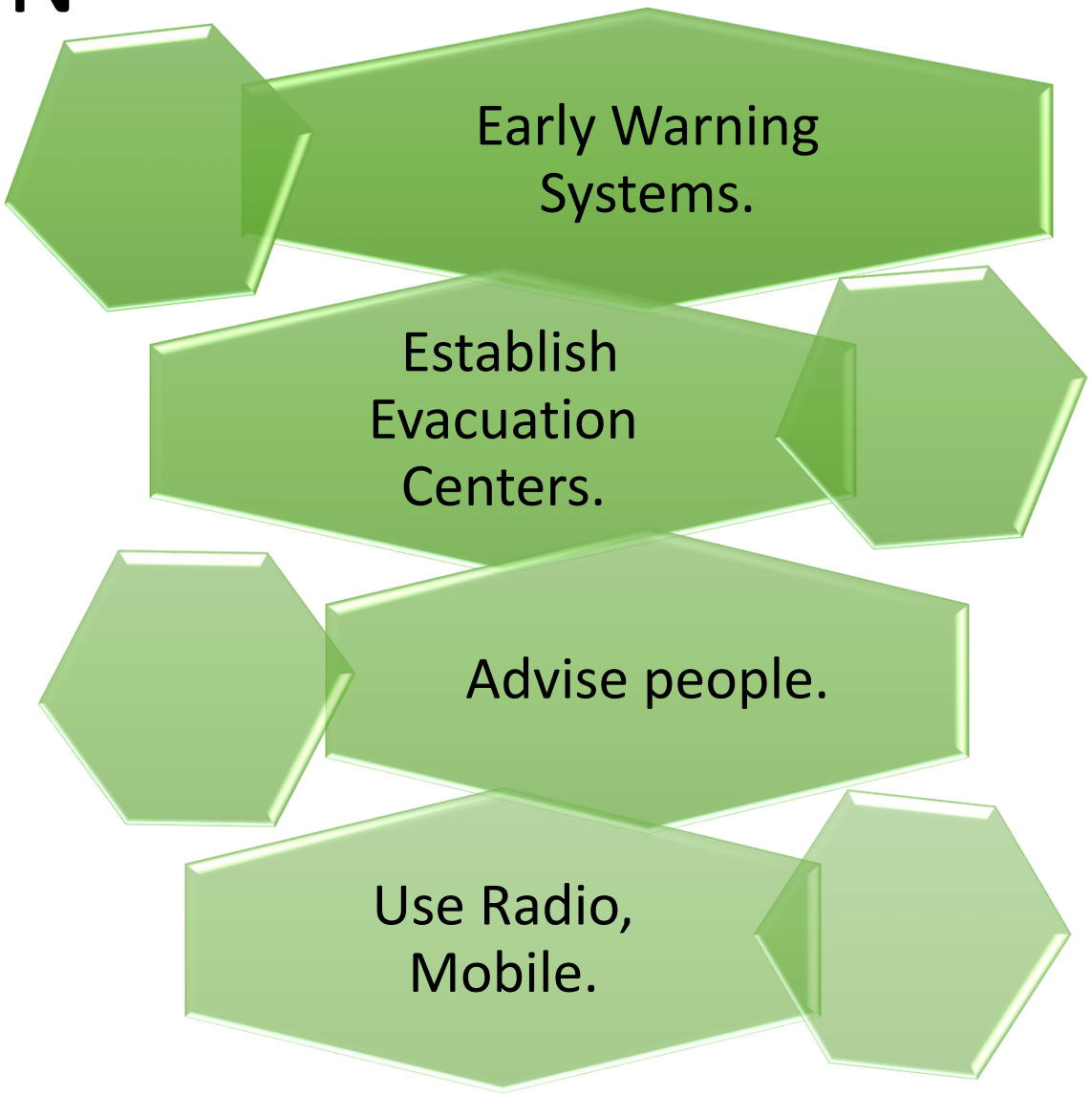
PREPAREDNESS



COMMUNICATION



MITIGATION


Early Warning Systems.
Establish Evacuation Centers.
Advise people.
Use Radio, Mobile.

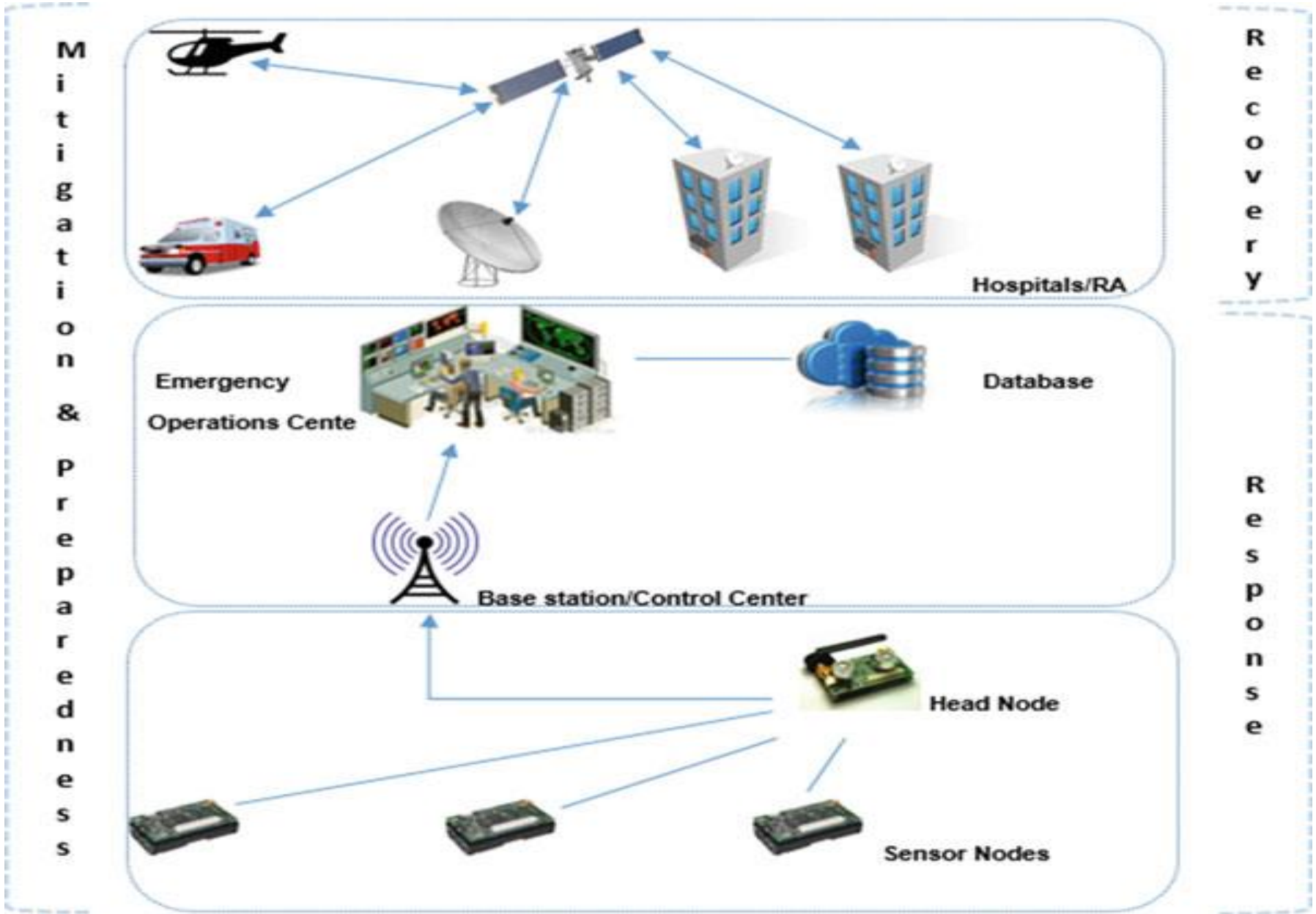
The major elements in an IoT concept are sensors, RFID, WSN, WiMAX, etc.

In a WSN environment, the important components to consider for WSN-monitored environments are WSN hardware, Communication Stack, WSN middleware, and Secure Data Aggregation. Thus, in an area of interest, it is significant to obtain the location information of sensor nodes within the margin of error. The Sensor Web and their categorization are in these types: space, underground, underwater, and creature sensors.

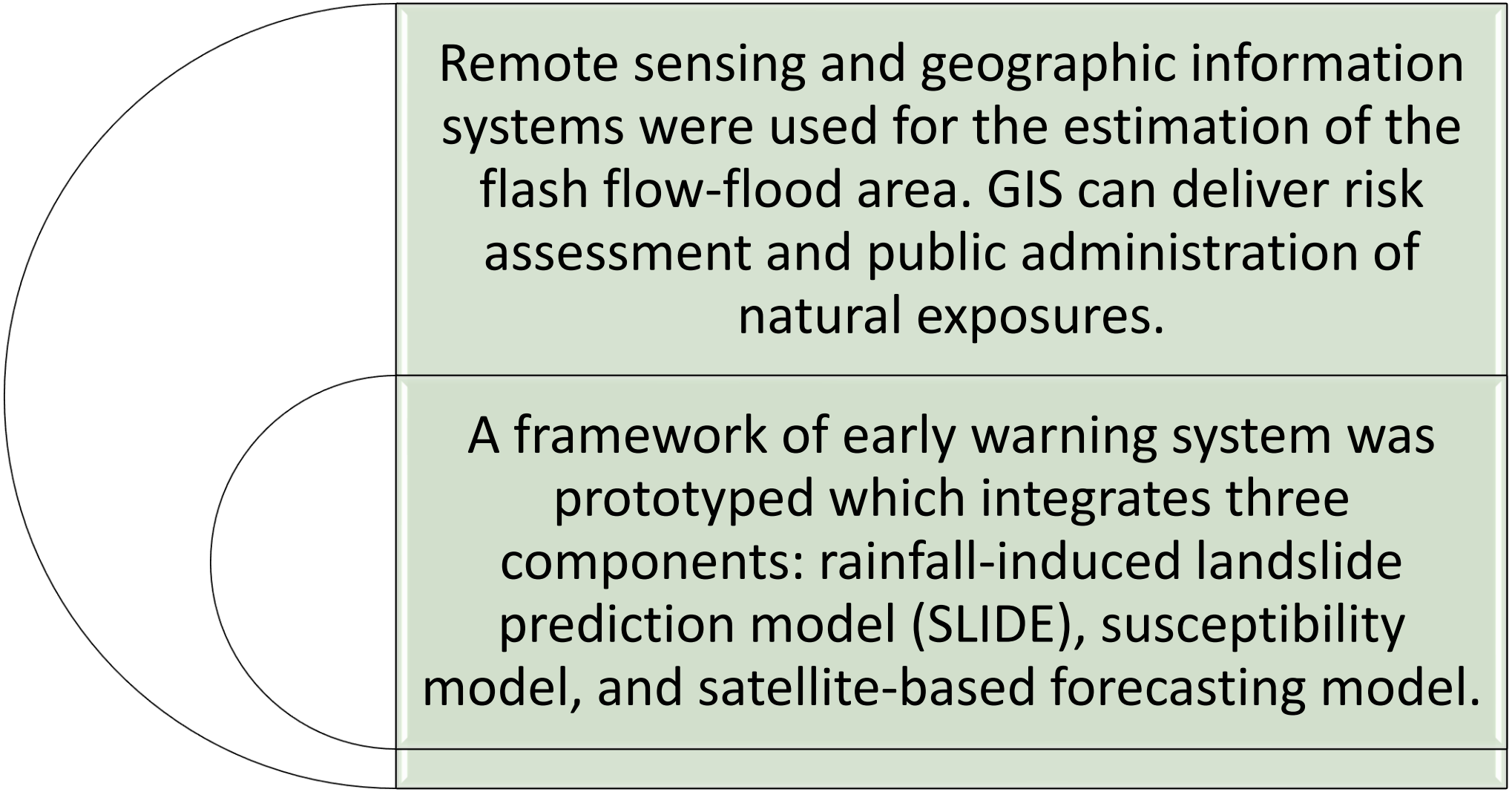
A well-known technology for IoT is the RFID technology. It is a basic and broadly used technology in this context and is considered a criterion for the IOT. RFID tags can automatically identify and track any object.

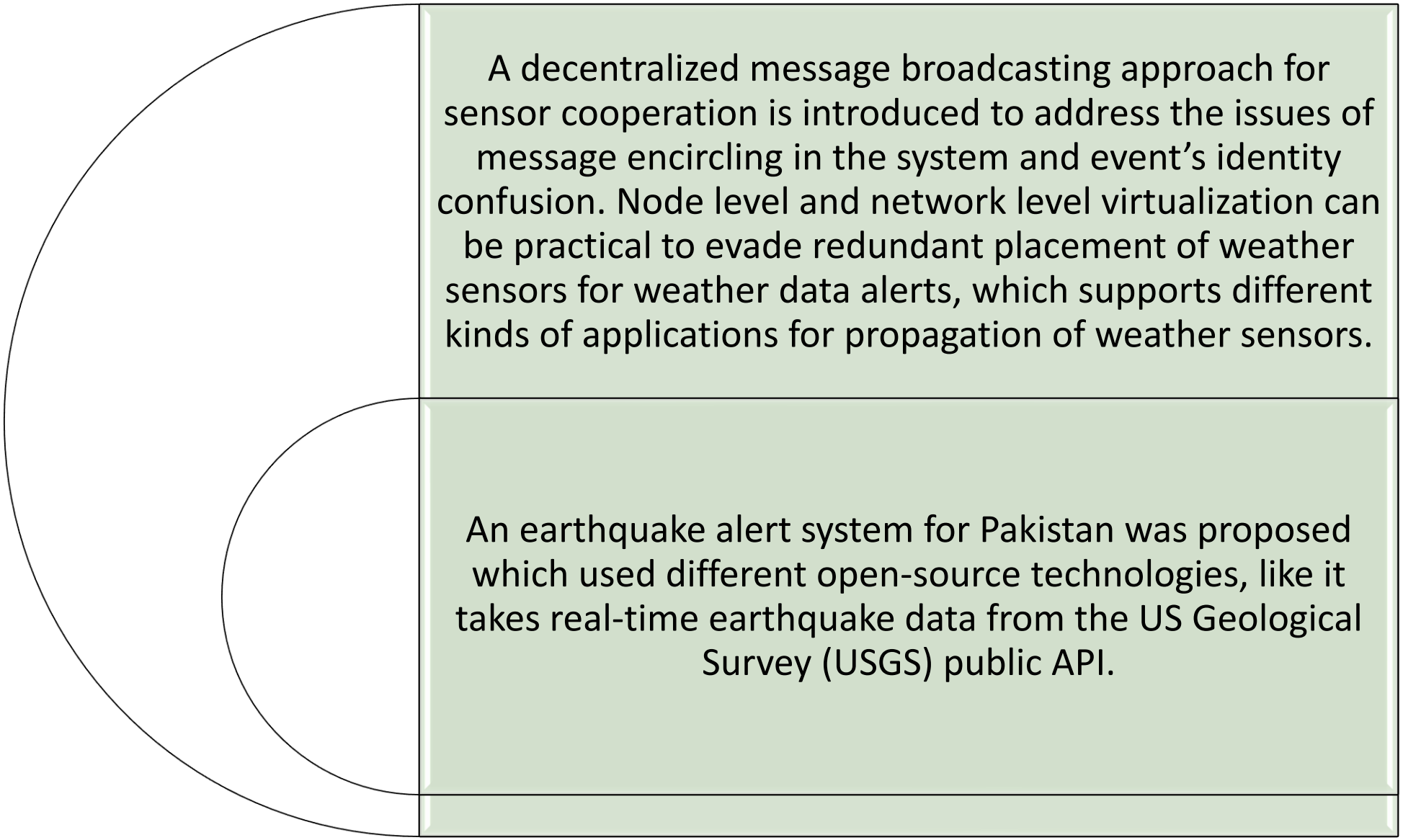
An RFID system has three parts:

- ✓ RFID tags, of two kinds either active or passive, refer to transponders attached to objects to identify and count.
- ✓ A reader or transceiver is a combination of a radio-frequency interface (RFI)module and a controller.
- ✓ A data processing/application system, depending on the application, may be any application/database or any other system.


Mitigation & preparedness
Hospitals/RA
Emergency
Operations Cente
Database
Base station/Control Center
Head Node
Sensor Nodes
Recovery
Response

By analyzing flood prediction techniques built on GIS using ad hoc wireless sensor network, a model for flood prediction is proposed which is considered to help calculate the influence of flood damage with the use of **GIS** simulation tool. When it comes to prime to detect the prime location of ambulance and or other rescue authorities, Google Maps integrated with GIS simulation tool can help; moreover, flood risk analysis can be performed through its use. Another important factor is that for flood management GIS can utilize unit hydrographs effectively.


Remote sensing and geographic information systems were used for the estimation of the flash flow-flood area. GIS can deliver risk assessment and public administration of natural exposures.
A framework of early warning system was prototyped which integrates three components: rainfall-induced landslide prediction model (SLIDE), susceptibility model, and satellite-based forecasting model.


A decentralized message broadcasting approach for sensor cooperation is introduced to address the issues of message encircling in the system and event's identity confusion. Node level and network level virtualization can be practical to evade redundant placement of weather sensors for weather data alerts, which supports different kinds of applications for propagation of weather sensors.
An earthquake alert system for Pakistan was proposed which used different open-source technologies, like it takes real-time earthquake data from the US Geological Survey (USGS) public API.

A multi-hazard early warning and response system was considered, which focuses on reducing the seismic alert time by exploring the use of vigorous seismic sensors in WSN such as Wi-Fi, WiMAX, and Zigbee which are used for different categories of networks.

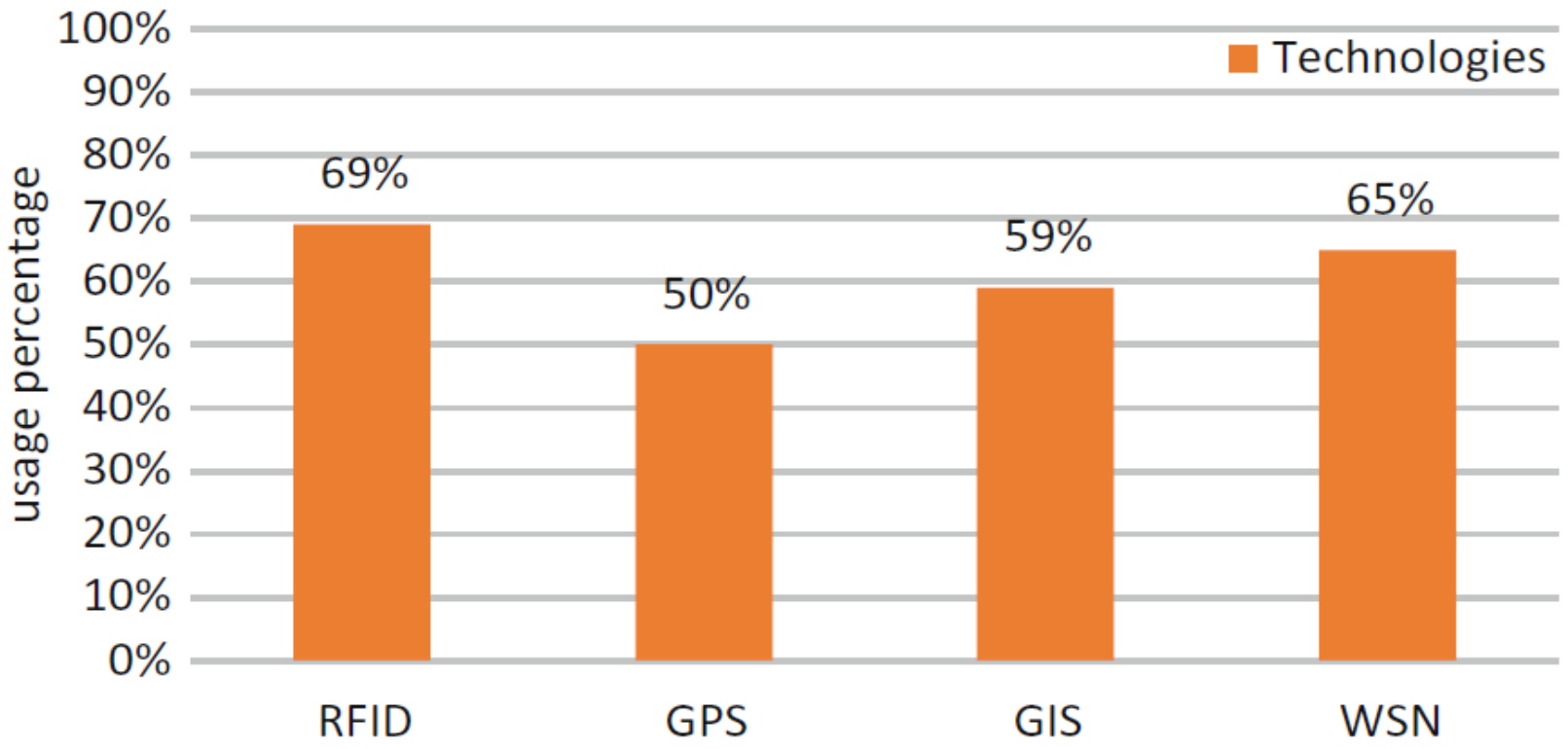
For detecting the earthquake, real-time wave signals are used in EEW (earthquake early warning) system. People are alerted based on the magnitude, velocity, and displacement detected. SEWAS (seismic early warning alert system) warns people about imminent strong shake so that people can take appropriate actions quickly, maintaining the integrity of the specifications.

Role of ICTs with disaster

There are many existent ways for implementing WSN in IoT scenarios such as the **smoothing algorithm** like“Savitzky Golay” and **classifiers** like **Naive Bayes**, **Tree Bagger**, etc.

An emergency management system based on IoT architecture was proposed in China, which can monitor any disastrous situation using sensors and intelligent video processing. In response to “Typhoon Morakot” in Taiwan, it suggests that a system of emergency response via the Internet can allow people to report any emergency to the government by using **mobile wireless devices** or computers to assist in search and rescue operations.

A system for evaluating disaster synthetically was designed based on seismic networks of things, which can collect data through IoT in real time and then estimate the loss and forecast by **GIS**. IoT may train the directional control function and accurate forecasting and discard of sudden emergencies effectively through different technologies.



Contribution of technologies in disaster management

Robots

A robot is a machine that is programmed to do one or more activities frequently and accurately and can be used in areas affected by disasters that are too dangerous for humans.

Reconnaissance and mapping, structural assessment, high-rise building fire response, chemical, biological, radiological, and nuclear events, search and rescue operations, risk assessment, and logistics support are all areas where robotics can help (Eastern Kentucky University, 2021). During 2001 terrorist attack in New York City, search-and-rescue robots were initially deployed to survey the ruins of the World Trade Center.

Drones

Drones are flying robots and part of unmanned aircraft system (UAS) that use inbuilt sensors and GPS to fly independently. They can be operated remotely or by employing flight plans that are controlled by software.

Drones can be used for several civilian and military missions, including search and rescue, surveillance, traffic monitoring, weather monitoring, firefighting, giving relief supplies, videography, agriculture, and a variety of other tasks. In the case of wildfires and conflict zones, autonomous drone technology is radically changing the way we discover individuals in need and automate assistance delivery. Drones are used by firefighters to inspect an affected region in order to estimate the level of damage and the rate at which a fire is developing.

Drones can also find persons who are isolated faster than ground-based rescue teams (Lutkevich & Earls, 2021). With Nepal facing much of the wildfire problem recently, drones can come in handy to firefighters due to these reasons. Studies are going on in accessing drones to prevent an animal attack. As of an online report by Beverley Head in ComputerWeekly.com, studies are going on to detect crocodiles lurking in the water so that crocodile attacks can be minimized and prevented using drones and machine learning.

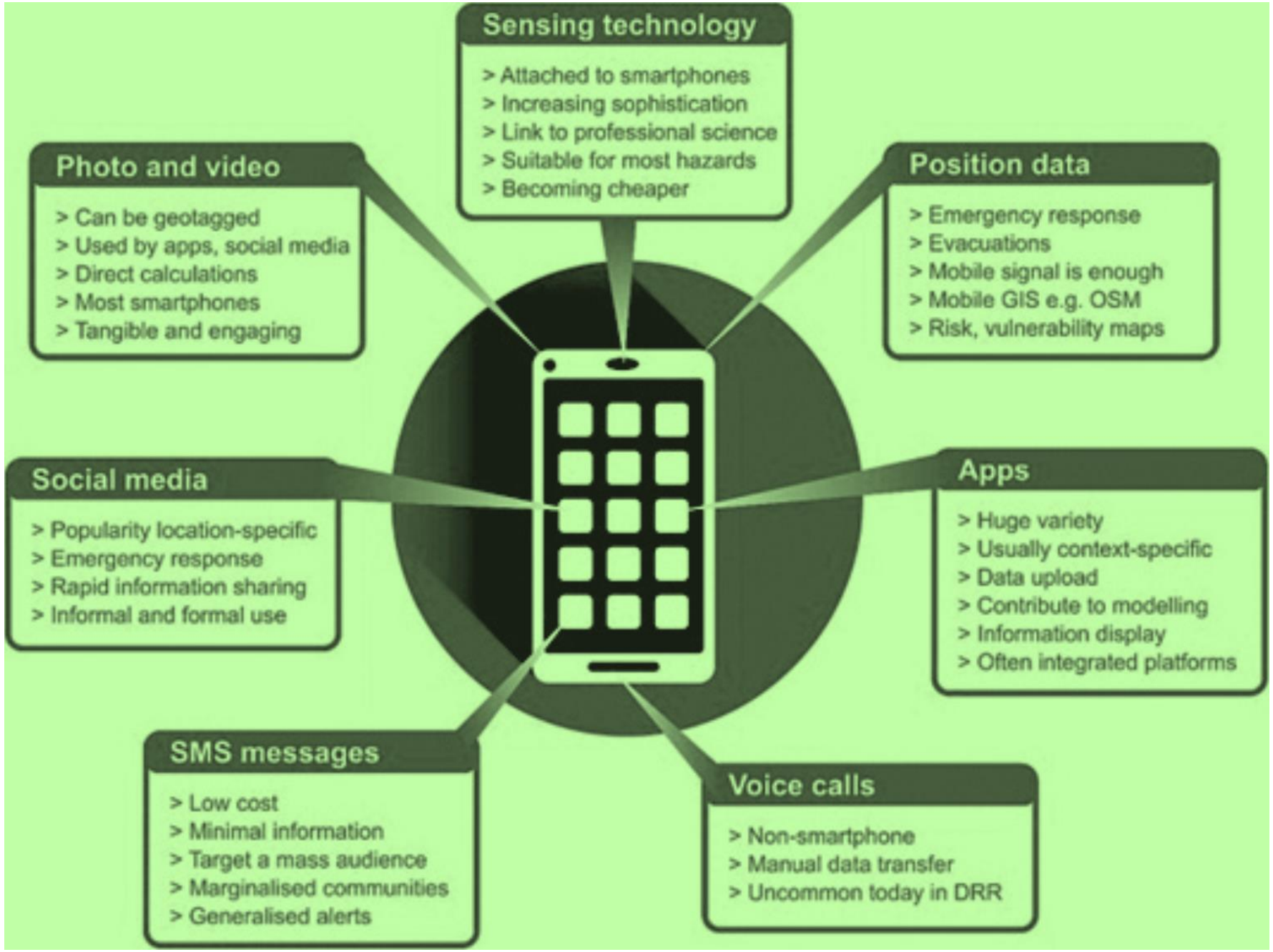
The major areas where drones can be used in disaster management are:

- Mapping/Damage Assessment
- Search and Rescue
- Supplying medicals and essential items
- Disaster recovery

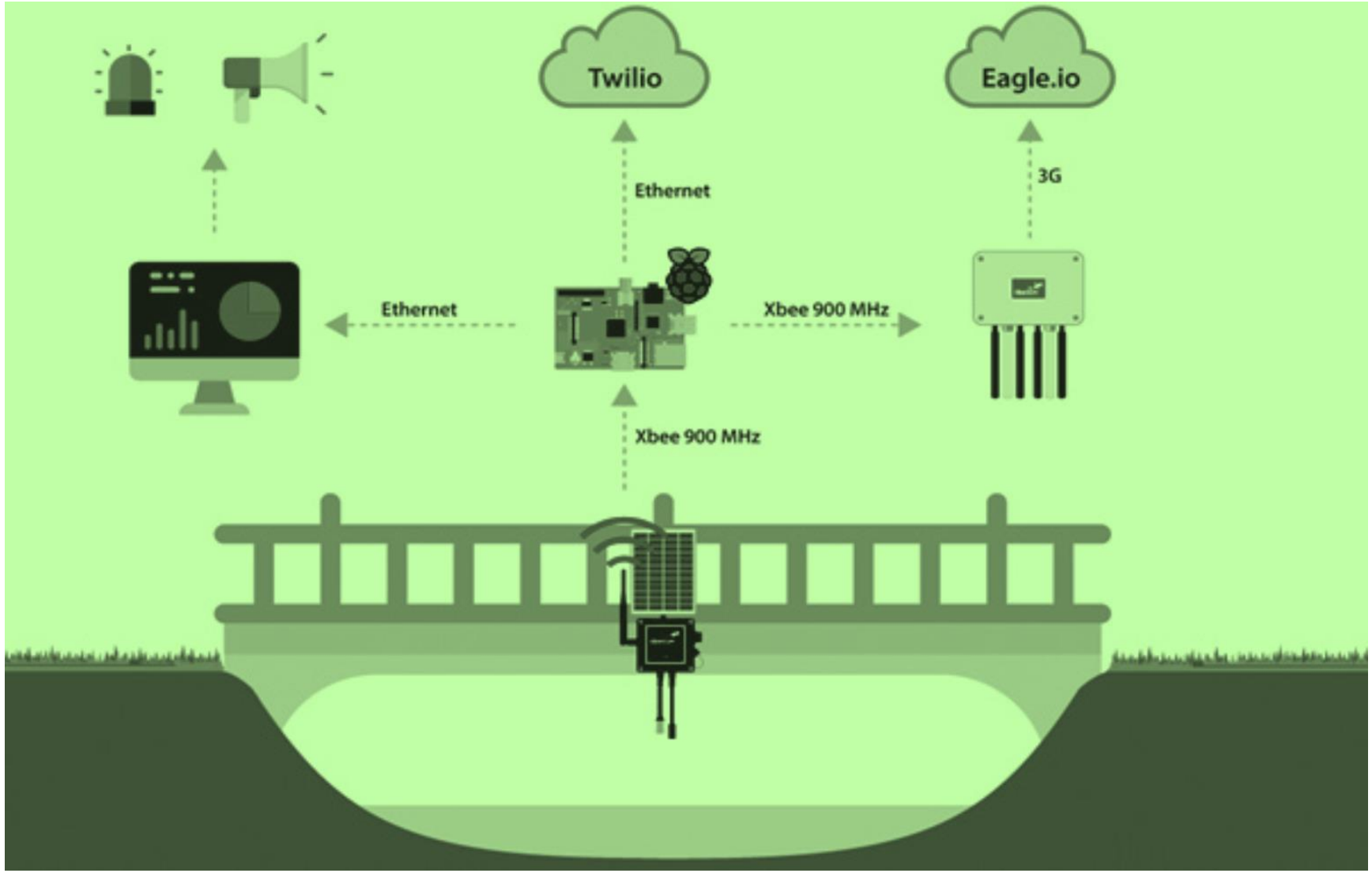
Mobile Phones and Social Medias

In the past few decades, there has been massive development in mobile phones and telecommunication. With the development of mobile phones, their functionality and uses have also improved a lot. Today majority of mobile phones have a function of camera, internet, and location service. These functions play a rapid role in disaster management. Using mobile phones, victims can contact their friends, families, relief workers, or concerned authorities in times of disaster. When calls are overloaded, SMS or text messages can be sent. Usually, a Toll-Free number and text message service are provided by the government for free where we can report about disasters or accidents like fire.

Social Media is another tool that can greatly improve the disaster management role. The information on social media amplifies and in many cases it spreads among the people faster than the daily newspaper, TV News, or radio. Hence, sharing awareness and information about the disaster and household accidents like short circuits, gas leakage fires, information regarding pandemics using social media can be very fruitful.


Sensing technology
> Attached to smartphones
> Increasing sophistication
> Link to professional science
> Suitable for most hazards
> Becoming cheaper
Photo and video
> Can be geotagged
> Used by apps, social media
> Direct calculations
> Most smartphones
> Tangible and engaging
Position data
> Emergency response
> Evacuations
> Mobile signal is enough
> Mobile GIS e.g. OSM
> Risk, vulnerability maps
Social media
> Popularity location-specific
> Emergency response
> Rapid information sharing
> Informal and formal use
Apps
> Huge variety
> Usually context-specific
> Data upload
> Contribute to modelling
> Information display
> Often integrated platforms
SMS messages
> Low cost
> Minimal information
> Target a mass audience
> Marginalised communities
> Generalised alerts
Voice calls
> Non-smartphone
> Manual data transfer
> Uncommon today in DRR

Internet of Things



Artificial Intelligence

Development in Artificial Intelligence can be a booster in disaster management roles. Using large sets of algorithm and data, AI helps in prediction of disaster as well as improves recovery and response time. AI analysis was utilized to detect damage to dwellings in the 2011 Tohoku earthquake. An effort was made to figure out where residences that were wiped away by the tsunami were located. With a 94 percent accuracy rate, the AI was able to locate the afflicted homes. AI was also used to identify landslides after the 2018 Hokkaido earthquake in Japan. Compared with visual interpretation, AI with 93% accuracy could detect damaged places in 5 minutes. Skilled engineers took roughly 5 days to determine damaged places with deceptive sites.

- Predicting Disasters using Animal Activity

- Artificial intelligence (AI) and machine learning (ML), is playing an increasingly important role in disaster risk reduction (DRR). Right from forecasting of extreme events and the development of hazard maps to the detection of events in real time, the provision of situational awareness and support for decision making

Thank you