



Design for Disaster Preparedness

A Self-Sustained Communication Network in Earthquake Scenarios

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Figure.1

Lisbon, Portugal, during the great earthquake of 1 November 1755

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Abstract

Design solution I am proposing here consists of an application interface for the disaster victims and an underlying communication network solution that can self-sustain by building a mesh network between the mobile devices that are in the disaster area. This new network comes into play when the existing internet or GSM network fails.

Aim of this project is to strengthen the communication between the citizens themselves as well as between the citizens and the governments civil defense organizations.

I was inspired to work on this topic as my home country, Turkey, is prone to earthquakes and has suffered multiple disasters in the past. Personally, I have great motivation to introduce design solutions in the area of natural disasters because I believe there is great potential to improve, and every step is important in the way to create a prepared society, social systems and governments.

Project begins with the research question on how to sustain the communication network in the case of a natural disaster.

Initial research consists of reading through literature, news sources, and internet sources of government organizations. This is to understand the risks, nature of an earthquake scenario, and how different systems in a city interacts with each other. Initial research is combined with Gigamapping method to create a gigamap of the earthquake scenario. Consisting of before, during the disaster and the situation after.

Research part has multiple additional categories as well; reading on existing technologies to understand how some communication systems work and going through social media websites of a selected time frame.

The research was followed by interviews. I used the initial gigamap as a reference during the interviews to make it easy for the attendants to visualize and propose solutions. Those solutions and then used to generate first concepts and follow up interviews were used to get feedback on the concepts.

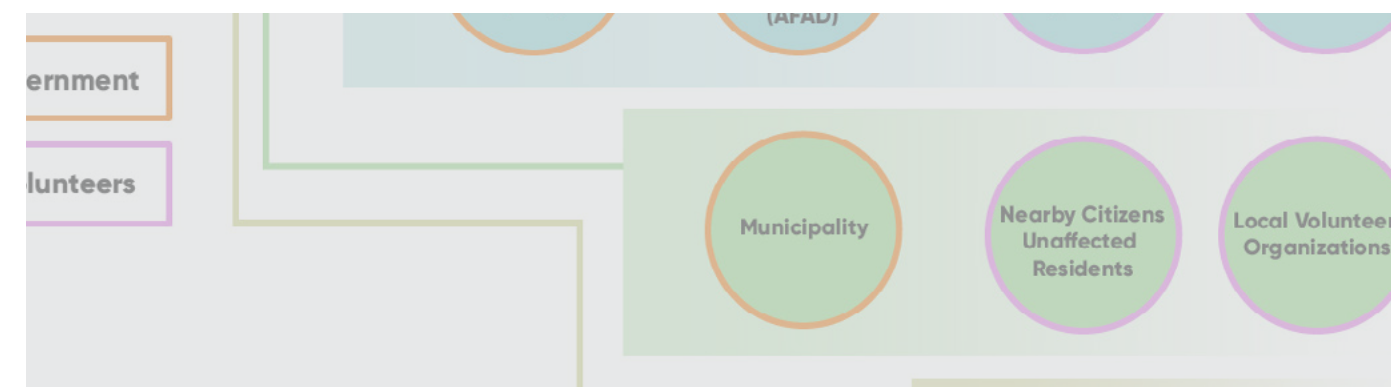
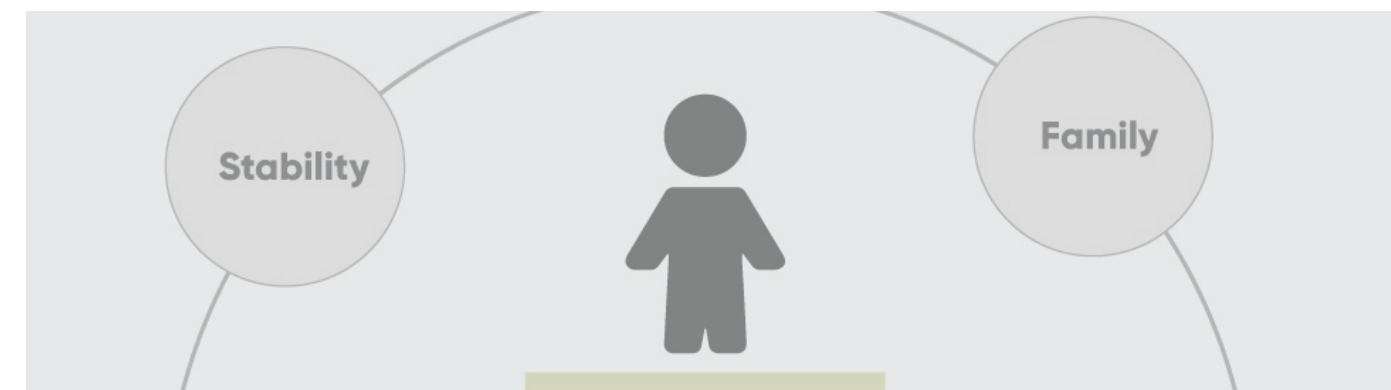
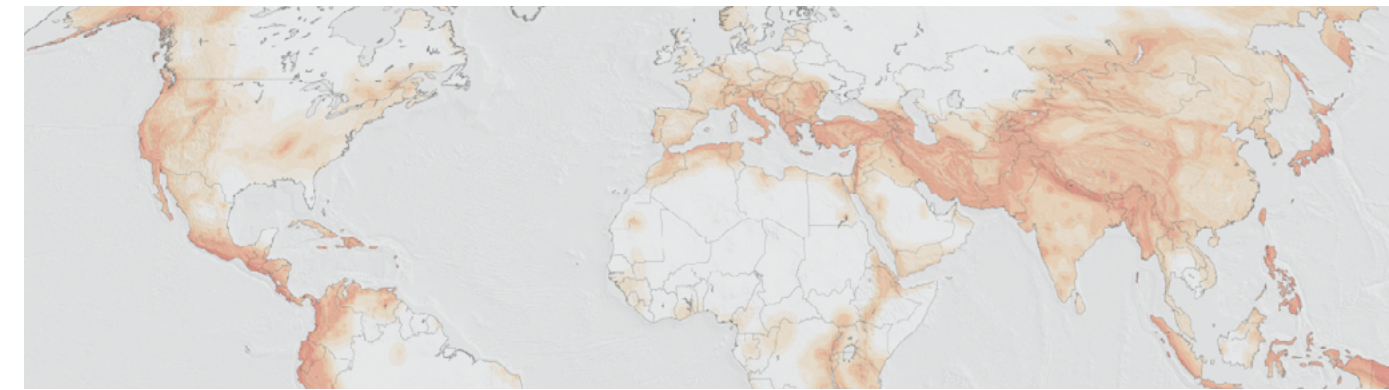
The final design solution was shaped after the feedback sessions.

Materials used in this project was mainly limited to digital, this is due to nature of the project as well as the global pandemic that was taking place while this project were in progress. Interviews were held through video and audio calls, also screen-sharing and digital white-board were used.

I think this project has an advantage of timing, digitalization is very on demand currently and I believe the design solution explored here has the potential to attract attention of the right organizations.

Background

Research Question
Progress Plan
Motivation
Nature of Earthquakes
Immediate Effects
Risks and Systems
Communication
Two Events



Research Question

"How can we sustain an improved communication network in the cities in case of a natural disaster?"

It is a common aspect of our lives now to expect technological advancements on the existing network systems, or new alternative systems that run in parallel with the existing ones. The scope of this project is not to propose a solution on the technological part of the advancements.

The projects goal is to create new opportunities in the existing systems and to answer to the needs of the victims that may arise in the disaster scenarios. Some of the needs, as argued in this project, was present even if the existing communication network was restored.

Progress Plan

January

February

March

April

May

June

Startup Seminars
Initial Project Description

Work on Gigamap
framing the scenario

Creating an outline for the research topic

Research on

The scenario of an earthquake
The challenges
Available resources and the stakeholders (responders)

Theories and Preliminary Ideas

Research on design theories and practices to implement

Data gathering

Design iterations with the collected data

Reflection Paper

Planned user feedbacks

Group Seminars

Course Meetings

Prototyping of the suggested design solution

Further iterations based on
collected data and selected design theories

New prototypes and visualization of the product

Design process documentation

Design process mapping

Course Meetings

Portfolio Work

Design work
Proof reading
Picking pictures

Portfolio Submission

Oral exam preparing

Oral Exam

Motivation

My motivation of working on disaster scenarios were begun even before my design education and career. Being born in a country that is placed on top of multiple active fault lines, I, with my family and friends have witnessed multiple earthquakes, most of which being not serious, except a few that caused unfortunately enormous damage to the surrounding cities that the one I was born in. From the television broadcasts to the emergency drills in the elementary school, it is an accepted reality of life in Turkey that one can expect an occurring of an earthquake. Regarding that, there always has been an emphasis on disaster preparation, especially on the government level, as well as in academics. Fast forwarding to my bachelor, I have done my product design bachelor thesis on medical equipment for mass casualty scenarios. This gave me the opportunity to have multiple dialogs with emergency personnel, victims, and government officials. Witnessing the difference of perspective in multiple actors, it led me to realize how crucial it is to decide where to position myself, as a designer, while having these dialogs and how to get the most out of the feedback I am given. Following that project with a year of employment in the same field, I continued my design journey in Norway. I believe living through a lifetime of sensibility against unexpected disasters, it has thought me to be more perceptive towards details. Those details, including how people perceive risk, or what they prioritize in an emergency were very valuable findings for me.

Although my topic was decided as an earthquake related design solution, it was still too broad of a topic to be tackled in one project. My interest in the communication network was rooted from multiple early experiences where I have tried to reach my friends but were unable to do so in that moment. In addition, some observations about the misinformation and the stale information on the social media, realizing the possible harm that may cause. As a result, the project was limited to the communication network.

This project documents my journey where I use the design tools I have acquired during my education to create a meaningful concept of a product that will answer to the needs of the people that may one day find themselves in a disaster scenario.

Nature of Earthquakes

As we name it, an earthquake is the shaking of the earth's surface that can have a natural or man-made cause. Usual cause of an earthquake is the move of the tectonic plates, although they can be triggered by volcanic activity as well. Earthquakes that are triggered by human activity are mostly due to mining or military testing, as they do not create an unexpected disaster, they were left out of the scope of this project.

Natural earthquakes are related to plate activity. As the plates on the earth's crust (outer layer) move, they cling into each other due to friction and accumulate tension. The plates are always slowly moving and bumping into each other, this process is very slow and happens on the course of many years. When the plates become unstuck, however, that tension is released and causes seismic activity, displacing a great amount of material in a short span of time. This resulting seismic activity is what we call an earthquake. It radiates starting from the fault line and outwards, can be compared to ripples in a pond. This point is referred to as the focus point, it is also used in naming of the earthquake. Focus point is usually deep into earth's crust but the point equivalent of it on the ground is used in naming instead. The shock waves that the earthquake creates on the ground can propel people or objects into the air, causing heavy damage especially in crowded areas of residence.

Although we have limited knowledge on when earthquakes happen, it is known that they happen around the plate boundaries. Plate boundaries are made up from multiple fault lines and most of the earthquakes in the world happen on these fault lines (Wald, 2020).

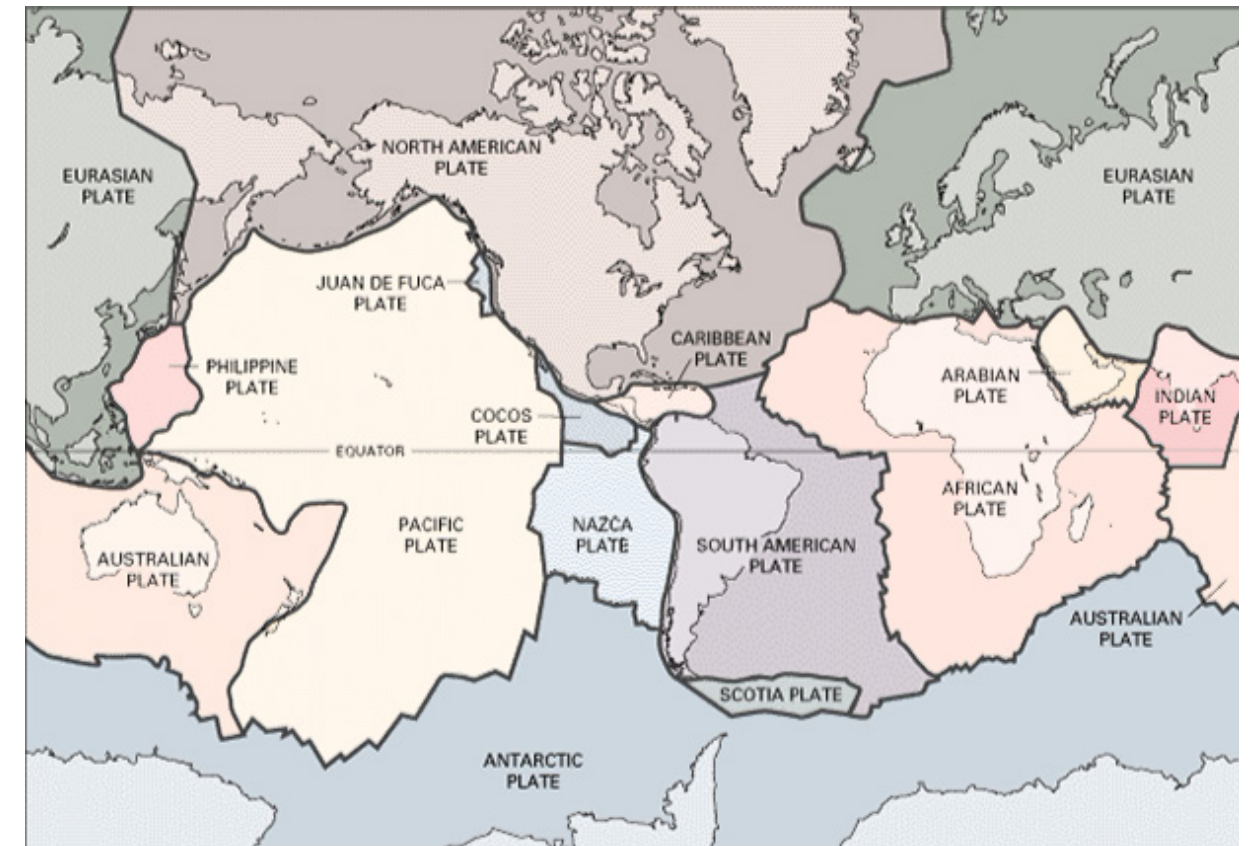
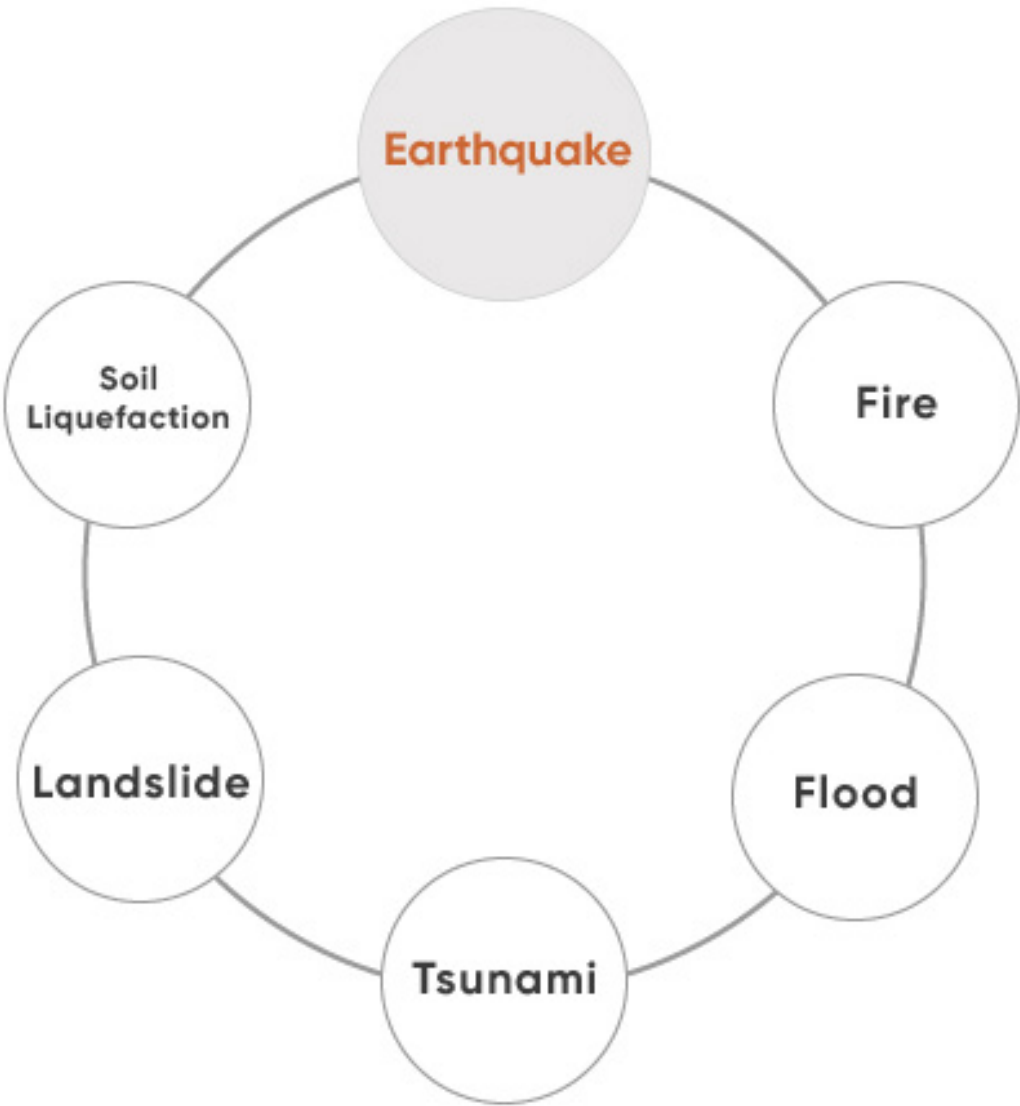


Figure.2

It is not possible to predict the timing of an earthquake, and as the current knowledge suggests it will be unlikely to predict them in the future as well. On the other hand, scientists can know that there will be a new earthquake on any particular fault, sometime in the future (Wald, 2020).

Earthquakes of different magnitudes happen all the time, and in lots of places around the world. Around the Mediterranean Sea countries, from Japan to Indonesia and the coasts of USA are some examples of high-risk countries of earthquakes. How frequent the earthquakes occur, or the magnitude of them does not necessarily scale with the impact they have on human life. When assessing a risk, we must consider multiple aspects of the area that is hit by an earthquake. Such as population density, and the preparedness of the society.

Moreover earthquakes can result in multiple types of damage to the surrounding environment, starting fire, flood, resulting in a tsunami or a landslide. Each of them possessing a risk to human lives and property.



In this project we will be focusing on a two earthquakes that has happened in the recent years and one potential earthquake that can be expected in the future. They are 1999 Izmit earthquake, 2020 Aegean Sea earthquake and an expected earthquake of Marmara sea in the future.

By studying the former earthquakes, it is possible to determine the possible earthquake locations in a selected region (Ambraseys, 2009).

"We observed that in the 1999 Izmit earthquake, strongly coupled fault patches were associated with the highest co-seismic slip."
(Bulut et al., 2019)

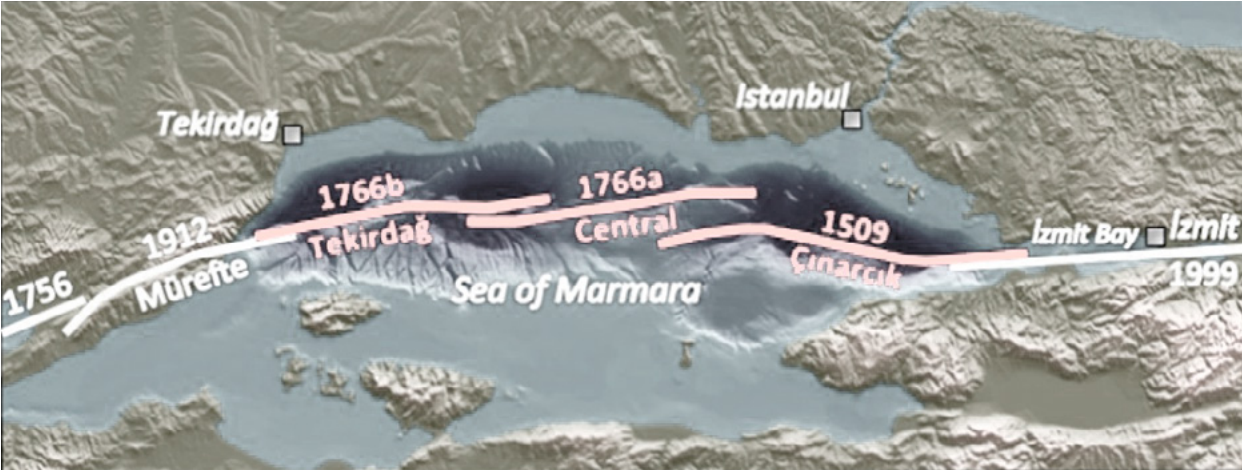


Figure.3

"This lends credibility to an interpretation of future earthquakes occurring in three seismogenic segments of the NAFZ corresponding to three deep basins in the Sea of Marmara."
(Bulut et al., 2019)

NAFZ (North Anatolian Fault Zone)

Expected Marmara sea earthquake, also named as "Istanbul earthquake" by the public, poses a great risk to 20 million people living and residing in Istanbul. Istanbul, being a very densely populated city, also forms a big portion of the countries economy. Although there is no help to make up for the damage that has happened in the past, I believe preparing for an upcoming Istanbul earthquake can make a big difference on the disasters impact that may happen.

"Damage from earthquakes as well as from other hazards and loss of life can to a great extent be reduced by mitigation and preparedness activities."
(Tekeli-Yeşil et al. 2010)

This project envelopes my personal career plans as well. Municipality level attentiveness is very high towards disaster preparedness in Istanbul, and I believe this project has the potential to gather the attention of the right people and be a step in the right direction towards a prepared society.

To continue, we will discuss upon how to assess the risk of a given area, and proceed to deepen our understanding of a disaster scenario and how different systems in a city is affected.

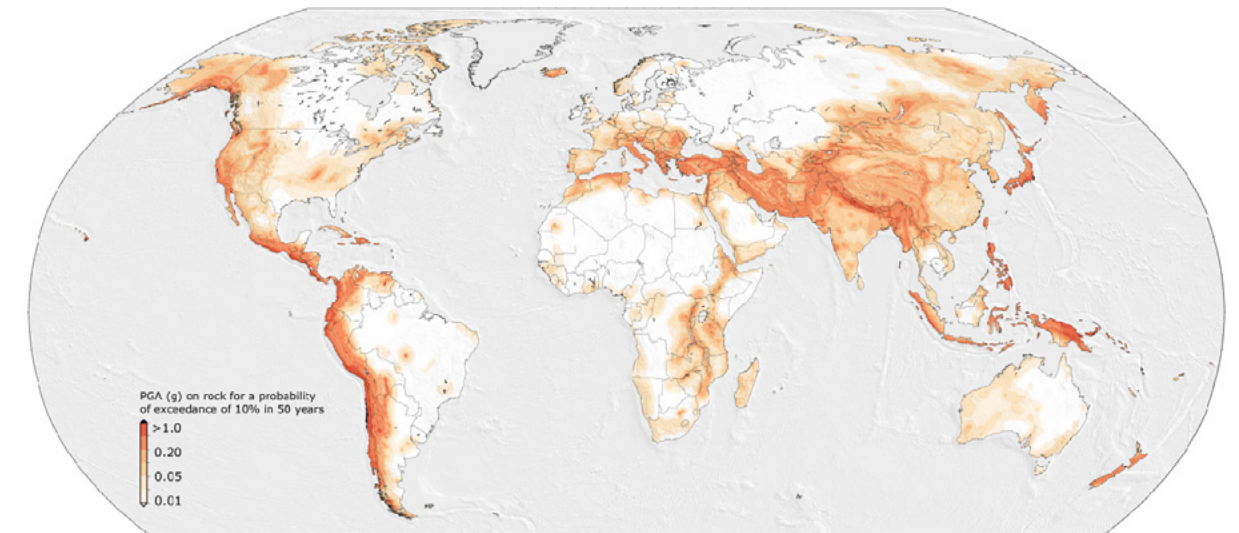


Figure.4

Map above shows the global seismic hazard. It is noticeable that high seismic hazard areas lie between the tectonic plates and the seismic hazard correlates with the location of the fault lines. This type of hazard assessment is beneficial in residency planning.

To name a few examples from this map, we see Japan on the Philippine sea plate, at the south of it Philippines and Indonesia; Turkey between Arabian and Eurasian tectonic plates; and India on Indian tectonic plate.

Although it does not tell the whole story. In order to design for the preparedness of the society, looking at the risk concerning the human life is more important.

"Surge of injured people are in need of various requirements like food, security, medicine, etc. in the case of such disasters. One of the most important requirements is to get immediate healthcare service from emergency medical centers."
(Acar, and Kaya, 2019)

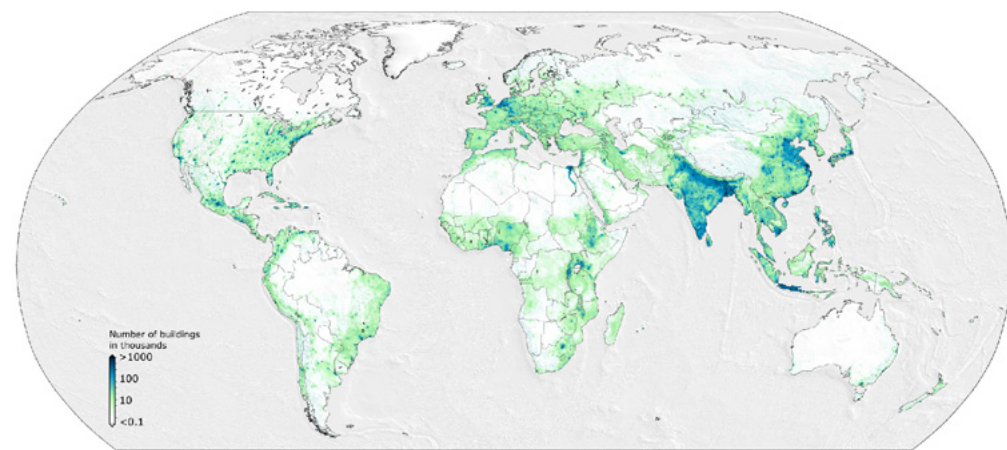
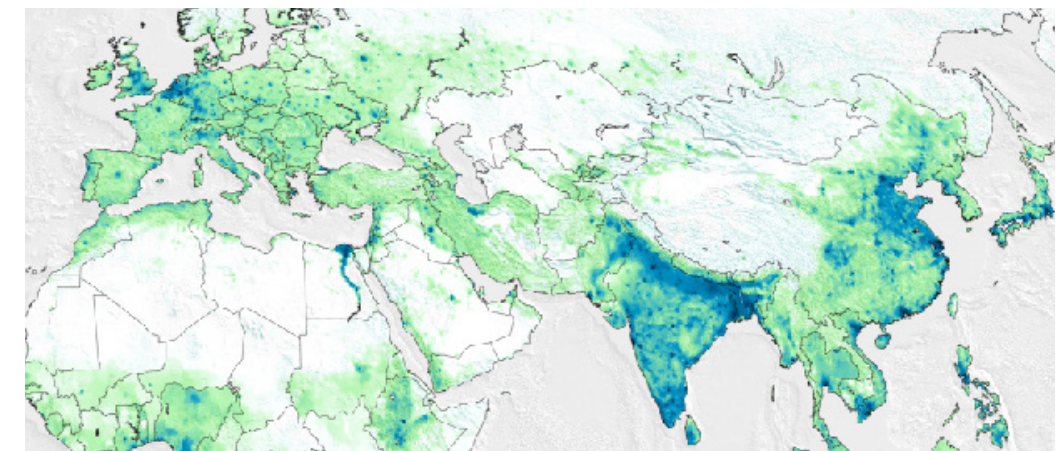


Figure.5

How many buildings are exposed to the earthquakes.



The seismic activity alone does not determine the magnitude of the problem.

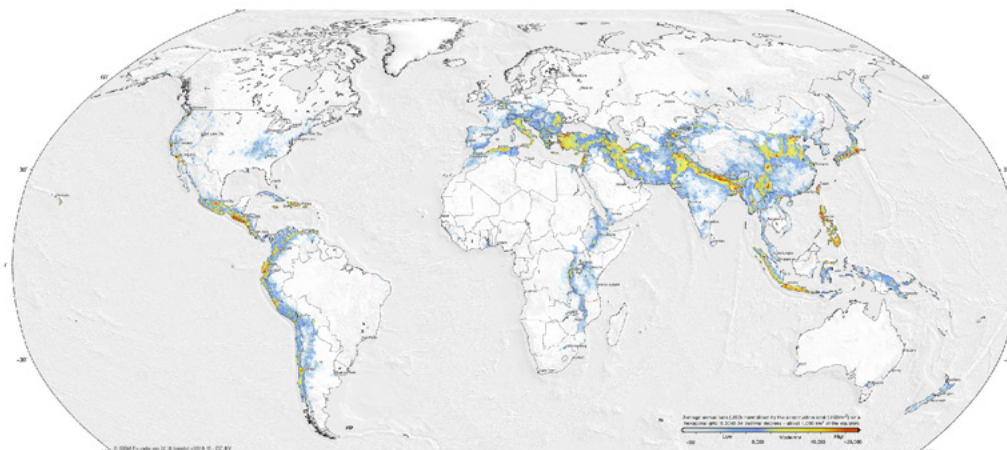
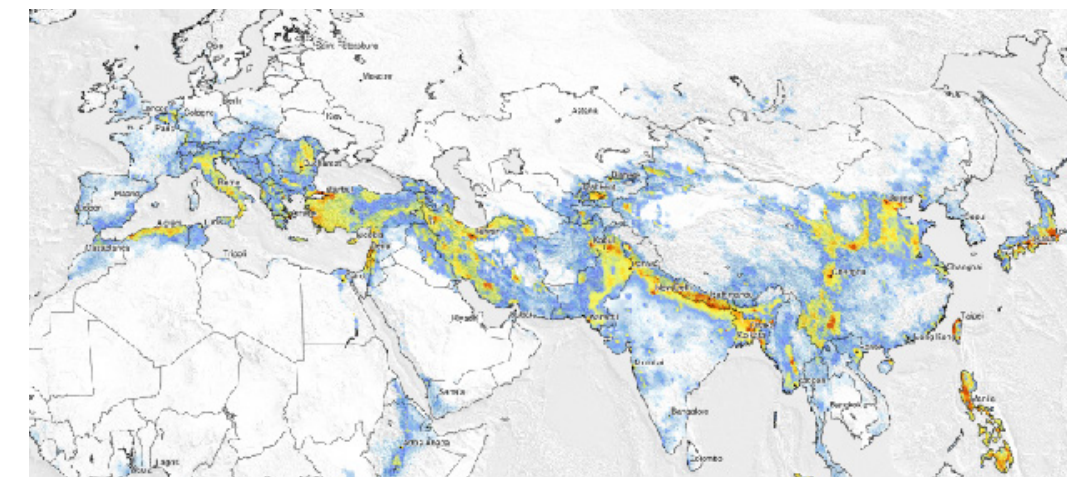


Figure.6

How much damage, loss, the buildings has suffered.



Preparedness, household density, building quality and more factors come into play when assessing the vulnerability of a certain population.

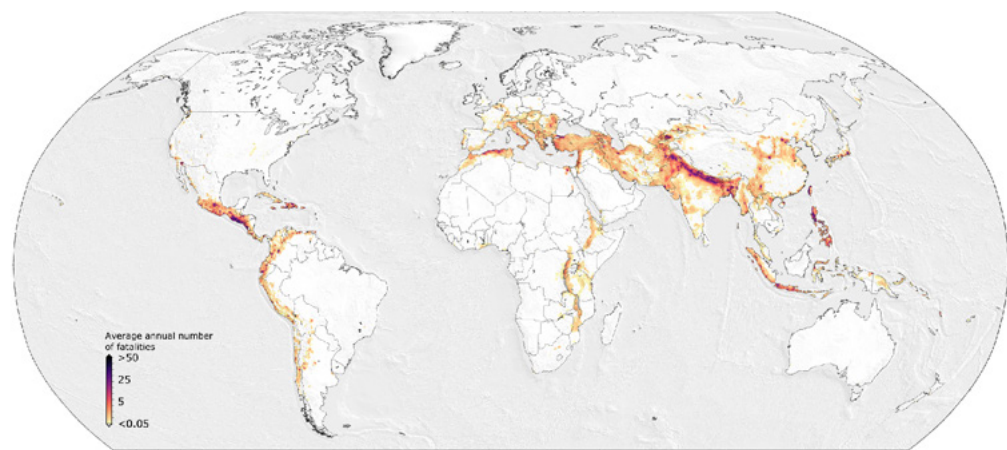
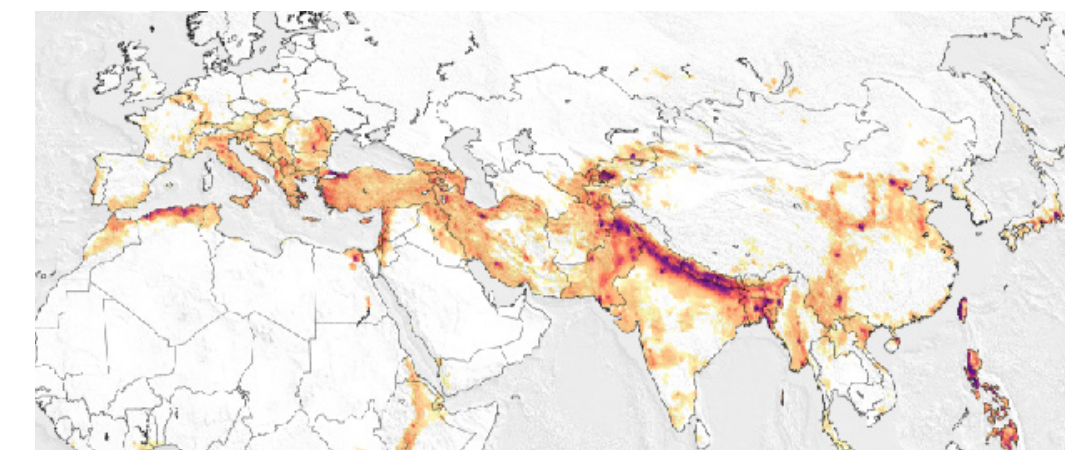


Figure.7

Fatality rate, yearly.



Less populated areas would tolerate an earthquake better than their counterparts.

Immediate Effects

In this part of the initial research, we will have a look at the immediate effects of an earthquake in urban areas.

Around this phase of my design project, the background information I have gathered was used in gigamapping. My gigamap started with an outline of my own understanding of the situation and then shaped as I have done more research on earthquakes. It was a back and forth process of multiple iterations and self feedback. Where gigamap differs from the research information is that, gigamap will employ points of interest of my design goals and my personal picks of design intervention opportunities.

In an earthquake scenario, the first felt effect would be the foreshock. Foreshocks are smaller earthquakes that happen before the mainshock. There is no telling of an earthquake if it is the foreshock or the main, until the event is passed. After the earthquake, the seismic waves are named as foreshock or mainshock. Moreover, there can be expected aftershock in the following days, weeks or months. Aftershocks also create risk as they may result in additional damage to the already weakened buildings.

"Although seismologists have carefully analyzed foreshock/mainshock pairs of earthquakes, and earthquake triggering in general, there are no special characteristics of a foreshock that let us know it is a foreshock until the mainshock occurs."
(IRIS, n.d)

Most common effect of an earthquake is damage to the man made structures, such as buildings, roads and bridges.

Building damage is usually correlated with the fatality rate of a scenario. Damage in housing structures pose immediate hazard to residents life, also are potential health hazard for the survivors during disaster recovery period. (Han, Y., et al. 2021).

Road damage from the seismic waves occur in highways, overpasses and bridges. This can prevent the emergency response units from entering to the disaster site. Additional road damage can be caused by the failing sewage system, this usually results in holes and ditches in the streets.

Additionally, earthquake triggered avalanches or landslides can occur. This is mostly a concern in remote areas as they can create significant road damage, preventing the response to be delivered quickly.

Risks and Systems

Risks regarding human lives can come from many different effects from an earthquake.

Aftershocks can follow up after the main earthquake, there can be expected additional building destruction due to aftershocks. Some buildings may already be weakened and even if they survived the mainshock, they may collapse hours or days after. This additional risk renders many people homeless, or results in more fatalities as the days pass. Moreover, aftershocks lasting through several months may delay the recovery of the affected region, it may not be possible for reparation and construction to proceed, before the disaster struck area is deemed as safe.

There are more effects to be considered besides the physical damage due to seismic waves. Earthquakes can disrupt multiple different systems in an urban area that we rely on our daily lives. Depending on the magnitude of the earthquake, disruption of one or more systems are to be expected. In addition, some of the systems may be shut off as a safety measure or can be inaccessible due to public's reaction.

Weather conditions may worsen the situation, damage in rainwater collection systems can result in floods in certain regions. Sewage and fresh water supply disruption, can lead to spread of diseases. Even if the fresh water system remains intact, it is often cut off as a safety measure to prevent floods. This also affects the neighboring areas.

Heating and gas network is another crucial system. Households that rely on natural gas for heating and cooking can pose a danger of emerging fires. This is another system that will be cut off during the emergencies and affect the life of the neighboring communities. Due to water supply being disrupted, putting out fires may not be possible in some cases.

Electricity system is another cause for emerging fire. Households that rely on electric for cooking and heating, will be rendered without power for many days. This is also the case for the areas around the disaster site. Without power, the ability to relay information to the citizens will be greatly reduced.

Transportation system is another important aspect to consider in disaster scenarios. Blocked roads prevent emergency response to arrive. Also heavy traffic is to be expected due to people trying to get out of the city. Public transport comes to an halt and people may become stuck in the areas of the city, away from their residencies. Lack of transport network would eventually lead the supply link to fail, people in the city may be left with lack of food, water and necessary supplies.

Communication network, being the main area of interest of this project, also gets disrupted in a case of a disaster. Paper based media is lost first, due to supply chain failing. Mobile phone lines are not able to handle the traffic and due to the damage to base stations people in the disaster area will be rendered without signal. It was noted that the Internet network is more resilient in disaster scenarios, although it is only limited to the areas with power access.

Communication

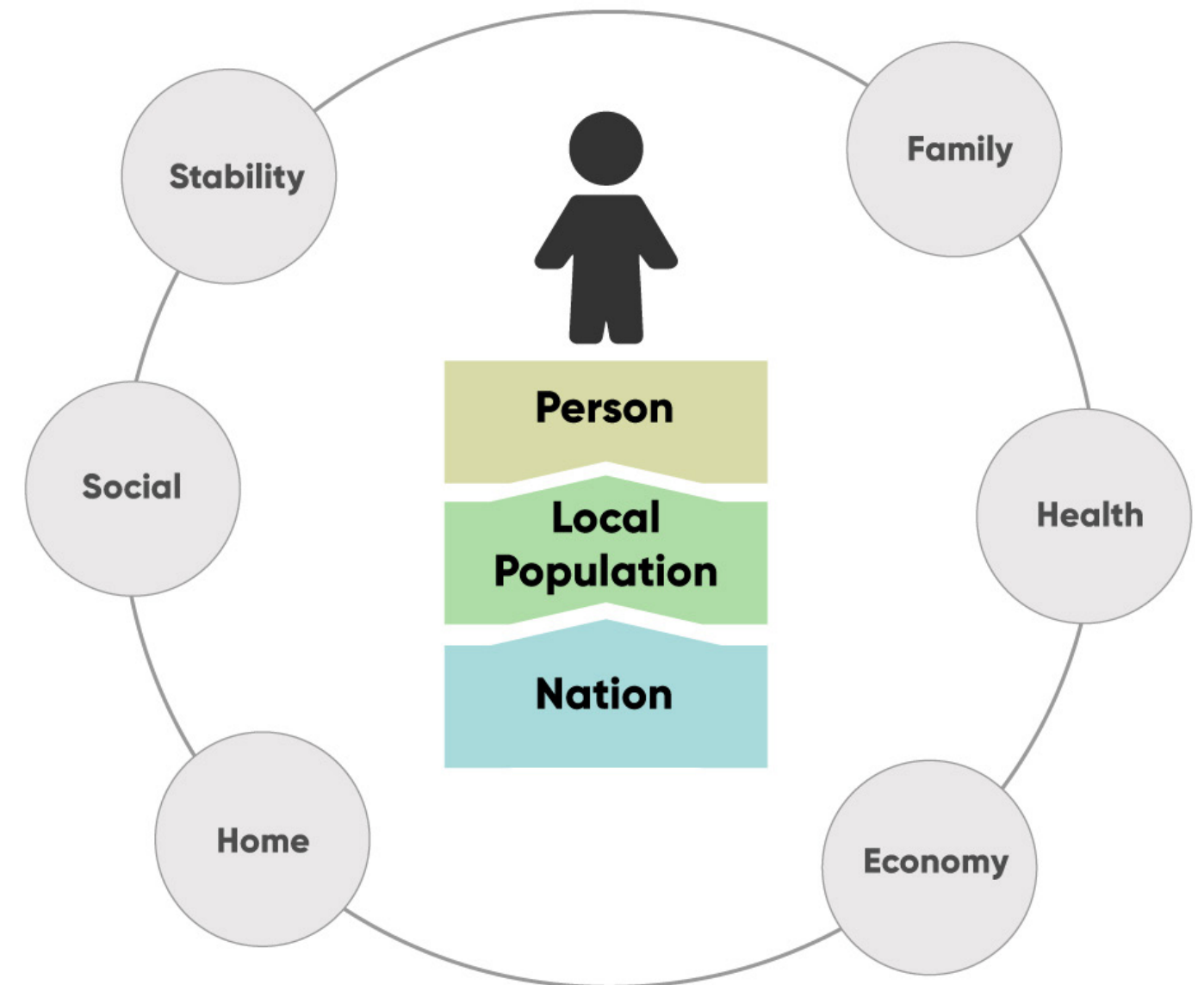
A restored communication network can be utilized to mitigate the effects of a disaster. It can be used to strengthen the existing systems or to ease the load in some of them.

The load on the transportation network can be eased, by reaching out to the citizens in the disaster moment and preventing them from creating a traffic, or to guide them into a safer place. A timely warning can keep the roads open for the emergency response to arrive, also will prevent additional risk of people exposing themselves to more risk by traveling through dangerous areas, or weakened overpasses and bridges.

Keeping the citizens updated with the announcements can help to reduce risks. People can be reminded on the point, to cut the gas and water pipe lines in their residencies to prevent future fires. In addition, public may tend to return to their homes even if the risk is present, informing the citizens about the future risks is crucial to prevent future casualties. Instead of returning to the buildings, public can be directed to the designated areas with electricity, heating and fresh water.

There is going to be immediate needs of the people in disaster areas. Starting with the food and supplies. Rationing, transportation and distribution of the supplies will be needed, in emergency cases this is handled by the civil defense organization. Health service will be needed in accordance with urban search and rescue teams in struck areas. It was also noted that in many cases there were immediate need of blood transportation and blood donations.

Emergency shelter solutions, tents or booths may not be available in the necessary quantities immediately. This is an important aspect of communication network that it can make use of emergency gathering locations more effectively.



Community

A single region being hit by a natural disaster is going to have effect on the whole country. Limited preparedness from the governments side, or the limited access to the necessary sources of supplies or personnel can alter the impact of the disaster greatly. Nations with limited preparedness are going to be affected more than their well equipped counterparts in comparison.

It is often that help and donation in global and local scale is offered to disaster struck areas. Although that help may not reach in the immediate moment that it is needed. First source that the countries rely on usually are their own population. Local population and the people in the surrounding cities can be the first supply of food and shelter until the emergency aid system is sustained. Local structures can be utilized as well shops, hotels, malls and sports fields can be spots of additional gathering and provide access to food, shelter, sanitation and information. From the first moments of the disaster, it will not be possible to relay information to the public.

People in other cities will begin to offer their help as well, immediate and effective utilization of a donation system will be needed. Apart from usual donation systems, it was noted in this project that the donation of money is not as immediate and helpful as one would assume. Disaster struck areas will be in need of supply donations of food, sheltering structures, sanitation supplies and blood. Connecting the people in need with the people who want to help, is need and a possible design opportunity.

This project is concerned with the communication between different actors; victims, public, government organizations and volunteer organizations. Effective delegation of tasks, and effective relay of information between these independent actors can prove itself to be highly beneficial to people in need.

Challenges

There are some challenges that comes with information sharing. These are the points I observed personally in the 2020 Aegean Sea earthquake on various social media platforms. Following this, I have also made a separate review on Twitter on the earthquake related tweets at the day of the earthquake.

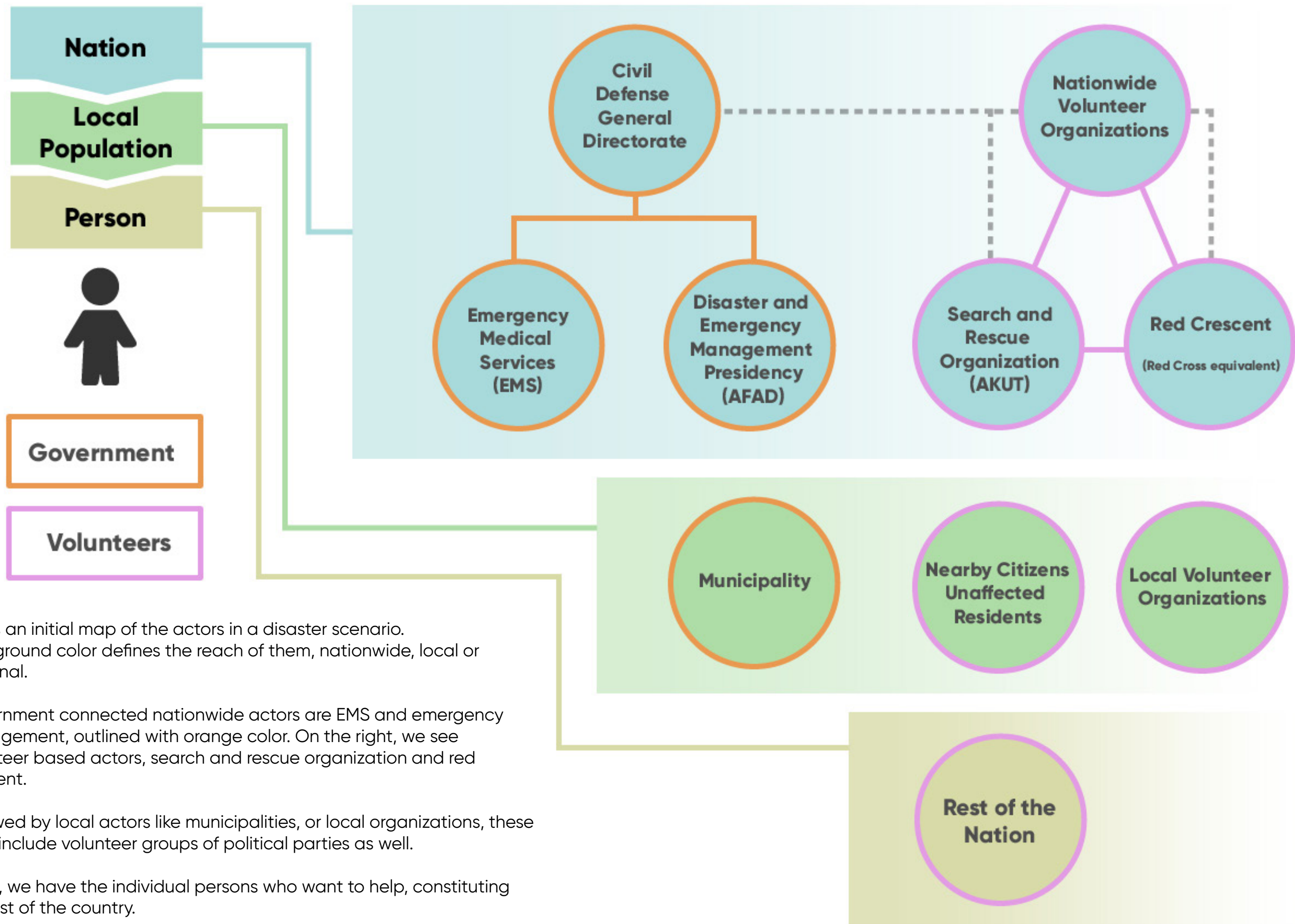
When a disaster happens, people with internet access in the affected city and people in the other cities start sharing information, that can be related to current news, or in relation to information about how to help people in the disaster struck areas.

Problems start to arise as the information is passed from one account to another, and as the days pass it is common to see stale information or recirculation of the information that was related to another earthquake years ago. Those kind of pictures, phone numbers, contact informations tend to resurface themselves and start circulating again, causing misinformation and unnecessary coverage. This will hurt the effectiveness of the help efforts.

Some of the information is related to the missing people, even after they are found, the redundant information still gets shared and gets coverage. Redundant information also applies to blood donation needs.

Moreover, it is possible to see wrong information on gathering areas, this mostly happens with stale information. People can be directed to a possible gathering area, only to see that there is no help there. True information however, may have an hard time reaching to the right people. There have been cases of people overcrowding some of the gathering spots, and missing out some other ones, preventing an equal distribution.

It is my aim with this design project to strengthen the communication between the government, victims, and people who want to help.



This is an initial map of the actors in a disaster scenario. Background color defines the reach of them, nationwide, local or personal.

Government connected nationwide actors are EMS and emergency management, outlined with orange color. On the right, we see volunteer based actors, search and rescue organization and red crescent.

Followed by local actors like municipalities, or local organizations, these does include volunteer groups of political parties as well.

Lastly, we have the individual persons who want to help, constituting the rest of the country.

Two Events

Many earthquakes and large scale catastrophes have happened through the history. Information regarding the earthquakes vary depending on the time they happened, where they happened, and the magnitude of them. There are more research focus on earthquakes with high magnitudes and greater number of casualties. Large scale disasters can push the limits of available response sources and can expose the weak links in a given countries emergency response system. There is much to be learned from individual cases, on what was done right, and what could be done better.

For this project I have picked two earthquakes, 1999 Izmit earthquake on August 17 and 2020 Aegean Sea earthquake. There are multiple reasons behind this decision. I have picked earthquakes that has happened in Turkey, to be able to reach to people that lived through those earthquakes and to interview them, as Turkish is my native language, this decision was made considering the time frame and the scope of this project.

1999 Izmit earthquake was one of the largest earthquakes that has happened in the borders of Turkey. Because it happened in the recent history, I was able to come in contact with people who has seen it. Another consideration point for this exact earthquake is that it is used in predicting the location of future earthquakes in the fault line that it happened. In izmit earthquakes case, it suggests an upcoming Marmara sea earthquake in the future, if triggered, will result in enormous damage to Istanbul, Turkeys most populated city.

2020 Aegean Sea earthquake has happened only a year ago, it was picked because it showed new dynamics of nationwide cooperation, local links of communication and utilization of internet network that was not possible in the 1999 earthquake.

17 August 1999 Izmit Earthquake

On 17 August 1999, around 3:00 AM Turkey was hit by an earthquake with a magnitude of 7.4, while most of the people were asleep. Earthquake epicenter was located around Izmit, about 70 kilometers to the east of Istanbul. Earthquake lasted for 37 seconds and did most of the damage to Izmit, also affecting the east part of Istanbul.

Initial estimation of magnitude was 6.4, this was considerably lower than the actual magnitude of 7.4, resulted in government officials getting the wrong impression of damage (Barka, A.,1999). In the first two days of the disaster, extent of the damage and the amount of lives lost were underestimated. This led to delays in the emergency response and was worsened by the damaged highways blocking the entrance to the city. Many buildings were collapsed completely, causing a high number of fatalities in the region.

Earthquake led to a fire, starting in the oil refinery that was located near the gulf. Fire spread near to the industrial site that the refinery was built in and took five days to put out.

All telecommunication network was down in the region and alternate routes leading to Izmit were blocked by the heavy traffic caused by the people trying to reach to their relatives in the affected region. Traffic was being caused by the people rushing in to the disaster site to help.

Death toll of the Izmit earthquake was announced as 15.000 by government officials and around quarter million of people were rendered homeless.

30 October 2020 Aegean Sea Earthquake

On 30 of October, 2020, an earthquake with magnitude of 7.0 occurred between the Greek islands and Turkey. Earthquake epicenter was north of the Samos island of Greece.

Earthquake caused most of the damage to Turkish city Izmir, which was located in the north of the Greek island. Many buildings severely damaged or collapsed in Turkey, also causing damage to structures in the Greek Island. Earthquake resulted in floods in Izmir and was responsible for multiple casualties. (ASP, n.d.)

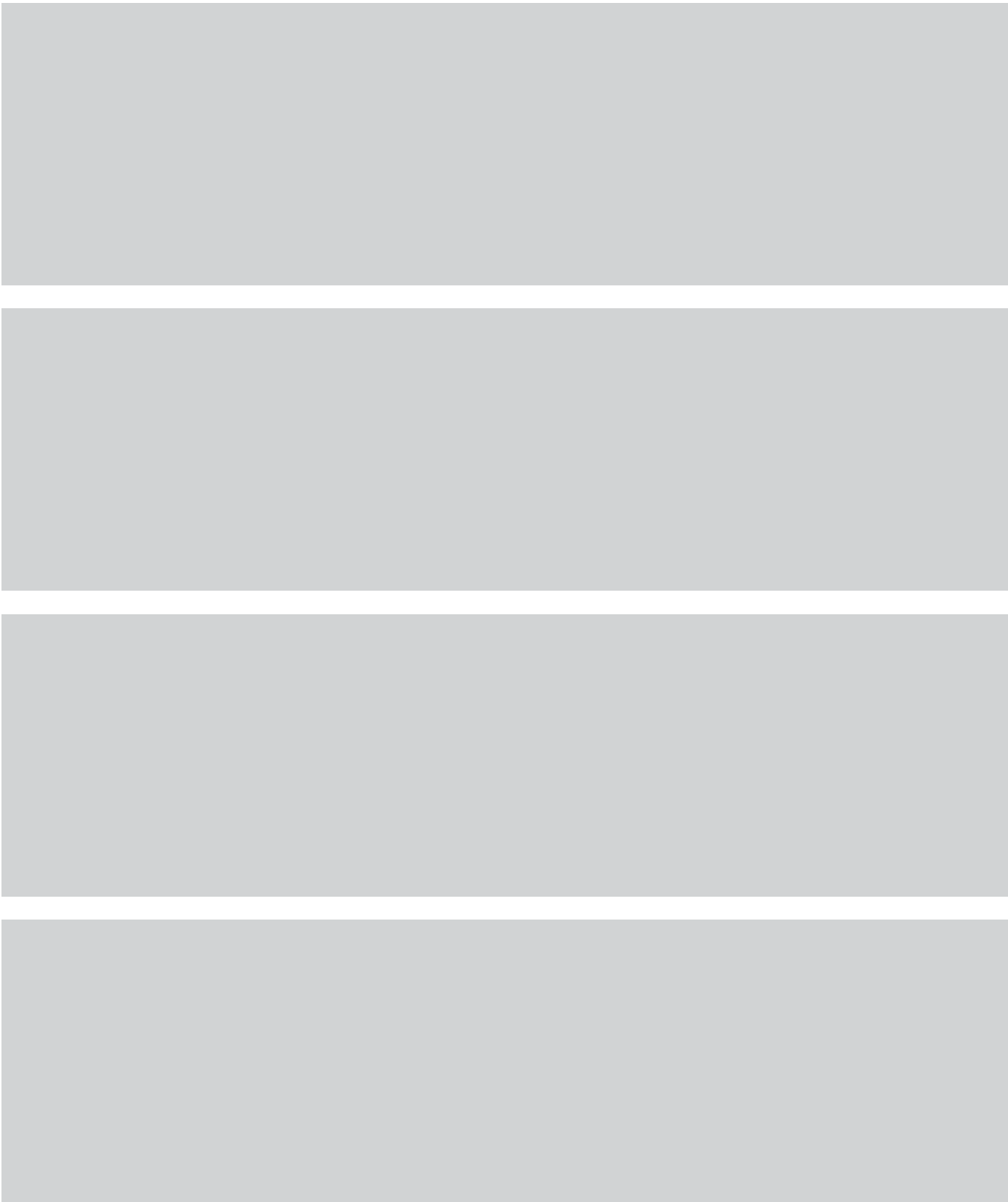
Rescue teams rushed to the area and rescue efforts continued for days after the incident. 117 people were reported as dead by the Turkish officials and more than a thousand were injured.

This earthquake is referred as Izmir earthquake by the general public. There was a significant media coverage and coordination of multiple donation programs were made in social media.

Note: Names of the cities Izmit and Izmir will be used in this project. Although the names are similar, Izmit and Izmir are completely different cities, located apart. For example, the earthquake in Izmir was not even felt by people that live in Izmit.

Method

- Gigamapping
- Online Research
- Interviews
- Initial Ideas
- Feedback



Gigamap

During the initial phase of my project where the background information were being collected to form an understanding of an earthquake disaster scenario. I employed one of the design tools, gigamapping. Gigamapping, being a part of systems oriented design framework, is a tool to visualize and understand complex networks of information (Sevaldson, 2012).

The way I employed gigamapping served two purposes, one is for contribution to my own understanding of the situation. I started with an outline of the map, filling with my existing knowledge first, then added and removed information in correlation with the references and information from the literature. This also helped me to decide where to position my design intervention and where my proposed design solutions fit in between the existing systems and actors.

Another benefit that the gigamapping method showed, was at interviews. The attendants were able to quickly access information regarding the overview of the situation, point things out easily and give input of their own thoughts. It served as a medium to help emerge further and deeper conversations on points that would otherwise left unnoticed.

It should be noted that a gigamap is a tool to be used during a design process and does not convey information just by itself.

Following gigamap was designed over the structure of a timeline. Starting before the earthquake, and ending after, including the events of recovery and making suggestions for the future.

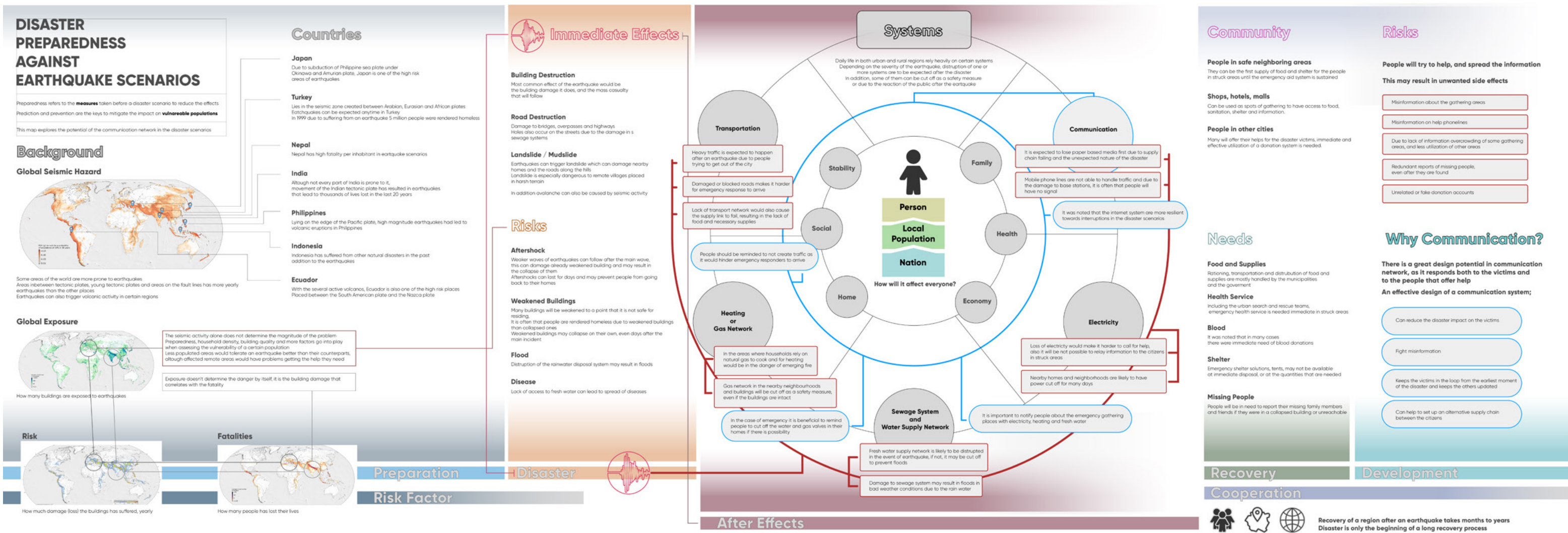
It begins with a contrast of preparation and the risk factor concerning the areas prone to risk, moves on to the immediate effects of the disaster.

After effects of the disaster forms the core of the gigamap, putting the victims in the center and explaining through the multiple systems in the city and how they were affected in an earthquake. At this core part, we also see the emerging problems (in red rectangle frames), and possible solutions that the communication network can provide (in blue rounded rectangle frames).

Design suggestions on the communication network is the main focus of this project. In the recovery part of the time-line, we see some of the needs of the population in the disaster area.

Lastly, development part of the time-line proposes that a design solution employing the communication network can be beneficial to respond to the challenges that was marked.

Gigamap



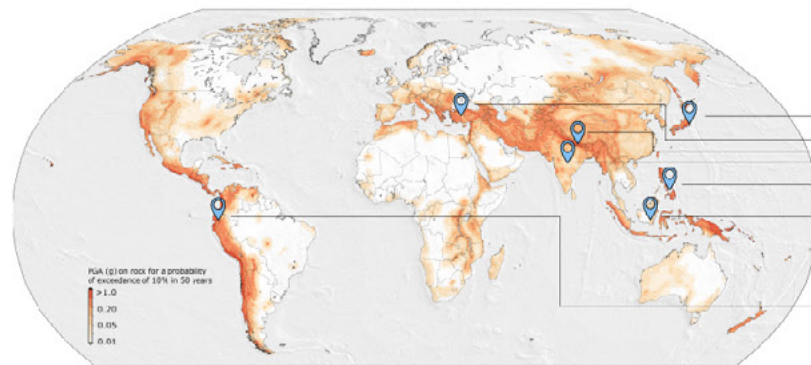
Better detail can be seen in the following pages

DISASTER PREPAREDNESS AGAINST EARTHQUAKE SCENARIOS

Preparedness refers to the **measures** taken before a disaster scenario to reduce the effects
Prediction and prevention are the keys to mitigate the impact on **vulnerable populations**
This map explores the potential of the communication network in the disaster scenarios

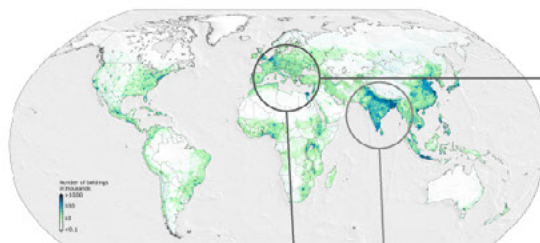
Background

Global Seismic Hazard



Some areas of the world are more prone to earthquakes
Areas inbetween tectonic plates, young tectonic plates and areas on the fault lines has more yearly earthquakes than the other places
Earthquakes can also trigger volcanic activity in certain regions

Global Exposure



How many buildings are exposed to earthquakes

The seismic activity alone does not determine the magnitude of the problem
Preparedness, household density, building quality and more factors go into play when assessing the vulnerability of a certain population
Less populated areas would tolerate an earthquake better than their counterparts, although affected remote areas would have problems getting the help they need

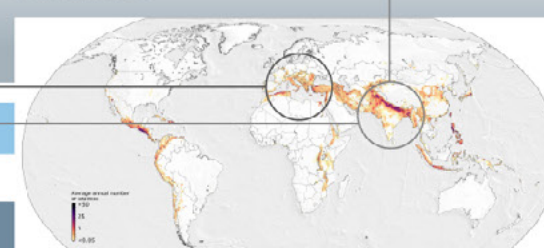
Exposure doesn't determine the danger by itself, it is the building damage that correlates with the fatality

Risk



How much damage (loss) the buildings has suffered, yearly

Fatalities



How many people has lost their lives

Countries

Japan

Due to subduction of Philippine sea plate under Okinawa and Amurian plate, Japan is one of the high risk areas of earthquakes

Turkey

Lies in the seismic zone created between Arabian, Eurasian and African plates
Earthquakes can be expected anytime in Turkey
In 1999 due to suffering from an earthquake 5 million people were rendered homeless

Nepal

Nepal has high fatality per inhabitant in earthquake scenarios

India

Although not every part of India is prone to it, movement of the Indian tectonic plate has resulted in earthquakes that lead to thousands of lives lost in the last 20 years

Philippines

Lying on the edge of the Pacific plate, high magnitude earthquakes had led to volcanic eruptions in Philippines

Indonesia

Indonesia has suffered from other natural disasters in the past addition to the earthquakes

Ecuador

With the several active volcanos, Ecuador is also one of the high risk places
Placed between the South American plate and the Nazca plate



Immediate Effects

Building Destruction

Most common effect of the earthquake would be the building damage it does, and the mass casualty that will follow

Road Destruction

Damage to bridges, overpasses and highways
Holes also occur on the streets due to the damage in sewage systems

Landslide / Mudslide

Earthquakes can trigger landslide which can damage nearby homes and the roads along the hills
Landslide is especially dangerous to remote villages placed in harsh terrain

In addition avalanche can also be caused by seismic activity

Risks

Aftershock

Weaker waves of earthquakes can follow after the main wave, this can damage already weakened building and may result in the collapse of them
Aftershocks can last for days and may prevent people from going back to their homes

Weakened Buildings

Many buildings will be weakened to a point that it is not safe for residing,
It is often that people are rendered homeless due to weakened buildings than collapsed ones
Weakened buildings may collapse on their own, even days after the main incident

Flood

Distruption of the rainwater disposal system may result in floods

Disease

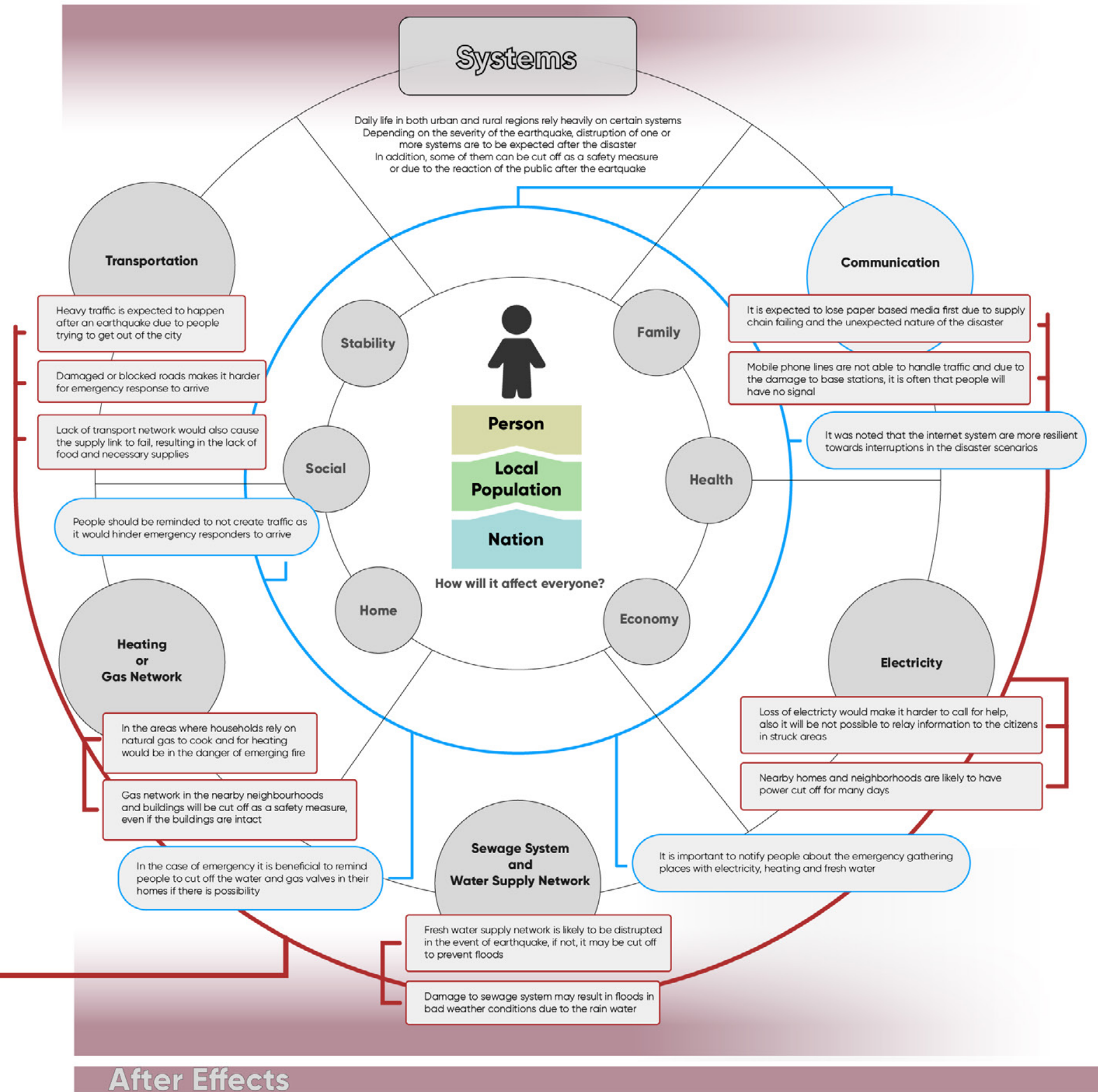
Lack of access to fresh water can lead to spread of diseases

Preparation

Risk Factor

Disaster





Community

People in safe neighboring areas

They can be the first supply of food and shelter for the people in struck areas until the emergency aid system is sustained.

Shops, hotels, malls

Can be used as spots of gathering to have access to food, sanitation, shelter and information.

People in other cities

Many will offer their helps for the disaster victims, immediate and effective utilization of a donation system is needed.

Risks

People will try to help, and spread the information

This may result in unwanted side effects

Misinformation about the gathering areas

Misinformation on help phonelines

Due to lack of information overcrowding of some gathering areas, and less utilization of other areas

Redundant reports of missing people, even after they are found

Unrelated or fake donation accounts

Needs

Food and Supplies

Rationing, transportation and distribution of food and supplies are mostly handled by the municipalities and the government.

Health Service

Including the urban search and rescue teams, emergency health service is needed immediate in struck areas.

Blood

It was noted that in many cases there were immediate need of blood donations.

Shelter

Emergency shelter solutions, tents, may not be available at immediate disposal, or at the quantities that are needed.

Missing People

People will be in need to report their missing family members and friends if they were in a collapsed building or unreachable.

Why Communication?

There is a great design potential in communication network, as it responds both to the victims and to the people that offer help.

An effective design of a communication system;

Can reduce the disaster impact on the victims

Fight misinformation

Keeps the victims in the loop from the earliest moment of the disaster and keeps the others updated

Can help to set up an alternative supply chain between the citizens

Recovery

Cooperation



Recovery of a region after an earthquake takes months to years. Disaster is only the beginning of a long recovery process.

Example Cases

These cases are picked and matched with the actors from the initial actor map (page 32-33), to see the examples of how different actors can utilize their sources to provide help. English translation of the tweets were used in these pictures.

Translated from Turkish by Google

Our charitable compatriots who want to send "Standard Aid Package" and "New Blanket" to our brothers and sisters in the earthquake in İZMİR; You can deliver your aid to Çarşamba Municipality and reach those in need through AFAD.

#izmir
#deprem
#İzmirinYanındayız

Municipality of Carsamba is collecting food boxes and blankets from individuals that want to donate, and then boxes are handed over to AFAD to distribute.

It is beneficial to note that this is not a monetary donation, donations are made by supplying food and blankets themselves.



İZMİR'deki Depremzede Kardeşlerimize, Standart Yardım Kolisi ve Yeni Battaniye Göndermek İsteyen Hayırsever Hemşerilerimiz;

Yardımlarınızı Çarşamba Belediyesi'ne Teslim Ederek **AFAD** Aracılığıyla İhtiyaç Sahiplerine Ulaştırabilirsiniz.

İrtibat No
444 90 55

GIDA KOLISI İÇERİĞİ			
AYÇİÇEĞİ	5 LT	FASULYE	2,5 KG
ÇAY	2 KG	MERCİMEK	2,5 KG
ŞEKER	5 KG	UN	1 KG
PIRİNÇ	5 KG	SALÇA	0,83 KG
BULGUR	3 KG	TUZ	0,5 KG

Halit Doğan
ÇARŞAMBA BELEDİYE BAŞKANI

8:33 PM · Nov 1, 2020 · Twitter for iPhone

Translated from Turkish by Google

Occurring in İzmir #deprem In-kind aid campaign has been initiated throughout our city to be distributed to the disaster victims.

One type of standard food parcel and unused blanket will be accepted.

Contact for our charitable citizens who want to donate

İZMİR İLİMİZDEKİ DEPREMZEDELER İÇİN AYNİ YARDIM KAMPANYASI

İzmir ilimizde meydana gelen deprem nedeniyle afetzedelere dağıtmak üzere ayni yardım kampanyası başlatılmış olup; aşağıda belirtilen tek tip standart gıda kolisi ve kullanılmamış battaniye kabul edilecektir. Bağışta bulunmak isteyen hayırsever vatandaşlarımız ile kurum ve kuruluşlarımızın İl/İlçe Sosyal Yardımlaşma ve Dayanışma Vakıflarımıza başvurmaları veya vakıflarımızın aşağıdaki tablodaki telefon numaraları ile iletişime geçmeleri rica olunur. Kamuya sızgı ile duyurulur.

BAĞIŞIN TESLİM EDİLECEĞİ SOSYAL YARDIMLAŞMA VE DAYANIŞMA VAKFI		GIDA KOLISI İÇERİĞİ	
İL BAŞKANLIĞI	0262 188 62 67	MALZEME TÜRÜ	MİKTAR
KARAKÖPRÜ	0237 213 28 13	Pirinç	5 Kg
HALIÇE	0263 014 84 88	Bulgur	2,5 Kg
EYYUBİYE	0243 766 53 57	Kuru Fasulye	2,5 Kg
AKÇAKALE	0242 223 93 22	Mercimek	2,5 Kg
HARBAN	0243 368 38 60	Ayçiçek Yağı	5 Litre
CEYLANPINAR	0262 397 40 29	Domates Salçası	800 Gram
VIRANŞEHİR	0232 763 64 13	Şeker	5 Kg
HILMAN	0243 590 75 73	Tuz	500 Gram
SİVRİNE	0267 352 52 82	Un	1 Kg
BOZDOVA	0243 968 08 08	Çay (Yerk)	2 Kg
BİRLİK	0239 114 52 30		
SURUÇ	0242 528 04 54		
HALPETİ	0243 548 04 94		

9:33 PM · Oct 31, 2020 · Twitter for iPhone

City governorship is collecting food boxes and blankets from the people, and then connecting them to other nationwide volunteer organizations.



Translated from Turkish by Google

On the application of thousands of people who want to deliver aid to earthquake victims bizizmir.com We started a solidarity campaign through the People's Bakka. #BizVarız Those who want to deliver food, food, hygiene packages and sleeping bags can apply here.

#BizVarız İYİLİK NOKTASI

Sıcak Yemek, Gıda Paketi, Hijyen Paketi ve Uyku Tulumu yardımları için

Bizizmir.com

İZMİR BÜYÜKŞEHİR BELEDİYESİ

7:54 AM · Nov 2, 2020 · Twitter for iPhone



Semi-Structured Interviews

After deciding on the two historical earthquakes that happened in Turkey, I started looking for people to interview. Initial idea was to reach out to multiple people that has been in the earthquake scenario, I was more concerned about finding out the needs of the victims.

I have reached out to people through the alumni groups of my bachelor university, this lead me to a designer alumni of my former school, who is currently working in Izmir, with their referral I got in touch with a person who witnessed the Izmir earthquake.

Another attendant was a person who lives in a city near the coast of Black sea, they were around 100km east of the 1999 Izmit earthquake epicenter when the earthquake happened.

I have chosen to make a semi-structured interview. The goal of a semi-structured interview is to gather information about a set of central topics, and also allow new topics to emerge. (Wilson,2014). I have prepared an interview guide for myself, consisting of different questions to lead the interview and also help the participants with the chronological order of what events happened during the disaster day.

Interviews were done through audio-calls over the internet, and participants were given the link of a digital white-board, it had the gigamap and sticky notes.

Interviews were not recorded digitally, I took notes during the interview and constructed the interview reports from my own notes.

Interview Guide

Intro:

Introduction of the purpose of this interview, and the topic.

Purpose is to have an understanding of the disaster scenario, which actors the participants interact with, and the order or priorities they had in their mind.

Topic is 1999 Izmit earthquake and the 2020 Aegean Sea earthquake, one for each participant.

Set questions:

From the beginning of the event,

Where were you, what were you doing?

What was the first thing you did?

How many people were you?

After the main shock,

How and when you received the first information about the earthquake? (From which actor, and with what medium (radio, TV, etc,)?)

What kind of help was provided, from whom?

Which facilities (power, water, phone, light) were inaccessible for you, for how long?

Interview: Participant A

My participant was a civil engineer from Turkey, born in 1943. Although being a 78 year old retired man, he is actively working as a safety specialist in a construction zone. He speaks Turkish, English, German, and French. Interview was done in Turkish, gigamap was in English.

Interview started with a video call, I sent the link for the digital white-board, Miro, and his daughter helped to set it up so his screen can follow my screen. White-board included a copy of my gigamap. Later in the interview we switched to an audio-only call, because of the bandwidth problems with the internet.

Topic is August 17th 1999 Izmit Earthquake. He was in a city near the Black sea coast, around 100km away from the earthquake epicenter.

Where were you, what were you doing?

-I woke up in the middle of the night (03:00) by the earthquake, the bed was shaking and there was the noise of stuff shaking in the drawers of my cupboard. Rechargeable torch was on, so I knew the electricity was out.

Note: It was common household item in Turkey back then to have a rechargeable torch always connected to the power outlet, when the power goes down, the torch lights up. People usually had multiple of these devices at their homes.

What was the first thing you did? How many people were you?

-I woke my wife and the kids and told them to get ready to head out. While we were heading out I looked for cracks in the walls, cracks or bends in the posts or beams of the house. I didn't notice any signs that will make our building collapse but we rushed out after all. Damage in beams are what makes a building collapse, I am a cold blooded person, I don't panic.

-At that time we knew that an earthquake happened but we had no information about where it happened, from my perspective we might be the only ones that were affected. I haven't seen any earthquake before in my life, I have heard that it happened in other cities years ago but that is it.

Actually, that earthquake was one of the deadliest ones that Turkey has faced. He continued his explanation of events.

-While we were waiting in the street, it was all dark and there were crowds of people. I saw my son in laws running towards us, they used to live close by. Earthquake was still going on, waves after waves and there was panic brewing. I thought these might be a foreshock and a big one is coming. I took everyone with me and we started walking to the sea side. People from our apartment started following us. I took everyone to a construction site that I was working on at that time, it was a port near the sea for trucks, very open and flat space.

How and when you received the first information about the earthquake?

-There were many people in the port, slowly gathering, we saw some people brought their cars in there. We gathered around the car to listen to the radio. Broadcast said there has been an earthquake around Izmit, and then the radio was cut off. People were saying some of the electric poles were bent and power lines were snapped.

What kind of help was provided, from whom?

-A few hours later, towards the morning a police car came by to check on us. People were asking about affected areas, wondering if their relatives are safe or not. Police were relaying their questions from the police radio, asking about remote villages and nearby areas of the disaster site. I remember the guys voice in the other side of the radio, he was almost crying, said that some areas were almost wiped out, none of the buildings were standing. We haven't heard anything more. After shocks was still coming, some people were on the ground with blankets.

Which facilities were inaccessible for you, for how long?

-Everything, the power was off, people had cellphones but the coverage was basically none. We walked back and got my car, we drove out of town in one of our relatives house, it was a single house with a back-garden. The power was still off, I tried using the landline phone but it was off as well. But we used propane tanks to cook back then, there was no main gas lines to be shut down so cooking was possible, even outside.

Note: landline phones do not require electricity in the house to function, it was possible to call, that was the reason he attempted to use the phone.

-We had power for a while in the second day, we were taking turns with going in the house and bringing some of the stuff outside. We turned on the TV and there were terrifying news about the disaster site. Later that day I was inside the building and an aftershock happened, it was stronger than the initial one we felt. I had trouble getting out of the building. Then the power, radio and everything was cut again. We spent the next three days sleeping outside. Aftershocks didn't stop for a week, every time we debated on going inside the home or not, we were hit by an aftershock.

Interview continued on what type of information that he wished he was able to get, and what kinds of needs they had during the time.

-None of the shops were open, we needed supplies but there was no way to get them. There were police cars everywhere, they patrolled day and night, and most of the help you get was from other people, or you would ask police to bring something. People were sharing blankets, water, also things like batteries and such, if someone receives signal in their cellphone, they would call people in other cities and get as much information they can. We were mostly interested in the well being of the people we know, we were able to only make guesses on if they were safe or not.

-I would help other people if I could, we returned home but many were homeless, people took other people in their homes. Donations went on for weeks, rest of the information we got was from the newspapers. I think it was luck that it happened in summer, and it was possible to sleep outside.

Interview: Participant B

Second participant was an aqua culture engineer, born in 1994. He is a certified rescue diver, part of the volunteered search and rescue organization in Turkey, also a member of PADI (Professional Association of Diving Instructors). He speaks Turkish and English. Interview was done in Turkish, gigamap was in English.

Interview was held through an audio-call, he opened the link of the digital white-board and joined.

The topic is 30th of October 2020 Aegean Sea earthquake. He was in Izmir when it happened, in the center of the most damaged city.

Where were you, what you were doing?

-I was in the office, in a meeting when the earthquake hit.

What was the first thing you did?

How many people were you?

-When we first felt the initial shake my boss started yelling, 'everyone out'. It didn't even take a second, the door of the meeting room were making cracking sounds and everything was shaking side to side. It was noticeably hard walking down the stairs, I just jumped from the whole staircase, even walking was difficult.

-It was a chaos, we evacuated the building, people from the whole office and the nearby buildings were on the street. Almost immediately I heard the sounds of sirens, I am not sure what it was.

How and when you received the first information about the earthquake?

-I didn't. Everything was shut down in an instant. I tried to call my girlfriend, there was phone signal but it wasn't connecting. She lives in the top floor, around a kilometer away from my work. I started running there, reached her apartment and started yelling for her. I found my girlfriend and we walked towards a more open area.

But how did you find her?

-Instincts I think, I just assumed that she would wait around the backyard and there she was, with people from the same apartment.

-We walked away from the center to find a more open place, like a park. She was able to reach to her parents through the phone. Around the same time I got a message from my work, our other office building was damaged and half of it has collapsed. We had an animal hospital there. I left my girlfriend with her parents and started walking to the other office.

Were you able to get any information from the government officials?

-None, at that time the streets were packed with people and it was really hard to get any reception. I only managed to receive that text message. I learned later that during this whole incident, people were calling me non-stop, hours on end, especially my parents.

When was the first time you saw someone in charge?

-Later around our other office.

-When I reached the other office, half of the building was on the ground, I could see the individual floors like a card stack on top of each other. That was actually a joined building, earthquake decoupled the other half and that half has collapsed. My boss and some colleagues were there, they had a car to transport the animals we had inside. We entered the main building, the walls were buckled and were full of cracks. We saw some personnel from AFAD arrive later, it was the first time I heard about the earthquake from an official. Apparently the damage was big and there were multiple collapsed buildings.

What kind of help was provided, from whom?

-It is called AFAD, that coordinates the emergency response, they also work with teams of volunteered rescue staff, I belong in one of them. I mainly do rescue diving however. They call for our assist when someone is missing for example. I was around the collapsed building until midnight, then I talked with the organization and they sent me to help with logistics for two other collapsed buildings.

Which facilities were inaccessible for you, for how long?

-There was no power. Water and gas lines were cut. We use natural gas in Izmir for heating and cooking. We had reception almost all the time but none of the calls were going through, text message works and if you can manage to refresh a page in your phone you can receive internet texts as well, but there were no Wi-Fi of course. It took around two or three days until the phones were working normally.

-I was outside until the morning, helping in the disaster area. We take turns in working, when you are done someone else takes over. Rescue attempts are also done in turns. We try to clear the area from the bystanders. We cleared the whole street that night, everyone was keeping silent, so the rescue team can hear peoples voice under the collapsed building. We dug out many people. Sometimes we need to run generators so we can charge the batteries for the flood lights, when we turn on the generators we also dig and break some of the rubble with construction machines. Then, it is silence again.

How do you think people can help?

-They need to evacuate, and keep their distance, that is the most important thing. I wouldn't ask for more than this. It is nice to remember to turn off the main valves (of gas and water) if possible before evacuation.

What kind of information would be the most valuable for you?

-Safety of my family, this is the first thing I can think of. The rest is just where to go and what to do.

-Military is also called for help in this kind of events, because almost all the military personnel actually comes from other cities, so they do not have to worry about their own families when they are on the field.

Later he explained more about the legal responsibility difference between AFAD, and the other volunteer organizations, who can be held accountable if things go wrong for example. Interview ended.

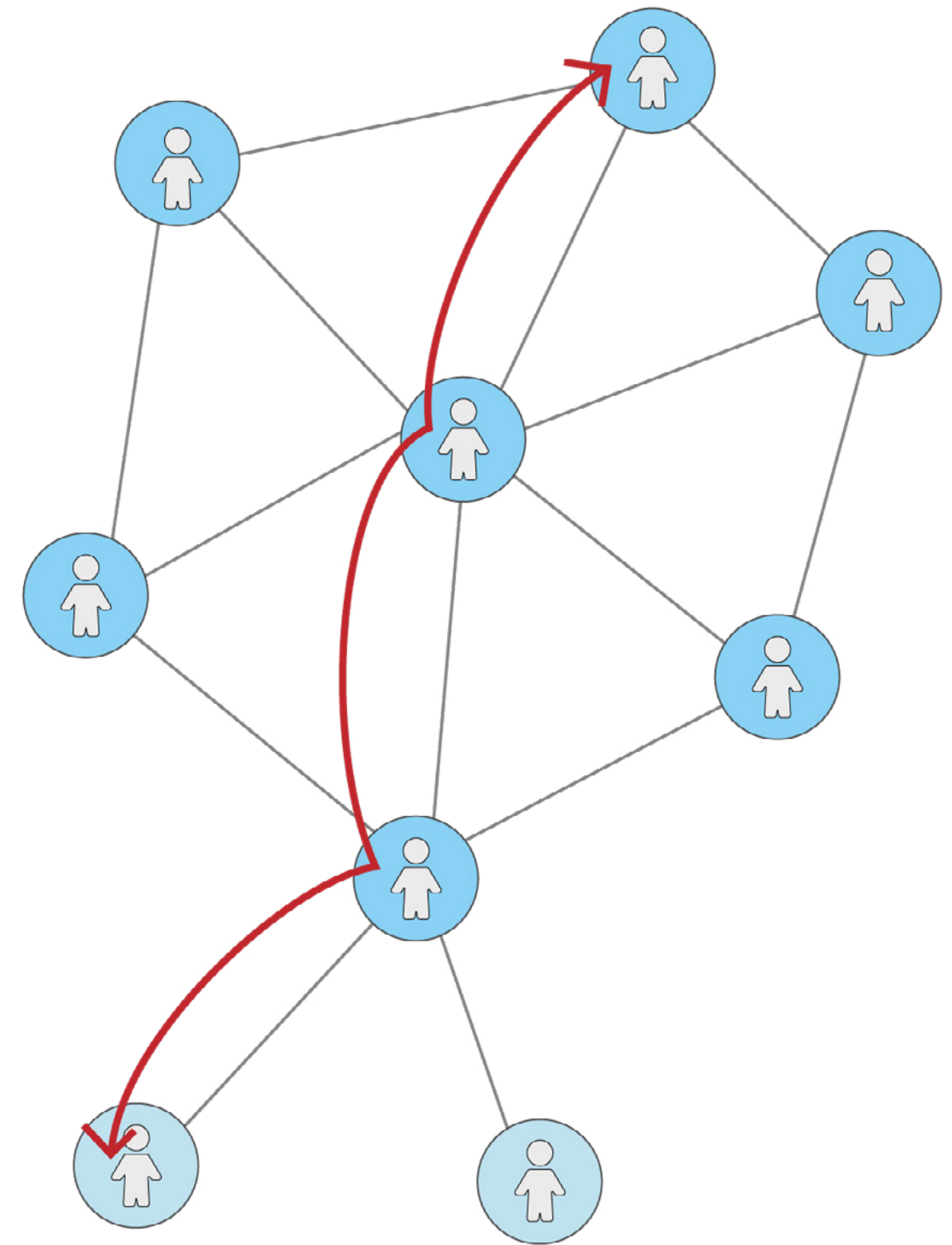
Initial Ideas

After the interviews, two concepts of solutions were proposed. These were aimed at restoring part of the communication network in the disaster area, also answering to some of the needs the interview applicants has stated.

More research were done on alternative network solutions, to see if some of the design proposals are feasible or not.

Peer-to-Peer Mobile Communication

P2P mobile communication is nothing new. In many protests around the world, people utilize local chat apps to communicate without the need of internet. It uses wifi direct and bluetooth to create mobile communication network and does not require internet access or reception to function. (Dennis, 2016).



When there are enough people in the mesh, one person can talk with another user even if they are not close enough to use wifi or bluetooth signal, it is possible to relay the message using other devices in the network.

Thread / Wireless Mesh Network

"Thread is primarily a mesh networking protocol. Each "node" (or product) in the network can act as a router, leader or end device. These then connect to a border router to get the data onto the network from and to the internet." (Patel, 2016).

Thread is designed to be used in homes, where devices can share the access of the internet between themselves and "carry" it towards an end product that does not have direct access to the internet itself.

I used these network technologies as a reference while coming up with the first ideas. These ideas were not finalized solutions as they were going to be used to emerge discussion in the feedback sessions.

Idea 1

A low energy consuming device that creates a peer to peer network, and receives signals from specific actors. This will be used to relay warning signals from the government, to the people in the disaster area. Aim is to make sure people have access to the right information. This can also be tracked by the EMS teams. Or a possible migration of the same concept on mobile phone level.

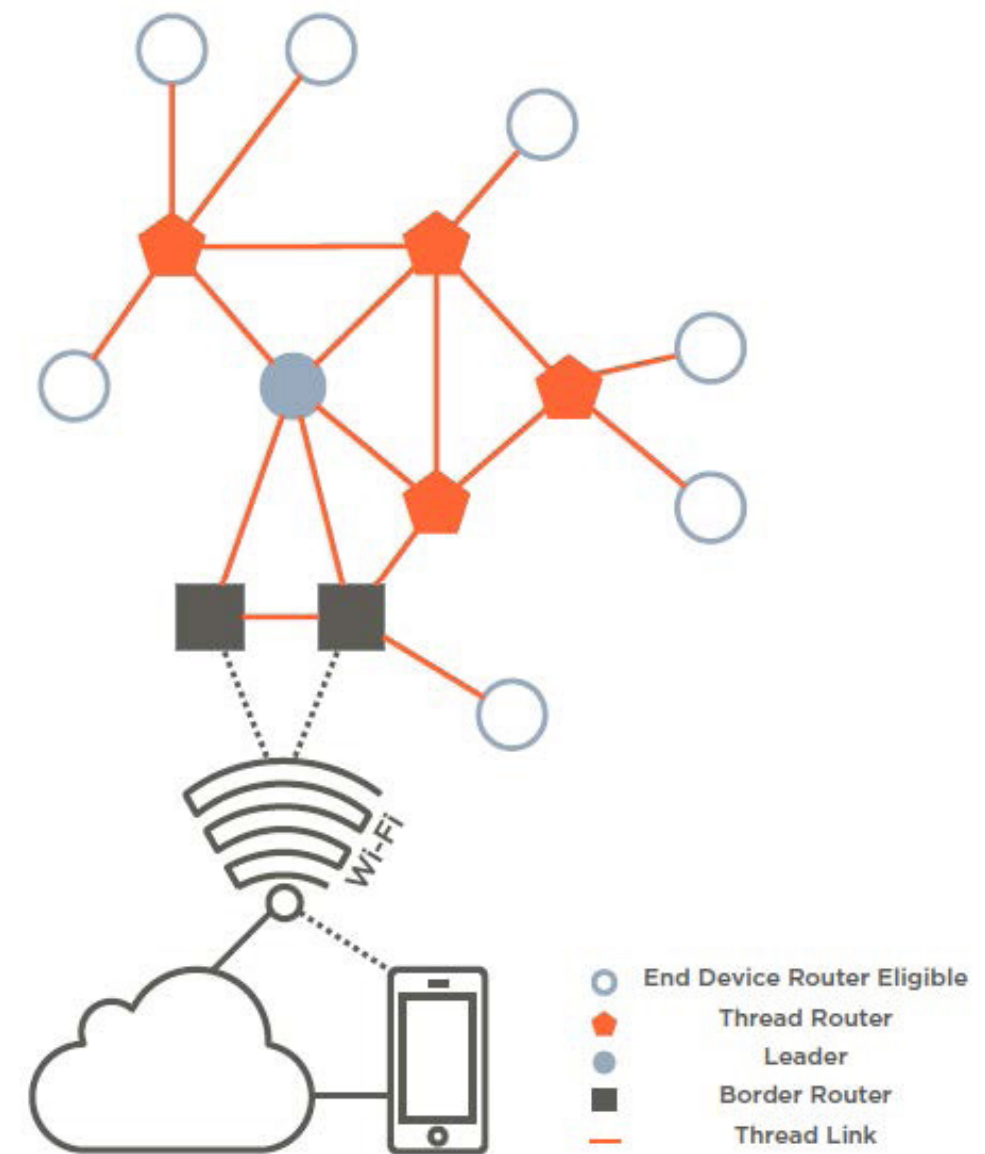


Figure.8

Idea 2

Access points to internet that are placed by the emergency response teams in order to help with the network outage. These can be bundled with generators as well. Aim is to keep as more people as possible in the loop.

Feedback: Participant A

Same setting as before, white-board is open in the background, audio-call was made.

I explained some of the technology that makes it possible to sustain a new communication network, and asked about what kind of features that they would like to see in these solutions. Also what do they think about the usability of it.

Idea of having to carry, or rely on a separate device was taken negative. Idea of making the emergency response teams set up additional devices didn't get much of his attention.

"I don't even know if I have first-aid kit in my car. I don't think I will ever remember to carry a gadget, even if it is on my key-chain. They say that we need to have prepared emergency bags in our homes, in case of an earthquake. I don't think most people even have them, let alone a gadget."

"Anything that takes batteries, will be a problem since if people have batteries available, they would rather put it in a torch."

"Learning is a problem for most of the people with new devices"

"We don't get earthquakes every year you know, it might get forgotten over the years. These things are only popular when an earthquake happens."

"I would like to just use my phone"

What would be the features you want, lets say your phone is working?

"I only need to know if people I know are safe or not, that is the most important thing. Last year my friends marked themselves safe when the Izmir earthquake happened, I saw it on Facebook, I want that."

"It is nice if they can text me, I will read, but I always call instead of texting"

"I would like to know where to go, where is it safe, also if my daughter is taken in an hospital, I would like to know where she is."

If you could contact emergency response, what would you report?

"You can report collapsed buildings, missing people, or injured people."

"I would like to report my medication, if I have left it at home, where can I get it"

"There is more that could be done, if I am away from disaster to begin with, I would like to know how I can help."

Feedback: Participant B

Same setting as before, white-board is open in the background, audio-call was made.

He took the point of view of the emergency responders and gave feedback on how they would perceive the kind of solution I am proposing.

"An external device suggests that it will be packed with the emergency preparedness bag, right?, The problem is I was at work then the earthquake happened, any earthquake that happens in day time is going to catch people at work."

"Providing alternative network access is a great idea, but it shouldn't come at a cost of making us carry those things around. Just merge it with the mobile phones and lets start from there."

I gave some examples of the features from the former feedback session.

"People marking themselves safe is a good idea, but don't show where they are to each other in a map. We don't want people running around trying to find each other."

"I also would like to override other marks etc. As responders we should have access to a different dashboard for example."

"They have their own dispatchers in AFAD, this can be a part of it"

"I would like to mark new gathering places and relay it as a broadcast to everyone."

If you could request stuff from other people, what would those be?

"Tools or vehicles can be requested, if I can make local broadcasts for example I can call for a nearby person that has a pickup truck."

Are there any problems you had before with the old system, that can be solved with this?

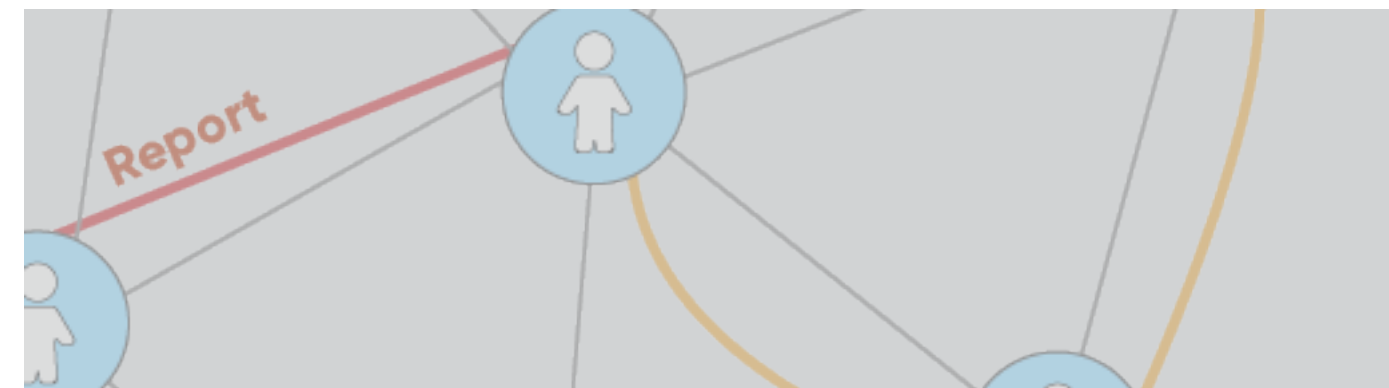
"Redundant information is a problem, we get multiple reports of the same person over and over."

"If person A reports person B as missing, is it possible to send message to every contact of person B, so maybe they have seen B?"

"They can report collapsed buildings, so we won't get same report again. They can see that it has been already reported."

The Product

About
Network
The Product
Conclusion

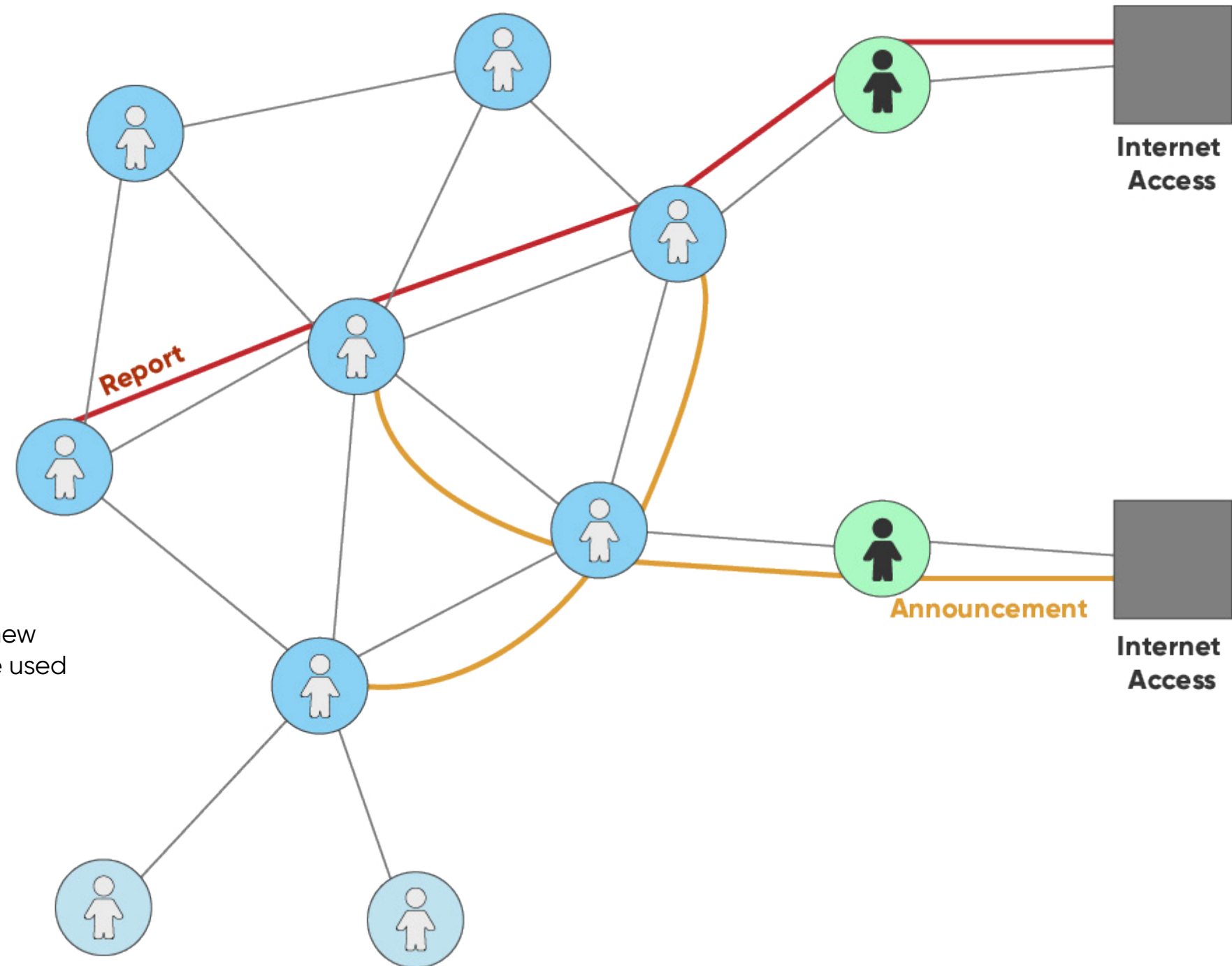


About

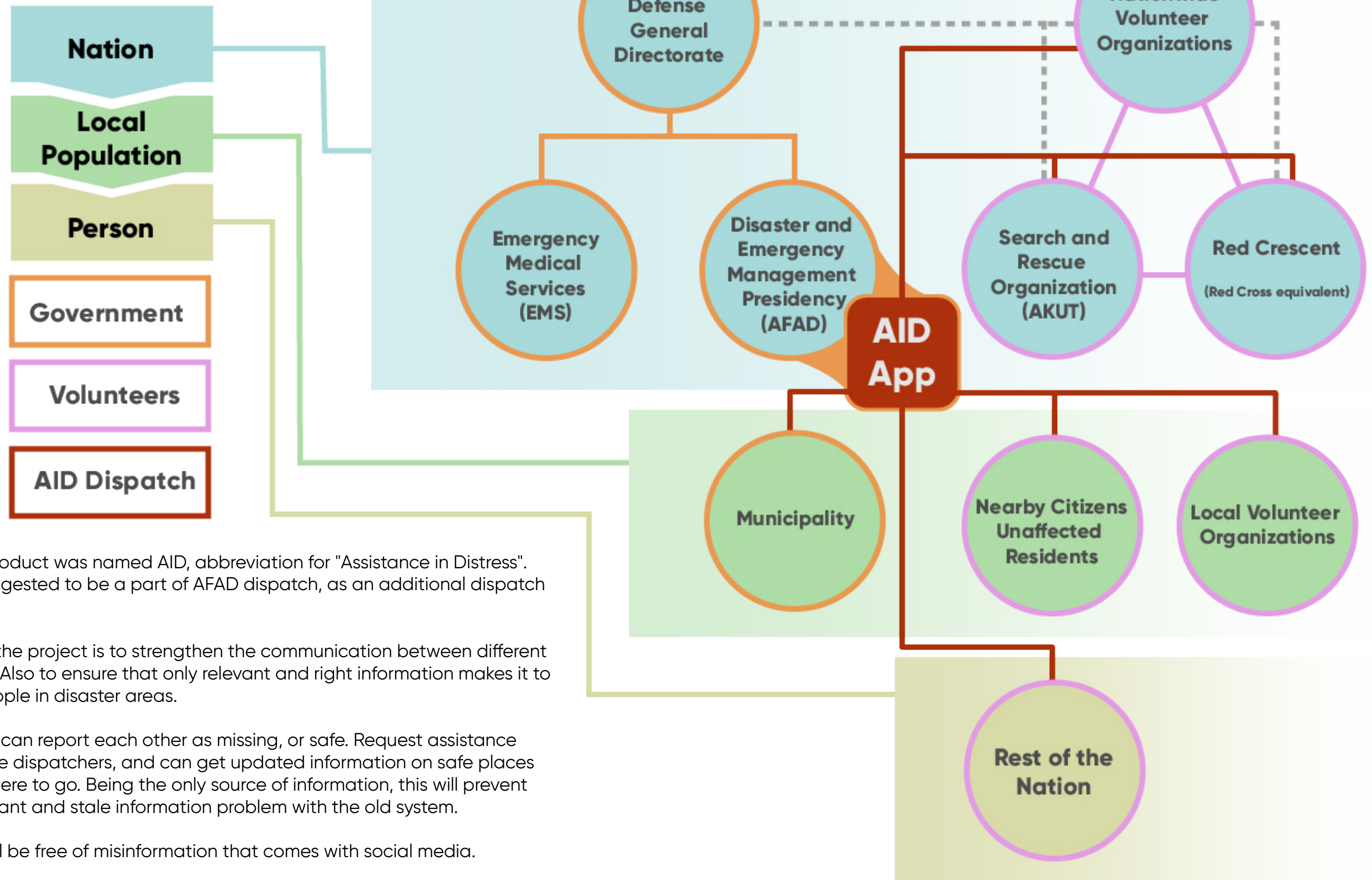
After the feedback sessions, design phase of the final product began. Looking at the system from the eyes of the different actors, I have decided to propose a solution, in the form of a mobile app, backed by a mesh network technology.

Network

I have combined the former network methods from my research and proposed a new one. Where people with internet access can fetch new information and pass it to everyone in the network. They can also be used to pass the reports to the government.



The Product / AID

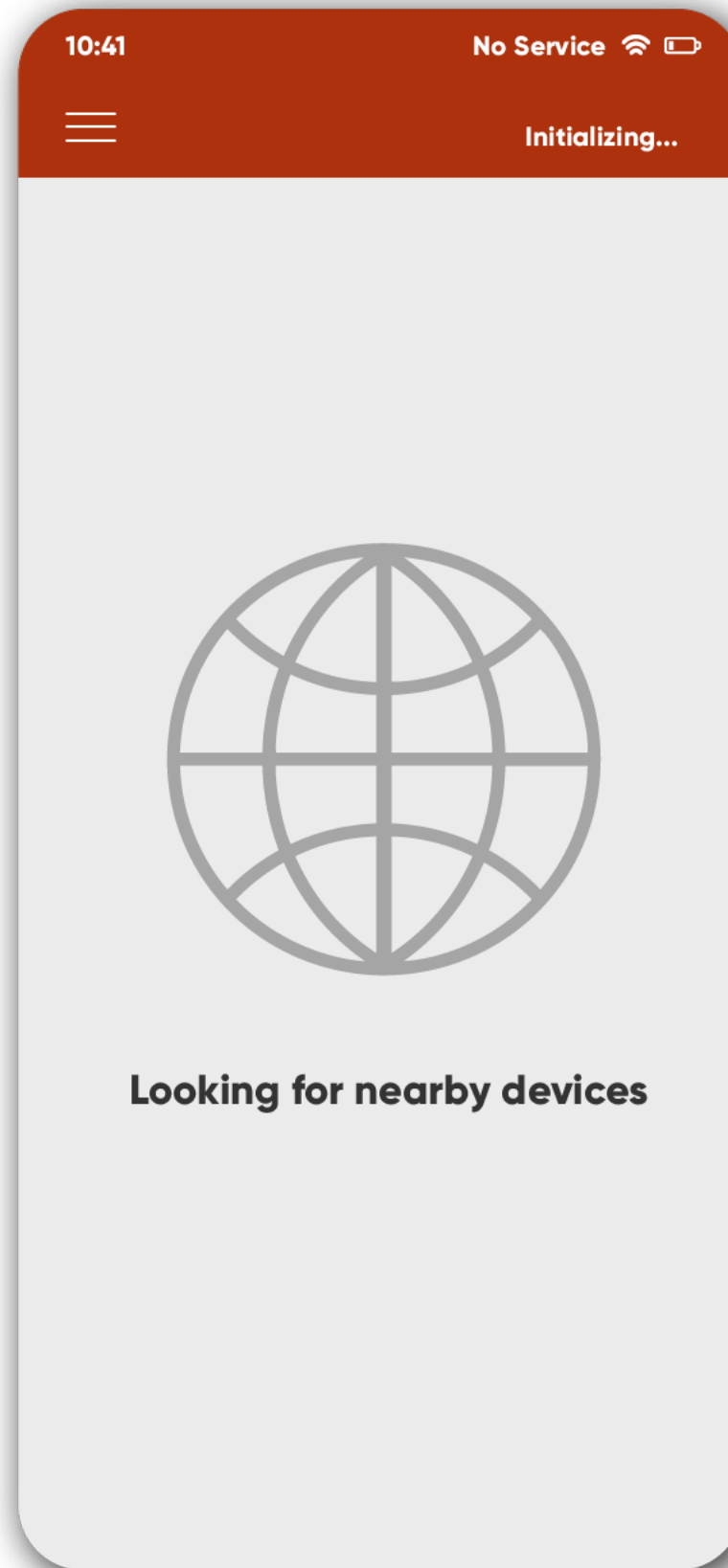
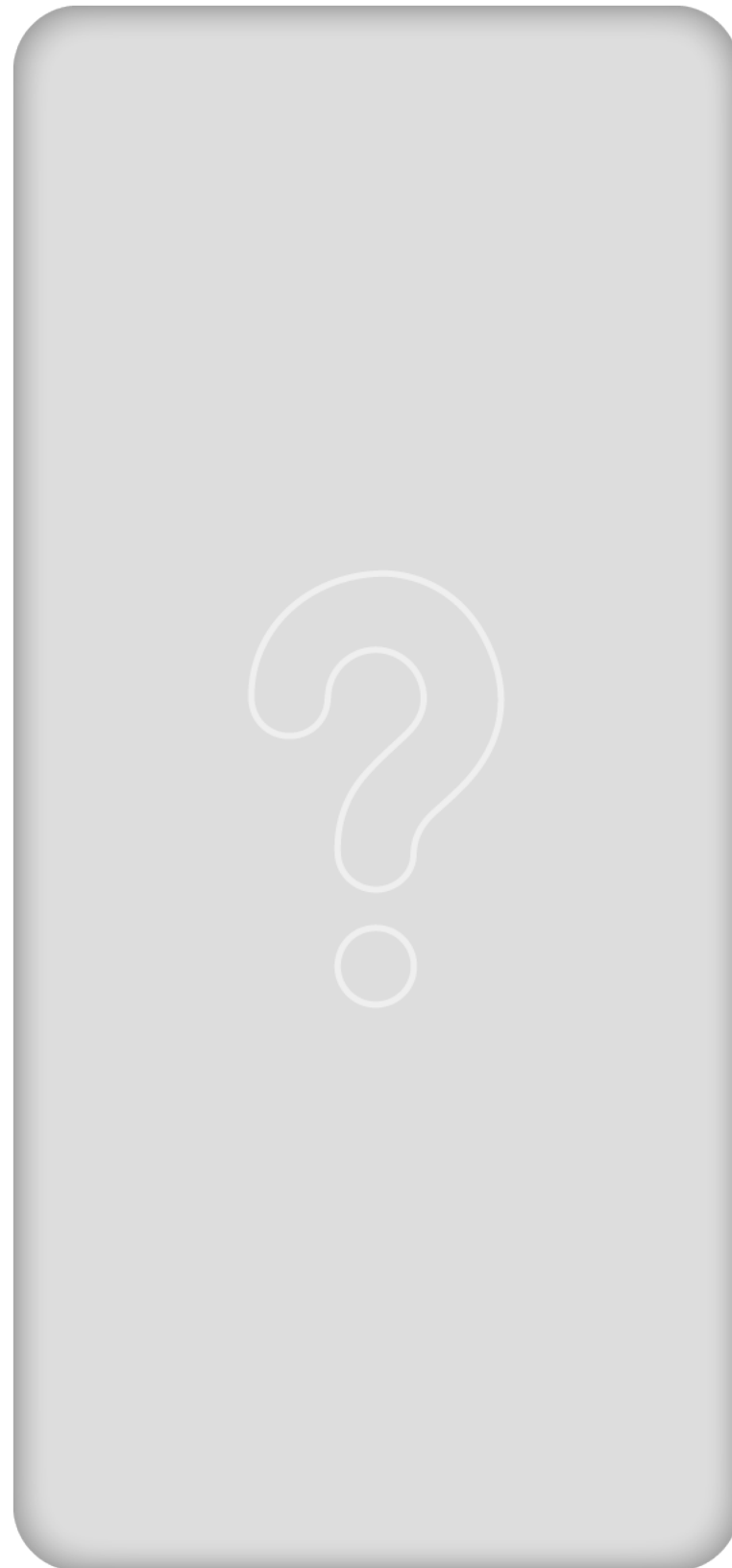


Final product was named AID, abbreviation for "Assistance in Distress". It is suggested to be a part of AFAD dispatch, as an additional dispatch center.

Aim of the project is to strengthen the communication between different actors. Also to ensure that only relevant and right information makes it to the people in disaster areas.

People can report each other as missing, or safe. Request assistance from the dispatchers, and can get updated information on safe places and where to go. Being the only source of information, this will prevent redundant and stale information problem with the old system.

Also will be free of misinformation that comes with social media.



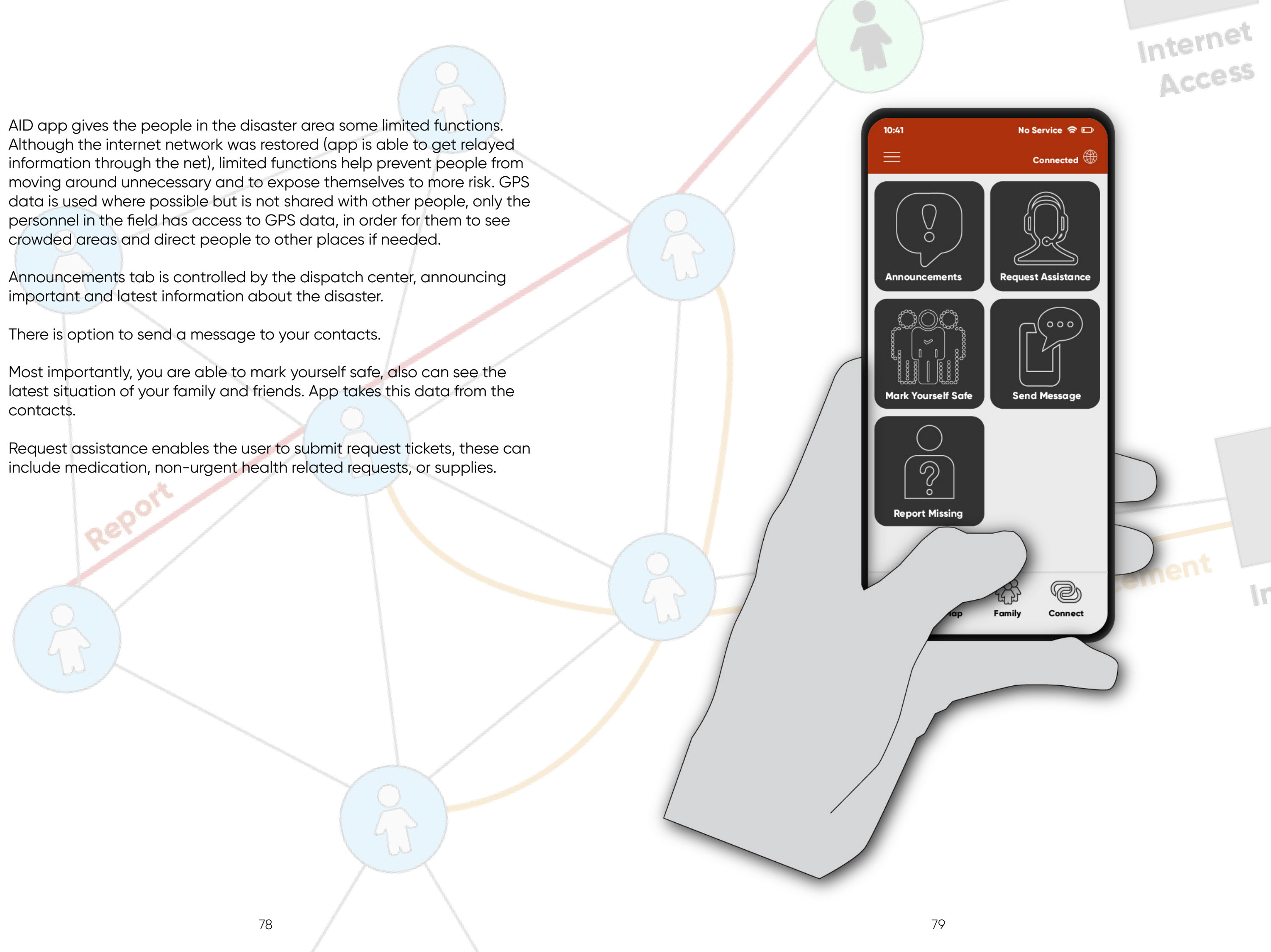
AID app gives the people in the disaster area some limited functions. Although the internet network was restored (app is able to get relayed information through the net), limited functions help prevent people from moving around unnecessary and to expose themselves to more risk. GPS data is used where possible but is not shared with other people, only the personnel in the field has access to GPS data, in order for them to see crowded areas and direct people to other places if needed.

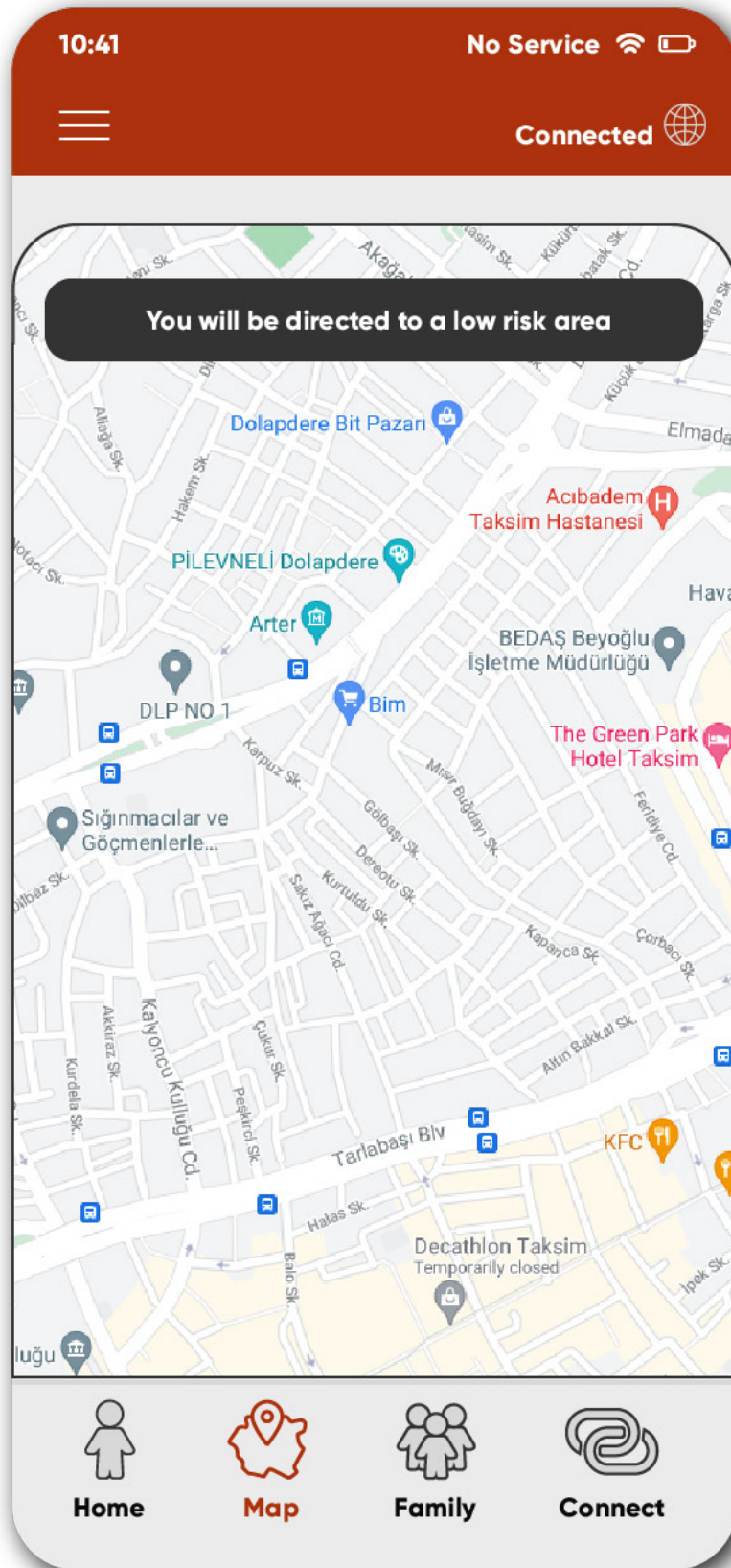
Announcements tab is controlled by the dispatch center, announcing important and latest information about the disaster.

There is option to send a message to your contacts.

Most importantly, you are able to mark yourself safe, also can see the latest situation of your family and friends. App takes this data from the contacts.

Request assistance enables the user to submit request tickets, these can include medication, non-urgent health related requests, or supplies.



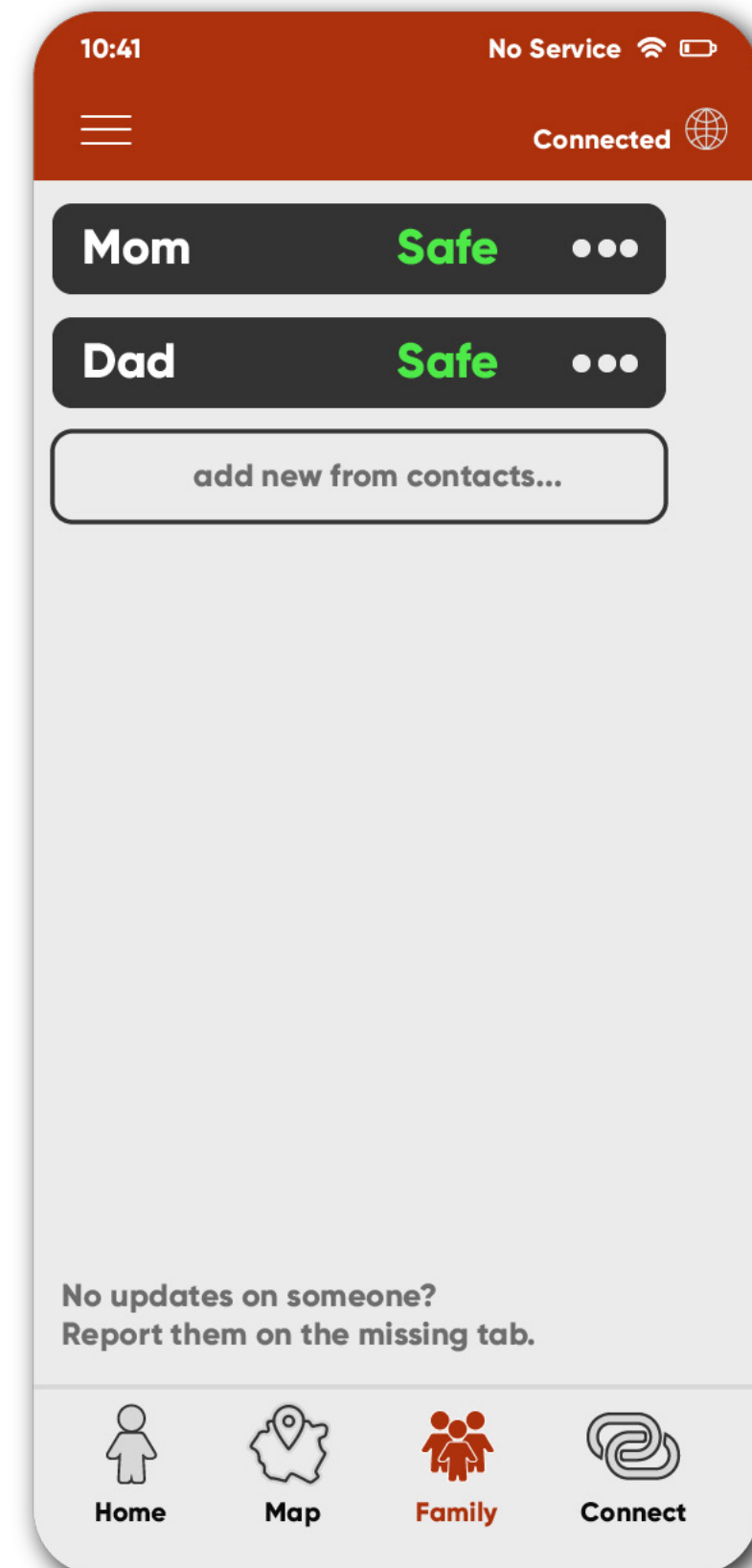


Conclusion

This project, or rather this design journey, started with the research question of how to achieve a self-sustained communication network in the case of a natural disaster. Initial part of the project was looking at the disaster scenario from a systems perspective. The concern and focus was on the existing systems and how to make them better, how to replace them if they were lost.

Project took a different turn during the design journey and for the better I feel. Interviews I made, people I talked to and their stories affected me. I started looking through the eyes of the actors, their selfish interests and agencies. I have noticed no system is sustained or kept alive by itself, the solution I was looking for was somewhere between all these different actors.

This product is not a solution to everything. It is not the final, one and only result of this project. The product is just a statement, pointing out the problems of the existing system and motivating us to dig deeper, to search for improvement.



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Figure.2: https://prd-wret.s3.us-west-2.amazonaws.com/assets/palladium/production/s3fs-public/styles/full_width/public/thumbnails/image/eq-ed-plates.gif

Figure.3: Bulut, F., et al. (2019). "Magnitudes of future large earthquakes near Istanbul quantified from 1500 years of historical earthquakes, present-day microseismicity and GPS slip rates." *Tectonophysics* 764: 77-87.

Figure.4: https://cloud-storage.globalquakemodel.org/public/Global%20Maps/GEM_Global_Risk_Map_v2018.1-CCBY.pdf

Figure.5: https://cloud-storage.globalquakemodel.org/public/Global%20Maps/GEM_Global_Risk_Map_v2018.1-CCBY.pdf

Figure.6: https://cloud-storage.globalquakemodel.org/public/Global%20Maps/GEM_Global_Risk_Map_v2018.1-CCBY.pdf

Figure.7: https://cloud-storage.globalquakemodel.org/public/Global%20Maps/GEM_Global_Risk_Map_v2018.1-CCBY.pdf

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