



DISASTER-RESILIENT COMMUNICATIONS

A Research by the Ateneo Innovation Center
Slides c/o Rosiel Villareal and Al Francis Bontogon

OUTLINE



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Disaster Situation
in the Philippines



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Technologies for
Disaster Resilient Communications



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AIC Projects and
Researches



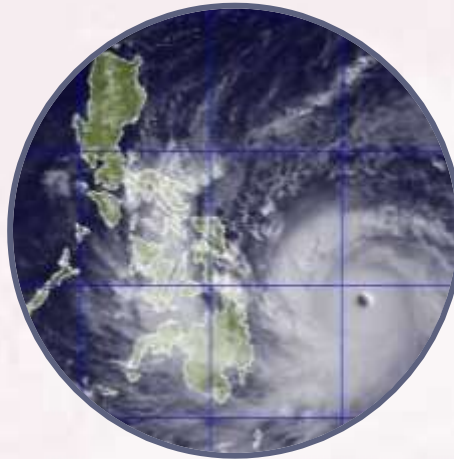
DISASTER SITUATION IN THE PHILIPPINES

DISASTER SITUATION IN THE PHILIPPINES



3RD OUT OF 171

in the 2017 World Risk Report of being struck by natural disasters



AVERAGE OF 20

typhoons hit the country every year



22 OUT OF 220

active volcanoes;
within the Pacific Ring of Fire, where 80% of the world's earthquakes occur



INFRASTRUCTURE DAMAGE



DISPLACED POPULATION



FOOD SCARCITY



LOSS OF LIVES

IMPACT OF DISASTERS IN THE PHILIPPINES



EMOTIONAL TRAUMA

ALL OF THESE WOULD BE EASIER TO ATTEND TO IF WE DIDN'T HAVE...

In the aftermath of a disaster, not all cellular sites fully operate. However, effective communication among first responders is necessary to immediately attend to people requesting for food, medicine, and other supplies.

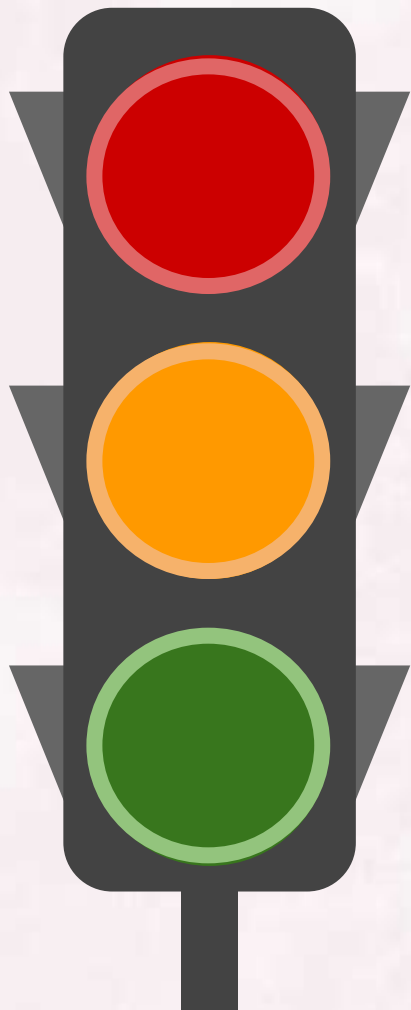
Developing disaster-resilient communications then becomes of urgent priority.



DISRUPTED COMMUNICATIONS



TECHNOLOGIES FOR DISASTER-RESILIENT COMMUNICATIONS



TECHNOLOGIES FOR DISASTER-RESILIENT COMMUNICATIONS

Drones (UAVs/RPAS)
Long-range radio (LoRa)
Delay-tolerant networks (DTN)
Facial recognition software
Software-defined radio (SDR)

DRONES

unmanned aerial vehicles (UAVs) or
remotely-piloted aerial systems (RPAS)



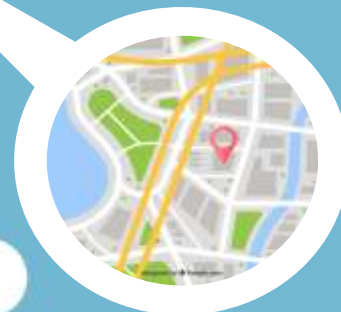
Delivery



Aerial photography &
videography



Power line
inspection



Aerial mapping

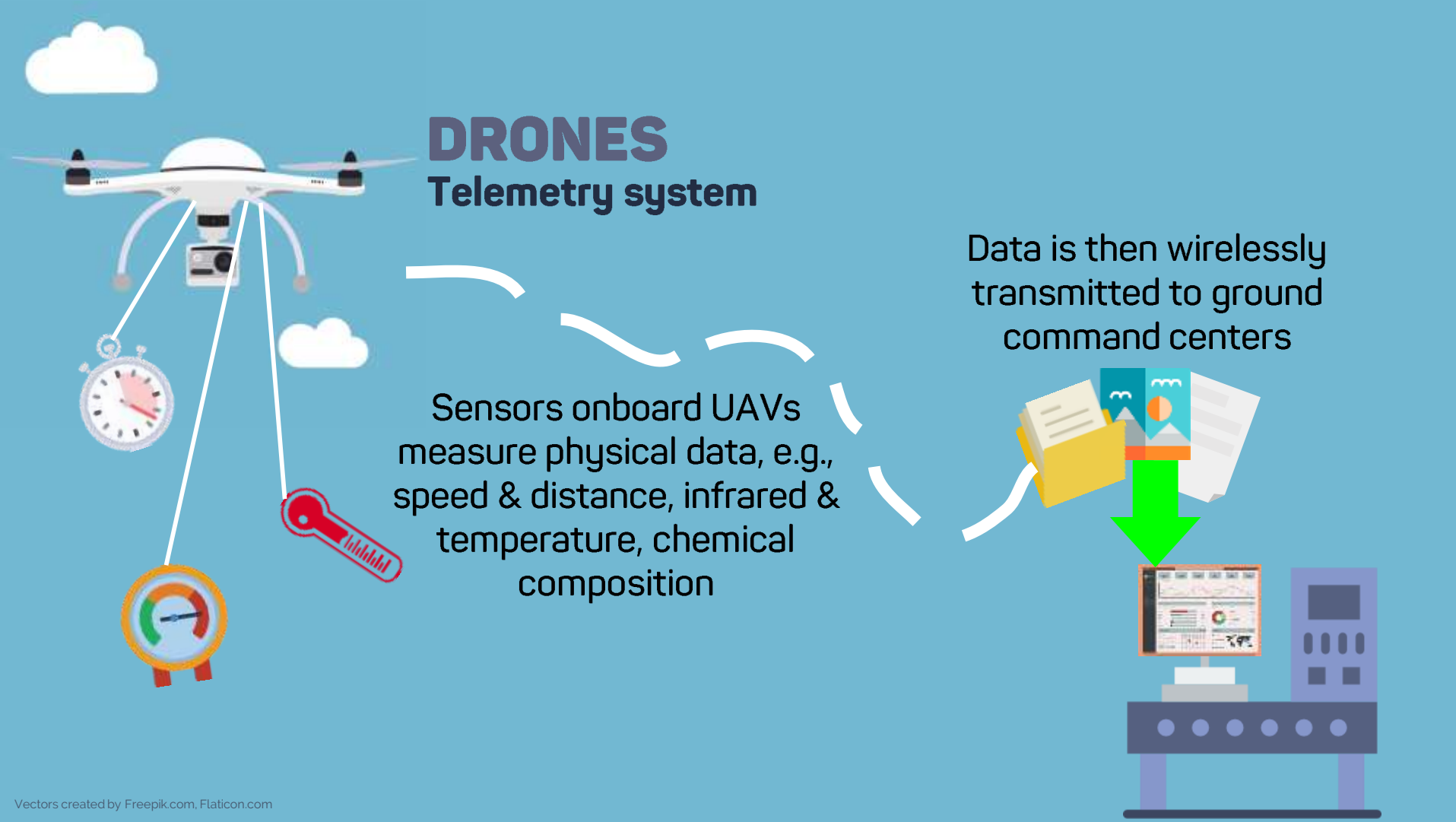


DRONES

Telemetry system

Sensors onboard UAVs measure physical data, e.g., speed & distance, infrared & temperature, chemical composition

Data is then wirelessly transmitted to ground command centers



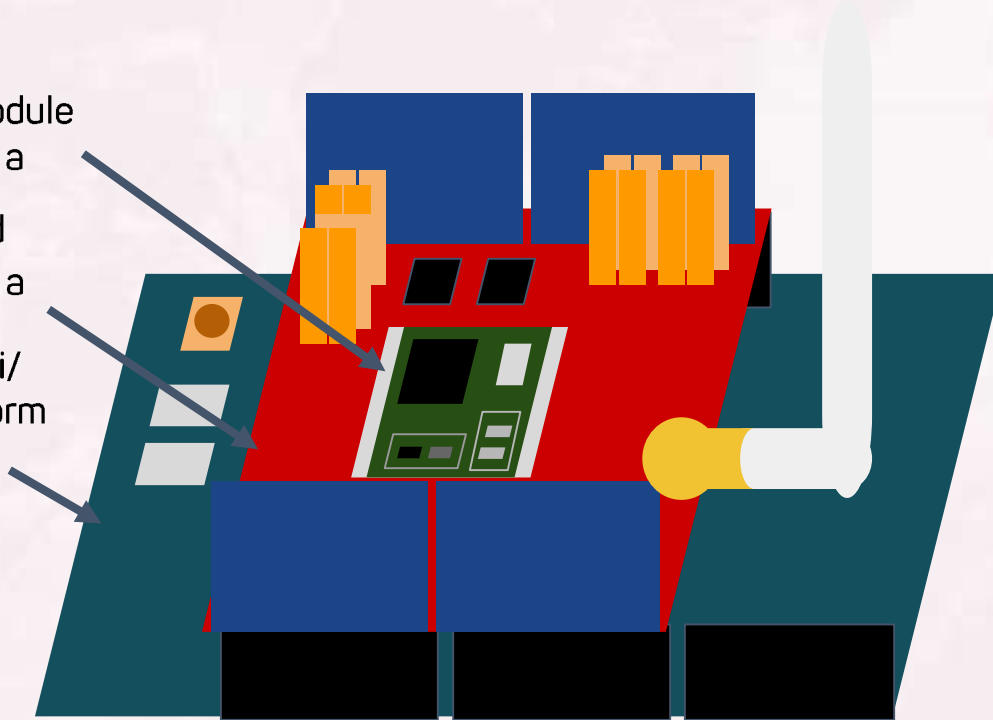
LORA

Long Range Radio

Transceiver module
mounted on a

LoRa shield
mounted on a

Raspberry Pi/
Arduino platform



Low power + Long range

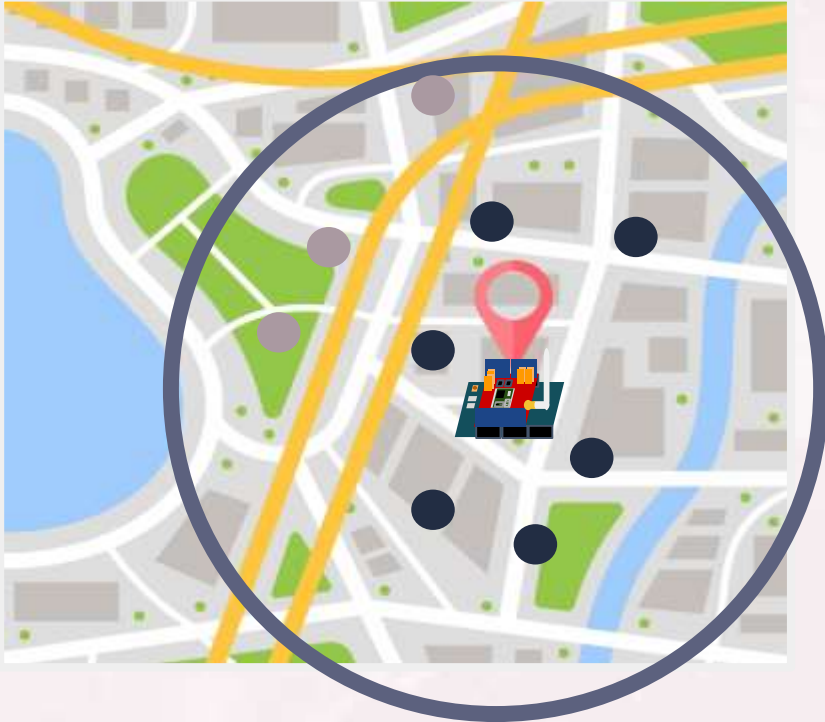
LOS: 21 km | NLOS: 2 km

Specs of RFM982-433S2,
an RF Transceiver Module

Freq	433 MHz
Data rate	300 kbps
Sensitivity	-148 dBm
V Supply	1.8-3 V
I (RX)	10.8-120mA
I (TX)	20-120 mA

LORA

Long Range Radio



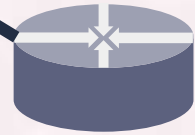
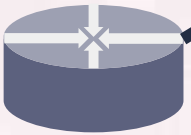
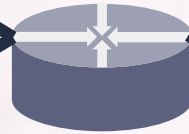
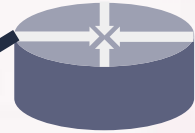
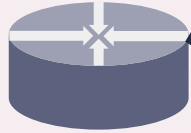
UAVs can act as “data ferries,” i.e., receive data from a network of nodes within range, then be flown to & forward data to another network

Transmitter mounted on UAV sends packets

Receivers may be characterized according to relative received signal strength indication (RSSI)

DTN

Delay-Tolerant Network



Specifically designed **routing protocols**, such as RFC5050, for challenging communication environments

due to limited wireless radio coverage, widely scattered mobile nodes, constrained energy resources, high levels of interference

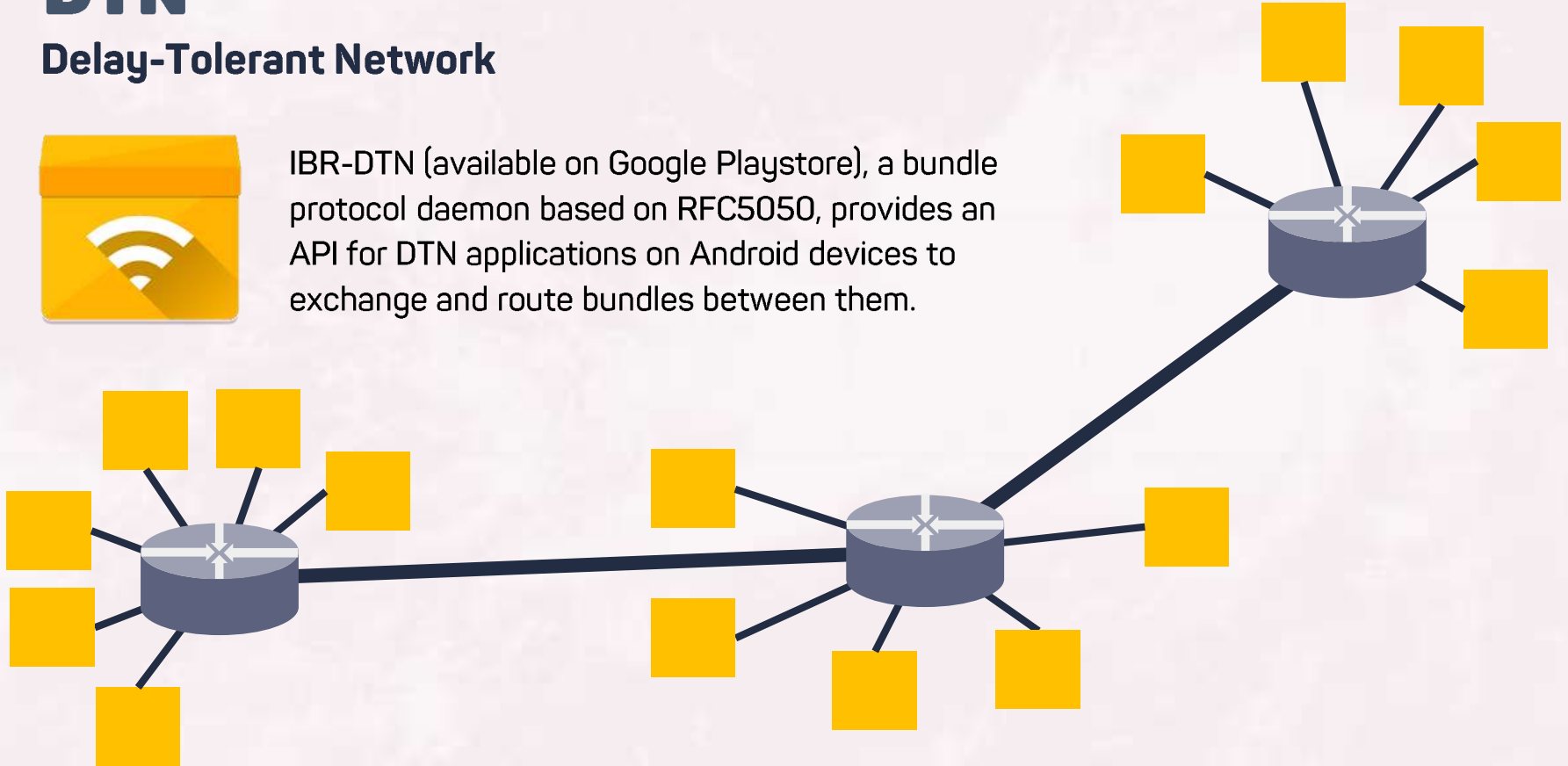
in case of frequent disruptions, long delays, high error rates

DTN

Delay-Tolerant Network

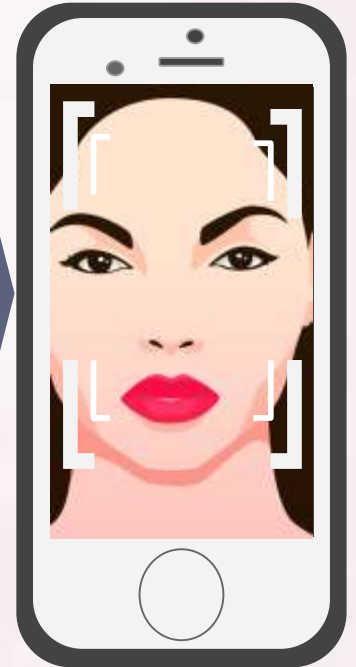
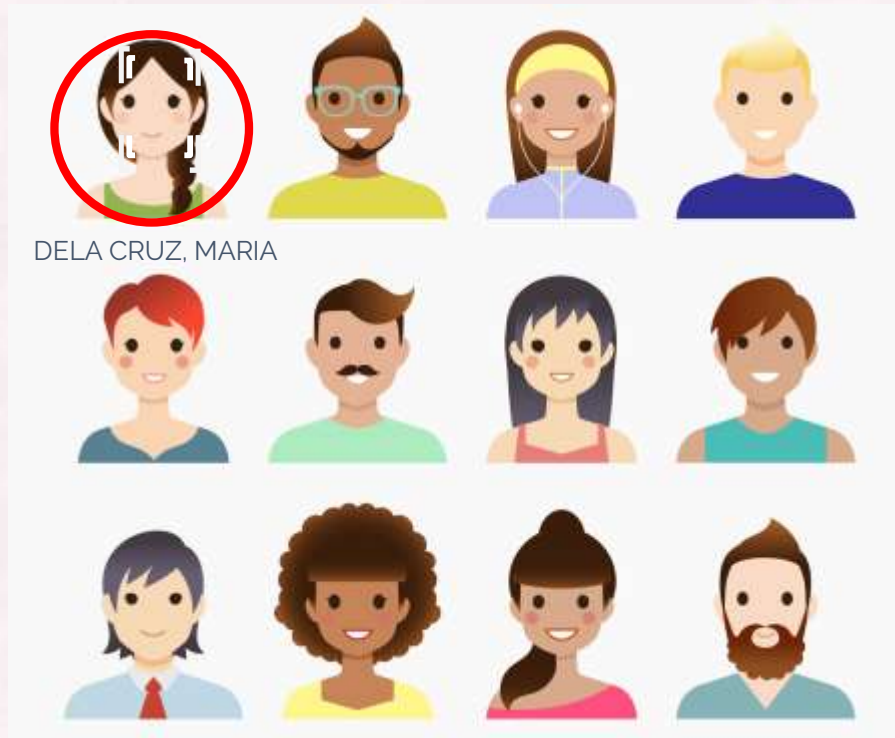


IBR-DTN (available on Google Playstore), a bundle protocol daemon based on RFC5050, provides an API for DTN applications on Android devices to exchange and route bundles between them.



FACIAL RECOGNITION SOFTWARE

Victim
identification on
mobile apps for
responders to
reunite families
and identify
deceased persons



SDR

Software-Defined Radio

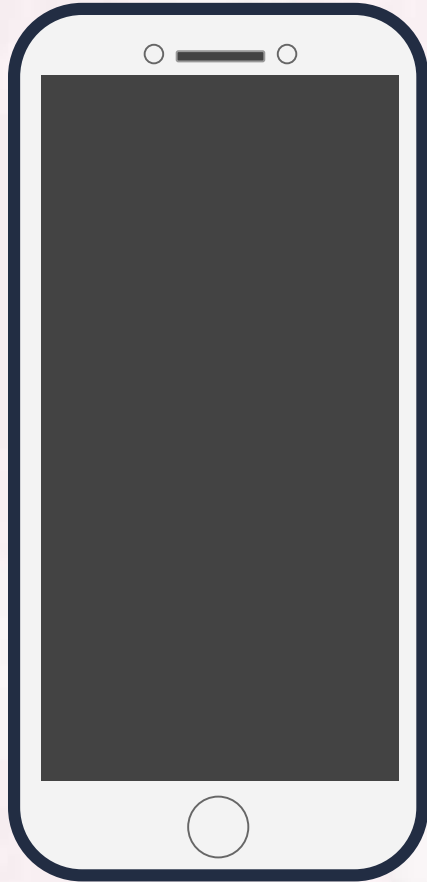
radio system with some or all
of its physical layer functions
software defined

functions performed by
traditional hardware
components (mixers, filters,
amplifiers, modulators, etc.) are
implemented on modifiable
software or programmable
firmware





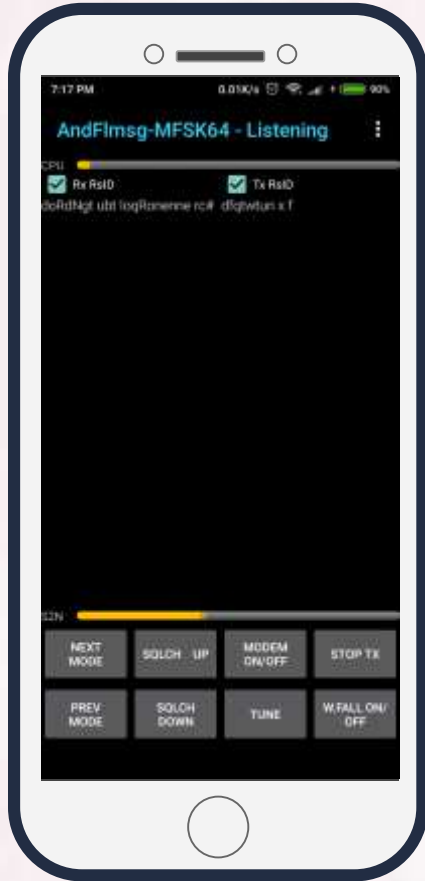
**HOWEVER,
THESE TECH ARE TOO
COMPLICATED FOR
THEIR INTENDED USERS:
THE PEOPLE.**



AND SO, WE MAKE USE OF THINGS THAT OUR COUNTRYMEN NORMALLY USE – THEIR SMARTPHONES.

Smartphones nowadays are equipped with apps that communicate without the need for data and cellphone signals.

An example of this is the AndFlmSg.



ANDFLMSG

Android Fast Light Message, or AndFlmsg is a combination of flmsg and fldigi, radio-supported standard message formats), running on **highly-portable but low-powered devices such as smartphones.**

LIMITATION

The receiver phone, however, has to hear the sounds emitted by the transmitter phone, and this effectively **shortens the maximum distance** between the two.



SOLUTION: TRANSCEIVER RADIOS!

Radios, more commonly known to people as walkie-talkies, have a **minimum transmission distance of 2 km** that effectively optimizes the distance.

LIMITATION

The speaker of the transceiver **uses 1W (out of 5.55W) of energy** that runs the battery out.

Radios are usually charged **3 hours** and can be used only for less than an hour → not energy efficient.

THE WORK OF AIC

Radio Transceiver Headphone Jack Circuit



THE WORK OF AIC

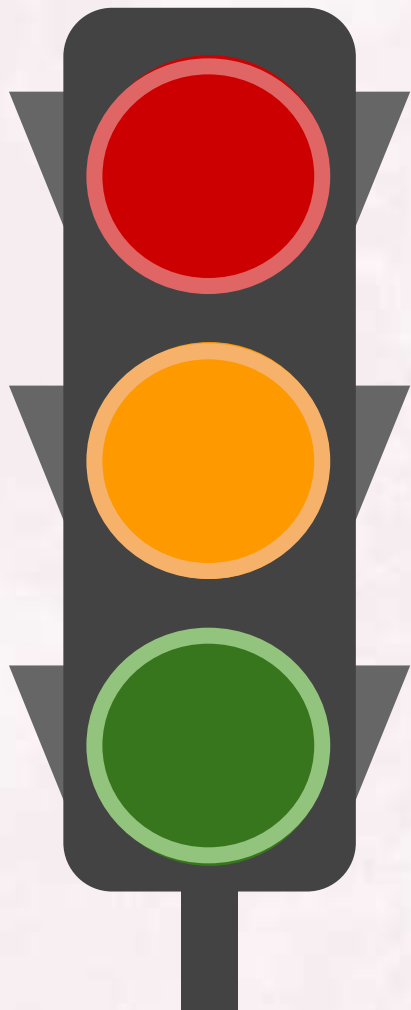
Radio Transceiver Headphone Jack Circuit

In the video at the right, the transmitter phone transmits the message "Hello there!" to the receiver phone.

Since the headphone jack is currently compatible only to one phone, the receiver phone is the one connected to the receiver radio (since it is the Rx radio that uses the speakers).

With this, the rx radio does not need to waste energy on producing sounds.





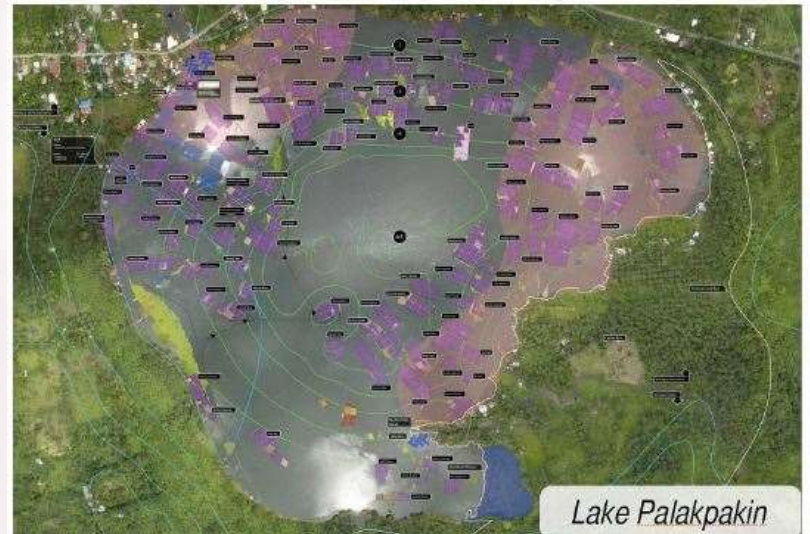
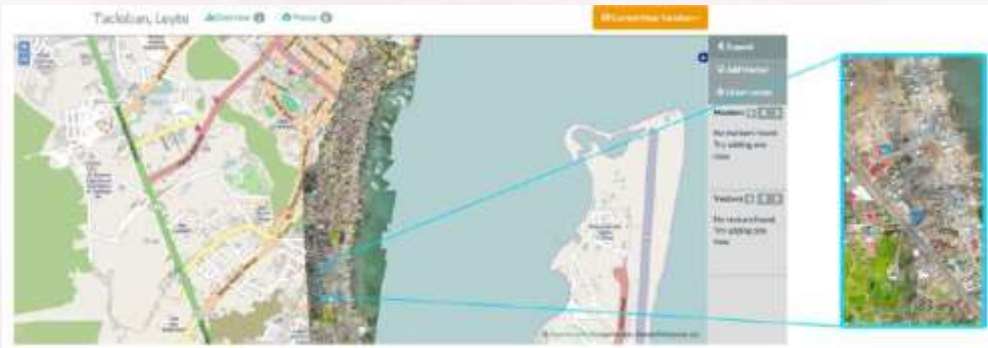
ATENEO INNOVATION CENTER PROJECTS ON DRC

Research in UAVs
Solar-powered radio communications

AIC PROJECTS

Research in UAVs

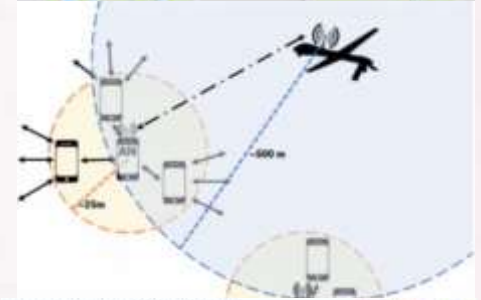
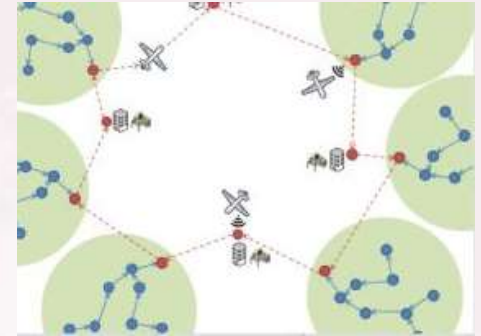
UAV Aerial Imaging Applications for Post-Disaster Assessment, Environmental Management, & Infrastructure Development (2014, Carlos Ezequiel et al.)



AIC PROJECTS

Research in UAVs

Demonstrations of Post-Disaster Resilient Communications & Decision-Support Platform with UAVs, Ground Teams, & Vehicles using Delay-Tolerant Information Networks on Sub-Ghz Frequencies (2017, Gema Abrajano et al.)



UAVs For Situational Awareness

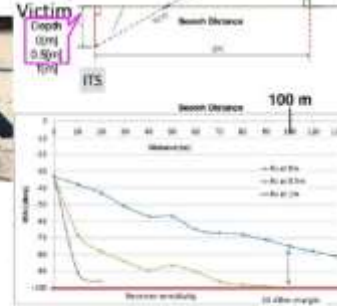


V-HUB Victim Location Experiment

Buried victim location at 0m, 0.5m, and 1m using ITS (ARIB STD-T109) Unit



VHUB has to be 100 m or less away before it can identify the location of victim buried under soil, and even closer for those under debris and saltwater.



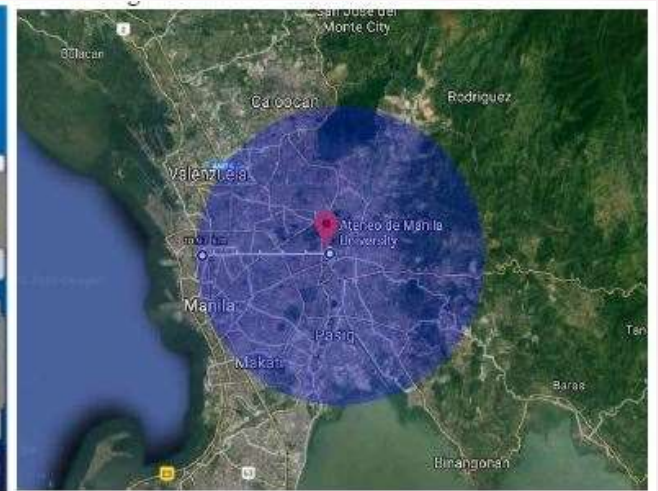
BUILT IN ANDROID APP TAGS FACES IN PHOTO ADDS METADATA -GPS, TIME, NOTES



AIC PROJECTS

Research in UAVs

Design & Development of a Long Range UAV Communication System for Disaster Preparation, Response, & Situational Awareness (2018, Harlan Arias et al.)



AIC PROJECTS

Solar-powered Radio Communications



Solar Radio Communication System