Relay Station Network Based on Low-power Wide-area Network (LPWAN) Technologies for Disaster Management

Background :

The loss of communication network is especially vital when the disasters are taking place because data under those situations are crucial either for analytics or strategic planning, such as rescue or evacuation. Thus, a backup telecommunication channel is mandatory in this case.

Targets:

We propose a relay station network as a solution to such situations. The relay station network consists of an array of relay stations that their only function is to forward the received data to the next station until the data reach the destination (base) station.

Speaker: Dr. Kanokvate Tungpimolrat
National Electronics and Computer Technology Center, Thailand

Relay Station Network Based on Low-power Wide-area Network (LPWAN) Technologies for Disaster Management

Project Members :

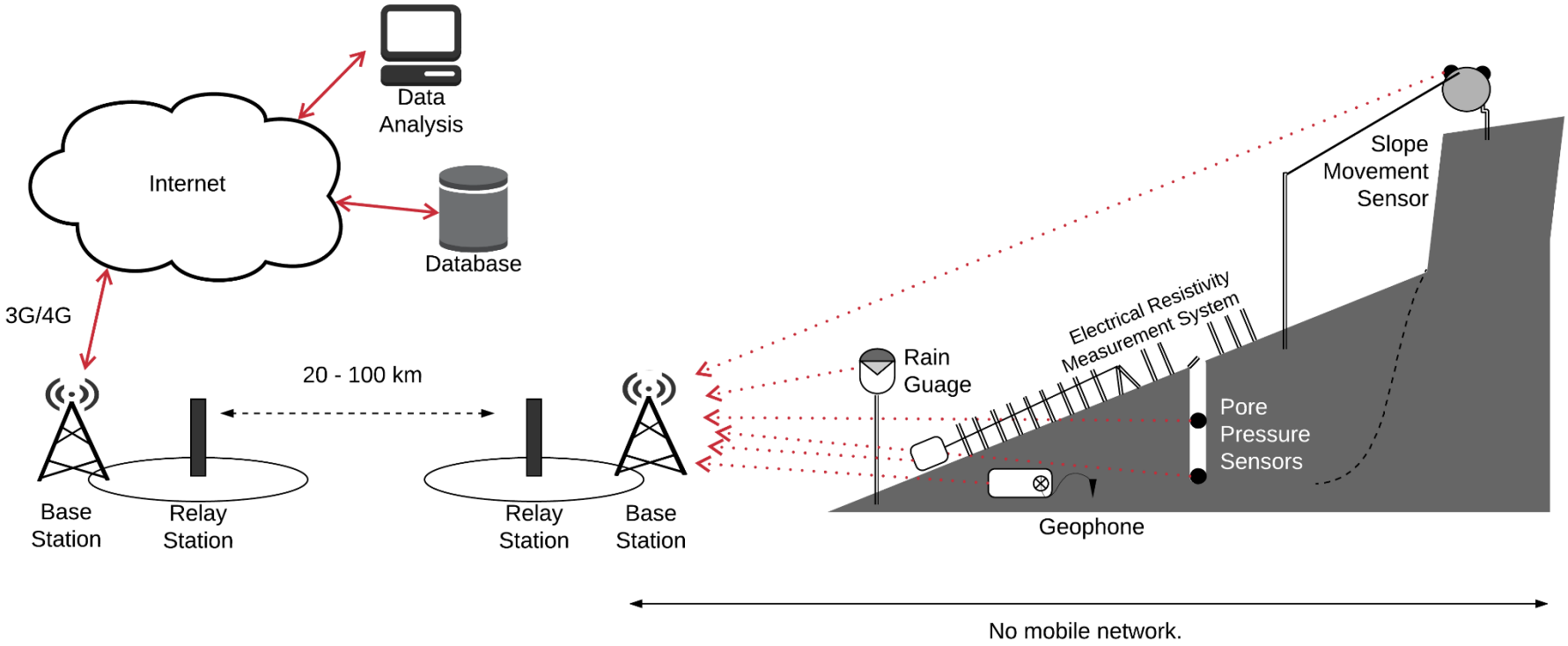
National Electronics and Computer Technology Center (NECTEC)
Chiang Mai Governor's Office
National Institute of Information and Communications Technology (NICT)
Universiti Teknology Brunei (UTB)
Mapua University
Advanced Science and Technology Institute (ASTI)
National University of Laos (NUoL)
Technology Computer and Electronics Institute (TCEI)
University of Computer Studies, Yangon (UCSY)
King Mongkut's Institute of Technology, Ladkrabang (KMITL) **(New Member)**
Ready Affiliate Japan **(New Member)**

Project Duration : 2 years (Jun 2019 – **May 2022**) (Request for 1-year extension)

Project Budget: 80,000 USD

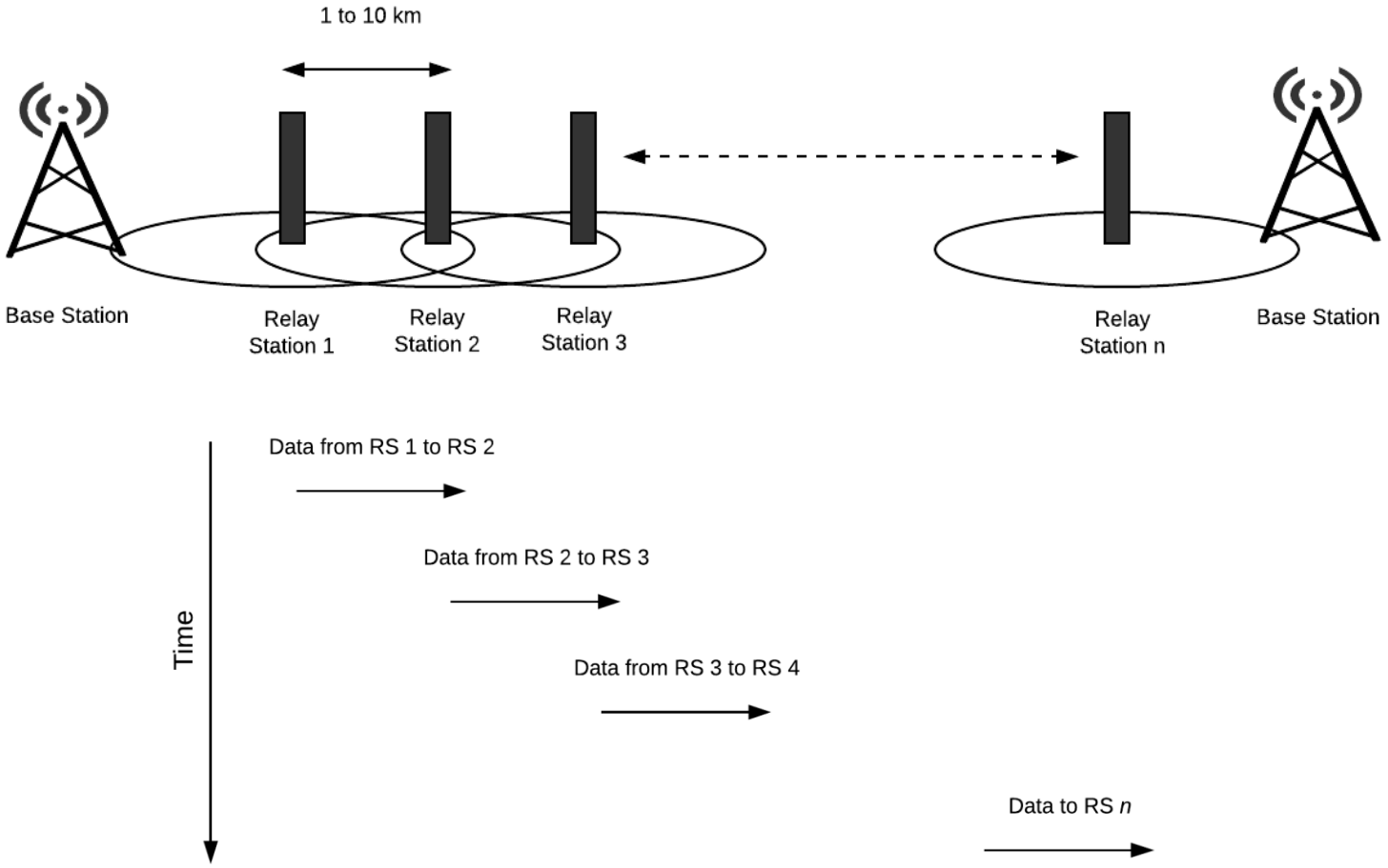
Project Activities

System Overview



Project Activities

System Overview



Project Activities

2019

- Kick-off Meeting
  - 31 July – 1 Aug 2019, @USCY & Thaton Computer University, Myanmar

2020

- 2nd Meeting
  - 6 – 7 Jan 2020, @Holiday Inn Chiang Mai & Doi Pui Village, Thailand
- 3rd Meeting (WebEx)
  - 8 Apr 2020
- Experiments in Thailand
  - Implementation and test of a simple relay function, @TSC & TU, Thailand
- Meeting with DDPM
  - 26 Oct 2020, @DDPM office, Chiang Mai, Thailand
- Manuscript preparation (by UCSY team, ASTI team, and UTB-NECTEC team)
- Development of an LoRa-based networks for Off-grid emergency communications (by ASTI team)
- Meeting and field survey in Lao PDR (by NOUL team)

Project Activities

2nd Meeting

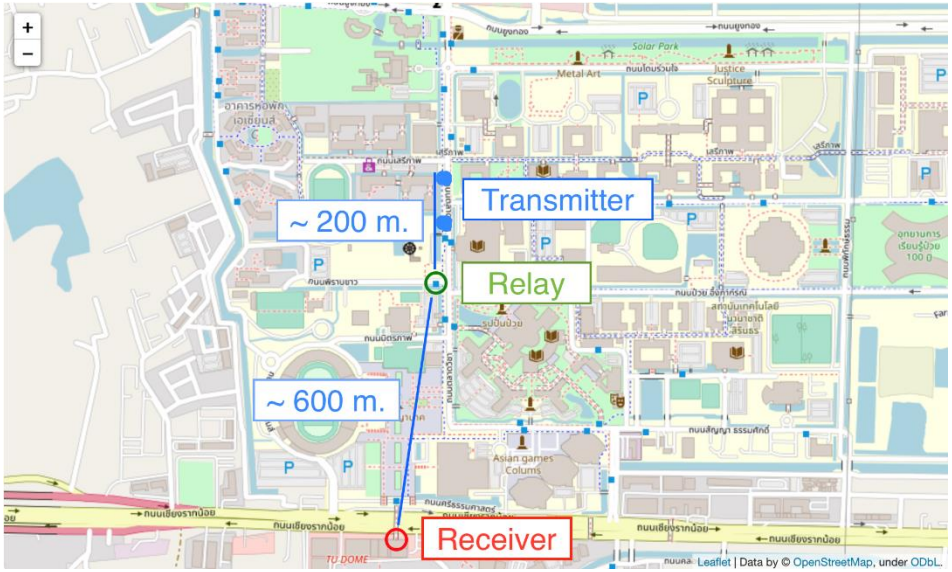
- Introducing DDPM & DMR
- Visiting the experiment site of the ASEAN COSTI's project
- Prototype demonstration

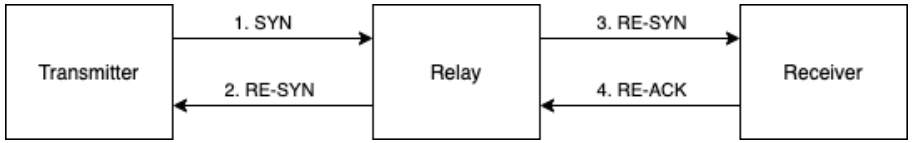
3rd Meeting (WebEx)

- Updating project progress and COVID-19-related situations
- Finalizing CRDA
- Budget re-allocation
- Testing plan for NICT's LoRa module

Project Activities

Experiments in Thailand We conducted experiments on a simple relay function.

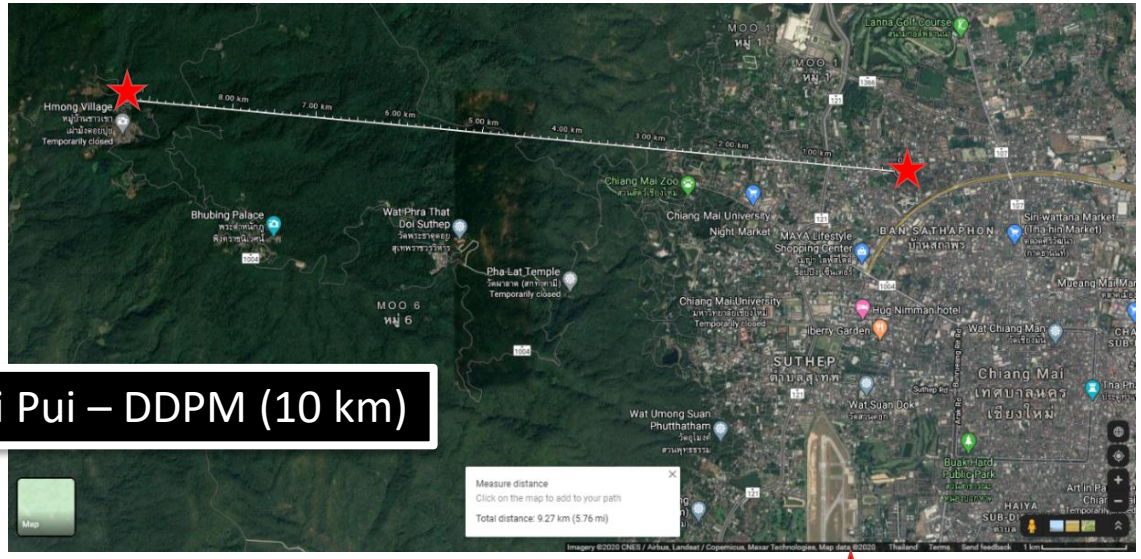




No. of relays	PRR	Corrupted data
0	0.994	0
1	0.795	0
2	0.678	0

Meeting with DDPM It aims to finalize the locations of relay stations.

Project Activities: Route Plan

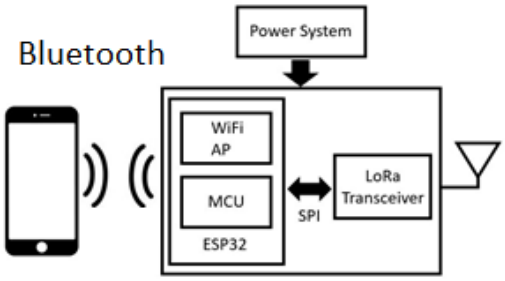


Route 1: Doi Pui – DDPM (10 km)

Route 2: Pa Miang – DDPM (35 km)

Project Activities in the Philippines

Paper presentation in 2020 IEEE Global Humanitarian Technology Conference held virtually



Node prototype of the LoRa-based Mesh Network

Development of an LoRa-based networks for Off-grid emergency communications

- Node prototype development using commercial-off-the-shelf modules
- Implementation of RSSI-based modified ad hoc on-demand distance vector (ADOV) routing algorithm in LoRa to enable mesh networks
- Simple and controlled experiments to characterize the performance of the system

Other activities

- Researched on appropriate hardware/modules and reviewed datasheet and technical documents
- Coordination with local suppliers for the procurement of hardware components for the LoRa relay station prototype
- Literature review and initial simulation for planned research paper on reinforcement learning-based routing for LoRa mesh networks

Project Activities in Lao PDR

Date	Location	Work	Person in charge
16/11/2020	Luangprabang Province	Travelling to site	Assoc.Prof.Dr.Khampasith Thammathevo, Dr.phoummixay Siharath, Dr.Phetnakhone Xaixongdeth, Ms. Malivanh Vongsalasinh
17/11/2020	Luangprabang Province	Meeting and discuss with local authorities	Assoc.Prof.Dr.Khampasith Thammathevo, Dr.phoummixay Siharath, Dr.Phetnakhone Xaixongdeth, Ms. Malivanh Vongsalasinh
18/11/2020	Luangprabang Province	Site investigation and survey	Assoc.Prof.Dr.Khampasith Thammathevo, Dr.phoummixay Siharath, Dr.Phetnakhone Xaixongdeth, Ms. Malivanh Vongsalasinh
19/11/2020	Luangprabang Province	Site investigation and survey	Assoc.Prof.Dr.Khampasith Thammathevo, Dr.phoummixay Siharath, Dr.Phetnakhone Xaixongdeth, Ms. Malivanh Vongsalasinh
20/11/2020	Luangprabang Province	Site investigation and survey a nd back to Vientiane	Assoc.Prof.Dr.Khampasith Thammathevo, Dr.phoummixay Siharath, Dr.Phetnakhone Xaixongdeth, Ms. Malivanh Vongsalasinh

- To discuss with the local authorities on how importance of the real time system.
- To survey the site to design and plan on the next proposal for setting up the water quality system by using wireless system to send and receive the signal through wireless to the centralized system.
- To identify the appropriate location for setting up water quality system.

Scientific Contribution:

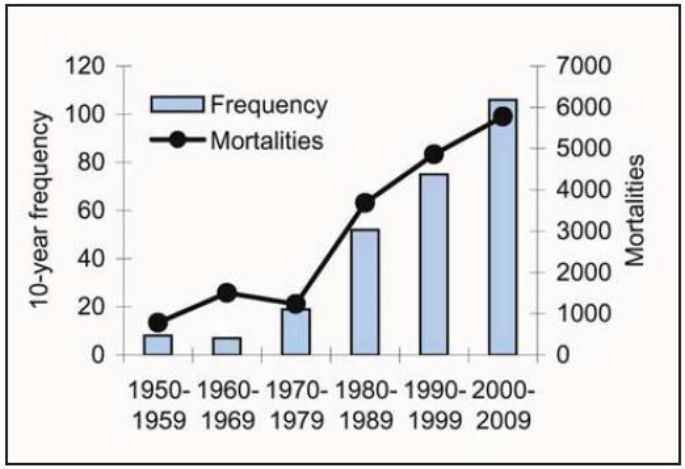
Presentations at International Conferences:

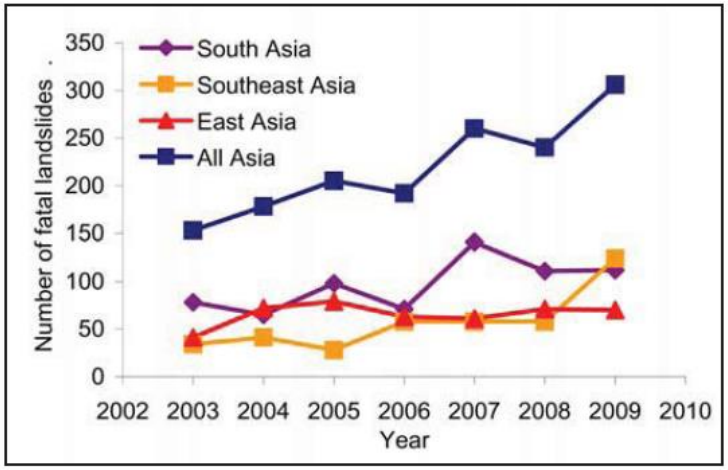
No:	Paper title:	Author names	Affiliation	Conference name:	The date of the conference	The venue of the conference
1.	Real-Time Monitoring and Early Warning System for Landslide Preventing in Myanmar	Thin Lai Lai Thein, Myint Myint Sein, Ken T. Murata, Kanokvate Tungpimolrut	[1]University of Computer Studies, Yangon, Myanmar, [2]University of Computer Studies, Yangon, Myanmar, [3]National Institute of Information and Communications Technology & NICT, Japan, [4]National Electronics and Computer Technology Center, Thailand	2020 IEEE 9th Global Conference on Consumer Electronics (GCCE), Kobe, Japan	13-16 October, 2020	Kobe, Japan
2.	LoRa-based Mesh Network for Off-grid Emergency Communications	Khazmir Camille Valerie G. Macaraeg[1], Calvin Artemies G. Hilario[1,2], and Charleston Dale C. Ambatali[1]	[1]Electrical and Electronics Engineering Institute, University of the Philippines - Diliman [2]Advanced Science and Technology Institute, Department of Science and Technology Quezon City, Philippines	2020 IEEE Global Humanitarian Technology Conference	29 October – 1 November, 2020	Seattle, Washington, USA (virtual)
3.	Experiments on LoRa Communication Used in a Relay Station Network for Disaster Management	K. Sangrit[1,2], K. Tungpimolrut[1], U. Lewlomphaisarl[1], M. Chatpoj[1], J. Karnjana[1], Ken T. Murata[3], Wida Susanty Haji Suhaili[4], Jennifer Dela Cruz[5], Fredmar Asarias[6], Phoumixay Siharath[7], Daoheung Bouangeune[8], and Thin Lai Lai Thein[9]	[1]National Electronics and Computer Technology Center, [2]Sirindhorn International Institute of Technology, [3]National Institute of Information and Communication Technology, [4]Universiti Teknology Brunei, [5]Mapua University, [6]Advanced Science and Technology Institute, [7]National University of Laos, [8]Technology Computer and Electronics Institute, [9]University of Computer Studies, Yangon	The 4th International Conference on Computational Intelligence in Information System (CIIS 2020)	25-27 January 2021	UTB, Brunei Darussalam

Societal Impact:

A direct social impact of this project has two folds.

- When we want to monitor environmental parameters in very rural areas where 3G/4G networks are not available and where electricity transmission via powerlines is out of reach, especially when the parameters could be triggers for disasters, a low-power-and-long-range communication channel is required. In such a case, the benefit of the proposed relay station network is crystal clear because, in order to send data from one station to another, each relay station is expected to operate by using only solar power.
- As it is known that under disaster situations (such as earthquakes or landslides) there is a high chance of losing the 3G/4G networks, and they are out of service in the areas where the disasters take place.





Conclusion:

Activities that have been done so far in 2020 are summarized as follows.

- **Meetings**: 3 meetings, which are 2nd Meeting, 3rd Meeting, Meeting with DDPM
- **Experiments**
  - LORA-based relay function
- **Publications**: 3 conference papers
- **Human resource development**: 1 Master's degree student (Mr. Kittikom Sangrit)

Budget Plan

- Budget used: approx. **12,000** USD (as of October 15, 2020)
- Budget allocation plan (**67,628** USD)

	NECTEC	UTB	Mapua U.	ASTI	NUOL	TCEI	UCSY
Conference	105			1,150			
Journal		3,000					
Field tests	15,250				2,060	2,680	2,260
Equipment	39,323			1,8000			

Future works:

- Field survey and gathering requirement for solar system implementation
- Field survey for installation locations
- Field test and data collection

Activities	2020		2021												2022
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	
Conference															
Journal															
Field tests															
Purchase															

Publication Plan

1. Journal of Disaster Research (Deadline: Nov 30, 2020)
   - Tentative title: Displacement Measurement Based on Software Defined Radio for Landslide-prone Areas Using Wi-Wi
   - Authors: K. Sangrit (SIIT), S. Laitrakun (SIIT), Kazuhiko Fukawa (Tokyo Tech), A. Wakai (Gunma University), G. Sato (Teikyo Heisei University), Hoang Viet Hung (Thuyloi University of Vietnam), Ken T. Murata (NICT), and J. Karnjana (NECTEC)