"Prevention of 4 Disasters and Their Single Recovery Networks based on Internet-of-Things with Airborne Capability (PATRIOT-41R-Net)"

[Year 2 of 2 Years]

Assoc. Prof. Dr. Eng. Khoirul Anwar (Telkom University, Indonesia)
Dr. Ashwin Sasongko (Telkom University, Indonesia)
Dr. Suryo Adhi Wibowo (Telkom University, Indonesia)
Prof. Brian Kurkoski (Japan Advanced Institute of Science and Technology (JAIST), Japan)
Dr. Dao Trung Kien (Hanoi University of Science and Technology, Vietnam)
Dr. Norul Husna Ahmad (Universiti Teknologi Malaysia, Malaysia)
Dr. Attaphongse Taparuggsanagorn (Asian Institute of Technology (AIT), Thailand)

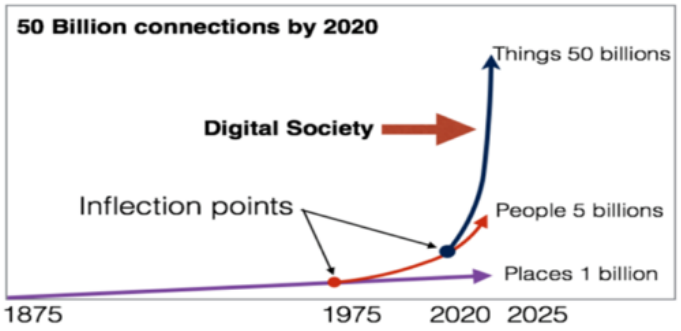
The Center for Advanced Wireless Technologies (AdWiTech),
School of Electrical Engineering, Telkom University, Indonesia

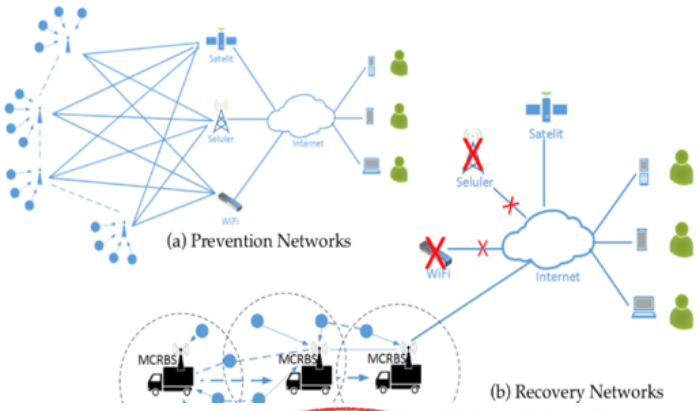
Meeting Report of ASEAN IVO FORUM 2020
Virtual Meeting, 10-29 October 2020

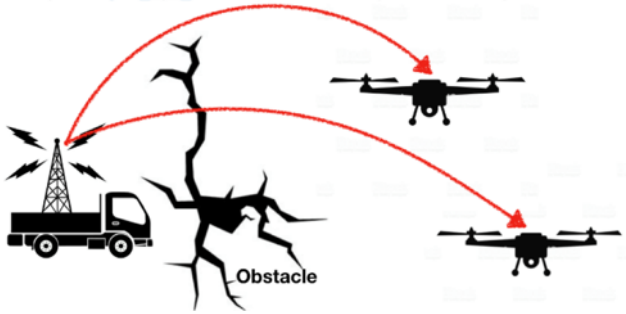
Prevention of 4 Disasters and Their Single Recovery Networks based on Internet-of-Things with Airborne Capability (PATRIOT-41R-Net)

Background :

- After the disaster, telecommunication networks cannot be be recovered soon and are suffering from difficulties of covering large areas.
- The rescue team and mobile base station are suffering from difficulties in finding the victims although the victim's mobile phones are active but is out-of-network range.







Targets:

- This PATRIOT-41R-Net project makes an experiment, especially on drone and/or HAPS, at Padang City, Sumatera, Indonesia.
- APPS for smartphone and SMS services.
- Patent and publications for real-field experiment and real-field parameters in high reputed IEEE magazines or similar.

Speaker:

Assoc. Prof. Dr. Eng. Khoirul Anwar (Telkom University, Indonesia)

Telkom University

Prevention of 4 Disasters and Their Single Recovery Networks based on Internet-of-Things with Airborne Capability (PATRIOT-41R-Net)

Project Members :

1. **Asct. Prof. Dr. Eng. Khoirul Anwar** (Telkom Univ., Indonesia)
2. **Dr. Ashwin Sasongko** (Telkom Univ., Indonesia)
3. **Asct. Prof. Brian Kurkoski** (JAIST, Japan)
3. **Dr. Dao Trung Kien** (Hanoi Univ. of Science and Tech., Vietnam)
4. **Dr. Norul Husna Ahmad** (UTM, Malaysia)
5. **Dr. Attaphongse Taparuggsanagorn** (AIT, Thailand)

New Members:

6. **Dr. Suryo Adhi Wibowo** (Telkom University, Indonesia)
7. **Obed Rhesa Ludwinianda Handoko** (Telkom Univ, Indonesia)
8. **Arini Fitri** (Telkom University, Indonesia)
9. **Cita Aisah** (Telkom University, Indonesia)
10. **Shafira Nur Andana** (Telkom University, Indonesia)
11. **Citra Dewi Anggraeni** (Telkom University, Indonesia)
12. **Oktaza Recy** (Telkom University, Indonesia)
13. **Dr. Hazilah Mad Kaidi** (UTM, Malaysia)
14. **Assoc. Prof. Dr. Liza Abdul Latiff** (UTM, Malaysia)
15. **Dr. Rudzidatul Akmam Dziyauddin** (UTM, Malaysia)
16. **Syed Aamer Hussain** (UTM, Malaysia)

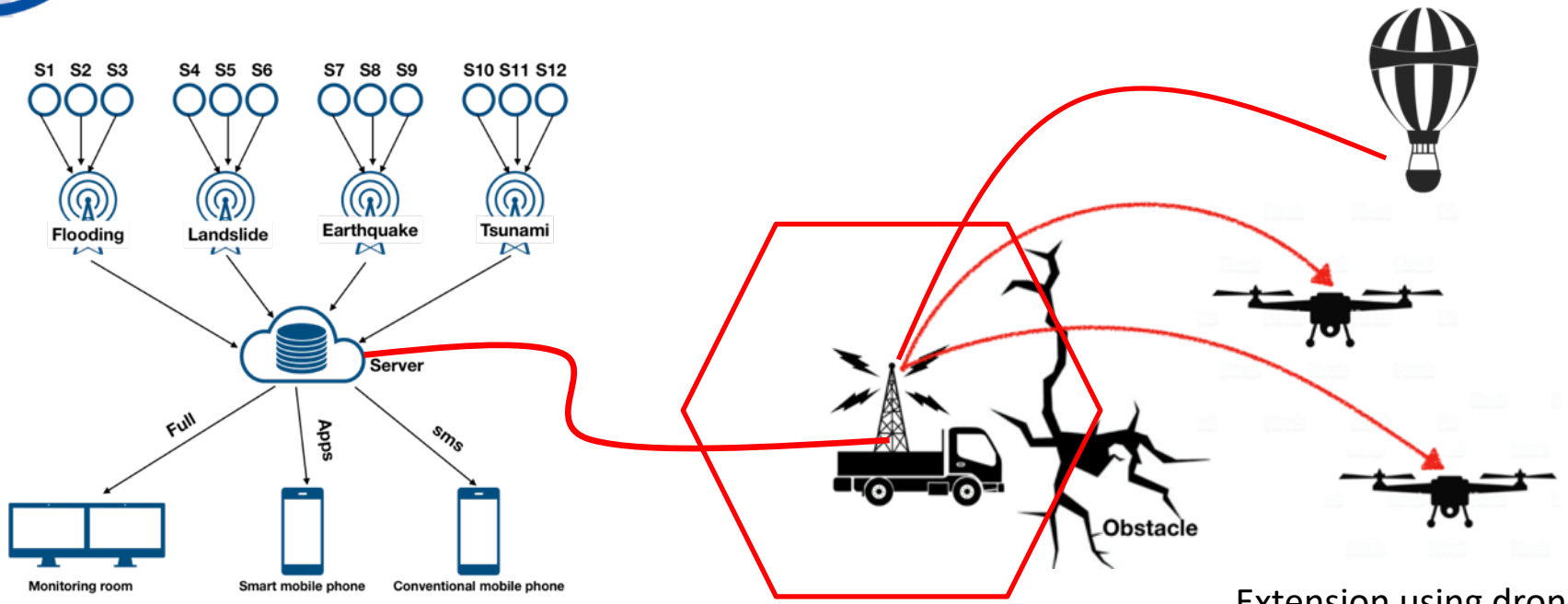
Project Duration :

24 Months (July 2019 – June 2021)

Project Budget:

Year 1: USD 1,049 (used), USD18,951 (planned)
Year 2: USD20,000 (planned)

Technology and Work Package (WP) Structure

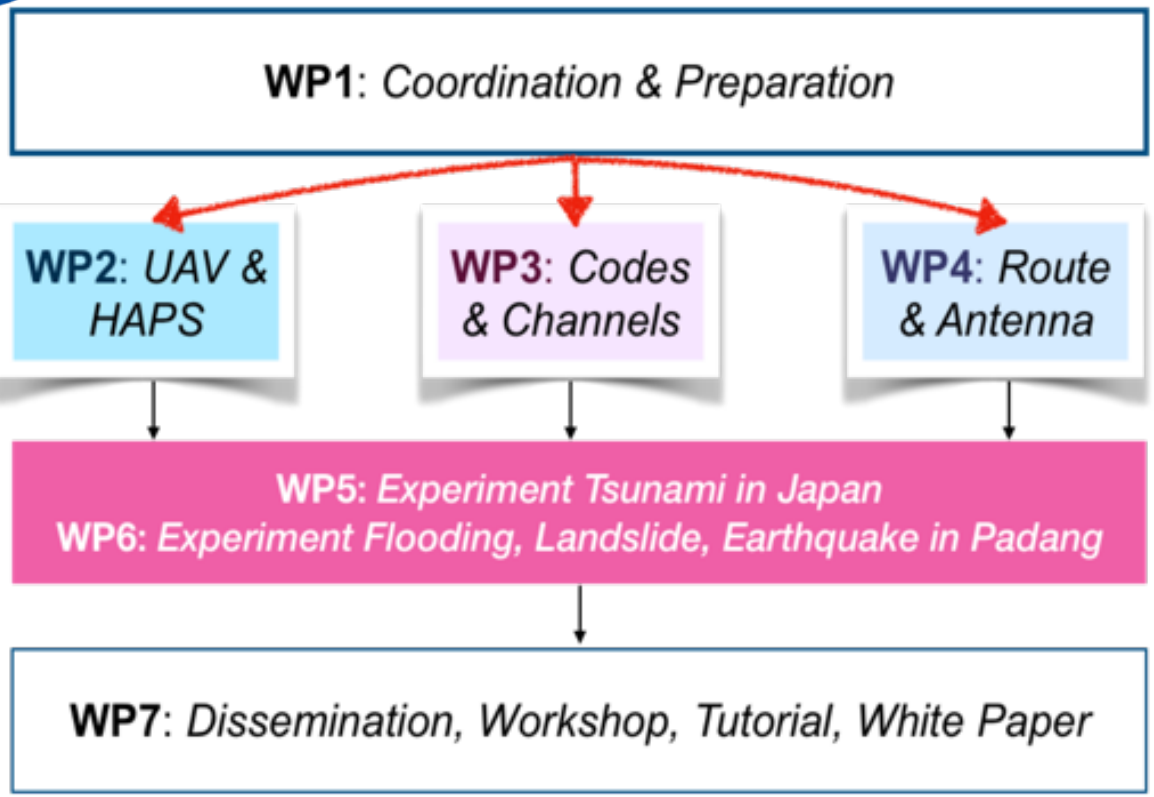


(a) Before disaster

(b) After disaster

- Network (a) monitors for damage prevention considering 4 disaster coditions: flooding, landslide, earthquake, tsunami.
- The rescue team and mobile base station use airborne capability provided by:
  - (i) Drone
  - (ii) High altitude platform system (HAPS)
  - To extend (1) network coverage and (2) find the victims having mobile devices emitting signals.

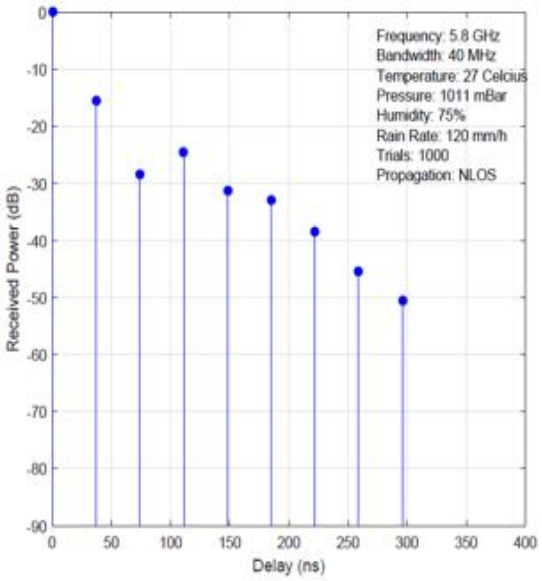
Work Packages (WP) Allocations *)

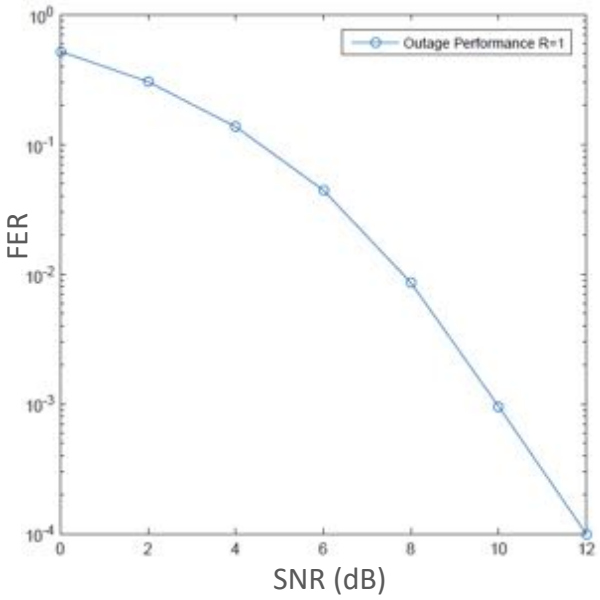


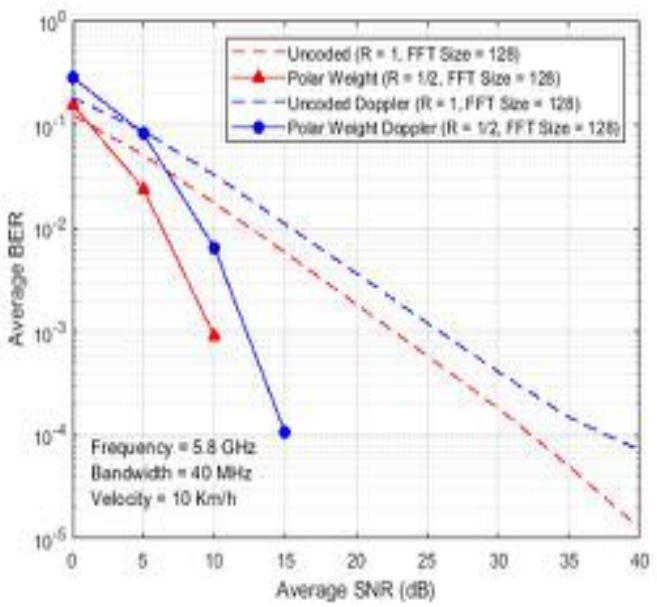
- WP1: Coordination and Preparation **(TelU, July 2019 – Jun 2021)**
- WP2: Experiment MCRBS, UAV Channels and HAPS **(TelU, AIT, Jul – Oct 2019)**
- WP3: Experiment Rateless Coding for UAV Channels **(JAIST, TelU Jul – Dec 2019)**
- WP4: Experiment for Routing and Antenna Dev. **(UTM, TelU, July – Dec 2019)**
- WP5: Experiment for Tsunami in Japan **(Tel-U, JAIST, HUST, Jan – Jun 2020)**
- WP6: Experiment for Flooding, Landslide, Earthquake in Indonesia **(TelU, AIT, July – Dec. 2020)**
- WP7: Dissemination, Workshop, Tutorial, Whitepaper **(ALL, Mar-Jun 2021)**

**) Agreed in Kick-Off Meeting 2019, Bandung, July 23, 2019.*

Current Progress 1: MCRBS

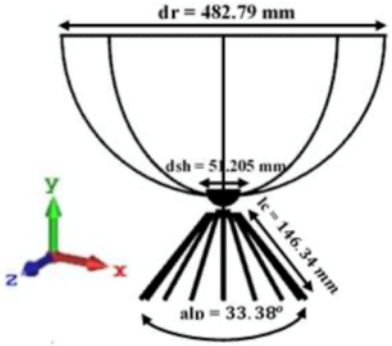




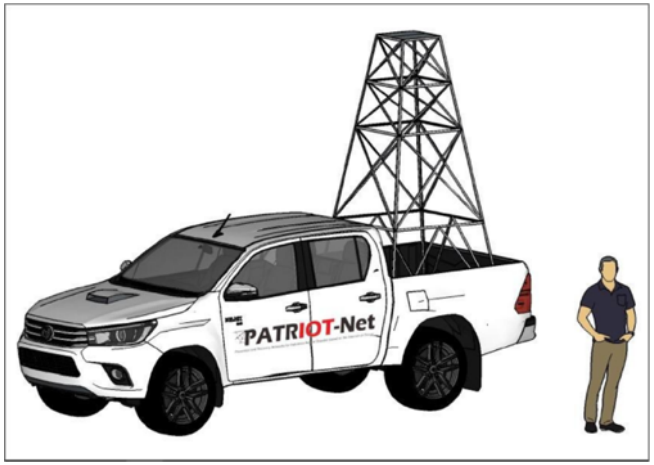


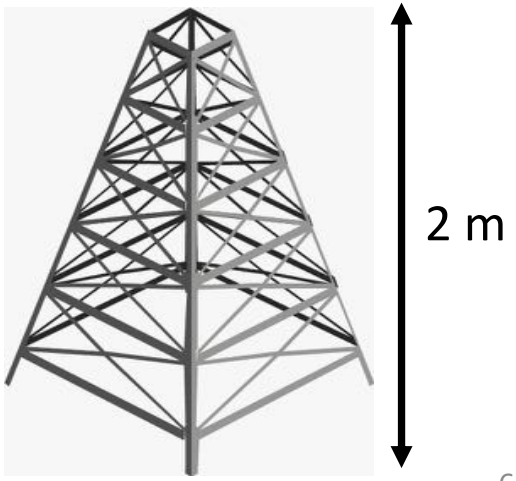
(a) (b) (c)

a. Power Delay Profile (PDP) for height of 0-10 m, b. Outage performance, (c) BER with Doppler



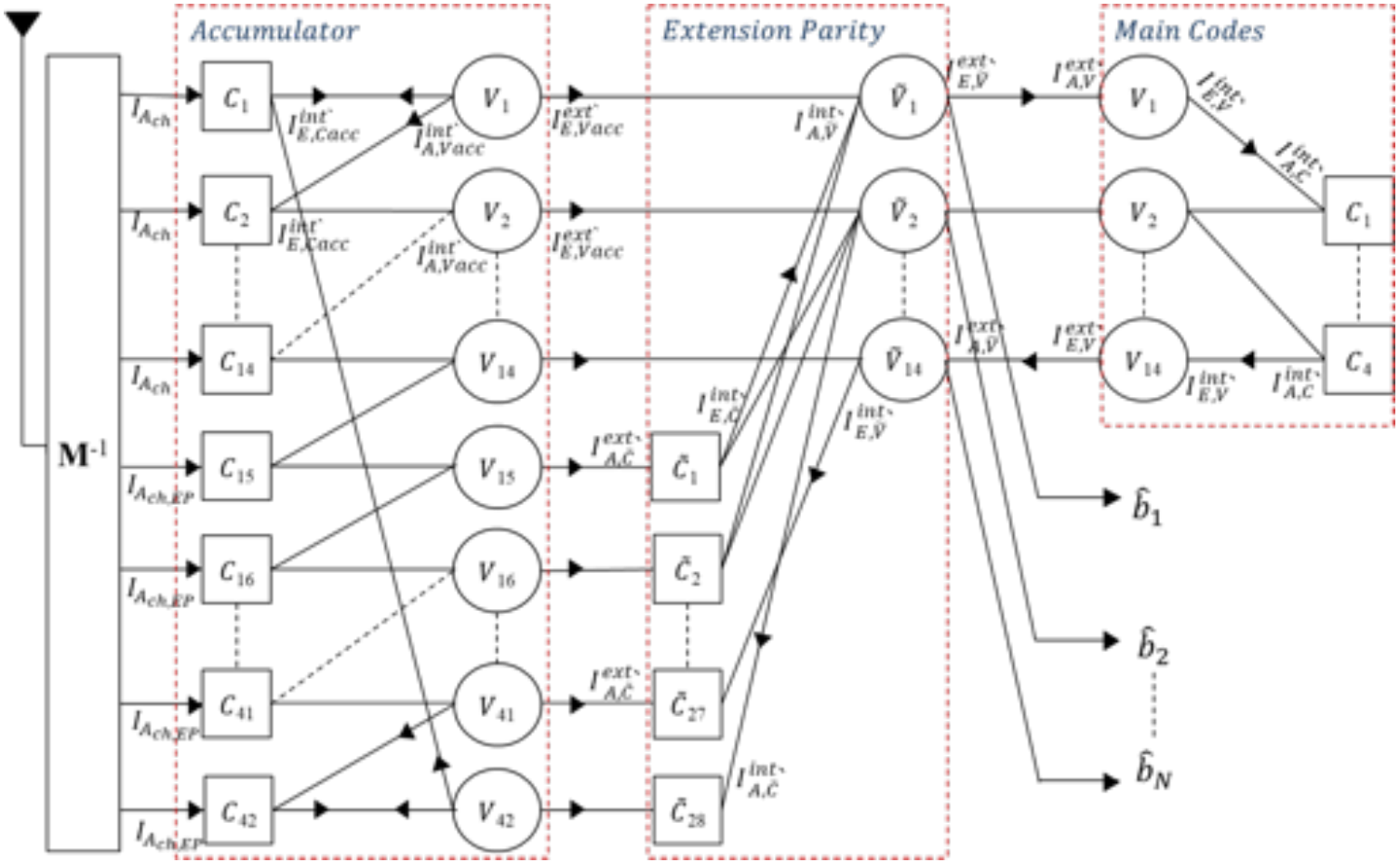
The type of outward curved asymmetric biconical (OCAB) antenna.





Current Progress 2: Accumulate Raptor-like Codes

Accumulate Raptor-like codes



- To extend the UAV communications, Semi-Rateless Accumulate Tornado Codes based on SR-QC-LDPC and Accumulator Codes will be designed with adaptive capability to the channel.
- Initial results are going to be done by June 2020 and the final result is planed for completion in August 2020.

Current Progress 3: UAV Channel Model

Indonesia Unmanned Aerial Vehicle Channel Model

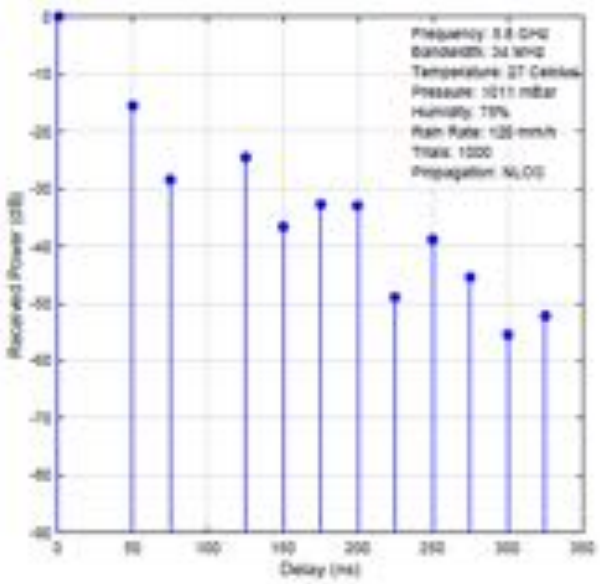


Figure: Power Delay Profile (PDP)

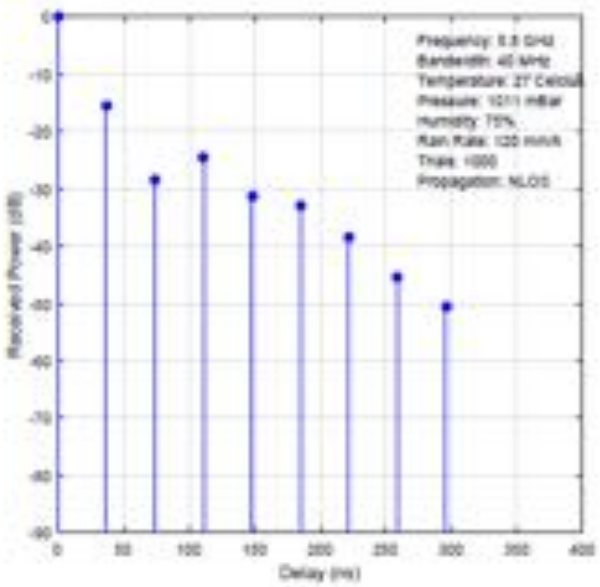


Figure: PDP mapped.

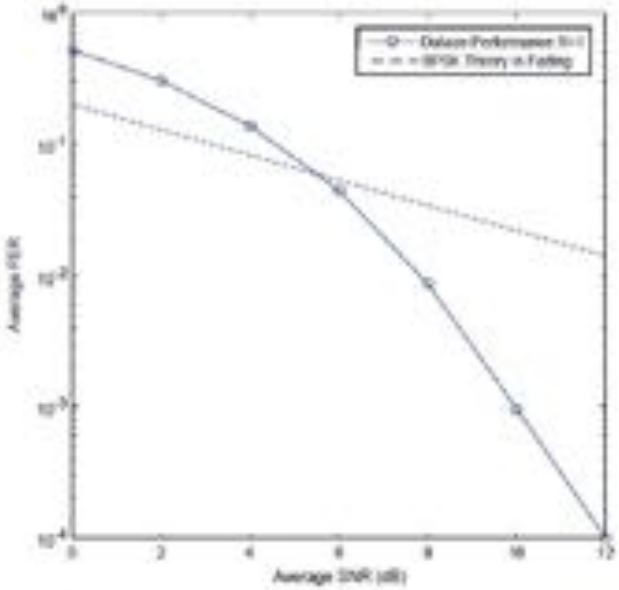


Figure: Outage Performance.

- The Indonesia UAV channel model is a representative PDP generated by NYUSIM using real-field parameters, such as average humidity of 70%, average temperature of 27°C, barometric pressure of 1011 mbar at average Altitude h=0-200 meters above sea level, and rain-rate *Q*=120 mm/hour with frequency F=5.8 GHz and bandwidth of 40 MHz.
- The proposed representative PDP of Indonesia UAV channel model has 9 paths. The proposed codes should be used to validate the outage performances.

Current Progress 4: Security with Polar Codes

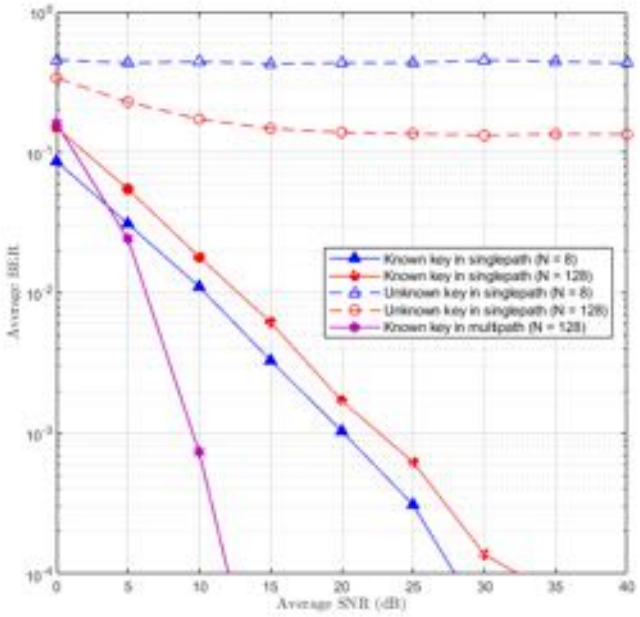


Figure 1. Security Polar in singlepath and multipath fading

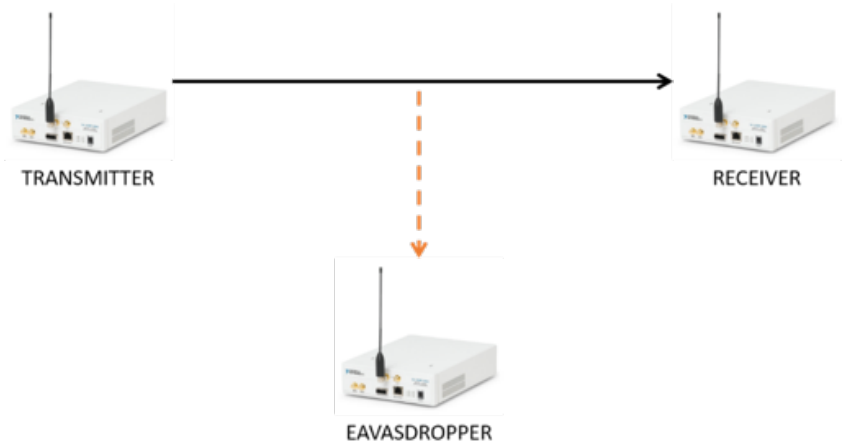


Figure 2. Polar security scenario with USRP

- We have obtained the simulation performance about the security of Polar codes in singlepath and multipath fading.
- We consider to use HAPS Channel model and OFDM to obtain the good performance of security Polar codes in fading.
- We obtained security of Polar codes in multipath have a better performance than singlepath fading in blocklength 128 by improvement of 13 dB at average BER of 10-3.
- We will evaluate the real-field performance of the propose Polar code-based physical layer security with USRP as illustrated in Fig. 2.

Current Progress 5: Rateless Accumulate Tornado Codes

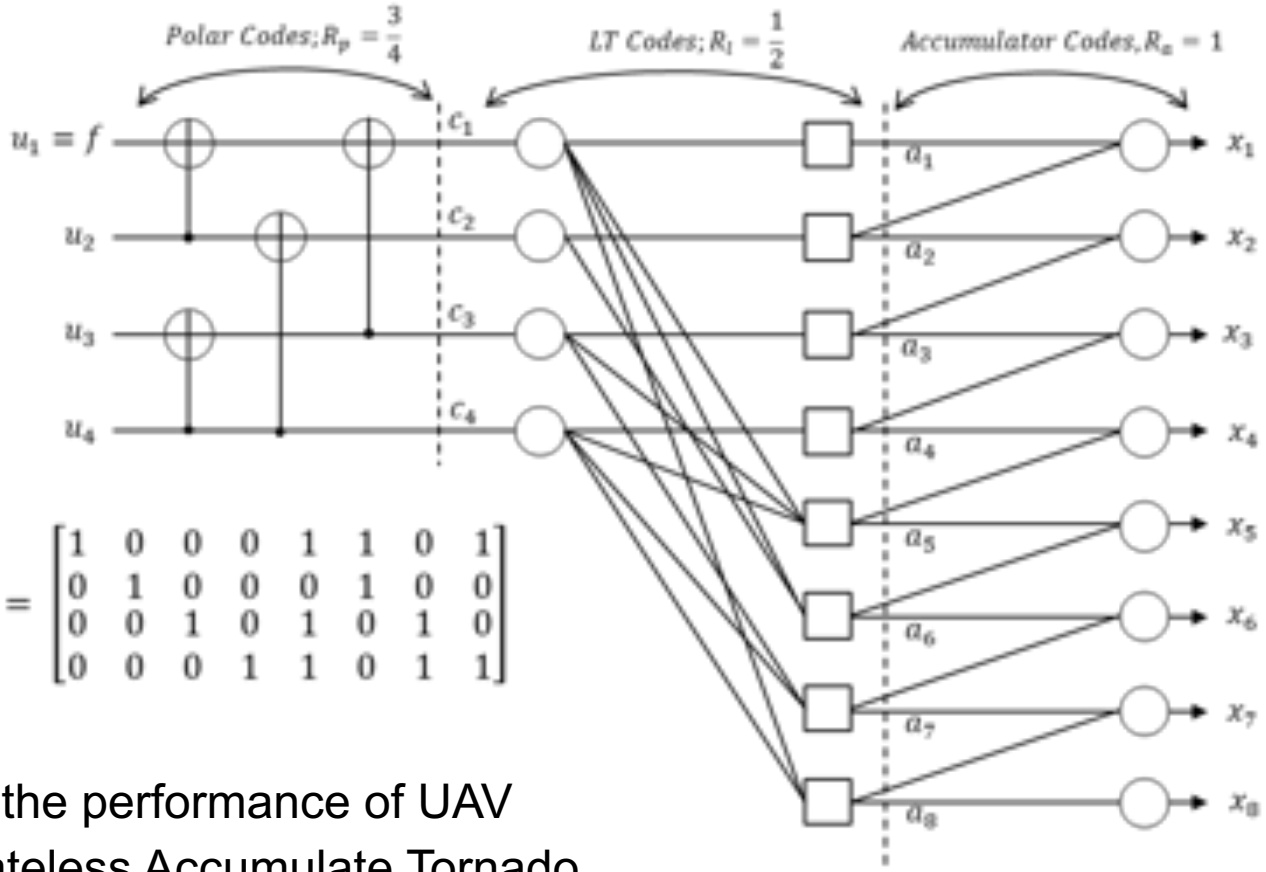
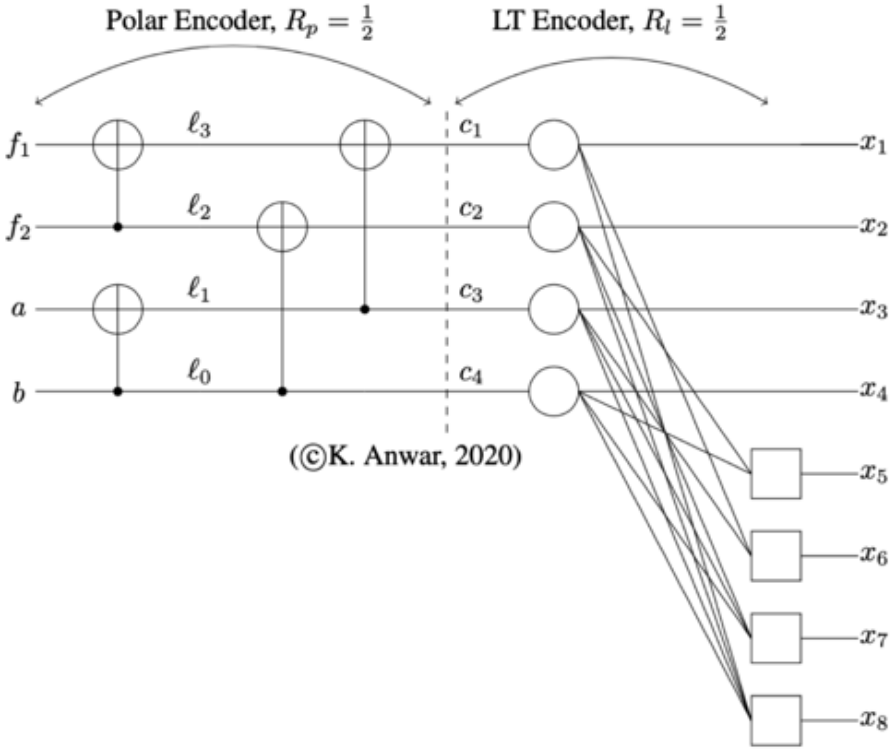


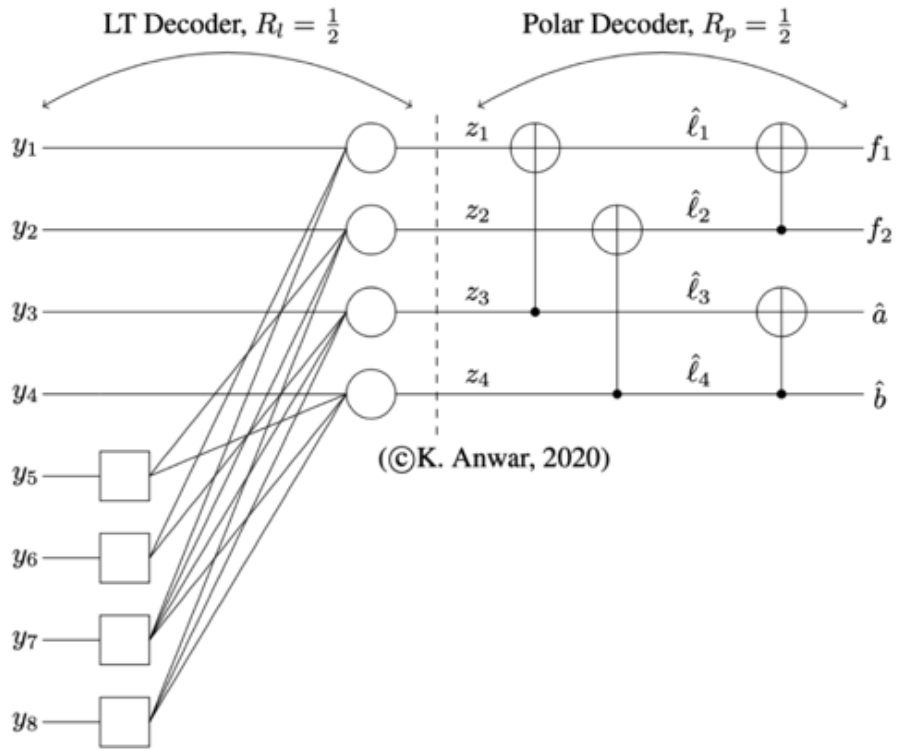
Figure 2. Construction of Rateless Accumulate Tornado Codes, in the transmitter side.

$$G_{Polar} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 \\ 1 & 1 & 1 & 1 \end{bmatrix} \quad G_{LT} = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 1 & 1 \end{bmatrix}$$

- In order to enhance the performance of UAV communications, Rateless Accumulate Tornado Codes based on Polar-LT-Accumulator Codes will be designed.
- The proposed code is going to be explored to find the best matching parameter.
- The final result is planed for completion in Desember 2020.

Current Progress 6: Polar-LT Codes (Corrected)





$$G = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 1 & 1 & 0 & 1 & 1 \end{bmatrix}$$

$$H = \begin{bmatrix} 0 & 1 & 0 & 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 1 & 1 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Current Progress 6: Polar-LT Codes

- Rateless Polar-LT codes have been designed for UAV and HAPS communications.
- Initial results confirmed that the proposed codes work well in minus SNR.
- Improvement is needed as well as the implementation to USRP and flying them to HAPS or drone.

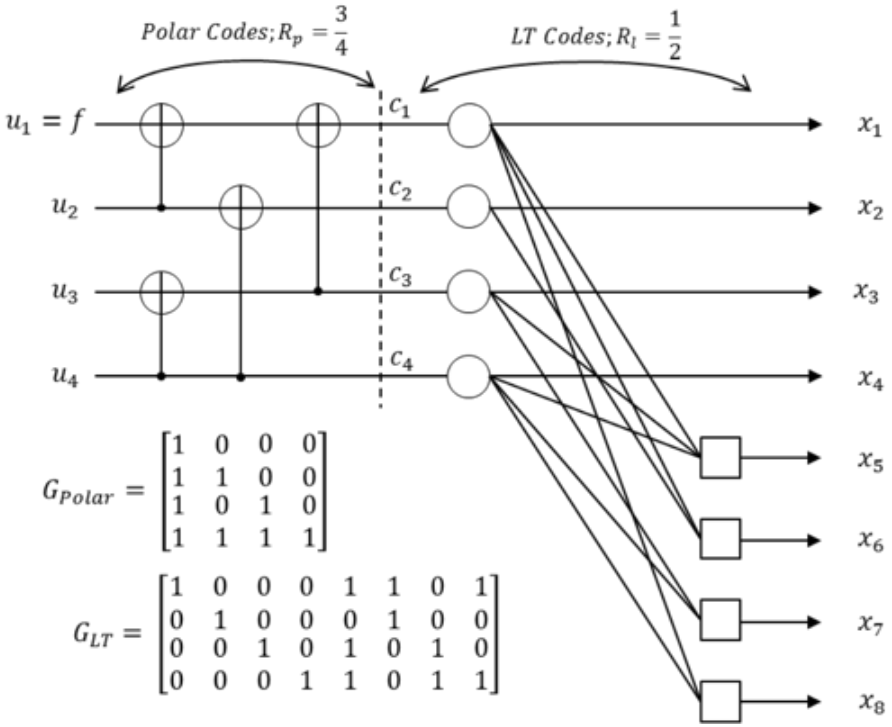
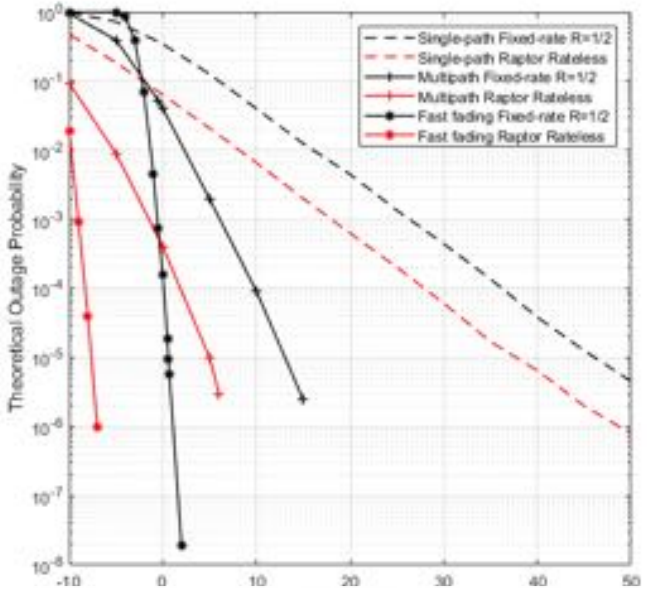
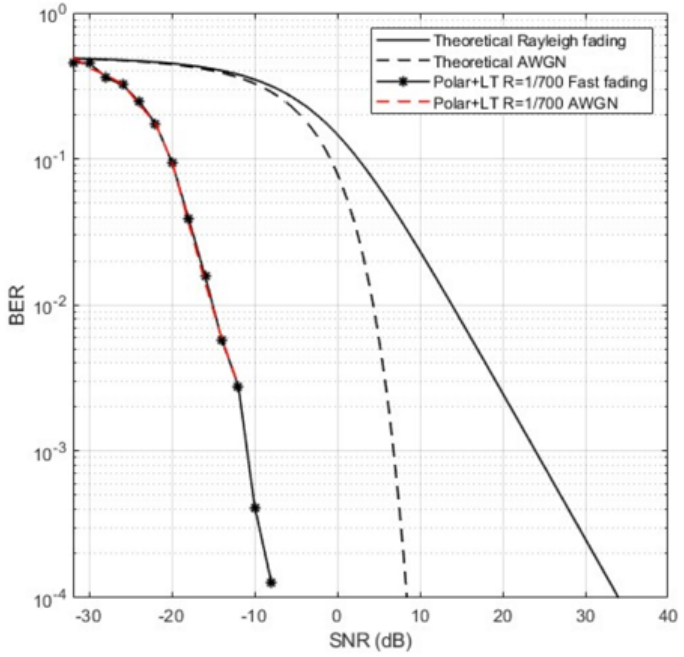
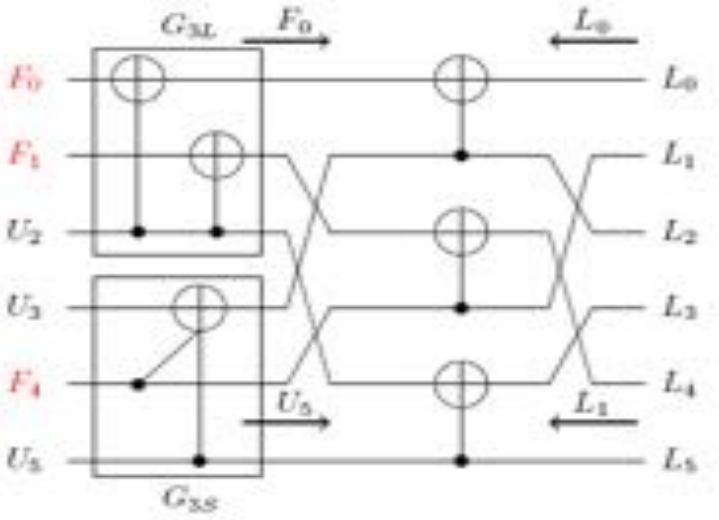


Figure 2. Construction of Polar-LT Codes, in the transmitter side.





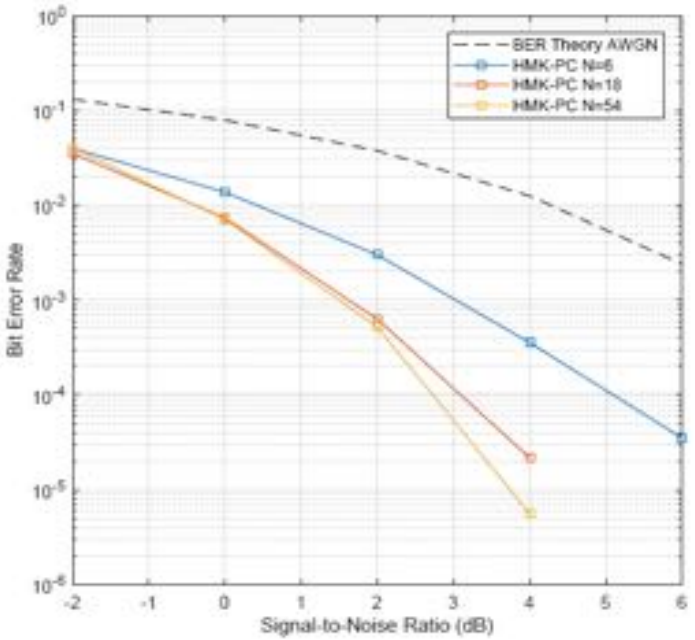
Current Progress 7: Hyrbrid Multi-Kernel Polar Codes

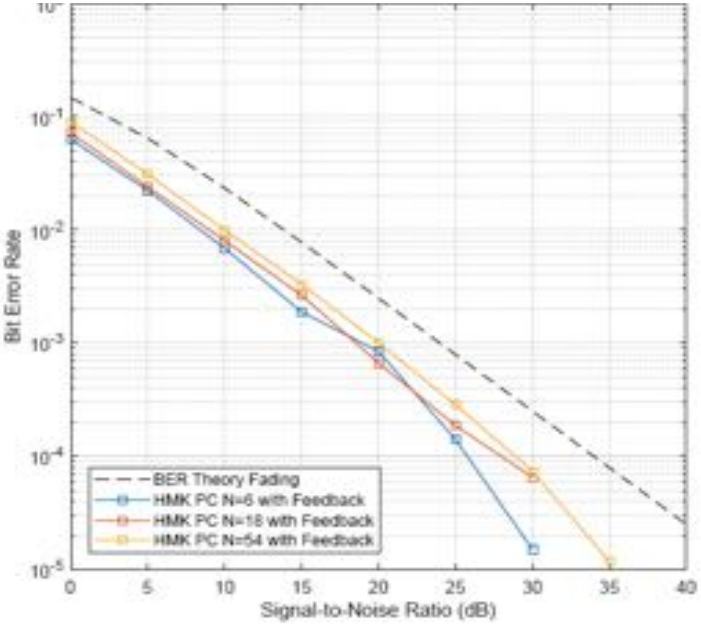


$$G_{6H} = T_2 \otimes T_{3H}$$

$$G_{6H} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 1 & 0 \\ 1 & 0 & 1 & 1 & 0 & 1 \end{bmatrix}$$

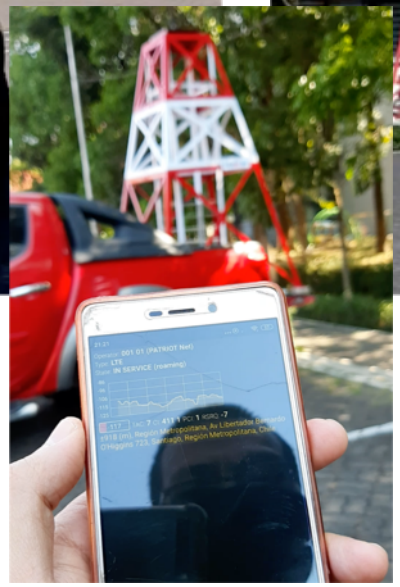
Figure 1. The Proposed Codes Constuctions: Hybrid Multi-Kernel Constucted Polar Codes.





- The proposed codes are designed a Hybrid Multi-Kernel Polar codes with different matrix for UAV communications,
- The initial results confrimed that the proposed codes are work well under BER Theory of AWGN and Fading channels,
- The proposed codes is going to be explore with List decoding algorithm.

Current Progress 8: MCRBS

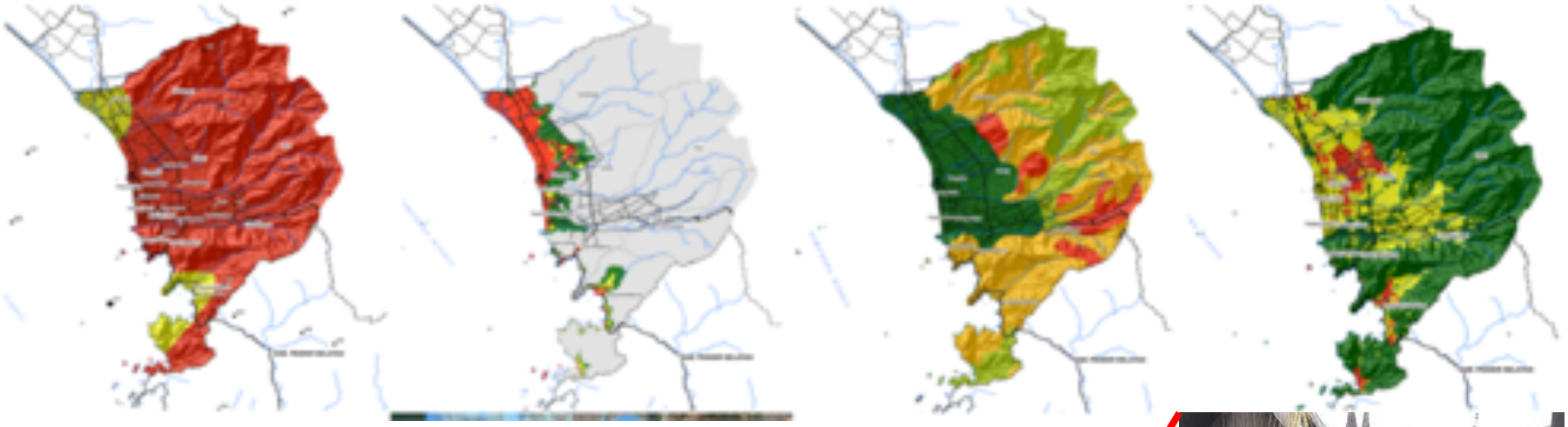


- MCRBS with antenna having capability of multiple generation detection.

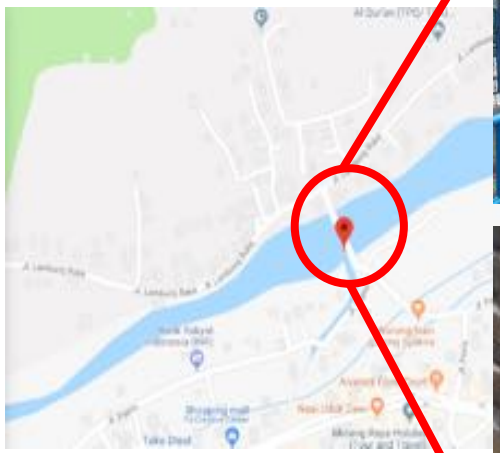
- We have proved to make connection with the mobile phone successfully.

Current Progress 9: 27 Locations of Experiment

Earthquake Tsunami Landslide Flooding



No.	Sensor	Locations	Number of sensors
1.	Tsunami	1. Muaro Batang Anai 2. Teluk Bayur 3. Muaro Batang Kuranji 4. Muaro Penjalinan 5. Pelabuhan Bungus	6
2.	Gempa	6. Air Pacah 7. Gor H. Agus Salim 8. UNP 9. Lubuk Kilangan	4
3.	Banjir	10. Nanggalo 11. Pintu Air Gunung Nago 12. Rawang Mata Air	5
	Banjir Bandang	13. Batu Busuk 14. Limau Manis Selatan 15. Tunbalun	
4.	Longsor	16. Bukit Gado-gado 17. Panorama Srimjau Laut 18. Gates	12
		Jumlah	27



Japan Visit (JAIST, 5GMF, and NICT)

Fig 1. MOU with JAIST, Ishikawa, Japan

Fig 2. Visiting ASEAN IVO project member, Brian Kurkoski at Ishikawa, Japan

Fig 3. Attending 5G International Symposium 2020

Fig 4. Meeting at NICT, Tokyo, Japan

Scientific Contributions July 2019-May 2020: Conference (1/3)

Published in Conference Papers:

No:	Paper title:	Author names	Affiliation	Conference name:	The date of the conference	The venue of the conference
1.	Extrinsic Information Transfer (EXIT) Analysis for Short Polar Codes	Fauzil Mufassa and Khoirul Anwar	Telkom University	3rd International Symposium on Future Telecommunication Technologies (SOFTT2019)	18-20/10/2019	UTM, Kuala Lumpur, Malaysia
2.	Biconical Antenna for Mobile Base Station for Post Disaster Area Wireless Communications	Dammar Adi Sujiansyah, Khoirul Anwar and Aloysius Adya Pramudita	Telkom University	SOFTT 2019	18-20/10/2019	UTM, Kuala Lumpur, Malaysia
3.	Cellular Communications-based Detection to Estimate Location of Victims Post-Disaster	Tides Anugraha, Khoirul Anwar and Sigit Jarot	Telkom University	SOFTT 2019	18-20/10/2019	UTM, Kuala Lumpur, Malaysia

Scientific Contributions July 2019-May 2020: Conference (2/3)

Published in Conference Papers:

No:	Paper title:	Author names	Affiliation	Conference name:	The date of the conference	The venue of the conference
4.	Interference Mitigation using Adaptive Beam-forming with RLS Algorithm for Coexistence between 5G and Fixed Satellite Services in C- Band	Cahya Budi Muhammad and Khoirul Anwar	Telkom University	IEEE ICERA 2019	12/2019	Yogyakarta, Indonesia
5.	On the Design of Optimal Soft Demapper for 5G NR Wireless Communication Systems	Alhamdi Syukra, Khoirul Anwar, and Desti Madya Saputri	Telkom University	The IEEE 10th Electrical Power, Electronics, Controls, Communications, and Informatics Seminar (EECIS) 2020	08/2020	Malang, Indonesia

Scientific Contributions July 2019-May 2020: Conference (3/3)

Published in Conference Papers:

No:	Paper title:	Author names	Affiliation	Conference name:	The date of the conference	The venue of the conference
6.	Experiment of Routing for Mobile Cognitive Radio Base Station (MCRBS)	Luthfi Fauzi, Khoirul Anwar, and Hafidudin,	Telkom University	The IEEE 10th Electrical Power, Electronics, Controls, Communications, and Informatics Seminar (EECIS) 2020	08/2020	Malang, Indonesia

Scientific Contributions July 2019-May 2020: Journal (1/3)

Published in Journal Papers:

No:	Paper title:	Author names	Affiliation	Journal name:	The publisher of the Journal	The volume number and Pages
1.	Study on Error Correction Capability of Simple Concatenated Polar Codes	Robin Sinurat, Muhamad Rizki Maulana, Khoirul Anwar, and Nanang Ismail,	Telkom University	Accepted in International Journal on Advanced Science, Engineering and Information Technology (IJASEIT), February 2020.		Accepted
2.	Communication System for High Speed Flying Devices with Repetition Codes	Dwi Juniarto, Khoirul Anwar, Dharu Arseno	Telkom University	Journal of Measurement, Electronic, Communication, and Systems, April 2020. (https://journals.telkomuniversity.ac.id/jmecs).	Telkom University	Published

Scientific Contributions July 2019-May 2020: Journal (2/3)

Published in Journal Papers:

No:	Paper title:	Author names	Affiliation	Journal name:	The publisher of the Journal	The volume number and Pages
3.	Indonesia 5G Channel Model Under Foliage Effect	Khoirul Anwar, Evander Christy, and Rina Pudji Astuti,	Telkom University	Buletin Pos dan Telekomunikasi, Volume 17 No. 2 Dec. 2019, https://online.bpostel.com/index.php/bpostel/article/view/170201.	Kominfo	Published
2.	Study on Early Warning Systems (EWS) for Indonesia Digital	S. F. Nurbadri, K. Anwar, D. Arseno	Telkom University	Journal of Measurements, Electronics, Communications, and Systems (JMECS), August 2020.	Telkom University	Published

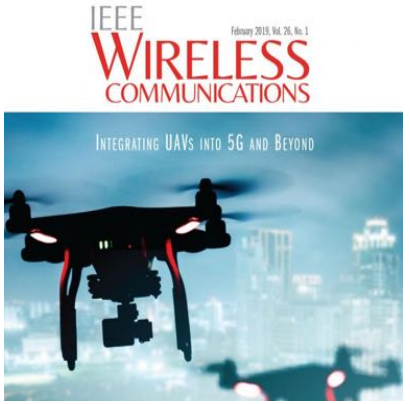
Scientific Contributions July 2019 – May 2020: Journal (3/3)

To-be Submitted Papers:

No:	Paper title:	Author names	Affiliation	Journal name:	The publisher	The volume number and Pages
1.	Simple Irregular Tornado Codes for Internet-of-Things Communications	Khoirul Anwar	Telkom University	IEEE Trans on Wireless Comm.	IEEE	To be submitted (this month)
2.	Wireless Access Networks Based on Coded Random Access for Simultaneous Multiple Natural Disasters Monitoring With Real Time Notifications	KHOIRUL ANWAR, WILLY ANUGRAH CAHYADI, SURYO ADHI WIBOWO,	Telkom University	IEEE Communications Magazine	IEEE	To be submitted (this month)
3	Polar Lattice	Obed Resha, Brian Kurkoski, and Khoirul Anwar	Telkom University and JAIST, Japan	IEEE International conference	IEEE	To be submitted
4.	Construction D' Lattices Quasi Cyclic Low Density Parity Check Codes	Arini Fitriyani, Brian Kurkoski, and Khoirul Anwar	Telkom University and JAIST, Japan	IEEE International conference ICC 2021	IEEE	To be submitted

Societal Impact of PATRIOT-41R-Net Project

- With this PATRIOT-41R-Net project, the people can have **direct access to the level of danger** in their living places.
- People will be **well prepared** about when they should leave or when they should keep staying.
- Furthermore, the government can have **accurate information** about what is happening due to the full information access provided in their monitoring room → can **inform people** with decision supported by accurate information source.
- Lesson learned from **real-field experiment** and real-field parameters for ASEAN countries.
- Submitted to **recommendation/standardization in** Asia Pacific Wireless Group and ITU.
- The impacts of PATRIOT-41R-Net project may also go indirectly to the economy of ASEAN people, especially when 4 sensors are **massively produced** by manufacture of in each country.
- The successful of this project will also impact to the **change of public policy rules.**



Conclusions

- This PATRIOT-41R-Net project proposes Airborne capability using drone and/or HAPS for disaster recovery networks.
- Airborne capability is performed using drone and/or HAPS to: (1) extend the network coverage and (2) find the victims.
- The rateless Polar-LT codes are developed to make networks communications stable and reliable.
- The project considers UAV channel modeling for reference of experiment.
- WP2, WP3, and WP5 are being tested in Year 1.
- WP4 and WP6 are to be experimented in Year 2.

Future works: Roadmap of PATRIOT-41R-Net

- **Year 1: July 2019 – June 2020**
  - *a. Kick-Off Meeting, Bandung, Indonesia*
  - ***b. Complete the Theoretical Derivations of the proposed technique.***
  - ***c. Evaluating the Theoretical Performances***
  - *d. Writing Patents*
  - *e. Publication I of First Year (WP of Telkom University)*
  - ***f. Performing WP1: Meeting I at KL, Malaysia***
  - *g. Progress Report Meeting of Year 1*
  - **h. Experiment of WP2: MCRBS**
  - **i. Experiment of WP3: Coding**
  - **j. WP1: Meeting II Online (Covid-19)**
  - **k. Experiment of WP5: Tsunami, Researcher Exchange to NICT and JAIST, Japan (TelU, JAIST, HUST)**
  - l. Publication II of First Year (Joint with Other Teams)

- **Year 2: July 2020 – June 2021**
  - **a. Experiment of WP4: Routing (UTM, TelU)**
  - b. Meeting III at Thailand (November 2020)
  - c. Writing Patents
  - **d. Experiment of WP6: Indonesia (TelU, AIT)**
  - e. Publications of the Year 2
  - f. Meeting IV at Vietnam
  - g. Experiment of HAPS
  - h. Progress Report Meeting of Year 2
  - i. Meeting V at Indonesia
  - **j. WP7: Tutorial/ Workshop/ Whitepaper**
  - k. Writing A Final Report

*) underline: has been completed.

Budget Allocation

- Remaining budget: 32,500 USD
- For meeting, experiment: 5500
- Progress report: 2,000
- Publication: 1 journal, 1 conference: 2,000 USD/partner → 10,000
- Equipment: 20,000
  - AIT: 2,500
  - JAIST: -
  - HUST: 2,500
  - UTM: 7,500
  - Tel-U: 7,500