“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; on the process of extension to March 2022]

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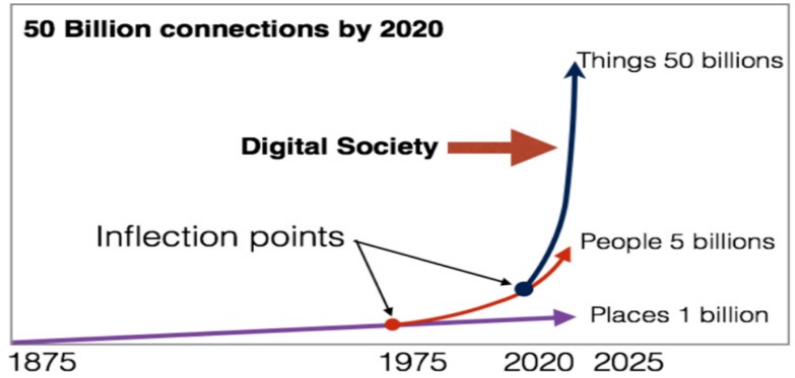
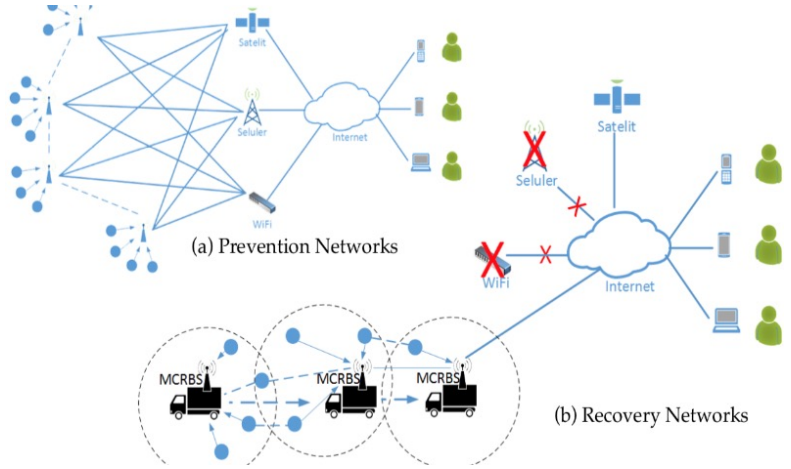
Final Project Review
November 30, 2022

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

Background :

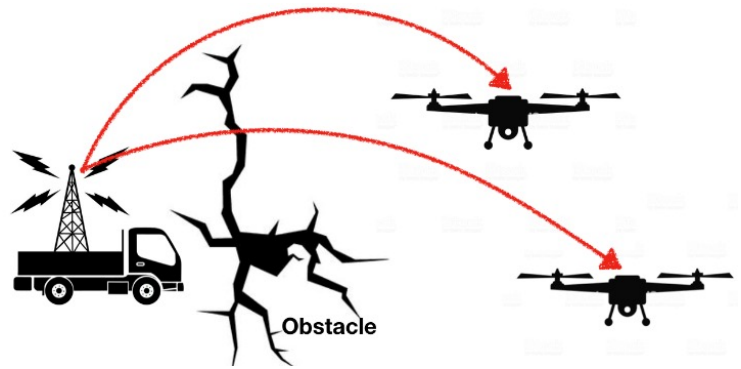
- After the disaster, telecommunication networks cannot be recovered soon and are suffering from difficulties of covering large areas.
- The rescue team and mobile base station are suffering from difficulties in finding the victims although the victim's mobile phones are active but is out-of-network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

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 University, Indonesia)
2. **Dr. Ashwin Sasongko** (Telkom University, Indonesia)
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8. **Oktaza Recy** (Telkom University, Indonesia)
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11. **Dr. Rudzidatul Akmam Dziyauddin** (UTM, Malaysia)
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15. **M. Bagir Qauman** (Telkom University, Indonesia)
16. **M. Daffa Abdillah** (Telkom University, Indonesia)

Project Duration :

24 Months (July 2019 – June 2021, Extended to March 2022)

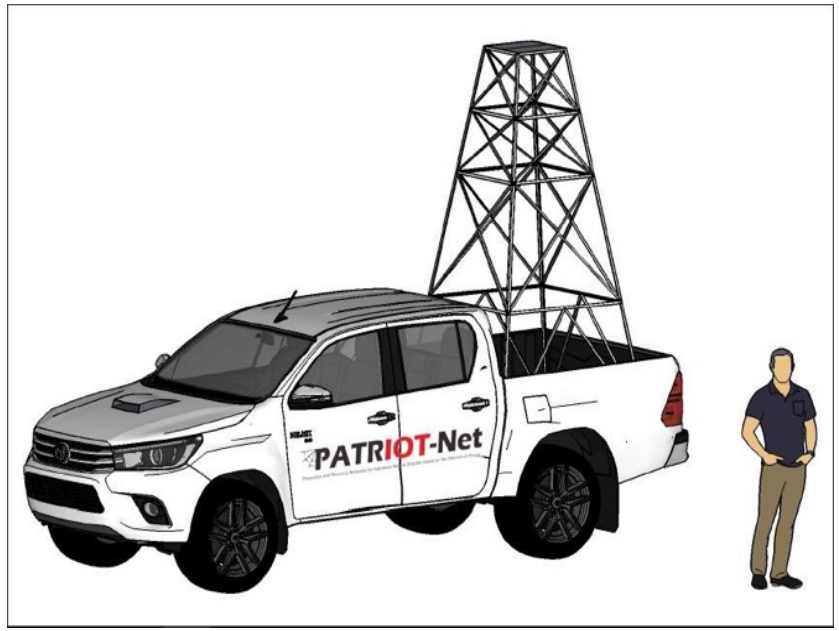
Project Budget :

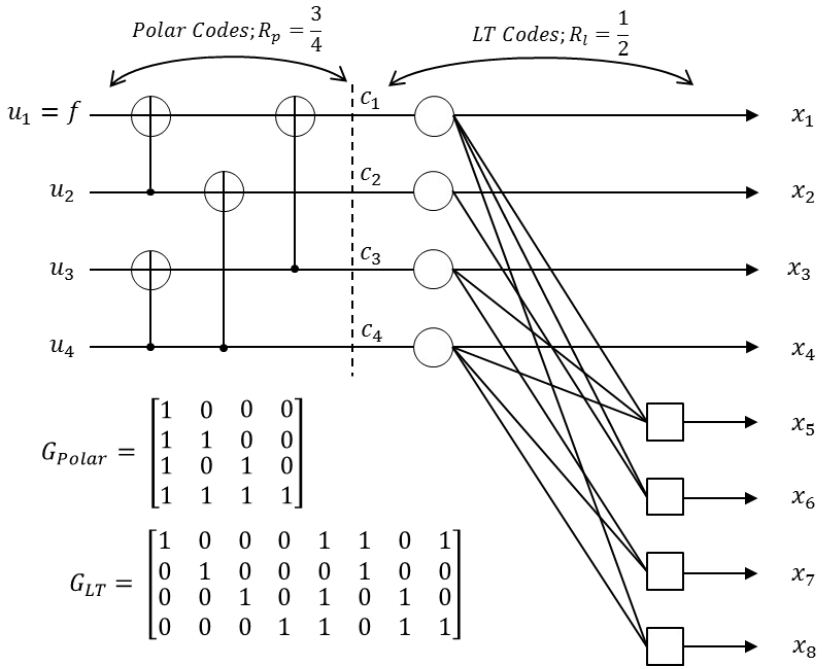
Budget Allocation : USD 40,000
Used : USD 23,660
Remaining: : USD 16,340

Achievement 1: Channel Coding for UAV

Rateless 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.





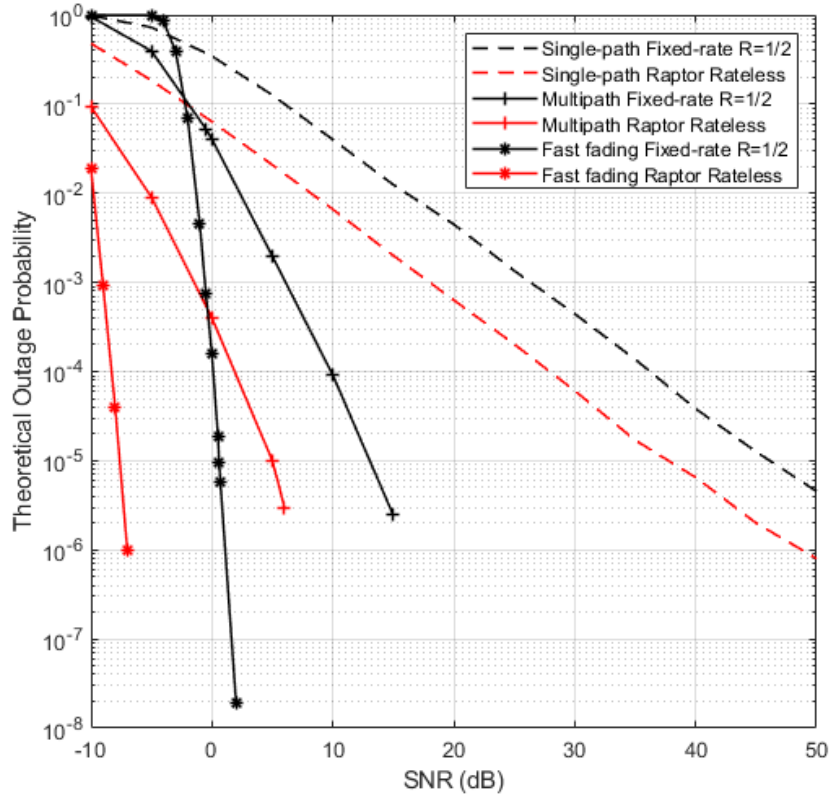


Figure 1. Construction of Rateless Polar-LT Codes.

Achievement 2: Security with Polar Codes

- 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.

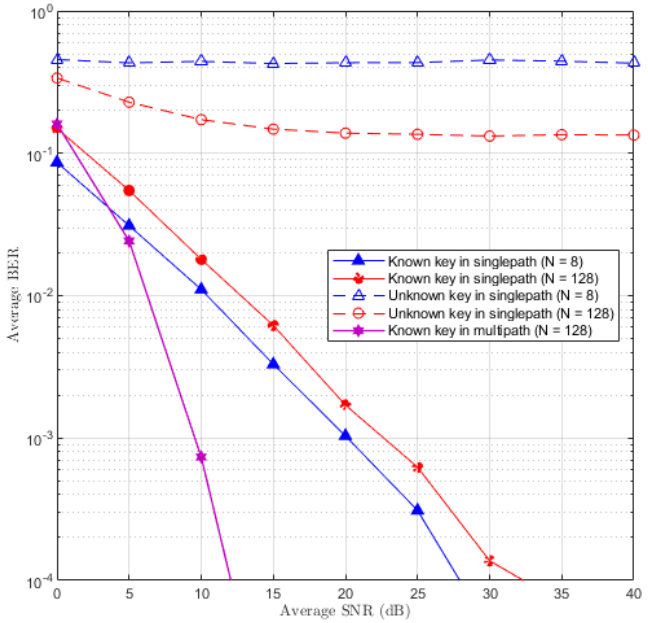


Figure 1. Security Polar in singlepath and multipath fading

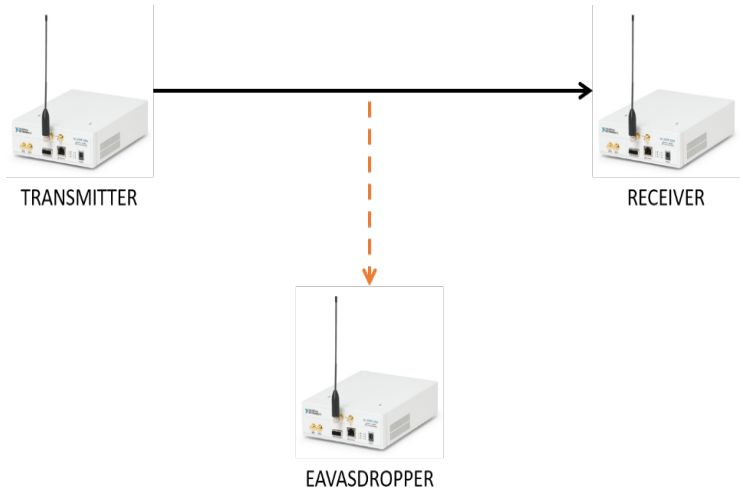
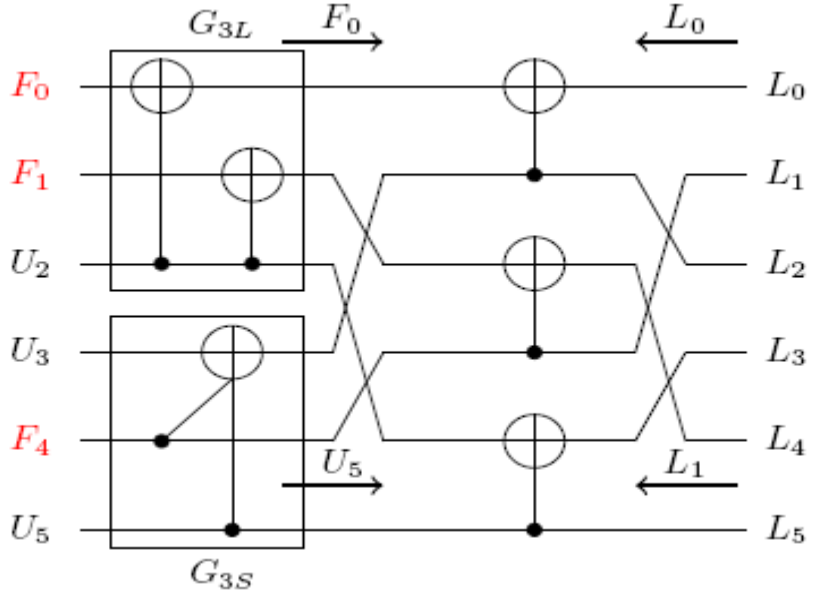
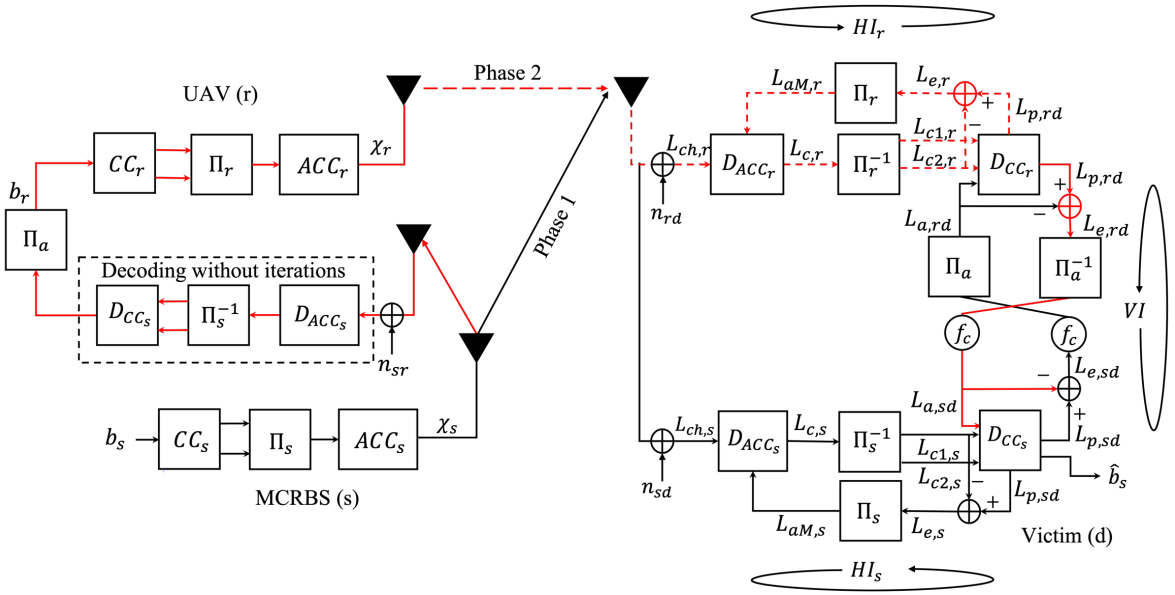


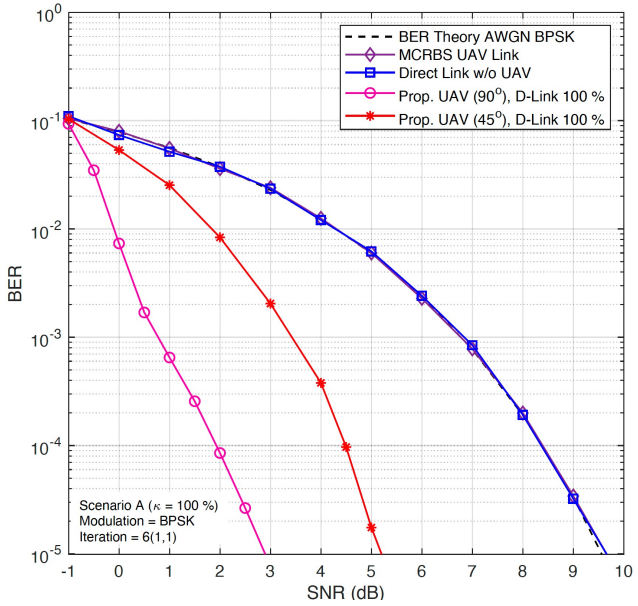
Figure 2. Polar security scenario with USRP



Achievement 3: Simple Virtual Turbo Codes

- We have proposed Turbo coding scheme that involving MCRBS and UAV, where the Turbo decoding combines signal from both MCRBS and UAV.
- We have obtained the simulation performance about simple virtual Turbo codes in AWGN and Rayleigh fading channels.
- The proposed UAV utilize: (i) 90° and 45° configurations, (ii) p is used in fc(·) to update the LLR from the VI.
- Our proposed simple virtual Turbo coding scheme shows the improvement is coming from the virtual Turbo decoded gathered signal from both MCRBS and UAV.





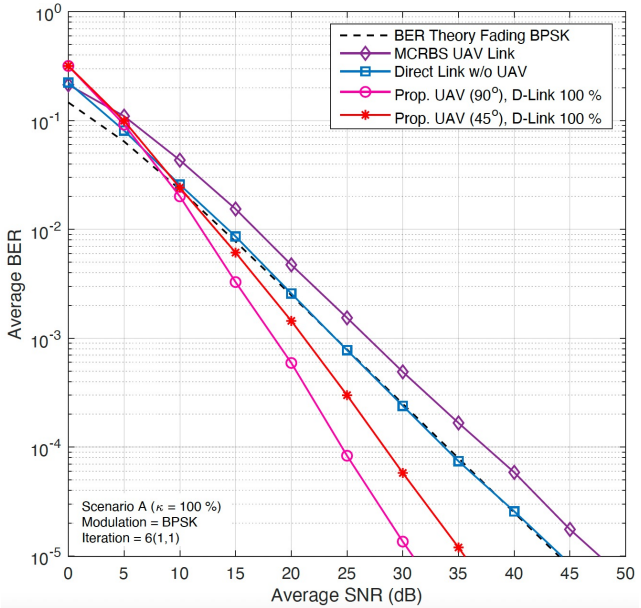
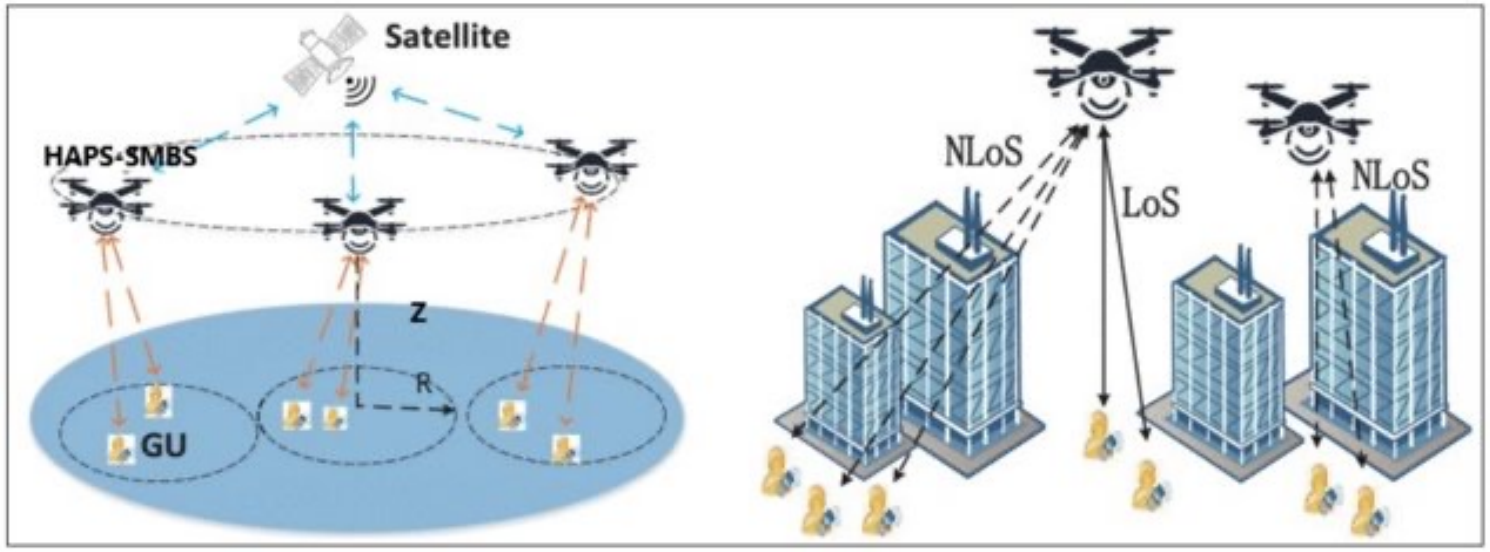
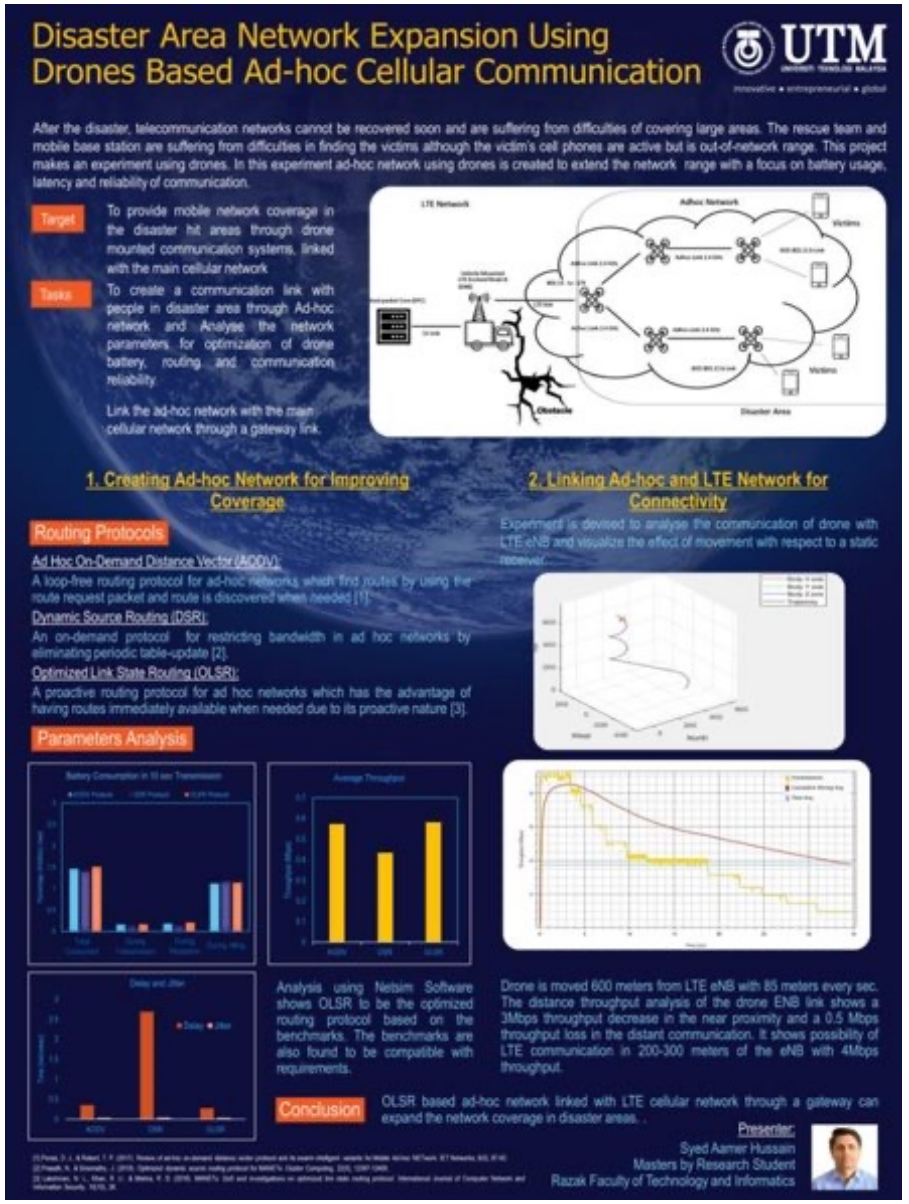


Figure 1. The Proposed Codes Constuctions: Simple Virtual Turbo Codes

Achievement 4: HAPS Positioning using Deep Learning





- Increasing the number of HAPS to provide connectivity for the users with different movements might work but that makes the network too much expensive and almost impractical. Hence, optimization of the available HAPS's positions can solve the problem cost effectively. Deep Machine Learning can be used to solve this problem. Moreover, if the positioning can be done a month ahead, it can be proved to be more efficient.
- The results show that if the user locations are predicted accurately by solving the optimization problem, then it is possible to provide faster and reliable continuous 5G connection with better performance to the users in cases of both normal and disaster scenarios.

Japan Visit (JAIST, 5GMF, and NICT)

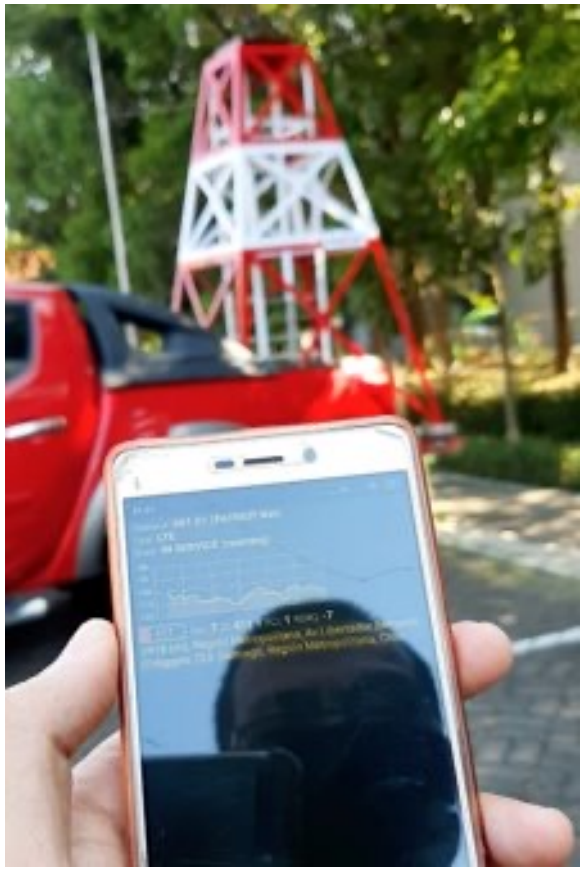
Fig 1. MOU with JAIST, Ishikawa, Japan

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

Experiment: MCRBS and UAV



- Drone experiment in 2022 for communications over the cellular networks.
- We have proved to make connection with the mobile phone successfully in 2020.

Scientific Contributions Jul, 2019 – Mar, 2022: Conference and Patent (1/2)

Presentations at International Conferences:

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
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
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
7.	Hybrid Multikernel-Constructed Polar Codes for Short Blocklength Transmissions	Cita Aisah Nurbani, Khoirul Anwar, and Willy Anugrah Cahyadi	Telkom University	17th Int. Wireless Communications & Mobile Computing Conference (IWCMC 2021)	June 28 - July 02, 2021	Harbin, China

Scientific Contributions Jul, 2019 – Mar, 2022: Conference and Patent (2/2)

No:	Paper title:	Author names	Affiliation	Conference name:	The date of the conference	The venue of the conference
8.	Design of Polar Code Lattices of Finite Dimension	Obed Rhesa Ludwinianandа[1], Ning Liu[2], Khoirul Anwar[1], and Brian M. Kurkoski[2]	[1]Telkom University, [2]Japan Advanced Institute of Science and Technology	2021 IEEE International Symposium on Information Theory (ISIT 2021)	July 12-20, 2021	Melbourne, Victoria, Australia
9.	Encoding and Decoding Construction D' Lattices for Power-Constrained Communications	Fan Zhou[1], Arini Fitri[2], Khoirul Anwar[2], and Brian M. Kurkoski[1]	[1]Japan Advanced Institute of Science and Technology, [2]Telkom University	2021 IEEE International Symposium on Information Theory (ISIT 2021)	July 12-20, 2021	Melbourne, Victoria, Australia
10.	Design of Rateless Polar Accumulate Tornado Codes Using EXIT Chart for UAV Communications	Citra Dewi Anggraeni and Khoirul Anwar	Telkom University	The 2021 IEEE Symposium on Future Telecommunication Technologies (SOFTT)	December 06-07, 2021	Bandung, Indonesia (Virtual)
11.	Simple Virtual Turbo Codes for Unmanned Aerial Vehicle (UAV) Communications	Okzata Recy and Khoirul Anwar	Telkom University	The 2022 IEEE Symposium on Future Telecommunication Technologies (SOFTT)	November 14-16, 2022	Johor Bahru, Malaysia (Hybrid)

Patent:

No:	Patent Title:	Inventor:	Affiliation:	Date of Submission:	Number of Patent :	Country:	Status:
1.	Antena Pita Lebar untuk Pemulihan Sinyal Komunikasi Pasca Bencana (Broadband Antenna for Network Recovery Post-Natural Disaster)	Khoirul Anwar and Dammar Adi Sujiansyah	Telkom University	July 07, 2021	P00202105209	Indonesia	Submitted
2	Teknik Pengkodean Kanal dengan Rate Adaptif untuk Teknologi Komunikasi Nirkabel	Khoirul Anwar and Citra Dewi Anggraeni	Telkom University	September 15, 2022	P00202209894	Indonesia	Submitted
3	Teknologi Telekomunikasi Relay untuk Wahana Terbang Tak Berawak*	Khoirul Anwar and Okzata Recy	Telkom University	To be submitted	To be submitted	Indonesia	To be submitted

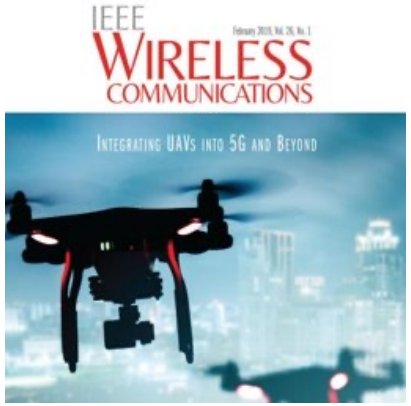
Scientific Contributions Jul, 2019 – Mar, 2022: Journal

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	International Journal on Advanced Science, Engineering and Information Technology (IJASEIT), February 2020.	INSIGHT - Indonesian Society for Knowledge and Human Development	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.	Telkom University (https://journals.telkomuniversity.ac.id/jmecs).	Published
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,	Kominfo https://online.bpostel.com/index.php/bpostel/article/view/170201.	Published
4.	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
5.	HAPS-SMBS 3D Installation for 5G FANET Performance Optimization Using a DNN, WCOP and NetSim Based Scheme	Joyeeta Rani Barai and Attaphongse Taparugssanagorn	AIT, Thailand	International Journal of Sensor Networks (IJSNET)	International Journal of Sensor Networks	Vol. 40., No.1, 2022
6.	Microstrip Rotman Lens for Mobile Base Station Backbone in Disaster Area Networks	Novia Nurhidayah Prihatiningtyas, Khoirul Anwar, Aloysius Adya Pramudita	AICOMS, Telkom University	International Journal on Advanced Science, Engineering, Information and Technology (IJASEIT)	INSIGHT - Indonesian Society for Knowledge and Human Development	August 2022

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

- PATRIOT-41R-Net project has proposed Airborne capability using drone and/or HAPS for disaster recovery networks and made successful achievement until 2022.
- Airborne capability is performed using drone and/or HAPS to: (1) extend the network coverage providing wireless connection, and (2) find the victims after communications with the RESCUER.
- The rateless Polar-LT codes are developed to make networks communications stable and reliable since the the coding rate can adapt to the change of capacity due to varying disaster environment.
- The project considers UAV channel modeling for reference of experiment.
- WP2, WP3, and WP5 were tested in Year 1.
- WP4 and WP6 were experimented in Years 2 and 3.

Future Works: Roadmap of PATRIOT-41R-Net

ASEAN IVO Y1:
Coding and MCRBS

2019-2020

ASEAN IVO Y2:
MCRBS II and UAV over Cellular

2021-2022

ASEAN IVO Y3 (Expected):
MCRBS III (AI) and UAV with Autonomous System

2023-2025

ASEAN IVO Y4 (Expected):
MCRBS IV (AI+Quantum) and UAV with Autonomous System for logistics

2026-2028

ASEAN IVO Y5-Y6 (Expected):
MCRBS V (AI+Quantum) Becomes 6G

2028-2030

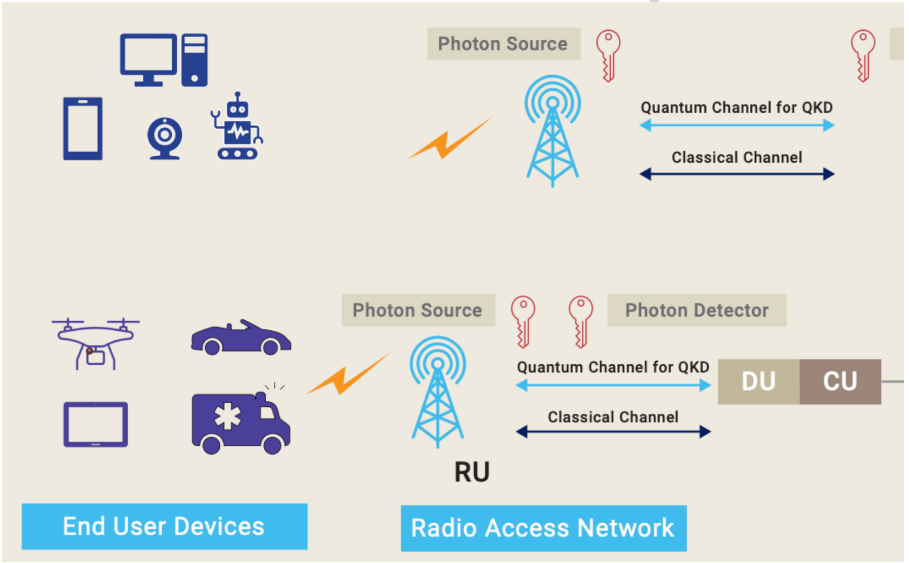


image: NEXTG Alliance, 2022.