Optimal resource allocation for UAV communication systems in disaster management

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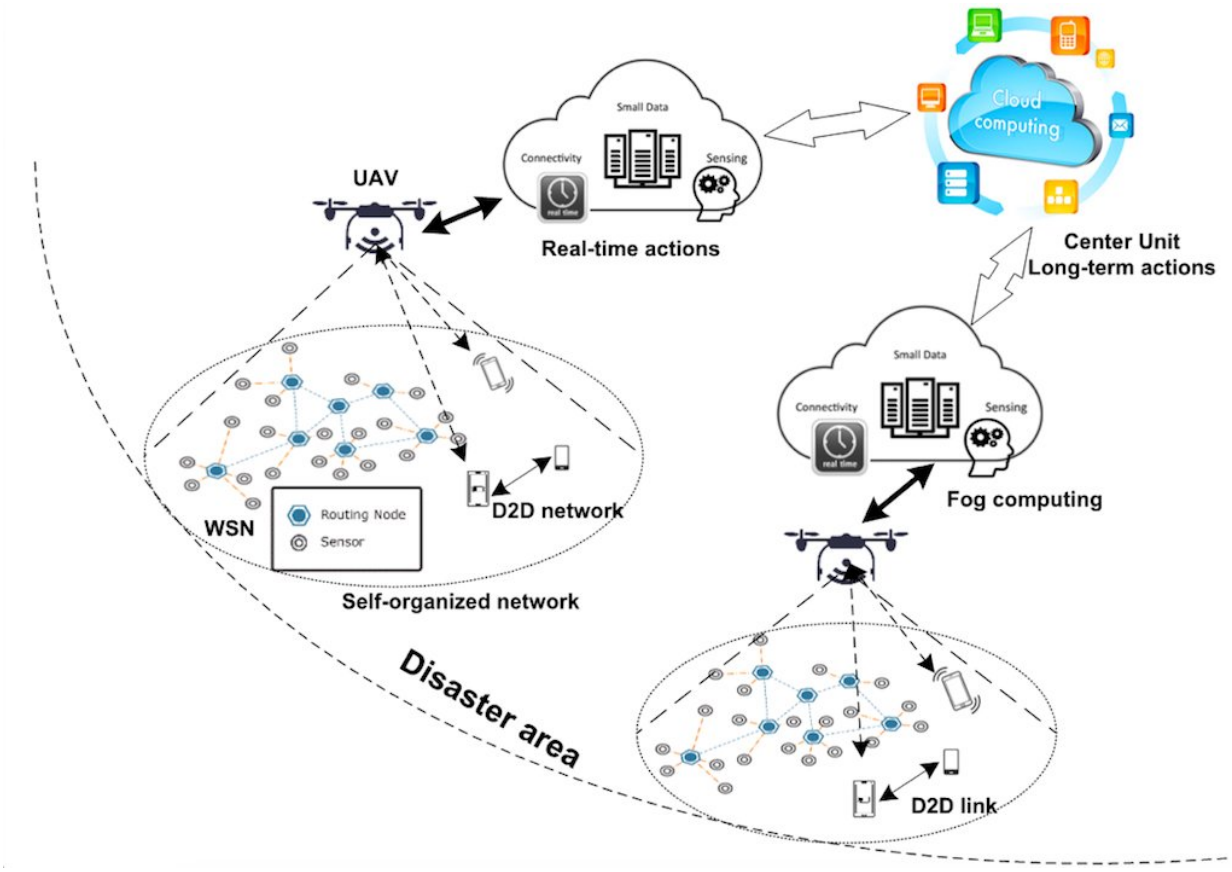

Real-time UAV communications system for disasters scenario. Credit: Duong et al.

Researchers at Queen's University Belfast (QUB) and Duy Tan University (DTU) have been collaborating on a project aimed at improving the communication systems of unmanned aerial vehicles (UAV). Their research was awarded the Newton Prize 2017, receiving £200,000 by the UK government for the development of a new communication system that can work in extreme weather conditions and at times of natural disasters.

Between 2015 and 2017, the same team of researchers had been working on a project funded by the Newton grant and managed by the British council, called "Building a foundation for sustainable development networked societies for the cities of tomorrow." This project was aimed at leveraging contemporary wireless technology and infrastructure to meet the demands for connectivity in the context of natural disasters in Vietnam.

"After successfully completing our project in April 2017, we were invited to submit our results and future plans to the call for Newton Prize 2017," Trung Duong, one of the researchers who carried out the study told TechXplore. "Among approximately 200 Newton Fund projects submitted, our project was in the last five winners. We are proud to have been awarded the Newton Prize 2017 and continue to develop our project to the next step by using unmanned aerial vehicles (UAVs) in mission critical communications for disaster management."

At times of extreme weather conditions or during natural disasters, technology could make a huge difference, helping to save lives and providing assistance to people living in affected areas. UAVs could play a key role in this, as they could help to reach parties involved and carry valuable resources.

In their recent study, which was published on *IEEE Wireless Communications Letter* and pre-published on arXiv, the researchers

developed a real-time resource allocation algorithm that could maximize energy efficiency for communications embedded within UAVs. Their algorithm works by jointly optimizing the energy-harvesting time and power control for device-to-device (D2D) communications between UAVs.

"Optimisation is central to any problem involving decision making, whether in engineering, economics or society," Duong explained. "In wireless communications, optimisation techniques are often used to choose or update the system parameters, to optimise network performance. However, these optimisation algorithms typically solve optimisation problems in minute or hour timescales."

Traditional convex optimisation methods are currently still expensive and implementing them can be extremely time-consuming. This calls for the development of new methods, which could be particularly beneficial when applied at times of emergency or natural disasters.

"In mission-critical communications supporting disaster management such as fire brigades, rescue teams, and emergency medical service, the time is a critical factor (e.g. with a minimum latency of millisecond to seconds)," Duong said. "A strict real-time deadline is the most important requirement for such scenarios, particularly under a constantly changing environment."

To develop tools that can truly make a difference in emergency situations, therefore, researchers should identify ways of reducing the solving time and computational complexity of optimisation problems. The real-time resource allocation algorithm developed by Duong and his colleagues does exactly this, effectively reducing the running time down to milliseconds.

Their algorithm could be integrated within UAVs, which could be of

great help in situations where networks are congested, buildings have been destroyed, and there is a lack of power supply. In these instances, UAVs that are flying above the affected area could help first responders to assess the situation as quickly as possible.

"UAVs strictly rely on batteries to operate, and hence, for UAVs to remain airborne longer, their amount of resources (including batteries, bandwidth, etc.) must be well optimized," Duong explained. "This is very important for conducting successful search and rescue missions within the first 72 hours of the disaster, considering that commercially available UAVs can only remain airborne for approximately 20 minutes. Therefore, maximizing the lifetime of a multi-UAV communication network is vital for such applications."

During and after natural disasters, disrupted telecommunications infrastructure can often prevent emergency responders and evacuation crews from fulfilling their missions. By reducing UAV communication time down to milliseconds, the optimal resource allocation algorithm for UAVs developed by Duong and his colleagues could help to save lives and provide timely assistance to survivors.

"In natural disasters, keeping communication connectivity provides a lifeline," Duong said. "The lack of communications in remote areas and poor conditions for communications in developing countries can have detrimental effects. We believe that our research for real-time optimisation in UAV communications is the first attempt in the field to tackle time constraint of UAV, which will play a crucial role in disaster scenarios."

Currently, the team working on this Newton fund project is comprised of 3 post-doctoral and 4 PhD students. These researchers will now continue working on their meaningful endeavour, focusing on a number of further theoretical and practical aspects.

"Our next step is to exploit cutting-edge technologies, (e.g. distributed and parallel computing) and integrate machine learning into the context of real-time optimisation, to boost the processing time," Duong said. "We will also continue disseminating our research via high-impact scientific journals, at conferences, and to industry partners."

More information: Real-time optimal resource allocation for embedded UAV communication systems. arXiv:1809.01710v1 [cs.IT]. arxiv.org/abs/1809.01710 , ieeexplore.ieee.org/document/8457275/

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