One of the goals of the fifth generation (5G) cellular network is to support a much higher data capacity (e.g., 1,000 times higher than today~~'s~~ current capacity). Despite its common usage, device to device (~~the~~ D2D) communications were used in different disciplines to mean other things. ~~The device to device (D2D)~~ communication acts as the relying functionality and includes multi-hops to improve cellular downlink throughput performance~~s~~. Therefore, most studies in the field of D2D communications have focused on multi-hop relay-assisted out-band D2D communications to ~~fulfil~~ increase overall ~~those~~ performances. In this context, ~~the~~ this study ~~scope here is~~ aims to ~~extending~~ the number~~s~~ of ~~the~~ hop~~s~~ in the communication link to efficiently reduce the receiving bit error ratio, ~~efficiently~~ and ~~thus~~ in turn improve the wireless coverage services efficiency [1, 2].

D2D communication~~s~~ are used under a centralized control by the cellular network to increase system capacity, energy/spectrum efficiency, and improve the wireless coverage in the public safety network. In ~~the~~ natural disaster event~~s~~, ~~the~~ coverage services to help ~~secure the~~ people is an essential requirement when the wireless network is damaged and unable to provide ~~the~~ wireless coverage service to user devices [4, 5,6]. The relay assisted D2D network ~~used~~ uses ~~to~~ the achievable transmission capacity of multi-hop D2D system over Rayleigh fading channels. ~~Then t~~The ~~conceivable the~~ optimal design of D2D parameters and ~~evaluate~~ the influence of the number of relays hops on the system capacity and power efficiency are evaluated [7]. The role of UAVs and multi-hop D2D communications is to ~~be~~ provide reliable connectivity in disaster situations, and establish~~ed~~ the communication link with user devices in ~~out~~ out-of-~~of~~coverage scenarios [3].

Therefore, extending the UAV coverage through the relay hop and D2D communication ~~act to~~ improve~~s~~ the wireless coverage services, spectrum, and energy efficiency in public safety communications [8].

The optimal relay nodes act as an essential role in public safety network~~s~~ by helping the ~~UAV~~ UAV to communicate ~~with~~ in long-distance, and overcome the transmission power limitation~~s~~ [9].

~~The~~ This study aims to extend the UAV coverage through relay hops and D2D pair for a downlink unmanned aerial vehicle (UAV)-aided wireless communication system, where D2D users coexist in an underlaying manner. The UAV ~~will be~~ is able to fly and transmit wireless coverage to the relays in the disaster zone. The relays will forward the wireless coverage services to the user device in out of the UAV coverage, through multi-hop D2D communications [10,11,12]

1.1 Contribution

The UAV is used in public safety networks to increase the system capacity and spectrum efficiency under control by the cellular system. In any natural disaster event, communication recovery ~~public safety~~ plays an essential role in public safety ~~communication recovery~~ and saving lives. Therefore, UAV has limitations for the transmission distance and ~~Power~~ power to recover disaster communication. An optimal relay is a promising approach to extend~~ing~~ the coverage based on multi-hop D2D communication to improve wireless coverage services ~~in an injured area~~during disaster

events. The UAV ~~will~~ provides configuration to centralize beamforming to an optimal relay for reliable connectivity, and increases the signal strength at relay nodes to be able to link with the nodes outside the coverage area. Furthermore, an optimal relay node is ~~selecting~~ selected based on the residual energy, and link quality in the edge of UAV coverage. The performance of an optimal relay ~~will~~ increases the coverage area through increased the number of hops and reliably provides wireless coverage services to remote user devices.

2. System model

The system model is presented in Figure 1. We consider a scenario to help public safety networks in disasters situations. The ground user devices will be distributed according to the passion point process (PPP) in the disaster area. The user device in the edge of UAV coverage will be selected as relay nodes. The relay nodes R_i are able to be received wireless coverage services for the UAV, and forwarded it's to the user devices in the out of the coverage area.

The multi-hop D2D communications architecture ~~is considering extending~~ extends the UAV coverage, and improves the energy and spectrum efficiency. The UAV is deployed to provide ~~the~~ wireless coverage services to ~~the~~ ground user devices (GUDs) in the range of the UAV coverage area. The UAV ~~provided~~ provides the ~~ling~~ line of sight coverage of the GUDs in full-duplex mode, and ~~transferred~~ transfers the wireless coverage ~~singles~~ signals to the cellular system in out of the disaster zone area. Then, the relays R_i, where i=1, 2,......N to users that will receive the wireless coverage services from the UAV, and forward the wireless coverage to GUDs in out of the UAV coverage, through multi-hop D2D communication.

The main goal of this proposed model is to verify the reliability and availability of QoS signals at ground user devices receivers during ~~a~~ natural disaster scenarios. The user devices can obtain ~~the~~ wireless coverage services directly from UAV, and the GUDs out of the UAV coverage ~~get~~ obtain indirect wireless coverage services for ~~the~~ optimal relays that link directly ~~with~~ to the UAV. The ~~multi~~ multi-hope D2D communication was able to extend the coverage services for user devices ~~in~~ that are ~~the~~ far away ~~for~~ from the UAV coverage. Therefore, the optimal relay hop is a promising technology to support the fifth generation (5G) of wireless communications for extending the coverage area in the case of coverage services ~~unavailable~~ unavailability. The optimal relays can change ~~its~~ location dynamically to respond to an emergency, and have fast reconfiguration to provide effective communication and quicker disaster recovery.