SATCOM, The Future UAV Communication Link

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Abstract

Unmanned Aerial vehicles (UAVs) can transmit critical Intelligence, surveillance, and reconnaissance data right from drones when operators need real-time access to information and find it hard to wait for the return of aircraft. Artificial satellites are applied in offering communication links between different points on earth. Satellite communication can be helpful in telecommunication systems globally. SATCOM is the data and voice service that allows aircraft to communicate using satellite using air traffic control and airline operations centres at high-frequency stations and when covering the conventional ground radar. Unmanned Aerial Vehicles Satcom are applied in different aspects of real-life applications like traffic monitoring, play load delivery, surveillance, and seemingly dangerous areas. They can go where one cannot go and experience experiences that were never seen before. UAV Satcom is used when transmitting the ISR, the Intelligence and reconnaissance data right from drones, especially in situations in which the decision-makers need near real-time. All current signs show the exciting and bright future for using unmanned aerial vehicle Satcom technology. The future generations are projected to feature enhanced autonomy and improve safety standards. SATCOM can be the future communication link for UAVs. SATCOM is being used increasingly in surveys in the aftermath of any disaster.

Keywords

UAV, UAS, Satcom, Supercomputer, ISR, Live aerial observations, HALE, HAPS

Introduction

Using unmanned aerial vehicles, SATCOM can easily offer a dynamic mobile network and overcome the issue of shadowing effects from obstructions in demand, having the ability to reconfigure the equipment [1]. After comparing the satellite communication (Figure 1), the UAV-based system's reduced slant range can offer improved round trip signals and reduce free space loss. It can make the performance advantages desirable, like increasing the bandwidth and reducing power consumption. SATCOM is the data and voice service that allows aircraft to communicate using satellite using air traffic control as well as airline operations centres at high-frequency stations and when covering the conventional ground radar. Unmanned Aerial Vehicles Satcom are applied in different aspects of real-life like in the military, traffic monitoring, play load delivery, surveillance, and seemingly dangerous areas. UAVs Satcom is a light and compact satellite communication system being used on the market. It involves using deep Satcom hardware expertise and is designed to offer the Inmarsat swift broadband services during the low-swap package in providing high-quality and real-time video streaming worldwide. The UAV Satcom system is reliable fast, and it is always available. It provides operators with the ability to send and receive data beyond BVLOS(beyond visual Line of sight), which enables the operations. The users of the systems can view streaming video using drone cameras and can download UAV collected data. Using UAVs Satcom requires planning the optimal and feasible trajectories for vehicles **[1]**.
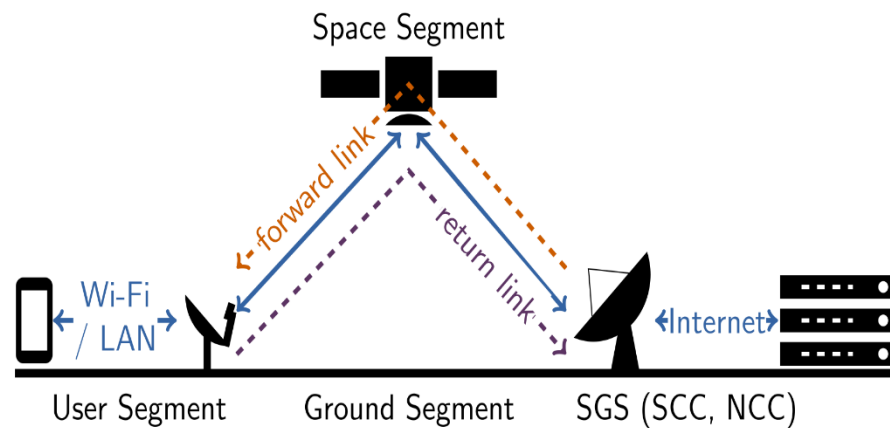
Figure 1: Satellite Communications for IP Services

The Unmanned Aerial Vehicle SATCOM systems can easily get controlled by onboard electronic equipment from the ground. When this is controlled remotely from the ground, it is termed a remotely piloted vehicle, and it needs reliable wireless communication to control. The dedicated control systems can easily be used on large UAVs. They can easily get mounted on the board vehicles to offer proximity to the UAVs, which is limited by the communications capabilities. Using different nations' Unmanned aerial vehicles, Satcom has created a new chapter of controversy that encompasses aviation navigation. SATCOM is the connectivity technology that allows unmanned aerial vehicles or drones to communicate among themselves while having the control stations or operators on the ground, and it offers aircraft tracking. The new technology has support from Inmarsat's global satellite communications network. It also provides the drones having the global connectivity and real-time video streamlining. The seamless connectivity helps offer efficient and safe aircraft management, which helps provide beyond-visual-of-sight drone operations [2]. This paper examines how SATCOM can be the future waiver for UAVs. It also presents the application of Unmanned Aerial Vehicles Satcom.

How SATCOM can be a future Communication link for UAVs

The interest in using Unmanned Aerial Vehicles SATCOM started booming in 2010 (Figure 2), and no sign shows the decline in using the technology**[2]**. All current signs show the exciting and bright future for using unmanned aerial vehicle Satcom technology. SATCOM is already being used in breaking the barriers on the way many organizations are doing their business. Companies like Google, Amazon, and Facebook apply the technology in remote locations. The future generations are projected to feature enhanced autonomy and improve safety standards. The enhancements have a chance of impacting different industrial sectors like logistics, transport, and the military. The improved camera technology works well with the improved drone technology. Due to the quality images resulting from the drone cameras and the way it continues to improve, the response teams can rely on the location as well as identify the victims more efficiently. Its efficiency can lead to increased survival rates of the victims. Drones are being used increasingly in surveys in the aftermath of any disaster, which could ease the response teams when deploying disaster relief and offering humanitarian aid to the regions affected in vulnerable areas [3].
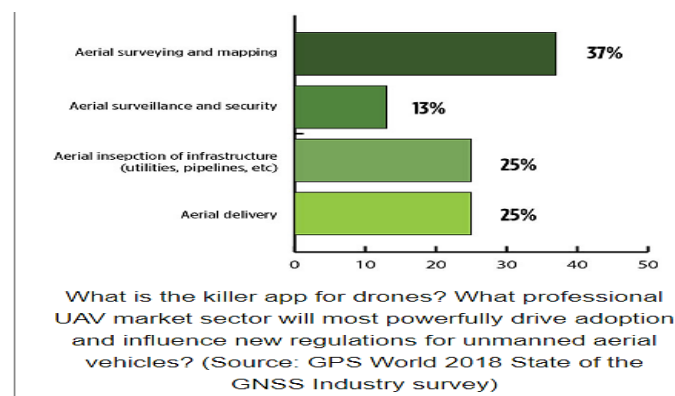
Figure 2: The graph showing overall market growth of UAV

Currently, there is a correlation between drone-based delivery to commercial goods such as amazon packages. However, the delivery aspect can have an actual application when providing health care in rural areas where it is hard to provide health care services **[3]**. Therefore, drones can easily get used in delivering deliver-time-sensitive materials like prescription refills, which can lead to timely medical care and improve the person's health journey. Unmanned aerial vehicles help cover the more enormous arrears quickly, and they can easily get equipped with the necessary tools to help generate 3D images. The double functions can be helpful during construction work because the workers can use them to gather the data used in producing different models at the start of the project and assess the construction process's progress. The elements can also lead to creating a safe, robust building, and it eases the construction team to reach the vital metrics at the right time.

How to work more closely with UAVs and SATCOM

The live aerial observations from the fields to the operations centres or control centres in videos and photos for awareness situations are paramount in different mission operations like search and rescue, disaster management, border control. Security and safety and police operations [4]. The small UAVs are used in obtaining observations but experience challenges because of the lack of adequate solutions for acquiring live images to the operators. During the critical mission operations, the observations can be accessed in real-time and shared beyond the pilot location. For UAVs flights anywhere at any time, beyond the radio line of light, it is hard for one to depend on terrestrial communications solely. Satellite communications or Satcom is needed in the form of UAVs themselves. The high-definition video and photos have provided high costs and a long delay which requires more capacity [5].

The increased use of unmanned aerial vehicles such as global Hawk aircraft and predators has contributed to making the military communication satellite bandwidth an essential aspect of the national military infrastructure. The UAV remote piloting and employing the UAV-carried sensors and the weapons can quickly turn the SATCOM band into essential in Unmanned aircraft operations. The Satcom can improve UAV's flexibility. Some unmanned aerial vehicles are critical on the modern battlefield. They help save people's lives by carrying out reconnaissance missions and offering mission-critical videos and imagery without creating any risk. The improvement in technology provides an opportunity for UAVs to be at the loft for more than 20 hours, but LOS communication limitations can affect their effectiveness. It is hard to overstate the technological limitation result **[5]**.
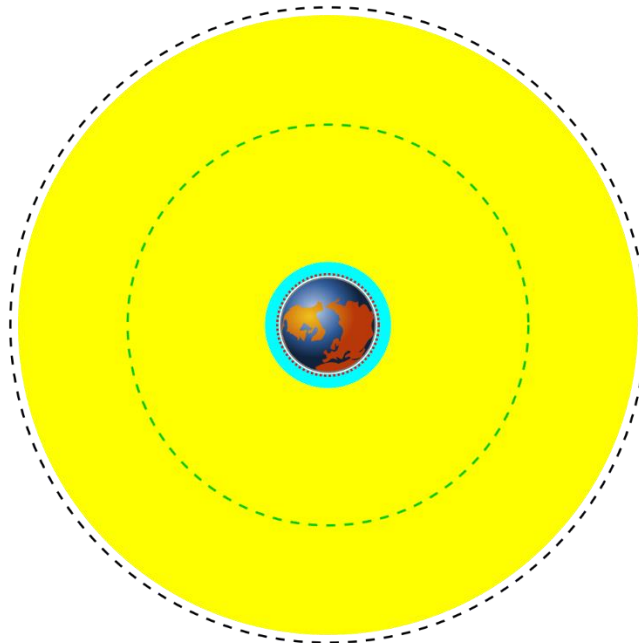
Figure 3: Various earth orbits to scale

In Figure 3 shows cyan represents low earth orbit, yellow represents medium earth orbit, the black dashed line represents geosynchronous orbit, the green dash-dot line the orbit of Global Positioning System (GPS) satellites, and the red dotted line the orbit of the International Space Station (ISS).

Because of the earth's curvature, the Line of light communication can restrict the missions, which forces UAVs to go higher the altitude. The increased distance between the targets and the UAVs SATCOM impacts the video quality and image resolution. Without the quality images to help in offering identification, the intelligence teams are at risk of receiving the unknown elements. Satellite communication or SATCOM for videos/photos are helpful for UAVs because it is high in weight, high cost, and very low bitrates. These small ones from Inmarsat provide the expected 100 kbps while Iridium options offer only kbps. It is hard for the micro UAVs to carry the SATCOM equipment having the capacity of sending the visual amount of data[6]

Application of UAV SATCOM technology

According to [**6**], UAVs Satcom is applied to different applications. They can go where one cannot go and experience experiences that were never seen before. The UAV Satcom is used when transmitting the ISR, the Intelligence and reconnaissance data right from drones, especially when the decision-makers need near real-time or real-time access to information and cannot wait for an aircraft to come back. They are also used when securing command and control links between the ground control stations and Unmanned vehicles, allowing users to monitor the status and control vehicles remotely and switch between autonomous operations and remote controls. Together with Unmanned vehicles, Satcom can use different services like Iridium and Inmarsat

that have different global coverage, bandwidth capabilities, and uptime percentages. The SATCOM terminals help offer an all-in-one solution when transmitting, receiving, and acquiring the satellite and tracking. These compact and lightweight terminals are readily available are well designed for SWAP-conscious needs, especially UAVs. The SATCOM antennas help create the significant aerodynamic drag and have sufficient gain to offer the necessary support enough data rates for its applications.

The SATCOM terminals offer the all-in-one solution used in transmitting and receiving as satellite tracking and acquisition, which is designed purposely to swap the conscious needs of UAVs. SATCOM antennas are well designed not to add excess weight on the aircraft and should have sufficient weight to help support the high data for the application. Satellite communications can be split into various frequency bands, decreasing wavelength order and increasing frequency order, the S-band, L-band, Ku-band, X-band, and Ka-band. The high-frequency bands can offer greater bandwidth and are also susceptible to signal degradation because they are absorbed by rain, ice, or snow. The x-band can be applied in military operations to compromise the two factors [6].
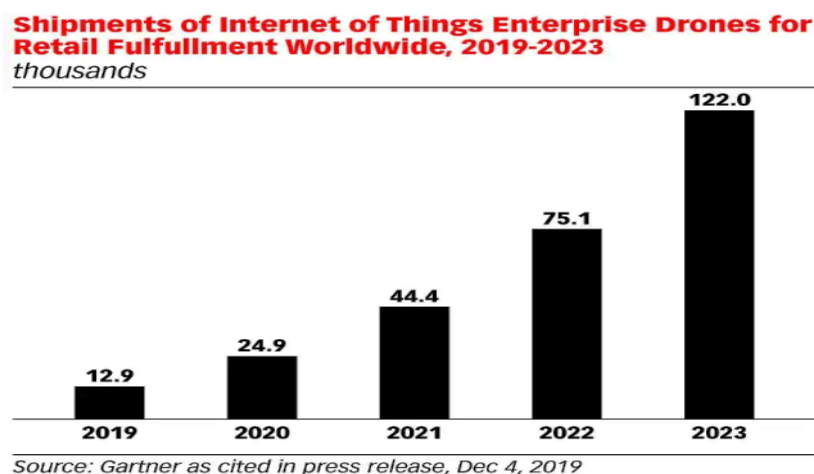
Figure 4: The graph showing the application of drones in retail fulfillment worldwide

UAVs Satcom is now being applied in making observations and tactical planning. The technology is used in emergency settings, especially when responding to emergencies in the field, to help the crew members[7]. The technology is classified based on its endurance, altitude range, weight, and the support of other applications, including commercial and military applications. Smaller technology categories are accompanied by using the ground-control stations that consist of laptops and various components, which appear to be very small to get carried using aircraft in the smaller vehicles and backpacks. The UAVs fitted with high precision cameras can navigate the disaster area, take pictures, and offer the opportunity for the team to perform structurally and image analysis. UAVS operations need onsite personnel, which helps the onsite crew members access the dangerous or disaster areas before accessing the point. A suitable system for outdoor operations that can fly up to altitude is crucial in disaster impact analysis. The vital part of the UAVs is that the initial assessments offer a clear planning direction. After detecting the survivors using the image analysis, the crew members can contact the survivors and perform certain operations. The robots also use the Nano UAVs to detect structural damage, especially in buildings, and to detect the survivors trapped in the debris [8].

More so, Unmanned aerial vehicle Satcom is applied in autonomous driving. These systems can improve traffic, offer comfort to the person driving the vehicle, and also offer better measurements **[8]**. Some problems are supposed to be solved by signal processing, limiting energy, and advanced processor functions. It is imperative to utilize UAV SATCOM now and in the future. After an accident, the survival of human lives depends on the team rescuing the people and the speed that can be used when reaching the accident because of the inefficient conditions they are

delayed. It involves the rescue team opting to fly the parameters like rescue helicopters, which can be costly and unsuitable for the cities. In these instances, the UAVs SATCOM drones are applied as the solution that helps the team reach the accident within the shortest possible time. UAVs SATCOM selection can be based on the UAVs numbers present during that time and the distance between the accident and UAVs. It offers a detailed and brief report concerning the location of the accident, which becomes easy to be handled. These systems can also carry the first aid kid and transports it to the accident scene.

Today the police use Unmanned aerial vehicles Satcom. The traffic police nowadays have the latest technology. CCTV is the commonly used technology in implementing safety rules. When an individual exceeds the speed limit, the CCTV will record. When people get to know that way of handling the traffic rules, they can adjust to the speed recording on the location of the CCTV camera. Technology such as embedded speed cameras is used in UAVs. UAV technology can fly over the road and capture the speeding vehicle and those breaking the traffic rules. The technologies also help during surveys and when counting vehicles on roads. The existing communication that exists between the Unmanned aerial vehicles requires to be maintained all the time [9].

Most western countries get rid of terrorism and believe that using Unmanned aerial vehicles is the best and most effective opinion because sending armed troops on the ground is an ineffective method that combats militant groups. The United States Senate intelligence committee approved the plan that helps increase b armed drones to help kill the suspected militants even though the collateral damage in the Middle Eastern countries can get involved in the process. The united states

government executive branch has the perspective of the drones, which were the critical part of the counter-terrorism strategy, and it is more effective than other techniques. The tactics used in modern wars mainly focus on the images of an enemy while there are minimal risks concerning the personnel [9].

Unmanned Aerial vehicles' Satcom is vital in creating and maintaining communication lines that exist between ground teams, victims, and control centres as well as with different disaster response agencies. Using UAVs, SATCOM helps provide communication support in times of disaster, and it is done by deploying the communication modules. According to [8], the fleet architectures regarding the fixed-wing UAVs are well discussed together with the communication strategies used in locating the people in times of disasters. There are many Unmanned Aerial Vehicles from a communication perspective ranging from sensing the data relaying and transmission. Unmanned Aerial Vehicle Satcom helps communicate the integrated data, especially from the ground teams to control stations, and relays these commands from the control station to ground teams. They act as relays that exist between control stations and first responders. UAVs Satcom is also used in communicating survivor information to the ground teams in rescue missions and during research. The network can easily be deployed in regions experiencing disasters to help restore disrupted communication services, and it is done by simply placing the UAV as relays. They are deployed like temporary systems to help act as relays, especially for broken links on the ground-based mesh networks during disasters. The technology can be used to coordinate and communicate effectively. Unmanned aerial vehicles are used to conduct aerial and ground missions [10]. Using this technology in these missions is straightforward. It can help offer an extra level of safety in the ground missions, especially in times of navigation and surveillance and reconnaissance. The UAVs

type can include semiautonomous vehicles, which require the person to operate or require the ground station to control the UAVs Satcom and autonomous vehicles that run independently when there is no human interaction while using the single onboard computer. The applications of UAVs can include firefighting, crowd management, high precision agriculture, remote emergency missions, and intelligent transport.

These UAVs can use sensors that enable this technology to navigate independently through the complex urban environment with unpredictable and dynamic obstacles. The sensors can include inertial measurement units based on micro-electromechanical technology using magnetometers, built-in gyroscopes, compasses, visual and thermal cameras, GPS, and various sensor types. The traditional technologies cannot handle heterogeneous data types generated by the sensors and other new technology like big data, which are being used in the sophisticated onboard computer that computes the computing applications and involve artificial Intelligence for target identification, detection, and recognition of the tasks. It creates a new industry, especially for commercial UAV applications [11].

High Altitude Long Endurance (HALE)

An innovative new category of aircraft is steadily emerging with the promise of offering lower-cost telecommunications to underserved parts of the world and surveillance and monitoring capabilities for commercial and government applications. These new aircraft would operate well above the typical 35- to 60,000- foot level of commercial air carriers and business aircraft – Flight Level 600 (FL600), or 60,000 feet and above – the area known as the "stratosphere," the second layer of the earth's atmosphere.

And though these HALE aircraft will operate above traditional airways, at a minimum, they must traverse those airways when they ascend and descend and therefore must be factored into the global air navigation scheme.

The only US-made platform in its class, Swift Engineering's flight team, performed a full-system check, validating the vehicle's configuration for high-altitude continuous surveillance missions, receiving both NASA's Airworthiness Certification and the FAA's Certificate of Authorization (COA).

Source: [American Made Swift High-Altitude-Long-Endurance UAS Completes Landmark First Flight | Business Wire](#)

High-altitude platform station (HAPS) Station

High-altitude platform station or high-altitude pseudo-satellite (short: HAPS) or high-altitude platform (short: HAP or HAPs[plural]) is – according to *Article 1.66A* of the International Telecommunication Union's (ITU) ITU Radio Regulations (RR) – defined as "a station on an object at an altitude of 20 to 50 km and at a specified, nominal, fixed point relative to the Earth". Since HAPS operate at much lower altitudes than satellites, it is possible to cover a small region much more effectively. Lower altitude also means much lower telecommunications link budget (hence lower power consumption) and smaller round-trip delay compared to satellites.

Furthermore, deploying a satellite requires significant time and monetary resources, in terms of development and launch. HAPS, on the other hand, are comparatively less expensive and are rapidly deployable. Another major difference is that a satellite, once launched, cannot be landed for maintenance, while HAPS can.

HAPS Applications

One of the latest uses of HAPS has been for radiocommunication service. Research on HAPS is being actively carried out mainly in Europe, where scientists consider it a platform to deliver high-speed connectivity to users over up to 400 km. It has gained significant interest because HAPS will be able to provide bandwidth and capacity similar to a broadband wireless access network (such as WiMAX) while providing a coverage area similar to that of a satellite. High-altitude airships can improve the military's ability to communicate in remote areas such as Afghanistan, where mountainous terrain frequently interferes with communications signals.

Surveillance and intelligence

One of the best examples of a high-altitude platform used for surveillance and security is Northrop Grumman RQ-4 Global Hawk UAV used by the US Air Force. It has a service ceiling of 20 km and can stay in the air for continuous 36 hours. It carries a highly sophisticated sensor system, including radar, optical, and infrared imagers. It is powered by a turbofan engine and can deliver digital sensor data to a ground station in real-time.

Real-time monitoring of a region

Another future use that is currently being investigated is monitoring a particular area or region for activities such as flood detection, seismic monitoring, remote sensing, and disaster management.

Weather and environmental monitoring

Perhaps the most common use of high-altitude platforms is environment/weather monitoring. Numerous experiments are conducted through high-altitude balloons mounted with scientific equipment to measure environmental changes or keep track of the weather. Recently, in partnership with The National Oceanic and Atmospheric Administration (NOAA), NASA has started using Global Hawk UAV to study Earth's atmosphere.

Conclusion

This paper examines how SATCOM can be the future communication link for UAVs and presents Unmanned Aerial Vehicles' application from simple fun to data collection. UAV Satcom is used to transmit the ISR, Intelligence, and reconnaissance data from drones, especially in situations where decision-makers need near real-time. They are also used to secure command and control links between ground control stations and Unmanned vehicles. SATCOM applications are now applied in making observations and tactical planning. SATCOM is critical in creating and maintaining the communication lines between the ground teams, victims, control centres, and different disaster response agencies. All current signs show the exciting and bright future of using SATCOMs various platforms to enhance autonomy and improve safety standards. UAVs can easily get used in delivering deliver-time-sensitive materials like prescription refills in all types of areas on earth, which can lead to timely medical care and improve the person's health journey.

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