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UAV

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UAS

Content:

1. What is UAS
2. History of UAS
3. Classification of UAS
4. WAVE and LTE D2D
5. UAV Use cases

What is UAS?

UAS stands for Unmanned Aerial System.

It is the entire package used to operate the system

It includes the UAV, the ground control system, camera, GPS and all the software.

High skills are needed to operate the system and many tools are required for maintenance.

What is UAV?

UAV stand for Unmanned Aerial Vehicle

It is the actual aircraft that flies around to collect the required data and imagery.

The UAV operate with various degrees of autonomy:

- by a human operator through remote control
- by onboard computers.

UAVs were specially designed for the missions that are too dangerous for humans.

One of the most popular UAV in the market is the DJI Phantom 3.

History of UAS:

- 1916: The earliest attempt at a UAV by A. M. Low using for Aerial target.
- World War I: Hewitt-Sperry Automatic Airplane
- 1935: The first scaled remote pilot vehicle was developed by Reginald Denny
- World War II: Nazi Germany produced and used UAVs during the war
- 1959: US Air Force began planning use UAV to reduce pilot loss
- 1964: UAVs were firstly used for combat missions in Vietnam War.
- 2012: USAF army employed 7494 UAVs -almost one in three USAF aircraft

Classification of UAV:

1. **ICAO Classification**
   - **Remotely-piloted aircraft system:**

     It consist of elements like remotely-piloted aircraft and associated remote pilot stations for required command and controlling links.
   - **Autonomous aircraft:**

     This type of unmanned aircraft does not allow pilot intervention in the management of the flight.

Classification of UAV:

2. **Classification based on weight**

UAVs classification in accordance with weight:

- Micro : Less than 2 kg.
- Mini : Greater than 2 kg and less than 20 kg.
- Small : Greater than 20 kg and less than 150 kg.
- Large : Greater than 150 kg.

Classification of UAV:

3. **Classification from spectrum perspective:**

UA category	Max Altitude	Cruise Speed (Km/h)	Tolerance (hr)	Max. Range (Km)
Small	<300	<111	<5	Visual LoS (<5)
Medium	300 - 5500	111 -185	5-30	RF LoS (105 - 258)
Large	>5500	>185	>30	Beyond RF LoS

Classification of UAV:

4. **Classification of UAVs by control methods:**
    1. Remote human Pilot
    2. Remote human operator
    3. Semi-autonomous
    4. Autonomous
    5. Swarm control

Classification of UAV:

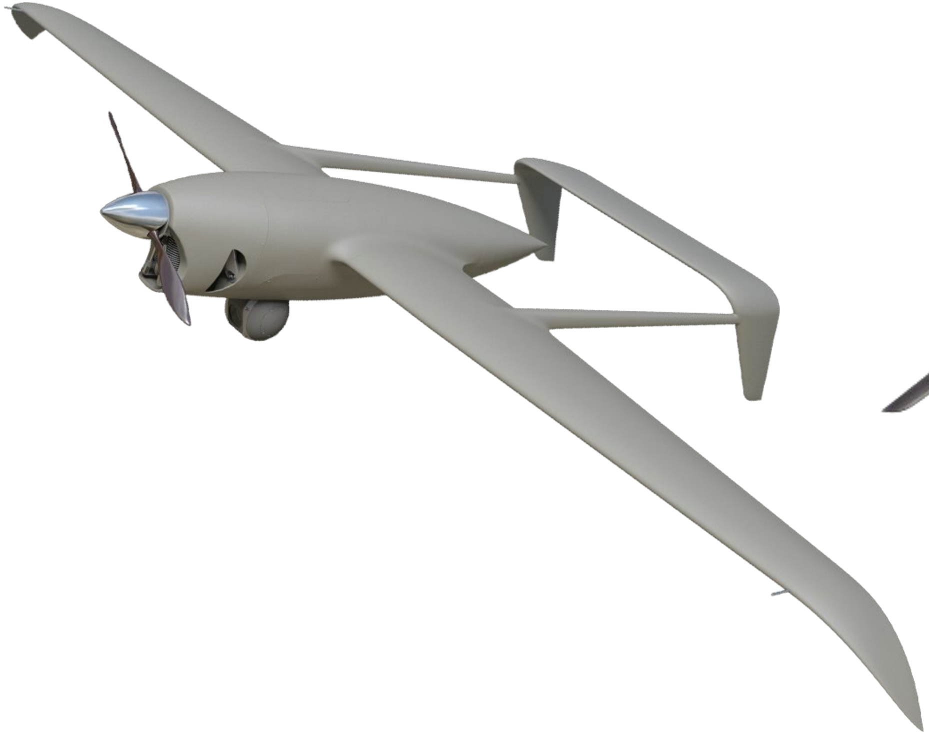
Fixed Wing

- Lift generated using wings with forward air speed
- Simple structure, usually higher payload and speed
- Need to maintain forward motion, need a runway
- Example: Q200 and DATAhawk

Rotary Wing

- Lift generated using blades revolving around a rotor shift
- Can hover and move in any direction, vertical takeoff and landing
- Usually hover payload, lower speed, shorter range
- Example: Y6 and X8

Classification of UAV:



Technology used:

WAVE

- Wireless Access in Vehicular Environments
- Support up to 200 km/h fast mobility
- Range < 1 km, Latency < 100ms
- PHY, MAC layer based on IEEE 802.11p
- Upper layer based on IEEE 1609 series

LTE - D2D

- 3GPP: ProSe (Proximity Services)
- In 3GPP Rel.12, LTE-D2D only in coverage
- In 3GPP Rel.13, addition of new functions such as Relays and Priority handling
- 3GPP Rel.14 known as LTE V2X

Applications:

Military Uses:

- International Border Patrol
- Maritime Patrol
- Road traffic monitoring and control
- Law enforcement
- Drug traffic monitoring
- Coastline monitoring

Civilian Uses:

- High Voltage power line monitoring
- Environmental monitoring
- Forest fire detection
- Crop and harvest monitoring
- High accuracy terrain mapping

Applications:

Application of drone in Disaster:

- Volcanoes Monitoring
- Nuclear Radiation Monitoring
- Earthquake Monitoring
- Search and Rescue
- Fire fighting
- Catastrophe Situations assessment
- Hurricane watch
- Disaster Operation Managements
- Flood Watch

Drones

Content:

1. IoD
2. Types of Network

IoD:

The Internet of Drones is an architecture designed for UAVs to provide synchronized access to controlled airspace.

The drones provide navigation services between locations known as nodes.

The architecture have different zones and each zone is supervised by one or multiple Zone Service Provider (ZSP).

IoD:

On going Work:

- NASA's UTM project organized a conference - which decide to begin the preparations of low altitude traffic management which will be proposed to the FAA.
- Amazon and Google - published white papers - search strategies for managing the airspace and coordinating aerial vehicles through onboard system requirements.

IoD:

Architecture of IoD based on three large scale network:

1. **Air Traffic Control (ATC) Network :**

   is a service which provide the ground-based air traffic controls.

   It direct aircraft on the ground and through controlled airspace

   Its primary aims are :

   - Preventing collisions
   - Organizing and accelerating the flow of air traffic
   - Providing information and support for pilots.

IoD:

Architecture of IoD based on three large scale network:

1. **Air Traffic Control (ATC) Network :** of United States

    FAA - incharge of regulation and air safety.

    It divide US airspace into 24 area - managed by 24 ARTCC.

    Two ARTCC have bilateral letter of agreement.

    Each ARTCC divided airspace into 20 - 80 sectors.

    Each sector is controlled by one controller.

    Flight plan are submitted to entity ATCSCC.

IoD:

Architecture of IoD based on three large scale network:

1. **Air Traffic Control (ATC) Network :**
   - Increase in number of drones in limited airspace at a time result in difficult use of centralized entity ATCSCC for load prediction and assignment.
   - Free Flight with IoD is difficult due to limited airspace, obstacles such as building, birds and high level of congestion.

IoD:

Type of large scale network structure tested for drones:

2. **Cellular network:**

- In case of drones, it is less expensive to hold the drone on the ground then to allow it to take off similarly it is difficult to ground it or hold it due to lack of resources.
- In cellular network, during handover process, BSC does not know the next cell to which mobile user move.
- But IoD , the source and destination is known for drones which allow more optimized utilization of the network resources.

IoD:

Type of large scale network structure tested for drones:

3. **Internet:**
    - Layer architecture of internet is useful for IoD
    - Routing is performed in internet as well as IoD network.
        - IoD need longer computation time.
    - Dropping of packet which overload the system only done in internet as the packet is buffered and can be resend.
    - In case of IoD, it is not possible to drop drones, since they are physical object.

Architecture

Content:

1. Airspace Architecture
2. Components
3. Layered Architecture

Architecture:

Structure:

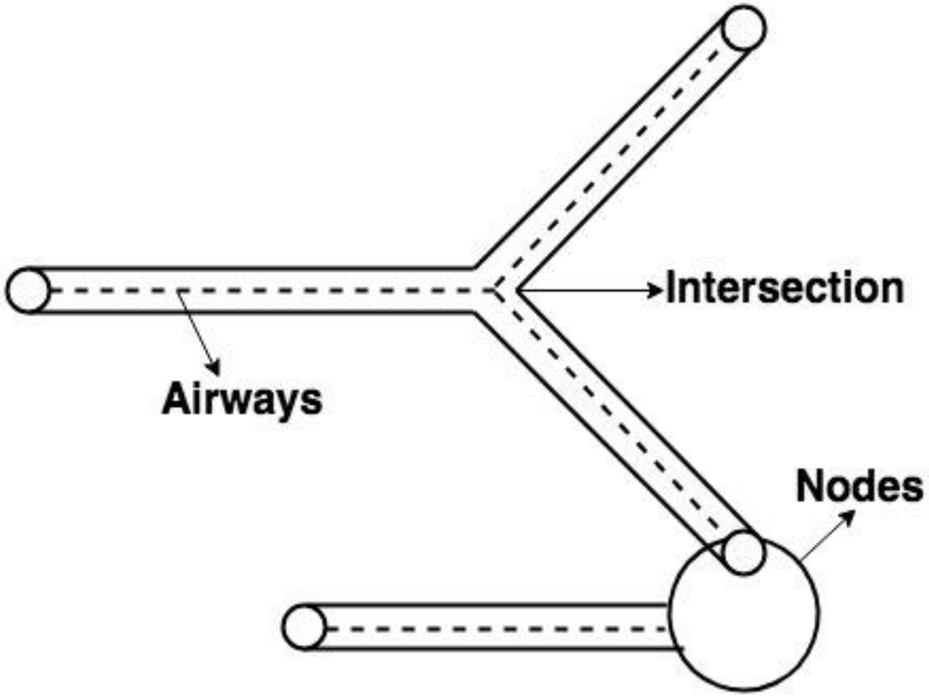
Airspace : is the resource that is utilized by the drone.

It is structured similar to the roads network in the cities.

Drones are only allowed inside the following three:

1. Airways : playing a similar role to road
2. Intersection : formed by at least two airways
3. Nodes : point of interest reachable through an alternatively sequence of airways and intersection.

Architecture:



Architecture:

Structure:

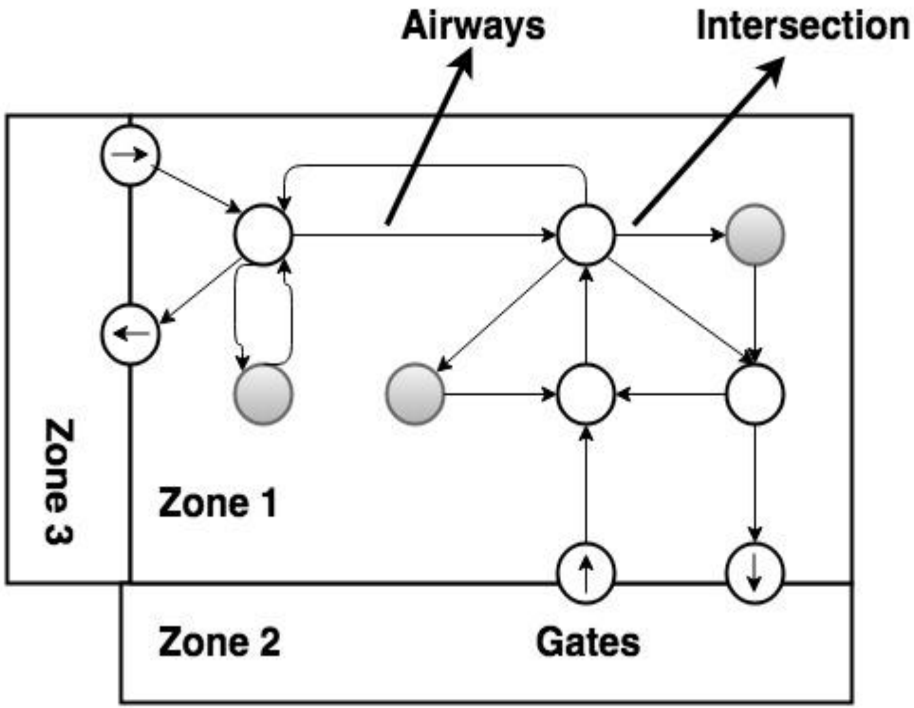
Airspace is partitioned into zones and each zones contain airways, intersection and nodes.

Inbound and outbound Gates: These gates are used for transition between two adjacent zones

Zone Graph: is graph that formed by treating both nodes and intersection as the vertices and airways as the directed edges.

A Path in the Zone graph is called pathway.

Architecture:



Components:

Architecture components :

1. **Zone Service Providers:**

   Provides navigation information

   License to operate a specific zone is granted by higher authorities.

   They establish and enforce the governing law.

   Organization that offers ZSPs are known as IoD Service Provider (IoDSP).

   ZSP can also order a drone to land or hold its position by hovering or executing holding patterns.

Components:

Architecture components :

2. **Drones:**

   Drones are the autonomous aerial vehicles.

   It constitute various performance characteristics such as range, VTDL capability and hovering etc.

   ZSPs receives broadcast information from drones about their position and their future path.

   ZSPs and drones interact with each other through standard protocol.

Layered Architecture:

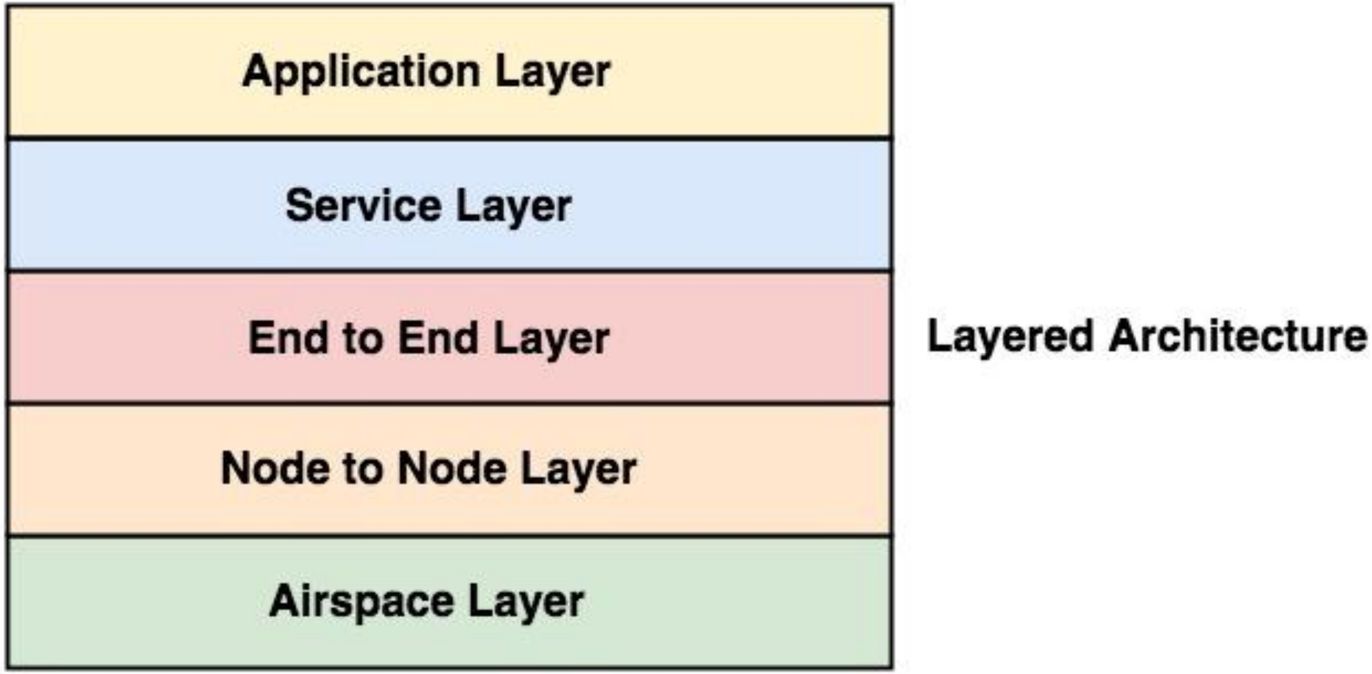
The layered architecture provide numerous benefits :

- Separation of Concern
- Scalability
- Maintainability of code base
- Flexibility

The layered architecture goals:

1. Provide assistance to a drone from source node to destination node
2. Coordinate all drones access to the airspace as a service to the drone.

Layered Architecture:



Layered Architecture:

Functions of Layers:

1. Airspace layer:
    - Map
    - Airspace broadcast and track
    - Plan trajectory
    - Airspace precise control
    - Collision avoidance
    - Weather condition
    - Security

Layered Architecture:

Functions of Layers:

2. Node to Node layer:
    - Zone Graph
    - Node to Node broadcast and track
    - Plan pathway and contingency
    - Refuel
    - Security
    - Node to node precise control
    - Emergency
    - Congestion notification

Layered Architecture:

Functions of Layers:

3. End to End layer:
   - Interzone graph
   - Routing
   - Handoff
   - Security
   - Explicit congestion notification

Layered Architecture:

Functions of Layers:

4. Service layer:
    - Zone broadcast
    - Security
5. Application Layer
    - Different application
    - Security

Vision for Drone Operations

Content:

1. Vision for designing drones
2. Level of connectivity and on board intelligence
3. Cellular connectivity
4. Technology developers

Vision for designing Drone:

Drones are provided with cellular connectivity for command and control , media sharing and autonomous flying

It provide :

1. Safe , autonomous navigation
2. Secure , coordinated, massive deployments
3. A plenty of use cases and capabilities

Levels of connectivity and intelligence:

Cellular Connectivity

1. Improved security options
2. Media sharing and payload status update
3. Communication beyond operators visual line of sight (BLOS)
4. Establishing Fail-safe link

On board intelligence

1. Professional Videography
2. Navigation
3. Machine Learning
4. Computer vision
5. High accuracy sensor processing
6. Precise location updates

Cellular Connectivity:

Uses:

1. Established connection providing service to a billion of connection worldwide
2. High reliability due to use of licensed spectrum
3. High Quality of Service (QoS)
4. Highly secure
5. Seamless mobility

Technology Developers:

1. **Regulatory bodies :**

    Develop international safety and performance standards for drone operations

    Global recognition of these standards

    Create registration and licensed program for commercial drones and their operators

Technology Developers:

2. **Network Providers :**

   Provide network coverage, performance metrics and manage coexistence with ground smartphones and IoT UEs.

   Evolution of existing network and used it for advanced technology implementation.

   Compatibility with new upcoming technology.

Technology Developers:

3. **Technology Providers :**

Development of on-board intelligence such as safe, automotive operation using sensors and camera processing , precise location, security, computer vision and machine learning

Enabling use of existing cellular network with high quality of service

Guide technology advancements from LTE to 5G

UAV -
Cellular Network

Content:

1. Cellular Radio communication links
2. BLOS and VLOS link

Cellular Network:

- **Radio communications links:**

  Under LoS and BLoS conditions, three types of radiocommunications are

  1. Radiocommunications in conjunction with air traffic control relay
  2. Radiocommunications for UAV command and control
  3. Radiocommunications for the sense and avoid function

Cellular Network:

- **Radio communications links:**
    1. Radiocommunications in conjunction with air traffic control relay :
        - In non segregated airspace, the link between ATC and UACs via UAV is called ATC relay.
        - For communicating with ATC, the UAV use the same equipment as a manned aircraft.
            - Downlink - ATC information from the UAV to the UACS
            - Uplink - from the UACS to the UAV

Cellular Network:

- **Radio communications links:**
    2. Radiocommunications for UAV command and control:
        - Command and control is the typical link between the UACS and the UAV.
        - The following two ways of communications are:
            - Uplink: To send telecommands to the aircraft for flight and navigation equipment control.
            - Downlink: To send telemetry (e.g. flight status) from the UAV to the UACS.

Cellular Network:

Command and Control

Remote Control

Regulatory Compliance

- Location Service
- Identification
- Airspace Enforcement
- Flight Planning
- Collision Avoidance

Formation Flying

Status Monitoring

Payload

Video (HD, 3D)

UAV delivered communication Services

- Backhaul
- Peer to Peer

Control of Actuators

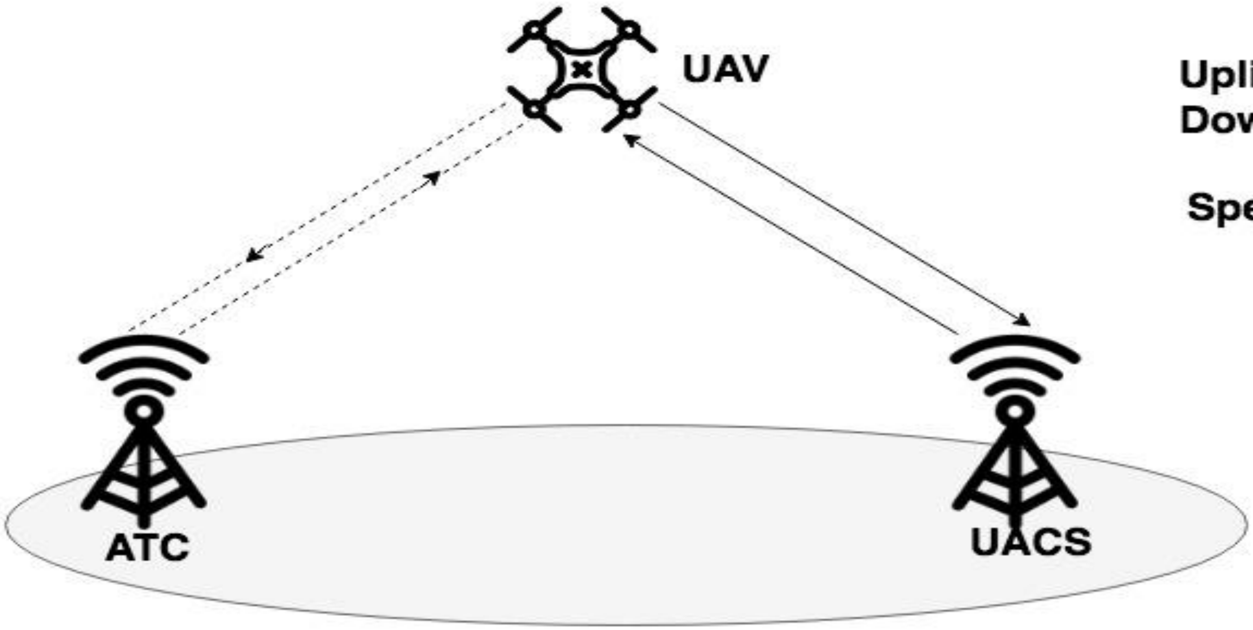
Environmental Information

Cellular Network:

- **Radio communications links:**

   3. Radiocommunications in support of “sense and avoid”:
      - Sense and avoid (S&A) - means - piloting principle “see and avoid”
      - It used in all air space volumes where the pilot is responsible for ensuring separation from nearby aircraft, terrain and obstacles (e.g. weather).

Cellular Network:

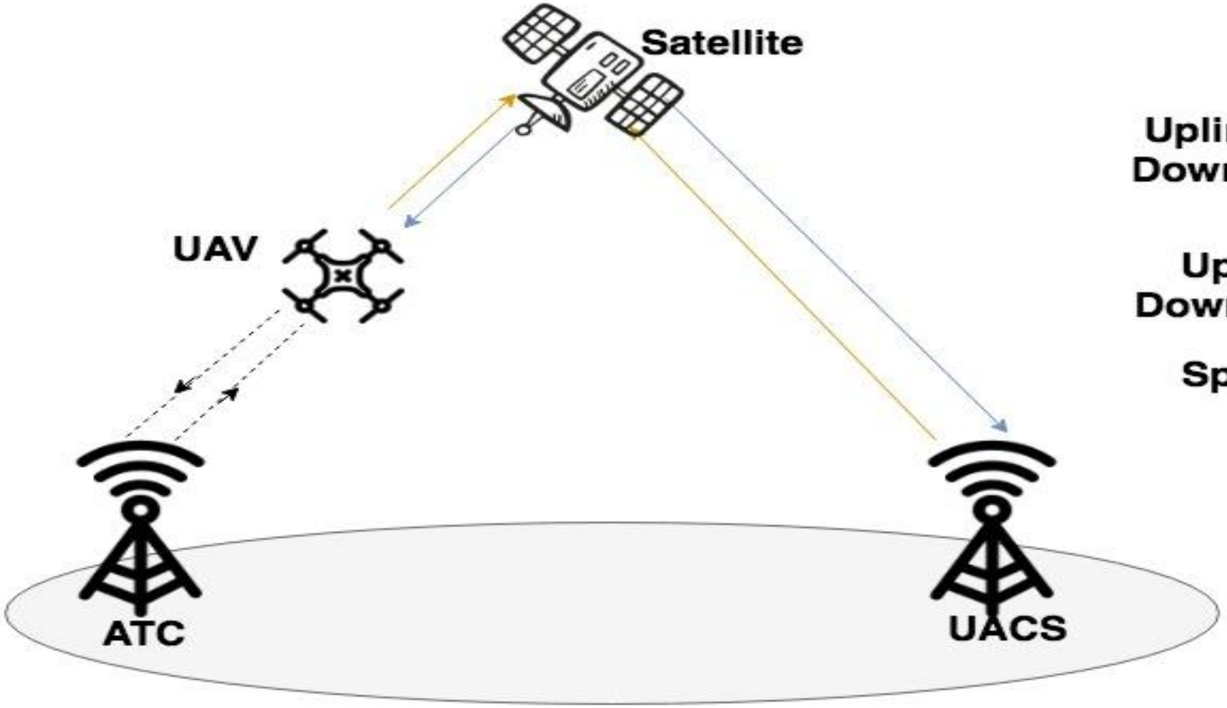


Uplink : UACS to UAV
Downlink : UAV to UACS

Spectrum Requirement:
LoS = 34 MHz

VLoS Link in UAS

Cellular Network:



Forward link
Uplink : UACS to Satellite
Downlink : Satellite to UAV

Reverse Link
Uplink : UAV to Satellite
Downlink : Satellite to UACS

Spectrum Requirement:
LoS = 46 MHz

BLoS Link in UAS

Cellular Network:

- **Frequency band for UAS:**
  - The category of small UAS mostly use the unlicensed band of 2.4 GHz, 5.8 GHz unlicensed 900 MHz and UHF bands for communication.
  - WRC-12 allocated the frequency band 5030 – 5091 MHz to be used for the terrestrial RPAS control links.
  - WRC-15 identified the various spectrum to used by satellite systems controlling drones.
  - Example Region 1 : 12.5 - 12.75 GHz Space to earth, 14.0 - 14.47 GHz Earth to space etc

Cellular Network:

- **Challenges faced by UAS network using cellular network:**
  1. Interference mitigation: As UAV receive signals from multiple base stations when in air and hence face interference.
  2. Handover optimization: As UAV receive signals from multiple base stations, which result into handover which leads to heavy signaling overheads.
  3. Cellular Network optimization: Cellular networks must capable of differentiating UAV from UEs for optimal operation of UAS in cellular networks

Drone in Telecommunication

Content:

1. WASP
2. Colibrex
3. Atmospheric Satellite
4. Phantom Eye

WASP:

WASP stands for Wireless Aerial Surveillance Platform.

Developed by two security engineers: M. Tessy and R. Perkins.

It is a hacking UAV designed to detect security vulnerabilities in wireless systems.

WASP target Wi-Fi, Bluetooth and GSM networks for both cracking and impersonating a trusted internet network to interrupt transfering of data.

This project strong focus is on system integration rather than component design.

WASP:

Colibrex:

Colibrex is a part of a German telecommunications consulting company - LST-elecom.

It offers a wide range of services

The drones carry high-end RF measuring equipment and HD cameras

It is used to perform both radiation pattern measurements as well as mast inspections and auditing.

Colibrex:

Atmospheric Satellites:

Titan Aerospace , a company originating from Moriarty,

USA has presented a prototype of an atmospheric satellite

It is a high altitude (20km) UAV plane designed to run on solar power

It stay airborne for along time as 5 years.

It's called an atmospheric satellite because it's capable of performing many tasks as satellites

Unlike a satellite they can safely come back to earth for maintenance and upgrades.

Atmospheric Satellite:

Phantom Eye:

Phantom Eye similar to Solara atmospheric satellites.

Phantom eye is a high altitude long endurance craft (HALE)

Phantom Eye is a military vehicle designed to provide intelligence and communication capabilities in combat zones and emergency situations.

Phantom Eye:

UAV - Network Deployment

Content:

1. UAS network deployment technology
2. Rules of UAS

Network Deployment:

UAS Deployment technology:

1. **Segregation :**
    - In this, UAV remain outside the airspace, open to civil aviation.
    - A Dedicated air volume is defined for UAV
    - ATS (Air Traffic Services) give instruction to the aircraft in order to prevent the UAV to enter the limits of reserved airspace

Network Deployment:

UAS Deployment technology:

2. **Visual Line of Sight Operation:**
    - Method applied to Remote Piloted Aircraft systems (RPAS)
    - In this, remote pilot maintain permanent visual contact with its aircraft and drones.
    - This allow RPAS to fly closer even into airspace of civil aviation
    - Reduction in drone operation radius i.e around the position of the RPAS operators

Network Deployment:

UAS Deployment technology:

3. **Beyond Visual Line of Sight:**
    - This method allow RPAS and autonomous aircraft to fly within civil aviation airspace
    - It does not require human operator to retain permanent visual contact with the drone.

Network Deployment:

- **Rules for UAS:**

1. **Open category:**
    - It consist of majority of unmanned aerial vehicles.
    - Firstly, Airspace segregation is used for the avoidance of collisions between the drones and ordinary aircraft
    - The devices are operate at low altitudes, below the airspace sectors used for civil aviation purposes
    - It also maintain the safe distance from airspace reserved for airport operations.

Network Deployment:

- **Rules for UAS:**

2. **UAS Traffic Management (UTM):**
    - Deployment of infrastructure to ensure the safety of drones operations outside the airspace open to civil aviation.
    - Its main aim is to keep drones separated from each other, but also from the few aircraft such as low flying helicopters

Network Deployment:

- **Rules for UAS:**

3. **Specific category:**
    - Nowadays, the airspace segregation and VLOS operations are used to ensure separation into civil aviation airspace.
4. **Certified category:**
    - It consist of drones which are expected to operate on a routine basis within the airspace open to civil air navigation.

Enhanced Cellular UAV

Content:

1. 3GPP Roadmap
2. 3GPP Requirements
3. Cellular network features

3GPP Roadmap:

Release 14 - Explain requirements for LTE Mission Critical Data.

High-level requirements for 5G defined

Release 15 - Study item on UAVs agreed.

Ensure that LTE bearers meets the appropriate requirements

- For Command and Control
- For Payload (e.g High Definition Video)
- Do not interfere with ground-based LTE users.

Meet regulatory requirements for UAV communications.

3GPP Roadmap:

Release 16 - Apply LTE lessons to NR (New radio).

Ensure that LTE/NR

- positioning technologies integrated with the UAV sensors
- Proximity Services (ProSE) used for direct UAV-to-UAV communication.
- support identities that are applicable to UAV identification.

3GPP Requirements:

3GPP TS22.282 (“Mission Critical Data services over LTE”)

It includes :

- Altitude up to 150m
- Prioritized telemetry data and prevented it from attack.
- Traffic will be identifiable.

3GPP TS22.261 (“Service Requirements for the 5G System”)

It includes:

- Accurate positioning including direction and velocity.
- Flexible prioritization of UAV communications.
- Highly secure communications

Cellular Network Challenges:

Existing cellular networks provide service to hand-held user equipment that

- At ground-level
- Carried into fixed vertical structures such as tall buildings.

Different propagation effects are seen in UE attach to UAV such as:

- Reduced radio performance
- High interference
- Handover

Cellular Network QoS:

Traffic QoS:

LTE and 5G support different QoS Classes.

Communications is provided via bearers

Each bearer is assigned a QoS Class Identifier (QCI)

There are nine QCI classes defined in LTE which vary depending on:

- Guaranteed minimum and maximum bit rates
- Non Guaranteed minimum and maximum bit rates

Cellular Network QoS

QCI	Bearer Type	Priority	Packet Delay	Packet Loss	Example
1	GBR	2	100 ms	10^{-2}	VoIP call
2		4	150 ms	10^{-3}	Video call
3		3	50 ms		Online Gaming
4		5	300 ms	10^{-6}	Video Streaming
5	Non GBR	1	100 ms		IMS Signaling
6		6	300 ms		Video, e-mail, chat, FTP
7		7	100 ms	10^{-3}	Voice, Video, interactive games
8		8	300 ms	10^{-6}	Video, e-mail, chat, FTP
9		9			

UAV - Location Services

Content:

1. Location Service Requirement
2. Technologies used

UAV Location Service:

UAV location services are essential for

- Navigation
- Air traffic control (e.g., UTM)
- Regulatory compliance.

UAV Location Service:

The requirements to access UAV location service include:

- Precise Location requirements
- Periodic Location update
- Real-time navigation and reporting requirements.
- High Availability
- Performance in various environments (rural, suburban, urban, dense urban, indoors).
- Reliability and redundancy of network
- Receiver cost and mass market availability

UAV Location Service:

In Release 13, LTE Positioning Protocol supports the following technologies:

- Assisted Global Navigation Satellite System (A-GNSS; Including GPS, Galileo, GLONASS, BDS),
- Wireless Local Area Network (WLAN), and
- Bluetooth
- Uplink Time Difference of Arrival (UTDOA)
- Observed Time Difference of Arrival (OTDOA),
- Enhanced Cell ID (E-CID),
- Terrestrial/Metropolitan Beacon Systems (TBS/MBS),

UAV Location Service: A-GNSS

Advantages:

- A-GPS is standalone, UE-based and UE-assisted positioning technology.
- Provide accurate location including altitude (<5 meters) in open sky conditions.
- Latest devices support multiple GNSS constellations (e.g., GPS, GLONASS, Galileo) .

Disadvantages:

- Multipath in urban and dense urban environments leads to increased position errors and availability problem.
- Local jamming operation from illegal jamming and spoofing devices.

UAV Location Service: OTDOA

Advantages:

- Support LTE and VoLTE
- Higher accuracy.
- High reliability.

Disadvantages:

- No accurate altitude capability.
- Accuracy issues in urban and dense urban environments.
- High inter- cell interference for airborne receivers.
- Lack of UE-assisted which create latency for navigation.

UAV Location Service: E-CID

Advantages:

- Support LTE
- High reliability.

Disadvantages:

- Low precision
- suitable only for particular area for flight.
- No accurate altitude capability.
- Lack of UE-based which create latency for navigation

UAV Location Service: Bluetooth

Advantages:

- One common receiver.

Disadvantages:

- UE-assisted only
- Short range
- Not reliable
- Works in indoors environment.

UAV Location Service: Barometric Sensor

Advantages:

- Accurately determine change in altitude
- Support standalone, UE-assisted, and UE-based positioning modes.

Disadvantages:

- Inaccurate if accurate reference information is unavailable.
- MEMS- based implementations have varying accuracy.

UAV Location Service: WLAN

Advantages:

- One common receiver.
- Operate independently of GPS
- Enables altitude determination

Disadvantages:

- Limited Coverage
- Variable Performance ,not reliable (power outage scenario).
- UAV use WiFi for command, control and data.
- Crowded unlicensed spectrum.
- Limited reliability.

UAV Location Service: T/MBS

Advantages:

- Wide area coverage
- High precision 3D geolocation
- Operated for mission-critical reliability requirements.
- Operate independently of GPS.
- Good performance in multipath/Non-Line of Sight (NLOS) signal environments.

Disadvantages:

- Not widely used.

UAV - Use of Location Service

Content:

1. Uses of Location services

UAV Location Service:

Use of Location Services: For navigation purpose

GPS is used for UAV navigation purpose.

Its performance such as position accuracy can be affected in urban and dense urban environments, because of the weak satellite signals

In the case of UE-based and standalone location modes location occurs naturally.

In the case of UE- assisted location modes the location is transmitted from the network to the UAV.

UAV Location Service:

Use of Location Services: For navigation purpose

To improve the performance and reliability, UAV is combined with other location technologies

For example:

- Barometric Sensors solution combined with OTDOA or ECID
- Inertial Sensors combined with A-GNSS

UAV Location Service:

Use of Location Services: For regulatory compliance

- Keeping UAV out of reach in restricted airspace
- Generate and share periodically report of their position
- Securing UE against tampering

UAV Location Service:

Use of Location Services:

Logging of airspace violations:

- When UAV flight breach the geofencing.
- When UAV is out of communication with the UAV operator
- It also include violation of file flight parameters such as rate of climb/descent, turning radius, etc

These logs are downloaded later for transmission to the FAA.

UAV -Unified Connectivity with 5G

Content:

1. Enhanced Mobile Broadband
2. Mission Critical Services
3. Massive IoT
4. Path of 5G

UAV-5G:

Unified connectivity with 5G

1. Enhanced mobile broadband:
    a. Data rates upto Multi-Gbps
    b. High capacity network
    c. Uniformity
    d. Deep awareness

UAV-5G:

Unified connectivity with 5G

2. Mission Critical services :
    a. Ultra-low latency
    b. High availability
    c. High reliability
    d. Strong security

UAV-5G:

Unified connectivity with 5G

3. Massive IoT
    a. Low cost
    b. Ultra-low energy
    c. Deep coverage
    d. High density

UAV-5G:

Mission Critical and massive IoT Capabilities:

For Wide scale deployment require:

1. Uniform throughput which scale up to multi-Gbps with wider bandwidths and massive MIMO
2. Coverage at all altitudes
3. Serving numerous devices
4. Direct Communication

UAV-5G:

Mission Critical and massive IoT Capabilities:

For Mission Critical Services

1. Ultra-high reliability
2. Strong E2E security
3. Ultra-high availability
4. Low end-to-end latency

UAV-5G:

Path to 5G:

- LTE advanced - Rel 10/11/12 with Advanced MIMO , 256 QAM, Carrier Aggregation
- LTE advanced Pro - Rel 13 and beyond with Shared spectrum, Gigabit class LTE, NB - IoT, Device to Device
- 5G NR - Rel 15 and beyond with Massive MIMO , enhanced broadcast, CV2X

Qualcomm Leadership

Content:

1. Technology Used
2. New level of intelligence and integration
3. Leading World to 5G

Qualcomm:

Qualcomm providing the connectivity for drones:

1. WiFi : Offering dedicated and integrated chipsets for remote control and first person view in drone operation
2. 4G LTE : Optimizing LTE for safe drone operation
3. 5G : Accelerating 5G technology development by supporting 5G specifications within 3GPP.

Qualcomm:

New level of on board intelligence and integration:

Bringing cognitive technologies to life

1. Machine learning
2. Precise Localization
3. High Fidelity sensor processing
4. Computer Vision
5. Real time flight control
6. 4K Video stabilization

Qualcomm:

Essential technologies:

- Compute intensive and diverse characteristics
- Heterogeneous platform : Location, GPU, CPU, Memory subsystem, display engine, video engine, camera ISP, Modem and DSP
- Smarter, lighter and safer autonomous drones

Qualcomm:

Leading World to 5G

1. Wireless/OFDM technology and chipset leadership offering 5G technologies to meet extreme requirements
2. End-to-end system approach with advanced prototypes
3. Driving 5G network from standardization to commercialization
4. Providing the experience and scale that 5G network demands

UAV
Policies and Future

Content:

1. Policymaker action
2. Regulatory agencies roles
3. Benefits
4. Economic Impact
5. CTIA work

Policies and Future:

Policymakers should take action in three primary areas:

- The FAA should validate the use of commercial wireless networks as the preferred communications platform for small, low-altitude UAV.
- Policymakers should work with industry to create a global standardization for FAA management of drone airspace.
- Policymakers should ensure that wireless network operators free up more spectrum to build the networks needed for drones.

Policies and Future:

Regulatory agencies Roles:

1. **FAA** :
   - Define the safety regulation for bringing drones into America’s skies
   - Authorize the drones for commercial and non-military governmental purposes
2. **FCC** :
   - Define the drones in spectrum which is already allocated for terrestrial wireless services
   - Free up the additional wireless airwaves for certain drone uses, including collision avoidance

Policies and Future:

Regulatory agencies Roles:

3. **DOT** :
    - Develop a regulatory framework for interstate drone service providers
4. **NASA** :
    - Develops air traffic control systems to manage drones at lower altitudes.
    - Collaborates with CTIA and its members through working groups to research traffic management
5. **FTC** :
    - Have Enforcement authority over drone privacy issues

Policies and Future:

Regulatory agencies Roles:

5. **DHS** :
   - Focus on security concerns associated with drones, such as malicious attack

6. **NTIA** :
   - Authorizes use of government spectrum
   - Considers privacy issues associated with the emergence of commercial and private use of drones

Policies and Future:

Benefit to american industry with a use of drones:

- **AGRICULTURE** : 33% of American farmers will be using drones in their operations this year.
- **LOGISTICS** : 84% of Americans expect to see drone delivery services within the next decade.
- **ENERGY** : Inspections done by drones of energy sites and oil rigs cost 80% less than traditional reviews.
- **HEALTHCARE** : Blood products delivered by drones can be transported ~40 miles in 15 minutes.

Policies and Future:

Future Economic impacts:

- In the United States, drone trade is expected to add over $80 billion to the economy
- It will create 100,000 new jobs by 2025.
- By 2020, the FAA forecasts that seven million small drones will be sold to commercial users in the United States.

Policies and Future:

CTIA Member Work on Drones

- Wireless networks for drone operations :
  - Qualcomm working with carrier partners to test how the coverage, handoff capabilities, and latency of wireless networks are impacted by drone use.
  - AT&T is testing and mapping the network vertically to inform drone flight.

Policies and Future:

CTIA Member Work on Drones

- Testing consumer-facing drone technologies :
    - Amazon is testing its Prime Air service,
- Disaster recovery applications for drones :
    - Using drones for inspections and rescue process