

- FPV drones usually record HD video for review or for entertainment purposes.
- Since FPV footage is often recorded at 1080p or 2.7K resolution, storage needs are lower compared to professional filming drones, typically requiring 32GB to 128GB storage.

### 3. Storage Format

- **File Systems:**
  - Most microSD cards and internal storage are formatted in **exFAT** or **FAT32**, which support large file sizes and are compatible with a variety of devices.
  - **NTFS** and **APFS** may be used in SSD-based systems on high-end drones, providing greater performance and security features.
- **Compression Formats:**
  - Some drones use file compression to save storage space. For instance, video may be compressed in H.264 or H.265 formats to reduce file size without significantly compromising quality.
  - RAW photo formats, such as DNG, are larger and uncompressed, offering greater flexibility in post-processing but requiring more storage.

### 4. Storage Management

- **Data Overwrite:**
  - Some drones feature automatic data overwrite systems, where the oldest data is deleted to make space for new recordings when the storage is full. This is common in drones with limited storage capacities.
- **Cloud Syncing:**
  - Certain advanced drones can upload data directly to the cloud via a 4G or Wi-Fi connection. This allows for offloading data mid-flight, ensuring that storage never becomes a limiting factor during long missions.
- **Dual-Recording Modes:**
  - High-end drones often feature dual-recording, where lower-resolution copies of footage are stored alongside the high-resolution versions. This provides an option for quick access or streaming, while the high-quality version is saved for post-processing.

### 5. Upgrading Storage

- **MicroSD Card Expansion:**
  - Many drones allow users to upgrade storage by using higher capacity or faster microSD cards. Cards with fast write speeds (UHS-I, UHS-II) are essential for recording high-bitrate video and continuous data capture.
- **SSD or NVMe Storage:**
  - For professional drones, SSDs can be upgraded for larger capacities. NVMe (Non-Volatile Memory Express) drives, which offer faster transfer rates, are often preferred for real-time 3D mapping or high-resolution video recording.

### 6. Data Transfer and Offloading

- **USB-C or Thunderbolt Ports:**

- Many drones offer direct data transfer options via USB-C or Thunderbolt ports, allowing fast offloading of large data files to a computer or external storage device.
- **Wi-Fi/4G Connectivity:**
  - Some drones have wireless data transfer capabilities, allowing files to be sent to cloud storage or other devices without needing to physically remove the storage media.

## 7. Data Redundancy and Backup

- **Dual-Slot Systems:**
  - Certain high-end drones have dual microSD or SSD slots, allowing data to be recorded on two storage devices simultaneously for redundancy. This is crucial for applications like filmmaking or critical infrastructure inspections where data loss is unacceptable.
- **Backup to External Devices:**
  - Some drones support real-time data backup to an external device, such as a hard drive or NAS (Network-Attached Storage) system, during or immediately after a flight.

## Examples of Onboard Storage in Popular Drones

- **DJI Inspire 3:**
  - Supports up to 1TB SSD storage, enabling the recording of 8K video footage with high data rates.
- **Autel EVO II Pro:**
  - Comes with built-in 8GB internal storage and supports microSD cards up to 256GB, ideal for 6K video recording.
- **DJI Phantom 4 Pro:**
  - Supports microSD cards up to 128GB, used for 4K video capture and large-scale mapping missions.

## Considerations for Selecting Onboard Storage

- **Video Resolution and Format:** Higher resolution and uncompressed formats (e.g., RAW video or images) demand significantly more storage.
- **Flight Duration:** Longer flight times, especially in industrial or mapping operations, require more storage to avoid running out mid-flight.
- **Data Transfer Speed:** Fast write speeds are essential for drones recording high-frame-rate or high-resolution video. Using slow microSD cards can result in dropped frames or lower-quality recordings.

## Conclusion

The onboard storage capacity of a drone is a critical factor that depends on the specific use case, such as filmmaking, surveying, or industrial inspections. Choosing the right storage medium, whether it's microSD, SSD, or a hybrid system, is essential for ensuring smooth operations and data reliability. For professional applications, redundancy and fast data transfer are equally important considerations.

### 3.8 REMOVABLE STORAGE DEVICES

Drones typically use **removable storage devices** to store videos, photos, and other data. The most common storage devices used in drones are memory cards, due to their small size, high storage capacity, and fast data transfer rates. Here are the key types of removable storage devices commonly used in drones:

#### 1. microSD Cards

- **Description:** The most common type of removable storage for consumer drones. They are small and lightweight, making them perfect for compact drones.
- **Capacity:** microSD cards generally range from **16 GB to 1 TB**.
- **Speed Classes:** The speed of the card is essential for recording high-resolution videos (e.g., 4K or 8K). Speed classes are as follows:
  - **Class 10:** Minimum write speed of 10 MB/s.
  - **UHS-I / UHS-II:** Higher-speed classes, with UHS-I capable of up to 104 MB/s and UHS-II up to 312 MB/s.
  - **V30, V60, V90:** Video Speed Class cards, with write speeds suited for high-quality video recording (30, 60, and 90 MB/s, respectively).
- **Uses:** Storing photos and videos captured by drones, especially in 4K and higher resolutions.

#### 2. SD Cards

- **Description:** Standard SD cards may be used in professional-grade drones with larger, more complex systems, though most consumer drones use microSD.
- **Capacity:** Typically range from **32 GB to 1 TB**.
- **Uses:** In higher-end drones or cameras where microSD cards may not be used due to physical size or performance requirements.

#### 3. CFast and XQD Cards

- **Description:** CFast and XQD cards are used in **high-end drones** and professional cinematography drones, which require extremely fast read and write speeds.
- **Capacity:** 64 GB to 1 TB or more.
- **Speed:** Extremely fast data transfer rates, making them suitable for **RAW video capture** and **high-resolution formats** like 8K.
- **Uses:** In professional drones used for film production or high-end photography where fast write speeds and large storage capacities are essential.

#### 4. External SSDs (For Some Professional Drones)

- **Description:** In some **professional drone setups**, external SSDs can be used for direct storage of high-quality footage. These setups are usually mounted on the drone or its camera system.
- **Capacity:** Typically range from **500 GB to several TB**.
- **Uses:** For high-end drone filming where large amounts of high-resolution data need to be stored quickly, such as in 6K or 8K video recording.

## Important Considerations for Drone Storage:

- **Storage Speed:** High-end drones that capture 4K, 6K, or 8K videos need high-speed storage devices to prevent dropped frames or data corruption.
- **Capacity:** The higher the video resolution, the more storage space is needed. For example, **4K video** will require significantly more storage than 1080p.
- **Durability:** Drone storage devices should be shock-resistant and durable, as drones often operate in rugged conditions.
- **Formatting:** Many drones require that the storage card is formatted in a specific file system, such as **exFAT** for handling large files (4 GB+).

## Conclusion:

Most consumer drones rely on **microSD cards** for removable storage, while professional-grade drones may use **CFast**, **XQD cards**, or even **external SSDs** for faster and larger storage capacity. Choosing the right removable storage depends on the type of drone, resolution of video recording, and storage needs.

## 3.9 LINKED MOBILE DEVICES AND APPLICATIONS

Drones can be linked to mobile devices and applications to provide users with control, real-time data, video streaming, and more. This integration between drones and mobile apps enhances user experience, providing seamless control and access to flight data, media storage, and analysis tools.

### How Drones Are Linked to Mobile Devices and Apps:

#### 1. Mobile Device as a Remote Controller

- Most consumer drones use mobile devices (smartphones or tablets) as their **primary controllers** or **paired screens** when linked to dedicated remote controllers.
- **Examples:**
  - **DJI Go 4**, **DJI Fly**, and **DJI Pilot** apps (for DJI drones).
  - **Parrot FreeFlight** app (for Parrot drones).
  - **Autel Explorer** app (for Autel Robotics drones).
- **Features:**
  - Live video feed (FPV – first-person view) from the drone camera.
  - Full control of drone settings (altitude, speed, camera angle).
  - Access to flight telemetry data (GPS location, battery level, etc.).
  - Smart flight modes (e.g., automated flight paths, tracking, and orbiting).

#### 2. Real-Time Video Streaming and FPV (First-Person View)

- Drones stream live video directly to the mobile device through the linked application, allowing users to see what the drone's camera is capturing in real time.
- **High-quality streaming:** Apps often offer high-resolution video (e.g., 720p, 1080p, or 4K) depending on the drone model.
- **FPV drones:** Some drones provide immersive experiences by connecting mobile devices to VR goggles for first-person flying.

3. **Flight Data and Telemetry**
  - Mobile apps linked to drones provide real-time **flight data**, including:
    - **Altitude, speed, distance** from the pilot.
    - **GPS positioning** for real-time tracking of the drone.
    - **Battery level**, with alerts for low power.
  - **Return to home** function: If the drone is losing signal or has a low battery, the mobile app can trigger an automatic return to the pilot's location using GPS.
4. **Camera and Media Control**
  - **Remote Camera Control**: Users can control camera settings such as resolution, frame rate, ISO, and exposure from their mobile device.
  - **Media Storage**: Photos and videos captured by the drone can be automatically saved to both the drone's onboard storage (like a microSD card) and the mobile device for instant viewing, editing, or sharing.
  - **Quick Transfer**: Some drones, like DJI's models, allow quick transfer of media from the drone to the mobile device over Wi-Fi or Bluetooth, enabling fast sharing on social media.
5. **Flight Planning and Automation**
  - Apps allow users to **pre-plan flight paths** by setting waypoints, altitude, speed, and camera angles before the flight begins.
  - **Automated flight modes** can be activated through the mobile app, such as:
    - **Follow Me**: The drone automatically follows the mobile device's GPS location.
    - **Waypoint missions**: Users set waypoints on a map, and the drone follows that exact route.
    - **Circle and Orbit**: The drone autonomously circles a set point or subject.
  - **Geofencing and No-Fly Zones**: The app may automatically limit the drone's movement to comply with local regulations, avoiding restricted airspace.
6. **Flight Logs and Data Analysis**
  - Mobile applications keep detailed **flight logs**, tracking each flight's metrics, including distance flown, time, speed, and altitude. This data helps users improve their flying skills and troubleshoot issues.
  - Some apps provide **post-flight data analysis**, helping users assess flight performance and detect anomalies or issues.
7. **Augmented Reality (AR) Integration**
  - Some advanced drone apps offer **AR features**, overlaying flight data or mission information on top of live video feeds.
  - **AR navigation**: Apps display flight path overlays or virtual waypoints on the mobile device's screen for more intuitive flight control.
8. **Drone Maintenance and Firmware Updates**
  - Mobile apps are essential for keeping drones updated with the latest **firmware**. Through these apps, users can:
    - Download and install the latest firmware.
    - Access **system diagnostics** to ensure the drone is operating properly.
  - **Error messages**: The app will display any drone issues, like motor failure, connectivity problems, or GPS signal loss, and guide users on how to resolve them.
9. **Emergency Control and Safety Features**
  - Mobile apps linked to drones offer **emergency control features**, such as:
    - **Auto-landing**: When the battery is critically low or the drone loses connection, it can automatically land safely.

- **Failsafe Return-to-Home:** When the connection between the drone and controller is lost, the drone returns to its takeoff point or the user's location.
  - **Real-time alerts:** The app notifies users of no-fly zones, low battery, or other safety concerns.

## 10. Social Sharing and Community Interaction

- Apps often include built-in options for users to share drone footage directly on social media platforms like YouTube, Instagram, and Facebook.
- Some drone apps also have **community features**, where pilots can share flight paths, flight logs, or photos/videos with other users.

## Popular Drone-Linked Mobile Apps:

1. **DJI Go 4 / DJI Fly / DJI Pilot**
  - Used by DJI drones, these apps offer full control over the drone's camera, flight data, and smart flight modes.
  - Provide detailed flight telemetry, live video feeds, and instant access to recorded media.
2. **Parrot FreeFlight**
  - Parrot's app for its drone models, which allows users to control flight, capture media, and view real-time telemetry.
3. **Autel Explorer**
  - The official app for Autel Robotics drones, used to control flight, adjust camera settings, and enable autonomous flight modes.
4. **Litchi**
  - A third-party app compatible with DJI drones, offering advanced flight features like waypoint missions, virtual reality mode for FPV, and panorama capture.
5. **UGCS for DJI**
  - Designed for professional users, this app allows for detailed flight planning, waypoint missions, and post-flight data analysis.

## Conclusion:

Linking drones with mobile devices and applications gives users full control, real-time data, and enhanced capabilities for capturing aerial footage, performing automated missions, and ensuring safe operation. These apps extend the functionality of drones, making them more versatile, user-friendly, and smarter with intuitive control interfaces, integrated safety features, and seamless media management.