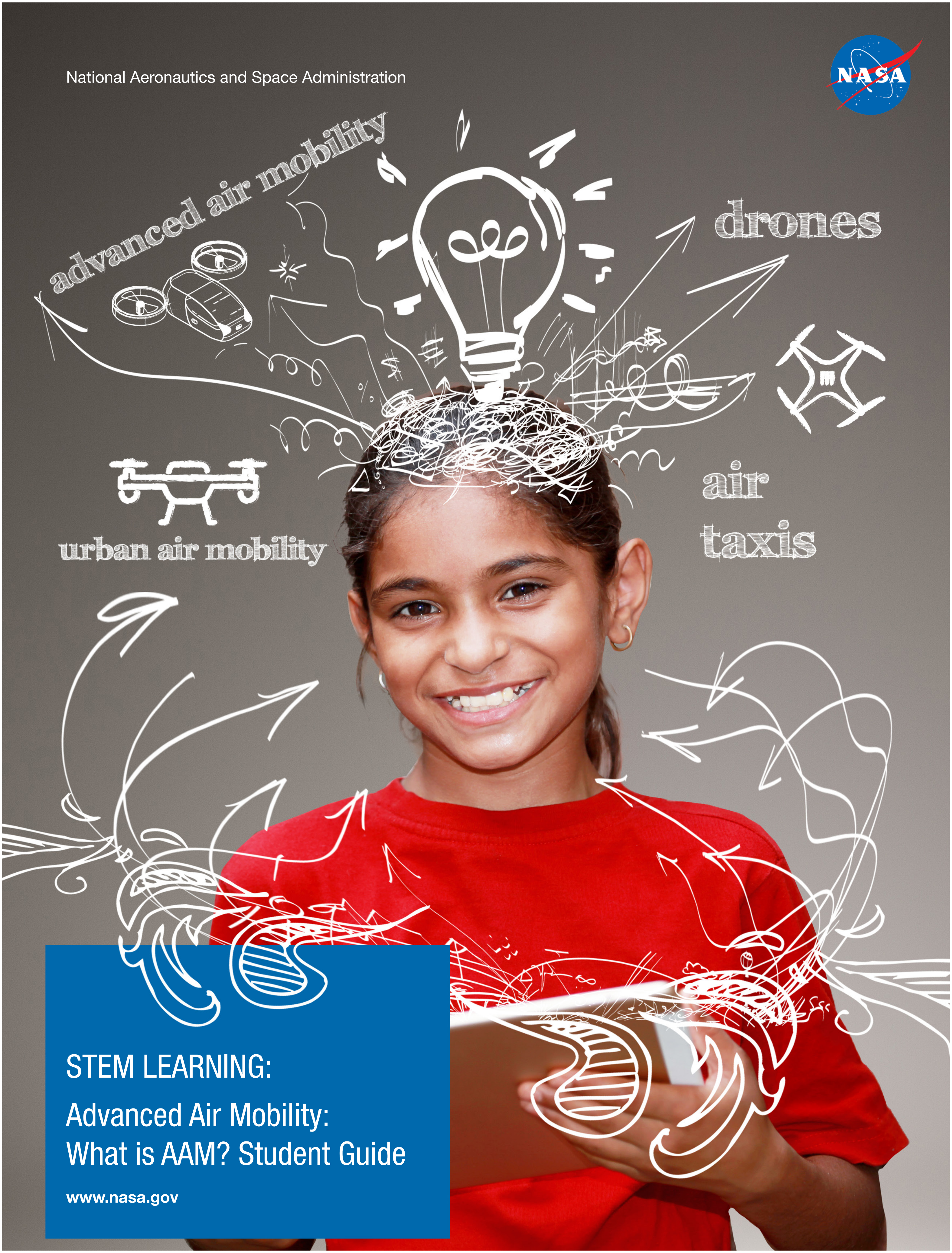
National Aeronautics and Space Administration



STEM LEARNING:

Advanced Air Mobility: What is AAM? Student Guide

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WHAT IS AAM?

Background

ADVANCED AIR MOBILITY

When most people think of aircraft, they usually think about airplanes that travel at great speeds and cover long distances while flying routes between airports. More and more, however, new types of aircraft are transporting people and equipment to urban and rural locations where traditional airplanes cannot access. These new aircraft range in size from small cargo carrying drones to passenger-carrying air taxis, and carry out short range missions.

NASA is leading the nation to quickly open this new era in air travel called **Advanced Air Mobility**, or AAM. The vision of AAM is that of a safe, accessible, automated, and affordable air transportation system for passengers and cargo capable of serving previously hard-to-reach urban and rural locations.

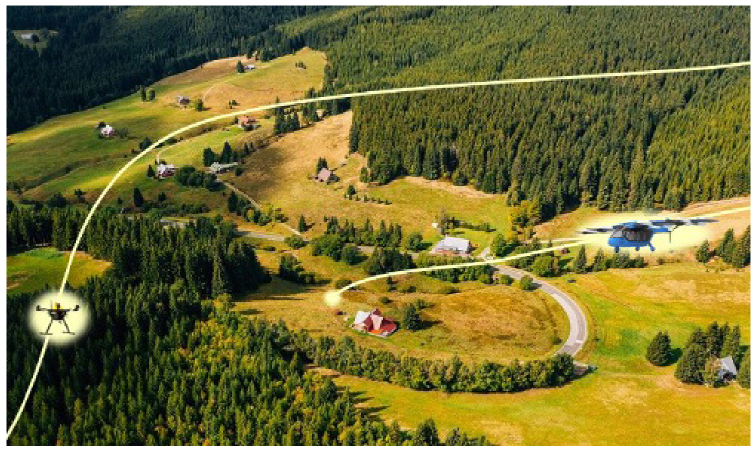

Figure 1. AAM is a system of safe, affordable, and automated air transportation for passengers and cargo in urban and rural settings. Credit: NASA

According to recent NASA-commissioned market studies, by 2030 there will be as many as 500 million flights a year for package delivery services and 750 million flights a year for air metro services. AAM will help ensure this new airspace is properly managed.

Compared to airplanes and helicopters, the aircraft that fly in this new airspace are small. This, along with where they fly, makes it unrealistic to continuously track or control these aircraft using radar or satellite technology. Many of these aircraft are **Unmanned Aerial Vehicles**, or UAVs, meaning they are self-flying or **autonomous**.

AIRCRAFT AND MISSIONS WITHIN AAM

The smallest aircraft operating in this new air transportation system are quadcopters. These small, autonomous aircraft are relatively inexpensive and are capable of performing tasks such as aerial observation, crop monitoring and treatment, and package delivery. Hospitals, for example, can quickly send a package containing samples to a remote lab, speeding up diagnoses and helping treat patients more effectively. Due to their size, quadcopters do not carry people.

Larger UAVs transport people. Air taxis and single passenger UAV's only carry a few people at a time, but they are able to bring people near their desired destination. Larger air metro UAV's carry more passengers, but they fly between predetermined stops similar to how a bus or subway operates.

Figure 2. Small quadcopters will perform a variety of tasks in urban areas. Credit: NASA, Maria Werries

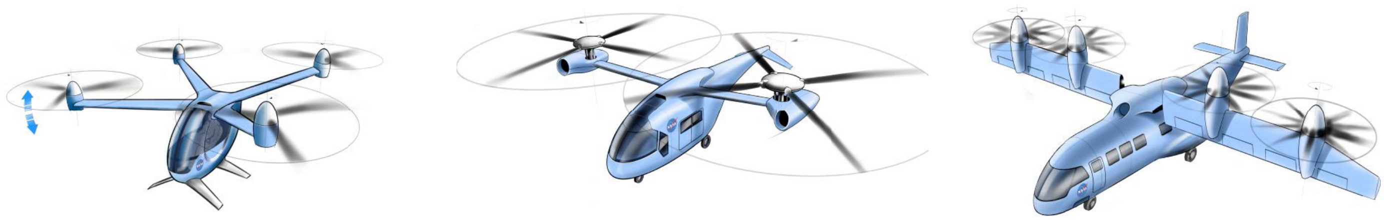

Figure 3. Some passenger carrying UAVs are single passenger aircraft, six passenger air taxis, and 15 passenger air metro aircraft. Credit: NASA

Aside from carrying passengers around, larger UAVs can accomplish different missions that take advantage of their flexibility. For instance, using a UAV as an ambulance means that it can avoid traffic and easily access locations that regular ambulances and helicopters cannot.

In rural areas, UAVs are used for aerial photography, agriculture, mapping, and inspection of buildings, power lines, and more. As more UAVs are developed, more and more uses for them will be discovered.

GEOFENCING

UAVs frequently encounter areas where they cannot fly. For example, if UAVs were to fly too close to an airport, they would pose a danger to airplanes landing and taking off. To combat this potential danger, a technology called geofencing is used.

Geofencing is when the global positioning system coordinates or a radio frequency transmission is used to define a geographical boundary—a virtual barrier. A microcomputer installed in the control system of a UAV automatically monitors its location. If the UAV gets too close to a restricted area, the microcomputer takes control of the aircraft and flies it away from the restricted zone. If this fails for some reason, it can also shut down the UAV, forcing it to land outside of the restricted area. Government regulations determine which areas are geofenced and this information automatically uploads to the microcomputer on the UAV.

Figure 4. Geofencing creates virtual three-dimensional fences to keep UAVs in or out of certain areas. Credit: NASA

Geofencing can also be used to keep aircraft within an area. Often, aircraft need to fly a specific flightpath and geofencing could be used to ensure they stay within the given corridor.

DETECT AND AVOID

Another issue AAM seeks to resolve is collision avoidance when two or more UAVs fly on paths that bring them too close to one another. Through a process called detect and avoid (DAA), a UAV automatically determines if there's any danger and adjusts its flightpath to avoid the other UAV.

The same microcomputer on the UAV that is used for geofencing also controls the DAA process. As a UAV flies, the microcomputer determines its current location and intended course. This information is broadcast to other UAVs located nearby so they can calculate whether there is a collision risk. If there is no danger, the UAVs continue along their current flightpath. If the flightpaths will be too close to one another, the microcomputer determines which UAV has priority and adjusts the course(s) and/or speed(s) accordingly.

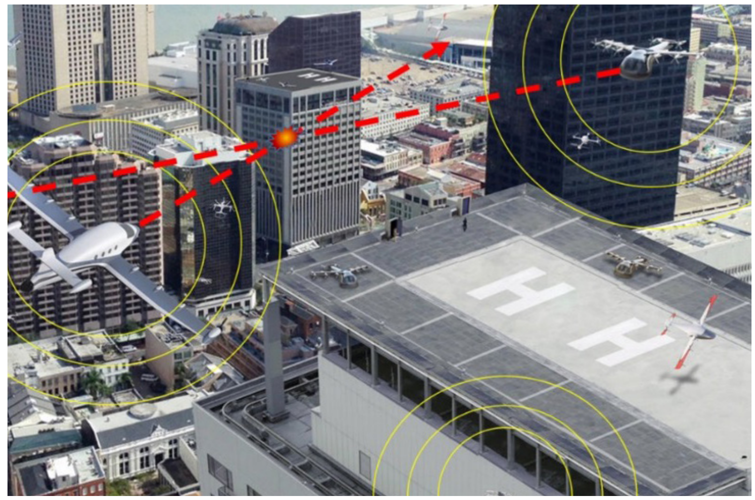

Figure 5. Autonomous UAVs transmit flight information to other UAVs to detect and avoid dangerous situations. Credit: NASA

WEATHER

While all aircraft are affected by the weather, UAVs are more heavily impacted by weather than traditional, larger planes and helicopters. Anything that affects the flightpath of a UAV poses a danger because they can operate close to people, buildings, and other UAVs. The microcomputer installed in the control system of the UAV monitors the weather and controls the UAV accordingly. If there are light winds, adjustments to the UAVs' courses and speeds are made to compensate for the wind. If the wind is too strong or another weather condition makes it too dangerous to fly the UAV, the microcomputer will prevent it from taking off or landing it if it's already in the air.

URBAN AIR MOBILITY

One of the most challenging aspects of AAM is controlling aircraft while flying in urban areas. Buildings make tracking aircraft difficult and special precautions must be taken to ensure aircraft do not harm people or buildings. As a result, a robust control system is required. **Urban Air Mobility**, or UAM, is the name given to this aspect of AAM.

It is important to note that passenger carrying UAVs in urban environments cannot land and takeoff anywhere they want because this interferes with other modes of transportation. Instead, they land at **Vertiports**, which are located throughout the city. Vertiports are flight terminals for UAVs similar to airports for larger planes. They can be located on top of preexisting buildings or in standalone buildings designed for UAV operations. Many vertiports must be located throughout the city to ensure passengers can leave from or arrive at a location near their origin or destination.

Reading Comprehension Questions

1. Why is a system like AAM needed instead of using traditional radar or satellite aircraft control systems?
2. How does AAM benefit both rural and urban areas?
3. According to what you just read, geofences are used around airports. Think of two other places where you would use geofences. Why you would use them in each place?
4. Why is DAA so important in AAM?
5. Aside from wind, what are some other types of weather that would make it difficult for a small UAV to fly?
6. You are in a city that has air taxis. You decide to take one to get to a restaurant. You find out it cannot deliver you on the street right in front of the restaurant but must deliver you at a nearby vertiport. Why is this?
7. Explain what a vertiport is. Why are they currently not commonly found?

Glossary

Advanced Air Mobility (AAM)—a safe, automated air transportation system for passengers and cargo in urban and rural locations

Autonomous—able to control the actions of oneself; in aircraft, flying without a human controlling it

Detect and avoid (DAA—system by which unmanned aerial vehicles communicate with each other to avoid collisions and maintain safe flying conditions

Geofencing—creating a virtual three-dimensional boundary around an area to keep unmanned aerial vehicles in or out

Urban Air Mobility (UAM)—a component of Advanced Air Mobility for controlling aircraft in an urban environment

Unmanned aerial vehicle (UAV)—small aircraft that can be remotely or autonomously controlled

Vertiport—location in an urban environment where unmanned aerial vehicles can land and takeoff

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