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The United States Army and Marine Corps are continuously developing small tactical Unmanned Aerial Vehicles (UAVs) to provide the local commanders immediate real-time intelligence. The Department of Defense is continually adding UAVs and complicated command hierarchy and employment procedures to manage the combat airspace. One obstacle to UAVs employment is the de-confliction of airspace for the Division to the Company level UAVs. These UAVs range in size from 1 lb. to 3,000 lbs., can fly from ground level up to 19,000 feet above ground level, are invisible on air traffic control radar, and do not always carry a means to identify itself to other aircraft. These UAVs can operate from areas as small as a few feet to close to 1,000 ft runways/roads.

Name	Weight (lbs)	Wingspan (Ft)	Ceiling (Ft)	Radius (NM)
RQ-2 Pioneer	452	17	15,000	100
RQ-5 Hunter	1600	29.2	15,000	144
RQ-7 Shadow	327	12.8	15,000	68
RQ-8 Fire Scout	2650	27.5	19,000	150
Dragon Eye	4.5	3.8	1,000	2.5
FPASS	5	4	1,000	5

Figure 1: Typical Tactical Unmanned Aerial Vehicles which would operate from SAAFs.

Occupying this airspace with the UAVs are helicopters, mortars and artillery shells, tactical aircraft, civilian aircraft (neutrals), other countries UAVs (enemy and allies), and natural obstructions. Clearly there are some obstructions which our services cannot effectively coordinate with (e.g., enemy aircraft, natural obstructions/birds), but we must find simple methods to de-conflict our UAV operations with the remaining airspace. If this airspace coordination is not done effectively, then we can lose UAV assets needlessly and at a critical time, prevent helicopter operations, shut down supporting artillery fire, and/or destroy coalition abilities. This airspace problem extends to domestic problems as well. Soon Commanders will want to exercise their UAV

assets within America to train their forces as they would want to “fight” their UAVs during a deployment.

In order to identify potential solutions to airspace de-confliction, I will look at Small Austere Airfield Operations (SAAFs) to see how some methods of small aircraft control are possible at potentially highly congested areas (e.g., small airports in a rural/remote settings) and congested non-“standard” airspace during limited times. Specifically, I will review Department of the Forestry, National Parks Service, and California Fire services information for their tactics, techniques, and procedures that they employ during the wildfire season.

The U.S. Department of Defense defines “austere” airfields as, “Unsophisticated airfield, usually with a short runway, that is limited in one or a combination of the following: taxiway systems, ramp space, security, materials handling equipment, aircraft servicing, maintenance, navigation aids, weather observing sensors, and communications.” U.S. Forces and civilian agencies worldwide require a detailed knowledge of Small Austere Airfields (SAAF) to rapidly support time sensitive missions (e.g. humanitarian contingency operations, rescue missions), disaster response to environmental hazards (e.g., wildfires) and long term remote regions economic development (e.g., oil, mineral, and natural gas exploration, fisheries support, timber operations). Currently, most SAAF operate at unknown capacities with decisions on mandated capabilities that are developed far removed from the local requirements and constraints. The military forces, particularly the U.S. Army, have developed manning requirements that teach only the text book solution to the problems.

In addition to the SAAFs, the U.S. and Korean Forces have developed a term for tactical support airstrips known as Air Terminal Supply Points (ATSPs).¹ The ATSPs primary function is to operate as a logistical drop off node. The ASTP, unlike a SAAF, does not have sustaining procedures and equipment for aircraft. The ASTP is chosen to provide rapid logistical support close to the main line of resistance (e.g., combat area). The ASTP might have only a tactical control team instead of a “tower” is a rough strip instead of true runway, not refueling or maintenance capabilities. The ASTP will have good transportation networks for ground movement of supplies. The ASTP is a transition step between a single Service (e.g., Army, Air Force, or Marine Corps) operating a forward base to a Joint Service (e.g., two or more services) or Combined (U.S. forces and one or more allies) base of operations. Even though ATSPs provide a term for a previous operations conducted during the Korean War, 1950-1953. The ATSP does not provide insights on how to control the airspace, but rather one technique which focuses the air and ground components to a point. Even though ASTPs do not provide insights on tactical airspace control, it does illustrate how forward direct support airfields can evolve to incorporate UAV locations particularly the larger tactical UAVs as well as how small tactical airfields mimic SAAFs.

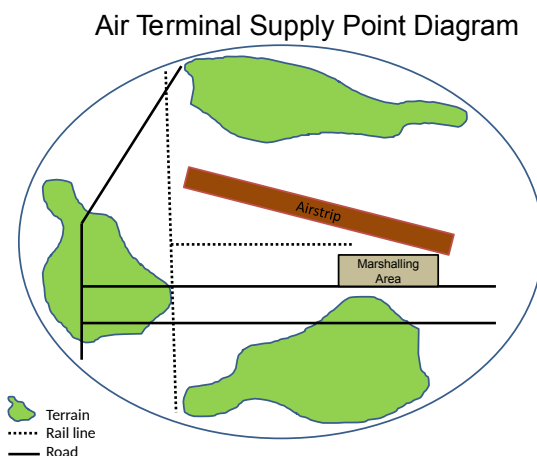


Figure 2: ATSPs primary focus is positioning logistics on the battlefield. However, these ATSPs can incorporate larger aviation support.

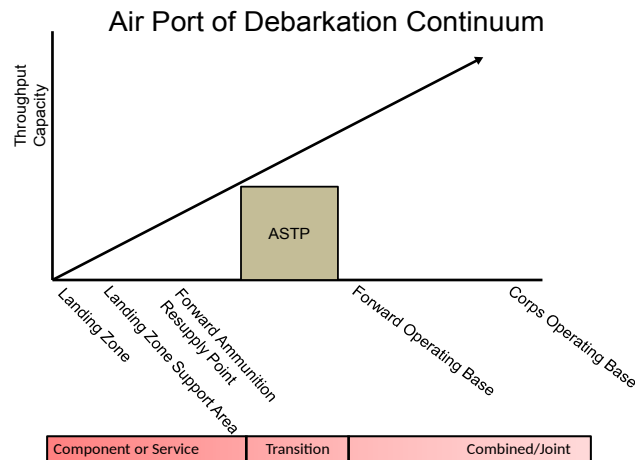


Figure 3: The APOD Continuum illustrates the transition from the smallest air operation points (e.g., LZs through FARPs to the left of the ASTP block) to large theater support bases which are equivalent to major airports.

The Small Austere Airfields will focus on the ICAO Code 1 and 2 airfields with focus on airplane design group I and II. These categories can accommodate the tactical UAVs, small airplanes, and helicopters which the U.S. Forces depend on to maintain a distinct advantage. This advantage can quickly become a burden if the aircraft cannot operate together and the coordination needed to train and de-conflict the corridors required to complete the mission.

FAA Airport Classification	
Airplane Design Group	Wing Span (m)
I	<15
II	15 to 24
III	24 to 36
IV	36 to 52
V	52 to 60
VI	60 to 80

Figure 4: The FAA's airport classification focuses on the airplane's design capable to land on the field.

ICAO Airport Reference Code	
Code Number	Field Length (m)
1	<800
2	800 to 1,200
3	1,200 to 1,800
4	>1,800

Figure 5: The ICAO airport code focuses on the dimensions of the airfield. (only length is shown in detail)

The FAA maintains information on the all publicly available airports within the United States. As of January 2008, the FAA reported that there were 5,190 airports open for public use within the United States. Of these 5,190 airports, 3,411 (65%) are identified as part of the National Plan of Integrated Airport System (NPIAS). [FAA, 2010] These NPIAS airports comprise 3,565 existing airports and 55 proposed airports. Of the existing airports, 3,251 are publicly owned while 113 are privately owned. A brief summary of existing NPIAS airports by FAA classification is as follows:

- 383 primary airports,
- 139 commercial service airports,
- 270 reliever airports,
- 2,564 general aviation airports.

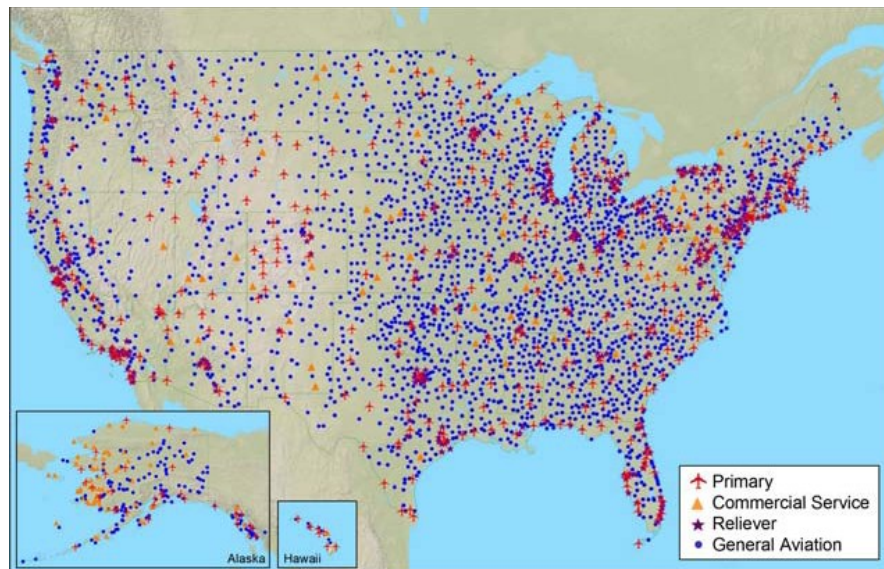


Figure 6: 3,411 airports in the National Plan of Integrated Airport Systems of the 19,815 total airports in the United States

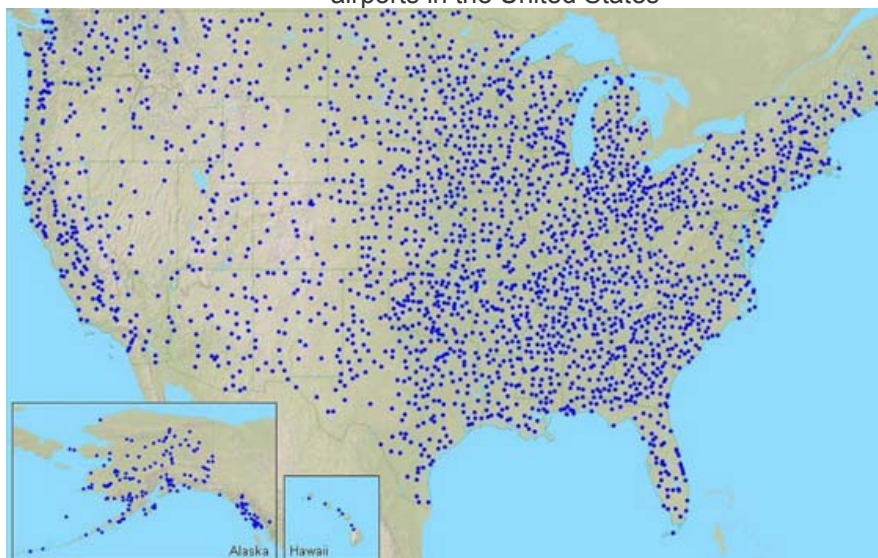


Figure 7: General Aviation airports in the United States, note the amount in Alaska

The Alaska airports are critical infrastructure for their stability. Despite the large number of airports within Alaska, there are large areas of the state without radio and / or radar coverage. Most of these airports are for small aviation which mimic Department of Defense aircraft in terrain which is similar to conditions around the world and function like the ASTPs discussed above. The flying conditions, “congested” areas, and poor

aircraft communication / tracking simulate the problems the Services have with airspace management for UAVs and other aircraft.

I attempted to match conditions in the Pacific Northwest and Southern California for similar aircraft conditions, poor coverage, and congestion. However, I found most of the California Department of Forestry wildfire services where well planned and drilled, operate from contracted airports, and have several command and control aircraft coordinating the other aircraft during operations. These well rehearsed airfields did not simulate the problems that I desired for austere, unfamiliar air operations.

The method that the U.S. and Europe is moving to reduce the congestion and delay problems focuses on improving air control. As noted in several articles, increasing the size and facilities at the existing airports cannot overcome over-scheduling. The current airports operate very efficiently. High capital costs, limited areas for expansion, and greater empathies on reducing noise and air pollution prevents the building larger airports to solve the immediate problem of congestion. Building any airport is a multi-year event. Even with large funding, immediate permits, community support, and FAA certification of the work at completion, “new” airports cannot provide the additional capacity which air travel demand is growing too. The European Union is projecting a doubling of current demand by 2020. [European Commission for Transportation, 2010] Luckily for the U.S. Armed Services and Coast Guard, the FAA, European Union, National Air Traffic Controllers Union and civil aviation industries are working to create a modern aircraft control system which can increase capacity while maintaining safety both in the air and on the ground.

Europe want to over comes it's 27 national air traffic control systems and 60 air traffic control centers.[Wielaard, 2010] The EU wants to begin their "Single European Sky" project now instead of 2012. The Single European Sky project (formerly, Project SESAME) is similar to the FAA NEXTGEN project. The project top five priorities are:

- a new regulatory framework based on efficient governance and performance-based air traffic management;
- the highest safety standards;
- the most advanced technology in Europe materialized by an ambitious European program (SESAR) aiming at replacing in a coordinated way throughout Europe an obsolete infrastructure by new products and equipments;
- the integration of the infrastructure in 'gate-to-gate' approach;
- the human factor dimension with a focus on social dialogue, open reporting as a means to increase safety. [Kallis, 2010]

The SESAR project can link the European community together. SESAR uses a similar Galileo GPS based system to provide greater situational awareness to its pilots and controllers. Unlike the FAA approach, SESAR must overcome many different National governments and is trying to expand with other nations as the system matures. The SESAR project does not currently incorporate the United States.

The FAA's NEXTGEN Air Transportation System program is incorporated into the Alaskan Aviation System. The basis of this program is the Automatic Dependent Surveillance–Broadcast (ADS-B) which was first used in Alaska, where accidents declined by 40% after implementation. [Alaska Aviation System Plan, 2009] The ADS-B has two main components to the system. The first is an onboard transponder that emits

a continuous signal from the aircraft. The second component is a ground-based transceiver that gathers location information and projects it onto a vehicle tracking/surface moving map used by pilots and air traffic controllers. This gives those using the system accurate position and terrain detail to within +/- 25 feet. This system relegates radar to a back-up system and places great emphasis on the pilots to monitor their position and that of other aircraft. In the spare airspaces of Alaska (even the lower half of the state), this system is a great success. However, none of my research currently mentions large scale testing in a major congested airspace.

This new system is undergoing testing in the Atlantic City to Philadelphia air space. [Lloyd, 2010] General aviation operations will be linked to the Universal Access Transceiver, while commercial operations will link with the 1090 MHz squitter. These frequencies are incompatible, which means to date the vehicle tracking/surface moving map might not depict both frequencies. The targeted implementation date for onboard avionic transponders is 2014 for commercial aircraft and 2020 for all aircraft. Because funding mechanisms for the system are unidentified at this time, it is questionable whether system-wide installation will be achieved by the target dates. The 1090 MHz frequency for commercial operations has been used in Europe. Based on experience with the same frequency, some officials there predict system overload in the early 2010s even despite greater space across the United States. This one critical frequency design feature might require additional experimentation since the system's success depends on a clear and continuous signal update from each aircraft.

The NEXTGEN and SESAR systems could be incorporated into military UAVs and rotor and fixed wing aircraft with common ground stations incorporated into maneuver

units to ensure indirect fires and civilian traffic are keep clear from military / “combat” airspace. The immediate problem is incorporating this technology into a small weight sensitive airframe which is governed by a strict bureaucratic acquisition process which is not easily adaptable to changes.

The Department of Defense and defense industries need to rapidly test and evaluate concepts, techniques, and procedures based on realistic information, field tested / proved airframes, in similar harsh situations in order to obtain the rapid fielding that is demanded by the needs of our uniformed personnel and Congressional insight. Currently the Services are employing new technologies that have had minimal testing due to the nature of the war on terror. The Services have several testing facilities, but this airspace management technology and requirement to integrate FAA mandated upgrades make it more than reasonable to use as much “pre-tested” and FAA certified equipment before the trying to incorporate into UAVs under-development and in-service aircraft.

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