3.0 The Autonomous Transportation System (ATS) Concept

The world is on the cusp of a completely new mode of transportation using electric powered, networked, fully autonomous vehicles. A new Autonomous Transportation System (ATS) is needed to facilitate this transformation within the U.S., to include standards for the development, manufacture and operation of autonomous Aerial Vehicles (AVs) and Ground Vehicles (GVs). This document proposes strategic-level standards for the ATS and for autonomous AVs and GVs, to enable safe, secure, reliable and swift transport of cargo and human passengers. Further, it proposes standards to safely incorporate traditional manually operated ground vehicles, pilot-controlled aircraft, and smalls drones into the system – initially and perpetually.

Topics, features, and design solutions presented in this document are the proposed strategic-level standards. The proposed new ATS includes the people, facilities, and hardware/software (HW/SW) required to manage, operate, and monitor all GVs operating on the ground, and all AVs operating within the authorized public airspace. The standards will ensure cargo, passengers, and people and property on the ground are kept safe, now and into the future.

OVER’s vision and intention is that this proposed ATS be discussed and revised as necessary by transportation and aerospace industry experts, government experts (DOT, FAA, etc.), and the American public. Once revised, it can provide a baseline for final standards to govern the design, production, integration and operation of large, fully autonomous GVs traversing public roads and AVs flying within the public airspace. The final ATS will ensure that all autonomous GVs/AVs are safe, secure, reliable and fully compatible with the HW, SW, networking and communication requirements, regardless of manufacturer, or will not be allowed to operate.

This document also proposes that customers will be able to order seamless transportation using GVs and/or AVs from point A to point B, with a single request/payment via a proposed mobile application called the “ATS APP” – regardless of vehicle manufacturer. It is anticipated that many passengers would be provided curb-to-curb transport using GVs before and after an AV flight.
The entire trip would be one convenient auto-debit price/transaction to the customer (through the ATS APP), even though the fare revenue may be divided appropriately between various manufacturers. The ATS APP would operate on both android and Apple mobile devices, as well as PC-based and Apple laptop/desktop computers.

Technologies and systems for medium/large Vertical Take-Off and Landing (VTOL) AVs are currently being developed and tested worldwide, and some systems are fully operational. For example, the Chinese company EHang and the German company Volocopter began aerial passenger taxi services in Dubai in 2018.\(^1\) (To gain an appreciation of the volume of electric-powered VTOL AVs currently being designed, developed or operated, see Appendices 1-3 for a brief synopses and image of 71 designs. Also see Appendix 4 for 11 autonomous shuttle-bus type ground vehicles). Because so many systems and components are available now, and because various companies are already developing and manufacturing AVs and GVs, the U.S. government needs to endorse, promote and establish a new, standardized, national ATS now, to facilitate the safe commercial use of these technologies in the U.S.

This document also proposes that the U.S. government should partner with industry, academia, and the scientific and engineering communities to spearhead a National ATS Initiative to develop and establish the final standards, and promote continual research, development, and testing of HW/SW to support and meet the final standards of the new ATS, and various GVs and VTOL AVs.

This discussion of the ATS focuses on the proposed system-wide features and benefits needed to manage, assign, and monitor all AVs operating within the public airspace at any given time (which would eventually be in the millions). It also focuses on the proposed system-wide features and benefits needed to manage, assign, and monitor all autonomous GVs operating on public roads. For the ATS to function safely and effectively, every AV (manned or unmanned) must communicate and operate in an identical manner, and every GV (manned or unmanned) must communicate and operate in an identical manner, regardless of manufacturer.

It’s anticipated that only Cargo Aerial Vehicles (CAVs) will be allowed to operate in the ATS on day one of operations, which will provide the government, industry and the general public time to evaluate whether the aerial operations are safe, secure, and reliable. Once proven and authorized by the government, Passenger Aerial Vehicles (PAVs) will begin operations. The ATS and the vehicles themselves must therefore meet standards from the very beginning that ensure safe, secure, reliable and swift travel for humans.

It is not the intention of this document to address the government’s oversight of the ATS, although it would fall under the responsibility of the DOT and FAA. However, it is important for government to realize the inherent benefits from providing oversight. These benefits include the ability to monitor and track every autonomous AV flight and GV ride, all cargo being transported, and every passenger on-board – in real time. The government will have the ability to exert overriding control over any AV/GV, as appropriate, and direct it to another GPS location.

The OVER concept GVs are designed to safely travel on existing roads using GPS-based mapping/routing, two (redundant) independent collision avoidance systems, and swarm-type technologies. Once fully developed, these systems will enable collision-free, concurrent operation of both autonomous and traditional driver-controlled vehicles on any mapped road.

\(^1\) https://www.seeker.com/dubai-to-launch-worlds-first-aerial-drone-taxi-service-2266163132.html
Similarly, the OVER concept AVs are designed to use GPS-based mapping/routing, two (redundant) independent collision avoidance systems, and swarm-type technologies. The primary means to ensure collision-free flight is OVER’s concept of pre-scheduled flight paths (hereinafter referred to as “Time-Paths”), which reserve a sphere of safe space in future time for each AV, throughout flight. The time-path system alone ensures that no AV will ever be approved to fly a route that is too close to any other AV. Further, AVs will be equipped with two (redundant) independent radar/reflection-based, 360-degree collision avoidance systems, for short-distance and long-distance detection, similar to the Airborne Collision Avoidance System X² (ACAS X). Further, they will use swarm-type technologies to override their approved time-path, and control flight as necessary to avoid unforeseen objects (e.g. non-networked pilot-controlled aircraft, non-networked drone aircraft, falling debris, birds, etc.). Once fully developed, these systems will enable millions of AVs to travel safely and securely through crowded airspace, in both urban and rural environments, as well as concurrent operation of both autonomous and non-autonomous aerial vehicles. (The proposed time-path and 360-degree collision avoidance concepts are so important in ensuring safe AV travel that they are illustrated in the OVER logo).

A key fact is that many of the systems and components needed for AV and GV operations have been invented, developed, manufactured, and are in operation, and many are available to the public. Examples include autonomous flight control, GPS-based navigation, collision avoidance, swarm technologies, electric-powered propulsion, and digital mapping/routing. Some systems and components are available as commercial-off-the-shelf (COTS) products. However, for the proposed ATS to function efficiently, some HW will need to be developed, modified/refined and/or scaled accordingly, and a good deal of specialized SW will need to be developed and/or modified/refined (e.g., AV/GV assignments, time-path mapping, etc.). Motors and power sources will certainly be improved upon through continual innovation, over time, resulting in more power, speed and efficiency, and less noise and pollution. Software will be a key development hurdle as multiple databases/systems need to be developed. However, similar SW systems are in existence, and with some modification should meet standards.

It’s OVER’s opinion that no single corporation can develop the ATS, or manufacture the proposed standardized GVs and AVs, as no single corporation has the patents or licenses for all required systems. OVER’s business approach is that a collaborative, multi-corporation “joint venture”, structured as a Limited Liability Company (LLC) will develop and operate the ATS, and manufacture and operate the standardized GVs and AVs, at little to no cost to the American taxpayer. This multi-corporation joint venture is referred to as the “LLC Team”. The LLC Team will include VTOL and manufacturing industry experts, from various disciplines, to evaluate, select, and obtain license to modify and manufacture existing “best-in-class” systems, from any corporation, individual entrepreneur or other entity worldwide - hereafter called “Contributors”. These Contributors will provide the LLC Team with license to modify and manufacture their HW/SW system(s), in exchange for receiving monthly cash dividend payments generated from taxi-fare revenue, once the LLC is profitable. OVER’s financial forecast currently provides a 100% annual Return on Investment (ROI) after distributions begin. (This is addressed fully in the OVER Business Approach chapter).

It is of no benefit to have a new ATS, if AVs and GVs with the needed capabilities cannot be manufactured and operated in a safe, secure, reliable and swift manner. Therefore, OVER

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2 https://www.skybrary.aero/index.php/ACAS_X
concept AV designs are presented in Chapter 4, and similar GV designs in Chapter 5, for both cargo and passenger services. AV and GV passenger models are designed to accommodate patrons using wheelchairs, strollers and walkers, and cargo models are designed to accommodate rolling stock. (Note: Single person AVs would probably be entered into operation before multiple passenger models, and will probably not accommodate wheelchairs, etc.). The unique OVER AV concept models contain the patented OVER Aerial Vehicle Autonomous Anchoring and Powering System (AVAAPS) and the patent-pending OVER Emergency Flotation System (EFS). Although the OVER multi-passenger concept models are designed to meet the proposed standards, they would certainly be refined/redesigned prior to production, to provide more efficiency, speed, functionality and convenience to customers.

Further, it is of no benefit to propose a new ATS if it will not be profitable for Investors and CONTRIBUTORS. The proposed OVER business approach for providing AV and GV services will be to provide on-demand, cargo and passenger taxi-fare (or long-term lease) services only, as opposed to selling the AVs and GVs to customers outright. The proposed approach is to never sell the vehicles, but rather provide on-demand taxi-fare type services based on the distance of each customer’s flight/trip (GPS departure point -to- GPS destination point), and long-term lease type services which generate similar revenue. The LLC Team will retain ownership, and pay to inspect, service, maintain, insure, fuel, and operate all its manufactured AVs/GVs – perpetually. Although this sounds complicated and expensive, the fare-based revenue system will, over a relatively short period of time, provide an inexpensive form of transportation for the masses, as well as significant, perpetual cash dividend payments to CONTRIBUTORS and Investors, as well as good wages and long-term bonus payments to employees.

3.1 Key Reasons why we Need a New Autonomous Transportation System (ATS) - Now

- Current forms of ground and air transportation are susceptible to accidents caused by human error, which are virtually eliminated in the new ATS.

- Current forms of ground and air transportation are highly susceptible to accidents caused by equipment failure, which is significantly reduced in this new ATS, which provides safer and more reliable systems (e.g. electric motors) as well as redundancies for all critical systems.

- Current forms of ground and air transportation are susceptible to hacking, theft and high-jacking, which are virtually eliminated in this new ATS, by requiring secure, password protected access to the flight control SW, joint Government/Manufacturer Control centers (hereinafter called “GM Control”), and highly-reliable iris identification for customer access, loading/unloading, and payment.

- Currently, the FAA doesn’t know the GPS location of every traditional aircraft in flight. Under the new ATS, the FAA can monitor the real-time GPS location of every AV, which is provided by the AVs themselves, and also by other AVs and fixed sensors in the area. If an AV goes down, the FAA can quickly direct search and rescue to the last transmitted GPS location. Further, the FAA will know where each AV is going, and who or what is on-board. If manned, they will know the identity of each occupant, via the passenger manifest generated through iris authentication which is transmitted to GM Control before each flight. If transporting cargo, they will know the contents via the cargo manifest, generated from Radio Frequency Identification (RFID) sensors.

- Currently, the DOT doesn’t know where every ground vehicle (e.g. car, truck) is located at any given time, nor where it is going, or who or what is being transported. Under the new ATS, the
DOT will know where every GV is located at any given time (via GPS), where it is going, and who or what is on-board. If manned, they will know the identity of each occupant via the passenger manifest, and if transporting cargo, they will know the contents via the cargo manifest.

- Currently, most traditional ground vehicles and aircraft have internal-combustion or jet engines which burn fossil fuels, creating a great deal of air pollution. The proposed AV and GV concept designs incorporate the low-voltage (48V) nanoFlowcell\(^3\) electric power generation system and lightweight electric motors, which use a safe, non-flammable, non-explosive, non-corrosive and non-hazardous bi-ION fuel, which produces no pollution. (*The proposed nanoFlowcell system and purported claims have not been verified to date*).

- Currently most forms of ground and air transportation are inefficient, when compared to the manner of travel that the proposed AVs and GVs could provide. Currently, ground traffic is congested and slow, especially in urban areas during rush hours, and traditional commercial air travel requires an inordinate amount of time and effort for passengers to travel to an airport, check in, get through security, and board. Under the new ATS, passengers board AVs and GVs at convenient locations across an area of operation, and their identity is quickly verified upon entry via iris scan, without delay. AVs will travel through airspace in a swift manner, without delay due to congestion, accidents, breakdowns, or security issues. AVs will travel to their GPS destination directly, at cruise speed, resulting in less total travel time – making the ATS swift and efficient.

- Current ground and air transportation infrastructure is expensive, when compared to the proposed ATS solution. U.S. taxpayers pay billions of dollars to build and maintain roads, highways, bridges, tunnels, subway systems, rail systems, airports, etc. The cost of implementing and maintaining the ATS pales in comparison with those expenses. According to the OVER business approach, initial and future ATS infrastructure, such as refueling stations, service/maintenance facilities, parking structures, etc.) and all AVs and GVs themselves will be manufactured and maintained by the LLC Team, at *little to no cost to the American taxpayer*.

Another reason why we need a standardized ATS now, is because existing and emerging technologies have made it possible to build large, VTOL AVs capable of manned flight now. *Large, VTOL, manned AVs are already being manufactured and operated in other countries, without the needed standards to ensure safe, secure, reliable, and swift flight. These AVs will continue to be developed worldwide, and eventually mass-produced, with or without U.S. government involvement or authorization.* Two examples of currently developed, large, manned autonomous AVs are the *EHang 184* developed by a Chinese company, and the *Volocopter 2X* developed by a German company, both discussed below.

### 3.2 Autonomous Aerial Vehicles (AVs)

Currently, there are over 200 VTOL AV concepts worldwide, most being “electric” powered. (*Electric VTOL AVs are sometimes abbreviated as “eVTOL” AVs*). Many aircraft manufacturers are in the process of developing and prototyping at least one cargo or passenger model. Various, proprietary designs are being manufactured and put into operations, some with full autonomous capabilities, but most with limited autonomy at this time. The proposed, concept OVER AVs are designed for full autonomous operation, having no pilot controls at all. The proliferation of autonomous AVs around the world, manufactured to various standards (or perhaps no standards

\(^3\) [https://nanoflowcell.com](https://nanoflowcell.com)
at all) may lead to accidents, injuries, and property damage – which can be avoided. Hence the need for the U.S. to develop and establish standards now, to ensure safe, secure, reliable and swift operations. Some examples of AVs currently in operation, as well as a list of many other AVs in development are provided below.

3.2.1 EHang\(^4\)

The EHang company has developed a 1-person, electric-powered VTOL AV (the EHang 184, pictured here), having 8 motors/propellers and 4 motor arms. They also recently demonstrated a 2-person model (EHang 216) with 16 motors/propellers, and 8 motor arms. Both are battery-powered and use electric motors and contra-rotating propellers. By using a mobile phone app, riders/passengers enter their GPS destination (and waypoints) by touch screen on a map. The EHang AVs then navigate to the destination autonomously, through waypoints if necessary, with no user/pilot controls. It was reported in July 2017 that the EHang 184 conducted numerous tests for Dubai’s Roads and Transport Authority (RTA), and that many passengers had been flown to date in China and Dubai\(^5\). EHang is pursuing the opportunity to provide air-taxi type services in Dubai, starting as early as 2018. Although the EHang 184 (and the 2-passenger model) are impressive machines, they have limitations (compared to the OVER concept AVs), including that power is provided by batteries alone so flight time is limited, no autonomous anchoring system, no emergency flotation system, entry/exit is difficult for all passengers, and entry/exit is virtually impossible for patrons using wheelchairs and walkers.

3.2.2 Volocopter\(^6\)

The Volocopter company has developed a 2-person, electric-powered, 18-motor VTOL AV having both conventional human joy-stick controls and autonomous capabilities. Volocopter is working to develop “mass air transport corridors” in highly populated areas, to provide air shuttle and personal aerial vehicle services. The initial Volocopter model VC200, and the newest model 2X will fly by joystick or autonomously from departure location to destination, through waypoints as required. In June 2017, Volocopter revealed that it would be flying its VC200 in Dubai. With funding from Dubai’s RTA, testing started in 2017 and will run for five years\(^7\). Although the Volocopter 2X presents a milestone in VTOL manned aerial vehicles, it has limitations (as compared to the proposed AVs), including a size 9.15m (~30ft) diameter which prohibits landing in small areas, power provided by batteries alone so flight time is limited, no

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\(^4\) [http://www.ehang.com/ehang184](http://www.ehang.com/ehang184)


\(^6\) [https://www.volocopter.com/en/](https://www.volocopter.com/en/)

autonomous anchoring system, no emergency flotation system, entry/exit is moderately difficult for passengers, and entry/exit is virtually impossible for patrons using wheelchairs and walkers.

3.2.3 Other Vertical Take-Off and Landing (VTOL) Aerial Vehicles (AVs)

The developed technologies and product innovations in use today enable a new world of VTOL AVs – both manned and unmanned. (See the list on the next page, and Appendices 1, 2 and 3).
Other Electric-Powered VTOL AVs
(eVTOL.news information current as of February 2019. Used with permission of the Vertical Flight Society http://evtol.news/aircraft)

**Vectored Thrust** (An eVTOL aircraft that uses any of its thrusters for lift and cruise):

1. A³ Vahana
2. aeroG Aviation aG-4
3. AgustaWestland Project Zero
4. AirisOne
5. AirspaceX MOBi
6. Aston Martin Volante
7. Autonomous Flight Y6S
8. Bartini Flying Car
9. Bell Air Taxi
10. Carter Aviation Air Taxi
11. DeLorean Aerospace DR-7
12. Digi Robotics DroFire
13. Digi Robotics Droxi
14. Dufour aEro2
15. EVA X01
16. HopFlyt Venturi
17. JAXA Hornisse 2B
18. Jetoptera J2000
19. Joby Aviation S4
20. Karem Butterfly
21. KARI PAV
22. Lilium Jet
23. Moller Skycar M400
24. Neoptera eOpter
25. Opener BlackFly
26. Piasecki eVTOL
27. Pipistrel (unnamed)
28. Pterodinamics Transwing
29. Rolls-Royce EVTOL
30. Sabrewing Draco-2
31. Sikorsky VERT
32. SKYLYS Aircraft AO
33. Starling Jet
34. Supervolant Pegasus
35. Terrafugia TF-2 Tiltrotor
36. Terrafugia TF-X
37. Transcend Air VY 400
38. VerdeGo Aero VY 400
39. Vertiia
40. Vickers WAVE eVTOL
41. Vimana AAV
42. VTOL Aviation Abhiyaan
43. XTI Aircraft Trifan 600
44. Zenith Altitude EOPA

**Lift + Cruise** (Completely independent thrusters used for cruise as for lift):

1. AeroMobil 5.0
2. Aergility ATLIS
3. Aurora Flight Sciences eVTOL
4. EAC Whisper
5. Embraer DreamMaker
6. Flexcraft (unnamed)
7. HoverSurf Formula
8. Kitty Hawk Cora
9. Napoleon Aero VTOL
10. Pipistrel (unnamed)
11. Ray Research VTOL Aircraft
12. Terrafugia TF-2 Lift + Push
13. Urban Aeronautics CityHawk
14. Zee Aero Z-P2

**Wingless (Multicopter)** (No thruster for cruise – only for lift):

1. Airbus Helicopters CityAirbus
2. Alauda Airspeeder
3. Astro AA360 ("Passenger Drone")
4. Avianovations Hepard
5. Boeing Cargo Aerial Vehicle
6. Cartivator SkyDrive
7. Davinci ZeroG
8. Dekatone (unnamed)
9. EHang 184
10. EHang 216
11. Jetpack Aviation (unnamed)
12. Kármán XK-1
13. Kenyan Passenger Drone
14. Kitty Hawk Flyer
15. PAV-UL Ultralight
16. PAV-X
17. Pop.Up Next
18. Skypod Aerospace Skypod
19. Sky-Hopper
20. Swarm Multicopter
21. Volocopter 2X
22. Volocopter VC200
23. VRCO NeoXCraft
24. Workhorse SureFly
Ten years ago, these vehicles could hardly be imagined, let alone manufactured and operated. The proliferation of large AVs around the world, manufactured to questionable standards or perhaps no standards at all, may lead to accidents, injuries, and property damage. News reports/videos of such incidents would produce negative impressions of autonomous transportation safety in the minds of the public. This can be avoided by implementing the ATS.

The continued development of larger AVs worldwide, is inevitable. Demand will grow and various manufacturers will build hundreds, and then thousands. If this goes unchecked, there may be large AVs flying independently, without a system in place to ensure the safety of people and property, inside the vehicle and on the ground. To promote these technologies and ensure they will be used in a safe and secure manner, the U.S. government must take the lead in implementing a completely new, standardized, national, networked ATS, by establishing standards now, in the U.S. These standards will then govern the design, manufacture and operation of autonomous AVs in the airspace - before other countries or foreign organizations do. These standards will dictate how AVs will communicate with the Government/Manufacturer Control centers (GM Control), what data will be transmitted/received, how AVs will fly through the airspace, and the resultant HW/SW requirements. These standards will then drive the development of mass-manufacturing facility plans (highly robotic) and mass-manufactured fully compliant HW/SW systems.

3.3 Drones

The “drone” is typically a small Unmanned Aerial Vehicle (UAV) normally controlled by a remote pilot via close-range remote control, as pictured here. Drones contain developed technologies (HW/SW) such as 3D gyro and accelerometer, which provide smooth and stable vertical ascent and descent, stable flight, and stable hovering. Other developed technologies enable precise control of multiple motors, autonomous GPS-based flight (waypoints and return home) and swift acceleration and flight (subject to motor size and total weight).

Today, a multitude of small remote-controlled drones are used to accomplish all kinds of work in a safe and cost-effective manner. Much of the work was previously performed by humans, but was difficult, dangerous, time-consuming, and/or expensive. These small drones have transformed the way many jobs are accomplished. Examples include search and rescue, inspections of wind turbines, power lines, towers, and pipelines; detailed aerial surveying and mapping; security, surveillance, aerial photography/video, and aerial delivery of small packages.

Although some drones are very speedy, the primary problems are that they are small, have limited flight duration, and can only carry a limited payload due to limited power (lift). The larger drones can currently carry only about 30kg (~66 lbs.) of cargo, and their power source (typically battery) provides flight duration of only about 30 minutes. However, these capabilities are expected to expand significantly in the near future.

8 https://www.gooyait.com/uploads/robot-digi2-1-600x382.png
As of January 2018, more than one million UAVs (878,000 hobbyist and 122,000 commercial) were registered with the FAA. According to Wikipedia, the civilian drone market is dominated by Chinese companies, followed by French company Parrot and U.S. company 3DRobotics. Chinese drone manufacturer DJI alone has 75% of civilian-market share in 2017 with $11 billion in global sales forecasted for 2020. The need and uses for small remote-controlled drones will only continue to expand in the future. This proposed new ATS will integrate, enable and accommodate safe, swift and congested “drone” traffic, even in highly congested urban airspace.

3.4 Autonomous Ground Vehicles (GVs)

Virtually every major automobile manufacturer is in the process of developing and implementing at least one semi-autonomous Ground Vehicle (GV). (See Appendix 4 for a brief synopsis and images of 11 electric-powered shuttle-bus type, ride-sharing GV, currently being developed or operated). Various, proprietary designs are being manufactured and put into operation, most with limited autonomy (e.g. Levels 1, 2, 3 or 4), but some with full autonomy (Level-5). The proposed, concept OVER GVs are designed for fully autonomous (Level-5) operation, having no driver controls at all. The proliferation of autonomous GVs around the world, manufactured to various standards (or perhaps no standards at all) may lead to accidents, injuries, and property damage. Hence the need for the U.S. to develop and establish standards for a safe, secure, reliable and swift ATS, including both GVs and AVs.

3.4.1 Baidu Apolong

One example of the development of autonomous GVs is the “Apolong” mini-bus (also called Apollo). Baidu (China’s leading search engine provider) partnered with Chinese manufacturer King Long to develop the Apolong, which is a Level-4 autonomous shuttle-bus type vehicle. It’s powered by Baidu’s Apollo open source autonomous driving technologies (e.g. Duer OS), and offers intelligent voice assistant, facial recognition, AR navigation, and other advanced technologies. According to a statement from King Long, the buses can travel at a speed of 60km/h (~37mph) for a distance of up to 100km (~62 miles) on a two-hour charge. The Apolong project has attracted more than 70 global partners, including automakers like Hyundai, Ford, Daimler, and Bosch. The Apolong achieved mass production in 2018, and will soon commence commercial operations in select tourist spots and airports in several Chinese cities including Beijing, Guangzhou, Shenzhen and Xiongan. Further, Baidu and King Long have entered an agreement with Japan to export Apolong buses to Japan in early 2019.

9 [https://en.wikipedia.org/wiki/Unmanned_aerial_vehicle#Civilian](https://en.wikipedia.org/wiki/Unmanned_aerial_vehicle#Civilian)
10 [https://www.parrot.com/us](https://www.parrot.com/us)
11 [https://3dr.com/](https://3dr.com/)
12 [https://www.dji.com/](https://www.dji.com/)
3.4.2 EasyMile EZ10

Another example of an autonomous shuttle-bus type vehicle is the “EZ10”, developed and manufactured by the French company “EasyMile”. The EZ10 autonomous shuttle pictured here was operating at Bishop Ranch business park in Contra Costa County, California. It is being considered for a year-long demonstration project in downtown Napa. The EZ10 driverless shuttle has already been deployed in 20 countries across Asia-Pacific, Middle East, North America and Europe.

Neither the Apolong or EZ10 offer all of the customer-focused features and benefits of the OVER-designed GVs presented herein. Main advantages of the OVER GVs include level entry/exit for rolling stock and wheelchairs, unified ATS APP for ordering transportation (whether GVs and/or AVs), and commonality with AV features such as similar entrance size, doors, seating, windows, grab bars, etc. (see Chapters 4 and 5 for details).

3.5 Incorporating Other Vehicles

It is anticipated that the new ATS will also incorporate vehicles used in all other modes of traditional transportation, to include trains, busses, 18-wheeler trucks, motorcycles, as well as the traditional aircraft and ground vehicles previously addressed. These non-networked vehicles will eventually be equipped with a small, battery-powered computer/transmitter/antenna device, perhaps the size of a domino, which will autonomously calculate and transmit their position-in-time (PIT) data, approximately once per second, without any human input. This will essentially “network” these vehicles into the system, so their position can be plotted into the MAP, both at GM Control and in each AV/GV in the area. When this is accomplished, the autonomous vehicles will have plotted each position and calculated trajectory of all traditional vehicles in the area, and can therefore better avoid accidents, heavy traffic, etc.

3.6 ATS Standards will Ignite a Multi-Trillion-Dollar Autonomous Vehicle Industry

The acceptance of fully autonomous transportation will require a paradigm shift in thinking, similar to the days when automobiles were just beginning to replace the horse and buggy. During this period of transition, demand declined for existing transportation (e.g. carriages, wagons, horses, etc.), and many workers in those affected industries lost their jobs and/or businesses (e.g. carriage/wagon makers, horse and mule sellers, blacksmiths, etc.). However, demand increased for automobiles and trucks that improved the customer’s transportation capabilities, and workers obtained new jobs or started new businesses in automotive manufacturing, service, repair, etc. There will be similar consequences of transitioning to an autonomous system. Businesses involved with traditional taxi and cargo transportation services, as well as individuals which drive traditional vehicles/trucks for a living, will be affected significantly. Businesses such as car dealerships will also be affected as private vehicle sales and ownership decline.

But as the autonomous vehicle industry emerges, new businesses will open and new employment opportunities will develop to meet the demands for AV and GV manufacturing, operations, service and maintenance, as well as AV and GV parking and service facility construction and
maintenance, and bi-ION manufacturing and distribution. Contrary to initial thought, the current automotive and aircraft industries will *boom* when they refocus and retool to manufacture and operate *millions and millions* of autonomous, taxi-fare and lease-type AVs and GVs.

The U.S. government, and the aeronautic, transportation and scientific communities, as well as academia are all encouraged to be proactive and lead the revolution, regardless of any industry or special interest opposition (e.g. automotive, trucking, aerospace, oil and gas, unions, Chamber of Commerce, etc.). U.S. citizens as a whole should embrace, enable, promote and invest in the autonomous vehicle industry and the new opportunities it will soon provide.

Consider and compare this proposed ATS industry with the traditional automotive and aircraft industries in their infancy, and let history guide us to better decisions. When first developed, many people said they would never ride in one of those “contraptions”, due in part to safety concerns, but within a decade many had. The first mass-produced automobiles, circa 1910, had few safety systems/features. As a result, a multitude (perhaps millions) of drivers, occupants, and pedestrians have been killed, maimed and injured over the last 100+ years. Today, automobiles are required to provide safety systems and features like safety glass, beams in doors, collapsible bumpers, seatbelts, airbags, and anti-lock brakes, and many offer advanced systems like collision avoidance, backup cameras, and handsfree communication technologies to meet growing customer demand. Many of these features were not invented when automobiles were first manufactured, but were developed over the years and are now in use.

A key goal of the proposed ATS is to *establish safety and security standards from the very beginning*, to ensure passengers, cargo, and the public are never killed, maimed or injured by an AV or GV. Over the years, as the ATS industry grows, business innovators, engineers, academia, manufacturers, and others will undoubtedly improve on many of the initial systems and components, to make future AVs/GVs even safer, secure, larger, faster, cleaner/greener, quieter, and more cost effective.

Although modern automobiles are safer than ever, there were still over 37,000 vehicle fatalities and over 340 civil aircraft fatalities nationwide, during 2017. This equates to over *100 vehicle-related deaths - per day*! Many (if not all) of these deaths could be prevented if people were using this new, proposed ATS. In addition to the death and injuries, U.S. citizens and businesses spend millions of dollars on fossil-based fuels, and waste millions of hours in a congested, slow-moving ground transportation system. There is also a high cost to taxpayers to build and maintain roads, highways, tunnels, and bridges. *Fossil fuel consumption, road congestion and infrastructure costs can all be reduced* by transporting at least some of the cargo and people through this new ATS.

The transformation to autonomous transportation does not require government mandate, elimination of fossil fuel production, or taxpayer funds. Rather, it can be accomplished by industry offering customers a safer, swifter, more convenient, and less expensive form of transportation. As the old saying goes “Build it and they will come”.

Safe aerial transportation using large VTOL AVs will forever change transportation as we know it. The U.S. needs to take aggressive action *now*, to ensure the U.S. dominates this near-future industry, and to thwart any attempt by China and others to direct and control the technical protocols and systems, as they have done in the civilian drone market. The autonomous vehicle
industry will be a key part of the U.S. Gross Domestic Product (GDP) in the future. Further, if implemented properly, it will generate significant trade surpluses for the U.S. as licenses are eventually sold worldwide, to manufacture the standard GVs and AVs, and implement the ATS.

By considering the economic, safety, and efficiency benefits of the proposed ATS, the U.S. government, industry and the general public will realize that a safer and more reliable mode of transportation is obtainable now. Therefore, it is recommended that Presidential, DOT, FAA, and industry endorse and support a new ATS, and an official National ATS Initiative be established to promote the development, implementation, and mass manufacturing of autonomous GVs and large autonomous VTOL AVs - now.

3.7 Key Features of the Proposed ATS, GVs and AVs

Key features of the proposed ATS, AVs and GVs include the following, regardless of manufacturer:

- Privately funded operation with little to no cost to U.S. taxpayers
- GM Control facilities, primary and backup, provided by the LLC Team
- Facilities for manufacture, testing, operation, parking/charging, refueling, inspection, service and maintenance
- Multiple load/unload and charging facilities for GVs and AVs
- Government ability to monitor and track every flight/trip, every cargo load, and every passenger in transit, and exert overriding control over any AV or GV if required
- Reliable and redundant HW/SW systems
- New, standardized rules for GV travel, including docking/undocking, acceleration, time-path routing, speed, deceleration, and customer loading/unloading, with or without ramp/platform
- New, standardized rules for flight including lift-off, acceleration, ascension, time-paths, cruise speed, deceleration, descension, landing and loading/unloading with or without ramp/platform
- Time-Path calculations for AVs based on a proposed ARC formula
- Standardized communication protocols and communication path redundancies
- A single, shared, real-time MAP used for calculating and plotting AV and GV time-paths
- Emergency Floatation System for AVs
- Autonomous Anchoring and Powering System for AVs, and
- Accommodations for traditional, non-networked aerial and ground vehicles.

3.8 Government and Manufacture (GM) Control

The LLC Team will provide at least one primary and one backup joint operations control center (GM Control), staffed with DOT/FAA and LLC Team personnel, to oversee AV and GV operations within their respective geographic area. Since the proposed AVs operate autonomously, GM Control personnel are not required to provide AVs with traditional air traffic control services such as permission to taxi to authorized runway, clearance to depart, in-flight direction or control, in-flight handoff to other FAA operation centers, clearance to land at specific runway, directions to taxi to parking area, etc. Required functions are performed autonomously and automatically in the new ATS, as appropriate, without human assistance or input.

If an AV or GV generates an alarm, the SW would automatically display information about that vehicle within GM Control, and open audio/video communications with the vehicle. Displayed
information could include sensor data, time-path data, camera images, etc. If the AV/GV contains passengers, the system would activate the microphone and speaker, and/or connect to the customer’s mobile devices to facilitate direct, real-time communications. GM Control personnel would monitor automated actions and initiate any manual actions, as required. Examples of automated actions include calculation and approval of a new AV/GV time-path to an emergency landing/parking location. GM Control would have the capability to exert overriding manual control over an AV or GV, if required. GM Control personnel will have expert skills to manually control and safely land an AV or stop a GV. Other manual actions performed by GM Control include directing inspection and recovery personnel to the landing/parked location, and directing another AV/GV to pick-up affected passengers/cargo and take them on their way.

Further, the new ATS will enable GM Control (and perhaps various Government agencies) to monitor and track any cargo flight/trip of interest, and view the cargo manifest which is transmitted prior to departure. They will also be able to monitor and track any passenger of interest, and view the passenger manifest which is also transmitted prior to departure. If authorized (e.g. with bench warrant), GM Control or government personnel could exercise overriding control over a specific AV/GV and direct it to a new GPS location. For example, suspicious cargo may be redirected to a DOT inspection station, or a person with an outstanding warrant may be redirected to a police station. An additional benefit of these capabilities will be that criminals with warrants will avoid the ATS facilities and vehicles, to avoid apprehension.

### 3.9 Hardware and Software Systems

Various computer HW/SW systems for the ATS will be needed to support manufacturing, operations and financial services. Computer HW includes redundant components and systems for infrastructure, data processing, data storage, networking, communications, etc. Many computer HW systems are available as COTS products, and with some modification could be adapted to meet requirements. Reliable and redundant SW systems will be a key development hurdle as multiple systems need to be developed. However, virtually all SW technologies are already in existence, so no “invention” per se, is required. Some SW systems have been developed and are in use today, and with some modification could be adapted to meet requirements. Both HW/SW will require backup and redundant capabilities to insure uninterrupted services. Software companies which may be able to provide applicable SW include Apple, Audi, BestMile, CA Technologies, General Motors, Google, Intel/Mobileye, Mercedes Benz, Microsoft, NVIDIA, Oracle, Otonomo, Symantec, Uber, VMWare, and others.

A summary of the major HW/SW requirements is provided below, however specific HW/SW solutions are to be determined (TBD). Mass data storage systems will be required to maintain select data, indefinitely, in support of all services - manufacturing, operations, and financial.

- **Manufacturing.** Computer HW/SW systems to support manufacturing include systems to record the receipt of raw materials, parts and components from suppliers; systems to track raw materials, parts and components within/between manufacturing facilities; systems to record the manufacture of parts and components, and networking and communications systems to support AV/GV testing prior to operations. Further, the systems must track details about suppliers, serial numbers, manufacturing line data, Autonomous Vehicle Identification Numbers (AVINs), Ground
Vehicle Identification Numbers (GVINs), testing, etc., and have the capability to generate custom Manufacturing reports.

- **Operations.** Computer HW/SW systems to support operations include the ATS APP, networking, communications, individual AV “airworthiness” and GV inspections, refueling, service, maintenance, replaced parts, upgrades, flight/trip assignments, time paths, cargo/passenger manifests, user/passenger familiarization training data, user/passenger profile data, user/passenger flight/trip data, landing area data, parking structure/pad data, and MAP data. The systems must have the capability to generate custom Operation reports.

- **Financial.** Computer HW/SW systems to support financial operations include Investor, Contributor, and employee data; revenue data for each AV/GV; calculations and payments for expenses, wages, bonuses, Investor and Contributor distributions; tax accounting, profit/loss statements, and other government-required reporting. The systems must have the capability to generate custom Financial reports.

### 3.10 New Standardized Rules for Flight and Ground Travel

The new ATS is built around a proposed new set of standardized “strategic-level” rules for flight, as compared to the current, traditional rules for non-networked, radar-based systems. With regard to current FAA rules and regulations, this document takes an “out of the box” approach, considering many of the existing rules restrictive and unnecessary for a safe, secure, reliable ATS using electric-powered networked AVs and GVs. The proposed new rules would establish the necessary standards pertaining to flight within the public airspace, including:

- Autonomous AV calculation of proposed time-paths
- Pre-flight communications to obtain GM Control approval of time-path
- Lift-off, corridor ascent, and acceleration
- Re-calculation of revised time-path based on actual payload weight, and transmission to GM Control for approval
- In-flight communications and procedures, including how AVs will interact/network with each other while in-flight
- Deacceleration, corridor descent, landing, anchoring, and powering
- Post-flight communications.

Upon lift-off, AVs will accelerate smoothly and steadily, maintaining a prescribed gravitational force (G-Force, or “Gs”) on cargo/passengers until reaching cruise speed. Upon reaching cruise speed, acceleration will cease as the AV adjusts motor arm tilt to obtain and maintain steady speed with a level interior space. Similarly, upon departure, GVs will accelerate smoothly and steadily, and maintain a prescribed G-Force on cargo/passengers until reaching cruise speed. Similarly, breaking force will not exceed a prescribed G-Force, unless necessary.

After lift-off, all AVs will recalculate and obtain GM Control approval of a second, more accurate time-path after departure, based on actual payload weight, which affects the actual cruise speed. *(Note: The maximum cruise speed would be the speed that the AV can travel with no payload).* The new calculated and approved time-path replaces the old time-path in the MAP.

AVs will establish and maintain network connections with all other AVs within a specified radius (e.g. 1km or ~0.62 miles). Each AV will transmit its own position-in-time (PIT) and future time-
path data for all other AVs within the radius, and all other AVs will plot this data into their copy of the MAP. If an AV has to perform an emergency maneuver where it has to deviate from its approved time-path, the AV transmits that data, and all AVs within its radius plot the change. Other AVs react to such deviations, making any necessary evasive maneuvers themselves, to avoid collision.

Similarly, GVs will establish and maintain network connections with all other GVs within a specified radius, howbeit smaller than the AVs (e.g. 0.5km or ~0.31 miles). GVs will transmit their own PIT and future time-path data for all other GVs within the radius, and all other GVs will plot this data into their MAP. If a GV has to perform an emergency maneuver where it has to deviate from its approved time-path (e.g. slow, stop, turn, etc.), the GV transmits that data, and all GVs within its radius plots the change. As with AVs, other GVs will react to such deviations, making any required evasive maneuvers themselves, to avoid collision. The proposed new rules would establish the necessary standards pertaining to GV travel on public roadways, including:

- Autonomous GV calculation of proposed time-paths
- Pre-trip communications to obtain GM Control approval of time-path
- Departure and acceleration
- In-route communications and procedures, including how GVs will interact/network with each other while traversing roads
- Deceleration, parking, idling, docking/powering
- Post-trip communications.

3.11 Communications

The new ATS will require standardized communication protocols and communication path redundancies to ensure reliable, continuous, secure communications. It is anticipated that AVs and GVs will communicate with GM Control and other AVs/GVs respectively, primarily through a “dedicated wireless network” (e.g. ABWN\(^{16}\)), and secondarily through any cellular network. Both systems will use the existing TCP/IP protocol, however a more secure protocol may be justified. Each AV and GV will contain a dedicated wireless network router as well as a cellular communication capability for redundancy, with circuitry being integrated into each computer motherboard, instead of being independent, stand-alone devices. Both communication systems will be capable of communicating navigation and other flight/trip data, as well as providing free Internet access to passengers. The cellular communication capability will be designed to work on any current cellular network using Global System for Mobile Communications (GSM or GSMC), Code Division Multiple Access (CDMA), or Integrated Digital Enhanced Network (iDEN); eventually using 5G technology. The dedicated wireless and cellular networks will inherently provide multiple communication paths to virtually eliminate any single point of failure.

In addition to AVs receiving MAP updates in real-time, AVs conduct pre-flight, in-flight, and post-flight communication routines with GM Control. Each AV transmission will include its unique Autonomous Vehicle Identification Number (AVIN). Each lift-off and subsequent landing are considered a “flight”, even though some ride-sharing cargo or passengers may continue on

\(^{16}\) [https://www.airbornewirelessnetwork.com/index.asp](https://www.airbornewirelessnetwork.com/index.asp)
additional “flights” to their final destination. AVs will perform pre-flight, in-flight, and post-flight communications for each “flight”.

- **Pre-flight communications** include transmitting passenger manifest, transmitting requested time-path data, and receiving GM Control approval prior to departure.
- **In-flight communications** include transmitting real-time PIT data, as well as the remainder of the time-path data for both GM Control and other AVs within the area. These transmissions occur regularly, every few seconds or so. If during flight, a passenger requests a new destination (in the ATS APP), the AV will request a revised time-path from GM Control. After receiving GM Control approval, the AV will change course (as required) to fly to the new destination. If, during flight, the AV determines that it cannot maintain its proper PIT (due to headwinds for example), the AV will autonomously request a revised time-path from GM Control. After receiving GM Control approval, the AV will follow the new time-path thereafter. If the AV experiences any alarms during flight, or if a passenger pushes the “emergency” button, GM Control will/may open audio/video communications with passengers, and (perhaps) direct the AV to land at an emergency landing area, hospital or law enforcement station, as appropriate.
- **Post-flight communications** include updates to manifests as cargo is removed or passengers exit. *(Note: some cargo or passenger may remain on-board, like passengers on a bus/train, until they arrive at their final destination. Such cargo/passengers will be included on the next manifest, prepared as part of the next flight’s pre-flight communications).*

Similarly, in addition to GVs receiving MAP updates in real-time, they conduct pre-trip, in-route, and post-trip communication routines with GM Control, for each “trip”. Each departure and subsequent arrival are considered a “trip”, even though some cargo or passengers may continue on additional “trips” to their final destination. Each GV transmission will include the Ground Vehicle Identification Number (GVIN).

- **Pre-trip communications** include transmitting cargo manifests, transmitting requested time-path (route) data, and receiving GM Control approval prior to departure.
- **In-route communications** include transmitting real-time PIT data for both GM Control and other GVs within the area. These transmissions occur regularly, every few seconds. If, during a trip, a passenger requests a new destination (in the ATS APP), the GV will request a revised time-path from GM Control. After receiving GM Control approval, the GV will change course (as required) and drive to the new destination. If the GV determines that it cannot maintain its proper PIT (due to heavy traffic, accident or otherwise), the GV will autonomously calculate a revised time-path and transmit it to GM Control. After receiving GM Control approval, the GV will follow the new time-path thereafter. If the GV experiences any alarms during the trip, or if a passenger pushes the “emergency” button, GM Control will/may open audio/video communications with passengers, and (perhaps) direct the GV to stop or park, or route it to a hospital or law enforcement station.
- **Post-trip communications** include updates to manifests as cargo is removed.

### 3.12 AV Time-Paths

All AVs will fly along their approved “time-path”, maintaining proper PIT all along the way. Each AV (whether CAV or PAV) will autonomously calculate a time-path within each of the two on-
board, redundant computers, based on user/passenger destination request. The time-path is calculated from the departure coordinate to the destination coordinate, through any waypoints as required to stay clear of other AVs, structures, terrain, etc., through authorized airspace as specified in the MAP. All time-paths are calculated along a standard “Arc” (ARC), and the standard ARC time-path will be *flown by all AVs, every flight, regardless of speed, flight duration, or manufacturer*. The standard ARC time-path is calculated based on a segment height at midpoint (above ground level), estimated to be 1/50th of the chord length, which is the linear distance to destination. The primary purpose of the proposed ARC-based time-path solution is to *distribute AVs vertically*, throughout the authorized airspace, eliminating congestion at the lower level if AVs were allowed to fly without an arc. Further, AVs will *ascend and descend vertically*, through vertical “corridors”, and will not fly at an angle or horizontally when below an estimated 20m (~65ft) above ground level, minimum.

The following identification and time-path data is transmitted to GM Control:

- **Autonomous Vehicle Identification Number (AVIN)**
- **Cargo or Passenger Manifest**
- **Departure point**: Longitude/Latitude/Altitude/Time (LLAT) of departure
- **Corridor Exit point**: LLAT when exiting corridor, ~20m (~65ft) above ground level (min)
- **Reaching Cruise Speed point**: LLAT when reaching cruise speed
- **Cruise Speed**: in kilometers per hour (km/h)
- **Waypoints**: LLAT at each waypoint (*May be multiple waypoints along a route, or none at all*)
- **Slowing from Cruise Speed point**: LLAT when beginning to slow
- **Corridor Entrance point**: LLAT when entering corridor, ~20m (~65ft) above ground (min)
- **Destination point**: LLAT at destination landing area/parking pad.
The standard arc (ARC) length is calculated using the formula $(2\pi r)a/360$, where “r” is the radius, “a” is the central angle set to 10 degrees, and the segment height is set to 50 (1/50th of the chord length). The time-path is calculated along the ARC, at the AVs cruise speed, and then routed/plotted in the MAP, in 3-dimensions. The calculation/formula used is subject to future revision/improvement.

A corridor is a vertical shaft of authorized airspace, extending from ground level, through unauthorized airspace, to ~20m (~65ft) above ground level, or until above the low altitude limit, whichever is greater. The corridors are centered above each approved landing area and parking structure. The corridor size is dependent on the estimated number of AVs traversing the corridor at any given time, subject to revision.

Cruise speed (in km/h) is determined by manufacture with full payload, but will/may increase when payloads are less than the maximum.

The two, independent time-paths calculated within each of the two redundant, on-board computers are compared and must be identical to proceed. If not, the two computers recalculate until an identical time-path is determined. Once an identical time-path is calculated, the AV transmits this to GM Control for approval. GM Control independently recalculates the time-path and if identical to the AV’s proposed time-path transmits an “Approved for Departure” message. If not identical, GM Control transmits a “Disapproved” message to the AV, which requires its complete recalculation in both computers again. AVs will not depart until their proposed time-
path has been approved. Once approved, GM Control and the AV plot the approved time-path in the MAP, along with all the other approved AV time-paths already there. All AVs will plot the approved time-paths of all other AVs into their MAP, who will fly or be within a 1km (~0.62 mile) radius of them, at any time. This plotting is accomplished continuously by all in-use AVs, whether in flight or parked. Once approved and plotted, a time-path becomes static, and no other AV will calculate a time-path that will come within its safety sphere (addressed below) at any point in future time, but rather will have to waypoint around it. An approved static time-path will not change unless a passenger, remote CAV operator, or GM Control requests a new time-path to a new destination, or unless an emergency landing is required.

3.13 Safety Spheres

All autonomous/networked AVs will have a digital “safety sphere” surrounding its location in the MAP. Autonomous/networked AVs will never enter or fly through the safety sphere of any other autonomous AV or traditional aircraft. AVs will also use data provided by its collision-avoidance system, and take any necessary evasive maneuver to avoid any detected object from entering its own safety sphere (e.g., birds, other aircraft, falling space debris, etc.). The size of the 360-degree safety sphere may be small (e.g. 10-meter/~33-foot radius) for corridor ascension/descension, and larger for cruise speed (e.g. 50-meter/~164-foot radius), probably variable based on speed.

It’s expected that every other form of transportation (e.g. traditional aircraft, traditional ground vehicles, trains, trucks, motorcycles, etc.) would also, eventually be networked into the system, using a small computer/transmitter/antenna device, which will autonomously calculate and transmit PIT data, approximately once per second. These transmissions would be received by GM Control and all networked AVs/GVs within the area, plotted into the MAP, and assigned a safety sphere by the system. Traditional/non-networked aircraft will be afforded a much larger safety sphere in the MAP than a networked AV, the size of which is TBD. The larger safety sphere around traditional aircraft will provide sufficient safe airspace to allow for unpredictable pilot-initiated changes in flight (e.g., turns, climb, descend, etc.) which occurs on every traditional aircraft flight.

Similarly, GVs will have a digital safety sphere (of sorts), but much smaller to allow for close-proximity travel in congested areas, narrow traffic lanes, etc. It’s expected that eventually, all traditional ground vehicles will be integrated into the network by requiring a small computer/transmitter/antenna device on each vehicle, which will autonomously calculate and transmit its PIT, without any human input. They would be received by GM Control and networked GVs in the area, and plotted into the MAP. The exact size of the GV safety sphere is TBD.

3.14 Airspace

Airspace can be defined as the three-dimensional portion of the atmosphere controlled by a country above its territory, including its territorial waters. For the purposes of this proposed ATS, airspace begins at ground level and extends to space, and the airspace would be divided into six zones, listed and explained in the table below. No AV (traditional or networked) can move through airspace without GM Control authorization. The MAP will be color-coded to illustrate the various airspace zones for easy recognition.

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17 [https://www.merriam-webster.com/dictionary/airspace](https://www.merriam-webster.com/dictionary/airspace)
<table>
<thead>
<tr>
<th>Airspace Zones</th>
<th>MAP Color</th>
<th>Authorized Users and Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Altitude (0’-65’)</td>
<td>Red</td>
<td>Authorized airspace for networked AVs only when ascending or descending through approved vertical corridors. Altitude range is from ground level up to ~20m (~65ft) above ground level. All other low altitude airspace is unauthorized for networked AVs. Low altitude airspace may be authorized for commercial- and hobby-type “Drones”, flown by a remote pilot, if approved by the FAA.</td>
</tr>
<tr>
<td>Networked (65’-2000’)</td>
<td>Green</td>
<td>Authorized airspace for networked AVs having GM Control authorization. Altitude range is from ~20m (~65ft) above ground level up to ~610m (~2,000ft) above ground level. Does not include any restricted airspace within this area (e.g. airports, military, etc.).</td>
</tr>
<tr>
<td>High Altitude (2000’-Space)</td>
<td>Blue</td>
<td>Unauthorized airspace for networked AVs. Authorized for traditional, non-networked aircraft. Altitude range extends from ~610m (~2,000ft) above ground level to space.</td>
</tr>
<tr>
<td>Airport</td>
<td>Yellow</td>
<td>Unauthorized airspace for networked AVs. Airspace above and surrounding airports, extending from ground level to ~610m (~2,000ft) above ground level. Authorized for traditional, non-networked aircraft, and includes traditional approach and departure corridors. However, networked AVs would eventually be authorized their own “Green Corridors” into or through Airport airspace, to load/unload cargo and passengers, etc.</td>
</tr>
<tr>
<td>Military/Government</td>
<td>Orange</td>
<td>Unauthorized airspace for networked AVs. Authorized for military/government use only. Networked AVs may eventually be authorized their own “Green Corridors” into/out of military/government airspace, to load/unload cargo and passengers, with special authorization from GM Control.</td>
</tr>
</tbody>
</table>

3.15 The MAP

The proposed ATS will operate by using the MAP, a 3-dimensional, digital/graphical representation of the various Airspace Zones, as well as ground features such as terrain, roads, buildings, structures, antenna towers, power lines, etc. The MAP will indicate all landing areas, parking structures/pads, emergency landing areas, refueling stations, inspection stations, service/maintenance facilities, hospitals, law enforcement stations, and popular commercial and retail facilities similar to current on-line mapping services. Further, it will contain/illustrate all AVs inflight and GVs in-route, along with a graphical representation of their approved time-paths.

Customers will be able to use the ATS APP to view the MAP, locate their desired destination area, zoom the MAP in/out as necessary, and select their desired landing area or parking structure/pad, all of which are established in the MAP. AVs then use the MAP to calculate and plot the shortest time-path through authorized airspace, and GVs use it to calculate and plot the quickest time-path to the desired/authorized destination.

The “master” version of the MAP is maintained by GM Control. It is initially uploaded to the redundant computers in each AV/GV during production. Thereafter, all AVs and GVs
autonomously maintain accurate copies, perpetually. GM Control’s master MAP is updated with construction information when received from community development planners and others (e.g. new antenna tower being built). Final GM Control approved MAP updates are transmitted to all AVs/GVs and plotted into their MAP copies in real time, whether in-flight, in-route or parked. AVs/GVs verify their MAP data after each flight/trip, while parked, to maintain 100% accuracy.

3.16 Load/Unload Locations

In order for the proposed ATS to become a widely accepted and functional form of transportation, it will need to be convenient and easy-to-use for cargo customers, walk-in passengers, and those with physical disabilities. The strategic design and placement of load/unload locations is a primary factor in meeting these goals. It is anticipated that there will be at least four types of load/unload locations in the ATS: (1) parking spots for GVs, (2) landing areas for standard AVs, (3) parking pads for standard AVs, and (4) helipads for both standard and non-standard AVs.

3.16.1 Parking Spots for Ground Vehicles (GVs)

As a general rule, step-in/step-out GV customers (cargo or passengers) may load/unload at any location with a hard surface (e.g. driveway, parking lot, along streets, etc.), not just at dedicated parking spots. Once the last cargo or passenger unloads from a GV, and if the GV has no further assignment, the GV will remain, parked at the unload location until the next assignment, if possible, even though it is not a dedicated GV parking spot. Typically, the load/unload location will not have a power pole/receptacle to provide 120VAC power to the parked GV. As such, the parked GV will use its internal lithium-ion (Li-ion) batteries to provide power to the computer, and other systems, as required. If unable to park at the unload location for whatever reason, the GV may (1) travel to a location where it can park, (2) travel to a dedicated GV parking spot having green striping, or (3) travel to a GV parking garage structure where it can back into a GV parking spot containing a power pole/receptacle and autonomously connect to electric power.

GV parking garage structures contain wall-mounted power receptacles (illustrated here) that provide electric power for back-in GV parking/charging against a wall. Another type is the floor-mounted power pole which will typically be positioned at the backend of perpendicular or angular GV parking spots, to facilitate back-in parking/charging. A two-receptacle floor-mounted power pole (illustrated on next page) is positioned in the middle of two back-to-back perpendicular or angular GV parking spots, to facilitate back-in parking/charging for two GVs at once. One-receptacle floor-mounted power poles (not illustrated) would have an 8” diameter metal cover instead of the rubber bumper and receptacle, on the side not used.
The LLC Team will provide materials and labor to install power poles/receptacles at GV parking spots. The height of the power receptacles and plugs above finished floor (AFF) is TBD. Since the specific power requirements for other manufacturer’s VTOL AVs are unknown, the final wire gauge and circuit breaker size are TBD. However, as for OVER’s concept GV, standard 14-gauge solid copper electrical wire and a 15-amp breaker are sufficient, and perhaps can be shared between two or three parking spaces. After installation, the technician establishes the parking spot by plotting it into the MAP for immediate use. Thereafter, the LLC Team will provide required maintenance for the power pole/receptacle, wiring, circuit breaker, striping, and pay for electric service/usage perpetually.

Standard GV will contain a power plug on the rear end of the vehicle, and will have the capability to autonomously align and dock to the receptacle, regardless of manufacturer. The GV’s Drive Control System (DCS) will maneuver the vehicle so to dock to the power receptacle, where its Powerpole connectors inserted and seat into the power receptacle Powerpole connectors. Once docked/plugged in, it’s anticipated that the power receptacle will connect 120VAC, 50/60Hz, 1-phase electric power to the GV’s power supply. Within the GV, it is rectified as required and used
to power the computer and other systems, as well as charge the Li-ion batteries. The powered parking spots may be used by any standard GV having the appropriate docking HW/SW and power plug, regardless of manufacturer.

Similarly, the LLC Team will provide materials and labor to establish dedicated GV parking spots (illustrated below) outside of garage parking structures. It is anticipated that municipalities would allow the LLC Team to establish multiple dedicated GV parking spots, along roads and around city blocks, and that business property owners would allow them to be established on their property as well—*all at no cost to them*. A dedicated GV parking spot would typically be located in a parallel parking space along a road, but may also be established in perpendicular or angled parking spaces, in parking lots, etc. Dedicated GV parking spots will typically be striped with green paint for rapid identification, and measure approximately 8’W x 16’L.

Parking spots with a ramp/platform will provide level entry/exit, essential for persons using a wheelchair or walker or having luggage, as well as for rolling cargo/stock. The LLC Team will provide and install ramp/platform structures at multiple dedicated GV parking spots, as appropriate. It is anticipated that GV parking spots with ramp/platform would be established at or near key public transportation hubs throughout an operational area, at or near AV parking garages and other AV load/unload locations, and eventually along every city block, roadway, parking lot, etc. Most of these exterior dedicated GV parking spots will have no power pole/receptacle due to the high costs of trenching, curb and gutter work, and other installation costs.

The first GV parking spot in an area or on a city block will contain a ramp/platform structure. Subsequent parking spots at the same location would be established without a ramp/platform, which will then limit customers to step-in/step-out service only. However, as a general rule, about 20%-25% of all parking spots in a given area (city block, parking lot, etc.) should contain
the ramp/platform, but each specific area would have at least one ramp/platform. For example, if four parking spots were established along a street in a city block, only one spot would have a ramp/platform and the other three would be the simple step-in/step-out type without ramp/platform. However, if a single parking spot is established with no other spot nearby, then that spot would have a ramp/platform. (Note: A bridgeplate is not necessary at GV platforms).

GV parking spots will be established daily, as GVs are manufactured and enter operation. The total number of GVs put into operation in a given area may exceed the total number of available GV parking spots, whether with or without power. Covered parking is not required for GVs, but typically they will be covered when parked in a parking garage. Parking garage parking spots will not contain a ramp/platform structure, as cargo/passengers will typically load/unload at street level. GVs parked in a parking garage will autonomously unplug from the power receptacle when departing the parking spot, and drive down to street level to pick up customers.

Parking spots with a power receptacle are not dedicated to any specific GV, but rather can be used by any standard GV manufactured with the appropriate docking HW/SW and power plug, regardless of manufacturer. It is anticipated that GVs will park at any authorized/available parking spot once the last cargo or passenger unloads, if it has no further assignment.

3.16.2 Landing Areas for Aerial Vehicles (AVs)

AV landing areas are simple, hard-surface, uncovered spaces designed to load/unload cargo and passengers. Example locations include private driveways and public/commercial parking lots. Prior to use, a technician establishes a landing area by inspecting the area and airspace above to ensure it is clear of obstacles, and adhering/painting a white reflective X-shape landing target decal on the surface. The technician adds the landing area coordinates into the MAP, including the proper angular position (attitude) that the AV doors will face when landing. Since they are not covered and exposed to weather, landing areas do not include the Aerial Vehicle Autonomous Anchoring and Powering System (AVAAPS) or a Ramp/Platform.
Public and commercial landing areas will normally be surrounded by a 6-foot fence that will minimize damage from pebbles and other objects being blown by propeller blast, and keep objects, animals and humans out of the area. AV landing areas do not require a painted “H” or other identification like typical helipads, but may. (A fence is optional for private landing areas). Landing areas will be established continuously/daily on private, public and commercial property, as required, to accommodate additional/new AVs. AVs will receive MAP updates in real time, including new landing areas and parking pads, whether parked or in flight. AVs will ascend and descend vertically, over a landing area. When descending, they will autonomously align the front of the AV to point in the direction of the arrow, which aligns the doors to face the angular position (attitude) specified in the programming for each landing area and parking pad.

3.16.3 Parking Pads for Aerial Vehicles (AVs)

Since AVs will need to fly in/out of parking structures and other facilities, a standard size parking “garage” is required that will accommodate the largest standard-size AV. The largest proposed OVER AVs (AP-5 and AC-4.4) are 5.33m (17.5 ft) square (propeller tip-to-tip) x 2.6m (8.25 ft) high. The proposed size of a standard AV garage is 10m (32.8 ft) square x 7m (23 ft) high, resulting in a fly in/out space 10m wide X 7m high. These standard sizes allow for approximately 2.33m (~7.6 ft) clearance on either side, and 2.2m (~7.2 ft) clearance above and below, when the largest OVER AVs fly into a structure. The standard size facility/structure entrances limit the maximum size of future AVs which can use the facilities. (Note: OVER’s operational concept allows all standard size AVs to enter and park at any standard size parking structure, regardless of manufacturer).

Parking pads are contained in covered, open-air parking structure garages of the standard dimension. Each parking structure would contain at least one covered parking garage with one parking pad, but most will contain two or more. The simplest parking structure (illustrated here) is a one-story open-air covered garage with a single standard parking pad, containing the X-shape landing target decal and the AVAAPS, addressed fully in Section 4.7.20. The single AV parking structure may also include a ramp/platform, as illustrated here. The structure is surrounded by a 6-foot fence and provides an additional 10m x 10m fenced space to ascend and descend next to the structure. These structures afford both cargo and passenger customers convenient ground-level load and unload capability.
A variation of a one-level parking structure is the “lean-to” concept (illustrated here) where passengers can load/unload directly to/from a building (e.g. retail store, office building, etc.). This type structure provides customers with convenient access to/from the building and protection from weather. This example illustrates a lean-to structure with three ground-level parking pads, but other designs may have more or less pads. All covered parking pads will contain the AVAAPS, and at least one of the three parking pads in this example would have a ramp/platform.

Other parking structure designs contain one or more ground-level parking garages and one or more levels/floors above for “parking only”. All ground level, covered parking pads have the X-shape landing target decal and the AVAAPS, and at least one pad has the ramp/platform. The elevated parking-only pads contain the X-shape landing target decal and the AVAAPS, but no ramp/platform because customers do not load/unload on these levels. The example illustrated here has a total of 16 standard parking pads consisting of 4 ground-level load/unload pads (Level 1) and 12 elevated parking-only pads (Levels 2-4), plus a helipad on the roof. These larger, rooftop helipads provide load/unload space for VTOL AVs too large to safely enter/exit a standard-size parking garage. Although shown with a painted “H” in these illustrations, they may also (or instead) have the X-shape landing target decal. Helipads may also have the AVAAPS and ramp/platform, to anchor and power large, winged AVs manufactured to use the AVAAPS. Customers would access the helipad level via elevator or stairs. If the larger VTOL AVs are not permitted to land in the area, the structure can be covered with a standard metal hip-type roof instead of a helipad.

Another type of parking structure is specifically designed for busy urban areas, and “straddles” a 2, 3 or 4-lane road or intersection. The example
illustrated here contains 16 parking garages/pads with load/unload capabilities on all floors, and a helipad on the top floor. These innovative road-straddling urban parking structures provide at least 7m (~23 ft) of clearance for ground traffic, which would flow underneath, unimpeded. They provide customers easy access to all elevated floors via elevators from both sides of the street, or from all four corners if it straddles an intersection. All parking pads will contain the X-shape landing target decal and the AVAAPS, and at least one on each floor would have a ramp/platform. If larger VTOL AVs are not permitted to land in the area, the structure can be covered with a standard metal roof. The most cost-effective parking structure would optimize height (the number of levels/floors) and the number of parking pads per level/floor, to provide the lowest cost per parking garage. The optimal size is TBD.

Parking structures (and other facilities) require space for AVs to ascend and descend next to the structure. This is typically accomplished with a 30’x30’ fenced area attached to a ground-level parking garage (as illustrated earlier), to keep the ground area next to the structure clear. Urban parking structures which straddle roads would not have a fence on the ground, as AVs never descend to ground level at these locations.

3.16.4 Helipads for Other Aerial Vehicles (AVs)

Helipads accommodate AVs which are too large to safely enter a standard AV parking garage or land in a standard AV landing area. Helipads are typically found at heliports, hospitals, offshore platforms and on top of buildings, and accommodate traditional helicopters and other VTOL vehicles. They are usually marked with a circle and a capital letter "H" for quick identification. Helipads should be provided on top of or near standardized AV parking structures. Helipads could contain the X-shape landing target decal, as well the AVAAPS and ramp/platform. An AV parking structure with co-located helipads will enable quick transfers between various forms of transportation (GVs, standard AVs, other VTOL AVs, and traditional helicopters). A concept drawing of an OVER-type parking structure collocated with an Uber-type helipad structure, is provided below. Other manufacture’s VTOL AVs that can only land on helipads, and which never use the standard parking pads, can still operate and be networked in the proposed ATS.
3.17 Aerial Vehicle (AV) Bridgeplate Concept

The AV bridgeplate concept (illustrated below) spans the gap between a ramp/platform and the floor of a parked AV, so wheelchairs, baby strollers, walkers, luggage, and rolling stock/cargo can transition smoothly in and out. Each platform has a 48” wide x ~24” deep x ¼-inch thick steel bridgeplate that autonomously extends and spans the gap to/from an AV upon arrival and autonomously retracts prior to departure. The bridgeplate is supported on four heavy-duty, ball-bearing type, steel drawer slides\(^{18}\) capable of supporting up to ~500 lbs. each.

The AV bridgeplate is pushed out and pulled back in by a single actuator\(^{19}\) installed within the platform. The actuator is powered by 12VDC, rectified from 120VAC available at the ramp/platform location. Power to the actuator is applied by a controller also mounted within the platform, which is a “connected” device that automatically connects to an AV via secure wireless communication, upon arrival. Once connected and after the AV lands, the AV sends an “ANCHOR” signal which is received by the platform controller (and the AVAAPS). Once received, the controller applies +12VDC to the actuator, to extend the bridgeplate until rubber bumpers contact the AV, at which time it stops. While extending, the two “alignment pins” on the bridgeplate slide into two tapered “holes” below the AV doors, to properly align the bridgeplate to the proper height/position. After the bridgeplate is in place, the AV doors will open without dragging on or touching the bridgeplate. After loading and the doors close, but prior to lift-off, the AV sends an “UNANCHOR” signal which would be received by the platform controller (and the AVAAPS). Once received, the controller applies -12VDC to the actuator, to retract the bridgeplate from the AV. After the bridgeplate is retracted, the AV can depart.

Other manufacture’s AVs would have to contain the same size/position tapered holes as the OVER concept AVs for bridgeplate alignment – if they are to use the ramp/platform structures. However, it’s not necessary for other manufacturers to use the ramp/platform and bridgeplate system at all, or have level entry/exit. These AVs can simply land at the parking pads that are not equipped with a ramp/platform and their customers would step in/out of their AVs.

The AV bridgeplate, slides, controller, actuator and other HW would be pre-assembled as a “system” within each platform, in the manufacturing plant, and then the platform would be installed and tested when the AV parking pad is established.


3.18 Aerial Vehicle Autonomous Anchoring and Powering System (AVAAPS)

The proposed ATS will require that standard autonomous AVs anchor and power themselves, especially if landing on elevated parking pads. OVER’s patent pending AVAAPS technology enables fully autonomous AVs to automatically and autonomously anchor and connect to electric power – without any human assistance. The AVAAPS will prevent AVs from moving or blowing off parking structures during high wind situations, and connect them to electric power while parked. The AVAAPS is comprised of two assemblies: (1) the “AV Assembly” and (2) the “Pad Assembly”, both illustrated below.

The AV Assembly is factory installed to the underside of an AV, during the AV manufacturing process, and includes three electrical connectors (pins), two high-definition (HD) cameras, four LED lights, and a ¾” hole to receive the anchoring dowel pin (contained in the Pad Assembly).

The Pad Assembly is permanently mounted to the parking pad landing surface, and contains three electrical connectors (sockets), the anchoring dowel pin, and its electric motor.

The two assemblies work together to automatically and autonomously connect electric power to, and anchor an AV upon landing in a standard, covered parking pad, and to automatically and autonomously un-anchor the AV and disconnect power upon lift-off. The AVAAPS could contain 2, 3 or 4 pins/sockets, to provide various DC voltages, or 1-phase or 3-phase AC power. However, a single power/amperage/ frequency standard should be established by government and industry, and utilized by all VTOL manufactures going forward.

It’s envisioned that the AVAAPS will be installed in all standard, covered ATS parking pads and on all standard AVs, regardless of manufacturer. (*Note: All AVs using the AVAAPS must have 6 inches of clearance between the bottom of the AV and the landing surface*). The LLC Team will work with other manufactures to design variations of the AV Assembly, as needed, so their AVs can also autonomously anchor and connect to power when landing on standard parking pads. It’s anticipated that the AV Assembly would be manufactured by multiple AV manufactures, through a licensing agreement, and installed on their AVs during the manufacturing process.
3.19 Manufacturing and Operating Facilities

There are many facilities required to enable a safe, secure, and reliable ATS, including manufacturing plants, bi-ION fuel “refinery” plants, test ranges, GM Control, refueling stations, inspection stations, and service/maintenance facilities. All facilities necessary for manufacturing, operating, and maintaining AVs/GVs will be provided by the LLC Team, at little to no cost to taxpayers. The LLC Team joint-venture will be an independent, privately-funded, commercial, for-profit enterprise, and will raise its own capital, purchase its own land, design all facilities, and obtain the required building permits. It will provide/pay for materials and labor to prepare concrete foundations, curb/gutter, sidewalks, and surrounding roads, and construct facilities.

Bi-ION Refinery. It is anticipated that each area of operation will require a nanoFlowcell bi-ION refinery plant, to produce the bi-ION electrolyte solution powering the OVER concept AVs/GVs, as well as other/future manufactured vehicles and static applications using the nanoFlowcell technology. However, bi-ION solutions could initially be transported by rail and/or 18-wheeler trucks, nationwide, from the first bi-ION refinery, until additional refineries can be built.

According to nanoFlowcell’s website, when compared with conventional energy carriers like gasoline, diesel, hydrogen and Li-ion batteries, bi-ION is not harmful to health or the environment, is non-flammable, non-explosive, not subject to any hazmat obligations; and is sustainable and environmentally compatible to produce. Compared with Li-ion batteries of the kind used in most electric vehicles, a nanoFlowcell® running on bi-ION currently delivers an energy density of 600 Wh per liter (latest from website) - sufficient energy for five times the range of a conventional electric vehicle. The electrolyte liquid is considerably less expensive to produce than refining fossil fuels or the manufacture of Li-ion batteries. In contrast to fossil fuels, the bi-ION electrolyte solution is not extracted and refined in just a few countries, but can theoretically be manufactured more-or-less in-situ all over the world, given the appropriate production equipment. Distribution would be relatively straightforward. Bi-ION would typically be transported by truck, from the refinery to LLC Team refueling stations in the area of operation, to existing “gas stations” for other ground vehicles, and to static applications.

Refueling Stations. Refueling structures will typically contain multiple refueling bays in covered, standard garage-size areas. AV and GV refueling stations will be distributed strategically across an operational region to minimize unproductive/unprofitable flight/travel time. Each AV refueling bay will contain the AVAAPS, but no ramp/platform. GVs may use the same refueling bays as AVs, or may have their own dedicated bays.

Electric vehicles using the nanoFlowcell® technology are easy to “recharge” with bi-ION. Refilling the tank with electrolyte liquid is almost identical to the refueling process for traditional vehicles with internal combustion engines, except that vehicles powered with nanoFlowcell technology require two liquids/electrolytes (one positive and one negative) to be filled into two separate tanks. It is anticipated that the entire AV/GV refueling process will take no longer than 10

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21 https://nanoflowcell.com/what-we-do/innovation-research/bi-ion/
minutes, and will eventually be completed autonomously, without human assistance. Employees will clean the interior and exterior of each AV/GV, after each refueling event.

Since the bi-ION fuel presents no risk of explosion, it is anticipated that CAVs and cargo GVs will refuel when most appropriate, regardless of whether cargo is aboard. However, it is anticipated that PAVs and passenger GVs will refuel only when empty, so not to inconvenience or delay customers. Refueling stations will be resupplied as required by 18-wheeler type tankers. Existing/traditional gas stations can also be adapted to refill other vehicles with bi-ION, manually, with just a few minor modifications to the pumps and nozzles.

**Other Facilities.** Other facilities include AV/GV manufacturing plants, test ranges, GM Control, inspection stations, and service/maintenance facilities. It’s anticipated that manufacturing plants will be constructed across the U.S. first, (before export), each producing approximately 1,000 AVs and/or GVs, per day. Each manufacturing plant will have a large test range situated next to the plant, to test each AV/GV after production and prior to entering operation. Test ranges will contain refueling, inspection, and service/maintenance stations, as well as multiple GV parking spots, AV landing areas, and AV parking pad structures (some with helipads), with each parking pad containing the AVAAPS. AVs and GVs will follow an established inspection routine/program, where all functionality and performance is tested and proven multiple times. The routine/program will test the AVs and GVs autonomous capabilities for at least 24 consecutive hours. Once tests are complete and personnel verify that the AV/GV performed all functions properly and safely, the AV/GV is transferred to the Operations Branch, status changed to “in-use”, transported or flown to the appropriate operational area, and made available for commercial fare-based or lease type operations.

An appropriate number of refueling, inspection and service/maintenance facilities will be constructed, as the number of AVs/GVs in operation increases over time. AVs will be scheduled, automatically to undergo airworthiness inspections as required by the FAA, and will fly autonomously to the inspection bay, as scheduled. It is anticipated that initially both AVs and GVs would undergo inspection every month, but the frequency may eventually be extended to quarterly, or based on flight/travel hours. AVs or GVs that require service or maintenance will fly/drive autonomously to a service/maintenance facility, or be transported there as required. Services include visual inspection, changing filters, lubrication, and cleaning. Maintenance would include replacing lights and sensors, and more technical tasks such as replacing propellers, motors, or other components/systems. Any AV or GV involved in an accident will be removed from service – permanently. Failed components/systems are inspected, and feedback provided to the Manufacturing Branch, who will evaluate applicable designs, materials, and processes to eliminate reoccurrence.

3.20 **Accommodating Traditional, Non-Networked, Driver-Controlled Ground Vehicles**

The proposed ATS will accommodate traditional “non-networked” driver-controlled ground vehicles (e.g. automobiles, trucks, motorcycles, etc.). The position, speed and trajectory of these non-networked vehicles are calculated by autonomous, networked GVs within range, by using data from their collision avoidance system. All networked GVs within range will detect, plot, and track the non-networked vehicles, and then transmit that data to GM Control and all other GVs in the area. Hence, all networked GVs will detect, plot, and share the location of non-networked
traditional driver-controlled vehicles near them, throughout their trip, thereby providing GM Control and all GVs in the area with precise location data for all vehicles within range.

However, to improve safety, the traditional driver-controlled vehicles should eventually be equipped with their own satellite (primary) and cellular (backup) communication circuitry, as well as a dedicated wireless network router, all contained within a single, battery-powered device expected to be no larger than the size of a domino. With such an integrated antenna device, these vehicles will regularly and autonomously determine their exact GPS position, and transmit it to GM Control and other GVs within the area. These devices will essentially transform the traditional, non-networked vehicles into networked vehicles, providing all with greater safety.

3.21 Accommodating Traditional, Non-Networked, Pilot-Controlled Aircraft

The proposed ATS will also accommodate the flight of traditional “non-networked” pilot-controlled aircraft (e.g. fixed wing jet and propeller aircraft, helicopters, and drones). Similar to the functions performed by GVs, the position of these non-networked aircraft is detected by the AV’s radar-based collision avoidance system, plotted into its MAP, and then transmitted to GM Control and all other AVs in range. By using the collision avoidance system data, the speed and trajectory of non-networked aircraft is calculated and plotted into the MAP by any/all AVs close enough to detect. All networked AVs within range will detect and plot the non-networked aircraft thereafter, until out of range. Hence, all networked AVs will detect, plot, and share the location of non-networked traditional pilot-controlled aircraft, throughout flight. This will provide GM Control and all AVs with precise location data for all aircraft (within range of any AV), eventually minimizing/eliminating the need for traditional Air Traffic Control (ATC) ground radar systems.

However, to improve safety, the traditional pilot-controlled aircraft should eventually be equipped with their own satellite/cellular/router device, similar to the GVs, all contained within an external aircraft-rated antenna pod. As with GVs, traditional aircraft having these devices will regularly and autonomously determine their exact location themselves, and transmit their position to GM Control and other AVs within the area. This system essentially transforms the traditional, non-networked aircraft into networked aircraft, providing all with greater safety.