

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

DJI EUROPE B.V.
Petitioner,

v.

TEXTRON INNOVATIONS INC.
Patent Owner

IPR2023-01227

U.S. Patent 11,288,972

**DECLARATION OF CHARLES F. REINHOLTZ, PH.D.
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW OF
U.S. PATENT 11,288,972**

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I, Charles F. Reinholtz, declare as follows:

1. I have been engaged by Perkins Coie LLP on behalf of DJI Europe B.V. (“Petitioner”) to provide this Declaration concerning technical subject matter relevant to the petition for *inter partes* review (“Petition”) of U.S. Patent 11,288,972 to Grant Mark Bristow, Matthew David Holvey, and Naveed Ahmed Siddiqui (the “’972 patent”).

2. I am over 18 years of age. I have personal knowledge of the facts stated in this Declaration and could testify competently to them if asked to do so.

3. I have reviewed and am familiar with the specification and the claims of the ’972 patent. In general, I will cite to the specification of a United States patent using the following formats: (Patent No., Col:Line Number(s)) or (Patent No., Paragraph Number(s)). For example, the citation (’972 patent, 1:5-10) points to the ’972 patent specification at column 1, lines 5-10. Also, for convenience, I use italics to denote limitations from the challenged claims.

4. The opinions contained in this Declaration are based on the documents I reviewed and my knowledge and professional judgment. In forming the opinions expressed in this Declaration, I reviewed the documents listed in the attached Appendix A. I have also reviewed and am familiar with the other materials referred to in this Declaration.

5. I have been asked to provide my technical opinions regarding how a Person Having Ordinary Skill In The Art (POSITA) would have understood the claims of the '972 patent at the time of the alleged invention. For purposes of whether the teachings of the prior art render the claims of the '972 patent obvious, I have been asked to assume the date of December 19, 2019, for the analysis in this Declaration. In reaching the opinions provided herein, I have considered the '972 patent, its prosecution history, and the references cited in Appendix A, and have drawn as appropriate on my own education, training, research, knowledge, and personal and professional experience.

I. Qualifications and Expertise

6. In formulating my opinions, I have relied on my knowledge, training, and experience in the relevant field, which I will briefly summarize. A more detailed summary of my background, education, experience, and publications is set forth in my curriculum vitae (CV), which is submitted as DJI-1004.

7. I have personal knowledge of the facts and opinions set forth in this declaration and believe them to be true. If called upon to do so, I would testify competently thereto. I have been warned that willful false statements and the like are punishable by fine or imprisonment, or both.

8. I am being compensated for my time at my standard consulting rate. I am also being reimbursed for expenses that I incur during this work. My

compensation is not contingent upon the results of my study and analysis, the substance of my opinions, or the outcome of any proceeding involving the '972 patent. I have no financial interest in the outcome of this matter or in any litigation involving the '972 patent.

9. I am currently Emeritus Professor and Chair at Embry-Riddle Aeronautical University, Daytona Beach, Florida. I was a Professor in the Department of Mechanical Engineering at Embry-Riddle from 2007 until my retirement from full time teaching in May, 2022. I also served as Chair of the department from 2007 through 2017.

10. From 1983 to 2007, I was a faculty member in the Department of Mechanical Engineering at Virginia Polytechnic Institute and State University (Virginia Tech) in Blacksburg, Virginia, most recently serving as Alumni Distinguished Professor from 2002 to 2007. In my time at Virginia Tech, I also served as the Assistant Department Head, W.S. White Chair for Innovation in Engineering Education and ABET Review Chair, among other appointments.

11. I earned a Bachelor of Science Degree (1976), a Master of Engineering Degree (1980), and a Ph.D. in Mechanical Engineering (1983) from the University of Florida. My Ph.D. research was in the field of optimization of spatial mechanisms.

12. I am a member of numerous professional societies and organizations.

For example, I have been a Fellow in the American Society of Mechanical Engineers (ASME) since 2003. That organization has recognized my work on a number of occasions, including with the award of the ASME Outstanding Faculty Advisor Award (1989-1990, 1991-92), the ASME National Faculty Advisor Award (1995), and the ASME Distinguished Service Award (2005).

13. For forty years, I have conducted research and taught classes in the field of mechanisms, mechanical design, robotics, robotics, aeronautics, and unmanned vehicle systems. My research in the robotics and unmanned systems area began in 1998, and I have remained continuously active in teaching and research in these areas through the present.

14. At Virginia Tech and Embry-Riddle Universities, I have taught a variety of courses, including Robotics, Advanced Robotics, Unmanned Systems, Mechanisms, Mechanical Design and Mechatronics and I have received several teaching awards such as the College of Engineering Certificate of Teaching Excellence (1987-88, 1997-98, 2001-02, 2006-07), Wine Award for Excellence in Teaching (1992), Virginia Tech Academy of Teaching Excellence (inducted 1992), Dean's Award for Excellence in Teaching (1998), Ingersoll-Rand Faculty Award for Outstanding Contributions to the Mechanical Engineering Department (2000),

Outstanding Faculty Member Award (2003), and the Alumni Teaching Award (2004).

15. I have also served as the advisor to many successful collegiate robotics teams, including the overall winning teams in the Association for Unmanned Vehicle Systems (AUVSI) Intelligent Ground Vehicle Competition (2003 through 2007), the International Aerial Robotics Competition (2005, 2007), the Unmanned Aerial Systems Competition (2007), and the RoboBoat Competition (2014, 2015). In particular, I continuously advised teams competing in the International Aerial Robotics Competition and the Unmanned Aerial Systems Competition since 2004. These competitions involve a broad range of avionics systems, including a variety of sensors, flight logs, data recording devices and wireless communications systems. As with all systems flying in the National Air Space, we were required to understand and adhere to FAA regulations.

16. I was also team lead for qualifying teams in the 2004 and 2005 DARPA Grand Challenge Competitions, and I was team lead and principal investigator of the third-place overall team in the 2007 DARPA Urban Challenge, a competition to develop a fully autonomous automobile capable of navigating a complex, dynamic urban course along with human-driven vehicles and other robotic cars.

17. I hold two U.S. patents and have authored a popular textbook and have over 125 publications related to the design and analysis of mechanisms, kinematics, manipulators, robotics and unmanned vehicle systems. I have several best paper awards, such as the National Instruments Virtual Instrumentation Applications Best Control Paper Award for “Developing a Fully Autonomous Vehicle for Virginia Tech’s Entry in the DARPA Grand Challenge.” I have received many awards, including the Presidential Young Investigator Award from the National Science Foundation (1987-1992) and the South-Pointing Chariot Award at the 1999 Applied Mechanisms and Robotics Conference, for lifetime contributions to the mechanisms community. I have co-founded three successful companies working in the area of robotics and unmanned vehicle systems.

18. I have served as an expert witness on multiple cases including cases involving Inter Partes Reviews (IPRs), ITC Investigations, contract disputes, and civil litigation in federal district courts. A number of these cases were in the area of air vehicle systems. In formulating my opinions, I have relied upon my training, knowledge, and experience in the relevant art.

II. Understanding of Relevant Legal Principles

19. I am not a lawyer, and I will not provide any legal opinions. Although I am not a lawyer, I have been advised that certain legal standards are to be applied

by technical experts in forming opinions regarding the meaning and validity of patent claims.

20. I understand that a patent claim is invalid if it is anticipated or obvious in view of the prior art, and that a claim can be unpatentable even if all of the requirements of the claim cannot be found in a single prior-art reference. I further understand that invalidity of a claim requires that the claim be anticipated or obvious from the perspective of a Person Having Ordinary Skill In The Art (POSITA) at the time the invention was made.

21. I have been informed that a patent claim is invalid if it would have been obvious to a POSITA. In analyzing the obviousness of a claim, I understand the following factors may be considered: (1) the scope and content of the prior art; (2) the differences between the prior art and the claims; (3) the level of ordinary skill in the art; and (4) any so-called “secondary considerations” of non-obviousness, if present. I am not aware of any evidence of secondary considerations of non-obviousness relevant to the '972 patent. I reserve the right to supplement this Declaration if Patent Owner introduces evidence of secondary considerations of non-obviousness.

22. I understand that to prove that prior art or a combination of prior art renders a patent obvious, it is necessary to:

- identify the particular references that, singly or in combination, make the patent obvious;
- specifically identify which elements of the patent claim appear in each of the asserted references; and
- explain why a POSITA would have combined the references, and how they would have done so, to create the invention(s) claimed in the patent.

23. I further understand that exemplary rationales that may support a conclusion of obviousness include:

- combining prior art elements according to known methods to yield predictable results;
- simple substitution of one known element for another to obtain predictable results;
- use of known technique(s) to improve similar devices (methods or products) in the same way;
- applying a known technique to a known device (method or product) ready for improvement to yield predictable results;
- “obvious to try”—choosing from a finite number of identified, predictable solutions with a reasonable expectation of success;

- known work in one field of endeavor may prompt variations of the work for use in either the same field or a different field based on design incentives or other market forces if the variations are predictable to a POSITA; and
- some teaching, suggestion, or motivating in the prior art that would have led a POSITA to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

24. I have also been informed that, in considering obviousness, hindsight reasoning derived from the patent at issue itself may not be used.

25. I understand that a patent's disclosure must clearly allow a POSITA to recognize that the inventor invented what is claimed in the patent and had possession of the claimed subject matter as of the filing date. I further understand that a claim is entitled to the priority date of an earlier application only if the earlier specification provides sufficient written description support for the full scope of the claim.

III. Technology Background

A. Unmanned Aerial Vehicles (UAVs)

26. Unmanned Aerial Vehicles (UAVs), commonly known as drones, have experienced a transformative evolution over the past few decades. Originating primarily from military applications, UAVs have rapidly expanded into numerous

civilian sectors. At the heart of their operation lies the crucial element of flight control and management.

27. Flight control is the process of piloting a UAV, determining its position, direction, speed, and altitude. This involves a combination of onboard systems and remote-control operations. Onboard systems, such as gyroscopes and accelerometers, provide stability, while external controls supply pilot commands.

28. UAVs may rely on different modes of control. In manual mode, a pilot directly controls the UAV using a remote control, relying primarily on visual observation or through the feed from an onboard camera. Autonomous UAVs, on the other hand, can make decisions and execute missions on their own using pre-programmed algorithms and real-time data processing. Autonomous UAVs can follow specific waypoints, return to a home position, or track moving objects without real-time human intervention. Semi-autonomous UAVs require more frequent human intervention for decision-making and mission tasks. The primary distinction between autonomous and semi-autonomous is the degree of independence in decision-making and mission execution.

29. Given the potential hazards of UAVs sharing airspace with manned aircraft, and the risk of property damage or injury, a robust UAV control and management system is essential. Regulatory bodies worldwide, such as the FAA in

the USA, have established rules that UAV operators must adhere to, emphasizing the importance of efficient flight control and management.

B. Key Features of UAV Fleet Control Systems

30. As the use of UAVs proliferates across industries, managing a single UAV is no longer the sole focus. Fleet control systems have emerged as a necessity for businesses operating multiple drones simultaneously. These systems offer features that simplify, optimize, and automate operations.

31. Modern UAV fleet systems allow operators to view the status, position, and live feeds from multiple UAVs simultaneously. This real-time monitoring ensures that drones can be redirected, grounded, or have their missions adjusted based on evolving situations.

32. With the ability to set specific waypoints and routes, operators can program drones to undertake missions autonomously. Systems consider factors like weather conditions, no-fly zones, and other potential hazards, optimizing routes for safety and efficiency.

33. Ensuring that drones remain operational is crucial. Modern fleet systems provide real-time data on battery life, equipment status, and any potential malfunctions. This ensures drones can be recalled for charging or maintenance before any issues arise.

34. Collecting data from each flight provides valuable insights. Fleet systems can record flight times, routes taken, energy consumption, and more. This data, when analyzed, offers actionable insights for improving future flights, conserving energy, and optimizing routes.

35. One of the key features in modern fleet systems is geofencing, which allows operators to set specific boundaries for UAV operations. If a UAV approaches these boundaries, the system can either send a warning or automatically redirect the UAV, ensuring it does not stray into restricted areas.

36. Many fleet systems now offer integration with other business tools and software. This can include inventory management for delivery drones, advanced imaging software for surveying drones, AI-driven analysis tools for data collection, or “flight planning services that ... provide optimized plans based on various parameters.” (DJI-1005, 5.)

C. NASA’s Unmanned Aircraft Systems Traffic Management (UTM) System

37. NASA began developing its Unmanned Aircraft Systems Traffic Management (UTM) system in 2013. (DJI-1016, 3.) The development process soon encompassed collaboration with the Federal Aviation Administration (FAA) and industry partners (e.g., Google, AirMap, Amazon, ANRA Technologies, Simulyze, and Transtrex), all sharing the common goal of “enabling large-scale

sUAS,¹ in presence of other traditional aviation, to safely operate at low altitude in uncontrolled airspace.” (DJI-1018, 3.)

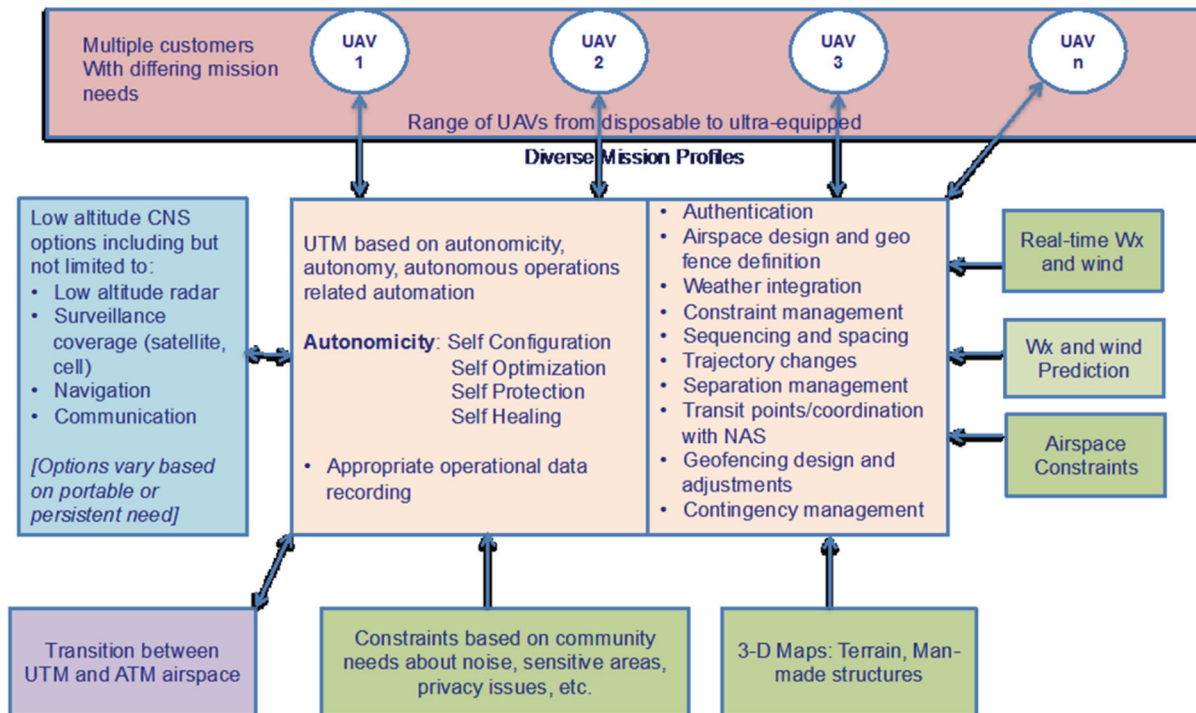
38. NASA’s UTM system was developed in response to the rapid growth in the use of UAVs for various applications, such as deliveries, monitoring, and surveillance. (DJI-1005, 3; DJI-1014, 3; DJI-1015, 1; DJI-1016, 16; DJI-1017, 15.) Traditional air traffic management systems were not equipped to handle this new form of traffic, especially at low altitudes where UAVs primarily operate. Accordingly, there was a need for a specialized management system that could ensure the safety, efficiency, and effective regulation of this growing sector.

39. NASA’s UTM system provided a scalable, flexible framework that supported the full spectrum of drone operations, including beyond visual line of sight (BVLOS), and supplied necessary functions to enable safe and efficient low-altitude airspace UAS operations, such as dynamic geo-fencing, congestion management, route planning and re-routing, and separation management. (DJI-1014, 3; DJI-1017, 14-17.)

40. Figure 1 of DJI-1014, reproduced below, illustrates a functional description of NASA’s UTM system. (DJI-1014, 5.) Inputs to the UTM system include the elements shaded in green (e.g., airspace constraints, weather/wind data

¹ In this declaration, the terms UAS, sUAS, and UAV are used interchangeably.

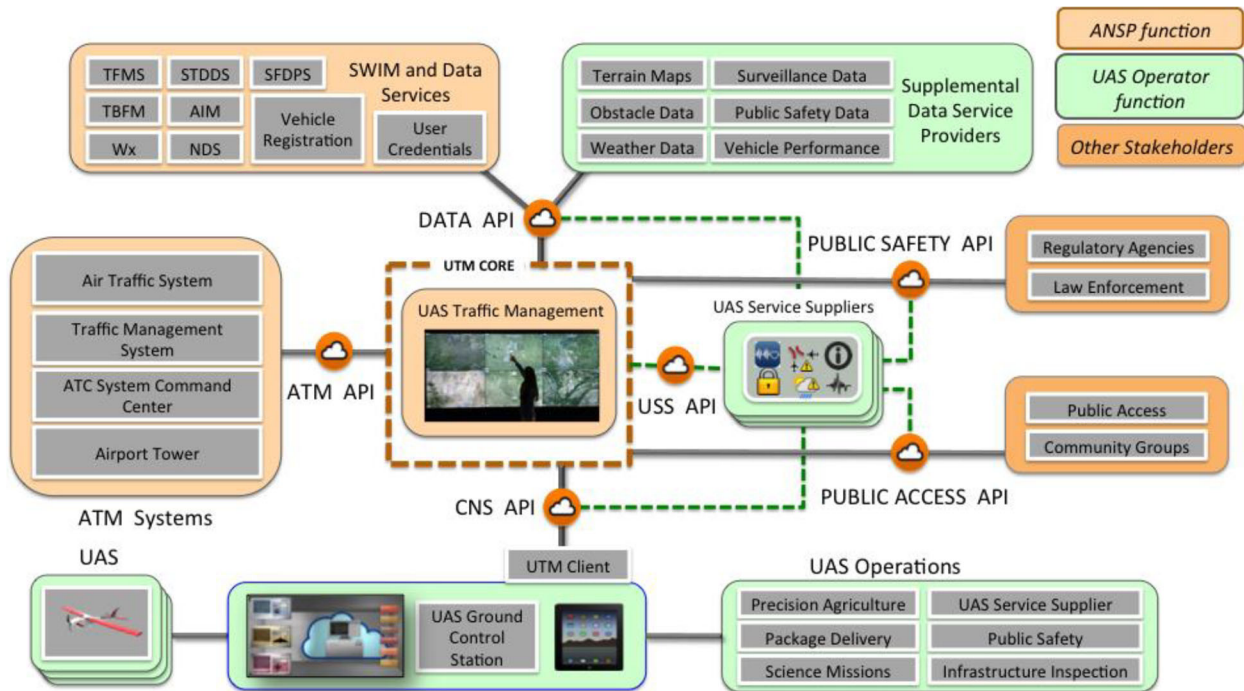
and 3-D maps). (DJI-1014, 4.) The right side of the center box lists UTM's functions (e.g., constraint management and trajectory changes). The left side of the center box highlights the importance of "autonomicity" (which includes, for example, self-configuration and self-optimization) and "related automation" within the UTM system. (DJI-1014, 4.)



DJI-1014, Figure 1.

41. The below figure illustrates a block diagram of the "Complete UTM Architecture." Specifically, it illustrates "interactions between seven main components" of the system: "the UTM core, USS functions, UTM clients, UAS, external data services, FAA systems, and other stakeholder systems (non-FAA)." (DJI-1018, 11.) "Standardized and internationally recognized protocols are used

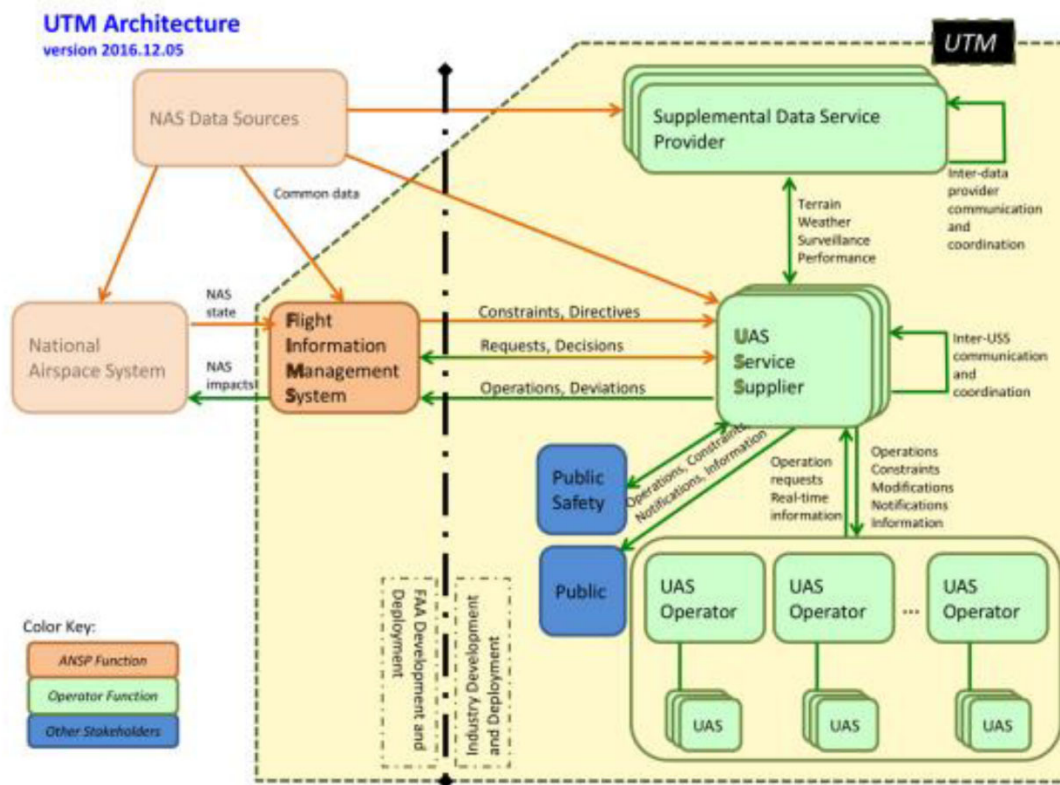
when possible. By adhering to established protocols and standards, integration of the UTM research platform within existing and future systems is expected to be easier.” (DJI-1018, 11.)



DJI-1018, Figure 4.

42. DJI-1016, titled “UTM Data Working Group Demonstration 1 Final Report” and published on April 1, 2017, describes a November 2016 “collaborative and distributed simulation of representative scenarios” between NASA, the FAA, and industry partners to test the “data exchanges” between “two key components” in NASA’s UTM system: the Flight Information Management System (FIMS) and the UAS Service Supplier (USS). (DJI-1016, 1, 4, 29-30.) “To accompany this effort, NASA endeavored to map the existing NASA UTM research platform

schemas to the FAA-identified data requirements, while identifying any gaps in the requirements that would be needed to enable future automated management of operations and the airspace.” (DJI-1016, 3.) The UTM architecture diagram in Figure 1 below illustrates UTM’s “overall concept and the flow of data in particular.” (DJI-1016, 1-2.)



DJI-1016, Figure 1.

43. As depicted in the data flows in Figure 1 above and discussed in the report, the USS submits flight operation requests to FIMS for approval. (DJI-1016, 17, 25, 31-32, 38-48, 70-71.) FIMS accepts or denies the requests. (DJI-1016, 17, 26, 32, 38-48, 70-71.) FIMS also provides real-time notifications to the USS of

airspace constraints (e.g., no-fly zones) and directives (e.g., all-land instructions).

(DJI-1016, 76-77, 80, 94-95; *see also*, 11-15, 34, 46, 57.) If necessary, the USS modifies the flight plans of ongoing operations to comply with the constraints/directives. (DJI-1016, 31-32, 48, 72-73, 81.)

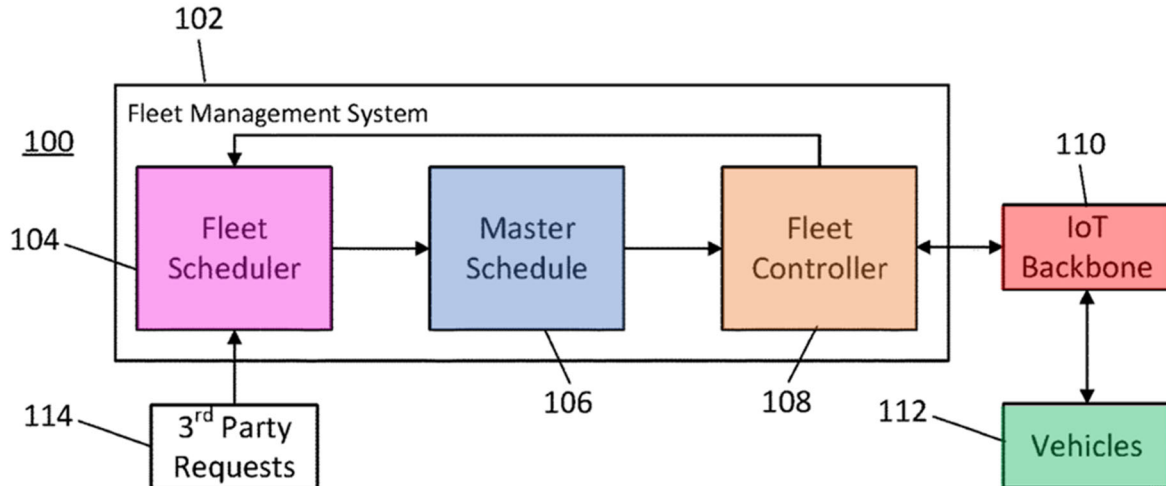
44. NASA's UTM system specifically addressed the complexities that arise in UAV fleet management by providing a comprehensive framework for managing UAV traffic, integrating factors such as airspace design, weather, public safety, and regulations, all of which contribute to the increasingly sophisticated nature of underlying UAV operation systems. I discuss NASA's UTM system further in the context of the UTM-DNET reference in § V.A.1.b below.

IV. The '972 Patent

A. Summary of the '972 Patent

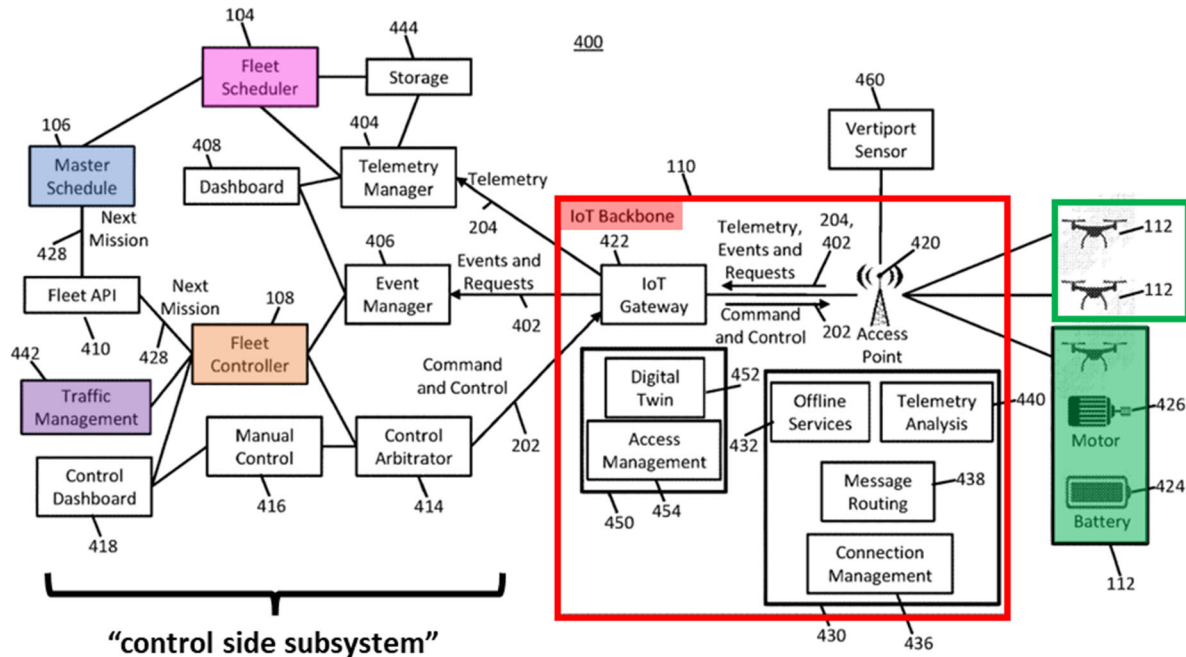
45. The '972 patent is generally concerned with “scheduling and controlling individual autonomous vehicles in a fleet.” (DJI-1001, 1:5-7.) Depicted in annotated Figure 1 below, fleet management system 102 incorporates “a fleet scheduler 104 [shaded pink] that generates, or submits entries to, a master schedule 106 [shaded blue].” (DJI-1001, 3:21-23.) This master schedule 106 is used by “a fleet controller 108 [shaded orange] to control one or more vehicles [shaded green] through a communications system such as an Internet-of-Things (IoT) backbone 110 [shaded red].” (DJI-1001, 3:23-26.) Vehicles 112 have the functionality to

“feed operational data back through the IoT backbone 110, which then delivers the operational data back to the fleet scheduler 104.” (DJI-1001, 3:26-30.)



'972 patent, Figure 1 (annotated with color-coded boxes).

46. The '972 patent's Figure 4, annotated below, illustrates operation of fleet management system 400. IoT backbone 110 (outlined in red) connects vehicles 112 (annotated in green) to a “control side subsystem” that includes fleet scheduler 104 (shaded pink), master schedule 106 (shaded blue), fleet controller 108 (shaded orange), and traffic management system 442 (shaded purple). (DJI-1001, 6:25-32, 8:50-59.)



'972 patent, Figure 4 (annotated).

47. In operation, fleet controller 108 generates a flight path and checks its availability using data from traffic management system 442 related to, for example, traffic, airspace restrictions, or weather. (DJI-1001, 8:64-9:4, 10:16-18, 10:21-23.) During performance of a mission, vehicles 112 transmit operational parameters (e.g., location, altitude, airspeed) and event data through IoT backbone 110 to the control side subsystem for use in tracking, controlling, and verifying the location of vehicles 112. (DJI-1001, 6:53-7:8, 8:17-22, 8:26-43.)

B. Level of Ordinary Skill in the Art

48. I understand that certain issues relating to the validity of the '972 patent must be judged from the perspective of a Person Having Ordinary Skill In The Art (POSITA), as I discuss below. I have been asked to define the level of a

POSITA at the time the alleged invention was made. In deciding the level of ordinary skill, I have considered the following factors, which I have been informed are relevant to the determination of ordinary skill in the art:

- the level of education and experience of persons working in the field;
- the types of problems encountered in the art;
- the prior art solutions to these problems;
- the rapidity with which innovations are made; and
- the sophistication of the technology.

49. In my opinion, a POSITA at the time of the purported invention described in the '972 patent would have had at least a bachelor's degree or equivalent in the field of aeronautical engineering, electrical engineering, mechanical engineering, computer science, or equivalent training and experience, and at least one year of experience in the field of unmanned vehicles. A higher level of education could compensate for less work experience, and vice versa.

C. Prosecution History

50. The application that led to the '972 patent was filed with three substantially similar independent claims corresponding to issued independent claims 1, 8, and 15. Representative claim 1 is reproduced below:

A method, comprising:

obtaining, by a fleet controller, from a master schedule, a mission for a vehicle of a fleet of autonomous vehicles, where the mission is associated with a mission entry of the master schedule;

generating vehicle commands according to mission parameters associated with the mission;

maintaining a persistent connection with the vehicle;

sending the vehicle commands to the vehicle using the connection, the vehicle commands causing the vehicle to execute the mission under control of the fleet controller; and

monitoring operation of the vehicle during performance of the mission.

(DJI-1002, 27.)

51. The Examiner rejected all originally filed claims as anticipated by U.S. Patent Publication 2015/0234387 to Mullan et al. (“Mullan”; DJI-1012.) The Examiner found that a collection of work orders related to UV missions met the “master schedule” limitation of the claim:

obtaining, by a fleet controller, from a master schedule, a mission for a vehicle of a fleet of autonomous vehicles, where the mission is associated with a mission entry of the master schedule; (Mullan paragraph 0023 discloses, “The fleet and mission operations controller may receive a work order related to UV mission. According to an example, work orders may be received from various enterprises and cover a variety of applications of UVs. The fleet and mission operations controller may operate in conjunction with the mission manager to translate a work order into a mission request. ...”)

(DJI-1002, 176 (citing DJI-1012, ¶ [0023].))

52. In response, the applicant did not rebut the Examiner’s rejection but instead amended the independent claims to recite limitations disclosed in dependent claims 2, 9, and 16, which were then cancelled: (1) identifying a flight path associated with the mission; (2) verifying a usability of the flight path with a UTM; and (3) modifying the flight path using data from the UTM. (DJI-1002, 207-14.)

53. In addition, the applicant argued that although Mullan disclosed “verifying the mission’s compliance with government regulations and policies,” Mullan failed to disclose “check[ing] for ‘traffic in the flight path, availability of the flight path due to flight restrictions and requirements for use of the flight path’ or ‘modifying the flight path according to data from the UTM in response to the UTM indicating that the usability of the flight path is not verified.’” (DJI-1002, 210-15.)

54. Based on the applicant’s amendments, the Examiner subsequently allowed the claims. (DJI-1002, 278-80.)

V. Ground 1: The Combination of UTM-DNET and Butler Renders Claims 1-5, 7-12, 14-18, and 20 Obvious.

A. Overview of the Combination

1. UTM-DNET

55. UTM-DNET is a joint 2018 paper by NASA and JAXA (“Japan Aerospace Exploration Agency”) that describes the integration of JAXA’s D-NET,

“a portable system for aircraft operation management in the immediate aftermath of a large disaster,” with NASA’s UTM, “which provides airspace management to enable large-scale high density operations.” (DJI-1005, 1, 3.)

56. UTM-DNET explains that “aircraft play a major role in disaster recovery, since damaged infrastructure often hinders the access to disaster-hit areas.” (DJI-1005, 2.) In Japan, disaster relief operation centers “manage aircraft operations in immediate post-disaster relief.” (DJI-1005, 2.) Dispatchers in these centers “oversee operations of multiple aircraft and coordinate with the disaster relief forces.” (DJI-1005, 2.) The aircraft “are involved in various missions, such as general reconnaissance, search, rescue, and transportation of personnel and goods.” (DJI-1005, 2.) “When the disaster is not spread over a large area, the number of vehicles involved allows the dispatchers to allocate the most appropriate mission to each vehicle and follow the mission progress, but as soon as the scale of the disaster grows, human controllers need a decision support system to allocate the available resources safely and optimally.” (DJI-1005, 2.) D-NET was developed to address this need.

a. D-NET

57. D-NET’s objective “is to acquire data efficiently from multiple sources such as satellites, helicopters, and unmanned aircraft systems to enable the analysis of these data in order to provide an optimal resource allocation and flight

trajectory plan(s).” (DJI-1005, 3.) These plans are then “integrated into actual rescue operations.” (DJI-1005, 3.)

58. The D-NET system, illustrated in exemplary operations Figure 1 below, “has three main blocks: 1) data/information acquisition block, 2) optimal planning block and 3) operation execution block.” (DJI-1005, 3.) The D-NET system “optimizes the performance” of vehicles, including manned aircraft and unmanned aircraft, “by assigning missions according to the vehicle’s equipage, state, and location.” (DJI-1005, 3.) For example, “D-NET plans and assigns data acquisition missions to UAS in order to spare resources from the manned aircraft fleet so that more helicopters can be assigned to rescue missions.” (DJI-1005, 3.)

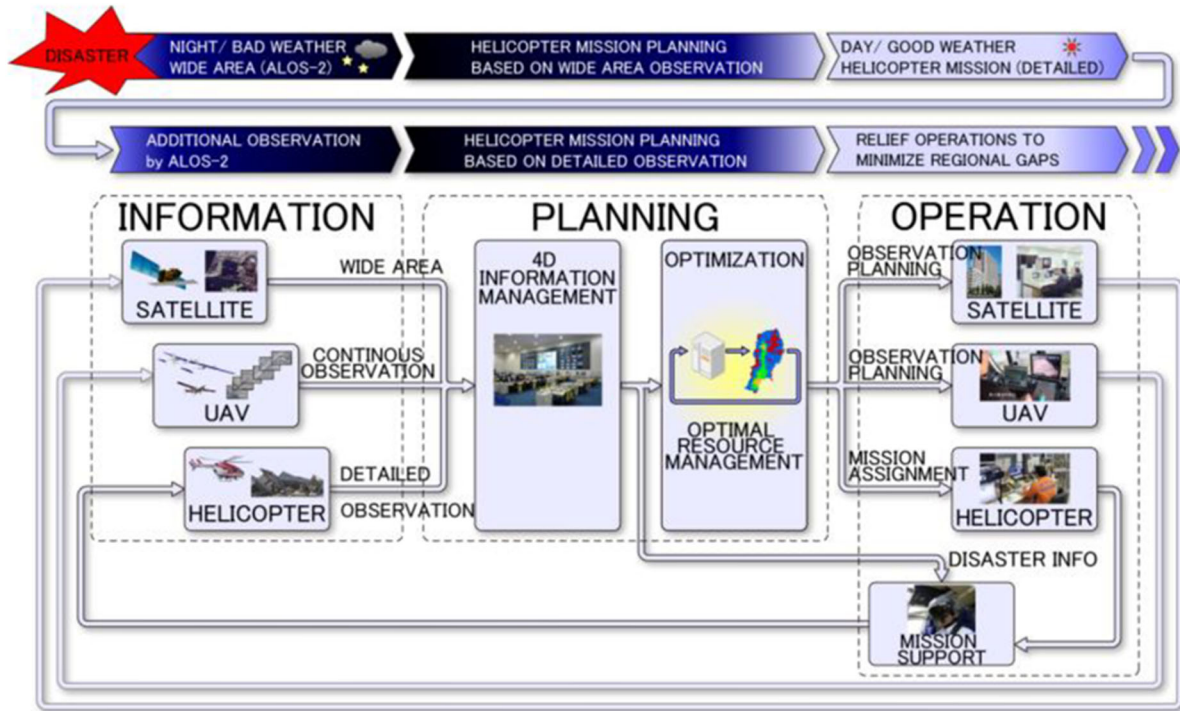


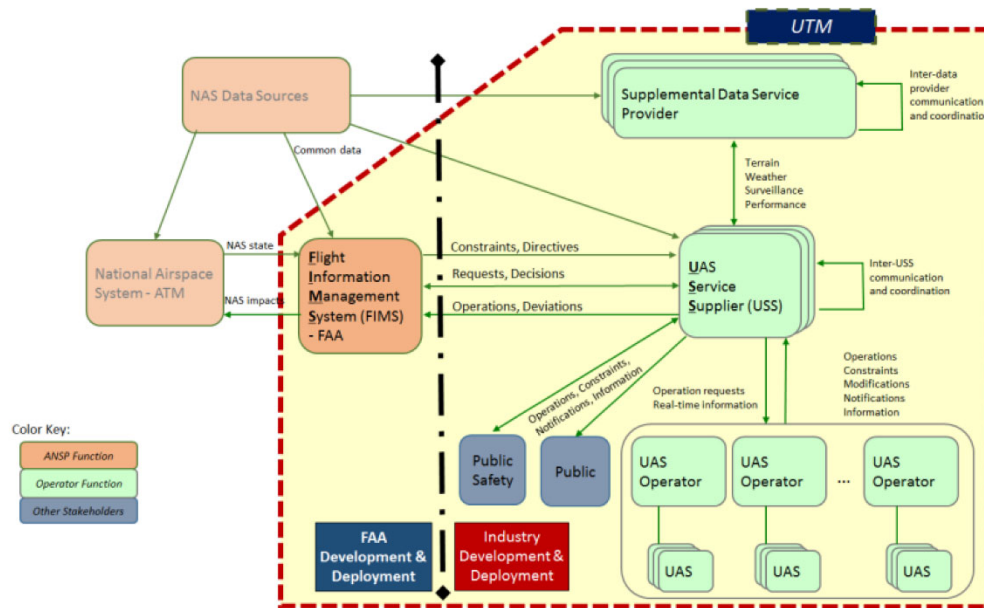
Fig. 1 D-NET operations.

59. UTM-DNET explains that for “large-scale disasters, hundreds of aircraft are deployed and engaged in search and rescue missions.” (DJI-1005, 3.) “Therefore, the overall coordination and integration of all aircraft are just as important, if not more, as the individual performance of any single vehicle.” (DJI-1005, 3.)

b. Unmanned Aircraft System (UAS) Traffic Management (UTM)

60. In response to the demand growth for commercial application of small UAS (sUAS), NASA embarked on “research to explore and define the concept, technologies, and guidelines necessary to provide a safe, scalable, efficient, and equitable approach to UAS traffic management.” (DJI-1005, 4.) Through this

research, a scalable architecture was developed “to incorporate high levels of automation” to manage traffic and provide separation services. (DJI-1005, 4; Figure 2 below.) The UTM system architecture includes a UAS Service Supplier (USS) which “facilitates communication between the different components and operators in the ecosystem, supports operation planning, assists in strategic deconfliction and airspace management, and is a source of operational information for its operators and other service providers.” (DJI-1005, 4.)



UTM-DNET, Figure 2.

61. A key part of the planning and deconfliction support provided by the USS is an Operation Volume, which is “a 4-dimensional volume that consists of a single or multi-segmented 3-dimensional polygonal volume with a temporal component that represents the time and duration that the volume(s), as part of an

operation, will be active within the UTM system.” (DJI-1005, 4.) An “Operation Volume serves to signal the intent of an operator to perform an operation and maintain the vehicle within the bounds of the volume(s) at all times.” (DJI-1005, 4.) The USS “uses the Operation Volume for strategic deconfliction of airspace by checking proposed volumes from other operators within the same USS and from other USSs to ensure that there is no overlap in time and space of volumes.” (DJI-1005, 4.) This check “provides a level of assurance to the operator and potential airspace managers (e.g., in disaster response situations) that the operation can be performed with reduced concern of sharing the airspace with other vehicles at the same time.” (DJI-1005, 4-5.)



Fig. 4 Example of UAS flight plan (left) and associated Operation Volume (right)

UTM-DNET, Figure 4.

62. As shown above in UTM-DNET Fig. 4, “an operator first identifies an area for the flight and, depending on the intended operation, develops a flight plan for the vehicle” (left). (DJI-1005, 5.) For that plan “to be communicated to the

UTM system, a polygonal volume or set of volume segments that encapsulates the developed flight plan or intended area of operations is constructed by the operator.” (DJI-1005, 5.) This initial volume represents a 3D volume “of where an intended operation is to occur with an associated temporal component that defines the duration for when that volume or segment will be active.” (DJI-1005, 5.) The USS may add additional buffers to the initial volume to account for uncertainties. The final volume that is “accounted for within the USS and communicated to the USS network and supporting services – if present – is the Operation Volume.” (DJI-1005, 5.)

63. After generation of the Operation Volume, the USS then “checks on the airspace to ensure that there are no overlaps with other operations or airspace constraints (e.g., airports or restricted areas).” (DJI-1005, 6.) “Once the USS determines that the submitted Operation Volume is clear of other operations and constraints, the operator is notified that it is ‘Accepted’ and the operation can commence within the specified times.” (DJI-1005, 6.)

64. The USS further provides “a level of monitoring and conformance checking as a means of ensuring that a given flight is performing appropriately.” (DJI-1005, 5.) When an operation becomes “Active”, “position data for the flight is sent from the vehicle to the USS via a UTM client interface (typically integrated with a Ground Control Station).” (DJI-1005, 6.) “While ‘Active,’ position updates

are required at regular intervals to the USS, and each of the updates is checked in relation to the bounds of the Operation Volume as a means of conformance monitoring.” (DJI-1005, 6.) If a vehicle nears the outer bounds, a “Non-Conforming” message is sent to provide the operator with “the opportunity to bring the flight back into conformance.” (DJI-1005, 6.) If the operator cannot control the vehicle and avoid an Operation Volume breach, “the operation transitions to a ‘Rogue’ state.” (DJI-1005, 6.) At this point, the UAS “must land and close.” (DJI-1005, 6.)

c. Integrated UTM-DNET System

65. The integrated UTM and D-NET system “is focused on the safe and efficient use of sUASs in immediate post-disaster relief operations.” (DJI-1005, 8.) The integrated system has “two main stages – planning and in-flight.” (DJI-1005, 8.) During the flight planning stage (Figure 7, left below), “D-NET is responsible for the generation of optimal flight plans for both manned and unmanned aircraft.” (DJI-1005, 8.)

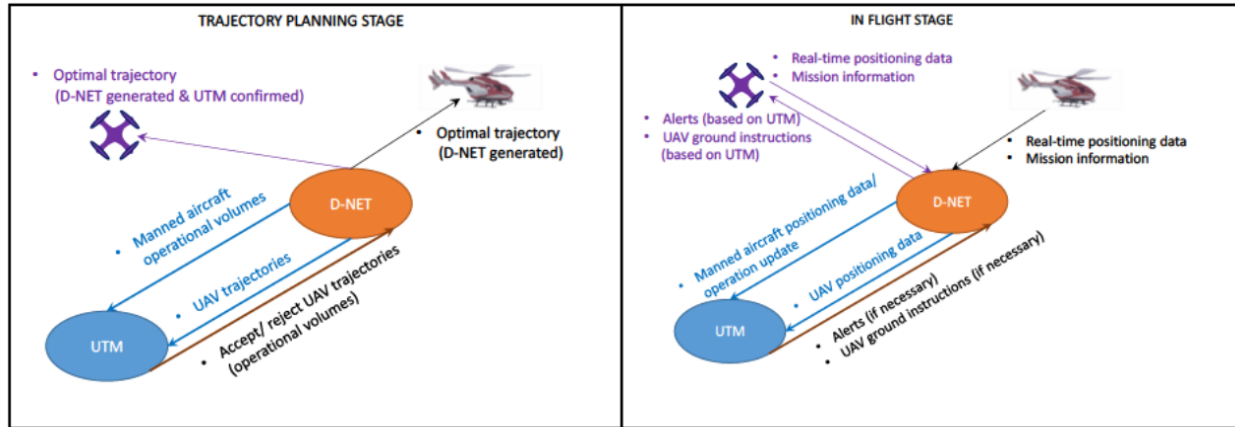


Fig.7. UTM and D-NET conceptual interaction at the flight planning (left) and in-flight stages (right)

66. UTM-DNET's system architecture and information flow are illustrated in Figure 8 below. (DJI-1005, 9.) D-NET includes an "optimization subsystem" (not shown) that "generate[s] flight trajectories[/flight plans] for all aircraft" based on input data from external components such as "aircraft databases, satellites, and supplementary data providers." (DJI-1005, 8.) D-NET stores data on the available fleet and onboard equipment and "real-time data on reconnaissance and rescue mission demands." (DJI-1005, 8.) For manned aircraft, D-NET's optimization system submits the manned aircraft operational volumes to the UTM. (DJI-1005, 8.)

67. As shown in UTM-DNET Fig. 8 below, for unmanned aircraft, D-NET submits the generated flight plans (as indicated by the top arrow labeled UAS flight plan request in Fig. 8 below) "as line segments defined by time-stamped waypoints" to UTM "for verification." (DJI-1005, 8, 11-12, Figs. 8, 12.) These flight plans are "either accepted when they meet the safety constraints imbedded in

the system, or otherwise rejected.” (DJI-1005, 8.) The acceptance/rejection is fed back to D-NET “for further planning and optimization.” (DJI-1005, 8.) If UTM approves the flight plan, D-NET sends the flight plan to its respective UAS through the UAS Ground Station. (DJI-1005, 8.) If UTM rejects the flight plan, D-NET “re-optimiz[es] the plan against the rest of the missions” and re-submits it to UTM. (DJI-1005, 8.)

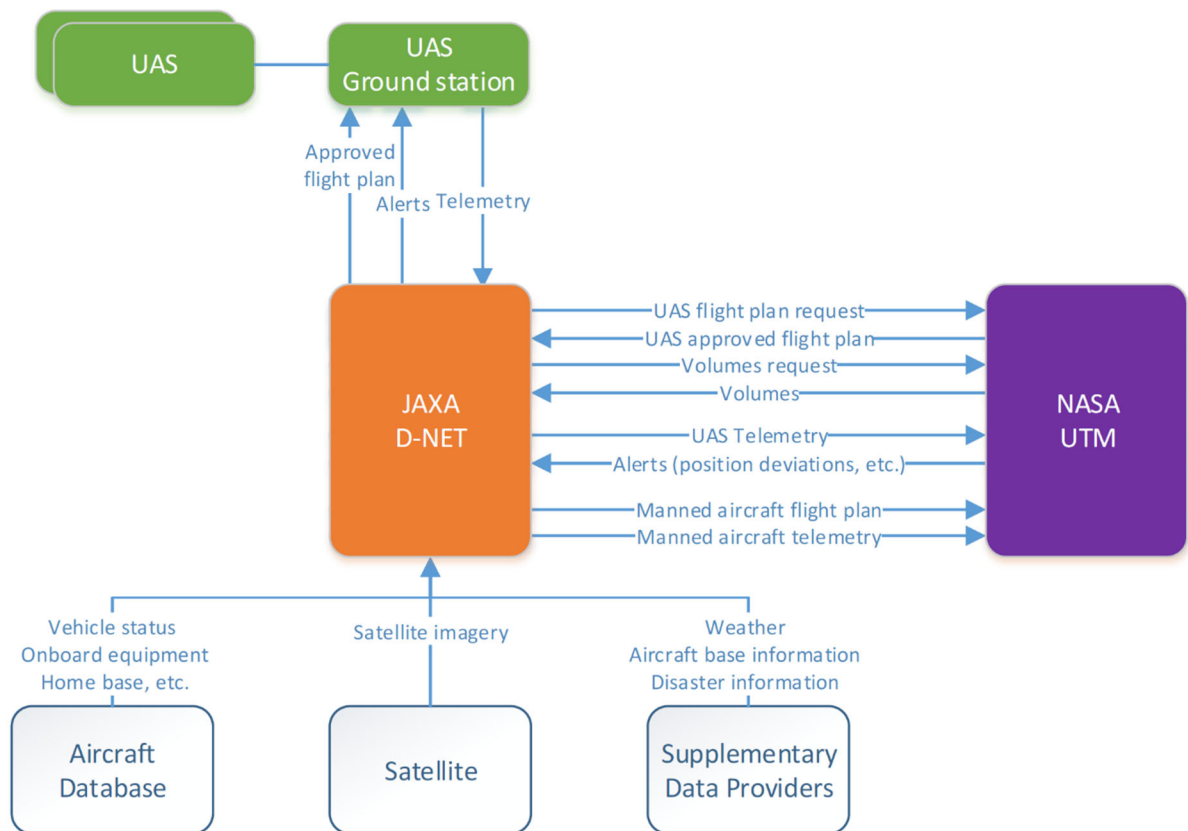


Fig. 8 Potential architecture and information flow between D-NET and UTM

68. During the in-flight stage, “D-NET provides the tracking data of the aircraft engaged in disaster relief missions to UTM.” (DJI-1005, 8.) The UTM then

“issue[s] alerts if unmanned aircraft do not conform to their operation volumes, or if a manned aircraft is expected to enter the airspace in use.” (DJI-1005, 8.)

2. Butler

69. Butler relates to “a scalable, flexible, automated, air traffic control and flight plan management system for drones.” (DJI-1006, 1:4-6. 3:7-9.) Butler’s system 200, illustrated in Figures 1 and 2 below, includes servers 210 and storage devices 220 having one or more databases such as database 400 that maintains a collection of executable flight plans 410 [red]. (DJI-1006, 2:1-3, 4:4-12, 4:41-44.) System 200 further includes zone controllers 60 that “control[] air traffic for a particular air traffic control zone.” (DJI-1006, 11:22-30.)

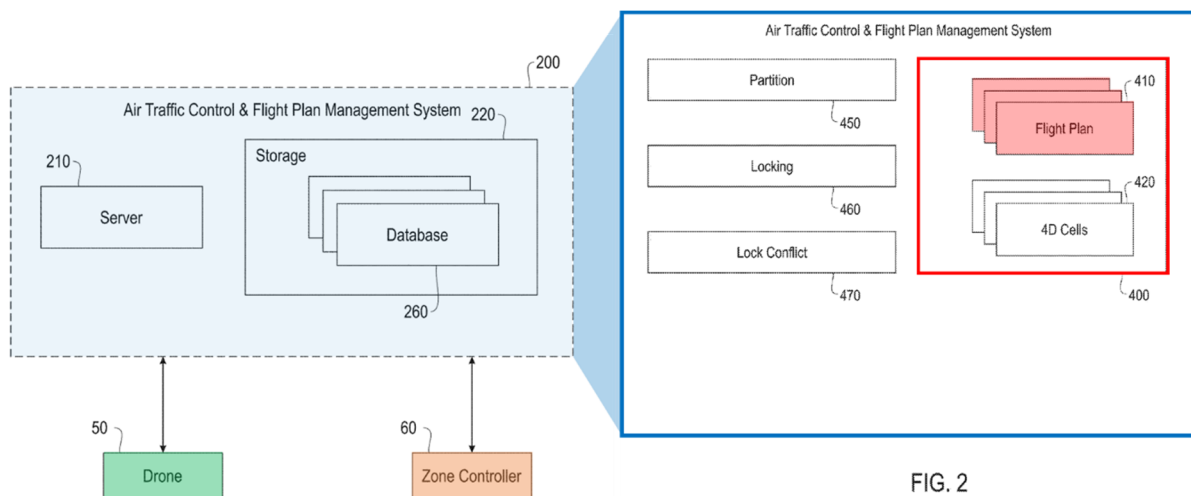


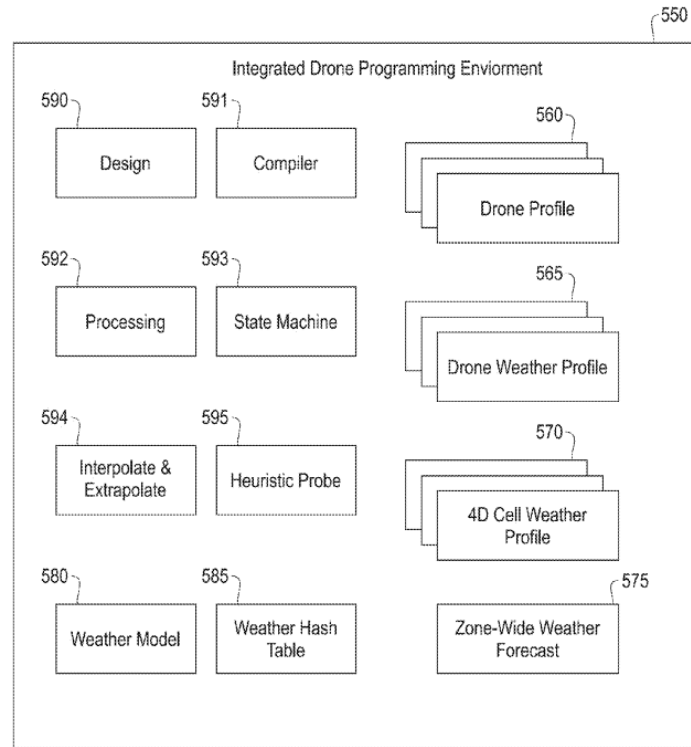
FIG. 1

Butler, Figures 1 and 2 (annotated).

70. Butler uses a “high level programming language for execution by a drone, the high level programming language compatible with a scalable, flexible,

automated, air traffic control and flight plan management system for drones.” (DJI-1006, 12:55-59.) Butler’s system 200, shown above, “receive[s], as input, flight plan requests including flight plans designed using the high level programming language.” (DJI-1006, 12:67-13:5.)

71. System 200 further includes framework 550 for a drone programming environment, illustrated below. Framework 550 includes “design unit 590 configured to design a flight plane for a drone 50 (FIG. 1) using the high level programming language, and generate a flight plan request for the drone 50 that includes the flight plan.” (DJI-1006, 14:1-4.) The high level programming language “comprises different high level control instructions representing actions that are understandable and describable by humans.” (DJI-1006, 14:5-8.)



Butler, Figure 7.

72. Butler further includes “a drone adaptor configured to adapt an executable flight plan for a drone 50 to a drone specific API 650” for the drone. (DJI-1006, 18:42-44.) The drone adaptor may be “an onboard drone adaptor” or a “remote adaptor implementing synchronous radio translation using a compute thread on a server 680 (FIG. 9) of a zone controller 60.” (DJI-1006, 18:46-49.) The drone adaptor provides commands to the drone-specific API 650 that “include low level commands addressing servos at individual rotors of the drone 50, such as low level commands that increase or decrease rotational speed, or change orientation of the rotors, with respect to a chassis of the drone 50.” (DJI-1006, 19:12-22.)

3. Combination of UTM-DNET and Butler

73. A POSITA would have been motivated to combine the teachings of Butler with UTM-DNET's system for controlling UAS in immediate post-disaster relief operations. First, a POSITA would have been motivated to incorporate Butler's teachings regarding flight plan design, including the design unit teachings and the drone adaptor teachings, into the D-NET system of UTM-DNET.

74. UTM-DNET discloses that the optimization subsystem of the D-NET system "assign[s] missions and generate[s] flight trajectories for all aircraft." (DJI-1005, 8.) UTM-DNET does not provide specifics about the methods used to create these flight plans, yet it does disclose that once the flight plans are verified, they are sent "to the UAS ground base, which will convey it to the vehicle." (DJI-1005, 8.) UTM-DNET also does not provide details regarding the interface required to provide flight plans to UAS. A POSITA would have therefore been motivated to search for references describing how to generate a flight plan and how to communicate the flight plan to a UAS. A POSITA searching for such references would have been led to Butler, which is in the same field as the '972 patent and UTM-DNET, namely, the field of vehicle fleet control. Butler contains explicit details that are left open in UTM-DNET regarding how to generate a flight plan and transmit it to the appropriate UAS for execution.

75. A POSITA would recognize the substantial value of combining UTM-DNET with Butler to facilitate the interoperability between the UTM-DNET system and various UAS models and manufacturers. UTM-DNET underscores the necessity for this interoperability, as it emphasizes the requirement to support a diverse array of aircraft in different organizational contexts.

76. Specifically, UTM-DNET describes the challenges of logistical coordination when multiple organizations are involved in relief efforts, highlighting how these challenges can lead to inefficiencies: “[t]ypically, multiple organizations support relief activities and this often creates logistics coordination challenges between agencies which can result in wasted time or resources.” (DJI-1005, 1.) UTM-DNET further specifies a particular problem that arises “when aircraft belong to different organizations (e.g., Japan self-defense forces, fire departments and medical services), real-time telemetry and mission-related information cannot be shared, as no common operational platform exists.” (DJI-1005, 2.)

77. In this context, the combination of UTM-DNET and Butler would provide a unified platform, enabling seamless interaction and information-sharing across different UAS models and manufacturers belonging to different relief organizations. This would alleviate the coordination issues that arise from disparate operational platforms, leading to more efficient disaster relief activities. By

creating a common interface for various organizations and their distinct aircraft, the combined system of UTM-DNET and Butler would enhance real-time collaboration and minimize wasted resources, aligning with the urgent and complex needs of disaster response scenarios.

78. UTM-DNET further discloses the use of various types of UAS in disaster relief efforts: low performance commercial off-the-shelf (COTS) UAS, industrial grade UAS, and fully-equipped high performance UAS. (DJI-1005, 14, Figure 13.) These UAS have different intended applications and therefore widely varying sets of capabilities. For example, COTS UAS usually offer essential functions and are often constrained to basic flying and imaging capabilities in Visual Line of Sight (VLOS) with limited advanced features and less rugged construction. Industrial grade UAS, on the other hand, are meant for more specialized and demanding applications, and may include enhanced features, such as better sensors, more robust construction, the ability to operate Beyond Visual Line of Sight (BVLOS) and the ability to integrate with specific industrial tools and software. Compared to COTS, industrial grade UAS generally offer higher reliability and precision.

79. Finally, fully-equipped high performance UAS refers to state-of-the-art UAS, often used in military, governmental, or highly specialized applications. These systems are designed to operate in the most challenging conditions,

providing capabilities well beyond those of COTS and industrial-grade UAS, and are usually equipped with top-tier sensors, advanced communication systems, superior performance characteristics, and are often customizable for specific mission requirements.

80. As a result, a POSITA would have recognized that incorporating Butler's flight planning design unit and drone adaptors in either the D-NET system or UAS to convert high-level commands into low-level commands would have provided the flexibility necessary for the D-NET/UTM systems to utilize the capabilities of the many types of UAS contemplated in UTM-DNET in disaster relief efforts.

81. Furthermore, to a POSITA, the combination of UTM-DNET and Butler is simply the application of a known technique (flight planning design and conversion of high-level commands to low-level commands) to a known device (the D-NET system) to yield predictable results (flight plans that can be executed by a variety of UAS). Butler is directed to an "automated[] air traffic control and flight plan management system for drones" (DJI-1006, 1:4-6), similar to the systems disclosed in UTM-DNET and the '972 patent. (DJI-1005, 8 (describing system for "managing manned and unmanned assets in a disaster response environment"); DJI-1001, 1:5-10 ("The present invention relates generally to a system and method for scheduling and controlling individual autonomous vehicles

in a fleet[.]”.) The result of the combination would have been foreseeable to a POSITA because defining a flight plan as a series of instructions/commands was well-known in the art, as was the use of an adaptor to interface with an application programming interface (API).

82. For example, UTM-DNET suggests that flight planning is performed by software (DJI-1005, 5) and Butler’s remote drone adaptor is implemented as “a compute thread² on a server ... of a zone controller,” (Butler, 18:46-59, which a POSITA would have understood to mean a computing process running on a remote server.

83. Thus, a POSITA would have had a reasonable expectation of success in modifying D-NET software to include Butler’s flight planning and drone adaptor because a POSITA would be familiar with software development and because Butler provides software flow diagrams and examples of high level and middle level commands for example programs (see for example Butler’s Tables 6 and 7 and Figure 4).

² A compute thread is a small sequence of programmed instructions that can run concurrently with other threads.

Table 6 below provides some example high level commands of executable code for the example program in Table 5.

TABLE 6

Cell(latival1, longival1, elevival1, timeival1)
Cell(latival1, longival1, elevival2, timeival2)
Cell(latival2, longival2, elevival2, timeival3)
Cell(latival2, longival2, elevival3, timeival4)
Land(beacon2)
...

Table 7 below provides example middle level commands converted from example high level commands.

TABLE 7

Time(timeival1[1]) → Up full power
Elev(elevival2[1]) → Hover;
Heading head(latival2-latival1, longival2-longival1), Forward full power

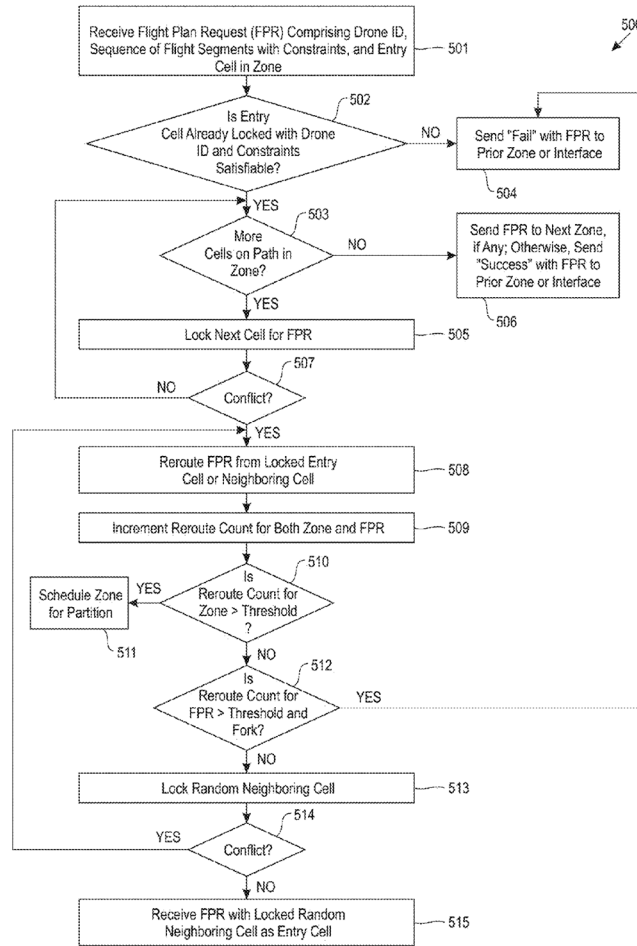


FIG. 4

Butler, Figure 4.

84. Second, a POSITA would have been motivated to store the flight plans generated by the D-NET system and submitted to UTM for verification in storage associated with the D-NET system like a database because UTM-DNET

suggests the necessity for such storage. UTM-DNET teaches that the D-NET system submits generated flight plans “as line segments defined by time-stamped waypoints” to UTM “for verification.” (DJI-1005, 8, 11-12, Fig. 12.) The flight plans are “either accepted when they meet the safety constraints imbedded in the system, or otherwise rejected.” (DJI-1005, 8.) The acceptance/rejection is fed back to D-NET “for **further planning and optimization.**” (DJI-1005, 8 (emphasis added).)

85. To “further” optimize a flight plan, the D-NET system must retain the ability to access the initial flight plan forwarded to UTM. In other words, the process of accepting or rejecting a flight plan based on safety constraints, and the subsequent feedback to the D-NET system for adjustments, implies that the original flight plan must be accessible within the D-NET system to be able to optimize it, thereby necessitating storage at that location. Thus, a POSITA would have understood that the generated flight plan is stored at the D-NET system.

86. D-NET further suggests that flight plans are stored at the D-NET system because the system provides visualization tools that require flight plans to be stored in order to be displayed. A POSITA would have been motivated to indicate the status of a flight plan, e.g., initially generated by DNET, verified (approved) by UTM, etc., so that the system knows whether a stored flight plan has been verified.

87. UTM-DNET provides visualization (see Figure 12 below) and operational awareness during disaster relief efforts when the verified flight plans are being executed. UTM-DNET highlights the advantage of this awareness, stating that “having an awareness of where operations are planned or are currently taking place can aid operators and managers in planning and managing their own operations and allocation of resources.” (DJI-1005, 5.)

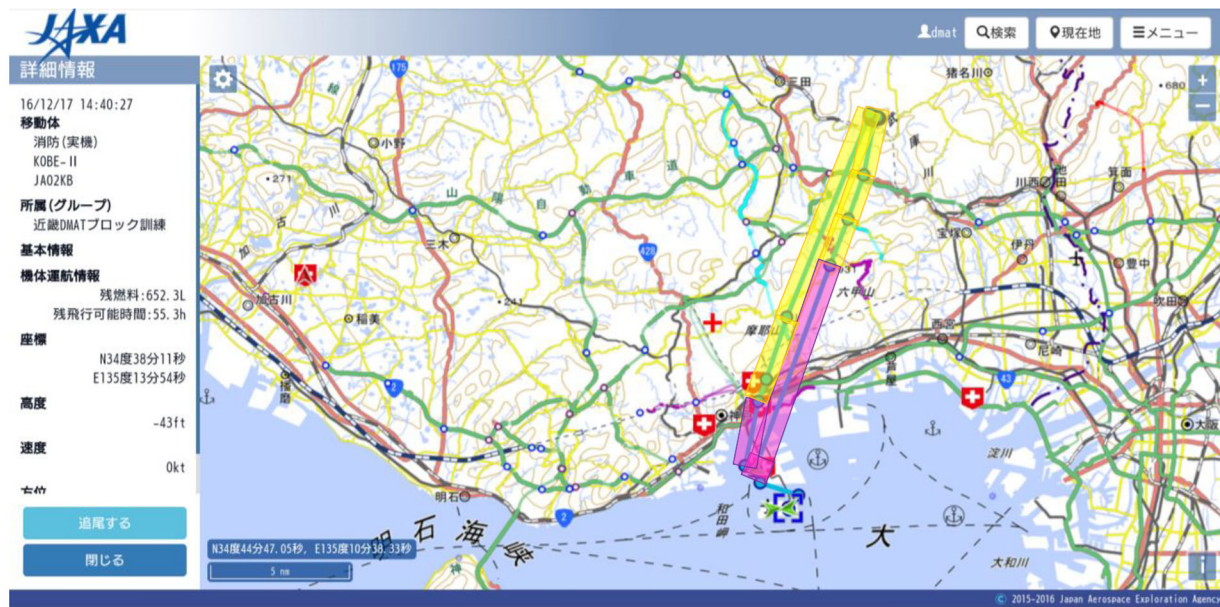


Fig. 12 Example of proposed D-NET/UTM integrated visualization

88. The individual D-NET and UTM systems provided users the ability to visualize planned and ongoing operations. (DJI-1005, 10-11, Figures 10-11.) The UTM research team regarded a user interface that offers real-time access to UTM information concerning adjacent operations as a “clear necessity.” (DJI-1005, 11.)

89. The D-NET interface offered visualizations of flight plans, operational volumes, and telemetry for “use[] by response management at local

disaster relief centers to follow the mission progress.” (DJI-1005, 9.) “This visualization is ... expected to **increase the situational awareness** and reduce any redundant communication regarding position updates and mission status.” (DJI-1005, 9 (emphasis added).) The individual D-NET and UTM systems therefore also emphasized the importance of operational awareness.

90. UTM-DNET additionally suggests use of a database by disclosing the use of an “Aircraft Database” for storing “Vehicle status, Onboard Equipment, and Home Base, **etc.**” (DJI-1005, 9.) A POSITA would have been motivated to modify the D-NET system to either (1) store flight plans in the existing database or (2) incorporate a separate database for storing flights plans. The motivation to modify the D-NET system in such a manner stems from the natural extension of the existing infrastructure, taking advantage of a database’s capabilities to manage complex data sets efficiently. By either expanding the existing “Aircraft Database” or incorporating a separate one for flight plans, a POSITA would not only streamline the process of storing and retrieving flight plans, but also enhance the system’s flexibility and adaptability, allowing for more coherent integration and management of different types of information critical to the operation.

91. Moreover, Butler suggests the use of a database to store flight plans. (See, DJI-1006, 2:1-3, 4:4-12, 4:41-44.) A POSITA would have been motivated to combine Butler’s flight plan storage teachings with UTM-DNET. As discussed

above, at a minimum, UTM-DNET suggests the storage of flight plans at various stages of planning and operation in a database. At the planning stage, UTM-DNET suggests the storage of flight plans for purposes of re-optimization. And at the mission execution stage, UTM-DNET suggests the storage of flight plans for real-time visualizations that promote situational awareness. A POSITA would have thus been motivated to incorporate Butler's flight plan storage teachings into UTM-DNET to support the flight-plan re-optimization and visualization functionalities of UTM-DNET.

92. A POSITA would have further been motivated to combine the flight plan storage teachings of Butler with UTM-DNET to facilitate “coordinated information sharing amongst different relief agencies,” which UTM-DNET explains is crucial in disaster response situations. (DJI-1005, 1.) UTM-DNET goes on to say that “insufficient or uncoordinated rescue demand information sharing might cause duplicate mission assignments and inefficiencies in search, rescue, and supply missions.” (DJI-1005, 2.) Accordingly, information “collection and sharing” is a key focus of both D-NET and the integrated UTM-DNET system. (See DJI-1005, 1 (D-NET “assists **collection and sharing of disaster information** ... for efficient and safe rescue operations by disaster relief aircraft” (emphasis added)), 3 (D-NET's objective “is to acquire data efficiently from multiple sources such as satellites, helicopters, and **unmanned aircraft systems** to enable the

analysis of these data in order to provide an optimal resource allocation and flight trajectory plan(s)” (emphasis added)).) The combination would enhance UTM-DNET’s expressed goal of aggregating and disseminating information among various emergency aid organizations by establishing a unified hub for information related to disaster-response activities.

93. The combination of UTM-DNET and Butler merely applies a known technique (using a database to store flight plans) to a known device (a UAS fleet management system) to yield predictable results (operational awareness for all stakeholders in UAS system). For example, a POSITA would know that the system described in UTM-DNET already interfaces with a database: “D-NET generates vehicle mission assignments and flight plans based on information ... obtained through the **aircraft database**.” (DJI-1005, 8 (emphasis added).) The results of the combination would have been predictable to a POSITA, who would understand that the UTM-DNET system would interface with the Aircraft Database and Butler’s database of executable flight plans in the same way or even combine the two into a single database.

B. Independent Claim 1

1. Preamble [1P]

“An autonomous vehicle fleet control method, comprising:”

94. The combination of UTM-DNET and Butler teaches “*an autonomous vehicle fleet control method.*” As stated in UTM-DNET, the “main components of the integrated system are UTM, D-NET, UAS ground stations, and vehicles.” (DJI-1005, 8.) Within this integrated system, vehicles encompassing both manned and unmanned assets such as small unmanned aircraft systems (sUASs) are coordinated to operate in “a disaster response environment.” (DJI-1005, 1-2, 8.) Specifically, the integrated system focuses “on the safe and efficient use of sUASs in immediate post-disaster relief operations.” (DJI-1005, 8.)

95. The sUASs described in UTM-DNET encompass “autonomous” vehicles. An objective of the combined D-NET and UTM system “is to leverage core capabilities that have been developed as part of UTM ... in order to provide the ability to deploy and manage sUAS as part of wider disaster response efforts.” (DJI-1005, 2.) NASA UTM documentation I reviewed in the course of preparing this declaration confirms that UTM supported autonomous vehicles. (DJI-1014, 4 (“The UTM will support a wide variety of UAS from those equipped with minimalistic avionics to **autonomous UAS.**” (emphasis added)), Figure 1; DJI-1018, 6 (“UTM will accommodate a diverse inventory of UAS. ... the vehicles will

span the entire spectrum of control mechanisms from remotely piloted to command-directed and **fully autonomous systems.**” (emphasis added)); DJI-1027, 10 (“As a set, the successive iterations will support development of the range of UAS operations for each operating environment - from remotely piloted aircraft to command-directed UAS and **fully autonomous UAS.**” (emphasis added)).)

96. UTM-DNET details that during large-scale disaster situations, “hundreds of aircraft are deployed and engaged in search and rescue missions.” (DJI-1005, 3.) The system ensures “overall coordination and integration of all aircraft” by “optimiz[ing] the performance” of the various available vehicles, such as manned and unmanned aircraft, “by assigning missions according to the vehicle’s equipage, state, and location.” (DJI-1005, 3.) Additionally, UTM-DNET discusses “multiple operations conducted by independent operators ... tak[ing] place in close proximity.” The combination of UTM-DNET and Butler therefore discloses an “*autonomous vehicle fleet*” that is utilized for disaster response, an approach that is consistent with the ’972 patent’s mention of a vehicle, which includes “flying vehicles, such as drones.” (DJI-1001, 2:25-27.)

97. UTM-DNET teaches an “*autonomous vehicle fleet control method.*” Within the framework of the integrated system, the primary objective is “to leverage core capabilities that have been developed as part of UTM and integrate them with D-NET in order to provide the ability to deploy and manage sUAS as

part of wider disaster response efforts.” (DJI-1005, 2.) UTM-DNET explains that “the integration process between UTM and D-NET established an initial interface and capability necessary for managing manned and unmanned assets in a disaster response environment.” (DJI-1005, 8.)

98. The emphasis is not merely on individual performance but on cohesive management. As UTM-DNET articulates, “the overall coordination and integration of all aircraft are just as important, if not more,” than the functioning of any single unit within the fleet. (DJI-1005, 3.) This involves the specialized role of D-NET, which “is responsible for the generation of optimal flight plans for both manned and unmanned aircraft.” (DJI-1005, 8; *see also*, 3, Figure 1, Figure 8.)

99. D-NET transmits flight plans to UASs for execution. (DJI-1005, 8.) The method by which D-NET transmits these plans to sUASs is through the UAS ground base, ultimately communicating the instructions to the respective vehicle. (DJI-1005, 8.)

100. During the active phase of a mission, D-NET engages in continuous monitoring. It receives positional information from the UAS, and in collaboration with UTM, “checks their conformance with submitted flight plans and assigned operational volumes.” (DJI-1005, 9; *see also*, 8, Figure 7 (right).) If there is any deviation detected, D-NET takes corrective action by “requir[ing] the UAS to adjust its behavior.” (DJI-1005, 9.) This command-and-control architecture allows

D-NET to exercise authority over the UAS within the combined UTM-DNET system. The combination of UTM-DNET and Butler therefore discloses “[a]n *autonomous vehicle fleet control method.*”

2. “*Obtaining*” Limitation [1A]

“obtaining, by a fleet controller, from a master schedule, a mission for a vehicle of a fleet of autonomous vehicles, wherein the mission is associated with a mission entry of the master schedule;”

101. The combination of UTM-DNET and Butler discloses “*obtaining, by a fleet controller, from a master schedule, a mission for a vehicle of a fleet of autonomous vehicles, wherein the mission is associated with a mission entry of the master schedule.*” Specifically, the combined system discloses “*a master schedule.*” Within this schedule, there are one or more “*mission entr[ies],*” each associated with “*a mission for a vehicle of a fleet of autonomous vehicles.*”

102. The objective of the D-NET system is to provide “optimal resource allocation and flight trajectory plan(s)” for integration into “actual rescue operations.” (DJI-1005, 3.) To that end, the D-NET system operates as a comprehensive hub for critical information regarding rescue operations. For example, the D-NET system maintains data “on the available aircraft fleet” and the “real-time data on reconnaissance and rescue mission demands.” (DJI-1005, 8.) Using this information, D-NET’s specialized optimization subsystem applies it “to assign missions and generate flight trajectories for all aircraft.” (DJI-1005, 8.)

103. A practical illustration of how this works is shown in how “D-NET plans and assigns **data acquisition missions** to UAS in order to spare resources from the manned aircraft fleet so that more helicopters can be assigned to rescue missions.” (DJI-1005, 3 (emphasis added).) In other words, the system leverages its resources intelligently to ensure that each autonomous vehicle’s mission aligns with the overall objectives and constraints of disaster relief efforts. This targeted approach underscores D-NET’s capacity for the creation of “*mission[s] for a vehicle of a fleet of autonomous vehicles.*”

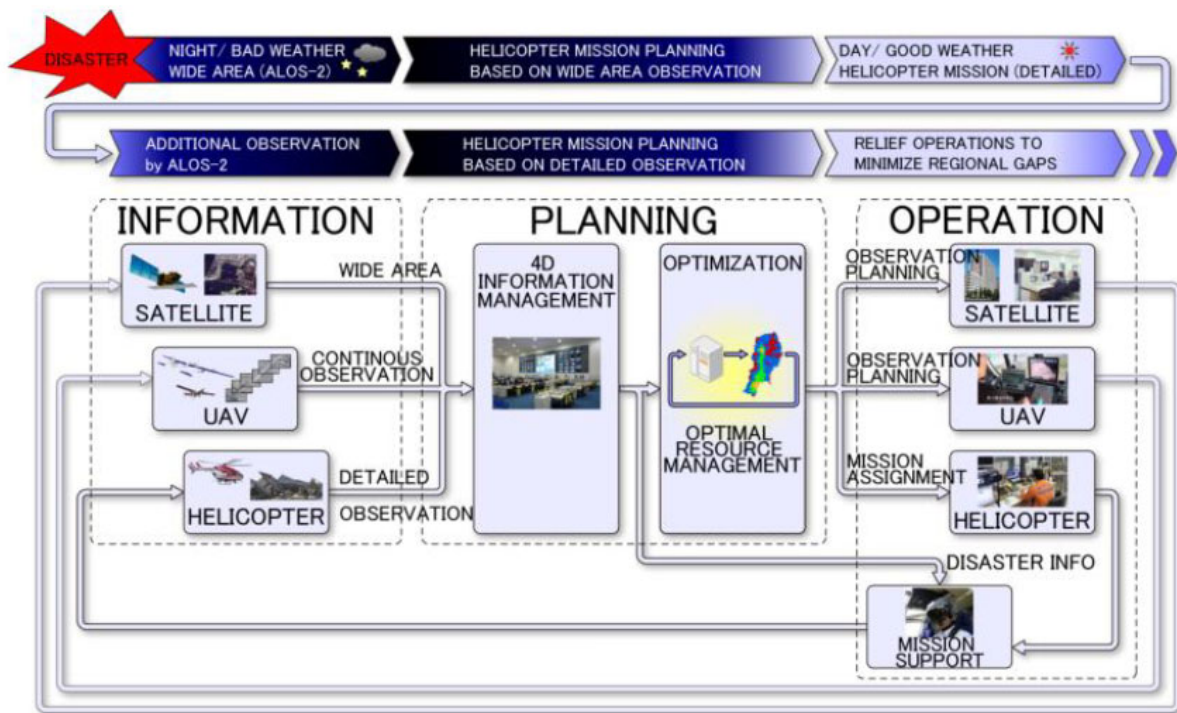


Fig. 1 D-NET operations.

104. As I discuss above in §V.A.3, the stored collection of missions and flight trajectories for both manned and unmanned vehicles, generated by D-NET’s

optimization subsystem, is retained in a database, in accordance with the teachings of Butler. This aggregation of missions/flight trajectories constitutes a “*master schedule*” for disaster relief activities, as it oversees and maintains the specific missions/flight trajectories (plans) that are to be executed throughout the operational phase of the disaster response.

105. NASA UTM documentation I reviewed in the course of preparing this declaration confirms that trajectories in the UTM system were schedule-based. In “Appendix A: Selected List of UTM System Requirements” of DJI-1014 under the heading “Congestion Detection, Prediction, and Management” is listed: “2. Able to provide sequencing and spacing under tight airspace corridors by creating required time of arrivals (**schedule based system to strategically manage traffic and deconflict original trajectories**).” (DJI-1014, 13 (emphasis added).) DJI-1017 lists “Scheduling” as a responsibility of UTM falling under the category of “Strategic Separation” / “Strategic Conflict Management” and further marked with a red square signifying “Airborne Hazards.”

		Strategic Separation	Tactical Separation		
		Strategic Conflict Management	Separation Provision		Collision Avoidance
UTM	USS / SDSP	Scheduling 	Conformance Monitor 		
		Airspace Constraints 	Separation Provision Conflict Alert 		
		Ground Constraints 	Dynamic Re-routing 		
		Operation Notice 	UAS Operator Report (UREP) 		
	UAS Operator / UAS	Flight Planning  	Flight Volume Containment 	Visibility and Audible Enhancements 	Cooperative De-confliction (Air-to-Air) 
				Position Broadcast 	Non-cooperative De-confliction (Air-to-Air) 
				Ground Surveillance 	Obstacle Avoidance 
ATM	Other Airspace Users	Flight Planning	Radio Communication	Position Broadcast	See and Avoid
			Data Communication		

(DJI-1017, 25.) A POSITA would understand this graphic to mean that scheduling of UAS missions/flight plans serves the purposes of “Strategic Separation” / “Strategic Conflict Management” and seeks to avoid “Airborne Hazards.” DJI-1028 in turn lists “Scheduling” as a “High-Level UTM Service[]”:



High-Level UTM Services

- SECURITY SERVICES
 - System Health Monitoring
 - Vehicle Registration
 - User Authentication
 - Flight Monitoring
- INFORMATION SERVICES
 - Airspace Definition
 - Weather Information
 - Terrain and Obstructions
 - Traffic Operations
- FLIGHT SERVICES
 - Flight Planning
 - **Scheduling** and Demand Management
 - Separation Assurance
 - Contingency Management

(DJI-1028, 12 (highlighted).)

106. A POSITA would thus understand that within the UTM system, missions/flight trajectories are conceptualized and managed within the framework of a “schedule.”

107. Every record within the database, representing a distinct mission or flight trajectory, contains a unique identifier and specific details like the earliest time requested for flight and/or the latest time for desired arrival, along with the planned route, including the point of departure and one or multiple destination locations, as taught by Butler. (*See* DJI-1006, 4:66-5:10; *see also*, 1:32-36, 3:10-14, claims 1, 9, 17.) These records are “mission entries” that that correlate with

“missions,” and vice versa. Thus, the combination of UTM-DNET and Butler discloses that each “*mission is associated with a mission entry of the master schedule.*”

108. I note that UTM-DNET’s “*master schedule*” (collection of missions/flight trajectories) is consistent with the Patent Owner’s interpretation of that term as set forth in its infringement contentions, which I have reviewed in the course of preparing this declaration. Specifically, Patent Owner asserts in its infringement contentions that the Task Plan Library used by DJI Flighthub 2 (illustrated below), which stores a collection of task plans, each comprising a flight route and task performance time, meets the “*master schedule*” limitation. (DJI-1013, 6-11.)

Planned/Actual Time	Status	Type	Plan Name	Flight Route Name	Doc Name	Creator	Media File Upload	Actions
2022-03-07								
08:30 08:31	To be performed	Timed & Recurring	L1 Inspection	L1 Inspection	No.1	L1 Inspect	--	[edit] [delete] [share]
2022-03-08								
08:30 08:31	To be performed	Timed & Recurring	L1 Inspection	L1 Inspection	No.1	L1 Inspect	--	[edit] [delete] [share]
2022-03-09								
08:30 08:31	To be performed	Timed & Recurring	L1 Inspection	L1 Inspection	No.1	L1 Inspect	--	[edit] [delete] [share]
2022-03-10								
08:30 08:31	To be performed	Timed & Recurring	L1 Inspection	L1 Inspection	No.1	L1 Inspect	--	[edit] [delete] [share]
2022-03-11								
08:30 08:31	To be performed	Timed & Recurring	L1 Inspection	L1 Inspection	No.1	L1 Inspect	--	[edit] [delete] [share]
2022-03-12								
08:30 08:31	To be performed	Timed & Recurring	L1 Inspection	L1 Inspection	No.1	L1 Inspect	--	[edit] [delete] [share]
2022-03-13								
08:30 08:31	To be performed	Timed & Recurring	L1 Inspection	L1 Inspection	No.1	L1 Inspect	--	[edit] [delete] [share]

109. I further note that UTM-DNET’s “*master schedule*” is consistent with the Examiner’s interpretation of that term during examination of the application that led to the ’972 patent, which I discuss above in § IV.C. (DJI-1002, 176-190.)

110. UTM-DNET discloses a “*fleet controller*.” The D-NET system is “designed as a **portable system for aircraft operation management** in the immediate aftermath of a large-scale disaster.” (DJI-1005, 3 (emphasis added).) The D-NET system, reproduced again in Figure 1 below, includes “three main blocks: 1) data/information acquisition block, 2) optimal planning block and 3) operation execution block.” (DJI-1005, 3.) These three blocks demonstrate that the D-NET system controls the fleet of unmanned and manned vehicles and is therefore a “*fleet controller*.”

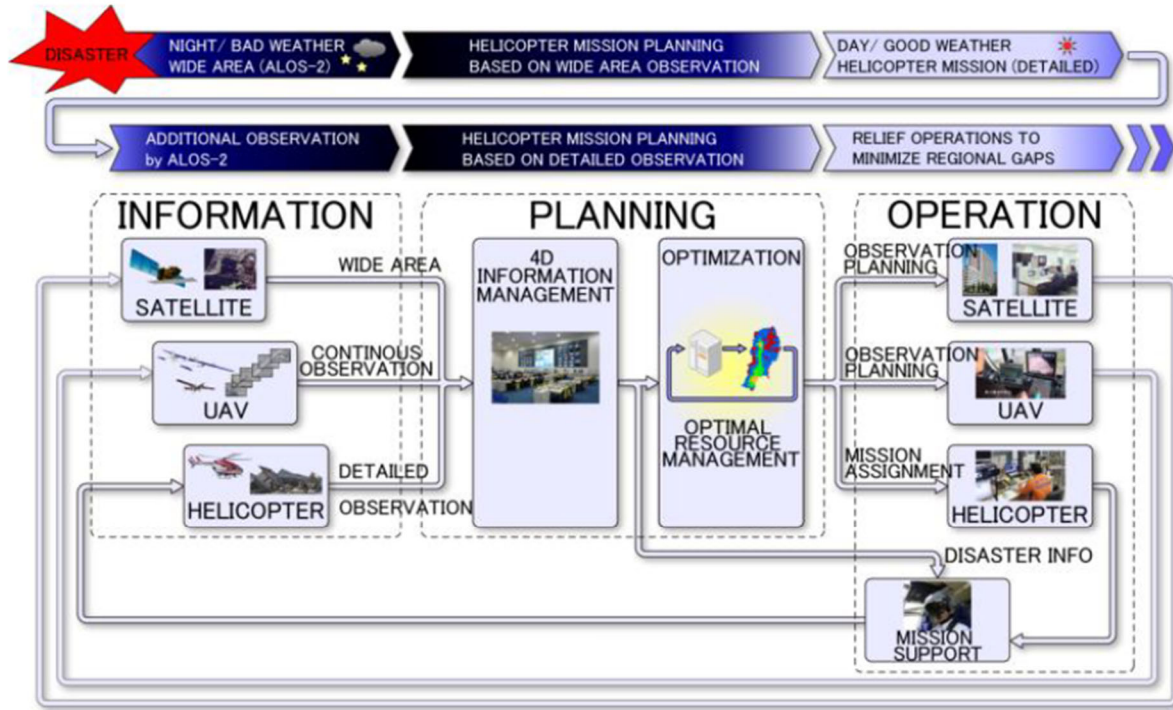


Fig. 1 D-NET operations.

111. Block 1 (“data/information acquisition”) reflects D-NET’s role in ensuring that UAV flights are planned and executed with a comprehensive understanding of the operational environment, thus acting as the foundation of the UAV fleet’s management. Block 2 (“optimal planning”) involves planning, coordinating, and optimizing flight paths to ensure the efficient and effective use of UAVs in the fleet. This planning phase is central to the role of a controller, reflecting its responsibility for aligning the UAV fleet’s operations with specific goals, timelines, and constraints. Finally, Block 3 (“operation execution”) involves the real-time management and oversight of the UAVs during flight, ensuring that the missions are executed according to the planned schedule. It includes

monitoring, command and control, adjustments to flight paths when necessary, and assurance of safety and compliance with regulations. The ability to dynamically manage the UAV fleet during operations embodies the controlling aspect of the role, underscoring D-NET's comprehensive responsibility for the UAV fleet from planning to execution and cementing its role as the claimed "*fleet controller*."

112. In the planning stage described in UTM-DNET, the the D-NET system's optimization subsystem of sends generated flight plans to UTM for verification. (DJI-1005, 8.) A POSITA would realize that the generated flight plans sent to UTM for checking are retrieved ("*obtained*") from the missions or flight trajectories ("*mission entr[ies]*") that reside in the database of the combined UTM-DNET/Butler system. Thus, the combination of UTM-DNET and Butler teaches "*obtaining, by a fleet controller, from a master schedule, a mission for a vehicle of a fleet of autonomous vehicles, wherein the mission is associated with a mission entry of the master schedule*" [1A].

3. "*Identifying*" Limitation [1B]

" <i>identifying a flight path associated with the mission;</i> "

113. The combination of UTM-DNET and Butler discloses "*identifying a flight path associated with the mission.*" UTM-DNET's flight trajectory or plan delineates the UAV's course during a mission, thus encompassing the stated "*flight path.*" Similar to the "*flight path*" described in the '972 patent, UTM-DNET's

flight trajectory/plan describes the intended route or course that a UAV will adhere to throughout its flight. (See DJI-1001, 4:52-54, 6:65-7:2, 10:26-31, Figure 2.)

These flight plans in UTM-DNET are depicted as “line segments defined by time-stamped waypoints,” as illustrated in the excerpt from Figure 4.

114. UTM-DNET’s flight trajectory or plan delineates the UAV’s course during a mission, thus encompassing the stated “*flight path*.” Like the ’972 patent’s “*flight path*,” UTM-DNET’s flight trajectory/plan describes the planned route or line of travel that a UAV will follow during its flight. (See DJI-1001, 4:52-54, 6:65-7:2, 10:26-31, Figure 2.) The flight plans in UTM-DNET flight plans are “line segments defined by time-stamped waypoints as illustrated in the excerpt from Figure 4 below. (DJI-1005, 11.)



UTM-DNET, Figure 4 (left panel).

115. In the combined system, UTM-DNET's flight plan is stored as part of the executable flight plan (and is thus "*associated with the mission*") because it is required for mission execution. That is because "[i]f a flight plan is accepted, D-NET will send it to the UAS ground base, which will convey it to the vehicle." (DJI-1005, 8.) If the flight plan is not conveyed to the vehicle, the mission associated with that flight plan cannot commence. The combination of UTM-DNET and Butler therefore discloses that the D-NET system (the "*fleet controller*") "*identif[ies] a flight path associated with the mission*" [1B].

4. "Verifying" Limitation [1C]

<p><i>"verifying a usability of the flight path with a unmanned aircraft system (UAS) traffic management (UTM), wherein ..."</i></p>
--

116. The combination of UTM-DNET and Butler discloses "*verifying a usability of the flight path with a unmanned aircraft system (UAS) traffic management (UTM).*" In UTM-DNET, generated flight plans "are sent to UTM for verification." (DJI-1005, 8.) The UTM "accept[s] or reject[s] the submitted UAS flight plan" based "on its own criteria." (DJI-1005, 8.) For example, the UTM determines whether the operation volume for the flight plan overlaps with other volumes. (See, e.g., DJI-1005, 4.) If a flight plan is rejected, meaning the flight plan is not useable, D-NET "correct[s] it by re-optimizing the plan" and "re-submit[ting it] to UTM." (DJI-1005, 8.) Thus, the system "*verif[ies] a usability of*

the flight path with a unmanned aircraft system (UAS) traffic management (UTM)”

[1C].

a. “Traffic” [1C.1]

“the UTM performs checking on the flight path for traffic in the flight path,”

117. The combination of UTM-DNET and Butler discloses this limitation. During the planning stage, when a flight plan is received from D-NET, UTM “performs checks on the airspace to ensure that there are no overlaps with other operations[.]” (DJI-1005, 6.) In addition, the USS component in the UTM system (which I discuss above in ¶¶ 42-43) “also uses the Operation Volume for strategic deconfliction of airspace by checking proposed volumes from other operators within the same USS and from other USSs to ensure that there is no overlap in time and space of volumes.” (DJI-1005, 4.) Checking for an overlap in volumes from other operators constitutes checking for “traffic” because such a check prevents collisions or near misses between the vehicles involved. Analyzing these overlaps enables proper coordination and conflict resolution between flights, thus ensuring safe navigation and avoidance of traffic-related incidents.

118. NASA UTM documentation I reviewed in the course of preparing this declaration confirms that the UTM system checks the flight plan for traffic during the operation planning stage. (DJI-1027, 23 (“The USS checks the prospective Operation Volume(s) against the larger USS network of proposed and active plans

to identify any Operation Volume conflicts.”); (DJI-1029, 5 (“**User or UTM may adjust trajectory for –Congestion or pre-occupied airspace; –Obstacle or terrain avoidance; –Airspace usability and restrictions. Verifies for wind/weather forecast and associated airspace constraints**” (emphasis added)).)

119. UTM-DNET thus teaches “*wherein the UTM performs checking on the flight path for traffic in the flight path*”³ [1C.1].

³ I note that Patent Owner’s infringement contentions, which I have reviewed in the course of preparing this declaration, appears to assert that preventing drones from “flying routes into restricted airspace” and ensuring a flight route is compliant with “flight safety and restriction updates” satisfies the “*wherein the UTM performs checking on the flight path for traffic in the flight path*” limitation. (DJI-1013, 18-25.) I discuss UTM-DNET’s disclosure of such functionality immediately below (§ V.B.4.b.) in the context of the claimed “*flight restrictions*.” However, to the extent Patent Owner’s assertion that such functionality is also covered by this limitation is correct, UTM-DNET further teaches this limitation for the reasons I discuss below.

b. “Flight Restrictions” [1C.2]

“the UTM performs checking on the flight path for ... availability of the flight path due to flight restrictions”

120. The combination of UTM-DNET and Butler discloses this limitation. During the planning stage, the UTM performs checks on “airspace constraints (e.g., airports or restricted areas).” (DJI-1005, 6.) Airports and restricted areas are areas in which a UAV may be restricted from flying. The operation of UAVs near airports is restricted, for example, because it poses a risk of collision with manned aircraft and interference with radar and other communication systems that are vital for air traffic control (ATC).

121. NASA UTM documentation I reviewed in the course of preparing this declaration confirms that the UTM system performs checks on airspace restrictions. (DJI-1029, 5 (“User or **UTM may adjust trajectory for** –Congestion or pre-occupied airspace; –Obstacle or terrain avoidance; –**Airspace usability and restrictions**. Verifies for wind/weather forecast and associated airspace constraints” (emphasis added)).) DJI-1017 lists “Airspace Constraints” as a responsibility of UTM falling under the category of “Strategic Separation” / “Strategic Conflict Management” and further marked with a blue square signifying “Airspace Hazards.”

		Strategic Separation	Tactical Separation		
		Strategic Conflict Management	Separation Provision		Collision Avoidance
UTM	USS / SDSP	Scheduling 	Conformance Monitor 		
		Airspace Constraints 	Separation Provision Conflict Alert 		
		Ground Constraints 	Dynamic Re-routing 		
		Operation Notice 	UAS Operator Report (UREP) 		
	UAS Operator / UAS	Flight Planning  	Flight Volume Containment 	Visibility and Audible Enhancements 	Cooperative De-confliction (Air-to-Air) 
				Position Broadcast 	Non-cooperative De-confliction (Air-to-Air) 
				Ground Surveillance 	Obstacle Avoidance 
ATM	Other Airspace Users	Flight Planning	Radio Communication	Position Broadcast	See and Avoid
			Data Communication		

(DJI-1017, 25.) A POSITA would understand this graphic to mean that managing Airspace Constraint serves the purposes of “Strategic Separation” / “Strategic Conflict Management” and seeks to avoid “Airspace Hazards.”

122. Specifically, the UTM system disclosed the use of “geo-fences,” which involve the implementation of virtual boundaries over prescribed geographical areas that dictate where UAVs are permitted to operate. A NASA UTM document dated April 2014 and titled “**Enabling Low-Altitude Airspace and UAS Operations**” includes an appendix titled “**Selected List of UTM System Requirements**” and includes a section on geo-fencing:

Airspace Design, Dynamic Airspace Adjustments, and Geo-fencing

1. Able to create airspace corridors and dynamically adjust them (e.g., lanes in the sky) with altitude for direction rules for nominal separation (similar to the right altitude for direction rules in the NAS) and

efficiencies. In the beginning separation in 100 ft. height (number chosen by analysis) increments and could gradually decrease over time

2. Set up rules of the road and right altitude for direction of traffic based on changing needs

3. Able to dynamically create and adjust geo-fencing areas which will need to be avoided due to special needs such as community concerns, security, fires, etc.

(DJI-1013, 11.) UTM discloses an “Airspace constraint geo-fence” that is “off limits to UAS operations (airports, TFRs⁴, etc.)” that therefore “have a geo-fence **prohibiting acceptance of plans that intersect**”:

⁴ TFR: Temporary Flight Restriction



Geo-fenced Areas



UAS area of operations geo-fence

Operators may request an area of operation. If granted, a geo-fence is implemented wherein other requests that intersect spatially and temporally with the operation could be denied.



UAS trajectory geo-fence

Operators may request specific trajectory for an operation. If granted, a geo-fence based on the vehicles operating parameters will be created to keep other vehicles within the UTM system from intersecting.



Airspace constraint geo-fence

Airspace that is off limits to UAS operations (airports, TFRs, etc.) will have a geo-fence prohibiting acceptance of plans that intersect.

2.

(DJI-1028, 23.)

123. UTM-DNET also discloses that certain fundamental rules are enforced, such as “basic operational constraints based on vehicle capabilities and minimum required separation are imposed.” (DJI-1005, 8.) For example, UAS “operate in UAS assigned airspace only.” (DJI-1005, 8.) By enforcing airspace and operational constraints, the combination of UTM-DNET and Butler thus teaches that “*the UTM performs checking on the flight path for ... availability of the flight path due to flight restrictions*” [1C.2].

c. ***“Requirements For Use” [1C.3]***

“the UTM performs checking on the flight path for ... requirements for use of the flight path;”

124. The combination of UTM-DNET and Butler discloses this limitation. First, I note that the '972 patent provides examples of flight path requirements including “weight or size, minimum or maximum altitude or airspeed, or the like.” (DJI-1001, 8:67-9:4; *see also* claims 7, 14, and 20 (defining “*requirements for use*” as “compris[ing] at least one of weight, size, minimum or maximum altitude, or airspeed”).)

125. The UTM in UTM-DNET checks the flight path for “minimum or maximum altitude.” “[U]nmanned aircraft flight plans are submitted to UTM, where they can be either **accepted when they meet the safety constraints imbedded in the system**, or otherwise rejected.” (DJI-1005, 8 (emphasis added), Figure 7 (left).) “UTM makes the decision on acceptance/rejection based on its own criteria which do not need to become visible to D-NET.” (DJI-1005, 8.)

126. A POSITA would have understood “safety constraints imbedded in the [UTM] system” to include constraints on minimum and maximum altitude. NASA UTM documentation I reviewed in the course of preparing this declaration confirms this understanding. (DJI-1016, 21 (listing “min_altitude_wgs84_ft” and “max_altitude_wgs84_ft” as required fields “used to describe an operation

volume” that define the minimum and maximum altitudes, respectively, for the operation corresponding to the operation volume); *see also*, 84-85.)

127. The combination of UTM-DNET and Butler thus teaches “*the UTM performs checking on the flight path for ... requirements for use of the flight path*” [1C.3] in addition to “*traffic in the flight path [and] availability of the flight path due to flight restrictions.*”

5. “*Modifying*” Limitation [1D]

<p><i>“modifying the flight path according to data from the UTM in response to the UTM indicating that the usability of the flight path is not verified;”</i></p>

128. The combination of UTM-DNET and Butler discloses “*modifying the flight path according to data from the UTM in response to the UTM indicating that the usability of the flight path is not verified*” [1D]. As I discuss above in §V.B.4, the DNET system sends generated flight plans to UTM for verification. The UTM’s “**flight plan acceptance/rejection is feedback to D-NET and input for further planning and optimization.**” (DJI-1005, 8 (emphasis added).) If UTM rejects a flight plan, D-NET’s optimization subsystem “**re-optimiz[es] the plan** against the rest of the missions and re-submit[s] it to UTM.” (DJI-1005, 8 (emphasis added).)

129. UTM-DNET’s Figure 9 depicts an example of the system rejecting a flight plan (below and on the left). The flight plan for Operation 002001 is rejected

“due to **overlapping times** in first and final segments.” (DJI-1005, 9-10.) The reason for the rejection (i.e., “overlapping times in first and final segments”) is “data from the UTM in response to the UTM indicating that the usability of the flight path is not verified.” In response, D-NET “**re-optimized and time-shifted**” the flight plan for Operation 002001 “**to avoid the overlap**” with the flight plan for Operation 001001. (DJI-1005, 10 (emphasis added).) The right-side panel of Figure 9 shows the “re-optimized and time-shifted flight plan” Operation 002003 accepted.

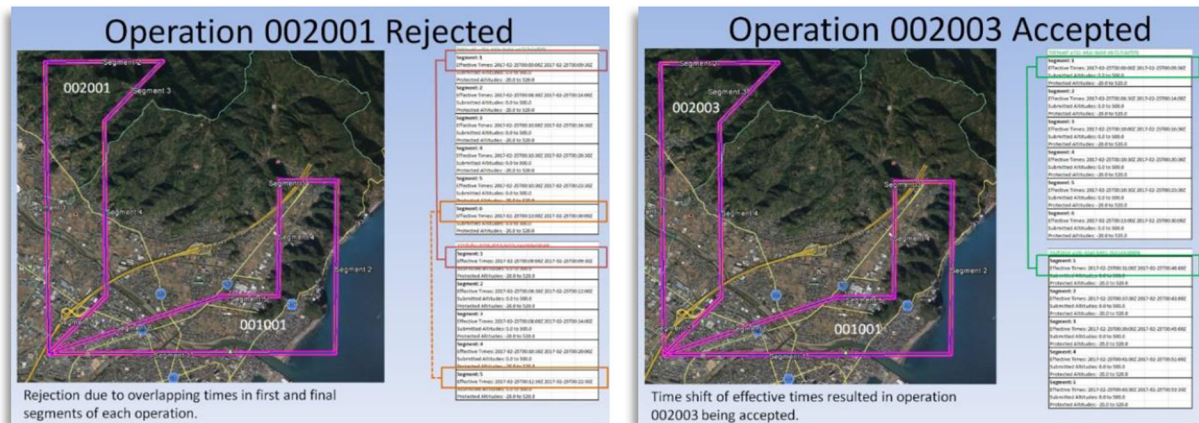


Fig. 9 UTM/D-NET collaborative simulation example

130. The combination of UTM-DNET and Butler therefore teaches “modifying the flight path according to data from the UTM in response to the UTM indicating that the usability of the flight path is not verified” [1D].

6. “**Generating**” Limitation [1E]

“generating vehicle commands according to mission parameters associated with the mission based on the flight path;”

131. The combination of UTM-DNET and Butler discloses “*generating vehicle commands according to mission parameters associated with the mission based on the flight path*” [1E]. During disaster relief operations, DNET assigns missions such as “general reconnaissance, search, rescue, and transportation of personnel and goods” to available disaster relief aircraft. (DJI-1005, 2-3.) For example, D-NET “plans and assigns data acquisition missions to UAS in order to spare resources from the manned aircraft fleet so that more helicopters can be assigned to rescue missions.” (DJI-1005, 3.) D-NET contemplates broader applications for UAS in disaster relief efforts such as “supply delivery and continuous monitoring.” (DJI-1005, 3.) UTM-DNET notes, however, that the “most likely role of UAS is in reconnaissance.” (DJI-1005, 9.)

132. Alongside the mission objective (e.g., reconnaissance, supply delivery), each mission incorporates other associated “*mission parameters*,” for example, mission duration and altitude of the mission flight path. In the planning stage, the D-NET system “generates vehicle mission assignments and flight plans based on information from available resources (obtained through the aircraft database), satellite imagery showing flooded areas, for example, and disaster area information.” (DJI-1005, 8.) While generating the flight path, “basic operational

constraints based on vehicle capabilities and minimum required separation are imposed.” (DJI-1005, 8.) Furthermore, during verification of the flight plan with UTM, the UTM system sends “operational volumes along with the accepted flight plans” to the D-NET system that represent “a 3D volume ... of where an intended operation is to occur with an associated temporal component that defines the duration for when that volume or segment will be active.” (DJI-1005, 5.) Essentially, the operational volume sets forth the specific time, area, and altitude constraints for a verified UAS mission.

133. These verified flight plans are “integrated into actual rescue operations.” (DJI-1005, 3.) As shown in Figure 7 (below left), the flight trajectory (i.e., flight plan) is conveyed to the UAV. More specifically, within the UTM-DNET system, “[i]f a flight plan is accepted, D-NET will send it to the UAS ground base, which will convey it to the vehicle.” (DJI-1005, 8.)

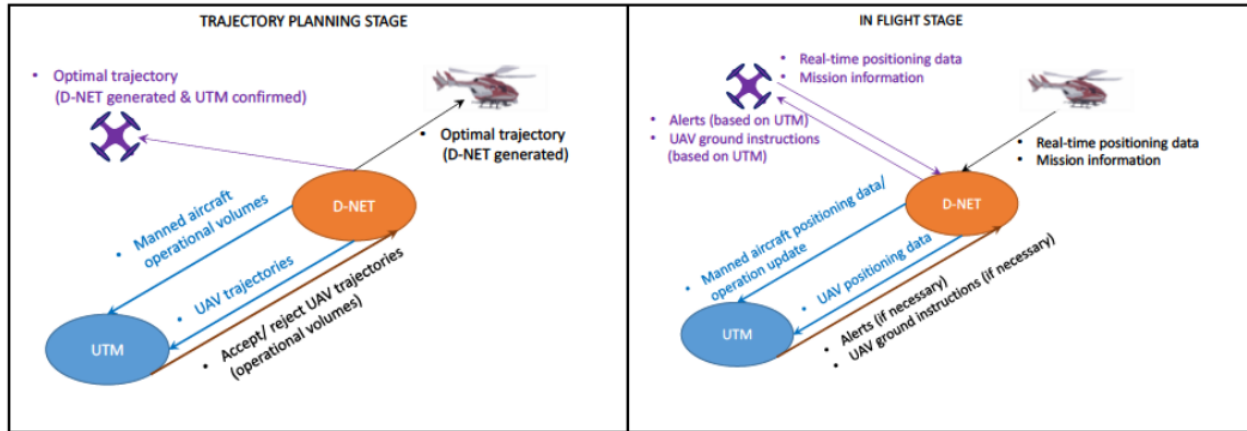


Fig.7. UTM and D-NET conceptual interaction at the flight planning (left) and in-flight stages (right)

134. UTM-DNET's generated flight plan that is associated with the mission and comprising mission parameters is converted to a set of "high level control instructions representing actions that are understandable and describable by humans" by a design unit, as taught by Butler (DJI-1006, 14:5-8), which is integrated into the D-NET system as I discuss above in §V.A.3.

135. Exemplary instructions (commands) used to define a flight plan include the following, from Table 4 of Butler:

Takeoff (x) represents an action that causes a drone to takeoff and rise up to the elevation x

Land (): represents an action that causes a drone to land at a current latitude and longitude.

From loc 1 proceed to loc 2: represents an action that causes a drone to move from loc1 to loc2. Each location is converted to latitude and longitude.

Move vertical from elevation1 to elevation2: represents an action that causes the drone to move vertically from the first elevation to the second elevation while maintaining a current latitude and longitude.

Complete by (t): represents a deadline by which a flight plan for a drone must be completed.

136. Table 5 illustrates an exemplary flight plan for a UAV:

TABLE 5

from loc1 takeoff and rise elevchange1 feet
from loc1 proceed to loc2
from loc2 land at beacon2
grasp package
from loc2 takeoff and rise elevchange2 feet
from loc2 proceed to loc1
from loc1 land at beacon1
release package

137. The above flight plan causes the UAV to “operate as follows: (1) takeoff from location loc1 and rise up by net elevation elevchange1 in feet, (2) move from location loc1 to location loc2, (3) from location loc2, land at beacon beacon2, (4) grasp package at beacon beacon2, (5) takeoff from location loc2 and rise by net elevation elevchange2 in feet, (6) move from location loc2 to location loc1, (7) from location loc1, land at beacon beacon1, and (8) release the package at beacon beacon1.” (DJI-1006, 15:26-49.) Thus, the combination of UTM-DNET and Butler discloses “*generating vehicle commands according to mission parameters associated with the mission based on the flight path*” [1E].

138. If the Patent Owner argues that the high-level programming commands are not “*vehicle commands*,” Butler further describes a “drone adaptor configured to adapt an executable flight plan for a drone 50 to drone specific API 650 (FIG. 8) for the drone 50.” (DJI-1006, 18:42-44.) The drone adaptor may be

“an onboard drone adaptor” or a “remote adaptor implementing synchronous radio translation using a compute thread on a server 680 (FIG. 9) of a zone controller 60.” (DJI-1006, 18:44-49.) The specific commands sent to the drone specific API 650 through the drone adaptor “include low level commands addressing servos at individual rotors of the drone 50, such as low level commands that increase or decrease rotational speed, or change orientation of the rotors, with respect to a chassis of the drone 50.” (DJI-1006, 19:13-17.) Under an interpretation of the term “*vehicle command*” as these low-level commands, the combination of UTM-DNET and Butler discloses limitation [1E].

7. “*Maintaining*” Limitation [1F]

“*maintaining a persistent connection with the vehicle;*”

139. The combination of UTM-DNET and Butler discloses “*maintaining a persistent connection with the vehicle.*” UTM-DNET describes various types of connections between a UAS Ground Station and the D-NET system (referred to as a C2, or command and control link), illustrated below in Figure 13. The connection between the ground station and UTM/DNET systems varies depending on the UAS. For example, industrial grade sUAS are equipped with SATCOM allowing “UTM/D-NET connection without ground-based infrastructure.” (DJI-1005, 13.) Fully equipped high performance sUAS include communication capabilities sufficient to operate the UAS “from the non-damaged area into the damaged area.”

(DJI-1005, 13.) Thus, the combination of UTM-DNET and Butler discloses “a connection with the vehicle.”

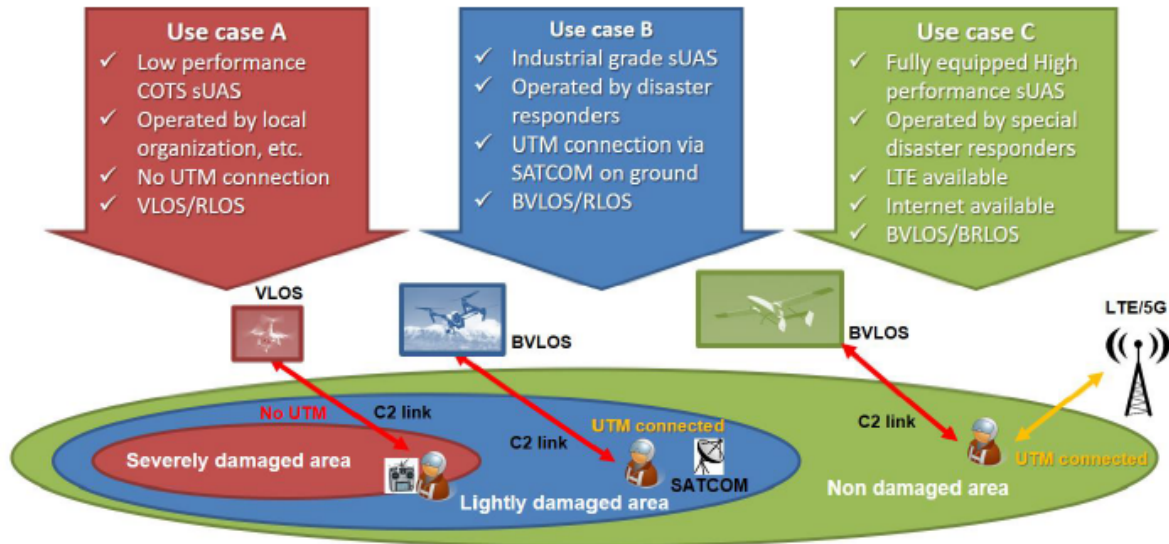


Fig. 13 Operation cases in a disaster response situation with integrated D-NET and UTM interactions.

140. As I discuss above in §V.B.6, the most common mission for a UAV in disaster relief efforts is reconnaissance. (See DJI-1005, 9.) A POSITA would recognize that reconnaissance by a UAS involves continuous observation of a video stream or images provided from the UAS. Reconnaissance involves the systematic observation and gathering of information and was one of the earliest applications of UAS technology. It was well known that reconnaissance missions require continuous and real-time monitoring to capture dynamic changes, movement, and evolving situations. Utilizing a video stream or continuous imagery aligns with the fundamental goals of reconnaissance, allowing for immediate analysis, decision-making, and potential response. A reconnaissance mission is

therefore equivalent to the continuous observation performed by a UAS as part of the “data/information acquisition block.” (DJI-1005, 3.)

141. Indeed, one example provided by UTM-DNET is “[w]hen a critically injured victim is found by a UAS.” (DJI-1005, 9.) A communications connection providing continuous streaming of video or images from a UAV through the ground station (or directly) to the D-NET system is a “*persistent connection*.”

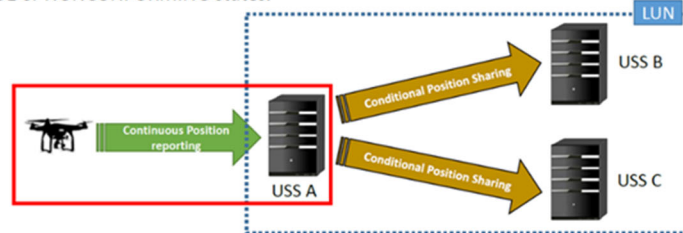
142. I note that a communications connection providing continuous streaming of video or images is consistent with the Patent Owner’s interpretation of the term “*persistent connection*” as set forth in its infringement contentions, which I have reviewed in the course of preparing this declaration. Specifically, Patent Owner asserts in its infringement contentions that the “mission live streaming” functionality of DJI’s FlightHub 2 software meets the “*persistent connection*” limitation. (DJI-1013, 42-43.)

143. NASA UTM documentation I reviewed in the course of preparing this declaration confirms that the UTM system required that a persistent connection exist with the vehicle. (DJI-1014, 4 (“**The UTM will need persistent communication, navigation, and surveillance (CNS) coverage** to ensure and monitoring conformance to the constraints.” (emphasis added)), DJI-1014, 7 & Figure 1 (“Two types of UTM system are envisioned. The first is the Portable UTM System, which will support operations such as agricultural needs. The

system will be moved from one area to another easily. The second, the **Persistent UTM System**, will support low-altitude operations that are much more diverse and heterogeneous in nature based on multiple operators, missions, and range considerations. **The Persistent UTM System will provide continuous coverage.**” (emphasis added)), DJI-1014, 10 (describing “system demonstration in real life” of persistent UTM system), DJI-1014, 11 (“The UTM system could function in two modes: portable and **persistent mode**.” (emphasis added)), DJI-1014, 13-14 (“Communication, Navigation, and Surveillance, Prediction and Separation Management including sense and avoid”; “1. Able to provide **persistent communication**, navigation, and surveillance coverage under day and night time (e.g., VMC and IMC) conditions” (emphasis added)); DJI-1028, 38 (“**Persistent UTM System: Sustained, real-time, and continuous operations**” (emphasis added)); DJI-1030, ¶¶[0064], [0094], [0116], [0262], [0269].) The NASA UTM documentation further provides that the UTM system receives “continuous updates” from the vehicles, which a POSITA would have understood requires a persistent connection with the vehicle. (DJI-1016, 35, 41-43, 58, 67-68, 73, 92.)

Position Sharing

- A USS MUST collect position updates from all ACTIVE Part 107X operations.
- A USS MUST provide access to all Part 107X operation position updates to FIMS upon request per the [USSREQ-API].
- A USS MUST provide access to position updates for a Part 107X operation (Operation A) to another USS upon request when that second USS has an active operation with an operation volume intersecting Operation A's operation volumes. (NOTE: 4D intersection)
- A USS MUST provide access to position updates (if available) to its LUN for all operations in the ROGUE or NONCONFORMING states.



DJI-1017, 21 (annotated).

144. Thus, the combination of UTM-DNET and Butler discloses

“maintaining a persistent connection with the vehicle.”

145. UTM-DNET additionally “provide[s] a level of monitoring and conformance checking as a means of ensuring that a given flight is performing appropriately.” (DJI-1005, 5.) UAVs submit “position updates ... at a defined rate (e.g., 1 Hz) throughout the entirety of an operation.” (DJI-1005, 5.) When referring to a rate of 1 Hz in the context of updates, such as data being sent from a system, this translates directly to one update being transmitted every second.

146. A POSITA would understand that establishing a new connection for each such update would be inefficient and impractical because a certain amount of overhead is required whenever a connection is established—the two devices need to find each other, negotiate the connection parameters, and authenticate, for example. This overhead would become a significant burden when sending position

updates every second and would introduce unacceptable latency into the system, particularly in the context of disaster response relief efforts, as contemplated by UTM-DNET. Thus, a POSITA would have been motivated to use a “*persistent connection with the vehicle*” to provide the position updates to UTM. For this additional reason, the combination of UTM-DNET and Butler discloses or at least suggests “*maintaining a persistent connection with the vehicle*” [1F].

8. “Sending” Limitation [1G]

“sending the vehicle commands to the vehicle using the connection, the vehicle commands causing the vehicle to execute the mission under control of the fleet controller; and”

147. The combination of UTM-DNET and Butler discloses “*sending the vehicle commands to the vehicle using the connection, the vehicle commands causing the vehicle to execute the mission under control of the fleet controller*” [1G]. As I discuss above in §V.A.3, in the combined UTM-DNET/Butler system, the UAS receives the flight plan or trajectory as a series of instructions or commands through the connection involving the D-NET system, UAS Ground Station, and the UAS itself. For a UAS equipped with an onboard adaptor, the D-NET system forwards the flight plan in the form of high-level commands to the ground station. The ground station, in turn, transmits the plan to the UAS, where the onboard adaptor translates these commands into low-level instructions tailored for the drone’s specific API. (See DJI-1006, 18:50-62, 19:11-23.) In contrast, for a

UAS without an onboard adaptor, the remote adaptor, in accordance with Butler's teaching and as part of the D-NET system, transforms executable flight plans into drone-specific low-level commands. These commands are then sent to the UAS Ground Station, and subsequently to the drone-specific API of the drone. (DJI-1006, 18:42-44, 18:63-19:10.) The execution of these low-level commands affects the individual rotors of the drone, enabling adjustments in rotational speed and orientation of the rotors, for example. (DJI-1006, 19:12-22.)

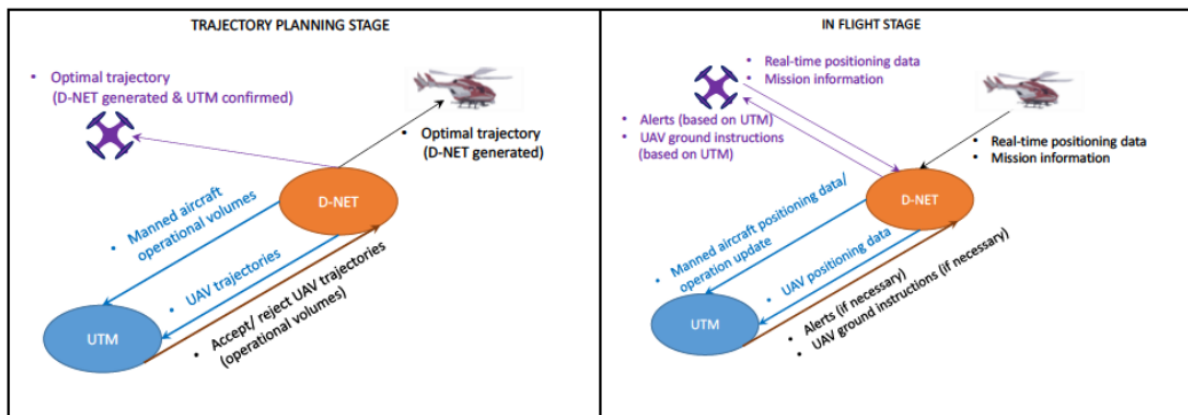


Fig.7. UTM and D-NET conceptual interaction at the flight planning (left) and in-flight stages (right)

148. The combination of UTM-DNET and Butler therefore discloses “sending the vehicle commands to the vehicle using the connection, the vehicle commands causing the vehicle to execute the mission under control of the fleet controller” [1G].

9. “*Monitoring*” Limitation [1H]

“monitoring operation of the vehicle during performance of the mission.”

149. The combination of UTM-DNET and Butler discloses “*monitoring operation of the vehicle during performance of the mission*” [1H] in at least two ways.

150. First, UTM-DNET discloses “*monitoring operation*” through its visualization tools. In UTM-DNET, flight plans are “**visualized on D-NET’s interface** and used by response management at local disaster relief centers **to follow the mission progress.**” (DJI-1005, 9 (emphasis added).) For example, in the interactive Insight UTM (iUTM) interface illustrated below, “the graphical display on the right gives users an understanding of the overall airspace and where operations are in relation to one another.” (DJI-1005, 11.) The operations list view (on the left) “is a gateway into a detailed view of the selected operation with, for example, a record of messages received, operation state, and vehicle state information.” (DJI-1005, 11.)

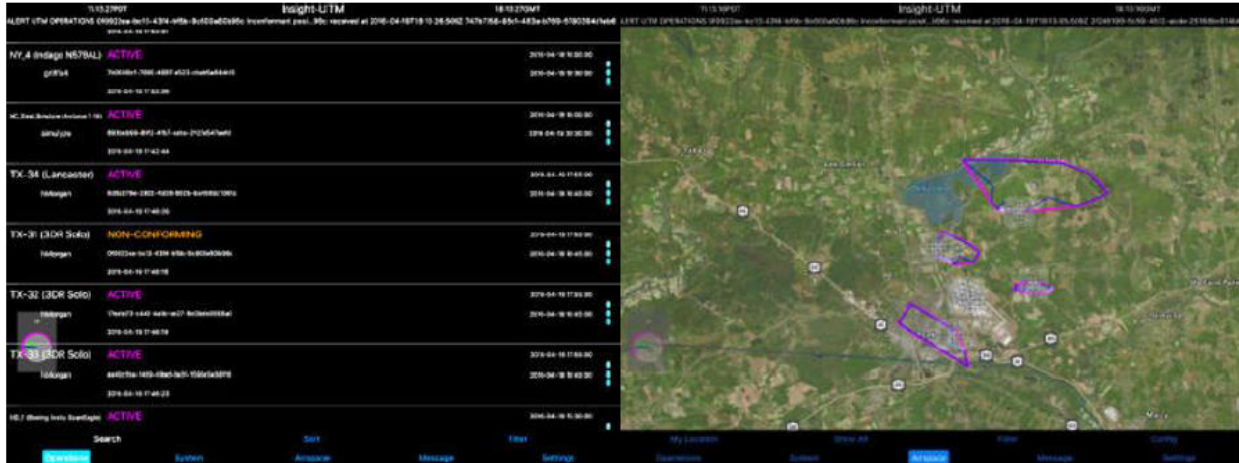


Fig. 11 Interactive user interface for UTM operations

151. Second, UTM-DNET discloses “*monitoring operation*” through its flight conformance checking. During flight, “D-NET provides the tracking data of the aircraft engaged in disaster relief missions to UTM,” which permits the UTM system to “issue alerts if unmanned aircraft do not conform to their operation volumes, or if a manned aircraft is expected to enter the airspace in use.” (DJI-1005, 8.) More precisely, the UAS relays position data to UTM through the UAS Ground Station and D-NET. (DJI-1005, 9.) The UTM system checks conformance of the position data against “submitted flight plans and assigned operational volumes.” (DJI-1005, 9.) If non-conformance is detected the UTM system sends an alert to D-NET “requiring the UAS to adjust its behavior.” (DJI-1005, 9.)

C. Independent Claim 8

1. Preamble [8P]

“A fleet controller for controlling an autonomous vehicle fleet, comprising:”

152. For the reasons discussed in § V.B.1, the combination of UTM-DNET and Butler thus discloses a *“fleet controller [D-NET system] for controlling an autonomous vehicle fleet”* [8P].

2. “Fleet Controller” Structural Limitations [8A]-[8B]

[8A] *“a processor; and”*

[8B] *“a non-transitory computer-readable storage medium storing a program to be executed by the processor, the program including instructions for:”*

153. The D-NET system is implemented on a “server,” constituting a computer or software running on a computer that provides information in response to external queries. (DJI-1005, 10; DJI-1031, 483.) While UTM-DNET does not reveal specific details regarding the configuration or workings of the D-NET server, Butler describes the familiar structure and components of a server computer system.

154. Butler explains that a computer system includes “one or more processors.” (DJI-1006, 30:33-34.) Butler’s computer system also includes removable storage comprising “a computer readable medium having stored therein computer software and/or data.” (DJI-1006, 30:53-55.) Butler therefore teaches “a

processor” and “a non-transitory computer-readable storage medium storing a program to be executed by the processor.”

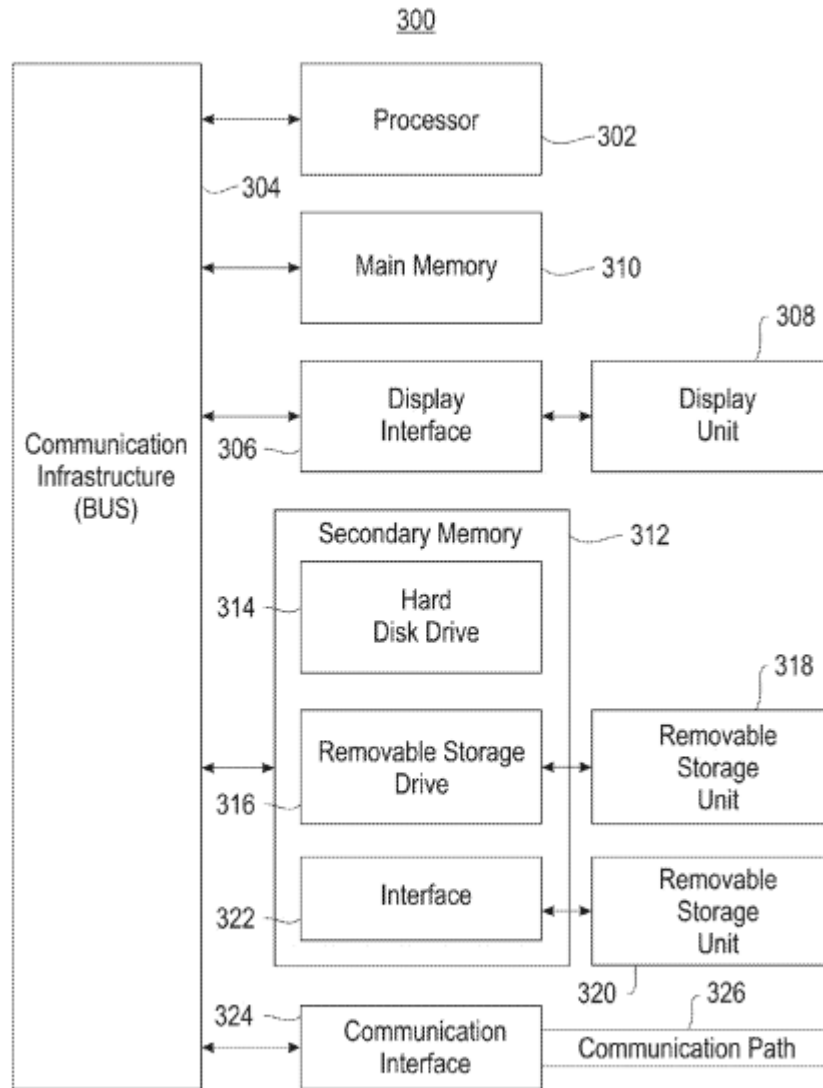


FIG. 18

Butler, Figure 18

155. A POSITA would have understood that the server of UTM-DNET is implemented using Butler’s conventional computer system. A POSITA would have further understood that the D-NET system functionality is implemented by

software (a program). First, the fact that UTM-DNET states that D-NET is carried out using a server indicates that the functionality is likely implemented as software, (DJI-1031, 483 (server includes “computer or program”).) Servers typically host, manage, and run software applications to provide requested services or data. Second, UTM-DNET discloses “flight planning software” (DJI-1005, 5) and “control software” (DJI-1005, 7), further suggesting the functionality performed by the D-NET system (flight planning and control) is performed by software.

156. Thus, the combination of UTM-DNET and Butler teaches or at least suggests a “*fleet controller*” comprising “*a processor*” [8A] and “*a non-transitory computer-readable storage medium storing a program to be executed by the processor, the program including instructions for*” [8B] performing the recited steps.

3. Limitations [8C]-[8G]

157. Limitations [8C]-[8G] recite substantially the same subject matter as limitations [1A]-[1E]. For the reasons set forth in the sections listed in the table below, the combination of UTM-DNET and Butler discloses limitations [8C]-[8G].

Claim 8	
[8C] obtaining, from a master schedule, ...	[1A] §V.B.2
[8D] identifying a flight path ...	[1B] §V.B.3
[8E] verifying a usability of the flight path with a [UTM]	[1C] §V.B.4
[8E.1] ... traffic ...	[1C.1] §V.B.4.a
[8E.2] ... flight restrictions ...	[1C.2] §V.B.4.b
[8E.3] ... requirements for use ...	[1C.3] §V.B.4.c
[8F] modifying the flight path ...	[1D] §V.B.5

[8G] generating vehicle commands ...	[1E] §V.B.6
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4. “Maintaining ... through a communications network” [8H]

<p><i>“maintaining a persistent connection with the vehicle through a communications network;”</i></p>
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158. Limitation [8H] is identical to limitation [1F] except limitation [8H] additionally requires that the persistent connection between the “*fleet controller*” and “*vehicle*” is maintained “*through a communications network.*” As discussed above in §V.B.7, UTM-DNET describes various types of connections between a UAS and the D-NET system including SATCOM and the cellular LTE network. (DJI-1005, 13.) SATCOM (Satellite Communication) is an example of a communications network because it utilizes satellites to facilitate communication across large distances. LTE (Long-Term Evolution) is an example of a communications network because it represents a standard for wireless broadband communication that provides mobile devices with high-speed Internet access and data transmission across a cellular network. A POSITA would understand both SATCOM and LTE to be examples of “*communications networks.*” The combination of UTM-DNET and Butler therefore discloses this limitation.

5. Limitations [8I]-[8J]

159. Limitations [8I]-[8J] recite substantially the same subject matter as limitations [1G]-[1H]. For the reasons set forth in the sections listed in the table below, the combination of UTM-DNET and Butler discloses limitations [8I]-[8J].

Claim 8	
[8I] sending the vehicle commands ...	[1G] §V.B.8
[8J] monitoring operation of the vehicle ...	[1H] §V.B.9

D. Independent Claim 15

1. Preamble [15P]

“An autonomous vehicle fleet control system, comprising:”

160. The combination of UTM-DNET and Butler discloses the subject matter of claim 15’s preamble for the reasons I discuss above in §V.C.1.

2. “Vehicle” [15A]

“a vehicle;”

161. The combination of UTM-DNET and Butler discloses this limitation for the reasons I discuss above in § V.B.1.

3. “Communications Network” [15B]

“a communications network; and”

162. The combination of UTM-DNET and Butler discloses this limitation for the reasons I discuss above in §V.C.4.

4. “Fleet Controller ... Communications Network” [15C]

“a fleet controller in communication with the vehicle by way of the communications network, the fleet controller configured to:”

163. For the reasons I discuss above in §V.C.4, the combination of UTM-DNET and Butler discloses a “*fleet controller in communication with the vehicle by way of the communications network*” [15C].

5. Limitations [15D]-[15K]

164. Limitations [15D]-[15H] and [15J]-[15K] recite substantially the same subject matter as limitations [1A]-[1E] and [1G]-[1H], respectively.⁵ Furthermore, limitation [15I] recites substantially similar subject matter as limitation [8H]. For the reasons set forth in the sections listed in the table below, the combination of UTM-DNET and Butler discloses limitations [15D]-[15K].

Claim 15	
[15D] obtain, from a master schedule, ...	[1A] §V.B.2
[15E] identify a flight path ...	[1B] §V.B.3
[15F] verify a usability of the flight path with a [UTM]	[1C] §V.B.4
[15F.1] ... traffic ...	[1C.1] §V.B.4.a
[15F.2] ... flight restrictions ...	[1C.2] §V.B.4.b
[15F.3] ... requirements for use ...	[1C.3] §V.B.4.c

⁵ Limitation [15J] discloses “*send[ing] the vehicle commands to the vehicle using the connection, wherein the vehicle is configured to receive the vehicle command and execute the mission according to the vehicle commands,*” whereas limitations [1G] and [8I] disclose “*sending the vehicle commands to the vehicle using the connection, the vehicle commands causing the vehicle to execute the mission under control of the fleet controller.*” Limitation [15J] is substantially the same as limitations [1G] and [8I] because “*receiv[ing] the vehicle command*” from the “*fleet controller*” and “*execut[ing] the mission according to the vehicle commands*” [15J] means that “*the vehicle commands caus[e] the vehicle to execute the mission under control of the fleet controller.*”

[15G] modify the flight path ...	[1D] §V.B.5
[15H] generate vehicle commands ...	[1E] §V.B.6
[15I] maintain a persistent connection ...	§V.C.4
[15J] send the vehicle commands ...	[1G] §V.B.8
[15K] monitor operation of the vehicle ...	[1H] §V.B.9

E. Dependent Claims 2, 9, and 16

Claim 2: *“The method according to claim 1, wherein the obtaining the mission comprises”*

Claim 9: *“The fleet controller according to claim 8, wherein the instructions for the obtaining the mission include instructions for”*

Claim 16: *“The system according to claim 15, wherein the fleet controller is configured to”*

[2A]/[9A]/[16A] *“obtain[ing] the mission from the master schedule according to a priority of mission entries in the master schedule.”*

165. The combination of UTM-DNET and Butler teaches or at least suggests *“obtaining the mission from the master schedule according to a priority of mission entries in the master schedule”* [2]/[9]/[16].

166. The UTM system “incorporates the capability for certain **operations**⁶ to have an associated **priority status** with an associated level of priority access to the airspace.” (DJI-1005, 7 (emphasis added).) UTM-DNET notes that “**priority operations [are] particularly relevant in public safety and disaster response situations.**” (DJI-1005, 7 (emphasis added).) In the UTM-DNET system,

⁶ An “operation” in UTM-DNET corresponds to the claimed “mission.”

“[p]riority status is declared as part of an operation submission from authorized entities that have elevated privileges.” (DJI-1005, 7.)

167. A POSITA would have been motivated to include a priority status along with the flight plan stored in the “*master schedule*,” or alternatively stored missions in priority order of execution in the “*master schedule*” in the combined system of UTM-DNET and Butler based on UTM-DNET’s explicit support for priority operations. First, UTM-DNET discloses that disaster response includes different phases. (DJI-1005, 1.) A POSITA would have therefore been motivated to assign missions to UAVs on a per phase basis. For example, missions in the first phase (e.g., data acquisition/reconnaissance) have a higher priority than missions in a later phase. This makes intuitive sense: UAVs can provide a rapid and accurate assessment of the disaster-stricken area by capturing real-time data, mapping affected regions, identifying hazards, assessing the extent of damage, and locating affected populations. This information is critical in strategizing and planning subsequent missions, including rescue efforts. Thus, first phase missions are obtained from the master schedule before later phase missions.

168. Second, UTM-DNET describes prioritizing missions based on the type of aircraft associated with the mission. For instance, D-NET assigns missions “according to the vehicle’s equipage, stage, and location.” (DJI-1005, 3.) D-NET “assigns data acquisition missions to UAS in order to spare resources from the

manned aircraft fleet so that more helicopters can be assigned to rescue missions.”

(DJI-1005, 3.) Reconnaissance/data acquisition missions occur first to identify victims for later rescue by manned aircraft. (*See, e.g.,* DJI-1005, 9 (“When a critically injured victim is found by a UAS, for example, a medevac helicopter must reach this victim”).) Thus, UAV reconnaissance missions are prioritized before certain manned missions (e.g., rescue and delivery missions).

169. Third, during rescue phase of disaster relief, D-NET discloses that manned vehicles are treated as “priority vehicles.” (DJI-1005, 10.) In this way, UTM uses the positions of manned vehicles to alert UAVs as necessary. (DJI-1005, 10.) For example, to reach a victim found by a UAS, the manned helicopter must enter UAS assigned airspace. (DJI-1005, 9.) By making the manned helicopter rescue mission a higher priority than the UAS mission, the UTM issues alerts to modify the lower-priority UAS flight plan to avoid the manned helicopter.

170. The combination of UTM-DNET and Butler thus teaches or at least suggests “*obtain[ing] the mission from the master schedule according to a priority of mission entries in the master schedule*” [2]/[9]/[16].

F. Dependent Claim 3

“The method according to claim 1, wherein the monitoring operation of the vehicle comprises monitoring a connection of the vehicle to a communications network associated with the fleet controller.”

171. Claim 3 recites *“monitoring operation of the vehicle comprises monitoring a connection of the vehicle to a communications network associated with the fleet controller.”* The '972 patent describes “monitoring a connection of the vehicle to a communication network” broadly as encompassing “monitor[ing] for periodic message initiated by the vehicles.” (DJI-1001, 10:55-60.) The combination of UTM-DNET and Butler discloses claim 3.

172. UTM-DNET facilitates real-time situational awareness and fleet supervision by way of its continuous function of “monitoring and conformance checking.” The specific implementation involves consistent position updates, which are forwarded to UTM at a prescribed frequency of 1 Hz “throughout the entirety of an operation.” (DJI-1005, 5.) “Each update is checked whether it is inside the Operation Volume or outside in order to determine the flight’s conformance.” (DJI-1005, 5.) If the vehicle nears the outer bound of a volume, a “Non-Conforming” message is sent to alert the operator of the situation “and provide the opportunity to bring the flight back into conformance.” (DJI-1005, 6.) If the UAV operator is “unable to control the vehicle,” however, the operation

“transitions to a ‘Rogue’ state,” at which point the UAV is required to land. (DJI-1005, 6.)

173. A POSITA would have understood that loss of communication and lack of updates would be indicative of a situation where the UAV operator is unable to control the vehicle. Loss of communication disrupts the ability to send or receive commands/data with the UAV, severing a critical link between the UAV and the operator. The lack of updates compounds this issue, making it impossible for the operator or the system to assess the UAV’s status or make necessary adjustments, thereby resulting in an uncontrolled state.

174. I note that UTM-DNET’s monitoring disclosure is consistent with the Patent Owner’s interpretation of the term “*monitoring a connection of the vehicle to a communication network*” as set forth in its infringement contentions, which I have reviewed in the course of preparing this declaration. Specifically, Patent Owner asserts in its infringement contentions that the DJI FlightHub 2 software’s capability for providing “‘real-time situational awareness,’ supervise the fleet, live stream missions, synchronize mission status, device status, and mission details” meets the “*monitoring a connection of the vehicle to a communication network*” limitation. (DJI-1013, 64.)

175. Thus, the combination of UTM-DNET and Butler discloses

“monitoring operation of the vehicle comprises monitoring a connection of the vehicle to a communications network associated with the fleet controller” [3].

G. Dependent Claim 4

“The method according to claim 3, wherein the monitoring the connection comprises:

[4A] *monitoring, by an access point of the communications network, a connection between the vehicle and the access point; and*

[4B] *reporting, by the access point, a last vehicle status to the fleet controller.”*

176. The main components of the UTM-DNET system are the UTM system, the D-NET system, UAS ground stations, and vehicles, illustrated in Figure 8 below. During an active UAS mission, “position data is sent from the UAS through the ground station and D-NET to UTM, which checks their conformance with submitted flight plans and assigned operational volumes.” (DJI-1005, 9.) The UAS ground station is an “*access point*” for one or more UAS, as shown below.

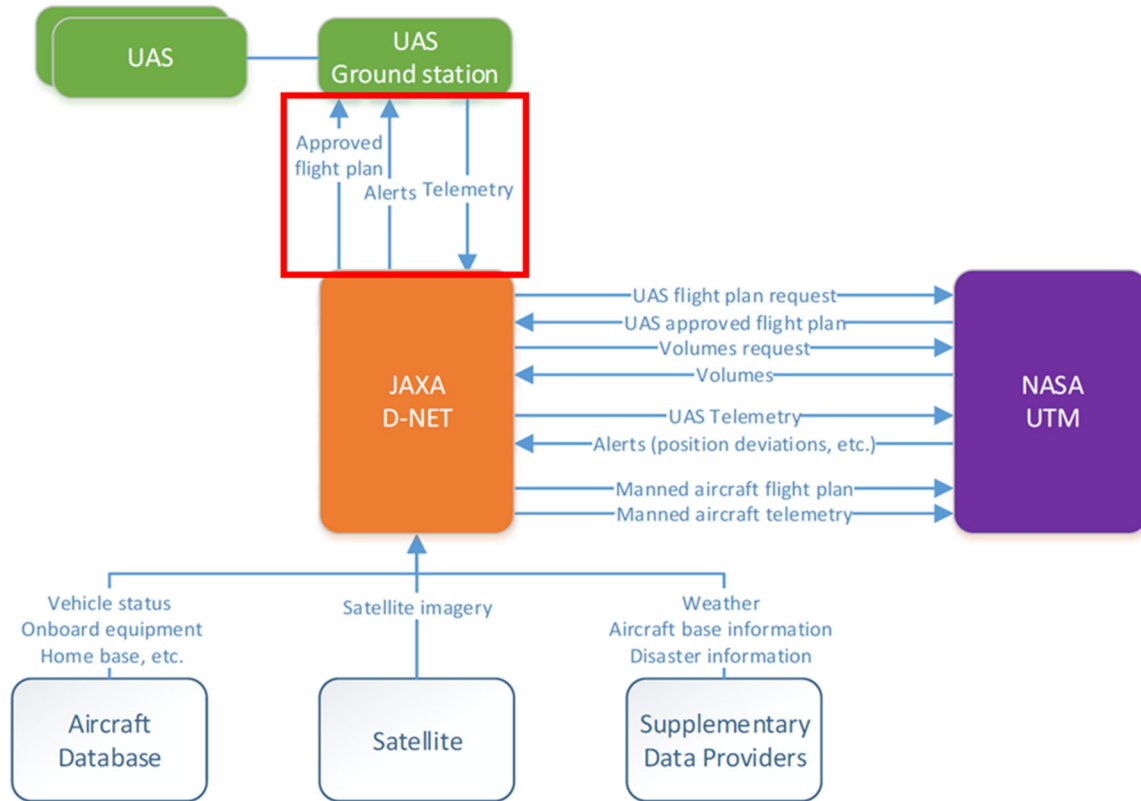


Fig. 8 Potential architecture and information flow between D-NET and UTM

177. A POSITA would have understood that a UAS ground station is a ground-based control system for one or more UAS. UTM-DNET explains, for instance, that commercial off-the-shelf (COTS) sUAS require ground communication infrastructure, which would be understood to be a “ground station,” for UTM/D-NET support. (See DJI-1005, 13.) Figure 8 above shows the ground station receiving flight plans from D-NET for one or more UAS and receiving telemetry (e.g., real-time position data) from each UAS and forwarding this data to the D-NET system, as discussed above.

178. Accordingly, for the same reasons I discuss above in § V.F, the ground station (“*access point*”) “*monitor[s] ... a connection between the vehicle and the access point*” [4A]. The combination of UTM-DNET and Butler therefore discloses this limitation.

179. The combination of UTM-DNET and Butler further discloses “*reporting, by the access point, a last vehicle status to the fleet controller*” [4B]. The ’972 patent explains that “[i]n some embodiments, the last vehicle status is the most recent status of the vehicle.” (DJI-1001, 8:10-11.) As discussed above, in UTM-DNET, when a UAS mission is active, “position data is sent from the UAS through the ground station and D-NET to UTM.” (DJI-1005, 9.) Thus, UTM-DNET discloses “*reporting, by the access point [ground station], a last vehicle status [the most recent status of a vehicle] to the fleet controller [D-NET system].*”

180. If the Patent Owner contends that limitation [4B] requires the “*last vehicle status*” be the last status update prior to a loss of connection, the combination of UTM-DNET and Butler also discloses this definition. Butler explains that “in response to receiving as input a detected failure of a drone 50, the system 200 responds with ... a notification that the drone 50 has gone missing near a **last known location** for the drone 50.” (DJI-1006, 4:31-37 (emphasis added).) A POSITA would find it trivial to include in UTM-DNET’s system Butler’s teaching of transmitting an indication of a connection loss with a UAS (e.g., missing drone)

with the last position received for the UAV before the connection loss. A POSITA would have been motivated to provide a real-time indication of a connection loss by the ground station with a UAV to D-NET and UTM to allow for UTM to incorporate this knowledge into its conformance monitoring and to permit D-NET to modify the UAV's mission (e.g., to return to base for maintenance) should connection be re-established.

181. Accordingly, the combination of UTM-DNET and Butler discloses “reporting, by the access point, a last vehicle status to the fleet controller” [4B].

H. Dependent Claims 5, 11, and 18

Claim 5: “The method according to claim 1, wherein the monitoring operation of the vehicle comprises ...”

Claim 11: “The fleet controller according to claim 8, wherein the instructions for the monitoring operation of the vehicle include instructions for ...”

Claim 18: “The system according to claim 15, wherein the fleet controller is configured to: ...”

182. Claims 5, 11, and 18 depend from independent claims 1, 8, and 15, respectively, and further limit the “monitoring” limitations of those claims, which I discuss above in §§ V.B.9, V.C.5, and V.D.5.

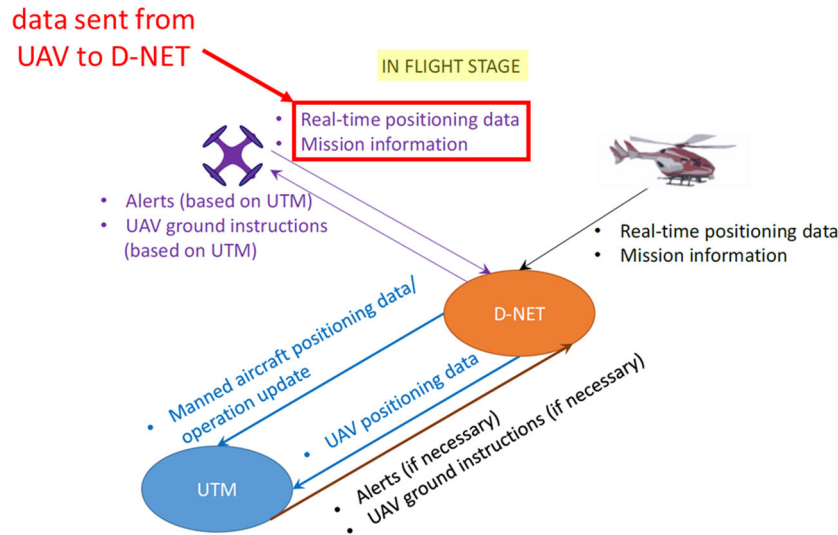
1. “Mission Parameters” and “Mission Impact Data” [5A]/[11A]/[18A]

[5A]/[11A]/[18A] “determin[ing], during performance of the mission, whether the mission parameters associated with the mission are

<i>supported by mission impact data received at the fleet controller; and</i>

183. The '972 patent provides three examples of “*mission impact data*”: (1) “event messages or requests sent by a vehicle,” (2) “UTM data,” and (3) “exterior condition data.” (DJI-1001, 11:16-19.) The combination of UTM-DNET and Butler discloses this limitation.

184. As I discuss above in § V.G, when a UAS mission is active, “position data is sent from the UAS through the ground station and D-NET to UTM, which checks their conformance with submitted flight plans and assigned operational volumes.” (DJI-1005, 9.) The position data corresponds to the '972 patent’s description of “UTM data” and is therefore “*mission impact data*.” (DJI-1001, 11:11-13 (UTM data includes “traffic updates or data”).) The operational volume “represents a 3D volume ... of where an intended operation is to occur with an associated temporal component that defines the duration for when that volume or segment will be active.” (DJI-1005, 5.) That is, the operational volume defines the time, area and altitude limits (e.g., “*mission parameters*”) for a UAS mission. If a non-conformance is detected by UTM, “an alert is sent to D-NET requiring the UAS to adjust its behavior.” (DJI-1005, 9.)



UTM-DNET, Figure 7 (right panel) (annotated)

185. Thus, the combination of UTM-DNET and Butler discloses “determin[ing], during performance of the mission, whether the mission parameters associated with the mission are supported by mission impact data received at the fleet controller” [5A]/[11A]/[18A].

2. “Generat[ing]” [5B]/[11B]/[18B] and “Send[ing]” [5C]/[11C]/[18C]

[5B]/[11B]/[18B] generat[ing], in response to the mission parameters not being supported by the mission impact data, adjusted vehicle commands according to the mission impact data and the mission parameters; and

[5C]/[11C] sending the adjusted vehicle commands to the vehicle using the connection, the adjusted vehicle commands causing the

vehicle to execute the mission under control of the fleet controller according to the adjusted vehicle command.

[18C] *send the adjusted vehicle commands to the vehicle using the connection, and wherein the vehicle is configured to execute the mission according to the adjusted vehicle command.*⁷

186. The combination of UTM-DNET and Butler discloses “*generating, in response to the mission parameters not being supported by the mission impact data, adjusted vehicle commands according to the mission impact data and the mission parameters*” [5B]/[11B]/[18B]. In UTM-DNET, [w]hen non-conformance

⁷ Limitation [18C] discloses “*send[ing] the adjusted vehicle commands to the vehicle using the connection, and wherein the vehicle is configured to execute the mission according to the adjusted vehicle command,*” whereas limitations [5C] and [11C] disclose “*sending the adjusted vehicle commands to the vehicle using the connection, the adjusted vehicle commands causing the vehicle to execute the mission under control of the fleet controller according to the adjusted vehicle command.*” Limitation [18C] is substantially the same as limitations [5C] and [11C] because “*send[ing] the adjusted vehicle commands to the vehicle ... wherein the vehicle is configured to execute the mission according to the adjusted vehicle command*” [15J] means that “*the adjusted vehicle commands caus[e] the vehicle to execute the mission under control of the fleet controller according to the adjusted vehicle command*” [5C]/[11C].

is detected, an alert is sent to D-NET **requiring the UAS to adjust its behavior.**”

(DJI-1005, 9 (emphasis added).) Specifically, a “Non-Conforming” message is sent to alert the operator of the situation and provide the opportunity to **bring the flight back into conformance.**” (DJI-1005, 9 (emphasis added).)

187. A POSITA would have understood that to bring the UAV flight back into conformance, D-NET must generate and communicate (send) the necessary vehicle commands to the UAS (via the ground station) to return the UAS to the verified flight path. As I discuss above in §§§V.B.5, V.C.3, V.D.5 for claim elements [1D]/[8F]/[15G] and §§§V.B.6, V.C.3, V.D.5 for claim elements [1E]/[8G]/[15J], UTM-DNET teaches “*generating vehicle commands ... based on the flight path*” and “*sending the vehicle commands to the vehicle using the connection ... causing the vehicle to execute the mission.*”

188. For the reasons in these sections and discussed above, the combination of UTM-DNET and Butler discloses “*generating, in response to the mission parameters not being supported by the mission impact data, adjusted vehicle commands according to the mission impact data and the mission parameters*” [5B]/[11B]/[18B] and “*sending the adjusted vehicle commands to the vehicle using the connection, the adjusted vehicle commands causing the vehicle to execute the mission under control of the fleet controller according to the adjusted vehicle command*” [5C]/[11C]/[18C].

I. Dependent Claims 7, 14, and 20

Claim 7: *The method according to claim 1, wherein ...*”

Claim 14: *“The fleet controller according to claim 8, wherein ...”*

Claim 20: *“The system according to claim 15, wherein ...”*

[7]/[14]/[20] the requirements for use of the flight path comprise at least one of weight, size, minimum or maximum altitude, or airspeed.

189. Claims 7, 14, and 20 depend from independent claims 1, 8, and 15, respectively, and further limit limitations [1C.3], [8E.3], and [15F.3] of those claims, which I discuss above in §§ V.B.4.c, V.C.3, and V.D.5, respectively.

190. The combination of UTM-DNET and Butler discloses “*the requirements for use of the flight comprise at least one of weight, size, **minimum or maximum altitude**, or airspeed*” [7]/[14]/[20]. As I discuss above in § V.B.4.c for claim element [1C.3], the UTM in UTM-DNET checks the flight path for “minimum or maximum altitude.” Thus, the combination of UTM-DNET and Butler renders claims 7, 14, and 20 obvious.

J. Dependent Claims 10 and 17

Claim 10: *“The fleet controller according to claim 8, wherein the instructions for the monitoring operation of the vehicle include instructions for receiving, ...”*

Claim 17: *“The system according to claim 15, wherein the fleet controller is configured to receive, ...”*

[10]/[17] *from an access point of the communications network, a last vehicle status in response to loss of a connection between the vehicle and the access point hosting the persistent connection.*

191. The combination of UTM-DNET and Butler discloses the fleet controller receiving, *“from an access point of the communications network, a last vehicle status in response to loss of a connection between the vehicle and the access point hosting the persistent connection,”* as required by claims 10 and 17.

192. Butler explains that its system sends “a notification that [a] drone 50 has gone missing near a last known location for the drone 50” in response to “receiving as input a detected failure of [said] drone.” (DJI-1006, 4:31-37.) A POSITA would find it to be common sense that “a detected failure” indicating a “missing” UAV includes loss of the communication connection between the UAS Ground Station and the UAS: a UAS that still has communication capabilities would be able to indicate its location. As I discuss above in § V.G, the combination of UTM-DNET and Butler discloses *“reporting, by the access point, a last vehicle status to the fleet controller”* [4B]. Thus, the D-NET system receives the last vehicle status from the UAS Ground Station.

193. Accordingly, the D-NET system in the combination of UTM-DNET and Butler includes receiving, “*from an access point of the communications network, a last vehicle status in response to loss of a connection between the vehicle and the access point hosting the persistent connection*” [10]/[17].

K. Dependent Claim 12

“The fleet controller according to claim 11, wherein the mission impact data comprises at least one of received event messages, traffic management system data, or exterior condition data.”

194. The combination of UTM-DNET and Butler discloses “*the mission impact data comprises at least one of received event messages, traffic management system data, or exterior condition data*” for the reasons I discuss above in § V.H.1 for claim elements [5A]/[11A]/[18A].

VI. Ground 2: Claims 6, 13, and 19 Are Obvious Over The Combination of UTM-DNET, Butler, and Bethke.

A. Overview of the Combination

195. For the reasons I discussed above, the combination of UTM-DNET and Butler discloses every limitation of independent claims 1, 8, and 15. However, the combination does not explicitly disclose “*determining whether the vehicle is subject to single source control*” recited in claims 6, 13, and 19.

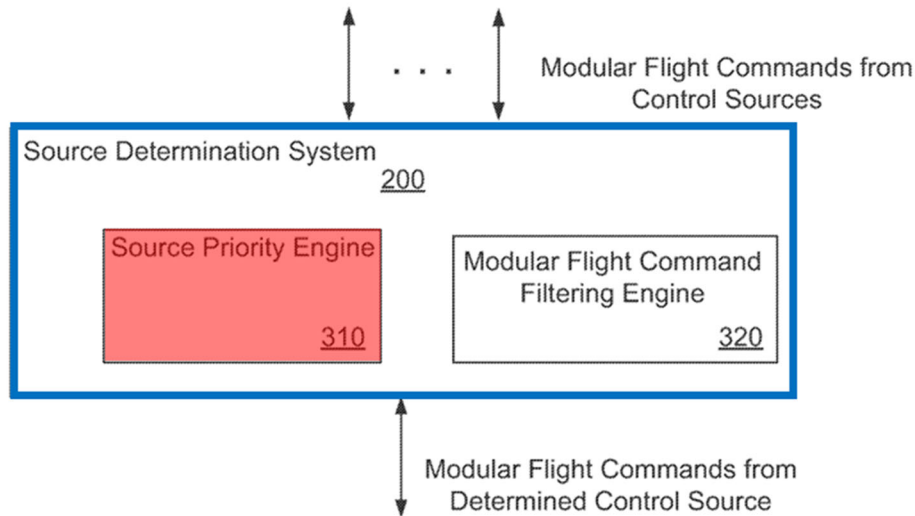
196. I note that the ’972 patent provides scant discussion of “*single source control*.” The ’972 patent mentions an embodiment in which vehicle commands “may be sent to a control arbitrator, and in block 510, the control arbitrator may

verify that the vehicle associated with the vehicle commands is subject to single source control.” (DJI-1001, 10:32-36, Figure 5.) After verifying that the vehicle commands have proper authority or are a single source of control for the relevant vehicle, the vehicle commands “may be forwarded to the vehicle, in block 530 to control the vehicle.” (DJI-1001, 10:36-40, Figure 5.) For the reasons explained below, Bethke discloses the subject matter of claims 6, 13, and 19.

1. Bethke

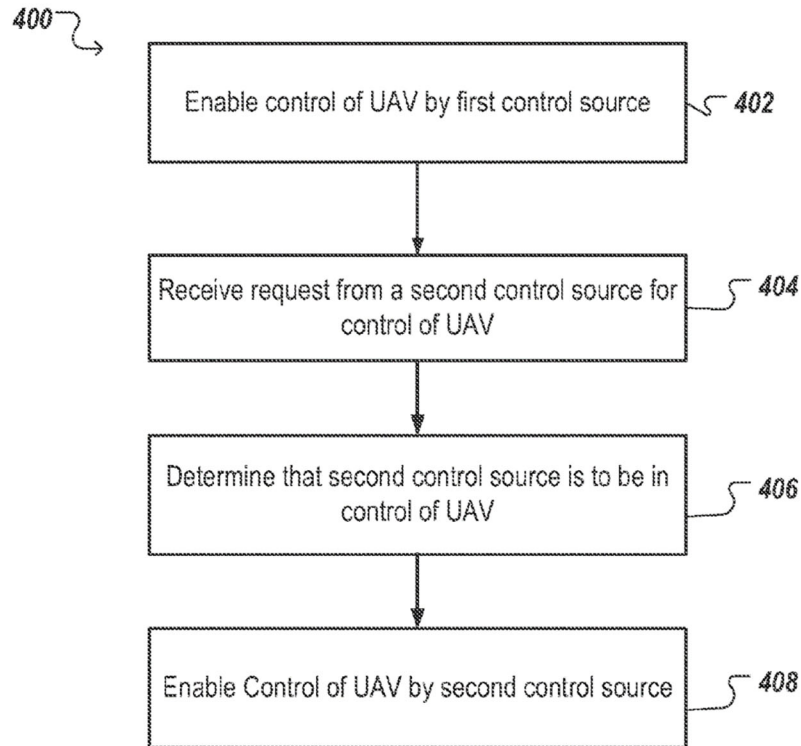
197. Bethke teaches a “source determination system” that determines a control source to be in control of an unmanned aerial vehicle (UAV). (DJI-1007, Abstract, 12:7-10, 19:5-8.) Annotated Figure 3 below illustrates source determination system 200 (blue) that includes source priority engine 310 (shaded red) which receives “requests” (*i.e.*, “modular flight commands”) from one or more control sources. (DJI-1007, 19:11-14.) Source priority engine 310 uses priority information associated with each control source to determine which control source should be in control. (DJI-1007, 19:11-42; *see also*, 3:60-62, 12:10-19.) After determining a particular control source to be in control, source determination system 200 “provide[s] modular flight commands received from the particular control source to the [UAV’s] flight control system 220 to implement.” (DJI-1007, 12:19-22.) Bethke discloses that its source determination system is “an

application” executing on a computer system and is therefore software. (DJI-1007, 2:46-49; *see also*, DJI-1007, 11:46-48.)



Bethke, Figure 3 (annotated with a colored block).

198. Figure 4 of Bethke (below) illustrates an example process 400 for enabling control of a UAV by a control source. (DJI-1007, 22:42-46.) At block 402, the system “enables control of a UAV by a first control source.” (DJI-1007, 22:47-53.) At block 404, the system “receives a request from a second control source for control of the UAV.” (DJI-1007, 22:54-59.) At block 406, the system determines that the second control source is to be in control of the UAV because the second control source is associated with a higher priority than the first control source. (DJI-1007, 22:65-23:2.) At block 408, the system “interrupts control by the first control source, and enables the second control source to provide modular flight commands [to the UAV] for implementation.” (DJI-1007, 22:3-23.)



Bethke, Figure 4.

2. Combination of UTM-DNET, Butler, and Bethke

199. A POSITA would have been motivated to incorporate Bethke's teachings regarding source determination into the combined system of UTM-DNET and Butler. Specifically, a POSITA would have been motivated to include the source determination logic of Bethke in the UAS Ground Station to determine whether the vehicle is subject to single source control and to ensure the vehicle is subject to a single point of control at any one time.

200. A POSITA would have been motivated to combine Bethke with UTM-DNET and Butler to avoid conflicting commands and reduce the risk of

midair collision. This integration is particularly vital in disaster relief scenarios where visibility may be extremely limited.

201. UTM-DNET itself suggests this combination, noting the complexities in disaster relief efforts where various organizations, such as the military, fire departments, and medical services, might be involved. (DJI-1005, 2.) A POSITA would have recognized that each of these entities has the capability to issue commands directly to their respective aircraft, but that commands may also be issued through D-NET. Consequently, a UAS operating through a ground station could potentially receive conflicting commands from both the overarching D-NET system and the individual organization that owns the UAS.

202. Furthermore, UTM-DNET explains that each UAS could be associated with a designated pilot who retains the ability to assume control of the UAS and override an executing flight path. (*See, e.g.,* DJI-1005, 13-14.) This capability underscores the necessity of the “source determination” concept, ensuring that the potential for conflicting commands is minimized, and that the system operates in a coherent and controlled manner. By combining these insights, the integration of Bethke’s teachings into UTM-DNET and Butler would facilitate a more streamlined and effective disaster response, particularly when operating in conditions where visibility constraints (e.g., extreme weather conditions that can accompany natural disasters, such as heavy rain, fog, smoke, dust, or ash) can

obscure the UAV's sensors and cameras, making it challenging to navigate and carry out missions.

203. A POSITA would have had compelling reasons to enable multiple sources of control within a UAS Ground Station. This provision would offer significant flexibility for specific use scenarios, particularly in the context of disaster response services. For instance, a POSITA would recognize the advantage of allowing a pilot to override a pre-programmed flight path for a UAS owned by emergency organizations. Such control could be vital in rapidly changing conditions where adaptive response is required.

204. A POSITA would have also been motivated to implement a system that prioritizes command sources where the prioritization reflects a hierarchy of control tailored to various use cases. This prioritization would serve to enhance coordination and prevent conflicts, particularly in complex scenarios. In the context of disaster relief efforts, for example, a POSITA would recognize that the D-NET system should be accorded the highest priority as the source for commands. This prioritization would serve to ensure that the overarching disaster relief strategy is consistently executed, enhancing the effectiveness and coherence of the response effort.

205. Conversely, in more localized emergencies, such as an isolated fire or medical incident, the control hierarchy would differ, with priority given to the

relevant emergency service, such as the fire department or medical agency. This flexibility in prioritization would enable the system to adapt to different operational contexts, thereby optimizing responsiveness and efficiency.

206. Furthermore, a POSITA would appreciate the vital importance of ensuring that the vehicle is subject to a single point of control at any time in disaster relief scenarios. This principle of singular control would mitigate the risk of collisions and facilitate the optimization of relief efforts, adding a crucial layer of safety and coordination to the operations. The integration of these aspects would make the system more robust and agile, aligning it with the diverse and demanding requirements of real-world emergency response situations envisioned by the UTM-DNET system.

207. To a POSITA, the combination of UTM-DNET, Butler, and Bethke would have been nothing more than the application of a known technique (Bethke's source determination functionality) to improve similar devices (the flight control system of UTM-DNET) in the same way. Bethke is directed to "systems and methods for prioritizing control sources vying for command and control of an unmanned aerial vehicle (UAV) implementing a flight plan." (DJI-1007, 2:34-37.)

208. As I discuss above in § V.A, the combination of UTM-DNET and Butler similarly includes a base UAS command-and-control system. The source determination functionality of Bethke would be viewed as an improvement to the

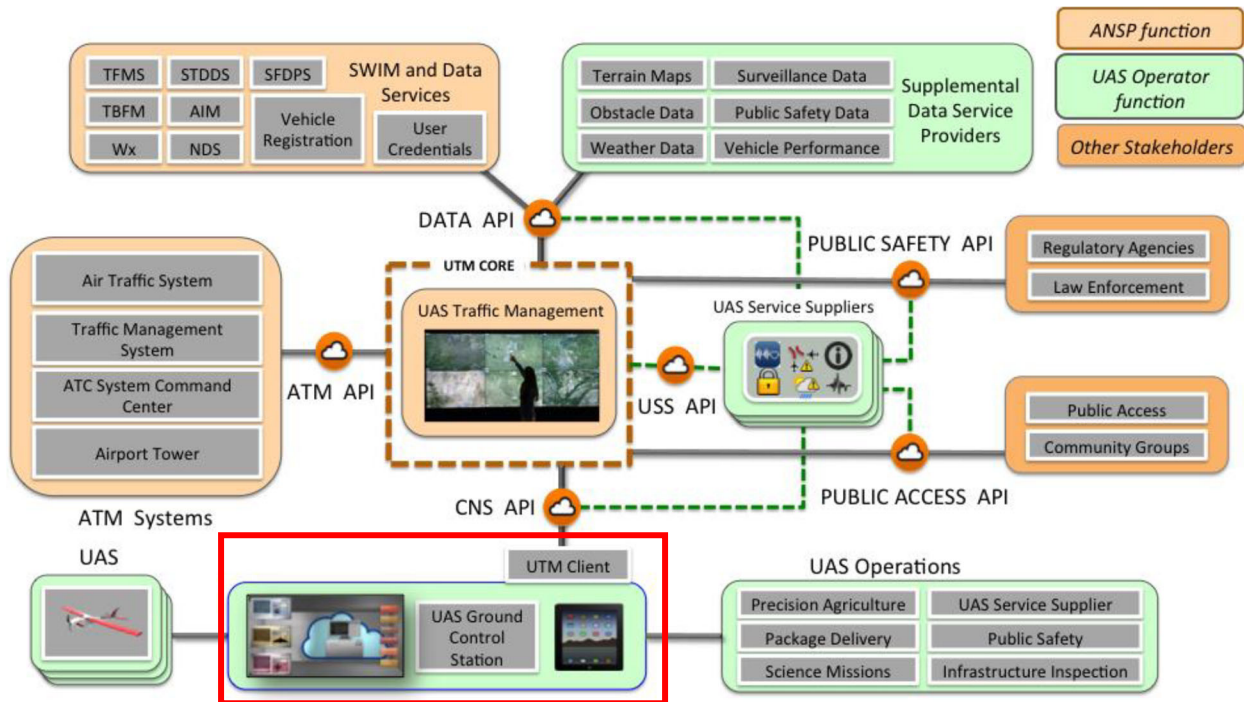
combined system of UTM-DNET and Butler in the same way that it improves Bethke's own command-and-control system.

209. The results of the combination would have been predictable to a POSITA and the POSITA would have had a reasonable expectation of success in integrating Bethke's teachings regarding source determination into the combined system of UTM-DNET and Butler. Bethke explains that its source determination functionality is implemented as an "engine," which may be "a collection of software instructions ... written in a programming language, such as, for example, Java, Lua, C or C++." (DJI-1007, 19:11-20; 29:5-9, 29:24-53.) The engine "may be stored on any type of, one or more, non-transitory computer-readable media (e.g., a computer storage product) or computer storage devices, such as hard drives, solid state memory, optical disc, and/or the like." (DJI-1007, 29:9-13.)

210. A POSITA would understand the UAS Ground Station, in turn, to be implemented on a server that executes software instructions stored on a computer storage device. NASA UTM documentation I reviewed in the course of preparing this declaration confirms this. For example, a NASA document titled "Unmanned Aircraft System Traffic Management (UTM) Concept of Operations" by Kopardekar, et al. (DJI-1018) illustrates a "Complete UTM Architecture" in Figure 4 (below) that includes a "UAS Ground Control Station" (annotated in red) that is a "UTM Client." (DJI-1018, 12.) A UTM Client is defined as "a **software**

application used to access the services provided by the UTM research platform.”

(DJI-1018, 12 (emphasis added).) “All UTM clients communicate with the UTM research platform via the same standardized message protocols.” (DJI-1018, 12.)



211. A POSITA would have thus had an expectation of success in implementing Bethke’s source determination logic in the UAS Ground Station because the POSITA would have a background in and familiarity with software development.

B. Dependent Claims 6, 13, and 19

Claim 6: *“The method according to claim 1, wherein the sending the vehicle commands to the vehicle comprises ...”*

Claim 13: *“The fleet controller according to claim 8, wherein the instructions for the sending the vehicle commands to the vehicle comprises instructions for ...”*

Claim 19: *“The system according to claim 15, further comprising a control arbitrator configured to: ...”*

212. Claims 6, 13, and 19 depend from independent claims 1, 8, and 15, respectively, and further limit limitations [1G] , [8I], and [15J] of those claims, which I discuss above in §§ V.B.8, V.C.5, and V.D.5, respectively.

1. “Control Arbitrator” [19A] and “Single Source Control” [6A]/[13A]/[19B]

[19A] *“a control arbitrator configured to:”*

[6A]/[13A]/[19B] *“determin[e] whether the vehicle is subject to single source control, wherein [the] determining whether the vehicle is subject to single source control comprises ensuring that the vehicle is subject to a single point of control at any one time; and”*

213. The combination of UTM-DNET, Butler, and Bethke discloses a “control arbitrator” that “determin[es] whether the vehicle is subject to single source control, wherein [the] determining whether the vehicle is subject to single source control comprises ensuring that the vehicle is subject to a single point of control at any one time” [6A]/[13A]/[19B].

214. In Bethke, the source determination functionality “determines a particular control source to be in control at any one time.” (DJI-1007, 12:7-10.)

When combined with the UTM-DNET and Butler systems, and specifically applied to the scenarios of disaster relief missions, Bethke's functionality operates to assign the highest priority to directives originating from the D-NET system. Consequently, throughout the duration of the disaster relief operations, this prioritization ensures that the D-NET system is recognized as the authoritative control source for all commands directed towards UASs.

215. Other prior art I reviewed in the course of preparing this declaration confirms that the source determination functionality taught in Bethke was conventional before December 2019. For example, Chinese Patent Application Publication Number CN 105334863 to Yang ("Yang"; DJI-1032) discloses a method for switching control of a UAV between different "control terminals." (DJI-1032, Abstract, ¶¶ [0074], [0084], [0092]-[0096].) Yang's system transfers flight control of a UAV to another pre-set authorized console (e.g., a backup console or relay console), for example, if the currently coupled console of the unmanned aerial vehicle fails so that control of the UAV can be ensured. (DJI-1032, Abstract, ¶¶ [0011], [0016], [0027]-[0028], [0044], [0074], [0084], [0092]-[0096].) The UAV then receives flight control instructions from the authorized console and forwards them to the UAV's flight control board for execution. (DJI-1032, ¶¶ [0011], [0044], [0075].)

216. As I discuss above in § VI.A.2, in the combined system of UTM-DNET, Butler, and Bethke, the source determination functionality is software implemented in the UAS Ground Station. In the '972 patent, the control arbitrator “ensure[s] a single point of control of a vehicle at any one time to prevent contradictory command or control from different users or sources,” for example, by giving “command instructions with an emergency priority the highest priority, any non-emergency manual command the next highest priority, and any scheduled control instruction the lowest priority.” (DJI-1001, 2:45-48, 9:36-41.) The source determination function of the combined system mirrors this functionality and is thus a “*control arbitrator*” [19A].

217. Thus, the combination of UTM-DNET, Butler, and Bethke discloses a “*control arbitrator*” (source determination functionality) [19A] that “*determin[es] whether the vehicle is subject to a single point of control at any one time*” by “*ensuring that the vehicle is subject to a single point of control at any one time*” [6A]/[13A]/[19B].

2. “*Forward[ing] the vehicle commands*” [6B]/[13B]/[19C]

<p>[6B]/[13B]/[19C] “<i>forward[ing] the vehicle commands to the vehicle in response the vehicle being subject to the single source control or a source of the vehicle commands being assigned an authority greater than any other set of vehicles commands associated with the vehicle.</i>”</p>

218. UTM-DNET discloses that flight plans verified by UTM are sent by the D-NET system “to the UAS ground base, which will convey it to the vehicle.”

(DJI-1005, 8.) As I discuss above in § VI.B.1, in the combination of UTM-DNET, Butler, and Bethke, source determination functionality in the UAS ground base “ensur[es] that the vehicle is subject to a single point of control at any one time” during disaster relief efforts by assigning highest priority to UAS commands originating from the D-NET system.

219. Given that the D-NET system acts as the centralized authority (i.e., single point of control) during disaster relief operations, commands designated by the D-NET system are the ones transmitted to the UAS Ground Station and ultimately to the vehicle. This hierarchical structure effectively eliminates the possibility of conflicting directives reaching the vehicle, as any such commands are overridden by the prioritized instructions from the D-NET system.

220. As a result, the combination of UTM-DNET, Butler, and Bethke discloses “forward[ing] the vehicle commands to the vehicle in response the vehicle being subject to the single source control or a source of the vehicle commands being assigned an authority greater than any other set of vehicles commands associated with the vehicle” [6B]/[13B]/[19C].

VII. Conclusion

In signing this Declaration, I recognize that the Declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject

to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Executed this 15th day of August in New Smyrna Beach, Florida.

Respectfully submitted,

A handwritten signature in dark ink, appearing to read 'C. Reinholtz', is written over a horizontal line. The signature is stylized with a large 'C' and a long horizontal stroke extending to the right.

Charles Reinholtz

APPENDIX A

Exhibit	Description
DJI-1001	U.S. Patent 11,288,972 to Bristow et al. (“’972 patent”)
DJI-1002	’972 patent file history
DJI-1005	Homola et al., “UTM and D-NET: NASA and JAXA’s Collaborative Research on Integrating Small UAS with Disaster Response Efforts” (“UTM-DNET”), <i>available at</i> https://ntrs.nasa.gov/api/citations/20180004805/downloads/20180004805.pdf
DJI-1006	U.S. Patent 9,852,642 to Butler et al. (“Butler”)
DJI-1007	U.S. Patent 9,658,619 to Bethke et al. (“Bethke”)
DJI-1008	Declaration of Trenton J. Roche regarding UTM-DNET
DJI-1009	NASA Technical Reports Server Record Details for UTM-DNET, <i>available at</i> https://ntrs.nasa.gov/citations/20180004805
DJI-1010	2018 Aviation Technology, Integration, and Operations Conference Table of Contents, <i>available at</i> https://arc.aiaa.org/doi/book/10.2514/MATIO18
DJI-1011	AIAA details for UTM-DNET (AIAA 2018-3987), <i>available at</i> https://doi.org/10.2514/6.2018-3987
DJI-1012	U.S. Patent App. Pub. 2015/0234387 to Mullan et al.
DJI-1013	Exhibit D to Plaintiff Textron Innovations Inc.’s P.R. 3-1 and 3-2 Disclosure of Asserted Claims, Infringement Contentions, and Document Production, <i>Textron Innovations Inc. v. SZ DJI Tech. Co., Ltd.</i> , Civil Action No. 2:22-cv-00351 (E.D. Tex. Sept. 9, 2022)
DJI-1014	Kopardekar et al., “Unmanned Aerial System (UAS) Traffic Management (UTM): Enabling Low-Altitude Airspace and UAS Operations,” <i>available at</i> https://ntrs.nasa.gov/api/citations/20140013436/downloads/20140013436.pdf
DJI-1015	NASA Facts. “UTM: Air Traffic Management for Low-Altitude Drones” (2015), <i>available at</i> https://www.nasa.gov/sites/default/files/atoms/files/utm-factsheet-02-23-16.pdf

Exhibit	Description
DJI-1016	Rios et al., “UTM Data Working Group Demonstration 1 Final Report” (April 2017), <i>available at</i> https://ntrs.nasa.gov/api/citations/20170010270/downloads/20170010270.pdf
DJI-1017	Rios et al., “Unmanned Aircraft Systems Traffic Management (UTM) Concepts and Architecture Overview” (March 2018), <i>available at</i> https://ntrs.nasa.gov/api/citations/20180001929/downloads/20180001929.pdf
DJI-1018	Kopardekar et al., “Unmanned Aircraft System Traffic Management (UTM) Concept of Operations” (June 2016), <i>available at</i> https://ntrs.nasa.gov/api/citations/20190000370/downloads/20190000370.pdf
DJI-1019	RESERVED
DJI-1020	RESERVED
DJI-1021	RESERVED
DJI-1022	RESERVED
DJI-1023	RESERVED
DJI-1024	RESERVED
DJI-1025	Jiang et al., <i>Unmanned Aircraft System traffic management: Concept of operation and system architecture</i> , International Journal of Transportation Science and Technology, 5.3, pp. 123-35 (2016)
DJI-1026	RESERVED
DJI-1027	“Unmanned Aircraft System Traffic Management (UTM) Research Transition Team Concept Working Group, Concept & Use Cases Package #2: Technical Capability Level 3, Version 1.0” (March 2018), <i>available at</i> https://ntrs.nasa.gov/api/citations/20190004908/downloads/20190004908.pdf .
DJI-1028	“Enabling Civilian Low-Altitude Airspace and Unmanned Aerial System (UAS) Operations by UTM” (March 23, 2015), <i>available at</i> https://ntrs.nasa.gov/api/citations/20160000434/downloads/20160000434.pdf .

Exhibit	Description
DJI-1029	“Safely Enabling Low-Altitude Airspace Operations” (June 23, 2015), <i>available at</i> https://ntrs.nasa.gov/api/citations/20150018862/downloads/20150018862.pdf .
DJI-1030	U.S. Patent App. Pub. 2016/0275801 to Kopardekar
DJI-1031	Webster’s New World Dictionary of Computer Terms (8 th edition) (excerpt)
DJI-1032	Chinese Patent App. Pub. CN 105334863 to Yang

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