Designation: F3411 – 19

Standard Specification for Remote ID and Tracking[1]

This standard is issued under the fixed designation F3411; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers the performance requirements for remote identification (Remote ID) of unmanned aircraft systems (UAS). Remote ID allows governmental and civil identification of UAS for safety, security, and compliance purposes. The objective is to increase UAS remote pilot accountability by removing anonymity while preserving operational privacy for remote pilots, businesses, and their customers. Remote ID is an enabler of enhanced operations such as beyond visual line of sight (BVLOS) operations as well as operations over people.

1.2 This specification defines message formats, transmission methods, and minimum performance standards for two forms of Remote ID: broadcast and network. Broadcast Remote ID is based on the transmission of radio signals directly from a UAS to receivers in the UAS's vicinity. Network Remote ID is based on communication by means of the internet from a network Remote ID service provider (Net-RID SP) that interfaces directly or indirectly with the UAS, or with other sources in the case of non-equipped network participants.

1.3 This specification addresses the communications and test requirements of broadcast or network Remote ID, or both, in UAS and Net-RID SP systems.

1.4 *Applicability:*

1.4.1 This specification is applicable to UAS that operate at very low level (VLL) airspace over diverse environments including but not limited to rural, urban, networked, network degraded, and network denied environments, regardless of airspace class.

1.4.2 This specification neither purports to address UAS operating with approval to use ADS-B or secondary surveillance radar transponders, nor does it purport to solve ID needs of UAS for all operations.

1.4.3 In particular, this specification does not purport to address identification needs for UAS that are not participating in Remote ID or operators that purposefully circumvent Remote ID.

1.5 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.5.1 Units of measurement included in this specification:

m	meters
deg, °	degrees of latitude and longitude, compass direction
s	seconds
Hz	Hertz (frequency)
dBm	decibel-milliwatts (radio frequency power)
ppm	parts per million (radio frequency variation)
µs	microseconds
ms	milliseconds

1.6 *Table of Contents:*

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Some specific hazards statements are given in Section 8 on Hazards.

[1] This specification is under the jurisdiction of ASTM Committee F38 on Unmanned Aircraft Systems and is the direct responsibility of Subcommittee F38.02 on Flight Operations.

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1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standard:*[2]

F3196 Practice for Seeking Approval for Beyond Visual Line of Sight (BVLOS) Small Unmanned Aircraft System (sUAS) Operations

2.2 *Other Standards:*

ANSI/CTA-2063-A Small Unmanned Aerial Systems Serial Numbers[3]

Bluetooth[4,5] Core Specification 5.0[6]

IEEE 802.11-2016 Standard for Information technology--Telecommunications and information exchange between systems - Local and metropolitan area networks--Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications[7,5]

IETF RFC3339 Date and Time on the Internet: Timestamps[8]

IETF RFC4122 A Universally Unique IDentifier (UUID) URN Namespace[9]

Neighbor Awareness Networking Specification [10,5]

FAA UTM ConOps v1.0 Unmanned Aircraft System (UAS) Traffic Management (UTM) Concept of Operations[11]

WGS-84 World Geodetic System — 1984[12]

3. Terminology

3.1 *Definitions:*

3.1.1 *authentication*—the process or action of verifying that the source of a Remote ID message is the originator of the message.

3.1.2 *beyond visual line of sight (BVLOS)*—the operation when the individual responsible for controlling the flight of the unmanned aircraft (UA) cannot maintain direct unaided (other than by corrective lenses or sunglasses, or both) visual contact with the UA, other aircraft, terrain, adverse weather, or obstacles to determine whether the UA endangers life or property, or both. **F3196**

3.1.3 *broadcast*—to transmit data to no specific destination or recipient; data can be received by anyone within broadcast range.

3.1.4 *broadcast UAS*—a UAS that is equipped for and is actively broadcasting Remote ID data during an operation; being a broadcast UAS is not mutually exclusive with being a networked UAS.

3.1.5 *discovery*—the process of determining the required USS data exchanges to successfully complete Net-RID services; this is accomplished using the discovery and synchronization service (DSS).

3.1.6 *DSS entity*—a generic concept that refers to information that can be discovered using the discovery and synchronization service (DSS).

3.1.6.1 *Discussion*—Entities are characterized by a 4-D volume of airspace (that is, a volume defined in x, y, z plus time limits). For Remote ID, the entity type is referred to as an identification service area. Operations and constraints are examples of other types of entities that are the subject of other UTM standards.

3.1.7 *DSS region*—the geographic scope supported by a set of discovery and synchronization service instances.

3.1.8 *dynamic data*—data that changes over the duration of the flight; for example, longitude and latitude.

3.1.9 *Ground Control Station (GCS)*—the part of a UAS that remotely controls the UA. It may or may not have a remote pilot directly manipulating the controls.

3.1.10 *identify*—the result of the process to establish the identity of a specific UAS that is traceable to the owner and remote pilot.

3.1.11 *network Remote ID (Net-RID) service provider*—a logical entity denoting a UTM system or comparable UAS flight management system that participates in network Remote ID and provides data for and about UAS it manages.

3.1.12 *network Remote ID (Net-RID) display provider*—a logical entity that aggregates network Remote ID data from potentially multiple Net-RID service providers and provides the data to a display application (that is, an app or website); in practice, it is expected that many USSs may be both Net-RID display providers and Net-RID service providers, but standalone Net-RID display providers are possible.

3.1.13 *network publishing*—the act of transmitting data to an internet service or federation of services; clients, whether air traffic control (ATC), public safety officials, or possibly the

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Used throughout the specification, Bluetooth is a registered trademark of Bluetooth SIG, Inc., 5209 Lake Washington Blvd. NE, Suite 350, Kirkland, WA 98033.

[5] Other names and brands may be claimed as the property of others.

[6] Available from https://www.bluetooth.com/specifications/archived-specifications/.

[7] Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., Piscataway, NJ 08854-4141, https://standards.ieee.org/standard/802_11-2016.html.

[8] Available from IETF Tools, https://tools.ietf.org/html/rfc3339.

[9] Available from IETF Tools, https://tools.ietf.org/html/rfc4122.

[10] Available from Wi-Fi Alliance, 10900-B Stonelake Boulevard, Suite 126, Austin, TX 78759, https://www.wi-fi.org/discover-wi-fi/wi-fi-aware.

[11] Available from https://utm.arc.nasa.gov/docs/2018-UTM-ConOps-v1.0.pdf.

[12] Available from International Civil Aviation Organization (ICAO), 999 Robert-Bourassa Boulevard, Montréal, Quebec, Canada H3C 5H7, https://gis.icao.int/eganp/webpdf/REF08-Doc9674.pdf.

general public can access the data to obtain ID and tracking information for UAS for which such data has been published.

3.1.14 *networked UAS*—a UAS that during operations is in electronic communication with a Net-RID service provider (for example, by means of internet Wi-Fi,[13] cellular, or satellite, or other communications medium such as short burst data satellite communications).

3.1.15 *non-equipped UAS*—in the context of Remote ID, a UAS that is neither a networked nor broadcast UAS (for example, a radio controlled model aircraft) and cannot directly report its location or identity.

3.1.16 *non-equipped network participant*—a non-equipped UAS for which the operator has reported an intended area (a volume of airspace) and time for an operation through a Net-RID service provider; such information is then reported through the network Remote ID infrastructure.

3.1.17 *operator*—entity or person responsible for flight which could include a company or individual, or both; this document makes no statement about legal responsibility in how these terms are used.

3.1.18 *operator location*—the geographic location of the remote pilot of a UAS.

3.1.19 *position extrapolation*—a capability of a Net-RID service provider to predict the location of a UAS based on a modeled 4-D trajectory derived from an intended UAS operation plan.

3.1.20 *remote pilot*—the person who has final authority and responsibility for the operation and safety of flight; synonymous with "remote pilot-in-command."

3.1.21 *registration*—the process by which an owner/operator (including contact information and other PII) and aircraft (for example, make, model) are associated with an assigned, unique identifier.

3.1.22 *shall, must versus should versus may*—use of the word "shall" implies that a procedure or statement is mandatory and must be followed to comply with this practice, "should" implies recommended, and "may" implies optional at the discretion of the supplier, manufacturer, or operator.

3.1.22.1 *Discussion*—Since "shall" and "must" statements are requirements, they include sufficient detail needed to define compliance (for example, threshold values, test methods, oversight, and references to other standards). "Should" statements also represent parameters that could be used in safety evaluations, and could lead to development of future requirements. "May" statements are provided to clarify acceptability of a specific item or practice, and offer options for satisfying requirements.

3.1.23 *static data*—data that remains the same or does not change often over the duration of a flight (for example, Unique ID); this is in contrast to dynamic data that may change more frequently (such as longitude and latitude).

3.1.24 *unmanned aircraft system (UAS)*—composed of unmanned aircraft and all required on-board subsystems, payload, control station, other required off-board subsystems, any required launch and recovery equipment, all required crew members, and command and control (C2) links between UA and the control station.

3.1.25 *UAS operation plan*—a flight plan for a UAS. An operation plan is developed prior to the operation and should indicate the volume of airspace within which the operation is expected to occur, the times and locations of the key events associated with the operation, including launch, recovery, and any other information deemed important (for example, segmentation of the operation trajectory by time). **UTM ConOps v1.0**

3.1.26 *UAS registration ID*—an identification number or combination of letters and numbers assigned by a CAA or authorized representative to a UAS; this is sometimes referred to as a registration number (which may or may not contain letters).

3.1.27 *UAS service supplier (USS)*—USSs provide UTM services to support the UAS community, to connect operators and other entities to enable information flow across the USS network, and to promote shared situational awareness among UTM participants. **UTM ConOps v1.0**

3.1.28 *unique ID*—a data element that can be traced to a unique UAS and its operator.

3.2 *Acronyms and Abbreviations:*

3.2.1 *AES*—advanced encryption standard

3.2.2 *AGL*—above ground level

3.2.3 *API*—application programming interface

3.2.4 *ARC*—aviation rulemaking committee

3.2.5 *BVLOS*—beyond visual line of sight

3.2.6 *C2*—command and control

3.2.7 *CAA*—Civil Aviation Authority

3.2.8 *CONUS*—contiguous United States

3.2.9 *DAR*—DSS airspace representation

3.2.10 *DSS*—discovery and synchronization service

3.2.11 *EIRP*—effective isotropic radiation pattern

3.2.12 *EMI*—electromagnetic interference

3.2.13 *FAA*—Federal Aviation Administration

3.2.14 *GCS*—ground control station

3.2.15 *Hz*—Hertz

3.2.16 *inHg*—inch of mercury

3.2.17 *km*—kilometers

3.2.18 *kts*—knots (nautical miles per hour)

3.2.19 *LAANC*—low altitude authorization and notification capability

3.2.20 *LE*—little endian (least significant byte first)

3.2.21 *LSB*—least significant bit

3.2.22 *LTA*—lighter than air (for example, balloon or blimp)

3.2.23 *m*—meters

3.2.24 *m/s*—meters per second

3.2.25 *mb*—millibars

[13] Used throughout the specification, Wi-Fi is a registered trademark of Wi-Fi Alliance, 10900-B Stonelake Boulevard, Suite 126, Austin, TX 78759.

3.2.26 *mm*—millimeters

3.2.27 *MAC*—media access control

3.2.28 *MPH*—miles per hour

3.2.29 *MSB*—most significant bit

3.2.30 *Net-RID*—network Remote ID

3.2.31 *PHY*—physical layer

3.2.32 *PII*—personally identifiable information

3.2.33 *PPM*—parts per million

3.2.34 *Remote ID*—remote identification

3.2.35 *TLS*—transport layer security

3.2.36 *UA*—unmanned aircraft

3.2.37 *UAS*—unmanned aircraft system

3.2.38 *USS*—UAS service supplier

3.2.39 *UTM*—UAS traffic management

3.2.40 *UUID*—universally unique identifier based on RFC4122 (128 bit)

3.2.41 *VIP*—very important person

3.2.42 *VTOL*—vertical take off and landing

3.2.43 *VLL*—very low level (airspace—generally below 150 m (500 ft))

4. Remote ID and Network Interoperability Conceptual Overview

4.1 This section provides a conceptual overview of Remote ID as defined in this specification, explains the scope of the specification, and clarifies the differences between broadcast and network Remote ID. This overview does not address all nuances of the specification. The intention is to provide a contextual framework to understand the requirements contained in this specification. No requirements are provided in this section.

4.2 This section also provides an overview of the general approach to interoperability between USSs for both Network Remote ID and other UTM-related services.

4.3 *Scope of Standard and Remote ID Components:*

4.3.1 Fig. 1 identifies the actors and interfaces between actors in the Remote ID environment.

4.3.2 The scope of this specification is identified by the contents of the dotted purple box in the center of the diagram.

4.4 *Broadcast Remote ID:*

4.4.1 Broadcast Remote ID is depicted in the upper, central portion of Fig. 1 in blue. Equipment on participating UAS continuously transmit Remote ID data using one of the transmit protocols in this specification (Bluetooth or Wi-Fi). It is possible that additional transmit protocols may be added in the future as warranted by available technology. The initial technologies were selected for compatibility with commonly carried hand-held devices that have their own receiver antenna. However, equipment to receive the broadcast data is not part of the specification. Other implementations, such as receivers not integrated with hand-held devices, are possible.

4.4.2 Both Bluetooth and Wi-Fi continuously broadcast messages to advertise the presence of the associated device. These advertisements normally allow other devices to discover and establish connections with the associated device, but the advertisements themselves can carry a payload. These advertisements contain the broadcast Remote ID data. A hand-held

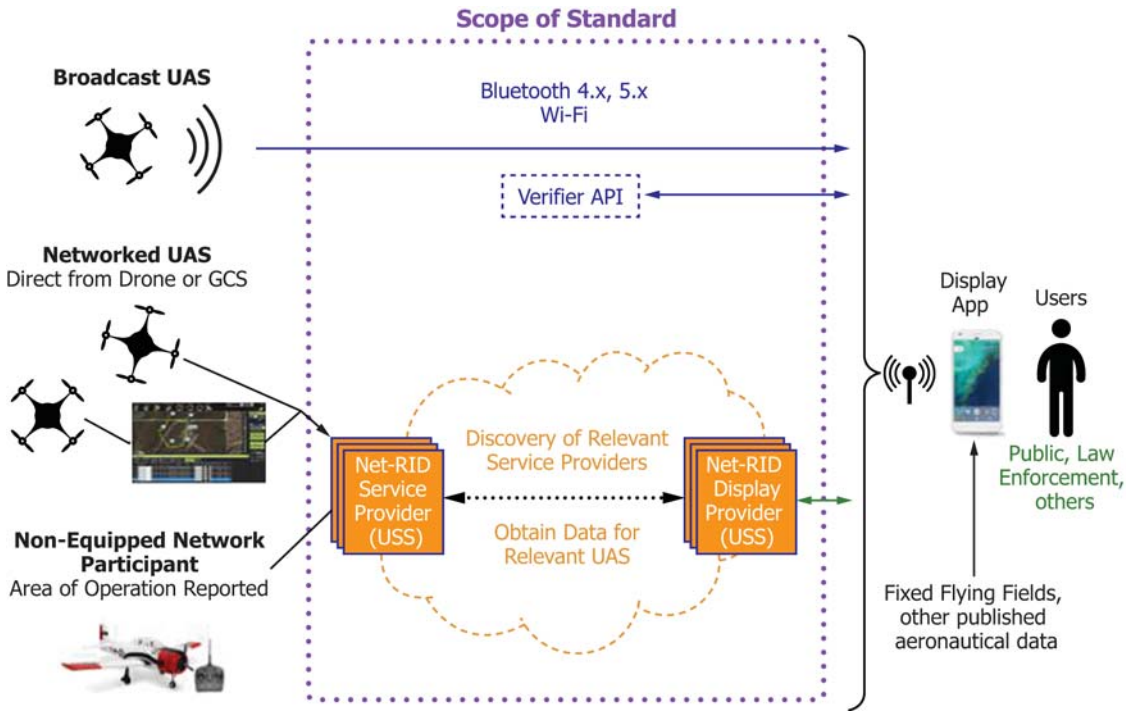

FIG. 1 Remote ID Conceptual Overview

device does not need to establish a connection to receive Remote ID data, instead it need only receive and process the advertisements.

4.4.3 Broadcast Remote ID can be used anywhere, but is necessary in areas where network coverage is unreliable, disrupted, or not available.

4.4.4 The specification also includes a range of options for authentication of broadcast data. Some of those options include digital signatures over portions or all of the Remote ID message set. While the specification does not specify the encoding format associated with signatures, it does include a standard API that would be used by a receiver of the broadcast data (for example, an app on a smartphone) to contact a verifier with the signature data for a broadcast to determine message validity. This is described in more detail in Annex A1, Broadcast Authentication Verifier Service.

4.5 *Network Remote ID:*

4.5.1 Network Remote ID can be used when both UAS operations and end users of Remote ID display applications access the internet, typically by means of cellular network. Cellular coverage tends to be higher in urban areas.

4.5.2 Network Remote ID is depicted in the lower, central portion of Fig. 1 in orange and enclosed in a dashed line cloud. The nominal case supports Networked UAS (that is, UAS that remain in contact with a Remote ID Service Provider during flight), although the specification accommodates intermittent loss of network connectivity. Network Remote ID also includes provisions for participation in Remote ID by non-equipped UAS (that is, UAS that are neither broadcast capable nor equipped to communicate with a Remote ID Service Provider during flight, such as most radio-controlled model aircraft). These non-equipped network participants report their operations (for example, aircraft ID, location in terms of a volume of airspace, operating times) in advance. The information is used to create a position report for use by Remote ID display applications where the uncertainty of the position report is defined by the airspace volume for the operation. The current telemetry of the aircraft within the volume is not known and cannot be displayed to a Remote ID end user, but the display application can display the volume and provide the identity of the UAS.

4.5.3 For Network Remote ID, two USS roles are identified: Network Remote ID (Net-RID) Service Providers and Net-RID Display Providers. In practice, these roles can be fulfilled by a single USS and potentially one that also provides flight planning and deconfliction, LAANC, or other UTM services, or combinations thereof. However, they are identified separately to provide flexibility for industry participants to pursue their preferred business objectives and implementation scope. This architecture supports one or more Net-RID Service Providers and one or more Net-RID Display Providers.

4.5.4 Net-RID Service Providers nominally remain in contact with UAS during flight and receive information (for example, position updates) used to fulfill requests from Net-RID Display Providers. For Network Remote ID, some required data (for example, the UAS ID) may be retained by the Net-RID Service provider after UAS authentication and not transmitted continuously from the UAS. As this specification does not specify the details of the UAS to Net-RID Service provider interface, implementations are generally valid as long as complete and correct Remote ID data is obtained by Net-RID Service Providers at some point and made available to Net-RID Display Providers.

4.5.5 Net-RID Service Providers may also have the ability to supply extrapolated position information for UAS that intermittently lose network connectivity.

4.5.6 Net-RID Display Providers fulfill a broker role between Remote ID Display Applications used by an end user and all Net-RID Service Providers that have flights in an area. When an end user display application requests Remote ID data for an area, the Net-RID Display Provider servicing the display application determines what Net-RID Service Providers have operations in the area and then obtains appropriate Remote ID data from each. The aggregated data is returned to the Remote ID Display Application. The aggregated data includes both current location and a window of near-real-time data for each flight.

4.5.7 Net-RID Display Providers ensure Remote ID Display Applications can only access and view data within a limited range and must dispose of aggregated data obtained from Net-RID Service Providers within a defined time period. Limiting the range helps implementations satisfy performance requirements in this specification by bounding the volume of data that must be gathered, processed, and displayed. Limiting the range (that is, only accessing required data) and disposing of such data when no longer needed helps protect privacy and sensitive data of consumers and operators.

4.5.8 For a UAS to be included in response to queries for Remote ID data, it must either be within the requested area at the time of the request or recently therein (that is, within a small window of time such as a minute). This specification does not provide remote identification data for UAS that are projected to be within an area in the future.

4.5.9 Industry-standard encryption and authentication are required from the UAS or the operator of a non-equipped network participant to the Net-RID Service and from the Net-RID Service Providers to Net-RID Display providers.

4.6 *Remote ID Display Applications:*

4.6.1 Receivers and Remote ID Display Applications are shown on the right side of Fig. 1. A typical implementation would be a smartphone or tablet with an internal receiver for Bluetooth and Wi-Fi, but other implementations are possible. The display applications ingest Broadcast Remote ID data or interact with a Net-RID Display Provider, or both, to acquire Network Remote ID data and present the information to end users.

4.6.2 A typical user interface might be map-based with symbols for UAS in the area. However, the manner in which the information is presented is beyond the scope of this specification and other implementations are possible.

4.6.3 It is anticipated that Remote ID Display Applications that integrate Broadcast and Network Remote ID data will be produced by industry; however, this also is beyond the scope of the specification.

4.6.4 From a network Remote ID perspective, this specification levies performance requirements on Net-RID Display Providers in responding to requests from Remote ID Display Applications.

4.7 *Representative Remote ID Scenario:*

4.7.1 Fig. 2 depicts a representative Remote ID scenario. The text that follows describes the flow of information amongst the Remote ID components introduced above.

4.7.2 Three UAS are simultaneously operating in close proximity (within 1 km) to each other: one is broadcasting Remote ID data, one is networked, and one is a model aircraft with no broadcast or network capability. An interested observer wants to identify the three UAS.

4.7.2.1 The broadcast UAS transmits Remote ID data using one of the methods described in 5.4. The UAS is controlled locally by the Remote Pilot and has no interface with a USS.

4.7.2.2 The networked UAS is operated under USS1. This USS acts as a Net-RID Service Provider and a Net-RID Display Provider.

4.7.2.3 The Remote Pilot of the model aircraft uses a smartphone app to report the location and time of the operation, and provides the ID for the model aircraft. The smartphone app is the user interface that connects the user to a second Net-RID Service Provider, USS2.

4.7.3 The interested observer accesses a Remote ID Display Application (RID App) that uses USS1 as its Net-RID Display Provider. This display application shows UAS locations and a near-real-time trail of position reports on a map, and associated identification information when a particular UA is selected.

4.7.4 When the interested observer opens the Remote ID app on a smartphone and centers the map on the current location, Remote ID data is acquired as follows:

4.7.4.1 The broadcast UAS is transmitting its Remote ID advertisements continuously. The smartphone uses its internal radios to listen for the advertisements from the UAS, extract the Remote ID data, and show the location of the UA on the map. As new position updates are received, the prior position reports become part of a near-real-time trail representing where the UA most recently flew.

4.7.4.2 Simultaneously, the Display App makes a request to its Net-RID Display Provider, USS1. USS1's role as a Net-RID Display Provider is to aggregate Remote ID data for all flights in the area managed by Net-RID Service Providers. USS1 knows that it is a Net-RID Service Provider and has flights in the area.

4.7.4.3 USS1 additionally discovers USS2, which has no real-time-managed flights in the area, but has an operation reported for the model aircraft (that is, the Non-Equipped Network Participant). The Remote Pilot of the radio-controlled model aircraft reports the operation to USS2 prior to the flight and no dynamic position updates are provided by the Non-Equipped Network Participant. USS2 provides the information for this operation back to USS1.

4.7.4.4 USS1 adds the Remote ID data for the networked UAS that it is managing (fulfilling its role as a Net-RID Service Provider) and provides the aggregated data back to the Display Application (fulfilling its role as a Net-RID Display Provider).

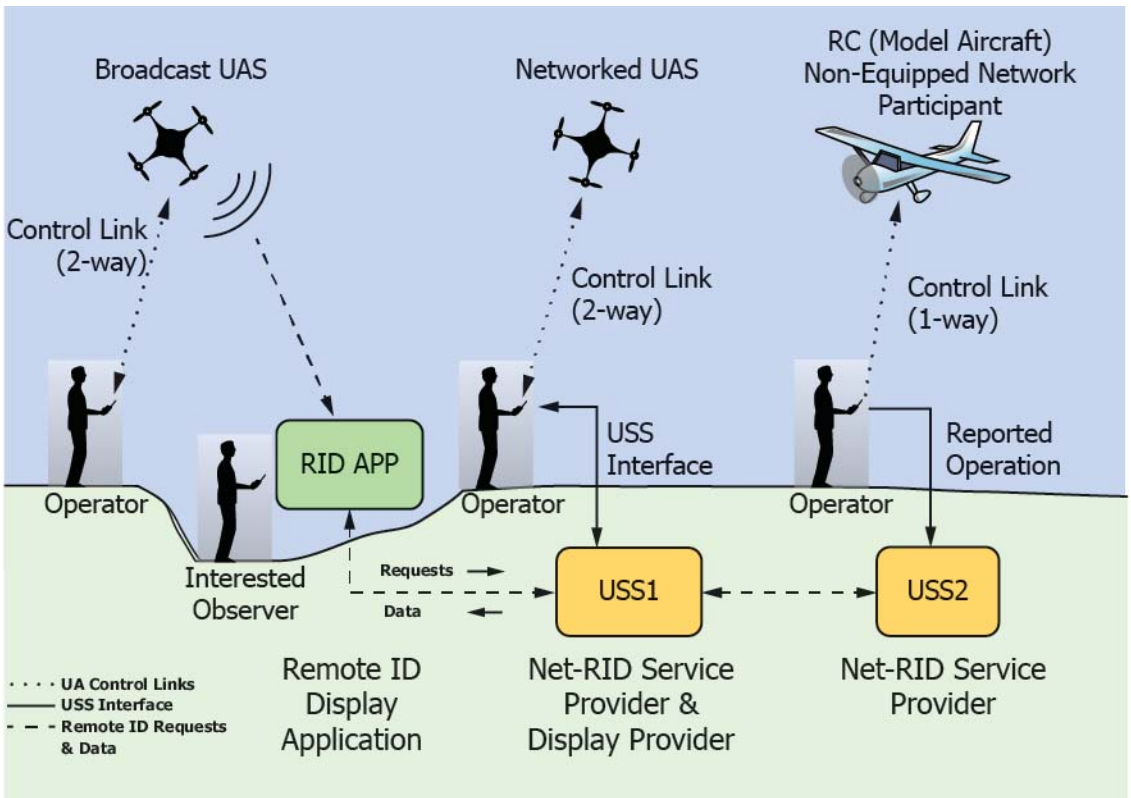

FIG. 2 Representative Remote ID Scenario

4.7.4.5 The display app adds the network data to the map that is already showing the broadcast information. The Networked UAS is shown with up to a 60 s trail of position reports (referred to as near-real-time data). The Non-Equipped Network Participant is shown as a polygon.

4.7.4.6 As long as the interested observer continues to view the Remote ID display app for the area, the app continues to communicate with USS1 as its Net-RID Display Provider to obtain position updates. Since the information for the non-equipped network participant does not update, no additional updates are provided for it from USS2. USS1 continues to provide position updates for the Networked UAS in its role as the Net-RID Service Provider.

4.7.4.7 The interested observer selects the UA symbols for the Broadcast UAS and the Networked UAS on the map and views the corresponding ID information. The interested observer then selects the polygon for the Non-Equipped Network Participant and sees the operation schedule and the ID of the aircraft.

4.7.4.8 The interested observer closes the app. After a period of time, USS1 discards the information for the non-equipped Network Participant because it is managed by a different USS (USS2).

4.8 *USS Interoperability:*

4.8.1 This specification assumes that UTM services in a given location are provided by a set of one or more UAS Service Suppliers (USSs). USSs must be interoperable in this environment, sharing data as necessary to accomplish the objective of a particular service such as Network Remote ID or flight plan exchange for strategic deconfliction.

4.8.2 The interoperability paradigm defined in this specification is intended to support both Network Remote ID and other services that may be included in subsequent UTM-related ASTM standards. The requirements and application programming interfaces (APIs) associated with the interoperability paradigm are included in this document because it is the first UTM-related ASTM standard. Subsequent UTM-related ASTM standards may introduce additional service-specific interoperability requirements and API functions. Some of the interoperability requirements and APIs may move to a different standard in the future.

4.8.3 The interoperability paradigm consists of two parts:

4.8.3.1 A standardized discovery mechanism, referred to as the Discovery and Synchronization Service (DSS), the primary functions of which are to identify USSs with which data exchange is required and to verify that a USS considered relevant information from other USSs when necessary (for example, when planning a new operation); and,

4.8.3.2 Service-specific data exchange protocols used to obtain the details of relevant information discovered by means of the DSS from the owning USS.

4.8.4 Fig. 3 illustrates the interactions involved in this paradigm in a service-independent manner. (The instantiation of this paradigm for Remote ID is detailed later.)

4.8.5 DSS-related interactions are shown at the top in the blue-shaded area; data exchange protocols between USSs are represented by the green-shaded area.

4.8.6 For availability purposes, the DSS is a redundant service as indicated in Fig. 3. Instances of the DSS in a region synchronize with each other in a standardized manner (described later in this specification). A region is the geographic scope supported by a set of DSS instances.

4.8.7 Only approved USSs will be given access to the DSS. (The specifics of an approval process are beyond the scope of this specification.)

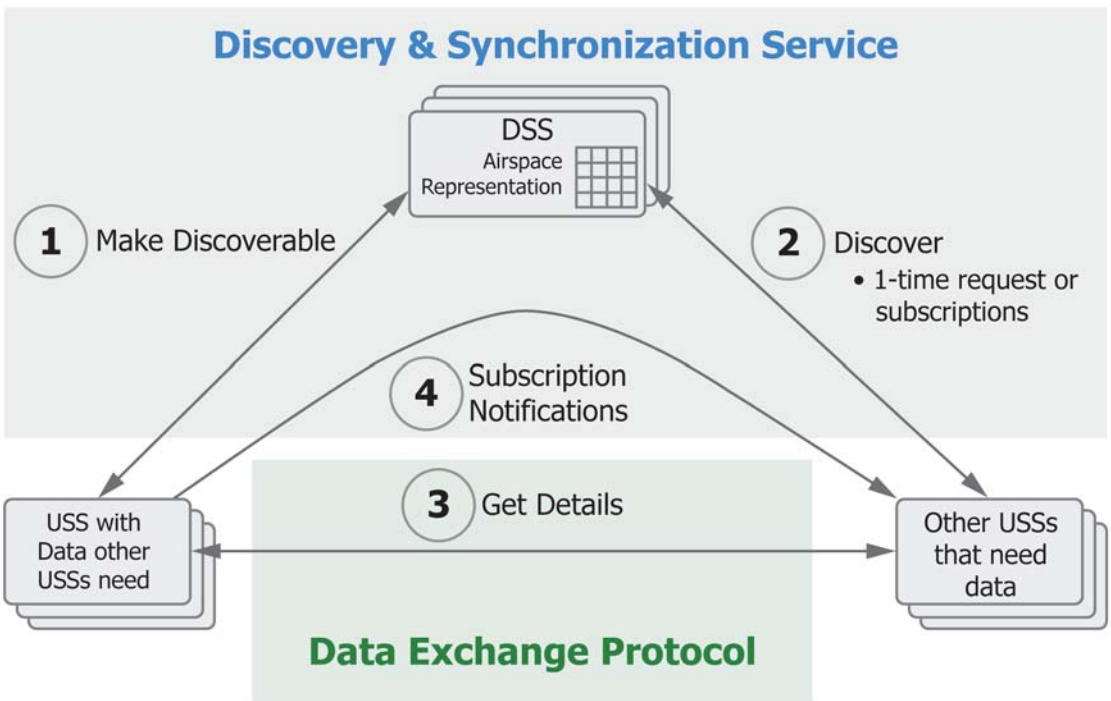

FIG. 3 USS Interoperability Overview

4.8.8 An instance of discoverable information is referred to as an entity. There are different types of entities, such as operations, constraints, or, relevant to this specification, an area where network remote identification services are being provided. The concept is extendable to future UTM services where other types of entities may need to be discoverable. A key characteristic of entities is that they have an associated 4-D volume (that is, a volume defined in *x*, *y*, and *z* plus time limits).

4.8.9 The DSS encapsulates an airspace model into which entities are mapped. The implementation details of this airspace representation are hidden from DSS clients; however, conceptually, the airspace model can be thought of as a grid and mapping an entity into the airspace model is determining what grid cells the entity intersects. The complete details of the entities and any associated Personally Identifiable Information (PII) are not stored in the DSS but instead are retained by the owning USS; only limited information such as the type of entity, its location (in terms of what cells of the airspace model it intersects), the current opaque version number (OVN) of the entity (OVNs are updated whenever the entity is modified), and how to contact the owner of the entity are stored in the DSS.

4.8.10 Given that context, the primary interactions (numbered in Fig. 3) are:

4.8.10.1 *Make Discoverable*—A USS with an entity about which other USSs need to know (for example, an operation, a constraint, an area where Remote ID services are provided) makes it discoverable by writing the limited entity summary information (information type, identifier, location, owner, OVN) to the DSS.

4.8.10.2 *Discover*—Other USSs that are interested in entities of some type query the DSS using a 4-D volume to characterize the area of interest. The DSS maps the query onto the airspace representation and finds intersecting grid cells with entities of the desired type (if any). (Because entities are mapped into grid cells and the DSS does not retain the precise extents, the DSS will occasionally return an entity that does not intersect the precise area of interest; however, it will never omit an entity that intersects the area of interest.) The DSS then returns to the requesting USS a list of the discovered entities and their owners. This can be a one-time query (often described as a *pull* of the information) or the requesting USS can also establish a subscription to be notified of new or modified entities in the area of interest (discussed further below).

4.8.10.3 *Get Details*—Given the list of discovered entities, the requesting USS switches to the applicable Data Exchange Protocol to contact the owning USS and obtain the complete details. Data Exchange Protocols are service-specific.

4.8.10.4 *Subscription Notifications*—If the requesting USS established a subscription in the DSS (for a 4-D area of interest), when another USS writes a new entity to the DSS that intersects the subscription, the DSS informs the writing USS of the subscription and the writing USS contacts the subscribing USS to provide the details. (This is often described as a *push* of the information.)

4.8.11 While not needed for Remote ID, OVNs come into play on interaction if the entity written to the DSS is of a type that requires deconfliction with other entities (for example, a new UAS operation requires deconfliction; a constraint does not). When writing the new operation to the DSS, the USS must provide the OVNs for all other operations and constraints in the area of the new operation. For applicable entity types, OVNs are part of the detailed information obtained from other USSs in step 3. If the DSS determines the set of OVNs is complete and current, it allows the new operation to be written; if not, the DSS informs the writing USS what OVNs are missing or obsolete.

4.8.12 Although complete details for entities are not stored in the DSS, it serves as the single source of truth for what entities exist in the airspace and provides the mechanism necessary to ensure that USSs attempting to create a new operation have considered the current version of all other relevant entities in the airspace.

4.8.13 Unless noted otherwise, references to the DSS throughout this specification refer to the set of DSS instances supporting the region in which a related activity is occurring (for example, creating entity summaries, discovering entities).

4.8.14 This overview omits many details of the DSS and data exchange protocols. The Remote ID-specific interoperability requirements, complete APIs, and additional details are provided in Annex A2.

5. Performance Requirements

5.1 Remote ID is comprised of a set of standardized data, messages, transport mechanisms for communicating the messages, and performance requirements governing certain attributes of an implementation such as message periodicity. For Broadcast Remote ID, the message format is the same regardless of the transport mechanism. These messages are coded as a "block message" implementation of the Data Dictionary to optimize for the transport mechanism size constraints and to minimize potential broadcast interference. For Network Remote ID, the message format is a network adaption of the Data Dictionary using common internet protocols. For broadcast messages, each message has a message type that is identified in the message header. The message type defines the message format and is classified as static or dynamic, which also sets the requirements for the minimal rate at which each message type shall be transmitted. The common name for this broadcast messaging protocol is "Open Drone ID."

5.2 Conventions used in this section:

5.2.1 Requirement IDs are shown below. The prefix to each ID identifies groupings:

5.2.1.1 BURxxxx - Broadcast Update Rate

5.2.1.2 BMGxxxx - Broadcast Messages

5.2.1.3 BB4xxxx - Broadcast Bluetooth 4

5.2.1.4 BB5xxxx - Broadcast Bluetooth 5

5.2.1.5 BWFxxxx - Broadcast Wi-Fi

5.2.1.6 NETxxxx - Network

5.2.1.7 DSSxxxx - Discovery and Synchronization Service (Annex A2)

5.2.2 Constant values representing a required time, distance, etc. are consolidated into Annex A3. These values are referenced within the requirements text in this section using square brackets around the constant name. Constants pertaining to