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# 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 intent-based 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] 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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1.7 *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.

1.8 *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 Standards:*[2]

F3060 Terminology for Aircraft

F3341 Terminology for Unmanned Aircraft Systems

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 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]

IEEE 1609.2 IEEE Standard for Wireless Access in Vehicular Environments--Security Services for Applications and Management Messages[7]

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

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

IETF RFC8126 Guidelines for Writing an IANA Considerations Section in RFCs[10]

Neighbor Awareness Networking Specification [11,5]

FAA UTM ConOps v1.0 Unmanned Aircraft System (UAS) Traffic Management (UTM) Concept of Operations[12]

WGS-84 World Geodetic System — 1984[13]

## 3. Terminology

3.1 This standard uses terminology contained within F3341, UAS Terminology Standard, and F3060, Aircraft Terminology Standard. These terms are not duplicated within this document.

3.2 *Unique and Common Terminology*—Terminology used in multiple standards is defined in F3341 and F3060. Terminology that is unique to this specification is defined in 3.3.

3.3 *Definitions of Terms Specific to This Standard:*

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

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

3.3.3 *broadcast UAS, n*—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.

3.3.4 *discovery, n*—the process of determining the set of USSs with which data exchange is required for some UTM function; discovery is accomplished by means of the discovery and synchronization service (DSS).

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

3.3.5.1 *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.

3.3.6 *DSS pool, n*—a synchronized set of DSS instances where operations may be performed on any instance with the same result, and information may be queried from any instance with the same result. A DSS region will often have a production DSS pool along with one or more test or staging DSS pools.

3.3.7 *DSS region, n*—the geographic area supported by a DSS pool.

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

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

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

3.3.11 *intent-based network participant, n*—a UAS for which the operator has reported an intended area (a volume of

[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 https://datatracker.ietf.org/doc/html/rfc8126.

[11] 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.

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

[13] 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.

airspace) and time for an operation through a Net-RID service provider; such information is then reported through the network Remote ID infrastructure. Intent-based Remote ID participation is an option for non-equipped UAS or UAS operating in environments that preclude broadcast or network participation.

3.3.12 *network Remote ID (Net-RID) service provider, n*—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.

3.3.13 *network Remote ID (Net-RID) display provider, n*—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.

3.3.14 *network publishing, v*—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 general public can access the data to obtain ID and tracking information for UAS for which such data has been published.

3.3.15 *networked UAS, n*—a UAS that during operations is in electronic communication with a Net-RID service provider (for example, by means of internet Wi-Fi,[14] cellular, or satellite, or other communications medium such as short burst data satellite communications).

3.3.16 *non-equipped UAS, n*—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.

3.3.17 *operator, n*—the individual or organization who uses, causes to use, or authorizes to use an aircraft for the purpose of air navigation, including the piloting of an aircraft, with or without the right of legal control (as owner, lessee, or otherwise). **F3060**

3.3.18 *operator location, n*—the geographic location of the remote pilot in command of a UAS.

3.3.19 *position extrapolation, n*—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.

3.3.20 *registration, n*—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.

3.3.21 *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.

3.3.21.1 *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.

3.3.22 *static data, n*—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).

3.3.23 *UAS operation plan, n*—a UAS 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**

3.3.24 *UAS registration ID, n*—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).

3.3.25 *UAS service supplier (USS), n*—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**

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

3.4 *Acronyms and Abbreviations:*

3.4.1 *AES, n*—advanced encryption standard

3.4.2 *AGL, adj*—above ground level

3.4.3 *API, n*—application programming interface

3.4.4 *ARC, n*—aviation rulemaking committee

3.4.5 *BVLOS, adj*—beyond visual line of sight

3.4.6 *C2, n*—command and control

3.4.7 *CAA, n*—Civil Aviation Authority

3.4.8 *CONUS, n*—contiguous United States

3.4.9 *DAR, n*—DSS airspace representation

3.4.10 *DSS, n*—discovery and synchronization service

3.4.11 *EIRP, n*—effective isotropic radiated power

3.4.12 *EMI, n*—electromagnetic interference

3.4.13 *FAA, n*—Federal Aviation Administration

3.4.14 *GCS, n*—ground control station

3.4.15 *Hz*—Hertz (cycles per second)

3.4.16 *inHg*—inch of mercury

3.4.17 *km*—kilometers

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

3.4.19 *LAANC*—low altitude authorization and notification capability

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

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

3.4.21 *LSB*—least significant bit

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

3.4.23 *m*—meters

3.4.24 *m/s*—meters per second

3.4.25 *mb*—millibars

3.4.26 *mm*—millimeters

3.4.27 *MAC*—media access control

3.4.28 *MPH*—miles per hour

3.4.29 *MSB, n*—most significant bit

3.4.30 *Net-RID, n*—network Remote ID

3.4.31 *PHY, n*—physical layer

3.4.32 *PII, n*—personally identifiable information

3.4.33 *PPM*—parts per million

3.4.34 *Remote ID, n*—remote identification

3.4.35 *TLS, n*—transport layer security

3.4.36 *UA, n*—unmanned aircraft

3.4.37 *UAS, n*—unmanned aircraft system

3.4.38 *USS, n*—UAS service supplier

3.4.39 *UTM, n*—UAS traffic management

3.4.40 *UUID, n*—universally unique identifier based on RFC4122 (128 bit)

3.4.41 *VIP, n*—very important person

3.4.42 *VLL, adj*—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

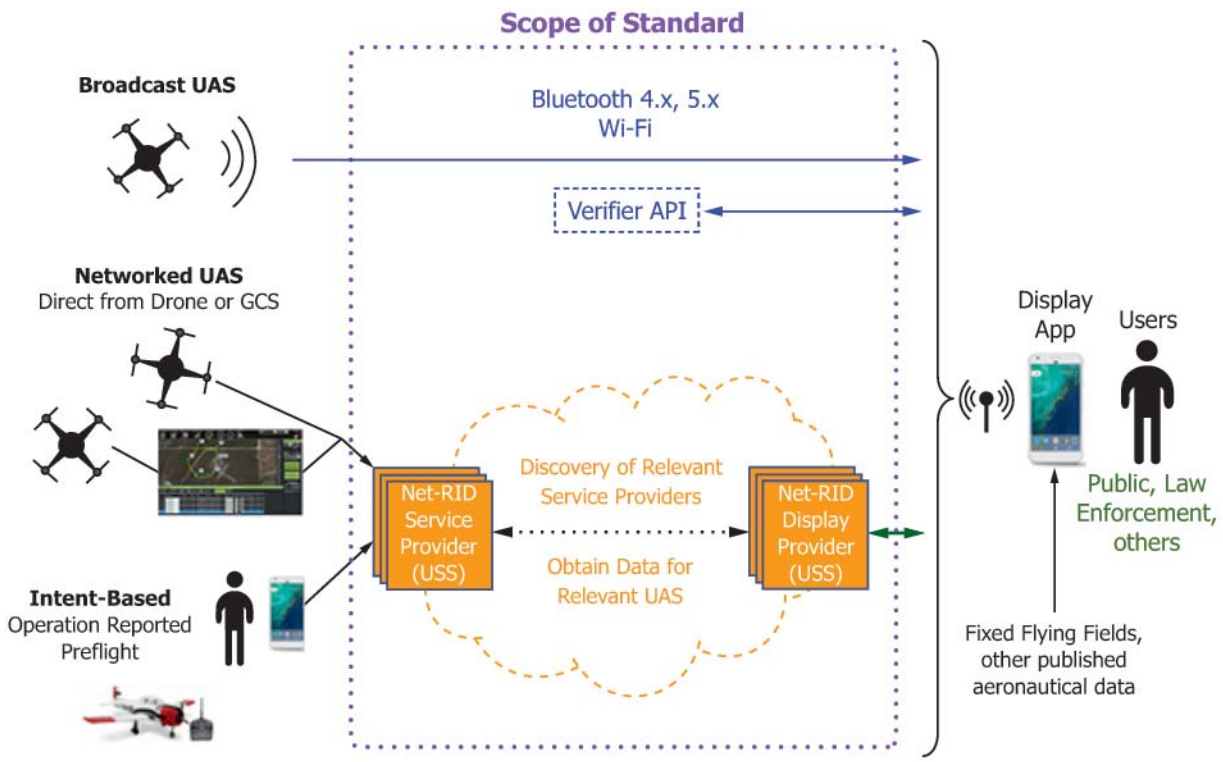


**FIG. 1 Remote ID Conceptual Overview**

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 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 either directly or through an intermediate device such as a ground control station), although the specification accommodates intermittent loss of network connectivity. Network Remote ID also includes provisions for participation in Remote ID through intent-based preflight reporting, also referred to as Intent-Based participation. This technique provides an alternative for UAS that are non-equipped (that is, UAS that are neither broadcast capable nor equipped to communicate with a Remote ID Service Provider during flight, such as many radio-controlled model aircraft) as well as for UAS that may be equipped but are operating in an environment where participation in either broadcast or network Remote ID is infeasible due to the presence of electromagnetic interference (for example, an inspection inside an electrical tower) or radio signal blocking material (for example, areas under a bridge shielded by thick concrete or inside a tunnel). Intent-based 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 an intent-based 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

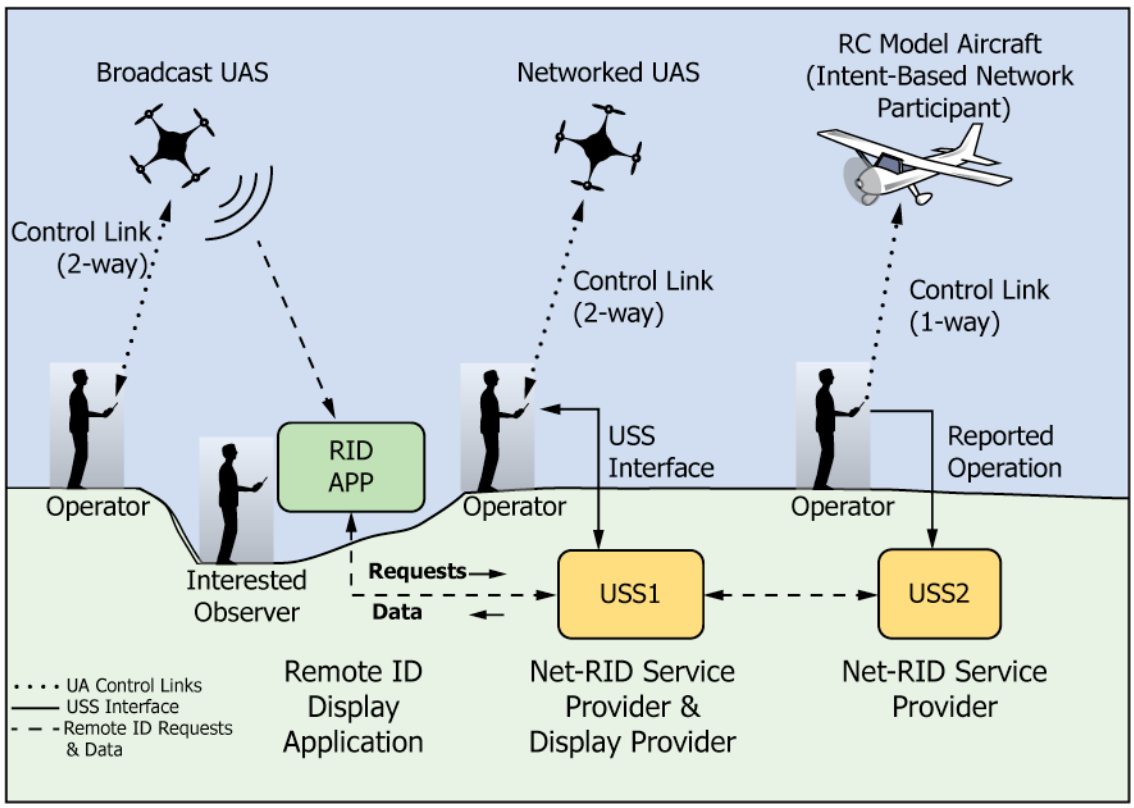


**FIG. 2 Representative Remote ID Scenario**