



UAS Traffic Management (UTM)

Research Transition Team (RTT) Plan

**FAA and NASA collaborative efforts planned through
September 2020**

January 31, 2017

Parimal Kopardekar
NASA Ames Research Center
NASA Senior Technologist for Air Transportation System, and
Principal Investigator, Unmanned Aerial Systems Traffic Management (UTM)
UTM RTT Co-Lead

3/2/17
Date

Steve Bradford
FAA
Chief Scientist, Architecture &
NextGen Development
UTM RTT Co-Lead

3/3/17
Date

Revision History & Plan

Version	Description	Date
0.1	Initial Working Draft	12/20/2016
0.5	Updated draft of RTT products, deliverables, and schedules	12/29/2016
1.0	Final RTT Plan	12/31/2016

Contents

Index of Figures	4
Index of Tables	4
Executive Summary	5
1 UTM RTT and JMP Overview	6
1.1 Historical Overview of RTTs.....	6
1.2 The need for UTM.....	6
1.3 UTM Research Platform (NASA).....	7
1.4 The UTM RTT	8
1.5 The UTM JMP	9
1.6 Statutory Requirements	10
2 Document Scope & Purpose	10
2.1 Research Transition Products (RTPs)	11
3 Scope of the UTM RTT – through September, 2020.....	11
3.1 Goals and Objectives of UTM RTT	11
3.2 Goals and Objectives of UTM RTT Plan.....	12
4 Coordination with other RTTs	12
5 UTM RTT Membership.....	12
6 NextGen, NASA, and Industry Evaluation and Demonstration Partnership	13
7 The UTM JMP	13
7.1 Integrated approach to UTM JMP Subgroup plans and deliverables	13
7.2 UTM RTT Risk Adjusted Schedule	15
8 Detailed plans of the JMP subgroups.....	16
8.1 Operational Concept & Scenarios Subgroup	16
8.1.1 <i>Goals and Objectives</i>	16
8.1.2 <i>RTPs & Activities</i>	17
8.1.3 <i>Schedule</i>	17
8.2 Data Exchange & Information Architecture Subgroup.....	17
8.2.1 <i>Goals and Objectives</i>	17
8.2.2 <i>RTPs & Activities</i>	18
8.2.3 <i>Schedule</i>	18
8.3 Sense & Avoid Subgroup.....	19
8.3.1 <i>Goals and Objectives</i>	19
8.3.2 <i>RTPs & Activities</i>	19
8.3.3 <i>Schedule</i>	20
8.4 Communications and Navigation Subgroup	20
8.4.1 <i>Goals and Objectives</i>	20
8.4.2 <i>RTPs & Activities</i>	21
8.4.3 <i>Schedule</i>	22
9 Pilot Program Transition Plan [Pending]	22
Appendix A: Acronyms & Glossary.....	23

Index of Figures

Figure 1-1 UTM Research Technical Capability Levels	8
Figure 1-2 Notional UTM Architecture	9
Figure 1-3 UTM JMP Subgroup areas of research	9
Figure 7-1 UTM RTT Risk Adjusted Schedule	15

Index of Tables

Table 5-1 UTM RTT Membership	12
Table 8-1 Operational Concept & Scenarios Subgroup Deliverables	17
Table 8-2 Operational Concept & Scenarios Schedule	17
Table 8-3 Data Exchange & Information Architecture Subgroup Deliverables	18
Table 8-4 Data Exchange & Information Architecture Subgroup Schedule	18
Table 8-5 Sense & Avoid Subgroup Deliverables	19
Table 8-6 Sense & Avoid Subgroup Schedule	20
Table 8-7 Communications & Navigation Subgroup Deliverables	21
Table 8-8 Communications & Navigation Subgroup Schedule	22

Executive Summary

The Federal Aviation Administration (FAA) and the National Aeronautics and Space Administration (NASA) share a long history of early collaboration to meet challenges confronting the National Airspace System (NAS). Leveraging the advanced research, analysis and development capabilities at NASA, as well as the knowledge and experience managing the air transportation network of the FAA, many operational capabilities and enhancements have been implemented. Responding to the complex nature of the challenges, the breadth of skills required to address, and the broad stakeholder community, the organizations have developed structured cross-agency processes and documents to effectively move forward together.

The creation of Research Transition Teams (RTTs) and the associated RTT Plan provides an agreed framework and forum to undertake the many interdependent activities. Similarly, development of Joint Management Plans (JMPs) memorialize specific actions, timetable for accomplishment, organizational roles and responsibilities, and description of the planned products and outcomes from the collaboration.

In the case of advancing Unmanned Aircraft System (UAS) operations, particularly at low altitudes, this RTT Plan summarizes and provides the overarching objectives for the detailed UTM JMP, which reflects the agreed lower level products, activities, and framework for organizational interactions (through subgroups). The RTT Plan serves as the basis for consistent communications and engagement with the broader public and UAS Community. It also endeavors to address the plan of action for joint FAA/NASA reporting and documents responding to legislative requests and requirements.

1 UTM RTT and JMP Overview

1.1 Historical Overview of RTTs

The Aeronautics and Space Administration (NASA) and the Federal Aviation Administration (FAA) have established Research Transition Teams (RTTs) to ensure that research and development needed for the Next Generation Air Transportation System (NextGen) implementation is identified, quantified, conducted, and effectively transferred to the implementing agency. This will be accomplished through collaboration among researchers, system planners, and implementers within the RTT.

The proposal to establish RTTs and a Coordinating Committee to guide them was approved on October 22, 2007, by the FAA's Air Traffic Organization Senior Vice President for NextGen and Operations Planning and by NASA's Associate Administrator for the Aeronautics Research Mission Directorate (ARMD).

The objectives of the RTTs are to: (1) provide a structured forum for researchers and implementers to constructively work together on a continuing basis; (2) ensure that planned research results will be fully utilized, and will be sufficient to enable implementation of NextGen air navigation services concepts; and (3) provide a forum for the inclusion of all of the NASA and FAA stakeholders who would be involved in the planning, conducting, receiving, and utilizing of the research conducted by the RTTs.

1.2 The need for UTM

Integration of Unmanned Aircraft System (UAS) operations into the NAS will present a variety of issues and novel challenges, including at low altitudes across controlled and uncontrolled airspace. Both NASA and FAA have activities and initiatives underway to identify and respond to the range of challenges and ensure the safety and integrity of the NAS. NASA's Research and Development approach includes supporting the integration of UAS into the NAS in the near-term while pioneering the more extensive transformative changes that increasingly autonomous aviation systems will bring over the mid to far term. FAA's focus includes both these R&D aspects, as well as operational implementation and potential impacts to current NAS processes, procedures, and systems.

The importance of developing close coordination with partners and stakeholders, as well as transparency regarding plans and activities cannot be overstated. Joint, structured plans and teaming, within the construct of RTTs, can provide the necessary cross-organizational construct to successfully transfer new operational concepts and technologies for commercialization by industry, or adoption by the FAA and other federal agencies to help them meet their missions. By matching NASA mid- and far-term research with current problems and making a timely transfer of the needed technology, these efforts would assist the FAA and other stakeholders to realize benefits in the near term. This relationship and general approach has been successful in several prior Joint Management Plans (JMPs) including:

- ATD-1 leading to TSS/TSAS development and deployment.

- ATD-2 collaborative surface efforts, including those underway at CLT, supporting TFDM requirement identification, development, and deployment.

Leveraging FAA's concept development and other activities along with NASA's research demonstrations and industry outreach, development of joint planning and execution will provide the most effective performance and delivery of services to the public.

The Unmanned Aircraft System Traffic Management (UTM) construct utilizes industry's ability to supply services under FAA's regulatory authority where these services do not exist such as low-altitude operation of small UAS (less than 55 pounds). In this construct, the FAA will maintain regulatory and operational authority for airspace and traffic operations. The UTM construct will be used by the FAA to inject directives, constraints, and types of airspace authorizations or zones (e.g. Drone Required Coordination Zone, Drone Required Notification Zone, No Drone Zone, Drone Right of Way [public safety]). FAA Air Traffic Organization can institute operational constraints at any time and the FAA has on-demand access to airspace operators and situation awareness of airspace operations continuously through UTM. It is expected that the UTM construct will be scalable to other airspace and vehicle classes as well.

1.3 UTM Research Platform (NASA)

In order to safely enable widespread civilian small Unmanned Aircraft Systems (sUAS) operations at lower altitudes, NASA has developed a UTM research platform to research and develop promising UTM technologies and data exchanges to support these future UTM operations envisioned, and to perform conceptual and technical research that can be transferred to the FAA to assist in the implementation of UTM capabilities that meet NAS service expectations. NASA's UTM research platform is a research prototype implementation of functions and technologies that support development and testing of UTM operations and technologies before operational technologies are available. The research platform is available to UTM research partners. The results and specifications of the research platform will be available as research transition products to the FAA and other stakeholders as appropriate.

NASA is spearheading the validation and research of UTM concept elements with its partners using combinations of simulations and field trials. The tests are aligned with NASA's spiral development and evaluation schedule of Technical Capability Levels (TCL) that demonstrate and evaluate increasingly complex operations. During the tests, potential UAS operators and service suppliers interact with NASA's UTM research platform electronically through application programming interfaces (APIs). Researchers, observers, and participants can interact with the UTM research platform and gain situational awareness through interface devices on iPads, iPhones, and desktop computers. A substantive amount of data is collected and analyzed during these trials to assess the effectiveness of the operations, the performance of the research technologies and components, and human-factors aspects related to UTM operations.

Each new TCL extends the capabilities of the previous TCL. The number of services provided and types of UAS operations supported increase. As a set, the successive iterations support a large range of UAS from remotely piloted vehicles to command-directed UAS and fully autonomous UAS. The TCLs are staged based upon four risk-

oriented metrics: the number of people and amount of property on the ground, the number of manned aircraft in close proximity to the UAS operations, and the density of the UAS operations. Each capability is targeted to specific types of applications, geographical areas, and use cases that represent certain risk levels. The pace of development targets a new UTM TCL to be tested and evaluated in simulation and field trials every 12–18 months. Figure 1-1 UTM Research Technical Capability Levels summarizes these capabilities.



Figure 1-1 UTM Research Technical Capability Levels

1.4 The UTM RTT

The UTM RTT was formed between NASA and the FAA in 2015 to jointly identify, quantify, conduct, and effectively transfer UTM capabilities and technologies to the FAA as the implementing agency and to provide guidance and information to UTM stakeholders to facilitate an efficient implementation of UTM operations. The goal of the UTM RTT is to: (1) research and mature increasingly complex UTM operational scenarios and technologies; (2) demonstrate those capabilities on the NASA UTM research platform (note: TCL 1 capabilities have been demonstrated on the NASA UTM research platform prior to the formation of the UTM RTT); and (3) deliver to the FAA technology transfer packages that enable NAS service expectations for low-altitude airspace operations by providing insight and capability requirements for critical services.

Critical services include, but are not limited to, airspace design and geo-fencing, separation management, weather and wind avoidance, routing, and contingency management. The UTM RTT will identify services, roles/responsibilities, information architecture, data exchange protocols, software functions, infrastructure, and performance requirements for low-altitude uncontrolled UAS operations. The UTM Research Platform has already completed TCL1 and is currently in process of TCL2 capabilities. The findings and research from these will be used as inputs within the UTM RTT Plan and daughter JMP plan for the conceptual and technical research. This will continue and should result in increasing alignment between the UTM Research Platform activities and the UTM RTT research focus and technology transfer packages. Figure 1-2 illustrates the

early notional UTM architecture that will guide UTM RTT and JMP research efforts toward technology transfer packages so that capabilities can be tested, evaluated, and refined to support the final UTM operational construct.

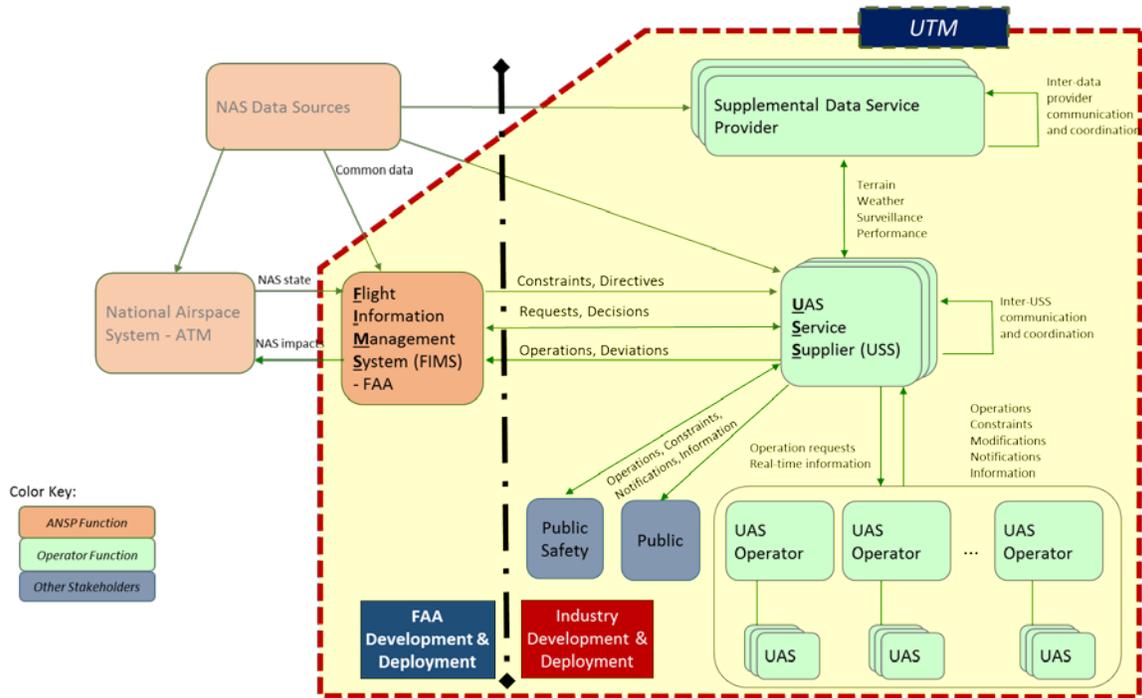


Figure 1-2 Notional UTM Architecture

1.5 The UTM JMP

The UTM RTT, recognizing the diversity of operating environments, technological areas, and activities, has been broken into four subgroups focused on: (1) Concepts and Use Cases; (2) Data Exchange and Information Architecture; (3) Sense and Avoid (SAA); and

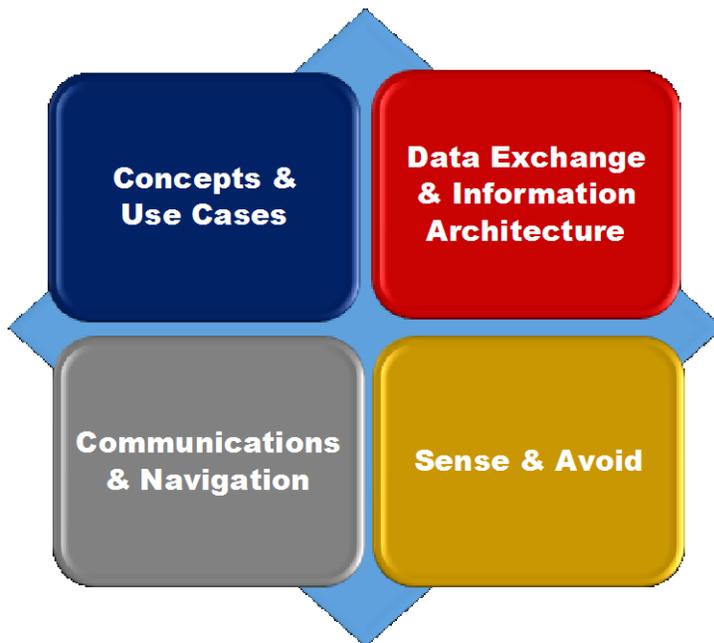


Figure 1-3 UTM JMP Subgroup areas of research

(4) Communications & Navigation.

The UTM JMP captures the subgroup plan for executing to support the UTM RTT. These subgroups are tasked with developing the UTM JMP, which consists of the subgroup activities, key milestones, and relationships with each other. The UTM JMP subgroups will explore concepts, data, engineering, and performance challenges related to implementing a UTM construct. It will also serve as a means for integrating these aspects and providing the necessary research and support to the UTM RTT to deliver a robust set of research products, identified in this RTT Plan, to support UTM operations.

1.6 Statutory Requirements

The FAA Reauthorization (PL114-190, July 2016) directs coordination / collaboration, development, and publication of a UTM Research Plan and establishment of a UTM system pilot program. The FAA Reauthorization (PL114-190, July 2016) directs the Administrator of the FAA, in coordination with the Administrator of NASA, to continue development of a research plan for UTM development and deployment. In addition to the cross-organizational coordination role JMPs fulfilled earlier, the development of a FAA/NASA UTM JMP covering UTM RTT (and subgroup) research efforts and products will serve as the basis for this UTM RTT Plan and in meeting the PL114-190 requirements that include the following elements:

- Identify research outcomes sought.
- Ensure the plan is consistent with existing regulatory and operational frameworks and considers potential future frameworks.
- Include assessment of the interoperability of a UTM system with existing and potential future ATM systems and processes.
- Establish a UTM system pilot program.

Key performance/delivery dates:

- Within 60 days after enactment (September 13, 2016): initiate research plan development (completed).
- Within 180 days after enactment (January 11, 2017): complete research plan, post to FAA website, and submit to Congress.
- Within 90 days after completion of research plan (April 11, 2017): establish a UTM system pilot program.
- Within 180 days of establishment of pilot program (October 8, 2017): submit update on status and progress.

2 Document Scope & Purpose

This document lays out the high level UTM RTT Plan with risk-adjusted schedules for the associated activities and key milestones of the UTM RTT. The UTM RTT Plan document provides a common reference of risk-adjusted activities and schedules across FAA/NASA, as well as the UTM larger community to develop Research Transition

Products supporting the UTM construct. It provides the information required to respond to the research plan requirements described in the FAA Reauthorization (2016). Finally, it focuses on details of the collaborative efforts of the RTT to advance the safe operation of UAS in the NAS.

2.1 Research Transition Products (RTPs)

Research Transition Products (RTPs) refer to artifacts and information that serve as the output from the collaborative efforts. Each RTP identified in this plan will, generally, be organized as follows when delivered:

1. Description
2. Elements of the RTP
3. NASA Research Contributing to the RTP
4. Maturity Level of RTP at Transition
5. Research Transition Date
6. Intended FAA or UAS Community Use of the RTP
7. Coordination

3 Scope of the UTM RTT – through September, 2020

3.1 Goals and Objectives of UTM RTT

- Conduct research, development, and testing to identify airspace operations requirements that enable large-scale visual and beyond visual line of sight (BVLOS) UAS operations in the low-altitude airspace.
 - Collaborate across government agencies
 - Collaborate with industry and leverage capabilities and insights – More than with any other RTT
 - Use UTM research platform for simulations and tests
 - Partner with FAA test ranges
- Use build-a-little-test-a-little strategy – Remote areas to urban areas.
 - Low density - No traffic management required, but understanding of airspace constraints
 - Cooperative traffic management - Understanding of airspace constraints and other operations
 - Manned and unmanned traffic management - Scalable and heterogeneous operations
- Ensure UTM RTT approach offers path towards scalability.
- The scope of the UTM effort encompasses operational concepts, procedures, and technologies supporting UAS operations, including:

- Predominantly small UAS (less than 55lbs)
- BVLOS of the operator
- Low altitudes (initially at or below 400 feet AGL)
- Initially Class G, but may evolve to include all airspace classes (B, C, D, & E) except Class A
- Airspace where the FAA does not interact directly (e.g., no controller clearances to each vehicle)

3.2 Goals and Objectives of UTM RTT Plan

- Tech transfer – to FAA and industry.
 - Concepts and requirements for data exchange and architecture, communication/navigation and detect/SAA, and other detailed technical documentation regarding operator to operator interaction and operator to Air Navigation Service Provider (ANSP) interactions
 - Multiple, coordinated BVLOS UAS operations (Aligned with TCL1/2)
 - Multiple BVLOS UAS and manned operations (Aligned with TCL3)
 - Multiple operations in urban airspace (Aligned with TCL4)
- Tech transfer to FAA.
 - Flight Information Management System prototype (software prototype, application protocol interface description, algorithms, functional requirements)

4 Coordination with other RTTs

NASA Airspace Operations and Safety Program will coordinate with the project leadership and NASA RTT Co-Leads to ensure that proper coordination, de-confliction, and application of lessons learned are conducted and implemented across all RTTs.

The FAA UTM Team Co-lead will disseminate this UTM Plan and will coordinate with the other FAA RTT Co-leads and FAA UAS/UTM Stakeholders to ensure proper coordination of activities between UTM and other research activities.

5 UTM RTT Membership

FAA and NASA have established a UTM RTT to orchestrate and guide joint research efforts to develop and mature UTM concepts, data exchange, and engineering supporting the implementation of UTM technologies and operations. The members of the RTT are identified in Table 5-1:

Table 5-1 UTM RTT Membership

FAA	
Steve Bradford	RTT Co-Lead
Sherri Magyarits	Concepts & Use Cases Co-coordinator
Maureen Keegan	Concepts & Use Cases Co-coordinator

Diana Liang	Data Exchange & Information Architecture Co-coordinator
Jarret Larrow	Sense & Avoid Co-Coordinator / Communication & Navigation Co-coordinator
NASA	
Parimal Kopardekar	RTT Co-Lead & Concepts & Use Cases Co-coordinator
Tom Prevot	Concepts & Use Cases Co-coordinator
Joseph Rios	Data Exchange & Information Architecture Co-coordinator
Marcus Johnson	Sense & Avoid Co-Coordinator
Jaewoo Jung	Communication & Navigation Co-coordinator

6 NextGen, NASA, and Industry Evaluation and Demonstration Partnership

- The research activities described in this document are supported by the full range of NASA and FAA research and development capabilities.
- Facilities expected to support the effort include FAA test ranges in Alaska, North Dakota, Nevada, New York, Virginia, Maryland and Texas, as well as the FAA William J. Hughes Technical Center and various NASA test facilities.
- Will support joint FAA/NASA/UAS Community (Industry) integrated, system-level evaluations and demonstrations of UAS concepts and technologies.

7 The UTM JMP

The detailed plans for each of the JMP sub-groups will collectively serve to support the overarching UTM RTT objectives and directives through the following:

- Define and build consensus between the FAA and NASA on the concepts and technologies associated with UTM, including definitions of UTM-related terms, an airspace framework to guide RTT development, operational and technological assumptions, and requirements associated with the UTM concept.
- Develop and/or review supporting use cases, information flows, roles and responsibilities of those entities interacting with UTM, performance, and prototype technologies and capabilities – products that will serve as input to the congressionally-mandated pilot program and all UTM RTT objectives.
- Ensure synthesis of key operational principles and technology drivers across concepts, data architecture, performance, and engineering to inform FAA and industry partners.

7.1 Integrated approach to UTM JMP Subgroup plans and deliverables

In the JMP, each subgroup is characterized by its goals and objectives, membership, products and activities, interdependencies, and schedule. Each subgroup has a particular focus within the UTM research, with specific goals to meet the UTM RTT objectives. Each subgroup is responsible for multiple RTPs that will provide information regarding

UTM operations to UTM stakeholders. The list of the milestones and deliverables for each subgroup are described, including high level scope and expected delivery in the sections below. In addition to the products delivered by each subgroup, these subgroups will not act independently, but rather, perform interdependent research to provide necessary inputs and feedback for the other subgroups in an integrated fashion.

As a general rule, the Concepts & Use Cases (CWG) subgroup will be providing the conceptual framework within which each of the other subgroups will explore scenarios and use cases in their respective areas of research. In this way, the Data Exchange & Information Architecture (DWG) subgroup will take outputs from the CWG to identify, develop, and test expected data exchanges and architectural implications and challenges. Similarly, the Com/NAV and SAA subgroups will perform analyses on the use cases & scenarios from the CWG to identify and evaluate key performance and operations challenges and constraints to guide their research. Each subgroup, in turn, will return outputs from their respective evaluations as clarifying and refining data for the CWG to include as it progressively elaborates the UTM concept of operations annually. In addition, there is also an expectation that each subgroup will be sending additional inputs to the other subgroups to inform prototype design, system performance characteristics, communications constraints, and other interdependencies throughout the course of the plan.

It should also be noted that the UTM Research Platform, which completed the TCL1 UTM capability in 2015, will serve as a central, cross-subgroup, integrating platform to test and explore the concepts, data exchange, SAA, and com/nav research. Although it is recognized that TCL1, which explored multiple UTM operations, was completed prior to the stand-up of the UTM RTT, work in the subgroups will include evaluation of scenarios, concepts, and research outcomes from TCL1 to gain relevant insight as the research progresses. Moving forward, the subgroups' research will be used to influence the testing and research for TCL 2 – 4.

Finally, an aggregated schedule of the products across the fields of research, along with key UTM research platform milestones and statutory requirement timelines, is illustrated in the UTM JMP to demonstrate the breadth and interplay across the subgroup activities to support the expected research and technology transfer objectives identified in the UTM RTT Plan.

7.2 UTM RTT Risk Adjusted Schedule

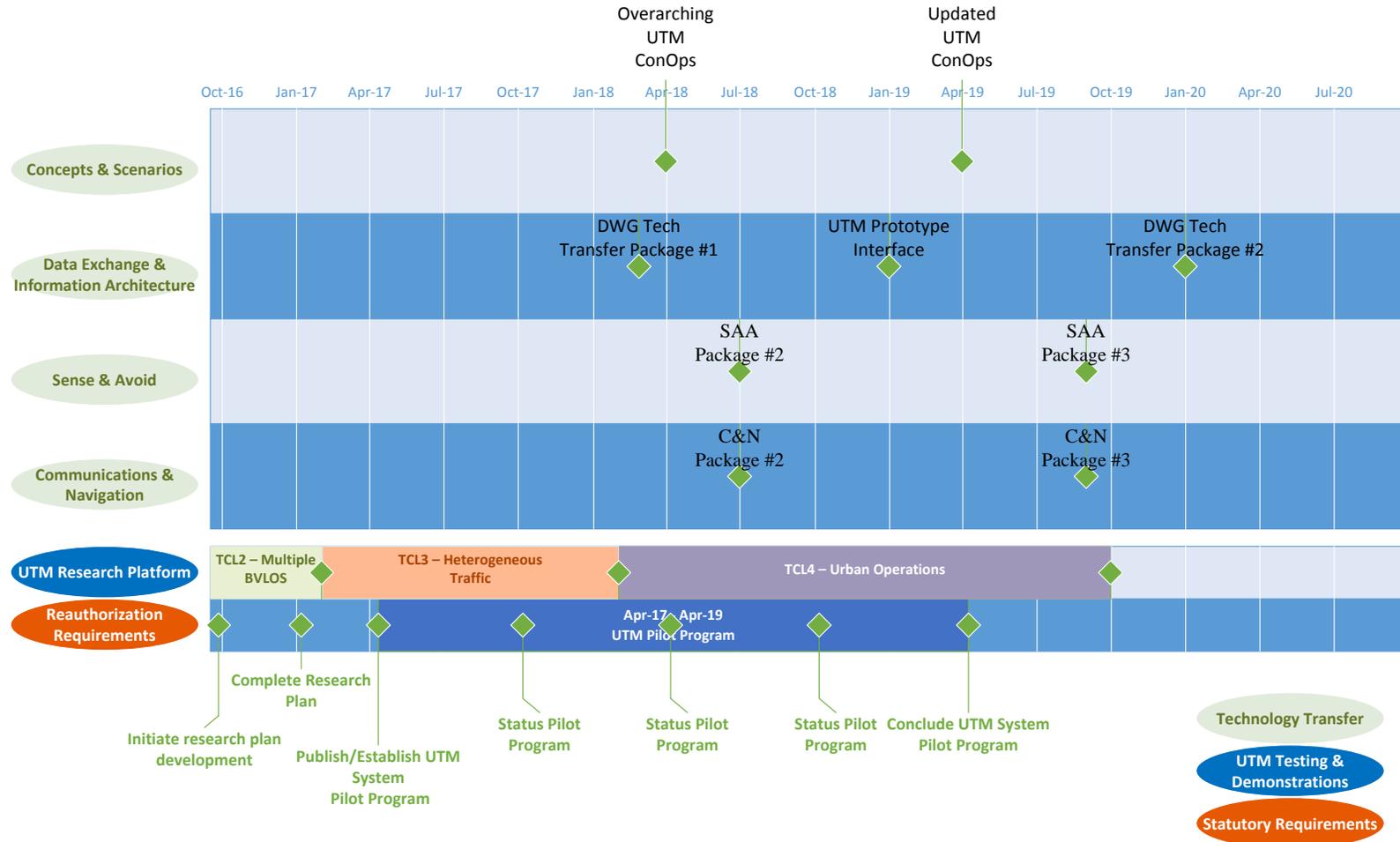


Figure 7-1 UTM RTT Risk Adjusted Schedule The UTM RTT schedule depiction across subgroups (L1) reflects the planned working schedule(s) as an aggregated summary of the work in each subgroup as well as the planned Research Platform Testing Phases and Reauthorization timelines.

8 Detailed plans of the JMP subgroups

8.1 Operational Concept & Scenarios Subgroup

The CWG will define the concept of UTM in terms of overall conceptual principles and assumptions, including those associated with operations, supporting architecture, information flows and exchanges, and FAA and UAS operator roles and responsibilities. This scoping and definition will: (1) ensure consistent messaging of a coordinated FAA/NASA view of UTM; (2) guide the efforts of other UTM RTT working groups; and (3) support the development of the UTM pilot program.

The CWG will focus on select use cases that span the primary range of UTM operations. The CWG will also assess the probable timeframe associated with enabling the use cases to help prioritize focus. The CWG will review these use cases to assess their application and consistency with the overall focus/scope and concept definition of UTM. The CWG will develop additional scenarios/use cases as necessary to explore the range of operations expected and ensure adequate coverage of UTM operations and how UTM data exchange may support these.

The CWG will determine the allocation of UAS operator, FAA/ANSP, and manned aircraft operator roles and responsibilities for different aspects of UTM operations using the agreed upon concepts and use cases, as well as products/input from other UTM RTT working groups (e.g., SAA, Information & Data Exchange). The range of operations across airspace classes and authorized areas of operation will be considered, along with any other distinguishing factors.

8.1.1 Goals and Objectives

- Define and build consensus between the FAA and NASA on the concepts associated with UTM, including definitions of UTM-related terms, an airspace framework to guide RTT development, initial scope of the CWG RTT, and assumptions associated with the UTM concept.
- Develop and/or review supporting scenarios/use cases, information flows, and roles and responsibilities of those entities interacting with UTM – products that will serve as input to the congressionally-mandated pilot program and all UTM RTT Working Groups as required.
- Conduct joint validation activities with NASA and UTM community on solution concept of operations and associated scenarios/use cases with respect to operational feasibility, technologies, business cases, stakeholder values, and other inputs to the UTM conceptual framework.
- Ensure UTM Working Groups are remaining within scope and products are consistent with the UTM concept, as defined, and adhere to the operating principles in the UTM scenarios/use cases.
- Support the UTM RTT Working Groups in any required further definition, and/or development of the UTM concept.

8.1.2 RTPs & Activities

Table 8-1 Operational Concept & Scenarios Subgroup Deliverables

Document #	Products (RTP) & Activities	Description of Content or Activity
1.	UTM Concept of Operations	Overarching concept for UTM operations that serves as a foundational construct for UTM scenarios and use cases. Updated as needed to reflect the outcome of research, demonstrations, and increasing information from across the subgroups and TCL demonstrations.

8.1.3 Schedule

Table 8-2 Operational Concept & Scenarios Schedule

Document #	Planned Date	Products (RTP) & Activities
1.	March 2018 – Updated Annually	Overarching UTM Concept of Operations

Schedule identifying delivery dates for RTPs and execution dates for activities (trials, demonstrations, etc.).

8.2 Data Exchange & Information Architecture Subgroup

8.2.1 Goals and Objectives

The objective of the DWG is to identify and collaboratively research and develop technical capabilities for the data/information exchange needed across stakeholders to support UAS operations that meet NAS service expectations. The data exchange and information architecture subgroup will work in conjunction with the Concepts & Scenarios, SAA, and Communications & Navigation subgroups to identify the data exchange and information gaps and/or deltas associated with the UTM concepts, strategies, and system capabilities to support safe expansion of the UAS operating envelope across the NAS structure.

Of immediate need and focus is the sUAS population and methods/mechanisms to meet information exchange and sharing within and across stakeholders such as; UAS Operator, UAS Service Suppliers (USS), ANSP, and airspace users other than UAS operators (including manned aircraft operations). These identified shortfalls will be analyzed to form a set of data exchange and information architecture requirements, recommended updates and extension to data standards, and technical documentation to facilitate technology transfer to stakeholders. Specific areas of exploration and effort include:

Data Exchange:

- Identify and collaboratively develop standards, protocols, and guidelines for provision and exchange of the data/information needed across stakeholders to support UAS operations that meet NAS service expectations.
 - Operator - Operator
 - Operator - NAS/ATM systems

- Complete concept engineering for the development of:
 - Flight Information Management System for data exchange between ANSP and UTM stakeholders
 - Required data exchange and supporting information architecture to enable UTM stakeholder interactions between UAS Operator, USS, and ANSP
 - Develop data exchange requirements for NAS AIXM/FIXM to support UTM
 - Conduct joint demonstration with NASA and UTM community on data exchange

Information architecture:

- Explore options with regard to:
 - Architecture and functionality / performance best meets regulatory needs for information access/provision to UTM participants and operators
 - Infrastructure needs to satisfy UTM data/information exchange requirements
- Develop architecture requirements for FAA system(s) to support UTM.

8.2.2 RTPs & Activities

Table 8-3 Data Exchange & Information Architecture Subgroup Deliverables

Document #	Products (RTP) & Activities	Description of Content or Activity
1.	Data Exchange & Information Architecture Technology Transfer Package #1	UTM Interface Control Document (ICD), UTM API, UTM data model gap analysis, information exchange schemas and data dictionaries, and other technical documentation supporting technology transfer of TCL1/2 capabilities: Including with multiple operations under constraints, BVLOS, and other scenarios.
2.	UTM Prototype Interface	Flight information management system prototype demonstrating capabilities of the ANSP interface for UTM and prototype capabilities for UTM stakeholder coordination.
3.	Data Exchange & Information Architecture Technology Transfer Package #2	Updates to technical documentation including UTM ICD, UTM API, UTM data model gap analysis, information exchange schemas and data dictionaries supporting technology transfer of TCL3/4 capabilities: Including operations over people, mixed environments, urban operations, large scale contingencies, and other scenarios.

8.2.3 Schedule

Table 8-4 Data Exchange & Information Architecture Subgroup Schedule

Document #	Planned Date	Products (RTP) & Activities
1.	February 2018	Data Exchange & Information Architecture Technology Transfer Package #1
2.	December 2018	UTM Prototype Interface

3.	December 2019	Data Exchange & Information Architecture Technology Transfer Package #2
----	---------------	---

Schedule identifying delivery dates for RTPs and execution dates for activities (trials, demonstrations, etc.).

8.3 Sense & Avoid Subgroup

8.3.1 Goals and Objectives

The objective for this subgroup is to explore operator solutions to ensure that unmanned aircraft do not collide with other aircraft (unmanned [UA] or manned). Specific areas of exploration include:

- In conjunction with Communication and Navigation Subgroup, analyze effectiveness of operational coordination through sharing of intent information in combination and in contrast to active avoidance, and through SAA capabilities for each use case identified by the CWG consistent with the phase of operation. Consider relative performance of both navigation and SAA capabilities.
- For each use case identified by the CWG consistent with the phase of operation, analyze trade-space between sensing and detection capability of UA versus the UA's capability to maneuver.
- Evaluate technology options for sharing positioning information in use cases. Potential considerations for radio frequency and network capacity, interoperability, density of operations, priority of positioning information on technology, reliability, etc. Explore industry wide solutions sets for near-term and longer-term operations.

Compliance and Data Collection

- Explore options for reporting on issues pertaining to SAA. Document best practices for operators and capture any recommendations for regulator macro-collection efforts.
- Evaluate operational corrective processes. With consideration for SAA, investigate data collection processes that could be used to take lessons learned to reinforce operational compliance. Potential considerations for data exchange between operator and UA manufacturer.

8.3.2 RTPs & Activities

Table 8-5 Sense & Avoid Subgroup Deliverables

Document #	Products (RTP) & Activities	Description of Content or Activity
1.	SAA Technical Documentation Package – Heterogeneous Traffic	Guidance to industry for assuring collision avoidance in dense UA environments, determining minimum separation standards for various technology solutions, and overall SAA system performance in avoiding manned aircraft. Report based on the evaluation of Scenarios & Use Cases Packages to include:

		<ul style="list-style-type: none"> - Conflict scenarios between UA and UA - Conflict scenarios between UA and manned aircraft - Analysis of minimum separation - Data sharing requirements <p>Analysis of SAA system-level performance.</p>
2.	SAA Technical Documentation Package – Large-scale contingencies mitigation	<p>Guidance to industry for assuring collision avoidance in dense UA environments, determining minimum separation standards for various technology solutions, and overall SAA system performance in avoiding manned aircraft.</p> <p>Report based on the evaluation of Scenarios & Use Cases Packages to include:</p> <ul style="list-style-type: none"> - Conflict scenarios between UA and UA - Conflict scenarios between UA and manned aircraft - Analysis of minimum separation - Data sharing requirements <p>Analysis of SAA system-level performance.</p>

8.3.3 Schedule

Table 8-6 Sense & Avoid Subgroup Schedule

Document #	Planned Date	Products (RTP) & Activities
1.	June 2018	SAA Technical Documentation Package – Heterogeneous Traffic
2.	August 2019	SAA Technical Documentation Package – Large-scale contingencies mitigation

Schedule identifying delivery dates for RTPs and execution dates for activities (trials, demonstrations, etc.).

8.4 Communications and Navigation Subgroup

8.4.1 Goals and Objectives

The objective for this subgroup is to explore operator solutions to ensure that UA are under operational control of the pilot (to the degree appropriate to the scenario) and remain within a defined area (around a planned trajectory or as a defined area). Specific areas of exploration include:

Command and Control

- For each use case identified by the CWG consistent with the phase of operation, define command and control (C2) performance attributes appropriate to the intended operation.
- Analyze methodologies and tools available to operators to assure there is sufficient C2 performance/coverage to ensure appropriate operational control for intended use cases. Potential considerations could include interaction with third

party providers, static terrestrial communication equipment, dynamically located equipment, and satellite communication.

- For each use case identified by the CWG consistent with the phase of operation, explore tradeoff of levels of C2 performance with differing levels of automation on the UA.
- Provide best practices for operator to plan for and manage off-nominal operational situations.

Navigation/Positioning

- For each use case identified by the CWG consistent with the phase of operation, define navigation/positioning performance attributes appropriate to respect airspace boundaries and/or designated routes.
- Explore common practices UA manufacturers could take to help in operator conformance to an airspace boundary¹.
- Investigate methodologies and tools available to operators to provide additional assurance of the ability of the UA to remain within a defined area.
- Provide best practices for operator to plan for and manage off-nominal operational situations.
- In conjuncture with the SAA Subgroup, analyze effectiveness of operational coordination through sharing of intent information in combination and in contrast to active avoidance, and through SAA capabilities for each use case. Consider relative performance of both navigation and SAA capabilities.

Compliance and Data Collection

- Explore options for reporting on issues pertaining to C2 and navigation operational performance. Document best practices for operators and capture any recommendations for regulator macro-collection efforts.
- Evaluate operational corrective processes. With consideration for C2 and navigation operational performance parameters, investigate data collection processes that could be used to take lessons learned to reinforce operational compliance. Potential considerations for data exchange between operator and UA manufacturer.

8.4.2 RTPs & Activities

Table 8-7 Communications & Navigation Subgroup Deliverables

Document #	Products (RTP) & Activities	Description of Content or Activity
1.	Technical Documentation Package – Heterogeneous Traffic	Report based on the evaluation of Scenarios & Use Cases Packages to include: - Communication and Navigation (C&N) guidance to industry for Use Case Packages – test & performance methodologies for

¹ Airspace boundary could be either stay-out, such as a ‘No Drone Zone’ or stay-in.

		maintaining operational control and remaining in designated areas or on designated routes - C&N best practices for performance data collection and aggregation of communication and navigation performance data
2.	Technical Documentation Package – Large-scale contingencies mitigation	Report based on the evaluation of Scenarios & Use Cases Packages to include: - C&N guidance to industry for Use Case Packages – test & performance methodologies for maintaining operational control and remaining in designated areas or on designated routes - C&N best practices for performance data collection and aggregation of communication and navigation performance data

8.4.3 Schedule

Table 8-8 Communications & Navigation Subgroup Schedule

Document #	Planned Date	Products (RTP) & Activities
1.	June 2018	Technical Documentation Package – Heterogeneous Traffic
2.	August 2019	Technical Documentation Package – Large-scale contingencies mitigation

9 Pilot Program Transition Plan [Pending]

- Consistent with the requirements identified in the FAA Reauthorization (2016), this section is planned for development following delivery of the initial UTM RTT Plan and the associated UTM Research Plan.
- Plan description focused on:
 - meeting requirements of legislation
 - development of prototype (for notification/authorization)
 - demonstration of capabilities (UTM)
- Description of relationship to other subgroup activities/dependencies.

Appendix A: Acronyms & Glossary

Acronym or Term	Description
AGL	Above Ground Level
AIXM	Aeronautical Information Exchange Model
AJV	FAA Office of Mission Support
ANG	FAA Office of NextGen
AOB	At or below
AOSP	Airspace Operations and Safety Program
APREQ	Approval Request
ARMD	Aeronautics Research Mission Directorate
ATM	Air Traffic Management
ATM	Air Traffic Management
ATM Community	The aggregate of organizations, agencies or entities that may participate, collaborate and cooperate in the planning, development, use, regulation, operation and maintenance of the ATM system. Includes, among others, aerodrome community, airspace users, ATM service providers, etc. [Re: Global ATM Operational Concept (ICAO Document 9854)]
ConOps	Concept of Operations
EA	Enterprise Architecture
EFICA	Efficient Flight into Constricted Airspace
FAA	Federal Aviation Administration
FIXM	Flight Information Exchange Model
HITL	Human in the Loop
IOC	Integrated Operations Center
JSON	JavaScript Object Notation
MSL	Mean Sea Level
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NextGen	Next Generation (Air Transportation System)
PBN	Performance-Based Navigation
PMO	Program Management Office
R&D	Research and Development
RTP	Research Transition Product
RTT	Research Transition Team
SWIM	System Wide Information System
TC	Technical Challenge
TCL	Technical Capability Level
TFM	Traffic Flow Manager

Acronym or Term	Description
TFMS	Traffic Flow Management System
TMI	Traffic Management Initiatives
TRACON	Terminal Radar Approach Control Facility
TRL	Technical Readiness Level
UAS	Unmanned Aircraft System
USS	UAS Service Suppliers
WJHTC	William J. Hughes Technical Center
WXXM	Weather Information Exchange Model
SAA	Sense and avoid