Formulative Input into Future NASA Aeronautics Planning

10/17/2019

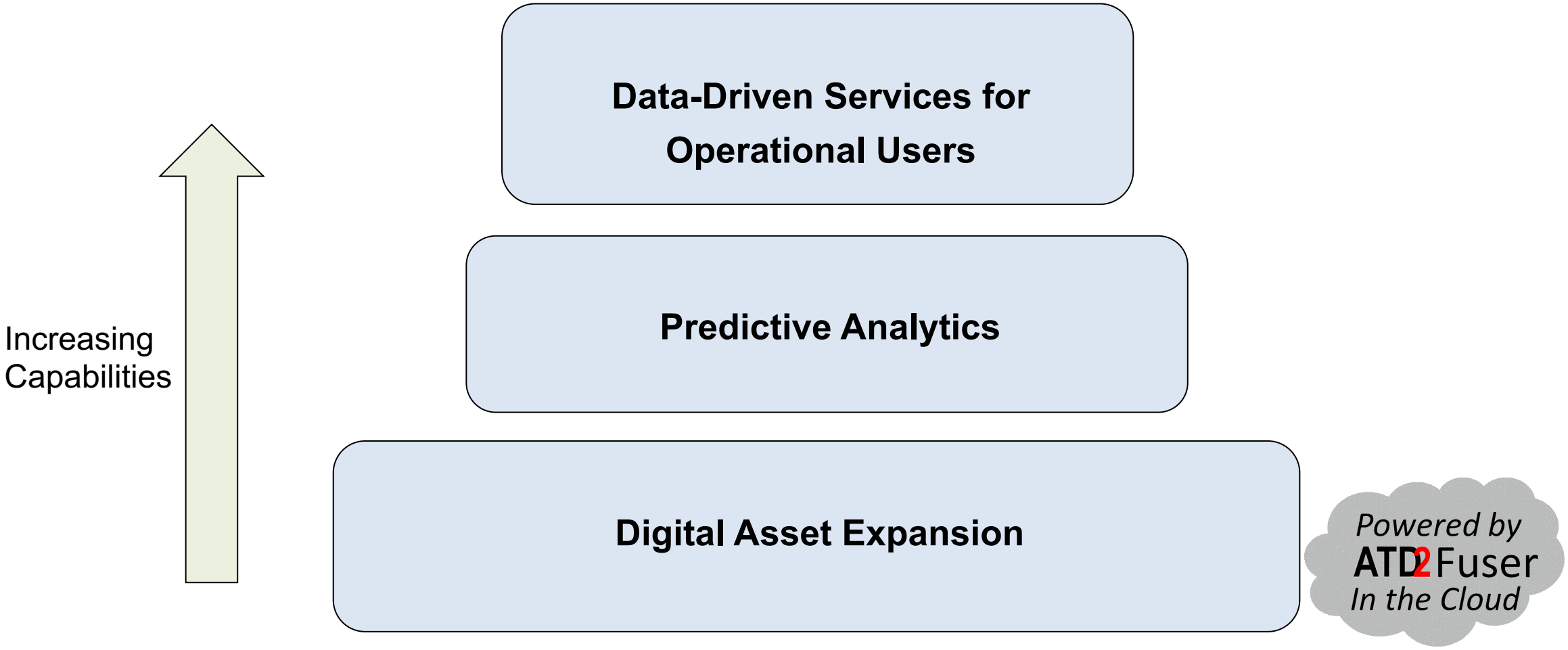
Goals of Efforts

- Goals of FY21-FY25 NASA investments in this area of aviation services:
  - Lower the barrier of entry for new industry solutions in aviation
  - Address challenging aviation system-wide problems that are difficult to solve in isolation
  - Establish an innovative marketplace within which new solutions can evolve
  - Maximize investment across domains and stakeholders through federation/consortiums
  - Leverage recent and emerging data science technology breakthroughs
  - Identify additional investments in future NASA aviation research portfolio investments

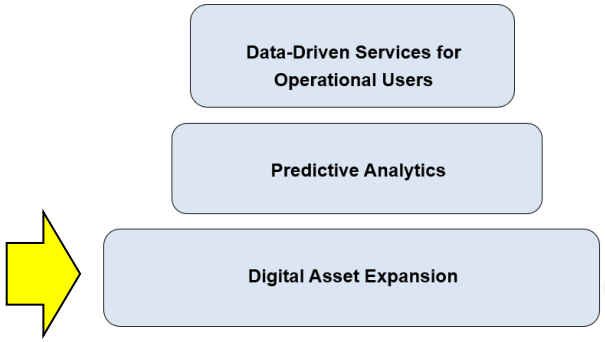
Formulative Input Timeline Leading Up to Today

- 9/5 NASA initiated dialog on formulative input for planning (requirements elicitation)
- 9/16 Initial feedback was incorporated into the following narrative for refined input.
- 9/17-10/11 NASA captured additional Industry input on revised slides (included here)
- 10/17 Today is a briefing both on the revised slides and input received thus far
- 10/17-10/31 You can provide additional comments for formulation until October 31st

Overview of Technology Areas NASA Received Significant Input



Expansion of NAS Digital Assets is a Foundational Need



Expressed interest in collaboration:

- Alaskan Airlines
- American Airlines
- Delta Air Lines
- United Airlines
- Southwest Airlines
- FAA SWIFT
- Your organization?

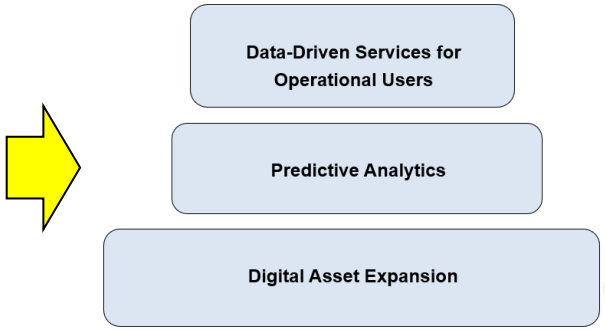
- Significant progress has been made in recent years on provisioning new data that was previously not available at all electronically, or only available in ATC systems
  - Substantial additional progress is needed for NAS evolution

- Investments in this area seek to
  - Produce "***operational quality***" data that the aviation community can leverage as a basis for new services. NASA work leverages "Fuser in the Cloud" and a process that allows it to evolve to meet needs while transferring solutions to Industry.
  - Identify additional data needs that would ***yield high benefit***. Known needs exist in TBFM delay/impact data, current and future capacity reporting, missing ATC or airport restrictions, etc. What are the biggest areas of need?
  - Engage and evolve the ***NAS-wide data governance process***. Helps flush out how new requirements for data provision and identify robust measures of quality. How do we improve the quality of data without an objective measure of quality?
  - Work with the community to ***identify key metrics*** that drive NAS-wide system health. Known needs are advocating for greater precision, incorporating tactical information, surface information, and analyzing current day metrics from DOT or cultural norms (e.g. D0)

Digital Asset Expansion – Strong Interest

- Provide Fuser-in-the-Cloud as aviation community wide example of SWIM flight data ingest, matching, filtering, mediation logic and lessons learned. Share the lessons, source code and results on cloud services. If this is transitioned to another entity, this work would include extensions based on community inputs (from data-centric collaborations).
- Greater digital transformation of TBFM operational data. This work includes analysis of current day delay propagation in operations and the controls within TBFM that are most relevant to varying delay.
- Greater/more arrival restriction and impact information in near real-time (on display and metrics)
- Data quality measures. This set of work focuses on objective quality measures for current day digital data as well as reporting findings to the community and the implementing organization. Quality measures may span sites, regions of airspace or other domain specific needs.
- Addition of new, available sensor data into NASA's current fusion capability. This would target the addition of one or more new data sources into the current set of fused capabilities and share the lesson's learned and logic with the aviation community.
- Compile and evolve a data dictionary across NAS aviation data that contains a mapping to the source information and a definition of the data and its potential uses.
- Identify data access right limitations that prevent broader consumption of data by the community. This may include technical or political barriers to obtaining key data which can be used to assess operational performance or more advanced algorithms

Leveraging Data Science – Predictive Analytics



Expressed interest in collaboration:

- American Airlines
- Delta Air Lines
- Southwest Airlines
- FAA SWIFT
- Your organization?

- Significant investments have been made in other markets that have advanced the state of the art in data science. However, the aviation market is not currently taking advantage of these breakthroughs for real-time decision making.
  - NAS-wide services with predictive analytics could provide substantially deeper benefits

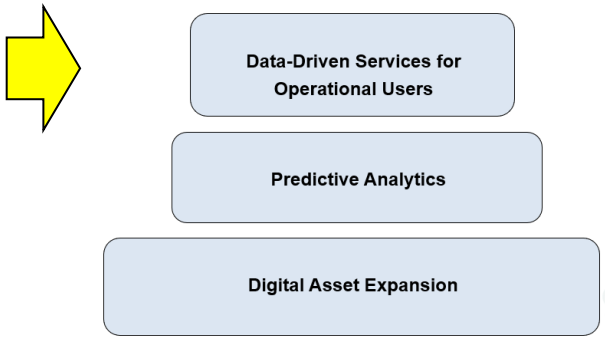
Investments in this area seek to

- Provide a community-wide platform to **grow relevant data science contributions** in an open manner that the entire aviation community can benefit from
- **Lower the cost and timelines** for solution providers to apply sophisticated data science solutions to NAS-wide challenges
- Establishing a truth-in-reporting and self-scoring framework for **objective analysis** of potential data science solutions
- **Challenge the community to innovate** in data science while identifying foundational needs that uniquely exist in the aviation market

Predictive Analytics – Strong Interest

- A processing framework (platform) that leverages data described in the digital transformation work to create operationally meaningful predictions of key events that are likely to transpire in aviation and publish the results on a cloud service that is available to the aviation community.
- Similar day analysis, and more generally classifications that help drive decisions and impact notification. Simple examples of this may be identifying a 'high traffic management restriction' day for a particular airport or region. While there could be many definitions for this classification, a community wide example could help expedite the ability to predict when a target classification if likely to occur.
- Uncertainty quantification data (NAS wide) as a function of time and domain. The idea is to empower the NAS user with information that can be used to assess the veracity of the data and associated predictions (at various look-ahead times).
- Self-scoring. Truth in reporting. This was seen as an important aspect of predictive analytics capabilities that allow a disciplined and objective analysis of how well these capabilities perform against their claims. Could be viewable across multiple services.
- Data science challenges to the community. This would financially incentivize and defines the requirements for specific aviation challenge for predictive analytics work targeting operationally meaningful problems. This would be open to a broad range of data scientists (e.g. similar to Kaggle.com data science competitions) and the results would be available to the broader community.
- Develop common aviation processing libraries for predictive analytics work. This work leverages commonly used development environments (like GitHub, etc.) to build products that others seeking to make analytical advances could leverage.
- Training data availability. This work is focused on allowing aviation-focused data scientists greater access to aviation data that NASA has available which could be used to train and test predictive models.
- Visualizations of complex operational problems. The data visualizations that can be generated via modern data science techniques can provide deep operational insights that previously were not available (or difficult to produce). This work would create and share the visualizations with the community, as well as the logic used to produce them.

Data-Driven Services for Operational Users



Expressed interest in collaboration:

- American Airlines
- Southwest Airlines
- Delta Air Lines
- CDM teams
- Your organization?

- Data-driven services are targeted at operational users of the NAS and :
  - Address challenging, multi-user problems that are difficult to plan/solve in isolation
  - Establish a mechanism for innovation from many contributors
  - Maximize investment in innovation by leveraging consortiums of interest and technological advancements that enable asynchronous electronic collaboration

Investments in this area seek to

- Help mitigate disruptions in the NAS before they happen, make good operational decisions during a disruptive event (IROP day) and help recover quickly from disruptive events
- Trailblaze NAS-wide foundational services that can lead to increases in system performance, predictability, reliability and improved experience for the flying public
- Explore the types of challenges that are most beneficial in this community-wide data-driven cloud-based environment. This exploration phase may also reveal challenges that are not a good fit.
- Establish a recurring process for candidate service selection and identification and explore market based funding mechanisms to promote their future growth

Data-Driven Services for Operational Users– Strong Interest

- Operational decision modeling services are an advanced set of capabilities to help the operational decision maker as the decision evolves over time. These are envisioned to leverage predictive analytics, business/operational rules, real-time uncertainty analysis, and other relevant insights to provide a repeatable/consistent methodology for the user to make complex decisions while managing risk/reward trade offs. Strong time-dependent decision with changing weights/factors.

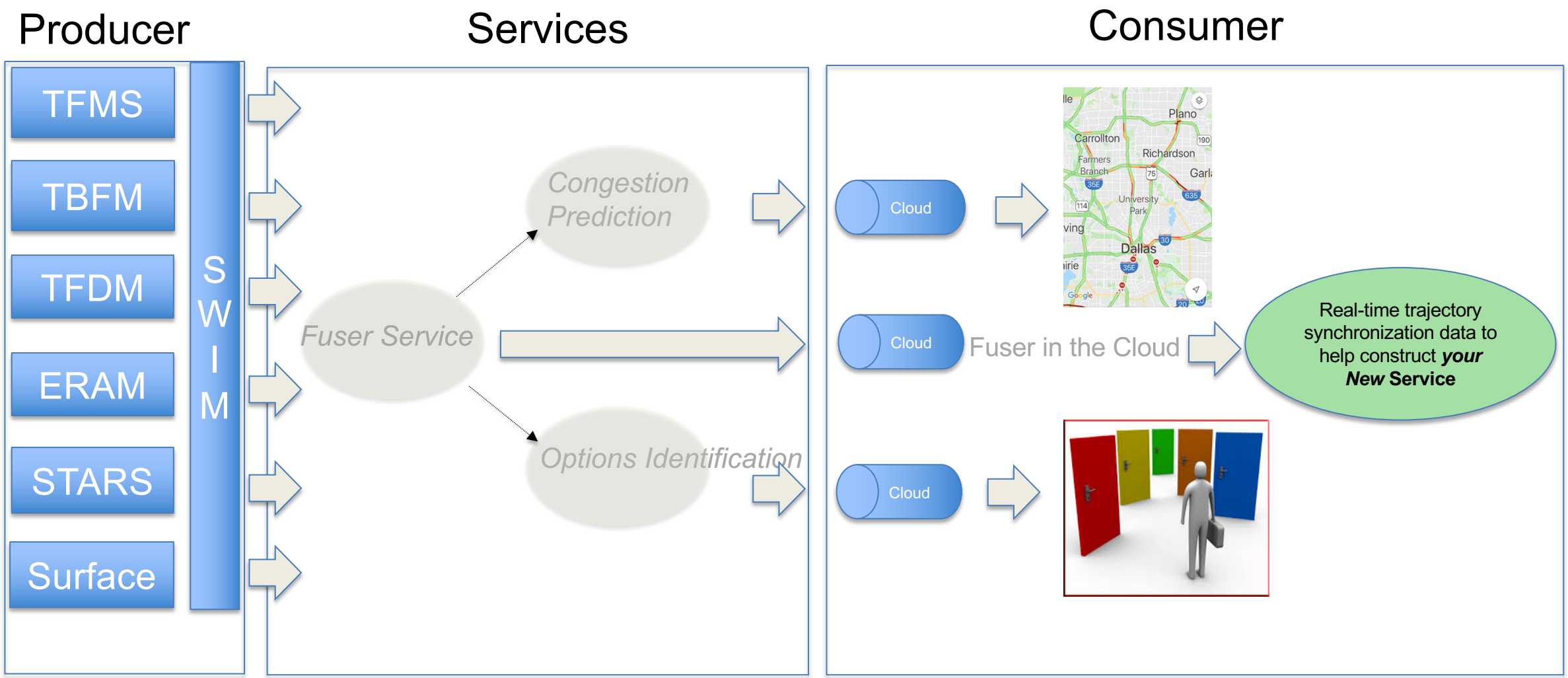
- Disruption management and recovery. This set of capabilities help to; mitigate disruptive events in the NAS before they happen, make good operational decisions during a disruptive event (IROP day) and help recover quickly from disruptive events.

- Greater NAS-wide usage of Trajectory Options Set (TOS). Significant interest in evolving all aspects of TOS usage (both strategic and tactical, inside and outside of CTOP). More demonstrations that help evolve multi-operator, multi-domain use of TOS to solve NAS challenges.

- Space flight disruption mitigation service. Increased commercial space launch is already impacting current day operations both in the initial launch and reentry. This is expected to increase substantially in coming years, which is leading to new ways of solving these challenges. The FAA, NASA and other groups within commercial industry and government have begun identifying potential solutions to these challenges.

- Gate-to-Gate congestion prediction service. This service builds and produces accurate predictions of delay flights are likely to encounter from gate-to-gate, specifies where the delay originates in the NAS and shares this information in near real-time on the cloud with operational personnel.

Building upon Existing Technologies for Data-Driven Services



Which Capabilities Will Be Developed?
Focus on Getting the Collaborative Process Right for Rapid Development

- We need your input on the most relevant use cases and vetting of the service
  - At this time in the exploratory work, NASA seeks to identify leading candidates
  - This process is envisioned to be agile and lead to additional candidate services

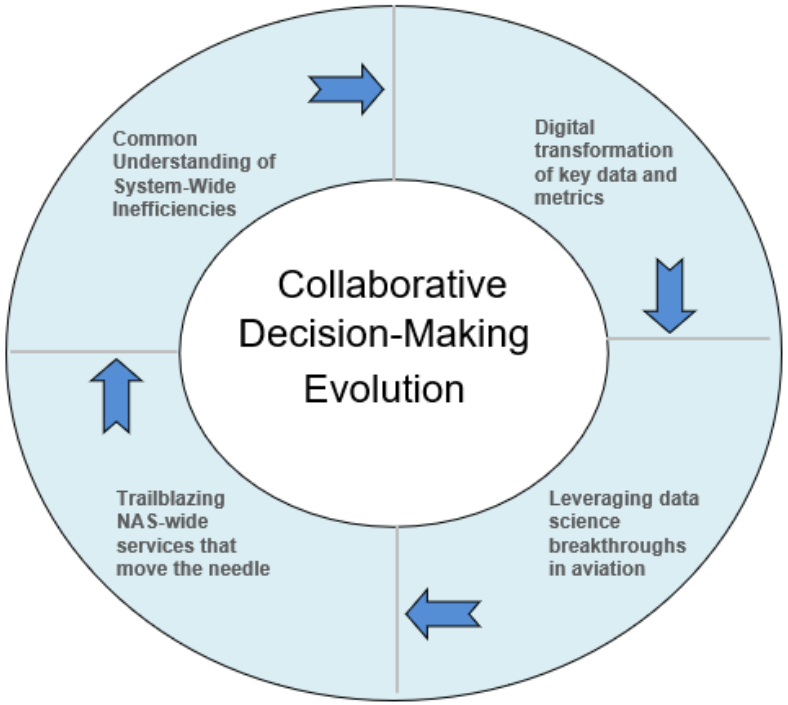
Create Candidate Service Ideas

- Multi-Operator Multi-Domain TOS Service
- Operational Decision Model Service
- Disruption Mitigation Service
- Similar Day Analysis
- Space flight disruption reduction

We are here!

Collaboratively Vet the Merits of a Candidate Service and Formulate Partnerships

Wash. Rinse. Repeat.



Formulation Input and Feedback

- Do you see value in the 3-focus areas that progressively build toward data-driven services with a solid data foundation and advanced analytics?
  - Note: strong community consensus thus far that this was the right vector.
- General questions on the overall body of work?
  - Lots on the ‘how’, and specifics that would come in next steps.
- Specific work or services you would like to see?
  - Mentioned in the previous slides. Surprisingly consistent across community.
- Willingness to collaborate and good venues to do so
  - Yes from multiple folks. If you are interested as well, let us know.
- Any additional feedback is welcome prior to Oct 31st, 2019
  - Send email to Al.Capps@nasa.gov

Thank You!

Thank you for your input!

We are listening!