

Emerging Trends in Aviation

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Outline

Airspace Operations

Supply Chain

Wildfire

Innovation

Summary

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Big Picture

One mile of surface transportation takes you one mile, whereas one mile of aviation land can take you anywhere

Vector 1: Driver/Environmental Considerations



Society and transportation could change

- Quieter, faster, and farther
- No need to congregate into higher density geographical areas
- Connects businesses without congestion
- More integrated living: business, residential, and recreational



Big Picture

One mile of surface transportation takes you one mile, whereas one mile of aviation land can take you anywhere

Vector 2: Enablers

New technology needs to be embraced

- IOT, Digitization, Electrification, autonomy, and AI/ML

Vector 3: Drivers/Need

Diversity, density, volume, complexity will continue to increase

- Commercial space
- UAS of all sizes
- Self-flying aircraft
- UAM/AAM
- Current aviation operators



Airspace “System”
Should be Ready
when Vehicles are
Ready

Need: Research to Reality

Karman Line

Class Upper E

Class A

Class E

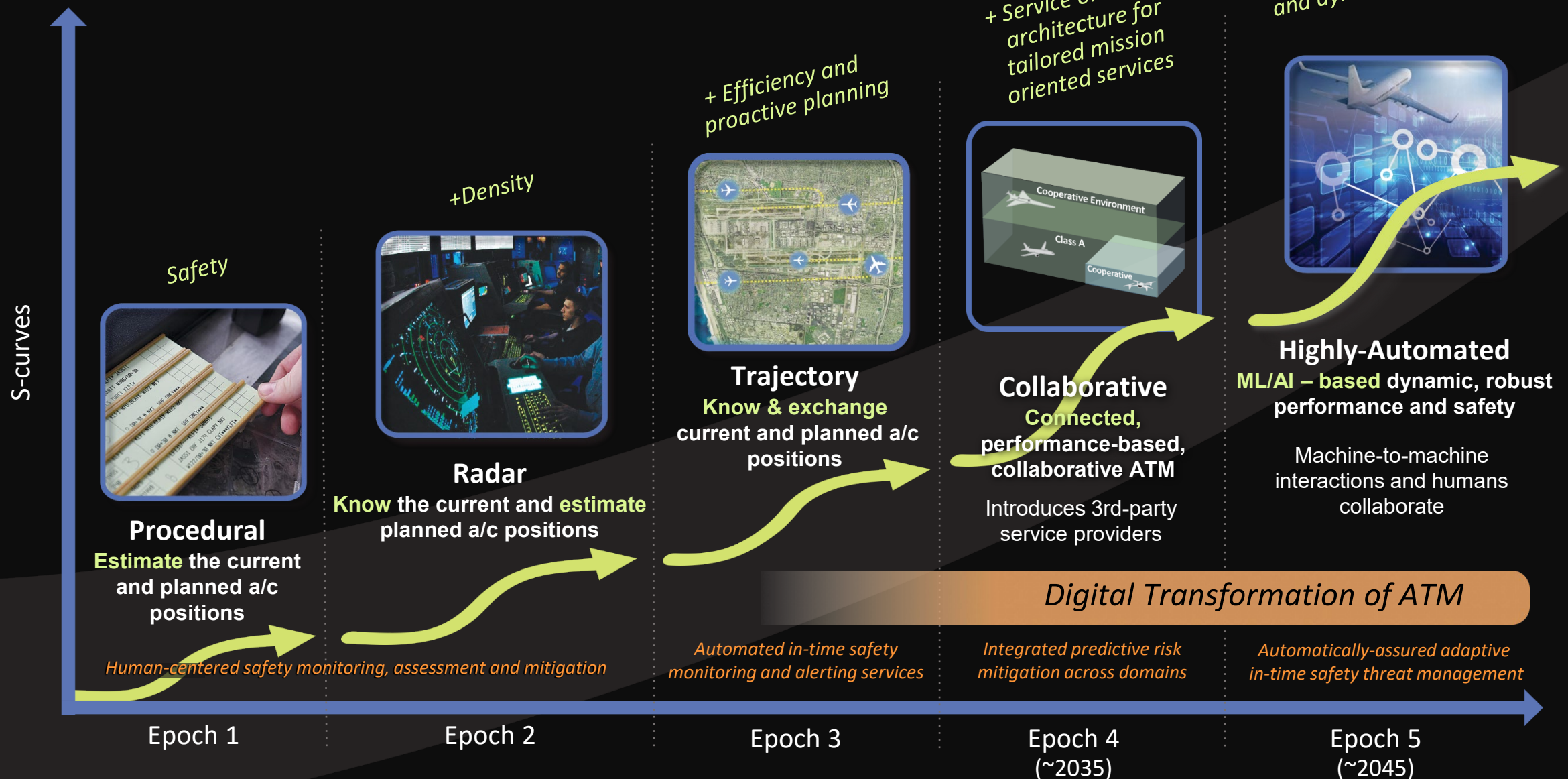
Class B, C, D

FAA

Commercial
Service
Providers

Class G

Evolution of Airspace Operations and Safety



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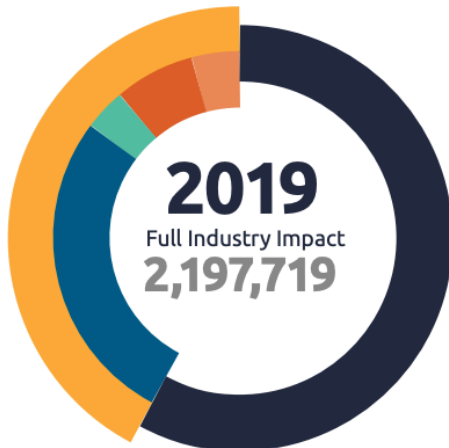
Innovation

Summary

Aerospace and Defense Industry Outlook

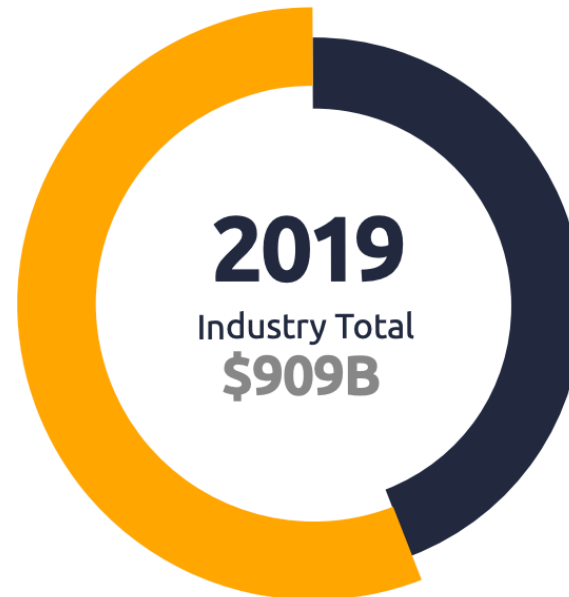
- \$909B Revenue, \$148B exports, and \$77.6B trade difference
- \$400B contributed by supply chain (44%)

Employment



Supply Chain ● 1,275,100
 End-Use ● 922,619
 Aeronautics/Aircraft ● 602,072
 Space ● 81,704
 Land & Sea Systems ● 152,893
 Cyber ● 85,948

End Use
56%
\$509B



Supply Chain
44%
\$400B

Reference: AIA 2020 Industry Outlook



Supply Chain ● \$400B
 Aeronautics/Aircraft ● \$387B
 Space ● \$42B
 Land & Sea Systems ● \$61B
 Cyber ● \$19B

7 Keys to Manufacturing and Supply Chain Success in AAM



- Digitization
- 3D Printing
- Composites
- Supply chain resiliency
- Modeling and simulation
- MRO strategy
- Standardization

Supply Chain Challenges and Strategies

Supply Chain Challenges

- Dependence on sole-source or limited suppliers
- Long lead time
- Financial challenges across the supply chain
- Large inventory needs
- No visibility in lower tiers
- Collaboration across complex supply chain
- Cyber and security
- Geopolitical considerations
- Natural disasters
- Foreign dependency
- Product security
- Gap in human capital

References:

- EY – A&D Edge, Supply Chain Management in Aerospace and Defense (Feb 2018)
- California Manufacturing Network (2018)
- Maine Pointe (Feb 2020) and many other references

Strategies*

- **Adoption of digital technologies**
- **Integration (data and supply chain network)**
- **Readiness assessment**
- **Enhance visibility in demand, supply, and constraints**
- **Provide and encourage proactive analytics, collaboration, and decision making**
- **Modeling, simulation, and analysis**
- Curriculum and training
- Monitor security
- Risks-sharing partnerships
- Cross-sourcing
- Multiple sourcing
- Local players in supply network

***Possible contributions are highlighted.**

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Wildfire Impacts

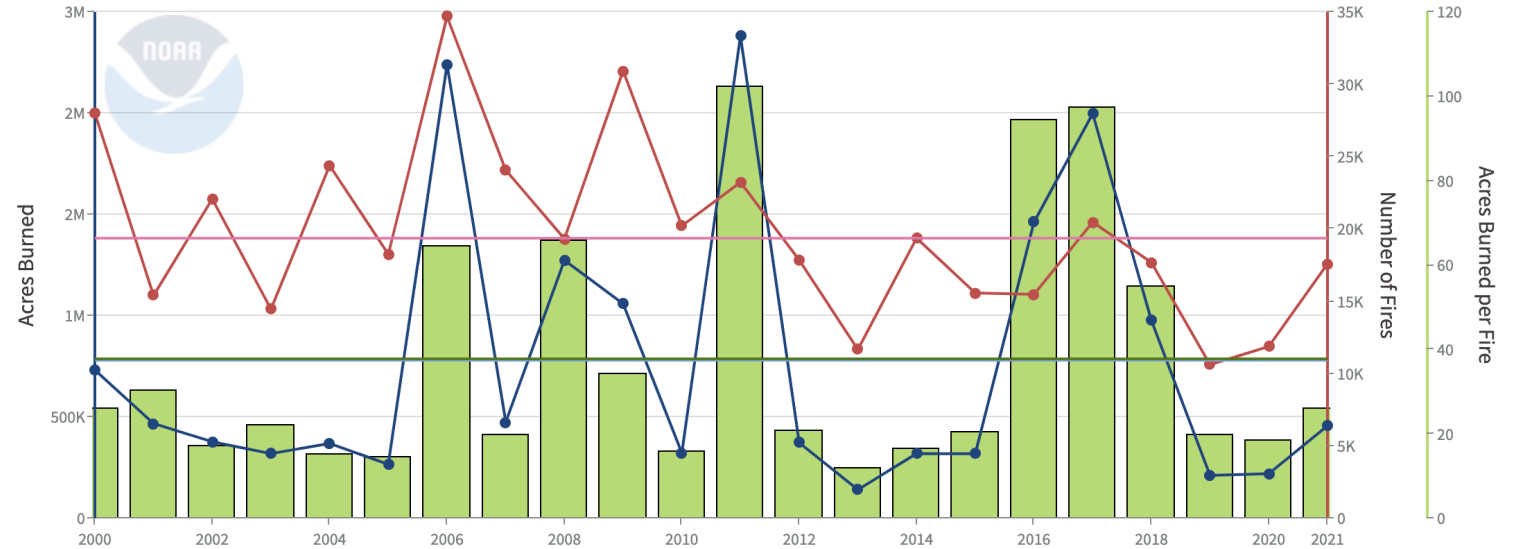
- **Total suppression costs**
 - 5-year average \$2.351B
 - 10-year average \$1.910B
- **10-year average**
 - 20,510 fires
 - 1,048,649 acres
- **2020 Statistics**
 - 58,950 fires and 10,122,336 acres
- **2021 Statistics**
 - 58,985 fires, and 7,125,643 acres

<https://fas.org/sgp/crs/misc/IF10244.pdf>

<https://www.nifc.gov/fire-information/statistics>

U.S. Wildfires

January-April



Powered by ZingChart

2021 Estimated Costs and Duration

Dixie Fire:	\$637M (over 3 months)
Beckwourth Complex:	\$542M (over 2 months)
Caldor Fire:	\$271M (over 2 months)
Monument:	\$163M (over 2 months)
Bootleg:	\$100M (over 1 month)

Wildfires contribute to climate change and climate change increases likelihood of wildfires



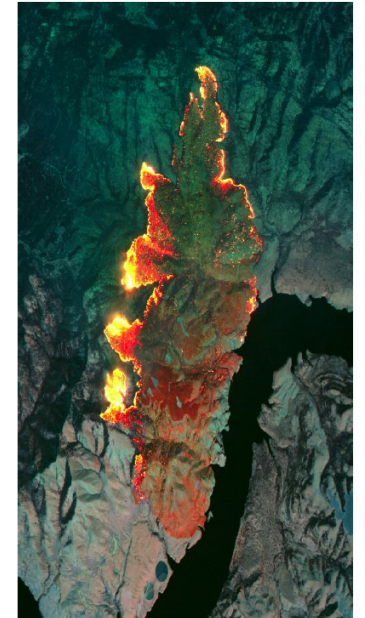
Current State-of-the-Art

NASA, in collaboration with US Forest Service, conducted a workshop to understand the state-of-the-art, needs, and opportunities to improve wildfire management

- Focused on pre-fire fighting, during fire fighting, and post fire needs
- Identify the needs and challenges of stakeholders at various decision cycles from planning, prediction, detection, tracking, mitigation, suppression, and post-fire remedial efforts
- 154 attendees from other government organizations, academia, industry, and NASA

Main Findings

- Lack of persistent surveillance for fire detection and tracking
- Lack of persistent communications
- Lack of persistent aerial operations particularly under poor visibility
- Lack of airspace technologies to enable multiple types of aircraft operating simultaneously
- Lower aircraft safety record than other areas of aviation
- Lack of adequate coordination among multiple government agencies
- Need a clear plan to mature research for operational use in the field



Workshop report available at
https://nari.arc.nasa.gov/sites/default/files/attachments/NASA%20ARMD%20WILDFIRE%20MANAGEMENT%20WORKSHOP_6.1.2021_v13.pdf

Findings offer insights where research and development could make a significant impact

Relevant Areas: Current Operations and Challenges

Detection, Tracking, Surveillance, and Prediction

- Surveillance - infrequent satellite or aircraft observations
- Fire detection accuracy is not precise enough for effective targeting
- Few models for tracking and predicting fire progress, many are unreliable
- Better sensing is needed, difficult to observe through cloudy conditions
- Data and model fusion is limited – particularly for users in the field



Aerial Suppression Support

- Duration of aerial firefighting limited to daylight, clear visibility (4-6 hours/day)
- Airspace operations are manual and workload intensive; only a few aircraft allowed at a time
- Not able to accommodate drones in the same airspace as other aircraft
- Lower aircraft safety record in aerial firefighting than other areas of aviation





Key Areas of Impact

Unified concept of operations

- Support development interagency concept of operations to ensure consistency of operational priorities, technology adoption, and programmatic alignment for national needs

Airspace management for near 24x7 continuous operations

- Airspace operations system-in-a-box for common situational awareness
- Enable simultaneous and coordinated operations of diverse vehicles

Sensing, data fusion and models integration for better prediction

- Increase access to reliable surveillance data and fire prediction models for in-time decision-making for planners and firefighters
- Develop advanced sensor fusion and fire prediction models

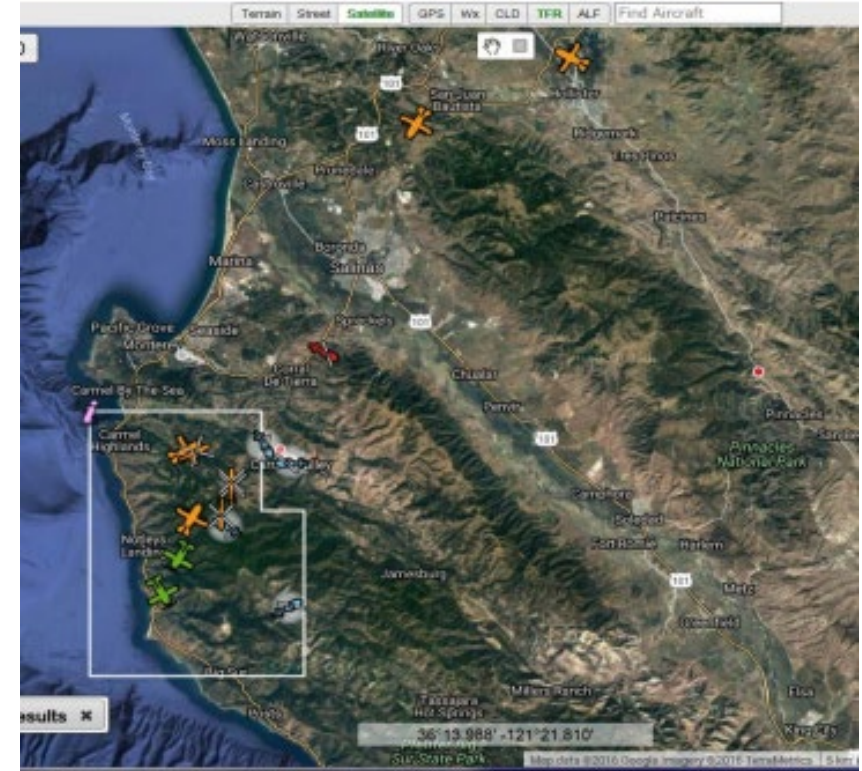
Key Areas of Impact

Aircraft capabilities for safe operations in adverse environments

- Expand operational envelope with aircraft technology for terrain avoidance and aircraft state management

Persistent, integrated, diverse manned and unmanned airspace operations

- Integrated system requirements, design and prototype for persistent surveillance and operations with multiple diverse vehicles for increased aerial response to wildfire



Prior research in airspace, aircraft, sensing, surveillance, communications, and data management is highly relevant

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Airspace Operations

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Innovation Needed

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Zero Impact Aviation



Summary

- Research to reality planning: air traffic management
- Public-Private-Philanthropic-Partnerships (P4): wildfire
- Supply chain risk planning for large-scale acquisitions
- Zero impact aviation – how do we get there?



Embracing Innovation in Aviation while Respecting its Safety Tradition

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Work for NASA, we will give you space to grow!
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