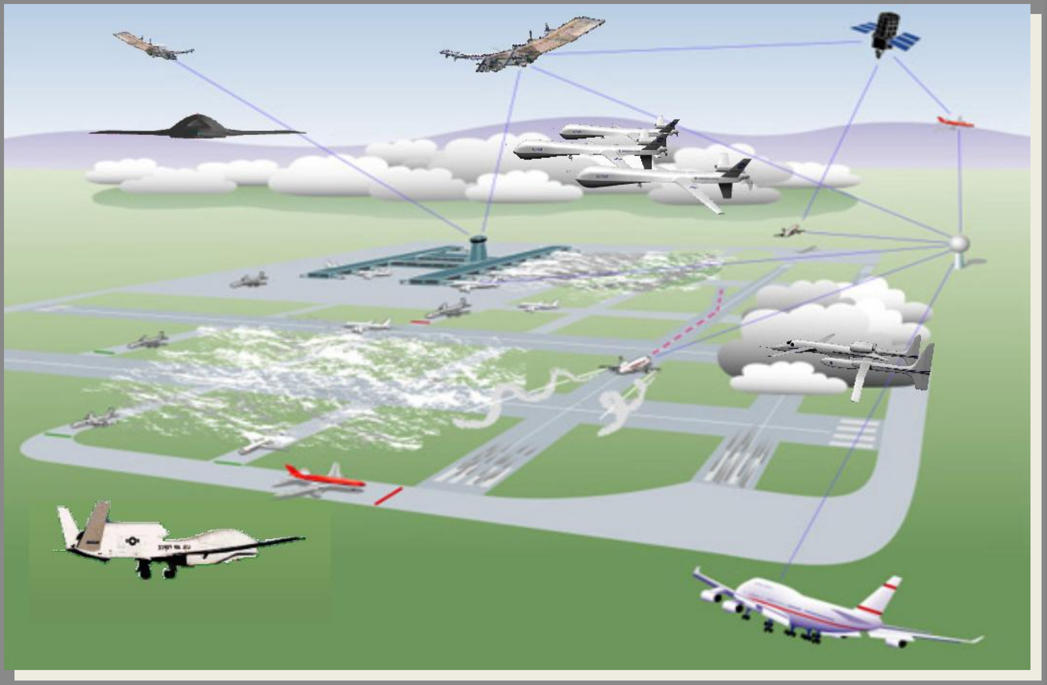
Regulatory Framework



Certification

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Langley Research Center

Meeting of Experts on NASA's Unmanned Aircraft System (UAS) Integration in the National Airspace Systems (NAS) Project

Aeronautics and Space Engineering Board
National Research Council
August 5, 2010

Where Certification Fits

- **Routine access to the NAS for UAS hinges on establishing that UAS can *operate safely* in the NAS**
  - Technologies that enable safe operation
    - Separation assurance
    - Communication
    - Command and Flight Control
    - Human Factors/Pilot Aircraft Interfaces
  - A regulatory framework that defines safe operation
    - acceptable means of compliance to the Federal Aviation Regulations (FARs) through standards and other guidance

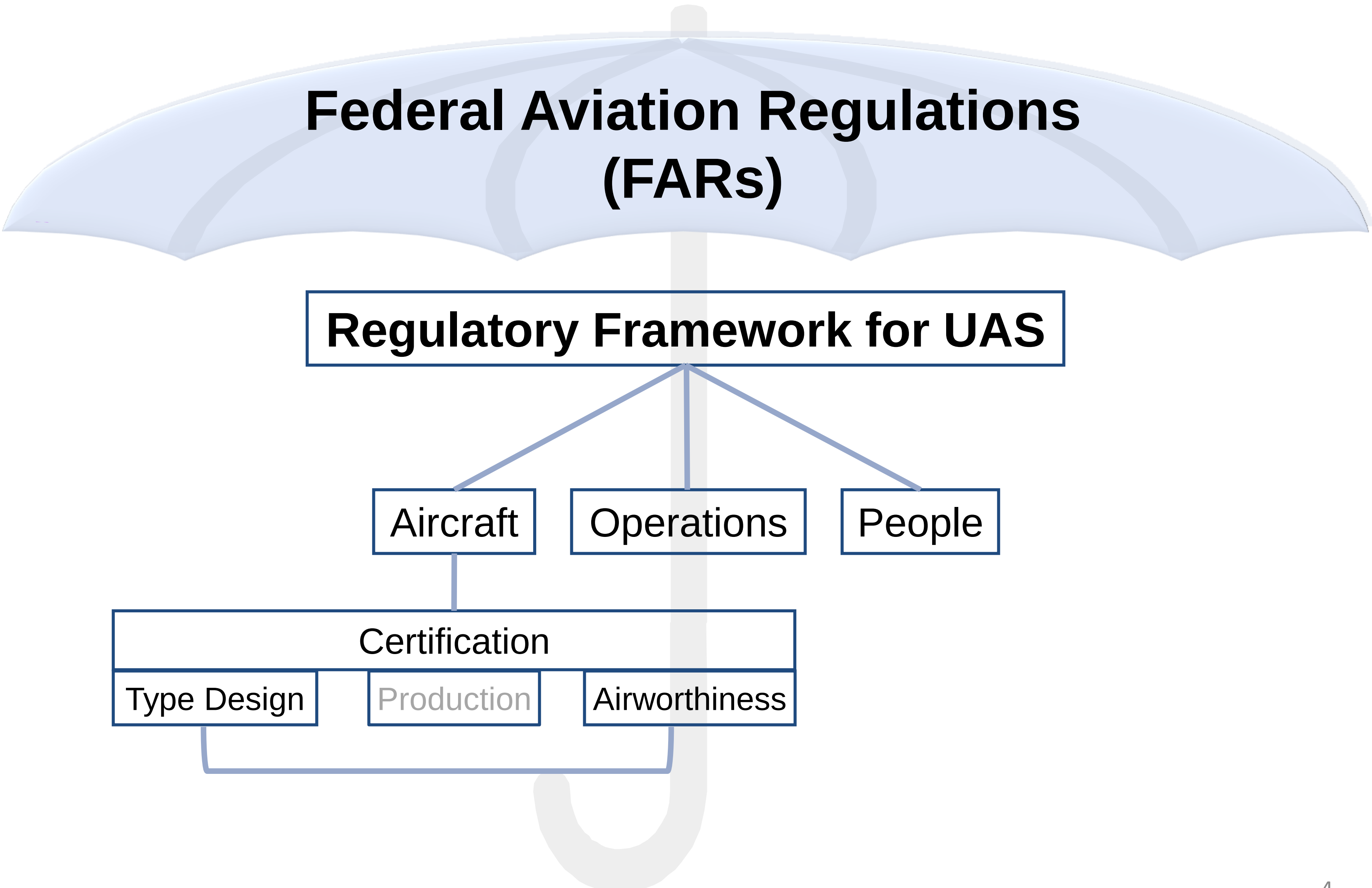
Context

"UAS operation in civil airspace means flight over populated areas must not raise concerns based on overall levels of airworthiness; *therefore*,

UAS standards cannot vary widely from those for manned aircraft without raising public and regulatory concern."

– from FY2009–2034 Unmanned Systems Integrated Roadmap

Scope


Federal Aviation Regulations
(FARs)
Regulatory Framework for UAS
Aircraft
Operations
People
Certification
Type Design
Production
Airworthiness

Certification & Airworthiness

Certification includes regulations, standards and other guidance necessary to provide assurance of the intrinsic safety and airworthiness of an aircraft

- **conforms to its type design and is in a condition for safe flight**

Key concepts :

- **assuring that systems and equipment perform their *intended functions* under any foreseeable operating condition**
- **assuring that *unintended functions* are improbable**

- from FAR 23 & 25.1309

Certification Issues

- **Working with existing regulations for a relatively few aircraft types and operations, when there are many diverse UAS types and operations**
- **Working without the benefit of relevant data to support risk assessment and regulation development**
  - incident and accident data
  - reliability data
- **Knowing that the pilot in command may not always be capable of discontinuing flight when un-airworthy mechanical, electrical, or structural conditions occur**
- **Increased reliance on automation (especially software) for safety**

Airworthiness Requirements

Allowable Probabilities of failure & Design assurance levels

Classification of Failure Conditions	No Safety Effect	Minor	Major	Hazardous	Catastrophic
Part 23 Class I	No Requirement	$<10^{-3}$ Level D	$<10^{-4}$ Level C	$<10^{-5}$ Level C	$<10^{-6}$ Level C
Part 23 Class II	No Requirement	$<10^{-3}$ Level D	$<10^{-5}$ Level C	$<10^{-6}$ Level C	$<10^{-7}$ Level C
Part 23 Class III	No Requirement	$<10^{-3}$ Level D	$<10^{-5}$ Level C	$<10^{-7}$ Level C	$<10^{-8}$ Level B
Part 23 Class IV Commuter	No Requirement	$<10^{-3}$ Level D	$<10^{-5}$ Level C	$<10^{-7}$ Level B	$<10^{-9}$ Level A
Part 25 Transport	No Requirement	$<10^{-5}$ Level D	$<10^{-5}$ Level C	$<10^{-7}$ Level B	$<10^{-9}$ Level A

- **These requirements drive the design of systems and equipment**

What would be acceptable for UAS?

Complying with 1309 requirements

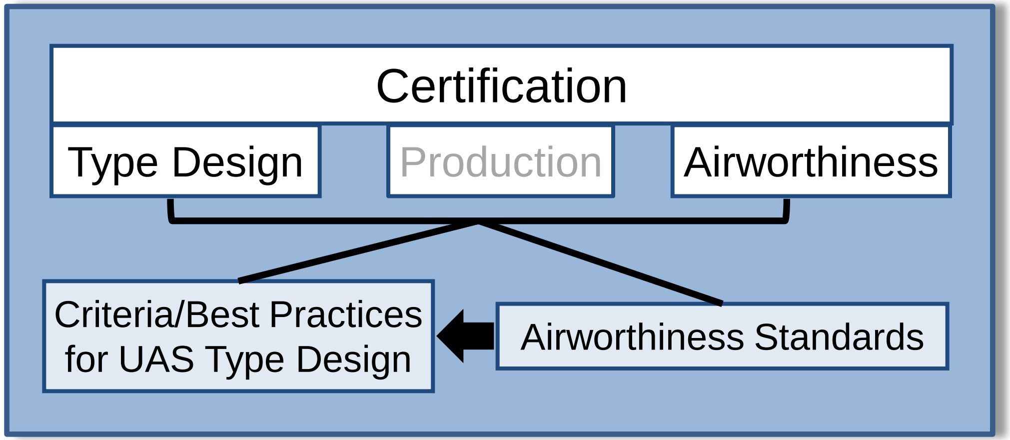
Classification of Failure Conditions	No Safety Effect	Minor	Major	Hazardous	Catastrophic
UAS Class I?	*No Requirement*	?	?	?	?
UAS Class II?	*No Requirement*	?	?	?	?
UAS Class III?	*No Requirement*	?	?	?	?
…	*No Requirement*	?	?	?	?

A general classification scheme that enables determination of appropriate values is still a challenge!

Classification/Airworthiness Conundrum

- **What parameters are needed for UAS classification that facilitate definition of 1309-type requirements?**
- **Can we take a service-based approach?**
  - **using RTCA/DO-264 for a specific UAS service**
    - for example, fire monitoring, communication tower

Type Design



Type Design consists of the drawings and specifications necessary to define aircraft configuration and design features needed to comply with airworthiness standards

- **What is needed to facilitate UAS designs that can comply with airworthiness standards?**
  - **lessons learned from incident and accident data**
    - **from use in military context and use under COAs**
  - **reliability data for system components unique to UAS**
  - **assessment of UAS-specific hazards and risks**

Best practices for UAS design for airworthiness

Certification Objective 1

- **Objective 1: Provide regulators with a methodology for development of airworthiness requirements for certification of UAS**
  - *Rationale*: a comprehensive methodology does not currently exist to support development of regulation for certification of UAS. Regulation is essential to enable routine access to the NAS.
  - *Approach*:
    1) assess existing approaches and classification schemes for deriving acceptable means of compliance to airworthiness requirements
    2) investigate a service-based approach to classification of UAS
    3) conduct comparative analysis of different methodologies
    4) work with FAA to determine best approach and conduct case study
    5) participate in regulatory/standards organizations developing safety and performance requirements for UAS

Certification Objective 1

– *Deliverables:*

FY	Deliverable	To	Used For
11	Initial assessment of approaches to airworthiness requirements	FAA	Decision aid for formulation of UAS airworthiness standards
12	Report on service-based approach to UAS classification	FAA	Decision aid for formulation of UAS airworthiness standards
12	Comparative analysis of certification methodologies for UAS	FAA	Decision aid for formulation of UAS airworthiness standards
14	Case study of certification methodology	FAA	Decision aid for formulation of UAS airworthiness standards
15	Final report on UAS certification methodology	FAA	Decision aid for formulation of UAS airworthiness standards

Certification Objective 2

- **Objective 2: Provide regulators and industry with hazard and risk-related data to support criteria for UAS type design**
  - *Rationale:* There is presently little UAS specific data (incident, accident, and reliability), especially in a civil context, to support risk assessment and development of standards and regulation.
  - *Approach:* Identify gaps in existing data, provide measured data as needed, and formulate recommendations by:
    1) evaluating UAS incident/accident data collection efforts and determining additional support necessary for regulation
    2) assessing UAS-specific hazards and risks
    3) evaluating need for reliability data for UAS-unique systems, components and subsystem, and determining additional measurement requirements
    4) developing guidance and best practices for UAS type design

Certification Objective 2

– *Deliverables:*

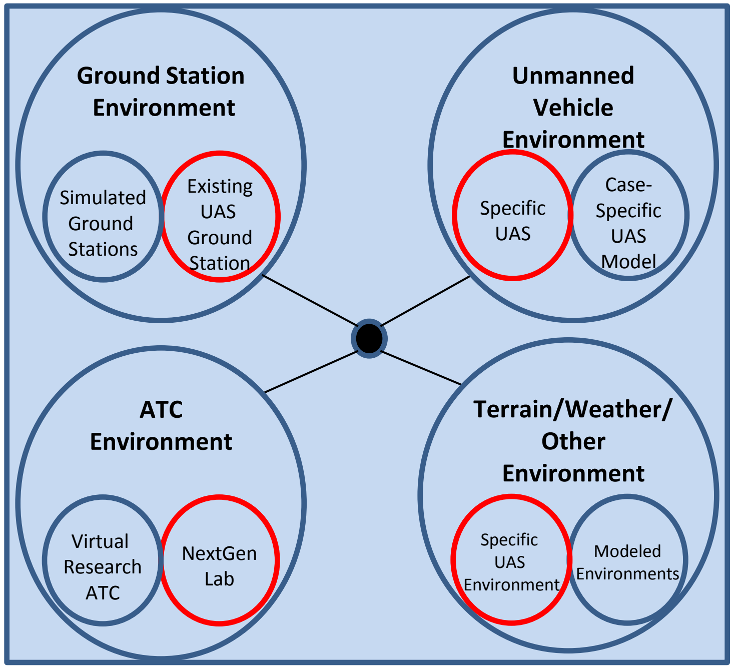
FY	Deliverable	To	Used For
11	Report on gap analysis for UAS incident and accident data	FAA	Determining needs for accident & incident reporting to support UAS regulation
11	Report on gap analysis for UAS component reliability	FAA, Industry	Development of risk assessments and potential regulatory requirements
12	Report on UAS hazards and risk assessment	FAA, Industry	Use in development of UAS regulation
12	Report on implications of hazard/risk to regulation	FAA, Industry	Development of risk assessments and potential regulatory requirements
15	UAS Type Design recommendations	FAA, Industry	Best practices for UAS developers & users

Partnerships, Links, and Integrated Test and Evaluation

- **Partnership with the FAA Tech Center and UAS Program Office, US Air Force, and US Army**
  - other informal coordination with RTCA SC-203, NATO STANAG 4671 Custodial Support Team, and ASTM
- **Links to FY10 In-Guide Funding**
  - linked with certification-related aspects of the roadmap and CONOPS
- **Links to Integrated Test and Evaluation**
  - there are preliminary expectations for the case study to leverage IT&E simulation and flight tests
    - ➢ difficult to clarify specific needs until the comparative analysis of approaches is complete

Facilities

- **That could support a certification case study**
  - Simulation Development & Analysis Branch Simulators – Langley
    - Test & Evaluation Simulator (TES)
    - Differential Maneuvering Simulator (DMS)
  - Air Traffic Operations Lab (ATOL) – Langley
  - AirSTAR Ground Control Station/Mobile Operation Station (MOS)/Generic Transport Model (GTM) Simulator – Langley
  - Manned surrogate UAS – Langley
  - FAA Tech Center UAS and NextGen lab facilities – FAA Tech Center
  - Ikhana – Dryden
- **Supporting small UAS type design studies**
  - SUAVELab – Langley
  - Electrochemistry Branch Testing Lab – Glenn



Notional Validation Architecture
supporting the case study