

National Aeronautics and Space Administration

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Accommodating Unmanned Cargo Operations in the National Airspace System

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December 8, 2020

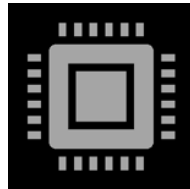
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Airspace System: Transformation Drivers



New Entrants need access to airspace now
(drones, commercial space, UAM, autonomous freighter)



Current system needs an upgrade
(technology obsolescence)



Airspace system need to accommodate future diversity
and growth

Preparing for
Future **scalability,**
density, and
diversity



More routine commercial space launches



Local and regional urban and advanced air mobility cargo, information, and passenger transport



Quieter, increasingly electrified aircraft will improve acceptance in communities, change runway length considerations, and optimal altitude profiles



High altitude operations

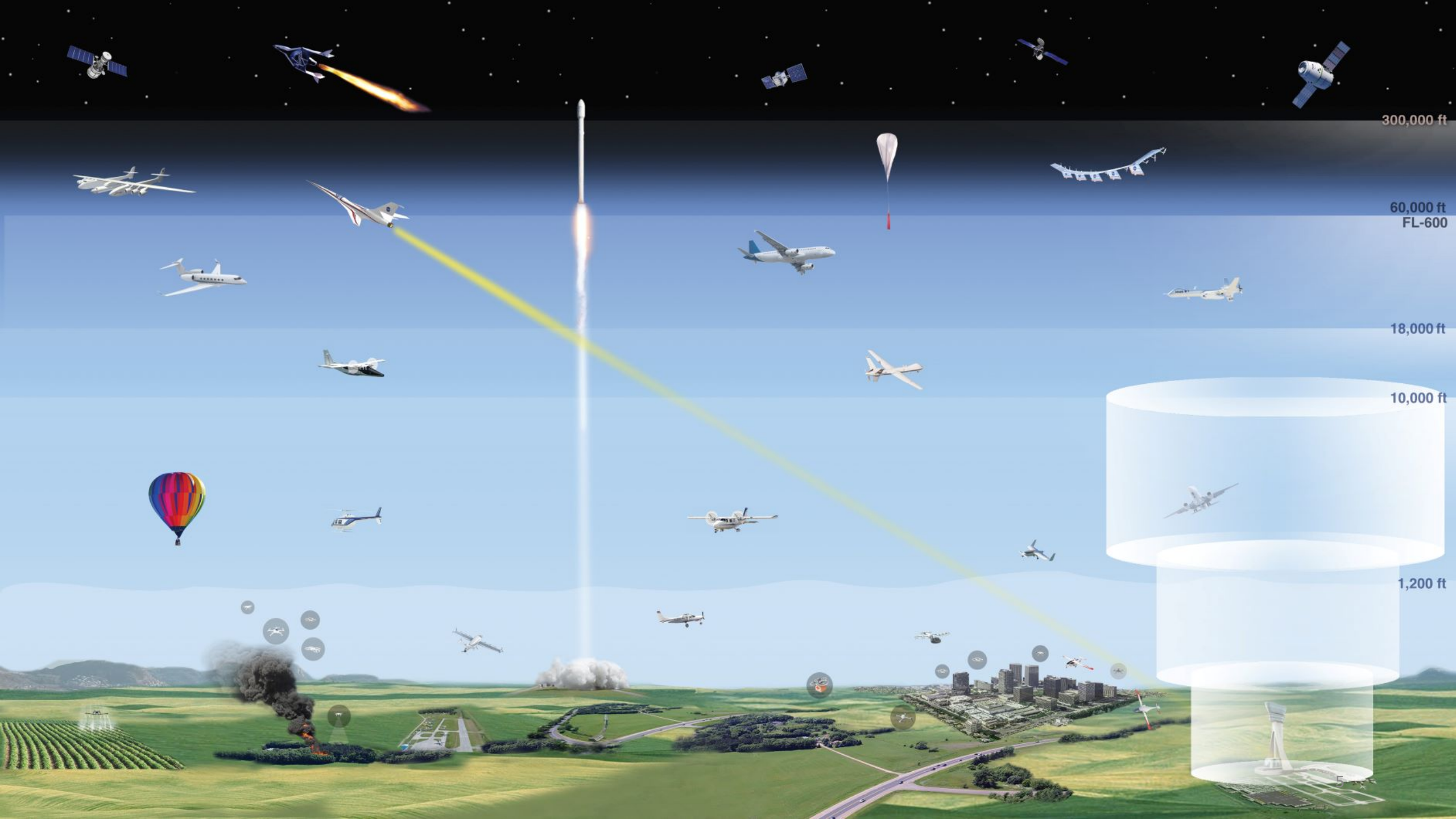


Integration of increasingly autonomous small, medium, and large aircraft

Mixed Equipage Challenge



Credit:Kamal Kishore/Reuters



300,000 ft

60,000 ft
FL-600

18,000 ft

10,000 ft

1,200 ft



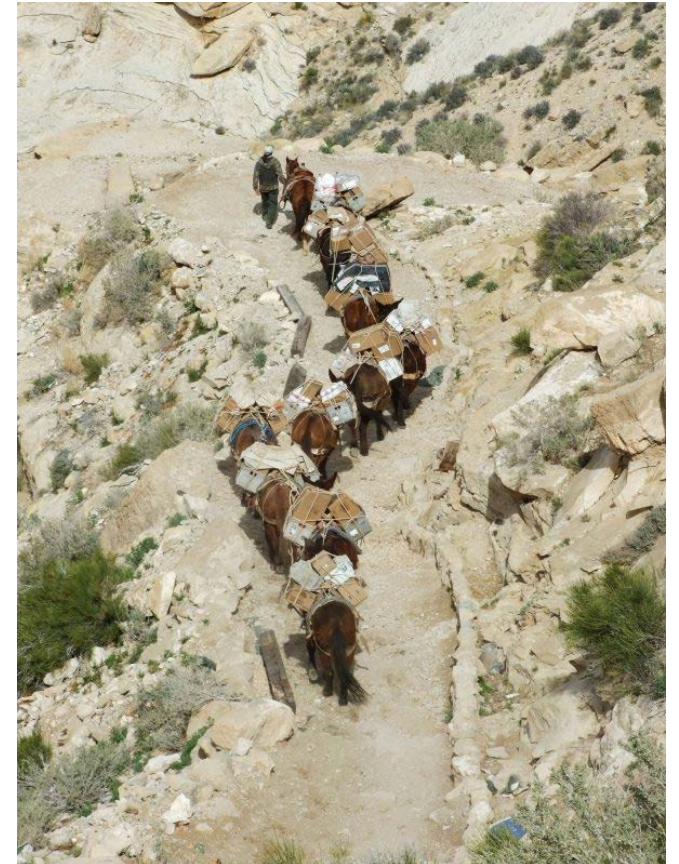
Contingencies, Corner Cases, & Off-nominal Conditions

Risk based progression

Inter-island Autonomous Cargo Delivery (2025+)

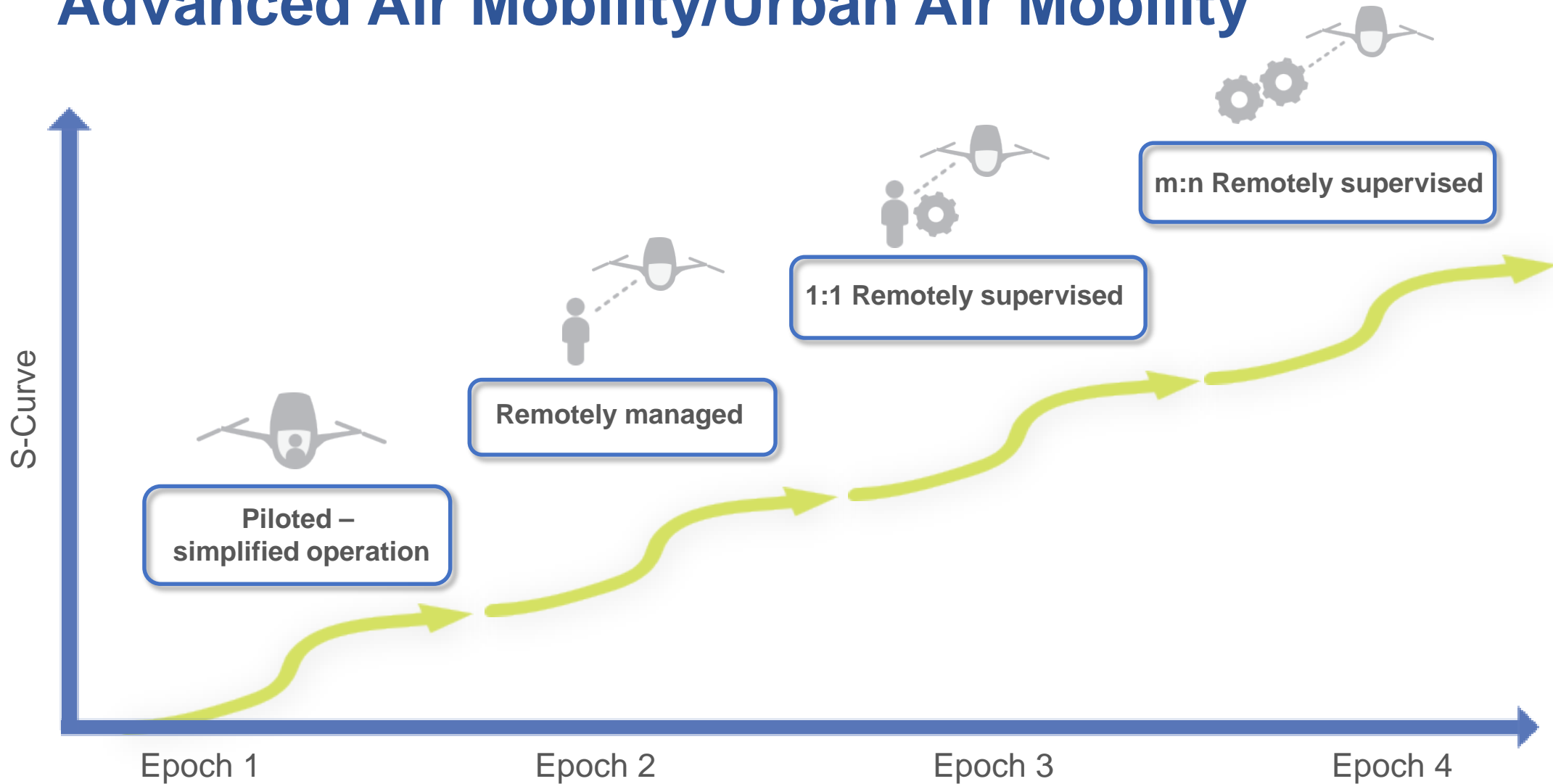


Mail delivery by mule into the Grand Canyon



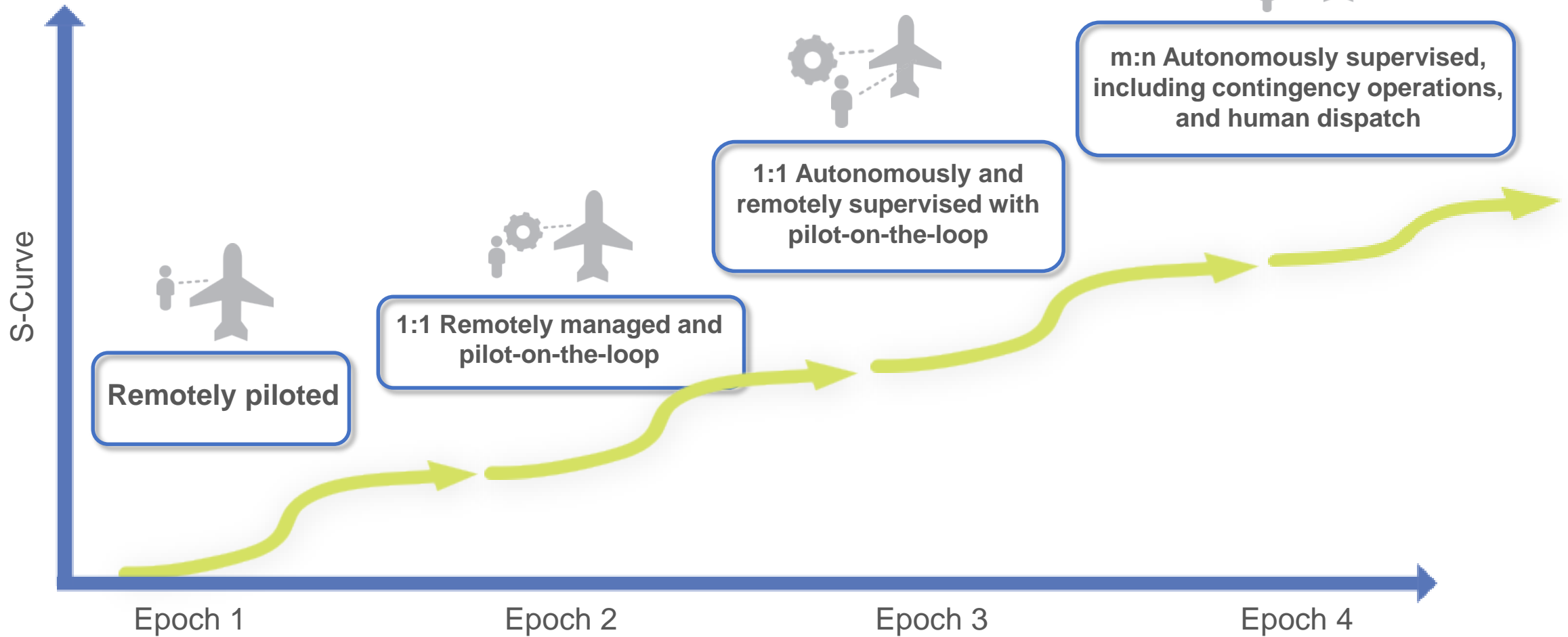
(Photo by Daniel Piazza)

Advanced Air Mobility/Urban Air Mobility



Note: managed vs supervised denotes different levels of responsibility and decision making, with supervision at a higher level than management; supervision is like a dispatch role

Small-, Medium-, and Large-Size Cargo



Autonomy Progression

Basics



- Algorithms
- m:N
- Perception

Integration



- eVTOL
- Vehicle autonomy
- Contingency

Interoperability



- eVTOL
- Drones (all sizes)
- Manned
- Supersonic
- Subsonic
- Hypersonic
- Balloons



Summary

- Systems thinking
- Scenario driven
- Risk-based implementation
- Build-a-little, test-a-little, and deploy-a-little
- Digital twin



Embracing innovation in aviation while
maintaining its safety tradition!

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