# From Shanghai to Lima in 19 Hours

A Vision for Human-Autonomy Trust

AAAI Spring Symposium Series, March 21st, 2022

Putting AI in the Critical Loop: Assured Trust and Autonomy in Human-Machine Teams

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# The Speaker

- Leads TAA @ LM ATL
- The Trustworthy Al and Autonomy (TAA) team at Lockheed Martin Advanced Technology Laboratories develops high assurance solutions (tools and methodology) supporting the entire lifecycle of Trustworthy Al and Autonomy.
- We help our customers deploy systems that incorporate complex decision-making (autonomy, AI/ML, + humans) with justified confidence that they are fit for purpose.



#### **Mauricio Castillo-Effen**

- > 15 Yrs in Aerospace with a focus on complex decision making, TEVV, and assurance.
- > 20 Yrs in robotics, autonomy, and controls.

## Disclaimer

The views and opinions presented in this presentation are solely the authors', and they do not represent the official policy or position of the Lockheed Martin Corporation or the Lockheed Martin Advanced Technology Laboratories.

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**Airbus Says Single Pilot** Flight Crews Are the **Long Term Future** 

Simple Flying, Sep. 27th, 2021

**A350F Timeline in** 'Right Place' for Single-**Pilot Operations: Faury** 

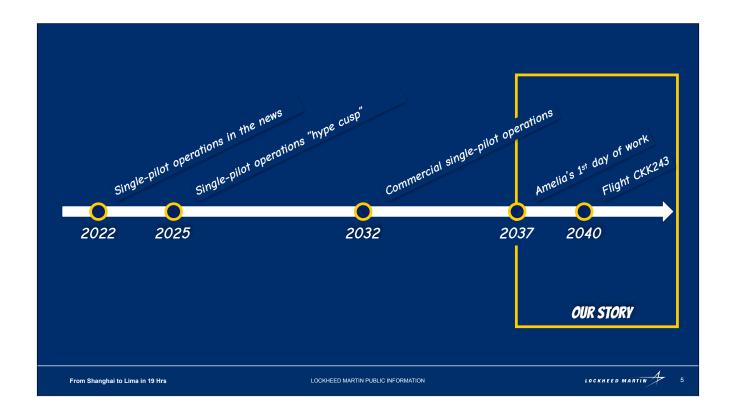
Flight Global, Nov. 15th, 2021

**Your Packages May** Soon Be Flown on a **Massive Jet With Only** One Pilot, and It's Only a Matter of Time Before **You Could Be Too** 

Business Insider, Dec. 5th, 2021

**Why Airplanes Might Soon Have Just One** Pilot

CNN, Jan. 13th, 2022

















#### Amelia

- ► Experienced pilot
- ▶ Works for the airline since 2037
- ► Mildly dyslexic
- ► Wears AR glasses and tiny headphones
- ► Her clothing monitors her physiology and cognitive states

#### Carlos

- ► Experienced dispatcher
- ► Works at Aircraft Operations Center (AOC) in Shanghai
- ► Ground support for Amelia

### Sully

- ► Amelia's synthetic copilot
- ► Can pilot the aircraft in all flight phases
- ► Trained with Amelia since 2037
- Maintained by 3rdparty developer
- ► Communicates with Amelia via voice and AR overlays on Amelia's glasses

#### Pilot Union

► Represents Amelia's rights as a pilot

#### Customer

► Cares about cargo

#### Insurance

► Reduces financial uncertainty and makes fortuitous loss manageable

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- ► CKK243 is Amelia's second and last long-haul flight of the week taking her back home (LIMA).
- ► Sully monitors Amelia's state of health. Amelia also keeps an eye on Sully's state of health. They know each other well.
- ► The flight cargo's monetary value and time-criticality are only known to Amelia and the airline's flight personnel, not to Sully, which is maintained by a 3rd party developer.
- ▶ A low priority warning flag is shown as a faint yellow overlay on the front panel of the flight director. Amelia plans to take care of it when they reach cruise altitude.
- ► Sully coordinates ground operations with the airport's ground control AI agents while Amelia watches.
- ► The aircraft takes off.



"A reasoned, auditable artifact created that supports the contention that its toplevel claim (or set of claims), is satisfied, including

While Amelia runs on \ systematic argumentation and its underlying evidence and JS increased in criticality explicit assumptions that support the claim(s)" — NIST

Amelia talks to the dispatch

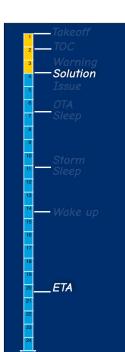
► CKK423's assurance case is monitored by the insurance company. It has triggered an alert of increased risk due to potential thunderstorm in the middle of the ocean.

- ► The insurance company advises modifying the flight plan to keep compliance with the insurance policy.
- ▶ The diversion suggested by the insurer is unacceptable because it adds 3 hours of flight time reducing the operation's profits.

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- ► An authorized developer has an App that could allow the aircraft to fly through rough weather.
- ► The App uses neural networks based algorithms that can handle unpredictable weather better than traditional control algorithms.
- ► The developer has produced a valid assurance case and evidence for the app.
- ► Since the App requires human monitoring, approval by the insurer is conditional on correct human-system integration.
- ▶ The AOC will generate the required evidence by using Amelia's Digital Twin on AOC's HPC facilities.
- ▶ Amelia resumes her exercise routine.



- ▶ Verification has been halted. Amelia's Digital Twin is missing an area of Amelia's cognitive profile protected by the Pilot Union. She knows its information related to her mild dyslexia.
- ▶ Amelia needs to pass tests proctored by the insurer and monitored by the Pilot Union.
- ▶ Amelia takes the tests in the aircraft's training room. This information can only be used for in situ verification. It cannot become part of her Digital Twin.
- ► The updated CKK243 assurance case is evaluated by the insurer.

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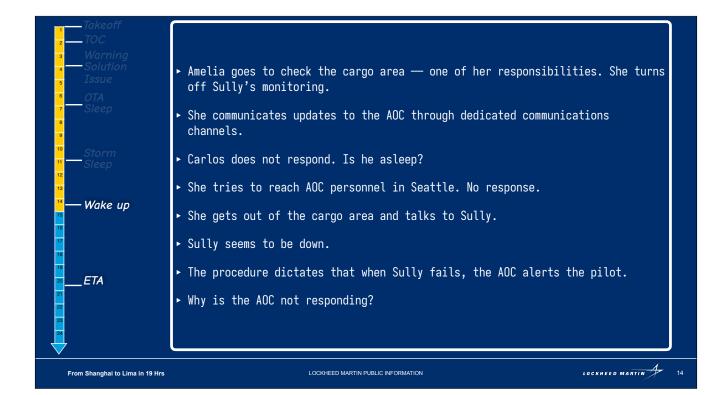
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- ► Carlos lets Amelia know that the insurance company is fine with the suggested use of the App.
- ► AOC performs an Over-the-Air update.
- ▶ Since it affects Sully's core skills, it must remain inactive during the update.
- ▶ During the update Amelia flies the aircraft entirely manually.
- ▶ 15 minutes later, Sully is back.
- ▶ The AOC advises Amelia to take a rest. She will need to be fresh when they cross the storm.
- ► Amelia goes to sleep.





## Discussion

- There are many commercial incentives for making single-pilot operations a reality, exacerbated by a steadily dwindling workforce and supply chain challenges.
- Unifying human-machine interaction around a single machine agent is plausible and effective.
- Dynamic Assurance Cases represent a meaningful computational artifact for communicating and assessing risk.
- Assurance cases could be generated, updated, assessed, and summarized by machines working on behalf of the operator and the insurer.
- Digital Twins of humans could be used in the context of evidence generation activities
- Operations described in the story highlight intricacies of confidentiality and privacy.

#### Discussion

- We may be moving towards a future where open avionics platforms enable easy 3rd-party functionality integration.
- ► There are many developments in DevSecOps that will enable updates "at the speed of relevance." Over-the-Air (OTA) updates help achieve the deployment step.
- Unpredictable weather will challenge the air transport industry in the coming decades.
- Neural networks offer advantages with respect to traditional algorithms, but also verification challenges.
- ► The asymmetric challenges of guaranteeing secure development and operation of increasingly interconnected cyber-physical systems and protecting them from malicious actors represents a major obstacle to this vision.

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## **Corollary and Questions**

- Trust can be multifaceted. It qualifies relationships between individuals, organizations, and machines. In some cases, machines are used as a trust vehicle for other forms of human trust.
- Performance, privacy, security and safety may be at odds, possibly raising ethical dilemmas.
- Humans remain the ultimate responsibility bearers and threats.
- Could this state of technology be achieved only with private investment? How much does de-risking do governments need to fund?
- What is the role of the government and regulators?
- In human-machine relationships, are trust and transparency always bidirectional?

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