



PACE

Bringing Physical AI into Aerospace Testing

ARTO · Automated Robotics for Testing Optimization

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Automation, the old way



A toy bird that presses the same key over and over.

It never gets tired. It never looks at the screen. It never notices when something goes wrong.

Repetition without perception is not automation.

From automation to Physical AI

Traditional robotics & automation

- Pre-programmed motions, fixed cells
- Repeats the same trajectory
- Blind to the outcome of its action
- Re-programming for every change



Physical AI

- Perceives: cameras, microphones, LiDAR, force sensors
- Understands what it perceives with AI models
- Acts in the real world — and checks the result
- Adapts to new situations

“Physical AI lets autonomous systems like cameras, robots, and self-driving cars perceive, understand, reason, and perform or orchestrate complex actions in the physical world.”

NVIDIA, “What is Physical AI?” — see Sources

- | | | |
|----|--------------------------------------|--|
| 01 | Context | Physical AI meets Aerospace Testing |
| 02 | Meet ARTO | Complex System, Simple Automated |
| 03 | Primitives & Capabilities | Building blocks, robotics, vision, audio |
| 04 | Software Suite & Delivery | 12 weeks to your automated testing |
| 05 | Live demo | A320 MCDU Flight Plan Init |

01

Context

Physical AI meets Aerospace Testing



Verification tools must be trusted — AI is probabilistic

SAE ARP4754

Development of civil aircraft and systems: the lifecycle every system follows

DO-178C

Software considerations in airborne systems and equipment certification

DO-330

Software tool qualification: a verification tool must be trusted before its output is

What certification expects from a test tool

High quality, repeatable, as deterministic as possible

What AI models are

Probabilistic: the same input does not always give the same output

EASA is already writing the rules: its AI Concept Paper (Issue 2, 2024) covers Level 1 and 2 machine-learning applications — learning assurance, explainability, human-AI teaming.

Humans are not deterministic either

0.1%

minimum human error rate, reached only on very simple accept / reject checks

Swain & Guttman, 1983

20–30%

typical error rates on complex, repetitive inspection tasks

Drury & Fox, 1975 — both cited in See et al., Sandia National Laboratories



ARTO design rule: the error of our AI models must stay within the order of magnitude of human error — and every step leaves evidence a human can inspect.

Why the human is still in the loop

On the right side of the V — integration and verification on rigs and real cockpits — repetitive procedures with little added value still cannot be fully automated, because they need a human to:



Touch

Move levers · push buttons · touch screens · turn knobs



See

Read words, numbers, colours and symbols on displays



Hear

Recognise alarms, voice messages and acoustic signals

The product that could combine these three is **ARTO**

02

Meet ARTO

Complex System, Simple Automated



ARTO – What is it?

Automated Robotics for Testing Optimization

A system for the complete automation of **human-machine interface operations**.

ARTO **executes and automates** the many repetitive tasks performed by test engineers during integration tests, on both laboratory rigs and real cockpits.

It acts like a human: it touches, sees and hears — and checks that every action worked.

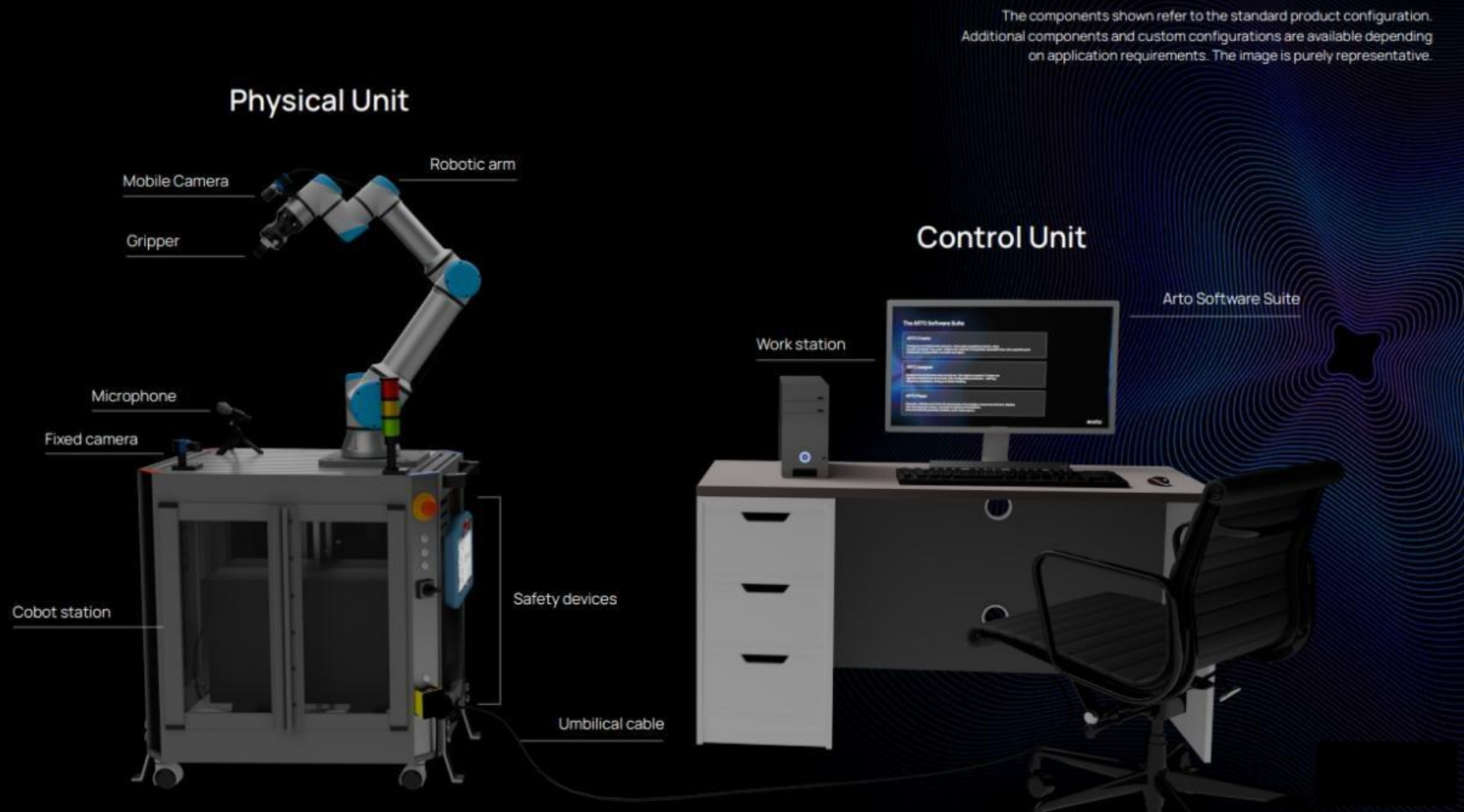
Quick Setup

Hardware Agnostic

Low-code



One physical unit, one control unit



Three senses, one brain



Robotics

To interact with the cockpit and physically execute the tests



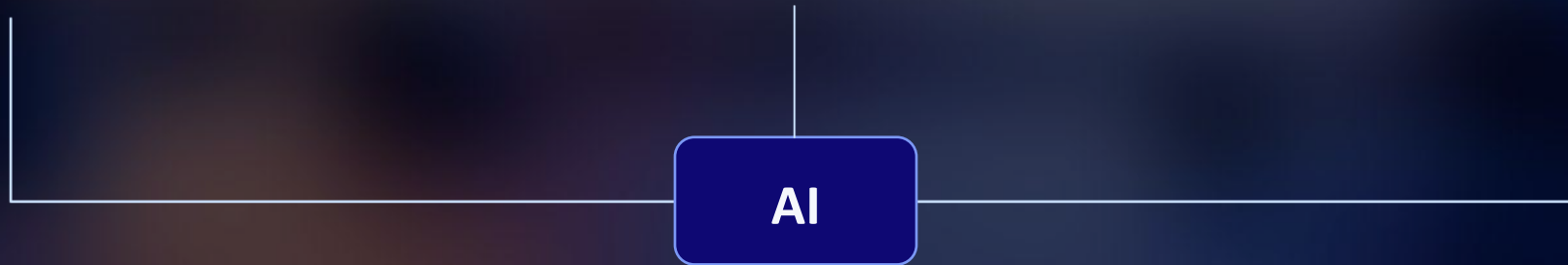
Computer vision

To analyse cockpit elements, automating checks traditionally done by eye



Audio intelligence

To recognise sounds, ensuring the accuracy of audio outputs during testing



Integrations with the existing laboratory environments

Real-Time Execution

What changes in the lab?



Continuous testing

Runs nights and weekends



Reduced human error

Same procedure, every time



Minimize operator workload

Engineers on engineering



Remote testing

Supervise from anywhere



Cost optimisation

Fewer hours per campaign



Higher value of human work

Focus on analysis

03

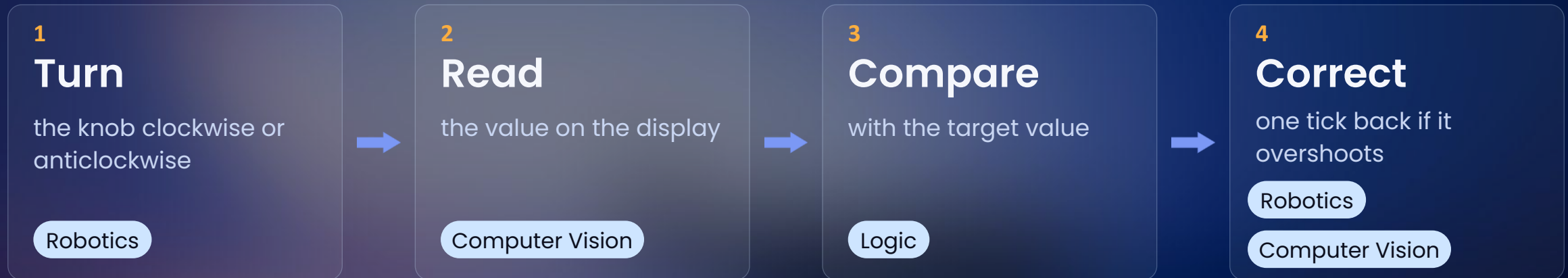
Primitives & Capabilities

Building blocks, robotics, vision, audio



Primitives: actions that think like a human

A **primitive** is TXT's proprietary building block: a parameterised function in which robotics, computer vision and audio work together. Example — **set the autopilot altitude knob**:



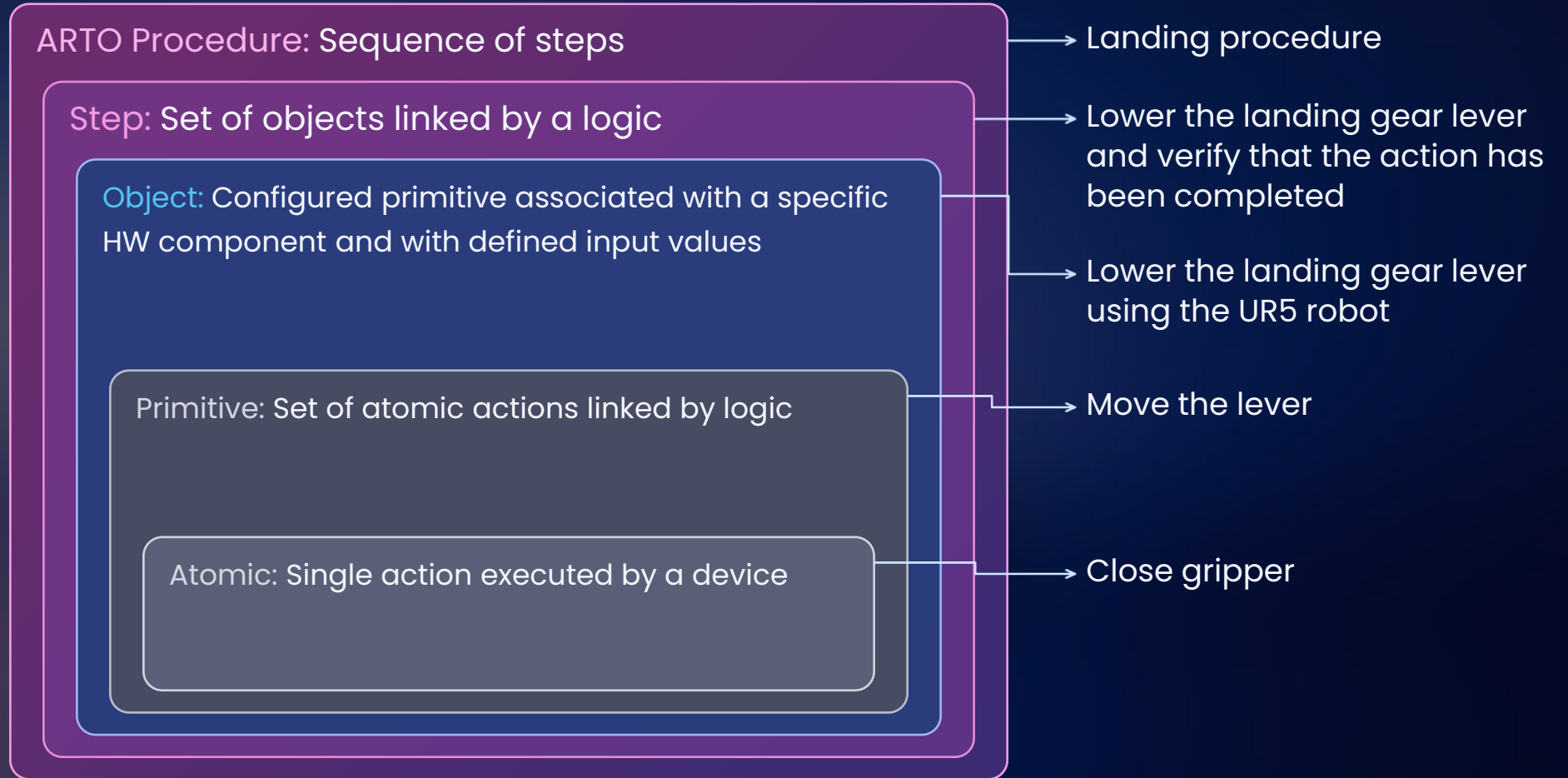
ARTO works in close-loops using the three subsystems, like human-in-the-loop interactions.

From atomic actions to test procedures

ARTO Designer

ARTO Creator

ARTO built-in library



Touch: robotics capabilities

Safe interactions

Force-based actions

Easy Calibration

Powered by CV + Robotics

Easy to program

Kinesthetic teaching

Custom tools

To interact with any component

Robotic gestures implemented



Move levers



Push buttons



Touch screens



Turn knobs / switches



Throttle lever

See: Computer Vision capabilities

Any Environment

Different lighting conditions

Quick Characterization

Powered by CV + robotics

Robust results

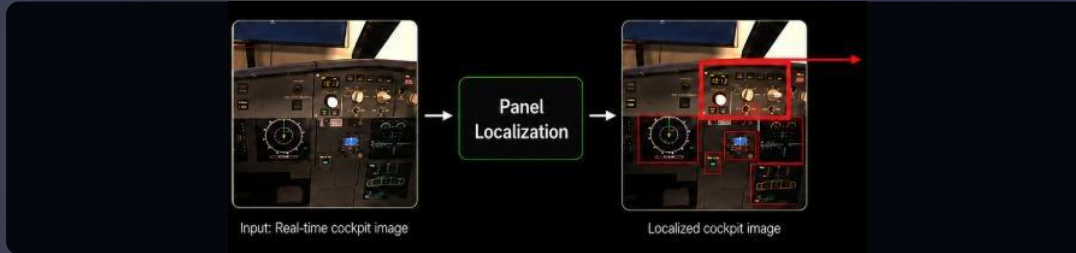
Validated on target scenarios

Any cockpit

Recognises elements across cockpits

- ✓ **Panel Localization**
Detects cockpit panels
- ✓ **Panel Identification**
Classifies cropped panels
- ✓ **Component Detection**
Identifies buttons, switches, knobs, displays
- ✓ **Optical Character Recognition**
Detects text regions and predicts characters
- ✓ **Symbol Matcher**
Detects and matches symbols
- ✓ **Directional Status**
Estimates switch / knob orientation and state
- ✓ **Color extraction**
Predicts foreground and background colors of texts and symbols

Neural networks at work



Panel Localization & Panel Identification

From a real-time cockpit image to the extraction of each panel



OCR & Color Extraction

Text regions, characters and their colours from a predefined dictionary



Component detection & Symbol Matcher

Buttons, switches, knobs and displays with their state; geometric symbols



Directional Status

Rotation angle of a knob, mapped to a discrete state or a number

Hear: audio intelligence capabilities

Cable or microphone

Direct line or ambient capture

Track repetitions

Repeated audio tracks

Compose sequences

With diverse audio tracks

Noise-robust

Works in noisy environments

Sounds recognised

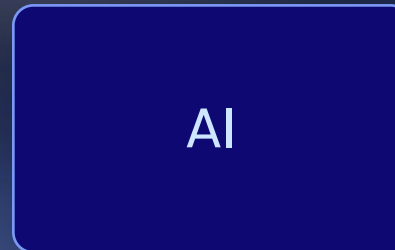
- Voice messages
- Acoustic signals
- Alarms

Microphone

Ambient audio input

Cable

Direct audio line



Results

Match / no match, with signal analysis

Golden audio set



04

Software Suite & Delivery

12 weeks to your automated testing



Three applications along the lifecycle

When ARTO arrives in the lab it is a blank canvas. Three applications take it from configuration to execution.

1 · CONFIGURE

ARTO Creator

Turns generic primitives into **objects** of your cockpit.

e.g. the altitude knob on **FCU 1** —
and, separately, on FCU 2

No coding: any engineer with normal
computer skills



2 · COMPOSE

ARTO Designer

Builds **procedures** — test,
operation or maintenance — as
workflows with conditions and
loops.

e.g. "set FCU 1 altitude to **2,000 ft**
and verify"

Checks procedure consistency before
execution



3 · EXECUTE

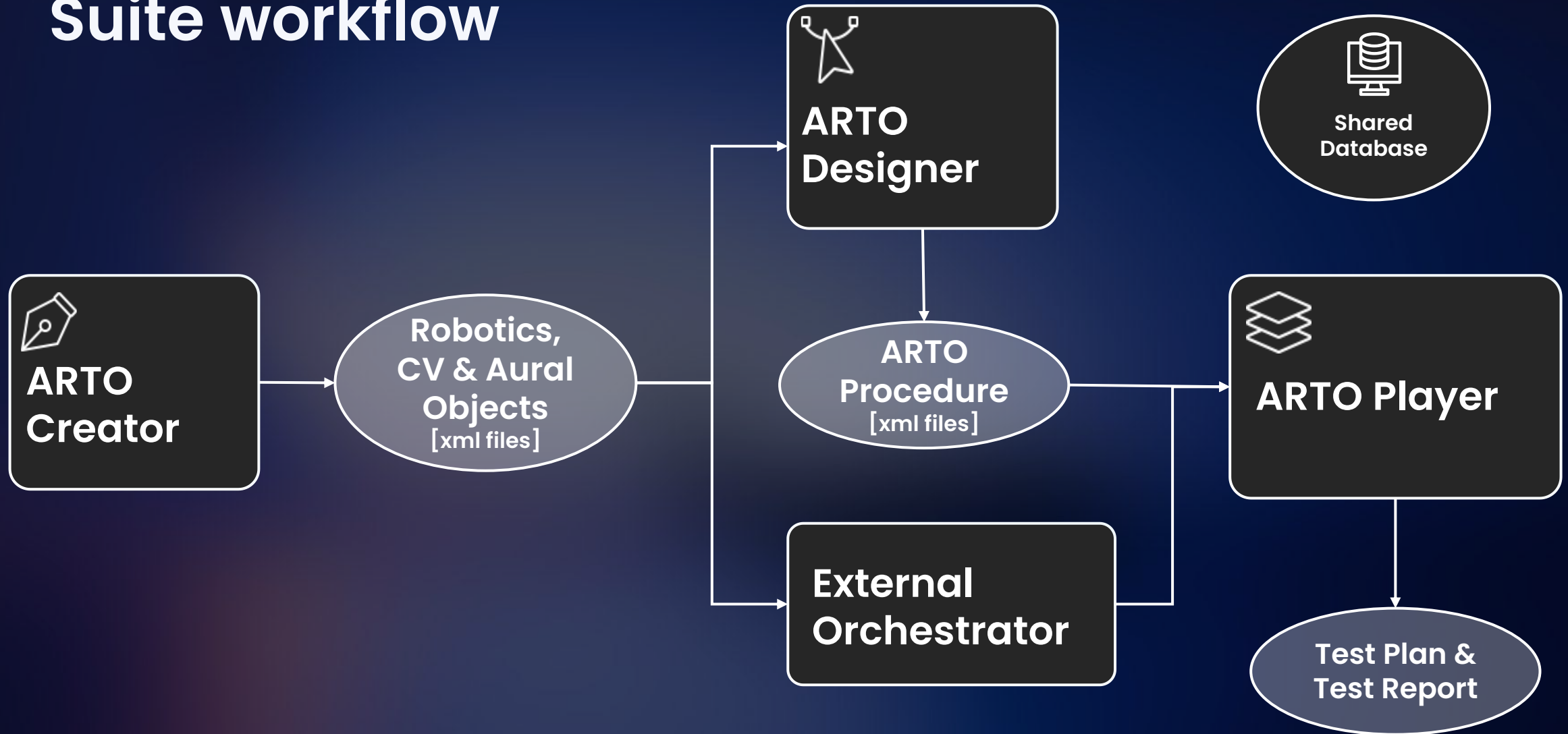
ARTO Player

Runs procedures and returns the
results to the engineer.

e.g. regression tests overnight,
PDF report next morning

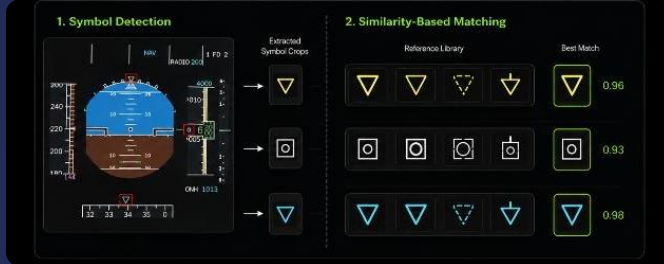
Inspect every step afterwards

Suite workflow



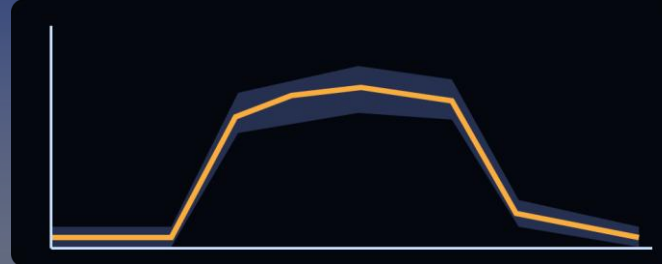
Trust by design

Every step leaves evidence



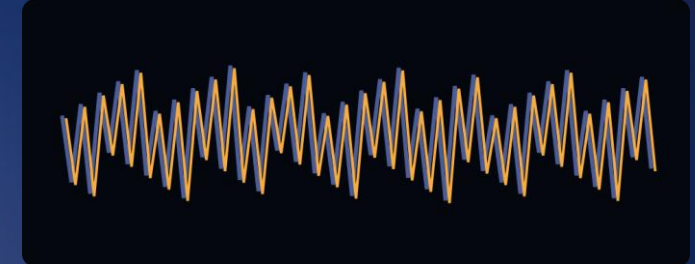
Computer vision

Screenshot of the display with the value ARTO recognised



Robotics

Force profile of the action, checked against the expected one



Audio intelligence

Signal analysis and match against the golden audio set



Usable in a **DO-178C** process as a support tool for the entire process



Report compares **expected vs actual** results

External orchestrator interface



Requests from the orchestrator

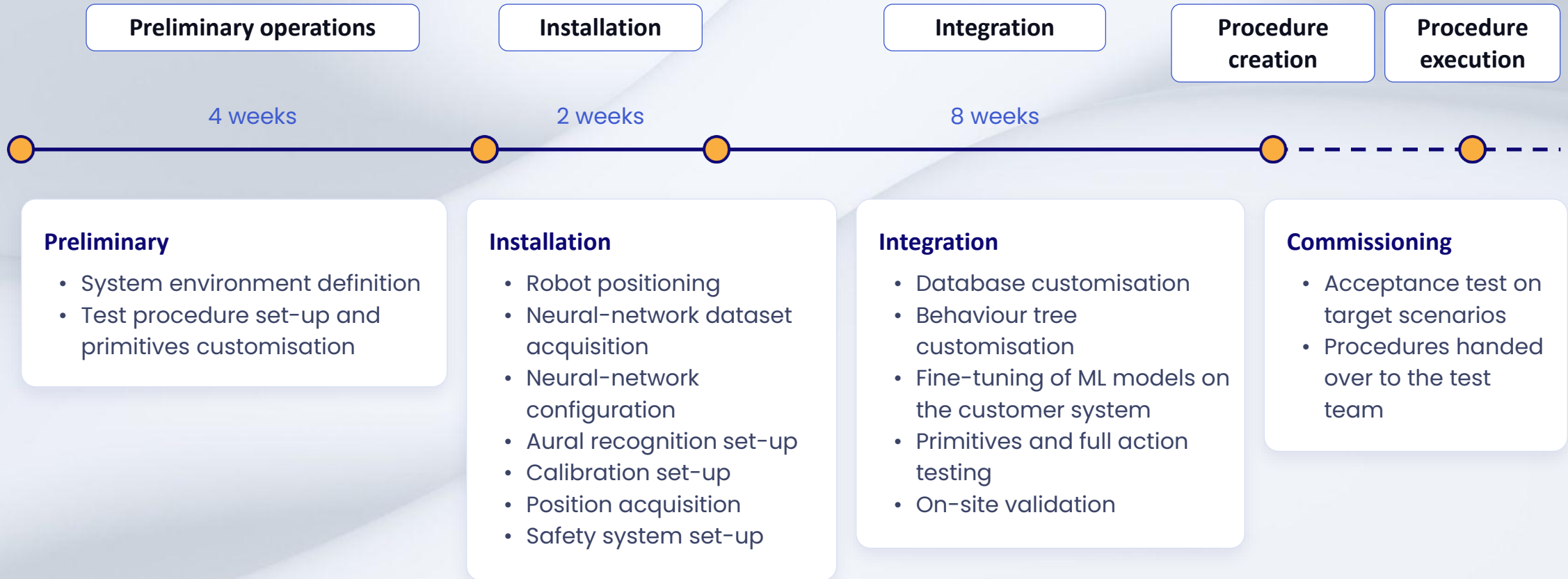
- Connect
- Execute step with parameters
- Pause · Resume · Stop
- End execution

Responses from ARTO

- Command status: accepted / rejected
- Step passed / failed + observed values (e.g. symbol coordinates)
- Error codes and diagnostic messages

Typical exchange: Connect → Command status → Execute step → Execution response → End execution

From kick-off to commissioning



05

Live demo

ARTO on an Airbus A320 MCDU



Live demo – What you will see today

A320 MCDU: flight plan Initialization

- 1 **INIT** Initialise the flight plan on the MCDU INIT page
- 2 **ROUTE** Enter the flight plan
- 3 **DISCONTINUITIES** Clear the flight-plan discontinuities
- 4 **CHECK** Verify the flight plan is consistent — read back by computer vision
- 5 **YOUR CALL** Pick a value live — e.g. the departure runway

Collaborative robot

Camera

Airbus A320 MCDU

ARTO Designer

ARTO Player



With ARTO Creator, users can easily create the objects that make up ARTO test procedures.

Main Functionalities

Intuitive workspace for creating objects in just a few steps

Customization of objects according to user needs

Shared database with other ARTO Suite tools

Integration with **External Orchestrators**

Install locally and create objects **remotely** from any PC

Work in **multiple test environments**

A320

pippo

General Data

Interface panel*

Position

Description

Go to here...

Configuration & Elements

FLOOD BRIGHT

OFF

Panel

OFF

Edit

gg: hold on Button dd

robot_ur5

gripper_hande

Free drive

Jog Robot

1

Grab tool

Select the plastic tool to be used for this operation from the available list. Press Grab Tool to start the automatic tool acquisition sequence. The robot will move to the selected tool, grasp it, and return to the required position. Ensure that the sequence completes successfully before continuing with the configuration.

FingerTool

Grab tool

2

Approach robot pose

Ensure that the robot gripper is holding the right tool. Using FreeDrive mode or the "Jog Robot" page, manually guide the robot arm to a safe approach position in front of the panel. This position will be stored as an intermediate waypoint and used before the robot proceeds to the target component.

Edit pose

Set pose

3

Contact robot pose

Using FreeDrive mode or the "Jog Robot" page, position the robot so that the tip of the selected tool is approximately 2–3 mm in front of the target button. Ensure that the tool is held securely by the gripper and that its tip is centered on the button. Align the tool so that it points straight toward the button, allowing it to press the button without slipping or applying force at an angles.

Save pose

4

Push force

Select the direction, relative to the Tool Center Point (TCP), in which the robot will apply the pressing force. In most applications, the default **"Z-axis"** is the correct choice, as it corresponds to the direction in which the tip of the selected tool points. Then, set the amount of force the robot will use to press the button. Use a lower force for touch screens or delicate buttons, and a higher force for buttons that require more pressure to activate.

force direction

Z

force module [N]

6

Save force

5

Drop tool

Manually move the robot away from the panel using FreeDrive mode or the "JogRobot" page.

Exit

Save object

Test object

+ Create new Ob

Search...

Last Tested



With ARTO Designer, users can assemble test procedures customised to their specific needs

Main Functionalities

Create test procedures in
XML format

Customize test procedures
according to user needs

Easy interaction with other
ARTO Suite apps

Intuitive workspace for
creating test procedures

Install locally and create
procedures **remotely** from
any PC

Create procedures for
different test environments

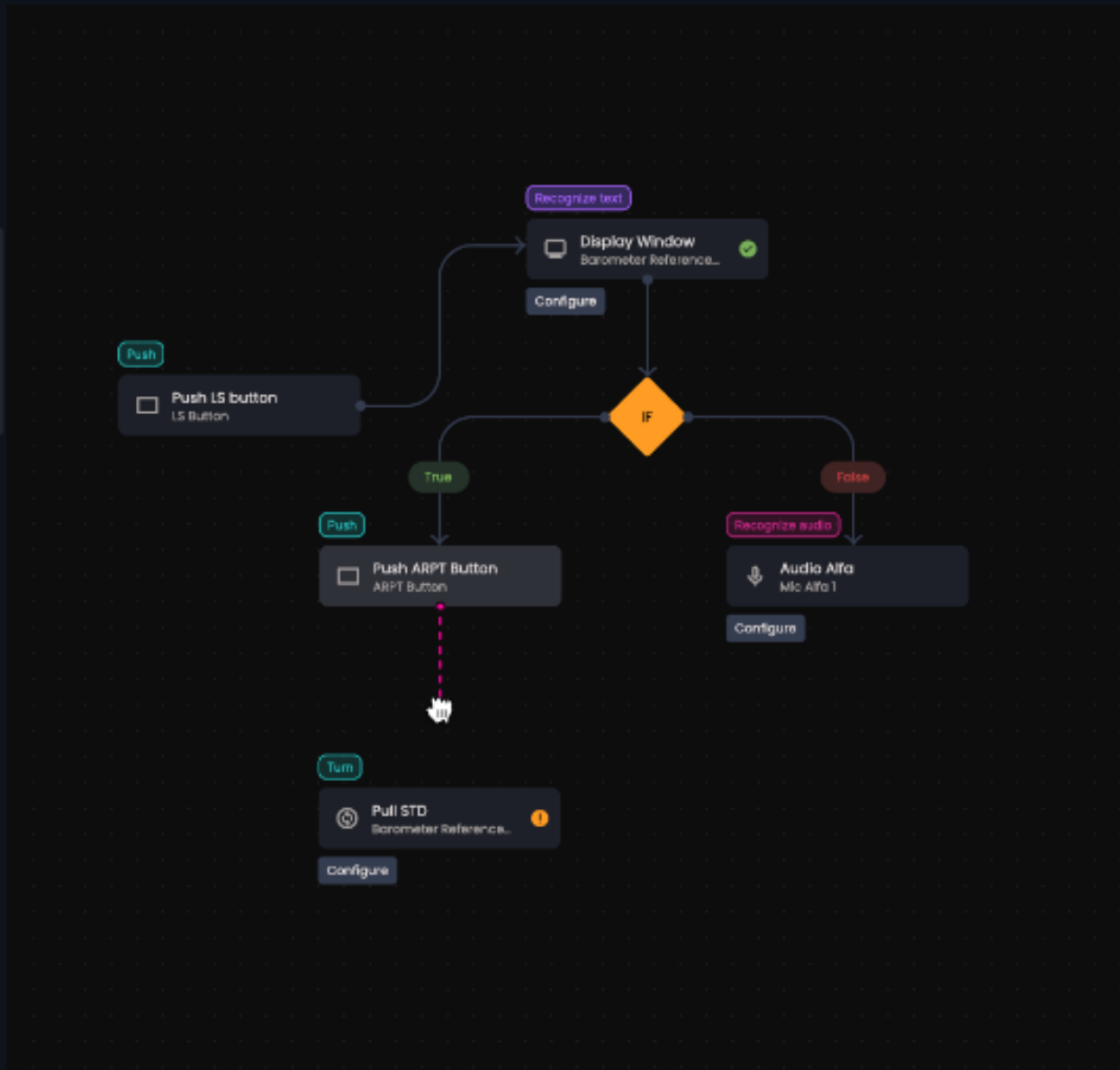
General data

Panels & Objects

Search...

All panels

- EFIS Control Panel F...
23 objects
- MCDU Capt.
32 objects
- PDF Capt.
24 objects
- ECAM Control Panel
16 objects
- FCU
20 objects
- MCDU F.O.
18 objects
- Lighting Panel Capt.
45 objects
- Thrust Lever and Ptc..
54 objects
- Audio Control F.O.
3 objects
- Upper ECAM Display
28 objects
- ADIRS Panel
22 objects
- ELT Panel
15 objects
- Fire Control Panel
26 objects



Actions 100%

- 1 Push LS button
LS Button
 - 2 Display Window
Barometer Reference Display...
 - 3 Push ARPT Button
ARPT Button
 - or
 - 3 Audio Alfa
Mic Alfa 1
- Pull STD
Barometer Reference Selector

Thank you!

Questions?



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