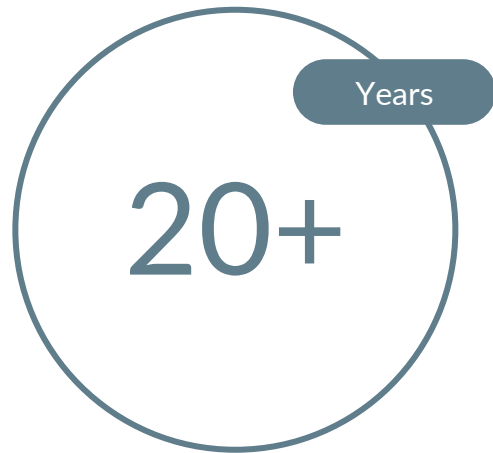# lusospace

**ARCE – Augmented Reality for Concurrent Engineering Activities**

**12th December 2023**

Inês Cadilha, Head of Digital Division,
icadilha@lusospace.com

# Lusospace numbers

From Lisbon, Portugal

| Years | Months | Missions |
|---|---|---|
| **20+** | **350+** | **30+** |
| Years in activity | HW Fly Time | Space Missions |

# Introduction

To the ARCE (Augmented Reality for Concurrent Engineering) project



- **Objectives**:

  1. Development of a collaborative AR application, for multidisciplinary and distributed design teams, to enable visualization and editing of design models;

  2. Test the developed application in a concurrent engineering design exercise, at ESA CDF (ESTEC);

  3. Reach TRL 4

- **Two phases**:

  - Phase 1 - 2020 to mid-2022

  - Phase2 – mid-2022 to mid-2023

- **Consortium:** Lusospace (prime) and Critical Software (subco for Phase 1)

# Technical Specification

Requirements Definition



- Target: Concurrent Design Facility of ESTEC
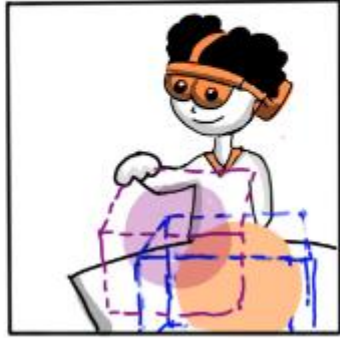
- Integration with OCDT/COMET Engineering Databases

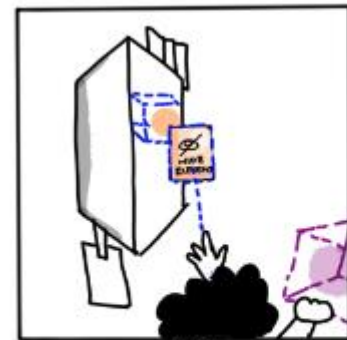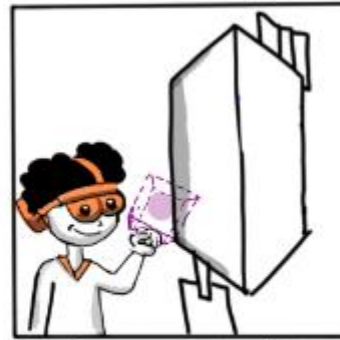# Technical Specification
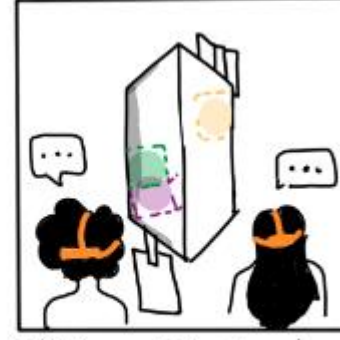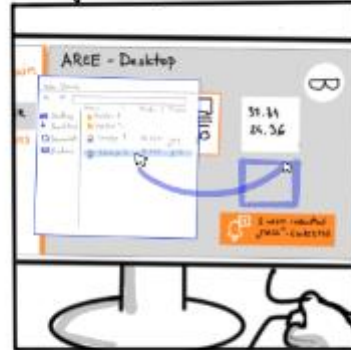
Requirements Definition

# Technical Specification

**Requirements Definition**



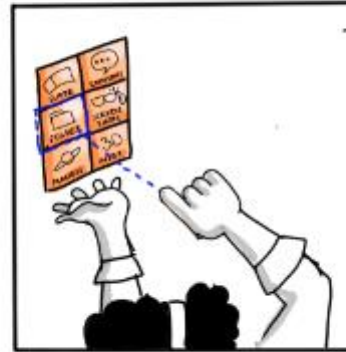① Prepare your assets in the ARCE desktop app

② This is done by dragging and dropping screen shots of any asset you wish to have at hand
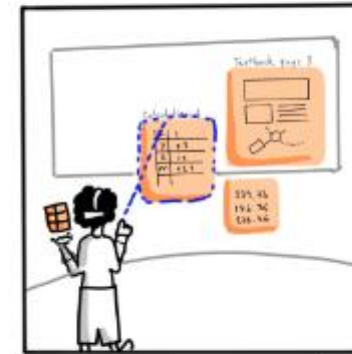
③ Put a hdolens on!

④ Sign in!

⑤ Select your folder option

⑥ Select or export all together the assets you put on your ARCE desktop folder!

# Technical Specification
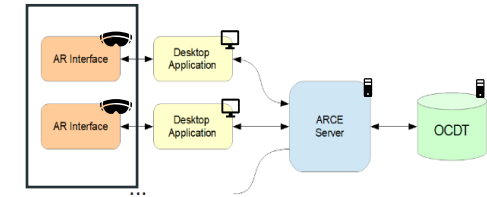
## Application Definition

Three main applications were defined as part of the ARCE system:

- **Server Application**: generates and manages the ARCE Design Session, synchronizing the connected Desktop Applications on the 'System's distributed features.

- **Desktop Application**: keeps the user logged in the session; video stream client on features like Presentation Mode.

- **AR Interface**: main means of interaction with the system. The user makes changes to the Concurrent Engineering (CE) Model, CAD Model and other Session data through the AR Interface
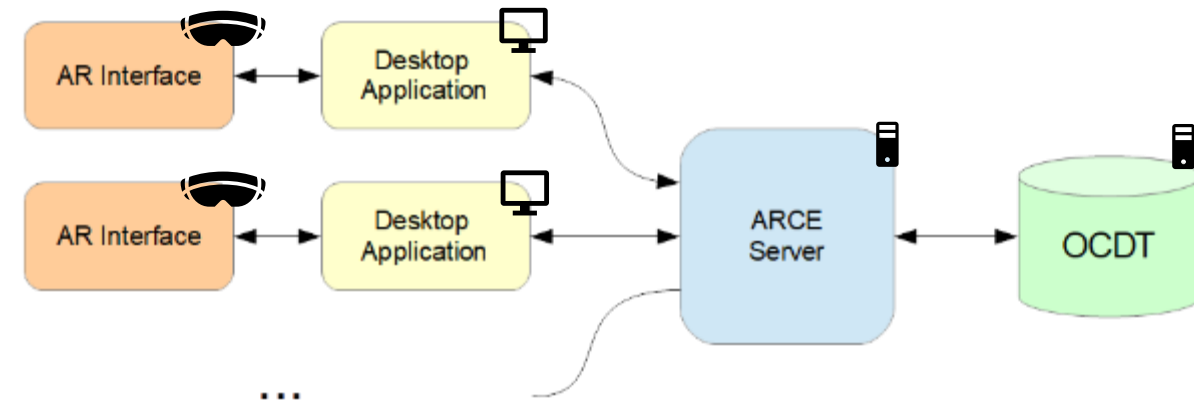
# Application Development

AR Interface



To comply with the established requirements, the UX/GUI design of the ARCE AR application was designed with two sets of main feature groups:
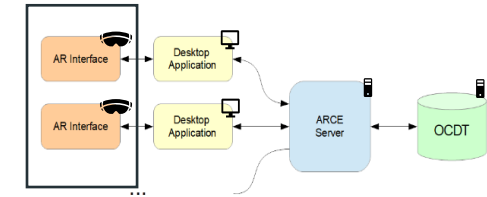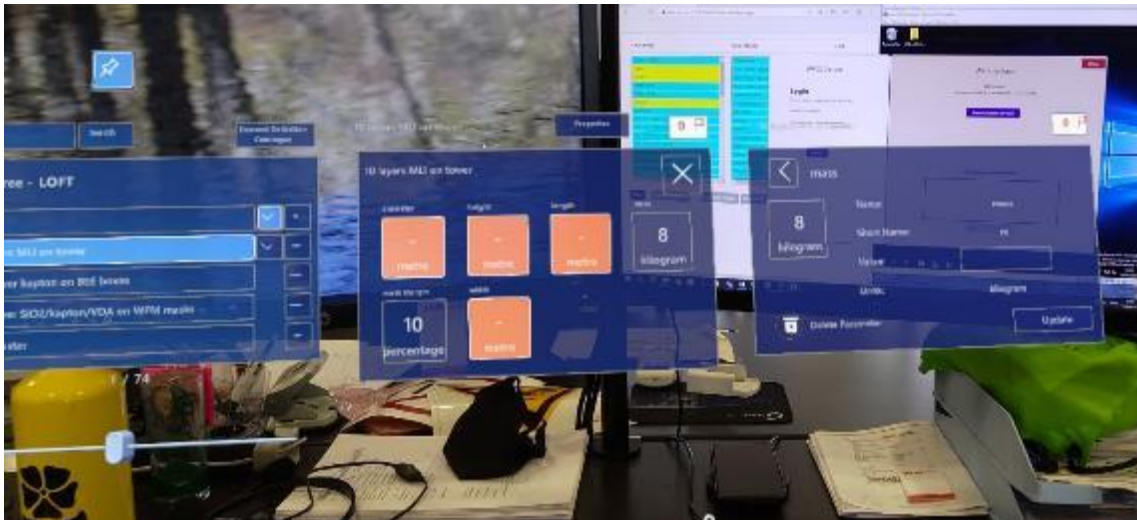


2D Information



3D Information

# Application Development

AR Interface



Main features: exploring the product tree, exploring/editing parameters, element definitions and design options, exploring budget and iterations, all in accordance to user profile/permissions
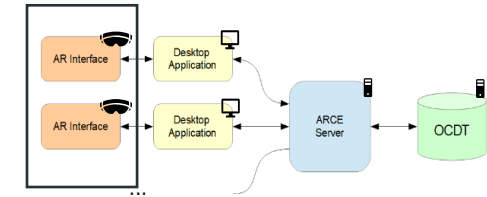


Inspect paramenter
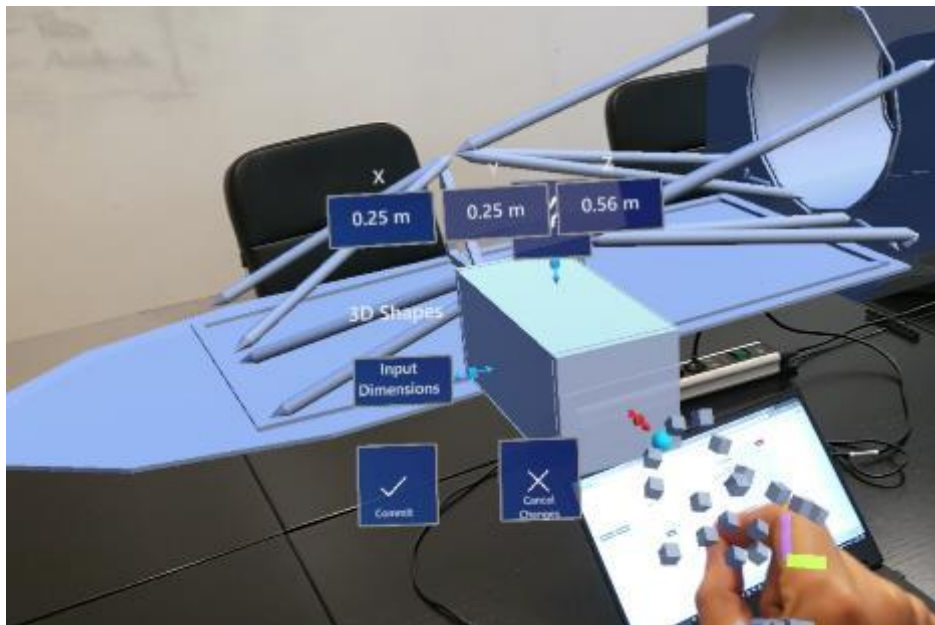


Budget feature

# Application Development

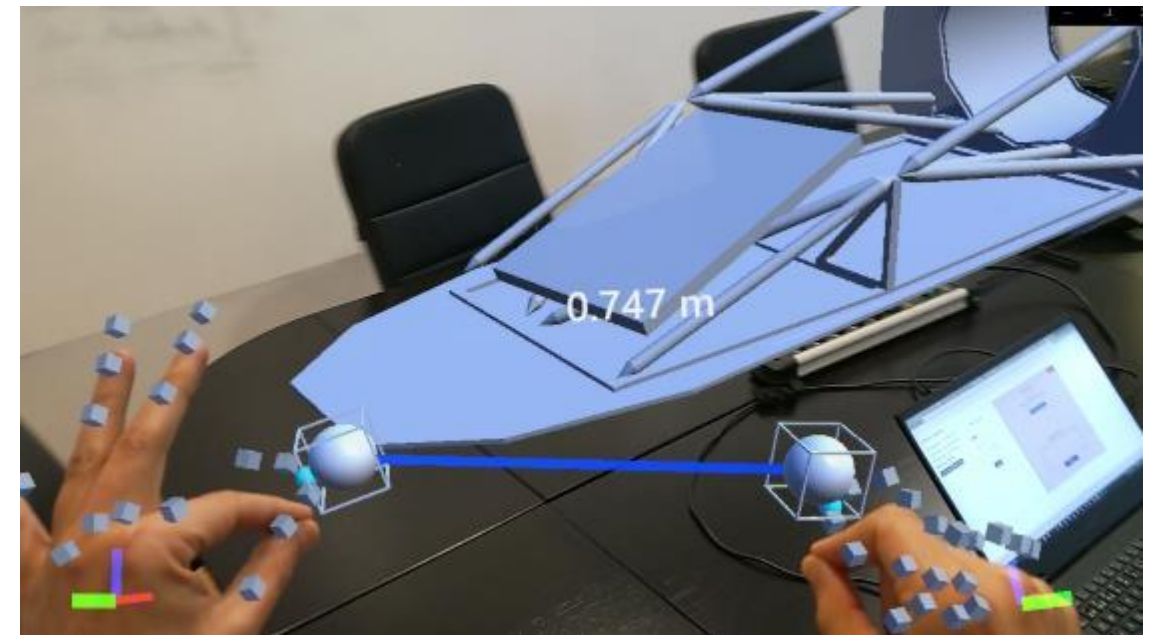AR Interface

The interaction with the 3D model designed includes moving/hiding components on the Working Model, adding shapes, ruler feature



Adding shapes



Ruler feature

# Application Development

AR Interface − Multi player view
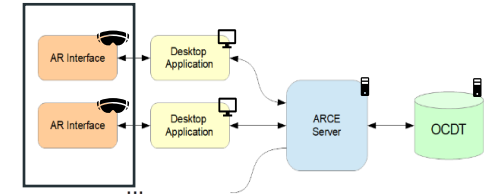
# Application Development
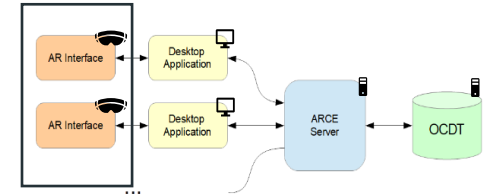
AR Interface – Product Tree

# Application Development

AR Interface – Budget feature
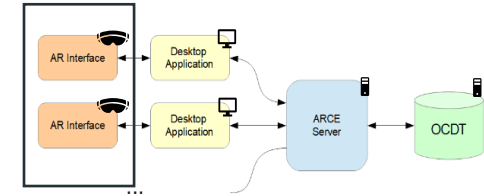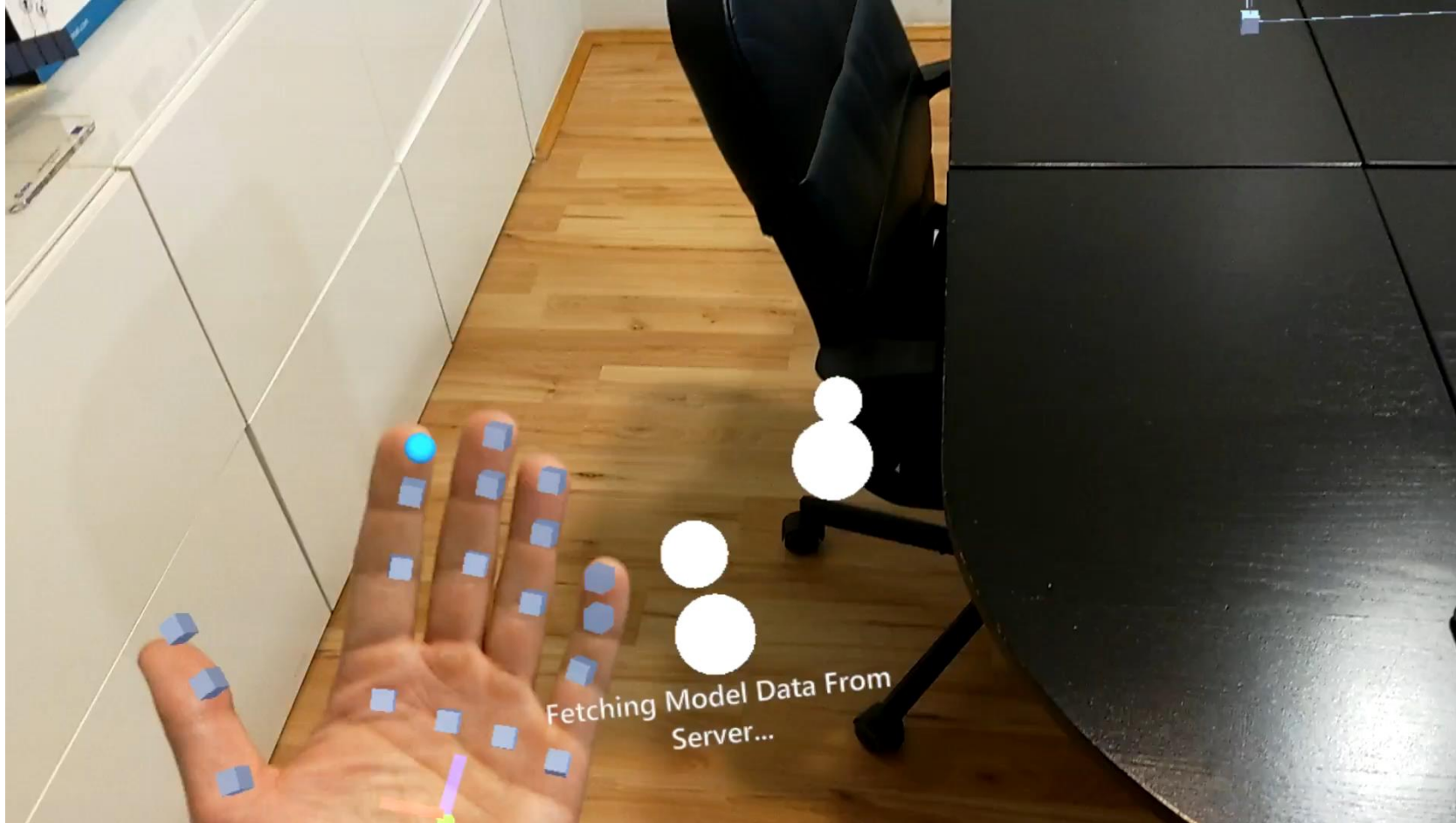
# Application Development

AR Interface – Ruler
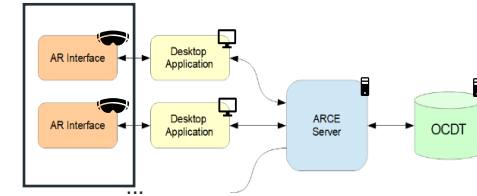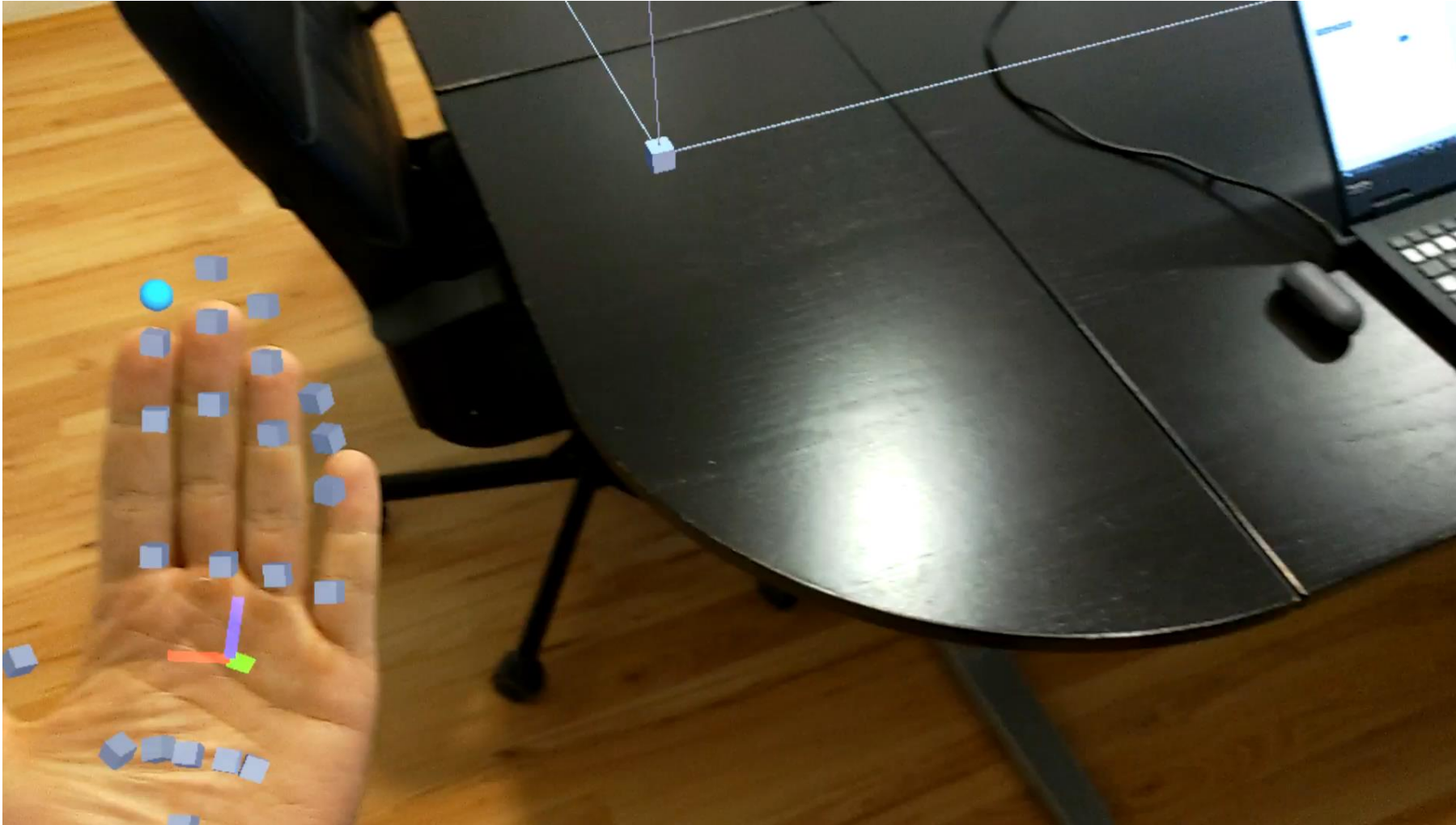
# Application Development

U X / U I   D e s i g n

**Desktop Interface**

UI designed as to allow for login, viewing presentations and user point of view
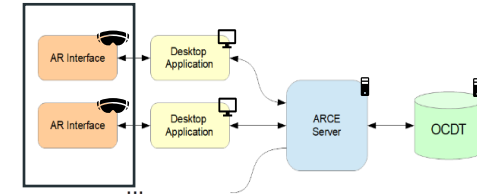
Main desktop menu

Presentation mode

# Application Development

UX/UI Design

**Server Interface**

A frontend for the server was designed to allow for starting the session, selecting the model and mapping CAD to CE elements



Server login menu



Selecting necessary elements
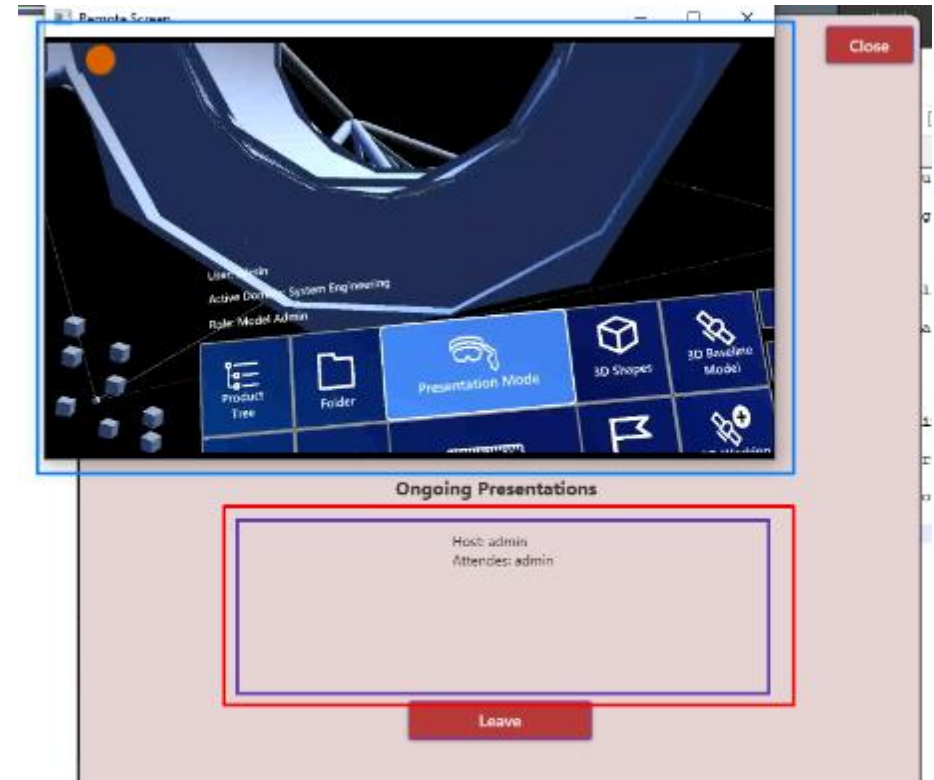


OCDT/CAD element mapping interface

# Validation

Design Exercise



Two users running a design exercise and moving pieces of the 3D model while the presentation mode is active and visible on the projector canvas



One user manipulating the Product tree and properties of an object while the presentation mode is active

# Conclusions

Validation

- At the end of the exercise, feedback was gathered though a survey with both quantitative and qualitative questions

- "I found that the ARCE application could add value to a concurrent engineering session" got a 4.5 out of 5

- Most useful features noted were the interaction with the 3D model shared by all users, presentation mode and budget feature

- Key improvements desired: undo/reset function, budget improvement, connectivity issues

# Second phase of ARCE

Objectives

- Implementation of network connectivity resilience improvement

- Implementation of UX/UI improvements
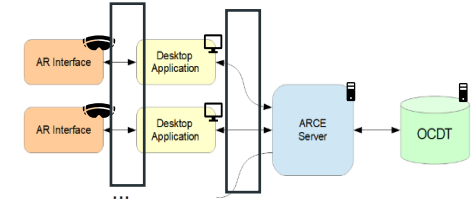
# Network Connectivity Improvement



1.  Implemented multiple communication channels between applications

2.  Streamlined communication paths:
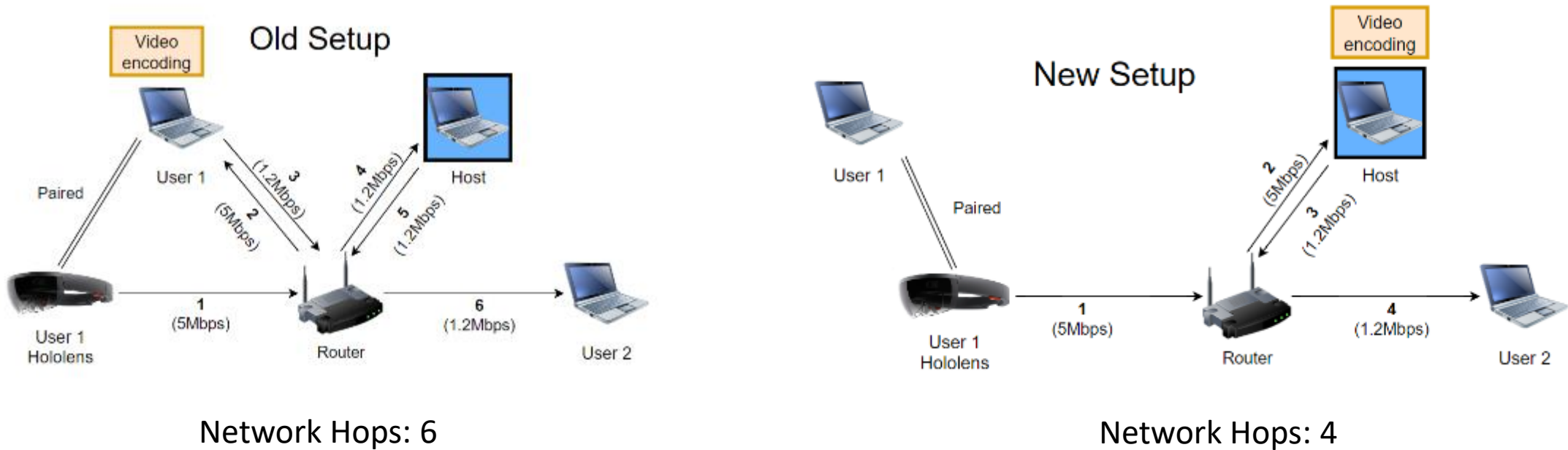


Network Hops: 6

Network Hops: 4

Latency reduction: -33%

# 3D interaction, menus

3D model interaction improved, with the following changes:

- Used raycasting (no bounding boxes) combined with hovering highlight – much easier to select specific components in the 3D model

- Improved the position/interaction with the dedicated menu (Hide/Parameters) – optimized size, interaction now enabled through direct clicking as well

- Optimized the current loading/instantiating of the objects every time a "Fetching data" is happening

Before
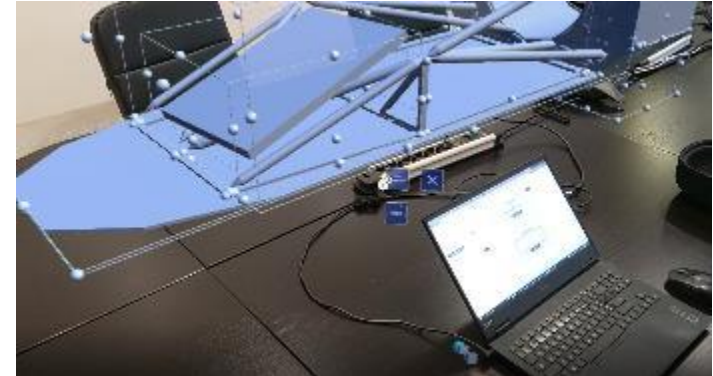


After
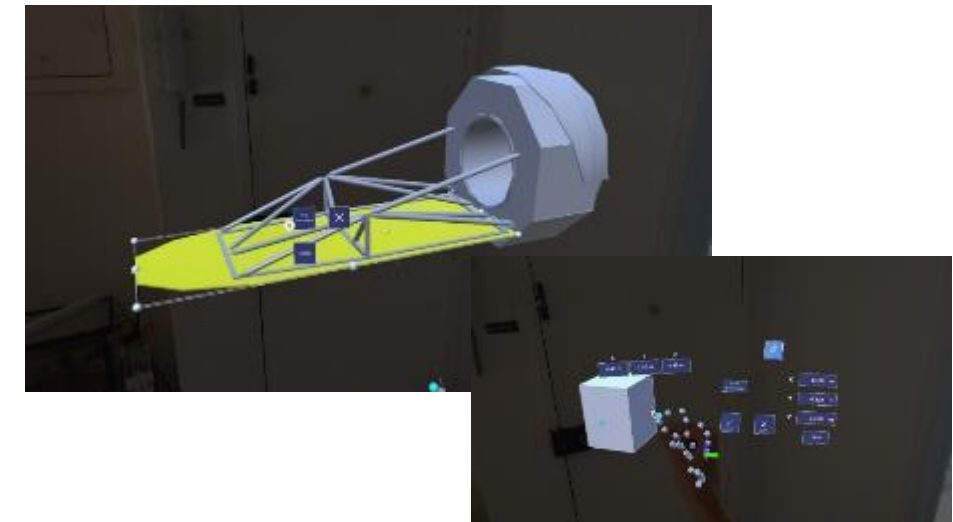
# Features undo / redo

Modifications implemented
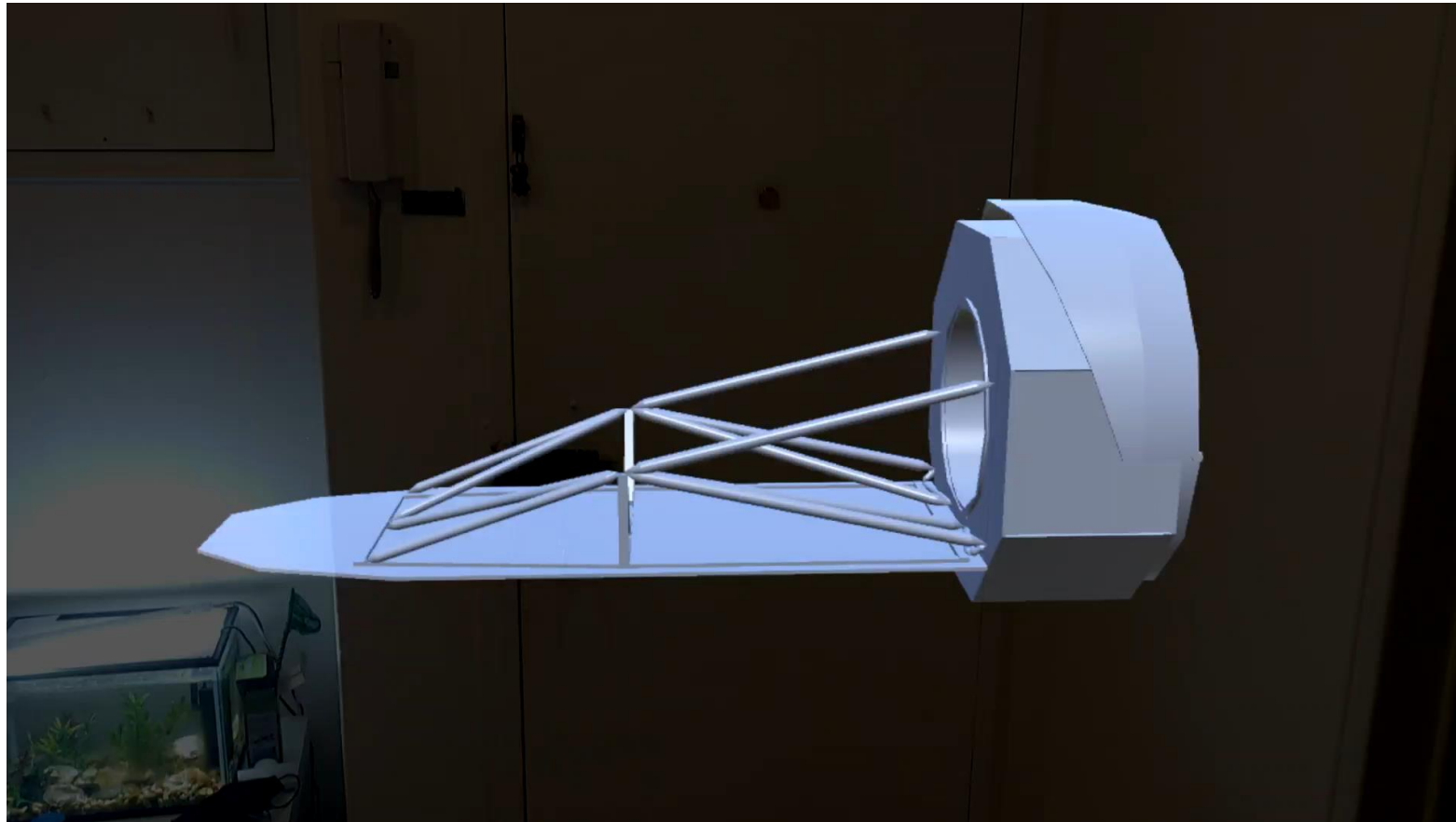
# Budget

**What was done**



*Improved colors*

- **Budget heat map betterment**:
- - Budgets visualization improved. Colors for the High, Medium and Low parts are now more linear and less ambiguous/confusing when Budget menu is open.

- In terms of **calculations**:
    - Mass budget was reviewed
    - Power budget: display P_on instead of P_mean
    - Fringe cases (e.g. all equal) fixed
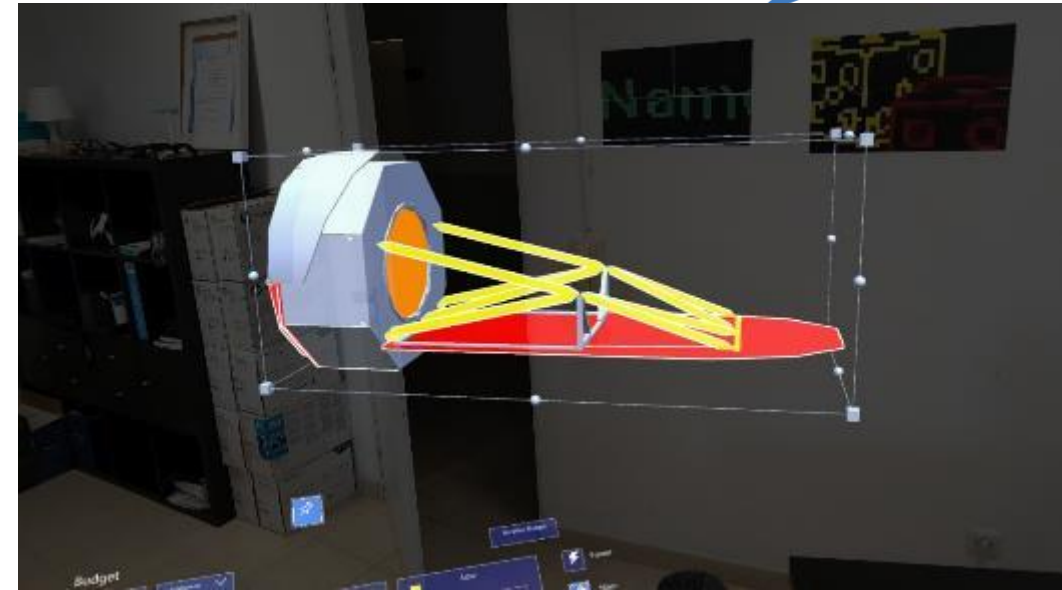


*All equal in the "medium"*

# Conclusions

Objectives met

- Successfully implemented a software suite that allows for **interacting with satellite 3D models** (modifying absolute/relative positions and orientation of the model/components, evaluating dimensions) **and engineering data** (consulting and altering parameters, design options, budgets and issues, amongst others) in an AR environment.

- **3D model's position and orientation is shared amongst all users in the session**, **engineering data is synchronized between all AR users and OCDT**, and a **presentation mode** is available for those users not wearing AR headsets.

- **Several users from different disciplines** can participate in the session (dully authorized and with corresponding permissions), and visualisation and editing of design models was **proven at the CDF during the final design exercise.**

# Next steps

Roadmap

- Overall raise of the TRL, from TRL 4 to TRL5/6 and further, based on user feedback

- Integration and harmonization with third-party ESA developments, e.g. to allow for automatic links between CAD model and Engineering Model in OCDT/COMET

- Final deployment at the ESTEC CDF

# Check out our demos outside!

# Questions?

# Get In Touch

We will be pleased to help you.
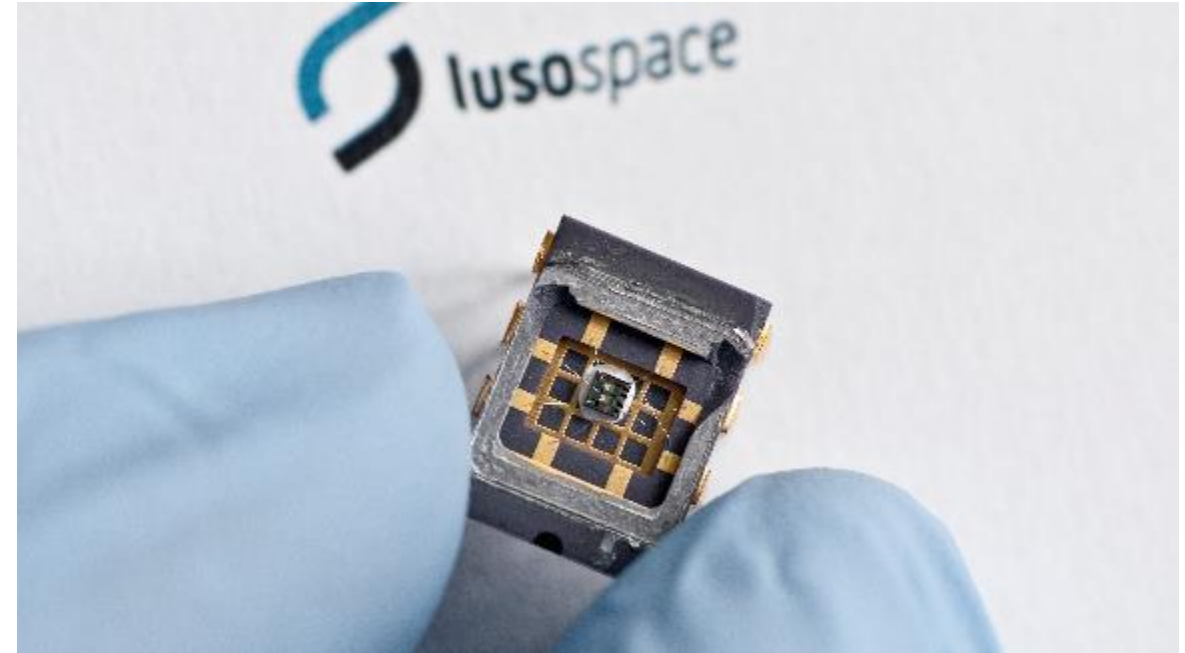


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