Airbus DS return on experience

ESA CSID

DEFENCE AND SPACE

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Agenda

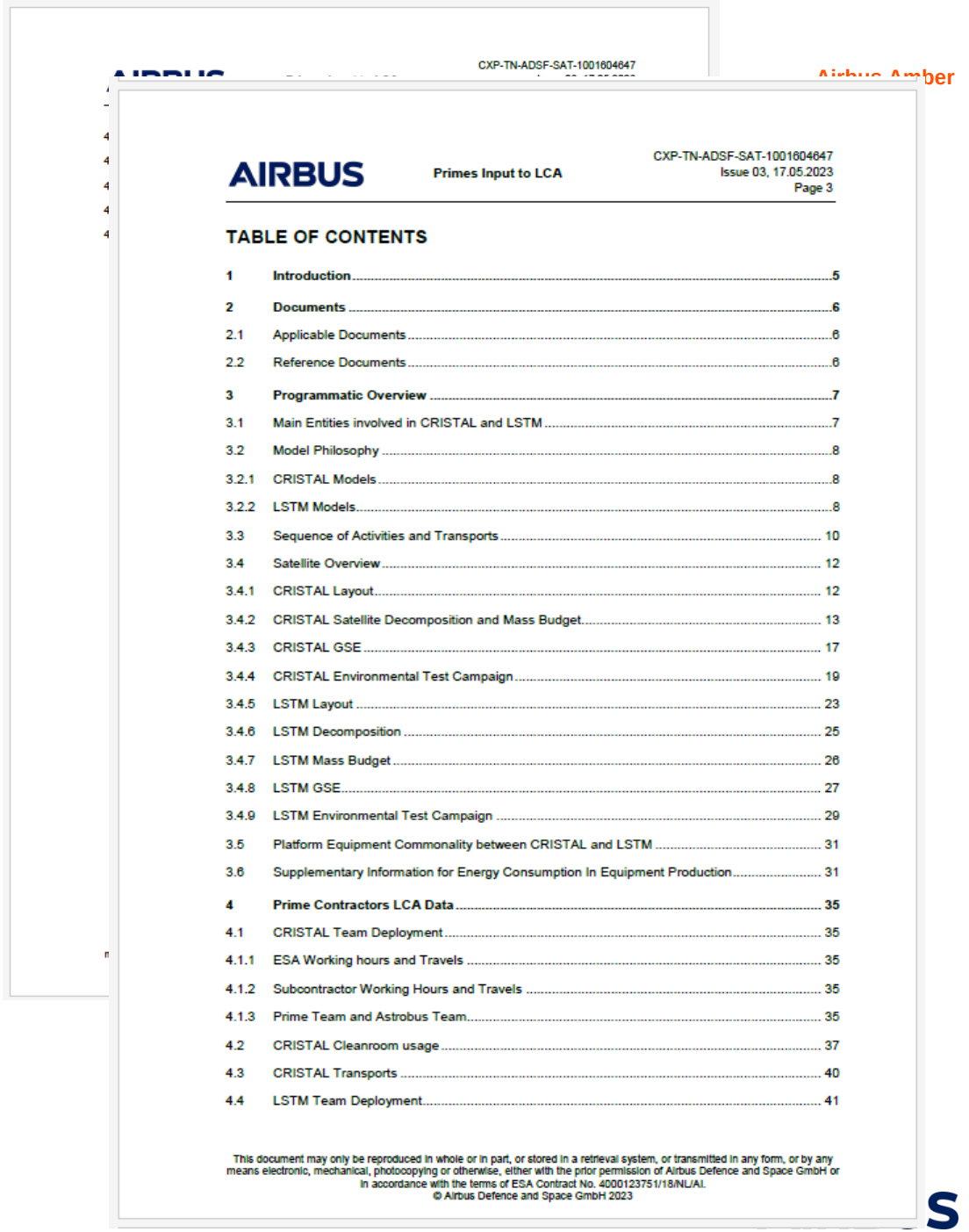
- **LCA data collection approaches in different ongoing projects**
- **LCI improvement possibilities and outlook**

LCA Data Collection Approaches

LCA Data collection approach
- *Prime*

All LCI collection approaches have in common the compilation of “Primes Input to LCA”.

- Collects all LCI Data linked to the Prime (Work hours, Travels, Transport, Environmental testing at satellite level, including cleanroom)
- Provides the Satellite Level Context (Project Phases, Product Tree, …) enabling the LCA Team to aggregate the the data collected in a meaningful way
- Bridges the Gap between the LCA Experts and the Satellite Experts coming from the Satellite Side



LCA Data collection approaches

Equipment ***-*** *ESA Space system LCA guidelines*

"Specific space LCI data-sets can be found in the annexes, from section 10.1 to 10.28 or in a database developed by ESA (RD [14]). ***In case a required LCI is not available or representative and a new up-to-date version has to be developed,*** *the following actions are carried out:*

Regarding equipment or materials:

- *1. Develop a specific LCI that is representative of the equipment or material that is included in the spacecraft(s), using the rules presented in this handbook in section 7.3 (preferred option);*
- *2. Use a proxy, i.e. an LCI that is representative of a similar equipment of material.*

Regarding instrument:

- *1. Develop a specific LCI that is representative of the instrument that is included in the spacecraft, using the rules presented in this handbook in section 7.3 (preferred option);*
- *2. Identify the mass breakdown of the instrument according to the following categories and use it to scale the respective LCI in the database (...)"*

LCA Tailoring
Tailoring specification

➔ Define System Boundaries, Environmental impact categories,etc

➔ *Define equipment LCI data collection approach*

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LCA Data collection approaches

- *Equipment*

Approach A

Dedicated LCA supplier questionnaires

➔ LCA data questionnaire template is cascaded to equipment suppliers via SoW

Approach B

Equipment documentation (ESA standards)

➔ Internal review of supplier design documents

Approach C

Reuse of LCA supplier questionnaires

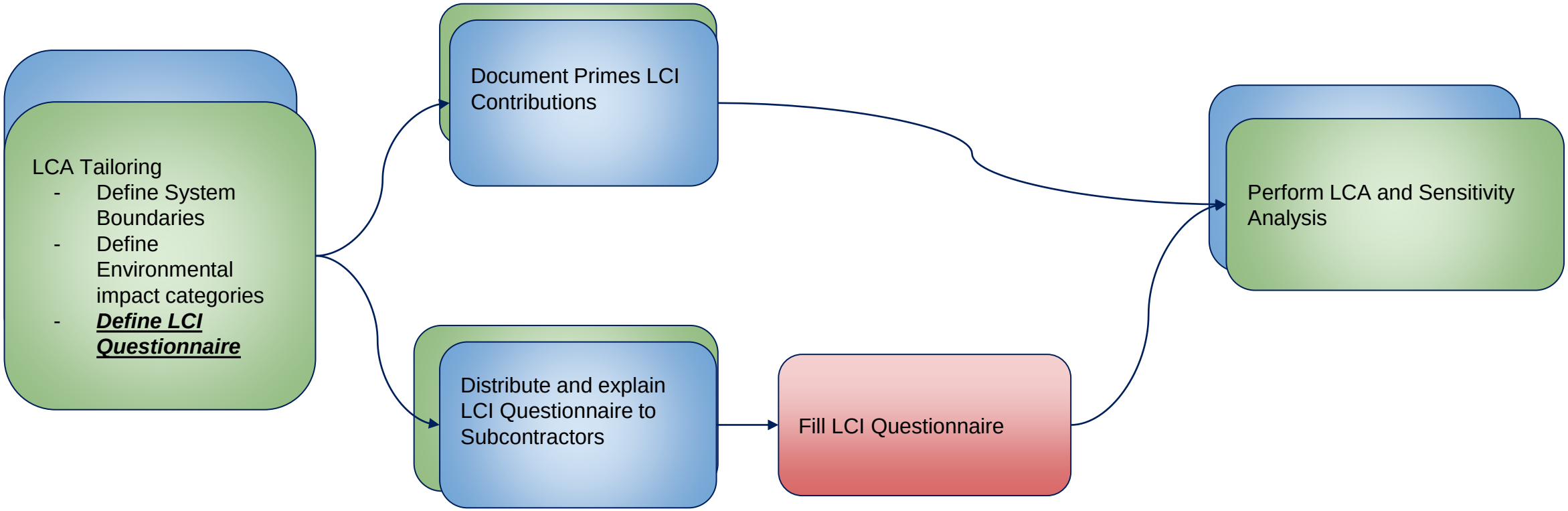
➔ Assess similarity, reuse LCI data / LCA models from past projects

LCA Data Collection **- equipment**

Approach A:
Dedicated LCA supplier Questionnaires

Process Flow in Airbus - Approach A

Dedicated LCA supplier questionnaires



Remark: Each step is established in iterations

Legend

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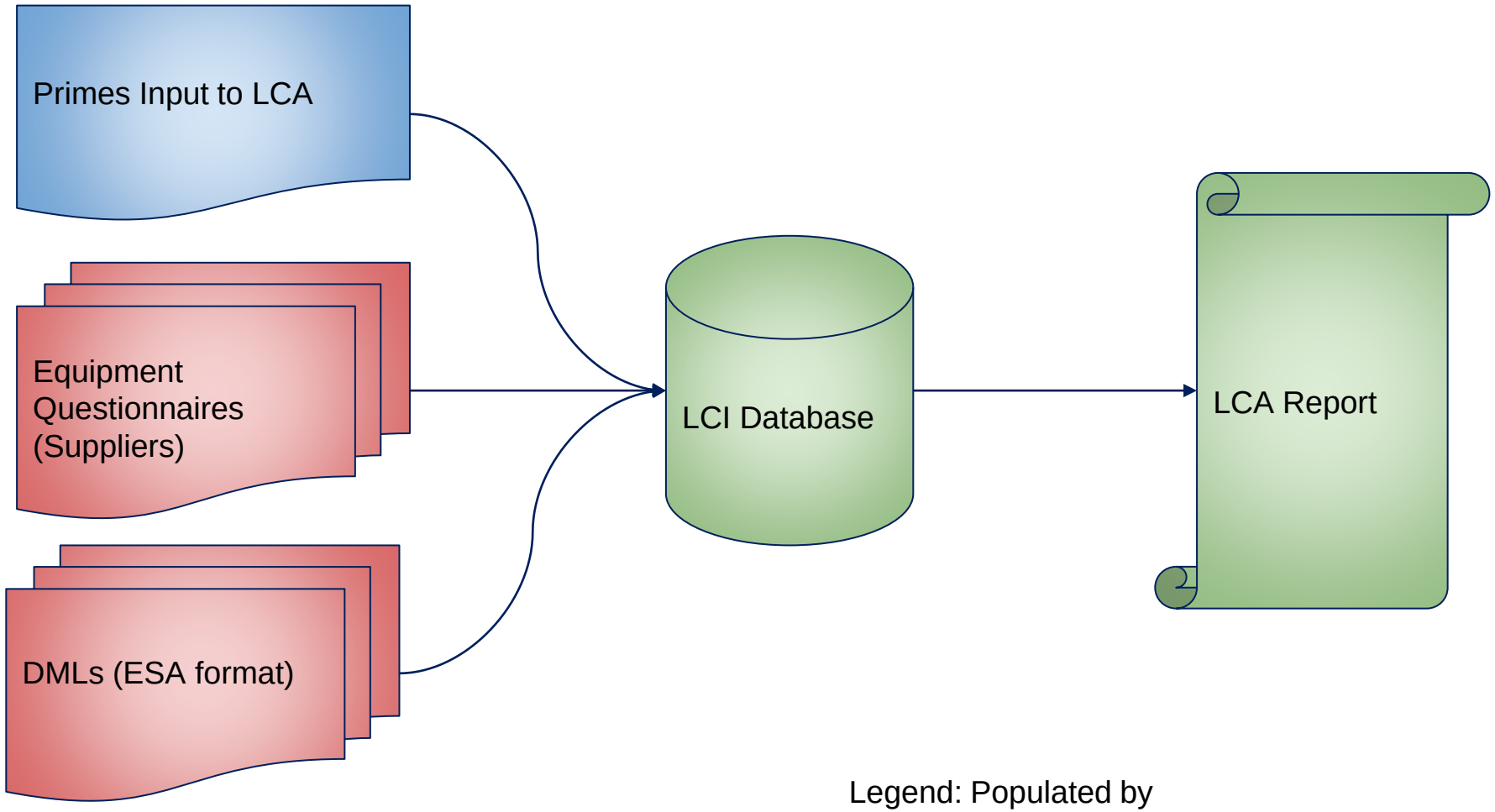
Data Flow in Airbus - Approach A

Dedicated LCA supplier questionnaires



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LCI Questionnaires

Dedicated LCA supplier questionnaires

- The Questionnaire approach overall is considered good for Equipment LCA data collection.
- Harmonisation towards an ESA standard is highly welcome, in order to avoid duplication of efforts on SubCos side.
- The Questionnaire has to be as **simple and pragmatic** as possible accompanied by clear guidelines. Currently SubCos have major difficulties to fill it. The data received is very inhomogeneous.
- Proposed to have more specific and simpler questionnaires in the future, *dedicated to equipment type*. This will allow to give better and simpler guidance to the SubContractors.

Dedicated LCA supplier questionnaires

LCI Questionnaires con’t

- Proposed Categories for LCI Questionnaires:
  - Electronic Unit (PCDU, STR,GNSS, MAG, RIU, OBC, MMFU)
  - Simple and Small Unit (CESS, CSS, MTQ, …)
  - Batteries
  - Solar Array
  - Mechanical Systems (Structure)
  - Propulsion Subsystem
  - Harness
  - Passive Thermal Hardware (MLI)
  - EGSE+OGSE
  - MGSE
  - Satellite Environmental Tests
  - For Major Payloads , an approach similar to the Prime input to LCA might be necessary

Dedicated LCA supplier questionnaires

LCI Questionnaires con’t

- Difficulties encountered in LCI :
    - In many cases the relevant manufacturing steps are at external suppliers (tier 2) in a “build to print” approach. (e.g.PCB production, Housing manufacturing, Panel production, …). It would be major cost driver (if not impossible) to roll-out the LCA requirements to this level.
    - DML and DPL might be used, they are however more focused on manufacturing quality not very useable for LCA.
    - The above problems are even more pronounced for EGSE, where the SubCos do mainly integration and functional testing of “COTS” units.

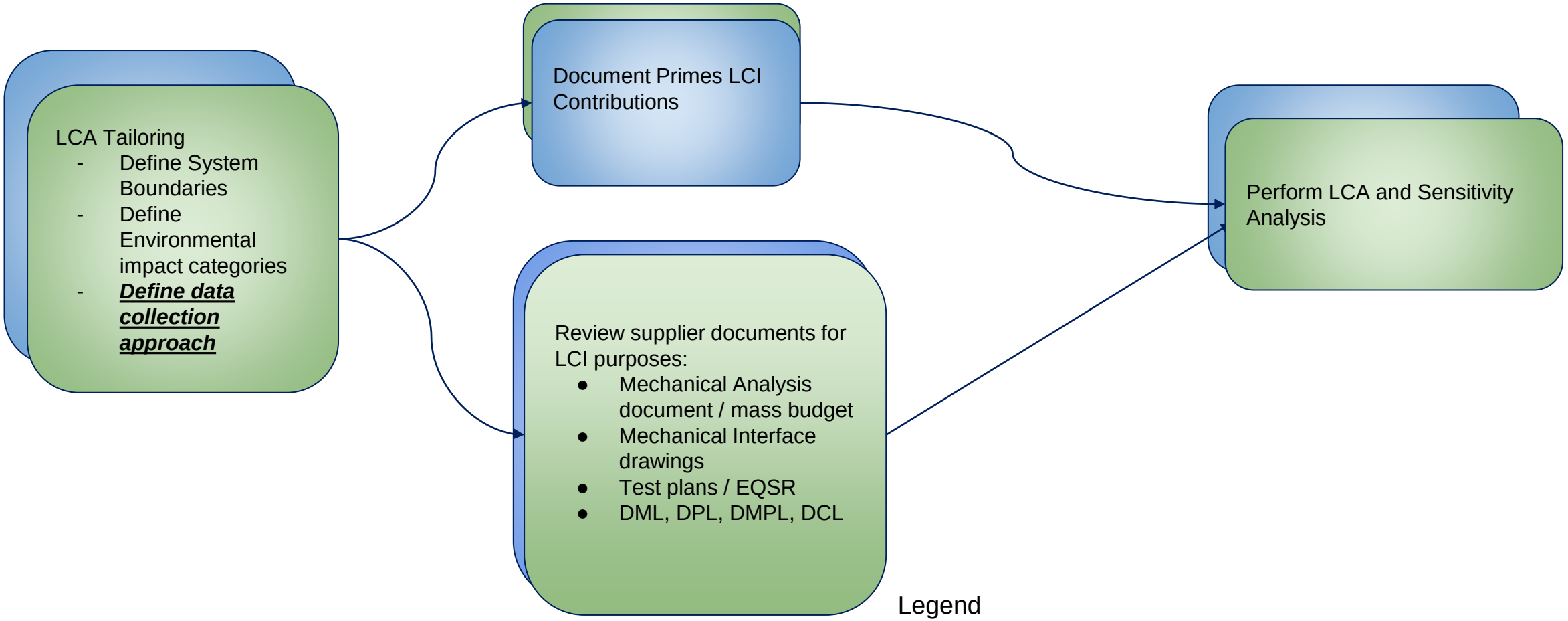
LCA Data Collection – **equipment**

Approach B

Usage of Standard Equipment Documentation

Process Flow in Airbus - Approach B

Equipment documentation (ESA standards)



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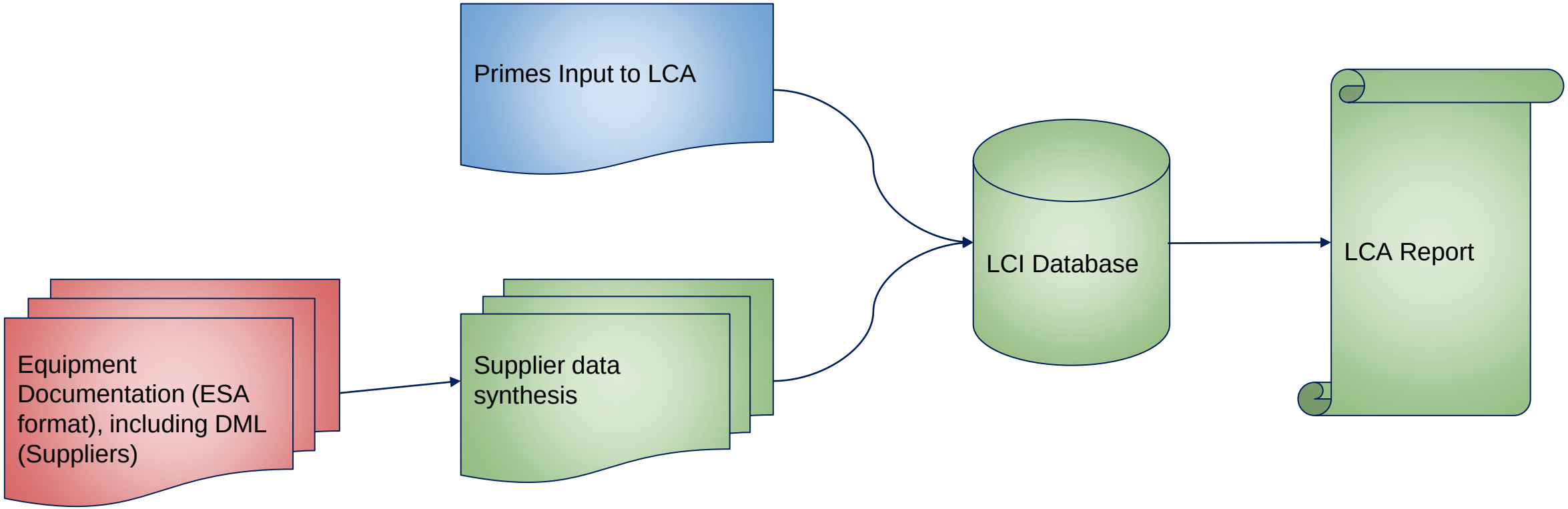
Equipment documentation (ESA standards)

Data Flow in Airbus - Approach B



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Equipment documentation (ESA standards)

- Mass budget level of details varies significantly in between equipment/suppliers. The necessary level of detail is known but not displayed in a consistent manner across documents. Possibility to improve/harmonise mechanical analysis document requirements and its link to the DML, capitalising on very good work already in place.
- Accuracy of mass estimations in DML do not allow to derive a consistent LCI, preventing a accurate mass repartition across DML, DMPL and DCL.
- DML makes no reference of waste generated nor all consumables.
- DML, DPL, DMPL and DCL are not created for GSE.
- DPL information could be used based on a dedicated data collection exercise targeting environmental flows of key processes such as surface treatments, pre-pegs and other requiring use of oven, etc.

Equipment documentation (ESA standards)

- Potential to avoid work duplication, by capitalising on existing documents
- Equipment team involvement is minimised
- Consistent approach in LCI compilation,which is performed by one single team
- Mass repartition using this approach has proven consistent with the approach A (i.e. when dedicated LCI supplier data is made available)
- Possibility to pre-fill LCI supplier data questionnaire
- Expert estimation/validation could be required for aspects such as:
  - environmental testing profile
  - repartition between type of electronic components
  - share of standard parts in the structural parts overall mass
- Efforts in accounting for radiative surface/paint, standard parts, conformal coating, proven not efficient - low sensitivity of results.

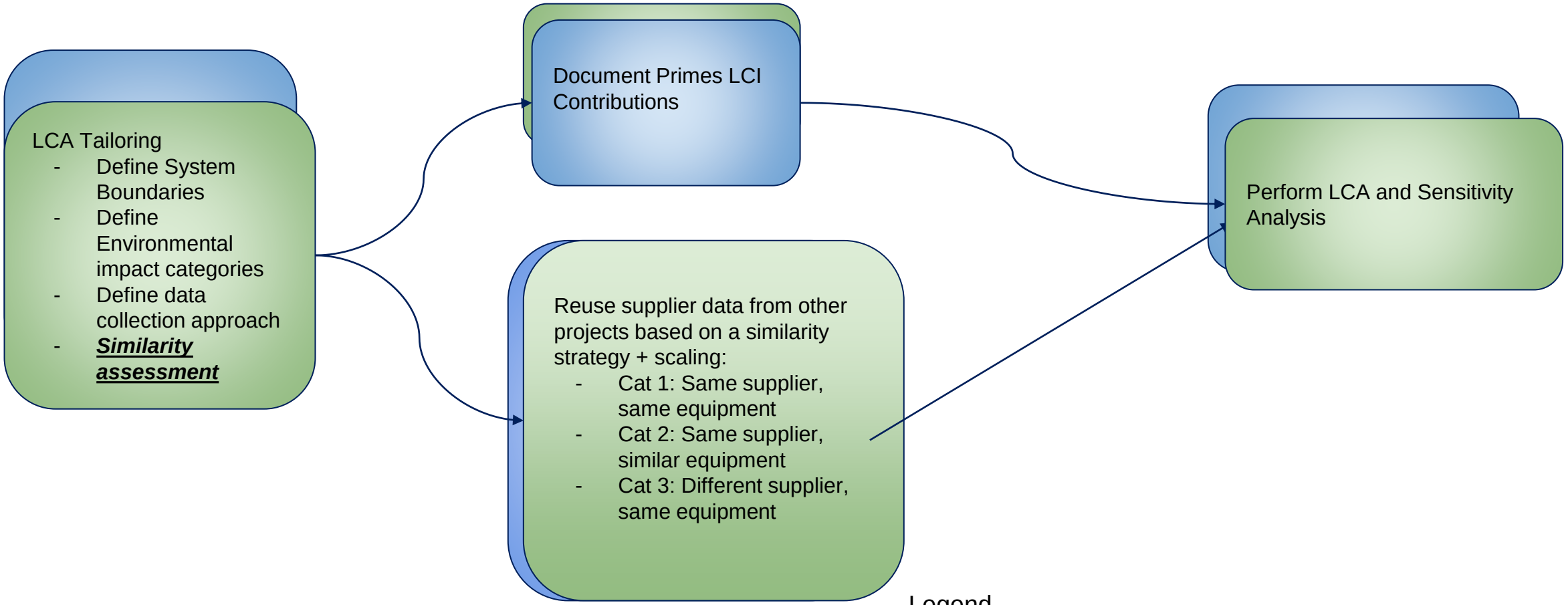
LCA Data Collection – **equipment**

Approach C

Reuse of LCA supplier questionnaires

Process Flow in Airbus - Approach C

Reuse of LCA supplier questionnaires



Remark: Each step is established in iterations

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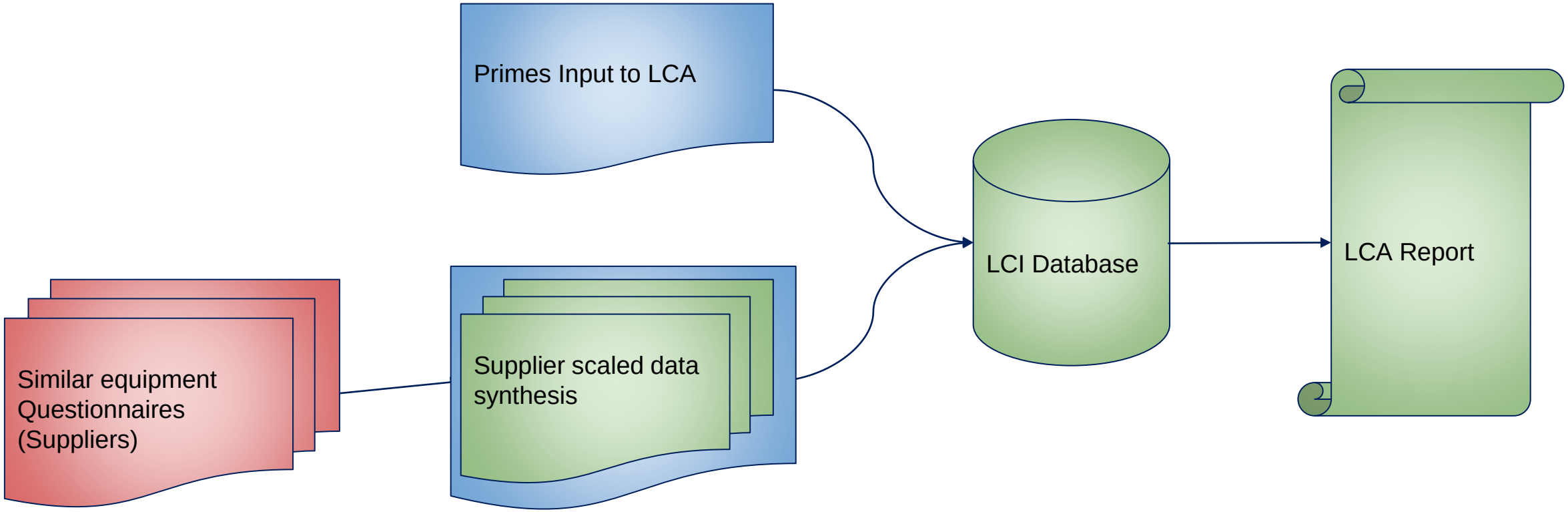
Reuse of LCA supplier questionnaires

Data Flow in Airbus - Approach C



Legend: Populated by

LCA Team | Sat Team | Equip.Team

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Data collection using a equipment similarity strategy

Reuse of LCA supplier questionnaires

- 3 similarity categories:
    - Cat 1: Same supplier, same equipment
    - Cat 2: Same supplier, similar equipment
    - Cat 3: Different supplier, same equipment
- Mass scaling proved effective when compared with supplier data (mass budget).
- Overall potential to be validated by DQR.

Summary

Approach A

- Good approach.
- Significant effort in advising, training and coordinating equipment supplier.
- Need for further simplification.

Dedicated LCA supplier questionnaires

Approach B

- Potential to avoid work duplication if document standards were to be harmonised (ECSS)
- Significant effort from both the Satellite and the LCA teams to review inhomogeneous sources of data.

Equipment documentation (ESA standards)

Approach C

- Efficient approach, valid as a complementary approach to A or B.
- Calls for optimisation strategy for supplier data collection.

Reuse of LCA supplier questionnaires

LCI improvement possibilities

LCI improvement possibilities

- Define standard on how to report technical data relevant for LCA purposes, eg: mass budget.
- Build library for DCL entries - automated analysis that could significantly improve DQR on electronics boards.
- Focus supplier LCA data collection on processes, testing, key substances. Complement with validation of pre-filled mass budget.
- Specific and simpler questionnaires in the future, dedicated to equipment type.
- Reuse of equipment LCA models provided by ESA, while focusing equipment supplier data collection on mission specific elements.
- Define strategy for reuse of supplier data collection.
- Use the approaches described in a complementary arrangement.

Outlook

- Finish the ongoing LCA to have **complete** Satellite LCA Models
- Cross Check the Results comparing approaches across the different projects
- Perform Sensitivity Analysis to distinguish the areas where more precise data would impact the overall result
- Perform selected bottom up studies to calibrate the LCA results, starting with the most impacting and/or most typical elements
- Continue to seek ways how to simplify specific LCI data collection, it is difficult to our subcontractors

Q&A

Thank you