D1.4: Report on Implementing Sustainable IOS Standardization Activities
### Document Information

<table>
<thead>
<tr>
<th><strong>Project</strong></th>
<th>CP-SETIS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grant Agreement No.</strong></td>
<td>H2020 645149</td>
</tr>
<tr>
<td><strong>Deliverable Title</strong></td>
<td>Report on Implementing Sustainable IOS Standardization Activities</td>
</tr>
<tr>
<td><strong>Deliverable No.</strong></td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Dissemination Level</strong></td>
<td>Public</td>
</tr>
<tr>
<td><strong>Nature</strong></td>
<td>Report</td>
</tr>
<tr>
<td><strong>Document Version</strong></td>
<td>V0.4 Final</td>
</tr>
<tr>
<td><strong>Date</strong></td>
<td>28.05.2017</td>
</tr>
<tr>
<td><strong>Contact</strong></td>
<td>Jürgen Niehaus</td>
</tr>
<tr>
<td><strong>Organization</strong></td>
<td>SafeTRANS</td>
</tr>
<tr>
<td><strong>Phone</strong></td>
<td>+49 441 9722 503</td>
</tr>
<tr>
<td><strong>E-Mail</strong></td>
<td><a href="mailto:Juergen.niehaus@safetrans-de.org">Juergen.niehaus@safetrans-de.org</a></td>
</tr>
</tbody>
</table>
Authors Table

<table>
<thead>
<tr>
<th>Name</th>
<th>Company/Organization</th>
<th>E-Mail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jürgen Niehaus</td>
<td>SafeTRANS</td>
<td><a href="mailto:Juergen.niehaus@safetrans-de.org">Juergen.niehaus@safetrans-de.org</a></td>
</tr>
<tr>
<td>Rainer Ersch</td>
<td>Siemens</td>
<td><a href="mailto:rainer.ersch@siemens.com">rainer.ersch@siemens.com</a></td>
</tr>
<tr>
<td>Frédéric Loiret</td>
<td>KTH</td>
<td><a href="mailto:floiret@kth.se">floiret@kth.se</a></td>
</tr>
</tbody>
</table>

Reviewers Table

<table>
<thead>
<tr>
<th>Name</th>
<th>Company/Organization</th>
<th>E-mail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Franziska Griebel, Katja Bonhagen</td>
<td>SafeTRANS</td>
<td>franziska.griebel</td>
</tr>
<tr>
<td>Ad ten Berg</td>
<td>ARTEMIS-IA</td>
<td><a href="mailto:ad.ten.berg@artemis-ia.eu">ad.ten.berg@artemis-ia.eu</a></td>
</tr>
<tr>
<td>Rainer Ersch</td>
<td>Siemens</td>
<td><a href="mailto:rainer.ersch@siemens.com">rainer.ersch@siemens.com</a></td>
</tr>
<tr>
<td>Frédéric Loiret</td>
<td>KTH</td>
<td><a href="mailto:floiret@kth.se">floiret@kth.se</a></td>
</tr>
<tr>
<td>Christian El Salloum</td>
<td>AVL</td>
<td><a href="mailto:christian.elsalloum@avl.com">christian.elsalloum@avl.com</a></td>
</tr>
<tr>
<td>Bernhard Josko</td>
<td>OFFIS</td>
<td><a href="mailto:bernhard.josko@offis.de">bernhard.josko@offis.de</a></td>
</tr>
</tbody>
</table>

Change History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Reason for Change</th>
<th>Sections affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>18.05.2017</td>
<td>Initial version</td>
<td>All</td>
</tr>
<tr>
<td>0.2</td>
<td>22.05.2017</td>
<td>Include reviewer comments</td>
<td>Minor modifications in all chapters, major ones in 3.2</td>
</tr>
<tr>
<td>0.3</td>
<td>25.05.2017</td>
<td>Finalization of Appendix 1</td>
<td>A1</td>
</tr>
<tr>
<td>0.4</td>
<td>28.05.2017</td>
<td>Include final review comments, finalization of document</td>
<td>Major: 3.2, 3.3., 3.4, Minor: all</td>
</tr>
</tbody>
</table>
# Content

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Introduction</td>
<td>5</td>
</tr>
<tr>
<td>1.1.</td>
<td>Role of the Deliverable and Summary of Content</td>
<td>5</td>
</tr>
<tr>
<td>1.2.</td>
<td>Relations to other CP-SETIS Deliverables</td>
<td>5</td>
</tr>
<tr>
<td>2.</td>
<td>Setting the stage: Purpose and Activities of ICF</td>
<td>6</td>
</tr>
<tr>
<td>2.1.</td>
<td>The Need</td>
<td>6</td>
</tr>
<tr>
<td>2.2.</td>
<td>IOS Database</td>
<td>10</td>
</tr>
<tr>
<td>2.3.</td>
<td>Two dimensional standardization</td>
<td>11</td>
</tr>
<tr>
<td>2.4.</td>
<td>Purpose of ICF</td>
<td>12</td>
</tr>
<tr>
<td>2.5.</td>
<td>Activities of ICF</td>
<td>12</td>
</tr>
<tr>
<td>3.</td>
<td>Implementing ICF</td>
<td>13</td>
</tr>
<tr>
<td>3.1.</td>
<td>Structure of ICF</td>
<td>14</td>
</tr>
<tr>
<td>3.2.</td>
<td>Hosting ICF</td>
<td>16</td>
</tr>
<tr>
<td>3.3.</td>
<td>Financing ICF</td>
<td>17</td>
</tr>
<tr>
<td>3.4.</td>
<td>Kick-starting ICF</td>
<td>18</td>
</tr>
<tr>
<td>3.5.</td>
<td>Final Steps to implement ICF</td>
<td>19</td>
</tr>
<tr>
<td>4.</td>
<td>Summary</td>
<td>19</td>
</tr>
<tr>
<td>Appendix 1: Proposal for Horizontal Standardization Process</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>References</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>
1. Introduction

1.1. Role of the Deliverable and Summary of Content

This deliverable D1.4 is one of the main deliverables of the project CP-SETIS. In it, we describe the implementation and set-up of the ICF, the IOS Cooperation Forum, which is a 'sustainable organizational structure' that enables stakeholders -- i.e., industrial and academic institutions -- to further one particular set of specifications/standards, the so called IOS (Interoperability Specifications). Thus ICF does not standardize this set of specifications itself, but enables stakeholders to do so. Neither does ICF support all kind of standardization activities of the stakeholders, but specifically those that are related to the IOS.

On the other hand, ICF is instrumental in handling IOS related standardization activities, because of the complex structure that the IOS specifications have evolved into in the past. This complexity is needed to optimally fit the IOS specifications to their purpose, but proves to need special support for (a) formally standardizing the specifications, and (b) extending and improving the specifications. Thus, without ICF, the effort that has been put in developing the IOS by industry, academia, and last but not least by the EU (by funding large scale R&D projects in which the IOS has been developed), would most likely be lost.

ICF is thus a coordination and cooperation platform for industrial and academic stakeholders that enables them to extend and standardize the IOS specifications efficiently and in a coordinated way.

Conceiving a concept for a structure like ICF, with appropriate roles, opportunities of participation for all stakeholders, and rules of operation, and setting up this structure within an existing organization, has been one of the major goals of CP-SETIS. This deliverable D1.4 describes how this major objective has been reached. We start by recalling the purpose of ICF and describing the activities it enables and supports in Section 2. This Section recalls the 'complex structure' of the IOS, which CP-SETIS together with experts from the ARTMIS-IA Working Group on Standardization, has dubbed a 'Multi-Standard' in its Deliverable D5.2, which is targeted to become the new ARTEMIS-IA Strategic Agenda on Standardization. Section 3 describes the implementation of the ICF as an organizational structure within ARTEMIS-IA, the ARTEMIS Industry Association, including proofs of stakeholder commitment both on the financial as well as on the participation level. In addition to its original goals, CP-SETIS has also supported the creation of a new SME company, named Data Frame, which was founded by Martin Törngren and Frédéric Loiret, both KTH and partners in CP-SETIS. Data Frame is a consulting company that offers services around the IOS, and which will take over a major part in running the ICF, namely the role of the Technical Chair. This role is described in Section 3.1, and its financing in 3.3.

Finally, Section 4 concludes the deliverable by summarizing its content and pointing to follow up activities. The appendices contain further details about the mode of operation of ICF (A1), list terms and abbreviations (A2), and contain references (A3).

1.2. Relations to other CP-SETIS Deliverables

This deliverable D1.4 builds upon and extends the results described in Deliverables D1.1., which described the roles within and the activities of the ICF, D1.2, which describes the concept of the ICF as a whole, and D1.3., which is an assessment and evaluation of potential hosting organisations for ICF. All of these three documents have been delivered during the first year of CP-SETIS.
An integral asset of ICF will be the so-called IOS database, which is described in D4.1-2.

The 'complex structure' of the IOS that necessitates the need for a structure like ICF, and the processes of 'horizontal and vertical standardization' are introduced in D5.2. (also available as [SN17]).

2. Setting the stage: Purpose and Activities of ICF

2.1. The Need

“Cyber-Physical Systems (CPS) are becoming omnipresent in our daily lives. However, because of their heterogeneity and increasing complexity, CPS development requires a huge variety of engineering tools from various engineering disciplines. To ease development – i.e., reduce costs and development errors – as well as to satisfy requirements for full-fledge traceability across the engineering artifacts and throughout the development lifecycle of safety-critical CPS – as required by more and more standards, like for example ISO26262 in the automotive domain – these tools need to be smoothly integrated into Engineering Environments, allowing fast and efficient development of CPS as well as smooth cooperation of all stakeholders (e.g., engineers, system architects, product managers, decision makers or analysts). This integration, however, poses huge challenges for CPS developing organizations, which are stuck between two extremes: Either to develop their own hard-to-maintain in-house and ad-hoc Engineering Environments, or to be locked-in with proprietary solutions, which are typically not fully tailor able for supporting their special needs. To overcome this challenge, past and ongoing large scale R&D projects – most in the context of ARTEMIS, e.g., iFEST, CESAR, MBAT, HOLIDES, CRYSTAL and others – have proposed open standards for data and tool interoperability in CPS development, namely the so called IOS (Interoperability Specifications).

[...]

The Interoperability Specifications covers many different aspects and all phases of the development process. It is neither feasible nor particularly desirable to put all these concerns within a single standard. On the other hand, there already are a number of standards that cover interoperability and/or data exchange between engineering tools, each of them covering specific aspects of CPS development, and it would be unwise not to take advantage of their existence and the trust in usability that stakeholders already put into them. The IOS therefore consists of different parts, each of which (a) deals with a specific aspect of CPS development (so called Engineering Concern), like for example Lifecycle Data Integration and Data Exchange or Heterogeneous Co-Simulation and (b) is based upon existing standards and possible extensions of them, whenever an appropriate standard exists. For Lifecycle Data Integration and Data Exchange, the underlying existing standard is OSLC (Open Services for Lifecycle Collaboration, see http://open-services.net/), for Heterogeneous Co-Simulation FMI (Functional Mock-Up Interface, http://www.fmi-standard.org) is under consideration. Two issues are noteworthy: On the one hand, IOS does not include all of the existing standards, but only those parts that are relevant for the respective Engineering Concern. On the other hand, IOS also includes additional specifications, either as extensions of existing standards (if the standard does not yet completely cover the Engineering Concern), or as an independent specification (if there is no existing standard yet covering this particular Engineering Concern). In addition, the IOS also includes
The Interoperability Specifications (IOS) are a set of specifications covering interoperability of Software-Tools used to engineer (i.e., design, develop, implement, analyze, test, integrate...) Cyber-Physical Systems. (Nota Bene: Therefore, the interoperability of components/sub-systems of a Cyber-Physical System – so called run-time interoperability) is not covered by the IOS).

Each part of the IOS (i.e., each specification in the set) is

- Either a specification about interoperability of tools used to support Engineers in one specific task during the development process, e.g. Lifecycle Data Integration, Requirements Engineering, heterogeneous co-simulation or similar. These tasks are called Engineering Concerns and corresponding IOS part is said to cover this Engineering Concern. These parts of the IOS are
  - Either based upon an existing standard, whenever an appropriate standard for this Engineering Concern exists, that is industrially accepted and proven-in-use. In this case the IOS specification typically extends (i.e., adds additional features) to the existing standard to make it fit better to Engineering Concern and the other parts of the IOS.
  - Or they are new specifications not based on any existing standard, if no proven-in-use and industrially accepted standard exists for this particular Engineering Concern.
- Or this part is a Bridge, i.e., a specification about the relations between other parts of the IOS.

Figure 1 (taken from the CRYSTAL project) on the next page depicts this structure and characteristics of the IOS.
The IOS specifications have been developed in a variety of large-scale European R&D projects, most of them in the contexts of the Joint Undertakings ARTEMIS and ECSEL, but some also in FP7, Horizon 2020 and ITEA. Various national projects, especially in Germany, have also contributed to the specification. Nonetheless, the IOS is not yet ‘complete’: It does not yet cover every Engineering Concern, and the specifications it consists of are of different maturity levels. In addition, only very few extensions of existing standards that are specified within the IOS have as yet found their way back into the corresponding base standard (with the OSLC standard as the basis for the IOS Lifecycle Data Integration Part being the notable exception) and no new formal standard has been derived from any part of the IOS. It must be stressed that these missing features are in no way any indication of shortcomings of the IOS specification per se, but are rather due to the fact that the focus of an R&D project is typically broader (thus, there is less effort available for interoperability) and the available time in theseprojects did not allow to fully pursue these goals.

Future projects – and in fact also currently running ones – and future and current activities of IOS Stakeholders will

- **Extend the IOS**, i.e. they will develop additional specifications covering additional Engineering Concerns, increase the maturity of existing parts of the IOS, and implement (prototypes of) CPS Engineering Tools that build upon the IOS.
- **Drive formal standardization of the IOS**, i.e., they will drive the inclusion of extensions specified by the IOS into the underlying base standards and/or derive new formal standards from IOS parts.

However, these two activities are currently not easily done:

- **The IOS specifications are scattered** among the (deliverables of the) various projects that produced them. It requires an expert to gain an overview about what has been specified
where and with what maturity. It is thus very hard to know the basis on which to build new specifications and which to use to drive formal standardization.

- The number of IOS Stakeholders – i.e. of people and organizations active in creating means of interoperability for Engineering Tools based on the IOS – has grown considerably in the past. However, they lack a focal point around which to build an active IOS community. In the past, the number of IOS projects had been small and a large number of IOS stakeholders were active in all IOS projects. Thus, the project consortia served as this focal point. Nowadays, the number of IOS projects has grown considerably with some projects having completely disjunct sets of members.

- Both of the activities described above – i.e. (a) extending the IOS and drive this extension to a sufficient maturity, and (b) drive formal standardization of the IOS – extend the scope (sometimes) and the timeframe (always) of typically R&D projects. Here, again, a focal point is needed to harmonize cross- and inter-project relations (i.e., support harmonization of project goals, support transfer of results from one project to another, etc.).

Therefore, there exist a strong need for

- A single place (repository, database,...) in which the complete IOS specification is openly available to all stakeholders

- An organizational structure that serves as a communication and harmonization platform to allow stakeholders to coordinate on their IOS related activities, find allies and cooperation partners for specific activities, find experts, and get support for their IOS related activities.

Typically, that is for a ‘normal’ set of specifications, these needs would be answered by formally standardizing the specification within an existing standardization body (c.f. [ASA11]). Depending on the processes of the specific standardization body chosen, stakeholders would for example set up a working group within that standardization body and use this group as a focal point for their further activities, especially for further developing and maturing the specification and continuing the process for converting it into a formal standard of that standardization body.

For the IOS, this solution is infeasible, because it contains many existing standards ‘owned’ by different standardization bodies, as well as specifications not yet based on an existing standard and bridges.

Therefore, the answer to this need derived in CP-SETIS is twofold:

a) Create an IOS database, i.e. a repository where all IOS specifications can be stored and are openly available to all stakeholders.

b) Create and implement a ‘sustainable structure as a forum (platform) for all stakeholders to coordinate their IOS related activities. This structure is called the ICF, the IOS Cooperation Forum. It will be open to all stakeholders, sustainable (i.e. beyond the lifetime of a single projects, and hosted with an existing, trusted structure.

Figure 2 depicts this solution; the purpose of the ICF is described in more details in the following subsections, Chapter 3 describes the implementation of the ICF.
2.2. IOS Database

A central asset of the ICF will be the IOS database, which is a repository that will contain the up-to-date specifications of all parts of the IOS and that will be open and accessible to all Stakeholders. The concrete content and set-up of the IOS database is described in Deliverable D4.1-2; here we only give a broad overview.

The IOS database will contain for each IOS part

- Description
- Technical Specification
- Documentation
- Version history
- Maintainer/Developer contact
- Additional type information
- Maturity level (or adaptation status)
- And more...

It will have this information either stored directly into the database or represented by references to e.g. the actual specifications (e.g. https://open-services.net/ for OSLC based specifications).

Deliverable D4.1-2 contains the complete specification of the IOS database and its technical implementation.
2.3. Two dimensional standardization

As explained in Section 2.1, the IOS comprises parts, each of which is a specification of interoperability of development tools used for one specific Engineering Concern and each of which may be build and may extend an existing base standard. We call specifications with a structure like this ‘Multi-Standard’ (see D5.2 and [SN17]). Multi-Stands have their own process of standardization, which is two-dimensional [c.f. SN17):

- **Horizontal Standardization** refers to the process of including a (new or extended) specification into the Multi-Standard. We have already developed and described the principles of this process in D1.2. This process has been refined and recommendations from the ARTEMIS Strategic Agenda for Standardization [ASA11] have been included. Since this horizontal standardization process will be supported by the ICF, we describe this refined process again in Appendix A1 of this document.

- **Vertical Standardization** refers to the process of including one specific specification of the Multi-Standard into a formal standard on which it is based (or – in the case of specifications that are not based on an existing standard – creating a new formal standard out of this specification).

Horizontal and Vertical Standardization both rely in large parts on the standardization processes described in [ASA11]. Figure 3 depicts these processes and their interaction.

![Figure 3: Two-dimensional standardization process for Multi-Stards](SN17)

This two-dimensional standardization process has a number of highly desirable advantages:

- **Independent maturity advancement**: Each part of the multi-standard can be in different stages of the horizontal process, and each part can be matured (i.e., advance in this process) independent of the other parts.

- **Independent vertical standardization**: The vertical standardization process can be undergone for any part of the Multi-Standard independent from each other part. Many vertical standardization processes can be done in the same time frame.

- **Early take-up of specifications**: The two-dimensional standardization process in combination with the IOS database, in which the actual version of each specification is available together with the information about its status both in the horizontal as well as the
vertical standardization process, allows users to take-up and implement specifications at any time, i.e. as early as they see fit. They can assess the completeness and usability of the specification, can see which other stakeholders support the specification and drive its maturity advancement, and thus have an excellent basis for their decision about take-up of the standard. This feature of the two-dimensional standardization process answers a demand of the reviewers of CP-SETIS of ‘implementing a fast-track’ for take-up of the standard.

### 2.4. Purpose of ICF

With the context set in the previous sections, we can now concisely describe the purpose of the ICF:

The **IOS Cooperation Forum ICF** is an organizational structure that serves as a cooperation platform for IOS stakeholders of all levels – i.e., end-users using development tools based on the IOS, tool providers using the IOS in their products, consortium partners in projects developing, extending and maturing the IOS, standardization bodies ‘owning’ standards on which the IOS is based, and similar – to coordinate on, plan, incubate and harmonize their IOS related activities.

Especially, ICF will

- Host the IOS database
- Support and coordinate the horizontal standardization process for the Multi-Standard IOS
- Support the vertical standardization process for the Multi-Standard IOS
- Be THE contact point for all IOS related activities and information

### 2.5. Activities of ICF

We now describe the activities of ICF in a little more detail:

- **Host the IOS-Database**: ICF will provide the technical means of hosting the IOS database. It will collect the content – i.e., the IOS specifications derived in the various European projects – and include them in the IOS database. It will maintain this database and update the content whenever new specifications are included into the Multi-Standard IOS and/or whenever the content or the status of an IOS part changes. Last, but not least, it will make the IOS database available to all stakeholders.

  A *first version of the IOS database has already been set up by CP-SETIS* (see D4.1-2).

- **Horizontal Standardization**: ICF will support and coordinate the horizontal standardization process for the Multi-Standard IOS. For this purpose, ICF will
  - Conduct, organize, prepare, and follow-up on Project-Incubation Workshops. During these workshops, stakeholders will be given the opportunity to
    - Present existing IOS activities (i.e., projects) and their expected results, thereby giving the community an up-to-date view on the current status and expected changes in the status of the IOS,
• Identify gaps in the current IOS specifications, i.e., Engineering Concerns that they want to be covered by the IOS but which as yet are not covered; or maturity level increases (i.e., advances in the horizontal or vertical standardization processes) that they want to realize.
• Find allies in filling these gaps
• Conceive ways as to how to fill these gaps together with their allies, e.g., planning new projects, push implementation activities, plan vertical standardization activities, etc.

The first Project- Incubation Workshop has already been conducted by CP-SETIS (c.f. Section 3.4).
- Implement the technical and organizational support for the horizontal standardization process (c.f. Appendix A1).
- Vertical Standardization: ICF will support formal standardization of the IOS, i.e. the inclusion of extensions to existing standards specified in the IOS back into the base standard and the creation of new standards from IOS parts. ICF cannot, by itself, conduct this standardization, because this has to be driven by (industrial) organizations. However, ICF can and will ‘pave the way’ and ease this process for the stakeholders. For this purpose, ICF will
  - Maintain contacts to relevant standardization bodies, and enable information flow in ‘both directions’: Make stakeholders aware of existing standards hosted by these bodies, of ways of working and processes of standardization bodies, etc.; as well as make standardization bodies aware of IOS extensions to ‘their’ standards, make them aware of standards similar to theirs, make them aware of bridges defined in the IOS, etc.
  - Supply the necessary information to stakeholders that drive vertical standardization
  - Support the activities of the stakeholders within the relevant standardization bodies
- Community building - Be THE contact point for all IOS related activities and information. ICF will
  - Set-up and maintain a Website with documentation, IOS advertising, success stories, dissemination material, and similar.
  - Maintain contacts to experts, pointers to implementer forums, etc.
  - Organize Events, Workshops, Conferences, Marketplaces
  - Lobby adoption of IOS by industrial stakeholders
  - support projects in adopting IOS
  - provide information to EC, Public Authorities, Funding Organizations,
  - Initiate/facilitate IOS related cooperation between stakeholders, standardisation organizations, and projects

3. Implementing ICF
This Section describes how CP-SETIS has succeeded in implementing the ICF in the second half of its funding period. Especially, we succeeded in reaching a decision of the ARTEMIS-IA Steering Board, the formal management body of the ARTEMIS Industrial Association, comprising 25 members of Large Industry (e.g., Airbus, AVL, Infineon, NXP, Philips, Siemens, STMicroelectronics, Thales, Valeo, ...), SMEs (BetterSolutions, Eurotech, TWT and many others) and research organizations, to agree to install the ICF within the ARTEMIS-IA Working Group on Standardization and to support its operations with 50.000,- Euro per Year budget (taken from ARTEMIS-IAs own funds) and sufficient
support from the ARTEMIS-IA Office. This decision was taken in the ARTEMIS-IA Steering Board meeting on March 16, 2017, and was on the following day seconded and approved unanimously by the ARTEMIS-IA General Assembly, which is the highest decision body in the association, making the decision on ICF legally formal. The unanimous decision of the General Assembly also impressively documents the approval and support of the whole ARTEMIS-IA community for ICF. Together with the CP-SETIS support in creation of a new SME named Data Frame, which is a consulting organization offering services centered around IOS and which will take over the role of the Technical Chair of ICF, CP-SETIS has thus reached its goal of setting up sustainable structures to support IOS extension and standardization.

In this chapter, we will describe the structure of the ICF in Section 3.1., the way it will be hosted within ARTEMIS-IA in 3.2, and financing of its operations in 3.3. All of these properties of ICF are directly derived from the concepts and processes we derived in CP-SETIS and described in D1.1 and D1.2 as well as from discussions with the ARTEMIS-IA Steering Board and Working Group Standardization about how to best fit ICF into the existing ARTEMIS-IA structures.

We will also describe a Kick-Start Workshop in Section 3.4., that CP-SETIS has conducted to show the feasibility of our approach and, moreover, acceptance of this approach by the community. This workshop was a first instance of the Project Incubation Workshops that ICF is going to hold and was conducted on May 9th, 2016 (back to back with the Digital Innovation Forum on May 10th and 11th, see https://dif2017.org/ in Amsterdam.

In Section 3.5., finally, we will describe the few missing steps to the final installment of the ICF, which are missing because of the generally slow way of work that official bodies of organizations like ARTEMIS-IA have to adopt.

### 3.1. Structure of ICF

ICF will be a subgroup of Working Group Standardization within ARTEMIS-IA. As such, it will have Chairpersons, which are the official ‘interface’ between ICF and ARTEMIS-IA. For ICF, we will have two Chairpersons, one as the Executive Chair, who is the person responsible for ICF activities and at the same time the ‘face’ of ICF activities. The Executive Chair should be a person with a good knowledge about IOS and with a track record in IOS related projects and activities. He/she will be nominated by all ICF members, who will vote for candidates, and endorsed by the ARTEMIS-IA Steering Board. While setting up ICF, CP-SETIS partners will nominate an Executive Chair: Pending the final decision of the ARTEMIS-IA Steering Board, Martin Törngren from KTH will be the first Executive Chair of ICF. The second Chairperson will be the Technical Chair, who is responsible for IOS database maintenance and updates and for smooth operations and running of the ICF. He/she will be nominated by ICF members and endorsed by the ARTEMIS-IA Steering Board, too, and will organize and execute the Horizontal Standardization Process (including giving support to corresponding IOS projects), support the Vertical Standardization Process as described in Section 2.5., maintain contacts to Standardization Bodies, and maintain and update the content of the IOS database. Both Chairs will prepare, execute, and follow up on meetings of ICF, especially on Project Incubation Workshops.

Membership to ICF is open for all stakeholders; there will be no member fees, and openness includes non ARTEMIS-IA members as well. However, unlike other working groups in ARTEMIS-IA, ICF will maintain a strict concept of membership, where potential members have to actively commit to
Advantages and benefits of memberships in ICF have already been discussed in D1.1, Section 5. For completeness, we repeat them here (slightly re-worded as to fit the new vocabulary introduced here): Membership to ICF enables stakeholders to...

- use ICF as an independent, neutral forum, to meet other stakeholders at eye level
- find allies, i.e., for IOS standardization activities and project incubation
- to efficiently standardize parts of the IOS (two-dimensional standardization)
- to find IOS experts to help them in adoption of IOS
- extend and shape IOS according to their needs
  - Extensions (horizontal standardization)
  - Further developments/concretization of existing parts (horizontal standardization)
  - Drive formal standardization (vertical standardization).
- be able to guarantee sustainability and accessibility for their IOS related project results
  - by bringing them into ICF, where they are stored in the IOS database and publically available
  - advertise about them
- be informed about all IOS related activities of all stakeholders
  - current baseline/snapshot of IOS
  - new extensions under development
  - standardization activities (horizontal and vertical ones).

ICF members can – by simple declaration followed by active participation – become participants of the following subgroups:

- **Proposer Group(s):** For each newly proposed part of the IOS there must be at least one organization, possibly and preferably more, that provides an initial specification and propose this to become a part of the IOS (first step in horizontal verification).

- **Interest Group(s):** For each part of the IOS that is as yet not fully standardized (i.e., not in status ‘accepted’ in the horizontal standardization process and/or not fully integrated in the underlying base standard in the vertical standardization process, there can be a group of stakeholders that want to further the horizontal or vertical standardization of this part. For new specifications, this group initially equals the ‘Proposer Group’, but this group can grow and shrink over time as the interest of stakeholders change.

Installing these two groups for all IOS parts will allow members to choose on which parts of the IOS they are active in and which other parts of the IOS they will rather only monitor, without actively driving their maturity advancements.

ICF will also install – by voting of its members – the following committees:
• **Strategic Board.** A group of members with an excellent knowledge about interoperability of development tools, the development process, and the roadmaps and strategies of the different stakeholders in this area. This group gives a recommendation about the final adoption of IOS parts into the IOS, which is voted on by all ICF members (c.f. Appendix A1). The initial Strategic Board of ICF will consist of CP-SETIS core members, with additional members being elected by ICF members.

• **Technical Board resp. Technical Expert Group.** A group of members that are experts in the whole IOS structure on a technical level. This group gives recommendations to the Proposer Group of a new specification to be included into the Multi-Standard IOS (i.e., conformity to basic concepts and methods, interfacing with other IOS parts, etc.), and supports other members in all kinds of deep technical questions about the IOS. The initial Group will consist of the Technical Chair and CP-SETIS core members, with additional members being elected by ICF members.

### 3.2. Hosting ICF

Based upon the initial evaluation of potential hosting structures described in D1.3, CP-SETIS conducted workshops with the community and discussions with members of official bodies of potential hosts in order to (a) more deeply explore the acceptance of ICF and its underlying concepts within the community and to (b) finally decide upon a host and agree with this host about the details of the implementation. For the second year, these activities are listed in Deliverable D6.2-2. For getting feedback from the community (goal (a) above), the dissemination activities of publishing in the ARTEMIS-IA magazine, the presentation at the CRYSTAL final event in Madrid (June 2016), and the workshops at the ARTEMIS Technology Conference in Madrid (October 2016) and at HIPEAC Conference in Stockholm (January 2017) have proven most useful. Each of these events was followed by a discussion with stakeholders about details of the implementation of ICF and a verbally expressed interest of the stakeholders to participate in this kind of activities. The presentations of CP-SETIS at the CPS Clustering and Communication Event (April 2016, Vienna) and the Smart CPS Concertation Event (January 2017, Brussels) also led to intensive discussions with stakeholders.

In these discussions, we especially confirmed our initial evaluation from D1.3, that ARTEMIS-IA would be seen as an ideal candidate as a hosting structure, because of its scope, its membership base, its involvement with previous IOS activities, and the general trust that stakeholders put in ARTEMIS-IA as to its sustainability and competence.

We followed up these activities by having in-depth discussions with people centrally involved in ARTEMIS-IA. These included Laila Gide (Thales, president of ARTEMIS-IA), Michael Paulweber (AVL, Treasurer of ARTEMIS-IA), Daniel Watzening (V2V, member of the presidium of ARTEMIS-IA), Knuth Hufeld (Infineon, member of the Steering Board), Jerker Delsing (Lulea University, member of the Steering Board) and Jan Lohstroh (Secretary General of ARTEMIS-IA and guest member of the Steering Board). These discussions finally led to an official proposal to implement ICF within ARTEMIS-IA which was presented by Jürgen Niehaus to the ARTEMIS-IA Steering Board on its meeting in November 2016. This proposal was (intentionally) not voted on, but served to inform the Steering Board and as an opening of the discussion with the whole Steering Board. The formal application for inclusion of ICF was presented in the March 2017 meeting of the Steering Board, which then decided to agree upon installing ICF as a subgroup of the ARTEMIS-IA WG Standardization and to support its operation with 50.000,- Euro/per year as well as with providing capacity to support
operation of ICF from the ARTEMIS-IA office. This decision of the Steering Board has meanwhile been seconded and accepted by the ARTEMIS-IA general assembly.

Minor details of the operation have to still be discussed with WG Standardization, and are at the moment worked out by representatives from CP-SETIS and WG Standardization. The official start of ICF is expected to come after the Steering Board Meetings in June and July, where the final decision will take place.

ICF will be the first working group of ARTEMIS-IA which needs extra funds for its operation. The fact that the ARTEMIS-IA Steering Board has decided to indeed grant these funds and that this decision has been approved by the General Assembly serves as an additional proof (next to the ICF being hosted by ATEMIS-IA at all) about the importance that the ARTEMIS-IA community assigns to this activity.

### 3.3. Financing ICF

ICF will operate on a mixture of in-kind-contributions from its members as well as from the budget assigned to it by ARTEMIS-IA.

In more detail, ICF must finance the following activities to be sustainable:

- **Executive Chair, Steering Board, Technical Board, member participation** in ICF activities. As with any ARTEMIS-IA Working Group and any Standardization body, these activities will be funded by the members of ICF resp. those, that hold these positions. This is the usual way of financing these kinds of activities, as by participating members actively further their own interest.

- **Technical Chair**

  Unlike the Executive Chair, the work of the Technical Chair far exceeds the amount of work that is usually expected from a Chair of an ARTEMIS-IA Working Group. In addition, this work is much more a service to the community than it is to further the own interest of the holder of this position and the deep technical knowledge about the IOS needed to do the job must be provided by an technical expert, of which there are not many that are also suitable to serve as an integration and community building focal point. Therefore, ICF – resp. ARTEMIS-IA as the hosting organization – will subcontract this work to an IOS consulting company. Between CP-SETIS partners – as the initial members of the ICF Strategic Board – and the Working Group Standardization as well as with the ARTEMIS-IA presidium we have agreed to offer this work to Data Frame, an SME newly founded with the support of CP-SETIS, which will supply Frédéric Loiret, an IOS expert that has participated in almost all IOS projects, for this job. The final details of this subcontract have still to be negotiated, but are expected also to be finished by the start time of ICF. The subcontract will be paid from the 50 K Euro budget assigned to ICF by ARTEMIS-IA.

- **Office support**

  ICF needs office support for (a) membership management, (b) organizing workshops and (c) collecting workshop fees, should those become needed (see below). In addition, technical infrastructure for hosting the IOS database as well as the webpages is needed. This support and infrastructure is part of the budget that ARTEMIS-IA has assigned to ICF.
• **Meetings**
  Meetings, especially Project Incubation Meetings, will be prepared by the Chairs and organized by the Office (see above). Costs for rooms, A/V equipment, and catering will be paid for by participants themselves (i.e. the costs will be split by the number of participants, who have to pay a participation fee). ICF will try to have as many meetings as possible alongside the standard ARTEMIS-IA events (like Spring-Event, Summer Camp, etc.; but also like the Digital Innovation Forum that was conducted this year for the first time and organized by ITEA and ARTEMIS-IA). In this way, much of these costs will not occur separately but are part of the general budget of the Event and thus be paid for by ARTEMIS-IA funds.

• **Technical Infrastructure**
  See above for Office support. Infrastructure for hosting the IOS database and the Webpages will be provided by ARTEMIS-IA.

With the budget that has been assigned to it by ARTEMIS-IA (both in terms of cash as well as in terms of Office support and infrastructure), ICF is thus fully sustainable.

### 3.4. Kick-starting ICF

On May 9\textsuperscript{th}, 2016, CP-SETIS conducted its ‘Final Dissemination Event and ICF Transition Workshop’ in Amsterdam. The objective of this meeting was twofold: First, we wanted to disseminate the final results of CP-SETIS, especially the ICF implementation and the publication of the Strategic Agenda on Standardization [SN17], and second, and for this Deliverable more important, we wanted to test the concepts, especially the project incubation workshops, of ICF. The second half of this Workshop was therefore dedicated to a first ‘test run’ of a typical Project Incubation Workshop that will be conducted by ICF in the future, i.e. it contained

- Presentations of running IOS projects
- Presentations of project ideas for future IOS projects
- Discussions and contact establishment between potential consortium partners for new IOS projects.

Some 25 stakeholders expressed their interest in participation, among them representatives from Airbus, AVL, Ensta, Infineon, NXP, Siemens, Thales, Volvo, CEA, Fraunhofer, OFFIS, KTH, Jotne, Lelua University, Tecnalia and other industrial and academic participants, of which 7 could unfortunately not make it to the workshop for timing constraints. Some of the absent stakeholders sent slides to be presented at this workshop (new project ideas as well as presenting existing projects). The following presentations took place:

- **Running IOS Projects**
  - ENABLE-S3 (JU ECSEL project)
  - Assume (ITEA3 project)

- **New project ideas**
  - Arrowhead-T, a project to include the IOS into the development process of (autonomous) production plants, being a follow-up of the ARTEMIS pilot project Arrowhead and scheduled to be launched in the 2018 call of the JU ARTEMIS
  - Three yet unnamed projects to extend the IOS specification for (a) model driven tool integration (led by Mondragon University), (b) heterogeneous Co-Simulation (led by OFFIS), and (c) model federation and formal verification (led by CEA)
- Company profiles and success stories
  o An SME (Jotne Enterprises) presented its capabilities and services in the area of interoperability as a basis for entering project consortia.

The wide variety of presentations, the intensive discussions of participants and the activities planned as a follow up – among them providing contact to parties interested in joining project consortia, discussions of time frames, planning of the next workshop of this kind in October 2017, discussion of time frames and activities that have to be conducted by the project presenters as well as by CP-SETIS partners resp. the ICF until then) was very lively. The actual results of these workshops can only be assessed after the round of call for project proposals, but both, the content of the presentations as well as the discussions and follow up actions lead us to believe that these kinds of activities is both needed as well as greatly appreciated by the community.

3.5. Final Steps to implement ICF

There are only a few minor steps remaining for the ICF to actually be implemented within the ARTEMIS-IA WG on standardization, supplied with its budget, Chairs, Strategic and Technical Boards, and able to start its operation (N.B.: the first ‘ICF workshop’ has already been held, as foreseen in the DoW, see Section 3.4). These missing steps are

- CP-SETIS partners need to conclude the discussion about the few minor implementation details with ARTEMIS-IA WG Standardization. These minor implementation details mostly concern the exact organization of the interface between WG Standardization and ICF and about the exact form the support of the ARTEMIS-IA office will have. None of these issues are critical, nor are major differences in positions expected. These discussions will be finished at the latest during the ECSEL JU Symposium 2017, 13.-14.06.2017, in Malta.
- Data Frame, the newly created SME, has to write a tender for their work in ICF, and ARTEMIS-IA has to install a contract with them. The major details of the tender as well as of the contract have already been agreed upon, therefore we also expect no difficulties here.
- Based on the votum of WG Standardization and on the contract with Data Frame, the ARTEMIS-IA Steering Board has to formally decide about (a) the actual installation of ICF within WG Standardization and (b) the appointment of Chairs. Since this is only a follow up on the existing decision and since in fact a budget for ICF has already been decided upon, this step will also present no difficulties. Depending upon the exact timing of the two issues above, this decision is expected for the ARTEMIS-IA SB meeting in June or latest in July.

After this decision, ICF will begin its work, starting with the completion of the collection of data for the IOS database and the increase in its membership, followed by strengthening the contacts to the relevant standardization bodies and organizing the next project incubation workshop in the beginning of October of this year, which will continue the work started in Amsterdam (c.f. Section 3.4).

4. Summary

This deliverable D1.4 presented how CP-SETIS is going to reach one of its major objectives, which is implementing a sustainable organizational structure within an existing host to support further extensions and formal standardization of the Interoperability Specifications IOS. Especially, CP-SETIS
• Defined the concept of a Multi-Standard, and corresponding activities of horizontal and vertical standardization (in D5.2, which is to become the new ARTEMIS-IA Strategic Agenda on Standardization; another objective of CP-SETIS that was also reached), and clarified its relation to the activities done in ICF (c.f. Section 2.5.).

• Derived a concept and implemented the IOS database (c.f., D4.1-2), which will be maintained and made publically available by ICF.

• Based on the work presented in D1.1, D1.2, and D1.3., derived an organizational structure for ICF, selected ARTEMIS-IA as hosting organization and prepared the necessary decisions by the official bodies of ARTEMIS-IA for ICF to become implemented within ARTEMIS-IA’s Working Group on Standardization, supplied with a budget of 50 K Euro/Year, organizational support from the ARTEMIS-IA office and technical infrastructure for hosting the IOS database, webpages, etc.

• Supported the creation of a new SME named Data Frame, which will take over the work of the Technical Chair of ICF.

A first project incubation workshop has already been conducted (c.f. Section 3.4.), ICF is supposed to be up and running in Summer 2017, and the next workshop will be held in October of this year. By that time, CP-SETIS will therefore have reached both of its major objectives, i.e. that of creating the sustainable organizational structure – the IOS Cooperation Forum ICF – as well as that of updating the ARTEMIS-IA Strategic Agenda on Standardization.
Appendix 1: Proposal for Horizontal Standardization Process

In this Appendix we present the horizontal standardization process in more detail, both on a ‘functional’ level as well as on a more technical level involving the implementation of the IOS database. Figure 4 on the next page shows this process (c.f. also Figure 3 in Section 2.3.).

The purpose of the horizontal standardization process is to include a new specification into a Multi-Standard, e.g. into the IOS. The process features some roles which can be taken by official bodies of the ICF and/or by the stakeholders. These roles are:

- **Proposer.** The individual or group of stakeholders proposing a new specification to become part of the Multi-Standard. This role exists for each (new) part of the IOS, i.e. for each specification; for different parts, different (groups of) stakeholders are the ‘Proposers’.

- **Interest Group.** The group of Stakeholders actively participating in developing and maturing a specific specification. Again, this role is present for each part of the IOS. If a new specification is proposed, the initial ‘Interest Group’ consists of exactly the Proposers. At later times, additional stakeholders can join this group.

- **Technical Board or Technical Expert.** A group of members of IOS who are technical experts for the Multi Standard IOS as a whole (c.f. Section 3.1). This role is a global one, i.e. at a given time the (single) Technical Board is responsible for all parts of the IOS. Members of the Technical Board are elected by the ICF members and serve for a given period of time.

- **Strategic Board.** A group of members of ICF the ICF that is responsible for the strategic development of the IOS and strategic directions of the ICF (c.f. Section 3.1). Again, at any given time there is a single Strategic Board, whose members are elected by ICF members and serve for a given time.

With these roles, the process of horizontal standardization works as follows:

1. **Proposed Process**
   Any group of stakeholders can propose a new specification to become a part of the Multi-Standard. They need to provide the initial specification complete with all the accompanying data. The new specification as well as the accompanying information is entered into the IOS database in state ‘Proposed’.

   **Technical Details**
   The proposers inform the technical chair of ICF about their intent to propose a new set of specifications. They need to provide a minimum number of information with this proposal, e.g., the name, scope, Engineering Concern for which interoperability is specified, whether or not this new specification is based upon an existing standard, contact points, etc. More content can of course be provided, e.g. the initial specification itself, etc.
   After being informed about the intent of the proposers, the Technical Chair creates a skeleton entry in the database, and enables access to the IOS database to the proposers (if
they do not already have this). He/She also prepares some bookkeeping data, i.e., initializing the ‘Interest Group’ for this new proposal with the proposing organizations. The proposers then fill the skeleton entry with all the missing information and inform the Technical Chair that they have done so.

With the current implementation of the IOS database, all of these changes/additions can be directly written into the database without anybody but the Technical Chair and the Proposers seeing this data. Only after the proposers are satisfied with the entry, the Technical Chair ‘accepts’ all changes in the database, thereby making them visible to all database users.

![Diagram](image)

**Figure 4: Horizontal Standardization Process in more detail**

2. **Proposed -> Tracked**

   **Process**

   A quick assessment by the Technical Board/Technical Expert of ICF decides about the new specification becoming ‘tracked’. The assessment focuses on general fitness of the specification into the Multi-Standard, i.e. does the new specification cover a relevant, tool supported Engineering Concern, does its scope fit into the overall scope of IOS as well as to the scope of ‘neighboring’ specifications, is the data provided by the proposers complete and correct, etc. Additional assessment criteria might be defined (e.g. are there ‘enough’ supporting organisations, etc.), but the objective here is that this assessment should be fast, in order to not hinder the speedy maturity level increase of this specification. After a successful assessment, the parts status is changed to ‘Tracked’.
Note that the ‘Tracked’ status is the first one in which the ‘Vertical Standardization Process’ might be started, e.g. for specifications that are base upon and extend existing standards this is the inclusion of the extensions into the underlying base standard; for specifications not based upon existing standards this is the selection of an appropriate standardization body in which this specification can become a new formal standard. Whether or not such an early start of the vertical standardization does make sense, depends on the new specification, especially its completeness, its maturity, and its ‘closeness’ to the underlying base standard, if any. The point is, that the two dimensional standardization process defined here does allow such an early formal standardization.

For specifications that fail this assessment, the Technical Expert gives the reasons for failure to the proposer, who may chose to change the specification accordingly (after which the assessment is done again), or to let the Technical Chair delete the specification from the IOS database.

Technical Details
No special technical details for this step. Proposers, Technical Chair, and Technical Expert can find all the information they need in the database, they can change it (again this is only visible to this group of stakeholders, until the Technical Chair adopts the changes in the database, at which point they become globally visible. Should vertical standardization for this new specification start this early, also the standardization bodies can access the information in the database.

3. Tracked -> Candidate

While a new specification has status ‘Tracked’, it can be modified by the Interest Group (i.e., the Proposers plus any additional ICF members, which want to mature this specification) as they see fit, i.e. (a) if the underlying base standard changes and/or (b) for ‘monitored’ specifications (see D1.2.) like e.g., AUTOSAR, whenever the corresponding standard changes or for similar reasons. All changes will have to be assessed by the Technical Board resp. Technical Expert on a regular basis, again using the ‘quick check’ assessment criteria from the last step.

During Tracked state, any member of the ICF, who is interested in actively participating in the development and evaluation of this specification, can become a member of the Interest Group (by simply applying for it at the Technical Chair).

At one point in time – for most new specifications this will be shortly after becoming ‘Tracked’ – the interest group will decide to give evidence to the fitness and usefulness of the specification. They might decide to do this within a public funded project, that they initiate, or by implementing it with a (set of) tools which they use for a use-case development project or similar. Once the means of evaluation has successfully been started, the specification becomes a ‘Candidate’.

The vertical standardization can continue (or be started, if it has not been already) both within the ‘Tracked’ as well as within the ‘Candidate’ state. ‘Candidate’ is also the first state, in which conceivably industrial take-up can take place, i.e. we’ll expect to see tool implementations using parts of the IOS that are in ‘Candidate’ state. Such a industrial take-up might even be part of the evaluation process. Even though one would not expect industrial grade implementations be based upon specifications that might still change, prototype
implementation to be used for example in funded projects to evaluate them, are perfectly conceivable.
Openness of the specification, openness to all stakeholders to participate in further development, and, last but not least, a clear definition of the horizontal and vertical standardization process that shows what might and what might not change anymore, ensure that a tool provider has complete control and an excellent knowledge base for his decision to take-up resp. use the specification and about the point in time when he/she does this.

**Technical Details**
Again, the technical implementation of the IOS database supports this process by having changes to the specification only visible to the Interest Group, until they are adopted by the Technical Chair.

4. **Candidate -> Accepted**

*Process*
The final step in the horizontal standardization process is for a new specification to become ‘Accepted’. After the evaluation results have been produced, the Strategic Board of the ICF decides whether to recommend acceptance of this specification. This is a recommendation only, which makes it easier for ICF members to understand the quality, fitness, and maturity of the new specification. However, the real decision about Acceptance is being voted upon by all ICF members.
Since the IOS specifications are very diverse and have a very broad scope, this voting will not be decided by majority; instead, it will be sufficient for acceptance that a (yet to be determined) minimum number of members (say: 10% or 20%) vote in favor of the specification. This ensures that no (group of) members can block a specification from becoming full part of the IOS, but that all parts that have a minimum support can be further developed.
If a part fails to become accepted, it stays in the ‘candidate’ state where the interest group may provide further evidence about its quality.

*Technical Details*
The IOS database supports this process step in the same way as described above.
References

