**Findable, Accessible, Interoperable and Reusable Digital Objects**

The research on Findable, Accessible, Interoperable and Reusable (FAIR) digital objects at SCS aims at improving interoperability and reuse of these digital assets in different layers of abstractions. The FAIR principles emerged from a workshop named "*Jointly Designing a Data FAIRPORT*", which took place in Leiden, the Netherlands in January of 2014. In the workshop over 30 experts representing academia, industry, funding agencies and scholarly publishers from all over the world discussed improvements in the global data management. As a result of this workshop, in March 2016 a paper title "*The FAIR guiding principles for scientific data management and stewardship*" has been published with a list of principles to guide the improvements in findability, accessibility, interoperability and reusability (FAIR) of digital objects.
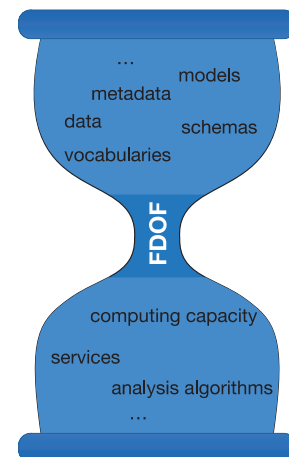

Since its publication in 2016, this seminal paper on the FAIR principles gained enormous momentum being cited over 4.500 times, explicitly mentioned in official reports of the G20 (September 2016) and the G7 (May 2017) summits, used as the basis of the European Open Science Cloud and as requirements for funding agencies around the world, including the European programs Horizon 2020 and Horizon Europe, the American's National Institutes for Health (NIH).
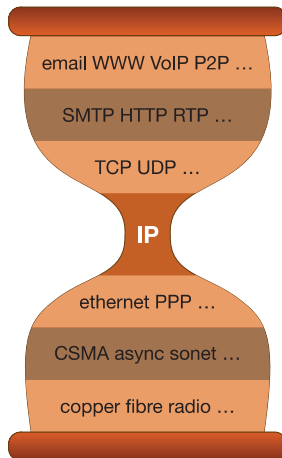
Internet hourglass

With so much attention, it was inevitable that stakeholders started to move from using the FAIR principles from general guidelines to design and implement approaches and technologies to realize them. In our research on FAIR, we adapted the hourglass metaphor used to describe the internet to be used as guidance for placing generic and specific approaches. In the Internet hourglass model, the Internet Protocol (IP) is placed at the thin waist of the hourglass to represent the minimal set of agreements that need to be made to connect the top layers, representing increasingly specialized protocols and applications, with the bottom layers, representing the physical networks and their protocols.

FAIR hourglass

In our FAIR hourglass, the thin waist represents a framework, named FAIR Digital Object Framework (FDOF) composed of basic elements such as a predictable identifier resolution behavior, a mechanism to discover the digital object's metadata, represented in a common presentation format, a digital object's typing system and a minimal metadata schema for each type of digital object. The research on the FDOF includes the definition of the elements of the framework, how the framework can be placed on top of the current communication infrastructures, e.g., Internet, WWW, and the related conceptual models to describe these elements for humans and machines.

Besides the research on the infrastructure foundation of FAIR represented by the FDOF, the SCS group also works on research covering other layers of the FAIR hourglass. From a methodological point of view, the work on the FAIRification process aims at defining a set of canonical steps to improve the FAIRness of existing digital objects. Regarding applications, we have been involved in the FAIR Data Point (FDP), a server solution aimed at defining how applications should expose their metadata in a FAIR way and the FAIRifier, a software solution to automate (parts of) the FAIRification process. Still in the application layer, we have been working on the FAIR Data Train (also known as the Personal Health Train), an

architecture for privacy-preserving distributed learning using the train system metaphor where trains (the algorithms) visit stations and there interact with data (or other types of digital objects) leaving with the analysis results instead of moving potentially large amounts of data around.

The group is also involved in education activities to help increase the availability of FAIR-related capacity. Lectures on the FAIR principles and the FAIRification process have been included in the last Smart Industries System course. A new master course named *FAIR data principles and the FAIRification process* has been proposed for Computer Science and BIT students. This course is centered in a practical FAIRification project to be conducted by the students with lectures to provide the required background knowledge for them to performed the activities. Since the work on FAIR is highly reliant on semantics and semantic technologies, two other course have been proposed by the group on ontology-driven conceptual modeling and Linked Data and Semantic Web technologies.