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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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Foreword

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This document was prepared by Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 38, *Cloud Computing and Distributed Platforms*.

Introduction

This document is intended to establish a common understanding of cloud computing interoperability and portability. In particular, it is of interest to cloud stakeholders focusing on cloud service agreements concerning interoperability or portability between cloud services.

Cloud computing is defined as a paradigm for enabling network access to a scalable and elastic pool of shareable physical or virtual resources with self-service provisioning and administration on-demand. ISO/IEC 17788 and ISO/IEC 17789 provide a starting point for understanding of different types of interoperability and portability, relationships with activities and roles and cloud capabilities types. Interoperability, data portability and application portability are essential to the use of cloud services. The goal of interoperability is to enable the interaction between non-cloud and cloud services, as well as between cloud services, in addition to enabling composition of new services from multiple services. The goal of portability is to enable cloud service customers (CSCs) to move their data or applications between non-cloud and one or more cloud services and between cloud services. The benefits of interoperability include lower costs of integration and increasing the value of services through enrichment or new functionality provided by composing cloud services. The benefits of portability include greater efficiency by lowering the costs of migration. Both interoperability and portability offer more choices to CSCs by limiting the effects of being locked in to any cloud service or cloud service provider (CSP). While there is no disagreement that interoperability and portability are advantages to cloud computing, there is no single way of handling either capability. Declaring interoperability or portability without doing a detailed analysis of what specifically is to be ported or is to be made interoperable is meaningless and does not lead to cloud solutions that meet the CSC's and CSP's business goals, which has led to significant and on-going confusion in the industry and needs to be resolved.

Interoperability is the ability of two or more systems or applications to exchange information and to mutually use the information that has been exchanged. In the context of cloud computing, interoperability should be viewed as the capability of public cloud services, private cloud services and other cloud service customer systems to understand each other's interfaces, configuration, forms of authentication and authorization, etc. in order to cooperate and work with each other.

Interoperability is a complex subject in the context of cloud computing because of the number of interactions involved and the potential variations for each interaction. While interoperability and standards add significant value and are advantageous to cloud computing, there are no comprehensive solutions. Many existing IT standards contribute to enabling interoperability between CSC applications and cloud services and between cloud services themselves. Using standards can be one way to build interoperable cloud services. Other techniques such as well-documented API specifications can also help.

Cloud computing services that enable portability using defined policies, standards or documented formats can ensure that CSCs are able to get their data into or out of cloud services in a reasonably easy and cost-effective manner, as this allows CSCs to move to a cloud service of another CSP and also to drive integration of heterogeneous cloud services.

As presented in ISO/IEC 17788, portability is the ability of a CSC to move their data or their applications between two different cloud services at a low cost and with minimal disruption. Portability is significant in cloud computing since CSCs are interested in avoiding lock-in when they choose to use cloud services. Therefore, in the context of cloud computing, portability can have multiple aspects depending on what is being ported (moved) and which cloud services are involved. For portability, there are no specific requirements for the source and target systems to be directly connected.

Portability in a cloud computing environment is not a binary concept. It would be a mistake to think of cloud services and the associated cloud applications and data as being either 100% portable or not portable at all. Almost all applications running in a cloud service can be ported to another cloud service offering equivalent capabilities if enough resources are invested. The critical considerations for portability discussions are the porting cost, the risks associated with the porting and how to control the costs and risks compared to the expected benefits.

Information technology — Cloud computing — Interoperability and portability

1 Scope

This document specifies cloud computing interoperability and portability types, the relationship and interactions between these two cross-cutting aspects of cloud computing and common terminology and concepts used to discuss interoperability and portability, particularly relating to cloud services.

This document is related to other standards, namely, ISO/IEC 17788, ISO/IEC 17789, ISO/IEC 19086-1, ISO/IEC 19944, and in particular, references the cross-cutting aspects and components identified in ISO/IEC 17788 and ISO/IEC 17789 respectively.

The goal of this document is to ensure that all parties involved in cloud computing, particularly CSCs, CSPs and cloud service partners (CSNs) acting as cloud service developers, have a common understanding of interoperability and portability for their specific needs. This common understanding helps to achieve interoperability and portability in cloud computing by establishing common terminology and concepts.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Interoperability terms

3.1.1
interoperability
ability of two or more systems or applications to exchange information and to mutually use the information that has been exchanged

[SOURCE: ISO/IEC 17788:2014, 3.1.5]

3.1.2
cloud interoperability
ability of a CSC's system to interact with a cloud service or the ability for one cloud service to interact with other cloud services by exchanging information according to a prescribed method to obtain predictable results

Note 1 to entry: Cloud service to cloud service interactions occur through a CSP: inter-cloud provider relationship.

3.1.3
transport interoperability
interoperability (3.1.1) where information exchange uses an established communication infrastructure between the participating systems

3.1.4
syntactic interoperability
interoperability (3.1.1) such that the formats of the exchanged information can be understood by the participating systems

3.1.5
semantic data interoperability
interoperability (3.1.1) so that the meaning of the data model within the context of a subject area is understood by the participating systems

3.1.6
behavioural interoperability
interoperability (3.1.1) so that the actual result of the exchange achieves the expected outcome

3.1.7
policy interoperability
interoperability (3.1.1) while complying with the legal, organizational and policy frameworks applicable to the participating systems

3.2 Data portability terms

3.2.1
data portability
ability to easily transfer data from one system to another without being required to re-enter data

Note 1 to entry: It is the ease of moving the data that is the essence here. This might be achieved by the source system supplying the data in exactly the format that is accepted by the target system. But even if the formats do not match, the transformation between them may be simple and straightforward to achieve with commonly available tools. On the other hand, a process of printing out the data and rekeying it for the target system could not be described as "easy".

[SOURCE: ISO/IEC 17788:2014, 3.2.21]

3.2.2
cloud data portability
data portability (3.2.1) from one cloud service to another cloud service or between a CSC's system and a cloud service

[SOURCE: ISO/IEC 17788:2014, 3.2.6, modified — "or between a CSC's system and a cloud service" has been added.]

3.2.3
data syntactic portability
data portability (3.2.1) using data formats that can be decoded on the target

3.2.4
data semantic portability
data portability (3.2.1) such that the meaning of the data model is understood within the context of a subject area by the target

3.2.5
data policy portability
data portability (3.2.1) while complying with the legal, organizational and policy frameworks applicable to both the source and target

3.3 Application portability terms

3.3.1
application portability
ability to migrate an application from a source system to a target system

3.3.2
cloud application portability
ability to migrate an application from one cloud service to another cloud service or between a CSC's system and a cloud service

[SOURCE: ISO/IEC 17788:2014, 3.2.2, modified — "or between a CSC's system and a cloud service" has been added.]

3.3.3
application syntactic portability
application portability (3.3.1) where the format of the application artefacts can be decoded on the target

3.3.4
application instruction portability
application portability (3.3.1) so that the application's instruction set executes on the target

3.3.5
application metadata portability
application portability (3.3.1) so that the application's metadata is retained and understood on the target

3.3.6
application behaviour portability
application portability (3.3.1) so that execution on the target produces equivalent results to those produced on the source

3.3.7
application policy portability
application portability (3.3.1) while complying with the legal, organizational and policy frameworks applicable to the source and target

4 Abbreviated terms

API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
ASN.1	Abstract Syntax Notation 1
BPEL	Business Process Execution Language
BPML	Business Process Management Language
CRM	Customer Relationship Management
CSC	Cloud Service Customer
CSN	Cloud Service Partner
CSP	Cloud Service Provider
CSV	Comma-separated values
ERP	Enterprise Resource Planning
ESB	Enterprise Service Bus
HCM	Human Capital Management
HTTP	Hyper Text Transfer Protocol

IaaS	Infrastructure as a Service
ICT	Information & Communication Technology
IdAM	Identity and Access Management
JSON	JavaScript Object Notation
MIME	Multipurpose Internet Mail Extensions
MQTT	Message Queuing Telemetry Transport
OVF	Open Virtualization Format
OWL	Web Ontology Language
PaaS	Platform as a Service
PII	Personally identifiable information
REST	Representational State Transfer
SaaS	Software as a Service
SDK	Software Development Kit
SOAP	Simple Object Access Protocol
UML	Unified Modeling Language
VM	Virtual Machine
VPN	Virtual Private Network
XML	eXtensible Markup Language

5 Overview of cloud computing interoperability and portability

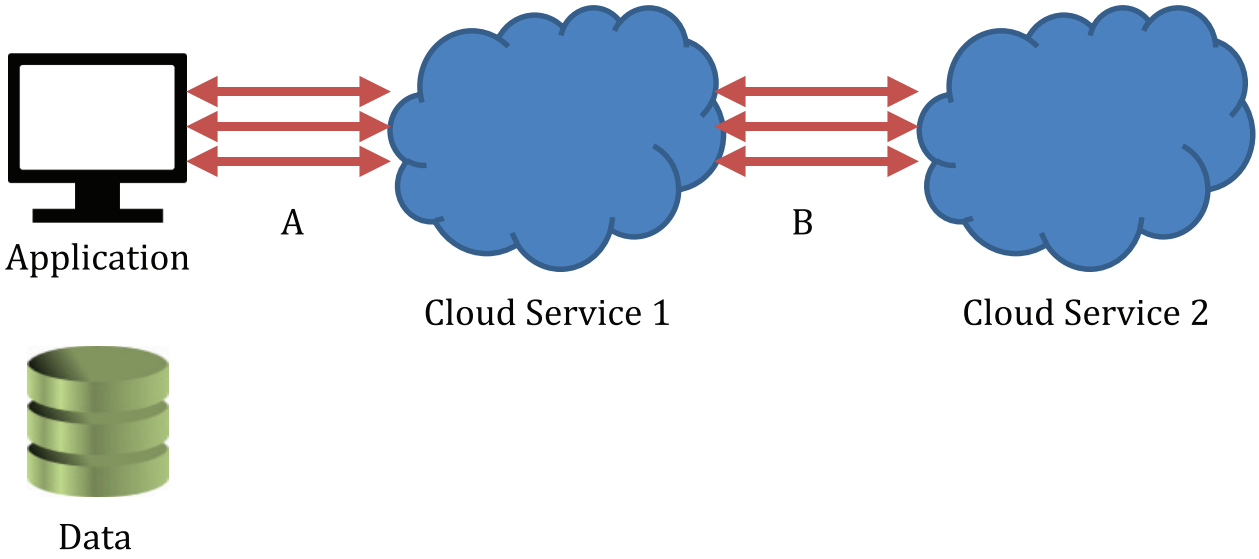
5.1 Description of cloud computing interoperability and portability

5.1.1 General

This clause provides an overview and models (known as “facet models”; refer to 5.2.1, 5.2.2 and 5.2.3 for details) for cloud interoperability, cloud data portability and cloud application portability. There are various perspectives of interoperability and portability that need to be considered. These perspectives are called “facets”.

Interoperability and portability in cloud computing involve interactions affected by technological, information and human aspects. Interoperability and portability related challenges are likely to intensify and become more difficult to manage as systems grow more complex and interconnected. In cloud computing environments with internationally interconnected systems, the complexities also include matters of corporate policy, regulation and international law.

5.1.2 Considerations for cloud interoperability



Key

A application to/from cloud service

B cloud service to/from cloud service

Figure 1 — High-level view of cloud interoperability

ISO/IEC 17788 defines interoperability as "*the ability for two or more systems or applications to exchange information and mutually use the information that has been exchanged*". In the context of cloud computing, interoperability is further described as a cross-cutting aspect providing the ability for a cloud service customer system to interact with a cloud service and exchange information according to a prescribed method and obtain predictable results (see ISO/IEC 17788:2014, 6.6). Interoperability also includes the ability for one cloud service to interact with other cloud services (see ISO/IEC 17789:2014, 8.5.5). Figure 1 indicates that cloud interoperability takes place both between a CSC's application and cloud services and also takes place between cloud services. It is also notable that there are typically multiple interfaces involved in both of these cases, as indicated by the multiple arrows.

Note that interoperability in cloud computing is rarely confined to a binary decision of possible or impossible. More often, interoperability is possible subject to implementation costs. A cost/benefit analysis is required to determine whether the resources needed to assure exchange of information in the prescribed method while obtaining predictable results is worthwhile. The ability of systems of a CSC and cloud services as well as multiple cloud services to interoperate with respect to the facets discussed below is more than a matter of investing the resources to assure the exchange of information between the interfaces at either end, since interoperability also requires validation that behavioural and policy facets are respectively compatible. In addition, any changes caused by interoperation requirements may entail additional training for end users, management and operations staff.

There are many considerations when addressing cloud interoperability. These include:

— the ability of a CSC to interact with a cloud service by exchanging information according to a prescribed method obtaining predictable results;

— the ability for a cloud service to work with other cloud services;

— properties needed to facilitate successful interactions between an organization's ICT facilities and a cloud service;

— roles and activities as defined in ISO/IEC 17789;

— cloud capabilities types as defined in ISO/IEC 17788;

— interfaces between different functional components as defined in ISO/IEC 17789:2014, 9.2.

By taking these considerations into account, this document promotes better understanding of the requisites for interoperable cloud services.

5.1.3 Considerations for portability in a cloud computing environment

5.1.3.1 General

This document distinguishes between cloud application portability and cloud data portability. In the context of cloud computing, portability refers to the ability of a CSC to move and suitably adapt their applications and data between the CSC's systems and cloud services, between different cloud deployment models, and between cloud services of different CSPs.

Note that portability in cloud computing is rarely confined to a binary decision of possible or impossible. More often, portability is "possibly subject to switching costs". A cost/benefit analysis is required to determine whether porting applications and/or data is worthwhile. The similarity of the CSC and CSP's systems with respect to the facets described in 5.2.2 and 5.2.3 is therefore more of a matter of lowering the switching cost than of "enabling" portability to take place, since almost any portability is possible if the customer is willing and able to pay for it. Switching concerns are not limited to costs; it also usually involves some risks and usually entail the CSC spending effort and time and perhaps a period of service interruption.

There are many considerations when addressing portability in cloud computing. These include:

— allowing CSCs to migrate applications and data in response to business needs such as faster service, lower cost, greater reliability or disaster recovery needs;

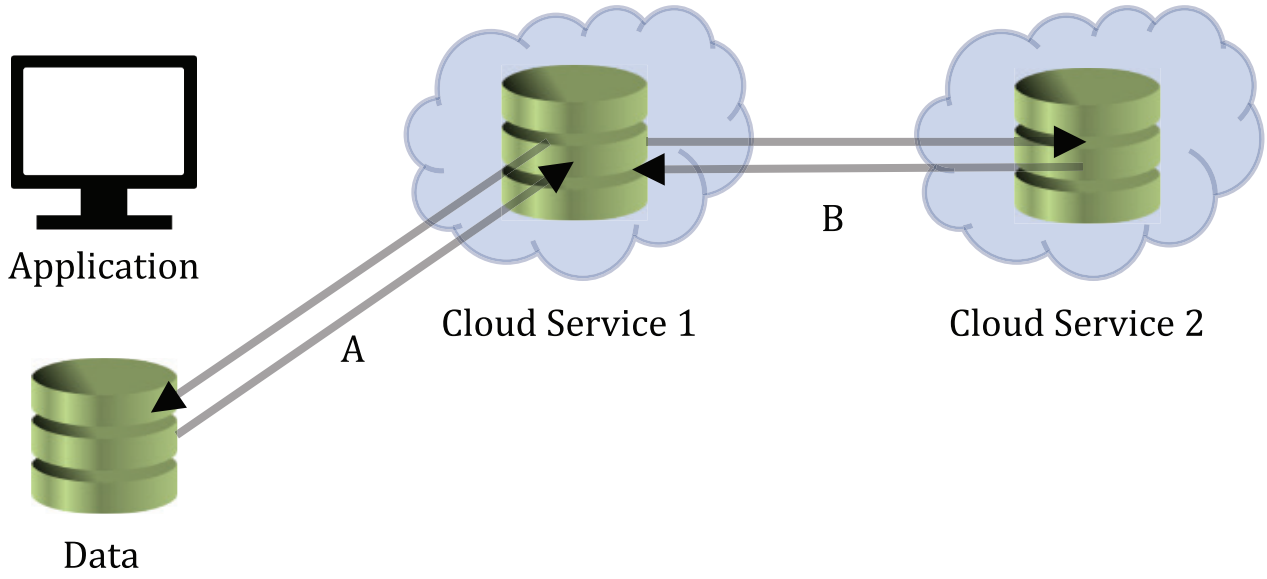
— wider availability of application and data allowing access to a broader market;

— time and effort required for porting both applications and data, however, such overhead may be reduced using common programming languages, standards, tools, frameworks, models, run times and APIs;

— limiting of lock-in situations where the CSC is tied to the cloud services of one CSP.

Portability is an aspect of the more general topic of migration. Other issues related to migration are not considered further in this document.

5.1.3.2 Cloud data portability



Key

A CSC system to/from cloud service

B cloud service to/from cloud service

Figure 2 — High-level view of cloud data portability

Cloud data portability is the ability to transfer data from one cloud service to another cloud service or between a cloud service customer's system and a cloud service. Figure 2 indicates the porting of data between a CSC's system and a cloud service and porting of data from one cloud service to another. The arrows in both directions indicate the potential to port data to and from any of those places.

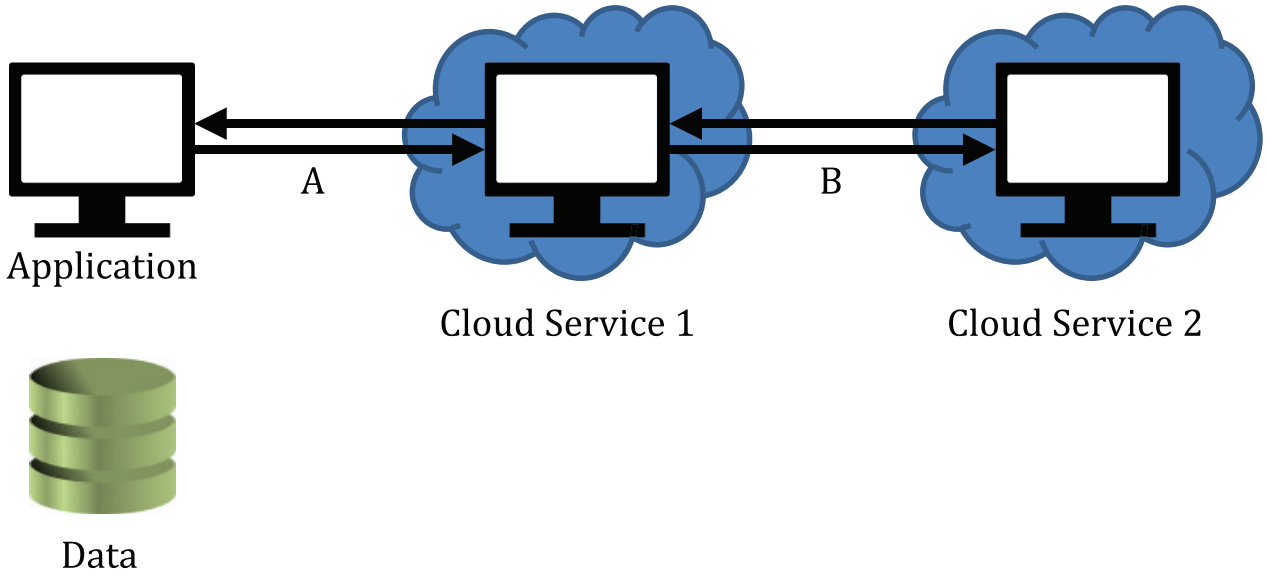
Considerations relating to cloud data portability include:

— retrieval of cloud service customer data. A capability to retrieve cloud service customer data from the source cloud service is needed and a capability to import cloud service customer data into the target cloud service. Cloud data is frequently large enough to tax available bandwidth between systems and data might therefore be moved by the physical movement of physical storage media. In some cases, data is moved electronically;

— syntax of the data. The syntax of the data is ideally the same for the source service and the target service. However, if the syntax does not match, e.g. the source uses JSON syntax but the target uses XML, it may be possible to map the data using commonly available tools;

— semantics of the data. The semantics of data are commonly expressed by an ontology. Compatible ontologies simplify the porting of data between source and target services. If the ontologies are incompatible, additional resources may be applied to detect inconsistences. These inconsistencies may be resolved or fidelity of the data may be reduced to enable the data to be ported.

5.1.3.3 Cloud application portability



Key

A CSC system to/from cloud service

B cloud service to/from cloud service

Figure 3 — High level view of cloud application portability

Cloud application portability is the ability to migrate applications from a CSC's system to a cloud service or from one cloud service to another including migration between instances of cloud deployment models (private, public, community and hybrid). Figure 3 shows the porting of an application between a CSC's system and a cloud service and porting of an application between two cloud services. The arrows in both directions indicate the potential to port applications to and from any of those places.

Considerations relating to cloud application portability include the following.

— Cloud application portability can require the movement of one or more application components that form part of a larger, multi-cloud application. For instance, in addition to application logic, it may be necessary to port and/or reconfigure the cloud application and/or the components upon which it depends, e.g. libraries, databases and web servers. The sequence of virtual machine and/or component start-up may also be important. Portability of complex applications may also require CSPs to share application metadata. This metadata might be acquired by capturing expert knowledge and best practices related to that application's deployment and subsequent management throughout its lifecycle, by automated inspection or discovery or by other means. Common examples of this metadata are details regarding the relationships and dependencies between various application components, requirements such as the acceptable range of component versions, start-up sequence, network and firewall configuration, processing capacity, co-location rules and load balancing requirements.

— Cloud application portability requires that interfaces needed by the application in the source environment are also available in the target environment. These interfaces, for example, might enable the application to use service discovery and communication protocols implemented by the environment, as well as providing access to the environment capabilities that support the application. In some environments, the interfaces may also enable applications to manage the underlying resources. In cases where an application is being ported between two cloud services, the ability of a target cloud service to replicate the environment that the source cloud service has for the application/service or at least create an environment that similarly satisfies the dependencies of the application, is a major consideration.

— The reduced disruption and increased choice enabled by cloud application portability provide CSCs with the capability to mitigate risks. Cloud application portability can facilitate greater business agility by enabling more rapid redeployment of cloud applications and services to alternative or complementary CSPs in response to changing business conditions and technical trends.

— Cloud application portability requires that the identified activities of CSC and CSN and their sub-roles that are supported in the source system are also supported, with acceptable fidelity, by the target system and its components. In practice, different cloud services rarely provide identical capabilities to support all of the activities for all sub-roles. The effort necessary to adjust for these differences and the potential benefits need to be considered. For example, a cloud application implemented on a infrastructure capabilities type cloud service (ISO/IEC 17788:2014, 3.2.25) moved to a different cloud service of the same type might provide identical capabilities to support the activities of the CSC:Cloud service user sub-role deploying and operating the application, but very different capabilities for the CSC:Cloud service administrator sub-role managing the use of the cloud service.

5.1.4 Relationship between cloud interoperability and cloud portability

It is important to understand that portability and interoperability are not synonymous. While interoperability and portability are often discussed in parallel and are related concepts, they are in fact separate concepts without direct dependencies.

The focus of interoperability is the ability to exchange information between a CSC's system and a cloud service or between a cloud service and another cloud service, resulting in the ability to mutually use the information that has been exchanged. A cloud service that is interoperable does not necessarily support portability of applications and/or data.

Portability is the ability to migrate data or applications from one cloud service to another or between a CSC's system and a cloud service. The degree of effectiveness and efficiency of the migration is considered as the ability to execute the application or use the data with as few or no manual changes in the migration process as described in ISO/IEC 17788. The focus of portability is the ease of migration of the data and application. A cloud service that supports portability is not necessarily interoperable.

5.2 Cloud interoperability and portability facet models

5.2.1 Cloud interoperability facet model

5.2.1.1 General

Interoperability is not a simple "yes/no" concept. Interoperability involves a number of elements, starting at the simple exchange of data bytes, facilitating an understanding of the semantics of the exchanged information and also an alignment of the business processes, behaviour and policies on either side of the exchange. It can be that semantic, behavioural and policy interoperability is a significantly bigger challenge than the bits and bytes.

The interoperability facet model described in this document defines five facets within the context of cloud interoperability. These five facets, shown in Figure 4, are transport, syntactic, semantic data, behavioural and policy. This model is derived by combining and abstracting the European Interoperability Framework[13] and the Levels of Conceptual Interoperability Model (LCIM)[14].

