



SPC BOARD
(COMMISSIONE DI COORDINAMENTO SPC)

**AN OVERVIEW OF THE ITALIAN “GUIDELINES FOR
SEMANTIC INTEROPERABILITY THROUGH LINKED
OPEN DATA”**



Agencia per l'Italia Digitale



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EXECUTIVE SUMMARY

The Digital Agenda for Europe [3] commits Member States to align their national interoperability frameworks with the European Interoperability Framework (EIF) within 2013 (action 26). As defined by CAD (Codice dell'Amministrazione Digitale – Digital Administration Code, Legislative Decree n. 82/2005), the Italian interoperability framework is the so-called “Sistema Pubblico di Connettività e Cooperazione” (SPC). SPC, together with the interoperability frameworks of other Member States, has been evaluated by the National Interoperability Framework Observatory (NIFO) of the ISA programme (the ISA programme is responsible for implementing at the European level the objectives of pillar 2 of the aforementioned Digital Agenda). The evaluation is based on five main criteria: “principles”, “governance”, “conceptual model”, “interoperability agreements”, and “interoperability levels”. From the assessment, which is publicly available, Italy [1] is “quite well” aligned with respect to the first three criteria, with a compliance of almost 100%. However, it still lacks with regard to the last two criteria and in particular on the interoperability levels.

Among the interoperability levels, the EIF model defines **semantic interoperability** as the possibility for the organizations to “*ensure that the precise meaning of exchanged information (concept, organization, services, etc.) is preserved and well understood*”. This definition highlights the central role that semantic interoperability plays in the collaboration among organizations. Thus, it is a fundamental basis for every innovative e-government process.

In the Public Administration (PA) sector, based on the actions performed at the European Union level, we are witnessing an increasing number of Open Data initiatives. These initiatives are showing up in order to facilitate transparency and accountability of PAs, and to provide citizens and enterprises with the vast amount of data that PAs produce on a daily basis when carrying out their institutional activities.

In this scenario, it becomes crucial to define technical guidelines that can drive PAs and enterprises in the production of interoperable Open Data. To this end, the SPC board (i.e., the governance body of SPC) decided to set up a specific working group with the aim to draw up such technical guidelines on semantic interoperability. The guidelines’ objectives are to provide a methodology for the production of interoperable Open Data, and to guarantee the compliance with the actions of the Digital Agenda for Europe and with the Italian regulation scenario. The work carried out by the group consisted of a first accurate analysis of current national and international state of the art on the management of Public Sector Information (PSI). From the analysis, a profound change in this sector emerged due to the increased usage of the Open Data paradigm. Data of PAs, typically hidden in applications or in databases, are now made available on the Web since they are recognized as a heritage for the society and an important means through which guaranteeing transparency, accountability and economic growth. Nevertheless, in order to fully exploit the possible benefits that can be gathered when making available public data, facilitating data reuse and, at the same time, data access and consumption by both human beings and machines becomes an essential requirement.

The working group evaluated a first set of data categories owned by PAs that could be opened (future works of the group foresee an update of the list of these categories), and specific Open Data initiatives born in Italy and in the rest of the world. One of the principal results of the evaluation has been to



consider Semantic Web technologies and the Linked Open Data paradigm essential means through which (i) providing an identity to the data (open and/or not open), (ii) interlinking the data and (iii) enriching the data with meaningful information that can be clearly understood by all their users. In other words, the working group unanimously agreed that the adoption of the Linked Open Data paradigm is necessary in order to enable a concrete semantic interoperability among Public Administrations at both national and cross-border levels.

The guidelines can thus be viewed as a technical support for Public Administrations: they offer a methodological approach to semantic interoperability through the Linked Open Data model that comes with the reuse of shared and common ontologies. They also provide an accurate analysis of the set of standards and tools to be utilized in order to enable the proposed approach. The guidelines include a number of recommendations, highlighted in the document, whose aim is to concentrate the attention of the readers on concrete actions to be undertaken.

To complement the study, the working group focused on legal aspects deriving from the licenses associated with the published data, and the business models that can be enabled, highlighting the interoperability aspects that involve the licenses, the sustainability and governance of the Linked Open Data initiatives.

Finally, the study has been contextualized within the Italian interoperability framework SPC so as to identify the specific role that can be assumed by SPC infrastructural and e-government services in the implementation of the proposed approach. As defined by the decree of the Presidency of the Council of Ministers (DPCM 1st April 2008) on the technical and security rules for SPC, a specific SPC service named “Catalogo Schemi e Ontologie” (Catalogue of Schemas and Ontologies) can be re-designed as a web of data within SPC. The service can be exploited to (i) produce Linked Open Data starting from data generated and exchanged in the SPC context, (ii) interconnect data to other data produced by PAs (central and local), and (iii) enrich data with proper semantic metadata so as to ensure a high level of quality for data publication and interoperability in the public government sector. The service can be also used for managing all those data generated by back-end functions of PAs.

1. PREFACE

This document provides an overview of the Italian guidelines for semantic interoperability through Linked Open Data that the Agency for Digital Italy published at the end of 2012 [24]. It reports the main contents of every section of the Italian guidelines, and includes the list of recommendations the SPC board's working group on semantic interoperability has identified.

The Italian guidelines are reference for Public Administrations and providers of public services in accordance with article 79, paragraph 2 letter c) of CAD (Codice dell'Amministrazione Digitale - Digital Administration Code) for the “*promotion and evolution of the organizational model and of SPC technological architecture as function of the changes in Public Administration requirements and of the opportunity offered by the evolution of the technologies*”. The Agency for Digital Italy, under the recent Law Decree n.179 (article 9), is responsible for releasing, annually, technical guidelines on Open Data specifying the technical standards and ontologies for data and services.

Both the Italian guidelines and this document are subject to Creative Commons – Attribution – Share Alike 3.0 (CC-BY-SA).

1.1. Acronyms

DPCM – Decree of the Presidency of Council of Ministers

EIF – European Interoperability Framework

ISA – Interoperability Solution for European Public Administrations

LOD – Linked Open Data

NIFO – National Interoperability Framework Observatory

NLP – Natural Language Processing

OD – Open Data

OWL – Ontology Web Language

PSI – Public Sector Information

RDF – Resource Description Framework

RDFS – Resource Description Framework Schema

SPC – Sistema Pubblico di Connettività e Cooperazione (Public Connectivity and Cooperation System)

URI – Uniform Resource Identifier



1.2. Terminology

The keywords "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED" are to be interpreted as described in RFC 2119.



2. OVERVIEW OF THE ITALIAN GUIDELINES

The guidelines consist of ten sections: the first two sections introduce the working group appointed by the SPC Board, reporting the participating Public Administrations with their representatives, and the principal objectives as well as the recipients of the guidelines, respectively. The remaining sections constitute the technical content of the guidelines and are organized as follows.

Section 3 introduces the main objectives of the work, discussing the renewed scenario of the Public Sector Information (PSI) and the general Open Data paradigm when applied to the government context. It states that *“opening data is not sufficient. Rather, it is desirable to make Open Data self-descriptive and to infer knowledge from the integration, aggregation and correlation of different datasets, thus facilitating data reuse, discovery and consumption for both human beings and machines”*. Based on these important concepts, the Linked Open Data model and Semantic Web technologies were identified as opportunities to overcome the limitations of the general Open Data paradigm. With them, users can use the data and refer to specific entities rather than positions inside databases, and developers can create applications by combining data of PAs with others available.

On this basis, the introduction clearly identifies the scope of the guidelines: *“to help PAs go a step further towards the direction of opening the data under the form of Linked Data (level five in the classification proposed by Tim Berners-Lee [2]) and thus permit Italian PAs’ data to become integral part of the Web of Data, i.e., a global space where multiple data are connected to each other through semantic links”*. The working group considered this way of managing PA’s data the correct methodology that, in perspective, can truly increase the value of the data themselves: *“they may no longer be used by one single application or website but by many other possible applications and for different uses”*.

The introduction concludes with a discussion on recent Italian legislation changes on semantic interoperability and open data (e.g., Law Decree 179 which includes the main principles of the Italian Digital Agenda), and on how positioning the technical guidelines with respect to the European Interoperability Framework [4] and the initiatives that the European Commission is currently carrying out on these topics within the ISA programme [6], [7], [8], [9].

Section 4 identifies a number of data categories that are owned by PAs and that, once opened, can contribute to meeting effectively transparency, accountability and service development requirements. Note that the list of data included in the guidelines is not exhaustive and future revisions of the document will likely analyse other data categories of interest.

At the time being, the discussed data categories are: (1) geographic data; (2) environmental data; (3) PA personnel data; (4) educational and academic data; (5) research and competencies data; (6) classifications and statistical data.

For each category, the guidelines present the legislation regulating its usage, including the possible limitations that can emerge when specific constraints are applicable (e.g., privacy requirements). In addition, for each data category an assessment on the opportunity and feasibility of opening the data under the form of Linked Data is introduced, highlighting possible existing Italian initiatives carried out



for this purpose. For instance, the guidelines report one single case currently available in Italy of geographical data made available as Linked Data¹.

Section 5 presents the state of the art on Linked Open Data and semantic interoperability. Firstly, the section analyses the numerous international projects and initiatives, focusing on W3C projects and working groups such as “Linking Open Data” project [10], RDF [11], Semantic Web Development [12], Government Linked Data [13], Provenance Interchange [14] working groups and many others. In addition, it introduces European Commission funded projects (e.g., LOD2 [15]) and working groups’ results that have been achieved in the ISA context (e.g., Asset Description Metadata Schema [8] and the e-Government Core Vocabularies [9]) and that are currently submitted to W3C for standardization purposes.

Secondly, the section reports the state of the art on Open Data and, in particular, on Linked Open Data in Italy. Although Italy is now active for what concerns Open Data initiatives, with an increasing number of brand new Open Data portals and available datasets, from a Linked Open Data perspective they are still a few. Nevertheless, “the working group unanimously considered existing Linked Open Data initiatives [16], [17], [18], [19], [20] leading examples for promoting, in the middle term, strategies for opening Public Administrations’ data as Linked Data”.

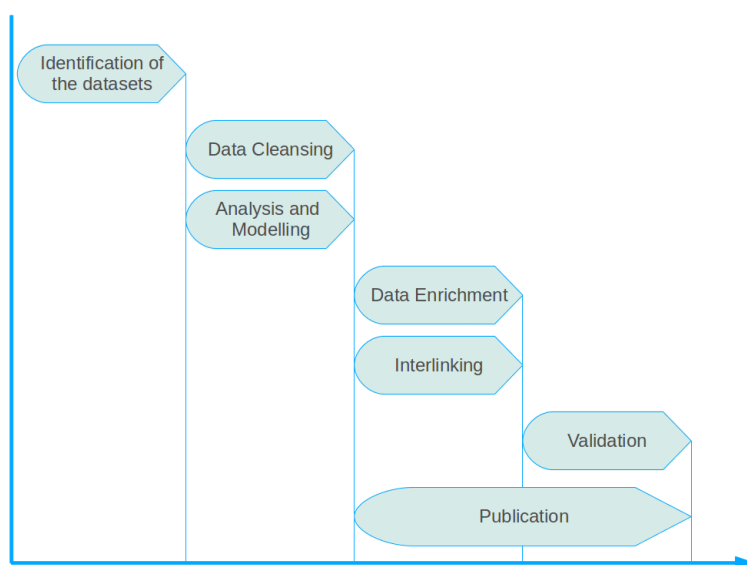


Figure 1: The phases of the proposed methodology for semantic interoperability through Linked Open Data

Based on the above mentioned study and PAs’ requirements in opening their data, **Section 6** introduces a methodology to semantic interoperability through the use of Linked Open Data. The proposed methodology is “sufficiently general to be adapted to the specific needs of single PAs and data producers”. It consists of seven principal phases, some of which can be also carried out in parallel, as illustrated in

¹ <http://blog.planetek.it/2012/06/20/verso-i-linked-open-data-geografici/>

Figure 1:

- **Identification of the datasets to open:** for this phase, the guidelines provide recommendations (e.g., evaluation of territorial needs, identification of possible legal and organizational constraints) that can guide Public Administrations in the selection of the datasets to make publicly available. To this end, *“gathering use cases, scenarios and requirements represents the best way to take effective and conscious decisions on the data to open”*;
- **Data cleansing:** for this phase, the guidelines recommend carrying out a data cleansing process in order to increase data quality. Typically data may (i) be incomplete, (ii) be available in different formats, (iii) exhibit ambiguities and inconsistencies; thus, *“the process of data cleansing must be carefully planned, keeping in mind future operations and transformations towards the RDF model and the alignment with the Semantic Web best practices”*;
- **Analysis and data modelling:** for this phase, the guidelines suggest a few steps to be undertaken in order to formalize or refactor the conceptual model of the data. In the simplest cases, the conceptual model can be obtained from a proper refactoring of existing data schemas (e.g., in UML or E-R) into RDFS or OWL. In more complex cases, the conceptual model can be formalized by reusing existing ontologies, by analysing requirements or previous documents and, in some case, by interacting with domain experts. As a result, the RDF dataset is produced along with the ontology that describes the dataset. Note that one of the most important recommendation of the working group at this phase is to adopt *“an incremental and modular approach rather than a monolithic approach”*;
- **Data enrichment:** for this phase, the guidelines recommend enriching the content of the data and discuss two ways to do that. The first way is to *“add metadata in RDF explicitly within the dataset; the metadata can be then exploited in order to facilitate the understanding, search and consequently reuse of the information of interest”*. Three types of metadata have been identified for this purpose: semantic metadata (e.g., comments, definitions, etc.), contextual metadata (e.g., space and time validity) and provenance metadata (e.g., the producer of the data). The second way is to infer new information with (i) the use of automatic reasoners and/or (ii) constructive SPARQL queries, based on the data and metadata already available. Finally, the guidelines point out a further way to infer new data, which however requires specific expertise: by adopting Natural Language Processing (NLP) techniques is possible to extract information from textual fields within the data;
- **Interlinking:** for this phase, the guidelines highlight the importance to enable the Linked Open Data principle of including, in the produced dataset, links to URIs that identify things other than the ones to be published, no matter if these other URIs belong to other datasets published by the same or a different organization. The working group considered this phase essential in order to help users discover new things and improve the quality and the value of the data. In addition, the guidelines recommend creating *“links that represent strong correlations (e.g., equality, inclusion, etc.) among entities since they provide additional information to the users”*;
- **Validation:** for this phase, the guidelines strongly recommend validating the produced dataset in order to avoid possible errors. The working group identified three levels of validation, *syntactic, logic and conceptual*. The syntactic validation is done with automatic tools that check whether the data formats are compliant with the W3C standards. The logic validation verifies,

by means of ad-hoc queries, that a user is able to obtain the expected answer over the data. The conceptual validation consists of verifying the adequacy of the ontology against the initial experts' requirements. *"In case one of the three validation fails, the previous phases of the proposed methodology (i.e. analysis, modelling, enrichment and interlinking) have to be revised"*;

- **Publication:** for this phase, the working group recommends proceeding in an incremental way: a first version of the dataset can be released after the modelling phase and then it can be progressively refined during the remaining phases of the methodology. The guidelines also highlight that a mere publication of files is not sufficient: *"it is preferable exposing a few high-quality Linked Data that are accessible in an accurate manner"*. To this aim, it is recommended providing a SPARQL endpoint as point of access to the data.

Section 7 focuses on the standard and technologies for the implementation of the described methodology. The section is structured into two parts: the first part identifies the W3C standards of the Semantic Web and the standards for statistical data; namely, Resource Description Framework (RDF) [11], OWL (Ontology Web Language) [21], Sparql Protocol And RDF Query Language (SPARQL) [22], and SDMX [25]. The second part concentrates on the specific tools that can be used to execute each methodological phase. When possible, the guidelines indicate advantages and limitations for each mentioned technology, highlighting whether it is commercial and/or open source.

Section 8 introduces legal aspects and business models concerning (Linked) Open Data. The working group considered the two topics strictly connected to each other. Legal aspects relate to the licences that can be associated with the datasets. Actually, the licence is one of the means through which implementing a specific business model since it regulates the access to the data. Thus, the guidelines provide the readers with an assessment of well-known licences, including the CC and ISA open metadata 1.1 licences. The assessment is conducted on the basis of seven criteria: multi-language portability, logo diffusion, re-use for commercial purposes, free re-use, support for derivative works and for attribution, compatibility inter-licences for derivative works. The section concludes presenting the impact on the society of (Linked) Open Data, describing the Open Data actors and roles, the market needs, the business models that can be enabled with the Open Data and the territorial indicators that are related to the development of Open Data. This discussion is mainly based on the results of the study entitled "Modelli di Business nel Riuso dell'Informazione Pubblica" [23] which has been conducted by Istituto Superiore Mario Boella on behalf of ICT Observatory of Piedmont Region.

Section 9 discusses the role that the Italian Interoperability Framework SPC – Sistema Pubblico di Connettività (Public Connectivity System) can assume to foster the production, publication and reuse of interoperable Open Data in the Public Administration sector. SPC can be a key actor in the Open Data context due to its (i) national shared infrastructures and (ii) the LOD e-government services that can be provided to Public Administrations. The guidelines highlight that a number of public data are already available in the context of SPC national shared infrastructures. The data are: those related to PA expenditures, those necessary to establish a (electronic) communication with legal value either among PAs or between PAs and citizens/enterprises (e.g., tax codes, e-mail and certified e-mail addresses, postal addresses, fax numbers, official web site URLs, PA managers and organizational structures of



PAs), and those related to geographical data of Italian PAs. Among these data, the guidelines report an effort of the Agency for Digital Italy in releasing, under the form of Linked Open Data, the data of the national index of Public Administrations containing the above mentioned tax codes, e-mail and certified e-mail addresses, postal addresses and so on of Italian PAs [5] [18]. *“The choice of starting from this SPC shared infrastructure is motivated by the fact that it includes the data that allow users to uniquely identify PAs; it can then be considered as the nucleus of a possible LOD cloud of Italian PAs’ data to which linking other data of SPC shared infrastructures and authentic LOD that are managed and published by central and local PAs”*. The working group recognized the advantages of this approach as *“it can contribute to the creation of the web of data of SPC, with authentic and certified data of Italian PAs, and it can facilitate the definition of a wide ontology constructed out of other specific domain ontologies made available by PAs.”*

Finally, Section 9 points out that PAs can also be helped in the LOD production process through the definition in SPC of e-government services, to be acquired by single PAs according to their needs. The guidelines affirm the necessity to *“define those services in such a way to meet the functional requirements as emerged from the phases of the proposed methodology. In addition to these requirements, standardization, openness and licences aspects must be considered in order to avoid possible vendor lock-in issues, and to provide services that are capable of guaranteeing high data quality and reuse, and semantic interoperability”*.

The guidelines conclude with **Section 10** that indicates some principles to follow in terms of governance of (Linked) Open Data initiatives. It has been pointed out that *“the PAs should identify a reference organizational area capable of implementing the governance of LOD initiatives and of supporting the actions to be undertaken (e.g., communication strategies, etc.)”*. In addition, a number of key aspects to sustain the initiatives over time are to be taken into account. For instance, the guidelines report key aspects as *“the integration of LOD management within the IT business processes of the organization”, “the development of demos able to show the benefits for Public Administrations in adopting the Linked Open Data model and technologies”*, just to cite a few.

3. GENERAL RECOMMENDATIONS OF THE GUIDELINES

From the assessment carried out by the working group that released the guidelines, a number of recommendations have been identified. In the Italian version of the guidelines, the recommendations are grouped in every section according to the topic they refer to. For the sake of simplicity, we list in the following all of them.

RECOMMENDATIONS

R1: In order to enable the creation of cross-border e-government services, it is recommended being compliant with vocabularies and schemas that are developed by the European Commission in such contexts as the ISA programme (e.g., Core Person, Core Location, Core Public Service, etc.).

R2: Data to be published shall be selected according to the demand and objectives of Public Administrations.

R3: When opening the data, both regulation constraints (e.g., sensitive data protection, copyright) and organizational limitations shall be carefully considered.

R4: When possible, it is recommended opening “atomic” data rather than aggregated data. In any case, aggregate data can be obtained from “atomic” data.

R5: When possible, it is recommended using natural keys in the creation of URIs, avoiding positional values included in a document or in a database.

R6: It is recommended designing ontologies starting from single services or single databases.

R7: RDFS and OWL shall be used when defining ontologies.

R8: New ontologies shall be developed only when strictly necessary. Ontologies and vocabularies that are widely shared and used at the national, European and international level shall be reused as much as possible.

R9: It is recommended not defining wide ontologies for modelling “monolithically” all types of data managed by Public Administrations. In contrast, an incremental and modular approach shall be applied.

R10: When defining the ontology, it is recommended using simple design patterns.

R11: It is recommended enabling an alignment among ontologies in order to facilitate information management over time.

R12: Specific constraints shall be added to disambiguate all those elements of the ontology that show ambiguities in the reference domain.

R13: Metadata shall be correctly managed in order to meet data quality and authenticity requirements. Specifically, it should be specified (i) the data producer; (ii) the time reference of the data and possibly the related period of validity; (iii) the precise description of the semantics of published information.



RECOMMENDATIONS

R14: The recommendations of W3C Provenance Interchange Working Group may be followed when dealing with data provenance.

R15: In order to guarantee cross-border semantic interoperability, it is recommended, when possible, linking your dataset to DBpedia and/or to any other dataset included into the LOD cloud.

R16: It is recommended choosing interlinks that represent strong connections among entities (e.g., equality, inclusion, etc.).

R17: It is recommended publishing few data of high quality, and under the form of Linked Data, rather than many data that are not interoperable.

R18: When publishing data, the consistency of URIs shall be carefully verified, especially in case of dynamic data. URIs of the same entity must not change when upgrading the dataset.

R19: When publishing data, a publication technology solution must be identified that permits a flexible integration with the information and organizational systems of the Public Administration.

R20: Publication should not be limited to the mere download of Linked Data, but a direct access to the data using standards such as SPARQL should be allowed.

R21: It is recommended registering the dataset in the CKAN portal.

R22: The compliance with the Semantic Web standards and best practices should be guaranteed when putting your LOD solution into production.

R23: It is recommended considering technologies that are mature in terms of (i) variety of offering, (ii) large usage, (iii) extensive documentation, and (iv) support by the reference community.

R24: When deploying LOD technologies, possible load balancing mechanisms should be taken into consideration, especially when dealing with large datasets queried by a large number of simultaneous user sessions.

R25: If there are no specific restrictions and constraints on the data, a license that permits the maximal reuse shall be associated with the data.

R26: For cross-border interoperability, multi-language and well-known licenses shall be used.

R27: It is recommended publishing data that are of large interest so as to allow users to execute queries that are distributed on a variety of databases.

R28: It is recommended publishing datasets that are of interest for the application developers' community.

R29: When acquiring LOD services, the different specializations and competences required in the methodological approach of the guidelines should be considered.

R30: Public Administrations may use pre-commercial procurement when acquiring LOD services.



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