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Title: ***Smart City Standardization: the case of Proxi-Produit project to the DPP policy***

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Abstract (up to 100 words)

In the context of a smart city, the Internet of Things (IoT) plays a pivotal role in enhancing urban living by integrating various devices and systems to collect, analyse, and act on data in real time. Identification of a particular object in IoT plays a crucial role. With the heterogeneity in IoT identification, Domain Naming System (DNS) infrastructure could play a vital role in ensuring seamless communication and interoperability among the myriad IoT devices deployed across the city. This article explains the process and technicalities involved in designing and implementing a proximity-based citizen service called 'Proxi-Produit'. The Proxi-Produit platform was built on a standard called the Object Naming Service based on DNS, which needed the cross-pollination between two different standards organisations, GS1 and IETF. We conclude by mentioning that the experience in this Proxi-Produit platform could help design and develop the tools and technology for the Digital Product Passport initiative, which will become mandatory in the EU for a range of different products.

Keywords

IoT, DNS, ONS, Smart city, Proximity-based services, circular economy

1. Introduction

The European Commission is driving a regulatory framework called the Digital Product Passport (DPP) [1] to create transparency around product information and accelerate the transition to a circular economy. The objective of DPP is that products sold in the EU will require an attached unique identifier that includes detailed information about materials used, manufacturing processes, recyclability, CO_2 impact, etc. By revealing a product's journey and environmental implications, DPPs will empower consumers to make informed purchasing decisions and pave the way for a greener, more ethical future, thus orchestrating a smart circular economy [2] (e.g., in a smart city).

The Internet of Things (IoT) will play a significant role in building a DPP. The IoT paradigm represents connecting anything and everything for communication purposes. IoT enables real-

time monitoring of product conditions throughout their lifecycle, improving data security, accuracy, and tracking capabilities.

The product must be associated with a carrier device to resolve the product identifier in an online information catalogue. To communicate on the Internet, a computer requires a carrier device such as a network card; similarly, mobile phones need a carrier device such as a SIM card. Examples of carrier devices in IoT are barcodes, RFID, sensors, NFC, etc.

The carrier devices in the Internet are identified uniquely in the scope of the Internet by identification mechanisms such as IP address, MAC address, domain names, etc. In IoT, we have a plethora of technologies. Each uses its identifiers, naming conventions, namespaces, and discovery process. A problem that arises due to this is that a "thing" using one technology (e.g., Zigbee protocol) will not be able to communicate with a "thing" using another technology (e.g., Wi-Fi). In simple terms, the problem is *"interoperability"*.

The question is: with such a heterogeneity in identifier naming conventions and provisioning structure, will it be possible to communicate between 'things' that use different identifier naming conventions and communication technologies? Two approaches to facilitate interoperability exist: *disruptive* or *evolutionary*. There are some disruptive approaches [3] for IoT. Most tend to be proposals from academia, implemented in a laboratory environment (or) tested in specific use cases.

The evolutionary approach uses existing technologies that have withstood the Internet's operational strains. The Domain Naming Service (DNS) [4] [5] is one such technology which has existed since the beginning of the Internet and remains its cornerstone. Even though the Internet evolved with a scale not initially thought of, DNS remains the essential infrastructure for resolving information on the Internet and interoperating between different applications and services.

DNS was conceived to translate *human-friendly* computer host names on a TCP/IP network into their corresponding *machine-friendly* IP addresses. Besides translating host names to IP addresses, DNS is used, for instance, by mail transfer agents to find out where to deliver mail for a particular address, as a general mechanism for locating services in a domain using Service (SRV) [6] records, as a resolution of identifiers that do not have traditional host components through DNS using Naming Authority Pointer (NAPTR) [7] resource records etc.

For IoT, overlay mechanisms services exist, such as Object Directory Service (ODS) [8], which uses the DNS infrastructure to resolve IoT identifiers (using legacy naming conventions) to their related digital information on the Internet.

This article will share the experience of a predecessor of DPP called "Proxi-Produit" [9], which was tested in France. In Proxi-Produit, we tested and implemented an architecture that described how a product identified by GS1 standards [10] could be linked to any number of resources on the Internet, wherever they may be, via DNS. The benefits of fusioning two standards for a project like ‘Proxi-Produit’ are explained in subsection 3.5. The article intends to show that lessons learned from the project could greatly benefit the development of the tools and technology for DPP.

2. Background

2.1 Context that led the 'Proxima Mobile' initiative – A bouquet of Citizen based services

The rise of the mobile Internet is accompanied by the consideration of contexts in which users are required to use the services made available to them. With a significant mobile communications market and a very dense network of innovative Small and Medium-Sized Enterprises (SMEs), France 2010 wanted to develop digital services to support citizens' daily activities. The Proxima Mobile[11] project was conceived with the dual objective of creating services that are useful to all citizens and stimulating the ecosystem of mobile services.

Proxima Mobile was to enable the creation of a bouquet of services of general interest in fields as diverse as education, law, health, tourism, disability, local life, employment, transport and even sustainable development. Proxi-Produit is one of the Proxima Mobile projects which focused on consumer products. The Proxima Mobile initiative was financed as part of France's recovery plan [12].

This project, coordinated by the "Délégation aux usages de l'Internet" (DUI) under the supervision of the French Ministry responsible for the digital economy and the Ministry of Research, had a double objective: to offer citizens services that make their daily lives easier and stimulate the development of the mobile services ecosystem. It was also about helping innovative SMEs to develop partnerships with administrations or local communities in order to develop services beneficial to citizens on a national, even European, scale.

2.2 Requirements of Proxima Mobile Service

Specific criteria were retained for the selection of applications and services of the Proxima Mobile services, which include:

Daily Use Citizen Services:
The requirement is to create a platform that enables the possibility to dynamically create new services (commercial, cultural, environmental, etc.) by adding new layers of information. Unlike the usual trend, which pushes marketing information towards the consumer, the requirement is to allow mobile users/consumers to access the product information they need or even essential.

A Shared platform for service providers :
The use of the Internet as a source of information by consumers and the rise of "unofficial" product information services are leading brands to organise themselves to obtain the visibility they deserve. Currently, the visibility is provided by individual corporate websites. The requirement is to use a shared channel to diffuse official product information.

Connectivity anywhere/anytime :
The requirement is to allow consumers to be connected anywhere, all the time (in stores, at home, etc.) and to search for contextualised information (geolocation, price comparison, in-store availability, etc.).

Ergonomics – Key for Citizen Services:
The rise of mobile devices is primarily linked to the simplification of interactions with the user. Touch screens have made the spread of, and access to information more easy. These improvements in ergonomics have enabled people who could not use computers to benefit from mobile services. Thus, the ergonomics of mobile services contribute to reducing the digital divide among disadvantaged households.

Accessible Citizen Services that are profitable and sustainable:
The objective was that Proxima Mobile services must not contain advertising. Rather than a political choice, it was a question of avoiding advertising banners, which occupy an important place on the screen and reduce the "useful" surface area for displaying and consulting content. In addition, mobile advertising remains the least appreciated by users. Accessible and free services enable a broad audience to benefit from it, but also to subsequently develop "premium" versions of said services that provide more features than the free version.

The aim was to use open standards to provide the services so that there is no recurring cost in terms of license, Intellectual proprietary rights, etc.

Innovative methodology:
Beyond mobile terminals, the objective was also to connect everyday objects. With IoT, it will become possible for network users to receive notifications from, and to interact permanently with all the objects present in their immediate environment. In addition to the trade, tourism and transport sectors, energy professions could also be transformed by the contribution of mobile technologies. Indeed, installing sensors on the electrical network and within subscribers' premises (companies and individuals) will enable significant energy savings. In the same way, energy, medical or environmental issues could be the origin of new services connected to mobile terminals.

2.3 Standardisation Committee

The basis for Afnic to be invited to be part of the 'Proxi-Produit' project under the Proxima mobile call for proposals is our previous experience developing a GS1 standard called the Object Naming Service (ONS) [13]. A process is followed to create the ONS standard under the GS1 ambit, which is explained in the following paragraph.

An adhoc group was created under the GS1 standards umbrella to develop the ONS standard. The adhoc group completed the work on the ONS requirements. The adhoc group is the initial step in forming a working group for the GS1 standards. A call for action was initiated to ask interested companies to join the Mission Specific Working group which is the next step to develop the GSMP GS1 EPCglobal Federated Object Naming Service. The interested parties could be GS1 organisations, solution providers, manufacturers, distributors and retailers. As ONS uses DNS, Afnic was invited to the group for their DNS expertise.

2.4 Proxi-Produit - Project partners and activities

As part of the call for Proxima Mobile projects launched by the French State Secretariat for Digital Economy Planning & Development, the "Proxi-Produit" consortium involved a number of stakeholders in France, including Afnic, the French Internet registry [14]; GS1 France [15], the organisation which manages the supply chain registry for France and Adenyo, a full-solution mobile marketing and media provider.

Adenyo was involved in Project management, technical development and operation of turnkey mobile solutions. GS1 France positioned itself in the consortium as a guarantor in implementing GS1 standards and in conducting subsequent standardisation work, which may prove necessary for encouraging the publication of information relating to products by brands. GS1 France's objective was to create a standard and open platform allowing citizen-consumers to access content relating to the product. Afnic, as an actor managing the Internet namespace for France and its overseas territories, appeared as an element of trust within the

consortium. Afnic also brought its expertise in the development of ONS, which played a role in resolving the product identifier to its resources.

The project planning was in three steps:

- Firstly, designing and implementing the 'Proxi-Produit' platform;
- Secondly, getting multiple stakeholders involved, such as manufacturers, retailers, distributors and consumer associations, and organise them in multiple working groups;
- Thirdly, implementnig the outcome of the different working groups and provision the Proxi-Produit database with different product information.

3. Proxi-Produit - Case study

3.1 Service and operational requirements

The Proxi-Produit project aimed to create proximity services linked to the product through an open and standardised architecture, allowing information owners (industrialists, distributors, and communication organisations) to communicate with consumers/citizens directly on their mobile phones.

On an operational level, the project objective was to democratise the use of mobile services by allowing the creation of a viable ecosystem around access to product information via mobile. On a technical level, the project aimed to develop a distributed architecture of mobile services and applications open to information owners to reach their "target" on mobile. Ethically, the project aimed to prioritise social, practical, and useful services for people with difficult or restricted access to information.

The applications developed as part of the Proxi-produit had the common prerequisites:

- **Openness to all:** allow any individual to access and use these services, as long as they have a mobile phone and an appropriate subscription.
- **Economic viability:** No service, however virtuous it may be, will be able to continue if the value perceived by the user shrinks and the economic model is not sustainable.
- **Interoperability:** this involves guaranteeing the solution's openness (aggregation and distribution) to as many terminals as possible while considering the evolution of mobile platforms and OS.
- **Industrializability:** Able to be developed with all industrial partners and distributors. From its origin, it must be built on an open, standard architecture capable of supporting significant load increases.

3.2 Process level issues implementing Proxi-Produit

This section describes the administrative and process issues in procuring and managing information related to Proxi-Produit as the Smart City project.

Too many commercial and proprietary offers:
"Product" information via mobile is already part of the commercial and marketing strategy of manufacturers and distributors. The approach is generally focused on the product and its merits and not on the benefit that the consumer can derive from it.

The aim of these information services is solely to increase consumption volumes and achieve the fastest possible “Return on Investment" (ROI). The industry generally follows two approaches:

- **Product launch:** This mercantile approach is generally temporary, centred around a product launch, and does not aim to build a sustainable mobile development model.
- **Product/brand loyalty:** This involves retaining/rewarding customers by offering them benefits/promises based on the use of the product. Even if the approach tends to qualify the individual based on their interests/tastes, it remains focused on direct ROI, such as the distribution of discount coupons.

Ultimately, none of these isolated approaches aims to build a proximity service-oriented model in a modular manner, communicating anywhere/anytime with open and shared solutions. So, the question was how to streamline all the information as described in subsection 2.2.

A Service-oriented for consumers:

There are many consumer-based social networks, such as travel with 'Tripadvisor.com', products 'amazon.com', restaurants 'thefork.com', etc.

These platforms are a social phenomenon, allowing a new category of informed consumers to buy based on community reviews and ratings. The brands/distributors have understood well that the leads provided by these exchange platforms ensure their profitability. Hence, there are questions on 'neutrality' and product information validation when presenting the product information and whether the real intent is for the consumer rather than benefiting the social networks.

A complex environment:

In France alone, there are different types of mobile devices in circulation with different Operating Systems, and the terminals are reconfigured by mobile network operators with different packaged offers, which distorts the terminal's navigation parameters.

3.3. Proxi-Produit technical consideration and implementation – A project for Extended Packaging services:

If, in a supermarket, one scans the barcode of a product (using the barcode reader available on the shelves), the information presented is only its name and price.

IoT allows brands and producers to present more information to consumers from their barcodes than those printed on the packaging. This additional information is termed as "extended packaging".

This data is present on servers accessible via the Internet. Thus, by using a mobile application that allows the barcode to be scanned and connected to the Internet, consumers can access all the information about the product that interests them. Studies have shown the importance of access to extended product information using a smartphone, both from the point of view of consumers and brands.



Fig. 1: Proxi-Produit – Extended packaging use-case for proximity)based City services

Figure 1 illustrates the Proxi-Produit service made available to citizens by the French government.

Role of Identifier and Identification Schema in Proxi-Produit:

Identification plays a crucial role in providing citizen-based proximity services. The identifiers that we are used to handling (such as telephone numbers, IP addresses, domain names, etc.) are globally unique. In the same way, the identifier of a product must necessarily be unique.

Thus, the definition and allocation of identifiers must follow specific rules to preserve their uniqueness. Firstly, it is necessary to establish an "identification scheme". Let's take the case of telephone numbers. The allocation of these identifiers follows the "E.164 numbering plan" [17] as an identification scheme. Each telephone number is limited to 15 digits and includes:

- Country Code (CC)
- National Destination Code (NDC)
- Subscriber Number (SN)

For example, in France, a telephone number following the E.164 numbering plan is 33-1-60760000, where '33' is the CC, '1' is the NDC for the Paris region, and '60760000' is the SN.

Once this identification scheme has been established, it is necessary to define how to allocate the identifiers so that no 'two' identifiers are assigned to the same entity. In the E.164 identification scheme, CCs are assigned according to ITU-T recommendations. NDC and SN are controlled directly by the governments of each nation or the dedicated national organisation. A similar hierarchical allocation scheme is also used in other identification schemes, such as domain names, IP addresses, etc.

The observation we can have here is that in the same way as for the identifiers we use (telephone numbers, domain names, etc.), effective identification of consumer products must follow specific rules:

- It must be based on an identification scheme. Thus, each identifier has the same structure. This allows the implementation and use of a common mechanism for identifier resolution.
- It must be allocated hierarchically. This ensures the uniqueness of the identifiers.
- It must be managed in a distributed manner for scalability and ease of administration.

As the 'Proxi-Produit' project focuses on product identification, there are different product identification schemes. Initially, we started with the Global Trade Identification Number (GTIN) identification scheme used in the consumer goods industry. The GTIN, the unique identifier, according to the GTIN identification scheme, can be used to identify objects globally.



Fig. 2: GTIN barcode example

GTINs are allocated hierarchically. Each GTIN is, therefore, composed of two parts (see Figure 2):

- The first, the 'company prefix', allows the company (having manufactured or produced the object) to be uniquely identified ("3112345" in the diagram (Fig. 2)). The first three digits of the company prefix indicate which Country the manufacturer belongs to. For example, if the company is based in France, the first three digits are between 300 and 379.
- The second is the 'product code' (67890 in the diagram above), which makes it possible to differentiate products from the same company (to differentiate two wines produced by the same winemaker, for example).

GTINs are managed in a distributed manner. Company codes are administered at the country level, and locally produced codes at the company level directly.

GS1 as an Organisation assigning and allocating GTIN in the Proxi-Produit project:

GS1 is a not-for-profit, international organisation developing and maintaining its barcode standards and the corresponding issue company prefixes. GS1 has 118 local member organisations and over 2 million user companies. Its main office is in Brussels.

The best-known GS1 standard is the barcode (based on the GTIN identification scheme), a symbol printed on products that can be scanned electronically. The GTIN in the barcode is used to identify a trade item, which could be a product. It's a globally unique number that can help you identify your specific product or service. Figure 3 shows the different types of GS1 barcodes and associated GTINs used in the consumer industry.

GS1 positioned itself in the Proxi-Produit consortium as a guarantor in evolving the GS1 standards for publishing information relating to consumer products by brands. It's in the interest of GS1 and its members (manufacturers and distributors) that the services developed consider existing standards (GTINs, barcodes, computerised data exchange protocols, etc.).

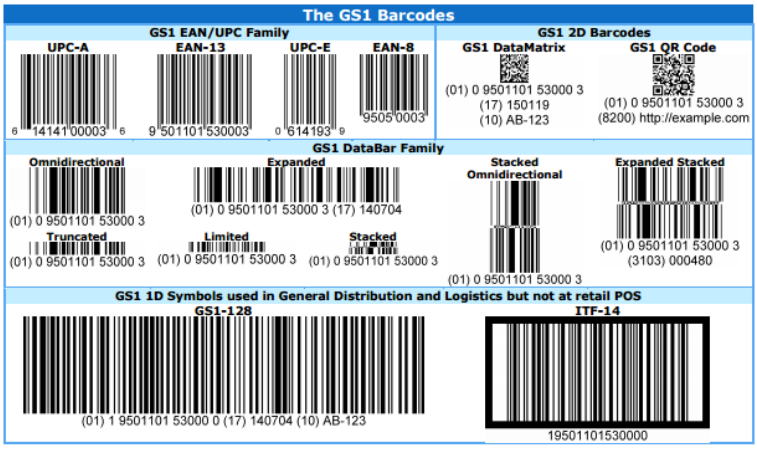


Fig.3: Different types of GS1 barcodes and associated GTIN[1] (Source https://www.barcode-us.com/gtins-prefixes-barcodes/types-of-gs1-barcodes)

GEPIR, the look-up service used by GS1:

The Global Electronic Party Information Register (GEPIR [16]) is a distributed database that provides a unique, internet-based service that allows users to look up information associated with a GTIN. GEPIR proposes to search for information using the GTIN code.

The architecture of GEPIR requires every node to know about every other node. While the number is limited, the maintenance of this list is still very much a manual process. There are other limitations of GEPIR, such as the fact that access to GEPIR is limited for companies that are members of GS1 [18]. GEPIR is not an open database or could be interoperable with identifications other than GS1 identifiers. Hence, it cannot be used in a service like Proxi-Produit. Figure 4 illustrates the resolution of a GTIN identifier to its extended packaging information using GEPIR.

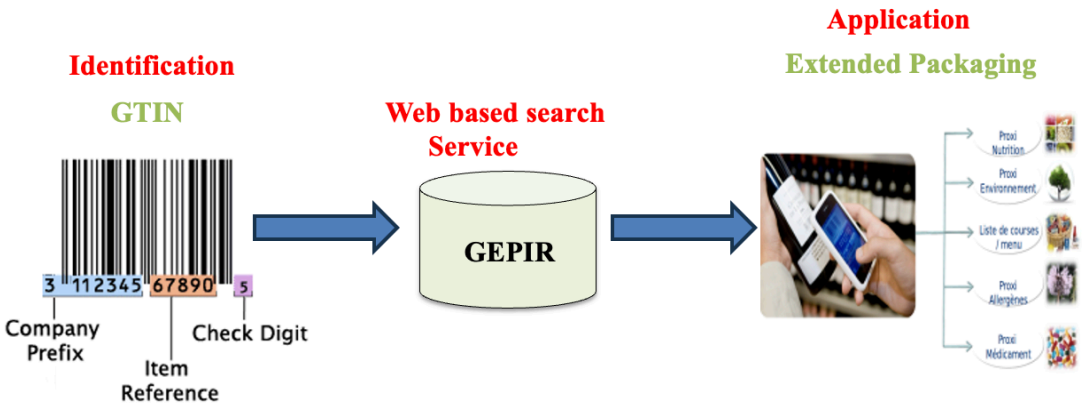


Fig.4: Product resolution using GEPIR

DNS as the look-up service:

Having one global identification scheme (such as GTIN) for all the products worldwide will be nearly impossible. The main reason is that some industries have been using their proprietary coding standards (i.e., identification schemes) for a long time. It is pretty impossible to convince them to move to a newer product identification system. Another difficulty is that it will require consideration of various identification schemes to achieve a global identification schema.

The GTIN allocates the identifiers hierarchically (as explained in subsection 3.3). The hierarchical nature of such allocations ensures that anyone from any part of the world can uniquely access any service/user in any other part of the world. So, most identification schemes for identifiers in IoT are also hierarchically structured.

The DNS is the look-up service on the Internet, translating "human-friendly" domain names on a TCP/IP network into their corresponding "machine-friendly" IP addresses. Both domain names and IP addresses are hierarchically structured. Hence, the objective was to check whether the product identifiers from the GS1, which are hierarchically structured, could converted to domain names. As mentioned earlier, a similar mechanism exists in ODS, such as using DNS to resolve the object identifiers (their respective identification schemes) to their related digital information.

Proxi-Produit – A fusion of two standards:

AFNIC, as the French Internet registry, manages the Internet domain namespace for France and its overseas territories. Afnic uses DNS, which was developed and evolved as a standard by the IETF [19] for publication and resolving identifiers such as domain names to its information on the Internet. Afnic is positioned in the Proxi-Produit consortium to use the DNS infrastructure to provision and resolve GTINs produced by GS1 Standards via the Internet.

Hence, two organisations working with two different standardisation bodies came together to develop a new standard that could benefit the community and enable openness and interoperability. This new standard is the ONS.

ONS Usage in Proxi-Produit:

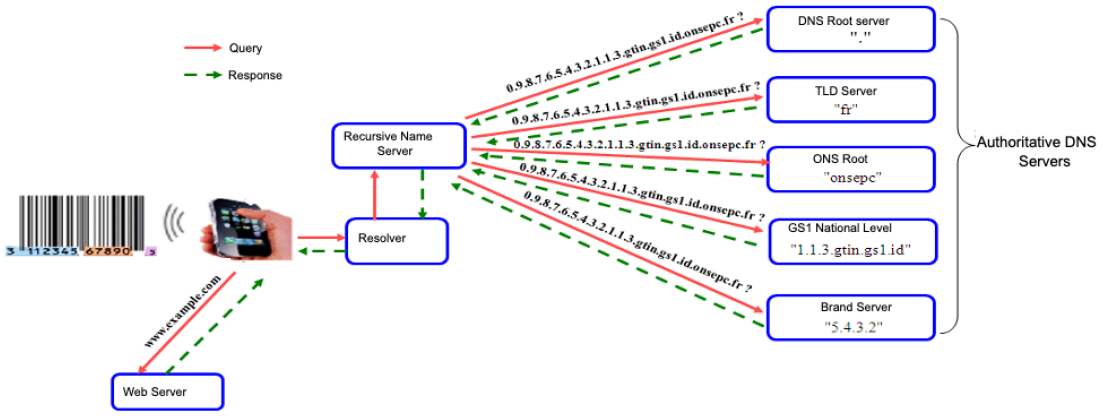
In Proxi-Produit, the ONS standard resolves extended information from the product identifier (e.g., barcode). It turns out that the ONS standard uses the DNS (Domain Name System) infrastructure to retrieve information from objects on the Internet. Therefore, the query and response formats must be compatible with DNS, meaning that object identifiers are converted into domain names, and the results correspond to DNS records.

The mobile application scans the product identifier (for example, its barcode with a GTIN identifier) and converts its identifier into the corresponding domain name. Below is the result of this conversion of a product identifier (i.e. the GTIN) to a domain name, according to the ONS standard:

0.9.8.7.6.5.4.3.2.1.1.3.gtin.gs1.id.onsepc.fr

The mobile application retrieves the information related to the corresponding domain name using the DNS resolver. This information is stored in the DNS server as a DNS record. Below is the DNS record corresponding to our bottle of wine:

0.9.8.7.6.5.4.3.2.1.1.3.gtin.gs1.id.onspec.fr. IN NAPTR 0 0 "u" EPC+http "!^*$!http://example.com/!" .



In the absence of cached data, the request is processed by the DNS resolver using the standard DNS resolution process (see Figure 3). The final response from the DNS resolution process will be the DNS record shown above. From the response received from the DNS, the application (on the mobile) extracts the URL (for example, http://example.com/) and requests the appropriate web server (see Figure 3) to obtain the extended packaging of the product. Using the DNS has multiple advantages, which are explained in subsection 3.5.

Security analysis of using DNS for extended packaging in the consumer industry:

As ONS reuses existing DNS procedures and infrastructure (to find information corresponding to the object identifier on the Internet), ONS's security inherits that of DNS. RFC 3833 [20] contains an excellent summary of DNS vulnerabilities, which (among others) are:

- Modification of IP packets relating to DNS information during transmission and reception
- A malicious person can retrieve the identifier of the DNS request and its type and thus send a false response to the client before it receives the correct one
- DNS "cache poisoning": it is now possible by different means to inject manipulated information into the DNS cache
- Also, a malicious person can compromise the DNS servers which contain the information.

In the 'Proxi-Produit' use case, a patient scans a medical product to find its contraindications. It is possible that a malicious person can hijack the DNS query launched by the application and send back erroneous information, thus leading to a significant risk of jeopardising the patient's health.

Even if the DNS service is, by definition, a highly exposed service, the underlying reason for the majority of vulnerabilities lies in the fact that DNS was not designed to guarantee the integrity of the information that is returned as a response to a DNS query.

The primary approach to addressing these DNS-related security vulnerabilities is called Domain Name Security Extensions (DNSSEC) [21]. DNSSEC uses public cryptography and DNS data signing. The zone administrator signs the zone file containing DNS data (like the example.com zone).

It is important to note that the signed DNSSEC zone contains the RRSIG and the original unsigned data. The example below shows the contents of record type "A" for an "example.com" zone signed with DNSSEC.

```
; "A" type Resource Record
example.com. 1   A  192.0.2.1
; RRSIG of the "A" record
example.com. 1 RRSIG A 5 5 1  (20130930064057 20130403064057 3960 example.com.
                s8dMOWQjoTKEo1bsK+EYUY+32dsqdsfdsfdsfsdfdssssdfsfsfdsssdfshqt0AaiD= )
```

When the client makes a DNS query, the signature arrives at the client as part of the response. The client can verify the signature and thus ensure that the response accurately represents the original data. With DNSSEC, authentication and data integrity of DNS responses are ensured.

3.5 The benefits of involving two standards for a smart city project such as Proxi-Produit

The "Proxi-Produit" project has multiple advantages, which are implemented with a cross-pollination of both the GS1 and the IETF standards. Some of the benefits are explained here:

- It enables unique and persistent identification of products that can be shared with many stakeholders consistently and accurately. The product's identity is managed and allocated by a trusted organisation, i.e. the GS1. The information linking the product identifier to its resource is a domain name provisioned by the company, the product owner in the DNS. Hence, the information received by the consumer is trusted information.
- It enables a Top-down approach: for example, in the case of a product recall, the information on recalled products is automatically transmitted to the manufacturer's database. When the consumer "scans" the barcode produced or enters the barcode number, i.e., the GTIN, the server clearly and simply indicates to the consumer whether their product is affected.
- It enables a bottom-up approach: if a consumer is registered with the application for a risk such as an allergy to certain minerals or a particular product, they will be informed when scanning the product.
- It enables an open standards-based approach: several proprietary product look-up services could be comparable to Proxi-Produit. However, they are not standards-based approaches and are tied to a single service provider. Such alternatives would not fulfil the international business requirements for transparent governance and control over critical network infrastructure.
- It enables dynamic services: 2D bar codes such as QRCode or Datamatrix can encode entire URLs, which are the information associated with the product identifier. This form of encoding URLs, which contains product information in a QR code, is a viable alternative to Proxi-Produit only in cases where the services available for the product are known when the product is commissioned. Usually, the services associated with the product are not known in advance. In addition, many potential web services could interest a user based on context (e.g. Product Authentication, Extended Packaging, Product Recall). Hence, a standardised mechanism must be used to interpret the service type at the URL's end. It is also possible to provide additional services based on contextual information. Some examples are allergen information, language translations, recipes and usage instructions. With Proxi-Produit, it is possible to enable

dynamic services based on context, user language preferences, current user location, etc.

- Enables interoperability: Lack of interoperability between different product identifiers has been a burden for the end users. Using DNS as the look-up service for GS1 identifiers enables the possibility of resolving that burden, thus extending its usage to other numbering authorities such as ISO and ITU.

3.6 Conclusion

In a dynamic environment like IoT, where new products and services keep evolving, and network topologies keep changing, automated discovery mechanisms are needed for overall communication management. The discovery mechanism should enable interaction between products or identify suitable services for products not pre-configured or hardcoded as far as the product's address or service endpoints are concerned.

In this article, we explain the Proxi-Produit case study, which satisfies the dynamic discovery requirements of IoT, particularly from a proximity-based citizen service perspective. In addition to technical details, the process involved in designing and implementing the Proxi-Produit platform is explained. We could say that the 'Proxi-Produit' project is the predecessor version of DPP, which was tested in France. The objective of this article is that the experience in the 'Proxi-Produit' project could help us design and develop the tools and technology for DPP.

The objective of DPP is that products sold in the EU will require an attached unique identifier that includes detailed information about materials used, manufacturing processes, recyclability, CO_2 impact, etc. By revealing a product's journey and environmental impact, DPPs will empower consumers to make informed purchasing decisions and pave the way for a greener, more ethical future, thus enabling a circular economy in a Smart city.

Acknowledgements

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