Building **R**adio frequency **ID**entification for the **G**lobal **E**nvironment

Requirements document of serial level lookup service for various industries

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About the BRIDGE Project:

BRIDGE (**B**uilding **R**adio frequency **ID**entification for the **G**lobal **E**nvironment) is a 13 million Euro RFID project running over 3 years and partly funded (€7,5 million) by the European Union. The objective of the BRIDGE project is to research, develop and implement tools to enable the deployment of EPCglobal applications in Europe. Thirty interdisciplinary partners from 12 countries (Europe and Asia) are working together on : Hardware development, Serial Look-up Service, Serial-Level Supply Chain Control, Security; Anti-counterfeiting, Drug Pedigree, Supply Chain Management, Manufacturing Process, Reusable Asset Management, Products in Service, Item Level Tagging for non-food items as well as Dissemination tools, Education material and Policy recommendations.

For more information on the BRIDGE project: www.bridge-project.eu

This document:

This document addresses the requirements serial-level lookup services (also called Discovery Services). Section A deals with the general requirements for designing serial level lookup services. To obtain those requirements, a web questionnaire has been running for several months, and also a number of end users have been interviewed about their requirements and expectations. Section B presents a report from interviews performed with potential users of serial level lookup services and experts on IT systems in various industries interested in RFID, who were interviewed in order to learn more about their existing IT infrastructure and assess the feasibility of integration of these new services with existing enterprise applications. Section C extracts the requirements and presents them in a formal way, so they can be taken into account by systems developments engineers working on T2.3, who are prototyping a serial level lookup service.

Disclaimer:

This document results from work being done in the framework of the BRIDGE project. It does not represent an official deliverable formally approved by the European Commission.

Introduction

The objectives of the BRIDGE project are twofold. Firstly, it is developing RFID and EPC Network technology covering different aspects tags, readers, serial level lookup services and user applications for track and trace. Secondly, Bridge aims to demonstrate and disseminate through Europe the value of RFID and EPC Network technology and its potential benefit for various business sectors.

Therefore, there is a clear division between those work packages working on the different aspects of RFID/EPC technology which may be considered as horizontal activities that provide the foundations for subsequent development of business oriented work packages activities, which implement RFID/EPC based solutions in the field and evaluate the benefits of the technology to improve business processes.

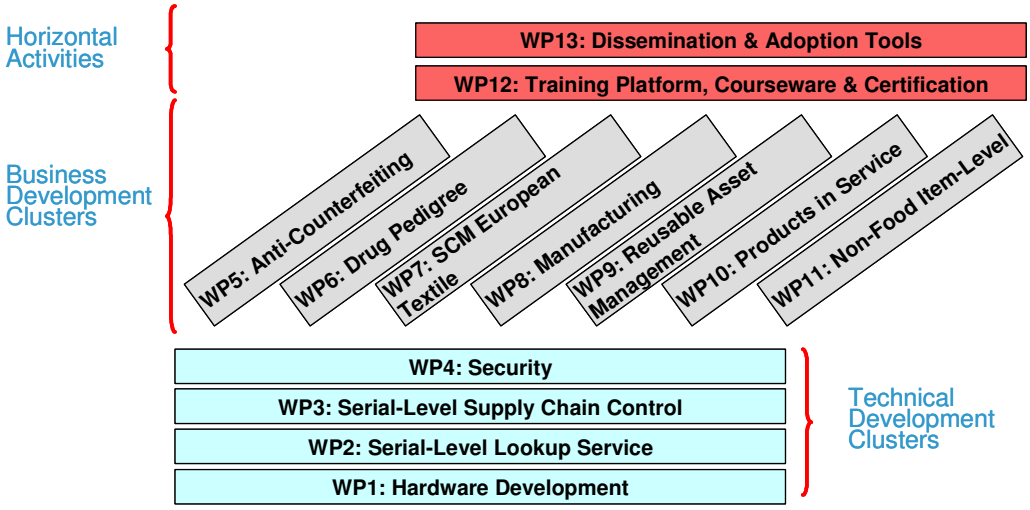

Figure 1: Work Package structure in the BRIDGE project

Among the technical WPs, WP2 focuses on serial level lookup services, which provide track and trace information of a given tagged item as it moves along the supply chain.

This deliverable, the first issued by WP2, is the result of the work developed on task 2.1 and 2.2 whose objectives are defined in the description of work as:

- T2.1: get requirements for designing a serial level lookup service for various industries
- T2.2: get requirements for the integration of a serial level lookup service with existing business information systems

The output of both tasks, contained in this document, bring forward the necessary input for subsequent task 2.3 which intends to implement a prototype of a Serial Level Lookup service.

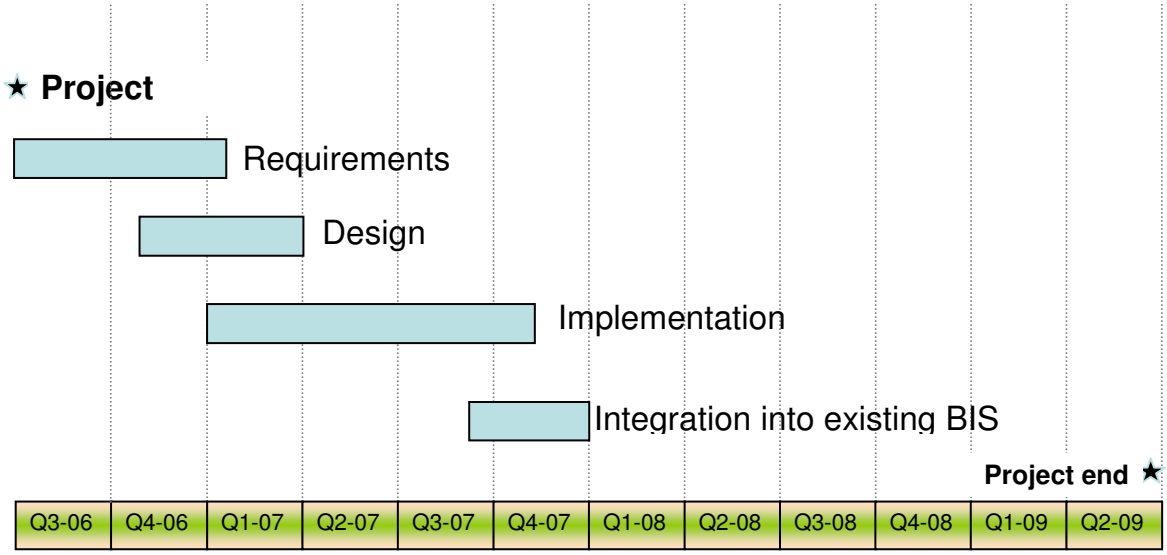

Figure 2 : Tasks and timeline of Bridge WP2

Background

EPCglobal was created with a concrete target: to develop a universal identification system and an open architecture to provide interoperability in a complex multi-vendor scenario. This universal identification system is based on the allocation of a unique EPC (Electronic Product Code) to every item. As a result, the EPC Network[1] is an architecture proposed for enabling sharing of information about individually identifiable objects among organizations (See Figure 3). Each individual instance of an object can be given a globally unique identifier (unique ID), enabling each object to be tracked worldwide, by means of automatic identification technologies such as Radio-Frequency Identification (RFID), as well as linear barcodes or two-dimensional barcodes. Furthermore, such Auto-ID technologies enable an individual 'life history' of each individual object to be collected efficiently – and this additional data can be linked to the object via the globally unique ID of each object. With a suitable service-oriented architecture, the unique ID can be used both to locate source of information, via lookup services, as well as for extracting relevant information about a particular object from each source, by using the unique ID as a lookup key within a database.

In the EPC Network, the Electronic Product Code (EPC)[2] serves the role of a globally unique ID for objects. In fact, as defined in EPC Tag Data Standards, EPC is not a single identifier scheme but rather a framework for an extensible family of unique identifiers, many of which are aligned with legacy identifiers, extended where necessary with the addition of a serial number, to achieve uniqueness. Each member of the family of unique identifiers is given a unique Uniform Resource Name (URN) prefix. For example, a serialized Global Trade Item Number (GTIN)[3] begins with the prefix 'urn:epc:id:sgtin:' whereas a Serialized Shipping Container Code (SSCC)[4] begins with the prefix 'urn:epc:id:sscc:'. In this way, all EPC identifiers are guaranteed unique, since the URN prefix is unique for each namespace or identifier scheme, while the remainder of the EPC is unique within that namespace or identifier scheme. It should be noted that 'Electronic Product Code' is something of a misnomer, since not all EPC identifiers necessarily indicate the product type.

There are considerable efficiencies to be gained within a supply chain resulting from exchange of more accurate and timely information about flows of goods between trusted trading partners. For example, many retailers are encouraging the adoption of Auto-ID technologies in order to reduce out-of-stocks and to improve replenishment processes. The pharmaceutical industry is considering item-level tagging of pharmaceuticals, together with electronic pedigree mechanisms in efforts to prevent counterfeit products from entering the supply chain. The aerospace sector is considering tagging aircraft parts, in order to automate the gathering of information about faults and maintenance operations, in order to improve maintenance processes, as well as being able to mine the data to identify systematic failure patterns across parts of a similar type or exposed to similar conditions, in order to improve safety and reliability of parts, by making necessary improvements to design and manufacturing processes.

Sharing of data is of course commercially sensitive, especially information about volumes and flows of good and relationships between trading partners, which could be used advantageously by competitor organizations if the necessary security mechanisms and access controls were absent or compromised.

As a result of such concerns, one of the fundamental design principles for the EPC Network is that each company should be able to retain control over the data that they collect or generate within their own organization, i.e. information is decentralized across multiple organizations[5].

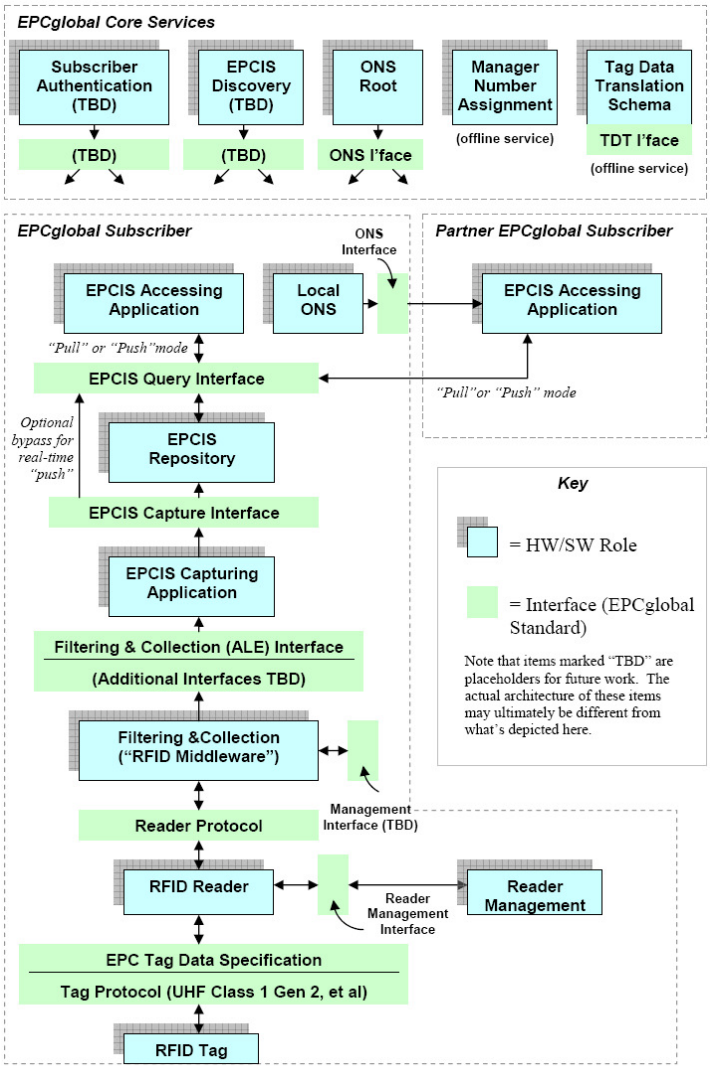

Figure 3: EPCglobal Network Architecture

EPCIS

The EPC Information Services are a *role* defined in EPCglobal Network Architecture Framework [1], which provide for storage and retrieval of filtered and processed information about different events within the supply-chain. The EPCIS offers two interfaces: one for query request and the other one for capture operations. The query interface allows trading partners to query information about any event data stored in the EPCIS-repository together with business context.

However for such a decentralized architecture, since the complete information about an individual object may be fragmented across multiple organizations, there is a need for lookup services for locating all the providers of the fragments of information that constitute the complete supply-chain or lifecycle history for an object.

The EPCglobal Network Architecture Framework document [1] envisages two complementary lookup services: the Object Name Services and the Discovery Services.

Object Name Services

Object Name Services (ONS)[7] provide pointers to authoritative information about an object; this usually means that they provide a pointer to the information services provided by the manufacturer of the object. Multiple types of services can be included in ONS records,

including not only EPC Information Services (EPCIS) but also product-specific web pages, web services and other data, such as XML data about products.
The ONS v1.0 standard[7] explains how to query the object name service, given a unique EPC identifier. It should be noted that the ONS lookup mechanism is currently only defined for serialized GTIN EPCs. Furthermore, the granularity of ONS resolution is currently limited to product type, rather than serial-level lookup. i.e. an ONS is not expected to retain distinct records for two objects of the same product type that only differ in their serial numbers – in this situation, ONS would only hold records for the product type. Another point to note is that ONS is currently implemented using the Domain Name System (DNS)[8], using Type 35 Naming Authority Pointer (NAPTR)[9] records to return the information. Queries to ONS are therefore performed by means of a DNS query for a hostname derived from an EPC – and no authentication or authorization is required to perform an ONS query. This is clearly not appropriate for serial-level lookup services for tracking and tracing of objects across the supply chain

Discovery Services

Discovery Services (DS) are envisaged to provide pointers to multiple providers of information across a supply chain, to indicate the addresses of information services of all organizations that hold information about a given EPC – not only the manufacturer. Unlike Object Name Services (ONS), it is expected that most clients querying a Discovery Service will be required to provide authentication credentials – and the amount of information returned in response to their query will be subject to filtering by access control policies based upon the authentication credentials they supply and the business relationship they have with each provider of information that registers records (and associated access control policies) with a Discovery Service.

Discovery Services will need to be designed to accept updates in close to real time from multiple providers of information across the supply chain or lifecycle of an object (including organizations that handle the object beyond the point of sale or delivery, e.g. for repair purposes, maintenance, returns and reverse logistics, as well as recycling, remanufacturing and other end-of-life processes). Because they store serial-level records, they will need to be sufficiently scalable to store large volumes of data, possibly up to trillions of records per year. They will also need to provide for authentication of both information providers (publishers) and those making queries (clients) and accept and enforce access control policies that are defined in a manageable way.

The complementary role of ONS and Discovery Services in relation to multiple EPC Information Services is shown in Figure 4 below:

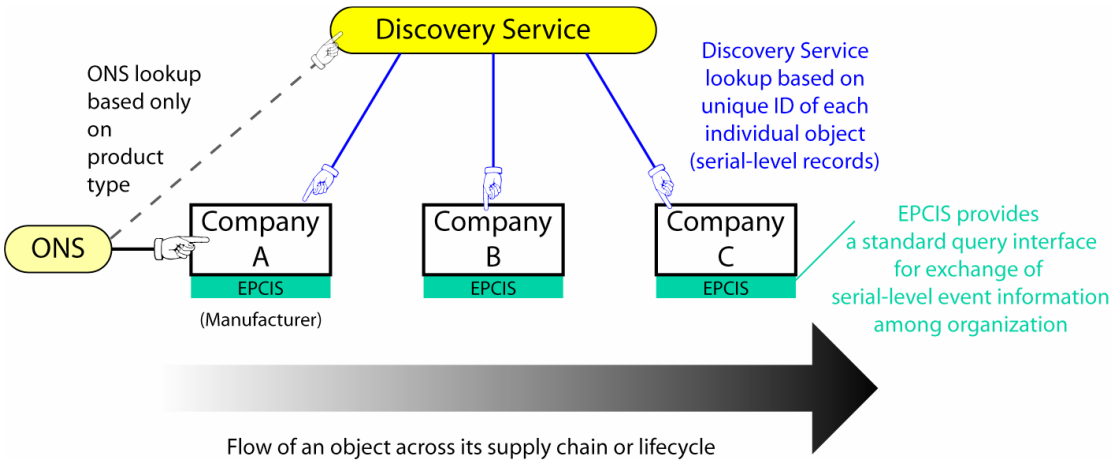

Figure 4 – Complementary roles of ONS and Discovery Services

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Executive Summary

The EPCglobal network already provides some capabilities for tracking goods. Specifically; given a certain EPC, the manufacturer can be found through a service which is called Object Name Service (ONS). However, this service does not provide distinct item level information, nor does it provide for tracking and tracing of an individual item across the supply chain and gathering information about it from multiple sources.

Therefore for a better understanding of WP2 objectives, it is worth making this distinction: while an ONS provides a URL to information from the company which created a certain item, a serial level lookup service provides a list of URLs to multiple providers across the supply chain where information about a certain tagged item is available (usually a list of links to companies' EPCIS addresses). Therefore, only a Serial Level Lookup service would provide a link to where lifecycle information of a tagged item is stored.

This document, the first deliverable from WP2 gathers information and results from two different tasks, T2.1 and T2.2. For that reason, it is divided into a set of three different reports, namely sections A, B and C.

Section A deals with the general requirements for designing serial level lookup services. To obtain those requirements, a web questionnaire has been running for several months, and also a number of end users have been interviewed about their requirements and expectations.

Section B presents a report from interviews performed with potential users of serial level lookup services and experts on IT systems in various industries interested in RFID, who were interviewed in order to learn more about their existing IT infrastructure and assess the feasibility of integration of these new services with existing enterprise applications.

Section C extracts the requirements and presents them in a formal way, so they can be taken into account by systems developments engineers working on T2.3, who are prototyping a serial level lookup service.

In addition to the requirements gathering process, and in parallel with it, task 2.5 has been working on a high level design for Discovery Services. Its results, included on D2.4 are complementary information for engineers facing the design of Discovery Services (Serial Lookup Services).

Note: Throughout the document the term *Discovery Service* is used instead of "Serial Level Lookup Service" , to give it a more precise meaning and avoid any possible confusion with EPC Information Services (which are already standardized and implemented).

Building **R**adio frequency **ID**entification for the **G**lobal **E**nvironment

Requirements document of serial level lookup service for various industries

Section A:
Report on Questionnaire on Requirements for Serial Level Look up and Supply Chain Control

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15 August 2007

Revision History

Version	Date	Author	Summary of Changes
0.1	July 2006 – August 2006	GS1 UK, ETH Zurich	Compilation of report and questionnaire, with comments and feedback from AT4 wireless, BT, Cambridge, SAP, ETH Zurich
0.15	August 2006 – October 2006	Cambridge	Compilation of Raw data from questionnaire and interviews
0.3	November 2006	GS1 UK	First Version of the document. Results analysis provided by AT4 wireless, BT, Cambridge, ETH, GS1 UK, SAP.
0.9	March 2007	Cambridge, AT4 wireless	Document Update
1.0	July 2007	Mark Harrison (Cambridge)	Proof – reading of the document
	July 2007	Nicholas Pauvre (GS1 France)	Bridge Internal Review. Minor comments, dates missing in front page and typos.
1.1	July 2007	AT4 wireless	Inclusion of comments from internal review

Note

The views expressed in this document are the views of the joint authors and the *Community* is not liable for any use that may be made of the information contained herein.

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1. Executive Summary

The project created an open online survey that was publicised to EPCglobal subscribers and to other companies in the Bridge project. The survey was completed either in part or whole by 12 companies and a further 3 companies agreed to answer questions in person or over the phone which allowed for a richer dialogue but did not strictly follow the same structure as the online survey. The survey showed that in most areas there was significant variation in expectations of what a serial level look up service should do.

Most respondents had a limited understanding of exactly what serial level look up services were and were uncertain of how their company might use them in practice. This is not surprising since serial level look up services are still being defined and developed. However almost all companies expected that serial level look up services would deliver benefits to their companies.

Respondents listed supply chain efficiency and product authentication/safety issues as the most important drivers for serial level look up services.

Respondents expected to track at both item level and single case level as well as at pallet level.

Serialisation is a step along the road to tracking and most respondents saw value in serialisation. Live implementations or trials were already in progress for returnable assets, cases, consumer items, subcomponents and people. Almost all respondents had considered the issues involved in managing serial numbers. However there was no agreement on whether numbers should be issued randomly, sequentially or in some other structured way. Almost all respondents expected that their supply chain partners would also record information about objects at serial level. The information recorded would be shipping and receiving, operations performed on the object and also sensor measurements.

Most respondents reported that, in their supply chain, objects are aggregated to larger units and also broken down from larger to smaller units. Handling of aggregation and disaggregation is therefore an important issue for lookup services.

Most respondents expected to store only the EPC unique identifier on the RFID tag. Of those respondents expecting to hold additional data on the tag it was unclear if there was a need to synchronise the information with networked databases.

No clear conclusions could be drawn about the privacy implications of embedding Stock-Keeping Unit (SKU) and/or company identifiers within the object identification. However most respondents expected to continue to embed the SKU in their product identifiers. Similarly there was no clear consensus as to whether killing tags at some point would be required.

Most companies expected to hold serial level information at enterprise level although others expected to hold serial level information at site level only, possibly in dedicated repositories. The majority of respondents expected to share information with their business partners through dedicated serial level repositories, although some expected to handle this through their existing business information systems.

There was a mismatch between the information that respondents wanted to extract from the look up service and the information that they were prepared to provide to the look up service. There was little support for providing more than the URL of the database or information service holding information about an object. However respondents wanted to be able to access a broad range of information, such as time of arrival and aggregation information, directly from the look up service.

Although tracking of where an object was last seen was the most common requirement respondents also wanted to be able to find out where an object is expected to be and also more powerful exception reports such as

- Misplacement – which items are not where they should be
- Duplication – identify objects with the same ID
- Sensor values out of range

Respondents wanted updates to the look up service to be available within one minute and preferably within one second. Respondents expected that the lookup service would be updated and queried on each shipping and receiving event. Straightforward queries should be returned with one second although some respondents agreed that answers to complex queries could be delayed and returned asynchronously. Look up services need to be available 24/7

The most common view from respondents was that lookup services should be certified but provided by for-profit companies on a competitive commercial basis, with all supply chain parties contributing to the cost of the service, preferably paid on a subscription basis rather than charged according to the number of queries or updates.

2. Technical requirements that can be extracted

The scope of the survey was quite broad, ranging from questions about each organization, whether/how they mass-serialize objects, as well as the granularity and organization of information stored internally and/or made available for sharing. Views regarding the operation policy of serial-level lookup services were also gathered.

One commercial provider of Discovery Services was interviewed and gave some responses, partly based on the experiences, needs and motivations of their customers and partly based on their own views of technical performance that should be expected from a commercial Discovery Service. These detailed responses to the questions are provided in Appendix B and were also considered in this section on technical requirements. The provider believes that there are many further potential uses for Discovery Services and that the views expressed so far only cover a portion of the possible applications.

From the results of this survey, we can extract the following technical expectations that are directly relevant for the design of Discovery Services:

Timescale for adoption of Discovery Services	around end 2007
Latency times for published records becoming visible:	< 1 minute, ideally < 1 second
Query response times:	within a few seconds
Core information to store:	URL of resource (e.g. of EPCIS), unique ID or EPC, timestamp
Need to allow for storage of aggregation changes:	yes
Business steps where records are published to DS:	shipping, receiving
Number of objects to track per year per company	up to 1 billion
Number of companies per object's supply chain	possibly over 50
Number of queries per day	possibly as high as 100,000/day from some companies
Discovery Service records link to:	mainly EPCIS, but also some existing systems and other Discovery Services
Types of query:	where last seen, trace (i.e. time-ordering and ability to request latest record is important)
Need to support standing queries:	Yes – according to 60% - filtered by info publisher or SKU

Availability and technical support:	24/7 and > 99.99% availability
Synchronous vs asynchronous response:	Most prefer synchronous responses
Updating of records:	not allowed; journalled log only need mechanism to mark records as void and re-assert – but never alter original records
Management of purging of records:	expiry time of record to be specified
'meta-data' to provide business context	Yes – but standardized vocabularies are needed

Many respondents expressed the need for standardized query and publishing interfaces across different providers of Discovery Services. Co-ordination with other Discovery Services was also mentioned, which might take the form of a 'lightweight' link between Discovery Services for an individual object – or (perhaps at a later stage) may take the form of greater co-ordination between Discovery Services, possibly even extending as far as proxy requests among them. These suggest that Discovery Service records should be flexible about which type of information service they link to (whether to a dedicated EPCIS or an existing system or even to another DS). A service-type meta-data field could be helpful to automatically distinguish between these distinct types of services, to provide the client's application with clues about how to interact with the service provided by each link address.

The main drivers were traceability and supply chain efficiency. One company said that it was important that their suppliers could not alter data after the fact, which suggests a need for a journalled approach to logging records in Discovery Services.

Some of the desired features, such as detection of duplicate IDs, misplacement / diversion, sensor values out of range are more likely to be handled by enhanced tracking models and application-specific modules, such as those being developed by work package 3. While they may be beyond the scope of the basic design of Discovery Services for work package 2, they do suggest a requirement for supporting standing queries by multiple client applications, using publish-and-subscribe interfaces so that they could also receive new records recently published to Discovery Services and react accordingly.

In future developments of Discovery Services, it may be interesting to investigate how the interaction between Discovery Services and such value-added services could be co-ordinated, so that for example a publisher could receive not only an acknowledgement 'update received OK' from a Discovery Service, but potentially also an advisory message if any of the EPCs they had just reported on had been identified as a duplicate EPC or an EPC already marked for recall.

3. Introduction

In the context of the BRIDGE WP2 activities to derive the requirements for the discovery service a survey was prepared, compiled as a web page survey and advertised to a number of organisations. The survey was started in August 2006 and a first round of results was compiled in October 2006. Because the survey response was low it was decided to keep it open for some time and to complement the results with interviews with a number of selected organisations. The document presents the results of the survey as compiled in October 2006. Respondents were not required to answer all questions – only those they decided to answer. Therefore for some questions there are very few answers.

4. Section A – General Questions Q1-Q12

4.1. Who received the questionnaire

The web questionnaire was sent to all members of the BRIDGE project and additionally to all recipients of the following GS1 EPCglobal mailing lists:

- European Adoption Programme
- Fast Moving Consumer Goods Business Action Group

4.2. Companies responding to the questionnaire

15 responses were received.

4.2.1. Type of organisation (Q5)

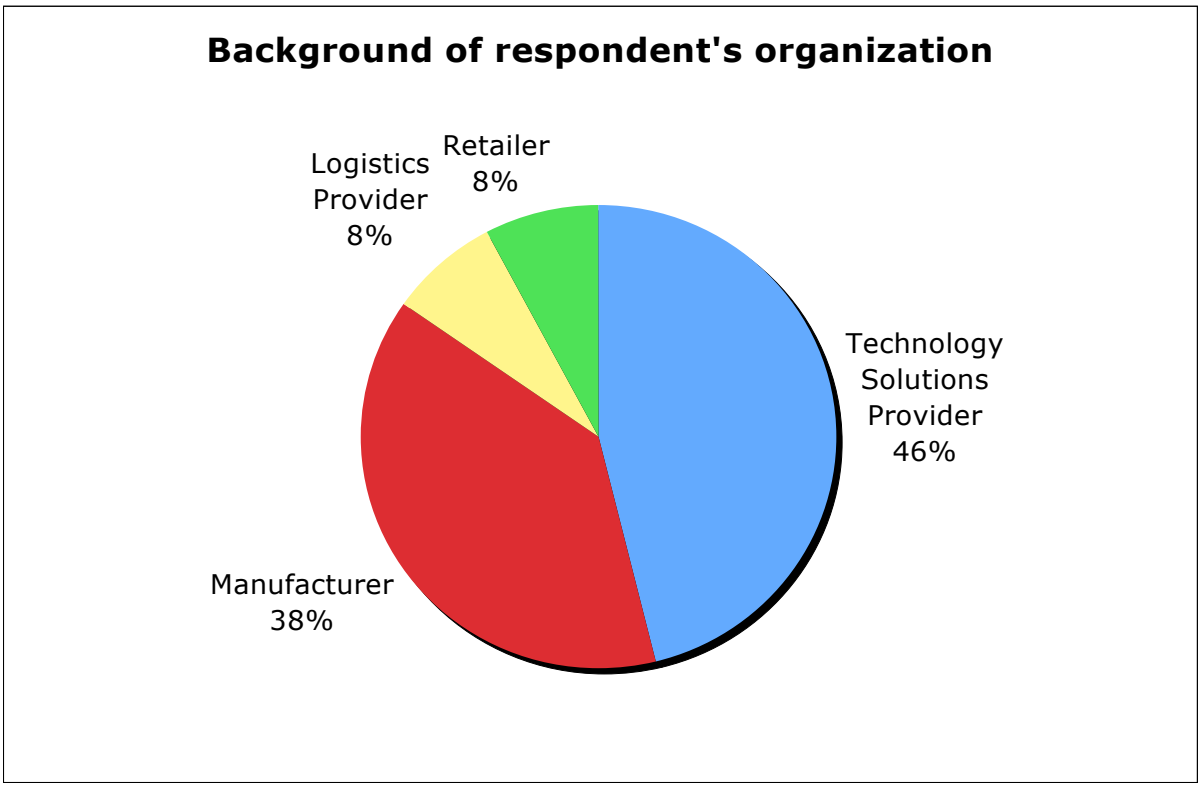

Figure 1: Background of respondent's organisation

The majority of responses came from technology solutions providers and manufacturers.

4.2.2. Size of Organisation (Q6)

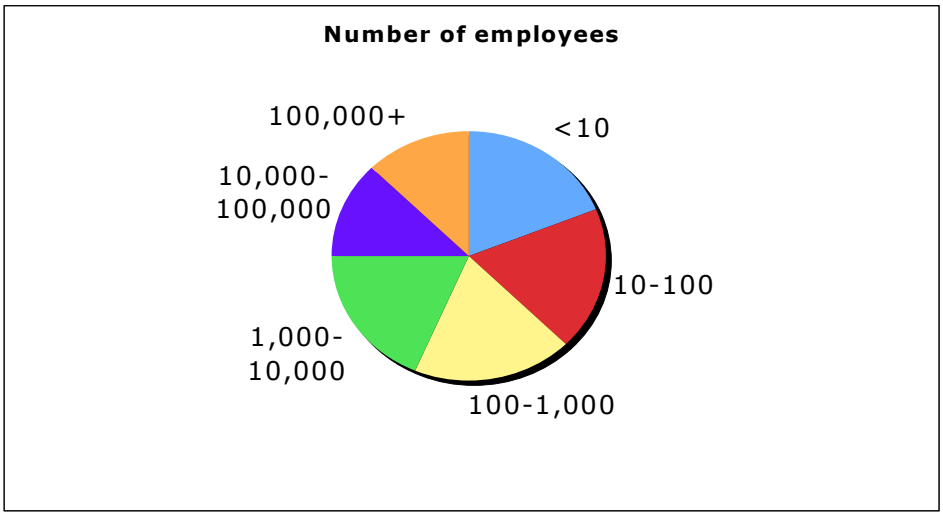

Figure 2: Number of Employees

The size of the organization responding varied from small companies to large multinationals, with a roughly equal contribution from all sizes, from small to large.

4.2.3. Industry Sector of Organisation (Q4)

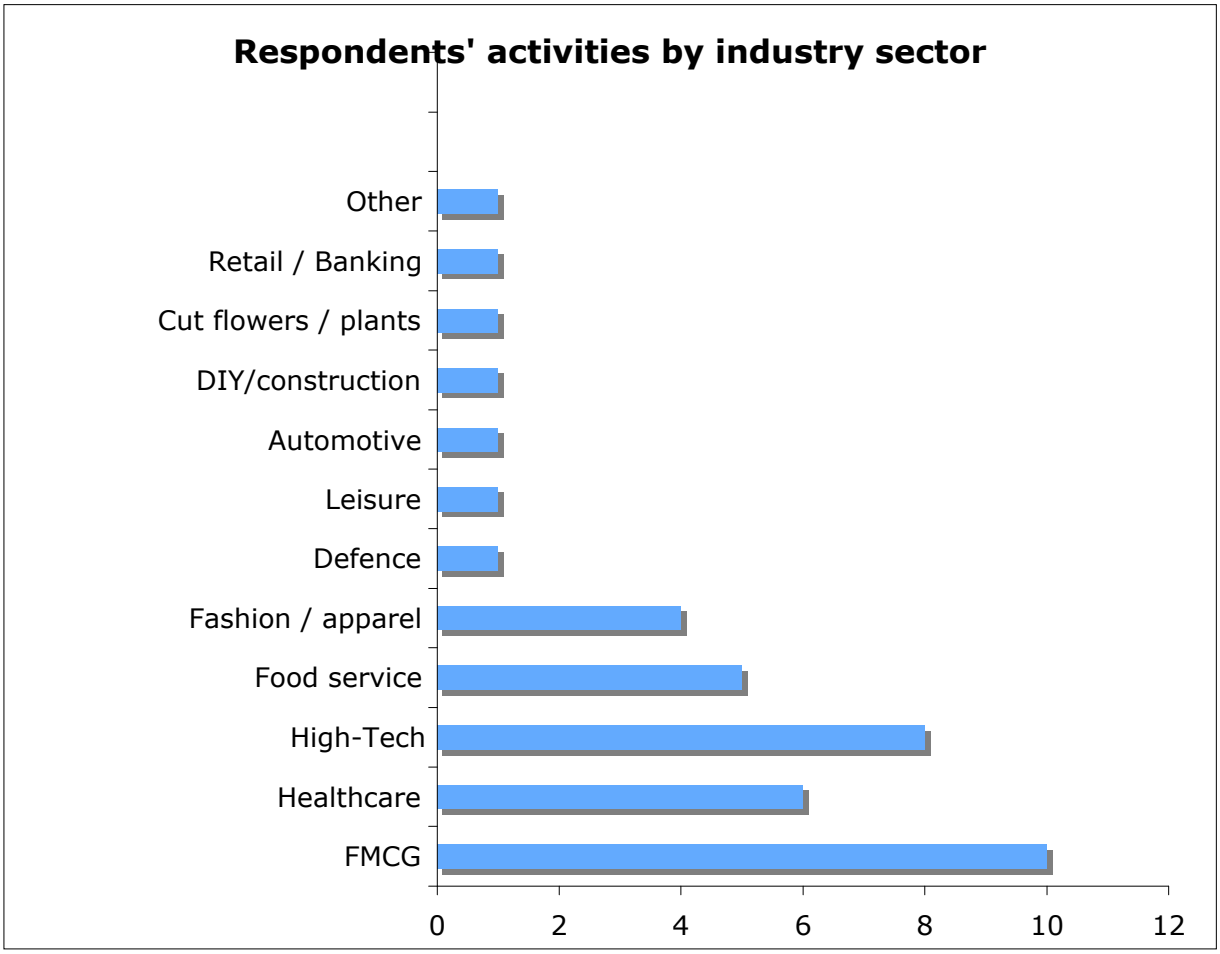

Figure 3: Respondents' activities by sector

The industry sectors represented were Fast-moving consumer goods (25%), high-tech (20%), healthcare (15%), and food service (12.5%) and fashion/apparel (10%).

4.2.4. Countries of Operation (Q8)

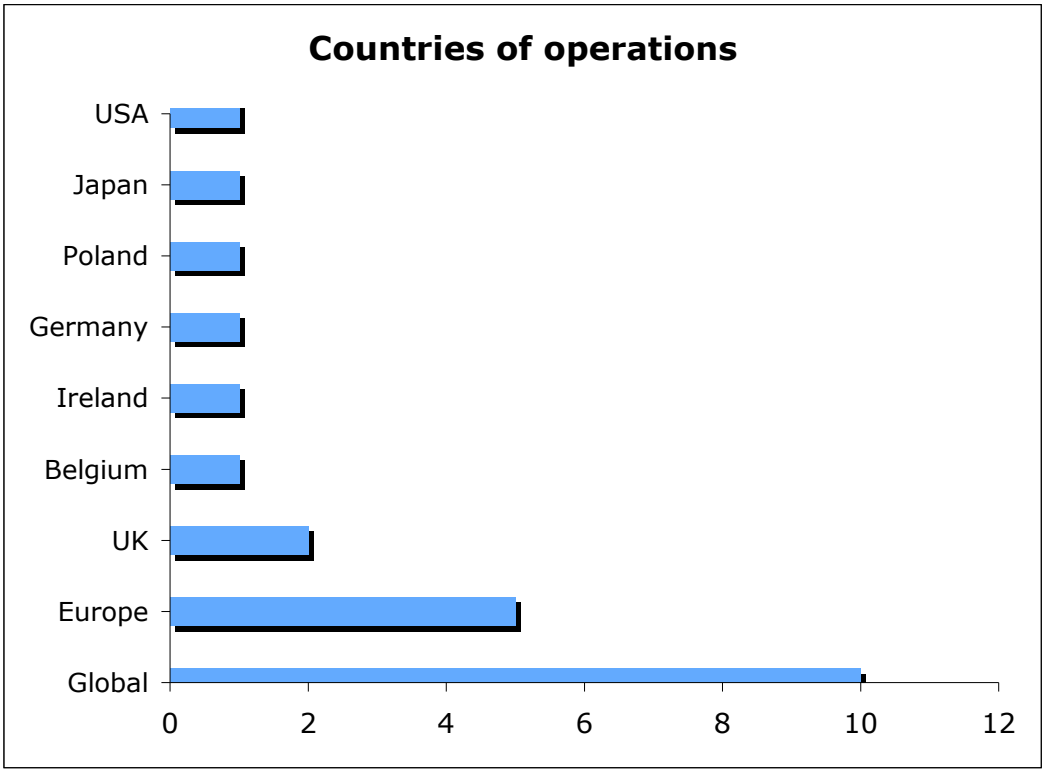

Figure 4: Countries of Operation

Most respondents stated that their operations were global/worldwide/international or European, although some respondents named particular countries of operation.

4.3. Individuals completing the questionnaire

4.3.1. Level of IT Knowledge (Q9)

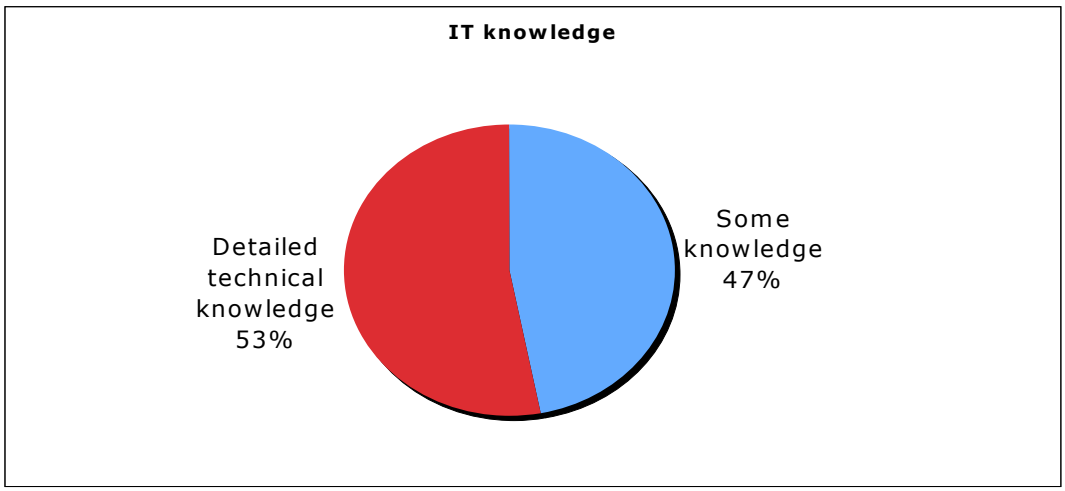

Figure 5: Level of Knowledge

In terms of IT knowledge, the respondents were equally divided between those having some IT knowledge and those having detailed technical knowledge.

4.3.2. Familiarity with Look up services (Q10)

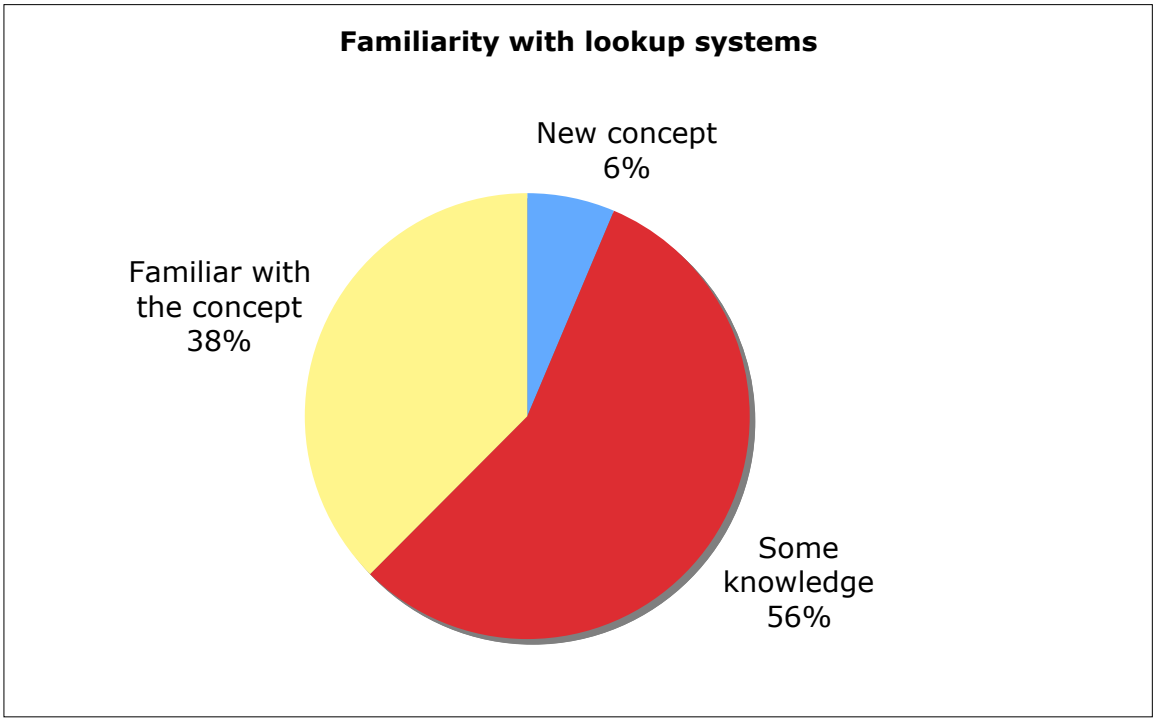

Figure 6: Familiarity with lookup systems

More than half the respondents had some knowledge of lookup services, with 38% being familiar with the concept.

4.4. Current awareness of serial lookup services (Q10)

Never heard of look up services	5%
Heard of look up services	47.5%
Familiar with look up services	47.5%

Table 1: Current awareness of serial lookup services

4.5. Will look up services deliver benefits? (Q11)

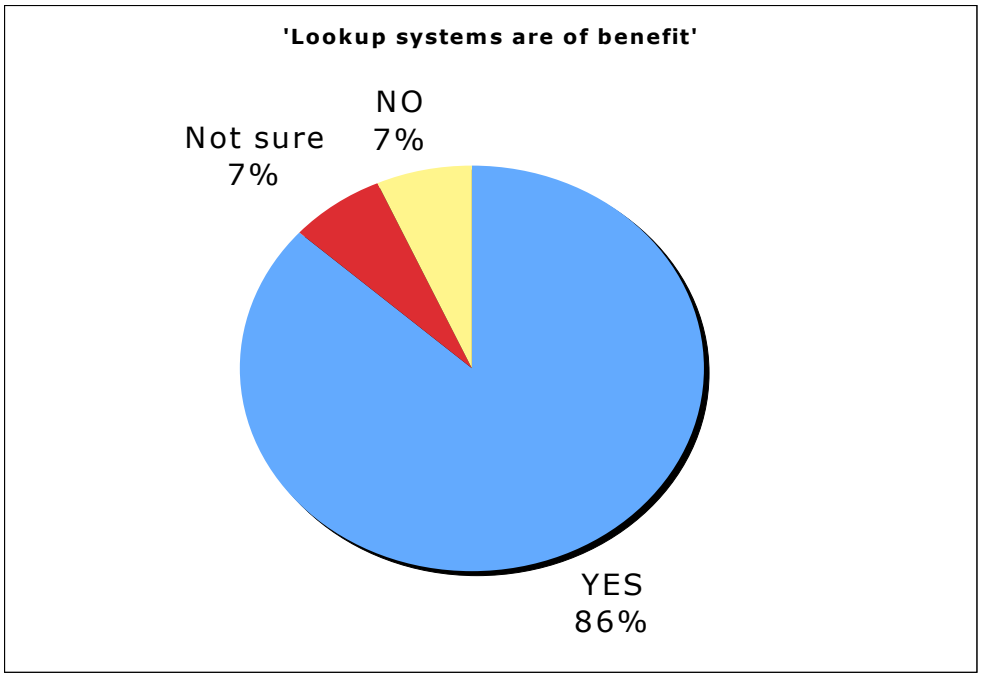

Figure 7: Look up system benefit

Almost all respondents felt that serial-level lookup systems are of benefit.

4.6. Date when look up services will be required (Q12)

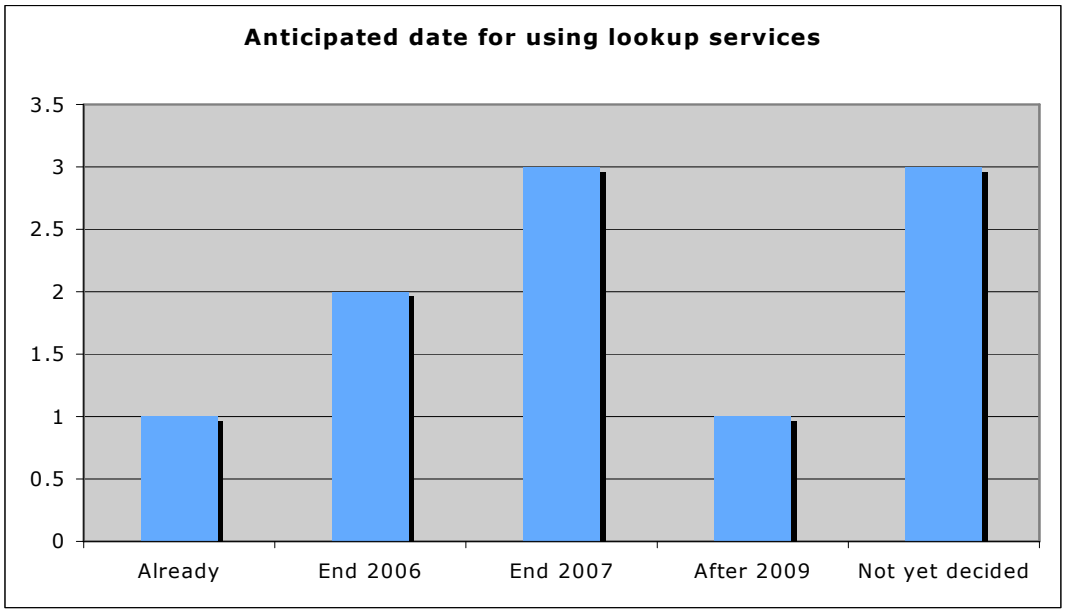

Figure 8: Date when lookup services will be used

The bar chart above indicates when companies anticipate using lookup services, with a peak around the end of 2007, although many organizations are still undecided or did not answer.

In terms of which lookup services respondents would use, there were very few responses. Two respondents mentioned the Object Name Service and two mentioned EPC Information Services, while one company stated that they would use most or all lookup services.
It's not clear that this question was particularly well understood by most respondents.

5. Section B – Drivers for Traceability Q13- Q29

5.1. Why are serial look up services required (Q14)

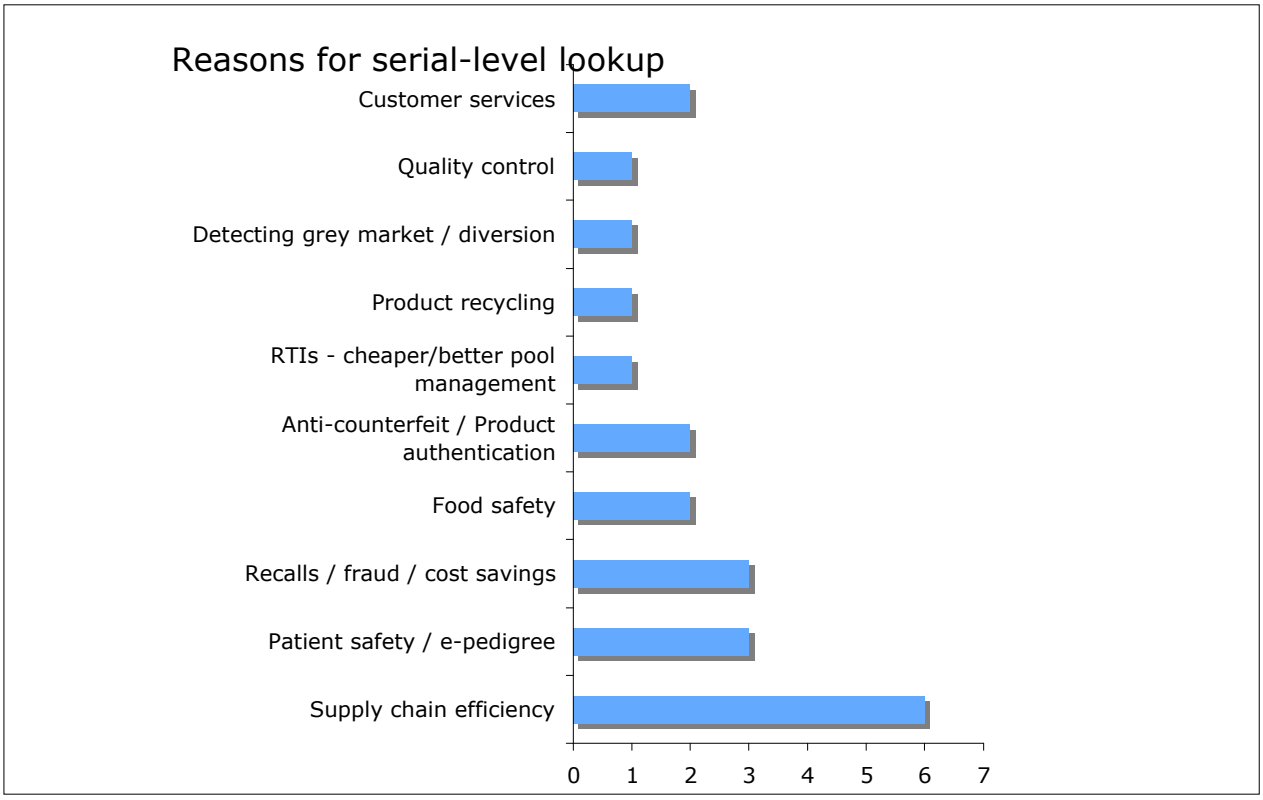

Figure 9: Reasons for lookup services

Most respondents clearly identified supply chain efficiency as a significant reason for the need for serial look up services.

5.2. Processes affected by serial look up services (Q15)

The question about which processes would be affected only received four responses, with roughly one vote for each of the following:

- Balance administration
- Product Development
- Store supplies / On Shelf Availability
- Sales
- Marketing
- Technical Support
- Maintenance
- Logistics
- Spares
- Pedigree

5.3. What objects need to be looked up (Q16)

Regarding the logistic level to be tracked, 11 organizations responded as follows:

- 9 are interested in item-level tracking,
- 7 are interested in case-level tracking
- 5 are interested in pallet-level tracking.

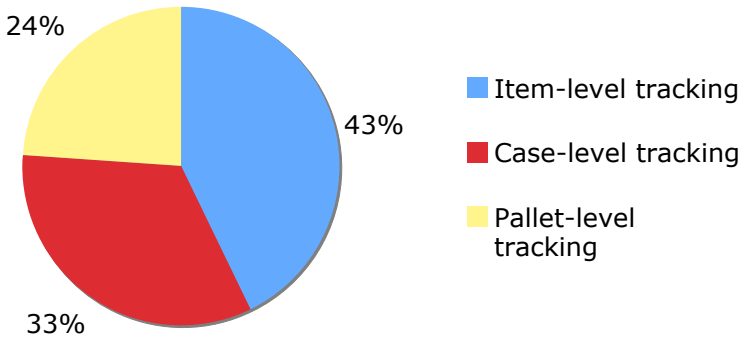

Figure 10: Logistics level which companies are interested in tracking

5.4. Regulatory drivers (Q17-Q22)

A number of regulatory drivers were cited, particularly in the areas of food and pharmaceuticals. These included:

- UK Food safety act 1990
- UK Food standards act 1999
- EU food regulation
- US bioterrorism act
- FDA Prescription Drug Marketing Act (PDMA)
- CFR 21 Pt 11 etc.
- EFPIA regulations

Other regulations from the EU and France were mentioned but not clearly specified.

5.5. Pedigree Initiatives (Q23-Q24)

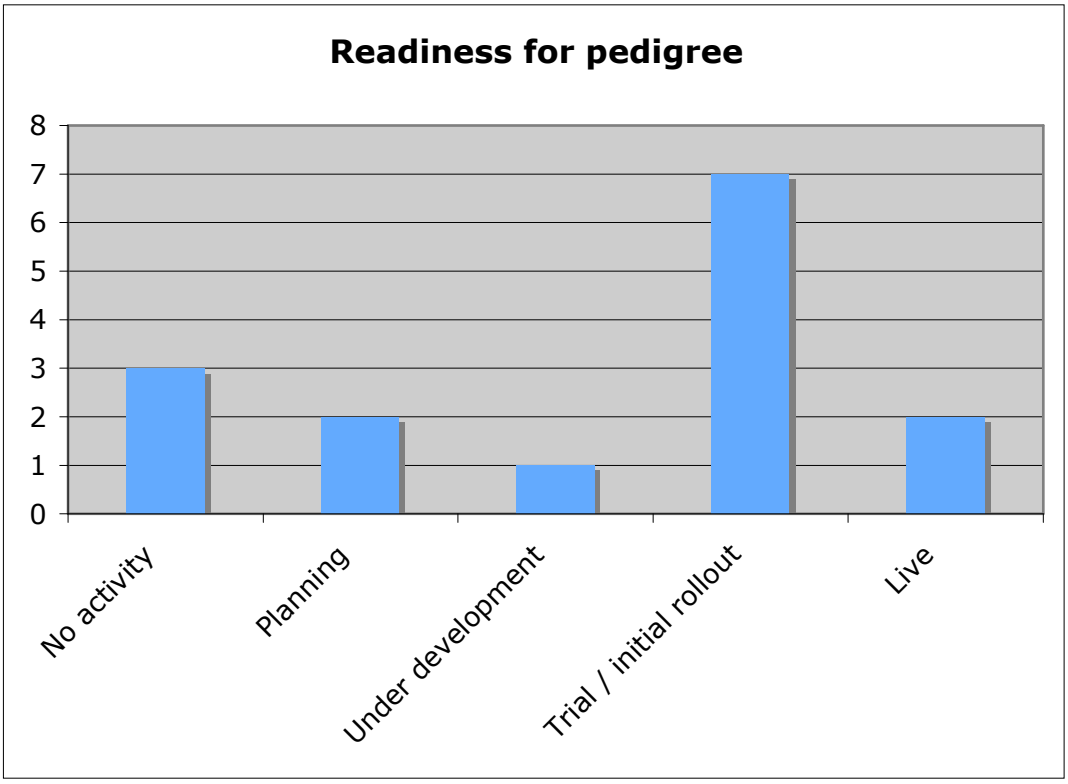

Figure 11: Readiness for pedigree

Regarding the downstream pedigree transmission mechanism, 8 out of 9 respondents anticipated using electronic transmission, while only 1 respondent anticipated using paper pedigree documents.

5.6. Anti-counterfeit and product authentication (Q25-Q29)

When asked about the importance of anti-counterfeit and product authentication, many of the respondents felt that it was a significant and complex problem, either for themselves or for their customers, even if their customers did not state this publicly. Even though the volumes of counterfeit goods may currently be small, companies are concerned about issues of liability, brand protection and loss of profits. Some respondents agreed to give further details in a follow-up interview.

When asked about the importance of having a product authentication service, 75% believed that this was important (primarily the technology solution companies), while 25% (mainly end-user companies) were not sure.

- 75% want their customers to be able to verify authenticity of the products; 25% were not sure
- 66% wanted to be able to verify the authenticity of goods from their suppliers; 25% were not sure
- 9% did not want to verify the authenticity of goods from their suppliers
- 7 companies stated that it would be useful to be able to cross-check the EPC programmed into the tag against the tag's own pre-recorded read-only Tag ID
- 7 companies stated that it would be useful to cross-check between the EPC and some characteristics of the physical object (including customized security markings, precise weight etc.).
- 5 companies indicated that they were interested in both types of cross-check (EPC – TagID and EPC – physical object)

In terms of other cross checks, one company wanted to be able to trace the chain of custody at all locations and times – and another company mentioned the need to consider a wider selection of carrier technologies for IDs – not just RFID tags.
One company mentioned that serial numbers are not sufficient to track counterfeit goods.

6. Section C - Benefits and Use Cases Q30 – Q36

In terms of the benefits and use cases, most activity seems to be focused on food, pharmaceuticals and returnable assets, with food activities at the most advanced stages of realization. There was a fairly even distribution between organizations who are at the development or planning stage and those who are trialling or live.

6.1. Serial Look up Status by Product Category (Q30)

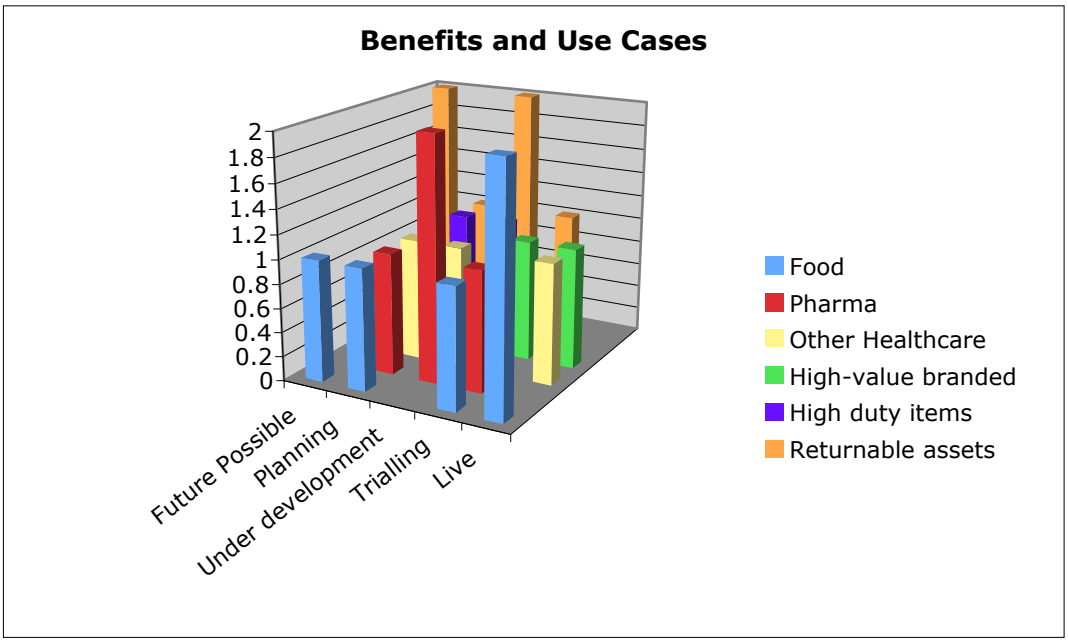

Figure 12: Benefits and use cases

The information about the current status of tracking activities was very incomplete.
At present, the current status of live tracking systems or trials seem to be mainly limited to small numbers of product types (i.e. less than 10 types of object), mainly in the sectors of food products, high value products, healthcare and pharmaceuticals, with some tracking of reusable assets. One company reported that they were already involved in tracing of food and meat.

One company reported that in future they may want to track 50,000 product lines, corresponding to volumes of 10 million units per year

Another company indicated that they are trialling tracking volumes of 30 million units per year.

6.2. Benefits of serial look up by business activity (Q32)

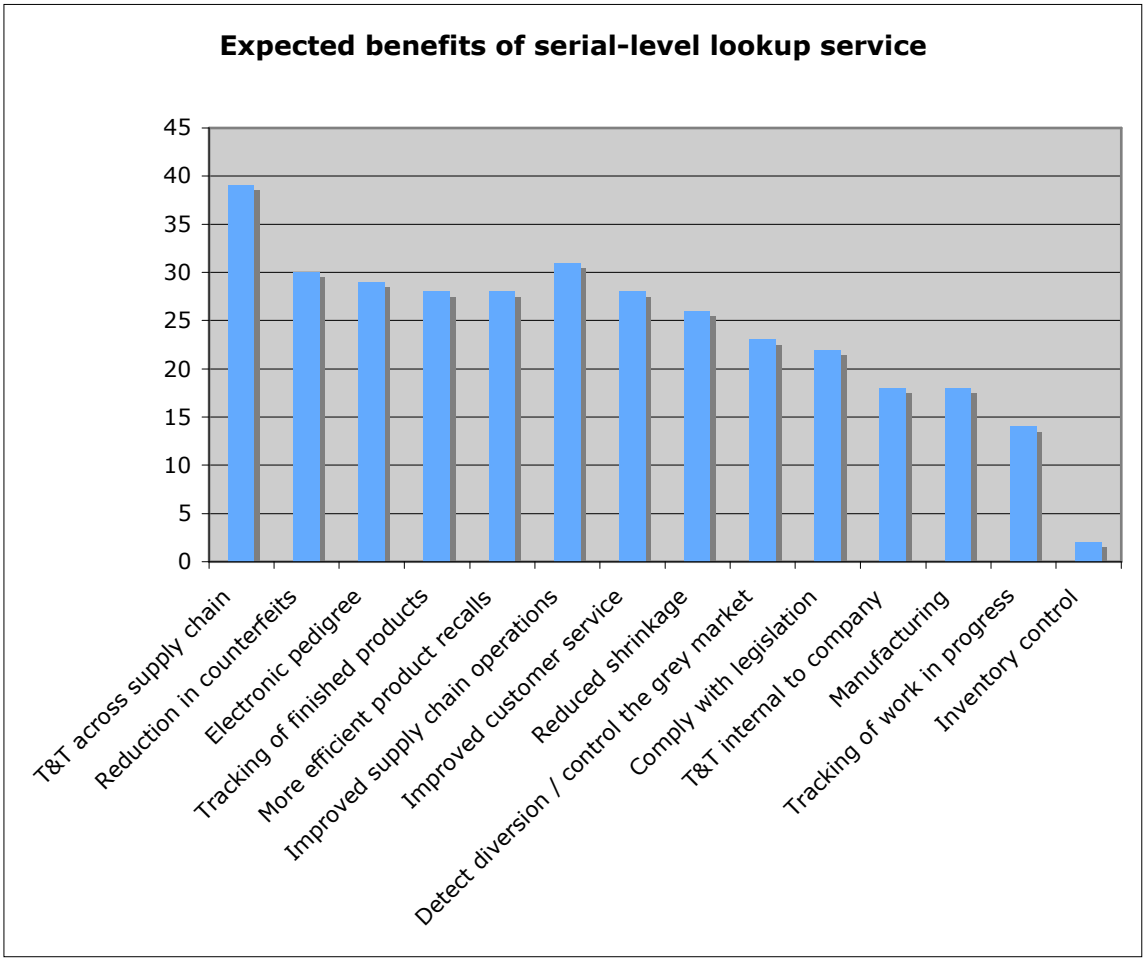

Figure 13: Expected benefits

Regarding the benefits and use cases expected from serial-level lookup services, most benefits (except inventory control) received a mixed expectation, from no perceived benefit in some cases, to high benefit. Ranking the responses (None=0, Some=1, Medium=2 and High=3), it is possible to prioritise the expected benefits as shown above.

6.3. Category of objects to be tracked (Q30)

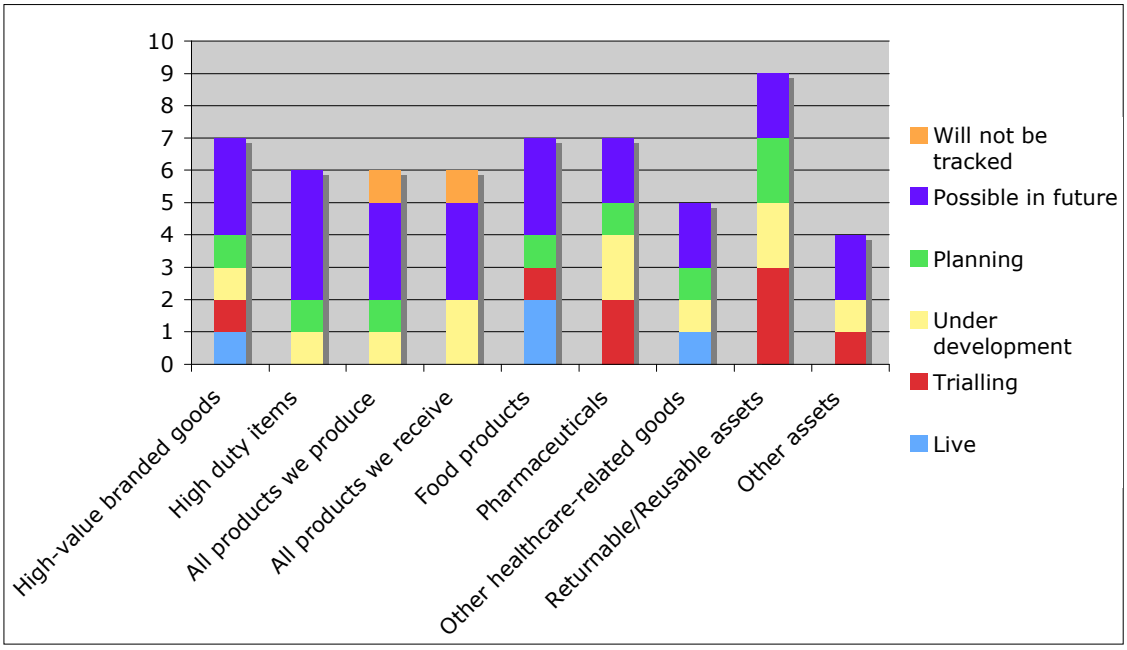

Figure 14: Objects to be tracked

6.4. Current status of tracking (Q30)

The responses were unclear.

6.5. # of your product lines in this category to be tracked (Q30)

The responses were unclear.

6.6. Logistic level expected for track and trace (Q31)

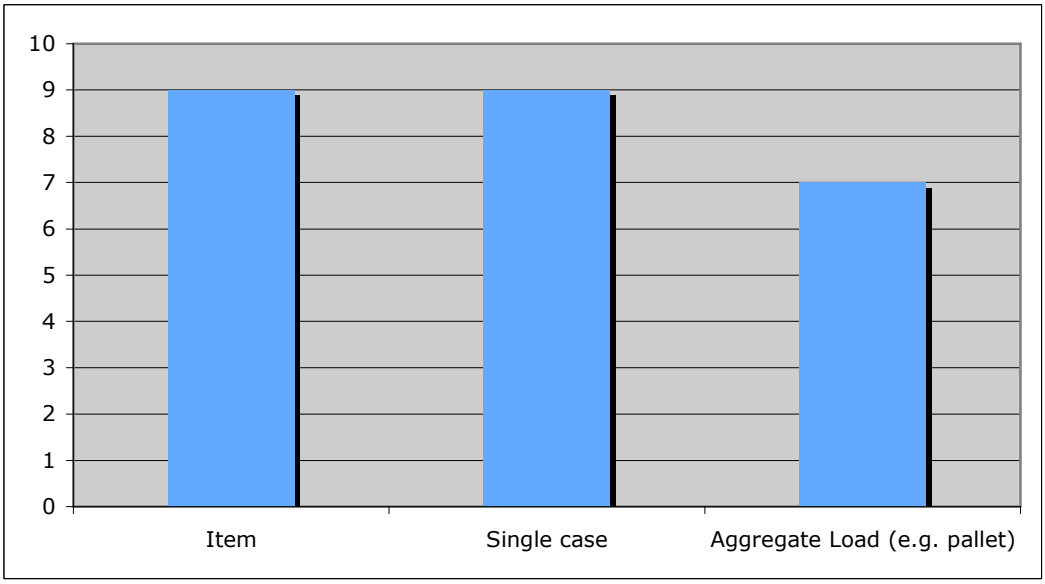

Figure 15: Logistics level for track and trace

6.7. Benefits / use cases expected from serial-level lookup service? (Q32)

Most important use cases:

- Track and trace across supply chain
- Electronic pedigree
- Reduction in counterfeits
- Tracking of finished products
- More efficient product recalls

Least important use cases:

- T&T internal to company
- Manufacturing
- Tracking of work in progress

The survey gave no data for the inventory control use case.

6.8. Benefits of greater downstream visibility? (Q33)

- Improved stock management
- Improved traceability
- Improved customer service
- Could enable more dynamic response to end-customer demand (e.g., dynamic re-allocation of products in-transit), improved location of spare parts to support installed base, improved technical support by more accurately identifying products to customer, etc.
- Reduce complexity and cut cost in logistics & maintenance processes
- Order tracking, expiration management, lot/batch recall, inventory replenishment, etc.

6.9. Benefits of greater upstream visibility? (Q34)

- Improved stock management
- Improved traceability
- Two participants indicated greater upstream visibility is already there without RFID
- Supply replenishment, lot/batch management, etc.
- Benefits expected if company provided data to a supply-chain tracking database (Q35)
- Better forecasting, promotion performance improvement, etc.
- Access to all supply chain data
- See where objects actually are; detect locations within the supply chain where problems occur; detect in case of loss or damage, where this happens (who is responsible)
- Doubt in providing data at all

6.10. Benefits expected if company provides a product authentication service (Q36)

- In maintenance processes: assure high quality, only genuine parts leading to less repair & maintenance cost
- Visibility to downstream product movement

7. Section D – Current State Q37 – Q51

7.1. Mass-serialization (Q37)

The current status of mass-serialization of objects is summarized in Table 2**.** Although only a few companies have already planned, developed or implemented RFID applications, most of them see a potential in the technology and envisage their usage in future applications. Of particular significance are some of the findings summarised as follows:

1. The majority of the respondents see the future in the mass-serialization in “Other assets” and “Sub-component level or ingredient”
2. Some respondents have mass-serialization of “Cases” and “Consumer item level” under development.
3. A couple have trials in “Returnable assets” and “Consumer item level”.
4. Respondents reported already serialising “Cases”, “Sub-component level or ingredient”, and “People”.”

	Not tracked	Future	Plan	Development	Trial	Live	Sum
Returnable assets	1	1	2	0	2	0	**6**
Other assets e.g. laptop computers	0	5	0	0	0	0	**5**
Load / Shipments	0	1	1	0	0	0	**2**
Cases	0	0	1	3	0	2	**6**
Consumer item level	0	2	0	2	2	0	**6**
Sub-component level or ingredient	0	3	0	0	0	1	**4**
Animals	1	1	0	0	0	0	**2**
People	0	2	0	0	0	1	**3**
Other	0	0	0	0	0	0	**0**
Sum	**2**	**15**	**5**	**5**	**4**	**4**	

Table 2: Current status of mass-serialization

7.2. Level of granularity at which information about a product is stored (Q38)

The level of granularity at which information about a product is stored is depicted in Figure 16 below. Based on our analysis, companies primarily have information stored about items on an individual level (37%). Nevertheless, information about the items is also stored on an aggregated level, at 38% on a batch level and 25% on a lot level.

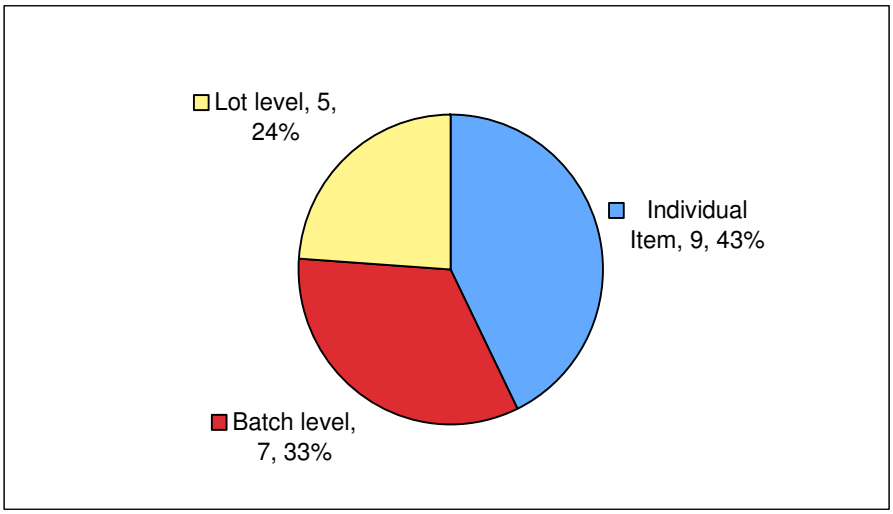

Figure 16: Database granularity

7.3. Internal management of data within your enterprise (Q39)

A graphical chart pertaining to the internal management of the data is plotted in Figure 17. 31% of the respondents have their data grouped by “Product type / SKU” (**S**tock **K**eeping **U**nit) and another 31% by “Batch number / Lot number”. 19% of them have a grouping by “Manufacturing plant / site of production” and another 19% by “Other”. The latter “Other” option includes unique item id (two answers) and Serial Shipping Container Code (SSCC) which is an eighteen digit number used to identify logistics units. The SSCC is encoded in a barcode.

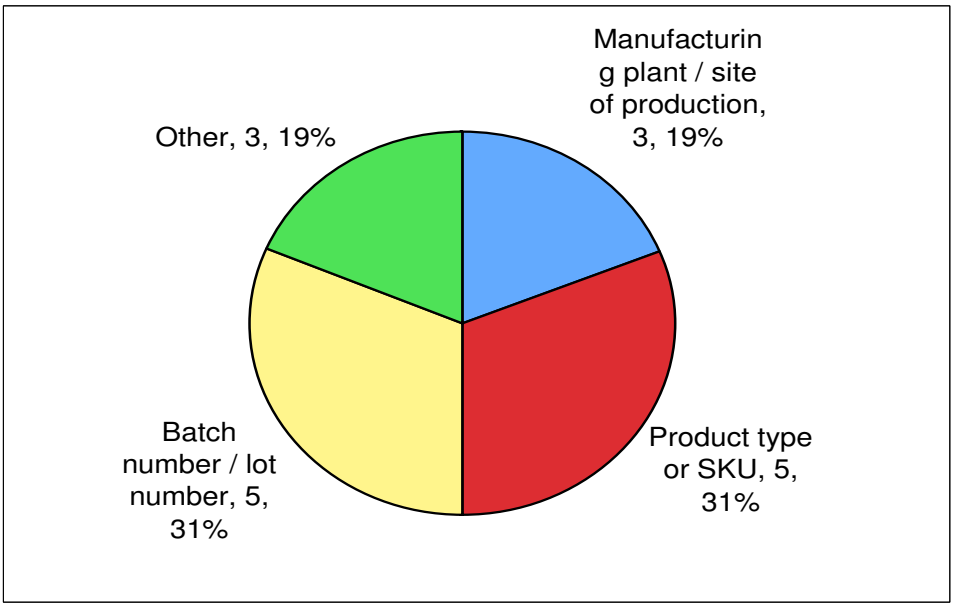

Figure 17: Grouping of data in internal information systems

7.3.1. Information recorded by supply-chain partners (especially downstream) (Q40)

80% of the companies envisage that their supply chain partners will record additional information about objects at serial level.

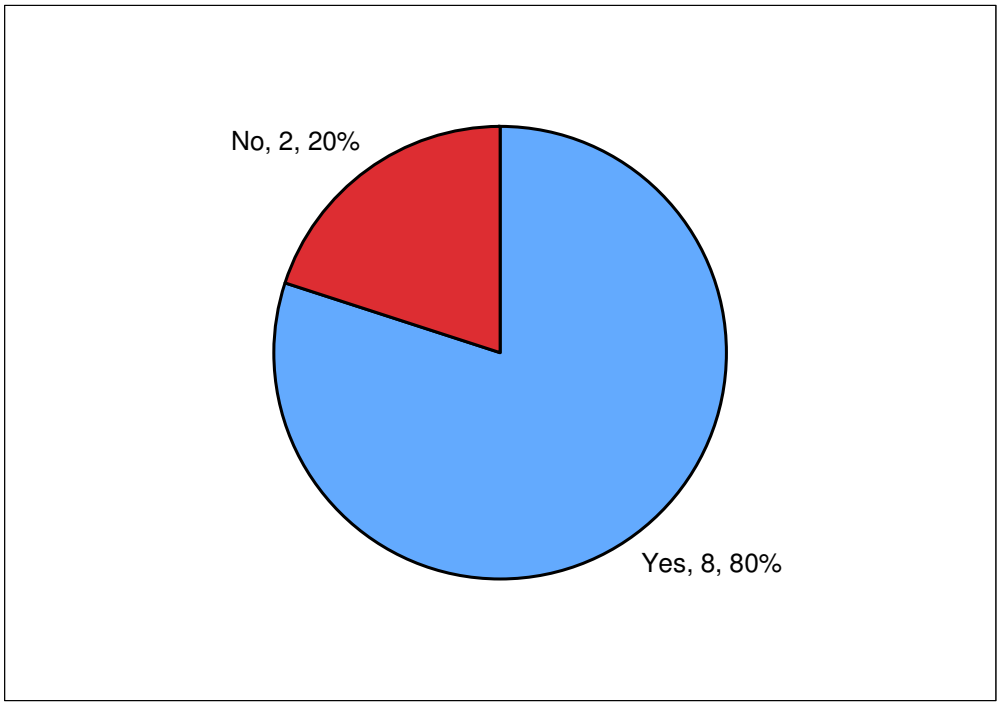

Figure 18: Additional information about the objects at serial-level recorded by supply chain partners

7.4. Type of information recorded by the supply chain partner (Q41)

The type of additional information recorded by their supply-chain partners is as illustrated in Figure 19 below. Those companies, who think that their supply chain partners will record additional serial-level information, believe that such information encompasses:

- 36% respondents mention “Shipping and receiving details”;
- 30% respondents mention “Operations performed on the object”;
- 19% respondents mention “Sensor measurements”; and
- 15% respondents mention “Other”. e.g.: One company mentioned that status information such as cleaned or dirty might be recorded. Another company stated that supply chain partners should record the history of the object.

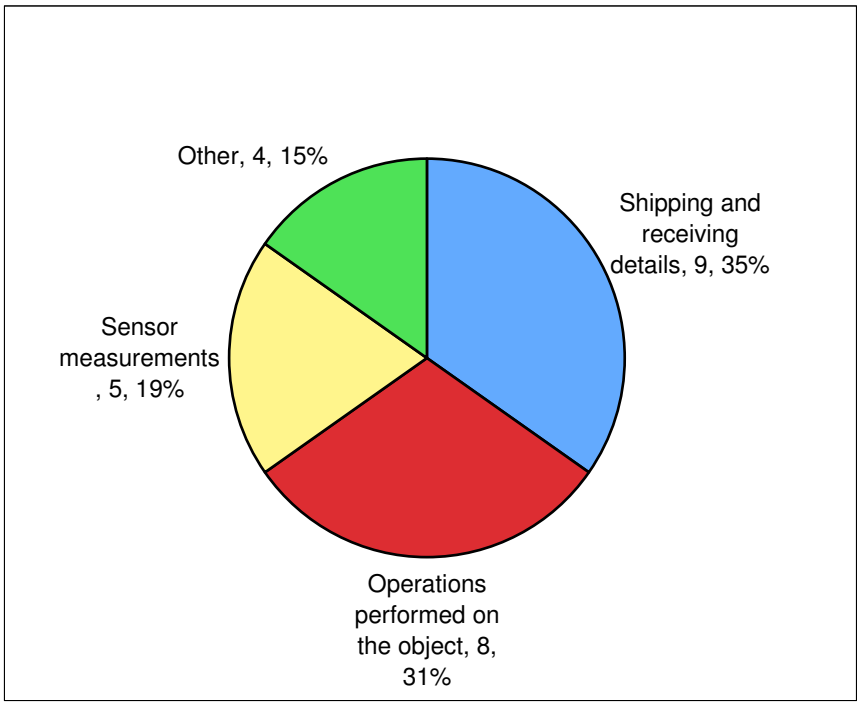

Figure 19: Type of information recorded by the supply chain partner

7.5. Data to be stored on Tag (Q42)

78% of the companies do not intend to have data other than the unique identifier or EPC stored on the tag itself (see Figure 20). The remaining 22% of the companies who intend to store additional information state that: (a) batch and expiry information is relevant because such information is constantly requested during the underlying process; and (b) data about alterations, maintenance and repair to the product is deemed worthwhile to be stored on the tag.

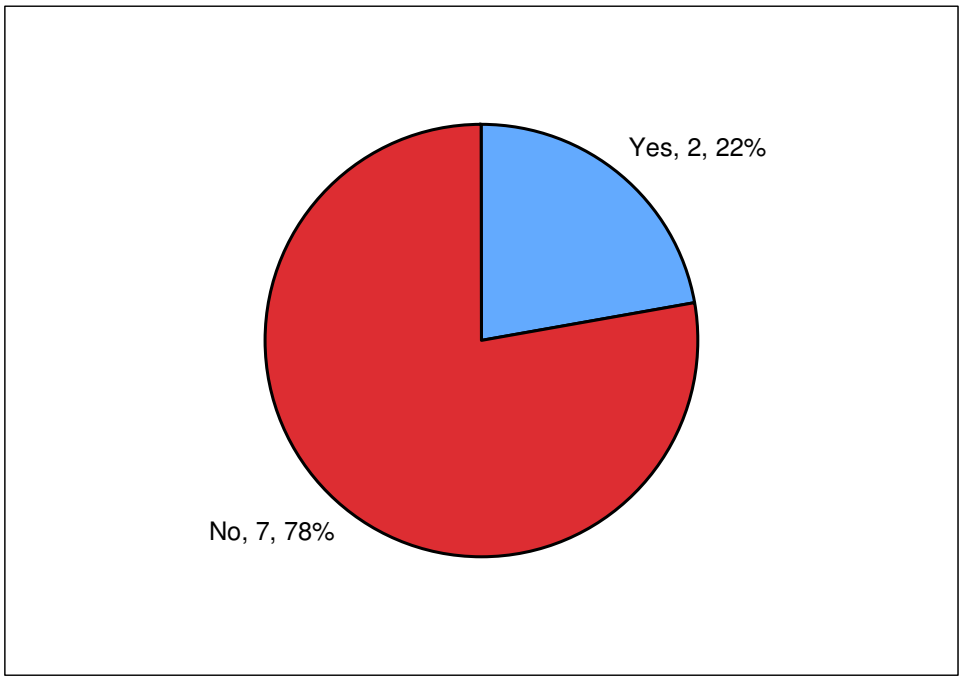

Figure 20: Recording of additional information besides the unique identifier or EPC on the tag

7.6. Synchronizing data on the tag with networked database(s) (Q43)

About 62% of the companies responded that the additional data stored on the tag should be synchronized with network databases, as shown in Figure 21. However, there are no significant specific details provided on their plans. One company did mention that an update should be done only upon an EPCIS query. Interestingly an ambiguous result is obtained when compared with the findings in the previous question. Although there are only two companies intending to record additional data on the tag, we obtained five responses who think that such additional data should be synchronized to the database. The result herein is therefore inconclusive as the respondents might have misunderstood the intended questions in the survey.

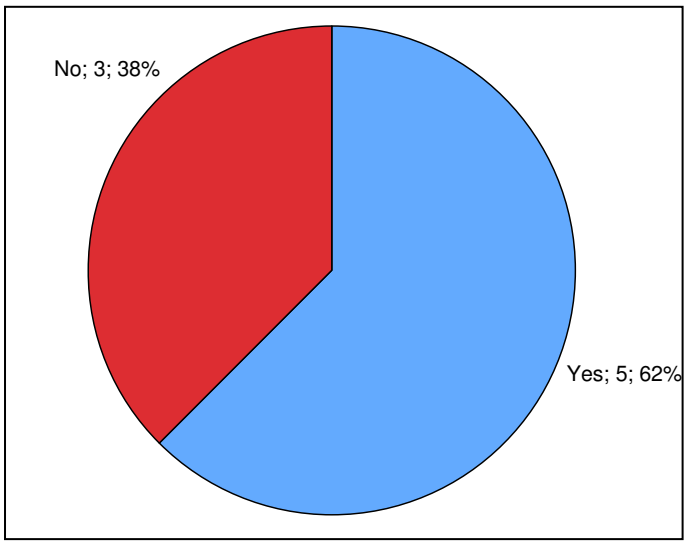

Figure 21: Synchronizing data on the tag with networked database(s)

7.7. Processes

7.7.1. Breakdown to smaller units (Q44)

As illustrated in Figure 22, 60% of the companies said that there are situations where it is no longer possible to track their products shipments because they are subsequently broken down into smaller units for distribution or retail.

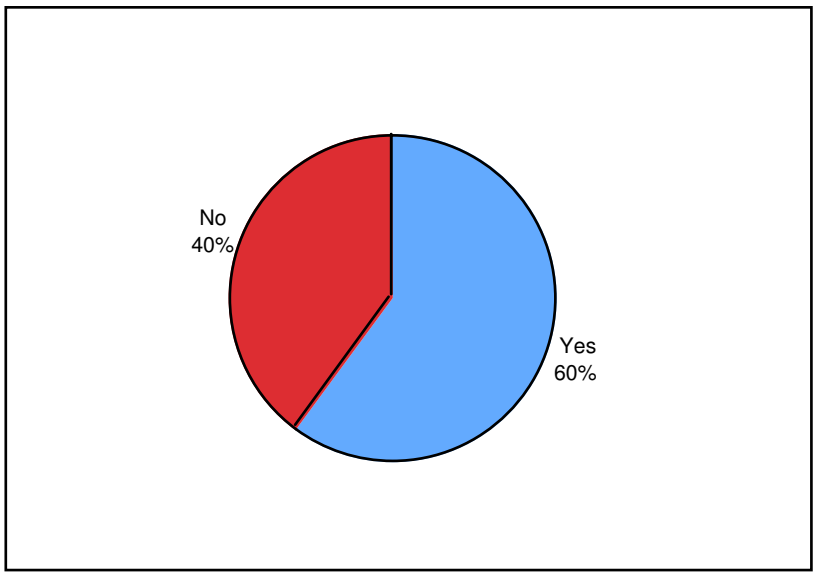

Figure 22: Breaking down objects into smaller units

7.7.2. Aggregation (Q 45)

Similarly, 62% of the companies had difficulty tracking their products because of subsequent aggregation of the objects for distribution purposes, as depicted in Figure 23.

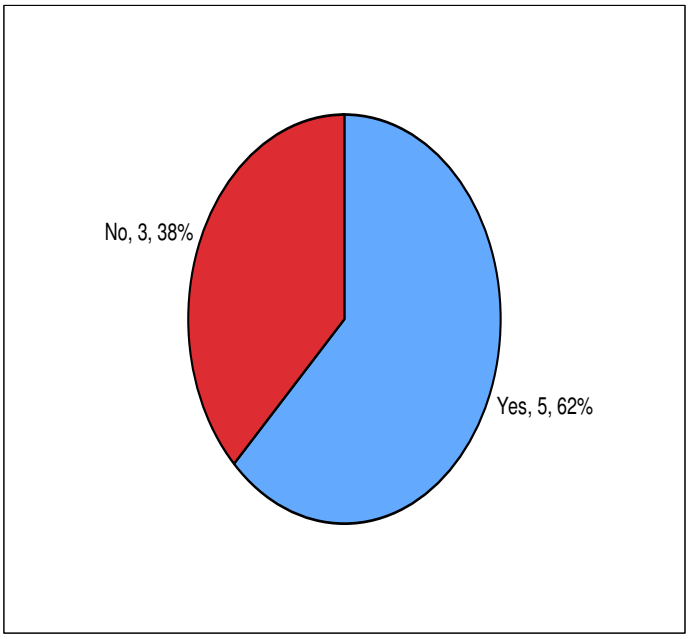

Figure 23: Aggregating objects

7.7.3. Paper Documentation (Q46)

The paper documentation currently sent with or in advance of the products arriving at the next recipient on the downstream supply chain is listed as shown in Table 3. An *Advanced Shipment Notice (ASN)* is an electronic notification of pending deliveries, e.g. an electronic packing list. *Certificate of conformity (COC)* attest that all described products are in accordance with the European policy.

Paper Document	Total responses
ASN	2
Delivery notes	2
Invoice	1
COC	1
Packing slip	1
Pedigree	1

Table 3: Paper documents sent

7.7.4. Electronic Documentation (Q47)

The electronic documentation sent with or in advance of the products arriving at the next recipient on the downstream supply chain is tabulated in Table 4. One company mentioned that its partners are able to gain access to an online system where the status of an order can be requested.

Electronic Document	Total responses
ASN	6
Despatch advice	2

Table 4: Electronic documents sent

7.7.5. Companies involved in distribution

The number of companies (including logistics providers) which are involved in the process of the product delivery varies from company to company as seen in Table 5.

Number of partners	Total responses
1-5	2
2	1
3-30	1
35	1
>100	1

Table 5: Number of companies involved in the delivery of products

7.7.6. Countries involved in distribution (Q49)

The number of countries typically involved in the process of product delivery from the company's production facilities to the end user ranged from one to six as shown in Table 6.

Number of countries	Total responses
1-3	1
1-5	2
2	1
4	1
6	1
Several	1

Table 6: Number of countries involved in the delivery of products

7.7.7. Industry sectors sold into (Q50)

The industry sectors, to which products are sold, which might require serial look up service are charted as shown in Figure 24.

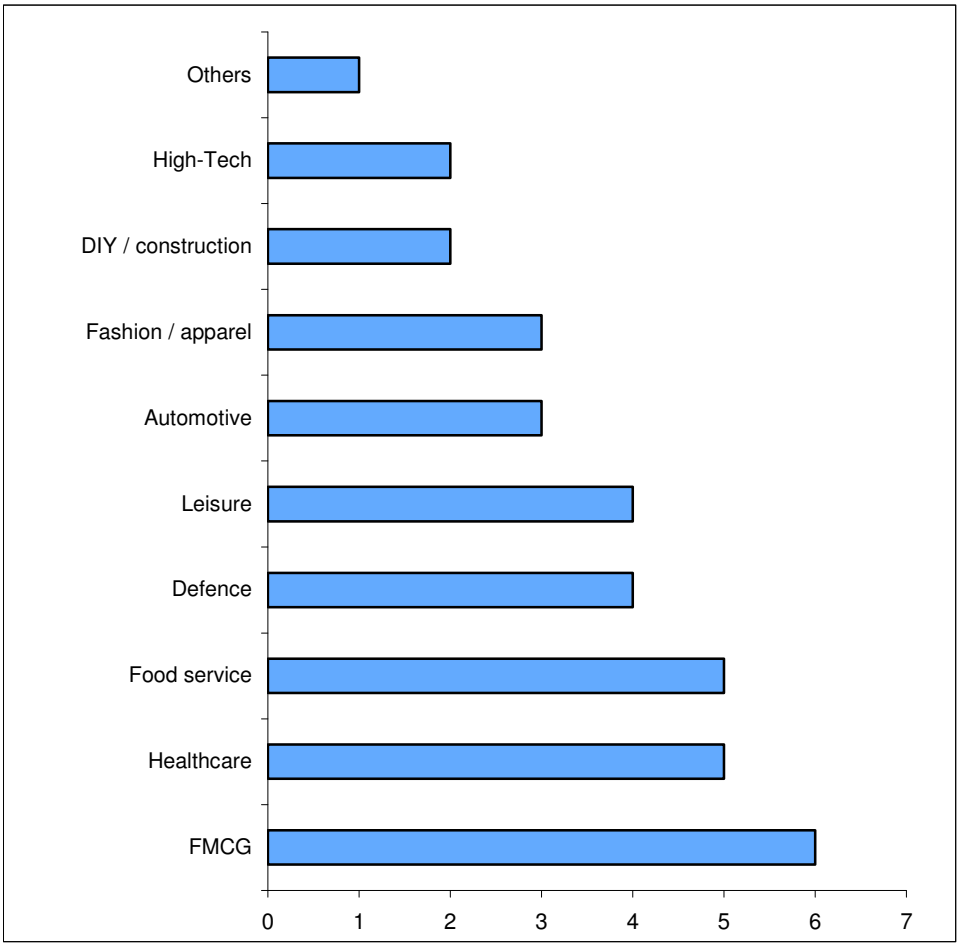

Figure 24: Industry sectors to which products are sold which might require serial lookup services

FMCG: Fast Moving Consumer Goods
DIY: Do-it-yourself

7.7.8. Upstream Supply chain companies (Q51)

The number of companies in the upstream supply chain, including logistics providers, varies from 3 to 200 (see Table 7). Nevertheless, one company highlighted that there is no typical figure as it varies in accordance to the product line.

Number of partners	Total responses
3	1
5	1
100	1
200	1
10000	1

Table 7: Number of companies in upstream supply chain

8. Section E1 – Managing Serialised Information Q51 – Q63

8.1. Identifiers - issuing of serial numbers (Q52)

As shown in Figure 25, close to two thirds of the companies (67%) currently include in their product identifiers an indication of the product type or of the SKU (Stock Keeping Unit).

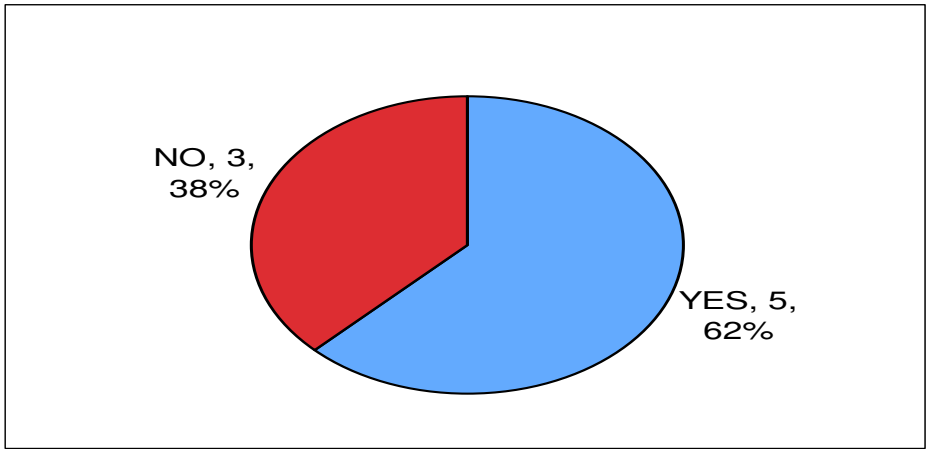

Figure 25: Inclusion of Product Type or SKU in the Product Identifiers

8.2. Management of Serial Numbers (Q54)

Most of the companies have apparently considered the issue of how to manage the serial numbers across the entire enterprise, for instance, in order to avoid duplication. This is depicted in Figure 26. Q53 gives an indication of the serial number management options that were considered.

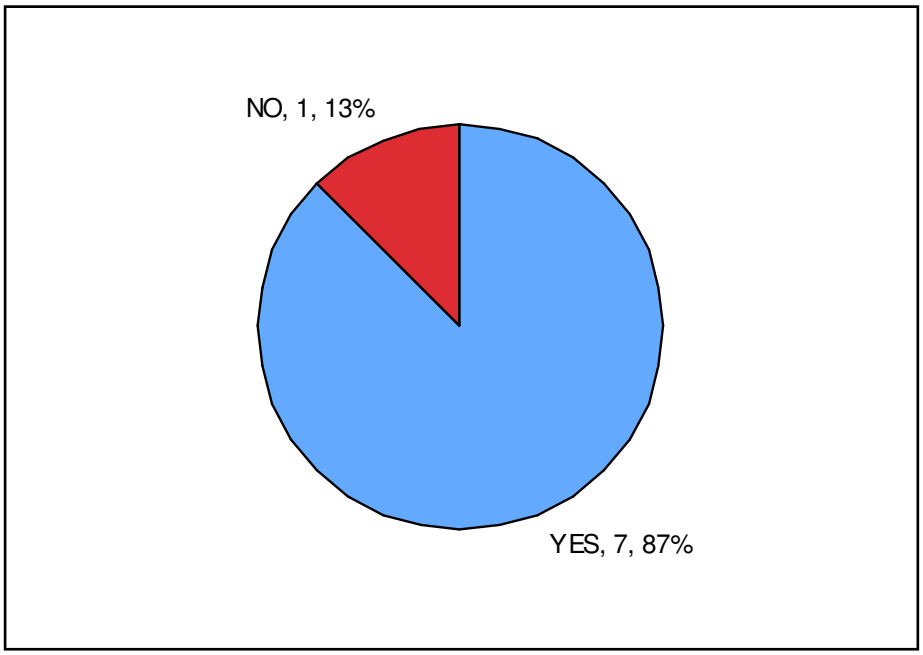

Figure 26: Management of Serial Number Allocation

8.3. Allocation of Serial Numbers (Q53)

With regard to the allocation of serial numbers, there is a preference to allocate them in a particular (pre-defined) order. Out of the companies that indicated a preference for ordered

allocation, a slight majority would in fact choose that the serial numbers are attributed *sequentially*, although some indicated that a pseudo-random allocation or some other significant manner may be appropriate. These findings are illustrated in Figure 27

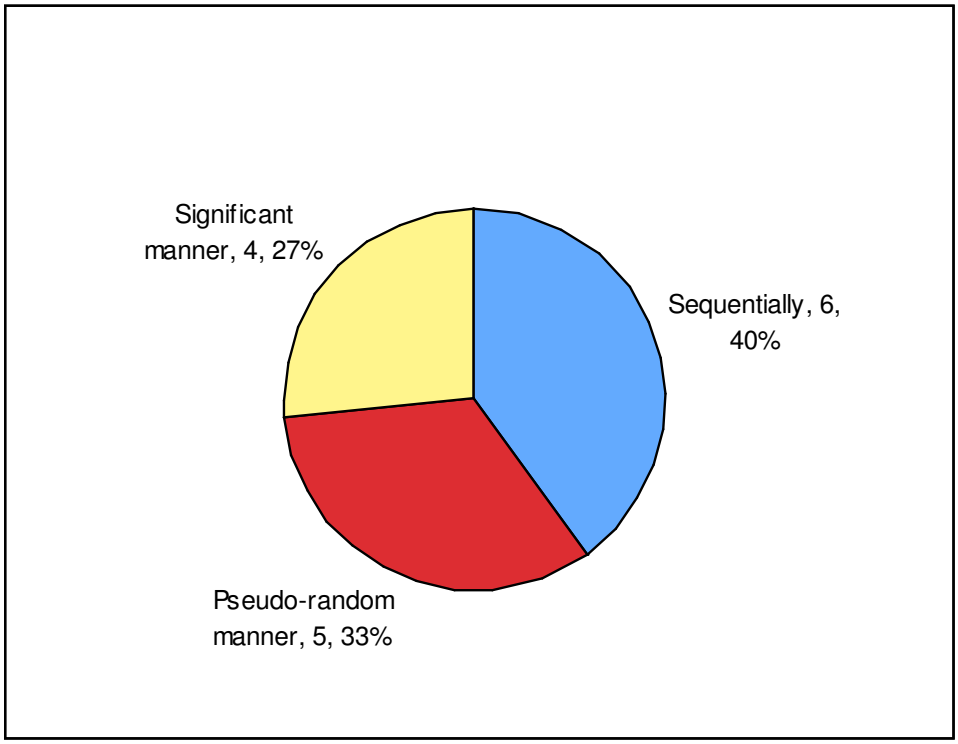

Figure 27: Allocation of Serial Numbers

8.4. Identifiers managing privacy

8.4.1. Would you require the killing of tags at some point, e.g. Point of Sale / store checkout (POS)? (Q55)

Seven respondents answered this question out of which 3 stated that killing of tags is required while 2 did not see it as a necessity. Though the remaining 2 respondents gave more detailed answers, they were rather inclined not to kill tags. Interestingly and ironically, one of them affirmed that they were not interested at all in item-level tagging, therefore it is a negative answer. The other explained the motivation for his negative answer as a desire of the corporate customers of his company to retain any RFID tags attached to the product for their internal management process.

8.4.2. Embed SKU in consumer level tags (Q56)

As shown in Figure 28, most of the companies would be likely to continue to embed the product type of SKU information in the EPC stored on the tag, given they would adopt the RFID technology to consumer-level items.

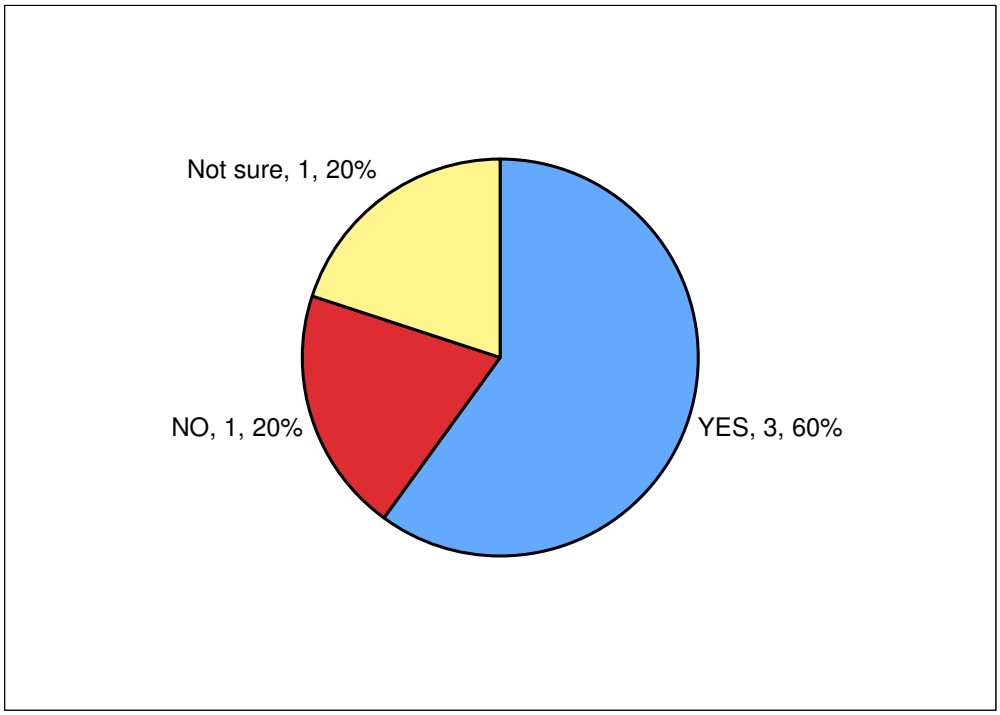

Figure 28: Continuation of SKU Embedding in the Consumer-Level Tags

If you answered NO to the previous question, what are your reasons for not including the product type?

The only respondent with a negative answer did not mention a reason for not including the product type or the SKU in the EPC.

8.4.3. Require an opaque identifier (Q58)

No clear conclusion on whether or not to favour the usage of opaque identifier on an RFID tag could be drawn. The provided answers made for a complete balance, as shown in Figure 29.

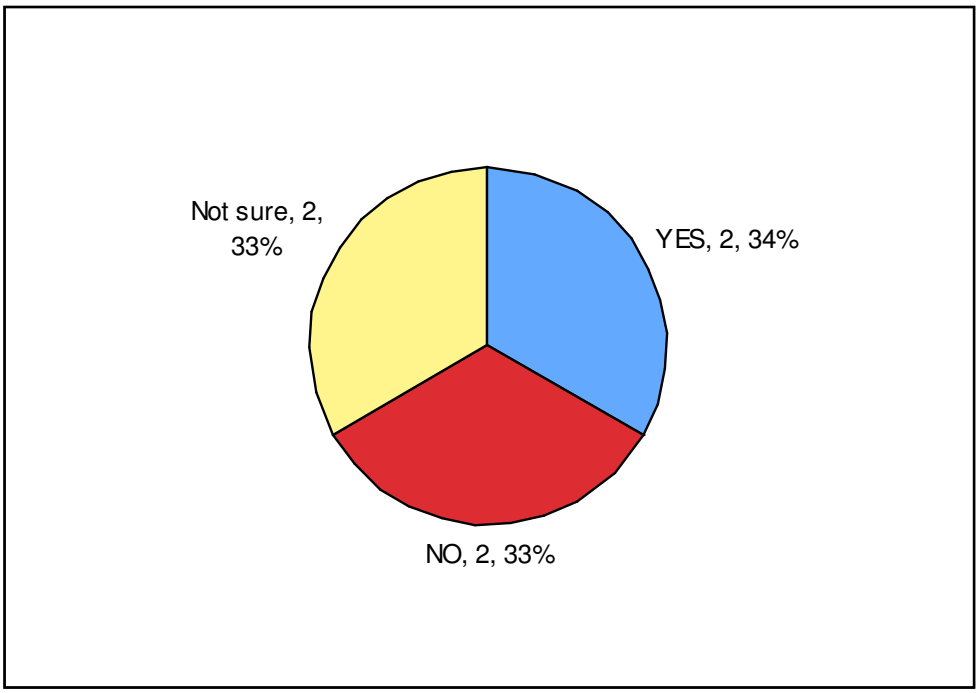

Figure 29: Preference for Opaque Identifier Usage

8.4.4. Company identifier has privacy implications (Q59)

Is (your) company identification a threat to privacy?

Again, there is no clear conclusion to be drawn with respect to revealing the company information. As plotted in Figure 30, opinions are roughly divided into halves, between companies which see the disclosure of their identification data as a threat to privacy and those that do not.

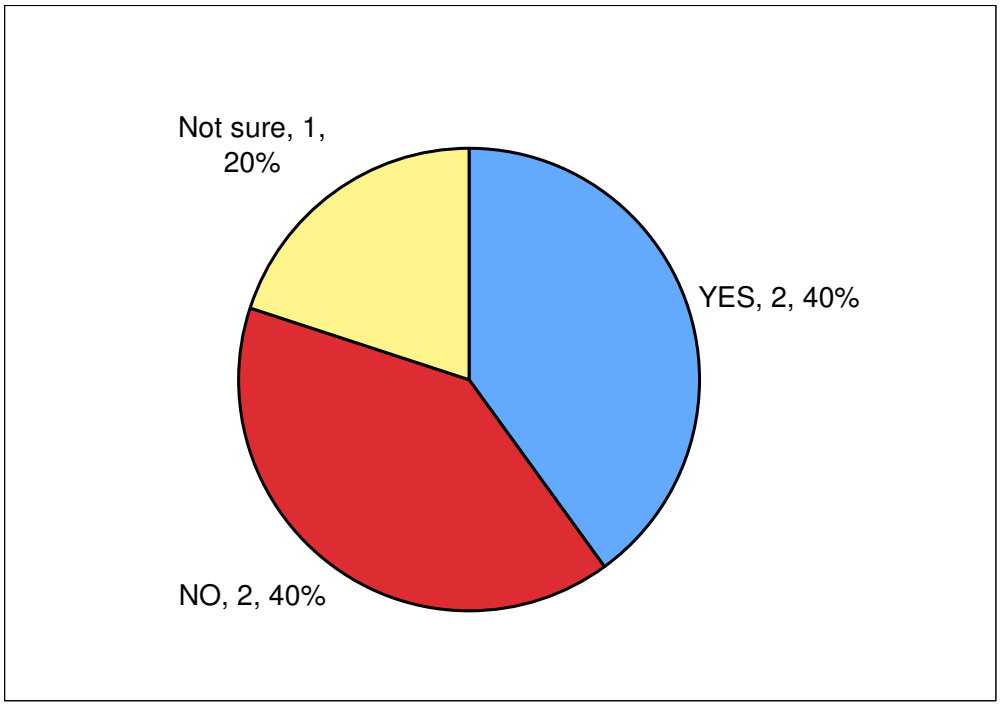

Figure 30: Company Identification as a Privacy Threat

8.5. Information and integration

8.5.1. Store serial level data in internal systems (Q60)

There is an obvious intention to store the serial-level information in the existing information systems, as illustrated in Figure 31 below. Most of the companies that want to include this kind of information in their systems prefer to store it on the enterprise level.

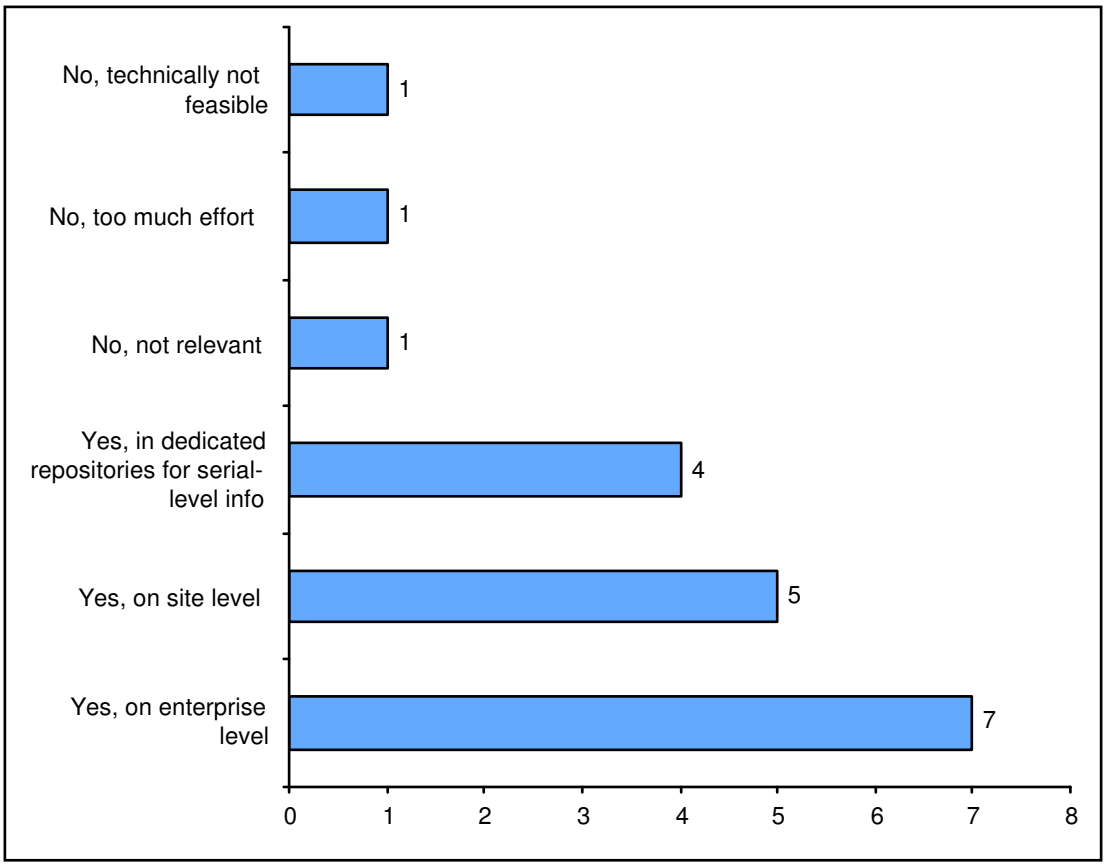

Figure 31: Storage of Serial-Level Data in the Existing Information Systems

8.5.2. What will be serialised (Q61)

Most companies (38%) indicated that the stored serial-level information would be predominantly used for “Finished goods”. Also, the “Reusable assets” account for an important share of the intended usage (33%). The serial-level information pertaining to “Unfinished goods” or “Components/Ingredients” is of less focus, accounting just for 17% and 6%, respectively. The findings are graphically represented in Figure 32 below.

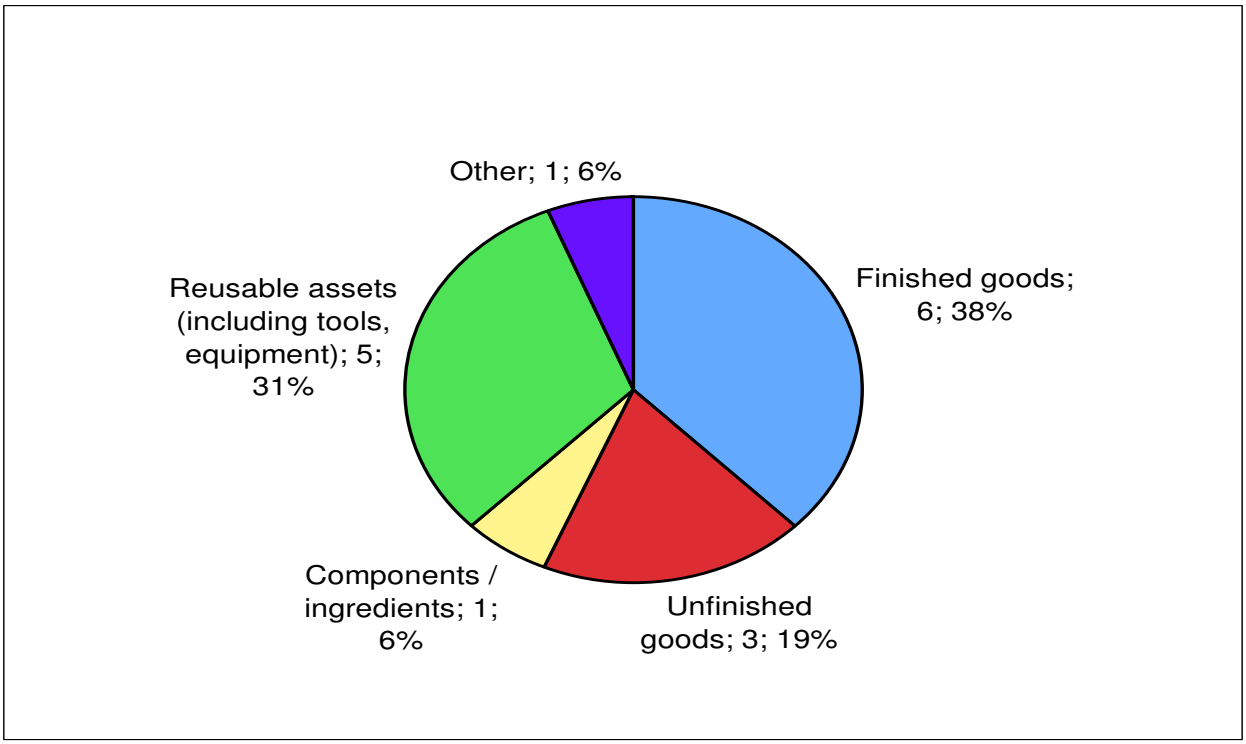

Figure 32: Intent of Serial-Level Information Storage

8.5.3. Sharing of serial level information (Q62)

Over two-thirds of the respondents indicated that their preferred method of inter-company exchange of serial level information would be, as shown in Figure 33 below, via dedicated repositories, such as EPCIS repositories. Nevertheless, the exchange of serial-level information directly via the ERP, **E**nterprise **R**esource **P**lanning, systems still represents a viable alternative as pointed out by just under one third of the companies.

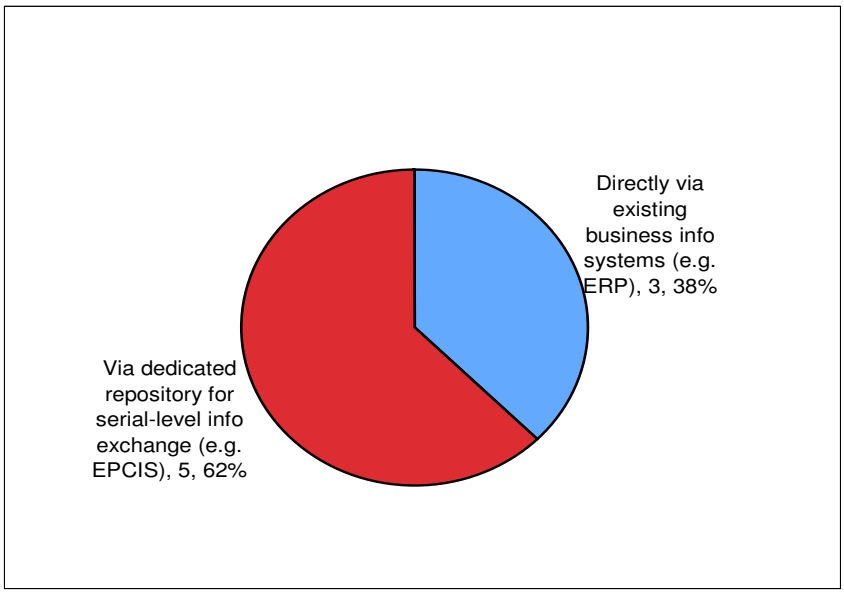

Figure 33: Data Transfer Modalities to External Partners

If you used serial-level information, which related information on items coming from your existing Business Information System (BIS) would you regard as relevant?
Only four respondents attempted to answer this question, out of which two clearly articulated the fact that they did not understand the question. One of the remaining two said it depends on the business issue they are trying to solve e.g., confirmation of receipt by partners, solving discrepancies between partners and 3rd Party Logistics, etc. The other respondent said that internally *all* information from ERP is relevant while externally, for sharing with supply chain partners, only a *limited* part of it would be shared.

9. Section E2 – Lookup Services –Functionalities Q64 – Q71

9.1. Data to be retrieved form look up services (Q64)

The type of data companies expect to be able to retrieve from the supply chain look-up service directly, without having to collate information from individual searched of partner EPCIS systems, is illustrated in Figure 34 below. This data includes according to the answers provided by the respondents:

- 12% links to databases of other custodians for that object
- 15% date/time of arrival with a custodian
- 15% date/time of departure with a custodian
- 15% info about changes of aggregation
- 8% metadata about what kind of data is available
- 12% whether the physical tag has been killed
- 12% current/updated status of the object
- 8% other data

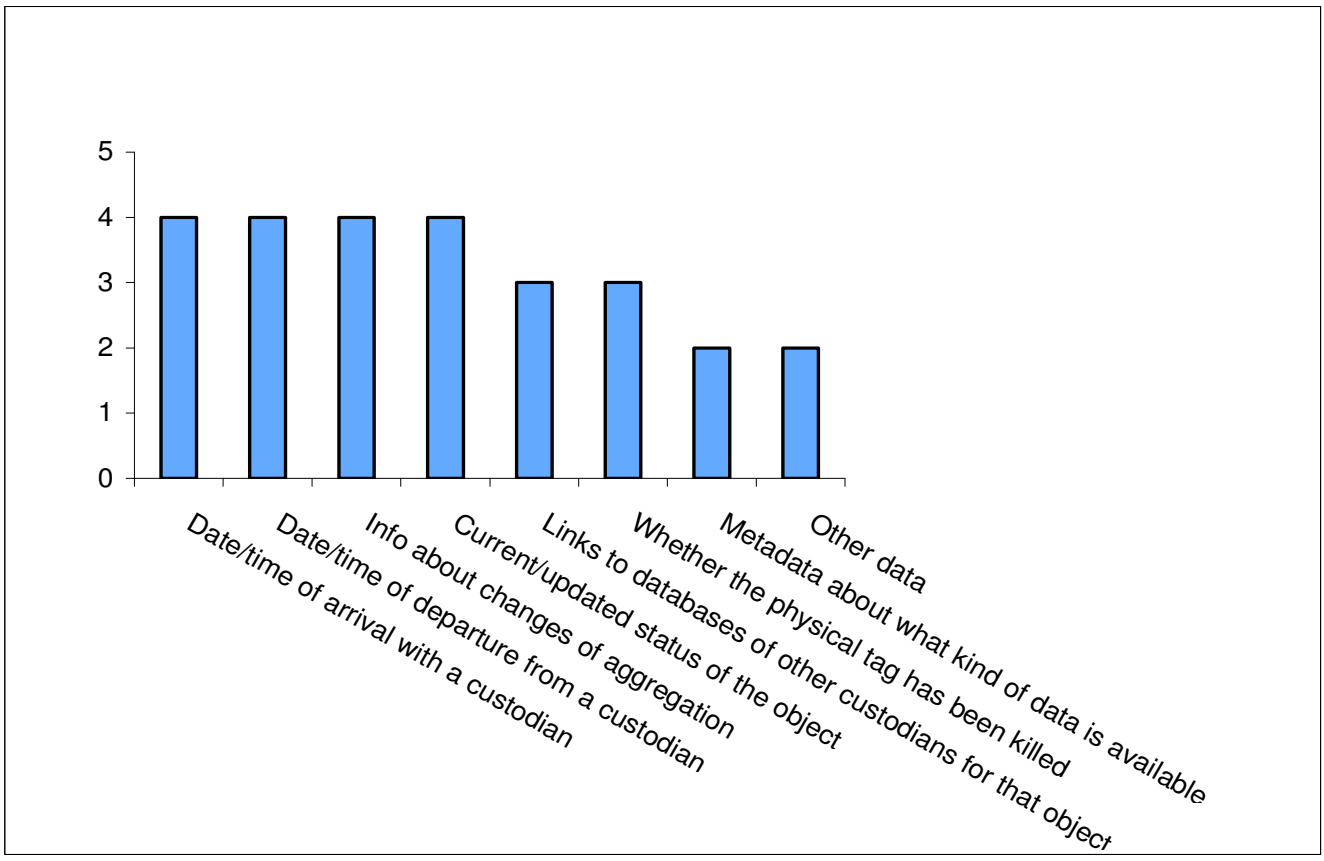

Figure 34: Types of Data to Be Collected Directly

9.2. Types of queries required (Q65)

It can be seen in Figure 35 below, that there is an evident tendency towards the look-up service being able to query directly the upstream information in the supply chain, e.g. the "Retrospective Tracking" or the "Trace". Direct querying of the downstream information in the supply chain, e.g. the "Prospective Tracking" or "Destination", is of less importance, but still occupies a considerable share.

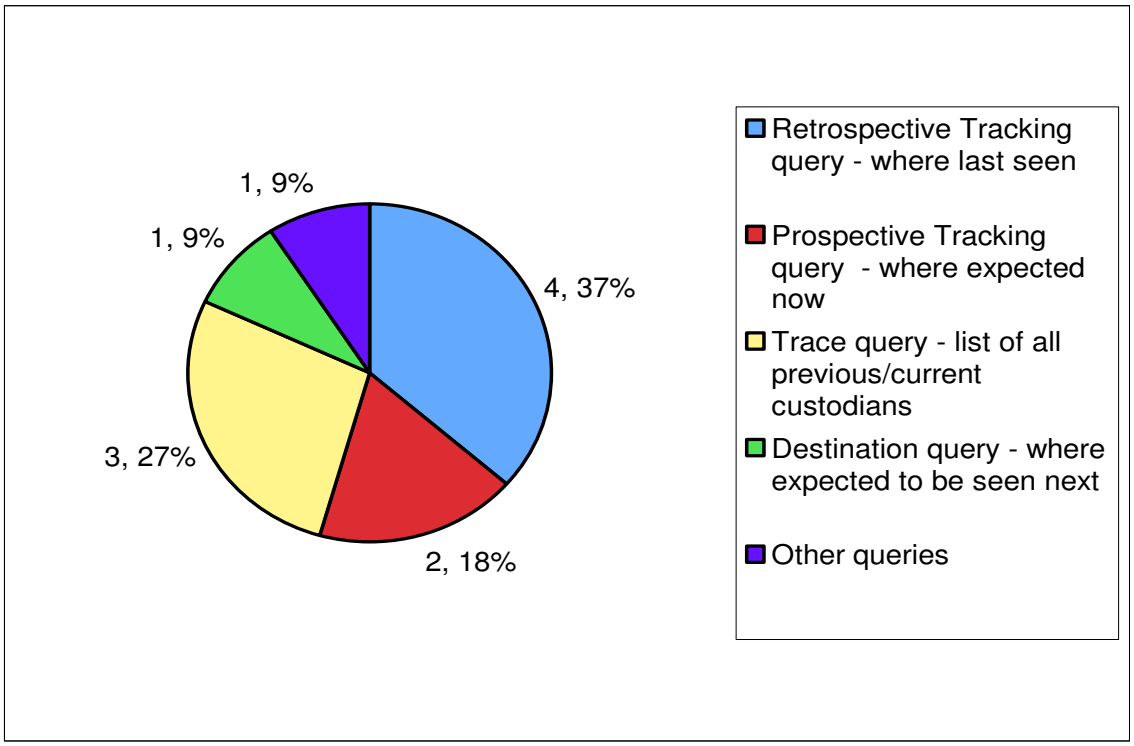

Figure 35: Types of Queries to Be Supported Directly

9.3. Data to be provided to lookup services (Q66)

Figure 36 below shows the types of data that companies are willing to provide to the look-up services. According to the answers given by the respondents, this data consists of:

- 21% URL/Address of database for additional Info
- 14% time/date of departure
- 14% info about changes of aggregation
- 14% record that a physical tag has been killed
- 14% current status of the object
- 7% metadata about kinds of additional data
- 7% time/date of arrival
- 7% other data

Interestingly, the companies seem rather reluctant to provide information pertaining to the time/date of arrival or to the metadata about kind of additional data available. One company (expressed its preference for a tiered approach. That is, its trusted partners would have access to all info while others might have a more limited data access.

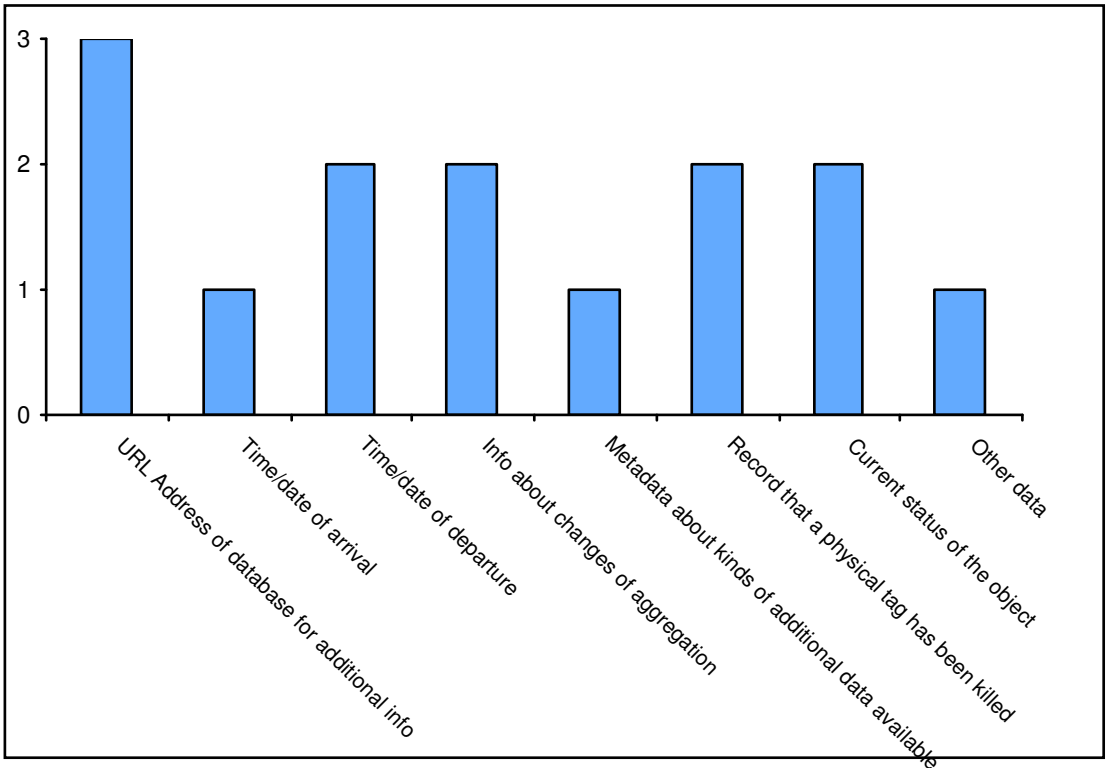

Figure 36: Types of Data to Be Provided to Look-up Services

9.4. Max number of companies to give info on a specific EPC (Q67)

The number of supply chain partners to which companies are willing to provide information to on a single EPC tag varies from 6 to more than 50, as illustrated in Table 8.

Number of companies	Total responses
1	0
2	0
3-5	0
6-10	1
11-50	0
More than 50	2

Table 8: Number of Partner Companies in the Supply- Chain Provided with Information on a single EPC

9.5. Max number of companies to give info for the product range (Q68)

The number of supply chain partners to which a company would provide information about its product range varies from 6 to more than 50, as illustrated in Table 9.

Number of companies	Total responses
1	0
2	0
3-5	0
6-10	1
11-50	0
More than 50	1

Table 9: Number of Partner Companies in the Supply Chain Provided with Information about Product Range

9.6. Anomalies to be detected (Q69)

The companies believe that the look-up service should be capable of detecting the following anomalies / discrepancies, as illustrated in Figure 37 below:

- 25% of the respondents mentioned “Misplacement”
- 25% of the respondents mentioned “Duplicate IDs/Cloning”
- 12.5% of the respondents mentioned “Diversion”
- 12.5% of the respondents mentioned “Invalid status”
- 12.5% of the respondents mentioned “Sensor values exceeding normal bounds”

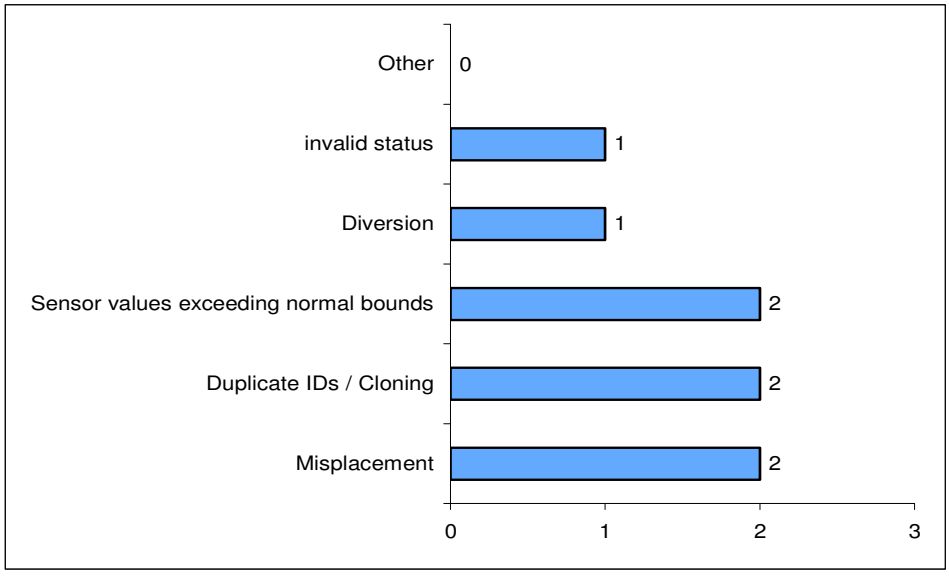

Figure 37: Anomalies or Discrepancies to be detected by the Look-up Service

9.7. Requirement for standing queries (Q70)

As plotted in Figure 38 below, there were few responses about the expectation to run standing queries, although three companies stated that they did expect this.

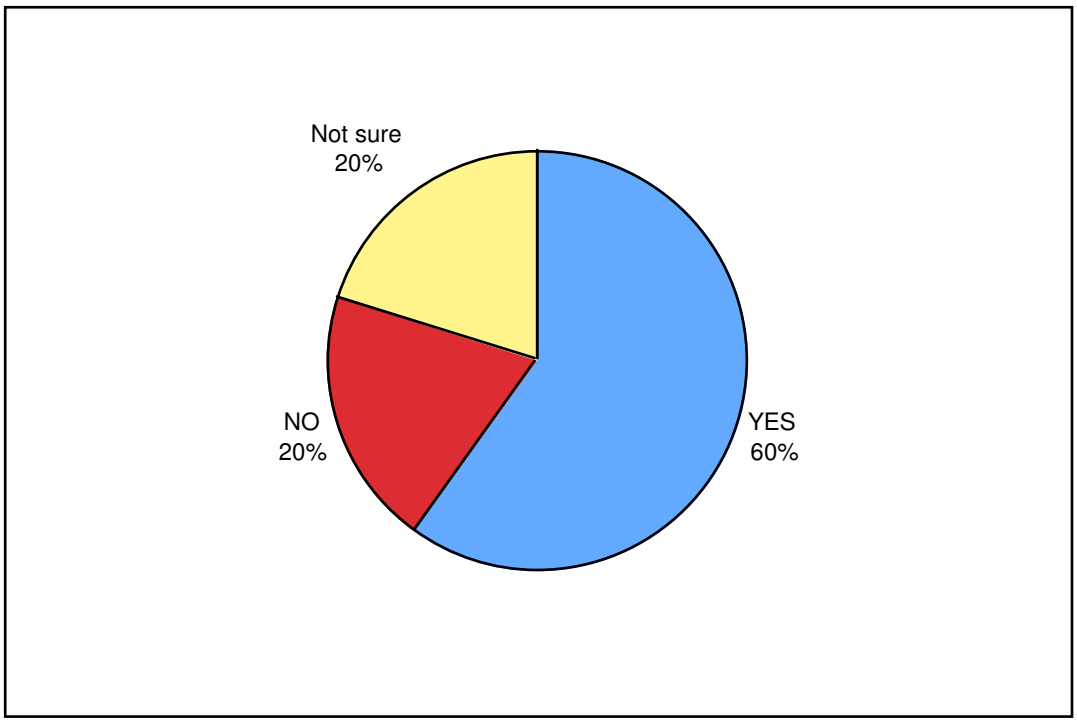

Figure 38: Expectation to be able to run Standing Queries

9.7.1. Filtering requirements for standing queries (Q71)

Figure 39 below shows the respondents' opinions on the criteria that should be used in order to filter the updates that are sent to them as a result of a standing query. These criteria are the following:

- 29% of the respondents mentioned "By the organization providing the update"
- 14% of the respondents mentioned "By the manufactures code / company prefix of the goods"
- 29% of the respondents mentioned "By product line / SKU"
- 14% of the respondents mentioned "By specific serial number / full EPC"
- 14% of the respondents mentioned "Other criteria for pro-active alerting"

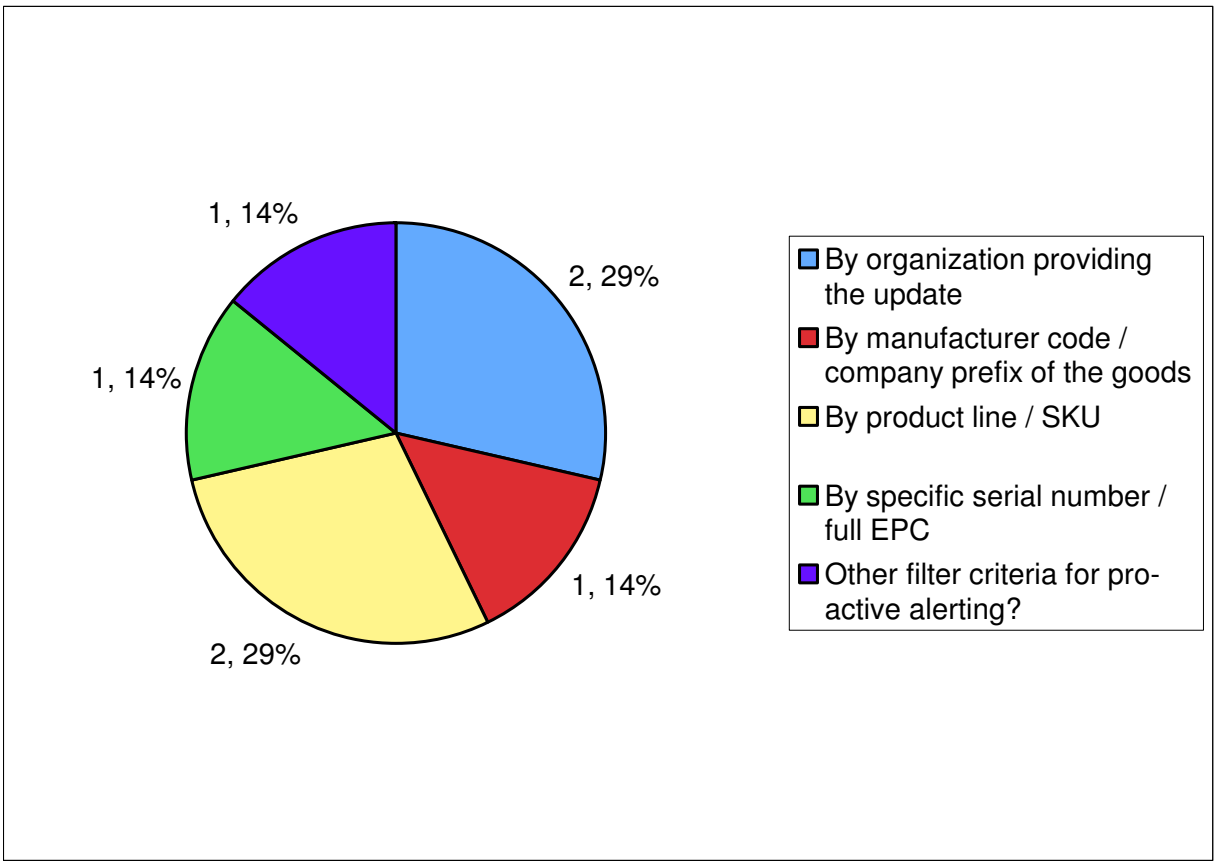

Figure 39: Criteria for Filtering of Queries

10. Section E3 Lookup Services – access control and security Q72 – Q79

There were only 4 responders to section E 3.

The four responders did recognise the need to share data with others; and there seemed a reasonable consensus that any *non-government* body might, with appropriate safeguards, be trusted to operate the look-up services.

10.1. Detailed Questionnaire Responses

10.1.1. Need for an internal lookup service within enterprise (Q72.)

The responses were unclear.

10.1.2. Kinds of information to share with all authenticated members of the supply chain on equal access basis. (Q73)

Information to be shared	Number
No information	1
EPCs of products handled	3
Timestamp of arrival	2
Timestamp of departure	1
Indication of geographic location	2
URL address of information service	0
Current/updated status of a serialized object	1
Other data	0
Other data specified...	

Table 10: Information to be shared

10.1.3. Level of access granted to other parties. (Q74.)

Access Level	Response
Government/regulatory body	None or Query
Suppliers	Query
Customers	Update or Query
Other - see below	Various
Other bodies - specified...	

Table 11: Level of access

[Questions Q72, Q73, Q74] None of the 3 respondents were prepared to share the URL address of the Information Services! This either demonstrates a serious misunderstanding of the look-up service, or carelessness in filling in the questionnaire, or possibly confusion at the way the question was phrased. The URL address is the fundamental response of the look-up service; the other 'attributes' are possible additional responses. Mixing these together might have been confusing for the respondents. Otherwise, the responders were willing to share differing kinds of data, with differing access controls.

10.1.4. Conditions/guarantees acceptable for hosting a serial-level lookup service. (Q75)

Acceptable host conditions	Number
Technical guarantees	3
Contracts	3
Monitoring/auditing by a common authority or regulator	3
Other - specified below	
Other conditions/guarantees specified	

Table 12: Acceptable host conditions

There was a desire to provide strong (technical, contractual and regulated) guarantees in hosting the look-up data.

10.1.5. Familiarity with digital certificates / PKI (Q76)

The responses were unclear

10.1.6. Organisations trusted to manage authentication of users of lookup service. (Q77)

Organisation trusted to authenticate	Number
Any private for-profit company, possibly certified	2
Government supported organisation / regulatory body	0
Non-governmental organisation (NGO)	1
Industry body for a particular industry sector	3
Supply chain partner	0
Industry consortium	1
Other organization - see below	2
Other org specified...	Verisign

Table 13: Organisations trusted to authenticate users

10.1.7. Organisations trusted to manage access permissions for lookup service (Q78)

Organisation trusted to manage access	Number
Any private for-profit company, possibly certified	2
Government supported organisation / regulatory body	0
Non-governmental organisation (NGO)	1
Industry body for a particular industry sector	2
Supply chain partner	1
Industry consortium	0
Other organization - see below	1
Other org specified...	unclear

Table 14: Organisations trusted to manage access

10.1.8. Organisations trusted to operate the lookup service infrastructure (Q79)

Organisation trusted to operate lookup services	Number
Any private for-profit company, possibly certified	2
Government supported organisation / regulatory body	0
Non-governmental organisation (NGO)	1
Industry body for a particular industry sector	2
Supply chain partner	1
Industry consortium	0
Other organization – see below	1
Other org specified...	unclear

Table 15: Organisations trusted to operate lookup services

[Questions Q75, Q77, Q78, Q79]. A variety of non-government organisations might be trusted to provide authentication, access-control, or operation of the look-up services.

11. Section E4 Lookup Services – Performance Q80 – Q87

11.1. Speed of events/updates becoming available/visible (Q80)

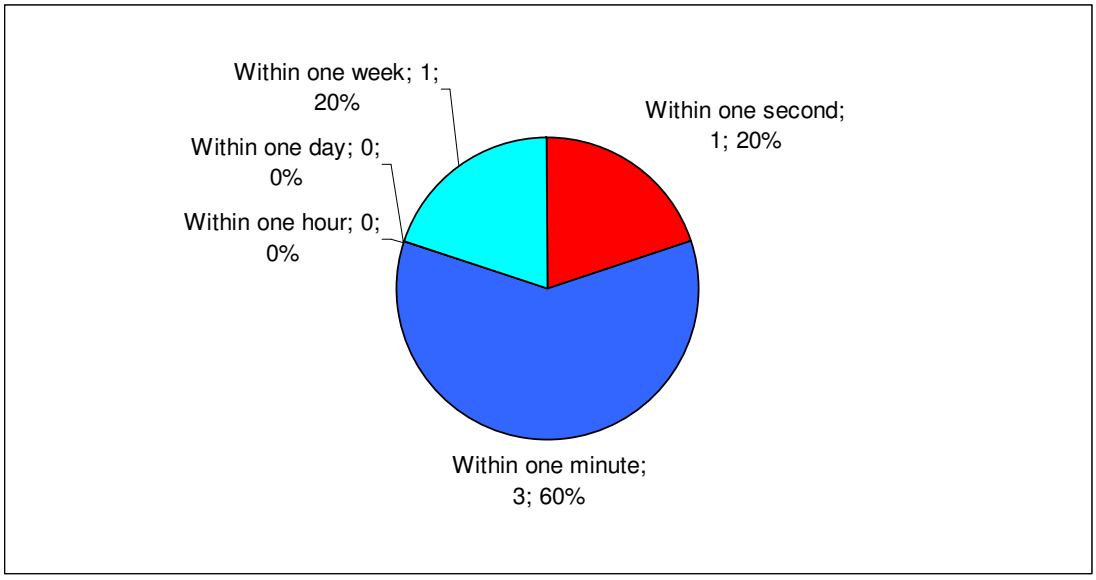

Figure 40: Speed of availability

Most responders prefer updates to the lookup service to become visible within one minute.

11.2. Expected speed of response to tracking / trace query (Q81)

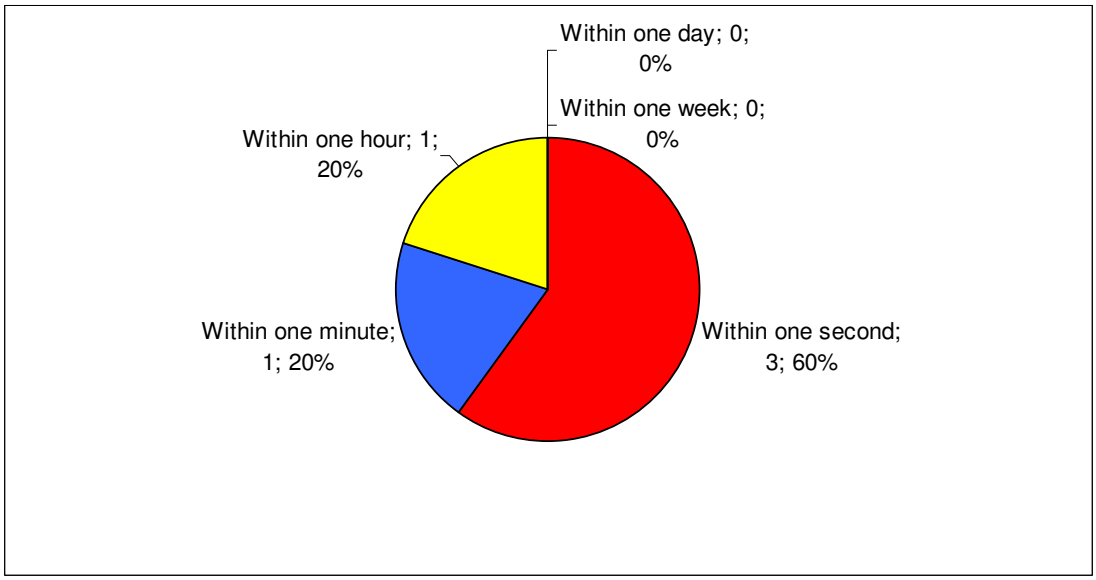

Figure 41: Response times

Like the previous answers, the responses show a preference for a short response time on queries, with the majority expecting a response within one second.

11.3. Delayed (asynchronous) response also acceptable? (Q82)

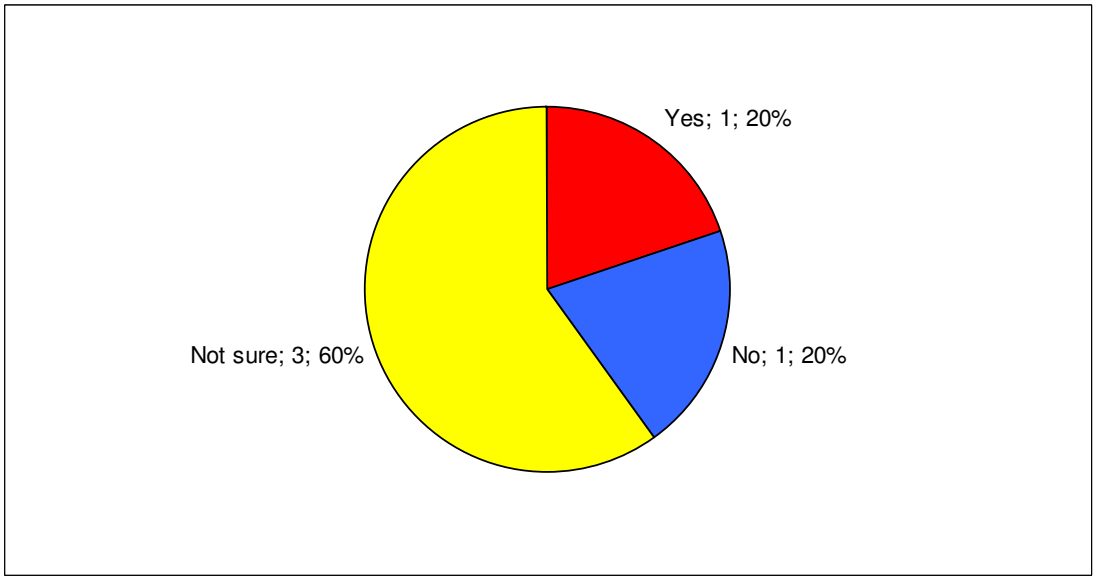

Figure 42: Asynchronous response

In this question there is no unanimity about whether a delayed response is acceptable, although in the previous questions they prefer an immediate one.

11.4. Communication mechanism for delayed/async response? (Q83)

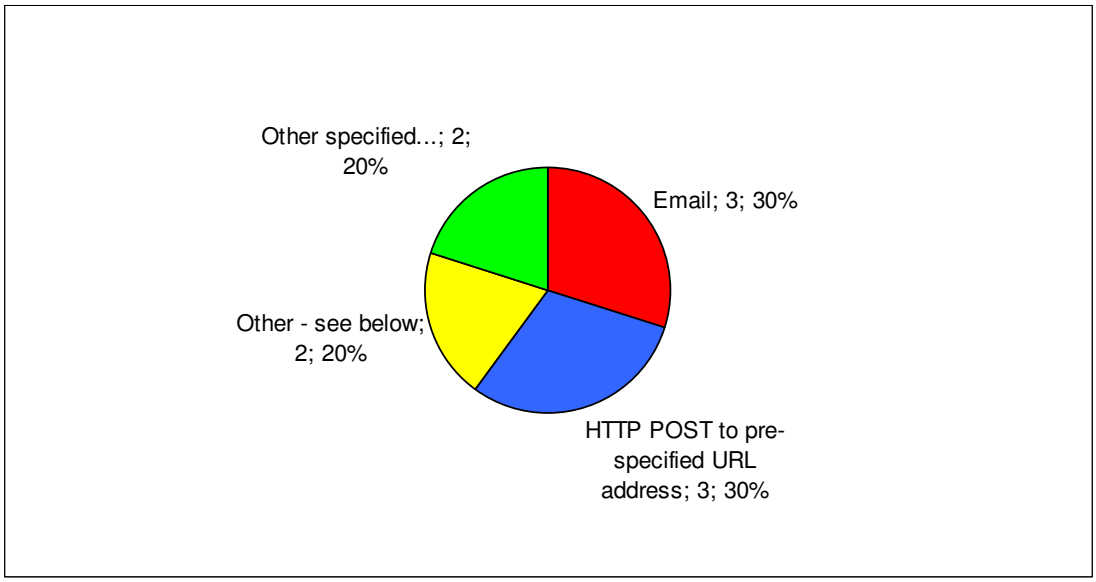

Figure 43: Asynchronous communications methods

The answers show that the preferred methods for communicating a delayed response are email and HTTP POST (which even could be SOAP like in one of the "Other" answers).

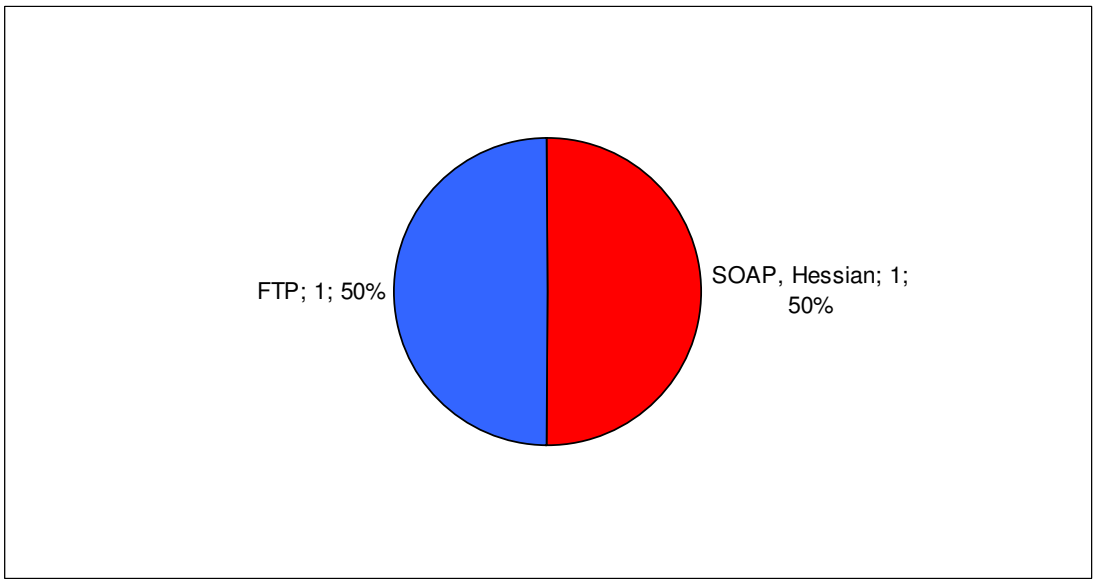

Figure 44: Other asynchronous methods

11.5. Level of uptime required from lookup service (Q84)

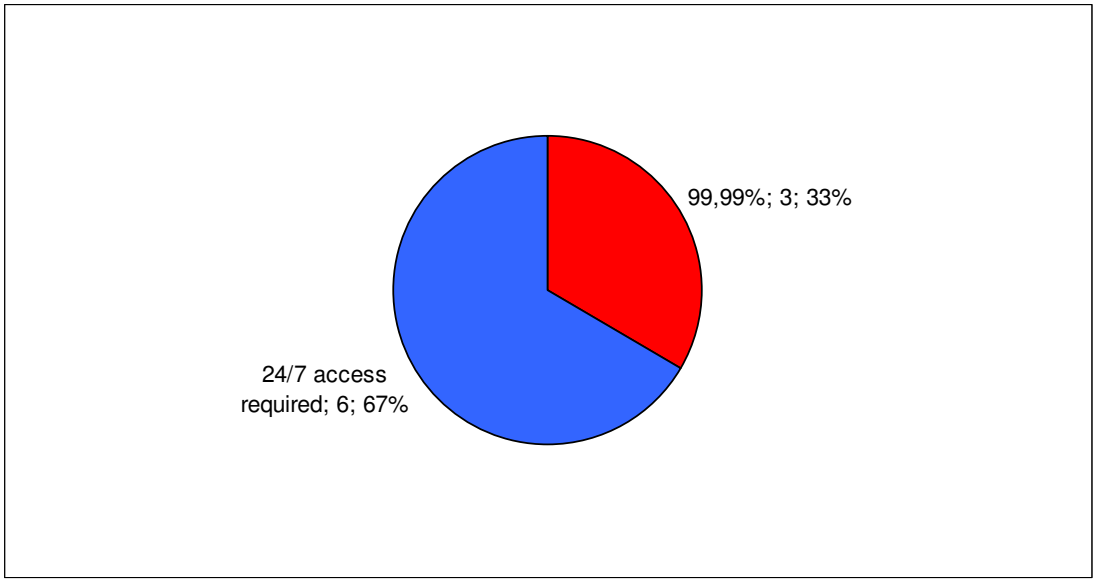

Figure 45: System uptime required

The level of uptime required is clearly 24/7 (99.99%).

11.6. Availability of technical support expected (Q85)

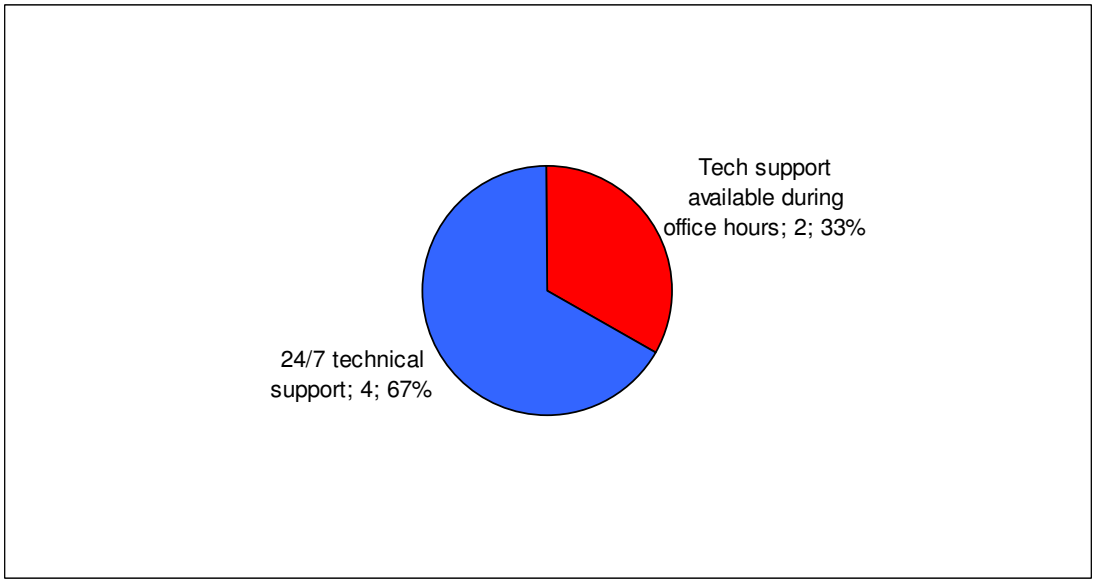

Figure 46: Technical support required

Most of the responders require a 24/7 of technical response (67%). Only 33% demands availability during office hours.

11.7. Anticipated frequency of querying a lookup service (Q86)

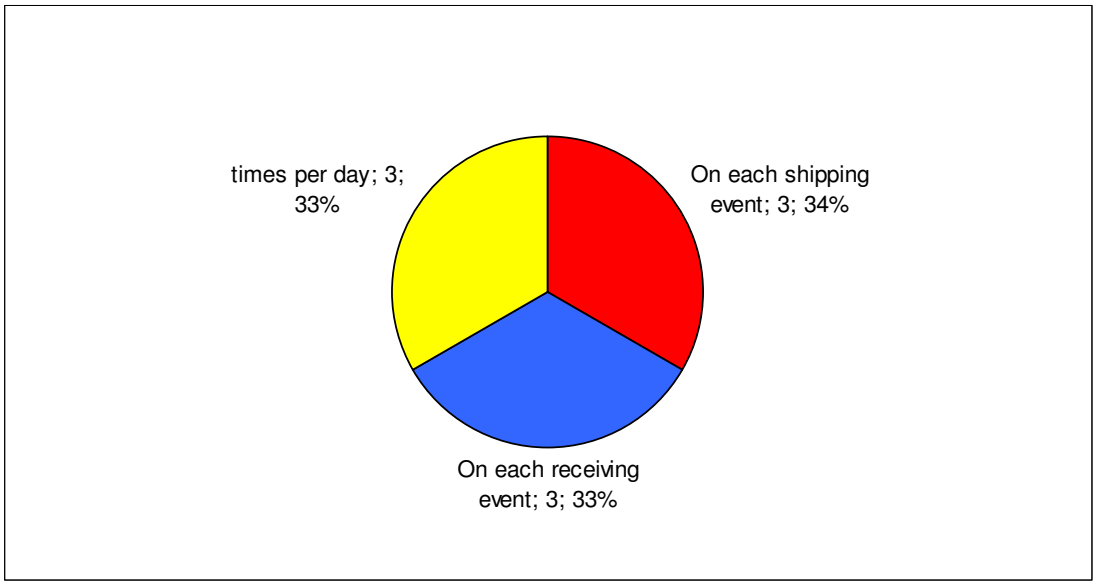

Figure 47: Query frequency

The responses to this question are divided into the three possibilities, from the point of view of the events, they show that both types of events (shipping and receiving) must be considered.

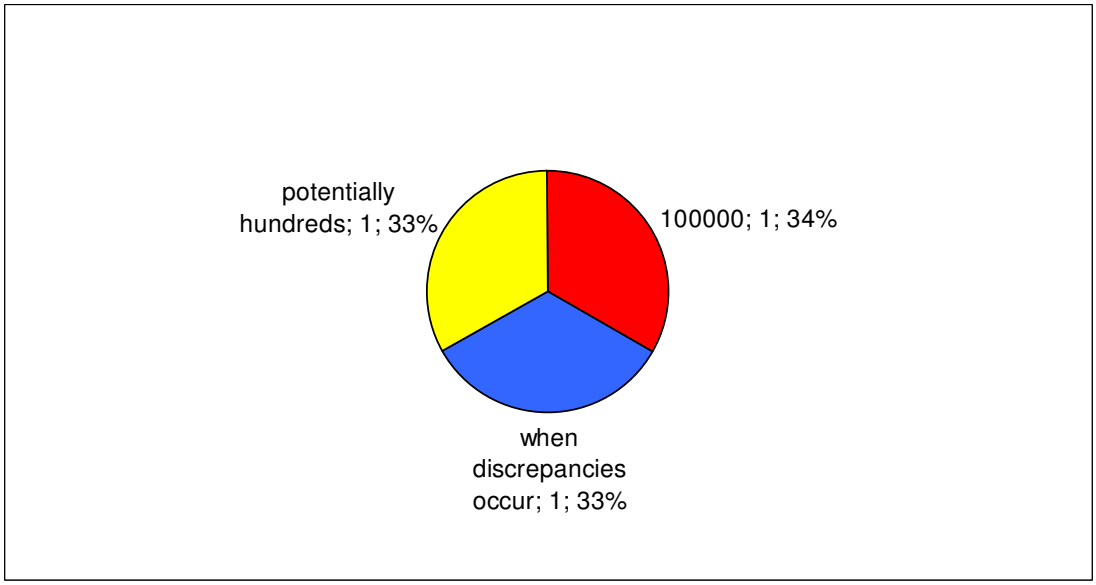

Figure 48: Number of queries

From the point of view of the times per day the answers indicate that more than hundreds (even hundreds of thousand) times per day can occur.

11.8. Anticipated frequency of updating a lookup service (Q87)

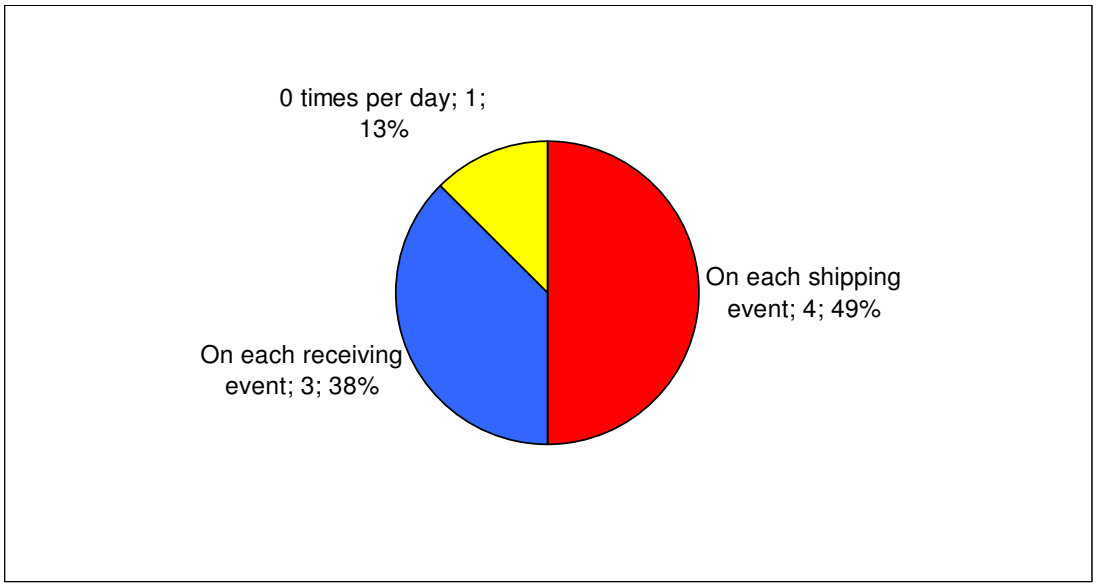

Figure 49: Update frequency

The answers for this question show that the updating frequency occurs on both events, shipping and receiving, and the "0 times per day" response seems to suggest there was some misunderstanding.

12. Section E5 – Lookup Services – Operation Q88 – Q97

12.1. Which orgs should provide the lookup service(s)? (Q88)

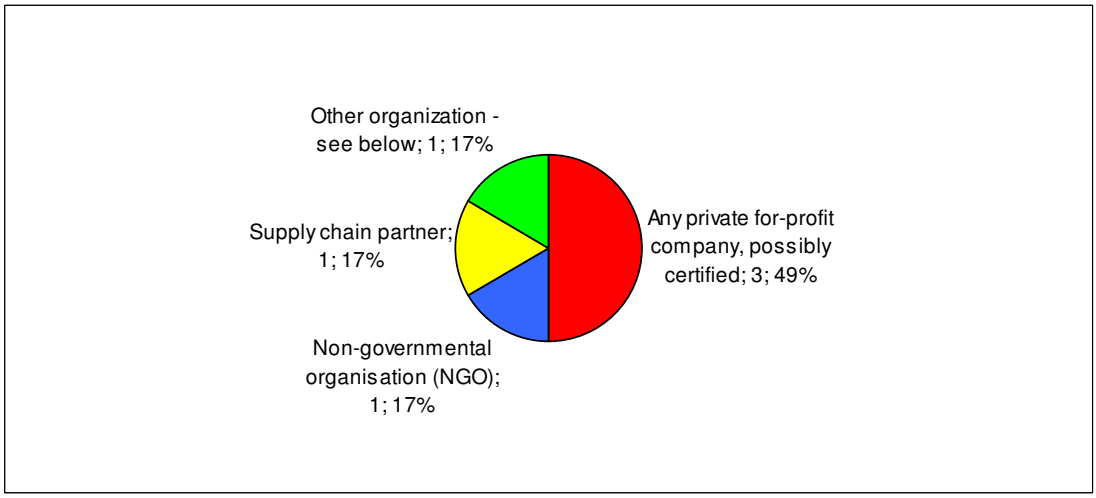

Figure 50: Organisations providing lookup services

Fifty percent of the respondents selected the first option, perhaps because of the advantages of a third party that can get some profit and that could be certificated.

One responder says that each company must own/control their own information.

12.2. Should serial-level lookup services be organised around. (Q89)

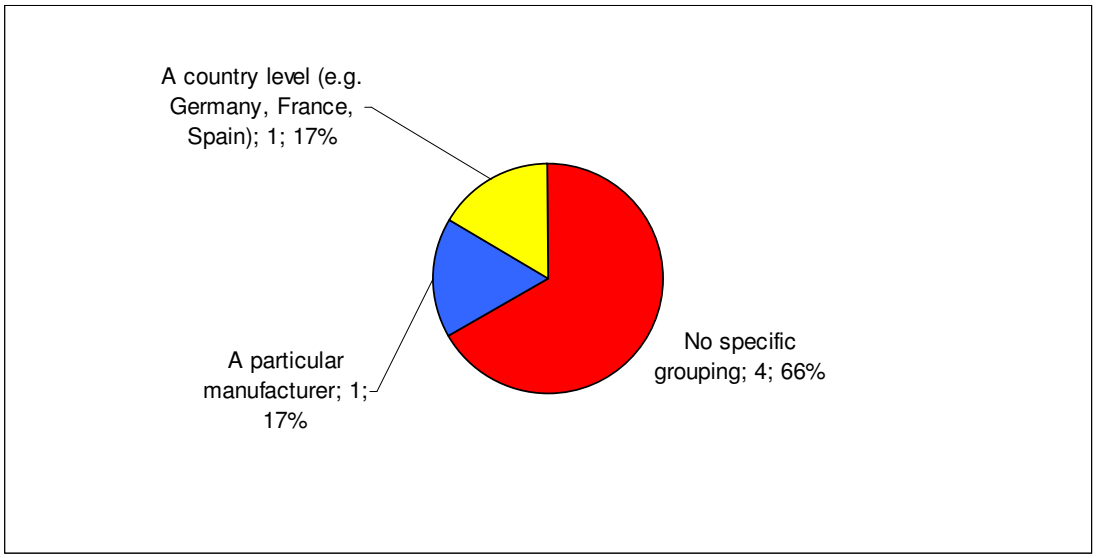

Figure 51: Organisations providing lookup services

The responders choose with a 66% the option “no specific grouping” to organize the serial-level lookup services while one selects “A particular manufacturer” and another “a country level” organization.

12.3. View on overlap between multiple serial-level lookup services (Q90)

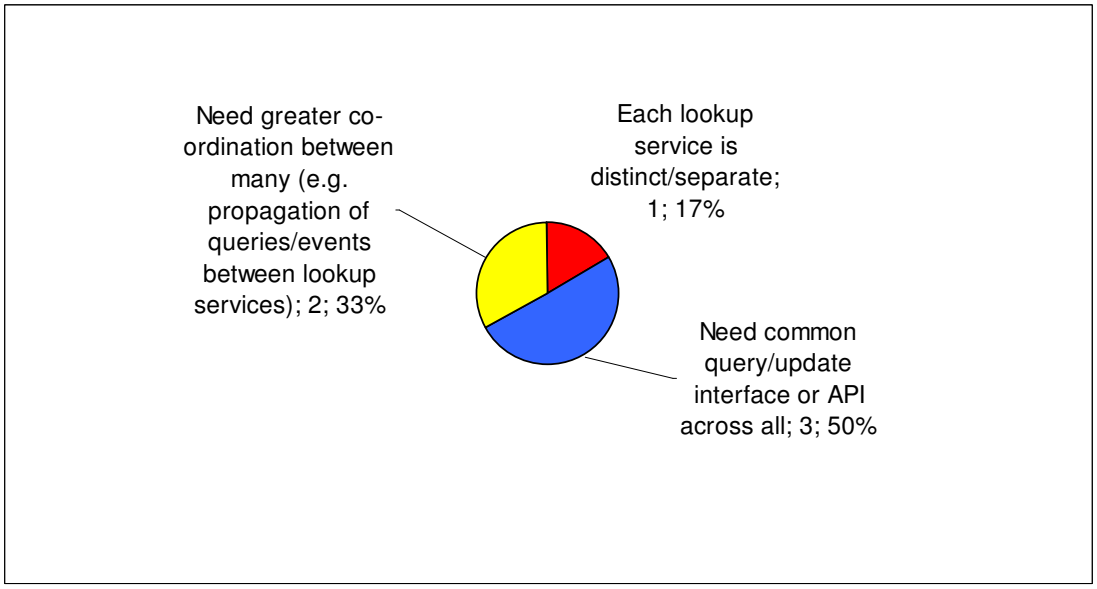

Figure 52: Overlap of serial look up services

The responders to this question prefer to have a common query interface or at least a greater coordination between multiple serial-level lookup services rather than separate ones (only one response).

12.4. How should an organization know which lookup service to report to? (Q91)

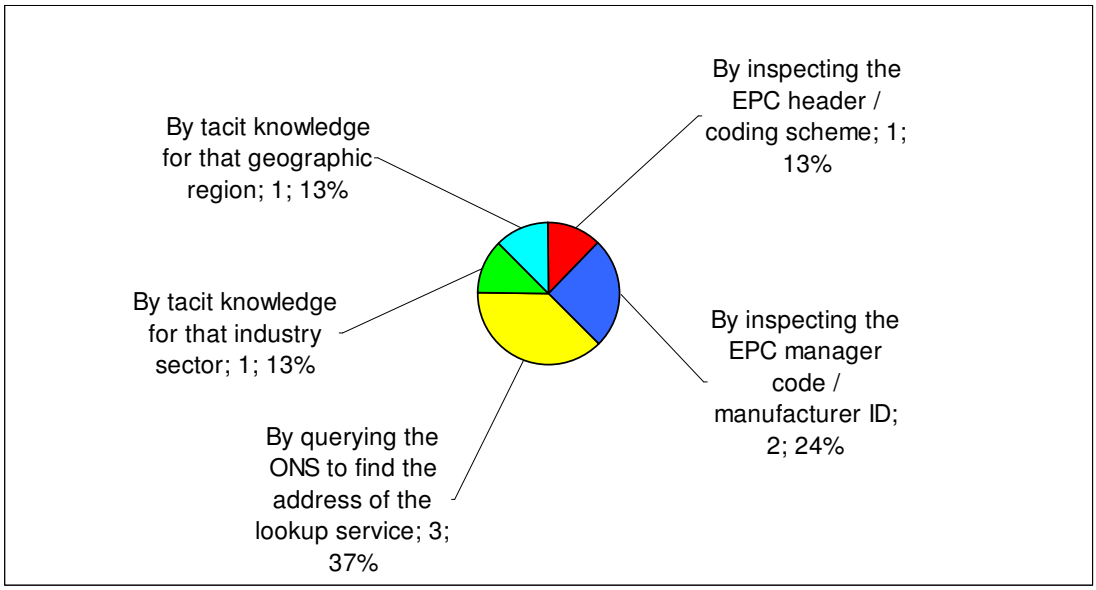

Figure 53: Finding relevant look up service

Most respondents choose either to use the ONS service or the EPC (with manufacturer ID or coding scheme) and only one response selects tacit knowledge options.

12.5. Views on organization of lookup and access control services (Q92)

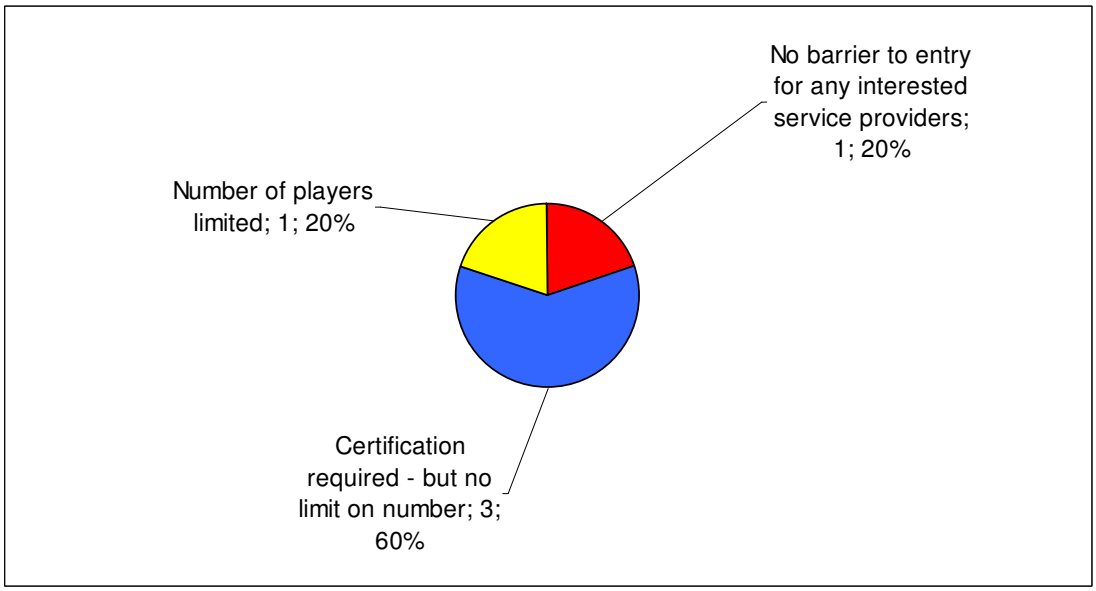

Figure 54: Regulation of look up services

The answers to this question are divided between 60% for “Certification required” and 20% for “No barrier” and the other 20% for “Number of players limited”.

12.6. How should these lookup services be priced? (Q93)

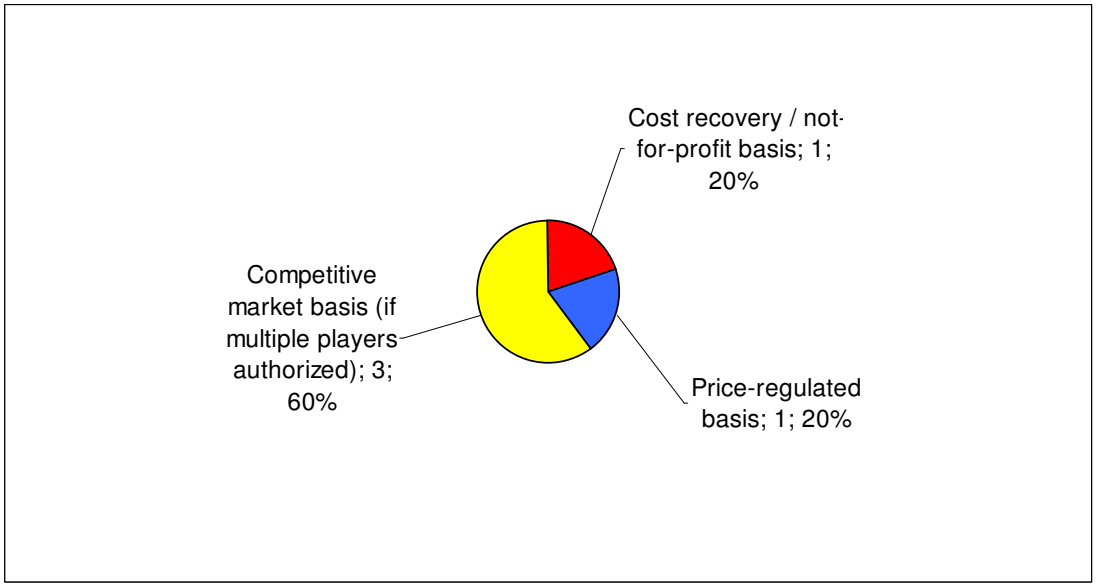

Figure 55: Look up services pricing

The majority of responses select the option “Competitive market basis” to price the lookup services.

Which organizations should have to pay for the cost? (Q94)

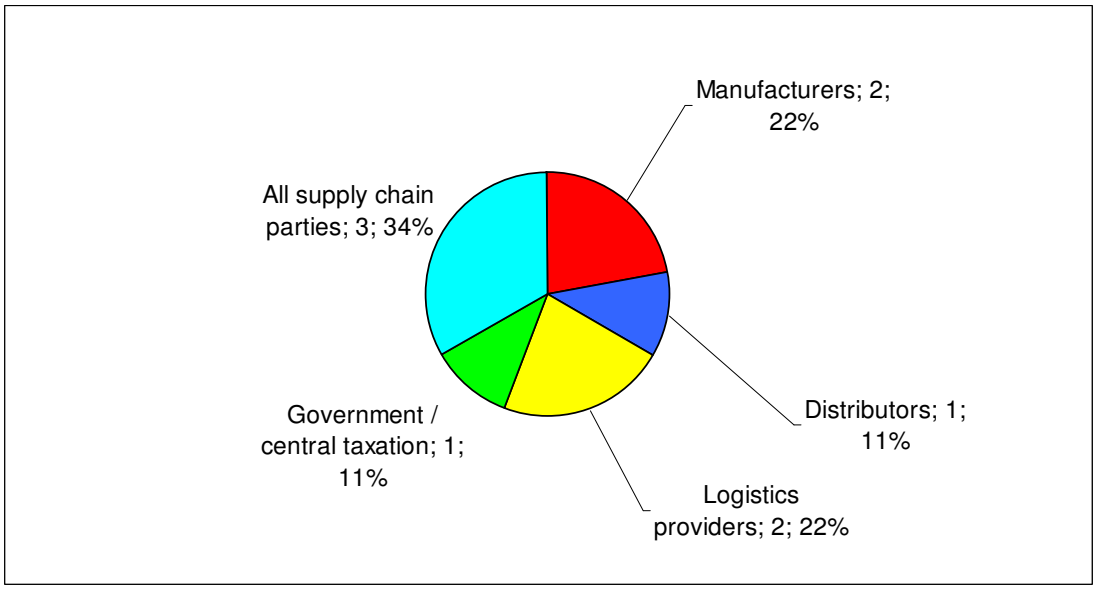

Figure 56: Who should pay?

In this question there are more differences in the selections of each respondent, but the most popular option was “All supply chain parties” with 33%, then the “Manufacturers” and “Logistic Providers” even with “Distributors” and on the other side, while one responder has selected “Government”.

12.7. You expect to have to pay to provide an update? (Q95)

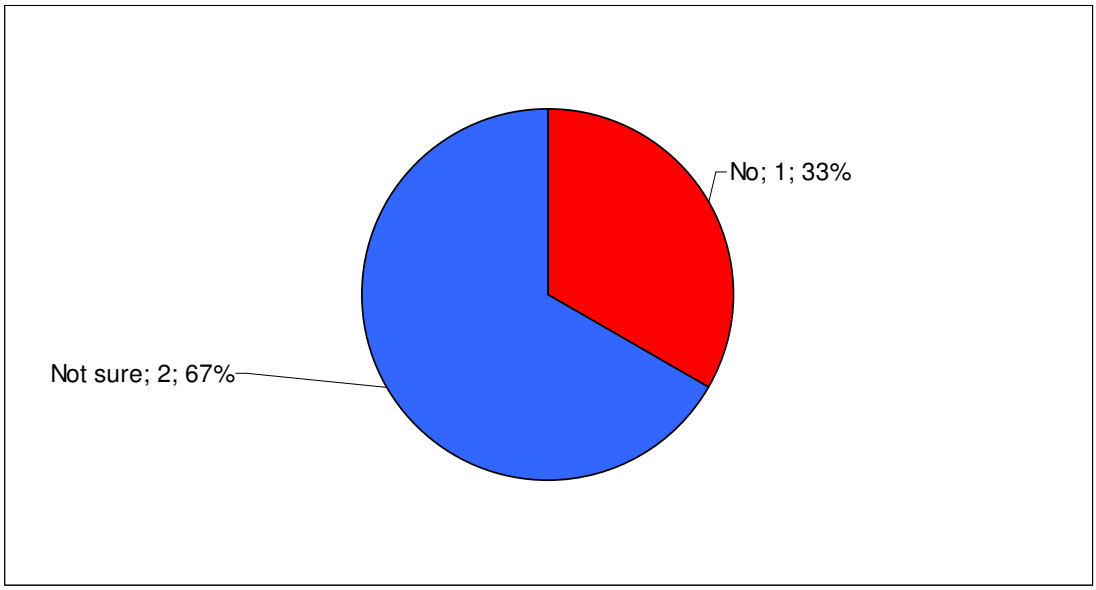

Figure 57: Pay to update

None of the responders definitely expect to have to pay to provide an update, but 66% are not sure of that and only 33% are clear that payment should not be required.

12.8. You expect to receive payment for providing updates? (Q96)

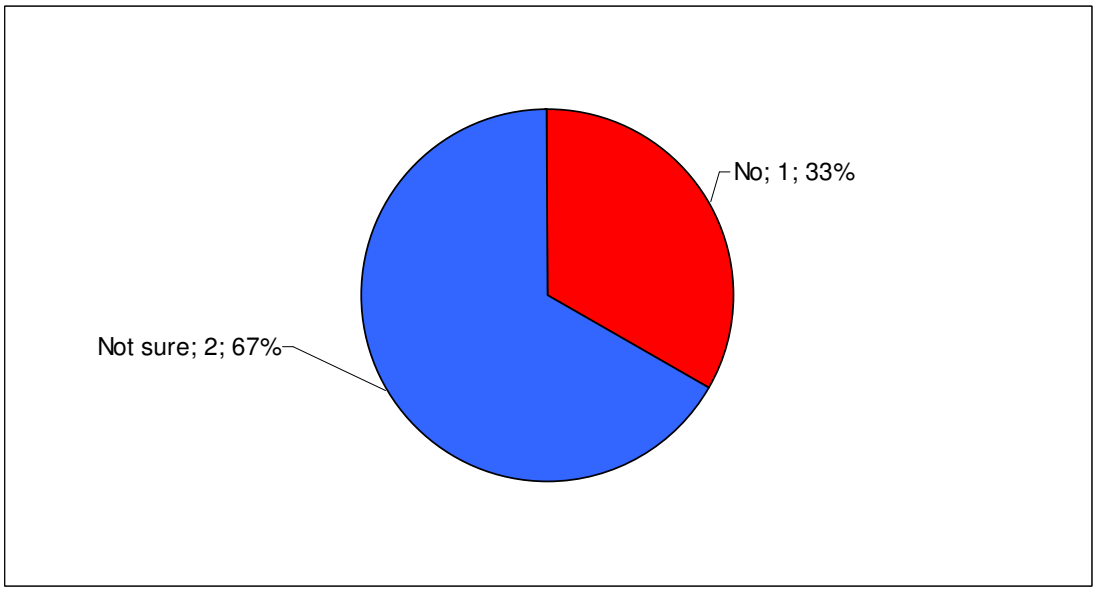

Figure 58: Receive payment for update

By the way of previous answer, none of the responders definitely expect to receive payment to provide an update, but 66% are not sure of that and only 33% thinks that he does not expect to receive payment.

12.9. Preferred payment mechanisms (Q97)

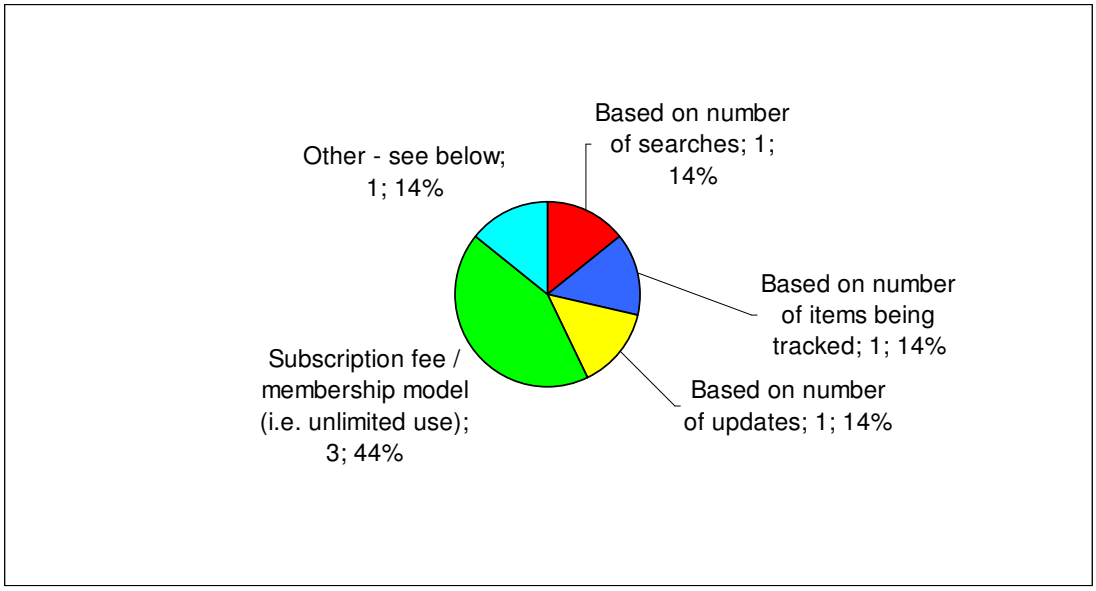

Figure 59: Payment basis

About the preferred payment mechanism, 42% selects the subscription fee with unlimited use and 14% for other options.

Other	Answers	%
We have not thought about the business model. But, other than charging a small fee to be used to authenticate participants, we don't think there should be any incremental cost to using the service. We don't want to have barriers to accessing information.	1	100,00%
Total	1	100,00%

Table 16: Comments on payment

13. Appendix A: The Questionnaire

The following is a listing of the questions used in the first version of the online questionnaire.

WP2: Serial-Level Lookup Service Questionnaire

Introduction

Lifecycle event information involves observations of an object (for example, returnable assets, pallet, cases, products or components) at various locations, as well as relations to the relevant sensor information applicable to that individual object such as temperature, pressure, humidity and shock sensors. The complete lifecycle information is likely to be fragmented across the supply chain, with each organization controlling access to information they hold about a particular object or EPC. Therefore, accessing the lifecycle event information is a highly complex task which consists of re-assembling a tremendous quantity of information from multiple sources in order to reveal the unique supply chain path taken by each object. Serial-level (or object-level) lookup services have to be provided in order to enable product lifecycle event information to allow various authenticated organizations (e.g. supply chain partners, possibly government regulatory/public safety bodies…) to gather this information from across the supply chain.

Within business applications work packages in the BRIDGE project, a serial-level lookup service is necessary if serialised track and trace is needed. Business application work packages 5 to 11 encompass various industry sectors such as retail, pharmaceutical and manufacturing. This provides a good opportunity to consolidate learnings from across the different industries in order to build a robust, secure and scalable serial-level lookup service for deployment within the BRIDGE project. The following questionnaire is necessary to gain preliminary understanding of look-up requirements of various BRIDGE partners.

The main points raised in this consultation are :

- Your needs in terms of traceability
- Your current processes
- Identification of traceable items : serialized ID codes and data management
- Lookup services : functionalities, access control, security issues, performance and organisation

If you feel the following questions do not fit well within your business practices, you may want to write freely about these points.

13.1. A - General Q1 – Q12

1) Please tell us your name

2) Please tell us your e-mail address

3) Please tell us the name of your company

4) Which is/are your industry sector/s?
   [ ] healthcare
   [ ] defence
   [ ] fast-moving consumer goods (FMCG)
   [ ] leisure
   [ ] automotive
   [ ] DIY / construction
   [ ] food service
   [ ] fashion / apparel
   [ ] High-Tech
   [ ] Others - please specify below

5) What type of company do you work for?
   [ ] Retailer or point of sale/use by consumer

[ ] Manufacturer
[ ] Logistics service provider
[ ] Technology solution provider

6) Approximately how many employees are in your organization?

7) How many geographic locations does your organization have?

8) In which countries are the scope of your activities?

9) How familiar are you with the technical aspects of information systems?
[ ] Not familiar
[ ] Some knowledge
[ ] Detailed technical knowledge
(If you are not familiar with the technical aspects of information systems, we suggest that you do not answer any technical questions that you do not understand but consider forwarding this questionnaire to an IT colleague who could help answer some of the questions relating to technical issues)

10) How familiar are you with serial-level lookup services as described above (also known as EPC Discovery Services)?
[ ] The concept is new to me
[ ] Some knowledge
[ ] Familiar with the concept

11) If you have some knowledge, do you agree that they could provide benefit to your company?
YES/NO

12) If YES, could you please state the earliest year when you plan/expect to start using serial-level supply chain lookup services?
[ ] Already using these services. If so, which ones?_____
[ ] End of 2006
[ ] End of 2007
[ ] End of 2008
[ ] End of 2009
[ ] After 2009
[ ] Not yet decided

12a) If you are already using these services, can you tell us which ones?

13.2. B - Drivers for traceability Q 13 to Q29

13.2.1. Business drivers for traceability

13) Are there business drivers in your sector for traceability ?
If NO, please go to Question 21
14) What is the incentive ?
15) Which of your internal processes are affected by this?
16) What is the finest level of granularity required by these drivers for tracking?
[ ] consumer-item
[ ] raw ingredients?
[ ] Pallet
[ ] Carton box
[ ] Other please specify

13.2.2. Regulatory drivers for traceability

17) Are there legislative/regulatory drivers in your sector for traceability?
If NO, please go to Question 23

18) Are they Global / European / National ?
19) Which regulatory authority is responsible for this driver?
20) When is the legislation likely to be in effect?
21) Would you be willing to provide more detail on the legislation in a follow-up phone call?
22) Which of your internal processes are affected by this?

13.2.3. Pedigree

Pedigree documentation can be used to provide a verifiable audit trail of each handover/exchange of good from manufacturer to point of sale (and potentially beyond point of sale to also include in-service repairs, maintenance, overhauls etc.).
Pedigree records are usually sent downstream, either with the goods or ahead of the goods.

23) Are you already involved in any form of supply chain pedigree initiative?
    [ ] No activity
    [ ] Planning
    [ ] Under development
    [ ] Trial / initial rollout
    [ ] Live

24) How is the pedigree information sent downstream?
    [ ] paper documents
    [ ] electronic/digital pedigree management system

13.2.4. Product authentication / Anti-Counterfeit measures

25) To what extent is counterfeiting of your products a major concern for you?

26) Is it important to provide a product authentication service, through which it is possible to determine whether a product is genuine or counterfeit?

27) Do you want your customers to be able to verify the authenticity of your products?

28) Do you want to be able to verify the authenticity of goods received from your suppliers?

    A product authentication service may be able to check whether a tag has been cloned (the same EPC written into a different tag) – or if a genuine tag has been moved from one product to another (possible a counterfeit one)

29) Which cross-checks would you consider useful for a product authentication service?
    [ ] check that the EPC corresponds to the TagID that the manufacturer programmed
    [ ] check that the EPC corresponds to the physical object (e.g. check against mass-customized security features (which are varied for different products and/or different serial numbers or ranges of serial numbers (e.g. different for each batch)) or checked against other characteristic features, e.g. precise weight of the object)
    [ ] other checks _____

13.3. C - Benefits / Use Cases Q30 – Q36

30) What category of objects are you intending to track? (A product should be entered under one and only one category)
    What is the current status?

Which categories e.g. High value, branded, high	Status Planning / Under	No. of your products in this	Total number of items you

duty, healthcare, food, returnable assets, other assets	development / trial/ Live	category	produce per year. in total for all your products in this category
High-value, branded goods			
High duty items			
All products we produce			
All products we receive			
Food products			
Pharmaceuticals			
Other healthcare-related goods			
Returnable assets (e.g. pallets, trays, dollies)			
Other assets			

31) At what level do you expect to be able to do track and trace?
[ ] Item
[ ] Single Case
[ ] Aggregate Load (e.g. pallet)

32) Which benefits / use cases do you expect from a serial-level lookup service?
[ ] Track & Trace – internal to the company Planning / Under development / Trial / Live
[ ] Track & Trace – across the supply chain Planning / Under development / Trial / Live
[ ] Tracking of finished products Planning / Under development / Trial / Live
[ ] Tracking of work in progress Planning / Under development / Trial / Live
[ ] Manufacturing Planning / Under development / Trial / Live
[ ] Inventory control Planning / Under development / Trial / Live
[ ] More efficient product recalls Planning / Under development / Trial / Live
[ ] Electronic Pedigree Planning / Under development / Trial / Live
[ ] Improved customer service Planning / Under development / Trial / Live
[ ] Reduction in counterfeits Planning / Under development / Trial / Live
[ ] Reduce shrinkage Planning / Under development / Trial / Live
[ ] Detect diversion / control the grey market Planning / Under development / Trial / Live
[ ] Improved supply chain operations Planning / Under development / Trial / Live
[ ] Comply with legislation Planning / Under development / Trial / Live

33) In what way would greater downstream visibility of your objects help your business?
_____

34) In what way would greater upstream traceability help your business?
_____

35) If your company were requested to provide data to a supply-chain tracking database, what benefits would you expect to receive?

36) If your company were requested to provide a product authentication service, what benefits would you expect to receive?

13.4. D - Current state Q37 – Q51

13.4.1. Mass-serialization

Many industry sectors, especially those considering RFID deployment are using mass-serialization of objects, where each object has a unique ID, so that it can be tracked individually and also so that information about each individual object can be stored and retrieved (e.g. using the unique ID or EPC as a database look-up key)

37) What is the current status of your company's mass-serialization of objects?

	Status : no activity, plan, development, trial, live	Expected date of trial	Expected go live date
Returnable assets			
Other assets (e.g. laptop computers)			
Loads (SSCC)			
Cases			
Consumer item level			
Sub component or ingredient			
Animals			
People			

Other ?_____

38) At what level of granularity do you currently store information about your products (e.g. individual item level, batch-level, lot-level)?

13.4.2. Internal management of data within your enterprise

39) For your internal information systems, would you normally store data grouped by:
[ ] the manufacturing plant at which they are produced
[ ] the product type or Stock Keeping Unit (SKU)
[ ] the batch number or lot number
[ ] other?

13.4.3. Information recorded by supply-chain partners (especially downstream)

40) Do you envisage that your supply chain partners would be recording additional information about the objects at serial-level?

41) What type of information would this consist of?
[ ] shipping and receiving details
[ ] operations performed on the object
[ ] sensor measurements (e.g. temperature history while in transit or storage) ?

42) Do you intend for other information to be recorded on an RFID tag in addition to the unique identifier or EPC?
(e.g. expiry date, sensor data, data about alterations/maintenance/repair to the product, etc.)?
YES/NO – If Yes, please specify what type of data…..

43) Do you intend that data stored on the tag should also be synchronized to the networked database(s) of at least one organization within the supply chain?
YES/NO – If Yes, can you provide any further details on your plans?_____

13.4.4. Processes

44) Are the objects you supply subsequently broken down into smaller units for distribution or retail?

45) Are the objects you supply subsequently aggregated together for distribution purposes?

46) What other **paper** documentation is currently sent with (or in advance of) your products arriving at the next recipient on the supply chain?

47) What other **electronic** documentation is currently sent with (or in advance of) your products arriving at the next recipient on the supply chain?

48) Typically how many companies (including logistics providers) are involved in the process of delivering product from your company to the end user of your product?

49) Typically how many countries are involved in the process of delivering product from one of your company's production facilities to the end user of your product, including logistics providers?

50) Typically, which industry sectors are your products, which are likely to need serial lookup sold to?
[ ] healthcare
[ ] defence
[ ] FMCG
[ ] leisure
[ ] automotive
[ ] DIY / construction
[ ] food service
[ ] fashion/apparel
[ ] High Tech
[ ] other

51) Typically how many companies are there in your upstream supply chain including logistics providers?

13.5. E1 - Managing Serialised Information Q52 – Q63

13.5.1. Identifiers – issuing of serial numbers

52) Do the identifiers that you use include an indication of a product type or SKU?

53) How do you intend to allocate serial numbers :
[ ] sequentially
[ ] in a pseudo-random manner
[ ] in a significant manner ? If yes, in which way ?

54) Have you considered how you might manage serial number allocation across your entire enterprise (e.g. to avoid duplication)?

13.5.2. Identifiers – managing privacy

55) Would you require the killing of tags at some point, e.g. Point of Sale / store checkout (POS)?

56) If you were to use RFID tags to tag consumer-level items, would you continue to embed an indication of the product type or SKU in the EPC stored on the tag?

57) If not, what are your reasons for not including the product type?

Some companies and organizations have proposed using a more opaque identifier (which only indicates manufacturer and a very long opaque serial number, with no obvious correlation between the ID and the product type).

58) Would you prefer to use this type of identifier on an RFID tag?

59) Are you aware of any companies where even this approach may be too much of a threat to consumer privacy or supply chain security (e.g. a small specialist pharmaceutical company only producing one specialized type of medication (e.g. for treating HIV patients), which might cause the patient to be embarrassed if others could snoop what they were carrying, using an RFID reader? (In this example, identifying the company identifies what they are carrying, since the company only produces one product line)

13.5.3. Information and Integration

60) Do you intend to store serial-level information in your existing information systems?
[ ] No, not relevant
[ ] No, related effort too high
[ ] No, technically not feasible
[ ] Yes, on the enterprise level (e.g. ERP or SCM systems)
[ ] Yes, on the site level (e.g. MES or LES systems)
[ ] Yes, in dedicated repositories / applications for serial-level information

61) If you store serial-level information in your existing business information – or intend to do so in the future, do you store it for:
[ ] finished goods
[ ] unfinished goods / work in progress (WIP)
[ ] components / ingredients
[ ] reusable assets (including tools, equipment)
[ ] other

62) If you would provide serial-level information to external partners via a standard interface (e.g. EPCIS), would you provide this data:
[ ] directly from existing business information systems (e.g. ERP)
[ ] via a dedicated repository for serial-level information exchange

63) If you would use serial-level information, which data coming from your existing business information systems (e.g. ERP) would you regard as relevant:
- when using the data only internally_____
- when sharing the data with external partners_____

13.6. E2 - Lookup services – functionalities Q64 – Q71

64) What data would you expect to be able to retrieve from the supply-chain lookup service directly, i.e. without having to collate information from individual searches of partner EPCIS systems ?
[ ] links to databases of other companies that have handled the object/EPC
[ ] the timestamp or date of arrival (first observation) of the object/EPC within an organization
[ ] the timestamp or date of departure (last observation) of the object/EPC from an organization
[ ] information about changes of aggregation
[ ] metadata to indicate what type of data each organization can provide – e.g. temperature history
[ ] record that a physical tag has been killed
[ ] the current/updated status of a serialized object (e.g., issued/in distribution/sold/dispensed/returned/recalled/killed/expired/spoiled etc.)
[ ] other data , please specify : …..

65) Which of these queries should the serial-level lookup service support directly?
[ ] Retrospective Tracking query – where, when, by whom was the object last seen?
[ ] Prospective Tracking query – where, with whom should the object be now?
[ ] Trace query – where has the item been and at what times?
[ ] Destination query – where and when should the object be seen next?

[ ] Other – please specify

66) What data would you be willing to provide to it?
[ ] the address of your database where additional data may be queried
[ ] the timestamp or date of arrival (first observation – e.g. receipt or creation) of the object/EPC within your organization
[ ] the timestamp or date of departure (last observation – e.g. dispatch) of the object/EPC from your organization
[ ] information about changes of aggregation
[ ] metadata to indicate what type of data each organization can provide – e.g. temperature history
[ ] record that a tag has been killed
[ ] the current/updated status of a serialized object (e.g., issued/in distribution/sold/dispensed/returned/recalled/killed/expired/spoiled etc.)
[ ] other data, please specify : ……..

67) To how many supply chain companies would you be prepared to provide information on a single EPC?
[ ] 1
[ ] 2
[ ] 3-5
[ ] 6-10
[ ] 11-50
[ ] more than 50

68) To how many supply chain companies would you be prepared to provide information for your product range?
[ ] 1
[ ] 2
[ ] 3-5
[ ] 6-10
[ ] 11-50
[ ] more than 50

69) What sort of anomalies / discrepancies should the lookup service help in detecting?
[ ] Misplacement - which items are not where they should be?
[ ] Diversion - which items are not following the intended route?
[ ] Duplicate IDs / Cloning - which items are seen in two places at the same time?
[ ] Invalid status - which items are still seen after being sold / recalled / returned / discarded / tag killed?
[ ] Sensor information – when, where has sensor data been recorded where the value was out of range or outside a particular threshold value / safe limits for the product?
[ ] Other - please specify

70) Would you expect to be able to run standing queries on a lookup service, so that you would always be pro-actively alerted to the relevant updates as particular goods/EPCs move along the supply chain, without having to periodically query the lookup service just to see if there had been any recent updates?
YES/NO

71) In what way might you want to filter the updates that are sent to you as a result of such a standing query?
[ ] By organization providing the update (receiving/dispatching the goods)
[ ] By manufacturer code / company prefix of the manufacturer of the goods
[ ] By product line or stock-keeping unit (SKU)
[ ] By a specific serial number for a particular product (e.g. full EPC)
[ ] Other filter criteria for pro-active alerting _____

13.7. E3 - Look-up services – access control and security Q72 – Q79

The scope of supply-chain-wide item-level tracking/lookup services is related not only to your current trading partners, but also the whole supply chain community, including partners that you don't already know, such as customers, other entities etc.
For this reason, serious thought must be given to the authentication, authorization and access controls used for serial-level supply chain lookup services.

72) Is there a need for an internal lookup service enabling your company to query your internal databases without external queries ?

73) Which kind of information would you agree to share with all authenticated members of the supply chain community on an equal-access basis?
[ ] No information
[ ] The EPCs of the products you have handled
[ ] A timestamp of arrival (when you first handled the goods)
[ ] A timestamp of departure (when you no longer handled the goods)
[ ] An indication of geographic location (useful for customs, detecting diversion, etc.)
[ ] The address of your information service which authenticated authorized clients may query for more detailed information.
[ ] The current/updated status of a serialized object (e.g., issued/in distribution/sold/dispensed/returned/recalled/killed/expired/spoiled etc.)
[ ] Other data, please specify

74) What level of access would you allow for share of this information with other parties?
[ ] Governmental/regulatory body
[ ] Suppliers
[ ] Customers
[ ] Other, please specify? :

These are all NO ACCESS / QUERY (READ) / UPDATE (WRITE) / QUERY AND UPDATE (READ/WRITE)

75) What sorts of conditions/guarantees would be acceptable for such hosting of a serial-level lookup service by a third-party organization?
[ ] Technical guarantees
[ ] Contracts
[ ] Monitoring by a common authority or regulator
[ ] Other, please specify? :

76) Are you familiar with digital certificates / public key infrastructure (PKI)?
NOT AT ALL / SOME KNOWLEDGE / VERY FAMILIAR / EXPERT

77) Which kinds of organization(s) would you trust to manage the authentication of users of the lookup service infrastructure (e.g. using digital certificates, Public Key Infrastructure (PKI)) ?
[ ] Any private for-profit company, possibly certified
[ ] Governmental supported organisation / regulatory body
[ ] Non-governmental organization (NGO)
[ ] Industry body for a particular industry sector
[ ] Supply chain partner
[ ] Industry consortium
[ ] Other, please specify : ….

78) Which kinds of organization(s) would you trust to manage the access permissions for the lookup service infrastructure?
[ ] Any private for-profit company, possibly certified
[ ] Governmental supported organisation / regulatory body
[ ] Non-governmental organization (NGO)

[ ] Industry body for a particular industry sector
[ ] Supply chain partner
[ ] Industry consortium
[ ] Other, please specify : ….

79) Which kinds of organization(s) would you trust to operate the lookup service infrastructure?
[ ] Any private for-profit company, possibly certified
[ ] Governmental supported organisation / regulatory body
[ ] Non-governmental organization (NGO)
[ ] Industry body for a particular industry sector
[ ] Supply chain partner
[ ] Industry consortium
[ ] Other, please specify : ….

13.8. E4 - Lookup services – Performance Q80 – Q87

80) How quickly should events/updates to the lookup service be available after sending updated tracking or tracing information? (Latency time)
___days; ___ hours; ___ mins; ___ secs

81) How quickly would you expect to be able to receive a response to a tracking or tracing query? (Response time)
___ hours; ___ mins; ___ secs

82) Would a delayed (asynchronous) response also be acceptable?

83) What communication mechanism would be acceptable for a delayed/asynchronous response?
[ ] E-mail
[ ] HTTP POST to a pre-specified address
[ ] other? _____

84) What level of 'uptime' would you require from a lookup service?
___ % uptime (e.g. 99.9% uptime)
___ 24/7 access

85) What level of 'technical support' would you require from a lookup service?
___ Technical support available during office hours
___ 24/7 tech support

86) How often do you anticipate querying a lookup service?
[ ] on each shipping event
[ ] on each receiving event
[ ] times per day

87) How often do you anticipate updating a lookup service?
[ ] on each shipping event
[ ] on each receiving event
[ ] times per day

13.9. E5 - Look-up services - operational issues / financing Q88 – Q98

88) Which organization(s) should provide the serial-level lookup service(s)?
[ ] Any private for-profit company, possibly certified
[ ] Governmental supported organisation / regulatory body

[ ] Non-governmental organization (NGO)
[ ] Industry body for a particular industry sector
[ ] Supply chain partner
[ ] Industry consortium
[ ] Other, please specify : ….

89) Should serial-level lookup services be organized around:
[ ] no specific grouping
[ ] a particular industry sector
[ ] a particular manufacturer
[ ] a supra-national region (e.g. EU, North America, Asia-Pacific)
[ ] a country level (e.g. Germany, France, Spain)
[ ] other grouping _____

90) If multiple lookup services exist, what is your view on the overlap between these serial-level lookup services?
[ ] Each lookup service is distinct / separate
[ ] There is a need for a common query/update interface (or API) across all serial-level lookup services
[ ] There is a need for a greater co-ordination between different serial-level lookup services
(e.g. propagation of queries or updates between lookup services)
[ ] Other interaction/overlap – please specify…

91) How should an organization know which lookup service(s) to report an EPC to?
[ ] by inspecting the EPC header / coding scheme
[ ] by inspecting the EPC manager code / manufacturer ID
[ ] by querying the Object Name Service (ONS) to find the address of the appropriate serial-level lookup service
[ ] by tacit knowledge of which industry sector they're operating in
[ ] by tacit knowledge of which geographic region they're operating in
[ ] other criteria _____

92) How do you see the organisation of the lookup and access control services ?
[ ] no barrier to entry for any interested service providers
[ ] certification required for any interested service providers but no limitation of number
[ ] number of players limited
[ ] only specific players authorized to enter this market (please specify : ……..)
[ ] other, please specify : ……;;

93) Should these lookup services be priced :
[ ] On a cost recovery (not for profit) basis
[ ] On a price regulated basis
[ ] On a competitive market basis (if multiple players authorized)

94) Which organizations should have to pay for the cost of the serial-level lookup services?
[ ] Manufacturers
[ ] Distributors
[ ] Logistics providers
[ ] Retailers, pharmacies, etc.
[ ] Government / central taxation
[ ] All supply chain parties
[ ] Other – please specify…

95) Would your organization expect to have to pay to query the serial-level lookup service?
YES/NO

96) Would your organization expect to receive payment for updates you provide to the serial-level lookup service?
YES/NO

97) Which payment mechanisms would you prefer for use of a serial-level lookup service?
[ ] Based on number of searches
[ ] Based on number of items being tracked
[ ] Based on number of updates
[ ] Subscription fee / membership model (i.e. unlimited use)
[ ] Other – please specify

98) Would you be prepared to be contacted for further information regarding this questionnaire?
[ ] YES / [ ] NO

THE END! Thank you!

14. Appendix B: Detailed notes from an interview with a commercial provider of Discovery Services

These interview notes provide detailed insight into how and why companies will consider using Discovery Services.

Motivation for using track and trace systems

Q13-14/32) Why would your organization want to improve its tracking capabilities across the supply chain?

Mainly: Electronic pedigree
Comply with legislation

... though all reasons suggested are valid to some extent.

Retailers are interested in latent analytics – algorithms for flow detection, pattern matching, leading to changing their shipping channels and greater supply chain efficiency. Also important as vendor management / partner management becomes more important. By controlling visibility, they can make smarter business decisions.

Security - Many organizations have concerns about losing controls of their data

Fraud – important for management of parts – Track & Trace reduces fraud

History of a product – especially for asset management
For some organizations, a big motivation is to be able to check whether they are shipping the correct part – i.e. one that is certified for use in that country.

Q17) Are you affected by legislation requiring better traceability?

A lot of companies have concerns regarding killing of tags and consumers' right to know what is tagged, what is being tracked, what information is being collected etc.

Many of our customers are involved in pilot stages right now. Many have existing legislative needs/requirements to comply with. For example, Sarbanes-Oxley legislation – RFID could provide audit trails.
Many of our customers are looking for more cost-effective ways of complying with existing legislation and want to reduce errors – for example by automating product authentication – ideally to reduce the amount of manual testing/inspection and at the same time reduce the chance of fake/counterfeit product passing through undetected.
They're looking for solutions that are cost-effective and reliable.

Q33) Why do you want better upstream visibility?
In some cases, companies are sourcing supplies from multiple suppliers (sometimes even for the same part) – and they want to avoid losing track of which manufacturer produced which part or product.

Q34) Why do you want better downstream visibility?
They want to be able to do more selective (i.e. cost-effective) product recalls.

Q33/34) Why is better visibility important generally?
To manage safety inventories (safety stocks) more efficiently – and also to be able to cope better with just-in-time deliveries

Q40) What sort of information do you think your trading partners store about each individual object you receive or ship?

Yes to:
* shipping and receiving details
* operations performed on the object
* sensor measurements (e.g. temperature history)

There are already many proprietary communications between trading partners – and quite a lot of duplicate data is stored.

Many organizations would like to know how long something sits on a shelf.
Retailers would like to know about extra capacity.
Some may be more willing to share quite a lot of information, if it helps improve operational efficiency – though this is often tied into conditions.
Many are very interested in helping their suppliers to perform more efficiently.
There is also interest in tracking quality control throughout the supply chain – and finding out what is the average quality control 'ranking' for each custodian.

Anti-counterfeit and Product Authentication

Q25) Is counterfeit a problem? Yes, for some of our customers

Q27) Do you want your customers to be able to verify the authenticity of goods you supply?
Yes – but should a Discovery Service have offer direct public access? – Maybe not – maybe only via the retailer, using an ID on the receipt to log in?

Q29a) Are you concerned about cloning of RFID tags?
Yes – but the networked service infrastructure helps, because it allows suspicious activities to be captured and detected.
Regarding tag security, the UHF Class 1 Gen 2 protocol does not support a long enough key – it's too easy to break

Q29c) Any special security markings to distinguish a genuine product from a counterfeit?
One large customer does this – they use a combination of an obscured meaningless bit pattern in the identifier – and a UV watermark on the tag – so a combination of physical marks with the technical protocol

Consumer Privacy

Q52) Does your unique ID indicate a product type or not?
Sometimes customers want a non-revealing tag – especially if they are involving private label suppliers. It's useful to be able to set this, depending on the type of product.

Volumes of data and existing information management within your organization

Q30b) Volumes per year?

One large company is tracking around 230 million reusable assets per year
Another is tracking around 700-800 million reusable assets per year
Another company is tracking 50-80 million crates of food goods

Q60) Do you intend to store serial-level information in your existing information systems?
Many of our pilot partners envisage extending their existing systems with an EPCIS standard interface. Hardware is becoming cheaper.

Q61) If you store serial-level information in your existing business information systems or intend to do so in the future, do you store it for?
Yes to: finished goods, unfinished goods / work in progress, components/ingredients

Many organizations move products (or work in progress) across various geographic locations during manufacturing. Sometimes, they need an internal Discovery Service as well as an external Discovery Service.

End-to-end tracking capabilities

Q46/47) Use of Advance Shipping Notices in electronic format?
Most already do this, although there are various proprietary systems

Some smaller companies would like to use Discovery Services not just for referral to EPCIS for aggregation details – but possibly as a cache of this information

Many (especially those managing reusable assets) are interested in being able to dynamically track the assignment between container and contents/shipments over time, as the content/shipment carried by the reusable container changes.

Q62) If you would provide serial-level information to external partners via a standard interface (e.g. EPCIS), would you provide this data directly from existing business information systems (e.g. ERP) or via a dedicated repository for serial-level info exchange?

Most are undecided. Some are pilots for interfacing with existing business information systems – although they may segregate the data into a dedicated data queue for optimised performance. Many prefer the security of existing business information systems.

Queries and information held by the track and trace service

Q65) Which kinds of queries would you want to be able to do?

Discovery Services need to be journalled to comply with regulations. No UPDATES of records are permitted.

Queries need to be by event type or business step and perhaps over specified time ranges.

Q64) What sort of info to store in addition to (EPC, URL of EPCIS)?
business step (e.g. 'shipping') from each supply chain partner.
This should be managed through ISO efforts at industry-standard vocabularies – i.e. we need an independent 3rd party to agree on the terminology to be used.
We have suggested some initial 'types' or business steps.

Q69) What sort of anomalies/discrepancies should tarck & trace help detect?
It helps to develop a big picture – a dynamic moving picture regarding the health of their supply chain network
Everyone is interested in timings – delays, efficiencies, etc., managing safety inventories more efficiently.

Q70) Do you want the tracking service to pro-actively alert you of new records?
Some of the problems of 'PUSH' :
1) possibility of SPAM or unwanted messages
2) network interface technologies – web services don't do multicast.
We recommend using a publish-and-subscribe interface to allow clients to subscribe to an object / range of serial numbers of interest – and then to periodically poll a queue (much like checking of a POP mailbox).

Q67/68) T&T service might hold some commercially-sensitive data about volumes and flows of goods. How to control which organizations are accessing data about your products?

As well as access control policies and authentication, we may need to consider rate-limiting (e.g. how many queries in a given time period) – and limiting by volume.

In terms of access controls, it is desirable to be able to define supply-chain loops, and even within those loops, access controls between partners within a loop.
So, three levels of granularity security seem to be useful:

- access to the DS as an authorized user
- membership of a particular supply chain loop or cluster
- special privileges as a trusted trading partner within a loop or cluster

The operator of the Discovery Service must be able to set policies that over-ride the permissions set by the user.
This form of over-ride could do either way – e.g. to enforce visibility of particular fields – or to suppress visibility of particular fields. These could be any data fields.

Performance

Q80) Latency time for published records becoming visible?

Writing is an interesting problem. With replication systems – records should be reflected in a local Discovery Service in under 100 ms – and outside, within 200 ms locally. Looking at around 5-10 minutes propagation with Dynamic DNS implementations.

Q81) Response time to queries?
Question of performance. Single event, < 10 milliseconds + network delays – for a complex query, 100-150 milliseconds.

New Q) Do you want to be able to publish an update to the tracking service listing several unique IDs or EPCs that you have handled, rather than having to send a separate update message for each ID?

There's an obligation to name a 'master' EPC – it's very difficult to act on a virtual group ID.

New Q) Do you want to be able to query the track and trace service for a list of several unique IDs or EPCs – or would you prefer to make one query for each ID you want to track or trace?

We're worried about over-defining an aggregation event.

Q82) If you made a really complicated tracking query, would a delayed (asynchronous) response also be acceptable?

Yes

Q83) How would you like to receive the delayed response?

Publish-and-subscribe model, but with POP-like polling by the client to collect new records from a queue. (i.e. no obligation on the Discovery Service to ensure delivery).
See also IETF RFC 3730-3735 on the Extensible Provisioning Protocol (EPP)

Q84) What level of 'uptime' would you require from a track and trace service?
99.98% uptime for writing, 99.999% uptime for reading

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Requirements document of serial level lookup service for various industries

Section B:
Requirements for the Integration of Serial-level Lookup Services with Existing Business Information Systems. Report on Performed Interviews

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15 August 2007

Revision History

Version	Date	Author	Summary of Changes
0.5	February 2007	Cosmin Condea (SAP)	First Version of the document
0.55	March 2007	AT4 wireless	Document Review
0.98	July 2007	Cosmin Condea (SAP)	Final document Release
1.0	July 2007	Mark Harrison (Cambridge)	Proof - reading of document
	July 2007	Nicholas Pauvre (GS1 France)	Bridge Internal Review. Missing dates, suggestion for a shorter title
1.1	July 2007	AT4 wireless	Inclusion of comments from internal review.

Note

The views expressed in this document are the views of the joint authors and the *Community* is not liable for any use that may be made of the information contained herein.

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1. Introduction

As the enabler of inter-organizational sharing of item-level data, EPC Discovery Services will work in conjunction with other enterprise applications like ERP, SCM, etc. Therefore, together with the set of EPCglobal Network standards, they need to be incorporated into the existing landscape of enterprise applications. BRIDGE recognized the importance of this issue and addressed it in Task 2.2. Here, the precise objective was to produce a list of requirements with regard to integration of the EPCglobal Network into today's business information systems.

To achieve this goal, we conducted semi-structured interviews with experts and end-users alike. These interviews enabled us to successfully extract the desired requirements and acquire a very good understanding of the current situation. Our findings show in fact that, the real integration is not to take place directly between a Discovery Service and the enterprise applications, but rather between an EPC-IS repository and enterprise applications. Thus, the EPC-IS repository functions as a company's gateway for exchanging item-level information with external parties. This approach is supported by several strong arguments like the ease to set business rules for security and trust on top of a repository, the avoidance of high load on the enterprise applications due to external access and, last but not least, the possibility to improve performance by optimizing the repository for specific usage like, for example, fast EPC-IS querying.

Given the above arguments, attention is drawn to the link between the EPC-IS and the enterprise applications. There are two aspects to be analyzed here: the types of item-level information that are requested from the enterprise systems and the transfer methods between these systems and the EPC-IS repository. We have found out from the interviews that the set of requested data is fairly broad and it depends on the business / industry specifics. To make it available for external access, our findings suggest that it should be almost entirely replicated from the enterprise applications to the dedicated repository. The reasons include timeliness and eliminating the need to actively query the enterprise applications.

To synthesize the outcome of our work, we list the three determined requirements:

1. A broad set of data from enterprise applications MAY be requested depending on context, industry, application, etc.
2. External users SHALL NOT have direct access to enterprise applications.
3. Externally available data SHALL be sufficiently isolated from enterprise applications.

2. Methodology

In order to elicit requirements for the integration of EPCglobal Network into the existing landscape of enterprise applications, we have conducted semi-structured interviews with end-user companies and with RFID solution experts. Two sets of questionnaires were developed to suit each of the aforementioned categories of respondents. In principle, the basic idea was to use the input received from the presumably more experienced interview partners, that is, the RFID solution experts, in order to tailor the questionnaire for the end-users. Consequently, it was only after carrying out a number of expert interviews that we started interviewing the end-users as well.

3. Questionnaire Rationale

Within the entire integration topic, we have identified three sub-focuses. These are the storage and usage of item level information, the inter-company exchange of item-level information and, finally, the technical aspects related to integration. Each of the stated sub-

focuses is described in one separate subsection. There are several standard interview questions we devise that address each sub-focus and they are listed together with a brief indication of their intention. Note that whereas the questions belonging to first two sub-focuses are primarily targeted at end-user, the questions in the last sub-focus are only relevant to experts.

Figure 1 is a visualization of the typical IT infrastructure managing RFID data in a company. From bottom up, it illustrates in a rather simplistic manner all necessary layers, starting from RFID item-level information collection, then storage and finally sharing of the RFID information with external parties. Let us now explain the figure and point out our focus. Assume the figure depicts one company. The RFID readers are the first to gather the item-level information. This information is processed by the middleware and either stored in a dedicated repository for information exchange, directly integrated into the enterprise applications like ERP, SCM, etc. or actually split between both places. From there, it has to be made available to the exterior. Our interest lies exactly at this point, namely, we want to find out how the Discovery Service or other parties who were pointed by the Discovery Service to the Company's address, would retrieve item-level information from its enterprise applications. In other words, we are interested in the workings of the Discovery Service in conjunction with enterprise applications. We analyze the possibilities systematically. To access the data that is stored in the back-end systems from the exterior, there are basically two options: either direct access to the enterprise applications or to the repository, in case it is desired that the access of external parties is decoupled from their own enterprise applications. In the latter situation it is interesting to learn about the link between the repository and enterprise applications in terms of data transfer, types of data needed, etc. This entire set of interactions between the Discovery Service, the repository and the enterprise applications which constitutes our interest regarding the integration topic is depicted in Figure 1 by orange arrows.

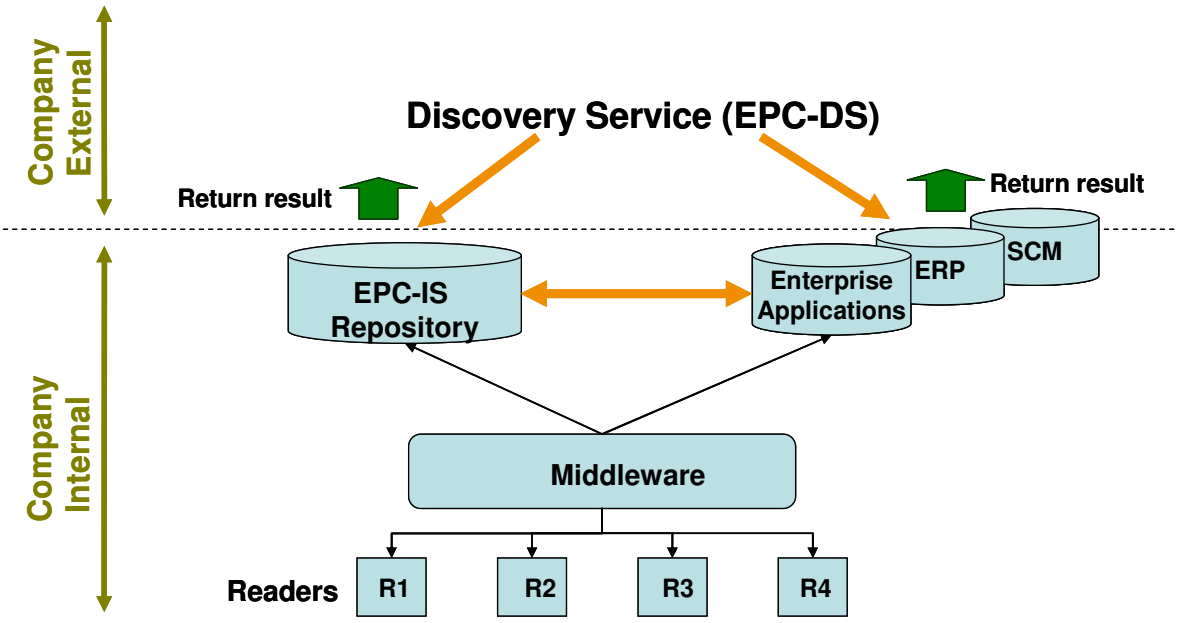

Figure 1: Simplified visualization of the typical enterprise IT infrastructure

3.1. Storage and Usage of Item-level Information

3.1.1. Relevance of Item-level Information

We aimed to learn whether companies currently store or intend to store item-level information in their existing enterprise applications.

The standard interview question was:

Question EU1. *Do you intend to store item-level information in your existing information systems?*

- *NO*
  - *not relevant*
  - *related effort too high*
  - *technically not feasible*
  - *Other:*
- *YES*
  - *on the enterprise level e.g. Enterprise Resource Planning (ERP) or Supply Chain Management (SCM)*
  - *on the site level e.g. Manufacturing Execution System (MES) or Logistic Execution System (LES)*
  - *in dedicated repositories / applications for item-level information*

3.1.2. Applications Using Item-Level Information

We tried to identify the applications within the interviewed companies where item-level information would be most relevant.

The standard interview question was:

Question EU2. *In what applications within your company could the item level information be relevant or is relevant already?*

3.1.3. From Capturing to Storage of Item-level Information

We wanted to discover how item-level information is collected in the back-end systems. Basically, there are two viable variants: either connecting the readers directly to the back-end systems using middleware or gather the data from a repository (EPCIS) where it was previously stored.

The standard interview question was:

Question EU3. *If you previously indicated that you store item-level information in your enterprise applications, do you directly connect the readers to these back-end systems using middleware or do you gather these item-level data from the EPCIS?*

3.1.4. Product Types

Our goal here was to identify the types of product, goods or assets for which companies would be inclined to store item-level information.

The standard interview question was:

Question EU4. *For what kind of products / goods / assets would you store item-level information?*

- *finished goods*
- *unfinished goods / work in progress (WIP)*
- *components / ingredients*
- *reusable assets (including tools, equipment)*
- *Other - please specify:*

3.2. Inter-company Exchange of Item-level Information

3.2.1. Business Contexts Requiring Exchange of Item-level Information

We wanted to identify the business contexts where, on one hand, one would need and, on the other hand, one would share item-level information coming from enterprise applications.

The standard interview question was:

Question EU5. *In which context would you like to share data from your company, or respectively, to retrieve data from across the supply chain or other business partners?*

Hints: *For a better understanding, here are some examples: track & trace, anti-counterfeiting, e-pedigree (for Pharma only), inventory control etc.*

3.2.2. Standard Interfaces

We tried to find out whether companies use standard interfaces to share data externally. In case they did not, we asked them to specify how they are prepared to solve compatibility issues.

The standard interview question was:

Question EU6. *Do you use a standard interface to provide information to external partners? If not, how are you prepared to handle compatibility issues?*

3.2.3. Required Item-level Information from Enterprise Applications

Our aim here was to make interview partners, end-user companies and experts alike, specify what item-information coming from enterprise applications is highly probably to be asked by other partners in the supply chain.

The standard question in the end-user interview guideline was:

Question EU7. *Given you used an item-level look-up service (EPC-IS or Discovery Service), which data / attributes coming from enterprise applications (versus "pure" reader data) would you like to get from external partners in the supply chain?*

Hints: *Do you need transactional data such as related purchase orders, shipments etc.?*

Is a reference number (e.g. purchase order number) sufficient or do you need additional details / attributes (think of the expiry date example for batches)?

Do you need master data information? Is it just identifiers (e.g. material or part number) or do you need additional details / attributes (e.g. material / part short description)?

The standard question in the experts' interview guideline was:

Question EX2. *RFID events, or the so-called transactional data, are stored in the EPC-IS repository. In your opinion, what additional information coming from back-end systems, if any, needs to be stored in the EPC-IS?*

3.3. Technical Integration Aspects

3.3.1. Direct Access vs. Repository

Given an appropriate interface is in place, there are two options to provide item-level data. The first one is to let other partners access the enterprise applications which store the desired item-level information directly and the second one is via a dedicated repository for item-level information exchange.

Note: this was the only question asked both to end-users and experts.

The standard interview question was:

Question EX1. *If you provided item-level information to external partners via a standard interface (e.g. EPCIS), how would you do this?*

- *Directly from existing business information systems (e.g. ERP)*
- *Via a dedicated repository for item-level information exchange?*

Note: The same question was asked from the end-users and had index ***Question EU7.***

3.3.2. Back-end Systems

We wanted to know from which enterprise applications could data be provided.

The standard interview question was:

Question EX3. *From what systems could you provide data?*

3.3.3. Link between Back-end Systems and Repository

Here, we asked for a description of the predictable link between the repository and back-end systems. We were mainly concerned with the direction “from enterprise applications towards EPC-IS”. In this respect, there are two feasible options: replication or references. We asked respondents to discuss the two.

The standard interview question was:

Question EX4. *How do you envision the link between EPC-IS and back-end systems?*

Hints: *Consider possibilities like references, data replication, etc.*

4. Interview Results

4.1. Storage and Usage of Item-level Information

4.1.1. Relevance of item-level information

In terms of item-level information storage, the interviewed end-user companies have mostly indicated that they have no current plans to store this. They considered RFID item-level information irrelevant for their situation and usually stated that the benefits would be far too

low compared with the effort or costs. For example, an end-user company from the food industry indicated the high volume of low-priced products they produce as a reason not to tag every item. A company from the spare-parts business in automobile industry affirmed that in their case, tagging is not technically possible due to environmental constraints. In other words, the nature of their products (e.g., metal or carbon parts in metal/mesh wire boxes) is currently preventing RFID-usage. However, this company realizes RFID item-level tagging offers a big potential for improvements, especially in logistics processes. Another company from the retail industry said that, given their limited infrastructure, resources, and size, it is not technically feasible to maintain information about all their 3.5 million products available for sale on an ongoing basis. Solely for products necessitating quality control, this company nevertheless indicated that they store the item-level information which is mandated by law in dedicated repositories.

4.1.2. Benefits of Tagging

Regarding the applications where item-level is relevant, companies from the food or personal care sector have stated that they are currently tagging batches, cases or pallets. Please note that this granularity of tagging is above pallet-level or case-level. Other applications include asset tracking and tracking of high-value spare parts. One of these companies has also considered item-level tagging of big containers like drums of perfumes as well as bulk quantities of tea and detergent. Still, they have no concrete plans for it. The abovementioned companies from the food or personal care sectors also indicated they would like to use RFID in promotional activities at the retailer in order to display advertisements depending on the products that are nearby. One interview partner representing a company from the spare parts in the automotive industry declared that his company would like to employ RFID item-level information in logistics systems and warehouse management systems. A company from the retail industry stated that they would use item-level information in regulated sectors like food traceability. While this company also realizes the importance of anti-counterfeiting, especially for expensive products, they do not have any plans in this respect at the moment.

4.1.3. Integration of Item-Level Information into Existing Enterprise Applications

A company from the retail industry stated that they do not connect the readers to the enterprise applications via middleware. The same approach seems to be pertinent to a company in the food industry, which has described the process of storing data for cases or pallets into enterprise applications.

1. Collect (pallet-level and case-level) information using RFID readers
2. Transfer that information to a central repository that is separate from other enterprise applications
3. Integrate selected information into enterprise applications.

Companies have indicated that they would store item-level information for the following categories of products:

- finished goods
- components / ingredients
- reusable assets (particularly tools and equipment)

Of high importance for a company from retail are the products that have to undergo a control / quality check. For these kinds of products, typically finished goods, this company would store item-level information.

4.2. Exchange of Item-level Information

In the following business contexts relying on RFID technology companies indicated that they would exchange data with other industrial partners. These are:

- Track & Trace
- Inventory Control
- Promotional Activities
- Anti-counterfeiting: in the short or medium term future RFID is not regarded however as a means to fight counterfeiting in food industry.

Note that none of the abovementioned applications have yet reached a high level of maturity.

There seems to be openness towards adopting EPCglobal standards in the food and retail industry. One company in this sector has already agreed with several other large retailers in US and Germany upon using the EPC standards for information sharing / exchange. The same company is currently negotiating with a UK retailer an agreement on the mutual adoption of EPC-standards. On the other hand, another retailer is using at present HTTP or SOAP (Simple Object Access Protocol) for exchanging XML messages with its partners but has nevertheless not yet considered the EPCglobal Network. This seems to indicate that they are using a proprietary exchange format over open web-standards. Also, in the automotive industry there is no decision about the usage of EPCglobal Network yet.

Our interview partners have identified the following information as being useful to be retrieved from other partners in their supply chain:

- Transactional information
- Distributed planning information of retailers
- EPC identifiers
- Inbound delivery number & line number
- Material number (especially for materials that represents the pallet/box)
- Expiry date
- Batch number
- Maybe physical dimensions & weight
- More detailed location information
- “Sold-by” date
- Arrival of physical goods
- Temperature
- Advanced shipping notice
- Pedigree-type data.
- Order number
- Shipping number
- Delivery number

However, most end-user companies and experts have acknowledged that this depends on the industry and the use-cases.

4.3. Technical Integration Aspects

The question of whether companies would share item-level information directly from their back-end systems or via a dedicated repository has been asked of both experts and end-users. All interview partners (except one expert who acknowledged this would depend on the ERP capacities) opted to use a separate repository to share information with external companies while excluding the direct access to enterprise applications by other companies. The reasons for that are:

- Possibility to more easily specify the precise business rules for trust and security on top of the repository.
- Avoidance of high-load on the back-end systems and thus the chance that these are overloaded and could not perform as expected*. Note: this reason was not mentioned by the any of the interview partners of Task 2.2, but extracted from the deliverable D4.1.*
- Performance reasons because one can always optimize that data storage specifically for the EPC-IS query.

The enterprise applications from where one can provide data would be, in view of some experts, the ERP and supply chain responsible application. However, one expert asserted that in theory any enterprise application can be a potential source of data.

With regard to the link between the EPC-IS repository and the enterprise applications, most expert interviewees suggest a complete replication from the ERP to the repository. Of course, this depends on the timeliness required, but in principal they do not see as likely that information is requested from outside and gathered internally from several sources. In other words, we should not expect the EPC-IS to query the enterprise applications.

5. Extracted Requirements and Requests

From the interview results above, we could draw the following requirements and requests. In order to avoid dictating a certain implementation or impose restrictions about how the Discovery Service is integrated with enterprise applications, we distinguish between requirements and requests. The interviewees often talk from experience; that is, end-users describe their company's specific setting whereas experts are most likely to consider their own solutions. Hence, we deem the statements from our respondents as stakeholder requests. They are presented in Section 5.1. Given these requirements, we believe the future EPCglobal Network should take into account the requirements presented in Section 5.2.

5.1. Requests

5.1.1. Request 1

Item-level information from enterprise applications SHALL be provided via a dedicated repository.

5.1.2. Request 2

Externally available data coming from enterprise applications SHALL be replicated to the dedicated repository for information exchange.

5.2. Requirements

5.2.1. Requirement 1

A broad set of data from enterprise applications MAY be requested depending on context, industry, application, etc.

5.2.2. Requirement 2

External users SHALL NOT have direct access to enterprise applications.

5.2.3. Requirement 3

Externally available data SHALL be sufficiently isolated from enterprise applications.

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Requirements document of serial level lookup service for various industries

Section C:
Report: Formal List of Requirements for Discovery Services

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15 August 2007

Revision History

Version	Date	Author	Summary of Changes
0.4	March 2007	AT4 wireless	Structure of the document, requirements taxonomy and first list of requirements
0.5	April 2007	Oliver Karsten (SAP)	Addition of extra requirements and comments to initial list
0.7	May 2007	AT4 wireless	New version of the document
0.85	June 2007	AIDA Centre, SAP, BT, Cambridge	Addition of missing requirements. Document update
0.90	June 2007	AIDA Centre	Document review
0.95	June 2007	AT4 wireless	Document final version
1.0	July 2007	Mark Harrison (Cambridge)	Proof – reading of the document
	July 2007	Nicholas Pauvre (GS1 France)	Bridge Internal Review. Eliminated reference to section 0 which was only on the draft “Assignment of tasks” On page 17. Change “Section 2 in deliverable 2.1 part A” by “Point 2 in deliverable by Chapter

Note

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1. Introduction

This document concludes the set of reports that compose deliverable D2.1 and reflects the work done in T2.1 and T2.2, the preamble to the prototype development.

The content of the document is focused on the final and formal list of requirements which has been extracted through the information collected in the questionnaire and interviews.

The WP2 partners clearly understand that such a requirements list may vary as soon as serial level lookup services become more familiar to final users so at this moment of time this "top layer" of the EPCglobal network it is not deeply known by the general public. For that reason this document, which sets some guidelines for the development of the discovery service prototype, should be reviewed if taken for any other use in the future.

To complement the work presented here, it is worth mentioning that apart from those requirements obtained here, for the final serial level lookup service, some other requirements on the privacy and security issues would be necessary. Those are however, collected by WP4 and included in D4.1.1.

Finally, as this is a cooperative project, there has been an interim document to the other BRIDGE members and specially those working on the business WPs presenting the results of WP2 development, so feedback to our WP is welcomed and can be done through our general meetings like Project Management and Co-operation Board (PCMB) or General Assembly meetings.

2. Requirements Management – Overview

The first step is to define a strategy of the process; this process is described below in Figure 1 and includes:

1) Requirements Elicitation and Analysis
2) Requirements Specification
3) Requirements Validation

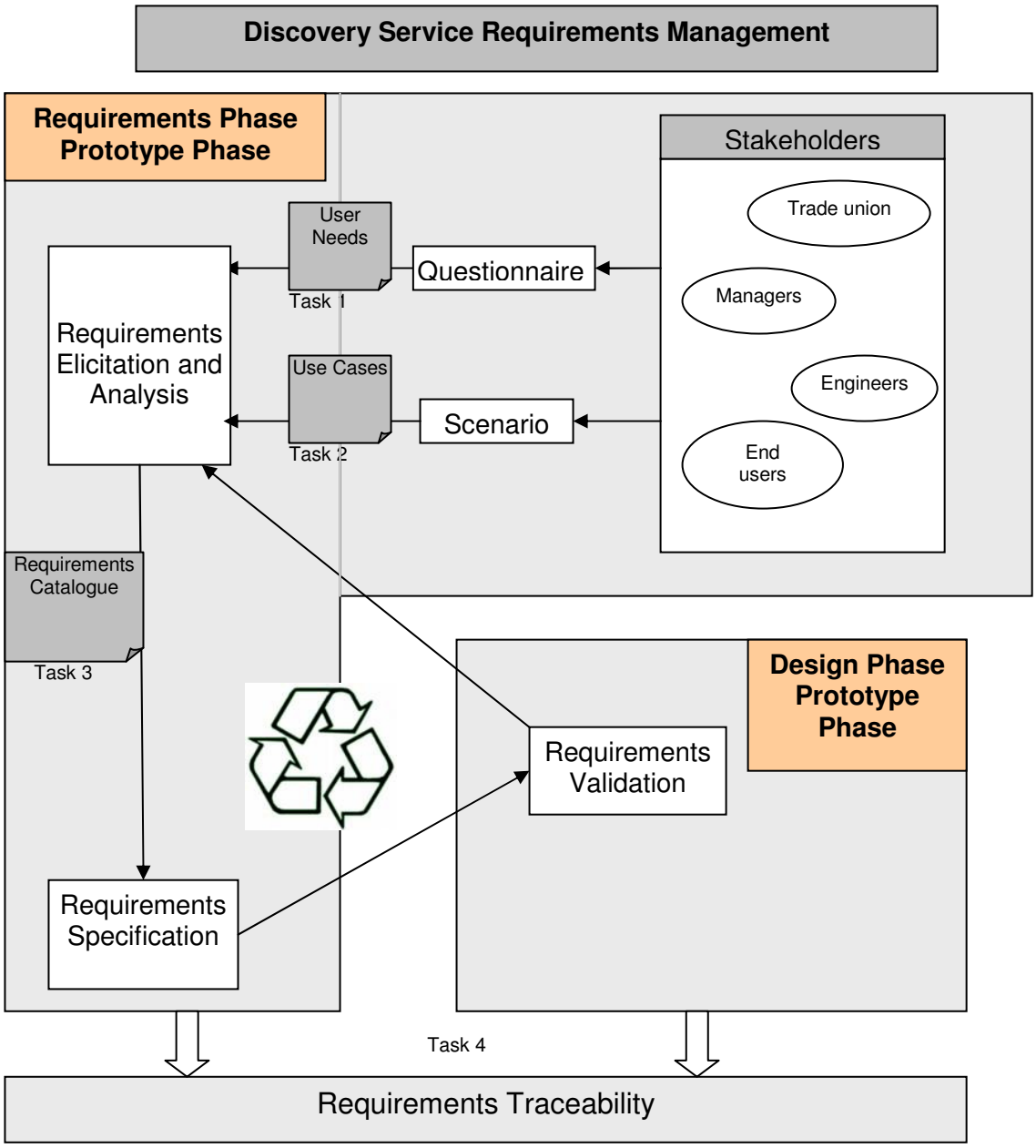

Figure 1: Requirements Elicitation Process

Requirement Elicitation

There are several complementary techniques to obtain system requirements from the potential users of the serial level lookup services:

1. Making questionnaires and/or interviews
2. Building scenarios that represent real-life examples of how a system can be used (e.g. use cases, scenarios implemented in UML).

In the case of serial-level lookup services, the questionnaires and interviews have been performed in both T2.1 and T2.2, and the reports are included in this document, specifically in section A for requirements of serial level lookup services and section B for integration requirements of discovery services with existing Business Information Systems (BIS).

About the use cases, in parallel to the elicitation process and although not initially described in project DoW, WP2 partners have completed a task focused on the High Level Design of the serial level lookup service. Thus, different design models architectures and their behaviours has been discussed and comparisons have been made in different aspects, among others; security and privacy, performance and scalability.

The public information from this task will be included in D2.4, however, during the task development some interim documents where written to support the discussion. Those have contributed to the development of the final document and were concerned with:

- Track and Trace Scenarios
- Data Model
- Aggregation Document
- Supporting Standing Queries Document

These issues will be, indeed, the core content of the above mentioned D2.4

Requirement Analysis

As stated in the introduction, it was detected when performing interviews and/or processing questionnaire responses that sometimes interviewees were not familiar with the serial level lookup services nor even with the EPCglobal architecture, and it is worth mentioning here that disseminating RFID/EPC Network technology through European industry is an objective of the BRIDGE project itself. Therefore, the raw data extracted has to be processed

- Sometimes, interviewees don't know what they really want to improve in the track and trace models
- Sometimes, interviewees are too afraid of sharing business information with third parties like discovery services – who will operate these services?
  (this is not possible to answer and outside the scope of this R&D technology WP)
- For the engineers, it is necessary to translate the "language" of interviewees to a formal description of system requirements
- There are different sorts of requirements: user requirements, system requirements, performance requirements, scalability requirements, etc.

Requirements Specification

After the analysis, the requirements must be formally structured by means of:

- Prioritisation by relevance.
- Classification by taxonomy.
- Documentation

The proposed taxonomy is:

<table>
<tr><td rowspan="9">Requirements</td><td colspan="2">Functional</td></tr>
<tr><td rowspan="8">Non-functional</td><td>Availability</td></tr>
<tr><td>Maintainability</td></tr>
<tr><td>Backward Compatibility</td></tr>
<tr><td>Forward Compatibility</td></tr>
<tr><td>Reliability</td></tr>
<tr><td>Scalability</td></tr>
<tr><td>Usability</td></tr>
<tr><td>Security (*)</td></tr>
</table>

To present the requirements, the following template will be use:

ID	**Unique identifier of the functional requirement**
Priority	One of: *high*, *medium*, *low*, or *dropped*.
Summary	Brief description of the requirement
Rationale	Description of the reason that the requirement is needed
Priority Rationale	A description of the reason for the assigned priority.
Requirement	The behavior that is required of the system.
References	Use cases and other functional and nonfunctional requirements which are relevant for understanding this one.
Originator	When particular system requirements are included, the entity which provided the requirement should be established.

Requirements Validation

The final list of requirements must be reviewed in the following terms,

- Validity: Does the system provide the functions which best support the user needs?
- Consistency: Are there any requirements conflicts?
- Completeness: Are all the required functions implemented?
- Feasibility: Can the requirements be fully implemented with the available budget and technology?
- Verifiability: Can conformity of requisites to be checked?

To do this review, there are two different techniques,

- Requirements Review: this has been done before compiling the final list, therefore, here is only included the final formal list of requirements
- Prototyping: this is the major task of WP2 and is expected to finalize at M15, after which the prototype will be evaluated to see how it fulfils the requirements.

3. Requirements Gathering and Assessment

Requirements extracted from Questionnaire

ID	REQ_REP_1
Priority	WP2: dropped
Summary	Customers may have access to DS to authenticate products
Rationale	75% of questionnaire responses agree on that.
Priority Rationale	This service is provided by EPC-IS
Requirement	Customers may have access to DS to look for the manufacturer of the product in order to authenticate it.
References	Customers may verify authenticity of the products. • Bridge WP2-3 report v0.3. Section 4.6 Anti-counterfeit and product authentication (Q25-29)
Originator	AT4 wireless
Taxonomy	Functional

ID	REQ_REP_2
Priority	WP2: dropped.
Summary	Members of the supply chain may access to DS to authenticate products from suppliers.
Rationale	66% of questionnaire responses agree on that.
Priority Rationale	This service is provided by EPC-IS.
Requirement	Members of the supply chain may have access to DS to look for the supplier of their product in order to authenticate them.
References	Users may verify the authenticity of goods from their suppliers • Bridge WP2-3 report v0.3. Section 4.6 Anti-counterfeit and product authentication (Q25-29)
Originator	AT4 wireless
Taxonomy	Functional

ID	REQ_REP_3
Priority	WP2: dropped
Summary	Discovery Services may have access to the manufacturer company.
Rationale	7 of the companies agree on that.
Priority Rationale	This service is provided by ONS.
Requirement	DS may have access to the manufacturer company to cross-check the EPC programmed into the tag against the tag's own pre-recorded read-only Tag ID
References	It would be useful to be able to cross-check the EPC programmed into the tag against the tag's own pre-recorded read-only Tag ID • Bridge WP2-3 report v0.3. Section 4.6 Anti-counterfeit and product authentication (Q25-29)
Originator	AT4 wireless
Taxonomy	Functional

ID	REQ_REP_4
Priority	WP2: dropped

Summary	Discovery Services may have access to the manufacturer company
Rationale	7 of the companies agree on that.
Priority Rationale	This service is provided by ONS.
Requirement	Discovery Services may have access to the manufacturer company to cross-check between the EPC and some characteristics of the physical object (including customized security markings, precise weight etc.).
References	It would be useful to cross-check between the EPC and some characteristics of the physical object (including customized security markings, precise weight etc.). • Bridge WP2-3 report v0.3. Section 4.6 Anti-counterfeit and product authentication (Q25-29)
Originator	AT4 wireless
Taxonomy	Functional

ID	**REQ_REP_5/6**
Priority	High
Summary	Discovery Services shall provide the client with a list of EPCIS and other EPC related resources.
Rationale	80% of questionnaire responses agree on that.
Priority Rationale	Main functionality of DS.
Requirement	DS shall provide access to recover additional information recorded by supply chain partners.
References	Supply chain partners will record additional information about objects at serial level. • Bridge WP2-3 report v0.3. Section 6.3.1 Information recorded by supply-chain partners (especially downstream) (Q40)
Originator	AT4 wireless & AIDA Centre
Taxonomy	Functional

ID	**REQ_REP_7**
Priority	High
Summary	Discovery Services may provide information about aggregation of objects.
Rationale	62% of questionnaire responses agree on that.
Priority Rationale	Main functionality of DS.
Requirement	Discovery Services may help recovering information about aggregation of objects.
References	Aggregation of objects • Bridge WP2-3 report v0.3. Section 6.7.2 Aggregation (Q 45)
Originator	AT4 wireless
Taxonomy	Functional

ID	**REQ_REP_8**
Priority	High
Summary	Discovery Services may provide disaggregation information of aggregated objects when broken into smaller units.
Rationale	67% of questionnaire responses agree on that.
Priority Rationale	Main functionality of DS.
Requirement	Discovery Services may provide disaggregation information of aggregated objects when broken into

	smaller units
References	Objects may be breakdown in smaller units • Bridge WP2-3 report v0.3. Section 6.7.1 Breakdown to smaller units (Q44)
Originator	AT4 wireless
Taxonomy	Functional

ID	**REQ_REP_9**
Priority	WP2: dropped
Summary	The Discovery Service shall provide to the client the possibility to gather additional information.
Rationale	60% of questionnaire responses agree on that.
Priority Rationale	This service is provided by EPC-IS
Requirement	The Discovery Service shall provide access to recover additional information.
References	Companies would likely continue to embed the product type or SKU information in the EPC stored on the tag. • Bridge WP2-3 report v0.3. Section 7.4.2 Embed SKU in consumer level tags (Q56)
Originator	AT4 wireless
Taxonomy	Functional

ID	**REQ_REP_10**
Priority	WP2: dropped.
Summary	The DS shall provide to the client the possibility to gather additional information.
Rationale	Most of the companies of the questionnaire agree on that.
Priority Rationale	This service is provided by EPC-IS.
Requirement	The DS shall provide access to recover additional information.
References	Companies propose to store the serial-level information in the existing information systems (on the enterprise level) • Bridge WP2-3 report v0.3. Section 7.5.1 Store serial level data in internal systems (Q60)
Originator	AT4 wireless
Taxonomy	Functional

ID	**REQ_REP_11**
Priority	high
Summary	DS shall help finding companies of the supply chain of a product.
Rationale	Most of questionnaire responses agree on that.
Priority Rationale	Main functionality of DS.
Requirement	DS shall help finding companies of the supply chain of a product.
References	Look-up service is able to query directly the downstream information in the supply chain (Retrospective Tracking) • Bridge WP2-3 report v0.3. Section 8.2 Types of queries required (Q65)
Originator	AT4 wireless
Taxonomy	Functional

ID	**REQ_REP_12**

ID	**REQ_REP_12**
Priority	high
Summary	Data that companies are willing to provide to the look-up services are mainly URL/Address of database for additional information.
Rationale	Most of questionnaire responses agree on that.
Priority Rationale	Publisher shall send this information to the DS.
Requirement	Data that companies are willing to provide to the Discovery Services are mainly URL addresses of databases / EPCIS repositories.
References	Data that the companies are willing to provide to the look-up services are mainly URL/Address of database for additional information, and changes in object status (aggregation, killing, etc) • Bridge WP2-3 report v0.3. Section 8.3 Data to be provided to lookup services (Q66)
Originator	AT4 wireless
Taxonomy	Functional

ID	**REQ_REP_13**
Priority	WP2: dropped.
Summary	The DS should be capable of detecting anomalies / discrepancies
Rationale	Most of questionnaire responses agree on that.
Priority Rationale	This service is provided by application specific modules (WP3)
Requirement	The DS should be capable of detecting anomalies / discrepancies
References	Look-up service should be capable of detecting anomalies / discrepancies • Bridge WP2-3 report v0.3. Section 8.6 Anomalies to be detected (Q69)
Originator	AT4 wireless
Taxonomy	Functional

ID	**REQ_REP_14**
Priority	high
Summary	Filtering requirements for standing queries
Rationale	Most of questionnaire responses agree on that.
Priority Rationale	Main functionality of DS.
Requirement	It should be possible to define filtering criteria in order to filter the updates that are sent to customers as a result of a standing query: - By the organization providing the update - By product line / SKU - By specific serial number/ full EPC - By the manufacturer code / company prefix of the goods.
References	• Bridge WP2-3 report v0.3. Section 8.7.1 Filtering requirements for standing queries (Q71)
Originator	AT4 wireless
Taxonomy	Security

ID	**REQ_REP_15**
Priority	high
Summary	The DS should be able to provide different access

	controls, for different kinds of data.
Rationale	Most of questionnaire responses agree on that.
Priority Rationale	Main functionality of DS.
Requirement	DS should implement different access control policies, depending on the type of data required.
References	• Bridge WP2-3 report v0.3. Section 9.1.2, Kinds of Info to share with all authenticated members of the supply chain on equal access basis, Section 9.1.3, Level of access granted to other parties (Q73-74)
Originator	AIDA Centre
Taxonomy	Availability

ID	**REQ_REP_16**
Priority	low
Summary	An external, non-government organisation might be trusted to provide authentication, access control, or operation of the DS
Rationale	Most of questionnaire responses agree on that.
Priority Rationale	WP2: depends on DS specific implementation
Requirement	DS should be able to implement authentication and access control policies, specified by an external organization.
References	• Bridge WP2-3 report v0.3. Section 9.1.6, Organisations trusted to manage authentication of users of lookup service, Section 9.1.7, Organisations trusted to manage access permissions for lookup service, Section 9.1.8, Organisations trusted to operate the lookup service infrastructure (Q77-79)
Originator	AIDA Centre
Taxonomy	Availability

ID	**REQ_REP_17**
Priority	high
Summary	Speed of events/updates becoming available/visible must be within one minute.
Rationale	Most of questionnaire responses agree on that.
Priority Rationale	Time critical requirement.
Requirement	Speed of events/updates becoming available/visible must be within one minute.
References	• Bridge WP2-3 report v0.3. Section 10.1 Speed of events/updates becoming available/visible (Q80)
Originator	AT4 wireless
Taxonomy	Availability

ID	**REQ_REP_18**
Priority	high
Summary	Expected speed of response to tracking / trace query must be within a few seconds
Rationale	Most of questionnaire responses agree on that.
Priority Rationale	Time critical requirement.
Requirement	Expected speed of response to tracking / trace query must be within a few seconds
References	• Bridge WP2-3 report v0.3. Section 10.2 Expected speed of response to tracking / trace query (Q81)

ID	**REQ_REP_18**
Originator	AT4 wireless
Taxonomy	Availability

ID	**REQ_REP_19**
Priority	medium
Summary	Methods for communicating a delayed response are the email or HTTP POST (which even could be SOAP like)
Rationale	Most of questionnaire responses agree on that. One of the methods will be chosen,
Priority Rationale	WP2: depends on DS specific implementation
Requirement	Methods for communicating a delayed or asynchronous response are via email or HTTP POST (which even could be SOAP like)
References	• Bridge WP2-3 report v0.3. Section 10.4 Communication mechanism for delayed/async response? (Q83)
Originator	AT4 wireless
Taxonomy	Functional

ID	**REQ_REP_20**
Priority	high
Summary	Level of uptime required from DS is > 99.99% within an access time of 24/7
Rationale	71% of questionnaire responses agree on that.
Priority Rationale	Availability critical requirement.
Requirement	Level of uptime required from lookup service is 24/7
References	• Bridge WP2-3 report v0.3. Section 10.5 Level of uptime required from lookup service (Q84)
Originator	AT4 wireless
Taxonomy	Availability

ID	**REQ_REP_21**
Priority	WP2: dropped
Summary	Updating frequency of both shipping and receiving events: within one minute.
Rationale	Most of questionnaire responses agree on that.
Priority Rationale	WP2: This requirement is already included in REQ_REP_17
Requirement	Updating frequency of both shipping and receiving events: within one minute.
References	• Bridge WP2-3 report v0.3 Section 10.8 Anticipated frequency of updating a lookup service (Q87)
Originator	AT4 wireless
Taxonomy	Availability

ID	**REQ_REP_22**
Priority	high
Summary	A common query/update interface or API across all DS is required.
Rationale	Most of questionnaire responses agree on that.
Priority Rationale	Interoperability between clients, publishers and DS is critical.
Requirement	A common query/update interface or API across all DS is required.

References	Need common query/update interface or API across all serial-level lookup services • Bridge WP2-3 report v0.3 Section 11.3 View on overlap between multiple serial-level lookup services (Q90)
Originator	AT4 wireless
Taxonomy	Functional

ID	**REQ_REP_23**
Priority	high
Summary	The ONS service or the EPC (with manufacturer ID or coding scheme) may be used in order to know which DS to report to.
Rationale	Most of questionnaire responses agree on that.
Priority Rationale	Prerequisite to work with open loop supply chains
Requirement	An ONS service or the EPC (with manufacturer ID or coding scheme) may be used in order to know which lookup service to report to.
References	How should an organization know which lookup service to report to? • Bridge WP2-3 report v0.3. Section 11.4 How should an organization know which lookup service to report to? (Q91)
Originator	AT4 wireless
Taxonomy	Functional

ID	**REQ_REP_24**
Priority	medium
Summary	The provision of lookup services and access control services should require certification but with no limit on number of operators.
Rationale	Most of questionnaire responses agree on that.
Priority Rationale	It depends on the industry sector.
Requirement	The provision of lookup services and access control services should require certification but with no limit on the number of providers.
References	organization of lookup and access control services • Bridge WP2-3 report v0.3. Section 11.5 Views on organization of lookup and access control services (Q92)
Originator	AT4 wireless
Taxonomy	Functional

Requirements extracted from Deliverable 4.1.1 (BRIDGE WP4)

Name	**REQ_T&T_1**
Priority	high
Summary	The EPCIS controller shall notify the DS about new EPC registrations that it wishes to announce to other parties.
Rationale	Track & Trace service requirement
Priority Rationale	Prerequisite
Requirements	When a new EPC is created, an EPCIS should be

	updated. A DS may be notified through a message that contains the EPC and its host EPC IS.
References	• Deliverable 4.1.1 of WP4: 5.3 Track & trace scenarios
Originator	AT4 wireless
Taxonomy	Functional

Name	**REQ_T&T_2**
Priority	high
Summary	The EPCIS controller shall notify the DS about product updates that it wishes to announce to other parties.
Rationale	Track & Trace service requirement
Priority Rationale	Prerequisite
Requirements	Product updates are automatically recorded in the company's own EPCIS. An information provider may notify a DS via a message to register that updated information about the object has been recorded.
References	• Deliverable 4.1.1 of WP4: 5.3 Track & trace scenarios
Originator	AT4 wireless
Taxonomy	Functional

Name	**REQ_T&T_3**
Priority	high
Summary	Track and Trace service shall query DS to get information about product updates (initialization, shipments, etc…)
Rationale	Track & Trace service requirement
Priority Rationale	Prerequisite
Requirements	Discovery Services may be notified by companies about product updates and where this information has been recorded (e.g. specifying the address of an EPCIS). Track and Trace services may query Discovery Services to retrieve links to that data.
References	• Deliverable 4.1.1 of WP4: 5.3 Track & trace scenarios
Originator	AT4 wireless
Taxonomy	Functional

Name	**REQ_T&T_4**
Priority	high
Summary	Discovery Service shall provide data from all EPC IS references to the Track & Trace service, which then aggregates the data into a complete record trace.
Rationale	Track & Trace service requirement
Priority Rationale	Prerequisite

Name	REQ_T&T_4
Requirements	Track and Trace services may query Discovery Services to retrieve links to that data. • Discovery Services shall return the EPCIS addresses that store the relevant information • A Track & Trace service may then query each EPCIS to retrieve detailed information, then assemble the complete information
References	• Deliverable 4.1.1 of WP4: 5.3 Track & trace scenarios
Originator	AT4 wireless
Taxonomy	Functional

Requirements extracted from Deliverable 2.4

Name	REQ_DES_1
Priority	high
Summary	Mandatory information to be held by the DS for Basic DS records.
Rationale	Track & Trace service requirement
Priority Rationale	Mandatory information stored by DS
Requirements	Mandatory information to be held by Basic DS records: - EPC unique ID - Service Type - Address
References	• Deliverable 2.4
Originator	AT4 wireless
Taxonomy	Functional

Name	REQ_DES_2
Priority	medium
Summary	Additional data fields for Basic records asserted by the DS:
Rationale	Track & Trace service requirement
Priority Rationale	Optional information stored by DS
Requirements	Additional data fields for a record, to be asserted by the DS: - Record ID - Record Time (created internally by the DS (timezone qualified)) - Publisher ID - Verified (indicates whether the DS was able to verify the identity of the publisher and integrity of the record)
References	• Deliverable 2.4
Originator	AT4 wireless
Taxonomy	Functional

Name	**REQ_DES_3**
Priority	high
Summary	Mandatory information for aggregation records.
Rationale	Track & Trace service requirement
Priority Rationale	Mandatory information stored by DS
Requirements	Mandatory additional information for aggregation records: - EPC unique ID - Action
References	• Deliverable 2.4
Originator	AT4 wireless
Taxonomy	Functional

Name	**REQ_DES_4**
Priority	medium
Summary	Additional information for aggregation records.
Rationale	Track & Trace service requirement
Priority Rationale	Optional information stored by DS
Requirements	Additional information for aggregation records: - Parent ID - Child EPCs
References	• Deliverable 2.4
Originator	AT4 wireless
Taxonomy	Functional

Name	**REQ_DES_5**
Priority	medium
Summary	Optional Metadata fields that the Publisher may provide
Rationale	Track & Trace service requirement
Priority Rationale	Optional information stored by DS
Requirements	Optional information that could be held by the DS: - DSAction - BusinessStepID - DispositionID - EventTime
References	• Deliverable 2.4
Originator	AIDA Centre
Taxonomy	Functional

Name	**REQ_DES_6**
Priority	medium
Summary	A private key may be used to sign DS records
Rationale	Audit trail of information providers and non-repudiation
Priority Rationale	Optional capability
Requirements	The information for records that are published to a Discovery Service may be digitally signed using a private key – and it may be valuable to retain a reference to the

	digital certificate (which binds the corresponding public key to the ID of the publisher) within a Discovery Service record
References	• Deliverable 2.4
Originator	AT4 wireless
Taxonomy	Functional

Name	**REQ_DES_7**
Priority	WP2: dropped
Summary	DS records will store business-level metadata
Rationale	The EPCIS data model allows the annotation of EPCIS events with additional metadata to provide business context help events' tracing.
Priority Rationale	This requirement is already included in REQ_DES_5
Requirements	There may be value in storing a small amount of business-level metadata within a Discovery Service record, if this could avoid making additional queries to the underlying EPCIS layer in order to obtain that metadata annotation.
References	• Deliverable 2.4
Originator	AT4 wireless
Taxonomy	Functional

Name	**REQ_DES_8**
Priority	WP2: dropped
Summary	DS record will store events about aggregation/disaggregation.
Rationale	Aggregation information in the DS will simplify the queries made by other application like Track&Trace
Priority Rationale	This requirement is already included in REQ_ REQ_REP_7 and REQ_REP_8
Requirements	DS record will store events about aggregation/disaggregation.
References	• Deliverable 2.4
Originator	AT4 wireless
Taxonomy	Functional

Name	**REQ_DES_9**
Priority	High
Summary	Discovery Service will support standing queries over a separate message-oriented infrastructure. The choice of messaging technology may be selected by the DS vendor or multiple options made available to the client. Depending on the message technology the client may receive direct notification or may have to poll a message queue server.
Rationale	DS does not have to cope with problems like retrying the delivery of messages.
Priority Rationale	Main functionality of DS.

Requirements	Discovery Service will support standing queries over a separate message-oriented infrastructure.
References	• Deliverable 2.4
Originator	AT4 wireless
Taxonomy	Functional

Name	**REQ_DES_10**
Priority	high
Summary	Query Formulation
Rationale	DS should support EPC IS query Syntax
Priority Rationale	Main functionality of DS.
Requirements	DS query interfaces should support the following constraints: - Mandatory filters: o MATCH_anyEPC - Optional filters: o MATCH_parentID o MATCH_epc o recordType o GE_eventTime o LT_eventTime o GE_recordTime o LT_recordTime o EQ_action o EQ_bizStep o EQ_disposition
References	• Deliverable 2.4
Originator	AIDA CENTRE
Taxonomy	Functional

Requirements extracted from chapter 2 of Deliverable 2.1 Part A

Name	**REQ_DES_11**
Priority	WP2: dropped
Summary	Business steps where records are published to DS
Rationale	DS should store shipping and receiving events.
Priority Rationale	This service should be provided by EPC IS
Requirements	DS record should record the following business events: • Shipping • Receiveng
References	• Deliverable 2.1 Part A, section 2
Originator	**Auto-ID Labs (Cambridge)**
Taxonomy	Functional

Name	**REQ_DES_12**

Priority	WP2:dropped
Summary	DS type of queries
Rationale	DS types of queries
Priority Rationale	This requirement is further explained in REQ_DES_10
Requirements	DS record should support the following types of queries: • Where Last Seen • Trace (i.e. time-ordering and ability to request latest record is important)
References	• Deliverable 2.1 Part A, chapter 2
Originator	**Auto-ID Labs (Cambridge)**
Taxonomy	Functional

Name	**REQ_DES_13**
Priority	high
Summary	Discovery Service security policies may be set to restrict update and delete actions on DS records to provide a journal functionality.
Rationale	DS may be set to restrict record updates
Priority Rationale	Main functionality of DS.
Requirements	Discovery Service security policies may be set to restrict update and delete actions on DS records to provide a journal functionality.
References	• Deliverable 2.1 Part A, chapter 2
Originator	**Auto-ID Labs (Cambridge)**
Taxonomy	Functional

Name	**REQ_DES_14**
Priority	high
Summary	Storage of aggregation changes
Rationale	DS should storage aggregation changes
Priority Rationale	Main functionality of DS.
Requirements	DS record should allow for storage of aggregation changes
References	• Deliverable 2.1 Part A, chapter 2
Originator	**Auto-ID Labs (Cambridge)**
Taxonomy	Functional

Name	**REQ_DES_15**
Priority	high
Summary	Number of queries per day
Rationale	DS should be able to support up to 100,000 queries per day
Priority Rationale	Performance prerequisite
Requirements	DS record should be able to support up to 100,000 queries per day for some companies.
References	• Deliverable 2.1 Part A, chapter 2

Originator	**Auto-ID Labs (Cambridge)**
Taxonomy	Functional

Requirements extracted from Deliverable 2.1 Part B

ID	**REQ_REP_25**
Priority	high
Summary	Access-control rights/ policies (set up by data owners) shall be protected.
Rationale	Most interviewers agree on that
Priority Rationale	Stakeholder requests
Requirement	Access-control rights/ policies (set up by data owners) are sensitive information; they shall be protected accordingly and shall not be published publicly.
References	• Deliverable 2.1 Part B
Originator	SAP

ID	**REQ_REP_26**
Priority	high
Summary	The data owner must be made aware of any restrictions to the access control of its data imposed by the DS.
Rationale	Most interviewers agree on that
Priority Rationale	Stakeholder requests
Requirement	The data owner must be made aware of any restrictions to the access control of its data imposed by the DS.
References	• Deliverable 2.1 Part B
Originator	SAP

ID	**REQ_REP_27**
Priority	high
Summary	Unique client identification to DS
Rationale	Unique client identification at the DS is required to control access to data stored on the DS (particularly EPC number and link).
Priority Rationale	Access control required by majority of end-user companies.
Requirement	Clients shall be uniquely identifiable to the DS.
References	• Deliverable 2.1 Part B
Originator	SAP

ID	**REQ_REP_28**
Priority	low
Summary	A client shall be provided with an identifier to contact those EPCISs that a DS has denied access to in previous query by the client.
Rationale	In a client query to the DS, the DS may deny access to the client for a particular EPCIS. From the client's perspective, the access may have been denied in error, for example, if the DS holds outdated access policies or access policies that are otherwise inconsistent with those of the requested EPCIS. Another example may be that the EPCIS has initially published erroneous access-policy

ID	**REQ_REP_28**
Priority	low
	settings to the DS.
Priority Rationale	Currently not backed up by potential DS users. Currently no promising implementation proposed.
Requirement	A client shall be provided with a mechanism to contact those EPCISs that a DS has denied access to in previous query by the client. The mechanism shall not infringe the publisher's (i.e., IS's) confidentiality.
References	Barcelona f2f meeting; Telephone conference 2007-02-20)
Originator	SAP

ID	**REQ_REP_29**
Priority	high
Summary	In order to limit the number of potential query results to a client, the DS shall allow companies to publish additional event data (e.g., business step, disposition) with EPC Numbers in order to allow clients to place more specific queries.
Rationale (Directory Lookup model)	A query only based on an EPC number or pattern may yield a very large result set of ISs. The client would typically have to query all of these ISs to find the one answer it's interested in. The result may be long overall transaction times (from initial DS query to receiving actual result), high client load, high IS load, and high client-network load from queries and replies.
Rationale (Query Relay model)	The client query is forwarded to a potentially large set of ISs that have information on a specific EPC number. The result may be relatively long overall transaction times (from initial DS query to receiving actual result), and high IS load.
Priority Rationale	Priorities are based on client load, overall transaction times, client-network load.
Requirement	In order to limit the number of potential query results to a client, the DS shall allow companies to publish additional event data (e.g., business step, disposition) with EPC Numbers in order to allow clients to place more specific queries.
References	Deliverable 2.1 Part B
Originator	SAP

4. Final Prioritized List of Requirements

The table below provides a concise categorized prioiritized summary of the requirements for Discovery Services. Note that these tables omit requirements that were marked as 'dropped' in Section 3. In most cases, requirements were dropped because they were either duplicates or in fact requirements for either the underlying EPCIS repositories or for the enhanced track & trace services being developed in WP3.

Purpose of Discovery Services

REQ_REP_5/6	DS shall provide access to recover additional information recorded by supply chain partners.	HIGH
REQ_REP_11	DS shall help finding companies of the supply chain of a product.	HIGH
REQ_REP_7	Discovery Services may help recovering information about aggregation of objects	HIGH
REQ_REP_8	Discovery Services may provide disaggregation information of aggregated objects when broken into smaller units	HIGH

Role within the EPC Network Architecture

REQ_T&T_1	When a new EPC is created, an EPCIS should be updated. A DS may be notified through a message that contains the EPC and its host EPC IS.	HIGH
REQ_T&T_2	Product updates are automatically recorded in the company's own EPCIS. An information provider may notify a DS via a message to register that updated information about the object has been recorded.	HIGH
REQ_T&T_3	Discovery Services may be notified by companies about product updates and where this information has been recorded (e.g. specifying the address of an EPCIS). Track and Trace services may query Discovery Services to retrieve links to that data.	HIGH
REQ_T&T_4	Track and Trace services may query Discovery Services to retrieve links to that data. • Discovery Services shall return the EPCIS addresses that store the relevant information • A Track & Trace service may then query each EPCIS to retrieve detailed information, then assemble the complete information	HIGH
REQ_REP_23	An ONS service or the EPC (with manufacturer ID or coding scheme) may be used in order to know which lookup service to report to.	HIGH

Data Model

REQ_REP_12	Data that companies are willing to provide to the Discovery Services are mainly URL addresses of databases / EPCIS repositories.	HIGH
REQ_DES_1	Mandatory information to be held by Basic DS records - EPC unique ID - Service Type - Address (e.g. URL of EPCIS)	HIGH
REQ_DES_2	Additional data fields for a record, to be asserted by the DS: - Record ID - Record Time (created internally by the DS (timezone qualified)) - Publisher ID - Verified (indicates whether the DS was able to verify the identity of the publisher and integrity of the record)	MED
REQ_DES_14	DS record should allow for storage of aggregation changes	HIGH
REQ_DES_3	Mandatory additional information for aggregation records: - EPC unique ID - Action	HIGH
REQ_DES_4	Additional information for aggregation records: - Parent ID - Child EPCs	MED
REQ_REP_29	In order to limit the number of potential query results to a client, the DS shall allow companies to publish additional event data (e.g., business step, disposition) with EPC Numbers in order to allow clients to place more specific queries.	HIGH
REQ_DES_5	Optional information that could be held by the DS: - DSAction - BusinessStepID - DispositionID - EventTime	MED

Querying a Discovery Service

REQ_REP_14	It should be possible to define filtering criteria in order to filter the updates that are sent to customers as a result of a standing query: - By the organization providing the update - By product line / SKU - By specific serial number/ full EPC - By the manufacturer code / company prefix of the goods.	HIGH

REQ_DES_10	DS query interfaces should support the following constraints:
	- Mandatory filters:
	  o MATCH_anyEPC
	- Optional filters:
	  o MATCH_parentID
	  o MATCH_epc
	  o recordType
	  o GE_eventTime
	  o LT_eventTime
	  o GE_recordTime
	  o LT_recordTime
	  o EQ_action
	  o EQ_bizStep
	  o EQ_disposition
		HIGH

REQ_DES_9	Discovery Service will support standing queries over a separate message-oriented infrastructure.	HIGH
REQ_REP_19	Methods for communicating a delayed or asynchronous response are via e-mail or HTTP POST (which could even be SOAP like)	MED

Access Control Policies

REQ_REP_15	DS should implement different access control policies, depending on the type of data required.	HIGH
REQ_REP_25	Access-control rights/ policies (set up by data owners) are sensitive information; they shall be protected accordingly and shall not be published publicly.	HIGH
REQ_REP_27	Clients shall be uniquely identifiable to the DS.	HIGH
REQ_REP_26	The data owner must be made aware of any restrictions to the access control of its data imposed by the DS.	HIGH
REQ_REP_16	DS should be able to implement authentication and access control policies, specified by an external organization.	LOW
REQ_REP_28	A client shall be provided with a mechanism to contact those EPCISs that a DS has denied access to in previous query by the client. The mechanism shall not infringe the publisher's (i.e., IS's) confidentiality.	LOW

Performance, Availability & Operation

REQ_REP_17	Speed of events/updates becoming available/visible must be within one minute.	HIGH
REQ_REP_18	Expected speed of response to tracking / trace query must be within a few seconds	HIGH
REQ_REP_20	Level of uptime required from lookup service is 24/7	HIGH
REQ_DES_15	DS record should be able to support up to 100,000 queries per day for some companies.	HIGH

Authenticity & Integrity of Records

REQ_DES_13	Discovery Service security policies may be set to restrict update and delete actions on DS records to provide a journal functionality.	HIGH
REQ_DES_6	The information for records that are published to a Discovery Service may be digitally signed using a private key – and it may be valuable to retain a reference to the digital certificate (which binds the corresponding public key to the ID of the publisher) within a Discovery Service record	MED

Standards & Governance, Provision of Discovery Services

REQ_REP_22	A common query/update interface or API across all DS is required.	HIGH
REQ_REP_24	The provision of lookup services and access control services should require certification but with no limit on the number of providers.	MED