FOODTRACE Concerted Action Programme
Generic Framework for Traceability

Framework Considerations

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1. Preamble

The primary objective of FOODTRACE is to specify and implement a generic framework for traceability that can be applied to any food supply chain. The framework must facilitate a system or systems for achieving unambiguous linking of items or item element transformations and transaction back to an identified source. It must also provide the facility to access appropriate transformation or transaction information relating to the item or item element at any defined point in the supply chain. It must also be sufficiently flexible to accommodate national and food-specific requirements with respect to food law and other regulatory constraints and facilitate the realisation of traceability systems in both developed and developing countries.

Such objectives are driven by national needs for traceability and the growing requirement to accommodate that need in the burgeoning climate of global trade and consumer demands. Other initiatives have and continue to address the needs for traceability, notably the Traceability of Fish – Application of EAN.UCC Standards (EAN International), Traceability of Beef Guidelines (EMEG), Fresh Produce Traceability Guidelines (EAN International), Traceability in the Supply Chain (GENCOD EAN France) and Traceability Implementation (EAN.UCC) project. In pursuing the FOODTRACE objectives it is clearly important to consider these and other initiatives, with a view to establishing a cluster forum and an ultimate consensus on traceability issues and systems structure. The programme will monitor and review these developments and, where appropriate make or seek representation, on issues that have a bearing upon the consensus view.

The starting point for the FOODTRACE initiative is to establish the generic framework and distinguish the issues that need to be addressed in order to allow the framework to be used an effective tool for interoperable systems development. The primary need[1] to be accommodated is a technology-independent, but technologically supportable, identification scheme for achieving traceability. This then allows developing countries to specify traceability systems that allow migration from rudimentary supported systems to technologically supported systems achievable in the more developed countries. The essence of such a scheme resides in agreement upon numbering and identification schemes, of which the EAN.UCC system is internationally recognised and, moreover, is supported by adopted technology for carrying data. However, it must be recognised that the EAN.UCC legacy, although stable, will undoubtedly require further development to accommodate needs arising from developments in handling of item-attendant and item-associated data.

It is important at the outset of the initiative to agree terms and definitions in relation to supply chain structures and traceability. A glossary will be constructed on an on-going basis to capture and record these terms and definitions, recognising in the process that new terms are likely to arise. Reference has already been made to items, item-attendant and item-associated data. On a broader basis items denote any physical entity identified within a business or service activity that requires handling in

[1] Primary need – that need which if unfulfilled compromises the target solution even though all other needs may be taken into consideration within the framework.

some way and for which there is information that also has to be handled in some way. So, in this respect an item can be virtually anything, from raw materials, components, sub-assemblies, assemblies, products, packages, containers, totes, bins, pallets and so on, but can also include animals, people and locations. From the view point of food supply items can again be anything from seeds, feedstuffs, raw produce, animals, carcasses, joints, minced and combined produce, processed foods, food products, packaging, containers, pallets through to consumer entities, including loose and variable measure products. The item-attendant and item-associated data terms relate to the data that accompanies the item (item-attendant) and data that is associated with the item but does not accompany it directly as it moves through the supply chain. A further term introduced above is that of the item identifier. This is the means of uniquely identifying the item or items concerned and the vehicle for facilitating traceability within the supply chain.

The glossary will thus form the frame of reference for new and potentially unfamiliar terms and definitions of this kind.

What follows is a reference to, and summary of, the considerations necessary for specifying a generic framework for traceability. Each section is deliberately brief but seeks to identify key generic elements that will need to be developed in order to provide a workable solution.

Section 2 simply identifies the key components of a supply chain in generic terms, the necessary focus upon items as the tangible entities that undergo transformations and transactions within supply chains and the basic requirements with respect to identification for traceability purposes.

Section 3 deals with the nature of traceability, how it may be defined for the purposes of the FOODTRACE concerted action, the functional roles for traceability, the need for added value in systems solutions and the legacy, standards and legal issues that need to be embraced in the development of a generic framework.

Section 4 deals more specifically with the basic features of a generic traceability framework in terms of information, links and communication issues, taking into account the growing needs to exploit connectivity potential provided by the Internet and mobile communications.

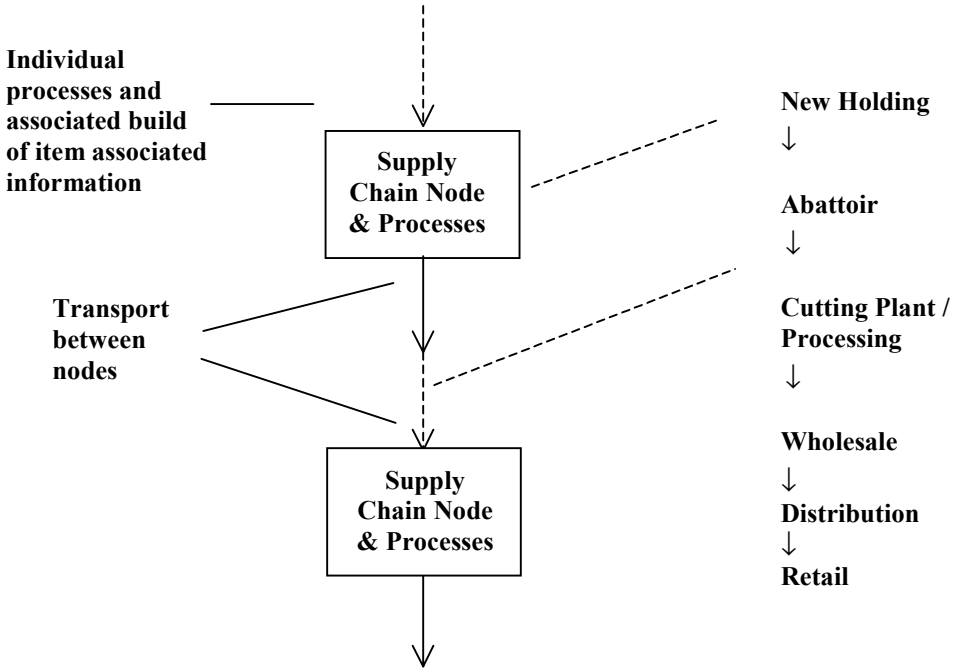
Section 5 draws attention to the enabling technologies for the realisation of traceability systems and the need for a universal data appliance protocol.

Section 6 seeks to provide an action list in relation to the key considerations and how they relate to the work packages and the work of the special interest groups.

2. Basic Components of Supply Chain Structure

Traceability is the core consideration in the FOODTRACE initiative for concerted action, but before considering the nature and significance of traceability it is appropriate to distinguish, in generic terms, the supply chain structures to which it relates. A supply chain may be viewed in its most basic form as a collection of nodes connected by events or actions through which items and information flow from one node to another. The nodes distinguish process-based transformations or transactions that facilitate the production and supply of food (for food supply chain). The nodal transformations invariably result in item changes and the need for identity linkages from pre-node items to the new item manifestations. Thus, for example, an animal carcass may be processed with a set of nodal processes to yield a range of cuts that require individual identification with links to the pre-nodal identified carcass. This is effectively an example of 'identity cascade' the pre-nodal identity being carried through to the cuts to allow traceability back to the source carcass. The nodal processes may also result in meat from different carcasses being processed to form mixed entity products. Here the resulting product requires identification that allows traceability back to the group of identifiers that distinguish the animals that contributed to the product. This is an example of 'identity fusion'.

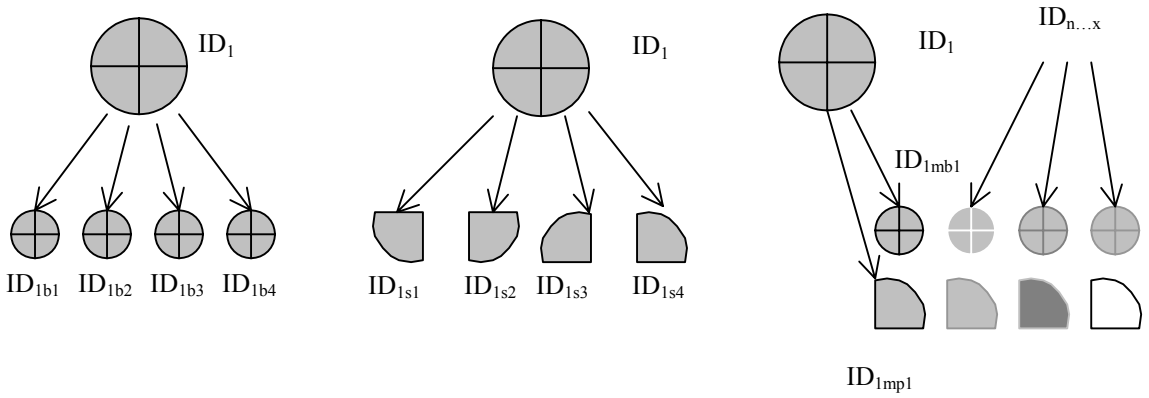
Illustrative example of Supply Chain segment



The above illustrates the basic components of a supply chain in terms of nodes and links. However, each node may exhibit distinctly different characteristics in terms of their structure and function, farm holding for example being substantially different from an abattoir, and the number and nature of inputs and outputs they support. Items entering (inputs) or leaving nodes (outputs) will be characterised in time as well by item features and, as appropriate, prevailing conditions. In reality the supply chain structures may be complex in terms of the number of nodes and links, and the continuity of links through constituent supply chain processes.

2.1 Item focus and Transformation within the Supply Chain

Items are the very essence of the supply chain, be they raw produce, ingredients or resultant products. The very nature of food production and supply distinguishes transformations in the form of processing, combining, packaging, containerisation and so forth that require identification in order to facilitate a traceability structure. There is therefore a need for item and item-attendant / item-associated data management that can accommodate the wide-ranging transformation and transaction processes to be found in supply chains. In essence there are two primary categories of transformation that relates to both items and information for traceability purposes, which for convenience are here referred to as cascade and fusion. Cascade refers to processes in which the incoming item is segmented or separated to yield elemental items, batches of item or inputs to mixed batches of items, each of which requires identification, linked to the source item for traceability purposes.



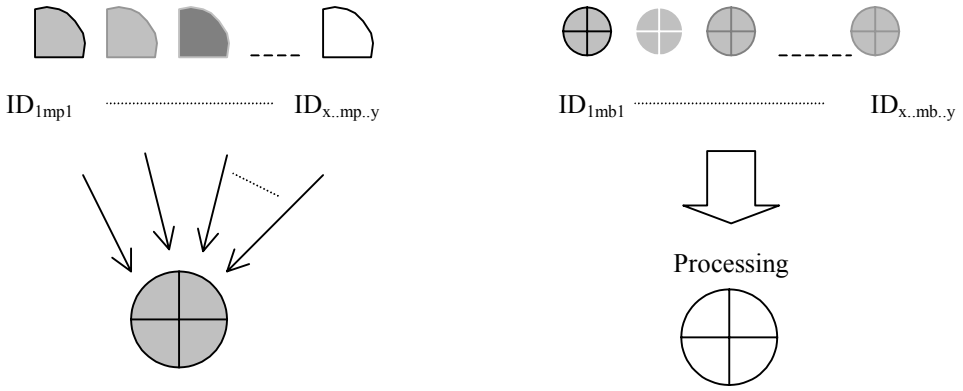
Batch separation of source item – batches linked to item by batch ID

Item segmentation – segments linked to item by segment ID

Item batch or segmentation for mixed batch or mixed product

Fus

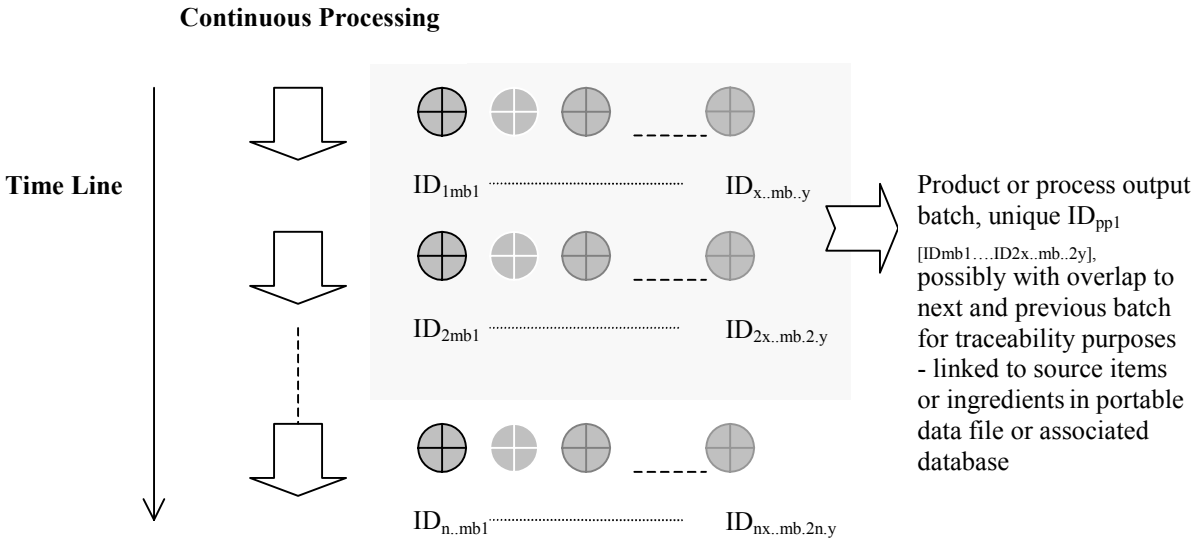
: combination of items to form a new item or product which, from a traceability standpoint requires an identity linked to the elemental items from which it was produced. In graphical terms this can be represented as shown below.



$ID_{p[1mp1....x..mp..y]}$
-mixed product unique ID linked to elemental item IDs in portable data file or associated database

$ID_{pp\ [1mb1....x..mb..y]}$
- processed product unique ID linked to source items or ingredients in portable data file or associated database.

Where continuous processing is involved a degree of uncertainty arises as new batches of ingredients are added to the process, requiring process-feed and time virtual batching of product and association management in defining IDs of final product or batching for traceability purposes.



The generic framework will need to specify the identifier cascade and fusion strategies for seamless traceability support, and allow scope for appropriate use of item-attendant identifiers / data and or item-associated handling of identification linkage.

A further dimension to identification for traceability in supply chains concerns packaging, containment and transportation units, and, of course, the supply chain companies / stakeholders. This demands a hierarchy of identification structures to accommodate items, trade units, returnable containers, locations and services.

3. Traceability and Functions

Traceability has been described in a number of ways, the following definitions being frequently quoted, the latter relating specifically to food supply chains:

- The ability to trace the history, application or location of an entity by means of recorded information (ISO 8402:1994).
- The ability to trace and follow a food, feed, food-producing animal or substance through all stages of production and distribution (draft EU Regulation – Food Law: 8/5/01).

The GENCOD, Traceability in the Supply Chain, guidelines distinguishes various roles for traceability, summarily specified as:

- **Bottom-up traceability** – capacity for locating products, from any point of the supply chain, using one or more given criteria – notably as a means of dealing with product recalls or withdrawals.
- **Top-down traceability** – capacity for finding the origin and characteristics of a product, from any point of the supply chain, using one or more given criteria – notably as a means of establishing the cause of a quality problem.
- **Upstream traceability** – describing the procedures and tools implemented in order to locate an event that has already occurred *before* the supply chain partner concerned has become legally or physically responsible for the products.
- **Downstream traceability** – describing the procedures and tools implemented in order to locate an event that has already occurred *after* the transfer of property or after the physical transfer of products from the partner to a third party.
- **Internal traceability** – describing the traceability implemented throughout the processing or transformation undertaken by partners to his products – independent of commercial partners.
- **Product traceability** – describing the *qualitative* follow-up of products – notably for finding the causes of a quality fault.
- **Logistical traceability** – describing the quantitative follow-up of products – notably for locating products and determining destinations and origins with respect to product recalls and withdrawals.

Within the FOODTRACE generic framework traceability is viewed as the expedient embracing the roles quoted above and capable of facilitating other functions that require traceability system. This then provides the flexibility for accommodating the functions identified within the GENCOD guidelines and other functions that may arise with respect to food production and supply. The traceability expedient is common to these functional needs, specific information structures and strategies being needed to support the concomitant functional needs, such as quality support, incident

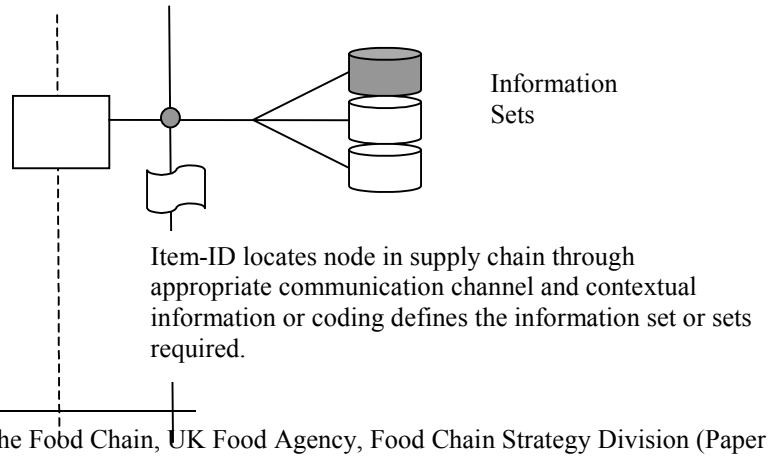
analysis for health and safety, process development and consumer information support.

3.1 Functional Roles for Traceability

The UK Food Agency has identified the following functional roles for traceability within the food supply chains[2]:

- **Food Safety Incidents** – where robust traceability can facilitate rapid response to breakdowns in food safety with supporting actions, such as withdrawals and recalls, for the purposes of protecting public safety.
- **Food Residue Surveillance Programmes** – in which food samples are collected at points throughout the food supply chain and tested for a wide range of residues, such as pesticides and where a traceability system is essential for tracing where in the supply chain levels causes of excessive residue levels may have occurred.
- **Risk Assessment from Food Exposure** – where a traceability system can facilitate access to information concerning foods or food ingredients that may relate to a food safety issue.
- **Enforcement of Labelling Claims** – where traceability can help to resolve allegations of false labelling and help determine supply chain integrity with respect to food claims.
- **Fraud** – wherein effective traceability, regular audit and reconciliation measures can assist in inhibiting fraud.
- **Food Wastage** – where traceability and quality control systems may be applied to reduce food wastage.
- **Meat Hygiene** – where traceability can help enforce and support meat hygiene in the farm to slaughterhouse components of food supply chains.

Each of these functions requires particular information in order to operate, both on the item or product and the associated processes (core entities). These and other functions, and their information sets, will need to be accommodated in the generic framework, the key to a flexible and extendable set of functions being appropriate item based identification and identifiers for the functional information sets.



[2] Traceability in the Food Chain, UK Food Agency, Food Chain Strategy Division (Paper Note 02/02/01), 14.02.2002.

In seeking to establish a generic framework there is a need to define the appropriate identifiers, exploiting where possible the best of legacy, information structures to satisfy various functional needs and the access strategies to allow the various functions to operate. In the first instance it will be necessary to define a structure that is independent of technology, but can be readily accommodated by technology to provide more efficient and effective traceability systems.

3.2 Traceability, tracking and added value process enhancement

While regulatory and consumer pressures can be seen as significant drivers for implementing traceability systems for health and safety and consumer information purposes the incentive for stakeholder acceptance of such systems must be enhanced through added value process enhancement. As GENCOD has pointed out a traceability system is essentially a permanent tool for occasional use. Consequently, any developments that allow more efficient and effective use of such a tool are to be welcomed, providing of course they do not compromise the primary functions supporting food safety and food quality.

Traceability provides the capability to track items which in turn can facilitate more efficient and effective handling and transfer of items, reductions in losses, wastage and storage requirements, speed and provide proof of delivery and upstream benefits in production methods and productivity, where appropriate supporting technology is applied. Such provisions thus make more effective use of traceability systems.

Process re-engineering to implement traceability must therefore address the issues of added value process and operational enhancement.

3.3 Legacy and standards for supporting traceability

A significant legacy exists for item numbering and identification that largely satisfies the dimensional needs expressed above, and will undoubtedly form the core structure for traceability within the generic framework. The legacy relates primarily to the EAN.UCC system, as summary of the numbering structures supported being presented in annex A.

The EAN.UCC system was designed to provide a common short-hand, unambiguous standardised means of identifying items and companies operating at different points along national and international supply chains. It was quickly realised that a classifying system for identifying all products and their intrinsic details would be too cumbersome as well as impossible to administer, and that the best approach was to use an identifier in which specific companies could be uniquely identified. The company identifier, or company prefix, is an intrinsic feature of the EAN.UCC system numbering structures and is allocated by an EAN Numbering Organisation (UCC in the United States), of which there are many throughout the world. An EAN prefix of two or three digits, allocated by EAN International to the EAN Numbering Organisation, can also be distinguished as part of some of the numbering structures, invariably preceding the EAN.UCC Company prefix.

The EAN.UCC Company prefix, once allocated, provides access to applications using EAN.UCC identification identifiers, including, for example, those involving the identification of items, logistical units, returnable containers, locations and services. The company prefix is an integral part of each of the numbering structures identified within the EAN.UCC standards, with the exception of the eight digit, EAN/UCC-8, structures. For situations in which a company changes legal status as a result of mergers, acquisitions, partial purchases, splits and spin-offs EAN.UCC have produced guidelines to assist in accommodating or transferring numbering support.

Each company that joins the EAN system is allocated a block of numbers comprising an EAN and EAN.UCC Company prefix and a range of numbers that the company can use to identify any of its products, locations or other business entities. The numbers themselves contain no information about the item or entity concerned, but provide a key to item or entity information held on a database or databases.

The EAN.UCC system defines a number of numbering structures appropriate to different applications. Each application determines how the number is to be used, but the standard requires that the numbers be used in their entirety and not as component parts. By complying with this requirement standard use and worldwide acceptance of the numbering structure for the inter-sectorial applications concerned is preserved.

The EAN.UCC system also defines a range of over 90, two-, three- and four digit application identifiers (AIs) and so provides a framework for supporting the identification of application measures. AIs are also available to identify features such as logistics units expressed as a serial shipping container code (SSCC), batch and lot numbers, serial numbers, production and packaging dates to name but a few. A data format is specified for each AI to indicate the number and disposition of numeric and alpha characters. The AI to denote the identification of a logistic unit comprising the SSCC is 00, having the format n2+n18, two digits (n) for the AI and 18 for the SSCC. An example of an alphanumeric AI is for a lot number (AI=10) having the format n2+an..20, denoting two digits for the AI and up to 20 alphanumeric (an) characters.

The AIs for measures are grouped into metric and non-metric trade item measures and metric and non-metric logistic item measures for parameters such as weights, lengths, areas and volumes.

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Extract from the list of Application Identifiers (AI)

AI	Encoded data content	Format
00	Serial Shipping Container Code	n2 + n18
01	Global Trade Item Number (GTIN)	n2 + n14
10	Batch or Lot number	n2 + an..20
13	Packing Date (YYMMDD)	n2 + n6
15	Minimum Durability Date (YYMMDD)	n2 + n6
21	Serial Number	n2 + an..20
30	Variable Count	n2 + n..8
310x	Net weight in kg	n4 + n6
400	Customer's Purchase Order Number	n3 + an..30
410	"Ship to – deliver to" EAN.UCC GLN	n3 + n13
421	"Ship to – deliver to" Postal Code with 3 digit ISO Country Code	n3 + n3 + an..9
...		

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For the purposes of structuring the identification features of the generic framework the EAN.UCC system provides a sensible foundation, recognising that further developments will undoubtedly be

required to accommodate additional needs. For example, the identification of manufacturing batches and data sources arising from traceability-supporting technologies, other than the data carrier / capture technologies adopted within the EAN.UCC system. This aspect of the development will also require a review of existing publications concerning EAN.UCC system usage for traceability. There is also a need to review other systems and standards relevant to the structuring of traceability systems, including FACT identifiers.

While numbering and identifiers constitute the means whereby traceability can be implemented functional information sources with appropriate access codes are required to exploit the traceability expedient. Also required is a vehicle for portioning information according to process and communication needs.

3.4 Legal Requirements for Traceability

Within Europe the only mandatory requirement for traceability within a complete food supply chain is for beef to be traced from point of sale to its animal origin. However, other aspects of legislation may be distinguished[3] that are directly relevant to traceability, including:

- UK Cattle Identification and Registration Scheme.
- UK Compulsory Beef Labelling Scheme.
- Materials and Articles in Contact with Food Regulations (1987)
- Food Premises (Registration) Regulations (1991).
- General Product Safety Regulations (1994) – implementing Directive 1992/59/EEC.
- Food Lot Marking Regulations (1996).
- Feeding Stuffs Regulations (2000).
- Food Irradiation Provisions (England) Regulations (2000).
- EU Health Mark.

These schemes and regulations are indicative of legislative measures currently in force. In prospect are the EU General Food Law regulations due to come into force in 2005. Contained within these regulations are clear requirements for traceability (Article 18).

Within the generic framework for traceability there is a clear need to accommodate the regulatory requirements. As an evolving set of measures the obvious vehicle for accommodating them is through information sets and meta-data identifies linking records and other relevant information to appropriate regulatory needs. In this way additional national and international requirements can be accommodated.

[3] Traceability in the Food Chain, UK Food Agency, Food Chain Strategy Division (Paper Note 02/02/01), 14.02.2002.

4. Traceability Systems

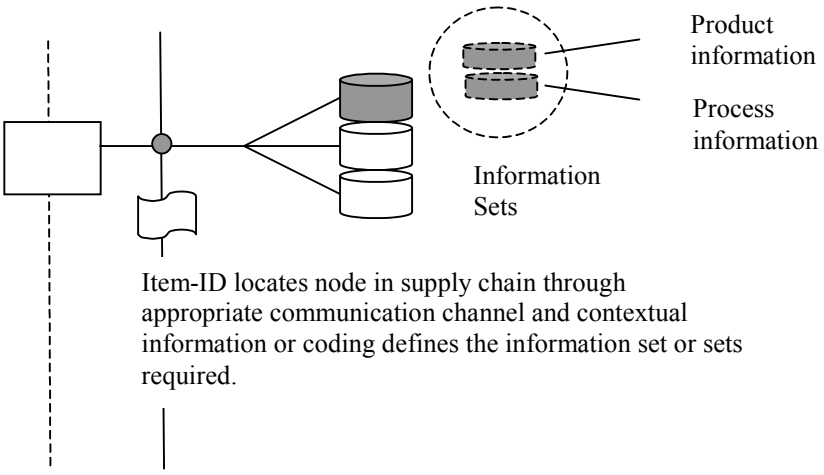
Traceability systems are the constructs that facilitate traceability. They may be paper-based or structured to exploit the benefits of information and communications technology. They facilitate, through appropriate record keeping and access capability, the migration of a product or product entity through all the stages of transformation, movement and transaction from source to consumer. A diversity of structures may be distinguished for this purpose. However, from a generic standpoint, all traceability systems, irrespective of supply chain items, industry affiliation and functions supported exhibit common structural features:

- Item identification, unambiguous and linkable for accommodating transformations and transactions in the supply chain.
- Item-attendant and / or item-associated Information appropriate to nodal transforms and transactions and any inter-nodal events that have a bearing upon traceability.
- Process-based information relating and linked to items processed or handled in the supply chain.
- Communication links to allow access and exchange of information.

4.1 Vertical and transverse partitioning of information

Within each node of a supply chain the constituent processes result in information concerning the items handled or produced in those processes. The information so collected may be for process and product management purposes, health and safety purposes, quality assurance, process control and hazard analyses for example.

It is significant in respect of the core product and process entities to distinguish essential information (possibly object-orientated) for more efficient access and routing to additional information.

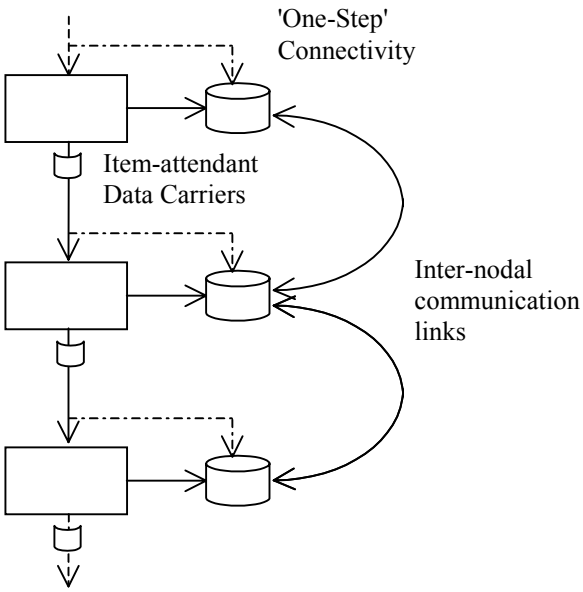


In seeking to specify a generic framework for traceability attention will have to be directed at the organisation and access to such databases.

In order to specify a generic traceability framework that can be applied irrespective of national and international needs requires consensus on the form of the identification, the classification and meta-data constructs and identifiers for handling information and the communication protocols.

On this basis traceability is achieved by means of item-attendant identifiers, most probably using EAN.UCC numbering and identifier structures, with information identifiers being defined to facilitate traceability supported functions. Thus the item-attendant and /or item-associated identifiers facilitate the traceability pathway by nodal reference and item identification and function support is achieved through information identifiers and suitably partitioned information at nodal points in the supply chain.

Particular information will relate to items received and items to be dispatched. As a consequence there is a particular information link to nodes above and below the node concerned. The one-step above and one-step below customer-client links should be seen as constituent links for traceability purposes, with traceability identifiers being communicated on item-attendant data carriers and through conventional customer-client communication links. This then provides a degree of protection against link failure, which would otherwise compromise the traceability chain. By including appropriate data carrier support for items between nodes the facility can also be provided for better control and performance of inter-nodal events. As a consequence further information may be generated that must be carried with or associated with items or communicated directly to appropriate nodal information management systems by mobile communications.



These 'one-step' links may thus support the flow of information between adjacent nodes for the purposes of added-value process support, transaction and supply chain management. The 'one step' look-forward, look-back structure, appropriately interfaced and extended may also facilitate first layer, node-to-node ('daisy-chain') communication linking along the supply chain. These holding facilities and associated information systems (ISs) may be viewed as local databases.

The generic framework must therefore distinguish the facility for deriving and holding item information relevant to particular processes and item status within the nodes of the supply chain.

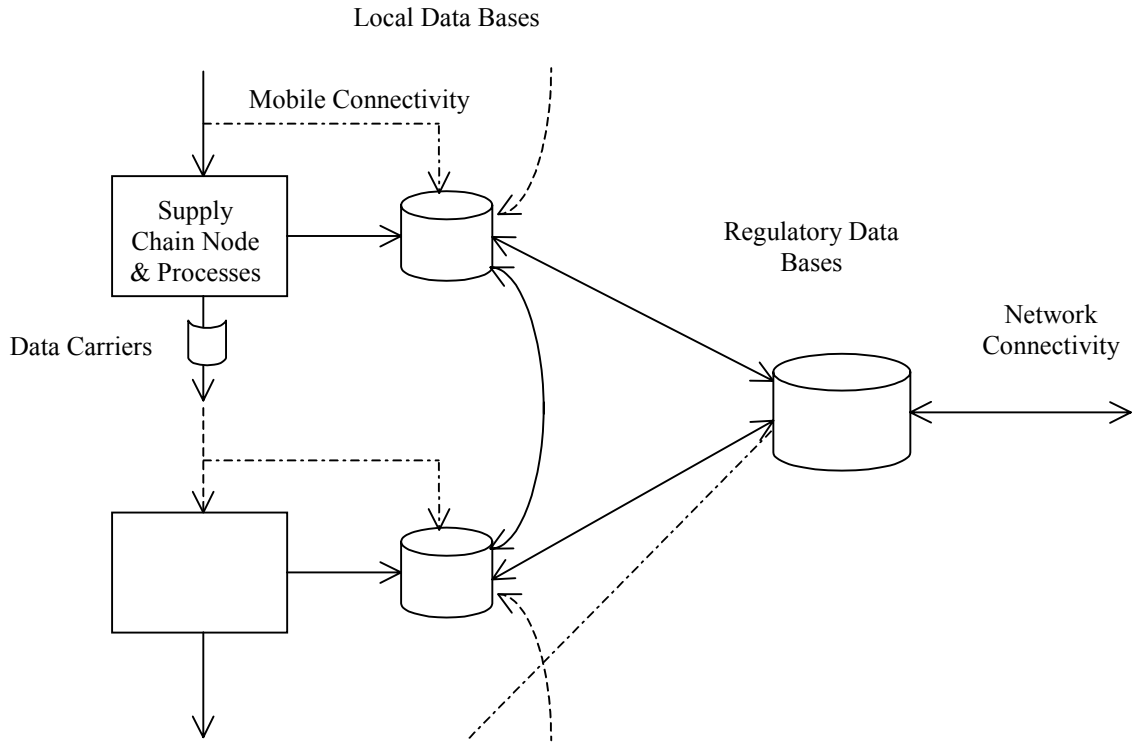
Within a minimalist traceability structure little if any information is conveyed with the item, the principal function of the item-attendant or item-accompanying data being for item identification purposes, but sufficient in form to allow linking and appropriate access to information stored in local

or linked databases through appropriate communication channels. In reality scope can be seen for item-attendant, machine-readable, portable data files that allow specific information to accompany the item, the nature and extent of the information depending upon item and nodal-specific needs. For example a consignment of perishable goods may be accompanied by a data file that specifies the content of the assignment together with information on dispatch time, destination and consignment handling details.

The generic framework must allow for flexible partitioning of information to satisfy a diversity of supply chain needs.

In some cases the amount of information stored in nodal databases could be substantial, requiring appropriate structuring into relational databases and, in some instances feeding into larger, national or other scheme-related databases. A further layer in the traceability infrastructure is to distinguish connectivity between local databases / ISs and regulatory or other centralised databases / ISs required for national and industry purposes. To allow access to these databases and management systems for traceability purposes requires a network infrastructure (including use of the Internet) with appropriately layer authorised access control and communication protocols.

Supply Chain Data Flow



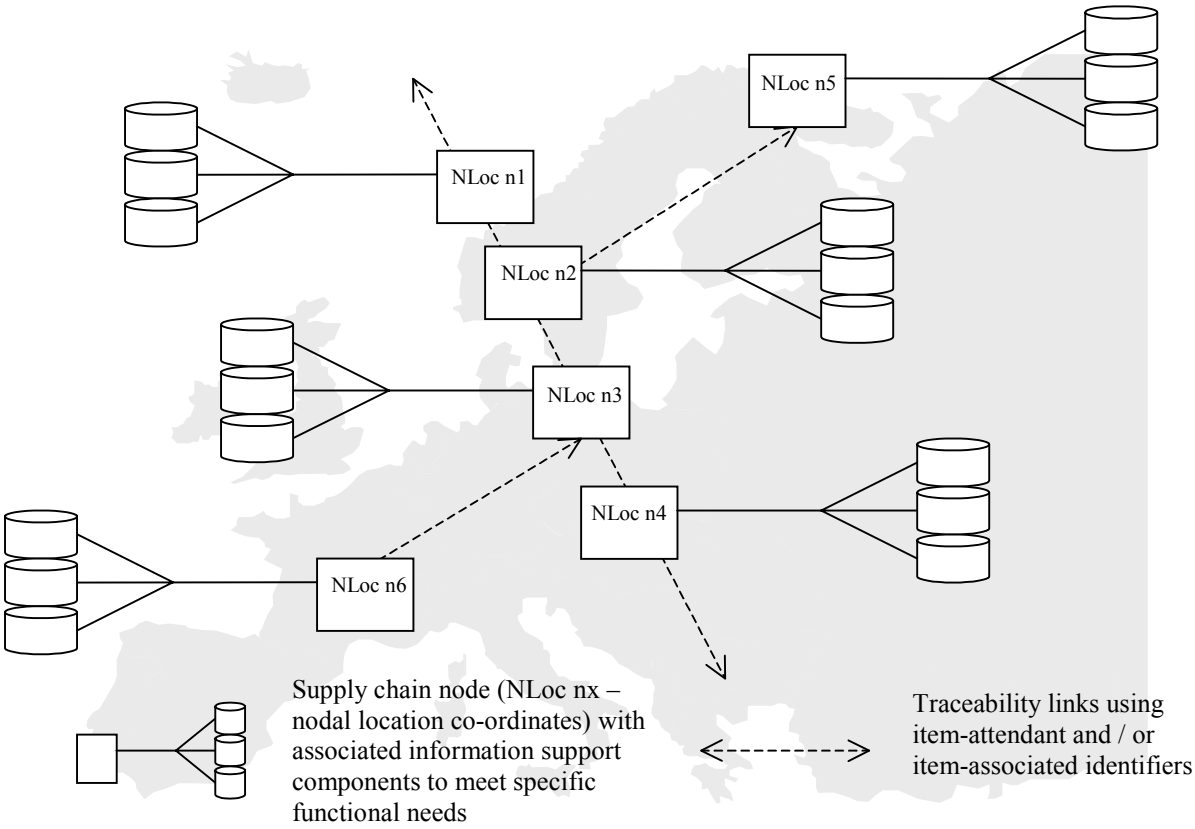
By distinguishing a generic structure of this kind, in which the data structures, identifiers and interface and communications protocols are specified for traceability purposes, systems may be engineered to meet the needs of different supply chains and allow connectivity within particular supply chains across national boundaries. Databases may hold information relevant to particular supply chain needs and National requirements together with standard related keys or identifiers to

appropriate traceability information.

To better accommodate this aspect of the framework development it will be necessary to review and consider the Z39.50 standard[4] for information retrieval and the developments concerning hierarchical management of relational databases.

4.2 Locational Considerations

In seeking to specify a generic framework for traceability in which appropriate identification and coding can facilitate a flexible, extensible and universally acceptable foundation for systems implementation it is appropriate to consider the requirements for identifying both items and locations.



The locational dimension can add value in traceability analyses in which rapid mapping of item movement and distribution histories can provide significant assistance in managing food item problems.

Various agencies can be recognised for implementing location-based identification, including the EAN.UCC Global Location Number (GLN), Real-time locating systems (RTLS) and Global Positioning Systems (GPS). The former provides the facility for assigning a code to a particular legal, functional or physical, fixed positional entity while the RTLS and GPS technologies provide the facility for locating items in fixed or non-fixed positions and specifying those positions by means of positional co-ordinates.

4.2.1 EAN.UCC Location Number (GLN)

[4] Z39.50 Information Retrieval Standard (ANSI/NISO Z39.50-1995)

In addition to item identification (see chapter 3.2 and 4.1) the EAN.UCC system also provides a unique numbering system for locations. The Global Location Number (GLN) of EAN.UCC identifies business or organisational entities such as:

- **Legal entities**: whole companies, subsidiaries or divisions such as supplier, customer, bank, forwarder etc.;
- **Functional entities**: a specific department within a legal entity, e.g. accounting department;
- **Physical entities**: a particular room in a building, e.g. warehouse or warehouse gate, delivery point, transmission point.

Each location is allocated a worldwide unique identification number. Those GLNs are reference keys for retrieving information from databases such as postal address, region, telephone and fax numbers, contact person, bank account information, delivery requirements or restrictions.

The identification of locations by GLN is required to enable an efficient flow of goods and information between trading partners through EDI messages, physical location marking and routing information on logistic units.

The use of GLN provides companies with a method of identifying locations, within and outside their company that are:

- **Unique**: with a simple structure, facilitating processing and transmission of data;
- **Multi-sectorial**: the non-significant characteristic of the EAN.UCC numbers allows any location to be identified and consequently any business regardless of its activity;
- **International**: location numbers are unique world-wide. Moreover, the international network of EAN.UCC Numbering Organisations, covering about 100 countries, provides support in the local language.

4.2.2 GPS and RTLS for Item Locating

By using global positioning system (GPS) based co-ordinates for nodal location mapping of supply chain structures and item movements can be readily achieved for analytical and planning purposes. Moreover, the locational facility may also be used for supply chain planning and logistical development and management purposes by supply chain stakeholders. Picking up on the added value incentives for traceability (3.1) GPS-based locational features can be seen as a further feature for enhancing processes in certain aspects of supply chain operations, including, for example, tracking of items in transit.

The prospect may also be seen for local area real-time location (RTL) capabilities for particular aspects of supply chain provision. The real time locating systems (RTLS) are essentially based upon the use of 'beacon' transponder (periodically transmitting identification codes). Various approaches to realising real time locating systems can be distinguished, notably zone-based location, time of flight and differential time of arrival. They are being seen as significant item-attendant technologies requiring consideration in schemes for track and traceability of items.

In specifying a generic framework for traceability provision should be made for the usage of the EAN.UCC Global Location Number (GLN) and for the RTL and GPS location capabilities.

4.3 EDI, Communications and Information Exchange

A significant feature of any traceability system is the facility for communication and information exchange. Electronic data interchange (EDI) has for some time been applied as a fast and reliable means of achieving electronic, computer-to-computer exchange of information between trading partners with a supply chain legacy based upon the use of the EANCOM® language (a subsystem of the EDIFACT (Electronic Data Interchange for Administration, Commerce and Transport). Some of the 47 message structures provided in this standard have relevance to traceability, including shipping notice (DESADV), product information (PRODAT), receiving notice (RECADV), transportation status (IFTSTA) and inventory status (INVRPT).

The advent of the Internet and mobile data communications have provided important new dimensions for communications and information exchange that can be readily applied for traceability purposes. They emerge as timely vehicles for helping to accommodate the developments in globalisation of trade and the growing diversity in supply chain structures and developments are now in prospect for exploiting XML (eXtensible Markup Langage) as a facility for supporting traceability communications.

Attention will need to be directed at the legacy and development issues for data communications including those relating to EANCOM® and XML. The opportunity should also be taken to review other methods of communication and information exchange to meet the needs of developing countries with respect to traceability.

4.4 Levels of Identification

In considering the component parts of a generic traceability system the need can be seen for an identification hierarchy, from supply chain type to item-level identification.

- Supply chain identification code – possibly based upon international standard industrial coding.
- Information database codes – national and local with associated access codes to accommodate restricted access.
- Information retrieval codes – for selective information retrieval, possibly based on the Z39.50 Information Retrieval Standard.
- Information Exchange coding – based possibly upon EDI legacy and XML developments.
- Information type coding – relating to particular traceability functions.
- Item-attendant technology codes – to distinguish different item-attendant technologies and facilitate an identity structure for a universal data appliance protocol.
- Item-attendant identifiers – to unambiguously identify items and an hierarchy of packaging and physical carrier entities, using the EAN.UCC numbering and identify legacy as the foundation on which to build.
- Nodal Identification and Location identifiers – to facilitate automatic identification of supply chain nodes for traceability and logistical purposes, linked to or based upon EAN.UCC coding.

5. Traceability Enabling Technologies

In recognising the need for flexibility in defining traceability systems to satisfy different supply chain needs it is necessary to identify a range of technologies and associated products to meet these needs. The technologies may be conveniently grouped as follows:

- **Item-attendant data carrier technologies** – including linear bar codes, two dimensional (multi-row bar code and matrix codes) and composite codes, contact and non-contact magnetic data carriers, contact memory and radio frequency identification (RFID) data carriers.
- **Item-attendant feature identification technologies** – including static and dynamic feature-based systems, identification based upon physical and chemical properties, including DNA profiling.
- **Item-attendant location and locating technologies** – exploiting GLN by carriers including RFID and EANCOM®, and active RFID (RTLS) and GPS locating technologies.
- **Item-attendant communication technologies** – including wireless local area network (WLAN) technologies.
- **Item-attendant sensory** – exploiting at the item level developments in sensory and telemetry technologies.
- **Item-attendant security technologies** – embracing a range of technologies for fraud prevention and security at packaging level.
- **Data storage and communications technologies** – including large volume relational data base technologies and both local and wide area communication technologies.
- **Software support technologies** – embracing the wide range of information management systems software and the needs for interfacing item-attendant technologies to appropriate management systems.

Of particular significance in engineering the core elements of a traceability system are the data carrier and communication technologies. While a number of linear bar code symbologies have been adopted for supporting the EAN.UCC system of numbering and identification wide ranging requirements in supply chain systems require a range choice for data carriers. However, where it is appropriate it is expedient to consider these EAN.UCC supported data carriers.

5.1 EAN.UCC Data Carriers and Application Identifiers

The EAN.UCC system distinguishes a number of bar code data carriers that have been adopted as an EAN.UCC standards, supported also by an important set of EAN.UCC application identifiers. The capability of being able to use the numbering structures in data carriers that can also allow further data to be added and distinguished in a standardised way offers considerable flexibility in supporting item-attendant data handling and process improvement/ innovation.

The data carriers adopted for EAN.UCC system applications presently comprise linear bar code symbols supported by the following standard symbology specifications (the rules that determine how a bar code is structured):

- EAN/UPC symbologies including, UPC-A and UPC-E, EAN-13, EAN-8. These are symbologies specifically designed for omni-directional scanning at point-of-sale retail outlets and constitute the standard for use on items scanned in this way. The symbols may also be used on other trade items.
- Interleaved Two-of-Five (ITF) symbology for symbols carrying identification numbers on trade items not for scanning at retail outlets. The symbology is particularly suited for printing directly onto corrugated fibreboard and similar substrates. However, in contrast to EAN.UCC standard symbologies the ITF is not exclusively licensed.
- UCC/EAN-128 symbology, a particular variant of Code 128 exclusively licensed to EAN.UCC as the symbology supporting systems applications in which the system numbering and application identifiers are exploited. It is a variable length, alphanumeric symbology offering considerable flexibility for identifying and handling item-attendant data. The symbols are not intended to be scanned at point of retail but within other areas of supply chain and industrial activity.

A reading device for EAN/UCC symbologies usually carry the facility to generate, on reading a bar code symbol, a symbology identifier to be transmitted along with the element string as a means of distinguishing between the different EAN.UCC data structures and those of other bar code symbologies. Such facilities are of course important for achieving automatic processing of data, particularly for transactions and EDI message formatting.

In seeking to support a generic framework specification with guidelines on the attributes of available data carrier and other item-attendant technologies it will be necessary to review and specify those technologies that have particular relevance to implementing traceability systems.

5.2 The need for a Universal Data Appliance Protocol

In the absence of a universal data carrier or a range of standards-supported data carriers a need arises for a universal protocol and interface platform to accommodate the diversity of data carrier and other item attendant technologies available for realising traceability systems.

The disparate nature of the technologies and the associated products present problems in interfacing different products to different software systems. A common protocol to accommodate these differences is therefore seen as an essential requirement for optimizing supply chain systems. Moreover, the need is seen for a flexible protocol that can accommodate the consequences of change and facilitate migration, as appropriate, to more advanced systems and systems intelligence.

The need for a universal method of integrating or connecting different item-attendant or associated appliances into systems is already being seen and accommodated through proprietary developments. From a generic traceability standpoint it is important to consider the need for an industry-wide standard. The basis for this assertion resides in the need to specify:

- A common interface between back-end enterprise software and a disparate range of item-attendant data collection devices.
- Forward compatibility for new data collection devices and support technologies.
- Plug and play capabilities with respect to bar code, RFID and other automatic identification and data capture devices.
- Remote network management with optimized network reliability.

Developments in the XML-based approach to messaging may be seen as a highly extensible solution, in this consideration, supporting the transfer of multiple elements in a single message.

Other features include:

- Simple command structure that allows easy configuration and administration.
- Automatic recognition and registration of new devices on the network supporting a unique level of interoperability with different data collection devices.
- Flexible and extensible device facility that enables the all the relevant characteristics of the devices on the network to be automatically described, including properties, methods and events.
- Automated monitoring of device availability and status.
- Alarm events to indicate problems with device functionality.

The need can be seen to review the requirements for a universal item-attendant data appliance protocol and enterprise software interface standard and the strategy for achieving such a goal and its specification within the generic framework for traceability.

6. Summary of Requirements and Actions

The practical framework for traceability must satisfy the following requirements in respect of traceability data flow and information retrieval:

- Data carrier and interchange structure along the food chain allowing identification of food items and the use of item-attendant traceability identifiers (data structures that facilitate access to food item and associated information backward traceable to source, and pre-source in respect to feed for animals) to facilitate access to supply chain information.
- Nodal (process or action points within the supply chain) data storage / information systems (IS) to accommodate identification and associated data from food items, derived from item-attendant and item-associated data carriers.
- One step, forward and backward connectivity, to nodal databases / MIS for the use of nodal stakeholders and authorised agents seeking traceability information.
- Connectivity between localised nodal databases / MIS and regulatory or concentrator databases / MIS (for national and industry-specific information holding and handling).
- Connectivity to networked databases and associated information sources to support full traceability.

Based upon the preceding considerations the basic reference model for traceability will need to determine and specify the following elements:

- Traceability functions and associated Information support structures – wherein stakeholders (SIG4 and SIG5) will need to define functions and associated information support needs, together with appropriate identifiers (SIG3) to support access and security strategies for traceability information.
- Identifier structures, based upon levels of identification listed in 4.4 (SIG3).

- Data carriers and other item-attendant and item-associated support technologies – with particular attention to identification and data support attributes (SIG3).
- Universal Data Appliance protocol for accommodating data carriers and other item-attendant and item-associated technologies (SIG2 and SIG3).
- Connectivity and Information retrieval strategies – to facilitate traceability functions and strategies for accessing appropriate information sources (SIG2 and SIG3).
- Added-value process support functions (SIG2, SIG3, SIG4 and SIG5).

These elements translate into actions required of respective special interest groups to assist in completing a framework specification.

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