



# Afilias Discovery Services: Enabling Whole Chain Traceability in Global Food Supply Chains

SEPTEMBER 2009

“60% of consumers are concerned about the safety of food they purchase”

## Introduction

Whole chain traceability is a growing requirement for many governments and private organizations today, particularly those impacted by product recalls, such as the recent recalls of peanut butter, meat products and pistachio nuts due to contamination. According to a recent survey in the US, “60% of consumers are concerned about the safety of food they purchase” .

The resultant demand for increased responsiveness and accountability in the area of food safety has highlighted the need to quickly locate and respond to sources of contamination in the food supply chain in order to address public safety concerns essential for maintaining product quality and consumer confidence.

In addition to addressing food safety concerns and the desire of consumers for more transparency in the food production process, the ability to document both product origin and movement history through the supply chain is also being seen as a way for organizations to protect product brand, minimize liability, provide competitive differentiation, and increase business efficiencies.

More advanced technology is needed to solve challenges in our increasingly global supply chain. These challenges include identifying and locating all supply chain participants as well as the management and sharing of tracking data for objects being handled. Achieving full traceability in the supply chain requires not only the ability to collect, store, query and analyze data, but also the ability to selectively and securely share data among all the various participants up and down the chain.

While there is no doubt that current “track and trace” applications can provide functionality that solves certain aspects of industry and government recalls, such as tracking within the four walls of a facility, or establishing product origin, they do not solve the following challenges to secure and selective data sharing that need to be resolved for true “end-to-end” visibility to occur:

- Increasing Supply Chain Complexity
- Non-interoperability of Proprietary Solutions
- Gaps in ability to view upstream and downstream partners
- Security of Shared Information

The globalization of the food supply poses further challenges as differences in international traceability mandates and technology solutions can impact the ability to achieve end-to-end traceability.

## Barriers to Achieving Whole Chain Traceability:

### Increasing Supply Chain Complexity

Today's organizations face increased supply chain complexity, both in terms of numbers of participants as well as the numbers and types of products to be tracked. Farm to fork supply chains, for example, can involve farmers, meat, produce and poultry producers, distributors, food processors, wholesalers and retailers. These participants represent steps in the chain that add complexity to the tracking problem since each participant may implement a different "track and trace" methodology and solution. Moreover, an animal source (e.g. a beef cow) with a single identifier tag, may be processed into multiple products of animal origin (steaks, roasts), necessitating the ability to track all aggregated event changes in each product identifier (e.g. relabeling), packaging (e.g. pallet breakdown), location and movement (e.g. wholesaler to retailer), as well as the ability to track any individual product identifier back to its source.

The globalization of the food supply poses further challenges as differences in international traceability mandates and technology solutions can impact the ability to achieve end-to-end traceability. (Contaminated food outbreaks are typically not contained to one country). In addition, the diversity of how food items are used, whether as an ingredient, sold wholesale for consumption at a restaurant or food service chain, or sent to a consumer channel through a supermarket, can also add to the complexity of tracking data sources and providers.

Within a supply chain network, partners use their respective internal business applications to capture life cycle data for products and services, which includes detailed information about the events and transactions that occur in a business process. This stored data enables partners to make business decisions within their own organizations. However, to communicate effectively with one another to achieve traceability, supply chain members need a mechanism that enables them to share relevant data in a secure and selective manner.

Existing solutions for a large scale and multi-participant traceability system often require the supply chain participants to use a single vendor for product information access, which raises issues of

The current trend of supply chain participants to deploy their own systems, based on non-standard software interfaces, limits the capacity to view and share data with other systems.

scalability, interoperability, security, data access and visibility control. For example, if the Produce Marketing Association recommends Vendor X's traceability solution, but the Beef Marketing Association recommends using Vendor Y's, then a national grocery retailer Z would have to keep separate traceability records in different repositories (X, Y), for each type of goods received. This would be impractical from a cost perspective, and unmanageable in terms of scale from a technical perspective.

## Non-interoperability of Proprietary Solutions

Another key barrier to the achievement of end-to-end visibility in the supply chain today is the fact that most traceability solutions in a supply chain are based on proprietary technology, and do not integrate easily with other systems. Whole chain traceability requires the use of standard interfaces and identifiers to be utilized at every layer of the industry (e.g. product movement capture, storage, query, and discovery and exchange of information between all traceability repositories). The current trend of supply chain participants to deploy their own systems, based on non-standard software interfaces, limits the capacity to view and share data with other systems. The solution is to either have one traceability system for all participants, which is impractical to mandate on a large scale, or to employ standards-based solutions which will enable traceability across disparate systems.

## Gaps in Ability to View Upstream and Downstream Partners

Supply chain participants today generally know where a product was immediately before they took possession of it, and they know where they have sent it. This "trace-forward" / "trace-back" approach is limiting in that they cannot locate or share data with partners that interacted with the product further up or further down the supply chain. This in turn means that the complete lifecycle information about any individual object would be held by multiple resources, although entirely visible to none, throughout the supply chain.

The problem lies when something goes wrong with a product, due to damage, contamination, loss, or mishandling. Without more upstream and downstream visibility of event data, partners have no traceable audit trail and the process of investigating where and when a problem occurred can be time consuming and costly.

“If a resource in a supply chain chooses not to participate, what’s required is way to ensure that it is always possible to ‘navigate beyond a broken link’ to find who currently has the object.”

“Full traceability should not imply that all members of a supply chain have full access to other members’ sensitive data.”

Another problem with relying on following the chain from the manufacturer to the current downstream custodian of the object is that there could be a broken link in the chain by just having one of the participants not providing an onward link or if their information service is temporarily or permanently unavailable.

In today’s morphing supply chains there will always be resources that cannot or will not participate in track and trace efforts. If a resource in a supply chain chooses not to participate, what’s required is a way to ensure that it is always possible to ‘navigate beyond a broken link’ to find who currently has the object.

## Security of Shared Information

Tracing data event movement across multiple supply chain participants and systems also raises questions of how to provide selective and secure access to information for authorized members of a supply chain.

Full traceability should not imply that all members of a supply chain have full access to other members’ sensitive data (e.g. shipping patterns, customer lists), but should have policies to govern who may have access to it and what data is published.

A common scenario today is loosely coupled supply chains where some of the participants have no prior business relationship. Serial-level data is commercially sensitive, since it can reveal information about stock levels and volumes and flows of goods. For this reason, most companies insist on maintaining strict control over who is granted access to their data. The entire lifecycle information for an individual object therefore can remain decentralized and fragmented across multiple actors in the supply chain without the ability for loosely coupled supply chain networks to exchange data securely and selectively.

Even partners in tightly coupled supply chains cannot always be selective in controlling access to their confidential data or be guaranteed that their proprietary data will remain secure and confidential when using existing technologies. (It is doubtful whether supply chain participants would agree to having a single government agency or

Discovery Services (DS) resolves the barriers to achieving true end-to-end traceability by making visible all sources of product observations.

vendor entrusted with operating an end-to-end system). A secure mechanism is needed that will enable supply chain partners with or without prior business relationships to discover one another in order to provide selective access to referral links to detailed information repositories.

## The Role of Discovery Services in Enabling Whole Chain Visibility

One of the key components for enabling whole chain traceability that is missing from traceability solutions today is the ability to securely and effectively share product movement data among authorized supply chain participants. Discovery Services (DS) resolves the barriers to achieving true end-to-end traceability by making visible all sources of product observations.

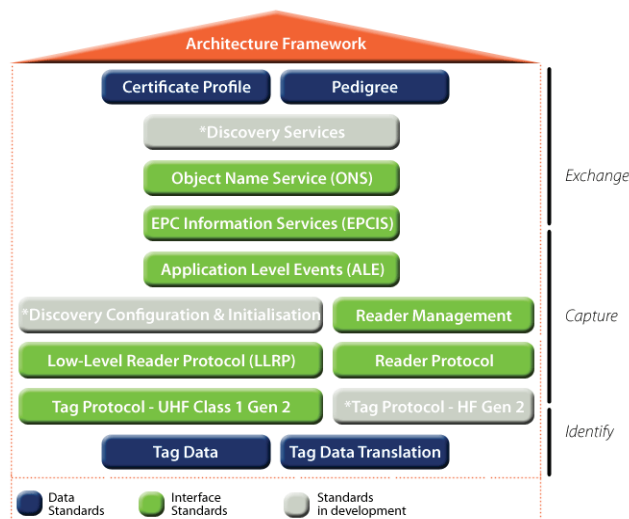
It does this by providing links or URLs to providers and sources of product information along one or more supply chains. This may include the original manufacturer or supplier of the object, as well as other organizations who have handled the object at some point during its lifecycle. This includes service organizations, and even organizations such as customs or insurance agencies, who might hold information records related to the object, though they may have never had physical custody of the object. It is a lightweight referral service, meaning that it doesn't contain detailed sources of product information, but points to traceability repositories where this information is located. It does however provide for some minimal business context information to be added to allow organizations to make selective decisions on which partners to share information with in the supply chain.

Another way to think of Discovery Services is as a "search engine" for serialized objects or as a common shared registry that will return a notification of information and links (or "referrals") to providers of product information along a chain of custody. Unlike search engines, which are open and publicly accessible, DS is only available to authorized partners with whom the information provider has an established trust relationship. In this regard, DS is similar to social networking applications such as Facebook which gives users the ability to control levels of access to information for sharing with those in their network. Also, like Facebook, DS enables users to request

Discovery Services is a proposed interface standard that defines a way for each organization in the chain to securely register the URL of their traceability repository and find other provider repository URLs.

connections between participants who have not had a previous relationship, as well as provide referral URLs to other sources of information.

The need to define requirements for a standard around Discovery Services has been recognized by standards bodies such as GS1 EPCglobal, who is leading the development of industry-driven standards for the Electronic Product Code™ (EPC). EPCglobal has incorporated DS into the Exchange layer of its Architecture Framework (see Fig. 1.0), which is the layer at which data lookup and sharing takes place. To date, standards exist for capturing, filtering, storing and querying serialized information collected within each organization. Discovery Services is a proposed interface standard that defines a way for each organization in the chain to securely register the URL of their traceability repository (called an EPCIS by GS1) and find other provider repository URLs.



<http://www.epcglobalinc.org/standards>

GS1 EPCglobal Standards Overview Diagram (Fig. 1.0)

ADS provides a secure mechanism for companies to “track and trace” business event data, as well as selectively share information regardless of the underlying business application, so that competitive data remains secure.

## Addressing the Challenges: Afilias Discovery Services

Afilias Discovery Services (ADS) is a standards-based implementation of a Discovery Services interface (protocol). As a hosted DS solution, ADS enables whole chain traceability by providing links to all repositories that contain product movement information/traceability information along one or more supply chains. This gives tracking and product lifecycle information systems the ability to gather complete information about a product or object’s movement through the supply chain. ADS provides a secure mechanism for companies to “track and trace” business event data, as well as selectively share information regardless of the underlying business application, so that competitive data remains secure.

ADS also features a hosted registry and lookup service that allows multiple supply chain partners with or without prior business relationships to register key records about an object’s movement events through the supply chain. It does this through a lightweight lookup and referral service that scales and is able to provide links to relevant event repositories in the supply chain, as well as store changes of identifier mappings (e.g. upon aggregation, relabeling) based on standard protocols for data exchange and communication. Unlike existing solutions, it provides referral services between loosely coupled supply chain management systems using granular security that provides selective visibility. Afilias Discovery Services address the current gaps in achieving end-to-end visibility for supply chains as follows:

This approach allows for existing disparate systems to selectively share supply chain event information without having to change or adapt their systems to any one particular implementation.

## End-to-End Visibility Challenges Solved by Afilias Discovery Services (ADS):

### Increasing Supply Chain Complexity

Afilias Discovery Services interact seamlessly with existing systems to link all partners to critical data. Unlike current solutions, ADS provides the ability for integrated supply chains to dynamically discover and locate information services provided by supply chain partners who may have no prior knowledge of each other's existence. ADS is also architected for scaling to support multiple participants, products and supply chains.

### Non-interoperability of Proprietary Solutions

ADS, through the use of open standards and the ability to query distributed repositories, is designed so that each participant can leverage existing infrastructure. This approach allows for existing disparate systems to selectively share supply chain event information without having to change or adapt their systems to any one particular implementation. It thus eliminates the need for companies to adhere to any one particular type of data source, or vendor system in order to be able to interconnect with other suppliers in the chain.

### Linking Upstream and Downstream Partners

ADS provides a "common bridge" to all partners to ensure that it is always possible to find who currently has an object, whether or not all partners in the chain choose to share their information. Its protocol architecture is designed to be "tolerant" of non-participatory supply chain players, and potential lags in adoption by providing partial traceability initiatives, which can grow to accommodate whole chain traceability.

### Security of Shared Information

ADS will enable only authenticated and authorized supply chain participants, even in loosely-coupled supply chains to become aware of each other, based on the goods that are moving within the supply chain. In situations where a client and the provider of a resource have no existing trust relationship with each other, ADS allows a resource to specify multiple levels of 'visibility' to such a partner, which enables partners to be selective and restrictive about the information they make visible to other supply chain partners.

## Sample Scenario: Meat Traceability

The following example illustrates the use of Discovery Services in a meat traceability scenario involving a recall. Note that the use of DS for assuring traceability applies equally to other safety-critical objects, such as other foods, pharmaceuticals, aircraft parts, medical equipment and automotive components.

Figure 2.0 shows a typical beef supply chain:

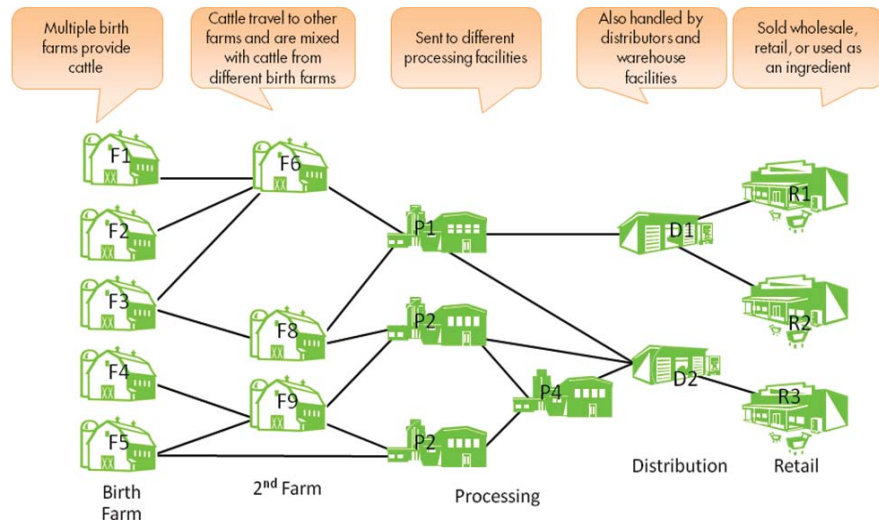


Fig. 2.0 Beef Supply Chain

The ability to capture and act on real-time temperature monitoring for example, can reduce waste from produce undergoing variations in temperature during transport as well as increase consumer confidence in product safety.

In this scenario, traceability using Discovery Services as the beef cow moves through the supply chain and is processed into meat products (Fig. 3.0):

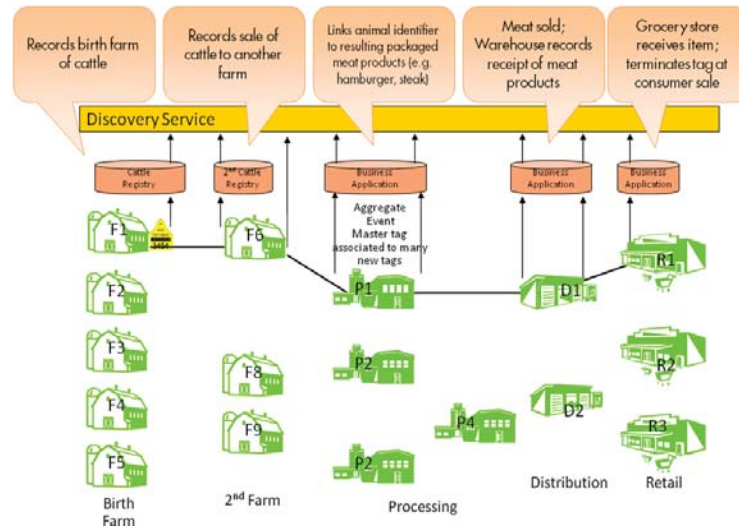


Fig. 3.0 Beef Supply Chain Traceability using DS

In the example above each beef cow would be tagged with a serialized identifier (bar code, RFID tag, etc.) and both location information (e.g. premise identifier) as well as event movement information (e.g. date, time a cow was sold, purchased at a particular location, etc.) would be collected, filtered and stored by each participant in the chain as the cow moves from the farm of origin through processing and packaging into various meat products. At this point other movement information such as lot number, product class, aggregation of meat products into case and pallet, as well as additional attributes (e.g. date of expiration) can be added before distribution and receipt by end retailers. Temperature information, critical to cold chain traceability could also be captured along the chain, including during transport, so that at the compliance and conditions stage, business rules could be defined for actions to be taken if a product goes outside of an acceptable range during a business process step. The ability to capture and act on real-time temperature monitoring for example, can reduce waste from produce undergoing variations in temperature during transport as well as increase consumer confidence in product safety. Finally, using Discovery Services, each participant in the chain can selectively share access to product movement information, enabling an end-to-end view of the product from point of origin to end consumer.

This ability is critical with respect to recalls. For example, in the event of a contaminated meat recall, DS could enable the recall issuer (government regulator or entity with recall authority) to surgically identify potential sources of contamination (Fig. 4.0):

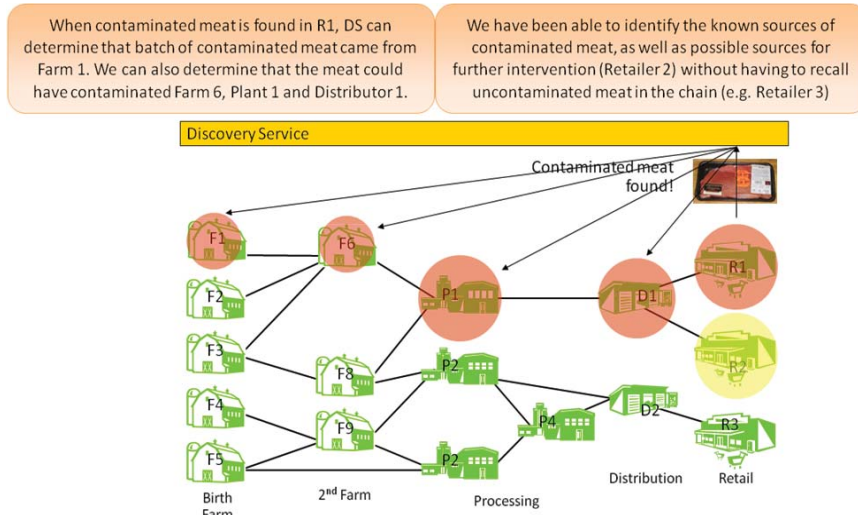


Fig. 4.0 DS enabled Meat Recall

Once Retailer R1 has discovered contaminated meat and notified the appropriate supplier; the supplier or organization issuing the recall notice, determines the affected identifiers from their internal traceability system and publishes these identifiers into DS. DS broadcasts this information to the supply chain or other parties who have subscribed to receive recall notifications for those identifiers. Once the recall notice is received, other affected parties can look at their traceability systems to see if they also have any of those other identifiers in their systems and if so, can take appropriate action. Discovery Services will know where affected identifiers are located because it will have had the URLs to each traceability system containing identifiers previously published (see Figure 3.0).

ADS is designed to respect the security and privacy requirements of users of the services since value chain information is commercially sensitive.

## How do Afilias Discovery Services Work?

Whole chain traceability information is first gathered from each participant tracking the flow of goods across the supply or value chain. These participants read RFID tags/barcodes and extract the object identifiers, such as an EPC. Then each object identifier is coupled with business context information to form an Event. The Event is then stored in an internal traceability event repository (e.g. EPCIS). When an object identifier is entered into the EPCIS traceability repository for the first time, a record is published to the Afilias Discovery Service (DS) instance which will tell ADS that if other supply chain participants are permitted access to ask about this particular object identifier, they will be referred back to the original traceability repository which has detailed traceability information about that object. Subsequent Events about the same object stored in the internal traceability repository would therefore not require a trigger for a record to be published to DS.

Afilias Discovery Services are then queried in much the same way as a Web search engine. A web search engine receives a query for a keyword and returns links to Web sites that have relevant information on that keyword. ADS would receive a query for an object identifier and return links to traceability repositories that have event information about that particular object. Unlike public search engines, though, ADS is designed to respect the security and privacy requirements of users of the services since value chain information is commercially sensitive.

Once all the available links are obtained, then each EPCIS traceability repository is queried for Event information through the EPCIS Query Interface. Once all the Event information is collected, then it can be consolidated to give whole chain traceability information.

Using an open standard client interface, supply chain partners can inject basic business event data into the ADS system with customized security options that specify which partners can access it. The same client interface provides a lookup service that enables authorized partners to seek referrals to more detailed information available from other partners in the supply chain. When no information is available about an object among partners in a supply chain, the ADS system will automatically provide exception handling (see Fig.5.0).

ADS also connects to other networks using the ESDS protocol, which allows existing Service Oriented Architecture (SOA) services to seamlessly integrate with the solution using common B2B exchange.

Regardless of the business application software that captured the event data, the configurable access to shared information ensures that competitive data stays secure.



ADS Exception Handling (Fig. 5.0)

ADS leverages an open, web services protocol called the Extensible Supply-chain Discovery Service (ESDS) to find multiple sources of serial-level information. This protocol is a server/client mechanism where the clients are capable of being implemented directly to backend managed services. This means that a company's inventory management system, ERP system, and even the edge servers in its conveyor environment can talk to a Discovery Services through a simple client. Additionally, a Discovery Services client can run on a smart handheld or fixed reader, enabling it to talk to a Discovery Service directly.

ADS also connects to other networks using the ESDS protocol, which allows existing Service Oriented Architecture (SOA) services to seamlessly integrate with the solution using common B2B exchange.



## Summary of Features and Benefits

Afilias Discovery Services enables the secure, selective, lookup of heterogeneous resources and databases as a result of the following features:

### Features

- Comprehensive ability to link to all participants in end-to-end supply chain. Provides pointers to the entire sequence of historical events associated with a product lifecycle; allows dynamic real-time updates.
- Open Standards-based approach to data exchange and discovery (EPCglobal DS is a protocol being established for defining standards around data sharing – ADS supports the following interface protocol standards under development: IETF ESDS and EPCglobal Data Discovery).
- Common Uniform traceability interface using a standard interface protocol across supply chain providers.
- Secure Lightweight referral service with minimal event information related to product changing hands. User/Role based permissions, secure connectivity, data transmission, certificate logging and built-in encryption, which can prohibit data mining of sensitive supply chain information. ADS allows for the creation of Access Control Lists (ACLs) for granular security.
- Customizable administrative interface to allow users to create and control their own supply chains. Security is also customizable and user configurable by such factors as event type, or even by supply chain partner, so that confidential and competitive data can only be seen by trusted parties.
- Interoperable - ADS is platform and identifier type agnostic. Removes the need to coordinate all traceability information across a single global hierarchical network.
- Provides client/resolvers for use with existing EPC Information Services (EPCIS). Supports multiple identifier types (e.g. Bar codes, RFID tags) and numbering schemas.
- Scalable and standards-based service-oriented architecture. Allows global intercommunication between chains of Discovery Services.



## Benefits

- Enables performing surgical recall and enhances ability to notify supply chain partners.
- Standards-based approach allows for freedom to choose the data collection and storage systems with applications best suited for each participant's needs for track and trace.
- The benefit for participating supply chains is interoperability with existing frameworks, solutions and object identifiers. For Discovery Services to be of value, there needs to be multiple Discovery Services vendors who are capable of interoperating with one another.
- Using a common traceability protocol means reduced complexity and cost in traceability systems integration.
- The use of access control policies and encryption for guarding referral links and thin event data, provides a safe avenue for event tracking and sharing in the supply chain without risking leakage or attempted mining of sensitive trade information.
- Being identifier type and schema agnostic allows participants to leverage existing technology and provide a migration path to adoption of new technology as needed.
- The pluggable nature of the architectural framework provides ease of integration with existing systems; scalability and extensibility of design allows DS to accommodate increased growth and complexity in the supply chain (e.g. such as the addition of emerging information services such as smart phone applications, as well as the potential to connect to cross-border/foreign supply chain systems).
- The ability to provide more upstream and downstream visibility means that DS satisfactorily addresses the needs of supply chain regulations by providing a reliable audit trail and for meeting compliance or regulatory requirements. DS allows policy and regulatory flexibility to provide full supply chain disclosure (e.g. minimally regulated commodity items) or selective visibility to data (e.g. pharmaceuticals).
- Increased visibility and/ or efficiency in accomplishing regulatory requirements for reporting on the supply chain can result in reduced cost, time, and labor, for an enhanced ROI.
- Businesses can also benefit from the increased visibility of data to perform supply chain heuristics e.g. a Discovery Service could give a company visibility that a shipping port it uses tends to be a hold up in its supply chain. Or that it should modify its manufacturing processes based on a product's maintenance history.

Afilias Discovery Services is the only open protocol data sharing solution that can most effectively meet traceability requirements for scalability, data aggregation, and architectural flexibility, while at the same time addressing security and privacy needs.

## Conclusion

Achieving full traceability in the supply chain is a challenge that requires the ability to collect, store, query, and analyze data as well as the ability to selectively and collaboratively share particular pieces of data among the various participants up and down the supply chain. Track and trace systems today cannot meet the challenge unless all participants are standardized on one system.

Discovery Services represents a critical piece in the creation of end-to-end, whole chain traceability: without it, the ability to provide full visibility across one or more supply chains and accommodate new partners, products and product aggregation is severely limited, if not impossible.

Afilias Discovery Services is the only open protocol data sharing solution that can most effectively meet traceability requirements for scalability, data aggregation, and architectural flexibility, while at the same time addressing security and privacy needs. It is the most comprehensive approach to solving the traceability problem today and can put the food safety industry on the path to improving the precision, effectiveness and efficiency of recalls.

Afilias' expertise and leadership in developing and implementing the Discovery Services protocol, as well as their early and continuing involvement in organizations focused on DS standards and protocols (GS1 EPCglobal, IETF) make Afilias uniquely qualified to implement and support data sharing in full traceability initiatives.



## About Afilias

Afilias is a global leader in advanced registry services and provides a wide range of capabilities essential to the smooth and efficient operation of any type of registry service.

Afilias launched its registry services in July 2001 with the launch of the top-level domain registry for .INFO the most successful of the seven new top-level domains (TLDs) selected by the Internet Corporation for Assigned Names and Numbers (ICANN). Today, Afilias provides registry services for .INFO, .ORG, .mobi (for the mobile Internet), .aero (for the aerospace industry), .asia (for the Asia Pacific region) and several country code TLDs (ccTLDs). Afilias supports nearly 15 million domain names.

Afilias has pioneered many advances in the area of Internet domain registry technology, and is now focused on the development of solutions and services for the Discovery Services layer of the RFID supply chain tracking vision. Afilias Discovery Services (ADS) is a DS solution that leverages the expertise Afilias has developed in global domain name systems as well as directory content and propagation. In an effort to create a standard for discovery services, Afilias has also developed the Extensible Supply-chain Discovery Service (ESDS) Protocol based on the original EPCglobal discovery services vision. This depth of expertise, combined with unmatched experience in supporting community software development for mission critical applications, makes Afilias a Discovery Services leader and innovator.

For more information on Afilias Discovery Services:

**Please contact:**

Brian Cute - VP, Discovery Services

P: 1.215.385.4790

E: [briancute@afilias.info](mailto:briancute@afilias.info)

**Or visit us online:**

[www.afilias.info/ads](http://www.afilias.info/ads)