DESIGNING AN OPEN TRACK & TRACE SYSTEM - THE SOCIO-ECONOMIC CONTEXT

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Abstract

The paper presents both the technical and the socio-economic issues that arise from the design of an open, multimodal end-to-end tracking & tracing system. A brief overview of the general technical design choices is followed by a discussion of the associated socio-economic aspects, including the business context, which is heavily influenced by an electronic commerce environment, and user requirements.

BACKGROUND AND GOALS

Many large logistics companies have developed solutions for delivering these services in order to meet the requirements of their customers and to improve their services. Smaller companies, however, cannot afford these investments and are mainly active in the 'old' point-to-point transportation market, or co-operate with the larger companies, using their respective systems.

The companies that have the necessary information systems in place to participate in the market for high-end transport solutions normally offer their customers methods for tracking and tracing their consignments. Even though many customers would benefit from using this information in their own information systems, only few of them are doing this today because of the large investments in their systems required to adapt to the proprietary interfaces of the transport companies. However, these systems typically have two major drawbacks:

- They do not normally work across company boundaries.
- They do not provide accurate 'life' information about location and, particularly, the status of individual units or items.

That is, continuous information about the current position or status of transport goods (in the sense that the geographic position can be queried at any time) at item level is not commonly available today. Typically, this information is provided – if at all – at a vehicle or container

level only. Existing solutions are typically based on scanning bar codes at process or control points. Furthermore, very few companies have true global or even European coverage. In daily business, products are frequently shipped by subcontractors of the transport company, which frequently means that tracking and tracing is no longer possible. Only in a few cases do carriers exchange tracing information, but in most cases the costs for adapting the proprietary systems to each other are prohibitive.

The key idea of the ParcelCall project is to provide relevant services on top of open and standardised communication protocols, potentially including e.g., GSM/GPRS, ISDN, UMTS, and TCP/IP. Easy adaptation of legacy systems, operated by the individual carriers, to the new information infrastructure will be another key design criterion. Seamless interoperation between these systems on the one hand and the new tracking & tracing system has to be guaranteed.

The key requirements on such an open tracking and tracing system include the following; i.e., the system should be:

- inexpensive,
- simple to implement and easy to maintain,
- easily accessible (via e.g., the Internet, ISDN, and cellular networks),
- scalable with respect to
  - the overall volume of data it stores and processes, and
  - the size of the individual user company's IT infrastructure,
- reliable and secure.

At the same time, seamless integration into existing corporate IT-infrastructures is a sine-qua-non. Figure 1 depicts a generic architectural model of the environment within which the workshop's output will be positioned. A dedicated interface is defined to realise the integration into existing infrastructures. This interface may also be used in the future for the integration of the tracking & tracing functionality into other applications.

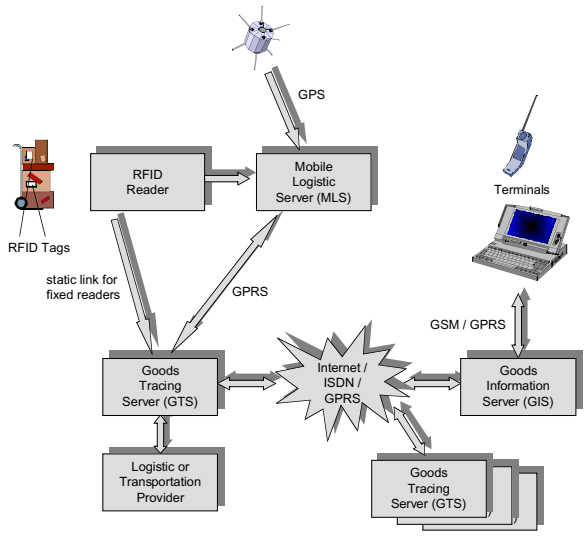

Figure 1: The ParcelCall Architecture

To ensure that these criteria are met, the system will utilise off-the-shelf standards-based components wherever possible. This holds for both the interfaces between the individual elements and the messages to be exchanged. If and when this is not possible recognised international and/or industry standards will be implemented. Only if these are not available

dedicated new specifications will be developed, which will subsequently be fed into the formal standards setting process (1).

Information on individual items, including position and status, are collected by a Mobile Logistics Server (MLS) located on board a vehicle. The former type of information is obtained via the Global Positioning System (GPS), 'intelligent' tags are utilised to collect the latter. These 'Thinking Tags', which are also being developed within the project, will form ad-hoc networks that can be applied to self-adapting hierarchical packing schemes or to active status monitoring of critical freight contents. Alarm messages will be actively generated if, e. g., an item enters a critical state (temperature, humidity, pressure, acceleration, etc.). It is also conceivable that in-vehicle shelves themselves are equipped with intelligent devices, such that the fine-scale location of an object within a vehicle can be determined.

The MLS sends the compiled information to a Goods Tracing Server (GTS). Every participating delivery company needs to install at least one GTS, which also serves as the interface between the respective internal IT system and the track & trace service. Thus, the set of GTSs forms a highly distributed data base holding the information available to the end-users (subject, of course, to appropriate access rights and successful authentication). The individual servers are interconnected via public networks (as e.g. the Internet or ISDN). It should be noted that even very small companies which do not have their own tracking and tracing system can utilise the ParcelCall service, as a GTS (typically a PC) and a few 'thinking tags' are pretty much the only additional pieces of hardware required (for more detailed information see e.g. (2)).

THE SOCIO-ECONOMIC CONTEXT

The success of a new technology depends on more than simply its technical efficacy; it must also be matched with its socio-economic context. In some cases this means tailoring technology to the existing environment, in others the market and context may need to be 'created', alongside the technology, by the technology's developers. Most obviously a technology must address the requirements of its various users. Typically, it is important that current needs, as seen in existing business practices, are taken into account. However, although existing practices provide a starting point, gaining the full benefit of new technology often depends on its more radical application.

Tracking & tracing systems need to address the requirements of two main types of transportation: business-to-business and business-to-consumer. While the former increasingly hinges on efficient logistics management, a key issue for the latter, especially as regards the growth of e-commerce, is customer satisfaction.

High quality tracking and tracing of parcels matters for business-to-business transportation because of the trend towards inventory reduction. The speed, reliability and timeliness of delivery have increasing commercial salience both in procurement and in the quality of service offered by a supplier. Enhanced logistics management based on Just-in-Time, Vendor Managed Inventory or similar approaches can not only minimise stocks held, but can also involve outsourcing logistics management either to the supplier or to a specialist logistics operator. With e-commerce, boundaries between different 'stages' in the supply chain may become eroded. Distributors may take on extended roles; for example, in fulfilment and final assembly.

Improvements in tracking and tracing can also play a significant part in eliminating one of the problems faced by Internet shopping – reliable, time-assured delivery, tailored to customer requirements. Although not unique to Internet shopping, heightened customer expectations along with internet/WAP access provide an opportunity for improved customer service using more accurate parcel tracking technology.

While fulfilling these business applications is central, it is also important to recognise that there are a variety of other socio-economic issues that may affect the technology's success. Security and confidentiality may be important. Above all, a technology that involves inter-organisational data exchange depends heavily on the success of standardisation efforts and on the willingness of firms to work together. These issues may affect the technical choices adopted in the design and configuration, as well as the commercial strategies for its promotion. Strategic thinking on these lines is embedded in the architecture and strategy of the ParcelCall project (3).

THE CHALLENGES FOR A TRACK & TRACE SYSTEM TODAY

To be successful, any tracking & tracing must achieve neutrality between the different actors. In the first instance this relates to transport and logistics operators. However, if we want to understand the business case and broader commercial context for tracking and tracing we must also address the wide range of players in the logistics system. In particular we must look beyond the immediate 'users' of the technology and address the logistics requirements of their customers. The enormous diversity of business models and 'users' of the network throws up a key problem in relation to establishing user requirements and the business case.

When looking at different types of organisation, this diversity increases. It is particularly instructive to refer to recent developments in electronic commerce. With Business-to-Consumer (B2C) we see an atomisation of the market into many suppliers and many buyers, where issues of trust are increasingly important, and likely to be the preserve of intermediaries in the commercial transaction, such as the third parties providing the transport, or the third parties that hold the money whilst the physical transaction takes place. When 'B' may represent anything from a multinational to a single-product, single-person company, and 'C' from a single person upwards, this creates a wide variety of business models to be supported, demanding not only flexibility, but also that costs scale as linearly as possible with volume and weight.

Though B2C e-commerce has grown rapidly over recent years, it has been predicted that B2B revenues will exceed B2C revenues by an order of magnitude in 2003 (4). This implies an increase in activities to help trading partners improve responsiveness to customers, reduce supply chain costs, increase manufacturing efficiencies and reduce inventories at every point in the supply chain from order to delivery. These Internet-based supply chain services are also planned to provide 'multi-tier demand, supply and inventory visibility, multi-tier constraint management and vendor collaboration, and improved material release stability.'

USERS

ALIGNMENT OF USERS

Attaining technical objectives will be of little significance if the technology itself is not widely implemented. Although individual companies could benefit from its local adoption, a system's full potential lies in the development of a standardised approach that can gain

general acceptance in the industry. Success will not depend simply on the development of the 'best' technology; equally important is the development of a constituency of users. The system will depend upon aligning expectations to ensure that a sufficient number of key users (critical mass) will be convinced to take part. It is crucial to convey that this represents the way forward, to win these kinds of commitments.

Thus, it is crucially important to recognise the diversity of players involved, with their very different commitments and needs. The development of a new Inter-Organisational Network System may involve an uneven distribution of costs and benefits between these players (5). In particular, it is important to ensure low barriers to entry - particularly for those players for whom a sophisticated track & trace system does not offer significant immediate benefits or strategic importance.

USER REQUIREMENTS

System senders, receivers, and carriers are the main users of a tracking & tracing. Their respective requirements are discussed in this section. Other users include Transport Broker, Packaging Services, Collection and Delivery Services, Depot/Hub/Terminal operators, and Vehicle Drivers.

Senders/Consignors

Senders can be either companies or individuals. Individual senders will typically take the parcel to a collection office. Home collection could also be possible, and it should be possible to arrange this service though internet/WAP access. The sender would like the options of email confirmation of parcel delivery, and internet/WAP access to transit status and estimated time of arrival.

The requirements of company senders will vary according to their business practices, and companies that are supplying goods to individuals may have similar requirements to individual senders. They will want to receive as much status information as possible because this can then be provided to their customers, providing value added to their service. Likewise, reliability in delivery times (or flexibility in rearranging them) is important, as would be the ability to confirm that the parcel has been received by the appropriate individual.

Companies that are shipping goods to other companies will in some cases also have similar requirements when dealing with small companies or supplying one-off ad-hoc shipments which also require precise tracing and proof of delivery. In many cases, however, company to company shipping will yield different requirements. Typically, the main difference will be that large numbers of parcels are being regularly sent and that on-time delivery may be more important than knowing exactly when the delivery will be made. Most companies will only want confirmation of delivery and alerts to any problems that may endanger delivery. Most importantly, expected time of arrival needs to be agreed between the sender and the carrier.

Receivers/Consignees

All receivers should receive advanced shipment notification with the parcels in transit given an ID to be used by both sender and receiver. In the case of individual receivers, the ID will usually be assigned by the sender. Individual receivers want to know when a parcel will arrive so that they can ensure that someone is there to receive it. Internet/WAP access and email messages can provide an attractive customer service, and is, for example, likely to be an important aspect of the development of internet shopping. This service could include 'real time' information on the parcel's movement, with updates in the estimated time of arrival

being the key feature. Further features, perhaps available at extra charge, could include enabling the customer to change the time of delivery or the delivery address.

In the case of corporate receivers, their dealings with senders will often be part of long-term supply relationships. For example, in B2B e-commerce, many manufacturing receivers may use EDI to send orders or call-offs based on long-term supply agreements and these may be generated directly from their internal systems. In these cases, the parcel ID may be assigned by the receiver, but this is a matter which it should be possible for the sender and receiver to decide between themselves. ID tags should also have the potential to satisfy any of the receivers' internal requirements for tracking the parcel within its warehouses and production processes.

Depending on the nature of the business, size of companies and the supplier-customer relationship, the level of detail of parcel movements and status can vary as agreed between sender and receiver.

Carriers

Companies providing express delivery, freight-forwarding and logistics management will be the main proximate users. Their customers (senders and receivers) may have certain data requirements (as noted above), but mainly they will want a high level of performance and service to be provided to them seamlessly and transparently. While a number of large, integrated carriers mainly use their own transportation (planes, trucks, etc), even they typically need to subcontract the physical carriage some of the time.

Parcels must carry an ID tag, either attached by the sender in agreement with the carrier (and in some cases also the receiver), or attached by the carrier following handover from sender to carrier. As with existing track & trace systems, this tag will be read at each control point – typically the hand-over between transportation units when arriving at or leaving a depot. (N.B. At present, much freight-forwarding done by small firms does not even involve the use of barcodes for ID.) With active tags (e.g. thinking tags), the reading of tags can be continuous, or at customer request rather than solely at handover points.

The carrier also requires regular feedback from moving transport units where this is possible. This information will comprise location and transport unit status (is it on time? what is the expected delay?), along with all the parcels carried and their routing, destination and estimated time of arrival.

Delays or route deviations will be identified by the system. It should also be possible for deviations to be manually notified by the transport operator. If 'thinking tags' are used, then any undesirable deviations in the status of the parcel (in temperature, for example) should result in alerts to both the carrier's main system and directly to the transport unit operator so that remedial action may be taken as soon as possible. Issues arise about whether to standardise these messages and, if proprietary and encrypted messages are being transmitted, whether carriers will feel happy to pass on to third parties information that they cannot themselves understand.

CONCLUSIONS

In this paper we presented the ParcelCall approach towards an open architecture for tracking and tracing in transport and logistics, as well as some of the socio-economic aspects associated with the design of such a system.

The chosen de-centralised architecture has several attractive features with respect to the requirements listed above. Most importantly, this architecture scales extremely well; it is no problem to install additional servers if need be. Almost as important, there is no need to modify existing corporate IT infrastructures. The only thing that needs to be done is specify and implement an interface between the infrastructure and the GTS. If required, incoming information (from the MLS) can first be processed internally before it is made available to the public (for instance, if exact location information must not be made available for security reasons). Moreover, small companies can compete on a more level playing field.

Internal details, such as change of transport mode or use of a sub-contractor are hidden from the end-user, to whom a virtual global delivery system is presented. (Mobile) end-users (i.e., consignors and consignees) can obtain information about a consignment from the Goods Information Server (GIS). The GIS holds the individual user profiles, checks and verifies a user's identity, forwards the query to an appropriate GTS and returns the response to the user's current end system.

A number of general design suggestions can be derived, for example:

- Use cheap, generic web or mobile phone-based interfaces so that SMEs are not deterred.
- Retain options for barcodes and scanners to ensure that those without RFID capability are not excluded, and to provide back-up in case of system failure.
- Avoid system requirements that will not be compatible with legacy systems. Where possible seek alignment with industry standard solutions. Another implication would be to have some kind of minimal specification for the system – coupled perhaps with more comprehensive specifications that players could migrate up to as they replace their internal systems.

Overall there is a key strategic choice about what one could call 'thin' and 'thick' concepts of what information will be transferred within the system. The 'thick' model implies to try and encompass and support the complex needs of diverse sets of players who will be receiving data about the parcel in the course of delivery. The 'thin' model implies that only limited data will be exchanged within the system itself, and that this will be supplemented by information provided by the internal systems and procedures of the different players.

Given the necessity to develop specific system, the socio-economic analysis mandates in favour of the 'thin' view of the system. Designing ParcelCall based on a 'thick' concept of business processes runs the risk that an inflexible approach will be 'hard-wired' into the technology, which will not be suitable for all the potential users. The 'thin' model allows diverse business users room to elaborate their own information strategy around the system.

These strategic considerations are also in line with pragmatic questions. The need to develop and agree on standards regarding the structure and meaning of messages, as well as rigorous security protocols regarding the release of information to particular players, mean that what can be developed in the lifetime of the project is likely to be a 'thin' implementation. Pointing to a spectrum of approaches between 'thick' and 'thin' models does not, however indicate the precise parameters of the standards and protocols that need to be developed. These detailed design choices will be resolved in the course of the project.

Ultimately, however, it is most likely that the success of a track & trace system will be determined by the actions of the companies with the most influence. If a number of the large, integrated express/logistics companies can be enrolled, then this will develop momentum for ParcelCall in two ways. First, these large companies can insist that their subcontractors become compliant. Second, the additional service levels provided by the system will raise the standard expected industry-wide, placing pressure on others to adopt as well.

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