TOPIC 10
FREIGHT AND LOGISTICS

ADVANCED LOGISTICS: THE ROLE OF GLOBAL INFORMATION ARCHITECTURE

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Abstract

The use of information technology to improve and substantially modify production processes of firms has made Information System and Telecommunications (IST) integration a critical strategic management issue. This paper discusses the role of global information architecture in advanced logistics.

INFORMATION TECHNOLOGY: A CRITICAL MANAGEMENT ISSUE

The use of information technology to improve and substantially modify production process of firms has made Information System and Telecommunications (IST) integration a critical strategic management issue. Integration of IST is leading to new forms of business organisation (flexible corporation). Information technology plays an crucial role in *business reengineering*, enabling to set up new configurations of business. Firms implementing these new structures are often identified as being less hierarchical, more oriented to client services. The advanced art of information technology is based on investments in architecture of Information System and Telecommunication.

First, information systems, and now system interconnections thanks to modern telecommunications infrastructures, changed the ways to do work and business in all sectors, specifically in transportation and distribution. Experts foresee that the so-called *nomadic networks* would increase the movement. As the surprising popularity of nomadic network indicates, the shift from wired to wireless channels is far more powerful force than anybody realised 10 years ago.

The possibility to burst data through the air will give rise to new approaches to networks, users being free to wander from their office to conference places, to home without losing their link to their information systems, with the same laptop or palmtop computer. In transportation the use of *wireless networks* allows to transmit pickup and delivery information between drivers and customer service centers, and permits to improve the efficiency of the fleet operations.

Modern information systems have great *organisational flexibility* since processing units may be located anywhere where they may be required, since information may be transmitted over large distances at reasonable costs, and since information may be stored in many different ways (magnetic and optical disks of various categories).

The main stake lies in gathering the information effectively (without useless transformations) and in transmitting it to the units concerned in time. Since the transmitter and receiver have no reason to be available and/or interested at the same time, it is necessary to store these quanta of information. This lack of synchronisation is the source of most of the problems since *the data must be stored somewhere, for a time.*

Schematically, the architecture is broken down into several strongly correlated fields:

- Input, which is undertaken as close as possible to the source, thanks to transponders and electronic labels; POS (Point Of Sale), in which information produced is automatically recorded in order to allow stock management, resupply, accounting, etc. Paradoxically for the local manager, this input may be considered a re-input, since the information was already digitised before being entered into the user system.
- Transport and distribution of information with the various agents concerned, using the multiple data network techniques (LAN, MAN, WAN, VAN, both public and private, wireless, etc.). The use of radio networks (wireless), or nomad networks, or indeed mobile networks, is enjoying some success in certain professional fields (sales teams, transport, distribution, etc.)
- Organisation of resources, for satisfying local requirements in warehouses, freight or breaking bulk platforms, ports for identifying container movements, active or proactive management, including security management.

Table 1 Security imperatives

continuity of service	The top priority is to keep components operating, even in a deteriorated condition,
confidentiality of information	so that it may not be used by an unauthorised party,
completeness of information	being certain that all the information has been transmitted, and has not undergone any modification during its storage and/or during transport,
authentication and non-repudiation of messages	being certain that the issuer and addressee of the information are indeed the parties they claim to be

The Client/Server model

All these developments favour the transformation of highly hierarchised information systems into the more horizontal and natural architectures of local networks, connected to each another by gateways or bridges, and possessing client/server machines.

The success of the term *server* to designate both a processing and information storage tool, and to replace the master or central computer, is a sign of this U-turn by information systems, which are now more directly in the service of the end user. From the outset, local networks have been operated from a non-hierarchical perspective: the various microcomputers could use resources they did not possess, and access localised disks on a more powerful computer or printer, or a telecommunications server with gateways, routers and bridges in order to access several other networks. This development towards *horizontal information systems* as opposed to hierarchical structures is gathering pace.

In the *client/server* relationship, the client machine is more than a passive terminal, since it uses the local power of a microcomputer to process applications, whilst taking advantage of the server's resources (files of data or programs, data or code servers, inter-network telecommunications server). This architecture is common to the majority of current microcomputer and/or work station networks. It has the advantage of maintaining part of the attraction of centralisation by localising the common or critical applications on the server, a single site to be maintained and updated, and the data for sharing the databases common to all the users.

Operation and development communications facilities as varied and complex as those on offer today require substantial administration in order to maintain a satisfactory level of availability, accessibility and reliability. This field of *network administration* has become primordial and plays a critical role in their development. Banks, insurance companies and airlines are unable to operate without their network and connections to neighbouring networks (clients, suppliers and partners). Increasing numbers of companies find themselves in this vital situation of having to maintain a broadly private telecommunications network.

The right combination of resources in terms of requirements forms the challenge for effective systems:

- databases shared and organised according to the relational model,
- interrogation language (SQL for example),
- use of resources according to client-server model,
- interconnection platforms for routing, through one or more intermediaries,
- telematic access networks, including radio networks.

It is interesting to note that major companies have a tendency to extend their applications by putting them on *servers*, rather than increasing the size of the mainframes, to the great despair of the manufacturers of mainframes. These organisational principles have the great advantage that they allow flexible location of processing units.

New stakes

In the immediate future, information technology will be pulled in a strongly *downward direction,* ie it is no longer a complicated instrument which resolves a few complex problems, but it can, in a simple manner, analyse and find many of them. This technology is indeed making itself available to a constantly growing population of users. It has become a relatively ordinary practice.

These problems are now more economic than intellectual in nature. Large processing centres will probably be the exception by the year 2000. Already today, total processing power is greater in *work stations* that in processing centres, even if these local capacities remain under-used, as a consequence of the excessive speed of transition.

THE ACTORS

The workforce

The "inverted organisation" or how to increase the responsibility of the "contact person"

Under the influence of progress in telecommunication and information processing systems, work organisation is being changed progressively and profoundly. This has led to a reduction of hierarchical levels, almost unlimited spatial distribution of employment, and generally modified distribution of services. As a consequence of the automation of simple tasks, we are seeing a steady increase in qualifications. The social phenomenon has had only partial repercussions until now in the logistic sector.

Nevertheless, the *inverted organisation* has first emerged in service activities. To the service customer, the most important person in the company is usually the one at the point of contact. What happens in the limited moments of the contact personifies what the company is to the customer. It verifies or invalidates the rest of the company that so expensively seeks to generate it through its many research, facilities, quality, distribution and advertising investments. For some company the contact person is so important that they will literally invert their organisations, making all line executives, systems and support staffs in the company "work for" the front-line person. They recognise that the contact person—normally considered as the organisation's lowest tier—is the one on whom every one else depends to deliver the company's full capabilities at the moment of customer contact. Managers in such enterprises try to conceptualise telanships and make their organisation perform as if they were an "inverted pyramid", with the contact people at the broad top level and the CEO at the pointed bottom (see Figure 1).

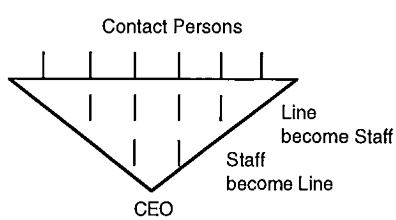


Figure 1 An inverted organisation

The managers and its tools: quality, service, development cycle

Role of quality

Among the profound changes in the modern economy, the quality factor plays a major role. It was initially known under the abbreviation TQC (Total Quality Control), but today ROQ (Return On

Quality) is the term more commonly used; this stresses the balance between costly efforts and the return which may be expected from them in income terms.

Although this idea has penetrated quite easily in industry, it has been more difficult to define in the services sector. As a consequence of the natural hazards experienced by the transport service, and the poor professional qualification which has for a long time characterised this industry, logistics has only lately realised the purpose of this economic factor.

Under the pressure of its clients, which now have severe criteria in the quality field, transport operators have made specific efforts by implementing appropriate tracing and tracking techniques.

A traditional means of classification in logistics consists in drawing a distinction between continuous monitoring, in which one is continuously informed of the position of an object in the transport chain (tracking), and the possibility of gaining information at any time about its position (tracing).

Apart from its general role of being in conformity with the performance required by its clients, these techniques are contributing greatly to multimodal transport, the weak point of which lay in transshipments. Goods, equipment and means of transport, equipped with their electronic identifier (ranging from a simple transponder to a re-recordable electronic label, and also bar-coding), are monitored automatically, using database servers which continuously record where these labels are. This helps increase the quality of the logistics services and also allows flows to be managed with response times matching clients' expectations.

Role of service

Transport has for a long time remained a commonplace service with very little differentiation in terms of the level of service delivered to clients; only the mode of transport varied from one service provider to the next. Here too, logistics has adapted to the givens of the modern economy by diversifying greatly its services, thus increasing its chances of income. Express transport is a good illustration of this movement, since, by stressing guaranteed performance levels, the operators in this sector are experiencing a growth in their turnover and a financial return considerably greater than that of the industry as a whole.

Differentiation of service may be related to internal and traditional transport factors such as speed or service quality. It may also consist of differentiation by external contributions, in which the operator provides additional services, such as warehousing, packaging, assembly and sometimes part of the marketing.

A large proportion of the added value of the advanced logistics services resides more in this diversification of services than in the use of sophisticated facilities. This can go as far as a completely personalised service, as has been found in the industry for some time now.

In any event, differentiated and diversified services will be better controlled if operators use appropriate information system architectures. Notably, as a consequence of the spatially splintered nature of transport services, nomadic communications and information processing facilities are assuming increasing importance. Among the latter, one should mention the increasing importance of specialised digital radios.

Taken to extremes, this logic may lead operators to do completely without means of transport. This is the case in maritime transport with NVOCCs (Non Vessel Operator Common Carriers), and it is also the case with a significant number of multimodal operators. But in this case, the company must have computing competences as specialised as those it has in the freight management field. Otherwise, this can lead to dissuasive prices which estrange clients instead of attracting them through the offer of additional service. Professional experience in this field is crucial. Many operators have failed in offering electronic transaction services (EDI or other), except in the field of air freight, in which companies have two to three decades' experience of the implementation of advanced information systems.

Role of the development cycle

The delicate problem of the assessment of rapidly evolving advanced techniques remains, because *in new technologies assessment timing is everything*. At a given time, a type of technology may be in any one of a number of states:

- subject to experimentation
- apparently promising, but premature
- applicable in specialised operational niches
- appropriate for widespread use under certain conditions
- commonplace
- superseded
- dangerous

A good means of assessing the status of a technique and/or organisation involves the use of accounts of case studies. In particular, it may be instructive to analyse a few cases of successes and failures in the implementation of advanced techniques.

Authorities' viewpoint

Although there will be no reversal of liberalisation, the goods transport sector will remain subject to technical and social regulations in order to meet security, safety and anti-fraud imperatives, and in order to continue to ensure indispensable and increasing mobility. Nevertheless, the authorities are seeking to facilitate this regulation such that transport activity may be progressively less perturbed by it.

Facilitating of operations

A large proportion of these controls may and should be undertaken electronically, such as those relating to documents accompanying drivers, means of transport and goods, together with loading lists of dangerous materials or Customs documents. Even in the case of more complex controls such as driving times, vehicle weights, and traffic duties and taxes, advanced technical solutions exist which resolve these problems without producing problems for the operators.

In the case of official papers accompanying drivers and vehicles, smartcards may record dynamically much useful data. In the case of those relating to goods, EDI technology and tele-transactions enable useful information to be gathered simply by duplicating pre-existing data required for the management of operations. Electronic labels and other transponders may also be used for flow management and the corresponding taxes.

However, although there are examples which prove the feasibility of such methods, they are little used, thus reducing the degree of efficiency of logistics systems. The main cause of this delay results from the large number of authorities with responsibility for these controls, the frequent technological delay of these governmental agencies, and the overlapping of, or even competition between, their missions. One example is that few countries undertake automatic electronic Customs clearance, despite the fact that it considerably reduces transit times at borders.

Regulations

Although information processing can simplify a number of operations by automating them, it can also enable authorities to set up new services with a view to improving the use of costly infrastructures shared by many users. The example of the circulation and delivery of goods which substantially aggravate traffic congestion in certain urban areas, and on overloaded road or motorway links, may be mentioned.

Just as this is found in the field of passenger transport, some thought may be given to encouraging and/or obliging users of infrastructures to make more rational use of them. This is the idea of Road

Pricing, which is a transposition to the road world of yield management. It has already been implemented in Europe in the form of dissuasive taxes for lorries on certain routes. But, in the absence of electronic control facilities, these measures remain coarse, relatively blind in their consequences, and hence ill-suited to ensure efficient traffic regulation.

THE NEW PARADIGMS IN IST USES

We are in the age of information society. The developments in computers have made possible their size reduction and increased their performance and functionality. Thus high performance portable systems are likely to be commonplace, they have made it possible to take information from wherever. The problem remains that basic information has to be carried around in the memory of portable computers. Some types of information age very rapidly, and some of information needs to be exchanged with the information system of business partners.

Voiceless

The developments in data communication have thus appeared quickly. Data wired networks are available in many forms, from local to wide area. The need for wireless networks for mobile data communication started in early 1980s. Despite the difficult competition for radio frequencies, the demands for wireless networks are very huge. The most dramatic acceleration in growth will be fuelled by users of portable PCs and PDAs who increasingly demand wireless connectivity.

In addition to this market factor for reducing the size of equipment, voice is realised as a poor media, because it is slow, not reliable and such information cannot be easily processed and stored in corporate databases. Furthermore, it required a synchronous exchange, not always possible due to time difference or because the nomad partner is engaged on something else.

Wireless

The wireless networks started in the 1960s, there were five basic technologies mainly focused for radio-based voice delivery:

- citizen's band over a local area,
- microwave, for urgency services or point to point delivery,
- wide-area radio communication such as maritime radio service,
- satellite-delivered service, starting in the early 1960s for telecommunications operators, then for corporate use (VSAT) and vehicle in the end of,
- wireless telephones for use within a small area in the mid 1970s.

Numerous methods of wireless technology are offered today. Satellite links are probably the only method to offer a virtually seamless nation-wide coverage, but it is the most expensive option in the case of in-car equipment.

On the other hand, there are specialised mobile radio, cellular radio and paging systems based on terrestrial antenna, but coverage may be lacking in remote, country areas. Several systems can share resources (frequencies, time ...) depending on a variety of needs and costs—these may be described as LANs (Local Area Networks), MANs (Metropolitan Area Networks) or WANs (Wide Area Networks)—and may, in fact, be based a wireless network.

Satellite system operators now can offer mobile data services. In Europe today two international operators are intended to meet the special requirements of transport industries: Immarsat at London (UK) and Eutelsat at Paris (FR.). In 1991, a third satellite service provider (Locstar) went bankrupt.

The great difference between satellite services and other types of wireless telecommunication is in that they offer seamless coverage. Certainly this ability can explain that charges for satellite services are four or five times greater than the others. The satellite based wireless networks transfers information at the lowest speed for nomadic networks, because of several specific characteristics of this media. Very few vehicles are equipped with the heavy, cumbersome and costly terminal device.

Specialised mobile radio systems, are based on a transmission technology similar to that of cellular telephone but it is often dedicated to corporate use. These wireless networks can offer voice and sometimes data transmission. Network protocols are based on error free end to end connection for data packets through wireless links.

Because of proprietary protocols, these wireless networks are certainly incompatible with the others. However these wireless packets based protocols have advantages in relation to others wireless technology system: for instance several users can share the same frequency transmission with integrated error correction, also they can carry data at lower charges and at better reliability.

The oldest and the most used specialised mobile radio system in Europe is the Scandinavian one: Mobitex (Ericson and Swedish Telecom Radio). Mobitex gear is also used by Ram Mobile Data and Bellsouth International specialised mobile radio systems (US), and in several countries in Europe.

Table 2 Existing nomadic networks

	Broadcast	Paging	Specialised radio	Cellular	Satellite
Actor	urgency services, police, taxi	health care & urgency services, maintenance	Parcel services, trucking, warehouse, maintenance	personal, corporate	corporate, transportation field
Scope	urban	urban	urban, regional	urban, regional, national	international
Mode	voice	data	data and/or voice	voice (soon data)	data and/or voice
Addressee	one to many	one to one	one to one, one to many	one to one	one to one
Capacity	one-way transmission, frequency channel sharing	one-way transmission, limited	two-way transmission, short messages, resources sharing	two-way transmission	two-way transmission
Quality	medium	good	good	restrictive	very good
Cost	low	low	medium	expensive	very expensive
Function	warning	warning, dispatching	warning, dispatching, distribution	dispatching, fleet management	dispatching, tracking, tracing, fleet management
Distribution rates	common	very common	new entrant	common	scarce
Services	low	fairly low	professional	commonplace	full range

Asynchronous

In this new world, more and more intelligent devices, terminals and software are being installed at the periphery of the network, especially on customer premises. Moreover, the emergence of powerful personal computers and local area networks capable of handling multimedia, as well as switching technologies like Asynchronous Transfer Mode (ATM), are blurring the borders between public and private networks, wire and wireless networks and between voice and data.

To save resources in terms of frequencies and money for user, and to give better services in providing a much more efficient solution, the main wireless data networks (Mobitex, RAM, SMR, CDPD) use the packet switching transfer. This means that all information is divided into packets and transmitted individually as traffic permits. The connection is instantaneous and exists only during data transfer; set-up time is minimised. With this technique a single frequency can serve a large number of users simultaneously. This mode of transmission named 'connectionless', also permits interactive processes. Some wireless data networks use also protocols that include built-in compression algorithms to save both time and money.

More generally and like for voiceless feature, asynchronous mode avoids too much coupling between remote processes in order to reach more flexibility.

Networking and international roaming

Today, fixed workers and roaming workers need to change business plan at the last minute, to redirect goods and services, to initiate orders and invoices, and to obtain information whenever and wherever the need arises. The network has to provide good coverage, particularly inside buildings. It has to have the capability from the start to connect from network to network, and across national borders. This is known as an international roaming service. The provision of this kind of service may be a crucial factor in favour of a mobile data solution.

There are still a number of issues to be resolved for building inter-network roaming. The mechanisms for handling billing, and for international numbering have to be defined and approved. One proposal is to reserve a range of subscriber numbers (MANs), and fixed terminal numbers for international roaming (Mobitex).

There are no real technical problems; nevertheless decisions must be made regarding the location of the roaming switch and the method of connection of the individual network to the switch. The most important users of international roaming service will be certainly found in transport field. There are many transport firms whose drivers cross international borders, not only in Europe but also in the American continent. In some cases international roaming is a necessary prerequisite for mobile data application.

New wireless connectivity is transforming all networking approaches. Thanks to internetworking through gateways, current information can be obtained whenever and wherever the need arises. For instance, RadioMail in the USA provides access to Internet, MCI mail, Sprint, ATT EasyLink, allowing users to send messages to paging services or to fax from nomadic site.

Because processing is distributed throughout the network and due to its hierarchical structure, data is only forwarded to the lowest network node common to the sender and the receiver. The principles of minimised searching and data moving, allow wireless networks to respond quickly and at minimal charge.

IDENTIFICATION TECHNIQUES AND THE SMART BOX: A VOICELESS AND WIRELESS PDA (PERSONAL DATA ASSISTANT)

The physical monitoring of objects is a technique which has many uses. It enables a routing error to be *corrected*, an event such as a preventive maintenance operation to be *triggered*, a fraud to be *detected*, or a stolen item to be *recovered*. This monitoring function, which for a long time has been assured by means of manual controls, has considerably increased thanks to new information technologies. This extension contributes to the maintenance and sometimes to the improvement of *product quality*, one of the characteristic features of the modern economy. It must also enable *fair conditions* to be maintained in the operation of markets, by detecting with greater ease, and more systematically, frauds and thefts.

Monitoring (or traceability depending on the professions using it) is indissociable from *automatic identification* facilities. The main use for this automatic identification technology is the monitoring of objects. The well-known case of the recognition of items at cash tills by means of bar code labels must be seen as an (accounting) monitoring of references, which effectively serves the re-supply logic. In a first analysis, identification may be considered the *material* part of the method and the monitoring the *software* part.

Purely electronic identification devices are more expensive than bar codes. Conversely, they occupy a wider field of application, and the characteristics of these devices, which are very difficult to falsify, make them a preferred support for *guaranteeing their origin*, in much the same way as seals affixed to sensitive documents.

Contrary to certain popular beliefs, automatic identification is currently a *mature technology*. The semblance of novelty essentially derives from the fact that it is beginning to emerge from the field where it developed. One should be aware that it has been used for approximately 15 years in mechanical manufacturing (aeronautics, then the car industry), where it has gradually become an essential component part of flexible production. Very many uses for automatic identification are currently being studied and/or implemented, from searching for lost luggage in air transport, to the tracing of stolen cars, thanks to cost reductions concomitant with its more widespread use.

The *multiplicity of uses* of identification techniques justifies investment in sophisticated methods, ie in machines operating under various conditions and for various purposes. In theory, therefore, an electronic label associated with a vehicle could allow the features in Table 3.

Table 3 The telematic instruments of a monitoring architecture

fees to be collected	fees for using public infrastructures (road pricing),
maintenance of it to be improved	using the information contained in the label (characteristics and interventions),
its **displacement** to be managed and its position to be detected	dynamic diversion, notably in cities in the case of theft.

Characteristic of identification

Identification of objects is reliant on two concepts: the support, and the identifier or nomenclature. Automatic identification is spoken of when digitised information attached to an object may be recorded at the moment when this object passes close to a recording device, without intervention being required.

Nomenclature

This idea of *identifying objects or persons* is nothing new but it has been given greater impetus with the arrival of computers and databases. We should recall that, in France, since the advent of social security, each individual has been identified.

Containers are distinguished from one another through a nomenclature managed internationally. In distribution, products are also identified using a product code. This *coding* is not an international norm. It is a GENCOD standard in France, harmonised at European level by EAN (European Article Numbering), which administers this nomenclature and handles certain trans-oceanic agreements. Where monitoring is concerned, the identifier acts as a *reference or access to the databases.*

Support

One of the oldest automatic identification technologies is that of *bar codes*. This process, which was invented in the 50s, is used in many applications and relates to a very wide variety of fields (identification of products in distribution, consignment labels in express transport, in the car sector, in stock management through the identification of locations and products, etc.).

It is easy to use since one need merely *print it directly* on to the object's label or packaging, or the object itself, at the same time as the text. There are hand-held printers with keyboards for printing the desired label on the fly. Its main features are:

- distance reading (1 metre or more, depending on conditions) is possible on objects moving at (low) speed,
- there are enough symbolisation systems to be able to adapt to the differing constraints of very diverse applications.

Bar codes are generally considered to be *the most flexible and least costly of automatic identification systems.* Conversely, this system responds less well than others to environmental constraints which may make the code illegible, and only operates with relatively low distances and speeds.

Moreover, although bar codes are all alike, there are unfortunately several international standards. All of them represent a character by a succession of dark bars and light spaces, but symbol coding varies from one system to the next.

The advanced age of the process has allowed the gradual development of solutions adapted to the constraints of a large number of cases, such as low-priced portable scanners, scanners able to read several types of symbol representations, etc. The impact of the various standardisation efforts has generally contributed to the quality and very relative (40 years) speed of the development of this process. International cooperation in Europe and North America is now, in certain economic sectors, producing a *common reference* for symbol representation and codification; this is the case above all in the car industry, retail trade, pharmaceutical industry and paper industry.

For some twenty years, radio labels have increasingly found a field in the identification of vehicles, equipment, and consignments in the freight world: wagons and locomotives, lorries, containers, swap bodies, packages, packets, etc. This new technology may be used in very varied fields. It is used to locate goods in warehouses, to control flows of materials within industrial processes, to give authorised persons access to controlled premises, and to undertake livestock monitoring. There can be multiple applications, depending on the type of component.

These identifier supports are components of various forms. They may be boxes of the size of a large box of matches, tubes of either plastic or glass of between 15 and 2 cm in length, or they may have the format of a credit card. They are called transponders or sometimes "radio chips" in professional publications. They may contain items of data associated with the identifier, of which there may be between 5 bytes and several kilobytes. There are now transponders in which some data which was previously frozen may be modified on request when it passes in front of the antenna-scanner.

These scanners contain a *radio device* which becomes active when it enters the scanner field. It consists of an antenna linked to a transmitter/receiver and an encoder. The frequencies used range from some one hundred kilo Hertz to several GHertz.

The advantage of these radio chips is that they operate at distances and speeds several times higher than those of bar codes. Scanning distances may be anything from fifty centimetres to a hundred metres depending on the models, power and regulation of radioelectric transmissions in the country of use, and the configuration of the scanner/antenna pair used.

Lastly, some of these transponders with batteries are called *active*. In theory, these batteries have a lifetime of approximately six years, even when used intensively, but this technology is too recent, relatively, for us to be certain of this. Unfortunately there is no practical detection system with this type of label for the battery use limit.

Transponders without batteries are called *passive* and in theory have an unlimited lifetime; they receive energy directly from the antenna, but their uses are more restricted.

These systems have the advantage of being unaffected by environmental conditions, but are perturbed by powerful magnetic fields, static and various types of interference of which there are many kinds in urban environments. The detection zone created around the scanner is also, unfortunately, influenced by any metallic elements which may be close at the time of the scan.

The relatively high price of transponders has until now been considered a handicap for the identification of low value objects. Low frequency radio chips containing only a single identifier currently cost between 3 and 6 francs each, when mass produced. Conversely, certain units used in identifying containers or wagons may cost 200 to 1000 francs, depending on the transponders' characteristics. However, the cost of entire antenna and encoder systems should continue to decline if their use becomes more widespread.

Specific radio network technology

Radio networks using satellites are now the only ones which provide practically *world-wide coverage*, but they are also the most expensive ones. There are specialised (and sometimes private) mobile telephone systems, the cell system, and the paging system, but their coverage remains limited. Other systems allow resources to be shared according to requirements and costs (time, frequency, etc.). These radio networks may be local networks (LAN), regional networks (MAN) or international networks (WAN). Certain improvements must, naturally, be made to this network technology in order to satisfy the increase in capacity rates and security and inter-operability requirements.

The continual technical progress in electronic components enables computers to be reduced both in size and in terms of consumption, whilst their power and functions are increased. High performance microcomputers will thus become ordinary items (PDA, Personal Digital Assistant). Information and telecommunications systems are becoming highly perfected. They are being developed to cover the differing requirements of all economic sectors. These information systems are becoming more easily accessible thanks to radio networks (PCS, Personal Communications Systems) by a nomadic personnel, whether they are in their offices, in warehouses or with clients.

With modern monitoring, based on automatic identification, direct and reliable input is possible, shortening information circuits. *Obtaining information at source* improves management process times and quality.

In most current commercial applications of these technologies, mechanical manufacturing or distribution, there is only one industrial operator, considerably simplifying implementation. In the case envisaged here, the compatibility of constituents throughout the chain consisting of the multiple operators must be resolved.

The success of effective implementation of monitoring involves the following elements:

- using technology to shorten channels and thus reduce times,
- finding organisation reconciling many users,
- bringing down costs through multiple and controlled use.

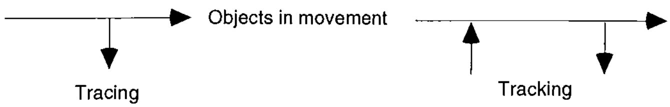
Sizes of solutions

With the explosion of micro-computing, the *field of possible solutions* to problems of information processing has increased considerably as a result of the flexibility of powerful and diversified resources, devoid of the joyless conditions of use of previous generations.

For the monitoring of goods, solutions are also naturally conditioned by the expected uses, the desired operational methods, and the organisational, administrative and legal constraints.

Monitoring methods (tracing and tracking)

Traditional classification in logistics consists of distinguishing between continuous monitoring, in which one is kept continuously *informed* of the position of the object in the transport chain (tracking), and the possibility of *obtaining information* at any time about its position (tracing).



In fact, there are other organisational methods the effectiveness of which must be assessed in relation to the requirements of individual organisations. In particular, the method in which information is supplied only in the event of a change compared to the initially determined campaign plan is called *proactive management.*

For the purposes of control, one must envisage implementing monitoring variants adapted to these individual requirements:

- in common cases a variant of tracking in which interrogation is undertaken by sampling,
- in the case of dangerous materials, a variant halfway between tracing and tracking may provide satisfactory guarantees,
- the method of *management by exception* (proactive) seems well-suited to the monitoring of sensitive products (fund transfer, funds in transit, etc.),
- in the case of accidents, searching in *back chaining* mode enables one to discover causes with a view to eliminating them.

Identity

The identity of an object is not always very simple to determine, no more than its attributes, origin, owner, composition, transfer conditions (material, regulatory, etc.), or the actual honesty of such data.

Identity in the strict sense generally consists in associating a unique mark with the object, which distinguishes it from all other objects, even those of identical appearance. Many objects which are marketed industrially physically bear a set of inscriptions enabling its manufacturer, model and series number to be reconstituted in a unique fashion. This constitutes the *guarantee that in the case of an accidental error* of manufacture or distribution dangerous items may be eliminated. Unfortunately, this practice appears to be systematic only for certain categories of products.

When properly managed, ie classified, listed and recorded with a certain degree of rigour, these marks are an indispensable precondition for *proving the authenticity of an object* and, indirectly, its ownership. Elementary precautions may moreover make counterfeiting difficult, such as engraving (or moulding) the identifier in an essential part of the object. One example that could be given is the principal microprocessor manufacturer, Intel, which has just decided to mark its central units physically in order to counter a recent and major increase in the theft of batches of chips from warehouses.

One should not ignore simple, old methods which have been revitalised by the possibilities of modern information systems. In certain cases, for example, *an object's description* may be sufficient to identify it, as with works of art. It is even the sole method for controlling the counterfeiting of craft products, or those which are difficult to mark, such as textiles. But here too, one must have this data available on a *documentary database*, equipped with relevant indexing. The textile industry is envisaging using a similar method to control counterfeiting, by storing the features of textile motifs.

Similarly, it is appropriate to include *packaging* in an effective monitoring strategy. Generally speaking, it is unlikely that active agents in the manufacturing and transport chain will have the same view of identification. One solution consists in adding specific identifiers, notably concerning the container. Certain carriers currently have their own bar codes, which they add to the others on the packages, because of the differences of codes and representation from one country to another. It may be imagined that the authorities may impose others for sensitive goods.

Electronic identifiers have intrinsic advantages which may justify use of them independently of monitoring. The most well-known consists in the possibility of being able to be read *at a distance* *and whilst in movement*, which is particularly valid for the monitoring of vehicles. However, the current characteristics of these devices involve major restrictions as to their use, preventing us from considering them to be universal tools.

The other major use is *authentication*. As with smart cards, part of the data contained in the machine is materially unchanging, making it a valued tool in the fight against crime. However, the *physical link between the object and the identifier* remains the Achilles heel of the method, especially if sufficient attention has not been paid to this problem before realisation.

Lastly, one should stress the fact that there can be no identifier without *server centres* where these marks and the attributes associated with them will be listed. Just as there can be no possibility of monitoring without *telematic networks* effective in accessing the data in the databases, stored at the nodes of the network. There is now no need to collect this data attached to the objects in a unique centre, due the efficiency of modern networks and the possibility of distributing the data, but good precautions should be taken in order to ensure the consistency required for a dispersed system.

Once the latter has been established it becomes possible to make useful and rapid *crosschecks of data* with the power of current processor units. This method is used particularly for American customs, which crosscheck customs clearance declarations against many other files. Similarly, the French police proceeds in the same manner in respect of stolen works of art.

THE AUTHORITIES AND MONITORING

One of the traditional roles of government is to control the movements of goods, for reasons of security and of economic interests. The latter have recently become weakened, but the *economic dimension* has strengthened considerably, since punishable actions now widely surpass the simple question of contraband. This is leading to new goals and new methods for control commensurate with the variability and speed of the changes in the structure of the economic factors characterising the modern economy.

Respect of regulations [information = prevention]

Over recent years, the systematic policy of deregulation has borne fruit by *intensifying exchanges*, and as a consequence by increasing the organisation of production. However, it also facilitates anti-economic behaviour which could quickly wipe out the benefits of this policy if measures appropriate to the new situation were not implemented.

The first duty of the authorities is to stay informed about the development of economic relations. From this point of view, provisions relating to the availability of information concerning the movements of goods is a favourite tool. The new information technologies may partly automate the elaboration of *statistics*, and thus prevent the perverse effects of poorly-adjusted regulatory measures.

Thefts and frauds

The authorities are finding it increasingly difficult to ensure exchange security. Many factors, by contributing to the *reduction of the efficiency of controls*, favoured faulty behaviour. Modern information systems must contribute to the improvement of control, both in terms of quantity thanks to automation, and in terms of quality, through improved input.

The precise recognition of products in circulation has become difficult through their intrinsic complexity, the large amount of variants, and the composition of elements of various origins. Control now consists in the perilous exercise of *comparing a paper document*, which is more or less reliable and accurate, with the physical appearance of the object. How can one check that the correspondence between the registration plate and the registration papers does not involve some sort of trick? How can one assess whether the logo associated with a luxury object is not an imitation? Identification techniques can help improve procedures.

Another problem relates to the globalisation of the economy, as a result of which there are a large number of *objects in the course of manufacture* in circulation. Long chains of subcontractors encourage all sorts of misunderstandings and deceptions about the nature and precise origin of controlled products. The possibility of interrogating databases in real time from the point of control will help dispel ambiguities, whether fortuitous or fraudulent, without at the same time penalising the production processes.

This organisational complexity of production makes it inevitable that *regulation should contain flaws* which are quickly exploited. The use of controls from an electronic support enables them to be recorded and thus analysed after the event. More or less sophisticated cross-checking of the control results can bring to light special or dubious cases. Physical monitoring naturally leads to monitoring of the regulations themselves, in order to make them less cumbersome and more relevant.

Direct pricing

The European authorities have become aware of the problem of the *fair distribution of taxes*, to reflect the real use of public infrastructures, and of the possibilities for regulation by *varying their amounts according to general interest-related criteria*. More generally, management closer to the field could lead to improved use of the capacities of the public infrastructures.

This is particularly true of the circulation of HGVs, in respect of which certain countries have already taken measures along these lines, whilst others are giving it serious consideration. It is thus possible to penalise circulation at certain times and/or in certain locations in order to induce improved use of resources, by significantly reducing the negative effects of congestion related to peak phenomena. It can operate like a bank card, except that it may be debited on the fly, as in certain motorway tolls.

This solution may practically be envisaged for all transport vehicles, and *avoids waiting times*, and the charges for use could be distributed better in the case of multiple partners. For example, there could be a tourist visiting card which would give free access to all transport facilities and visiting locations.

Improved maintenance and security

Identification and monitoring of objects reinforce the possibilities for maintenance and security operations. In the case of maintenance operations, quality identification enables a set of data on the composition of the product and *instructions for intervention actions* to be associated with it. In addition, a history of such interventions may be added which will give a statistics office a means of improving subsequent products. Car manufacturers are actively exploring this application in order to facilitate the work of garage mechanics and improve the lifetime of their products. The American army is testing similar equipment for aircraft which, using an EDI technique, automatically gives the order for what is required for the next maintenance operation.

In the event of an accident, identification and monitoring techniques may speed up operations considerably by supplying, directly on to the electronic label, or indirectly through a server centre, relevant data on the products concerned. The authorities should consider *new labelling regulations* taking account of new technologies, at least for sensitive or dangerous products.

When controls on roads are made, it is also possible to check *consignment safety*. The circulation of dangerous or sensitive products constitutes a growing danger that the technical weakness of the controls is unable to contain easily. A renewal of monitoring methods should take this dimension of the problem into account.