Project P947

Impacts of Information Overload

Deliverable 1

Impacts of information overload

Suggested readers:

Senior management, technical specialists, Human Factors specialists, HR managers, knowledge and information management personnel.

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Preface

Information overload has a more and more profound impact on many aspects of our life with the proliferation of telecommunications services and information systems.

The EURESCOM Future Directions Workshop that took place in Potsdam the 14 - 16 March 1999, identified the question:

"How do we protect ourselves from information overload?"

as strategically important to our Shareholders.

This question is certainly not new. In day to day business life, new ICT services are increasing the quantity of information that everybody is exposed to in his or her business activity.

The information overload phenomenon could lead to a negative image of telecommunications and even induce a decrease of its use.

The main objective of short Strategic Study P947 was to understand this phenomenon better and investigate its effect on people at work, and especially on TelCo business. This Deliverable reports on the results and findings of P947.

Executive Summary

The wonderful advances in information & communications technology over the past decade or so, has vastly increased the availability and ubiquitous proliferation of information on practically every conceivable topic. While human society now has the technical capacity to deliver vast amounts of information in multiple media formats to everybody, anywhere and at all times, a human being's capacity to absorb, filter and analyse the amount of information available has not increased similarly. Accordingly, there is widespread evidence that many people are experiencing difficulties in coping with the volume of information that is targeted in their direction or in extracting information they require from the data sources available.

In this paper we have identified two aspects of this problem: information & communication overload. Information overload refers to difficulties in locating, retrieving, processing, storing and/or re-retrieving information due to the volume of available information. Communication overload refers to difficulties resulting from the increasing demands from colleagues, relatives and friends for instant accessibility.

The causes of information & communication overload include:

- the volume of information available,
- the medium in which information is communicated,
- the manner in which it is delivered and presented,
- the structure of the information,
- the constant requirement to verify the quality of information,
- the lack of tools to filter out irrelevant information,
- emerging technologies that direct specific classes of information at individuals,
- new marketing strategies and technologies,
- the distractive nature of the internet/intranet in general and hypertext in particular,
- and the existence of multiple data sources and the lack of integration of data.

The problem of information & communication overload has potentially very profound consequences for society, the business world and the individual. The effect of information & communication overload is manifest in many ways including:

- health problems,
- frustration, disillusionment and depression,
- diminished productivity of individuals and companies,
- organisational inefficiency throughout society,
- including impaired judgement and bad decision making.

As large organisations heavily involved in the information & communication technology revolution, Telcos have an obvious vested interest in minimising the impact of this problem on our organisations and also in developing solutions to these problems which can be used to enhance the services we offer to our customers, who are very likely also suffering from the problem of information & communication overload.

In this study we therefore focussed our attention on the aspects of information & communication overload on Telcos, their employees and their customers. We examined the human aspects of information & communication overload in order to identify personal knowledge management mechanisms which can be used to increase the individuals capacity to deal with the problems of information & communication overload. We also studied current and emerging information management techniques, which might aid people in coping with the effects of information & communication overload.

From our study we have identified that a viable solution to the problems of information & communication overload in Telcos will involve a combination of approaches as follows:

- Producers of information can be educated to reduce or eliminate their contribution to the problem of overload.
- The adoption of a corporate information policy, which recognises the human aspect of the problem, can contribute positively to mitigating the effect of information overload on Telcos.
- The selective use of the products offered by information service providers enable users to extract the information they want better and filter out that information that is not of interest.
- Transformation projects should recognise the importance of information flows as much as organisational structure and operational systems when implementing changes.
- Funding research into solutions to the problem of information and communication overload and better management of internal information and knowledge.
- Senior management attention is required to co-ordinate a timely and effective response to the problem of information & communication overload and the related problem of bad information & knowledge management.

Finally new technologies have been identified which promise to deliver and organise information in a more efficient and effective manner.

As the market value of Telcos is increasingly vested in corporate memory and intellectual capital, our study concludes that Telcos must develop discipline and corporate skills aimed at managing these intangible assets.

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Abbreviations

AI – Artificial Intelligence

CMC – Computer-mediated communication. Interactive, computer-mediated technologies that facilitate interpersonal communication among several individuals or groups.

CO – Communication overload. A situation experienced by an individual as a result of demands of accessibility. Usually associated with an inability to successfully manage incoming and outgoing sources of interpersonal communication (fax, e-mail, traditional letters & memos, voice messaging, telephone calls, etc.)

EPG – Electronic programming guide.

ICT – Information and communication technology

IO – Information overload. A situation experienced by an individual when the amount/form of accessed or potentially accessible information exceeds the individual's ability to locate, retrieve, process, store and/or re-retrieve that information.

IM – Information management. Cognitive processes and behaviours that include the receiving, integrating, filtering, processing, seeking, transferring and exchanging of information by an individual decision maker in an organisation [15].

PIM – Personal information manager.

1 Introduction: The nature and impact of information overload

Technological developments during the last decades have made vast amounts of information available to more people than at any other time in human history. Within the course of a century easy access to seemingly limitless amounts of information has had an impact on virtually every domain of human activity - personal as well as professional - in industrialised countries. The creation of a worldwide telecommunications network that can convey multimedia content has been the driving force behind this information revolution in recent years. As technology takes over the task of processing, manipulating and sharing information, workers are rapidly moving up the 'information value chain' from handling information and data to converting pre-processed information into knowledge and action. Documenting, understanding and exploiting the socio-economic transformations accompanying the technological revolution should be a priority among EURESCOM members.

Large amounts of information are available to everybody. Public discourse, however, is increasingly focusing on the less beneficial aspects of ubiquitous information. In the world of information, one can clearly have *too* much of a good thing (Shenk, 1997); *more* is often *less*. Information overload (IO) has become a popularised reference to this state of 'too much information'. Infoglut, data smog, cognitive overload, information plague, sensory overload, information anxiety, Attention Deficit Disorder, information fatigue syndrome, communication overload/overkill, cognitive system overload, information plethora and information black-out, are a collection of terms used by laypersons and academics to describe how exposure to too much information affects the individual.

We believe a useful distinction can be made between "information overload" (IO) and "communication overload" (CO). The former includes what one traditionally associates with IO – a situation experienced by an individual when the amount/form of accessed or potentially accessible information exceeds the individual's ability to locate, retrieve, process, store and/or re-retrieve that information. We believe this also includes situations when the individual experiences knowledge deficiency, i.e. the individual is unable to locate or make use of sought-after information . CO on the other hand is more closely linked to our need to coordinate our activities with others. One needs to reach and be reached by one's co-workers, any*where* and any*when*! The demands of accessibility contribute significantly to our experience of being overloaded, but the issues and solutions are at least partly of a different nature than those associated with IO as this concept is defined traditionally.

Ideally, IO should be addressed within a more inclusive framework which can be referred to as an 'information ecology' (Nardi & O'Day, [22]). An information ecology may be defined as a system of people, practices, values, and technologies in a specific (organisational or end-user) environment. The focus of descriptions of IO and CO as well as proposed solutions should be on the *relationship* between tools, people and practices within organisations rather than on an isolated outcome variable (such as information overload). We believe this will also make it easier to identify interrelationships and propose solutions and countermeasures. By adopting an ecological perspective we will hopefully avoid proposing solutions which merely serve to escalate the problem to a higher level by means of 'improved' technologies, i.e., by treating symptoms rather than seeing these symptoms within a more inclusive framework.

Precisely because IO and CO are embedded in a more inclusive organisational context, making estimates of their isolated impact on, for example, decision making and physical or psychological well-being is a hazardous undertaking. Frequently cited studies (e.g. the Reuters studies published in 1996 and 1998 [24]; [25]) report that 70% (1996) of all managers suffer from IO, 50% (1996) of all managers think that information in their company is badly used, and 94% (1996) of all managers think that the situation will only worsen. Although the situation seemed to have improved slightly by 1998 according to Reuters, 60% of managers feel that the cost of gathering information outweighs its value to their companies and 54% worry about making poor decisions in spite of all the information at their disposal. The methodology (telephone interviews) and limited scope of the Reuters and similar studies may be questioned, but there is little doubt that there is a genuine concern about the impacts of IO and CO at every level in a wide range of companies. Findings are far from conclusive on the role of the Internet as a contributor or solution to overload, but most of the studies reviewed during the preparation of this report identify a fundamental paradox. i.e. Although there is an ever-increasing amount of information available on the Internet, obtaining useful and relevant information when needed is becoming more and more difficult. (See Edmunds & Morris [14] for a recent and more comprehensive review of the literature).

2 Human aspects of information overload

Although the consensus in literature as well as 'informed public opinion' is that we are surrounded by 'data smog' (Shenk, 1997), a well-defined school of research focusing exclusively on IO as a individual *syndrome* or feature of organisations has not emerged. We are therefore forced to piece together research findings from such fields as organisational communication, cognitive and social psychology, anthropology, sociology and knowledge management when searching for causes, symptoms and cures. Findings from one study are often difficult to relate to findings from other studies because terminology is discipline-specific. How can a psychological study of sensory or stimulus overload enhance our understanding of IO, for example, and how do such studies fit into the larger picture? Furthermore, studies of IO in organisations often fail to filter out the effects of stress induced by *other* factors. Finally, data from observational studies of *real* users performing *real* tasks in *real* settings are lacking. With these caveats in mind, we now examine the major causes, symptoms and consequences of overload.

2.1 Causes of information overload

IO and CO are directly related to the development of technologies for collecting, organising and distributing information and interpersonal communication. Equally important and often overlooked, however, are developments in the way work groups collaborate. Organisational models evolve as a response to new options afforded by information and communication technologies (ICT), and ICTs develop in response to the emergent needs of, for example, distributed/virtual organisations and a nomadic labour force. The dynamics of overload are to be found in this co-evolutionary process.

Narrowing our focus somewhat and examining the generic relationship between information and the actual or potential user of that information, several factors that contribute to overload have been identified. A single or any combination of the following factors can produce overload:

- **Volume**. The sheer *amount* of information exceeds the individual's capacity to process (access, digest, store, react to) that information.
- **Comprehension**. The information's *complexity* or *format* does not match the user's needs and/or cognitive skills required to process that information.
- **Integration**. The information arrives from *multiple sources* requiring the user to adapt not only to content but also demands made by each individual source.
- **Location**. The potential user is unable to determine if sought after information actually *exists*.
- **Access**. The potential user is unable to *access* existing information.
- **Relevance**. The user is unable to filter out *relevant* information.
- **Verification**. The user is unable to determine the *quality* or *accuracy* of accessed information.

The impact of printed mass media, office copiers, urbanisation, public mail services, the telegraph and telephone, public transportation and business travel have all contributed to overload in an organisational setting because they changed the way we organise work and do business. Employees were drowning in *paper* long before Internet entered the office. It was the increased availability of information from *electronic* sources such as the Internet and the many new synchronous and asynchronous communication forms that followed, that most clearly demonstrated the limitations of human information processing (described above) and laid the foundation for our modern conception of information and communication overload. Restricting the present survey to this 'Internet age' conceptualisation of overload, the following ICT and life-style related factors are frequently cited as major causes of IO and/or CO. The same ICTs may also be categorised as solutions, however. The final verdict can only be arrived at by means of observational studies of end-users – individuals as well as organisations.

- **Computer mediated communication (CMC**). Synchronous as well as asynchronous forms of communication such as e-mail, news groups, on-line conferencing and an ever-increasing variety of IP-based messaging services have been identified as major sources of CO and IO. Kraut and Attewell [20] point out, however, that e-mail is less likely to interrupt *workflow* because it is an asynchronous form of communication. On the other hand, analyses of in-box contents frequently reveal outstanding tasks, unread and partially read documents and a great deal of one-way information that should have been distributed through other channels (Wittaker & Snyder, [31]). Although unread e-mail does not interrupt workflow, it clearly contributes to CO as well as counterproductive information management practices. E-mail that is not acted upon is often followed up with a fax, phone call or visit, channelling overload from one medium to another. It should be recognised, however, that many irrational or sloppy e-mail habits are more or less successful ways of *avoiding* overload. Users are becoming increasingly adept at coping with overload by juggling the numerous ICTs at their disposal. E-mail has even been linked to power politics. Romm and Pliskin [26] document how e-mail is used to manipulate, control and coerce, adding interpersonal and political dimensions to overload.

- **Mobile access.** Telephony is no longer restricted to certain locations. Changes in communication patterns, communication cultures and decision-making processes in families as well as organisations have accompanied the explosive growth in mobile telephony in Europe and elsewhere. The ubiquitous mobile phone serves as an extension of the professional sphere into the private (and vice versa), contributing not only to CO but also to the disappearing boundaries between work and home. Accessibility, once a blessing of modern technology, has turned into a burden. Decision making processes often rely on unrestricted access to decision makers using mobile phones, contributing greatly to managers' overload problems. Many employees are also reluctant to turn off their mobile phones (even after normal working hours) for fear of being 'out of the loop', getting left behind, etc.
- **Push technologies.** Users need not hunt down information. Despite being written off three years ago by the media and much of the technology establishment (in the wake of the PointCast disaster), push technology is staging a comeback and promises to play a key role in the way content will be distributed as the Internet

matures. Software such as that developed by BackWeb is used primarily to deliver content over corporate intranets. For instance, companies can push product information to salespeople or let employees know when corporate manuals are updated. Push technology's comeback has coincided with the emergence of broadband, which makes it possible to deliver large amounts of data to corporate desktops without bringing the network to its knees. Warning us that 'push' can easily turn into 'shove', Cerami [13] believes that overload rather than enlightenment is a likely outcome. Unless wisely implemented within the framework of corporate information management policies, push technologies will add a new dimension to CO, yet another example of a technological solution which *may* become a problem down the road.

- **'Always-on' capabilities of networks.** Always-on poses the greatest danger to the private consumer. When combined with push technologies, new marketing strategies and increasing bandwidth, for example, enormous amounts of solicited as well as unsolicited information may be channelled into the home.
- **Hypertext.** Hypertext can be defined loosely as a way of structuring information in such a manner that it is manifested in an interconnected set of words and images that can be 'browsed' instead of simply accessed in a particular, fixed order. This non-sequential approach to information structuring has produced numerous applications and is the foundation of the WWW. This promotes the 'never-ending' quality of information search - the road continues (often returning to already visited nodes) without end or guideposts. The seductive qualities of hypertext combined with poorly designed user interfaces have turned a technology originally conceived to combat overload [11] into a major source of IO. Guidelines for the implementation of navigation aids, reference points, information displays, dialogue design and on-line help have all been identified as areas in need of improvement (Nielsen, [23]).
- **User-friendliness.** Ironically, the increasing emphasis on user-friendly applications may also contribute to overload. The capability of *sharing* information produced or accessed by applications such as word processors, browsers or photo editors with others is frequently added to these applications in the form of a button or command. One click will bring up all your e-mail addresses, allowing you to send or forward information to one or more persons. By removing unnecessary barriers to information exchange, critical assessments of how specific information will benefit the recipient become less likely. The distinction between 'need to know' and 'nice to know' gradually disappears.
- **Life-style related factors.** Some of the recent changes in the way we live our lives and do business are associated with overload. The lack of clear-cut boundaries between private and work domains often results in an uncontrolled process where information and interpersonal communication from one domain overflows into the other. Family life is intertwined with professional activities. Nomadic working further dissolves spatial and temporal boundaries, resulting in a state where information flows that were formerly restricted to certain locations and hours now transcend all such boundaries.
- **New marketing strategies and technologies.** Marketing strategies that take advantage of always-on, push technologies, increased bandwidth and the ability to systematically *target* specific users/customers will contribute to IO in the home and business setting. Rushkoff [28] argues that ICTs are not being used for enlightenment and information distribution, but to hawk products in an even

more targeted fashion, thanks to data-mining, online profiling (cf. the DoubleClick inquiry), e-mail address harvesting and other sophisticated techniques. Unsolicited advertising is moving from the mailbox to the in-box.

Butcher [12] has described a common approach to management which frequently results in overload. According to Butcher, managers tend to:

- Collect information in order to adhere to a 'rationalistic' approach to decision-making – knowledge before action.
- Receive great amounts of *unsolicited* information.
- Seek more information to confirm that already received.
- Anticipate a need to demonstrate justification of their decisions.
- Collect information 'just in case it might be useful'.
- Use information as 'currency' in the organisation – the more you have, the better.

2.2 Symptoms (effects) of information overload

Our working definitions of IO and CO focus on individual *experience* rather than objective criteria (see section 1). The same applies to symptoms: information flows that exceed the individual's processing capacity will result in a large variety of individual symptoms and reaction patterns. Those that have been documented include (compiled from Shenk, 1997 and Eppler, [16]):

- **Cardiovascular stress**. Increased blood pressure and strain on heart and other organs (Ettema & Zielhuis, [17])
- **Reduced vision.** Japanese researchers (Ishikawa, [18]) have documented a general decline in visual acuity during the last 30 years, caused by increased exposure to 'screens'.
- **Confusion and loss of priorities.**
- **Frustration.** Lowered frustration tolerance and tolerance of complexity (Rotten [27]).
- **Impaired judgment.** As information load increases beyond a certain point, integrated decision-making decreases (Streufert [29]).
- **Decreased benevolence.** An overloaded individual is less likely to respond to a request for help (Korte [19]).
- **Overconfidence.** More information produces greater confidence in one's judgements, in spite of the fact that accuracy does *not* increase (Stewart [30]).

2.3 Consequences of information overload

Individuals' reactions to overload will generate characteristic patterns of behaviour. Some of these are maladaptive, irrational and even pathological. Others are necessary and adaptive attempts at dealing with overload. The majority of these behaviour patterns are well documented in laboratory studies, usually under the heading of 'stimulus or sensory overload.'

Classic stimulus overload research carried out by Milgram [21] document six basic responses to stimulus overload:

- *Less time* is allocated to each input.
- Low-priority inputs are *disregarded*.
- Attempts are made to *shift* the burden to others participating in the interaction.
- Reception is *blocked off* by means of unlisted phone numbers or unfriendly facial expressions.
- *Filtering devices* are used to diminish the intensity of inputs.
- *Specialised institutions* are created to absorb inputs that threaten to overload the individual.

Although Milgram's urban environments of the early 70's and today's corporate climate are not entirely comparable, his conclusions merit further consideration. As online technologies supplement or replace face-to-face encounters and information is digitised, many of the basic responses to overload documented in urban environments seem hauntingly familiar to the 'inhabitants' of today's cyber environment.

Cognitive psychologists have studied some of the mechanisms employed by persons suffering from IO. As illustrated in Figure 1, decision quality will improve as information load increases. Entering into the area of overload, however, individuals will resort to a variety of heuristics in order to reduce complexity to manageable proportions. Cognitive 'shortcuts' such as framing, anchoring and generalisation allow individuals to survive at the expense of decision quality, and – as demonstrated by Stewart [30] – with unwarranted confidence in their performance.

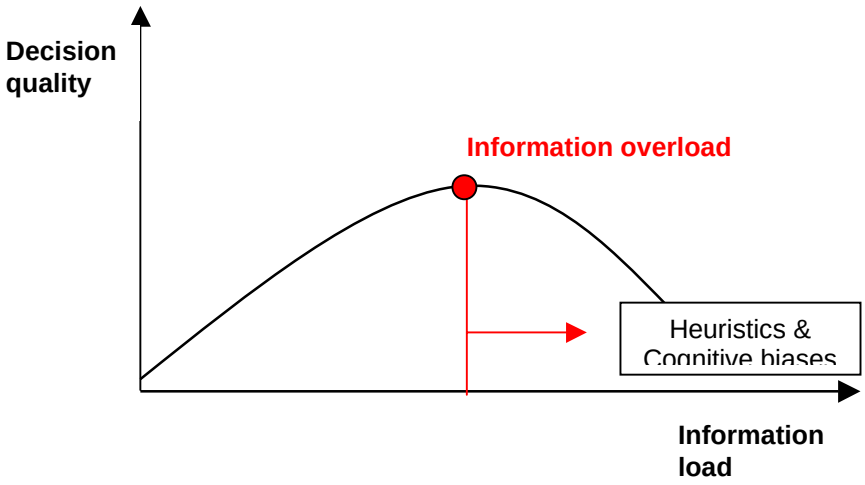

Figure 1. The generalised relationship between Decision Quality and Information Load. (Adapted from Eppler, [16])

The frequently cited Reuters reports [24]; [25] describe a set of generic reactions to overload in the work place that seem to apply across various industry sectors and job functions. These are:

- Ill health.

- Loss of job satisfaction. 50% reported loss of job satisfaction.
- Tension with colleagues. 33% reported tension as a result of overload in the 1998 study – down from 77% in 1996.
- Overtime work & working at home. 70% have PCs at home and over 75% of them view the PC as an extension of their office.
- Reduced levels of social participation. In 1998, 33% reported that information consumption left them too tired for leisure activities – down from 60% in 1996.
- Damage to personal relationships.

2.3.1 Implications for Telco employees

Some general organisational trends affecting the telecommunications sector (as well as other sectors) tends to increase the likelihood of IO. Downsizing often reduces the number of qualified information and communication 'filters', e.g. secretaries, archivists, information managers and research librarians, resulting in lower quality services for remaining personnel. The increase in business communications combining with new technologies (push technologies, more effective targeting) has been pointed out above. Content/channel mismatch (e.g. the use of e-mail to distribute general information) has also been mentioned, reflecting a lack of corporate information policy and guidelines or inadequate enforcement of such policies. Outsourcing and an increasing number of alliances create larger networks of partners and contacts. Maintaining such networks – especially global networks where time zone differences disrupt traditional communication patterns – greatly increases the likelihood of CO. Finally, decision making processes are increasingly dependent on speed and accessibility of key personnel, creating a norm of accessibility at nearly every level in the corporate hierarchy.

2.3.2 Implications for organisations

Information & communication overload has profound impact on the productivity and performance of individuals and consequently on the ability of organisations to meet their goals. While the application of new technologies has vastly increased the information available to people and expanded their capability to communicate with others, very often the result is that people are working harder than ever but without commensurate gains in efficiency and effectiveness. This is because disproportionate time is spent on minor tasks that are symptoms of information and communication overload.

Information & Communication Overload often results in a proliferation of bad working practices and behaviours such as:

- Unnecessarily lengthy and detailed documents;
- Hoarding of information because its easier than searching for information;
- Unnecessary emails, faxes and telephone calls;
- Circulating paper documents to attract attention.
- Wasteful presentations, seminars, workshops, attendance at conferences etc.
- Excessive inclusion of detail that exacerbates the problem.

- Increased use of specialised jargon and incomprehensible acronyms in many internal communications
- Widespread deployment of external consultants in order to shortcut many of the problems caused by bad information and knowledge flows. Very often these consultants contribute to the problem of information & communication overload.
- Because of the scale of the information that is directed at people, people are skimming but not reading documents and messages.
- Similarly because people increasingly cannot take in more information they shut out often very important messages and notices.

Other symptoms of information and communication overload identified in many organisations:

- Difficulty in getting access to the right people and information required;
- Multiplicity of data sources, all of which contain inaccuracies;
- Necessity to confirm accuracy of information from numbers of sources;
- Difficulty in bringing information to the attention of others;
- Human symptoms: stress, illness, tensions/arguments between colleagues, absenteeism, disillusionment and unhappiness.

The consequences of these work behaviours include:

- Inefficiency and ineffectiveness;
- Difficulty in implementing change;
- Wasteful use of resources;
- Delays in responding to new challenges;
- Errors and mistakes;
- Staff problems including stress, illness, bad relations between staff, unhappiness, disenchantment with work and organisation;
- Creeping generalisation and consequent lack of specialisation. (Instead of accumulating expertise, technical specialists in important disciplines acquire much knowledge about everything but not enough about anything.)

In this context it is our contention that Telcos that suffer least from information overload, (i.e. has best information & knowledge management), will have important strategic competitive advantages over rivals, as they can respond better to market challenges and offer solutions that minimise the problem of information & communication overload to customers.

2.4 Coping with information overload

Attempts to deal with IO and CO in a corporate setting may be divided into four basic strategies:

1. **Skills-based approaches.** Focusing on the *individual* producers and consumers of information, these approaches seek to inform, educate and promote proven information handling practices. There is no lack of useful suggestions and 'how-to' books in this area. Suggestions range from individual techniques for

structuring data and time management, to filtering techniques on the recipient side. Information producers and distributors are encouraged to exercise discipline when sending e-mail and using exploder lists and taught sound principles of information design which can be applied in everyday work settings.

2. **Services**. Service providers have clearly seen a market for overload prevention. *Collaborative filtering services* such as Sixdegrees and Firefly that automate the search for and creation of online communities of reliable sources – people who share your background and opinions – are becoming increasingly visible on the Internet. *Personalised information services* tailor information to meet the needs of specific clients. So-called *info-preneuring services* take it one step further by converting, simplifying and packaging information as required by customers. All this new potential for selective information access may, however, be the ultimate social and intellectual insulator. As the Web allows us to ever-more-finely slice our online experience, we unwittingly cultivate a *selective blindness* for issues critical to our understanding of the more-inclusive context – issues that will presumably enhance the quality of our knowledge-based action. In this context, random encounters with new and potentially useful information are however also reduced or eliminated.

3. **Technologies**. It should come as no surprise that technology is proposed as the ultimate solution to IO and CO. *Meta-content providers* (portals, EPGs, Hotlists, Indexes) flourish on the Internet to the extent that they themselves may promote overload as they compete for our attention (and revenue in the form of advertising response). *Unified messaging services* (UMS) integrate numerous sources of interpersonal communication in one location, eliminating the need to check several in-boxes, voice mail accounts and FAX machines.

   Personal information managers (PIMs) have undoubtedly made life easier for many users. These programs usually run on individual PC's and rely on a technique referred to as 'mind mapping' to organise information. At its simplest, mind mapping consists of jotting down key words on the screen and connecting them with lines representing various types of relationships. The software then creates a tree or network representing the entire contents of the mind map. Examples of such products are Mind Manager, Mind Mapper, The Brain, VisiMap and Visual Mind.

   Data mining, search engines and agents embrace techniques aiding the process of extracting and dealing with relevant information from various data sources. Data mining is the process of establishing rules of user behaviour based on statistical data. For instance a company could track it's sales to its customers. By means of data mining the users could then be divided into different interest groups. This would help the company to send only relevant product information to different customers. Data mining is a research area largely aided by statistical and mathematical means. Search engines comprise techniques helping the user to find relevant information in some sort of data. When speaking of search engines the data is often The World Wide Web on Internet. Today search engines are more or less restricted to text-string search. This means that search engines have difficulties in helping the user to search for a given topic. Agents are like search engines in that they search for information on behalf of the user. But the agent is also able to work while the user is "offline". The agent may also be able to act on the users behalf without the users interfering. For instance an agent might be able

to buy and sell on the stock market on behalf of the user. Today the development of search engines and agents are research areas that are not well understood.

4. **Corporate Information Policy** In many organisations while there are often policy standards on information management systems frequently there is an absence of deliberate corporate policy on the management of information and knowledge. In many companies where they have implemented corporate information management strategies there is evidence to suggest that the problem of information & communication overload has been reduced. For example in Proctor & Gamble they have specified that all reporting documentation should be a maximum of one A4 page, recognising that people frequently read only summaries and if they wish to get greater detail will contact the information provider directly. It is suggested therefore that a customised information management strategy can refocus information providers to the actual needs of an organisation and positively contribute to gains in productivity and efficiency.

3 Information Management Techniques

There exist computer-based solutions that per se are tools to aid information management. Examples are email management systems, bulletin board systems and various database systems. However, computer-based solutions and equipment play a part in all phases of information creation and management. Nowadays a word-processor is used to create documents with information. A physical disk is used to store the document information. The physical disk-size might have an impact on how much information can actually be stored. The word-processors search facilities might have impact on how efficiently information is provided in response to a query.

In this section we deal with computer techniques that influence information management. First, we discuss the concept of information and related words from a computer technical viewpoint. Then, we give a broad viewpoint on what we expect from computer techniques with respect to information management. Using this as a basis we then look at different computer techniques that have an impact on knowledge management. Finally, we comment on how this influence might have impacts on information overload.

3.1 Data, Information, Knowledge, Techniques and Expectations

Through the history of computing, there has always been a need to talk about information. Over time mainly three words have been used for this. These are *data*, *information* and *knowledge*. The word data has been used as long as computers have existed. In computing data means native encoding of information. Information encoding always end up in representations comprised by lists (tables), trees (directories) or networks (for example the web) of numbers, strings or binary arrays. The information in these representations makes no sense for the computer. For example a representation might contain a list with two columns, *name* and *address*. But the computer has no means to grasp the concepts behind. A common understanding is needed between humans to understand that the information in the list actually is the addresses of the people (with names) in the list. Further this human understanding is needed to write programs to process the list – like formatting letters to be sent to these people. Some believe that concepts like *Artificial Intelligence* (AI) and *Agent* already has or will change this. We will discuss this later on.

One of the difficulties in computing lies in the fact, that computers do not process information. They process information encodings – and humans are needed to translate processing of information into processing of data (encodings). One might believe that this improves as computer and information technology evolves, and the transformation between information and data becomes more and more easy. However, in reality the opposite happens in many aspects, and difficulty increases with the increase of complexity. The reason is, that computers are used for an ever widening range of different purposes – and therefore used to process ever more different kinds of information (encodings). For all kind of encodings human skills are needed to deal with the relations between the information and the encodings. (Dealing with this in essence means writing programs.) Things are further complicated by the fact that the relations between the information and the encodings tend to become more and more complicated. The ultimate example is a text document. The encoding is very simple – a list of characters. But in general it requires a human specialist to make use of the information herein. Again there might be hopes that AI changes that.

Different scientific fields have entirely different understanding of the notions of information and knowledge, and their relation. In the field of psychology the notion knowledge describes human insight at a higher level than insight given by information. Accepting this differentiation the technical implication is that encoding of knowledge as data for computer processing is more difficult than encoding of information for the same purpose. Hence from a technical viewpoint: the difference between information and knowledge should be the complexity of the corresponding computer-processing encodings. To stretch this viewpoint to the limit: Information is insight that can be processed by computers. Knowledge is insight that can not be processed by computers.

However, the commonly accepted technical viewpoint is that there is no clear distinction between the notions of information and knowledge. One reason is, that commercial IT system developers refer to knowledge, where academia and university experts would use the word information – in the same context with the same meaning.

For pragmatic reasons we will adopt this viewpoint. Further, we prefer the word information instead of the word knowledge since the interpretation of this word seems more consistent.

As computer users we expect three things from computer techniques with respect to information management:

- Help to manipulate information
- Ability to store information
- To be notified on important events

In general it can be said, that information manipulation based on computer technology is difficult. The reason is that it requires the translation of information manipulation into manipulation of information encodings (data) which require human insight.

The physical performance of computers is improving very fast. Today it is for instance possible to store several hours of high quality video on a desktop computer. There seems to be no limit to how much information can be stored. On the other hand, manipulating the information in just a single digital picture stored on a computer is still posing a problem. For instance the particular information in the picture may be the different objects appearing and recognised by humans as chairs, tables and humans. How to extract this “information” from the pixels of the picture is still not solved and a subject to research.

We would like to be informed on events that are important to us. For instance some people would like to be informed on events on the stock market. To some extent this is easy to implement using well-known computer technology. A simple agent can scan the stock market prices and raise some sort of alarm when the average prices hit a certain level. On the other hand, it is very difficult to create an agent that can forecast stock market prices. Implementing such an agent needs more than computer technology. This requires insight into the stock market process – and this insight has to be encoded using computer technology. A middle-way of such encoding might be various statistical and mathematical means – supported by AI techniques.

3.2 Portals

Using computer technology we often store logically related information in different systems. For instance we might be working in a project, where the project group use

an electronic folder to store shared documents. But at the same time relevant background material may be available in an electronic library or as web pages found on the Internet. Furthermore, the project participants might use e-mail to communicate. In this situation a project participant may have to search the electronic folder, the library, the web pages and the e-mail system for a particular piece of information. It would be much more convenient, if all of these different information systems can be viewed, accessed as one, and one query would search all the systems for the relevant information. This leads to the idea of portal.

We suggest the following general definition of a portal: A *portal* is an attempt to express a uniform view or index of a diverse set of information structures.

The word portal is often used to characterise some of the web sites available on the Internet. Mostly two kinds of portals are found on the Internet: search-engines and directories. Internet search-engines and directories are discussed in detail later.

Portals may also be a part of the enterprise intranet. Often the intranet is implemented using the same technology as the technology used to implement the public web site. So the Internet and intranet also share techniques used to set-up a portal. Portals exist on different levels of ambitions to express a uniform information view. A very simple portal may be a simple entry for making text-search queries in all the documents existing on the intranet. Per se this should be a simple task. But the intranet might be the storage of documents in a variety of different document formats. This is often the case, for historic reasons.

Construction of this simple portal at least requires the necessary software to scan the different types of documents. Again this is often quite difficult for historic reasons. Some ten years ago – and still today, to a certain extent – software vendors produce products making use of proprietary data formats. So it might prove difficult to get the necessary software to scan the different documents. Today some software vendors offer special software with the ability to scan different document formats – including formats produced by other vendors – to make a general search facility available. One example is the DocFather product [3] that scans HTML files, Text-based files, Adobe PDF, Microsoft Word files and Microsoft Excel files.

Problems with attempts like DocFather is that they work on fixed set of data formats (that might evolve as the product itself evolves.) It would be more convenient if the scanning software could adapt automatically as new document formats evolve. This would be possible if software vendors in general could agree on some general way of accessing different document types independent of the actual document-type. The Document Management Alliance (DMA) [4] is the driver of implementing such a general way – Open Document Management API (ODMA). The idea is that each Vendor of a document format must implement and provide the implementation of the same document access interface. ODMA falls into the category of document management systems – and as such it may very well be part of a portal.

Another approach in the same direction – though different - is The Open Information Model (OIM) driven by Meta Data Coalition [5].

In a text search system – or document management system – a simple textual search for the term "table" (for instance) may yield a result set that covers furniture items as well as relational database definitions, e.g. the order entry table. It would be up to the user to sort through the set of items and determine their relevance. However, if "table" items had been classified either as furniture or data definitions, then the retrieval results would have been of much higher quality for the end user. The main idea

behind OIM is to provide a taxonomy and framework for mapping non-uniform enterprise data into uniform structures reflecting their logical roles and purposes. The idea is to make all the enterprise data available for one uniform search mechanism. The ambition is to include as different data-sources as document management systems, data warehouses, resource planing systems, various groupware applications etc. Portals based on this approach might provide a high level of flexibility. But again it puts a burden on the participating subsystems to provide the necessary mappings to the OIM taxonomy. OIM is based on UML and XML, which might help implementing these mappings.

Different attempts exist on providing the means for creating of portals. Portals exist because different enterprises are based on different information- and process-structures, and further because each enterprise within itself uses different information- and process-structures. Some of the attempts are based on “standards” like UML and XML. Still a problem may be, that a mapping from non-uniform structures to a single structure at least initially require human resources. Human resources are needed because the information only exists as data. Humans are needed to transform data representing non-uniform information into data representing uniform information. It is hereby noted that also UML and XML are only a way to represent data.

3.3 Search engines and directories

The ideas of search engines and directories have found use in many areas of computer techniques and applications. With respect to the Internet World Wide Web (the web) *search engines* and *directories* refer to the two classes of portals found most often on the web. To repeat the definition of portal given above: A *portal* is an attempt to express a uniform view or index of a diverse set of information structures.

In case of the web the information structures are the various web sites available. The information given by the web sites is mainly informal plain text (in English or any other language) – often in complicated typographical layouts – decorated with different sorts of graphics. Here decorated implies that there is often no relation between the contents of the graphics and the meaning of the text. For example some of the graphics are often the so-called banner commercials. These commercials provide links to other sites offering services often with no logical relation to the site containing the link.

The web portal designer face a lot of problems:

Since the information is given by plain text it is very difficult to computer automate the process of extracting the information and create logical data structures feasible as a basis for user queries.

The web sites make any kind of information available. So defining the proper structures is a big challenge.

Collecting the information itself on the web is also a difficult task. Each piece of information (an HTML file in most cases) is identified by a URL. Given the URL the corresponding piece of information can be retrieved. But no index of valid URLs pointing out information exist.

The ways web-portals differentiate mainly depend on the way these problems are solved. The search engine takes some highly computer automated approaches, whereas directories depend more on manual resources. The rest of this Section

elaborates a bit more on directories. (Search engines are discussed in detail separately.)

3.3.1 Directories

In principle a directory appears – like the word implies – as a directory to the end-user. A directory can also be thought of as a tree with a root node that points out leaves and other nodes through branches, where these branches again point out leaves and branches, and so on. The directory determines how the available information is structured. For instance, the directory might divide the information into categories called *Business*, *Computers* and *Education*. The category Business may be subdivided into the categories *Banking* and *Stock Market*. All directory paths end up in URLs pointing out information available on the Web. Stock Market might point out the Wall Street Exchange. In any case the actual structure of the directory is up to the directory designer and will differ from one directory to the next.

The actual information in the directory is given by the URLs found in the directory leaves. Instead of implementing a sort of computer-based mechanism the directory invites its users to add URL locations pointing out relevant information for different parts of the directory. Usually user added entries are not entered directly into the directory. Rather their relevance is first investigated by human resources and then approved or disapproved as entries.

In general directories avoid problems of having computer-automated processes investigating contents by letting human resources do the job.

One prominent example of a directory is Yahoo [6]. Yahoo was the first well-known directory in the web-community. However, Yahoo has evolved over time. Today, Yahoo is actually a mixture between a directory and a search engine.

3.3.2 Search Engines

Whereas the approach of directories is to use human resources to establish it initially, the approach of search engines is to automate it and use computer resources. The ambition of the classical search engine is simply to gather all text information available and create a dictionary mapping words to URLs pointing out text containing the words. An end-user query is then simply a lookup in the dictionary. Search engines are all variations of this concept. Even if this concept could be implemented in its full extent, it would mean a lot of useless references. For instance many of the millions of pages available contain the word computer. But if the end-user is looking for information about computers most of these pages are probably not useful. So the raw search engine concept lacks a quality assurance mechanism. Various search engines try to implement such quality mechanisms - although it appears as an as-concept search engine to the end-user. There are different approaches to implement such quality assurance. We touch on this further below. But as a rule the search engines designers keep their various method in-house secret. The impact for the end-user is that he never knows how his query is handled or what kind of reasoning lies behind the answers given to queries. The end user simply has to trust in the response!

First of all a search engine needs to collect the information on the web to create the index (or more advanced information structures). As already mentioned, the web itself contains no kind of index from URLs to web-information. Instead, the search engine scans the web by means of a *spider*. The spider works in the following way: First the spider is given a set of URLs pointing out static HTML [7] files. Static pages exist as

plain files in a local file system and are not further processed or changed automatically by computers. This set of pages works as an offset for searching for more pages. The pages are scanned for links to other pages. The found pages are scanned for more links etc. There is no guarantee that this process eventually will reach all pages with information. For this reason search engines often also contain a facility, where end-users can suggest relevant links to pages.

There is other information available on the web, than the information contained in the static HTML files. Some web-sites generate content dynamically in response to a user input. An example may be a music store having a web-site giving access to the CD-database from a simple HTML form. There may be millions of entries in the database. But the search engine mechanism cannot have an idea of the contents, since it is only accessible from the HTML form. Probably it would not make sense to try having the search engine collect the entire information into a database. But the point is that automated techniques have a limitation. In any case no search engine actually nearly indexes the entire web. Today the "biggest" search engines (Northern Light, Snap, AltaVista) comprise less than 20% [10].

As mentioned already search engines may apply different techniques to implement quality assurance, but their implementers keep the methods used an in-house secret and tend not to make it public. In any case some advanced techniques used more or less experimentally are mentioned below:

Vector space model: In the *vector space information retrieval model* (IR), a unique vector is defined for every term in every document. Another unique vector is computed for a query. With the queries being easily represented in the vector space model, searching translates to the computation of distances between query and document vectors. [R_3]

Conceptual indexing: IR and statistical models can be used to group words / terms into clusters called *concepts*. The IR / statistical model can for instance be used to recognise words often appearing together. If for instance the words *bus* and *car* are recognised as appearing together these words could appear together in a concept *vehicles*. [1] [2]

Relevancy ranking: Only the end-user can ultimately judge if the retrieved information match his needs. In information retrieval this is known as *relevance* or judging how well the information received matches the query. (Here we disregard the fact that the end-user is often not sure what he is looking for). Applied vector space modelling techniques have characteristics that improve the chances that the user will receive a relevant document to his query.

Applied mathematics plays an integral part of vector-based search engines because there is already in place a quantifiable way to say, “Document *A* ranks higher in meeting your criteria based on your search terms than document *B*”. The idea can be taken one step further, when the user is asked “Do you want more documents like Document *A* or Document *B* or Document *C* …”. Again this process is known as relevance feedback.

A search engine might choose to store the end-user feedback on relevance. This can be used later, when the end-user returns to the search-engine to do more queries. Such a facility might be considered to be an agent, since it helps the individual user in searching. Furthermore, the end-user feedback might be stored without the knowledge of the end-user. Hence the agent is operation without the end-users awareness . [R_3]

3.3.3 Using Search Engines and Directories

Today search engines and directories are very complex with respect to implementation. Still implementers try to make them as easy to use as possible. The biggest problem with respect to information overload is that the end-user never knows how his query is handled. Practical experience shows that the same queries entered in different search engines yield very different results.

3.4 Emerging Tools and Technology

The words *agent*, *XML* and *Java* are found regularly in the IT debate. Often they are believed to be technologies that will boost the future. It might be that they will be the carriers - but they do not contain important news from an information management perspective.

Actually *agent* do not itself imply any technology. The word can be used to express the hope that some new interesting things eventually will be implemented - or are implemented. An agent or "intelligent agent" can be anything:

The concept "intelligent agents" is used in almost any aspect, when somebody tries to explain how computer technology can be used to solve problems for humans. The physical appearance of an agent can be almost anything. For example: A computer program, a microprocessor, a complete computer set-up or a future super intelligent science fiction robot. An agent might be used for purposes like

- Sorting / grouping emails
- Lurking for interesting info (depending on its master's preferences) in news groups or on the world wide web.
- Adjusting the room lights depending on its master's needs.
- Bringing food to its master when he needs it. (He would otherwise forget to eat, because he is too occupied with something else.)

The agent concept itself is too wide to explain anything alone. However, agents are expected to posses some kind of intelligence (the above examples certainly requires intelligence). Therefore the agent concept might be convenient, when explaining an audience, that a system is doing something on your behalf in an intelligent manner. But the agent concept does not imply a certain technology or explain how its promises will be achieved.

Java is sometimes very convenient in solving practical information management jobs. Per concept Java is practical because it makes it possible to do general (Turing complete) programming of the end-user terminal without safety risks for the end-user. However Java do not define new means to encode information as data. Therefore the same general problems with handling information as data exist in Java (including Jini and JavaBeans).

XML is simply a new way to encode data as sets, lists and trees. XML may be convenient in the process of moving information from one system into another, because transformation tools and concepts support XML. Some newer XML related concepts are XSL and XSLT [7] [8]. These concepts are used to define mappings between different XML structures and mappings from XML to HTML. Tools supporting these newer concepts might also make information migration easier. But

again using the concepts and tools will require the same kind of core insight about how to interpret data as information.

In general: Many modern "hyped" technologies have proved themselves convenient to solve practical problems. But as such they do not yield improvements in how to deal with information and improving information management.

3.5 Information Management Products

Today, software vendors like to talk about knowledge management and knowledge management products. According to our definition knowledge and information is the same. Some vendors believe that almost everything is knowledge management. For instance some even refer to their Internet Meeting Facilities as knowledge management. Everything from a back-end SQL server to a front-end mail- or browser-system is classified as knowledge management tools. It is not clear, how back-end and front-end tools are moving. But it seems to be on the implementer's agenda to make information storing and retrieving more open using technologies like XML and more open information platforms like OIM.

It's not clear if there are real improvements in search-facilities in the newer platforms. Examples and demos might show some particular good properties. But like the case of search engines, vendors do not openly explain what they do to deal with informal text and queries on these. Again, specialised knowledge is kept in-house secret. There are probably close relation between search engine technologies and interesting technologies for dealing with searching etc. in information management products.

3.6 Conclusion

Many interesting concepts and technologies that might improve information management have seen the light of the day. However, the real problems in information management are dealing with informal text. Dealing with text is not very well understood. But new ideas have evolved - probably mainly boosted by needs in Internet search engines. Some interesting results can be found inside search engines (of which some most likely can be reused in personal information systems) - but the really interesting results are kept in-house by the vendors. From the viewpoint of information overload the worst problem with these new technologies is that the end-user does not actually know how queries are handled. Therefore there is no guarantee that the user gets the right information (in the right time), and usage becomes a question of trust.

4 The impact of Information Overload on Telcos

The delivery of good quality products to the customer in an acceptable length of time, is a mission critical requirement for all Telcos.

Some of the major difficulties experienced by Telcos, which hinder the achievement of this goal, include:

- achieving quick product delivery times;
- new product development lead-times;
- providing consistently high standard of customer service in a manner which meets the needs of different customer segments;
- costing, budgeting, planning and scheduling;
- managing growing product portfolios;
- efficiently managing skill competence;
- trialling, testing & maintaining increasingly complex systems.

Commonly cited causes for these problems include

- fierce competition;
- the need to cut costs;
- rapid organisational change/transformation;
- rapid technological change;
- multiplicity of technologies used in our networks;
- huge growth in demand;
- fickle customer requirements;
- regulatory constraints.

While acknowledging that these factors significantly hinder the profitable delivery of quality services to our customers, we contend that a major contributing factor is information & communication overload and bad information & knowledge management. Accordingly we suggest that tackling the problem of information overload and better management of internal information and knowledge by Telcos is fundamental to the continued profitable delivery of quality service to our customers.

4.1 How information & communication overload and bad information & knowledge management impacts on Telcos

The pace of change in the telecommunications industry is extremely rapid. At present the industry is witnessing revolutionary advances in technological and service development. Similarly the structure and nature of the market environment in which the industry operates is also changing dramatically. Coupled with this there is extremely high growth in demand for service in many product areas, especially mobile and data communications services. Correspondingly the advent of these new technologies and the trend towards convergence of the telecommunications industry with the IT and entertainment industries is threatening Telcos traditional core product

areas. Also as the focus of technological and service development moves towards convergence, the number of competitors in the marketplace is growing all the time, such that almost every market niche is feeling the effects of vibrant competitive market forces.

For large traditional organisations with a history of market dominance and deeply ingrained corporate cultures, the speed and nature of change which is being attempted by Telcos, in order that they may survive and thrive is unprecedented. In response to the above challenges Telcos are constantly attempting to transform their organisational structures and operational processes to better reflect the prevailing orientation of the industry and respond to market defined requirements. These transformation initiatives though clearly necessary as engines of change have very serious downsides, which are not always readily apparent. From our analysis we have identified that transformation projects negatively impact the management of information and knowledge within Telcos and are significant contributing factors to information & communication overload, which intuitively hinders the performance of the company and its employees.

Price and speed of delivery are predominant business drivers in the telecommunications industry at present. Transformation projects in most Telcos therefore focus on adapting management structures and operational systems in order to meet the challenge of lowering costs and speeding up delivery of service to customers. However this has the effect of upsetting important information and knowledge flows, such as those resulting from critical interpersonal relationships. This system orientated approach to change, therefore often ignores critical (but often intangible) components in the successful and profitable delivery of quality services to customers. These strategically important information flows take time to develop. They are often difficult to identify and once broken they are difficult to re-establish being dependent often on the personality and capacity of the individual rather than the particular job function of that individual. We believe that lack of attention to the problem of protecting and preserving information flows is a significant factor in the growing problems of information & communication overload and bad information & knowledge management.

It is clearly outside the scope of this study to identify all the possible effects of information & communication overload and bad information & knowledge management but the following example illustrates the potential scale of the problem.

In the context of ongoing organisation and staff changes, employees often do not know the target audience for the information they produce. When providing information, many employees take a proactive approach by taking into consideration the requirements of unknown potential users, as well of those they can identify. In this context information tends to be less tailored to the specific requirements of an individual user and presented in a manner that is more likely to attract the attention of multiple potential users. For example, very often too much information will be produced, making it difficult for the individual potential user to locate the specific information he/she needs. Alternatively, the information is provided in very general terms, which does not meet a potential users' individual requirement for detail. In too many cases the information is made available in a format such that the potential user cannot easily reuse it. This results very often in duplication of effort and increases the potential for error. As it is increasingly necessary to interrogate many more information sources in order to get the information that required in the detail desired, it is necessary to check and recheck the validity of the information in order to

minimise the potential for error. Likewise in the context of ongoing transformation and change, information is distributed more widely as employees naturally strive to ensure that their work is brought to the attention of as many potential users as possible as well as their well meaning desire to communicate important information more widely. Thus we see how in this context lack of attention to the management of information flows contributes to information & communication overload and affects performance. The potential impact of widespread dissemination of errors is increasing accordingly also.

It is impossible in a study of this nature to quantify the scale of the problem or the resulting cost to Telcos. Intuitively however it is readily apparent that the inability to access specific information required in a timely manner hinders the performance of the individual and accordingly the performance of the organisation in which he/she is employed suffers similarly.

The above example illustrates how despite the massive increase in the availability of online information, the potential gains in productivity is unrealised if effective management of information and knowledge cannot also be implemented. This example also suggests that the increase in availability of online information has been matched by a similar increase in the potential for data errors. Unfortunately as electronic information dissemination is more widely used, the potential seriousness of these errors has also increased.

4.2 Why tackling the problem of information & communication overload is a strategic imperative for Telcos

We contend that tackling the problem of information & communication overload and the related problem of managing internal information and knowledge is of strategic importance to Telcos for a number of reasons.

At present Telcos are faced with enormous challenges in the profitable delivery of quality services to customers, within an increasingly demanding timescale . As competition intensifies and the speed of market and technology change increases, the pressures on Telcos and their management and staff will most likely similarly increase. It is our contention that good information and knowledge management is important if a Telco is to be successful in responding to these challenges.

As the market for telecommunications evolves it is commonly accepted that important requirements for future success as a telecommunications service provider will be:

- innovation;
- customisation;
- technical expertise;
- quality of customer service;
- speed of response to change;
- flexibility.

Intuitively efficient internal communication and management of internal knowledge is important in responding to these challenges. In this context good information and knowledge management will be a critical core competence for a successful telecommunications service provider.

Furthermore, as the largest telecommunications service providers in their respective markets Telcos are to a certain extent answerable to the charge that they are partially responsible for the problem of information & communication overload. As Telcos themselves are suffering from the effect of this problem on their own internal processes, so their customers being large or small are exhibiting symptoms also. Accordingly as well as delivering the services which contribute to the problem of information & communication overload, it is in Telcos interest to begin providing solutions to these relatively new problems, which are being manifest as a by-product of telecommunications services.

If appropriate solutions to these problems are not provided it may have an impact on the take up of the advanced services such as e-commerce, m-commerce and broadband services on which so much is being staked. In this context developing systems and procedures that effect good internal information and knowledge management and solutions for information overload may be a primary source of future competitive advantage for Telcos.

4.3 Awareness of the problem of information overload and bad information/knowledge management in Telcos

While many people experience the problems of information & communication overload and bad information & knowledge management in their working environment first hand every day, frequently it is dismissed as integral part of work and not a problem that can or should be solved. Our study identifies low awareness of these problems among senior managers in particular, who are arguably the worst affected of all employees by this problem. Within Telcos the market and environmental context in which they operate easily explains the low ranking of these problems among critical issues to be addressed. We have identified a vicious circle at work in many Telcos, which obscures management visibility of the problem.

Bad information & knowledge management contributes to the already burgeoning problem of information & communication overload caused by the massive increase in the availability of information of all kinds and advances in mobile communications. This increases the pressure on employees' time & resources with the result that managers and staff are increasingly engaged in 'fire fighting' problems which often result directly from information & communication overload and bad information & knowledge management. In this environment managers understandably have less time, energy and resources available to improve information/knowledge management and tackle the related problem of information overload.

Thus the very people who should be at the forefront in identifying and tackling information & communication overload and bad information & knowledge management are not able to do so as their attention is diverted attending to mitigating the effects of the symptoms of the problem.

When attention is given to information and knowledge management, understandably the focus tends to be on co-ordinating the major information flows in a Telco such as:

- billing information;
- traffic using the network;
- fault statistics;
- customer orders;

- revenue statistics.

While accurate and efficient dissemination of these important data types are critical to the effective management of Telcos, in the real world of work in a Telco, the free flow of informal data appears to be very important to high performance and productivity. Our analysis suggests that the cumulative effect of difficulties in disseminating and retrieving seemingly innocuous, non-mission critical information is hampering the ability of Telcos (and other large organisations) to achieve their goals. This is because disproportionate amounts of employees' time are devoted to attending to seemingly minor matters.

Simple tasks such as:

- finding the correct form to claim travelling expenses,
- or ascertaining the correct procedures governing annual/sick leave,
- or ordering office supplies,
- or finding out how to make small purchases,

very often command more time and effort than completing key tasks as identified in the employees job description.

In the course of this study, an informal survey was conducted among Telco colleagues working in major functional areas, who were asked to identify the mission critical information flows in their work area, with particular emphasis on those information flows which most hampered their performance or the performance of their functional area. The information flows identified vary from the general, were cited by all respondents to those flows which are specific to individual work areas. This survey indicated that in many cases critical information flows are not the specialist information flows used by a specific area, but intangible flows that result from the interaction of human beings in a community that is the telecommunications industry in general or the Telco in particular. Table 4.1 summarises the responses received.

This exercise suggests that tackling the problem of information & communication overload in Telcos will necessitate taking steps to improve the management of internal information and knowledge in particular. In many cases this will prove very difficult, as many of the information flows identified are informal in nature and derive from the professional competence, personality and work history of the individual.

4.3 Roadmap for Telcos in Combating Information & Communication Overload

While it is easy to argue that Telcos like many large organisations suffer from information & communication overload and bad information / knowledge management, it is difficult, if not impossible to define a generic solution to the problem. Our analysis identifies that a viable solution to this problem in the context of Telcos will involve a combination of the following elements:

4.3.1 Heightening awareness of the problem of information & communication overload among management and staff.

As previously stated there is low awareness of the extent and nature of information & communication overload within Telcos and this contributes to the problem. It is felt

that if there is greater understanding of the causes of the problem, then it is likely that individual employees will direct more conscious and subconscious effort to minimising their personal contribution to the problem. Also greater awareness is likely to stimulate more concerted action at management level to solving the problem.

All functions & activities •Contact information – tel./fax. nos, email addresses, www sites, physical addresses etc. •Organisational information •Job role descriptions •System relationships between functional areas & job roles •Purchasing procedures & cost allocation codes •Time management/efficiency •IT user helplines •Information on entitlements (salary/leave/expenses) •Reporting templates, administrative forms and documentation etc. •List of nominated deputees or successors Staff Planning/HR •Up to date information on skills, competences, experience of staff Strategy •Industry 'gossip' •Manufacturers 'spin' Customer Service •Compensation policies/discretion available to customer service staff •Product information •Maintenance information •Sales information (advertising, pricing, discounts)	Finance •Aggregated 'accounts payable' info. •Budget submissions •Revenue info. Network Planning •Business plans/market assessments/estimates of customer requirements •Current information on duct occupancy Technical Operations •Technical support info. •Trial/test/maintenance info. on real world deployment of systems Product Delivery/Project Management •Up to date inventory of stores •Staffing rotas/leave plans •'What's (left) in the budget' •Nominated deputees/backup personnel •List of authorised signatories & approving authorities Product Development •What customers don't want to have to do •What service/technology is intended to do •What service/technology can't do & why IT •Manufacturers technical support •Staffing rotas, leave plans •Usage info.

Table 4.1 - Overview of the information flows identified as critical to conduct of work and where difficulties often or sometimes arise.

4.3.2 Educating all staff on personal information management techniques, which will improve their personal management of information and knowledge and reduce their contribution to the problem of information & communication overload.

Most employees suffer from information & communication overload but ironically most employees also contribute to the problem. Therefore educating staff to eliminate or reduce those practices in their working behaviour, which most contribute to information & communication overload can have a positive effect on reducing the problem. The problem is analogous to the problem of waste disposal. Most people who are socialised in a civilised society will not deliberately pollute the environment where they can possibly help it. Similarly most responsible employees will not deliberately pollute the information environment with 'info smog', where a sensible code of practices to minimise this pollution are widely publicised.

4.3.3 Setting company guidelines and standards for the presentation of information, use of emails, etc. and enforcing this 'netiquette'.

The professional individual's altruistic desire to act correctly, is best harnessed in the context of a well designed and considered framework of recommendations on how to reduce the problem of information & communication overload, that is sponsored by senior management and adopted as standard practice. Accordingly guidelines and policy on information dissemination specifically aimed at minimising the problem of information & communication overload are recommended.

4.3.4 Educating information providers on best (and most concise) way of getting their argument across in the context of technologies such as intranet.

A major contributing factor to the problem of information & communication overload, is that information technology in general and intranet technologies in particular, have been applied to replicating in electronic format those formats and systems of organising and presenting information, that were optimised for paper based data. Consequently the current document structure most widely used for communicating information of all types, differs little from the traditional document style that has been employed for centuries. With the onset of the internet/intranet, there are enormous potential gains to be exploited in effectively communicating ideas and information, if it is organised so as to take advantage of the new functionality available. A new document structure which is designed to better harness the capabilities of electronic information management technology and mitigate the problems experienced by humans in working with these systems, would greatly assist in tacking the problem of information overload and the related problem of bad management of internal information.

Many innovative information management products are becoming available, which are redefining the concept of the document, as a combination of interlinked files containing formats varying from text through image, spreadsheet, and video.

4.3.5 Implementing information management systems that better capture information flows likely to be affected by organisational and staff changes.

As previously stated if company's could succeed in capturing informal information flows in a user-friendly format then this could go someway towards reducing the problem of information & communication overload and also protect the company from many of the effects of increased staff mobility. Suggested initiatives include:

- the implementation of open electronic diaries and address books
- job handover procedures which are focussed on recording electronically informal information flows
- helpdesks, FAQs and chatboards which would help employees better navigate organisational structures and procedures.

4.3.6 The appointment of dedicated personal efficiency specialists.

Many key, mission critical people at all levels of Telco organisations, are working with office tools and systems in a very inefficient manner, because they do not have the time to customise these tools to their preferred way of working or to keep up to

speed with the functionality enhancements available with system upgrades. The appointment of problem solving specialists should be considered, who would be proficient in tasks such as integrating and customising PCs, personal digital assistants, software packages etc., so that these tools can be optimised to enhancing the effectiveness of individuals who most impact on the productivity and performance of the company.

4.3.7 Adopting new sophisticated information management tools which are tailored to the way the human brain manages and processes information.

There is considerable development work being done at present in the area of improving the search capability of internet search engines. Early adoption of these systems for use on internal intranet platforms when they become available is recommended, as they have the potential to radically improve the performance of the individual and the company. Combining these tools with software whose design is heavily influenced by research into the way human beings process information, are possible contributing elements to a solution to these problems. These new approaches will most likely only be of benefit if they are implemented on a wide scale. Accordingly their implementation requires sanction at a senior level.

4.3.8 Adopting more human friendly design philosophies in corporate intranets.

Corporate intranets are at the core of most Telcos corporate internal communication strategy. However, in many cases the design and management of these systems leaves a lot to be desired. In many cases these intranets are spin-offs of corporate presence sites, and as such are less suited as the primary internal information source. Corporate presence sites are designed primarily to present a favourable image of the company to the public at large. A corporate intranet if it is to be effective as the prime internal communications tool within a company should be specifically designed for this purpose and reflect the reality of how a company actually works and the likes and dislikes of those who use it. In the last number of years much knowledge has been gained on how best to use corporate intranets for internal information dissemination and retrieval. As the prime communication mechanism for most Telcos it is recommended that significant investment be made into developing our corporate intranets in line with current best practice, so that they are more responsive to the needs of the individual.

4.3.9 Transformation projects should recognise the importance of information flows as much as organisational structure and operational systems when implementing changes.

Transformation projects are a fact of life in all Telcos and it is likely that constant change will continue to be a feature of company life from now on. Inevitably, these transformation projects focus on reviewing organisational structures, operational systems and procedures in the context of evolving market conditions and mapping individuals into the roles identified in the course of this review. In the course of this activity, it is our contention that protecting and preserving important information flows does not appear to be a priority. We recommend that those functional areas involved in transformation be mandated to take into consideration the maintenance of such information flows when redesigning internal structures and systems.

4.3.10 Funding research into solutions to the problem of information and communication overload and better management of internal information and knowledge.

Telcos like most large organisations suffer significantly from the problem of information & communication overload and the related problem of bad information & knowledge management. For this reason and as the providers of much of the technology that is causing the problem, Telcos have an interest in promoting research into solving these problems. While research and development into developing new search engines is being carried out by many of the leading IT companies, there is scope for Telcos to invest in human factors research into how people can best use technology in the context of the limitations imposed by human physical and mental capabilities. It is also recommended that Telcos could usefully fund human factors research into their internal structures and systems, in order to examine the contribution of these structures and systems to the problem of information & communication overload. Similarly the promotion of research into novel document structures and formats that are optimised for the new technologies, in the context of shared information resource platforms such as corporate intranets, could usefully be considered.

4.3.11 Senior management attention is required to co-ordinate a timely and effective response to the problem of information & communication overload and the related problem of bad information & knowledge management.

Telcos like most large companies are political organisations and fundamental change in the way a company operates requires the enthusiastic commitment of senior management. We feel that because information and communication overload is so pervasive and the potential impact of this problem is so serious for the future of Telcos that the appointment of a Chief Information Officer (CIO) or Chief Knowledge Officer (CKO) should be seriously considered.

The CIO/CKO would be a senior manager whose importance would be equivalent to that of the Chief Technology Officer (CTO). While the CTO is normally responsible for the management and deployment of the technical systems in use in a company, it is envisaged that the CIO/CKO would be responsible for the management of information and knowledge flows within an organisation. He/she would champion the preservation and protection of these flows within the organisation, optimising the management of internal information and knowledge and be charged with minimising the instance of information and communication overload. Accordingly, among the tasks which we envisage would fall within the control of the CIO/CKO are:

- establishing corporate policy on information dissemination, use of emails etc;
- defining guidelines for presenting and organising information so as to effect efficient re-use within the organisation;
- setting company standards for use of information management tools;
- monitoring compliance with corporate policy;
- mapping information flows within the company;

- establishing procedures to capture strategically important internal information and knowledge;
- evaluating emerging information management tools and techniques;
- identifying bad practice and problem areas;
- conducting information audits where problems are identified;
- establishing training programmes.

5 Conclusions & Recommendations

5.1 General recommendations

5.1.1 What can be done next?

Telcos should tackle the Information Overload at 4 different levels :

1. Organizational Measures
   - New roles and institutions (brokers, centers)
   - New processes (life cycle, cleansing)
   - Standardisation & simplification initiatives (i.e. for investment proposals)
   - Policies and guidelines (information quality standards, push-pull uses)
2. Common Behaviour

   The individuals behaviour plays a significant role

E-Mail	Voice Mail
▪ Avoid distributing your e-mail address ▪ Check e-mail subject ▪ Write brief responses ▪ One topic per email ▪ Informative, indicative titles ▪ Separate facts, consequences, required actions ▪ Add a signature and protocol ▪ Respect hierarchic levels ▪ Do not get personal in e-mails ▪ The wording in business e-mails should correspond to that in business letters ▪ Selects cc's carefully ▪ Stop repeated spam ▪ Prevent needless responses	▪ Check voice mail often ▪ Skip the outgoing messages ▪ Discourage return calls ▪ Return calls late at night ▪ Have a short but comprehensive outgoing message ▪ Change your outgoing messages (e.g. if you are on vacation) ▪ Let callers skip your outgoing message
Paper	Meetings
▪ Throw it away, if there is no reason to keep it ▪ Make sure the fax machine is attended ▪ Avoid publishing fax numbers ▪ Complain loudly the senders of junk faxes ▪ Use a fax modem to sort, store and delete electronic faxes ▪ Set up an automatically responding faxback service	▪ Be sure you need a meeting ▪ Have an agenda for all meetings ▪ Ask for RSVPs ▪ Minute the meetings ▪ Answer every question

3. Individual Strategies

   Different tools can be used at individual level to organise the information and put them in the right context. These are:

- Planning tools. e.g. flow charts, decision tables
- Gathering tools. e.g. information classification maps
- Structuring tools. e.g. clustering & segmentation tools, hierarchical diagrams
- Relating tools. e.g. organigrams, data flows

4. Information Technology Platforms

   Many platforms are now available for presenting the knowledge and information in an efficient way. The simplest tools use structuring and relating tools in 2-dimensional colourful graphical presentations. The availability of multi-media technology shall enrich such tools and provide more effective ways of storing and presenting the information.

The implementation of the above mentioned measures will achieve tremendous results only if they are embedded in a thorough Knowledge Management (KM) program. But why such a program at all? Financial analysts are beginning to consider intellectual and knowledge capital as assets that contribute to the total value of an organisation. Companies, especially in businesses where intellectual capital is a high portion of overall assets, will be compelled to manage, measure and maintain a valuation of their knowledge and other intellectual assets. Examples of such companies include engineering, consulting, high technology and even manufacturing.

5.2 Telcos' sources of knowledge

Telcos and their knowledge workers require broad information access and diversity; it must match the reach and range of their job responsibilities. The sources for this information can be grouped into two broad categories – *internal* (those information assets owned and managed within the physical company of the knowledge worker) and *external* (all the knowledge and information from external sources). Telcos and their knowledge workers have access to an almost unlimited supply of information from internal and external sources. The reliance on external knowledge is growing because of expanding user needs and because of availability of information – e.g., from the Internet, strategic partnerships (e.g., outsourcing, delivery chain and supply chain partners), numerous subscription news and research services. Therefore, a company's vision for KM programs must encompass the extended company.

The primary external sources of information content needed by companies and their knowledge workers include:

- Customer information from sources such as subscription services. This information is increasingly used to supplement the internal expertise, research and communication programs of Telcos.
- Information from external business partners which are participants in the supply chains or delivery chains of a company. In these partnerships, components of the processes (including the information, process tasks and experts) reside outside the physical boundaries of the process-owning Telco.
- Internet provided information, including messages, public information available to all users, and commercially purchased information that relies on the Internet as the delivery channel.
- Competitor information acquired from external sources such as market intelligence providers.

As the market value of Telcos is increasingly vested in corporate memory and intellectual capital, Telcos must develop a discipline and corporate skills aimed at managing these intangible assets. Among the skills are:

- Identifying the linkages in the company between the cultural foundation and the conversion of intellectual capital into business value
- Influencing and managing cultural change; eliminating obstacles and implementing motivators; and directing cultural change toward achieving business value
- Viewing intellectual capital as an earning asset; identifying and protecting these assets; and measuring the value of intellectual capital
- Designing and building processes to capture and share intellectual capital across the people and the business activities of the company
- Stimulating collaboration and innovation to convert intellectual capital into products, services, reusable components, idea bases and best practices
- Building a business strategy, a cultural environment, and KM processes that operate in concert to manage intellectual capital

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