INFORMATIONSTECHNIK UND ARMEE

Vorlesungen an der Eidgenössischen Technischen Hochschule in Zürich
im Wintersemester 2000/2001
Leitung:
Untergruppe Führungsunterstützung - Generalstab
Divisionär E. Ebert, Unterstabschef Führungsunterstützung

Neue IT-Technologie und ihre Bedeutung für die Armee

Referent: Prof. Dr. B. Plattner

Neue IT-Technologie und ihre Bedeutung für die Armee

Prof. Dr. B. Plattner

Vorbemerkung

Der Vortrag von Prof. Plattner stützte sich auf die Erkenntnisse aus einer Studienreise in die USA, die er als Mitglied einer Delegation von Mitarbeitern des VBS, der Forschungsstelle für Sicherheitspolitik und Konfliktanalyse und von Vertretern der Privatwirtschaft unternahm.

Der nachfolgende Text ist ein Auszug aus dem Reisebericht der Delegation, der von der Forschungsstelle für Sicherheitspolitik und Konfliktanalyse aufgrund von Diskussionsbeiträgen der Delegationsmitglieder erstellt wurde.

Inhaltsverzeichnis

Adresse des Autors:

Institut für Technische Informatik
und Kommunikationsnetze (TIK)
ETH-Zentrum
8092 Zürich

Informationstechnik und Armee
40. Folge 2000/2001

The Unleashed Knowledge Society: Prospects of Information Technology Trends

2.1. Executive Summary: Key Trends, Themes and Concepts

The following sections elaborate on five overarching trends which describe general observations that have been made at the various site visits in research and development on information technology products, services and the knowledge economy. While certain site visits may have provided greater insights than others, the critical trends have run through all of the demonstrations, presentations and conversations that were held. For example, digitalization of all media, be they images, sound or data, presents a red skein of the unleashed knowledge society; so does the convergence of all major media types. Knowledge management indeed occurs now on practically any office desk and has engulfed more comprehensive information components than the mere collection of data. The following ***technological trends*** thus define the knowledge society:

- *Media convergence*
- *Unlimited bandwidth availability*
- *Miniaturization*
- *Ubiquity, invisibility and universal connectivity*

Based on these information technology trends, two key ***opportunities*** and applications have presented themselves:

- *E-Commerce*
- *E-Learning*

E-Commerce is bound to become virtually all commerce. The internet has emerged as a key global economic forum in which increasingly greater shares of the world's commercial and financial transactions will be held. Shopping, advertising as well as booking and paying for services occurs more and more through the web, posing considerable technological challenges in the field of information security. Transaction and opportunity costs experience an exponential decline, while access to tailor-made products and services is made easier and faster. Electronic transactions have become the single package through which communication strategies, marketing instruments and distribution channels are being articulated and conveyed. These trends facilitate also the applications for E-Learning, notably for intraweb-based training in the corporate sector. Finally, it is important to keep in mind that the speed at which these applications are being implemented is bolstered by plunging component prices (from USD 10 per MB of harddisk in the early 1980s down to USD 0.2 in the late 1990s).

Third, the site visits have christallized a series of considerable debates on information technology trends:

- Centralization versus decentralization;
- Knowledge management: content—context—community;
- Co-evolution of technology and society: blurring of human—machine divide;
- Information technology security: end-to-end problems;
- Information technology and international relations, security policies, strategies and doctrines: full spectre information dominance.

Finally, the visits generated substantive observations, which included

- Open standards and the importance of networked environments;
- The persistence of the sheer complexity of certain kinds of technologies;
- The vital importance of mission critical applications for suppliers of services;
- The ephemerous nature of past and current technological achievements and the speed of innovations as well as their product realization;
- Limiting factors and circumstances such as limited natural resources (energy supply) and the human factor.

2.2. Media Convergence: One Technology Format for All Your Information, Communication and Entertainment Needs

While "convergence" may be one of the most overstretched buzzwords of the information technology industry and the exact form of that convergence may eventually differ from what is currently envisioned, the site visits have given clear indications that some form of media convergence is indeed occurring. Media convergence is happening at the user interface as well as at the semantic levels, with the splitting of channels and codes in user device protocol devices (television, monitors, phones, ISDN, cell phones, PCs and newspapers).

Digital television is more than just simply a collection of an abundant number of channels; cell phones are more than just simple wireless communication devices if online services can be accessed through handsets; workstations and desktops are more than just working platforms if upgraded with entertainment possibilities. Digital television affords multiple channel and interactive applications; video technology research strives for the melting of television and multimedia. The convergence of various functionally and physically separated media technologies advances at a considerable speed, with the most notable convergence trends being the merger of platforms for wired/wirless communications and video technology. Examples and demonstrations of that trend were provided notably at the Fuji-Xerox Palo Alto Laboratory, Microsoft, the MIT Media Lab and MicroStrategy. Microsoft in particular has been pursuing "enhanced television" services that combine television programming with internet-style information and eCommerce. Also, several demonstrations at MicroStrategy indicated that the mobile phone is increasingly seen as a bridge between the converging worlds of traditional media and the Internet.

Media convergence raises complex issues: are cable networks public or proprietory domains? To what extent can competing Internet service providers have equitable access to cable networks run by telecommunications companies? Do telecommunication companies have a legitimate right to control high-speed Internet access providers? Conversely, are the latter entitled to offer telephony services over cable networks? Does it make sense to continue to distinguish between telecommunications and broadcasting industries if the former develop fixed wireless services on the broadband front? These are the complex regulatory issues which have received considerable attention; as such, they provide an indication of the type of media convergence which will become prominent in the foreseeable future. WebTV is already a reality as television stations have conquered new virtual space on the Internet. Convergence at that level can typically occur between the Internet, teletexts, Wireless Application Protocols (WAPs) and electronic program guides, featuring the melting of the Internet with digital television. On other fronts as well, traditional print media have moved online with their products, with exclusive electronic news providers offering for example multimedia services and television programming on their sites. Thus, one could reach the conclusion that media convergence is already on its way on the technological front given that some of the concerns now focus on convergence implementation. The question is no longer whether or not WebTV materializes, but how for example wireless networks can deliver speedier web downloads of digital media such as music, software or video games, without the need for high-speed cable or phone lines.

2.3. The Knowledge Society

Databases and data warehousing have become critical elements for business competitiveness. Customers and users expect well-structured and rapid information in response to their queries, this is why the access to any data, on any server, over any network, from any client device will become a key pillar of effective customer relationship management (CRM). Databases for Internet computing have faced the challenge to offer added functionalities; knowledge management has as a result graduated to be any organization's central nervous system for the management of numbers, texts, images, sound and video data.

Depending on an organization's specific data management context, services and applications, the issue of data centralization vs. decentralization emerges as a key element in any eBusiness strategy. Can business intelligence serve the specific needs of CRM and enterprise resource planning more effectively if its applications are supported by fewer, but more powerful servers? Conversely, can locally generated service needs in consulting, support and training be managed more effectively from less powerful, but more numerous servers matching the specific configuration of local information needs?

2.3.1. Data Management Solutions

One way to answer these questions is to distinguish clearly between functions and hardware. Functional requirements and specifications always grow and develop

in locally rooted services. But these functions can be made available either from decentralized or centralized hardware. While in a first phase centralized hardware was the consequence of high costs — notably in IBM 360 architectures of the 1960s — a second phase (DEC, POP II of the 1970s) made decentralized computing affordable. This trend was accelerated with the increasing availability of PCs in the 1980s. Today, the shortage and costs of labor seem to override the drawbacks of expensive hardware and centralization becomes an issue again.

A second answer points towards product trends in massive *scalability, availability, extensibility and manageability* of server capacities. eBusiness has to cope with rapidly expanding markets, the challenge of retaining customers, and the call for universal access to data. The time frame for market access has shrunk dramatically; in conjunction, users and customers expect a better service at lower costs. Universal access, if designed properly, has offered a solution that matches customer requests with self-service interfaces which in turn cut overhead costs for serving growing numbers of user requests and inquiries.

- With ***massive scalability*** servers, databanks and storage capacities, the ability to respond to and support exponential increases in activity both in the short-term and over time has been enhanced considerably. Automatic load balancing and caching of web traffic can provide a scalable system to meet increasing demand even at peak times.

- ***Availability through redundancy*** of server capacities means that data can be delivered for transactions in a 7x24 hour environment with little or no tolerance for downtime. Core features such as fast-start fault recovery, hot backup as well as replicated databases ascertain a high software availability that is being matched with increased hardware availability, achieved for example through storage area networks (SANs).

- ***Extensibility*** enhances a system's basic capabilities without major rework efforts. This is accomplished through software that allows developers to create and deploy new eBusiness applications to browser users anywhere.

- Finally, increasing ***manageability*** of server capacities is strengthened through web-based and user-friendly eBusiness tools that reduce the need for installing, configuring and maintaining multiple client software. Additional manageability innovations have included partitioning, transportable tablespaces (an alternative solution to migrating tables, indexes) as well as recovery "managers" for backups.

In conclusion, while the technological responses to the divergent needs of centralized and decentralized data management systems become more sophisticated, the certain basic issues may remain open. Advocates for centralized databases call for the transfer of data complexities away from individual personal computers and client/server models towards professionally managed and centralized data servers accessible for all authorized users requesting integrated information for their own improved decision-making. Their major arguments include

1) economies of scale;
2) simplification of client/server support;
3) security; and
4) significantly reduced costs.

Proponents of decentralized databases point towards the need for individualized local information that is installed, upgraded and maintained by people who not only own the data, but are also aware of the specifications of their business data needs. In order to disentangle the seemingly contradictory lines of argumentation, it may be useful to distinguish between the management of the content and the hosting of data. Data content can still be managed locally if centralized! There the issue becomes one of massive redundancy and single points of failure as well as data security. Data centralization raises some serious security concerns and poses considerable challenges to the maximization of encryption standards. Indeed, with centralization, connectivity becomes a bottleneck in which single points of failure render data less robust than in decentralized systems. It is important to keep in mind, though, that the security problems in decentralized solutions may be analogous and that encryption remains only one part of comprehensive security solutions.

While the debate continues nonetheless, the key trends in database technology are indisputable. These trends are defined by *Internet features*. Through web-based technologies, databases have indeed received new qualitative and quantitative dimensions permitting dynamic, data-driven applications that develop markets, online services and efficient CRM with the ease-of-use offered by web browsers. A prominent example of this trend was demonstrated in the context of Microsoft's data management search system.

2.4. The Connected World: the Network is the Computer

The major empirical manifestations of an increasingly connected world include bandwidth explosion and Internet growth. By the year 2003, the web is expected to contain over 15,000,000,000 URLs; traffic and capacity is expected to double every 100 days. Technological advances turn videos into phones and vice versa. E-Commerce/Business once reserved for a small specialized segment of consumer needs will become part of personal lives and an integral part of shopping. Indeed, global sales of these transactions by the year 2001 are expected to top 1,000 billion USD. Physical shopping will become increasingly an experiential happening rather than an activity to cover essential needs. In response to these connectivity trends, industries have become "amazoned" (allusion to amazon.com) with traditional "bricks and mortar" companies supplementing their physical presence with a virtual dimension that expands market shares. Conversely, purely virtual eBusinesses have added physical infrastructures to provide certain services and a presence which otherwise would not have been possible. Business-to-business eCommerce was mentioned notably as a major booster of traffic. As a third manifestation of global connectivity is the sheer pace at which communcation flows have accelerated, undermining the traditional correlations between costs and reliability and speed.

Finally, it is expected that voice traffic over internet providers will soon outweigh voice traffic through traditional telecommunication networks. At the same time, voice traffic will soon be reduced to a small if not insignificant percentage of overall data traffic.

2.4.1. Connectivity Technology

Major research efforts in support of enhanced connectivity have centered around distributed operating systems, wired and wireless networking, and location-based services. Demonstrations of appliances communicating directly with each other using Jini technology were particularly impressive at Sun Microsystems. Network-based software availability has been gradually replacing disk-dependency of devices. Distributed object-computing systems have emerged as well as a critical network dependency for a competitive service provision. While traditionally network interfaces and protocols have been present since the inception of the Internet, more recent innovations have focused on integrated technology solutions for smart cards and supercomputers delivering mainframe-class reliability, practically unlimited expandability of network storage, and cross-platform information sharing.

Key ingredients underpinning the connected world are formed by

- high-availability servers;
- high-speed networking;
- robust system software;
- intelligent storage systems;
- platform independent applications;
- advanced security systems (e.g., biometrical user identification using maximal encryption).

Servers offering high scalability afford the flexibility needed for expanding business or client/user transactions, or what has been labelled "mission-critical availability". Further, high-speed network architectures for information sharing, protection and cross-platform management are also an essential element for coping with incremental traffic growth and the fluctuating degree of scalability needs. With high-bandwidth networking and availability, even simple desktops will be able to perform at supercomputing precessing speeds. In conclusion, the connected world of data centers revolves around

- seamless network computing;
- management of very large data sets;
- high-speed rendering of large and complex models of varying dimensions;
- demand for reliable and safe global electronic transaction systems.

2.5. Personalization of Computers and Individualization of Services

The fourth overarching trend is the identifiable research emphasis towards human-aware information technology, or human computing. The origins of human

computing can be traced to increeasing computing power (Moore's Law) and cheap storage capacity affording advanced interfaces, user profiling as well as user dependent behavior. The human computing trend is already clearly present in certain kinds of software with learning capabilities that were presented (e.g., at Microsoft and the MIT Media Lab). The gap that currently still separates the (human) user from technologies narrows rapidly. Human computing not only equips technology with certain interactive capabilities, but also merges it with multimedia entertainment. Thus, technologies will on the one hand gain an awareness of user tasks, actions and interactions, physiological states, and on the other, transform structures of decision-making, support and augment therefore human capabilities.

2.5.1. Human Computing Technology

Human computing equips information technology with speech recognition, language understanding capabilities, natural language processing, adaptive systems and interfaces, learning systems, and multimodal interfaces combining these elements. Research on vision capabilities has recently focused on perceptual computing with sensors, cameras, awareness and video with vision interfaces. The purpose behind the development of these added capabilities revolves around the idea that information technology has to become more aware in real time of what the people it is supporting are doing. The need for systems aware of the effect that they have on their social contexts will drive the development of technological capabilities that are in a position to support people's work and daily lives more effectively.

Human computing is therefore about strengthening and extending human capabilities through information technology and interfaces that expolit knowledge on how people learn, train, respond to directions, co-experience and collaborate. The urgency for such technologies increases as humans grapple with information overflow in a 24-hour economy and call for technological aids. Research on human computing epitomizes a response to a dilemma created by technological advances themselves, notably with the growth and proliferation of ubiquitous sensors and communications networks. Rapid context switches and "MindNets" (Microsoft's automatically generated knowledge bases from dictionaries with nodes linked by relationships) could go a long way in extending human memorization and processing capabilities in the management of information.

2.5.2. Customization: Knowledge Management and User Profiling

Knowledge management has not remained isolated from human computing innovations. No longer merely a concept for the collection and dissection of large amounts of data, knowledge management has increasingly focused on user profiling and extracting quality information out of raw user data for enhanced decision-making. What has happened as a result is an increasing trend towards *individually-tailored and customized information technology services.* With expanding bandwidth availability, individualized platforms and learning networks have adopted this concept not as an exclusive service, but rather as a complement to the existing infrastructure that has been offered on the web. Knowledge workers in particular

look for improved structured information retrieval systems and sites with easy to use, scalable and integrated resource management. Information services have used individually tailored sites in order to maintain and expand their market through added customer value and for data mining purposes. Outstanding examples of this clear trend were provided at Oracle and CNN (through mycnn.com), Cisco (training platforms), and MicroStrategy (through their personalized intelligence portal solutions). In conclusion, customization of services and knowledge management form an integral practical dimension of human computing and describe in broad parameters the trends in human-aware information technology research. A most pertinent demonstration of that trend was given at MicroStrategy through its prototype product, Angel.com. At the same time, the CNN visit made clear that only a fraction of users currently draws upon the capacity of customizing their websites; this is an important qualifier that one should keep in mind when looking that customization approaches.

2.6. The Silicon World

Finally, one important research dimension deals with the general move away from keyboard/screen settings towards spaces, environments and wearables that transform computing and render it a more pervasive and integral part of communication networks. Besides connectivity, the key technology trends of the Silicon World are represented by miniaturization and ubiquitous sensing. Computers and processing capacities have come a long way since the days of exclusive use of high-maintenance server clusters, enterprise servers and terraservers which may still be used for centralized solutions. On the one hand, processing power has grown exponentially, on the other, the cost and the space needed to host the same capability has eroded dramatically. Component prices of a single megabyte on a hard disk, for example, have dropped from some USD 5 to 0.5 and continue to fall. Mobile and task-based user tools and handheld PCs will even supersede the processing capacities of today's workstations.

As basic research on miniaturization advances, market applications of computing and sensoring technologies start permeating most physical objects, injecting communcation technology into practically any consumer item. The Silicon World's driving elements are already recognizable. Research centers around four technological devices:

- speech and handwriting recognition;
- user interfaces for small/invisible devices and for "environments";
- wearable computing technology;
- Micro-Electronic Mechanical Systems (MEMS).

Along with human-aware technology, the Silicon World propels adaptive and learning technologies that make human computing and support possible in the first place. While increased network bandwidth, higher resolution displays and other advances can define a certain technological reality, the development of the Silicon World ultimately depends on the effectiveness through which technology can match

human sense-making ability. In conjunction with the basic technology ingredients needed for a Silicon World, hardware device research serves as a critical vehicle for taking the computer out of its infancy state. Mobile and wirelss computing, new display technologies and MEMS epitomize cornerstones of cognitive computers capable of seeing, speaking, listening, adapting and taking care of themselves.