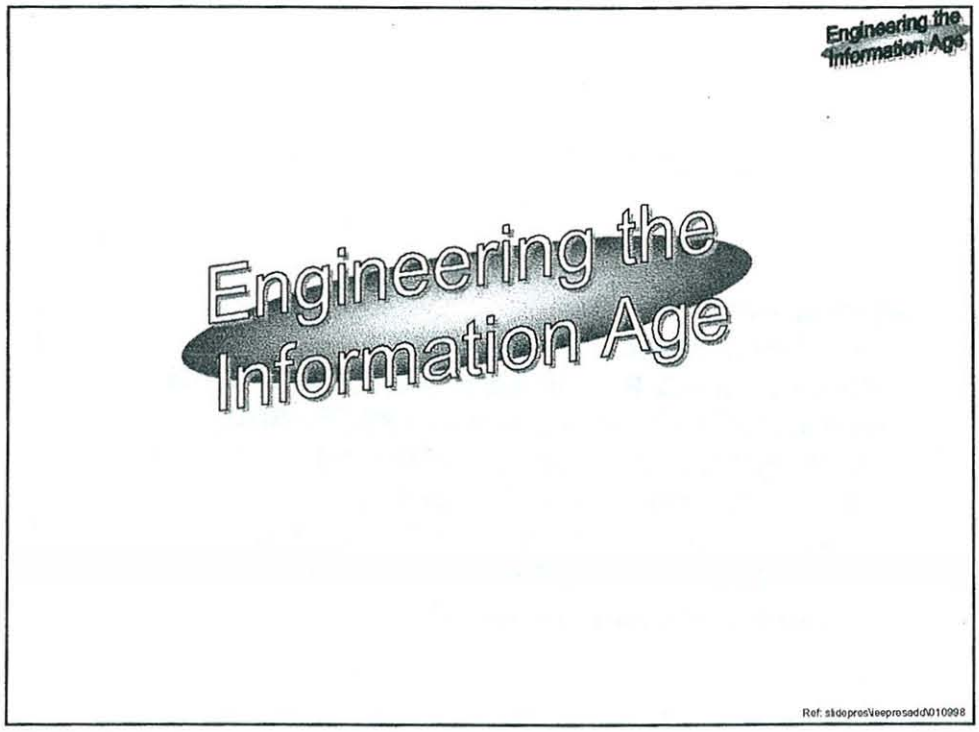
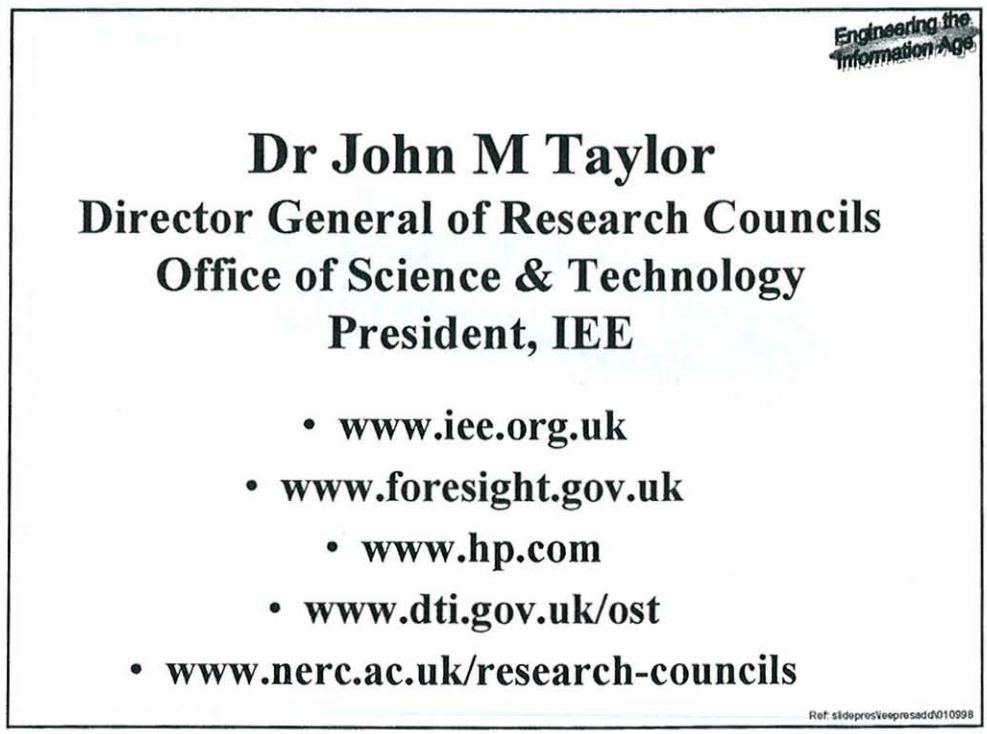
ENGINEERING THE INFORMATION AGE

THE LAST FIVE YEARS: THE EMERGING INFORMATION INFRASTRUCTURE & SOCIETY

J M Taylor

Rapporteur: Thomas Rischbeck


Engineering the Information Age
Engineering the Information Age
Ref: slidespresVeeprosaddv010998


Engineering the Information Age
Dr John M Taylor
Director General of Research Councils
Office of Science & Technology
President, IEE
• www.iee.org.uk
• www.foresight.gov.uk
• www.hp.com
• www.dti.gov.uk/ost
• www.nerc.ac.uk/research-councils
Ref: slidespresVeeprosaddv010998

Engineering the Information Age

UK Office of Science & Technology (OST)
Director General of Research Councils (DGRC - £1.5B per year)

1

- UK Research Councils:
  - Medical Research Council (MRC)
  - Engineering & Physical Sciences RC (EPSRC)
  - Particle Physics & Astronomy RC (PPARC)
  - Biology & BioSciences RC (BBSRC)
  - Natural Environment RC (NERC)
  - Economic & Social Sciences RC (ESRC)
  - Central Council of Laboratories of the Research Councils (CCLRC)

Ref: slidespresVeepresadd\010998

Engineering the Information Age

Ref: slidespresVeepresadd\010998

Engineering the Information Age

Engineering the Information Age

The Last Five Years:
the Emerging Information Infrastructure & Society

Where Next:
Information Utilities and Information Appliances

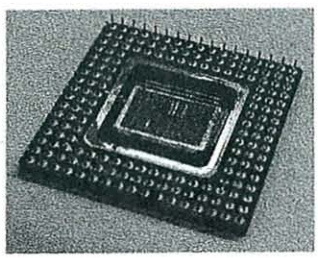
Ref: slidespresVeepresadd\010998

Engineering the Information Age

A Century of Electronics

1904

1947



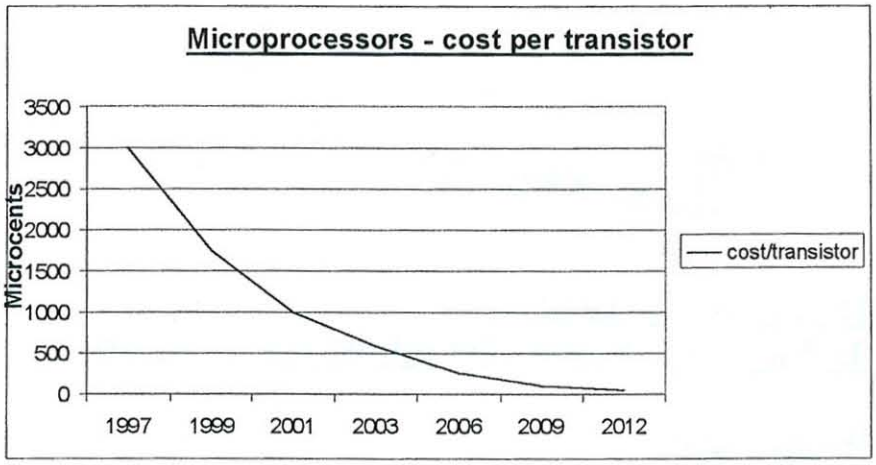
1997

INSPEC 100 YEARS OF SCIENCE ABSTRACTS
1898 - 1998

Ref: slidespresVeepresadd\010998

Moore's Law

Engineering the Information Age

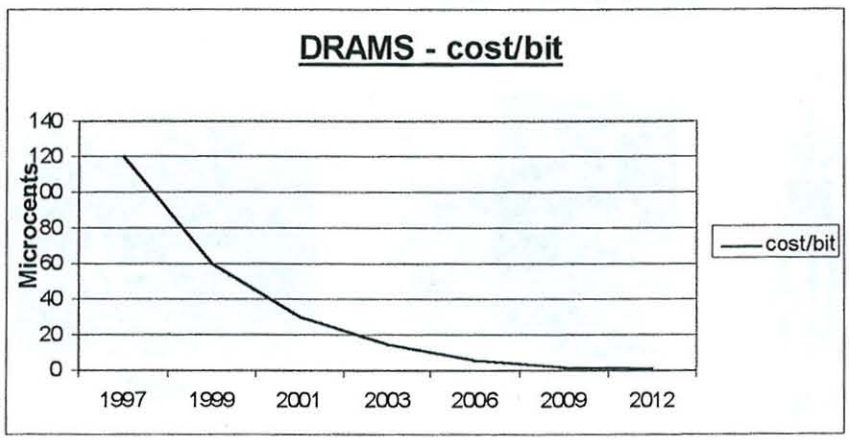


Year	1997	1999	2001	2003	2006	2009	2012
Cost per transisitor	3000	1735	1000	580	255	110	49

Source: The National Technology Roadmap for Semiconductors 1997

Moore's Law

Engineering the Information Age



Year	1997	1999	2001	2003	2006	2009	2012
Cost per bit	120	60	30	15	5.3	1.9	0.66

Source: The National Technology Roadmap for Semiconductors 1997

Storage - Facts and Figures

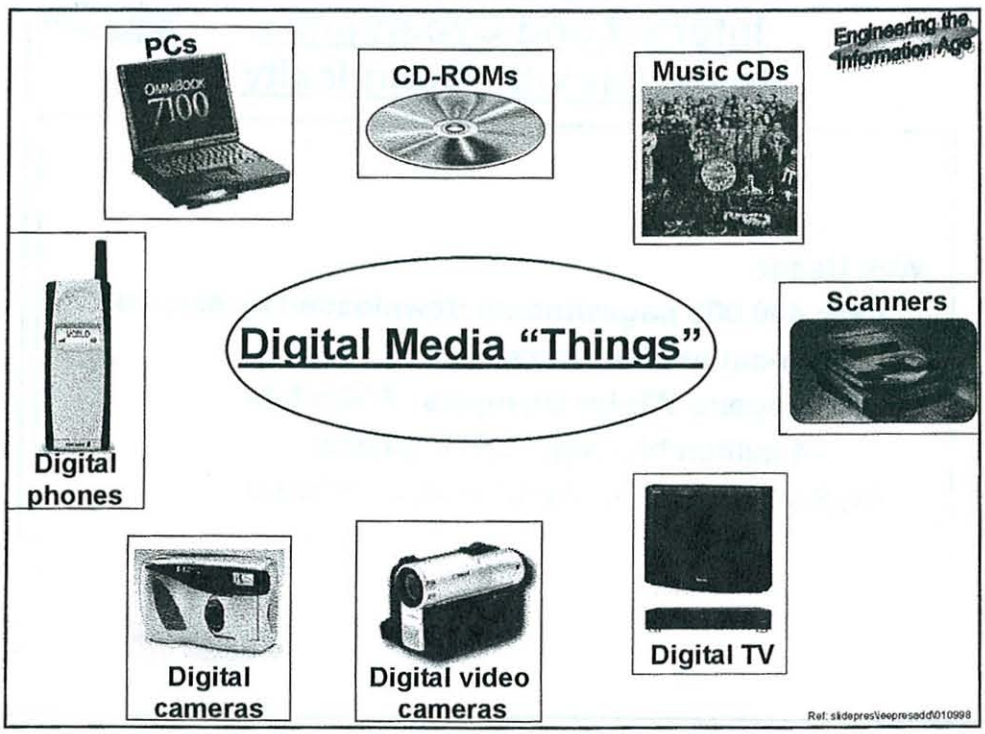
Engineering the Information Age

Memory size:	1998 - $1 per Megabit 2000 - double capacity for $1
Hard disk drives:	capacity will double over next 18 months 50% pa reductions in cost/Megabit
Optical storage:	2001 - introduction of green or blue lasers
First commercial applications:	2002 - 1Gigabit memory chips 2005 - single storage and replay device for audio, video and data 2007-2010 - 1 Terabit memory chip - Atomic Resolution Storage

100 million transistor IC - next year?

Source: Forward Look and Visions of the Future Paper, ITEC Technology Group, May 1998

Ref: slidepres\eepresadd\010998



Internet and Cyberspace
Scale, Growth, Complexity

Engineering the Information Age

Internet Users:	1996 - 27m
	1999 - 130m
	2003 - 350m++
PC's on Internet:	1996 - 30m; 1998 - 100m; 2000 - 230m
Geographical:	North America - 176m
world-wide 1999	Europe - 32m
	Asia/Australia - 17m
Geographical:	Germany 30%
WWW users	UK 23%
in Europe 1998	France 10%
UK households on WWW:	1997 - 960,000;
USA households on WWW:	1997 - 15m; 1999- 1/3 of all US h/holds

Ref: slidespresVeepresadd010998

Internet and Cyberspace
Scale, Growth, Complexity

Engineering the Information Age

- Web Usage
  - IEE: 400,000 pages/month downloaded by external non-automated users
  - IBM Nagano Winter Olympics: 650m hits - 4 million hits/day, 4.5 terabytes
  - Sydney Olympics: 2 billion hits expected

Ref: slidespresVeepresadd010998

Internet and Cyberspace
Scale, Growth, Complexity

Engineering the Information Age

PC's on Internet:	1996 - 30m; 1998 - 100m; 2000 - 230m
Host computers:	1998 - 30m; 1999 - 43m; 2000 - 100m
WWW Sites:	1997 - 1.7m; July 1998 - 10m
URLs:	Dec 1996 - 72m; Sept 1997 - 200m
Storage per Server:	1998 - 50Gb; 2000 - 500Gb+
Storage per PC:	1999 - 4Gb; 2000 - 20Gb+
Total Internet Storage:	1998 - 2000m Gbytes 2000 - 50,000m Gbytes - 50KMGbytes *--Increase 25x in 2 years*

Ref: slidepresVeepresddf010998

Communications Infrastructure

Engineering the Information Age

Mobile phone subscribers: 1997 - 200m
2000 - 400m
2001 - 600m

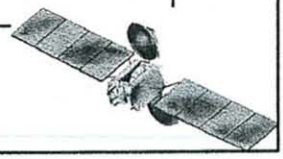
Digital cellular systems overtaking analogue

Wireless data phones 1997 - 500,000
2000 - 5.5m

UMTS - Wireless Web Browsers

GPS Next Generation - Location Based Services

Low Earth Orbit - LEO:
Five largest satellite network projects will spend $25bn launching 500+ satellites. Iridium now advertising for business



Engineering the Information Age

Communications Infrastructure
NG Internet and WWW

- Internet Technology
  - IP switching at 2.4 Gb/s, routing at 40Gb/s
  - RealMedia, RealAudio, WebTV
  - MP3 for music download
  - IPv6
- Web Technology
  - Browsers - Netscape, Internet Explorer
  - Mark-Up languages - HTML, VRML.....
  - Search Engines - Yahoo, Alta Vista

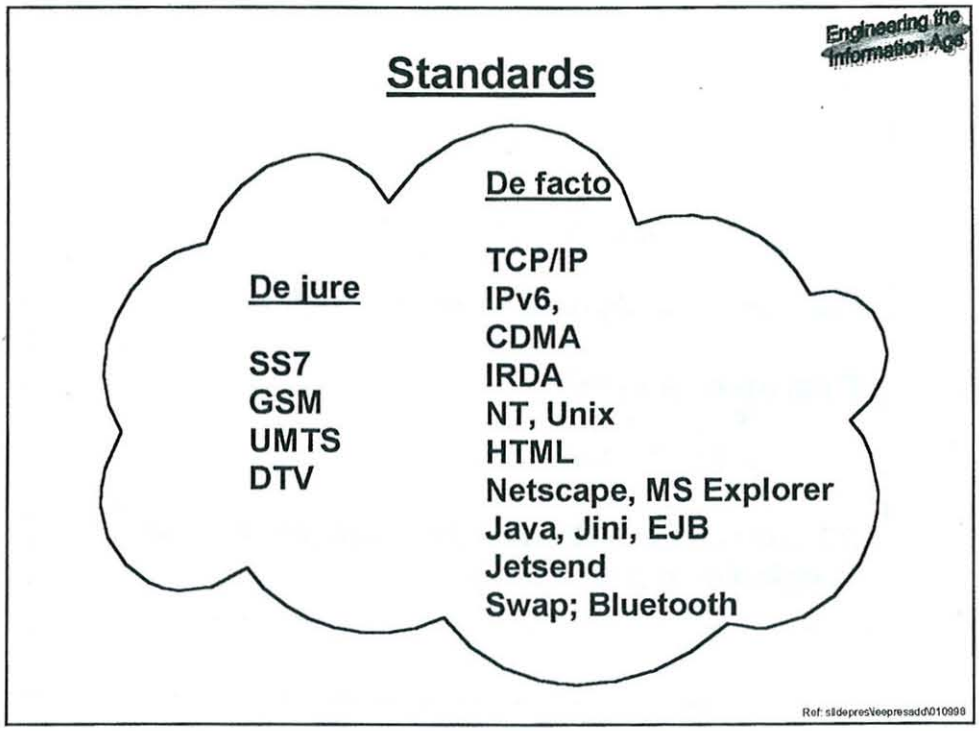
Ref: slidespresVeepresadd010998

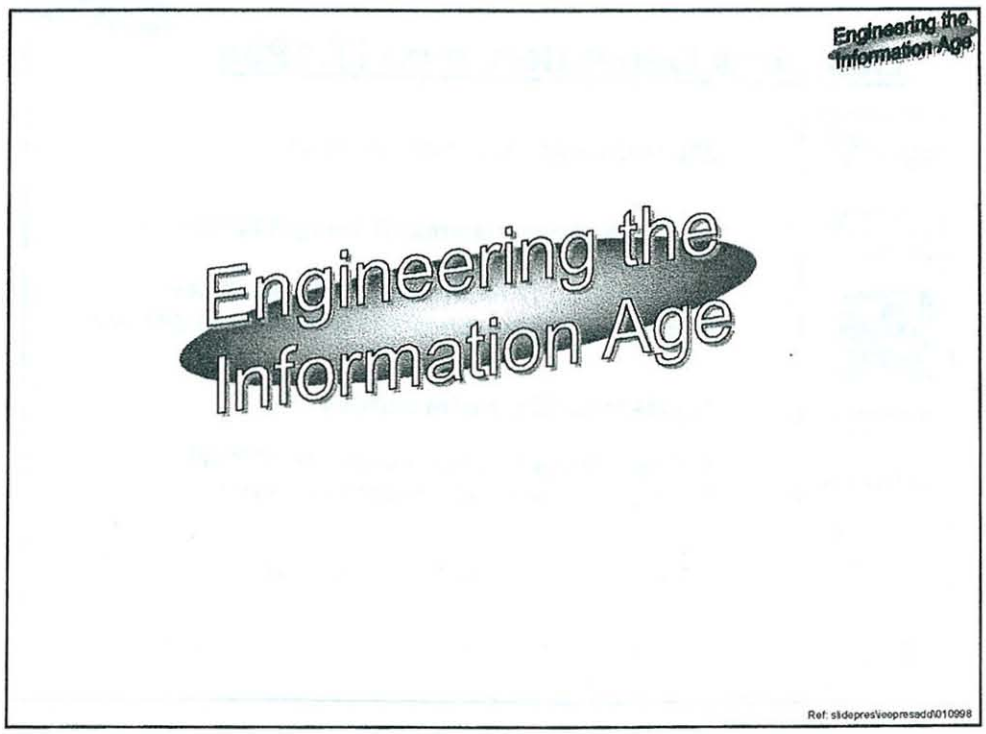
Software Engineering

Engineering the Information Age

- Object Oriented Programming
- Java, Jini, EJB (Enterprise Java Beans)
- Operating systems - Unix, NT, Linux
- Development models: Waterfall, Chaos, Evolutionary
- Learning, adaption, artificial intelligence
- Browsers - Mosaic, Netscape, Internet Explorer
- Search engines - Yahoo, Alta Vista

Ref: slidespresVeepresadd010998


Engineering the Information Age
Standards
De facto
TCP/IP
IPv6,
CDMA
IRDA
NT, Unix
HTML
Netscape, MS Explorer
Java, Jini, EJB
Jetsend
Swap; Bluetooth
De jure
SS7
GSM
UMTS
DTV
Ref: slidepres\eepresadd\010998


Engineering the Information Age
Engineering the Information Age
Ref: slidepres\eepresadd\010998

Consumer Dependence on IT

Engineering the Information Age

UK statistics

5.8m households have a PC (1998)

2.6m households have a modem (1998)

Total number of PCs:
1992 - 5.8m
1997 - 11.2m

PC adoption in both workplace and homes has doubled over past 5 years

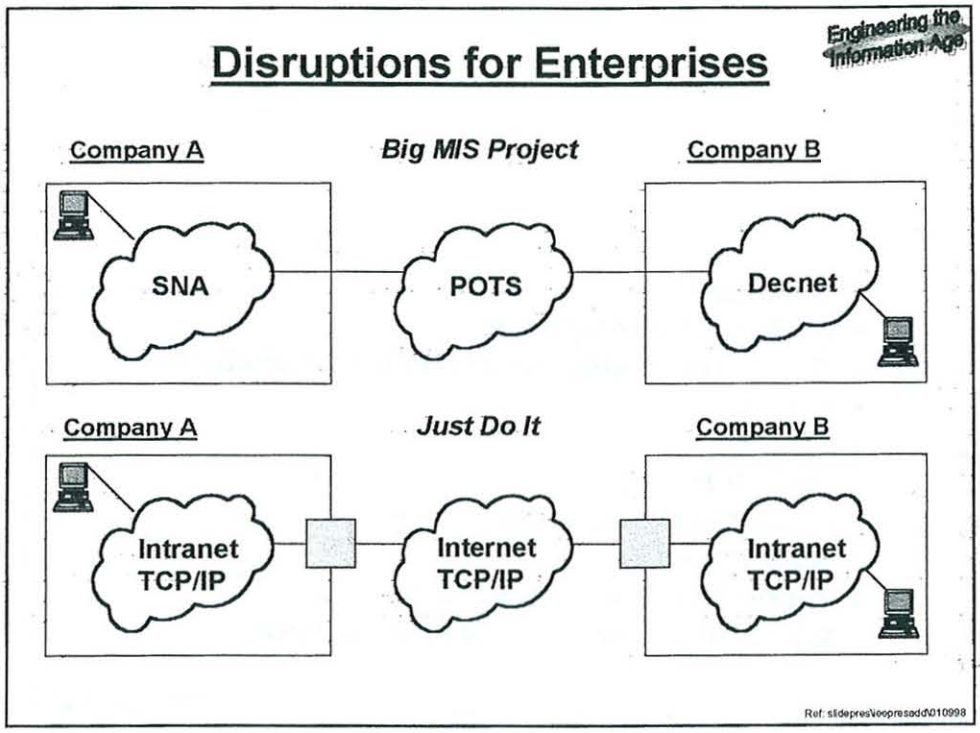
Ref: slidespresVeepresaddv010998

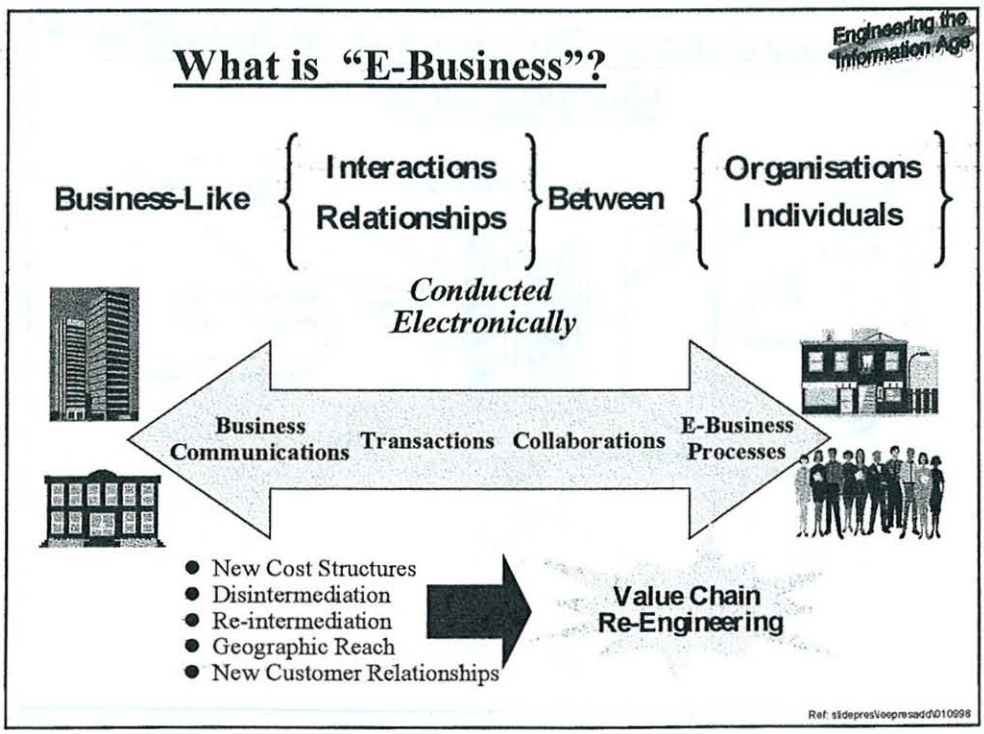
Business Dependence on IT:1998

Engineering the Information Age

BT	3000+ Unix servers; 100,000+ PCs
BRITISH AIRWAYS	30,000 desktop systems; IT budget £313m p.a.
SABRE	200,000 PCs, 17 mainframes, 15+ terabytes storage capacity; sends 190m messages per day
SAFEWAY	7,000+ PoS tills; 2 data centres
NHSnet	Government initiative to connect all local health authorities and doctor surgeries
DVLA 50 YEARS CELEBRATING THE PAST LOOKING TO THE FUTURE	200+ mainframe computers; 65m records
HEWLETT PACKARD Expanding Possibilities	9,300 servers, 166,000 clients, 14m hits per day on web site

Ref: slidespresVeepresaddv010998


Disruptions for Enterprises
Engineering the Information Age
Company A
Big MIS Project
Company B
SNA
POTS
Decnet
Company A
Just Do It
Company B
Intranet TCP/IP
Internet TCP/IP
Intranet TCP/IP
Ref: slidepres\eopresadd\010998


What is "E-Business"?
Engineering the Information Age
Business-Like
Interactions
Relationships
Between
Organisations
Individuals
Conducted Electronically
Business Communications
Transactions
Collaborations
E-Business Processes
New Cost Structures
Disintermediation
Re-intermediation
Geographic Reach
New Customer Relationships
Value Chain Re-Engineering
Ref: slidepres\eopresadd\010998

Engineering the Information Age

E2S - End to End Security over the Internet
An EU Esprit Project

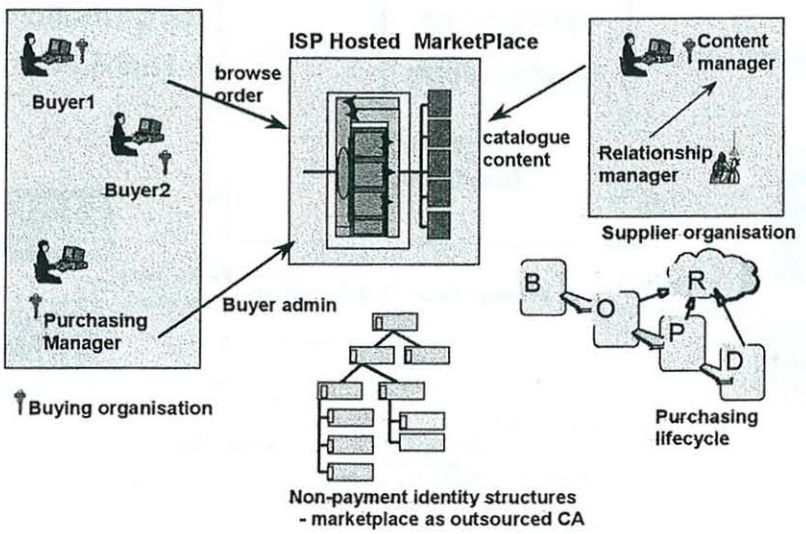
Consortium Members :

- APM Ltd
- Gemplus Development
- GMD Forschungszentrum Informationstechnik
- HP France
- HP UK
- Onyx Internet
- Swiss Bank Corporation - SBC Warburg
- Smart Card Forum
- Technische Universitat Berlin
- Visa International Service Association

Ref: slidespresVeepresadd\010998

Engineering the Information Age

E2S Marketplace: ISP Hosting of Bi-lateral Relationships



Ref: slidespresVeepresadd\010998

Engineering the Information Age

ITEC Foresight Panel

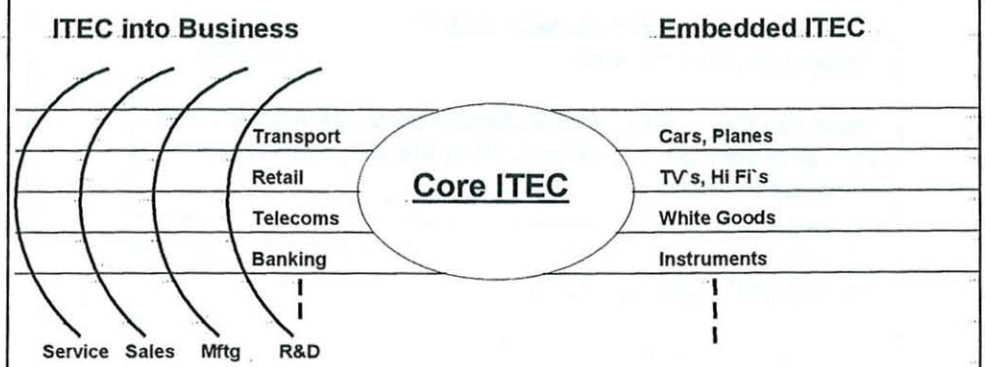
1. Identity fertile areas of emerging technologies where major new user needs and market opportunities are likely to be
2. Understand how to make UK a (more) attractive place for (continued) investment in high-tech, high value added business

Not picking winners - "Pick Your Own"

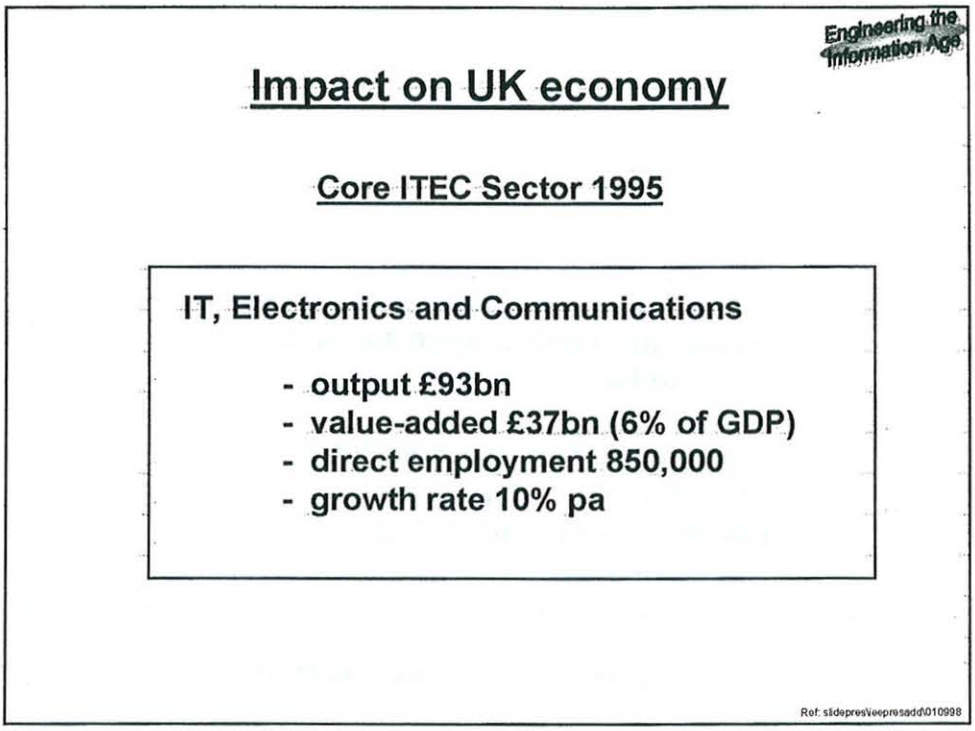
Ref: slidespresVeeprosaddv010998

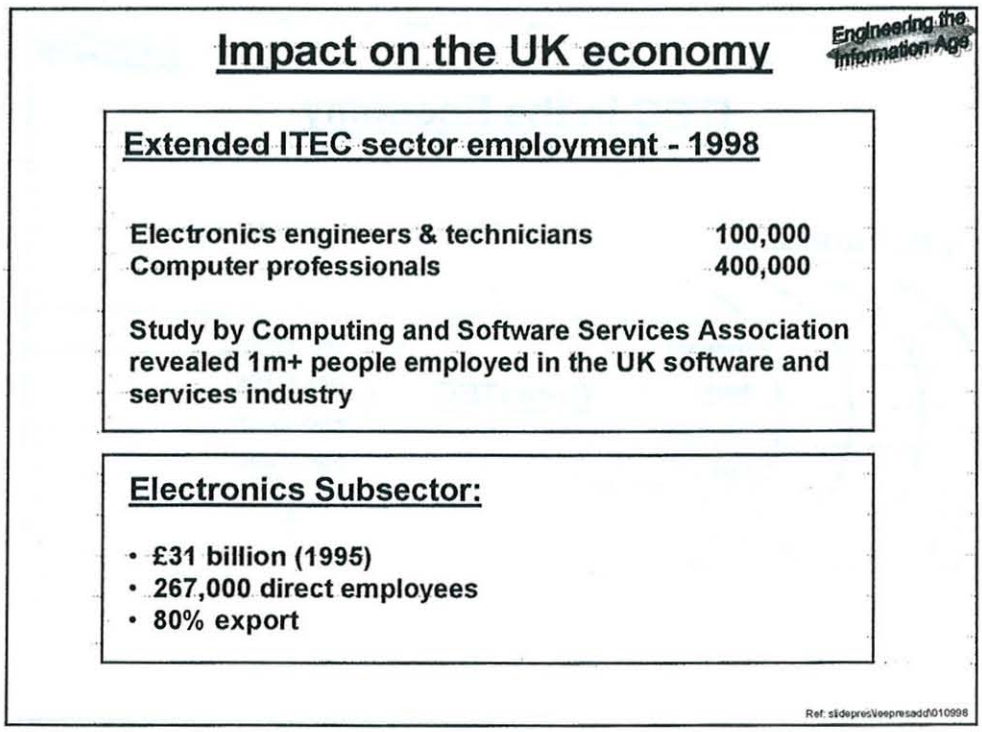
Engineering the Information Age

ITEC in the Economy



Ref: slidespresVeeprosaddv010998


Engineering the Information Age
Impact on UK economy
Core ITEC Sector 1995
IT, Electronics and Communications
- output £93bn
- value-added £37bn (6% of GDP)
- direct employment 850,000
- growth rate 10% pa
Ref: slidespresVeepresadd\010998


Impact on the UK economy
Engineering the Information Age
Extended ITEC sector employment - 1998
Electronics engineers & technicians 100,000
Computer professionals 400,000
Study by Computing and Software Services Association revealed 1m+ people employed in the UK software and services industry
Electronics Subsector:
• £31 billion (1995)
• 267,000 direct employees
• 80% export
Ref: slidespresVeepresadd\010998

Engineering the Information Age

ITEC in the Economy
E-Business, E-commerce

- Global E-commerce revenues:
  - $15B in 1997
  - $68B in 1999
  - $1000B by 2002 - US: $840B
    - Asia: $50B
- Cisco E-Commerce revenues:
  - 1997 - <$1B
  - 1998 - $3.8B
  - 1999 - $10B
- Global Internet Project - 1996:
  - 1.1million new jobs world wide directly Internet
  - 760,000 in US - half of all new US jobs that year

Ref: slidespresVeepresadd\010998

Engineering the Information Age

Impact on the Economy

ITEC:
What would Success Look Like in 2005?

Study:
- sponsored by DGRC
- lead by ESRC
- complete by mid 2000

Ref: slidespresVeepresadd\010998

Engineering the Information Age

Year 2000 (Y2K) Problem

The Millennium Bug

"Nobody could possibly be still running my software in the Year 2000, so why should I worry about taking short cuts in how it represents dates?"

Ref: slidepres\veepresddd010998

Engineering the Information Age

Year 2000 (Y2K) Problem
Facts and Figures-1998

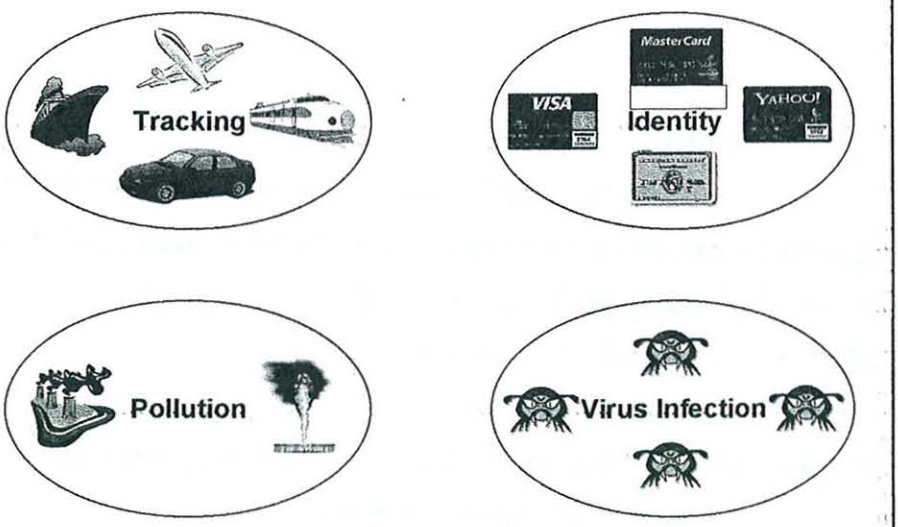
Worldwide cost - $300bn - $600bn *(Gartner Group)*
-could be up to $3500 bn
Examples of cost to achieve compliance:

- **UK Dept of Social Security - £45m**
- ***UK Central government - £420m***
- **NHS - £312m minimum**
- **Shell UK - £40m; *Shell w-w - $460m***
- **British banks - £1bn+**
- **General Motors and Citicorp - $500m each**
- **US Federal Aviation Authority - $162m**
- ***Airlines w-w - $2.3bn***
- **US organisations will spend $276bn**
  ($71bn to achieve compliance, $105bn on secondary repairs, $100bn on litigation and damages)

Ref: slidepres\veepresddd010998

Engineering the Information Age

Quality of Life - Societal Impact



Ref: slidespresVeepresadd\010998

Engineering the Information Age

Conflicts of Needs

Freedom of Information vs Confidentiality

Privacy vs Safety

Access vs Overload

Communications vs Intrusion

Visibility vs Anonymity

Openness vs Misuse

Individual Democracy vs Organised Lobbying

Ref: slidespresVeepresadd\010998

Engineering the Information Age

New Civil and Human Rights?

New Individual and Organisational Responsibilities?

Right to Fuzziness - not to be correlated & tracked
Right to Agnosticism -
not to be forcibly told things I can't un-know
Right to Break the Rules - to choose to take personal risks
Right to Visibility and Reciprocity
Right to Individual Democracy -
not government by cyber-pressure groups
Right to Clean Cyberair - mistakes, viruses, junk, spam....
-should the polluter pay?

Ref: slidepres\eepresadd\010998

Engineering the Information Age

Disrupters: What's Different about the Information Society and Cyberspace?

Changes the way we do things-new ways, new exclusions?

news
voting
sports
learning
work
extended families
pets, toys, play
publish, read, view, collect - books, music, movies, art
DIY healthcare
punishment

Ref: slidepres\eepresadd\010998

Factors Driving Exclusion

Engineering the Information Age

- Ownership of means of access
  - information appliances
- Access to communications and services
  - information utility
- Literacy and education
- Techno-comfort
- Diversity/Cultural mismatches
- Collateral disadvantages/penalties eg tracking
- Fashion
- Purchasing power - interest to advertisers
- Cost of services and appliances

Ref: slidepres\eopresadd\010998

Engineering the Information Age

Engineering the Information Age

President's Information Technology Advisory Committee (PITAC) - US, Feb 1999

- Transforming the way we:
  - communicate
  - deal with information
  - learn
  - conduct commerce
  - work
  - practice healthcare
  - design and build things
  - conduct research
  - deal with the environment
  - conduct government

Ref: slidepres\eopresadd\010998

Engineering the Information Age

Engineering the Information Age

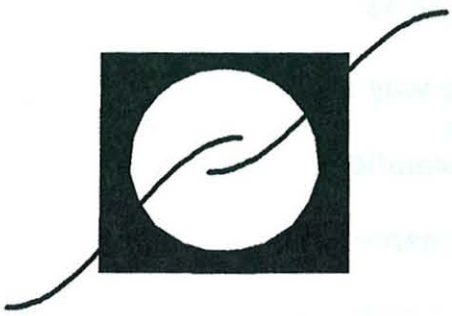
President's Information Technology Advisory Committee (PITAC) - US, Feb 1999

- Increase funding for long term research on
  - software
  - scalable information infrastructure
  - high end computing - petaflops by 2010
  - socioeconomic impact
- by $1 billion per year by 2004

Ref: slidespresVeepresadd\010998

Engineering the Information Age

Utilities & Appliances - The Next Generation



Ref: slidespresVeepresadd\010998

DISCUSSION

Rapporteur: Thomas Rischbeck

During the first talk Professor Nygaard mentioned that new fast search engine technologies are demanded by the capture market according to his experience in Norway. This issue was identified by Dr Taylor as only part of a bigger task which actually goes "way beyond search engines." "Human problems" are involved here; informal information as e.g. represented by images, does not have any meaning for the computer. This leaves it to the human operator to narrow down search results and also to keep the retrieved information in an organised way (counter-example: bookmark file). The speaker deferred a more detailed elaboration of the up-coming issues to the second talk.

The audience noticed that a slight confusion between standards and products appeared on the slide of "de facto standards", e.g. NT is an implementation, not an interface. Dr Taylor agreed.

Later on, the (internet) connectivity rate of UK households was brought into discussion by Professor Martin and Professor Randell. There was an agreement that saturation at a high modem/PC ratio will eventually be reached. However, overall connectivity will increase with a diversification of products as brought about by "new information utilities and appliances". This awkward classification defines a new class of "web-enabled" devices as represented by early product offerings from the field of set-top-boxes, PC-less digital imaging or wireless web-browsers.

On the topic of e-commerce Professor Nygaard pointed out the inadequacy of the present legislation. Dr Taylor amused the audience with the anecdote of the "bank in the satellite" which traverses different countries during a financial transaction. Which national laws apply in these cases and where does taxation take place?

Professor Wharton questioned disruptive technologies against the background of established companies. The speaker explained that advocates of mature technology often underestimate the potential for much higher growth rates of disruptive technologies. They are hard to incubate, seem far fetched and are often not applicable for product offerings. Though, if successful they will sooner or later take over the conventional product or service. Likewise, as Dr Davis showed with an example, changes in the industrial landscape can bring about sudden competition amongst previous partners.

Dr Taylor concluded with an invitation for leading-edge R&D investment to pave the way towards next generation science and technology. Involvement from the audience to reflect upon fundamental changes to come and also on bounds of feasibility and reasonability is welcome. More information can be found on the EPSRC website with Rod Kuhns signing responsible for further workshops, etc.