Measuring the use of Internet in research and development. Empirical evidence from seven European countries

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SIBIS project (IST-2000-26276) (01/2001-09/2003)

- **Main contractor: empirica (D)**
- **Partners:**
  - Work Research Centre (IRL)
  - Dansk Teknologisk (DK)
  - Technopolis (UK)
  - Databank Consulting (I)
  - RAND Europe (NL)
  - FH Solothurn NWCH (CH)
- **Objectives:**
  - Development and testing of statistical indicators benchmarking progress towards the Information Society
  - Evaluation of e-Europe actions
  - Benchmarking of achievements and progress

SIBIS project (IST-2000-26276) (01/2001-09/2003)

Candidate Country Partners as of summer 2002:

- Faculty of Social Sciences, University of Ljubljana (Slovenia)
- ASM Market Research and Analysis Centre (Poland)
- Budapest University of Economic Sciences and Public Administration (Hungary)
- Faculty of Management of the Comenius University Bratislava (Slovakia)
- “Dunarea de Jos” University (Romania)
- Institute of Economics at the Bulgarian Academy of Sciences (Bulgaria)
- Estonian Institute of Economics at Tallinn Technical University (Estonia)
- Social Policy Unit (Sozialinnen Politicus Group) (Lithuania)
- Computer Science Institute of the University of Latvia (Latvia)
- SC&C Ltd. Statistical Consultations and Computing (Czech Republic)

SIBIS Topics

- **No. 1: Telecommunications and access**
- **No. 2: Internet for research**
- **No. 3: Security and trust**

Objective 1:
A cheaper, faster and secure Internet

- **No. 4: Education**
- **No. 5: Work, employment and skills**
- **No. 6: Social inclusion**

Objective 2:
Investing in people and skills

- **No. 7: e-Commerce**
- **No. 8: e-Government**
- **No. 9: Health**

Objective 3:
Stimulate the use of the internet

= eEurope 2000 topics

SIBIS Surveys 2002 & 2003

- **General Population Survey 2002 (GPS):**
  - Target population: resident population (15+) in private households
  - Country coverage: EU15 + CH + USA (sample size 500-1,000 per country)
- **General Population Survey NAS10 2003 (GPS-NAS):**
  - Target population: resident population (15+) in private households
  - Country coverage: NAS10: BG, CZ, EE, HU, LT, ,LV, PL, RO, SI, SK (sample size 1,000 per country)
- **Decision Maker Survey 2002 (DMS):**
  - Target population (observation unit): establishments; reporting unit: IT decision makers
  - Country Coverage: D, E, F, I, UK + FIN, GR (sample size 300-500 per country)

Benchmarking in eEurope 2002/2005

- **eEurope 2002 Action Plan**
  - Introduced the "open method of co-ordination and benchmarking"
    - to ensure that actions are carried out efficiently
    - and have the intended impact
  - List of 23 indicators (Nov. 2000)
    - included "simple" indicators and complex compound indicators
    - data collected through different sources (mostly Eurobarometer)
- **eEurope 2005 Action Plan**
  - Defines benchmarking as a 3-stage process:
    - 1. Definition of indicators
    - 2. Measurement and analysis
    - 3. Policy development
  - 15 policy indicators
    - plus a number of "supplementary indicators"
  - Interim Benchmarking Report expected for early 2004

= done by SIBIS for EU15 and NAS10 using 2002/03 data

SIBIS new Indicators

- **203 new IS indicators** developed for eEurope topic areas:
  - *Telecommunications and access,*
  - *Security & Trust,*
  - *Internet for R&D,*
  - *Education,*
  - *Work, Skills and Employment,*
  - *Social Inclusion,*
  - *E-Commerce,*
  - *e-Government,*
  - *eHealth*
- **134 piloted and tested** in representative surveys of the population and companies in EU15, CH, USA and NAS10 with year 2002 and 2003 data, statistics and different reports and booklets with results from analysis available
- **26 compound indicators (indices)** developed, e.g. Digital divide index, Adaptability in work arrangements index)
- **Final set of 133 indicators including 34 SIBIS key indicators** and indices in **SIBIS Indicator Handbook**

- Introduction
- Indicator tables

Indicator table

Table 3.3-43: Publications in scientific journals per capita

Definition and explanation	Publications in scientific journals per million population $\frac{\text{Publications in scientific journals}}{\text{Million inhabitants}}$ **Formula** Value range: ≥ 0
Importance and value added - **for benchmarking IS developments** - **at European level** - **static and dynamic interpretation**	Among the different outputs of scientific R&D (skilled graduates, new instruments, new methods, prototypes, publications) scientific publications are one of the most important. They partially capture the essence of other output forms and contain the theoretical knowledge that constitutes the base for many discoveries [241]. Previous scientific analyses have tested the hypothesis that Internet applications increase the productivity and raise the output of scientific research [169][191][295] and more often than not found positive effects. The indicator on articles in scientific journals per capita covers the quantitative aspect of scientific publications. An increase of the number of publications per capita can be considered as an increase of scientific output.
Sources of data	Institute for Scientific Information (ISI) data on publications in scientific journals, further processed and published for instance in [120] [241].
Countries and time intervals covered	Globally available, time lag of approx. 2 years (in 2003: 2001 data available)
Question wording	–
Discussion	Publication data used for the indexes is based on journal publications only. This may lead to a misrepresentation of actual scientific output. First of all, the propensity to publish differs across countries and scientific fields [241], p. 62.

Indicator table

intervals covered	
Question wording	–
Discussion	Publication data used for the indexes is based on journal publications only. This may lead to a misrepresentation of actual scientific output. First of all, the propensity to publish differs across countries and scientific fields [241], p. 62. Also scientific fields which rely on other types of publications to a larger extent (such as books, conference presentations) may not be represented appropriately. And last but not least the mere number of publications doesn't say much about their quality, though the journals may be peer reviewed. Another weakness is that the only available data from ISI tends to reflect the structure of US science. Therefore, publications are underestimated for countries specialised in fields which are not well represented in the indexes ([120], p. 43; [217], p. 5-37). As most journals included in the indices are published in English, the indexes also contain a language bias towards researchers from English-speaking countries [290].
	Another possible denominator is the number of researchers of a country. The indicator then relates more to the productivity of research, than the size of the research system. The SIBIS e-Science analysis used this figure, as publication data was only collected for a fraction of the national scientific communities. A breakdown of the indicator by field provides insight into variations across scientific fields.

- strengths and weaknesses
- advantages compared to similar indicators
- alternative ways of calculating the indicator
- for compound indicators: reasons for prefering it to a simple indicator
- validation results
- not part of the indicator system
- useful for further analysing the issue at stake
- for instance ways to break down the indicator or indicators with additional information not suitable for benchmarking (e.g. the barriers against using a technology, the motivations or purposes for using it etc.)

Criteria for evaluating each indicator

Example: Topic 2: Internet in Research and Development (R&D)

Contents

- Introduction
- Indicator system
- Method and data basis
- Selected results
- Conclusions

Introduction

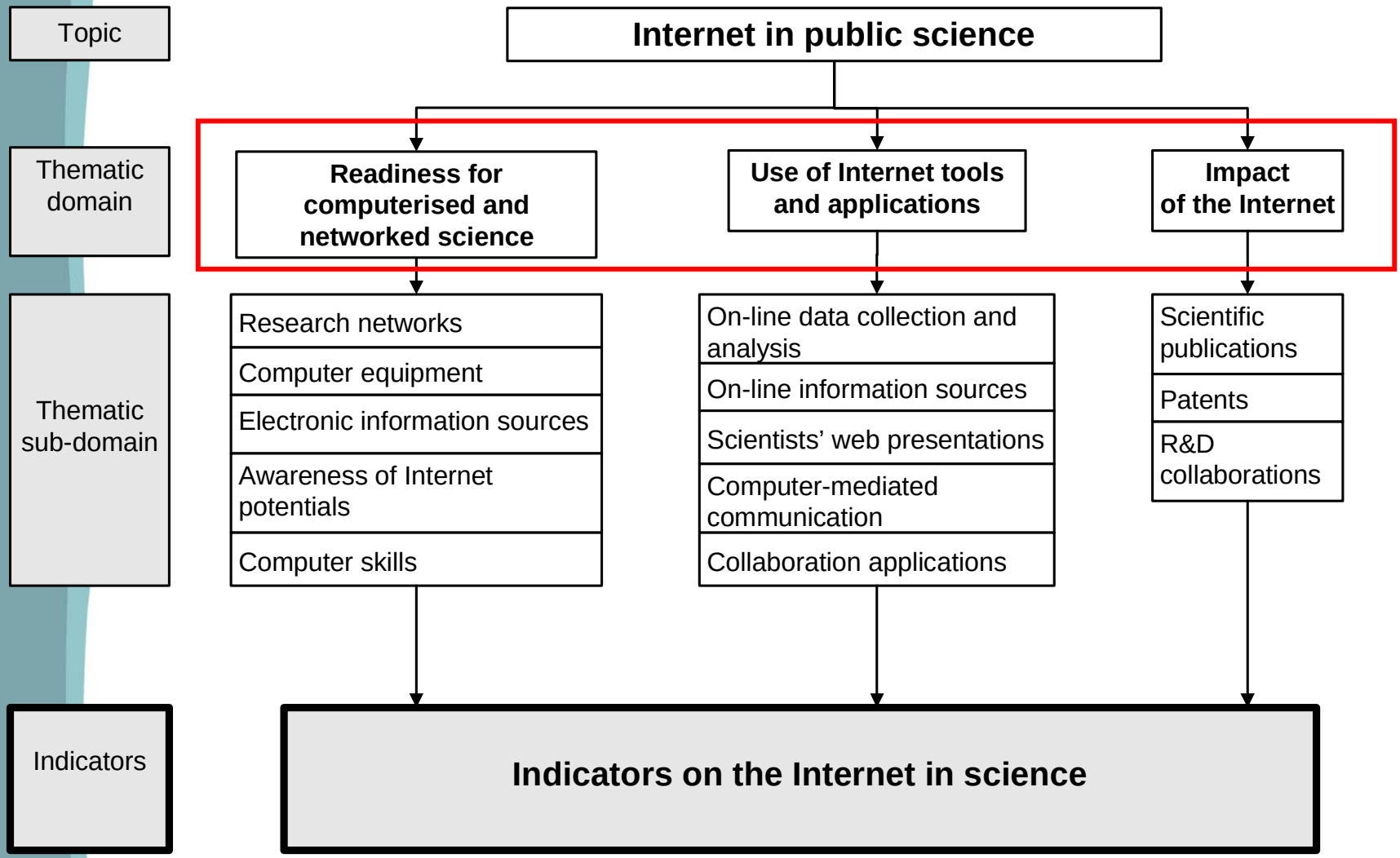
- **Statistics context:**
  No data on the use of ICT in science available
  - "There is a pressing need to increase efforts and resources to undertake in-depth empirical studies on the innovative uses of Internet in science and to carry out European-wide surveys on this issue. Such studies are the only way to generate a sufficient amount of data and information necessary to evaluate the impact of new, high capacity electronic communication facilities upon the organization, distribution and conduct of collaboration on fundamental research problems." (Foray 1999, p. 9)
  - "Indicators of facilities available for R&D may be envisaged but are seldom collected and are not discussed in the Manual. Standardised equipment, library facilities, laboratory space, journal subscriptions and standardised computer time would all be possible measures." (OECD 2002 "Frascati Manual", 6th draft, p. 13)

- **Policy context:**
  Several initiatives on computer networks in science at European and national levels
  - ***e*Europe**
  - **European Research Area (ERA)**:
    - enhancement of Research and Education Networks for data transmission
    - grid development
    - development and implementation of further computer-based tools
    - training of researchers about the possibilities of ICTs
    - promoting the use of computer networks to connect the best researchers in Europe to form "virtual centres of excellence"
  - **National level:** e.g. Finland and the UK

Objectives of the analysis

- **Development of an indicator system to measure the use of computer networks/the Internet in R&D**
  - public science, i.e. universities and public non-university research organisations
- **Benchmarking of European science in regard to its progression towards computerised science**
  - limited sample of countries and scientific disciplines

Indicator system on the Internet in public science



Indicator system on the Internet in public science

Thematic Domain	Sub-domain	SIBIS indicators	Sources of data
Readiness	Research Networks (RN)	Core usable backbone capacity on a national RN	Data from TERENA
		Total congestion ratio on the RN	
		Average budget of a national RN	
	Computer equipment	Quality of scientists' computer equipment	SIBIS R&D survey
	Electronic information sources	Size of digital journal collections	Not yet piloted
		Staff providing electronic library services	
		Scientists' access to on-line information sources	SIBIS R&D survey
	Awareness of Internet potential	Influence of the Internet on choosing R&D topics	
	Computer skills	Computer skills levels of scientists	
		Internet skills levels of scientists	

Indicator system on the Internet in public science

Thematic Domain	Sub-domain	SIBIS indicators	Sources of data
Use	**On-line data collection and analysis**	**Use of Internet-based data collection and data analysis methods**	**SIBIS R&D survey**
	On-line infor-mation sources	**Use of on-line information sources**	
	Scientists' web presentations	**World Wide Web penetration rate**	
	E-publishing	**Working papers available via the Internet**	
	Computer-mediated communication	**Computer-mediated social communication for R&D purposes**	
	Collaboration applications	**Use of collaboration applications**	

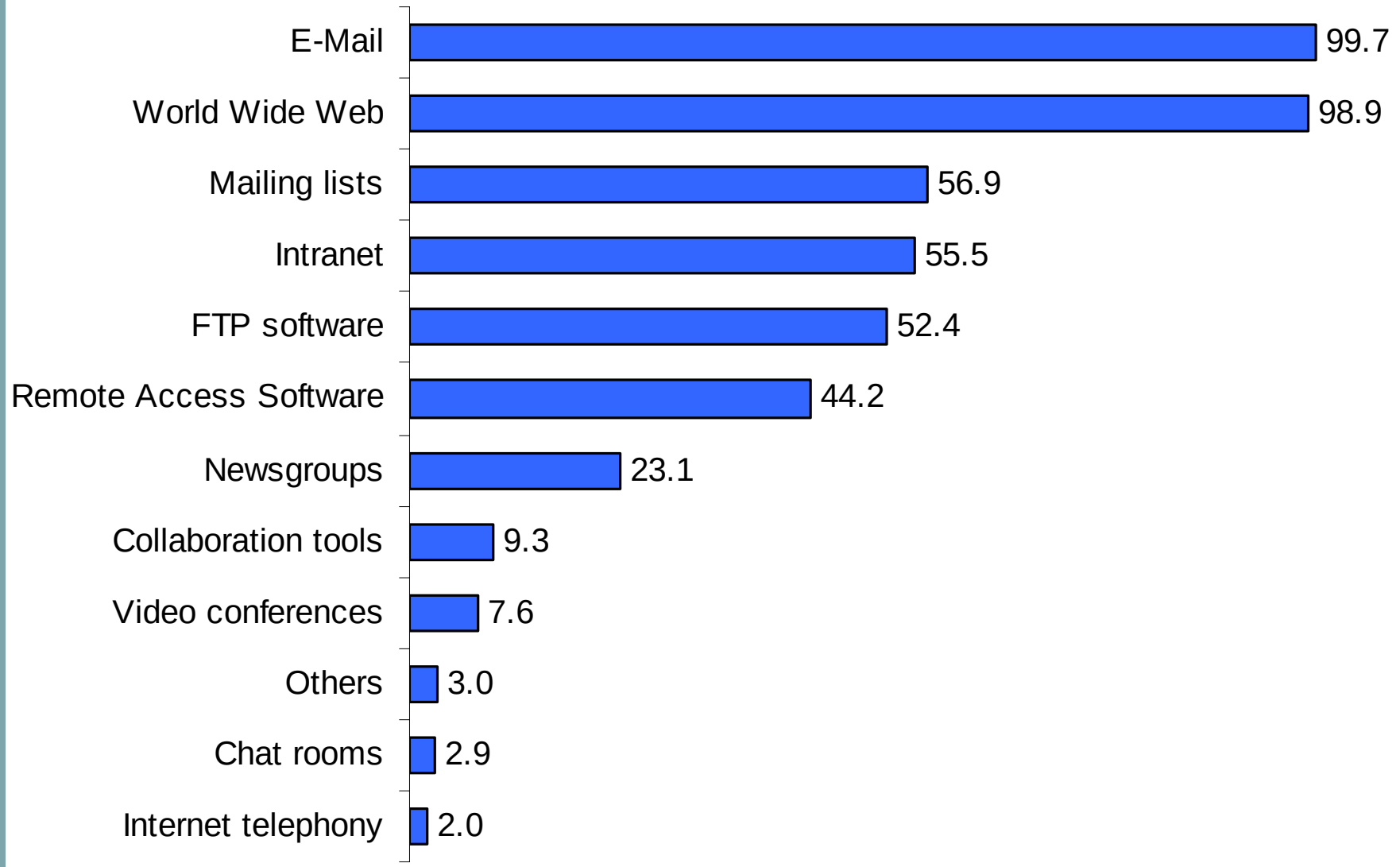
Indicator system on the Internet in public science

Thematic Domain	Sub-domain	SIBIS indicators	Sources of data
Impact	**Scientific publications**	**Publications in scientific journals per capita**	**ISI data**
		Citation index	
	Patents	**Triad patent families per capita**	**OECD / patent offices**
	R&D collaborations	**Involvement in international R&D collaborations**	**SIBIS R&D survey**
		Percentage of co-authored scientific articles	**ISI data**

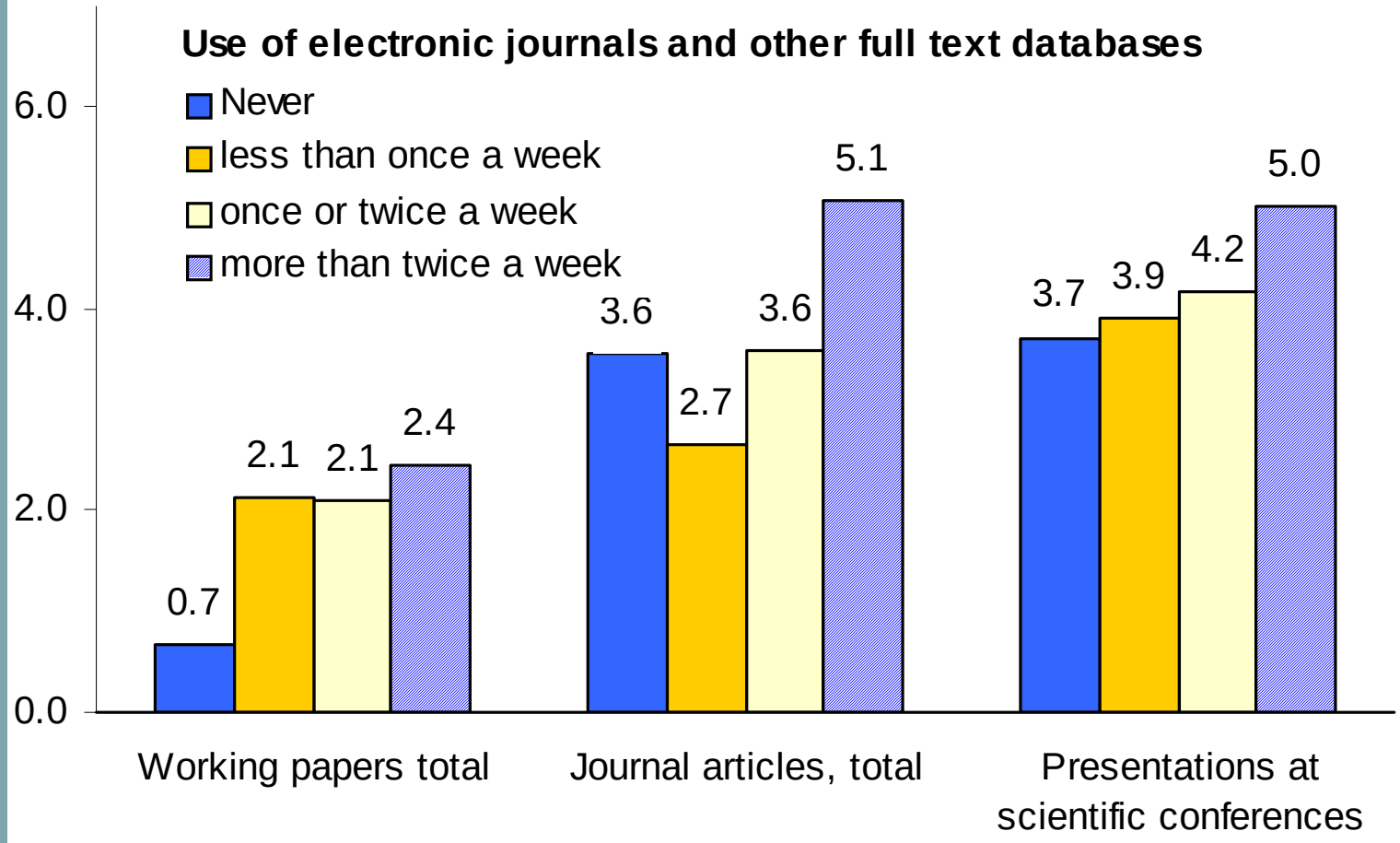
Data basis

- Exploratory **sample of researchers in public R&D organisations ("science")**
- 5 scientific disciplines**: astronomy, chemistry, computer science, economics, psychology**
- 7 countries**: Denmark, Germany, Ireland, Italy, the Netherlands, Switzerland and the UK**
- **Address collection from scholarly organisations and by means of the WWW**
- **Total sample size:** 6,518 researchers
- **Postal survey from April to July 2003**
- **Total responses:** 1,602 (response rate 25%), 1,482 usable responses

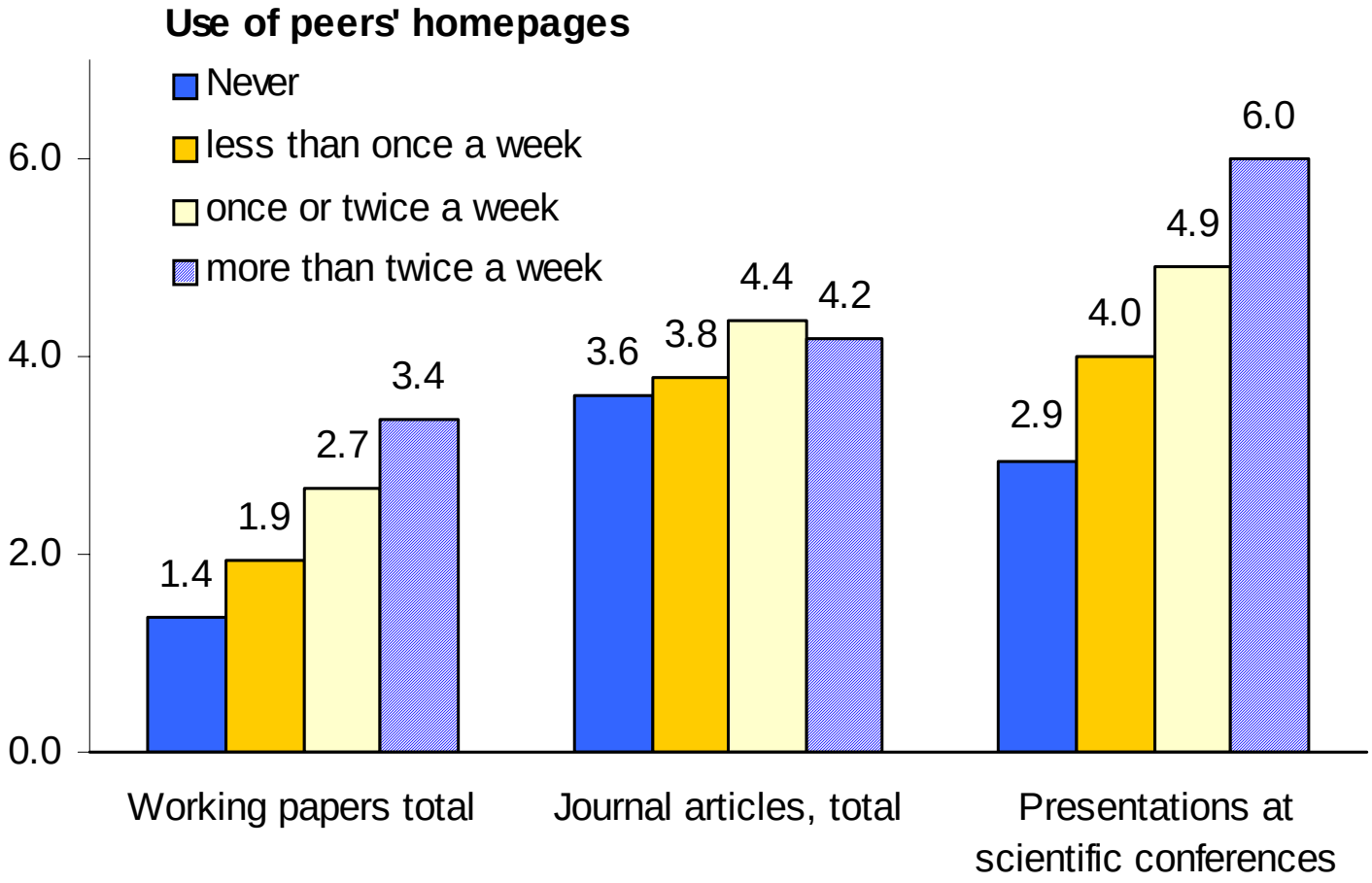
Selected Results: Use of Internet applications for R&D (in % of all respondents)



Average number of publications in 2001-2002 (arith. mean) by use of electronic journals



Average number of publications in 2001-2002 (arith. mean) by use of peers' homepages

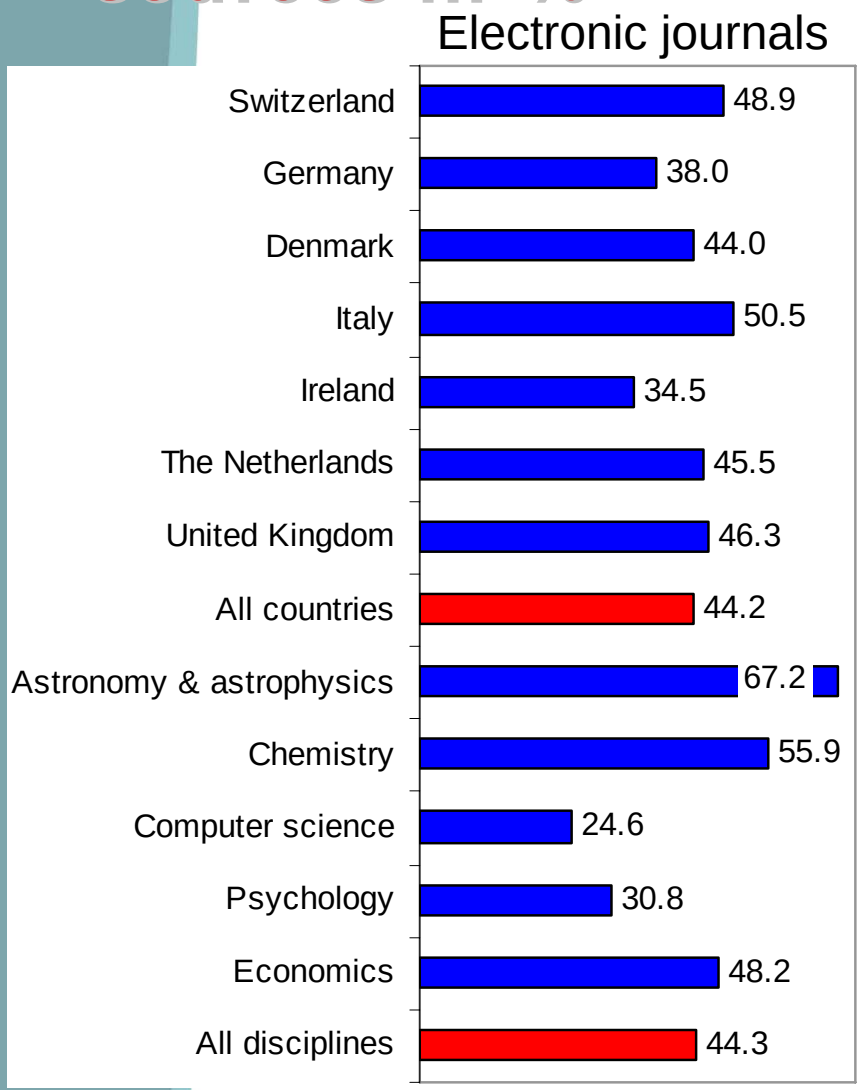


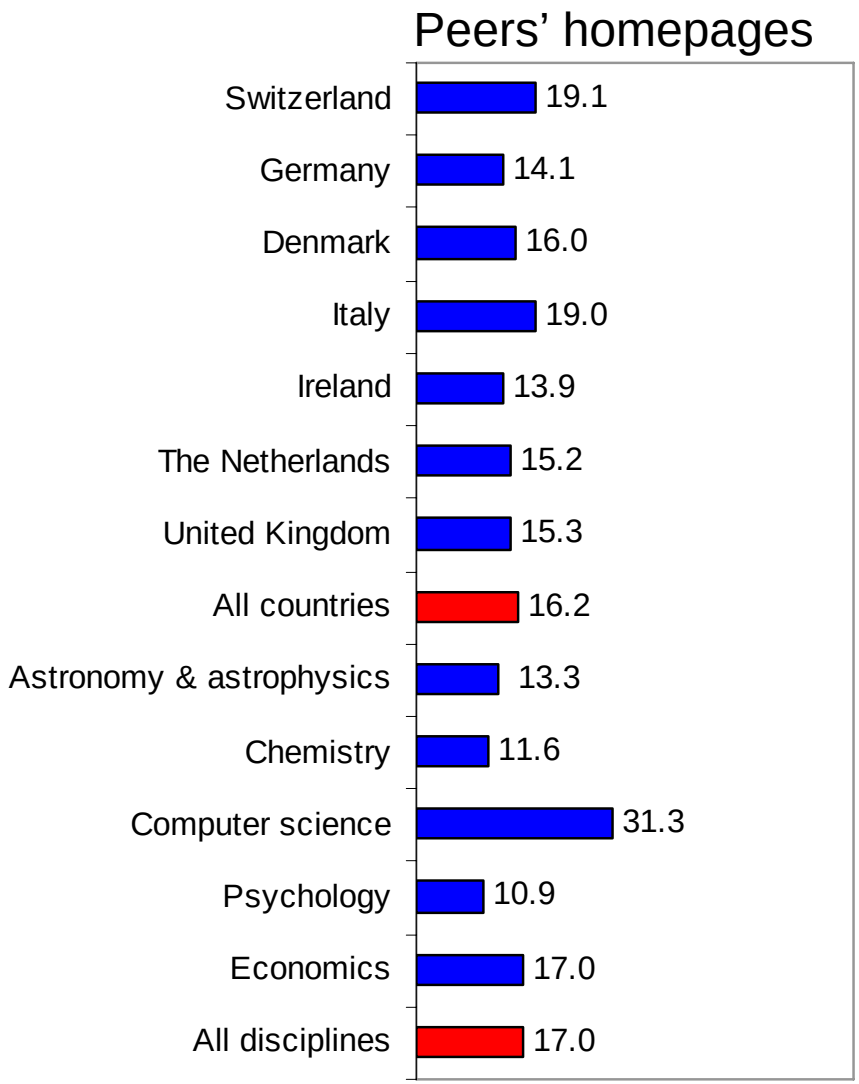
Ranking: Internet access and use indicators and output indicators

	Internet access and use indicators				Output indicators	
Country	**Computer quality index 2003**	**Access to electronic info. sources 2003**	**Years of Internet use for R&D 2003**	**Use of electro-nic journals 2003**	**Publ. in scientific journals per researcher 1999**	**Rel. promi-nence of the scientific lit. 1999[a]**
Switzerland	1	2	3	2	1	1
Germany	3	4	6	6	7	5
Denmark	**2**	**1**	**4**	**5**	**5**	**3**
Italy	7	6	4	1	4	6
Ireland	6	7	7	7	5	7
The Netherlands	3	2	1	3	3	2
United Kingdom	**5**	**5**	**2**	**4**	**2**	**3**

a Relative prominence: share of cited literature divided by the share of published literature

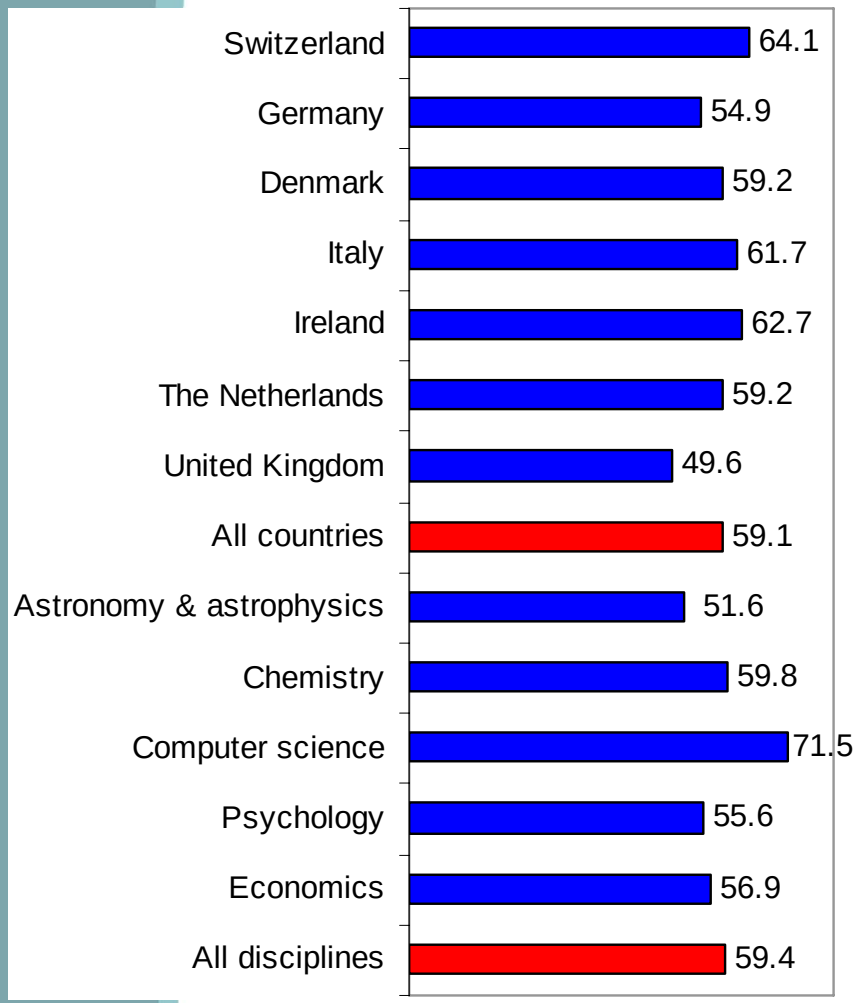
Frequent users of information sources in %



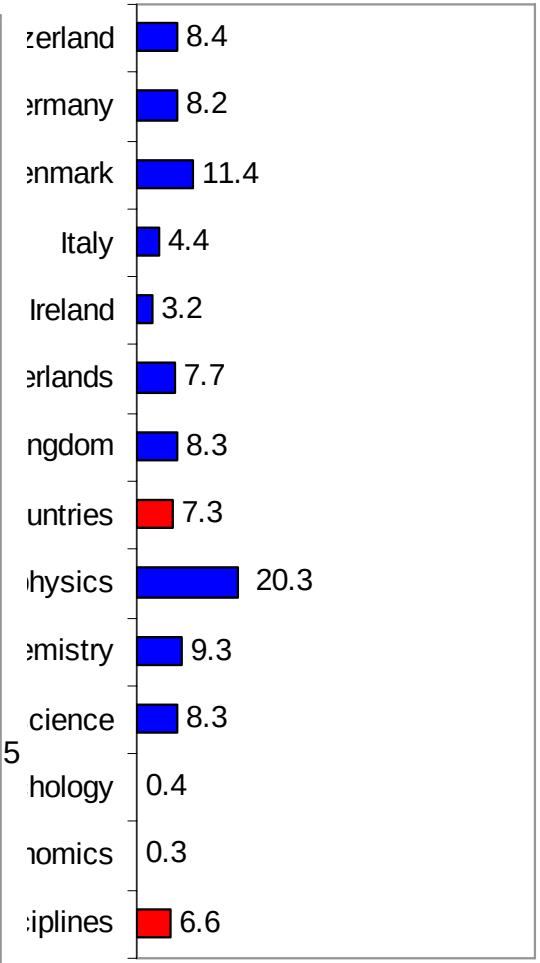


Quality of computer infrastructure

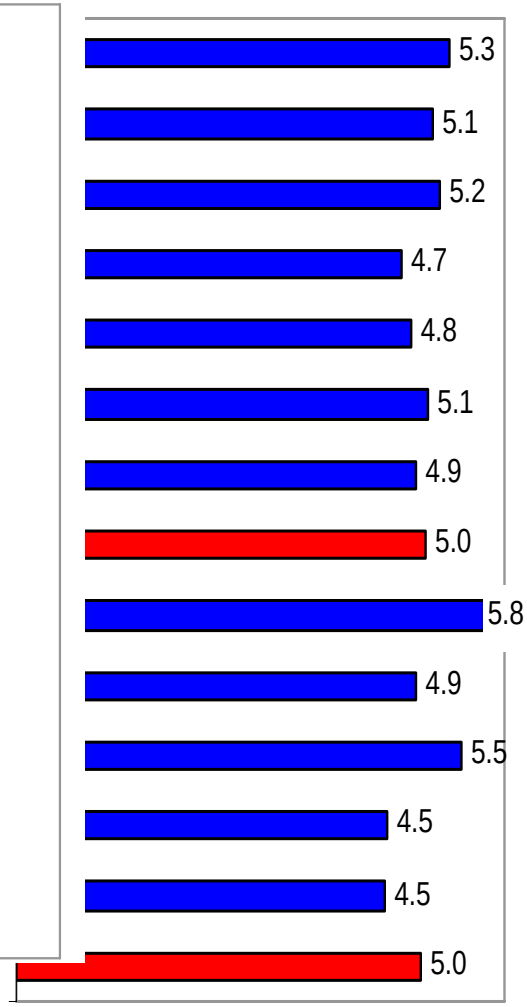
Computer less than 2 years old (in %)



Use of supercompu-ters (in %)



Computer quality index



Summary and conclusions

- **Almost all scientists in Western European countries are e-mail and WWW users.**
- **Internet access and use make a difference: Positive relationships between the access to/use of electronic sources and scientific productivity.**

➢ Further data collections and analysis on the Internet readiness of European science and the use of ICT are necessary.

➢ Initiatives of improving the network infrastructure make sense.

- **Differences between scientific disciplines overshadow the differences between countries.**

➢ Infrastructure-related science policy should be tailored to the needs of scientific disciplines all over Europe and not along national borders.

Methodological annex

Computer quality index: **Average quality index of scientists' computer equipment (arithmetic mean of all researchers in a country)**

- **The type of computer available; ascending "quality ladder" from PC to supercomputer**
- **The age of the computer used most of the time**

(1) Scores of the quality index of the computer equipment

These values were recoded into quality levels 0 to 10 (1 = level 0, 2 = level 2, 4 = level 4, 8 = level 6, 16 = level 8, 32 = level 10).

Age	Type of computer			
	PC	Work-station	Main-frame	Super-computer
Older than 4 years	1	2	4	8
2-4 years	2	4	8	16
Less than 2 years old	4	8	16	32

(2)

$$\overline{QCE}_S = \frac{\sum_{1}^{S} QCE_s}{S}$$

$\overline{QCE}_S$ Average Quality index of the Computer Equipment available to the scientists of a country

QCE_s Quality index of the computer equipment of an individual scientist s

S Total number of scientists in a country (here: sample of SIBIS survey

Annex: Basic descriptives of the dataset

	n	%*		n	%*
Country of the organisation			Discipline of R&D		
Switzerland	**232**	**15.7**	**Astronomy**	**191**	**12.9**
Germany	**281**	**19.0**	**Chemistry**	**284**	**19.3**
Denmark	**183**	**12.3**	**Computer Science**	**261**	**17.7**
Italy	**307**	**20.7**	**Psychology**	**277**	**18.8**
Ireland	**154**	**10.4**	**Economics**	**307**	**20.8**
The Netherlands	**144**	**9.7**	**Other disciplines**	**155**	**10.5**
United Kingdom	**177**	**11.9**	Current position		
Other countries	**4**	**0.3**	**Research Manager**	**281**	**19.1**
Type of organisation			**Senior Researcher**	**656**	**44.7**
University or technical univ.	**1206**	**81.4**	**Junior Researcher**	**493**	**33.6**
Non-university R&D inst.	**202**	**13.6**	**Other positions**	**38**	**2.6**
Polytechnic/university of applied sciences	**44**	**3.0**	Gender		
Other	**29**	**2.0**	**Male**	**1130**	**76.4**
***% of total valid N for the variable**			**Female**	**349**	**23.6**

Now available:

- **Benchmarking Highlights 2002**
  - Synthesis of some key results from 2002 surveys in EU15, CH and US (70 pages)
- **Statistics and Indicator Pocketbook**
  - Presentation of analysis results on key statistics and indicators from 2002 and 2003 surveys in EU15, CH, US and NAS10 (211 pages)
- **Publication of Topic Reports no. 1-9:**

  Telecommunication and Access, eScience, Security & Trust, Education, Work, Employment & Skills, eCommerce, eGovernment, Social Inclusion, eHealth
- **10 Candidate Country Reports:**

  Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia
- **eEurope 2005 Evaluation and Benchmarking EU15 & 10 Acceding / Candidate Countries Reports**
- **SIBIS New eEurope Indicator Handbook**
- **SIBIS Statistics on website: www.sibis-eu.org**
- **SIBIS Raw Dataset (SPSS)**

Thank you for your attention!

More information:

SIBIS

www.sibis-eu.org