

UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT

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ICT Benchmarking Tool Product Report

Version 1.0

<http://www.unctad.org/stdev>



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Product Report

1. Introduction

At its sixth session, held in Geneva from 5 to 9 May 2003, the United Nations Commission on Science and Technology for Development (UNCSTD) requested the development of a user-friendly tool for ICT benchmarking. This tool allows countries to assess their ICT development and e-readiness and compare themselves with other countries in terms of Internet access and connectivity.

The UN ICT benchmarking tool has been produced for UNCSTD by UNCTAD in close collaboration with the Institute of Software Technology & Interactive Systems of Vienna University of Technology (Professor A Min Tjoa and Mr. Amin Andjomshoaa) with the generous financial support of the Government of Austria.

2. Software Requirements

2.1 Server side requirements

To install and run the software on server machine, the following are needed:

- j2sdk1.4.2_01
- Apache Tomcat 4.0 (included in installation bundle)

2.2 Client side requirements

The benchmarking tool can be used with any of the following browsers:

- Internet Explorer 5.5 +
- Netscape 6.0 +
- Mozilla 0.9.1 +

3. Product Overview

The ICT benchmarking tool is a web-based application which receives the user's data as input and creates comparative reports as output. Results are stored in a database and can be later retrieved and monitored later.

3.1 User interfaces

The user interface includes a list of parameters on the left, and the work area to carry out the calculation and assessments on the right.

Figure 1: Main page



For each type of parameter a different page is shown. Figures 2-5 illustrate the pages shown for each kind of parameter.

Figure 2 shows the input page for assessing statistical parameters indicative of infrastructure (e.g. the number of main telephone lines, the number of Internet hosts, etc.). The user should provide the information using statistics for a given country and enter the value in the specified fields.

Figure 2: Parameter Entry input page

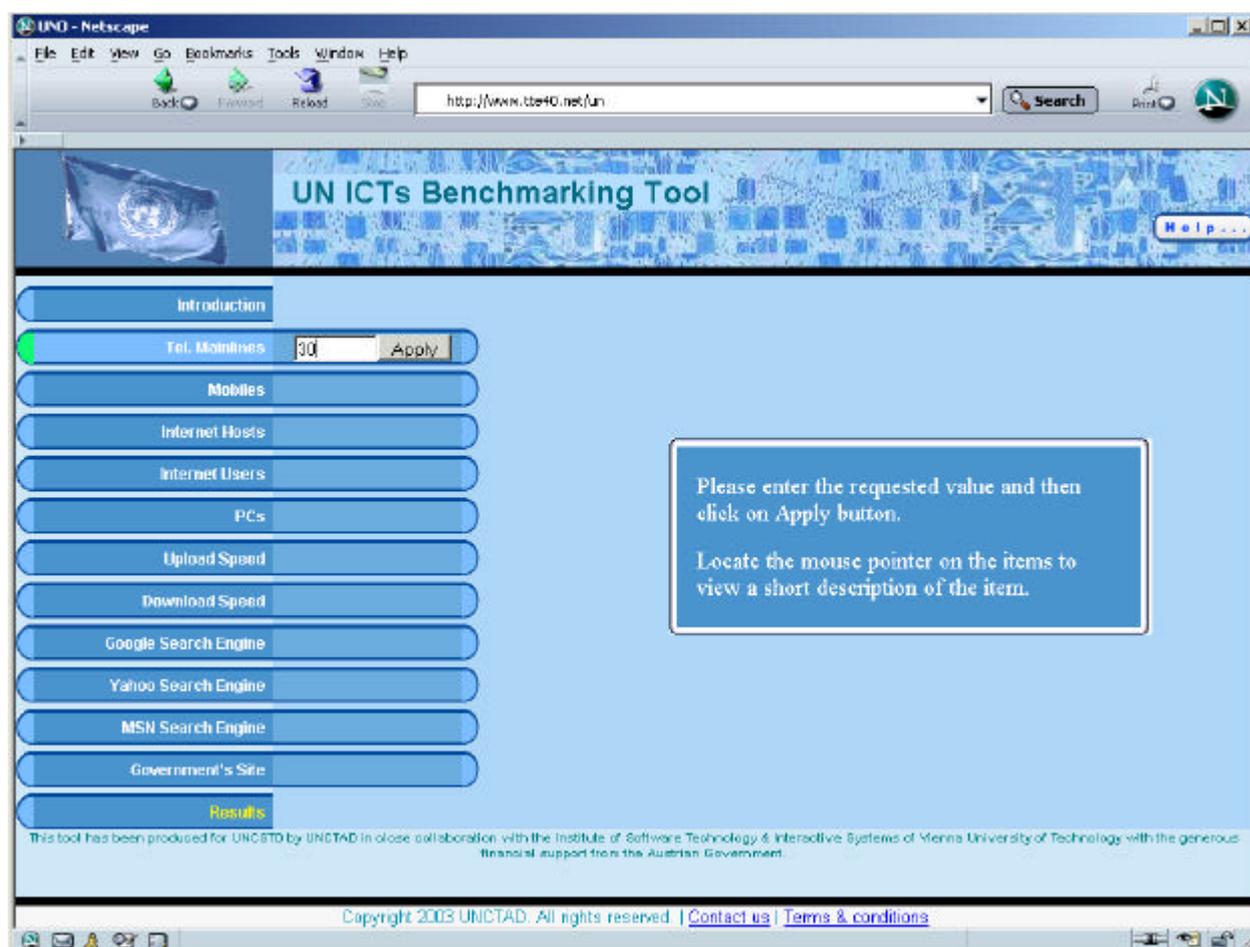


Figure 4 shows the input page for assessing download speed. A predefined image is downloaded 10 times from the central server and the average download delay is used to calculate the download speed.

Figure 4: Download Speed input page

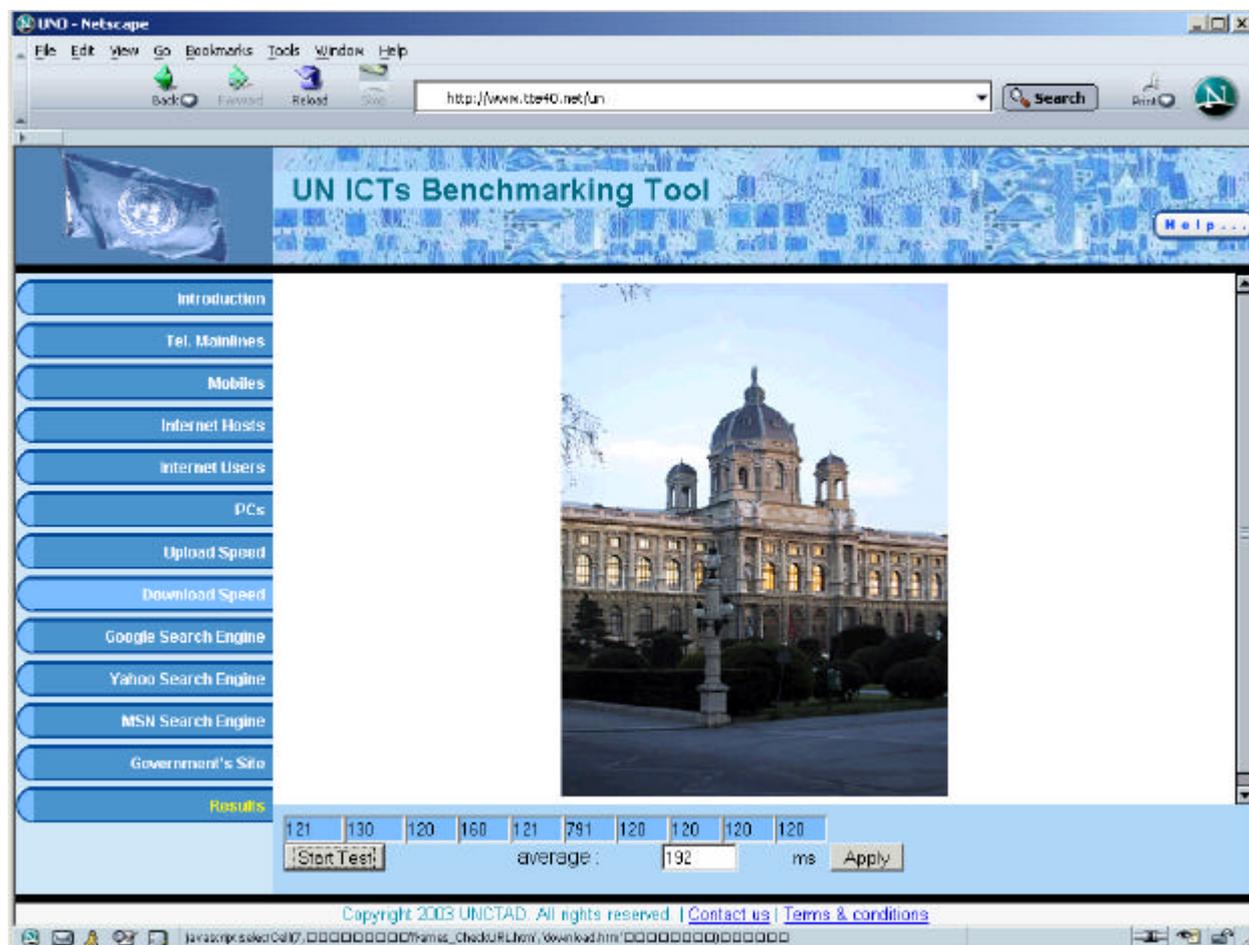


Figure 5 shows the input page for assessing search engine speeds. In order to have more precise results, 10 different queries are sent to the search engine and the average response delay is used to calculate the search engine speed.

This test is repeated for each search engine. The following list of keywords is sent to the search engines as a query string:

{Technology, Java, UN, Vienna, internet, university,
apache, e-readiness, developing, UN-CSTD}

Figure 5: Google Search Engine Speed input page



On the result page, the user can view the results, generate reports, store the data or load the already existing data sets.

Figures 6 to 11 show the Result page, the Data Set Retrieval page and generated reports.

Reports generated by this tool:

- Graphical benchmark in HTML format (Figure 8)
- Tabular report in PDF format (Figure 9)
- Raw data report in XML format (Figure 10)
- Tabular report in HTML format (Figure 11)

Figure 6: Result page

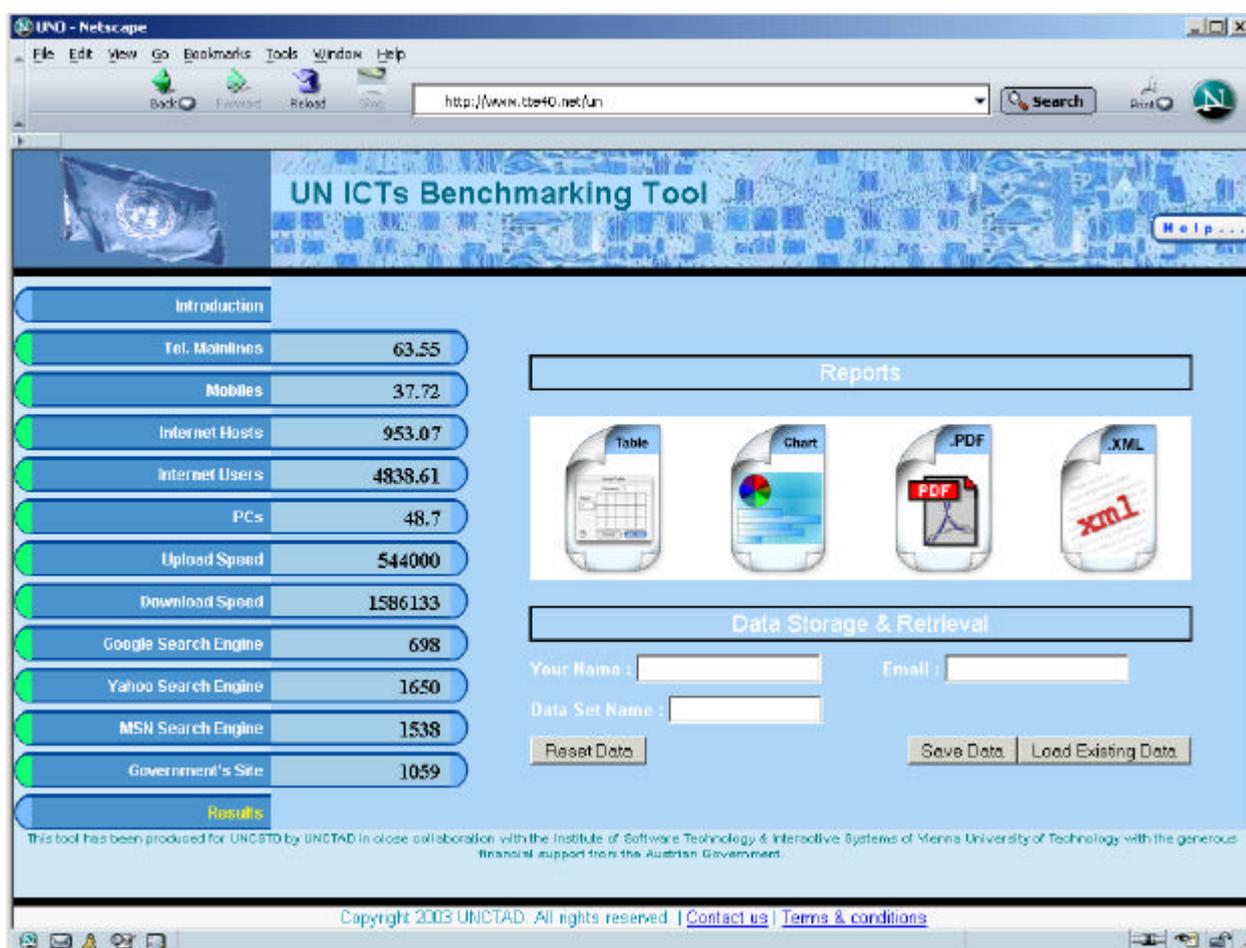


Figure 7: Data Set Retrieval page

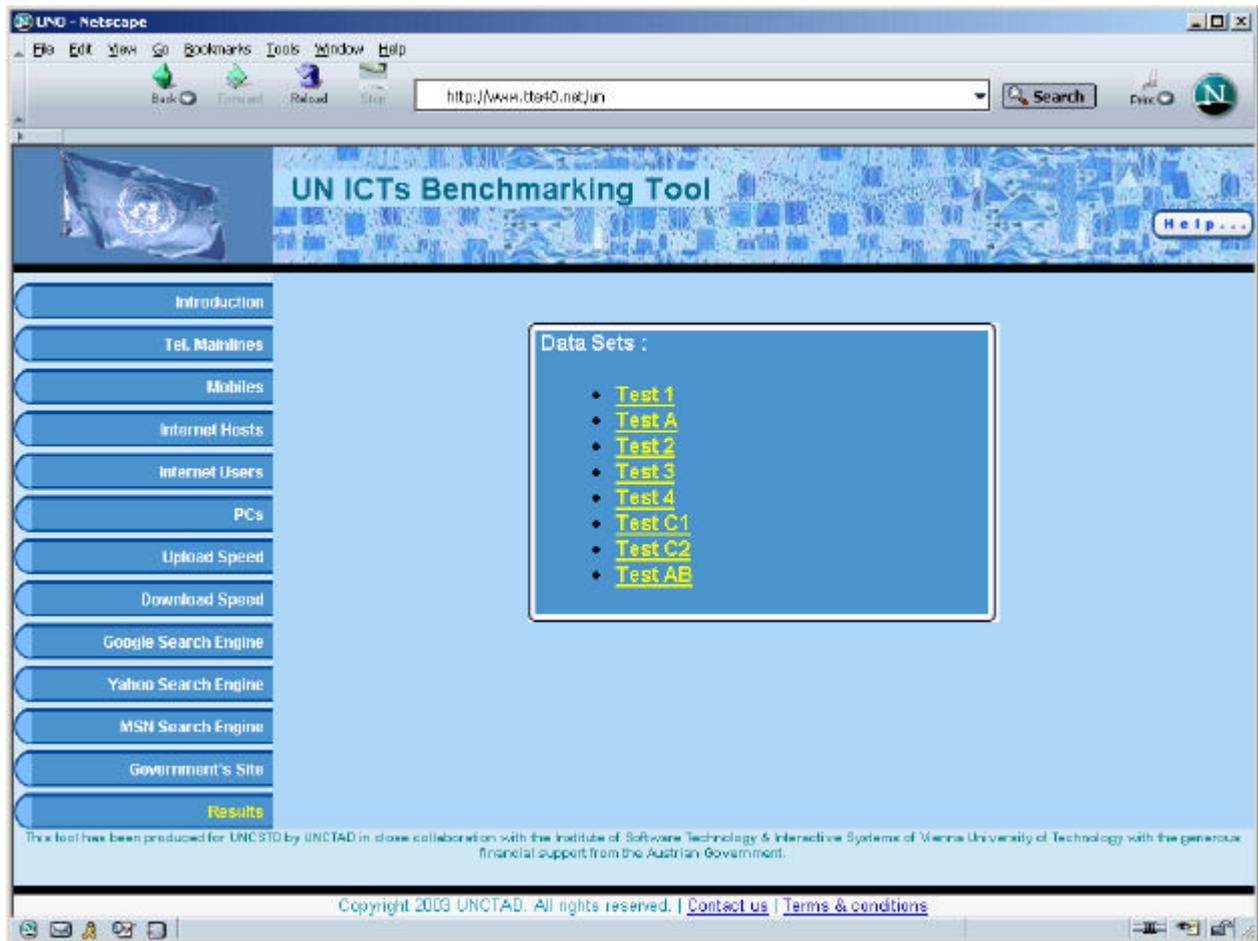


Figure 8: Benchmark Report

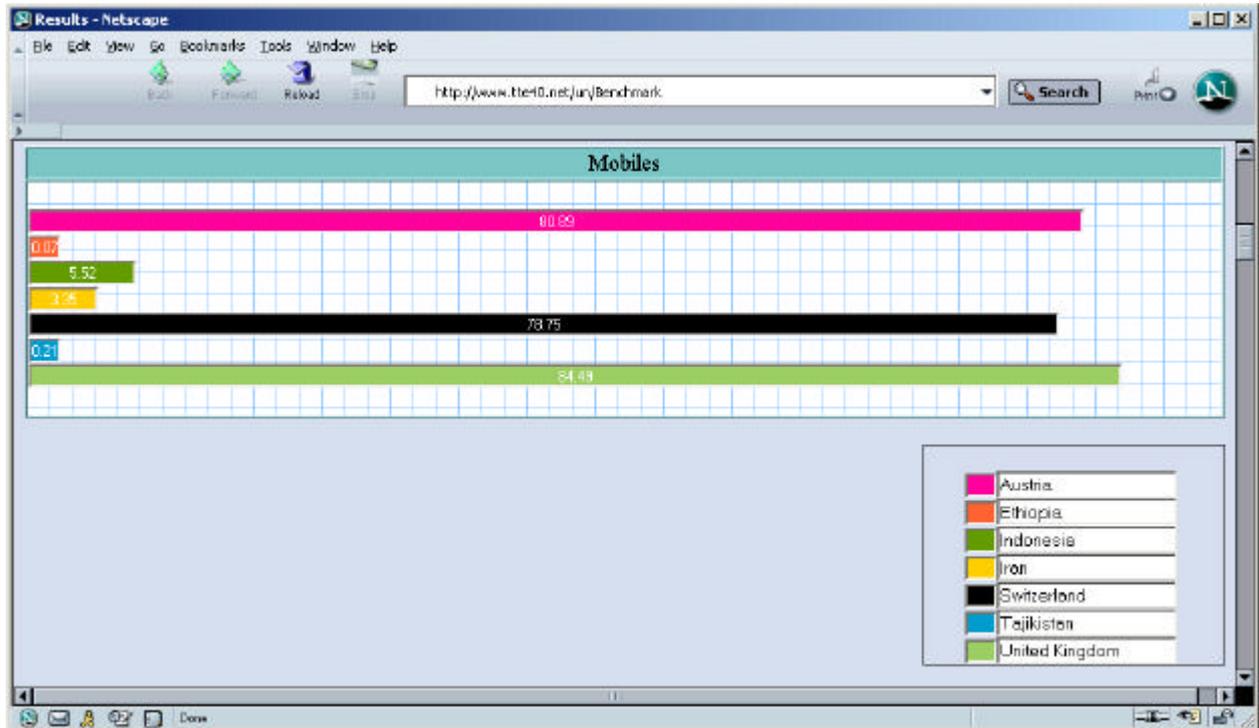


Figure 9: PDF Report

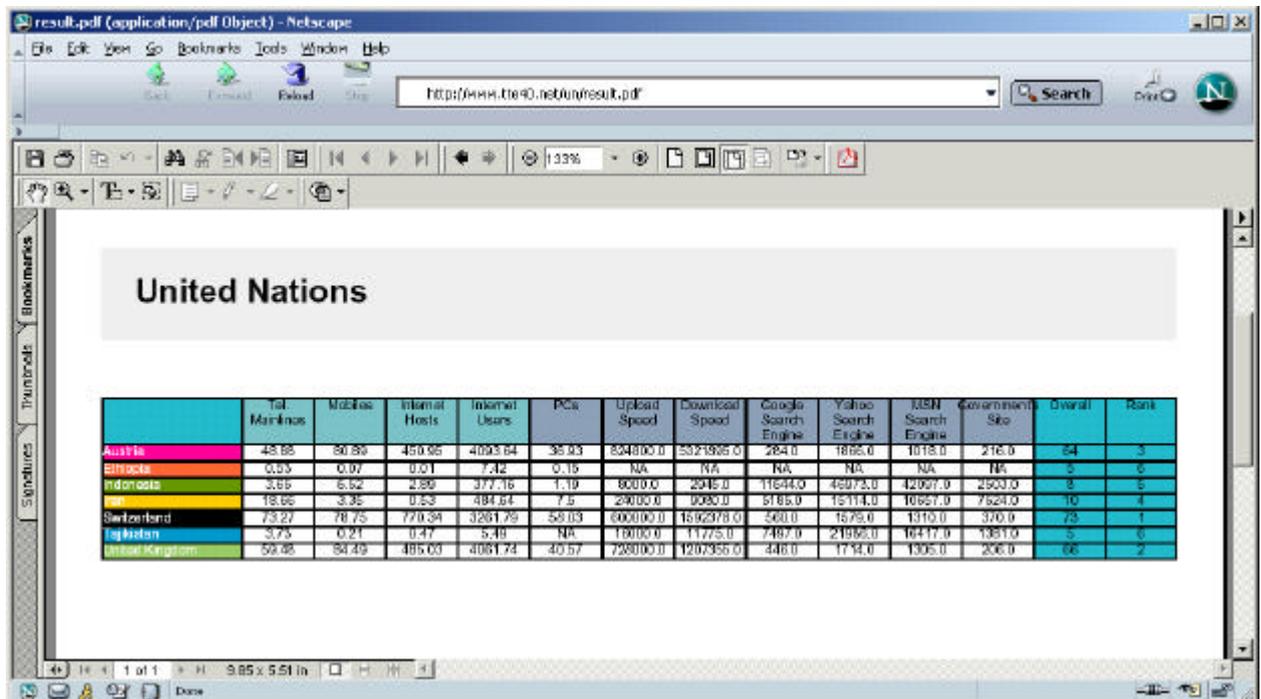


Figure 10: XML Report

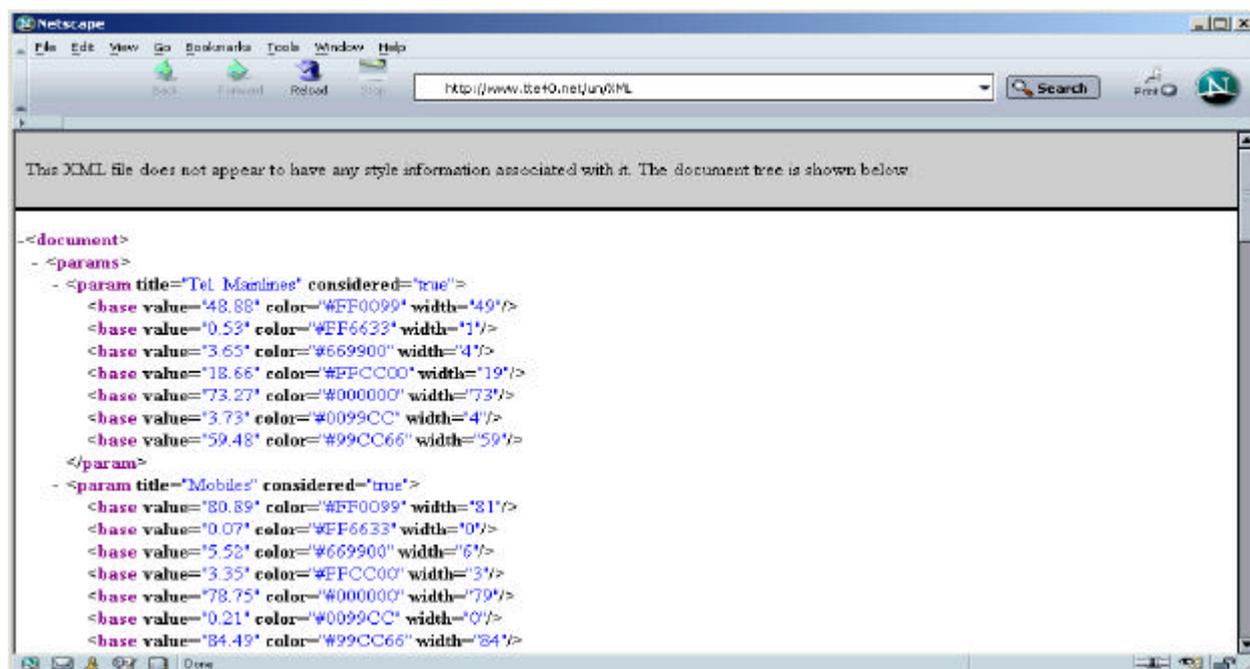
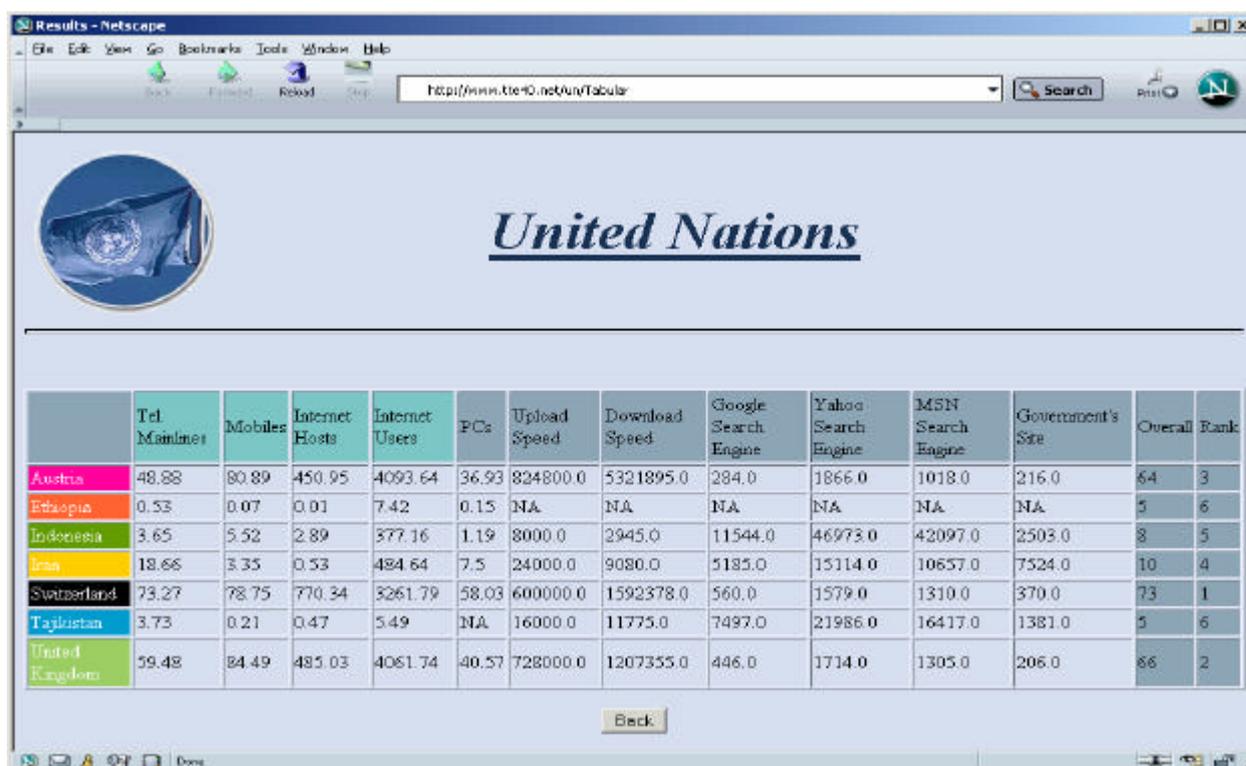


Figure 11: Table View Report



3.2 Database

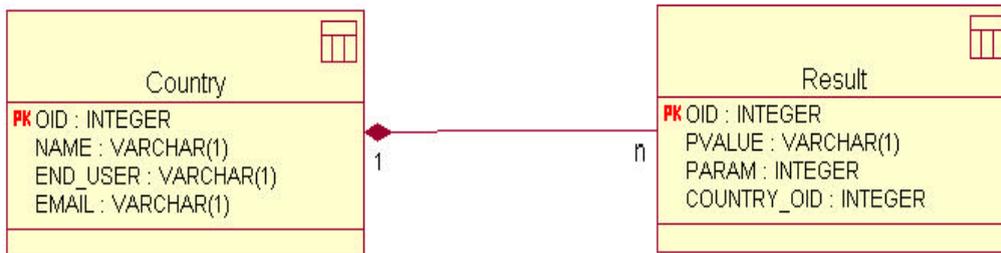
HSQLDB 1.7.1, open source, 100% Java.

HSQLDB is based on HypersonicSQL, a general-purpose database. It is small and is easy to install and use.

Another advantage of HSQLDB is that it is part of Apache Cocoon; therefore, when the Cocoon XML framework runs, the database is accessible and no extra installation or configuration is needed.

The ERD (Entity Relationship Diagram) of this benchmarking tool is shown in Figure 12.

Figure 12: Entity Relationship Diagram



3.3 Technical overview

This product is based on Apache Cocoon technology. Apache Cocoon is an XML publishing framework that raises the usage of XML and XSLT technologies for server applications to a new level. Designed for performance and scalability around pipelined SAX processing, Cocoon offers a flexible environment based on a separation of concerns between content, logic and style. In addition, Cocoon's centralized configuration system and sophisticated caching help users to create, deploy and maintain rock-solid XML server applications.

Cocoon interacts with most data sources, including file systems, RDBMS, LDAP, native XML databases and network-based data sources. It adapts content delivery to the capabilities of different devices like HTML, WML, PDF, SVG and RTF, to name just a few. The strength of this base enables us to provide a multilingual and XML-configurable application.

The base data of the benchmarking tool are stored into an XML file called Base.xml. The data in this file include the definition of parameters and the value of these parameters for canonical countries.

To facilitate management and configuration of the benchmarking tool, we have provided a web-based XML editor. This editor enables administrators to add new parameters or modify the base data and canonical countries. When the end user browses the main web page of our application, this file is read by Cocoon generator and then transformed to the main HTML form.

Since the Cocoon framework cleanly separates content and style, the generated pages can be easily modified to support other languages and styles.

The user provides the required data either by using the measurement wizards or by simply entering the desired data into the corresponding fields. The measurement wizards are implemented using Javascript, and they run on the client machine to calculate upload speed, download speed, and the time required to access specified websites such as search engines.

When the user submits this data entry form, the data is passed to a Cocoon pipeline on the server side to generate the selected output. This pipeline starts with a Java server page generator that combines the submitted data and the base data located in base.xml to generate the raw results. These raw results are later passed through the following transformers to generate the selected output:

- Benchmark.xsl, which generates a graphical benchmark in HTML format
- Tabular.xsl, which generates a tabular report in HTML format
- Pdf.xsl, which generates a tabular report in PDF format
- Cocoon's default serialization mechanism to generate XML output

The base data and static definitions are saved in an XML file. Then, using XSL transformations, the style and logics are applied on this data.

3.4 Calculation methods

The width of parameter value in the Benchmark diagram is calculated using the following transformation, which maps the original value to a value between 0 and 100:

$$final = \frac{100 * value}{max}$$

where *value* is the parameter value and *max* is the max value for that parameter.

The calculation of an overall value for each country is done in several stages. First, the data submitted by the user are compared with the range defined for that parameter in Parameter.xml and a value between 1 and 20 is assigned to the parameter. (In our ranking 1 means “very bad” and 20 means “very good”). The ranges are defined in the body of each parameter in Base.xml and have the following format:

```
<ranges>
  <range min="0" max="5" level="1"/>
  <range min="5" max="10" level="2"/>
  .
  .
  .
  <range min="95" max="100" level="20"/>
</ranges>
```

Each range has a *min* and a *max* which specify the range of values that will fall into a specified level. This ranging transformation unifies the parameter values such that all the values increase for an increasing quality. The quality of a parameter is not always directly related to the quantity of that parameter. For example, for a parameter such as “Number of Internet users per 10,000”, the bigger values are qualitatively better; for other parameters, such as “Download speed” smaller values are better.

Next, the weighted sum of the parameter values of each country is calculated to map the result. For simplicity, all the parameter weights have been set at 1. This value can be set in the Parameter.xml for each parameter.

The calculation of the overall value is done as follows: For n parameters ($i = 1, \dots, n$), each with a value v_i and a weight w_i :

$$overall = \frac{100 * \sum_{i=1}^n w_i v_i}{20 * \sum_{i=1}^n w_i}$$

Notes:

- Only parameters that have a value for all data series considered are taken into account in the overall calculation. Parameters that are considered in the overall calculation will be highlighted in the reports.
- If the intersection of the “parameter sets with values” for selected data sets (countries) is empty, then the overall value cannot be calculated, and in the reports the note “Not Comparable” will appear.
- A "Rank" column has been added, next to the "Overall value" to allow users to analyze quickly the results. This rank is based only on the "overall" calculation and is thus only indicative, depending on the number of data sets selected as well as parameters taken into consideration.

3.5 Sample data and benchmark

To initiate the system, some real-world data were provided. The following table shows the assessed data for some countries. These data sets, which are known as “base values”, can be modified using the administration user interface (see page 19).

Table 1. Collected data from some canonical countries

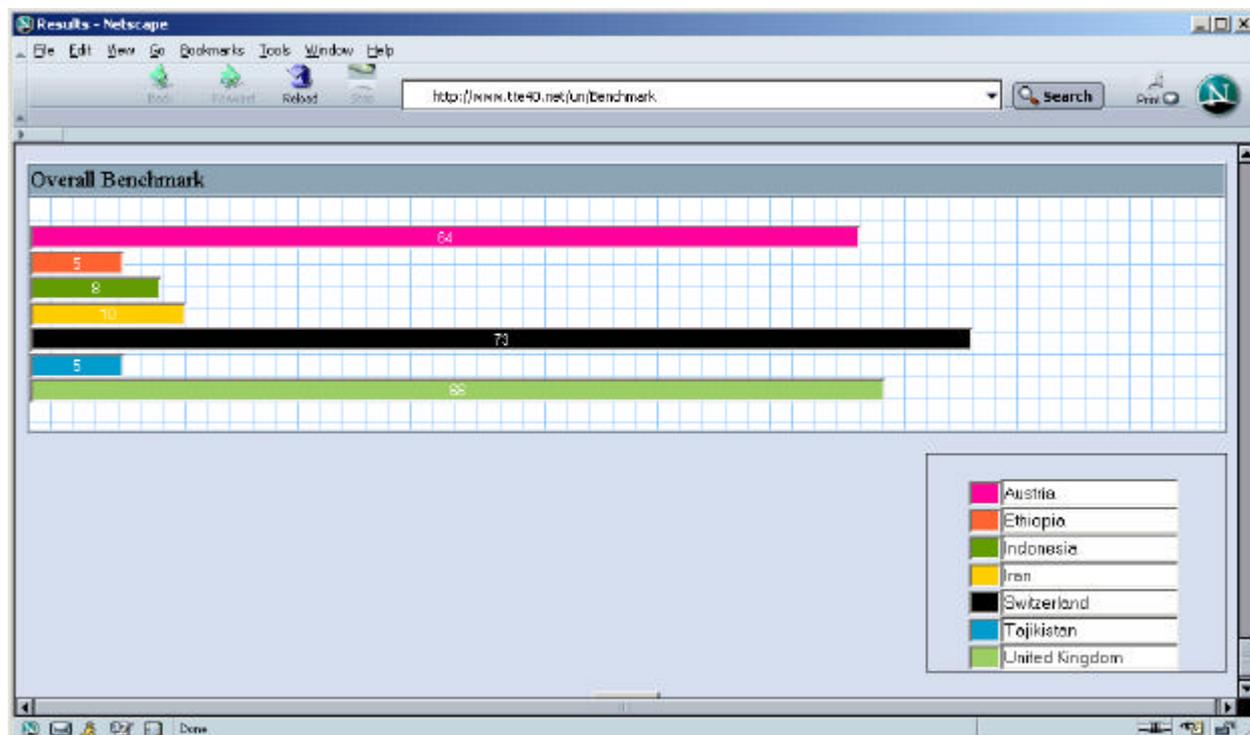
Parameter/Country	Austria	Indonesia	Iran	Pakistan	Turkey	Vietnam
Telephone main lines per 100 *	48.88	3.65	18.66	3.73	28.12	4.84
Mobile subscribers per 100 *	80.89	5.52	3.35	0.21	34.75	2.02
Internet Hosts per 10000 *	450.95	2.89	0.53	0.47	22.98	0.07
Internet Users per 10000 *	4093.64	377.16	484.64	5.49	728.39	184.62
Estimated PCs per 100 *	36.93	1.19	7.50	NA	4.46	0.98
Upload Speed (bps)	8248000	8000	24000	16000	296000	32000
Download Speed (bps)	5321895	2945	9080	11775	55558	16106
Google Search Engine (ms)	284	11544	5185	7497	977	5763
Yahoo Search Engine (ms)	1866	46973	15114	21986	4717	10423
MSN Search Engine (ms)	1018	42097	10657	16417	4189	6726
Government's Web Site (ms)	216	2503	7254	1381	1639	11027

Notes:

1. Values specified by * are from the International Telecommunication Union 2002 (<http://www.itu.int>).
2. The upload and download speeds are calculated with regard to file download from and file upload to the server at the Vienna University of Technology. Therefore, the measurements are not valid if the server is installed elsewhere. All measurements should be calculated using the settings and location of the actual server.
3. The values of rows 6 to 11 are estimates and are strongly dependent on Internet connection. The results show Internet accessibility for a typical user.

When creating reports, users will be able to select countries from the reference countries to compare with their data. The resulting benchmark appears as shown in Figure 13.

Figure 13: Benchmark comparing overall value parameters of countries



3.6 Licensing and installation

The ICT Benchmarking Tool is built as an open-source system. This enables the users to modify the system and adapt it to their needs. The installation needs no licensing. Furthermore, the implemented software is designed to be installed and used independently of the operating system.

The minimum software requirements to install this product are:

- j2sdk1.4.2_01
- Apache Tomcat 4.0 (included in installation bundle)

The web-based interfaces are tested with:

- Internet Explorer 6.0
- Mozilla 1.4
- Netscape 7.1

4. Administration User Interface

Administrator users (Admin users) are able to configure the system with new parameters or bases. All these configurations are saved into a Base.xml or Parameter.xml file and are used dynamically by the benchmarking tool. This feature makes the system completely adjustable; numbers of entities (parameters and bases) and their values can be easily manipulated.

Admin users can configure the system by:

- Adding, removing or editing parameters
- Adding, removing or editing base countries

4.1 Parameter manipulation

When adding a parameter, the Admin user is asked to enter parameter's specific items, the parameter's ranges and the value of the new parameter for existing base countries. Figure 14 shows the administration UI for parameter manipulation.

Figure 14: Parameter Administration UI

Parameter View

Title: Maximum Value: Weight:

Description:

Type: URL:

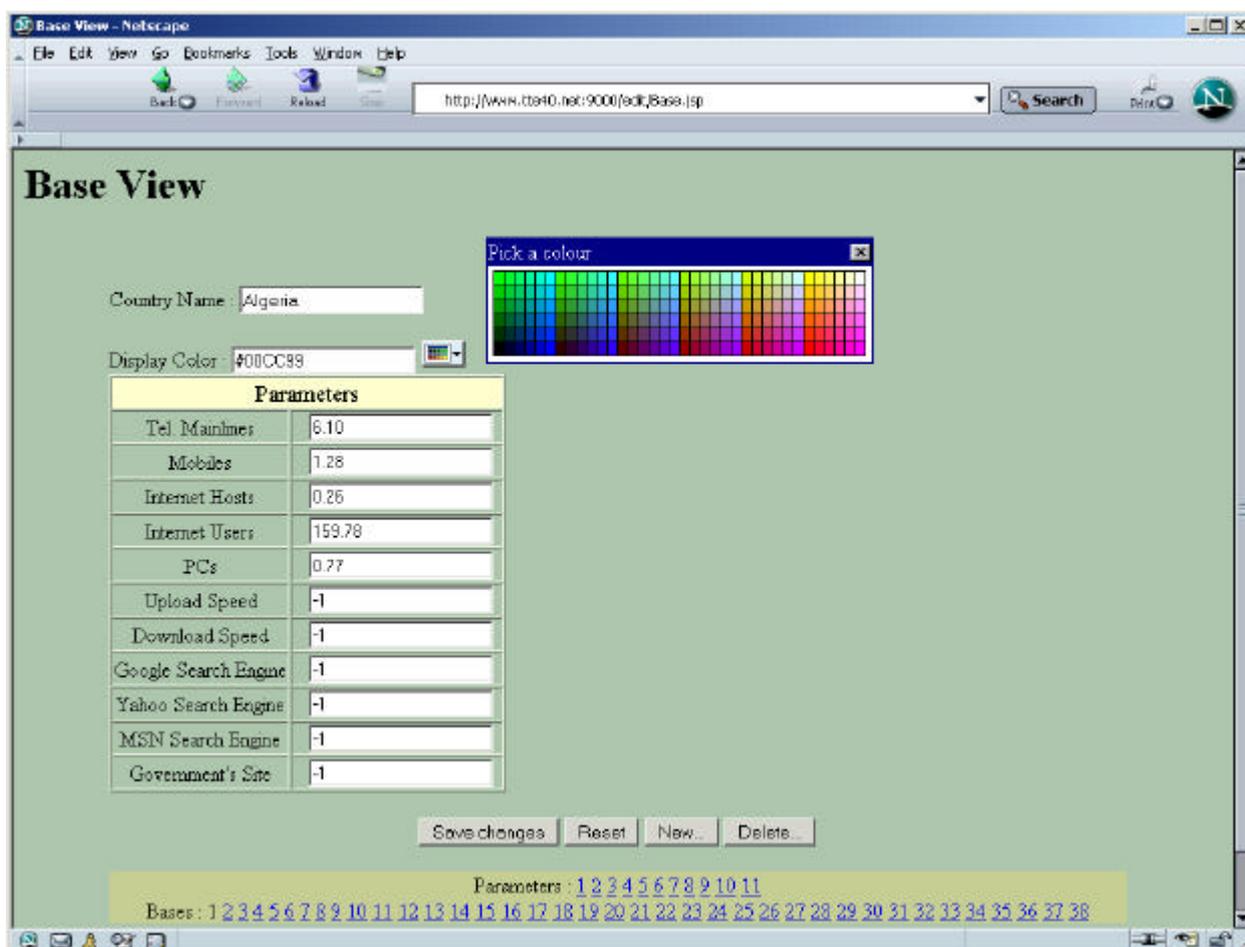
Ranges					
Level 1	from	<input type="text" value="0.0"/>	to	<input type="text" value="5.0"/>	
Level 2	from	<input type="text" value="5.0"/>	to	<input type="text" value="10.0"/>	
Level 3	from	<input type="text" value="10.0"/>	to	<input type="text" value="15.0"/>	
Level 4	from	<input type="text" value="15.0"/>	to	<input type="text" value="20.0"/>	
Level 5	from	<input type="text" value="20.0"/>	to	<input type="text" value="25.0"/>	
Level 6	from	<input type="text" value="25.0"/>	to	<input type="text" value="30.0"/>	
Level 7	from	<input type="text" value="30.0"/>	to	<input type="text" value="35.0"/>	
Level 8	from	<input type="text" value="35.0"/>	to	<input type="text" value="40.0"/>	
Level 9	from	<input type="text" value="40.0"/>	to	<input type="text" value="45.0"/>	
Level 10	from	<input type="text" value="45.0"/>	to	<input type="text" value="50.0"/>	
Level 11	from	<input type="text" value="50.0"/>	to	<input type="text" value="55.0"/>	
Level 12	from	<input type="text" value="55.0"/>	to	<input type="text" value="60.0"/>	
Level 13	from	<input type="text" value="60.0"/>	to	<input type="text" value="65.0"/>	
Level 14	from	<input type="text" value="65.0"/>	to	<input type="text" value="70.0"/>	
Level 15	from	<input type="text" value="70.0"/>	to	<input type="text" value="75.0"/>	
Level 16	from	<input type="text" value="75.0"/>	to	<input type="text" value="80.0"/>	
Level 17	from	<input type="text" value="80.0"/>	to	<input type="text" value="85.0"/>	
Level 18	from	<input type="text" value="85.0"/>	to	<input type="text" value="90.0"/>	
Level 19	from	<input type="text" value="90.0"/>	to	<input type="text" value="95.0"/>	
Level 20	from	<input type="text" value="95.0"/>	to	<input type="text" value="100.0"/>	

Bases	
Algeria	<input type="text" value="1.28"/>

4.2 Base country manipulation

When adding a base or canonical country, the Admin user will be asked to enter the value of parameters for defined system parameters. Figure 15 shows the administration UI for base country manipulation.

Figure 15: Base Country Administration UI



5. Product Features

5.1 Configurability

The base data and configurations can be easily changed without affecting the style and interface. These modifications can be done through a web-based XML editor. The administrator can do the following configurations:

- Adding or modifying a parameter
- Adding or modifying a canonical country's base data
- Modifying the presentation attributes of each canonical country

5.2 Multilingualism

The interface language can easily be changed by adding a new transformer to the pipelines. Currently only English is implemented.

5.3 Future extensions

Further development of this tool may include the following extensions:

- Adding support for other languages
- Creating more reports and diagrams