Hyper-G: A Large Universal Hypermedia System and Some Spin-Offs.

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Abstract

The incremental implementation of a thoroughly modular, large, networked hypermedia system called Hyper-G has been in progress in our research institutes in Graz for a number of years. By incremental we mean that certain parts of the system are not only working but are in actual use, while others are still in the process of being tested, developed or even specified. As additional modules become available they will improve current possibilities or add new functionality. Despite the fact that Hyper-G is a Unix-based networked system some parts of it can and have been ported to stand-alone PC platforms. In this paper we will first briefly describe Hyper-G, will then detail a few of the more unusual characteristics of it and will also explain a number of stand-alone applications that have become important on their own, mainly in the area of electronic publishing.

Note: An eletronic version of this report (including images) has appeared in ACM SIGGRAPH's experimental special online issue of "Computer Graphics" (May 1993) and can be retrieved by anonymous ftp from host `siggraph.org` in directory `publications/May_93_online/Kappe.Maurer`.

Contents

1 Hyper-G: a first survey

Hyper-G is a large distributed hypermedia system suitable for a wide range of applications. Documents of different types (text, graphics, raster images, video- and audioclips) can be stored and associated with each other using the well-know technique of links, but also other more sophisticated methods to be detailed later.

Hyper-G is designed to handle not just megabytes of data but mega-quantities of documents. This necessitates storing documents in a distributed fashion in a network consisting of potentially hundreds of computers. It also implies that the usual sole reliance on links as found in most hypermedia systems (for a survey of such systems see the papers [6] or [32] or the books [2], [17], or [29]) for navigation has to be supported by other techniques. Hyper-G permits the structuring of information into hierarchies of so-called *collections* to present the user with a rough feeling of what might be found where and supports advanced techniques such as fulltext and "fuzzy" search in domains defined by the user. Further, guided tours are available as help given by experts to persons first entering the information jungle of such a large system.

2 Main areas of applications and some special features of Hyper-G.

Hyper-G is mainly conceived as an informational and communicational infrastructure for large organizations such as universities, research institutes, companies of substantial size, administrative bodies etc. As a first test bed Graz University of Technology in Austria has been used: it is prototypical for most universities in that it provides a variety of user dependent wishes, applications and hardware and system platforms.

Hyper-G can be used to present university institutions and affairs for the interested public, potential and actual students, and all members of the university: administrative, teaching and research activities have to be thus supported equally well; Hyper-G is used for archiving information (from student records, to high-quality scientific picture material, to architectural drawings or planning materials); it supports teaching (both in class-room lecturing as a new presentation and delivery vehicle and as a CAI system in the more traditional sense, see e.g. [13] and [25]); and - maybe most important of all - it facilitates computer supported communication and cooperation in the sense of for example [10] or [11].

The above enumeration shows that Hyper-G does indeed claim to be a fairly flexible and universally applicable system. In a number of aspects it builds conceptually on earlier efforts such as the IRIS system at Brown University [12], yet it has a number of features going beyond local-area systems such as IRIS and other large wide-area networked system such as the World Wide Web [3], the WAIS project [31], the Gopher Network [1] or Nelson's dream of Xanadu [28]. We will briefly mention some of them. For a much more detailed discussion of many of the points we must refer to [14], [15] and [16].

2.1 Hyper-G is a distributed hypermedia system.

As is apparent from the above description Hyper-G is conceived as a distributed system consisting of servers and workstations. The development of Hyper-G can thus be understood as consisting of two clearly defined parts: the development of the servers (providing the information management side) and of the so-called "viewers" that provide the user-interface and are very much dependent on the user's hardware, software and application environment. The viewers are independent programs that run on a variety of platforms, e.g. X-Windows, PC, Apple, VT100 Terminal etc. They access the servers via some network connection. However, to conserve server and network resources the local facilities of the user's workstations are exploited as much as possible (see figure 1).

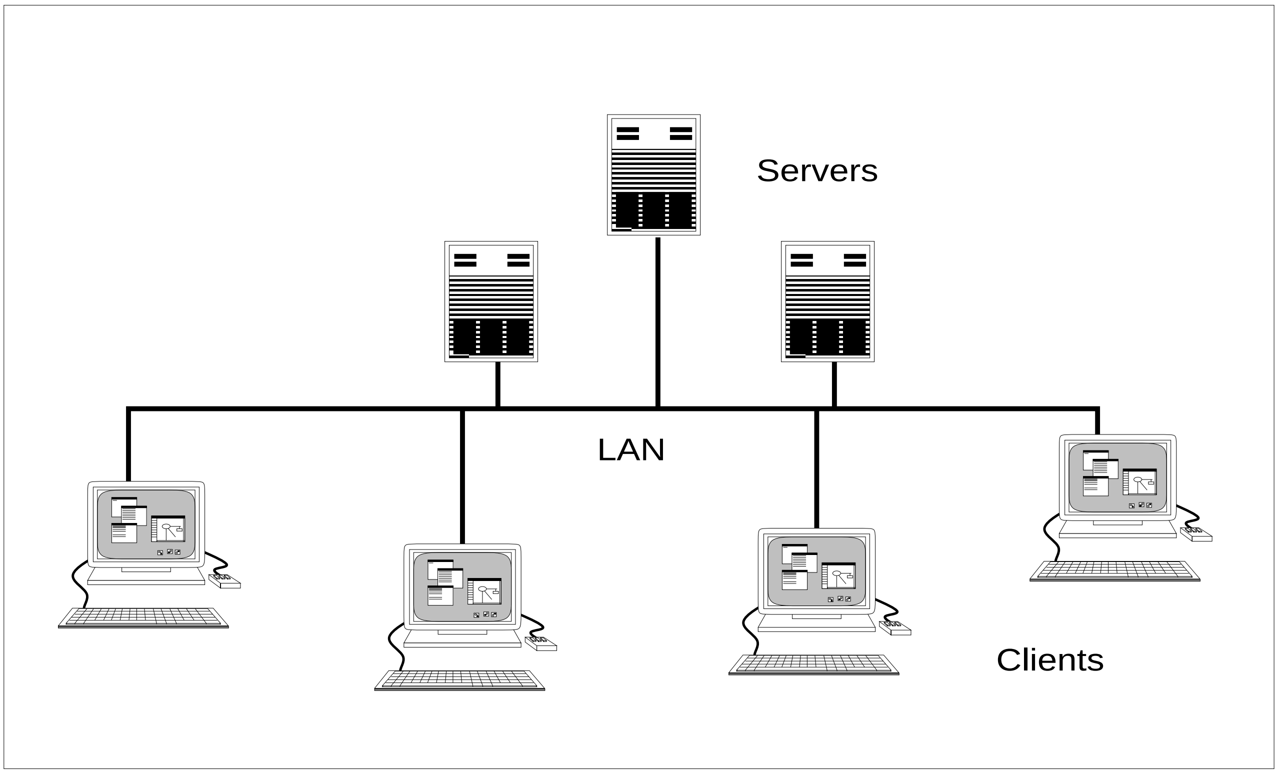

Figure 1: Hyper-G's Client/Server Architecture

In most currently available "Campus Wide Information Systems" users actually log interactively into a central computer system. (Incidently, this is not so in systems based on the Gopher-concept [1], but those system lack the hypermedia linkage support that Hyper-G provides). The client-server model that was chosen for Hyper-G offers a number of important advantages over conventional systems that have to be clearly understood:

1. When logging into a conventional system the local processing power of the workstation cannot be used. Hence annoying delays have to be accepted: after all, each key-press is sent from the user terminal to the host; and the host, simultaneously handling a large number of sessions may have problems responding with a visible echo within the 250 ms that are considered essential for smooth human-machine interaction [5]. It is well-known that fairly large and expensive systems are required if more than, say, a hundred users are logged-in simultaneously. Furthermore, due to the fact that very many small packages are routed through the net this approach poses quite

a burden on a network: it is particularly inefficient in token-ring networks, but even in other networks the load is higher than necessary.

In contrast to the above situation many of the actions carried out by the user in the client-server model can and are indeed handled locally, i.e. without putting any load either on the network or the host. This is true for such often used functions as cursor movements, scrolling of text, searches within a piece of text, entering keywords and may include fancy operations such as scrolling or zooming a picture, reformatting a window and so forth. Only when new data is required a request has to be sent via the net. The server, in response, sends the complete document to the viewer. All of the perusal of that document is now again carried out in local mode. Note that this eases the burden on the server and the network in a variety of ways: not only is there less traffic to start with, in most network technologies the transmission of large packages is more efficient than sending the same amount of information in smaller packages.

Thus, if 100 persons are using a client-server system, the workload is distributed to over 101 computers. Even if some delays do occur (when large packages are transmitted) this is not felt to be as annoying as a general very sluggish behaviour of the system, like waiting after each keypress.

2. To log-in interactively into a host means that the user interface must be reduced to the smallest common denominator. Thus, typically, the user interface may have to be reduced to VT100 standards, i.e. a 80x24 text only display, no mouse, no pictures, no sound, input of commands by typing, etc. For anyone used to working under Windows or on a Macintosh this is like being thrown back to the stone-age.

   In the client-server model used in Hyper-G the client (i.e. the viewer we have mentioned earlier) can make use of all the facilities provided by the workstation at issue, including mouse, windows, icons. Further, the interface the user is familiar with is still available, be it MS Windows, X Windows, Macintosh, NeXTStep, or whatever. Finally, it is much easier this way to export data from Hyper-G into other applications that are running on the workstation. Imagine, for instance, working with a word-processing application in which a paragraph on the history of Austria or New Zealand is required. In Hyper-G, a suitable encyclopedia is selected and the desired paragraph is exported and inserted into the document in a "cut and paste"-fashion.

3. If the system is to be used from "the outside", i.e. via some WAN then an interactive log-in becomes totally unattractive because of the now serious delays encountered with every key-press: the satellite links involved may provide high-speed data transfer rate but the waiting times already resulting from the limitation of the speed of light over the distances involved cause delays of at least 500ms per package (keypress). This is unacceptably slow for any but the most primitive applications. The client-server model, however, profits from the high data throughput achieved; the short waiting times that occur here and there when new information is sent become quite bearable, if not unnoticeable.

Let us now mention a few first facts concerning server and clients. The documents as such are stored as ordinary Unix files. However, all information concerning the documents, such as title, keywords, access privileges, date of creation etc. are stored in a data base. The same is done with the links between the documents: they are kept on a special "link server". (As we will see, even this link server may be distributed all over the network.) To avoid legal problems and to optimize access speeds we developed a data base engine tailored towards the specific requirements of Hyper-G. Note that Hyper-G is designed to handle 10^7 to 10^8 documents which are concurrently accessed by a multitude of users; the number of changes in the database is, however, a small percentage of the number of documents in it. This has been exploited in the Hyper-G data base engine. The architecture of the distributed link servers is described in detail in [16].

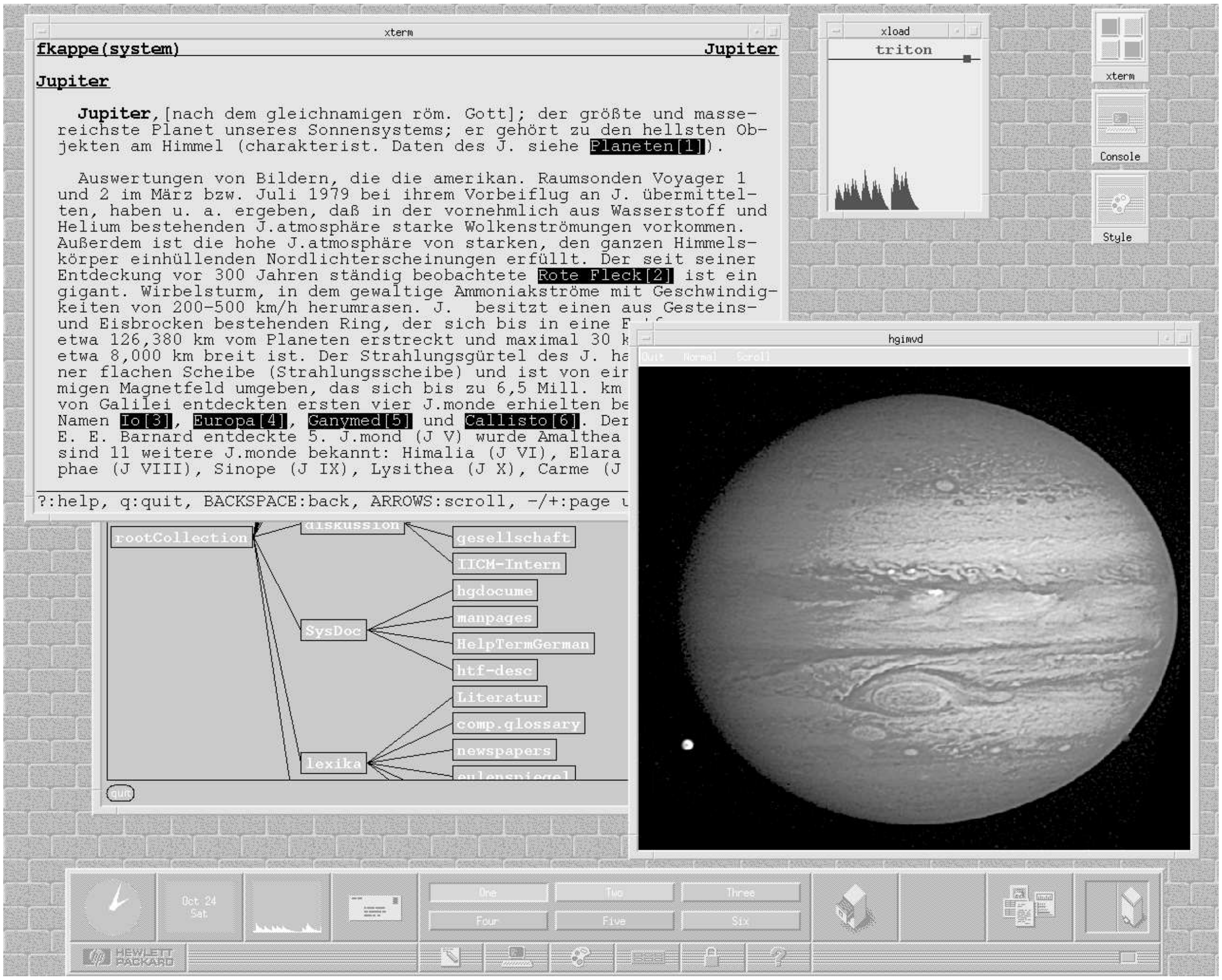

Figure 2: Hyper-G Viewer under X-Windows

Concerning the clients, we developed as a first step a VT100 viewer. Since an emulator for VT100 is available on almost all platforms this assured that Hyper-G was accessible (albeit in a limited form) by every interested user from the beginning. Beyond this, fancy viewers for X-Windows (see figure 2) and MS-Windows have been implemented as prototypes. Anyone interested can try out the VT100 viewer by `login` or `telnet` (login 'info') to the host `finfo.tu-graz.ac.at`. In this way the university information system of the Graz University of Technology can be reached: the services in this system are being continuously expanded. Note that many are "invisible", since they can only be used with special access privileges.

2.2 Hyper-G is an open system.

It is clear that even in the very largest systems not all information can be stored locally, let alone kept up to date. Hence it is essential that Hyper-G allows access to other existing services, such as Dialog, BIX, CompuServe, Videotex (the German-speaking BTX variant containing much useful information), just to name a few. Such services are often not free of charge, they have different user interfaces and there are few (if any) cross-references between them.

However, there are at least three projects in addition to Hyper-G that have the potential to reduce this kind of limitation considerably.

- The *Wide-Area Information Server (WAIS)* Project was initially sponsored by Thinking Machines, Apple Computer and Dow Jones News/Retrieval; it is now being operated by the Clearinghouse for Networked Information Discovery and Retrieval [31]. It is based on a standardized protocol for full-text search. At this point in time some 300 servers are available world-wide, and clients have been implemented for almost all platforms.[1]
- The Gopher Project [1] developed at the University of Minnesota makes it possible to connect Campus Wide Information Systems with each other. The systems are menu-based and (unfortunately) do not support hypertext features. The protocol being used permits access to various types of documents and the search for keywords.[2]
- The WorldWideWeb (WWW), developed at CERN in Switzerland is a distributed hypermedia system [3]. Documents can be distributed all over the world and connected by links much as envisaged by hypertext pioneer Ted Nelson in his proposed Xanadu system [28].[3]

All of the above systems are based, exactly like Hyper-G, on the client-server model. Hyper-G permits access to all information stored in any of the above three systems and - this is crucial - without change of user-interface. Conversely, the clients for Gopher and WorldWideWeb (that are available for PC, Mac, NeXT, Unix and VMS) can also be used for Hyper-G.

The big difference between those systems and Hyper-G is Hyper-G's distributed link server. This server keeps track of all the relations (e.g. links) between Hyper-G objects, allowing for automatic maintenance of the information network. For example, when an object gets deleted, the link server will be able to find and delete all links pointing to the object. In contrast, in Gopher and WWW there is no easy way to find out what other documents are pointing to a given document.

Also, having all relations for a given object at hand in the link server allows a display of graphical representation of the 'surroundings' of the current object (e.g., a fisheye view). In addition, the link server allows a search for objects in specific parts of the database ("give me all objects under this collection with keyword 'foo' that were created by user 'bar' in the last week), maintains user accounts, user groups, access rights and accounting information.

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[1]The WAIS source code is available free of charge; it can be downloaded via anonymous ftp from `think.com` in directory `/wais`.

[2]Gopher source is available free of charge; it can be downloaded via anonymous ftp from `boombox.micro.umn.edu` in directory `/pub/gopher`. A demo-session can be initiated with `telnet` to host `consultant.micro.umn.edu`.

[3]WWW is available free of charge for non-commercial and non-military applications; it can be downloaded by anonymous ftp from `info.cern.ch` in directory `/pub`. A demo-session can be started with `telnet` to host `info.cern.ch`.

2.3 Hyper-G supports heterogeneous users and platforms.

Different users of Hyper-G have different user platforms, and their computer science know-how varies widely. So-called "user profiles" and "platform profiles" assure that when accessing Hyper-G the most suitable user-system dialogue is supported.

2.4 Hyper-G is multi-lingual.

The user profile (or the workstation profile, or both) can also contain language preferences. For instance a user might specify English, German, and Italian (in this order) as language preferences. All commands, menus, help information and the actual documents are then presented in the preferred language (in our example this would be English), and only if this is not possible the next-preferred language will be used.

2.5 Hyper-G has no fixed usage metaphor.

Hypermedia specialists are often at odds about which of the many usage-paradigms is optimal: the "stack-metaphor", "the book metaphor", "the holiday travel paradigm", or whatever else (see [8]). Hyper-G does not attempt to resolve this issue but rather supports the idea that each of the above ways of inter- facing with a hypermedia system may have its advantages depending on the user, the application and the workstation. Thus, Hyper-G is designed in such a fashion that a wide variety of usage paradigms is supported: the choice is left to the user or system administrator.

2.6 Hyper-G can be used at various levels of anonymity.

To avoid the "Big-Brother-Syndrome" [22] Hyper-G can be used both anonymously or identified. Of course anonymous users are not allowed to modify the data base while identified users may have this option, e.g. for leaving annotations (notes) for themselves or a wider public for later perusal.

It is worth noting that between anonymous use and identified use there are many levels of "partial" identification that can be very useful. We mention just two in passing, supported by Hyper-G:

- In the **semi-identified mode** the real identity of the user is known to the system, but to nobody else. This assures that users are prevented from making slanderous comments, contributions violating some pornography law, etc. (since they can be identified by the law, if necessary) yet their real identity is shielded from other users: they can choose an arbitrary pen-name. This mode has proven to be particularly valuable for discussions in groups to assure that the usual barriers of job-hierarchy or such are broken down, and a discussion in a "space free of power and fear" (to quote the title of a book by the Austrian author Visotschnigg: "Verstaendigung im machtfreien Raum") can be conducted. Semi-identified users are allowed to create both private and publicly accessible documents.

- The **anonymously-identified mode** is similar to the the semi-identified one except that the real identity of the user is not known even to the system. Users can select any still available pen-name and password, and this combination can be used whenever accessing the system. The advantage of this mode, when contrasted with the fully anonymous mode is that user preferences, bookmarks etc. can be stored across session boundaries. In this mode only documents for private use can be entered into the system.

2.7 Hyper-G uses the annotation facility in an "orthogonal" fashion.

Information in Hyper-G can be annotated by users with both textual and graphical comments ("annotations") : such annotations may be accessible only by the person who created them ("private annotations"), by a designated group ("group annotations": e.g. a professor for the students in a particular class) or by all users ("public annotations"). By allowing to annotate annotations and to associate a type with each annotation (such as "counter argument", "generalization", "supporting example" etc. much as in gIBIS [7]) and by using links pointing to other documents, all of this supported by various other tools, Hyper-G provides a good basis for a structured discussion and for computer supported cooperative work. This feature has been used at the Graz University of Technology successfully to support a number of classes in which large structured group discussions seemed to be essential. (E.g. in courses on "Societal impact of information technology").

It was A. van Wijngaarden who introduced the notion of "orthogonality" into programming language design: a feature available in one context should be available in all analogous contexts. We have attempted to design Hyper-G along these lines, exemplified by the above discussion of the use of annotation and levels of anonymity.

2.8 Hyper-G permits "unorthodox" data-input.

There is no single "best" editor or "best" authoring system in Hyper-G. It is our philosophy that Hyper-G should provide tools to import data and program modules produced by as wide a variety of application packages as possible.

As one speciality, textual documents can also be entered by scanning them (in a very simple mode by just faxing them to a designated phone number). Using OCR the raster images obtained are re-converted into a text file for two reasons: economy of storage and the wish to perform full-text searches. Note that in the process of re-conversion to text using OCR software a small percentage of errors is introduced. Since manual proof-reading would be too cumbersome we propose NOT correcting the errors mentioned. Note that this causes problems with full text-searching: a search for e.g."Amsterdam" may fail since the OCR software might have produced "Ansterdam" from the scanned document. To avoid such cases of "missing" information in search-processes we are using a "fuzzy" search that ignores certain simple textual errors. To our knowledge this approach has never been taken before on a large scale. Yet imagine the advantage when e.g. the tables of contents of new books or periodicals purchased for a particular library are available for full-text search using Hyper-G.

Clearly, the same technique applies to announcements to be posted on an electronic bulletin board, to pieces of printed information one might want to send as email as text-files, etc. Again, the combination "scanning-OCR-fuzzy search" is applied in Hyper-G in an orthogonal fashion.

3 Hyper-G spin-offs

As desirable as large networked hypermedia system such as Hyper-G are, there are many situations when smaller, stand-alone systems are essential, e.g. for applications in electronic publishing. Also, without electronic publishing, typically on CD-ROM or in the near future CD-I or similar data-storage devices the volume of material that may make networked hypermedia systems really valuable might never come into existence. Without our efforts to produce a world-atlas with pictures on CD-ROM as a commercial product for an Austrian publishing house Hyper-G would never contain high-quality cartographic material and thousands of pictures from all over the world; without our efforts to create an electronic presentation of Austria at the EXPO '92 in Spain and '93 in Korea, Hyper-G would not contain some 3000 pictures of Austria; without the PC-Library project Hyper-G could never contain dozens of dictionaries and lexica of both general and special-purpose nature, etc.

For this reason it seems appropriate to discuss in what follows some of the more interesting "spin-off" products of Hyper-G. These products are the outcome of projects with their own justification. Yet in designing them, much know-how from Hyper-G proved to be essential; conversely and curiously, these products will provide much of the information that will be found in the Graz University of Technology server of Hyper-G in the near future. Most projects to be discussed run on PC under MS Windows. The flexible client-server structure of Hyper-G allows us in many cases to combine a small server and a particular client in a stand alone system.

3.1 The world atlas

In this project high quality cartographic material (in various resolutions) is combined with textual information from a geographic dictionary and some 2000 pictures. It will be distributed as a "small version" (on CD-ROM) for e.g. schools in Austria. A larger version with over 10.000 pictures will be made available via Hyper-G (see 3).

In addition to the "obvious" functions of such an electronic atlas we have incorporated various computational facilities, allowing the determination of distances or the length of a route, or showing the location of objects too small to appear on even very detailed maps (such objects can be located, however, because a data base with coordinates of most objects of interest from most parts of the world does exist). In incorporating functions such as "determine the rivers in the area I am currently indicating with the cursor" interesting non-trivial problems to handle fast searches in polygonal areas have to be solved. The support of scrolling and zooming at high speed offers another interesting challenge.

3.2 City maps on CD-ROM

The similarity with the world atlas project is surprisingly superficial. The real problems emerging when designing city maps are of a rather different nature: the most obvious one is the question of route optimization. We want to be able to indicate two points on the map and ask for the best (fastest) route between these two points while taking into account the mode of transportation (by foot, by bike, by car, by public transport?) and even the time of day (certain routes like the South-East Autobahn in Vienna, or the Motorway 1 South in Auckland will not be optimal during rush-hours!).

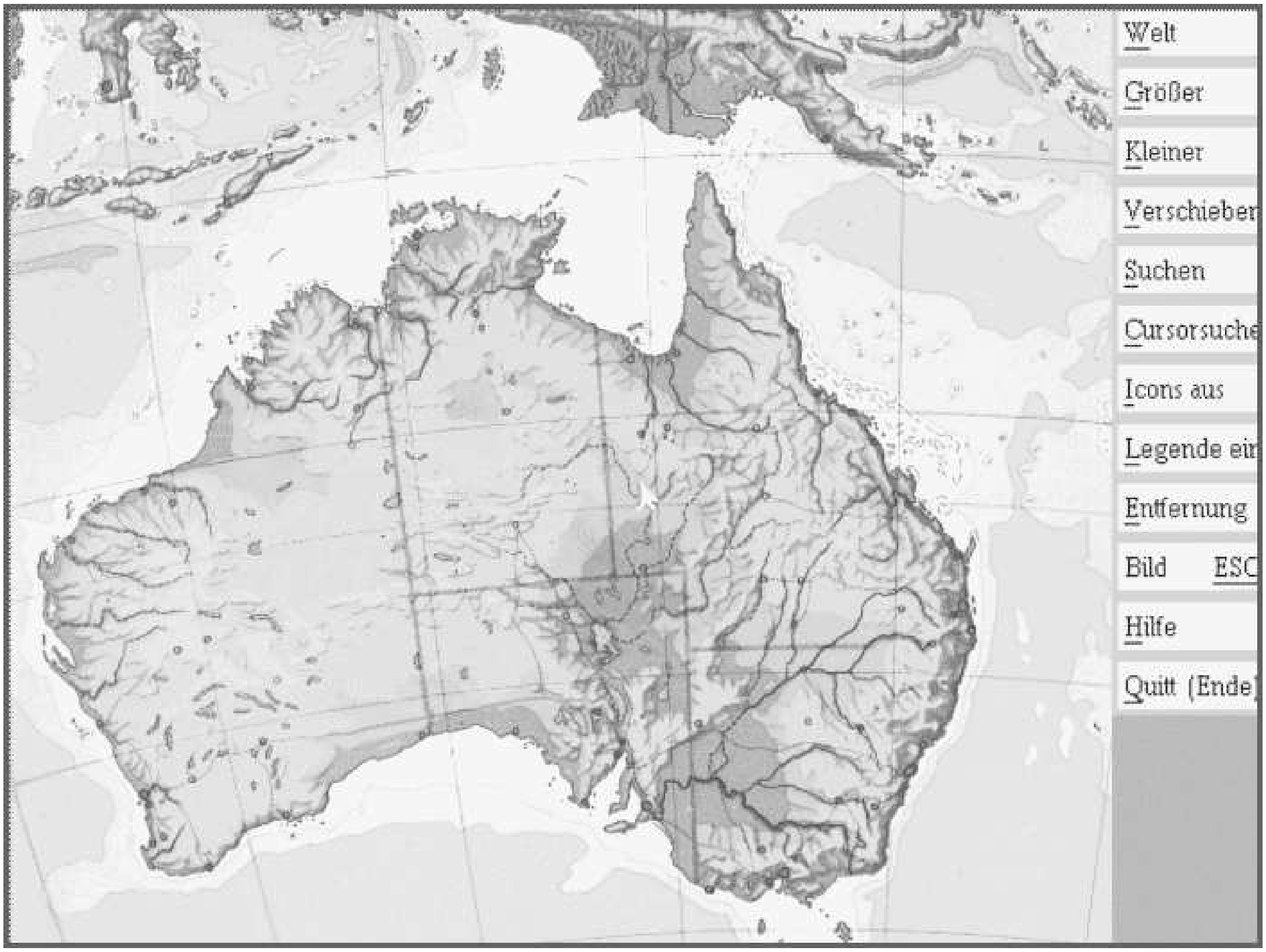

Figure 3: The Electronic World Atlas

Maybe the biggest challenge is the incorporation of day-to-day information (detours, impediments due to road repairs, some kind of rally or celebration, etc.):the idea is to download such information from a system such as Hyper-G maybe by even plugging your portable PC into an information port provided at a service-station when you enter a city while your car is being filled up!

Also, city maps require a large amount of customization. Users want to enter their favorite restaurant or shopping center, their friends and appropriate routes to them, thus combining the city map with part of an address data base. Users may even want to send the route to a particular place via modem (or Hyper-G) to a friend who is unfamiliar with the city at issue yet is about to arrive by car in a few days time.

As with the world atlas project: since a number of city maps will be available commercially in electronic form by early 94 these maps will also be available via Hyper-G world wide, potentially for a certain usage fee. For a sample of a city map see figure 4.

Figure 4: Elektronic City Map

3.3 The PC library

The PC library consists of a collection of books in electronic form, initially mainly dictionaries and encyclopedias on various subjects. They are available as packages of floppies (and potentially on CD-ROM for still larger applications; note, however, that the textual component of a 10 volume universal encyclopedia can be squeezed onto 8 $3\frac{1}{2}$" floppies and will not require more than some 15 Megabytes of harddisk when decompressed).

Users will install some of the volumes of interest on their hard disk: typically, a user might install a universal encyclopedia, a special purpose one in the main area of interest, a few language dictionaries and some collections of maps and pictures, with a total storage requirement of some 10-100 MB on a hard disk. Although this may sound like a lot of storage, with the price of hard disk space dropping to about 1-2 US $ per MB for large drives this will not be excessive.

The software developed by us will be marketed by the second largest German publishing group as of summer 93, including the necessary contents (i.e. electronic books). It permits users to "open" any combination of books stored on the hard disk: all subsequent searches will be performed within the open books only, thus permitting users to control the range of their searches. Searches can be carried out on title only or full-text basis, with or without "fuzzy" search (by this we mean that certain spelling errors, abbreviations, synonyms and phonetic similarities are taken into account while searching). Also, logical connectives are permitted to allow queries such as “find all contributions containing England and culture but they must not contain the word London”. By just clicking at any word in a text displayed a search for that word (lightning fast unless full-text search is required) is carried out; explicit links can be both predefined or be defined by the user; picture icons can be included, and expanded into full-size pictures by clicking at them. Pictures can be resized and rescaled in real-time (See figure 5).

Figure 5: The PC Library

Information found in any of the electronic books can be exported into other user applications. Conversely, self created material or material from other sources (both text and pictures) can be imported into the PC library as a separate volume, or as part of an existing volume. Of course pictures from a Kodak Photo-CD can be imported as well, tied together into a private slide show, with the possibility of looking up any information in an encyclopedia at any point in the show by a single mouse click. Working with a PC library in the background is indeed a new experience, particularly because all data is easily customizable, including annotation. For further information see [27] and [4], or [30] as a similar, large project.

3.4 Hypermedia presentations at fairs, exhibitions and in museums.

The world exhibition at Seville, Spain in '92 gave us the opportunity to try out our hypermedia developments on a large scale. We tied together some 3000 pictures of Austria, with high quality cartographic material, a number of video clips and an number of "special topics" (like a presentation of the major provinces, or of our Habsburg heritage)... all this in 5 languages (see figure 6: Impressions of Austria). The user-interface had to be sufficiently simple to allow immediate operation without any instruction.

Figure 6: Impressions of Austria (from EXPO '92 in Sevilla)

The result, a typical Hyper-G spin-off, was a cluster of six stations, disguised as "crystals" growing out of the soil, one face of the crystal being a touch-sensitive screen. The screen would show pictures of Austria until one of the languages was selected: from then on all menus and all information would appear in the proper language.

User options in this presentation included the selection of one of a number of special topics, or of any point in Austria for a detailed map with photo and video-icons, or of any of the larger Austrian communities by name. The 1.2 million persons using the system were particularly impressed by its speed (average speed to display a picture was 0.8 seconds) and by a number of gadgets whose implementation was anything but simple: it is e.g. possible in this application to move around in the map of Austria by just shifting the map with the finger.

Technically speaking, the whole map is stored as one very large raster image (resolution some 6000 x 4000 pixels); at any point in time a "window" of this map of roughly 600x400 pixels is shown. This window can be moved around at will by touching one spot and moving the finger.

The fact that we were able to scroll a map, and display pictures and video-clips fast on ordinary PCs with no extra hardware necessitated some adaptations in Hyper-G but attracted considerable attention from those familiar with the problems involved in such an undertaking.

A number of similar applications, for company presentations, for museums and for other purposes have been carried out by us using the same software basis. The largest one is a CD called "Around the Himalaya" with about 1500 high quality pictures (some of them quite unique) of 10 expeditions of Austrian groups into the Himalaya photographed by the well-known author Willi Senft. This CD also contains a number of interesting sound-tracks: from an interview with the Dalai Lama to the sounds of various indigenous musical instruments.

3.5 Hyper-PC

Our efforts to use multimedia techniques for computer assisted instruction (CAI) go back a number of years, see e.g. [13], [18] and [19].

Since the end of 1992 we have had a cooperation agreement with a group in St. Petersburg, Russia, with which we have developed a new PC-based authoring and execution system Hyper-PC. Hyper-PC facilitates the preparation of CAI material under MS Windows [21]. Despite the fact that Hyper-PC does contain its own powerful graphics and animation editor its strength is the fact that it allows the importing of text, graphic objects and raster images that are produced with other MS-Windows tools. Imported objects can be linked together, modified and animated. A powerful question/answer dialogue, a graphical "undo" function, sophisticated navigation facilities and the possibility of annotating lessons on various levels, plus the compatibility with some 400 existing COSTOC lessons and the use of Hyper-PC within Hyper-G seem to justify the development of yet another authoring tool. In contrast to rather expensive yet elaborate systems such as Authorware in combination with Macro Mind Director, Hyper-PC will be distributed as shareware, and will allow the easy distribution of CAI material through Hyper-G or just Internet.

3.6 HM-Card

Different persons rarely mean the same thing when they talk about a "hypermedia system". The smallest common denominator is usually "a hypermedia system is a computer based multimedia system where links provide the main navigational facility". However, papers like [9] and [34] have already pointed out some time ago that links have a certain similarity with "goto's" in programming languages and are hence potentially quite dangerous.

We support and extend in [23] this line of argument and propose replacing links as much as possible by structuring hypermedia data-bases into so-called S-collections. S-collections are an extension of the hierarchical collections we are currently using in Hyper-G and allow advanced navigation and easy generation and maintenance of large hypermedia systems without links. HM-Card is a prototype development of this idea, an idea already partially implemented in Hyper-G [15]. If tests with HM-Card prove successful, HM-Card will provide a convenient umbrella to pull together a number of our Hypermedia developments under MS-Windows.

3.7 HOTACT

Data in a hypermedia system cannot only be accessed via keyboard or mouse. The "Viewseum" project [26] proposes other techniques (in particular a museum in which all exhibits are computer supported and are equipped with unorthodox input/output devices), and [33] goes even a step beyond this by introducing a museum which itself exists only virtually: the visitor, wearing 3 D glasses, walks around the museum (a computer generated 3 D animated picture) and activates exhibits while walking around. (Simpler version have also been distributed as e.g. "Virtual Museum" by Apple on CD-ROM to show the power of "interactive" movies.... video clips which really are not interactive themselves, but can be combined in a variety of ways hence leaving the impression of interaction).

In the HOTACT project that was used in a number of exhibitions with great success [24], pictures and text are explored by combining a hometrainer with a PC: the user sits on a hometrainer, sees a map and the hometrainer as small bike on the map, moving at a speed depending on the efforts expended pedalling the bike. Pictures and explanations of the scenery are shown. At road junctions the "biker" can choose where to continue (using a "one button" interface that we have first seen in use at the Franklin Institute of Technology in Philadelphia). By the way, when the road goes uphill, pedalling starts to be (of course!) much harder. Thus, HOTACT can be seen as a low-cost and simple minded yet effective entry into merging hypermedia and virtual reality ...

4 Summary

In this paper we have presented a large networked hypermedia system Hyper-G which will be used as an informational and communicational infrastructure for large institutions. By indicating some current applications and some spin-offs we have shown by means of examples the breadth of the Hyper-G undertaking, and have tried to indicate the significance of Hyper-G for the future. Although many parts of Hyper-G are not complete, the main core is already in use and has attracted considerable attention. More than a dozen major organizations have made preliminary commitments to Hyper-G.

Hyper-G is a project of the Graz University of Technology. Yet we want to share Hyper-G with academic institutions around the world in a non- commercial atmosphere. We will need lots of cooperation in developing further clients (viewers), applications that fit as seamlessly as possible into Hyper-G, studies of user interfaces and users' behaviour, and we will need many servers with interesting and widely accessible material to make our visions – in many ways Ted Nelson's visions – work. We have started cooperations with a number of universities by now (the University of Auckland of course being one of them), but we will need much further help.

We believe in the importance of hypermedia systems [20]; if you are interested in cooperating, give us an electronic shout!

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