190

ESRIN EEOS Workshop on Networks - Panel 1, Frascati, Italy
13 -15 December 1994

DATA COMMUNICATIONS IN AUSTRIA A REMOTE SENSING PERSPECTIVE

F. Leberl [1] and F. Haselbacher[2]
Graz University of Technology
A-8010 Graz, Austria
E-Mail leberl@icg.tu-graz.ac.at

ABSTRACT

There exists a modern R&D data network in Austria denoted as ACOnet. It currently uses a 34 Mbit/sec backbone infrastructure offered by the Austrian PTT. Participating Universities and research institutes have access to this infrastructure via a 2 Mbit/sec connection. Via Vienna each node in ACOnet is connected to other international nodes. A backup consists of an ISDN network at 128 Kbit/sec. The international connection is through E-BONE as the "European Backbone"-network for the R&D-community.

The future is with ATM. First experiments are being performed with ATM at 140 MBit per second. However, these experiments are performed locally at this time. It is to be expected that large scale availability of ATM will materialize by 1997. These ATM-experiments may include studies about the access to large remote sensing data bases (400 GByte of image data).

Rural areas dominate the Austrian scene. These will continue to be accessed by ISDN, although fiber glass lines are currently being put in place across all of Austria at a rapid pace. We will discuss the details of the Austrian data networks, the current pricing strategies for services on these lines, and we will examine their roles for future remote sensing applications, in particular in local districts and provincial monitoring tasks.

1. INTRODUCTION

The transfer of data via public communication lines is currently a monopoly of the Austrian PTT, a nationalized organization whose employees are civil servants. The situation does not differ significantly from that in most European countries. It is the major factor for the complaint that in Europe the use of communication lines costs a user approximately 10 times more than it would in the United States where competition in the offering of communication services has become possible many

---

[1] Institut für Computerunterstützte Geometrie und Graphik (Institute for Computer Graphics).
[2] Manager of Networks, University Computer Center.

years ago. But plans in the European Union will change the situation in Europe too. Concerning Austria, plans call for a termination of the PTT-monopoly by 1998.

The perhaps largest issue in future data transfer discussions may be less the data rates as the pricing policies. It is for this reason that the termination of PTT-monopolies will also have an impact on the policies for remote sensing data bases and transfer methodologies.

We will present in this paper a review of current networking capabilities in Austria and its connection to the international scene. We will also sketch a requirement for Austrian future data transfer services as they may evolve through the applications of satellite remote sensing data streams.

Austria is a highly regionalized country with a considerable autonomy of its 9 provinces, more than 60 districts and more than 2000 municipalities. This may lead to requirements for networking of remote sensing data that are different from those that may exist in countries with a tradition of centralized management and decision making. In Austria, networks may have to carry large data quantities even into the smaller towns since many environmental decisions are being taken there, and it is in those towns that agriculture, forests and water are being managed.

2. CURRENT AUSTRIAN NETWORKS

2.1 The Major Network and its Access

The major communications network in Austria today is offered by the PTT. It has been installed in the spring of 1994 as a ring connecting 7 nodes in some major cities (see Anon., 1993 a,b). These are the provincial capitals with universities. Figure 1 illustrates the situation. The primary net is denoted as Metropolitan Area Network (MAN), a name chosen by Austria's PTT independent from the broader meaning of this term. This major net offers data rates at 32 MBits per second.

MAN is used by the universities via local access connections at a rate of 2 MBit per second. The resulting service is denoted as ACOnet. Its individual users are universities or semi-public research organizations. ACOnet uses the TCP/IP protocol for mail, telnet and ftp services.

All data are routed via the node in Vienna. Therefore a bottleneck may exist at the Vienna node's 2 MBit access rate. Access to the network is the result of a contract between the Ministry of Science and Research in Vienna and the national PTT.

A back-up system consists of an ISDN network at a data rate of 128 KBit per second.

2.2 International Access

The international connection is through the E-Bone network at a data rate of 1 MBit per second. This connects to Paris. Other European networks, for example DANTE, are not relevant.

Internationally, Vienna is a central connecting point for Eastern European capitals. International connections in Eastern Europe are at a rate of 9.6 KBit to 128 KBit per second. In Western Europe the connections are at 256 KBit to 2 MBit per second.

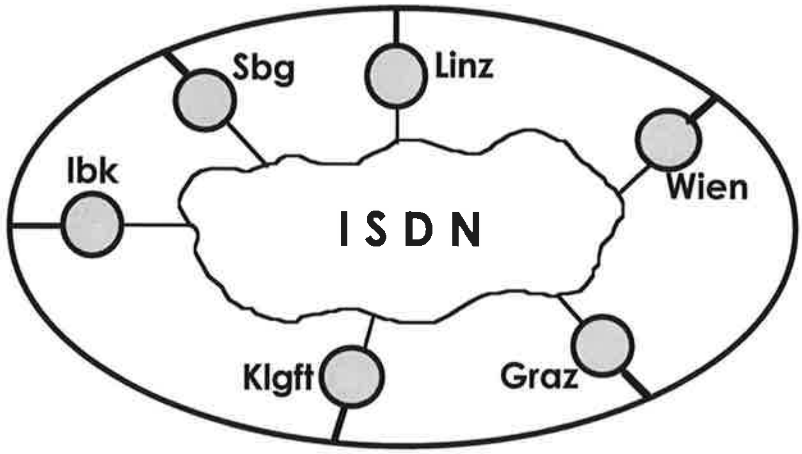

Figure 1: Major Austrian network, the Metropolitan Area Network MAN, at 34 MBit per second, operated by the PTT. ACOnet is the R&D service using this net and offering local access at 2 MBit per second.

2.3 Pricing

Users of the MAN-service offered by the PTT are being charged per volume of use, plus a flat monthly access charge of about öS 16,500.-- which includes about öS 3000 of usage. The charge increases if MAN is used at rates higher than 2 Mbit per second. Access at fullcapacity of 34 MBit/s costs an access fee of öS 57,200.-- per month. For Universities this would result in an unpredictability of its data services budgets. Successful negotiations between the Ministry of Science and Research and the PTT have resulted in an exception for R&D use of the MAN: the network is available for a fixed fee per year paid at ministerial level; the individual user at Universities is not being charged for the use of the net.

The back-up service through ISDN is available for a load price, just as is the case with conventional telephone services. For inner-Austrian calls across distances greater than 100 km, the Austrian PTT charges öS 6 per minute. International calls cost between öS 8.67 and öS 28.-- per minute.

2.4 Other Networks

Of course there exists also commercial access to international networks. This access is being offered by the PTT as well as by commercial vendors such as EUNet GmbH, CompuServe, Sprint and others. These vendors have to use PTT services, for example in the form of leased lines.

3. REGIONAL NETWORK ACCESS WITHIN AUSTRIA

3.1 Example in a Metropolitan Area

Fig. 2 presents a metropolitan network in the city of Graz, capital of the province of Styria and site of three Universities. The network consits of a 100MBit/sec FDDI ring and connects the three universities and two other research organisations. It also connects all organisations in the FDDI-ring to the MAN-service of the Austrian PTT via a 2 Mbit/sec connection (Theurl and Haselbacher, 1990).

3.2 In a Small Town

In principle, the PTT offers now ISDN connections to all major cities in Austria, and there is plan to set up an ISDN infrastructure for the entire country by the end of 1996. That means that nearly every telephone number will have the option of migrating to an ISDN-connection by 1997 (Anon., 1994).

Therefore any data services user in any city, town or village in Austria will have access to data rates supported by ISDN at 128 KBits per second.

4. FUTURE CAPABILITIES

4.1. Cabling the country

At this time, the Austrian PTT is actively placing fiber optic cables throughout Austria. Current plans call for a completion of an initial effort by 1997/8 to reach nearly every small town in Austria (Anon., 1993a). Efforts exist also in the private sector, for example with the railroads, the electric utilitities and the cable television providers, to put fiber optic cables into their right of ways. This may be for their private use, or it may be in preparation for the time when the PTT-monopoly falls.

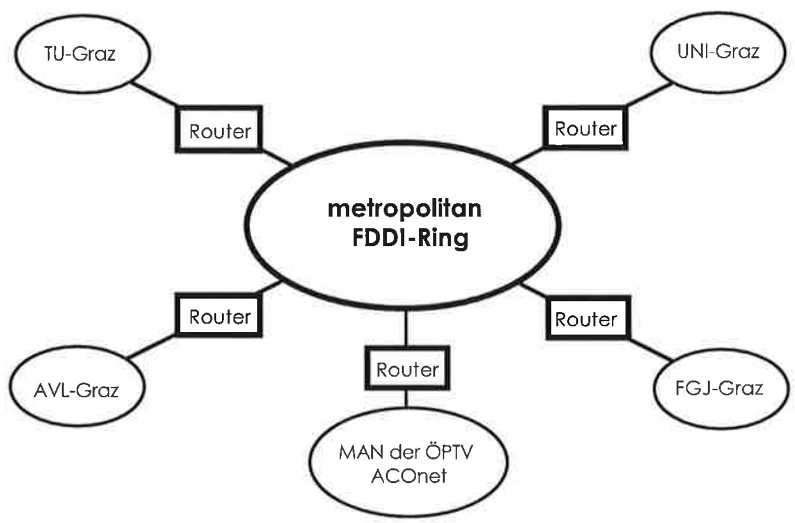

Figure 2: Example of a high data rate urban network in the city of Graz, capital of the province of Styria. A 100 MBit/Second FFDI ring connects all research and development organisations in the city, and provides access tio the national MAN-servide of the PTT. All physical wiring is based on fiber glass lines owned and operated by the PTT.

4.2 ATM

The Asynchronous Transfer Technology ATM is on its way into Austria. This is a switching technology which supports transfer speeds from 100 Mbit/sec to Gigabits/sec. It is based on fiber optic cables for long distances and can also operate on twisted pair cables (category V) for short distances of up to 100m. The international consensus about the future acceptance of ATM as the basis for all future high speed services makes it the central tool for the information highway; it will support interactive TV, video on demand and the like.

ATM is on its way to become the basis for Austria's university campus networks and for the broadband ISDN services offered by the PTT. It will be the first technology that will be used both in local or campus networks as well as in wide area networks. It will also be the first service to meaningfully transmit many different high volume types of information to include video, audio, graphics, still pictures, data, movies and the like.

At the current time the PTT is testing an ATM connection from Vienna to Switzerland (CERN). The PTT is also testing some ATM-connections inside Austria. The interest to familiarize the PTT and pioneering users with issues of such high performance networks is the motivation for other ATM-tests with partners inside Austria, for example employing remote sensing image data.

5. NETWORKING REQUIREMENTS FOR REMOTE SENSING

5.1 Types of Users

We may find four types of users of remote sensing data with a need for significant data transfer services:

* the user concerned with global phenomena and therefore seeking access to data from large portions of the entire globe, for example from all of Europe;

* the user concerned with data about all of Austria, an area of 82.000 square kilometers, or areas about this size;

* the user concerned with a province's surface which may be in the range of 10.000 square kilometers;

* the user in charge of a small area; given Austria's surface area and more than 60 districts, the average district's surface area is about 1.000 square kilometers.

The complete coverage with remote sensing images of each of these areas is presented in Table 1. The data quantities in this table reflect the number of "pixels" recorded, not the number of Bits or Bytes. These are a product of the number of bits or bytes that a pixel may contain. In the case of the US's Landsat program, each pixel holds 7 bytes; France's SPOT holds 4 bytes per pixel. Future satellite sensors from the Earth Observation System EOS may contain 200 bytes per pixel. The German-Russian MOMS-Priroda project intends to cover Austria at a resolution of 5 meters to 15 meters per pixel with either 3 or 4 bytes per pixel. Planned US commercial satellite coverages promise resolutions of 1 meter per pixel at 1 byte per pixel.

Table 1 presents a range of data quantities that may be processed by a single user in a project or in routine operations. This then means that such data quantities may have to be transferred during a short time, say an hour or so, and at reasonable cost commensurate with the benefits derived from the data.

Image Resolution in Meters per Pixel	Austria 82.000 sqkm	Province 10.000 sqkm	District 1.000 sqkm
10 (SPOT-France)	900 MPixel	100 MPixel	10 MPixel
5 (MOMS-Germany)	3 GPixel	400 MPixel	36 MPixel
1 (Eyeglass-USA)	90 GPixel	10 GPixel	1 GPixel

Table 1: Review of single image coverage per area, in pixels. Each pixel may consist of 1 byte as in a black and white image, or of multiple bytes, such as in multi-spectral images. In brackets are indicated which ongoing or soon to be current satellite imaging project would typically produce the geometric resolutions reported here.

It is somewhat misleading to present only the pixels that cover all of a territory once. In reality, any imaging sensor will cover a given area multiple times with overlaps. These are not considered in the current discussion. Oftentimes the true, original data set will be larger and will will have to be processed into the minimum needed to cover an area. The overlap factor may be 2 to 3 and therefore the data can be expected to reduce by this factor if one were to simply avoid image overlaps.

5.2 Types of Data Uses

Users may want to process data physically at their desk top and lock the results away locally. These users will have a requirement for bulks of data to be transferred to their data base, possibly in a batch mode and during non-work hours. High data transfer rates will mainly help to hold the costs of such services down; but the speed itself is not the central issue for the user. The following reviews the quantities of data in such applications.

A user in charge of covering all of Austria with images at a pixel size of 5 meters will need to cope with 3 to 10 Gigapixels to cover the entire area once. If each pixel contains 3 to 7 bytes that user may have to process 10 to 70 GBytes of images.

In a local area, say a province, the resolution may increase to 1 m per pixel, but the spectral information may be less important at that pixel size. If we assume that each pixel holds 3 bytes we need to transfer 30 Gigabytes.

On the level of a local district, remote sensing coverages may only be of interest if the resolution is at 1 meter. A single coverage of such a district will represent data quantities of several Gigabytes if we assume that the relevant images have multiple spectral bands.

Another approach may be that the data physically are stored, maintained and backed up at a remote location. In that case the user may need data access within minutes or seconds. Now the high data rates are of interest not only for the reduction in transfer cost, but also because large data quantities can be used interactively without the data being physically at the user's desk.

Table 2 presents the cost of transferring remote sensing images when using today's telephone charges as they apply to ISDN and MAN services in Austria. We also extrapolate these costs into the future when ATM-services will be available. Table 3 summarizes the transfer times. We see that transfer costs and the duration of the transfer vary greatly between ISDN and ATM since we assumed that ATM charges should at one point approximate those for ISDN per second. We need the capabilites of ATM and a willingness of the ATM-provider to be reasonable in the cost issue to make the large scale transfers of remote sensing data feasible at low cost.

		Costs in öS		
Pixel Size (m)	Service	Austria 82.000 sqkm	Province 10.000 sqkm	District 1.000 sqkm
10	ISDN	5,625	624	63
	MAN	5,616	624	62
	ATM	5	1	0
5	ISDN	18,750	2,500	224
	MAN	18,720	2,496	224
	ATM	17	2	0
1	ISDN	562,500	62,500	6,250
	MAN	561,600	62,400	6,240
	ATM	514	57	6

Table 2: Cost in öS for the transfer of typical remote sensing data sets. Assumed is a transfer within Austria across a distance greater than 100 km at current charges of öS 6 per minute for ISDN-services by the PTT in Austria. Commercial MAN service is assumed at 2 MBit/s. This is available in Austria for a monthly base charge of öS 16,500.-- and a load charge of öS 0.78 per MBit. Costs change to öS 57,200.-- for the base charge plus a load charge of öS 0.48/MBit if the rate is at a full 34 MBit/s. Note that for R&D the MAN service is accessible through ACOnet and is "free". ATM-pricing is entirely open at this time. We simply assume that prizes should be related to costs and speculate that under this asumption the rate per time for ATM should be about the same as for ISDN.

Pixel Size (m)	Service	Data Transfer Time in Seconds Austria 82.000 sqkm	Province 10.000 sqkm	District 1.000 sqkm
10	ISDN	56,250	6,248	632
	MAN	3,600	400	40
	ATM	51	6	0
5	ISDN	187,496	25,000	2,248
	MAN	12,000	1,600	144
	ATM	171	23	2
1	ISDN	5,625,000	625,000	61,496
	MAN	360,000	40,000	4,000
	ATM	5,143	571	57

Table 3: Same as Table 2, but presenting transfer times in seconds for remote sensing data sets at the given resolutions, using a single black and white coverage at 1 byte per pixel. ISDN transfer is assumed at 128 kbits per second for the individual user, MAN at 2 MBits per second, ATM at 140 MBit per second.

6. OUTLOOK AND CONCLUSIONS

The Austrian PTT is currently offering a 34 Mbit/sec infrastructure for data transfer in all major provincial capitals. The universities in Austria have 2 MBit/sec access to this service. The access to Internet is via Vienna to Paris at 1 Mbit/sec. The Ministry of Science and Research has entered into an agreement with the PTT for a fixed annual fee to use this infrastructure.

By the end of 1996 the Austrian PTT expects to begin the extension of the 34 Mbit/sec infrastructure to an ATM-based service with much higher data rates. Pricing for this new service will still need to get resolved.

Data transfer reqirements in remote sensing may differ among users by the size of the geographic area of interest and by the responsibility as well as the type of data processed for a specific application. We find that the largest use of remote sensing data may occur if applications penetrate to the local government levels. At that time data may be useful at a rate of perhaps 1 GByte per week. The time of about 17 hours it will take to transfer such data quantities to each town may be acceptable if done by ISDN; however, the cost may not be acceptable. The way to bring costs down is of course the installation of an ATM service at prices for the user commensurate with the costs of such service. It will be a central issue in the future to insure that pricing for data transfer services are structured favorably for the applications in remote sensing.

ACKNOWLEDGEMENTS

Work done for this paper was supported in part by the Austrian Academy of Sciences and in part by the Austrian Ministry of Science and Research. This support is greatly appreciated.

REFERENCES

Anon. (1993a) Glasfaserausbau in Österreich: Netz mit Zukunft. Postrundschau, Vol 6-7/93. Generaldirektion für Post- und Telegraphenverwaltung, pp. 18-19.

Anon. (1993b) MAN - die Hochgeschwindigkeitskommunikation. Postrundschau, Vol. 6-7/93. Generaldirektion für Post- und Telegraphenverwaltung, pp. 20-22.

Anon. (1994) Start frei für das EURO-ISDN. Postrundschau, Vol. 1/94. Generaldirektion für Post- und Telegraphenverwaltung, pp. 13-15.

Theurl J., F. Haselbacher (1990) Konzept zur Erstellung eines MAN im Raum Graz. Internal Memorandum, Computing Center (EDV-Zentrum), Graz University of Technology, Graz, Austria.