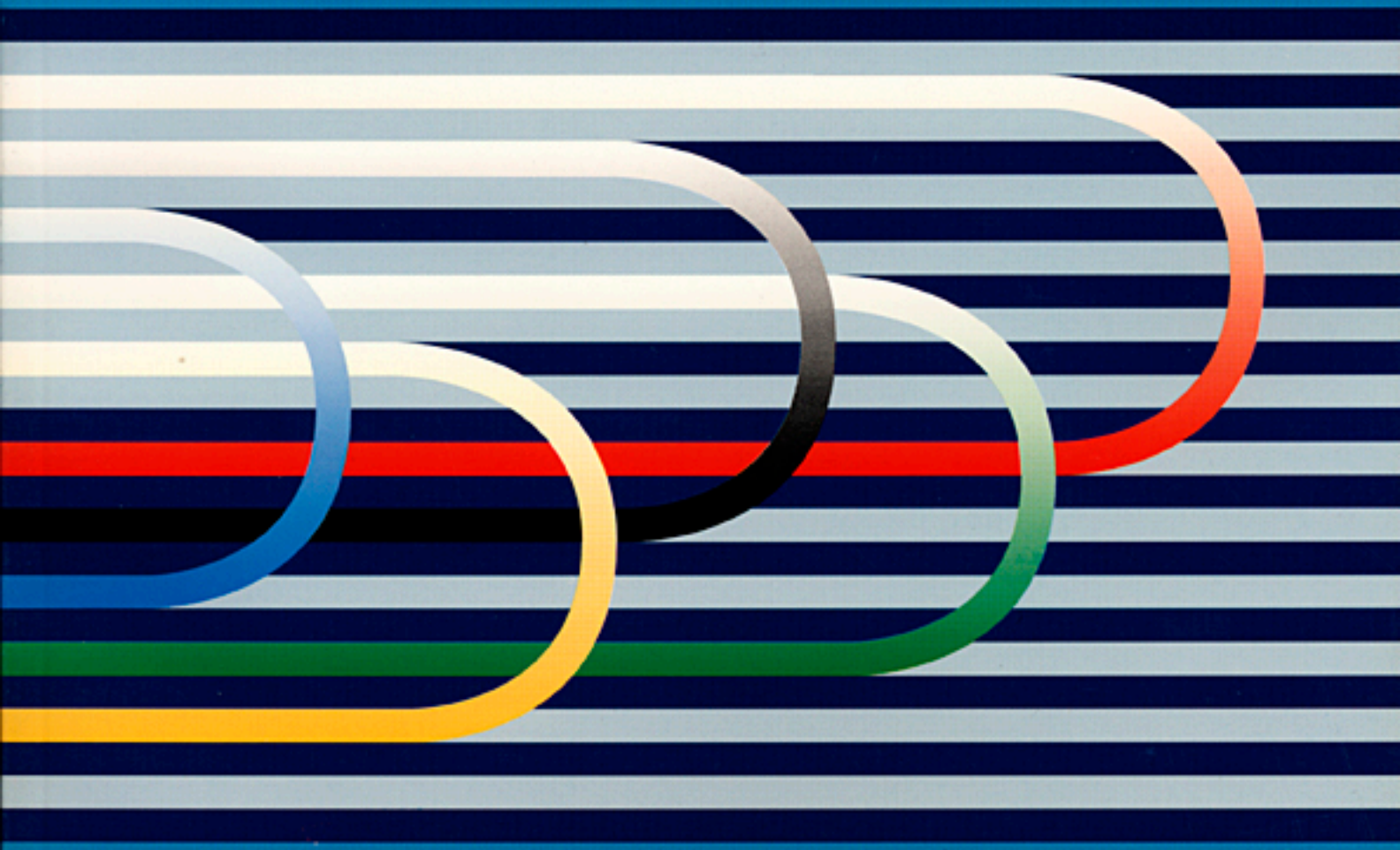
Telektronikk 1.95

The telecommunication project of the XVII Winter Olympic Games at Lillehammer 1994



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Guest editorial

BY OLA TOFTEMO

Excellent telecommunications was a decisive factor in making the Lillehammer Winter Olympic Games 1994 available to the world. When two billion television viewers the world over turned on their sets on February 12, 1994 at 1600 to watch the opening ceremony at Lillehammer, they expected telecommunications solutions to function down to the smallest detail. So did 8,000 media people ready to report live from the arenas and the athletes' achievements.

And responsible for all telecommunications during the Olympic Games, comprising practical consultancy, supply of all equipment, installation, operation and maintenance – was the Norwegian Telecom Group.

Our staff of over 700 people as well as 50 hired experts were busy handling the operation and serving the customers in the 16 days the Games lasted. The technical personnel did an excellent job keeping the various networks operating: the computer network, the telephone network, satellite communications, ISDN and the mobile network.

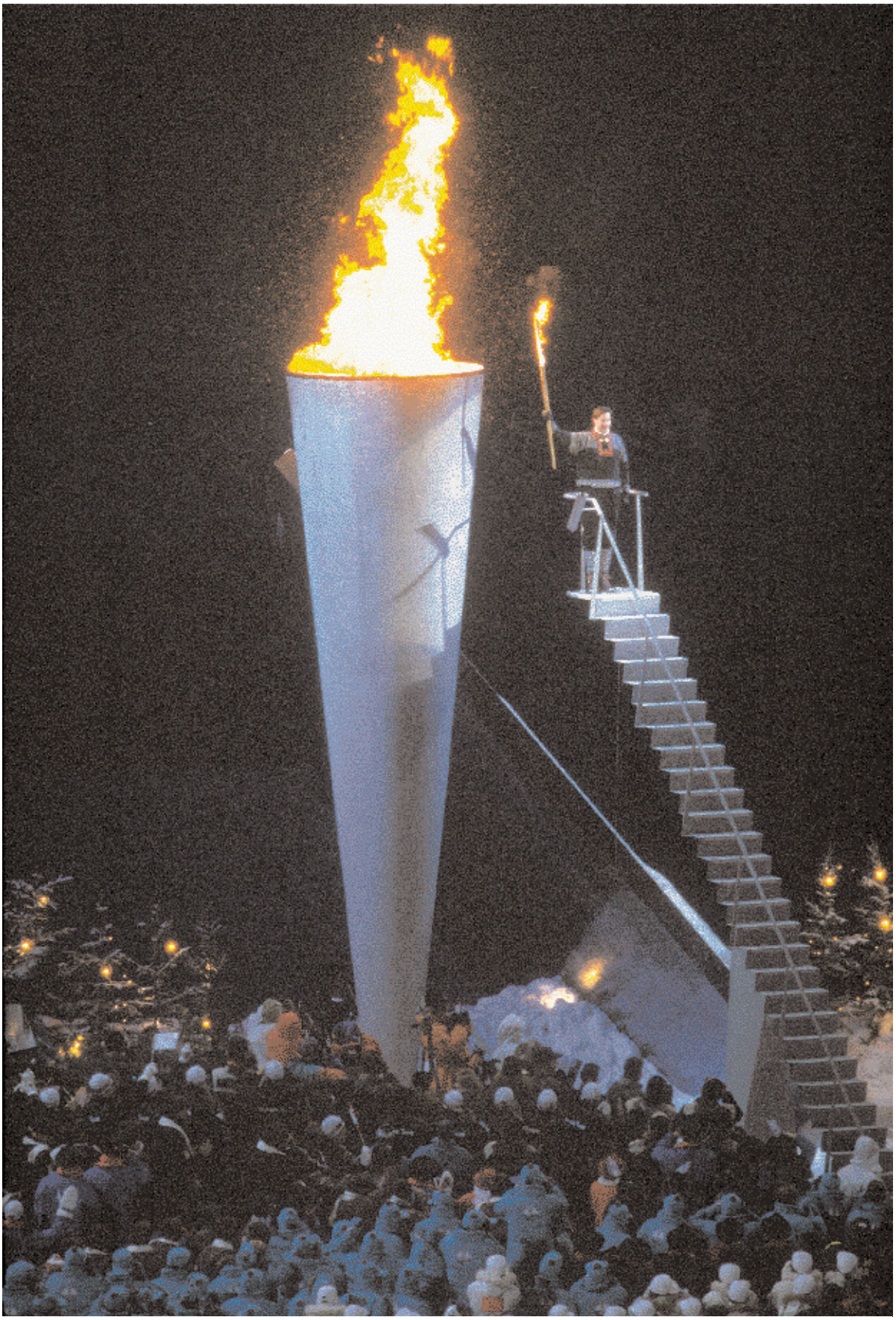
And throughout the 16 days event visitors, viewers all over the world, athletes, media - people, customers, suppliers and co-operation partners experienced sporting excellence, public rejoicing and perfect telecommunications in excellent harmony.

We expected first class sport achievements and first class telecommunications. The latter was our concern during the Winter Olympics 1994. It was a tremendous challenge – but also a great experience. I hope you appreciate the technical solutions described in this volume of Telektronikk.

Ola Toftemo
Project Director, Lillehammer Olympic Games 1994

IMAGE BANK

From the opening ceremony on February 12, 1994



The Olympic flame was lit by Crown Prince Haakon of Norway

Norwegian Telecom and the XVII Winter Olympic Games at Lillehammer 1994 – a survey

BY OLA TOFTEMO

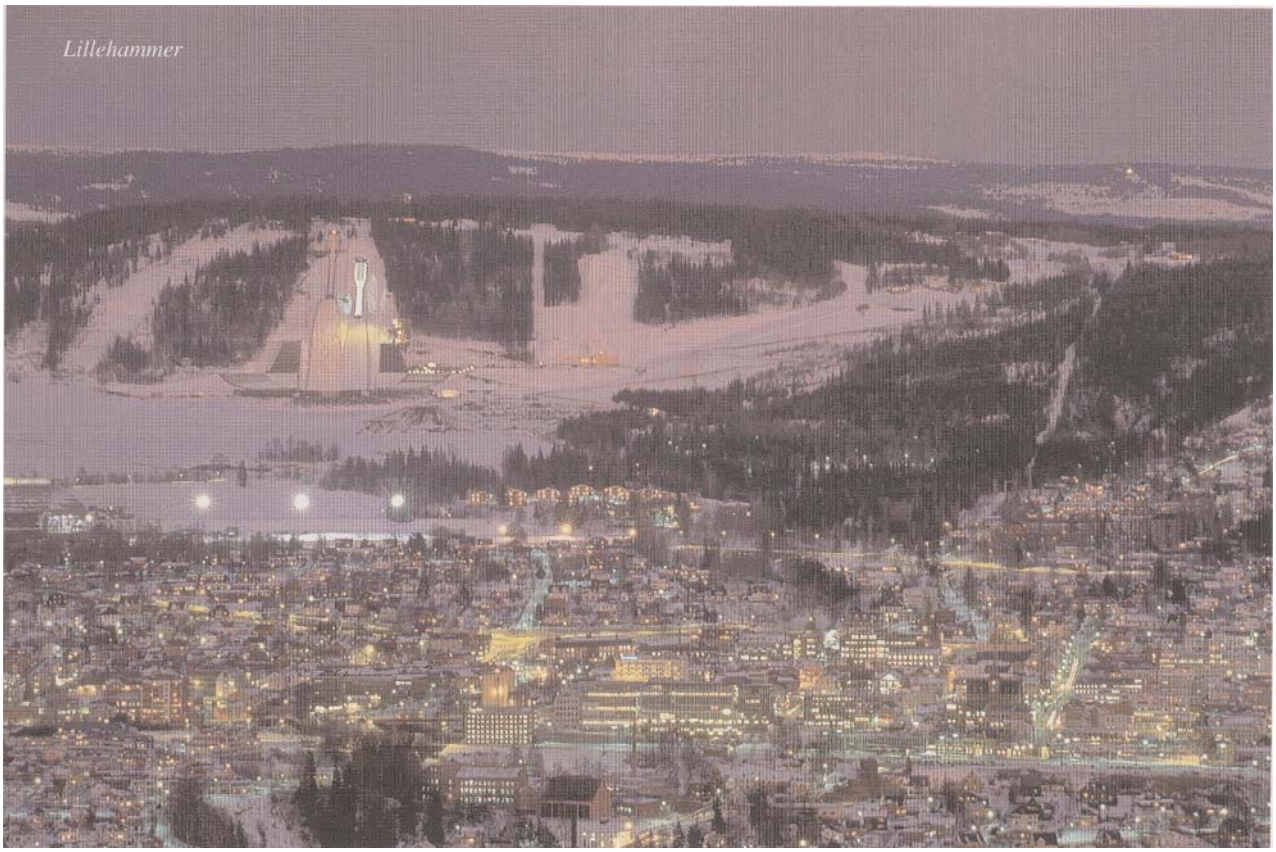


IMAGE BANK

Norwegian Telecom's Olympic efforts were based on established technology incorporating advanced and sometimes new system solutions and services. Developments over the past 10 years within satellite communications, optical fibre cables, digital switching and mobile services, provided us with a very good basis for meeting the challenges in flexibility, capacity and security.

The centre

The International Broadcasting Centre (IBC) in Lillehammer housed all the television companies producing pictures from the individual venues in the region around lake Mjøsa. The 26,300 square metres was the work place for over 4,000 people from NRK ORTO '94 (the host broadcaster), Norwegian Telecom, CBS, EBU and other broadcasting companies covering all aspects of telecommunications, broadcasting and other media services. In the centre of the building all "threads" were gathered before the final product was transmitted via six uplink/downlink stations in Norway to 15 satellites 36,000 km over the equator, and from there down to viewers and listeners in some 70 countries around the globe.

Transmission

Optical fibre cables were laid from the radio and television centre to all the main Olympic venues. For security reasons each venue was connected via two cables, each with sufficient capacity for handling all the traffic in case of a fault.

Two fibre cables were also used for communication from Lillehammer to Oslo, and further on to other countries. The transmis-

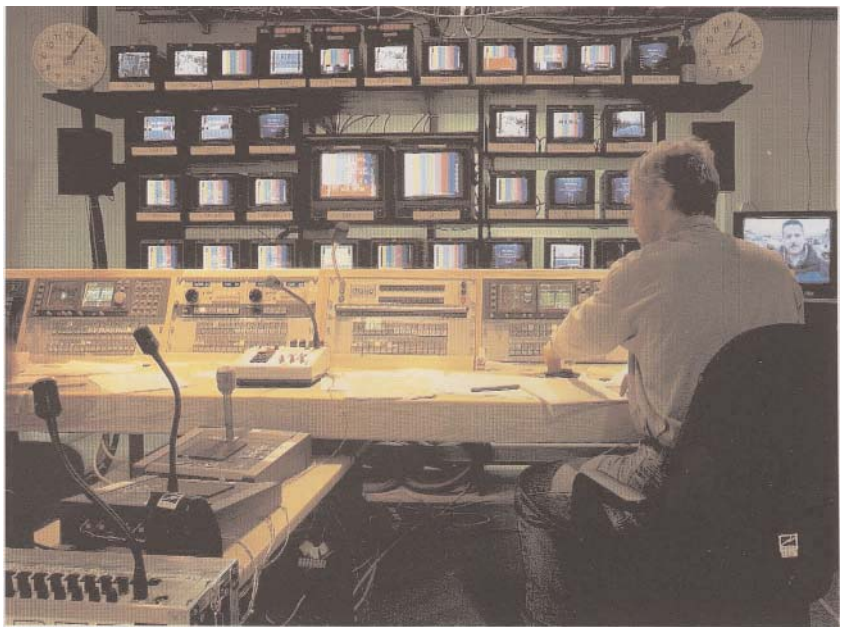


Foto: Morten Brun

International Broadcasting Centre (IBC)

Foto: Morten Brun

The work of installing technical areas and thousands of permanent cables started already in 1992.

sion of television pictures in particular required such a great capacity that it could hardly have been done by other media than optical fibre transmission systems.

The new synchronous digital transmission system (SDH) with a speed of 2.5 Gbit/s was taken into use for the first time in Norway. The system offers a capacity of 16 television connections or some 30,000 telephone channels per fibre. All signals (except cable-TV signals) were digitized before transmission – even some 95 local/regional television channels.

Cable-TV network

Norwegian Telecom was responsible for developing a trunk network for cable-TV, while our daughter company TBK was responsible for local distribution at the venues and accommodation villages. This implied solutions based on optical fibres and radio links with a capacity of 24 channels to 23 destinations, as well as ether distribution of cable-TV signals with 8 channels in the IBC area.

Foto: Morten Brun

Olympic Network

In order to alleviate communication between the various Olympic partners – LOOC, the police, hospitals, athletes, the media, etc. – a specific telephony solution was established: the Olympic Network. A VPN network (Virtual Private Network) was installed by Norwegian Telecom and TBK, consisting of public exchanges (Centrex lines) and PABXes (internal exchange lines) offering the users a large degree of flexibility in choice of service and user friendliness. In the course of the 16 days of the Olympics a total of 12 million telephone calls were transferred in the three Olympic exchanges in Lillehammer. The Olympic Network was initially established to increase efficiency of the Olympic communication but brought with it a concept which may easily be transferred to the telecommunications requirements of business and trade.

ISDN

During the Olympics ISDN had its debut in this country as a commercial service. Among others, ISDN was employed by NRK (Norwegian Broadcasting Corporation) for interviewing athletes live using a videophone, as well as by the press for national and international data communication.

Nearly 400 ISDN connections were supplied to customers like LOOC, the national newspapers Dagbladet and Aftenposten, and various broadcasting companies, and for Norwegian Telecom's own use. We would particularly like to mention that several customers from the Japanese press had advanced installations requiring ISDN solutions.

Another important service was our ISDN based switchboards for Centrex use. Norwegian Telecom had a total of 14 ISDN switchboards successfully operating – a service which is new to us.

Mobile services

Mobile telecommunications played a major part both in the communication between the various Olympic participants, and between Lillehammer and the rest of the world. Never before have mobile telephones been used to such an extent as was seen in Lillehammer. Paging with text was developed as an internal communications network for the Lillehammer Olympic Organizing Committee – LOOC, and as part of the common services from the Telecom Group. In addition, GSM was introduced – the new European mobile telephony system which offers the customer greater mobility since he may use his GSM subscription wherever it is established, independent of country boundaries. With GSM added to the existing system, NMT, the capacity for mobile communications was six times larger than normal in the area. Total capacity in the Olympic region and along the supply roads to/from Oslo was over 2,200 mobile channels, with a distribution of one quarter NMT 450, one quarter GSM, and one half NMT 900.

During the Olympics about three million mobile telephone calls were made in the Lillehammer area.

The press terminal

Norwegian Telecom developed a telephone for the Olympics specifically intended for the press. Journalists had access from one and the same terminal to whatever telecom service they might wish for, with a possibility to add on various equipment from PC with modem to photo transmitters. Payment was done by use of prepaid cards or VISA cards in the actual telephone set. The terminal also had a display window which could offer user assistance in six different languages.

A total of 1,000 terminals were located in all the press centres as well as in indoor public areas during the Olympics.

Security

In order to meet the strict demands to security in our telecommunications solutions, we hired consultants to carry out three different vulnerability studies with consequent reports.

An exercise was carried out in connection with a bigger test event called the Telehockey cup which confirmed that we were well prepared to handle unexpected situations. But we also uncovered areas which were important to improve in the time leading up to the Olympics.

Norwegian Telecom's technical installations and cable routes carrying vital Olympic traffic were inspected to discover possible weaknesses in security. We would like to mention, for example, that the cable route to Nittedal near Oslo was examined on foot in order to find any weak spots.

Norwegian Telecom was never subject to threats of any kind during the Olympics. We had frequent contact with the Police for updates on any development of threats, so that preventive measures could be taken if necessary.

Surveillance, operation and maintenance

All network administration and surveillance was carried out in Norwegian Telecom's Surveillance and Operating Centre for the Olympics (DSOL), situated at IBC. This centre handled all the telecommunications networks including LOOC's corporate network supplied by TBK and Tele-mobil's mobile network. In addition, a common fault notification service was established for all types of faults in private and public networks as well as equipment faults. In the preparation period leading up to the Olympics the service was very busy with an average of 100 reported faults per day. This number was quickly halved, after a week the number was reduced to 20, and the last few days it was below 10.

It was the first time in this country that surveillance and operation of all telecommunication networks in an area were gathered on one floor – a concept which proved very favourable with regard to acquiring a complete overview when identifying problem areas.

Norwegian Telecom Group employed a total of more than 600 people during the Games. In the course of 1993 they were all given training and particular experience in connection with all the trial events. The trial events helped us obtain a good knowledge of which areas we were well prepared for and which areas we had to concentrate more on. The training emphasized customer handling, Olympic information, training in co-operative work, equipment know-how, technical solutions and various security aspects. There were also elements of language training in English.

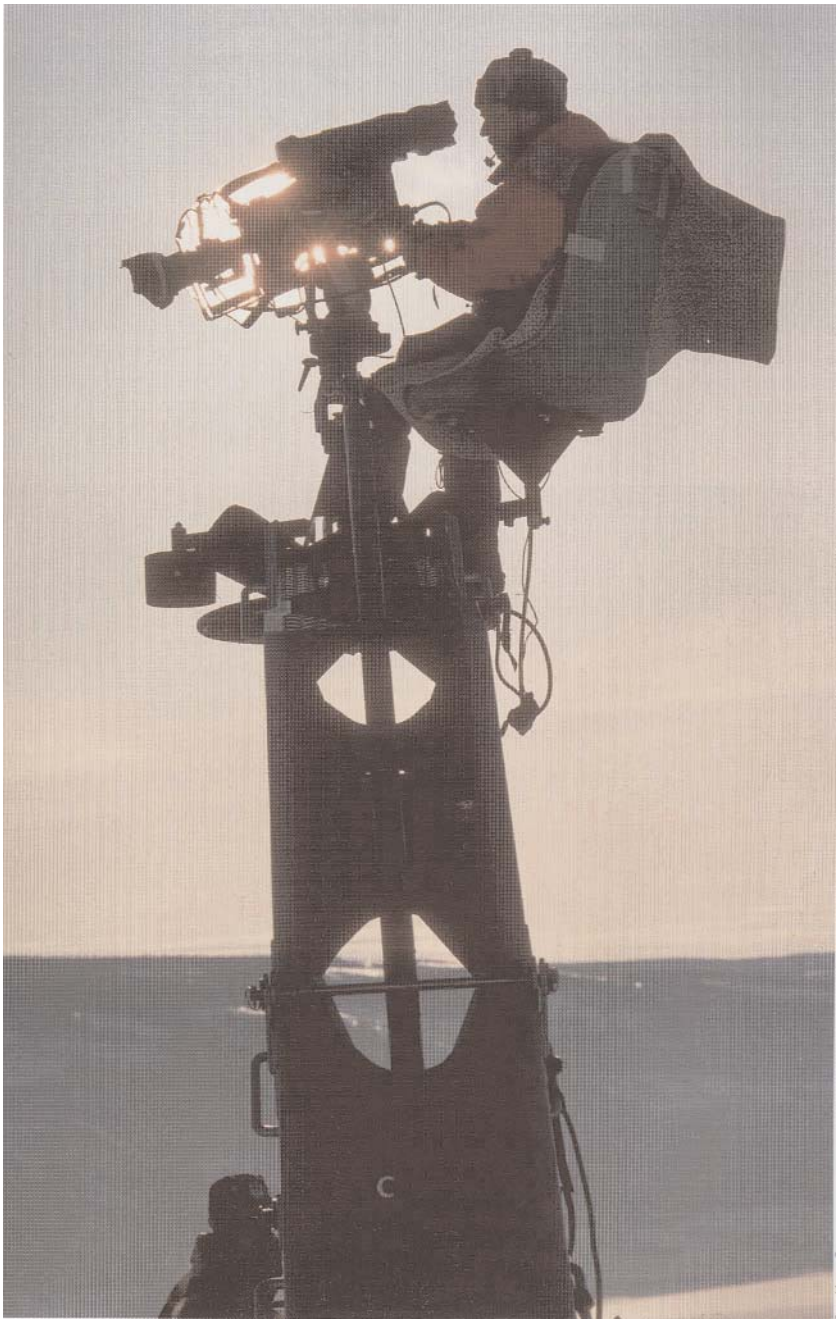


Foto: Morten Brun

Many cameras were designed to provide total views of the venues and the surroundings.

Sale and prices

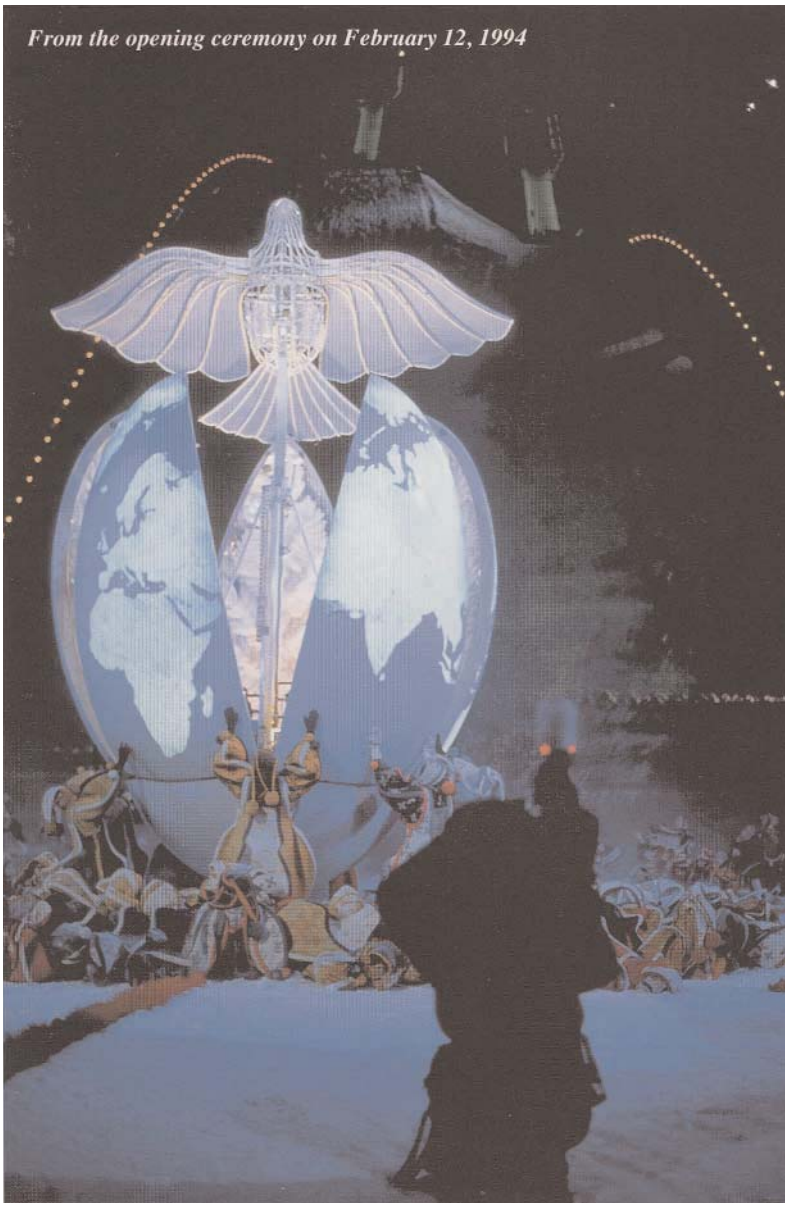
The national and international sale of telecom services for the Olympics started two years before the event. Our own sales personnel took care of the various types of customers, like the national press, broadcasting companies, LOOC, national Olympic committees, etc. Through extensive contacts, both face-to-face and via post and telephone, we achieved the

largest sale of telecommunications services for any Winter Olympic Games.

The prices of services and products for the Olympics were stipulated on the basis of the extensive development and short earning time. Thus, prices were higher than "normal prices", but lower than the prices charged by France Telecom during the Albertville Winter Olympics. The pricing system was a progressive one; i.e. the nearer to the event the orders came in, the higher the prices were. With orders being handled early, Norwegian Telecom would have an opportunity to offer development as rational and cost effective as possible.

Teleservice

15 Teleservice centres were established in the Olympic region and in Oslo, the majority of them for the media at the venues, in the Main Press Centre (MPC), at IBC and in the participants' village in Lillehammer. They were located in connection with common work rooms for the press at each venue and were responsible for selling and hiring out various types of equipment: mobile telephones, adapters, calling cards, telefax machines, etc. In addition, the centres handled new subscriptions and gave assistance in sending telefaxes. During the trial event the previous year it became clear that many needed assistance in transferring their articles to their newspaper's main office. We therefore had technically skilled personnel at the Teleservice centres who could assist if need be.



From the opening ceremony on February 12, 1994

Foto: Morten Brun

Project management

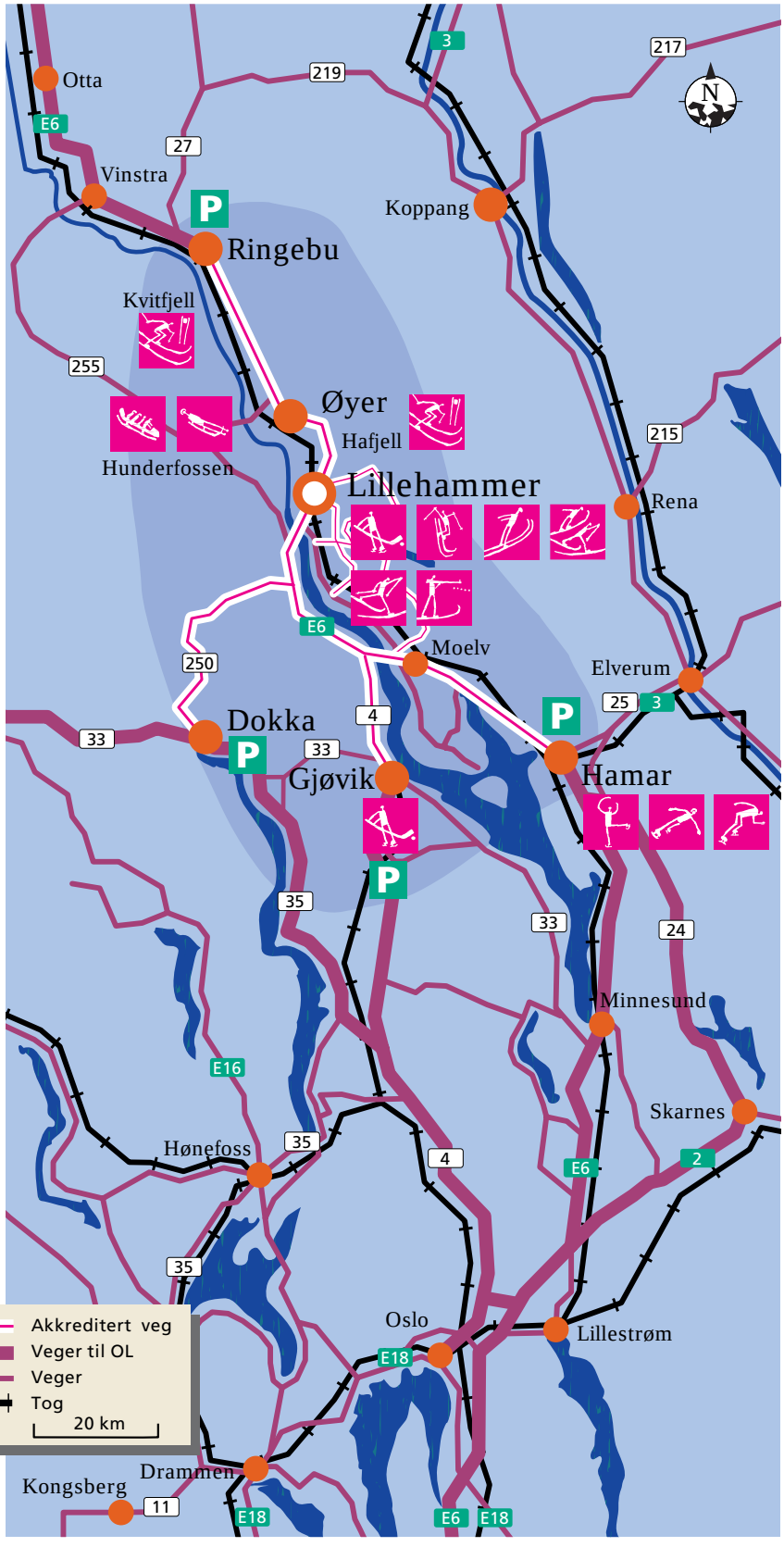
The realization that telecommunications was an important prerequisite for a successful Olympics brought Norwegian Telecom into the planning process at an early stage. Norwegian Telecom's Olympic Project (TOP) was established as early as 1989, with a particular responsibility for planning, co-ordinating and following up Norwegian Telecom's total Olympic commitments. The project organization was kept as small as possible with just over 50 people as a maximum, while the regional and central basis organization was largely responsible for the operative planning and development in accordance with agreements made with TOP. The total development, comprising nearly 5,000 defined activities, was implemented with the help of a project management program for keeping track of costs, time schedules and personnel resources. Such a tool is necessary for meeting requirements of quality, follow-up and time schedules in an event like the Olympics.

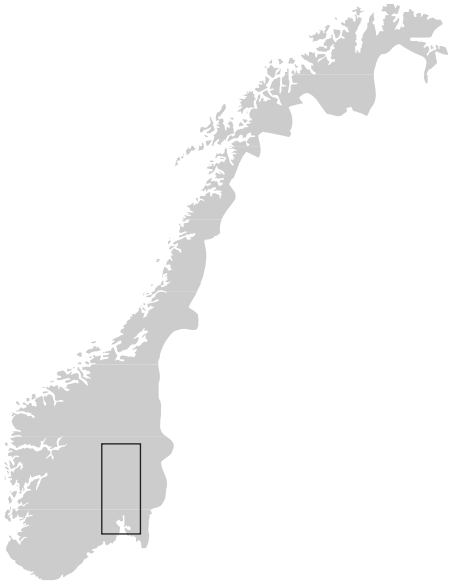
The project management program used during the installation was also used for the dismantling period. More than 90% of the installed equipment was dismantled.

After-use

Norwegian Telecom, together with our subsidiaries TBK and Tele-mobil, supplied overall telecommunications solutions for the Olympics. After the Olympics, the Norwegian Telecom Group was left with experiences which our customers could also benefit from, firstly in the form of

- Installations
- Experiences and skills within new technology, new services, project management, quality assurance of overall solutions and international sales
- A modern telecommunications network in the Olympic region
- A stronger telecommunications network to other countries
- Re-use of dismantled equipment.





Map of Norway showing the area from the Oslo fjord in the south to Otta in the north. The Olympic region around Lillehammer is shown in a darker colour

Technical solutions

BY JAN ERIK SVENSSON

This article describes general aspects on master plans, security, project process and project tools, dismantling, logistics, instrumentation, quality securing, etc.

Other articles will have more detailed information on the technical equipment and solutions related to this equipment.

1 Introduction

As telecommunication is the most important element for a successful modern sports event, it was a big challenge to produce the right technical plan at the right time in a most cost-effective way.

The pre-planning period started just a few weeks after Lillehammer had been awarded the XVII Winter Olympic Games, and some conclusions were reached quite soon, like:

- Fibre and digital equipment to be used instead of micro-wave links
- Well-known systems with no younger technology than 1992 to be used
- Secure systems important
- Very high capacity necessary
- At least two transmission ways to/from every important venue were needed
- Requirement analysis had to be done before detailed technical plans and construction could start.

The basis for our requirement analysis was earlier plans from Calgary, Barcelona and especially Albertville, compared to special conditions in Lillehammer like topography, "Compact Games", and the fact that the Winter Games would be of great interest in the Scandinavian countries.

The plans also aimed at allowing maximum re-use of the equipment after the Winter Games.

2 Master plans

During the planning period five master plans were published, based on corresponding requirement analyses. A number of smaller technical groups worked with details concerning plans for mobile systems, switching systems, data systems, transmission systems, traffic analysis and all types of terminals.

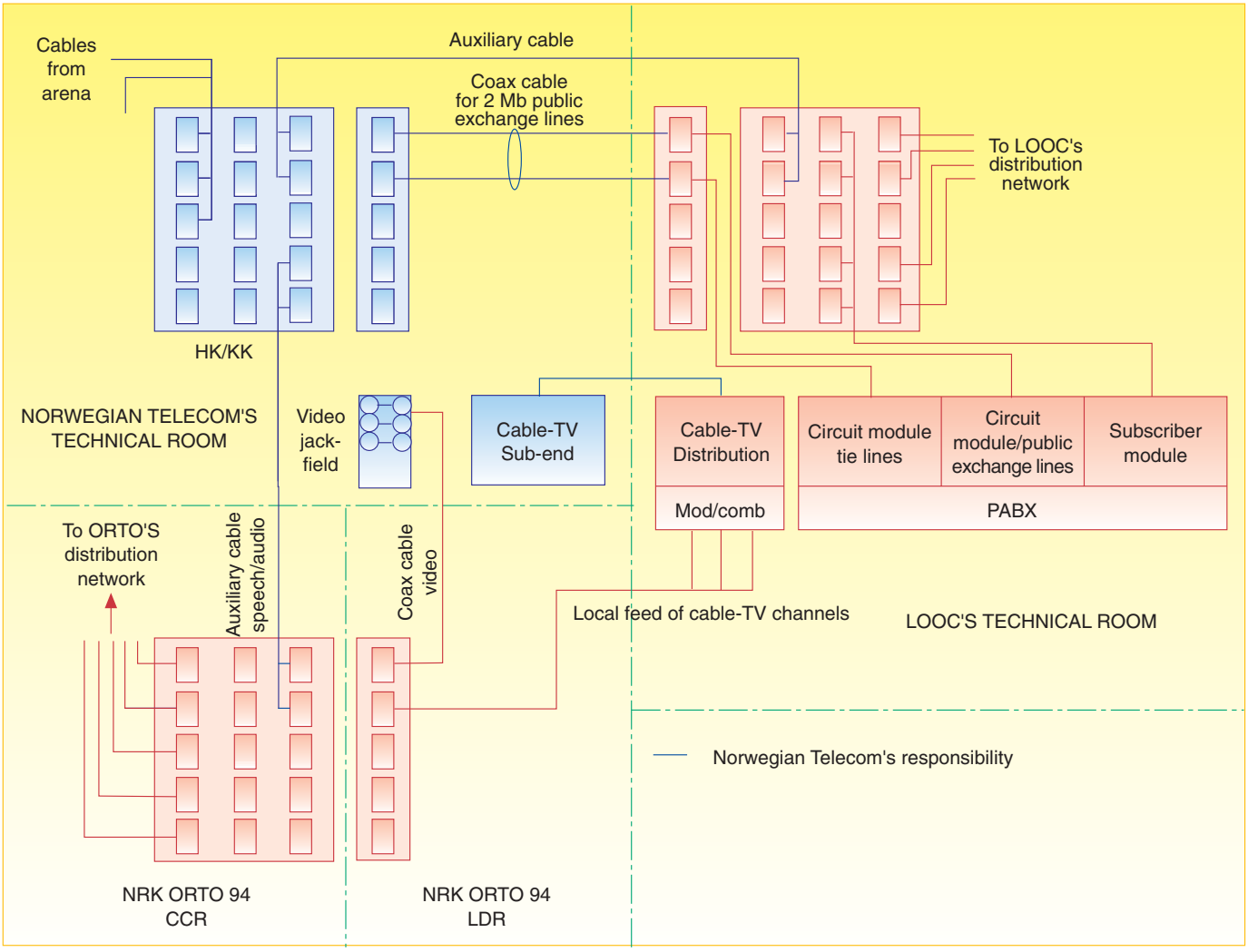


Figure 1 Outline of interface between Norwegian Telecom, LOOC and NRK ORTO '94 at IBC

The plans described Norwegian Telecom's construction of layouts and installations to be used during the Olympics. The Olympic region itself is limited geographically from Kvitfjell in the north to Hamar/Gjøvik in the south, a total distance of nearly 100 km, but our plans and installations covered in all nearly 70 technical rooms in the eastern and southern part of Norway.

At first, we only made plans for the Olympic venues and for the transmission ways to/from them, but as we realised that the normal infrastructure would also have a lot of installations (nearly 3,000 subscribers), detailed plans were made in co-operation with Region East of Norwegian Telecom.

Early on in the process we also realised that it was very important to define the correct interface towards LOOC, NRK ORTO '94 and TBK. In the contracts with these partners, we therefore made some interface outlines. The interface outlines are shown in Figure 1 for IBC and Figure 2 for the other venues.

We also stressed the importance of including in the contract with LOOC some main items concerning power consumption, area for technical/logistic/relaxation/office use, area for telecommunication services and area for Telecom cars and technical towers. Table 1 shows details of these items.

2.1 Responsibility

Together with TBK, Norwegian Telecom had the total responsibility for telecommunications between all venues and to/from the rest of the world. For Norwegian Telecom this responsibility included high-capacity construction of infrastructure for TV pictures and sound, lines for radio commentary, normal subscriber lines, Olympic Network lines, ISDN, secure systems, satellite communications, cable-TV, mobile and paging, telex and data communication, and all the maintenance systems. It also included installation of the equipment for using the infrastructure, including space in ordinary sites for Norwegian Telecom for radio base equipment for TBK, LOOC, the police, NRK ORTO '94, etc.

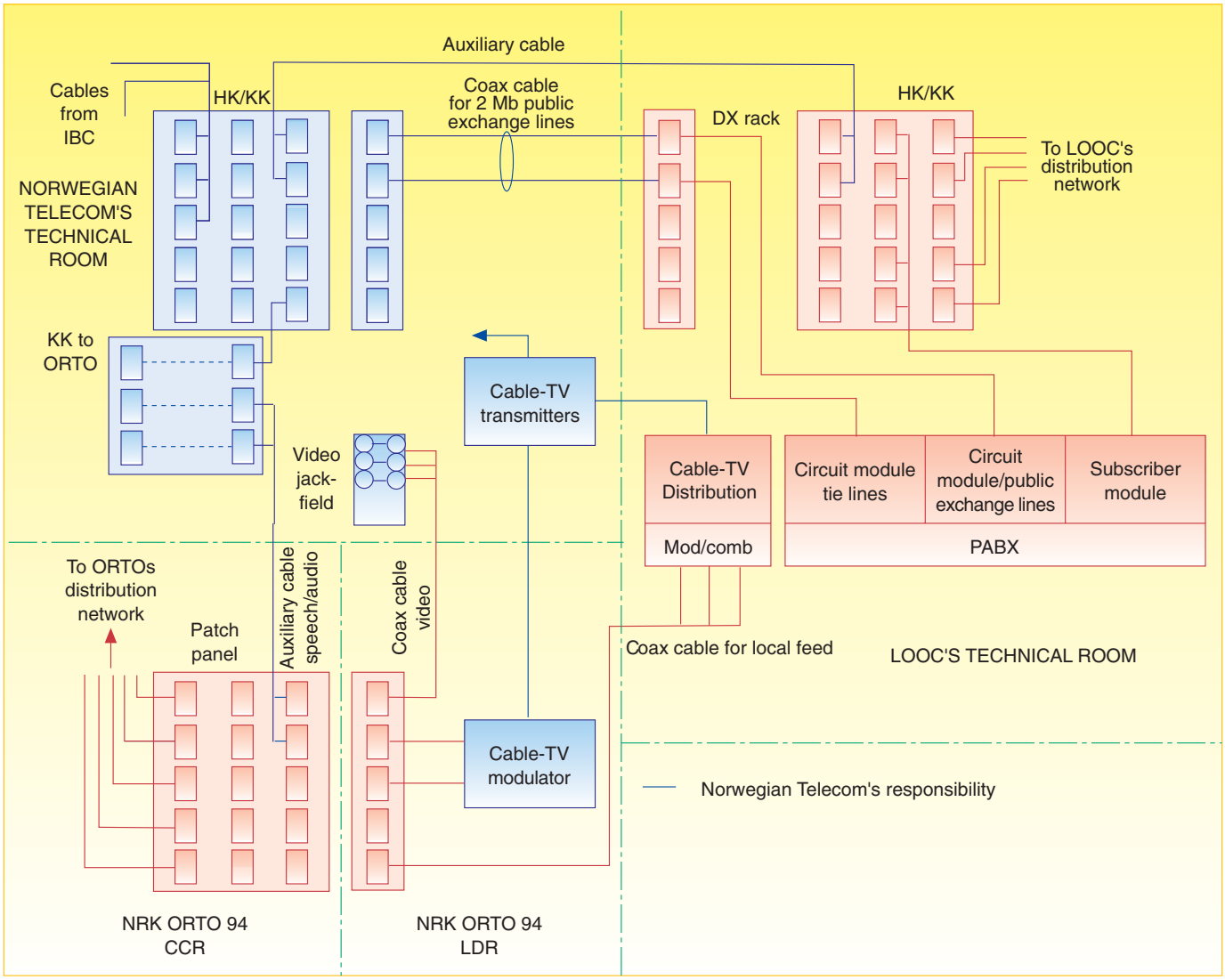


Figure 2 Outline of interface between Norwegian Telecom, LOOC and NRK ORTO '94 at an Olympic arena

2.2 Choice of equipment

As mentioned before, we had to choose equipment that was technically well-known and in stable production in 1992. This applied to most of the equipment. But it was not so for the switching system and for some of the broadcasting systems concerning the transmission parts.

The switching system was based on S-12 delivered by Alcatel Telecom Norway in co-operation with Bell. Due to problems in the new program package to be delivered, we had a long and heavy way to go before the solutions were stable and working well. Thanks to a fantastic effort and skilled persons it was successful, but not until some days before the Games started. The delay concerning the broadcasting part was caused by the fact that the host broadcaster (NRK ORTO '94) changed from analogue to digital production so late that we had some problems ordering equipment to match the new technical interface.

Table 1 Installations/arenas – area, power consumption, car parks and tower foundations

Arena/venue	Technical area, NT				MPC and SMC			
	m^2/net	Power (kW) UPS/prior.	Storeroom NT/LOOC (m^2)	Operations room, NT (m^2)	Telecom service centre	Office (m^2)	Car park (No. of places)	Tower foundation
Kvitfjell	55	7/19.9	50	15	50	15	5	X
Hafjell	55	3/10	50	15	50	15	5	X
Hunderfossen	60	3/8	60	5	35	20	5	X
IBC	585	28/53	60	180	60		12	X
IBC/Booking					140			
IBC/Satellite area	5000	250/0						
MPC/ Press centre	50	6/4	30	100	140	30	12	
Olympic village	35	2/4	50	10			5	
Håkons Hall	100	8/33.2	40	15	35	20	5	X
Kanthaugen	70	3/8	60	15	40	30	5	
Abbortjern satellite	600[1)]	83/0						
Abbortjern	70	13/19.9	50	20	35	15	5	X
Gjøvik Olympic Cavern Hall	38	3/10	40	25	35	20	5	X
Hamar Olympic Hall	45	3/8	40	20	35	15	5	
Hamar Olympic Amphitheatre	50	3/8	50	20	35	15	5	
Ceremony/ Medal awards	35	3/6					2	
Hamar/Media	35	3/6	50	10			2	
Hafjell/Media	35	3/6	50	10			2	X
Storhove/Media	35	3/6	50	10			2	
Nordseter/Media	35	3/6	50	10			2	X
Jorekstad/Media	35	3/6	50	10			2	X
Skeikampen/ Media	35	3/6	50	10			2	X
IOC Hotel	20	0/3	30	10			2	
Banken/ Maihaugen	10	0/3						
LOOC	10	5/3						
Police	3							

[1)] Outdoor area

A main task for us was also to use identical equipment in all technical rooms to simplify the operation concept, so that the operation personnel were familiar with the installations at all the different venues.

In Table 2 is listed some of the equipment that was installed.

2.3 Re-use

From the beginning all our plans had an overall goal to plan for re-use of the equipment after the Olympics. Because of that, we had to get equipment that would fit into the ordinary network and to construct the infrastructure for maximum re-use. Of course, some of the equipment will have no re-use due to the sher mass of equipment and the fact that not all of it consisted of standard components (only Olympic standard).

3 Security

In order to get through such a big, complex and media focused event as the XVII Winter Olympic Games and with the Norwegian Telecom as the main bearer of all telecommunications in the region and out to the world, the security had to be managed very strictly.

Table 2

Purpose	Type of equipment	Supplier
48 V power station	Rectifier, PRS 1500/PRS 500	Eltek
	Batteries (ventilator regulated)	Eltek (Tungsten)
	Batteries (lead)	Eltek (Varta)
Switching	S-12, N-4	Alcatel
Transmission	2500/622 Mbit/s FOT-line equipment	Philips
	140/34 Mbit/s FOT-line equipment	Siemens
	2 Mbit/s pair cable, line equipment	Telettra
	140/34 Mbit/s muldex, GEN 90	Alcatel
	140 Mbit/s micro waves, 700 mkII	NEC
	34 Mbit/s micro waves	SIAE
	DACS	Siemens
Satellite	Antenna	NEC, Vertex and ABB Nera
	GEC equipment	NEC
	HPA equipment	MCL and NEC
Codec	Video, PAL/140 Mbit/s	Siemens
	Video, 4:2:2/3 Mbit/s/140 Mbit/s	Siemens
	Audio, 15 kHz	Siemens
	Audio, 7 kHz	Philips
Cable-TV	Fibre equipment	Teleste
	Modulators	Teleste
	CTV micro waves	Lyscom
Mobile base stations	NMT 450	Mitsubishi
	NMT 900	Nokia and RS
	GSM	Ericsson
	Paging with text	Magnetic
Data	Datapak	Sprint
	Flexi-mux, DXX	Martis

If Norwegian Telecom did not succeed, the Olympics would not succeed:

We bring the Olympics to the world – and we did!

Working with our plans in the installation and operation period the security aspects had been one of the main items to discuss and to solve.

These main items were evaluated:

- Physical security of the constructions
- Different transmission ways
- Technical security, with focus on hacking and data virus
- Security concerning fire
- Security concerning burglary
- Security concerning documents
- Security concerning personnel
- Types of alarm and where to put detectors for alarms
- Co-operation between the police and Norwegian Telecom for where to put on security staff to protect technical installations
- Locking system with high reliability.

We had discussions with the Ministry of Justice and LOOC to get some general outlines, but most of the rules that we worked with were prepared by Norwegian Telecom itself. We also established a security group that gave recommendations and carried out security inspections at all venues several times. The Olympic Project also had its own security deputy.

Because we started rather early with our installations at the venues, the security was not a primary aspect for LOOC at that time. To us it was important to have a total control of the equipment to prevent anybody from stealing/damaging the equipment or install unauthorised equipment that could cause failure during the Olympics. After the Games we have to say that the co-operation with LOOC was quite good, but not as good as we had hoped, and we therefore did not reach the desired level of security.

Our highest tension was at IBC (International Broadcasting Centre) because all of our lines had to go to/ from this building, including all video and audio lines. Beside IBC, we also had one of the most important temporary satellite stations.

In the process we decided to hire a neutral company outside Norwegian Tele-

com (Scandpower AS) to give us an evaluation of our security level. In their work the personnel at Scandpower had full access to all our plans, to all venues, and to all our installations including places where we did not have dedicated Olympic installations.

They were asked to do investigations during three periods:

- 02.92 – 03.92: Work on analyses concerning security work in general, security from sabotage from outside and inside the organisation, security from damage because of fire, high temperature, water, snow or dust, security if some of our technical equipment should not be operational in time for the Games, the survival of the network in case of sabotage, technical fault or human fault should occur, security of the data network, security of the information and loss of vital information.

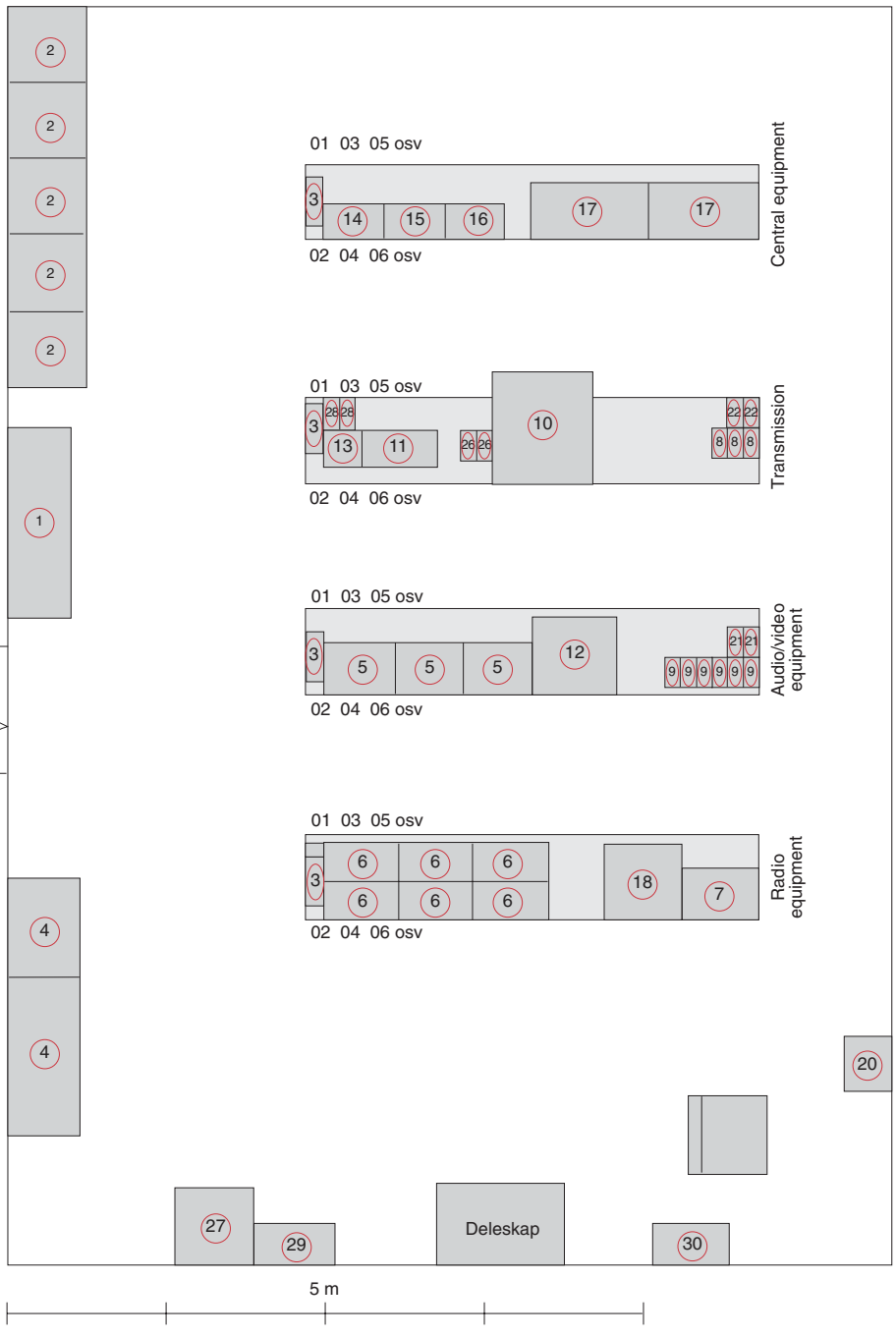
  All the analyses were presented to us in a report consisting of 42 points of action which were implemented during 1992.

- 05.93 – 06.93: Work on the same items as in the first period, both to check whether the 42 points of action were finished and whether new aspects of the same items had occurred.

  In addition, work on analyses were done concerning restriction of admittance to "our" buildings/ areas, security of the networks in the Olympic region and to/from Oslo/Nittedal/Stavanger, spare parts, plans for readiness and internal communications.

  These analyses involved Region East, Region Oslo, Region South and Region Stavanger, plus Norwegian Telecom International, Norwegian Telecom Satellite and Tele-mobil AS.

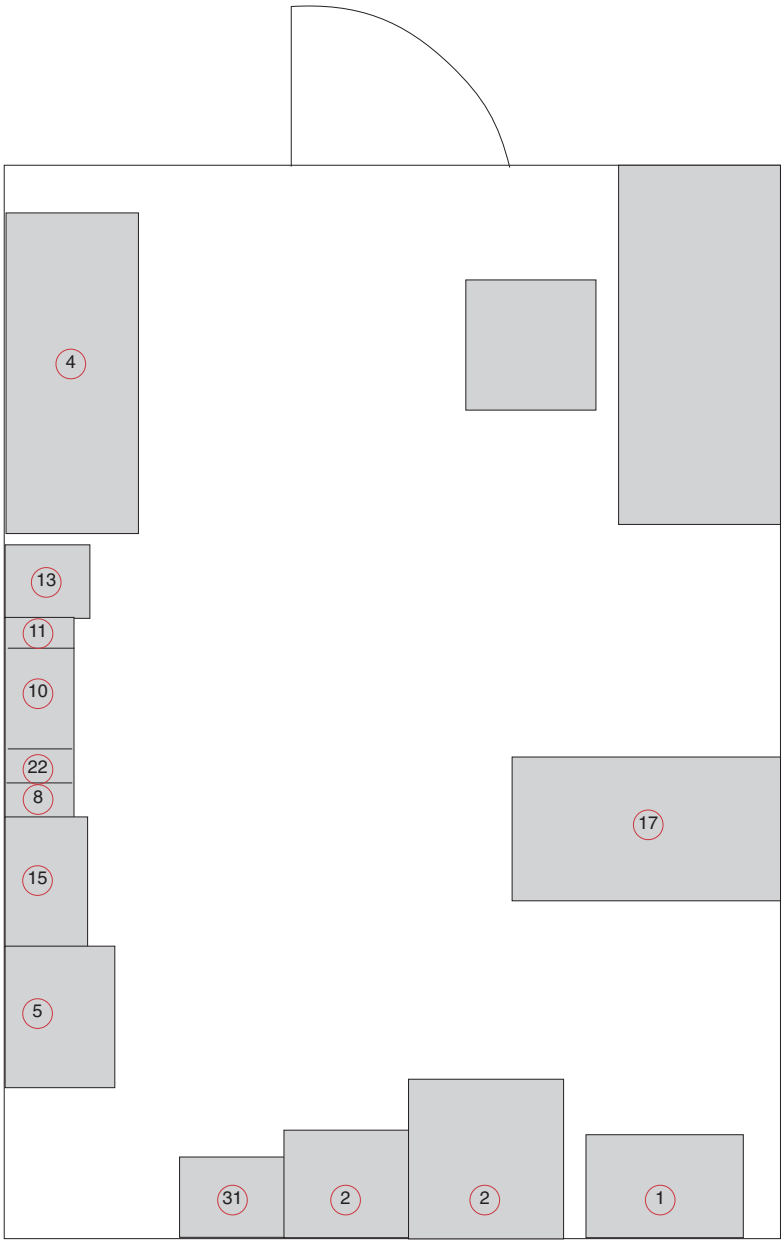
  All the analyses were presented to us in a report consisting of 166 points of action which were implemented at the end of 1993.



Tegnforklaring:

1. Fordelingsskap 400/230V
2. Batt./likeretter
3. Radskap
4. HK/KK-stativ
5. Kabel-TV
6. NMT900
7. GSM
8. Mux 2 Mb/s
9. Videokodek
10. DX-stativ
11. FOT linjeterminal
12. Audiokodek, 7.5 kHz Videoterminering
13. FOT-kabelterminering
14. DXX
15. AK-hyller+div
16. Modemstativ + div.
17. IRSU
18. PS-tekst
20. Alarmskap for S12
21. Audiomux, 15 kHz
22. Mux 2/34, 34/140 Mb/s
26. Svitsj 1+1
27. Overdrag korttelefon
28. Modem radiolinjelink
29. Miljøskap
30. Skap for fiberskjøt

Figure 3 a)



Tegnforklaring:

1. Fordelingsskap 400/230V
2. Batt./likeretter
4. HK/KK-stativ
5. Kabel-TV
8. Mux 2 Mb/s
10. DX-stativ
13. FOT-kabelterminering
15. AK-hyller + div
17. IRSU
22. Mux 2/34, 34/140 Mb/s
31. Fordelingsskap 48V

Figure 3 b)

- 11.93 – 12.93: More work on the same items as in the first and second period to check whether all points of action had been finished. Inquiries were made whether the plans were updated and well known to the hired people and it was made sure that the plan for readiness was well known.

  When all activities were closed, Scandpower prepared a statement. This statement was very positive to Norwegian Telecom and concluded with "... in our opinion this implies that Norwegian Telecom has secured itself against all aspects that can be regarded as a realistic picture of threat".

4 Project process

As mentioned earlier, all technical constructions were based on requirement analyses. Nearly 5,000 activities were defined into a project planning system – Prima Vera. The Olympic Project established an internal customer/contractor agreement, where the project was the customer and the Networks Division of Region East was the main contractor. Every contract was signed by the two partners and was followed up in monthly meetings. Other contract partners were Region Oslo, Region South, Region Stavanger, Norwegian Telecom Satellite and Norwegian Telecom International. The contracts were based on the NS-3401 standard.

As soon as the installation was completed a statement had to be signed concluding with an agreement that the installation was as specified. If not, we had to make a supplementary agreement.

Our plans and constructions were based on the ordinary infrastructure in Region East. But as most of the venues were new and had no connection to this infrastructure, we had to both rebuild the ordinary infrastructure and construct a lot of new infrastructure.

Most of the cabling was done in 1991 and 1992, and the main installations in the technical rooms took place from the summer of 1992 to the end of 1993. Work at IBC was started in January 1992.

Our experiences in using a project planning system was that it would have been very difficult to go through such a huge project without a project system. Concerning the use of hours, we learnt early in the project period that the use of hours should be minimised in similar projects

later on. The project system also told us to move some projects around within the time schedule to optimise the use of manpower. If we did not finish in time, the system would always tell us (in red).

5 Dismantling

Before we had finished the construction, we also had to start planning the dismantling. The construction plans included an after-use part, and we also started discussions with the owner of the venues to get an agreement for Norwegian Telecom to have some installations left after the Games.

We made detailed plans in 1993 for the dismantling and started dismantling meetings in January 1994. The dismantling period started in March 1994 and was closed in August 1994. It was a very short dismantling period and it was very important not to damage any part of the equipment because of the re-use of it. And another challenge was to disconnect all the customer lines nationally and internationally, and to normalise all the computer supporting systems.

6 Logistics (Material administration)

It was very important to have good logistics system. This system should cover the installation period, the period for packing and delivering of hired equipment to our customer and also to handle all equipment after the Olympics.

For this purpose we had two storehouses – one in Hamar and one in Lillehammer, and we also had small storerooms at nearly all the venues.

All equipment had to be registered in the storehouses before installation, making it possible to follow up if some equipment was missing.

Equipment for installation came from different countries and companies, as shown in section 2.2 and involved a lot of meetings with the central administration of Norwegian Telecom and with sales companies. These meetings took place in the period 1989 – 1993.

Equipment for our customers was hired from LOOC and TBK. After registration and packing it was brought out to our customers. Nearly 1,000 such packages were produced in the storehouse in Lillehammer.

To ensure that we had sufficient spare equipment, TOP had established an agreement with the most important companies. In the storehouse in Lillehammer and the storerooms at each venue, and also in some cars, we kept spare equipment. It was important that spare equipment was readily available if failure should occur during the Olympic period.

7 Other aspects

7.1 Earth connection

An experience from earlier Olympics had been the problems with earth connection for the equipment. As a result of this, TOP established an agreement with LOOC and NRK ORTO ’94 taking the overall responsibility to measure and report the quality of this issue.

We had meetings with companies which were responsible at the venues for electrical installations. The importance of understanding this issue could not be stressed enough. Our technical specialist had to measure several times and give instructions at the installation sites before we could inform LOOC that the result was approved by us.

7.2 Instruments

Because we had to install a lot of new equipment in a short time, we had to collect instruments from all parts of Norwegian Telecom as well as initiate the purchase of instruments. Nearly 80 instruments were hired from the instrumental bank at Lødingen and about 35 instruments were hired from other parts of Norwegian Telecom. During the Olympics all the venues had their own bank of instruments and IBC had an extra supply of special instruments.

7.3 Static electricity

To avoid having the equipment damaged by static electricity all technical rooms were marked on the floor with a yellow line, and crossing this line without personal antistatic equipment was not allowed. All personnel who worked in technical rooms were equipped with special antistatic shoes and we also bought some test instruments for control.

Because of all the visits we had to buy some antistatic equipment: a special heel strap. All visitors who were allowed to enter the technical rooms had to use these heel straps.

7.4 Handbook for the construction of technical rooms

The technical rooms at each venue were delivered to us by LOOC ready for technical installations. It was therefore important that the rooms had a technical standard similar to our normal standard given in our own technical manuals.

Early in the process we produced a special handbook to inform LOOC, the Directorate of Public Construction and Property (SBED), consulting engineers and all other contractors, how to construct the rooms to fit our standard.

7.5 Assembly handbook

We early decided to produce an assembly handbook for standardisation of all the technical rooms. We were of the opinion that it was very important during the operational period that the technicians were familiar with the rooms if they had to move from one venue to another in an emergency.

As can be seen from Figure 3 we had one standard for a large technical room and one for a small technical room. That covered all technical rooms, except small rooms for cross connection and IBC. IBC was so special and so huge that we had to make a special plan for this.

7.6 Quality assurance

In the contract with LOOC it was stated that we should reach a quality level corresponding to the NS-ISO-9001 standard. Since Norwegian Telecom is not certified for this standard we spent a lot of time proving that all our work was at least as good as this standard.

Construction of transmission network

BY SVEIN EGIL MOEN

1 Scope of the construction

As early as the pre-project phase in 1989 it was anticipated that Norwegian Telecom (NT) in all probability would be given the responsibility for transmitting services requiring large capacities, such as pictures and sound for the broadcasting companies. The transmission of pictures in particular demands such large capacities that it was a vital issue in laying down the premises for dimensioning Norwegian Telecom's transmission network. Each picture transmission requires a whole 140 Mbit/s channel in the transmission systems. With an anticipated need for 4–5 such channels from each venue into the Radio and Television Centre (IBC), any other need for telecom services would have a minimal effect on the total capacity requirement.

Another scope of the construction of the transmission network lay in the demands from Lillehammer Olympic Organising Committee (LOOC) / International Olympic Committee (IOC) of operation times for the telecom services. This, together with NT's own wish to appear as a serious supplier of telecom services with a high quality and wide availability, indicated that security had to be emphasized in the construction of the telecommunication network. It was therefore stated quite early that alternative routes had to be established between the main venues and IBC, as well as between IBC and the connection points for international transmission.

A third important condition was of course which termination points NT should cover, which in the Olympic region were all the Olympic sites, as they were defined one by one. As regards international connections a discussion went on for some time about which up-link stations to use. Nittedal earth station was decided quite early on. At a later stage, Eik earth station and Tryvann were introduced as important up-link points, together with two locations in Lillehammer. The international exchanges in Oslo were also early defined as important connection points in a transmission network.

2 Choice of transmission medium

In order to meet the transmission requirements stated above, high-capacity transmission systems would be needed. On the basis of the relevant technology at this time and the developments visualized in the time leading up to the Olympic Games, three alternative ways of construction became apparent:

- Construction with satellite connections between the sites
- Construction with digital radio links
- Construction with fibre optic transmission systems.

Bearing in mind the wish for "Compact Games", with relatively short distances between the venues and IBC, and after a brief financial assessment, it was concluded that conditions were suitable for fibre and high-capacity transmission systems in the Olympic region. Radio links and satellite transmission were so costly that they would require long distances of transmission in order to be competitive solutions. On this basis it was early decided that fibre optic connections were to be established between the venues and IBC.

The national fibre optic network was at this point being expanded between Oslo and Trondheim via the Gudbrandsdalen valley. This expansion was taking place independent of the Olympics. Some sections were already established, while new sections were planned.

Conditions were therefore found to be well suited for thinking in terms of fibre optics even for national transmissions over great distances.

In order to cover the international transmission demands for pictures, satellites were the unquestionable solution. Long distances in combination with a large number of points receiving the same pictures has made this a unique solution in other connections, too.

For services requiring less capacity, however, the earth-bound network was a relevant alternative. The needs for international connections were undeniably great, but not of a magnitude requiring the establishment of separate transmission media. International connections, with the exception of picture transmission, were to be based on existing media with increased capacity.

3 Construction of fibre cables

As mentioned above, the starting point for this construction was the decision to use the national network cables where possible in Norway, and otherwise establish new fibre cable sections, particularly in the Olympic region itself.

The demand for a high degree of security and alternative transmission routes contributed to the fact that ring structures were sought in all parts of the network. Leading into each individual venue, the two cables were completely separate as far as inside the walls of the actual building where the cables were to be terminated. Furthermore, at least one of the cables to the venues should be underground. Aerial cables should only be used on the alternative route.

3.1 Construction in the Olympic region

With IBC as the starting point, fibre rings were established to all the Olympic sites. All sports arenas, the press centre and LOOC's administration building were defined as high priority and should be included in the ring solutions. The accommodation villages were defined to be of a lower priority; consequently one transmission route would be sufficient. In addition to the fibre cable connections, copper cables were established from the Olympic sites to IBC or to the nearest existing NT building. The purpose of this was to be able to run alarm circuits and other types of control circuits in NT's own cables and routes independent of the cables they were monitoring.

3.1.1 Co-operation with other partners

There were naturally other service organizations who needed to dig trenches close to the Olympic sites and NT had to work closely with them. A co-ordination committee was established to make sure that all digging activities were co-ordinated so that trenches only had to be dug once. Furthermore, NT made an agreement with LOOC whereby LOOC would undertake to establish all cable trenches inside the arena boundaries. This implied that LOOC would have the trenches dug and pipe trenches laid from a manhole at the arena boundary into NT's technical rooms. Then NT would pull their cables through and connect them up in the manholes.

3.1.2 The Olympic Park ring

The Olympic Park – comprising Håkons Hall, Lysgårdsbakkene, Kanthaugen Freestyle and Birkebeineren Ski Stadium – was included in one ring. The accommodation village and Skihytta satellite station were also on this ring. There were no existing cables on this ring, so completely new cables had to be installed in

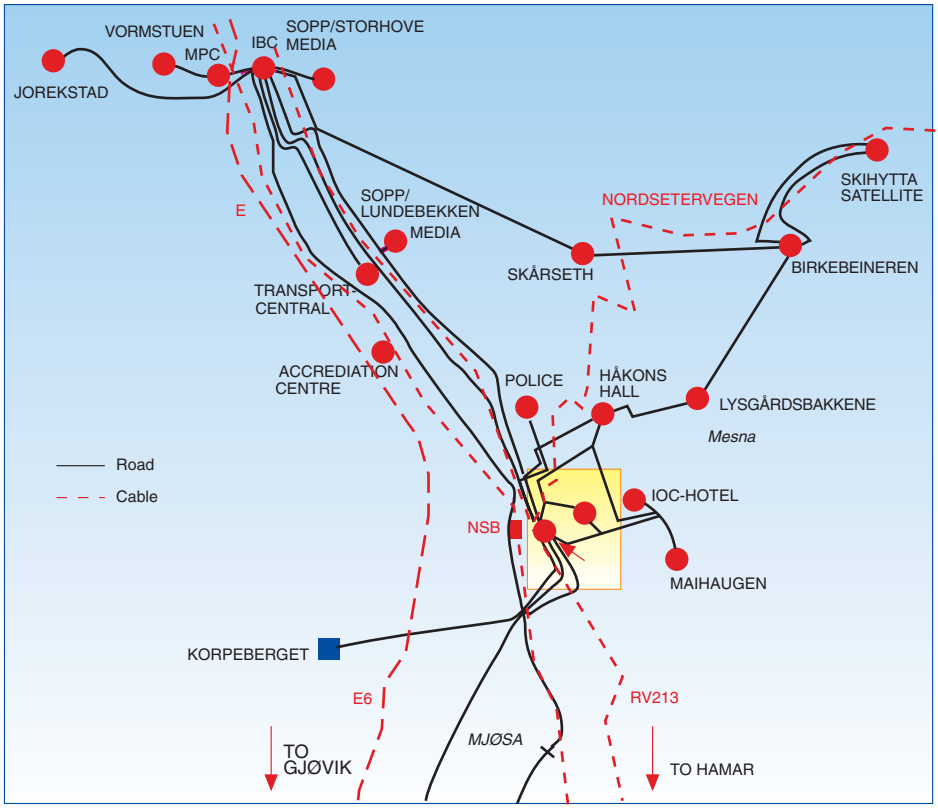


Figure 1 Fibre cables in the Olympic Park in Lillehammer

this area. Pipe trenches were laid in the whole of the ring, and a G16 fibre cable was pulled through with termination in each of the technical rooms of the ring. As a further safety precaution for the connections to Håkons Hall – where one of the two Olympic exchanges was located – a through-connection across to the accommodation village was established, so that transmissions between Håkons Hall and IBC would not have to take the detour via Birkebeineren Ski Stadium.

3.1.3 The Gudbrandsdalen ring

Further up the Gudbrandsdalen valley were the venues Hafjell Alpine, Kvitfjell Alpine and Hunderfossen Bob/ Luge. These three arenas were included in one ring. Even before the Olympic construction was started, a fibre cable had been laid up the Gudbrandsdalen valley. This passed close to all the three sites. A large part of this cable was mounted on poles, making it necessary to lay new sections of earth cable in order to bring these arenas a new main route. Hafjell and Hunderfossen were close to IBC, making new earth cable routes economical. Kvitfjell, however, was situated so far from IBC – some 60 kilometres – that a financial assessment indicated that a radio link connection there would be more favourable as an alternative route to the existing fibre cable. The result here was a fibre ring comprising Hafjell, Hunderfossen and IBC. Kvitfjell had its own ring including the existing fibre cable from IBC to Fåvang with a new section between Fåvang and Kvitfjell, while the alternative route became a radio link from Kvitfjell to Korpeberget radio link station near Lillehammer. From Korpeberget these connections were transferred via fibre back to IBC.

3.1.4 The Mjøsa ring

In order to connect the Olympic sites in Hamar and Gjøvik to IBC the national network cables were used. There was already a fibre cable in the lake Mjøsa between Gjøvik and Lillehammer. The planned work between Hamar and Lillehammer was brought forward because of the Olympic Games and was used as the other half of the ring to the two towns on the Mjøsa. The new cable between Hamar and Gjøvik was also included in this ring.

Hamar Olympic Amphitheatre in Hamar was directly connected to the national network fibre. From the Amphitheatre a section of fibre was laid to Snekkerstua Media Village. The national network fibre was further terminated at NT's building in Hamar, and a separate new fibre ring was laid from this building to Hamar Olympic Hall. A single fibre section was also laid to the accommodation village in Hamar.

In Gjøvik, the national network fibre was terminated in NT's installation inside the mountain next to Gjøvik Olympic Cavern Hall. All that needed doing here was to lay new cables inside the mountain installation.

3.2 National network

Before the "Olympic construction" was started, fibre cables were already established on the sections Oslo – Gjøvik, Gjøvik – Lillehammer, Lillehammer – Trondheim, as well as Oslo – Hamar and Hamar – Gjøvik. New installations were being started up between Hamar and Lillehammer as well as a replacement of the installation between Hamar and Gjøvik. Both the latter installations were started up at such a late date that the Olympic requirements could be taken into consideration when dimensioning the cables.

The cable between Oslo and Gjøvik had a branch to Nittedal earth station and was the obvious one to use for traffic between IBC and Nittedal. However, this cable included a number of aerial sections. The cable between Oslo and Hamar was laid in water and earth all the way, and it was therefore natural to define this route as the main route for all traffic out of the Olympic region.

There was a branch to Nittedal from the Oslo – Hamar route, too, however, this was an aerial cable. In order to avoid further work laying this underground, it was decided to carry the Nittedal traffic down to Oslo and back again on the existing Oslo – Nittedal cable. In this way a fibre ring was established comprising the points IBC – Hamar – Oslo – Nittedal – Gjøvik – IBC.

The traffic to Eik earth station was initially carried along the alternative routes between IBC and Oslo, and from there along a single route to Eik earth station. Immediately before the Olympics, however, the installations from Lillehammer to Trondheim and from Trondheim southwards along the coast to Bergen and Sta-

vanger were opened for traffic. This made it possible to bring an alternative route to Eik, which was established at the eleventh hour.

3.3 International connections

In addition to using satellite connections via earth stations at Nittedal, Eik, Tryvann and Lillehammer, international traffic was routed in the earthbound network via fibre cables to Denmark and through Sweden. Four different cable connections out of the country were used: two fibre cable connections directly between Norway and Denmark across the Skagerrak (Norway – Denmark 5 and 6), and two cables between Norway and Sweden and further south to Denmark (Sarpsborg – Tanum and Kongsvinger – Arvika). From Copenhagen the traffic was distributed in different directions to Europe. The trans-Atlantic cables PTAT, TAT8, TAT9 and TAT10 were used to the USA.

4 Transmission systems

The transmission systems in the Olympic network were to be used for transmission of all ordinary telecom services as well as the special broadcasting services for sound and picture. They comprised:

- 2 Mbit/s lines for telephony (S12, RSU and PABX connections)
- 2 Mbit/s lines for data network (DXX connection)
- 2 Mbit/s lines for broadcasting network (Codec connection)
- Analogue leased lines, 3.4 kHz
- Digital leased 2 Mbit/s lines
- 140 Mbit/s lines for picture transmission.

Given the premises on capacity for dedicated Olympic purposes, new transmission systems had to be established both in the Olympic region itself and from the Olympic region to Oslo/Nittedal. For traffic being routed from Oslo to other countries and to the satellite earth stations, capacity in the established transmission systems could be utilized, requiring only a strengthening of the multiplexing equipment.

4.1 Choice of equipment types

Right from the start, the general policy in choosing equipment types was to use modern equipment with a high post-Olympic value. But the Olympics should not be used for testing of new, unknown technology. On this basis it was decided not to use equipment which had not become generally available and had been thoroughly tested by the first half of 1992. As time went by, the latter requirement had to be relaxed.

4.1.1 Fibre optic line systems

The dimensioning of the line systems was mainly given by the transmission of television pictures, where one TV picture would occupy a whole 140 Mbit/s channel. (See chapter on broadcasting transmissions.)

For connections between the sports venues and IBC and connections from IBC to Nittedal and IBC to Oslo, it became necessary, for capacity reasons, either to establish several parallel 565 Mbit/s systems, or to use 2.5 Gbit/s line systems. The latter were not yet on the market at the time when these assessments and decisions had to be made, but they were promised delivered by the time new equipment should be available and tested.

After a careful study of the needs for TV transmissions it became clear that such transmissions required so many parallel 565 Mbit/s systems on some sections that the fibre capacity in the cables were totally consumed. This was particularly critical for the section Oslo – Gjøvik. On summing up the needs for dedicated Olympic systems, national systems and regional systems on sections of this cable, it was found that there would not be enough fibres to cover all this. The use of capacity present in the new 2.5 Gbit/s SDH systems was therefore more or less forced upon us.

At this point in time a close co-operation started up between NT's Olympic Project, special divisions in NT's central administration (TLT and TMI) and the relevant suppliers. After extensive negotiations where prices and times of delivery were the most important parameters, Philips was chosen as supplier of 2.5 Gbit/s and 622 Mbit/s SDH line systems. Both these systems were able to operate on alternatively 140 Mbit/s or 155 Mbit/s interfaces at the station side. In the Olympic network these systems were only utilized as pure line systems. But one of the conditions for this choice was the fact that the systems could be updated to form part of a future up-to-date synchronous network with other SDH facilities.

On the basis of what the suppliers were able to deliver, NT's Olympic Project chose to use these systems also in the Olympic region itself. Firstly, this presented a uniform and simple operational situation with regard to many different systems, and secondly, it offered a flexibility to handle unexpected requirements, which later proved to be very useful.

There was also a need for low capacity systems in the Olympic network. The equipment chosen was generally available as stock goods. For the 140 Mbit/s and 34 Mbit/s levels were used Siemens PDH systems, and for 2 Mbit/s twin cable systems, Telettra was chosen.

4.1.2 Multiplexing systems

In order to meet the requirements outlined in the Requirement analysis it would be necessary to establish the whole mux hierarchy from K/30-mux upwards. The needs for K/30-mux were mainly initiated by the large number of commentary connections with return and conference lines. The 34 Mbit/s and 140 Mbit/s levels naturally had to be used in order to enter these connections into the large transmission systems. For the 2/34 Mbit/s and 34/140 Mbit/s muxes a clarification was necessary with regard to choice of supplier. Alcatel was about to sign an agreement with NT on the delivery of a new generation 90 mux with new and improved control functions. Following negotiations on terms of delivery this type was chosen. The ordinary Siemens mux was chosen for the K/30 mux.

4.2 Network construction

The premises laid down regarding ring structures to the most important arenas and telecom installations in the Olympic network were taken a step further in the planning of the transmission systems. Where capacity requirements so indicated, dedicated 2.5 Gbit/s systems were established from IBC to the individual arena, and two systems were established to each of the arenas – one on the main route and one on the alternative route. This solution was chosen for all the arenas in the Olympic Park, Gjøvik Olympic Cavern Hall and for the systems between IBC and Nittedal earth station.

Where capacity requirements were lower, the 2.5 Gbit/s systems were connected in series along the fibre ring with a through-connection of the 140 Mbit/s level lines at each arena. This solution was chosen for the section IBC – Hafjell – Hunderfossen and for IBC – Hamar Olympic Amphitheatre – Hamar Olympic Hall. For these arenas one system was estab-

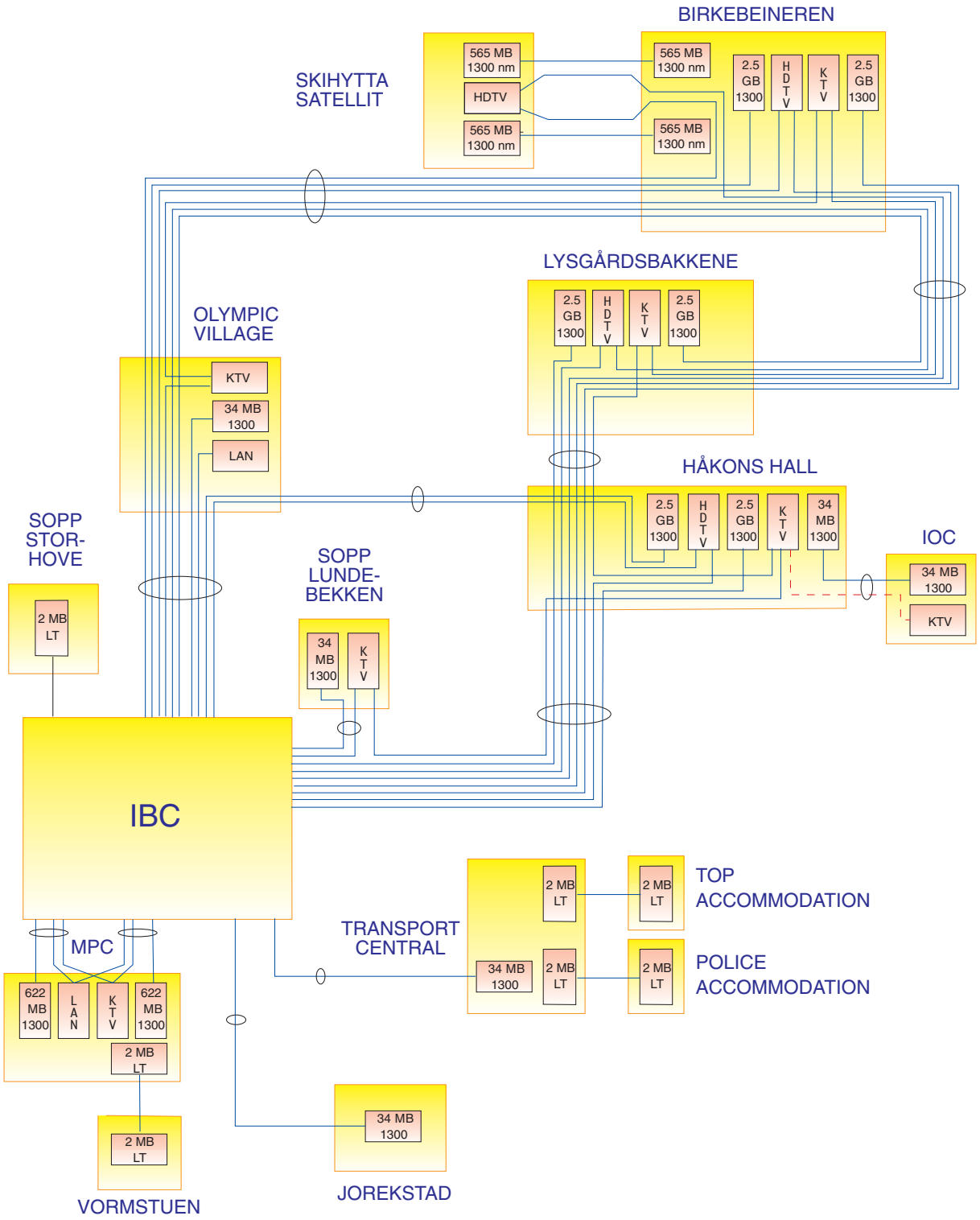


Figure 2 Transmission systems in the Olympic Park

lished directly to IBC and one system between the two neighbouring arenas.

In the national network 2.5 Gbit/s systems were established on both routes between Lillehammer and Oslo. They had vacant capacity which could be used for Olympic purposes. Dedicated Olympic systems between IBC and Nittedal earth station were established, while all other traffic to be terminated or through-connected in Oslo were transferred to the national network systems.

A total of 48 line terminals with 2.5 Gbit/s capacity were purchased as well as ten 622 Mbit/s terminals. These figures include the purchase of spare parts.

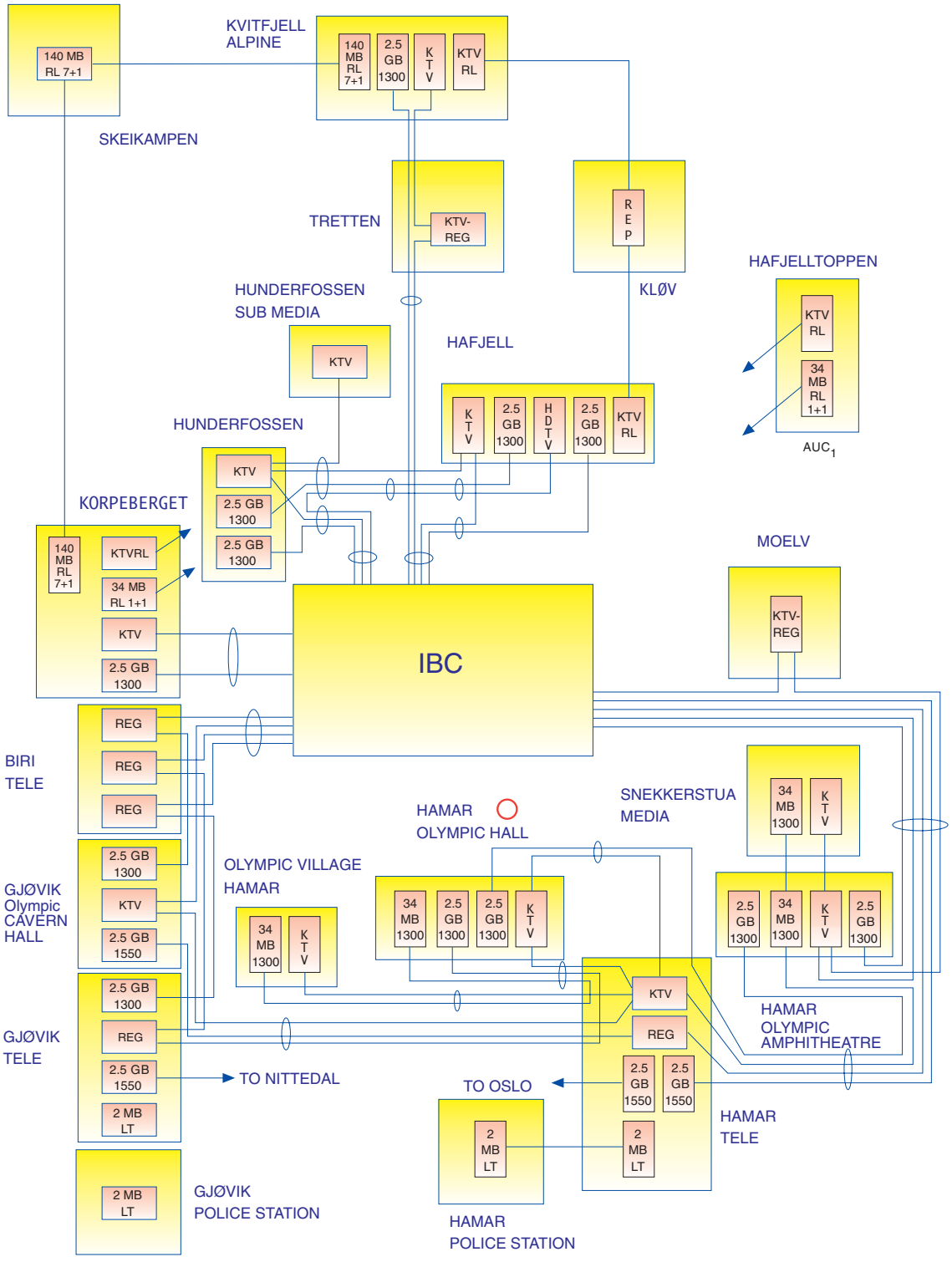


Figure 3 Switching system between the two alternative routes

4.3 Alternative routes

The above mentioned ring structures for fibre cables and their two transmission systems to each arena had formed the basis for giving all lines an alternative route in case of a fault in one route. The transmission systems were so well dimensioned that they were able to transfer all traffic in one system. There was also a strong wish for using automatic switch-over between main and alternative route. For this purpose was chosen a 1 + 1 alternative route switch which was already in use in the local network in Oslo and in the national network in Northern Norway. The switch could operate on both the 34 Mbit/s and the 140 Mbit/s level. It was

decided to use it in the Olympic network for switching both the 34 Mbit/s and the 140 Mbit/s level.

All telephony, data and commentary lines were to be switched on the 34 Mbit/s level. Most of these connections entered the transmission network on the 2 Mbit/s level and were multiplexed in a 2/34 Mbit/s mux. It was assumed that all this traffic should be carried with load sharing, i.e. the traffic should be equally distributed on the two alternative transmission routes. In order to achieve this, a complete mux hierarchy from 2/34 Mbit/s mux upwards had to be established to both alternative transmission routes.

By placing the switches between 2/34 Mbit/s mux and 34/140 Mbit/s mux, a control function in case of faults in the 34/140 Mbit/s mux was also included.

Switching on the 140 Mbit/s level was only done for video transmissions. These connections had an interface on the 140 Mbit/s level and therefore could not be switched at lower speeds.

A great challenge in connection with the switching system was achieving good switching parameters and an alarm sensor which would render a clear general view of network status. Considerations of space forbid me to describe this set-up in detail here. For example, in order to keep a clear view of the network status, the principle of re-routing all traffic from one system to the reserve system had to be introduced even if only one channel was faulty (the 2.5 Gbit/s systems had sixteen 140 Mbit/s channels). Furthermore, it was necessary to always make sure that there was a continuous 140 Mbit/s multiplex system between two opposite switches. On certain sections the lines passed through several transmission systems in series, necessitating an alarm sensor which could sense the status on the whole section. If there was insufficient traffic to have a whole 140 Mbit/s multiplexing system in a section, a system working solely as an alarm sensor had to be established.

5 Operational experiences

The operational situation in the transmission network may be divided into two phases:

- Operation before the Olympics
- Operation during and after the Olympic Games.

In the pre-Olympic period the operational situation was characterized by a lot of faults and a turbulent existence for the technical engineers. In particular the introduction of the new SDH systems brought with it a disturbingly unstable network. Components – particularly fibre optic transmitters – as well as software were burdened with numerous faults. The German suppliers had to make several visits to Lillehammer to assist in fault finding and repair.

Even the new multiplex systems had to go through an updating procedure before they functioned as intended.

On the international connections, there were several serious faults in the fibre cables to Denmark, and the consequent re-routing of traffic progressed very slowly.

This situation brought a lot of stress to the technical personnel as it coincided with the most intense installation period. In addition to delays because of fault-finding, the personnel also had to accompany service personnel from the suppliers to the installations.

However, as the opening day of the Olympic Games approached, this situation changed radically. All of a sudden it seemed as if the equipment got rid of all its teething trouble and it played up as it should do. Both software and components were stabilized and the fishing fleet's ravaging with the North Sea cable ceased. At last, we had reached a stage with regard to equipment where we had originally wanted to be in the summer of 1992. Throughout the whole of the Olympic Games and later on during the Paralympics the transmission network functioned almost without a single noticeable fault.

Satellite communications

BY EINAR M HEMB

Satellite communication was widely used for international transmission of speech, video and data signals during the Olympic Games. Satellites were partly used also nationally for contribution of TV signals. In total, 49 satellite earth stations located at six sites were available for communication to 16 satellites! The TV transmission time counted 768,240 minutes in total!

1 General

Norwegian Telecom (NT) has a long history of involvement with the Winter Olympic Games. The first such Games took place in Oslo way back in 1952 with all telecommunications planned and executed by our people at that time. In 1952 there was no television, mobile phones or other means of communication that modern times make extensive use of. The operation was somewhat easier, but just the same, it took lots of planning and money which is an essential part of any large scale operation such as Olympic Games telecommunications. Norwegian Telecom got its first indication of what was to come already in 1985 when Lillehammer started talks of applying for the Winter Olympic Games in 1992! This started a process in NT as well, since TV now had become an essential part of all such sporting events and it was now possible to reach a large part of the world by this means of communication. At first, all that was done was to do surveys in Lillehammer to see if it was possible to transmit TV from the arenas or from the planned International Broadcasting Centre, IBC, located a few kilometres north of the city centre.

The initial survey pointed at possibilities of transmitting to the western hemisphere from an area just below the expected IBC. The eastern hemisphere was blocked for transmissions by satellite by the high mountains in the eastern direction. We had to look for an another site and found that we could transmit to the satellites in the Indian Ocean region from sites on the hills above the city of Lillehammer. Unfortunately for us, the skijumps were built where our sites were first planned. We had to move to another site a few kilometres from our initial choice.

Lillehammer did not get the Games for 1992, but we had made our choice of sites and made no further arrangements in Lillehammer for a couple of years.

We estimated the number of TV circuits to be transmitted on the basis of previous games and came to a total number of 12-13. We thought this number to be reasonable at the time. We estimated the number of commentary circuits to be a couple of hundred.

No planning was done for a couple of years, but the plans were not shelved since we in fact had the feeling that Lillehammer would succeed in 1994. Lillehammer was awarded the arrangement of the 'Winter Olympic Games 1994' on September 15, 1988.

The Satellite Division of the Norwegian Telecom started serious planning, and an internal organisation to cater for the activity was arranged. The organisation encompassed experts from all telecommunication fields from satellite transmissions to telephone, telex, data, as well as TV circuits on fibre cables. This proved to be a very capable group of experts.

Norway is a member and signatory to two large international satellite organisations. The INTELSAT organisation with headquarters in Washington and the EUTELSAT organisation with headquarters in Paris. By the aid of the satellites belonging to these organisations we would be able to transmit TV programs to more than 2 billion people around the world.

2 TV customers

We started to work with the American company CBS as the first of the foreign right-holder (with the right to transmit TV signals). This proved to be a very close co-operation. We had several meetings at the CBS headquarters in New York as well as in Lillehammer later on.

CBS became our first large customer with 4 fixed (24 hours) TV channels to the USA as well as one in the opposite direction. CBS also rented one of our mobile satellite stations with Norwegian personnel for day-time as well as night-time transmissions.

With the Canadian company CTV we made an agreement for transmission of 2 fixed TV channels. From Canada the transmissions also went to New Zealand by receiving in Canada and re-transmitting to New Zealand through one of the satellites above the Pacific Ocean.

Japan was very early in asking for transmission of the so-called High Definition Television from Lillehammer to Japan. The result of our discussions with NHK was that we got an order for such transmissions for this company. In addition came two ordinary fixed TV channels from the Games to Japan.

Our largest customer turned out to be the EUROVISION (EBU) which is a mother organisation for most of the European broadcasters. There are also members outside Europe as far away as Baghdad and Cairo. Russia is also a member and this had its impact on the transmissions later on, since we had to arrange for separate TV transmissions for them. We made an agreement with EBU for the transmission of 10 programmes to all European satellites as well as to a Russian satellite in the Intersputnik system. We also transmitted TV channels by radio link to Sweden and Finland as the only international earth-bound transmissions.

To cater for Mexico and Latin- and South America we made arrangements with the American satellite system PanAmSat for transmission of two TV channels from Lillehammer. Later on, another TV channel was added because of their large requirement for transmissions to their customers.

In addition, we had agreements for fixed TV-channels for transmissions to Korea and Australia.

Summing up, we come to 26 fixed TV channels for TV transmissions and one for reception from the USA.

For these fixed TV transmissions we used 16 different satellites. Three of them were located above the Indian Ocean, whereas the others were above the Atlantic Ocean in different positions.

Occasional transmissions were also used to a large extent. In total, we had such transmissions for 343 hours and 34 minutes. For these transmissions we used 18 different satellite stations and 12 different satellites. China was one of the largest users of occasional transmissions.

Altogether, we made use of 35 different satellite earth stations in regular use, and in addition, we were equipped with reserve stations. The total number at our disposal during the Olympic Games came to 49 stations! Counting satellites we used a total of 16 different ones taking into account those used for occasional transmissions.

The TV transmission time comes to the incredible number of 768,240 minutes. During all this time we had a down time of only 4 minutes giving a regularity of 99.9995 %.

Our customers have expressed their satisfaction with our services during the Olympic Games 1994.

Telenor AS

Eik earth station

Telenor AS

Nittedal earth station

3 Satellite earth stations

Taking into account the initial surveys made back in 1985 it took nearly 10 years in planning for the Olympic Winter Games 1994. The early beginning was modest compared to what was to be the final result with regard to the number of TV-channels that had to be transmitted. There is a large gap between the projected 13 TV channels and the final 26 with a large number of occasional transmissions.

We have had the satellite earth site Eik in Rogaland in south-western Norway since 1976. The site was built to cater for communication with the oil-platforms in the North-Sea. Later on, the site was built out for communication with the Arctic islands of Svalbard. The INMARSAT system was also established at Eik in the early eighties. A new subsidiary site to Eik was built a year before the Games. Two new large antennas were built there to cater for satellites that could not be reached from the main site Eik due to the hills around the site.

Norwegian Telecom also built another site in 1984-1985, Nittedal earth station near Oslo, to transmit and receive TV programmes as well as data communication with the aid of the European EUTELSAT system. The site has later been extended with several large antennas with diameters from 11–18 metres as well as a number of smaller antennas.

At Tryvann (which can be seen from the city of Oslo) two small stations were built in 1986 to distribute some programmes to remote parts of Norway.

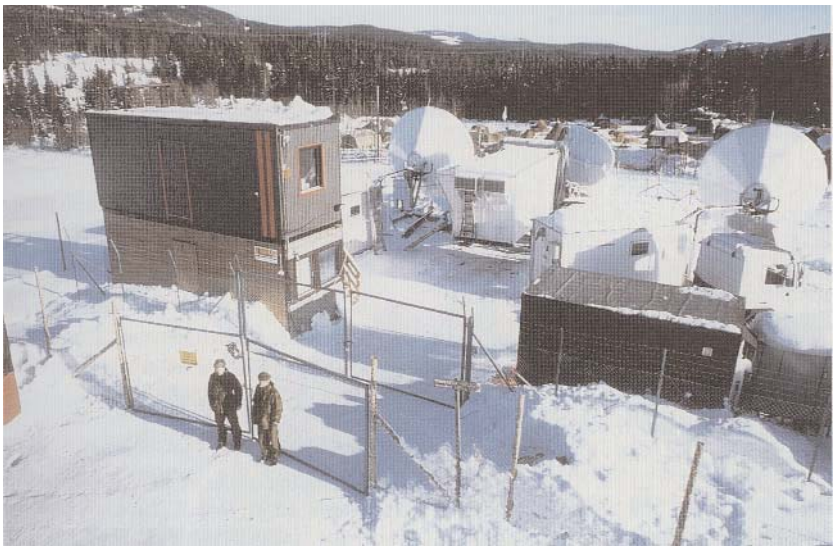
We therefore had a good starting point with many large antennas that could be used for this traffic. In spite of this, we had to build three large new antennas to cater for the Olympic traffic. Two were built at the Nittedal site and one at Eik with diameters from 13 to 16 metres. These came in addition to several smaller antennas. The “older” stations were equipped with a great deal of new transmitters and other equipment as well.

We built six additional stations for the Lillehammer sites. These were in the form of containers with transmitting equipment and small antennas from 1.8 m at Ku-band to 4.6 m at C-band. A couple of stations had two antennas enabling transmission of two programmes from each container without redundancy in this case. These stations were installed at two temporary sites in Lillehammer, at the IBC and at Skihytta east of the ski-jumps. We stationed four of our own mobile SNGs at Lillehammer and these were in extensive use.

Germany had large mobile stations with enough transmitting power, and we rented four from Deutsche Bundespost with personnel. In addition, we had a French mobile station used for European HDTV with personnel from France.

4 The transmission in cables

We had six different sites at as many different geographical locations with satellite earth stations to be connected by fibre optical means. Modern optical cables can transfer large information ‘bundles’. We needed to transfer 13 simultaneous video channels to Nittedal earth station as well as 3 to Eik earth station and one in the opposite direction. This in itself presented no problem since the country-wide fibre network is well built out with a 2.5 Gbit/s system. The problem was to protect the information along the routes to the earth stations. This problem was solved by using reserve routes carrying the same information as the main route.



Telenor

Skihytta earth station at Lillehammer. HDTV to Japan was transmitted from this station. Double fencing and military guard in front

Telenor

C-band containers with antennas of 4.6 m diameter at the IBC/Satellite site

We had one broken fibre connection in Nittedal just before the Olympics because of repair of a water pipe. In addition, an avalanche on the west coast broke one of the reserve routes. The communication did not suffer because of these problems.

The international communication by whatever means at disposal was also the responsibility of NT's Olympic Organisation. The planning of the transmission routes and the lay-out of reserve circuits were started as soon as Lillehammer was awarded the Olympic Games. Transmission by means of international sea cables is a lengthy process that normally takes several years from the start of planning to the implementation.

The connection between the sites had a similar history of planning and execution as the international cable connections. Both types of circuits had to be connected by reserve routes in case of faults in the cables. For the inland circuits, Norwegian Telecom could do all the planning themselves, but for the international circuits one had to rely on agreements with the different countries. These circuits can also be connected by reserve routes by failure of the main circuits, but for the Olympic Games a higher degree of reliability was needed. The countries

Table 1

Country-direct

Country/ Company	Minutes Jan. '94	Minutes Feb. '94	Change %
USA/AT&T	231,344	820,252	255
USA/MCI	33,679	141,168	319
USA/Sprint	20,177	71,715	255
Canada	13,385	140,340	948
Japan	6,819	33,485	391
Australia	1,998	15,039	653
New Zealand	870	5,364	517
Denmark	14,538	15,103	4
Finland	1,147	3,670	220
France	4,172	18.299	339
Italy	362	8,897	1,358
Netherlands	20,578	73,837	259
Sweden	34,716	38.070	10
Germany	2,723	5,968	119

in Europe were very responsive in this connection. Denmark and Sweden both delayed planned work that involved the Norwegian traffic until after the Olympics. We were grateful for this attitude.

For international switched services the most important were the telephone- and ISDN circuits which received the highest degree of attention both before and during the Olympics.

We expected large traffic to the USA for the "country-direct" service and this was also the case. US direct had a mean connectivity of 99.2 %, which is a good result.

New switches for international switched circuits should replace the previous ones. We had some delay here, but enough circuits were established in time for the Games. For the ISDN circuits a very tedious and time-consuming testing had to be done. The necessary ISDN circuits were after all established and the customers' requirements were fulfilled.

The international telephone traffic measured in minutes did not come up to expectation compared with the traffic of the previous year. The increase was in the order of 20 %. The reason for the rather small increase is probably the decrease of "business-traffic" in normal hours. Country-direct traffic is normally around 10 % of "dialled-up" traffic. The increase in this traffic from January '94 to February '94 can be seen in Table 1.

5 Security

The security of the earth stations and particularly the long land-lines as well as the international cables was a major concern for the Project Management. NT had its own security officer that was stationed at Lillehammer before and during the Games. The security officer suggested at an early stage that the most important earth station sites should be protected by double fences with an alarm system. The system would be connected to the police who would take action in case of an alarm. The recommendation was adopted. In addition we had military personnel as guards at the most important sites. We had no problems with sabotage during the Games.

6 Emergency Plans

As already mentioned, the Project Management put great emphasis on the security of the communication. A comprehensive "Emergency Plan" was prepared. This plan consisted of three volumes totalling 600 pages. The plan covered all aspects of failures that we could think of and the ways to act if a failure should happen in spite of every precaution. In a couple of instances the responsible people were alerted and prepared to follow the plan. The incidents causing the alerts were corrected and normal operation was restored without break in communication. The Emergency Plan was a large work, but we were happy that we had made it. It gave us confidence and preparedness during the whole operation.

7 Organisation, operation and personnel

The total responsibility for the NT engagement in the Olympic Games 1994 operation was at Lillehammer. Norwegian Telecom, Satellite Division as well as Norwegian Telecom International are located in the NT headquarters in Oslo. These two divisions operated as a group under the Management of the Satellite Division and according to an internal contract with NT's Olympic Project stationed at Lillehammer. Personnel from both divisions were involved in the yearlong planning of the operation.

From January 29 until February 28, 78 persons were directly involved in the satellite related operation. In addition, we had personnel from Norwegian Telecom International working with international circuits of all kinds.

The Network Operations Centre at the IBC switched and controlled the TV traffic for all satellite stations in the system as well as co-ordination with INTELSAT and EUTELSAT. INTELSAT had two persons at the IBC with direct computer contact with the headquarters in Washington. The personnel at the IBC satellite site had automatic fault-reporting by computer from all satellite stations in the Lillehammer area which was a great help since all major faults were reported and action could be taken at once. The mobile satellite stations were located at the IBC satellite site and were directed by the network centre from there. All satellite stations involved from Eik to Nittedal reported to the Project Management at the IBC satellite site and meetings were held with the Lillehammer Project Management every morning for the duration of the Games. During these meetings, major problems, if any, were discussed and corrective steps were taken without delay.

The NTS Project Management also had experts from the major equipment suppliers at their disposal. These experts were stationed at different sites where equipment from their firms was in use in larger quantity.

Personnel from Tanum earth station in Sweden were engaged as well as personnel from USA, Germany, Japan and France.

The positive attitude of all personnel regardless of origin and their flexibility in working under cold climatic condition resulted in a perfect overall operation.

We look back with satisfaction on the performance of NT during the Winter Olympic Games 1994.

Satellite stations used during the Olympics 94

The Project Management of NTS had a total number of 49 satellite stations at their disposal with antennas ranging from 1.8 m in diameter up to 18 m. Some of these antennas had both C-band and Ku-band capability and are at present quite unique in the world.

EBU For EBU and their members, stations at IBC/SAT (earth stations at IBC), Nittedal, Tryvann and Eik earth stations were used.

CBS For CBS, stations at Nittedal, Sætra and a mobile station were used. A large range of other stations were also used for occasional transmissions for CBS.

CTV For Canada/New Zealand, stations at IBC/SAT and at Eik (Sætra) were used.

NHK For Japan, stations at Nittedal and Skihytta were used. HDTV for Japan was transmitted from Skihytta at Lillehammer.

CH9 For Australia we used a station at Nittedal.

MBC For Korea we used a station at Nittedal.

PAS For PanAmSat we used stations at IBC/SAT.

The planning of the traffic through all satellite stations took a couple of years with the final routing being done the last 6 months before the Olympics.

Traffic through the satellites started on January 28, when the satellites became available to us.

Satellites used during the Winter Olympics 1994

Satellites from a number of organisations were used.

- INTELSAT with the following satellites:

  INTELSAT 504 (328.6°), 505 (66°), 512 (359°), 601 (332.5°), 602 (63°), 604 (60°) and 605 (335.5°).

- EUTELSAT with the following satellites:

  EUTELSAT 1F5 (21.5°), 2F1 (13°), 2F3 (16°) and 2F4 (7°).

- KOPERNIKUS with the following satellites:

  KOPERNIKUS DFS-2 (28.5°) and DFS-3 (33.5°).

- INTERSPUTNIK with the satellite:

  STATIONAR4 (346°).

- TELECOM with the satellite:

  TELECOM 2B (355°).

- PanAmSat with the satellite:

  PAS1 (315°).

- TELE-X with the satellite:

  TELE-X (5°).

Audio and video services

BY ROLF SÆTHER

Olympic Games is first of all a spectacular TV-show. To ensure reliable TV and sound transmissions to all parts of the world, high transmission capacity and special equipment is required. This article is divided into three major parts: TV-transmissions, sound transmissions and HDTV-transmissions, each dealing with their own specialities.

This article covers the technical solutions for the transmission of video and sound in the Lillehammer area. The international transmissions are described in the article describing the satellite operations.

1 TV-transmissions (4:3-format)

Modern Olympic Games are characterised by a very large number of TV-channels being transmitted at the same time due to the following circumstances:

- Competition activities at several venues at the same time
- High degree of parallel unilateral productions
- High degree of production outside the competition venues to describe Norwegian nature and folklore
- Other special needs.

1.1 Production and transmission of the official TV-signal

LOOC made a contract with NRK (the Norwegian National Broadcasting Company) to fulfil the IOC-requirement of producing an official TV-signal covering all competitions, ceremonies and medal awards. To handle this operation, a special organisation was established, called NRK ORTO '94 (Olympic Radio- and TV-Organizer). Norwegian Telecom had the responsibility for transporting these signals from the venues into the International Broadcasting Centre (IBC). To ensure sufficient capacity, high quality and reliability, a close co-operation between Norwegian Telecom and NRK was established already back in 1989.

The discussion on whether to use analogue or digital transmission was very strong at the beginning. Analogue technique was well known and accepted by NRK ORTO '94. Norwegian Telecom early decided to go for a purely digital transmission between the venues and the IBC. This turned the discussion into which coding techniques to be applied to convert the TV-signals into digital form in accordance with the CCITT hierarchical bit rates.

At this time the specification work in ETSI for the 34 Mbit/s video codec was almost completed. Due to our schedules we soon concluded that the price for the codec units for 34 Mbit/s would be much higher than codecs for 140 Mbit/s transmission. Due to a flexible fiberoptical transmission network we concluded that transmission capacity would not be a limiting resource from venues to the IBC, and therefore we could use 140 Mbit/s video encoding which would give us the highest possible transmission quality and equipment at reasonable costs.

1.2 Production format for international signal

In the first planning period composite PAL-production was assumed to be dominant. As time went by, the discussion on whether to use digital production format was actualized. During work in NRK ORTO '94 to develop the graphical standard to be used in the production, it soon appeared that only graphical units with digital interfaces could fulfil the demands of flexibility and high quality standards. This meant that the production signal had to be digitized before putting on the graphics at the venue. Due to reasons like timing information input and distribution to other broadcasters at the venues it had been decided that the graphics had to be put on the video signal at the venues, and not in the IBC. NRK ORTO '94 also decided to go for a digital recording standard in the IBC for the archives. Using PAL transmissions from venues to IBC would result in the following conversions:

- Analogue PAL production
- A/D conversion to insert graphic
- D/A conversion to prepare for PAL-codec
- A/D conversion for transmission in 140 Mbit/s format
- D/A conversion to deliver PAL in IBC
- A/D conversion to record for archiving.

This transmission chain was said not to be satisfactory according to the quality standards that NRK ORTO '94 required for the signals distributed to all the rightholders in the IBC.

During the Winter Olympic Games in Albertville '92, digital production units were introduced by Thomson CSF. The working principle is to digitize the camera signal as early as possible and do all the mixing in the digital domain. This ensures very high quality, and also enables embedded sound production/mixing in AES/EBU-format.

1.3 Digital TV-formats

There are two "established" digital studio TV-formats, digital composite and digital component. Digital composite is "pushed" by Panasonic/Japan, and has its supporters especially in NTSC-countries. During the Summer Olympic Games in Barcelona '92 digital composite was used for archive recording (D3-format) by the host broadcaster RTO '92. This digital TV/sound-signal has a bit rate of 177 Mbit/s.

For some years analogue component production has been used among some EBU members. SONY/Japan has been very active in promoting the digital component format. This standard is described in CCIR Rec. 601. Up to 1991–1992, equipment worked in the parallel form according to CCIR 656. This gave complicated cabling and mixing units, and was not highly used, even if the quality was improved significantly. The introduction of low price parallel to serial converters suddenly made it possible to reduce complexity in cabling and mixing and started a new trend in production units. Fully digitized units have become the new standard for TV-production units. The new production units that NRK ORTO '94 provided for Lillehammer '94 TV-production was based on this technique.

CCIR 601 describes this digital standard. The analogue components signals; luminance and two colour difference signals, are digitized as shown in Table 1.

CCIR 656 describes how to serialize this signal (8 bit/word or 9 bit/word) which gives serial signal with the bit rates of 216 or 243 Mbit/s. The 216 Mbit/s signal is also named D1-signal.

However, SONY has made their own standard based on 10 bits/word which gives the serialized bit rate of 270 Mbit/s. This has been established as de facto digital TV-studio standard. Available equipment works in accordance with this "standard".

In fact, due to the available graphical units and the development of a reasonably priced digital recording machine to record this signal format, NRK ORTO '94 chose to go for this production for-

Table 1

Signal	Sampling frequency	Bit/ sample	Resulting bit rate
Luminance	13.5 MHz	8	108 Mbit/s
Colour difference signal Ca	6.75 MHz	8	54 Mbit/s
Colour difference signal Cb	6.75 MHz	8	54 Mbit/s
Resulting signal	27 MHz	8	216 Mbit/s

mat. The affordable recording units which SONY developed for the NRK ORTO 94 recorded in the new digital Betacam format (not true D1 format). This decision was also based on the fact that transmission of this signal at 140 Mbit/s bit rate had been successfully demonstrated by Thomson CSF and France Telecom during the Winter Olympic Games in Albertville 1992.

1.4 140 Mbit/s transmission of 270 Mbit/s serial digital format

To transmit the 270 Mbit/s signal (containing digital video and embedded sound) in a 140 Mbit/s CCITT channel bit rate reduction is required before transmission. In the reduction process video and sound have to be handled separately. CCIR Rec. 721 describes a technique for reducing the D1-signal (216 Mbit/s). The main principle is to adapt the 8 bit signal into a 6 bit signal through Hybrid DPCM-technique (HDPCM) and remove hidden information. The reverse process has to be done at the decoding side.

1.5 CCIR Rec. 721 – HDPCM

To enable transmission in a 140 Mbit/s channel the van Buul technique is applied. This is described in CCIR G.721. To reduce information the horizontal and vertical blanking is removed. Only the 576 visual lines out of 625 are transmitted. This gives no quality reduction. Through the HDPCM-process signal levels are digitally approximated from a 128 level table to a 32 level table where the approximation for low digital levels are none (PCM) to an increasing degree of approximation for higher digital signal levels (DPCM); hence the name HDPCM. The conversion table is shown in Table 2.

Each of the 576 lines will have a structure where the words are transmitted as shown in Figure 1.

Adding FEC (Forward Error Coding, Reed-Salomon type) and frame alignment word the resulting bit rate of 135 Mbit/s is obtained (standardized bit rate for the so-called "TV-container"). Multiplexing with auxiliary information gives the standardized CCITT transmission bit rate.

The video decoding process at the receiving end is based on calculating the 6 bit words into 8 bit words by the inverse HDPCM process. Combined with this process two-dimensional prediction with 8 bit accuracy brings the signal back to its original form with very small degradation.

1.6 Choosing equipment supplier

Two companies handed in bids for developing this type of equipment. Thomson CSF had a model used in '92, but some adjustments had to be made to achieve the correct interfaces towards the supervising system. Siemens/Germany offered a solution with same mechanical outfit and alarming as the PAL-codecs which had been used for some time in Norwegian Telecom. Siemens was chosen due to price and mechanical solution.

The realisation of the practical codec system was done in co-operation between Norwegian Telecom and Siemens/Germany. Siemens had a contract with "Institut für Rundfunktechnik" in Munich to develop the video coding and decoding ASICS. This work was managed by Dr. Hoffman. The project manager at Siemens/Germany was Dr. Friedrich Schalamon.

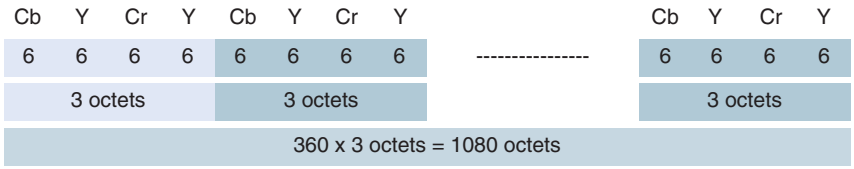
The first prototype of the video part was tested at "Institut für Rundfunktechnik" in February 1993. The operation was tested with test signals like "sound plate" and the EBU test tapes. The operation was excellent. Only some minor adjustments to achieve the EMC requirements had to be made. To keep the costs down, this implementation of the HDPCM process did not include the forward error coding process. This was acceptable as long as almost all circuits would be implemented into a fiberoptical network. One microwave system was used as the half of the ring structure to Kvitfjell, but the fading conditions in February were considered to be favourable.

Table 2 Quantizer characteristic CCIR Rec. 721

Level No	From	Value	To
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	11	12
11	13	14	15
12	16	17	18
13	19	20	21
14	22	23	24
15	25	26	27
16	28	30	32
17	33	35	37
18	38	40	42
19	43	45	47
20	48	50	52
21	53	55	57
22	58	61	64
23	65	68	71
24	72	75	78
25	79	82	85
26	86	89	92
27	93	96	99
28	100	103	106
29	107	110	113
30	114	117	120
31	121	124	127

1.7 The sound part

The digital codec was developed with some parts of the existing PAL-codec. The video part was completely new, but the multiplexer between digital video signal and additional information was the same. The PAL-codec contained 1 x 2.048 Mbit/s and 1 x 1.024 Mbit/s channel for additional information. For the PAL transmission it had been decided to use 15 kHz sound codec (384 kbit/s) through these capacities. NRK ORTO '94 used the AES/EBU standard (20 bit resolution/48 kHz sampling) at the production side, so it was required to transmit this signal together with the digital video. The AES/EBU-channel consists of stereo sound, 48 kHz sampling and 32 bits word, independent of the choice of 20 or 24 bit resolution for the sound itself. The 32 bits/word also contains information about channel identification (left or right) and pre-emphasis settings. This leads to a bit rate for a stereo channel of 3.072 Mbit/s, which equals the sum of the two existing channels in the Siemens solution. Modifying the multi-



The resulting video bit rate will then be:
1080 octets/line * 8 bit/octet * 576 lines/frame * 25 frames/second = 124,416 Mbit/s

Figure 1

Table 3

Company	Event
NRK, Norway	Ceremonies, cross-country, ski jumping, Nordic combined
SVT, Sweden	Freestyle
YLE, Finland	Biathlon
SRG, Switzerland	Alpine/downhill and super-G
FR3, France	Alpine/slalom, giant slalom
BBC, England	Bob/luge
NOS, Netherlands	Speed skating
CTV, Canada	Ice hockey, short track, figure skating
DR, Denmark	Medal award ceremonies, press conferences in MPC

plexer, necessary converting between AMI/ CMI and impedance/level adjustment was a rather simple implementation compared to the video part.

1.8 ASO – automatic switch-over unit

At the IBC NRK ORTO ’94 received two similar signals from each venue, transmitted via two different routes. To change between the hot and standby signal an automatic change-over unit (ASO) was used. This unit included a frame store to prevent picture distortion during change-over. This operation became more complicated than anticipated. The digital decoder unit produced a true digital video signal even on signal loss at the coding end or at loss of signal (e.g. AIS to the decoder). This picture did not contain information, but the signal format contained correct digital synchronisation signal. Viewed on a monitor it was either a total magenta or black/deep green signal. Magenta or green signal was set by coincidence by a flip-flop in the parallel to serial converter chip (SONY-made). The magenta picture occurred as maximum chrominance, and deep green with minimum luminance. The prototype of the ASO unit checked the digital sync, but with this described decoder, no response was produced during real failure situation (unless it was a decoding failure or cable failure between the decoder and the ASO). Therefore, this unit had to be modified to search for the special magenta and deep green signals occurring in such a long part of the signal that the probability that this was a real failure could be high enough (to avoid unnecessary switchings). This problem was only discovered quite close to the Games, so SONY and NRK ORTO ’94 had some thrilling days before it was solved. The ASO software was based on PROMs that had to be renewed after the new software was implemented.

The network for contribution of the international TV-signal is shown in Figure 2.

1.9 Operation through the Games

The local digital TV-circuits for NRK ORTO ’94 operated very well during the Games. There were some minor problems with a couple of NRK ORTO ’94’s A/D converters at two venues with PAL production. There were no equipment failure in the codec equipment during the Games.

1.10 Production assistance

Due to the large number of venues to be covered to make a complete international production, NRK ORTO ’94 made a contract with several other broadcasting companies for assistance in this production. The list in Table 3 shows which companies were hired by NRK ORTO ’94 to make the productions of the different events.

In total, 26 OB-vans (editing units), 220 cameras and 142 VTRs wwere used to make this complete NRK ORTO ’94 coverage of all events.

1.11 Unilateral production/ transmission of digital video

Beside the NRK ORTO ’94 international production, the national unilateral NRK production was also produced in digital video. For the NRK unilateral feeds the ASO-switching unit was not implemented. The switching involved here was the Norwegian Telecom spare route switching at the 140 Mbit/s level which is described in another article (transmission network).

1.12 Analogue TV-formats (4:3)

All unilateral production and transmission besides NRK was in analogue composite form. The major part of this was PAL production/transmission. A few TV-circuits were produced and transmitted in NTSC-format.

1.13 Codecs for analogue composite transmission

To transform the analogue composite signals PAL and NTSC a Siemens codec system was used. This system is based on PCM-coding, 9 bit resolution, 13.5 MHz sampling rate. FEC (forward error coding) is implemented with 1 bit per word. This gives 10 bits word and a bit rate of 135 Mbit/s. 2 Mbit/s and 1 Mbit/s channels for auxiliary information are added and with stuffing bits, the hierarchical bit rate of 140 Mbit/s is reached.

Due to this PCM technique the codecs were usable for PAL, NTSC and SECAM TV-formats. SECAM was not used in Lillehammer.

1.14 The TV-sound part

The PAL/NTSC-circuits were established with 2 * 15 kHz sound circuits based on digital coding and compression in accordance with CCIR Rec. 660. The circuits were established with Siemens equipment, 5 x 15 kHz channels encoded into one 2.048 Mbit/s channel (384 kbit/s per 15 kHz channel).

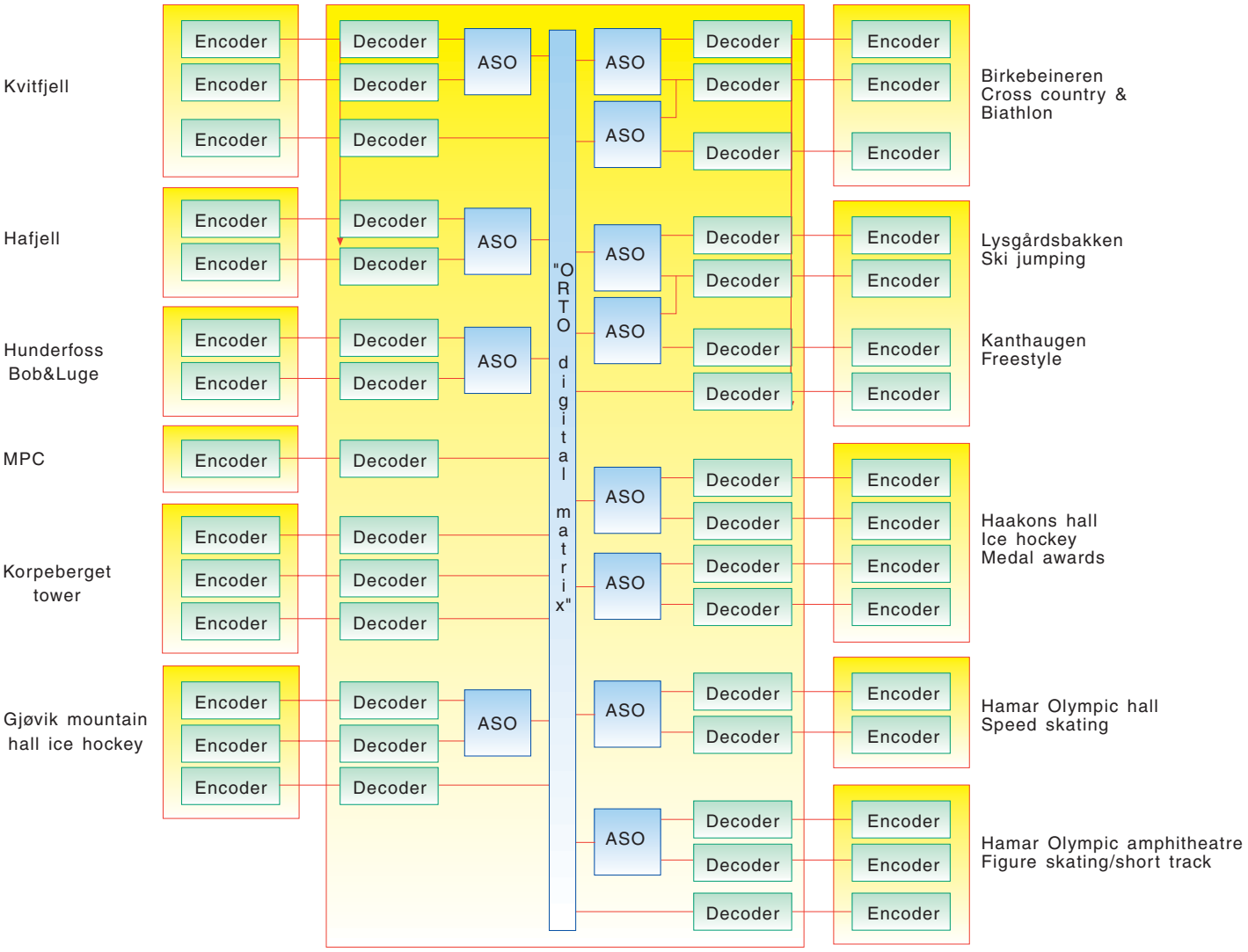


Figure 2 ORTO VANDA Contribution Network

The unilateral VANDA (Video AND Audio) network for Lillehammer '94 is shown in Figure 2 (excluding the internal solution at each venue). For special purposes in news gathering and helicopter shooting, receivers for mobile cameras were established at strategic sites for some broadcasters. A video network for police operation was also established with receiving points strategic in the Olympic area. Mobile cameras in vans and in helicopters for traffic supervision was used with great success.

2 Commentary circuits

The commentary circuits were established with 3 different qualities:

- Ordinary 3.4 kHz telephony quality
- 7 kHz high quality
- 15 kHz music quality.

2.1 3.4 kHz telephony quality

This is called "ordinary 4-wires" and is the low price alternative for commentary purposes. The service was established by using ordinary 2 Mbit/s multiplexers with analogue 4-wire connection cards.

Circuits for co-ordination purposes (between production areas and IBC and between IBC and home office) were established in the same way.

The majority within this quality class was the co-ordination circuits.

2.2 7 kHz high quality commentary circuits

This service was established by using equipment working in accordance with the CCITT G.722 standard. This standard describes the coding of a 7 kHz signal into one 64 kbit/s channel.

The coding process is based on 16 kHz/14 bit uniform encoding (resulting bit rate of 224 kbit/s). This digital signal is digitally filtered through a transmit quadrature mirror filter which splits digitally the band into two sub-bands 0 – 4000 Hz and 4000 – 8000 Hz each with 8 kHz sampling rate. The lower band is by an ADPCM encoder (mode 1) adapted through a 60 level (6 bit) adaptive quantizer. The resulting bit rate is 48 kbit/s. The upper part of the band is by an ADPCM encoder adapted through a 4 level (2 bit) adaptive quantizer. The resulting bit rate is 16 kbit/s. After multiplexing the resulting bit rate is 64 kbit/s. The standard also describes two other modes for allocating bits to the lower band, mode 2 (30 level/5 bit) and mode 3 (15 level/4 bit). The resulting multiplexed bit rates are 56 kbit/s and 48 kbit/s.

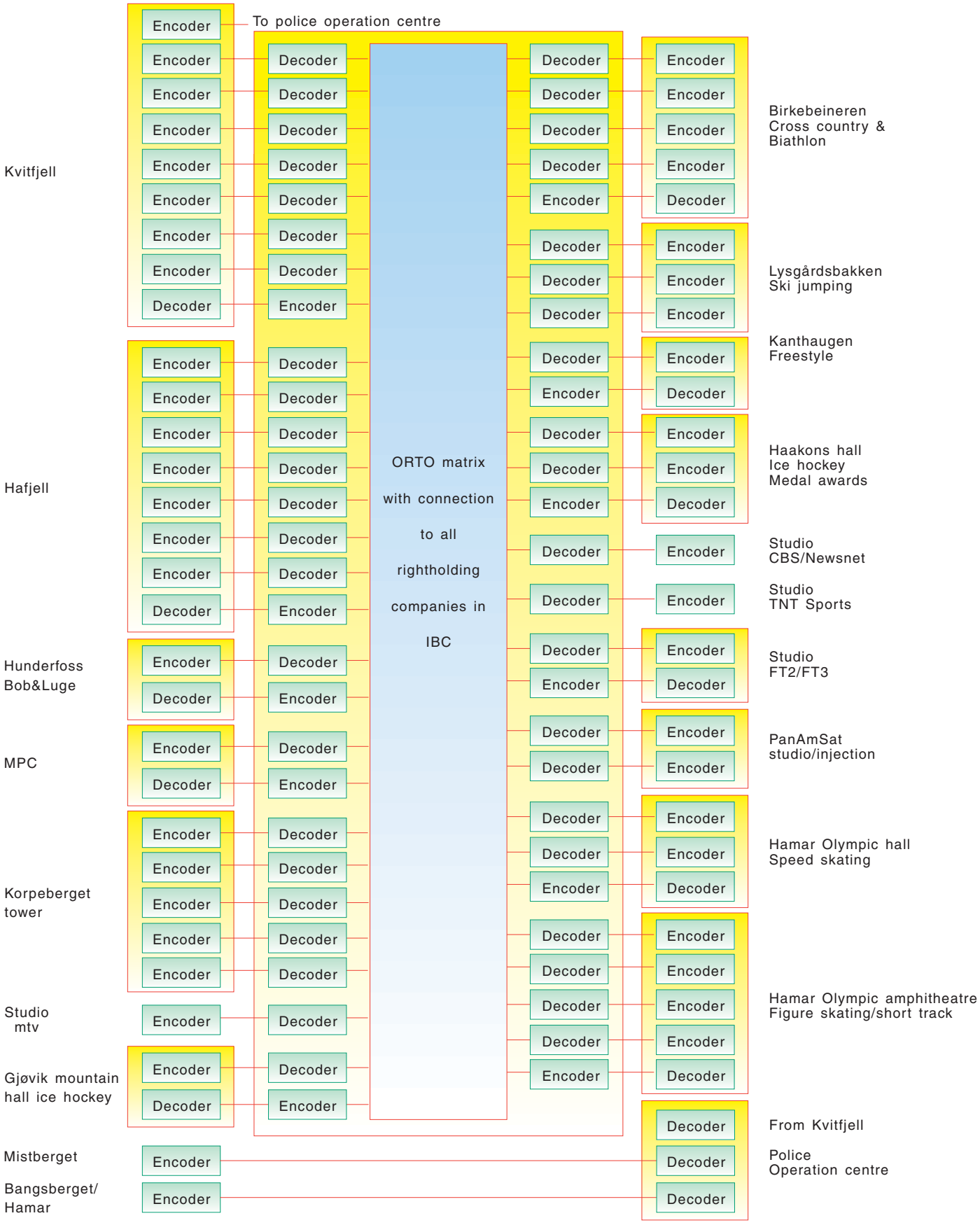


Figure 3 Unilateral VANDA network

Table 4

Event	Venue	Producing company	Fibre opt. connection
Slalom/giant slalom	Hafjell	HD/Thames	HD/Thames
Speed skating	Hamar Olympic Hall	NHK Hi-Vision	HD/Thames
Ice hockey	Håkons Hall	HD/Thames	HD/Thames
Ceremonies/ski jumping	Lysgårdsbakken	NHK Hi-Vision	HD/Thames
Cross-country	Birkebeineren	NHK Hi-Vision	NHK Hi-Vision
Figure skating	Hamar Olympic Amphitheatre	NHK Hi-Vision	Only recording

Only mode 1 was used during the Lillehammer '94 operation.

Equipment from two different suppliers (Philips/Germany and RE/Denmark) was used in the Lillehammer '94 network. The Philips equipment has a layout with up to 28 circuits per rack (4 channels per card) with a standard 2.048 Mbit/s interface (G.703). This equipment was used between the competition venues and IBC where the number of circuits was high. From other sites with a few 7 kHz circuits the RE equipment was used. On international circuits RE equipment was used. The RE equipment was used with both G.703/64 kbit/s and X.21 interfaces. Full compatibility between equipment from different suppliers is not achieved even though all equipment is working in accordance with this same recommendation. This proved to create some problems for the international commentary circuits.

Norwegian Telecom applied this equipment on leased 64 kbit/s circuits for international 7 kHz circuits. Some broadcasters also applied such equipment on Euro-ISDN or switched 64 kbit/s circuits.

2.3 15 kHz music quality circuits

As described in the chapter for VANDA transmission the music circuits were established with Siemens equipment, 5 x 15 kHz channels encoded into one 2.048 Mbit/s channel (384 kbit/s per 15 kHz channel). The coding is uniform PCM, 32 kHz sampling, 14 bit resolution, bit compressed to 12 bit/sample (including error correction) with instantaneous compounding technique described in CCIR Rec. 660.

3 HDTV (16:9)

Two companies implemented HDTV production in Lillehammer '94:

- NHK Hi-Vision/Japan
- HD Thames/Vision 1250/Europe.

The HDTV operation was quite similar to the former operations of these groups in Albertville '92 and Barcelona '92. At Lillehammer there were HDTV production at 5 venues.

The production was co-ordinated between these two companies due to restrictions from LOOC concerning use of camera space in the venues. To enable both companies to use all the production signals a conversion between 1125/60 and 1250/50 and vice versa was done in IBC. HD/Thames converted the 1125/60 signals to 1250/50 from Hamar Olympic Hall and Lysgårdsbakken. NHK Hi-Vision converted the 1250/50 signals to 1125/60 from Håkons Hall and Hafjell.

The venue list shown in Table 4 also shows the producing company and who ordered fibre connections to the IBC.

3.1 Transmissions venue – IBC

As an agreement between Norwegian Telecom and the operators, NHK Hi-Vision and HD/Thames brought in their own equipment to be used on Norwegian Telecom optical fibres. Both analogue and digital type of equipment was used. The digital transmissions were based on serialized digital components (luminance and two colour-difference signals) with a resulting bit rate of 1.3 Gbit/s (including digital audio) transmitted on dedicated optical fibres. The analogue systems were based on FM/FDM modulation of analogue components and sound and were also applied on dedicated fibres. The need for these transmissions from venue to IBC was greatest by the European producers due to no time difference. The different time-zone in Japan enabled NHK Hi-Vision to record much of the material at the venue and to transmit from IBC at suitable Japan-time. Only at Birkebeineren ski stadium they established a direct line to give the possibility for transmitting directly to Japan the events in Nordic Combine where the chances of a Japanese gold medal was highly anticipated.

3.2 International transmissions

The HDTV-programmes were edited in IBC and encoded before transmission internationally.

The NHK Hi-Vision 1125/60 was encoded to digital MUSE with a resulting bit rate of 60 Mbit/s. After being modulated (QPSK) in IBC the resulting IF-signal was transmitted on dedicated optical fibres to the up-link station. At the up-link station this IF-signal was passed to the satellite up-converter and HPA and antenna pointing to IOR 66 degrees with an elevation angle of about 4 degrees. After receiving this digital MUSE signal in Yamaguchi/Japan the signal was converted to analogue MUSE before domestic distribution by the direct broadcasting satellite BS-3b.

The European 1250/50 was encoded to a 45 Mbit/s signal before satellite transmission. This signal was connected locally to the up-link station by an optical fibre (short distance transmission system). A French Telecom satellite was used for this transmission. The signal was received at some test receiving points in Europe.

4 References

1 Recommendations of the CCIR, 1990 Rec. 601,656, volume XI-1.

2 Recommendations of the CCIR, 1990 Rec. 660, 721, volume XII.

3 Recommendations of the CCITT (blue book) G.703,722, volume III - fascicle III.4.

Cable-TV in the Olympic Network

BY SVEIN EGIL MOEN

1 Introduction

One of the requirements from the International Olympic Committee (IOC) to Lillehammer Olympic Organizing Committee (LOOC) was to make available a cable-TV service with two main aims:

1 To offer a better service to coaches, team leaders and athletes both at the arenas and in the accommodation areas

2 To serve the media with pictures from all ongoing activities, also to be used as a working tool in connection with commentating individual events.

In addition, it would also be a service offered to the public, by the fact that TV monitors would be placed in busy locations which the public had access to.

In order to fulfil the first requirement, offering the athletes and leaders a varied selection of entertainment, it was important that the cable-TV network was fed with commercial channels like BBC, CNN, Eurosport, etc. To meet the needs of the media, the network had to be dimensioned so as to receive all simultaneous events, making it possible to be at any arena or accommodation area and at the same time make commentaries on events going on in quite different places.

Based on these prerequisites, LOOC themselves produced a specification for the cable-TV network regarding the need for number of channels and the programme selection on these. Dimensioning the number of channels was based on a principle by LOOC that each arena should have its own dedicated channel. This opened for the individual broadcasting companies being able to buy space for their own channels, while space was being reserved for a result service and an Information channel. On this basis, 23 channels were needed.

The next important parameter to clarify was which locations in the Olympic area to cover with cable-TV signals. LOOC themselves needed to cover all arenas, press centres and accommodation areas in addition to their own administration. Others also expressed a need for the use of cable-TV signals, which resulted in 23 geographically different locations being defined to be covered by the cable-TV and the number of monitor connections to be some 10,000. The point of programme feed of cable-TV signals was the radio and TV centre at Storhove (IBC). This was also the place where signals from all the arenas could be picked up, and it was therefore natural to establish reception point of the other signals at this location.

2 Delivery agreement

LOOC made an inquiry to Norwegian Telecom (NT), TBK and other possible suppliers with the intent of signing an agreement on the delivery of a cable-TV service.

For NT it was natural to concentrate on carrying cable-TV signals from IBC out to the geographically different destinations.

Planning the transmission network was based on establishing fibre-optic cables to all the arenas. As early as the project phase, in 1989, there was technology available on the market which could carry cable-TV signals via fibre over relatively large areas. Conditions were therefore well suited for NT to offer this service to LOOC even if it was outside the monopoly scope of NT.

NT therefore entered into negotiations with LOOC which ended in NT getting the responsibility for carrying cable-TV signals from IBC to a given interface at each arena/venue.

TBK accordingly handed in a bid to supply the distribution network within each arena. This also resulted in an agreement, making the Telecom Group responsible for the total delivery of the cable-TV side. In addition to supplying the distribution network, TBK also made an agreement to take down commercial channels from satellite and deliver these signals to the cable-TV network.

3 Interface

Norwegian Telecom and TBK had signed separate agreements with LOOC and formally operated as two different parties. Because they were to supply separate parts of the network, the definition of unambiguous interfaces between the two different network segments was vital.

At the point of programme feed at IBC, the interface between NT and the suppliers of programmes was defined to be base band signals in PAL or NTSC format 1 Vpp for pictures. Furthermore, the interface for sound was defined to be base band signals with a level of 0 dBm. Modulation of signals to the RF level were included in NT's delivery.

Several programme suppliers were to feed their signals to the network:

- LOOC data, as supplier of result service and information
- Norwegian Broadcasting Company (NRK) ORTO '94, as supplier of pictures from the arenas
- Other broadcasting companies, as suppliers of self-produced pictures from the arenas
- TBK, as supplier of commercial service channels.

NRK ORTO '94 was given the role as co-ordinator for feeding the signals to the cable-TV network, and it was they who collected the signals from the various "producers" and supplied them to NT on a given interface.

Interfaces on the various arenas between NT and TBK were defined. The part of the network supplied by NT was defined as a D1-network, and should consequently meet requirement specifications accordingly:

- Signal voltage on the output:
  >= 74 dBmV
- Maximum signal fluctuation:
  +/- 1 dB
- Signal/noise ratio:
  >= 46.5 dB

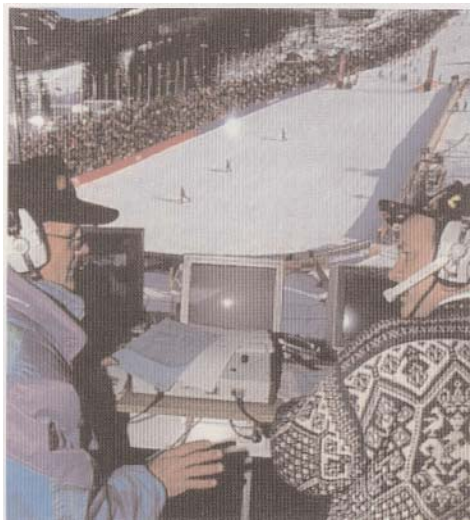


Foto: Morten Brun

Figure 1 TV reporter at his commentary desk looking at a monitor

Figure 2 Teleste SOF 900 FM-system. Transmitter (right), receiver (left)

A detailed definition of the interface was prepared stating cable types, connector cards and who supplied what at which locations. This resulted in personnel being confident regarding areas of responsibility when the installation phase started, and the work progressed rapidly and efficiently.

4 Technology

One of the prerequisites which formed the basis for selecting equipment types and technology for the cable-TV transmission, was the predominant use of fibre technology. The greatest challenge was to cover the arenas furthest away from IBC. This applied to the following arenas:

- Kvitfjell Alpine Arena:
  Distance to IBC 52 km
- Hamar Olympic Amphitheatre:
  Distance to IBC 64 km
- Gjøvik Olympic Cavern Hall:
  Distance to IBC 50 km.

Following a detailed assessment, the Finnish company Teleste with their system SOF900 was chosen as supplier of the transfer network.

Teleste is an analogue system with integrated modulator and fibre transfer equipment. The system is built in modules so that units may be placed arbitrarily in shelf positions with power and alarm cabling supplied. All other cabling takes place at the front of the units. The system may be supplied as an AM or an FM system. The AM system modulates the base band signals up to normal RF signals with the correct channel distances, so that the signals may be carried directly to an ordinary distribution network. Typical range for this system is approx. 15 km. The FM system has a wider range – typically 40–50 km, but it also has a greater channel distance than the AM system. Near the interface to the distribution network the signals must therefore pass through an FM demodulator and be modulated up again in an AM system before hand-over. This makes the FM system considerably more expensive than a pure AM system.

5 Network structure

The network was constructed as a ramification network, based on LOOC's requirements for where sub-ends for cable-TV were to be established and on the choice of system made by NT. With IBC as a centre, a star network was established out to the arenas branching off along the way where the attenuation budget would allow. With fibre technology and short distances, conditions were very well suited for the use of optical distributors, thereby saving on both transmitter equipment and capacity in the fibre cables.

The three arenas furthest away were originally planned to use FM systems, but then Teleste introduced more powerful optical transmitters and more sensitive receivers for the AM system. This enabled the use of the AM system even on the distance IBC – Kvitfjell, although with a repeater along the route. Consequently, the need for FM systems was reduced to comprising the connections to Hamar Olympic Amphitheatre and Gjøvik Olympic Cavern Hall. Gjøvik might have been covered in the same way as Kvitfjell, had the solution of an emergency route to Hamar not been prepared (see below).

5.1 Emergency routes

For safety reasons LOOC wished to have emergency routes established for cable-TV along the lines of emergency routes for ordinary transmission systems. This only applied to the sports arenas and the Main Press Centre. Since there were no built-in functions in the system to handle this, NT chose to base the emergency solutions on establishing blank fibre on alternative routes, and rely on manual change of cable-TV signals from one fibre to another. One problem connected to this was to achieve the same level of signal into the receiver independent of which route was chosen. This was alleviated by adding optical attenuation nodes on the route which obtained the strongest signal.

5.2 Use of cable-TV radio link

One of the media villages was situated so far from existing cable routes that radio link was chosen to maintain ordinary connection with it. It then seemed obvious to evaluate the possibility for using radio link even for the cable-TV signals. There were already special cable-TV radio links in use, with a capacity of up to 24 channels. They had ordinary RF interface and could thus be fed directly from the network. One such link was established from Korpeberget to the top of Hafjell, and one link was also used as emergency route from IBC to Kvitfjell.

6 Distribution network

As mentioned before, TBK had the responsibility for establishing the distribution network. With one exception, this was built as an ordinary coax-based distribution network within the individual arenas/venues. Where two arenas were close together – e.g. Lysgårdsbakken Ski Jump and Kanthaugen Freestyle – TBK also built a D2 network between these arenas.

The one exception was the distribution of cable-TV signals to the media accommodation quarters around Storhove and at Jorekstad. This was a particularly big and concentrated accommodation area and would mean a large and expensive distribution network to erect. LOOC therefore signed an agreement with TBK on establishing an ether based distribution network to cover these locations.

7 Ether distribution of cable-TV signals

In order to establish an ether based distribution of the signals, TBK signed an agreement with Norwegian Telecom as sub-supplier. Because of a special regard

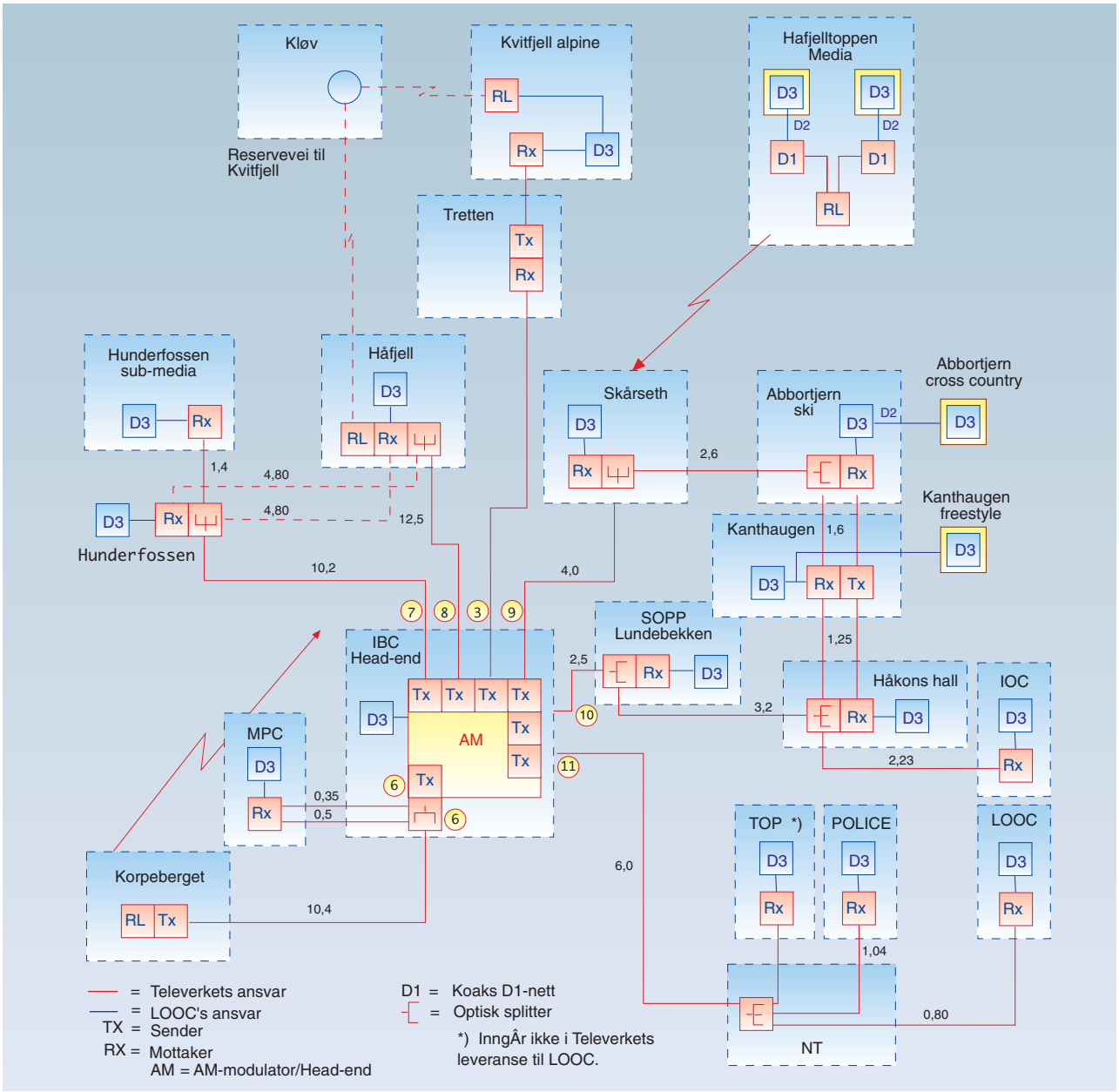


Figure 3 CTV network with AM-systems

both to economy and to the capacity in the frequency plans, the number of channels for ether distribution was reduced to 8. The technical solution to this was to mount 8 transmitters on two antennas. The transmitters were fed with signals on the MF level. These signals were tapped directly from the Teleste equipment by placing a divider between the MF step and the RF step in the modulator equipment. This was done on four of the permanent channels in the main station at IBC. A further 4 modulators dedicated for ether distribution were mounted, which were then fed from alternative programme sources, depending on the activity at the arenas. NRK ORTO '94 was responsible for feeding these programmes. Antennas were erected at each of the accommodation units in the media villages with a distribution network from the antennas in each building.

8 Key figures

- Number of cable-TV connections: Appr. 10,000
- Number of sub-ends: 23
- Number of channels in the network: 24
- Distance of fibre: Appr. 272 km

Switching

BY HJALMAR A HANSSEN

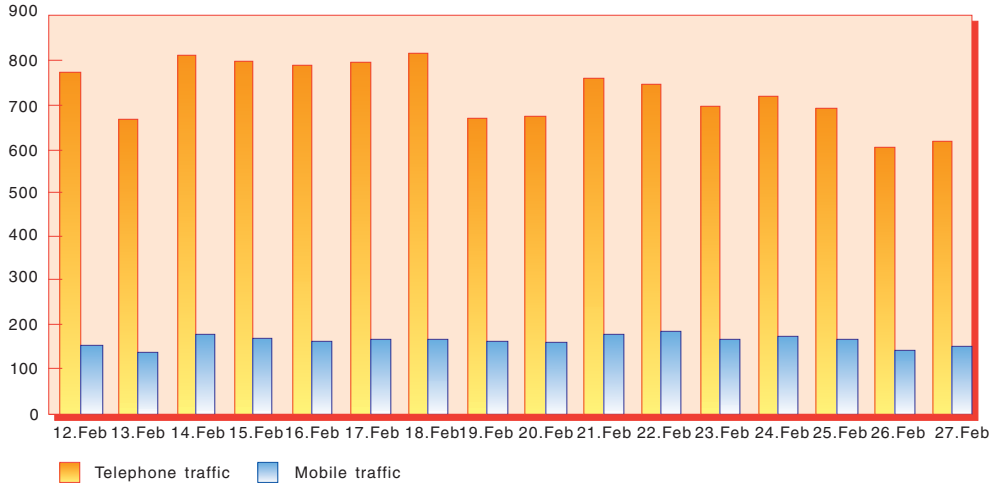


Figure 1 Traffic during the Olympics

The telephone network used in Lillehammer to serve the XVII Winter Olympic Games was a very sophisticated Virtual Private Network (VPN), based on Alcatel S-12 public switches and Northern Telecom Meridian SL-1 PABXes with services never seen before in such a network.

1 The initial phase

To supply a PSTN for the Olympics many surveys had to be done. Items of great importance were:

- Traffic load based on user patterns and type of users/services
- Total estimated number of subscribers/ user groups
- Overall synchronization of the network
- How to achieve the best integration between a public exchange and a PABX network (ref. supplementary services across the interface)
- Integration of the public exchanges in the existing switching network in Norway
- Level of reliability and back-up facilities
- Signalling systems, public switches
- Signalling systems, between PABXes and public switches
- Type of supplementary services to be provided
- Final testing of the network.

2 Major components in the network

Two parties co-existed in the so-called Olympic Network (ON). Norwegian Telecom supplied two S-12 public switches especially for the Olympics, and these were connected to the public switches in Lillehammer, Gjøvik and Hamar, five switches in total in a Wide Area Centrex configuration (WAC). Beside the public switches, the network comprised 38 ISDN Remote Subscriber Units (IRSUs) mainly connected to the two Olympic public switches in Lillehammer (IBC and Håkons Hall).

The other party in this network was LOOC, represented by TBK and their Meridian PABXes. Total figures were two main switches, one in IBC and one in LOOC's administration building, and 25 nodes at the venues/media villages.

3 Traffic handling calculations

Before any purchase of the equipment was possible, NT had to do several traffic handling calculations based on figures from previous events, such as the Albertville Olympics, besides LOOC's and NT's own estimates. To achieve realistic figures for the traffic load all users were divided into main groups with subgroups covering each single telecom service to be provided. NT made several calculations, based on figures handed over from LOOC. The basic figures to purchase switching equipment was based on NT's third calculated traffic report. To include changes in the number of users/user groups and traffic, NT made two additional calculations themselves during the project phase. Because there always is a limitation in any system, NT found it convenient to ask Alcatel (NT chose Alcatel S-12 exchanges in the end) to do final traffic load calculations based on the ordered system. The reason for this was related to a predicted extensive use of supplementary services. These five reports and the one from Alcatel proved to be quite accurate because NT had made their calculations so that a built-in redundancy was available. In

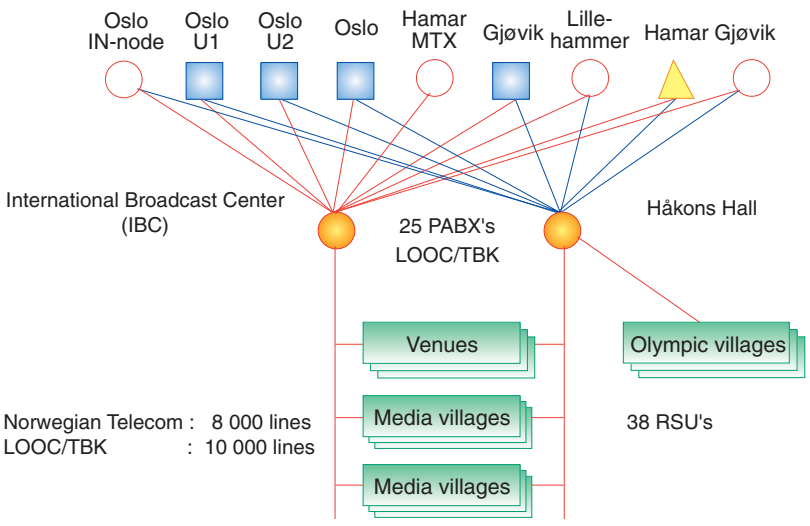


Figure 2 Telephone network

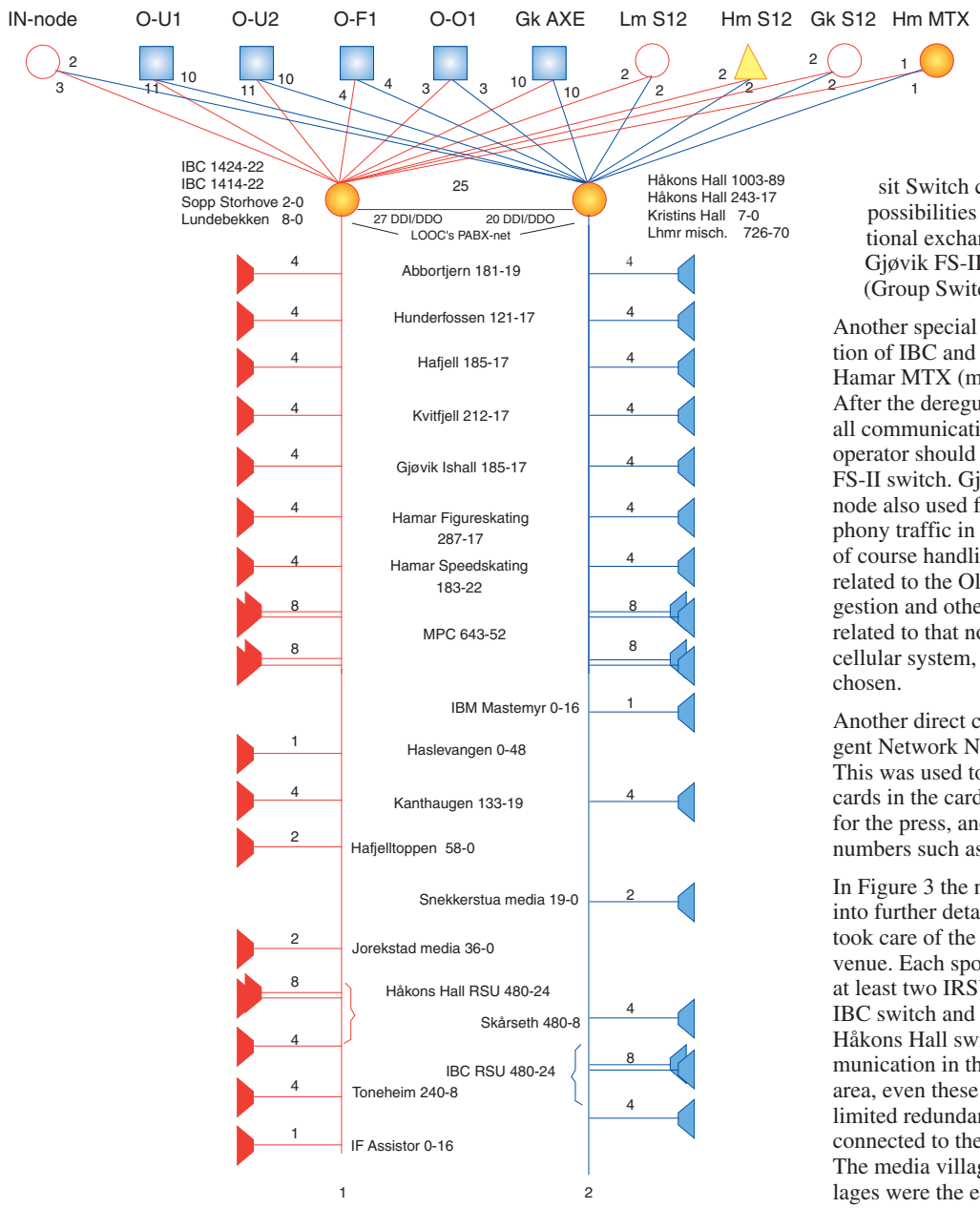


Figure 3 Details of the overall switching network

Figure 1 are shown the traffic figures covering the Olympic days. Normal traffic in the area is approx. 1/3 of the maximum per day.

4 The overall switching network

The overall switching network (ref. Figure 2) comprised two Alcatel S-12 public switches and 38 IRSUs. As seen in Figure 2 the main switches were located in IBC and Håkons Hall, and the IRSU mainly installed at the sports venues and the media- and Olympic villages.

In order to have a secure and stable international communication, the main switches were connected directly to the international exchanges Oslo U1 and U2. This was a special solution for the Olympics because the switches in IBC and Håkons Hall were classified as subscriber switches which implies that such communication always should follow the hierarchical structure of the national switching network. In addition, this was done by connecting the IBC and Håkons Hall switches to Gjøvik FS-II (Transit Switch class II) switch. Overflow possibilities towards the four international exchanges were established via Gjøvik FS-II and Lillehammer GS (Group Switch).

Another special solution was the connection of IBC and Håkons Hall switches to Hamar MTX (mobile telephone switch). After the deregulation of mobile services all communication towards a cellular operator should always be done via an FS-II switch. Gjøvik FS-II is a network node also used for the commercial telephony traffic in the Mjøsa region, and is of course handling much traffic not only related to the Olympics. To avoid congestion and other possible problems related to that node, especially for the cellular system, the shown solution was chosen.

Another direct connection was the Intelligent Network Node (IN-node) in Oslo. This was used to serve the use of VISA cards in the card operated telephone set for the press, and to convert the 8xx-numbers such as Country Direct.

In Figure 3 the network is broken down into further details, showing how NT took care of the importance of each venue. Each sports venue was covered by at least two IRSUs, one connected to the IBC switch and the other one to the Håkons Hall switch. To secure the communication in the IBC and Håkons Hall area, even these locations were given a limited redundancy in the form of IRSUs, connected to the opposite main switch. The media villages and the Olympic villages were the exceptions, because each of these venues were connected to a single IRSU. All IRSUs, except those in the media villages, were equipped with some ISDN 2B+D subscriber cards in addition to analogue subscriber cards.

Euro-ISDN (2B+D) proved to be a popular service, especially because of the data communication capabilities and the very short establishing time for the communication. One of the main users of this service was LOOC Data Department. This client had a very sophisticated data communication network, based on IBM Token Ring. To serve their needs for a secure communication they chose ISDN as their third back-up possibility. ISDN

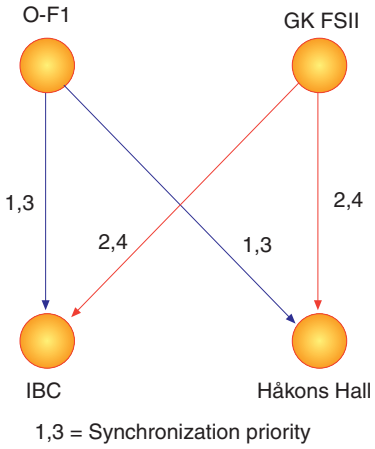


Figure 4 Priority chain

was not available in all regions in Norway, and to be able to provide this service for important use at Mastemyr and in Horten, NT had to install mini-IRSUs in these locations.

5 PSTN signalling system

In the Norwegian PSTN the CCITT #7 signalling system is used. The standard implementation has been to use Telephone User Part (TUP), but in order to serve the extensive use of EURO-ISDN, NT had to implement ISDN User Part (ISUP) between the exchanges in the Olympic Network.

6 Synchronization of the network

The synchronizing sources are Oslo F1 and Gjøvik FS-II. To secure the synchronization, NT had to establish a priority chain (see Figure 4). The priority was as following:

Priority 1: Oslo F1 to IBC and/or Håkons Hall

Priority 2: Gjøvik FS-II to IBC and/or Håkons Hall

Priority 3: Oslo F1 to IBC and/or Håkons Hall

Priority 4: Gjøvik FS-II to IBC and/or Håkons Hall.

7 Call charging in the PSTN

Charging in the Olympic Network was based upon real-time charging instead of the tax pulse charging normally used in the PSTN. The new system is named SENTAKS, and offers a flexibility superior to the older charging system. In a SENTAKS solution the data is stored centralized, covering a geographical region or more. Data may now be processed on the basis of specific tariffs for specific customers or other "algorithms". Production of detailed bills or specific bills is also easier in this new system.

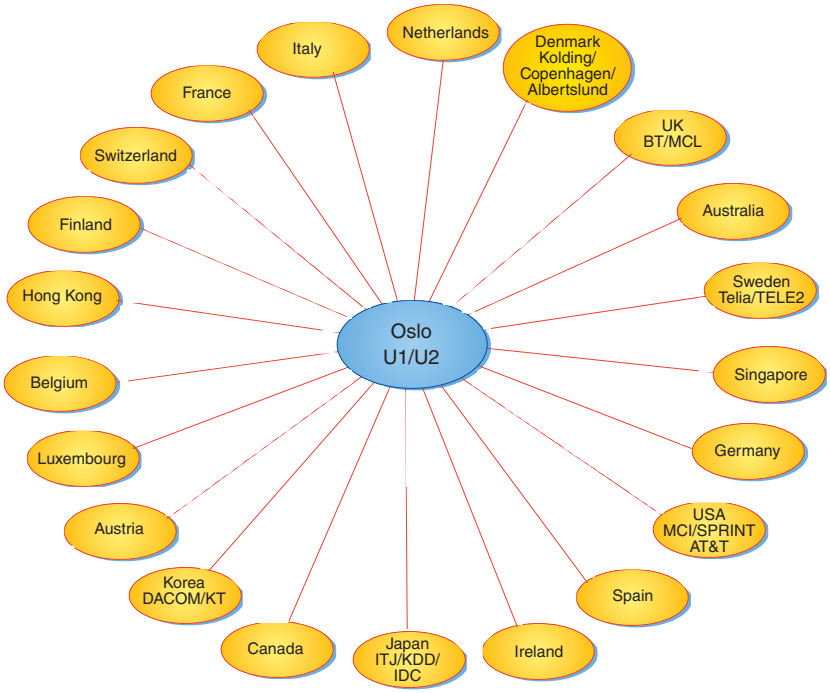


Figure 5 Availability of ISDN based on TUP

8 The Wide Area Centrex

An advantage of the S12 exchanges with the new software package N4E was the capability of networked centrex solutions (WACs). This feature was used during the Olympics covering the S-12 switches in IBC, Håkons Hall, Lillehammer, Gjøvik and Hamar.

In Lillehammer S-12 the capacity had to be reinforced by installing an additional IRSU to serve Olympic Network customers in premises outside the Olympic venues.

9 International communication

International traffic was routed via the international switches in Oslo, which are:

- Oslo AKE
- Oslo Dig1 (East)
- Oslo Dig2 (Centre).

Oslo AKE mainly dispatched overseas traffic to South America, China and African countries. In addition, most of the traffic with destinations in eastern European countries was dispatched via this switch because of the lack of CCITT #7 capabilities both in the AKE switch itself and the counterpart at the destination.

10 ISDN

ISDN was offered as an integrated service on the S12 exchanges and IRSUs. ISDN may be divided into two subgroups:

1 ISDN based on TUP-signalling, also know as "switched 64 kb/s"

2 ISDN with ISUP-signalling.

ISDN based on TUP was available to the following countries (Figure 5):

Australia, Belgium, Denmark, Finland, France, Italy, Netherlands, Great Britain (BT), Switzerland, Sweden, Germany, USA (AT&T/ MCI/ Sprint), Canada, Hong Kong, Japan (KDD), Singapore, Spain and Austria.

Special considerations had to be taken to USA because they use 56 kb/s (DS0).

The following services used switched 64 kb/s:

- Videophone (up to 128 kb/s)
- Data communication
- Telefax group IV
- File transfer PCs to PC-networks
- Surveillance (video)
- High quality audio (7 kHz)
- Telephony (3.1 kHz).

ISDN based on ISUP was possible to the following countries:

Sweden, France, Germany, USA (AT&T), Great Britain (BT) and Japan (KDD).

NT used NT-1s from Ericsson to terminate the ISDN-lines. Terminal adapters (TAs) were supplied by IBM and Philips.

Many NT customers brought their own terminal adapters to use on NT's ISDN lines. To help these customers to interface to our ISDN lines, NT established an ISDN test team. This test team took care of all problems related to interface of customer owned TAs at each venue when necessary.

Total number of ISDN lines used during the Olympics was 400.

11 ISDN Attendant Console (ICAT)

In a Centrex group comprising several extensions the use of an attendant console may be mandatory. NT, together with Ericsson and Walladata, developed an ISDN based attendant console named ICAT.

Two different types of attendant consoles were offered to our customers, the Ascom Crystal and the ICAT. The Ascom Crystal was a low-cost choice with limited use.

The ICAT hardware was based on an industry standard 486-PC (IBM compatible) equipped with an ISDN plug-in card. The software was developed to run under Microsoft Windows 3.1. By using Windows, we achieved a graphical user interface that should give easy access to all facilities in the software, and in addition, it should be easy to use for non trained operators (the last statement proved to be partly wrong).

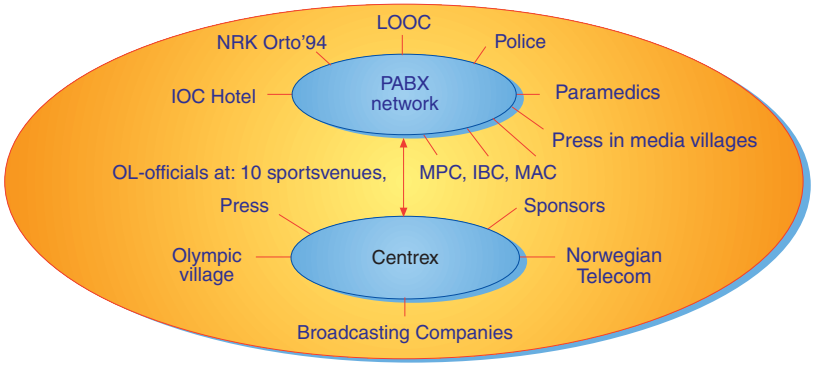


Figure 6 Members in the PABX network

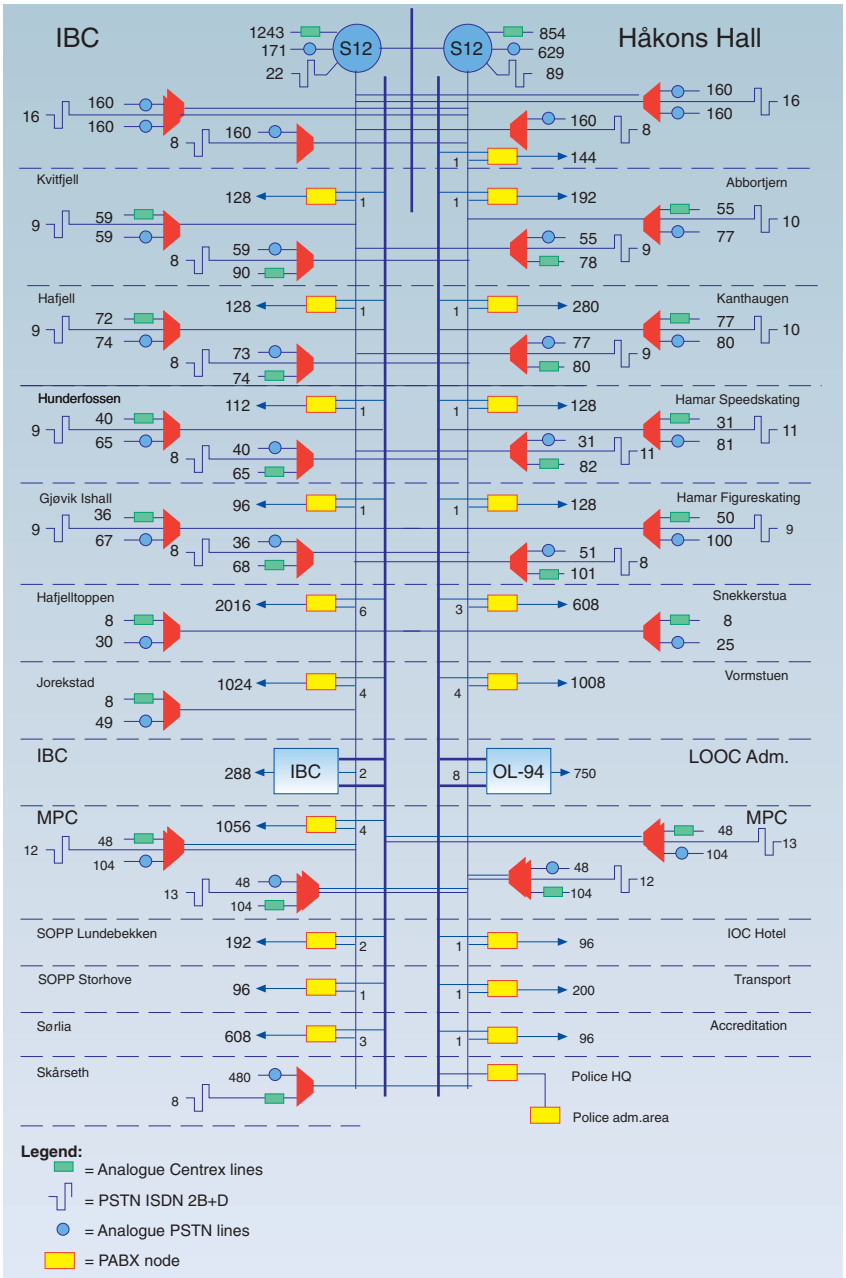


Figure 7 The Olympic Network

From \ To	ON outside media villages	Media villages	Public network
ON outside media villages	Free	Free	Public rates
Media villages	Free	Free	Publlic rates+ 30%
Public network	Public rates	Public rates	Public rates

Figure 8 Charging rates for ON

To serve both foreign and Norwegian operators, the ICAT software and Microsoft Windows were supplied in an English or a Norwegian version.

It was possible to equip ICAT with a headset and an external speaker, and these components were also supplied to each customer. In total, fourteen ICATs were used during the Olympics.

12 The Olympic Network

As previously mentioned, the Olympic Network (ON) comprised two different parties, LOOC/TBK and NT. LOOC/TBK supplied the PABX network and NT the Centrex solution. To understand the network concept it is necessary to know the difference between the customers placed in the PABX network, and those placed in a Centrex solution. The only possible members in the PABX network were (Figure 6):

- LOOC (administration, sports venues and volunteers)
- NRK ORTO '94
- Police
- Paramedics
- IOC hotel
- Press/media in the media villages.

Members in the Centrex solution:

- Press/media
- Olympic villages
- Broadcasting companies
- Sponsors
- Norwegian Telecom
- Others allowed to connect to ON.

12.1 Why an Olympic Network

The idea of ON was to have a user-friendly network covering the whole Olympic region and to offer a 5-digit Private Numbering Plan (PNP) common for all members (Figure 7). The elegance of the network gave all the users the impression of similar functionality whether a PABX or Centrex extension was used and a very flexible and effective solution. Another fundamental function was the use of common attendants, which gave the possibility to dispatch calls on to the network in a manner not previously seen. All members of the network were listed in LOOC's Olympic Telephone register, and the major parts of these users were also a part of the TESS attendant service system used by LOOC. This gave easy access to all customers in the Olympic region.

12.2 Interfaces used in the Olympic Network

- Between PABX and PSTN:
  2 Mb/s DDI/DDO with CAS.
- Between PABXes:
  2 Mb/s leased lines.
- Extensions in the PABXes:
  Digital attendant lines, analogue extensions and system internal digital extensions.
- Centrex extensions:
  ISDN attendant lines, analogue extensions and in some extent ISDN extensions(only on demand).

13 Routing

The main principle used for routing of calls was to obtain a minimum of congestion in the PSTN and to avoid loop situations in the PABX network. The solution was to establish alternative routing only in the PABX network (only valid for PABX-Ctx-PABX communication, not the PSTN itself).

- DDI to the PABX network was directly terminated without any possibilities for alternative routing in the PSTN network.
- Outgoing calls from the PABXes to the Centrex/PSTN was routed directly to the PABX direct outgoing line as first choice, and a second choice either via the IBC PABX node or the LOOC Adm. PABX node.
- Traffic between subscribers in the PABX network was routed in the following manner:
  1 First choice via trunks in the PABX network
  2 Second choice via alternative trunks in the PABX network (not valid for all nodes in the network)
  3 Last choice via PNP in ON.
- Alternative routing in PNP ON was only used from the originating exchange. The reason for this was to avoid unnecessary use of trunks before the call was routed to the PNP ON.

14 Charging

Charging in Centrex and the rest of the PSTN was based upon real-time charging instead of the tax pulse type charging previously used in the PSTN. Charging rates for ON is shown in Figure 8.

Mobile communication

BY STEINAR SANDBU, HARALD FAGERMOEN
AND PER KOLBJØRN BJØRSETH

This article describes the whole process starting with the collection of planning data, the preparation of preliminary and final plans, implementation, and finally, the operation of the networks for mobile communications during the XVII Olympic Winter Games in Lillehammer, February 1994. The Norwegian Telecom Olympic Project (TOP) signed a contract with the Lillehammer Olympic Organizing Committee (LOOC) for the delivery of mobile services, comprising services inside as well as outside the governmental telecommunications monopoly. Mobile data communication is also mentioned, even if this was not part of the contract.

1 Preliminary plans

When Lillehammer on the 15th of September 1988 was awarded the XVII Winter Olympic Games, to be held in 1994, a preliminary planning project was immediately established to work out recommendations regarding the participation of Norwegian Telecom in this respect. A group of four engineers was given the task to look into the field of mobile services.

By April 1989 the preliminary plans and recommendations were presented to the management of the Norwegian Telecom.

1.1 NMT-450

NMT-450 is a Nordic cellular system, giving radio coverage over great areas, but suffering of a capital lack of capacity in several areas of heavy traffic demand within the Nordic countries.

The recommendation was to expand the capacity of this system to the maximum extent possible, without introducing expensive changes in the structure of this cellular network. In other words, there would be no introduction of something like a small cell structure for this system, inside or outside the activity area of the Olympic games. It was recommended not to enhance the coverage of this system in the mountainous part of the accommodation area, as these areas already were reasonably well covered, and a further enhancement would prevent the limited frequency sources to be used in the areas of more heavy traffic demand. Besides, it would not be desirable to make this system more attractive compared to the NMT-900, than was already the case. Temporary expansions of the traffic capacity were to be implemented by use of already available transportable base stations (trailers).

1.2 NMT-900

NMT-900 is a Nordic cellular system, also being used in Switzerland and the Netherlands. At that point of time, this system was established throughout the Nordic countries, providing good traffic capacity in heavy traffic areas to reduce the congestion in the NMT-450 system, but suffering from some lack of radio coverage compared to the NMT-450 network. It would be necessary to improve the image of the 900-system to obtain a further relief of the 450-system congestion. The convenient size of the 900-system terminal equipment and the tendency of diminishing cost of this hand-portable equipment was, however, considered to contribute to a heavy growth in the number of mobile subscribers. This type of equipment would also be convenient to bring along with other hand luggage for people visiting the Olympic area during the Games.

The NMT-900 system was considered 'the main traffic machine' for cellular services for the period before and during the Olympic Games, as this network could be dimensioned according to the traffic demand without severe problems regarding frequency sources (available radio channels). To get the subscribers and potential subscribers to have the same confidence in the 900-system, the coverage and capacity of the system had to be properly established early in the remaining time before the Olympic Games. A secondary effect of this strategy would be the tendency to get new subscribers to choose the 900 system instead of the congested 450 system. As a consequence of this strategy, it was recommended to establish base stations for the 900 system in some mountainous parts (tourist and recreation areas) of the accommodation area. Temporary expansions of the capacity should be done by existing transportable base stations (trailers).

1.3 GSM

This European system was supposed to be implemented in several capitals in Western Europe and their main airports as a first phase in 1991. This service would be offered during the Olympic Games in Albertville 1992. At the time of the preliminary planning, it was difficult to foresee if the GSM subscriber terminals would be offered as hand portable equipment at reasonable prices as early as in 1994, but it was supposed that leasing of terminals would be offered from both Norwegian and foreign (European) companies.

A forced implementation of the GSM system was recommended for the areas in question for the 1994 Olympic Games. The capacity should be dimensioned in reasonable accordance with the expected traffic demand. As the GSM system was expected to be implemented all over Norway during the years 1991–1997, there would be no problem to redistribute any excessive equipment after the end of the Games.

2 Contract of delivery

The contractional discussions for mobile telephone and paging services with the Lillehammer Olympic Organizing Committee were based on the recommendations from the preliminary planning group.

The Norwegian Telecom offered to implement the necessary networks for mobile communications comprising the associated switches, transmission systems and base stations for good capacity and radio coverage within the Olympic Area before and during the 1994 Games, and also to take care of the administration of special subscriptions. Delivery of subscriber terminals was not included as part of the offer.

The services were offered as follows:

2.1 Mobile telephone (Cellular service)

NMT-450 and NMT-900 are Nordic cellular systems. Transmission systems, trunks and base stations will provide good capacity and radio coverage within great parts of the Olympic Area before as well as during the 1994 Games. The services will be offered in accordance with normal public standards.

GSM is a pan-European digital cellular service.

2.2 Paging services — as public services

The Norwegian Telecom undertakes to implement paging networks for numerical as well as alphanumerical paging. The network structure, including base stations, will provide good capacity and radio coverage within great parts of the Olympic Area before as well as during the 1994 Olympic Games. The services

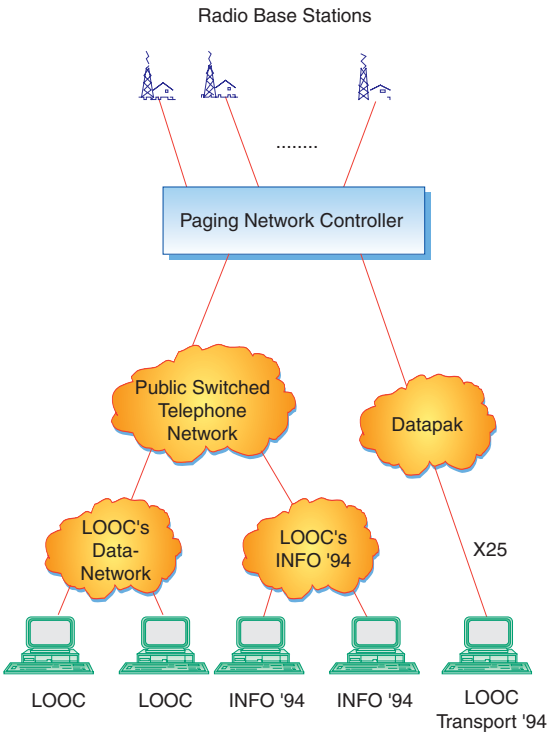


Figure 1 Principle of internal paging system for LOOC

will be offered according to normal public standard.

For the alphanumeric paging system, redundant radio coverage will be provided in important parts of the central Olympic Area. Pagers will not be provided by the Norwegian Telecom.

A paging system conforming to the new European standard, ERMES, is supposed to be implemented within parts of the Olympic Area during the Games. This service will provide the same functionality as the offered alphanumeric paging system, including some additional functions. Pagers will not be provided. (Due to late implementation of this system throughout Europe, no implementation was done for the 1994 Olympic Games.)

2.3 Alphanumeric paging – as non-public system

An internal paging system for LOOC is offered by using the same system as for the public alphanumeric paging system. Figure 1 describes the principle of this solution. LOOC will have to provide pagers from other parties, and will have to bear all associated costs.

This system is established by several radio base stations, connected to the network controller in Trondheim by leased lines in a star structure. The coverage area is extending from Ringebu as the northern area, along the main roads E 6 and road No. 4 south to Oslo, including the city of Oslo. Figure 2 shows the coverage area for this Tele-mobil system as per January 1, 1994.

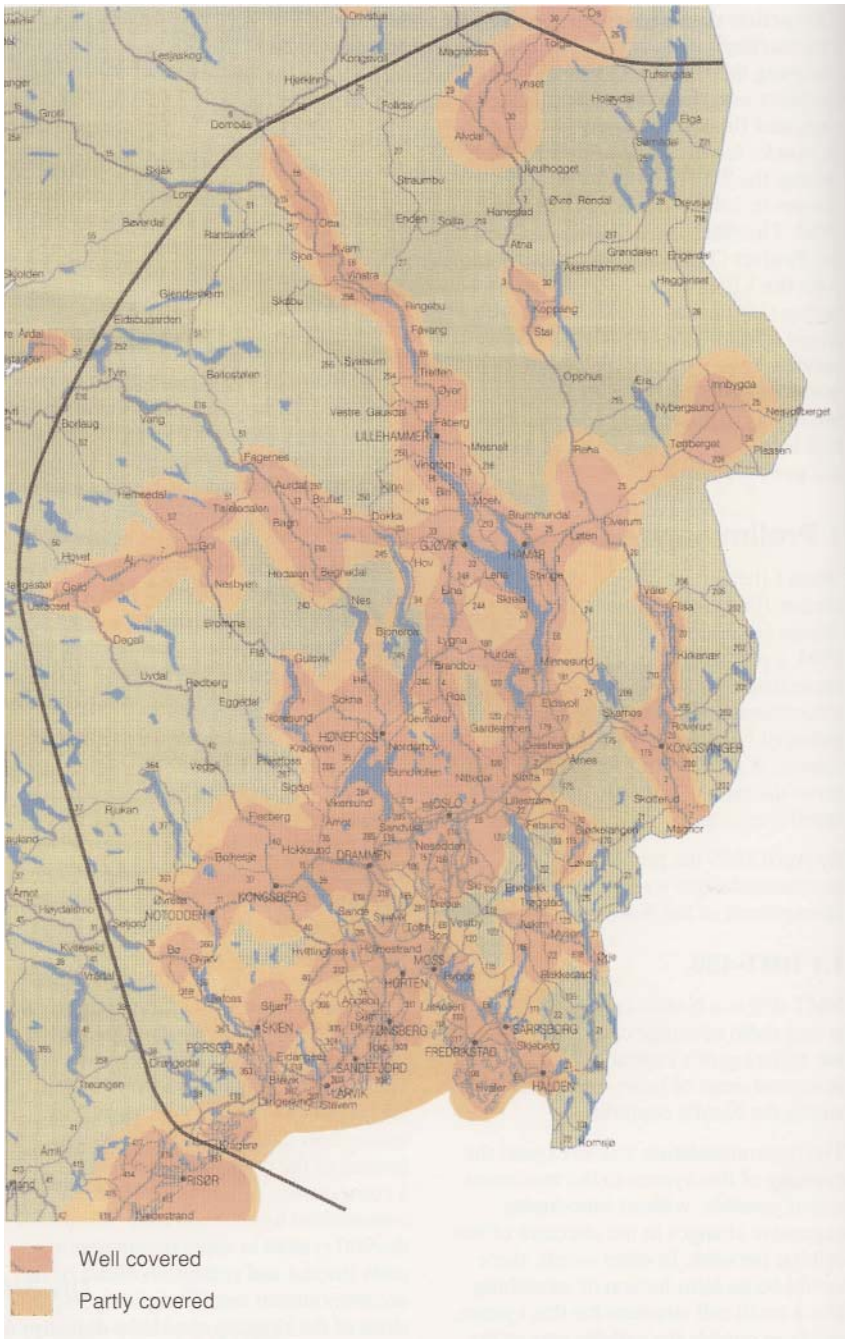


Figure 2 Coverage area for Tele-mobil's alphanumeric paging service

The system will conform to the POCSAG 1200 standard.

Access to the network controller is offered by the DATAPAK service as well as via the PSTN. The long-distance part of the leased lines will be secured by double routing.

Each Olympic arena, except the Gjøvik Olympic Cavern Hall, will be covered by two separate and independent radio base stations. This redundant coverage will also be established for IBC, MPC, Hafjell media, Storhove media and the Olympic Village Skårsetlia.

The reliability of the network controller in Trondheim is at a high level.

3 Project organization

When the Norwegian Telecom Olympic Project (TOP) was officially established, a joint working group was formed between this project and the main Telecom administration, to take care of the planning of cellular systems and other mobile radio networks associated with the 1994 Olympic Games. The group was called Olympic mobile, and the members were appointed from the following departments:

- The Norwegian Telecom Olympic Project (TOP)
- The Department of Radio Communication, Norwegian Telecom/Eastern Region
- The Telecom Administration of Gjøvik area
- The Telecom Administration of Hamar area
- The Technical Centre for Mobile Services, Fåberg
- The Department of Mobile Services, Norwegian Telecom Headquarters
- The Department of Switching, Norwegian Telecom Headquarters.

During the period of heavy technical activity, engineers and technicians from Region Oslo of Norwegian Telecom were included in the group to optimize the co-ordination of re-using second-hand base station equipment from that region.

When, after some time, Tele-mobil was established as a separate division within Norwegian Telecom, and then as a Limited Company as per January 1, 1993, Tele-mobil AS took over the responsibility of the planning activity, done by the Olympic mobile group. The premises were stated by TOP, as they had signed a contract with LOOC. After some clarification, Tele-mobil AS accepted the premises as stated, and a formal contract was signed between TOP and Tele-mobil AS for operation of the mobile networks during the 1994 Olympic Games.

4 Implementation programme

4.1 Cellular services

Already at the stage of preliminary planning, a model for dimensioning of the three different cellular systems was established, based on prognoses for expected amount of people of different categories coming to the Olympic Region during the Games. Qualified guessing was done to assume the percentage of mobile telephone subscribers within the various categories of people, and how much traffic one subscriber within each different category would generate during busy hour.

Based on these assumptions and data, the total traffic demand within the area of Olympic activity was calculated for each of the cellular services. Then, a certain part of this total traffic demand was associated with each of the Olympic arenas, based on the programme schedule for the Olympic activities at these arenas. In this respect, we tried to assume whether an activity would be most popular for spectators from Central Europe or from the Nordic countries. The dimensioning model was established as a work-sheet system for quick updating as new and more reliable information gradually was obtained.

As there was very little experience to refer to for mobile communication during such events as the Olympic Winter Games, two members of the Olympic mobile group went to Falun, Sweden, in the spring of 1993, to collect any experience done during the World Skiing Championships. During some of the pre-Olympic test arrangements throughout 1993, some experience was also gained.

For the main roads leading into the Olympic Region and for the accommodation area outside the Olympic Region, the prognoses already existing for NMT-900 and GSM were laid down as a basis for further planning. These prognoses were considered as being prognoses for NMT-900 only. In addition, expansions scheduled for 1994 were rescheduled for 1993, to bring up the extra capacity at an early stage. Starting from these plan data, further dimensioning was based on qualified judgement of the ongoing development of traffic demand.

During summer/autumn 1993, it was decided to establish coverage for NMT-900 as well as GSM hand-portable telephone sets on the main road, E 6, from Oslo to Lillehammer. For this purpose, the following 4 base stations were established along this route:

- Prøysen
- Veslenga
- Andelva
- Hovinmoen.

Repositioning of two base stations to the sites Skedsmo and Lindeberg was already ordered, also to improve the coverage of this route. Hence, a much awaited and necessary improvement of the coverage of E 6 was initialized and had to be finished before the start of the 1994 Winter Olympic Games.

4.2 Numeric paging

This service was implemented according to normal plans, regardless of the Olympic Games, but the construction program for coverage of the main road E 6 through the valley of Gudbrandsdalen, was speeded up. A repeater was put up to cover the Gjøvik Olympic Cavern Hall.

4.3 Alphanumeric paging

The implementation of this service was done at a later stage than the initial planning of the services for the Olympic Games. LOOC showed special interest for this service and signed a special contract with TOP to use it for Info '94 and for administration of its transportation fleet. For this purpose, Norwegian Telecom undertook to improve the radio coverage along some roads and to establish indoor/redundant coverage at the areas of the arenas. For this purpose, transmitters were put up at the following locations:

- Ringebu
- Tandelykkja
  (As part of normal coverage)
- Åsletten
- IBC
- Håkons hall
  (back up for IBC)
- Østhagan
  (Grua, Road 4)
- Kråkhugukampen
  (Road 250)
- Gjøvik Olympic Cavern Hall
  (Repeater, constructed by Tele-mobil).

The area surrounding the lake of Mjøsa was covered by transmitters already in service in Lillehammer (Korpeberget), Gjøvik (Bergstoppen), at Bangsberget

and in Hamar. The transmitters at Kråkhugukampen and in Håkons hall were put up just before the Olympic Games to cover road No. 250 and to establish a back-up for the transmitter at IBC. The governmental department of frequency administration was very concerned about possible interference with various electronic equipment at IBC, and therefore advised us that the transmitter at this site could possibly have to be shut down at short notice. However, this never turned out to be a problem.

4.4 M-TEL

During the autumn of 1993, Tele-mobil signed a contract with the American company M-TEL, for temporary provision of radio coverage for their 900 MHz paging system within the Olympic Region down to Oslo. Equipment for this purpose was put into spare space in the transmitters for alphanumeric paging at several sites. This system utilized the same paging controller and same leased lines as the system for alphanumeric paging. Separate antennas of the same type as for NMT-900 were put up for this paging system. In this way, M-TEL transmitters were put in service at the following sites:

- Ringebu
- Tandelykkja
- Åsletten
- Korpeberget
- IBC
- Håkons Hall
- Bangsberget
- Hamar tele
- Bergstoppen
- Mistberget
- Tryvann
- Røverkollen
- Toåsen.

Additionally, a transmitter was put up in the Gjøvik Olympic Cavern Hall, connected by separate leased lines to the transmitter controller in Gjøvik.

Even though the M-TEL transmitters produced a rather high power output into the antennas, the resulting radio coverage was beyond all our expectations. When the transmitter at Mistberget was finally put into service, continuous coverage was a fact from the central Olympic area south to Oslo.

The company SKY-TEL, doing the marketing for M-TEL, established their own office in the central part of Lillehammer during the Games.

4.5 Mobile data

Mobile data communication was not a part of the contract between LOOC and TOP. However, radio coverage for the Mobitex system was established from Oslo up to the central parts of the Olympic area by a forced construction programme. In addition, the old Mobitex base station (160 MHz) at Sprinklerfjell (Fredrikstad) was replaced by the new Mobitex system using 400 MHz band. Hence, base stations were put into service at the following sites before the Olympic games started:

- Åsletten
- Korpeberget
- Bangsberget
- Mistberget
- Bjørnåsen
- Sprinklerfjell
- Høyås.

5 Installation phase

5.1 Planned installation of base stations

A great part of the extra capacity for the NMT-900 network was put up by reusing second-hand equipment from Oslo, as this equipment was replaced by new equipment, more suitable for a small cell network structure.

As far as possible, the same personnel was used for dismantling of the equipment in Oslo and for reinstallation within the Olympic area. This idea of work organization proved to be very effective.

All planned construction and expansion of radio base station capacity were fulfilled before the opening of the Olympic Games.

5.2 Planned installation of mobile telephone switches

The installation of an additional Mobile Telephone Exchange (MTX) at Hamar was done for the purpose of reliability and because the capacity of the existing MTX, according to the expansion programme, was about to be fully utilized as far as number of connected base stations was concerned. This extra MTX was planned to be reinstalled at another site after the Games. However, already in 1992, this extra MTX was so badly needed in the area of Oslo and Drammen, that a new evaluation of the need at Hamar concluded that it should be dismantled and reinstalled in the Oslo/Drammen region during the spring of 1993.

To take care of the system reliability at Hamar, plans were made for rerouting the mobile telephone traffic onto another MTX.

5.3 Installation outside the planned programme

TOP and Tele-mobil agreed during December 1993, that a base station for extra capacity in the NMT-900 system should be put up within the city of Lillehammer. This was finally done by putting up a base station for NMT-900 and GSM at the Technical Centre for Mobile Services at Fåberg. By doing this, the system capacity was expanded for the northern part of Lillehammer city, and the radio coverage was improved along the E 6 up beyond Fåberg towards Øyer. The base station was put into service before the Games started.

During a test arrangement in the Hamar Olympic Amphitheatre, we received complaints of bad coverage for NMT-900 in some office areas underneath the amphitheatre. A mobile base station equipped with 8 channels was put up to solve this problem. This mobile base station remained at that site during all of the Olympic Games, giving the necessary coverage, but with a capacity which should have been doubled.

During the period just before the Olympic Games and partly after the opening of the Games, some complaints and strong demands for improvements were set forth. This was concerning the following areas:

The air-raid shelter at IBC

The American TV company CBS had a great deal of their personnel and technical equipment installed in the air-raid shelter at IBC, where the NMT-900 coverage for obvious reasons was very bad. After request from LOOC, an active repeater was installed for NMT-900 and GSM coverage inside the shelter. This was done just before the Olympic Games were started.

Olympic village Skårsetlia

Complaints were received about bad indoor coverage in the service building of this village. Measurements showed extraordinary high attenuation from outdoor to indoor position. Hence, it was decided to put up a separate base station, which was installed in the room for technical equipment. This was done before the Games were opened.

Main Press Centre – MPC

In spite of short distance from the base station at IBC, the coverage inside MPC proved to be very bad, except for the top floor. Measurements showed reasonably high field strength, but with a rapidly varying pattern as the mobile telephone was moved inside the building. In other words, a complicated multipath field strength pattern made it very difficult to use cellular telephones. The problem was solved by installing an active repeater connected to a "feeding" antenna on top of the roof and an antenna installed in each of the two difficult floor levels. Measurements as well as installation were done during two days of the first week of the Olympic Games.

Brøttum

LOOC complained via NTOP that an area at Brøttum was badly covered. No solution was established as the signal strength was considered to be too low for a repeater. This seemed to be a problem for only a few persons within LOOC.

5.4 Capacity adjustments

Already two days before the official opening of the Games, questions about expansion of the NMT-900 capacity in the central part of Lillehammer were raised by the management of Tele-mobil AS. Therefore, an expansion of the base station at Lillehammer tele was put into service the day before the official opening. The concentration of people in the centre of Lillehammer city and their use of NMT-900 resulted in a very high traffic demand at this base station. The same happened at the Abbortjern base station, which covered the cross-country ski arena, Birkebeineren. High traffic demand was also expected at Hafjell. Expansions can be summarized chronologically as follows:

11.02.94 Lillehammer tele NMT-900 expanded from 64 to 80 channels

16.02.94 Abbortjern NMT-900 expanded from 44 to 48 channels

17.02.94 Abbortjern NMT-900 expanded from 48 to 61 channels

20.02.94 Lillehammer tele NMT-900 expanded from 80 to 96 channels

21.02.94 Åsletten NMT-900 expanded from 64 to 80 channels, by using equipment from Ringebu

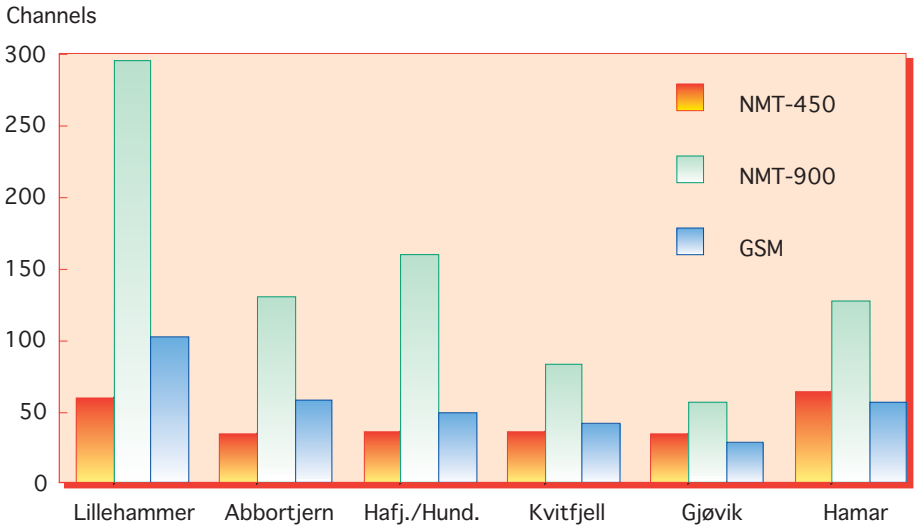


Figure 3 Channel capacity

base station and frequencies from Fåvang base station.

Figure 3 shows the capacity for NMT-450, NMT-900 and GSM as it was established at the various arenas/areas.

Expansions could be made on short notice because equipment, equipment space, power supply of relevant voltage and transmission capacity was available, and because Tele-mobil had available engineers and technicians at the Olympic Network Operations Centre (NOC) and at the Technical Centre for Mobile Services, Fåberg. Easy communication between TOP and Tele-mobil was equally important, enabling quick decisions to be taken.

6 Quality Evaluation Project

A quality project was established for evaluation and possible optimization of the NMT-900 network as far as call quality and utilization of the frequency resources are concerned. The evaluation concentrated on the Olympic Region Hamar – Gjøvik – Lillehammer – Ringebu, including main roads from Oslo, emphasizing the E 6 main road.

Initially, all parameters for the concerned base stations were examined and compared to theoretical values. Necessary corrections were done. In addition, practical tests were carried out. Weekly routines for measuring a set of quality parameters were established, as for instance call breakdown, successful handover, congestion in measuring channel, etc. Further on, a car, specially equipped for network analysis, was leased together with a driver/operator from the Swedish Telia Mobitel. This was driven around throughout the Olympic Region to verify radio coverage and network operation. The result indicated that some parameters had to be changed, and that the main road E 6 still suffered from low field strength at some few locations.

When all planned radio base stations were put into service and new adjustments had been made, a new network analysis was carried out by the leased Swedish test-wagon throughout the Olympic area including the main road E 6 from Oslo to Ringebu. After some minor adjustments, the network seemed to be as optimized as possible, given the available number and locations of the radio base stations.

At an early stage of the quality project, routines for automatic measurements and checking of all radio channel equipment and associated leased lines at least once a week, were established at the Mobile Network Control Centre in Hamar.

In early January 1994, terminals for an automatic traffic testing system (TVP-M) were distributed at important locations within the central Olympic area, like arenas, the Main Press Centre and the city centre of Lillehammer. By this system, the degree of service was tested as well as the quality within certain limits.

As from February 1, these tests were intensified. The degree of service was tested from the PSTN into the cellular

network and vice versa, as well as traffic measurements within the cellular network. As from February 5, these tests were followed up by daily meetings, where the latest findings as well as possible improvements were discussed and analyzed.

Looking back at this activity, we can conclude that the quality project by its intense checking activity, succeeded in maintaining the NMT-900 network close to its optimum shape, contributing to reasonably good degree of service even during periods of heavy traffic demand.

7 Operation during the Olympic Games

By signing the contract with TOP, Tele-mobil accepted to participate with qualified personnel in the Olympic Network Operations Centre (NOC). By being collocated with personnel responsible for other parts of the telecommunication networks, Tele-mobil had a good opportunity to be quickly updated regarding possible network problems.

As NMT-900 had been deemed the main traffic machine of cellular services, the attention was focused on this service together with the alphanumeric paging system, which was also part of the contract with LOOC.

At the NOC, Tele-mobil installed terminals for monitoring and operation of all the cellular services as well as the alphanumeric paging system within the Olympic area. For NMT and GSM, advanced control systems were used; as for the alphanumeric paging system, a standard terminal was connected to the paging controller in Trondheim.

This centre was attended continuously by one of four experienced engineers from Tele-mobil. In addition, Tele-mobils regional Mobile Network Control Centre in Hamar was attended from 0600 hours until 2200 hours throughout the week. Two experienced engineers were added to the 5 engineers usually operating at this centre. The corresponding centre in Oslo as well as the paging controller in Trondheim, was also attended for the same period every day, but without additional engineers.

Tele-mobils centre for subscriber services (164) was attended 24 hours a day, being able to clarify all questions regarding subscription at any time.

All NMT-900 base stations within the Olympic area were monitored 24 hours a day from NOC. This centre also took over the monitoring of the NMT- and GSM-networks for the centres in Hamar and Oslo, as well as the paging controller in Trondheim for the period 2200 till 0600.

The Tele-mobil engineers at NOC also had the possibility to call out engineers for service at the radio base stations within the Olympic area 24 hours a day.

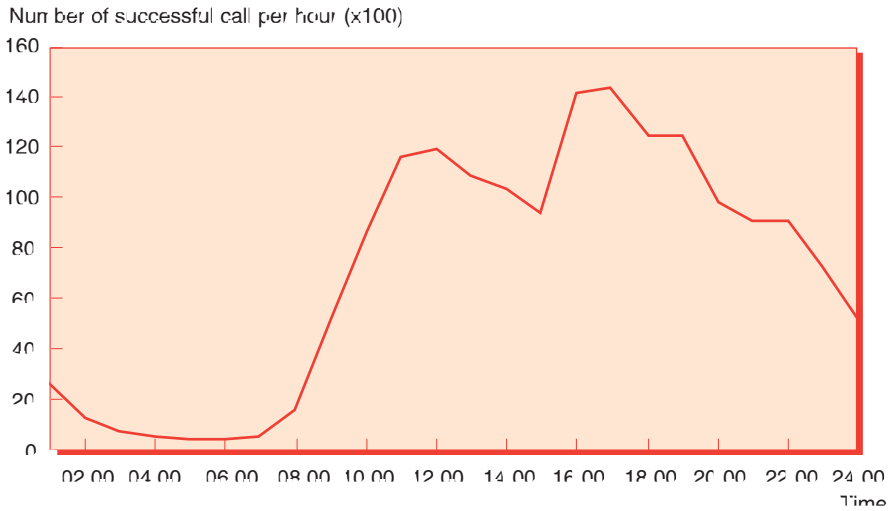


Figure 4 Traffic in the Olympic region

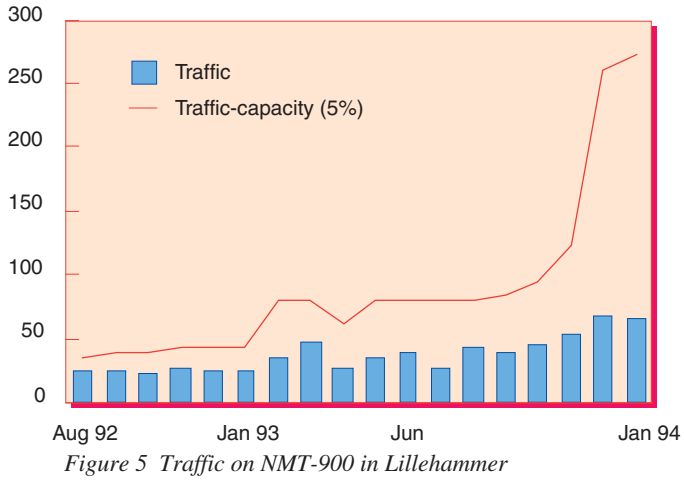


Figure 5 Traffic on NMT-900 in Lillehammer

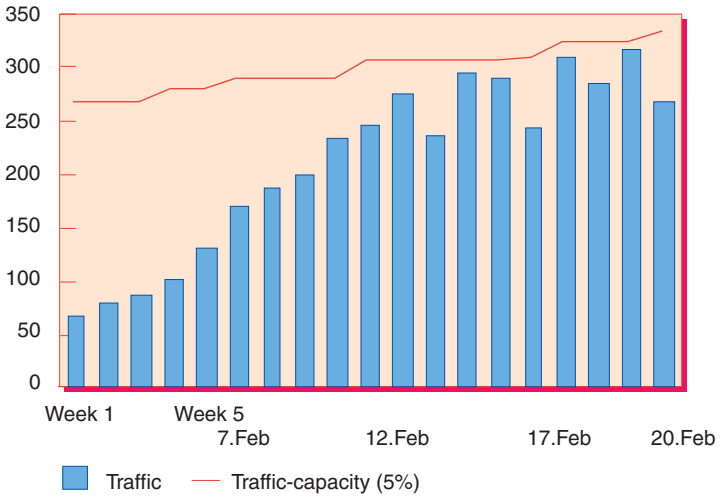


Figure 6 Traffic capacity on NMT-900 in Lillehammer

At NOC the traffic demand at each radio base station was registered continuously, enabling traffic statistics to be produced for every hour during the Olympic Games.

8 Some key numbers

2.6 million mobile telephone calls were set up during the 16 days of the 1994 Winter Olympic Games, i.e. an average of 160,000 calls every day. The maximum traffic demand was registered the day before the official opening.

During the hour from midnight until 0100, the traffic demand was three times the normal demand during daytime busy hour.

In total, 296 radio channels in the NMT-900 system covered the city of Lillehammer. This was three times the normal capacity. In addition, 100 channels of GSM and 60 channels of NMT-450 were available for traffic. This capacity enabled a call intensity of 15,000 per hour. Figure 4 shows that this was sufficient.

Figures 5 – 7 show the development of the traffic in the NMT-900 system in the city of Lillehammer for the time period from August 1992 until February 28, 1994.

Figure 8 shows the number of 'NMT-900 guest subscribers' roaming into the Olympic region during the period 18 – 25 February 1994.

Figure 9 shows the number of 'GSM guest subscribers' roaming into the Olympic Region during the period 7 – 22 February 1994.

It should also be mentioned that very few subscriber complaints were registered for the mobile services during the 1994 Winter Olympic Games. At NOC an average of one complaint per day was registered, taking all of Tele-mobils services into account.

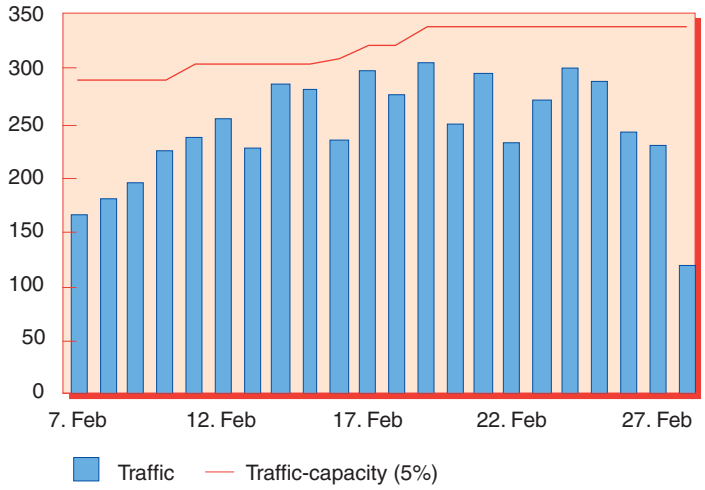


Figure 7 Traffic on NMT-900 in Lillehammer

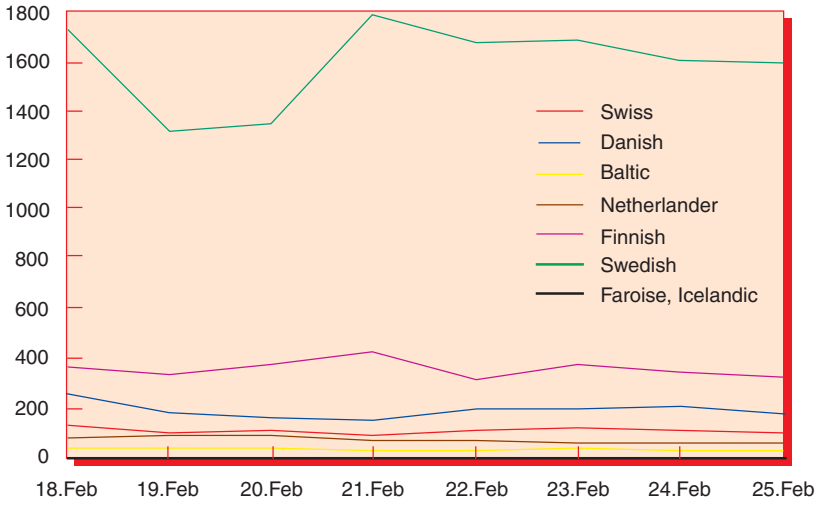


Figure 8 Guests in the Olympic region

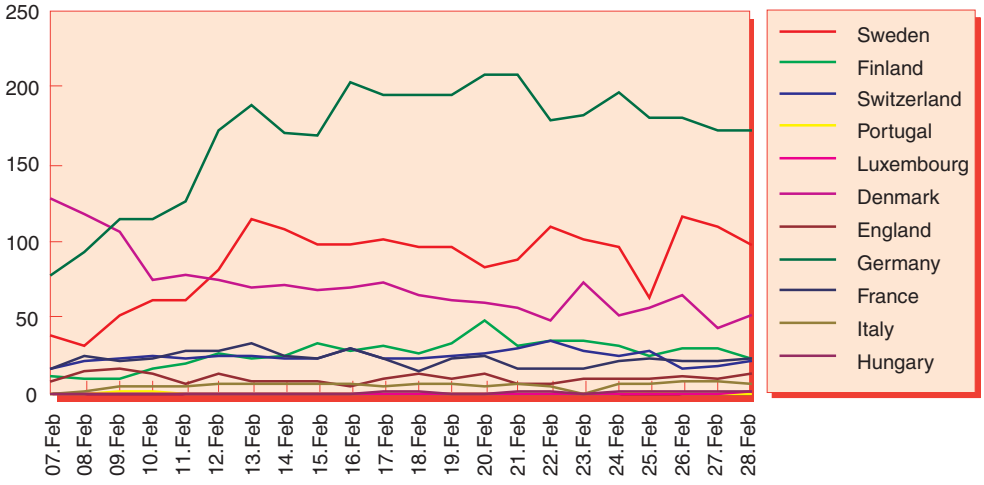


Figure 9 Roamers in the Olympic region

Datacom

BY HJALMAR A HANSSEN

Standard data communication services such as X.25, X.28 and leased lines (several data rates from 2.4 kbit/s up to 2 Mbit/s) were the backbones of the Olympics. To serve data communication needs such as leased lines, Norwegian Telecom (NT) introduced a new network concept and a brand new technical equipment for the XVII Winter Olympic Games. The solution was based on the DXX concept from Martis OY of Finland. The new network solution was easy to reconfigure and was also very stable and reliable. Data rates in the network spanned from low speed data (2400 bit/s) up to 2 Mbit/s, all routed through DXX access nodes and the DXX cluster node. Such a mixed solution also gave us an easy overview and maintenance of the network and few types of equipment to handle.

1 The planning phase

To plan the network for the leased line services, NT had to take into account estimates from LOOC's and NT's own experiences from such networks. Several calculations were made as a result of several (five) updated estimates from LOOC. The last calculation was merely correct compared to what we met during the Olympics, but slight modifications had to be made.

2 The network concept

2.1 The telex service

When visiting Albertville in '92 we experienced that equipment like the telex machines were very rare, but of course, a few were in service. NT thought that the situation for the telex service would be even worse in '94, and this proved to be correct. NT did not make any new investments in the telex services for the Olympics because our investigations in the Olympic region showed a situation where most of the telex lines were disconnected because of the introduction of the telefax machines. Because of this, a high capacity telex network already existed in the area, and we found this useful for the Olympics in its present state.

During the Olympics approx. three telex machines were operating. The telex network is shown in Figure 1.

2.2 The X.21 service

In Norway the X.21 service is named "Datex", a service that has decreased in use over the last years and still seems to decrease. Consequently, NT found it wise not to make any new investments to upgrade this service because the spare capacity in the Olympic region was sufficient to supply this service anyway. A decision that proved to be very wise.

2.3 The X.25 and X.28/V.24 services

Our estimates concluded in an extensive use of X.25, but this proved to be wrong. Only a few subscribers used this network, and the X.25 service is obviously not of major importance for events such as the Winter Olympic Games. The network concept is shown in Figure 2.

2.4 Leased lines

Two types of leased lines were supplied, an analogue and a digital type. The analogue one was in accordance with CCITT M.1040 for domestic use, and for international use in accordance with M.1020. These circuits were established via the PCM-muldexes and will not be further discussed in this chapter.

Digital leased lines were established via the DXX network, and served data rates from 2.4 kbit/s up to 2 Mbit/s, both synchronous and asynchronous circuits. The DXX network design was a star configuration built around a DXX cluster node at IBC (see Figure 3). The digital leased line service was a very popular one, but as expected we observed that several users preferred ISDN, and the reason might be obvious: it is cheap, it is secure

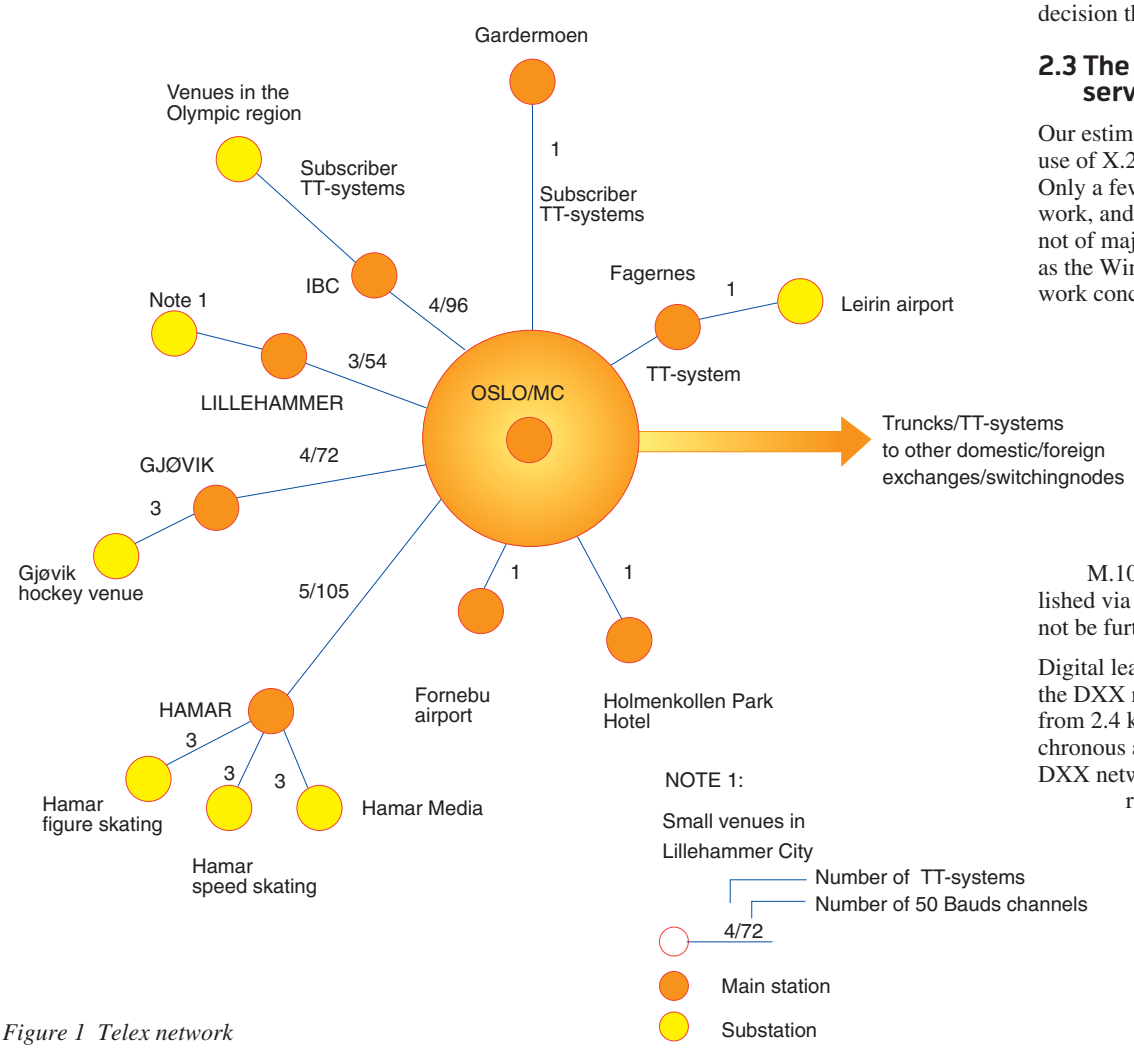


Figure 1 Telex network

and the same connection may be used for a normal telephone conversation.

2.5 The DXX-system

DXX components were supplied by the company Martis OY in Finland. The system itself is a static switched system with a functionality previously not seen in such a network. It also enabled an easy installation of subscribers and a very good maintenance and supervision system.

The main system components are:

- A cluster node with a maximum capacity of 512 Mbit/s (8 * 64 Mbit/s). The internal data bus rate is 2 Mbit/s.
- Several access nodes each with a maximum capacity of 64 Mbit/s (32 * 2 Mbit/s). The internal data bus rate is 64 kbit/s.

The cluster node at IBC, comprising 5 subracks was, so to speak, the hub in the DXX network. Each single DXX access node was connected to the cluster node with a number of 2 Mbit/s G.703 circuits. The number of 2 Mbit/s circuits per access node was a result of the maximum traffic load (number of leased lines and their data rate). In addition we also established the routing between the access nodes and the cluster node according to the spread routing principle to have at least 50% of the capacity available if the main transmission route failed. Such a solution of course occupied many 2 Mbit/s circuits in the transmission network, but we did not have any other choice because of the type of traffic dispatched through the DXX-network and the demands concerning reliability of our network.

2.6 DXX network topography

See Figure 3.

- Point-to-point communication

  For example the timing/result service for LOOC, data rate 128 kbit/s.

- Point-to-multipoint communication

  Bankomats (cash withdrawal) and POS-terminals for VISA/NOR-bank.

- The X.25 service was available on each venue via the DXX-network.

2.7 The access nodes

An access node is the type of equipment that was installed at each venue and in some user premises. The access node is equipped with several so-called data

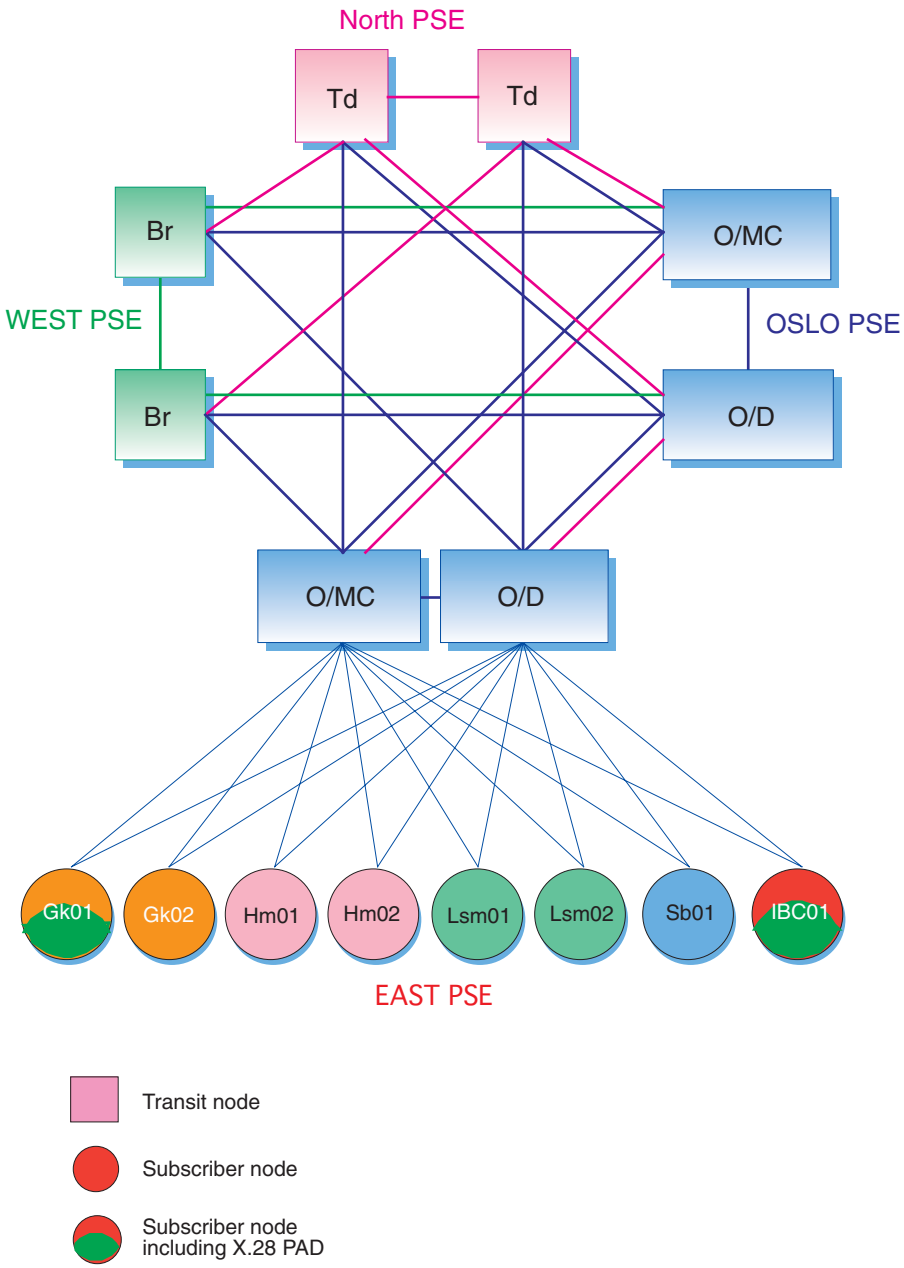
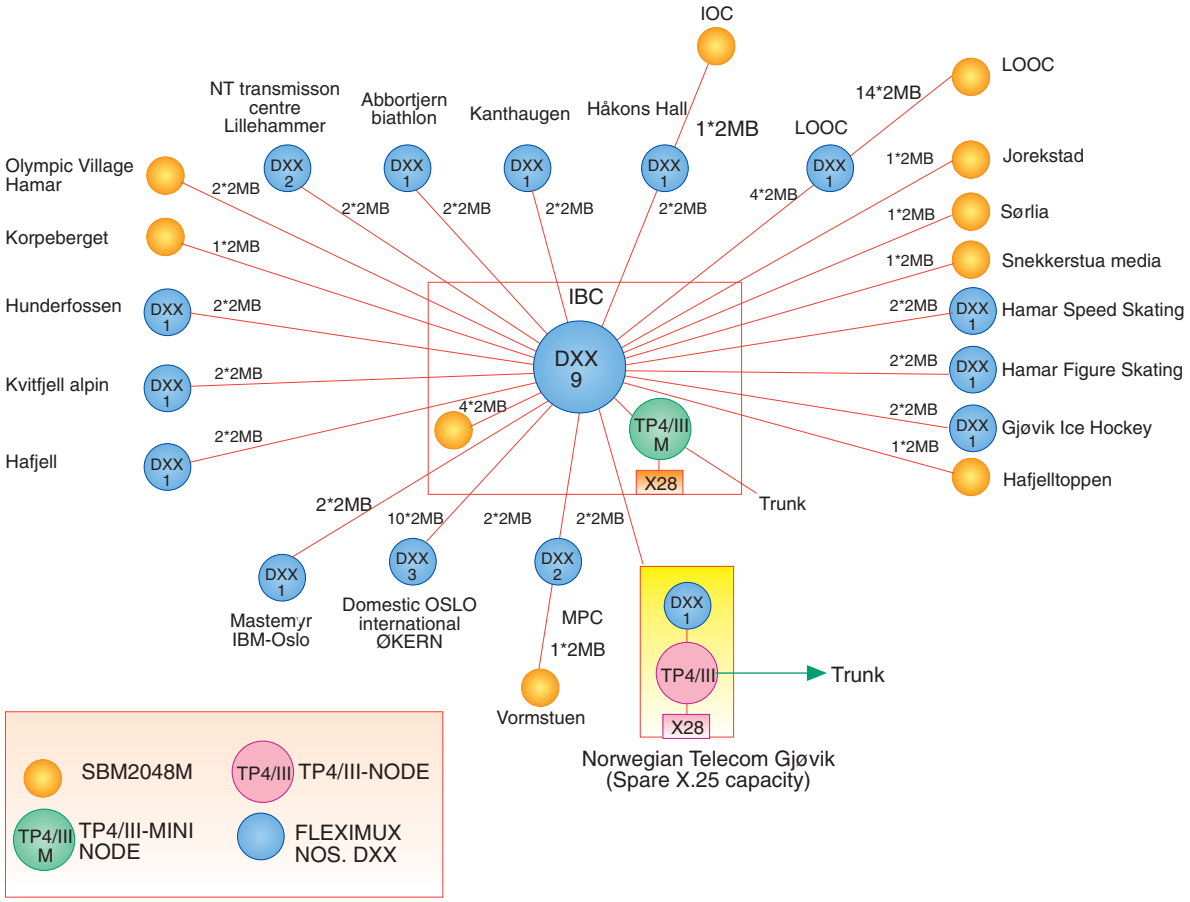


Figure 2 X.25 and X.28/V.24 network concept

interfaces, and the freedom of choosing a proper interface is quite big. The following list shows the interfaces delivered:

- V.35 (ISO 2593), synchronous. VCM222 with VDM240 and 4 interfaces per unit.
- V.36 (ISO 4902), synchronous. VCM222 with VDM241 and 4 interfaces per unit.
- V.24/V.28 (ISO 2110), synchronous/asynchronous. VCM223 with VDS242 and 4 interfaces per unit.
- X.21/V.24 (ISO 4903), synchronous. VCM223 with XDM244 and 4 interfaces per unit.
- G.703 (co-/contra directional, 64 kbit/s). VCM223 with GCL243 and 4 interfaces per unit.
- G.703 (2 Mbit/s). One interface per unit.



Venue	LOW SPEED DATA DIGITAL				HIGH SPEED DATA DIGITAL		
	4,8kb/s	9,6kb/s	19,2 kb/s	Sum	DATAPAK	64 kb/s	2 Mb/s
Hunderfossen	3	5	2	10	3	6	
Kvitfjell	4	7	2	13	6	7	
Hafjell	2	5	2	9	6	7	
Abbortjern	4	9	4	17	3	11	
Kanthaugen	5	7	4	16	3	11	
Håkons Hall	1	7	2	10	4	8	
Lillehammer LOOC		5	30	35	1	11	2
Hamar Speed Skating	4	7	2	13	6	8	
Hamar Figure Skating	4	9	4	17	6	10	
Gjøvik Ice Hockey	1	5	4	10	4	7	
MPC	1	17	2	20	15	17	
IBC	15	71	6	92	5	22	4
Domestic/International	12	70	6	88		31	6
Lillehammer City	7	24	2	33		24	

Figure 3 DXX network topography

As seen from the list of available interfaces, all these, except one, are equipped with four interfaces per unit. One unit could either consist of a single card or a double card (two cards mounted on the same front cover). Anyway, if one card failed, the maximum of four users were disturbed by this. Another Martis speciality is the way they built their interface cards. By studying the list of interfaces we find that in practice only three major types exist. The ingenuity is that small add-on boards installed on either VCM222 or VCM223 gives the proper interface, except the 2 Mbit/s G.703 interface.

The total number of access nodes was approx. 40 units (double racks), and approx. 40 mini-nodes (SBM 2048A), not all of them in use because some were spare nodes.

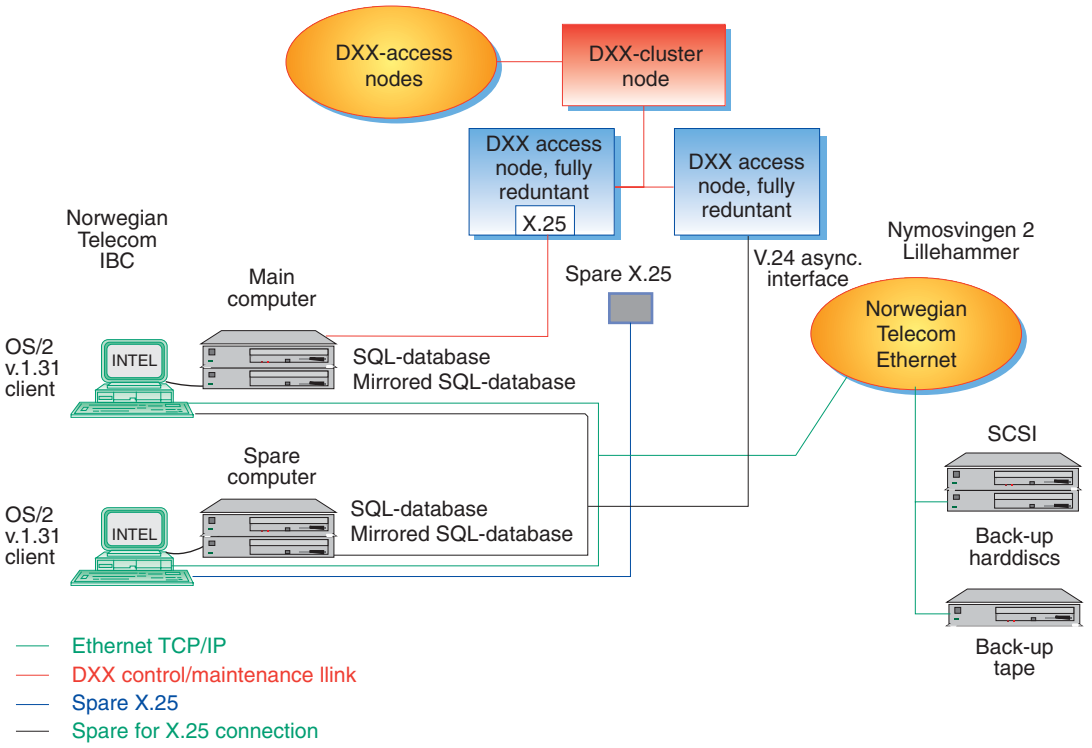


Figure 4 DXX control/maintenance network

2.8 Modems

The new modems had of course new functions giving NT a possibility to supervise these types of digital lines previously never possible. In practice, NT was able to supervise the communication link from V.xx interface to V.xx interface, and this without disturbing an ongoing communication thanks to the implementation of CCITT V.110 frame (modified version) and the use of spare bits in timeslot 0.

In the new modems the Adaptive Echo Canceller technique was implemented, a function that made it possible to transmit data up to 384 kbit/s on a two-wire line. Data rates higher than 384 kbit/s was transmitted on four-wire lines. Because many customers used the 64 kbit/s data rate, much money was saved both in the transmission part and the internal network cabling systems at the venues.

The following list shows the modems used:

- Two-wire modems:

  SBM-64A 64 kbit/s max. Two-wire (strappable to four-wire).

  SBM-384A 384 kbit/s max. Two-wire (strappable to four-wire).

- Four-wire modems:

  SBM-768A 768 kbit/s max. Four-wire.

  SBM-2048A (Also named MINI-node). Four-wire (four low speed data interfaces and one 2.048 Mbit/s interface).

A = Advanced (remote supervision and remote parameter setting).

As a rarity, the French and Japanese use X.21/V.24 to transmit high speed data.

When installing a 64 kbit/s for a customer, and if we though this line could be subjected to change to a higher data rate (e.g. 128 kbit/s), we installed a 384 kbit/s modem instead of a 64 kbit/s modem. One of our major clients, LOOC Datacom, ordered many 64 kbit/s circuits to each single venue, in fact two or more. On these lines we expected a data rate change and installed 348 kbit/s modems. Days before the Games started, the order for a 128 kbit/s data rate arrived. Normally, a change like this would have made a great impact in our organization because of the work effort of effecting this type of order, especially concerning the time frame. Because of our preparations, upgrading from 64 kbit/s to 128 kbit/s for almost 30 links was only a 30 minutes job to do, which is fabulous for these types of connections in a public data network like NT's.

2.9 The subscriber premises

A subscriber installation was quite a simple task with this new equipment compared to earlier procedures. When the venue internal lines were finished a modem was installed on each side of the communication link (point-point). Then all definitions concerning the type of communication, i.e. the data rate, use of the V.- interface and other communication parameters were set from the DXX network control terminal at IBC. All necessary tests could be initiated from this terminal, which also was the case in practice. Possible test loop was digital-digital and analogue-analogue as with standard modems. Besides, a complete transmission test could be done by using spare bits in timeslot 0 in the V.110 data frame if enabled. Normally the V.110 frame was enabled, giving NT a lot of

important data to supervise the network quality and information to hand out to the customer if any problems arose (statistical data).

2.10 DXX network control

See Figure 4.

The overall network control of the DXX system was based on a single control site. At the control site a powerful PC equipped with the OS/2 operating system was running the Martis NMS software (Network Management Software), and using a standard SQL database. The main control PC was connected to NT's LAN via an Ethernet connection and running the TCP/IP communication protocol. Such a protocol also enabled communication with all other resources in the LAN. To have a complete back-up of the database (including all routing information and all subscriber information for the complete DXX network), the database was locally mirrored on a harddisk on site. Besides this, an automatic file transfer of all the data from the SQL base was done every two hours to the main server at Nymosvingen 2. It was mandatory to have a secure storing of data on another safe location in case of a fire at IBC. After the file transfer was done, a tape back-up was made at Nymosvingen 2. If the main DXX control PC should fail, the spare control PC would automatically fetch the data stored at Nymosvingen 2, restore these and start the process towards the DXX network. The only manual operation in this process was to change the interface cable on the IBC access node (the X.25 interface connection). Each control PC had its own X.25 cable run to the DXX access node used for DXX network control/management, but only the active PC was physically connected, and the same goes for the V.24 cables.

Both the main control PC and the spare one were equipped with an X.25 interface, a V.24 interface and an Ethernet II interface.

Control of the DXX cluster node was done via a control interface on an access node at IBC. The same access node was of course also used for connection of customers at IBC. If this access node should fail, then the control of the DXX network could be performed via another DXX access node at IBC, but now via a V.24 interface.

The X.25 data rate was 64 kbit/s.

2.11 Supervision and maintenance

All of the low speed data rates were supervised by using the CCITT V.110 modified frame. This enabled access to spare CRC-bits (Cyclic Redundancy Check) in TS0 (timeslot zero). Via these spare bits we could perform end-to-end supervision on each single digital leased line, in fact including the V.xx and X.yy interface on the modem installed in the customer premise.

Performance data might be stored for up to three months if necessary. Before and during the Olympics we used these data for fault correction if a customer reported a fault or an error with their digital leased lines. The pooling time from the DXX cluster node to each single access node was approx. 500 ms. The time used, in the worst case, from an error occurred the first time until it was registered by NT's DXX operator would not be longer than 30 seconds (with approx. 60 DXX access nodes in the network).

Pay phones

BY HJALMAR A HANSSEN

Four types of pay phones were used for the Olympics. Two special models, the indoor card operated telephone set (the Press terminal) and an outdoor version were developed and produced mainly for the Olympics. Coin operated pay phones were the standard model GN Elmi AY-4 and a Schlumberger PF-08 outdoor card operated telephone (only prepaid smartcards).

The new in- and outdoor card operated telephone sets handled both prepaid telephone cards (smartcards without µprocessor) and credit cards (e.g. VISA).

The Press terminal was mainly designed as a tool for journalists in the press centres, offering extended features for operation, connection and help.

1 The planning phase

There were three items of great importance:

1 Public pay phones outside Olympic venues

2 Public pay phones inside the Olympic venues

3 Press terminals in the Main Press Centre and in the Sub Media Centres.

The location of each single card- and coin-phone inside an Olympic venue was found in co-operation with LOOC. Locations outside the venues were done by Norwegian Telecom (NT) alone.

In order to secure further income, some terminals outside the Olympic venues were defined as permanent and others as temporary installations.

The total number of Press terminals at the Main Press Centre (MPC) and the Sub Media Centres (SMC) was decided by LOOC, and these terminals were rented from NT. The rental included terminals, installation, maintenance and user instruction on-site.

2 The network concept

The total network concept is shown in Figure 1. The telephone functions including the use of the IN node is described in later chapters.

2.1 Supervision

Maintenance is normally very important for this kind of public pay phones, so also for the Olympics. Integration of all types of public pay phones in the same supervision system was mandatory in order to have a complete network overview. Schlumberger PF-08 and GN ELMI AY-4 were already defined in the DOSAT software. To integrate ABB indoor and outdoor card phones, we used the AY-4 definition.

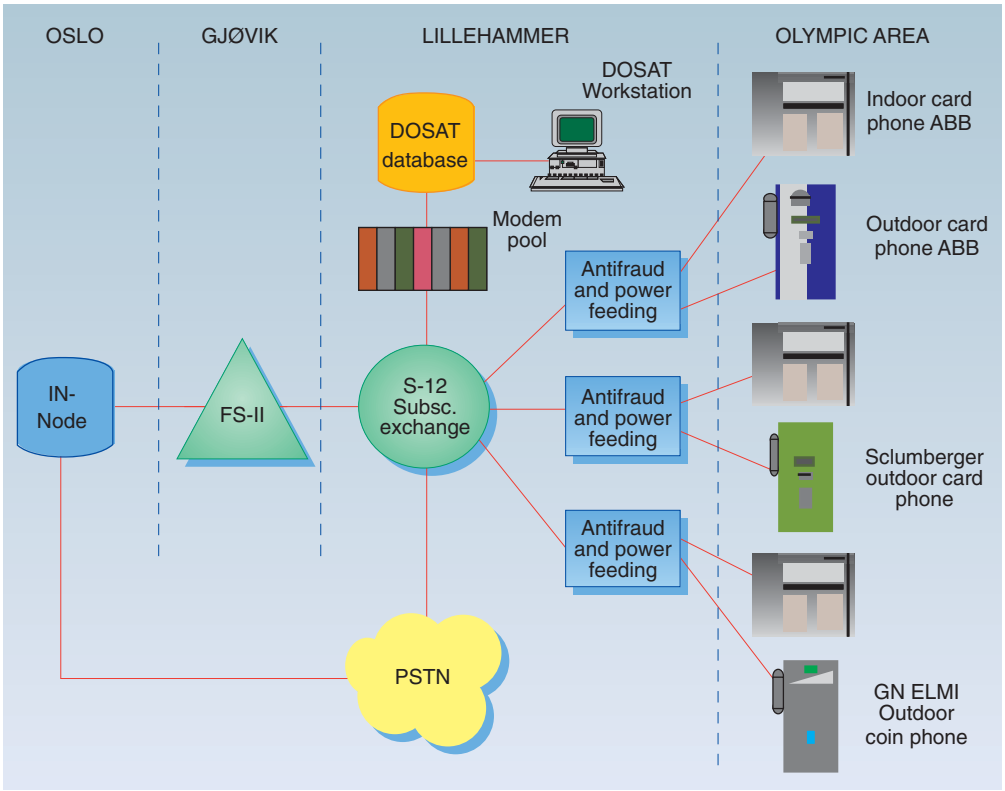


Figure 1 Network concept

A total of six terminals could present their operation and maintenance data simultaneously. This was possible because six modems were installed in a modem pool, and given the same telephone number defined as a common PBX-group in the public switch. Data was sent from each single terminal on a daily basis according to a predefined scheme. This scheme stated exactly when each terminal should call the DOSAT database. This was necessary in order for all the installed terminals to give at least one report daily.

2.2 The antifraud and power feeding units

All terminals took advantage of the antifraud device. This device is a single card performing receipt and restoring of the 16 kHz tax-pulses from the S-12 exchange, and then sending these tax-pulses to the pay phone. Inside the antifraud card a counter is started at the very moment the tax-pulse is sent to the pay phone. This counter supervises the time in which the antifraud device receives the correct pulse train from the pay phone. If no pulse is received before the counter elapses, the call will be disconnected immediately. If the proper pulse is received within the counter's time frame, the call is continued.

NT encountered some problems for the 16 kHz levels from/to the ABB terminals (because these were mainly used inside a venue and a very short distance from the switching node). Because of the high levels to/from the terminals some crosstalk existed, and the input circuits on both the terminals and the antifraud cards were overloaded. This was solved by decreasing the input sensitivity and the output levels on the antifraud cards. These modifications were simply done by changing resistor values already pinpointed in the card's documentation. This is a common problem when operating pay phones with such short line lengths.

Schlumberger and GN ELMI terminals got their power feeding from the telephone line itself as usual. Remote power feeding for the ABB terminals was nec-

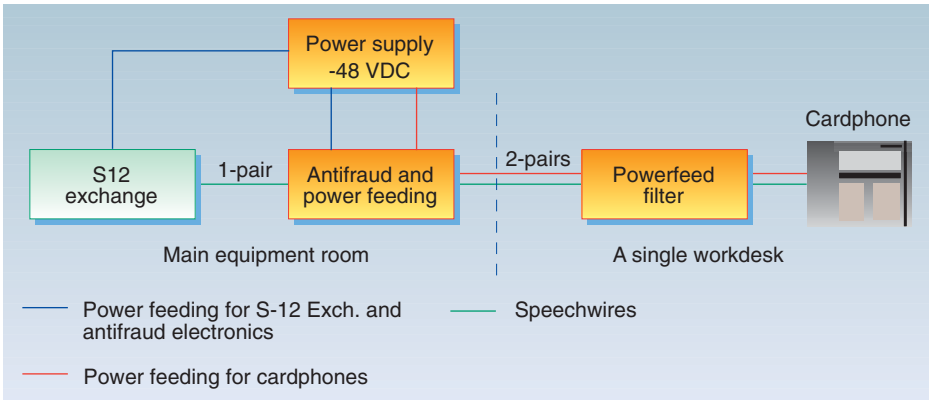


Figure 2 Power feeding

essary because they use too much power to be fed from the telephone line as normal (see Figure 2). This feeding is also used to charge the built-in batteries in the ABB terminals to secure 14 hours of continuous operation in case of a power failure. To use this feeding system 48 VDC was sent from the exchange to the terminal on specific pairs. In the terminal end a power filter was installed.

For the Press terminal, local power feeding was available, too, in a form of a mains operated power supply delivering 12 VDC, 700 mA.

3 The press terminal

In the planning phase NT soon realized that a specific type of telephone set had to be purchased for the Olympics (see Photo 1). In order to get a market overview, NT visited Telecom '91 in Geneva and contacted several pay phone manufacturers. When all the information was processed and all of NT's own requirements were incorporated we had a firm basis for our own specification for this type of telephone set.

After an international bid the equipment was ordered from the Norwegian company ABB Contec.

Telenor

Photo 1 The Press terminal

3.1 Main advantages of the press terminal

It is always a problem to serve new users with a non-familiar telephone system or a new terminal. One major item when specifying this terminal was to overcome such problems, and give the user easy access to our network and services. NT put a lot of effort in the use of PC communication (modems) with this Press terminal. When using a PC connected to the EXT connector in front of the Press terminal, the user only inserts his valid prepaid card in the card reader. The rest of the communication is performed from the PC as usual if connected to a direct telephone line.

Another feature is the possibility to choose help in one of six languages, where the default language is Norwegian.

When used with a VISA card, the language selection is done automatically on the basis of the country code in the VISA card. This means that all display messages are given in the proper language as written text (if the language is not among the six installed languages, English will be used). All speech messages from the IN node will also be given in the same language.

3.2 Telephony functions

- Full featured numeric keypad including * and #
- Special functions keyboard including new line key, card change key, programming and sending of abbreviated telephone numbers, volume adjustment, function key and register recall key
- Language keys; Norwegian, English, French, Italian, Spanish and German
- Graphic display; 4 lines and 40 characters per line
- Auxiliary RJ-11 connector to interface telephone line equipment
- Two card readers, one for smartcards and one for magnetic stripe cards (ISO 7815, track 2)
- DB-9 female connector for software upgrade via RS-232C computer interface
- Inlet for local power feeding including a fuse
- Headset connector (RJ-45)
- Telephone receiver equipped with electret microphone to avoid electro-

magnetic interference from sources like hearing aid coils and other “noise” sources

- Spare handset connector (RJ-45)
- Telephone line and remote power interface connector (RJ-11)
- Built-in back-up battery for 14 hours of full operation
- Built-in modem for reporting, general communication and remote software upgrading
- Buzzer for card change alarm.

3.3 Programming functions

- Three programming methods: Remote software upgrade, directly connected computer programming or RAM-card programming
- On-site programming
- Quick updating of special numbers
- Built-in software to check debiting functions (16 kHz received and transmitted).

3.4 Supervisory and maintenance functions

- Centralized supervision
- Daily report
- Immediate report upon specific internal errors.

3.5 User functions

- Use of prepaid telephone cards
- Use of 800-services and emergency calls (free of charge)
- Use of credit cards such as VISA and AmEx
- Direct connection of laptop modems, telefaxes and similar telephone line equipment.

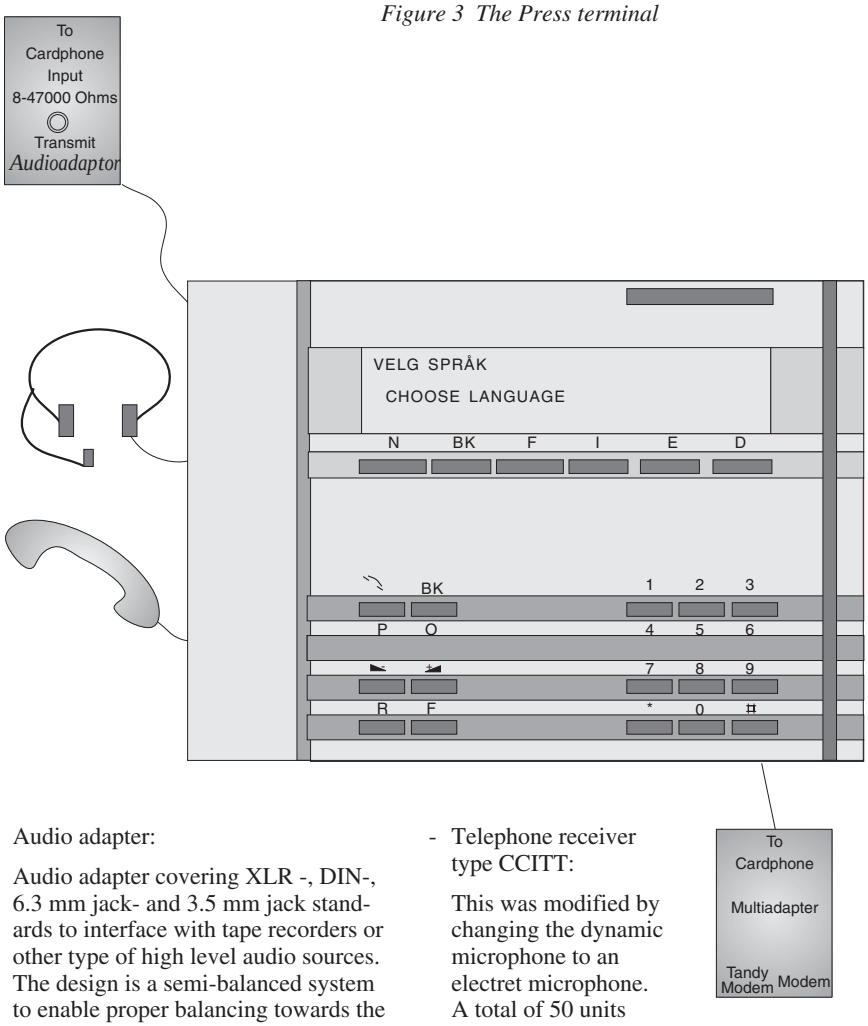
3.6 Accessories

See Figure 3.

- Headset:

  The headset with boom microphone and microphone switch was used to have a hands-free operation of the Press terminal, or used in a noisy environment. The headset was model 808 from GN Elmi equipped with an electret microphone and a dynamic loudspeaker.

Figure 3 The Press terminal



- Audio adapter:

  Audio adapter covering XLR -, DIN-, 6.3 mm jack- and 3.5 mm jack standards to interface with tape recorders or other type of high level audio sources. The design is a semi-balanced system to enable proper balancing towards the microphone- and loudspeaker circuits in the Press terminal. The adapter is also equipped with a monitor outlet and a rocker switch to send from the audio source or the telephone receiver handset. During transmission from an audio source, monitoring could be done via the telephone receiver loudspeaker.

- Multi adapter:

  Multi adapter covering Tandy model 100/200 and RJ-45 (USA and Norwegian standard and most other standards). The multi adapter is equipped with a DIN-connector for attaching Tandy computers, an RJ-45 (4-pole) to cover most of the modems in the market, and an RJ-11 (also called ISDN or ISO 8877) to interface to the PSTN or EXT connector on the press terminal. We also included banana sockets to simplify interfacing to older types of connectors.

- Telephone receiver type CCITT:

  This was modified by changing the dynamic microphone to an electret microphone. A total of 50 units were modified. This handset was intended for use with older versions of acoustical modems, which some of our customers did use. Because of the shape of the telephone receiver on the Press terminal this could not be used with these modems.

- Software (see Figure 4):

  The Press terminal is designed around a Siemens SAB 80C537 µController, and the software is stored on several different stores.

4 The outdoor cardphone

The outdoor card operated telephone uses the same electronics as the Press terminal, but slightly modified to withstand different environmental conditions. In addition, some services used in the Press terminal are removed in this outdoor version. Because of this, the description of the Press terminal also applies for the outdoor version with slight modifications.

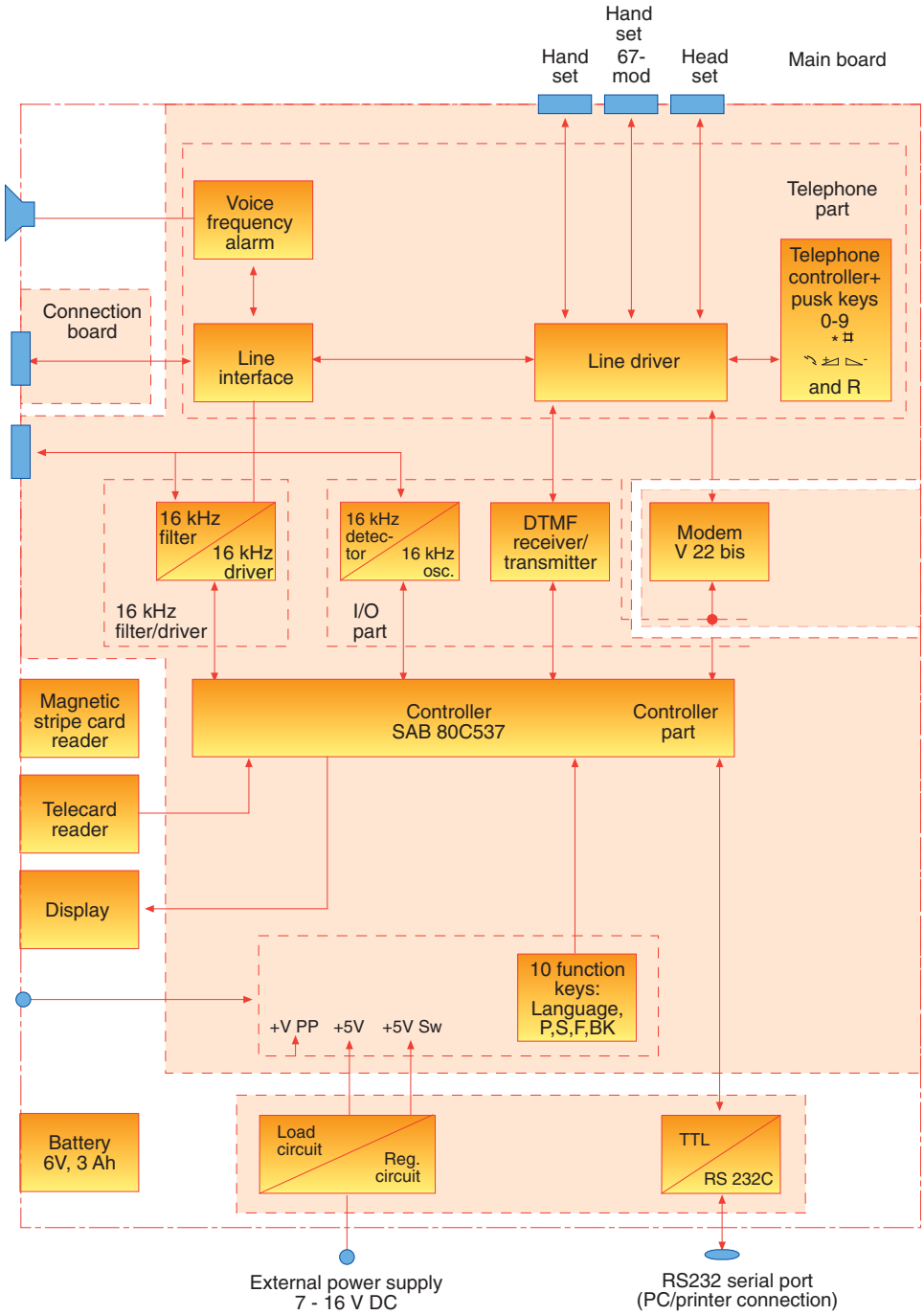


Figure 4 Press terminal software

4.1 Telephony functions

- Full featured numeric keypad including 0–9, *, #, new line key, card change key, card change key, language change (only Norwegian and English) volume adjustment and register recall key
- Graphic display; 2 lines and 20 characters per line
- Two cardreaders; one for smartcards and one for magnetic stripe cards (ISO 7815, track 2)
- Telephone receiver equipped with electret microphone
- Built-in back-up battery for 14 hours of full operation
- Built-in modem for reporting, general communication and remote software upgrading
- Buzzer for card change alarm.

4.2 Programming functions

- Two programming methods: Remote software upgrading or RAM-card programming
- On-site programming
- Quick updating of special numbers
- Built-in software to check debiting functions (16 kHz received and transmitted).

4.3 Supervisory and maintenance functions

- Centralized supervision
- Daily report
- Immediate report upon specific internal errors.

4.4 User functions

- Use of prepaid telephone cards
- Use of 800-services and emergency calls (free of charge)
- Use of credit cards such as VISA and AmEx.

5 Prepaid card

The following types of Schlumberger prepaid card were used:

Prepaid cards:

- F-256: 22, 65 or 150 units
- F-1024: 500 units (max. 1000 units).

Prepaid card type F-256 could be used in both the ABB terminals and in the Schlumberger terminal.

Prepaid card type F-1024 could only be used in the ABB terminals because the Schlumberger terminal was not upgraded to handle this type of card. Such an upgrade involves a change of software, which means changing the PROM.

6 VISA/IN communication

For the first time ever, because of the Olympics, general credit cards could be used in Norwegian pay phones. Because VISA was a TOP3 sponsor, only VISA cards could be used to serve the Olympics, although the ABB terminals can

handle other types of credit cards. Such cards are AmEx and Master Card or others that comply with ISO 7815 specification and the use of track two of the magnetic stripe.

The overall system to enable use of VISA is shown in Figure 5.

A description of the communication between the telephone terminal and the IN node is shown in Figure 6.

To implement this service, NT had to find solutions to a lot of problems, like:

- How to overcome the antifraud card?
- How to overcome charging problems related to the correct area code and charge rate?
- How to identify the terminal?

To overcome the antifraud card we simply removed charging in the specific direction 613XXXXX that was the "area code" to the IN node. Charging problems were solved by establishing specific 613XXXXX-numbers for each single county where the card terminals were installed. In total, we made 15 different call numbers to identify the county and the route to the IN node.

Identification of the terminal was done by updating the IN node with the terminals A-number and to transfer this number to the IN node during the establishing phase of the call. If the A-number in the IN node was missing, it would be impossible to establish a call.

One problem when using VISA for PC-communication was the lack of blind dialling features of the modems. Blind dialling means that the modem can dial a telephone number without having a dialling tone, which the IN-node does not have. When using VISA under such conditions, the dialling can be done in two ways: Either by normal dialling from the Press terminal, or by changing modem internal result code from X4 to X0, which is quite simple if you know how to do it. The last solution was widely used to overcome this problem.

7 Overall figures

- ABB indoor card phones: 1300
- ABB outdoor card phones: 130
- SCHLUMBERGER outdoor card phones: 20
- GN ELMI outdoor coin phones: 100

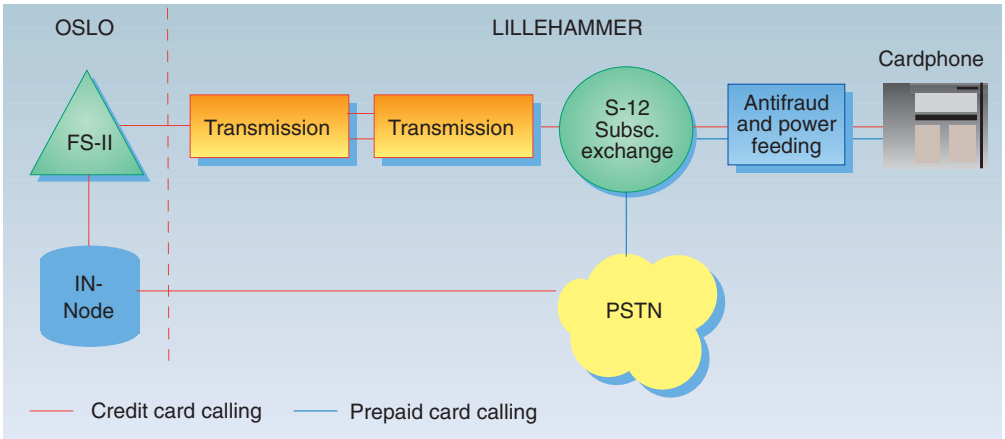


Figure 5 Overall system to enable use of VISA

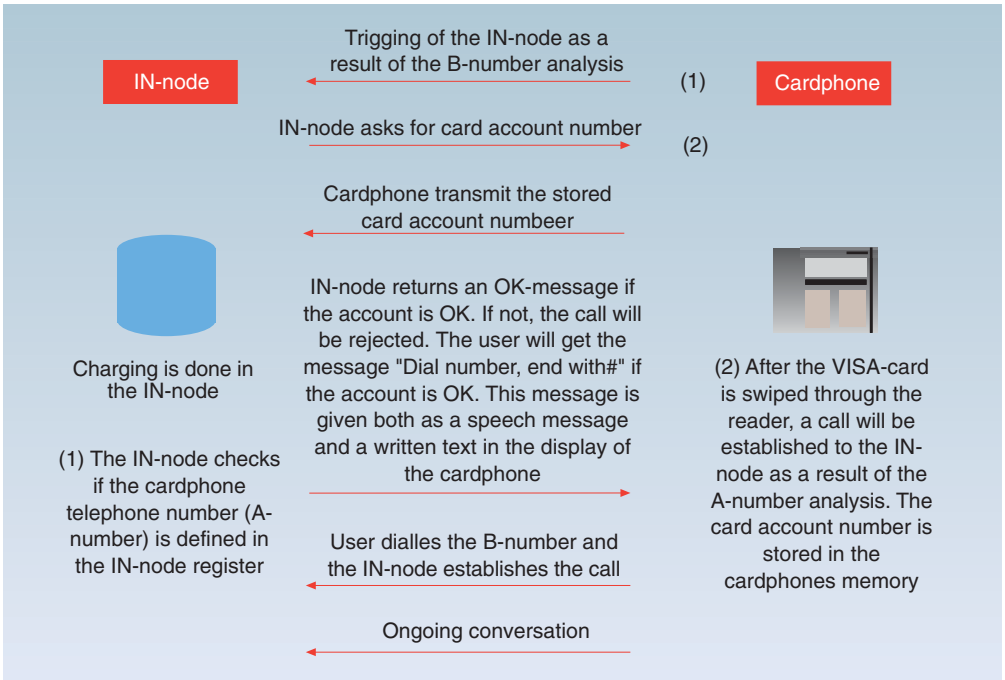


Figure 6 Description of communication between the telephone terminal and the IN node

Network operations and maintenance

BY HANS-KRISTIAN RINGVOLD

This article describes the organisation, manning, installations and support systems established by the Norwegian Telecom Olympic Project to fulfil the obligations of operations and maintenance of networks and services for the XVII Winter Olympic Games in Lillehammer in February 1994. For the first time the technical management and supervision for all networks and services was performed from one central location – the Network Operations Centre. This also included the services for transmission of pictures and sound for the Broadcasters, and the in-house communications for the Lillehammer Olympic Organising Committee (LOOC) with a common Fault Complaint Service.

1 Introduction – operations and maintenance concept

In order to serve every customer and meet all demands for the Olympics, Norwegian Telecom had technical installations at 31 Olympic venues and sites. In addition, new installations and expansions were needed at numerous existing Telecom sites. Efficient operations and good control of all networks and services were of course very important. It was early decided to centralise operation and control and establish a Network Operations Centre (NOC) for the Olympics. The International Broadcasting Centre (IBC) was the focal point for all communication networks, not only the television- and radio signals. This site had naturally much more equipment than any other site, and for obvious reasons the NOC was located here. The NOC coordinated all operations and maintenance activities for all sites. The best skilled technicians and engineers were located at the IBC/NOC. They were consultants and assisted the other sites. However, all sites were manned with fully qualified personnel. The manning at the sites was much more extensive than it would be under normal conditions. The manning is further described in chapter 2.

The Lillehammer Olympic Organising Committee (LOOC) was responsible for all private networks. The contract for installation and operation of these networks was awarded to TBK, also part of the Norwegian Telecom Group. The operations were managed in close co-operation with the operational management of the public networks in a separate part of the NOC and with common fault reporting centre. The NOC is described in chapter 3 and the fault complaint service in chapter 4.

Norwegian Telecom was responsible for transmission of television pictures and commentator sound (radio and television) from the venues to the IBC and from the IBC to all the world via satellites. This service was very important and the operation and surveillance were performed in close co-operation with the host broadcaster, NRK ORTO '94. Their Master Control Room was located next to the NOC with direct access.

Operational agreements were negotiated and signed with involved regions and central units of Norwegian Telecom. These agreements established the manning and working hours for all installations involved. The NOC had to establish contact with a number of operational authorities and their centres both in Norway and internationally.

The Olympic Project assumed responsibility for the network operations September 1, 1993. Most networks and services were fully operational until March 20, 1994, when the Paralympic Games were over.

Figure 1 depicts the different aspects of operations and control and the central location of the NOC at the IBC with close co-operation with NRK ORTO '94 and LOOC.

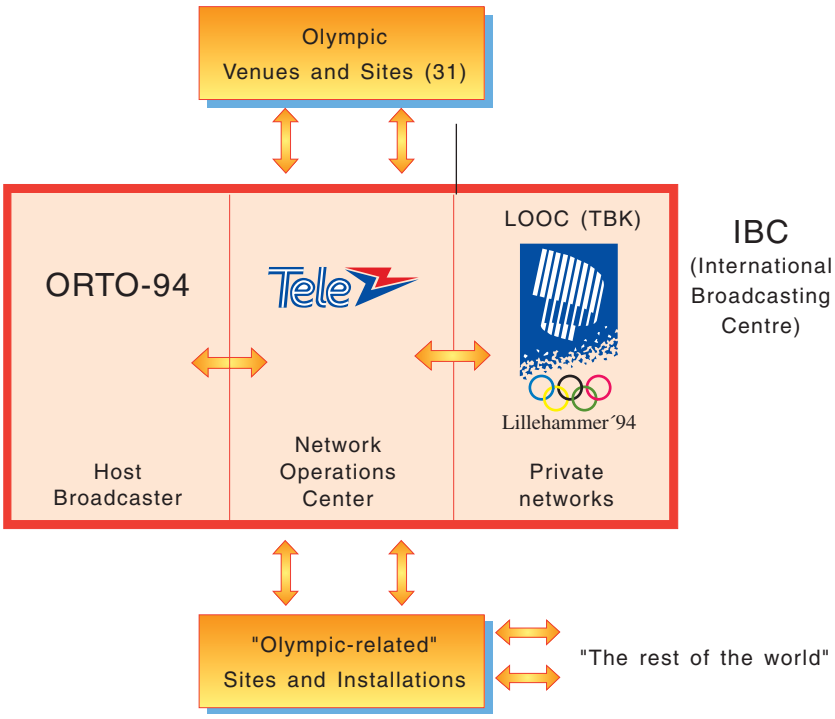


Figure 1 Overview of network operations for the Olympics

2 Manning

2.1 General

The Project Director with his staff (Technical Manager, Marketing Manager, Financial Manager and Administration Manager) had the overall responsibility for the operational organisation. At all sport venues, the International Broadcasting Centre (IBC) and the Main Press Centre (MPC) Norwegian Telecom had a triad management with Venue Manager, Manager Customer Services and Manager Technical Services. The manning for the technical services is described in chapter 2.2. The other categories are not further described, but the total figures are listed in Table 1 (including technical operations).

73 persons were hired, 548 were employed on short term contracts of variable length, from 3 weeks to over 7 months.

Figure 2 depicts the operational organisation.

2.2 Technical services

The Network Operations Centre (NOC) co-ordinated the technical operations and maintenance activities at all venues. The manager of the NOC was placed under the manager technical operations (see Figure 2). The total number of persons in technical services were 415. Table 2 shows the different categories.

There were 15 manned Olympic venues and sites. The manning at each site varied between 6 and 93. The NOC had the highest manning, and together with the collocated IBC technical room 160 persons were employed on short term contract plus approximately 55 hired persons.

A total of approximately 70 persons were hired for technical operations. All the personnel for satellite up-link operations were hired, partly from the equipment suppliers. The personnel for the emergency microwave operations were hired (internally). The rest of the hired personnel came from different equipment suppliers, the main part from Alcatel Telecom Norway. Tele-Mobil was responsible for the manning of their control and supervisory functions at the NOC.

2.3 Recruitment process

The main objective in the recruitment process was to get a well motivated staff. It was decided to send an invitation to all employees in Norwegian Telecom to apply for temporary engagement in the Olympic project. If engaged, the personnel would be granted a leave of absence from their normal jobs. 1,500 applications were received for the 550 jobs. Some personnel categories were special or the resources in Norwegian Telecom was limited, and the remaining 70 persons were hired (see chapter 2.2).

Interviews were done with the applicants for managing positions. The rest were selected after reference checks. Candidates were asked to indicate in their applications the time span they wished their contracts to cover, and this, together with conversations with their superiors, determined the term of the contracts. They varied between 3 weeks and 7 months. The first group, consisting of 12 persons, started at the NOC/IBC August 16, 1993. By December 1 the total manning at NOC/IBC was approximately 70. For the other venues it started in December 1993 and the last arrived February 9, 1994. Most of the personnel were dismissed on March 1, 1994, but 46 persons at 5 sites stayed until March 20, 1994 to take care of the network operations for the Paralympics.

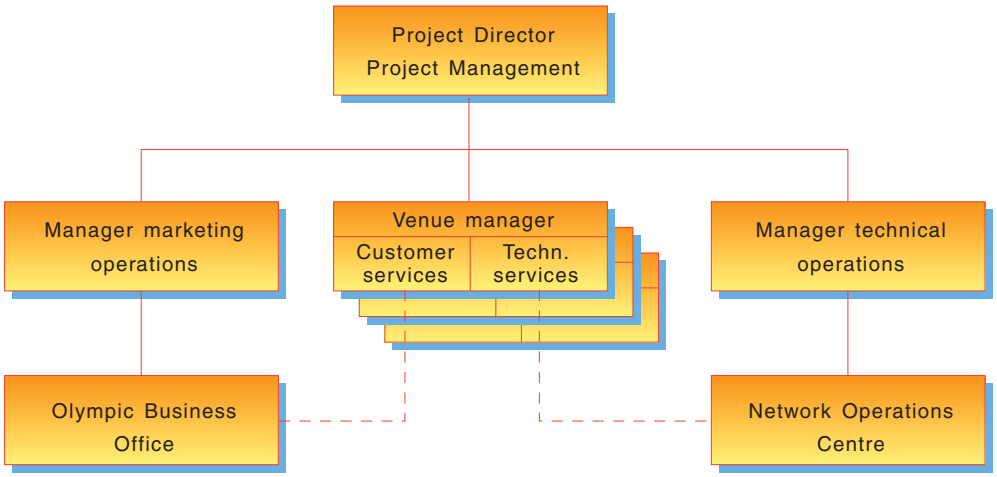


Figure 2 Operational organisation

2.4 Training

The following subjects were considered most important in the training of personnel for network operations:

- Knowledge of Norwegian Telecom's involvement and responsibilities
- Knowledge of networks, services and operations concept
- Knowledge of own venue, its equipment and interfaces with other partners
- Knowledge of new equipment
- General knowledge of the Olympic Games.

The training was accomplished in connection with the test competitions at the venues in February – March and October – November 1993. This was done because the personnel should get to know some of the other partners at the venues and get an idea about the whole concept. 2 – 3 days at the venue, and a 2 day classroom course was compulsory for all. Specialist equipment courses were 2 – 6 days.

Most of the instructors were from the project team, but Norwegian Telecom Training Department, LOOC and equipment suppliers were involved as well.

2.5 Exercise

Test competitions at the venues were individual events and were therefore not ideal for Norwegian Telecom to test personnel and systems. There was a require-

Table 1 Personnel employed or hired by Norwegian Telecom's Olympic Project for operations (all categories)

Technical services	415
Customer services	128
Management and administration	45
Logistic support	18
Visitors programme	15
Total number of persons	621

Table 2 Technical personnel for network operations

Technical managers	24
Network surveillance	10
Fault report reception	13
Routing/distribution	10
Power supply techn./engineers	5
Transmission network techn./engineers	75
Public data network techn./engineers	25
Video-/audio codec techn./engineers	20
Mobile communications techn./engineers	10
Cable-TV network techn./engineers	10
Switching techn./engineers	35
Computer-/PC-/LAN operations	10
Lines/cables installations and repair	75
Equipment installations	35
Satellite up-link techn./engineers	30
Emergency microwave operations	16
Miscellaneous	12
Total	415

ment for a large-scale test and such an exercise was accomplished in November 1993.

The main purpose was to test plans and systems and train the personnel to manage difficult and unforeseen situations. The exercise took place in parallel with test competitions at some of the venues. These venues had live traffic and television transmissions in addition to the test, and this was a special challenge. The exercise lasted for 48 hours and 36 scenarios were accomplished. 325 persons were involved. LOOC, NRK ORTO '94, police, fire brigade and media participated in addition to Norwegian Telecom.

3 Network Operations Centre (NOC)

3.1 Organisation

The NOC was located at the International Broadcasting Centre (IBC) and the organisation was established to have a common utilisation of the well qualified engineers and technicians both at the NOC and at the technical rooms at the IBC. The Managers of the NOC and the Technical Services had a very close co-operation. The different personnel categories were organised in 5 groups and an assistant manager handled the personnel administration in each group. The 5 assistant managers worked shifts and manned the position as 'Manager on duty' twenty-four hours a day from January 24, 1994.

The organisation is shown in Figure 3.

3.2 Main tasks

The NOC had control of all networks and services for the Olympics and co-ordinated operations and maintenance activities. The main tasks were:

- Alarm supervision
- Receipt and distribution of fault reports
- Co-ordination of maintenance activities
- Expert support to venues
- Monitor video transmissions
- Monitor traffic flow and quality
- Network routing/distribution.

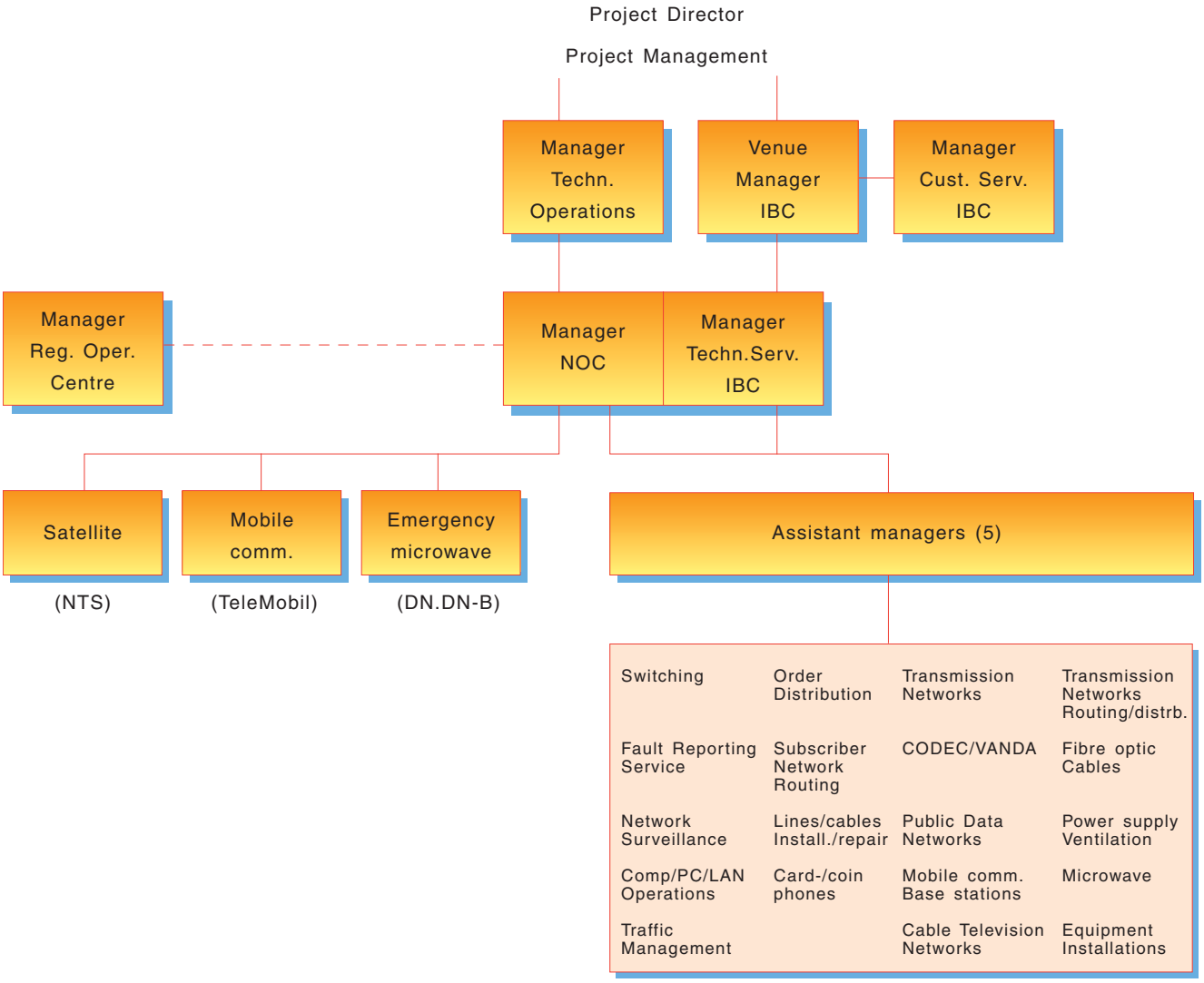


Figure 3 NOC/IBC organisation

3.3 Control room

Most of the NOC functions were performed from a 190 m^2 control room at the IBC. A false floor was laid in 3 levels (17.5, 35 and 70 cm) to obtain free sight for everybody in the whole room to a big wall screen at the front wall (see chapter 3.6). Figure 4 depicts the floor plan of the control room. The text in the figure describes the functions, but some additional information is given below:

Level 1: Supervision and control of public networks and services through general alarm- and command system and specific support systems

Monitoring of video transmissions from the venues (contribution) and out to satellite uplink stations (distribution)

Wall-screen with alarm status and other vital information

Level 2: Fault Reporting Centre (14594) with support personnel

Manager on duty

Level 3: Operation and control of LOOC's in-house networks and services performed by TBK personnel.

Figure 5 shows a picture taken in the control room.

3.4 Functions outside control room

The following functions were performed from offices at the IBC outside the control room:

- Network routing/distribution: Subscriber networks and transmission networks (incl. international networks)
- Operations of computers, PCs and LANs
- Traffic management
- Support groups/consultants on:
  - ISDN
  - fibre optic cables
  - cable television networks
  - microwaves
  - power supplies and cooling/ventilation.

There was a close contact between this support personnel and the control room.

The personnel for emergency microwave operations was not located at the IBC. They had a separate base location and dedicated 4-wire communication with the NOC control room.

3.5 Internal communications

Good communications for exchange of data and messages between the NOC and the venues were vital for the operations. A data network was established to all venues and sites. The network used routers and bridges and had interconnections with Norwegian Telecom's ordinary networks for this purpose. All applications installed at servers locally, at regional computers or at central main-frame computers, were in principle available from any terminal connected to the network. Access rights were assigned to each user at application level.

The VPN/Centrex Olympic Network was used for telephone and telefax. Dedicated 4-wire lines routed to be independent of

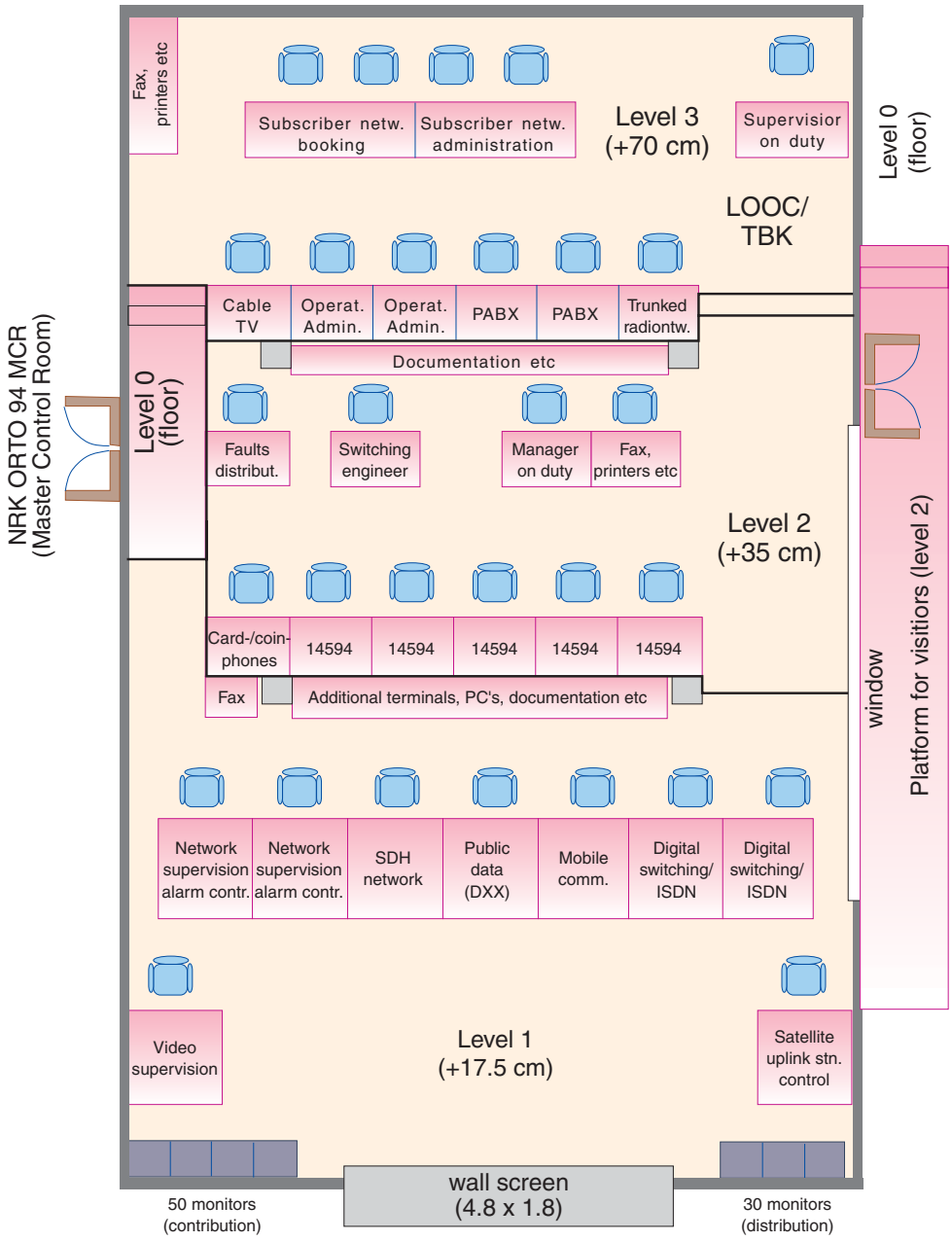


Figure 4 Network Operations Centre – control room, floor plan

the Olympic networks and equipment were used as back-up for voice communication. The central unit was installed in the NOC control room and remote units at the technical rooms at the venues, satellite up-link stations and various operational centres. This was a very fast and simple way to establish contact, and it was used even under normal conditions.

The project management used trunked radio network as back-up communication to the venue managers and other key personnel. The LOOC (TBK) system with a dedicated user group was used.

3.6 Support systems for networks and services

This chapter describes the support systems specific to networks and services. The general alarm- and command system is described in chapter 4.

3.6.1 Switching

The Olympic digital switching network consisted of 2 Alcatel S-12 switches and 38 remote subscriber units (IRSU) with ISDN-, VPN/CENTREX- and IN-functionality. The VPN, Olympic Network (ON), comprised in addition all LOOC PABXes and the public switches in Lillehammer, Gjøvik and Hamar.

The main operational tool was terminals and printers in the NOC connected to the switches via modem lines. These terminals and printers were used to send ordinary man-machine commands and receive status- and alarm print-outs. All subscriber definitions were also done this way.

Workstation with access to the TMN-based TMOS-system was established in the NOC, but could not be used for S-12 because of problems with the new S-12 software (N4). It was however used for the AXE toll exchange in Gjøvik.

A support system based on signalling system number 7 (SS#7) called S-MAN was used to monitor telephone traffic both nationally and internationally. The results were presented as matrixes and were also displayed at the wall screen.

A traffic route tester (TVP) was used to generate test calls and analyse test results. Daily reports were presented to the management.

A large number of card-phones were used all over the Olympic region, especially in press centres. Operation and control of these were performed from NOC by a dedicated support system (DOSAT) installed on a UNIX server. Coin-phones were less used, but were handled by the same system.

The traffic analyses made before the Olympics had many uncertain factors. Good traffic measurements and means for traffic management were therefore important. Norwegian Telecom's system for this purpose (MEAS) was modified to handle 15 minute intervals. Special installations were made to collect data from the two Olympic switches, the ON switches in Lillehammer, Gjøvik and Hamar, the toll exchange in Gjøvik, and 5 switches in Oslo i.a. the IN-node and the two international exchanges. A UNIX-server and database was installed at NOC, and reports were generated every 15 minutes. Re-routing was accomplished when serious congestion problems were detected.

3.6.2 Mobile communications

Mobile services offered for the Olympics were: NMT 450/900, GSM, numeric paging and alphanumeric paging. Tele-Mobil was responsible for the operations of the services and manned the control- and supervision function at the NOC. Olympic Project employed personnel was responsible for the maintenance of the base station equipment.

The support system (STRAX-MOBIL) had a graphical presentation of alarm status in the mobile networks with switches, lines and base station. A UNIX workstation at NOC was connected to a server at Hamar. Another support system for the paging systems switch (in Trondheim) was installed on a MS-DOS PC at the NOC.

Traffic analyses were performed continuously. Traffic reports were generated every hour and actions were taken immediately to increase channel capacity when congestion occurred.

3.6.3 Transmission networks

Most of the transmission networks were based on fibre optic cables with two separate routes to all sites and automatic switching between main and back-up. The only microwaves used was IBC – Kvitfjell (7+1 * 140 Mbit/s) and analogue microwaves for cable television.

All network components had alarms and controls connected to the alarm- and command system. The only additional support system accessible from the NOC was for the SDH line system (2.5 Gbit/s and 622 kbit/s). The support system had configuration/control- and alarm subsystems and was installed on a PC in the control room of the NOC. A manual switch was used to connect the PC to separate sections of the network.

Telenor

Figure 5 Control room – interior

3.6.4 Video/audio

The transmissions of television pictures and commentator sound (radio and television) from the venues to the IBC and from the IBC to the whole world was a very important part of the operations. Back-up communication lines and equipment were used to a great extent, but immediate actions should be taken if a malfunction occurred.

Alarm outputs from coders and decoders were connected to the alarm- and command system. The video transmissions were visually monitored both at the technical room at the venues and at the IBC. At the IBC, 9 inch monitors were installed in separate racks for incoming (contribution) and outgoing (distribution) lines. 48 monitors were used to monitor the 90 contribution lines by manual switching between morning- and afternoon competitions. A special control desk with built-in instrumentation, intercom to NRK ORTO '94 and switches for selection of video signal from the NRK ORTO '94 matrixes was used. Any input- or output video signal could be brought to this control desk for control and measurements.

The video distribution lines were monitored by the engineer on duty at the satellite up-link stations control at the NOC. 30 monitors were used, one for each line. Audio transmissions were not monitored continuously (except for alarms), but monitoring and measurements could be easily performed both at the venues and at the IBC when needed.

3.6.5 Satellite

Satellites were used for all television transmissions from the Olympics except for dedicated lines on microwave to Sweden and Finland. Satellite up-link stations were established in containers at 2 different locations in Lillehammer and one in Oslo. Norwegian Telecom's fixed installations in both the Oslo and Stavanger areas were also used.

A control desk for satellite up-link stations control was established at the NOC control room. All satellite up-link operations were co-ordinated from this desk including booking of occasional transmissions. An alarm- and control system for the up-link stations was installed on a PC. Dedicated communication lines (4-wire) were established to all stations. The video distribution lines were surveyed on 30 monitors in front of the desk (see chapter 3.5.4).

3.6.6 Public data communications

The following services were offered for the Olympics: DATAPAK (X.25), DATEX (X.21) and DIGITAL (digital leased lines with speeds from 2,400 bit/s to 2 Mbit/s). The DIGITAL service was by far the most used. The new DXX-system from Martis was used for all speeds and also for access to DATAPAK. The DXX-system had a sub-system for operations and control based on a powerful OS/2 PC connected to the systems cluster node at the IBC. Configuration, control and alarm supervision was performed from this PC in the NOC control room, and a graphical picture of the network with alarm status was shown on the wall screen.

3.6.7 Cable television network

Norwegian Telecom was responsible for the cable television network between venues (D1-network). Operations were mainly performed by personnel at the NOC/IBC. A PC-based support system used for similar installations in Bergen was used.

3.6.8 Power supplies, cooling and ventilation

Equipment at all venues had alarm outputs to the alarm- and command system. These alarms were presented in a separate window of the screen at the surveillance terminal. All technicians and engineers were located at the NOC and turned out for maintenance and repair. The 48 V rectifiers had dial-up modems. Configuration and control could be performed from a PC at the NOC.

3.6.9 Network filing systems – data bases

These systems were needed to issue orders and to keep track of routing and changes. Existing Norwegian Telecom systems installed on IBM-mainframe computers were used for both subscriber- and transmission networks. TBK was responsible for the local cabling systems at all venues except the two Olympic villages. They had their own data base for registration of cables and connections.

Public telephone subscribers were stored in TELSIS by the Olympic Business Office (OBO), and the orders were sent to NOC for subscriber definitions in the exchanges. The sub-system for lines, TELSIS-LK, was used for the interface cables between the main distribution frames in TBK- and Norwegian Telecom technical rooms at all venues and the subscriber networks at the Olympic villages.

Users of public data services, video and audio were registered in a subscriber system called MARIUS by the OBO. Orders were distributed to NOC and copied to the network systems called INSA and INTRA. The routing was found and the orders were forwarded for execution.

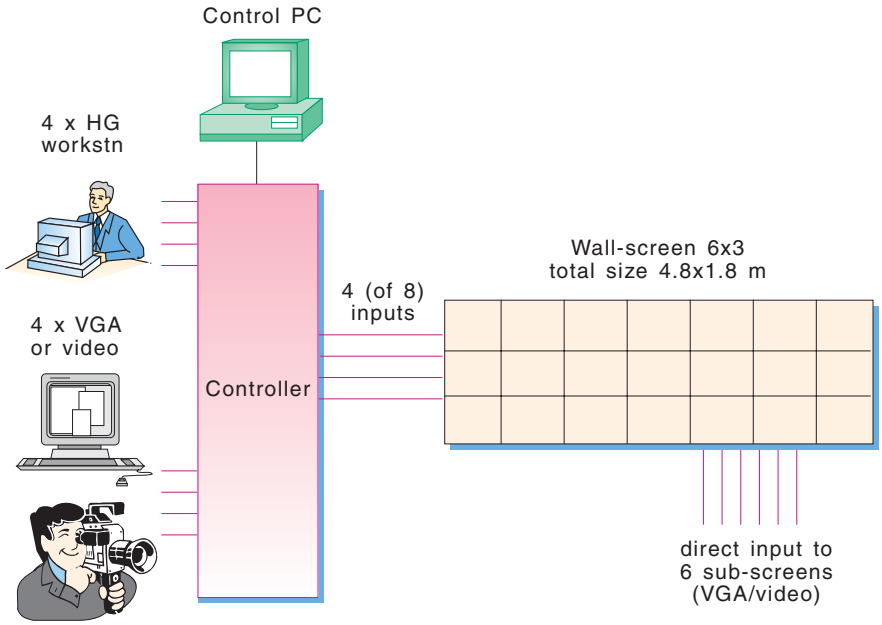


Figure 6 Wall screen

Network information from INSA/INTRA could be represented graphically by the use of a program called DIMAN. An application in INSA was used to analyse alarms received from the alarm- and command system . A graphic picture of the network with a red indication of the faulty section or station could in that way be displayed on the surveillance terminal and the wall screen.

3.7 Wall screen

The main purpose of using a wall screen was that vital information should be visible for everybody in the NOC control room. The screen was 4.8 m long and 1.8 m high, and was installed at the front wall of the control room. Figure 6 depicts the principle of the system.

The system was delivered by a French company, SYNELEC. The screen was built by 18 sub-screens, each 80 cm wide, 60 cm high and 160 cm deep. The pictures were projected on the flat screen from the rear with very narrow stripes between each sub-screen. A software operated controller made it possible to display up to 4 out of 8 input signals simultaneously. The size of each of the 4 images was independently adjustable to any size within the complete screen. Pictures could be frozen, inverted etc. and all parameters were adjustable in software.

The input signals to the controller could be up to 4 pictures from graphical high definition workstations and up to 4 VGA (PC) or video (RGB) pictures. In addition, up to 6 VGA/video pictures could be sent directly to 6 separate sub-screens outside the controller. The size of these pictures was fixed to the size of the sub-screen and they could be overlaid by images from the controller.

Systems with graphical presentation of networks are best suited for wall screen displays. DXX-support system and STRAX MOBIL were such systems that gave the alarm status of the networks and change of colours with degradation or malfunction. Both these were shown on the wall screen. The system for control of traffic parameters in the switching networks, S-MAN, was shown with separate pictures for national- and international traffic. It used tables and matrixes and change of colours in rows/columns with degradation. Transmission networks were shown graphically by the use of INSA/DIMAN.

An electronic log system was used and the 5 last events was shown on the wall screen. This was very useful in order to keep everybody in the control room updated with the latest information. The international television signal was shown on one of the sub-screens. The screen was also used for presentations of videos/slides and demonstrations for visitors.

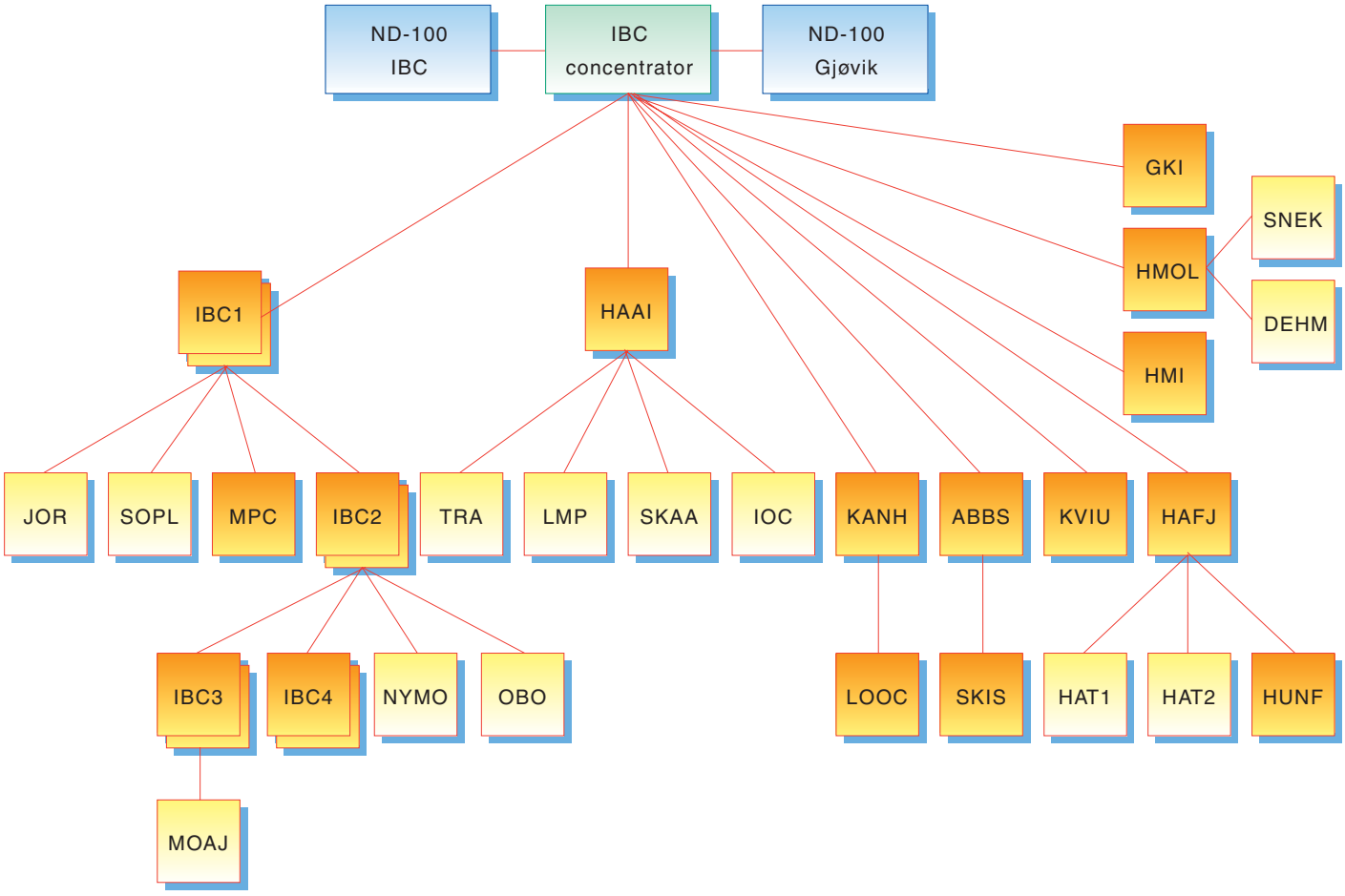


Figure 7 Alarm collection network

4 Network surveillance – alarms

Norwegian Telecom's ordinary system for alarm- and command handling, AK, was used. The system consists of an AUTRONICA System-S alarm collection network with a concentrator connected to an ND-100 mini-computer. The software has been developed by Norwegian Telecom and has been in use for many years. The computer is connected to other AK-computers for transfer of alarms and commands from/to other regions.

Figure 7 depicts the data collection network with concentrator at the IBC and 29 remote units at Olympic venues and sites. Some of the remote units had up to 4 sub-units as shown in the figure. All lines from the concentrator to the first level of remote units were duplicated. The primary line was routed through the ordinary networks, independent of the Olympic networks and equipment. The total number of alarms was 2,450 and the number of commands was 70.

Since all Olympic operations were surveyed from the NOC, alarms were collected and commands sent to a number of installations outside the Olympic venues. Figure 8 depicts the AK-computers serving these alarms/commands and the connections. All AK-computers in Norwegian Telecom are connected in a common network called ALFNET ('alarm distribution network') through dedicated communication computers. ALFNET was used as back-up for the dedicated lines shown in Figure 8.

The following types of alarms were used:

- Environmental:
  Fire (smoke detection), temperature, humidity, ventilation, intrusion
- Power:
  Mains (230 V), 48 V, rectifier
- Digital switching:
  Summary alarms from exchanges
- Transmission-, public data-, cable television networks:
  Equipment alarms from all types of equipment
- Protection switches:
  Information of position.

The protection switches were automatically operated, but could be switched by force to certain positions by commands from the NOC. The command part of the system was not used apart from this.

5 Fault complaint service

5.1 General

Norwegian Telecom had the overall responsibility for the operation of the fault complaint service. The service covered cable television, security systems and all telephone, data and mobile services for the Olympics, both public (Norwegian Telecom) and in-house (LOOC/TBK). An exception was INFO '94 and LOOC's data network which was served by the Help Desk at each venue. The operation of the fault complaint service for the LOOC/TBK in-house networks was part of the LOOC/Norwegian Telecom delivery agreement and a description of the service was printed in 7 languages (Norwegian, English, French, Italian, Spanish, German and Japanese).

The telephone number for the service was 14594. Since the number to the fault complaint service in the ordinary telephone network in Norway is 145, and a 5-digit number was needed in the Olympic Network, the number gave itself by adding the 'Olympic year' to the ordinary number. Subscribers who tried to call 14594 on the national network ended up at the ordinary fault reception centre, and the call could be transferred to the Olympic NOC/fault reporting centre.

5.2 Fault reporting centre

The fault reporting centre was established inside the control room at the NOC, see floor plan in Figure 3. The intention behind this location was that the operators at the fault reporting centre should be updated with the status of networks and services at all times.

The centre opened for the public services on September 1, 1993 with normal office hours. The service opened for LOOC on January 2, 1994. Until February 8 it was manned from 0700 to 0200 hours. From February 8 until March 1, 1994, the fault reporting centre was manned twenty-four hours a day. There was room for 5 simultaneous operators and they were obliged to answer in Norwegian, English and French at any time.

14594 had a call storage device with message. The answering phones were equipped with short time tape recorders that could be started manually by the operator. The purpose was that the operator could get 'a second chance' to get the right number, address, etc.

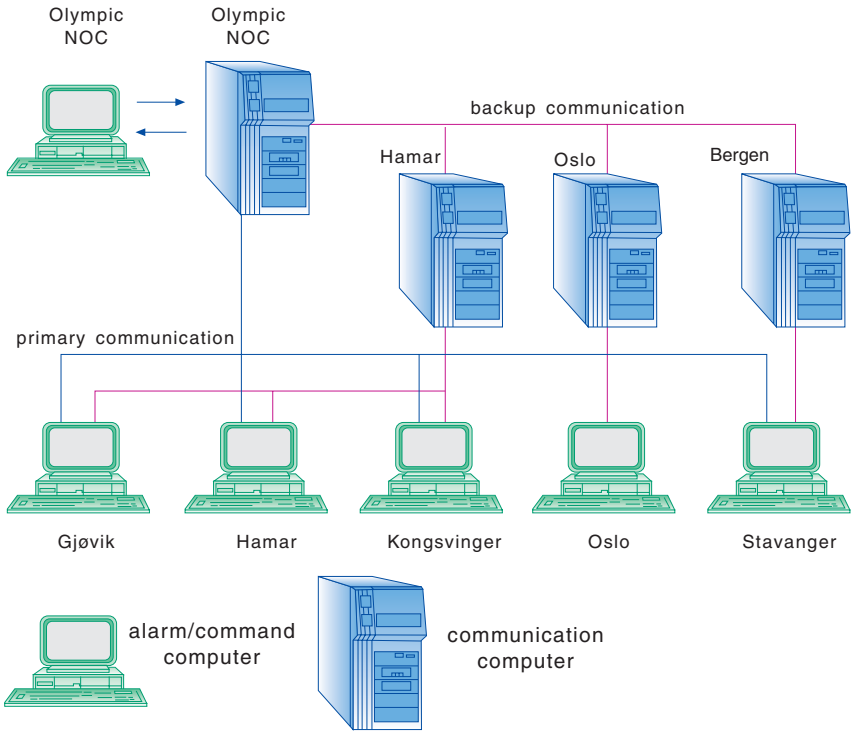


Figure 8 Alarm/command system – connection to units outside Olympic venues

5.3 Fault distribution – follow-up

Norwegian Telecom's system for registration and distribution of faults, TREF, was used. Faults were registered under the different services, and each fault was given a reference number ('trouble ticket') and became one report in the system. The reports were distributed electronically for follow-up/repair. The reports could be sent to all venues. Fault reports on in-house networks and services were transferred to TBK personnel in the control room. The subscriber who reported a fault was notified when the problem was corrected, or given information, no later than one hour after his complaint, about the progress and the anticipated correction time.

3 persons in the control room were assigned to give support to the fault reception operators:

- Fault distributor for lines/cables
- Operator on support-/control system for card- and coin-phones
- Switching engineer, expert on Olympic network services.

In addition, all experts in the control room were available for support when needed.

6 Plans and procedures

Plans and procedures were prepared to describe operations both under normal conditions and in case of emergency. This was important since most of the personnel were engaged for a short time, and the plans were quite detailed. The information was compiled in two separate books, one unclassified (Operations Plan) and one confidential (Contingency Plan). The plans were tested during an exercise in November 1993 (see chapter 2.5) and corrected before the final edition.

6.1 Operations Plan

The Operations Plan contained one general part and one part for each venue. The general part described the management organisation (with names, telephone-, mobile- and pager numbers), meetings, reports, spare parts etc. and procedures for fault handling, alert and information. The venue part contained the venue/site specific information such as complete venue organisation and work schedules.

6.2 Contingency Plan

The confidential Contingency Plan had separate sections for each venue. The venues had only the section concerning their own venue. The project management and the operational management at the NOC had complete plans. The plan should be enforced in case of breakdown on both the primary- and secondary communication systems. It stated the priority of services and customers and described in detail the restoration by use of emergency microwaves and other back-up communications.

7 Experiences

The centralised operations with the NOC and the collocation of TBK, Tele-Mobil, NTS (satellite up-link operations) and Norwegian Telecom in one control room worked very well. Everyone in the control room, including the operators at the fault reporting centre, was always updated with information on the wall screen. The NOC had good control of networks and services and sent frequent status reports to the project management.

It was a great advantage to have the fault reporting centre located in the control room with the possibility of direct contact with system experts. One common number to report faults for all services made it easier for the subscribers.

The exercise in November 1993 gave useful experiences for the operations during the Games.

International sales and marketing

BY BIRGER G BARLI

We all know that in order to succeed in communication business, excellent technical solutions are important, but it is the fulfilment of the customers' total requirements that makes it a complete success. The services offered have to be according to customers requirements, the sales personnel must be skilled and professional, the price level has to be acceptable, and lastly, deliveries have be according to agreements.

Very early in the process we realized that our knowledge of the customers, their requirements and needs, was very limited. When the Norwegian Telecom Olympic Project was established in 1989 the work with the requirement analyses started in co-operation with the Lillehammer Olympic Organizing Committee (LOOC) and later NRK ORTO '94, the host broadcaster.

When we had obtained a general understanding of the needs, and after the overall service and product strategy was decided, the work started to describe in detail the services to be offered from NT and at what prices and conditions. We also had to establish an organization that was able to communicate our telecommunication solutions to all groups of "Olympic Customers", and of course, we had to be able to understand correctly the returned orders from all our international customers. Routines and computer systems had to be developed to handle orders, technical implementations and invoicing.

This article describes the main phases in the sales process, how the work was organized, general description of services, prices and conditions.

1 Requirement analysis

The analysis of total needs for telecommunication services for the Olympics was made in co-operation between NT and LOOC. LOOC had the responsibility for all user groups inside their own organization, and they were also responsible for telecommunication services to NRK ORTO '94, the police, the International Olympic Committee (IOC), health care, media villages, etc. NT was responsible for deliveries to LOOC, the media customers (press and broadcasting), sponsors, the Olympic villages, and of course all establishments outside the venues. The analysis was a continuing work, started in 1989 and completed in the summer 1992. During this period, 5 versions of the document were distributed, due to changes in needs.

The analysis described the telecommunication services each user and user group required at each venue or site. The result of this analysis was used to plan all technical investments and developing of telecommunication infrastructure and solutions. But it was also very useful to the sales organisation to estimate the total deliveries in order to plan all the sales and marketing activities.

Another important part of the analyses was to collect information from similar arrangements. In the early phase of the project, experiences from Calgary were used to estimate the needs, and later, a close collaboration with France Telecom Olympic Project was established. Because of the short period of time (two years) between the Olympic Games in Albertville and Lillehammer, we estimated the needs for telecommunications not to be too diverging. Some of the services had different technical solutions, and the availability and price levels had of course influence on the choice made by the customers. These factors were taken into consideration, and we developed a table of figures comparing the Albertville figures with the result of the requirement analysis we had carried out together with LOOC. We also had to correct for additional countries that participated in the Lillehammer Games. As the Olympics were approaching, we realized that some of the needs were underestimated. This was first of all international video circuits and telephone services outside Olympic venues and sites, but also ISDN was underestimated. Generally, the estimated figures were very close to the services we installed and delivered. One surprising factor was, however, all the orders from customers close up to the start of the Games. This was not in accor-

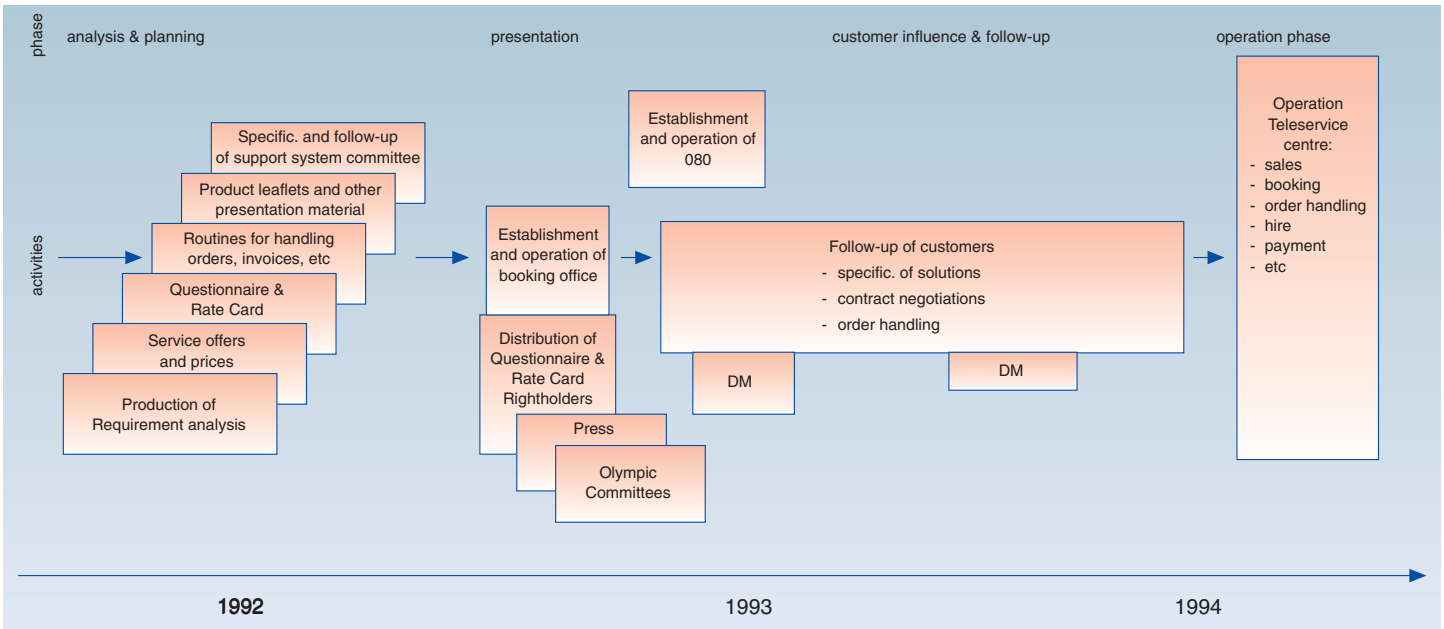


Figure 1 Sales process – NT Olympic Project

dance with France Telecom's experiences. We were told that in France, 95 per cent of the total orders (including deliveries from Telecom Service Centres) were received before January 1.

2 Sales process – activities and organization

It was very important to inform the customers as early as possible that NT was responsible for telecommunication services and what kind of services were offered. This also included having to describe the services correctly (as they would be delivered two years later!), and decide the price level and strategy. "A Guide to Telecommunication Service" was developed as the first and general description of services and prices offered. This description was later supplied by "Product Description" leaflets, containing more specific information on the services and equipment. These documents were distributed to the customers and handed out in presentation meetings.

"One stop shopping" was defined as a critical factor in order to succeed in the handling of all international customers. First of all, the different Telecom companies within the Norwegian Telecom Group decided that Norwegian Telecom Olympic Project should co-ordinate all the sales and marketing activities within the company group on behalf of TBK, TeleMobil, Norwegian Telecom and partly Norwegian Telecom International. LOOC, NRK ORTO '94 and NT agreed to establish a common booking office for broadcasters. It was the first time in any Olympics that such an agreement had been made. The broadcasters were very satisfied with this solution. The office was situated in Oslo, in the offices belonging to NRK ORTO '94.

These three organizations developed a common description of all services and products offered to the broadcasters. "Description and Rate Card" including common ordering forms called "Questionnaires" were worked out. These documents were distributed to all rightholder broadcasting companies in May 1992.

For press companies, a common booking office was established in the press section of LOOC, and likewise for the Olympic Committees. The Rate Card and Questionnaires for these categories were distributed in February and March 1993. These documents were based on the documents for broadcasters but adjusted for press and Olympic Committees.

In addition to the more general description in the documents mentioned above, "product leaflets" were developed. Due to the fact that some of the specifications were changed during the process, these documents included detailed and updated information. Lots of customers also needed specific information on the equipment in order to make interface to own equipment or to train their own employees.

When the customers returned the order forms to the common booking office or address, the form was split and sent to the responsible supplier. In the Norwegian Telecom Olympic Project all orders were registered in a computer system (TOPKIS) with all information necessary to implement or install the services.

When the first orders and basic information about the customer were received and entered into the system, the process of "influencing" the customer started. If the customer's orders did not correspond with our expectations, the Account Manager took necessary actions to ensure that the understanding of our services offered was correct. NT did also participate in meetings with the largest media companies, Olympic Committees and sponsors arranged by LOOC. An important part of this were the OBAC meetings with the rightholders twice a year from 1991. In addition to the formal meetings, "post" and "pre" meetings were arranged to discuss agreements and deliveries of telecom services. In the planning phase of any Olympic Games, it is very important to work hard to convince the broadcasters and the main press agencies that the services offered will satisfy the need for telecommunication services, and of course convince them about price level and conditions. We had some disagreements in the early planning phase, but with a few exceptions the prices were never changed. NT also succeeded in the work towards the Norwegian Government to avoid VAT on international telecommunication services, which was strongly demanded by the broadcasters.

It was a major challenge for Norwegian Telecom to handle all the international customers in a professional way within the time limits and available resources. A sales organization was established with a Sales Manager, 9 Account Managers and a secretary. The customers were segmented into different groups: Broadcasting, International Press, Olympic Committees, Sponsors, National Press and Organizations. In this way the Account Managers gathered experience and knowledge within one of the customer segments. Most of the contact between an Account Manager and an international customer was of course by use of telefax and telephone. All the major companies visited

Figure 2 Participants in the OBAC meeting

Lillehammer during the planning process, and meetings were held to discuss special customer demands and implementation details. English was defined as a "project language", but we really did have some language problems, especially with customers in Japan, but none of these problems caused any serious disagreements according to completion of deliveries. In addition to meetings, discussions and telephone calls, two Direct Mails were distributed to the customers in 1993. The main message was to remind them of the progressive increase of prices in the time leading up to the Games and also to describe the latest changes in, or additional, services offered.

The sales team worked very closely with the Olympic Business Office (OBO). As opposed to NT's ordinary organization, it was only the Account Managers that had direct contact with the customers. The idea was to have only one "access point" to our organization to avoid misunderstandings and multiple handling of customers. Based on forms printed out from the customer data base (TOPKIS) OBO was able to implement necessary information in all other computer systems to establish the services, including invoicing systems. As described later in this article, all of the services had to be paid before any deliveries could be made. The terms of payment are described later in this article, but they imply that the first invoice had to be issued at the time of ordering. The invoices were produced by OBO, verified and distributed to the customers by the Account Manager. The invoicing and payment process was complicated and probably the most time consuming part in the process. This was also due to the fact that we did not have "state of the art" or flexible invoicing systems.

OBO handled a total of 14 computer systems in order to register the implementation of all the different telecommunication services. One month before the Games started, 12 people were working at the Olympic Business Office. As mentioned above, they worked in very close co-operation with the sales team, especially because of changes in orders close up to the Games.

3 Telecommunication services

This section gives a short summary of the main telecommunication services offered by NT for the Olympic Games at Lillehammer. All services were offered at a price based on three weeks rental and the possibility for additional weeks.

3.1 Telephone services

NT and LOOC established a special Olympic Network (ON) in the region covering all Olympic venues and sites where telephone services were demanded. Basic elements in the Olympic Network were PBXes delivered by TBK and Centrex services implemented in NT's Olympic switches forming a hybrid Virtual Private Network (VPN). In addition, Centrex was delivered as part of the Olympic Network through NT's public switches in Lillehammer, Gjøvik and Hamar. This was to cover all needs outside the Olympic venues. The agreement with LOOC regulated which customer could be connected to the ON.

The Olympic Network users were offered a 5-digit number plan with no traffic charges on telephone calls within the network. Calls out of the network were charged according to normal traffic charges. A switchboard operated by LOOC was installed at each venue. All lines were enabled for direct dialling out and direct dialling in. The customers were also offered two types of switchboards, ICAT (based on a PC) and a simple switchboard solution by use of ASCOM.

Main Centrex services offered in the Olympic Network:

- Call Transfer
- Call Hold
- Call Waiting
- Call Forwarding
- Fixed Destination Call
- Three Party Services.

Additional services could be ordered, and adjustments to special customer demands could be made upon request. Our experiences after the Games are that most of the customers only needed basic services for their operations. Because of the limited time to train personnel, only a few customers were using the additional services offered. But NT decided very early in the process to implement "state of the art" services in the Olympic Network, reflecting the services to be offered in the near future.

In addition to the Olympic Network, ordinary subscription was offered at all sites.

3.2 ISDN

Euro-ISDN was introduced for the first time in Norway as a commercial offer during the Olympics. Only Basic access (2B+D) was offered due to the fact that the PBXes installed were not equipped with Euro-ISDN interface. It also appeared that very few of the customer requested 30B+D. The ISDN services were primarily used for data communication and transfer of pictures. But NT also delivered ISDN for 7 kHz high quality sound for commentary use and ISDN for monitoring of venues and buildings. ISDN applications like EuroFile (file transfer), videophone and Fax Gr. 4 were demonstrated at our Telecom Service Centres at IBC and MPC.

3.3 Leased Circuits and Data Communication

Leased analogue circuits were offered as Class T telephone-type circuits according to CCITT M.1040 for national installations and CCITT M.1020 for international circuits.

Leased digital circuits were offered with transfer rates from 2.4 kbit/s to 2 Mbit/s for national use and for international connections 64 kbit/s, nX 64 kbit/s and 2 Mbit/s.

Other services offered like Datapak (X.25), Datex (X.21) and Telemax 400 (X.400) were requested on a very limited scale.

3.4 Mobile communication services

Major investments and installations were made before the Olympics to satisfy the demand of mobile telephone services. Three different automatic cellular systems were offered: NMT 450, NMT 900 and GSM. Two types of NMT 900 mobile telephone sets were offered for rental: TBK Fighter and TBK VIP. The equipment was offered as a "package" including subscription for three weeks.

Two types of paging services were also offered: Paging Numbers and Paging Text. Paging Text was the most popular service, and it was also possible to send text messages by help of INFO '94, LOOC's Information system, available at all Olympic sites.

3.5 Broadcasting services

NT had the responsibility for all transfer of video and audio signals from all venues to IBC, from sites outside venues to IBC and international transmissions from IBC.

VANDA, a one way transmission of a video signal and two associated 15 kHz

Table 1 Services delivered

	Number ordered	NT own needs	Total
Audio occasional			
3.4 kHz	16		16
15 kHz	4		4
Coordination circuits	4		4
Total	24	0	24
Audio international			
3.4 kHz	60		60
7.0 kHz	9		9
15 kHz	13		13
2 x 15 kHz	1		1
Coordination circuits	68		68
Total	151	0	151
Audio national			
3.4 kHz	157	50	207
7 kHz	232	36	268
15 kHz	36	10	46
2 x 15 kHz	21		21
Coordination circuits	189		189
Total	635	96	731
Data communicat. services			
X.25, 2.4 kbit	2		2
X.25, 9.6 kbit	2	32	34
X.25, 64 kbit	1		1
X.28, user ID	3		3
X.21, 9.6 kbit	1		1
Total	9	32	41
ISDN			
ISDN, Attendant services	28		28
2B+D	229	60	289
Total	257	60	317
Leased int'l digit. circuits			
64 kbit	10		10
128 kbit	6		6
512 kbit	2		2
2 Mbit	6		6
Total	24	0	24
Leased int'l anal. circuits			
M1020 - Eur	21		21
M1040 - Eur	1		1
Total	22	0	22
Leased nat'l anal. circuits	94		94
Leased nat'l digit. circuits			
2.4 kbit	1		1
19.2 kbit	3		3
9.6 kbit	3		3
64 kbit	4		4
128 kbit	3		3
2 Mbit	12		12
N x 64 kbit	160		160
Not specified	71		71
DDI/DDO	29		29
Total	380	0	380
Paging services	945	98	1043
Mobile telephone services	1033	46	1079
Olympic Network	3686	224	3910
Public network	1100		1100
VANDA international	27		27
VANDA national	95	26	121

audio channels, was offered in the following video formats:

- PAL 625/50
- NTSC 525/60
- Digital Component Video
- 34 Mb/s (DCT-coded video).

In addition, HDTV was offered upon request. However, HDTV transmissions were solved by offering rental of fibre circuits with the customers' own equipment connected.

Occasional VANDA for transmission from outside the venues to IBC was offered by renting of mobile satellite buses. The service could be booked through our booking office at IBC. It was also possible to book capacity for international VANDA transmission from IBC and MPC based on the "first come – first serve" principal.

Commentary and co-ordination circuits were offered with the following qualities:

- Audio 3.4 kHz w/3.4 kHz feedback
- Audio 7 kHz w/3.4 kHz feedback
- Audio 15 kHz w/3.4 kHz feedback
- Audio 2 x 15 kHz w/3.4 kHz feedback
- 4-wire co-ordination circuits.

Occasional Audio International was also offered at the quality of 3.4, 7 and 15 kHz.

4 Prices – terms and conditions

The telecommunication services offered were based on a minimum of three weeks rental. The rental period could be extended by ordering additional week(s). Some elements that were evaluated when the price level was set were:

- Price level in the Olympic Games in Calgary, Albertville and Barcelona
- Ordinary telecommunication prices in Norway
- Cost of development and constructions.

The development costs were fairly high, but it was very difficult to exceed the price levels set by telecom companies responsible for past Olympic Games.

Terms of payment were adapted and adjusted from Albertville 92 and the main principles were as follows:

The charges for the products and services offered were subject to price increases according to the date of validation of the order as follows:

- 10 per cent discount on catalogue prices for orders placed before January 1, 1993
- Catalogue prices given for the Olympic Games for orders placed before July 1, 1993
- 20 per cent surcharge on catalogue prices for orders placed between July 1, 1993 and December 31, 1993
- 40 per cent surcharge on catalogue prices on orders placed after December 31, 1993.

On receipt of an order, the customer should pay 20 per cent of the charges for the services featured in the order confirmation, within 30 days at the latest. No agreements were considered valid until the amount due was paid. The balance (80 per cent of the total amount) plus deposit on terminal equipment and prepayment of traffic were charged in October and November 93. Immediate payment was required if the order was placed after October 1, 1993.

Prepayment on traffic was balanced and the remaining deposit, if applicable, was reimbursed after the expiry under the condition that all sums owing to NT were paid. In the event of damage or loss of equipment, NT deducted from the deposit the sum necessary to cover expenses.

If the customer at any time cancelled his order/request, the amount due for payment at the date of cancellation was kept by NT to cover expenses.

Due to the principle of no deliveries before payment, the amount due to NT after the Games was less than 0.2 per cent of total income.

5 Delivery of services

After implementation of all services in the different computer systems at the Olympic Business Office, orders were routed to DSOL (Surveillance and Operating Centre for the Olympics) for installation and implementation. Circuits and configurations were tested by installation personnel and completion messages were sent back to DSOL. The Account Managers were also involved in the quality control of configurations and physical installations to ensure the best possible delivery. After all, it was the Account Managers and service personnel who would welcome the customers to the venues, and if any mistakes were made,

ANP Stichting Algemeen Nederlands Presbureau, Den Haag:
"We also want to extend to you our congratulations for a splendid job done and thank you for your co-operation."

M.L. Weydert, Associated Press, USA:
"... I've been coordinating the setup of our Olympic facilities since 1984 and can say, without exception, that Lillehammer was the best ever! To those of us who were there, the 1994 Winter Olympics were almost magical. Not only have they given us pleasant memories that will stay with us for a long time to come, they have set a standard by which we will judge future Games."

The Sankei Shimbun, Japan:
"Thank you so much for your cooperation. We could succeed in covering the XVII Olympic Games. We were very happy to know the power of high technology by Norwegian Telecom Olympic Project. Please say hallow to your all staff and come to Japan for next Olympic Games in Nagano."

Allsport UK, London:
"Many thanks for all the services provided during the Olympic Games, and the support that your team gave to Allsport in Lillehammer. The telecommunication facilities were excellent, and we, as a sports photo agency, had a very successful operation because your facilities worked so well. So thanks again."

Bayerischer Rundfunk, Munich:
"I can confirm that these Games have been one of the most successful ones ever. Especially the very friendly, always cheerful atmosphere attributed to this success. You and your staff made work in and around the IBC so much easier. Please accept our sincere thanks for the excellent work you have rendered to ARD and ZDF."

Deutsche Presseagentur GmbH, Hamburg:
"The cordial welcome we received, the perfect organisation, the technical support we received previous to and during the Games – all of these aspects contributed to make our stay in Norway most enjoyable. This was reflected in our products to our clients, too. It was a great pleasure to cooperate with you."

Knight-Ridder Inc., Miami, Florida:
"Thank you again for your kindness and professionalism before and during the wonderful Olympic Games in Norway. You and your countryment should feel proud of the great accomplishment. It was the best Olympics ever."

FLT Press, Stockholm:
"Thanks for a formidable OL and a by all means perfect service. From now on in Sweden we don't talk in national terms when it comes to i.e. Olympic medals – we talk in Nordic terms and consequently we count Nordic gold medals. We did win a lot in Lillehammer ..."

Xinhua News Agency, Beijing, China:
"We are impressed by your excellent telecommunications service and equipment and we will cherish such nice impression for quite some time to come, perhaps until the next sporting event which offers state-of-the-art service and equipment, as good as we used in Lillehammer. Thank you very much for your cooperation and help."

Sportinformation AG, Zürich:
"At this moment, we want to thank you very, very much for the perfect service from you personally and from Norwegian Telecom."

Commercial Communication Studios GmbH, Frankfurt/Main:
"... I want to thank you once again for all the effort, flexibility and dedication you put into your work with us. It really was an absolute pleasure to be working with you."

Axel Springer Verlag AG, Hamburg:
"We have had a nice time in Lillehammer. Everything was well organized. Thank you very much for your help that we could cover the Olympic Games with success."

Fédération Francaise de Ski, France:
"Thank you very much for your so much appreciated and helpful cooperation. These XVII Olympic Winter Games were a huge success and all the French officials, athletes and coaches will keep wonderful memories of them."

AT&T, USA:
"It was a pleasure dealing with you during the Lillehammer Games. I hope the USA can do as good a job as Norway!"

APC:
"I would like to thank you very much for all your kind assistance and cooperations during the time of preparations and the time of the Games itself ... We are really proud that we could enjoy and experience working with you and your company. Thanks again on behalf of all the APC marketing agency."

Figure 3 Some of the statements made by our international customers after the Games

these people were responsible on behalf of Norwegian Telecom.

The very first customer arrived in Lillehammer in August 1993, and the company was of course CBS. Only a few others started their work at the venues before 15 January 1994. Due to the fact that many of our customers ordered additional services or changed orders, NT had a huge amount of work to be done very close to the day of the Opening Ceremony. Most of the customers arrived between January 25 and February 10. The most hectic time in the Telecom Service Centres was between 10 days before the opening of the Games and three days after the Games had started.

Table 1 is a summary of telecommunication services delivered by NT for the XVII Olympic Winter Games.

6 Conclusion

With regard to sales, NT really did succeed in offering the services requested, and the total income was higher than estimated. The question was: Did we succeed in fulfilling the customers' demands and expectations for telecommunication services?

In May 1994 Norsk Gallup carried out a Customer Satisfaction Monitoring involving 300 Olympic customers asking various questions relating to NT's total involvement in the Olympics. The answers were analysed by Norsk Gallup, and the result was nothing but sensational. The total score, on a scale of up to 100, was 10 points better in many of the customer relationships than other research shows for general deliveries in this market in Norway.

From March to August 1994, the NT Olympic Project received letters from over 60 international customers. Figure 3 shows some of the statements.

A small company, in a global view, has taken a considerable step forward in the process to state the position in the International Telecommunication market.

People came in their thousands to watch the Olympic Games

The VI Olympic Winter Games, Oslo 1952

In connection with the articles on the XVII Olympic Winter Games in 1994 we would like to present to you a retrospective glance at the VI Olympic Winter Games in Oslo in 1952. The articles are abridged versions of two articles published in *Tekniske Meddelelser* (the former name of *Telektronikk*) No. 10–12, October–December 1952, and give us an idea of the organizing of the Games with their 72 international telephone connections, the 2 AM/FM radio connections used for traffic to New York and reversed to Tokyo, and the facsimile service via radio to Hamburg and New York, whereby a photo could be transmitted in the course of a few minutes.

Telecommunications for the VI Olympic Winter Games, Oslo 1952

BY J RINGSTAD, SENIOR ENGINEER

The dimensions of the preparation and coverage of the VI Olympic Games were hardly foreseen by anybody at the outset. Several committees were established well in advance to take care of the varying tasks. One of them was the Telecommunication Committee, or TC for short, with representatives from the municipality of Oslo, the Norwegian Broadcasting Corporation, the press and the Norwegian Telecommunications Administration (NTA).

In this paper the term telecommunications covers telegraph, telephone and broadcasting. However, the TC also had other responsibilities, e.g. public address systems for the various sports venues.

Comparatively few spectators can be present at the actual arenas, so it was considered an important task to keep the public – at home and abroad – adequately informed at any time by radio or text and pictures from broadcasting and press. We knew that foreign broadcasting and press would make great demands, so our international connections were important.

In the following I will concentrate on NTA's work before and during the Games. The NTA is responsible for the operation of broadcasting stations and channels, while the Broadcasting Corporation takes care of the studio work.

The TC first met in January 1949, and at regular intervals since. The committee dealt with the individual sports venues, and agreed on the extent of telecommunications needed in each case: the number of cable pairs or lines for broadcasting, telegraph and telephones, the number of broadcasting booths, etc. In this respect, we benefited from experienced press representatives who had covered Olympic Games before and knew the demands.

All venues (except Norefjell) are located inside the City of Oslo boundaries. Thus, it was the responsibility of Oslo Regional Telecommunications Administration to establish lines and cables for broadcasting, telegraph and telephone, as well as management of all the telephone installations at the various sites.

The cable and line installations in the Oslo area were extensive. No further comments should be required, but I would like to quote a passage from an observation made by the Director of the Oslo Regional Telecommunications Administration in the NTA bulletin *Verk og Virke:*

> "It was our duty to carry out all installations of the telephone switchboard at the Hotel Viking, with a separate long distance switchboard in combination with the hotel switchboard. Furthermore, we installed the switchboards at Bislet, Holmenkollen, Jordal, and Dælenenga and in the accommodation quarters at Sogn, Ullevål and Ila. We also installed telephone boxes and telephones on the press stands at the various venues. We initiated the work a couple of years ago, but received new orders until the last minute. Luckily, we had installed plenty of cables everywhere and this turned out to be necessary.
>
> The biggest outdoor task was to lay underground cables from Slemdal to Midtstua with extensions to Rødkleiva and the bob track. As we had ample time on our hands and accordingly could work efficiently, we did not feel the work pressure too heavily – until the last days before the opening of the Games".

I must mention that NTA's maintenance centre installed all teleprinters at the Hotel Viking, in the press offices and at the sports venues.

The telephone situation in Oslo was strained, and we particularly feared a severe strain on the information desk. Therefore, a switchboard with an information desk was installed for the Games in the Hotel Viking with opening hours 0700 – 2200. This switchboard did not give information on sports results; still, three operators were busy answering miscellaneous inquiries. The press committee kept the desk updated.

Besides, the press committee published an "Olympic address and telephone book". The preface says that it was intended as an aid to all persons who in some way work within the framework of the VI Olympic Games, in order to avoid bothering each other with unnecessary questions and telephone calls.

Oslo's international telephone connections

During the Winter Games we had two direct telephone connections Oslo – New York by radio, compared to one before the Games. Furthermore, we were connected to Tokyo by radio. Otherwise, all international telephone connections from Oslo were routed via Denmark or Sweden.

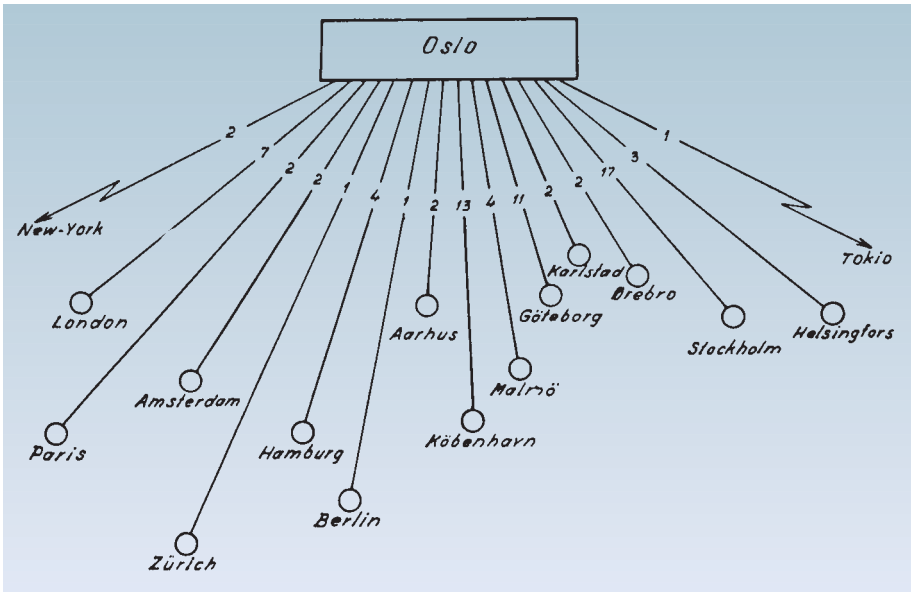


Figure 1 International telephone connections

We had two telephone cables through Skagerrak to Denmark. Some connections were routed to Denmark and some to other countries in Europe.

Already before World War II earth cables were laid to the Swedish border at Kornsjø, connecting us to the Swedish cable network. This cable routing carries to many connections to Sweden and also additional connections to other countries.

Expanding the number of connections is expensive, and plans to be implemented must be built on future demands. One cannot expect foreign administrations to agree to costly expansions being used only for a couple of weeks.

The question of connections to and across Denmark and Sweden was discussed at a Nordic telegraph and telephone conference in Oslo in the autumn of 1949. At that meeting the NTA put forward proposals for expansions to be completed before the start of the Winter Games.

In this connection I would like to mention the understanding and accommodating attitude on the Danish and Swedish part. Without the good support from our two neighbouring countries during the preparations as well as during the traffic handling, the result would not have been the success it turned out to be.

The increase in number of international connections was based on further exploitation of existing cables. Some of the pairs are lightly coil loaded. This makes it possible to use a carrier channel on each quad in addition to the low frequency circuits. In this way, 31 new telephone circuits were established.

As of January 1, 1951, Oslo had 41 international telephone circuits, but at the start of the Olympic Games, 74 were at our disposal, e.g. Stockholm: an increase from 10 to 17, Helsinki: 1 to 3, Copenhagen: 7 to 13, London: 5 to 7, Paris: 1 to 2, Hamburg: 2 to 4, Zürich: 0 to 1, etc.

However, all these new lines required room for operators, and the Oslo long distance switchboard was already congested. This was a major problem. It was solved by introducing long distance dialling to Oslo, so that for example long distance operators in Drammen could dial subscribers in Oslo directly. Thus, trunk lines are connected directly to the automatic exchange in Oslo, and both space and operators are saved for the long distance switchboard. On the other hand, it required new equipment for the automatic exchanges, and Oslo Telephone Administration (OTA) was forced to step up the construction of a planned local tandem exchange.

Telephoto

Telephoto, or picture telegrams, are transmitted on ordinary telephone lines. In principle, it is done in two ways:

1 The pictures are handed in at the local telecom and are rated there. The rate depends on the size of the picture and the method of transmission.

   In this country we have only one public telephoto station (in Oslo). On the occasion of the Winter Games, the old equipment was replaced by a construction of the very latest technology. If the pictures were delivered at other local telecoms, they had to be sent to Oslo by mail.

2 Newspapers, news agencies and other interested parties buy their own telephoto equipment. They hire lines from the NTA on a periodic basis and set up the transmission themselves.

   Newspapers and agencies often have their own mobile transmitters to take with them to the location of the events. From there they transmit the pictures to the stationary receiver at home.

Today, reporting by pictures is an important part of the news service. In fact, we were afraid that the extent of telephoto transmission would reach such dimensions that it would congest other traffic. We expected many foreign correspondents to bring their own telephoto transmitters, which turned out to be the case. No less than 24 telephoto transmitters were placed at Hotel Viking and they were in frequent use.

It was also possible to transmit pictures directly from Holmenkollen and from Norefjell. The transmitters at these locations were placed in crew trucks belonging to the Oslo Electricity Board. These vehicles also served as dark rooms for developing films.

The transmission of pictures to the USA posed a problem. Earlier, they had been transmitted via London or other towns which had telephoto connections to USA. But such a relay system caused delay and reduced the quality.

Therefore, it was necessary to establish direct telephoto connection to New York via radio. This was arranged at the beginning of this year, with the Norwegian transmitter being placed at Jeløy Radio. This mostly worked very well, but radio connections over such distances are bound to be unstable and re-transmissions could not be avoided. Still, the traffic ran smoothly and many pictures were sent to the USA by this route.

Telegraph service

Before I deal with the telegraph service during the Olympic Games, I would like

to mention the general development in this field concerning lines as well as equipment. The general public is probably not aware of the development in this field over the last few years.

The telegraph service in this country will be 100 years old in 1955. In the first year and for many years on, a network of single wire telegraph lines were constructed throughout the country. Construction of long distance telephone lines began towards the turn of the century. Gradually, methods were developed for simultaneous transmission of telegraph and telephone traffic through one telephone line. Through the years many methods have been employed. The last step in this development is the voice frequency telegraphy. This system employs a telephone connection on which up to 24 telegraph connections can be established. I cannot go into technical details in this paper, but in principle, the system is based on a different frequency for each individual telegraph channel.

In this country we established the first voice frequency telegraph system in 1939. It was followed by a strong expansion during and after the war, so that today we have a network of voice frequency channels throughout the country – from Oslo to Kirkenes, to the South coast, to the West coast and abroad. I could mention that before the war we had 3–4 telegraph connections on the distance Oslo – Trondheim. Today we have 30.

This development has resulted in an almost complete closing down of the large network of single wire telegraph lines.

As long as the number of telegraph connections was small, it was necessary to employ telegraph apparatus that could deal with heavy traffic in a short time. In the years before the war we used Siemens rapid telegraph on the lines with heavy traffic. It could handle 600 letters or characters per minute. In the thirties, teleprinters were taken into service, and they gradually displaced the Morse apparatus. Siemens rapid telegraph is now abandoned and only a very few Morse apparatuses are now in use.

After the war, the NTA re-assumed the work with subscriber telegraphy, or telex (teleprinter exchange) which is the designation internationally, whereby the subscriber hires a teleprinter and a line to the nearest telex exchange. In this way he obtains direct connection to other telex subscribers.

In this as well as other countries there is a strong interest in telex, which has had a tremendous boom during the last years. Figure 2 illustrates the Norwegian telex exchanges and the Norwegian telex network.

Figure 3 shows the international telegraph network during the Games. In the upper left-hand corner we see the available telegraph channels to Gothenburg, Stockholm, Copenhagen, and Hamburg. From the three latter towns the channels are connected further on to other towns in Europe. The numbers in brackets are telex lines. The other numbers state the total number.

Several newspapers and agencies took out telex subscriptions during the Winter Games, and sent their material by the telex network to their home offices from the teleprinters in their rooms at the Hotel Viking.

In addition, they had the opportunity to use teleprinters installed in five small booths at the reception desk in the hotel. The journalists then paid according to the time they occupied the lines. They could either operate the teleprinter themselves, or they could hire an operator from the NTA.

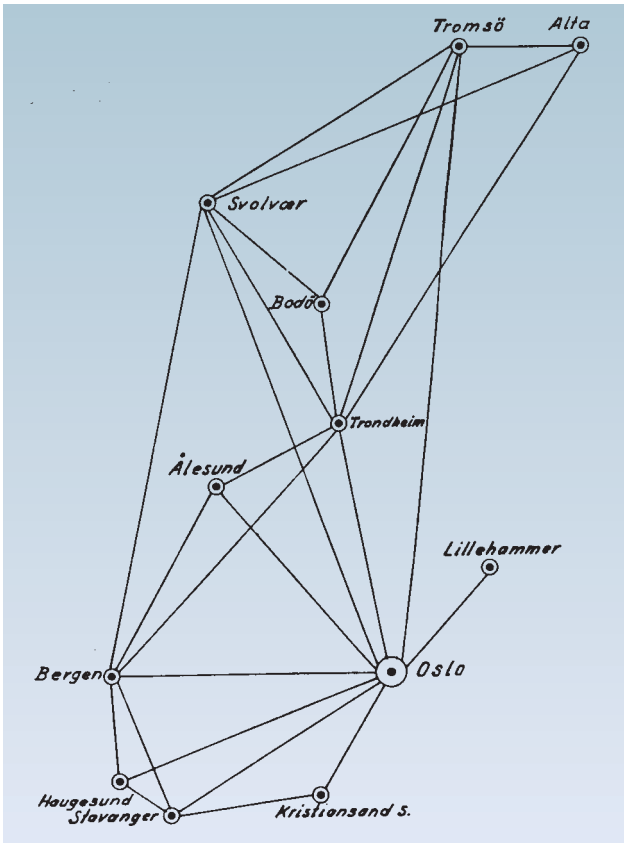


Figure 2 Norwegian telex exchanges and the domestic telex network

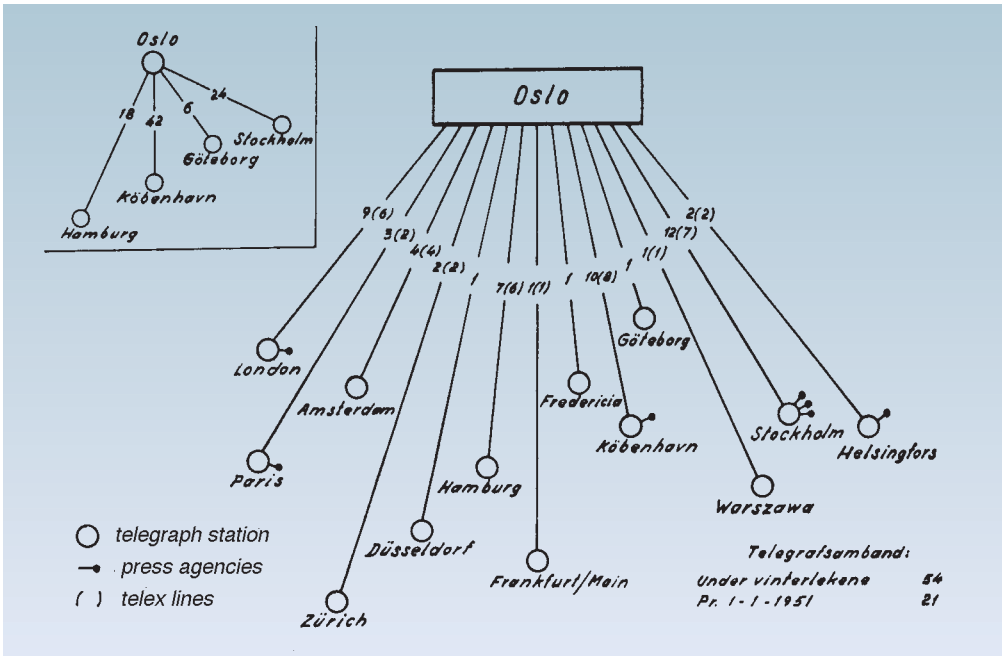


Figure 3 International telegraph connections

The big news agencies went yet another step. They hired their own telegraph channel, which was at their disposal around the clock. In this way they could at any time send correspondence from the hotel room to the main offices in London, Paris, etc. They could handle a heavy traffic volume by this kind of connection. Figure 3 shows which towns such leased lines were directed to.

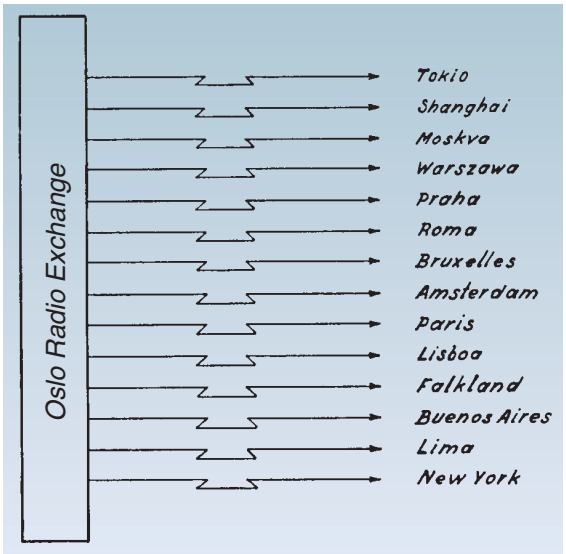
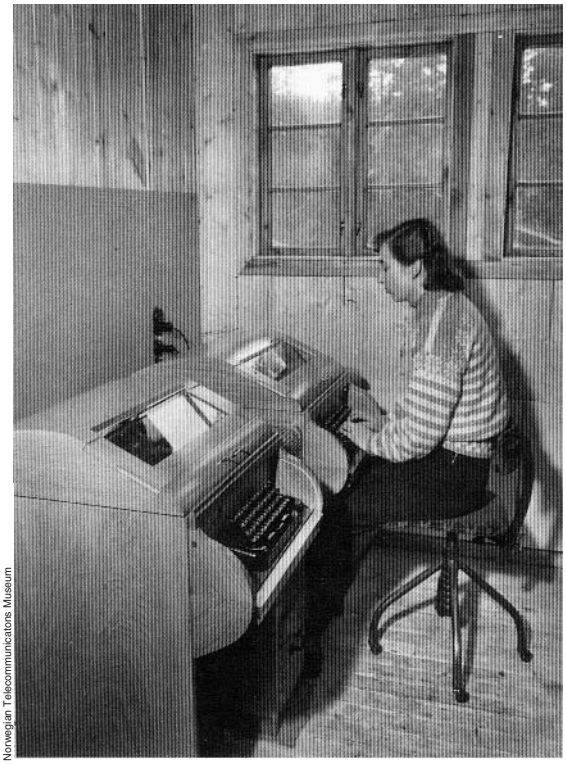


Figure 4 International radio telegraph connections



Norwegian Telecommunications Museum

Figure 5 Teleprinter at Holmenkollen

Under such circumstances the old and well known procedure of delivering press telegrams to the NTA for dispatch recedes into the background, even if it is still used.

To complete the picture, I include a sketch (Figure 4) showing the radio telegraph circuits attended to by the Oslo Radio Exchange.

The press service wished to have sports results from Bislet and Holmenkollen to its office at Hotel Viking via teleprinter. Some news agencies and newspapers requested the same arrangement. This was done by installing a distribution exchange in the telegraph building in Oslo. In this way a transmission from e.g. Bislet was received simultaneously by all teleprinters connected to the distribution exchange.

Telephone service at Hotel Viking and at the sports venues

Hotel Viking was the main centre for foreign journalists and broadcasting reporters. There was hustle and bustle in this new hotel. It was an advantage that the hotel was newly built, because that made it possible to take into account that its first task was to house press and broadcasting personnel during the Winter Games.

At the outset it was clear that we could expect a heavy trunk traffic from the hotel – mainly to other countries. Since it would amount to many times the normal traffic, special measures had to be taken. It was decided to set up a long distance switchboard with six operator desks in the hotel. For comparison, it may be mentioned that a town like Namsos has six operator desks. The arrangement is outlined in Figure 7.

Normally, a long distance connection to the hotel would be set up by Oslo long distance switchboard through the automatic equipment in the Oslo area, and transferred to the hotel room by the internal hotel PMBX. An expansion of the switchboard to make it handle such extra heavy traffic would be costly.

The long distance switchboard at the hotel operated some of the international lines directly. As can be seen from Figure 7, the operators had direct connection with the rooms without going through the hotel switchboard. In this way the operation was easy and efficient.

It was of course only a small number of lines that could be operated directly from Hotel Viking. The remaining connections were established via a number of lines between Oslo long distance switchboard and the Viking long distance switchboard.

Next to the long distance room on the ground floor was a booking and informa-

Norwegian Telecommunications Museum

Figure 6 Long distance switchboard at Hotel Viking

tion desk. If desired, the call could also be made from one of the eight telephone booths near the reception desk.

Separate lines were set up for telephoto transmission from the operator desks in the hotel to the rooms equipped with telephoto apparatus.

Figure 7 also shows the network from the long distance switchboard to the sports venues. As already mentioned, switchboards were installed at Holmenkollen, Bislet and Jordal Amphitheatre, which had direct circuits to the Oslo and Viking long distance switchboard. Rødkleiva and the bob track were connected to the Holmenkollen switchboard. The switchboard at Dælenenga had no direct lines to long distance switchboards. Just a few ice hockey matches were played here, and the traffic was not heavy.

The network of direct lines is shown in Figure 7 and the long distance switchboard at Hotel Viking was an important part of the set-up. It made it possible to handle the traffic without going through the automatic telephone network. Otherwise, the automatic exchanges would have been subjected to heavy overload.

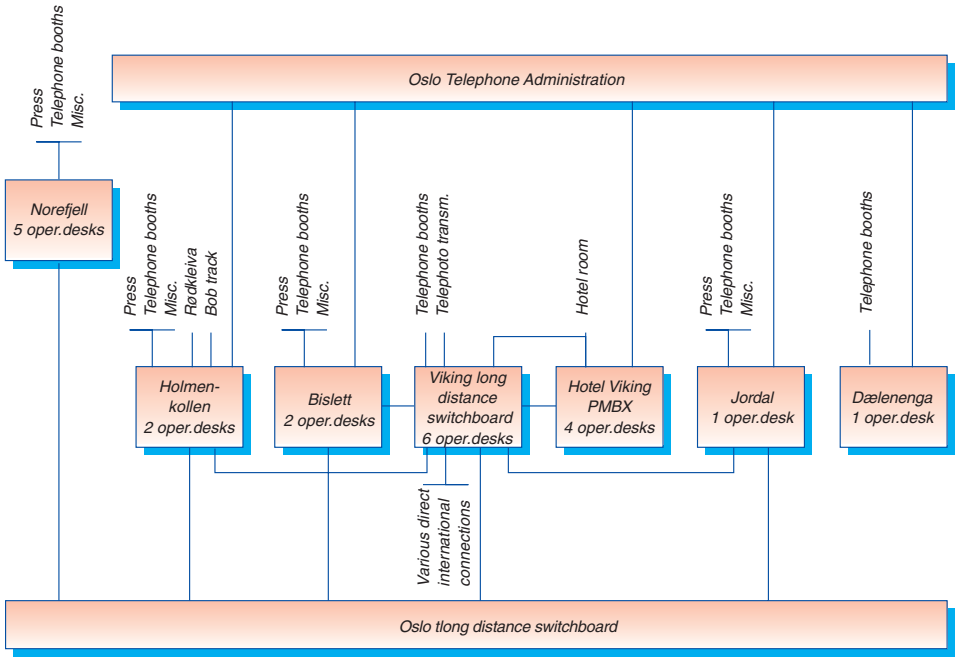


Figure 7 Connections between long distance switchboard and sports arenas

Broadcasting

I will only deal with the line connections and not the preparations and arrangements for broadcasting at the sports venues and in the main centre. The programme director said that this was the largest task ever undertaken by the Norwegian Broadcasting Corporation.

A large number of lines were laid from the venues to the main centre at Marienlyst. Here, the individual lines were routed to either recording or direct transmission. As more than 30 nations participated in the Winter Games, there were many different descriptions of the same event.

By direct transmission the lines were routed to the long distance switchboard and onward by special lines to the receiving country. Recordings were routed the same way at hours booked in advance.

Figure 9 illustrates the broadcasting network at disposal for international transmission. They were special lines able to transmit a far broader frequency band than ordinary telephone lines, which was essential to obtain the required quality.

As will be seen, a total of ten international programmes could be transmitted simultaneously.

Figure 8 Telephone counter at Hotel Viking

Two of the lines were routed to the short wave transmitters at Lambertseter and Fredrikstad, and the remaining eight to Helsinki, Stockholm, Copenhagen, Berlin, Hilversum, and Hamburg (3). From some of these locations the lines were connected if needed to e.g. Paris, Rome, London, etc.

It should be mentioned that broadcasting personnel required a conference line in addition to the programme line as long as direct transmission took place.

Norefjell

Norefjell was the venue for the giant slalom and downhill for men and women.

It is located on the west side of Krøderen lake, approx. 120 km from Oslo. The nearest long distance switchboard is Krødsherad, some 5 km from the bottom of the tracks. It was obvious that this small rural station with a few trunk lines and a simple operator desk could not cope with the expected traffic. The station was also located too far from the track. We had no choice but to build. The committee designed the building and arranged for the installation, and it was completed at the beginning of 1951.

On the ground floor was the NTA's reception desk with admittance only for reporters, as well as 12 telephone boxes. Telegrams could also be handed in here.

Behind the desk were two rooms, one with five operator desks and one for technical equipment. On the same floor was the cafeteria, with a good view to the tracks. The telephones installed in the cafeteria were heavily utilised.

The offices for the games administration were located on the first floor. The broadcasting equipment was also located on this floor, consisting of 10 complete recorders, among other things. Telephoto could be transmitted from Norefjell from four crew vehicles hired from the Oslo Electricity Board. So, that was the building with its contents, but lines had to be provided.

The NTA decided to establish two double copper telephone lines from Krødsherad to Hokksund, and then on to duct cables to Oslo. These lines were previously planned by the Administration, and they were now brought forward in order to be ready for the Winter Games. The Olympic Committee paid for the required lines from Krødsherad long distance switchboard to the Norefjell building.

The new quadded cable could now carry 8 voice frequency telephone circuits. Further, a few one channel systems were established so that a total of 16 telephone circuits were at our disposal from the Norefjell building directly to the long distance switchboard in Oslo. One of the circuits was earmarked for the Broadcasting Corporation, which also set up three short wave circuits from Norefjell to Oslo. A couple of Oslo newspapers had their own short wave transmitters. To a great extent this relieved the load on the regular lines.

But lines were also needed on the actual slopes. We were asked to lay underground cables from the telecommunication building to the start of the downhill and slalom. The cable had lines for broadcasting, electronic timekeeping, police, medical service, loudspeaker service, ski lift and two military quarters. There were several branching points, such as Vågehalsen and Fossumjuvet.

The police was well prepared for heavy traffic, among other things by having telephone lines from their transportation office at Kroa to the parking lots and main cross-roads.

We were rather tense on the opening day at Norefjell. We did not know what traffic load to expect. The station chief later said that already from the first competition the traffic was handled almost without waiting time and to everybody's satisfaction.

From the newspapers we remember the tremendous amount of work done to cover the competitions at Norefjell. While the snow was pouring down everywhere else in the country, it was very sparse where we needed it most. But the efforts were highly successful.

According to the programme, the competitions at Norefjell were to last for three days. They were extended to four days. Considering the short period of time, it was a large and costly arrangement – maybe too much so.

It was actually foreseen that conditions might be so difficult that it would be impossible to go through with the competitions at Norefjell. Contingency plans were made to move the giant slalom and downhill race to Voss. All the equipment was therefore made ready to be moved on short notice. Luckily, that was not necessary.

Traffic carried

In the article "An important service", the newspaper Aftenposten wrote on March 29, 1952:

> "When more than 500 foreign journalists, broadcasting reporters and press photographers want to transmit to their home offices without delay, insufficient connections or weak operation lead to irritants that may be detrimental to the total arrangement. Now, weeks after the completion of the Games, we are glad to say that we have heard almost solely praise of this part of the arrangement.
>
> The service was perhaps best westwards and to Sweden. This traffic was carried so to speak on the minute. The traffic to Finland was subject to a hard strain on Wednesday February 20, when Hakulinen won the 50 km cross country competition. Every decent Finnish newspaper was then supposed to cover this triumph on a full page. Even if we borrowed five extra circuits from Stockholm, several Finnish reporters had to wait up to one hour for connection to their home offices.

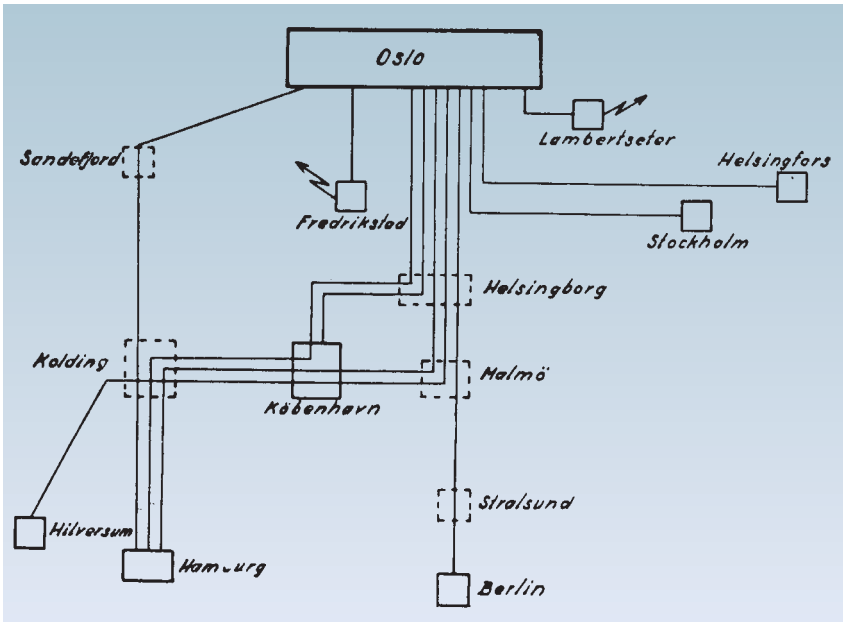


Figure 9 Lines for international broadcasting

The traffic to America went smoothly, especially because there happened to be a very good short wave transmission during the critical days. A Japanese reporter kept up a conversation to Tokyo for 44 consecutive minutes. The occasion was the speed skaters Sugawara from Japan and Hjallis from Norway starting in the same pair."

The Oslo Regional Telecommunications Administration managed the traffic and provided operators. The organisation in Oslo is such that the local telephone operation is managed by a telephone director and the telegraph and long distance telephone by a regional director. It was mainly telegraph and long distance telephone traffic that was carried from Hotel Viking and the sports venues. It was no easy task, because at the same time we had an increased load on the ordinary traffic because of the numerous visitors.

During the Olympic Games we had to place 45 long distance telephone operators and 20 telegraph operators at Hotel Viking and the sports venues, and they had to be replaced at their ordinary work places. Both operators and technical personnel carried out their assignments wholeheartedly. They received much praise both during and after the Games.

Domestic news service

The Norwegian News Agency (NTB) plays an important role in distributing news to the Norwegian newspapers. The agency receives news from all over the world via radio, teleprinter, telegram and telephone. NTB has its own teleprinter exchange in Oslo. The Oslo-based newspapers and some newspapers in nearby towns are connected to this exchange. By transmitting from NTB some or all the connected teleprinters can receive simultaneously.

NTB also distributes news to the press via Jeløy Radio. A so-called Hell teleprinter is used. Newspapers nationwide equipped with the Hell teleprinter can receive the messages in printed form. Some newspapers are telex subscribers and can receive information in this way – often from political news agencies in Oslo.

The telephone and press telegrams which only a few years ago were dominating the distribution of news, have now strong competition from the teleprinter.

Domestic broadcasting channel network

Figure 10 shows a sketch of the network of the Norwegian broadcasting channels. The letter K designates a transmitter and F a repeater. All transmitters (except for Røros, Odda and Lista) receive the programme via the long distance telephone network.

On the previous pages I have tried to outline the tasks facing the NTA before and during the Olympic Winter Games. It was a difficult undertaking and much effort was made to solve the problems as well as possible. The personnel made an admirable achievement and some persons deserve to be mentioned by name. However, this is difficult to embark on.

It was impossible in advance to estimate the extent of the traffic. Certainly, the Press Committee had made inquiries at the news agencies and newspapers about estimated traffic and which hours of the day they expected to use telegraph and long distance telephone. Still, many unexpected factors could be introduced. For example, if one nation won a medal, especially a gold one, this resulted in heavy traffic to that country. By and large, the installations were properly dimensioned.

Luckily, we were spared large failures and damage to the line network, even if we had some uneasy moments in the beginning. A couple of days before the opening ceremonies a cable to Denmark was damaged. A cable ship was ready at hand at a harbour in Jutland, but a repair would be an awkward set-back. But the cable stood the strain without interruption of traffic.

A few days after completion of the Winter Games the second cable to Denmark failed. We must conclude that fortune favoured us.

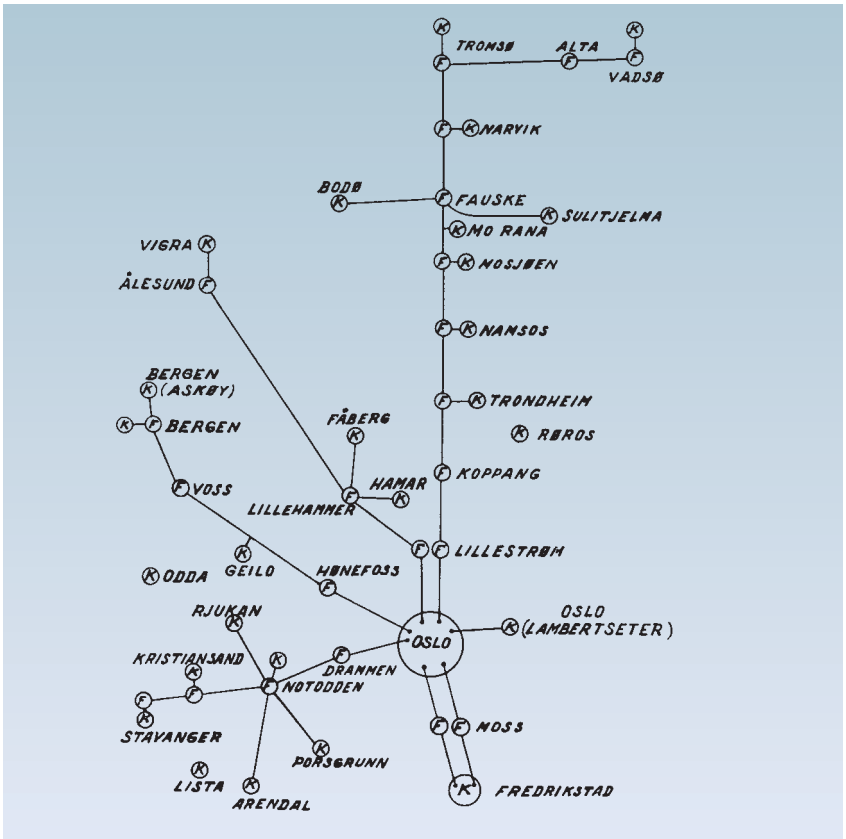


Figure 10 The domestic broadcasting channel network

Plans by Oslo Telephone Administration in connection with the VI Olympic Winter Games, Oslo 1952

BY J S MIDTTUN, ENGINEER

In 1947 it was decided that Oslo was to host the VI Olympic Winter Games. To prepare for this occasion, Oslo Telephone Administration (OTA) sent representatives to St. Moritz to study the telecommunication requirements for the Olympic Winter Games in 1948, mainly to study the telephone and cable requirements for press, broadcasting, competitors and Games management.

The local conditions in St. Moritz differed on essential points from the conditions in Oslo. Especially, in St. Moritz the location of sports venues, accommodation facilities for the press, broadcasting and athletes were very compressed. Still, a number of telecommunication problems were relevant and worth studying. OTA had experience from many large summer and winter sports events, but not one with so many simultaneous events during a short period of time. At the outset it was realised that the arrangement would put a heavy strain on the Norwegian Telecommunications Administration (NTA) due to scarcity of cables and other important material after the war.

Norwegian Telecommunicatons Museum

Figure 1 Ullevål accommodation facilities. The cables had to be laid on the outside of the walls and through the air vents to every room that was to be fitted with telephone

Due to the general lack of spare cable pairs, in particular to the sports venues, it was obvious that we would have to install switchboards at the arenas as well as at the accommodation facilities for the athletes and the press. This was necessary to satisfy demands for communication on short notice. Experience shows that improvisations within short time limits are needed, even with the most careful preparations and discussions with the parties involved.

Location vs. communication to sports venues and accommodation areas

Holmenkollen (ski jump, cross country, and relay)

Holmenkollen is situated approx. 9.5 km from the centre of Oslo and the press hotel. The nearest telephone exchange (Slemdal) is located some 3 km from the ski jump. We had already 50 pair twin cable from Slemdal to Holmenkollen; however, it was already in use for other urgent purposes. To make sure new demands were met, a new 160 pair cable was needed to the ski jump. The cable was laid from a cable cabinet at Midtstua, some 1.5 km from Holmenkollen. In addition to the existing cable from Slemdal to Midtstua an extra 200 pair cable was required. For practical reasons a switchboard was installed at Holmenkollen in order to serve Rødkleiva and the bob track as well as Holmenkollen. This was one of the reasons for the large demand for lines between Midtstua and Holmenkollen, because all local connections were carried by this link.

Rødkleiva (slalom)

From the outset, there was no telephone connection to Rødkleiva. Hence, it was necessary to lay a 60 pair cable from a cable distributor at Frognerseteren to half-way up the slope (approximately 1.7 km). Furthermore, internal connections within the slope area was needed. To this end, 30 pairs were laid from half-way up the slope to the start, 50 pairs from the middle of the track down to the finish and 80 pairs across the track to the main stand. The cost of these cables was defrayed by the organising committee, as they were valuable for after-use. To reinforce the cable connection between Midtstua and Frognerseteren, a 100 pair cable was laid.

The bob track at Frognerseteren

For the bob track, a 50 pair cable was laid from Midtstua to Frognerseteren (approx. 2 km). As the cable route mainly runs along the track, two distribution points in and out were installed, one to the finish and one to half-way along the track. This was done to ensure reliable connection to the emergency telephones along the track, and at the same time provide telephones for the press and broadcasting at these locations.

Between the cable distributor at Frognerseteren and the start of the bob track a 20 pair cable was required at one point in order to obtain 50 pairs all the way.

An additional temporary cable was laid from the start of the bob track to the officials' tower with connections for track officials, police, and broadcasting. Some temporary parallel manual telephone sets were installed for the traffic police at some car parks in the area.

Bislett, Jordal, Dælenenga

A 100 pair cable was already installed to Bislett, and no further capacity was needed. Previously, we only had a couple of telephones at Jordal and Dælenenga, so considerable expansion was needed here; 100 pairs were laid to Jordal and 20 pairs to Dælenenga.

Kadettangen, Sandvika

Kadettangen is located some 20 km from Oslo. From the parallell exchange at Sandvika, 800 m from the rink, 20 connections were provided. A 20 pair cable had to be laid in the snow for a distance of 400 m. Only three matches were to be

played here, and as this was decided at the last moment, it was the only way to obtain the connection. The cable was retrieved as soon as the matches were completed.

Marienlyst, Drammen

A couple of ice hockey matches were played at this location. As the Telephone Administration building was located nearby, no extra provision was needed.

Other plans, Norwegian Broadcasting Corporation (NRK)

In addition to the lines to the sports venues, a 200 pair cable was laid from Fagerborg exchange to the Broadcasting Centre (approx. 1.5 km) in order to strengthen existing installations.

Accommodation facilities at Sogn, Ullevål, and Ila

The athletes were mainly staying at the above locations. The buildings were intended for students' hostel, staff at Ullevål hospital and an old people's home. Common to all buildings was that their intended use did not warrant a great number of telephone installations. The greatly increased number required during the Olympic Games posed some difficulties. At Ullevål the lines had to be placed on the outside of the walls and through the air vents. The buildings are located in an area where the cable network was already highly loaded and where it was difficult to lay new cables. Furthermore, as the decision to use these buildings was taken at a late stage, the work had to be carried out in a short time.

Telephone arrangement

In the planning of equipment and installations at the various locations, the Press Committee estimated that most of the main news agencies would be represented at the main venues. In addition, some 500 journalists would have official Olympic status. It was assumed that the news agencies and the large newspapers, especially in Norway and Sweden, would require their own equipment at the sports venues.

The following news agencies were represented at the Games:

1	NTB Norsk Telegrambyrå	N
2	AFP Agence France Press	F
3	ANR Algemaine Niederl. Reisebureau	NL
4	AP Associated Press	USA
5	DPA Deutsche Pressagentur	D
6	KNS Kyodo News Service	Jap.
7	Reuter	Eng.
8	TT Tidningarnas Telegrambureau	S
9	UP United Press	USA
10	INS International News Service	USA
11	Polish News Agency	Pol.
12	Finska Notisbyråen	Fin.

The following countries were represented by newspaper correspondents: Denmark, England, Finland, France, Greece, Italy, Japan, Canada, Netherlands, Norway, Poland, Romania, Spain, Switzerland, Sweden, Germany, Hungary, USA, Austria.

As the automatic telephone network in Oslo normally carries a heavy load, we feared long delays during the Games. Consequently, we made provisions for direct lines from the arenas to Hotel Viking, and that connections to the toll switchboard could be obtained through direct lines.

The telephone switchboards at the venues were amply fitted with cords, special lines to Hotel Viking and the long distance manual switchboard as well as public exchange lines. Thus, we intended to provide newspapers and news agencies with connections from the stands via the switchboards. It turned out that the journalists were worried about delays in communication to their rooms at Hotel Viking by using the switchboards. Therefore, most of them booked direct manual lines between the venues and their editorial offices at Hotel Viking, or – in the case of the Oslo newspapers – other offices in the city. This created problems, because considerably more cable pairs were used for this purpose than was planned. The switchboards were CB types. It seems that a better solution would have been magneto boards and inductor apparatus, which would have enabled a connection from e.g. a stand at Bislet to a room at Hotel Viking to be connected as long as it was needed for another call. The operators would not have to cut off the connection before a new booking was placed and the line was not in use at that moment.

Plans for Holmenkollen, ski jump

On the north stand, in front of the press, was an operator room for booking trunk calls and handing in telegrams. This room also included five telephone booths

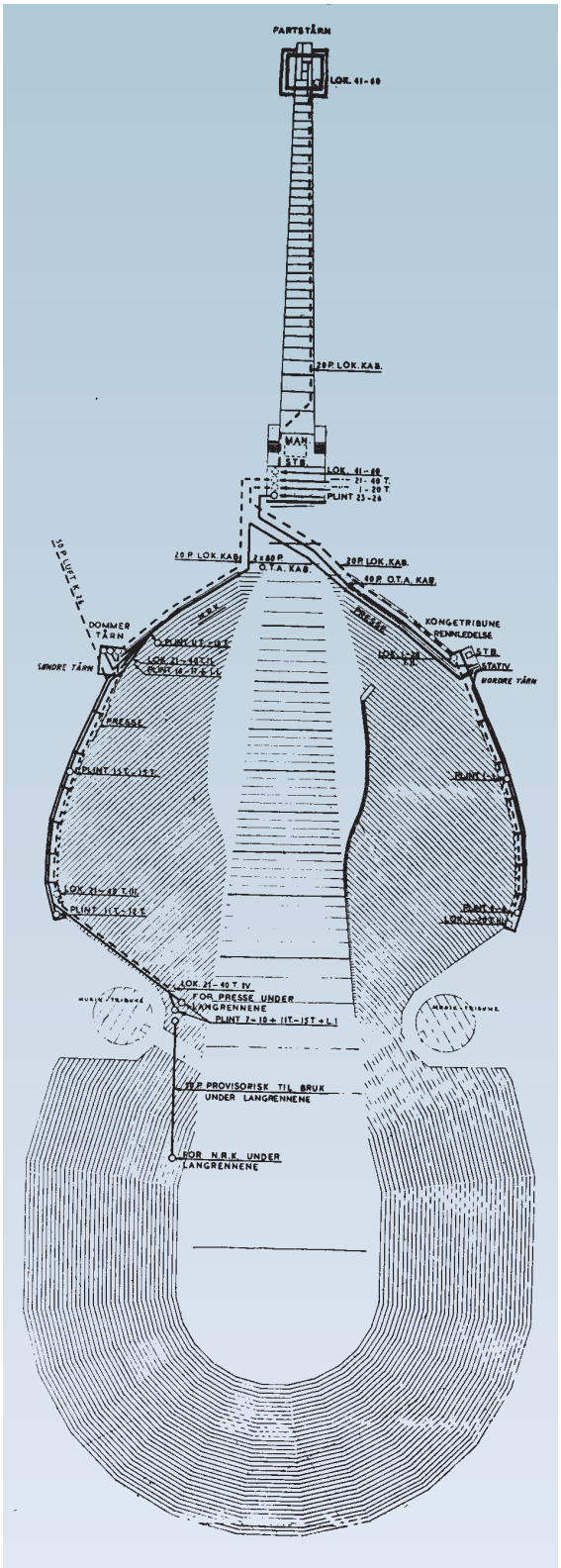


Figure 2 Cable lay-out at Holmenkollen for ski jump and cross-country. The continuous lines show the provisional cables for the Games, while the dotted lines show the permanent set-up for the track officials

Norwegian Telecommunications Museum

Figure 3 Reception desk and telephone booths at the north tower

Norwegian Telecommunications Museum

Figure 4 Holmenkollen switchboard. In the upper left-hand corner we see the shaft through which the order forms were transmitted

for journalists who did not have a telephone at their work place. Booking of telephone calls was written on a special order form which was transported through a shaft down to the switchboard which was located directly below. Here, two teleprinters transmitted the telegrams to the telegraph station.

When a trunk connection was established, the operator informed the reception which booth the call was established to. The reception had an assistant who would fetch the journalist who had booked the call. Six press assistants were busy passing on such messages. The conversation time and charge was noted in the order form which was sent to Hotel Viking to be added to other bills for the journalist concerned. This arrangement was used for all the venues.

The press service had a teleprinter (telex) in the south tower for sending all official results to Hotel Viking.

At the press stand four foreign news agencies and the organising committee had direct lines to their rooms at Hotel Viking and to NTB, and six domestic newspapers had direct lines to their editorial offices in Oslo. Another two news agencies and two newspapers at the stands had telephones connected to the switchboard, as well as four lines for transmitting pictures. The police had one direct line and one set, and the Broadcasting Corporation had one set connected to the switchboard.

Each competition lasted approx. two hours. The service time for the operators was considerably longer, as they had to be at their places well before the start of the event. This was necessary because of crowded transportation facilities and in order to test the connections.

Personnel concerned with fault correction and installation had a strenuous and demanding task of every day installing and testing all sets and disconnecting them at the end of the day. This work was made considerably easier by placing the telephone sets in specially constructed boxes for easy transportation. In such boxes the sets are well protected against snow and rain and are easy to install and reconnect every day.

The location of the press was the same for all cross country competitions. Holmenkollen switchboard was used. The press was located at the bottom of the south stand at the ski jump. 90 pairs were terminated here in strips underneath the stand. The direct lines could then be crossconnected in the cabinet in the north tower. Ten telephone booths were installed at the side of the stand. Two operators received booking of trunk calls sitting at a table beside the booths. By a separate telephone set the bookings were transferred to the exchange operators, who could inform back which booth the call was connected to. This set-up is shown in Figure 6. The equipment was satisfactorily dimensioned and the traffic was effected quickly and without problems.

For information on interim times a number of direct manual connections were established from various locations of the track to the stand for the referees at the south tower. These reporting stations were partly located at trackless places far into the wood. With permission from subscribers their telephone lines were used for the connections needed. Large crowds could be assembled at the reporting stations. To avoid disturbance from

cheers and jubilation, pilots' helmets with incorporated telephones and laryngophones were provided. The sets were constructed in such a way that the operators could choose between ordinary microphone or laryngophone. All in all, there were ten reporting stations, two for the 17 km event, four for 50 km and four for the relay.

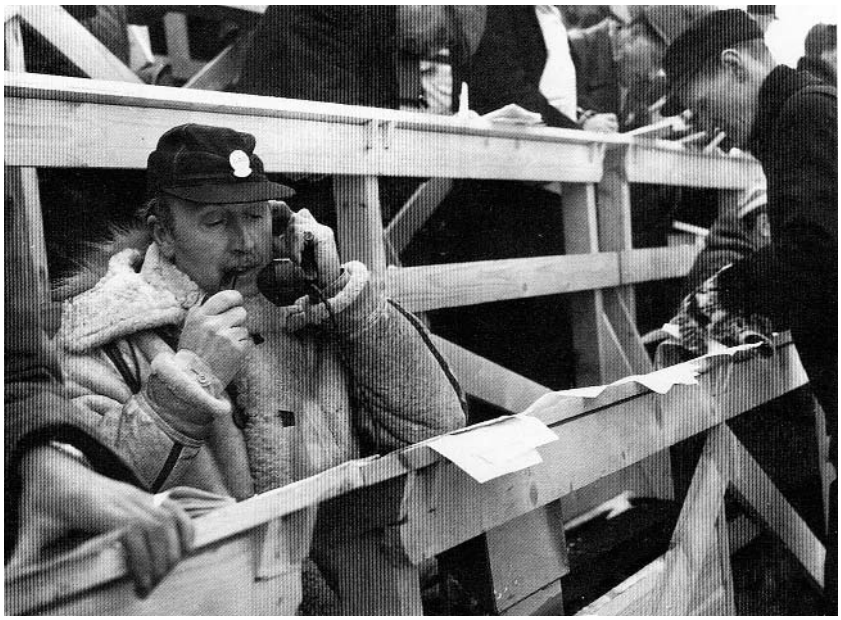
The press telephones were the same as for the ski jumping events, with addition of three telephone lines to the switchboard.

Incoming and outgoing trunk connections were set up in the same manner as for the cross country events at Holmenkollen, but the 6 telephone booths were employed for booking purposes. On the first day the service was marred by the great rush of journalists and spectators. A crush arose which prevented the journalists reaching the telephone booths during the men's slalom event. During the women's slalom event measures were taken to avoid this problem, and the traffic was carried without a hitch.

A quick and satisfactory service in the slalom is a demanding task. During the short time each competitor is in the track, many things can happen that require immediate information and instruction to various locations. Additionally, a rather extensive set-up is required for the public address system. Due to the high power in the public address system this cannot be transmitted through the telephone cables because of crosstalk.

Bislett had a switchboard similar to that of Holmenkollen, with two operators, 14 exchange lines and 14 lines to Hotel Viking. They included one booking line (eight for trunk calls, one of which was reserved for bookings). The switchboard also had a direct line to the telegram telephone for transmitting telegrams. The press service had a teleprinter giving results from the competition to Hotel Viking and to some newspapers connected to the distribution central. Six foreign news agencies had direct lines from the press stand to Hotel Viking. Four Oslo newspapers and NTB had direct lines to their editorial offices. Five newspapers had telephones at the stand connected to the switchboard. In addition to these telephones some automatic telephones were established to medical services, restaurants, and others. These telephones would also be needed after the Games.

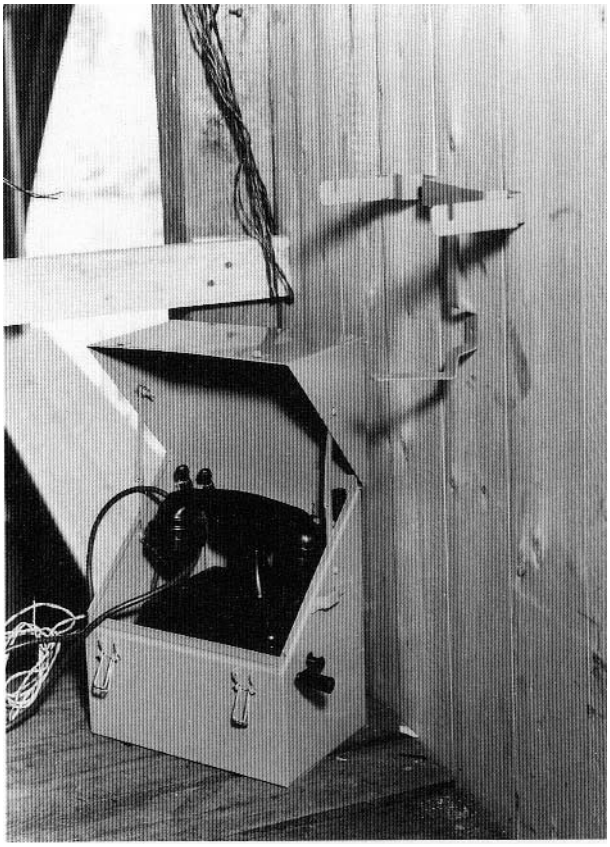
As the tariff for a telephone at the press stand was the same whether it was used at one event or all, we have no specification of how the traffic was distributed for the various events.



Norwegian Telecommunications Museum

Figure 5 Press telephone at the stand. The telephones were spread out across the stand to prevent journalists disturbing each other

The telecommunication side of traffic handling at Bislett was satisfactory, as well as the over-all arrangement. Even if the passage between the press stand and the press cafeteria with telephone booths was narrow, the entry was quick and easy. Some crush was only experienced at the closing ceremonies due to the unusually large number of press representatives present. All booked calls were effected, and among them several calls to Tokyo.



Norwegian Telecommunications Museum

Figure 6 Telephone in a portable case with a hoop for suspension of the case

Jordal amphitheatre

Jordal amphitheatre was used for at least two ice hockey games every day, at 1700 and 1900 hours. The switchboard here was about half the size of those at Holmenkollen and Bislett. It had one operator, five lines to Hotel Viking including a line for booking, seven lines to Oslo long distance switchboard (including one line for booking and ten exchange lines).

Norwegian Telecommunications Museum

Figure 7 Telephone booths with operators sitting at a table in front

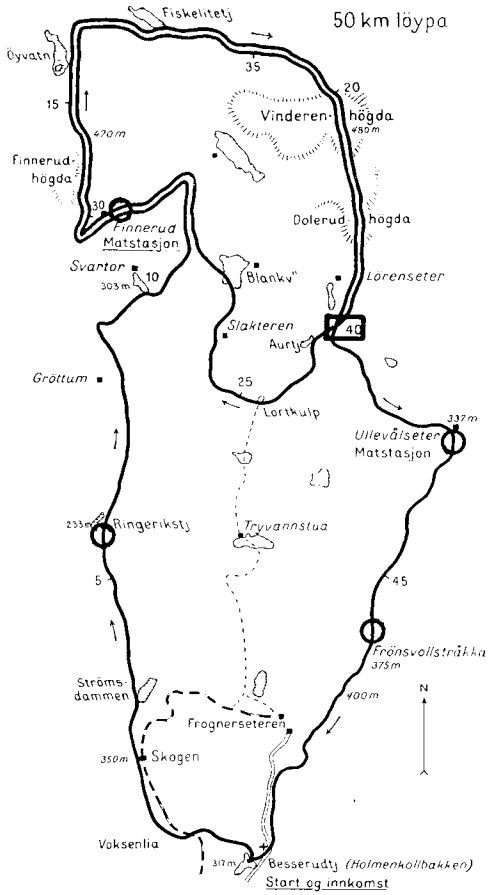


Figure 8 Sketch of the 50 km cross country track with reporting stations

Norwegian Telecommunications Museum

Figure 9 Reporting stations along the cross country tracks. The helmet has incorporated telephone in the ear pads and a laryngophone in the chin strap

Four foreign news agencies, two Oslo newspapers and NTB had direct lines to Hotel Viking and their own editorial offices. One foreign newspaper had a telephone connected to the switchboard. In order to report results, the press service had a direct line from a booth at the stand to Hotel Viking. As shown in Figure 14 the reception contained ten telephones to the switchboard as a service for the press. Also, two booths were installed at the stand with connection to the switchboard. These were reserved for the press assistants for information on booked and incoming trunk calls for journalists.

For outgoing telegrams there was a direct connection from the reception to the telegram telephone.

Besides these telephones there were four automatic telephones and 14 parallel telephones for administrative purposes. The traffic carried here was very variable according to the importance of the events. The interest increased as the game of ice hockey became known to the Norwegian public. This affected the foreign traffic to a small degree, but increased the domestic traffic.

Accommodation facilities at Sogn, Ullevål, and Ila

As already mentioned, these buildings were planned with a minimum of telephone installations. Therefore, the set-up for the Olympic Games had to be very restricted because of difficulties in laying new lines. The switchboards at Sogn and Ullevål were dimensioned for ten exchange lines and 60 extension lines, and six exchange lines and 24 extension lines at Ila. Besides the required telephones to shops and administrative offices, one telephone on each floor was installed where possible, preferably to the head of each nation staying there. A

small number of telephone booths were also provided in connection with the switchboard.

The arrangement was rather on the scanty side. At times it was difficult for the athletes to get through if their group official was not present. A paging system would have been of great help, especially because of the heavy incoming traffic.

However, with the available equipment the traffic was handled in a very satisfactory manner, and we had no serious complaints.

In the beginning the operators had some language problems, but this obstacle was soon overcome.

Hotel Viking

The hotel was newly built and was only just completed for the Winter Games. With minor changes it was fitted out with a view to housing a substantial part of press and broadcasting personnel with all their equipment at the hotel. Also, it provided offices for the Organising Committee, accommodation office, ticket office, the transport section, the press director and the head of the telecommunications committee.

It is obvious that such an arrangement had to be very extensive in order to comply with the requirements for connections and equipment.

All guest rooms had a telephone connected to the switchboard. Four operators served 20 exchange lines and 400 extensions.

The hotel administration was provided with its own switchboard with five exchange lines and 50 extensions. The switchboard was only for outgoing calls, and had no operator.

The organising committee also had its own switchboard with 10 exchange lines and 15 extensions. It was connected to the hotel switchboard through four tie lines.

Heavy trunk traffic was expected to and from the hotel, commonly called the "press hotel". To avoid delays, part of the Oslo long distance switchboard was actually moved to the hotel. To this end special switchboards for six operators were installed. They were equipped with a few direct international trunk lines, but most (30 lines) were connected to multiple fields at Oslo long distance switchboard. As the switchboard was to be connected to all guest rooms, the multiple from the hotel switchboard was also installed in the long distance switchboards. These had another 21 connections to the switchboards at the venues, six connections to the hotel switchboard, 30 lines for telephoto and 8 lines to booths near the operator desk. The switchboards had seven external lines.

Outside the switchboard room was the operator desk for booking of long distance calls for the eight telephone booths.

For booking of long distance calls from the guest rooms, connection to the hotel exchange was obtained by unhooking the handset. By asking for "Olympic long distance" the connection was transferred via a tie line to the long distance switchboard where the booking was recorded. When the call came through, the switchboard could route directly to the local subscriber without going through the hotel switchboard.

Booking a picture transmission took place in the same way as a long distance call. The long distance switchboard

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Figure 10 Track officials on their stand during slalom events at Rødkleiva

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Figure 11 Telephones for the news agencies at the veranda at Frognerseteren restaurant

ordered a telephoto line and set up the connection on the subscriber's telephoto line via a bypass cord. He could now talk to the other parts directly from his manual set and transmit the picture. After completing the transmission the subscriber would give notice via his ordinary local set. All in all, 14 telephoto lines were employed during the Games.

The trunk traffic increased steadily from a few days before the opening of the Games and culminating a few days before the close of the Games. During the last days there was practically no traffic. During the days of heaviest traffic there were not sufficient lines between Hotel Viking and Oslo long distance switchboard. As a relief measure the lines from the trunk exchange to Bislett were linked by cords to the tie lines to Viking. In this way Viking obtained some additional connection lines.

Relatively few long distance call were booked from the desk to the eight telephone booths. The reason must be that all rooms were provided with telephones. Paging of journalists receiving long distance calls was effected by a public address system operated from the desk.

The traffic handling at Hotel Viking was mainly smooth without much delay. The only problem was that the switchboard for the Organising Committee was too small, so that the hotel switchboard had to handle calls that normally should be carried by the other switchboard.

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Figure 12 Operator set with operators and press assistants (with arm bands) waiting for bookings

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Figure 13 The switchboard at Bislet with a hatchway to the operator desk. The set for the telegram telephone is seen in the background

Information Office for the VI Olympic Winter Games

The directory enquiry service at OTA usually carries a very heavy load. During the Games it was feared that the office would be totally overloaded by enquiries for telephone numbers of the various offices and institutions connected with the Games.

Therefore, we established a special information office for the Games in collaboration with the Press Committee. OTA defrayed the cost of the telephone set-up and provided three operators for the service. Administration of the office was placed under the press director. He also provided the attendants, consisting of nine operators.

The office was opened just over a month before the start of the Games, and at the beginning it was attended by one operator during normal office hours. The traffic was light until approximately a fortnight before the opening of the Games, when the opening hours had to be extended to 0800 – 2300 hrs. But only during the actual Games did the traffic increase to an extent that required three operators on the two first shifts between 0800 – 1800 hours.

The information material was partly collected in advance and partly as need arose. It included questions about the competing countries' active and official members, press, radio and film personnel and their addresses. To support this service, the press director had in advance edited an Olympic telephone catalogue containing such data. Further, it contained everything concerning the events, programmes with alterations, detailed information on communication possibilities within Oslo as well as to and from other

countries. It also contained updated information on weather and snow conditions and moreover everything that could be of interest in connection with the Games.

The only thing it did not report was the results of sports events. If such a task had been allocated to the office, the scanty lines would have been blocked.

According to statements from the press director's office most of the enquiries concerned tickets, accommodation, telephone numbers to the venues, addresses, access possibilities, times and dates of the various events, training hours, telephone numbers to the committees and officials, starting sequence, and personal information about the athletes.

It was said that the office satisfied a great demand and that it relieved the switchboard of the Organising Committee to a great degree.

Charges for the various telephone arrangements

The installations and establishments described here were so comprehensive that the preparations had to begin at a very early date, and long before we had a clear idea of how the costs would be covered.

However, the NTA could not commence such an undertaking without having secured settlement of expenses. As organiser of the Games, the City of Oslo had to grant the amount estimated by the OTA. Even if the city was credited with the value of after-use of the cables, it had to pay for all installations. This amounted to several hundred thousand kroner.

The Organising Committee was the sole subscriber for all installations. Expenses for installations as well as call charges were calculated at normal rates.

It seemed reasonable that the press should pay for some of the work and installations carried out in order to render the press an effective and good service. If the individual agencies and newspapers were to have ordered their own services, the charge would have been very complicated and costly. A panel was selected to assess fair charges for the various events. However, it turned out that if the Organising Committee was to have somewhere near full coverage of its expenses, the charges would have seemed exorbitant. The charges had to be reduced to a reasonable level and let the Committee bear the difference. The charges stipulated were:

1 telephone in a room at the Press Hotel for the duration	kr	120
Additional for one extra telephone for the duration	kr	60
Use of telephone booths at the arenas, per journalist for the duration	kr	60
Telephone in a covered room at the stand during ski jumping competition in Holmenkollen	kr	1,000
Telephone in the stand at Bislett or Jordal for the duration	kr	500
Telephone in the stand during cross country competition	kr	400
Telephone in the stand during women's and men's slalom	kr	400

All local calls were free of charge. For other services normal tariffs were applied. Many calls were booked with reversed charges.

Conclusion

In planning the local traffic demand it was difficult to rely on comparison with similar arrangements elsewhere because geographical conditions and existing telecommunications networks were different. Also, the means of transmitting news was subject to changes. The tendency is to use telephone or teleprinter, while telegrams are only used when other possibilities are lacking. By and by, as the telex network is developed, it is possible that news communication will be effected by teleprinters.

The plans for the various venues were adequate. All booked calls were effected quickly and without much delay.

Summing up, it can be said that most arrangements were adequately dimensioned, and all demands for equipment were complied with. Certainly, consideration to the telegram service from the arenas could have been less than planned, as this was in little demand, perhaps because of the ample telephone service, which reduced the demand for the telegram service.

When the telecommunication service was effected as efficiently as was expressed in the newspapers and in various letters of thanks from different sources, it is first of all due to the individual efforts of all personnel involved. A special honour is due to all workers and installers who were on call day and night in order to make the installations ready every day and at the right time.

Norwegian Telecommunications Museum

Figure 14 Telephones for the press at Jordal amphitheatre