CONSTRANTS AND COMPLEXITY IN SEISMIC DATA ACQUISITION

3.1 CONSTRAINTS OF SEISMIC DATA ACQUISITION

The most crucial part of a seismic network array of small, medium and large size is the design of its Base-station which receives continuously and simultaneously radio telemetered data from all its remote stations. In order to cover wide frequency spectrum of local micro-seisms, the digital data at every remote station, in general, is sampled at a very high rate of the order of 300 samples per second. For a three components seismometer (remote station consists of two horizontal and one vertical seismometers), the data is generated transmitted at a rate of 4800 bits (600 bytes) per second.

With a view to obtain good quality and quantity of field data, generally eight or even more remote stations are operated simultaneously under one Intelligent local seismic network (ILSN). Hence, the total seismic data arriving per second at its Base-station from all the eight remote outstations is of the order of 5 K bytes or 40 K bits per second [4,18,34,38].

3.1.1 Characteristics of telemetered seismic data

a) The nature of the seismic problem is such that each and every data sample is to be acquired and processed before either rejecting it or retaining it. It is because
the information on - the exact arrival of first P and S phases of seismic waves in terms of time, amplitude and polarity along with the few seconds of pre-event data is foremost to seismologists. After the detection of true event, the whole data pertaining to pre-event, event and post-event period is required by the seismologists for indepth analysis of the event.

b) The other problem is the duration of event which may vary from few seconds to several minutes, or even more. Longer the duration, more is the data to be acquired, processed and recorded by the system. Very oftenly, it is essential to preset a very long post-event period and under such circumstances the total event duration may go as long as 30 minutes or even more.

c) The next constraint is the number of events which may occur in a slot of 24 hours. These events may be fairly large in number particularly when the detection threshold level is set quite low and the place under the investigation is seismically active.

It is, therefore, evident that seismic field data is generated and transmitted in enormous quantity and every sample is important. Because of the necessity of its fast processing and analysis in realtime mode round the clock, the Base-station of the local array till date is configured around powerful mini-computer. The computer used for this purpose is further provided with the additional hardware and special operating software to handle the enormous and fast
arriving data in the real time mode [39,40,41,42].

3.2 PROBLEM OF COMPUTER BASED SEISMIC NETWORK ARRAY

The concept of National Seismic Data Centre (NSDC) for Indian subcontinent is practical and feasible only when a fairly good number of local seismic networks (approximately twelve or more in numbers) with lot of inbuilt intelligence are operated all over the region to cover vital geological zones. But a fairly large number of such arrays (local networks) is possible only if the initial cost of the array and its subsequent operation and maintenance expenses are considerably low.

Computer is the most expensive and sophisticated component incorporated as an essential unit of the Base-station of every local network array. The mini-computer is powerful enough to carry out in realtime mode the seismic data acquisition, processing and recording. But it is not field worthy, inexpensive, light in weight, easily mobile and not even low power consuming. The later considerations for computer used for this purpose, put serious constraints on the design of Base-station of local seismic network array. Some alternate is required.

Personal Computer though light in weight, small in size, easily mobile and economical on power consumption, appears very suitable but could not be considered for designing and configuring the base station of local seismic network array. No Personal Computer operating under 'DOS' inspite of its advanced version based on improved processor
like 80286/80386, can acquire, process and store the telemetered seismic data from the remote stations of an array in the realtime mode. Directly addressable memory (RAM) under "DOS" in any personal computer is not more than 640 k byte. Therefore, even the highly advanced PC/AT operating under 'DOS' can not be used as such and has not been used or reported for "real time seismic data telemetered network applications".

The simple PC/XT which is based on 8-bit 8088 microprocessor, does not possess the speed, memory capacity and hardware support anywhere near to that of PC/AT which is a 16/32 bit machine. The design and configuration of Base-station around PC/XT for this purpose has not been considered and attempted till now.

3.3 SHORTCOMINGS OF PERSONAL COMPUTER TO HANDLE DATA IN REAL TIME MODE

When it is proposed to design the Base-station of a seismic network array around the simple PC/XT, huge quantity of digital data telemetered at a rate of 5K bytes per second is required to be stored continuously into PC/XT-RAM for a very long time (may be for more than 30 minutes) that too without loosing any part of the event. Sometime even few consecutive events may occur one after the other without appreciable time gap between them.

The incoming data is stored after performing upon it the necessary computation required to test if the trigger criteria is met or not. No PC/XT can store in its RAM
directly in realtime mode the field data when it is arriving at such a high speed for longe time. For example an event of ten minutes duration produces digital data of the order of 3.0 Mega-bytes. The data of this magnitude can not be stored directly into the PC/XT-RAM which is limited in its capacity (maximum only 640 k bytes). It can be done only by transferring into hard-disk the data block stored into PC/XT-RAM. Hard disk is the fastest device for writing and retrieval of data.

The data cannot be written into hard disc directly byte after byte when it is arriving at such a fast speed. The system operational requirement is such that sixteen bytes of fresh data are always available after every 3.3 mili seconds from the remote stations of a single network. Technically it is not possible to take these bytes which are coming at such a fast rate, directly into the hard disc because of- a) total inability of hard-disk to respond to data arriving at such a high speed, b) these incoming bytes are first to be processed for their either retetion or rejection.

Therefore the fast incoming data is first written into active random access memory (RAM) and when a block of predetermined length of data is accumulated into RAM, then it is transferred into hard disc. The largest size of this block is always less than the total size of the active RAM available in PC/XT, since a good part of this RAM is utilized in accommodating the computer "Operating-software" and other software.

As indicated earlier, the active RAM of PC/XT is not
big enough to store into it the entire data of an event of several minute duration. Therefore much before the running event is over, the PC/XT RAM gets completely filled with the incoming data which corresponds to only some part of it. But the event is still running. In order to take the remaining part of the still running event into PC/XT RAM, the part (data) of the event which has been just stored, is transferred from PC/XT-RAM into hard disc to make RAM again available to store the incoming data.

The transfer of data block from active RAM into hard disc takes certain necessary time of the order of one second and even more depending on the size of the block. When this data block is smallest possible in size, even then the inevitable minimum time required to execute transfer task is nearly of the order of 0.8 second.

During this period when data block from PC/XT-RAM is being transferred to hard disc, the PC/XT cannot do any task other than this. The processor of PC/XT does only one task at a time. Therefore PC/XT has to suspend totally the earlier ongoing task of data acquisition, processing and storage of fresh incoming data which is being telemetered from all remote stations of the network during this period.

But as discussed earlier, the data being telemetered from the remote stations of the network during this period cannot be ignored and left out at all. In case of a seismic event of several minutes duration, PC/XT would have to suspend intermitantly almost for one second the task of
acquisition of fresh incoming data every time after the PC/XT-RAM is filled to its capacity. The temporary suspension of data acquisition would happen several times when the event is of long duration.

The fresh incoming data cannot be attended during the block transfer period from PC/XT-RAM to Hard-disk and therefore, lot of incoming data pertaining to the event is lost every time of data block transfer. The problem cannot be handled with PC/AT working under DOS if it is used as a direct replacement for mini-computer.

Therefore a new design strategy and approach has to be worked out if PC/XT is to be used at Base-station of ILSN for this purpose.

In this research work, efforts have been made to evolve an entirely new design strategy and methodology for realizing the Base-station of an Intelligent radio telemetered seismic network array. Simple PC/XT, inspite of its serious technical limitations and shortcomings, has been incorporated in place of a mini computer to realize the Base-station of the telemetered network array to acquire and process seismic data in real time mode. Through the new design approach, the limitations of PC/XT for its application for the present purpose have been removed.

The novelty and sophistication of the worked out design is this that the acquisition of freshly incoming telemetered data from all the 8 remote stations and its simultaneous processing in realtime mode is maintained even during the period when just stored data block from PC/XT-RAM is being
transferred to hard disc. No incoming data from the remote stations of the array during this period is lost.

In the following chapters of this thesis, the research work done by the author towards design and configuration of intelligent data telemetered local seismic networks and the design strategy worked out to realize a National seismic data centre for Indian sub-continent has been presented.