CDSN: Present Status and Future Development

G. W. Zhou, X. L. Liu, L. S. Xu, C. Y. Hao, Z. L. Wu, and Y. T. Chen

Institute of Geophysics, China Seismological Bureau, Beijing 100081, China

1. Introduction

The CDSN program is supported jointly by the China Seismological Bureau (CSB), the United States Geological Survey (USGS) and the Incorporated Research Institutions (IRIS). The operation and maintenance of the network are conducted by the Institute of Geophysics, China Seismological Bureau (IGCSB) and the USGS Albuquerque Seismological Laboratory (ASL). The CDSN includes eleven field stations, i.e., Beijing (BJT), Lanzhou (LZH), Enshi (ENH) , Kunming (KMI) , Qiongzhong (QIZ) , Shanghai (SSE) , Urumuqi (WMQ) , Hailar (HIA) , Mudanjiang (MDJ) , Lhasa (LSA) and Xi'an (XAN) (Figure 1.1).

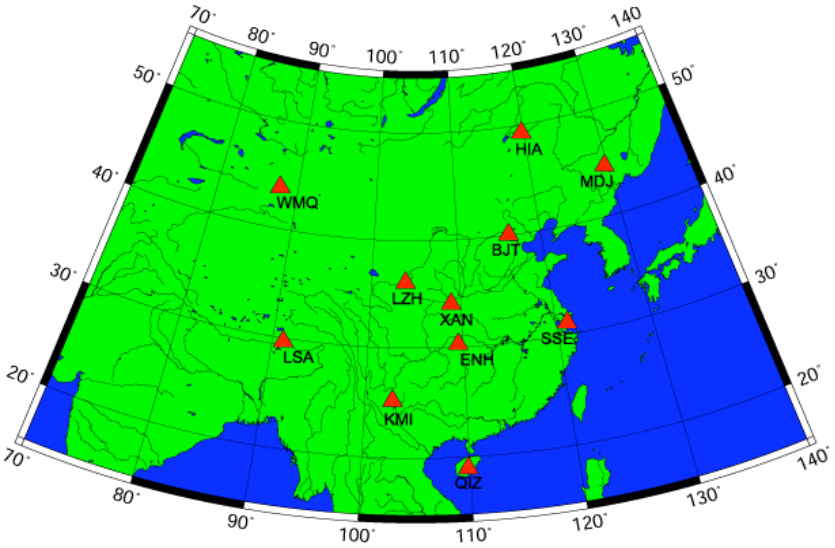


Figure 1.1 The China Digital Seismograph Network (CDSN)

Lanzhou station had been stopped on September 1, 2000, due to the lack of new digitizer for upgrading. The Network Maintenance Center (NMC) and the Data Management Center (DMC) are operated by the IGCSB in Beijing.

Major Tasks for NMC and DMC of the New CDSN (NCDSN) are :

NCDSN station equipments installation ;
NCDSN station equipments maintenance and technical management ;
Data quality control and monitoring network operation ;
Creating NCDSN station's CD from station tape ;
Providing data service for research applications in seismology ;
Quick CMT report ;

Sponsored by the Ministry of Science and Technology, People's Republic of China
Project No. 2001CB711005-1

International data exchange .

In 1992, the second-phase technique improvement of the CDSN started. The aim of the second-phase technique improvement is to upgrade the network into a new generation with the instrumentation and data transmission meeting the standard of the IRIS Global Seismograph Network (Chen et al., 1994). The second-phase technique upgrading made the CDSN into a new generation, and accordingly the NCDSN became one of the partners of the IRIS/GSN and the FDSN.

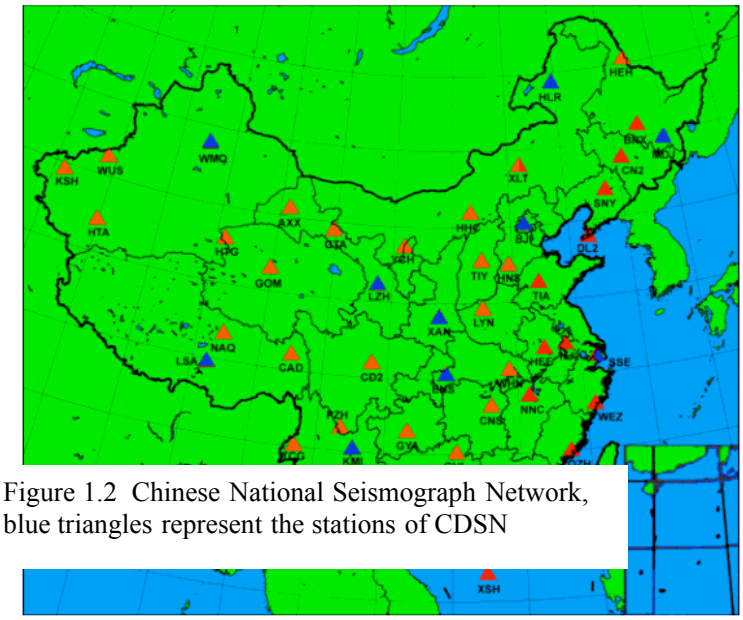


Figure 1.2 Chinese National Seismograph Network, blue triangles represent the stations of CDSN

Since 1990s, to promote the modernization of the seismological observation system in China, the China Seismological Bureau had started a program to upgrade the Chinese National Digital Seismograph Network (CNDSN) (Figure 1.2) which comprised 47 stations with very broad band seismometer and 24 bits data acquisition. The waveform data are transmitted by satellite to Beijing.

2. CDSN operation status in 2002

2.1 Stations information

Stations information is summarized in Table 1.

Table 1 Information of CDSN Stations

Station Code	Latitude (° N)	Longitude (° E)	Elevation (m)	Vault Type	Geological Fundation	Digital Broad-Band	Strong Motion	Remark
BJT	40.0190	116.1703	197.5	Tunnel	Limestone	existent	existent	NCDSN
LZH	36.0867	103.8444	1560 1440	Surface Borehole	Loess Sandstone	existent	none	CDSN 09/01/00 stopped
ENH	30.2762	109.4934	487	Surface	Limestone	existent	existent	NCDSN
KMI	25.1233	102.7400	1952	Tunnel	Limestone	existent	existent	NCDSN
QIZ	19.0294	109.8433	230	Surface	Granite	existent	existent	NCDSN
SSE	31.0947	121.1908	15	Tunnel	Andesite	existent	existent	NCDSN
WMQ	43.8211	87.6950	901	Subsurface 6m depth	Sandstone	existent	existent	NCDSN
HIA	49.2667	119.7417	610	Tunnel	Andesite	existent	existent	NCDSN
MDJ	44.6164	129.5919	250	Tunnel	Granite	existent	existent	NCDSN
LSA	29.7000	91.1500	3789	Tunnel	Granite	existent	existent	NCDSN
XAN	34.0394	108.9214	630	Tunnel	Granite	existent	existent	NCDSN

2.2 Recording

Seismometer Type:

Streckeisen Model STS-1/VBB 3 component System
Streckeisen Model STS-2/VSP 3 component System (except for BJT, HIA)
Teledyne-Geotech Model GS-13/VSP 3 component System (only for BJT, HIA)
Kinemetrics Model FBA-23/LG 3 component System (except for LZH)
Digitizer Type: ADC is Quanterra Model Q-680 (except for LZH)
Digital Format: 24 bit integer data words for all components.
Range: +8,388,607 to –8,388,608 counts
Dynamic Range: 140 dB

2.3 The feature of data channel

The feature of data channel mostly contain three kinds, that is

1. BJT, HIA
2. ENH, KMI, SSE, WMQ, MDJ, LSA, XAN
3. QIZ

Take BJT, ENH and QIZ as examples, we give the feature of data channel in Tables 2.1 to 2.3.

Table 2.1 IC-BJT

SEED ID	SPS	DATA CHANNEL
10-SHZ	40	Short Period / High Gain Seis / Vertical
10-SHN	40	Short Period / High Gain Seis / North-South
10-SHE	40	Short Period / High Gain Seis / East-West
10-EHZ	80	Very Short Period / High Gain Seis / Vertical
10-EHN	80	Very Short Period / High Gain Seis / North-South
10-EHE	80	Very Short Period / High Gain Seis / East-West
00-BHZ	20	Broadband / High Gain Seis / Vertical
00-BHN	20	Broadband / High Gain Seis / North-South
00-BHE	20	Broadband / High Gain Seis / East-West
00-LHZ	1.00	Long Period / High Gain Seis / Vertical
00-LHN	1.00	Long Period / High Gain Seis / North-South
00-LHE	1.00	Long Period / High Gain Seis / East-West
00-VHZ	0.10	Very Long Period / High Gain Seis / Vertical
00-VHN	0.10	Very Long Period / High Gain Seis / North-South
00-VHE	0.10	Very Long Period / High Gain Seis / East-West
00-VMZ	0.10	Very Long Period / Mass Position / Vertical
00-VMN	0.10	Very Long Period / Mass Position / North-South
00-VME	0.10	Very Long Period / Mass Position / East-West
00-UHZ	0.01	Ultra Long Period / High Gain Seis / Vertical
00-UHN	0.01	Ultra Long Period / High Gain Seis / North-South
00-UHE	0.01	Ultra Long Period / High Gain Seis / East-West
20-HLZ	80	High Broadband / Low Gain Seis / Vertical
20-HLN	80	High Broadband / Low Gain Seis / North-South
20-HLE	80	High Broadband / Low Gain Seis / East-West

Table 2.2 IC-ENH

SEED ID	SPS	DATA CHANNEL
10-BHZ	40	Broadband / High Gain Seis / Vertical
10-BHN	40	Broadband / High Gain Seis / North-South
10-BHE	40	Broadband / High Gain Seis / East-West
10-HHZ	80	High Broadband / High Gain Seis / Vertical
10-HHN	80	High Broadband / High Gain Seis / North-South

10-HHE	80	High Broadband / High Gain Seis / East-West
10-LHZ	1.00	Long Period / High Gain Seis / Vertical
10-LHN	1.00	Long Period / High Gain Seis / North-South
10-LHE	1.00	Long Period / High Gain Seis / East-West
10-VMZ	0.10	Very Long Period / Mass Position / Vertical
10-VMN	0.10	Very Long Period / Mass Position / North-South
10-VME	0.10	Very Long Period / Mass Position / East-West
00-BHZ	20	Broadband / High Gain Seis / Vertical
00-BHN	20	Broadband / High Gain Seis / North-South
00-BHE	20	Broadband / High Gain Seis / East-West
00-LHZ	1.00	Long Period / High Gain Seis / Vertical
00-LHN	1.00	Long Period / High Gain Seis / North-South
00-LHE	1.00	Long Period / High Gain Seis / East-West
00-VHZ	0.10	Very Long Period / High Gain Seis / Vertical
00-VHN	0.10	Very Long Period / High Gain Seis / North-South
00-VHE	0.10	Very Long Period / High Gain Seis / East-West
00-VMZ	0.10	Very Long Period / Mass Position / Vertical
00-VMN	0.10	Very Long Period / Mass Position / North-South
00-VME	0.10	Very Long Period / Mass Position / East-West
00-UHZ	0.01	Ultra Long Period / High Gain Seis / Vertical
00-UHN	0.01	Ultra Long Period / High Gain Seis / North-South
00-UHE	0.01	Ultra Long Period / High Gain Seis / East-West
20-HNZ	80	High Broadband / Unknown Device / Orientation Z
20-HNN	80	High Broadband / Unknown Device / Orientation N
20-HNE	80	High Broadband / Unknown Device / Orientation E
20-LNZ	1.00	Long Period / Unknown Device / Orientation Z
20-LNN	1.00	Long Period / Unknown Device / Orientation N
20-LNE	1.00	Long Period / Unknown Device / Orientation E

Table 2.3 IC-QIZ

SEED ID	SPS	DATA CHANNEL
01-BHZ	40	Broadband / High Gain Seis / Vertical
01-BHN	40	Broadband / High Gain Seis / North-South
01-BHE	40	Broadband / High Gain Seis / East-West
00-BHZ	20	Broadband / High Gain Seis / Vertical
00-BHN	20	Broadband / High Gain Seis / North-South
00-BHE	20	Broadband / High Gain Seis / East-West
00-LHZ	1.00	Long Period / High Gain Seis / Vertical
00-LHN	1.00	Long Period / High Gain Seis / North-South
00-LHE	1.00	Long Period / High Gain Seis / East-West
00-VMZ	0.10	Very Long Period / Mass Position / Vertical
00-VMN	0.10	Very Long Period / Mass Position / North-South
00-VME	0.10	Very Long Period / Mass Position / East-West
00-UHZ	0.01	Ultra Long Period / High Gain Seis / Vertical
00-UHN	0.01	Ultra Long Period / High Gain Seis / North-South
00-UHE	0.01	Ultra Long Period / High Gain Seis / East-West
00-HHZ	80	High Broadband / High Gain Seis / Vertical
00-HHN	80	High Broadband / High Gain Seis / North-South
00-HHE	80	High Broadband / High Gain Seis / East-West
00-VHZ	0.10	Very Long Period / High Gain Seis / Vertical
00-VHN	0.10	Very Long Period / High Gain Seis / North-South
00-VHE	0.10	Very Long Period / High Gain Seis / East-West
10-HNZ	80	High Broadband / Unknown Device / Orientation Z
10-HNN	80	High Broadband / Unknown Device / Orientation N
10-HNE	80	High Broadband / Unknown Device / Orientation E
10-LNZ	1.00	Long Period / Unknown Device / Orientation Z
10-LNN	1.00	Long Period / Unknown Device / Orientation N
10-LNE	1.00	Long Period / Unknown Device / Orientation E

2.4 The amplitude response to velocity of NCDSN stations

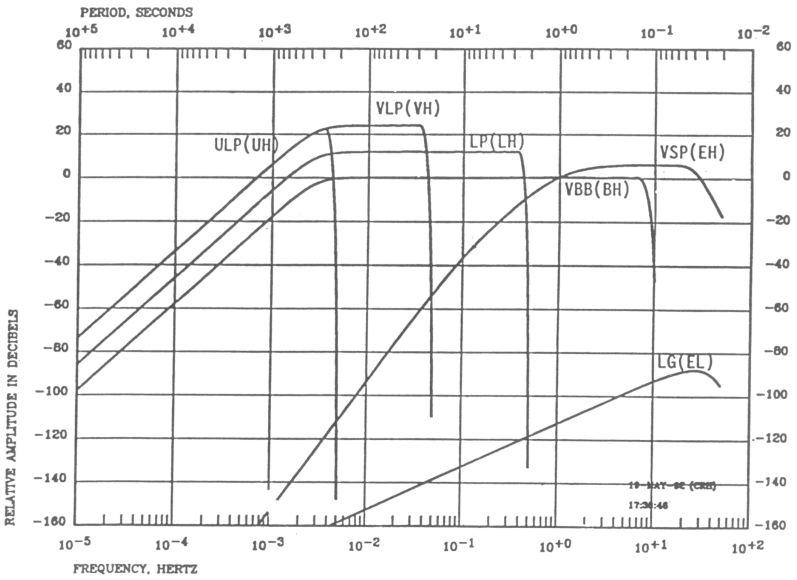


Figure 2.1 IRIS/GSN-Q system Amplitude Response to Velocity

2.5 CDSN Operation Status in 2002

In 2002, after the technique upgrade of NCDSN stations（BJT, ENH, KMI, SSE, QIZ, WMQ, HIA, MDJ, LSA, XAN）according to the technical standard of IRIS/GSN, the data availability reach to about 97% (Figure 2.2).

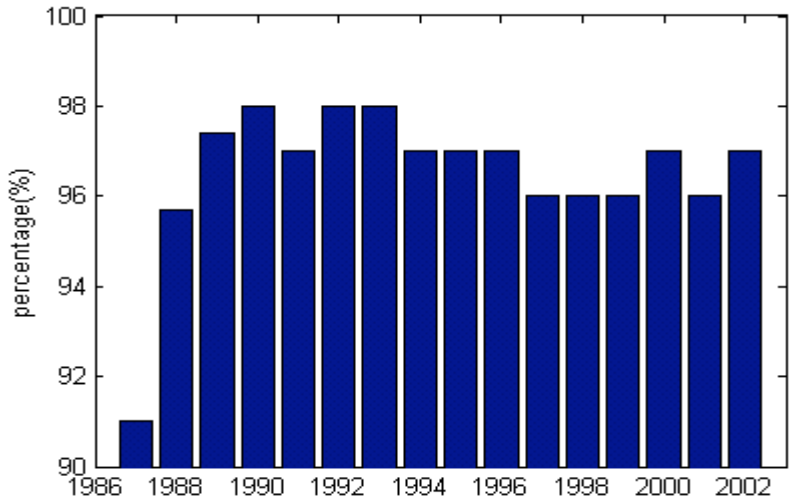


Figure 2.2 The data availability of NCDSN from 1987 to 2002

In 2002, CDSN/DMC had received and processed 775 station tapes (about 105GB) and created 220 CD for the keeping in the archives.

In 2002, CDSN/DMC provided 775 NCDSN station original recording tapes (about 105GB) to USGS/ASL; CDSN/DMC received 1088 GSN SEED vol. 546 CDSN SEED vol. from USGS/ASL;

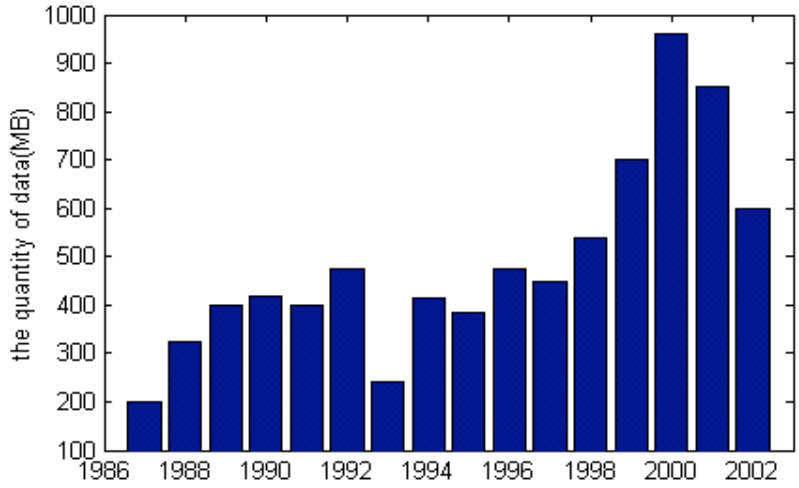


Figure 2.3 Data served for Chinese seismologist from 1987-2002

In 2002, CDSN/DMC had provided 600MB seismic event waveform data (Figure 2.3) for Chinese seismologist to research and they published 8 research papers. From 1990 to 2002, Chinese Seismologists have published 156 research papers in which the CDSN data had been used (Chen at al.1996, Zhou at al. 1997, Zhou et al. 2002).

CDSN/DMC developed a " CDSN Near Real-Time Data Processing Toolkit" software, which is a special software for near real-time data processing. The function of this system is:

(1) to keep the NCDSN near real-time data in archives and the creation of network –day vol;

(2) the pick-up and storage of NCDSN near real-time data;

(3) collecting and picking-up seismic event waveform data, providing data for the calculation and fast response of the source parameters of large earthquakes.

3. The quick report of the earthquake source parameters

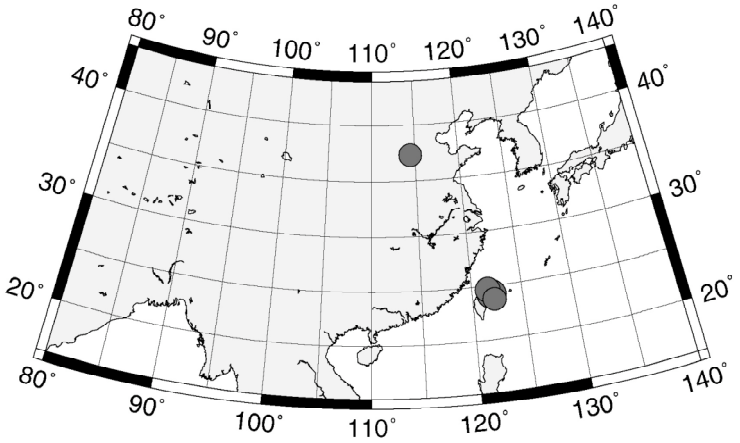
The CDSN has been making quick reports of the moderate to large-size earthquakes, as requested by China Seismological Bureau (CSB) in 1996. According to the requirement, the source parameters such as mechanisms and moment magnitudes of the earthquakes with magnitudes of $M_S \geq 5.5$ in the east of 100°E , with magnitudes of $M_S \geq 6.0$ in the west of 100°E, with magnitudes of $M_L \geq 4.0$ in the area of Beijing, and with magnitudes of $M_S \geq 7.0$ in the neighboring countries must be quickly determined and immediately reported to CSB. It is one of the applications of the CDSN data In 2002, the quick reports of 4 events were made using near-real-time data of CDSN. The parameters of these events are listed in Table 3.

Table 3 The catalog of moderate-large events whose source parameters are determined in 2002

Date y-m-d	Origin time h:m(Local time)	Latitude	Longitude	Magnitude	Region
2002-03-31	14:52	24.18°N	121.98°E	M_S 7.5	Taiwan
2002-04-22	03:34	37.3°N	114.5°E	M_L 5.7	Xintai, Hebei
2002-05-15	11:46	24.6°N	121.6°E	M_S 6.5	Taiwan
2002-07-11	15:36	23.7°N	122.2°E	M_S 5.9	Taiwan

Up to the end of 2002, the source parameters of 46 earthquakes have bee determined, and the results have been reported to CSB.

Figure 3.1 The location of events calculated in 2002



for quick reporting to the CSB

4. NCDSN stations merged into the national seismic network

China Digital Seismograph Network, as a project of Sino-U.S. cooperation, has been playing an important role both in scientific research and in promoting the development of seismic observational system in the Chinese mainland since its establishment in 1986. To be consistent with the other stations of national-level network of CSB, NCDSN stations are fit up the PC-based software DIMAS for station operators to do analysis. One channel of real-time datastream is connected to PC at the stations, which is done by the DMC of CDSN. NCDSN stations have the same configurations as the other stations of the national-level seismic network of CSB, and the waveform signals of NCDSN stations are also available at the national data center of CSB.

5. CDSN Future development

One of the major developments of CDSN will come from the benefit of a five-year project supported by the Ministry of Science and Technology, People's Republic of China. The project has been approved and commenced in April 2002. The execution institution of the project includes Institute of Geophysics, CSB and the Center of Analysis and Prediction, CSB.

The main contents of the project are:

Building the hardware platform of China seismological data near real-time analysis system ;

Building the software platform of China seismological data near real-time analysis system ;

The research in applications of real-time waveform ;

Developing 1 or 2 sets of marine seismograph ;

Carrying out the research in marine seismology ;

International cooperation working like CDSN mode .

The project is planned from 2002 to 2007, the execution of the project was divided into two stages, the first stage is from 2002 to 2004, the second stage is from 2004 to 2007. At present, the development of the project mainly concentrate to the first stage that building software and hardware environment of CDSN/DMC.

References

Chen, Y. T., Zhou, G. W., and Wu, Z. L., 1996. Seismological network in China celebrates first 10 years. *Eos*, *Transactions*, *AGU*, **77** (47): 468

Chen, Y. T., Mu, Q. D., and Zhou, G. W., 1994. The China Digital Seismograph Network. *Annali di Geofisica*, **37** (5): 1049-1053

Zhou, G. W., Chen, Y. T. and Wu, Z. L., 1997. Seismological studies in China using data of the China Digital Seismograph Network (CDSN). *Seismological and Geomagnetic Observation and Research*, **18** (5): 68-79 (in Chinese with English abstract)