



CTBT Beijing National Data Center
Beijing Radionuclide Laboratory

CTBT:
SCIENCE AND
TECHNOLOGY
2017 CONFERENCE

T4.1-07

The Waveform Data Processing System Establishment Based on the Private Cloud Platform

CTBT Beijing National Data Center

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1. Background



CTBT Beijing National Data Center
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- In order to fulfill the obligation of the Treaty, the national data centre(NDC) was established in December, 2005.
- For the purpose of compliance with the CTBT
- Our duty
 - Data collecting and forwarding
 - Data request and transfer
 - Data analysis
 - Technical support
 - Capabilities development

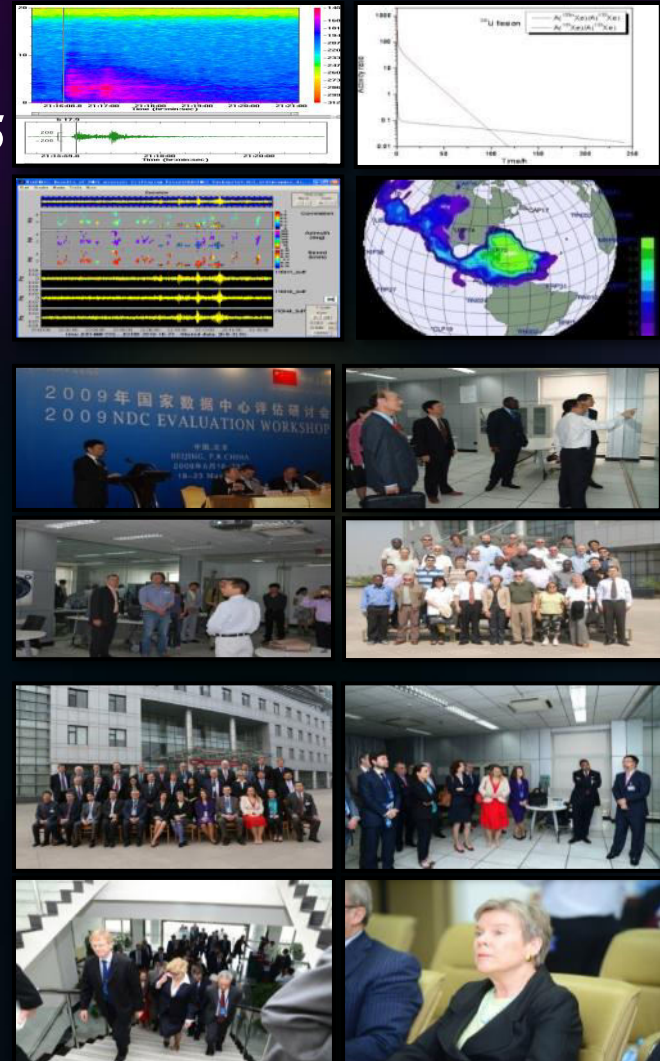


1. Background



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- Participated NPE08-10, NPE12, NPE13, NPE15
- Helped MFA hosted the NDC Workshop 2009 and East Asia Regional NDC Workshop (EARNW) 2016
- Visited by CTBT officers and others
- Helping inner IMS stations Certification and T&E
- Developing waveform data P&A technique



1. Background



2. Structure of Automatic Processing System based on Private Cloud



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Legacy System:

- China NDC data processing system is established in 2005.
- The architecture of data processing software is similar to IDCR3 software.
- The operation system is Solaris, hardware adopts the SPARC platform.

New System:

- Linux OS based on X86 architecture
- Huawei Technologies Co. Ltd. , FusionSphere cloud operating system
- Huawei RH5885 server, S5700 Switcher, OceanStor S5500

2. Structure of Automatic Processing System based on Private Cloud



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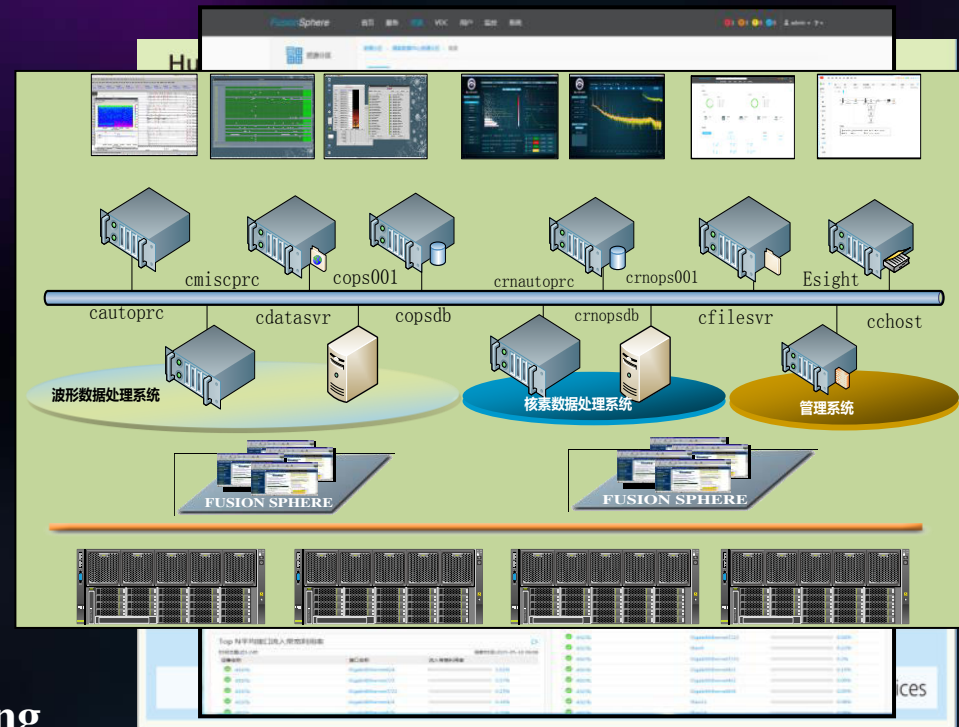
Server Virtualization Platform:

■ Server Virtualization platform based on Huawei hardware and its Cloud OS software.

- ▶ RH5885
- ▶ S5500 Switcher
- ▶ OceanStor
- ▶ Fusion computer
- ▶ Fusion Manager
- ▶ Esight

■ Benefits

- ▶ Cost effective
- ▶ Easy development and extending
- ▶ Convenient O&M



2. Structure of Automatic Processing System based on Private Cloud



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Data processing system based on Virtualization Platform :

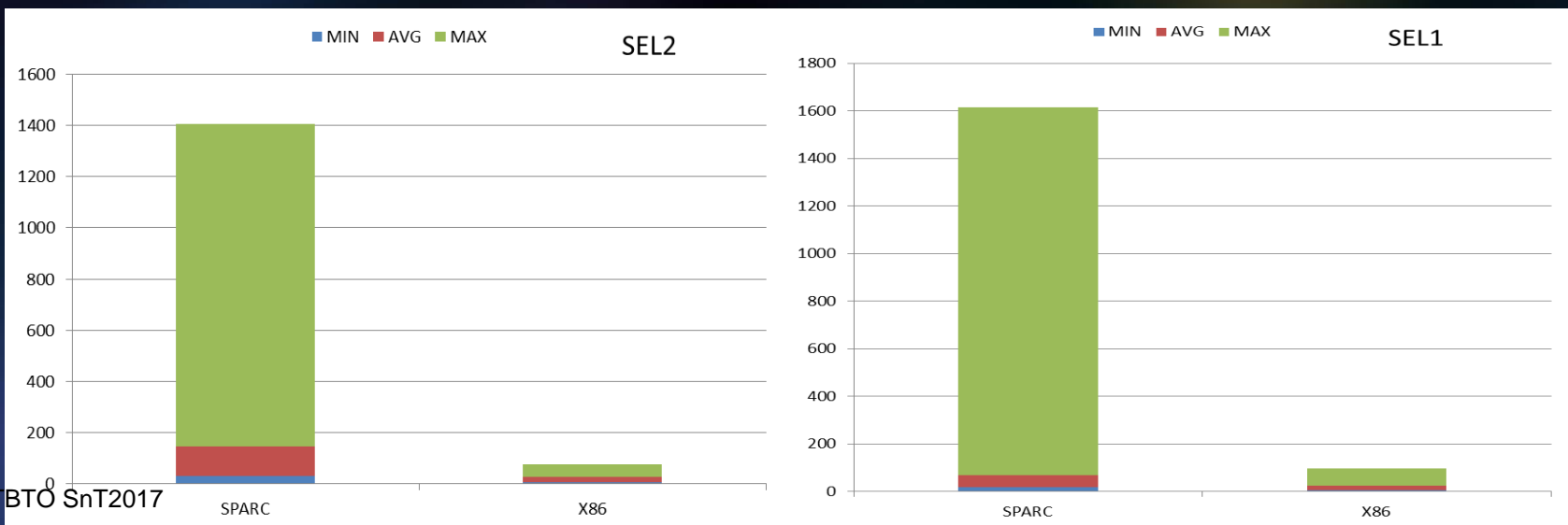
■ Virtualization Machine

- Data receiving、Data processing、Interactive analyzing、Task scheduling、LDAP、system management

- HA type, HyperDP

- Taking Oracle RAC to improve the database reliability.

- Data processing system establishing and testing.



3. Improvement of Processing system



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Tagerts:

The performance of data processing need to be improved to meet the requirements , to fulfill NDC duties better.

Requirements:

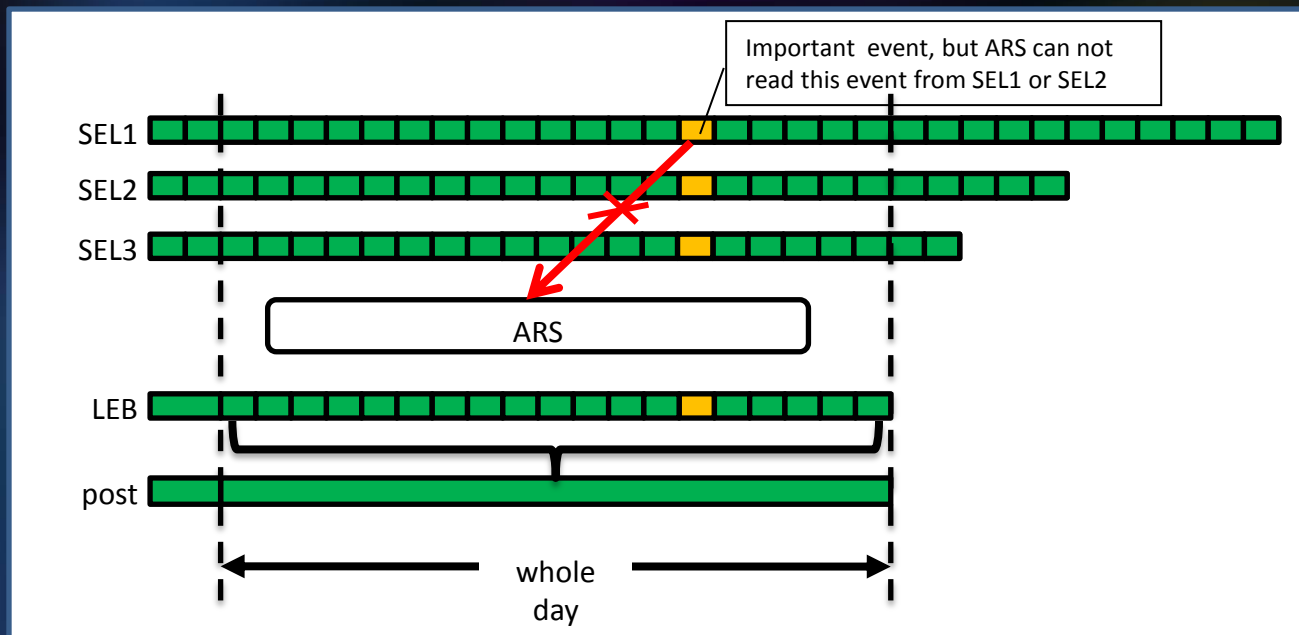
- Optimization of the processing pipeline
- New processing methods
- Data acquisition from different source
-

3. Improvement of Processing system



The Fast Data Processing Flow

- Considering the signal propagation mechanism, the automatic bulletins (SEL1,2,3) have different latency.
- The analyst can't review automatic result in a timely manner.

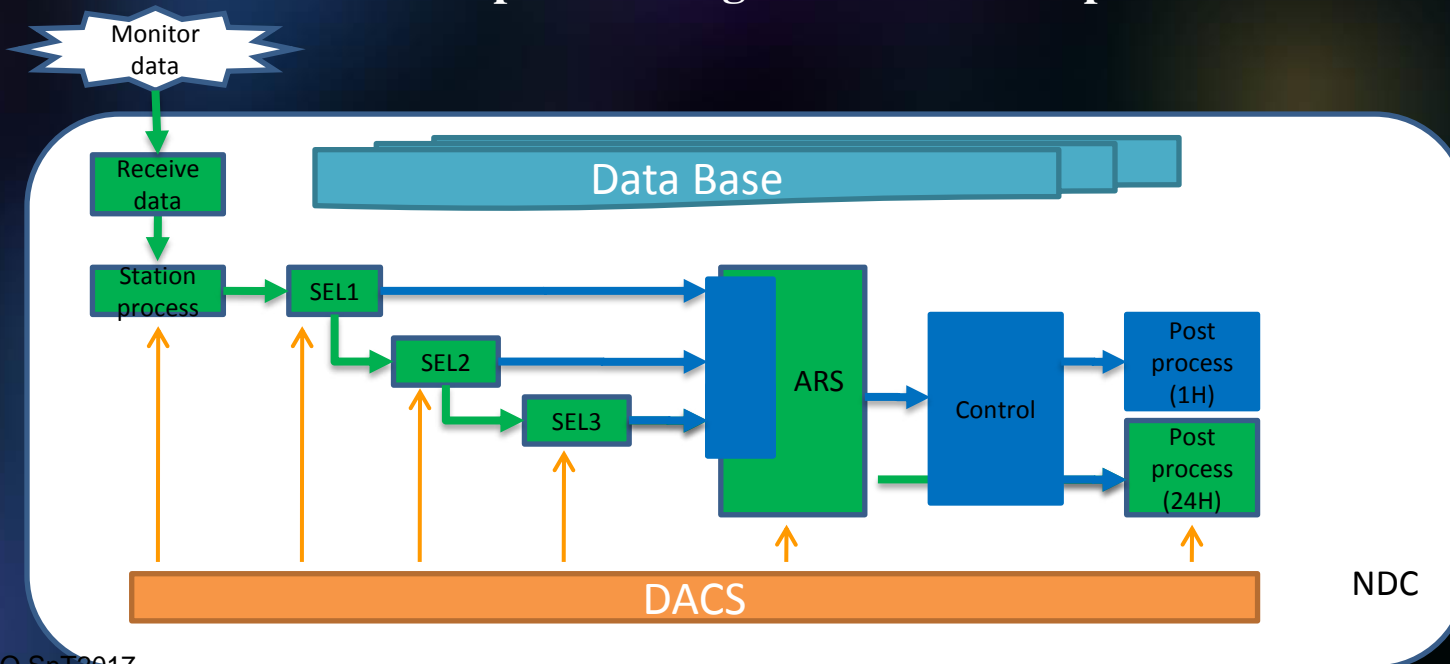


3. Improvement of Processing system



The Fast Data Processing Flow

- The New Processing Flow Control realizes the analyst can interact with results at different network processing stage. And the post-processing also is executed immediately after the analyst reviews.
- The timeliness of the response to urgent events is improved.

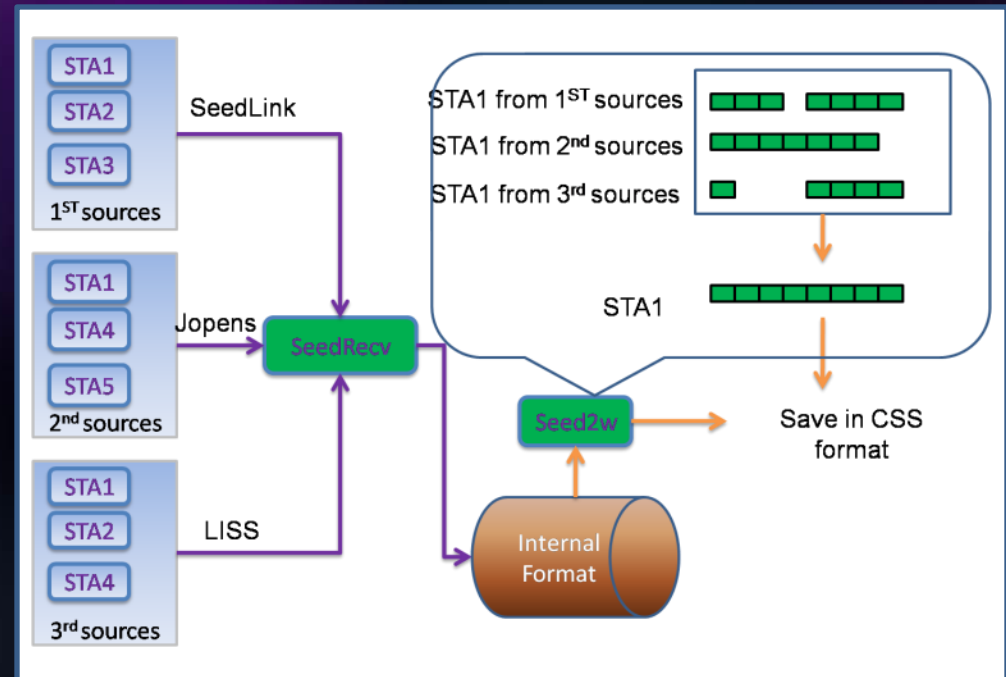


3. Improvement of Processing system



Multiple Source Data Acquisition

- The CD2Server
CD → miniSEED
- SeedRecv and Seed2w
miniSEED → CSS
- SeedRecv supports multiple data fetching methods, such as LISS, SeedLink and Jopens.
- Seed2w reads the formatted miniSEED files, drop the duplication data of each station, reorder data and convert them to CSS.

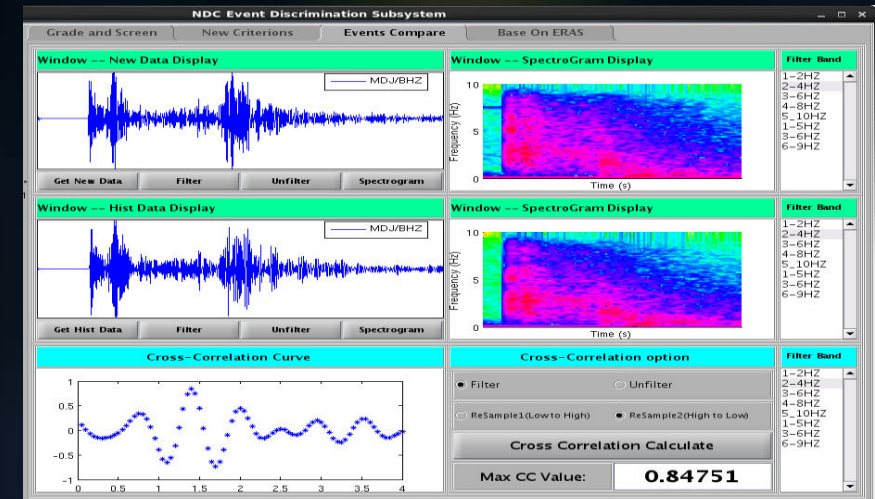
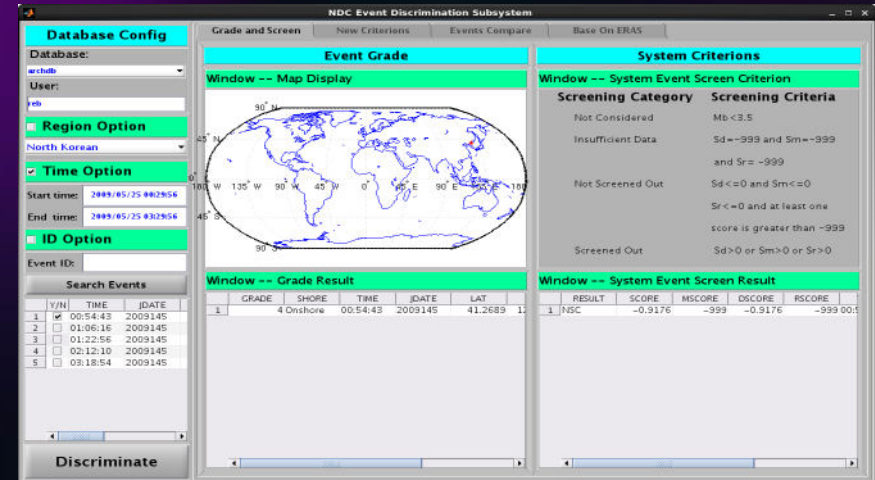


3. Improvement of Processing system



Event Screening Method

- Different spectrum characteristics of nature event and nuclear explosion
- New Event Screening criteria
 - Waveform Complexity
 - Signal Spectrum Ratio
 - Combined ratio
- New Event Screening Software



3. Improvement of Processing system

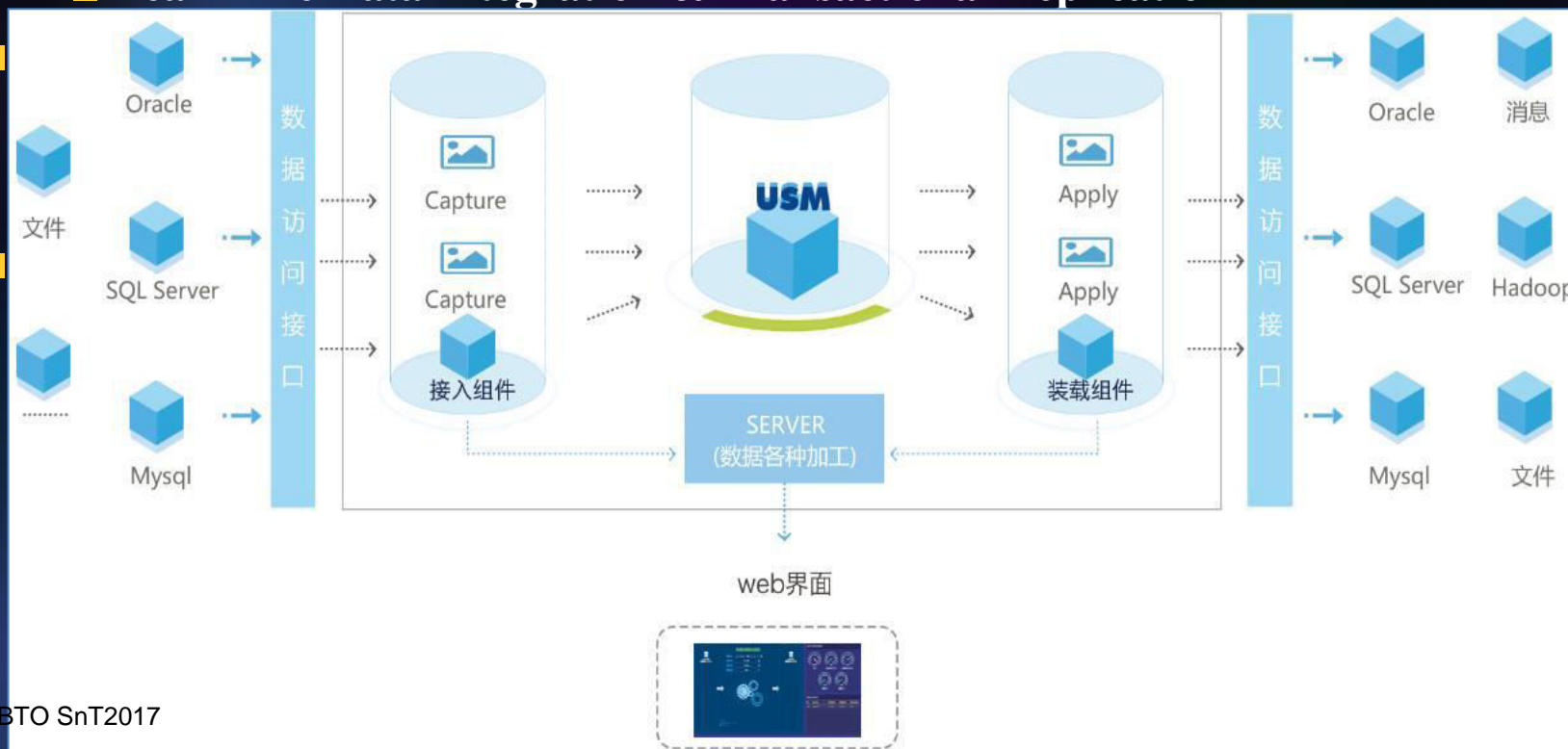


Database Synchronization and Products Archiving

■ R7 DIP

■ Log-based changed Data Capture

■ Real-Time Data Integration & Transactional Replication



4. Monitoring the Operation of System



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Tagerts:

Develop an integrated tool to monitor the status of whole system to

- find any faults of the processing pipeline on time
- reduce the pressure of system maintenance

Requirements:

Centralizing monitoring ...

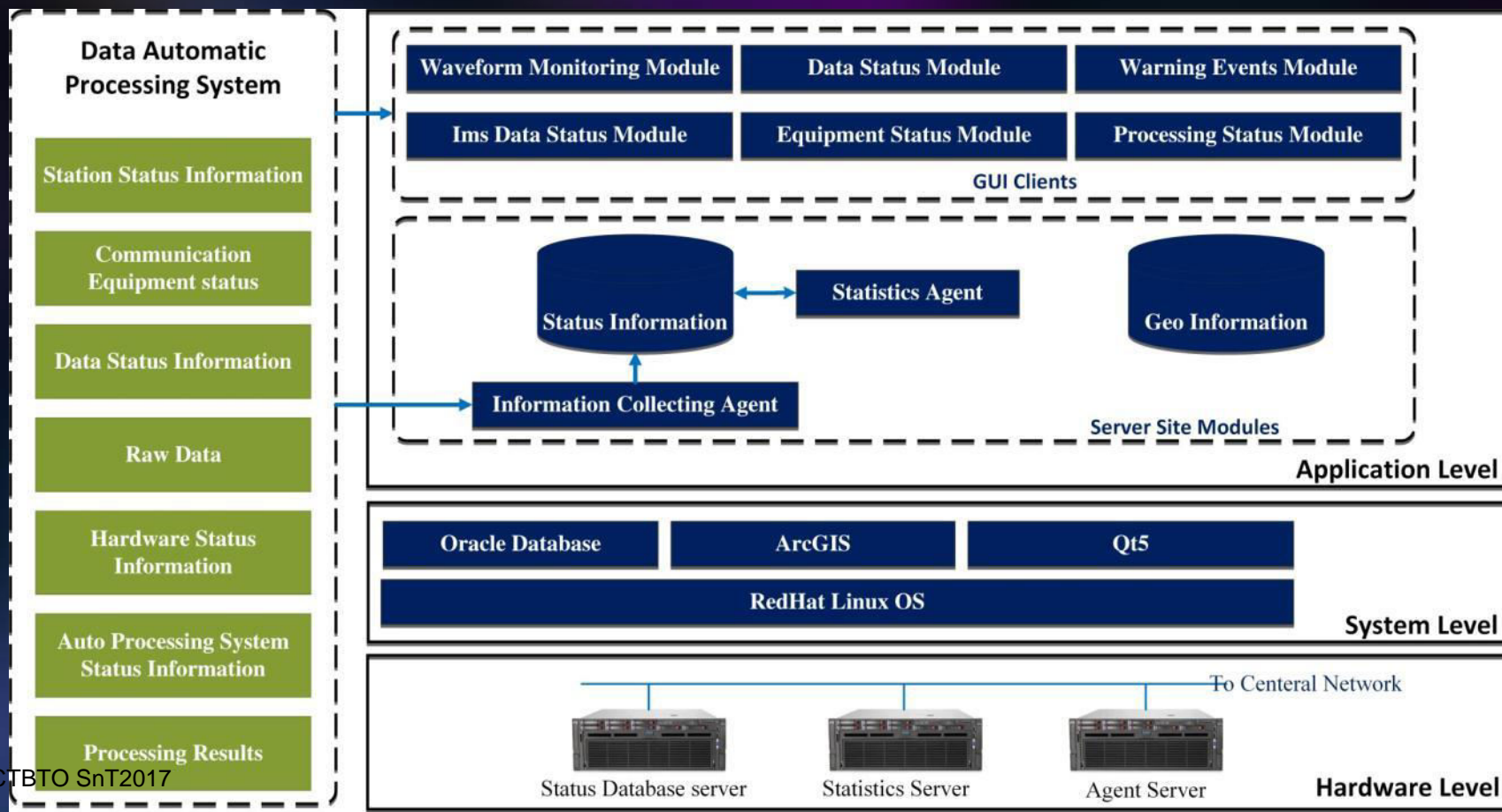
- stations status
- communication system status
- IT equipment's status
- autoprocessing procedure status
- results status
- future needs: monitoring capability status, etc.

4. Monitoring the Operation of System



OMMS:

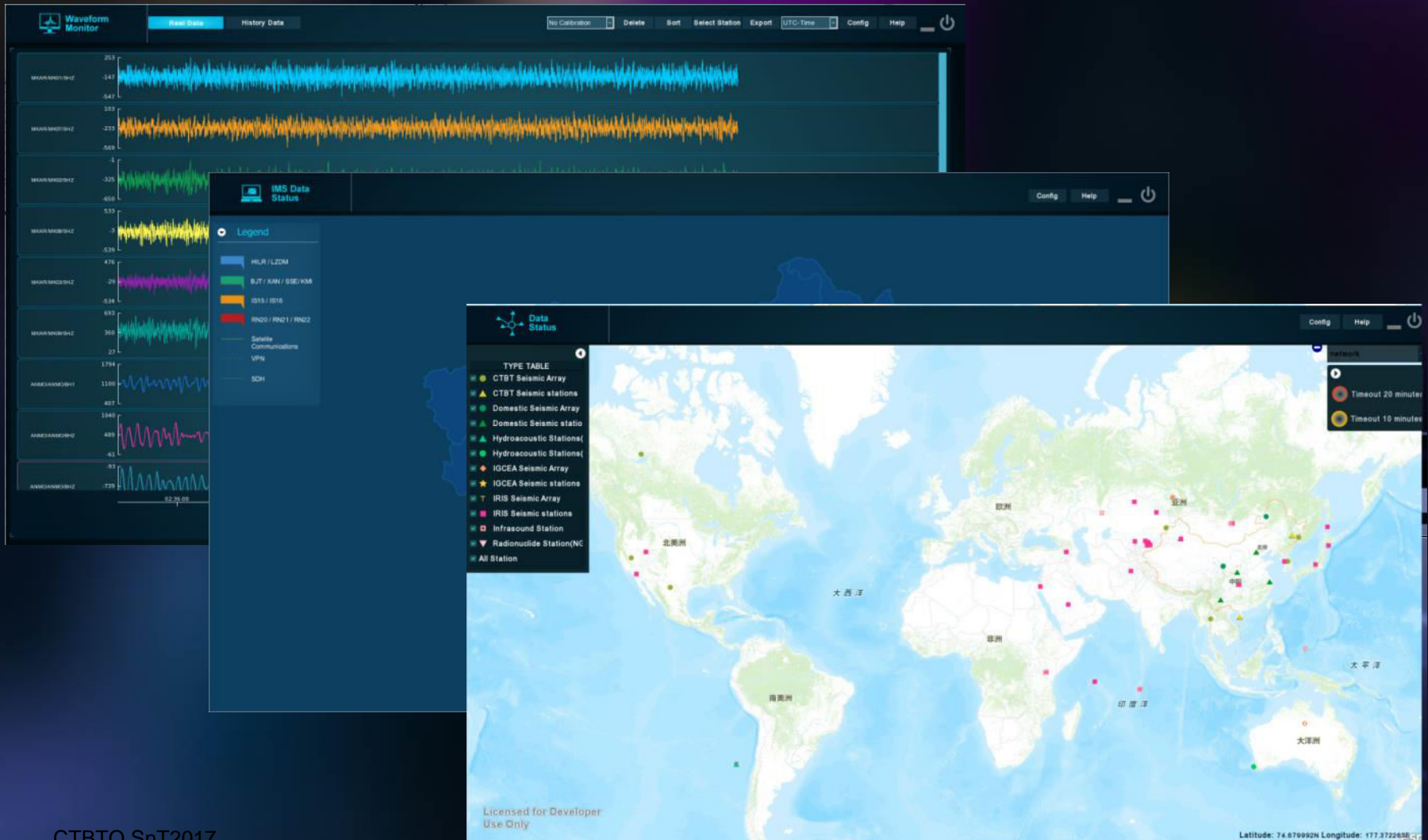
Operation Management and Maintenance Software



4. Monitoring the Operation of System



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4. Monitoring the Operation of System

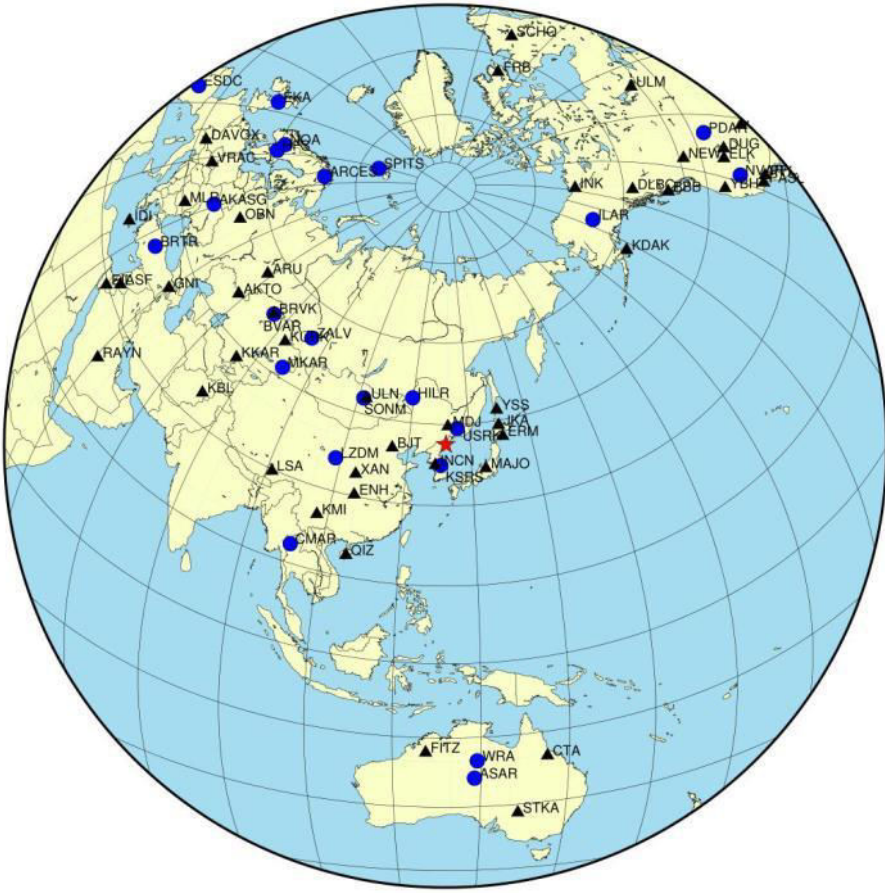


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5. DPRK2016 Events



AlphaList

Sei	orid	evid	lat	lon	depth	sdepth	date and time	mb	ms	ml	majax	minax	strike	sdobs
<input type="checkbox"/>	596052	596051	41.31 N	129.07 E	0.00	--	2016-09-09 00:30:00.958	5.1	--	5.2	8.72	7.68	140.34	0.52

Sei	phase	sta	delta	arid	orid	date and time	tres	td	azi	ares	ad	slow	sres	sd	amp	per	dsnr
<input type="checkbox"/>	Pn	MDJ	3.33	1910057	596052	2016-09-09 00:30:54.350	0.09	d	184	-2.8	n	7.5	-6.3	n	25053.4	0.4	--
<input type="checkbox"/>	Pg	MDJ	3.33	4393317	596052	2016-09-09 00:31:02.000	0.36	d	171	-15.5	n	11.0	-7.2	n	25963.7	0.4	--
<input type="checkbox"/>	Lg	MDJ	3.33	1910058	596052	2016-09-09 00:31:46.799	0.08	d	18	-169.3	n	16.4	-15.4	n	12237.5	0.4	--
<input type="checkbox"/>	Pn	USRK	3.60	1910115	596052	2016-09-09 00:30:57.999	-0.01	d	215	-2.9	n	12.1	-1.7	n	765.2	0.4	--
<input type="checkbox"/>	Pg	USRK	3.60	4393318	596052	2016-09-09 00:31:05.700	-0.93	d	186	-31.7	n	16.9	-1.3	n	1031.3	0.4	--
<input type="checkbox"/>	Pn	KSRS	3.97	1910102	596052	2016-09-09 00:31:03.050	-0.01	d	13	-0.4	n	13.2	-0.6	n	475.5	0.4	--
<input type="checkbox"/>	Pn	INCN	4.27	1910092	596052	2016-09-09 00:31:07.250	0.04	d	30	4.3	n	9.9	-3.8	n	2617.7	0.4	--
<input type="checkbox"/>	Pn	MAJO	8.56	1910125	596052	2016-09-09 00:32:06.249	0.09	d	334	27.4	n	9.0	-4.7	n	294.7	0.5	--
<input type="checkbox"/>	Pn	BJT	9.89	1910080	596052	2016-09-09 00:32:24.750	0.47	d	76	-1.9	n	10.5	-3.2	n	187.7	0.4	--
<input type="checkbox"/>	Pn	JKA	10.35	4393084	596052	2016-09-09 00:32:31.225	0.64	d	--	100.0	n	--	--	n	--	--	--
<input type="checkbox"/>	Pn	HILR	10.52	1910069	596052	2016-09-09 00:32:32.975	-0.00	d	141	2.7	n	13.6	-0.1	n	117.7	0.4	--
<input type="checkbox"/>	Pn	ERM	10.57	1910123	596052	2016-09-09 00:32:35.349	1.74	d	210	-60.6	n	10.0	-3.7	n	1053.9	0.6	--
<input type="checkbox"/>	Pn	YSS	11.34	1910127	596052	2016-09-09 00:32:45.799	0.07	d	202	-43.1	n	8.0	-5.6	n	259.0	0.4	--
<input type="checkbox"/>	Pn	ULN	16.97	1910113	596052	2016-09-09 00:34:00.150	0.41	d	96	-8.4	n	10.7	-1.9	n	61.3	0.6	--
<input type="checkbox"/>	Pn	SONM	17.39	4393095	596052	2016-09-09 00:34:05.360	0.35	d	108	4.3	n	11.8	-0.6	n	11.2	0.7	--
<input type="checkbox"/>	PcP	SONM	17.39	4393098	596052	2016-09-09 00:38:46.579	0.17	d	172	68.3	n	2.8	1.2	n	2.7	0.5	--
<input type="checkbox"/>	P	XAN	17.50	1910119	596052	2016-09-09 00:34:08.200	1.73	d	124	64.4	n	6.0	-6.5	n	42.3	0.5	--
<input type="checkbox"/>	P	ENH	19.28	4393316	596052	2016-09-09 00:34:27.400	0.16	d	50	-0.1	n	7.9	-3.1	n	319.3	0.8	--
<input type="checkbox"/>	P	LZDM	20.49	1910153	596052	2016-09-09 00:34:42.724	1.93	d	--	-68.2	n	--	--	n	49.2	0.7	--
<input type="checkbox"/>	P	KMI	27.16	1910139	596052	2016-09-09 00:35:46.299	0.03	d	23	-24.3	n	6.2	-2.8	n	12.9	0.7	--
<input type="checkbox"/>	P	QIZ	27.61	1910148	596052	2016-09-09 00:35:50.200	0.09	d	27	-5.7	n	7.7	-1.3	n	1.4	0.3	--
<input type="checkbox"/>	P	ZALV	31.85	1910158	596052	2016-09-09 00:36:27.474	0.14	d	99	4.2	n	8.7	-0.1	n	7.5	0.6	--
<input type="checkbox"/>	PcP	ZALV	31.85	1910161	596052	2016-09-09 00:39:17.174	-0.53	d	78	-16.9	n	1.0	-1.7	n	12.2	0.7	--
<input type="checkbox"/>	P	LSA	32.74	1910146	596052	2016-09-09 00:36:36.199	0.28	d	125	66.0	n	3.5	-5.3	n	55.7	0.5	--
<input type="checkbox"/>	P	MKAR	33.66	1910193	596052	2016-09-09 00:36:43.474	0.16	d	89	7.5	n	9.5	0.8	n	9.8	0.6	--
<input type="checkbox"/>	PcP	MKAR	33.66	1910197	596052	2016-09-09 00:39:22.224	-0.72	d	60	-22.5	n	1.8	-1.0	n	0.5	0.3	--
<input type="checkbox"/>	P	CMAR	34.37	1910162	596052	2016-09-09 00:36:49.750	0.15	d	28	-4.5	n	8.7	0.8	n	24.8	0.8	--
<input type="checkbox"/>	PcP	CMAR	34.37	1910164	596052	2016-09-09 00:39:25.000	-0.33	d	19	14.4	n	2.0	-0.1	n	2.1	0.7	--
<input type="checkbox"/>	P	KURK	35.71	1910173	596052	2016-09-09 00:37:00.950	0.06	d	89	3.5	n	6.6	-2.0	n	620.0	0.8	--
<input type="checkbox"/>	PcP	KURK	35.71	1910177	596052	2016-09-09 00:39:28.150	-0.58	d	--	-86.1	n	--	--	n	249.2	0.7	--
<input type="checkbox"/>	P	RVAR	40.48	4393068	596052	2016-09-09 00:37:41.099	0.07	d	86	3.5	n	8.8	0.6	n	5.3	0.6	--

Hide Undisplay All Undisplay Resize Help Default Map QC BullQC Xik Time n Az+Slo n Unzf Save Locate

There are 72 seismic stations used for DPRK 20160909 event analysis, most of Stations from IMS, others from IRIS and CDSN.

5. DPRK2016 Events

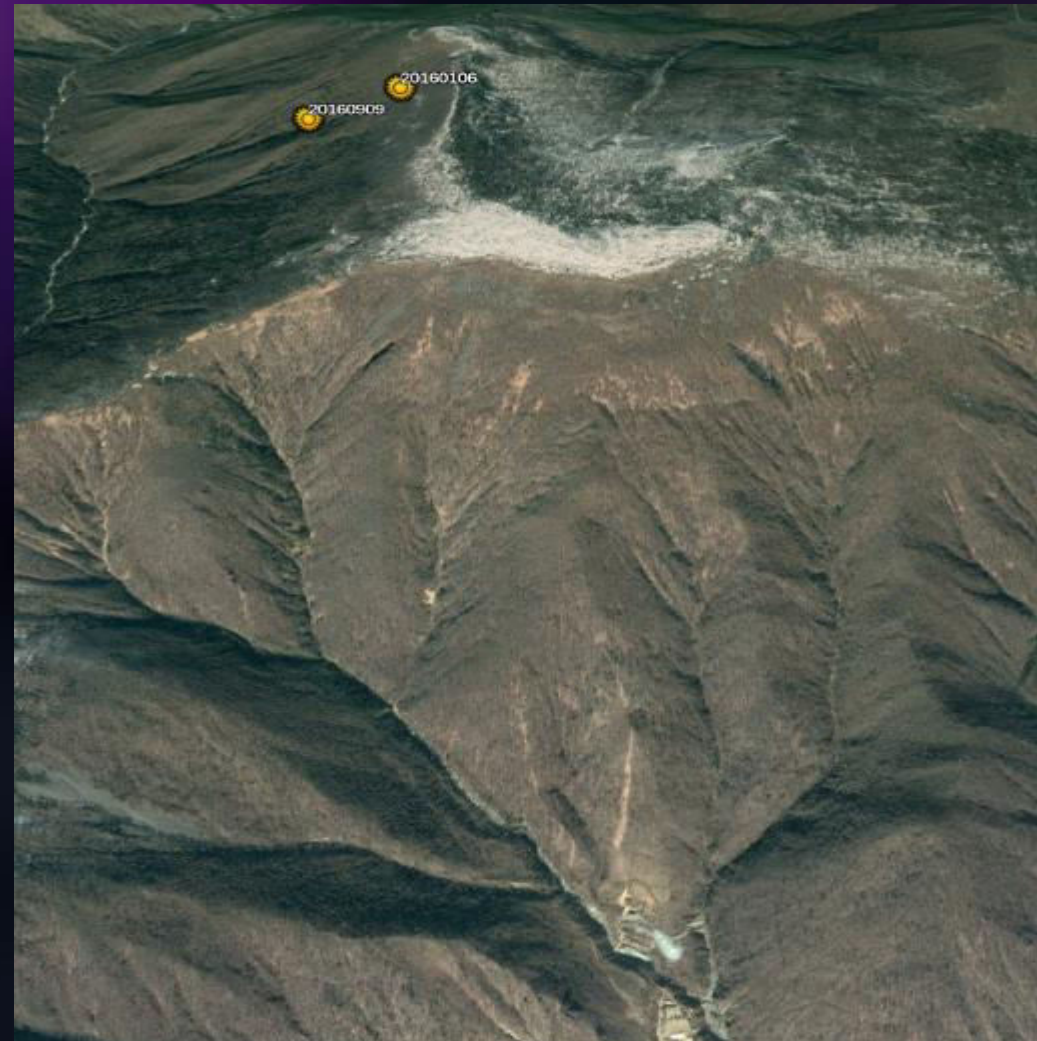


Magnitude Arrivals

Station Magnitudes												
Td	M/A	D/N	D/E	Station	Phase	Amptype	Delta	S	F	R	mb_av	mlppn
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	XAN	P	AS12	17.50	5.28	5.25	3.85	0.19	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	ENH	P	AS12	19.28	5.68	5.66	4.02	0.59	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	KMI	P	AS12	27.16	4.92	4.90	4.28	-0.17	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	QIZ	P	AS12	27.62	4.36	4.34	5.40	-0.73	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	ZALV	P	AS12	31.85	4.78	4.77	4.56	-0.30	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	LSA	P	AS12	32.74	5.67	5.65	5.78	0.58	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	MKAR	P	AS12	33.66	4.86	4.85	4.76	-0.22	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	CMAR	P	AS12	34.37	5.14	5.12	4.20	0.05	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	KURK	P	AS12	35.65	6.54	6.52	3.96	1.46	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	BVAR	P	AS12	40.48	4.60	4.58	5.49	-0.49	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	BRVK	P	AS12	40.54	6.06	6.04	6.07	0.97	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	KKAR	P	AS12	42.65	4.12	4.10	0.48	-0.97	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	ARU	P	AS12	46.65	5.10	5.08	5.35	0.01	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	KBL	P	AS12	47.01	4.64	4.62	5.05	-0.45	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	AKTO	P	AS12	48.55	4.84	4.82	4.39	-0.25	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	ILAR	P	AS12	51.12	5.28	5.26	2.57	0.19	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	SPITS	P	AS12	54.30	4.73	4.71	4.89	-0.36	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	INK	P	AS12	54.95	5.13	5.11	5.24	0.04	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	DLBC	P	AS12	61.03	4.79	4.77	3.97	-0.30	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	WRA	P	AS12	61.13	5.24	5.22	4.55	0.15	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	GNI	P	AS12	61.35	4.99	4.97	4.66	-0.10	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	ASAR	P	AS12	64.80	5.03	5.01	4.45	-0.05	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	AKASG	P	AS12	64.81	5.50	5.48	4.47	0.41	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	BBB	P	AS12	65.46	4.77	4.75	4.72	-0.32	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	HFS	P	AS12	65.93	5.29	5.27	3.90	0.20	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	NOA	P	AS12	66.22	5.20	5.18	4.72	0.11	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	BRTR	P	AS12	68.67	4.92	4.90	5.20	-0.17	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	MLR	P	AS12	69.69	5.10	5.08	4.62	0.01	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	RAYN	P	AS12	70.22	5.94	5.92	4.43	0.85	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	VRAC	P	AS12	72.02	5.50	5.48	5.10	0.41	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	NEW	P	AS12	73.38	4.83	4.82	4.59	-0.25	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	STKA	P	AS12	73.73	5.00	4.98	4.63	-0.09	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	EIL	P	AS12	73.93	4.28	4.26	5.22	-0.80	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	FRB	P	AS12	74.36	5.69	5.67	6.39	0.60	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	EKA	P	AS12	75.50	5.31	5.29	3.72	0.22	--
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D	IDI	P	AS12	76.86	5.31	5.29	3.66	0.22	--

Sort by: Magtype / Delta

Hide Help

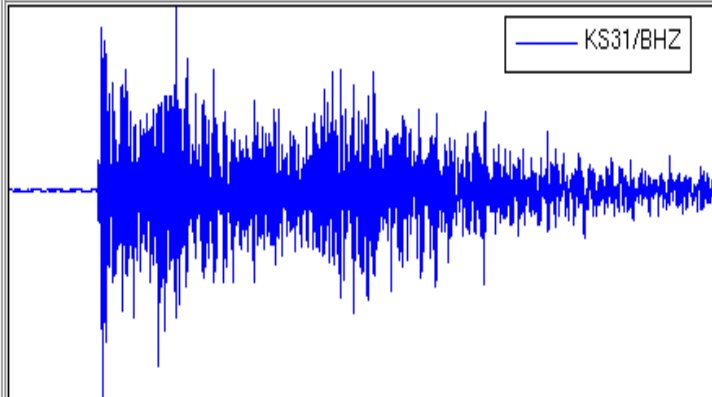


5. DPRK2016 Events



Window -- Display Data of Selected Sta

KS31/BHZ



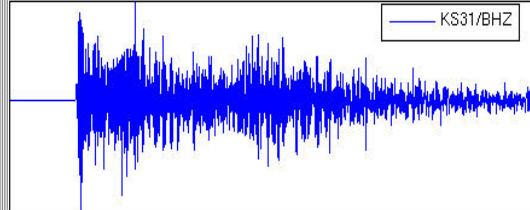
Window -- New Criterions Discrimination Info

	Criterion	Prob.EQ	Prob.EX	Prob.UN	Conclusion
1	Complexity	53.4429%	12.7726%	33.7845%	Earthquake
2	SR	3.3616%	79.5821%	17.0563%	Explosion
3	SRC	1.6121%	80.994%	17.3939%	Explosion
4	Fusion	5.1076%	92.7438%	2.1486%	Explosion

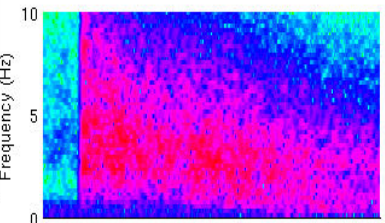
New Criterions Dis. Result: Explosion

Window -- New Data Display

KS31/BHZ



Window -- SpectroGram Display

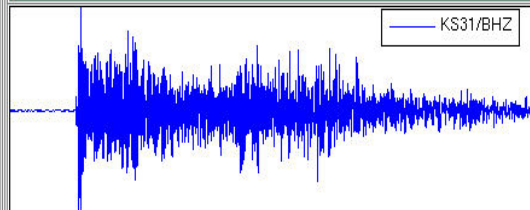


Filter Band

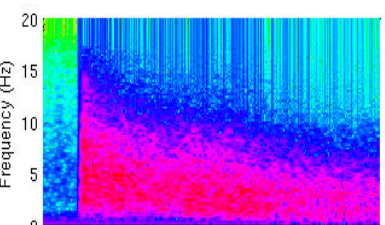
- 1-2HZ
- 2-4HZ
- 3-6HZ
- 4-8HZ
- 5_10HZ
- 1-5HZ
- 3-6HZ
- 6-9HZ

Window -- Hist Data Display

KS31/BHZ



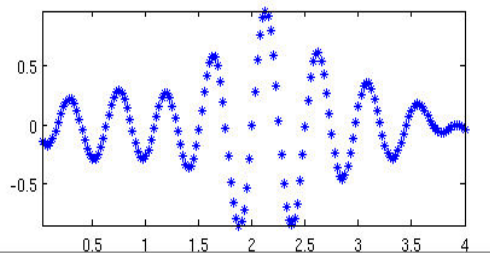
Window -- SpectroGram Display



Filter Band

- 1-2HZ
- 2-4HZ
- 3-6HZ
- 4-8HZ
- 5_10HZ
- 1-5HZ
- 3-6HZ
- 6-9HZ

Cross-Correlation Curve



Cross-Correlation option

Filter
 Unfilter

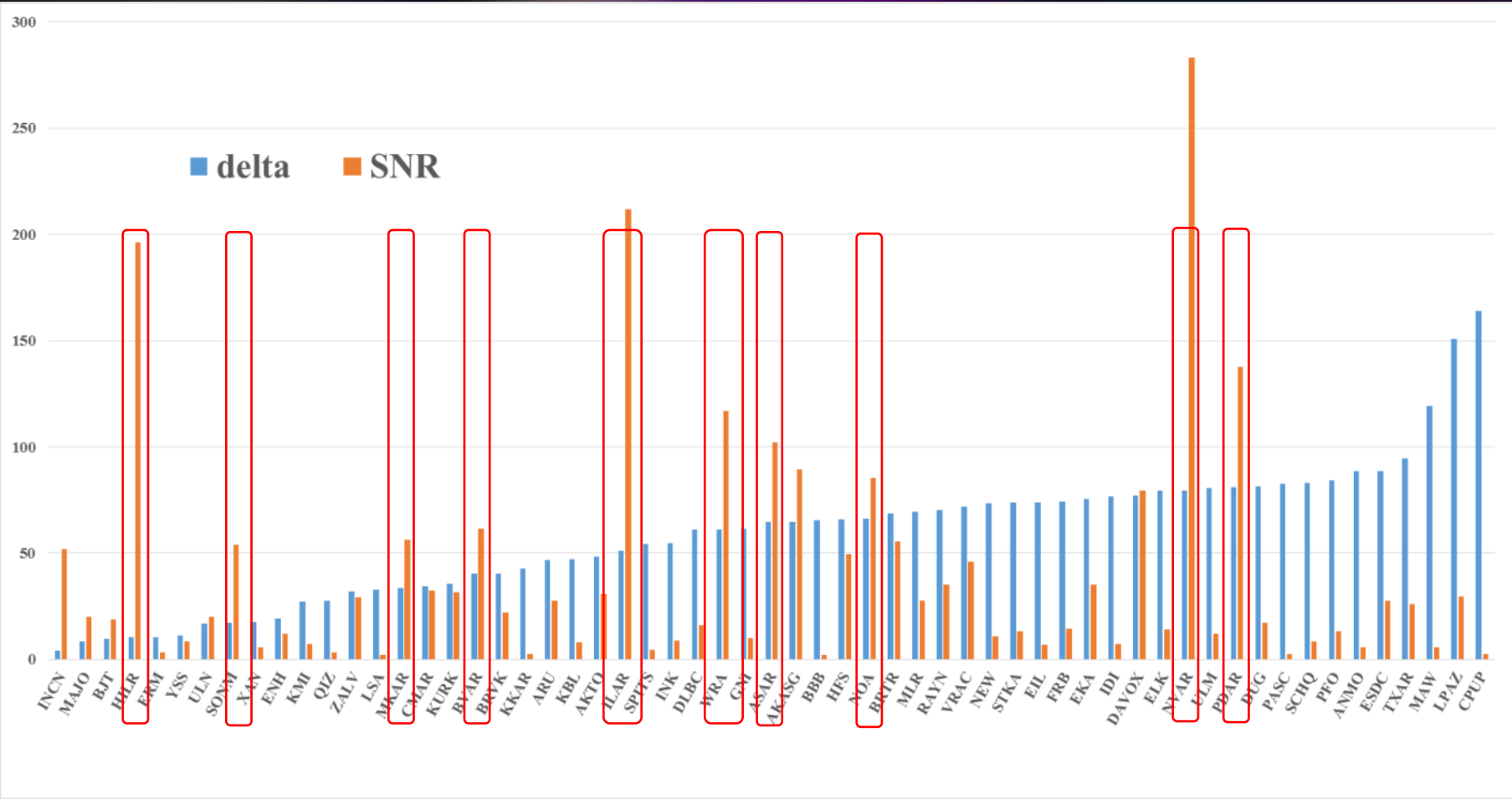
ReSample1(Low to High)
 ReSample2(High to Low)

Max CC Value:

0.96928



5. DPRK2016 Events



Distribution of delta and SNR of stations associated by DPRK 20160909 event

5. DPRK2016 Events



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Amplitude Ratio between 2016-2 and 2013 Amplitude Ratio between 2016-2 and 2016-1

sta	phase	amp of 2013	amp of 2016-2	ratio of amp	ratio of energy
ASAR	P	12.69	15.40	1.21	1.29
BRTR	P	3.00	8.13	2.71	3.77
BRVK	P	147.94	191.70	1.30	1.41
CMAR	P	23.88	24.80	1.04	1.05
DUG	P	4.23	6.85	1.62	1.90
HILR	Pn	72.62	117.70	1.62	1.90
ILAR	P	15.73	26.87	1.71	2.04
KMI	P	9.50	12.91	1.36	1.50
KSRS	Pn	393.35	475.54	1.21	1.29
MKAR	P	7.15	9.83	1.38	1.53
NVAR	P	25.88	40.47	1.56	1.81
PDAR	P	9.77	13.84	1.42	1.59
TXAR	P	2.16	3.28	1.52	1.75
USRK	Pn	520.31	765.18	1.47	1.67
XAN	P	29.59	42.28	1.43	1.61
ZALV	P	4.77	7.54	1.58	1.84
AVERAGE					1.75
STD					0.58

sta	phase	amp of 2016-1	amp of 2016-2	ratio of amp	ratio of energy
BRTR	P	4.68	8.13	1.74	2.09
BRVK	P	87.51	191.70	2.19	2.84
CMAR	P	14.98	24.80	1.66	1.96
DUG	P	3.80	6.85	1.81	2.19
HILR	Pn	63.93	117.70	1.84	2.25
ILAR	P	14.22	26.87	1.89	2.33
KMI	P	6.97	12.91	1.85	2.27
KSRS	Pn	353.24	475.54	1.35	1.49
MKAR	P	5.43	9.83	1.81	2.20
NVAR	P	24.13	40.47	1.68	1.99
PDAR	P	7.92	13.84	1.75	2.10
TXAR	P	1.90	3.28	1.73	2.07
USRK	Pn	565.20	765.18	1.35	1.50
USRK	Pg	455.61	840.25	1.84	2.26
XAN	P	27.19	42.28	1.55	1.80
ZALV	P	3.63	7.54	2.08	2.65
AVERAGE					2.12
STD					0.34



Summary and Discussion

- ◆ **Based on X86 architecture and Huawei ICT hardware, includes servers, switches and storages, integrated Private Cloud solution is satisfied with our data processing requests.**
- ◆ **Migrated our system to Linux, and made some improvements to data processing system.**
- ◆ **Adopted the C/S architecture and QT tools based on GIS system, we developed OMMS software, which realized real-time monitoring the whole system, include stations, communications, servers, storages, processing procedures and results.**
- ◆ **Based on the data from IMS, IRIS and CDSN, analyzed the 2016 DPRK events, the two events located in the same mountain and are not far away, the field of the last one is almost twice of the 2016.01, and 1.75 times of the 2013, and all of them should be manmade explosions.**

Thanks for your attention!



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