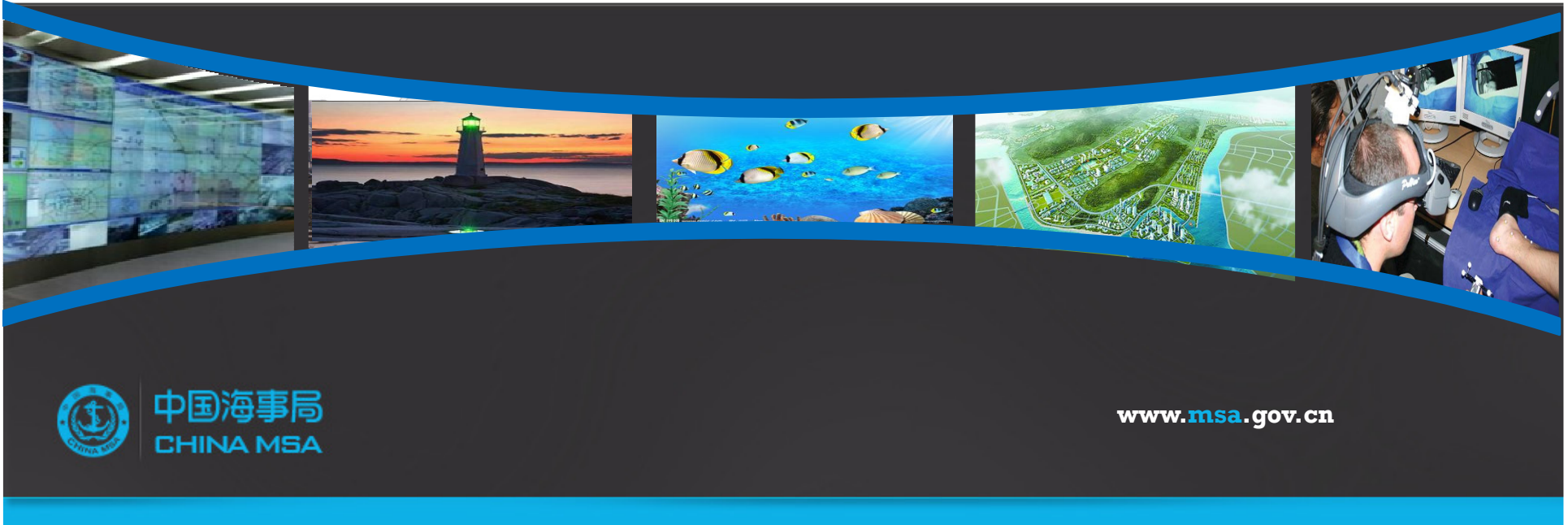




# China VDES Testbed System Report

---



中国海事局  
CHINA MSA

[www.msa.gov.cn](http://www.msa.gov.cn)

The e-Navigation concept was first introduced on the MSC81 (MSC: Maritime Safety Committee) in 2005. It was pointed out that IMO should finish the research on the e-Nav developing strategy in 2008, expecting to involve new technologies under this strategy.

The new technologies should work together with the current Navigation aids technologies and services, thus maximizing the benefits of these services.

The government of China actively takes part in this new strategy. The construction of e-Nav illustration project has been put into the basket of nation's prior projects.



The China MSA would force the support on the development of e-Nav strategy. By supporting this strategy, China would remain competent in the realm of navigation security services. Additionally, it is coherent with the idea of The Belt and Road Initiatives to promote cooperation among nations under an international frame.

In 2016, Tianjin Communication Center, together with the Beijing Caton Global, took the responsibility of setting up a VDES Testbed system in China, while aimed at verifying the realizability of this system, and solving the relevant technical issues.

Tianjin Communication Center(under the Northern Sea Security Authority) is located in Bohai Gulf, with several ports nearby.

The communication center owns VHF data transceiving stations and data exchange centers, making the transceiving and data exchanging of VDES information convenient.

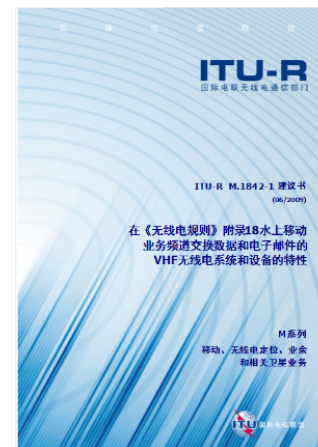
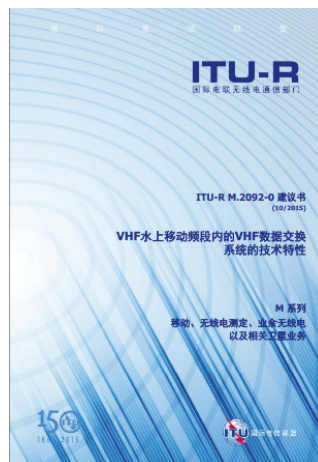


# References:

# Situation of VDES Research

## References:

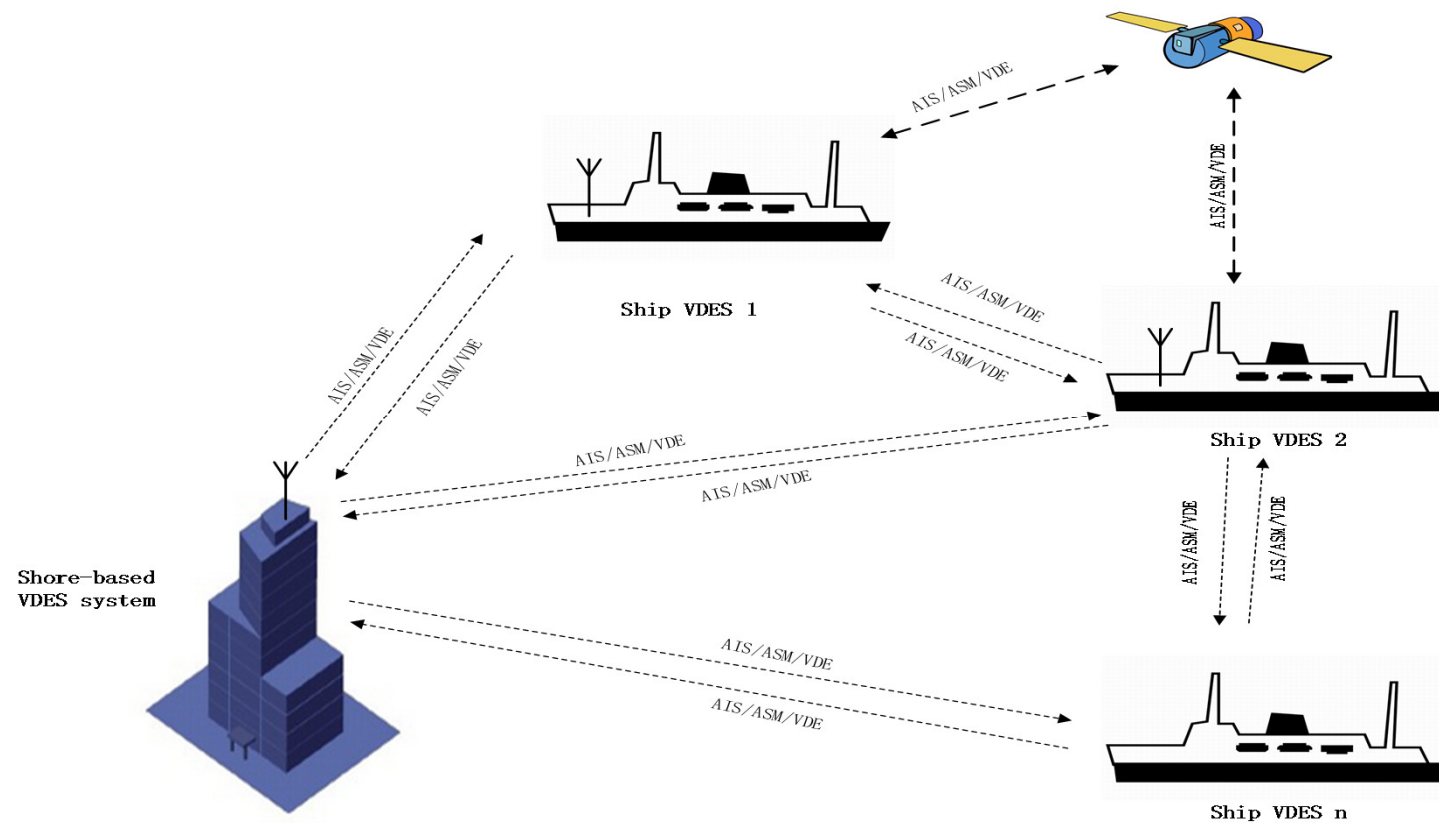
- 1、《ITU-R M.2092-0 Recommendations(10/2015) 》
- 2、《ITU-R M.1371-4 Recommendations ( 04/2010) 》
- 3、《ITU-R M.1842-1 Recommendations ( 06/2009) 》



中国海事局  
CHINA MSA



地址：北京市建国门内大街11号



## VDES application infrastructure



中国海事局  
CHINA MSA

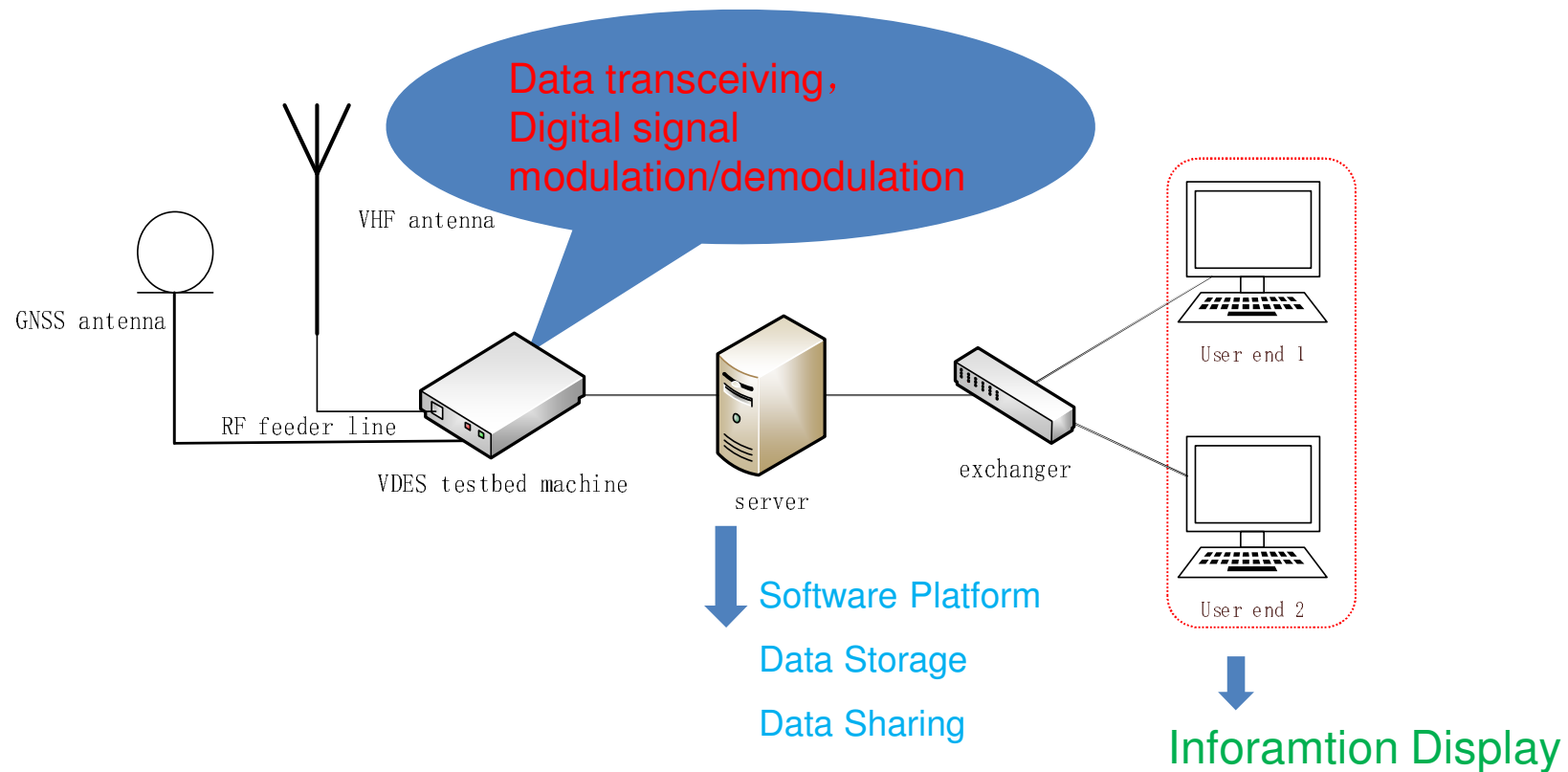


地址：北京市建国门内大街11号



# Situation of VDES Research

## Shore-based VDES infrastructure



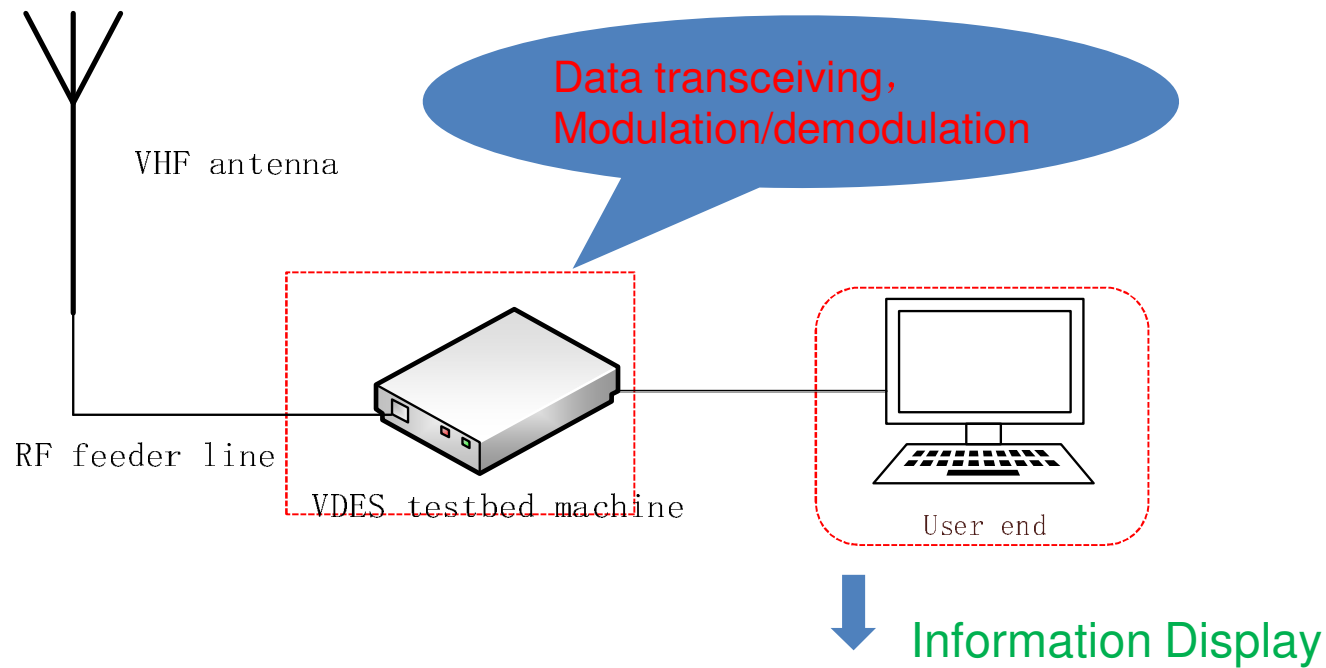
中国海事局  
CHINA MSA



地址：北京市建国门内大街11号

# Situation of VDES Research

## Ship-based VDES Infrastructure



中国海事局  
CHINA MSA

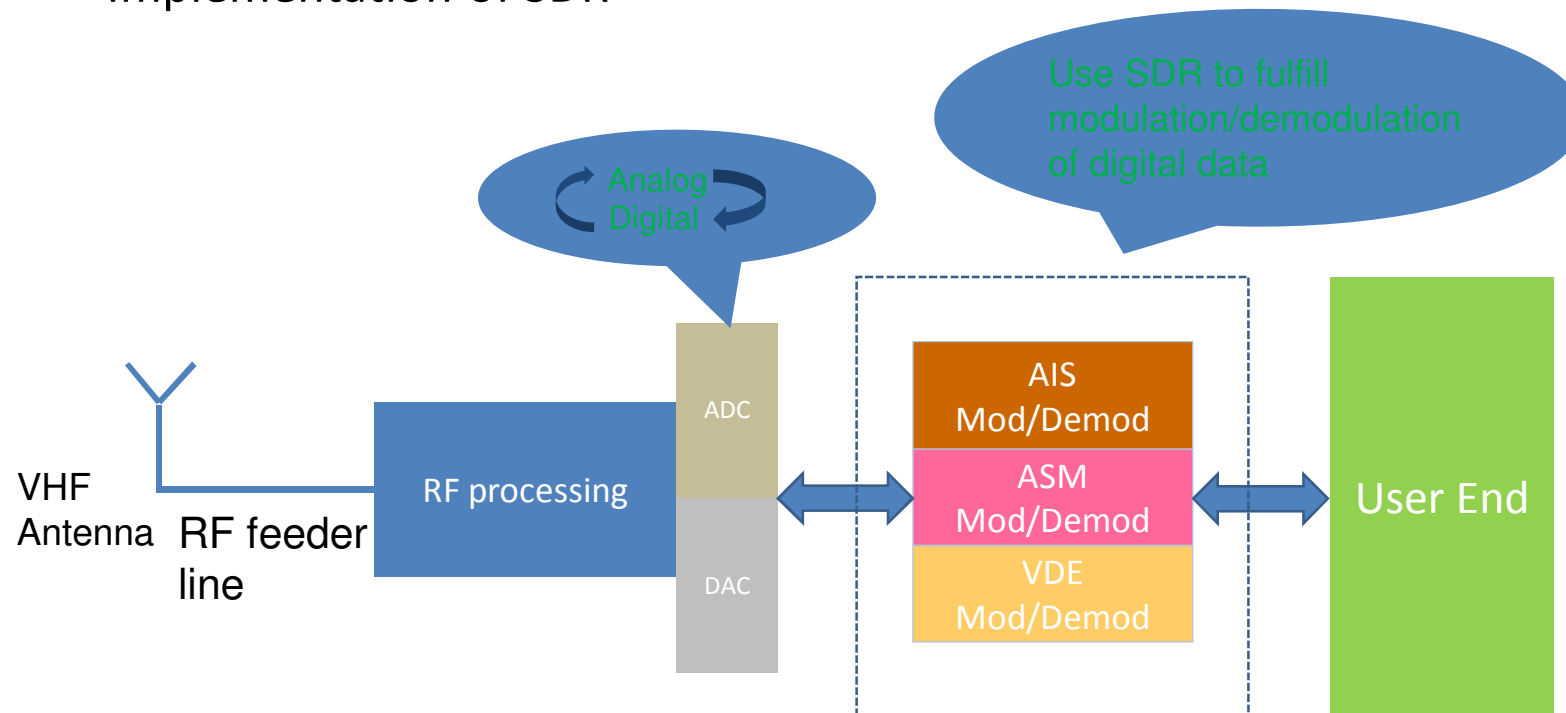


地址：北京市建国门内大街11号



# Situation of VDES Research

## Implementation of SDR



# Situation of VDES Research

## Operating Frequencies and Bandwidths

| Operating Modes | Operating Frequencies | Bandwidths   |
|-----------------|-----------------------|--------------|
| AIS             | 161.975MHz            | 25KHz        |
|                 | 162.025MHz            |              |
| LAIS            | 161.775MHz            | 25KHz        |
|                 | 156.825MHz            |              |
| ASM             | 161.950MHz            | 25KHz        |
|                 | 162.000MHz            |              |
| VDE             | 157.200/161.800MHz    | 25/50/100KHz |
|                 | 157.225/161.825MHz    |              |
|                 | 157.250/161.850MHz    |              |
|                 | 157.275/161.875MHz    |              |
|                 | 157.300/161.900MHz    |              |
|                 | 157.325/161.825MHz    |              |



中国海事局  
CHINA MSA



地址：北京市建国门内大街11号

## Networking of VDES System

### Access Modes

- 1、CSTDMA: Carrier Sense Time Division Multiple Access
- 2、SOTDMA: Self-organized time division multiple access
- 3、ITDMA: Incremental Time Division Multiple Accesss
- 4、RATDMA: Random Access Time Division Multiple Access
- 5、FATDMA: Fixed Access Time Division Multiple Access



# Situation of VDES Research

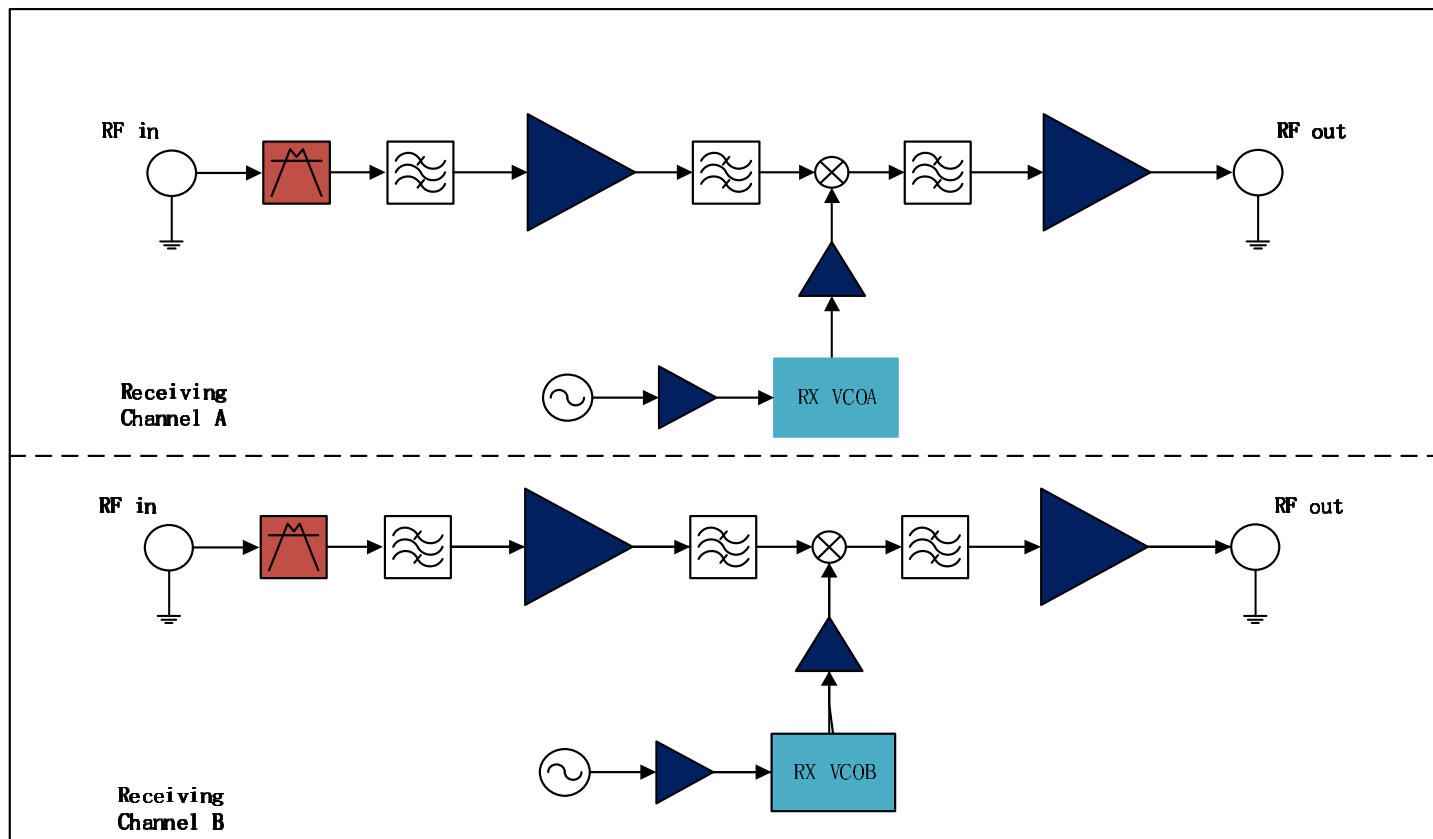
## Design of VDES Transceiver

| VDES Transceiver |                    |              |             |               |              |             |
|------------------|--------------------|--------------|-------------|---------------|--------------|-------------|
| Modes            | Frequencies        | Bandwidths   | Speed       | Modulation    | Output Power | Sensitivity |
| AIS              | 161.975MHz         | 25KHz        | 9600bit/s   | GMSK          | 50W          | -107dBm     |
|                  | 162.025MHz         |              |             |               |              |             |
| LAIS             | 161.775MHz         | 25KHz        | 9600bit/s   | GMSK          | 50W          | -107dBm     |
|                  | 156.825MHz         |              |             |               |              |             |
| ASM              | 161.950MHz         | 25KHz        | 19200bit/s  | $\pi/4$ DQPSK | 50W          | -107dBm     |
|                  | 162.000MHz         |              |             |               |              |             |
| VDE              | 157.200/161.800MHz | 25/50/100KHz | 307.2Kbit/s | FMT           | 50W          | -107dBm     |
|                  | 157.225/161.825MHz |              |             |               |              |             |
|                  | 157.250/161.850MHz |              |             |               |              |             |
|                  | 157.275/161.875MHz |              |             |               |              |             |
|                  | 157.300/161.900MHz |              |             |               |              |             |
|                  | 157.325/161.825MHz |              |             |               |              |             |



# Situation of VDES Research

## Two parallel Receiving Channels



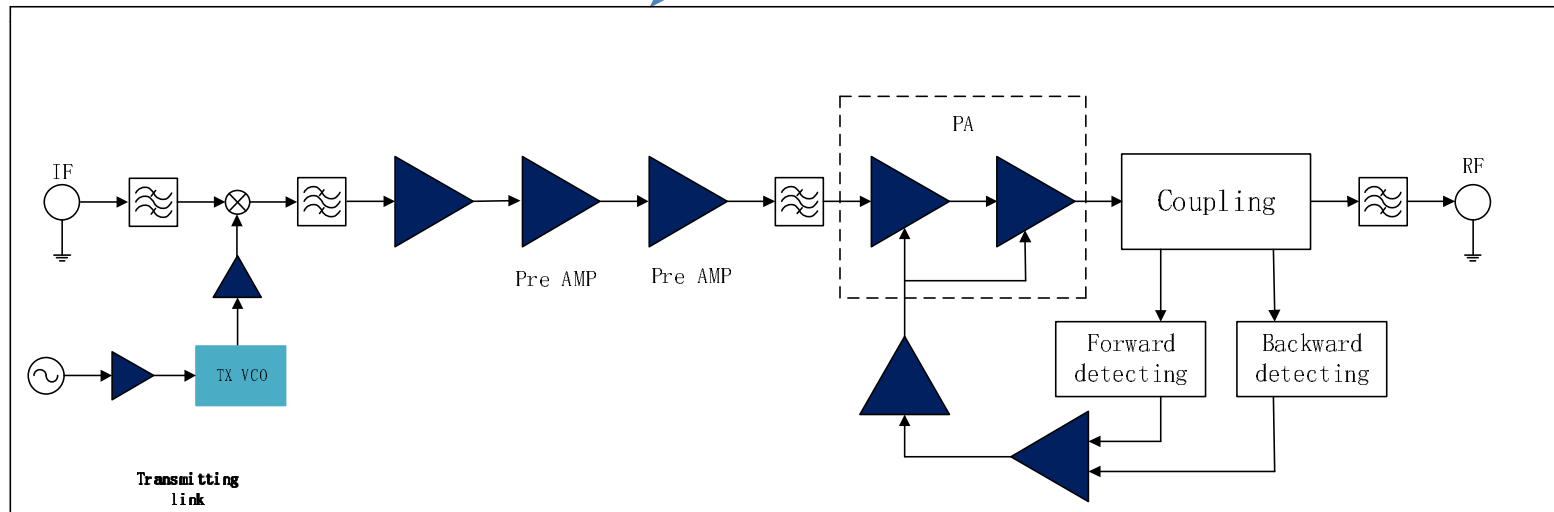
中国海事局  
CHINA MSA



地址：北京市建国门内大街11号

# Situation of VDES Research

Transmitter link



Implementation of Digital Pre-distortion to achieve high linearity of end power amplifier.



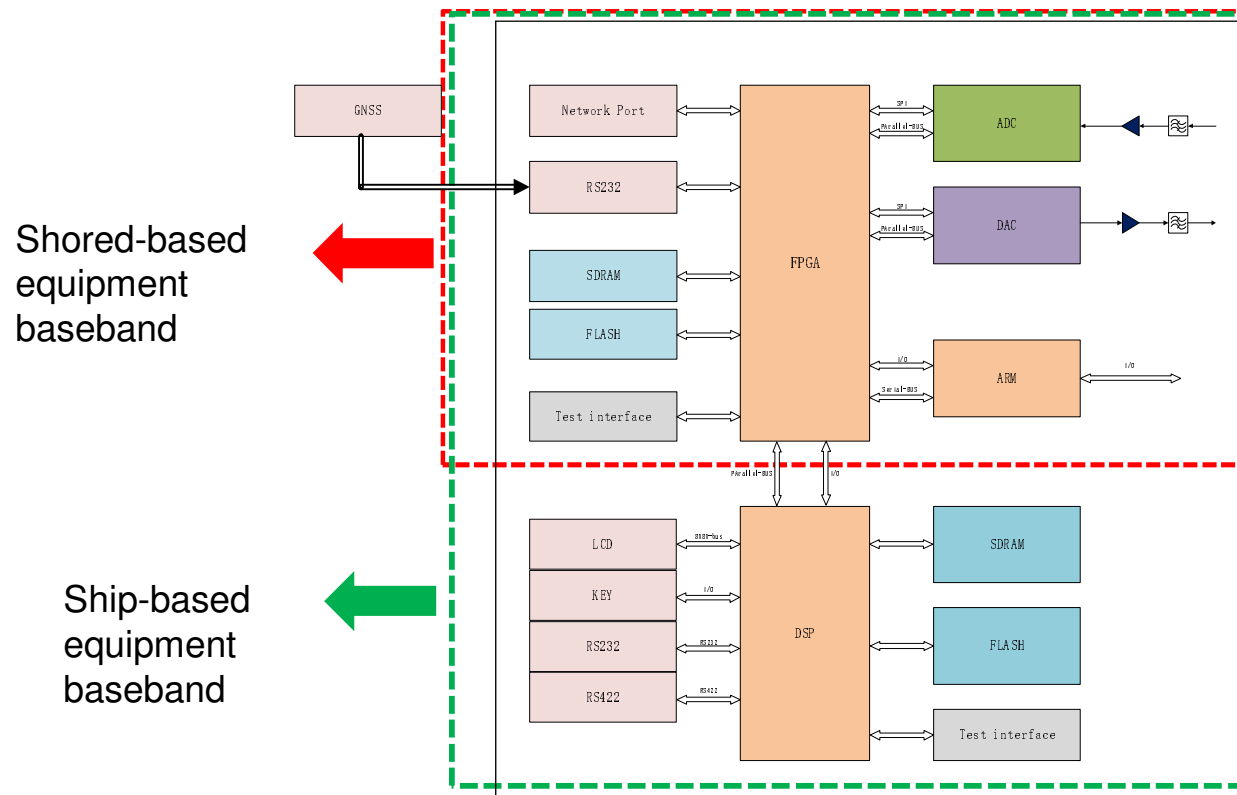
中国海事局  
CHINA MSA



地址：北京市建国门内大街11号

# Situation of VDES Research

## Baseband Processing



中国海事局  
CHINA MSA



地址：北京市建国门内大街11号



# Situation of VDES Research

## VDES Modulation/Demodulation

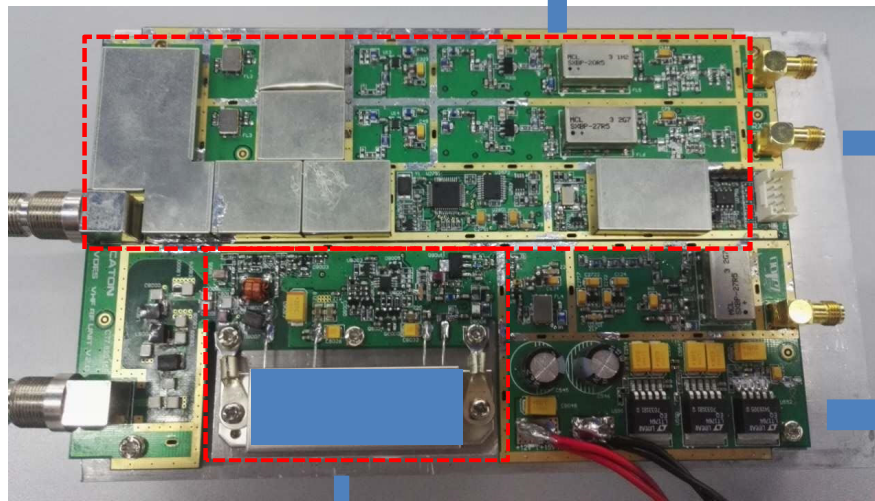
| Modes | Modulation    | Bandwidth    | Speed       | Illustration |
|-------|---------------|--------------|-------------|--------------|
| AIS   | GMSK          | 25KHz        | 9600bit/s   |              |
| LAIS  | GMSK          | 25KHz        | 9600bit/s   |              |
| ASM   | $\pi/4$ DQPSK | 25KHz        | 19200bit/s  |              |
| VDE   | FMT           | 25/50/100KHz | 307.2Kbit/s |              |



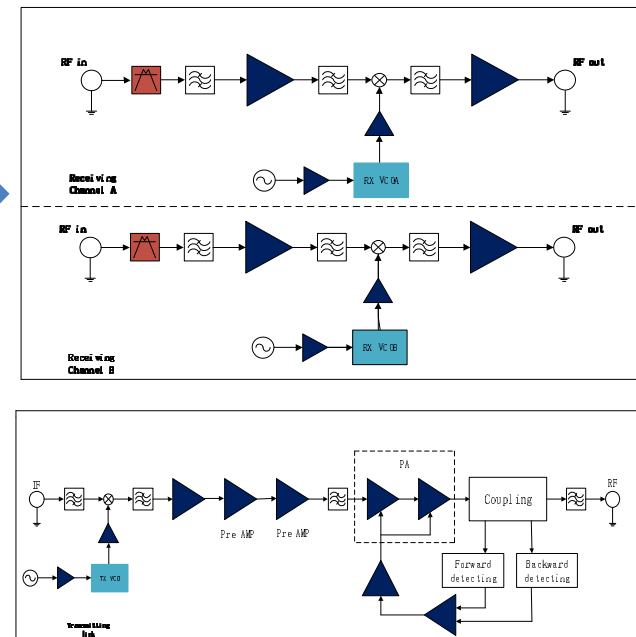
# Situation of VDES Research

## VDES Transmitter

Two parallel receiving channels



End Power Amplifier



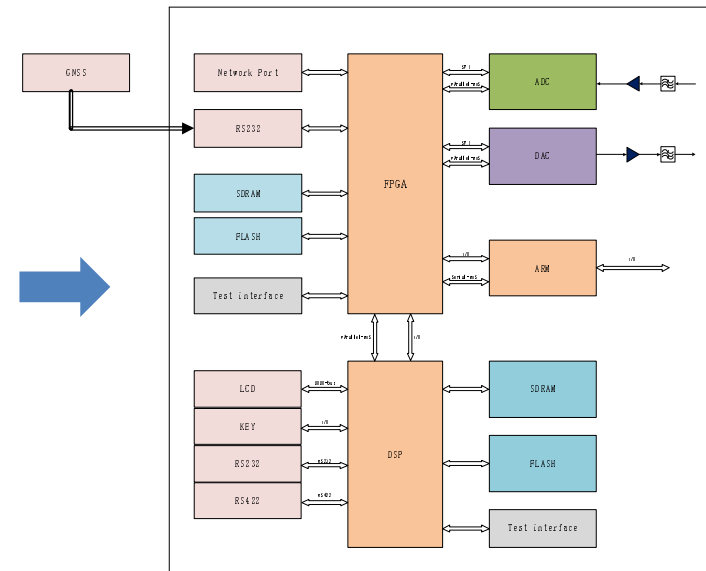
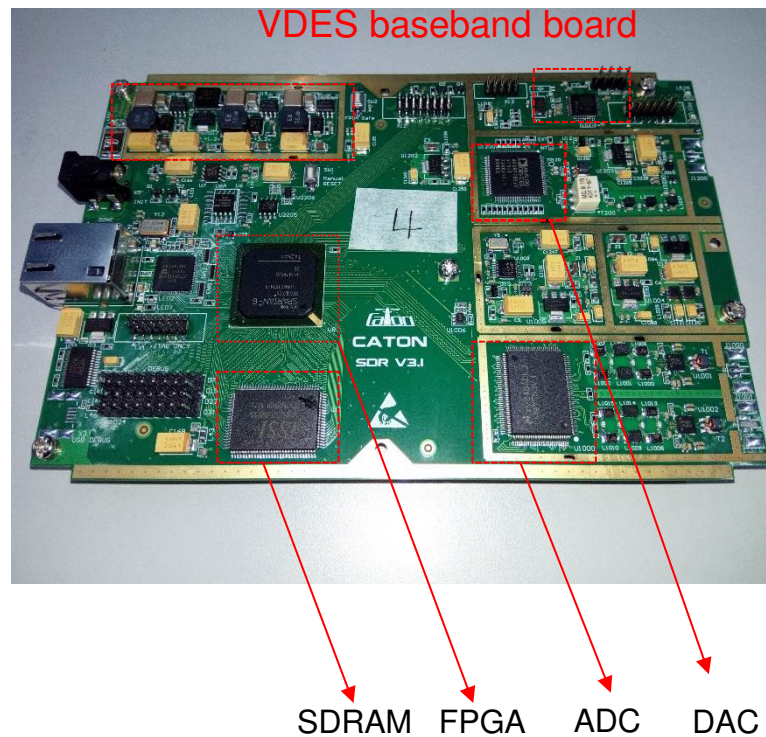
中国海事局  
CHINA MSA



地址：北京市建国门内大街11号

# Situation of VDES Research

## VDES Baseband(SDR Unit)



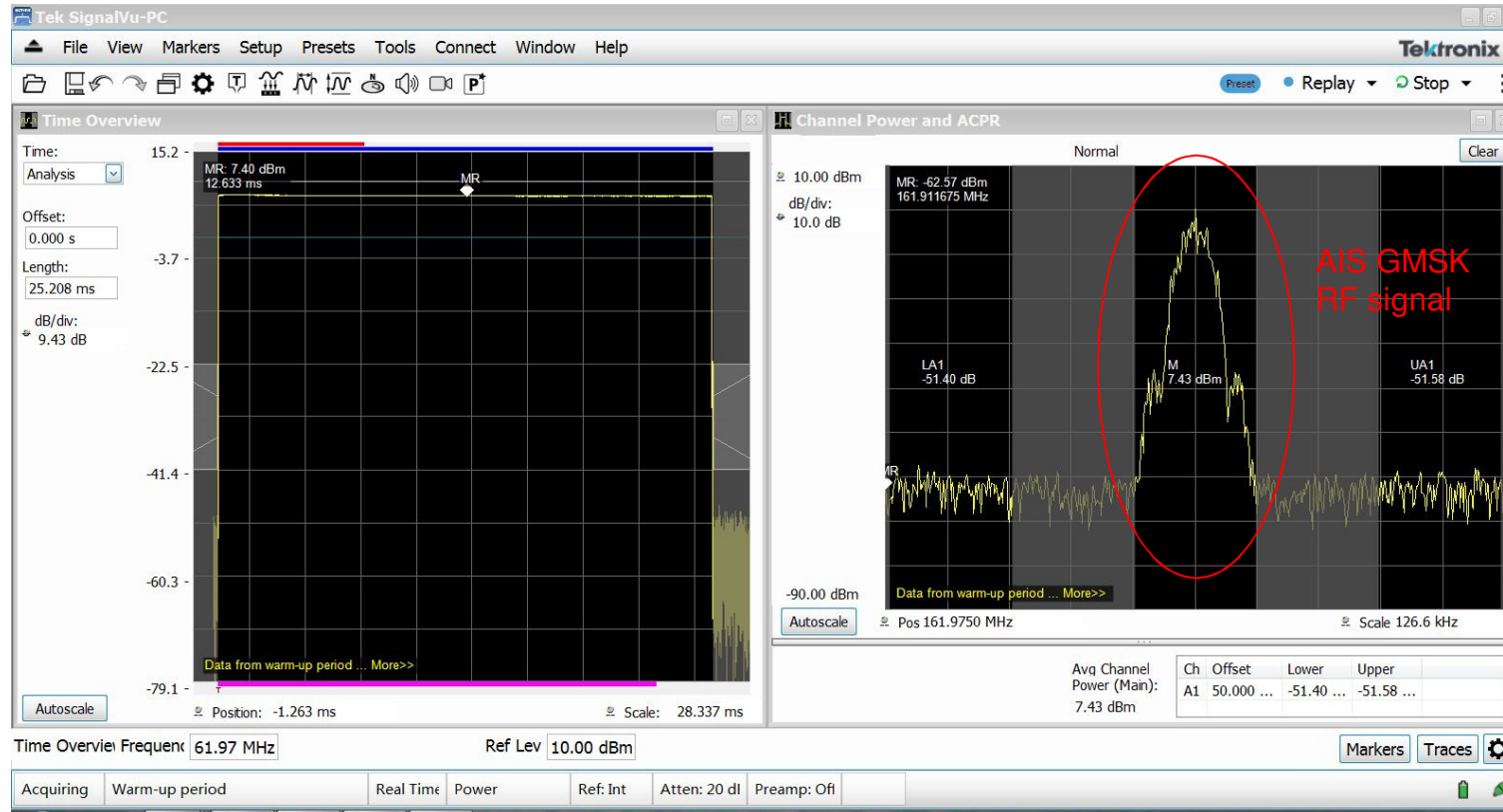
中国海事局  
CHINA MSA



地址：北京市建国门内大街11号

# Situation of VDES Research

## AIS GMSK RF signal



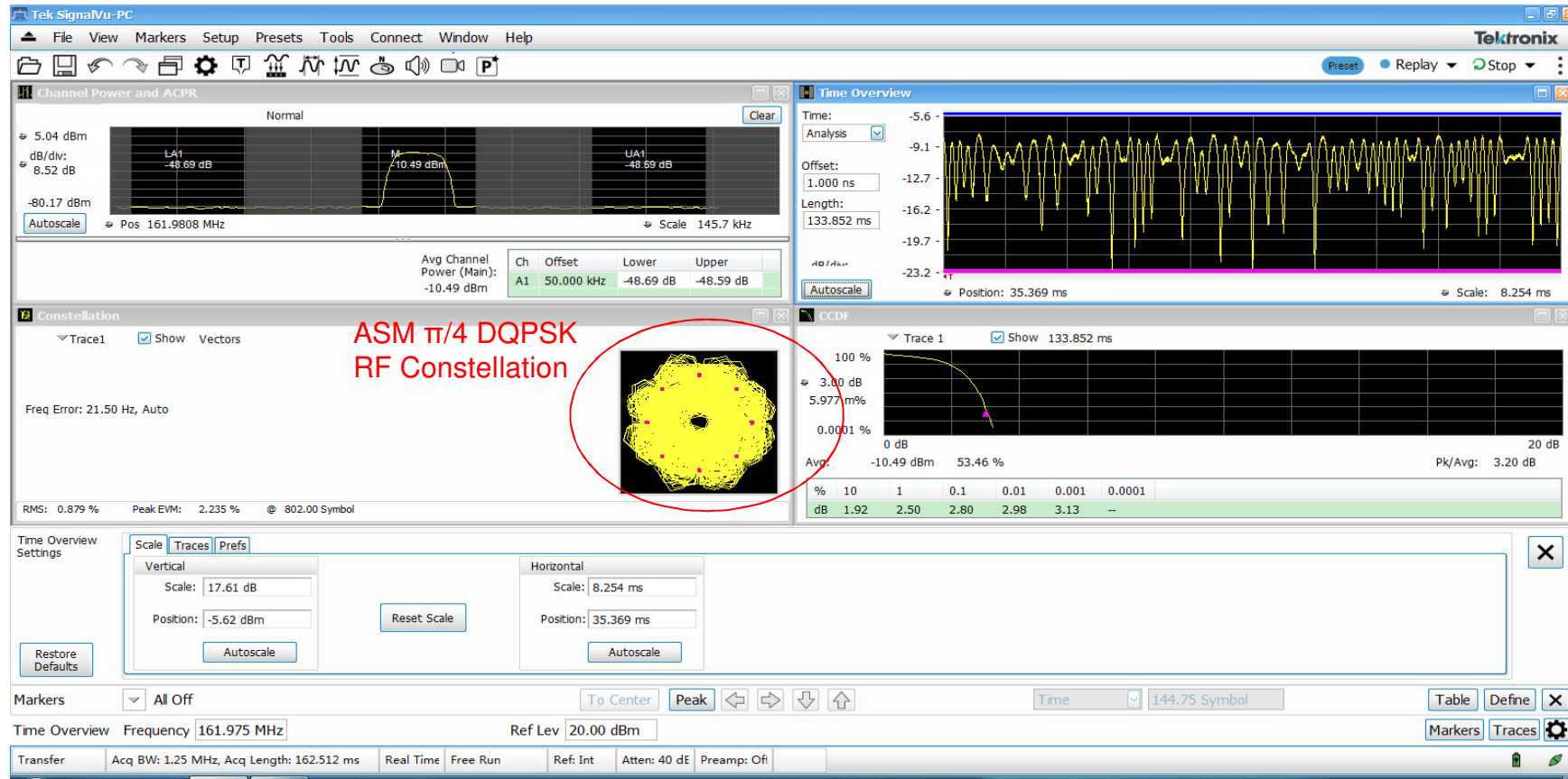
中国海事局  
CHINA MSA



地址：北京市建国门内大街11号

# Situation of VDES Research

## ASM $\pi/4$ DQPSK RF signal



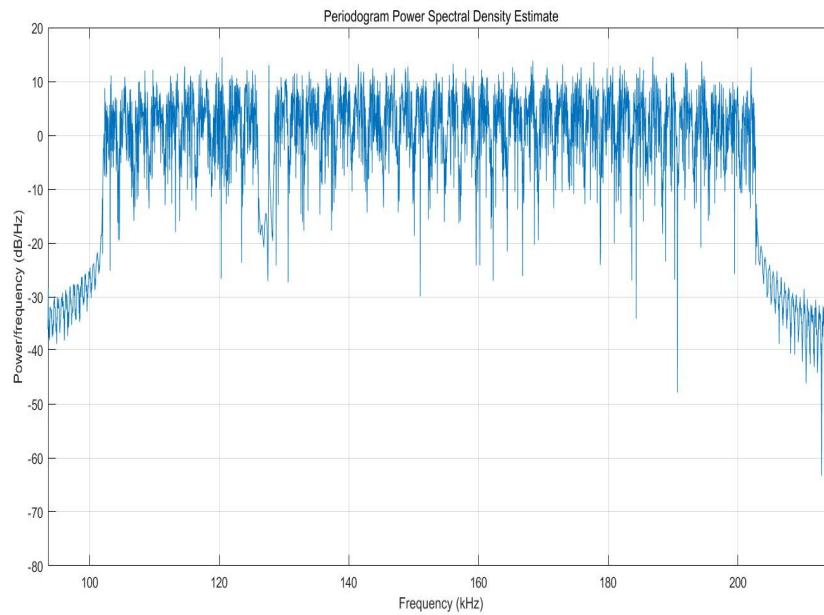
中国海事局  
CHINA MSA



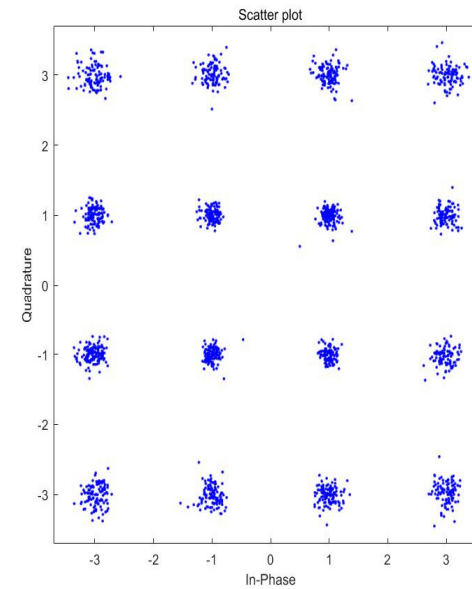
地址：北京市建国门内大街11号

# Situation of VDES Research

VDE FMT signal



VDE FMT Constellation



中国海事局  
CHINA MSA

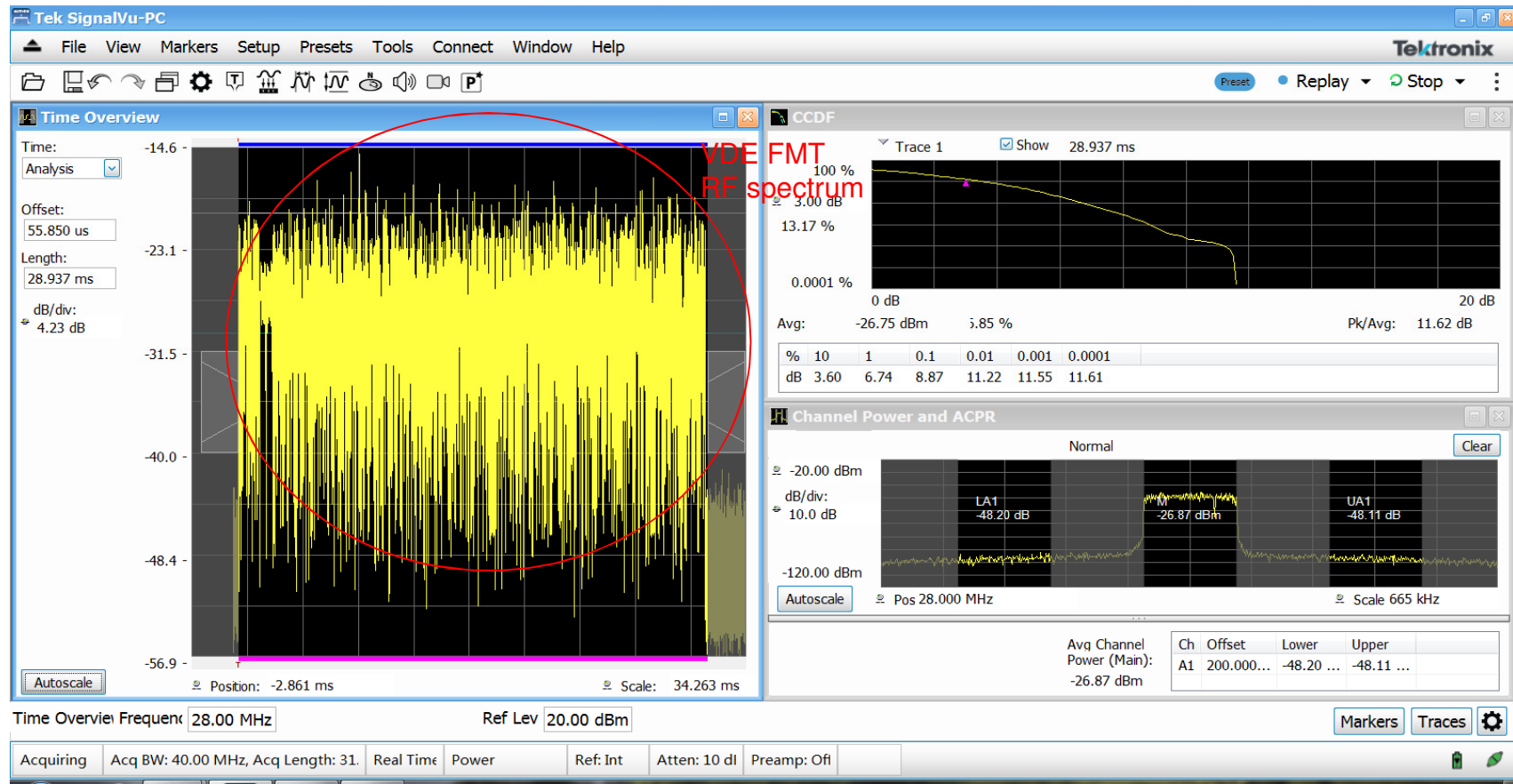


地址：北京市建国门内大街11号



# Situation of VDES Research

## VDE FMT RF signal



中国海事局  
CHINA MSA



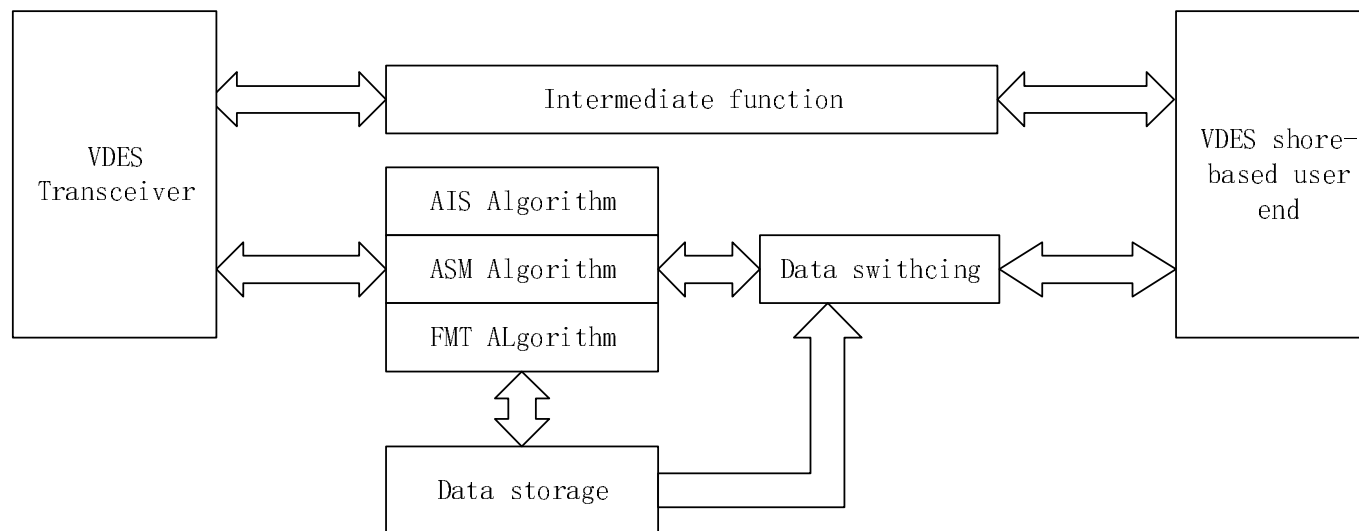
地址：北京市建国门内大街11号



# Situation of VDES Research

## System Software design

By using SDR, VDES front-end transforms analog signal into digital signal, and restore data from demodulating the digital signal. Inversely , it transforms digital signal into analog signal via DAC.



# Situation of VDES Research

## VDES message forms

Standard AIS message forms:

| Message content            | Data form | Illustration  |
|----------------------------|-----------|---|
| Header indicator           | ASCII     | Fixed !   |
| Data indicator             | ASCII     | AIVDM/AIVDO   |
| Number of total packets    | ASCII     | 0~9   |
| Current Packet ID          | ASCII     | 0~9   |
| Universal Series indicator | ASCII     | Same Series Character (0~9 cycle)   |
| Channel number             | ASCII     | The channel while receiving the message (A/B)   |
| Data message               | ASCII     | 6 mapped ASCII  |
| Padding character          | ASCII     | When some 8 ASCII transforming to 6 ASCII, and can not Exactly do so, then use 0s to fill in. The number of 0s. |
| *                          | ASCII     | Tail indicator  |
| Checking                   | ASCII     | Exclusive or ( ! and * do not take part in check )  |
| <CR>、<LF>                  |           |   |



中国海事局  
CHINA MSA



地址：北京市建国门内大街11号

# Situation of VDES Research

## ASM message form

| Message content            | Data form | Illustration  |
|----------------------------|-----------|---|
| Header indicator           | ASCII     | Fixed !   |
| Data indicator             | ASCII     | ASVDM/ASVDO   |
| Number of total packets    | ASCII     | 0~9   |
| Current Packet ID          | ASCII     | 0~9   |
| Universal Series indicator | ASCII     | Same Series Character ( 0~9 cycle )   |
| Channel number             | ASCII     | The channel while receiving the message ( A/B )   |
| Data message               | ASCII     | 6 mapped ASCII  |
| Padding character          | ASCII     | When some 8 ASCII transforming to 6 ASCII, and can not Exactly do so, then use 0s to fill in. The number of 0s. |
| *                          | ASCII     | Tail indicator  |
| Checking                   | ASCII     | Exclusive or ( ! and * do not take part in check )  |
| <CR>、<LF>                  |           |   |



# Situation of VDES Research

VDE message form:

| Message content            | Data form | Illustration  |
|----------------------------|-----------|---|
| Header indicator           | ASCII     | Fixed !   |
| Data indicator             | ASCII     | AVVDM/AVVDO   |
| Number of total packets    | ASCII     | 0~N   |
| Current Packet ID          | ASCII     | 0~N   |
| Universal Series indicator | ASCII     | Same Series Character (0~N cycle)   |
| Channel number             | ASCII     | The channel while receiving the message (A/B)   |
| Data message               | ASCII     | 6 mapped ASCII  |
| Padding character          | ASCII     | When some 8 ASCII transforming to 6 ASCII, and can not Exactly do so, then use 0s to fill in. The number of 0s. |
| *                          | ASCII     | Tail indicator  |
| Checking                   | ASCII     | Exclusive or (! and*do not take part in check)  |
| <CR>、<LF>                  |           |   |



中国海事局  
CHINA MSA

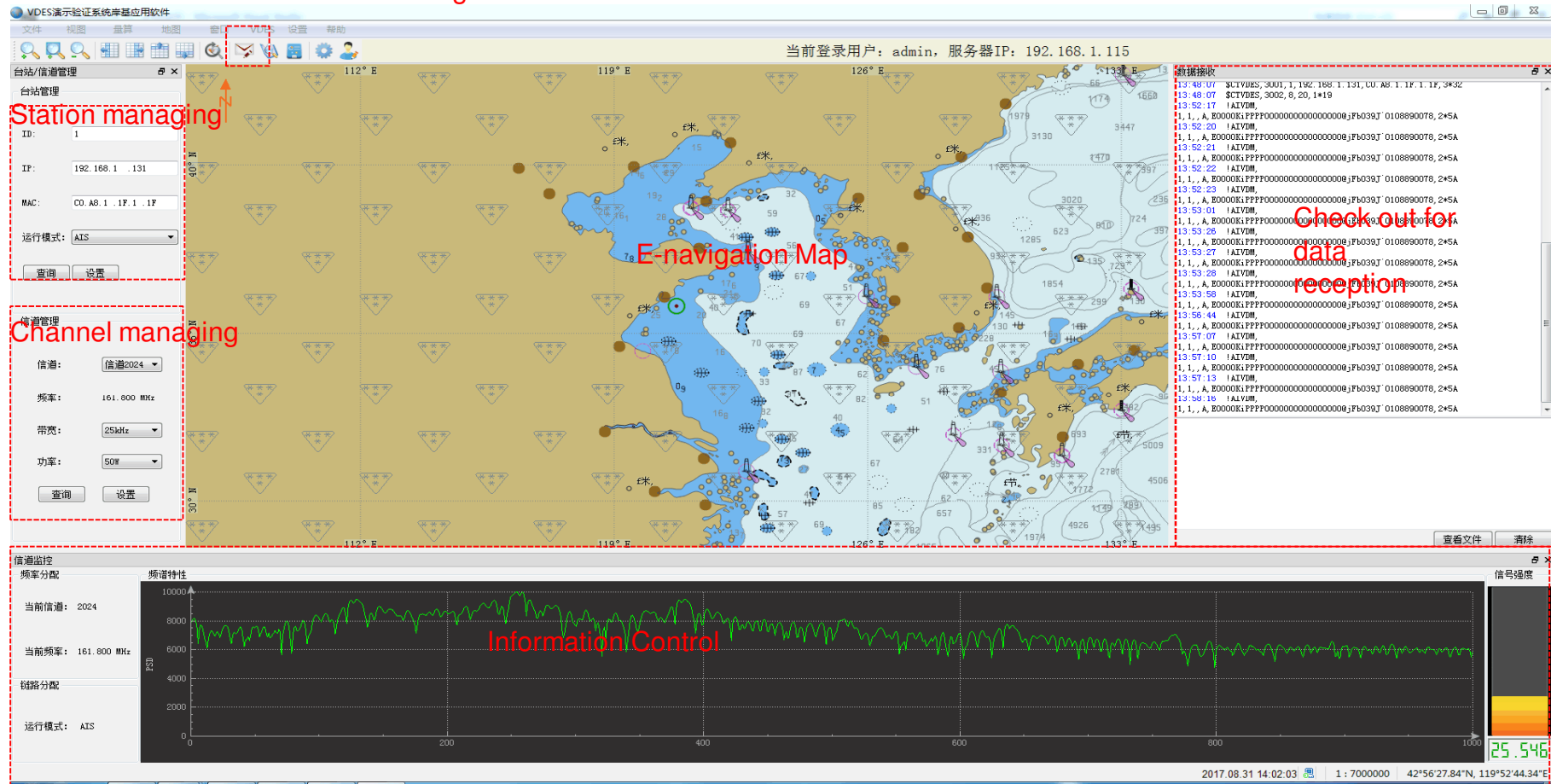


地址：北京市建国门内大街11号

# Situation of VDES Research

## VDES user end software

Data transmitting



中国海事局  
CHINA MSA

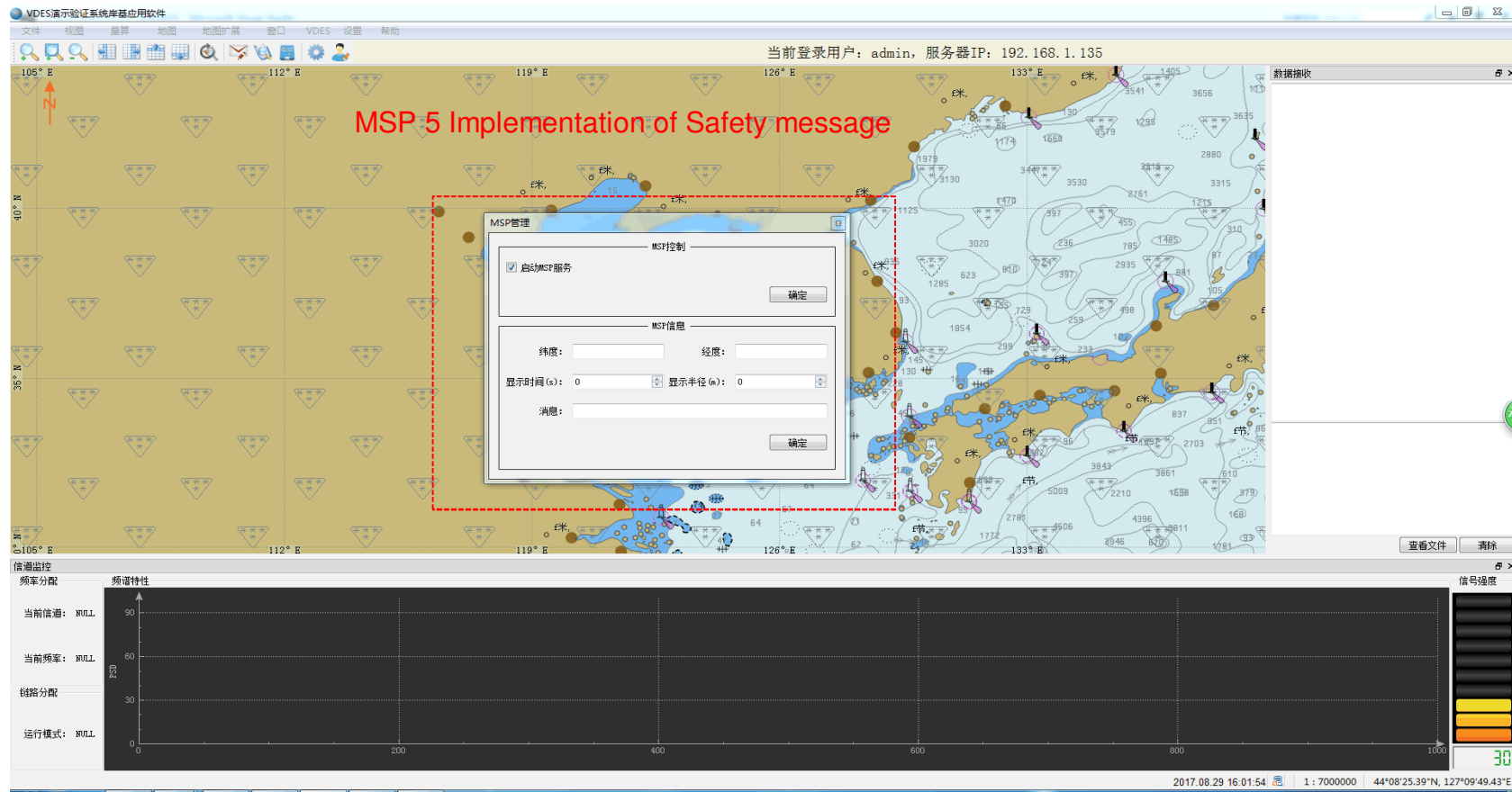


地址：北京市建国门内大街11号

# Situation of VDES Research

## Implementation of MSP function

MSP messages can be transmitted via ASM channels .For Instance, virtual Atoms being used to indicate forbidden area or special area



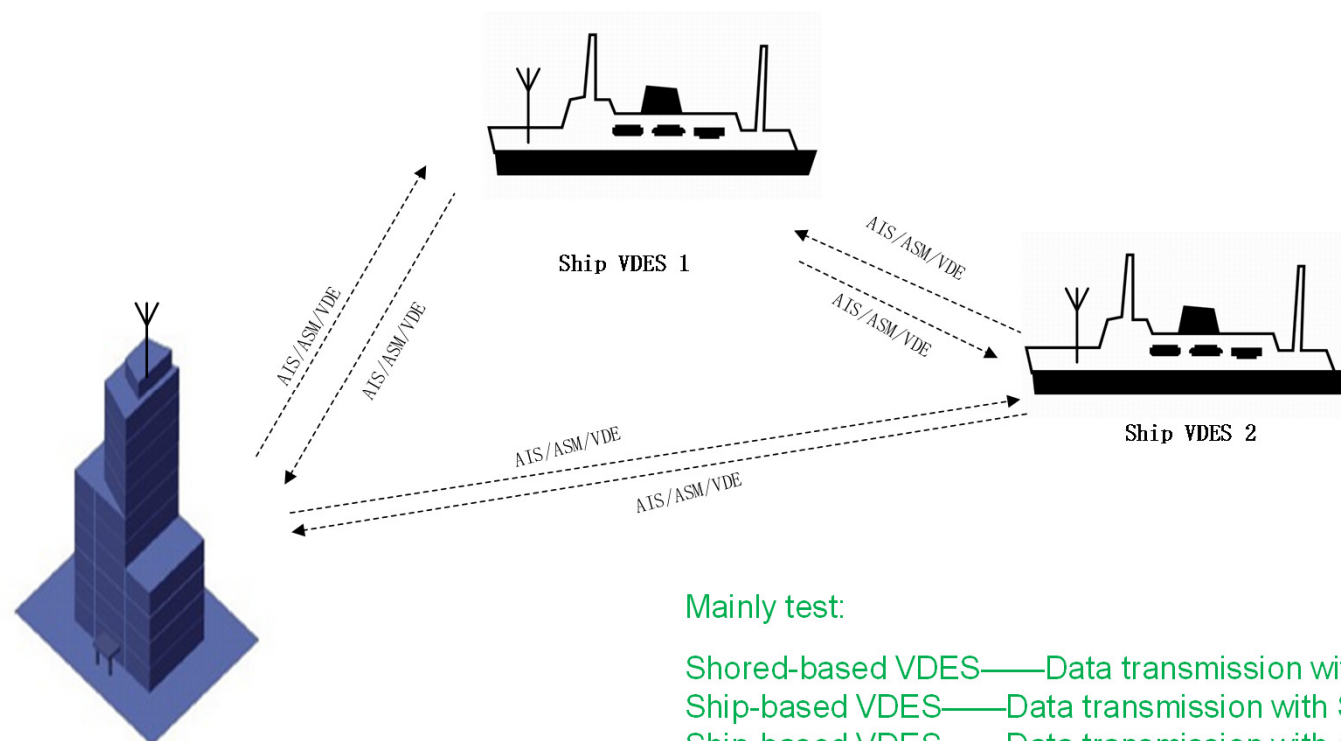
中国海事局  
CHINA MSA



地址：北京市建国门内大街11号

# Setup of VDES Testbed

## VDES Testbed Infrastructure



Mainly test:

Shored-based VDES——Data transmission with ships

Ship-based VDES——Data transmission with Shore station

Ship-based VDES——Data transmission with other ships



中国海事局  
CHINA MSA



地址：北京市建国门内大街11号



## VDES Equipment

### VDES Shore-based Equipment

Voltage supply: 220V AC

Modes: AIS/ASM/VDE

Power output: 50W

Receiver sensitivity: -107dBm



### VDES Ship-based Equipment

Voltage supply: 48V DC

Modes: AIS/ASM/VDE

Power output: 50W

Receiver sensitivity: -107dBm



## Setup of VDES Testbed

### Setup of VDES Testbed

#### Test position

The test positions are chosen around the Tianjing Communication Center.



中国海事局  
CHINA MSA



地址：北京市建国门内大街11号

# Setup of VDES Testbed

## Fixed location test parameters

| Oriental Shipping Container Terminals |          |              | DongJiang Bay      |          |              | Binhai Aircraft Carrier Theme Park |          |              |
|---------------------------------------|----------|--------------|--------------------|----------|--------------|------------------------------------|----------|--------------|
| Freq range                            | Freq MHz | Signal Power | Freq range         | Freq MHz | Signal Power | Freq range                         | Freq MHz | Signal Power |
| 156.025-162.025MHz                    | 161.950  | -45dBm       | 156.025-162.025MHz | 157.300  | -50dBm       | 156.025-162.025MHz                 | 161.825  | -49dBm       |
|                                       | 162.000  | -78dBm       |                    | 157.325  | -74dBm       |                                    | 161.975  | -47dBm       |
|                                       | 157.200  | -64dBm       |                    | 161.800  | -65dBm       |                                    | 162.025  | -80dBm       |
|                                       | 157.225  | -50dBm       |                    | 161.825  | -52dBm       |                                    | 161.775  | -50dBm       |
|                                       | 157.250  | -65dBm       |                    | 161.850  | -60dBm       |                                    | 161.825  | -54dBm       |
|                                       | 157.275  | -74dBm       |                    | 161.900  | -61dBm       |                                    | 161.800  | -80dBm       |



中国海事局  
CHINA MSA



地址：北京市建国门内大街11号

### Mobile test plan

The previous tests were done in fixed locations. Real scenario mobile tests will be held from September to October, in 2017.

The VDES equipment will be loaded on vessel. The communication links will be tested while the vessels move at different speeds.

Encountered problems in test:

Other communication equipment occasionally use the frequencies of ASM and VDE for different purposes, such as vocal calling. This will cause interrupt to the whole VDES system. It is expected that relevant authorities make rules and guidelines for this issue.





Thank You!



中国海事局  
CHINA MSA



地址：北京市建国门内大街11号