An overview of wireless communication technology in ocean observing system

Jiajia Liu   NOTC, SOA, China
National Ocean Public Benefit Industry Research Special Funds Key Project

Research on Operation Application of Offshore Observing Data Transmission in Ocean Environment
Classifcation by frequency

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Wavelength</th>
<th>Designation</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3–30 Hz</td>
<td>$10^5$–$10^4$ km</td>
<td><em>Extremely low frequency</em></td>
<td>ELF</td>
</tr>
<tr>
<td>30–300 Hz</td>
<td>$10^4$–$10^3$ km</td>
<td><em>Super low frequency</em></td>
<td>SLF</td>
</tr>
<tr>
<td>300–3000 Hz</td>
<td>$10^3$–100 km</td>
<td><em>Ultra low frequency</em></td>
<td>ULF</td>
</tr>
<tr>
<td>3–30 kHz</td>
<td>100–10 km</td>
<td><em>Very low frequency</em></td>
<td>VLF</td>
</tr>
<tr>
<td>30–300 kHz</td>
<td>10–1 km</td>
<td><em>Low frequency</em></td>
<td>LF</td>
</tr>
<tr>
<td>300 kHz – 3 MHz</td>
<td>1 km – 100 m</td>
<td><em>Medium frequency</em></td>
<td>MF</td>
</tr>
<tr>
<td>3–30 MHz</td>
<td>100–10 m</td>
<td><em>High frequency</em></td>
<td>HF</td>
</tr>
<tr>
<td>30–300 MHz</td>
<td>10–1 m</td>
<td><em>Very high frequency</em></td>
<td>VHF</td>
</tr>
<tr>
<td>300 MHz – 3 GHz</td>
<td>1 m – 10 cm</td>
<td><em>Ultra high frequency</em></td>
<td>UHF</td>
</tr>
<tr>
<td>3–30 GHz</td>
<td>10–1 cm</td>
<td><em>Super high frequency</em></td>
<td>SHF</td>
</tr>
<tr>
<td>30–300 GHz</td>
<td>1 cm – 1 mm</td>
<td><em>Extremely high frequency</em></td>
<td>EHF</td>
</tr>
<tr>
<td>300 GHz – 3000 GHz</td>
<td>1 mm – 0.1 mm</td>
<td><em>Tremendously high frequency</em></td>
<td>THF</td>
</tr>
</tbody>
</table>
Classification by transmission media

Air(radio) \non-satellite
\satellite

Water
Satellite

- Stable transmission loss
- Negligible multipath fading
- High success rate of data transmission
- Acceptable time delay
- Distance-independent cost for station establishment
- Remote and desolate area
Satellite

- **Inmarsat**: High data rate, Large coverage, High cost
- **VSAT**: High data rate, Large coverage
- **Iridium**: Total globe coverage, Power saving, High cost
- **Argos**: Power saving, Low realtime performance, Rough positioning
- **Beidou**: Low cost, Asia region

Mainstream satellite communication used in ocean observation
Inmarsat

- 3rd generation Inmarsat-C  Low data rate 1.2kbps

- 4th generation Fleet Broadband
  High data rate 432kbps  500$ monthly rent, 1M=20$, high cost

- 5th generation Global Xpress  High speed broadband  5Mbps

High cost
Iridium
Low earth orbiting satellite

- Total globe coverage
- Small size/DT module
- Power saving
- High cost

- Expandable meteorological buoy
**VSAT**

- Wide frequency range: 4GHz~40GHz (C, Ku, Ka)
- High data rate: 2Mbps/video transmission
- Flexible pricing by users’ requirement
- Large and heavy antenna
- Considerable rain attenuation at Ku, Ka band (C sea)
Argos

A Data Collection and Localization System dedicated to environmental applications

- Total globe coverage
- Power saving/remote, mobile/long period
- **Long time delay**: 10min~220min
- Low positioning precision: 250m
ARGO in 2014

Data transmission

- Iridium
- Argos
Beidou (compass)

- Low cost
- Data package: 78 bytes/420 bytes
- Transmission frequency: 1 min/1 s
- Positioning precision: 10 m
- Coverage: Asia-Pacific /world 2020
Non-satellite

HF
Long distance
Ionosphere dependent
Environmentally sensitive

VHF
Small size
Medium distance

Cellular mobile
Low cost
Anti-destroy

High data rate
Small and cheap
Regional coverage
Short distance
HF

- Long distance communication
- Ionosphere (unstable) dependent
- Narrow frequency range: 3MHz~30MHz
- Environmentally sensitive
- Frequency range: 30MHz~300MHz
- Small size/portable
- Line-of-sight transmission
- Medium/short distance
Cellular mobile (CDMA/LTE)

- Small and cheap
- High data rate
- Regional coverage
- Short transmission distance
Serious attenuation
Very short distance
Only VLF, ULF available

High data rate: 1Gbps
Significant directivity
Turbidity sensitive
Short distance

Best carrier for subsurface transmission
Long distance
Multipath fading
Narrow bandwidth
Huge device size

Sonic

Electromagnetic wave

Optic

Subsurface wireless communication used in ocean observation
Subsurface Electromagnetic Wave

- Frequency
- Attenuation
- Data rate
- Distance
Subsurface Optic Communication

- High data rate: 1Gbps
- Turbidity sensitive
- Short transmission distance
- Exception: Blue-green laser

Frogman → AUV
image
video
Subsurface Sonic communication

- Long transmission distance
- Low data rate
- Considerable time delay
- Environment(T/P/S) sensitive
- Huge device size
Subsurface sonic communication application

Jiaolong manned deep-sea research submersible

- Long distance/low speed command transmission: 16bps
- Medium speed/medium distance data transmission: 300bps
- High speed/short distance image transmission: 10kbps

2013
- South China Sea
- Northwest Pacific
- Northeast Pacific
Radio & hydro-acoustic integration application
How to choose

Data
- Realtime performance
- Data transmission rate
- Data volume
- Data security

System Architecture
- Simple point to point
- Complex network

Environment
- Transmission media
- Distance
- Location/surroundings

Business Requirement
Thank You!