PICES

An overview of wireless communication technology in ocean observing system

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Source

National Ocean Public Benefit Industry Research Special Funds Key Project

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

Classification by frequency

Frequency	Wavelength	Designation	Abbreviation
3–30 Hz	10^5–10^4 km	Extremely low frequency	ELF
30–300 Hz	10^4–10^3 km	Super low frequency	SLF
300–3000 Hz	10^3–100 km	Ultra low frequency	ULF
3–30 kHz	100–10 km	Very low frequency	VLF
30–300 kHz	10–1 km	Low frequency	LF
300 kHz – 3 MHz	1 km – 100 m	Medium frequency	MF
3–30 MHz	100–10 m	High frequency	HF
30–300 MHz	10–1 m	Very high frequency	VHF
300 MHz – 3 GHz	1 m – 10 cm	Ultra high frequency	UHF
3–30 GHz	10–1 cm	Super high frequency	SHF
30–300 GHz	1 cm – 1 mm	Extremely high frequency	EHF
300 GHz – 3000 GHz	1 mm – 0.1 mm	Tremendously high frequency	THF

Classification by transmission media

Air(radio)

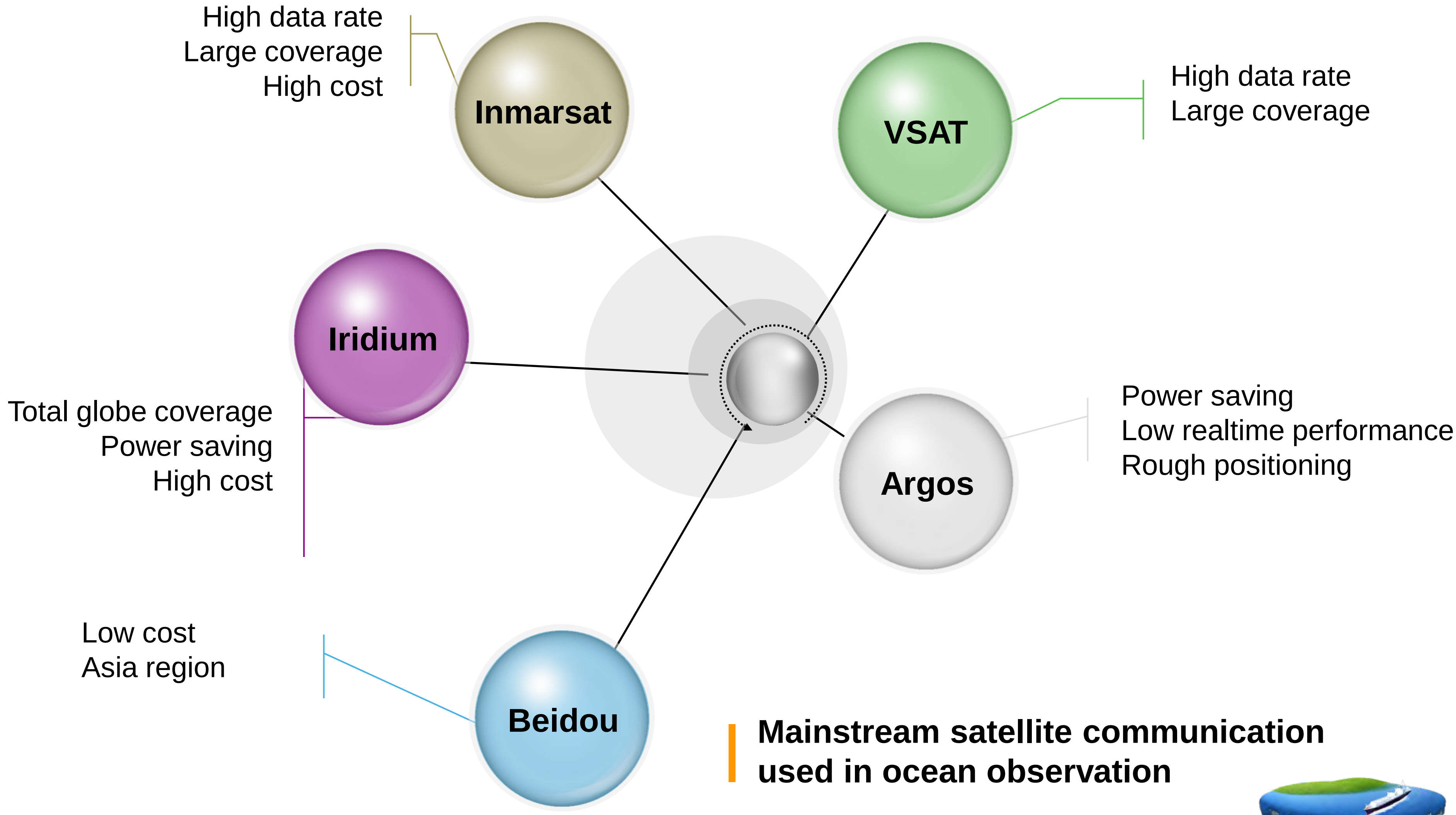
- satellite
- non-satellite

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

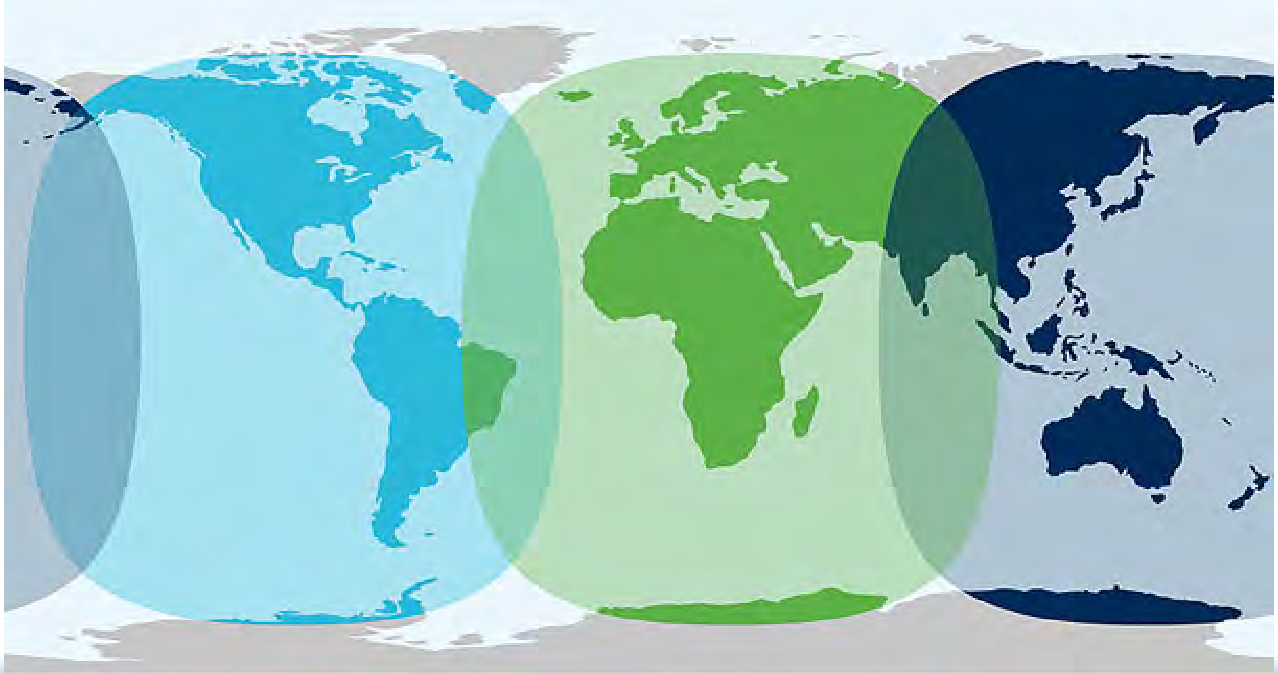
Inmarsat

- 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

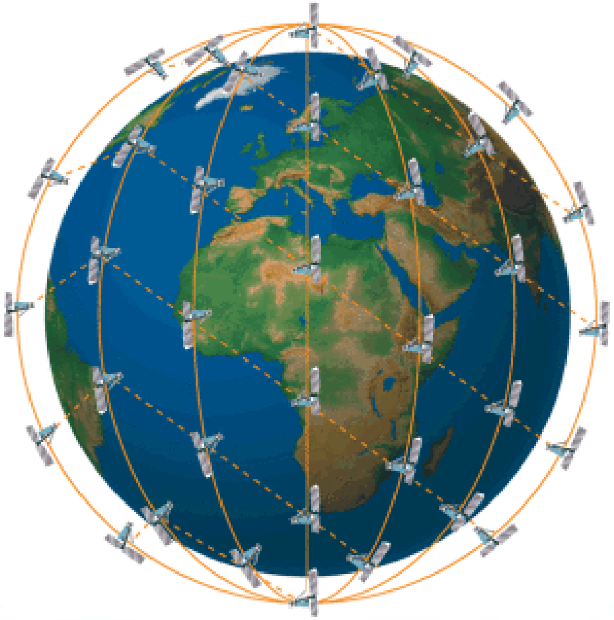


High cost

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)

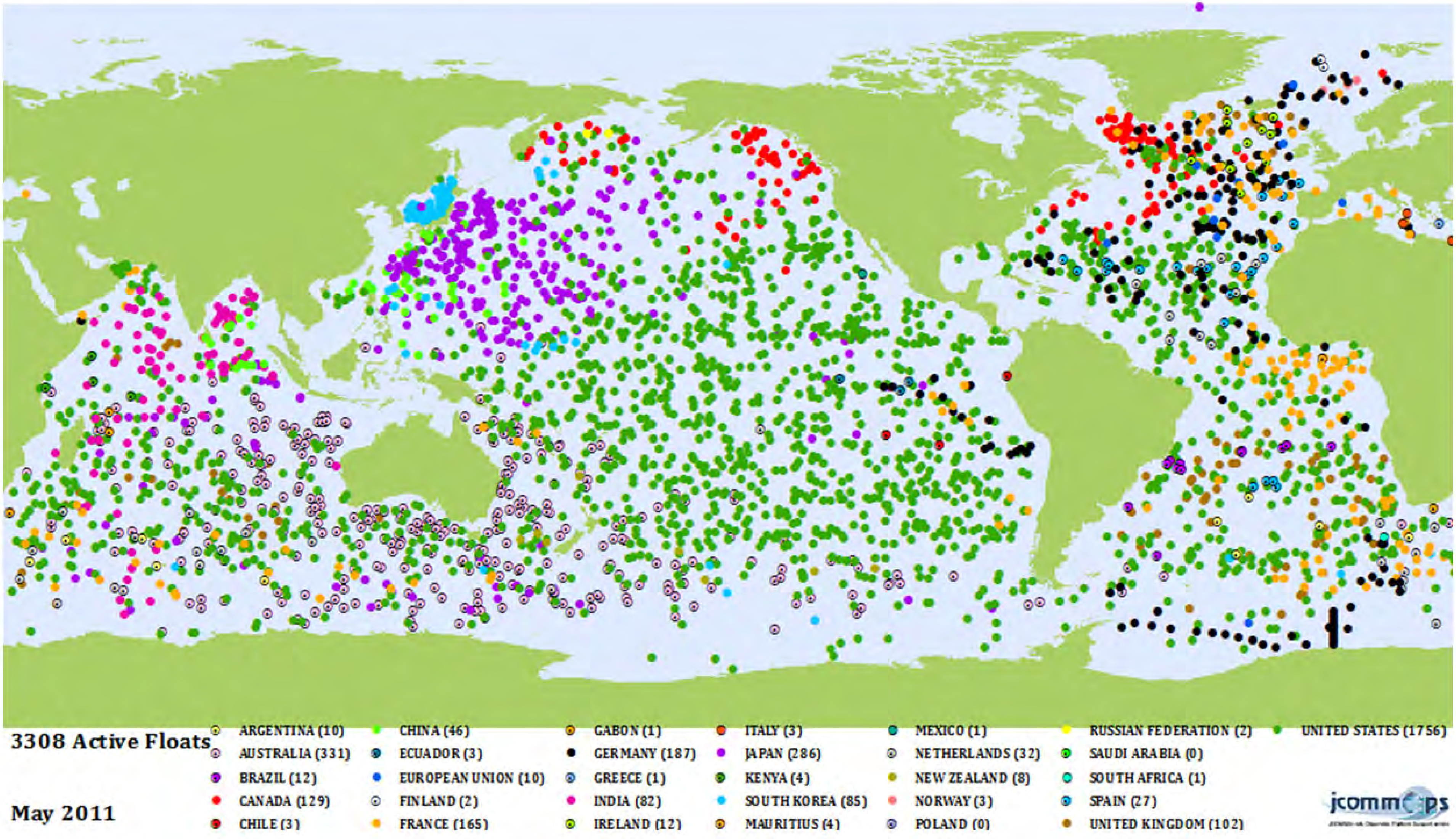
Argos

A Data Collection and Localization System dedicated to environmental applications

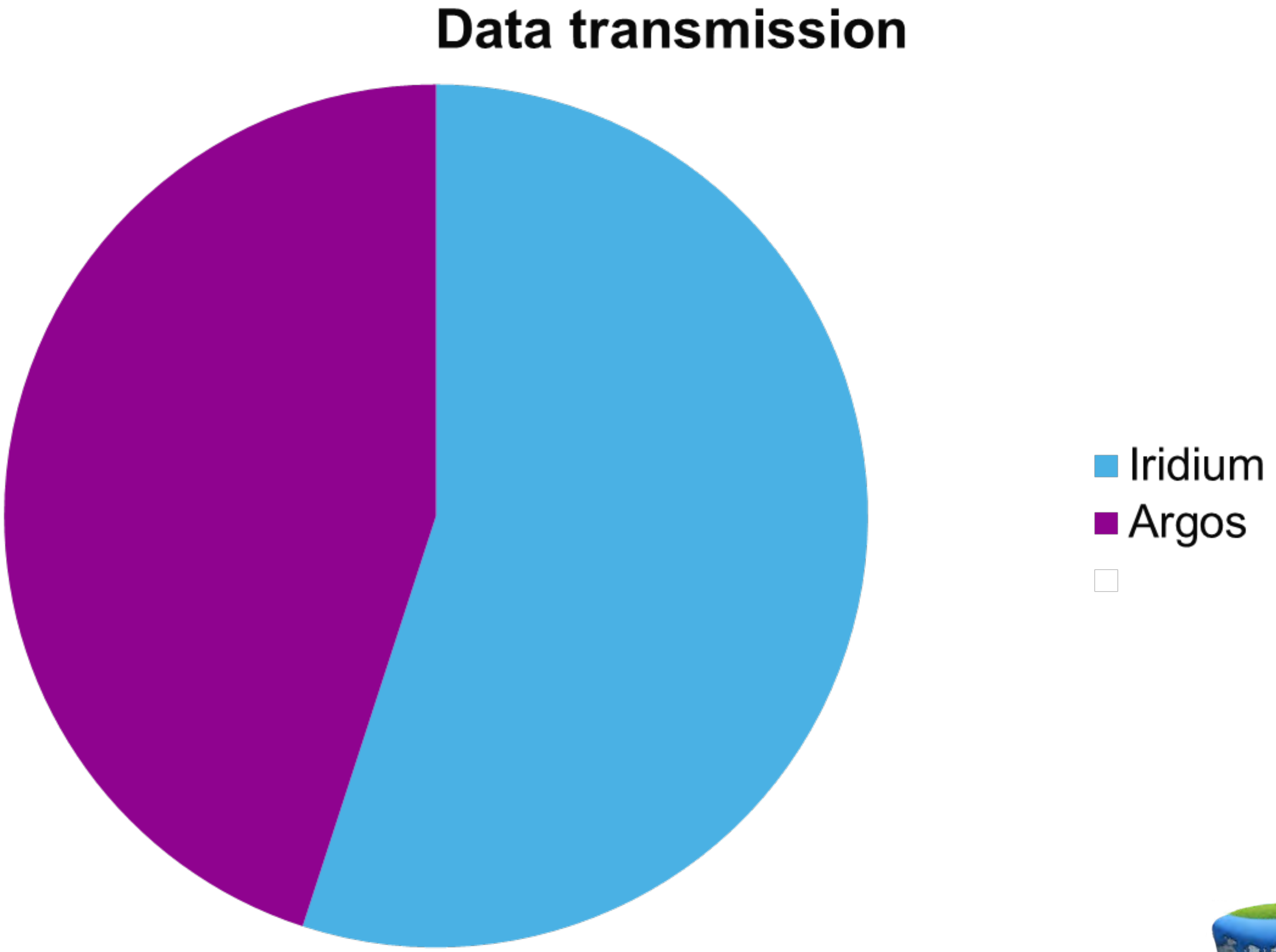
polar orbiting satellite

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

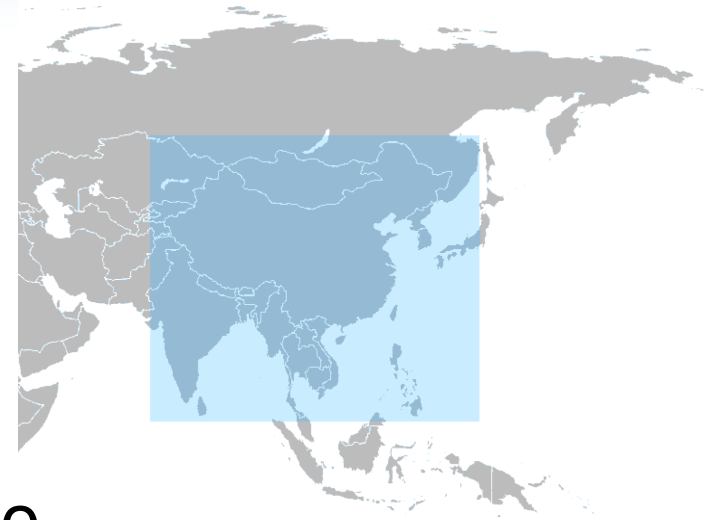
ARGO


3308 Active Floats
May 2011
ARGENTINA (10)
AUSTRALIA (331)
BRAZIL (12)
CANADA (129)
CHILE (3)
CHINA (46)
ECUADOR (3)
EUROPEAN UNION (10)
FINLAND (2)
FRANCE (165)
GABON (1)
GERMANY (187)
GREECE (1)
INDIA (82)
IRELAND (12)
ITALY (3)
JAPAN (286)
KENYA (4)
SOUTH KOREA (85)
MAURITIUS (4)
MEXICO (1)
NETHERLANDS (32)
NEW ZEALAND (8)
NORWAY (3)
POLAND (0)
RUSSIAN FEDERATION (2)
SAUDI ARABIA (0)
SOUTH AFRICA (1)
SPAIN (27)
UNITED KINGDOM (102)
UNITED STATES (1756)
jcommops

ARGO in 2014

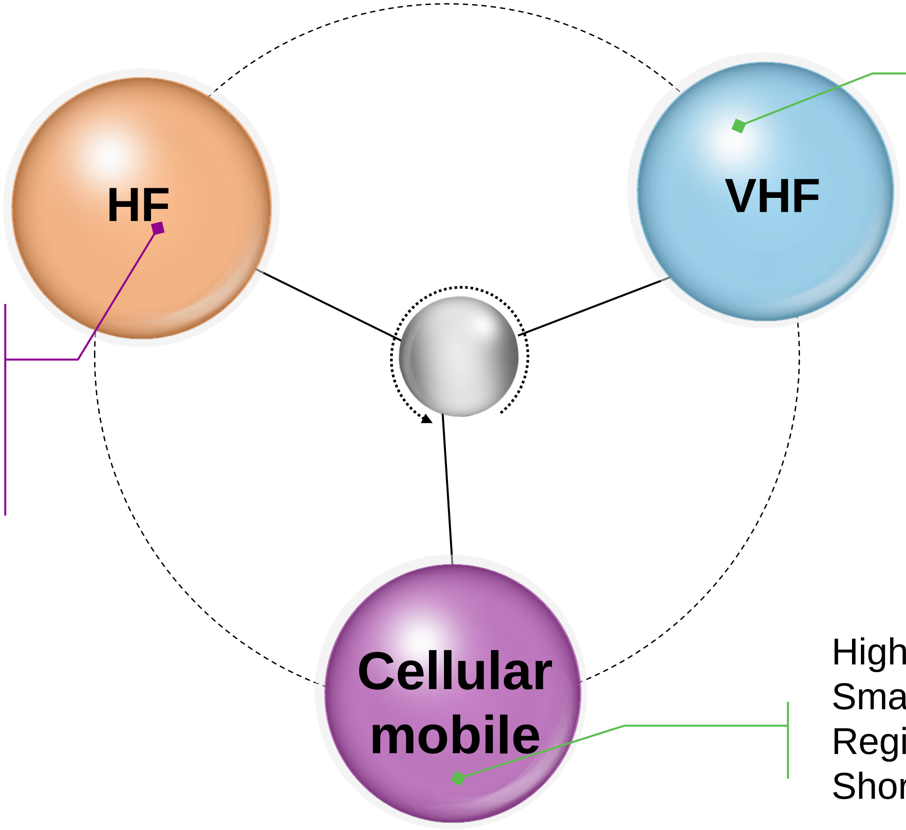


Beidou(compass)



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

Non-satellite



Small size
Medium distance

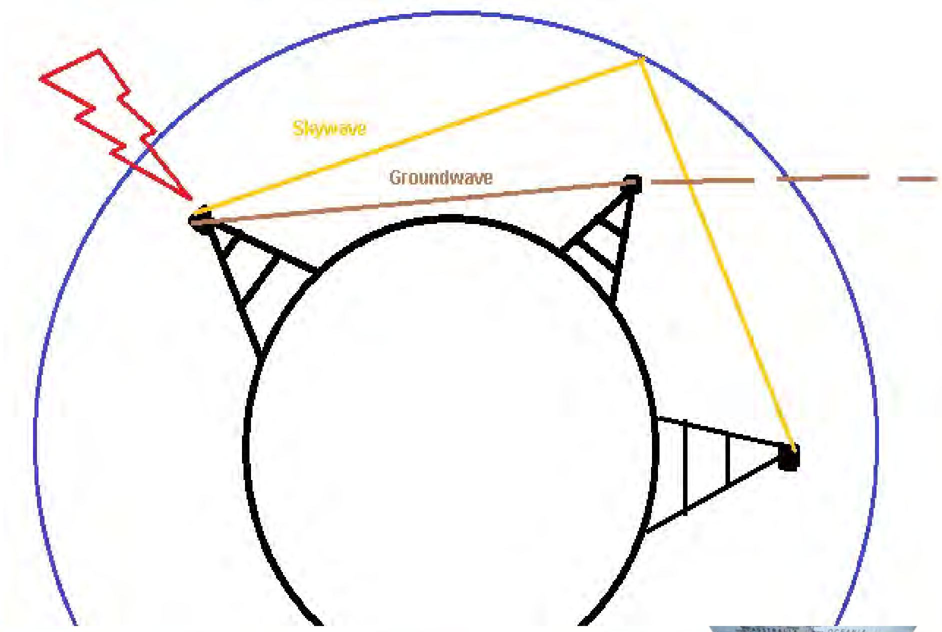
Long distance
Ionosphere dependent
Environmentally sensitive

High data rate
Small and cheap
Regional coverage
Short distance

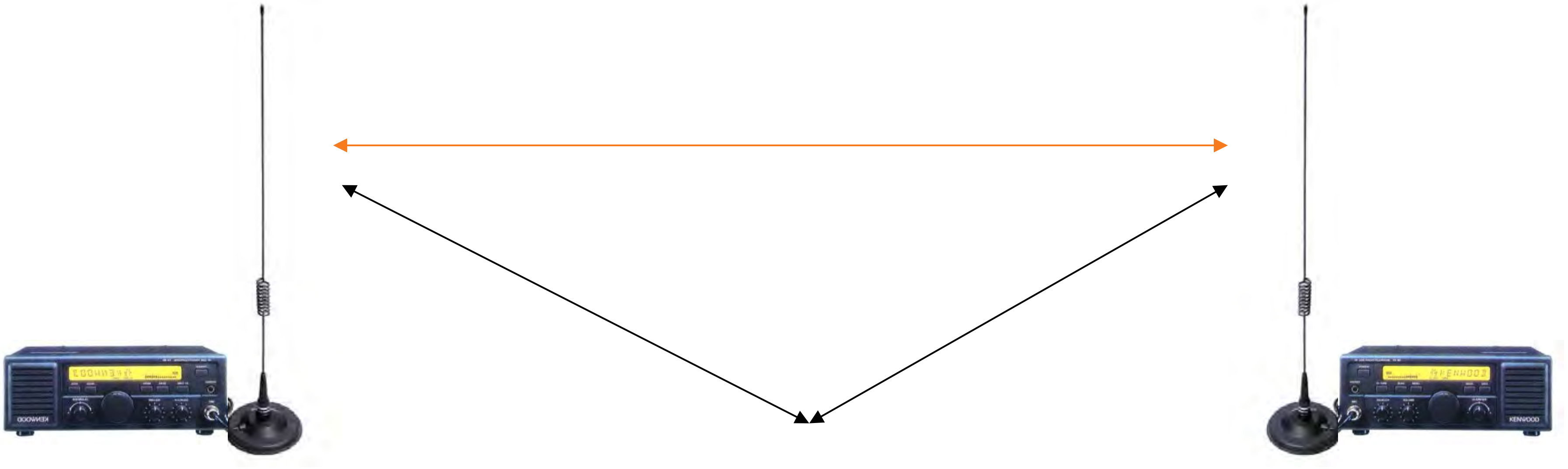
Low cost
Anti-destroy

HF

- Long distance communication
- Ionosphere(unstable) dependent
- Narrow frequency range: 3MHz~30MHz
- Environmentally sensitive



VHF

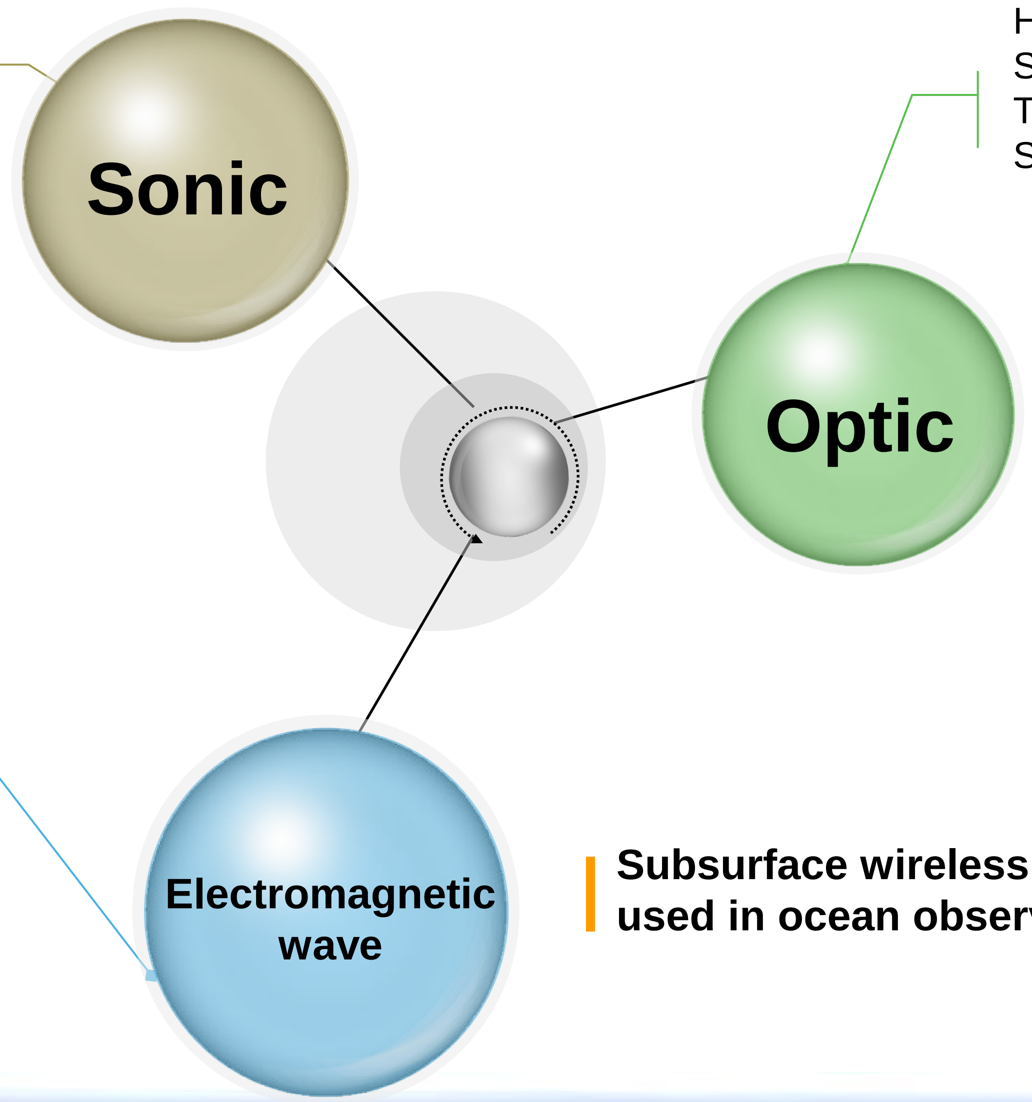


- Frequency range: 30MHz~300MHz
- Small size/portable
- Line-of-sight transmission
- Medium/short distance

Cellular mobile(CDMA/LTE)

- Small and cheap
- High data rate
- Regional coverage
- Short transmission distance

Subsurface



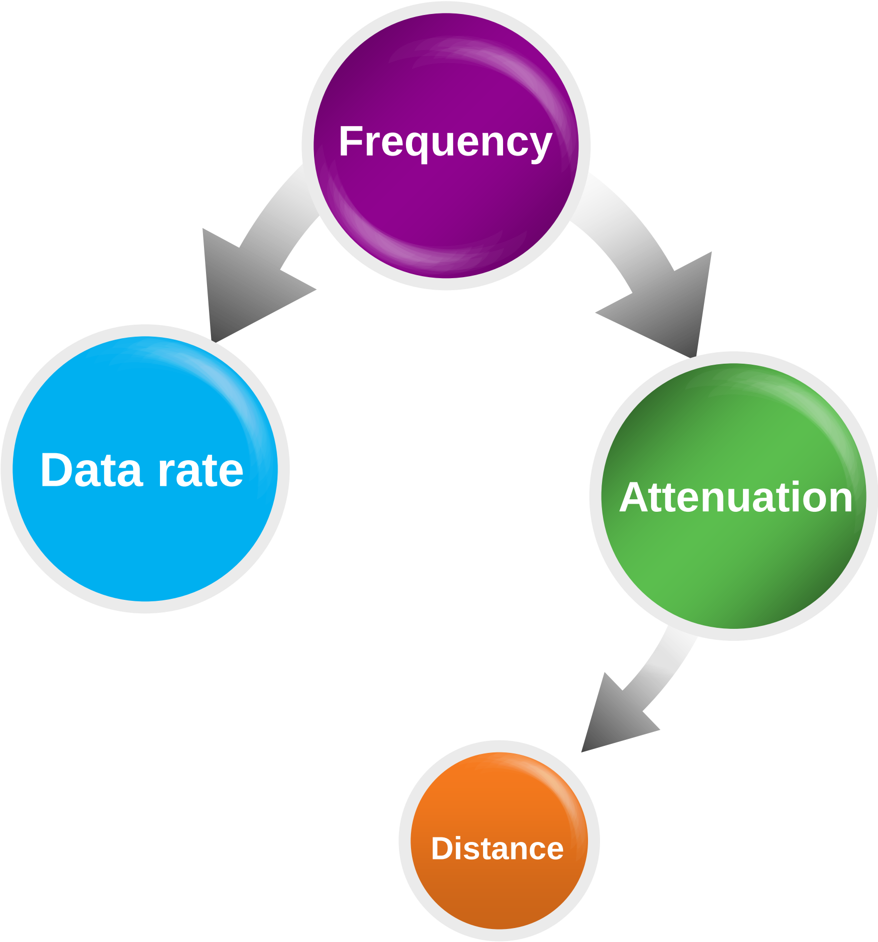
Best carrier for subsurface transmission
Long distance
Multipath fading
Narrow bandwidth
Huge device size

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

Serious attenuation
Very short distance
Only VLF, ULF available

Subsurface wireless communication used in ocean observation

Subsurface Electromagnetic Wave



Frequency

Data rate

Attenuation

Distance

Subsurface Optic Communication

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

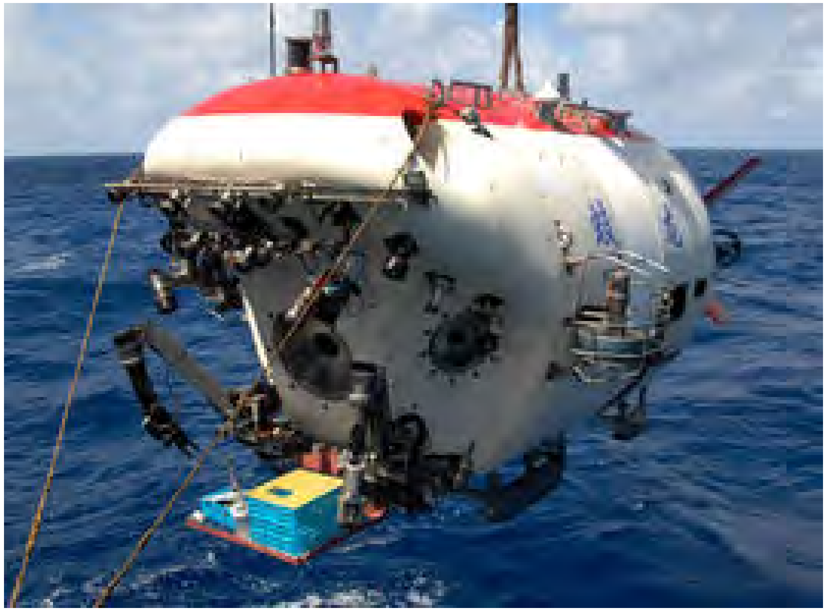
$$\text{Frogman} \xrightarrow[\text{video}]{\text{image}} \text{AUV}$$

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

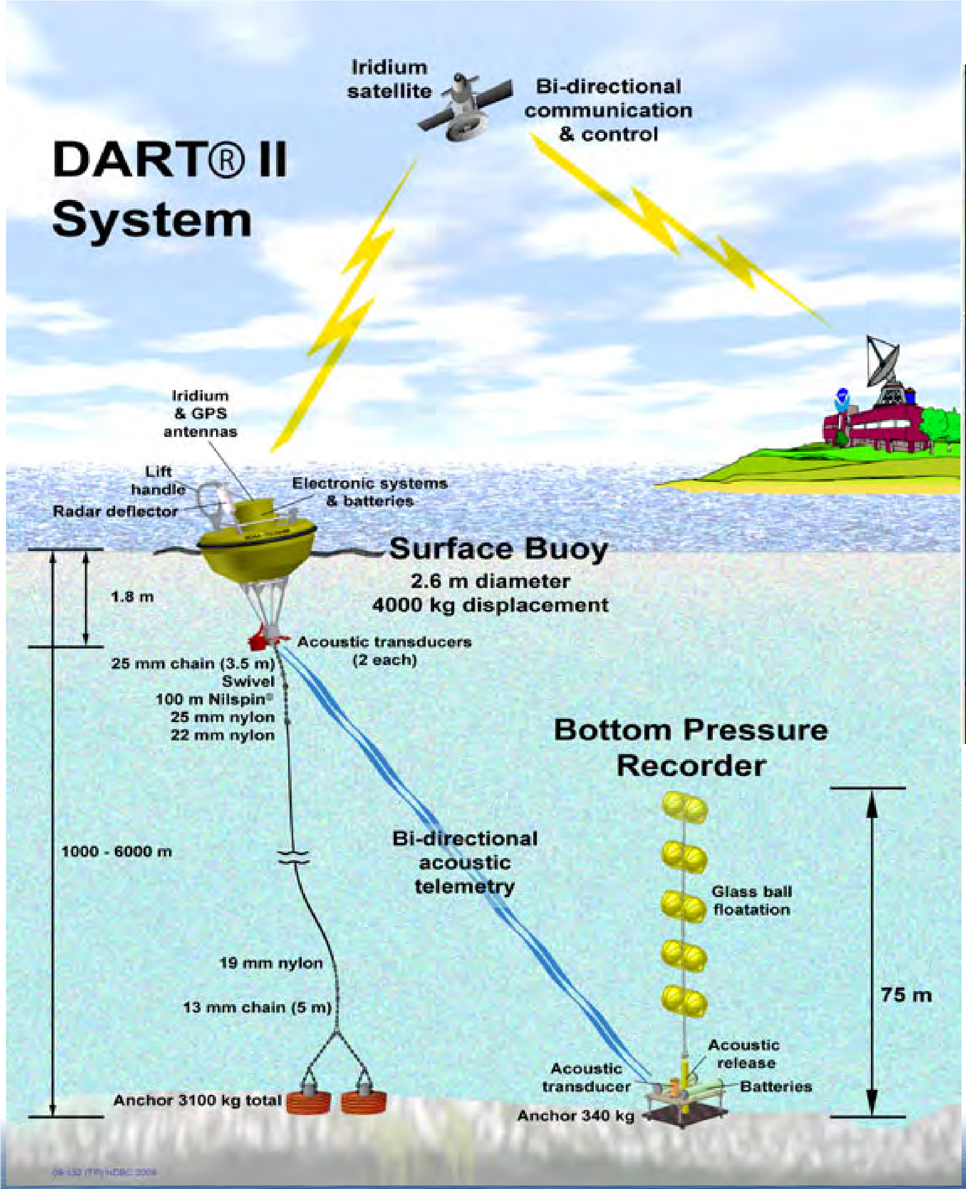


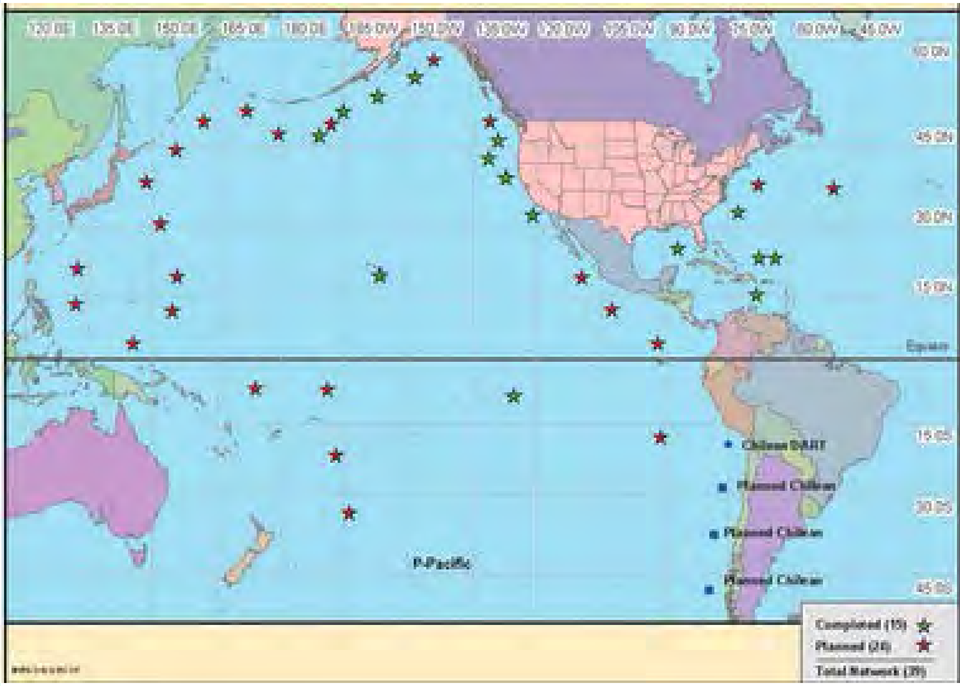
2013

- South China Sea
- Northwest Pacific
- Northeast Pacific

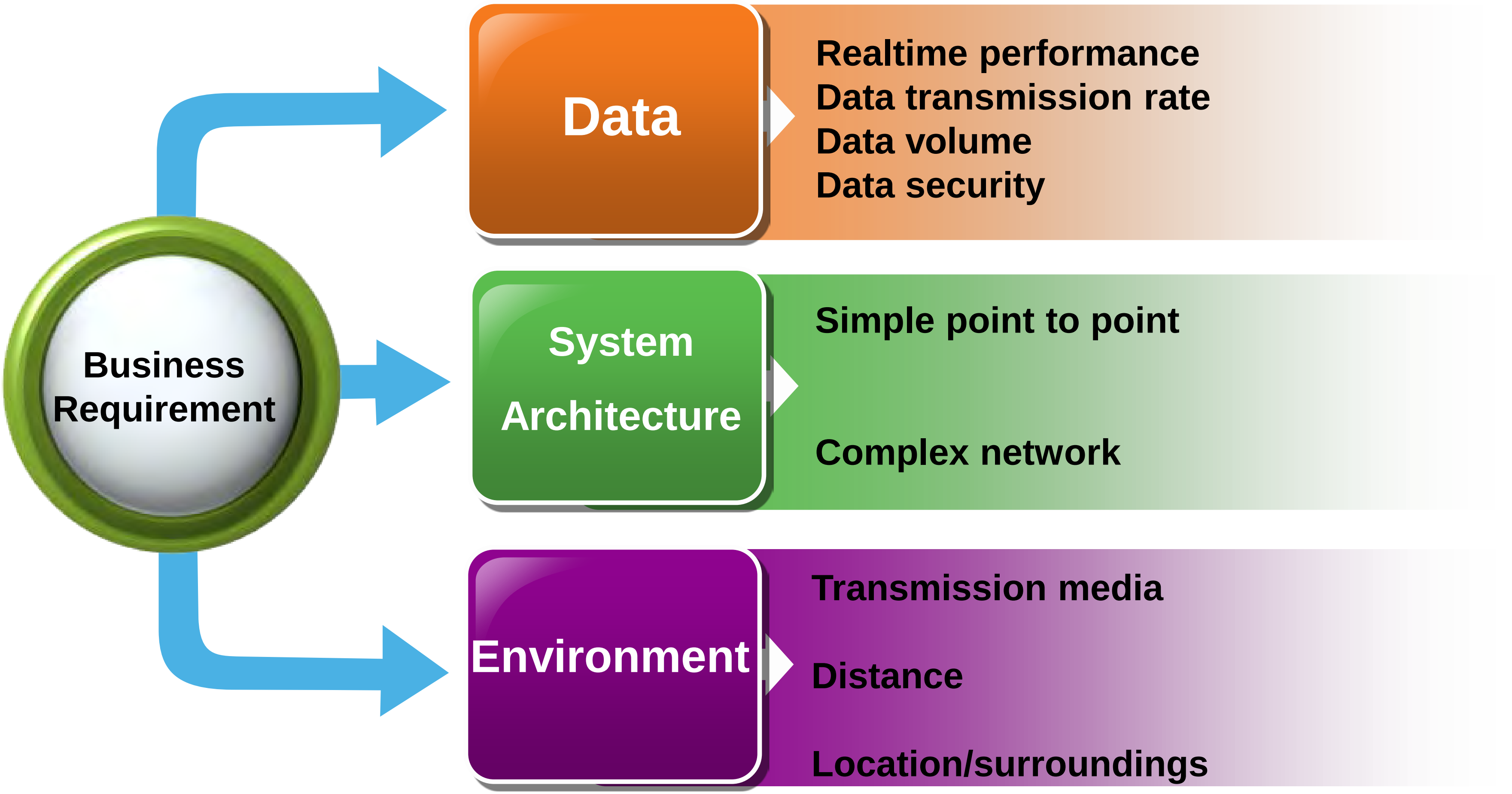
- Long distance/low speed command transmission: 16bps
- Medium speed/medium distance data transmission: 300bps
- High speed/short distance image transmission: 10kbps

Radio & hydro-acoustic integration application





How to choose



Business Requirement

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

System Architecture
- Simple point to point
- Complex network

Environment
- Transmission media
- Distance
- Location/surroundings

Thank You !


Northern Territory
Queensland
AUSTRALIA
OCEANIA
New Caledonia
VANUATU
TONGA
NEW ZEALAND