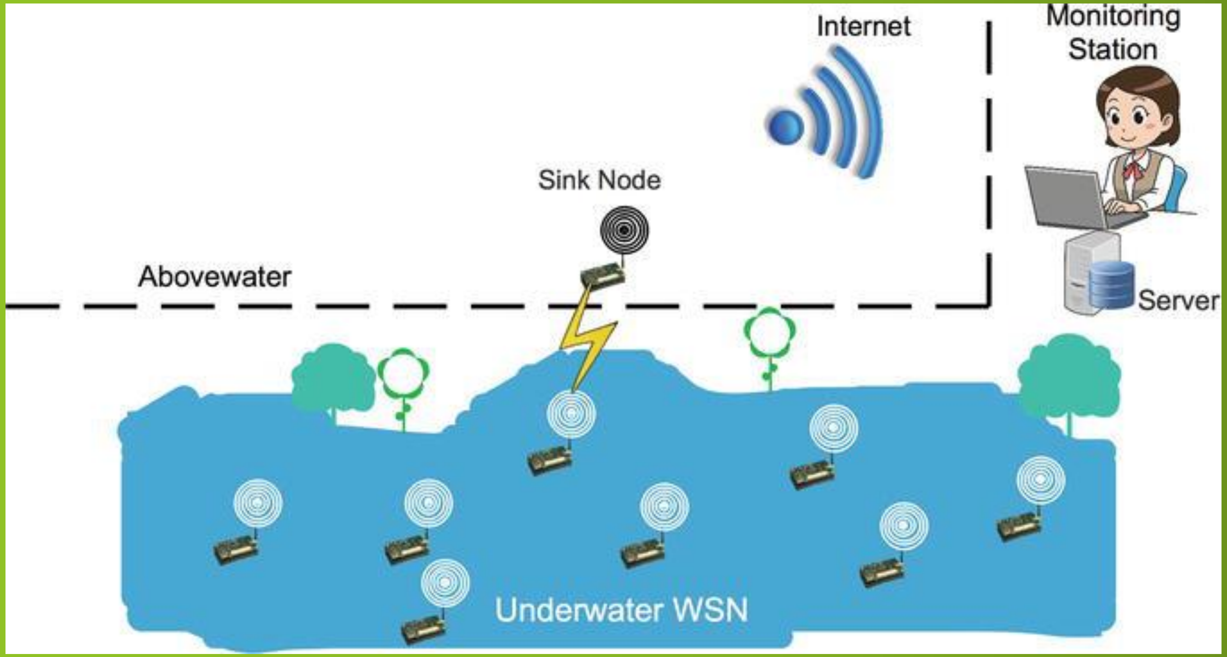
# Underwater Wireless Network Nodes (UWSNs)




**Mr. Mohammad Furqan Ali**
Research Engineer & Ph.D scholar
(Computer Sci. & Wireless Communication Engineering)
School of Computer Science & Robotics
National Research Tomsk Polytechnic University Russia

# Underwater Sensors Architecture

- ❑ Underwater Wireless Acoustic Sensor Networks (UWASNs)
- ❑ Underwater Electromagnetic (RF) Sensor Networks (UWRFSNs)
- ❑ Underwater Wireless Optical Sensor Networks (UWOSNs)

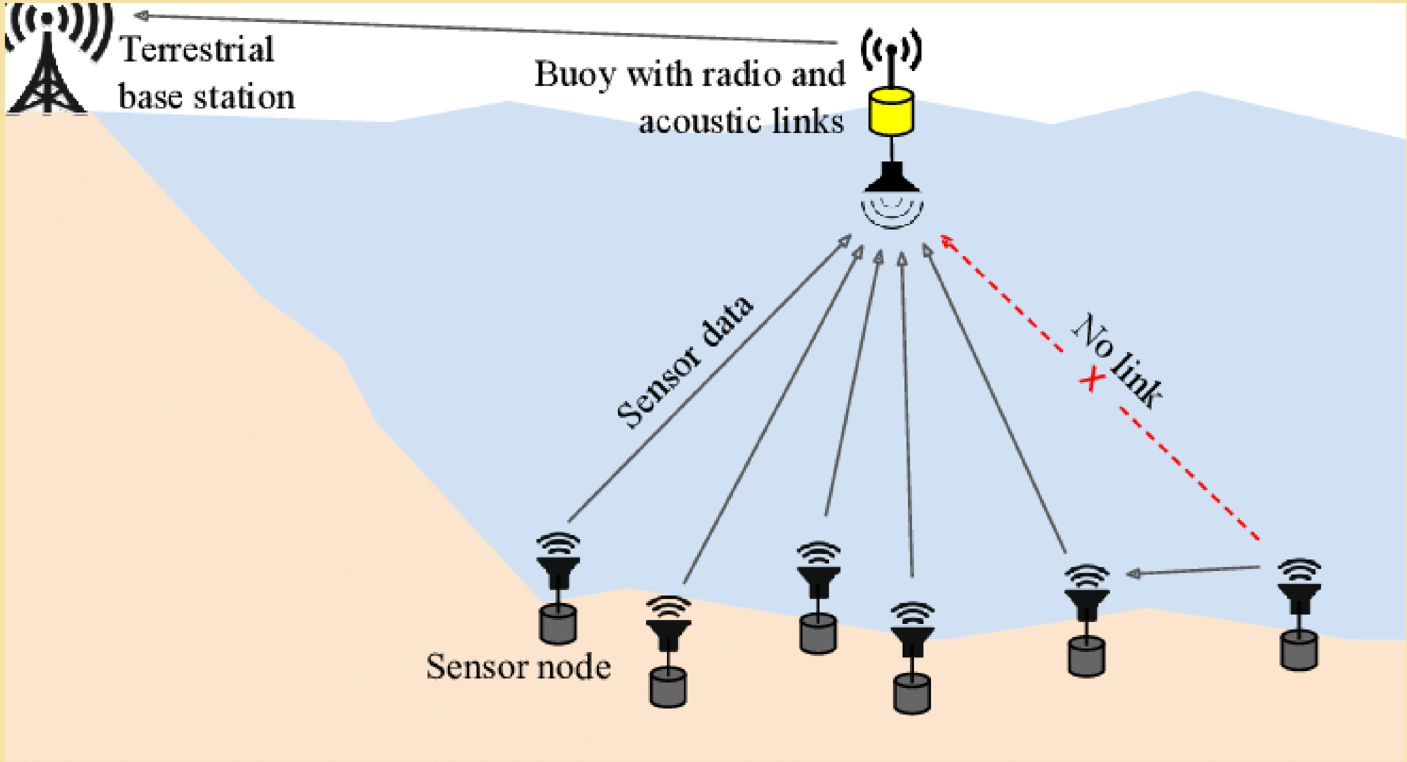



**Fig.1 The Underwater Sensor Network Nodes Architecture**

*Ali, Mohammad Furqan, Dushantha Nalin K. Jayakody, Yury Alexandrovich Chursin, Soféine Affes, and Sonkin Dmitry. "Recent advances and future directions on underwater wireless communications." *Archives of Computational Methods in Engineering* 27, no. 5 (2020): 1379-1412.

# 1D-UWSNs-Architecture

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- UWSNs is commonly used for underwater exploration but quite adequate to meet the demand for real-time streaming and high data rate scenario
- **1D-UWSNs Architecture:-** These are self-employed type of sensor networks. This type of structure could be fixed or anchored with the seabed and shared the sensed with cluster-head
- The **1D-UWSNs Architecture** enables acoustic, EM, and optical communication based
- The **1D-UWSNs Architecture** widely deployable for single-hop communication where the nodes directly communicate with the base-station
- VLC scenario 1D type of UWSNs usable for plenty of underwater applications in shallow waters such as rivers, dams, lakes, etc.

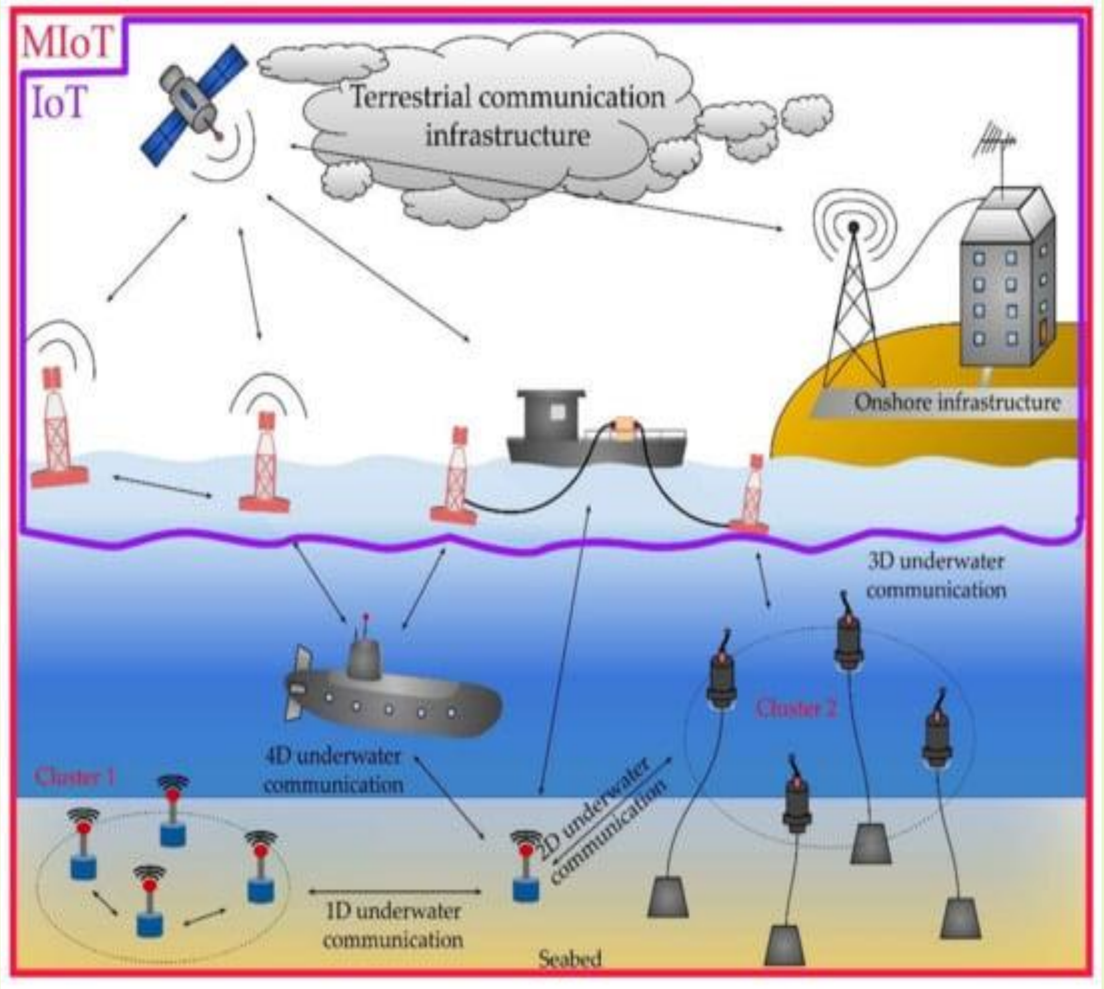
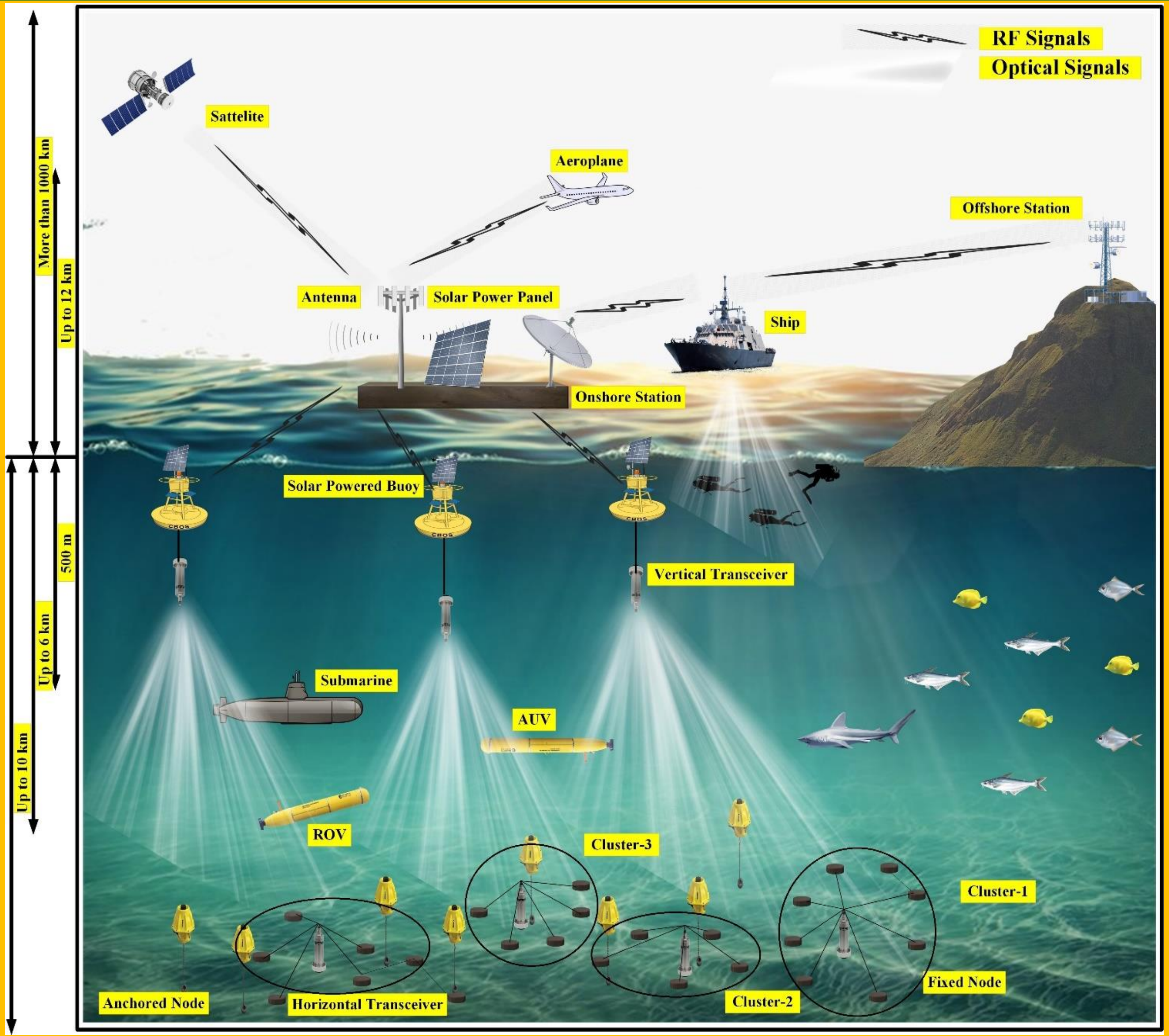



**Fig.2 UWSNs Architecture**

# 2D-UWSNs Architecture




1. These types of structure deployable for underwater environmental monitoring along with the tectonic plates movement
2. The 2D-UWSN refers of grouping sensors as cluster-head
3. The fixed or anchored cluster head collects the sensed data from each node and further transmit to the vertical buoyant transceiver of the base-station
4. The 2D-UWSNs architecture based on acoustic, EM, and optical waves-based wireless signaling technology
5. This type of structure is widely use for long range communication
6. These types of structures are used for short and long-term aquatic mediums

*Ali, Mohammad Furqan, Tharindu Dilshan Ponnimbaduge Perera, and Dushantha Nalin K Jayakody. "O2O: An Underwater VLC Approach in Baltic and North Sea." *Electronics* 11, no. 3 (2022): 321.

# 3D-UWSNs Architecture



- These types of structure deployable for geographical, geo-chemical process, water stream, and for water-pollution monitoring
- 3D-UWSNs are deployed for varying depth (floating nodes)
- The floating nodes collect the sensed data from cluster head and further transmit to the water surface (Base-Station)
- These types of structures use to explore 3D underwater space

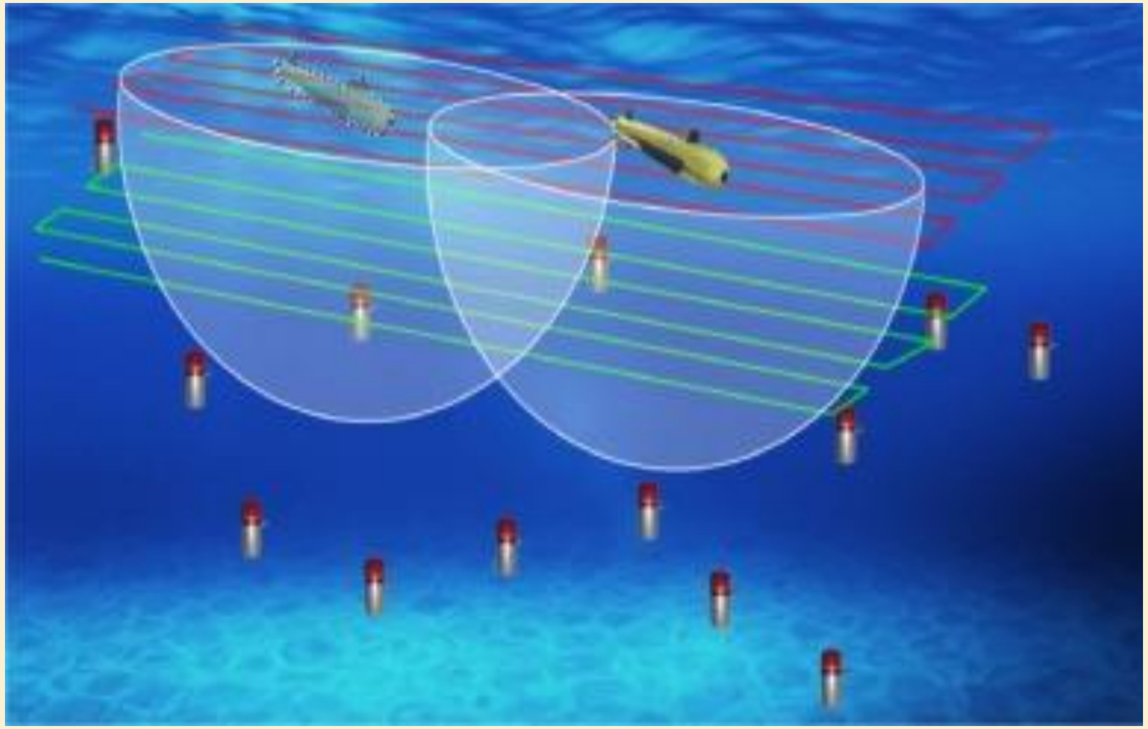


Fig.4 The 3D types of UWSNs

*Ali, Mohammad Furqan, Dushantha Nalin K. Jayakody, and Yonghui Li. "Recent trends in underwater visible light communication (UVLC) systems." *IEEE Access* 10 (2022): 22169-22225.
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# 4D-UWSNs Architecture

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- These types of structure combines the anchored nodes with the floating or mobile UWSNs
- 4D-UWSNs are deployed for long range vertical and horizontal ranges
- Remotely operated vehicles (ROVs), submersible robots, ships and submarine are the best example of 4D-UWSNs
- These types of structures use for mapping and natural source in water mediums

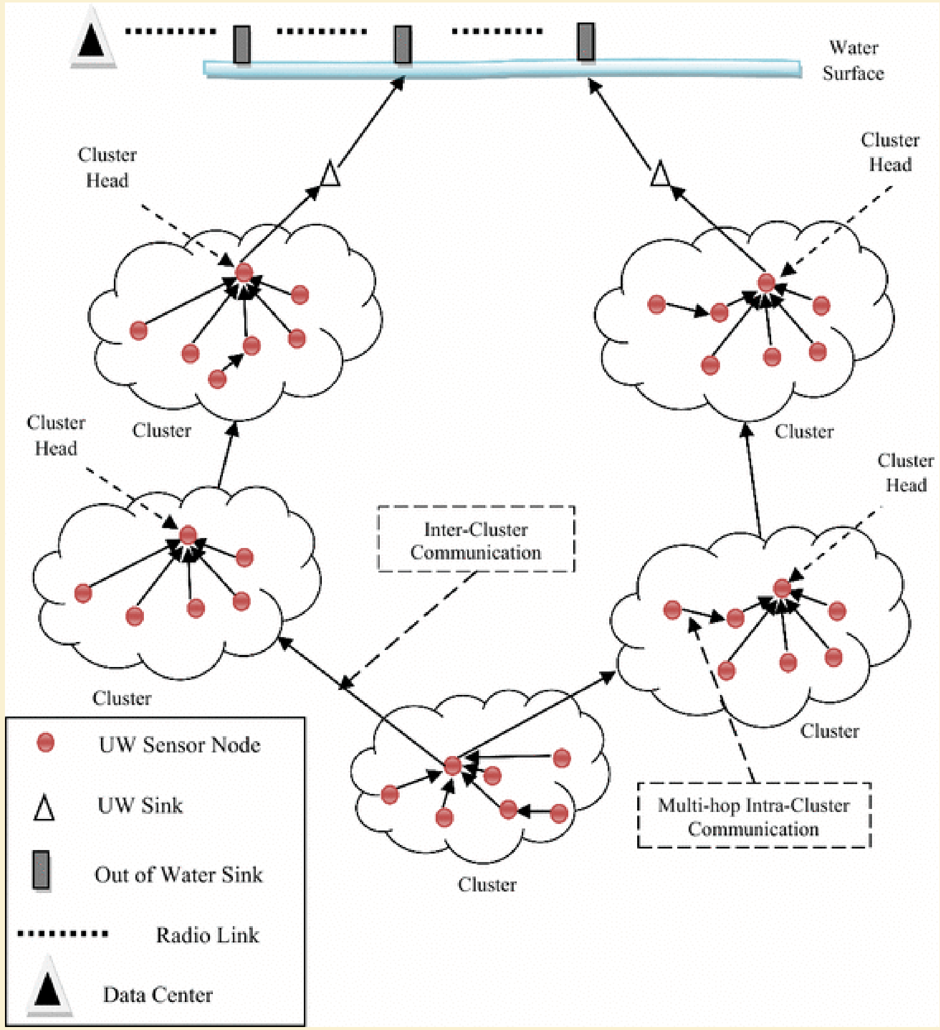


Fig.4 The 4D types of UWSNs


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# Hydrophones Structures

- Hydrophones are an array of underwater sensor networks
- It produce a limited voltage signal over high-frequency range while receiving the underwater sounds from any direction
- Omnidirectional and Hemi-directional hydrophones support to collect the sound from a particular direction such as to track the movement of underwater species
- This type of structures are widely used for long-term dataset of global ocean acoustic environment

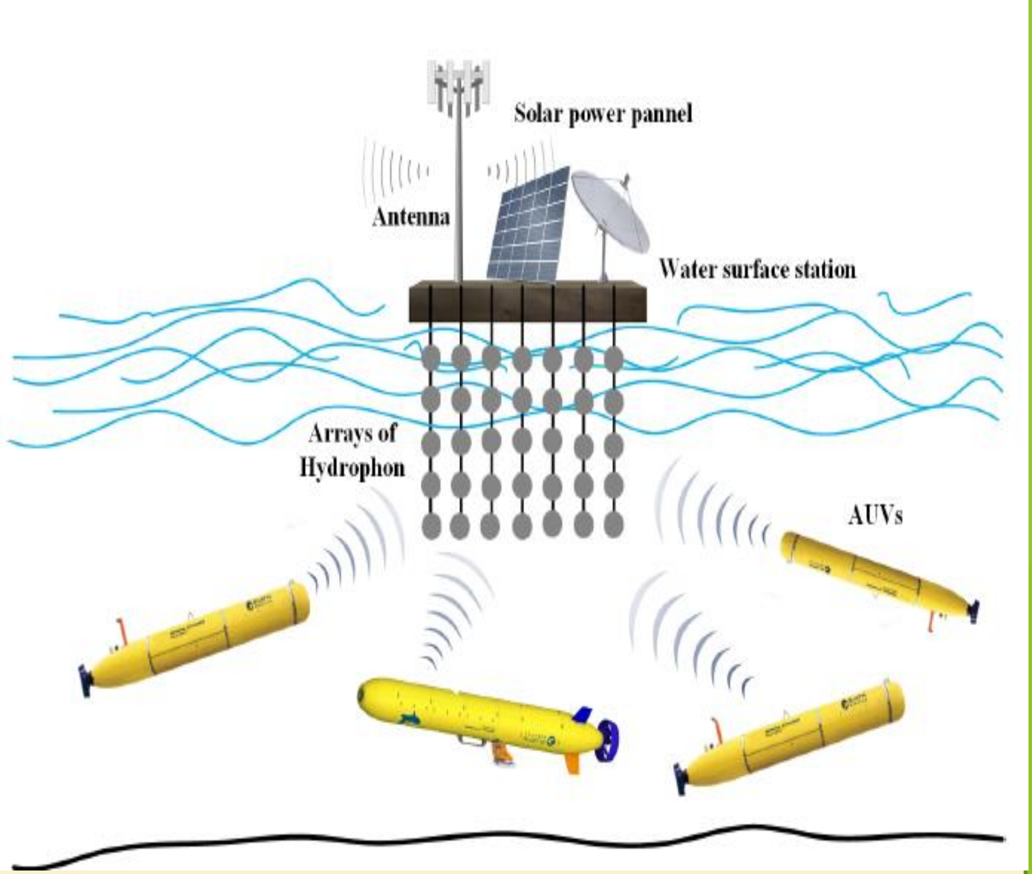


Fig.5 The Hydrophone array structure

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# UWSNs Emerging Techniques

- Energy harvesting
- Massive MIMO System Aided Underwater Communication
- Non-Orthogonal Multiple Access (NOMA)
- Mm-Waves Enabled underwater communication

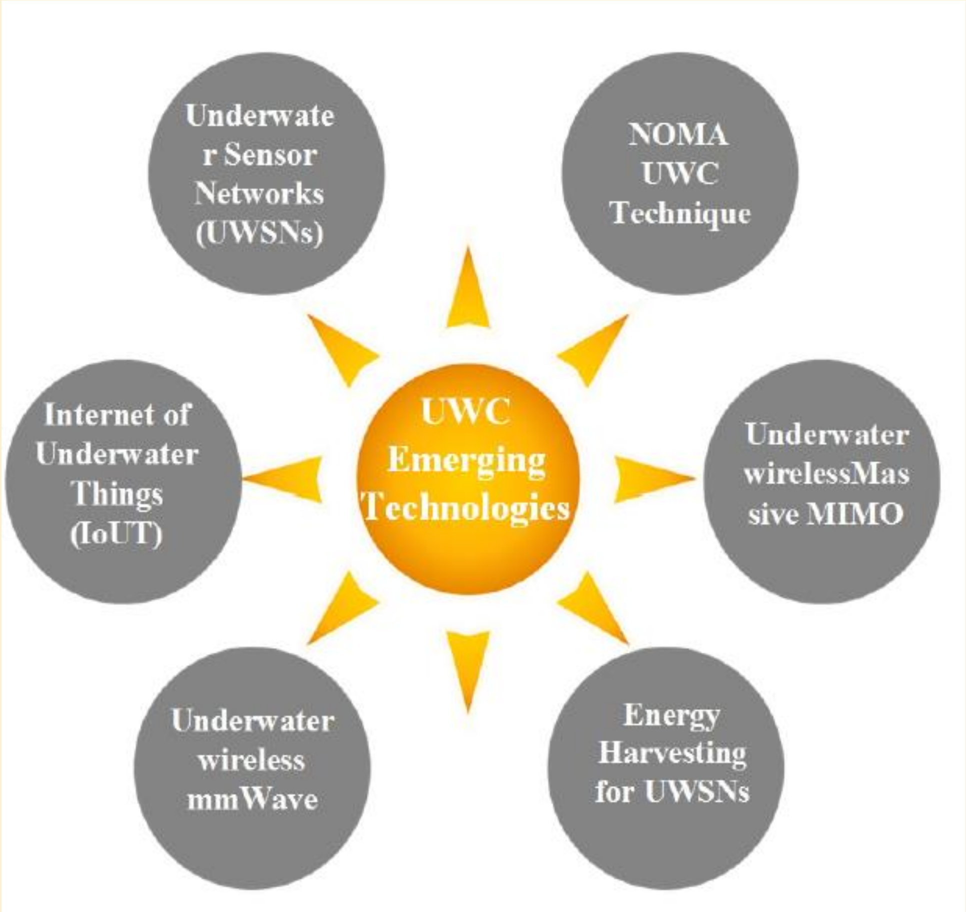


Fig.5 Emerging Techniques


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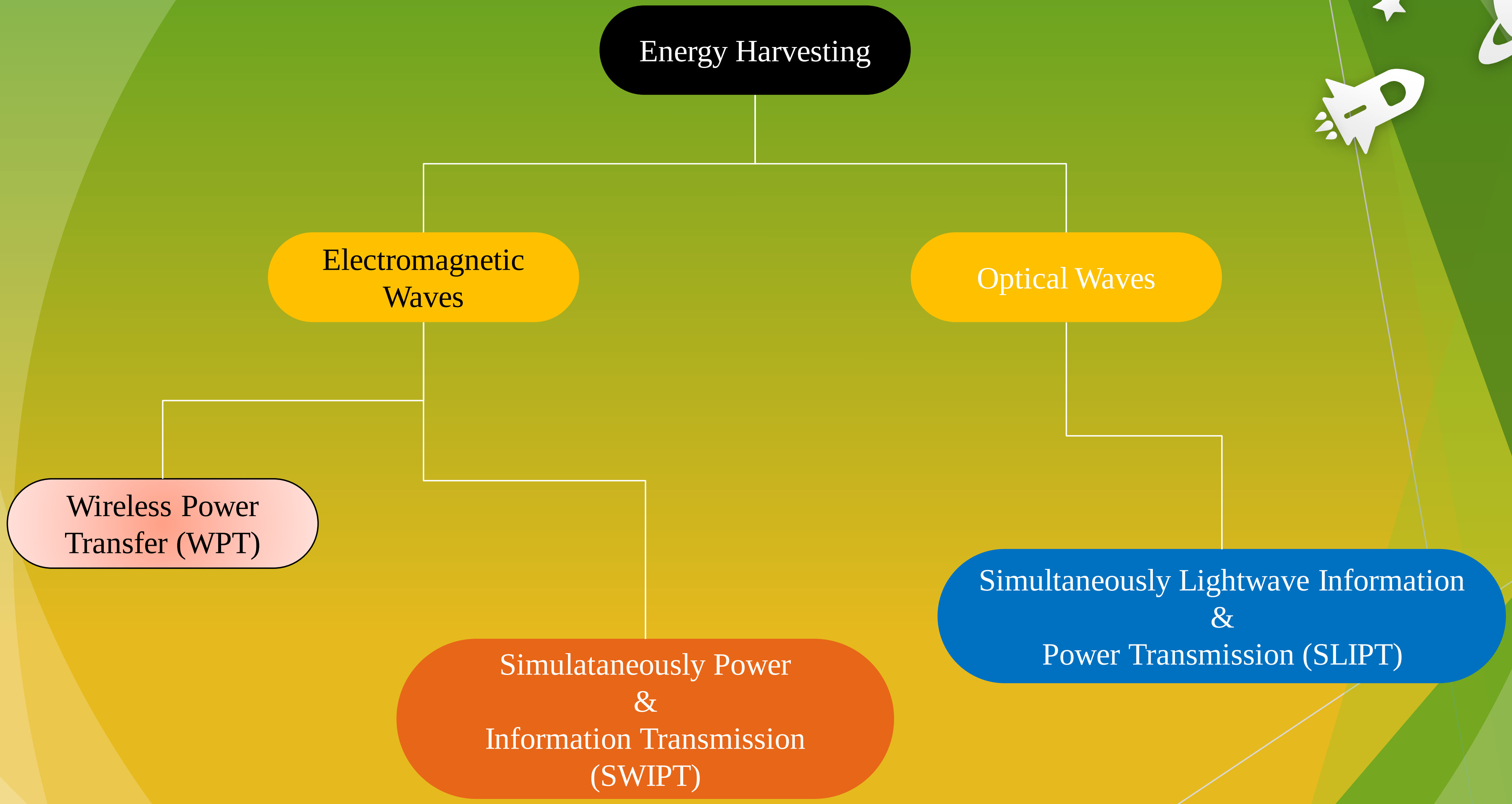
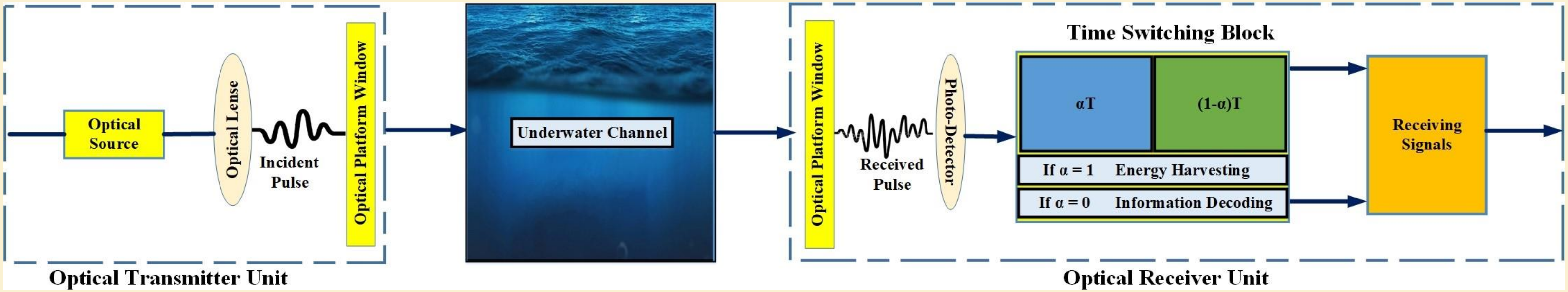
# Wireless Energy Harvesting (EH)

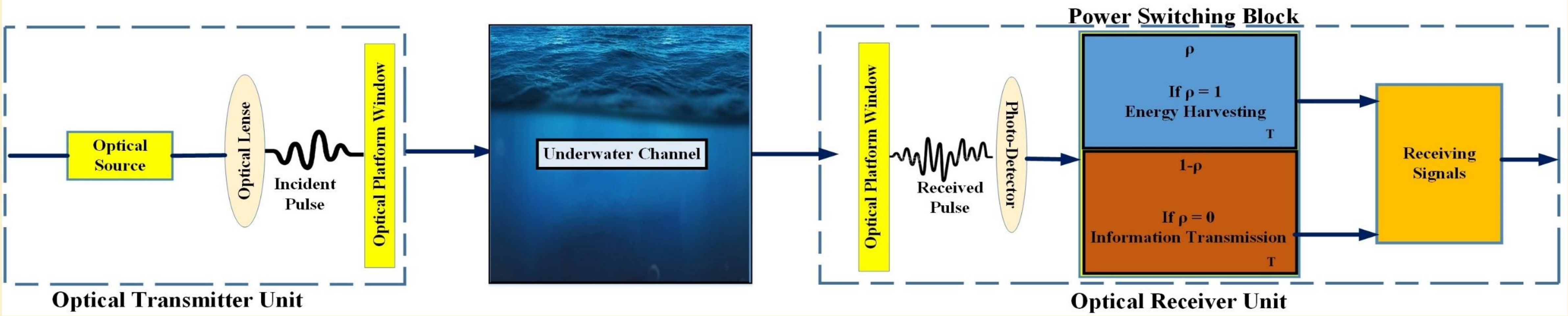


# EH Underwater

- ❑ ***Time Switching (TS) Protocol**:-The signal splits into two time fraction coefficients where one is responsible for energy harvesting while other uses for information decoding




- ❑ ***Power Switching (PS) Protocol**:-The signal splits into two power fraction coefficients where one is responsible for energy harvesting while other uses for information decoding

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# Thank You
# &
# Questions