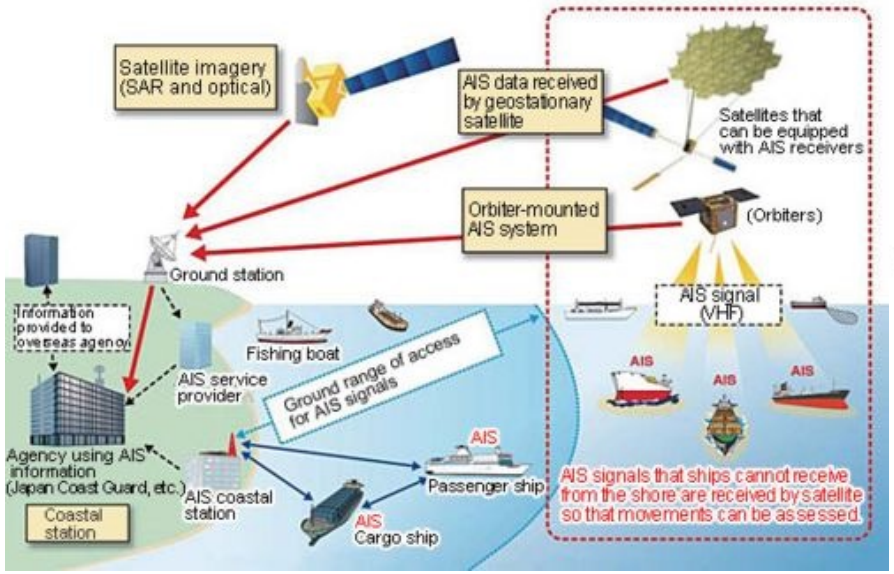
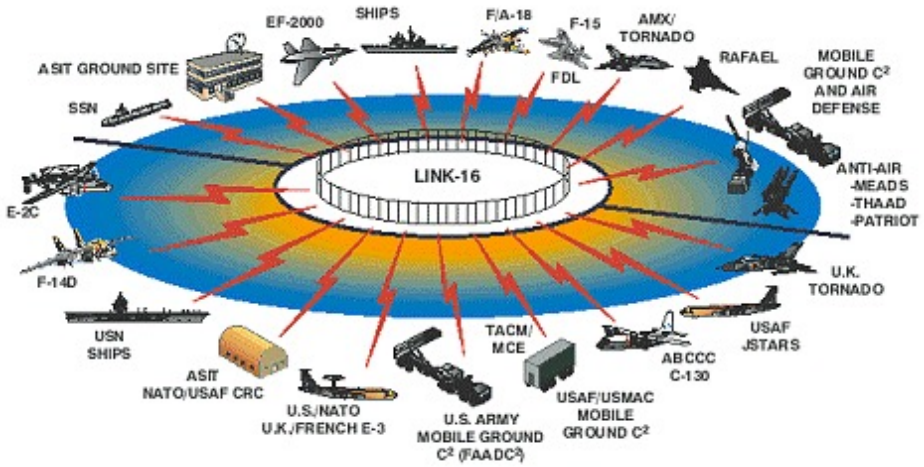
5G Enabled Maritime Wi-Fi Buoy (FiBu)

IW4500

Summer 2020 Quarter

Bridging Capabilities



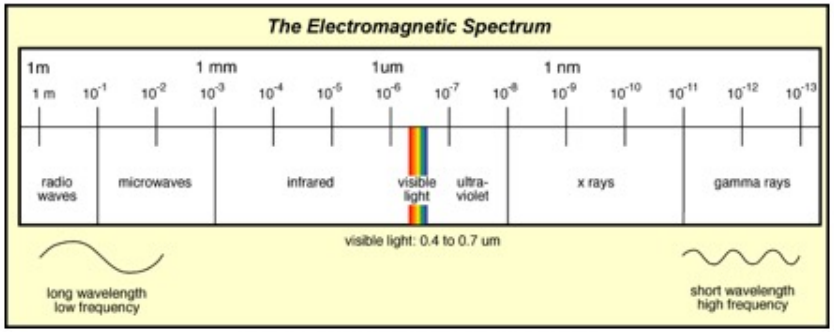


The Indo-Pacific, EABO, and UxS

- Archipelagos, vast distances, and numerous countries describe the Western Pacific.
- Expeditionary Advance Base Operations will employ non-permanent locations to evade adversary targeting.
- Unmanned systems (UxS) associated with the EABO will require automated power and communications infrastructure in order to provide a useful military function.

Western Pacific

The 5G Network Environment



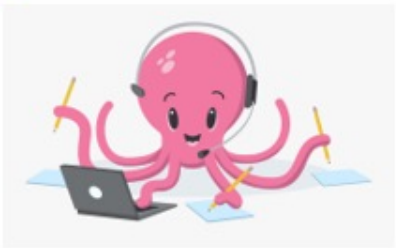
Millimeter Wavelengths

Full Duplex

5G Networks

Small Cells

Beamforming



Massive MIMO

Exemplar System

<u>What it is:</u>

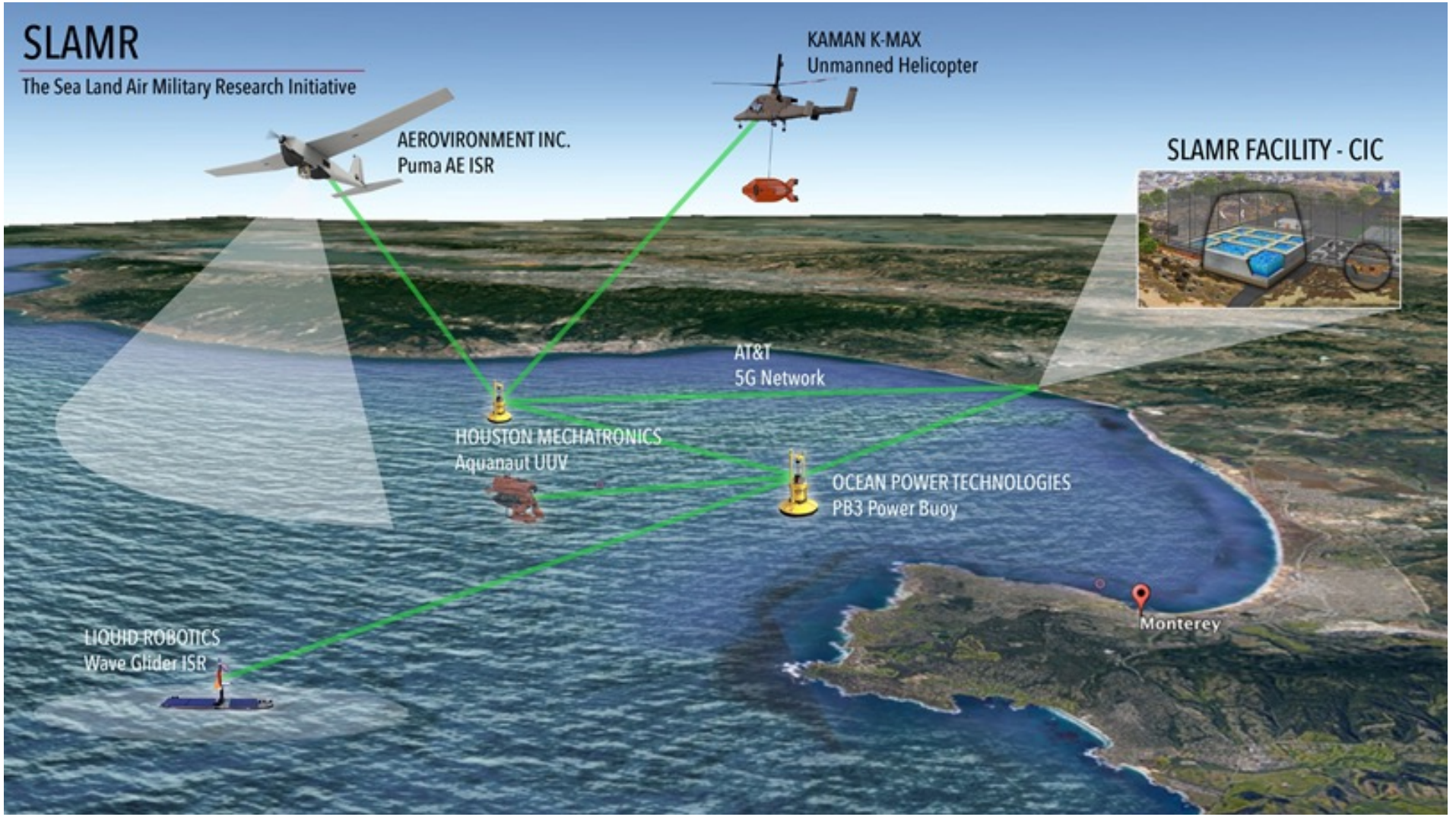
- Ocean Power Technologies PB3 Powerbuoy
- Utilizes wave energy for electricity generation with sub-surface battery storage
- Developed to connect sea and shore facilities via data transmission.
- Currently used in the offshore oil and gas production industry.

<u>Why it is exemplary:</u>

- Proven capability in power generation
- Designed for the appropriate environment
- Currently researching network hosting on the buoy

DIMENSIONS	ELECTRICAL
Height: 13.3 m	Continuous Average Power based on 8.4 kWh/Day (typical) (Annual Average: Site Dependent)
Draft: 9.28 m	Payload Peak Power: up to 3 kW peak power to load: 7.5 kW (custom)
Spar Diameter 1.0 m Float Diameter: 2.65 m	Nominal Battery Capacity (ESS): 50 kWh (approx.); Modular and Scalable to 100, 150 kWh (appx.)
Weight: 8,300 kg	Zero wave day capacity: 100 W load for 1+ weeks (50 kWh ESS)
MOORING	DC Output: 24 V and 300 V (standard) 5 V to 600 V (custom)
Type: Single point or 3 point	Power Generation Sea States: 1 - 5
Point: Anchor or shackle	
Min Depth: 25 m	
Max Depth w/ standard design: 1,000 m*	*Other mooring designs available for deeper deployments

PB3 Testing



Notional Representation

FiBu

- Requirements include:
  - Ship deployable and recoverable
    - Must keep operational pace with EABO
  - Moored
    - Reduces power demand
  - Power generation and storage
    - Cannot require outside “tending”
  - Edge computing
    - Reduces computational load on UxS
  - 5G Local network for UxS control and computing
    - Reduces computational load on UxS
  - High bandwidth long range communications
    - Connects local networks to larger networks
  - Docking for UxS charging and data transfer
    - Disperses UxS away from easily found ships
  - Organic sensors
    - Provide “trip wires” for EABO

Note: Requirements internally generated and not sourced from outside information.

Use Case Scenario: USS Cole Bombing

- Current: OPT Buoy-mounted surveillance (in development)
- Use Case
  - USS Cole (DDG-67) Bombing (12 Oct 2000)
  - Avatars: Crew of USS Cole; Minion: Al-Qaeda terrorists

  DTG: 120630Z OCT 00

  USS Cole arrives in Aden harbor for routine fueling and begins mooring to waterborne "dolphin" platform, 600 meters offshore the quayside.

  DTG: 120730Z OCT 00

  Cole completes mooring and begins fueling on the "dolphin."

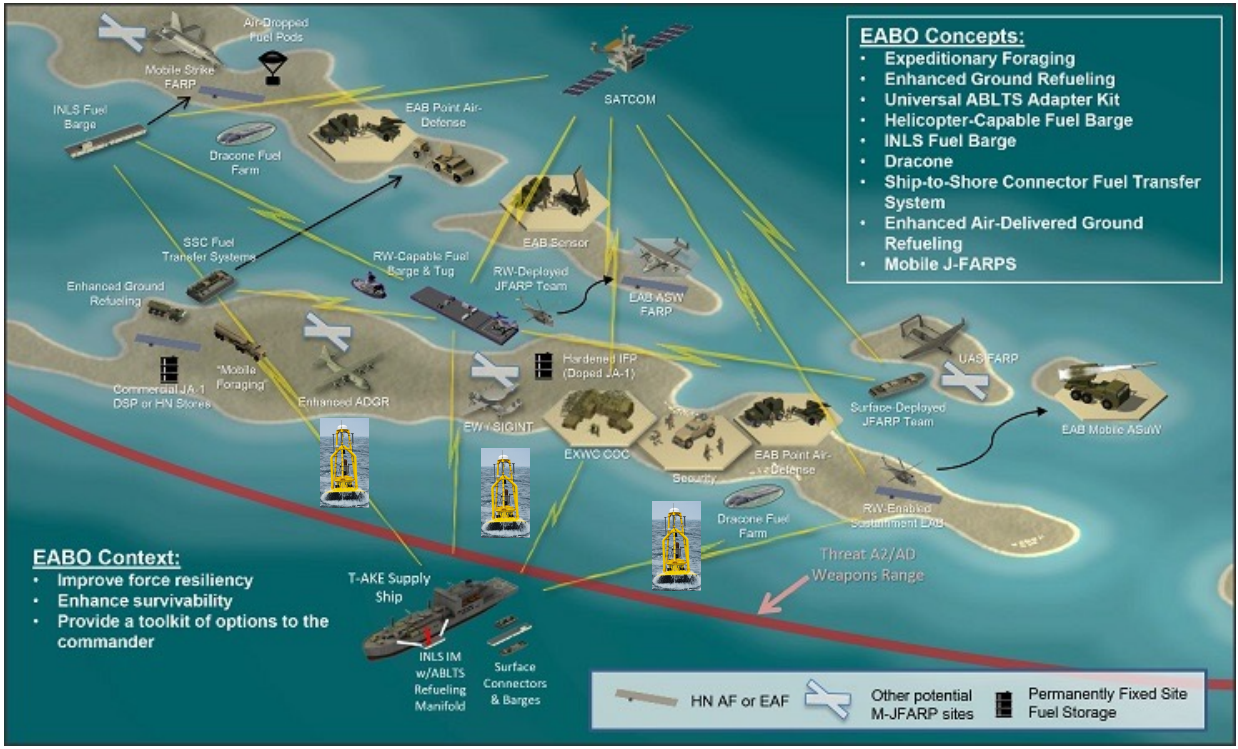
  DTG: 120818Z OCT 00

  A small, fiberglass boat approaches the *Cole* on her port side and detonates.

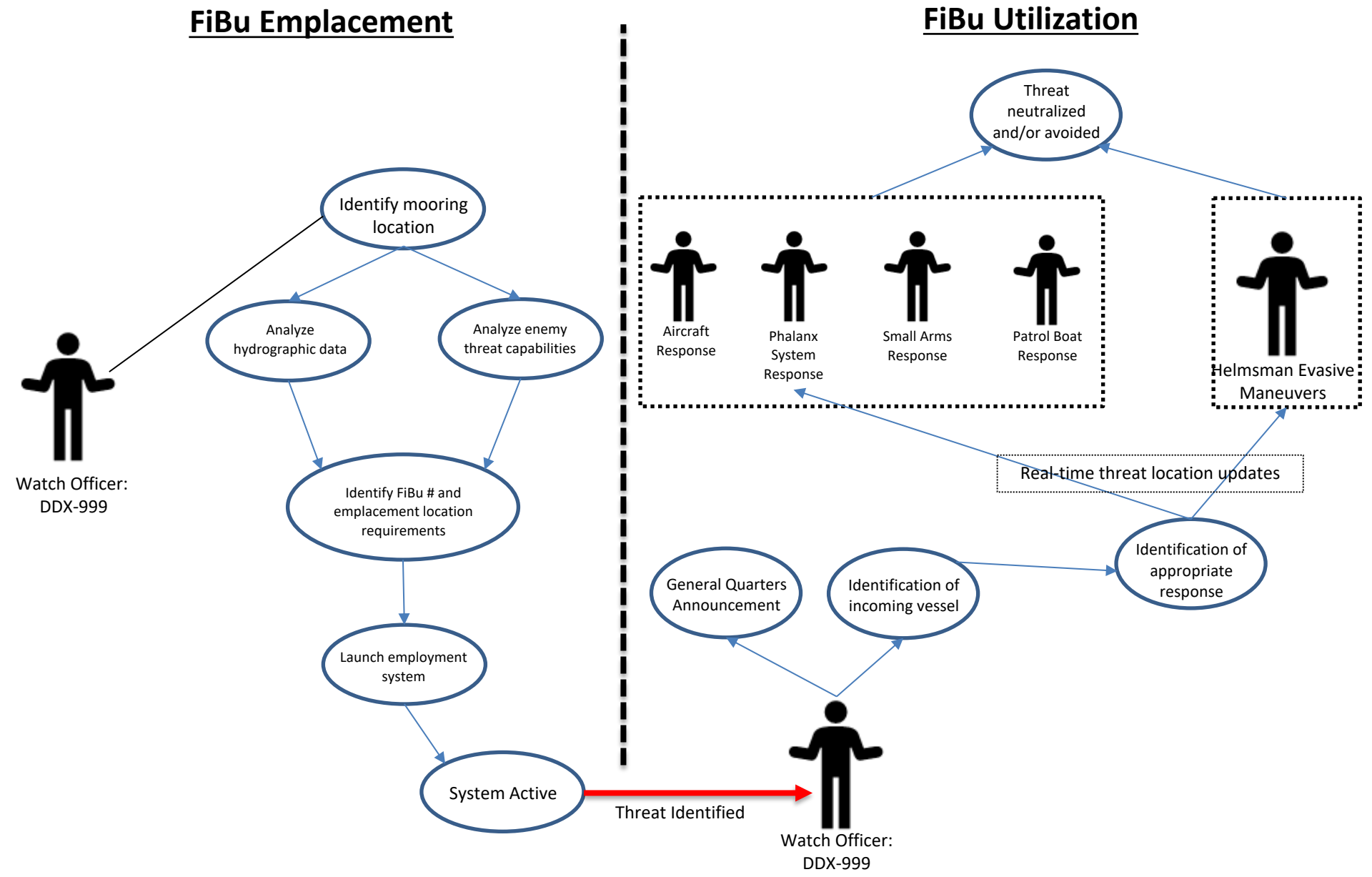
- Lessons Learned:
  - There was no coordinated effort to track the movement of small boats in the harbor;
  - Fire hoses and crew were not ready to drive away any small craft that came too close;
  - The *Cole*'s own small boat, which should have been used to investigate the approach of any suspicious craft, was not ready for launching.

Use Case Scenario: Future Use

- USS Floating Fortress (DDX 999) arrives in Aden harbor for routine fueling and begins emplacing buoys via shipboard crane. Employment pattern is one ring, 600 meters offshore the quayside.
- Buoy system automatically initiates as each unit is deployed. System connects to shipboard CIC for monitoring of proximity threats and emplaced mines. Initial system checks report strength of signal between nodes. Solar and wave power estimates generated in *Fortress'* combat systems.
- *Floating Fortress'* 5G enabled system in place and operational. Each buoy is spaced roughly 200m apart in one ring of radius 0.5NM from ship. Ring spacing is condensed on landward side due to space constraints. *Floating Fortress'* begins mooring for follow-on fuel, deploys patrol boats for surveillance.
- Buoy system detects approach of small fiberglass boat through defense ring and sends alert to patrol boats, Combat Systems, armed and roving deck watch-standers, and fire-fighting personnel.
- Patrol boat crews receive SITREP and maneuver to threat, defensive measures aboard ship ready.
- Boat crew intercepts and challenges approaching small boat, forcing aggressor into course correction and incident avoidance.



Use Case Diagram (Future)



FiBu and 5G

What are the implications
and impacts to the Marine Corps?

Category	Negligible	Low	Medium	High
Doctrine		X		
Organization			X	
Training				X
Material				X
Leadership		X		
Personnel			X	
Facilities			X	

Doctrine – Low Impact

- *Doctrine: the way we fight, e.g., emphasizing maneuver warfare combined air-ground campaigns.*
- No significant changes to doctrine because we are looking to enhance the method of communications not alter why or what we communicate on the battlefield.
- Capability enhances real-time communication while extending the range of the Common Operational Picture.
- Enhances the integration of Naval capabilities with Marine Corps capabilities, primarily for amphibious operations.
- Buoys would support decentralizing command to smaller squad-size elements.
- Increased flexibility to support EABO and naval operations.
- "Distributed Operations (DO) capable forces are a critically important component of Marine Corps modernization." (CPG)
- "Maneuver across the seaward and landward portions of complex littorals; and sense, shoot, and sustain while combining the physical and information domains to achieve desired outcomes." (CPG)

Organization – Medium Impact

- *Organization: how we organize to fight; divisions, air wings, Marine-Air Ground Task Forces (MAGTFs), etc.*
- Establish Marines that understand 5G capabilities within existing communications organizations of all MEFs in order to facilitates its tactical and operational uses.
- Additional detachment support to MEU/MEB integrated with existing communications organizations.
- Smaller, task-organized units could deploy to remote islands and littoral environments and maintain communications.
- "Smallest, lowest signature options that yield the maximum operational utility." (CPG)

Training – High Impact

- *Training: how we prepare to fight tactically; basic training to advanced individual training, various types of unit training, joint exercises, etc.*
- Training at all levels (strategic, operational, tactical)
- Educate the warfighter of the presence and functions of buoys, how to access and use the information.
- Addition to communications MOS school for 5G capabilities training.
- Addition to communication systems maintenance MOS school for maintaining and troubleshooting 5G systems.
- Additional amphibious operations service-level training implementing buoys.

Material – High Impact

- *Materiel: all the "stuff" necessary to equip our forces, that is, weapons, spares, etc. so they can operate effectively.*
- Environmentally-sensitive buoy construction material (to neither harm nor encourage sea life).
- Water compatible construction material (to reduce cleaning and maintenance requirements).
- Add tiny device appendages to vehicles, aircraft, and other equipment that connect/expand the 5G network.
- Interfacing with aviation assets must be NATOPs approved before devices can be placed on aviation assets.
- Hand-held or attached devices that connect to buoy.

Leadership – Low Impact

- *Leadership and education: how we prepare our leaders to lead the fight from squad leader to 4-star general/admiral; professional development.*
- Educate all levels as to 5G capabilities and flexibility created by buoy network on sea to land.
- Continue to emphasis denial of services training and resiliency.
- Squad level: send reports quickly over device.

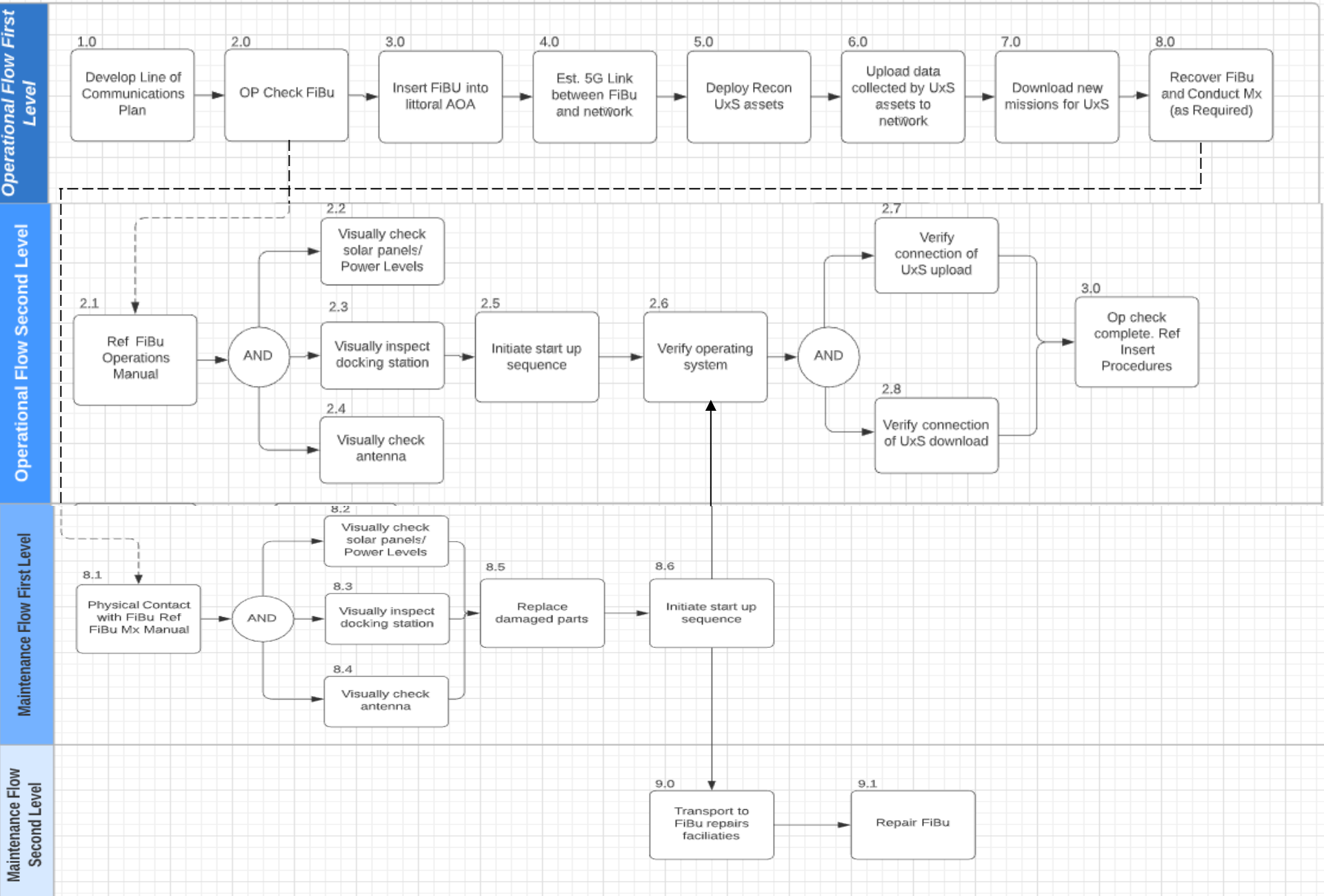
Personnel – Medium Impact

- *Personnel: availability of qualified people for peacetime, wartime, and various contingency operations*.
- Create additional 5G MOS with knowledge set to operate, troubleshoot, maintain (1st and 2nd echelon) the physical buoy device.
- 5G Marine to work in conjunction with other MOSs who have established the network.
- 3rd echelon maintenance to remain with manufacturer.

Facilities – Medium Impact

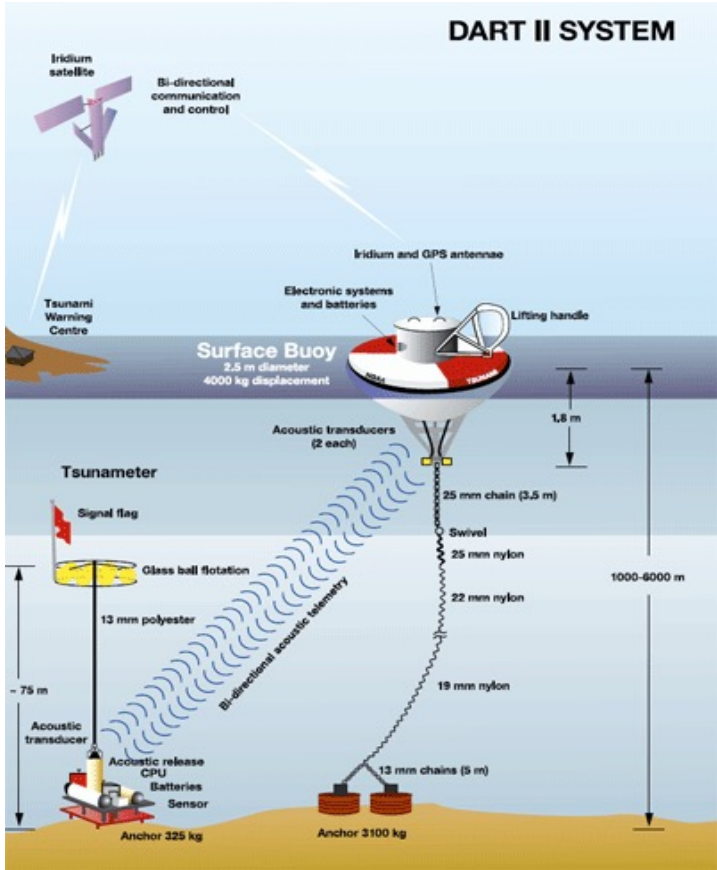
- *Facilities: real property; installations and industrial facilities (e.g. government owned ammunition production facilities) that support our forces.*
- Buoy is considered an independent facility.
- Regularly scheduled servicing/maintenance required.
- Network of buoys that feed data into a network accessible by many distributed devices.

FiBu Systems Diagram



Topics for Consideration

- Change mission statement?
  - To reduce manpower required to monitor ingress / egress routes and nearby littorals --> "To monitor naval LOCs and friendly littorals."
- Is there an existing "appropriate network" which the system needs to be tied to?
  - Link 16 operates in RF band 960-1215 MHz which limits use to LOS however coupled when with TCP/IP (satellite) connections can range OTH
  - Automatic Identification System (AIS) operates in VHF mobile maritime band
  - Assuming current networks will become obsolete and 5G-supported network will exist?
- Desired comms architecture for buoy-to-buoy comms?
- Power efficiency of solar panels?
- Can we use existing hydro-powered technology for our system?
- Power consumption for desired capabilities on buoy?
  - Sonar
  - Radar
  - Full-Motion Video (FMV)
  - Electronic Warfare (EW)
- Does the buoy need to be surface-based?
- Overall use?
  - Contractor Owned/Contractor Operated (CO/CO)
  - Government Owned/Government Operated (GO/GO)
  - Any combination of the two
  - Maintenance and repair (USN vice USMC funding)



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