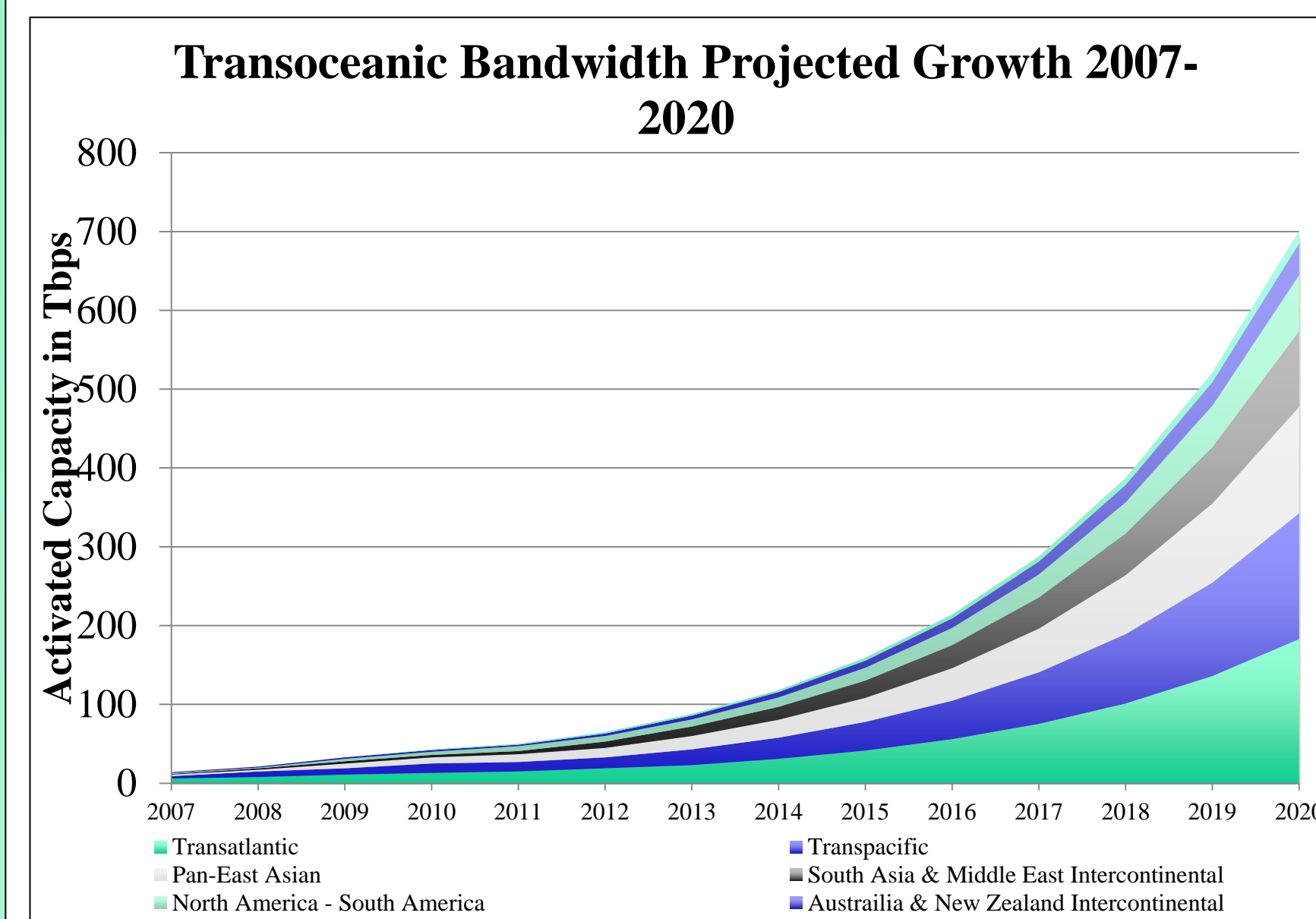


## CONTEXT



Underwater cables' main purpose is to transmit valuable financial data and government communications.

\$11.8 billion investment in new cables from 2008-2014  
31 New cable systems worth \$4.8 billion will come online by 2017.

Approximately 150 faults reported per year. Over 20% are unknown causes. When the cause is known, identifying a responsible party is difficult.

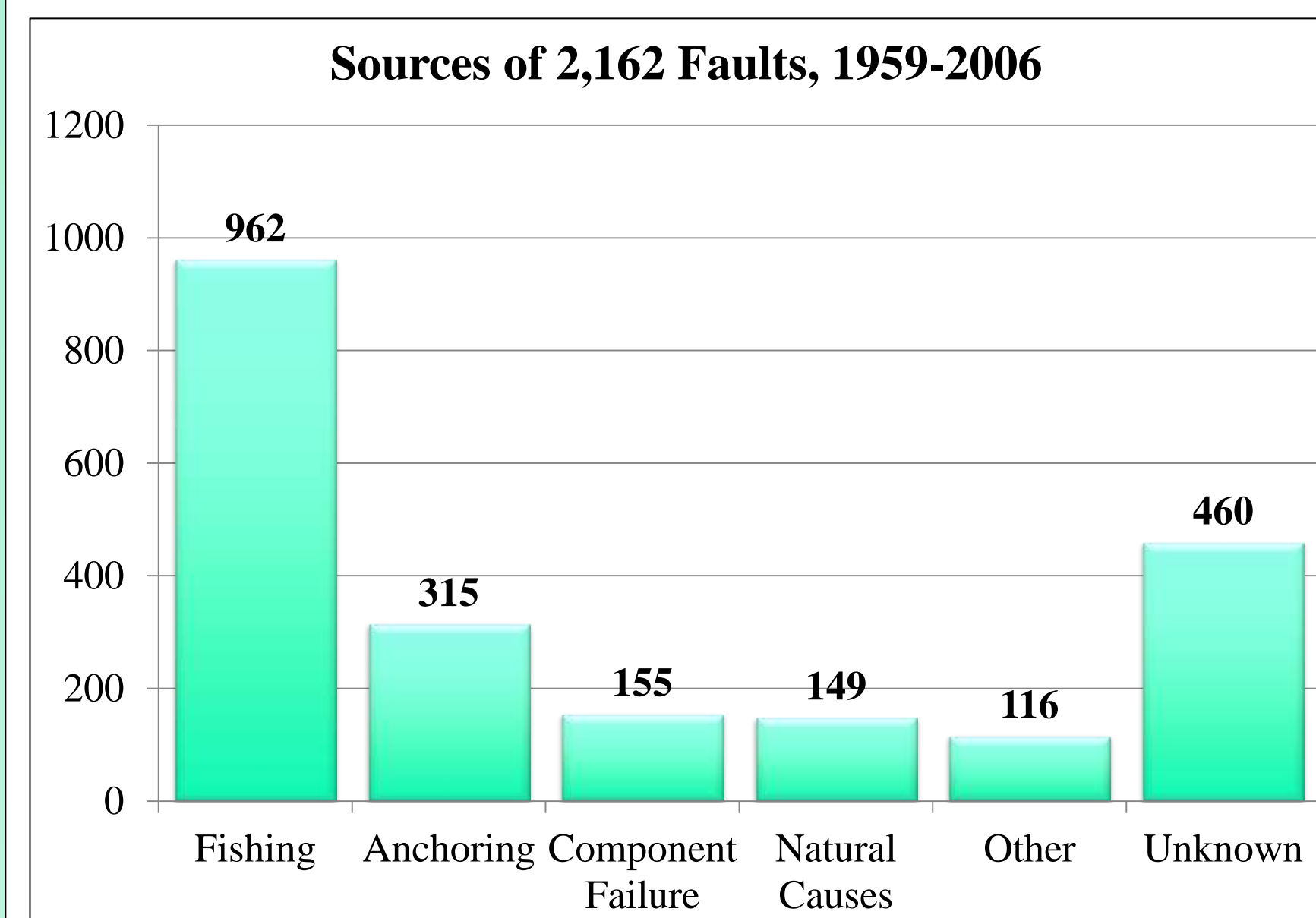
70% of faults occur in water of less than 200m deep.

Each fault costs millions of dollars in lost bandwidth revenue and repair costs.

Increasing fears of intentional cable sabotage and espionage.

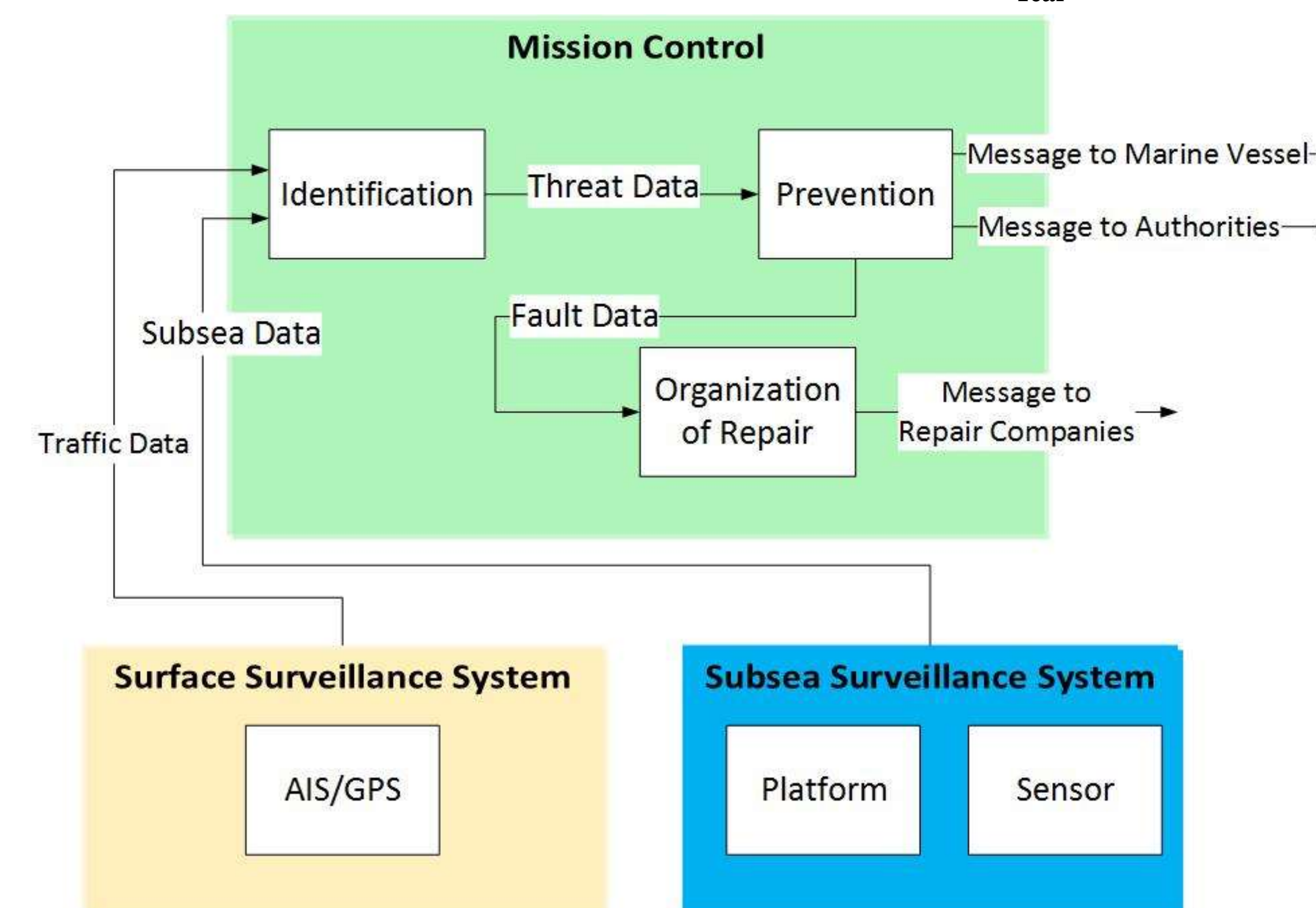
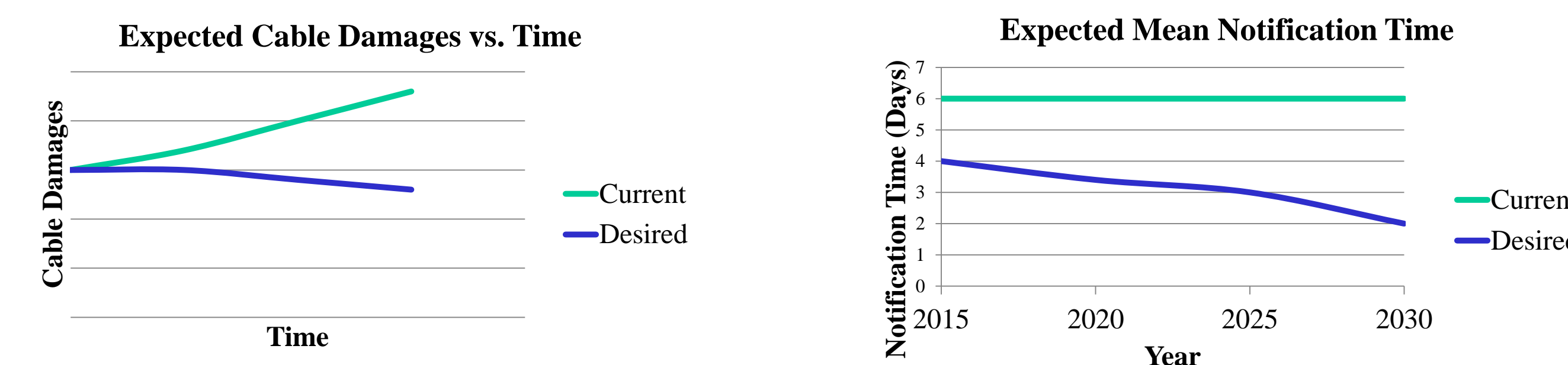
No central database or logging of threats/faults exists.

Current cable protection technologies (cable armor and burial) and international organizations and treaties (ICPC, ACMA, and NASCA) are not impactful.



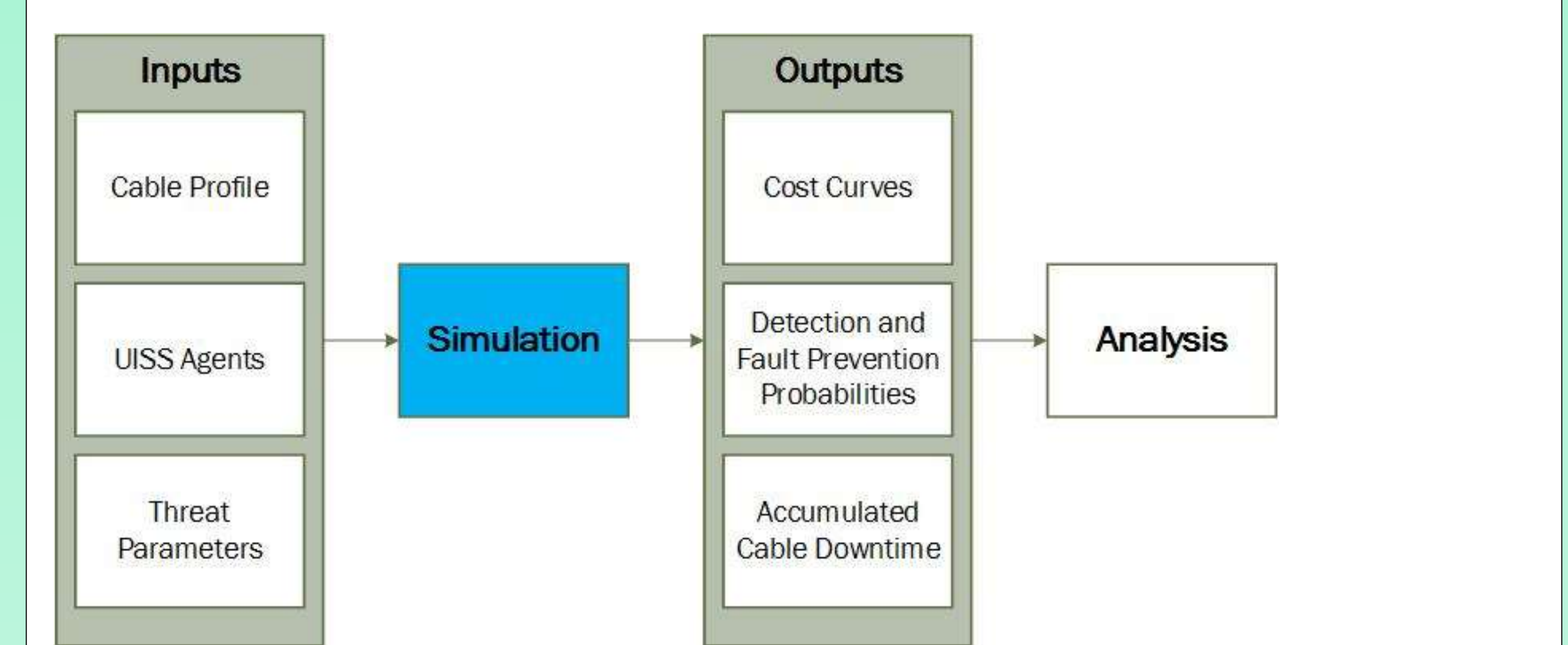
## NEED STATEMENT & OPSCON

**NEED STATEMENT:** There is a need to increase surveillance of cables in order to decrease the number of faults, increase the rate of detection, and improve the mean notification time of damaged cables.



## ALTERNATIVES & SIMULATION

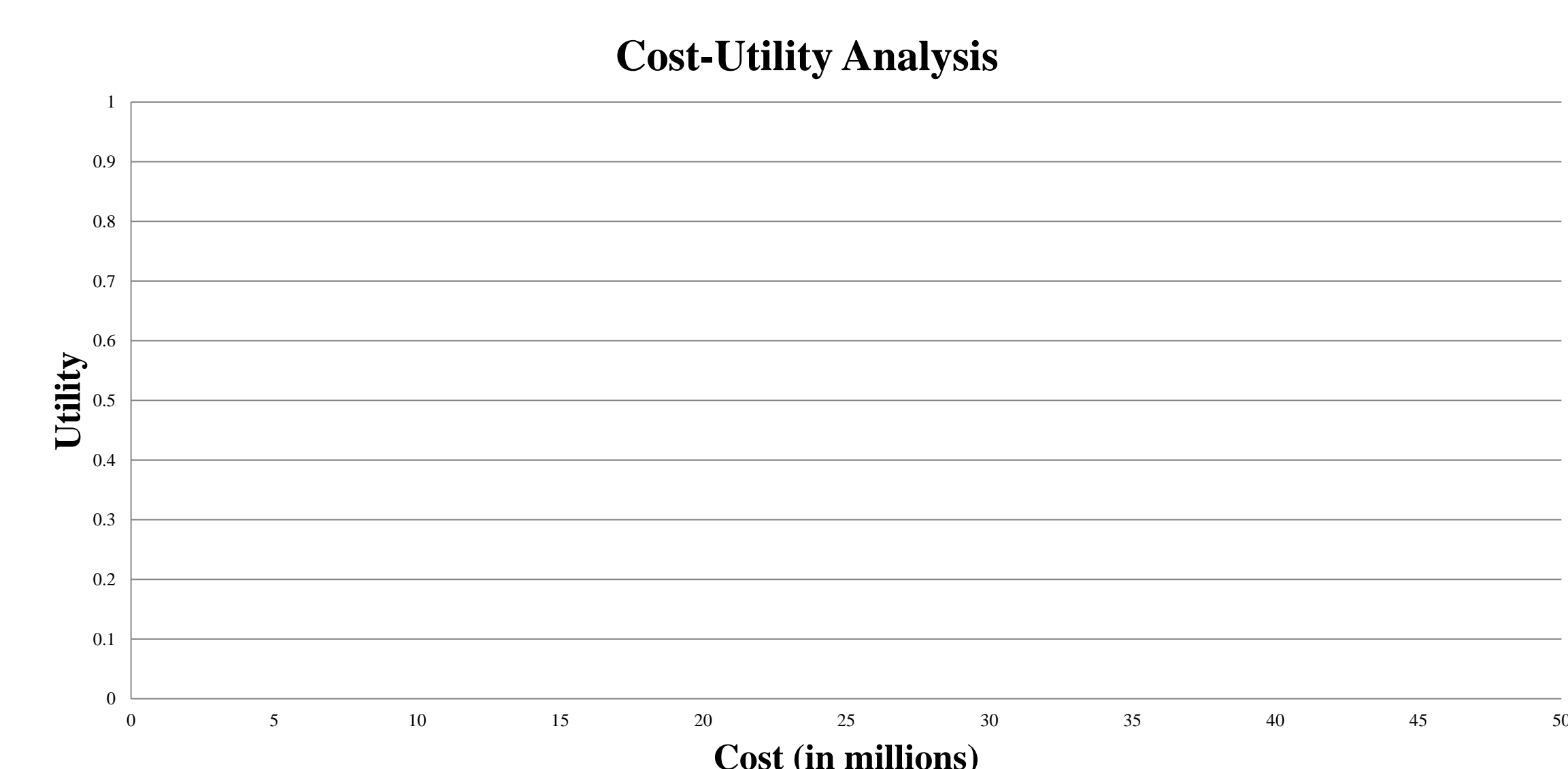
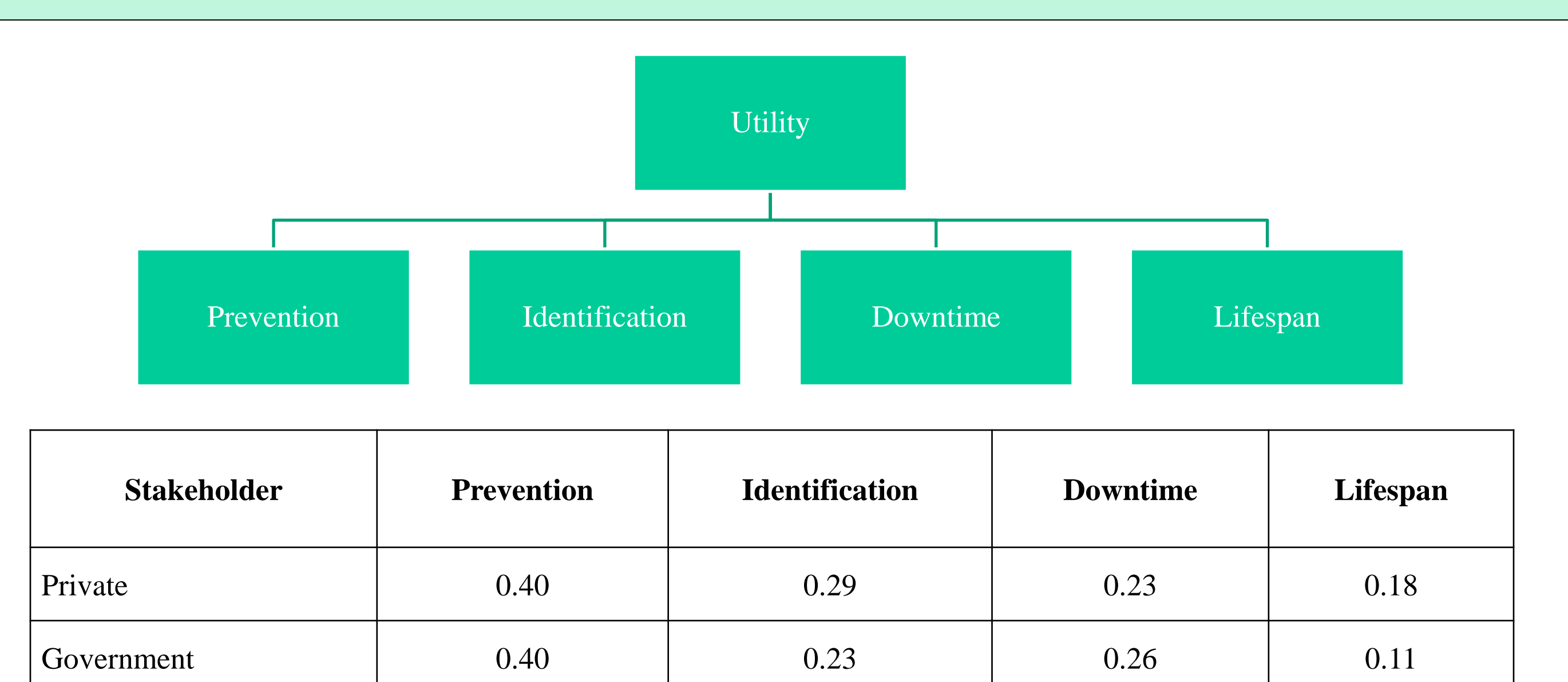
Underwater Surveillance and Threat Detections	
PLATFORM DESIGN ALTERNATIVES	SONAR DESIGN ALTERNATIVES
<b>ACTIVE:</b> <b>Autonomous Underwater Vehicles</b> Raytheon AQ/ANS-20A Minehunting Sonar Kongsberg REMUS 6000 AUV Kongsberg HUGIN AUV Klein System AUV 5000 V2 <b>Remote Operated Vehicles (ROV)</b> ASI Falcon ROV Oceaneering NEXXUS ROV Oceaneering Millenium Plus ROV	<b>Synthetic Aperture Sonar (SAS)</b> 300m signal range; 3cm resolution; 6,000m depth rating  <b>Compressed High Intensity Radar Pulse (CHIRP)</b> High-resolution images; 300m signal range  <b>Side-scan and Multibeam</b> Lower resolution but greater coverage area  <b>Hydrophone</b> 16km listening range; Uses localization techniques; 3,500m depth rating
<b>PASSIVE:</b> Node Network	



## RESULTS

Lost Bandwidth and Repair Cost Calculations		Detection probabilities:				
capacity = 2.4 Tbps		Based on platform, sonar, other parameters				
10 Gbps rental rate = bandUnitCost = \$25,000 (est)		Interaction of UISS Agent and threat type, location and depth				
shipCost = \$12,000 per hour (est)		Still being implemented				
bandwidthCost = downtime * bandUnitCost * capacity		<b>Delay, Travel, Repair and Downtime Calculations</b>				
repairCost = (travelTime + repairTime) * shipCost		downtime = notifyDelay + travelTime + repairTime				
FA-1 Cable						
		Threat Type				
	Fishing	Anchoring	Component	Natural	Espionage	Sabotage
Mean per 10 years	56.65	4.00	0.47	4.68	0.66	0.20
Totals (AS-IS)						
	Threats	Faults	Downtime (hrs)	Repair Cost	Lost Bandwidth Cost	
Mean per 10 years	66.65	4.11	1236.63	\$9,971,023.31	\$10,107,639.98	
Mean per Fault	-	-	301	\$2,426,960.00	\$2,460,212.67	

## COST-UTILITY ANALYSIS



## CONCLUSIONS & FUTURE WORK

- In Progress**
- Complete implementation of agents
  - Calculate detection probabilities of alternatives
  - Account for various movement patterns of AUVs/ROVs
  - Determine costs for alternatives
  - Model additional cable systems
- To be Implemented**
- Add dimensions to cable model to account for vertical and lateral movement
  - Add movement of appropriate threats