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2022

# Distributed Maritime Logistics for Theater Undersea Warfare

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Monterey, California: Naval Postgraduate School

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<https://hdl.handle.net/10945/71956>

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## Research Problem

Increased use of many small autonomous sensors needs to be supported with new concepts for logistics support. Vice a hub and spoke model of logistics for large platforms, a new model similar to the “traveling salesman” problem should be considered. Different undersea, seabed and small surface systems will have a variety of support needs that also includes retrieving data for further transport and analysis.



*Sail driven USV with undersea sensors*

## Research Method

- Using an approach from Operations Research, we capitalize on past theses that are considering different logistics needs but are very similar to our problem. Professor Kline calls this a “capacitated team orienteering problem with time windows and synchronization.”
- A sample of current undersea systems will be considered.
- Applications of the mathematical form: The objective is to minimize the total cost of travel on the network, as in Equation  $nn\min\sum\sum cijxij. i=1 j=i;j=1$

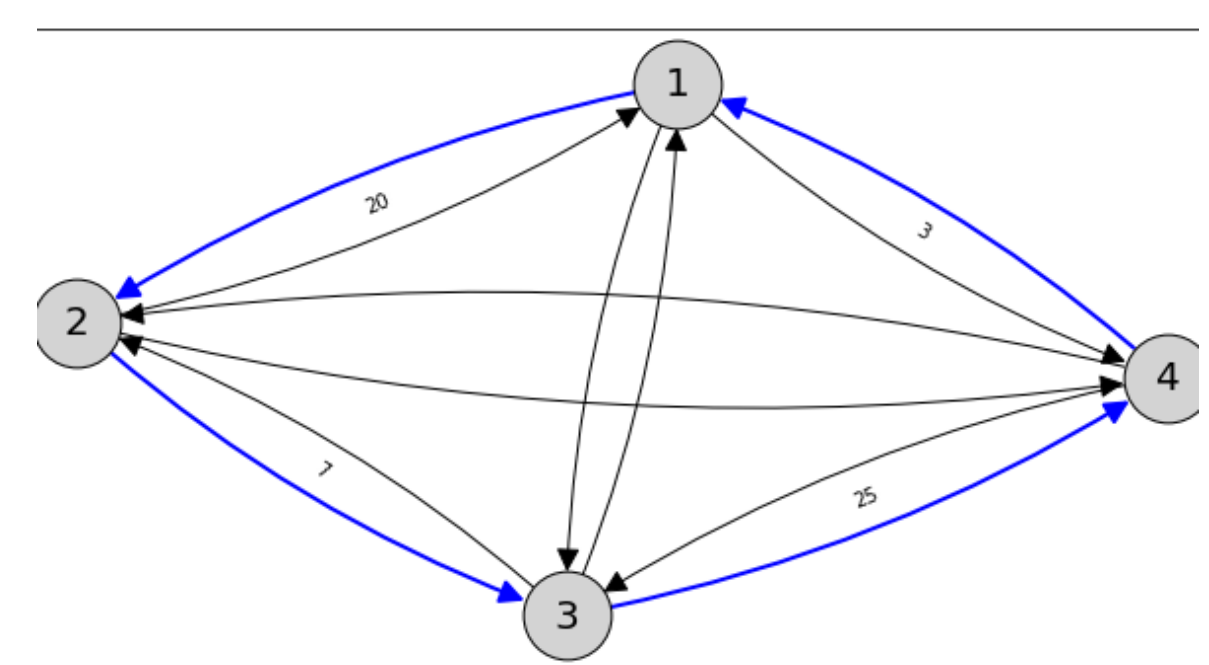
A complex problem.....

- “nodes” are unmanned sensors, moving or stationary.
- Logistics of different types, sustainment, maintenance, data extraction, mission updates
- Covert or non-covert?
- Time critical or not?

## Operationalizing the Optimization Problem

We envision a mathematical model that produces a unitless score for each UUV to be serviced by taking into account variables such as need for service as well as each UUV’s individual data payload. Then, using the score, use a mixed integer, shortest path optimization algorithm, to deliver the best service schedule that minimizes cost while producing the greatest strategic impact.

Three elements, the sensor, servicing craft and shore synchronization must be optimized to form a coherent and low-cost capability under different contexts (emerging priorities).



LCDR Stephen Cone thesis (2022) depicting the Traveling Salesman problem as nodes and network



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**Topic Sponsor:** Naval Undersea Warfighting Development Center (UWDC)

NRP Project ID:  
NPS-22-N355-A