



# The Size of MARS

## Quantifying Requirements for the Royal Navy's Future Afloat Support Fleet

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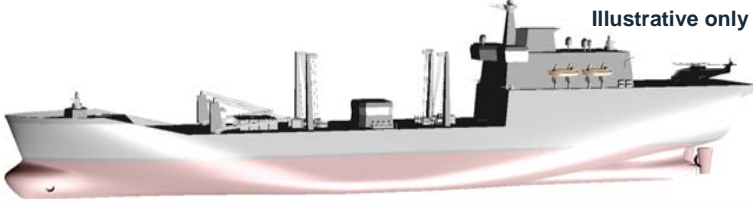


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# Introduction

- Afloat support to the Royal Navy warships is provided by the Royal Fleet Auxiliary (RFA)
- Most RFA ships currently in service are scheduled to be replaced over the next decade
- Logistic demand will change with the introduction of new platforms such as the future aircraft carrier
- Military Afloat Reach and Sustainability (**MARS**) programme aims to procure a new fleet of ships for supporting Maritime Forces operating at sea and landed Joint Forces operating ashore

# Future Afloat Support Ship Classes

Class	Primary Role (commodities)	
<b>Wave Tanker</b> (already in service)	Liquid support (bulk ship fuel, aviation fuel, oil, fresh water)	
<b>MARS Fleet Tanker</b>	Liquid support (bulk ship fuel, aviation fuel, oil, fresh water)	 Illustrative only
<b>MARS Fleet Solid Support</b>	Solid support to carrier groups (bulk ammunition, food, stores)	 Illustrative only
<b>MARS Joint Sea-Based Logistics</b>	Solid support to amphibious groups (bulk ammunition, food, stores)	 Illustrative only

# Outline

- Overview of OR toolset developed for assessing:
  - Fleet size requirements (number of support ships)
  - Capacity requirements of individual support ships
    - From group-level optimisation
    - From platform-level simulation
- Key factors considered
- Lessons learned

# Force Generation Modelling

- **Ship Scheduler** simulates the programming of various fleet activities

Activity types		Description
Deployments	Contingent ops	Unpredictable deployments (e.g. response to a conflict or crisis)
	Other commitments	Standing commitments and other predictable deployments (e.g. patrol task, major international exercise)
Pre-scheduled activities		Activities being planned long in advance and associated with specific ships (e.g. refit, trials)
Routine tasks		Routine peacetime tasks that do not require long-term planning (e.g. routine training)

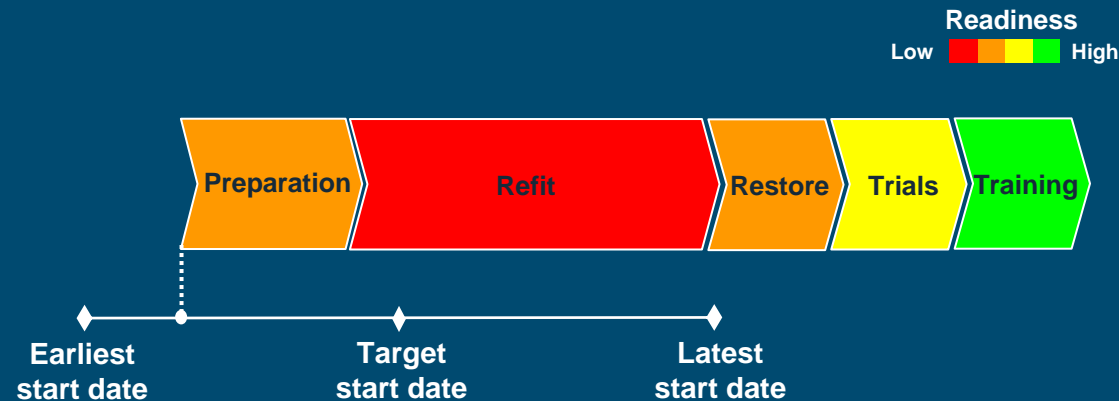
# Force Generation Modelling

## Deployment

- Preferred set of ships
- Specific start time
- Duration
- Priority
- Warning time
- Readiness time for re-deployment

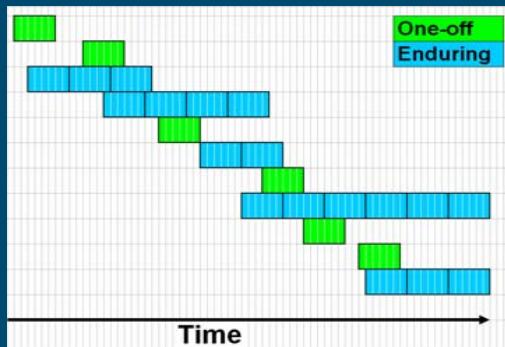
## Pre-scheduled activity

- Ship it applies to
- Flexible start time
- Duration and readiness for each phase
- Priority
- Action to take in case of interruption



# Fleet Size Assessment

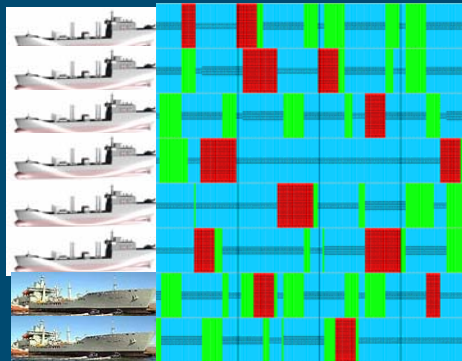
1 – Demand stream is stochastically generated



## Factors considered

- Deployments to conflicts and other commitments
- Concurrency limits
- Recuperation intervals

2 – Fleet is scheduled



## Factors considered

- Generation priorities
- Upkeep cycles
- Readiness levels
- Scheduling flexibility

3 – Generation capability is measured

- % of deployments with required support ships
- % of concurrencies with required support ships
- % of activities being interrupted
- Other MOEs

Process repeated for multiple demand streams and fleet sizes

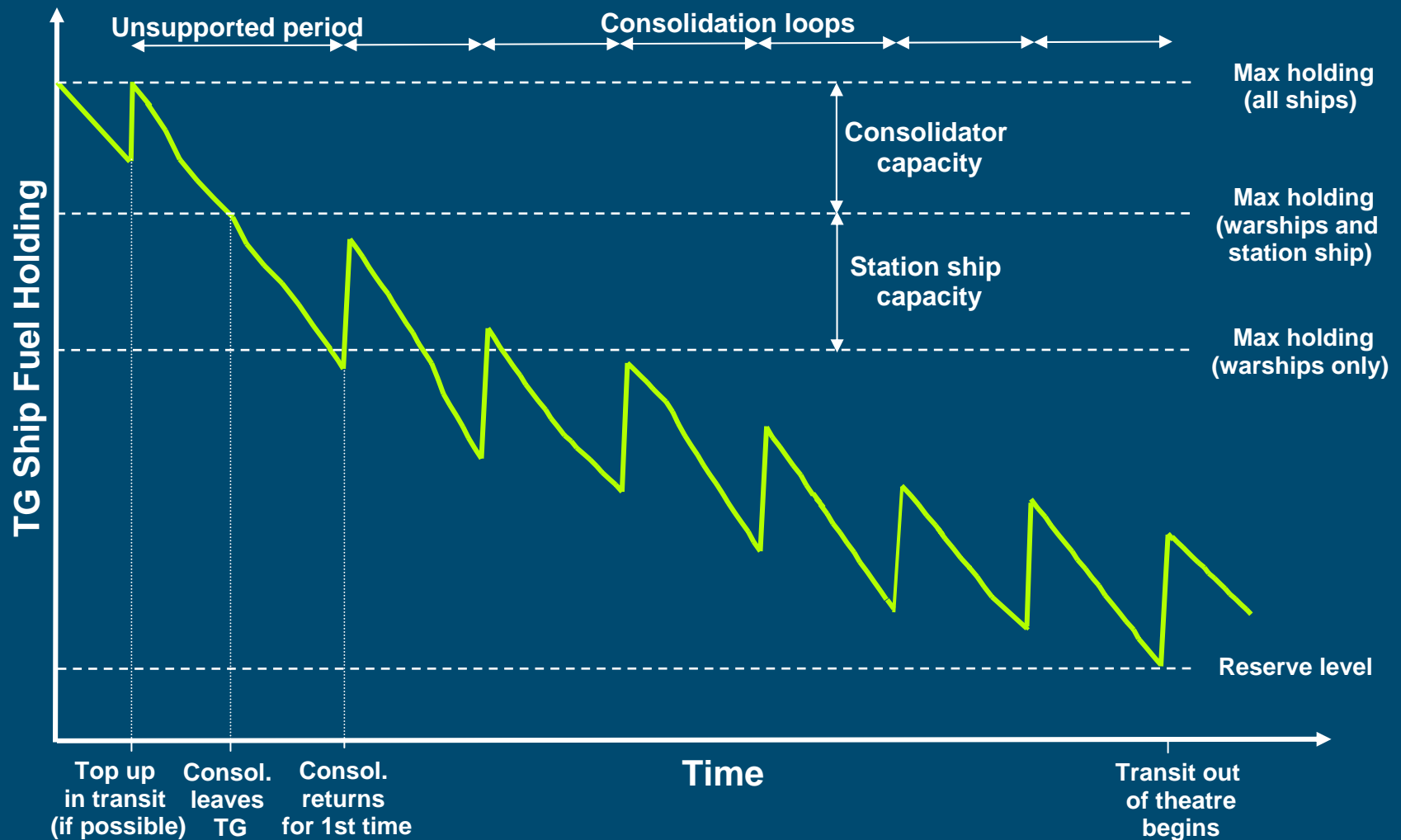
# Capacity Requirements - Background

- Two distinct roles for support ships:
  - **Station role**: remain with task group (TG) for replenishment and extra holding capacity
  - **Consolidation role**: travel to and from port for replenishing TG's stock
- Consolidation process takes time to establish. TG must hold enough to sustain an **unsupported period** at the beginning of a campaign
- TG holdings must not go below a pre-defined **reserve level** (minimum allowable to maintain operational flexibility)





# Example: Ship Fuel



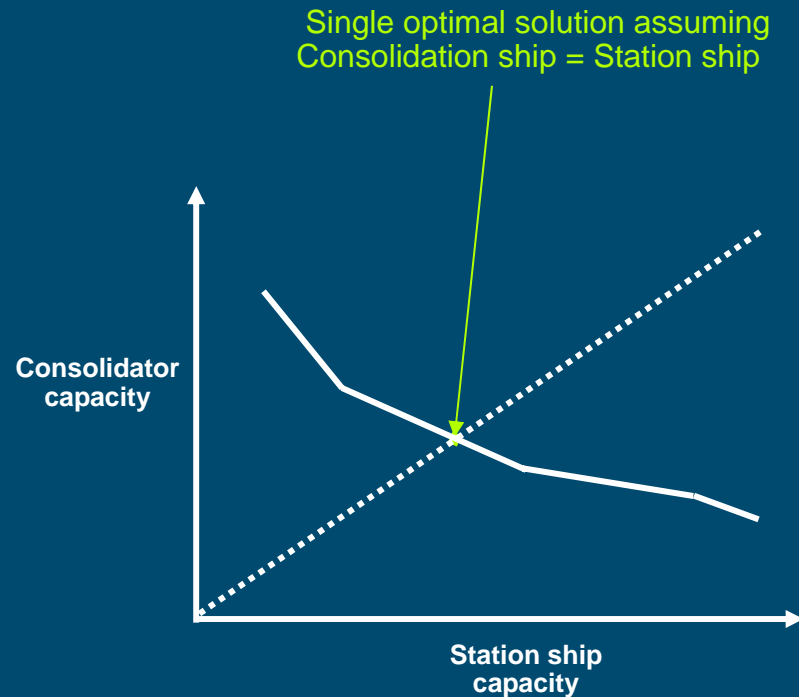
# Setting Capacity Requirements

- Process repeated for all TGs, commodities, and force planning scenarios of interest
- Most demanding requirements identified
- Must account for possible re-configurations of usable volume



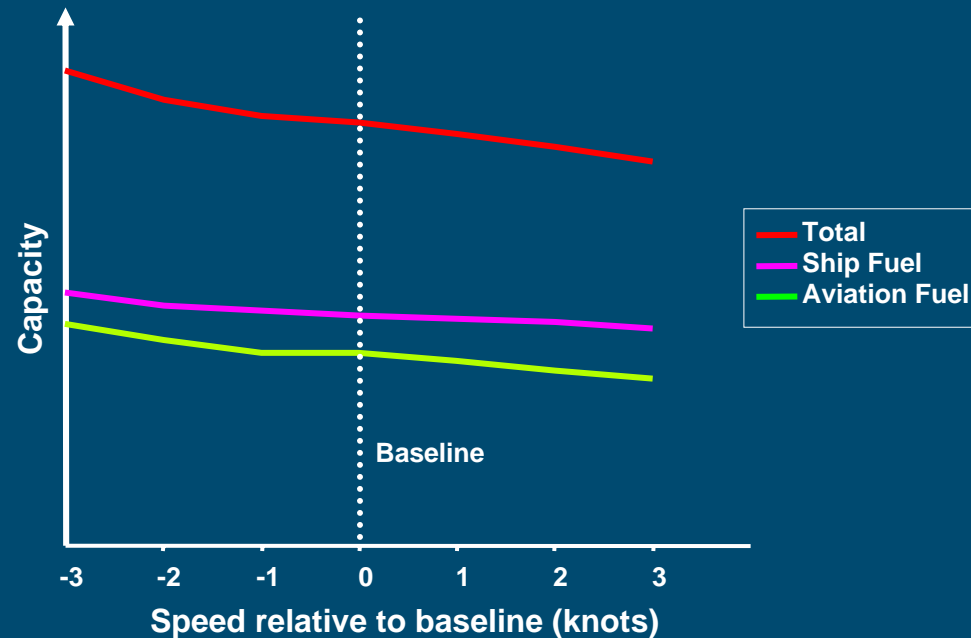
# Tradeoffs and Sensitivities

- Consolidator capacity vs. station ship capacity



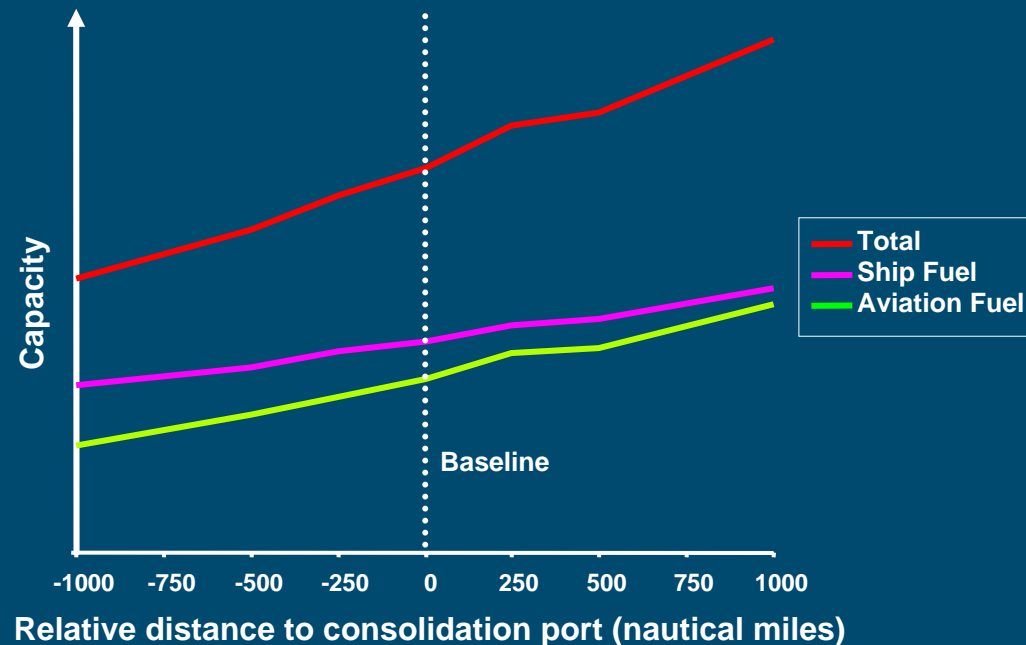
# Tradeoffs and Sensitivities

- Consolidator capacity vs. station ship capacity
- Capacities vs. consolidation speed



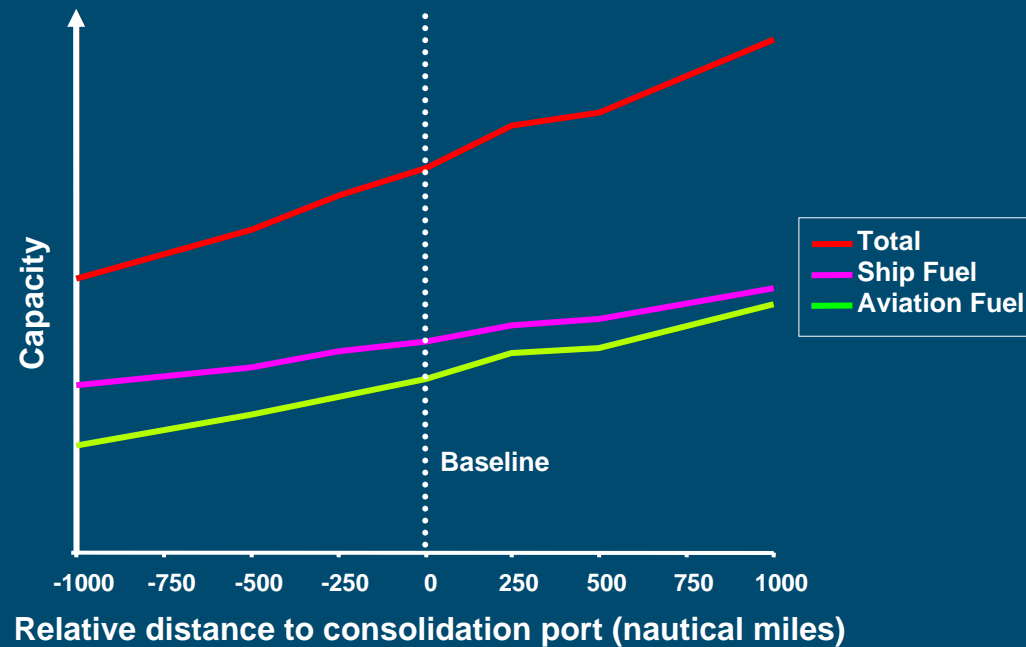
# Tradeoffs and Sensitivities

- Consolidator capacity vs. station ship capacity
- Capacities vs. consolidation speed
- Capacities vs. consolidation distance



# Tradeoffs and Sensitivities

- Consolidator capacity vs. station ship capacity
- Capacities vs. consolidation speed
- Capacities vs. consolidation distance
- Capacities vs. other scenario assumptions



# Platform-Level Simulation

- **Fleetflow** simulates Replenishment At Sea (RAS) process down to the platform level
- Minimum holding levels defined for individual ships
- Many ships approaching minimum level may request RAS every day
- Fleetflow emulates the decisions made by a TG logistic coordinator when producing daily RAS plans





# Daily RAS Plans

- Initially derived from many predictable factors:
  - Ship(s) expected to go below minimum level
  - Achievable number of replenishments based on
    - Transit time before RAS can be performed
    - Time to connect or disconnect
    - Transfer rates
    - Quantities to be transferred
    - Number of rigs that can be connected
    - Manpower limits
- Unpredictable factors such as breakdowns or battle damage may force RAS plans to be changed

# Availability and Survivability

- Mean time between failure of critical systems and estimated time offline derived from a historical database of repairs
- Combat models run to obtain the time and severity of each battle damage
- Impact on RAS plans depends on the timing and nature of the damage / defect
- Primary MOE: percentage of missions adequately supported during campaign

# Lessons Learned

- Optimising a support fleet can be complex!
- A scheduling model is essential for measuring deployability and assessing fleet size requirements
- A group-level logistic model can provide reliable estimates of the minimum cargo capacities needed and help identify the driving factors
- A platform-level logistic model is necessary to understand the distribution of consumables within a group. Also very useful for analysing ship availability, survivability, and complex RAS strategies

# Lessons Learned

- Many scenarios should be analysed
- Flexible, multi-commodity cargo capacity can significantly reduce requirements
- Some models are easily applicable to operational planning and could be used to inform CONOPS

# Questions?



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