The Size of MARS

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

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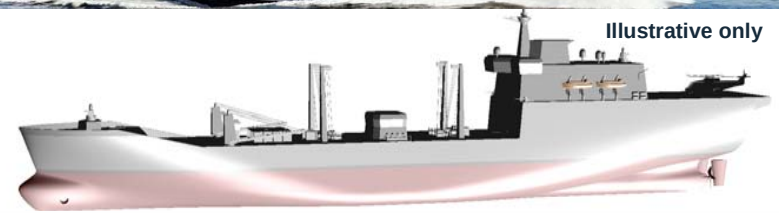
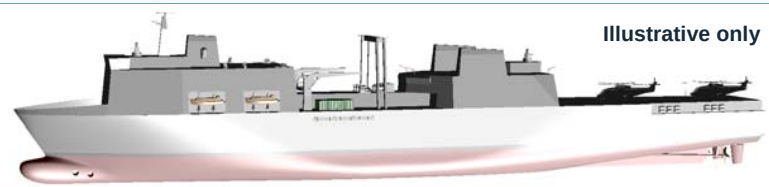
Introduction

- 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)	
Wave Tanker (already in service)	Liquid support (bulk ship fuel, aviation fuel, oil, fresh water)	
MARS Fleet Tanker	Liquid support (bulk ship fuel, aviation fuel, oil, fresh water)	 Illustrative only
MARS Fleet Solid Support	Solid support to carrier groups (bulk ammunition, food, stores)	 Illustrative only
MARS Joint Sea-Based Logistics	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)

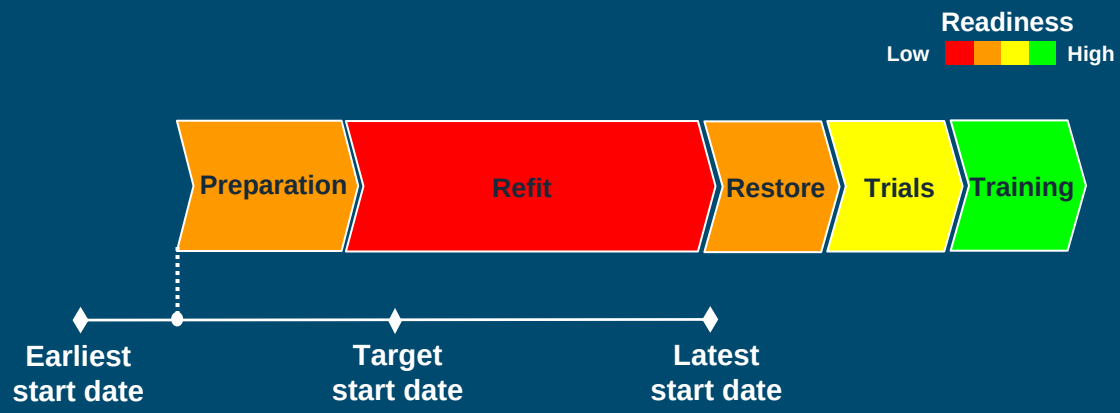
Force Generation Modelling

Deployment

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

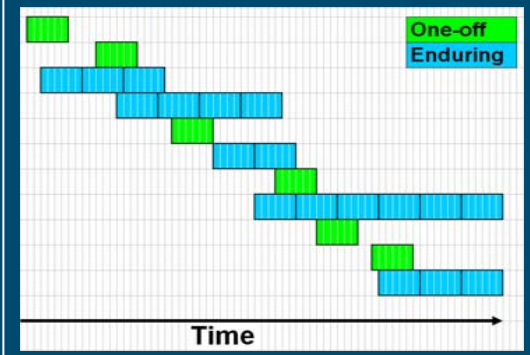
Pre-scheduled activity

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



Fleet Size Assessment

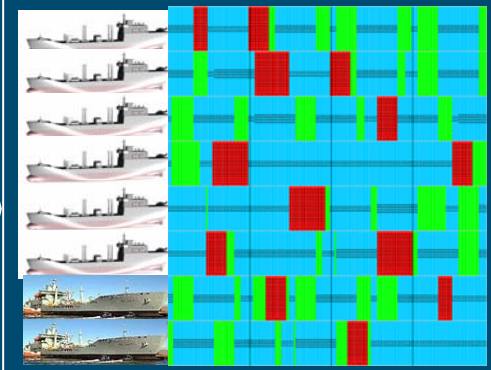
1 – Demand stream is stochastically generated



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

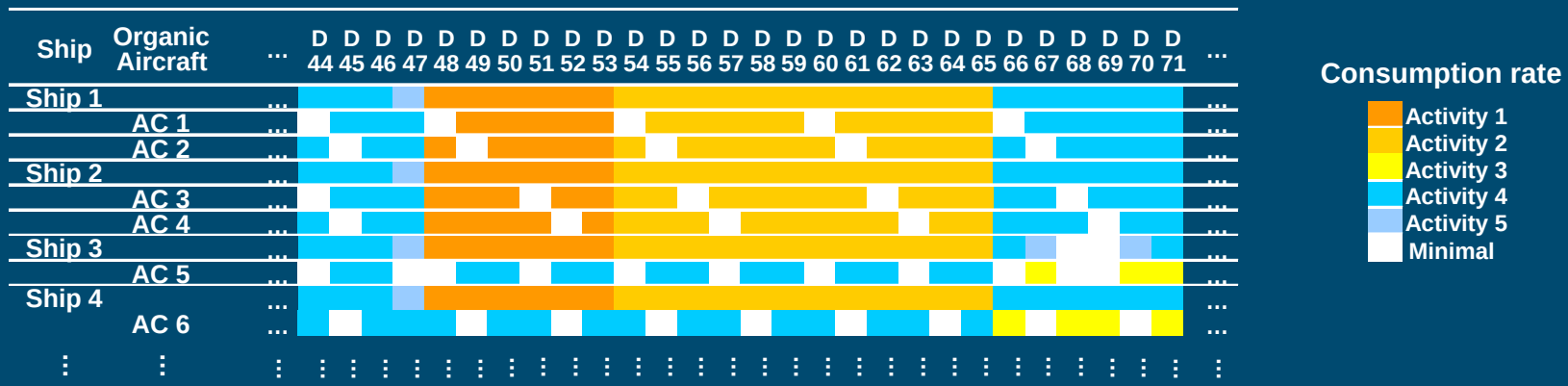
Process repeated for multiple demand streams and fleet sizes

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)

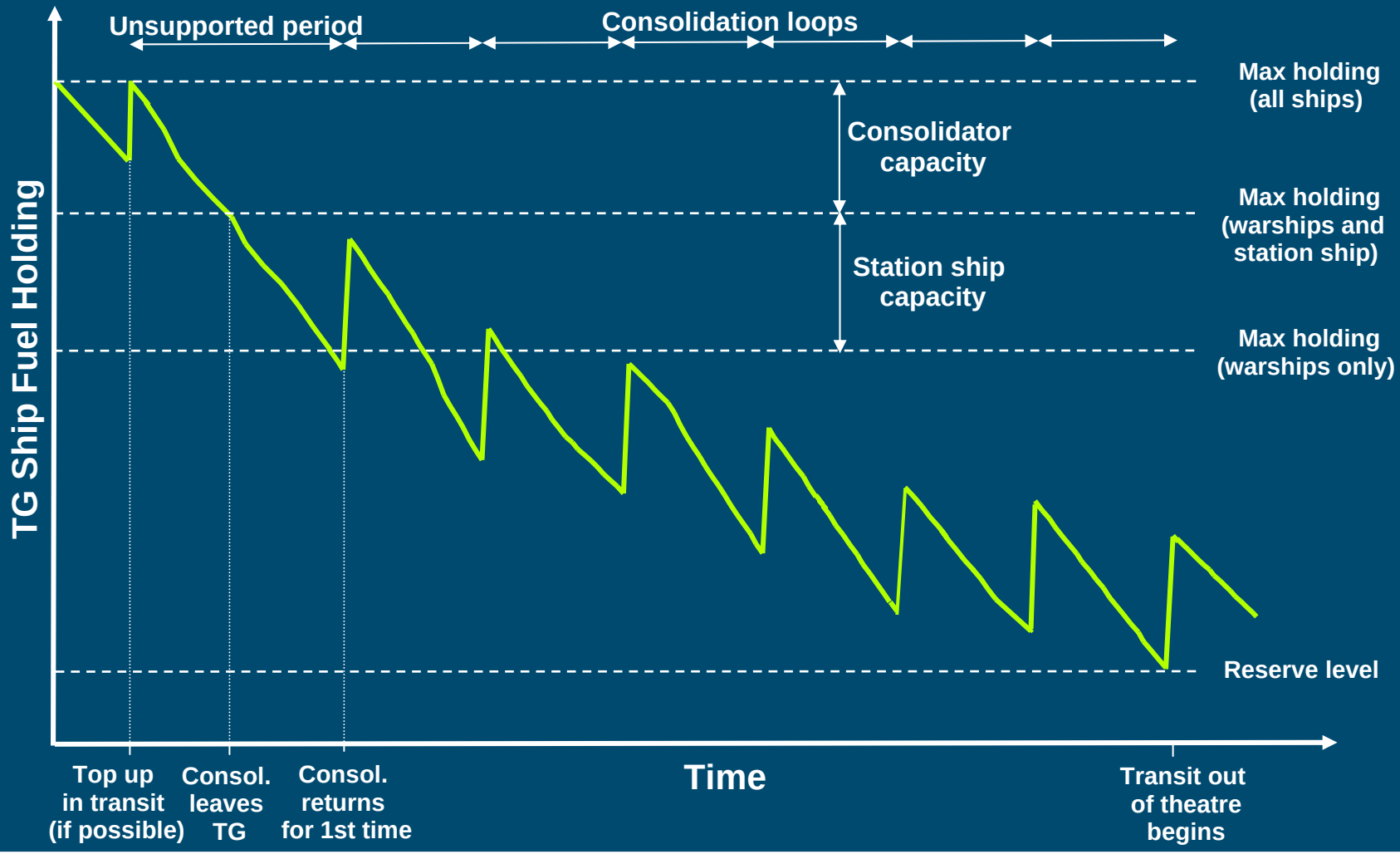
Group-Level Optimisation

- Capacity requirements first derived at the group level using the Support Ship Optimiser (SupShOp)
- TG's consumption rates estimated from the expected daily activity of each platform (e.g. transit, loiter, training, maintenance, peak air ops, amphibious ops, etc.)



- SupShOp finds the minimum station and consolidation capacities satisfying operational constraints

Example: Ship Fuel

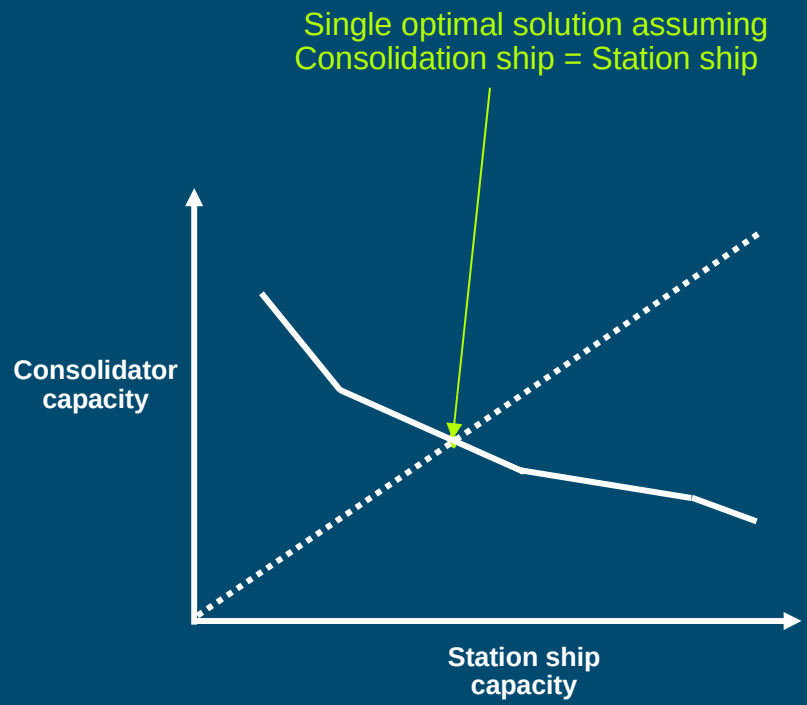


Setting Capacity Requirements

- 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

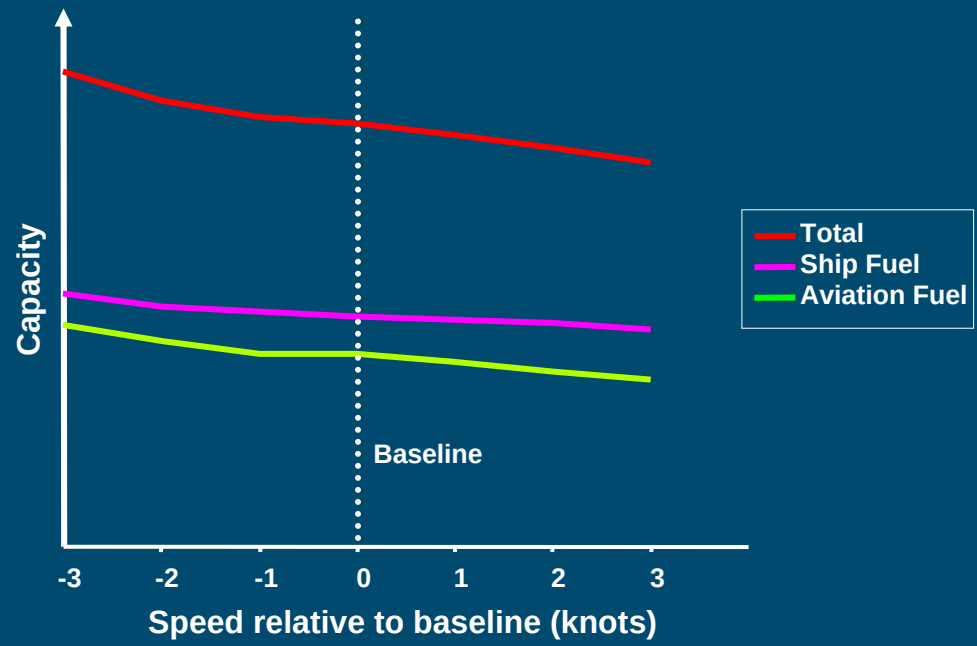
Tradeoffs and Sensitivities

- Consolidator capacity vs. station ship capacity



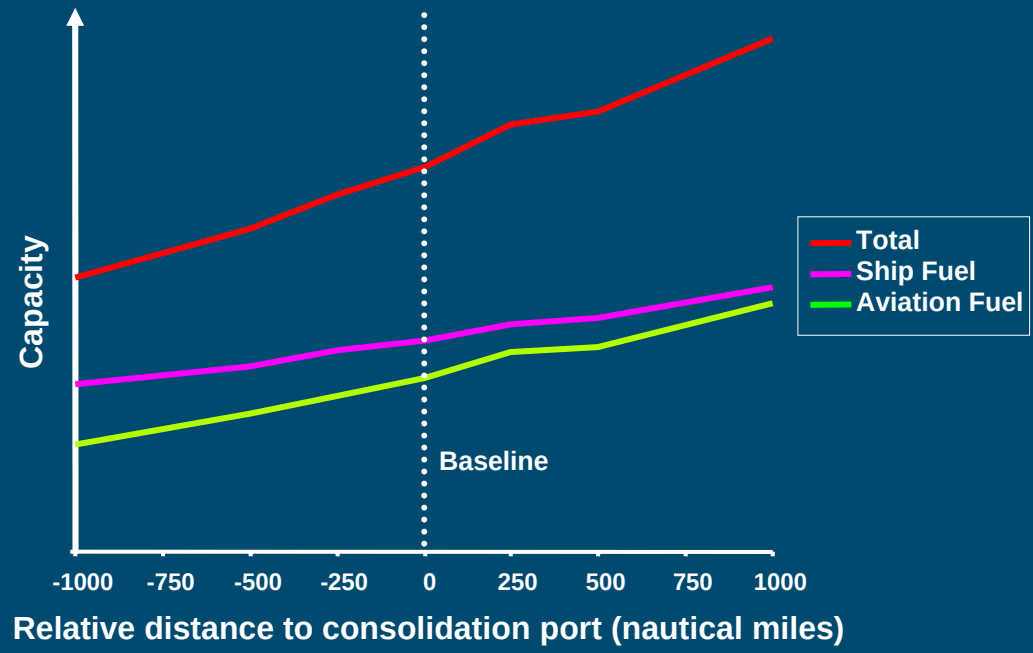
Tradeoffs and Sensitivities

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



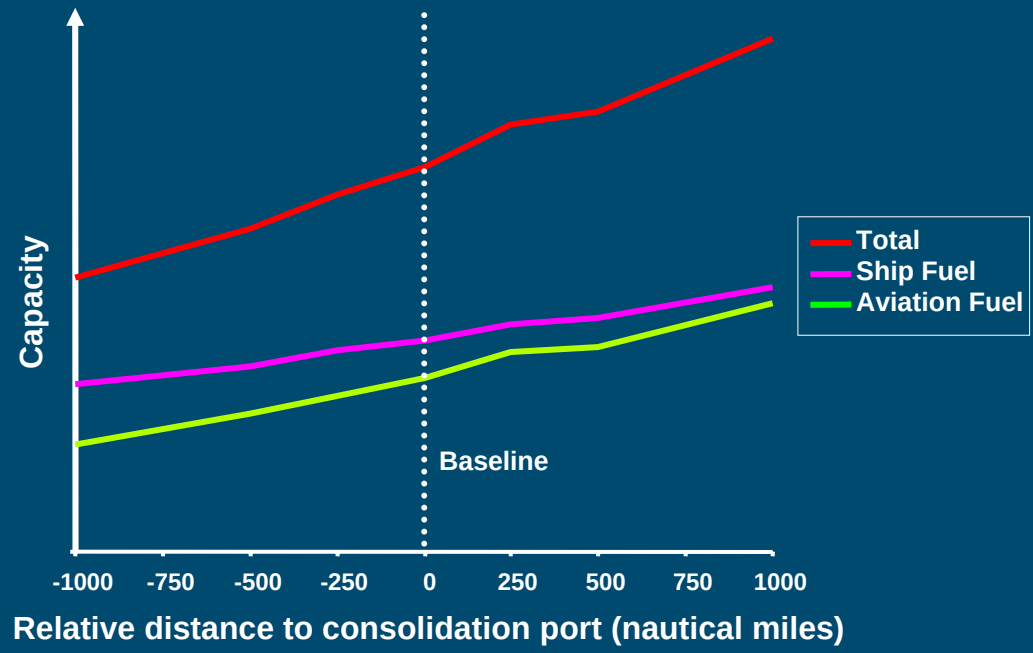
Tradeoffs and Sensitivities

- 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?