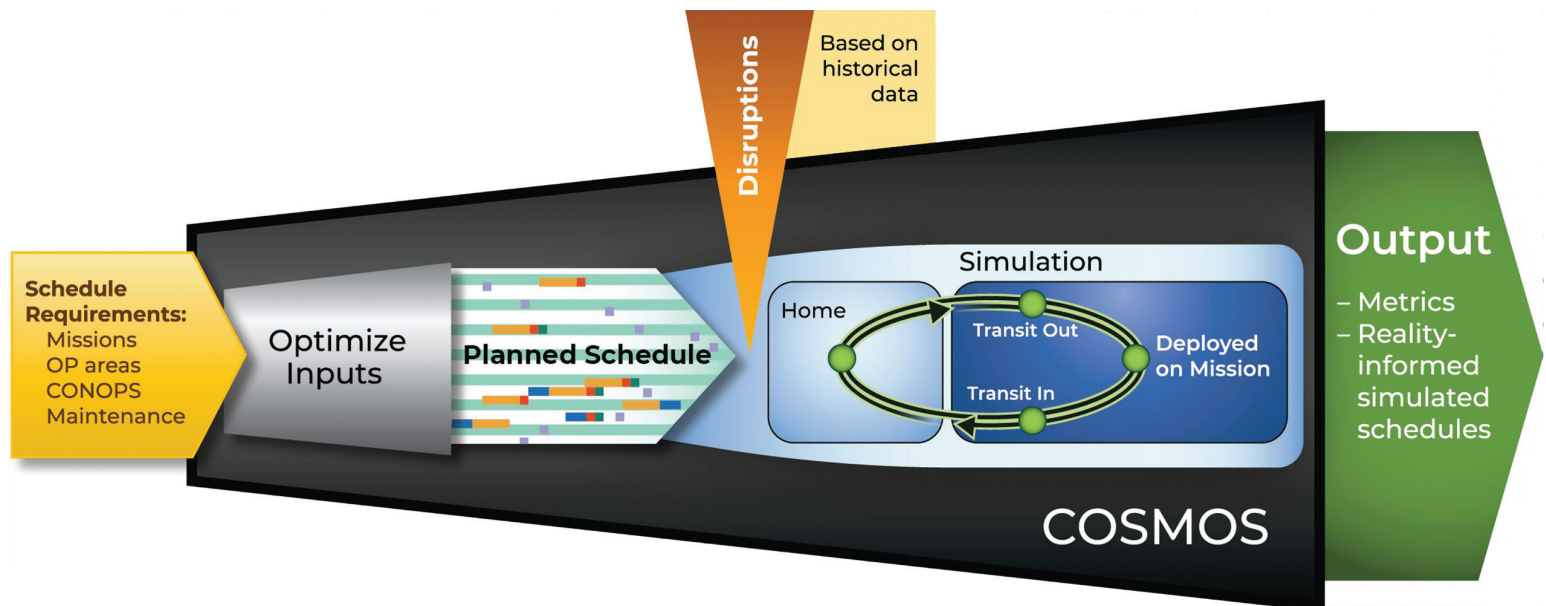




Scheduling effective force deployment is complex and challenging; deployment cycles must balance force numbers with sufficient time for training and maintenance. To account for temporary reductions in force availability (e.g. mechanical breakdowns), schedule flexibility is critical.



The Coordinated Optimization and Simulation Model for Operational Scheduling (COSMOS) tool tackles these complex problems by **combining mathematical optimization with simulation** to create deployment schedules that make **objective predictions** about force availability and mission accomplishment. The results provide insight into the **range of effects** that operational changes could have on a mission.

### A customizable analytic tool that helps answer an array of force structure and operational questions by:

- Objectively evaluating an asset's ability to fulfill a mission and the **probability of meeting that mission** within specific parameters including: force structure, operating areas, deployment cycles, and during periods of unavailability (e.g. major maintenance)
- Simulating operations to quantify force and schedule **resilience to unplanned disruptions**
- Providing insight into **interactions between individual force assets** that aggregate and average views do not provide

### How does COSMOS work?

**Optimization** – ability to fulfill a mission is evaluated by creating a planned schedule that shows the location and activity (ie status) of each asset and can:

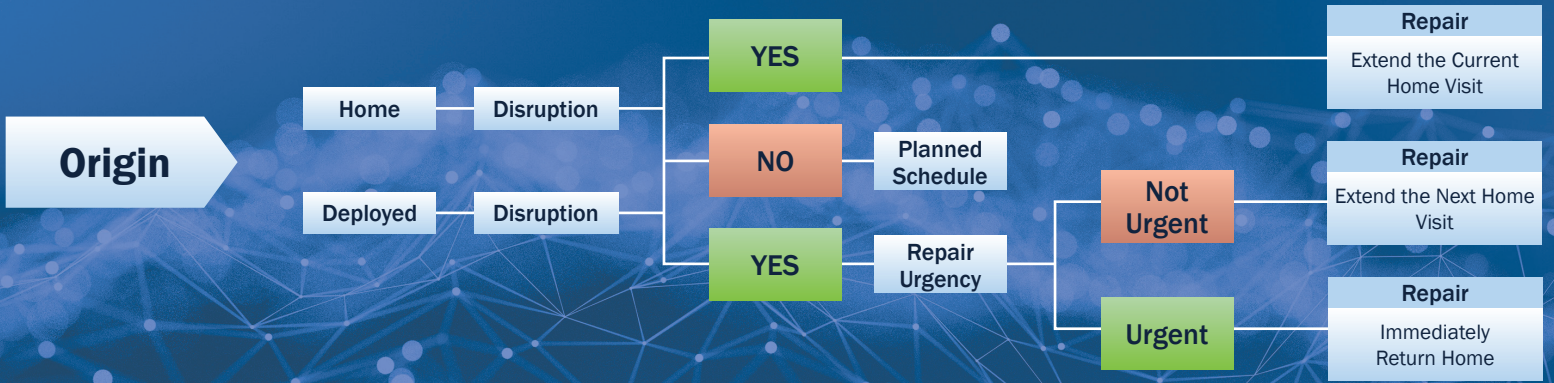
- Be built to achieve a specific objective
- Be tailored by:
  - force size
  - operational cycle (e.g. time home and deployed)
  - operational area locations and routes
- Accommodate various levels of detail in force activity

**Simulation\*** – schedule resiliency is tested by injecting randomly generated disruptions to the optimized schedule, outputting **demonstrated schedules**

- Disruptions\*\* are generated based on historical information or what-if cases
- Real-world scheduling challenges are incorporated
- Disruptions can be tailored force-wide or to individual assets and activities

\* simplifications and assumptions are used for modeling purposes - optimized schedule should only inform planning

\*\* patrol data is currently used to generate disruptions, but disruptions can also be derived from other sources



## What Does COSMOS Offer Users?



### The means to understand how force operations are affected by:

- **Inputs**
  - Requirements and constraints (e.g., operational cycles, procurement, and decommission plans)
  - Force size - specifying number and type(s) of assets in the force
  - Planning factors - coordinating operations between all assets to satisfy constraints
- **Disruptions (e.g. maintenance issues)**



### The best possible schedule, optimized to meet all requirements

- Analyze relationships between operating areas, weapon range, force structure, and presence requirements
- Quantify schedule trade-offs (e.g. taking a longer path to an operational area may have better security outcomes, but could come at the cost of operational effectiveness)



### Real-world impacts to the schedule using historical disruptions

**Analyzed Impacts** + **Optimized Schedule** + **Inserted Disruptions** = **Demonstrated Schedules**

- Quantify disruptions to a schedule caused by a temporary reduction in force size
- Historical disruptions are informed by data-driven analysis

### Used to:

- Make projections of future force availability
- Analyze risk (e.g. SSBN fleet transitions from OHIO class to COLUMBIA class submarines)
- Test the resilience of a schedule
- Compare options and look at decision impacts
- Understand how many disruptions the schedule can manage before the mission is impacted
- Examine how individual asset reliability interacts and contributes to overall force attrition

### COSMOS Application:

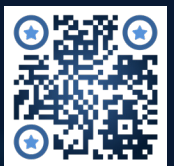
- Estimate future risk of meeting mission by applying historical disruption rates
- Quantify the level of strain on forces and operational planners to compensate for disruptions and ensure mission accomplishment
- Evaluate the impact of potential upgrades on maintenance cycle duration, force capabilities, and operating areas
- Account for historical performance and real-world scheduling difficulties

- Modeled SSBN operations to inform decisions on CONOPS and operating areas
- Informed risk analysis on fleet performance for what-if cases involving force structure, CONOPS, upgrades, operating areas, and maintenance cycles
- Estimated the improvement in SSBN operational availability by reducing time in the Explosive Handling Wharf



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