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An Optimization-Based Toolkit to Support Contingency Contractor Planning

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NNSA

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Outline

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- Motivation
- Problem statement and approach
- Contingency Contractor Optimization Tool (CCOT) prototype
  - Requirements
  - Model formulation
  - Data requirements
  - Web-based user application
  - Analysis example
- Conclusion

Motivation

- Secretary of Defense guidance (24 January 2011) requires the Department of Defense (DoD) to improve centralized planning & contingency contractor capabilities

- DoD plans at all levels for military forces but has not historically planned at the strategic level for contractors

- DoD needs a tool to estimate the number of contractors required for contingency operations/contingency costs

Problem Statement and Approach

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- Provide a “what if” capability for strategic planning of contingency contractors that:
  - Assesses full spectrum of contractor requirements [logistics, force protection, signal, interpreters, etc.] for all contingencies
  - Assesses impacts, risks and mitigating strategies for allocations options between the elements of the Total Force
  - Is “tailorable” to a variety of variables [cost, force mix, intensity and duration]
- Developed a tool-kit that is:
  - Based on a rigorous mathematical model
  - Accessed through a web-based user interface
  - Fits into the current planning processes

CCOT Prototype Requirements

"Strategic and Operational Planning for Operational Contract Support (OCS) and Workforce Mix" **Robert Gates memo**, Jan 2011 *"…better planning at the strategic and operational levels for contracted support"*

Strategic level
(annual, long term)

DoDI 3020.41, December 2011
"…fully consider, plan for, integrate, and execute acquisition of, contracted support, including synchronizing and integrating contracted support flowing into an operational area from systems support."

Plan across multiple scenarios

DoDI 1100.22, April 2010
"Establishes policy, assigns responsibilities, and prescribes procedures for determining the appropriate mix of manpower (military and DoD civilian) and private sector support."

Observe existing manpower mix criteria

CCOT Prototype Requirements

Annex W
CJCSM 3122.03C, February 2006
2010 GAO Report 10-472 (*DOD Needs to Improve Its Planning for Using Contractor to Support Future Military Operations*): "…most of the draft Annex Ws developed…included few details on the type of contractors needed to execute a given plan, despite guidance requiring Annex Ws to list contracts likely to be used in theater."

Results must include number and type of contractors

DoDD 1100.4, February 2005
"Assigned missions shall be accomplished using the least costly mix of personnel (military, civilian and contract) … Manpower authorities shall consider all available sources when determining manpower mix to include the Active and Reserve military manpower, U.S. and foreign national civilian manpower, intra-governmental, contract and host nation support."

Minimize cost and consider all available personnel groups

CCOT Prototype Model Formulation

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- *Optimization*: linear program (LP)
  - DODD 1100.4: minimize cost and consider all available personnel groups
  - Tractable: well established solution algorithms
  - Rigorous: closed-form mathematical model
  - Consistent: common set of logic is used for all analysis
- *Objective:* Determine the mix of military personnel, civilians and contractors that accomplishes all mission requirements and minimizes the total cost
- *Subject to:*
  - Resource requirements
  - Resource availability
  - Resource use rules
  - Budget limitations (optional)

CCOT Prototype Model Formulation

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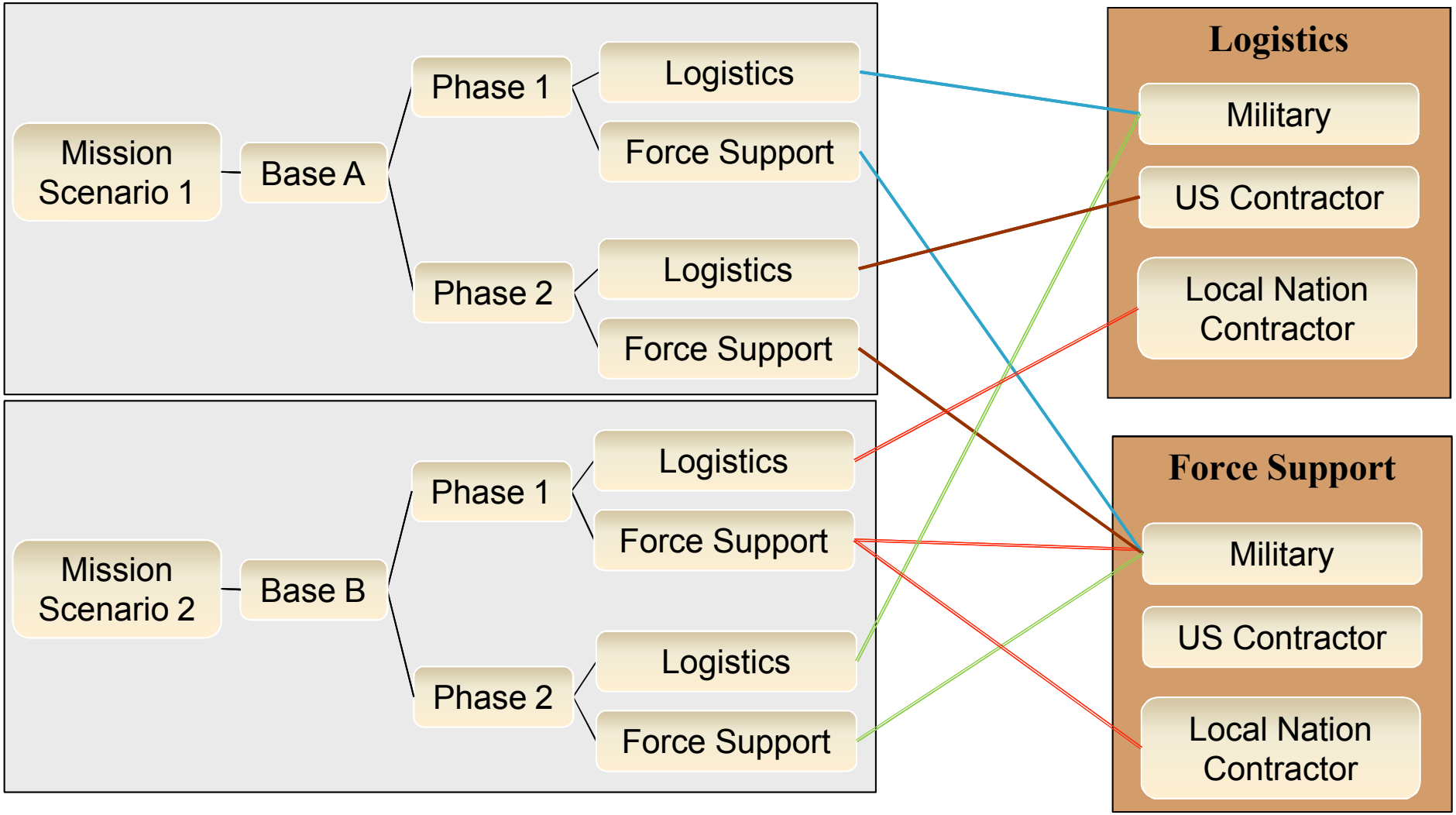
The model assigns personnel from resource pools to mission scenario tasks while honoring use rules, resource limits, etc.



Resource Requirements Constraint

Required Resources (Input Data)

Personnel Group Efficiency (Input Data)

$$a_{iskt} = \sum_{p \epsilon P(i,s)} \epsilon_{spk} \left[x_{ispkt} + g_{ispkt} \right] \qquad \forall i, s, k, t$$

Use Rules (Input Data)

Assignments (Decision Variable)

Overages (Decision Variable)

- Where
  - *s*: mission scenario ID
  - *i*: work element ID
  - *k*: skill ID
  - *t*: time period ID
  - *p*: personnel group ID (e.g. military, civilian, contractor)

Resource Availability Constraint

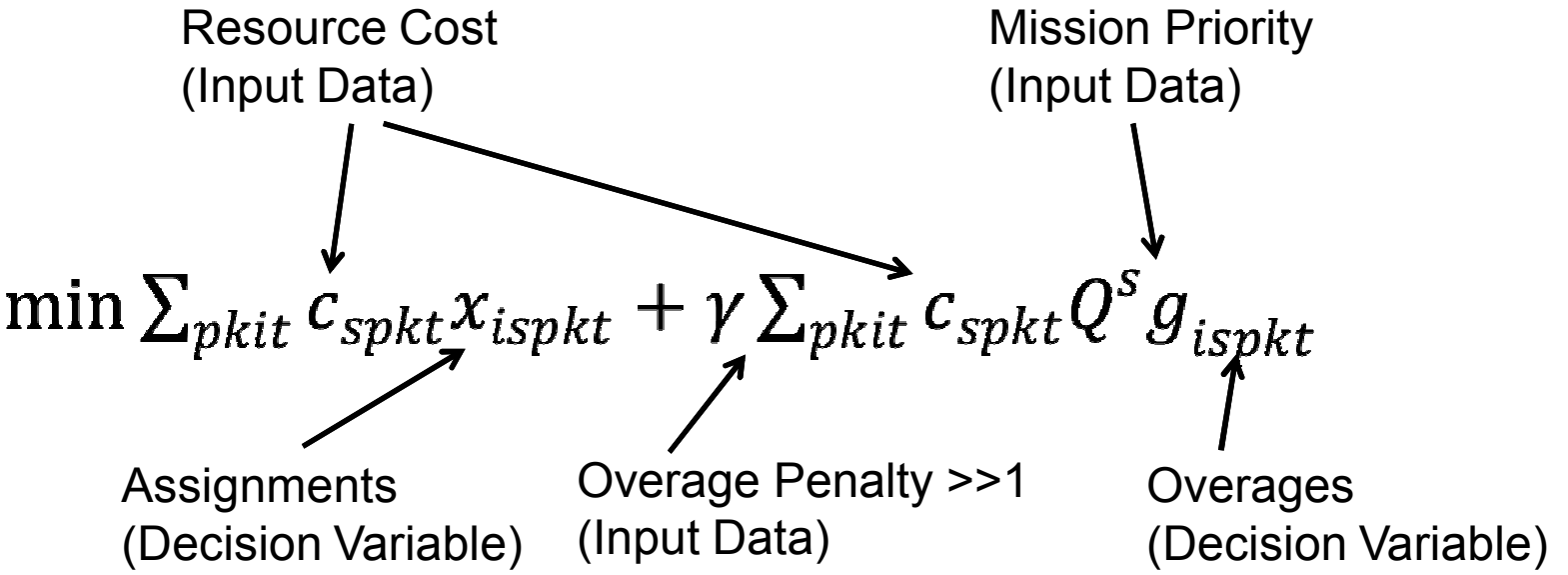
$$\sum_{i,s} x_{ispkt} \leq h_{pkt} \qquad \forall p, k, t$$

Total Resource Usage by Time Period (Decision Variable)

Resource Availability (Input Data)

- Where
  - *s*: mission scenario ID
  - *i*: work element ID
  - *k*: skill ID
  - *t*: time period ID
  - *p*: personnel group ID (e.g. military, civilian, contractor)

Objective Function



- Where
  - *s*: mission scenario ID
  - *i*: work element ID
  - *k*: skill ID
  - *t*: time period ID
  - *p*: personnel group ID (e.g. military, civilian, contractor)

CCOT Application

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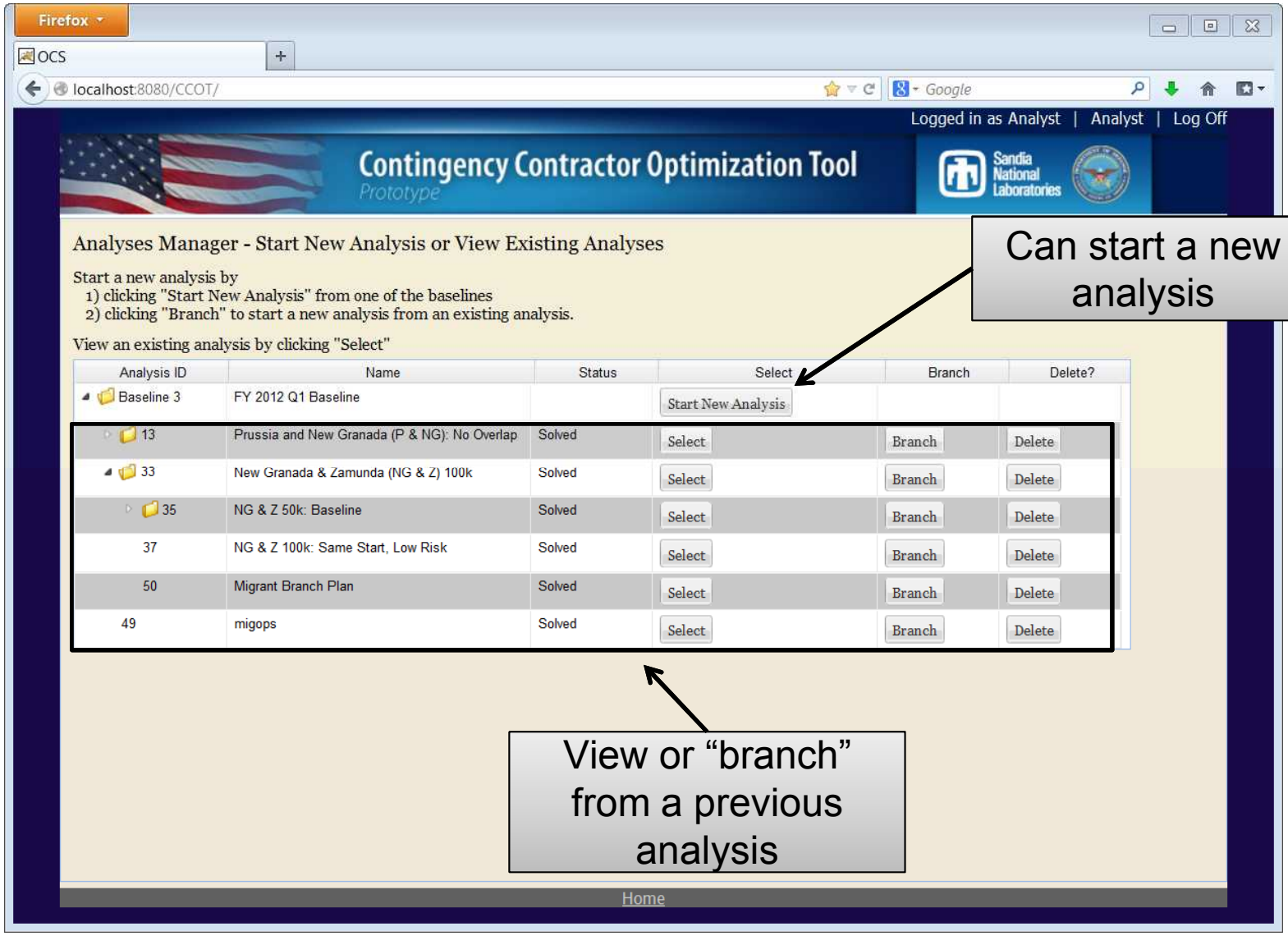
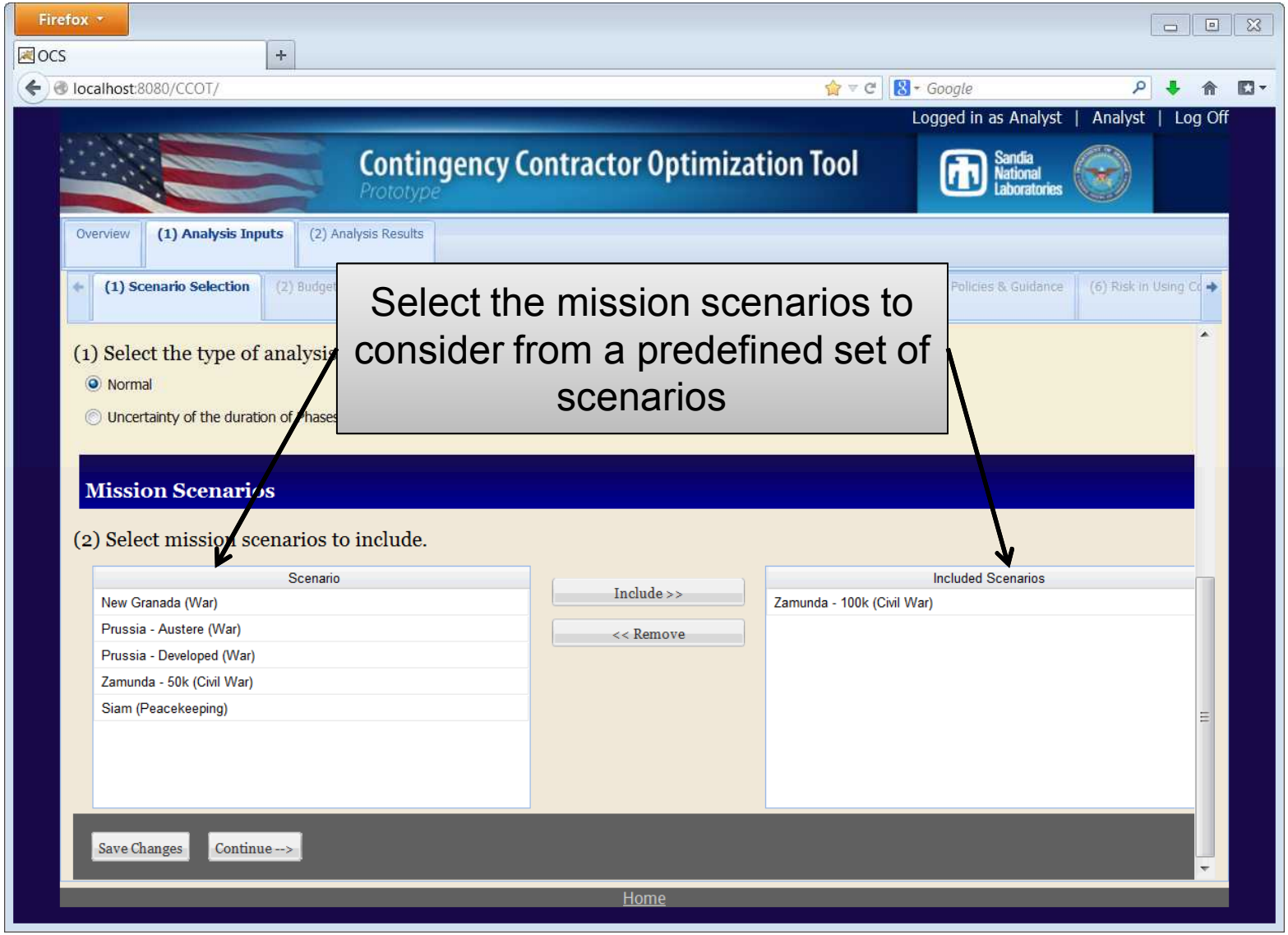
- Web-based application that allows users to populate model data, solve model and view results
- Intended to be an intuitive, user-friendly application that can be used by non-modelers
- Multiple user roles
  - All analysts (lowest level role) work from a common set of data provided by users at a higher level
    - e.g. all potential mission scenarios and associated requirements are defined by a planning manger
  - Allows analysts to perform “what-if” analysis while working from a common set of assumptions
- Potential users
  - Joint Staff/Combatant Commands/Military Services
  - Joint Contingency Acquisition Support Office (JCASO)
  - Whole of Government/Inter-Agency

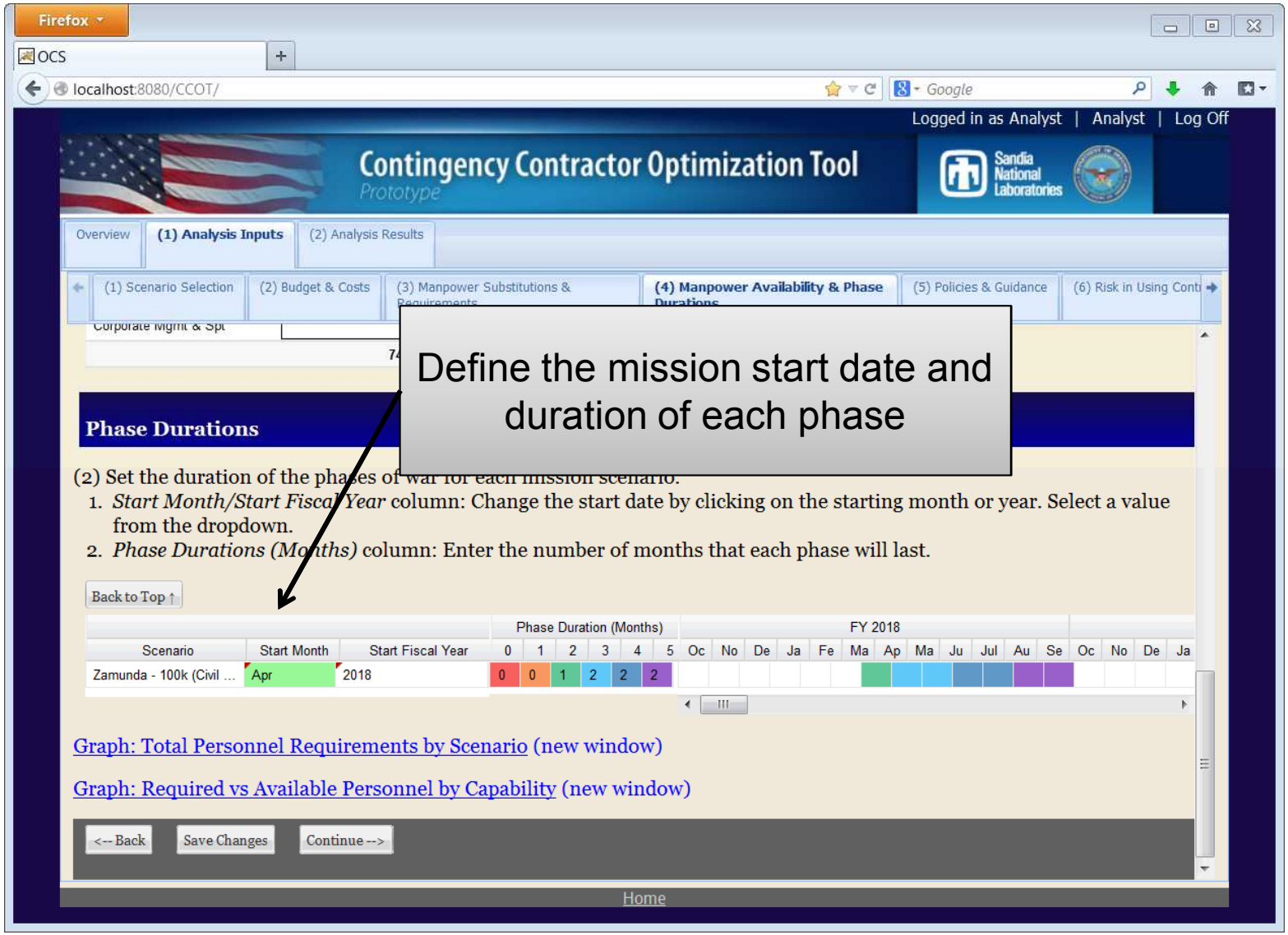
Analysis Example



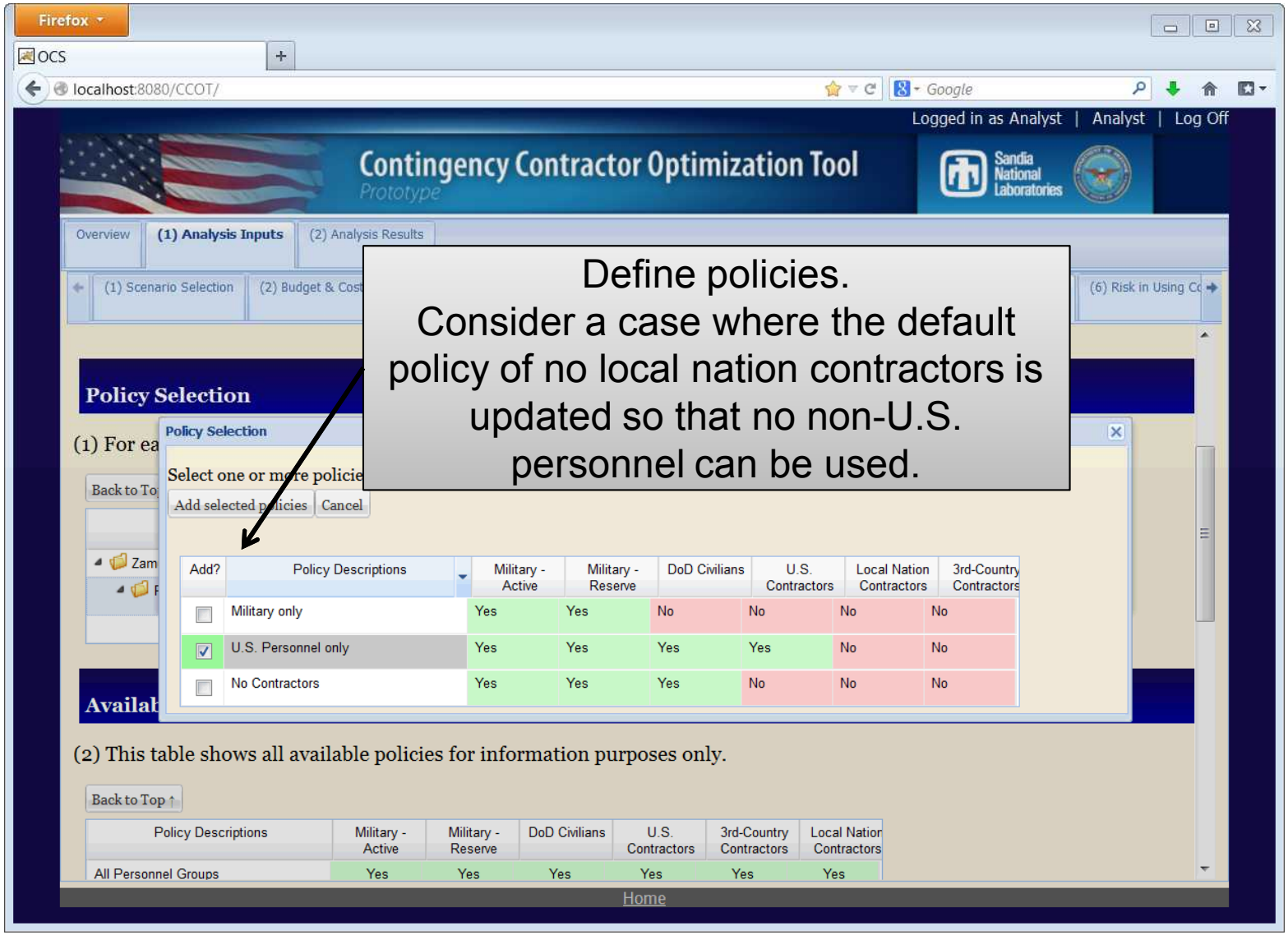
Analysis Example



Analysis Example



Analysis Example



Analysis Example

- Once all inputs have been entered, the optimization problem can be solved
- Once a model is solved, all inputs are locked to provide data integrity and traceability of previous analysis
- Model results can be viewed and compared with other analyses
- In this case, the results when only U.S. personnel can be used can be compared to the case where 3rd-country contractors can also be used
  - Manpower mix
  - Manpower costs

Analysis Example

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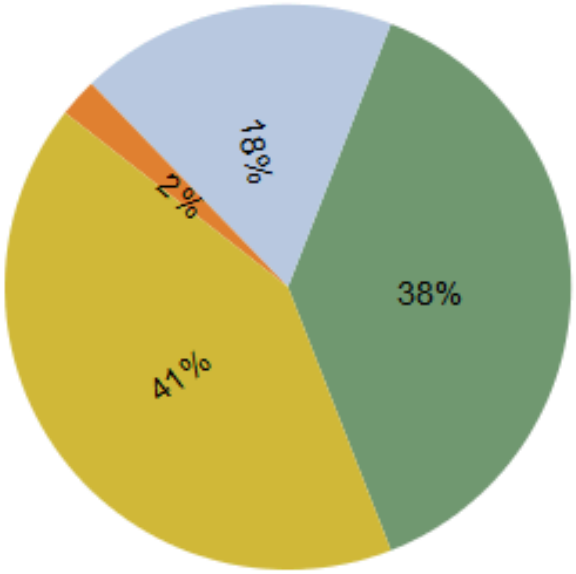
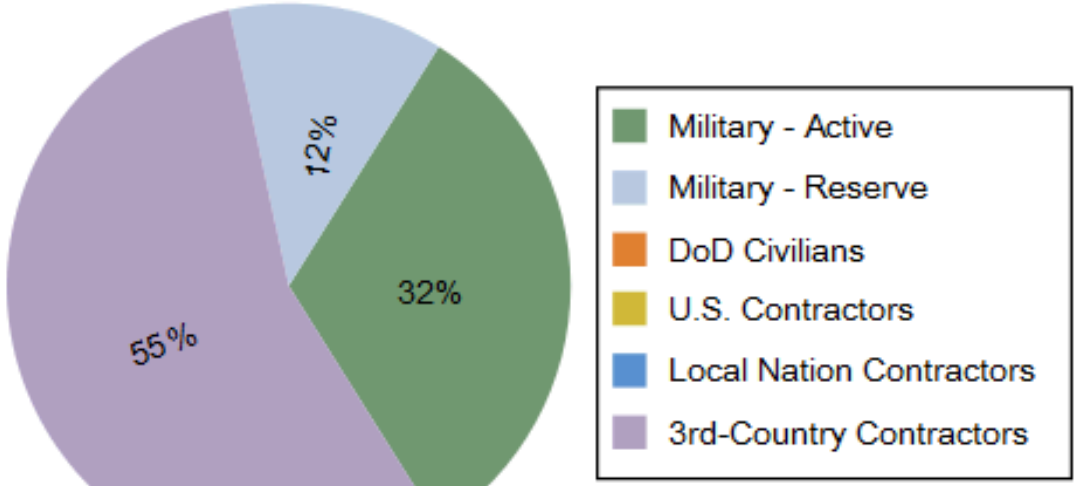
Manpower Mix when 3rd-Country Contractors are Allowed



Manpower Mix when Only U.S. Personnel are Allowed



Costs increase by 64%, from $2.5 billion to $4.1 billion

Conclusion

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- There is a need for a tool that supports contingency contractor planning
- Developed a “what if” capability for strategic planning of contingency contractors that:
  - Addresses the requirements identified by senior DoD leadership
  - Uses a rigorous mathematical framework to determine the optimal Total Force Mix
  - Provides analysts with a user-friendly and intuitive application

Questions???

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BACKUP

CCOT Prototype Model Formulation

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- Budget limitations
- Uncertainty
  - Formulation extended to consider a distribution of possible requirements
  - Provides a framework for incorporating strategic decisions into model (multi-stage stochastic programming)
- Implementation
  - Originally implemented in IBM's OPL math programming language and solved using CPLEX
  - Currently implemented in custom code and solved using COIN-OR's CLP solver to allow for wider distribution

Key Input Data

- Resource requirements by mission scenario
  - Need requirements by time period and skill at a minimum
  - Formulation supports any breakout of resource requirements
  - Application currently uses Time Phased Force Deployment Document (TPFDD) like data
    - Tier 1 JCAs
    - Phases of war (0-V); analysts define start of operation and duration of each phase
    - Bases
- Resource availability and use costs
  - Need data for each time period, skill and personnel group
  - Resource availability can be limited or unlimited

Key Input Data

- Resource use rules
  - Use rules define what personnel groups are allowed to perform each task
  - A function of the implementation of instructions such as DoDI 1100.22
    - e.g. “A regulation states that local nation contractors cannot be used to provide the protection capability”
  - A response to operational risk tolerance
    - e.g. “No more than 25% of the logistics capability can be provided by non-military personnel”
  - Any specific restriction desired
    - e.g. “Planners do not want to use local nation contractors for a given mission scenario”