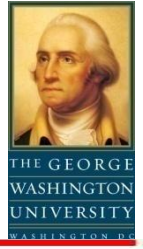

Enterprise Consolidation for DoD Using AdvancedTCA: A Modeling and Simulation Approach Toward Enterprise IT Planning

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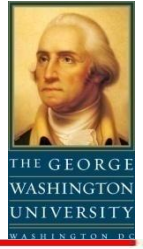
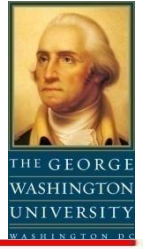
Agenda



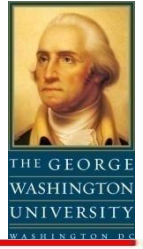
- The Problem
- Benefits of AdvancedTCA for DoD
- The Problem with Benchmarks
- Why Use M&S?
- Does AdvancedTCA Degrade System Performance?

The Problem



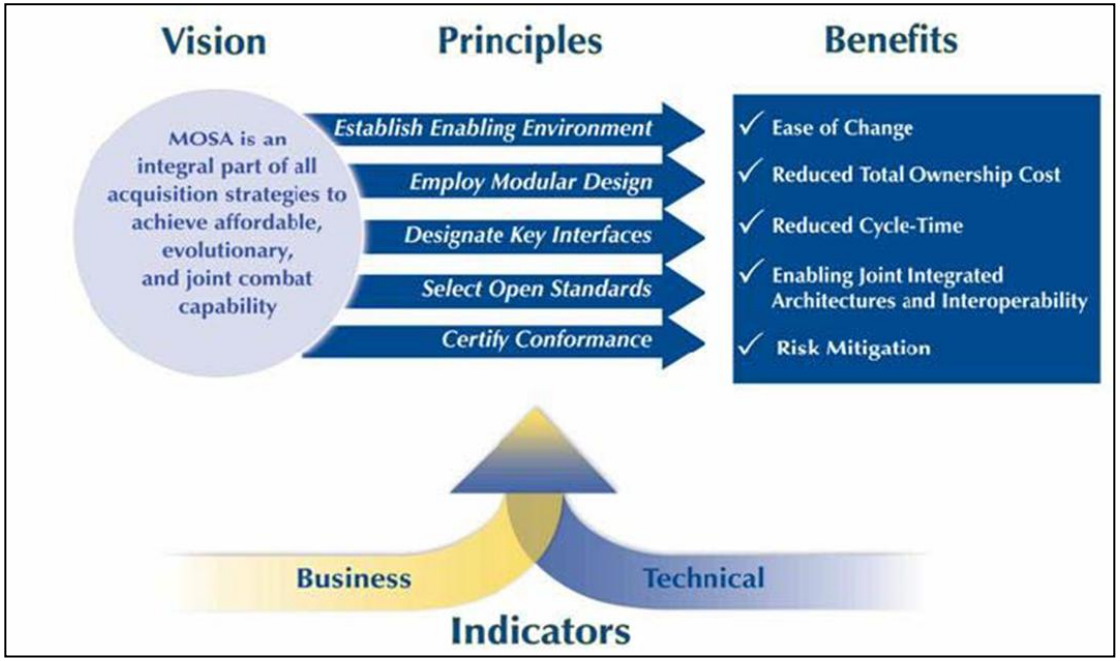
- Enterprise Consolidation within DoD is a mandate from on high
  - OPNAV N2/N6: Increase to 50% Server Utilization
  - CANES, DISA RACE, USAF AOC
- Why Consolidate?
  - It's all about the "Benjamins"
  - Cost savings
  - Facilities reduction
- How much consolidation?
  - No good heuristics regarding what COTS equipment can handle
  - Perception that AdvancedTCA servers are too slow (one or more generations behind commodity IT)

Benefits of AdvancedTCA to DoD



- Design for High A_O
  - Redundant Components
  - Redundant Backplanes
  - Design for AO ≥ 0.99999
  - Increased Availability
  - Decrease downtime (modular design, hot swap)
  - Decreased Logistics Delay (easier to maintain spares)
- Design for Extreme Conditions
  - NEBS Level III Standards
  - Operating Temperatures of 55°C
  - Humidity up to 85% N/C

AdvancedTCA is Designed for MOSA Compliance!

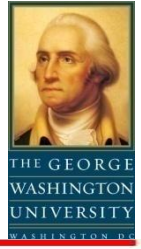


Source: http://www.acq.osd.mil/osjtf/pmguide.html

"Typical" Server Rack

Oracle CT900 AdvancedTCA Chassis Used in SPAWAR ISNS Baseline

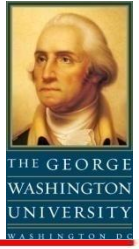
AdvancedTCA is Designed to Reduce TOC



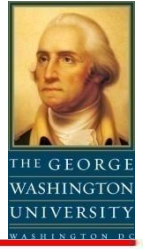
- Modularity
  - Reduces logistics impact (spares, documentation, etc.)
  - Unified design reduces training burden
  - Reduces integration costs by standardizing interfaces
- Power Reduction
  - Reduces fuel consumption
  - Reduces need for Power/HVAC improvements in space
  - Enables better use of space
- Open Standard
  - ELIMINATES VENDOR LOCK IN
  - Competition = Cost Savings
  - LCS, ARCI, CANES acquisition models


So Why doesn't DoD use AdvancedTCA more often for Enterprise Consolidation programs?

AdvancedTCA Has a Perception Issue



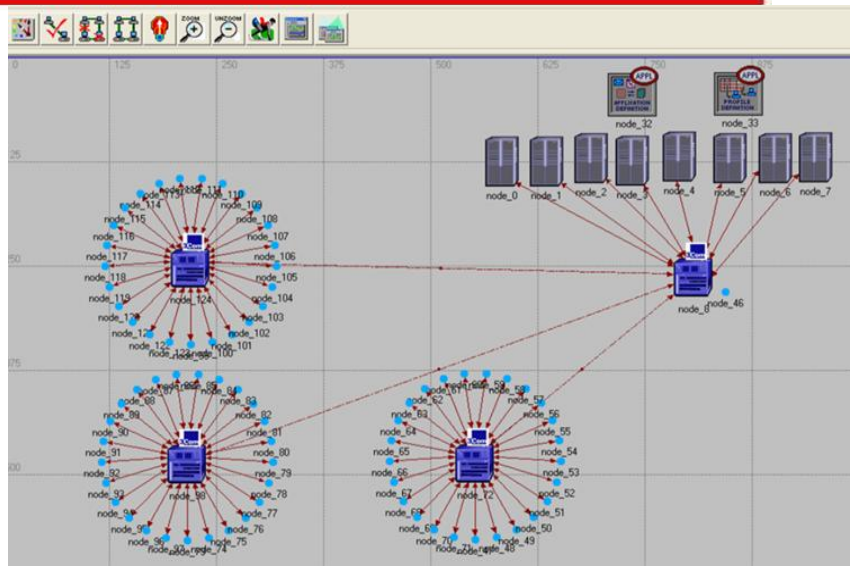
- Only 2 of Top 5 Server Vendors Build AdvancedTCA
  - IBM: N/A blade.org
  - HP: Blade
  - DELL: N/A
  - SUN/Oracle: CT900; Focusing on software in future
  - Fujitsu: N/A
- AdvancedTCA Servers generally follow Commodity IT Market by a generation
  - Perceived as slower, less capable
  - Viewed as overall system performance risk

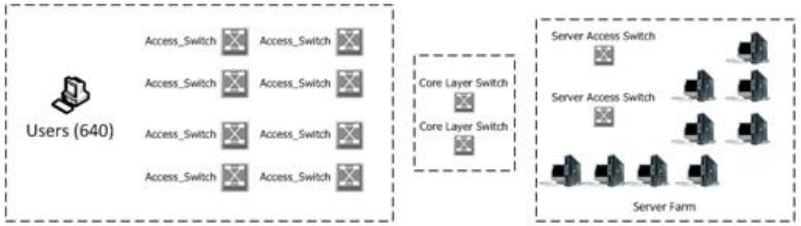


Research Question: Does the use of AdvancedTCA reduce overall system performance (and hence, hinder ability to consolidate an enterprise)?

Research Approach

1. Establish architecture model, & System Goodput metric (G_S)
2. Develop Enterprise System Model to simulate network dynamics / system behavior
3. Execute Simulation, varying:
   - Server Architecture
   - Network Architecture
   - Server Virtualization
4. Compare GS performance of architectures (ANOVA, Tukey, Kruskal-Wallis)





Lies, Damn Lies, and Benchmarks

COMPONENT Benchmarks (SPEC.org, Network Throughput) are NOT accurate predictors of SYSTEM performance!

Source: http://www.chevrolet.com/corvette-zr1/

The 638-hp Corvette ZR-1 can reach top speeds in excess of 200 miles per hour …

Lies, Damn Lies, and Benchmarks

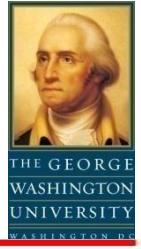
… but not on THIS road!

Enterprise IT is a SYSTEM; more than just its component parts

We need a SYSTEM level benchmark as a predictor of system-level performance

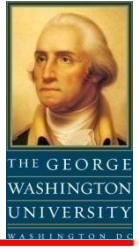
End to End Metrics: P_E: Email P_W: Web-based Application P_D: Database P_F: File Transfer

Why Use M&S?



- Sensitivity Analysis in a lab adds too much cost/schedule to a program
  - Multiple scenarios
  - Multiple lab facilities in parallel
  - Component obsolescence
- System dynamics of IT Enterprise are complex to analyze by hand
  - Many interrelationships
  - Difficult to predict emergent behavior
  - Many-to-one node to function ratio

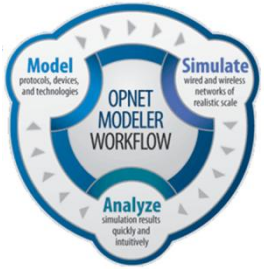
Which Modeling Tool to Use?



- MatLAB
  - Excellent tool for mathematical simulation
  - Generally used for mechanical systems

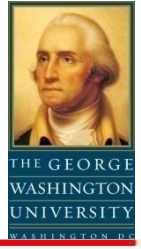
- iThink
  - Very Strong system dynamics modeling tool
  - Object-oriented representation
  - Requires user definition of performance characteristics

- OPNET Modeler
  - Object-oriented modeling
  - IT Hardware vendors provide templates with pre-defined performance attributes



Researchers chose OPNET Modeler due to pre-defined performance attributes to ensure accurate model performance

Modeling Approach / Data Collection



- Developed 4 Separate Use Cases of Enterprise IT Model
  - 3 Tiered Star Architecture
  - 640 end user nodes
  - Multiple user types

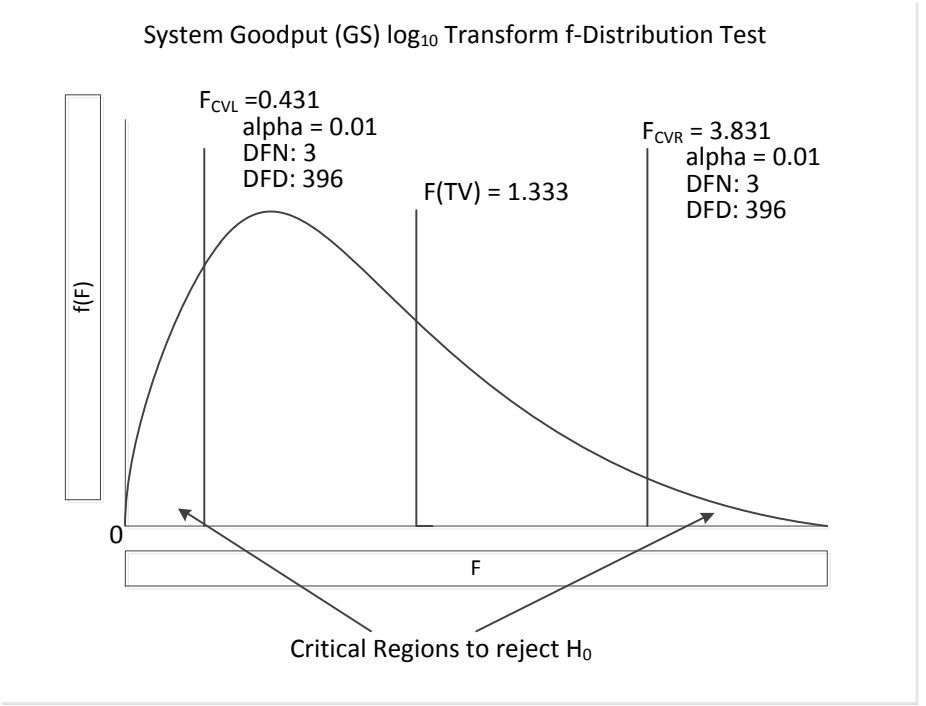
Scenario	Network	Server	Spec CINT2006 Rate
Baseline	1 Gbps	Model: HP DL580 # CPUs: 2 # cores per CPU: 6	58
10 Gbps	10 Gbps	Model: HP DL580 # CPUs: 4 # cores per CPU: 1	58
ATCA	1 Gbps	Model: HP BI460c # CPUs: 1 # cores per CPU: 4	34.5
High End	1 Gbps	Model: HP DL585 # CPUs: 4 # cores per CPU: 2	98.3

- Ran 100 Simulations of network traffic (ranging from 15 to 75 minutes per run)
- Collected server, network, client, and system-level performance data
- Translated individual Statistics into System Goodput G_S
  - Used Log_{10} Transform to establish Normality

Data Analysis: ANOVA, f-Test

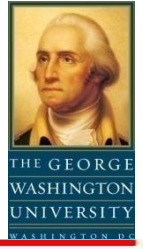
System Goodput (log10 Transform)				
Value	Baseline	10Gbps	ATCA	High End
i	1	2	3	4
$\bar{x}_i$	0.082377	0.078218	0.076542	0.07891
n_i	100	100	100	100
s_i^2	0.00594	0.005234	0.00675	0.007078
$\bar{x}_{GM}$	0.079011655			
$(n_i - 1)$	99	99	99	99
$(n_i - 1)\, s_i^2$	0.58807	0.518212	0.668235	0.700675

ANOVA Stats		F_{TV}		F_{CV}	
$xBar_{GM}$	0.079012	F_{TV} =	$MS_{Between}$	α	0.1
			MS_{Within}	D_{FN}	3
k	4			D_{FD}	396
$MS_{Between}$	0.008334	F_{TV}	1.333333	F_{CVR}	2.627441
MS_{Within}	0.00625			F_{CVL}	0.430611



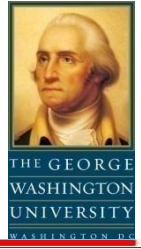
Researchers found NO STATISTICALLY SIGNIFICANT DIFFERENCE among network architectures

Findings of Research

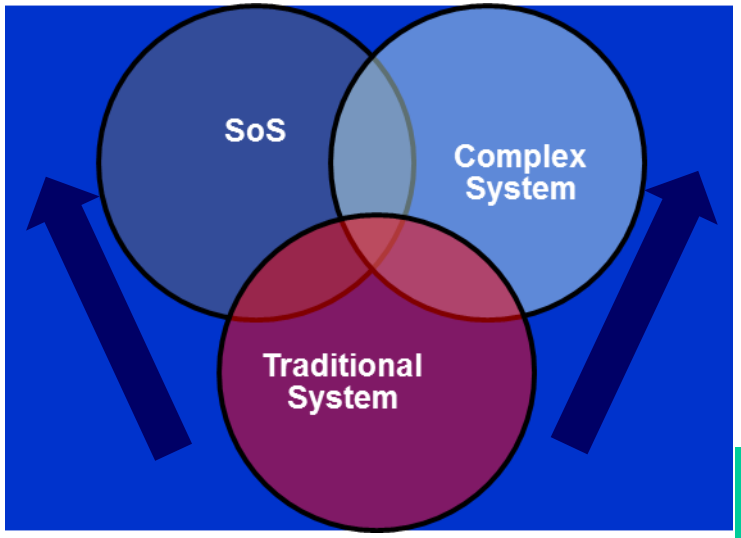


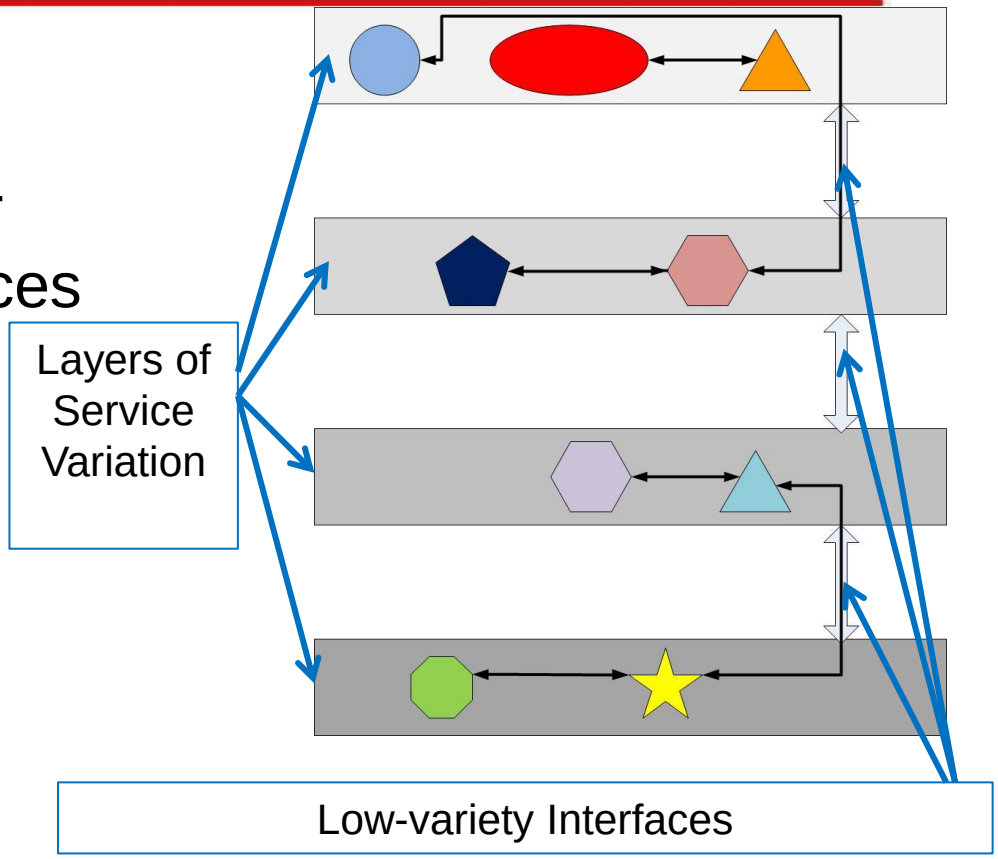
1. There is NO evidence to support perception that AdvancedTCA reduces overall system performance
2. Benefits of AdvancedTCA greatly outweigh any perceived performance risk
3. DoD should continue to invest in AdvancedTCA
   - Designed for AO ≥ 0.99999 systems
   - Modularity, Scalability ideal for MOSA Compliance
   - Reduced TOC through modularity, unified design
   - Significant Power Savings
   - **No Vendor Lock-in = Significant Cost Reduction**

Enterprise IT Consolidation: A Complex System



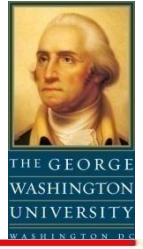
1. Not readily decomposable
2. Evolving emergent behavior
3. Requires nee PM/SE practices





Complex Systems require Process Triage: Choose your battles and focus on the Interfaces

Areas of Future Research



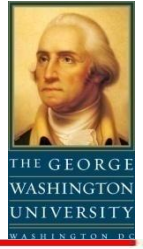
1. Extend Model to include Server Virtualization
2. Use System Dynamics tool (e.g., iThink) to evaluate system architecture
   - Identify queuing bottlenecks
   - Establish QoS/QoE recommendations
3. Normalize Simulation Data:
   - Increase number of nodes captures during simulation
   - Repeat simulation with static simulation run times

Questions?

Remember, there are no dumb questions …

… except maybe this one

Thank You



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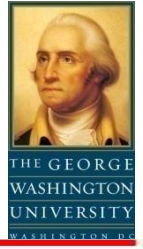

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  - Chief Engineer, SPAWAR/PMW 160 SCN, Modernization & CANES Future
  - ~18 Years DoD and Commercial Experience w/ Enterprise IT Consolidation
  - B.S., U.S. Naval Academy
  - M.S., George Washington University
  - PhD Candidate, George Washington University

Research Advisors:

- Shahram Sarkani, PE, PhD, George Washington University
- Thomas Mazzuchi, DSc, George Washington University

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