

Modeling the Influence of System and Application Complexity on the Cost of Cloud Hosting

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And Analysis Training Workshop

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Background/Motivation

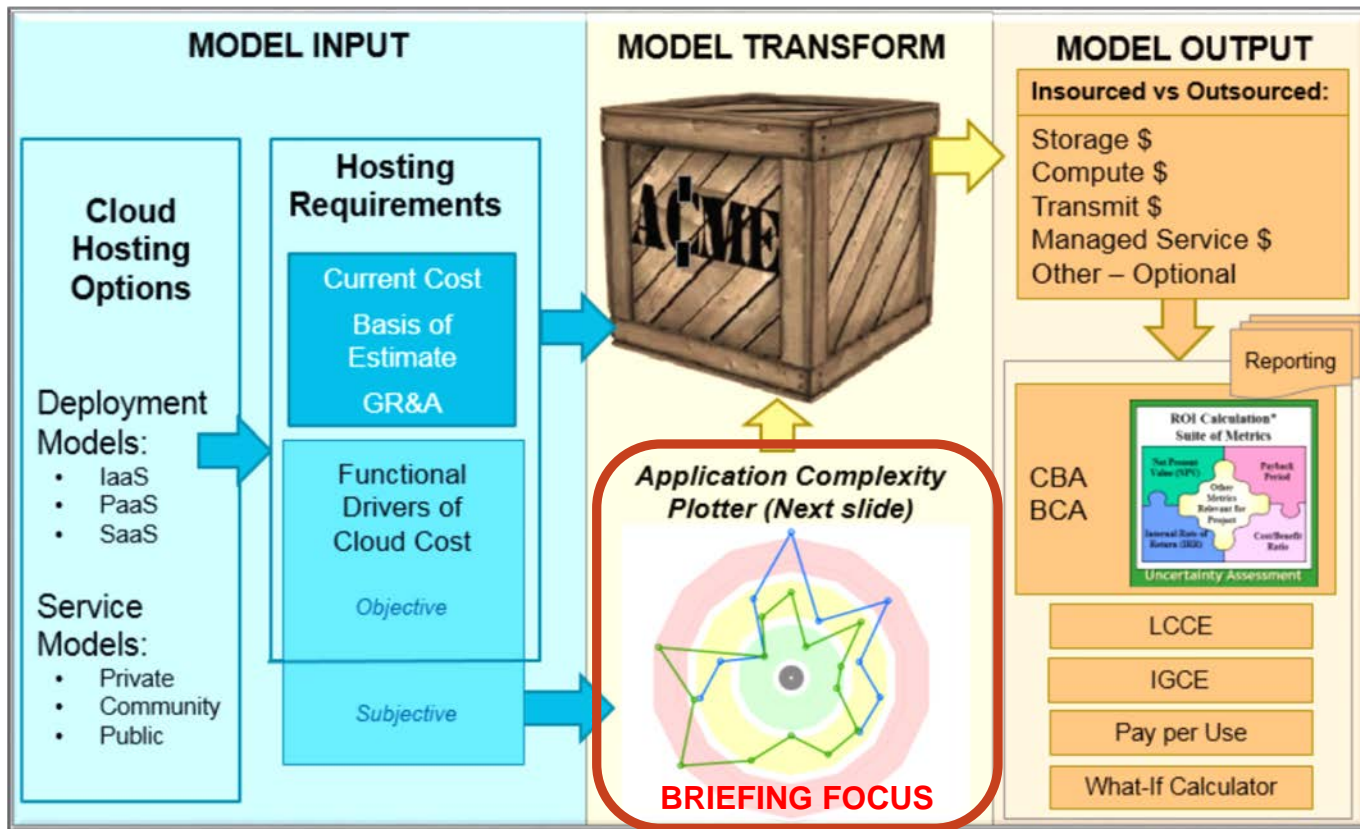
- **Army Network Enterprise Command (NETCOM) recently awarded a contractor-owned/contractor operated (COCO) cloud pilot contract (Army Private Cloud Enterprise – APCE) to support data center consolidation**
 - MITRE developed the APCE Cost Modeling Environment (**ACME**) to help inform Program Manager decisions regarding migrating and hosting applications in the APCE
- **MITRE postulated that candidate APCE applications/systems possess inherent complexity (e.g., interdependencies) that likely affects hosting costs significantly**
 - The impact of complexity on cloud hosting costs could not be readily estimated using available cloud cost tools (e.g., Amazon Web Services)
- **The team thus developed the Application Complexity Plotter to assess/visualize relative complexity and formulated a hypothesis regarding the relationship between complexity and cloud migration and hosting cost**

Context of Complexity Assessment within AÇME*

*APCE Cost Modeling Environment

- Complexity assessment is one element of a comprehensive cost model that can support different users and cost evaluation requirements

AÇME FEATURES



➔ The cost impact of complexity depends on hosting solution (e.g., Platform as a Service) and the costs to be estimated (e.g. Total Ownership Cost)

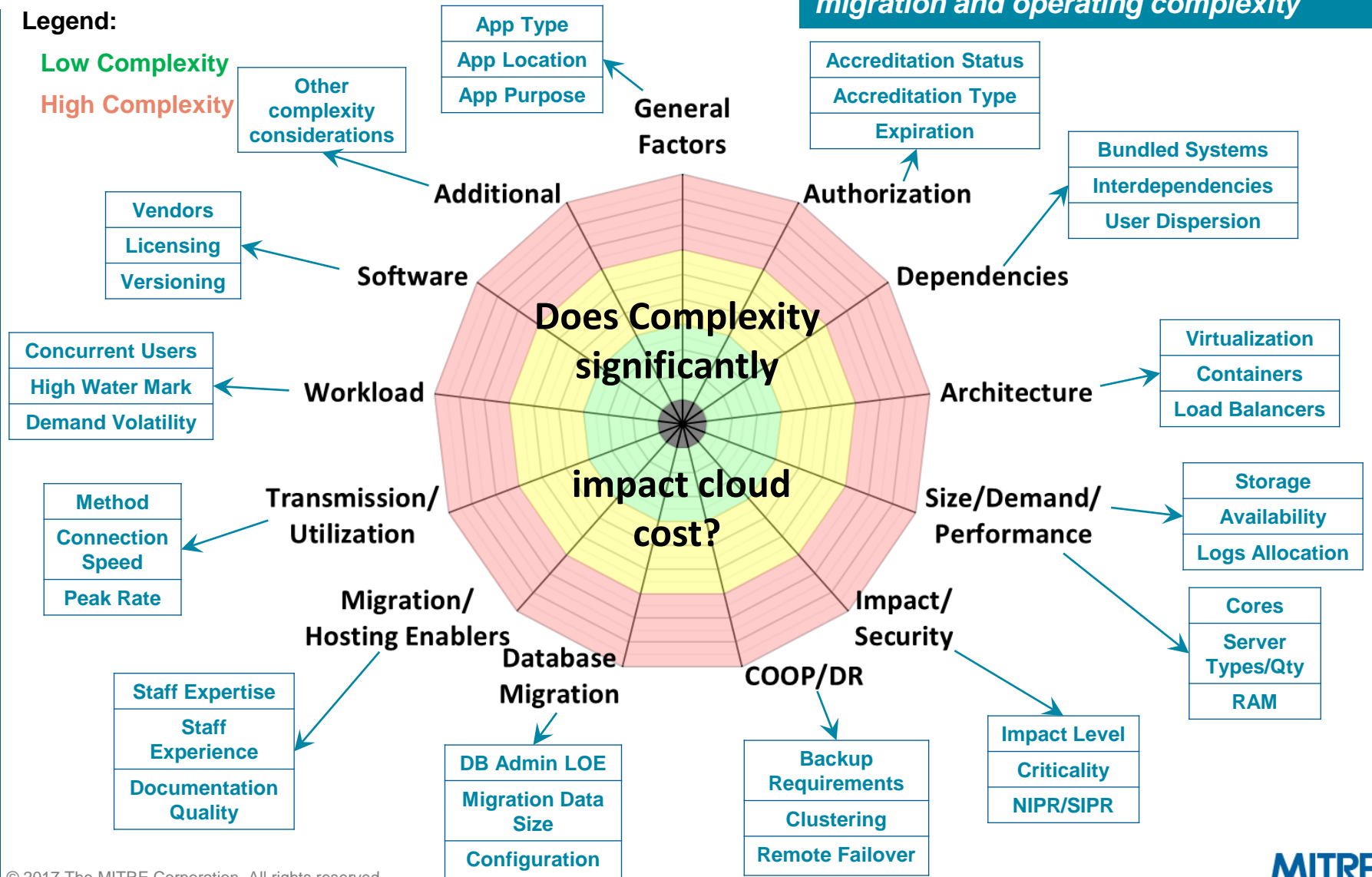
Defining Application/System Cloud Hosting Complexity

13 attributes (consisting of 71 individual factors) significantly influence cloud migration and operating complexity

Legend:

Low Complexity

High Complexity



Defining Application/System Complexity

- **“Application/system complexity” means the demands and challenges that a given application/system will place on the cloud hosting environment**
 - Certain aspects of complexity influence migration costs/requirements (“Transitional Complexity”) and certain aspects influence operations and sustainment costs/requirements (“Operational Complexity”)
- **AÇME evaluates 13 complexity attributes:**

General:
App type, location, user population, accreditation/authorization

Dependencies:
Interrelationships with other applications/systems

Architecture:
Virtualization technology, requirements for clustering and load balancing

Size:
Required Cores, RAM, backup, and bandwidth

Database Migration:
Size of data to be migrated, Database Administrator LOE

Security/Impact:
Cross-boundary solution required? Information Impact Level, Mission Criticality

COOP/DR:
High availability requirements, current COOP/DR requirements

Staff Expertise/Experience:
Focus is on staff that will help/hinder migration

Transmission:
LAN connection speed, network usage volatility, peak transmission

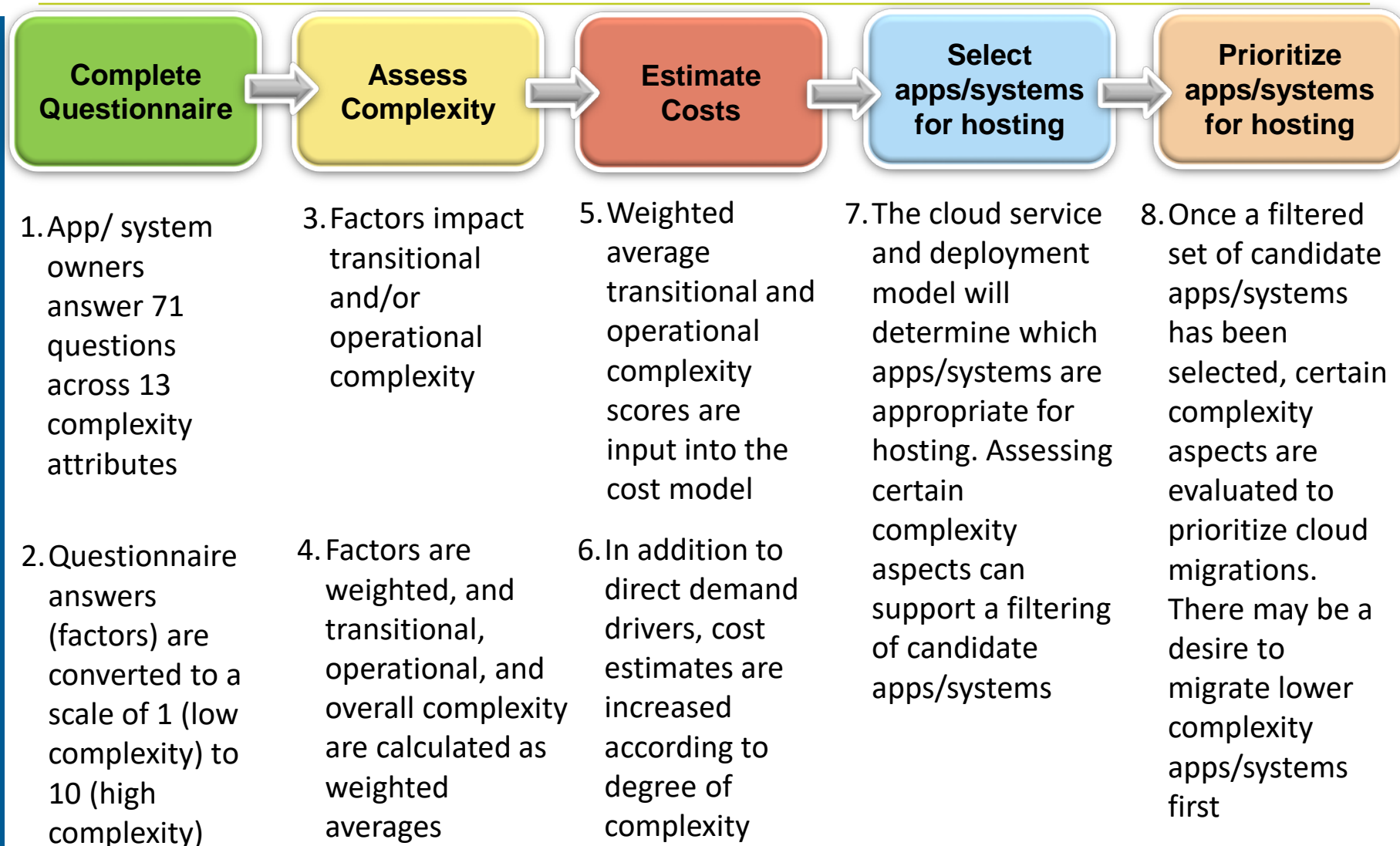
Utilization/Workload:
Number of users, current system/network utilization

Performance:
Availability and response requirements

Documentation Quality

Risk:
Database configuration conversion requirements

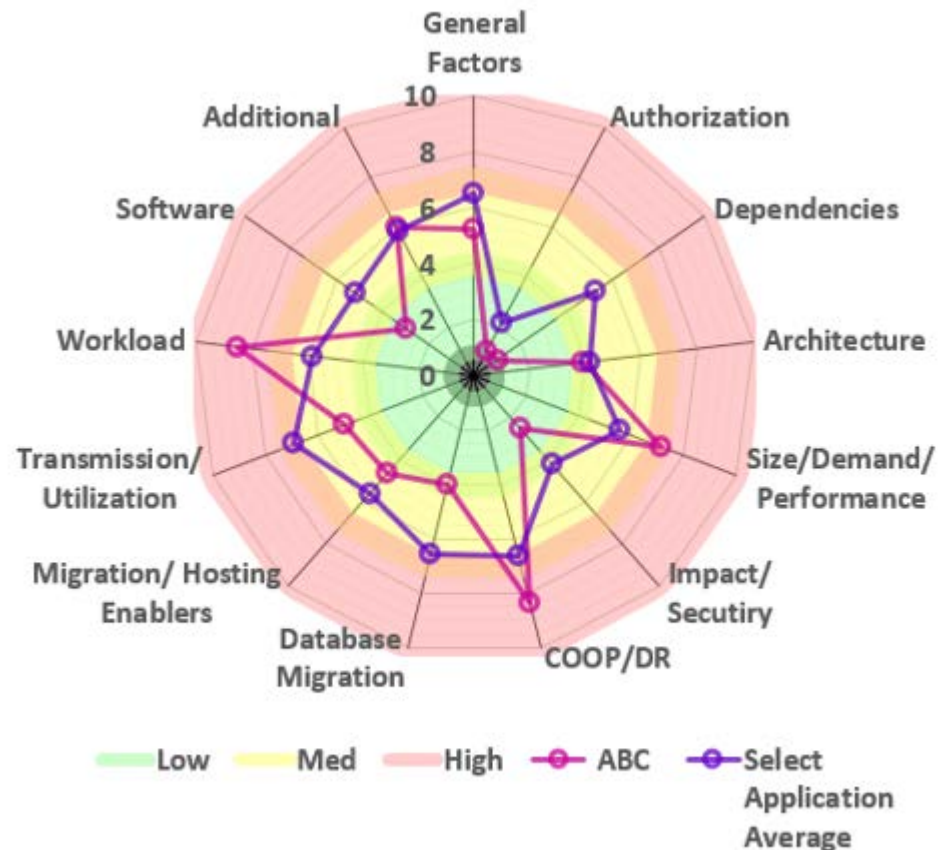
Complexity Assessment Process and Application



Visualizing App/System Complexity

Spider Diagram/Radar Plot

- Complexity plots are automatically generated based on questionnaire inputs/assessments
- Plots are created for transitional, operational, and combined complexity
- Plots compare a specific application/system to selected population of applications/systems
- Scoring for each attribute is on a scale of 1 (lowest complexity = green) to 10 (highest complexity = red)

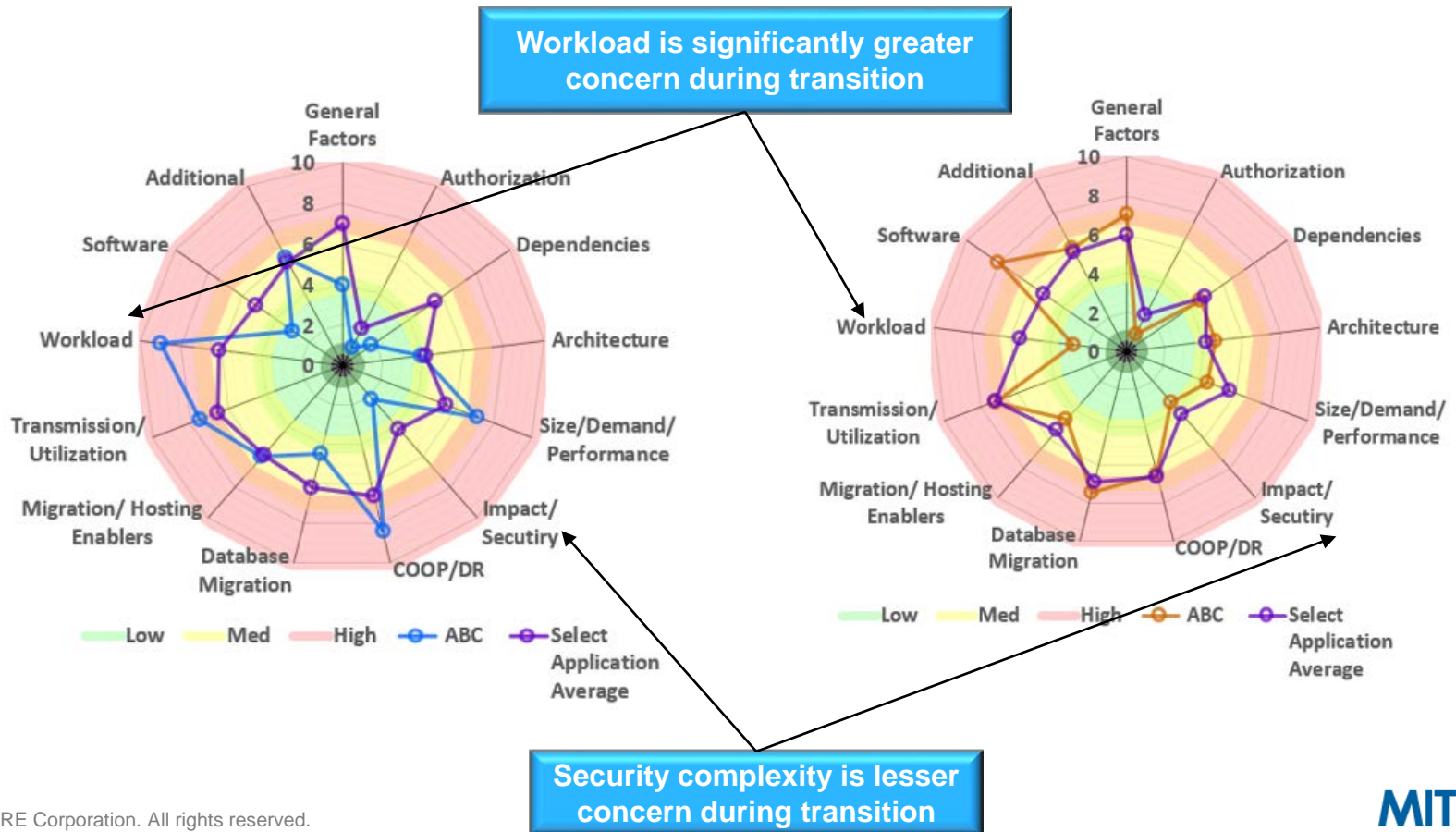


Spider Diagrams Highlight Significant Complexity Considerations

- We make a distinction between migration and hosting complexity
 - Solely considering overall complexity may mask key influences

Transitional Complexity

Operational Complexity



Conclusions

- **The contribution of overall complexity to cloud cost is a hypothesis to be further tested**
 - Does complexity significantly drive cost of initial migration as well as recurring operations and support?
 - Are there more objective and mathematically valid methods for assessing complexity (e.g., “Equity” Balanced Beam/Analytical Hierarchy Process)
- **Considering only overall complexity may mask significant differences in Transitional vs O&S complexity**
- **Although the *Application Complexity Plotter* is designed to inform decisions with consideration of additional environmental factors, inclusion of this assessment in cloud cost estimates should likely be optional**

Way Forward and Next Steps

- **Capture data from initial system migrations**
- **Capture analogous data from other system migrations to the cloud**
- **Analyze data for statistical relationships and any cost factors**
- **Prove/disprove complexity hypothesis: Based on pilot results, compare actual migration and hosting costs to AÇME estimates**
- **Continue collaboration with other Army, DoD, and Federal agencies to transfer knowledge and support other cloud hosting solutions**

Discussion

- **Are any of you engaged in cloud cost modeling efforts?**
- **Have any of you attempted to account for application/system complexity in cloud hosting cost estimates?**
- **What do you believe most significantly includes application/system complexity?**

Backup

Attributes and Supporting Factors that Impact Complexity (1 of 3)

- APCE application questionnaire includes 83 questions; hypothesis: 71 are leading indicators of complexity

General Factors	Application Title:
General Factors	Application Owner:
General Factors	Application POC:
General Factors	Why transition this app to the APCE Cloud?
General Factors	What is the purpose/function of this application/system?
General Factors	Application Type:
General Factors	Programming language(s): If the OS is Solaris SPARC or currently runs on another non-x86 chip, what language
General Factors	Is the app currently housed at Redstone Arsenal?
General Factors	APMS #:
General Factors	Have you completed a DISA System Requirements Form and/or an AAMBO Assessment Form?
General Factors	How dispersed are the majority of app users?
General Factors	Does this application get deployed with the unit when mobilized?
General Factors	Accreditation Status (only systems w/current CON or RMF will be candidates for APCE):
General Factors	Accreditation Expiration Date
General Factors	If not accredited with RMF, describe progress in achieving interim RMF accreditation milestones:
General Factors	Accreditation Status Further Description:
Dependencies	If this a bundled app or system, identify the other apps or systems included in the same bundle:
Dependencies	Outside of the bundle, are there other apps or systems that this app or system is dependent on?
Architecture	Unique virtual machine images:
Architecture	If virtualized using Hypervisor technology, what software is used?
Architecture	Clustering
Architecture	Does the app/system maintainer require physical access to the hardware?
Architecture	Is the app deployed through the use of containers?
Architecture	Is the Application web-enabled?
Architecture	Currently applying Load Balancers?
Architecture	Applications sharing the same database
Size	Code/ Program size:
Size	How much re-writing (architecture, design, development) will be necessary?
Size	How much WAN bandwidth is used for the currently traversed circuits?
Database Migration	Database Administrator Level of Effort:
Database Migration	How large is the data to be migrated?

Attributes and Supporting Factors that Impact Complexity (2 of 3)

Security	Once hosted in APCE, will the application require a cross-boundary solution?
Security	Current Number of CAT 1 Vulnerabilities:
Security	LDAP/Active Directory entries required?
Impact	Information Impact Level:
Impact	Mission criticality:
Impact	Is the application utilizing NIPR, DREN, SDREN, and/or SIPR?
COOP/DR	If currently providing COOP, provide locations:
COOP/DR	If currently providing DR, provide locations:
COOP/DR	Does the system require any specific local high availability feature for any specific OEs or functions (e.g.,
COOP/DR	If Yes, please elaborate on the requirement (if possible identify the OEs to be clustered and the type of clustering required, e.g., active, passive, RAC) below:
COOP/DR	Does the system require remote or second site high availability features for any specific OEs or functions (e.g., remote failover, clustering, Oracle RAC)?
COOP/DR	If Yes, please elaborate on the requirement (if possible identify the OEs to be clustered and the type of clustering required, e.g., synchronous, asynchronous, RAC) below:
COOP/DR	Back-up requirements:
COOP/DR	Average size of data from periodic back-up:
Staff Expertise / Experience	Staff expertise
Staff Expertise / Experience	Staff experience
Transmission	Current LAN connection speed:
Transmission	Peak transmission rate in MB/sec:
Transmission	Is network usage steady or variable?
Utilization	What is the current system utilization rate?
Utilization	Current network utilization:
Workload	Total Number of User Accounts:
Performance	Availability metric
Performance	Response time metric
Quality	Documentation quality:
Risk	To what degree is the target database configuration identical to the existing database configuration, i.e., is it the same vendor and version or will it require Big Endian to Little Endian conversion, are there triggers and stored

Attributes and Supporting Factors that Impact Complexity (3 of 3)

■ Server-specific questions

Architecture	Server Name (hostname or unique identifier if not known)
Architecture	Server Function
Architecture	End Date (indicate date no longer needed, if applicable)
Architecture	Environment
Architecture	Operating system
Architecture	CPU Type
Architecture	Is App virtualized?
Architecture	Do any components of the app run on commodity or specialized hardware?
Size	# of virtual machines
Size	# of Cores Req
Size	Req RAM:
Size	What is the expected average annual storage requirement growth over the next 5 years?
Size	Total Req'd Cloud Storage
Size	Total Req'd Direct Attached Storage
Size	Total Required Backup storage:
Software	SW Vendor (indicate any required software other than OS)
Software	Software Name (other than OS)
Software	Software Function
Software	Version
Software	License Acquisition Notes
Workload	Concurrent Users
Workload	High Water Mark
Workload	Volatility in demand: