



# My Dog Ate my Engineering

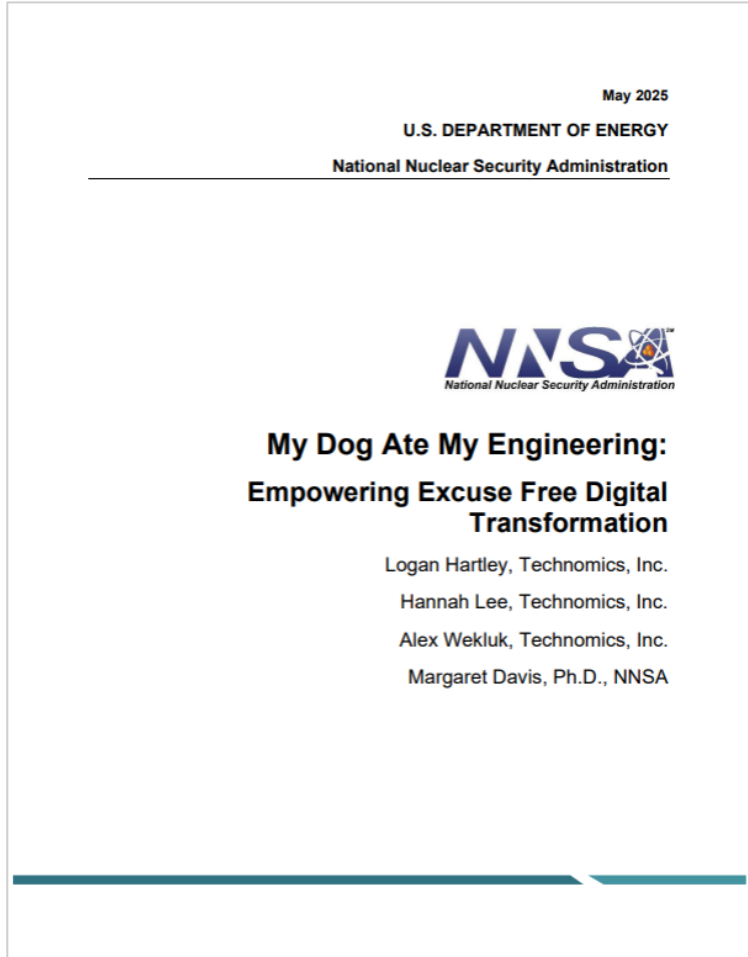
Empowering Excuse Free Digital Transformation

Logan Hartley, *Technomics*





# Agenda



Overview of Digital Transformation, NNSA, and PA&E



Case Study Introduction



Approach and Methodology



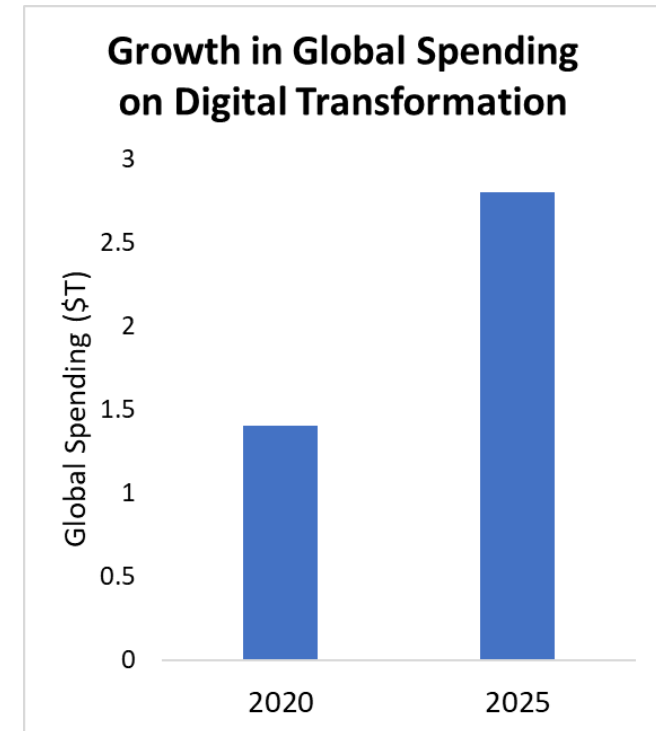
Results



Conclusion

# Bottom Line Up Front (BLUF)

- The **National Nuclear Security Administration (NNSA)** is striving to adapt and thrive in today's ever-growing digital engineering ecosystem
- **Digital Transformation** enables increased business efficiency, uplevels agility and resilience, and accelerates innovation
- A **mixed-methods approach to cost estimating** provided decision makers with a clear picture of how best to incorporate DT into their architecture
- A **multi-system framework** best allowed the team to consolidate data from disparate resources and visualize what specific DT approaches were most feasible



Digital Transformation Spending projections. Source: Bloomberg

While the NNSA has made significant strides in capturing DT scope, much remains to be done in the accurate accounting and capturing of costs for these efforts

# NNSA and Programming, Analysis & Evaluation

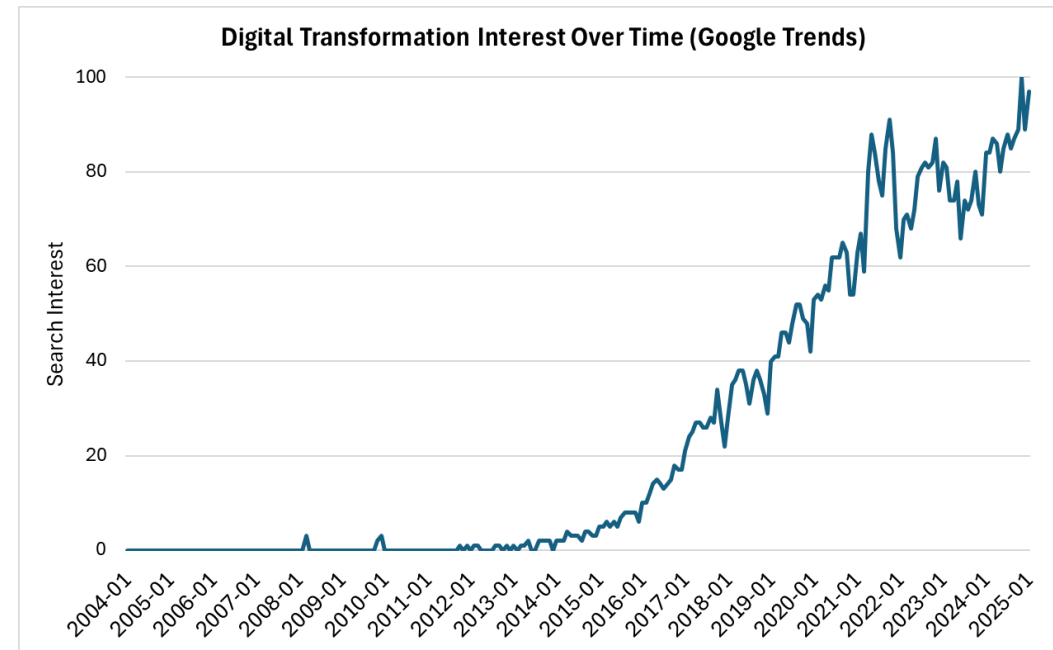
- The NNSA **enhances national security** through four major missions: Maintaining the Stockpile, Nonproliferation, Counterterrorism and Counterproliferation, and Powering the Nuclear Navy
- Office of Programming, Analysis, and Evaluation (**PA&E**) is part of the NNSA Office of Management and Budget
- PA&E develops **models and tools** to support Programming, Planning, Budgeting and Evaluation (PPBE) and capital acquisition processes, and to help **inform decision-making at the highest levels**
- With PA&E's cost estimating capabilities and experience in analogous work, there has been an **increased demand** for DT estimating



Extracted from U.S. Department of Energy's website ([energy.gov](http://energy.gov))

# Introduction to Digital Transformation

- Interest in DT has rapidly increased in both the private and public sectors
- DT is defined as ***the incorporation of digital solutions and technologies to change and improve business operations***
  - However, there is often an unclear understanding of scope, objectives, and costs associated with DT
- When implemented correctly, DT can enable the government to spend taxpayer dollars more efficiently while improving the services it provides



Interest in Digital Transformation over time, according to Google Trends

# Mission Need of Digital Transformation

- DT encompasses a large number of capabilities, such as MBSE, data virtualization, and smart manufacturing. An example of which is below:
  - **Smart Factory** - Technology at Y-12 and KCNSC that allows for real time tracking of machinery, allowing sites to proactively plan maintenance thus leading to less production downtime
- DT also adheres to multiple executive orders that revolve around improving efficiency and modernizing digital environments within government

ESTABLISHING AND  
IMPLEMENTING THE PRESIDENT'S  
“DEPARTMENT OF GOVERNMENT EFFICIENCY”

*Sec. 4. Modernizing Federal Technology and Software to Maximize Efficiency and Productivity.*

*Snippet from Executive Order 14158*

# Case Study Introduction

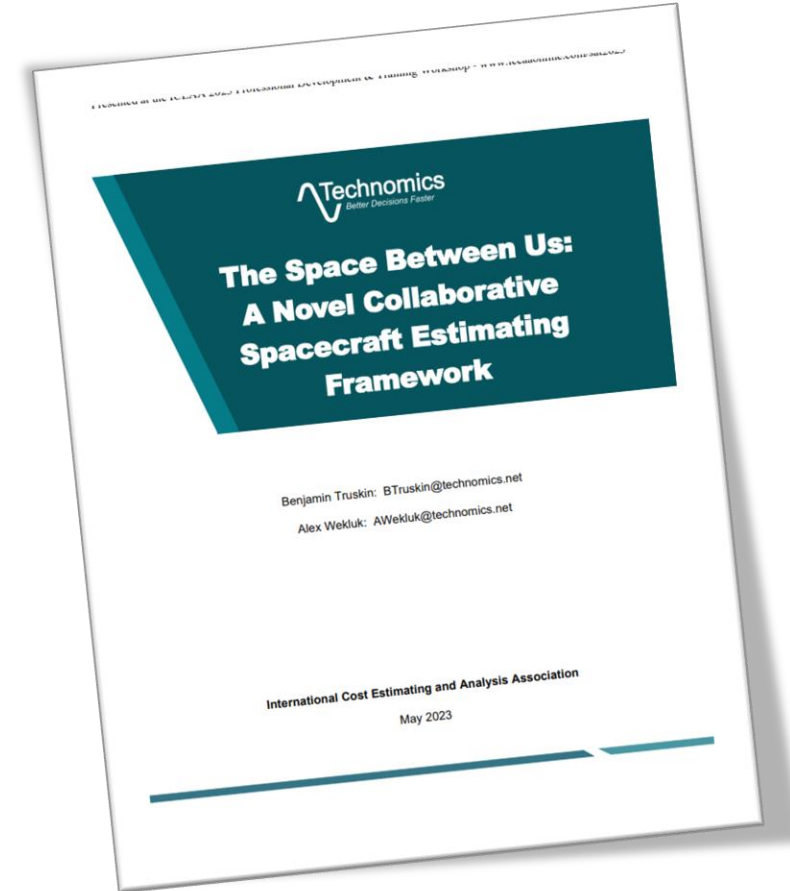
- PA&E was asked to evaluate a pilot program for a collaborative cloud environment
  - **Problem:** How best can the objectives of the project be quantified?
  - **Primary Goals:** Given only high-level conceptual requirements and budget, categorize costs, define and quantify technical scope of integrated digital computing and storage, network bandwidth, FTEs, and identify areas to reduce costs
- Study gave decision makers insight into the true costs and technical requirements of DT

Level	WBS	Infrastructure	FY Budget
1	1	Collaboration Space - Project	\$ 27,000,000
2	1.1.	Leadership Staffing	\$ 3,000,000
2	1.2.	Instantiation	\$ 4,000,000
2	1.3.	Hardware	\$ 20,000,000
3	1.3.1.	On-prem HW/storage	\$ 2,000,000
3	1.3.2.	Network upgrades/Redundance	\$ 3,000,000
3	1.3.3.	Lifecycle and management reserve	\$ 9,000,000
3	1.3.4.	Network Staffing	\$ 6,000,000
2	1.i	...	X

*Example of budget data discretely binned into WBS format*

# Approach & Methods – Multi-System Analytical Tool

- First, the team needed a way to **aggregate**, **store**, and **organize** the project data
- The team also needed an **engine** to run Cost Estimating Relationships (CERs), Cost as an Independent Variable (CAIV) analyses, and visualize findings
- The resulting solution was a **centralized** and **robust framework** that allowed for all study analysis in a scalable and modular tool
  - *A similar framework was introduced in the space cost estimating industry (called SPACEFRAME), and written about in a 2023 ICEAA paper*



# Approach & Methods – Cloud Services

- The team identified the need for several **cloud CERs**
- With a few exceptions, all cloud **CERs were created** for this effort by leveraging publicly available data from common providers
- Cloud services enable users to access powerful digital infrastructure for storage and computing without owning physical hardware
  - **Cloud Storage:** Users can securely store, manage, transfer, and access data
  - **Cloud Computing:** Deployment of virtualized servers called ‘instances’ that can run applications, process workloads, host websites, or train and deploy Artificial Intelligence/Machine Learning (AI/ML) models



# Approach & Methods – Cloud Services & Parametrics

- Cloud pricing tools are comprehensive, but require many inputs
- By creating CERs, the core cost drivers can be identified and thus require minimal input
- An example of a CER developed for the study:

*Cost of Cloud Storage = Storage Type Dummy Variable (1/0) \* Storage Rate Cost (\$/TB) \* Amount Stored (TB)*

- In the example, the ‘storage type dummy variable’ is a multiplicative factor based on data access frequency; more frequent data access = higher multiplier = higher cost of storage
- **Cost as an Independent Variable (CAIV)** could then be leveraged with our cloud CERs to solve for a quantitative technical variable

Storage Tier	Cost per TB/Year (\$)
Frequent	264
Infrequent	156
Yearly	48
Archival	12

*Extracted from the Amazon Web Services website (aws.amazon.com) for Simple Storage Service (S3)*

# Approach & Methods – CAIV

- Whereas in most CERs, we are trying to solve for the cost of something, CAIV turns this concept around and instead of solving for cost, is used to solve for a technical variable instead.
- In a project such as this where high-level budget costs and little technical scope exists, CAIV can be used to provide a user with technical magnitude predicated on available funding
- Using the CERs that the team developed, some of the technical items solved for were:
  - The number of computing instances
  - Approximate storage size (Terabytes) as a function of cost

$$1) \text{ Cost of Storage } (y) = \text{ Storage Rate Cost } (a) * \text{ Amount Stored } (x)$$

$$2) \frac{\text{ Cost of Storage } (y)}{\text{ Storage Rate } (a)} = \frac{\text{ Storage Rate Cost } (a) * \text{ Amount Stored } (x)}{\text{ Storage Rate } (a)}$$

$$3) \text{ Amount Stored } (x) = \text{ Cost of Storage } (y) / \text{ Storage Rate Cost } (a)$$

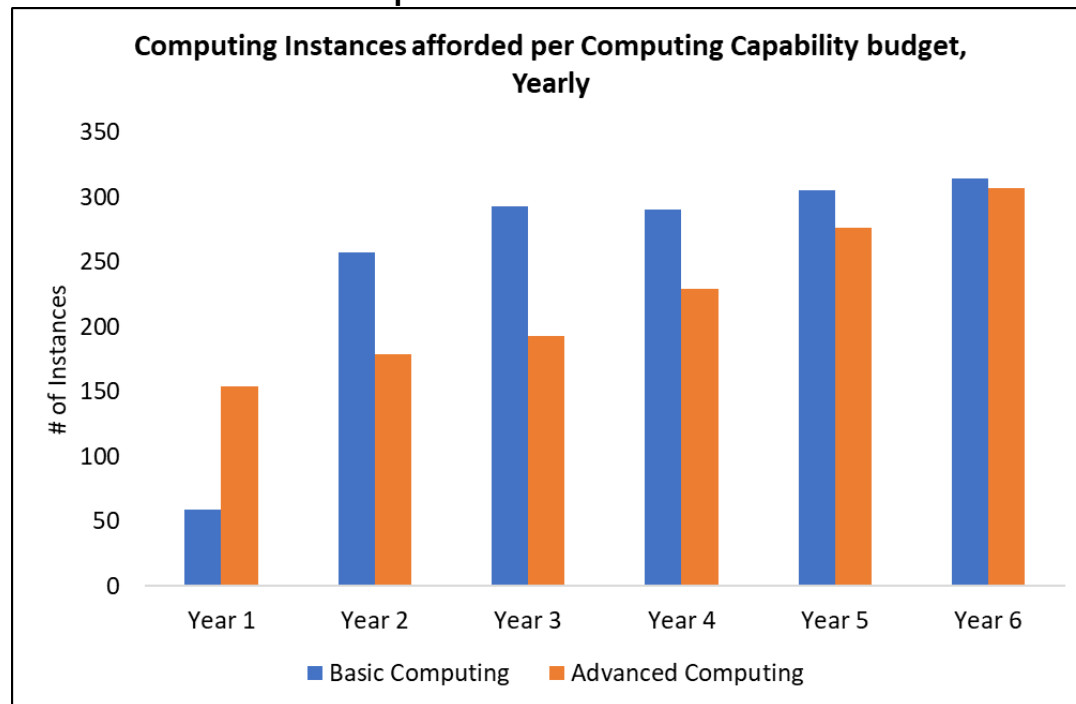
*An example of a CER being transformed into CAIV space*

# Approach & Methods – Non-Cloud costs

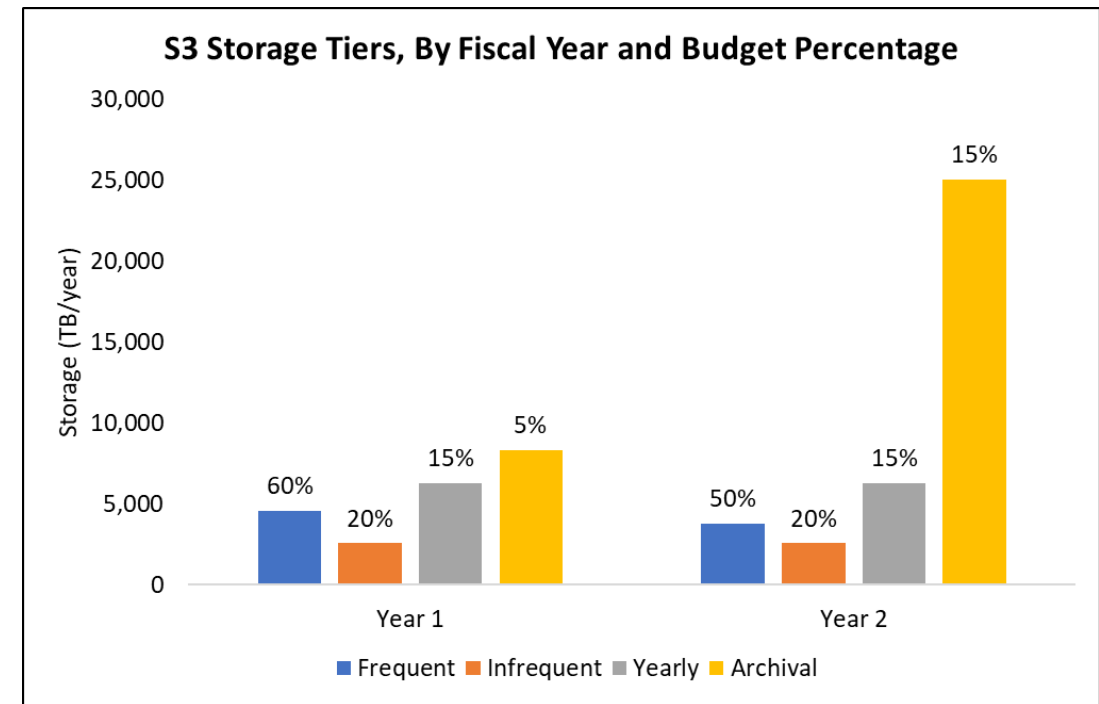
- **Other areas of cost and technical uncertainty included:**
  - **Network redundancy**
    - Leveraged NNSA's BUILDER database to capture costs for fiber optic cabling components
      - These costs included both material and labor
  - **Bulk procurement of software**
    - Utilized public software pricing data to demonstrate cost savings using bulk procurement vs. individual site procurement
      - I.E. How much cheaper is it to buy 30,000 licenses and distribute from a centralized entity, than it is to buy 10,000 licenses for three sites?
  - **Labor**
    - Found historic labor rates to assist in approximating the number of Full Time Equivalents (FTEs) needed for project
      - Analogous Cloud Center of Excellence (CCOE) project leveraged

# Analysis – Cloud

- **CAIV analysis** was critical in defining what cloud procurement could look like where there was little technical information provided or available
  - In both cloud compute and cloud storage, the team looked at what cost could afford given various technical inputs



Amount of computing instances afforded by budget



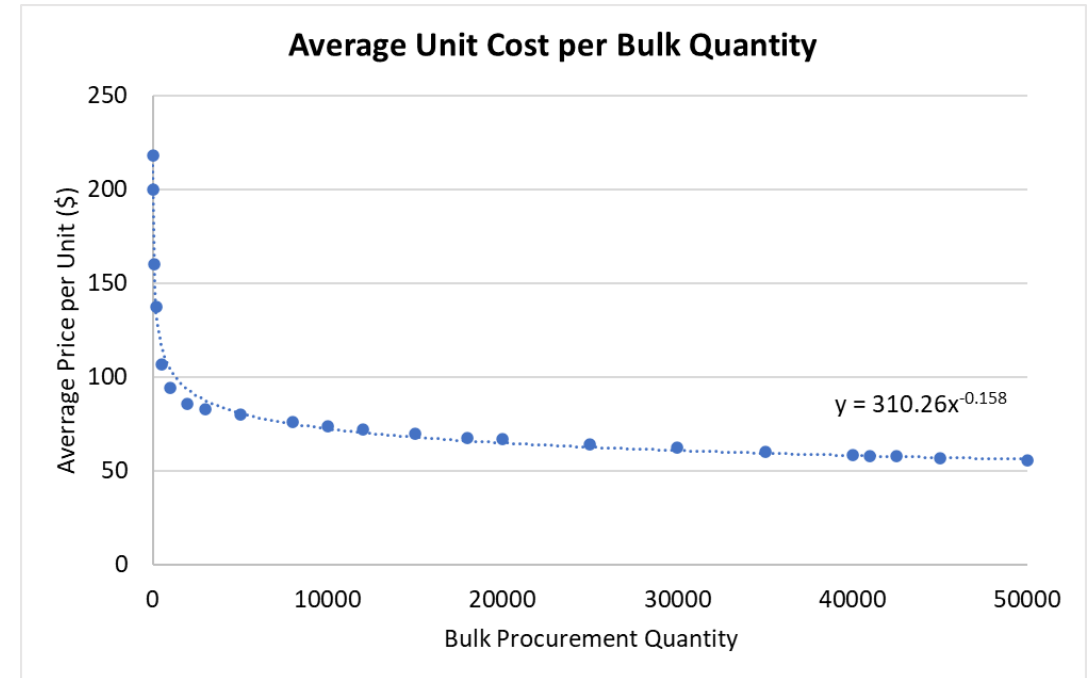
Amount of cloud storage afforded by budget at different storage tiers

# Analysis – Network and Software

- The team used BUILDER data to provide insight into what underground fiber optic cabling capabilities look like given two arbitrary scenarios:
  - How much would 1 mile of cabling cost?
  - How many linear feet could their proposed \$3M budget afford?
- To illustrate the concept of a bulk software procurement, the team used pricing data for an analogous tool
  - Observed a power curve; as the quantity of procurements increased, the average cost per unit of software decreased

Scenario	Cost (BY\$24M)	Linear Feet
Buying Power of \$3M	3.00	12224
Cost of 1 mile of cable	1.30	5280

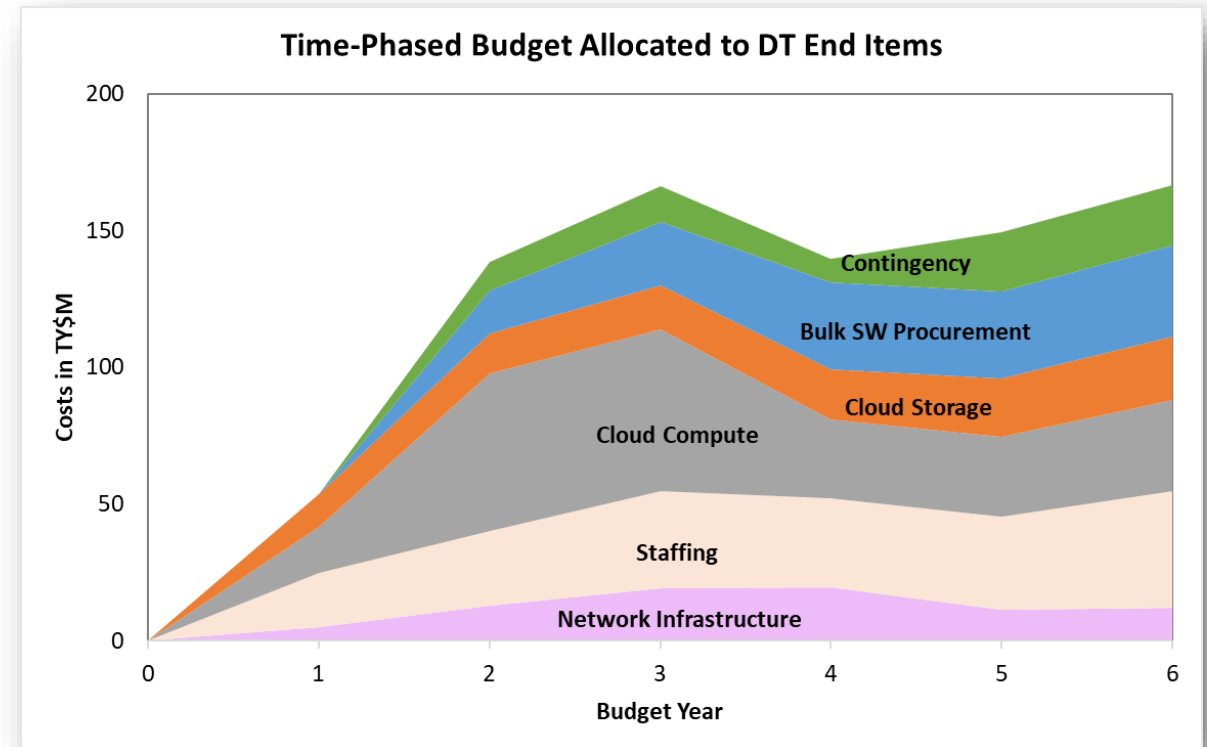
Cost scenarios for network redundancy



Cost savings curve, based on increasing quantities of procured software

# Results

- Using the project's annual budget data and minimal technical information, the team provided a broad decision space encompassing cloud storage, cloud computing, fiber optic cabling, bulk software procurement, and buying power over time
- This analysis paved the way for more informed discussions about priorities and goals of DT



*Funding profile allocation proportional to the total amounts*

# Limitations of the study and DT & Future Work

## Limitations

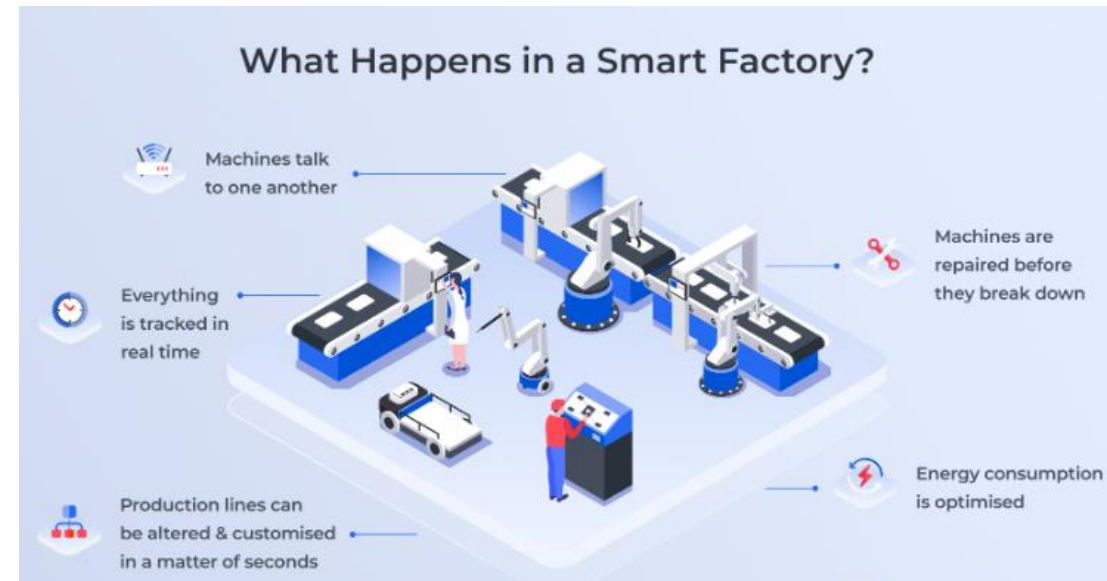
- Lack of concrete technical requirements
  - Made assumptions for cloud needs and FTEs
  - Gave example analyses for network redundancy but did not have enough information for actuals
- Lack of a formal Work Breakdown Structure (WBS)
  - Unclear what money was going where, and how much; how were costs being bucketed?
- Federal agencies can have rigid policy compliance standards

## Future Work

- Analysis into the concept of chargeback as it relates to the bulk procurement of software or hardware
- Standardized WBS for Digital Transformation

# Final Thoughts

- Digital Transformation is often used as a catchall for any effort that involves utilizing or transitioning to a digital environment
  - Organizations should clearly define objectives and requirements before commencing these efforts
- There are many ways to offer insight into how much these efforts may cost and what they can accomplish
- The **success** of DT efforts will ultimately depend on the ability of organizations to navigate challenges such as resistance to change, scope uncertainty, and implementation problems



Smart Factory, a key application of DT. Graphic extracted from Altamira.

# Contact us

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