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Informing decisions that shape the Nation's future

2016 Acquisition Research Symposium

Acquiring Technical Data with Renewable Real Options

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Acquiring Technical Data with Renewable Real Options

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- Research Question & Focus
- Business Model
  - Comparing current practice to new model
  - Contracting method
- Business Case Analysis
  - Real options theory
  - Decision tree
  - Dynamic programming & recursive algorithm
- Example Scenario
  - Optimal decision path
  - Monte Carlo sensitivity analysis

Research Question

In situations where needs for contract deliverables are uncertain over a long life cycle, how can program managers hedge against the risk of procuring deliverables that may not be needed, or failing to procure deliverables that are needed?

Focus on case of contracting for technical data to support competitive spares procurement

- Business model: renewable data maintenance contract with options to deliver technical data at pre-negotiated price at time of need and required level of data rights
- Business case analysis tool
  - Price analysis to calculate value of option for technical data
  - Decision support to determine when to exercise option

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Business Model

Current Practice & New Model

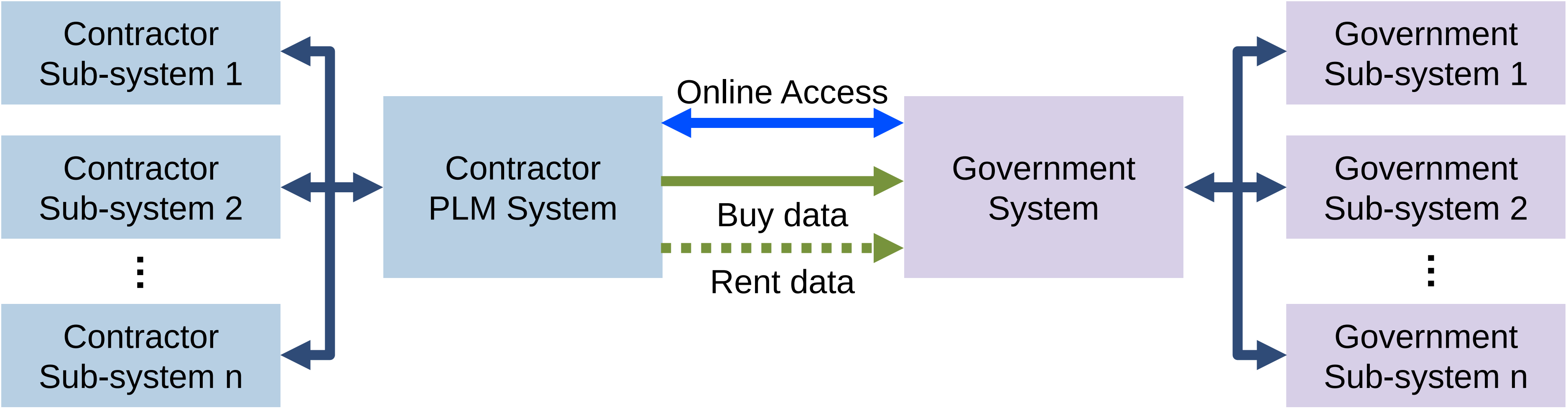
Contract option to acquire technical data & deliverables at time of need

Practice	Current	New Business Model
Acquire tech data…	during acquisition phase	at time of need
Amount of tech data acquired…	all tech data	only tech data needed
Type of environment tech data is priced under…	sole-source environment (if not acquired in acquisition phase)	always priced in competitive environment
Level of rights acquired…	highest level of rights	level of rights needed

Business Model

Contracting Method

Phase 1: Requirements, strategies and plans	Phase 2: Contracting	Phase 3: Contract performance and delivery	Phase 4: Post-performance and sustainment
Use BCA tool to develop options-based acquisition strategy	• Online access to tech data through subscription to contractor's PLM system • Options for delivery or rental of TDPs	• Option to accept delivery of tech data • Plan and negotiate follow-on data maintenance contract	Meet life cycle needs by: a) using data already delivered into government system, or b) making decision at time of need to exercise option data delivery or rental



Phases 3 & 4 – data flow between contractor and government

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Business Case Analysis
Real Options Theory

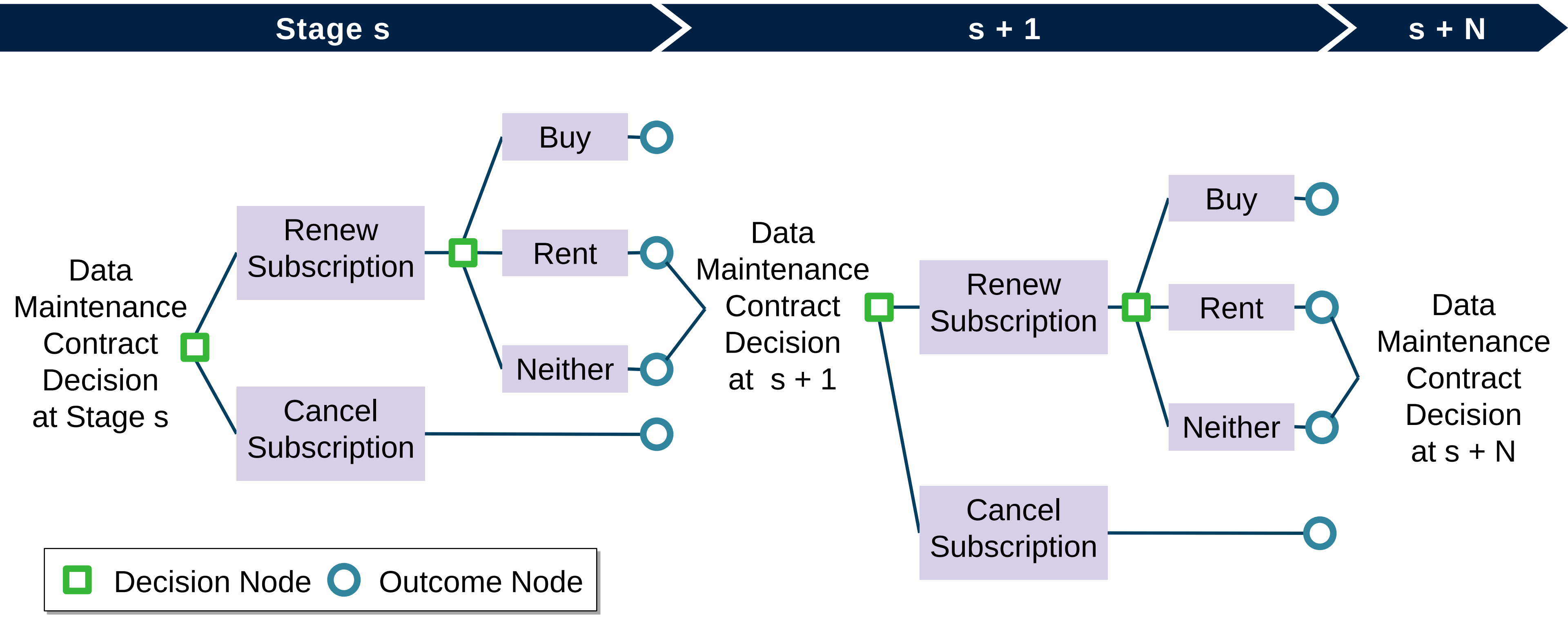
Real options theory
- Originates from Wall Street options
- Offers right, but not obligation to buy
- Handles uncertainty in outcomes

Black-Scholes model
- Closed form solution under restrictive assumptions
  - Constant volatility in price, Normal distribution of returns, Lognormal distribution of underlying asset value
- European-style option

Decision tree model
- Reflects underlying logic, relaxes assumptions, but no closed form solution

Business Case Analysis

Multi-Stage Decision Tree



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Business Case Analysis

Dynamic Programming Problem

For stage $s = period$ (e.g. year)for $s = [1,2, \ldots N]$

Decision variable $x_j = $ [Buy, Rent, Neither] for j=1,2,3

C_{sx_j} = expected net cost avoidance in period s if x_j is chosen

$C_s^* = \max_j C_{sx_j}$

CG_{sx_j} = expected gross cost avoidance in period s if x_j is chosen

$f(s, x_j)$ = total cost avoidance of the best policy (i.e. sequence of choices) for the remaining stages given we are in stage s and choose x_j

We maximize total cost avoidance by starting at stage $N-1$ and working backward, choosing the x_j in year s that maximizes

$$f(s, x_j) = C_s^* + (1-\delta_s)\sum_{i=s+1}^{N} C_i^* + \delta_s \sum_{i=s+1}^{N} CG_{ix_1}$$

where δ_s if $C_s^* = C_{sx_1}$
$= 0$ otherwise

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Business Case Analysis

Recursive Algorithm

$Let\ OY_{sx_1}$ = outyear gross cost avoidance if x_1 is chosen in period s

$$= \sum_{i=s+1}^{N} CG_{ix_1}$$

$$Then\ f(s, x_j) = C_s^* + (1 - \delta_s) \sum_{i=s+1}^{N} C_i^* + \delta_s OY_{sx_1}$$

Starting at $s = N - 1$ and working backward,

$$f(N-1, x_j) = C_{N-1}^* + (1 - \delta_{N-1})C_N^* + \delta_{N-1} OY_{(N-1)x_1}$$

$$f(N-2, x_j) = C_{N-2}^* + f(N-1, x_j)$$

$$\vdots$$

$$\boldsymbol{f(s, x_j) = C_s^* + f(N - s + 1, x_j)}$$

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Example Scenario

Assumptions & Cost Figures

Assumptions

- Buy quantity: 100
- Sole-source price: $1000
- Competitive price: $750
- Subscription cost: $0
- TDP for single spare part
- TDP purchase price: $50,000
- TDP rental price: $5,000
- PBL for first three years
- Discount rate: 0

DMSMS Cost Figures

Resolution Type	Mean Cost	Implied Probability
Approved parts	$1,028	.34
Life-of-need buy	$5,234	.15
Simple substitute	$12,579	.33
Complex substitute	$25,410	.09
Extension of product or support	$25,472	.02
Repair, refurbishment or reclamation	$65,015	.01
Development of new item or source	$655,411	.03
Redesign – next higher assembly	$1,092,856	.03
Redesign – complex/system replacement	$10,287,964	.01
Weighted Average	$159,179	1.0

Example Scenario

Optimal Decision Path

Expected Cost Avoidance at Year 4

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
p(spares)	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.1	0.01
Buy	0	0	0	209	192	174	156	138	120	104	88	72	55	41	27	12	5	-18	-34	-45
Rent	0	0	0	174	162	149	136	123	110	99	88	77	65	57	47	37	25	17	6	0
Neither	0	0	0	-259	-242	-224	-206	-188	-170	-154	-138	-122	-105	-92	-77	-62	-45	-32	-16	-5

Evaluate optimal decision path

Optimal Decision	Wait	Wait	Wait	Buy	Buy	Buy	Buy	Buy	Buy	Buy	Buy	Rent	Rent	Rent	Rent	Rent	Rent	Rent	Rent	Rent

Greatest cost avoidance is 0k, avoiding loss of
45k if tech data is bought or 5k if tech data is not rented

Optimal decision: rent
Expected cost avoidance: 0k

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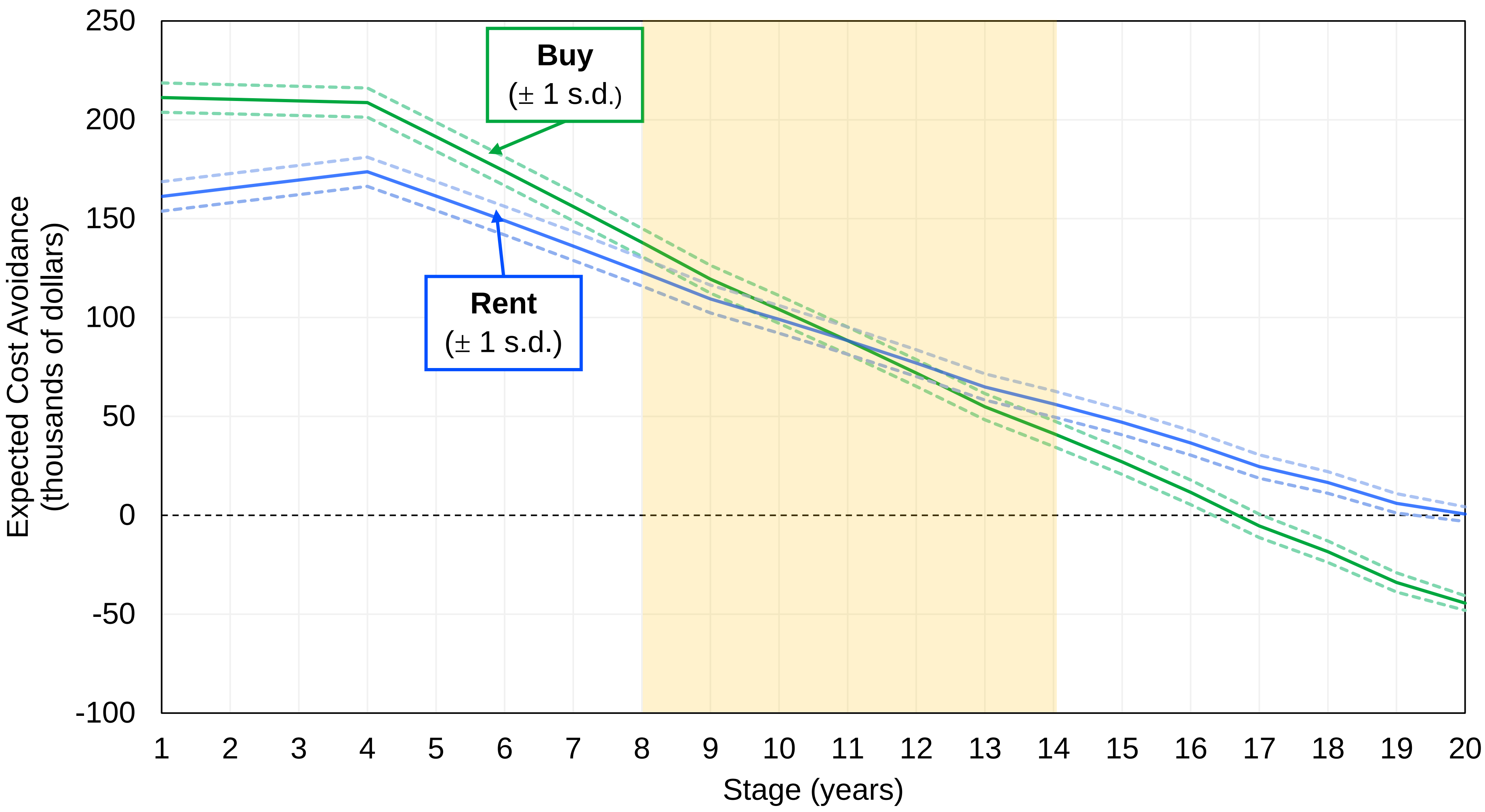
Example Scenario

Monte Carlo Sensitivity Analysis



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Recommendations

Real options for acquiring technical data

- Business model provides new way to acquire tech data
- Business case analysis tool provides way to value options
  - http://anser.org/docs/reports/Tech_Data_with_Real_Options_Spreadsheet_Model.xlsx

Recommended next step: pilot program

- Solicitation and contract language to incentivize competitive pricing
- Identification of data sources for business case analysis tool
- Provisions for government online access to contractor PLM system
- Documentation of costs and savings compared to prior costs
- Evolution of BCA tool, connection to data, and user interface

Further Research

- Extension into other application cases

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