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QUANTIFYING THE FUTURE

Using Real Options to Quantify Portfolio Value in Business Cases

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Agenda

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Introduction

- B.S. in Finance from the University of Florida
- MBA in Corporate Finance from The University of Texas at Austin
- Over 20 years of Finance experience in capital investment valuation, forecasting & budgeting, cost estimation, benefits quantification, and business case development
- 6 years of Energy Finance experience in Investment Appraisal
- Developed discounted cash flow models for major Power Generation capital investments at ConocoPhillips
- Created buy vs. lease analyses for deep-water drilling rig projects
- Evaluated major capital investments/acquisitions in the Business Case Group of Investment Planning & Analysis at the FAA
- Project Management Institute (PMI) Project Management Professional (PMP)
- Currently lead investment analysis consultant teams developing costs, benefits, and business cases as Director of FAA Programs at Cobec Consulting, Inc.

Real Options in Investment Decisions

Agency Example

- FAA invests more than $2.8B per year in capital investments
  - Replace aging infrastructure of communication, navigation, automation, and surveillance systems using outdated technology
  - Modernize National Airspace (NAS) with next generation (NextGen) of air traffic control systems to more accurately and efficiently navigate aircraft with less dependency on ground-based radar systems
- Conservative approach toward investment analysis
  - Risk-adjusted cost estimates and benefits quantification
  - Adjustment programs for program and portfolio dependency risk
- Complex programs and dependencies
  - Some programs still do not meet planned targets
  - Require flexibility within portfolios to allow for changes in dependencies
- Is the agency making the best investment decisions?
  - Limited capital funds to invest; must choose between programs
  - Uncertain program upside “potential” not quantified.
- Real Options allow for agencies and decision-makers
  - To better understand and realize opportunities within uncertainty
  - To make better informed decisions with the flexibility to make program adjustments as more info is revealed
  - To better sequence capital investments to maximize value

Capital Investment Value

- **Capital investment**[1] – money invested in a business venture with an expectation of income, and recovered through earnings generated by the business over several years. It is generally understood to be used for capital expenditure rather than for day-to-day operations (working capital) or other expenses.
- When companies evaluate capital investments, they often use a discounted cash flow (DCF) valuation approach, where the company calculates free cash flow (FCF) and discounts these cash flows by the company's cost of capital to calculate NPV and other valuation metrics.
- Government capital investments use the same metrics to calculate value – net present value (NPV), payback, internal rate of return (IRR), and benefits/cost ratio (B/C ratio).

[1] http://www.businesdictionary.com

Finance Value in Business Cases

- In government agency capital investments, how is value quantified?
  - Quantified benefits to agency and stakeholders
    - Cost avoidance by implementing an infrastructure program that is more efficient than the legacy system it is replacing
    - Time savings provided by a new technology that enables users to do their jobs quicker, or
    - A new technology which provides quicker transportation and saves time for the general public and direct operating costs for service providers
  - Use standard Finance metrics – NPV, IRR, payback, and B/C ratio
  - Benefits and Costs discounted by cost of capital (LT gov't bond for government investments)
  - Risk-adjusted to account for uncertainty of cost and benefits
  - Does **not** account for upside opportunities, integration with other investments, or portfolio impact.

Drawbacks for Using NPV Only

- In government agency capital investments, pay special attention to accounting for risk
  - Risks associated with implementation, dependencies, and cost estimation
  - Both benefits and costs are risk-adjusted and discounted to account for downside risk
    - Civil agencies calculate 80th percentile of cost and 20th percentile of benefits as expect costs to exceed risk-adjusted estimate and expect fewer benefits to materialize
    - Pessimistic view of valuation – worst case benefits and costs estimated
- No consideration for upside risk
  - Under certain conditions, benefits will exceed point estimate
  - **Maximize upside risk** – In segmented programs or programs with follow-on investments, one investment might inform the other. Manager can make better decisions and realize upside value.
  - **Limit downside risk** – Can reduce risk of additional capital allocations – cancel or delay

Need New Way to Measure Value

- Need new way to measure value in business cases
  - Discounted benefits and costs – best for stand-alone investments
  - Few government investments are stand-alone
  - First investment impacts subsequent investments
  - Strategic portfolio implications

- Potentially undervaluing capital investments
  - Some investments have follow-on investments.
    - Information from first investment informs future investments, enabling previously trapped value
    - Incremental value of follow-on investments not captured by NPV
  - Mutually exclusive projects often decided by enabling value – future incremental value
- Value to Portfolio
  - Program interdependencies and portfolio impact not automatically calculated by NPV
  - Changes to one investment in a portfolio could have profound impact on value of another

What Are Real Options?

- **Real option** – "choice made available with business investment opportunities" (Investopedia, 2017) and are "the right but not the obligation to invest in a project." (van Putten and MacMillan, 2004)
- Real options measure the opportunity to realize value of subsequent investments or program segments and identify probabilistic incremental project value that the initial capital investment would enable.

- NYU professor Aswath Damodaran states in his book, *Strategic Risk Taking,*
  - "The value of real options stems from the fact that when investing in risky assets, we can learn from observing what happens in the real world and adapting our behavior to increase our potential upside from the investment and to decrease the possible downside."

Real Options – Option to Expand Example

- Company considering investment in brown field power generation project
  - **Methodology:** Calculate revenue, expenses, cost of capital, and tax impacts on cash flow to calculate project NPV
  - **Real Option:** Investment in the power plant provides option to expand power generation and to monetize offshore natural gas reserves company cannot currently use.
    - Company has offshore natural gas reserves without the market to sell the natural gas, so they currently flare the natural gas associated with oil drilling.

- Calculate Project Value
  - $Total\ Project\ Value\ (TPV) = NPV + \text{Real Option Value}$

- Calculate NPV
- Calculate real option value – incremental value of increased power generation capacity and electricity revenue generated using offshore natural gas reserves (very little cost to generate electricity)

Four Options to Realize Real Option Value

Can realize real option value via four investment options:

- Option to make follow-on investments **(expand)**
  - Initial investment enables option to invest in follow-on complementary investments, like expansion
- Option to abandon a project **(abandon)**
  - If limit initial investment size, follow-on investment decisions could reveal unfavorable market conditions
  - Option to change course and not continue to invest in project which does not bring the agency value
- Option to wait before investing or delay the project **(delay)**
  - If investment conditions are not favorable, could delay investment until conditions are favorable to realize most value.
- Option to vary output, deployment, or production **(variable quantity)**
  - After first phase of project, managers have more information to optimize production volume and deployment

Using Real Options in Portfolios

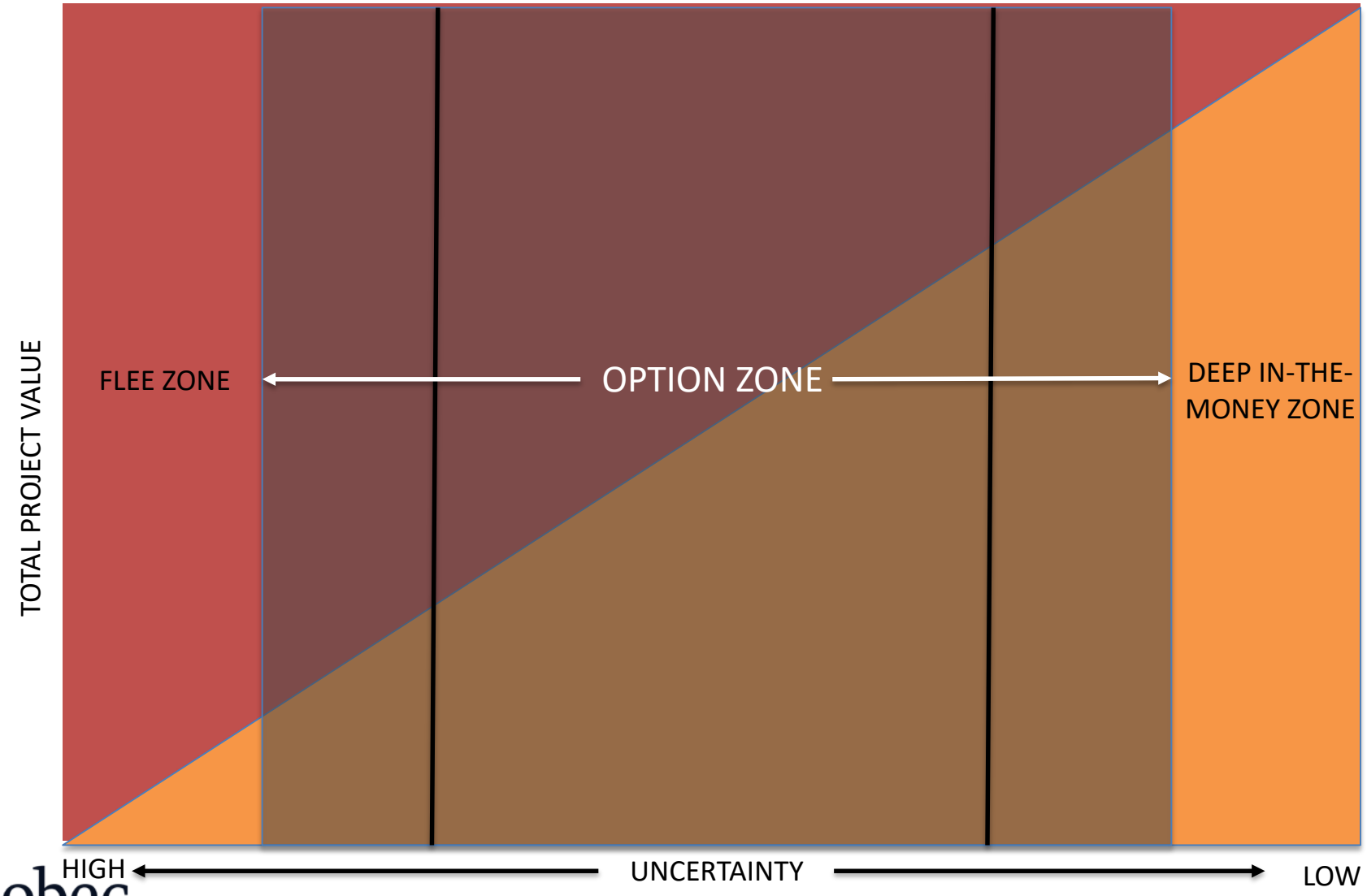
- **Using Real Options to Estimate Portfolio Value**
  - Can assign value to interdependency risks
  - Can map out multiple investment scenarios, measuring the impact on multiple interdependent projects
  - Use “decision trees” to estimate probability of each sequential investment decision
  - Sequence and timing of each investment in the portfolio impacts aggregate portfolio value

When to Use Real Option Valuation

When Do You Use Real Option Valuation in Government Business Cases?

- At beginning of project, uncertainty is highest.
  - More of total value is attributed to real option value, less to NPV.
- Later in project timeline, uncertainty decreases.
  - More of total project value is measured by NPV, less to real options.
- Do **not** calculate real option value if –
  - **Deep-in-the-money Zone –** If DCF valuation is high (high NPV), project value is nearly guaranteed (B/C of at least 1.5 or NPV significantly greater than zero).
  - Real option value will not contribute to the investment decision. However, it could add value in portfolio analysis.
  - **Flee Zone –** If NPV is very negative – risk-adjusted discounted costs far outweigh risk-adjusted discounted benefits
  - A very negative valued project could not be justified just by real option value because the risk would be so high.
- Exceptions to the rule
  - FAA safety programs exempt NPV justification
  - Infrastructure programs sometimes need replacement even if value proposition is not evident.

When to Use Real Option Valuation



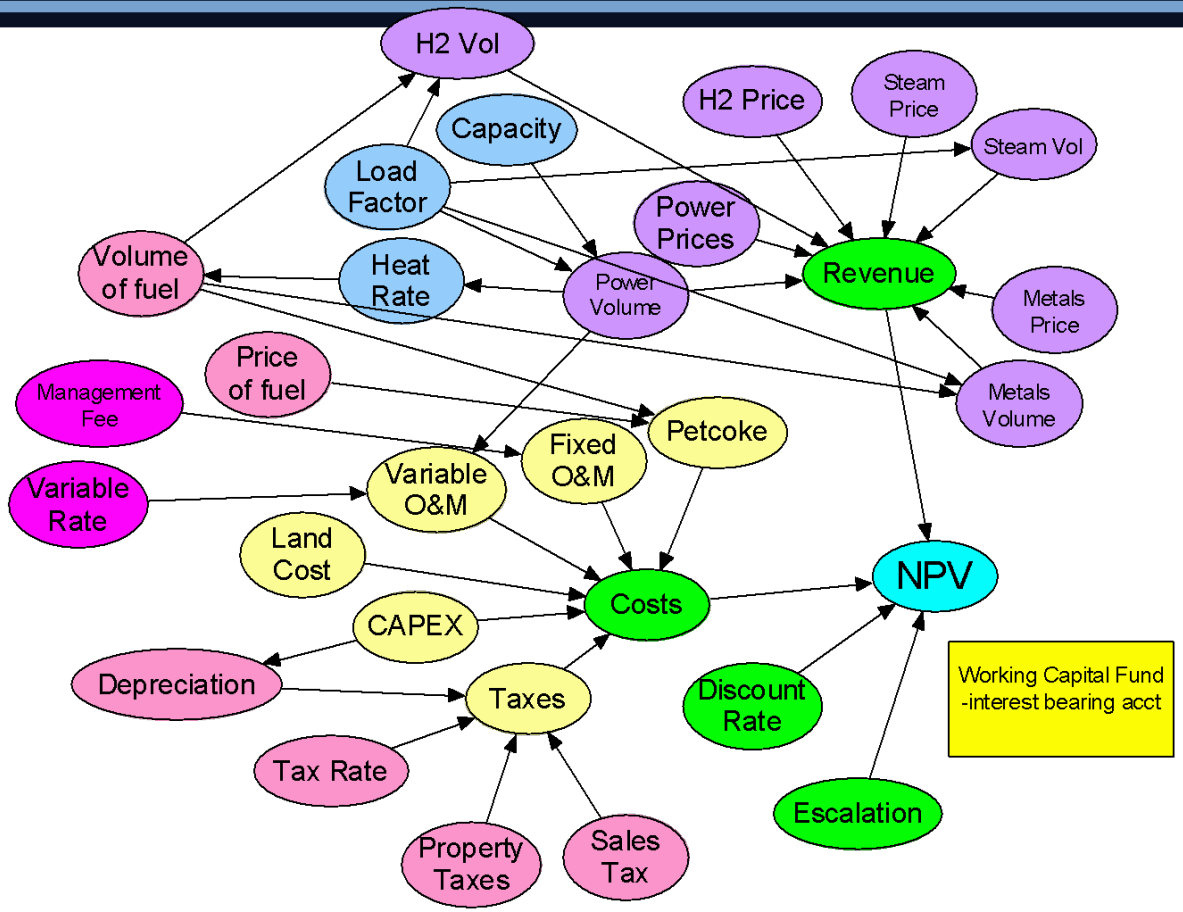
1 Van Putten and MacMillan, Making Real Options Really Work, Harvard Business Review, 2004

Strategic Diagrams

Drawing Strategic Diagrams

- In government acquisitions, can illustrate complex program relationships using Strategic Diagrams
  - Shows portfolio interrelationships
  - Demonstrates interdependencies in a graphical format with directional arrows
  - Can show big picture perspective and apply to multiple programs
  - Method to get management buy-in for a strategic directive
  - Identify real options and value proposition
  - Can be used to quantify investment and portfolio value

Influence Diagrams – Energy Example



- Influence diagrams are used to determine all of the factors, assumptions, and drivers of value in a business case.
  - Start from the end product and work backward to capture all factors

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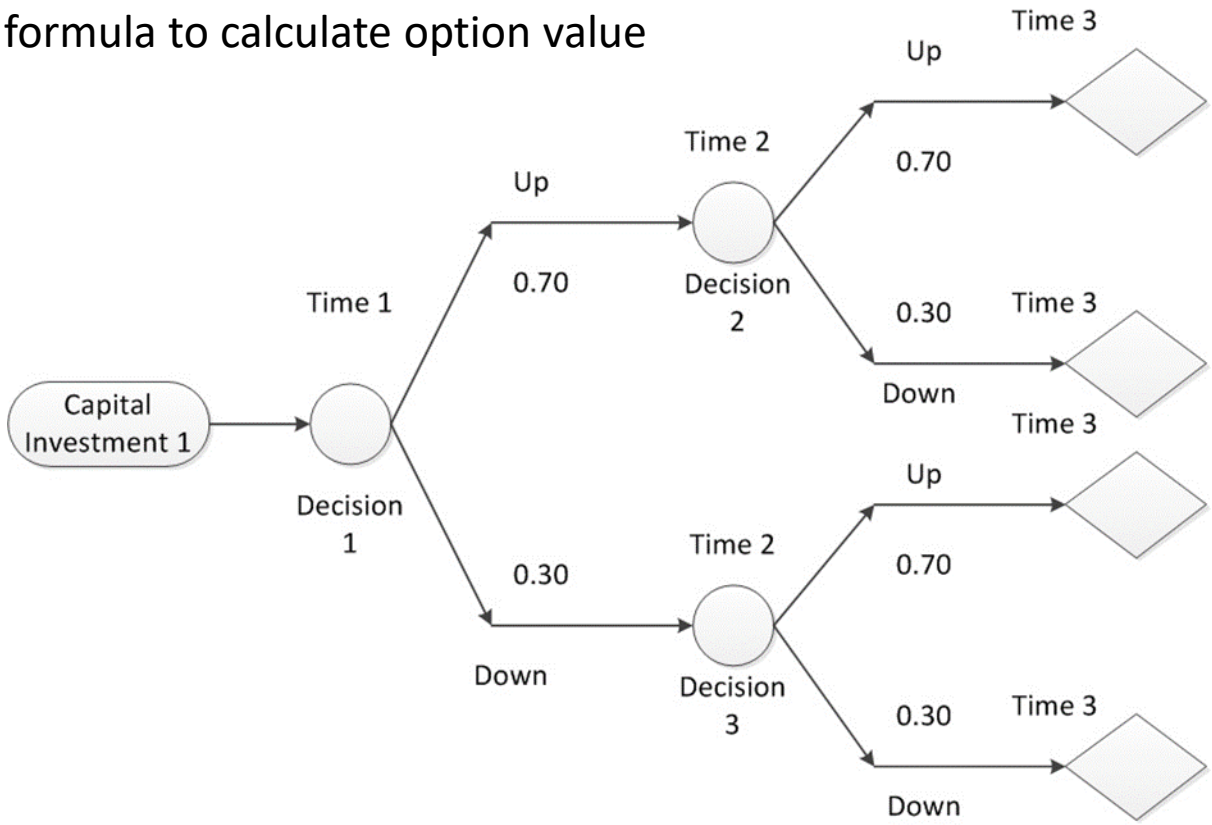
Influence Diagrams

- Influence Diagrams – Tools to Create a Business Case
  - Influence diagrams are used as brainstorming tools to determine all of the inputs, assumptions, and driving factors of value in a business case.
    - Work backward from the end product, usually NPV
    - Start with direct and broad components of the end product, like “Discounted Benefits” and “Discounted Costs”
    - Keep breaking out components, calculations, and assumptions that drive each subcomponent until all driving factors are listed.
    - Brainstorm with your team and the program office to collect all driving factors and assumptions
    - For civilian agency business cases, influence diagrams can be used to determine or rule out different alternatives
    - Include interdependencies with other programs
  - Can be used at IARD to help determine:
    - Program scope
    - Determine sources of value
    - Define alternatives
    - Identify risks
    - List cost drivers
    - Identify real options

Binomial Decision Trees

Real Options Use Decision Trees to Calculate Project Value

- Each real option decision is depicted as a decision node
- Attribute a probability for the up and down branches
  - For binomial Geometric Brownian Motion (GBM) decision trees, up and down probabilities are consistent throughout
- Calculate up and down probability-weighted value for each up and down branch through each consecutive time period
- Complex formula to calculate option value



Real Option Value Using Estimated Probabilities and Decision Trees

Drawing Decision Trees with Multiple Decisions or Investments

- Agency Supply Chain Example
  - Initial supply chain investment, Supply System Modernization (SSM), is platform investment for agency's supply chain modernization portfolio
- Project enables value of subsequent investments.
  - Real option decision tree analysis with multiple probability-weighted investment decisions
- Optimizes portfolio value as well
  - View with multiple scenarios and sequences to understand value and assign probabilities.
- Value calculated at each decision node is the PV net of incremental benefits and costs enabled by each subsequent investment.
- Essentially, a successful SSM implementation enables a series of follow-on investments at values and probabilities that would not be enabled without investing in SSM first.

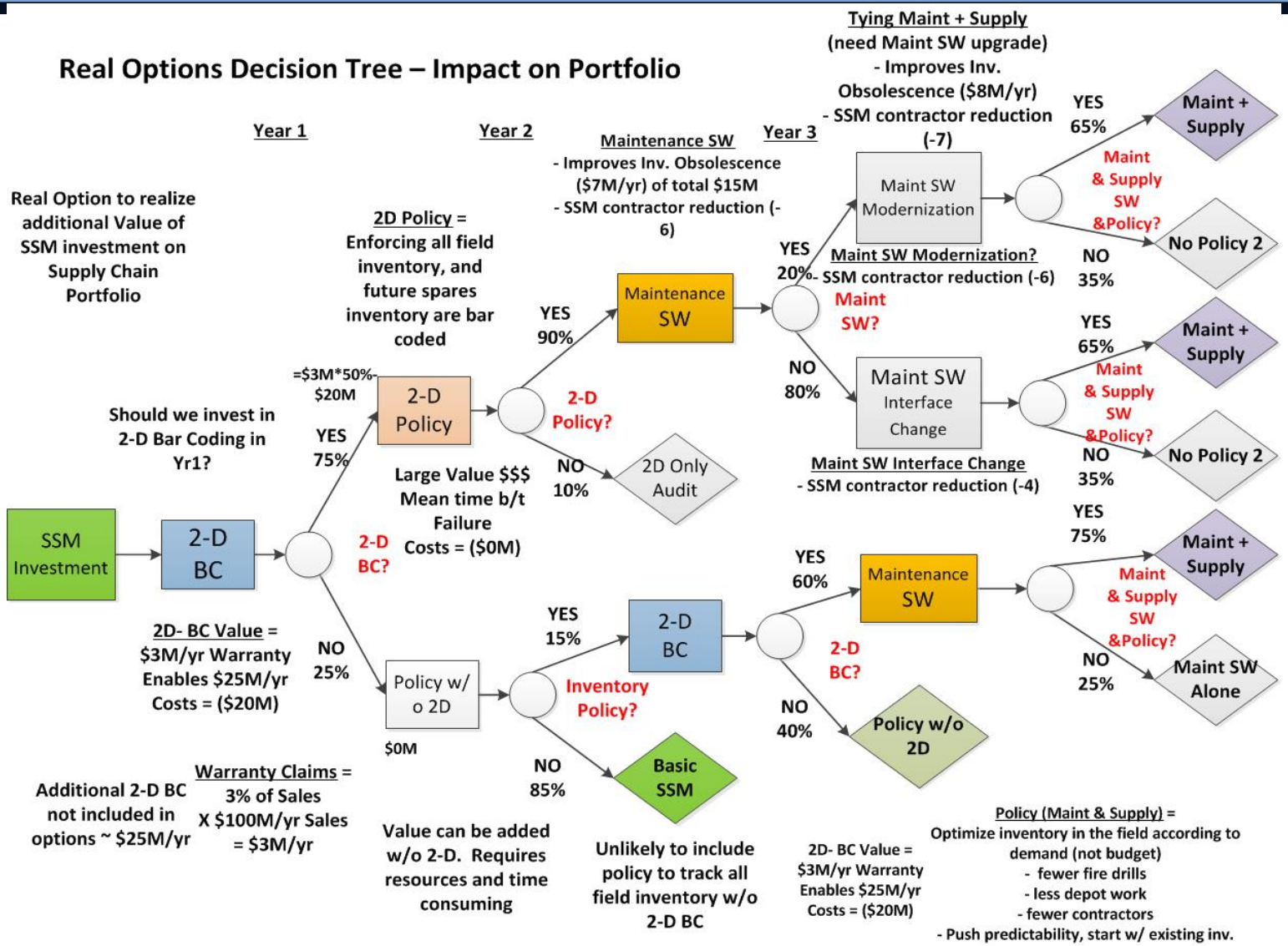
Real Options – SSM Example

- Real Options for SSM
  - 2-Dimensional Bar Coding to record all field inventory
  - 2-D Policy – change the policy to enable additional value from bar coding, providing transparency into field inventory
  - Standard requiring field to record “every maintenance action”
    - Right now, recording maintenance actions in the field are at the discretion of field techs – sometimes they do; sometimes they don’t.
  - Development of a database
    - Used to populate ach maintenance action in the field with “standardized data”
    - No more typing in different words or acronyms that mean the same thing.
  - Maintenance software
  - Maintenance software modernization & policy to tie maintenance and supply together

Applying Real Options

- How do you apply Real Options to your business case?
  - Does your program have additional value that cannot be realized just by program implementation? Is it dependent upon future investments?
    - If the answer is yes, you may have real options.
  - Identify decisions or follow-on investments that would enable your program to add value to the agency, the public, or industry.
  - Determine the cost of the follow-on investments or decisions
  - Estimate the economic value (benefit-cost) of each future decision
  - Assign a probability that one of these decisions or investments will be approved
    - You need a probability of approval for each decision in your decision tree
    - You will multiply the probability times the economic value at each branch
  - Assign a likely sequence or "required sequence" of the future investments which enable your program to realize additional value
- Draw your Real Options Decision Tree

Applying Real Options



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Quantifying Real Options

Node	Scenario	Probability	Potential Savings	Probabiity-Adjusted Savings	Assumptions
1	2DBC, Maint SW Modernization+ Maint/Supply	9%	100.04	8.78	- Includes 2DBC cost ($20M) - 2dbc savings -FY14(3% of $100m inventory) - Maint SW Cost ($3M) - Maint SW (6 FTEs,$7M) - M+S (7 FTEs, $8M)
2	2DBC, Maint SW Modernization+ No Policy	5%	47.08	2.22	- Includes 2DBC cost ($20M) - 2dbc savings (3%) - Maint SW Cost ($3M) - Maint SW (6 FTEs) + $7M - Excludes M&S
3	2DBC, Maint SW Interface Change+ Maint/Supply	35%	92.96	32.63	- Includes 2DBC cost ($20M) - 2dbc savings (3%) - Maint SW Cost ($1M) - Maint SW (4 FTEs) + $4M - M&S (7 FTEs, $8M)
4	2DBC, Maint SW Interface Change+ No Policy	19%	40.00	7.56	- Includes 2DBC cost ($20M) - 2dbc savings (3%) - Maint SW Cost ($3M) - Maint SW (4 FTEs) + $4M - Excludes Policy and M&S
5	2D Audit Only	8%	3.57	0.27	- Includes 2DBC (Year 3) cost ($20M) - 2 dbc savings (3%) - Excludes policy, Maint SW and M&S
6	2D in Yr 3, Maint SW, Maint+Supply	2%	96.95	1.64	- Includes 2DBC cost ($20M) - 2dbc savings (3% of $100M Inventory) - Maint SW Cost ($3M) - Maint SW (6 FTEs) + $7M - M&S (7 FTEs, $8M)
7	2D Yr 3, Maint SW Alone	1%	7.85	0.04	- Includes 2DBC (Year 3) cost ($20M) - 2 dbc savings (3%) - Excludes Maint SW and M&S
8	Policy w/o 2D	2%	0.00	0.00	- 2D policy efficiency - Exludes 2DBC cost and savings, - Excludes Maint SW and M&S
9	Basic Supply Chain SW	21%	0.00	0.00	No Benefit
		100%		**53.14**	

The incremental benefits and costs are placed on a timeline to apply discounting and to account for the time value of money.

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Real Options in Practice

- When evaluating a business case with Real Options, you can present the program with two sets of metrics:
  1) Stand-alone without any future investments
  2) In a Portfolio Context, where your program realizes the value of Real Options based on the probability that future investments will be approved and on the incremental value these decisions will have on your program.

Program Real Option Valuation

- Real options allow managers flexibility to minimize project risk and realize full program potential.

Portfolio Real Option Valuation

- Can calculate real option value of series of investment decisions, adjusting for optimum sequence of investments, program interdependencies, and incremental program benefits.

Conclusion

Real Option Value

- Real Options are valuable for government agencies, where
  - Large capital investment portfolios have multiple interdependencies,
  - Government-constrained capital budgets require tough choices between competing capital investments.
- Real options provide a process for quantifying the upside risk and enabling value of program acquisitions and capital investments.
- Incorporating real options with traditional NPV valuation techniques helps decision-makers make better informed decisions.

Business Case Approach

- Drawing visual diagrams to illuminate program and portfolio interrelationships and value drivers through influence diagrams and decision trees will help managers make better informed decisions.
- Consider multiple investment sequences and contingencies to optimize portfolio value.